UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

PANASONIC AUTOMOTIVE SYSTEMS CO., LTD.,

Petitioner,

v.

UNM RAINFOREST INNOVATIONS,

Patent Owner.

DECLARATION OF JAMES L. LANSFORD, Ph.D.

Ex. 1015

I, James L. Lansford, declare as follows:

1. I submit this Declaration at the request of Panasonic Automotive Systems Co., Ltd. for consideration by the Patent Trial and Appeal Board in *inter partes* review proceedings.

2. I reside in Florissant, Colorado.

3. I am over eighteen years of age, and I would otherwise be competent to testify as to the matters set forth herein if I am called upon to do so.

4. I am being reimbursed for my time spent on drafting this Declaration and on collecting any factual information included in this Declaration. I am being reimbursed for my time at a rate of $700 per hour, which is my standard consulting rate that I would otherwise collect when working on other professional matters. I am also being reimbursed for any reasonable expenses that I may incur during the preparation of this Declaration. Any reimbursement I may receive is not contingent upon the substance of my testimony, or the outcome of any proceeding involving the challenged patent or patents. I have no financial interest in the outcome of this matter or in any litigation involving the challenged patent or patents.

5. I have held numerous leadership positions in IEEE 802 over the last 25 years, including:

a. Founding Chair, IEEE 802.19 Coexistence Working Group. In this role, I was a member of the Sponsor Executive Committee (SEC), the leadership team for all of IEEE 802 (including 802.11, 802.3, and 802.15, among others).

b. Vice-chair, IEEE 802.15.2 Wi-Fi Bluetooth Coexistence Technical Group.

c. Chair, IEEE 802.11 DSRC Coexistence Tiger Team.

d. Chair, IEEE 802.11 Wireless Next Generation Standing Committee. The IEEE 802.11 WNG SC is the incubator for all new activity in 802.11; individuals bring forward proposals for new standards activities and if there is sufficient support, a motion is brought forward to the Working Group to start a Study Group. Once the Study Group completes work on the formal proposal and gets approval from IEEE Standards Association ("IEEE-SA") to begin a new amendment, a Task Group is formed to begin work writing a standard. The well-known amendments 802.11n (Wi-Fi 4), 802.11ac (Wi-Fi 5), 802.11ax (Wi-Fi 6), and 802.11be (Wi-Fi 7) all started out as presentations in WNG.

6. I was employed as Chief Technical Officer and Vice President of Business Development by Mobilian Corporation in Hillsboro, Oregon from

February 2000 to November 2003. During my tenure at Mobilian, I was responsible for, among other things, strategy and tactics with respect to standard-setting bodies, including the IEEE, the Bluetooth special interest group, the European Telecommunication Standards Institute's Broadband Radio Access Network group (ETSI/BRAN), the Software Defined Radio forum, and the Wi-Fi Alliance (formerly known as WECA). While I was at Mobilian, I regularly attended meetings of the IEEE 802.11 and 802.15 Working Groups and was an active contributor, having posted and presented several documents to both the 802.11 and 802.15 Working Groups.

7. I regularly accessed and reviewed documents that were submitted by members of both the 802.11 and 802.15 working groups, including through the IEEE's 802wirelessworld website discussed below. In addition, during this period, I was the founding Chair of the IEEE 802.19 Coexistence Working Group, which gave me automatic membership in the IEEE 802 Sponsor Executive Committee (SEC), the group that oversees all working group activities in IEEE 802.

8. During this period, the IEEE 802.11, 802.15, 802.18, and 802.19 Working Groups collaborated closely, including by holding meetings on the same dates and in the same venue, where attendees of any Working Group could and often did attend meetings of other Working Groups, by sharing the 802wirelessworld document server and website discussed below, and by awarding

cross credit across Working Groups, for attending sessions of any of the Working Groups, for purposes of gaining or maintaining voting privileges.

9. I was employed as Chief Technology Officer of Alereon, Inc. in Austin, Texas from November 2003 to February 2010. During my tenure at Alereon, I was responsible for, among other things, defining and executing on the company's standards and regulatory strategy. During that time, I was also the co-chair of the IEEE 802.15.3a Task Group, chair of the WiMedia Technical Steering Committee, co-chair of the WiMedia 60GHz Study Group, chair of the WiMedia Mobile Applications Study Group, Vice-Chair of the WiMedia Video Study Group, and a member of various other related boards and working groups.

10. During this period, the meetings of the 802.11 and 802.15 Working Groups continued to be held at the same times and places, the 802.11 and 802.15 Working Groups continued sharing document servers and websites (including initially the 802wirelessworld server and website and later the Mentor server and website discussed below), and the Working Groups continued allowing cross credit for attendance.

11. The IEEE 802.11 and 802.15 Working Groups were also formally coordinated via a liaison.[1] Because of my role as an 802.15 co-chair, I attended

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[1] For example, see https://mentor.ieee.org/802.15/dcn/05/15-05-0473-00-0000-tgn-liaison-report-jul05.ppt which was the TGn – 802.15 liaison report for July 2005.

every such meeting from 2004 through early 2006. During my tenure at Alereon and as co-chair of the IEEE 802.15.3a Task Group, I also continued to regularly submit documents and to access and review documents that were submitted by other members of the 802.11 and 802.15 working groups, including through the IEEE's 802wirelessworld server and through the IEEE's successor (and current) server called Mentor.

12. I was employed by CSR plc ("CSR") from February 2010 to September 2015. After Qualcomm Incorporated ("Qualcomm") acquired CSR in September 2015, I continued working for Qualcomm through May of 2023. While I was at CSR, among other work, I was the head of CSR's Wi-Fi Alliance and IEEE 802.11 Standards teams. During that period, I was Chair of the 802.11 Wireless Next Generation Standing Committee, in addition to being an active participant, contributor, and voting member of the IEEE 802.11 Working Group. After transitioning to Qualcomm, I became a director of technical standards, where I continued as an active member of the 802.11 Working Group and also continued as chair of the IEEE 802.11 Wireless Next Generation Standing Committee, among other work.

13. Since 2010 I have been a lecturer at the University of Colorado, Boulder, in the department of Computer Science. I have taught the Wireless Local Area Networks class in the graduate school since 2011, which is exclusively

focused on IEEE 802.11 technology. Among other topics, I teach my students about the IEEE's standard setting processes, including the processes by which 802.11 Working Group participants submit and retrieve documents in order to discuss various proposals in periodic Working Group meetings. As part of those lectures, I show my students how to use the IEEE's Mentor website to find and download Working Group submissions, and we frequently review current proposals to evaluate their technical content. Students are able to browse and download submissions on Mentor without any need for a username, password or any other restrictions on access to documents.

14. I have been a member of the Institute of Electrical and Electronics Engineers ("IEEE") since 1984 (39 years) and am currently a Life Senior Member. I have participated in the activities of the IEEE Standards Association ("IEEE-SA") continuously since 2010, and before that with some breaks in voting membership. I have participated in the IEEE 802.11 Wireless Local Area Networks ("WLAN") Working Group since 1999, also with some breaks in voting membership.

15. The IEEE-SA generates standards using processes that are recognized by the International Organization for Standardization (ISO) as meeting typical standards development processes. IEEE-SA members can participate in what used to be called Sponsor Ballots (now called SA Ballots) which is the review process

for draft standards that have passed from the Task Group to the Working Group to the Sponsor Executive Committee. I have participated in several Sponsor/SA ballots over the last 13 years as an IEEE-SA member.

16. The 802.11 Working Group operates indirectly under the IEEE-SA (with the IEEE 802 SEC providing overall oversight of all 802 Working Groups), and includes several Task Groups, each of which is typically responsible for generating a single amendment which will ultimately become part of the baseline IEEE standard. The Task Groups generate draft amendments for approval by the Working Group, which the Working Group presents (indirectly) for approval by IEEE-SA using the Sponsor/SA Ballot process after approval by the IEEE 802 SEC. Task Group n (TGn), which was formed in September 2003, was one task group that operated under the 802.11 Working Group.

17. During the 2004 to 2006 timeframe, I was active as co-chair of the IEEE 802.15.3a Task Group, and attended every 802 meeting (which included meetings of the IEEE 802.11, 802.15, 802.18, and 802.19 Working Groups), posting, downloading, and reviewing submissions to the 802wirelessworld server as an active chair of an IEEE 802 Task Group.

18. During the 2004 to 2006 timeframe, the 802.11 Working Group would hold regular meetings throughout the calendar year; these meetings were (and continue to be) held every two months, so there are a total of six meetings per year.

These meetings, including the interim session in Hawaii during January 16-20, 2006 as discussed below, were open to the public. The only requirement for attending these meetings was that the attendee had to pay a registration fee.[2] Generally, attendees of the 802.11 Working Group meetings were engineers, researchers, and business persons interested in networking technologies, including wireless local area networking (WLAN) technologies.

19. During the 2004 to 2006 timeframe, 802.11 Working Group members could provide submissions to the group for consideration. These submissions were presented at 802.11 Working Group meetings and were available to all participants. Submissions typically contained technical material that the group would discuss and consider whether to include in a standard.

20. During this timeframe, members could make these submissions through the IEEE 802wirelessworld website.[3] The attached "New Participant Orientation" slides, which were presented at the July 2004 meeting, explain how documents were submitted via the 802wirelessworld website. New Participant

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[2] The registration fee can be waived for attendance by visitors.

[3] The website was publicly available as http://www.802wirelessworld.com (This website no longer exists, since it was replaced by Mentor.).

Orientation Slides[4] (Appendix A); July 2004 Meeting Minutes,[5] p. 5 (Appendix B). As shown below, to submit a document, a member clicked the "Document Control Numbers" tab, entered some information about the document, clicked the "Request DCN" button to request a document control number, and uploaded the document to the server. New Participant Orientation Slides, slides 35-37 (Appendix A). A member could submit revisions to a document using the same process. New Participant Orientation Slides, slides 35-37 (Appendix A).

21. A submission's Document Control Number provides some descriptive information about the submission. Slide 10 of the New Participant Orientation Slides (Appendix A) explains the meaning of the Document Control Numbers. Submissions were assigned a filename in the format gg-yy-sss[1]r(n)-G-HumanName.ext. The "gg" is the group (for example, "11" for 802.11), "yy" is the year the original document was submitted (for example, "04" for 2004), "sss" is a unique number sequentially assigned to each document, "l" is an optional letter for companion documents, "r" and "n" indicate the revision number (for example, "r0" indicates an original document and "r2" indicates a second revision), and "G" indicates the group to which a document is assigned. New Participant Orientation

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[4] Available at https://mentor.ieee.org/802.11/dcn/04/11-04-0422-04-0000-new-participant-orientation.ppt.

[5] Available at http://grouper.ieee.org/groups/802/11/Minutes/Cons_Minutes_July-2004.pdf.

Slides, slide 10 (Appendix A). Note that slide 10 refers to the "old" document submission process that was in operation before the 802wirelessworld website was used. For documents submitted via the 802wirelessworld website, Document Control Numbers were assigned automatically by the website. New Participant Orientation Slides, slides 36-37 (Appendix A).

22. In addition to being presented at the public Working Group meetings, submissions to the Working Group were accessible to any member of the public after free registration through the 802wirelessworld website during the 2004 to 2006 timeframe. To access Working Group submissions via the website, an interested member of the public could visit the 802wirelessworld website, click the "become a member" link, enter some required contact information, and create a password. New Participant Orientation Slides, slides 25-30 (Appendix A). After creating an account, such a person could view the "Working Group Document Listing" and download any submissions that had been uploaded. New Participant Orientation Slides, slide 35 (Appendix A).

23. In addition, submissions to the Working Group were also publicly available via FTP at ftp.wirelessworld.com. After creating a free account on the 802wirelessworld website, a new user would be given the FTP server's address and instructed to use the "ieee" login with a password of "wireless." New Participant Orientation Slides, slide 35 (Appendix A). The FTP server's address and login

credentials were also publicly available elsewhere. For example, U.S. Patent No. 7,415,074, which was filed on December 21, 2004 and published on July 28, 2005, refers to IEEE submission number 802.11-03/714r0 relating to the IEEE 802.11n and states that it is available at “ftp://ieee:wireless@ftp.802wirelessworld.com/.” U.S. Patent No. 7,415,074, col. 1, ll. 20-39 (Appendix C). In the forgoing URL, “ieee” is the username, “wireless” is the password, and ftp.802wirelessworld.com is the domain name.

24. As another example, My colleague Adrian Stephens also wrote a paper which was published in April 2005 in Volume 35, Issue 2 of the ACM SIGCOMM Computer Communication Review.[6] With respect to the activities of TGn, the paper states that “802.11n will define modification to both PHY and MAC layers to provide substantially higher throughput than 802.11 a/g[]” and “TGn is currently in its down-selection process to select between proposed solutions.” (Appendix D). The paper also identifies “[t]he IEEE 802.11 WG homepage: “http://www.ieee802.org/11/.” and states that “[t]his contains more detailed description of the scope and status of the individual task groups.” (Appendix D). The paper further states that “[t]he IEEE 802.11 WG working group documents are available (after free registration) from: http://802wirelessworld.com.” (Appendix D).

[6] Available at https://dl.acm.org/doi/10.1145/1064413.1064427

25. The IEEE now maintains a website at the address https://mentor.ieee.org/802.11/documents ("Mentor") where any member of the public can download documents submitted to the 802.11 Working Groups. The Mentor website provides a variety of bibliographic information about each document. This bibliographic information includes the document number, title, authors, and the date a document was uploaded to the IEEE's database (and made available to the public) as discussed above.

26. The IEEE's current Mentor website was established in mid-2007 to replace the 802wirelessworld website. All documents thereafter uploaded by members were available on the Mentor website. Member submissions that had been uploaded to the 802wirelessworld server prior to establishing the Mentor website were copied over to the Mentor website shortly after the Mentor website was created. I personally used the Mentor website between 2007 and 2009, including to download documents that were previously submitted using the 802wirelessworld website. These documents retained their original titles, authors, and document number. These documents also retained their original upload dates. From the time it was first available in 2007 to the present, the Mentor website and all of the documents that it contains, have been freely available to members of the public.

27. The entries in the Mentor website can be searched and extracted by year, task group, title, or other parameters. In the normal course of business of the 802.11 Working Group, these database entries and the corresponding documents would have been available to any member of the public as of the indicated upload date, through either the 802wirelessworld or Mentor websites, and the documents that were previously submitted via the 802wirelessworld website would have been available via the Mentor website in 2007, shortly after the Mentor website was put into service.

28. Appendix E shows an extract of all documents in the Mentor website for Task Group N (TGn) with Document Control Number (DCN) 1102. The first entry in Appendix E indicates that revision 4 of document 1102 (*i.e.*, IEEE 802.11-05/1102r4) submitted to Task Group N was entitled "Joint Proposal PHY Specification" by Sean Coffey (Realtek Semiconductor) ("Joint Proposal") and was originally uploaded to the database on January 14, 2006, at which time it would have been publicly available. This entry corresponds to the document attached as Appendix F, which I personally downloaded from the Mentor website on December 12, 2023. Appendix F is a true and correct copy of the document I downloaded from the Mentor website.

29. Appendix G shows an extract of document in the Mentor website for Task Group n (TGn) with DCN 37. The entry in Appendix G indicates that

revision 0 of DCN 37 (i.e., IEEE 802.11-05/0037r0) submitted to Task Group n was entitled "TGn Minutes January 2006 Meeting" by Garth Hillman (Advanced Micro Devices), and was originally uploaded to the database on January 23, 2006, at which time it would have been publicly available. This entry corresponds to the document attached as Appendix H, which I personally downloaded from the Mentor website on December 12, 2023. Appendix H is a true and correct copy of the document I downloaded from the Mentor website.

30. The Joint Proposal shown in Appendix F was presented by TGn Joint Proposal team to the IEEE 802.11TGn body in an interim session of the TGn meeting in Hawaii from January 16- 20, 2006 (Appendix H), which I personally participated and reviewed the proposal. As discussed above, all the IEEE 802.11 Working Group project timelines[7] (Appendix I), and meeting plans[8] (Appendix J) including this interim session of the TGn meeting in Hawaii[9] (Appendix K) were advertised and open to the public prior to and after each meeting.

31. After IEEE-SA approved a final standard for publication (after the draft passed Sponsor/SA Ballot), the standard would be copy-edited by the IEEE-

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[7] Available at https://grouper.ieee.org/groups/802/11/Reports/Summary-report-06-Jan-meeting.html
[8] Available at https://grouper.ieee.org/groups/802/11/Meetings/Meeting_Plan.html
[9] Available at https://grouper.ieee.org/groups/802/11/Reports/Summary-report-06-Jan-meeting.html

SA editorial department. The purpose of this process is to catch editorial (e.g., stylistic, grammatical, linguistic and syntactic) errors not caught by the balloting participants. During this process, the copy editor engages with the Task Group editor to ensure that no changes have any technical impact.

32. After publication, IEEE standards are made available to members of the IEEE and for purchase by any member of the public. The IEEE-SA makes ratified standards available for no cost access to the public for a limited period of time through the Get IEEE802 program, after which they are still available to the public, but there may be a fee to download[10]: Quoting from the IEEE Get802 guidelines:

> **Program Description**
>
> IEEE shall provide the following:
> a) Unlimited, online, public access to individual IEEE 802 standards six months after publication date (unless otherwise agreed), residing on an IEEE determined and approved server, and at no cost to end-users, based on the following criteria:
>
> i. The Program will make available current versions of IEEE 802 standards as well as those whose superseding version is not available in the Program. Current IEEE standards are defined as standards that have been approved by the IEEE Standards Board and are not withdrawn or superseded. Superseded standards will include notice that the document has been superseded. A link to the superseding version for purchase may also be made available.

[10] Accessible at https://www.ieee802.org/2016_Get_IEEE802_Program_Guideline.pdf

ii. Standards will be made available beginning six months after the date of publication by IEEE;

iii. Draft IEEE 802 standards are not included in the Program;

iv. IEEE 802 standard Editions are not included in the Program;

v. Inactive or historical standards will not be made available in the Program, but will be made available for purchase.

33. The Get IEEE program has existed at least since April 2003; according to a report to the IEEE 802 Sponsor Executive Committee by Jonathan Goldberg of IEEE staff, a total of over 7.2 million documents were downloaded by the public during the period from April 2003 to September 2017 as part of the Get IEEE802 program, with over 2.6 million downloads by academia, including students.[11] (Appendix L).

34. The Get IEEE 802 program (part of the overall IEEE Get program for all standards, not just IEEE 802) is one of four ways to access standards and standards in development (Standards Store, IEEE Xplore Digital Library, IEEE Standards Reading Room, and the IEEE Get Program).[12] All IEEE standards are available for anyone in the public to obtain, either for free via the Get IEEE802 program or for purchase through the Standards Store. Anyone can create an

[11] *See* https://mentor.ieee.org/802-ec/dcn/17/ec-17-0180-00-00EC-ieee-802-nov17-get802-report.pdf

[12] *See* https://ieeexplore.ieee.org/Xplore/home.jsp

account in IEEE Xplore and view a copy of any of the published standards via the IEEE Standards Reading room. The Reading Room allows view-only privileges to the general public; institutions that have an IEEE-SA corporate or university account allow their users to download documents for free, even ones that are no longer free under the Get IEEE802 program. Hence, millions of university students and company employees have free access to all versions of IEEE Standards. Anyone else in the general public can purchase any IEEE standard after it transitions out of the Get IEEE802 program.

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willfully false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1101 of Title 18 of the United States Code.

Date: 31 December 2023

Location: Timisoara, Romania

Signature: ______________________

James L. Lansford, Ph.D.

APPENDIX A

New Participant Orientation

IEEE 802.11 Vice-Chair

Al Petrick

IEEE 802.15 Vice-Chair

Jim Allen

IEEE 802.18 Chair

Carl Stevenson

IEEE 802.19 Chair

Steve Shellhammer

IEEE 802.20 Chair

Jerry Upton

IEEE 802.21 Chair

Ajay Rajkumar

IEEE 802.11 Officers…Primary Roles Wireless LANs

- Stuart J. Kerry, Chairman
- Al Petrick, Vice-Chair…Attendance record and Treasury
- Harry Worstell, Vice-Chair….Documentation, Voter Database
- Tim Godfrey, Secretary ...Working Group Minutes and Wireless Network Lead.

IEEE 802.15 Officers…Primary Roles Wireless PANs

- Bob Heile, Chairman, Documentation
- Jim Allen, Vice-Chair…
- Pat Kinney, Secretary ...Working Group Minutes
- Mike McInnis, Asst Secretary
- James Gilb, Parliamentarian
- Rick Alfvin, Webmaster/Docmaster/Attendance
- John Barr, Treasury

IEEE 802.18 Officers…Primary Roles Radio Regulatory TAG

- Carl Stevenson, Chairman, Documentation
- Denis Kuwahara,Vice-Chair/Secretary
  - WG minutes
  - Attendance

IEEE 802.20 Officers…Primary Roles

Mobile Broadband Wireless Access

- **Jerry Upton, Chairman, Documentation, Voting Rights**
- **Gang Wu, Vice-Chair, Voting Tokens**
- **Rao Yalla Pragada, Secretary ...Working Group Minutes, Attendance**

IEEE 802.21 Officers…Primary Roles
Media Independent Handover Services

- **Ajay Rajkumar Chairman, Documentation, Voting Rights, Voting Tokens**
- **Vice-Chair, OPEN**
- **WG Secretary, OPEN**

IEEE-SA Standards Board Bylaws on Patents in Standards

6. Patents

IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard. This assurance shall be provided without coercion and prior to approval of the standard (or reaffirmation when a patent becomes known after initial approval of the standard). This assurance shall be a letter that is in the form of either

a) A general disclaimer to the effect that the patentee will not enforce any of its present or future patent(s) whose use would be required to implement the proposed IEEE standard against any person or entity using the patent(s) to comply with the standard or

b) A statement that a license will be made available without compensation or under reasonable rates, with reasonable terms and conditions that are demonstrably free of any unfair discrimination

This assurance shall apply, at a minimum, from the date of the standard's approval to the date of the standard's withdrawal and is irrevocable during that period.

Approved by IEEE-SA Standards Board – March 2003, May 2004

Inappropriate Topics for IEEE WG Meetings

- Don’t discuss licensing terms or conditions
- Don’t discuss product pricing, territorial restrictions or market share
- Don’t discuss ongoing litigation or threatened litigation
- Don’t be silent if inappropriate topics are discussed… do formally object.

**If you have questions,
contact the IEEE Patent Committee Administrator
at patcom@ieee.org**

Approved by IEEE-SA Standards Board – December 2002

General Information

- Meetings governed by Roberts Rules of Order. latest edition
- Meetings operated under published IEEE 802 and IEEE 802.11/.20 Policies and Procedures
  - IEEE 802.11 Policies and Procedures
    - document: IEEE 802.11-00/331r7 (on the 802.11 Website)
  - IEEE 802.15 Policies and Procedures
    - document: 99001r6P802-15_Policies and Procedures
  - IEEE 802.20 Policies and Procedures
    - document: 802.20 – PD -05
  - Participation and Representation
  - Individual representation and voting…. Not by company!!!!
  - Open participation with conference fee
  - www.IEEE802.org/11 802.11 working group web page
  - www.IEEE802.org/15 802.15 working group web page
  - www.IEEE802.org/18 802.18 working group web page
  - www.IEEE802.org/19 802.19 working group web page
  - www.IEEE802.org/20 802.20 working group web page
  - www.IEEE802.org/21 802.21 working group web page

- Photography not permitted unless approved by WG Chair
- Audio taping of IEEE 802.11/.15 meetings is NOT allowed
- Media – Press and Analyst briefings
  - Only the 802.11/.21 Chair and Vice-Chairs are allowed to give verbal statements/interviews to the media on behalf of IEEE 802.11/.21 WG

Old Document – Submissions for 802.11

- The file name starts with:
- File names and document format: gg-yy-sss[l]r(n)-G-HumanName.ext
- where
  - “gg” is the 802 group
  - "yy" is the last digit of the year
  - "sss" is the sequence number of the document
  - "l" is an optional letter "A" added to the document number
  - (for companion documents as a Power Point Presentation on
  - a Word document submission
  - "r" is the letter r
  - "n" is the revision number
  - "G" is the group to which the document assigned to (see above
  - in the document list)
- The human name should be as short as possible.
- (please use either a dash or underscore for the coupling letter)
- Try to avoid adding the TG in the name.
- **Example:**

  11-01-462r8-W-New-Participant-Orientation.ppt

See Harry Worstell – Vice Chair for document – submission numbers

Document – Submissions for 802.15

- File names and document format: yysssrnP802-15_TGx-title.ext

- where

  - "yy" is the last digit of the year
  - "sss" is the sequence number of the document provided by the Chair
  - "r" is the letter r
  - "n" is the revision number
  - “x" is the group to which the document assigned to (see above
  - in the document list, e.g.TG3,SG3a or WG)
- The title should be as short as possible with dashes between all words.
- Try to avoid adding the TG in the name.
- **Example:**

  01273r0P802-15_TG3-sample-document.doc
- **Boiler Plate is available, copyright statement MUST be on all submissions.**

Document – Submissions for 802.18

- The file name starts with:
- File names and document format: gg-yy-sss[l]r(n)-G-HumanName.ext
- where
  - “gg” is the 802 group
  - "yy" is the last digit of the year
  - "sss" is the sequence number of the document
  - "l" is an optional letter "A" added to the document number
  - (for companion documents as a Power Point Presentation on
  - a Word document submission
  - "r" is the letter r
  - "n" is the revision number
  - "G" is the group to which the document assigned to (see above
  - in the document list)
- The human name should be as short as possible.
- (please use either a dash or underscore for the coupling letter)
- Try to avoid adding the TG in the name.
- **Example:**

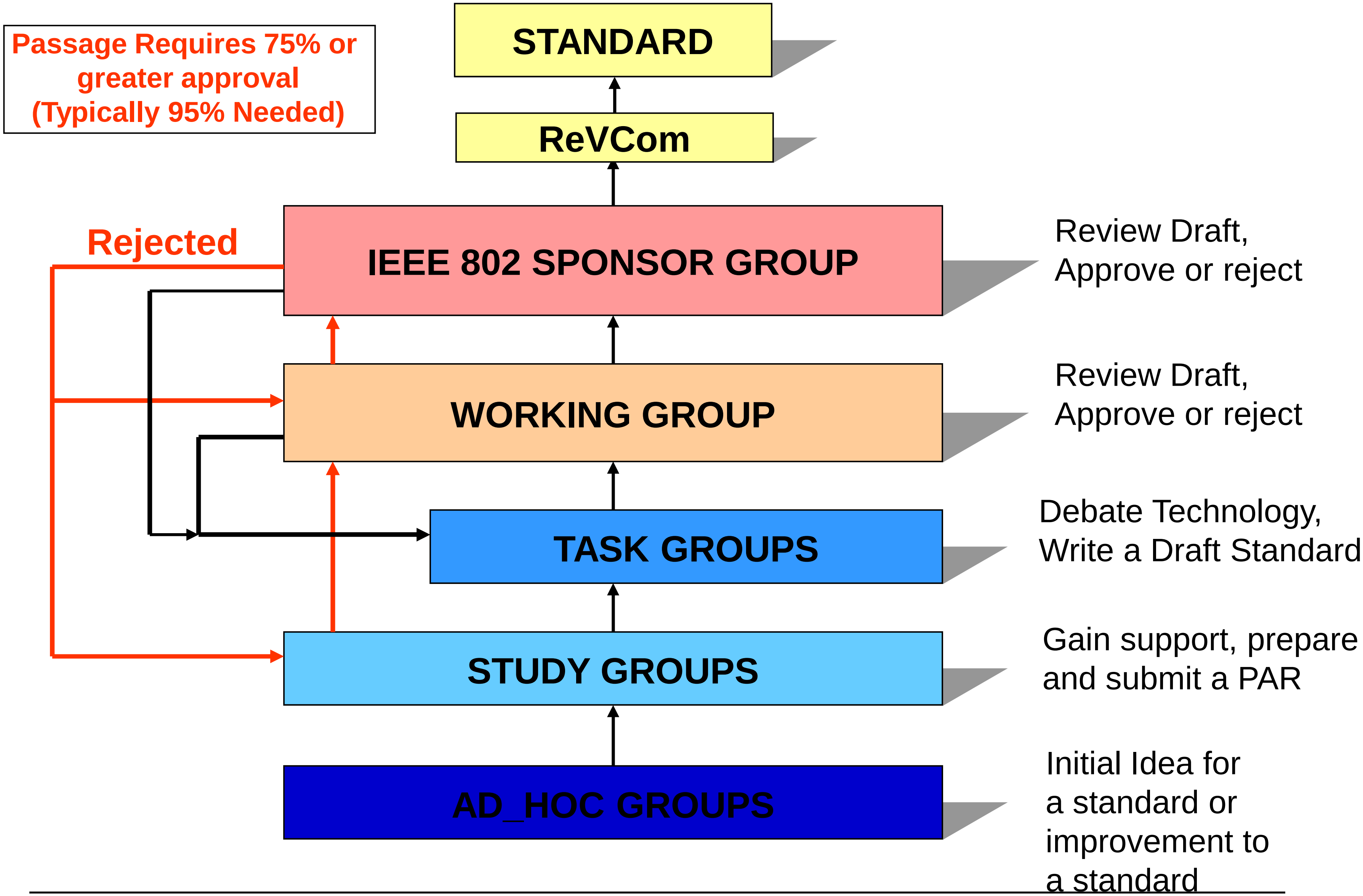
  18-01-462r5-W-New-Participant-Orientation.ppt

See Carl Stevenson – Chair for document – submission numbers

Voting Rights

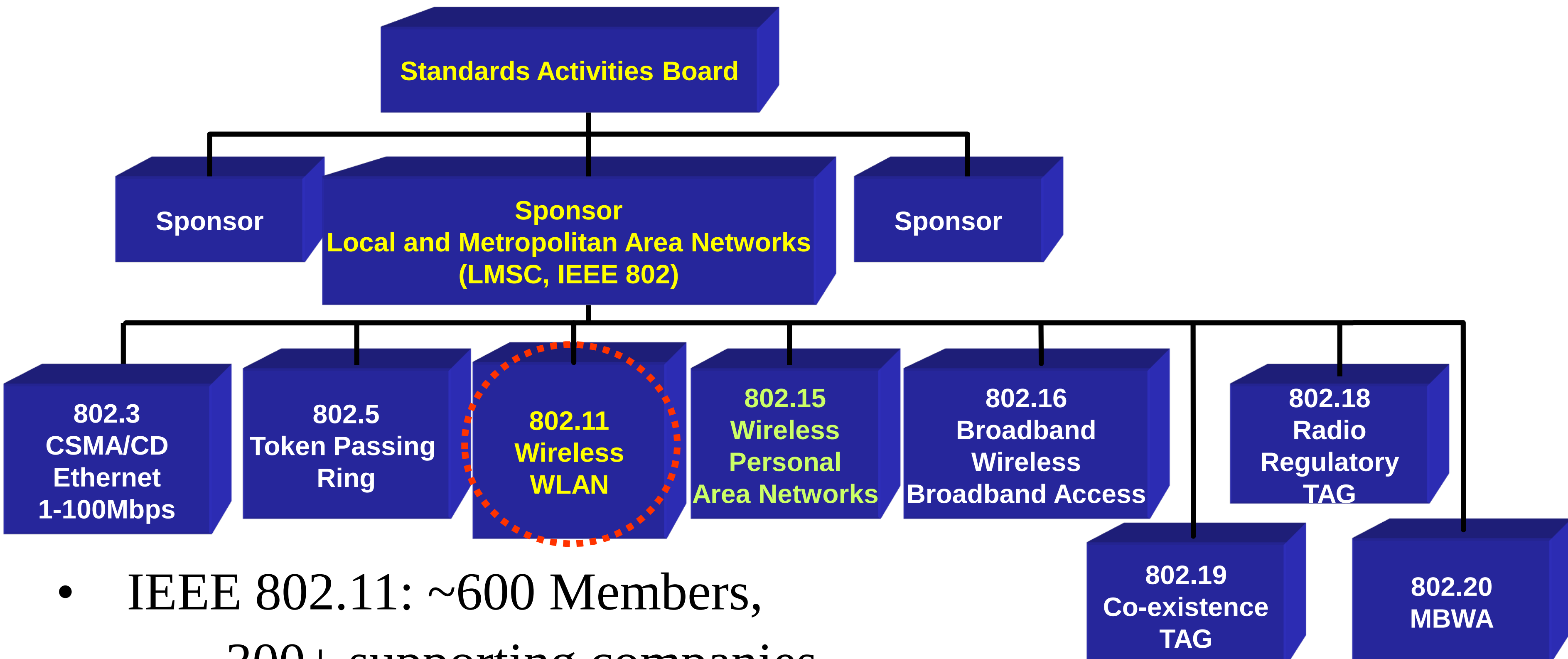
- Earned by attending and participating in meetings for each session in progress.
- Two (2) types of meeting sessions
  - Plenary:….3 sessions per calendar year (March, July, November)
    - Organized by IEEE 802
  - Interim: .. Currently 3 sessions per calendar year (January, May, September)
    - Organized by working group IEEE 802.11/.20 and sponsored by a host
- Voting rights can be earned by participation in 2 plenary sessions within 4 consecutive plenary sessions
  - One (1) Interim session may be substituted for a plenary
  - Definition of participation…..
    - Must be present in at least 75% of ALL meetings in a session
- 802.11 and 802.15 voters **attending 802.18** will receive voting credit for maintaining voting rights in 802.11 and 802.15

IEEE 802: Standardization Process



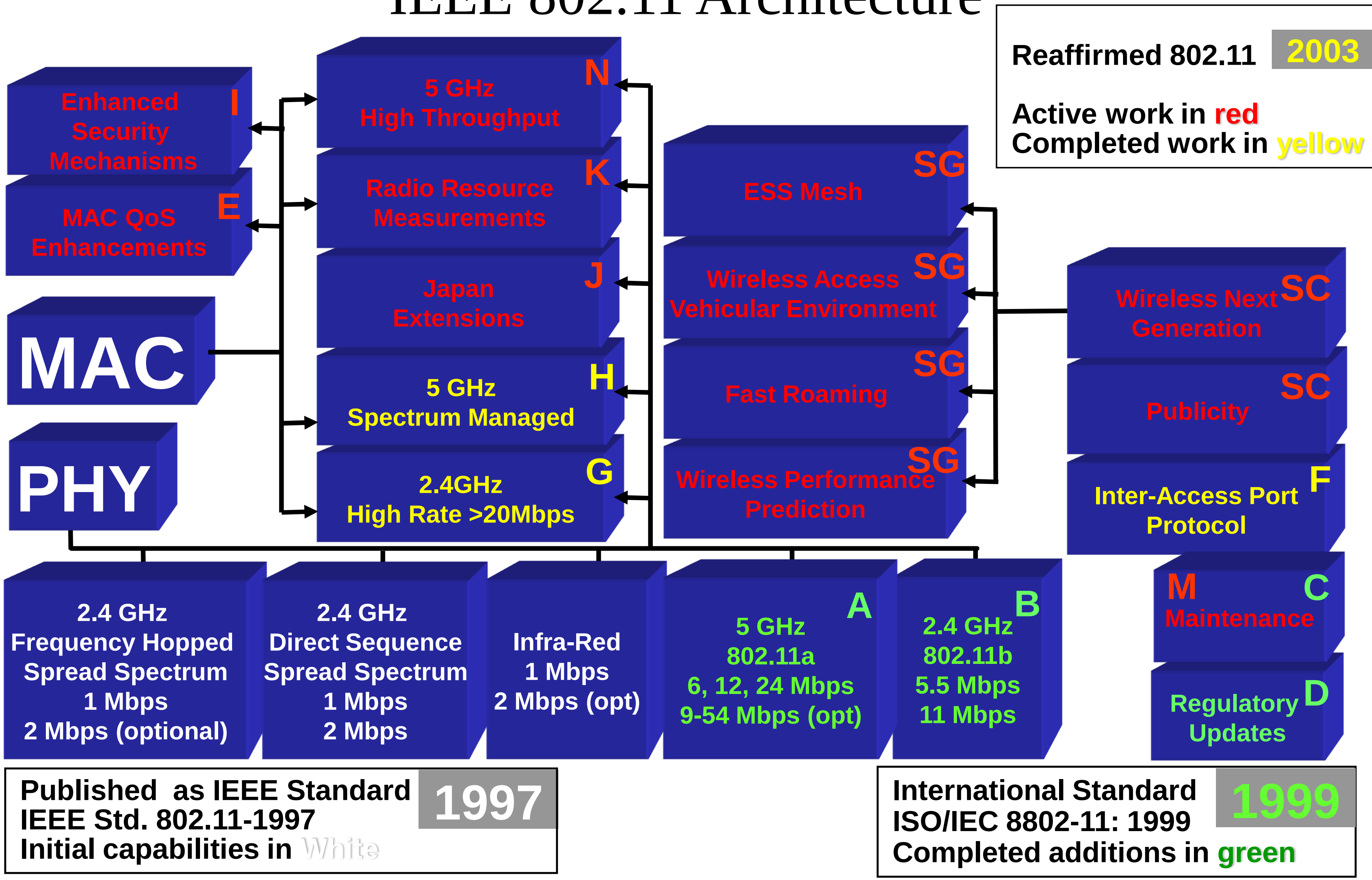
802.11: Standards Organization in IEEE

IEEE Standards Association

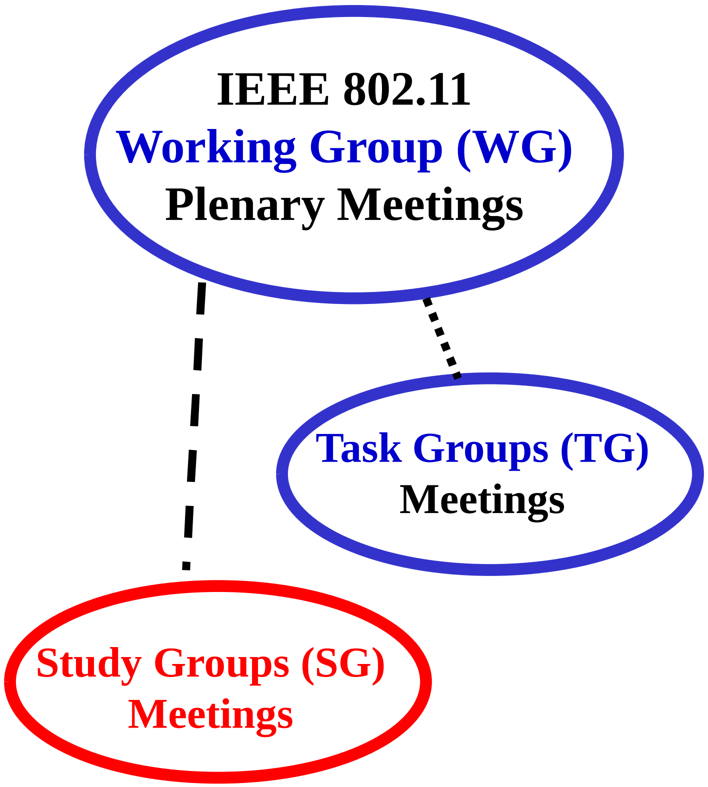


- IEEE 802.11: ~600 Members,
  300+ supporting companies
- www.ieee802.org/11

IEEE 802.11 Architecture



Voting Rights (cont.)

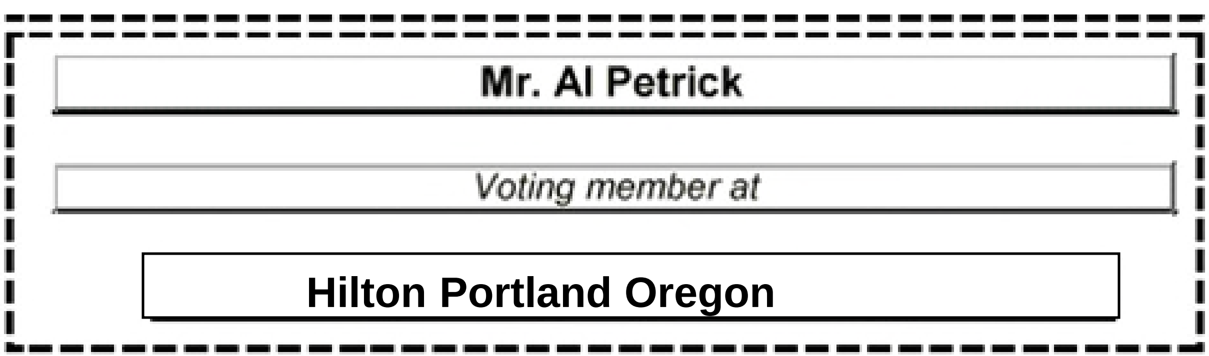


- Must be present at a session to VOTE
- Participation in debates, Motion(s) moved, seconded is only permitted by VOTING members in ALL 802.11,.15,18,19,20 meetings
- However WG & TG Chairs may permit observers/attendees to participate in debates and discussions….
- In Study Groups ALL attendees and have VOTING rights

Voting Tokens

- Once you become a Voter, a Voting "token" will be printed for each session and can be obtained at the opening of a session, providing you have paid your attendance fee!
- Display session Badge at ALL times
- If you loose your Voting token during a session please see Al Petrick, Harry Worstell or Stuart J. Kerry for a replacement in 802.11.
  - See Rick Alfvin for 802.15 voting tokens
  - See Carl Stevenson for 802.18 voting tokens
  - See Steve Shellhammer for 802.19 voting tokens
  - See Gang Wu for 802.20 voting tokens
- Voters are required to use this "token" when a vote in progress on a Motion.

Acrobat Document



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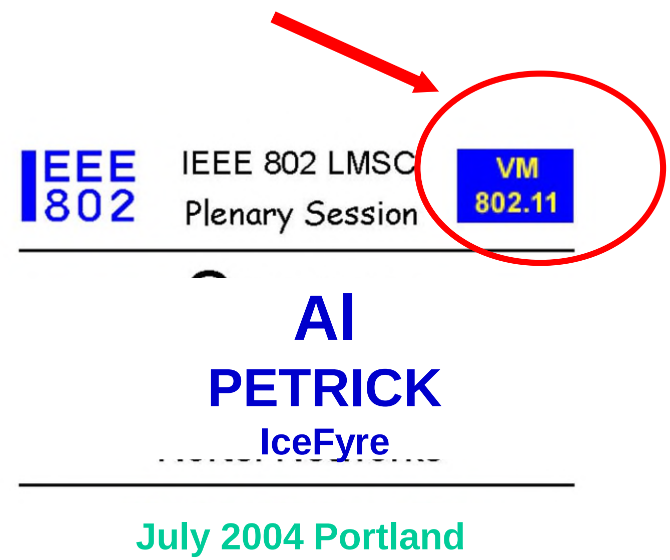
  - See Jerry Upton for 802.20 voting tokens
- Voters are required to use this "token" when a vote in progress on a Motion.

Acrobat Document

Registration badges are Voting Tokens for 802.11



Becoming a Voter

- Pay conference fee
- Provide contact/email information

New Participant

1st (Plenary) Meeting

•"Participate" in 75% of ALL meetings of 1st session

- Get added to the IEEE 802.11 email reflectors

Aspirant

2nd Meeting

- Must attend 75% of ALL meetings of a session
- "Participate" in 2 out of 4 consecutive Plenary sessions
  - However you can substitute (1) Interim for a Plenary session
  - Get access to "Members Only" IEEE 802.11/.15 WG

Nearly Member

3rd Meeting

- If present, at this session, you become a Voting member
- Participate in Working Group Letter Ballots
- Open to Nomination for Officers, & Chair

Voter

Access to the Website

- When you become an "Aspirant"
  - Your email address is added to the technical reflector
    - Stds-802-11
- When you become a "Nearly Voter"
  - You get access to the "Members Only" private section of the website
    - Member ID and Password
    - Includes documents of draft standards for the "task groups

Achieving Voting Rights

If you start on a “Interim”

2004	2004	2004	2004
May Interim	July Plenary	Sept Interim	Nov Plenary
B- New Part. E- Aspirant	B- Aspirant E- Nearly Voter	B- Nearly Voter E- Nearly Voter	B- Voter

B = Beginning
E = End

Substitute an **“Interim”** for a Plenary
Must participate in 2 out of 4 Plenary Sessions

Note: 802.11/20 voter rights begin at the “**start**” of the plenary.

Achieving Voting Rights

If you start on a "Plenary"

2004	2004	2004
July Plenary	Sept Interim	Nov Plenary
B- New Part. E- Aspirant	B- Aspirant E- Nearly Voter	B- Voter

B = Beginning
E = End

Substitute an **"Interim"** for a Plenary
Must participate in 2 out of 4 Plenary Sessions

Note: 802.11/20 voter rights begin at the "**start**" of the plenary.

Maintaining Voting Rights

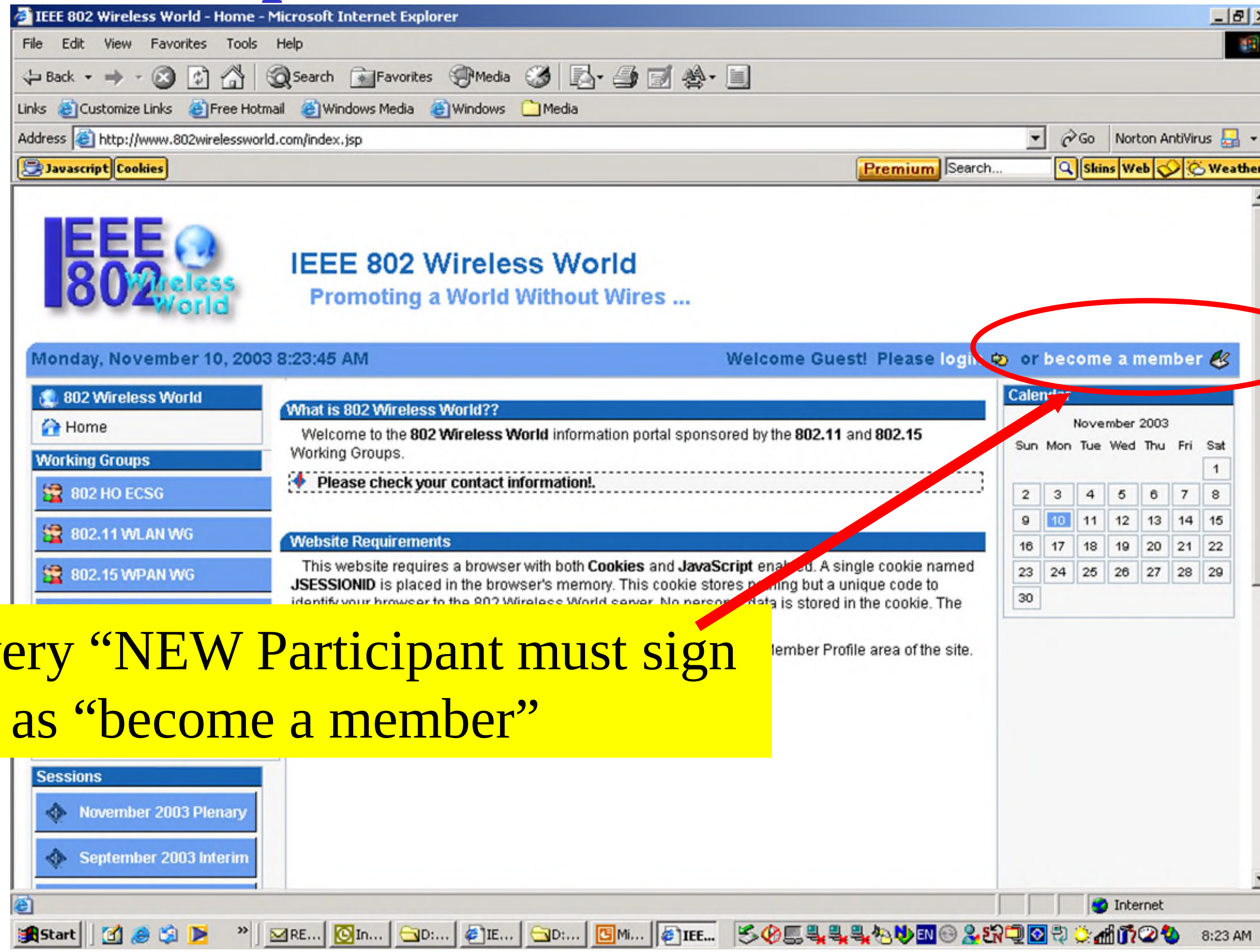
- Every voter is responsible for keeping track of their voting status as recorded on the electronic attendance server www.802wirelessworld.com
- In the Event of Discrepancies…bring it the attention of Al Petrick - 802.11, Rick Alfvin for 802.15, Carl Stevenson – 802.18, Jerry Upton - 802.20
- How to loose voting rights……

Voter

Non-Voter

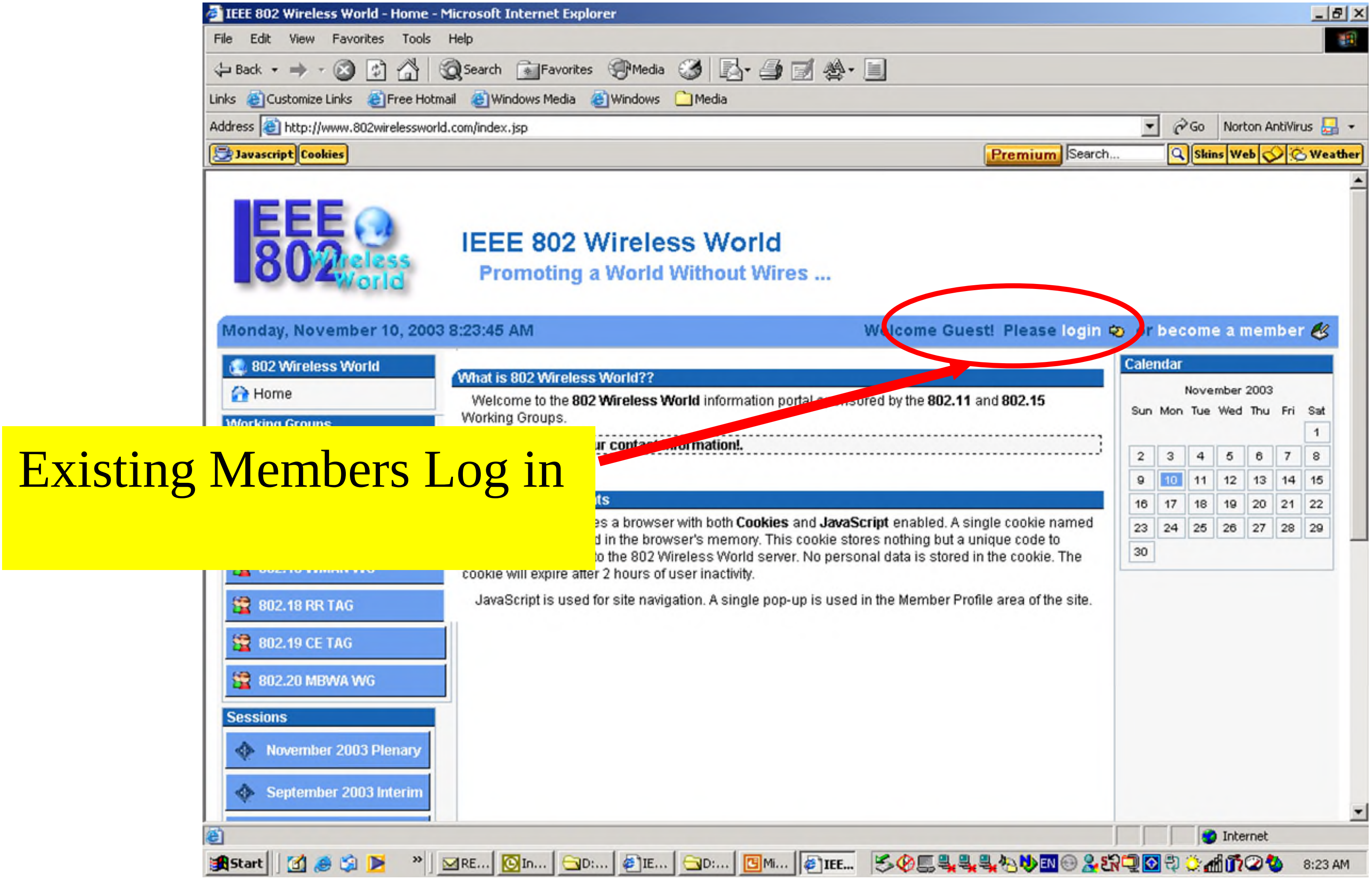
- Fail to "Participate" at least 2 out of 4 consecutive Plenary sessions
  - Participation is to attend 75% of ALL meetings within a 802.11 session
  - May substitute (1) Interim session for Plenary
- Fail to respond and vote on 2 out of 3 mandatory working group letter ballots
- Fail to pay either Interim or Plenary conference fees

http://www.802wirelessworld.com

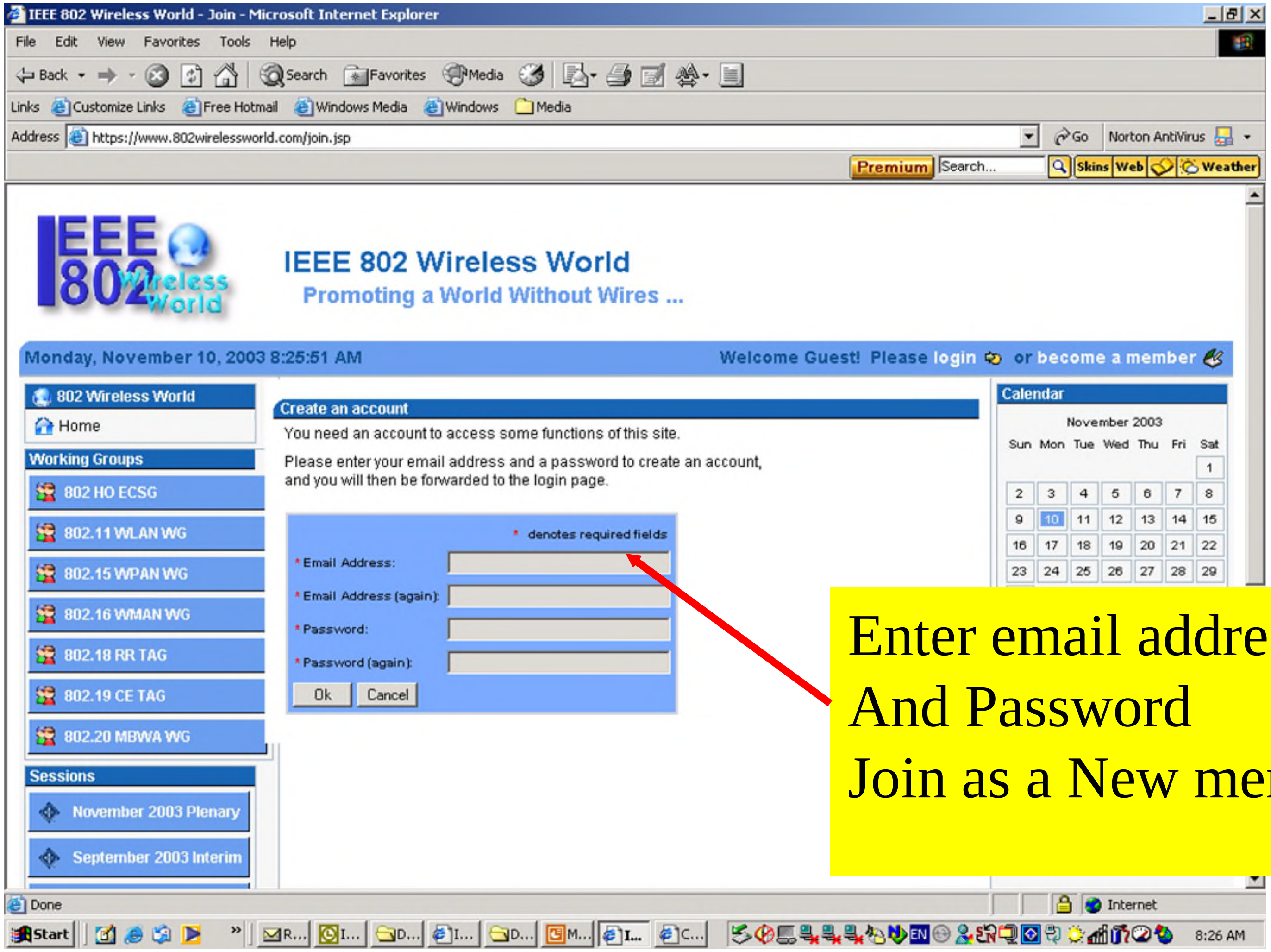


Every "NEW Participant must sign in as "become a member"

http://www.802wirelessworld.com

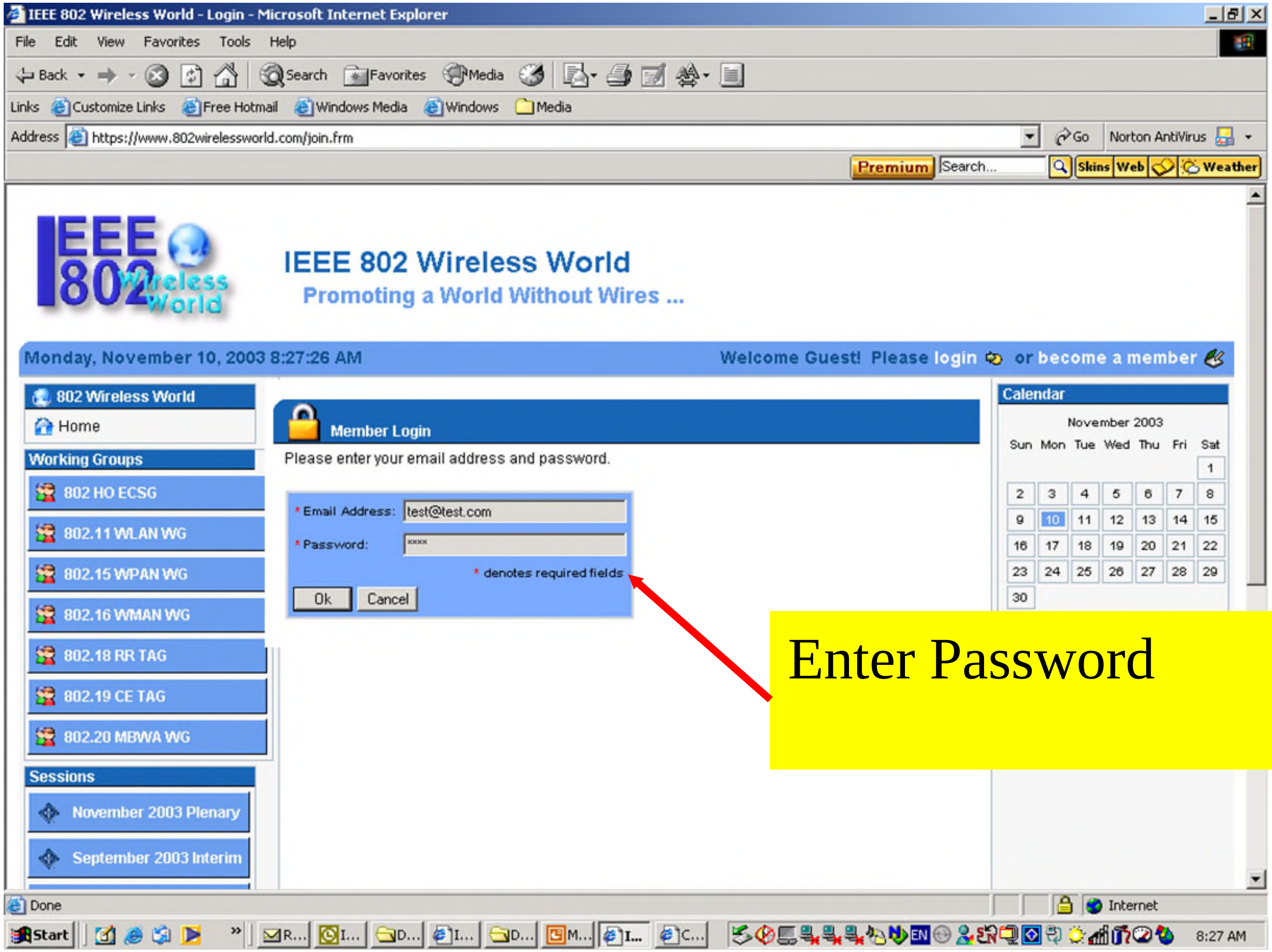


http://www.802wirelessworld.com



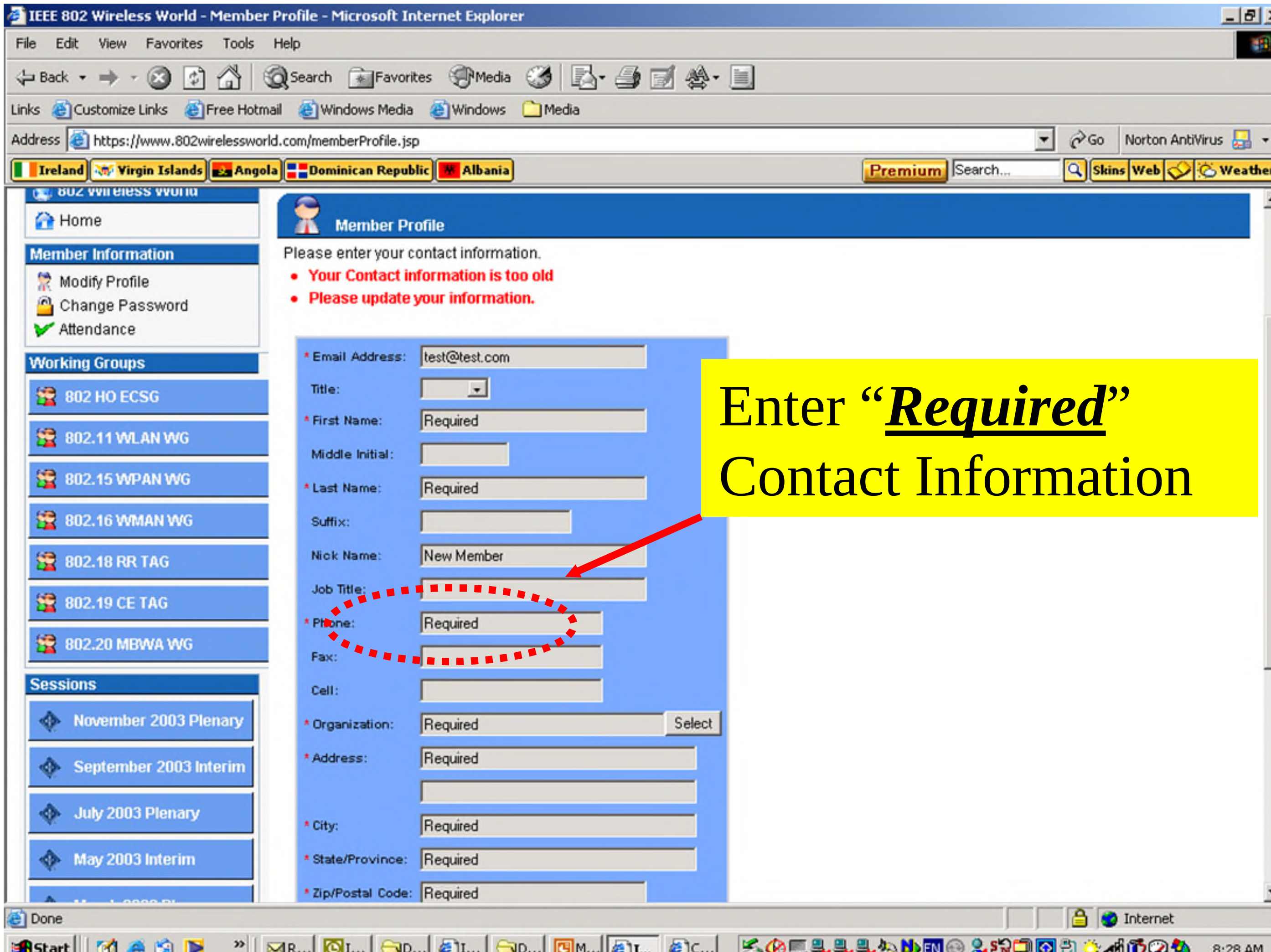
Enter email address
And Password
Join as a New member

http://www.802wirelessworld.com



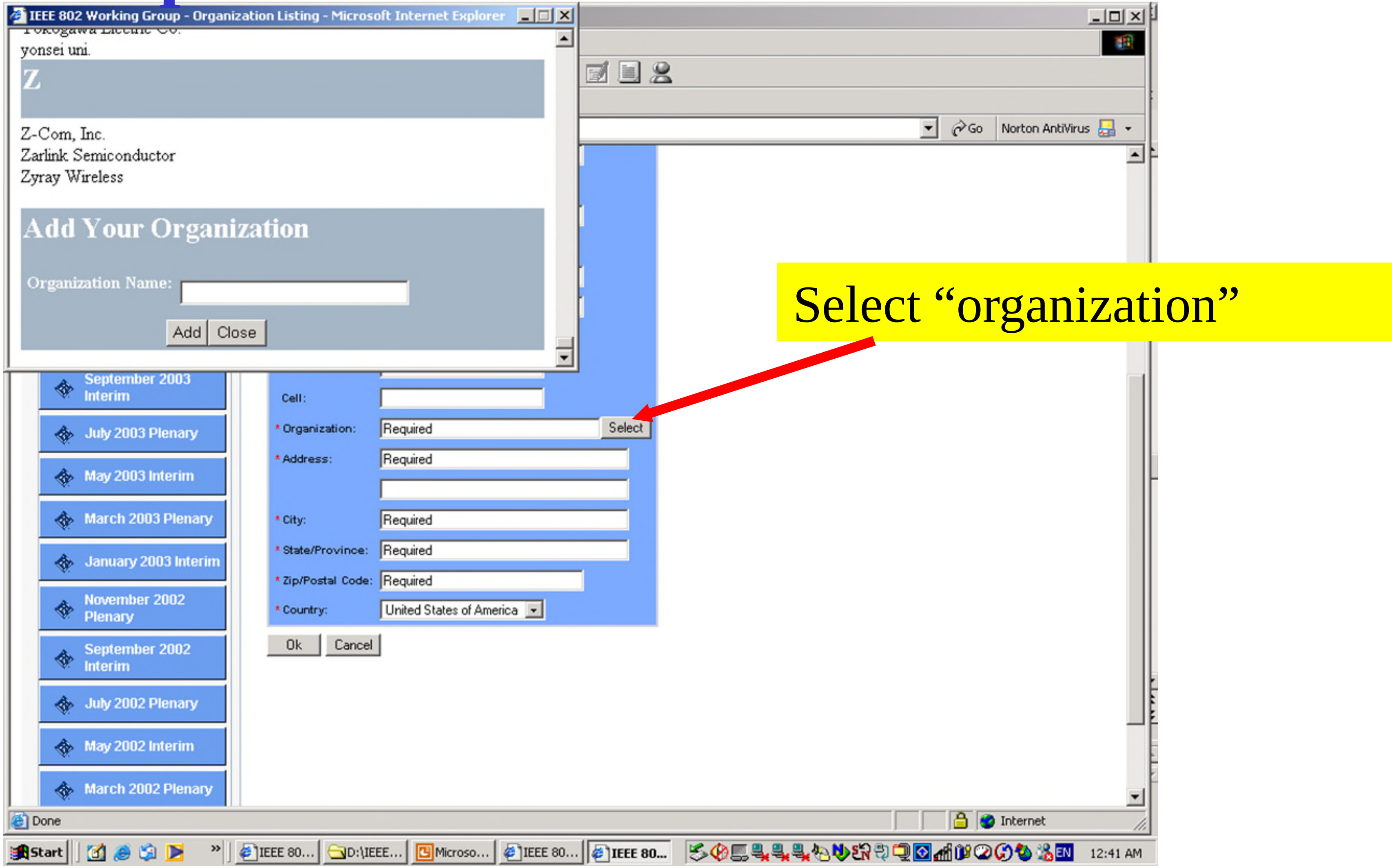
Enter Password

http://www.802wirelessworld.com

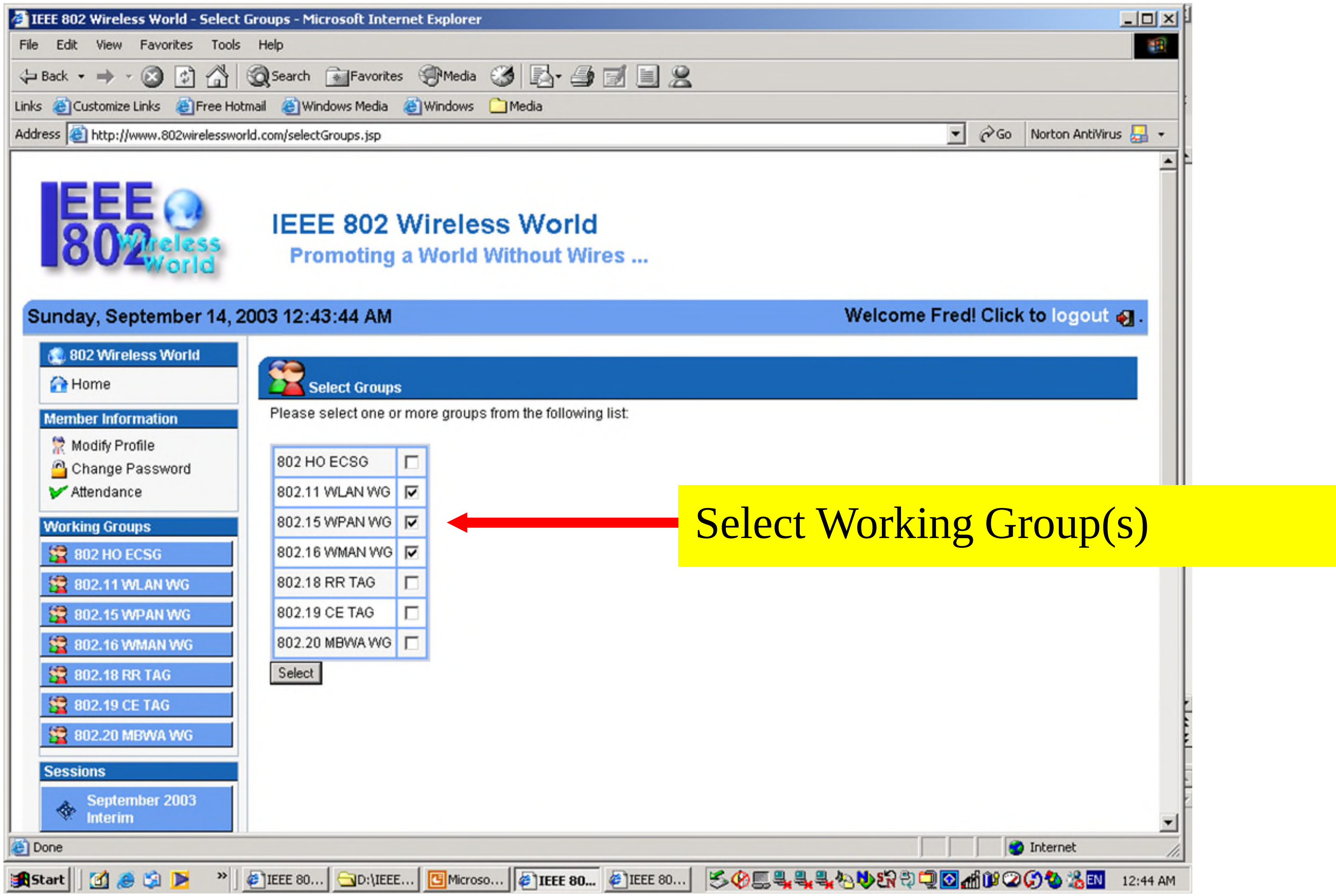


Enter "***Required***"
Contact Information

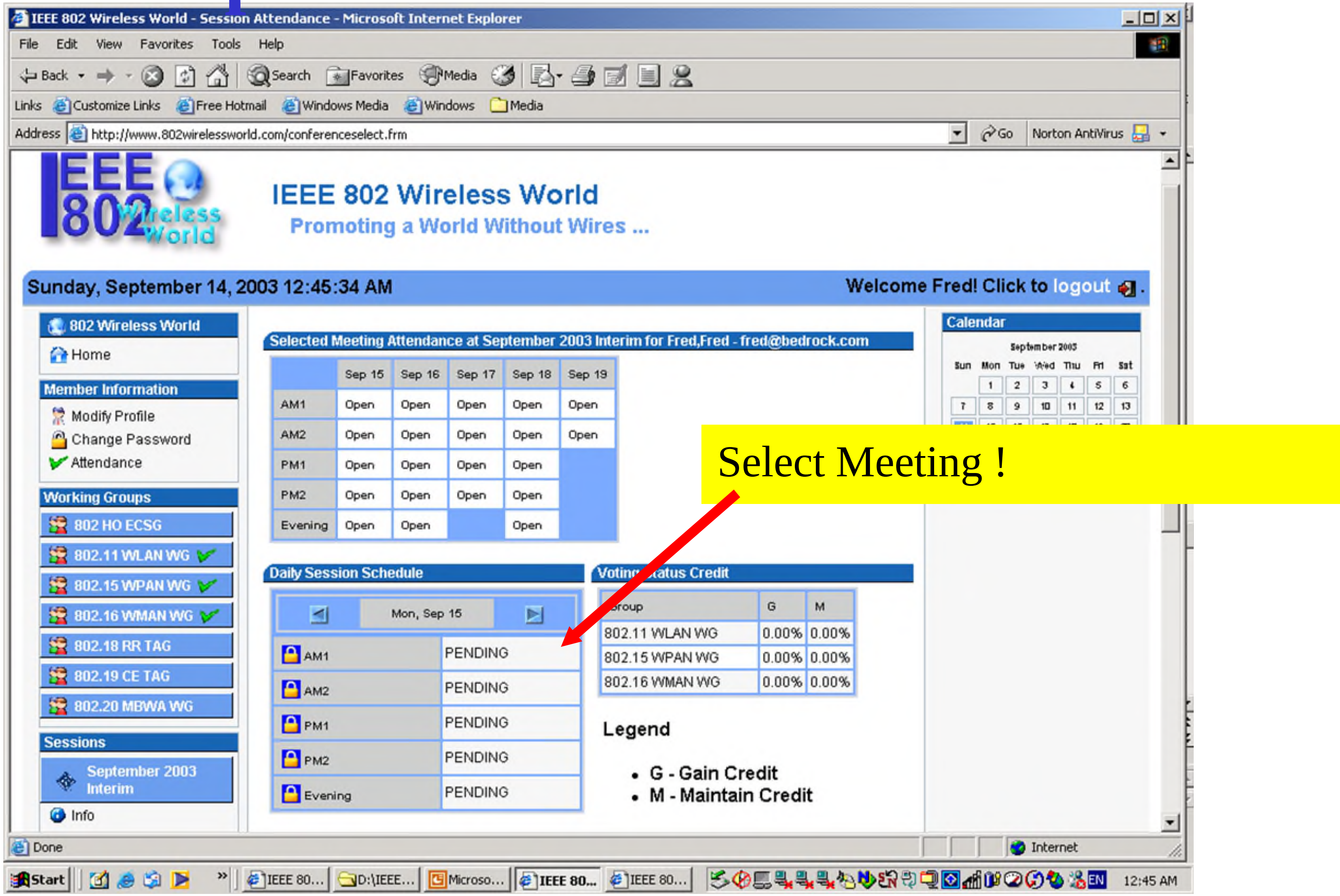
http://www.802wirelessworld.com



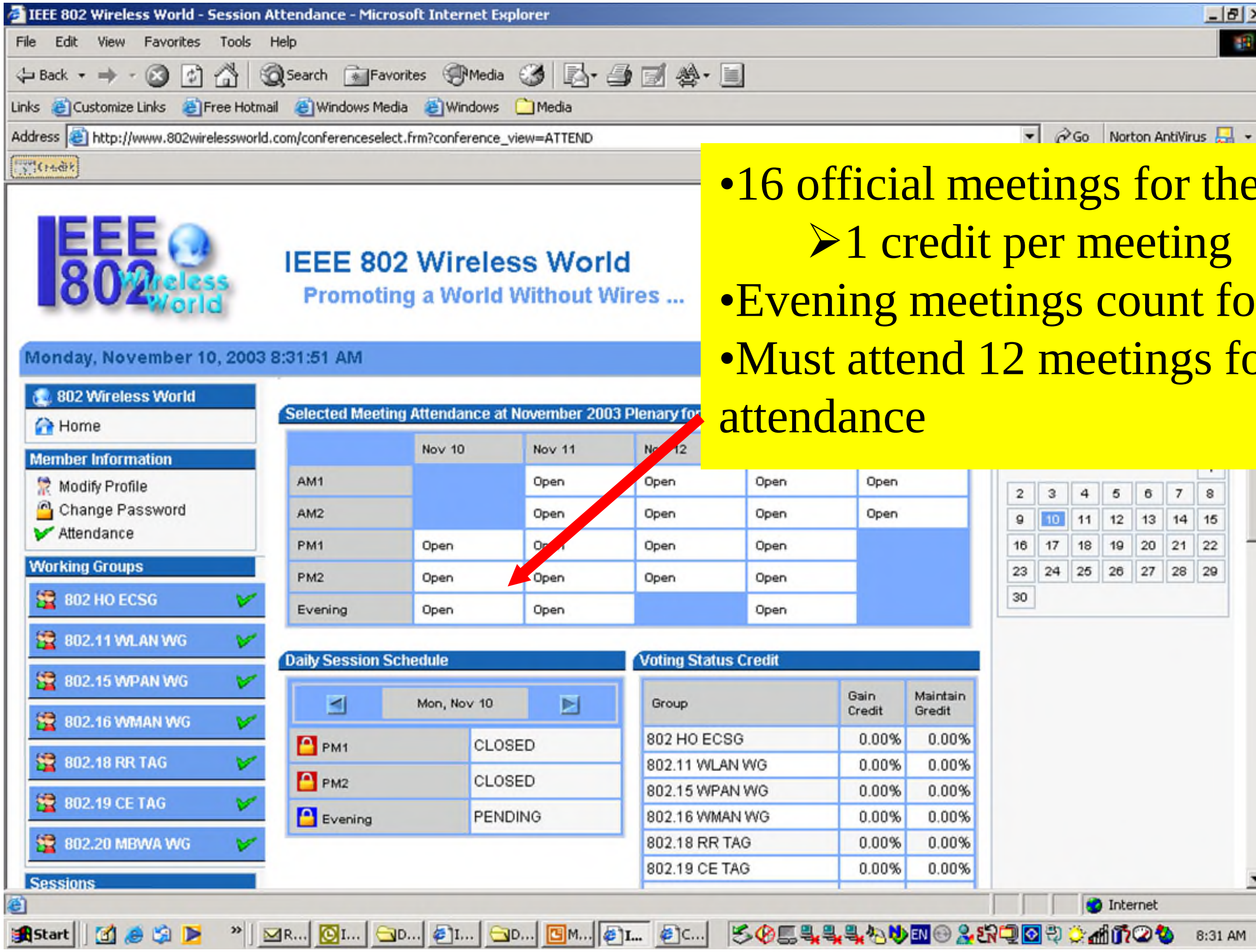
http://www.802wirelessworld.com



http://www.802wirelessworld.com



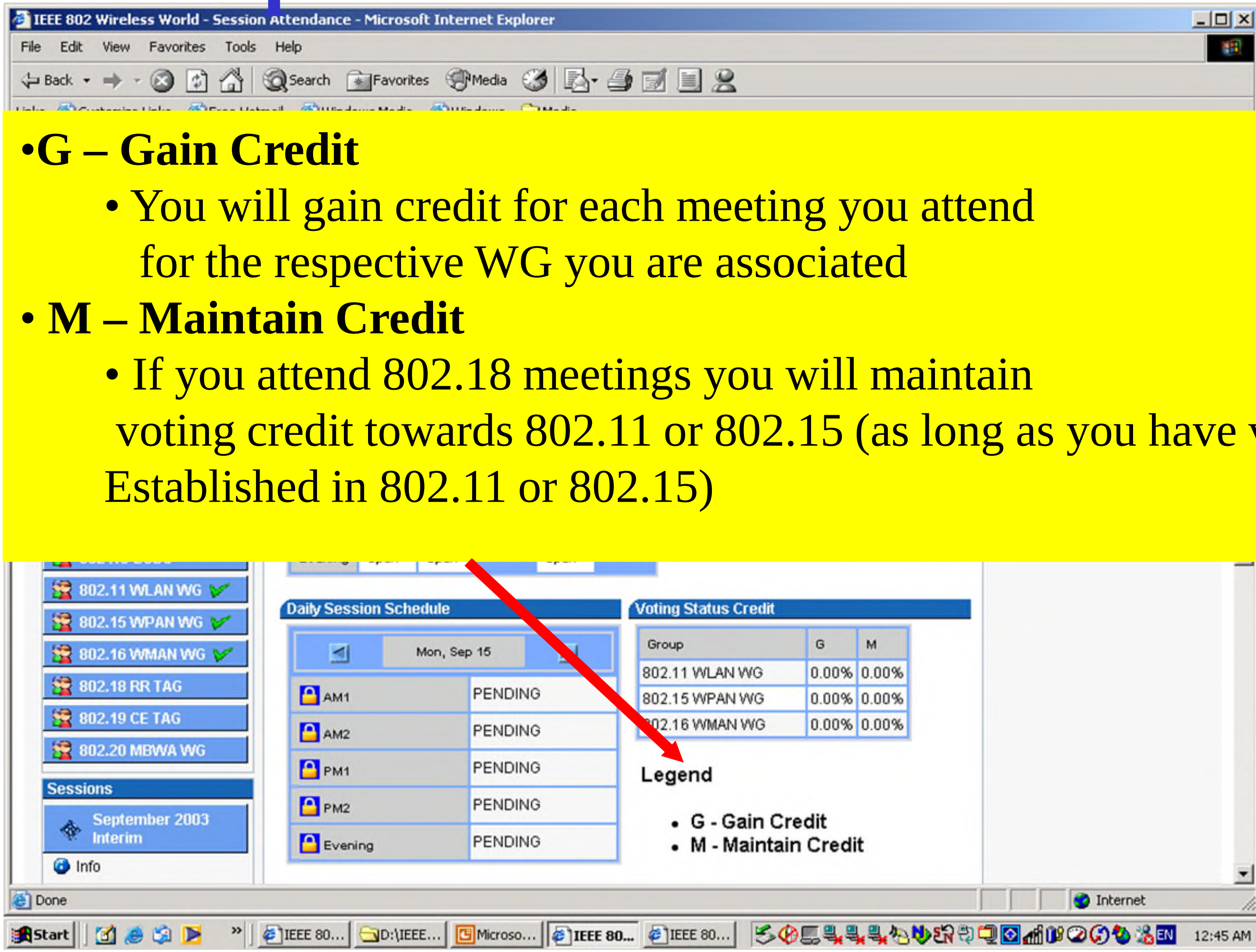
http://www.802wirelessworld.com



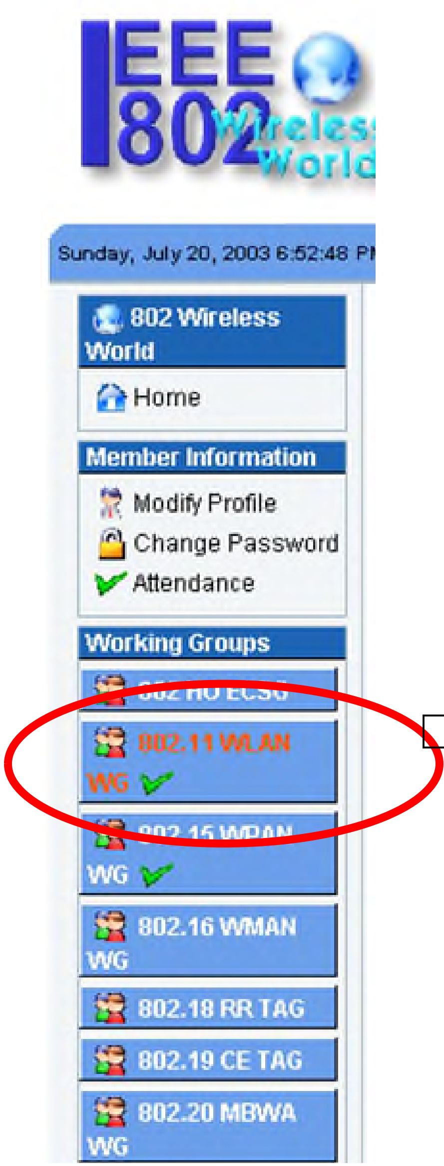
- 16 official meetings for the session
  - 1 credit per meeting
- Evening meetings count for 1 credit
- Must attend 12 meetings for 75% attendance

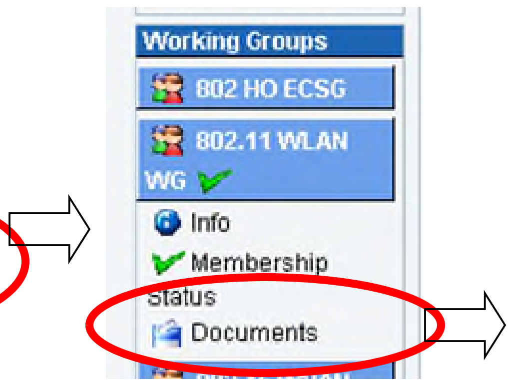
http://www.802wirelessworld.com

- **G – Gain Credit**
  - You will gain credit for each meeting you attend for the respective WG you are associated
- **M – Maintain Credit**
  - If you attend 802.18 meetings you will maintain voting credit towards 802.11 or 802.15 (as long as you have voting rights Established in 802.11 or 802.15)

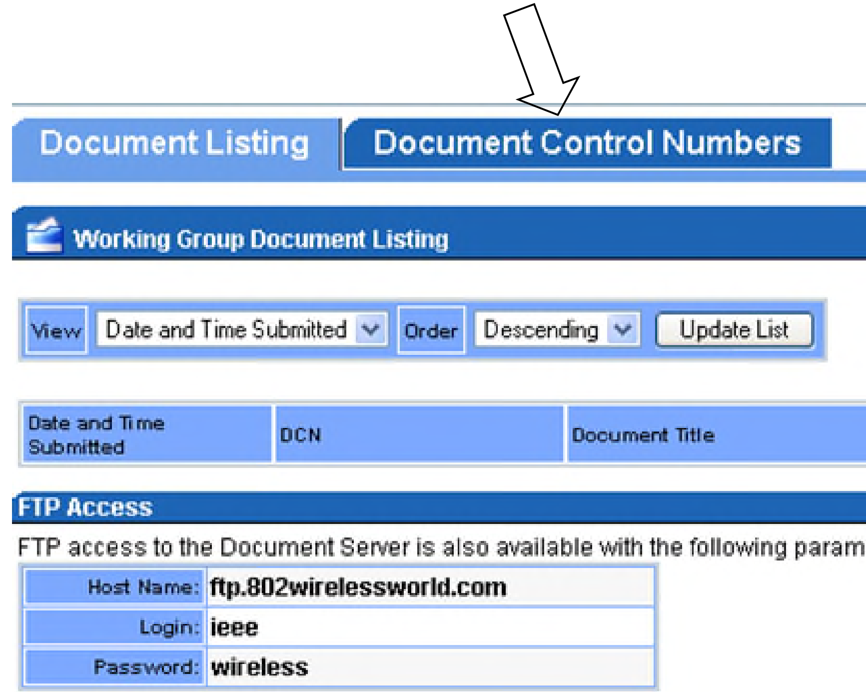


Doc Submissions Process

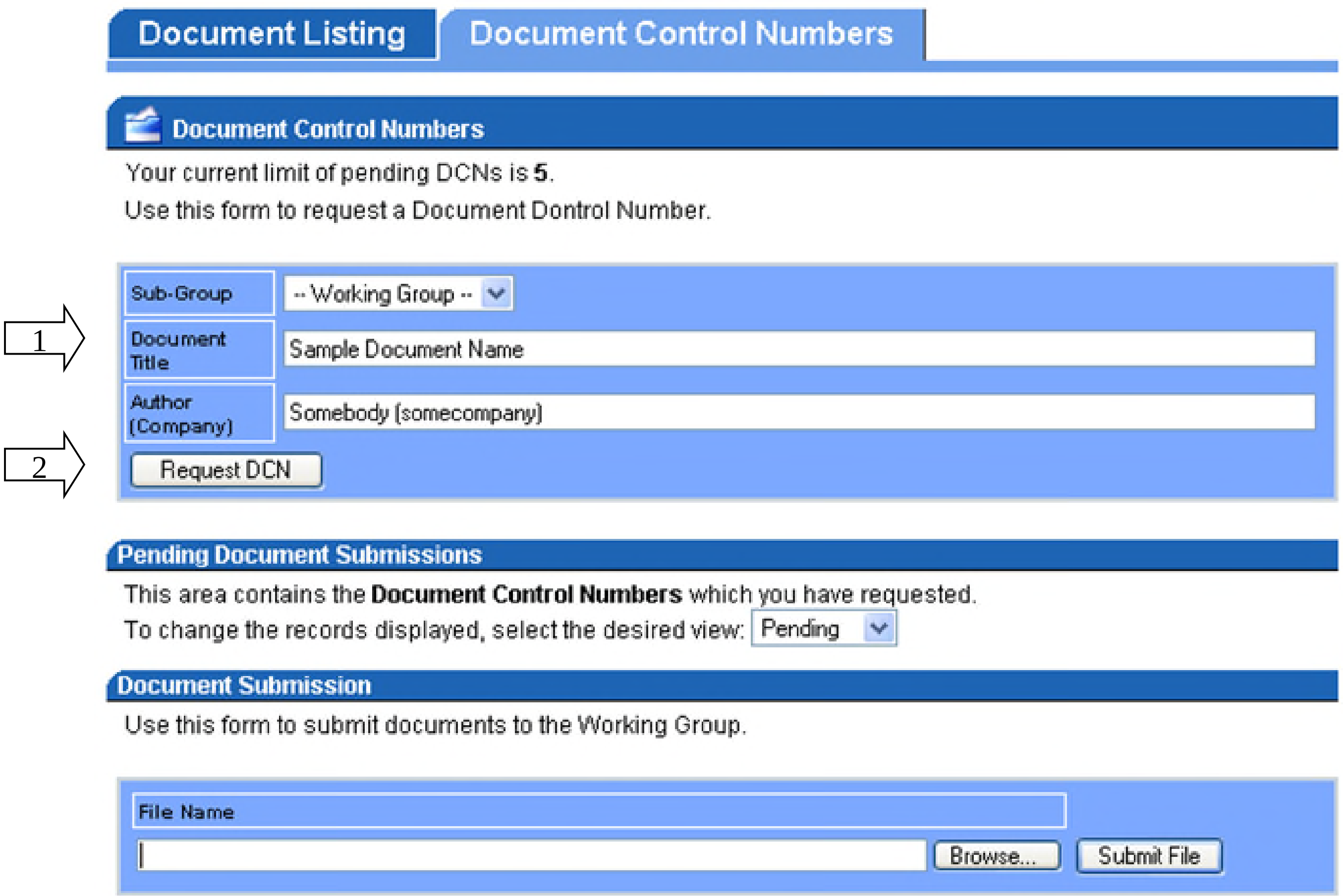




Click this tab

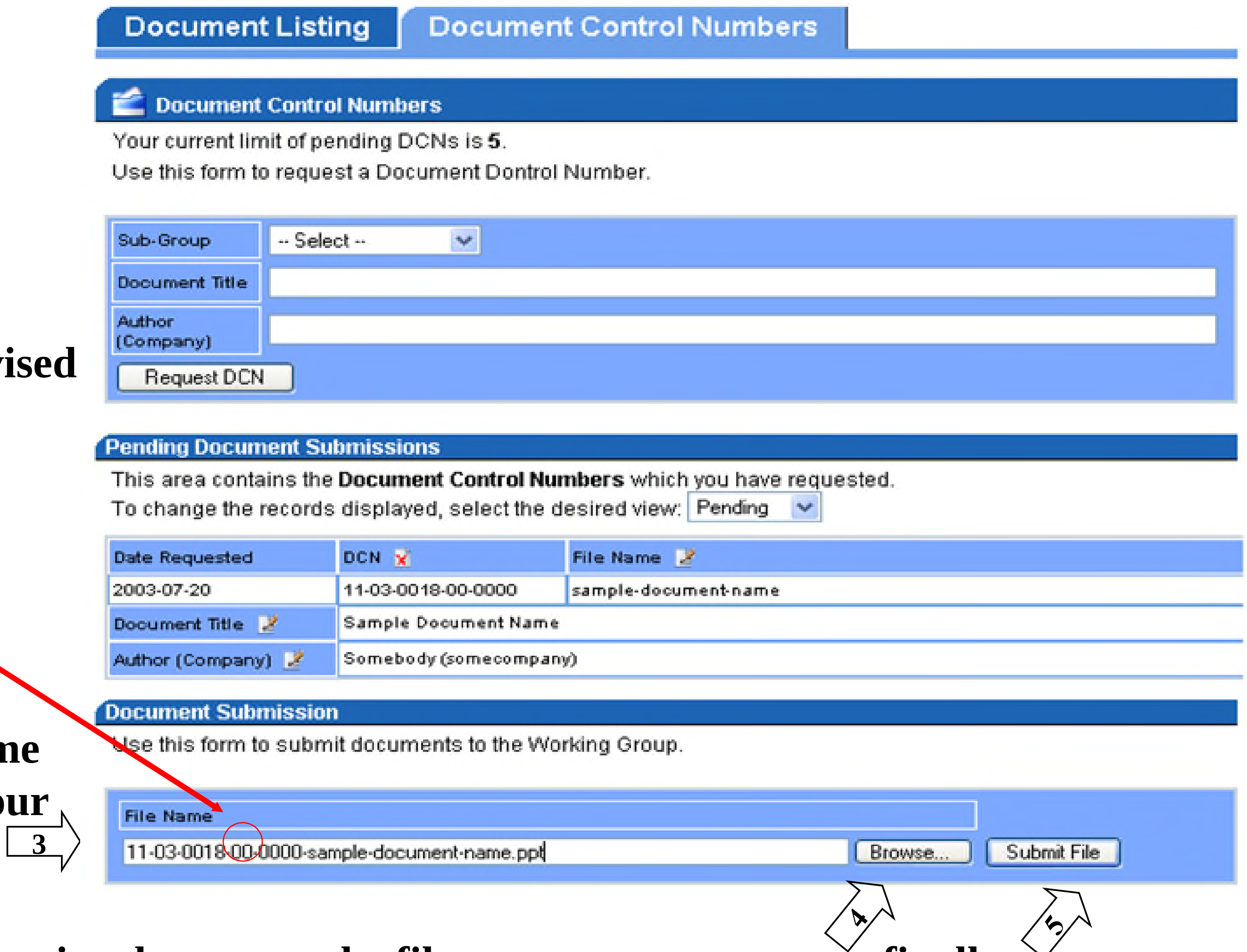


Doc Submissions Process



Doc Submissions Process

To submite a revised Document
Change revision Number in the File name

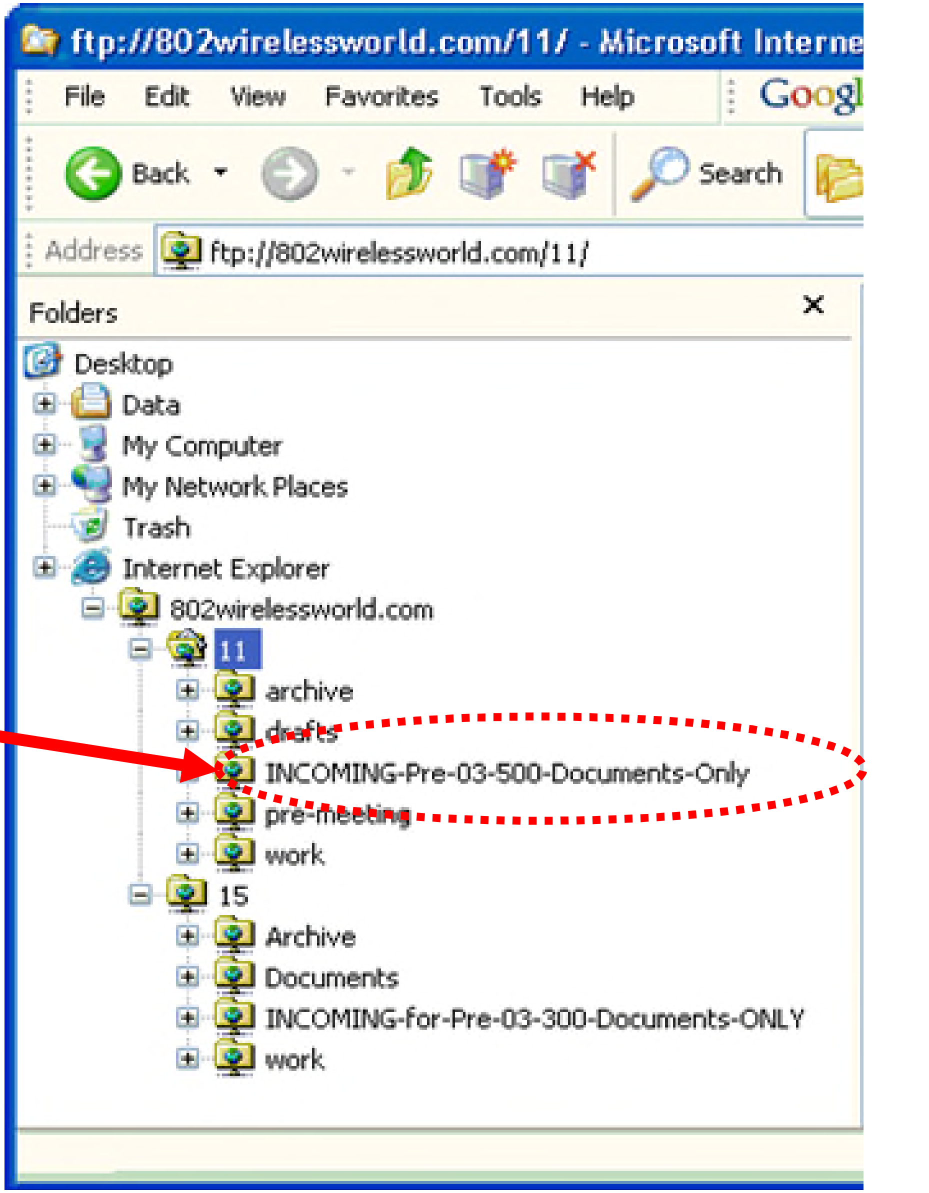


Enter filename (as it is on your computer)

……or….. just browse to the file on your computer, finally

Revised Doc Submission

- Revisions to documents should be transferred by FTP to the working area(s) on Pluto.
- **ftp://802wirelessworld.com/11**



Wireless Network Information

- Only 802.11b networks are available
- SSID (case sensitive)
  - IEEE
- Enable DHCP in the Netcard's TCP/IP properties
  - "Obtain IP Address Automatically"
- No WEP is being used. Be sure your WEP is disabled.
- Outgoing SMTP Server is 10.0.1.1 mail.802wirelessworld.com

Attendance Server

- Electronic Attendance and Document Number Server: 802WirelessWorld
  - Access in web browser as: **http://www.802wirelessworld.com/**
    - Static IP of local server is 10.0.1.3
  - This site will continue to be available on the Internet between meetings.

File Server information (new)

- Meeting File Server (802.11 and 802.15)
  - PLUTO 10.0.1.3 (AKA 802wirelessworld)
    - Meeting Document Access (only via FTP)
      - FTP Login - **user: IEEE password: wireless**
      - ftp://pluto or ftp://www.802wirelessworld.com
        - Contains multiple Working Group directories
    - Document Submissions
      - Via web site at www.802wirelessworld.com
        - Documents link under your working group link
        - Note – some Working Groups may not use this for document submissions yet. Currently, 802.11, 802.15, and 802 Handoff SG are using this method. Other servers are still on-line for other Working Groups. Check with your WG for status.

Other WG server information

- 802.15: MARS
  - Replaced by ftp.802wirelessworld.com
- 802.18, 19, and 20: 802-18-19 10.0.1.18
  - 802.18 Radio Regulatory \\802-18-19\RadioReg
  - 802.19 Coexistence \\802-18-19\Coexistence
  - 802.20 MBWA \\802-18-19\MBWA
  - 802.20 MBWA \\802-18-19\MBWA-Subm

Troubleshooting

- Make sure your wireless association is to **SSID: IEEE**
  - There are several other wireless networks in the area
- Make sure you have an IP address
  - Run IPCONFIG and be sure your IP address is 10.0.x.x
- If you can't access or find a particular server
  - Ping it – is the address being pinged in some other range than our local network 10.0.x.x? Is the name being pinged something like pluto.yourcompany.com? That means you have some other host with the same name on your home network.
  - To solve, run: IPCONFIG /flushdns from a command prompt to flush your DNS cache.

Network and Electronic Assistance

- Help desk
  - Outside of the Ballroom
    - During regular IEEE 802 registration hours
      - 8AM til 5PM
  - See Doug Hock or Tony Awtrey
    - IDEAL Corporation

IP and Virus Protect!

- Enable DHCP and Do NOT configure your wireless card with a static IP address!
- Do NOT enter the wireless network without having the most current
  - Virus Protection installed,
  - Firewall installed
  - Microsoft security updates

and turned on !

Enjoy IEEE 802
at the
Hilton Towers
Portland, Oregon

APPENDIX B

IEEE P802.11
Wireless LANs

Approved Minutes of the IEEE P802.11 Full Working Group

July 12 - 16, 2004

Portland Hilton, Portland, Oregon, USA

8th Joint 802 Wireless Opening Plenary: Monday, July 12, 2004

1.1. Introduction

1.1.1. Meeting called to order by Stuart J. Kerry at 1:30PM

1.1.2. The agenda of the 86th session of 802.11 is in doc: IEEE 11-04-592r4. This session is including 802.11, 802.15, 802.18 RREG TAG, 802.19 Coexistence TAG, 802.20 MBWA, and 802.21.

1.1.3. Stuart J. Kerry reminds the group regarding the rules against audio recording or photographs without permission.

1.1.4. Count of new participants at this meeting: 63.

1.1.4.1. There are 459 people in the room.

1.1.5. Secretary – Tim Godfrey

1.1.6. Officers and Chairs of 802.11:

IEEE 802.11 WORKING GROUP OFFICERS			
Name	Position	Work Phone	eMail
Stuart J. Kerry	IEEE 802.11 WG Chair Philips Semiconductors, Inc., 1109 McKay Drive, M/S 48A SJ, San Jose, CA 95131-1706, USA Fax:+1 (408) 474-5343	+1 (408) 474-7356	stuart.kerry@philips.com
Al Petrick	WG 1st Vice-Chair / Treasurer Policies & Treasury	+1 (321) 235-3423	apetrick@icefyre.com
Harry R. Worstell	WG 2nd Vice-Chair / WNM SG Chair Attendance, Ballots, Documentation & Voting	+1 (973) 236-6915	hworstell@att.com
Tim Godfrey	WG Secretary Minutes	+1 (913) 664-2544	tim.godfrey@conexant.com
Terry Cole	WG Technical Editor Standard & Amendment(s) Coordination	+1 (512) 602-2454	terry.cole@amd.com
Brian Mathews	WG Publicity SC Chair Communications & Reports	+1 (321) 259-0737	brian@linux-wlan.com
Teik-Kheong "TK" Tan	WNG SC Chair	+1 (408) 474-5193	tktan@ieee.org
John Fakatselis	TGe Chair	+1 (321) 327-6710	john.fakatselis@conexant.com
Sheung Li	TGj Chair	+1 (408) 773-5295	sheung@atheros.com
Richard H. Paine	TGk Chair	+1 (206) 854-8199	richard.h.paine@boeing.com
Bob O'Hara	TGm Chair	+1 (408) 635-2025	bob@airespace.com
Bruce P. Kraemer	TGn Chair	+1 (321) 327-6704	bruce.kraemer@conexant.com
Clint Chaplin	TGr Chair	+1 (408) 528-2766	cchaplin@sj.symbol.com
Donald E. Eastlake 3rd	TGs Chair	+1 (508) 786-7554	donald.eastlake@motorola.com
Lee Armstrong	WAVE SG Chair (TGp Chair Elect)	+1 (617) 244-9203	LRA@tiac.net
Stephen McCann	WIEN SG Chair	+44 (1794) 833341	stephen.mccann@roke.co.uk
Charles R. Wright	WPP SG Chair	+1 (978) 268-9202	charles_wright@azimuthsystems.com

1.2. IP Statements (Letters of Assurance)

1.2.1. Stuart J Kerry calls for any letters of assurance related to IP for any Working Groups represented in this joint meeting.

1.2.1.1. None.

1.3. Announcements

1.3.1. Members are cautioned to not leave personal items unattended in the meeting rooms.

1.4. Policies and procedures

1.4.1. Petrick reviews the documents containing the 802.11 policies and procedures. Current P&P document is 00/331r7. Updates in 421r1 was posted in March. The latest red-line document is 04/510r0

1.4.2. Al Petrick presents the overview of policies and procedures from the presentation in 04/424r2.

1.4.2.1. Review of officer duties.

1.4.2.2. Review of voting tokens – 802.15 through 802.20 will continue to use paper tokens. 802.11 is using printed voting status on their registration badges. We are continuing this from the March meeting. There were only 16 discrepancies. If anyone else has a question about voting status, see Al Petrick or Harry Worstell.

1.4.2.3. Hierarchy of policies and procedures.

1.4.2.4. The use of Roberts Rules of Order latest edition.

1.4.2.5. Review of registration and media recording rules.

1.4.2.6. Review of attendance list and recording procedures, and rules for statements to the press.

1.4.2.7. Review of attendance procedures, and rules for voting rights (earning and maintaining). More details in document 04/422r2

1.4.2.8. Review of membership and anti-trust rules.

1.4.2.9. Review of IEEE-SA Standards Board Bylaws on Patents in Standards. This information was last updated in February 2004.

1.4.2.10. The following text from document 04/424r2 was read in its entirety to the membership by Al Petrick:

IEEE-SA Standards Board Bylaws on Patents in Standards

6. Patents

IEEE standards may include the known use of essential patents, and patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard. This assurance shall be provided without coercion and prior to approval of the standard (or reaffirmation when a patent becomes known after initial approval of the standard). This assurance shall be a letter that is in the form of either

a) A general disclaimer to the effect that the patentee will not enforce any of its present or future patent(s) whose use would be required to implement the proposed IEEE standard against any person or entity using the patent(s) to comply with the standard or

b) A statement that a license will be made available without compensation or under reasonable rates, with reasonable terms and conditions that are demonstrably free of any unfair discrimination

This assurance shall apply, at a minimum, from the date of the standard's approval to the date of the standard's withdrawal and is irrevocable during that period.

Approved by IEEE-SA Standards Board –, March 2003, Feb 2004

March 2004 doc.: IEEE 802.11-00/278r10

Inappropriate Topics for IEEE WG Meetings

- **Don't** discuss licensing terms or conditions
- **Don't** discuss product pricing, territorial restrictions or market share
- **Don't** discuss ongoing litigation or threatened litigation
- **Don't** be silent if inappropriate topics are discussed… do formally object.

If you have questions,
contact the IEEE Patent Committee Administrator
at patcom@ieee.org

Approved by IEEE-SA Standards Board – December 2002

General Agenda Information Slide 13 Stuart J. Kerry - Philips Semiconductors, Inc.

1.4.2.11. The rules and status of copyright are reviewed.

1.4.2.12. Meeting Etiquette

1.4.2.12.1. Stuart J. Kerry reminds the membership that meetings are to be conducted in an orderly and professional manner. Roberts rules requires that conversations are through the chair. Members exhibiting inappropriate conduct will be removed.

1.5. Review of the Agenda

1.5.1. The joint meeting agenda is reviewed

1.5.2. The agenda is approved with unanimous consent

1.6. Matters arising from the Minutes

1.6.1. No matters arising from the minutes

1.6.2. The minutes from Garden Grove are approved with Unanimous consent.

1.7. Interim Meetings

1.7.1. September 12-17, Berlin Germany.

1.7.1.1. Registration for meeting and hotel are available on the web site.

1.7.1.2. Members must provide credit card to guarantee the hotel and also to pay the meeting fee. We have a 300 room block at the Estrel Hotel.

1.7.1.3. The Hilton will be an overflow hotel.

1.7.1.4. There is a 3 tier registration fee, based on time of registration. We will have an early-bird for $700US until the end of the month. Regular is $900US, after August 27, the fee is $1100US.

1.7.1.5. Cancellation – If you cancel before 25 August, there is $100AU fee. No refund after August 25th. In addition, 2 room nights must be paid to the hotel if canceling.

1.7.1.6. Meetings will be managed by Tourhosts of Australia.

1.7.1.7. Booking at the Estrel is only until the 18 but not beyond.

1.7.1.8. The IEEE rate at the Estrel is 139 Euros.

1.7.2.

1.7.3. November 14-19, 2004: Plenary San Antonio TX

1.7.4. January 16-21, 2005, Interim, Monterey, CA

1.7.5. March 13-28, 2005, Plenary, Atlanta, GA

1.7.6. May 15-20, Sydney Australia.

1.7.6.1. At the Hilton in Sydney which has been recently renovated.

1.7.7. July 17-22, 2005, Plenary, San Francisco, CA

1.7.8. September 18-23, 2005 – Boston (tentative)

1.7.9. November 13-18, 2005, Plenary, Vancouver BC

1.7.10. January 2006 – Interim TBD

1.7.10.1. Straw Poll on locations.

1.7.10.1.1. Hawaii – (Maui or Kauai) 176

1.7.10.1.2. California 26

1.7.10.1.3. Florida 26

1.7.10.1.4. Mexico 116

1.7.11. March 12-17, 2006 – New Orleans

1.7.12. May 15-19, 2006

1.7.12.1. China

1.7.12.2. Istanbul, Turkey

1.7.12.3. Yokohama, Japan

1.7.12.4. Seoul, Korea

1.7.13. July 2006, San Diego

1.7.14. September 18-22, 2006 (unknown, - but North America)

1.7.15. November 2006 – Dallas downtown.

1.8. Attendance and Network

1.8.1. Al Petrick reviews document 04/422r4 and the instructions for accessing the meeting attendance and document server at 802wirelessworld.com.

1.8.2. Going forward there is no grace period for forgetting to log attendance during meeting sessions.

1.8.3. Instructions for uploading and downloading documents are reviewed.

1.8.4. The wireless network overview is explained.

1.8.5. Members are reminded to verify their virus and firewall protection is up to date.

1.9. Joint Treasurer report

1.9.1. John Barr gives the report for the joint 802.11/802.15 treasury.

1.9.2. Document 802.15/04/333r1.

1.9.3. Expenses at Anaheim were $209K, and income was $291K, giving a surplus of $83K.

1.9.4. $60K was targeted to help reduce costs for Berlin meeting.

1.9.5. Since we have our own treasury, we have to carry the reserve to cover cancellations or penalties.

1.9.6. Discussion

1.9.6.1. When do we expect to achieve the goal of $68K reserve? In January 2005.

1.10. Report on ExCom activities

1.10.1. Bob Heile presents document 15-04-332r0

1.10.1.1. There is an a problem with the IEEE SA Ballot Tool.

1.10.1.2. John Hawkins replaces Bill Quackenbush as 802 treasurer.

1.10.1.3. An architecture group was established to look at 802 issues. WGs are to nominate 2 people to participate.

1.11. 802 PARs

1.11.1. New PARs for approval at this meeting

1.11.1.1. 802.3ar: Frame Expansion

1.11.1.2. 802.11p: Wireless Access for the Vehicular Environment

1.11.1.3. 802.11T: Wireless Performance Prediction

1.11.1.4. 802.16e modification

1.11.1.5. 802.16f: MIB

1.11.1.6. 802.16g: Management Plane Procedures and Services

1.11.1.7. 802.18 TV Band from 802.18 SG1 (Proposed as P802.22)

1.11.2. Comments due by Tuesday at 5:00PM, responses due Wednesday by 5:00PM.

1.12. 802.11 Agenda

1.12.1. Voter Summary in 04/511r1

1.12.1.1. We have 350 voters, 146 nearly voters.

1.12.1.2. We have lost 147 voters due to failing to respond to LB69 and LB70. These individuals have been contacted by email. These members have the right to appeal. (Send to Harry Worstell and Stuart J. Kerry)

1.12.1.3. Appeals are a one-time proposition. There will be no second chances.

1.12.1.4. We went from 548 to 350 voters.

1.12.2. Review of 802.11 agenda

1.12.2.1. Stuart J. Kerry reviews the 802.11 agenda for the week. 04/592r3.

1.12.2.2. The agenda is adopted with Unanimous consent.

1.12.3. Matters arising from the minutes of 802.11 Garden Grove – none

1.12.3.1. The minutes are approved with Unanimous consent.

1.12.4. WG Policies and Procedures.

1.12.4.1. Al Petrick reviews document 04/750r0 regarding the current state of P&P.

1.12.4.2. Current document is 00/331r7. 421r1 was created in March, with changes.

1.12.4.3. Document 331r7 with changes was created as 04/510r0 and posted in March. There are no new comments on that document.

1.12.4.4. At the May meeting, we announced that this document would be voted upon at this meeting.

1.12.4.5. Motion: Move that document 04/510r0 becomes the policies and procedures for IEEE 802.11 WG and be posted on the IEEE 802.11 WG website after the close of the 802.11 July 2004 Plenary.

1.12.4.5.1. Moved Al Petrick

1.12.4.5.2. Second Colin Lanzl

1.12.4.5.3. Vote: passes 137 : 0 : 0

1.12.5. Documentation update

1.12.5.1. Harry Worstell reminds members to continue using the old format for the document number in the upper right hand corner of the documents (not the filename).

1.12.6. TGe – John Fakatselis

1.12.6.1. Received results of first Sponsor Ballot. Will address comments. Will ask for extension of the PAR Wednesday or Friday.

1.12.7. TGj – Sheung Li

1.12.7.1. TGj completed first sponsor ballot. The results from the IEEE SA 66 are read: There were 93 in the pool. 66 affirmative, 9 negative with comments, 0 negative without comments, 3 abstain, 78 votes received. Met 83% return, 88% affirmative.

1.12.7.2. TGj expects to complete comment resolutions

1.12.8. TGk – Richard Paine

1.12.8.1. Details in 04/739r1

1.12.8.2. Reviewing draft 0.14.

1.12.8.3. Hoping to finish and have LB this week.

1.12.8.4. Still issues with security of measurement frames.

1.12.9. TGm – Bob O'Hara

1.12.9.1. Will meet in Salon 3 across the street.

1.12.10. TGn – Bruce Kraemer

1.12.10.1. CFP was issued in May. Will discuss results, and prepare for presentations that begin in September.

1.12.10.2. Joint sessions with 802.18, .19, and .21.

1.12.10.3. Will have nominations for vice chair and editor.

1.12.10.4. Stuart Kerry announces that candidates for editor and vice chair should see himself or Bruce Kraemer .

1.12.10.5. 802.11n will have priority in the Berlin meeting, with 32 hours. There are currently 61 proposals.

1.12.11. TGr – Clint Chaplin

1.12.11.1. Will elect editor and secretary. Document 04/761 has the agenda. Will work on framework document in preparation for possible Call for Proposals.

1.12.12. TGs – Donald Eastlake

1.12.12.1. First meeting – will elect secretary and editor. Agenda in 04/663r2.

1.12.13. WNG – TK Tan

1.12.13.1. Four sessions this week. Will have an update from Darpa XG project.

1.12.13.2. Re-affirmation of motion from May to form AP study group, which passed with Unanimous consent.

1.12.13.2.1. Move that the WNG SC recommends that the IEEE 802.11 WG form a study group to determine how to formally describe the Access Point functions and behaviors (ref 11-

04/604r0), with the intent to create a PAR and five criteria to form a new Task Group.

1.12.13.3. Move to reaffirm the decision of the May 2004 interim 802.11 WG session that approved by unanimous consent the formation of an AP Functional Description Study Group and forward to 802 ExCom for approval.

1.12.13.3.1. Moved TK Tan

1.12.13.3.2. Second Clint Chaplin

1.12.13.3.3. Vote (802.11 members) Passes 122 : 1 : 1

1.12.14. WAVE SG – Broady Cash

1.12.14.1. Will discuss the draft submissions to the draft amendment, and respond to any comments on the PAR and 5C.

1.12.15. WEIN SG – Steven McCann

1.12.15.1. Agenda is in 04/689r1. Will refine scope and draft PAR and 5C. Will address specific issues with technical submissions. Looking for volunteers for liaisons to 3GPP. Joint meetings with TGr, and with 802.21. WEIN will be in an ad-hoc session for the joint meeting with 802.21 on Wednesday.

1.12.16. WNM – Harry Worstell

1.12.16.1. Working on PAR and 5C. Will vote to approve this week. Will consider proposals on direction. Looking for secretary for group.

1.12.17. WPP – Charles Wright

1.12.17.1. The LB to confirm forwarding PAR and 5C was approved. Will resolve comments on PAR and 5C, and hear presentations.

1.12.18. 5GHz chairs ad-hoc – Al Petrick

1.12.18.1. First meetings were in May. Generated protection statement for 802.11a in 5GHz band. Will work with 802.18 this week to complete the document.

1.12.19. WG Technical Editor – Terry Cole

1.12.19.1. Delayed until Wednesday

1.13. 802.15 Agenda

1.13.1. Voter status – 234 voters, 80 nearly voters – could have up to 314 at this meeting

1.13.2. P&P documents will be combined and updated at the next plenary.

1.13.3. TG1a – Tom Seip

1.13.3.1. Will meet one time – in the process of instituting a Sponsor ballot. Will plan for future activities of BT sig.

1.13.4. TG3a – Bob Heile

1.13.4.1. Will continue downselection process. Special orders were postponed from Anaheim. Will vote on Wednesday.

1.13.5. TG3b – John Barr

1.13.5.1. MAC amendment for 802.15.3. Have issued a call for submissions, and have listed contributions received. Will have presentations tomorrow, and make decisions Thursday

1.13.6. TG4a – Pat Kinney

1.13.6.1. Alt Phy for 802.15.4. Will have tutorials on location awareness. Wednesday will work on selection document, and start on CFP.

1.13.7. TG4b – Robert Poor

1.13.7.1. Revision of the 802.15.4 spec to clean up holes. Main activity is tutorial, review contributions, and form draft.

1.13.8. SG 3C – Reed Fisher

1.13.8.1. MMwave PHY for 802.15.3. Issued call for applications, ending August 31st. Working on PAR and 5C documents.

1.13.9. TG5 – John Booth

1.13.9.1. Mesh Networking. There has been limited response to CFP. Will discuss whether to extend or proceed.

1.14. Joint Publicity

1.14.1. Greg Rasor, Brian Matthews.

1.14.2. Will receive updates from industry groups, press releases, media coverage

1.15. 802.18

1.15.1. Carl Stephenson presents document 18-04-027.

1.15.2. FCC extended comment deadline on 3GHZ NPRM will move from 802.18 document to 802 document..

1.15.3. Prepared documents for industry Canada regarding 5470-5725.

1.15.4. Approved PAR and 5C for WG on WRAN using TV band.

1.15.5. Will process comments on NPRM, and work on 5GHz protection criteria.

1.16. 802.19

1.16.1. Steve Shellhammer presents document 19-04-0023r1

1.16.2. 802.19 TAG produced proposed changes to 802. P&P for coexistence. A LB was unanimously approved. These proposed rule changes were discussed within ExCom, and will be presented to 802.11, 15, and 16.

1.16.3. There will be a tutorial Tuesday at 6:30 on Coexistence.

1.16.4. There will be a joint meeting with 802.11n Wednesday.

1.16.5. The new rules will require that each group create a coexistence assurance document, and 802.19 will develop an Coexistence assurance method document.

1.16.6. The document will be updated and presented on Wednesday.

1.17. 802.20

1.17.1. Jerry Upton presents document 20-04-xxx

1.17.2. 802.20 can be signed for attendance at this session.

1.17.3. Document server on Neptune/mbwa

1.17.4. 802.20 and 802.21 have reciprocal attendance

1.17.5. Will work on requirements document this week on Tuesday and Wednesday.

1.17.6. Will then work on evaluation criteria, channel models, traffic models, etc. Will look at work plan schedule.

1.17.7. We have an agreement with all 802. groups (except 802.2, 3, and 16) to grant member access to documents.

1.18. 802.21

1.18.1. Ajay Jajkumar presents document 21-04-xxx

1.18.2. Review of officers. Attendance is still TBD – 802.21 has not been added to the 802wirelessworld system. Will use paper attendance recording.

1.18.3. Working on requirements and comments on the requirements. Working on handover usage scenarios.

1.18.4. There will be joint meetings with 802.11.

1.18.5. Documents are on server handover (10.0.1.21)

1.19. Announcements

1.19.1. Stuart J. Kerry personally thanks Al Petrick and Harry Worstell for running 802.11 while he was attending to his brother's funeral.

1.20. Adjourn of the Joint Meeting

2. Wednesday, July 14, 2004

2.1. Opening

2.1.1. The meeting is called to order by Stuart J. Kerry at 10:35AM

2.1.2. Following the agenda in document 04/592r4

2.1.2.1. Changes to agenda 802.18 PAR

2.1.2.2. 802.11e PAR extension

2.1.2.3. 802.19 coexistence rules proposal

2.1.2.4. AP Methodology

2.1.2.5. Chair nominations on AP Methodology SG

2.1.2.6. SEC Architecture SC

2.1.3. There are 378 people in the room

2.2. Announcements

2.2.1. Social is by bus at Crystal Ballroom. Shuttles from 6:00pm to 10:30pm.

2.2.2. There are still some CDs available of the 2004 standards if you didn't get one in November.

2.2.3. TGs announces an informal gathering to discuss submissions this afternoon at 1:30pm.

2.2.4. TGn announced that nominations for vice chair and editor were open, but the elections are postponed indefinitely – at least until November

2.2.5.

2.3. Agenda

2.3.1. The agenda is affirmed.

2.3.2. There is no WAVE meeting on Thursday. There is an informal WAVE meeting this afternoon.

2.3.3. TGn a

2.4. LOA letters

2.4.1. The chair asks for any IP letters

2.4.1.1. None

2.5. Attendance

2.5.1. Harry Worstell reports that about 150 voters lost rights due to non-response on the last letter ballots. Some have been restored based on the use of the one-time appeal. Anyone who has appealed but not received voting tokens, see Harry.

2.5.2. Some members have not sent in the voter status request. All members are required to send in a request to continue to be a voter in 802.11. The request period closed on June 30th. If you didn't, you need to send a request to get your voting status back.

2.5.2.1. The same appeal would be used for failing to request voting rights as for failing to respond to Letter Ballots.

2.5.3. The chair notes that the attendance recording method is on the honor system. We are coordinating with WG and TAG chairs and performing snap audits of certain individuals.

2.5.4. Discussion

2.5.4.1. Sometimes specific groups are not available to sign in on the server? We will fix this.

2.5.4.2. A member suggests that sign in time for sessions be extended into the break. The chair rules this is not possible – the 2 hour slot is sufficient.

2.5.4.3.

2.5.5. The chair reminds members that discussions is by addressing the chair. This is part of our P&P.

2.6. Approval of Agenda

2.6.1. The agenda is approved by Unanimous consent

2.7. Liaison Reports

2.7.1. 802.11 to 802.15.3a – Atul Garg

2.7.1.1. No Report

2.7.2. 802.11 to 802.18 Denis Kuahara

2.7.2.1. Report in document 18-04-0028

2.7.2.2. RR TAG SG1 is working on TV Spectrum Re-use, developing PAR and 5 Criteria

2.7.2.3. Next meeting will be in September

2.7.3. 802.11 to WiFi Alliance – Bill Carney

2.7.3.1. Report in document 04/808

2.7.3.2. Nearly 1500 devices certified, new logo program in effect.

2.7.3.3. WPA is mandatory as of Sept 2003. WPA2 certification starts in September 2004. There will be an 18 month time before WPA2 becomes mandatory.

2.7.3.4. CE products are expected to be introduced this year. WFA is starting QoS certification based on WME subset. Additional features from 802.11e will be added at a later date. WFA will announce a new name for consumer branding of QoS features.

2.7.4. 802.11 to JEDEC JC61 – Tim Wakely

2.7.4.1. No Report

2.7.5. 802.11 to IETF – Dorothy Stanley

2.7.5.1. Report in document 04/776

2.7.5.2. 802.11 EAP Method Requirements – input from 802.11 has been provided to IETF. Based on IETF comments, the document was updated in May. Now before the IESG. There will be a motion to revise incorporating latest changes in 04/160r6.

2.7.5.3. CAPWAP WG – IETF requested 802.11 to review CAPWAP taxonomy document. Ad hoc group has completed this work and provided comments.

2.7.6. 802.11 to MMAC – Inoue-san

2.7.6.1. Report in document 04/809

2.7.6.2. Committees (until March 2004): High Speed Wireless Access Committee (HiSWAN WG, CSMA WG). Wireless Home-Link Committee (Wireless 1394 WG, UWB WG).

2.7.6.3. MMAC-802.11 WG was formerly called T71 Ad hoc WG. Standardizing in parallel with TGj

2.7.6.4. Support of new frequency bands and new rules for the existing wireless LAN systems

2.7.6.4.1. 5.470 – 5.725 GHz band

2.7.6.4.2. Information Council of MPHPT recently recommended to allocate this band for wireless LAN/wireless access systems.

2.7.6.4.3. 5.250 – 5.350 GHz band

2.7.6.4.4. Center frequency shift for 5.150 – 5.250 GHz band

2.7.6.5. Discussion

2.7.6.5.1. What is the meaning of center frequency shift? To coordinate with USA allocation

2.8. Reports

2.8.1. Bonneville Tiger Team

2.8.1.1. Al Petrick reports in place of Brian Mathews. There is no Report – Will present update in Berlin

2.8.2. Secretaries Tiger Team

2.8.2.1. Harry will issue report by Friday of this week.

2.9. Old Business

2.9.1. 802.18 PAR and 5C response from 802.11

2.9.1.1. Al Petrick presents the 802.11 response to the 802.18 PAR, contained in document 04/798:

2.9.1.1.1. Suggested changes to scope: a. Scope suggests that Cognitive functions are exclusive to point-to-multipoint systems.

2.9.1.1.2. Comment on scope: “2. Are there other standards or projects with a similar scope? (Item 15 of the PAR): We believe a No answer is inadequate and requires an explanation. For example; why 802.16d and 802.16e, 802.11j, 802.11h are not discussed as having similar or different scope and application.”

2.9.1.1.3. 3. Distinct Identity (PAR 5 Criteria): The justification of distinct identity is insufficient. For example;

2.9.1.1.3.1. a. With respect to point-to-multipoint systems the only distinction of the proposed project is the frequency of operation.

2.9.1.1.3.2. b. With respect to Cognitive radio functions, we note that these apply equally to FCC Part 15 systems such as; 802.11, 802.15 and 802.16.

2.9.1.1.4. 4. Technical Feasibility (PAR 5 Criteria):

2.9.1.1.4.1. We believe the subsequent discussion does not support the elements above and we believe further study is needed. This is particularly true of the Cognitive radio functions.

2.9.1.1.5. 5. General Recommendation: The 802.11WG recommends that the 802 ExCOM sponsor an executive study group to further develop the scope of the Cognitive radio functions and their application to the wireless IEEE 802 systems and propose one or more PARs as applicable.

2.9.1.2. Stuart J. Kerry informs the group that a duly-constituted ad-hoc group created these comments on behalf of 802.11.

2.9.1.3. Carl Stephenson, 802.18 chair, takes the floor and provides the 802.18 response to these comments directly to the 802.11 members.

2.9.1.3.1. Carl presents Document 18-04-031

2.9.1.3.2. Developed by 802.18 and 802.18 SG1 as an official response.

2.9.1.3.3. The 802.18 group presents a rebuttal to the 802.11 comments.

2.9.1.3.4. They believe that a new 802 working group is needed to address the TV-band application and unique requirements.

2.9.1.3.5. They believe that the 802 working group should be formed without further delay for additional study.

2.9.1.3.6. Carl reads an email from Victor Talow, SR VP of MS TV organization of telecasters: Victor supports the effort to establish a new working group for standardizing unlicensed operation in the TV band.

2.9.1.3.7. Carl reads a message he from Vina Newrock from the Canadian Research Center. Canada is also very interested in this TV band activity.

2.9.1.4. Stuart notes that the ExCom makes the determination of whether a new WG is formed, or the PAR goes to an existing WG.

2.9.1.5. Discussion

2.9.1.5.1. In support of the 802.18 chairs position, and believes a separate WG is needed.

2.9.1.5.2. Stuart Kerry notes that the position of the Ad Hoc group was not yet approved by the full WG. Al Petrick will bring a motion on Friday for the entire 802.11 WG to vote on to confirm the official WG position.

2.9.1.5.3. Stuart J. Kerry announces that there will be an ad-hoc meeting to resolve this issue. It will be posted on the message boards. Al Petrick will coordinate this activity.

2.9.2. 802.11i

2.9.2.1. Stuart J. Kerry thanks Dave Halasz for his work in leading the 802.11i task group. Dave thanks the all the members of the TG that helped, including Editor Jesse Walker, and Secretary Frank Ciotti.

2.9.3. 802.11e PAR Extension

2.9.3.1. The 802.11e Task Group filled in the extension form in document 04/791. It is purely a procedural form that changes nothing substantive in the PAR, but only extends the TG duration.

2.9.3.2. Move to submit document 11-04-0791-00-000e as the PAR extension request for TGe.

2.9.3.2.1. Moved John Fakatselis on behalf of TGe
2.9.3.2.2. Discussion

2.9.3.2.2.1. What is the new date of extension? The standard extension is for four years.
2.9.3.2.2.2. The motion passed unanimously in TGe with 20-30 voters.

2.9.3.2.3. Vote: Passes 137 : 0 : 0

2.9.4. 802.19 proposed changes to 802 P&P for Coexistence

2.9.4.1. Steve Shellhammer, 802.19 chair, presents document 19-04-0010r6.
2.9.4.2. 802.19 plans to move to conduct an 802 ExCom Letter Ballot.
2.9.4.3. If passed the changes would take effect in November.
2.9.4.4. Would require an addition to the PAR process to specify that WGs create Coexistence Assurance documents (if applicable).
2.9.4.5. A new procedure to forward a draft wireless standard would require a Coexistence Assurance document that would address coexistence with all relevant 802 wireless standards.
2.9.4.6. Discussion

2.9.4.6.1. How may votes would 802.19 have in a sponsor ballot pools? It would be one vote. It is not a veto power.
2.9.4.6.2. 802.19 has a TAG vote. 802.19 members can still vote as an individual in addition.
2.9.4.6.3. Is it the intention to preclude 802.19 from becoming a bottleneck that could impede progress due to lack of time. Correct – 802.19 could abstain due to lack of time like an individual voter.
2.9.4.6.4. The wording of the procedure needs to be fixed. Agreed.
2.9.4.6.5. Would it be possible to remove the reference to unlicensed bands? No, the ExCom specifically limited this to unlicensed bands.

2.9.4.7. Stuart J. Kerry asks Al Petrick to form an Ad Hoc to develop an 802.11 position on this topic by Friday. See Al Petrick for details.
2.9.4.8. Steve Shellhammer states that 802.19 will hold a joint meeting with 802.11 TGn today after lunch.

2.9.5. EAP Methodology Requirements

2.9.5.1. Move to request Stuart J. Kerry, Chair of IEEE 802.11 to send the letter in 04/160r6 to Harald Alvestrand IETF Chair, with copies to the IAB and the IESG, Requesting publication of the “EAP Method Requirements for Wireless LANs” as an IETF Informational RFC.

2.9.5.1.1. Moved Dorothy Stanley
2.9.5.1.2. Second Sandy Turner
2.9.5.1.3. Discussion

2.9.5.1.3.1. Correction to the spelling of Alvestrand. No objection to amendment.

2.9.5.1.4. Vote: Passes 127 : 0 : 4

2.9.6. Chairs Nominations for AP Functionality SG

2.9.6.1. Dorothy Stanley was nominated by Darwin Engwer
2.9.6.2. Is there any objection to affirm Dorothy Stanley?

2.9.6.2.1. None

2.9.6.3. Dorothy is elected chair by acclamation.
2.9.6.4.

2.9.7. 802 Architecture Standing Committee

2.9.7.1. Stuart J. Kerry reviews the presentation sent to the reflector regarding the 802 Architecture Standing Committee.

2.9.7.2. This is not approved until a vote tomorrow. It would be chaired by 802.1 chair Tony Jeffree. There would be a maximum of 2 participants from each WG. The WG chair plus one other.

2.9.7.3. We may have to have two to have an alternate.

2.9.7.4. Stuart J. Kerry is looking for volunteers among people who really understand the standard.

2.9.7.5. Discussion

2.9.7.5.1. We have been discussing architecture within 802.11 for a long time. The best way to couple in our concerns to ExCom would be to create an 802.11 Architectural TAG. We could have the chair of our TAG serve as the liaison to ExCom's committee.

2.9.7.5.2. This should be an ad-hoc to let people discuss both the top-down and bottom-up perspectives. An all-encompassing architecture would be a difficult thing. Suggest another Ad Hoc to discuss how this could be addressed.

2.9.7.5.3. Stuart Kerry assigns Harry Worstell to convene an Ad Hoc group to discuss this.

2.9.7.5.4. 802.1 has produced an architecture, but it doesn't correspond in many cases. Some mechanisms are not being used. Is this a way for 802.1 to gather additional input since few members attend 802.1?

2.9.7.5.5. We don't want this group to have any improper use against or for any other WG.

2.9.7.5.6. How soon do we need to identify volunteers? We need to know by September, so they meetings can start in November.

2.9.7.5.7. Disagrees that the preservation of layering is required. New layers have been created. There may be dissention of opinions.

2.10. Announcements / Discussion

2.10.1. Procedural question on document 04/0767r0

2.10.1.1. A paragraph seems to imply that standards should consider existing implementations.

2.10.1.2. Concern that implementations are used to influence drafts.

2.10.1.3. Requests the chair clarify if drafts are provided for the purpose of implementations.

2.10.1.4. This was regarding Task Group E

2.10.1.5. The WG Chair requests that this be taken off-line.

2.10.2. Document Preparation Instructions

2.10.2.1. Straw Polls: Do members plan to submit? Know where the templates are? Do they know how to fill in fields in Word / PowerPoint / Excel

2.10.2.2. Darwin Engwer presents a list of specific instructions for how to fill in templates and fields for document submissions.

2.10.2.3. Is this worth providing on the web site or server? The group is Unanimous that this should be provided.

2.10.2.4. Darwin Engwer and Harry Worstell will create the formal document of instructions.

2.10.2.5. Suggestion that instructions should be put right in the template.

2.10.3. The 802.18 document was 18-04-0031.

2.11. Recess

2.11.1. The meeting is recessed at 12:19pm

3. Friday, July 16, 2004

3.1. Opening

3.1.1. The meeting is called to order by Stuart J. Kerry at 8:00AM.

3.1.2. This session has a hard stop at 12:00 noon, due to the following ExCom meeting.

3.1.3. The chair informs the group that we will adhere to the times for standing orders strictly.

3.1.4. Estimate of 200 people in the room.

3.2. Review of officers

3.2.1. Harry Worstell is in charge of attendance, ballots, documentation and voting.

3.2.2. Al Petrick is in charge of Policy and Treasurer

3.2.3. Tim Godfrey is Secretary

3.2.4. Terry Cole is Technical Editor

3.2.5. Brian Mathews is publicity chair.

3.3. Agenda

3.3.1. From document 04/592r4 – there are no changes for this session so far.

3.3.2. Stuart J. Kerry reviews the agenda for this session.

3.3.3. The agenda is approved with Unanimous consent.

3.4. Announcements

3.4.1. In the standing orders section, we have two motions: empowerment and teleconferences. Chairs are requested to review their motions at the break.

3.4.2. Members are reminded to sign in.

3.4.3. The chair notes that attendance is on the honor system, and some members may have signed in for others.

3.4.4. CAC members are requested to review their slots for the Berlin meeting. Updates are due in 2 weeks.

3.5. Letters of Assurance

3.5.1. The Chair has not received any LOAs./

3.5.2. The chair verifies if all members are aware of the IEEE patent policies. The membership assents.

3.6. Documentation Update

3.6.1. Remember to correctly format the upper corner of documents. The format has not changed – do not use the filename format.

3.7. Group Reports

3.7.1. TGe

3.7.1.1. Report in document 04/840

3.7.1.2. Sponsor Ballot completed with 84%. This meeting addressed all 377 comments. Will conduct recirculation SB after this meeting. Will plan for

December RevCom submission. A comment resolution meeting will be held

3.7.1.2.1. The WG chair addresses a question from the floor from Jennifer Bray: She asked the for his opinion about the use of implementations. The chair declines to answer because the question refers to his personal sponsor ballot comment, and he didn't want to influence the body. Question 1 answer: Standards move ahead, but standards are not to be used for products in the market place. It is an unadopted draft, per the ballot instructions and draft headers. Question 2 answer. Should implementations be considered? We are individual technical experts. Refer back to question 1 We are looking for high quality – 75% is no excuse for reducing quality. The chair declines to answer, noting we produce quality drafts. The member can bring this matter to the LMSC if they wish.

3.7.2. ANA Status

3.7.2.1. There are no new requests for assignment or revocation of numbers. It is important to send them by email. There is at least one motion outstanding for such a change.

3.7.3. TGj

3.7.3.1. Report in document 04/844

3.7.3.2. SB of Draft 1.5 was approved with sufficient return rate. A comment resolution was held. We want to have a very high quality document suitable for submission to RevCom and standards groups in Japan. TGj will have motions to initiate SB recirc, authorize a comment resolution ad-hoc, and conditionally submit to RevCom. Expecting to be done by September.

3.7.4. TGk

3.7.4.1. Report in 04/842

3.7.4.2. Worked on security for measurement frames, MIB review, and integration of Draft 14. Security of measurement frames will be recommended to be handled in a new SG. A motion to initiate LB will be made. Will continue weekly teleconferences. Will have LB comment resolution at next meeting.

3.7.5. TGm

3.7.5.1. Report in document 04/699

3.7.5.2. Worked on standard updates, based on submissions and open issues. Three submissions were received and discussed and adopted. They will generate new next in 802.11-rev-ma.

3.7.5.3. Clarify the broadcast SSID = rename to "wildcard'. Clarify use of status and result codes, and probe requests.

3.7.5.4. Halfway complete with work items.

3.7.5.5. Tracking document is 04/801.

3.7.6. TGn

3.7.6.1. Report in document 04/839

3.7.6.2. Comparison document was updated – all others remain the same. Timeline remains as planned. Proposals to be posted August 13th.

3.7.6.3. Estimated first LB July 2005.

3.7.6.4. September meeting will be on proposal presentations.

3.7.6.5. Bruce clarifies that partial proposals can be merged to create new proposals. There will be a revised document posted.

3.7.6.6. Stuart notes that TGn will have 34 hours of meeting. Stuart and Harry will assist in running TGn in Berlin.

3.7.6.7. The AP functionality SG does have slots in Berlin.

3.7.7. TGr

3.7.7.1. Report in 04/846

3.7.7.2. Selected editor and secretary, framework documents, scope and requirements, had presentations. Joint meetings with TGs and 802.21. Will continue to have joint TGr/TGs meeting once per session. Ad Hoc meetings were set up: Security for TGr, Current BSS Transition description, and Test Methodology.

3.7.7.3. In September, complete framework. CFP is open – proposals to be presented in November. Letter of Intent required by August 17th, Presentations on server by October 15th.

3.7.8. TGs

3.7.8.1. Report in document 04/xxx

3.7.8.2. Will have teleconferences. In September, will work on requirements and functional specs. CFP is expected in November.

3.7.9. Publicity

3.7.9.1. Report in document 04/838

3.7.9.2. Completed industry group updates, reviewed press releases, and other media coverage.

3.7.9.3. Planning for press releases for 802.11J, 802.11K and 802.11E.

3.7.9.4. Q&A

3.7.9.4.1. there is a document number conflict for 04/838 be sure to get the right one.

3.7.10. WNG

3.7.10.1. Report in document 04/755r1

3.7.10.2. WNG had updates from other standard groups and projects, XG communications, TV spectrum NPRM. There were several presentations on AP functional descriptions and behavior. The SG request on management frame security was approved.

3.7.11. WEIN SG

3.7.11.1. Report in document 04/834r0

3.7.11.2. Refined scope, PAR and roadmap. Open issues include Air Interface and Network to Network issues.

3.7.11.3. Steven requests volunteers liaisons with 3GPP.

3.7.11.4. Held joint sessions with 802.21 – will ensure that PARs are separate and non-overlapping. WEIN will address only 802.11-specific issues.

3.7.11.5. Will work to complete PAR and 5C in Berlin.

3.7.11.6. Will forward liaison letter to IETF.

3.7.12. WNM SG

3.7.12.1. Report in document 04/848r0

3.7.12.2. Still looking for permanent secretary. Completed PAR and 5C, will forward to ExCom.

3.7.13. WAVE SG

3.7.13.1. Report in document 04/837

3.7.13.2. Discussed draft submissions regarding draft amendment. Passed motion to extend SG. Will have a draft submission in September to integrate submissions up to this point. Will have motion in ExCom to approve PAR and 5C to begin Task Group.

3.7.14. WPP

3.7.14.1. Report in document 04/781

3.7.14.2. There were 53 attendees. There were no comments from other 802 groups on the PAR and 5C. There were 6 technical presentations. There was discussion of the name of the SG, but the name will go away when the groups becomes a TG. The name in the PAR is “evaluation of wireless performance”.

3.7.14.3. Will have motions for teleconferences and extending the SG.

3.7.14.4. Will forward PAR and 5C to NesCom.

3.7.15. WG Ad Hoc Committee

3.7.15.1. Report in document 04/845r0

3.7.15.2. Responded to 802.18 PAR - generated response documents regarding scope and distinct identity. We believe that the 802.18 responses satisfied our concerns. Straw Poll approved supporting 802.18 PAR.

3.7.15.3. 802.19 coexistence changes to 802 P&P – reviewed latest document requiring CA to be tagged to WG and SG Letter Ballots. There will be an ExCom Letter Ballot on this topic. We will be able to forward comments through Stuart Kerry on this issue. Straw Poll indicates that we are satisfied with the changes.

3.7.15.4. 5GHz RLAN protection – We had a teleconference to generate text and analysis. There will be another teleconference to finalize for September. Will review in Berlin.

3.7.15.5. Q&A

3.7.15.5.1. Regarding the responses to the 802.18 PAR – we missed the opportunity for the WG to discuss this issue as a whole. Requests that the chair allocate time on Monday plenary sessions to address such issues.

3.7.15.5.2. The WG chair notes that PARs are posted on the reflector 30 days before meetings. He also notes that the ad-hoc group was going on.

3.7.16. WG Technical Editor

3.7.16.1. Report in 04/005r5

3.7.16.2. 802.11i will be published on July 24th. 802.11h will have an errata due to publishing error.

3.7.16.3. Looking for a rollup of 802.11g/h/i. Also considering the rollup of 802.11e and j.

3.7.16.4. ISO/IEC ballot has closed. 802.11g/h are submitted for fast-track.

3.7.16.5. Q&A

3.7.16.5.1. Was the errata in 802.11h been fixed in the submission to ISO? We have ways to get this corrected.

3.7.17. 802.19 report

3.7.17.1. We are up to revision 7 of the 802.19 P&P changes as a result of WG input. Have coordinated with all wireless WGs. Had a tutorial on Coexistence.

3.7.17.2. Have first draft of Coexistence Methodology document. Created list of standards in unlicensed bands, will also include drafts.

3.7.17.3. Q&A

3.7.17.3.1. Stuart J. Kerry requests that 802.19 documents are copied to 802.11 reflector

3.8. Special Orders / Motions

3.8.1. TGe

3.8.1.1. Request the working group to authorize two sponsor group recirculation ballots, requesting that the sponsor group approve forwarding the 802.11e draft to RevCom for publication

3.8.1.1.1. Moved Kitchin on behalf of TGe
3.8.1.1.2. Motion ID 493

3.8.1.1.3. Discussion

3.8.1.1.3.1. There is a lot of traffic on the reflector regarding power save modes? Is it done? A lot of work was done this week, and many resolutions were made. Based on the discussion this week and the resolutions, the Task Group believes the issue is solved.
3.8.1.1.3.2. The WG chair notes that debate is limited to 1 minute per person.
3.8.1.1.3.3. Can the recirculation be extended to longer due to the number of changes? Suggests 20 to 25 days.
3.8.1.1.3.4. We have specific dates in our procedure 10 document.
3.8.1.1.3.5. Without specific durations in the motion, can we meet the schedule?
3.8.1.1.3.6. We need to have a package for RevCom by the end of October.
3.8.1.1.3.7. There are specific dates for meetings.
3.8.1.1.3.8. The TGe editor says that 25 day recirculation will work.
3.8.1.1.3.9. the WG chair states that the recirculation will be 25 days.

3.8.1.1.4. Vote: Motion passes 147 : 1 : 1

3.8.1.2. Request the task group and the working group to authorize two properly constituted meetings, which may be conducted by telephone, to resolve any comments that might arise as a result of the first and second sponsor group recirculation ballot.

3.8.1.2.1. Moved Kitchin on behalf of TGe
3.8.1.2.2. Discussion

3.8.1.2.2.1. Can we have telephone votes? There is no current mechanism.
3.8.1.2.2.2. What about dates and times? They are in the next motion. We do need to specifically authorize the meeting.
3.8.1.2.2.3. What kind of meeting? Ad Hoc / Formal / etc. This motion is as suggested. It needs to say it is a task group meeting.
3.8.1.2.2.4. The WG chair questions why telephone meetings? If it turns out there are few comments, F2F meeting might be unnecessary.
3.8.1.2.2.5. Objects – resolving comments from a SB should be done at regularly scheduled sessions.
3.8.1.2.2.6. Isn’t it the WG chairs prerogative for how comments are resolved?
3.8.1.2.2.7. We have to specify the number of ports for teleconferences. How would we know?
3.8.1.2.2.8. The WG chair rules that this is not by telephone, but a physical meeting, published in advance. Any objections?
3.8.1.2.2.9. Time limit reached: Defer…

3.8.2. TGj

3.8.2.1. Motion: Believing that sponsor ballot comment responses in 11-04/703R1 and the document mentioned below satisfy IEEE-SA rules for sponsor ballot recirculation, authorize a sponsor ballot recirculation of P802.11j draft 1.6 to conclude no later than 9/13/2004.

3.8.2.1.1. Moved Sheung Li, on behalf of TGj

3.8.2.1.2. Motion ID 494
3.8.2.1.3. Vote: Motion passes 103 : 0 : 0

3.8.2.2. Motion: Believing that their work will be progressed significantly and the work conducted per IEEE-SA rules, and believing the meeting has been announced at least 30 days in advance using the WG 802.11 reflector, move to authorize an ad hoc meeting to resolve P802.11j sponsor ballot recirculation comments

3.8.2.2.1. Moved Sheung Li on behalf of TGj
3.8.2.2.2. Motion ID 495
3.8.2.2.3. Discussion

3.8.2.2.3.1. Where has the meeting been announced? On the technical reflector – it was conditional on approval. It will be held on August 13th in San Jose.

3.8.2.2.4. Vote: Motion passes 116 : 0 : 4

3.8.2.3. Motion: believing that the sponsor ballot recirculation of P802.11j D1.6 will likely result in approval of the draft, conditional upon sponsor recirculation approval of D1.6 and review by the comment resolution group that it be placed on the next available RevCom agenda.

3.8.2.3.1. Moved Sheung Li on behalf of TGj
3.8.2.3.2. Motion ID 496
3.8.2.3.3. Vote: Motion passes 106 : 0 : 0

3.8.2.4. Motion: believing that the first sponsor ballot recirculation may not be successful and that subsequent recirculation will likely result in approval of the draft, authorize a SB recirculation of the P802.11j draft produced subsequent to the ad hoc meeting to conclude no later than 11/15/2004 and request that approval of the aforementioned draft be placed on the next available RevCom agenda.

3.8.2.4.1. Moved Sheung Li on behalf of TGj
3.8.2.4.2. Motion ID 497
3.8.2.4.3. Vote: Motion passes 98 : 0 : 1

3.8.3. TGk

3.8.3.1. Move to authorize a 40-day Working Group Letter Ballot of 802.11 TGk, draft 1.0 to conclude no later than 9/13/2004.

3.8.3.1.1. Moved Richard Paine on behalf of TGk
3.8.3.1.2. Motion ID 498
3.8.3.1.3. Vote: Motion passes 106 : 0 : 6

3.8.4. TGn

3.8.4.1. Motion: Request the .11 WG Chair that a formal liaison with 802.19 be created.

3.8.4.1.1. Moved Bruce Kraemer on behalf of TGn
3.8.4.1.2. Discussion

3.8.4.1.2.1. The WG chair will ask for volunteers after approval.
3.8.4.1.2.2. These liaisons are approved by the WG chair with Unanimous consent of the body.

3.8.4.1.3. Colin Lanzl is nominated as the 802.19 Liaison. No other volunteers.

3.8.4.1.4. The body affirms Colin Lanzl as the 802.19 liaison by acclamation.

3.8.4.2. No action was taken on the 802.21 liaison at this time.

3.8.5. WNG

3.8.5.1. Move that the WNG SC recommends that the IEEE 802.11 WG form a study group to examine how to formally describe the IEEE 802.11 Management Frame and Control Frame protection functions and behaviors, with the intent to create a PAR and five criteria to form a new Task Group.

3.8.5.1.1. Moved TK Tan on behalf of WNG

3.8.5.1.2. Discussion

3.8.5.1.2.1. Stuart J. Kerry notes that this has been considered as Maintenance, but it was not appropriate.

3.8.5.1.2.2. What will be the relation to the Security SC? They are separate.

3.8.5.1.2.3. It may not be possible to protect control frames, but still in favor of this. Will unify security for management frames.

3.8.5.1.2.4. Would this start in Berlin? The WG states that it would not start until November.

3.8.5.1.2.5.

3.8.5.1.3. Vote: Approved with Unanimous consent.

3.8.6. WAVE SG

3.8.6.1. Motion: Believing that sufficient interest continues and that the PAR and 5 Criteria can be completed per IEEE-SA guidelines during the extension period, request that 802.11 WG continue the charter of the WAV-SG through the January 2005 meeting.

3.8.6.1.1. Moved Broady Cash on behalf of WAVE

3.8.6.1.2. Discussion

3.8.6.1.2.1. There is a PAR going to ExCom today? Yes – it was approved in May, and also with a 15 day LB.

3.8.6.1.3. Vote: Motion is approved with Unanimous consent

3.8.7. WEIN SG

3.8.7.1. Move to request the IEEE 802.11 Working Group to extend the (WIEN) Study Group for another 6 months.

3.8.7.1.1. Moved by Steven McCann on behalf of WEIN

3.8.7.1.2. Discussion

3.8.7.1.2.1. Requests a vote on the motion.

3.8.7.1.3. Vote: Motion passes 96 : 0 : 7

3.8.7.2. Move to request the IEEE 802.11 Working Group to approve document 11-04-833r0 and request the IEEE 802.11 Working Group chair to forward it to the IETF.

3.8.7.2.1. Moved by Steven McCann on behalf of WEIN

3.8.7.2.2. Discussion

3.8.7.2.2.1. Steven McCann shows the letter and reads part of it to the body Document 04/833r0

3.8.7.2.2.2. Why is this a priority in creating the PAR and 5C? It is to assist WIEN in creating PAR and 5C.

3.8.7.2.3. Vote: approved by Unanimous consent

3.8.8. WNM SG

3.8.8.1. Move to approve the PAR document IEEE 802.11-04/537r5 and 5 Criteria document IEEE 802.11-04.0681r1 for the Wireless Network Management Study Group and forward to ExCom for Approval.

3.8.8.1.1. Moved Harry Worstell on behalf of WNM SG

3.8.8.1.2. Discussion

3.8.8.1.2.1. Concerns about the PAR – not clear on what the group is going to do. Schedule is aggressive. Lack of explanation in the PAR. Proposes sending PAR to Letter Ballot and collect and address comments.

3.8.8.1.2.2. The SG has considered this thoroughly. The timeline is less aggressive than TGk.

3.8.8.1.2.3. Believes this work should not start until TGk is completed. This work should be concurrent with TGk since there is commonality and a need for coherence between groups.

3.8.8.1.2.4. Is there an empowerment to allow changes to the PAR or 5C in Berlin? Yes.

3.8.8.1.2.5. It would be easier to deal with issues in our WG, rather than have other WGs make comments in November. There is no rush to approve today – suggests it would be approved in September. These group meetings have been posted in advance, and those that worked hard on the PAR and 5C did their best effort. These concerns should have been brought to the SG meetings.

3.8.8.1.2.6. Before we proceed, the WG chair asks for a straw poll: Voting members only. Should this PAR and 5C go to ExCom? Appears to be even for and against.

3.8.8.1.2.7. We could either go to WG Letter Ballot, or further work in Berlin.

3.8.8.1.2.8. Any objection to withdraw motion from the floor? None.

3.8.8.1.3. The WG chair will conduct a 40 day Letter Ballot on the PAR and 5C, and comments will be addressed in Berlin.

3.8.8.1.4. Any objection? None

3.8.8.1.5. Discussion

3.8.8.1.5.1. Since this is a SG can anybody vote? No, this is a WG letter ballot. Any comments from non-voters should be sent to Harry Worstell WNN Chair.

3.8.8.2. Move to request the IEEE 802.11 Working Group to extend the Wireless Networking Management Study Group for another 6 months.

3.8.8.2.1. Moved Harry Worstell on behalf of WNM

3.8.8.2.2. Vote: Approved by Unanimous consent

3.8.9. WPP

3.8.9.1. Request that 802.11 WG continue the charter of the Wireless Performance Prediction SG through the January 2005 meeting.

3.8.9.1.1. Moved Charles Wright on behalf of WPP

3.8.9.1.2. Vote: Approved by Unanimous consent.

3.8.10. Technical Editor

3.8.10.1. Move to submit 802.11i for ISO Fast Track approval through the UK national body. Robin Tasker has volunteered to make the submission and Terry Cole will be the project editor.

3.8.10.2. Moved Terry Cole

3.8.10.3. Vote: Approved by Unanimous consent

3.8.11. WG Motions

3.8.11.1. Move to empower the IEEE 802.11 Working Group, Task Groups, Study Groups, and Standing Committees to hold an interim session September 12-17, 2004, to conduct business as required.

3.8.11.1.1. Moved Harry Worstell

3.8.11.1.2. Second Al Petrick

3.8.11.1.3. Discussion

3.8.11.1.3.1. Why do we need to do this? This is because an interim doesn't always have a Quorum.

3.8.11.1.4. Vote: Motion approved by Unanimous consent

3.8.11.2. Move to empower the following TGs/SGs to hold teleconference calls beginning no sooner than July 26th, 2004 through 15 days pas the end of the September Interim session.

3.8.11.2.1. Moved Harry Worstell

3.8.11.2.2. Second Colin

3.8.11.2.3. Discussion

3.8.11.2.3.1. Would it be possible to use a common timezone for all teleconferences? The WG Chair states that the time zone to be used is that of the IEEE office in New Jersey.

3.8.11.2.3.2. The duration needs to be 15 days past the November session, since it is a plenary? No, we authorized ourselves to extend it at the Interim meeting.

3.8.11.2.3.3. Can we adjust the schedule so that all meetings are not on Wednesday?

3.8.11.2.3.4. Having this schedule on the web site would be helpful. The WG chair states it will be posted on the front page of the web site.

3.8.11.2.3.5. The WG chair points out that all information still has to be posted on the reflector.

3.8.11.2.4. Vote: motion passes with Unanimous consent

3.8.12. 802.18

3.8.12.1. Closing Report in document 802.18 04/0036

3.8.12.1.1. Worked on PAR for TV band, received input on 5GHz protection. Will create ITUR contribution.

3.8.12.1.2. In September will prepare additional documents, and hold joint meetings and briefings

3.8.12.2. Discussion

3.8.12.2.1. What is the status of the PAR? It was responding to WG comments, attempting to satisfy issues and answer questions. Were there any major objections? There were minor process issues from the wired groups. There were objections from 802.16 – they feel it is their area.

3.8.12.3. Motion: To approve document C80216-04_20.doc (a .16 document reviewed and approved by .18 as a contribution to ITU-R WP9B on Fixed Wireless Access) authorizing the Chair of 802.18 to do necessary editorial and formatting changes, submit to the EC for approval, submit to IEEE-SA for approval, and submit the document to the ITU-R in a timely fashion.

3.8.12.3.1. Moved Carl Stephenson on behalf of 802.18

3.8.12.3.2. Second Al Petrick

3.8.12.3.3. Discussion

3.8.12.3.3.1. What are the issues here? There is work going on in WP9B with respect to broadband access in the licensed bands. This is a revision to point to 802.16 as well as ETSI BRAN standards. To further internationalize 802.16.

3.8.12.3.4. Vote: Motion passes 55 : 0 : 28

3.8.13. TGe – continued

3.8.13.1. Motion back on the floor:

3.8.13.2. Request the task group and the working group to authorize two properly constituted meetings, which may be conducted by telephone, to resolve any comments that might arise as a result of the first and second sponsor group recirculation ballot.

3.8.13.2.1. Moved Kitchin on behalf of TGe

3.8.13.2.2. Discussion

3.8.13.2.2.1. What was the vote tally? There were zero disapproves and zero abstains. There were either 17 or 18 voters approving.

3.8.13.2.2.2. The motion on the screen does not reflect the WG chairs changes. Requests an amendment.

3.8.13.2.2.3. Any objection to amend the motion to remove the option of telephone meetings, and

3.8.13.2.2.4. Suggestion that the TGe be specifically stated.

3.8.13.3. Motion as amended: Request the Task Group E and the Working Group to authorize two properly constituted meetings to resolve any comments that might arise as a result of the sponsor group recirculation ballots.

3.8.13.3.1. Amendment approved with Unanimous consent.

3.8.13.3.2. Discussion

3.8.13.3.2.1. What about stating when and where? There is a separate motion that specifies them.

3.8.13.3.2.2. If there is a need for a Venue, it would be hosted in Portland by Sharp.

3.8.13.3.2.3. This motion is simply to obtain authorization.

3.8.13.3.2.4. Need to authorize TGe to conduct a meeting, not request.

3.8.13.4. Motion as amended: Authorize Task Group E to hold two Ad-Hoc comment resolution meetings to resolve any comments that might arise as a result of the sponsor group recirculation ballots.

3.8.13.4.1. Any objection to the amendment? None

3.8.13.4.2. Discussion

3.8.13.4.2.1. Do we need an authorization to issue drafts? Is the Ad-Hoc meeting authorized to issue a new draft? It is a Sponsor Group – we don't need to.

3.8.13.4.3. Vote on the motion: passes 73 : 1 : 3

3.8.13.5. Motion to Approve the 802.11 TGe sponsor ballot package as specified in document 04-841r0

3.8.13.5.1. Motion ID 502

3.8.13.5.2. Moved Kitchin on behalf of TGe

3.8.13.5.3. Discussion

3.8.13.5.3.1. Is this procedure 10? No this is just the package, so we can point to the specific documents.

3.8.13.5.3.2. Can we amend the document to 841r1 to correct a date internally to September 7th.

3.8.13.5.3.3. Amendment approved with Unanimous consent

3.8.13.6. Motion to Approve the 802.11 TGe sponsor ballot package as specified in document 04-841r1

3.8.13.6.1. Amendment approved with Unanimous consent.

3.8.13.6.2. Discussion

3.8.13.6.2.1. Does this meet the ExCom time requirements? Yes.

3.8.13.6.2.2. What if they ask if we voted on it before we produced the document? R1 is on the server?

3.8.13.6.3. Vote: Motion passes 77 : 0 : 2

3.8.13.7. Motion: Request the LMSC ExCom conditional approval to forward the P802.11 TGe draft, as defined in the package approved as document 04-841r1, to RevCom for publication, provided the conditions specified in LMSC procedure 10 should be met.

3.8.13.7.1. Motion ID 503

3.8.13.7.2. Moved Duncan Kitchin on behalf of TGe

3.8.13.7.3. Second Colin Lanzl

3.8.13.7.4. Vote: Motion passes 74 : 0 : 3

3.9. New Business

3.9.1. Security Study Group

3.9.1.1. The Security SG is looking for Nominations.

3.9.1.1.1. Jesse Walker nominated by Harry Worstell

3.9.1.1.2. Any others? None

3.9.1.1.3. Jesse is willing and supported by his sponsor.

3.9.1.1.4. Jesse Walker is elected SG Chair by acclamation

3.9.2. Wireless Performance Task Group

3.9.2.1. Charles Wright has been WPP SG chair.

3.9.2.2. Charles Wright is nominated by Colin Lanzl as WPP Task Group chair.

3.9.2.3. Charles Wright is willing and has sponsorship.

3.9.2.4. Charles Wright is elected TG chair by acclamation

3.9.3. 802.21 liaison

3.9.3.1. Any nominations for 802.21 Liaison? None

3.9.3.2. The WG chair requests nominations to be sent to him by email.

3.10. Next Meeting

3.10.1. Berlin, Germany, September 12-17th

3.10.1.1. The WG chair displays the tentative meetings schedule graphic. TGn has 34 hours. The final agenda will be published 30 days in advance.

3.10.1.2. The hotel and registration is open on the web site.

3.11. Adjourn

3.11.1. The meeting is adjourned at 11:25AM

Attendance List Not Yet Available

IEEE P802.11
Wireless LANs

Minutes of 802.11 Task Group E
MAC Enhancements - QoS

Portland, OR

Date: July 12-16, 2004

Author: R. R. Miller
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1. Monday 4:00 pm Afternoon Session, July 12, 2004

1.1. Opening

1.1.1. *Call to order*

1.1.1.1. John Fakatselis (JohnF) called the meeting to order.

1.1.1.2. Meeting begun at 4:07 pm.

1.2. Agenda

1.2.1. *Review of the agenda*

1.2.1.1. JohnF showed the tentative meeting agenda, 11-04-0592-00-0000

1.2.1.2. 11-04-0592-00-0000-802-11-wg-tentative-agenda-july-2004.xls, on the screen and reviewed the proposed agenda:

1.2.1.3. We would like to go over the objectives, approve the last meeting minutes, have a few papers, and then address the comment resolution process. We shall also need to approve a PAR extension. We will break for dinner at 6 pm, and resume in the evening.

1.2.1.4. Potentially the week will be used for comment resolution. If we are successful in resolving all of the comments, we shall recirculate the draft.

1.2.2. *Approval of the agenda*

1.2.2.1. JohnF: Is there any discussion on the agenda?

1.2.2.2. JohnF: Hearing none. Any comments, or objections? May we approve the agenda?

1.2.2.3. JohnF: I see no objections, so the agenda is approved.

1.2.3. *PAR Extension*

1.2.3.1. JohnF: The original PAR expires in November, so we will have to apply for an extension. Duncan will help us with framing this extension.

1.3. Reviews of voting rules and process

1.3.1. *Structural Review*

1.3.1.1. JohnF: TGE uses Roberts Rule of Order. You must be a voting member to bring a motion. If you are not a voting member you may ask a voting member to act on your behalf. Please do not vote if you are not a voting member. Any questions? Hearing, none we shall proceed. We will work on comment resolution. So, I am going to ask, “Are there any questions on the minutes?” “Are there any objections to accepting the minutes?” Hearing none, the minutes are approved.

1.3.1.2. JohnF: I would like to invite Srini to give us an update on comment status.

1.3.1.3. Srini: The sponsor ballot closed about 2 weeks after the meeting with additional comments. We should proceed the same as last time, breaking into ad-hoc groups. The comments are listed in document 546r4. There are about 20 editorial comments, the balance are technical.

1.3.1.4. JohnF: I would like to divide into sub-groups. Srini, what do you recommend for the groups?

1.3.1.5. Srini: EDCA, Power-Save and Other.

1.3.1.6. JohnF: We shall divide into three groups and will work privately on resolutions to provide a list of recommended resolutions later in the week. I shall give priority to the ad-hoc groups, but I will also allow individuals to submit separate resolutions. Any suggestions or questions? Any objection to dividing into ad-hoc groups?

1.3.1.7. Mathilde: Would like to make motions on individual resolutions.

1.3.1.8. JohnF: Wait until we get to that point. Whenever we deal with the resolution process, I will ask for individual and ad-hoc motions before we break. You will have a chance at the 7:30 pm session tonight.

1.4. Process

1.4.1. *Call for Papers*

1.4.1.1. IvanO: I have a paper, document 0744, with companion 0745 offering normative text regarding Block ACK. The material was submitted at 10 o’clock this morning.

1.4.1.2. JohnF: Does this paper address a comment? It would be best to do that.

1.4.1.3. JohnK: I have a paper with motions on TSPEC parameters, document 0767 submitted about 10 minutes ago (4:10 pm). Would like to do it at the 7:30 session. There is no normative text.

1.4.1.4. JohnF: I have three papers so far.

1.4.1.5. Floyd: I have a paper (0694) with normative text to be brought later. It has been on the server since last Friday.

1.4.1.6. Greg: I don’t have a document number, but have prepared a paper on power save and will address when it is my turn.

1.4.1.7. JohnF: I would like to get the papers out of the way as soon as possible so ad-hoc groups can have the benefit of the information.

1.4.1.8. Srini: I submit document 0768 with a list of contributors to TGe, and would like the membership to check the names and add names who feel they should be listed. Later I would like to have a motion to add this list. We don’t have such a list now, but I was instructed to add one.

1.4.1.9. JohnF: Are there any more papers? Between now and 6 pm, we shall handle this business. Mathilde will present first with a paper and motions on comment resolutions. We will continue with Ivan’s paper. Then we shall hear from Srini. But before we start, who will lead the ad-hoc groups? For Power save, Floyd volunteers. For EDCA, Matthew Fischer is sought (not in attendance). Default to Srini. Srini will also handle the “Other” group’s comments.

1.4.2. Individual Comment Resolutions

1.4.2.1. Mathilde: I shall present two motions regarding power save. Concerns focus on final frame in the service period. When a service period is initiated and the AP sends frames to the station, we must make sure the last frame has the End of Service bit set. For reference, see Benveniste comment 9. Row 198. The motion would be to add text at the end of sub-cause (g).

1.4.2.2. JohnF: This will be part of resolutions? Yes.

1.4.2.3. Mathilde: I wish to make a motion:

1.4.2.4. "Move to adopt as the resolution to comment Amann/7. In the section entitled "AP operation during CP", add the following text at the end of sub-clause (g):

1.4.2.5. 'The frame with the ESOP sub-field in the QoS Control field set to 1 shall be the last frame transmitted by the QAP to the non-AP QSTA using the APSD during the SP' Comments addressed: Amann/7

1.4.2.6. JohnF: Are there any suggestions before we make the motion?

1.4.2.7. Duncan: How many comments are addressed?

1.4.2.8. Mathilde: One.

1.4.2.9. AndrewE: Why are you bringing this as an individual vs. ad-hoc group?

1.4.2.10. Mathilde: I want to get it over with up front.

1.4.2.11. Greg: Is this duplicating something that's already been said in the draft?

1.4.2.12. Mathilde: There are many possibilities, so we must make explicit so that in all conditions the EOS bit is set properly.

1.4.2.13. Greg: Will we stipulate exactly how the AP will do it, or allow the AP to decide how to handle it?

1.4.2.14. Mathilde: The second.

1.4.2.15. JohnF: Any friendly suggestions?

1.4.2.16. Floyd: Make third to last rather than last sentence in the comment.

1.4.2.17. JohnF: Do I have a second?

1.4.2.18. Second: Jennifer Bray

1.4.2.19. JohnF: Is there discussion on the motion?

1.4.2.20. MarkB: Clause (g) is already pretty large, so is this covered already. I don't think we need more words.

1.4.2.21. Mathilde: Must make sure it is the last frame transmitted in service period.

1.4.2.22. Duncan: Given what we've heard, the way we've dealt with this in the past is to let the editor handle it. Isn't this an editorial change?

1.4.2.23. Srini: I'm not sure how to resolve the comment.

1.4.2.24. Mathilde: With differing priorities in different streams, the low priority frame could be the last stream being released. If the high priority buffer has many frames and the low has few, the low priority frame could arrive first. If that happens, the EOS bit will put the station to sleep, but there may still be high priority traffic. We must ensure the last frame transmitted to the station has the EOS bit set.

1.4.2.25. JohnF: Any more discussion?

1.4.2.26. Duncan: Do we have an agreement from the commenter that this would change a "no" to a "yes"?

1.4.2.27. Mathilde: Yes.

1.4.2.28. AndrewE: What about the concern on retries? [Discussion]

1.4.2.29. JohnF: Any more discussion? We can vote against the resolution. Put back the motion.

1.4.2.30. Mathilde: I move to table the motion.

1.4.2.31. JohnF: Is there a second? Jennifer Bray. Is there any objection to table? Hearing none, the motion is tabled.

1.4.2.32. Mathilde: Benveniste/10 is the next comment I wish to address. The problem is that if the ACK to downlink frame with EOS set is missing it's possible that the frame might not be received by the station. This would trigger a repeat. If the frame is received, but the ACK is lost, the station will have gone to sleep. In such a case, the service period should be considered ended, but currently it would be “awake” now. Mark, want to add any more?

1.4.2.33. MarkB: Essentially this change is trying to maintain alignment with (h). I think it does help the alignment.

1.4.2.34. GregC: This seems similar to rules for bursting frames. Rules say if you don’t have an ACK, the burst is ended, regardless of whether in a service period or not. The rules for bursting anytime seem to cover this, so not really a ”loose end”.

1.4.2.35. AndrewE: It is probably necessary to correct this, though.

1.4.2.36. JohnF: I would like to ask you to make a motion.

1.4.2.37. Mathilde: “Move accept the proposed resolution to comment Benveniste/10”

1.4.2.38. JohnF: Motion seconded? Jennifer seconds

1.4.2.39. JohnF: Any discussion? No. Any objection to accepting this motion? Seeing none, the motion passes.

1.4.3. *Paper Presentation Preparation*

1.4.3.1. Ivan are you ready with your paper?

1.4.3.2. IvanO: My paper doesn’t address a comment, but I would like to insert anyway.

1.4.3.3. JohnF: If it doesn’t address a comment, I don’t know how to allow---it would be out of order.

1.4.3.4. Mathilde: Does anyone else remember a comment like that?

1.4.3.5. Greg: There have been many comments like that, but not recently.

1.4.3.6. JohnF: The paper will be out of order, since we can’t couple to a comment.

1.4.3.7. IvanO: Can someone put in a comment with it so we can address next go-round?

1.4.3.8. JohnF: No, that would conflict with the process.

1.4.3.9. IvanO: I have no choice but to withdraw it. I will try to find someone with a related comment, and bring it up later.

1.4.3.10. JohnF: Any other papers?

1.4.3.11. Floyd: I have a paper to present now.

1.4.3.12. Secretarial note: JohnF Exits 5:05, Mathilde temporarily takes chair, John returns at 5:10 pm.

1.4.4. *Presentations*

1.4.4.1. Floyd: This paper addresses enhancements to APSD, building upon discussion in Anaheim expressed in a joint proposal document 694. There was a motion at the last meeting, but time ran out.

1.4.4.2. Secretarial note: JohnF Exits 5:05, Mathilde temporarily takes chair, John returns at 5:10 pm. Floyd presents paper.

1.4.4.3. Floyd: I request a Straw Poll: “Do we agree that we want the Max SP Length Static?” Yes or no. Yes 11, No 0.

1.4.4.4. Floyd: I request another Straw Poll: “Do we agree that the downlink AC should be disabled/enabled?” Yes 6, No 0

1.4.4.5. Floyd: I request another Straw Poll: “Do we agree that uplink AC should be disabled/enabled?” Yes 8, No 0

1.4.4.6. Floyd: I request another Straw Poll: “Do we agree with TSPEC signaling to override AC configuration?” Yes 10, No 1

1.4.4.7. Floyd: I request another Straw Poll: “This proposal recaptures the More Data ACK bit. Should we do so?” Yes 6, No 2

1.4.4.8. Floyd: I request another Straw Poll (responding to request from Mathilde): “Do we agree that the QAP should be able to turn down particular configuration of the ACs selected at (re)association time?": Yes 11, No 1 This concludes the straw polls I need.

1.5. Closing

1.5.1. Recess

1.5.1.1. Any objection to recess? Hearing none, we are in recess until 7:30pm

1.5.1.2. Recess at 6:00 pm.

2. Monday 7:30 pm Evening Session July 12, 2004

2.1. Opening

2.1.1. Call to order

2.1.1.1. JohnF: The meeting is called to order.

2.1.1.2. Meeting in session at 7:36 pm.

2.2. Process

2.2.1. Presentations (continued)

2.2.1.1. JohnK: John presents document 0767, with treatment of resolutions related to TSPEC parameters.

2.2.1.2. JohnK: I wish to make several motions:

2.2.1.3. "Move to decline del Prado1, Soomro2 and Kerry2 for reasons stated in bullet point 3, slide 7 and all bullet points on slide 6 of 0767r0."

2.2.1.4. Srini Seconds

2.2.1.5. JenniferB: I move to table the motion, based on the fact that none of the commenters is present.

2.2.1.6. JohnF: We shall vote on tabling the motion. The vote fails 3 yes,10 no, 0 abstain.

2.2.1.7. JohnF: We now vote on the motion itself. The vote passes. 10 yes, 2 no, 1 abstain..

2.2.1.8. JohnK: "Move to decline del Prado2, Soomro1, Soomro3 and Kerry1 for reasons stated on slide 3, bullet point 2 of 0767r0"

2.2.1.9. Second Srini

2.2.1.10. JohnF: We shall vote on the motion. The motion passes 10 yes, 2 no, 1 abstain.

2.2.1.11. JohnK: "Move to accept the suggested resolution in Kandala 50"

2.2.1.12. Second Srini

2.2.1.13. JohnF: We shall vote on the motion. The vote passes 9 yes, 0 no, 4 abstain. Are there any other comment actions.

2.2.1.14. Srini: I have written resolutions for about 25 comments in advance corresponding to "low hanging fruit", which I hope to present tomorrow.

2.2.1.15. JohnF: Anything else?

2.2.1.16. MarkB: I would like to conduct some straw polls on APSD.

2.2.1.17. JohnF: OK, Proceed.

2.2.1.18. MarkB: "Should multiple ACs per service period be allowed?" I would like to poll "yes" and "no", including voters and non-voters. My intention is to encourage discussion on the issue.

2.2.1.19. JohnF: (responding to discussion by Mathilde on Wi-Fi dialogs regarding APSD) I want to divide this away from Wi-Fi issues. Straw Polls are not debates, they should be kept simple. If you don't understand all the details, then say "I abstain/don't know".

2.2.1.20. Greg: We should have four categories instead. "Yes", "No", "Abstain" and "Don't Know"

2.2.1.21. JohnF: OK, let's take the vote. 14 yes, 1 no, 2 abstain, 3 don't know.

2.2.1.22. MarkB: "Should multiple ACs per service period be mandatory (for stations implementing APSD assuming the traffic is present?" 0 yes, 11 no, 0 abstain, 4 don't know.

2.2.1.23. MarkB: "Should overlapping service periods be allowed?" 2 yes,10 no, 4 don't care/abstain, 3 don't know.

2.2.1.24. JohnF: Any other members with comments or presentations?

2.2.1.25. IvanO: Srini found comment 0328 on line 564, Mike Moreton/16, relevant to my paper. I would like to present it now, with a motion and vote tomorrow. Presents document 0744 (author will add title page to file on server) on Block ACK.

2.2.1.26. JohnF: A reminder regarding ad-hoc Power-Save, EDCA and Other. Floyd has indicated that he will remain in the room, so that anyone wanting to discuss power-save resolutions could do so.

2.3. Closing

2.3.1. Recess

2.3.1.1. Unless there is an objection, I will recess until 10:30 am Tuesday. Seeing none, we are recessed until then.

2.3.1.2. Recessed at 8:37 pm.

3. Tuesday 10:30 am Morning Session July 13, 2004

3.1. Opening

3.1.1. Call to Order

3.1.1.1. JohnF: The meeting is called to order

3.1.1.2. Reconvene at10:35 am.

3.2. Comment Resolution Process Update

3.2.1.1. JohnF: Duncan, do you want to help with the PAR extension?

3.2.1.2. Duncan: Not ready yet. Will work for readiness at 1:30 pm session.

3.2.1.3. JohnF: I am going to give Srini an opportunity to discuss the comments and resolutions recorded so far. Then I shall recess for members to review the document. Then we shall do a block vote on the resolutions after re-convening.

3.2.1.4. Srini: Document 0627r2 contains the current resolution spreadsheet with comment resolutions I have added.

3.2.1.5. Floyd: While we wait for Srini to set up, I would like to say that the ad-hoc group has been working on power save, with discussion of several proposals for resolution of power save issues. We plan to move on 0695r1 later, as it contains normative text for power save joint ad-hoc recommendations.

3.2.1.6. Srini: This document (627r2) has been on server since last Friday, with comments with resolutions written. Green rows mark ad-hoc group recommendations completed last time, but not acted upon. I shall ask that we examine the document and then do a block acceptance. These are fixes for minor bugs or issues visited several times over the past years with member-determined agreement on way to go.

3.3. Closing

3.3.1. Recess

3.3.1.1. JohnF: Any questions for Srini? No. Any objections to recess until 11:00 am? Hearing none, we are recessed until 11:00 am.

3.3.1.2. Recessed at 10:49am.

3.4. Opening

3.4.1. Call to Order

3.4.1.1. JohnF: The meeting will come to order.

3.4.1.2. Meeting in session at 11:00 am

3.5. Process

3.5.1. Comment Resolution Motions

3.5.1.1. Srini: There was some confusion. The document contains several resolutions, and I shall be asking that we act on all of them, not just the green ones. I wish to move that we accept the resolutions as written. Are there any questions or comments that would prompt us to remove any of the proposed resolutions?

3.5.1.2. AndrewE: Comment #23?

3.5.1.3. Srini: Comment 23 had a long resolution, and it will be removed from the block motion.

3.5.1.4. AndrewE: Comment #86?

3.5.1.5. Srini: This is a comment wondering if 802.11e can be used for medical applications, especially life-critical ones.

3.5.1.6. Duncan: There is a liability here in using unlicensed for life-critical functions.

3.5.1.7. Srini: We shall remove this one.

3.5.1.8. AndrewE: Comment #289?

3.5.1.9. Srini: Would you like it removed?

3.5.1.10. Estrada: No, just questioning…No need to remove.

3.5.1.11. Srini: This is only an editorial comment. If no more issues, I wish to move:

3.5.1.12. “Move to accept the resolutions as written in 04/627r2 for the comments for which resolutions have been written in 04/627r2 with the exception of comments, Amann/5 (Comment #23), Cooper/1 (Comment #86), and Siep/10 (comment 284).”

3.5.1.13. Greg seconds.

3.5.1.14. JohnF: Is there any objection to passing this motion? Seeing none, the motion passes unanimously.

3.6. Closing

3.6.1. Recess

3.6.1.1. JohnF: Is there any objection to recessing to allow the ad-hoc groups to process resolutions? Seeing none we are recessed until 1:30 pm.

3.6.1.2. Recessed at 11:10 am.

4. Tuesday 1:30 pm Afternoon Session July 13, 2004

4.1. Opening

4.1.1. *Call to Order*

4.1.1.1. JohnF: Called meeting to order

4.1.1.2. Meeting reconvened at 1:39 pm.

4.2. Resolution Progress Discussion

4.2.1.1. JohnF: Are there any resolutions or papers?

4.2.1.2. Floyd: I will be bringing a motion to the floor on behalf of the ad-hoc power-save group.

4.2.1.3. JohnF: I would like to go through the PAR extension request. I would like to determine that the group is OK with submitting Duncan's work on extending the PAR.

4.2.1.4. Duncan: Basically a formality, but necessary. The only substantive bit is why an extension is required, and why the extra time will help. 90% of draft is stable, agreed to by Srini. Corrected mistake on "first draft date" on form to March 01 from March 04. No document number yet.

4.2.1.5. JohnF: Must get document number for motion: [Supplies number] 04-0791.

4.2.1.6. "Move for TGe to submit a PAR extension request as presented in Document 11-04-0791-00-000e" Seconded by Duncan

4.2.1.7. JohnF: Let's vote. Vote Yes 27, No 0, Abstain 0 Is there any other resolution business ready?

4.2.1.8. Floyd: "Move to instruct the TGe editor to incorporate the normative text in document 11-04-0695r0 into the 802.11e draft, with the following changes to the definition of the Max SP Length in document 11-04-0695r0

4.2.1.9. - The Max SP Length is shortened to two bits (bit 1 and bit 2 in the QoS Info field) and the More Data Ack bit (bit 3 in the QoS Info field) is retained

4.2.1.10. - The final two paragraphs of document 11-04-0695r0 are modified as follows (shown on the next page…)

4.2.1.11. 'Move to instruct the editor to incorporate the following text into the 802.11e draft (changes relative to document 11-04-0695r0 are shown in blue)

4.2.1.12. Max SP Length subfield is 2 bits in length and indicates the maximum number of downlink frames the QAP may deliver to a non-AP QSTA during any service period triggered by the non-AP QSTA. Values in the Max SP Length subfield shal be set as follows by a non-AP QSTA.

4.2.1.13. Max SP Length = 00 QAP may release all buffered frames

4.2.1.14. Max SP Length = 01 Maximum of 2 frames per SP

4.2.1.15. Max SP Length = 10 Maximum of 4 frames per SP

4.2.1.16. Max SP Length = 11 Maximum of 6 frames per SP'

4.2.1.17. Non-AP QSTA shall set bit 1, bit 2 and bit 4 thru bit 7 to zero if it does not wish to enable U-APSD triggering and delivery mechanisms during (re) association or if the QAP has indicated not supporting APSD through the APSD subfield in the Capability Information Field"

4.2.1.18.

4.2.1.19. Greg: Is there any way we can adopt a "merger" of Floyd's and Mathilde's proposals?

4.2.1.20. JohnF: [to Floyd] Do you wish to continue?

4.2.1.21. Floyd: Yes Motion seconded by JohnK.

4.2.1.22. JohnF: Any discussion?

4.2.1.23. Jennifer: Would it be possible to modify this later in the week?

4.2.1.24. JohnF: Can move to reconsider later in the week.

4.2.1.25. Duncan: Move to table. ThomasK seconds

4.2.1.26. JohnF: Let us vote on the motion. Vote Fails 5-15-7 Back to the main motion. More discussion?

4.2.1.27. AndrewE: Speak in favor. Proposal in circulation for several weeks downloaded last Thursday, with much discussion following. Enough time to formulate concerns regarding the issues involved. To delay would invoke downside because will pick up more comments on recirculation. Progress will be slowed by trying to add more.

4.2.1.28. JohnF: Speak against the motion?

4.2.1.29. Greg: I advocate a joint proposal, without ambiguity regarding More Bits.

4.2.1.30. JohnF: Before I ask for a second are there any comments? [Much discussion on details of implementation and candidate changes]

4.2.1.31. JohnK: Suggest 10 minute recess to allow for further wording

4.3. Closing

4.3.1. Recess

4.3.1.1. JohnF: Do we have anything else before we break? Is there any objection to 15 minute recess? Hearing none, we are recessed until 2:45 pm.

4.3.1.2. Recessed at 2:27 pm.

4.4. Opening

4.4.1. Call to order

4.4.1.1. JohnF: The meeting is called or order.

4.4.1.2. Meeting called to order at 2:45 pm

4.5. Process

4.5.1. Comment Resolution

4.5.1.1. JohnF: There is a motion on the floor.

4.5.1.2. Duncan: Can we move to postpone? I would like to move to postpone until 1:30 pm tomorrow.

4.5.1.3. JohnF: There is a motion to postpone. I believe this motion is debatable. Is there a second? Greg seconds. Any debate on motion?

4.5.1.4. MarkB: Can we confirm there is still enough time for the editor to meet time constraints?

4.5.1.5. Srini: I think it can be ready.

4.5.1.6. Duncan: I move "To postpone the main motion brought by Floyd Simpson until the TGe Wednesday afternoon session beginning at 1:30 pm"

4.5.1.7. JohnF: Is there any objection to postpone. Hearing no objection, the motion is postponed as stated. Srini, you have the floor.

4.5.1.8. Srini: I would like to get a feel for the disposition of the group for the comment on line 151. I wish to move:

4.5.1.9. Move to resolve comment 151 with the resolution: " Comment declined. The group believes that there are benefits to using the mechanism in certain cases"

4.5.1.10. Second MarkB

4.5.1.11. JohnF: Any discussion on the motion? None Any objection to accepting the motion. None, so motion passes unanimously.

4.5.1.12. Srini: The next comment is 153, More Data Ack Bit. There a few who think it should be kept. I wish to move:

4.5.1.13. Move to resolve comment 153 with the resolution: " Comment declined. The group believes that there are benefits to using the mechanism in certain cases"

4.5.1.14. Second MarkB

4.5.1.15. JohnF: Is there any objection to accepting the motion. None, so motion passes unanimously.

4.5.1.16. Srini: Next is comment 282.

4.5.1.17. Duncan: I suggest that this comment be declined, as it has no technical impact.

4.5.1.18. JohnF: Do you wish to so move?

4.5.1.19. Duncan: I move to decline the comment

4.5.1.20. Move to resolve comment 282 with the resolution: "Comment declined. The comment has no technical impact."

4.5.1.21. Second Ivan

4.5.1.22. Duncan: I move to call the question. JohnK seconds.

4.5.1.23. JohnF: Are there any objections? No. The question is called. We shall vote. The vote is technical, requiring 75%. The motion passes 9 yes, 3 no, 4 abstain..

4.5.1.24. Srini: Next comment is 186. This should not have been accepted because we did not have a consensus.

4.5.1.25. JohnF: To allow reconsideration you must state why you feel it is necessary.

4.5.1.26. Srini: It is better handled in the fast-roaming TG.

4.5.1.27. JohnF: You are the commenter. You have no reason to say it is incorrect. Therefore, I see no basis for reconsideration.

4.5.1.28. Duncan: I feel that the load element is necessary, but motion must be brought for reconsideration by someone who voted for it..

4.5.1.29. Mathilde: I voted for it and I move that we should reconsider.

4.5.1.30. MarkB seconds for reconsideration.

4.5.1.31. JohnF: Is there any objection to reconsider? None, so motion to reconsider passes.

4.5.1.32. Duncan: Move to amend the motion to resolve comment 183 with the resolution: "Comment declined. the functionality provided by the QBSS Load element is different from that being considered by the Fast Roaming TG."

4.5.1.33. Seconded by Ivan

4.5.1.34. Any objection to accepting this motion? None, so motion passes.

4.5.1.35. JohnF: Anything else from anyone in the room? In order to go for RevCom in November, we must finish the draft this week.

4.5.1.36. Srini: We have 138 comments remaining. 546r5 will be the new comments document and I will upload shortly.

4.6. Closing

4.6.1. Recess

4.6.1.1. JohnF: If there is no objection, we will recess until 8:00 am tomorrow. Seeing none, we are recessed.

4.6.1.2. Recess at 3:22 pm.

5. Wednesday 8:00 am Morning Session July 14, 2004

5.1. Opening

5.1.1. Call to Order

5.1.1.1. JohnF: The meeting is called to order

5.1.1.2. Meeting called to order at 8:09 am

5.2. Process

5.2.1. Comment Resolution Continuation

5.2.1.1. JohnF: We would like to pick up with Floyd, whose motion was postponed until Wednesday afternoon.

5.2.1.2. Greg: The compromise has been up on the server since last night. We need the motion to have an r1 instead of r0, and must list the comments addressed.

5.2.1.3. Srini: You can do the latter by making a separate motion.

5.2.1.4. JohnF: Where do we stand on power-save resolutions?

5.2.1.5. Floyd: We have resolved 19 power-save comments. About 38 will be resolved by the compromise proposal. There's an additional 5 or so which could be addressed by Annex H being worked by Mathilde. I will produce a document addressing the remaining 19.

5.2.1.6. JohnF: Please add a note describing the color-coding you are using.

5.2.1.7. IvanO: I have a motion regarding Block ACK. On Monday I presented a document outlining a proposal for improving Block ACK capabilities. I wish to move:

5.2.1.8. "Request that the Editor incorporate changes in document 11-04-0745-00-000e relating to Block Ack Identifier (BID) into the TGe draft."

5.2.1.9. JohnF: Who is the commenter to which this is attached? 0328, Mike Moreton

5.2.1.10. Second by Srini

5.2.1.11. JohnF: Call the question. Vote: 1 yes, 4 no, 14 abstain

5.2.1.12. JohnK: I wish to address a resolution on the TSPEC. I wish to move:

5.2.1.13. "Move to accept the following resolution to Myles/20. 'Comment declined. Although the TSPEC has many parameters, there is an Annex that describes their use for typical applications, aiding developers. Moreover, accepting this change would not fix anything that is broken with the protocol, nor add any required functionality.' "

5.2.1.14. Greg seconds

5.2.1.15. Hearing no discussion. Is there any objection to accepting the motion. No objections. The motion passes unanimously.

5.2.1.16. JohnK: Comment 316, Tan/7 I wish to move:

5.2.1.17. "Move to decline the comment Tan/7 for the same reason as in comment 151"

5.2.1.18. Mat Sherman seconds.

5.2.1.19. Any more discussion?

5.2.1.20. JohnF: I call the question. Is there any objection to accepting this motion? None. Motion passes unanimously.

5.2.1.21. JohnK: Comment 175.

5.2.1.22. "Move to decline the comment Kandala/55 for the reason that "the group believes there is benefit to this feature."

5.2.1.23. Moved by JohnK, seconded Bob Miller

5.2.1.24. JohnF: Any discussion? Hearing none, is there any objection to accepting this motion? None. The motion passes unanimously.

5.2.1.25. JohnK: I wish to propose Kandala/57 consideration. I wish to move:

5.2.1.26. "Move to accept the proposed resolution to Kandala/57"

5.2.1.27. Greg seconds

5.2.1.28. JohnF: Is there any discussion on the motion? None. Is there any objection to accepting the motion? None. Hearing none, the motion passes.

5.2.1.29. JohnK: I'm done.

5.2.1.30. JohnF: We appear to have a shot at recirculation, so we should try to complete resolutions to all comments. Are there any other resolutions ready?

5.2.1.31. Floyd: I wish to announce that 0804 is on the server with proposed resolutions shown in green. I want to bring forward the vote on the motion to this morning.

5.2.1.32. JohnF: I do not want a protest by someone who anticipated the previously announced schedule to miss the activity. I would like to recess until 1:30 pm.

5.3. Closing

5.3.1. Recess

5.3.1.1. JohnF: We are recessed.

5.3.1.2. Recessed at 9:10 am.

6. Wednesday 1:30 pm Afternoon Session July 14, 2004

6.1. Opening

6.1.1. Call to Order

6.1.1.1. JohnF: I call the meeting to order.

6.1.1.2. Meeting in session at 1:40 pm

6.2. Process

6.2.1. Continuation of Comment Resolution

6.2.1.1. JohnF: We are continuing to resolve the EDCA comments to complete the comment resolution process. Floyd, please begin with the power-save resolutions.

6.2.1.2. BobM: Minutes up to the end of the morning meeting of July 14 are now available on server as document 0813.

6.2.1.3. Floyd: 0804r1, on sheet 1 there are 19 green comments of a total of 62. The ones colored yellow we believe will be resolved with the "compromise" proposal to be discussed later. The 5 remaining white ones will have to be addressed to close out the power-save resolutions. I wish to move:

6.2.1.4. "Move to accept the resolutions in document 0804r1 that are colored in green"

6.2.1.5. JohnF: We need to determine if there are any exceptions for the block motion.

6.3. Closing

6.3.1. Recess

6.3.1.1. Is there any objection to a 15 minute recess to allow members to review the resolutions. Hearing none we are recessed until 2:05 pm.

6.3.1.2. Recessed at 1:49 pm.

6.4. Opening

6.4.1. *Call to Order*

6.4.1.1. JohnF: I call the meeting to order.

6.4.1.2. Meeting in session at 2:05 pm

6.5. Process

6.5.1. *Continuation of Comment Resolution*

6.5.1.1. JohnF: We revisit the motion brought by Floyd. Are there any resolutions members would like to pull out for separate discussion?

6.5.1.2. “Move to accept the resolutions in document 0804r1 that are colored in green except Benveniste/10,14,15”

6.5.1.3. Greg seconds.

6.5.1.4. Any discussion. None. Is there any objection to accepting this motion. Seeing none, the motion is passed. We had a motion to postpone on a motion, which will be brought up now.

6.5.1.5. JohnF: There has been a good deal of discussion regarding this motion, and I would like to entertain friendly changes to create a final motion. Floyd, please create the modified motion and show the original and modified text. [Blue is added/modified, red is old text]

6.5.1.6. Move to instruct the TGe editor to incorporate the normative text in document 11-04-0695r2 11-04-0695r0 into the 802.11e draft, with the following changes and which addresses the comments listed on slide 3.

6.5.1.7. – Delete section 7.3.1.9 of doc 11-0400695r2

6.5.1.8. – Remove following 2 sentences from section 11.2.1.4:

6.5.1.9. “The QAP may reject (re)association requests if it is incapable of supporting the U-APSD usage selection a non-AP QSTA has made in (re)association requests. QAP shall inform non-AP QSTA its rejection by including Status Code 44 in (re)association responses.”

6.5.1.10. to the definition of the Max SP Length in document 11-04-0695r0

6.5.1.11. – The Max SP Length is shortened to two bits (bits 1 and 2 in the QoS Info field) and the More Data Ack bit (bit 3 in the QoS Info field is retained

6.5.1.12. – The final two paragraphs of document 11-0400695r0 are modified as follows (shown on next page…)

6.5.1.13. ‘Move to instruct the editor to incorporate the following text into the 802.11e draft (changes relative to document 11-04-0695r0 are shown in blue)

6.5.1.14. Max SP Length subfield is 2 bits in length and indicates the maximum number of downlink frames the QAP may deliver to a non-AP QSTA during any service period triggered by the non-AP QSTA. Values in the Max SP Length subfield shal be set as follows by a non-AP QSTA.

6.5.1.15. Max SP Length = 00 QAP may release all buffered frames

6.5.1.16. Max SP Length = 01 Maximum of 2 frames per SP

6.5.1.17. Max SP Length = 10 Maximum of 4 frames per SP

6.5.1.18. Max SP Length = 11 Maximum of 6 frames per SP’

6.5.1.19. Non-AP QSTA shall set bit 1, bit 2 and bit 4 thru bit 7 to zero if it does not wish to enable U-APSD triggering and delivery mechanisms during (re) association or if the QAP has indicated not supporting APSD through the APSD subfield in the Capability Information field”

6.5.1.20. Comments addressed by the motion:

6.5.1.21. Amann/7, Amann/11, Barr/7, Barr/8. Barr/9, Barr/13, Barr/14, Barr/16, Barr/21, Barr/25, Barr/26, Barr/27, Barr/28, Bjose/28, Ecklund/1, Ecklund/2, Ecklund/3, Ecklund/4, Ecklund/5, Ecklund/6, Ecklund/7, Ecklund/8, Hansen/10, Hansen/12, Kandala/9, Kandala/22, Benveniste/6, Benveniste/7, Benveniste/8, Benveniste/12, Benveniste/13, Myles/1, Myles/2, Myles/3.

6.5.1.22. Amann/7, Amann/11, Barr/7, Barr/8. Barr/9, Barr/13, Barr/14, Barr/16, Barr/21, Barr/25, Barr/26, Barr/27, Barr/28, Bjose/28, Ecklund/1, Ecklund/2, Ecklund/3, Ecklund/4, Ecklund/5, Ecklund/6, Ecklund/7, Ecklund/8, Hansen/12, Kandala/9, Kandala/22, Benveniste/6, Benveniste/7, Benveniste/8, Benveniste/12, Benveniste/13, Myles/1, Myles/2, Myles/3.

6.5.1.23. Motion to amend the motion as shown by Floyd. AndrewE seconds

6.5.1.24. Is there any objection to amending the motion as shown. None. Therefore the motion to amend passes. The motion is now:

6.5.1.25. Move to instruct the TGe editor to incorporate the normative text in document 11-04-0695r2 into the 802.11e draft, with the following changes and which addresses the comments listed on slide 3.

6.5.1.26. – Delete section 7.3.1.9 of doc 11-0400695r2

6.5.1.27. – Remove following 2 sentences from section 11.2.1.4:

6.5.1.28. "The QAP may reject (re)association requests if it is incapable of supporting the U-APSD usage selection a non-AP QSTA has made in (re)association requests. QAP shall inform non-AP QSTA its rejection by including Status Code 44 in (re)association responses."

6.5.1.29. Comments addressed by the motion:

6.5.1.30. Amann/7, Amann/11, Barr/7, Barr/8. Barr/9, Barr/13, Barr/14, Barr/16, Barr/21, Barr/25, Barr/26, Barr/27, Barr/28, Bjose/28, Ecklund/1, Ecklund/2, Ecklund/3, Ecklund/4, Ecklund/5, Ecklund/6, Ecklund/7, Ecklund/8, Hansen/12, Kandala/9, Kandala/22, Benveniste/6, Benveniste/7, Benveniste/8, Benveniste/12, Benveniste/13, Myles/1, Myles/2, Myles/3.

6.5.1.31. [Discussion]

6.5.1.32. Moved by Floyd/Second AndrewE

6.5.1.33. JohnF: Is there any objection to accepting this motion? Seeing none, the motion passes unanimously. Is there any objection to recessing until 4:00 to allow ad-hoc committees to resolve the remaining resolutions?

6.6. Closing

6.6.1. *Recess*

6.6.1.1. Seeing no objections, we are recessed.

6.6.1.2. Meeting adjourned at 2:59 pm.

6.7. Opening

6.7.1. *Call to Order*

6.7.1.1. JohnF: I call the meeting to order.

6.7.1.2. Meeting in session at 4:05 pm

6.8. Process

6.8.1. *Continuation of Comment Resolution*

6.8.1.1. JohnF: Informally, people who understand Annex H should try to get together so that resolutions can be completed. We are running low on time, and will have to post a document in time to act upon it. Our meeting tomorrow is late (4:00 pm) so we will not have a whole lot of time to act.

6.8.1.2. Mathilde: We will have to post a document by 12:00 noon. I need changes by 10:00 am in order to incorporate the inputs. Mathilde will submit a paper this evening for comment.

6.8.1.3. JohnF: [to Floyd] Please coordinate with members working on Annex H.

6.8.1.4. Srini: We have resolved a total of 1 comment for EDCA. We still have about 18 to go. I have a motion to bring on the "Other" comment resolutions. Reference for this block move is in document 0627r4. There are 28 resolutions included. I wish to move:

6.8.1.5. Move to accept the resolutions as written in 04/627r4 for the comments for which resolutions have been written in 04/627r4 with the exception of comments…

6.8.1.6. JohnF: Before I request a second, I would like to have any exceptions for resolutions members wish removed from the motion. None. Hearing none, the motion is without exceptions. The motion reads:

6.8.1.7. Move to accept the resolutions as written in 04/627r4 for the comments for which resolutions have been written in 04/627r4.

6.8.1.8. Ivan seconds.

6.8.1.9. JohnF: Is there any discussion on the motion? None.

6.8.1.10. JohnF: Is there any objection to accepting the motion on the screen? None. Seeing none, the motion passes unanimously. Is there any objection to recess for the ad-hoc groups to conduct their work on the balance of the comments? None.

6.9. Closing

6.9.1. Recess

6.9.1.1. JohnF: Seeing no objections, we are recessed until tomorrow.

6.9.1.2. Meeting recessed at 4:20 pm.

7. Thursday 4:00 pm Afternoon Session July 15, 2004

7.1. Opening

7.1.1. Call to Order

7.1.1.1. JohnF: I call the meeting to order.

7.1.1.2. Meeting in session at 4:00 pm

7.2. Process

7.2.1. Continuation of Comment Resolution

7.2.1.1. JohnF: I wish to try to wrap up all of the technical comments, and then address some procedural issues. These procedural issues are related to making sure that we are ready for November. For example, we may have to pursue recirculation now, then prepare a procedure 10 process, ask for recirculation again, and then submit to Revcom.

7.2.1.2. Floyd: I wish to present some resolutions. 0804r2 posted to server yesterday, contains ~62 documents, with about 9 highlighted for action in this session. I wish to move:

7.2.1.3. Move to accept the resolutions provided and colored in green in document 04/0804r2 for the following comments Benveniste/14. Benveniste/15, and the resolutions provided and colored in yellow in document 04/0804r2 for comments Barr/18, Barr/23, Barr/24, Hansen/10, Benveniste/1 and Benveniste/11.

7.2.1.4. [Benveniste/4 and Benveniste/5 had been included in the motion, but were removed by friendly amendment by MathildeB]

7.2.1.5. JohnF: Does anyone need additional time to review these documents. No. Very well, may I ask for a second?

7.2.1.6. Srini seconds.

7.2.1.7. JohnF: Is there any discussion on the motion? None. Is there any objection to accepting the motion? None. Seeing none, the motion passes unanimously.

7.2.1.8. Srini: I wish to work with the group on documents 627r6 and 0771r2. In 627r6 we have 4 comments, missed during previous resolutions. Most of the comments are straightforward. I wish to move:

7.2.1.9. Move to accept the resolutions as written in 04/627r6 for the comments for which resolutions have been written in 04/627r6.

7.2.1.10. JohnK seconds.

7.2.1.11. JohnF: Is there any discussion on the motion? None. Is there any objection to accepting this motion? None. Seeing none, the motion passes unanimously.

7.2.1.12. Srini: The next motion is 077r2. There are 32 comments in the document; we have resolved 31 of them. I wish to move:

7.2.1.13. Move to accept the resolutions as written in 04/771r2 for the comments for which resolutions have been written in 04/771r2.

7.2.1.14. JohnF: Is there anyone who needs more time to review this document. None. May I have a second for the motion?

7.2.1.15. JohnK seconds.

7.2.1.16. JohnF: Is there any discussion on the motion? No. Are there any amendments? No. Is there any objection to accepting this motion? None. The motion passes unanimously.

7.2.1.17. Srini: I'd like to address the last remaining comment on line 6 (EDCA) in 04/0771r2.

7.2.1.18. MarkB: The reason for this is the More Data Ack issue.

7.2.1.19. Srini: I wish to move:

7.2.1.20. Move to accept the comment Kandala/41

7.2.1.21. Second by JohnK.

7.2.1.22. JohnF: Is there a need to discuss this motion? No. Hearing no wish to discuss, is there any objection to accepting this motion? None. Seeing none, the motion passes unanimously. I shall limit debate on the remaining comments/resolutions to 5 minutes each. The motions will be understood as approving acceptance of the resolution(s).

7.2.1.23. Mathilde: I wish to discuss Chaplin/3. There is no document reference.

7.2.1.24. "Comment declined. This is clear in Section 11.4.1.5 and the Annex of the TGe draft. The AP will observe medium access rules of Clause 9 using the EDCA parameter selected for the AP. The AP will transmit the buffered frames for a PS station as close to, and following, the scheduled wake up time by not transmitting to other stations."

7.2.1.25. JohnK seconds.

7.2.1.26. JohnF: Is there any discussion on line 62 on the screen. Is there any objection to accepting this resolution? No. The motion passes unanimously.

7.2.1.27. Mathilde: The next comment is on Line 61, Chaplin/2. "Comment declined. Replace the word "immediately" in H.4.2.2 with the words: ' The station will access the channel using normal EDCA rules. The station experiences less contention when it wakes up for scheduled APSD because there are fewer stations contending for the channel; other PS stations will not typically be awake competing for the channel at the same time' "

7.2.1.28. Srini: I suggest an alternate resolution: Delete Annex H.

7.2.1.29. JohnF: Time has expired for consideration of this resolution. Mathilde, do you wish to move on?

7.2.1.30. Mathilde: No. I want to stay with this one.

7.2.1.31. Jennifer seconds.

7.2.1.32. JohnF: Is there any discussion on the motion? Yes.

7.2.1.33. JohnK and DuncanK speak against the motion.

7.2.1.34. JohnK calls the question. Seconded by Duncan.

7.2.1.35. JohnF: It requires a 2/3 majority to call the question. Is there any objection to calling the question? None. Then we shall vote. Voting members, please. Hold up your tokens. The motion requires 75% to pass. It fails 3 yes, 13 no, 4 abstaining. We shall consider this comment unresolved. Next comment?

7.2.1.36. Mathilde: The next comment is Barr/10. "Alternate resolution: Change the paragraph to 'It should be evident that unscheduled service periods are useful if there exists at minimum one uplink and one downlink TESPEC; because if there is no downlink TSPEC, the QAP will not buffer frames for unscheduled delivery and if there is no uplink TSPEC the non-AP QSTA will be unable to issue trigger frames. A bi-directional reservation is considered to be equivalent to an uplink plus a downlink TSPEC with identical characteristics---including the setting of the APSD and schedule subfield---so a single admitted bi-directional reservation satisfies the minimal requirement. If necessary, the non-AP QSTA may establish an uplink traffic stream consisting of QoS-Null frames, and use these frames to trigger unscheduled service period each time the QSTA is ready to receive buffered frames and use these frames to trigger unscheduled service period each time the QSTA is ready to receive buffered frames via unscheduled delivery.' "

7.2.1.37. DuncanK calls the question. Second JohnK.

7.2.1.38. JohnF: Is there any objection to calling the question? No. Let us vote. The vote fails 2 yes, 14 no, 4 abstaining, so this comment will remain unresolved.

7.2.1.39. Mathilde: The next comment is Tan/3, line 60, referring to Annex H 4.1. "Accepted. Clarification is provided in document 04/073r4. Instruct the editor to… "

7.2.1.40. Srini: I protest. I need to have an explicit resolution.

7.2.1.41. JohnF: I have given the floor to Mathilde. She is almost done. We have a half hour before we are done.

7.2.1.42. Mathilde: "Accepted. Clarification is provided in document 04/073r4. Instruct the editor to incorporate the text of 04/073r4 into the TGe draft to address this comment."

7.2.1.43. JohnF: Is there a second for this motion?

7.2.1.44. Jennifer seconds.

7.2.1.45. JohnF: Is there discussion? Yes.

7.2.1.46. Duncan: If you look at the suggested change, it says clarify or remove it. I would like to remove the whole thing, and I will make a motion to that effect. I call the question.

7.2.1.47. Second JohnK.

7.2.1.48. JohnF: The question is called. We shall vote on calling the question. The vote passes 18 yes, 1 no, 1 abstain. We shall now vote on the motion. Vote fails 2 yes, 15 no, 5 abstaining, so this comment remains unresolved.

7.2.1.49. Mathilde: The next comment is Benveniste/4. "Accepted. Adopt the informative text in 04/073r4"

7.2.1.50. JohnK: I suggest that you also make the motion for Benveniste/5 as well.

7.2.1.51. Duncan: I'd like to lodge a point of order.

7.2.1.52. JohnF: I suggest you withdraw this. [Withdrawn] Is there any discussion. No discussion is proper unless there is a motion on the floor. OK the motion was completed. Mathilde, you can go ahead with discussion.

7.2.1.53. Mathilde: Discussions in Wi-Fi have centered on use of APSD for voice and data. After debating this for several months, several companies have designed it in, so now Wi-Fi has…

7.2.1.54. JohnF: Time has run out.

7.2.1.55. Duncan: I second the motion.

7.2.1.56. JohnF: Is there any discussion on the motion?.

7.2.1.57. JohnK: I move to amend the motion to include Benveniste/5 with Benveniste/4 in the resolution.

7.2.1.58. Duncan: I second the motion to amend.

7.2.1.59. JohnF: Are there any clarifications needed? No. Is there any discussion? Yes.

7.2.1.60. Mathilde: The reasons are different for resolving the two comments. I object to the amendment.

7.2.1.61. JohnK: My reading of Benveniste/5 and Benvieniste/4 is that they are the same, therefore the resolutions must be the same.

7.2.1.62. JohnK: I call the question. Seconded by Duncan.

7.2.1.63. JohnF: Is there any objection to call the question? Yes. We vote. The vote passes 21 yes, 0 no, 1 abstaining. So the question is called, we vote on the motion to amend. The vote passes 24 yes, 0 no, 3 abstaining.

7.2.1.64. JohnK: I call the question.

7.2.1.65. Duncan seconds

7.2.1.66. JohnF: We now vote on calling the question. Vote passes 21 yes, 1 no, 1 abstaining. We now vote on the main motion, now amended to include Benveniste/5 and Benveniste/4.

7.2.1.67. Mathilde: The motion now reads: “Comment Accepted. Adopt the informative text in document 04/073r4 in resolution of Benveniste/4 and Benveniste/5”

7.2.1.68. JohnF: We now vote on the motion. The vote fails 2 yes, 16 no, 2 abstain

7.2.1.69. JohnF: I would like to entertain some alternative resolutions.

7.2.1.70. Duncan: I have a motion:

7.2.1.71. Instruct the editor to make the following modifications to the draft in resolution of comments Tan/3, Chaplin/2, Benveniste/4, Benveniste/5, Barr/10 and Barr/11: “ Delete Annex H Subclause 4 and provide the following text as a comment resolution: ‘In order to resolve numerous points of confusion in the informative annex H.4, the text from that subclause has been removed.’ ”

7.2.1.72. JohnF: Mathilde has the floor.

7.2.1.73. Mathilde: I suggest a friendly amendment that we should take the entire document 073r4, take the relevant portions and take the changes and incorporate those, to preserve Annex H and avoid gathering more no votes than we had.

7.2.1.74. Duncan: I am not going to accept this as it is clearly not a friendly amendment; it changes the intent completely.

7.2.1.75. JohnK: I second the motion.

7.2.1.76. JohnF: Is there any discussion? Yes.

7.2.1.77. Jennifer: Why can’t we simply bring back the resolutions?

7.2.1.78. Duncan: It is impossible to bring back the previously voted resolutions, as it would be out of order.

7.2.1.79. JohnK: I wish to call the question.

7.2.1.80. Srini seconds.

7.2.1.81. JohnF: Are there any objections? Yes. We shall take a vote. The vote passes 10 yes, 3 no, 0 abstaining. The question is called.

7.2.1.82. Jennifer: Parliamentary inquiry?

7.2.1.83. Duncan: Motions which have been made cannot be called back, without motion to reconsider.

7.2.1.84. JohnF: Is there any further parliamentary inquiry? [pause] No. Is there any objection to continuing? [pause] No. Bob, please record in the minutes. We will now vote on the motion. It is technical. The motion passes 18 yes, 2 no, 2 abstaining. We have only two minutes left. Is there any objection to recess for dinner? No.

7.3. Closing

7.3.1. *Recess*

7.3.1.1. JohnF: Seeing no objection, we are in recess.

7.3.1.2. Session recessed at 5:59 pm.

8. Thursday 7:30 pm Evening Session July 15, 2004

8.1. Opening

8.1.1. *Call to Order*

8.1.1.1. JohnF: I call the meeting to order.

8.1.1.2. Meeting in session at 7:39 pm.

8.2. Process

8.2.1. *Preparation for Recirculation and RevCom Submittal*

8.2.1.1. JohnF: All we have left is old business, new business, special orders, and approving a new draft. The next will be submission for recirculation and the necessary motions to do that. Duncan will assist with the recirculation process setup. We had a motion at the working group on Wednesday, and have done all the work to extend the PAR. I know Srini has two items. At 8:00 pm we shall start on the recirculation process.

8.2.1.2. Srini: I refer to Document 957r1, TGe's request to ANA.

8.2.1.3. Tgi has used the Status Codes 40-43 assigned to TGe. I wish to move:

8.2.1.4. Move to request the ANA to reassign Status Codes for the described settings in slide 3, preferably with the values in the left column.

8.2.1.5. JohnK seconds.

8.2.1.6. Duncan: I'm not sure whether these numbers are available. If you ask for specific numbers, you can get them if they are available. You need not ask for specific numbers.

8.2.1.7. JohnF: Is there any discussion? No. Is there any objection to passing this motion? No. The motion passes unanimously.

8.2.1.8. Srini: TGe also needs some new reason codes. I move:

8.2.1.9. Move to request the ANA to release Reason Code 36 and be made available for future assignments.

8.2.1.10. JohnK seconds.

8.2.1.11. JohnF: Is there any discussion? No. Is there any objection to passing this motion? No. The motion passes unanimously.

8.2.1.12. Move to request the ANA to assign Reason Codes for the described settings in slide 7, preferably with the values in the left column.

8.2.1.13. Seconded JohnK.

8.2.1.14. JohnF: Is there any discussion? No. Is there any objection to passing this motion? No. The motion passes unanimously.

8.2.1.15. Srini: I present document 768r1 on the screen. I have assembled some names of individuals I believe have contributed the standard, however I would entertain addition of others who feel they have contributed. [Members add some names, and Srini changes to 768r2] I wish to move:

8.2.1.16. Move to instruct the editor to add the names in 04/768r2 to the next TGe draft as contributors to the draft.

8.2.1.17. Seconded by BobM.

8.2.1.18. JohnF: Is there any discussion on this motion? No. Is there any objection to accepting the motion as shown? No. The motion passes unanimously. I want to give the floor to Duncan to provide motions to prepare the TGe draft for the RevCom review.

8.2.1.19. Duncan: In order to do this, we have to ask ExCom to submit the draft to RevCom at a plenary. In order to prepare for this we have to invoke Procedure 10 to allow a conditionally-approved draft to be forwarded. So we shall do two recirculations of the same document to meet the conditions for Procedure 10 (which requires no new comments). First, we will ask the editor to release a draft. Then we shall submit two requests for recirculation. Lastly, we shall prepare for submission to RevCom.

8.2.1.20. Duncan: I wish to move:

8.2.1.21. Instruct the editor to create a revision of the 802.11e draft, incorporating all comment resolutions accepted by the task group and noted in document 04-546r9 into draft P802.11e D8.0.

8.2.1.22. Document placed on server by Srini. Seconded by JohnK.

8.2.1.23. JohnF: Is there any discussion? No. Is there any objection by any voting member to passing this motion? No. The motion passes unanimously

8.2.1.24. Duncan: I wish to move:

8.2.1.25. Request the working group to authorize two15-day sponsor group recirculation ballots, requesting that the sponsor group approve forwarding the 802.11e draft to RevCom for publication.

8.2.1.26. Seconded by JohnK.

8.2.1.27. JohnF: Is there any discussion on the motion? No. Voters, please hold up your tokens. The vote is 17 yes, 0 no, 0 abstaining. The motion passes unanimously.

8.2.1.28. Duncan: I wish to move:

8.2.1.29. Request the task group and the working group to authorize a properly constituted meeting, which may be conducted by telephone, to resolve any comments that might arise as a result of the first sponsor group recirculation ballot.

8.2.1.30. Seconded by JohnK.

8.2.1.31. JohnF: Is there any discussion on this motion? No. Voters, please hold up your tokens. The motion passes unanimously 18 yes, 0 no, 0 abstains.

8.2.1.32. Srini: I would like to show document 841r0 on the server with TGe Sponsor Ballot Information in preparation for the submission process. The document specifies that the package includes the document itself, the 802.11 TGe draft 8.0, and the sponsor ballot comment resolution document IEEE 802.11-04-546r9. We should approve another resolution meeting in addition to the one just approved for resolutions from the second recirculation ballot.

8.2.1.33. Duncan: I wish to move:

8.2.1.34. Approve the 802.11 TGe sponsor ballot package as specified in document 04-841r0

8.2.1.35. Seconded by BobM.

8.2.1.36. JohnF: Is there any discussion on this motion? No. Voters, please hold up your tokens. The motion passes unanimously with 16 yes, 0 no, 0 abstains.

8.2.1.37. Duncan: I wish to move:

8.2.1.38. Request the task group and the working group to authorize a properly constituted meeting, which may be conducted by telephone, to resolve any comments that might arise as a result of the second sponsor group recirculation ballot.

8.2.1.39. JohnK seconds.

8.2.1.40. JohnF: Is there any discussion on this motion? No. Voters, please hold up your tokens. The motion passes unanimously with 18 yes, 0 no, 0 abstains.

8.2.1.41. Duncan: I wish to move:

8.2.1.42. Approve the 802.11 TGe sponsor ballot package as specified in document 04-841r0.

8.2.1.43. JohnF: Is there any discussion on this motion? No. Voters, please hold up your tokens. The motion passes unanimously 18 yes, 0 no, 0 abstains.

8.2.1.44. Duncan: I wish to move:

8.2.1.45. Request the working group to request of the LMSC ExCom conditional approval to forward the P802.11 TGe draft, as defined in the package approved as document 04-841r0, to RevCom for publication, provided the conditions specified in LMSC Procedure 10 should be met.

8.2.1.46. JohnK seconds.

8.2.1.47. JohnF: Is there any discussion on this motion? No. Voters, please hold up your tokens. The motion passes unanimously 18 yes, 0 no, 0 abstains. This brings to a close our scheduled work for this week. Is there anything else from anyone in the meeting?

8.2.1.48. MarkB: I have a particular issue that came up as part of the activity on APSD. May I present an short paper informally?

8.2.1.49. JohnF: You may proceed.

8.2.1.50. MarkB: I've prepared some slides which are not on the server. One of the sentences in the power-save resolutions yesterday was that the "QAP shall ignore subsequent trigger frames sent by a non-AP QSTA if it has already started an unscheduled SP for the station." The intention of this sentence is to further strengthen clause c) of 11.2.1.9 to avoid the client complexity of tracking multiple SPs. However, the protocol will still function (albeit less efficiently) even when SPs inadvertently overlap. Further, the normative statement is problematic because it places some additional and unnecessary restrictions on the AP.

8.2.1.51. I propose that we consider softening the sentence by replacing the "shall" with "should" (e.g. The QAP should not regard a frame as a trigger until the current SP has ended). We may also want to say that the "QSTA should not trigger-enable an AC that carries bursty uplink traffic"

8.2.1.52. Floyd: I support Mark's change.

8.2.1.53. [Discussion]

8.2.1.54. Duncan: I move to adjourn

8.2.1.55. Seconded by JohnK.

8.3. Closing

8.3.1. Recess

8.3.1.1. JohnF: Is there any objection to recess the work of this task group? Seeing no objection, we are adjourned.

8.3.1.2. Session recessed at 8:59 pm.

9. --------------------END OF MINUTES--------------------------

IEEE P802.11
Wireless LANs

Meeting Minutes for 802.11j July Plenary, 2004

Date: July 15, 2004

Author: Andrew Myles, et. al.
Cisco Systems
e-Mail: andrew.myles@cisco.com

Wednesday, July 14, 4:00PM session

Called to order at 4:07pm

Chair reviewed IP policy

TGj approved agenda by unanimous consent

There was no further material to review on Japanese regulations (see 04/809 for mid week plenary report)

Chair reviewed status of ballot process, noting that the ballot process is owned by the Sponsor Ballot pool

Chair stated today's task is to review remaining Sponsor Ballot comments, so that:

- we can achieve a result much higher than 75%
- we satisfy or respond to all commenters

Chair stated that comment resolutions to date are in document 04/703-00

Peter Ecclesine (editor) stepped through comment resolutions to date and led a discussion on each of the resolved and unresolved comments

Move to accept 04/703-01 and instruct the editor to make appropriate changes to D1.5 and so construct D1.6

- Peter Ecclesine moves
- Andrew Myles seconds
- Yes: 14
- No: 0
- Abstain: 1
- Motion passes

Move to authorise a Sponsor Ballot recirculation of 802.11j D1.6 to conclude no later than 13 September 2004

- Pankaj Karnik moves
- Tom Schaffnit seconds
- Yes: 13
- No: 0

- Abstain: 1
- Motion passes

Move to approve an ad hoc meeting for the purpose of resolving comments in 802.11j D1.6 Sponsor Ballot recirculation to be held prior to 13 September 2004

- Andrew Myles moves
- Thomas Kurihara seconds
- Yes: 14
- No: 0
- Abstain: 0
- Motion passes

Move to authorise a Sponsor Ballot recirculation of 802.11j D1.7 to conclude no later than 15 November 2004, and request that approval of D1.7 be placed on the next available RevCom agenda

- Yasuhiko Inoue moves
- Gunnar Nitsche seconds
- Yes: 15
- No: 0
- Abstain: 0
- Motion passes

Recess for the day at 5:30 pm passes by unanimous consent

Thursday, July 15, 1:30PM session

Called to order at 1:35pm

Move to request that approval of D1.6 be placed on the next available RevCom agenda

- Yasuhiko Inoue moves
- Peter Molnar seconds
- Yes:3
- No: 0
- Abstain:0

Adjourn for the session at 1:40 pm passes by unanimous consent

IEEE P802.11
Wireless LANs

Minutes for the TGk July 2004 Session

Date:

July 15, 2004

Author:

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Monday, July 12, 2004
4:00 PM – 6:00 PM

1. Chair calls the conference to order at 4:00 PM
2. Attendance
3. Review IEEE 802 & 802.11 Policies and Rules
    a. Patent Policy
    b. Inappropriate Topics
    c. Documentation – 4 hour rule for changes that are normative
    d. Voting
    e. Roberts Rules
4. Objectives for Meeting 04-739r1
    a. Comment incorporation into new draft (D0.17)
    b. Security of Measurement Frames Vote
    c. Neighbor Report Vote
    d. MIBs Vote
    e. Incorporation of editor to do
    f. Next major milestone: Letter Ballot
5. Technical Presentation Review
    a. Vote on editor assigned comments
    b. Security Presentation
    c. Zhong
    d. Site Reporting
    e. Bernard – Security Presentation 722
    f. Black (6,11,75,76,96,162,163,191,194,221)
    g. Edney (53)
    h. Kwak (61,63,65,66,67,68,104,107,208,210,219)
    i. Olson (225)
    j. Approval of the teleconference minutes (Garden Grove – Portland)
    k. Moreton
    l. Autonomous Reporting (23) Black Document #758
    m. Black (15)
    n. Johnson (43)
    o. Kwak
    p. Vote on Letter Ballot
6. Move to accept modified agenda – motion passes unopposed
7. Motion for acceptance of editorial comments

    Move to accept the editor-to-do comment resolution from teleconferences contained in document 11-04-480r17.

    [40,41,42,78,79,80,82,83,84,86,91,98,99,100,101,103,106,112,115,116,119,120,121,122,124,126,133,139,140,146,147,150,151,152,153,155,158,159,162,164,166,167,169,170,171,175,177,178,180,181,183,188,189,195,196,197,199,200,201,202,203,204,205,206,207,209,212,214,215,216,217,220,222,223,224,228,230,236,237,238,240,242,243,244,245]

    Moved: Kwak
    Seconded: Johnson

For: 15 Against: 0 Abstain: 1
Motion passes 100%

8. Technical Presentation – Radio Measurement Action Protection - Jesse Walker - 11-04/685r0 & 11-04/686r0 (Normative Text)
   a. STAs will use 802.11k messages to optimize performance
   b. Two sources of errors
      i. Mis-measurement
      ii. 802.11k messages forgery
   c. Protect Radio Measurement frame from **forgery**, not measurement error
   d. Define an **optional** protection mechanism for Radio Measurement Action Frames
   e. Utilize **existing** security mechanism rather than creating new ones
   f. Define a new Action Frame attribute
      i. Protection-Capable or Non-Protection-Capable
      ii. Action Frames are Non-Protection-Capable by default (backward capability)
   g. Protection-Capable Action Frames are protected by the same Pairwise Cipher Suite as an ordinary Data MPDU.
      i. MPDU payload is TKIP or CCMP encrypted
      ii. MPDU payload and header are TKIP or CCMP integrity protected
      iii. Protected Frame subfield or Header Frame Control Field is set
      iv. Only cipher suites already implemented required
   h. Question – What is the timing on sending a protected Action Frame? Answer – all Radio Measurement Request/Response are class 3 frames. You can't protect anything until you have the keys.
   i. Comment – CCM is balanced to use the same key for authentication and encryption. Using CCM for encryption **only** breaks down in security scrutiny.
   j. Question – if there is a need for protecting action frames, why should a STA ignore an unencrypted Action Frame? Answer – if you receive a frame that is unencrypted you ignore it in this proposal.
   k. Comment – The reason why you negotiate is to reject forgeries. Any station that is in the Neighborhood may need information that the AP has.
   l. Question – Can we leave it to local policy to transmit Site Report in the clear? Answer - We voted that Action Frame as Class 3.
   m. Comment – In multi SSID you want to keep the secure channel secure and the insecure channel insecure and don't mix them.
   n. Comment – we **only** voted Request Frames as Class 3.
   o. Comment – we are introducing a different mechanism for 11k multicast and unicast, 11i, and 11h.
   p. Question – Why strive to make things better than 11i? Answer – we need to raise the issue so people are aware of security and functionality tradeoffs. Comment – we should distinguish between broadcast and unicasts.
   q. Question – Why have Protection-Capable? Answer – To make this framework backwards capable and extensible for any user of Action Frames. This does implement client functionality (Action Frames) which could be applicable to WMN. WMN is going to work within 11k for measurements.
   r. Comment – On slide 11 – negotiation model is all or nothing, it is not optional. The 4-way handshake is done in the OS. The driver is reconstructing the IE (Information Element). The driver will only pass up the stuff they know about.

   s. Question – What if there are some Action Frames that not worth protecting? Answer – this is a valid observation. The task group looked at 3 levels of granularity (1) All Action Frames should be protected, (2) Different protection mechanism for different Action Frames, and (3) our proposal. Example of an Action Frame that shouldn't be protected is "What country am I in?"
   t. Comment – If the AP does not support Protection-Capable, then the STA can't associate. Jesses will rework the presentation to address this issue.

9. Motion to modify the agenda to allow Mike to present early. Motion passes unopposed.
10. Motion to recess meeting 10 minutes early to allow Mike work in his presentation
    Moved: Worstell
    Seconded: Walker

    Motion passes unopposed
11. Meeting recess until 7:30 PM tonight.

Monday, July 12, 2004
7:30 PM – 9:30 PM

1. Chair calls meeting to order at 7:30 PM
2. Motion to amend agenda to allow Zhun to present prior to the other security presentations. Motion is rejected
3. Technical Presentation – Frame Encapsulation – Mike Moreton - 11-04/737r0
    a. Question – If it is not an Action Frame, why keep the Action Frame format? Answer - It makes it easier to keep a consistent format.
    b. Putting it into a data frame provides a mechanism for SME to talk to SME.
    c. Uses exactly the same protection as Data frames – even WEP or none.
    d. Advantages (1) Guaranteed to work on all existing hardware, (2) no extra configuration, (3) no need to define a new protection mechanism, (4) frame type field is protected in TKIP, and (5) extensible
    e. Disadvantages (1) SME-SME protocol
    f. Questions – How to stop someone across the DS from generating an Action Frame and sending it to one of the STAs?
    g. Question – What's to stop someone across the DS generating an Action Frame and sending it to the AP?
    h. Question - How do you stop these frames getting through before the keys are installed?
    i. Question – How do you allow STAs outside the BSS to participate? Answer – they can't just like the other security proposals.
    j. Question – How about broadcast Action Frames from and valid STA within the BSS?
    k. Extension – could probe a remote AP?
    l. Question – How does the affect quality of service? Management frames are generally prioritized over data frames. Answer – This should diminish the need to cheat because you can define priority.
    m. Comment – Are we defining a new data frame? Answer – we are defining a new Ether type not data frame.
    n. Comment – The PAR for 11k is to define interfaces to upper layers.
    o. Comment – There are 2 scenarios (1) Application and (2) MAC. Both mechanisms can work, but what is important is to decide which avenue we should go down. The TGi PAR was vague. If the group decides protecting management frames is at the application layer architecture, then it should be done in 802.16.
    p. Comment – This is already done at the bridging layer within access points today. There are a couple of advantages to this proposal (1) Legacy drivers can implement 802.11k and (2) 802.11k measurements can be sent at different priorities.
    q. Comment – you are giving up the ability to send management frames outside the BSS.
    r. Comment – Terming this as a mechanism for securing Action Frames is a Red Herring – it really defining a new mechanism for communicating.
    s. Question – is the tool we are trying to use to heavyweight? Do these frames need both authentication and encryption? Answer – The reason we are using encryption and authentication is because it is much easier.
    t. Comment – TGh and TGi created new action frames for a reason. Will this negate the ability to bridge packets at the chip level without popping out to software? Answer – the Ether type is on significant at the end points. The Bridge just passes it through.
    u. Comment – This is probably not the best approach, but it does offer simplicity and speed. If we adopt Jesse's proposal it will be backwards compatible with 11h/e.

v. Comment – All existing hardware has the ability to support this proposal.
w. Comment – This is a business driven argument, MAC versus and OS. Answer – There are Chip and OS people who both support this proposal.
x. Comment – If 802.16 and 802.20 make it; then, like 802.1, we have to create an architecture that can be extended. It still all done at the driver level.
y. Comment – The 11k frame management frame might become to large and require fragmentation.

4. Technical Presentation - IEEE 802.11k Security: A Conceptual Model – Aboba - 11-04/724r1
   a. Question – This means that you don't value confidentially? Answer – This is security of measurements and not reality. There is still a heavy burden on the AP to validate this information regardless if the data is secured or not.
   b. Comment – Commands to change settings should be covered by security. Measurements are not worthy of security.
   c. Comment – The group should carefully consider if we should add sample heuristics to determine if the data is good or bad.
   d. Comment – Measurements are hints, this is a correct statement. But what about your statement that an insecure Beacon is more accurate than a secure action frame? Answer – shelf life is more useful and the Beacon is the most real-time hint you can get.
   e. Question – Perhaps we should add security to Beacons and Probe Responses? Comment – all of the reports can be spoofed in the current draft.
   f. Comment – You might **not** want to throw away the data from a malfunctioning access point and/or station. You may want to go and repair the AP after determining that they are sending bad data.
   g. Comment – You don't want to throw out security, because your heuristics are not correct. You must have both.
   h. Question – Are there 11k situations that need protection? Answer – require a STA to go off-channel and do measurements. Comment – This proposal addresses reports, but does not address requests.
   i. Question – Can you distinguish between your proposal and Mike's proposals? Answer – They are very close. Comment – The normative text varies widely between the two proposals.
5. Discussion on addressing security
   a. Comment – we should go to letter ballot without security included in the draft.
   b. Comment – we have to put in normative text in the document very quickly.
   c. Comment – we have had several straw polls that indicated that we are not ready to go to Letter Ballot.
   d. Comment – It is the responsibility for this group to put out a Draft that is complete.
   e. Comment – I would rather sleep on the 3 proposals and allow the 3 groups to come together and present a unified proposal tomorrow morning.
   f. Comment – We could always add normative text after going to Letter and Sponsor Ballots.
   g. Comment – Every Task Group comes to this decision point. If you go to Letter Ballot, you will get thousands of comments which must be addressed.
6. Motion to recess early passes unanimously
7. Meeting in recess until 8:00 AM tomorrow morning.

Tuesday, July 13, 2004
8:00 AM – 10:00 AM

1. Chair calls the meeting to order at 8:00 AM.
2. Motion to modify agenda to allow 5 Editor-to-do comments and add a straw poll.
3. Motion

   Move to accept Editor-to-do resolutions from teleconferences [35, 61, 65, 72, 73] contained in 11-04-480r17.

   Moved: Kwak
   Seconded: Black

   For: 19 Against: 0 Abstain: 3
   Motion Passes 100%
4. Straw Poll regarding security

   Straw Poll
   How should action frames be protected?

   (1) By encapsulating Data Frame [Add Proposal Number] (10 Votes)
   (2) By protecting Action Frame [Add Proposal Number] (10 Votes)
   (3) By some other mechanism (1 Vote)
   (4) Action Frames should not be protected (1 Vote)

   No clear resolution for security.
5. Technical Presentation – Neighbor Report – Aboba - 11-04/0766r1 (PPT) & 11-04/735r3 (Normative Text)
   a. A report providing information on the Neighbors of the AP Answering the query.
   b. What is a Neighbor AP? A neighbor AP is defined as an infrastructure BSS where the BSA overlaps, or is adjacent to the BSA established by the AP sending the neighbor BSS report.
   c. Issues addressed by the Neighbor Report
      - (Unnecessary time spent scanning)
      - Inability to focus on APs of interest (RSN, QoS, PHY, etc.)
      - Scanning on media or channels with no relevant APs
      - Inability to do scheduled passive scanning
      - Inability to target a potential handoff candidate in an active scan
      - Issues addressed by the Neighbor Report (Pre-authentication attempts that can't succeed)
      - Target AP cannot be reached
      - Coverage overlap area insufficient

   Motion
   Instruct the editor to incorporate text from 11-04-0735-03-000k-site-report-enhancements.doc into the TGk draft

   Moved: Aboba
   Seconded:

   Discussion on Proposal

Question – you added a new element should septuples be changed? Answer – no.
Comment – Describe RSN bit. Answer – the AP has the same RSN security policy.
Question – How would an AP go about configuring trusted APs? Answer – (1) configure through the MIB and (2) via the default VLAN. You don't learn your neighbor list. Both ways are really configured through the MIB.
Comment – Using on VLAN ID seems short sited. The definition or reach ability needs to be expanded. This is a very simple Layer 2 geometry problem.
Comment – You can have an AP without an IP. Answer – yes you can, but it outside the scope.
Comment – You might need two bits for CMX.
Comment – There are other places in the draft which will need to be updated from site report to neighbor report (MIB).
Comment – TBTT allows you do passive scanning.
Comment – The mechanism for determining TBTT Offset is outside the scope.
Comment – To maintain the accuracy specified in the document time drift would need to be checked every 1.2 seconds.
Comment – Beacons are CSMA.
Comment – The Neighbor List is going to be very static in practice except for the TBTT Offset.
Comment – If this is device independent, then we should burden these devices (VOIP devices) which require this functionality. There is a bandwidth cost. You might be able accomplish this via a Passive San. There are devices on the market today which can accomplish this today for Rogue Access Point detection. Answer – we are only talking about 4 bytes.
Comment – It is no more efficient than a probe request/response. Answer – you are not changing channels.
Comment – Active scanning is no longer a viable option.
Comment – We might want to steal a bit from Lower PHY to increase efficiency.
Comment – This should increase standby battery life.
Comment – This useful information and should be included in a report. Why transmit the accuracy? Take the granularity of your TUs.

6. Meeting in recess until 10:30 AM today.

Tuesday, July 13, 2004
10:30 AM – 12:30 PM

1. Chair calls the meeting to order 10:30 AM
2. Resumption of Discussion on Motion on the floor– Neighbor Report – Aboba - 11-04/0766r1 (PPT) & 11-04/735r3 (Normative Text)

Discussion on Proposal (Continued)
Question – Not sure about the accuracy of the measurement. How does the client know the accuracy degradation? Answer – the algorithm is outside the scope. The STA itself must go out and maintain the accuracy.
Comment – It might be beneficial to separate the TBTT out of the proposal.
The proposal will be resubmitted on Wednesday

3. Technical Presentation - 'Additional' Site Report Mechanism – 11-04/0784r0 – Peyush Agarwal
   a. Question – How does this work in mesh? Answer – the MAC would be changing all of the time.
   b. Comment – On probe response there is only a single AP.
   c. Question - this mechanism builds a network based on Beacon Reports, so what is new? Answer – This enables an AP to build a database and provide it to the STAs.
   d. Comment – This uses the Probe mechanism to initially build the network and uses the DS to update the network.
   e. Comment – It is an automatic collection mechanism between AP to AP. The distribution is from AP to STA via the Site Report.
   f. Comment – this only works where the APs can hear each other.
   g. Comment – There are plenty of wireless networks where transmitters can't hear each other, but they do know they are neighbors.
7. Motion to modifying the schedule to allow MIB presentation on Wednesday. Motion passes unopposed.
8. Technical Presentation – Comment Resolution – 11-04/757r0 (Text) & 11-04/756r0 (PPT) - Simon Black
   a. Comment #6 – Should "MLME primitives" be linked to MIB attributes? Answer – Other groups like 11e have done in the past.
   b. Comment #11 – describe returning BSSMeasurementSet for a .11k STA
   c. Comment #17 – Mandatory response if STA incapable of making measurements
   d. Comment #74, 75, 76 – Clean up of the notes column of Table 12
   e. Comment #96 - Rewording of BSSID field in beacon request. BSS is not a property of a STA or and AP.
   f. Comment #191, 194 – leave as is
   g. Comment #221 – TSFType

Motion
Move to instruct the editor to apply the comment resolutions in document 11-04-757r0 when preparing the next version of the IEEE802.11k draft.

Moved: Black
Seconded: Barber

For: 14 Against: 0 Abstain: 1
Motion Passes 100%

9. Technical Presentation – Medium Sensing Time Histogram Corrections - 11-04-763r0 - Kwak
   a. Addresses Comments #161, 162, 163
   b. Comment – No indications out of the PHY to produce this information. You must ensure that each of the PHYs make this information available to the MACs.
   c. Comment – This could be a problem with the Noise Histogram as well.
   d. Question – Are the Bin durations still in time slots? Answer – yes.
   e. Comment – change Bin Interval to Bin Duration.
10. Technical Presentation – Comment Resolution - 11-04-762r0 - Kwak
   a. Addresses TPC Comments #61, 63, 65, 66, 67, 208, 210
   b. Addresses Beacon Reporting Conditions Comments #104, 219
   c. Comment – Averaged over 20 measurements, we have not defined increments or thresholds. Answer – Thresholds are relative to the serving AP's RCPI.
   d. Comment – Each packet received is a measurement.
   e. Comment – These measurements should be called out on a per packet measurements. Fragmentation will give you a measurement per fragmented packet.
   f. Comment – There is a concern about measuring across an entire packet. If you have short packet is better to measure only the Preamble.
   g. Comment – This does not have any thing to do with modulation only the power.
   h. Comment – The PHY has been modified in our text.
   i. Comment – You need to add (1) the primitives interface and (2) something in Clause 11.5 specifying which frame (Spectrum/Measurement) type you are using. Answer – this should is already specified in the category.
   j. Comment – The reporting conditions where specified, from last meeting, to be a single measurement. How do we reconcile this? Answer – This is a threshold.
   k. Question – Why 20? Answer – Because it brings the sampling error down to a fraction of dB. Answer – It is easier for a client to derive and average from a 2x number like 16 or 32. Joe will modify the text to indicate at least 20 so the implementer could do 32 if it was easier.
   l. Joe will make necessary modification and present on Wednesday.
11. Chair recesses meeting at 1:29 PM.
12. Meeting in recess until 1:30 PM today.

Tuesday, July 13, 2004
1:30 PM – 3:30 PM

1. Chair calls the meeting to order 1:30 PM
2. Technical Presentation - Radio Measurement Action Protection Normative Text – 11-04-686r1 - Walker

Motion
Move to instruct the P802.11k editor to incorporate submission 11-04/686r1 into the P802.11k draft.

Moved: Walker
Seconded: Qi

For: 12 Against: 5 Abstain: 4
Motion Fails at 71%

Discussion on Motion
Comment in favor of the motion
Comment – The wording on the MIB variable is unclear.
Comment – This MIB definition is only applicable to an AP.
Comment – 11i only applies non mutable data

3. Straw Poll on Security

Strawn Poll
In light of a security deadlock, would you consider moving ahead to Letter Ballot without a security proposal?

Yes: 24 No: 3

Discussion on Straw Poll
Comment in favor of poll – We are not required to define security and it can be defined later.
Comment in favor of poll – There are many more ways to bring down a wireless network.
Comment in favor of poll – This issue should be spun into a new task group.

4. Motion to proceed to Letter Ballot without defining a security policy

Motion
Move for TGk to proceed to a first Letter Ballot without including a security proposal
Comment – The wording on the MIB variable is unclear.

Moved: Walker
Seconded: Durand

For: 14 Against: 3 Abstain:3
Motion Passes at 82%

Discussion on Proposal

Question – Does this mean we have to undo something to get security in the proposal?
Comment – Friendly amendments add "first letter ballot"

5. Motion to accept teleconference minutes

Motion
Move to accept TGk cumulative teleconference call minutes (May-July) in document 11-04-0743r0.

Moved: Kwak
Seconded: Stanley

For: 16 Against: 0 Abstain: 3

Motion Passes at 100%

6. Technical Presentation – Autonomous Reporting – 11-04-758r0 - Black
   a. Addressed Comment #23
   b. Comment – Autonomous reporting is good. If you enabled this on a client, a client can continue to blast me with information that I don't want. Answer – you can turn that off.
   c. Comment – I can turn it off, but it is on by default. Every time a client roams into my BSS, I have to turn this feature on. Answer – you can broadcast this.
   d. Comment – If you broadcast this a client can still send several reports between broadcasts.
   e. Comment – We defaulted autonomous reporting on, because TGk's mission is to increase measurements. We could modify to default off by default.
   f. Question – As an implementer, when do I send the reports?
7. Comment #13 - Clause 11.7.2 – Black
   a. Problem – How does the need to return to the serving channel for a particular length of time between measurements relate to periodic measurements. This could result in no periodic measurements being made..
   b. Remedy – Clarify
   c. Comment – Joe presented last meeting and it was rejected.
   d. Resolution – Open – Joe Kwak will research
8. Comment #14 – Clause 11.7.2 – Johnson
   a. Problem - What is wanted in paragraph two? To always return to the serving channel after every non-serving channel measurement. Don't we want to be able to make multiple non-serving channel measurement in a row?
   b. Remedy - Delete paragraph 2 or make this paragraph clearer in its description.
   c. Resolution – open – assigned to Kwak
9. Comment #16 – Clause 11.7.5 - Black
   a. Problem - P40, L23 A STA may issue another measurement request while a previous measurement request is pending and has not yet started'. How does the sending STA know that the request is pending, or started since there is no start time specified. All it can determine is that there was a measurement request outstanding. The text needs to cover both measurements that have not been started and those in progress. It might be useful to get the partial results if there are any. The text here currently mandates discarding results.

   b. Remedy - Clarify the behavior if a measurement request is received while a previous request is outstanding.
   c. Comment – Station asking other stations for measurements will cause thrashing on the network. Our point of view has been AP centric. We do not have the ability to request measurements in IBSS.
   d. Comment – Each station can only have 1 outstanding request. The source address does not matter, there can only be a single outstanding request.
   e. Comment – A measurement requests can be a concatenation of many measurement requests.
   f. Question – Why can't we leave it to the implementation to decide how to handle requests? Answer – How do I know how big the queue is? How do I know when I am going to receive the measurements.
   g. Comment – I am favor of allowing the implementation to queue and add a reset option.
   h. Comment – If am requesting measurements, I will send a reset and then a request.
   i. Comment – Create a 2 deep queue (1) what you working on and (2) the latest request received.
   j. Comment – Add a refused response as well.
   k. Comment – Add "place in queue" to the response.
   l. Motion to reject the comment
   m. Comment – we shouldn't cancel, but clean it up.
   n. New Remedy – A STA may issue another measurement request while a previous measurement request is in process,
   o. Resolution – accept – instruct editor to make changes described in New Remedy.
10. Comment #17 - Clause 11.7.5 – Black
   a. Problem - P41, L11 If responses indicating refusal, or incapable are optional how are requesting STAs meant to get any information about what can and cannot be requested? One incapable refusal could save many wasted requests.
   b. Remedy - Make responses to measurement requests mandatory.
   c. Comment – This was resolved this morning - Make response in the case a requested STA is incapable of making a measurement mandatory.
   d. Resolution – accept – already contained in 11-04-757r0
11. Comment #20 – Clause 11.7.5 - Johnson
   a. Problem p40, l28-31 - This paragraph describes PS notification but doesn't list case of application information defined in 11.7.2
   b. Remedy – Add information about application-specific information or delete the sentence starting with "Rather"
   c. Comment – "rather" adds a great deal information to the sentence. The power save notification is important information.
   d. Question – Why do we care if it uses power save or not?
   e. New Remedy – Modify P40 l29-l31 "Rather, the measuring station is responsible for maintaining data services by using Power Save notification or other techniques."
   f. Resolution – accept – instruct editor to make change described in New Remedy.
12. Technical Presentation - Comment #43 – Johnson

   <u>Motion</u>

   Move to instruct the editor to replace the following sentence on P44, L38-40 of the TGk draft v0.14 within the latest editorial TGk draft.

   "Otherwise, the Site Report elements shall contain information from the MIB table dot11RRMSiteReportTable concerning neighbor APs that match the current SSID the requesting STA is associated with."

with
"Otherwise, the Site Report elements shall contain information from the MIB table dot11RRMSiteReportTable concerning neighbor APs that match the current SSID with which the requesting STA is associated."

Moved: Johnson
Seconded: Kwak

For: 17 Against: 0 Abstain: 0

Motion Passes 100%

13. Meeting is in recess until Wednesday at 1:30 PM.

Wednesday, July 14, 2004
1:30 PM – 3:30 PM

1. Chairperson calls meeting to order at 1:30
2. Review Agenda
3. Technical Presentation – Neighbor Report – 11-04-735r4 - Aboba
   - Change Site Report to Neighbor Report throughout the document
   - Clarification of what APs are contained in Neighbor List
   - Clarification of Reserved Field for WMX add 2 bits
   - Changes relating to TBTT
   - Comment Related to TBTT – This must be done in hardware. Answer – It does not require hardware, because it can be addressed in software. When you collect a Beacon Report you have timing information. The Beacon has the time that the Beacon was transmitted. You have the TSF of the remote and the TSF transmitting.
   - Question – What happens when the peer has a large receive queue?
   - Question – Is the Lower TSF mandatory?
   - Comment – Add some text if there about the offset

Motion
Move to instruct the editor to incorporate text from 11-04-0735-04-000k-site-report-enhancements.doc into the TGk draft

Moved: Aboba
Seconded: Harkins

For: 23 Against: 0 Abstain: 3

Motion Passes 100%

2. Technical Presentation – Action Frame Class Scope – 11-04-702-01

Motion
Move to instruct the editor to incorporate text from 11-04-0702-00-000k into the TGk draft

Moved: Edney
Seconded: Harkins

Discussion on Proposal
Comment – Simon Black would like to make a friendly

Motion to Amend
Move to instruct the editor to incorporate text from 11-04-0702-00-000k into the TGk draft with the following exceptions
(1) Delete bullet VII from Class 1 Frames and make editorial adjustments
(2) Remove the words "Containing measurement request and report messages" from bullet II Class 3 Frames

Moved: Black

Seconded: Lefkowitz
For: 19 Against: 3 Abstain: 5
Motion Passes at 83%

Discussion on Proposal
Comment – insert comments

Amended Motion
Move to instruct the editor to incorporate text from 11-04-0702-00-000k into the TGk draft with the following exceptions
(1) Delete bullet VII from Class 1 Frames and make editorial adjustments
(2) Remove the words "Containing measurement request and report messages" from bullet II Class 3 Frames

For: 22 Against: 1 Abstain: 5

Motion Passes at 96%

3. Technical Presentation – RM MIB Clarification – (11-04-821r0) - Olson
Motion
Move to instruct the editor to apply the comment resolutions in document 11-04-812r0 when preparing the next version of the IEEE802.11k draft.

Moved: Olson
Seconded: Johnson

For: 20 Against: 0 Abstain: 4

Motion Passes 100%

4. Comment #132 – Clause 7.3.2.22.5, 11.7.7.4 - Black
   a. Problem - P23, L9: power is measured 'when CCA indicates no 802.11 signal is present' I think CCA can only indicate the states busy, or idle.
   b. Remedy - Clarification required
   c. Comment - What does Idle mean
   d. New Remedy – Append to the end of the first sentence P22 L1 of D0.16 "Over the specified measurement duration when CCA indicates idle".
   e. Resolution – accept – instruct editor to make change described in New Remedy
5. Comment #137 – Clause 7.3.2.22.6 - Black
   . Problem - P21, L20: 'All information elements, except ...' Timestamp is not an information element, it is a fixed field. The same for Beacon Interval and Capability Information. The general statement about Beacon Report does not belong here.
   . Remedy - Replace whole paragraph with: 'The Received Elements portion of the Beacon report Contains a number information elements from the received Beacon, or Probe Response. All information elements that are present in the reported frame shall be included if the reported BSSID does not correspond to the BSS that the measuring STA is a member of. TIM elements shall be truncated such that only the first 4 octets of the element are reported.'

- New Remedy - The Received Elements portion of the Beacon report contains a number of information elements from the received Beacon, or Probe Response. All information elements that are present in the reported frame shall be included. TIM elements shall be truncated such that only the first 4 octets of the element are reported.
- Resolution – accept – instruct editor to make change described in New Remedy

10. Comment #143 – Clause 7.3.2.22.7 - Black
    - Problem - P22, L7 'BSSID contains the 6-byte BSSID of the STA that transmitted the frames.' BSSID is a property of a BSS, not a STA.
    - Remedy – Replace with 'The BSSID field contains the BSSID from the frames being reported.'
    - Resolution – accept – instruct editor to make change as described above
14. Comment #172 – 7.3.2.26 - Black
    - Problem - P28, L12 each quadruplet describes an AP. Quadruplet should be quintuplet and describes a BSS.
    - Remedy – Correct
    - Resolution – accept – no action needed, already accepted text to resolve
18. Comment #173 - 7.3.2.26 – Black
    - Problem – P28, L15 The BSSID is the address of the STA contained in the AP'. Would be better as 'The BSSID field contains the BSSID of the BSS to which the site report entry relates'.
    - Remedy - Consider suggested rewording.
    - Resolution – accept – no action needed, already accepted text to resolve
22. Comment #198 – Clause 7.4.2.3 - Black
    - Problem – Various editorials: P31, L9 Table 1 should be Table 19a P31, L11 Table 5 in 7.4.1 should be Table 20f in 7.4.2 P31, L9, L11, L13 remove 'equal' in each case
    - Remedy – Fix editorials
    - Resolve – accept – no action needed, already resolved in D0.15
26. Comment #211 – Clause A4.13 – Black
    - Problem - There are some PICS entries missing: (1) MIB (based on conformance groups) (2) RCPI in Probe Response
    - Remedy - Make new entries
    - Resolution – open – assigned Black/Gray
30. Comment #235 – Clause General – Black
    - Problem - The preamble says 'NOTE—The editing instructions contained in this supplement define how to merge the material contained herein into the existing base standard to form the new comprehensive standard as created by the addition of IEEE Std 802.11-1999 Reaff (2003). (1) We are writing an amendment (2) 'as created by the addition of IEEE Std 802.11-1999 Reaff (2003)' is meaningless and not relevant
    - Remedy - Reword: NOTE—The editing instructions contained in this amendment define how to merge the material contained herein into the existing base standard to form the new comprehensive standard.
    - Resolution – accept – no action need, already addressed in D0.16 – Black
    - Note to Editor – Now 11i has become part of the Base Draft in 11-04-703.
35. Meeting in recess until 7:30 tonight

Wednesday, July 14, 2004
4:00 AM – 6:00 AM

1. Chair calls the meeting to order at 4:08
2. Harry Worstell acting Chair
3. Technical Presentation - Measurement Duration – 11-04-560r1 (Normative Text) 11-04-559r1 (PPT) - Black
   . Added a "duration mandatory" bit
   . Related to Comment #15
   . Typo repeated "not"

Motion
To instruct the editor to apply the editing instructions in document 11-04-560r1 when preparing the next version of the IEEE802.11k draft.

Moved: Black
Seconded: Olson

For: 17 Against: 0 Abstain: 1

Motion Passes 100%

Discussion on Proposal
Comment – The Noise Histogram has a qualification to measure RPI density. Answer – you only make measurements in the idle periods.

4. Technical Presentation – AP Service Load – Joe Kwak - 11-04-550r1 and 11-04-0632r1 (Normative Text)
   a. Since DCF packets are lower priority than PCF or HCF packets, the DCF access delay values are sensitive to all PCF, HCF, and DCF channel loads
   b. While channel is busy for PCF or HCF, DCF backoff counting is suspended while access delay timing continues.
   c. Comment – Your measurements are against DCFs. Answer – DCF is constrained by the higher priority classes which means for a given period the Access Delay will grow.
   d. Comment – If I am a priority STA this would not be applicable. Answer – Their stream gives them priority, right.
   e. Comment – We are adding a mechanism which will be going away with 11e.
   f. Comment – It is primarily useful for DCF traffic which is low priority by nature. Answer – correct, but you still need to advertise a load. The load is still beneficial.
   g. Question – Are you getting station count from TGe? Answer – yes.
   h. Question – What if the AP/STA is not capable. Answer – It is defined in the 11k MIB.
   i. Question – Do you think this mechanism requires additional hardware? Answer – not necessarily, put possibly. These are MAC signals.
   j. Comment – These queues may not be available in some MACs
   k. Question – Could this be extended to ECDF? Answer – yes this basic concept could be extended to each class.
   l. Question – By measuring DCF aren't you measuring spare capacity? Answer – it is measuring the inverse of that. We are providing a good overall metric for loading.

m. Comment – In QoS, the schedule is not defined in the Standard.

Motion

Move to instruct the editor to incorporate text from document 11-04-0632-01-000k-BSS_Service_Load.doc into next TGk draft specification document

Moved: Kwak
Seconded: Andren

For: 6 Against: 5 Abstain:7
Motion Fails at 54%

5. Technical Presentation – MIB Comment Resolution – 11-04-816r0 - Gray
   . Comment – Need to incorporate Neighbor Report
   . Comment – Need to incorporate Conformance
   . Submit r1 for vote tomorrow
6. Late Comment#1 – Clause 11.7.4 – Bala (11-04-821r0)
   . Problem – Line 1: Should this not refer to "Measurement Request" instead of "Measurement Report"
   . Remedy - Replace "Measurement Report" with "Measurement Request"
   . Resolution – accept – instruct editor to make change as described above
7. Late Comment #2 – Clause 7.3.2.22.5 – Bala (11-04-821r0)
   . Problem – Regarding the text: RPI densities measured over the specified duration when CCA indicates no 802.11 signal is present. The CCA can be busy (based on the CCA mode setting) even when no 802.11 signal is present (for example when the measured signal energy is above ED threshold and the CCA mode requires ED threshold to be considered)
   . Remedy – Clarify
   . Resolution – decline – duplicate see Comment #132
8. Late Comment #3 – Clause 7.3.2.25 – Bala (11-04-821r0)
   . Problem – What does the channel list parameter which is part of the 'channel report' element pertain to (derived from the AP channel report table)? Are these channels relevant to the specific AP or is it any AP which is part of the ESS ?
   . Remedy – Clarify
   . Resolution – open – assigned to Black
9. Late Comment #4 – Clause 7.3.2.22.9 – Bala (11-04-821r0)
   . Problem – What should the RPI threshold be set to if medium sensing sub-type is not RPI time histogram?
   . Remedy – Clarify
   . Resolution – open – assigned to Kwak
10. Late Comment #5 – Clause 7.3.2.21.9 – Bala (11-04-821r0)
   . Problem – In the measurement request what if measurement duration is >= Bin Interval x Number Of Bins ?
   . Remedy – The receiver of the request should refuse it (reason being mal-formed request).
   . Resolution – open – assigned to Black
11. Late Comment #6 – Clause 7.3.2.22.8 – Bala (11-04-821r0)
   . Problem – Noise Histogram Report should bye Hidden Node Report
   . Remedy – It should be Hidden node report instead of Noise Histogram Report in this section
   . Resolution – accept – instruct editor to make change as described above
12. Late Comment #7 – Clause General – Bala (11-04-821r0)

- Problem – What is the need for autonomous reporting in 802.11k? I understand it was useful in the context of 802.11h to inform other STAs regarding the presence of a RADAR but for 11k, measurement reports should be generated only in response to specific requests so what is the point in generating and sending the reports if the receiver has no use for it ? As an exception, it may be OK to just allow autonomous site reporting by an AP to be broadcast to all STAs in the BSS since this is useful information which could be used by the STAs to use scanning and roaming optimizations.
- Remedy – Remove Autonomous reporting from 802.11k
- Resolution – open – assigned to Black relating to Comment #23

13. Late Comment #8 – Clause 7.3.2.2.26 – Bala (11-04-821r0)
    - Problem – Channel band is not mentioned or accounted for in the size of the quadruplet
    - Remedy – Replace 10 with 11 octets. Also mention channel band in the when you list what constitutes the quadruplet.
    - Resolution – decline – already addressed in 11-04-735r4 approved today
14. Late Comment #9 – Clause 11.5 – Bala (11-04-821r0)
    - Problem – In this section I notice that in the 4 paragraphs following "For the purposes of TPC" that procedures are effective if "dot11SpectrumManagementRequired" is set o TRUE. Should this not refer to 'dot11RadioMeasurementEnabled or dot11SpectrumManagementRequired' flag instead of just "dot11SpectrumManagementRequired' ?
    - Remedy – Replace “dot11SpectrumManagementRequired” with “dot11RadioMeasurementEnabled” or “dot11RadioSpectrumManagementRequired”.
    - Comment – Text reference spectrum management only
    - Resolution – decline
15. Late Comment #10 – Clause 11.7.6 – Bala (11-04-821r0)
    - Problem – “A STA may process only one periodic measurement per BSSID at any given time” – Does this refer to one periodic measurement request across all measurement types or does it refer to a per measurement type?
    - Remedy – Clarify
    - Comment – We only have one periodic measurement. Should we expand it now when we incorporate additional periodic measurements.
    - Resolution – decline – It is implicit only to one periodic measurement.
16. Meeting in recess until Thursday 1:30 PM.

Thursday, July 15, 2004
1:30 PM – 3:30 PM

1. Chairperson calls meeting to order at 1:30 PM
2. Motion to approve editor-to-do

   Motion
   Move to accept the editor-to-do comments from document 11-04-480r19 and 11-04-821r0.

   11-04-480r19 [Comment #137, 143, 132, 43 (text in minutes), 20, 16]
   11-04-821r0 [Comments #1, #6]

   Moved: Gray
   Seconded: Johnson

   For: 15 Against: 0 Abstain: 3
   Motion Passes 100%

3. Technical Presentation – MIB Comment Resolution – 11-04-816r1 & 11-04-825r0 - Gray
   a. Comment – Are the Descriptions corrections incorporated in this submission? Answer – no.
   b. Comment – There are a changes which are not address in submission

   Original Motion
   Move to instruct the editor to apply the comment resolutions in document 11-04-816r1 when preparing the next version of the IEEE802.11k draft.

   Moved: Gray
   Seconded

   New Motion Prior to Second
   Move to instruct the editor to replace TGk D0.16 Annex D with document 11-04-816r1 when preparing the next version of the IEEE802.11k draft

   Moved: Gray
   Seconded: Qi

   Motion to Amend
   Move to instruct the editor to replace TGk D0.16 Annex D with document 11-04-816r1 applying all subsequent approved MIB changes when preparing the next version of the IEEE802.11k draft.

   Moved: Black
   Seconded: Arden

   For: 19 Against: 0 Abstain: 1

   Amended Motion Passes at 100%

Amended Original Motion
Move to instruct the editor to replace TGk D0.16 Annex D with document 11-04-816r1 applying all subsequent approved MIB changes when preparing the next version of the IEEE802.11k draft.

Moved: Gray
Seconded: Arden

For: 19 Against: 0 Abstain: 0
Amended Motion Passes at 100%

4. Straw Poll regarding going to Letter Ballot

Straw Poll
Do you think TGk should go to Letter Ballot including all approved changes to the end of the session?

Yes: 8 No: 2 Abstain: 10
Affirmative on Straw Poll

5. Technical Presentation – Medium Sensing Time Histogram Corrections -11-04-763r1 - Kwak
   a. Addresses Comments #161, 162, 163
   b. Addresses - Added corresponding changes to Medium Sensing Time Histogram Request, per Bala's comments.
   c. Addresses - NAV histogram modified to indicate intervals when set, and not reset. Special value added to RPI Threshold field to use when Histogram is not RPI histogram.
   d. Joe will make motion in the evening session.
6. Technical Presentation – Comment Resolution - 1-04-762r1 - Kwak
   a. Addresses Comments (TPC Cleanup) #61, 62, 63, 65, 202, and 210
   b. Addresses Comments (Beacon Reporting Condition) #104, 219
   c. R1 addresses - Added Modifications to 10.3.16 (from TGh) to modify the MLME interface for TPC.
7. Technical Presentation - Neighbor Report Generation – 11-04-820r0 - Agarwal
   a. Question – How do you handle a down AP? Answer – manual configuration.
   b. Question – This only happens during MAC initialization? Answer – Also anytime there is a MAC change.
   c. Comment – The STAs will try to associate with Beacon, if it is one.
   d. Comment – There should be text regarding initialization. Answer – The MLME initialization is already defined in the standard.
   e. Comment – you can't delay boot time of an access point. Answer – You can pay for the delay on startup or while the AP is in service.

   Motion
   Move to instruct the editor to incorporate text from document 11-04-0820r0 into the next version of the IEEE802.11k draft.

   Moved: Agarwal
   Seconded: Moreton

   For: 1 Against: 11 Abstain: 7
   Motion Fails at .08%

Discussion on Proposal

Comment Against – Should be sending energy on a channel until you know about the channel.

Comment Against – The document is not formatted properly

The motion was out of order, because Peyush Agarwal is not a voting member.

8. Discussion on MIB Conformance Statement
   a. Comment – 11i and 11j created new conformance groups
   b. Comment – SMT5 – don't take into account 11e
   c. Olson/Black are working on submission
9. SDL Override
   a. Question – How did 11j do it? Answer – They did nothing.
   b. Comment – You only need a paragraph that describes that this is not included in the SDL.
   c. Comment – Terry will include a comment.
   d. Comment – 11i put something in Annex C
10. Meeting in recess until 4:00 PM

Thursday, July 15, 2004
4:00 PM – 6:00 PM

1. Chairperson calls meeting to order at 4:00 PM
2. Discussion on going to Letter Ballot
   - Option #1 – Empower the editor, Motion to WG asking to go to LB
   - Option #2 - Action item teleconferences aiming for LB in Sept.

   Strawn Poll
   How should we proceed to Letter Ballot:

   1 – Empower the editor, Motion to WG asking to go to LB (8)
   2 – Action item teleconferences aiming for LB in Sept. (6)

   No clear distinction.
3. Discussion on virtual access point
   - There is trend where APs act as multi BSSs.
   - Put an information element in the Probe Request thereby reducing the amount of information you get back.
   - Probe Requests can be directed or non directed.
     - If it is non-directed, some MFG only respond on primary BSS
     - If it is directed, then respond to directed BSS.
   - Beacon Request/Response might not be fully defined for virtual APs
   - Put in a “Recommended Practice” for virtual APs
4. Motion for approval of working empowerment
   Motion
   Move to request the Working Group to authorize a 40-day Letter Ballot of 802.11TGk, draft 1.0 to conclude no later than 9/13/2004.

   Moved: Gray
   Seconded: OHara

   For: 9 Against: 5 Abstain: 5
   Motion Passes at 64%

   Discussion on Proposal
   Speak against motion – Still outstanding changes to the MIB which might have to come back to working group.
   Speak against motion – Reservation on open items, we should wait one more cycle
   Speak against motion – This will slow the group overall.
   Speak for the motion – We have had plenty of comment review
   Speak for the motion – We will get Letter Ballot comments sooner
   Speak for the motion – Don’t benefit in delaying another session
   Comment – For an external observer – believes this TG has done a great job of producing a complete document.
   Comment - Because we are at the level of detail for MIB Conformance Statements we have done more than most groups.

5. Motion to Empower Editor

Motion

To empower the TGK editor to produce a Letter Ballot draft (D1.0) based on approved documents from the Portland meeting

Moved: Johnson
Seconded: O'Hara

For: 17 Against: 0 Abstain: 2
Motion Passes at 100%

6. Motion to recess passes unopposed
7. Meeting is in recess until 7:30 PM.

Thursday, July 15, 2004
7:30 PM – 9:30 PM

1. Chairperson calls meeting to order at 7:30 PM
2. Comment Review with Editor on D0.17 compliation
   . Comment #35 – Open
   . Comment #61 – Comments unclear, no action taken – addressed in 11-04-762r1
   . Comment #65 – Comments not provided, no action taken – addressed in 11-04-763r1
   . Comment #159 – Comments unclear, no action taken - addressed in 11-04-763r1
   . Comment #202 conflicts #200 - Section has been removed and motion approved to correct
   . Comment #237 – not clear – at editors discretions
   . Comment #238 – Base standard is not clear on figure format – at editors discretions
   . Comment #240 – already addressed
   . Schedule for upcoming drafts
     - D0.17 posted tonight
     - D0.18 28th
     - D0.19 posted without change bars soon after left.
3. Technical Presentation – Comment Resolution (TPC, Beacon Reporting Condition) -11-04-762r1 Kwak

   Motion

   Move to instruct the editor to apply the comment resolutions in document 11-04-762r1 when preparing the next version of the IEEE802.11k draft.

   Moved: Kwak
   Seconded: Olson
   For: 12 Against: 0 Abstain: 0
   Motion Passes at 100%

4. Technical Presentation – Medium Sensing Time Histogram Corrections - 11-040763r1 Kwak

   Motion

   Move to instruct the editor to apply the comment resolutions in document 11-04-763r1 when preparing the next version of the IEEE802.11k draft.

   Moved: Kwak
   Seconded: Qi
   For: 12 Against: 0 Abstain: 0
   Motion Passes at 100%

5. Discussion on upcoming teleconference
   a. 07/21/04 – 2 hours starting at 7:00 AM Pacific
   b. 07/28/04 – 2 hours starting at 7:00 AM Pacific
   c. Chair will setup an 800 and DID (non US)
6. Motion for empowerment for future meetings

   Motion

   Move to request the working group to empower TGk to hold meetings as required to conduct business necessary to progress the Letter Ballots, conducting teleconferences, and handling other business necessary to progress through the IEEE standards process.

Moved: Kwak
Seconded: Ecclesine
Motion Passes 100%

7. Resume discussion of virtual AP
   - Put in a information element in Beacon and Probe Responses
   - How do we get the information without active scans
   - There is language in the country code element which does not totally describe how the element is used. It is not always used.
   - What about unicast Probe Response? Virtual AP will send on a single Probe Response.
   - The 2 options (1) Create a new measurement request/report {RSSI Ping}, (2) Include a new IE in the Probe Request.
   - Phase II – Add things in the Beacon that describes all Virtual APs within transmitter
8. Moved for adjournment (Moved: Black – Seconded: Kwak) passes unopposed
9. Meeting adjourned until Berlin

802.11m Report
July 2004

Goals for July 2004

- Develop updates to standard
  - Address submissions received
  - Continue work from spreadsheet of work items

Submissions

- Are there any submissions?
  - – 04/698 Use of Status and Result Codes
  - – 04/759 Wildcard SSID
  - – 04/795 Active Scan Inconsistencies
- Are there any new interpretation requests?
  - – None

Proposed Agenda

- Review IEEE Patent Policy
- Review interpretation request procedure
- New business
  - 04/698 Use of Status and Result Codes
  - 04/759 Wild Card SSID
  - 04/795 Active Scanning
  - 03/619 tracking document
- Adjourn

Motion to adopt Agenda

- Moved: to adopt the agenda
- Mover: Simon Black, Michael Montemurro
- Passes: unanimous

IEEE-SA Standards Board Bylaws on Patents in Standards

http://standards.ieee.org/board/pat/pat-slideset.ppt

Interpretation Procedure

- http://standards.ieee.org/reading/ieee/interp/
- Send email to Linda Gargiulo (l.gargiulo@ieee.org)
- IEEE forwards requests to the WG
- WG responds

Motion #2

- Moved: to adopt the text in 04/759 and to underline the first two occurrences of “wildcard” in the normative text.
- Mover: Simon Black, Michael Montemurro
- Passes: unanimously

Motion #3

- Motion: to adopt the revised resolution proposed in 04/795 to item 27 in 04/801r0 for use of individual BSSID in Probe Requests.
- Mover: Darwin Engwer, Simon Black
- Passes: unanimously

Motion #4

- Moved: to accept the following as the resolution to item 31 of 03/619:
  - Delete "If the medium is determined bythe CS mechanism (see 9.2.1) to be unavailable, the AP shall delay the actual transmission of a beacon" and combine the remainder of that sentence with the previous sentence.
- Moved: Dave Bagby, Donald Eastlake
- Passes: unanimously

Motion #5

- Moved: to adopt the following as the resolution to item 35 of 03/619:
  - Change 9.3.2.1 to describe SIFS timing after Beacon for buffered mcast frames and first data frame or poll following mcasts. Delete "at least" from the second paragraph.
- Mover: Andrew Myles, Dave Bagby
- Passes: unanimously

Motion #6

- Moved: to adopt the following as the resolution to item 53 in 03/619:
  - Delete "in the DA field" from 7.1.3.3.2 b) 2).
- Moved: Andrew Myles, Jan Kruys
- Passes: unanimously

Motion #7

- Moved: to adopt the following as the resolution to item 50 in 03/619:
  - Change value of aPreambleLength from 20us to 16us in the table.
- Mover: Andrew Myles, Donald Eastlake
- Passes: unanimously

Motion #8

- Moved: to adopt the following as the resolution to item 57 of 03/619:
  - In the second sentence, delete "initially" and from "as provided" to the end of the sentence.
- Moved: Donald Eastlake, Jan Kruys
- Passes: unanimously

Motion #9

- Moved: to adopt the following as the resolution to item 67 of 03/619:
  - Insert the following as the first sentence of the second paragraph: "A fragment is an MPDU, the payload of which carries all or a portion of an MSDU or MMPDU." Also replace "fragment MPDU" with "fragment" wherever it occurs.
- Mover: Dave Bagby, Andrew Myles
- Passes: unanimously

Motion #10

- Moved: to adopt the following as the resolution of item 68 in 03/619:
  - Replace the "a" prefix with "dot11" before LongRetryLimit in 6.2.1.3.2 b), 9.2.4, and 9.2.5.3.
  - Also before MaxTransmitMSDULifetime in 6.2.1.3.2 h) and 9.4 (twice).
  - Also before FragmentationThreshold in 9.1.4 (four times) and 9.4 (three times).
- Mover: Terry Cole, Donald Eastlake
- Passes: unanimously

Motion #11

- Moved: to adopt the following as the resolution to item 70 of 03/619:
  - Change "dot11MultiDomainOperationImplemented" to dot11MultiDomainCapabilityImplemented" on page sta_Start_Ibss_3d(8) and 3201_d\StationConfig(5) and 14.8.2.20
- Mover: Terry Cole, Donald Eastlake
- Passes: unanimously

Motion #12

- Moved: To adopt the text in 04/698r1 and incorporate it into the draft.
- Mover: Darwin Engwer, Terry Cole
- Passes: 1/0/1

Motion #13

- Moved: To adopt the following as the resolution to item 84 of 03/619:
  - In 11.1.3.4, change dot11RegDomainsSupportEntry to dot11RegDomainsSupportedValue and add the value "Other (0)" to the "INTEGER SYNTAX" line for dot11RegDomainsSupportedValue in the MIB.
- Moved: Jon Rosdahl, Terry Cole
- Passes: unanimously

Motion #14

- Moved: To adopt the following as the resolution to item 85 in 03/619:
  - Insert "and the dot11RegDomainsSupportEntry shall be set to Other" at the end of the sentence beginning "If the dot11MultiDomainCapabilityEnabled attribute is true". See item 84 and 86 for complete resolution.
- Mover: Jon Rosdahl, Darwin Engwer
- Passes: unanimously

Work completed

- Adopted
  - Wildcard SSID
  - Directed Probe Request
  - Use of Status and Result Codes

Summary

Work Items at start	75
Work Items added	2
Work Items closed	8
Work Items to Editor	11
Work Items remaining	58
Percentage completion	51%

Output Documents

- 759r0: “Wildcard” SSID
- 795r0: Directed Probe Requests
- 698r1: Use of Status and Result Codes
- 699r0: This report
- 801r0: Tracking list of work items

Adjourn

- Meeting adjourned at 5:00pm, 7/15/2004

Attendance

- Darwin Engwer
- Andrew Myles
- Jon Rosdahl
- Terry Cole
- Donald Eastlake
- Mike Montemurro
- Dave Bagby
- Jesse Walker
- Nancy Cam-Winget
- Jan Kruys

Goals for September

- Consider new submissions
- Continue to process items in 04/801

IEEE P802.11
Wireless LANs

Minutes of High Throughput Task Group Meetings

Date: July 12-16, 2004

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Abstract

Cumulative minutes of the High Throughput Task Group meetings held during the IEEE 802.xx Plenary meeting in Portland from July 12 through 16, 2004.

Executive Summary (see closing report doc. 11-04-0839r0):

1. **14 Technical presentations were heard**
2. **Clarification made to CC67**
3. **Joint meetings were held with 802.18, .19 and .21**
4. **Decision was made not to hold elections for the technical editor and vice-chair at this meeting or the September meeting**
5. **Overview of TGn timeline was presented**
6. **Logistics for the September meeting in Berlin, where the proposals will be heard for the first time, were agreed upon. Deadline for posting proposals is August 13.**

Detailed minutes follow:

Monday July 12, 2004; 4:00 – 6:00 PM [~ 204 attendees]

:

1. Meeting was called to order by Task Group chairperson elect Bruce Kraemer at 4:02 PM
2. New participants in .11n ~25
3. Voting for the week – Straw Polls are open voting unless indicated differently, otherwise voting members only
4. Chairs' Meeting Doc 11-04-0658r0
5. Chair read IEEE Patent Policy and issued a call to make patents known
6. No patents/patent applications were indicated
7. Chair noted topics NOT to be discussed during the week:
    a. license T&Cs
    b. territorial restrictions
    c. litigation
    d. pricing
    e. market share
8. Review of May Session – 11-04-0532r0 has the submissions given at that meeting
9. Plan for this meeting:
    a. Objectives for July
    b. Opening remarks
        i. Agenda
        ii. May minutes 11-04-0496r0
        iii. Other information items
    c. Status of Call for Proposals
    d. Technical Presentations
    e. Overall TGn timeline
    f. .19 liaison planning (joint meeting)
    g. Regulatory issues discussion with .18 (joint meeting)
    h. .21 liaison planning (joint meeting)
    i. TGn organization/officer planning
    j. Planning for September Berlin
    k. Correction to CC
10. **Motion to approve agenda by Colin Lanzl and seconded by George Vlantis**
11. Discussion
    a. Include meeting time for interpretations of FRCCs? A - OK
12. Motion passed (89,0,1)
13. Motion by Garth Hillman to approve May minutes was seconded by Colin Lanzl passed without comment
14. Total Letters of Intent to Propose = 21 complete + 41 partial = 62 total

15. Countries represented by looking at email addresses of respondents
    a. Canada
    b. Finland
    c. France
    d. Germany
    e. Ireland
    f. Japan
    g. Korea
    h. Netherlands
    i. Singapore
    j. Sweden
    k. Taiwan
    l. US
16. Next Critical Date August 13 for actual proposal
17. Discussion
    a. Can one person submit multiple proposals? A – yes
18. Presentations logged to date for presentation at this session:

a.	LDPC vs CC over 11n channels	Huaning Niu	04-0682-r0	Samsung
b.	Performance comparison of antenna selection and DSTBC (M)	Henry Horng	04-0681-r0	Samsung
c.	IEEE 802.11n MAC Design Considerations	Daqing Gu, J Tao	04-0727-r0	Mitsubishi
d.	Antenna selection for MIMO systems	Andy Molisch	04-0713-r0	Mitsubishi
e.	LDPC coding for MIMO systems	Jianxuan Du	04-0714-r0	Mitsubishi
f.	Physical Layer Approach for 802.11n (M)	Mustafa Eroz	04-0746-r0	Hughes NS
g.	PHY Design for Spatial Multiplexing MIMO	John Ketchum	04-0721-r0	Qualcomm
h.	Link Level Sim results for Spatial Multiplexing MIMO	John Ketchum	04-0720-r0	Qualcomm
i.	MAC Overview (M)	John Ketchum	04-0717-r0	Qualcomm
j.	MAC Performance Results (M)	John Ketchum	04-0279-r0	Qualcomm

19. New Technical Presentations

a.	Synchronization Requirements for 802.11n	John Kowalski	xxxxx	Sharp
b.	40 MHz-20 MHz Interoperability	Jeff Gilbert	xxxxx	Atheros
c.	Channelization	John Sadowski from Intel to *precede* Gilbert's		
d.	????	Bart van Poucke	xxxxx	IMEC

20. 14 Makes a total of 7 hours at 30 minutes each
21. Sequence of Presentations?
    a. John Ketchum volunteered to present two (#s 9&10) this evening
    b. Hughes volunteered to present tonight

   c. Samsung volunteered to present #s1&2 this evening
   d. Tuesday morning volunteers?
      i. John Kowalski volunteered
22. Time Line was outlined and will be reviewed Tuesday
23. Joint Sessions topic
   a. .19 Wed. 1:30-2:30 PM
   b. .21 Thursday 8:00 AM – 9 AM
   c. .18 Wed. 2:30-3:30 PM
      i. Colin Lanzl volunteered on Tuesday afternoon to chair an ad hoc meeting to generate a set of agenda topics for the joint meeting with .18 on Wed.
24. Nominations for Officers topic thoughts:
   a. Positions
      i. Technical Editor
      ii. Vice Chair
   b. Discussion
      i. Vice Chair needed now to help handle the 62 proposals
      ii. Not much editor can do until down selection is completed and a baseline doc is established
      iii. Floor noted that a tutorial session on technical editor's responsibilities is scheduled tomorrow evening
      iv. Chair stated he had no objection to electing both at this meeting
      v. Should we defer until November meeting?
      vi. Topic will be revisited later this week
25. Berlin Logistics Thoughts
   a. Implicit – all proposal presentations will be given in September
   b. Presentation times = available time/number of proposals
   c. Speaking Order – use random number generation
   d. Merger will impact time slot durations
   e. Discussion
      i. Chair will know length of time slots when he counts number of proposals on server after August 13
26. Correction to CC67
   a. Adrian P Stephens (11-04-725r0)
      i. Revision 28 changed simulation scenarios BDF to BDE in definition column
      ii. Proposal in Revision 30 change F to E
27. **Motion that CC67 in doc. 11-03-0814 (currently revision 30) be amended so that its "disclosure" entry references channel models B, D and E, and to accept document 11-03-0814r31 thus modified as the modified CC for the TGn selection process and instruct the chair to notify the members of the updated selection process – by Adrian Stephens and seconded by Colin Lanzl passed (65,0,3)**

28. Meeting was recessed at 5:50 PM until 7:30 PM tonight.

Monday evening; 7-12-04; 7:30 – 9:30 PM;

29. Chair reconvened at 7:33 PM
30. Presentation #1 – doc. 11-04-717r0; MAC Elements for 802.11n; Sanjiv Nanda; Qualcom
    a. Objectives and Requirements for MAC Enhancements
    b. Description of Proposed Enhancements
        i. Frame Aggregation
        ii. Backward Compatible PLCP Header
        iii. Compressed BlockAck
        iv. Adaptive Coordination Function (ACF): Enhancement of HCF
        v. QoS capable IBSS Operation: RRBSS (Round robin)
    c. System Simulation Results (separate presentation)
        i. ACF
        ii. EDCA with Frame Aggregation
    d. Conclusions
        i. Detailed design of MAC enhancements for MIMO OFDM
            a. Completely Backward Compatible
            b. Enhancements required for high throughput, low latency operation
            c. Features applicable to different operating regimes
        ii. List of proposed features
            a. Frame Aggregation. Aggregation Header.
            b. Extended SIGNAL field and PPDU Type
            c. Closed Loop Rate Control and MIMO Mode Control
            d. Compressed BlockAck
            e. SCHED Message, SCAP and Scheduled TXOPs
            f. Flexible Operating Modes with ACF
            g. RRBSS – QoS capable IBSS Operation. Token PPDUs.
        iii. Simulation results for ACF and EDCA. Next Presentation
31. Presentation #2 – doc. 11-04-716r0; System Performance Results for Scenario 1; Sanjiv Nanda; Qualcom
    a. The simulator is based on NS2
    b. Includes physical layer features
        i. TGn Channel Models
        ii. PHY Abstraction determines frame loss events
    c. MAC features

i. EDCA
ii. Adaptive Coordination Function (ACF): SCHED and SCAP
iii. Frame Aggregation
iv. ARQ with Block Ack
v. Closed Loop Rate Control (DRVF and DRV)
vi. MIMO Modes (ES [Eigen spreading] and SS [spatial spreading])

d. Transport
  i. File Transfer mapped to TCP
  ii. QoS Flows mapped to UDP
e. Conclusions:
  i. TGn Usage Models Scenario 1 requirements can be met and exceeded with 2x2.
  ii. Using Scheduled operation:
    a. MAC Efficiency is in the range 74%-78%.
    b. Scenario 1 HT: Throughput can be increased to above 100 Mbps
    c. Scenario 1 LD: Video stream latency can be reduced below 50 ms (from 200 ms). Total throughput: 103 Mbps
    d. Scenario 1 IR: Range of HDTV flows can be increased from 5 m to 25 m. Total throughput: 92 Mbps
  iii. MAC Efficiency of EDCA with Frame Aggregation is around 56% for 2x2 and falls to 35% for 4x4.
  iv. Throughput with 256 QAM (7 bits per symbol after 7/8 bit convolutional coding)
    a. ~15% throughput improvement with 256 QAM
    b. By setting Maximum MCS=5 bits/symbol obtain 80-92 Mbps for IR, LD, HT.
f. Comments:
  i. Make sure to carefully document the CC scenarios

32. Presentation #3 – doc. 11-04-746r0; Physical Layer Approach for .11n ; Mustafa Eroz; Hughes Network Systems
  a. Introduction:
    i. To meet .11n requirements must use MIMO systems if S/N and power are to remain unchanged in the wireless channel
    ii. Shannon Limit codes have been discovered and have been put into real systems in the 3G systems
    iii. Turbo codes in 1999; LDPC codes in BCTV in 2003
    iv. Conclusions:
      a. Advanced LDPC codes bring the performance of practical communication system very close to theoretical limits for single-input, single-output AWGN.
      b. With clever customization and optimization, LDPC codes can approach Shannon limit for MIMO fading channels as well.
      c. We intend to submit a physical layer proposal based on a set of LDPC codes highly optimized for 802.11n application before the next meeting.

33. Presentation #4 – doc. 11-04-682r0; LDPC Codes versus Convolutional Codes over MIMO-OFDM .11n Channels; Huaning Niu; Samsung Electronics
    a. Conclusions:
        i. Performance comparison of regular LDPC codes and convolutional codes in 11n channel models B and D is presented.
        ii. The indoor fading channel provides limited timing diversity, and cause degraded coding gain for LDPC codes in SISO link [2,3]
        iii. LDPC codes can effectively utilize the spatial diversity in MIMO link and the frequency diversity
34. Presentation #5 – doc. 11-04-681r0; Performance Comparison of Antenna Selection and DSTBC [Double Space Time Block Codes]; Henry Horng; Samsung Electronics
    a. Closed Loop simulation
    b. Open Loop simulation (DSTBC)
    c. Conclusions
        i. Channel correlation matrix plays an important role in system design
            a. Performance of the antenna selection is highly sensitive to channel correlation.
            b. DSTBC has less performance sensitivity to channel correlation. It provides better performance but with higher complexity (Require more RF chains, higher MIMO detection complexity).
            c. When channel is highly correlated (channel B with λ/2 spacing), SCK antenna selection gives the best design tradeoff (less RF chains, less complexity in feedbacks)
        ii. The effectiveness of antenna selection is reduced with higher frequency selectivity (as in the case of channel model D)

Tuesday Morning 7-13-04; 8:00 – 12:30 PM [~191 attendees]

1. Chair reconvened session at 8:03 AM
2. Chair updated status of session
3. Presentation #6; PHY Design for Spatial Multiplexing MIMO WLAN; 11-04-0721r0; John Ketchum; Qualcom
    a. Complementary to Sanjiv's presentations yesterday
    b. Introduce new OFDM symbol, long 256 sub-carriers to reduce overhead due to cyclic prefix
    c. Fully backward compatible with 802.11a/b/g
        i. 20 MHz bandwidth with 802.11a/b/g spectral mask
        ii. OFDM based on 802.11a waveform with additional long OFDM symbols (256 sub-carriers)
    d. Modulation, coding, interleaving based on 802.11a
        i. Expanded rate set
    e. Scalable MIMO architecture
        i. Supports a maximum of 4 wideband spatial streams

f. Two forms of spatial processing
    i. Eigenvector Steering (ES): via wideband spatial modes/SVD per sub-carrier
        1. Tx and Rx steering
        2. Over the air calibration procedure required
    ii. Spatial Spreading (SS): modulation and coding per wideband spatial channel
        1. No calibration required
        2. SNR per wideband spatial stream known at Tx
g. Sustained high rate operation possible via adaptive rate control
h. Only STAs need to calculate the SVD and sends resulting training sequence to AP
i. Summary
    i. MIMO PHY design builds on existing 802.11a,g PHY design
    ii. Two operating modes provide highly robust operation under a wide range of conditions
        1. Eigenvector Steering (ES) provides best rate/range performance
        2. Spatial Spreading (SS)
    iii. Adaptive rate control through low-overhead rate feedback supports sustained high throughput operation
    iv. Low-overhead training sequence exchange supports high-capacity Eigenvector Steered operation for best rate/range performance
    v. Spatial Spreading operation provides robust high throughput operation when Tx does not have sufficiently accurate channel state information

4. Presentation #7; 802.11n MIMO Link Performance, Some Simulation Results; 11-04-0720r0; John Ketchum; Qualcom
    a. Outline
        i. MIMO system overview
        ii. Link simulation overview
        iii. Preliminary simulation results:
            1. Throughput and PER performance with 802.11n channel B and rate adaptation (CC67)
            2. PER vs. SNR performance in AWGN (CC59)
        iv. Hardware prototype summary
    b. Summary
        i. Eigenvector steered mode supports high throughput operation in 2x2 and 4x4 configurations
        ii. Stable wideband spatial channels synthesized from Eigenmodes easily support 256 QAM under full PHY impairments
        iii. High throughput eigenvector steering operation proven in hardware prototype
    c. Questions
        i. none
5. Presentation #8; Synchronization Requirements and Solutions for 802.11n; 11-04-0775r0; John Kowalski; Sharp
    a. The Problem

i. Consumer electronic devices figure prominently in 802.11n usage models.
ii. CE devices however, require tight synchronization to maintain high quality audio if multicasting is done.
iii. This presentation presents some results on the state of the art for synchronization in 11a, and recommendations to improve it for 802.11n.
iv. Without some solution in this regard, the user experience of CE over 802.11n may be compromised.

b. Conclusions
    i. The use of 8 byte 10ns unit time stamp in all QoS packets should be considered as option.
    ii. A great improvement from legacy 802.11 (10us to 25ns) can be achieved.
    iii. Synchronization can be further improved to acceptable stereo audio level by using higher precision oscillators (10ns)
    iv. Presently investigating the effects of synchronization when MIMO preambles, other information, other preamble formats, etc. are used.

6. Presentation #9; 40/20/10 MHz Channelization for Robust, High-Performance, Cost Effective 802.11n Operation; 11-04-0786r0; John Sadowski; Intel
    a. Why is this important?
        i. Cost and Performance
            1. Shannon's law
            2. For comparable RF configurations
            3. Higher S/N is higher cost therefore lower S/R is preferred
            4. MIMO => multiple radios AND higher SNR
        ii. Just increasing the channel BW most cost effective way to meet .11n spec
        iii. Issue is that a wider channel reduces overall system capacity
        iv. Not clear that two 20 MHz disjoint channels offers more system capacity than one 40 MHz channel
        v. Gave cellular reuse example
        vi. Simulation conditions enumerated
        vii. Result – 40 MHz channel gave higher reuse numbers
        viii. Conclusion 40 MHz is, wrt 20 MHz
            1. Robust
            2. Low cost
            3. Low Power
        ix. Questions
            1. Would nearest neighbor problem not be exacerbated? A – not if the receiver adjusts RX threshold
            2. Why 40 MHz mandatory vs Optional? A – you will loose efficiency if majority of BSS is 20 MHz
            3. How do you deal with regulations which don't allow 40 MHz? A – cannot make spec which ties mandatory to the regulatory requirements of a country
            4. How many rings? A – two rings and only co-channel

5. Channel propagation? A – TGn channels

7. Chair recessed meeting at 9:53 AM until 10:30 AM tomorrow morning

Tuesday 7-13-04; 10:30 – 12:30 PM

8. Chair reconvened meeting at 10:31 AM
9. Tech. Presentations
   a. Completed 9
   b. 5 left one of which has been withdrawn
   c. These will be slotted for Wed. at 4 PM
10. Chair introduced Time Line topic
    a. Relative to initial time line (11-03-488) we are ~ 1 year late
    b. At present, using average of other TG's we would get a ratified standard Dec. 2006 at the earliest
    c. Proposed the following dates as Schedule Highlights
       i. Issue First Letter Ballot on Draft 1.0 July 2005
          1. 3 sessions to review edit (Sep, Nov, Jan)
       ii. Issue First Sponsor Ballot Mar 2006
          1. 3 sessions to review & edit (May, July, Sept)
       iii. Complete Sponsor ballot – accepted by ExCom Nov 2006
       iv. Publish Mar 2007
11. .19 Joint Meeting Wed 1:30-2:30 PM
    a. Goal - to assure that the proposed .11n standard and existing 802.xx standards will coexist
    b. Suggested change to PAR P&P - TG must issue a CA (Coexistence Assurance) doc
    c. No Discussion re: .19
12. .18 Joint Meeting Wed. 2:30-3:30 PM
    a. Topics
       i. MIMO
       ii. Regulatory issues around 40 MHz channelization
    b. Ad hoc meeting at 1:30 in hotel lobby to prepare a list of topics
13. .21 Joint meeting 8-9 AM Thursday Morning
    a. .21 doc for now must be retrieved from IEEE site not Wireless World
    b. Should we form an official Liaison?
14. Officer Nominations Topic
    a. On Monday Chair suggested Tech editor could be elected on Thursday and Vice Chair in November
    b. Additional thought
       i. tech editor will not have a doc to edit until after the down selection process

ii. use WG vice chairs to help prepare for September "Proposal" meeting

c. Chair considering "not" holding officer elections until Nov. at the earliest

d. Discussion

i. Why are we delaying this election? A – not enough work

ii. Let's hold straw poll? OK

iii. .11r and s have already elected a tech editor; what is different in our case? A – .11s chair said they wanted to have an editor to 'hit the ground running'

iv. Straw Poll – When do you want to hold officer elections?

1. July 2004 – 19
2. Later – 39

v. Chair said Nominations are now open for vice-chair and technical editor but the elections will not happen until Nov. 2004 at the earliest

15. Chair turned body over to Colin Lanzl and his ad hoc committee to develop an agenda for the .18 Joint meeting and the following questions/topics were generated:

a. Is the use of MIMO legal in all the important regulatory domains (NA, China, Japan, EU)
b. Are extended channels (multiples of 20 MHz a/g) legal 'All The Important Radio Regulatory Domains (ATIRRD)'
c. Are the 802.11 agh radio emission rules applicable in ATIRRD (TX power, DFS/TPC; channels; channel mask; …)?
d. What is the process of interacting with regulatory bodies; history and prior results
e. Is beam forming legal in regulatory domains? If yes how is it measured
f. If Regulatory Domains (RDs) don't have uniform rules how should .11n respond
g. If FRs violate any RD requirements, how can .18 help?
h. How is output power measured (per antenna or aggregate?)
i. Will DFS and TPC become a requirement in the US for all bands and when
j. How will DFS/TPC impact .11 in general and .11n in particular
k. When will the test procedures be in place to allow certification to occur
l. How does TGn deal with radar detection and channel avoidance
m. Has the FCC widened the 2.4 ISM bands or does it plan to do so?
n. What are the specifications across the regulatory domains? Will they enforce the spectral mask as well as the out-of-band emission across the band and bands beyond
o. For the extended channels what is the required output power and PSD mask that will be allowed?
p. Will RDs spec specific wave form modulation in addition to PSD masks?
q. Will RD constrain access methods (e.g., TDMA, OFDMA, …)?

16. Action - Colin will create a submission and send it to the .11n chair who will forward it to the .18 chair before Wed. meeting.
17. Chair recessed meeting at 11:45 and will reconvene at 1:30 PM on Wed.

Wednesday 7-14-04; 1:30 – 3:30 PM

1. Chair reconvened meeting at 1:34
2. Chair opened Joint meeting with .19 and Chair Steve Shellhammer and Vice-Chair Tom Siep
3. Proposed P&P rules change (19-04-10r6)
4. Will use balloting process to solicit acceptance
5. CA prior to first LB ballot but AFTER the down selection process
6. What is CA doc (19-04-25r0)
    a. Two way street
    b. Must coexist with CURRENT standards not drafts
    c. CA should reference (hopefully) an interference model for interference with EACH of the 802.xx standards
    d. Analysis needs to be in the ball park not +/- 1 dB
    e. Not intended to materially slow down the standardization process
    f. Show trends of relative performance
7. Questions:
    a. What is expected to happen at Ex Com (Paul Nikolich) on Friday? A – approval of Ex Com LB to affirm adoption at the Nov Plenary meeting
    b. Could you maintain a list of 802.xx bands licensed and unlicensed? A – unlicensed for sure
    c. Will .11n be grandfathered? A – as things have developed recently, probably not! This is a change
    d. How should .11n maintain relationship with .19? A – Colin Lanzl volunteered to be the liaison at the WG level
    e. Roles for Liaison? A – report to WG AND help development of the CA doc
    f. Chair asked Colin to create a document defining the duties of the Liaison spanning entire WG as well as .11n. Colin agreed and chair agreed to devote time at Thursdays' meeting for group comment and affirm the submission
    g. Prototype of CA? A – not now; presently working on methodology document
8. Floor suggested we use the 20 minutes before the .18 Joint Meeting to ask the TG for a list questions relating to the logistics of the Berlin meeting:
    a. What precisely must be uploaded on August 13 - doc, presentation, results?
    b. What can change wrt material on the server after Aug 13?
    c. Can new material be presented on the server after Aug 13?
    d. How many hours before the start of the session can anything be changed?
    e. If the numbers of presentations drops significantly can >1 hour be allotted?
    f. Partial and full presentations given at the same time?
    g. Can you yield your time?
    h. Can you yield your time to someone in particular?
    i. Any limitations on time for those that have submitted many partial proposals?
    j. Are there any limitations to what can change between rounds?
    k. Review logistics to voting rounds

    l. Adrian will submit a submission listing the questions above. (doc. 11-04-0817r0)

9. Chair recessed at 2:17 until 2:30 at which time the .18 Joint meeting will be started.
10. Chair reconvened at 2:43 PM
11. Joint Meeting with .18 Radio Regulatory
    a. .11n questions for Carl in (11-04-0789r0)
        i. MIMO legal in ALL reg domains? A – No; in US channel bonding using MIMO may be controversial
        ii. Expand 2.4 band? A – nothing published yet in the US
        iii. How will bonded channels be handled? Expected that bonded channel would be uniform in the center. A – TBD in US
        iv. Will regulatory bodies spec modulation etc in addition to PSD? A – trend is to allow innovation
        v. Carl commented 183 states represented at the ITUR!! Most regulations not published in English
        vi. Can we formalize answers to these questions? A – Carl said he would get formal answers as time permits however .11n needs to formalize the questions first
        vii. Also, Julius Knapp from FCC will attend the Nov meeting
12. Andy Gowan from UK Office of Communication (Ofcom) took a crack at answering the set of questions in (11-04-0789r0)
    a. Are MIMO techniques legal? A – legal as long as allowable EIRP is not exceeded at any instant in time by the devices antenna array; note, this will apply to MIMO techniques using transmission delay techniques
    b. Bonding? A – limited by PSD and EIRP per ECC decision and ETSI standard; ETSI limited to 20 MHz channels; ETSI is presently reconsidering the 20 MHz limit; at present there is no channel plan in the ECC 5GHz decision; in general there is no channelization plans in the 2.4 GHz bands in Europe, just a PSD and EIRP limit
    c. Beam Forming? A – see b above
    d. DFS? A – limits based on PSD relative to 1 MHz ; EIRP gain achieved from beam forming still limited by EIRP limits
    e. OFDM or TDMA? A – no issue, quite open in ETSI standard and ECC decision do not mandate any modulation
    f. Jan Kruys was one of the authors of a paper by Intel and Cisco on MIMO and channel bonding techniques which was submitted to CEPT and he volunteered to make the content available which could be used as the basis of a submission to 801.11n.
    g. Andy stressed that these are his interpretations of the current rules and he recommended that the questions be formalized and submitted to Ofcom UK for an official answer.
13. Any other business?
    a. Review the agenda for remainder of this session?
    b. Presentations this afternoon (5 pending); Andy and Geoff will present first after the break
    c. .21 meeting tomorrow morning
    d. Plans for Berlin
14. Chair recessed the meeting until 4:00 PM at 3:23PM
15. Chair reconvened the meeting at 4:04 AM

16. Presentation # 10; 40 / 20 MHz Interoperability for Robust, High Performance, and Compatible 802.11n Systems; 11-04-0772r0; Jeff Gilbert; Atheros
    a. Introduction
        i. In IEEE presentation 802.11-04/0786, we described the benefits of 40 / 20 / 10 MHz channelization for speed, robustness, and low-cost
        ii. One key design issue is how to coexist and interoperate with legacy 20 MHz devices while operating in 40 / 20 MHz mode
        iii. Efficiency is critical – the legacy interop mechanisms cannot notably degrade performance (e.g. 11g)
        iv. This presentation details the 40 / 20 MHz PHY-level interoperation mechanisms
    b. Conclusions:
        i. Full interoperability between 20MHz and 40MHz
            1. Use differential sub-channel energy to detect 20MHz vs. 40MHz signal
            2. Duplicate legacy compatible preamble in 40MHz signal
                a. 20MHz STA can decode legacy SF (Signal Field)
                b. 40MHz STA can use simple combining scheme to decode both 20MHz and 40MHz signals
    c. Questions:
        i. If adjacent 20 MHz channels in use, what happens? A – packet silence techniques; yes 3 dB penalty for 20 MHz channel just to get the Signal field (SF)
17. Presentation #11; Antenna selection and RF processing for MIMO systems; 11-04-0713r0; Andy Molisch, MERL
    a. Outline
        i. System model
        ii. Performance analysis
        iii. Antenna selection algorithms
        iv. Effect of nonidealities
        v. RF preprocessing
        vi. Summary and conclusions
    b. Summary and Conclusion:
        i. antenna selection retains the diversity degree, but SNR penalty
        ii. for spatial multiplexing, comparable capacity if $Lr \geq Nt$
        iii. optimum selection algorithms have complexity N!/(N-L)!; however, fast, good selection algorithms exist
        iv. for low-rank channels, transmit antenna selection can increase capacity
        v. channel estimation errors do not decrease capacity significantly
        vi. frequency selectivity reduces effectiveness of antenna selection
        vii. RF preprocessing greatly improves performance, especially in correlated channels
        viii. Covariance-based (beam forming) preprocessing especially suitable for frequency-selective channels
        ix. switches with low attenuation required both for TX and RX

x. antenna selection is attractive for reducing hardware complexity in MIMO

18. Presentation #12; Preambles for MIMO Channel Estimation; (11-04-0794r0), Andre Bourdoux; IMEC
    a. Motivation
        i. MIMO-OFDM is key to achieve 100 Mbps at the MAC SAP
        ii. Conventional SISO preamble (11.a, g) is not sufficient
        iii. MIMO channel estimation requires a new preamble
    b. Recommendation
        i. Several preamble structures are possible for MIMO channel estimation
        ii. Preambles with simultaneous transmission from all TX antennas are mandatory $\Rightarrow$ no problem from AGC
        iii. Least-square solution provides better estimate, is mandatory for FDM-based preambles
    c. Questions
        i. Was Noise AWGN? A-y
19. Presentation #13; Transmit Processing a Viable Scheme MIMO – OFDM in 802.11n ; (11-04-0792r0), Andre Bourdoux; IMEC
    a. Recommendations
    b. MIMO-TX and MIMO-RX schemes are both interesting for 802.11n
    c. MIMO-TX needs channel knowledge at TX side
        i. Estimation in reverse link has lower latency
        ii. Delay between reverse link estimation and MIMO-TX transmission must be minimized
        iii. must be supported by MAC Protocol
    d. MIMO-TX has been demonstrated
        i. Real-time (VHDL, 5GHz band)
        ii. Wireless, 2x2 antennas
        iii. MIMO-OFDM-SDM (108 Mbps) and MIMO-OFDM-MRC (8 dB SNR improvement)
    e. Questions:
        i. None
20. Presentation #14; Co-Channel Interference in.11n Networks; (11-04-0819r0); Aon Mujtaba; Agere Systems
    a. System A
        i. Target a max PHY throughput greater than 200Mbps
        ii. Constrain BW to 20MHz
        iii. introduce 4 transmit antennas for spatial multiplexing
        iv. Assume 4 receive antennas
        v. 64QAM, R=3/4, GI=0.8us, 64-point FFT
        vi. Achieve: 216Mbps
        vii. System A: “4x4x20”

b. System B
   i. Target a max PHY throughput greater than 200Mbps
   ii. Enhance BW to 40MHz
   iii. introduce 2 transmit antennas for spatial multiplexing
   iv. Assume 2 receive antennas
   v. 64-QAM, R=3/4, GI=0.8us, 64-point FFT
   vi. Achieve: 243Mbps
   vii. System B: “2x2x40”
c. Conclusions:
   i. In an isolated cell, bandwidth expansion coupled with spatial multiplexing provides a more robust path to throughput enhancement
   ii. 2x2x40MHz is ~5dB more robust than 4x4x20MHz at 1% PER
   iii. In a multi-cellular deployment:
   iv. BW expansion increases Co-Channel interference
   v. SNR degradation due to CCI increase is balanced out by increase in link robustness
   vi. “comparable” capacity of 2x2x40 and 4x4x20 systems

21. Chair announced that all known presentations have been given
22. Chair reviewed morning session plans – Joint .21, plans for Berlin
23. Chair recessed at 5:42 PM until tomorrow morning 8:00 AM

Thursday Morning; 7-15-04; 8:00 AM

1. Chair convened the meeting at 8:02 AM
2. ~ 50 .11n members and ~20 .21 members were in attendance at 8:10
3. Joint meeting with .21 commenced
   a. Ajay Rajkumar (Lucent); Joint IEEE .21 and TG .11n Meeting doc (21-04-0082r0)
      i. Introduced his team
      ii. Focus – Facilitate roaming across heterogeneous networks
      iii. Some Elements of a solution might include
         1. Some ‘make before break’ mechanism
         2. Network neighborhood discovery mechanism needed
         3. Standardized MAC interface to higher layers
            a. MAC service model (e.g., Some sort of QoS continuity i.e., a QoS service/mapping leading to admission control)
            b. Transport link delivery
         4. Heterogeneous networks – e.g., Cellular and WLAN

iv. Questions:
1. How to handle different MAC layer architectures? A- use/define a new layer just below the IP layer
2. How will we get Cellular to cooperate? A – service continuity and session continuity is being investigate by Cellular as we speak

b. Bruce Kraemer, chair of .11n, described goals and status of TGn (11-04-0824r0)
i. Amendment to standard
ii. >100 Mbps at MAC Data SAP (not over-the-air rate)
iii. We are at the CFP stage and will hear initial proposals in Sept 2004
iv. LDPC coding, channel expansion, aggregation, MIMO are some of the likely candidates to be offered for the new standard
v. MAC SAP interface will not be altered
vi. Backward compatibility with .11 in at least one mode is a requirement with .11 and its amendments a,b,d,e,g,h,i,j assumed as the baseline to be backward compatible with
vii. Timeline reviewed
1. 1^{st} LB fall of 2005 with 1^{st} publication in 2007

4. Questions:
a. How does .21 fit with TGr and WIEN? A - TGr will deal with intra-ESS roaming and .21 will deal with inter-ESS. The question is the definition of an ESS; the relationship with WIEN is still under discussion
b. Will .21 protocol enable traffic across 3GPP - .16 - .11n interfaces? A - basically, that is the hope; the concept is just as cellular uses AAA service agreements today with other operators, why not .11 and .16?
c. What is the timeline to formulate interoperability mechanisms? A by Chair – within the next year; i.e., before the 1^{st} draft
d. What does .21 need from TGn? A – TBD but will take as an action item within the 1 year window
e. Would .21 simulations be useful? A – too late to include in our down selection process as those have been defined in the CC and FRs but TGn would be open to inputs/useful mechanisms and would endeavor to incorporate them in the standard; the object is after all, a standard of high technical quality
f. Straw Poll - .11n members interested in establishing a WG liaison with .21 – (18 for,1 against,16 abstain)
g. Straw Poll - .21 members interested in establishing a liaison with .11 - (12,0,0)

5. Colin Lanzl lead a discussion re: Liaisons in general; (11-04-0823r0)
a. Motion by Adrian Stephens that the .11n chair request of the .11 WG Chair that a formal liaison with .19 be created was seconded by Steve Shellhammer passed (44,0,2)

6. Chair lead discussion of Logistics for Berlin doc. (11-04-658r3)
a. Overarching goal – timely high quality technical amendment
b. Answers to doc. 11-04-0817
i. Maximum time will be made available in Sept. meeting = 34 hours
ii. 62 presentations => ~.5 hours per presentation

iii. Equal time => time pool/# presentations
iv. All presentations will be heard in Sept.
v. Final time will be done on morning of Sept. 13
vi. No changes to presentation, order or time allocations after presentations begin on Monday Sept. 13
vii. Speaking order established on Monday Sept. 6
viii. Order will be established using a random process overseen by .11 WG chair
ix. Speaking order will be communicated asap on Monday Sept 6.
x. Doc. 11-04-0796r0 to be posted on Wireless World and will contain speaking order
xi. How to handle changes to docs posted on 8-13-04
    1. Presentations will be frozen for the week on morning of Sept 13
    2. Selection procedure doc remains (11-04-665r9) and contains definitions of Partial and Complete proposals
    3. What about mergers occurring in 10 day interval before Sept. 13?
    4. How do we handle the post presentation panel discussion?
    5. Potential solution - Mergers and re-presentations would be given in Nov, not Sept and followed by a panel discussion
    6. Voting would BEGIN in Nov. in San Antonio at the earliest
    7. What needs to be posted?
        a. Compliance with FRs, table 3.1 in FR doc
        b. Comparison Criteria table in section 4 of CC doc (pages 6-16)
    8. Discussion
        a. Limitations on changes between rounds of voting? A – none since changes are encouraged between rounds
        b. Limitation on time for those who have registered presentations? A – fixed
        c. Will everyone who is presenting know when the other presenters are presenting? A – yes
        d. To accommodate orders of the day in other Task Groups can presentation slots be exchanged? A – After discussion the conclusion was that presentation slots cannot be exchanged.
        e. Is swapping in general allowed? A – no
        f. Once agenda for week of Sept is approved at the start of the session it cannot be changed? A-yes
        g. What precisely must be on server? A – FR and CC material
        h. If someone opts out will slots be moved up? A – yes; accordion process
    9. Chair recessed at 10:02 until 10:30
    10. Chair reconvened at 10:37 AM
    11. Return to Discussion of Berlin Logistics
        a. Only complete presentations have voting status

b. Partials can be combined to create a complete proposal; partials can combine with complete proposals to create a new complete proposal
c. First voting will take place in November at the earliest
d. How do we handle the merged presentation posting after Berlin? A – probably use the same format by requesting merged proposals be put on server in advance (at least 10 days) of November meeting
e. What must be posted? A – Presentations, FR compliance, CCs, simulation results
f. How much can change between 8-13 and 9-13? A – honor system, up to membership to decide with their votes
g. Chair will take all comments into consideration and will create a separate procedure clarification doc and post by next week
h. Adrian will repost his questions doc 11-04-0817 with the answers developed in the meeting today

12. Colin Lanzl motioned to adjourn this July session and was seconded by John Kowalski passed by acclamation.
13. Chair adjourned the July meeting at 10:52 AM
14. See you in September

IEEE P802.11
Wireless LANs

Minutes of WAVE Study Group

Date: Portland, July 12 -16, 2004

Author: Filip Weytjens
Transcore
filip.weytjens@transcore.com

Tuesday, July 13, 2004 4:00PM Session

The meeting was started by Broady Cash. (ARINC) at 4:05PM. Broady substituted Lee Armstrong as the chair of the WAVE sessions. He went over the policies and rules and mentioned that there would be no meeting on Thursday.

The objective of the meeting was to discuss the amendment for WAVE and comments on the PAR and 5 criteria. At this point the letter ballot has passed and excom is reviewing the PAR and 5 criteria. A motion needs to be presented to the 802.11 body to extend the working period of the study group.

Minor changes were proposed to the agenda, which were approved by the group.

The minutes from previous meeting (May 2004) were reviewed and approved by the group.

The document under discussion was available on the server (document nr 11-04-0793-00-WAVE). It was presented by Broady. He discussed the DSRC concept, usages and the rules for the control and service channels. The definitions were addressed for the WAVE information element and action frame including the PST, VST, and safety messages. The different scenarios were described that are supported by the WAVE technology and he also discussed the supporting network technology.

The meeting was adjourned at 5:15PM until 7:30PM.

Tuesday, July 13, 2004 7:30PM Session

The meeting started at 7:30PM.

Broady further discussed the presentation. The spectral masks were discussed and further detail was provided for the WAVE Information elements, and Action frames.

A question was raised on the beacon interval. Justin Mcnew (Technocom) explained that the beacon interval on service channel and control channel was the same and that the mechanism was already defined in 802.11h.

The meeting was adjourned at 8:00PM.

Tuesday, July 13, 2004 8:00 AM Session

The meeting was started by Broady Cash. (ARINC) at 8:05AM. The goal was to address comments to the PAR and 5 criteria. No comments were received and therefore, the meeting recessed to prepare the motion.

The meeting was recessed at 8:10AM till 8:30AM.

The meeting reopened at 8:30AM with the motion to extend the Study group. The motion stated "Believing that sufficient interest continues and that the PAR and 5 criteria can be completed per IEEE-SA guidelines during the extension period, it was requested that 802.11WG continue the charter of the WAVE-SG through January 2005 meeting." Wayne Fisher and Tom Schaffnit moved the motion. The result was 30-0-0.

The meeting was adjourned at 8:45AM.

IEEE P802.11
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TGr Meeting Minutes for July 2004 Session

Date: July 12-16, 2004

Author: Michael Montemurro
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Monday May 12, 2004
4:00pm

Chair: Clint Chaplin
Secretary: Mike Montemurro

- Call to order
- Agenda – Document 11-04/761r0
- Review operating rules for a Task Group.
- Review IEEE 802 policies and procedures for Intellectual Property.
- Election of Task Group Secretary:
  - Michael Montemurro is the only person who has volunteered for this role.
  - Michael Montemurro is acclaimed as Task Group Secretary.
- Approve meeting minutes from last meeting 11-03/520r0.
  - No objections to approving the minutes.
- Approve teleconference meeting minutes 11-04/664r2.
  - No objections to approving the minutes.
- Election of Task Group Technical Editor:
  - Bill Marshall is the only person who has volunteered for this role.
  - Bill Marshall is acclaimed as Task Group Technical Editor.
- Discussion on the Agenda – Document 11-04/761r0.
  - Remarks on the agenda content – None.
  - Call for presentations:
    - Nancy Cam Winget – Establishing PTK Liveness - Document 11-04/707r0.
    - Jeremy Spilman – Roaming Test Methodology – Document 11-04/748r0.
      - This sounds like a proposal for a core document.
      - Why do we need a test methodology?
      - We need to be able to define a definitive test methodology to compare proposals.
      - We could compare proposals on an ad hoc basis without a test methodology defined.

    - Marian Rudolf – Discovery and Passive Scanning Discussion – Document 11-04/718
    - Marian Rudolf – Make before break handover – Document 11-04/719
        - Isn't Discovery out of scope for this work? This may be an informational presentation.
        - Do we have an approved scope document at this time? No, but we have an agenda item to discuss the scope document.
  - Any objections to approving the agenda as Document 11-04/761r1?
    - None
  - Agenda is approved.
- Discussion on Fast BSS-Transition Requirements – Document 11-04/666r1
  - Any objections to the Chair leading the discussion on this document? None.
  - This document hasn't been updated with the changes from the teleconference
  - Table this discussion until the document has been updated.
- Discussion on Fast BSS Transition Use Cases – Document 11-04/677r1
  - Perhaps we should split authentication from key management (key management being the handshakes and so forth).
  - Should we consider full authentication vs. pre-authentication?
  - The current table of use cases multiplies out to 135 combinations, some combinations are easy problems, and some combinations are hard problems.
  - The entries in the table are independent; that is, the entries in a particular row are not related.
  - Do we want to discuss fat AP architectures vs. wireless switch architectures?
  - AS communication time is not under TGr's control, and may not be under the control of the user.
  - The QoS decision result may not be done in the AP; the AP may refer to a central controller.
  - What's the minimum value for the roaming time metric?
  - Do we need to make an assumption about the AS architecture that the DS has?
  - We should take scanning time into account.
  - We can't define the DS problem away. Must be able to do fast roaming in a slow DS.
  - Components for Security and QoS that are normally in discovery phase may fall into TGr scope.
  - Parts of the solution that are demonstrably broken shouldn't be accommodated.
  - Can't assume DS architecture or AS architecture (We need to capture in requirements doc.)
  - What is meant by RF coverage overlap? What cases should we attempt to solve, and which can we safely ignore (if we do inadvertently solve it).
  - There should be at some point in each proposal in indication of just which frame that triggers the switch of data from the old AP to the new AP. (unclear from discussion if this should be mandatory).
- Recess until the Monday evening session

Monday July 12
7:30pm

- Call to order
- Continue Use Case document discussion:
  - Do we want to cover unplanned roaming versus "planned" roaming?
  - Unplanned roaming is cut-off from an AP.
  - At the point where we make a roaming decision, does it matter how the decision was reached (i.e. unplanned roam).
  - There are conditions under which you can do a fast roam and there are other conditions where you can't.
  - Some proposals may be applicable over more scenarios
  - The Access Point could force a STA to move
  - Add "planned" versus "un-planned" roam to use cases.
- Should we create a document to describe how roaming works now?

STRAW POLL: Should TGr describe the current process for BSS Transition?

a) Yes
b) No

Result: a – 29; b – 0.

MOTION: Move that TGr should describe the current process for BSS Transition to be included as informative text in the IEEE 802.11 TGr draft.

By: Charles Wright
Second: Bill Brasier
DISCUSSION: None.

Result: Yes - 20; No - 0; Abstain - 0. Motion passes.

- Volunteers to create the text: Bob Beach, Nancy Cam Winget, Haixiang He, Bill Brasier
- There are current guidelines for engineering an 802.11 network. Fast BSS-Transition assumes a well engineered network. Perhaps we need to define what that is.
- This sounds like a discussion we have earlier.
- We could document this in a use case.
- This would likely need to go into the requirements document.
- Discussion on the selection procedure:
  - How formal do we want this process to be?
  - Should we do this on an adhoc basis? We likely won't have a universal best.
  - TGn spend a year preparing documents before they called for proposals. They did a lot of work.
  - The formal process in not ambiguous.

STRAW POLL: All those who think they may bring a proposal for Fast Roaming to TGr, or know someone you might.

a) Number

Result: a – 8.

  - Take a look at Document 11-03/665r9
    - They had Functional Requirements, Comparison Criteria, Usage Models.
    - They classified the proposals as complete or incomplete.

- Partial proposals may be combined to form a complete proposal.
- We need to decide what makes a proposal complete for our group.

STRAW POLL: All those who think they may bring a proposal for Fast Roaming to TGr, or know someone you might.

a) Craft a solution to the Fast Roaming problem as a body of the whole
b) Select a proposal from a group of candidates
c) other

Result: b – unanimous.

STRAW POLL: Does TGr want to use a formal selection process?

a) Yes
b) No

Result: a – 23; b – 0.

- We don't need to go through Comparison Criteria because all proposals are likely to meet the requirements.
- The possibility of 8 or more proposals dictates that there should be a formal selection process.
- Did TGi have a formal selection process? No.
- Should TGi have had a formal selection process?
- TGi crafted their proposal as it goes – the group had to go through the learning process
- The Chair will complete his selection process document and present it tomorrow – time permitting.

- Recess until the first session tomorrow

Tuesday July 13

8:00am

- Call to order
- Discussion on the TGr Scope, Document 11-04/678r1
  - Is 802.11F in scope?
  - 802.11F is due to expire some time around now?
  - The content of 802.11F can be folded into a TGr amendment.
  - WEIN in the document should be WIEN.
  - Should replace Auth (Authentication server) with AS, the 802.1x acronym.
  - Make VLAN/SSID mapping should be in scope.
  - BSS-Transition should be out-of-scope.
  - What about APSD and 802.11e compliance?
  - Do we want to support Fast Transition if the STA is in Powersave mode? Yesterday we determined no.
  - Legacy power save should be out of scope. APSD should be in scope.
  - Determine the ability to support BSS-Transition for non-overlapping cells are in scope.
  - Support for tangential cells should be in scope.
  - Do you want to solve Fast BSS-Transition for the case where the STA cannot communicate with either AP for an interval in time?
  - We are assuming that changing frequencies are instantaneous seeing several AP's at the same time.
  - From a STA point of view, the STA doesn't know whether it's in or out of range until it sends a packet.
  - There are other ways to know about an Access Point without data communications. (for example, TGk has mechanisms to give the location of Access Points).
  - Most well designed networks are designed for overlapping coverage.
  - Customers decide how much overlapping coverage they want.
  - There are mechanisms that could be designed to work without overlapping coverage.
  - Do we want to assume that in all solutions, the STA must be able to see at least two AP's.
  - We require that the STA be able to see at least one AP at one time.
  - We need to define what it means to be tangential coverage.
  - It relates to whether we allow the overlapping coverage definition in the Use Case document to have a negative value.
  - We need to determine whether the mechanism for a STA to select a candidate AP for roaming is in scope.
  - Why is load balancing out of scope?
  - TGk is defining the candidate AP list and the site report and is out of scope for TGr
  - TGe is also giving hints to STA to facilitate roaming
  - It is out-of-scope for TGr to define the algorithm for the decision to roam.
  - The cause for the BSS-Transition is out of scope.
  - We are trying to solve the "how", not the "why" of BSS-Transition.
  - A STA could hint about an impending move to another AP.
  - TGk may not need to address the TGr requirements in a timely manner.
  - We are focused on Fast Handoff and we are ignoring the most timely component of Fast Handoff.

  - Why is BSS-Transition determination out of scope?
  - Different applications need to use different algorithms to make roaming determinations.
  - There has to be enough information so that the STA can make a roaming determination.
  - The roaming decision is a STA decision unlike the Cellular network. The AP provides information.
  - TGk and WNM provide information to the STA in order for it to make roaming decisions.
  - There have been proposals made to push the scanning process before the roam.
  - Any scheme for fast BSS-Transition should indicate when the scanning occurs. These elements should be part of the solution proposals.
  - The scan could be a continuous long-term process could take minutes and not interrupt data transmission.
  - We should add the reasons for our conclusions that are described in the scope document.
  - We may want to bring the discussion up again on Thursday.
- Discussion on the Selection Procedure:
  - The procedure discusses partial solution versus complete.
  - There could be complementary proposals, which could be combined into a single complete solution.
  - There are comparison criteria in the process – should we put comparison criteria together?
  - If we don't know exactly know what we're trying to solve, how are we going to define the comparison criteria.
  - The criteria could be that we want to have fast BSS-Transition occur within the time budget.
  - Delaying proposals by putting more structure in place would be counter productive.
  - Less formal is a good thing to do. However we need to do a minimum amount of work to define the problem.
- Recess until the next session.

Tuesday July 13

10:30am

- Meeting is called to order.
- This is a joint session between WIEN and TGr.
- The following presentation present the issues to be discussed at this forum.
- Presentation by Jon Edney on Anonymous MAC Address – Document 11-04/780:
  - The number of packets in the proposed exchange stays the same.
  - The delay budget is only increased by the time it takes for the Access Point to confirm that the address is unique.
  - What information do you compromise if someone knows your MAC address?
  - Different companies bind user information to the MAC address.
  - The Service Provider doesn't really know the real identity of the user.
  - How is this different from credit card transactions? Credit card information is encrypted and not available to the transitions.
  - The IETF tried to solve this problem in 1996 and classified it as a business problem.
  - There are 2^{23} MAC addresses that are possible, why does the AP need to determine uniqueness.
  - If you give the Service Provider your username and password, how does changing the MAC guarantee better identification?
  - The WAVE study group is interested in MAC address randomisation. It's not a good idea to tie 802.11 to the assumption that the IP layer is secure.
  - The goal of this proposal was to completely disconnect the MAC address from the user.
  - Some Service Providers do billing by MAC address. This proposal would break these business plans.
  - This proposal sounds more like a nice-to-have rather than a hard requirement.
  - There is a lot of public resentment to the potential of being tracked by MAC address.
  - It would be better for WAVE to adopt an anonymous authentication scheme rather than MAC address manipulation.
  - The sequence of generating a MAC address takes up time in a roaming budget. However this procedure on is done on the first Association with an Access Point.
  - There is a negative use case where the MAC address expires in the middle of the roam. This would force a new Association.

STRAW POLL: Is Anonymous MAC addressing a concept that should be addressed by the 802.11 working group?

a) Yes
b) No

Discussion:

- Should this be re-worded to ask whether this should be pursued as a standardization activity? No that changes the intention.

Result: a – 26; b – 22.

- Presentation by Eleanor Hepworth on Network Selection – Document 11-04/691r1:
  - NAI is at least 72 bytes, not up to 72 bytes.
  - The scope for this work is looking at Network Selection over the wireless network.
  - It would be interesting to have Network Selection on both wired and wireless networks.
  - You need to know that when you discover an Access Point, you can identify the services that are available.

STRAW POLL: Is Network Selection information introduced in Document 11-04/691r1 a concept that should be addressed by the 802.11 working group?

a) Yes
b) No

Discussion: None.

Result: a – 55; b – 0.

STRAW POLL: In which Task Group or Study Group should this concept be pursued?

a) WIEN
b) TGr
c) Other

Discussion: None.

Result: a – 50; b – 0; c – 1.

- Presentation on access router identification by Daniel Park - Document 11-04/710r0:
  - Why would this work not be included with the work on network selection?
  - This work can be applied to TGr to advertise a mobility domain.
  - If you have to change your IP address you won't get fast roaming. The term Access Router is misleading.
  - If you change the IP address, the session ends.
  - This problem is larger than just subnet domains. The identifier defines the logical connectivity between to the Access Point and the Access Router.
  - We need to distinguish between a layer 2 handoff and a layer 3 handoff.
  - This problem does not exist if an ESS can only span one subnet.
  - Advertisement of networks is part of TGk's scope. There may be pieces that go in different groups.
  - This problem hasn't been defined sufficiently to decide who should solve it.
  - WIEN will examine this problem further.
- Recess until the next session

Tuesday July 13

1:30pm

- Call to order.
- Joint session with TGs and 802.21.
- Presentation on "What is an ESS?" from Jon Edney – Document 11-04/614r1
  - 802.21 use the concept of a bridged LAN. Layer 2 transitions are part of 802.11. Layer 3 transitions are part of 802.21.
  - It would be useful for 802.21 to see each mobility group of 802.11 Access Points as a single entity.
  - The definition of an ESS has a single SSID as an identifier. However there is no restriction on two ESS's have a common SSID.
  - The ESS, BSS, and SSID should be defined as part of the Layer 2 technology.
  - Mobility domains would be a useful concept in defining how roaming works.
  - You could include introduce another identifier to define a group of AP's as an alternative to SSID. You could deprecate SSID entirely.
- Presentation on "Definition of an ESS" from Darwin Engwer – Document 11-04/629r1
  - The ESS Distribution system could include the Router or could be constructed without including the Router.
  - The SSID is a means of defining the ESS, not a means of defining the network infrastructure that you are connecting to.
  - Layer 2 signalling could be used to improve Mobile IP inter-working.
  - The usage and definition of SSID should be changed to facilitate its usage.
- Presentation on "Cross-domain handover" from Michael Williams – Document 21-04/100r0
  - 802.21 is looking to define an event which the mobile node will send to the infrastructure to indicate that it is going to move.
  - The Domain is defined as an administrative domain. There are a number of different definitions of the domain depending on the topology.
  - The 802.21 signalling needs to work inside existing security models. 802.21 is not looking to define this security model.
- Presentation on Service Definitions by Steve Conner – Document 11-04/785r0
  - No discussion.

STRAWPOLL: Should one joint TGr/TGs session at each 802.11 meeting to be the default?

a) In favour
b) Opposed

Discussion: None.

Result: a – 48; b – 5.

- Recess until 4pm on Thursday.

Thursday July 15

4:00pm

- Call to order.
- The goal for this week is to issue a "call for proposals". If we miss the call for proposals at this session; it will slip another two months.
- The Requirements document needs to be agreed on before we can issue the call for proposals.
- We have stated that partial proposals may be submitted.
- Jim Wendt has posted a revised Requirements document as 11-04/805r0
- Any objections to going through the Requirements document after Jeremy's presentation?
- We will need to make a motion to approve the Requirements document – does it need to be on the server for four hours?
- Presentation by Jeremy Spilman on Roaming Test Methodology – Document 11-04/748r0
  - There are other conditions other than RF that could cause a roaming condition. RF would still play a large role in the roam.
  - The traffic was bi-directional.
  - The roaming times were measured from last data packet to new data packet.
  - The STA does not decide to roam at the same time that it fails to receive a data packet.
  - If the STA does a DHCP request, the value for t_{data} was substantially larger.
  - Having a controlled environment is really good.
  - As mentioned in Document 11-04/086r3, the HUB should be replaced by a switch.
  - Uplink only traffic would yield much more reliable results versus downlink traffic.
  - It would be good to know what the $t_{associate}$ times – the information will be updated as a separate submission.
  - The attenuation rate should be reported in the results.
  - How would you evaluate a proposal that did roaming process in a different order? You can control the coverage overlap and you could modify the test set-up to accommodate other solution proposals.
  - This presentation was also given at one of the WPP SG sessions.
- Discussion on the Requirements Document, Jim Wendt – Document 11-04/805r0:
  - The Requirements Document will be edited during the discussion and updated as 11-04/805r1.
  - This captures the minimum requirements for a Fast BSS-Transition solution.
  - A DS is a logical concept, so that logical does not needed.
  - Why can't you roam from a TKIP-enabled AP to an AES-enabled AP?
  - An adhoc group will determine and propose security requirements for Fast BSS-Transition.
  - The definition of Fast BSS-Transition time is theoretical, it is not measurable. You can use periodic data to get an approximate measurement of this metric.
  - The problem with DHCP can be solved. However for the purpose of defining the Fast BSS-Transition requirements, a proposed solution may address this issue.

STRAW-POLL: How do we want to handle requirement PHYMAC.4?

a) Remove the text.
b) Change "does not have to" to "shall"

Discussion:

Result: a – 22; b – 15;

  - This is not decisive enough to edit the text. We will re-work the text.
- Recess until the 7:00pm session.

Thursday July 15

7:30pm

- Call to order.
- There is a willingness to issue the call for proposals for TGr before the end of this meeting.
- Although we are not finished working through the requirements, we should still issue the call for proposals for the November session.
- We can use the September session to finalize the requirements, scope, use cases, etc.
- There are still concerns that the Requirements are not finalized before the call for proposals. Something requirements might change in September? This will reduce the overall quality of the proposals.
- If there are significant changes to the Requirements, the call for proposals could be extended.
- November seems like a reasonable amount of time to get agreement on the requirements. We will be tinkering with requirements anyways.
- Could we accept proposals November and January?
- We did do a straw poll earlier.

STRAW POLL: How many people intend to submit proposals for fast roaming?

a) Count

Result: a – 5;

STRAW POLL: How many people would have a proposal ready by October 15?

a) Count

Result: a – 4;

Motion: Publish a call for proposals for IEEE 802.11 TGr, proposals will be presented starting at the November 2004 plenary; presentations must be available on the IEEE 802.11 document server by October 15, 2004, and intent to submit a proposal must be sent to Stuart Kerry, Clint Chaplin, and Harry Worstell by August 17, 2004.

By: Michael Montemurro
Second: Jesse Walker
Discussion:

- This is a good process to follow.
- The intention to submit will only include the name of the people.
- The letter of intention is not binding.

Result: Yes – 16; No – 1; Abstain – 9. Motion Passes.

- Suggestion to keep moving forward for continuing conference calls.
- Are conference calls really necessary? No.
- We should get through the entire Requirements document before the end of the September meeting.
- We can set a hurdle but it would not be very high.
- Given that we have passed a motion for a call for proposals, and the requirements are not complete. What do you expect the content for proposals to be?
- The requirements are hard enough that people can begin working on proposals.
- The current revision of the requirements does not include security.
- Continue on the Requirements document discussion:
  - Document is being edited as part of the discussion.

  - We should create an adhoc group to define metrics for fast-BSS transition.
  - We should make the proposals mention the differential between the pre fast-BSS transition solution and the BSS-transition solution.
  - We need to supply the measurement methodology and the metric as part of our PAR.
  - The PAR doesn't state which order we need to do things.
  - How should we address dependencies on standards which are currently under development?
  - The proposal should mention its dependencies in order to be a complete submission.
  - This document will be updated as Document 11-04/805r1
  - Document 11-04/086r3 should be listed as a reference.
- Jesse Walker has volunteered to co-ordinate the Security Adhoc group.
- We still need a volunteer to co-ordinate the Test Methodology Group. Clint will issue a call for volunteers at the Closing Plenary.
- Presentation by Nancy Cam-Winget on Establishing PTK Liveness - Document 11-04/707r0
  - This proposal is different from the one in Document 11-03/241, which was a merge of the optimisation and the TGi structure. This is a completely new construction based on the 4-way handshake.
  - The maximum size of the EAPoL-key message is 256 bytes.
  - Why weren't the EAPoL-key messages moved into the Authenticate messages? You have to do this kind of handshake at re-association because the authentication messages can occur long in advance before the re-association.
  - The QoS reservation request should be requested. This proposal does not address this case.
  - You need a path for the AP to reject the optimisation. The AP will reject the re-association.
  - Pre-computing information is really useful.
  - The proposal is too focused on security; it does not address QoS as well.
  - The QoS negotiation could occur within the re-associate transaction as well.
  - The goal of this proposal is to maintain compatibility with IEEE 802.11i.
- We are out of time.
- The next meeting will be in Berlin.
- Adjourn for this session.

IEEE P802.11
Wireless LAN
Task Group S ESS Mesh
Meeting Minutes for July 2004

Date: July 20, 2004

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Abstract

Minutes of the Meeting of the IEEE 802.11 Task Group S ESS Mesh held in Portland, Oregan, USA, from July 12 to July 16, 2004 under the TG Chairmanship of Donald Eastlake 3rd of Motorola Laboratories. Minutes taken by Tyan-Shu Jou and edited by Donald Eastlake. An extended agenda for the meeting is at 11-04/663r6.

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Significant Actions

(For the detailed minutes, including these actions, see the next section of this document.)

Monday Afternoon Session (Monday, 12 July, 2004, 4:00PM-6:00PM)

1. **Audience unanimously approved the previous (Grove Garden, California) meeting minutes (11-04/652r1) and the June 30th teleconference meeting minutes (11-04/683r1).**
2. **Due to the lack of volunteers, the SG secretary Tyan-Shu Jou of Janusys Networks continued to take the Recording Secretary position for TGs.**
3. **There were two candidates ran for the Permanent TGs Technical Editor position. W. Steven Conner of Intel Corp. won the election and took the position.**
4. **Presentation #1: "Draft Terms and Definitions for 802.11s" (IEEE 802.11-04/730r1) Tricci So presented for the definition subgroup**

Monday Evening Session (Monday, 12 July, 2004, 4:00PM-6:00PM)

1. **Presentation #2: "802.11s Security Proposal" (IEEE 802.11-04/777r0) Robert Moskowitz, ICSA Labs**
2. **Presentation #3: "802.11s Routing Sub-Group Discussion on May '04 Report" (IEEE 802.11-04/765r0) Tyan-Shu Jou, Janusys Networks**
3. **Presentation #4: "A View on 802.11s Routing, A Framework for a Discussion" (IEEE 802.11-04/778r0) Robert Moskowitz, ICSALabs**

Tuesday Afternoon Joint Session of TGs, TGr, and 802.21 (Tuesday, 13 May, 2004, 1:30PM-3:00PM)

1. **Presentation #5: "What is an ESS?" (IEEE 802.11-04/614r1), Jon Edney, Nokia**
2. **Presentation #6: "The Nature of an ESS" (IEEE 802.11-04/629r1), Darwin Engwer and Bob O'Hara**
3. **Presentation #7: "Cross Domain Trigger and Handover Talking Points" (IEEE 802.21-04/100) Michael G. Williams**

Tuesday Afternoon Joint Session of TGs and TGr (Tuesday, 13 May, 2004, 3:00PM-3:30PM)

1. **Presentation #8: "Interpretations of the Distribution System Service Based on the 802.11 Specification" (IEEE 802.11-04/785r1), W. Steven Conner, Tricci So, Tyan-Shu Jou**

2. **Straw poll: Should one joint TGr/TGs session at each 802.11 meeting be the default? Result: Favor: 48 Against: 5. Chairperson of each group will work on the arrangement.**

Tuesday Late Afternoon Session (Tuesday, 13 May, 2004, 4:00PM-6:00PM)

1. **Presentation #9: "WLAN Mesh Usage Model and Considerations for Hot Spot Service" (IEEE 802.11-04/680r0), Taejin Lee (Broadwave), Jongtaek Oh (Hansung Univ.), Sukhee Bae (RRL), Jaewoo Lim (RRL)**

2. **Presentation #10: "Defining Comparable Usage Models for 802.11s" (IEEE 802.11-04/764r1, 662/r7), W. Steven Conner**

3. **Presentation #11: "Suggested Major Functional Components for 802.11s" (IEEE 802.11-04/749r0) W. Steven Conner, Koji Omae**

Tuesday Evening Session (Tuesday, 13 May, 2004, 4:00PM-6:00PM)

1. **Presentation #12: "Outdoor 802.11 Mesh Links RF Impacts Considerations" (IEEE 802.11-04/731r0) Tricci So**
2. **Task Group Process initial discussion (11-04/800r1, by Donald Eastlake 3rd). A heads-up for the audience on this topic.**

Thursday Early Morning Session (Thursday, 15 May, 2004, 8:00AM – 10:00AM)

1. **Presentation #13: "MAC Considerations for 11s" (IEEE 802.11-04/760r0), L. Lily Yang, Akira Yamada**
2. **Presentation #14: "802.11s Security Ad Hoc" (IEEE 802.11-04/826r0), Robert Moskowitz, ICSALabs**
3. **Presentation #15: "Outdoor 802.11 Mesh MAC Problems" (IEEE 802.11-04/732r0), Tricci So**

Thursday Late Morning Session (Thursday, 15 May, 2004, 10:30AM – 12:30AM)

1. **Presentation #16: "Multi-hop Connections Using 802.11" (IEEE 802.11-04/709r0), Guido R. Hiertz, Yunpeng Zang, Jorg habetha**
2. **Presentation #17: "Additional Draft terms & Terminology for 802.11s" (IEEE 802.11-04/0822r0) Jonathan Agre**
3. **Task Group Process discussion (11-04/800r3)**

    a. **Straw poll**
    If a TGs call for proposals was issued right after the September meeting with a deadline shortly before the November meeting, how many would submit a proposal?
    Result:
        Reasonably certain to submit a proposal: 4
        50/50 chance: 10
        Might but probably not: a few people

    b. **Straw poll**
    If a TGs call for proposals was issued right after the November meeting with a deadline shortly before the January meeting, how many would submit a proposal?
    Result:
        Reasonably certain to submit a proposal: 13
        50/50 chance: 4
        Might but probably not: 4

    c. **Straw poll**
    Is documenting Usage Cases important?
    Result:
        Yes: 48
        No: 0

    d. **Straw poll**
    Is each category in document important?
    - **Residential: 36**
    - **Office: 43**

- **Campus/Community/Public Access: 42**
- **Public Safety: 34**
- **Car to Car: 7**

e. Straw poll on Informal Group Submissions Status
What should be the status of relevant submissions from informal groups if a majority of TGs agrees with the submission?
- **Strongly included as part of call for proposals: 12**
- **Adopted as internal working documents: 29**
- **Included on a TGs recommended reading list: 3**
- **No special status: 2**

f. Straw poll
What is the current feeling of TGs as to when we should call for proposals?
- **July 2004: Favor: 3. Against: 31**
- **September 2004: Favor: 10. Against: 28**
- **November 2004: Favor: 16. Against: 10**
- **January 2005: Favor: 8. Against: 1**

g. Straw poll
Should any call for proposals require that proposals be "complete"?
Result:
Yes: 18
Not: 19

h. Straw poll
How long should be the call for proposal window?
2 months: 2
4 months: 17
6 months: 10

i. Motion: One teleconference 15 August, 3PM PDT.
Moved: Peter
Second: W. Steven Conner
Result:
In Favor: 18
Against: 2

Full Minutes

Monday Afternoon Session:

Date & Time: Monday, 12 July, 2004, 4:00PM-6:00PM
Location: Ballroom II-IV Hilton Hotel Executive Tower, Portland, Oregan, USA.
Officer presiding: Donald Eastlake 3rd

Meeting was called to order at 4:00PM by Donald Eastlake 3rd, ESS Mesh SG Chair.

The initial slides used by the SG Chair are 802.11-04/663r4

Reviewed policies and procedures of IEEE:

The Chairperson went through the IEEE-SA Standards Board Bylaws on Patents in standards and Inappropriate Topics for IEEE WG meetings.

On-line attendance recording reminded.

Audience unanimously approved the previous (Grove Garden, California) meeting minutes (11-04/652r1)
Audience unanimously approved the minutes of the teleconference meeting held on June 30, 2004 (11-04/683r0)

Agenda Discussion based on IEEE 802.11-04/663r4

Permanent TGs Recording Secretary Position election:

No volunteers hence SG secretary Tyan-Shu Jou of Janusys Networks will continue to serve the position.

Permanent TGs Technical Editor election:

Candidates:

- **W. Steven Conner** (Intel): Current SG Editor; started working on this group even before ESS Mesh SG was formed; has full support from the employer for the position.
- **Thomas Maufer** (Nvidia): 20 years of experience on networking; author for 3 networking books, the latest one is on wireless LAN; also has full support from his employer for the position.

Voting Result: W. Steven Conner: **22**; Thomas Maufer: **4**.
W. Steven Conner of Intel was elected to serve as the IEEE802.11s Technical Editor.

Presentation #1:

"Draft Terms and Definitions for 802.11s"
(IEEE 802.11-04/730r1)
Tricci So presented for the contributors to this submission

- This document is a joint work from many members of this group to define the core terms for ESS Mesh as a discuss base. It is intended to be put into a motion to make the task group to adopt it as a working document on Thursday.
- A question raised on the figure which shows the existence of multiple Mesh Points in a mesh network. The response from the audience is that figure just shows one possibility of that scenario. The task group has not decided whether that scenario will be in the scope of the task group of not.
- A question was raised whether a laptop PC can be a Mesh Point. The response from the audience was the PAR limits ESS mesh to use infrastructure mode hence ad-hoc mode has been excluded. With that limit, any entity/device that matches the Mesh Point function description can be called a Mesh Point.
- A discussion on the definition of Mesh Point STA
- A suggestion to add "Link Metric", "Mesh Neighbor Discovery", and some other necessary terms. The response was this will be a working document. There had been a long list of terms that yet to be defined. We will re-visit this issue on Thursday.
- A question on "Mesh Topology", whether it contains end STAs or not. The response was no.
- There were questions on Mesh Unicast and Mesh Broadcast definitions. A scenario that a broadcast/multicast frame to multiple STAs associated with the same Mesh AP appears as a unicast frame to the Mesh network should be counted as Mesh Unicast or Mesh Broadcast. The response was that would be Mesh Unicast—all the terms focus on the network consists of Mesh Points only. End STAs behaviour is not included.
- One suggestion was the definition for a probing mechanism will be needed since neighbour discovery will be necessary for Mesh Path Selection.
- Tricci plans to work out a list of supplementary terms and will show them to the audience on Thursday.

Session recessed at 5:30PM until 7:30PM

Monday Evening Session:

Date & Time: Monday, 12 July, 2004, 4:00PM-6:00PM
Location: Ballroom II-IV Hilton Hotel Executive Tower, Portland, Oregan, USA.
Officer presiding: Donald Eastlake 3rd

Session called to order at 7:40PM by Donald Eastlake 3rd, TGs Chair.

Presentation #2:

"802.11s Security Proposal"
(IEEE 802.11-04/777r0)
Robert Moskowitz, ICSALabs

- The author presented two possible security models both utilize connectivity association and secure channel concept based on the on-going 802.1ae and 802.1af works.
- A question was raised that maybe we can focus on the security among Mesh Points only. Furthermore, we only need to consider directly linked Mesh Points. Considering end STAs can make the security issue very complicated. The response was that's possible although the security issue of STA roaming within the mesh then will have to be solved by TGi or TGr. Predefining/Building Secured Connectivity Associations and keys to all other Mesh Points at Mesh Point initialization time may in fact easier than to dynamically build up SCA to a Mesh Point that just comes up.
- A suggestion was there may be a balancing point between Model 1 and 2. Depending on the needed security level requirement, we can choose a solution more scalable.
- A question was raised on whether this proposal is centralized or decentralized. The response was that will depend on implementation. For example, key refresh without traffic is possible.
- It is raised to audience's attention that there are many issues yet to be solved if we pursue either of the models. And 802.1af is still working on some proposals on device rejoining issues.
- A notice came from the audience mentioned in the proposed models any unsecured traffic will waste bandwidth along the path until being rejected at the destination.

Presentation #3:

"802.11s Routing Sub-Group Discussion on May '04 Report"
(IEEE 802.11-04/765r0)
Tyan-Shu Jou, Janusys Networks

- This was a report of the 2-hour informal meeting held in May on routing issues of ESS mesh. One of the purposes was to attract audience's attention on this issue and to solicit more participants to discuss this subject.
- There were some comments from the audience on the pros and cons on using Spanning Tree Protocol on mesh. The response was this topic has been discussed in a presentation in previous meeting but no conclusive decision has been made so far.
- There was a comment on using broadcast mechanism to build unicast routing path that the wireless broadcast may not be reliable hence may affect the reliability of the routing result.
- There was a suggestion to refer to a paper using IS-IS on wireless network which may provide some hints on this subject.
- There was an opinion that this discussion was not effective and should be replaced by calling for proposals. The task group should either define better requirements or just use the PAR as the requirement to call for proposals rather than discussing solutions. The response was the members of this task group need more knowledge on this subject for all the foundation work, such as terminologies definitions. Without basic understanding and knowledge, this task group will not be able to evaluate the routing proposals.

Presentation #4:

"A View on 802.11s Routing, A Framework for a Discussion"
(IEEE 802.11-04/778r0)
Robert Moskowitz, ICSALabs

- In the short presentation, the author emphasized there will be no 802.1D bridge in a mesh; hence no STP should be running on the ESS mesh. Current 802.1 LAN model does not fit a mesh.
- A question was raised that 802.11 spec mentioned ESS has to be like a LAN to the higher layer.
- There was disagreement from the audience on the sentence of "mesh is ill defined," especially given the Internet is basically a mesh.

Session adjourned at 9:20PM

Tuesday Afternoon Joint Session of TGs, TGr, and 802.21

Date & Time: Tuesday, 13 May, 2004, 1:30PM-3:00PM
Location: Ballroom II-IV Hilton Hotel Executive Tower, Portland, Oregan, USA.
Officers presiding: Donald Eastlake 3rd (TGs), Clint Chaplin (TGr), Ajay Rajkumar (802.21)

Session called to order at 1:30pm

Presentation #5:
"What is an ESS?"
(IEEE 802.11-04/614r1)
Jon Edney, Nokia

- The presentation explained the meaning of ESS from the 802.11 spec. As a conclusion, the presenter argued ESS is not a useful definition for standards.
- A question was asked shouldn't all BSS of the ESS share the same SSID in one ESS? The response was yes. But the reverse was not necessarily true, that is, different ESS's can have the same SSID.
- There was a question on the suggestion of "Tie group definition information into 802.21."
- Current 802.21 thinking has dependency on using SSID for station to learn it has crossed the ESS boundary. If that's not always true, a different attribute will be needed.
- A comment from the audience mentioned the topology can be hidden from the network.

Presentation #6:
"The Nature of an ESS"
(IEEE 802.11-04/629r1)
Darwin Engwer and Bob O'Hara

- The authors agreed with the previous presentation (11-04/614) which had strictly interpreted the definitions of ESS, DS, and SSID. But argued there were other possible interpretations of the definitions that don't violate the 802.11 spec.
- A question from the audience on Slide 16 which included a router in between two BSS, was on whether the router should be included in the DS shadow or not. The response was the router can be part of the DS, and the slide just shows one example.
- There were comments on seeing the same SSID not identifying whether the APs are in the same ESS means there will be more work on identifying ESS migration.
- One comment pointed out unfortunately people had mistakenly using SSIDs for a while. Hence to ask the whole world to take the "correct" definitions can cause problems to the real world.

Presentation #7:
"Cross Domain Trigger and Handover Talking Points"
(IEEE 802.21-04/100)
Michael G. Williams

- The presentation talked about BSS, ESS, DS, triggers and handover from 802.21 perspectives.
- A question was asked on what can be the trigger on APs for domain transition.
- STA triggers the transition and the associated AP can let the new AP to know the event.
- A question raised from the audience was on cross domain messages, how AP can talk across domains since there will be different policies.
- A question was asked saying the between domain message may have security issues. The response was the slide shows an example, it doesn't necessarily suggest the real implementation.

Session recessed for 5 min at 2:55PM. 802.21 will resemble in a different location

Tuesday Afternoon Joint Session of TGs and TGr:

Date & Time: Tuesday, 13 May, 2004, 3:00PM-3:30PM
Location: Ballroom II-IV Hilton Hotel Executive Tower, Portland, Oregan, USA.
Officers presiding: Donald Eastlake 3rd (TGs), Clint Chaplin (TGr)

Presentation #8:
"Interpretations of the Distribution System Service Based on the 802.11 Specification"
(IEEE 802.11-04/785r1)
W. Steven Conner, Tricci So, Tyan-Shu Jou

- This presentation pointed out the DS (distribution system) is logically defined by DSS and is not defined by the physical network which is used to implement the DS.
- (Due to the lack of time no discussion time is given on this presentation)

Straw poll:
Should one joint TGr/TGs session at each 802.11 meeting be the default?
Result:
Favor: 48
Against: 5
The chairperson of each group will work on the arrangement.

Session adjourned at 3:30PM

Tuesday Late Afternoon Session:

Date & Time: Tuesday, 13 May, 2004, 4:00PM-6:00PM
Location: Ballroom II-IV Hilton Hotel Executive Tower, Portland, Oregan, USA.
Officer presiding: Donald Eastlake 3rd (TGs)

Session called to order at 4PM

Comments for Presentation #8 above were invited but no response from the audience.

Presentation #9:
"WLAN Mesh Usage Model and Considerations for Hot Spot Service",
(IEEE 802.11-04/680r0)
Taejin Lee (Broadwave), Jongtaek Oh (Hansung Univ.), Sukhee Bae (RRL), Jaewoo Lim (RRL)

- The presentation introduced the characteristic of hot spots in Korea and suggested a few examples of WLAN mesh usage models.

Presentation #10:
"Defining Comparable Usage Models for 802.11s",
(IEEE 802.11-04/764r1, 662/r7)
W. Steven Conner

- It's the summary report resulting from the study of usage models. The document described all the submitted usage models and categorized them into five categories.
- One suggestion based on 802.11n experience was TGs has gone very rapidly and far at this stage, and should be more focus rather than support all usage models. The other comment from the same person was the task group should construct simulation scenarios and keep them simple.
- One comment was functional requirements eventually will be very much like what is in the PAR. So it is suggested to avoid taking a long time effort to reach there.
- A different opinion was TGs is building a network. We'd better be careful and cautious along the way and not to skip any necessary efforts.
- One opinion was from the experience of working in IETF MANET, just one usage model can create all kinds of simulation scenarios. The task group should come up with common and useful scenarios and focus on them.

- A person with 802.15 experience asked whether APs can be mesh nodes. The response was yes, and TGs is focused on infrastructure mode only.
- One audience suggested collecting a set of common attributes. Response was hopefully the scope of TGs defined in the PAR has been smaller than that of IETF MANET and can be used to derive the requirement. Hopefully the convergence time of our proposals can be shorter.
- One comment on evaluation criterion: don't spend too much time to create evaluation criteria.
- Steve Conner invited people to send him additional usage case material for possible inclusion in the presented document.
- One suggestion: TGs should create Functional requirements as soon as possible.

Presentation #11:

"Suggested Major Functional Components for 802.11s",
(IEEE 802.11-04/749r0)
W. Steven Conner, Koji Omae

- The presentation describes proposed major functional components for TGs and suggest this group to work toward these functions:
  - Routing and Forwarding
  - Mesh security
  - MAC/MLME Enhancements for 802.11s Mesh
  - Mesh network measurement
  - Interfaces for Configuration / Management & internetworking
- One comment was in Slide3, a "Service Integration" box should be added there to provide the existing DS services. The response was the slide was created to emphasize the new functions hence the existing functions are not included.
- A question was whether 11s is going to take care of all mesh related issues or 11s should be work with other groups. The response from Steve Conner was we should work together with other groups to avoid duplicate work.
- One comment was the "MAC/MLME enhancement" may cause some inconsistency if the scale is large.
- The other opinion was we do need to do some enhancement on the MAC to build a useful WLAN mesh. Current MAC may not be sufficient for WLAN mesh network. The response was TGs is going to make amendments to 802.l1, and many other works are being done before us.
- One comment was it might be too early to take AC enhancements out from the table at this table.
- One caution from the audience was to be careful on doing "necessary enhancement" on the MAC, but not much more than that. Otherwise, the process will be lengthy and the resistance will be high.
- A question was how the functional blocks were derived. The response was they are high-level requirement mainly coming from the PAR.

Session recessed at 5:50PM

Tuesday Evening Session:

Date & Time: Tuesday, 13 May, 2004, 4:00PM-6:00PM
Location: Ballroom II-IV Hilton Hotel Executive Tower, Portland, Oregan, USA.
Officer presiding: Donald Eastlake 3rd (TGs)

Presentation #12:

"Outdoor 802.11 Mesh Links RF Impacts Considerations",
(IEEE 802.11-04/731r0)
Tricci So

- This presentation introduced a few RF related issues on deploying outdoor mesh networks.

Task Group Process, Take 1

- The discussion was based on "Mesh Networking Task Group Process", IEEE 11-04/800r1, by Donald Eastlake 3rd.
- This topic will be discussed again on Thursday. The fundamental question was "How should we proceed toward a Draft?"
- According to the average working length time from other 802.11 groups, we should expect to have the first letter ballot approved at the May or July 2005 802.11 meeting.
- There were discussions on process, schedule, and informal subgroups. No conclusive decision was made.

- Some subgroup announced their ad-hoc discussion gathering time and place.

Thursday Early Morning Session:

Date & Time: Thursday, 15 May, 2004, 8:00AM – 10:00AM
Location: Ballroom II-IV Hilton Hotel Executive Tower, Portland, Oregan, USA.
Officer presiding: Donald Eastlake 3rd (TGs)

Session called to order at 8AM

Presentation #13:
"MAC Considerations for 11s",
(IEEE 802.11-04/760r0)
L. Lily Yang, Akira Yamada

- This was a preliminary analysis on 802.11e for TGs to draw the attention and interests from the audience. Those who are interested in working with Lily Yang on MA C enhancement are welcome to contact her at lily.l.yang@intel.com
- A question was raised on Slide 16. In 11e, the mesh coordination function may have some interference on HCF. Also, the mesh coordination function should not be based atop DCF.
- An opinion from the audience mentioned HCCA is very important in mesh network. Mesh Coordination Function can utilize it.
- On comment: we possibly can treat QoS issues from a network point of view. The routing protocol should be able to help traffic engineering hence is related to overall QoS. Some mechanisms suggested in 11e may not be efficient to be implemented in the MAC layer.
- One comment: in Slide 7, the most important function Mesh Coordination Function has to do is to share the information among the mesh nodes.

Presentation #14:
"802.11s Security Ad Hoc",
(IEEE 802.11-04/826r0)
Robert Moskowitz, ICSALabs

- This was the discussion result of the Security ad-hoc group
- Those who are interested in working with Robert on the security issues for TGs can email him at rgm@trusecure.com

Presentation #15:
"Outdoor 802.11 Mesh MAC Problems"
(IEEE 802.11-04/732r0)
Tricci So

- This presentation highlighted MAC issues for outdoor mesh networks to raise people's awareness on large scale long-distance deployment.
- A question was TGs wasn't charted to change the 802.11 MAC behaviours. Is this work in the scope of our task group? Tricci's response was tuning timing parameters should not be a problem.
- Another comment was CTS/RTS problem is a common problem for 802.11 networks. Those problems might be solved outside TGs.
- Comments on the timers: There are only two PHY related timers – SIFS and aSlot. They depend on the PHY technology since they are related to Transceiver turnaround time, sensing time and so on. Therefore the audience didn't see the relationship to TGs. The other comment was there should be no need of changing the parameters of 802.11. These timers are independent of TGs since TGs does not define a new PHY mode. However, there are some other parameters that can be changed, e.g. CWmin etc.

Session recessed at 10:00AM

Thursday Late Morning Session:

Date & Time: Thursday, 15 May, 2004, 10:30AM – 12:30AM
Location: Ballroom II-IV Hilton Hotel Executive Tower, Portland, Oregan, USA.
Officer presiding: Donald Eastlake 3rd (TGs)

Presentation #16:

"Multi-hop Connections Using 802.11",
(IEEE 802.11-04/709r0)
Guido R. Hiertz, Yunpeng Zang, Jorg habetha

- This presentation raised the awareness of the audience that 802.11 MAC may not fit multi-hop network requirement. Modification will be needed to make WLAN mesh works better.

Presentation #17:

"Additional Draft terms & Terminology for 802.11s",
(IEEE 802.11-04/0822r0)
Jonathan Agre

- This presentation reported the result of an ad-hoc discussion on additional terms of TGs. This is intended to be a working document.

Task Group Process Discussion

The discussion is based on the slides in IEEE 802.11-04/800r3

Information on some groups working on submissions can be found at the following URL:
http://ieee.comnets.rwth-aachen.de/cgi-bin/wiki.pl?AdHocGroups

- On the slide 12 "Possible liaison to 802.15.5", one suggestion was to have two liaisons to report to the other meeting since the two groups usually meet at the same timeframe.
- No volunteer to be the above liaison, so the chair persons may have to report to each other group.

Straw poll

If a TGs call for proposals was issued right after the September meeting with a deadline shortly before the November meeting, how many would submit a proposal?

Result:

Reasonably certain to submit a proposal: 4
50/50 chance: 10
Might but probably not: a few people

Straw poll

If a TGs call for proposals was issued right after the November meeting with a deadline shortly before the January meeting, how many would submit a proposal?

Result:

Reasonably certain to submit a proposal: 13
50/50 chance: 4
Might but probably not: 4

Straw poll

Is documenting Usage Cases important?

Result:

Yes: 48
No: 0

Straw poll

Is each category important?

– Residential: **36**

– Office: **43**
– Campus/Community/Public Access: **42**
– Public Safety: **34**
– Car to Car: **7**

Straw poll on Informal Group Submissions Status

What should be the status of relevant submissions from informal groups if a majority of TGs agrees with the submission?

– Strongly included as part of call for proposals: **12**
– Adopted as internal working documents: **29**
– Included on a TGs recommended reading list: **3**
– No special status: **2**

Discussion on group submissions and the TG process:

- To answer the question on whether informal group submissions will be merged, the Chair mentioned there is no strong need to merge all the documents. We can use them to generate requirements
- One comment was we should make case by case decisions. We can also make call for proposals for individual functionality.
- One comment was to advise audience not to underestimate the complexity of the task we are working on.
- One comment was this group should not create solutions but should evaluate existing ones. No partial proposal should be considered. Do not spend too much time working on the formal process or requirements.
- There is a question challenge the usefulness of the above straw pool results.
- Some people expressed that if we take every partial proposal, we may end up with a large number of proposals. We should limit to full proposal only, which can encourage people to work together. We then can get the task done as soon as possible.
- On the contrary, a few people suggested the call for proposal should allow partial proposals to include all good ideas. One of the opinions mentioned partial proposal will naturally get less support in evaluation, but we should not put limitation on it when call for proposals.
- One suggested we need to spend a bounded period of time to discuss the requirements so we can know how to evaluate proposals.
- One opinion was we cannot use the PAR to evaluate the proposal yet. How much time other groups spent on their proposal is irrelevant to the time used in this group?
- One opinion was we cannot have a procedure for invention. We can call for complete proposals first, and maybe partial proposals for some areas to improve the best proposal. We can even ask for proposals now, and use 6 months to evaluate them.

Straw poll

What is the current feeling of TGs as to when we should call for proposals?

– July 2004: **Favor: 3. Against: 31**
– September 2004: **Favor: 10. Against: 28**
– November 2004: **Favor: 16. Against: 10**
– January 2005: **Favor: 8. Against: 1**

Straw poll

Should any call for proposals require that proposals be "complete"?

Result:

Yes: **18**
Not: **19**

- A few comments were the definition of "completeness" is not clear hence the straw poll result may not make much sense since people have different ideas.
- Another comment was completeness will naturally be reflected in the evaluation process. We should not put that limitation at the call.

Straw poll

How long should be the call for proposal window:

2 month : **2**
4 month: **17**
6 month: **10**

Motion To hold a TGs teleconference 15 August, 3PM PDT.
Moved: Peter
Second: W. Steven Conner
Result:
In Favor: **18**
Against: **2**

Audience was advised by the Chair to check for 11-04/800r3 for the latest information.

Meeting adjourned at 12:30PM.

IEEE P802.11
Wireless LANs

Wireless Performance Prediction Study Group Meeting Minutes

Date: July 15, 2004

Authors: Tom Alexander
VeriWave, Inc.
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Abstract

Minutes and attendance of the meetings of the IEEE 802.11 Wireless Performance Prediction Study Group held in Portland, Oregon, USA on Tuesday, Wednesday and Thursday, July 13, 14 and 15, 2004 under the SG Chairmanship of Charles Wright.

Session Proceedings

Meeting 1:

Date: 13 July 2004

Location: Studio Suite

Meeting called to order at 4.00 PM Pacific Time Monday May 10th by Charles Wright, WPP SG Chair. Tom Alexander was recording Secretary.

Charles opened meeting at 4 PM PST. He welcomed the participants to the meeting and introduced the Chair and Secretary. He began by setting the meeting tone with the customary opening slide. He then reviewed the policies and procedures of the SG, noting that while all 802 and 802.11 procedures applied, as this was a Study Group, everyone gets to vote; 75% consensus was required, however, regardless of whether it was a technical or procedural vote. He also read out, verbatim, the IEEE Bylaws on patents in standards to the SG. He then covered inappropriate topics for discussions, such as pricing or litigation. Charles also mentioned that the general policy was to discuss technical topics and not the persons proposing them, and personal attacks were not going to be tolerated. He passed around a signup sheet, noting that SGs are required to take attendance, but also stated that participants were only required to sign in once for the week.

Charles then brought the proposed agenda for the week before the group, and opened up discussion of the agenda. He said that he was going to do a call for technical presentations, and noted that Rick Denker had sent in a submission. He also noted that Larry Green had uploaded a presentation. He then noted that he would review the progress in the teleconferences. He said that there was a good bit of time allotted to review comments from 802; however, as of 20 minutes ago, there were no comments, and it was doubtful that there would be any. He would check at 6 PM for comments; if there were none, then he could collapse the time allotted to discuss comments, and devote it to presentations and discussions instead.

Question from Paul: I have a technical presentation wrapping up some of the discussion and discussing what went on in the teleconferences. What do you suggest? In response, Charles asked him if he would like to make that presentation. Answer: Yes.

Charles then asked Paul what the document number was. Paul said that it was document #674r2, titled “WPP Development Milestones Roadmap Proposal”. Charles amended the agenda with this presentation.

Charles then asked if the order of items in the agenda (technical presentations, followed by a discussion of how to proceed, followed by more technical presentations) worked for people. He noted that Rick could not present today, but could present either tomorrow morning or afternoon. Larry also requested time on the agenda for his presentation, document #729 r3, titled “WPP Baseline Metrics”, and said that about 30-40 minutes would suffice. Charles assigned him about 35 minutes.

Charles then called for any additional presentations from people. Bob Mandeville volunteered to present on the template at some point during the week. The document did not have a number as yet, but would be titled "Test Specification Template Overview and Proposal"; Bob felt that it would take about 40 minutes to present. Niels said that he had a presentation as well, but he had some time limitations (he would prefer tomorrow morning); his presentation was document #346r0, titled "Proposal for how to measure Receiver Sensitivity".

Tom suggested that perhaps Bob Mandeville could walk us through RFC 2285, as an introduction. Bob and Charles thought this was a good idea; Bob felt that it would take about 40 minutes. Charles put him on the agenda for a presentation titled "RFC 2285 / 2889 Walkthrough". No document number was assigned.

Charles then asked if there were any objections to accepting the agenda as shown. There were no objections, so the agenda was duly accepted.

The next item of business was approval of the minutes. Charles asked if there were any objections to accepting the minutes from the Garden Grove meeting. There were no objections, so the minutes were accepted. He further asked if there were any objections to accepting the minutes from the last teleconference (July 8) as well; there were no objections, so the teleconference minutes were approved as well.

The timeline going forward was brought up. Charles noted that at the May meeting, there had been a vote before the full WG to forward the PAR & 5 criteria to the 802 Executive Committee; due to quorum issues, however, the WG decided to use a full letter ballot instead of settling the issue at the meeting itself. The letter ballot passed, and so we are now in the position of resolving the comments from the 802 WGs and ExCom, and also requesting 802.11 to extend the life of the SG to do the work of the TG (for eventual reaffirmation as and when the TG is formed). In August NesCom would vote on the PAR, and if all went well by September we would begin work as a formal TG.

Charles then went over the presentations during the teleconferences. He noted that Paul Canaan had presented document #674r0, and Mike Foegelle had presented document #675r1. He noted also that we could not take any actual decisions during the teleconferences, but certainly the presentation gave rise to much discussion. He then opened the floor to any comments on the teleconferences; there were none.

The initial business being over, Charles then invited Paul Canaan to come forward and present his roadmap.

Presentation titled “WPP Development Milestones Roadmap Proposal” by Paul Canaan (document #674r2)

Paul began by noting that this presentation was originally given during the teleconferences. The purpose of the presentation was to outline the key deliverables for WPP per the scope and purpose. He noted that one of the reasons for the presentation was to ask two fundamental questions: where do we go from here, and what time frame will that be in? He also remarked that this presentation grew out of work done in the measurement methodologies ad-hoc.

He started off by reviewing the concept of "performance" as a function of components, applications and environment, and briefly reviewed all three areas. However, he noted, there was still a lot of discussion about this in the teleconferences, and it was all not very clear. He therefore wanted to go off on a different take on this.

Paul then went to the next slide (#5). He said that wireless performance is a function of multiple things. For instance, there is the environment: whether LOS, NLOS, or conducted. He said that there was nothing to measure out of that. The second aspect is device configurations, which was called "components" before this. The notion was: what are we doing? We are always going to have pieces; what we are really concerned about here was how these pieces were set up and configured. The last piece of the puzzle would be applications. He noted that the target was to measure device performance in a given environment with a given traffic stream representing some application. He then asked for questions to this point.

Question from Bob: What does "traffic pattern" mean to you? Answer: The issue with application level was that it was too dependent on the specific application. Let's get away from this and focus on traffic patterns; in terms of traffic patterns, we should specify a tool down the road to measure wireless performance.

Paul then noted that the biggest idea was that wireless performance is a function of multiple things. He had originally proposed that there be three ad-hoc teams to focus on three buckets: component, application, environment. However, this is still very nebulous, and this was what he was going to talk about today. For example, we talked about the “environment” ad-hoc team. What would the people in this ad-hoc do? They would focus on defining the diagram of the test setup for NLOS environments (LOS and conductive environments would be scheduled later). He gave an example of a diagram for a test setup for a laptop testing. He also covered a concept presented in a previous contribution, namely that of the simple, multi-client, and complex environments of clients/APs. He then summarized this as the recommended environments for getting your test results.

To give an example, Paul then went back to slide #5, and asked the question: what environment would be important to a user? That would clearly be NLOS. However, going to slide #6, what would be the test setup? He gave some examples of various parameters in the environment that could be used in the test setup.

The next topic Paul covered was the device configuration for the wireless ecosystem. We have APs, encryption, power settings, etc. For different combinations of APs and clients, therefore, the group would give guidelines on the settings that were required for the APs and clients involved in the test. Again, to provide an example, Paul went back to slide #5, and discussed how the devices would be configured for a given test.

The final aspect that Paul discussed was the applications. He noted that the ad-hoc group should focus on defining the traffic patterns and the key variables underlying these traffic patterns that should be used in the performance characterization.

Question from Joe: Were you planning on uploading this revision of the presentation to the server? Answer: Yes.

Paul then went on to the development proposal. He suggested that we should get something in 6 months, focused entirely on measurement methodologies. We should develop the guidelines and publish them when the 6 months was up, and then turn the attention to prediction.

Question from Tom: did you actually say that we could publish in 6 months, and then turn to prediction? Answer: Yes. This is aggressive, but there is no reason why it cannot be done.

Question: could you clarify what you mean by “performance”? Answer: After we measure all the stuff out, in time there could be mathematical guidelines developed on how to predict performance once we get all the measurements in place. The idea is that performance is represented by an equation, and thus can be defined and then predicted.

Paul finally presented his development roadmap proposal (#13). He suggested that the separate groups would work separately on these topics, and then reconvene in 6 months.

Question from Larry: Paul, could you map the new standards (WPA, etc.) into the three buckets? Answer: OK, that's the encryption protocol. I'm glad you brought up that one. You notice I have on the bottom an “encryption” topic, this would really go into device configuration. If you have an AP that does only 802.11b, it's 3 years old, then it probably can't do WPA and this doesn't do you any good at all. However, the encryption stuff should probably go in the device configuration bucket.

Paul noted that the term "components” was too nebulous, and didn't make sense. Instead, he proposed, let's focus on configuration.

Comment from Larry: in one of your slides (#14) you mentioned authentication. This is very good; we're seeing as much as 1 second to authenticate, this is a significant problem in a real system.

Question from Bob: On slide 13, I'm very much attached to the concept of a metric. In my view, this group's task is to define metrics. Packaging the definition of a metric will involve the discussion about components and configurations. However, there is no discussion in this presentation about defining metrics; there is something that touches on it later, but not really. Are we going to have metrics for environment, applications, components? Answer from Paul: On slide 10, for example, we would have metrics defined from different applications. Bob rejoined: I would say to that: no. A metric is a metric, it is not a function of an application. The objective is not to derive a metric for jitter from a voice application, it is to define the metric for jitter and then see how this applies to the voice applications.

There was some complaint from the back of the room that they couldn't hear Bob; Charles therefore handed him the mike and requested Bob to repeat. Bob said that he was essentially saying that the fundamental task of the group, which was defining metrics, was missing from the presentation. He said that he believed that metrics would be applied to applications and not defined by applications.

Comment from Don Berry: if you exchange the words “measurements” and “metrics” on slide 4, that may address your concerns. Paul clarified that slide #5 grew out of his dissatisfaction with slide #4, and was his attempt to restructure it to better match what we needed to do.

Question from Bob: What do the arrows on slide #5 mean? Answer: For example, a hotspot designer might need to look at environments first, then look at device configuration, then the applications that were to be supported. These three things determined wireless performance.

Comment from Tom: I think what Paul has done here is to define setup parameters. RFC 2889 has the concept of setup parameters; the actual metrics are well-understood, but the setup parameters are very different for wireless as compared to wired LANs.

Question from Joe: Something that Tom just said makes me think of setup parameters. There are APs, for instance, that don't allow you to configure certain setup parameters. For instance, a home AP may not allow you to configure the link rate, but an enterprise AP will; how do we allow compare apples and oranges in this case? Answer from Paul: This work is more of a project management sort of thing; the corporate vs. the consumer market is certainly something we have to figure out.

Comment from Charles: The link rate could be another configuration parameter, so that this becomes part of the conditions under which the test was taken.

Question from Larry: Paul, I'd like to understand this concept of a management tool to guide our thinking. Let's take contention window maximum and minimum. I'm a little mixed up on where contention window settings would go in the test setup and process. Answer from Paul: My thoughts on a lot of stuff like this is that a lot of these variables impact the performance metrics. For streaming media, for example, packet error ratio would be a metric. Things such as noise would impact performance on the very far right.

Comment from Charles: I can point out that for example, WME has some settings for the AP for CWmin, etc. These fall into device configuration; it's a knob on the AP. Also, I agree with Tom that the big difference between wired and wireless is that there are so many things that should be adjusted - it's not just wires hooking into a switch, even people walking in the hallway will affect it. Also, I don't like the bucket below the three boxes. Encryption should be in device configuration, interference and signal strength is in environment, and so on.

Comment from Tom: The topic of “protocol” might fall in the application bucket. For example, VoIP or RTP.

Question from Niels: In this whole exercise, what's the value of reproducibility? You have a lot of variables there you can't control at all. How can you, as a vendor, reproduce results somewhere else? Answer from Paul: Unfortunately that's going to be a difficult challenge; if a customer calls up and says that my wireless doesn't work, what do we do? This is the million dollar question. You can start dissecting the problem piece by piece, but you can't really start reproducing the problem until you get to defining it.

Comment from Niels: I think 802.11k will help with that. You do radio measurements and metrics at the radio, and if you have a way to quantify the interference environment you can come to some predictions eventually. Paul replied, however, that one of the drawbacks with this is that you still have to go to the customers to get your measurements. Niels rejoined that you can get it automatically from the end-user equipment. Charles noted, however, that this was not the domain of WPP; it belonged to 802.11k, and it could help in an install situation. He remarked that it’s the old business about on-line vs. off-line measurements; 802.11k deals with on-line measurements, WPP needs to characterize it in a test bench environment.

Question from Niels: You want to have reproducibility, so how do you guarantee that? Answer from Charles: That's not our job, we're not here to say "make air go away". In a test environment, however, you have a lot of liberties to constrain stuff.

Comment from Paul: The only way to reproduce it is to constrain it completely. Therefore, guidelines are called for.

Question from Charles: Guidelines are another possible thing we could write, but that was not checked off in the PAR. Do you view that guidelines should be an output of WPP? Answer from Paul: Yes.

Larry commented that 802 people did not look at guidelines, and so he much preferred a Recommended Practice.

Tom said that he had three comments. Firstly, on the topic of setup parameters, the RFCs typically test in the following way: first, they establish a baseline configuration for the DUT and the setup against which all devices must be tested, as a kind of lowest common denominator. Then they vary different configuration parameters and repeat the tests to get an idea of how the performance depends on these parameters. Secondly, the definition of “repeatability” may be different for wired versus wireless LANs. In the case of wired LANs, the error rates and the statistical variations were very low, on the order or parts per billion, so we could have absolute repeatability. However, for wireless LANs, error rates are measured in percentage points, and so we may have to accept that repeatability may be true only in the statistical sense. Finally, he noted that 802.11k and WPP are two sides of the same coin; correlating WPP measurements with 802.11k measurements may enable people to truly figure out what’s going on in the field, and compare it with what they thought would happen (i.e., prediction).

Question from Joe: The purpose of WPP is to do something similar to cellular, where they make metrics that actual users can then use to make measurements that tell them whether something can work in their own environment (each users sets his or her own bar). Answer from Charles: Yes, this is correct. Users and magazine people would set their own bars, but use our measurement methodologies to make the measurements.

Question from Niels: Can you make conducted measurements and then use that measurement for prediction? Answer from Charles: Yes. Conducted measurements are the best way to get repeatable measurements with the smallest sigma, and while they are not real life they can give us a baseline. As soon as you put it in the real world, we know that the device would do worse.

Question from Niels: It's all about making it predictable, right? You can do X, Y and Z measurements conducted, and then you say that you are done? Answer from Charles: Yes, if X, Y and Z measurements can lead you to performance prediction.

Comment from Taylor Salman: This may be a problem with the way you are defining applications. For example, I can take an e-mail application traffic pattern, but when my environment changes, the offered load to the MAC layer changes. I can't define my offered load to the MAC layer as an “e-mail application” because of this. Paul replied that he was more focused on what the traffic pattern would look like. Taylor then said that he would caution us against labeling that as an "e-mail application". Paul replied that he didn't mean to clarify that this was what e-mail looks like, it was put there to spur discussion.

Comment from Charles: We like to define things that make applications perform well. When it gets down to brass tacks, we're going to measure the big four - forwarding rate, latency, loss, jitter. These are very familiar metrics from the wired world, and these are used as indicators of performance. We've got the same thing here with wireless, but there's more. We have other application-related performance. For example, roaming performance and privacy are factors that impact usability. I exhort you to think of other application kinds of stuff and what the impact to performance is; perhaps there's a metric there. If application performance is impacted, we should think about turning it into a metric.

Comment from Taylor: The term “application” has a very specific meaning in the IP world. I would change this to "traffic pattern". However, I would almost go the other way and say that a generic traffic pattern is somewhat meaningless.

Comment from Charles: I think the RFCs address it. In RFC 2889, for example, there are a whole lot of ways of referring to traffic patterns - mesh, full mesh, etc. - and they let you stress the switch in different ways. There are also bridge learning characteristics in 802.3, and we have an analog in 802.11 like association. Perhaps we should change “applications” to “traffic patterns”.

Comment from Mark: On this topic, both of these two comments do make sense. One says something about the traffic pattern being offered, and it also says something about what metrics we need to define. I think it's both.

Comment from Charles: I think we should look to what we have in the 802.11 protocol - for instance, roaming comes to mind - to figure out the protocol features that are offered to support applications. That would be a lot easier that saying "let's see, we want to simulate NetMeeting, with white boarding, and so on".

Question from Bob: Paul, is this sort of discussion contained in your 6 month schedule? Answer: The 6 month schedule is very aggressive, even for my own labs, but it can be done. In order for WPP to really deliver on its purpose and scope, it needs some boundary conditions, as it can easily get off track.

Charles began to speak, but Paul interrupted, stating that this was his ending speech, and not to spoil it. (Laughter.)

Charles then asked whether Paul had a motion to make, or if he was just done with his presentation. Paul was somewhat undecided.

Question from Larry: Paul, do you plan to make some changes to your titles and the document? Answer: I plan to change the colors.

Question from Tom: Should we have another group that looks at metrics? Answer: This was supposed to be under applications. However, applications has changed to traffic patterns, so maybe we should have another on metrics. Charles said that we should keep this in mind. He noted that the TGn folks created Special Committees within the group to agree on what channel models should be used to describe MIMO channels and so on. They also had usage model committees. Once the Special Committees were formed, they had a special charter; they had no power per-se, but went off, did work, and brought it back for approval by the TG. I clarified this with Bruce Kraemer. We can form these groups now, but we have to re-affirm them when we become a TG.

Comment from Mark: I was wondering whether it would be better to hear all the other tech presentations, and see if this makes sense after that. I'd like a straw poll.

Question from Paul: Mark, do you think any of the other presentations were orthogonal to mine? Should we wait before deciding on the ad-hocs? Answer: Maybe or not, I would still like to have more information before you make a decision. It's not going to hurt us to wait and see what other people have to say before you make a decision.

Charles then ran a straw poll for Mark's question. He said that if the straw poll came up positive, we could add an agenda item for discussing the formation of Special Committees later.

Straw Poll #1:

Question:

Is it the will of the group to hear technical presentations on the agenda before further discussion of formation of Special Committees?

Results:

In favor: 17
Opposed: 0

Question from Larry: Tom, coming back to a question you had earlier, could you elaborate on the metrics ad-hocs? Answer: We need to have the metrics ad-hocs because there are more metrics here than what's defined by wired metrics. We can't simply lift the metrics from the RFCs.

Larry then formally requested that the group consider the formation of a fourth ad-hoc to discuss metrics.

Question: Is there a difference between ad-hocs and special committees? Answer from Charles: Let's consider all of these special committees.

Fanny then requested a presentation slot to discuss a roaming metric. Charles duly modified the agenda to cover Fanny's presentation, and also the discussion on the formation of Special Committees.

Question from Bob: Shouldn't it be terminology and metrics? Don chimed in and asked if terminology should be also part of the metrics group. There was some discussion on this topic. Finally, Charles directed that the minutes should show that the title of the metrics group should indicate that terminology should be part of the metrics group. This was duly recorded. Don also requested time on the agenda for a presentation on "Terminology Definitions". Tom noted that we have a document like this; Charles said that we should add these terms to the terminology document.

Question from Fanny: Bob, you mentioned terminology, isn't this something the whole committee should do? Answer: Terminology is broader than attaching it to one of the sub-groups. By this I mean that terminology should not be part of any single sub-group.

Charles said that we should postpone this discussion to 8 PM, under the "Terminology Definitions" discussion. He then asked for suggestions on what to do with the remaining time. Tom suggested, tongue-in-cheek, that we recess until tomorrow. Charles looked incredulous. After some discussion and joviality, Don proposed that we should discuss the terminology after the break on Tuesday. Charles then presented the modified agenda to the group, and asked for approval. Larry requested Charles to describe the meeting times of the group for the week. Fanny read out the meeting times, and Bob clarified that the presentations were listed out of order. With that, there were no objections to accepting the agenda.

Charles recessed the meeting until 7.30 PM.

Meeting 2:

Date: 13 July 2004

Location: Studio Suite

Charles opened the meeting at 7.35 PM PST. He noted that Don Berry had agreed to collect a list of items for terminology. This would be a good thing in order to start solidifying these things, and also these would be a good source of material for the "Terminology and Definitions" section of the recommended practice. Charles then turned it over to Don.

Don started with a blank slide on which he proposed to free-form the terms that needed to be defined, and then define them. The document was titled "WPP Terminology Definitions". He noted that this was no more than a working document; we can decide to categorize terms, throw them away, etc.

Bob, Larry, Charles, Paul, Mark, etc. proposed a number of terms to be defined. There was a lively discussion. Tom suggested that all terms in RFC 1242 and RFC 2285 should be included by reference; these RFCs were added to the slide. The topic of a "client" came up: namely, what's a client? This also sparked a lively debate. Charles brought up the notion of defining an “STA”. The topic of repeatability was discussed.

Charles noted that he had checked Stuart Kerry's mailbox, and there were no comments from the other 802 WGs on the WPP PAR. There was happiness and jubilation all around. Charles gave a short rundown on the process going forward, culminating with a NesCom decision in August.

Question from Larry: There are a number of terms in the 802.11 standard that probably don't need to be redefined here. What should we do about that? Answer from Charles: Things like “station” might be well understood by all, but something like "authentication" could be construed by different people to mean different things. Tom noted that something IEEE 802.17 used with good effect was an extensive list of definitions in the draft standards; many of these definitions were simply pointers to good definitions already present in other standards. The presence of the pointer stopped further debate on the definitions. Charles also discussed the issue of defining roaming in conflict with 802.11r. The topic of 802.21 was also brought up.

After a page full of words to be defined was created as a result of the lively discussion, the issue of what to do with them was brought up. Various schemes were proposed to palm off the work of actually filling out the definitions on to various people, which led to much back-and-forth repartee between the group members. The possibility of putting the definition task on hold, until the Special Committees got under way, was raised. There was some agreement on the notion of doing this. Finally, the group decided to identify some definitions that would be universally needed, i.e., required for the general work of the group, and leave the rest to be defined by a Special Committee or committees. These general definitions would be identified by bold font in the slide.

Tom brought up the notion of referencing IEEE STD 100, which was the compendium of all terms and definitions taken from all IEEE standards, and suggested looking at IEEE STD 100 before settling on our own definitions. He volunteered to approach the IEEE editorial staff to see if we could get hold of a copy for standards development purposes. Paul echoed that this was true, we should not repeat the definitions. It was further suggested that the definitions be categorized (which, Paul remarked, would be a big job for “someone”). Also, Bob suggested that we should italicize the metrics to distinguish them from other words, and underline measurement conditions. Bob and Don worked to do this.

There was considerable discussion about whether different words were conditions, metrics, etc. Asterisks were then added to indicate terms over which there was contention. “SNR”, “BER” and “signal strength” were specially flagged as combinations of conditions, metrics and contentious issues. "Quality" was also brought up and discussed; Charles terminated the discussion with a reference to "Zen and the Art of Motorcycle Maintenance". The discussion continued apace. The definitions for "link" and "connection" came up as well. References were made to the autonegotiation done by 802.3 interfaces. The terms "trial", "duration", "test set", "test case", "test suite", "benchmark" and "real-world" were also added. Eventually, the list was completely categorized.

At 8.45, Charles stopped the free-form discussion on the list, and asked what people would like to do next. Bob suggested that we should now decide which ones we wanted to define and which ones were already defined. Don suggested that we should take these definitions, sort them by their loose categorization, and then post the document. Charles suggested instead that we should take the words and put them into document #673r2. Tom volunteered to copy and paste the words into document #673 and post that as revision 3.

There being only about 15 minutes left, Charles asked Larry if he wanted to present at this time, or whether he wanted to present later. Larry elected to present on Wednesday, as he felt there was not enough time. Charles then informed him that he would be presenting after Rick Denker. A short discussion took place on the sequence of presentations.

All business until the start of the presentations being complete, Charles then asked for a motion to recess.

Motion #1:

Move to recess until 8.00AM Wednesday.

Moved: Larry Green

Seconded: Mark Kobayashi

The motion passed by acclamation.

Charles declared the meeting in recess until 8.00 AM Wednesday.

Meeting 3:

Date: 14 July 2004

Location: Forum Suite

Charles started the meeting at 8.10 AM PST. He reminded people to sign in on the attendance sheet as well as the 802 attendance server. He then confirmed that we had officially not received any comments from 802, and therefore could go directly to technical presentations. The first presentation was by Rick Denker; Charles turned the floor over to Rick.

Presentation titled "Wireless Performance Prediction and Environments" by Rick Denker (document #770)

Rick remarked that this presentation was sparked by the proceedings at the previous teleconferences. He said that as he was the VP of Marketing at VeriWave, he'd be approaching it from the customer rather than the technical perspective. He started by noting that a key difference between wireless and wired LAN testing was that there was a tremendous variation in customer environments in wireless LANs, vs. the typical cubicle farm view in wired LANs. There was a significant interaction of the interference and the attenuation with the wireless network. For example, he sees WLANs set up in factories and hospitals, with lots of metal objects (a "room full of wheelchairs") to cause problems with propagation. These issues did not exist in wired LANs.

Rick then noted that there was a huge difference in the two environments of interest, namely the test environment and the customer environment. The test environment is set up with a high degree of control and isolation, whereas a customer environment is completely uncontrolled, and there was a huge variation. The four basic types of test environments were: open-air, cabled, test boxes and Faraday cages. All the developers he'd talked to were using some combination of these environments; nobody was using just one. Rick then went on to describe the characteristics of the four different test environments.

Question: By open air, do you mean "in the open" or "inside"? Answer: Both. However, this is a good question; there may be a need for a fifth environment. Note from the audience that "open-air" may mean different things to different people. For example, "open-air" in the RF context generally refers to an outside antenna range or other uncluttered outside scenario.

Question from Rick: Is there a better term? Answer: How about "greenfield" or "free space"? Group did not like either proposal. Some debate. Charles pointed out that the term "open-air" is overloaded and we need to get a different term. "Over the air" was suggested, and met with some approval, but still a mixed reaction. Rick noted that what he was really getting at was that there are two classes here: the "test environment" which could be controlled, and the "customer use" model where there could be 10 or 20 different configurations.

Fanny: When you talk about "open-air" do you mean that there would be different configurations for the different test conditions, such as the conditions for a hospital, the condition for a steel mill, etc.? Answer: Typically we would have to define the base conditions for each customer use model environment. And yes, this could include hospitals and steel mills.

Rick then went on to the cabled environment. After the previous debate over customer use environments, he stated that he hoped this was a fairly consistent and non-controversial term. He briefly described the strengths and weaknesses of this type of test environment.

Question: On the test setup you are using, you can simulate some of the interference that you see on the air, right? Answer: Yes, this is possible, but you need to get a bunch of interactions there to simulate the actual behavior in a real network.

Question: When you say "cabled", are you talking about shielding the NIC and the AP as well? Answer: Generally, no. However, we might have to have two sub-categories to cover "cabled with shielded DUTs" and "cabled without shielded DUTs".

Fanny noted that a cabled environment might have to be both controlled and shielded, because NICs have a high sensitivity (on the order of -80 dBm) and need to be put into a shielded chamber in order prevent stray pickup. Charles also underlined this. Tom suggested that we might want to wait for the next slide before continuing with this debate. Rick then stated that his goal was really to put a structure to the environments, something we can use for discussion rather than a definite proposal.

Rick then went on to cover shielded chambers and Faraday cages. He noted that Faraday cages were expensive and normally regarded as shared resources.

Comment from Colin: You have to be careful in mixing Faraday cages and anechoic chambers. Anechoic chambers are good for antenna testing. Faraday cages have so much multipath in them that they really don't do very well for antenna testing.

Question: How do you differentiate between a Faraday cage and a shielded chamber? Answer: Size, basically. Tom noted that the difference could be quantified by whether the walls of the chamber were within the near field or not.

Question: Are the test boxes cabled together or is the whole device in the test box? Answer: That's a good way of looking at the difference between the cabled and the shielded chamber / Faraday cage environments. However, one can see both situations in the industry; we see people cable up chambers, and we see people put the whole test system into one chamber.

Rick then presented a summary of the test setups. He then went on to the customer use environment.

Question: How about multipath effects – how do you account for them in the customer use environment? Answer: Perhaps we can lump all of this into one box, under the noise category. Tom suggested that we could simply express this as an addition to the PER, because the multipath causes smearing at the symbol level and shows up as bit errors above the RF level.

Comment from Fanny: The throughput and so on can be highly affected by the multipath effects, so we need to make sure that when these types of measurements are made they are accounted for or eliminated.

Comment from Charles: If you are going to characterize the customer environment, you need to characterize the multipath delay spread. You can compress it all into a noise effect, but then you need to map that into a standard model for the RF layer. Rick then agreed and said that we might need a fourth category for this sort of approach.

Comment from Fanny: Characterizing in terms of CRC errors in terms of bit errors per frame is not a smooth distributed effect. This may not be sufficient.

Comment from Colin: These kinds of things are statistical, and you could characterize these by a statistical model. Tom further noted that this in fact underlined the notion that repeatability in wireless may be expressed in a statistical rather than an absolute sense.

Comment from Niels: This also brings up the concept of the averaging time; the averaging time could have a big impact on the measurements. The group discussed this. It was noted by Colin that statistical effects might also raise their head as more than just CRC errors. For example, by affecting the CCA. Rick agreed that Layer 1 effects might start interacting with Layer 2 protocols. He stated that we should try to quantify this separately, and see what the effect on CRC errors was.

Comment from Colin: There is a really important point about the CCA, if there is a low-level noise effect you don't get CRC errors but you don't even get access to the media. The PHY may see this but the MAC doesn't. I would claim that the CCA issue is a high-order problem, CRC errors are 1 level down in comparison. Some discussion of this topic followed.

Rick went on to discuss the issues of overlap of wireless traffic. He viewed the nature of the background traffic as being important. After this he moved on to the signal strength issues, displaying as an example a graphic from a Wireless Valley site survey tool, and noted that this was the most common thing that people would do when installing a network. (Veera Anantha from Wireless Valley clarified that the picture on Rick's slide was actually a signal strength plot and not a site survey plot. The correction was duly noted.)

Question: How different is the prediction from the actual site survey? Answer from Veera: There is a considerable difference. Different environments have different characteristics that cannot be deduced by simply doing a site survey. There was a general discussion on site surveys vs. prediction. Rick ended up by stating that there was clearly a need for site surveys.

In his final slide, Rick covered the issue of setting good expectations for the customer site; he said that we should try to get to a framework where we separate out the test environments and then see how the variables that affect the customer use environment can be factored into the test environment. With this, he concluded the presentation.

Charles called for a round of applause for Rick's presentation. He then noted that we are going to be forming a standing committee on environments, and this would be a great first crack at the basis for the work on the committee. With this, he threw the floor open to questions and comments.

Question from Colin: Let's look at a hypothetical situation, like a hospital. In this case, we have two different usage processes to cover it - low use, which were things like monitors reporting infrequently, versus high use, like VoIP calls. How was this covered? Rick said (referring to Paul's presentation previously) that there were three categories: applications, components and environment, and this could be part of the environment. Fanny said that the test setup implies an environment, and while there may be merit in defining an environment out of context, we don't need to do this for testing (i.e., test the environment). Colin noted that we still need to make a distinction between range, multipath, etc. and things like load and traffic patterns. Charles stated that we had already had this discussion on Tuesday, where we explained that there was a difference between the terminology relating to propagation, and the terminology relating to traffic. Colin noted that network traffic load can include things like latency, jitter, etc. that were environmental. The discussion continued for some time.

Question from Charles: Were you proposing that we need to identify the needs for those applications, or just provide metrics that could be used by applications? Answer from Colin: Both. The success of the user's experience depends not only on the environment, but also on the types of applications that they are trying to impose on the environment. A guy who is trying to ram video through the environment would have a different result from a guy who would be simply doing e-mail transfers. Charles then noted that our PAR had in scope the definitions and methodologies for the specific applications.

Question from Colin: Don't you need the traffic models for the different types of applications? Answer: I would appreciate people who have input on traffic models to provide their input.

Comment from Mark: I think what Colin brought up is really important; we need to include the load, multipath channel, etc. in the environment.

With this, Charles closed the discussion on Rick's presentation. He then turned the floor over to Niels, to give his presentation.

Presentation titled "Proposal how to Measure RF Sensitivity for WPP" by Niels van Erven (document #346)

Niels presented document #346, which was basically a proposal on how RF sensitivity could be measured. He started by saying as an equipment manufacturer that he would like to bring up one small issue, namely, how to measure sensitivity. Sensitivity is key in that it affects throughput and QoS and so on. He noted that we have talked about conducted and radiated measurements, but in his view a "true" sensitivity measurement was valuable, and he felt that a "true" sensitivity measurement could not be done with a conducted or radiated measurement.

Niels then identified the problem as follows: receiver test measurements with cables cannot guarantee a true sensitivity, as it does not take into account the radiated characteristics of the device. He therefore presented a diagram of a measurement setup to identify the radiation pattern (depicted on slide #4 of his presentation). He also showed a picture of the anechoic chamber he was using, which he said was basically a large wooden box lined with foam absorption material.

Question from Fanny: How big is this chamber? Answer: I'll cover this later.

Niels then described the characterization of the chamber itself, and presented some guidelines on how to set up a test situation using this approach. He then presented some radiation patterns from actual measurements, followed by a graph between measured bandwidth in KB/s versus receiver sensitivity. He noted that when you do a conducted sensitivity measurement, you get a discrepancy of about 8 dB or more versus that of the radiated measurements. He attributed this to the high noise levels generated by the processor, which desensitized the receiver.

Question: Are these averages, or one-shot measurements? Answer: These were done with FTP transfers; the transfer length was a sort of average, plus you had to do multiple measurements because of the uncertainties there. Bob noted that his hackles rose whenever people mentioned using FTP to do measurements, because there are lots of issues with using application layer programs to do Layer 2 measurements.

Niels then concluded that in order to get a true RF measurement, you would like to do at least a radiated sensitivity measurement in the open air, and not a conducted measurement. When you do radiated measurements you get a significant difference.

Question from Tom: Would you expect to see significant differences between measurements such as CCA and rate adaptation that are influenced by receiver sensitivity effects such as you show? Answer: The conducted vs. radiated measurements are clear on this issue.

Question from Fanny: With this radiated measurement, you see value in terms of a full picture. However, do you see value in a conducted measurement as well, as it is a lot easier to do? Answer: If you have the time, then yes, definitely.

Comment from Colin: To Tom's point earlier, I find this graph eye opening.

Question from Tom: Does this suggests that measuring rate adaptation in open-air vs. conducted won't give you much benefit in terms of a final measurement? Some discussion ensued on this topic.

Question: How do you improve this? Answer: An 8 dB difference is huge, you try to eliminate it by shielding.

Question from Charles: FTP is a TCP algorithm, and TCP has well-known problems over wireless. Did you try with UDP? Answer: You also try to do this with radio control software. However, with UDP you have other issues. There is a piece of SW to get this kind of measurements. (A discussion followed on the "piece of software".)

Joe: Your wired measurements, are they also inside the chamber? Answer: Yes, we did it inside the chamber; if you do it outside the chamber you can get lots of issues. Also, the door of the chamber gets very leaky after a couple of years, and 90 dB isolation can drop down to 50 to 60 dB.

Charles thanked Niels for his presentation. He then turned the floor over to Larry for his presentation (#729r3).

Presentation titled "WPP Baseline Metrics" by Larry Green (Document #729r3)

Larry started by apologizing in advance if anyone's favorite metrics were not present in his slides. He reminded the audience about the definition of the STAs and APs in the 802.11 standard. He also suggested that we stick to the standard, in terms of vocabulary and processes. He reviewed the standards that were in development, among them 802.11i, 802.11k and 802.11n. He also mentioned that some of us are living every day with the vagaries of the air interface, and noted that, while conducted environments provide nicely repeatable results, the test environment did not represent the real world which installers and IT managers had to live in.

He then hoped that we ended up with one set of metrics for all the different environments; we should not have a complete set of metrics for Faraday cages, and a whole different set of metrics for the air interface - this is not a good thing. He felt that we should look for commonality between the metrics used in the different environment. With that, Larry proceeded to cover the specific metrics categories, beginning with STA management counters: authentications, associations, etc.

Question: Are these measured per unit time? Answer: Yes, hopefully to something like microsecond or even nanosecond accuracy. Clarification: these are not cumulative, but over some period of time, right? Answer: yes.

Larry went on to metrics for signal quality, such as RSSI,

Question from Tom: Why distinguish between ACK signal strength and RX signal strength? Answer: Some of us like to dig deeper and characterize them differently.

Question from Don: Perhaps this can be used to distinguish between the AGC characteristics imposed by short packets vs. long packets? Answer: Probably.

Question from Colin: Why specifically ACKs? Answer: Because we lose ACKs frequently.

Question from Bob: Would you distinguish between diagnostics and performance? Some of these are diagnostic in nature. Answer: Yes, good point.

Comment from Carl: To answer the question of why ACKs, those are the closest packets to any other packets. Measurements on ACKs would determine things such as settling time and so on, which in turn would show up as lost ACKs.

Question from Fanny: Would the power level have any effect? Answer: Yes, this could determine whether the stations pick up the ACKs or not.

Larry then went on to cover things like MSDU performance and receive errors, reiterating Bob's point about diagnostics vs. performance. He then moved on to cover APs as well, decomposing the various metrics in the same way as the client metrics. Finally, he showed a summary slide showing 31 metrics dealing with the MAC layer. He also noted that these did not include any of the RF layer measurements, saying that he was leaving this up to people like Niels to describe. Further, on looking at the other 802.11 standards, for example, you would have about 16 or so additional metrics to deal with WPA. Also, the QoS and fast roaming work, plus the dynamic frequency selection stuff would apply, leading to still more metrics.

Comment from Bob: Could I suggest that three or four really key metrics - loss, delay and jitter - are not in your list. Answer: Yes, you get to do this! (Laughter)

Bob commented that by sticking to counters, you run the risk of not picking up some of the fundamental metrics that the standard needs.

Question from Fanny: There are metrics and there's diagnostic info. If you simply report counters, what can a network admin do with this? Is this really useful? Answer: I could classify this as a diagnostic metric, not strictly performance. Charles noted that the group's name is "wireless performance prediction", so this might not be in scope.

Charles: Would you recommend that specific implementations make these counters available? Very many of what you mentioned are not accessible by Over The Air (OTA) passive measurements. Are you suggesting that we should propose changes to the management base? Answer: Perhaps.

Question from Tom: Charles, why would you say that these are not available OTA? Answer: Things like RX CRC errors are not available, for example.

Comment from Bob: If you distinguish diagnostics from performance, then this list might be useful, because many of these in a second step could be escalated to performance metrics. For example, if you looked at offered load, but when you mix this with capacity, this might be useful. This is a good start, but it needs some work.

Question from Colin: If you are doing these statistics, you are assuming the presence of Layer 3 and up to do this. Once you have an assumption of offered load, for example, one can make these statistical measurements. Could we say that we should "ram" a certain type of traffic pattern through the device under test and then measure these metrics? Answer: Yes.

Charles then thanked Larry for his presentation. He noted that this would get us all thinking. He then noted that he would like to have the group thinking about the difference between diagnostics and performance metrics.

Question from Fanny: Is this a list of statistics to be used in the metrics? Answer: Agreed.

Comment from Colin: But you need to couple that with the methodology. For instance, what methodology are you going to use to "ram" traffic through the device? It is silly to expect random traffic coming through the network to produce the traffic you want. Instead, we should use special processes to generate the traffic, and then relate the traffic to the actual traffic seen in the network.

Question: Regarding the scope of the work here, how does prediction really fit into the scope of the work? I was reading the PAR and it wasn't clear to me. Is it only measurement and metrics that we are concerned about here? Answer: I'll tell you after this Microsoft moment ends ... (pause for PC to reboot) We want to define measurements and methodologies to enable people to make predictions. This is another discussion we need to have, and we should have it in the Task Group: what do we mean when we say prediction? Some people might want to say that prediction includes measurement of the antenna pattern plus a conducted measurement of the device, and then put them together and say something about the radiated performance. Other people might say that prediction implies knowing the future. (Laughter, and comments about crystal balls.) The discussion also brought up the topic that estimates of performance could be other interpretations of "prediction".

Question: Item 12 in our PAR says that the development of prediction algorithms do not fall within the scope of the project. Can you explain how we can even discuss prediction? Charles: We are talking about *enabling* prediction and not *doing* it. Looking at TGe as an example, 802.11i was spun out of that group because their scope became too large. This is an example of how we should choose to scope our work very carefully.

Comment from Bob: I would rather have called the group "wireless benchmarking", but it would have resulted in a very rough ride in the IEEE with that name. "Wireless prediction" is a much nicer name.

Comment from Fanny: I'd like to dissent from that. A lot of people are used to working with prediction models, so this is a confusing name – it would imply that we need to do prediction. I think the name should be more like "wireless performance modeling" or "wireless performance benchmarking".

Comment from Colin: You have the opportunity to change your name during the formation of the TG, if you want to do that.

Charles stated that he would take that under advisement; he noted to the group that it would be possible to do this by means of a motion.

Comment from Tom: I would prefer to have the name "wireless performance prediction" to remind people that the metrics and measurements that we come up with are to be actually useful to end-users when they are using/installing equipment, as opposed to benchmarking for its own sake.

There were no further comments. The business on the agenda for this meeting being completed, Charles declared the group to be in recess until 1.30 PM on the same day.

Meeting 4:

Date: 14 July 2004

Location: Council

Charles opened the meeting at 1.30 PM, noting that we had more technical presentations to cover. He said that the first presentation would be on RFC2285 by Bob Mandeville. Bob did not upload a contribution, as RFC 2285 was a publicly available document and freely available on the Web; instead, he would provide instructions on how to download it from the Web, by simply typing "RFC 2285" into Google and clicking on "I feel lucky". Charles then turned the floor over to Bob.

Presentation on "Review of RFC 2285 and RFC 2889" by Bob Mandeville

Bob started by repeating how RFC 2285 could be downloaded from the Web. He then asked how familiar the group was with the RFC process and the BMWG; some members of the group were familiar with this, others were not. He then briefly talked about how the wired Ethernet benchmarking process had started, with RFC 1244 and RFC 2544 (formerly 1944) from Scott Bradner. He noted that RFCs in the BMWG come in couples: generally, a terminology document comes first, followed later by a methodology document. The two RFCs that he had authored were the next two in the series, after RFC 1244 / RFC 2544. He had originally not followed a template; however, in later standards work, he preferred to use a template, because it gave a structure and forced you to get the work done.

Bob noted that one fundamental rule in the BMWG was the notion of "black box" testing. Another fundamental principle was that the BMWG results were never "good" or "bad"; it was merely some number, with a defined reporting format, but no value judgement as to whether the device was good or bad. Yet another principle was to enable testing of one variable at time. Yet another tenet of the BMWG was to test a device completely, but only at the layer at which it was designed; so, for instance, you don't use Layer 7 traffic to test a Layer 2 switch. You would instead design tests to test each characteristic at a specific layer. The BMWG would frown upon doing an FTP transfer to determine the performance characteristics of an L2 switch, for instance.

Yet another aspect of the approach taken by the BMWG is that the experience of the largest possible community of testers should be used as fundamental input into the terminology and methodology documents. For example, his lab had been doing Ethernet switch testing for about 4 years before he started working on the RFCs; thus their lab already knew what mattered in the user environment and what did not. In a sense, they pretty much knew where they wanted to go before starting the testing. He noted that this wasn't really the case in WLAN today. Bob also mentioned that the IETF doesn't really require implementations of the test methodology before publishing an RFC any more, but this was definitely a good idea.

Before the discussion of the RFC itself, Bob stated that his objective was to go through the RFC page by page and then determine what was applicable and what was not. He then started reviewing the RFC from beginning to end, from the table of contents onwards. While doing this, he pointed out that one of the great challenges for Ethernet switches in 1998 and onwards was to support fully-meshed traffic patterns. In fact, this testing helped drive the development of ASICs and off-the-shelf components that makes all Ethernet switches wire speed today.

Question from Charles: When you went into this process, did you have any notion of "meshing" at all? Answer: I was very much familiar with the notion of meshing. The very first test that I did was named X-stream and it was considered by many vendors to be a very challenging test.

Bob went on. He stated that the concept was to first define a limit of a given parameter - e.g., wire-rate forwarding, or wire-rate address learning - and then to drive towards test equipment that could exercise to that limit. It was only time to write an RFC after 2-3 years of getting test equipment to drive to this limit. He also pointed out that there was no talk about delay or jitter capability in this document; this was because, in 1998, no tester had any form of time stamping capability, apart from a custom setup that Scott Bradner had in his lab. Time stamping came along after the RFC was written, and thus one thing missing was a definition of latency.

Question from Tom: In a WLAN, what is a "SUT"? Does it include the environment? Answer from Larry: The SUT would include the DS, but my "opinion light" is flashing. Charles stated that in his case the environment would be specified, but not necessarily included as part of the SUT. Discussion ensued, and there was considerable debate. Finally, Charles recorded an action to put the term "SUT" on to the list for terms to be defined. Bob further noted that in the wired world, a DUT was an Ethernet switch, and a SUT was an Ethernet switch that was connected to other Ethernet switches. Charles felt that one could treat the DUT as a device in isolation, and it had been done.

Comment from Tom: You can't consider the DUT in isolation, you have to take the surroundings along with it. Response: It's getting complicated. Tom replied that testing a Gigabit Ethernet switch that required Cat-5 interconnections to the tester with Cat-3 voice grade cables instead would be an invalid; in the same way, regarding a WiFi SUT without including the environment and the antennas was invalid. Bob retorted that testing an Ethernet switch with the power turned off was invalid too, so what was Tom's point? The discussion continued in this vein for a short time.

Bob then proceeded to the actual definitions of the terminology. He noted that Scott's RFC had the concept of "modifiers", which may be applicable to wireless. He went on to talk about traffic orientation (unidirectional/bidirectional).

Comment from Charles: There are analogies that apply to wireless: an AP acts more like a hub, because of the shared medium, while the switched side still applies because of the Ethernet port. Response from Bob: The reason why "unidirectional" and "bidirectional" tests were designed was because in 1998 a lot of switches were half duplex and so would not give more than 60% capacity.

Bob went on to traffic meshing patterns (i.e., traffic distributions). He said that he wondered if these applied to WLANs.

Question from Bob: Are we comfortable with non-meshed, partially-meshed and fully-meshed traffic patterns? Answer from Charles: I'm uncomfortable with it; we can't just take these definitions and drop them in. We need to find out what really matters to an AP and come up with our own traffic distribution.

Bob then said that after figuring out the direction and patterns, the next step was to determine out what sort of traffic was going to be used to stimulate the device or system under test. The first requirement for Ethernet was to figure out what a burst was; in 1998, some devices would buckle when the burst lengths became larger, and forwarding rates could plummet from 90% to 20% at the longer burst lengths. He noted that one of the things that the group would have to settle on is to just make decisions; for instance, RFC 1242 arbitrarily decided that frame sizes would be 64, 128, etc., and everyone followed this. Similarly, burst lengths were decided on as well. WPP would have to do something like this.

Bob then noted that someone in the morning had mentioned "cheating" on the IFS. He noted that while informational RFCs are not allowed to put in "musts", this was one exception: the RFC had to ensure that the interframe gap was being adhered to, and require the tester to note in the test results when it wasn't. He noted that this was especially true for contention - if the protocol requires contention, and the DUT cheats, then it makes the entire benchmarking exercise worthless.

Bob discussed the "intended load" (Iload) and the "offered load" (Oload). He said that there may be a difference between the two, especially in half-duplex cases. In addition, this was also a result of testers that could not actually drive the rate up to the maximum possible. As a result, this difference had to be reported, as a precaution against people using lousy testers. In many cases, it might be easier to assume that with a hardware tester your offered load is equal to your intended load.

Comment from Tom: WLAN protocols have backoff. The backoff time is random, hence we need to have a long averaging time, and the behavior over a short time would be different. Also, for WLANs, there is a significant proportion of bit errors, and this can cause retries and resulting long backoff periods.

Question from Charles: Do we only count the goodput of the tester, or do we count everything? Answer: We should only count goodput.

Question from Tom: Well, then if a device retries, and gets through on the second try, should we count both packets or only the second packet? Answer: Only the second packet. Tom: You see why this is an interesting problem; what is the throughput? Is it half that of the effective throughput? Answer: Yes, it’s half.

Bob noted that the difference between “throughput” and “forwarding rate”, as defined by Scott Bradner. Throughput is defined at the rate below which not a single packet is dropped. Throughput hence does not allow you to characterize how the device behaves after it drops the first packet. For instance, after dropping that first packet, no more packets might be dropped; in this case, this is actually a good device, and this should be characterized. He felt that throughput was something that grew out of the simple measurement technology that Scott Bradner had available. Forwarding rate, however, does not take loss into account; it simply injects traffic and counts the number of packets received at the far end.

Question from Larry: Do you count SNMP packets in the throughput? Answer: No. Larry then went on: We have management frames, control frames, etc., which comes to a high degree of overhead. Bob felt that as a result you would have to include some level of management overhead in the tests.

Bob then continued, reviewing the definitions of maximum offered load, overloading, etc. as given in the RFC.

Question from Charles: What's "overloading"? Answer: For example, 2 ports in, 1 port out. There's another way you can overload, which is not good, which is for the tester to deliberately go below the IPG; if the DUT reports no packets lost, then you know that it's cheating.

Bob then discussed the iterative process of determining maximum forwarding rate, because a device might get confused when presented with a huge amount of traffic beyond its capacity, while the iterative process won't confuse the device in this manner. These days, however, this was not a problem; ASICs no longer got confused.

Question from Charles: Is this likely to be a problem with WLAN devices, though? Answer: Yes, very likely.

Bob talked about congestion control and forward pressure. He characterized "forward pressure" as "cheating". If you reduce your IFG every time, then you can always win, and you can get the medium every time.

Question from Charles: In half-duplex Ethernet, there was a backoff algorithm; did anyone cheat? Answer from Tom: Yes, I did that. However, by the time the equipment got to the point where this can be tested, half-duplex had gone away and nobody cared. Hence it did not become an issue, really.

Charles noted that this would be different in WiFi; WME for example builds it into the system, that's how they get priority of service. We might want to test this sort of stuff.

Bob moved on through the RFC. He covered head-of-line blocking; he noted that devices that suffered from head-of-line blocking would have to do a complete and total redesign in order to get over this issue. This was an important test in the Ethernet world. He noted that a DEC switch in particular had to be totally re-architected to pass this test. He then went on to address tests, such as capacity and learning rate. The process was to start with the capacity test, and determine how many addresses it could learn, and then use that for the address learning rate test. The definition of "flood count" came up as well.

Bob proposed that the term "behavior" be added to the list of terms to be defined, in the context of the "behavior of the device" under different error conditions. He then went on to discuss error conditions and broadcast as well.

Question from Charles: Regarding broadcast forwarding rate: if there is a difference between uplink and downlink broadcast forwarding rates, then this test would be useful, right? Answer: Yes.

Bob concluded the discussion of RFC 2285 and went on to RFC 2889, the methodology document. Rather than covering all of the tests, which was quite laborious, he went to a single test (fully meshed traffic throughput) and discussed it in detail. He started with the setup parameter section first, and then moved progressively down the test.

Question from Tom: Why was the maximum burst size set at 930 packets, specifically? I've always wondered why this strange number was selected. Bob did not really know, but guessed that this was the point at which the medium was fully occupied. Tom did not agree; he said that you could have an inter-burst gap even with a 930 packet burst, which was only a few tens of milliseconds long with 64-byte packets. There was much discussion, but the end consensus was that this was probably something that was limited by the tester.

Bob noted the random address generation requirement for stressing the address capacity of a tester, which he asserted was the kind of qualification which could only be done if you had already done this sort of testing. He then went on to enunciate a key principle behind the methodology document: basically, tests should be defined in a sufficiently abstract way so that different kinds of test equipment could implement the tests. Bob felt that we had to be extremely mindful of this principle, and not put the cart before the horse; the only way we can overcome this, and not fall into all sorts of traps, is to keep our eye on the ball. With that, he concluded his presentation. There were no more questions.

Charles thanked Bob for his walkthrough, and then turned it over to Fanny for presenting document #748r1.

Presentation titled "Test Methodology for BSS Transition Time" by Fanny Mlinarsky (document #748r1)

Fanny gave thanks to Jeremy Spilman for creating the presentation and collecting the results, and noted that this presentation would also be given to TGr. She started by showing a view of the test setup; the idea behind the test was that there was a station that had to be roamed from AP1 and AP2, and we were interested in measuring the roaming time. She noted that one way to do this was to put the station on a cart and roll it from one end of the building to the other, which was physically challenging. The method they had used, instead, was a cabled topology that would isolate the APs and then use programmable attenuators and combiners in the test. There were variable and fixed losses that were set up such that the APs and stations could not hear each other under maximum attenuation, but could hear each other with a strong signal with minimum attenuation. As the attenuation changed, the station was forced to roam. They also analyzed the Ethernet side of the AP, to look at the traffic being generated.

Fanny then went on to slide #11 of the presentation, showing the transition process and the delays. She explained the roaming process by reference to the slide. She showed the representation in terms of the packets as well, and noted that the script extracts all these packet traces and puts the results together.

Question: Is the rate adaptation included in this roaming time? Answer: In failover roaming, the adaptation time is factored in, but in smooth roaming, the adaptation time is not counted into the results. There was much discussion on the roaming parameters. Fanny noted that there were variations in the roam, depending on the degree of overlap and the speed of roaming. Basically, there was some time where the station does not hear the AP altogether.

Comment from Bob: It would be interesting to know where it was at in the rate adaptation process. In some cases it might slow down a lot, in other cases it might not slow down at all.

Fanny then showed the measurements performed on a number of different clients; there were 40 iterations of the roaming test, and the client took about 2-10 seconds to do the roam. There was some discussion about the impact of the roaming time on things such as VoIP.

Question: Does the roaming client use Microsoft Windows zeroconfig, or does it use client-specific management software? Answer: We configured the station through NDIS. There was no reconfiguration happening during the roam.

Fanny noted that TGr would be looking at this. The largest contribution was the scanning time required by the client. A member of the group asked about the term “Cone of Silence”. Fanny clarified that the Cone of Silence referred to was the practice of putting a coffee can over the AP under test in order to persuade a station to roam; however, Charles noted that this was not a very good way to do the roam either. The advantage of the method presented was that it could be done rapidly and repeatedly.

Question from Charles: Are you proposing this as one of the methodologies for our group? Answer: Yes.

Question from Tom: Did you try this with different APs? Answer: Yes. The 802.11b APs took a lot less time than a/b/g, especially in the case of one vendor that had coordinated their APs and their client cards.

Question from Fil: Did you notice a significant difference between 802.11a/b/g and b-only? Answer: Yes, if you restrict the PHY modes used by the client, you restrict the scanning, and this speeds up the roaming.

Charles noted that, speaking for TGr, they want to have roam times on the order of 20 - 50 milliseconds, which is a small fraction of the actual roaming time measured. This is present state of the art, however. We need to coordinate with TGr to define the same metric, otherwise we will end up “hating” them and they will end up “hating” us and we don't want that.

Question: Why is Tdata so high sometimes? Answer: I'm guessing that the client lost the IP address and had to regain it.

Question: What is the "inter-roam delay"? Answer: The scripts wait for a short period of time to stabilize. The amplitude is changing during the scanning. Charles noted that we want to test with different inter-roam delays, to account for settling.

Comment from Bob: In the future, it would be necessary to figure out a way to isolate the client's contribution to the transition time, and the AP's contribution to the transition time. Fanny responded: This is not quite brought out in the diagram, but is actually done - the response times are separated. Also, this is dependent on the traffic load as well.

Charles noted that these long roaming times are what happens in devices now, but TGr is going to change that. It's hopefully going to change for the better. On that note, and seeing no other questions, Charles closed the presentation.

Charles then noted that there were 20 minutes remaining in the time until the break. He asked if anyone would like to discuss changing the name of the group. Fanny said that she would like to have such a discussion. Charles therefore opened the topic.

Bob stated that, as much as he would like to change the name, he felt that we could not do so, because the PAR did mention “prediction”. Charles recapitulated, for the benefit of the people who were not present in the morning, that a discussion on this topic had taken place on Tuesday and that there were people in the group that said that we could change our name if we so chose. Fanny said that she had spoken to a large number of people who were just confused about what the group did and the source of confusion was partially the name, which led people to confuse the charter of the group with propagation modeling and so on. Paul noted, in counterpoint, that there was a lot of ROI to be obtained on the overall purpose and scope, which was still nebulous. Until that was obtained, he did not feel that we should spend any time discussing the name. Larry, on the other hand, echoed Fanny's comment that that there was a lot of confusion around the word “prediction”, and this was also giving rise to a number of jokes. The big issue, in his mind, was: what should the new name be? He said that, to Paul’s comment, we shouldn't spend a lot of time on this.

Question: How much does it matter, and does it discourage participation? Answer from Fanny: I feel that a bad name could definitely discourage participation.

Bob noted that if we are going to change the name, we should change it now, and he would like to see it changed to “Wireless Performance Metrics”. Fanny concurred, saying that she liked that name. Charles said that we should do it right now or not at all, and preferably with a motion.

Bob brought up the issue of "now" vs. "right now". He preferred that "now" equals "in this session", rather than “now” equals "in the next 10 minutes". (Laughter).

Paul then asked about the agenda for tomorrow. Charles replied that there was one more presentation on the agenda, and then there was a discussion about special committees. At that point, Fil stated that he would like to give the name change some more thought before deciding on whether to change it and what to change the name to. Charles concurred, and said that he would put it on the agenda at the very bottom, after the formation of Special Committees. He then declared the meeting in recess until 4 PM tomorrow.

Meeting 5:

Date: 15 July 2004

Location: Parlor C

Charles opened the meeting at 4.00 PM. The group was entranced during the first few minutes by a pink spot on the screen (generated by a defective VGA projector) that gradually shrank and eventually disappeared, to the accompaniment of a countdown by Tom. The projector having returned to (somewhat) normal, Charles started the official business of the group by reviewing the agenda and the plans for the remainder of the meeting. He said that we had one presentation from Bob Mandeville on the subject of a test template, followed by a general discussion on the formation of Special Committees, the charter of the group, the deliverables and the lifetime of the group, plus some procedural work. He also noted that there was some discussion on the name of the group that could be dispensed with right away: the title of the document, from the PAR, was "Recommended Practice on Wireless Performance", and would not change, and so changing the name of the group was a moot point. He also announced that two motions would be coming up later: a teleconference motion, and also a motion to extend the life of the SG until the TG is formally approved. He stated that he would like to go back to the terms document that was started Tuesday night as well, and start working on some of the terms. He felt that this would keep us busy until 9.30 PM. Charles then passed around a signup sheet for the newcomers to the session to sign in, and reminded everyone to sign in to the attendance server as well.

With that, he turned it over to Bob for his presentation. After a bit of fiddling with the video projector and the screen, the presentation began.

Presentation titled “Wireless Performance Test Template Proposal” by Bob Mandeville (document #832)

Bob began by noting that he wanted to start the entire process by looking at the end point. The end point is a document that describes tests. If we are going to do this, then we need to think about how we are going to describe tests. The way to do this was within the confines of templates. To this end, he said that he would present a template that is unlike anything else he had ever seen. He wanted to do this early because the structure should be in place as soon as possible.

Bob noted that it was important to build a structure to all of the work that the group would be undertaking, and this was hence an ambitious proposal. He would therefore go through the template item by item and describe how each item should be dealt with. He forthwith plunged into the description of the template.

The first item in the template was the title, which should be the test name, with each word capitalized. He then went on to the test definition ID, which should be a number. He stated that he would not want a hierarchical numbering scheme; only one single number should be used to identify a test. A significant amount of discussion ensued about the numbering scheme to be used.

Khaled Amer asked if it would not be useful to have subtests with a hierarchical numbering scheme. Bob disagreed with this; he would prefer to have a single level of numbering because it would be easier to maintain. Charles noted that, as editor of the WSM test plan, he was all for simplicity, and was all for one level himself. Don noted that one thing that might be helpful is to work backwards, and then see what we would like to produce as a working group. His idea was that there would be a certain number of metrics - one or two dozen at the most - so that we can compare products and develop profiles for those. We should consider a limited number of very specific test scenarios, very controlled, and very limited. Thus we didn’t need an extensive numbering scheme.

Question from Joe: Do we want to relate this to what some of the other bodies do? You are discussing various configuration changes (modifiers) to take a different metric in the same device. In the case of the WiFi Alliance, are they changing the numbering scheme? Answer Charles: The WiFi Alliance does something different with each test plan, so that’s not a good example. Don further pointed out that in terms of reducing the amount of numbering, a single test layer without modifiers is best.

Bob then noted that you could have tests that supersede older tests; in this case, you could have the older test number in brackets next to the new test number.

Question from Mark: Are there categories of tests? Answer: Yes, that's coming up.

Question from Don: Are you talking about revisions of tests in this? Answer: Yes. Don then continued: I would support revisions of tests rather than a single test.

Comment from Tom: I suggest postponing all the format stuff until we have a draft, the IEEE Standards Style Manual says what can be done and what cannot.

Bob therefore continued with the presentation. He talked about the reference document source entry.

Question from Charles: The “source of the test”? Answer: This refers to some IEEE 802.11 document that is the underlying specification.

Bob went on to discuss the “test type” field. He noted that the TG had to maintain a number of lists, which would be definitions. He felt that it was the duty of the group to create the list of tests.

Question from Mark: did you intend this as part of the numbering scheme, such as "FRP1"? Answer: No, we would have "Test 1", "Test 2", "Test 3", etc. for the numbering. The specific test would be some type of test.

Bob noted that he had added "baseline performance tests should be conducted in a fully shielded environment" for controversy, and looked archly at Tom while saying this. He noted that he wanted to characterize the particular test as being either a baseline test, or a test with modifiers. He then went on to talk about the test purpose, which would talk about why a test would be useful, how it would be useful, and to whom it would be useful.

Question from Mark: Do you see a separate document, such as an RFC, that would be kept by the group? Answer from Charles: I don't think the test purpose should be separated into another document. The intention was to have a very brief definition here. Mark then continued, stating that the RFC was very well described. Charles asked whether there was another document in the IEEE standards collection that could serve as a model for this work. Tom brought up IEEE 1802.3, which was an 802.3 test document; however, he noted that it was probably not a very good example of our work.

Question from Gerard: Should the “purpose” of the test be the specific subclause in 802.11? Answer: No, that's in the reference document source. The “purpose” explains why the test is useful.

Bob proceeded to discuss the description of the DUT/SUT. In general, you would be required to indicate the device type, which would be pulled from a list maintained by the TG.

Comment from Charles: I would suggest that the definitions be drawn from the existing device types. Rebuttal from Don: That becomes muddier in some cases, such as when the AP is part of a switch or is a thin AP. Bob noted that in all of RFC2285, there was no definition for an "Ethernet switch". The group may in fact come up with a definition for a device type that is not in the standard. Gerard then commented that he would make a friendly amendment: we should talk about the STA, which includes several of these items.

Question from Larry: Are we defining the list right now, or are we talking about a template? Answer: We are talking about the template. Larry then reiterated that we should agree on the template first, and leave the specific items for later.

Charles then noted that he was hoping that this presentation would take no more than an hour, but given the amount of discussion, suddenly the 3 hours and 15 minutes remaining to WPP didn't seem like a lot. Larry noted that we should hurry up. Bob therefore proceeded apace.

Question from Gerard: If this were a station, would you want to describe whether this was a Pentium 4 or whatever? Answer: Yes, you do want this.

Question from Tom: What happens if the make and model number of the device hosting the DUT is no longer available at the time of the test? Answer: I don't know, what do you want me to do about it? Gerard then clarified that this information might be necessary in order to determine the test conditions, so that equivalent equipment could be found to reproduce them.

Bob noted that he added the “test result range” field because this seemed to be very significant for wireless performance testing. He said that, for example, you don't get 54 Mb/s out of 802.11a, and people reading the reports should be fully aware of that. He then went on to test environment, noting that he'd taken a crack at it. He stated that he wasn't necessarily an expert in this type of environment; this would have to include all sorts of effects, such as cables, areas, camels passing by in the hallway, etc.

Comment from Don: I think the test environment would be a definite requirement. Next! (Laughter.)

The next topic of discussion was the “test configuration” field. Bob said that the test configuration would have to be generic, not naming specific vendors or equipment. It should be described in a generic fashion.

Question from Gerard: A simple diagram of the test setup, perhaps? Answer: Yes. For instance, I used to have a simple schematic for the SUT.

Bob went on to the description of “test parameters”. He noted that the list he'd presented was not exhaustive, and would be a work order for the group. He went on to modifiers. There was considerable discussion about what the difference between a test parameter and a modifier. Tom defined the test parameters as a configuration of the traffic generator, such as the addresses used and the load. The modifiers were defined as configuration of the DUT. Charles said that he liked this definition, and paraphrased it as "parameter is a configuration of the tester, and modifier is a configuration of the tested".

Chris Polanec, in the interim, noted that he'd found a document we could use as an example for our work, which was IEEE 829, "Test Plan Outline". He said that this would be something we should look at.

Question from Don: Overall, do we have the concept of "subtests" in a test? Is that a "modifier" concept? If we have a few metrics to publish, we would need some way to aggregate those into a meaningful output. Answer from Charles: We still have to find a way to do this. For example, in the case of power consumption of a laptop, we would have a test procedure to measure the voltage and another to measure the current, and we would multiply the two.

Question from Don: We could easily define a thousand tests, would this have any value? Answer: One way would be to make it incumbent on the group to make it a pretty contained list to keep things from being an exponential explosion of stuff.

Bob stated that in the BMWG there was a definition of the frame lengths that would be used, and there were 8 of them, and this kept things fairly manageable. Don then asked how we would weight those, and distil them into one integer. Charles remarked that he did not believe that this would be in scope for the group, as there were a lot of different types of equipment that would require a number of different modifiers for tests, so that different modifiers would be applied to different categories of equipment. Don noted that he'd seen all these test plans that had hundreds of modifiers, but there was nothing that would distinguish good performance from bad. The discussion went on for some time.

Bob skipped over "test procedures" as being something that would involve the most amount of work, as an output of the TG, and went to "units", "variables" and "results". He noted that this was the item that would probably address Larry's point the most. The issue of how to present the results was significant and needed to be decided. The format would have to be fixed by the group.

Question from Fanny: Can it be generic, or would it be specific to the test? Answer: It might be hard to make it generic, so we might have 2 or 3.

Finally, Bob covered "remarks", where he said wryly that this is where we put things such as "we didn't know what we were doing, so we retired halfway through". (Laughter).

In closing, Bob exhorted the group to take this test template effort seriously, and said that we needed to work hard at it. He noted that extensive work remained to be done on the test types, device types, environments, parameters, modifiers and units section. He suggested that these six tasks may be a way to structure some of the work going forward, and may dovetail with Paul's scheme going forward (or it could be viewed as an alternative approach to how the group would go forward). He further noted that this hasn't covered a single test yet; our work was just beginning. This closed his presentation.

Charles then thanked Bob for his presentation, and said that he saw two levels of work: first, we need to agree on a template, and then we need to agree on the methodology. He therefore called for a straw poll: How many generally liked the template?

Question from Tom: Did you mean the formatting of the template, or the contents thereof?

Charles clarified: The contents, particularly the contents of the leftmost column, leaving aside the colors and so on.

Straw Poll #2:

Question:

How many participants like the template format?

Results:

Like it: 17
Do not like it: 1

The sole dissenter was Chris Polanec, who stated that the IEEE had some similar documents that were done in the past and we should consider the formats and structure of these documents before deciding on a template of our own. For example, the IEEE 1802.3 standard, or IEEE 890 (Chris was not quite sure of the number). He thought that perhaps we should look at these other standards first and then come back to Bob's presentation. Bob then broached the topic of another straw poll in terms of how to break up the work. Charles noted that he was hoping to use the remaining 40 minutes to discuss the work of the ad-hocs, and promised to give Bob some time later. He noted that this was a great start and we should settle on it within another couple of months.

Tom had to leave for the airport at 5.25 PM, so Bob Mandeville kindly volunteered to take over as recording secretary for the rest of the meeting time. The following are the minutes taken by Bob M.:

Charles discussed generic process of getting to letter ballot and formation of special committees to handle the tasks. Paul suggested that the revised group titles be 1. Device configuration, 2. Traffic patterns and 3. Application. After discussion, the group added another group for 4. Metrics. There was an open discussion on groups.

Mark and Don discussed how to approach tasks going forward. Fanny stated that she saw application driving the tasks which would include metrics and under that device configuration and environment. Charles noted that he did not see voice metrics as governing the process. Fanny suggested that applications should drive metrics.

Paul then reminded the group of the scope. Charles stated that the definition of tests and recommended practices is the goal of the group. Paul suggested that metrics are goal of an application driven approach. Dalfor said that variables, units and results must be defined.

Charles asked if we need to form ad hoc groups. Mark suggested that the whole group might work together. Paul wanted terminology to be defined by the ad-hoc groups. Chris suggested that the ad hoc groups can co-exist with the larger group; however, Mark preferred splitting into groups at a later stage. Charles noted that two positions are being taken on ad hoc group formation.

Charles asked who will be going to Berlin for next meeting. About half of group said that they planned on doing so.

Don suggested that the conference calls focus on topics, and then later break into smaller groups. Fanny suggested two groups: one for metrics, and one for the template.

Charles called for proposals to be posted well ahead of time. Fanny later suggested that we work first on template and then develop tests once the template is ready. Mark proposed defining a minimum set of terms and template. Paul, however, felt that most terms are defined. Dalton said that some terms may be arduous to define.

Finally, Charles suggested the order of work to be: terminology, template, environment, device set up and application. Uriel said that he wanted the template to be left to the end. Mark remarked that the template will be an iterative process, and that he was hoping that there would not be too many iterations. Gerard said that in his view terminology is an ongoing process through the life of the test definition.

No agreement was reached on this topic, but much discussion took place. Charles then declared the meeting in recess until 7.30 PM.

Meeting 6:

Date: 15 July 2004

Location: Parlor C

The session resumed after dinner at 7.42 PM for the final meeting of the week. Fil Moreno served as recording secretary in Tom's absence. A discussion ensued on what the remaining time was to be spent on. There was some uncertainty from the group. Charles finally elected to move forward with the terminology discussion as planned, focusing on the terms that had been identified from earlier in the week as belonging to the "general" category.

Some discussion on the teleconferences also took place. Charles notified the group that he would be traveling next week and therefore no teleconference would be scheduled.

After this, the group resumed the terminology discussion. Bob provided a list of terms that need to be defined for the template. Paul expressed some concern over the direction of activity; in his view, we were diving into minutia at this point, and should be devoting our efforts to planning and structuring the overall work. On consensus from the group, therefore, the terminology definition activity ceased and the efforts of the members were directed to outline the "plan for now. Chris suggested that Rick Denker's presentation (#770r0) was a good start towards describing environments; however, he felt that we should wait until the next teleconference before starting in on this topic.

Discussion on the scope of work led to an extensive discussion on the meaning of the word "application" as applicable to WPP. After considerable debate, the group finally elected to accept a suggestion from Dalton, which enabled them to extricate themselves from the "rat hole" and move on. The suggestion was to encapsulate, within each test in Bob's template, an example of an application to which the test is most pertinent. It was also noted that this speaks to the Purpose item in the template.

This culminated the technical discussions. Charles then turned to settling the procedural matters: primarily, the continuance of the teleconferences and a request to the WG to continue the SG charter until such time as we would safely cross the threshold into becoming a formal TG. Two motions were invited by Charles to settle these matters.

Motion #2:

Move to hold teleconferences every Thursday at 12.00 noon ET, starting with July 29th.

Moved: Chris Polanec

Seconded: Don Berry

Voting: Yes: 16 No: 0 Abstain: 0

The motion passes.

Motion #3:

Move to request the 802.11 Working Group to continue the charter of the Wireless Performance Prediction Study Group through the January 2005 meeting.

Moved: Gerard Goubert

Seconded: Chris Polanec

Voting: Yes: 16 No: 0 Abstain: 0

The motion passes.

Charles then noted that he would be moving this same motion on behalf of the WPP SG before the 802.11 WG on Friday.

All business of the group being over, Charles then entertained a motion to adjourn. The motion was passed by acclamation and the group adjourned.

The WPP SG session ended at 9.30 PM PST on Thursday, July 15, 2004.

Attendance

Abraham, Santosh
Alexander, Tom
Amer, Khaled
Anantha, Veera
Andren, Carl
Bartel, CR
Baysal, Burak
Berry, Don
Billhartz, Tom
Bowles, Mark
Canaan, Paul
Chen, Michael
Daube, Zvika
Denker, Rick
Ellis, Jason
Euscher, Christoph
Goettemoeller, Mike
Green, Larry
Hayes, Kevin
Jose, Bobby
Karcz, Kevin
Kobayashi, Mark
Kojukhov, Andrei
Lanzl, Colin
Lemberger, Uriel
Mandeville, Bob
Mlinarsky, Fanny
Moreno, Fil
Mourot, Patrick
Narasimhan, Partha
Oh, Jongtaek
Paglia, Pete
Patel, Vikas
Polanec, Chris
Polland, Joe
Rangwala, Noman
Repice, Joe
Salman, Taylor
Schreder, Brian
Sivam, Reuben
Skidmore, Roger
Slosson, Brian
Surineni, Shravan
Tokubo, Eric
van Erven, Niels
Victor, Dalton
Vishwanathan, Chandrasekhar
Visscher, Bert
Wright, Charles
Yamada, Katsuhiko
Zeira, Eldad

IEEE P802.11
Wireless LANs

Minutes of Wireless Interworking with External Networks (WIEN) Study Group (SG) Meetings

Date: July 12-16, 2004

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Abstract

Minutes of WIEN SG meetings held during the IEEE 802 Interim meeting in Portland, OR, from July 12 - 16, 2004.

1. Executive Summary:

1. Background to WIEN SG presentation (04/688r1)
2. Technical Submissions:
   Network Side Issues (04/708r0)
   Hotspot issues (04/751r0)
   MAC address anonymity (04/780r0)
   Network Selection Issues (04/691r1)
   Access Router Identifiers (04/710r0)
   Key Management Issues (04/690r0)
   3GPP issues (04/733r1)
   ARID scenarios (04/835r0)
3. Liaison Issues to external standardization bodies
4. Extension of the Study Group
5. Initial drafting of PAR and 5Criteria
6. Plans for Berlin Meeting

Morning Session of IEEE 802.11 WIEN SG, Tuesday 13 July 08:00 – 10:00 am

2. Logistics

WIEN Meeting called to order by Stephen McCann (Chair) at 08:00am.

Agenda was reviewed (04/**689r2**) and it was agreed to bring the MAC address presentation forward to the joint session with TGr. Two joint sessions was scheduled for the week:

With TGr (Fast Roaming) Tuesday 1030 – 1130
With IEEE 802.21 Wednesday 0900 – 1030 (in ad-hoc mode)

The IEEE 802 & IEEE 802.11 Policies and Rules were reviewed.

Patents and By-laws read out by the chair, together with licensing terms and associated conditions.

There are 3 sessions, 2 on Tuesday 13th July between 0800 – 1230, and one on Thursday 15 July 1600 – 1800.

3. Background (04/688r1)

Stephen McCann (Chair) gave a short presentation about some of the background to the creation of this study group.

4. Network Side Issues of the interworking (04/708r0) Cheng Hong

Andrew Myles: Any example of the policy enforcement?
Cheng: e.g. the MAC addresses filtering at the Access Point (AP).

Stephen McCann: Are these functions at the AP or other network nodes?
Cheng: Could be on other nodes, if the architecture introduced in the AP functional description group (split MAC) is adapted. But these functions will be related to the MAC.
Ted Kuo: There is no need to define the physical location of the function.
Cheng: Yes. Only the functions need to be defined. Location could be left for implementation.

Chair suggested having straw polls regarding the discussed issues to decide if they are within the scope of WIEN.

Jon Edney: Are the straw polls per item or take as a package?
Chair: It could be carried out per item.
Floor: If the items address by other group, e.g. IEEE 802.21, turns out to have requirements on MAC and PHY, we may still have to deal with them in IEEE 802.11.
Chair: Yes. So, the straw poll is about whether we should ultimately deal with the issues in IEEE 802.11.

Stefan Rommer: Are we assuming a certain solution when we say it is in the scope of the group?
Chair: Not necessary to think about solution now. A future Task Group (TG) will be the place to work on detail technical problems.

Floor: User revocation relates to the WNM (Wireless Network Management). Will this straw poll decides on whether it would be dealt within WNM or WIEN?
Chair: We don't need to specify the group yet. Only need to consider if it is within IEEE 802.11's scope.

Straw Polls:

◊ Is the "Access Control & User revocation" in the scope?
Result: 17-0-2 (Yes-No-Abstain)

◊ Is the "Policy Enforcement" in the scope?
Result: 4-2-9

◊ Is the "QoS control and mapping" in the scope?

Result: 15-1-1

◊ Is the "Admission Control" in the scope?
Result: 13-1-5
◊ Is the "Simultaneous Access" in the scope?
Result: 6-4-8

Chair: Would like to know about the reason for the objections?
Andrew Myles: Feeling those points may not really relates to .11
Chair: Currently, cellular network made some assumptions about the WLAN, and these has to be checked in the WLAN standardization group.
Andrew Myles: Not sure about this from the presentation.
Chair: We are not yet in the stage of finding solutions. These are just a list of issues for future study.

Jon Edney: Some policy issues may be combined with the QoS issues.
Stefan Rommer: All of the items could be in the scope if we have some solutions that require changes to the MAC and PHY.
Chair: We need to list out the items, and then make some decisions in a future TG.
Ted Kuo: Maybe some contributions based on pervious work in other groups, e.g. ETSI BRAN, could help in understanding of the problems.
Chair: Yes. That is why we have started the technical discussions in the SG. The items listed are to be studied in IEEE 802.11, not necessary WIEN only.

Chair: Regarding the user revocation issues, it could be addressed in a joint session with WNM group in next meeting.

5. Hot spot issues (04/751r0) Max Riegel

Jon Edney: What is the anonymous authentication? Is that he authentication of the network?
Max: The network is authenticated to the user, but user is not yet known to the network. It is kind of similar to the PEAP process.

Jon: Secure web page is providing the protection to the user data.
Max: That does not provide security at the link layer, and that is the reason for the combination.

Chair: Item identified as "Secure UAM" and support of anonymous service, and user interaction/help. Would be useful to have a straw poll for these items.
Chair: Is there an equivalent term in IEEE 802.11 for the UAM which is a Wi-Fi term?

Straw Poll: Should we put secure UAM in the items in the list for WIEN group?
Jon Edney: Why this has to be done in IEEE 802.11?
Max: There is IEEE 802.11i, but not sure this could be done in IEEE 802.11i. This also touches the MAC.
Jon Edney: That is why PEAP is mentioned.
Max: PEAP does not provide the change of the sequence (of authentication). It is only contained in the authentication process. Here is trying to get the link layer key in place first, and then authenticate the user. PEAP does not allow doing IP connection before doing the authentication.
Jon Edney: Could be doing an open authentication first, and then establish another authentication. The issue is how to combine them and make them work.
Stefan Rommer: There are already proprietary solutions using the PEAP to do similar things.

◊ Straw Poll: To add this issue to the open issue list (tentative name “secure portal page”)
Result: 12-1-5

Joint Session with TGr, Tuesday 13 July 2004, 10:30 – 11:30 am

6. MAC addresses (04/780r0) Jon Edney

Floor: how many packets involved? What is the delay budget (of this scheme)?
Jon: The same as current association procedure, so same number. There may be some delay since the AP needs to check with other AP (using IAPP) for the uniqueness of the address. But it may not affect FR, since it is only for the first time the address is used in side the group. For the transition, it does not change the MAC address

Floor: what needs to be done for the DS to ensure uniqueness?
Jon: Maybe for the DS to keep a table for the bridging. It does not really bring much overhead, except a bit extra storage.

Bob: what kind of information is encrypted?
Jesse Walker: the authentication could be resolved to the user identity.
Jon: Some company will bind the MAC to the identity of the personal identity
Flo (FT): For user@homenetwork identity, the visiting network cannot know my real identity.
Floor: Fail to see the linkage of the problem. Why does it matter if your identity is known? And how the third party would get info about user identity?
Flo: 3G has not solved the problem. Would that mean it is not a big issue?
Floor: It is similar to the credit card issue, and credit card is even more serious.
Pat Calhoun: There were some efforts in IETF, and it was decided that it is a business problem. And this solution still doesn’t solve the problem.
Henry: why not just have a random address than using the protocol
Jesse: there are still possibilities of collision.
Jon: This is to reduce even the possibility of collision.
Floor: WAVE also would like to see this. The MAC address would also allow law enforcement agencies to track the user. This is a concern there.
Nehru Bhandaru: it is good, and we should have it studied in the group.
Pat Calhoun: Is it too much to do to tie the MAC to the identity?
Jon Edney: It is not so difficult now. And there is a trend to do that in the industry.
Floor: The request and ack will add extra time for the FR
Jon: It only affects first time association.
Floor: When the MAC expire, it may affect the FR

◊ **Straw poll**: “Is anonymous MAC addressing a concept that should be pursued within IEEE 802.11?”
Yes-No: 26-22

7. Network Selection Issues (04/691r1) Eleanor Hepworth
Flo (FT), 72 bytes in RFC2486, it could be longer. It is AT LEAST 72 bytes.

Jon Edney: Are you considering distributing the info wirelessly or in the wired network?
Eleanor: In WIEN it is wireless, in IEEE 802.21 could also be wired.
Bernard Aboba: The mobility for the EAP may not be well understood.

◊ **Straw poll**: “is network selection information as presented in 04/691 a concept that should be pursued within IEEE 802.11?

Floor: This is a specific solution. Is the straw poll about general issue, and will other solutions be considered?
Stephen: Yes. We will not concentrate on the solution but only on the issue.

Result: 55-0

◊ **Straw poll**: "Where should the network selection information as presented in 11-04-691 be pursued?
: WIEN-TGr- Other within 802.11:
Result: 50-0-1

8. Access Router Identifier - ARID (04/710r0) Daniel Park

Floor: Those fields are already not free. You need to put a bit somewhere else.
Jesse: Why would not include this in the discovery work?
Stephen McCann: It could be.
Pat Calhoun: It may not be the AR, could be a mobility domain.
Floor: What is the delay like if you move between ARs
Pat Calhoun: If you change IP address, there is no FR.
He HaiXiang: One AR could have multiple subnet associated, is the ID identifying the physical AR or the subnet?
Stefeno: Need to distinguish between whether we need to provide the info, and how we do it. As for how to do it, the proposed may not be the best solution.
Floor: Clint: What is the range of the ESS?

Decision: To take this back to WIEN and discuss more.

Morning session of IEEE 802.11 WIEN SG, Tuesday 13 July 11:45 – 12:00 am

9. Key Management (04/690r0) Eleanor Hepworth

Chair: Will carry out a straw poll to see if these are still in the scope.

◊ Straw Poll: "To have keying material/issue in the open issue list"
Result: 1-1-9

Needs further presentations to clarify what needs to be done for the issue.

Joint Session with IEEE802.21, Wednesday 14 July 09:00 – 10:30 am

10. Stephen McCann presented WIEN scope and issue list
Stephen: Should the scenario 3 of 3GPP interworking be covered in WIEN?
People are confused about the scenarios. Stephen will come back in Sept to present about the different scenarios.

Floor: Will also deal with 3GPP2? Or will it be dealt with in a serial manner?
Stephen: In parallel, although the questions in the slides are biased towards 3GPP.

Ajay: Any liaison has to be from the WG, so it would be an IEEE 802.11 & IEEE 802.21 joint LS instead of WIEN & IEEE 802.21

Mani: How is the network detection and selection related to interworking?
Stephen: It needs to provide info of the network behind the WLAN.
Sanjeev: When you said the IETF requires that, would it be a more generic issue than interworking or layer2?
Stephen: Yes.
Mani: Would that be more of an IEEE 802.21 issue?
Cheng: There are different levels of solution to the problem. The items at IEEE 802.11 could be solved with existing IEEE 802.11 mechanisms, and not really conflicting with IEEE 802.21
Ajay: Would this cause confusion when IEEE 802.21 produces a different architecture?
Cheng: They should co-exist

Ajay: Do you have idea of where those functions to be implemented?
Stephen: No. AP function description group could be a place to look at.

Ajay: what are layer 2 interactions?
Stephen: If IEEE 802.21 has any architecture that would have interaction with layer 2, WIEN will have to look at that in IEEE 802.11.
Stephen: WIEN is not working on these items, e.g. triggers, but expect inputs from IEEE 802.21 regarding those. WIEN will try to look at those issues.

Vivek: In what form the output from IEEE 802.21 would the WIEN expect? The final specification or just some understandings? Some model would be done by individuals that would also work in WIEN? Also how to ensure that models would conform to IEEE 802.11?
Stephen: IEEE 802.11 will have to watch the draft in IEEE 802.21, not wait for the final spec. If significant changes are needed to the IEEE 802.11 MAC, feedback would be expected earlier than late. IEEE 802.11 will take the IEEE 802.21 output and made the changes. IEEE 802.11 not expect IEEE 802.21 to specify the exact changes to the IEEE 802..11 since that is not scalable. Those would still be sort out in IEEE 802.11 groups. In the end IEEE 802.11, IEEE 802.16, etc will still try to be IEEE 802.21 compliant. They will have to make changes to achieve that.

Yogesh: When you become a TG, would WIEN carry out any changes required from IEEE 802.21 in IEEE 802.11?
Stephen: yes

Michael: Procedures questions. IEEE 802.11 people are not working on the same problems as we are. They have their market and customer demand, and they will not just wait for IEEE 802.21. Therefore, we need to work together with them, to influence them, and even cellular, since some our changes suggested would be fundamental

11. ARID issues, Daniel Park
Floor: How to sync the use of ID in different domains.
Daniel: needs more study

Michael: in IEEE 802.16, the IP address may not change even if the domain changes. Basically, there needs to be more information than just he AR. IETF has several drafts talking about that. Also, there needs to be input from mobile node to inform the network of its identity and its intension.

Xiayu: It is true there should be some solution to identify the mobile domain. ARID is just one solution, link identifier in the DNA group stands as another solution. ARID needs manual configuration and that may have problem.

Micheal: In IEEE 802.21, no need to have ID limited to the beacon of IEEE 802.11

Afternoon session of IEEE802.11 WIEN, Thursday 15 July 16:00 – 18:00

12. Ratification of issues raised by IEEE802.21-WIEN ad hoc

* No issue to be ratified.

13. 3GPP Issues (04/733r1) Cheng Hong
Stefan Rommer: What else does the IEEE 802.11 needs to do to support USIM?
Cheng: We know IEEE 802.11i could support EAP, but not sure about the USIM, and the keying stuff.

Q: (Mike, Dorothy): would the keying thing be an IETF issue?
Stephen: There is a liaison regarding the IETF to be mentioned later. And, now we are not going to the details yet. Just to get a feeling of whether the items should be in the scope.

◊ Straw Poll: USIM support
Result: 5-2-9

◊ Straw Poll: Network Sharing
It is decided that the item will be the same as the network detection and selection issue that is already in the open issue list.

◊ Straw Poll: Traffic Enforcement
Result: 8-0-8

◊ Straw Poll: Charging
Result: 12-0-5

14. 3GPP/2 Liaison issues

Liang Jie: Why haven't we sent something already?
Chair: We are not sure where to send?

◊ Straw poll: Is it a good idea to sent liaison (LS) to 3GPP and 3GPP2? (Not define the time)
Result: 13-0-3

Take the drafting of the LS offline.
It would contain the open issue list.

15. ARID presentation II (04/835r0) Daniel Park

Lang: How is the ARID are propagated to the AP?
Daniel: Not sure now.

Eleanor: What info do you need to support the FR, and it would fall into TGr's scope? And another issue is how you made that info available, which would be the network selection issue? Also, for how to make it available, it could fall into IEEE 802.21's scope.
Stephen: It is indicated that it is an issue, and we are not sure which group should deal with it. We will see Daniel to come back with the issue for Berlin meeting.

16. Letter/Liaison to IETF (04/833r0)

◊ Motion: Move to approve document 11-04-833r0 and request the IEEE802.11 Working Group chair to forward it to the IETF

Discussion of the motion:
Q: May doc submitted to the IETF. Does this document represent the direction? Will it just die off?
Bernard Aboba: IETF will grant high priority to contributions from other SDO. One is a WG draft. The other is an individual draft. The process could be common, but there are couples of ways to deal with the comments.

Stefan Rommer: We need to have a time estimate for the comment process.
Bernard Aboba: One has a 3GPP posed deadline. When the letter is received, you can have a discussion about when the deadline is.

Moved: Mike Moreton
Second: Eleanor Hepworth
Result: 19-0-2

17. SG extension motion:

Motion: "Move to request the IEEE802.11 Working Group to extend the (WIEN) Study Group for another 6 months"

Moved: Hong Cheng
Second: Takashi Aramaki
Result: 20-0-1

18. Update of open issues list (04/834r0)

Air Interface Issues:
AR identifier (needs further work)
MAC address anonymity (Possibly)
Network Detection and Selection (Yes)
Beacon Scalability (Yes)
Universal Access Method/11i co-existence /Secure Portal Page (Yes)
User clear down (possible)
Keying issue (Possibly)
~~USIM Based access control (Yes) – 3G/cellular based access control~~
Eleanor: This may be similar to the keying material issue.
This point modified into:
"3G keying issues (possible)
- USIM based access control
- Length and entropy"

Stefan Rommer: The 3GPP SA3 may have already solved the issue

Network-Network Issues:

Policy enforcement (Not sure)

- configuring public access AP - WNM

Access control (Yes)

- user revocation - WNM

~~Simultaneous access (not sure)~~

External QoS mapping (Yes)

Admission control (Yes)

Traffic enforcement (yes)

Charging (Yes)

“Simultaneous access” is taken out.

Bernard Aboba: Comment in IEEE 802.1 thinking that not all IEEE 802.1 QoS is supported in AAA. Especially in VLAN mappings.

Insert under “External QoS mapping

- o IEEE 802.1 issues
- o Admission Control”

19. Roadmap for SG/TG (04/712r0)

◊ Straw poll: To have Teleconference to review PAR and 5 Criteria and the LS to 3GPP/3GPP2

Result: 17-0-0

Dates to be announced in the Mailing List (ML). (initially 2nd week of Aug)

◊ Straw poll: If you intend to take part, what time zone region do you prefer?

Asia: 3

US: 7

Europe: 3

Chair: The Teleconference time should be around noon central US time.

20. PAR and 5 Criteria preparation

- Audio conference – 2nd week of August

04/628r2

PAR Title:

“PAR for IEEE 802.11 Wireless Interworking with External Networks”

◊ Scope:

This document amends the IEEE 802.11/1999 (2003 Edition) MAC and PHY to support interworking with external networks, such as 3GPP, 3GPP2, etc.

Mike Geipel: Should we mention any one of the external networks.

Chair: No, hence remove the reference to 3GPP etc.

Mike Moreton: Should we change the IEEE 802.11/1999 to reflect the IEEE 802.11i, etc?

Chair: may come back and update these words at the Berlin meeting.

Result:
“This document amends the IEEE802.11/1999 (2003 Edition) MAC and PHY to support interworking with external networks”

◊ Purpose:
The purpose of this document is to provide an interface to using the IEEE802.11 PHY/MAC layers which enables interworking with non IEEE802 networks. This document will specifically address changes required within the IEEE802.11 PHY/MAC layers to enable interworking with external network

Mike: The “provide an interface” may cause confusion. People may think it is protocol or similar things.
Floor: suspect will not involve changes to the MAC or PHY. More of a the API
Chair: Maybe some specific changes to the MAC would be possible, e.g. Beacon.
Chair: Agree to get rid of the word “PHY”

Result:
The purpose of this document is to provide an interface to the IEEE 802.11 PHY/MAC layers which enables interworking with other networks.

This document will specifically address changes required within the IEEE 802.11 MAC layers to enable interworking with other network

◊ Additional Explanatory Notes:
The scope of this project is to develop a standard for the interworking of IEEE 802.11 with external networks. It is necessary for IEEE 802.11 to create a standard, which specifies the requirements and interfaces between IEEE 802.11 and external networks, such as those found in cellular systems.

The amendment will address specific interfaces to address external authentication, authorization and accounting, together with policy enforcement and resource management.

Such interface provides interaction method between IEEE 802.11 entities and the interworked external network to achieve required security, QoS, accounting support.

The standard also specifies how the interface works with existing IEEE 802.11 functions, e.g. IEEE 802.11i, to meet the interworking requirements

Comment: To add the open issues into the second paragraph.
Comment: Will you mention AAA or RADIUS.
Chair: AAA will be OK. RADIUS will be too specific.
Eleanor: Will mention network selection.

Result:
The scope of this project is to develop a standard for the interworking of IEEE 802.11 with external networks. It is necessary for IEEE 802.11 to create a standard, which specifies the requirements and interfaces between IEEE 802.11 and external networks, such as those found in cellular systems.

The amendment will address specific interfaces to support external authentication, authorization and accounting, together with network selection, encryption, policy enforcement and resource management.

21. Agenda for the Berlin meeting

To discuss the PAR and 5Criteria created by the teleconference.
Start the procedure to form a TG.

IEEE P802.11
Wireless LANs

Management Study Group Minutes, Portland

Date: July 2004

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Wensdeay, 8-10:

Harry Worstell announces this is a study group

Jesse Walker volunteers to be secretary for this session.

Harry reads the intellectual patent policy.

Harry explains rules for study groups. Study group will ask for an extension if the study group does not finish PAR. 75% approval needed on any subject. Attendence list required and being circulated.

Proposed agenda presented.

Motion: Approve Agenda

First: John Klein

Second: Richard Paine.

Need secretary on Thursday.

Call for proposals.

C: .11k looked at scenarios for service provider versus enterprises deployments. Each try to control their environment.

Chair: After PAR and 5 Criteria work done, we will talk about that.

Chair: Working through teleconference on PAR and 5 criteria. Need to examine it and approve it. Work due to Richard Kennedy. He will go through PAR and 5 criteria when he arrives. Document 537r03.

Most areas of PAR are boiler plate (through item 12). Item 12 begins to define scope of project. Discussion of item 12 (project scope)

C: Should we add the word “secure” to the scope clause.

Chair: We should discuss this. Some feel it is not required, but chair thinks making it explicit.

C: Rather not have it there. Security implicit in the notion of management. Putting it in doesn’t help.

Chair: This statement says what we are allowed to do and what not.

C: But if the word is not present, that doesn’t preclude you from talking about it.

Chair: That is the question. What is in the PAR and 5 Criteria is what is allowed.

C: How does .11k deal with it?

.11k Chair: Asked .11i and they said too far along, so trying to address it. Deadlocked, so will go to first letter ballot without security.

C: If you want it to be part of the scope, you should say so.

C: Based on .11k experience, that would be an error in strategy. Stalled if there is deadlock. Put it is as a side note, but don’t make it a requirement.

Chair: Item 18 is further explanation. That may be a better place to explain this.

C: Is there value for a management interface without security?

C: The TG is to do management, and security is a separate expertise. Security is a feature of management, not the goal itself.

C: Adding security after the fact is difficult and sometimes impossible to add after the fact.

C: Don’t completely agree. If there was another group that has defined a way to secure action frames, then other groups could built on it. Want to layer secure transport. We could create a new study group to secure the management transport.

Chair: Some of the .11k discussion has moved to this group. Do we need security more than .11k? This is a pertinent topic for the PAR discussion.

C: The management group needs security more than in .11k. In .11k can impose a denial-of-service. Management issues command and control messages. These cannot be compromised.

C: Agree.

Chair: Does anyone feel security is unnecessary?

C: You need a secure transport, but does that have to be part of the work of this WG?

C: Until now .11 has build management and control explicitly in the clear.

C: Concerned about different groups building different mechanisms.

Chair: A new PAR may be appropriate. It is a broader subject than .11k. It was inappropriate to delay .11i to do this. We should ask Stuart about this.

C: Security has been mentioned in WNG, and brought up with Stuart to start advisory board 6 months ago, but nothing has happened.

C: But this belongs as part of architectural discussion. Anyone can go to WNG to propose a new SG.

Chair: Would like .11i participants to go into WNG to start a new study group. If I have to deal with security, it will lengthen time needed to complete my PAR. It will help all TGs. There is still a major need.

C: An orthogonal solution that can go across all messages. For those who live in pre-.11i days, we don't want to release something that allows command and control of network.

Chair: If they started now, then might finish sooner, because all the pieces of .11i are in place.

C: There are three cases: command and control can go its own PAR or in any TG. There are also problems like reassociation, disassociation, and deauthentication that should be handled by .11r. Finally there are corner cases, like wake up.

Chair: Seems like we are getting consensus for unified approach under separate PAR. Strawpoll: How many believe this? Vote: virtually unanimous.

C: Is there not a requirement to not break existing functions?

Chair: Yes

C: But adding new command and control degrades security.

Chair: The consensus is a unified approach is needed. We state we know it is an issue, but state it should be handled by another PAR.

C: We know security is required for this application, but it is not necessary this is required from a standards perspective. This is different than WEP, because we aren't advertising we have security.

Chair: The only concern is if we make another study group or TG, will loose many participants in Management. But narrowing scope speeds standard. Enough on plate to figure out what command and control is. Is everyone happy with item 12 without a security statement?

C: One question is it explicitly identifies MAC and PHY. Why not enhancements to DS and AP?

Chair: Let me scroll to item 18. First paragraph in Item 18 attempts to define manageability.

C: But scopes says making changes to only MAC and PHY, whereas item 18 says want to control 802.11 devices.

C: in TGk it has brought up current thinking is to put management as an application, but 802.11 has never viewed the problem this way. Say MAC, PHY, and selected application.

C: This does not apply to DS.

C: DS is part of the MAC

C: This is not my understanding of the architecture.

C: Annex C defines the DS as part of the MAC.

C: Disagree. The DS was separated from the MAC so it did not need to be specified.

Chair: Added "DS" to MAC and PHY..

C: Not sure about AP

Chair: What about the link layer?

C: The standard is nebulous so we can avoid this.

Chair: There is nothing in 802.11 PAR restricting us to the MAC and PHY.

C: If you go higher, don't you begin to imply AP architecture?

Chair: Possibly. We should stay within a delimited scope and leave hooks for the rest.

C: It is better to leave it open to cover as many entities as possible.

C: Are you asking that we change the backbone?

C: Associations happen with the DS, not to a STA or an AP. When you roam you reassociate back to the DS.

C: Are you talking about distribution service or system?

C: The Distribution System provides distribution services.

C: We need to clarify what DS means if we leave it in.

C: Need to clarify what is meant.

C: The term ESS has already cause problems. DS needs to be very well defined.

C: Current standard defines DS as distribution system and explicitly does not define it, but rather defines services it provides. These services are part of the MAC. If you want the distribution services included, it is sufficient to discuss services, so including DS goes beyond the scope of current architecture.

C: It is always useful to include layers you will be working in in PAR. If we know, we should include within our scope.

C: The problem is specifics make it harder to address what you need later.

C: In 802.11k we say MAC and PHY and also say we will define interface to upper layer. Could say MAC, PHY, and selected Upper Layers

C: Would prefer to say interfaces to upper layers than upper layers itself.

C: Like suggestion to say 802.11 devices, to maintain flexibility to improve manageability of entire device.

C: add "and selected upper layer as required, to effect a complete and coherent upper layer interface"

Chair: Everyone happy with this? No complaints, so we will go with this for the time being. Anyone want to make a motion?

C: Are we really managing network or network devices? Last sentence says "managing wireless networks" which is removed from managing 802.11 interface on the device. We are talking about an interface to manage device on the network.

C: But we want to manage entire network.

C: We will provide an interface for that function.

Chair: We are not gleaning much information out. This takes the information .11k provides and does something about it.

C: All of the work is within the device. But we won't be able to effect synchronization, etc.

C: Disagree. A lot of the work is outside the devices.

C: The facilities to do device synchronization will be above the device. Like that management of networks is the goal.

C: Say network managbility.

C: We are focused on 802.11 devices, but customers focus on APs, switches, RADIUS servers, etc. We are not going to do anything about RADIUS servers. Should say wireless network devices.

C: Upper layer interfaces

C: Upgrade of software or firmware will apply to all devices and is device specific, not radio specific.

C: Try “for managing 802.11 devices in wireless networks”

C: Over the next few years we will see lots of non-laptop devices entering the market. Are they covered?

C: There will be more such devices than attended devices.

Chair: Are people happy with this language? Hereing no objection, go to item 13, “Project Purpose”

C: What is the value of the phrase “ESS-wide management”? It enables management. Whether it is in an ESS seems irrelevant.

C: There is the physical RF medium, which may be shared among different ESSes. If you don’t tak account of this, you can degrade performance for all.

C: But that isn’t relevant.

C: TGk is attempting to improve efficiency of network operation. This Purpose statement doesn’t address this.

Chair: Believe we are providing hooks for network manager to adjust the network as he sees fit, not make it more efficient.

C: Assumption was that Management would include this.

Chair: You want to broaden scope then?

C: Yes.

Chair: The problem seems that there are “multiple definitions” for “ESS” What would you like instead of “ESS”?

C: Seems like statement about manageability of large networks already says everything needed.

C: What does local and remote management mean?

<no consensus on the meaning>

C: all of the interpretations of local and remote seem fine. We need the ambiguity.

C: Are we going to allow full management of device from the wireless interface? Or do you have to manage device by crossing distribution service? Can you get to the MIB through the 802.11 interface, or do you have to access it through the distribution system.

C: This is network management enhancements.

C: But .11k is just measurements, no command and control.

C: Need an interface to allow management to effect the command and control. Is the whole mechanism on the radio side.

C: It should not matter. It should be capable of effecting command and control from any device.

C: We don’t care where the manager should be. We want to effect flexible management.

C: Want to make sure we can access interface from a wireless device.

C: Want wireless in-band management, but don’t want it to be hacked.

Chair: We have already discussed security. Consensus is a unified proposal needed developed by a new TG coming out of WNG.

Chair: Next item is boiler plate. Disccussed SNMP issues, list groups doing similar things, but none doing within 802.11. We are trying to enhance work going on in these other groups.

C: But we just extended scope to include upper layers.

Chiar: This gives us ability to do things as upper layers if needed. Move on to item 18. Additional explanatory notes. (Reads and explains current text to membership).

C: Security is a necessary feature of the management function, but it is assumed that another group will provide a unified protection scheme for 802.11 management.

C: What do we mean by another group? 802.11 group?

Chair: yes.

C: Does this preclude us from working on this if another group does not come forward?

C: Other groups like 802.11k may be working on this already.

C: Say “will become available” instead of “another group”

Chair: Change accepted. Do we need anything else added to Item 18?

Chair: Here is a time-table.

C: Return to item 18. Change “limits” to “limit”

C: What happened to boilerplate?

Chair: This is not yet the correct form. There is no way to get your hands on correct form, because it has become a web-based form. Complained to IEEE that we con’t do business this way. Plan to cut-and-paste into the form, with no changes. Will go through the process until we get this fixed. If we can approve the text, then we have a PAR.

C: Sroll down to “manageability is defined.” Does this limit us to building upon measurement, because we need to add command and control.

Chair: These are restrictions. If you don’t like wording, change it. First sentence includes word “controlling.” Perhaps you want to add something?

C: Supposed to be controls that use the measurements. Want to be able to add other measurements as required.

C: Want to build on .11k. Don’t say anything about control in that sentence.

Chair updates the document.

Chair: Ok, we have gotten through.

C: The scope clause allows selected upper applications. Is this a legal scope?

Chair: Intent is to restrict this to interface to upper layers.

C: Put in “if required” with “upper layer applications”.

C: Wasn’t management a common concern from architecture meeting.

C: Concern that language allowing work on upper layer applications will allow groups whose goal is to misue TG extract functions from 802.11 MAC instead of enhance 802.11 MAC

C: Change “as” to “if”

C: Should include language for prediction?

Recess due to orders of the day.

End Jessie Walker Meeting Minutes

WNM Meeting

Thursday 07/15/2004 (8:00 – 3:30 pm)

Harry called the meeting to order at 8:15

Secretary for the duration of this meeting will be Victoria Poncini

Harry went over Study group voting rules – requires 75% of group to approve any person can vote regardless of voting status.

Harry opened meeting with proposed agenda and presents the agenda with leaving the discussion session open

Harry: Any objection to approve agenda unanimously?

No objections.

Harry: agenda approved unanimously

No presentations to present in the morning session.

PAR is finished.

Richard Kennedy is presenting the 5 Criteria of the WNM PAR which was finished yesterday to the group.

Doc 684-000wnm

Richard Proceeds through review of the 5 Criteria document with the group.

Broad sets of applicability

> No changes.

Multiple Vendors, numerous users – no comments

> Only new addition
>
> Multiple vendors from around the world have participated in the development of this PAR and 5 Criteria. (Suggested by David DJ Johnson) to amend this section.

Balanced Costs (LAN versus affected stations)

David Johnson, explained the reasons for this section of the five criteria on balanced costs

> The widespread of commoditization of 802.11 wireless LAN devices yields an environment where standardized manageability of features can be deployed cheaply and efficiently.
>
> In large deployments standardized manageability features can reduce the currently high cost of deployment and management of the network.

Compatibility

The proposed amendment shall be (shall be) was added on review.

Distinct identity

David Johnson suggestion John Klien /Marty / Pat Calhoun/ Tim Olson: final wording follows:

There exists no WLAN network management standard for 802.11 systems enabling network-wide management of wireless device. The current 802.11 standards do not address the needs of current products, such as load balancing and virtualization.

One unique solution for the problem

Okay no changes

Removed network management and added wireless network management.

Easy for document reader to select the relevant specification

It will be obvious from the title and content of the standard that it is a standard for wireless network management within 802.11.

Technical Feasibility

Demonstrated system feasibility

Network Management systems are deployed in cellular networks and in proprietary ways in 802.11 networks therefore they are demonstrably feasible.

Proven technology reasonable testing

DJ and Marty: modified the wording under this section to read:

The main components of the technology for wireless network management have precedents proving their feasibility and testing.

Confidence in Reliability

Wireless network management implementations are widely deployed and thus are widely demonstrated to have the capacity to be reliable.

Economic Feasibility

Known cost factors, reliable data

Wireless network management is an integral part of wireless communications systems. Standardizing such behavior is likely to add costs to implementations. Any additional costs will likely be insignificant.

Reasonable cost for performance

No objections to the original wording

Considerations of installation costs

The proposed wireless network management standard will typically be directly embedded in devices and will not require additional installation costs. In addition,

A standardized network management system may serve to reduce installation costs of 802.11 networks.

Kennedy reviewed the finished 5 Criteria Document

****

Harry discussed the timing for when WNM will be a task group. Task group will likely be awarded in November.

It was announced that WNG just voted to start a new SG for Security by Emily…to address the security issues around securiting management frames.

A vote will be taken at the WLAN WG closing.

****

Tim Olson asked about content or transport? Not a transport but agreement over the issue is content and how it is to be used.

Harry:

Bring a motion to 802.11 working group to extend the study group for another 6 months

Motion:

Move to extend the Wireless Network Management Study Group for another 6 months

Moved: Richard Kennedy

Seconded: Roger Skidmore

No discussion on the motion

Called the question

Harry: explained that the study group must be extended every 6 months and either submit a PAR & 5 Criteria or else stop.

Results: Yes 11 No 0 Abs 0

Orders of the day called at 10:06 for break.

Any objection to approve the revised agenda.

Harry presented the new motion to bring the PAR and 5 Criteria for Wireless Network Management forward in the 802.11 Working Group session.

Motion:

Move to approve document 11-04-537-04-wnmdraft par.doc and 11-04-0648-01-0wnm-draft 5 Criteria Wireless network management.doc and forward them to the IEEE 802.11 working group for approval.

Moved by Richard Paine

Seconded by Richard Kennedy

Pat Calhoun: asked if the right version on the server?

Harry: …No it was not posted. So Harry needs to post the document to the server. Vote will not be able to be taken until after 4 hours. 802.11 WG requires documents must be posted 4 hours for review before taking a vote.

YES: NO: abs

Vote Cancelled due to document posting time on server. Vote delayed until the afternoon.

Richard Paine Presentation

Doc 11-03-270-00k

Use case scenarios for RRM advised WNM to do the same thing

Detail environments and suggestions for management

Factory floor

Airplane Environment

Home/Apartment buildings

Office Buildings

VoIP

IBSS: Jesse walker wanted to know why people would deploy IBSS?

Richard: Military example, what about software AP?

Jessie: had that in mind. But he stated that he was satisfied with the application that Richard mentioned.

Richard is presenting the additional use case for 802.11k to produce the requirements

Desire was to get more and more specific about what a use case was and what exactly the measurement were.

Richard: presented working set of scenarios

Hot spot

Hot Zone: airports train stations, malls what measurements needed

Multiple dwelling units: apts, townhouses, condos

Enterprise w/rogue access point

Ubiquitous WLAN coverage

Non-ubiquitous WLAN coverage

Handheld scenario: battery levels and power consumption are important criteria

Handheld non ubiquitous scenarios

High speed mobile environment: even in .11k neighbor report doesn't cover very high speed, but it does cover slow speed and Bernard presented doc # which explained the mobile environment and what could be covered by the neighbor report

Airplane environment

Any questions on how 802.11k evaluated scenarios so that they could come up with scenarios. Richard stated that 802.11WNM could use the documents to come up with scenarios to create requirements document.

Harry asking if task group K could provide the scenarios they used.

Joe Kwak and Jessie suggested that Harry call the vote in TGk for sending the PAR & 5 Criteria forward.

Harry: stated that hopefully people will come to WNM meeting this afternoon to vote on sending the proposal forward to 802.11WG

Harry: asking question whether there was general or concise proposals to bring forward, Harry wanted to know whether or not we should bring forward with a general proposal that addresses all of network management? Anyone have a complete solution for network management? No one responded affirmative.

Then Harry wants individual proposals or to use the ones like the one Richard Paine presented.

Any comments on how to bring in proposals?

Richard: will present his Network Management ideas from the one presented in .11k

Harry wants to know how we are going to run the group.

Harry: Pat Calhoun if he was going to bring forth a use case,

Pat Calhoun will bring one in?

Harry: What people envision on what they want to control and derive out of this how people are going to do it.

Harry: How many are going to Germany? How many would be putting together use case for September … results were that 5 submissions would bring use case papers at the Berlin meeting

Harry: also is going to try to get Pat Calhoun to come and present CAPWAP at the meeting.

Pat Calhoun: I will present a second paper on CAPWAP.

Harry talking about service provider campus/home environment with adaptive AP's,etc.

Harry brought up issues what you believe that WNM will control?

Harry: talked to Dorthy Stanely (?) about security (she felt that no reason to having a standing committee and a study group and the same time) Harry agreed with Dorthy to leave the standing group to later and let the study group handle the security issues.

Harry: What needs to be controlled? Where they need to be controlled from?

Marty: Are we going to tackle or change the way roaming is done?

Harry: there is a group looking at fast roaming?

Marty: the station is completely in charge of the roaming decision – kinda a scared cow in 802.11? Are We going to influence the stations' decision?

Pat: talked abut the MIB is not sufficient for today's devices, Pat not sure that having the snmp manager influence roaming

RichardPaine: stated that snmp is not being used

Marty: the MIB is not the exclusive method, but one of the methods which could be used to influence the roaming decisions

Harry: some discussions MIB is not fast enough to do this? Is the MIB the right way to do this or are there other mechanisms to do this, how we going to go about it? A lot of people are already doing it, want to have companies doing it to bring in the proposals on how they are doing it.

Harry: what happens when I roam to other technologies like cellular, other groups also looking at this but 802.11 needs hooks to move not only from the station but from the manager where there may be a lot of things that must happen before the move occurs?

Richard: spectrum management, even though I don't believe in it. As WLANs become more ubiquitious spectrum management may give you more assistance than you really want.
They will remind you of the Part 15 requirements and is quite an issue for an enterprise

Being able to select the actual spectrum and manage it equivilant to load balancing

Scenario

Also if we get into the TB frequency space and system will need to adapt and manage

Marty: there is a difference between freq agility and spectrum management

Richard: worried about RFID , and needs to address spectrum management … not sure if it is a requirement for this group.

Harry: co-existence is an issue that is now raising its head between the groups with activities in that area, and can't predict where this will go in the future?

Harry: roaming, MIbs good enough, spectrum management, how do things like handoff to cellular, triggers to know when you want to move, Network management interactions need to be initated between (mobile assisted handoff) wwan and wlan networks

J: Does this model make sense in the unlicensed band?

Marty: scope for interworking?

Harry: not in scope

Marty: do we need liason to go between 802.11

Harry: 802.11 must be ready with the mechanisms to do handoff …we may need somebody from the 3gpp group to look at this

Marty: hope that 802.21 would

Harry: if 802.21 is in Germany to come in and give presentation to WNM

Marty: what about having manufacturer of multie mode phones come in and present the issues they are dealing with?

Marty: is there a difference between enterprise, home and cellular with different requirements for management of Voice,

Jessie: public access have the same or different or overlapping requirements

Harry: you have home vs enterprise vs public

Mark: Seems like what we are talking about is different from network policy? Confused defining interface between network and administrator or other lower mechanisms

Harry: network manager managing the enterprise is one scenario that should be there, but that cellular may have similar hooks that need to be there, the hotspot may be a little different

Adaptive APs which adapt to its surroundings – we are general solution for many thing and accommodate actions

Cellular, network manager and how to best accommodate all of them within

802.11

R: the majority of devices are going to need to manage themselves, what hooks that you provide

Marty: adaptive AP rules that it adapts to, or does it sniff the air and configure itself?

Marty: this AP does adapt and all around it also adapt to it

Jessie: observation – conclusion different solution for the different problem domains, mobile AP or mobile sta must have the ability to detect and adapt to the environment and do the right thing, Solutions good for one thing may not work for another? Do we want to work on the core common to everything or specific to a solution?

Marty: device needs a discovery phase in whatever we do

Mark: confused self managed doesn't need management? One of the end points is the management station and the administrator

Marty: work out of the box what it needs to know to be deployed

Harry: need to understand tthe hooks that go into the mac and phy

Klien: sees AP needs configured by management station, load balancing needs to be done in a real-time but th e configuration of load balancing and parameters for mechanism can be configured and threshold assignments should be done by the network management.

Mark: says that real-time operation is out of scope for the group.

Marty: says that you can't have real-time mechanisms unless they are defined to facilitate

Jessie: how you read this is a closed loop mechanism,

Tim: we need to assume that we are creating some functionality there are things that need to be defined for load balancing…go to next closest AP,etc blah

Use network management looking to load some parameters to manage devices, and improve the operations of WLAN?

Jessi: do we need to change the PAR?

Tim: I just want to be able to provision the configuration and update the firmware, but not dealing with roaming and load balancing

Harry: wants the group to define where are our limits? Need more to create value add?

Klien: things that controlling and shaping the spectrum is in PAR and need to do real-time things and are not limited to just configuration? One of the broad goalls of the group so that the WLAN will work better than it does today…through some control mechanisms would work better

Marty: we don't want to define a load-balancing algorithm but want the mechanism in there so that both sides could see this

Harry PAR is R5: Harry brought up the PAR definition and asked if it covered Tim's question.

Klien: if we have requirements before .11k finishes then WNM will add measure ments when required

Harry: said that WNM do management and do measurements if we have to but won't do it as long as .11k has the ability to do it.

Harry is trying to have group have a discussion on what manageability is and how we are going to accomplish this.

Harry will compile from his notes and the meeting notes to see what applications are needed. Not writing applications, and algorithms, but what issues are so that hooks can be put in so that it is flexible and people can do what they need to over the wireless networks?

Harry: anyone have anymore scenarios enterprise scenarios, airplanes scenarios with no wireless lan experts to, load balancing –Marty, ? Any more?

Harry: good time to break for lunch? Come back after lunch to hear more ideas from other people? Think about writing some papers and bringing them in to move this forward?

H: afternoon, work on scenarios…around 3:15-3:30 will have the vote for the PAR and 5 Criteria so that we can move forward? Suggestions on how to move forward please bring forward,

Marty: moved that we recess early

Harry any objection? NO objections to adjourning early.

Harry adjourned the meeting at 12:08.

Harry: opened the afternoon session at 1:30pm by his watch.

Harry ran through the completed items on the agenda

Harry discussed the results that people are going to present case scenarios for network management for next meeting.

Harry mentioned that 802.11 does not have the hooks to do management from an external entity. Nothing from an upper layer down to manage your wireless network.

Other people want to handle roaming in fast manner, even though there is another group looking at it,

For control need to add mechanism in a timely manner

Spectrum management and have 802.21 come in and give presentation to the WNM group.

Scenarios of auto configuration of AP themselves would be an application where the AP ran this themselves, but WNM would still need to have the hooks

Marty/Richard/Harry: that finding location would this be important…FCC may put 911 regulations on companies deploying VoIP and we would need locations based activities.

Harry: More ideas? For Network Management…what does it mean to you?

Harry would consolidate these and put together some scenarios which could take advantage of this function. It shouldn't be limited to enterprise could be used in home networks and hot spots.

Victoria: sensor overlay network….and having network management system that would reconcile

It could be access port or a dedicated device. But would also like to see receive only

802.11k will not be providing this feature

Bob: can use WNM to make cognitive radio (localized intelligence) at the radio and a coordinated intelligence that would be residing at a higher level

Cognitive radio with 802.11k could provide spectrum management and then have a centralized intelligence for the coordination function.

Harry: not sure how to do this

Bob: says using the sensors can simulate cognitive radio.

Roger: Centralized intelligence can override the localized intelligence … have all the information available to the centralized

Harry: example go from autoconfiguration and then shut off for a time and go to centralized intelligence for management.

Bob: localized implies you don't corrupt the spectrum, works with FCC new view of what unlicensed, also if localized belong to group and can coordinate

Unusual that local radios can optimized global with centeralized management

Roger: there are really three levels here: localized, distributed and centralized coordination

Harry: cognitive radio: may be other frequency bands that you can be configured to use them, have the devices look around to see what available and then have the management station tell the devices to move back down to the other frequency. We currently have multi-band cards with receivers on them that can use different front end but can change to another frequency.

Roger: thinking about the roaming question, possible to set up roaming thresholds.

Harry: key to what we do is to have the ability to go in and set these thresholds.

Roger: when to begin the association and reassociation process

Harry: and Load balancing

Roger Durand: in order to do load balancing you must be able to control the client

Harry: many people feel that the client is the determining factor as to when they move others want the AP to have some control of moving, or to have both

Roger: the client does it today…you are thinking about some type of trigging mechanism

Bob: the client has to because it is in the know

Harry: having intelligence to go down and determine what it needs to know but you still need to have the ability to direct the client to where they are going, what power they are using,

Yaron: Upper layer hooks, layer 2 needs to know why don't we define upper layer hooks and the 802.11 in the management scenarios

Harry: No conclusion as to how far up we go into the upper layers that IEEE works in the MAC and PHY layer, but don't generally go up a level to do that. Given that we are in an area which is new territory, we can go ahead and there needs to be a lot of thought on this. SNMP may not be the only way of doing network management, and we may need to make other hooks to allow for the management needs required for 802.11 systems.

Harry: we can continue the teleconferences and continue the discussions need to get something down on paper, we are going to spend time understanding the scenarios and interfaces to come up with the information

Mike Pellcheck(?): wake on LAN related to network management…managers like to use wake-on lan related to laptops , but the wired wake-on-LAN doesn't totally fit the wireless requirements, but need to define the hooks and special requirement needed for 802.11 devices

Harry: says this does apply to wake-on-LAN/WLAN can be either in our discussions where an AP comes in and wakes you up.Power save is always and issue even with desk tops. Harry asked Mike to present something.

Mike: may be in Berlin and will prepare something for presentation

Harry wants to elaborate on the current list:

Load Balancing what do we need in the area of hooks within the 802.11 netowrks

Charles: need an indication from the AP to the client of what the load is rather than having the client have to guessing The QBSS element in 802.11e but has been removed and is needed, could be in the beacon but something that is on the AP

Roger: Need a common metric

Charles: that is what the work entails, defining what that load metric would be

Merman Rudoldf: Loading of the bss that was discussed in .11k

Harry: said there is overlap because the measurements .11k are doing are needed for WNM is needed here. The .11k people also want to work on the management

Harry: we will not put in new measurements in WNM unless .11k is finished .11k is looking at what measurements are needed from the mac and phy and in here what hooks do we need

Merman Rudoldf: load indication is very much needed, seemed that there was some resistance to the idea in .11k that loading is needed?

Harry: thinks that 11k is needed but didn't know how to do

Charles: It needs to be in .11k but is TBD

Harry: we will put your comments in this is a brain storming session so it will be put in for discussion in WMN

Richard: needs to be a very general mechanism that tells clients when to move (for load balancing)

Harry: where does it need to be in client AP or both

Richard: needs to be in both

Merman Rudoldf: maybe more of an admission control, AP could force certain stations to go over to another AP

Richard: the application will use it but we won't be defining the applications but we will neeed to provide the mechanisms

Harry: Marty could be associated with more than one AP at a time

Sounds like Fast Roaming

Harry: what do you do when you have time bounded traffic? This is clearly a fast roaming issue they are going to take care of it 802.11r

Merman Rudoldlf: will this be handled in 802.11r

Clint: some one doing a presentation with rebuttal this afternoon, yes this is in scope for 802.11r

Harry: what about location, Richard talks about the Boeing building locatons

Merman: mentioned about 911 requirement, location and 911 must come together

Harry: Location needs within 802.11

Richard: location is a requirement

Joe levey: now that mimo will be reality in 802.11n, location will be needed to be delt with in 802.11n. This group can float this requirement to 802.11n

Harry: it does apply to 802.11n, but doesn't mean we can't look at it here

Joe pel: training sequences in the mimo phy portions will make locations services important

Harry: .11n needs to determine platform before location

Roger: location RF Path loss information enabled in 11k, another is antenna information from 802.11n but we don't have phase control or time control

Harry: phase and time control is coming think about overlapping cells where the AP's time share

Roger: I can see a multi phased environment but not time

Harry: what if you can do your timing across the backbone using UTC

Roger: need time info

Harry: or the ability to do time offset to do your timing

Harry: Neils APs do triangulation; we could also do directional arrival, and would be good for 802.11n

Harry: there will be mimo's in regular 802.11 devices

Merman Rudoldf: should we keep the door open for certain antenna measurement techniques

Harry: what we need is someone to present how this would work and how fits into the standard, with the different antenna techniques, lets get the max in we can to accommodate the maximum scenarios, how you implement it makes your

Implementation unique…GPS is not likely indoors, but there are companies looking at GPS location within buildings, we need someone to come in and share there experiences

Yaron: Time Domain synchronizing (like a TDD) be between AP's would this be included

Harry: yes this would be SDMA

Yaron: what is SDMA
Neils: 802.11n Mimo can be used for some other arrival SDMA transmission can be at the same time but because the antennas can be transmitting out of the two separate antennae?

Harry: not mimo, but each of the antennas can share and coordinate share the transmission space

Harry: Interfaces to the upper layers should be discussed. Whether use MIB's or some other mechanism, some people think that MIB's aren't timely enough a mechanism, Yaron had brought up the interfaces what does this mean?

Yaron: start to make a decision to roam needs a lot of information (load, hook from the type of application currently running: VoIP will not roam, but doing ftp or browsing then easier to do the roaming) he does not think it should be SNMP when was the last frame, application sensitive for jitter, or roaming help make a better decision, timestamps

Harry: .11k is working on timestamps, number of clients are unresolved at this time .11k is going a little early to letter ballot.

Harry: has no metric set up to determine the quality of the data that is being reported.

Joe ?? 802.21 group will be looking at interfaces between the upper layers and talks to the example that was just mentioned…someone having a voice over IP session running and making the determination to roam.

Harry: 802.11n may be a different animal and may become a stand alone group. 802.11n will be touching the MAC and PHY

JOE: 802.21 only focusing on requirements this week, output will be an updated set of requirements and some use cases as to what it will handle in the first phase and what will happen in the next phase and they are also looking at network management

Harry: anybody is welcome to stay to vote on the PAR and 5 criteria

BoB: 802.21 was asking 802.11n what it needs of it?

Harry: looking to 802.21 to give us a framework to work to, but because they are in early phase they are looking and we need to have close cooperation and some joint meetings between the groups. Need cross fertilization between the group. Harry going to promote this? Mike is here – what do you think of the wake on wLAN, what do you envision

Mike: outlined presentation to WNG what some of the issues: main some ambiguities as how it works in wired and how those would translate into wireless, and doesn't know if could add some extra elements to handle it, or whether it could be done as a best practices type Document: was presented at Orlando

Harry or Mike will look up and send out on the reflector for the group to review document number 388-00.

Richard: stated that the documents have been up on the server for 3hours and 04 minutes

Harry:

Motion:

Move to approve document 11-04-0537-05-0wnm draftpar.doc and 11-04-0684-01-0wnm-draft 5 criteria wireless network management.doc and forward them to the IEEE 802.11 working group for approval.

Moved: Richard Kennedy

Second: Clint

Results: YES: NO: Abs

Clint offering friendly amendment.. to change the wording of the proposed motion

Move to approve document 11-04-0537-05-0wnm draftpar.doc with the following change: change all instances of 802.11k to IEEE 802.11TGk and approve and 11-04-0684-01-0wnm-draft 5 criteria wireless network management.doc and forward them to the IEEE 802.11 working group for approval.

Harry: reread the changes proposed by Clint. And asked, Is there any objection to accepting the change?

Hearing no objections

No discussion

Any objection to call question

Question called

Motion presented.

Harry read the motion:

Move to approve document 11-04-0537-05-0wnm draftpar.doc with the following change: change all instances of 802.11k to IEEE 802.11TGk and approve and 11-04-0684-01-0wnm-draft 5 criteria wireless network management.doc and forward them to the IEEE 802.11 working group for approval.

Harry: All participants of the study group can vote.

Yes: 23 No: 0 abs: 4

Henry??: In the WMN PAR references 802.11k should you mention that? Anyone who looks the PAR can't look at 802.11k and the timing of this as to where .11k is at. Had the same issue with TGr and r was postponed, the stated date is December 5, 2005 and we've stated we dependent on .11k also concerned about the time to do the work, and he is worried about the same people in .11k will be in WMN. Worried about the ability of people to do the work?

Harry: we are not dependent on .11k and Harry has the ability to ensure that the schedules do not overlap between the two groups. When work for .11k required, the study group was postponed.

The proper wording should be the TGk and does not have the appropriate reference.

Harry: said that we can put it through and then make editorial comments

Harry: a lot of it is how you plan the work and manage the meetings.

Henry: still concerned but question answered and sees your point.

Harry: stated that we've now completed the study group activities

Charles: Teleconference times?

Harry: Thursday 12:00 continue on with teleconferences? And if so when?

What is a good time?

Carry on conference calls? Wanted at most only one.

He would prefer not to have teleconferences until the next meeting period.

The group agreed that no teleconferences would be held between July and September

Berlin Meeting.

Mike moved to adjourn the meeting

Joe levey seconded

Meeting adjuroned.

End Victoria Poncini Meeting minutes.

Attendance List from July 15, 2004 Morning session:

Richard Kennedy

Victoria Poncini

Roger Skidmore

Veera Anantha

Sebastien Dure

Wayne Allen

Mariko Yoshida

Jim Wendt

Burak Baysal

Patrick Mourot

David ‘DJ’ Johnson

Marty Lefkowltz

Pat Calhoun

Tim Olson

Marian Fudoy

Katsuhiko Yamada

IEEE P802.11
Wireless LANs

Minutes of Wireless LAN Next Generation Standing Committee Meeting

Date: July 10th-16th, 2004

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Abstract

Minutes of WNG SC meetings held during the IEEE 802 Plenary meeting in Portland, Or from July 10th-16th, 2004.

1. Executive Summary:

1. MMAC Briefing: providing an overview of the current work on going within this forum
2. Cooperative Transmission Schemes: summarizing the results of the Romantiq EU project
3. XG Communications Program Overview: highlighting results from a DARPA workshop in June
4. TV Spectrum Reuse: providing updates to the information presented in May
5. Access Point Functions and Behaviors: presenting possible functions and ways forward for the AP functions activity
6. Management Frame Protection Study Group Request: requesting formation of a new SG to look at management frame protection issues.

Afternoon Session Tuesday 16:00-18:00

2. Logistics

WNG Meeting called to order by TK Tan (Philips) at 16:00.

The objectives of the session were reviewed.

The IEEE 802 & IEEE 802.11 Policies and Rules were reviewed.
Patents and By-laws read out by TK Tan, together with licensing terms and associated conditions.

There are 4 sessions, 2 on Tuesday 13th July 2004 and 2 on Thursday 15th July 2004.

The agenda was reviewed (**755r0**), no updates were required. It was requested that the document numbers be added to the agenda documents for information.

The minutes from the Orlando 2004 meeting (**635r0**) were reviewed. There was no discussion on the minutes and no objection to approve as presented.

Move to accept minutes: TK Tan, seconded: Bruce Kraemer, minutes approved unanimously

3. MMAC Update July 2004: 791r1, Yasuhiko Inoue

The presentation provided an overview of the current status of activities within MMAC, and future planned work items. Changes to the organization of MMAC (from Council to Forum) were highlighted along with an overview of the current internal structure. Future work includes allocation of new frequency bands to support the 802.11n standard.

Question from floor (slide 3): will there be a public enquiry for the allocation of new frequency band 5.470-5.725 GHz
Answer: Yes, there will be a public enquiry. The information council has recommended use, and technical requirements will be submitted to MPDHPT in October 2004, and changes may occur one year after that.

Question from floor: is there a possibility of a wider allocation?
Answer: that would be hard, and is not currently on the roadmap. This item may be in scope of a new MMAC working group.

A presentation regarding Korean Spectrum Policy Updates was scheduled on the agenda; however the speaker was unable to attend the WNG session. The slides are available on the server, document number 783r0.

4. Cooperative Transmission Schemes for Capacity Increases in 3G and Beyond Wireless Systems: 797r0, Josep Vidal

The presentation outlined the on-going work and results from the Romatiq project funded by the EU commission. The focus of this project was to study what gains could be made using cooperative transmission in wireless networks, where a cooperative network consists of a set of terminals that cooperate to improve quality of transmission and reduce the effects of path loss and/or shadowing i.e. by providing relaying services.

Question from floor (slide 13): Why is the value Mx2N
Answer: the 2N comes from the use of two timeslots in a TDD system.

Question from floor (slide 20): Doesn’t the multi-hop relay approach drain other people’s batteries?
Answer: of course, but the relay may be a laptop, in which case battery use is not so much of a concern.

Question from floor: are you assuming licensed or unlicensed bands?
Answer: assuming licensed, within framework of UMTS or WLAN TDD

Question from floor (slide 42): is synchronization an issue for cooperative schemes when using space time channels?
Answer: Synchronization is not important because you can consider the receipt of two transmissions as being the same as multi-path propagation.
Question from floor: for CDMA this in understandable, but can TDMA be recovered in this way?
Answer: if the delay is longer than one symbol then this is possible
Question from floor: In practice, would you buffer all soft decisions out of the equalizer to handle this?
Answer: Yes – this is not any different to any other communication system

Question from floor: if the relays are moving, what impacts does this have on capacity?
Answer: this was not studied within the scope of this project

Question from floor: would you expect similar improvements with other access control algorithms, e.g. FDMA
Answer: yes you can expect similar results
Question from floor: is this even true for CDMA?
Answer: it is possible but with the limitation that you cannot transmit and receive on same frequency at same time

Question from floor: (in response to previous comments that all frames are relayed regardless of whether they are corrupt or not) another method would be for relays not to forward incorrect frames.
Answer: yes, you could filter on CRC, but for some reason (that the project couldn't explain) they observed that if the number of errors is low it is good to retransmit al frames anyway.

Question from floor: 3GPP considered a similar scheme for 3G cellular systems (ODMA). Was this considered?
Answer: ODMA was dropped by 3GPP and was not considered further within the project.

Question from floor: were the issues of delay and QoS a consideration for the system design?
Answer: there was not enough time for the project to consider these issues.
Question from floor: so the decision to consider only one relay was not based on QoS considerations?
Answer: The project did not consider more that two hops, but Telenor have developed a full simulator for ODMA to consider multi-hop issues but they are only looking at best effort. With two hops it is feasible and simpler to manage QoS, it gets much harder with multiple hops.

Question from floor: did you consider security implications
Answer: no

Question from floor: Are there any delay or jitter implications from using a relay?
Answer: Up to now, every unit is only involved in relaying a single transmission, so it's not an issue yet.

Session adjourned.

Evening Session Tuesday 19:30-21:30

Meeting called to order at 19:35.

5. XG Communications Program Overview: 697r1, Peter Ecclesine
The presentation summarized the results of the DARPA workshop on June 30th. Peter began by drawing attention to the list of references at the end of the slide set, which cover the architecture, vision and policy of the next generation of DARPA communications.

The key issue is how to enable the reuse of spectrum without conflicting with primary users and their operation, and how to regulate software radios and their co-existence. One conclusion of the meeting was that it is recognized by the FCC and other regulatory bodies that there needs to be some way to trace software radio downloads and ensure that such downloads have safe behavior.

Question from the floor: how should the IEEE prepare for this?
Answer: near term need to take back to regulators and companies that there are ways forward for use of spectrum and development of new behavior that do not lock down spectrum and allocations. We need to respect licenses granted in the past, but also allow sharing of this spectrum for new uses.

Question from the floor: with regard to the "policy reasoner" (slide 6), the possible use of a clipper chip to implement this functionality implies a closed solution, but doesn't this need to be upgradeable to support for example, policy changes?
Answer: yes, this has to be future proof and this is a work in progress. We also need to persuade regulators that their current approach will not be useful in future.

6. Wireless Network Operation in the TV Bands Update: 803r0, Barry O'Mahony
Presented updates from the original information presented at the May meeting to reflect new rules that have been released regarding new proposal for unlicensed operation in channel not locally used by licensed TV stations, and new guidelines to prevent interference to unlicensed devices. The schedule

for providing comments on these guidelines was also highlighted, with comments due at the start of September 2004.

Session recessed.

Morning Session Thursday 15th July 2004, 08:00-10:00

Meeting called to order at 08:00

7. Access Point Functions and Behaviors

7.1. AP functions for IP Broadcasting: 700r3, Jongtaek Oh
Presented a new approach to support IP broadcasting services where broadcast traffic is sent to the IP address of the AP, which then broadcasts the information to all STAs in range. The AP matches incoming packets to a set of filters (destination IP address, protocol number), and if the packet is determined to be part of a broadcast service, the IP address is translated to the broadcast IP address, and the packet is broadcasted to all terminals. To prevent broadcast of information into cells with no interested STAs, a subscriber service is introduced to enhance efficiency.

The additional functions that would be required in the AP to support this service were highlighted, along with further standardization work that would be required.

Question from the floor: what are the advantages of providing this service at layer 2 instead of layer 3?
Answer: the solution is much simpler in terms of requirements on the terminal
Comment from the floor: but it does require more state in the APs. In addition, this solution only works in wireless environment, and would not be applicable to wired situations.
Response: this is only that start of this work, work needs to be done to define exact process and protocols.

Comment from the floor: still can't see the advantage of this approach over current L3 solutions.

Comment from the floor: you suggested the use of IPsec for securing this service, IPsec will not protect multicast/broadcast traffic. It was designed for unicast only.
Reply: Only suggesting the use of IPsec between server and AP where the traffic is unicast
Comment from the floor: If you want any value from the security, it has to be end-to-end.

Comment from the floor: the scenario on slide 22 looks like something the WAVE group might be interested in, perhaps you should go along and see if this is the case.

Comment from the floor: the purpose of the AP function SG is to describe existing behavior, not introduce new functions. As such, this work is not in scope.

7.2. AP Function Classification and Requirements: 692r0, Cheng Hong
This presented some initial thoughts on classification and grouping of AP functions, and possible approaches for how to approach this problem. It was also suggested that the ability to enable/disable functions in the AC might be useful to allow interoperability between ACs and APs that have assumed different functional splits.

Comment from the floor: please bring this work to the new study group. We need to make sure we balance describing the old functionality without defining too many new ones.

Comment from the floor: the figure on the last slide is very useful, and similar things would be useful in other groups, especially TGe.

7.3. AP Architecture Changes: 738r0, Mike Moreton

This presentation highlighted the changes to the AP architecture that were defined by TGi to integrate the 802.1X standard into 802.11. Changes included introducing the concept of logical ports, access to which can be controlled based on whether the STA in authenticated or not.

An issue related to how to securely fit multicast/broadcast services into the architecture was also raised, with reference to a couple of solutions that could used to secure such services.

Comment from the floor: on the issue as to how to support multicast services, prefer the first approach (where you have a single logical port for multicast/broadcast traffic) but appreciate the fact that 802.1D spanning trees and multicast addresses are alien concepts to each other. This seems to raise a more fundamental issue that should be addressed.

Comment from the floor: earlier in the presentation you raised the question as to whether an AP typically includes 802.1D bridging. The answer is yes, it usually does, but this typically falls within the logical concept of the DS.

8. Management Frame Protection Study Group Request: 814r1/r2, Emily Qi

This presentation raised a request to form a new Study Group to look at security for management frames, and provided justification as to why such a group would be needed. TGi defined mechanisms to secure data frames, but a need has been identified in other groups, such as TGk and WNM SG that protection of management frames is also needed. The principle reason is that having a single group to develop and co-ordinate a solution between different TGs with management frame security requirements would lead to a better and more cohesive solution, and would allow other groups to focus on the main issue they are chartered to solve without being side-tracked by the security problems.

Motion reads "Move that the WNG SC recommends that the IEEE 802.11 WG form a study group to determine how to formally describe the 802.11 management frame protection functions and behaviors, with the intent to create a PAR and five criteria to form a new task group."

Moved: Emily Qi
Seconded: Jon Edney

Question from the floor: a couple of meetings ago we passed a motion to form a security SC, but this doesn't seem to have materialized. Would the SC help address this problem?

Answer: haven't checked the status of the SC, but we ought to do so. The reason or raising this motion is in direct response to a discussion within the WNM SG and from informal discussions with TGk. Both these groups want a solution, but also want to progress the work they were set up to address.

Comment from floor: As far as I can tell, the security SC cannot write standards, but could only propose text that is picked up by other groups. At the moment there is a need to develop a solution that is coordinated across multiple TGs, we need one coherent way to move forward.

Comment from floor: the SC was more of a last resort, because there didn't seem to be any other group able to deal with these issues. It also provides a forum for security experts to work on these security issues and come up with solutions that are not last minute solutions, and also do not interfere with the progress of the other TGs.

Comment from floor: having a single group addressing these issues also allows input to be taken from other 802 groups considering security architectures and infrastructure.

Question from floor: should this run in addition to the security SC. Would rather see a single place for these issues.
Answer: need to discuss this with Stuart.

Comment from floor: are we formally saying that we want to withdraw the recommendation for a security SC? Also, what about timing issues where we can't reference a standard that hasn't been published yet. TGk would not have a security solution until TGk and any new TG completes. This is why it might be worth TGk continuing with their security discussions.

Comment from floor: TGk has a specific security requirement in measurements, there is a more general requirement that needs to be addressed.

Comment from floor: if leave TGk measurements in the clear, then the system is opened up to a few more DoS attacks, but there is no opportunity for other types of attack. The WNM group has a much clearer need for such security because they will be managing and controlling the network.

Question from floor: should control frames also be in scope?

Friendly amendment made to motion to include control frames.

Comment from floor: RTS and CTS also need to be seem by other APs, isn't this a really tricky trust model?
Answer: we've only agreed to look at it – not necessarily do anything.

Friendly amendment to motion: to determine is a bit strong, changed to examine.

Motion now reads: "Move that the WNG SC recommends that the IEEE 802.11 WG form a study group to examine how to formally describe the 802.11 management frame and control frame protection functions and behaviors, with the intent to create a PAR and five criteria to form a new task group."

Question from floor: should we also include data frames? For example to address multicast issues?
Answer: we don't want to turn this into a security maintenance group, so this should be excluded from the scope.

Results: 45, 0, 1

Motion to adjourn session, no objections.

Session adjourned.

APPENDIX C

US007415074B2

(12) **United States Patent**
Seto et al.

(10) **Patent No.: US 7,415,074 B2**
(45) **Date of Patent: Aug. 19, 2008**

(54) **MIMO TRANSMISSION AND RECEPTION METHODS AND DEVICES**

(75) Inventors: **Ichiro Seto**, Fuchu (JP); **Tsuguhide Aoki**, Kawasaki (JP); **Hiroshi Yoshida**, Yokohama (JP)

(73) Assignee: **Kabushiki Kaisha Toshiba**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 647 days.

(21) Appl. No.: **11/016,808**

(22) Filed: **Dec. 21, 2004**

(65) **Prior Publication Data**

US 2005/0163244 A1 Jul. 28, 2005

(30) **Foreign Application Priority Data**

Jan. 9, 2004 (JP) 2004-004848

(51) **Int. Cl.**
H04K 1/10 (2006.01)
H04L 27/28 (2006.01)
H04L 1/02 (2006.01)
H04B 7/02 (2006.01)

(52) **U.S. Cl.** **375/260**; 375/267

(58) **Field of Classification Search** .... None
See application file for complete search history.

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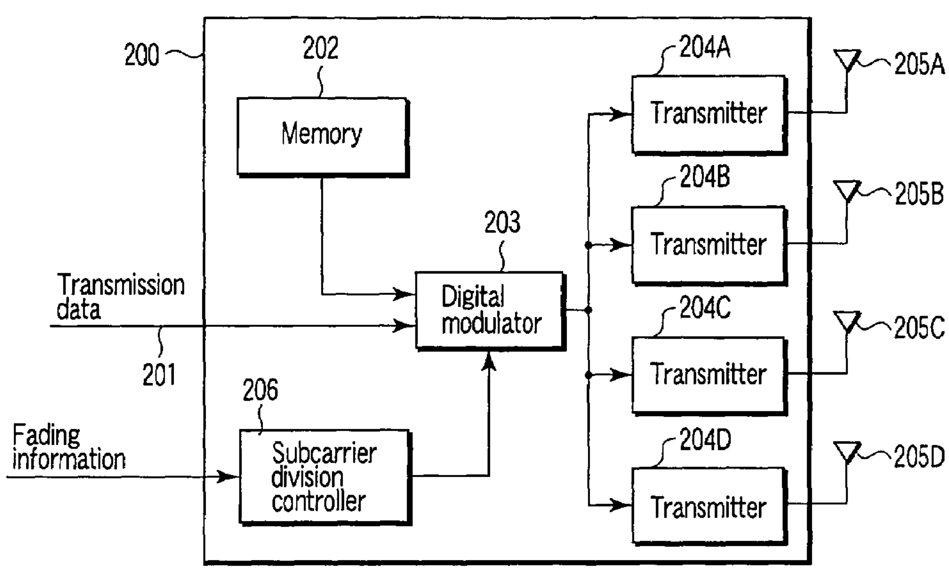
Primary Examiner—Shuwang Liu
Assistant Examiner—Gina McKie
(74) *Attorney, Agent, or Firm*—Oblon, Spivak, McClelland, Maier & Neustadt, P.C.

(57) **ABSTRACT**

In a wireless transmitting device which performs transmission by an OFDM using a plurality of subcarriers orthogonal to each other, a plurality of preambles to which a plurality of different subcarrier groups selected from a plurality of subcarriers within an OFDM signal band are allocated are transmitted by using a plurality of transmit antennas, and data is transmitted by using the antennas after the preambles are transmitted.

4 Claims, 11 Drawing Sheets



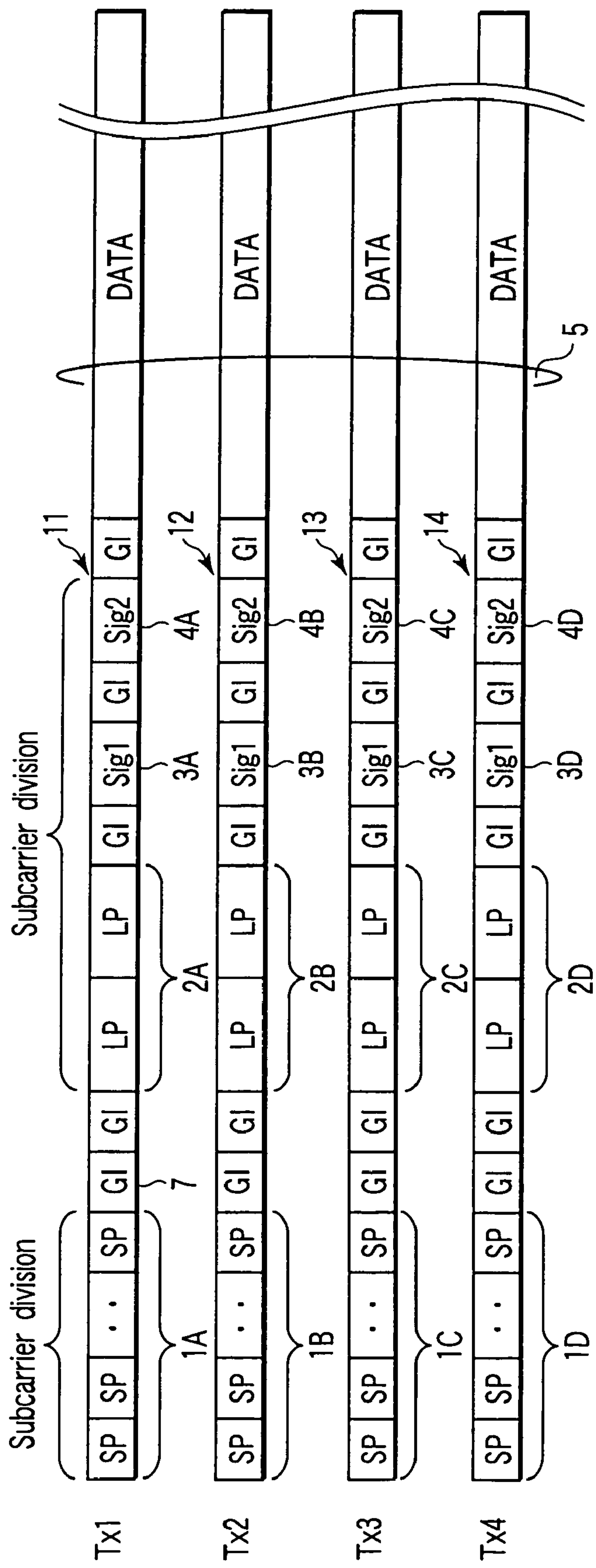

Subcarrier division
Subcarrier division
Tx1
Tx2
Tx3
Tx4
SP
SP
SP
GI
GI
LP
LP
GI
Sig1
GI
Sig2
GI
DATA
1A
1B
1C
1D
2A
2B
2C
2D
3A
3B
3C
3D
4A
4B
4C
4D
5
7
11
12
13
14

FIG. 1

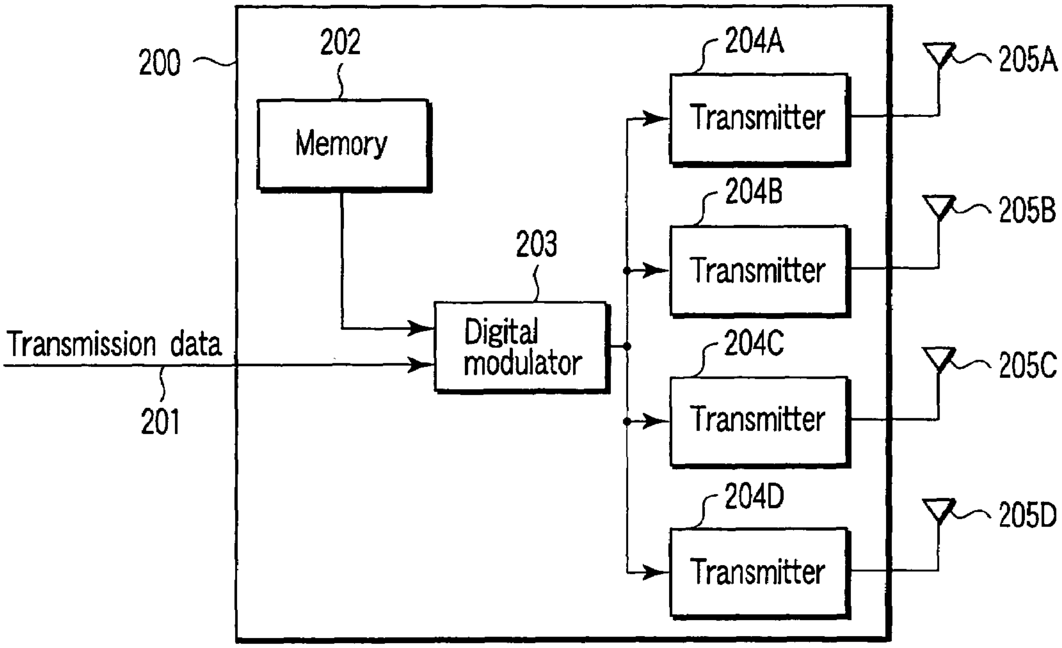

200
202
Memory
204A
Transmitter
205A
204B
Transmitter
205B
203
Digital modulator
Transmission data
201
204C
Transmitter
205C
204D
Transmitter
205D

FIG. 2

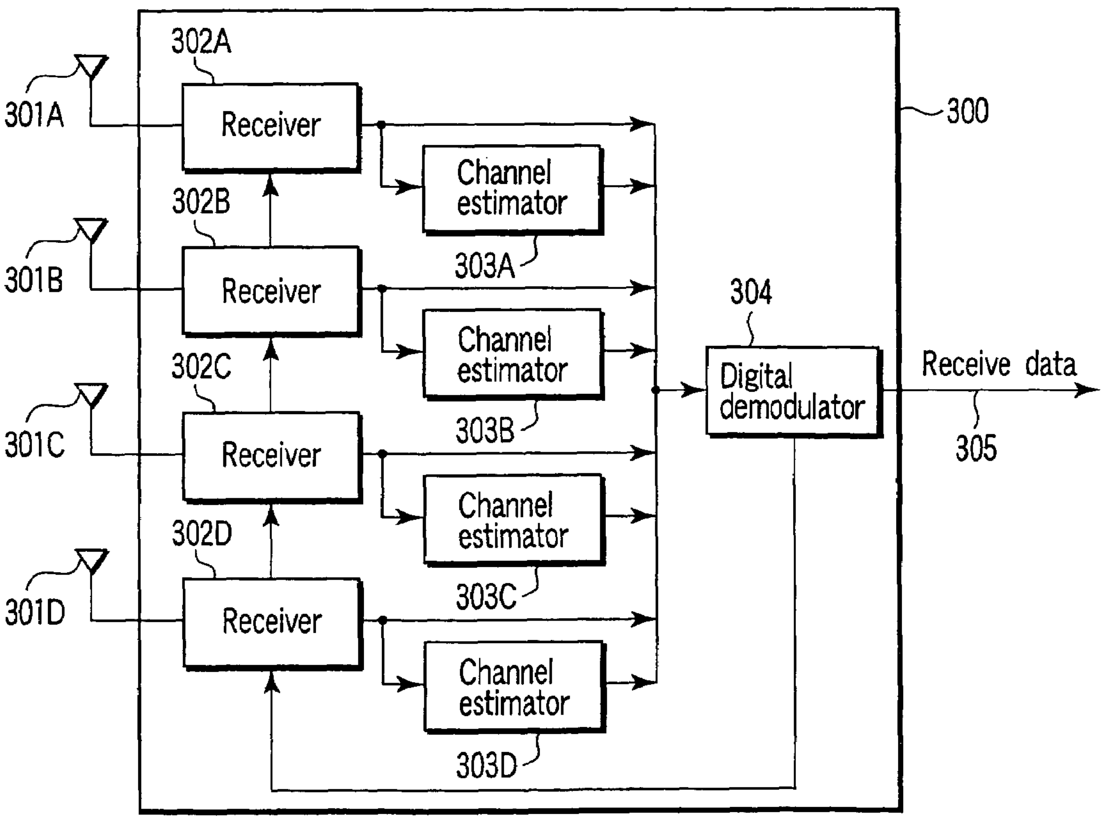

302A
301A
Receiver
Channel estimator
300
302B
303A
301B
Receiver
304
Channel estimator
302C
Digital demodulator
Receive data
303B
301C
Receiver
305
Channel estimator
302D
303C
301D
Receiver
Channel estimator
303D

FIG. 3

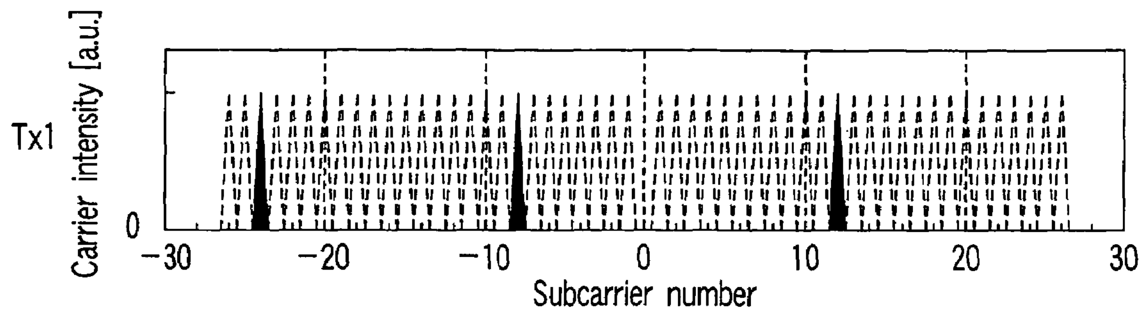


FIG. 4A

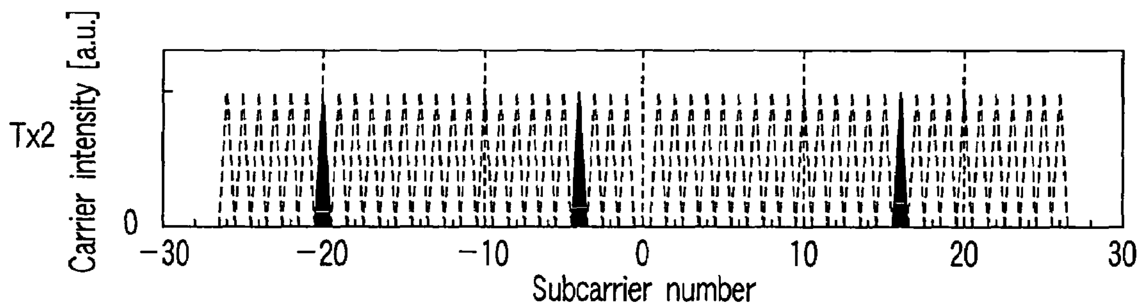


FIG. 4B

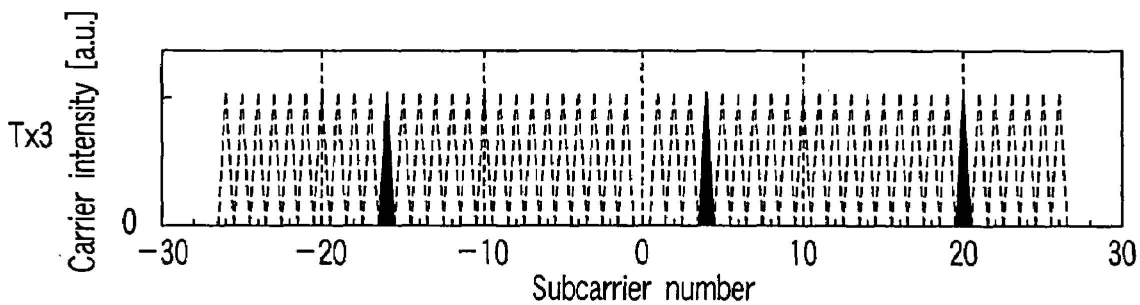


FIG. 4C

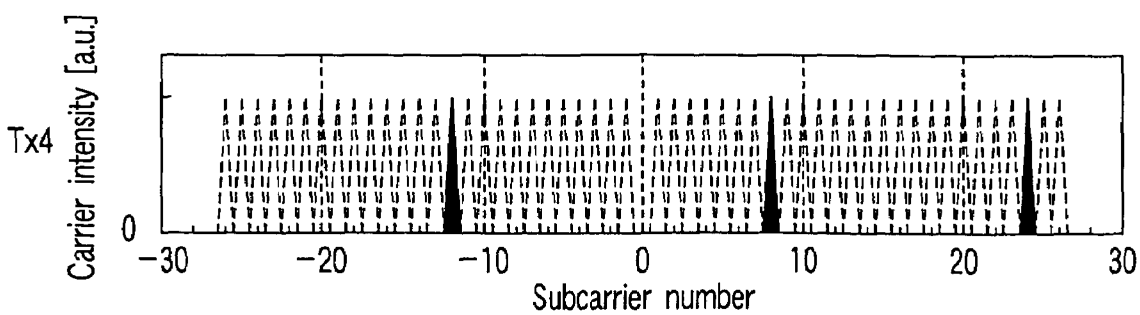


FIG. 4D

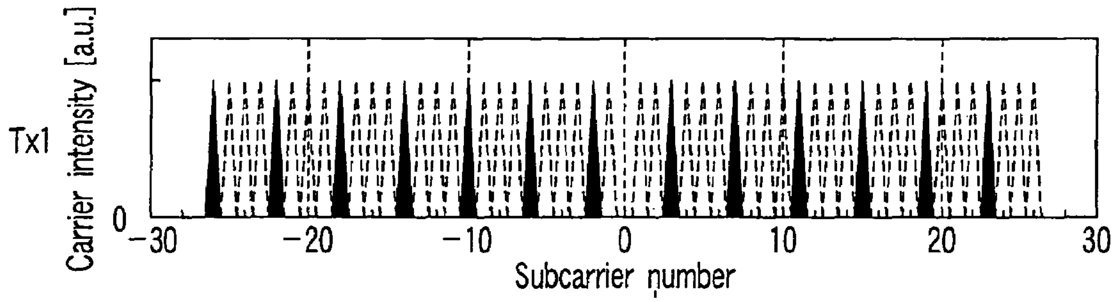


FIG. 5A

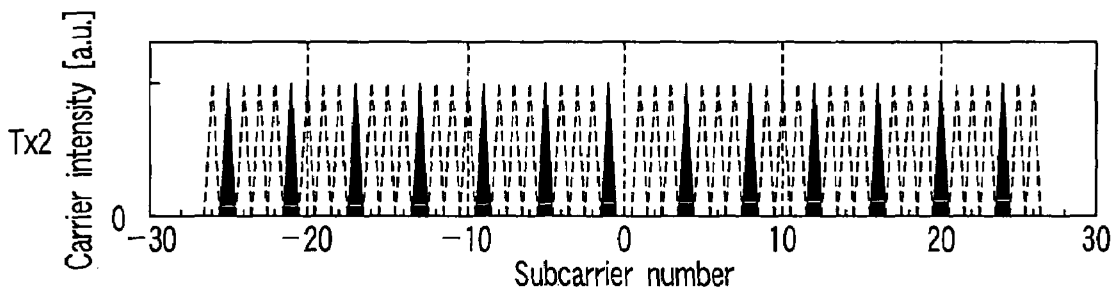


FIG. 5B

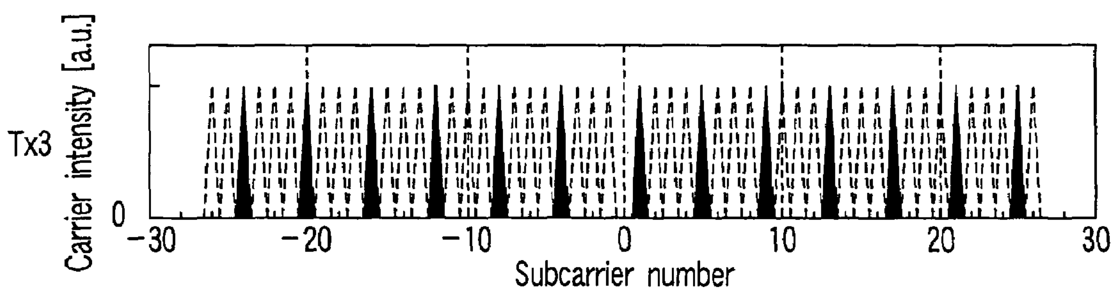


FIG. 5C

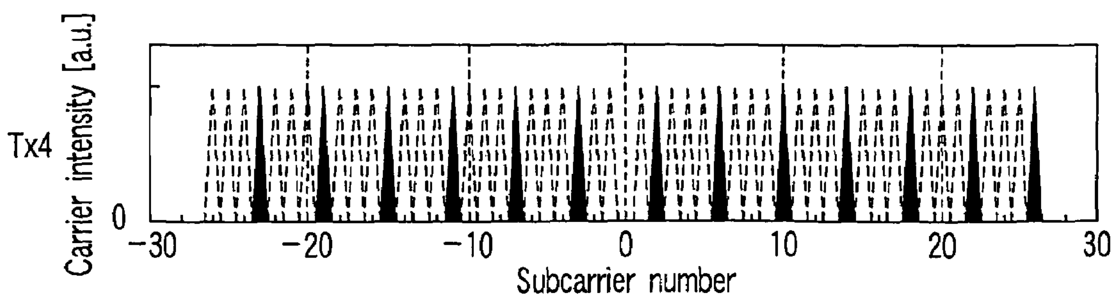


FIG. 5D

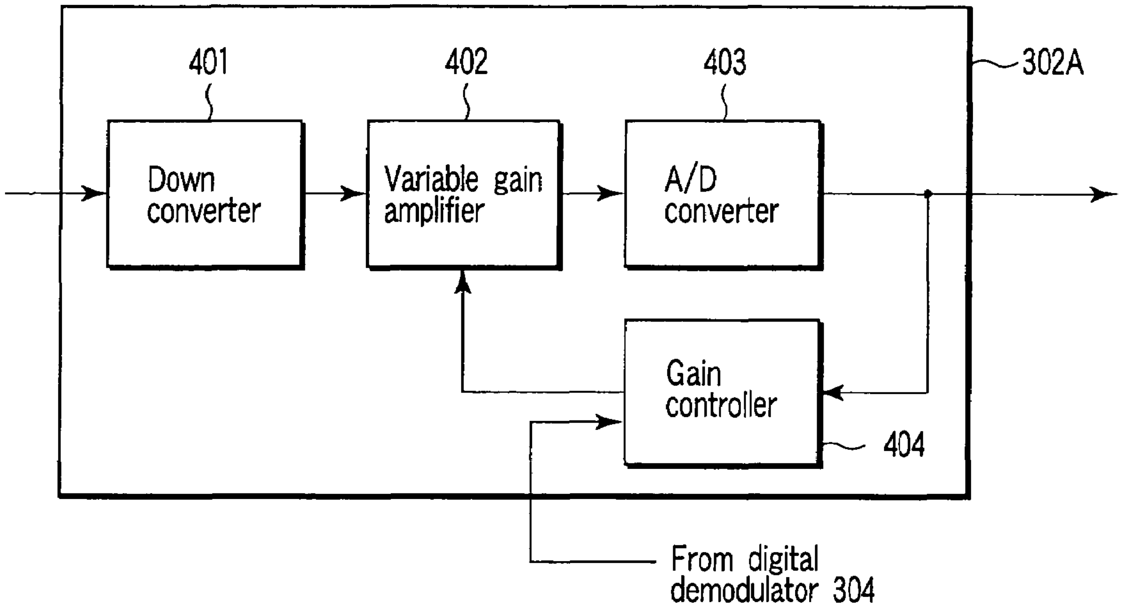

401
402
403
302A
Down converter
Variable gain amplifier
A/D converter
Gain controller
404
From digital demodulator 304

FIG.6

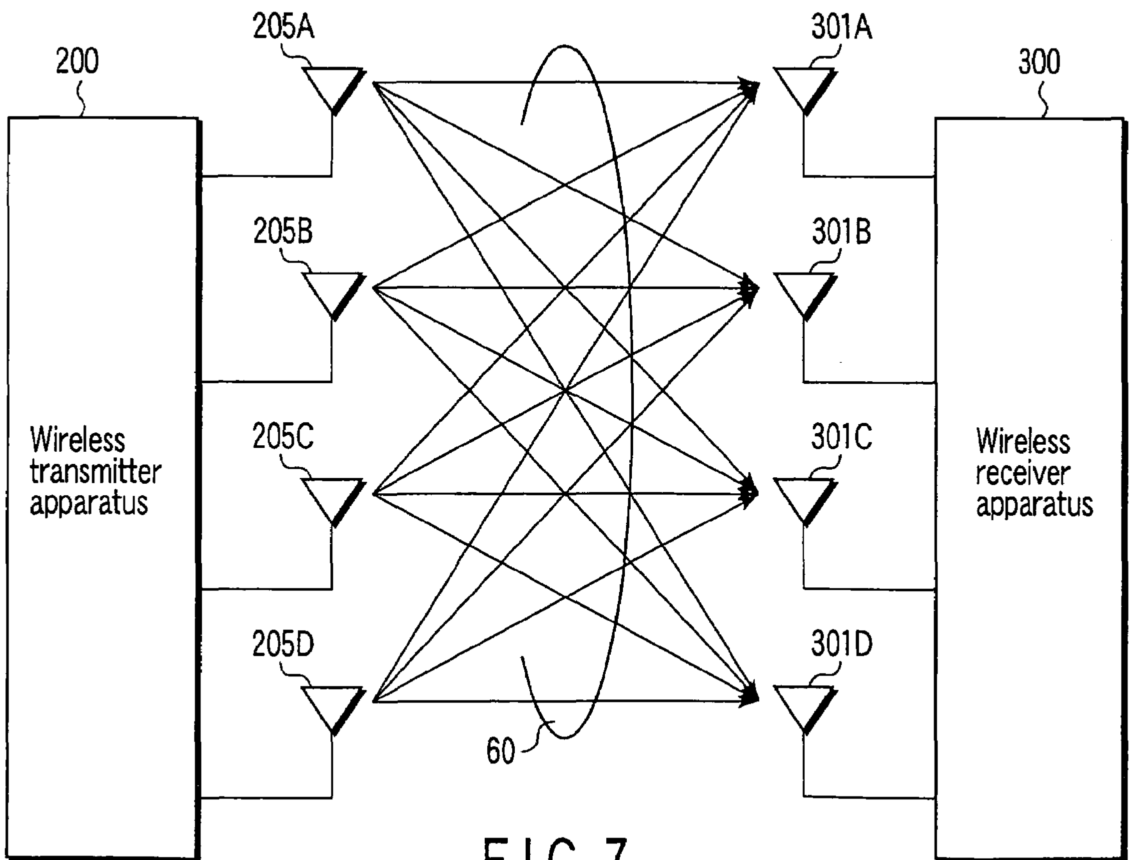

200
205A
301A
300
205B
301B
205C
301C
205D
301D
Wireless transmitter apparatus
Wireless receiver apparatus
60

FIG.7

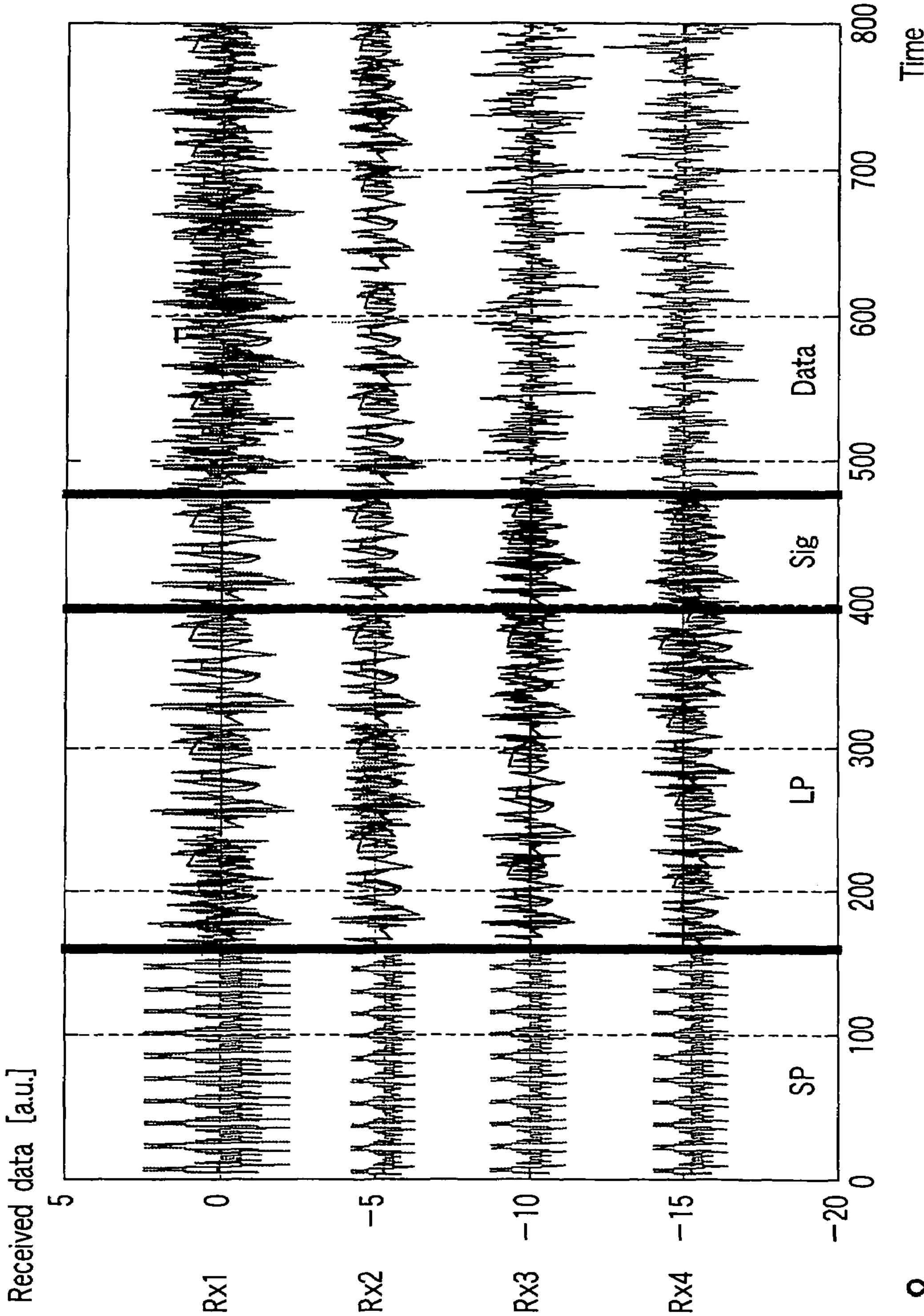

Received data [a.u.]
5
0
−5
−10
−15
−20
Rx1
Rx2
Rx3
Rx4
0
100
200
300
400
500
600
700
800
Time
SP
LP
Sig
Data

FIG. 8

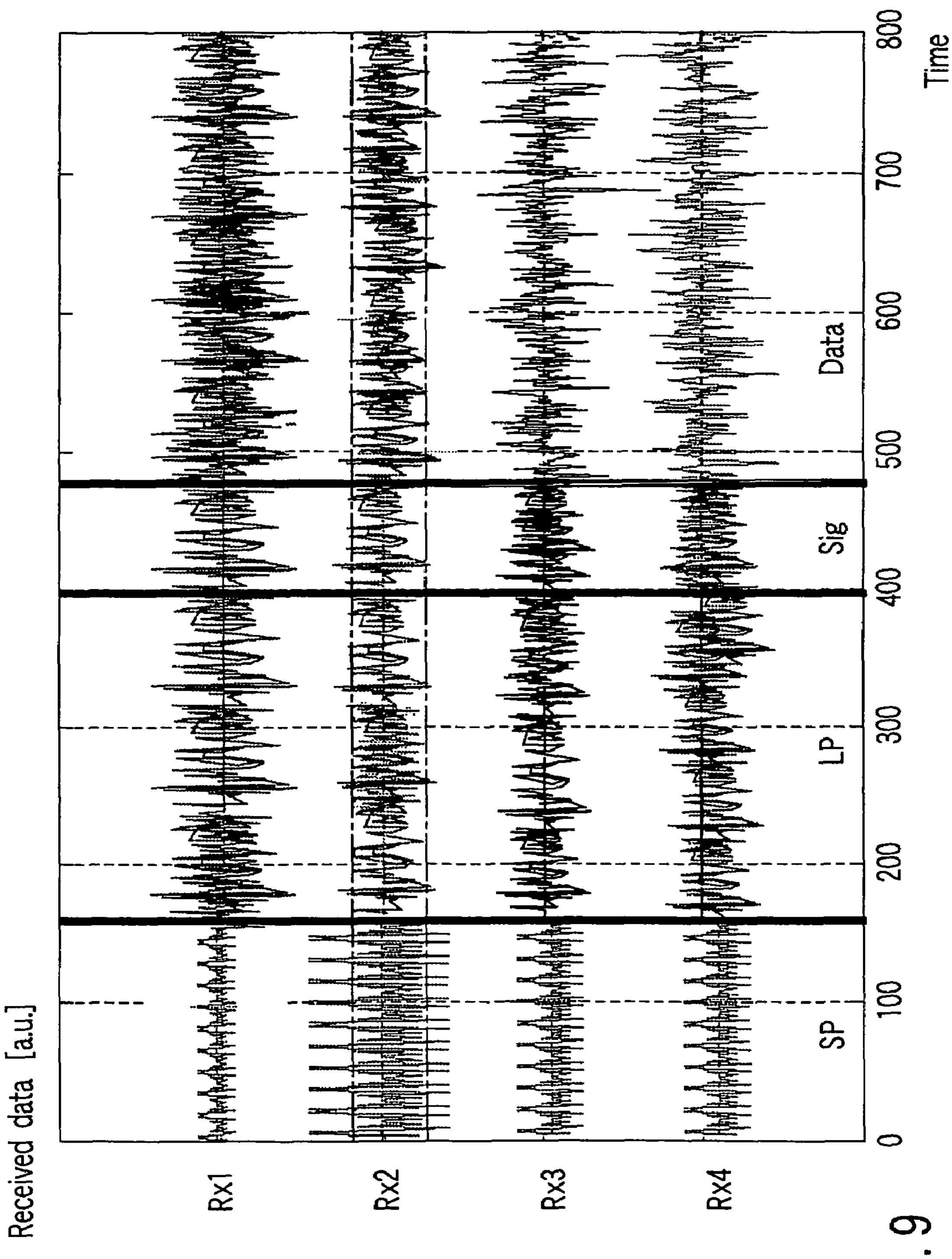

Received data [a.u.]
Rx1
Rx2
Rx3
Rx4
SP
LP
Sig
Data
0
100
200
300
400
500
600
700
800
Time

FIG.9

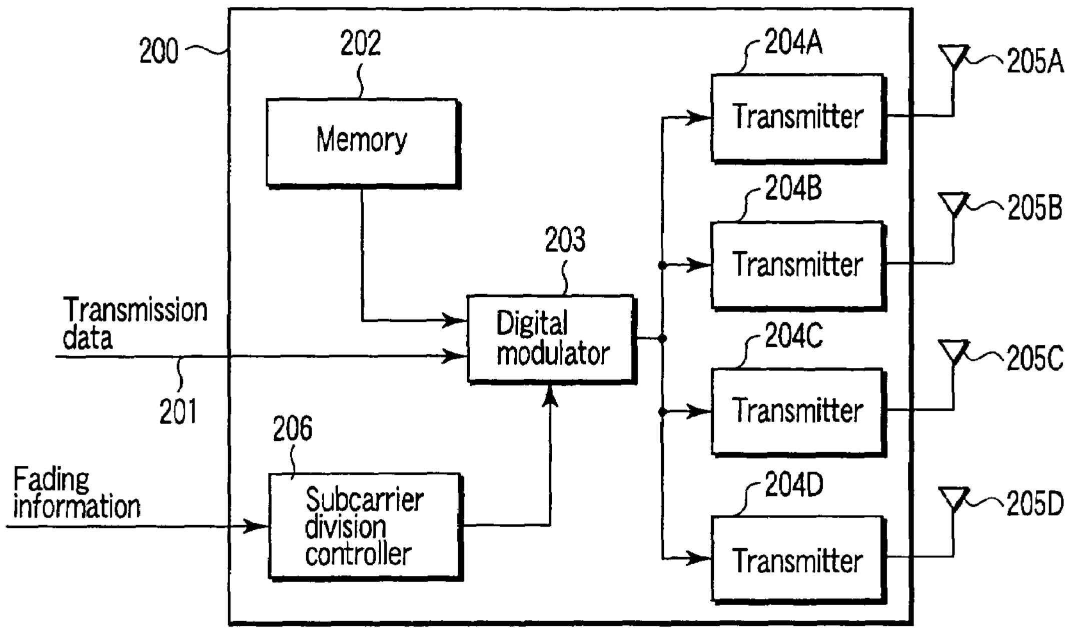


FIG. 10

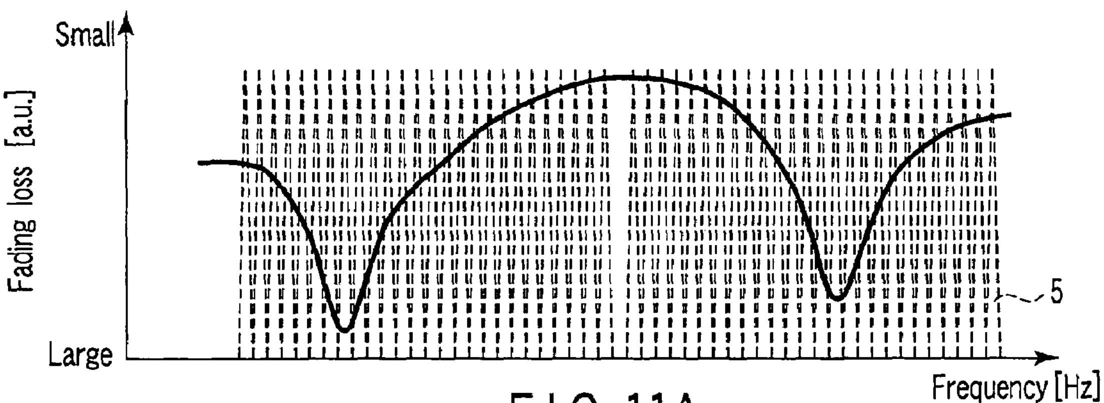


FIG. 11A

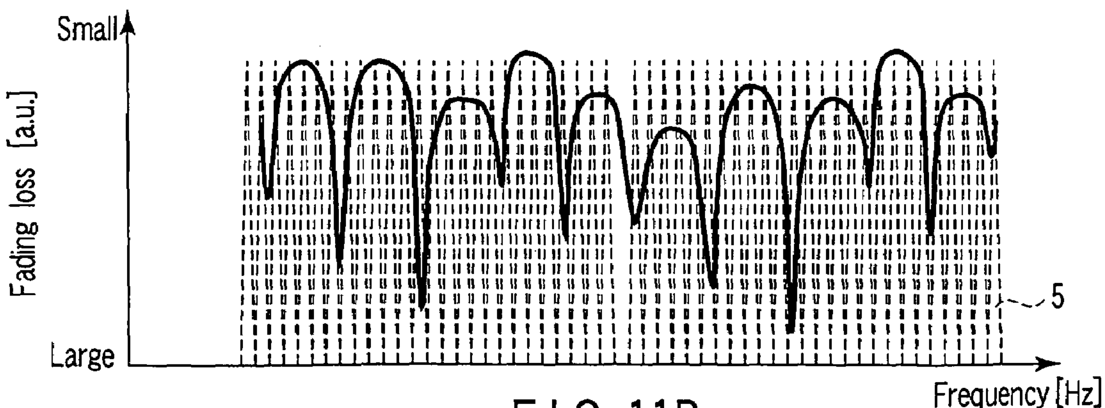


FIG. 11B

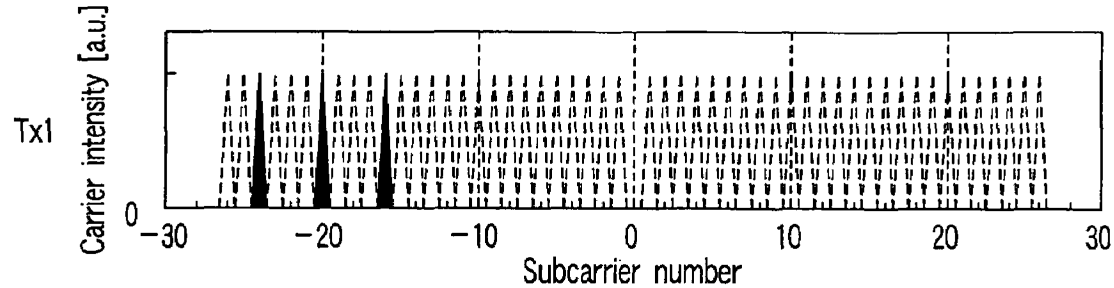


FIG. 12A

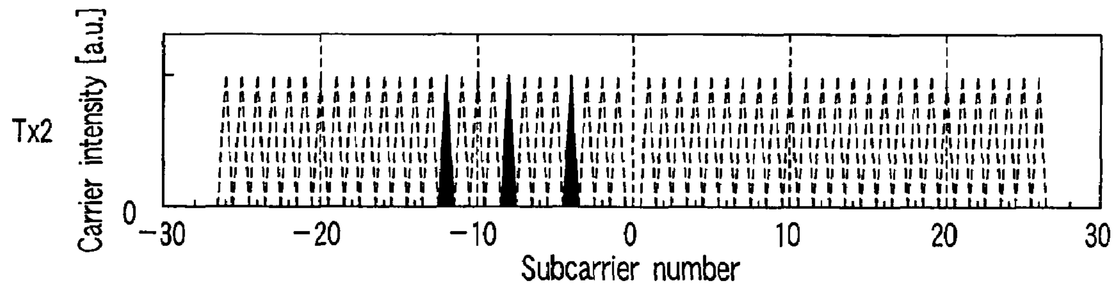


FIG. 12B

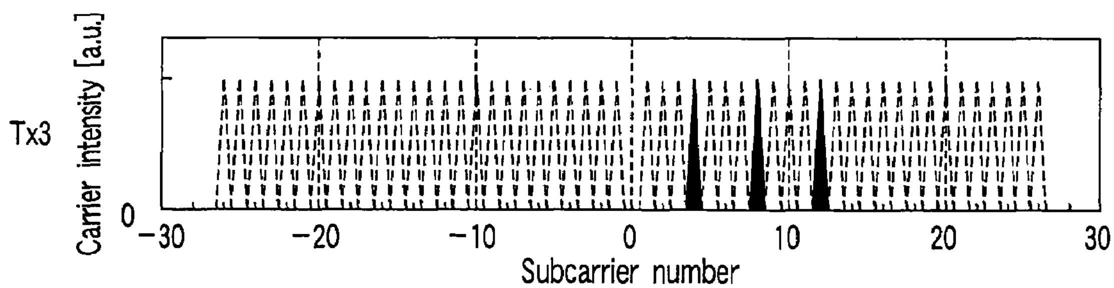


FIG. 12C

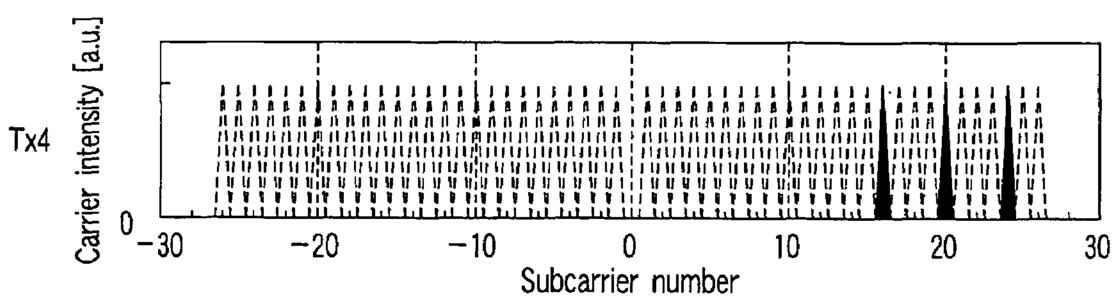


FIG. 12D

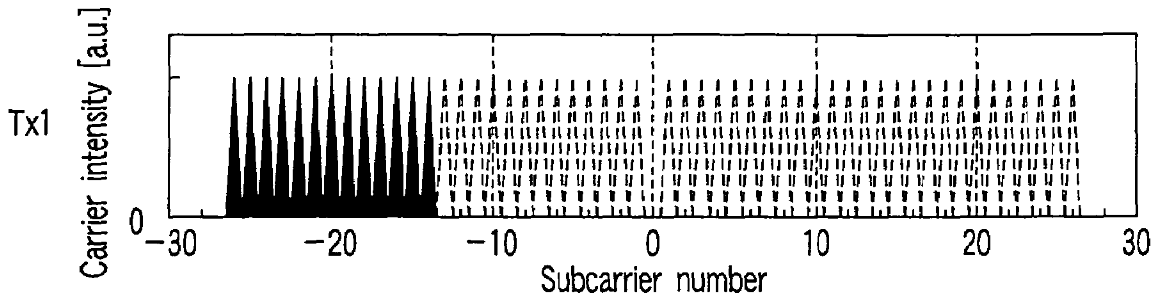


FIG. 13A

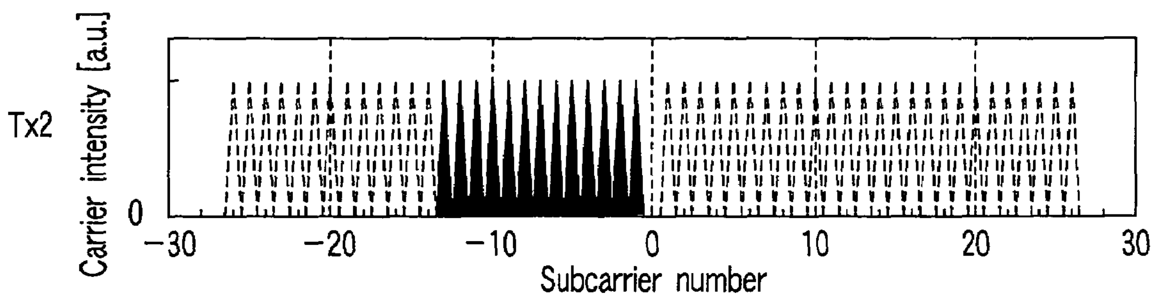


FIG. 13B

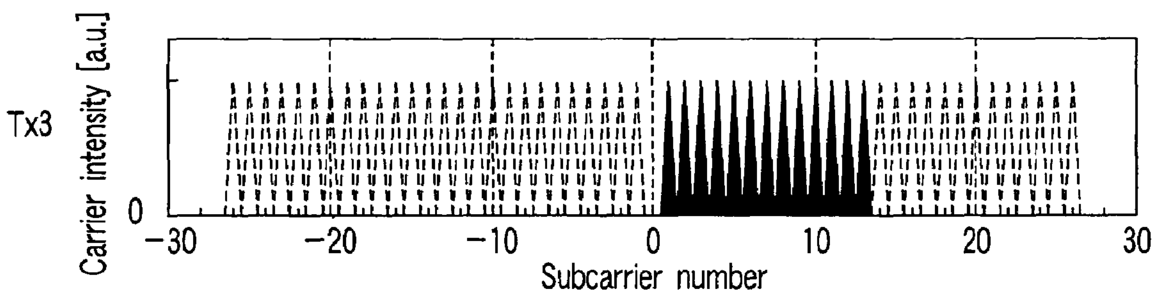


FIG. 13C

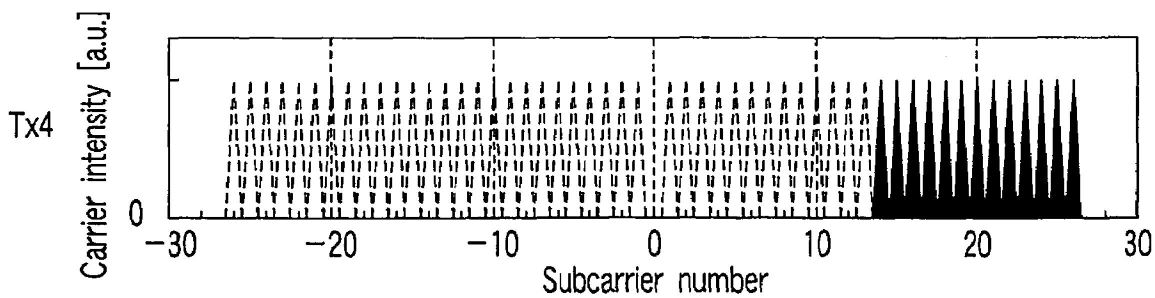


FIG. 13D

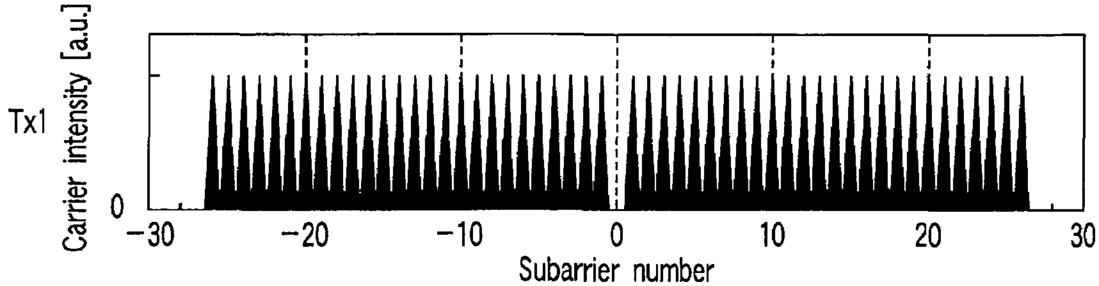


FIG. 14A

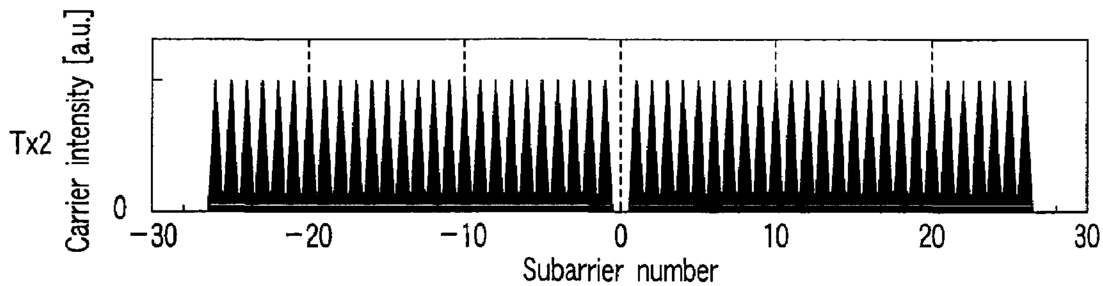


FIG. 14B

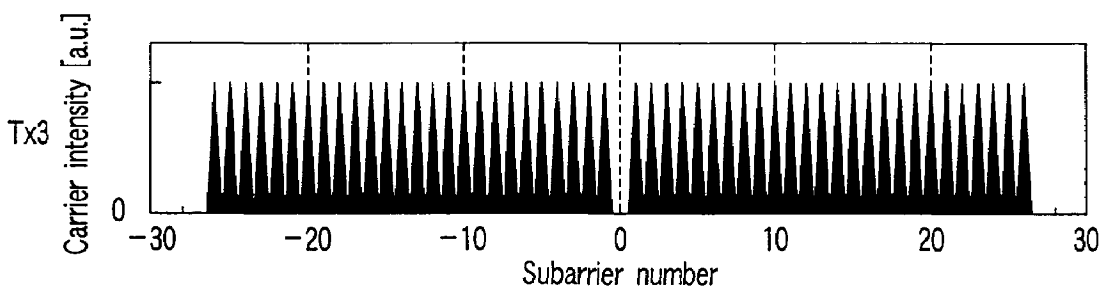


FIG. 14C

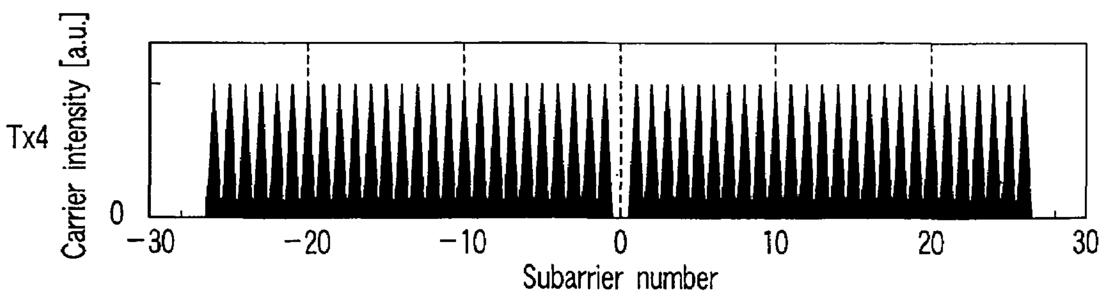


FIG. 14D

MIMO TRANSMISSION AND RECEPTION METHODS AND DEVICES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based upon and claims the benefit of priority from prior Japanese Patent Application No. 2004-004848, filed Jan. 9, 2004, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates particularly to a wireless transmitting device, wireless receiving device, wireless transmitting method and wireless receiving method by which preamble are transmitted before data.

2. Description of the Related Art

The institute of Electrical and Electronics Engineers (IEEE) is establishing a wireless LAN standard called IEEE 802.11n which aims at a throughput of 100 Mbps or more. In IEEE 802.11n, a technique called multi-input multi-output (MIMO) which uses a plurality of antennas at transmitters and receivers, may be adopted. IEEE 802.11n is required to coexist with the existing IEEE 802.11a. In the MIMO technique, to measure responses (called channel impulse responses) of channel impulse response from a plurality of transmit antennas to each receiving antenna, a preamble as a known sequence must be transmitted from these transmit antennas.

In a preamble proposed by Jan Boer et al. in "Backwards compatibility", IEEE 802.11-03/714r0 (Jan Boer, "Backwards compatibility", IEEE 802.11-03/714r0, Section 2, Slide 14 to 19, (URL:ftp://ieee:wireless@ftp. 802wireless-world.com/)), Paragraph 2 "Diagonally loaded preamble", a short preamble sequence for performing timing synchronization and automatic gain control (AGC) is transmitted from a single transmit antenna. After that, a long preamble sequence for estimating channel impulse response is transmitted from a plurality of transmit antennas. The receiving side performs automatic frequency control (AFC) by using the short preamble sequence and long preamble sequence, and estimates channel impulse response between the antennas. In this manner, the MIMO technique is used in transmission of data signals and the like after that. That is, after the long preamble sequence, a signal field indicating the arrangement of a data signal, e.g., the modulation coding scheme and length of a wireless packet is transmitted, and then the data signal is transmitted.

Jan Boer et al. describe only that the short preamble sequence is transmitted from one antenna and the long preamble sequence is divided into subcarriers and transmitted from a plurality of antennas, and do not describe any signal field transmission method. The preamble proposed by Jan Boer at al. is the same, in a portion from the short preamble sequence to the signal field, as the preamble of IEEE 802.11a standard based on transmission from a single antenna. Therefore, a wireless receiver based on IEEE 802.11a standard which has received the proposed preamble can recognize that the received packet is a wireless packet based on IEEE 802.11a. Accordingly, the proposed preamble allows IEEE 802.11n and IEEE 802.11a standards to coexist on a single wireless station.

The short preamble sequence is transmitted as an orthogonal frequency division multiplexing (OFDM) signal from a single antenna. The long preamble sequence is transmitted, from a plurality of antennas, as different subcarriers divided from one OFDM signal. Likewise, the signal field is transmitted, from the plurality of antennas, as subcarriers divided from one OFDM signal. Since the long preamble sequence is transmitted by dividing one OFDM signal into subcarriers as described above, the receiving side can simultaneously estimate channel impulse response.

In the OFDM receiver apparatus, a received signal is generally demodulated by digital signal processing, so an analog to digital converter is prepared to convert an analog received signal into a digital signal. This analog to digital converter has an allowable level range (called an input dynamic range) permitted to an analog signal to be converted. Therefore, AGC by which the level of a received signal falls within the input dynamic range of the analog to digital converter is essential.

In the preamble by Jan Boer et al., channel estimation is performed by using the long preamble. Since this channel estimation is done by digital signal processing, AGC must be performed by using the short preamble sequence which is a signal before the long preamble sequence. That is, the received level of the short preamble sequence is measured by a receiver connected to each receiving antenna, and the input level of the analog to digital converter is adjusted on the basis of this received level.

Unfortunately, other transmit antennas than the transmit antenna which transmits the short preamble sequence transmit nothing before the long preamble sequence. To receive the long preamble sequence, therefore, AGC must be performed by using the short preamble transmitted from the single transmit antenna. Accordingly, when the receiving side receives the long preamble sequence transmitted from the other transmission antennas or receives a data signal, the received level becomes much higher or lower than the level adjusted by AGC using the short preamble sequence transmitted from the single transmit antenna. If the received level is higher than the upper limit of the input dynamic range of the analog to digital converter, the analog to digital converter saturates. If the received level is lower than the lower limit of the input dynamic range, the analog to digital converter produces a large quantization error. In either case, the analog to digital converter cannot appropriately convert a signal, and this adversely affects processing after the conversion.

Also, since a data signal is transmitted from the plurality of transmit antennas, the changing range of the received level in the interval of the data signal further increases. Accordingly, the problems of the saturation and quantization error of the analog to digital converter described above become significant, and the receiving performance greatly deteriorates.

Generally, a wireless apparatus desirably holds the output level of a transmission signal constant. Assume that the number of transmit antennas is N, and the transmission output is α [watts]. In a wireless communication system obtained by combining the MIMO technique and OFDM, i.e., in a so-called MIMO-OFDM system, the transmission output of a single antenna must be α [watts] for the short preamble sequence because the signal is transmitted from a single antenna. In contrast, for the long preamble sequence, signal field, and data signal, the transmission output of each antenna is α/N [watts] because these signals are transmitted from all antennas.

Accordingly, in a path which transmits the short preamble sequence by using a single antenna, N-fold transmission output is required only to transmit the short preamble. That is, a transmission path for the short preamble produces the redundancy that the specifications of an up converter and power amplifier are required to be able to control the transmission output α [watts] only when the short preamble sequence is transmitted. On the transmission side as described above, a plurality of transmitters corresponding to a plurality of transmit antennas cannot be given equal structures, and this complicates the whole transmitter apparatus. In addition, since the power consumption of the transmitter apparatus strongly depends on the transmission output level, this is not advantageous in achieving low power consumption.

BRIEF SUMMARY OF THE INVENTION

The first aspect of the present invention provides a wireless transmitting method of performing transmission by an orthogonal frequency division multiplexing (OFDM) using a plurality of subcarriers orthogonal to each other, the method comprising: transmitting, by using a plurality of transmit antennas, a plurality of preambles formed of a plurality of different subcarrier groups selected from a plurality of subcarriers; and transmitting a data by using the plurality of transmit antennas after the preambles are transmitted.

The second aspect of the present invention provides a wireless receiving method for an orthogonal frequency division multiplexing (OFDM) using a plurality of subcarriers orthogonal to each other, the method comprising: receiving, via a plurality of receiving antennas, a plurality of preambles containing a plurality of short preamble sequences formed of a plurality of different subcarrier groups selected from a plurality of subcarriers, and data following the preambles; amplifying the received preambles by a variable gain amplifier having a gain; and controlling the gain in response to reception of the short preamble sequences.

The third aspect of the present invention provides a wireless transmitting method with a plurality of antennas, comprising: transmitting a plurality of preamble signals with the plurality of antennas, the preamble signals being formed of a plurality of different subcarrier groups selected from a plurality of subcarriers orthogonal to each other, using an orthogonal frequency division multiplexing (OFDM) system; and transmitting a data signal with the plurality of antennas, after transmitting the preamble signals.

The fourth aspect of the present invention provides a wireless receiver apparatus comprising: a plurality of antennas; a receiver, associated with the plurality of antennas, which receives a plurality of preamble signals containing a plurality of short preamble strings formed of a plurality of different subcarrier groups selected from the plurality of subcarriers being orthogonal to each other, and a data signal following the preamble signal, using an orthogonal frequency division multiplexing (OFDM) system; a variable gain amplifier which amplifies signals received by the receiver; and a gain controller which controls a gain of the variable gain amplifier depending upon the short preamble strings of the preamble signals.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

FIG. **1** is a view showing a wireless packet format including a preamble according to an embodiment of the present invention;

FIG. **2** is a block diagram showing a wireless transmitting device according to the embodiment of the present invention;

FIG. **3** is a block diagram showing a wireless receiving device according to the embodiment of the present invention;

FIGS. **4**A to **4**D are views showing the subcarrier arrangements of short preambles shown in FIG. **1**;

FIGS. **5**A to **5**D are views showing the subcarrier arrangements of long preambles and signal fields shown in FIG. **1**;

FIG. **6** is a block diagram showing a receiver shown in FIG. **3**;

FIG. **7** is a view showing channel impulse response of an MIMO-OFDM system according to the embodiment of the present invention;

FIG. **8** is a view showing the received levels of receiving antennas for PLCP signals and data signals according to the embodiment of the present invention;

FIG. **9** is a view showing the received levels of the receiving antennas for PLCP signals and data signals based on IEEE 802.11a;

FIG. **10** is a block diagram showing a wireless transmitting device according to another embodiment of the present invention;

FIGS. **11**A and **11**B are graphs showing two typical fading characteristics used to explain the other embodiment of the present invention;

FIGS. **12**A to **12**D are views showing the subcarrier arrangements of short preambles according to the other embodiment of the present invention;

FIGS. **13**A to **13**D are views showing the subcarrier arrangements of long preambles and signal fields according to the other embodiment of the present invention; and

FIGS. **14**A to **14**D are views showing the subcarrier arrangements of data signals.

DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the present invention will be described in detail below with reference to the accompanying drawing.

A preamble according to an embodiment of the present invention contains first to fourth physical layer convergence protocol (PLCP) signals **11** to **14** transmitted from transmit antennas Tx**1** to Tx**4**. The PLCP signals **11** to **14** includes short preamble sequences **1**A to **1**D, long preamble sequences **2**A to **2**D, first signal fields (Sig**1**) **3**A to **3**D, and second signal fields (Sig**2**) **4**A to **4**D. The transmit antenna Tx**1** transmits the short preamble sequence **1**A, long preamble sequence **2**A, first signal field **3**A, and second signal field **4**A of the first PLCP signal **11** in order. Likewise, the antenna Tx**2** transmits **1**B, **2**B, **3**B, and **4**B of the second PLCP signal **12** in order, the antenna Tx**3** transmits **1**C, **2**C, **3**C, and **4**C of the third PLCP signal **13** in order, and the antenna Tx**4** transmits **1**D, **2**D, **3**D, and **4**D of the fourth PLCP signal **14** in order.

Unit preambles SP contained in the short preamble sequences **1**A to **1**D and unit preambles LP contained in the long preamble sequences **2**A to **2**D are signal sequences having predetermined lengths. The length of LP is relatively larger than that of SP. After transmitting the PLCP signals **11** to **14**, i.e., the second long preamble sequences **4**A to **4**D, the antennas Tx**1** to Tx**4** transmit data signals (DATA) **5**.

The short preamble sequences **1**A to **1**D, long preamble sequences **2**A to **2**D, and first signal fields **3**A to **3**D are based on IEEE 802.11a standard. The second fields **4**A to **4**D are not based on IEEE 802.11a standard, but contain information such as the modulation coding scheme and data length of wireless packet for communication by MIMO technique. The second signal fields **4**A to **4**D are desirably based upon IEEE 802.11n currently being in standardization process.

Guard intervals GI are arranged between the short preamble sequences **1**A to **1**D and the long preamble sequences **2**A to **2**D, between the long preamble sequences **2**A to **2**D and the first signal fields **3**A to **3**D, between the first signal fields **3**A to **3**D and the second signal fields **4**A to **4**D, and between the second signal fields **4**A to **4**D and the data signals **5**. In the preamble based on IEEE 802.11a, GI**7** having a double length is placed before each of the long preamble sequences **2**A to **2**D.

The short preamble sequences **1**A to **1**D are mainly used in timing synchronization, AGC, and coarse adjustment of AFC for frequency synchronization. The long preamble sequences **2**A to **2**D are mainly used in fine adjustment of AFC, and signal processing for channel estimation. The first signal fields **3**A to **3**D are based on IEEE 802.11a, and transmitted as OFDM symbols. In the first signal fields **3**A to **3**D, the modulation coding scheme of the data signals **5** following the PLCP signals **11** to **14**, the length of a wireless packet, and the like are described. Therefore, a wireless receiving device based on IEEE 802.11a can perform a normal receiving operation. During the interval of the data signals **5** following the PLCP signals **11** to **14**, no other wireless transmitting device based on IEEE 802.11a starts transmission and destroys wireless packets.

The PLCP signals **11** to **14** can meet IEEE 802.11a standard during the interval from the short preamble sequences **1**A to **1**D to the first signal fields **3**A to **3**D. This makes it possible to construct an MIMO-OFDM system capable of matching both IEEE 802.11a and another wireless LAN standard (e.g., IEEE 802.11n).

In this embodiment, the second signal fields **4**A to **4**D describing the modulation coding scheme for communication by using MIMO and the length of a wireless packet are inserted in the endmost portions of the PLCP signals **11** to **14**. The receiving side demodulates the second signal fields **4**A to **4**D, and recognizes, e.g., the modulation coding scheme of signals transmitted from the antennas Tx**1** to Tx**4**, the wireless packet length, and the MIMO operation. Therefore, the receiving side can recognize that the data signals **5** following the PLCP signals **11** to **14** are wireless packets based on a wireless LAN standard (e.g., IEEE 802.11n) other than IEEE 802.11a, and perform a receiving operation as the MIMO-OFDM system.

FIGS. **2** and **3** show a wireless transmitting device **200** and wireless receiving device **300** according to this embodiment which implements the MIMO-OFDM system. The wireless transmitting device **200** shown in FIG. **2** includes transmit antennas **205**A to **205**D, wireless transmitters **204**A to **204**D, a digital modulator **203**, and a memory **202**. The wireless receiving device **300** shown in FIG. **3** includes receiving antennas **301**A to **301**D, wireless receivers **302**A to **302**D, channel estimators **303**A to **303**D for performing channel impulse response estimation (channel estimation) on the basis of information from the wireless receivers **302**A to **302**D, and a digital demodulator **304**.

The transmit antennas **205**A, **205**B, **205**C, and **205**D shown in FIG. **2** correspond to Tx**1**, Tx**2**, Tx**3**, and Tx**4**, respectively, shown in FIG. **1**. In this embodiment, the numbers of the transmit antennas and receiving antennas are four. However, the number of the transmit antennas is not limited to four and can be any plural number. The number of the receiving antennas may also be one or any plural number other than four. The numbers of the transmit antennas and receiving antennas need not be equal.

A practical operation of the wireless transmitting device **200** shown in FIG. **2** will be explained below. First, the digital modulator **203** modulates transmission data **201** and an output preamble from the memory **202** to assemble a wireless packet. The output preamble from the memory **202** corresponds to the first to fourth PLCP signals **11** to **14** shown in FIG. **1**.

The assembled wireless packet undergoes processing necessary for transmission performed by the transmitters **204**A to **204**D, e.g., digital to analog conversion, frequency conversion (up conversion) to the radio frequency (RF) band, and power amplification. After that, the wireless packet is supplied to the transmit antennas **205**A to **205**D corresponding to the antennas Tx**1** to Tx**4** shown in FIG. **1**. As a consequence, the RF signal is transmitted from the transmit antennas **205**A to **205**D to the wireless receiving device shown in FIG. **3**. In the following explanation, the transmit antennas **205**A to **205**D are Tx**1** to Tx**4** shown in FIG. **1**.

The transmitted RF signal is based on an OFDM signal, and contains a plurality of subcarriers of the OFDM signal. The first to fourth PLCP signals **11** to **14** shown in FIG. **1** are simultaneously transmitted from the transmit antennas **205**A to **205**D as subcarriers allocated to the transmit antennas **205**A to **205**D while frequency orthogonal conditions are maintained.

Generally, in the OFDM signal based on IEEE 802.11a, the short preamble sequences **1**A to **1**D contain 12 subcarriers, and the long preamble sequences **2**A to **2**D, the first signal fields **3**A to **3**D, second signal fields **4**A to **4**D, and data signals **5** contain 52 subcarriers.

As shown in FIGS. **4**A to **5**D, the first to fourth PLCP signals **11** to **14** are transmitted as different subcarrier groups from the transmit antennas **205**A to **205**D (corresponding to Tx**1** to Tx**5** in FIG. **1**). FIGS. **4**A to **4**D illustrate the arrangements of 12 subcarriers in the short preamble sequences **1**A to **1**D shown in FIG. **1**. FIGS. **5**A to **5**D illustrate the arrangements of 52 subcarriers in the long preamble sequences **2**A to **2**D and first signal fields **3**A to **3**D in FIG. **1**. Referring to FIGS. **4**A to **5**D, the abscissa indicates the positions where the subcarriers are arranged, and the ordinate indicates the subcarrier numbers. The dotted lines indicate subcarrier positions where subcarriers can be arranged, and the solid portions represent that subcarriers are actually arranged.

The subcarrier numbers are 0 in the center of the signal band of the OFDM signal, negative numbers on the lower sideband side, and positive numbers on the upper sideband side. No subcarrier is placed in a position where the subcarrier number is "0", and 52 subcarriers are arranged in the positions of subcarrier numbers ±1 to ±26. For example, as shown in FIGS. **4**A to **4**D, 12 subcarriers of the short preamble sequences **1**A to **1**D are arranged in the positions of subcarrier numbers ±24, ±20, ±16, ±12, ±8, and ±4 on the basis of IEEE 802.11a.

As a subcarrier dividing method, i.e., as a method of allocating a plurality of subcarriers of the OFDM signal to the first to fourth PLCP signals **11** to **14**, the embodiment of the present invention uses a method, as shown in FIGS. **4**A to **5**D, by which subcarriers are sequentially selected and allocated one by one to the PLCP signals **11** to **14** in order of subcarrier arrangement (order of subcarrier number).

For example, the allocation of subcarriers to the short preamble sequences **1**A to **1**D of the first to fourth PLCP signals **11** to **14** is as shown in FIG. **4**A to **4**D. That is, subcarriers having subcarrier numbers −24, −8, and +12 are allocated to the short preamble **1**A. Subcarriers having subcarrier numbers −20, −4, and +16 are allocated to the short preamble sequence **1**B. Subcarriers having subcarrier numbers −16, +4, and +20 are allocated to the short preamble sequence **1**C. Subcarriers having subcarrier numbers −12, +8, and +24 are allocated to the short preamble sequence **1**D. In this manner, the phases of subcarriers allocated to the short preambles **1**A to **1**D are shifted by four waves.

The allocation of subcarriers to the long preamble sequences **2**A to **2**D of the first to fourth PLCP signals **11** to **14** is basically the same as the allocation of subcarriers to the short preamble sequences **1**A to **1**D described above, except that the phases of those subcarriers allocated to the long preambles **2**A to **2**D are shifted by one wave as shown in FIGS. **5**A to **5**D.

The PLCP signals **11** to **14** containing the subcarrier groups divided as shown in FIGS. **4**A to **5**D are transmitted from the transmit antennas **205**A to **205**D. The data signals **5** following the PLCP signals **11** to **14** are transmitted by MIMO channels. That is, the transmitters **204**A to **204**D generate different OFDM signals corresponding to the individual data signals **5**. These OFDM signals are transmitted as four RF signals, corresponding to the number of the transmitters **204**A to **204**D, from the transmit antennas **205**A to **205**D.

In the wireless transmitting device according to this embodiment as described above, the four PLCP signals **11** to **14** are transmitted, from the transmit antennas **205**A to **205**D by the transmitters **204**A to **204**D, as four subcarrier groups obtained by dividing a plurality of subcarriers of one OFDM signal. On the other hand, the four data signals **5** are transmitted as different OFDM signals generated by the transmitters **204**A to **204**D from the transmit antennas **205**A to **205**D.

When subcarriers are uniformly divided in accordance with the transmit antennas **205**A to **205**D, the PLCP signals **11** to **14** are transmitted at equal levels (transmission powers) from the transmit antennas **205**A to **205**D. Even when subcarriers are not uniformly divided, the PLCP signals **11** to **14** are transmitted at substantially equal levels. For example, when the number of the transmit antennas **205**A to **205**D is four as in this embodiment, the transmit antennas **205**A to **205**D transmit three subcarriers for each of the short preamble sequences **1**A to **1**D, and transmit 13 subcarriers for each of the long preamble sequences **2**A to **2**D and signal fields **3**A to **3**D and **4**A to **4**D. When the number of the transmit antennas is three, each transmit antenna transmits four subcarriers for each of the short preamble sequences **1**A to **1**C, and 17 or 18 subcarriers for each of the long preamble sequences **2**A to **2**C and signal fields **3**A to **3**C and **4**A to **4**C.

Since the data signals **5** are not divided into subcarriers unlike the PLCP signals **11** to **14**, the data signals **5** have a subcarrier arrangement different from the PLCP signals **11** to **14**. However, a total of 52 subcarriers are transmitted as the data signals **5** from the transmit antennas **205**A to **205**D, so the transmission level of the data signals **5** is equivalent to that of the PLCP signals **11** to **14**. As described above, the transmission levels of the transmit antennas **205**A to **205**D are equal between the PLCP signals **11** to **14** and the data signals **5**, and substantially equal between the transmit antennas **205**A to **205**D. Therefore, the transmitters **204**A to **204**D can have identical structures having the same output level. Furthermore, the output level of each of the transmitters **204**A to **204**D can be decreased in proportion to the number of antennas, against the total output level of the transmitter apparatus **200**. This makes it possible to reduce the current consumption by suppressing the output power of the power amplifiers used in the transmitters **204**A to **204**D, and alleviate the distortion characteristics. That is, it is possible to simplify the transmitter apparatus **200**, and thereby realize low power consumption.

The operation of the wireless receiving device **300** shown in FIG. **3** will be explained below. The RF signals transmitted from the wireless receiving device **200** shown in FIG. **2** are received by the receiving antennas **301**A to **301**D. The wireless receiving device **300** may also have a single receiving antenna. The RF received signals from the receiving antennas **301**A to **301**D are input to the receivers **302**A to **302**D. The receivers **302**A to **302**D perform receiving processes, e.g., frequency conversion (down conversion) from the RF band to the baseband (BB), AGC, and analog to digital conversion, thereby generating baseband signals.

These baseband signals from the receivers **302**A to **302**D are input to the channel estimators **303**A to **303**D and digital demodulator **304**. The channel estimators **303**A to **303**D estimate channel impulse responses from the wireless transmitting device **200** shown in FIG. **2** to the wireless receiving device **300** shown in FIG. **3**. The channel demodulator **304** demodulates the baseband signals in accordance with the channel impulse responses estimated by the channel estimators **303**A to **303**D, and generates received data **305** corresponding to the transmission data **201** shown in FIG. **2**.

More specifically, the digital demodulator **304** has a channel equalizer on the input stage. This channel equalizer performs equalization for removing distortion of the received signals from the channels in accordance with the estimated channel impulse responses. The digital demodulator **304** demodulates the equalized signals at an adequate demodulation timing based on the timing synchronization process described above, and reproduces the data.

The receivers **302**A to **302**D shown in FIG. **3** will be described below. FIG. **6** shows details of the receiver **302**A. Since the receivers **302**B to **302**D are the same as the receiver **302**A, only the receiver **302**A will be explained. A down converter **401** down-converts the RF received signal input from the receiving antenna **301**, and generates a baseband signal. The down converter **401** can convert the RF received signal into the baseband either directly or after converting the signal into an intermediate frequency (IF) band.

The baseband signal generated by the down converter **401** is input to a variable gain amplifier **402**, and AGC, i.e., signal level adjustment is performed. The output signal from the variable gain amplifier **402** is converted into a digital signal by an analog to digital converter **403**. The digital signal from the analog to digital converter **403** is output outside the receiver **302**, and also input to a gain controller **404**. The gain controller calculates the gain in accordance with the digital signal from the analog to digital converter **403**, and controls the gain of the variable gain amplifier **402** on the basis of the calculation. Details of AGC will be described later.

The operation performed by the wireless receiving device **300** to receive a transmission signal containing the PLCP signals **11** to **14** shown in FIG. **1** will be described below. First, the wireless receiving device **300** receives the short preamble sequences **1**A to **1**D transmitted from the transmit antennas **205**A to **205**D shown in FIG. **2**, and coarsely adjusts frame start detection, timing synchronization, AGC, and AFC by using baseband signals corresponding to the short preamble sequences **1**A to **1**D. In response to the reception of the short preamble sequences **1**A to **1**D, the digital demodulator **304** sends a command signal to the receivers **302**A to **302**D to perform AGC.

In the following description, the gain controller **404** measures the received level from the analog to digital-converted received signal and calculates the gain. However, it is also possible to measure the received level by analog detection of an RF-band or IF-band received signal, and calculate the gain. The variable gain amplifier **402** amplifies the baseband signals corresponding to the short preamble sequences **1**A to **1**D in accordance with a predetermined initial gain. The output signal from the variable gain amplifier **402** is input to the gain controller **404** via the analog to digital converter **403**. The gain controller **404** calculates the gain from the level after analog to digital conversion of the received signals corresponding to the short preamble sequences **1**A to **1**D, and controls the gain of the variable gain amplifier **402** in accordance with the calculated gain.

Letting X be the level before analog to digital conversion of the baseband signals corresponding to the short preamble sequences **1**A to **1**D. If the level X is high, the baseband signals exceed the upper limit of the input dynamic range of the analog to digital converter **403**, so a digital signal obtained by analog to digital conversion saturates. This particularly distorts high-level signals. If the level X is low, large quantization errors caused by analog to digital conversion are contained particularly in low-level signals. That is, regardless of whether the level X is high or low, the analog to digital converter **403** does not perform any adequate conversion, and this largely degrades the reception quality.

To solve this problem, the gain controller **404** controls the gain of the variable gain amplifier **402** such that a level Y after analog to digital conversion of the baseband signals corresponding to the short preamble sequences **1**A to **1**D is a predetermined target value Z. If the level of the baseband signals is very high to such an extent that all input signals to the analog to digital converter **403** saturate, or if the level is very low, it is sometimes impossible to appropriately control the gain of the variable gain amplifier **402** by one-time control. In this case, gain control is repeated. Consequently, the level of the baseband signals input to the analog to digital converter **403** can be adjusted to an adequate level falling within the input dynamic range of the analog to digital converter **403**. By thus controlling the gain of the variable gain amplifier **402** by using the baseband signals corresponding to the short preamble sequences **1**A to **1**D, appropriate analog to digital conversion can be performed, so deterioration of the reception quality can be avoided.

AGC can be either individually performed for the receivers **302**A to **302**D, or collectively performed for the receivers **302**A to **302**D by using, as a target value, a received level obtained by measuring one specific receiver or the highest received level. Although the former method will be explained in this embodiment, the latter method may also be used. Accordingly, the same AGC is individually performed for the receivers **302**A to **302**D, and the gain of the variable gain amplifier **402** is adjusted for each of the receiving antennas **301**A to **301**D.

As described previously, the short preamble sequences **1**A to **1**D are transmitted from the transmit antennas **205**A to **205**D after being divided into subcarriers, and received by the receiving antennas **301**A to **301**D. As shown in FIG. **7**, therefore, the fading statuses of all channel impulse response **60** between the transmit antennas **205**A to **205**D and the receiving antennas **301**A to **301**D are accurately transmitted to the receiver apparatus **300**. In this embodiment, the four transmit antennas **205**A to **205**D and four receiving antennas **301**A to **302**D are used, so the number of the channel **60** is **16** as shown in FIG. **7**.

The statuses of the channel **60** when the short preamble sequences **1**A to **1**D are transmitted are equal to those of the channel **60** when the long preamble sequences **2**A to **2**D, first signal fields **3**A to **3**D, second signal fields **4**A to **4**D, and data signals **5** are transmitted. Therefore, unlike in the case proposed by Jan Boer et al. in which short preamble sequences are transmitted from a single antenna, the receiver apparatus **300** can accurately recognize the fading statuses of the channel **60** when the short preamble sequences **1**A to **1**D, long preamble sequences **2**A to **2**D, first signal fields **3**A to **3**D, second signal fields **4**A to **4**D, and data signals **5** are transmitted. Accordingly, AGC can be accurately performed for each of the receivers **302**A to **302**D.

This effect will be explained below with reference to FIGS. **8** and **9**. Referring to FIGS. **8** and **9**, the abscissa indicates the reception time of the preambles and data signals, and the ordinate indicates the received levels of the receiving antennas Rx**1** to Rx**4** with respect to the preambles and data signals. FIG. **8** shows this embodiment, and FIG. **9** shows the case proposed by Jan Boer et al. In FIG. **8**, reference symbol SP represents the received levels of the short preamble sequences **1**A to **1**D; LP, the received levels of the long preamble sequences **2**A to **2**D; Sig, the received levels of the first signal fields **3**A to **3**D and second signal fields **4**A to **4**D; and Data, the received levels of the data signals **5**. FIG. **9** shows examples of the received levels of short preamble sequences SP, long preamble sequences LP, signal fields Sig, and data signals Data assumed in practice when the preambles by Jan Boer et al. are transmitted in the MIMO-OFDM system.

The received levels of Rx**1** and Rx**2** corresponding to the receiving antennas **301**A and **301**B will be described in detail below. To clearly distinguish between the received levels of LP, Sig, and Data received by Rx**1** and Rx**2**, alternate long and short dashed lines and alternate long and two short dashed lines are added to FIGS. **8** and **9**. As shown in FIG. **8**, at the receiving antennas **301**A to **301**D, the received levels of the short preamble sequences **1**A to **1**D match the received levels of the long preamble sequences **2**A to **2**D, first signal fields **3**A to **3**D, second signal fields **4**A to **4**D, and data signals **5**. For example, the received level of SP and the received levels of LP, Sig, and Data at Rx**1** and Rx**2** shown in FIG. **8** are uniform as indicated by the alternate long and short dashed lines and alternate long and two short dashed lines. On the other hand, as shown in FIG. **9** indicating the case by Jan Boer et al., at some receiving antennas the received level of the short preamble sequences SP is different from the received levels of the long preamble sequences LP, signal fields Sig, and data signals Data. For example, at the antenna Rx**1**, the received level of SP is lower than the alternate long and short dashed lines and alternate long and two short dashed lines indicating the received levels of LP, Sig, and Data. At the antenna Rx**2**, the received level of SP is higher than the received levels of LP, Sig,. and Data. The reasons are as follows.

A general MIMO-OFDM system has an MIMO transmitter, a plurality of transmit antennas, a plurality of receiving antennas, and an MIMO receiver. In this MIMO-OFDM system, when the transmit antennas and receiving antennas are spatially separated from each other, channel from given transmit antennas to given receiving antennas are independent of each other. Therefore, the correlations between these channel are low. For this reason, even when transmission signals of equal powers are transmitted from these transmit antennas, the levels of these signals received by the receiving antennas are naturally different.

According to the proposition by Jan Boer et al. in which short preamble sequences are transmitted only from the transmit antenna Tx**1**, of the 16 channel impulse response between the four transmit antennas Tx**1** to Tx**4** and the four receiving antennas Rx**1** to Rx**4** shown in FIG. **7**, the short preamble sequences propagate on only four channel from Tx**1** to Rx**1**, Rx**2**, Rx**3**, and Rx**4**, and do not propagate on the 12 remaining channel from Tx**2**, Tx**3**, and Tx**4** to Rx**2**, Rx**3**, and Rx**4**. That is, since the channel are different, a phenomenon occurs at high probability in which received levels when the receiver receives the long preamble sequences LP, signal fields Sig, and data signals Data transmitted from the transmit antennas Tx**2** to Tx**4** are much higher or lower than the received level assumed by using the short preamble sequences SP transmitted from the transmit antenna Tx**1**.

On the other hand, when the short preamble sequences **1**A to **1**D, long preamble sequences **2**A to **2**D, first signal fields **3**A to **3**D, and second signal fields **4**A to **4**D are transmitted from the antennas **205**A to **205**D in accordance with the embodiment of the present invention, the short preamble sequences **1**A to **1**D propagate on the same 16 channel, shown in FIG. **7**, as the long preamble sequences **2**A to **2**D, first signal fields **3**A to **3**D, second signal fields **4**A to **4**D, and data signals **5**. Consequently, at the receiving antennas Rx**1** to Rx**4**, the received levels of the short preamble sequences **1**A to **1**D match the received levels of the long preamble sequences **2**A to **2**D, first signal fields **3**A to **3**D, second signal fields **4**A to **4**D, and data signals **5**.

For example, compare the received level of the short preamble sequences SP and the received levels of the long preamble sequences LP, signal fields Sig, and data signals Data at the receiving antenna Rx**2** shown in FIGS. **8** and **9**. In this case, in AGC using the short preamble sequences **1**A to **1**D based on this embodiment, the received level of the short preamble sequences is equal to the received levels of the long preamble sequences, signal fields, and data signals as shown in FIG. **8**. This realizes fine AGC. That is, since the accuracy of AGC performed using the short preamble sequences increases, it is possible to avoid saturation or the increase in quantization error when the received signals are converted into digital signals by the analog to digital converter **403**. Consequently, wireless communication can be performed at a high transmission rate by suppressing communication errors of data signals.

When AGC control can be performed at high accuracy by using the short preamble sequences, the following effects are also obtained. That is, since received signals input to the analog to digital converter **403** in each of the receivers **302**A to **302**D are adjusted to adequate levels, channel estimation using the long preamble sequences can be rapidly performed. In addition, since channel estimation can be performed by using accurate digital signals, the estimation accuracy of the channel impulse response can be increased.

In this embodiment as described above, the transmitters **204**A to **204**D can be designed by the same level diagram in the transmission states of all the short preamble sequences, long preamble sequences, first and second signal fields, and data signals. This simplifies the wireless transmitting device **200**. Also, the output level of the transmitters **204**A to **204**D is1/(the number of antennas) of the total output level of the transmitter apparatus **200**. This makes downsizing of the power amplifier in the final stage and lower power consumption feasible.

Since the channel impulse response of the short preamble sequences are the same as the channel impulse response of the long preamble sequences, first and second signal fields, and data signals, AGC using the short preamble sequences can maintain high accuracy capable of tracking level variations with respect to transmission from a plurality of transmit antennas. Accordingly, the reception quality can be increased by suppressing the influence of saturation or quantization errors in the analog to digital converter.

Furthermore, since the reception accuracy increases, the number of bits of the analog to digital converter for converting received signals into digital signals can be reduced. This makes low power consumption of the receiver apparatus possible.

Another embodiment of the present invention will be described below. In the other embodiment of the present invention, as shown in FIG. **10**, a wireless transmitting device **200** additionally has a subcarrier division controller **206** connected to a digital modulator **203**. A memory **202**, transmitters **204**, and transmit antennas **205** are the same as in FIG. **2**, so an explanation thereof will be omitted.

The frequency fading statuses of the channel impulse response **60** shown in FIG. **7** of the MIMO-OFDM system can be detected by the known method. The subcarrier division controller **206** shown in FIG. **10** receives channel fading detection information indicating that fading is short-delay fading having a relatively short delay time or long-delay fading having a relatively long delay time. To detect the channel fading, the frequency response, included in the transmitting device **200**, of a received signal of a receiving device **300** can be used as a reference. It is also possible to cause the transmitting device **200** to notify the receiving device **300** of frequency response information of RF signals actually transmitted from transmit antennas **205**A to **205**D to receiving antennas **301**A to **301**D, and use this frequency response information as a reference. The propagation fading detection method may also be some other method, and is not particularly limited.

The subcarrier division controller **206** controls the digital modulator **203** in accordance with the channel fading detection information, thereby controlling the subcarrier dividing method, i.e., the allocation of subcarriers of short preamble sequences **1**A to **1**D, long preamble sequences **2**A to **2**D, first signal fields **3**A to **3**D, and second signal fields **4**A to **4**D to transmitters **204**A to **204**D.

FIGS. **11**A and **11**B illustrate the frequency fading. FIG. **11**A shows typical frequency fading in a short-delay fading environment, and FIG. **11**B shows typical frequency fading in a long-delay fading environment. The frequency fading is roughly divided into these two patterns. The period of a valley in which the frequency fading loss is large is typically about a few MHz indoors. The bandwidth of an OFDM signal to be used in IEEE 802.11a or in IEEE 802.11n whose standard will be established in the future is about 20 MHz. Therefore, a plurality of fading valleys shown in FIGS. **11**A and **11**B are present within this OFDM signal band.

The characteristics of the two frequency fading patterns described above will be briefly summarized below. The short-delay fading shown in FIG. **11**A has the characteristics that a specific signal band produces fading valleys and suffers a propagation path loss, but propagation path losses are relatively small in other bands. On the other hand, the long-delay fading shown in FIG. **11**B is characterized in that fading valleys appear in the entire signal band at narrow frequency intervals, i.e., periodic bands suffer large losses. These fading characteristics are determined in a channel between a transmit antenna and a receiving antenna. Therefore, the fading statuses of the 16 channel **60** shown in FIG. **7** are not the same, but have similar tendencies.

In this embodiment, the above-mentioned characteristics of the short-delay fading and long-delay fading are taken into consideration, and the subcarrier division controller **206** switches the subcarrier dividing methods of the digital modulator **203** on the basis of the channel fading status detection information. More specifically, if the channel **60** has the short-delay fading, subcarriers are sequentially selected and allocated one by one, in order of subcarrier arrangement shown in FIGS. **4**A to **5**D, to first to fourth PLCP signals **11** to **14** transmitted from the transmit antennas **205**A to **205**D, in accordance with the subcarrier dividing method explained in the above embodiment. That is, in the first to fourth PLCP signals **11** to **14**, subcarriers are allocated to the short preamble sequences **1**A to **1**D as shown in FIG. **4**, and are allocated to the long preamble sequences **2**A to **2**D as shown in FIG. **5**.

As shown in FIG. **11**A, in the short-delay fading, the influence of a frequency fading valley is small in a remote band. Accordingly, as the subcarrier dividing method as described above, subcarriers allocated to the first to fourth PLCP signals **11** to **14** are dispersed in terms of frequency to avoid concentration of subcarriers to a band which suffers a large loss. This makes it possible to avoid the influence of a large propagation path loss caused by a frequency fading valley in a specific band.

On the other hand, if the channel **60** has the long-delay fading, as shown in FIGS. **12**A to **13**D, subcarriers selected from a plurality of subcarriers for each of a plurality of partial bands obtained by dividing the OFDM signal band are allocated to the first to fourth PLCP signals **11** to **14** transmitted from the transmit antennas **205**A to **205**D.

For example, to allocate subcarriers to the short preamble sequences **1**A to **1**D of the first to fourth PLCP signals **11** to **14**, the whole band of the OFDM signal is divided by the number of the transmit antennas, and these divided bands are allocated to the individual transmit antennas and transmitted. As shown in FIGS. **12**A to **12**D, the OFDM signal band is divided into four partial bands (first to fourth partial bands), and subcarriers at a period of four waves as subcarrier numbers are selectively allocated to each partial band.

That is, three subcarriers in the first partial band having the lowest frequency are allocated to the short preamble sequence **1**A, and three subcarriers in the second partial band having the second lowest frequency are allocated to the short preamble sequence **1**B. Similarly, three subcarriers in the third partial band having a frequency higher than that of the second partial band are allocated to the short preamble sequence **1**C, and three subcarriers in the fourth partial band having the highest frequency are allocated to the short preamble sequence **1**D.

The allocation of subcarriers to the long preamble sequences **2**A to **2**D of the first to fourth PLCP signals **11** to **14** is basically the same as the allocation of subcarriers to the short preamble sequences **1**A to **1**D described above. However, a larger number of subcarriers in the individual partial bands, e.g., all subcarriers having consecutive subcarrier numbers in the partial bands in the example shown in FIGS. **13**A to **13**D are allocated to the long preamble sequences **2**A to **2**D.

In the long-delay fading as shown in FIG. **11**B, frequency fading valleys periodically appear even in remote bands. However, in a narrow band of a few hundred kHz to a few MHz, e.g., in the adjacent subcarrier or the next adjacent subcarrier, large losses can be avoided on average. As shown in FIGS. **12**A to **13**D, therefore, subcarriers are divided for each of adjacent partial bands, and subcarrier groups close to each other in each partial band are allocated to the first to fourth PLCP signals **11** to **14**. This makes it possible to avoid a large propagation path loss caused when a frequency fading valley and the subcarrier arrangement match.

That is, when a signal is transmitted from a given transmit antenna and received by a given receiving antenna, it is possible to avoid a loss caused by superposition of a subcarrier on a band which periodically appears and has a large loss, and eliminate the influence of a fading loss on a subcarrier in one of adjacent bands. Accordingly, it is possible to smoothly perform frequency synchronization, channel estimation, and MIMO channel configuration information transmission by using the long preamble sequences **2**A to **2**D and first signal fields **3**A to **3**D, without degrading the accuracy of AGC control by the short preamble sequences **1**A to **1**D. It is also possible to suppress the influence of saturation and quantization errors in the analog to digital converter and improve the reception quality while maintaining the accuracy of the AGC function which tracks variations in received level in the receiver apparatus.

As described earlier, in a wireless propagation environment using the MIMO-OFDM system, fading patterns having various characteristics such as short-delay fading and long-delay fading occur. By switching the subcarrier dividing methods in accordance with the fading characteristics as in this embodiment, the influence of fading can by minimized in the receiver apparatus in any wireless propagation environment. This makes it possible to maintain the accuracy of the AGC function with respect to received level variations in a wireless propagation environment, suppress the influence of saturation and quantization errors in the analog to digital converter, and thereby improve the reception quality.

The MIMO-OFDM system desirably minimizes the influence of frequency fading by which a specific band suffers a large loss, when transmitting the short preamble sequences **1**A to **1**D, long preamble sequences **2**A to **2**D, first signal fields **3**A to **3**D, and second signal fields **4**A to **4**D by subcarrier division. This is so because 52 subcarriers as shown in, e.g., FIGS. **14**A to **14**D are arranged in the data signals **5**, and this averages the influence of frequency fading.

By contrast, in a subcarrier arrangement in which bands having undergone subcarrier division as shown in FIGS. **4**A to **4**D or FIGS. **12**A to **13**D are limited to portions of the signal band, the whole transmission signal may significantly deteriorate depending on the characteristics of frequency fading. This is so because AGC adjustment using the short preambles **1** may deviate from the gain adjustment target value which is optimized when the data signals **5** are received.

In this embodiment, however, it is possible to avoid a large loss of divided subcarriers in a channel between a given transmit antenna and a given receiving antenna, regardless of the fading environment of the propagation path. This makes it possible to smoothly perform frequency synchronization, channel estimation, and MIMO channel configuration information transmission by using the long preamble sequences **2**A to **2**D and first signal fields **3**A to **3**D without degrading the accuracy of AGC control by the short preamble sequences **1**A to **1**D.

In the embodiments of the present invention as described above, the output levels of the transmitters can be made uniform independently of transmission information of the short preamble sequences, long preamble sequences, signal fields, and data signals. Since this eliminates the problem that the output power of one antenna increases only when the short preamble sequences are transmitted, the redundancy of the transmitters can be suppressed. Also, since the output powers of the transmitters can be made uniform at a low level, the power consumption can be reduced.

In addition, the short preamble sequences are transmitted from a plurality of antennas and used in AGC. Therefore, the input levels of the analog to digital converter and wireless receiving device can be appropriately adjusted to data simultaneously transmitted from a plurality of antennas in MIMO, and the receiving performance of the wireless receiving device can be improved. Also, since the input level of the analog to digital converter can be set at an adequate value, the number of bits of the analog to digital converter can be reduced.

Furthermore, since the short preamble sequences transmitted from a plurality of antennas are used in AGC, accurate AGC can be performed not only when data is received but also when the long preamble sequences are received. Accordingly, deterioration of the reception accuracy can be avoided. This also prevents the transmission efficiency from being decreased by insertion of an extra preamble sequence.

On the other hand, in a propagation path in which signals are transmitted from a given transmit antenna and received by a given receiving antenna, subcarriers of the short preamble sequences can be propagated while the influence of fading is minimized. Therefore, AGC which tracks received level variations on the receiving side can be made to correspond to the propagation path loss from each transmit antenna to each receiving antenna, so the reception accuracy can be increased. Furthermore, it is possible to reduce the number of bits of the analog to digital converter inserted to perform digital signal processing on received signals.

Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

What is claimed is:

1. A wireless transmitting method of performing transmission by orthogonal frequency division multiplexing (OFDM) using a plurality of subcarriers orthogonal to each other, the method comprising:

transmitting, by using a plurality of transmit antennas, a plurality of preambles formed of a plurality of different subcarrier groups selected from the plurality of subcarriers; and

transmitting data by using the plurality of transmit antennas after the plurality of preambles are transmitted, wherein

transmitting the plurality of preambles includes, if a fading status of a propagation path to a wireless receiving device is short-delay fading, sequentially allocating, to each of the plurality of subcarrier groups of the plurality of preambles, subcarriers selected one by one from the plurality of subcarriers in order of arrangement, and, if a fading status of a propagation path is long-delay fading, allocating, to each of the plurality of subcarrier groups of the plurality of preambles, subcarriers selected from the plurality of subcarriers for each of a plurality of partial bands obtained by dividing a signal band in which the OFDM system is used.

2. The method according to claim **1**, wherein a preamble of the plurality of preambles contains a short preamble, a long preamble, and at least one signal field.

3. The method according to claim **2**, wherein the at least one signal field contains a first signal field based on IEEE 802.11 a.

4. The method according to claim **2**, wherein the at least one signal field contains a first signal field based on IEEE 802.11 a, and a second signal field placed after the first signal field and based on a standard other than IEEE 802.11 a.

* * * * *

APPENDIX D

802.11 "Decrypted"

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ABSTRACT
This short paper introduces wireless IEEE 802 standards and activities with a focus on explaining the purpose of the many 802.11 amendments.

Categories and Subject Descriptors
A.1 [**INTRODUCTORY AND SURVEY]**

C.2.5 [**Local and Wide-Area Networks**]

General Terms
Standardization

Keywords
TBD

1. INTRODUCTION
As wireless technology increasingly pervades our lives, the decisions made in wireless standards bodies such as the IEEE 802.11 have the potential to impact our lives. From the user viewpoint, emerging standards will support new applications, higher throughput and increasing mobility. From the implementer viewpoint, the increasing complexity must be hidden from the user. New standards create new challenges and emergent behaviors that call for academic scrutiny.

The question addressed here is: what are 802 and 802.11, and what do the various letters after ".11" signify?

2. IEEE 802
IEEE 802 is a project of the Institute of Electrical and Electronic Engineers (IEEE) LAN/MAN Standards Committee (LMSC). It was created in February 1980 – hence the name 802.

The LMSC is a committee of the IEEE Standards Association (IEEE-SA), which is the body that publishes completed standards and their amendments.

Within project 802, are various *working groups* – each of which defines one or more standards or recommended practices.

The currently active working groups are listed in Table 1.

Table 1 - IEEE 802 Working Groups

Working Group	Name
802.1	Higher Layer LAN protocols
802.3	Ethernet
802.11	Wireless LAN
802.15	Wireless PAN
802.16	Broadband Wireless Access
802.17	Resilient Packet Ring
802.18	Radio Regulatory technical advisory group
802.19	Coexistence technical advisory group
802.20	Mobile Broadband Wireless Access
802.21	Media Independent Handoff
802.22	Wireless Regional Area Networks

3. 802.11
The 802.11 working group working held its first meeting in September 1990 and issued the first draft of the 802.11 standard in early 1995, completed in late 1997. This document included a medium access controller (MAC) and physical layer (PHY) definitions for three media:

- Infrared
- Frequency Hopping Spread Spectrum (FHSS) in the 2.4GHz ISM band (1, 2 Mbps)
- Direct Sequence Spread Spectrum (DSSS) in the 2.4 GHz ISM band (1, 2 Mbps)

Originally the FHSS PHY was the most popular because of its lower cost and robustness. The author is not aware of any commercial products using the Infrared PHY. The DSSS PHY did not become popular until 802.11b increased the PHY rates to 5.5 and 11 Mbps. 802.11b is the version that has made wireless networking a popular commercial product.

Since the original version, 802.11 spawned *task groups* to produce amendments to the 802.11 standard. The first task group (TG) is called "TGa", and its amendment is called 802.11a, and so on. Each TG is authorized by the IEEE-SA and has a well-defined scope defined in its Project Authorization Request (PAR) document. The 802.11 task groups are described in Table 2. Those task groups that are currently active are indicated as such.

Table 2 - IEEE 802.11 Task Groups

Task Group	Description
TGa	This group developed a higher speed PHY based on orthogonal frequency division multiplexing (OFDM) in the 5GHz bands. The group cooperated with the European ETSI BRAN project and the two produced very similar

	PHY specifications. 802.11a has the advantage of several hundred of MHz of spectrum in the 5GHz band. However, it did not have the popular impact that 802.11b had due to the increased cost of operating at these frequencies. 802.11g made 802.11a speeds available in the 2.4GHz band. As the costs of 5GHz components has fallen, 802.11a looks increasingly attractive, and 802.11 a/b/g combination products are commonly available.
TGb	802.11b extended the DSSS PHY to support 5.5 and 11 Mbps. It has been the most successful version of 802.11 to date, and is now being replaced by 802.11g.
TGc	This defines 802.11 MAC procedures to support bridge operation. It is a supplement to 802.1D developed in cooperation with the 802.1 working group.
TGd	This extends support to additional regulatory domains and provides on-the-air signaling and control of parameters affected by the regulatory domain (such as channelization and hopping patterns).
TGe	TGe is still active, although it has nearly completed the standards process. It defines support for QoS for both distributed (EDCA) and centralized (HCCA) mechanisms. It supports QoS flows based on a user priority, suitable for connectionless data. Although the 802.1 MAC interface does not support connection-oriented data transfer, the 802.11e traffic specification (TSPEC) comes close to defining a connection – describing a flow in terms of size, rate, period and many other parameters. This makes 802.11e also suitable for periodic data such as VoIP. Additional improvements include power-saving (APSD) and additional efficiency gains through a selective acknowledgement (Block Ack).
TGf	This group developed recommended practices for an Inter-Access Point Protocol (IAPP) intended to provide interoperable management of the distribution system between APs from different manufacturers. It is uncertain what impact this recommended practice has had.
TGg	The 802.11g amendment essentially allows operation of the 802.11a OFDM modulation in the 2.4 GHz band. It provides 802.11a throughput at close to 802.11b prices. The challenge for 802.11g devices is to coexist with the installed base of 802.11b devices. This is achieved through various protection mechanisms, although there is some penalty in performance for operating in such an environment.
TGh	802.11h defined enhancements to 802.11a to support operation in the license exempt bands in Europe. It supports measurement and reporting of channel energy in order to provide dynamic frequency selection (DFS). It also provides control of transmit power (TPC).
TGi	This group was created to address issues and concerns with the original 802.11 WEP security mechanism. 802.11i defines two new mechanisms. TKIP is a medium strength mechanism designed for compatibility with hardware implementing the original 802.11 WEP security mechanism. WEP has proven to be susceptible to various types of attack, and TKIP provides a stopgap solution to these. AES provides the much stronger 128-bit block encryption, which is supported by newer hardware.
TGj	802.11j supports operation in Japan in the 4.9 and 5GHz bands. It extends the operation of the 802.11a PHY to operate in a 10MHz channel (half the channel width of 802.11a), and also allows longer range communication by increasing the turnaround interval to allow for longer propagation delays.
TGk Active	802.11k defines measurement of the radio channel that allows a device (a client device or an access point, or management software above) to make informed decisions relating to selecting an access point and selecting an operating channel. TGk is currently active.
TGma	This group provides maintenance changes (editorial and technical corrections) to 802.11-1999, 2003 edition (incorporating 802.11a-1999, 802.11b-1999, 802.11b-1999 corrigendum 1-2001, and 802.11d-2001).
TGn Active	802.11n will define modifications to both PHY and MAC layers to provide substantially higher throughput than 802.11 a/g. The project requires 100Mbps of useful throughput (at the top of the MAC interface), which requires about 200Mbps at the PHY. TGn is currently in its down-selection process to select between proposed solutions. Current proposals use multiple antenna technology and increased channel width to achieve significantly higher than the target. A maximum throughput of ~600Mbps at the PHY has been described, although first generation products are unlikely to support the optional features that achieve this figure. The PHY fixed overheads are not reduced, and aggregation and other enhancements are necessary in the MAC to restore an acceptable level of efficiency (~70%).
TGp Active	The TGp amendment will support communication between vehicles and the roadside and between vehicles while operating at speeds up to a minimum of 200 km/h for communication ranges up to 1000 meters. It will use the 5.850-5.925 GHz band within North

	America defined for this purpose.
TGr Active	TGr is chartered with developing a secure, fast BSS transition solution, when a Station (STA) roams from one Access Point (AP) to another AP, within an Extended Service Set (ESS). High BSS transition latencies using existing 802.11 mechanisms (including 802.11i Security addendum), along with a lack of inter-operability between STA and AP vendors in harmoniously executing these procedures in performing this transition, are technical hurdles for widespread deployment of Voice over Internet Protocol (VoIP) over 802.11 LANs. Delay and jitter sensitive applications like multimedia, video, and voice, which have to co-exist with traditional, intermittent data traffic, demand a flexible and scalable solution, which maintains the security guarantees provided by IEEE 802.11i. It is a market-driven requirement that the BSS transitions be executed with minimal latencies, while maintaining the same Quality of Service (QoS), and confidentiality and integrity protection, that the STA was being afforded at the existing AP, when the STA moves to the next AP. By some estimates, the procedures recommended by TGr should take less than 50 milliseconds, in order to be effective for the voice/video class of applications. TGr is progressing the merger of two proposals that were voted in at the January 2005 meeting, through a down-select process, from an initial pool of eight.
TGs Active	TGs is considering how to create a Mesh of APs to provide a Wireless Distribution System (WDS) using the existing IEEE 802.11 MAC/PHY layers. The mesh needs to support broadcast and directed transmissions over potentially multiple "hops" between APs. It has to be self-configuring. TGs are executing their selection process. They have

	a call for proposals out that will results in proposals being heard in July 2005.
TGu Active	TGu will define an amendment to IEEE 802.11 to support interworking with external networks. The group is currently working on its functional requirements.
TGv Active	This group will provide Wireless Network Management enhancements to the 802.11 MAC, and PHY, to extend prior work in radio measurement to effect a complete and coherent upper layer interface for managing 802.11 devices in wireless networks.
TGw	802.11 and later 802.11i established mechanisms to protect data frames, but does nothing to protect control frames internal to 802.11. For example, it is possible to forge disassociation requests. 802.11w is being chartered to extend the 802.11i protections to data frames. It is expected that 802.11w will begin its work in May 2005.

4. References

The most accessible source of information are the IEEE web-sites.

The IEEE 802 LMSC home page is: http://grouper.ieee.org/groups/802/

The IEEE 802.11 WG home page is: http://www.ieee802.org/11/. This contains more detailed description of the scope and status of the individual task groups.

The IEEE 802.11 WG working documents are available (after free registration) from: http://802wirelessworld.com.

Approved amendments are available for download here: http://standards.ieee.org/getieee802/.

The author speaks for himself. Views expressed by the author are not necessarily endorsed by his employer.

APPENDIX E

Documents

Join group

Everything | All Years | TGn (inactive)

1102

Created (ET) ▼	Year	DCN	Rev	Group	Title	Author (Affiliation)	Uploaded (ET)	Actions
14-Jan-2006 ET	2005	1102	4	TGn	Joint Proposal Phy Specification	Sean Coffey (RealTek)	14-Jan-2006 00:00:00 ET	Download
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APPENDIX F

IEEE P802.11
Wireless LANs

Joint Proposal: High throughput extension to the 802.11 Standard: PHY				
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Abstract

This document contains the PHY layer parts of the 802.11 TGn Joint Proposal Technical Specification.

1

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1

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1 Introduction

This document specifies those features of a device that are necessary to achieve interoperability. It specifies the signals that may be transmitted by the device and received by the device's receivers. This device is referred to as an HT (High Throughput) device.

The HT device is assumed to be compliant with 802.11a/b/g/j standards. This document describes the extensions needed in the physical layer for high throughput transmission.

2 PHY Interface

The PHY interfaces to the MAC through the TX vector and the RX vector. The TX vector supplies the PHY with per-packet [1] TX parameters. Using the RX vector, the PHY informs the MAC of the received packet parameters. The specification of this interface is outside the scope of this document.

3 PLCP packet format

Two new formats are defined for the PLCP (PHY Layer Convergence Protocol): Mixed mode and Green Field. These two formats are called HT formats. Figure 1 shows the legacy format and the HT formats. In addition to the HT formats, there is a legacy duplicate format (specified in section 4.8) that duplicates the 20MHz legacy packet in two 20MHz halves of a 40MHz channel.

[1] *Packet* is equivalent to PPDU in this document.

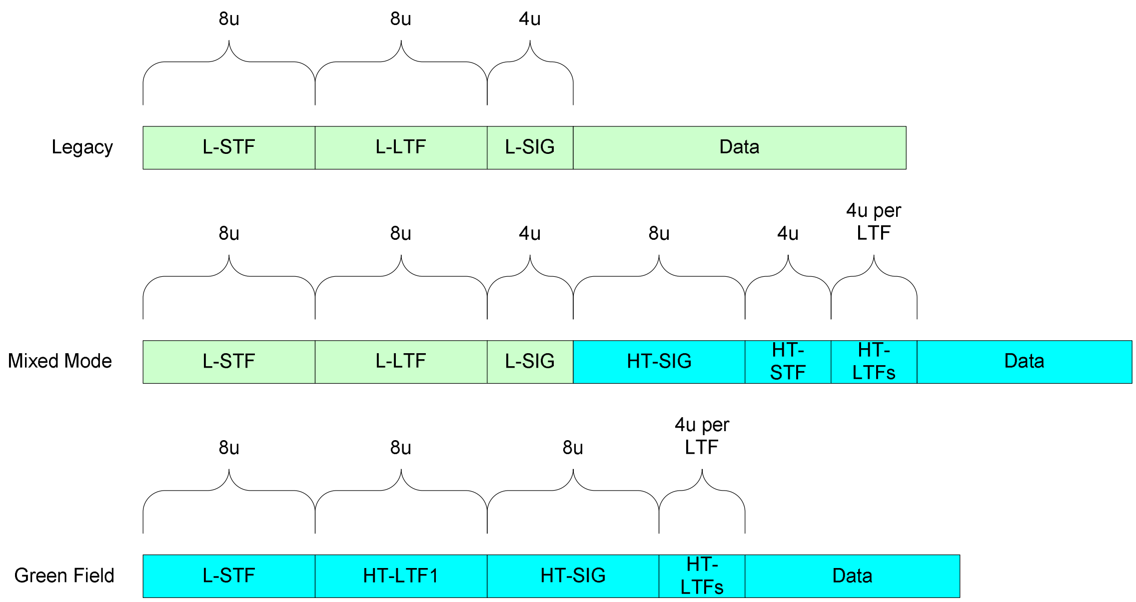

Figure 1- PLCP packet format

The elements of the PCLP packet are:

L-STF: Legacy Short Training Field

L-LTF: Legacy Long Training Field

L-SIG: Legacy Signal Field

HT-SIG: High Throughput Signal Field

HT-STF: High Throughput Short Training Field

HT-LTF1: First High Throughput Long Training Field

HT-LTF's: Additional High Throughput Long Training Fields

Data – The data field includes the PSDU (PHY sub-layer Service Data Unit)

The HT-SIG, HT-STF and HT-LTF's exist only in HT packets. In legacy and legacy duplicate formats only the L-STF, L-LTF, L-SIG and Data fields exist.

3.1 Operating Mode

The PHY will operate in one of 3 modes –

- **Legacy Mode** – in this mode packets are transmitted in the legacy 802.11a/g format.
- **Mixed Mode –** in this mode packets are transmitted with a preamble compatible with the legacy 802.11a/g – the legacy Short Training Field (STF), the legacy Long Training Field (LTF) and the legacy signal field are transmitted so they can be decoded by legacy 802.11a/g devices. The rest of the packet has a new format**.** In this mode the receiver shall be able to decode both the Mixed Mode packets and legacy packets.

- **Green Field –** in this mode high throughput packets are transmitted without a legacy compatible part. This mode is optional. In this mode the receiver shall be able to decode both Green Field mode packets, Mixed Mode packets and legacy format packets. An HT device which does not support the reception of a GF packet shall be able to detect that GF transmissions are HT transmissions (as opposed to legacy transmissions) and treat them as HT packets with a failing HT-SIG CRC.

The operation of PHY in the frequency domain is divided to the following modes:

- **LM –** Legacy Mode – equivalent to 802.11a/g
- **HT-Mode –** In HT mode the device operates in either 40MHz bandwidth or 20MHz bandwidth and with one to four spatial streams. This mode includes the HT-duplicate mode.
- **Duplicate Legacy Mode –** in this mode the device operates in a 40MHz channel composed of two adjacent 20MHz channel. The packets to be sent are in the legacy 11a format in each of the 20MHz channels. To reduce the PAPR the upper channel (higher frequency) is rotated by 90º relative to the lower channel.
- **40 MHz Upper Mode –** used to transmit a legacy or HT packet in the upper 20MHz channel of a 40MHz channel.

40 MHz Lower Mode – used to transmit a legacy or HT packet in the lower 20MHz channel of a 40MHz channel

LM is mandatory and HT-Mode for 1 and 2 spatial streams at 20MHz are mandatory at the AP. LM is mandatory and HT-Mode for 1 spatial stream at 20MHz is mandatory for non-AP STAs.

3.2 Modulation and Coding Scheme (MCS)

The Modulation and Coding Scheme (MCS) is a value that determines the modulation, coding and number of spatial channels. It is a compact representation that is carried in the high throughput signal field.

Rate dependent parameters for the full set of modulation and coding schemes (MCS) are shown in Appendix A in Tables A-1 through A-15. These tables give rate dependent parameters for MCSs with indices 0 through 76. MCS indices 77-127 are reserved.

MCS Tables A-1 through A-4 show rate-dependent parameters for equal-modulation MCSs in one, two, three, and four streams for 20 MHz operation. Tables A-5 through A-8 show rate-dependent parameters for equal-modulation MCSs in one, two, three, and four streams for 40 MHz operation. The same equal modulation MCSs are used for 20 MHz and 40 MHz operation. Table A-9 shows rate-dependent parameters for the 40 MHz, 6 Mbps HT duplicate mode.

The remaining Tables, 10 through 15, show rate-dependent parameters for the MCSs with unequal modulation for use with TxBF and unbalanced STBC modes including the N_SS=2, N_STS=3 case, and N_SS=3, N_STS=4 case as specified in Table 15. Tables A-10 through A-12 are for 20 MHz operation. Tables A-13 through A-15 are for 40 MHz operation. The same unequal modulation MCSs are used in 20 MHz and 40 MHz operation.

MCS 0 through 15 are mandatory in 20 MHz with 800 nsec guard interval at an AP STA. MCS 0 through 7 are mandatory in 20MHz with 800ns guard interval at all STAs. All other MCSs and modes are optional, specifically including Tx and Rx support of 400 nsec guard interval, operation in 40 MHz, and support of MCSs with indices 16 through 76. The parameters in the table are:

- Rate: Coding Rate
- N_{SS}: Number of Spatial Streams
- N_{SD}: Number of Data Subcarriers
- N_{SP}: Number of pilot subcarriers
- N_{BPSC}: Number of coded bits per subcarrier per spatial stream
- N_{CBPS}: Number of Code Bits Per OFDM Symbol (total of all spatial streams)
- N_{DBPS}: Number of data bits per MIMO-OFDM symbol
- N_{TBPS}: Total number of coded bits per subcarrier

3.3 Transmitter Block Diagram (this section is informative)

The transmitter is composed of the following blocks:

- **Scrambler** – scrambles the data to prevent long sequences of zeros or ones – see section 4.2.
- **Encoder Parser** – de-multiplexes the scrambled bits among N_{ES} FEC encoders, in a round robin manner.
- **FEC encoders** – encodes the data to enable error correction – an FEC encoder may include a binary convolutional encoder followed by a puncturing device, or an LDPC encoder
- **Stream Parser** – divides the output of the encoders into blocks that will be sent to different interleaver and mapping devices. The sequences of the bits sent to the interleaver are called **spatial streams**.
- **Interleaver** – interleaves the bits of each spatial stream (changes order of bits) to prevent long sequences of noisy bits from entering the FEC decoder.

- **QAM mapping** – maps the sequence of bit in each spatial stream to constellation points (complex numbers).
- **Spatial Mapping** – maps spatial streams to different transmit chains. This may include one of the following:
    - **Direct mapping** – each sequence of constellation points is sent to a different transmit chain.
    - **Spatial expansion** – each vector of constellation points from all the sequences is multiplied by a matrix to produce the input to the transmit chains.
    - **Space Time Block coding** – constellation points from one spatial stream are spread into two spatial streams using a space time block code.
    - **Beam Forming -** similar to spatial expansion: each vector of constellation points from all the sequences is multiplied by a matrix of steering vectors to produce the input to the transmit chains.
- **Inverse Fast Fourier Transform** – converts a block of constellation points to a time domain block.
- **Cyclic shift insertion** – inserts the cyclic shift into the time domain block. In the case that spatial expansion is applied that increases the number of transmit chains, the cyclic shift may be applied in the frequency domain as part of spatial expansion.
- **Guard interval insertion** – inserts the guard interval.
- **Optional windowing** – smoothing the edges of each symbol to increase spectral decay

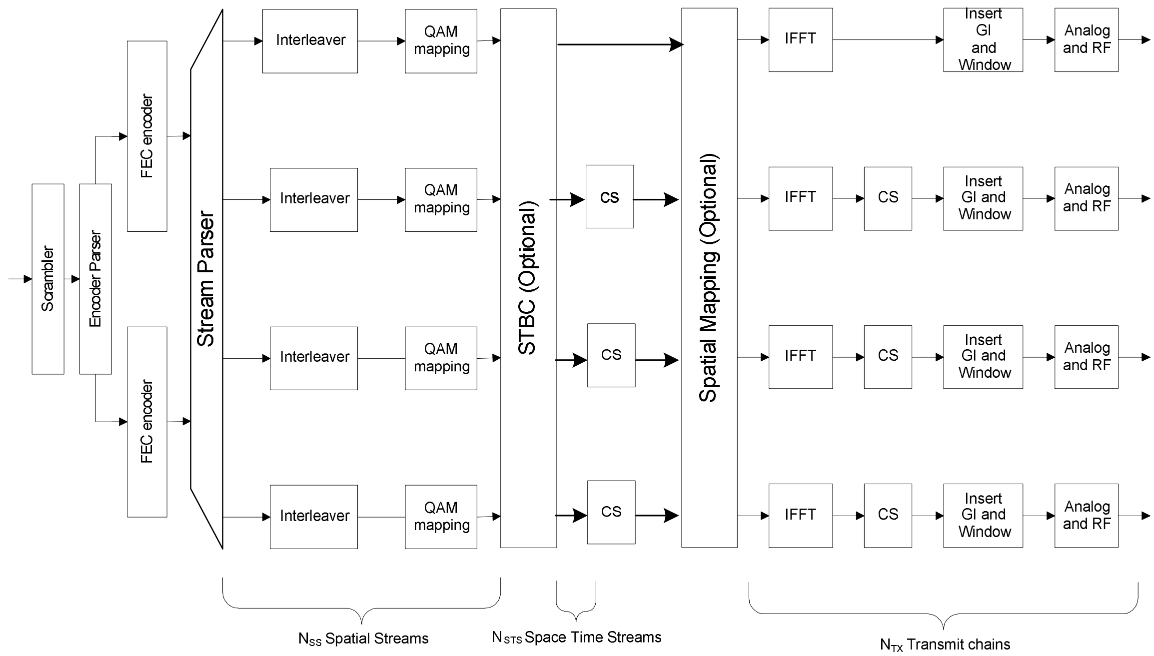

Figure 2 - Transmitter block diagram

Figure 2 shows a block diagram of the transmitter. Different implementation are possible as long as they are mathematically equivalent.

3.4 Mathematical description of signals

For the description of the convention on mathematical description of signals see section 17.3.2.4 of [1]

In the case of a legacy mode and HT mode transmission over a 20MHz channel, the channel is divided into 64 sub-carriers. In the legacy mode, signal is transmitted on sub-carriers -26 to -1 and 1 to 26, with 0 being the center (DC) carrier. In the HT modes signal is transmitted on sub-carriers -28 to -1 and 1 to 28.

In the case of a 40MHz HT transmission, two adjacent 20MHz channels are used. The channel is divided into 128 sub-carriers. Signal is transmitted on sub-carriers -58 to -2 and 2 to 58.

In the case of the legacy duplicate mode over 40MHz, the same data are transmitted over two adjacent 20MHz channels. In this case the 40MHz channel is divided into 128 sub-carriers and the data are transmitted on carriers -58 to -6 and 6 to 58.

Table 1 - Timing related constants

Parameter	Value in legacy 20MHz channel	Value in 20MHz HT channel	Value in 40MHz channel	
			HT format	Legacy Duplicate
N_{SD}: Number of data subcarriers	48	52	108	48[2]
N_{SP}: Number of pilot subcarriers	4	4	6	4[1]
N_{ST}: Total Number of subcarriers	52	56	114	
N_{SR}: Number of subcarriers occupying half of the overall BW	26	28	58	
Δ_F : subcarrier frequency spacing	312.5kHz (20MHz/64)	312.5kHz	312.5kHz (40MHz/128)	
T_{FFT}: IFFT/FFT period	3.2μsec	3.2μsec	3.2μsec	
T_{GI}: Guard Interval length	0.8μsec= $T_{FFT}/4$	0.8μsec	0.8μsec	
T_{GI2}: Double GI	1.6μsec	1.6μsec	1.6μsec	
T_{GIS}: Short Guard Interval length	0.4μsec= $T_{FFT}/8$	0.4μsec	0.4μsec	
T_{L-STF}: Legacy Short training sequence length	8μsec=10× $T_{FFT}/4$	8μsec	8μsec	
T_{L-LTF}: Legacy Long training sequence length	8μsec=2× $T_{FFT}+T_{GI2}$	8μsec	8μsec	
T_{SYM}: Symbol	4μsec= $T_{FFT}+T_{GI}$	4μsec	4μsec	

2 This value used for HT duplicate mode

Parameter	Value in legacy 20MHz channel	Value in 20MHz HT channel	Value in 40MHz channel HT format Legacy Duplicate
Interval			
T_{SYMS}: Short GI Symbol Interval	3.6μsec= $T_{FFT}+T_{GIS}$	3.6μsec	3.6μsec
$T_{L\text{-}SIG}$	4μsec= T_{SYM}	4μsec	4μsec
$T_{HT\text{-}SIG}$	NA	8μsec= $2T_{SYM}$	8μsec
$T_{HT\text{-}STF}$: HT STF time	NA	4μsec	4μsec
$T_{HT\text{-}LTF1}$: HT first long training field length	NA	4μsec in mixed mode, 8usec in green field	4μsec in mixed mode, 8usec in green field
$T_{HT\text{-}LTFs}$: HT second, and subsequent, long training fields length	NA	4μsec	4μsec

Table 2 - frequently used parameters

Symbol	Explanation
N_{CBPS}	Number of coded bits per symbol
N_{CBPSS}	Number of coded bits per symbol per spatial stream
N_{DBPS}	Number of data bits per symbol
N_{BPSC}	Number of coded bits per single carrier
N_{STS}	Number of space time streams
N_{SS}	Number of spatial streams
N_{ESS}	Number of extension spatial streams
N_{TX}	Number of transmit chains.
N_{ES}	Number of FEC encoders
N_{LTF}	Number of HT long training fields

The transmitted signal is described in a complex base-band signal notation. The actual transmitted signal is related to the complex signal by the following relation:

$$r_{RF}(t) = \mathrm{Re}\left\{ r(t) \exp\left(j2\pi f_c t \right) \right\} \qquad (1)$$

where

$\mathrm{Re}\{\cdot\}$ represents the real part of a complex variable;

f_c denotes the center frequency of the carrier.

The transmitted baseband signal consists of several fields. The timing boundaries for the various fields are shown in Figure 3.

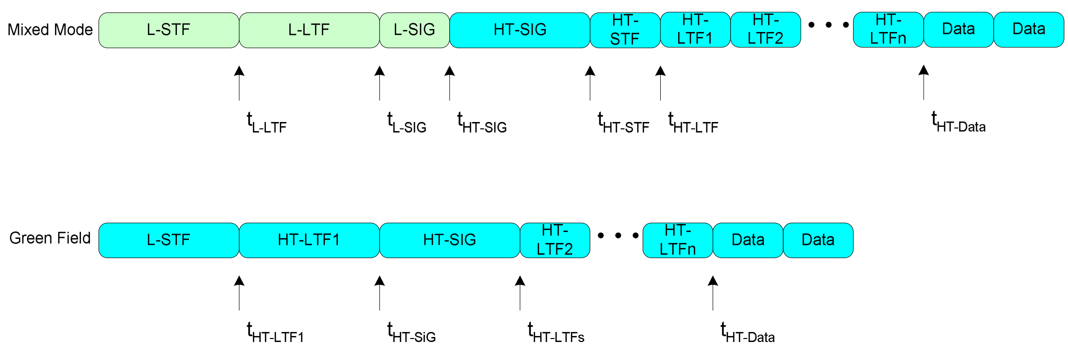

Figure 3: Timing boundaries for PPDU Fields

The time offsets t_{Field} determines the starting time of the corresponding field.

In Mixed mode, the signal transmitted on transmit chain i_{TX} is

$$\begin{aligned} r_{PPDU}^{(i_{TX})}(t) = \; & r_{L-STF}^{(i_{TX})}(t) + r_{L-LTF}^{(i_{TX})}\left(t - t_{L-LTF}\right) \\ & + r_{L-SIG}^{(i_{TX})}\left(t - t_{L-SIG}\right) \\ & + r_{HT-SIG}^{(i_{TX})}\left(t - t_{HT-SIG}\right) \\ & + r_{HT-STF}^{(i_{TX})}\left(t - t_{HT-STF}\right) \\ & + \sum_{i_{LTF}=1}^{N_{LTF}} r_{HT-LTF}^{(i_{TX},i_{LTF})}\left(t - t_{HT-LTF} - \left(i_{LTF} - 1\right)T_{HT-LTFs}\right) \\ & + r_{HT\ DATA}^{(i_{TX})}\left(t - t_{HT\ DATA}\right) \end{aligned} \quad (2)$$

where

$$t_{L-LTF} = T_{L-STF}, \quad (3)$$

$$t_{L-SIG} = t_{L-LTF} + T_{L-LTF}, \quad (4)$$

$$t_{HT-SIG} = t_{L-SIG} + T_{L-SIG}, \quad (5)$$

$$t_{HT-STF} = t_{HT-SIG} + T_{HT-SIG},$$

$$t_{HT-LTF} = t_{HT-STF} + T_{HT-STF} \quad (6)$$

and

$$t_{HT-Data} = t_{HT-LTF} + N_{LTF} \cdot T_{HT-LTFs}. \quad (7)$$

In the case of Green Field mode the transmitted signal on transmit chain i_{TX} is:

$$\begin{aligned} r_{PPDU}^{(i_{TX})}(t) = \; & r_{L-STF}^{(i_{TX})}(t) + r_{HT-LTF1}^{(i_{TX})}\left(t - t_{HT-LTF1}\right) \\ & + r_{HT-SIG}^{(i_{TX})}\left(t - t_{HT-SIG}\right) \\ & + \sum_{i_{LTF}=2}^{N_{LTF}} r_{HT-LTF}^{(i_{TX},i_{LTF})}\left(t - t_{HT-LTFs} - \left(i_{LTF} - 2\right)T_{HT-LTFs}\right) \\ & + r_{HT\ DATA}^{(i_{TX})}\left(t - t_{HT\ DATA}\right) \end{aligned}$$

where

$$t_{HT-LTF1} = T_{L-STF} , \tag{8}$$

$$t_{HT-SIG} = t_{HT-LTF1} + T_{HT-LTF1} , \tag{9}$$

$$t_{HT-LTFs} = t_{HT-SIG} + T_{HT-SIG} \tag{10}$$

and

$$t_{HT-Data} = t_{HT-LTFs} + (N_{LTF} - 1) \cdot T_{HT-LTFs} , \tag{11}$$

Each baseband waveform $r_{Field}^{(i)}(t)$ is defined via the discrete Fourier transform as

$$r_{Field}^{(i)}(t) = \frac{1}{\sqrt{N_{Field}^{Tone}}} w_{T_{Field}}(t) \sum_{k} X_k^{(i)} \exp(j 2\pi k \Delta_F t) \tag{12}$$

This general representation holds for all fields. The definition of $w_{T_{Field}}(t)$ is given in section 17.3.2.4 of [1]. The frequency domain symbols $X_k^{(i_{TX})}$ define the field, as shall be specified in the following subsections.

The $1/\sqrt{N_{Field}^{Tone}}$ scale factor in (12) ensures that the total power of the time domain signal as summed over all transmit chains is either 1 or lower than 1 when required. The following table summarizes the various values of N_{Field}^{Tone} :

Field	N_{Field}^{Tone}	
	20 MHz	40 MHz
L-STF	12	24
L-LTF	52	104
L-SIG	52	104
HT-SIG	52/56*	104/114*
HT-STF	12	24
HT-LTF	56	114
HT-Data	56	114
HT-Data- 40 MHz Dup. Format	-	104

Field	N_{Field}^{Tone}	
	20 MHz	40 MHz
Notes: *56 and 114 are for green field mode, 52 and 104 are for mixed mode. The numbers in the table refer only to the value of N_{Field}^{Tone} as it appears in equation (12) and in subsequent specification of various fields. It may be different from the actual number of tones being transmitted.		

Table 3 - number of tones in each field

3.4.1 Transmission in the upper/lower 20MHz of a 40MHz channel

When transmitting in the upper/lower 20MHz portion of a 40MHz channel, the mathematical definition of transmission shall follow that of a 20MHz channel with f_c in equation (1) replaced by $f_c \pm 10MHz$.

3.5 Legacy Field Transmission

The following section describes the transmission of the legacy training field and the legacy signal field as part of a mixed mode packet.

3.5.1 Cyclic shift definition for the legacy fields.

In the rest of the document cyclic shift is used to prevent unintentional beamforming when the same signal or similar signals are transmitted through different spatial streams. A cyclic shift of length τ on a signal $s(t)$ on interval $0 \le t \le T$ is defined by replacing $s(t)$ with $s(t-\tau)$ when $\tau < t \le T$ [3] and with $s(t-\tau+T)$ when $0 \le t \le \tau$. Cylic shift is applied to each OFDM symbol in the packet separately. The following table specifies the values for the cyclic shift that is applied in the legacy short training field (in a MM packet), the legacy long training field, and legacy signal field. It also applies to the HT signal field in a mixed mode packet.

$T_{CS}^{i_{TX}}$ values for the legacy portion of the packet				
Number of Tx	cyclic shift for	cyclic shift for	cyclic shift for	cyclic shift for

[3] $$s_{CS}(t) = \begin{cases} s(t-\tau) & \tau < t \le T \\ s(t-\tau+T) & 0 \le t \le \tau \end{cases}$$

Chains	Tx chain 1	Tx chain 2	Tx chain 3	Tx chain 4
1	0ns	-	-	-
2	0ns	-200ns	-	-
3	0ns	-100ns	-200ns	-
4	0ns	-50ns	-100ns	-150ns

Table 4 - Cyclic shift for legacy portion of the packet

3.5.2 Legacy Short Training Field

The L-STF is identical to the 802.11a short training symbol. The legacy short training OFDM symbol in the 20MHz mode is

$$\begin{aligned} S_{-26,26} = \sqrt{1/2}\,\{&0,0,1+j,0,0,0,-1-j,0,0,0,1+j,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,\\ &0,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0\}. \end{aligned} \quad (13)$$

The normalization factor $\sqrt{1/2}$ is the QPSK normalization.

The legacy short training OFDM symbol in 40MHz mode is based on:

$$\begin{aligned} S_{-58,58} = \sqrt{1/2}\,\{&0,0,1+j,0,0,0,-1-j,0,0,0,1+j,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,\\ &0,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,0,0,0,\\ &0,0,0,0,0,0,0,0,0,0,1+j,0,0,0,-1-j,0,0,0,1+j,0,0,0,-1-j,0,0,0,-1-j,0,0,0,+1+j,\\ &0,0,0,0,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,+1+j,0,0\} \end{aligned} \quad (14)$$

The tones in the upper sub-channel (sub-carriers 6-58) are phase rotated by +90º. The 90º rotation helps keep the PAPR of the STF in 40MHz comparable to that in 20MHz.

In mixed mode the L-STF on the $i_{TX}\,'th$ transmit chain is

$$\begin{aligned} r_{L-STF}^{(i_{TX})}(t) &= \frac{1}{\sqrt{N_{TX}\cdot N_{L-STF}^{Tone}}}\, w_{T_{L-STF}}(t)\cdot\\ &\left(\sum_{k=-N_{SR}}^{0} S_k \exp\left(j2\pi k\Delta_F\left(t-T_{CS}^{i_{TX}}\right)\right)+\right.\\ &\left.\Upsilon\sum_{k=1}^{N_{SR}} S_k \exp\left(j2\pi k\Delta_F\left(t-T_{CS}^{i_{TX}}\right)\right)\right) \end{aligned} \quad (15)$$

In green field the L-STF on the i_{TX} 'th transmit chain is

$$
\begin{aligned}
r_{L-STF}^{(i_{TX})}(t) \;=\; & \frac{1}{\sqrt{N_{STS}\cdot N_{L-STF}^{Tone}}}\, w_{T_{L-STF}}(t)\cdot \\
& \left(\sum_{k=-N_{SR}}^{0} \sum_{i_{STS}=1}^{N_{STS}} [Q_k]_{i_{TX} i_{STS}} [P_{HTLTF}]_{i_{STS},1} S_k \exp\left(j2\pi k\Delta_F \left(t - T_{CS}^{i_{STS}}\right)\right) + \right. \\
& \left. \Upsilon \sum_{k=1}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} [Q_k]_{i_{TX} i_{STS}} [P_{HTLTF}]_{i_{STS},1} S_k \exp\left(j2\pi k\Delta_F \left(t - T_{CS}^{i_{STS}}\right)\right) \right)
\end{aligned} \tag{16}
$$

In the case of Mixed Mode operation $T_{CS}^{i_{TX}}$ takes values from Table 4. In the case of Green Field operation $T_{CS}^{i_{STS}}$ takes values from Table 6. The value of Υ is 1 for 20MHz and j in 40MHz. Q_k is defined in section 4.7.1. The L-STF has a period of 0.8 μs. The entire short training field includes ten such periods, with a total duration of T_{L-STF} = 8 μs.

3.5.3 Legacy Long Training Field

The legacy long training OFDM symbol is identical to the 802.11a long training OFDM symbol. In the 20MHz mode, the long training OFDM symbol is given by

$$
\begin{aligned}
L_{-26,26} = \; & \{1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0, \\
& 1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,1\}
\end{aligned} . \tag{17}
$$

The legacy long training OFDM signal in the 40MHz mode is based on:

$$
\begin{aligned}
L_{-58,58} \; = \; & \{1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0, \\
& 1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,1,0,0,0,0,0 \\
& 0,0,0,0,0,0,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0, \\
& 1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,1\}
\end{aligned} \tag{18}
$$

The tones in the upper sub-channel (sub-carriers 6-58) are phase rotated by +90º (see equation (19)).

The sub-carriers at ±32 in 40MHz, which are the DC sub-carriers for the legacy 20MHz transmission, are both nulled in the L-LTF. Such an arrangement allows proper synchronization of the 20MHz legacy device.

The L-LTF waveform is

$$r_{L-LTF}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{TX} \cdot N_{L-LTF}^{Tone}}} w_{T_{L-LTF}}(t) \cdot \left(\sum_{k=-N_{SR}}^{0} L_k \exp\left(j 2\pi k \Delta_F \left(t - T_{GI2} - T_{CS}^{i_{TX}} \right) \right) + \Upsilon \sum_{k=1}^{N_{SR}} L_k \exp\left(j 2\pi k \Delta_F \left(t - T_{GI2} - T_{CS}^{i_{TX}} \right) \right) \right) \quad (19)$$

where T_{G12} = 1.6 μ sec. The value of Υ is 1 for 20MHz and j in 40MHz.

3.5.4 The Legacy Signal Field

The signal field is used to transfer rate and length information. It has different meaning when used in legacy transmission and when used in a non legacy transmission. When transmitted in a legacy 20MHz mode, it is transmitted using the same method and meaning as specified in section 17.3.4 of the IEEE 802.11a standard [1].

Rate (4 bits)					Length (12 bits)												Tail 6bits					
				R												P						
R1	R2	R3	R4														"0"	"0"	"0"	"0"	"0"	"0"
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Figure 4 - The signal field

When the transmission is not a legacy transmission the fields in the signal field have different meaning. The bits in the rate field are [1,1,0,1] – corresponding to a rate of 6Mbps in legacy representation. The value in the length field is given through the TX vector. This value is used to spoof legacy devices to defer transmission for a period of corresponding to the length of the rest of the packet. When L-SIG TXOP Protection is not used (see "L-SIG TXOP Protection" section of the MAC spec), the value to be transmitted is $l = 3\left(\lceil N_{\text{data}} \rceil + N_{LTF} + 3 \right) - 3$ where *N_{data}* is the number of **4usec** symbols in the data part of the packet. While using short GI *N_{data}* is equal to the actual number of symbols in the data part of the packet multiplied by $\frac{9}{10}$. N_{LTF} is the number of HT training symbols. The symbol $\lceil x \rceil$ denotes the lowest integer greater or equal to x.

When L-SIG TXOP Protection is used the value of l is defined in the "L-SIG TXOP Protection" section of the MAC spec.

If the Length field of the HT-SIG (see Table 7) is set to zero N_{data} shall be set zero in the formula for calculating l.

The length field is transmitted LSB first.

The reserved bit shall be set to 0.

The parity field has the even parity of bits 0-16.

The signal field shall be encoded, interleaved and mapped, and have pilots inserted following the steps described in sections 17.3.5.5, 17.3.5.6, 17.3.5.8 of the IEEE802.11a standard [1]. The stream of 48, complex numbers generated by these steps is $d_k, \quad k = 0 \dots 47$. The conversion of these into a time domain signal is described in the following table

Table 5 - generation of the signal field

Modulation Method	Conversion to Time Domain signal
20MHz transmission on several transmit chains – *iTX*'th tx chain	$r_{L-SIG}^{(i_{TX})}(t) = w_{T_{SYM}}(t) \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tone}}} \cdot \left(\sum_{k=0}^{47} d_k \exp\left(j2\pi M(k) \Delta_F \left(t - T_{GI} - T_{CS}^{i_{TX}} \right) \right) + p_0 \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi k \Delta_F \left(t - T_{GI} - T_{CS}^{i_{TX}} \right) \right)$
40MHz transmission on several transmit chains – *iTX*'th Tx chain.	$r_{L-SIG}^{(i_{TX})}(t) = w_{T_{SYM}}(t) \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tones}}} \cdot \left(\sum_{k=0}^{47} d_k \exp\left(j2\pi \left(M(k) - 32 \right) \Delta_F \left(t - T_{GI} - T_{CS}^{i_{TX}} \right) \right) + j \sum_{k=0}^{47} d_k \exp\left(j2\pi \left(M(k) + 32 \right) \Delta_F \left(t - T_{GI} - T_{CS}^{i_{TX}} \right) \right) + p_0 \sum_{k=-N_{SR}}^{N_{SR}} P_k \left(\exp\left(j2\pi (k-32) \Delta_F \left(t - T_{GI} - T_{CS}^{i_{TX}} \right) \right) + j \exp\left(j2\pi (k+32) \Delta_F \left(t - T_{GI} - T_{CS}^{i_{TX}} \right) \right) \right) \right)$

$M(k), P_k$ are defined in section 17.3.5.9 of the 802.11a standard [1].

p_0 is the first pilot value in the sequence defined in section 17.3.5.9 of the 802.11a standard [1].

3.6 The High Throughput Preamble

The high throughput preamble consists of the HT signal field, the HT short training field and the HT long training fields.

3.6.1 Cyclic shift for the High Throughput preamble

Throughout the high throughput preamble, cyclic shift is applied to prevent beamforming when similar signals are transmitted in different spatial streams. The same cyclic shift is applied to these streams during the transmission of the data portion of the packet. The values of the cyclic shift to be used during the HT preamble and the data portion of the packet (except the HT-SIG in a MM packet), are specified in Table 6:

$T_{CS}^{i_{STS}}$ values for HT portion of the packet				
Number of spatial streams	Cyclic shift for Spatial stream 1	Cyclic shift for spatial stream 2	Cyclic shift for spatial stream 3	Cyclic shift for spatial stream 4
1	0ns	-	-	-
2	0ns	-400ns	-	-
3	0ns	-400ns	-200ns	-
4	0ns	-400ns	-200ns	-600ns

Table 6 – Cyclic shift values of HT portion of the packet

3.6.2 The High Throughput Signal Field

The high throughput signal field is used to carry information required to interpret the HT packet formats. The high throughput signal field (HT_SIG) includes the following fields:

Table 7 - Fields of High Throughput Signal Field

Field Name	Num of Bits	Explanation and coding
Modulation and Coding Scheme	7	Index into The MCS table, LSB first
BW 20/40	1	0 if 20MHz or 40 MHz upper/lower; 1 if 40MHz
Length	16	The number of bytes of data in the PSDU – 0*-65535

Field Name	Num of Bits	Explanation and coding
Smoothing	1	1 – channel estimate smoothing is allowed 0 – Only per-carrier independent (unsmoothed) channel estimate is recommanded.
Not Sounding	1	Indicates that the packet is a sounding packet. 0 –Sounding Packet 1 – Not a sounding packet
reserved one	1	set to 1
Aggregation	1	Set to 1 to indicate that the PPDU in the data portion of the packet contains an A-MPDU. Set to 0 otherwise
STBC	2	Indicates the difference between either the number of space time streams $\mathbf{N_{STS}}$ and the number of spatial streams $\mathbf{N_{SS}}$ indicated by the MCS 00 – No STBC ($\mathbf{N_{STS}=N_{SS}}$)
Advanced Coding	1	1 - LDPCC 0 - BCC.
Short GI	1	Set to 1 to Indicate that the short GI is used after the HT training. Set to 0 otherwise
Number of extension HT-LTF	2	Number of extension spatial stream(s) N_{ESS} . –b'00 – no extension spatial stream, b'01 – 1 additional spatial stream, b'10 2 additional spatial streams, b'11 3 additional spatial streams.
CRC	8	CRC of bits 0-23 in HT-SIG1 and bits 0-9 in HT-SIG2 – see section 3.6.3. The first bit to be transmitted is bit C7 as explained in aforementioned section.
Tail Bits	6	Used to terminate the trellis of the convolution coder. Set to 0.
Integer fields are transmitted least significant bit first. A value of 0 in the Length Field indicates a PPDU which does not include a data field. The packets ends after the last HT-LTF or the HT-SIG.		

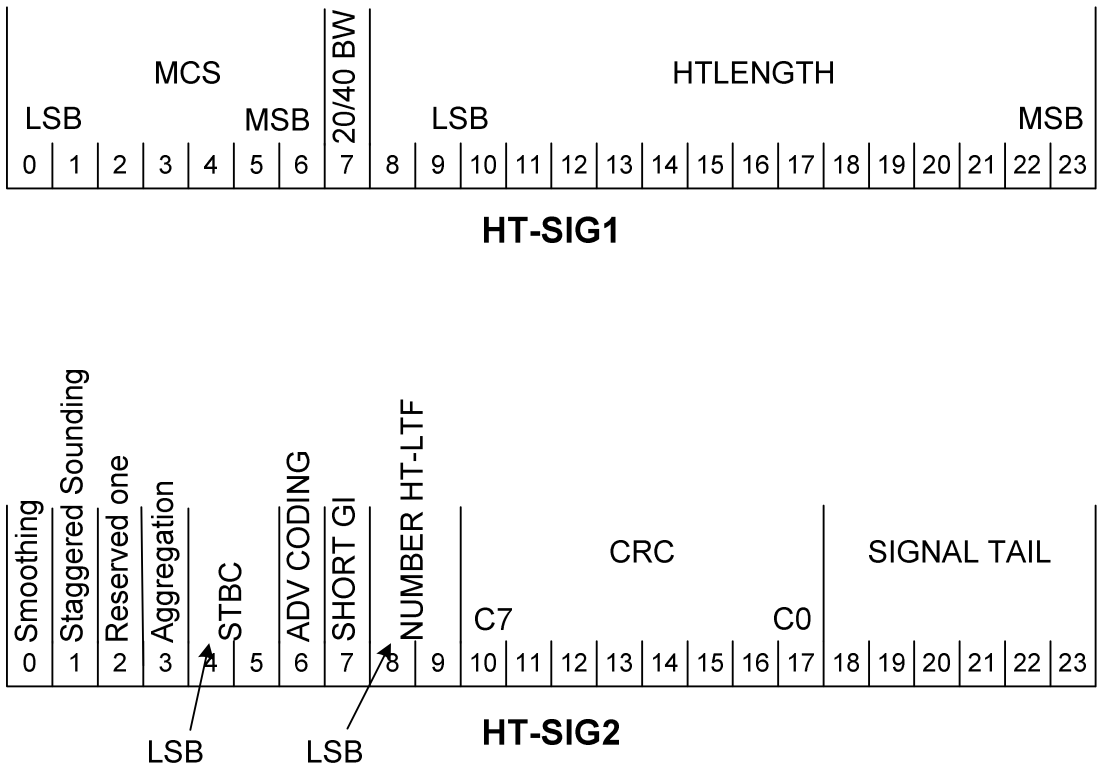

Figure 5 - HT SIG breakdown to HT-SIG1 and HT-SIG2

The HT-SIG is composed of two parts $HTSIG_1$ and $HTSIG_2$ each containing 24 bits. All the fields in the HT-SIG are transmitted LSB first.

The HT-SIG parts are encoded, interleaved, mapped, and have pilots inserted following the steps described in sections 17.3.5.5, 17.3.5.6, 17.3.5.8 of the IEEE802.11a standard [1]. The stream of 96, complex numbers generated by these steps are divided into two groups of 48 complex numbers: $d_{k,n}, \quad k = 0 \ldots 47, n = 0,1$ see Figure 5. The conversion of these into the time domain signal is according to the next tables:

Table 8 - Modulation for the High Throughput Signal Field in a Mixed Mode Packet

Modulation Method	Conversion to Time Domain signal
20MHz transmission - i_{TX} 'th stream	$r_{HT-SIG}^{i_{TX}}(t)=\frac{1}{\sqrt{N_{TX}\cdot N^{Tones}}}\sum_{n=0}^{1}w_{T_{SYM}}(t-nT_{SYM})\cdot \left(j\sum_{k=0}^{47}d_{k,n}\exp\left(j2\pi M(k)\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{TX}}\right)\right)+p_{n+z}\sum_{k=-N_{SR}}^{N_{SR}}P_k\exp\left(j2\pi k\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{TX}}\right)\right)\right)$
40MHz Tx on several streams – i_{TX}'th stream	$r_{HT\_SIG}^{i_{TX}}(t)=\frac{1}{\sqrt{N_{TX}\cdot N^{Tones}}}\sum_{n=0}^{1}w_{T_{SYM}}(t-nT_{SYM})\cdot \left(j\sum_{k=0}^{47}d_{k,n}\exp\left(j2\pi\left(M(k)-32\right)\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{TX}}\right)\right)-\sum_{k=0}^{47}d_{k,n}\exp\left(j2\pi\left(M(k)+32\right)\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{TX}}\right)\right)+p_{n+z}\sum_{k=-N_{SR}}^{N_{SR}}P_k\exp\left(j2\pi(k-32)\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{TX}}\right)\right)+jp_{n+z}\sum_{k=-N_{SR}}^{N_{SR}}P_k\exp\left(j2\pi(k+32)\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{TX}}\right)\right)\right)$

Table 9 - Modulation for the High Throughput Signal Field in a Green Field Packet

Modulation Method	Conversion to Time Domain signal
20MHz transmission - i_{TX} 'th stream	$r_{HT-SIG}^{i_{TX}}(t)=\frac{1}{\sqrt{N_{STS}\cdot N^{Tones}}}\sum_{n=0}^{1}w_{T_{SYM}}(t-nT_{SYM})\cdot \left(j\sum_{k=0}^{47}\sum_{i_{STS}=1}^{N_{STS}}\left[Q_{M(k)}\right]_{i_{TX},i_{STS}}\left[P_{HTLTF}\right]_{i_{STS},1}d_{k,n}\exp\left(j2\pi M(k)\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{STS}}\right)\right)+p_{n+z}\sum_{k=-N_{SR}}^{N_{SR}}\sum_{i_{STS}=1}^{N_{STS}}\left[Q_k\right]_{i_{TX},i_{STS}}\left[P_{HTLTF}\right]_{i_{STS},1}P_k\exp\left(j2\pi k\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{STS}}\right)\right)\right)$

40MHz Tx on several streams – i_{TX}'th stream	$\begin{aligned} r_{HT-SIG}^{i_{TX}}(t) = & \frac{1}{\sqrt{N_{STS}\cdot N^{Tones}}}\sum_{n=0}^{1} w_{T_{SYM}}\left(t-nT_{SYM}\right)\cdot \\ & \Bigg(j\sum_{k=0}^{47}\sum_{i_{STS}=1}^{N_{STS}}\left[Q_{M(k)-32}\right]_{i_{TX},i_{STS}}\left[P_{HTLTF}\right]_{i_{STS},1} d_{k,n}\exp\left(j2\pi\left(M(k)-32\right)\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{STS}}\right)\right) \\ & -\sum_{k=0}^{47}\sum_{i_{STS}=1}^{N_{STS}}\left[Q_{M(k)+32}\right]_{i_{TX},i_{STS}}\left[P_{HTLTF}\right]_{i_{STS},1} d_{k,n}\exp\left(j2\pi\left(M(k)+32\right)\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{STS}}\right)\right) \\ & +p_{n+z}\sum_{k=-N_{SR}}^{N_{SR}}\sum_{i_{STS}=1}^{N_{STS}}\left[Q_{k-32}\right]_{i_{TX},i_{STS}}\left[P_{HTLTF}\right]_{i_{STS},1} P_k\exp\left(j2\pi\left(k-32\right)\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{STS}}\right)\right) \\ & +jp_{n+z}\sum_{k=-N_{SR}}^{N_{SR}}\sum_{i_{STS}=1}^{N_{STS}}\left[Q_{k+32}\right]_{i_{TX},i_{STS}}\left[P_{HTLTF}\right]_{i_{STS},1} P_k\exp\left(j2\pi\left(k+32\right)\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{STS}}\right)\right)\Bigg) \end{aligned}$

$M(k), p_n, P_k$ are defined in section 17.3.5.9 of the 802.11a standard. [1]

N^{Tones} is equal to the number of tones in the HT-SIG.

The value of *z* is zero in a GF packet and 1 in a mixed mode packets.

Values for $T_{CS}^{i_{TX}}$ are taken from Table 4 in the case of MM. In the case of a GF packet the values of $T_{CS}^{i_{STS}}$ are taken from Table 6.

P_{HTLTF} is defined is section 3.6.5.

Q_k is defined in section 4.7.1.

The value of N_{SR} used in these equations, both for 20MHz and 40MHz, is 26 tones.

Note: this definition results in a BPSK modulation in which the constellation of the data tones is rotated by 90º relative to the legacy signal field.

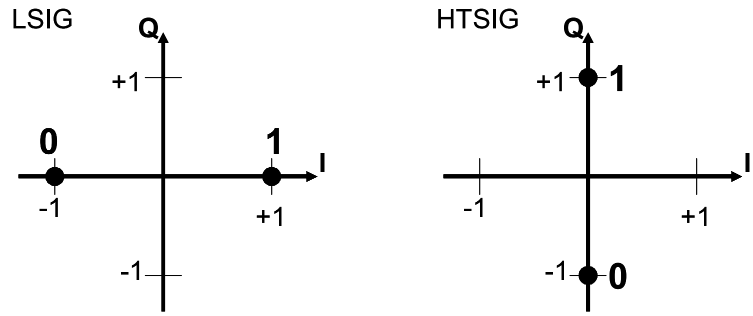

Figure 6 - constellation for the legacy signal field and the HT signal field

3.6.3 CRC calculation

The CRC protects bits 0-33 of the HT-SIG. The value of the CRC field is the ones complement of

$crc(D)=M(D)D^8$ modulo $G(D)$

where the shift register is initialized to all ones and

$M(D)=m_0D^{k-1}+m_1D^{k-2}+\ldots+m_{k-2}D+m_{k-1}$ is the HT-SIG represented as polynomial where m_0 is bit 0 of HT-SIG1 and m_{33} is bit 9 of HT-SIG2,

$G(D)=D^8+D^2+D+1$ is the CRC generating polynomial, and

$crc(D)=c_0D^7+c_1D^6+\ldots+c_6D+c_7$

The CRC field is transmitted with c_7 first

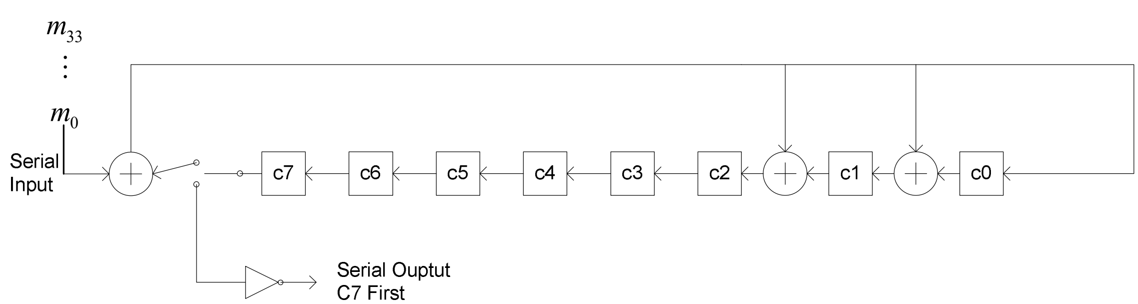

Figure 7 - HT-SIG CRC calculation

Figure 7 shows the operation of the CRC. First the shift register is reset to all ones. The bits are then passed through the XOR at the input. When the last bit have entered, the bits are outputted, C7 first, through an inverter.

3.6.4 The HT STF training symbol

The purpose of the HT STF training field is to improve AGC training in a multi-transmit and multi-receive system. The duration of the HT-STF is 4μsec; the frequency sequence used to construct the HT-STF in 20MHz transmission is identical to legacy STF; in 40MHz transmission the HT-STF is constructed from the 20MHz version by frequency shifting and duplicating, and rotating the upper sub-carriers by 90°. The frequency sequences are:

For 20MHz:

$$\begin{aligned}HTS_{-28,28} = \sqrt{1/2}\,\{&0,0,0,0,1+j,0,0,0,-1-j,0,0,0,1+j,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,\\&0,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,0\}\end{aligned}$$

The HT-STF in 40MHz is based on:

$$\begin{aligned}HTS_{-58,58} = \sqrt{1/2}\,\{&0,0,1+j,0,0,0,-1-j,0,0,0,1+j,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,\\&0,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,0,0,0,\\&0,0,0,0,0,0,0,0,0,0,0,1+j,0,0,0,-1-j,0,0,0,1+j,0,0,0,-1-j,0,0,0,-1-j,0,0,0,+1+j,\\&0,0,0,0,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,+1+j,0,0\}\end{aligned}$$

The time domain representation of the transmission in the i_{TX} *'th* transmit chain is:

$$\begin{aligned}r_{HT-STF}^{i_{TX}}\left(t\right) = w_{T_{HT-STF}}(t)\frac{1}{\sqrt{N_{STS}N_{HT-STF}^{Tones}}}&\\\Bigg(\sum_{k=-N_{SR}}^{0}\sum_{i_{STS}=1}^{N_{STS}}\left[Q_k\right]_{i_{TX},i_{STS}}&HTS\left(k\right)\exp\left(j2\pi k\Delta_F\left(t-T_{CS}^{i_{STS}}\right)\right)\\+\Upsilon\sum_{k=1}^{N_{SR}}\sum_{i_{STS}=1}^{N_{STS}}\left[Q_k\right]_{i_{TX},i_{STS}}&HTS\left(k\right)\exp\left(j2\pi k\Delta_F\left(t-T_{CS}^{i_{STS}}\right)\right)\Bigg)\end{aligned}$$

The value of Υ is 1 for 20MHz and j in 40MHz. The values for $T_{CS}^{i_{STS}}$ are given in Table 6. Q_k is defined in section 4.7.1.

3.6.5 The HT-LTF long training Field

The HT long training field provides means for the receiver to estimate the channel between each spatial mapper input (or spatial stream transmitter if no STBC is applied) and receive chain; the number of training symbols N_{LTF} is equal or greater than the number of space time streams (with an exception in the case of 3 space time streams). The number of training symbols is greater than the number of space time streams if the transmitter is providing training for more spatial streams (spatial mapper inputs) than the number used for the transmission of the PSDU. This happens in a sounding PPDU.

The HT long training field portion has one or two parts. The first part consists of from one to four HT long training fields (HT-LTFs) that are necessary for demodulation of the HT-Data portion of the PPDU. These HT-LTFs are referred to as Data HT-LTFs. The optional second part consists of from zero to four HT-LTFs that may be used to probe extra spatial dimensions of the MIMO channel that are not utilized by the HT-Data portion of the PPDU. These HT-LTFs are referred to as Extension HT-LTFs. If a receiver has not advertised its ability to receive Extension HT-LTFs, it may discard a frame including Extension HT-LTFs as an unknown frame type. The number of Data HT-LTFs is denoted N_{DLTF}. The number of extension HT-LTFs is denoted N_{ELTF}. The total number of HT-LTFs is

$$N_{LTF} = N_{DLTF} + N_{ELTF}.$$

N_{LTF} shall not exceed 5.

Table 10 shows the determination of the number of space time streams from the MCS and STBC HT-SIG fields. Table 11 shows the number of data and extension LTFs as a function of either number of space time streams N_{STS} or number of extension spatial streams N_{ESS}.

Number of Spatial Streams (from MCS) N_{SS}	STBC field	Number of space time streams N_{STS}
1	0	1
1	1	2
2	0	2
2	1	3
2	2	4
3	0	3
3	1	4
4	0	4

Table 10 - Determining the number of space time streams

N_{STS} or N_{ESS}	N_{DLTF} or N_{ELTFs}
1	1
2	2
3	4
4	4

Table 11 - Number of LTFs required to probe spatial streams

When Extension HT-LTFs are used, the result is referred to as a segmented HT-LTF. When a PPDU includes a segmented HT-LTF, or if the number of LTF is greater than the number of space time streams it is optional for a receiver to decode the data portion of the PPDU.

The following HT-LTF sequence is transmitted in the case of 20MHz operation:

$$HTLTF_{-28:28} = \begin{bmatrix} 1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0, \\ 1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,1,-1,-1 \end{bmatrix}$$

Note that this sequence is an extension of the legacy LTF where the 4 extra sub-carriers are filled with +1 for negative frequencies and -1 for positive frequencies

In a 40MHz transmission the sequence to be transmitted is based on:

$$
\begin{aligned}
HTLTF_{-58,58} = \{&1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,\\
&1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,1,-1,-1,-1,1,0\\
&0,0,-1,1,1,-1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,\\
&1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,1\}
\end{aligned}
$$

Note that this sequence is also constructed by extending the legacy LTF in the following way: first of all, the legacy LTF is shifted and duplicated as explained in 3.5.3 for the duplicate legacy mode; then the missing sub-carriers are filled: sub-carriers [-32 -5 -4 -3 -2 2 3 4 5 32] are filled with the values [1 -1 -1 -1 1 -1 1 1 -1 1] respectively.

This sequence is used even if the HT-duplicate mode (MCS 32) is used in the data.

The duration of each long training field HT-LTF is 4 μsec and it consists of a single occurance of the sequence plus a GI insertion. An exception is the first HT-LTF in a GF packet which is 8μsec long consisting of two instances of the sequence plus a double GI insertion. In case of multiple space time streams cyclic shift is invoked as specified in Table 6

The generation of Data HT-LTFs is shown in Figure 8. The generation of Extension HT-LTFs is shown in Figure 9. In these figures, and in the following text, the following notational conventions are used:

- $[Q]_{m,n}$ indicates the element of in row m and column n of matrix Q
- $[Q]_N$ indicates a matrix consisting of the first N columns of matrix Q
- $[Q]_{M:N}$ indicates a matrix consisting of columns M through N of matrix Q

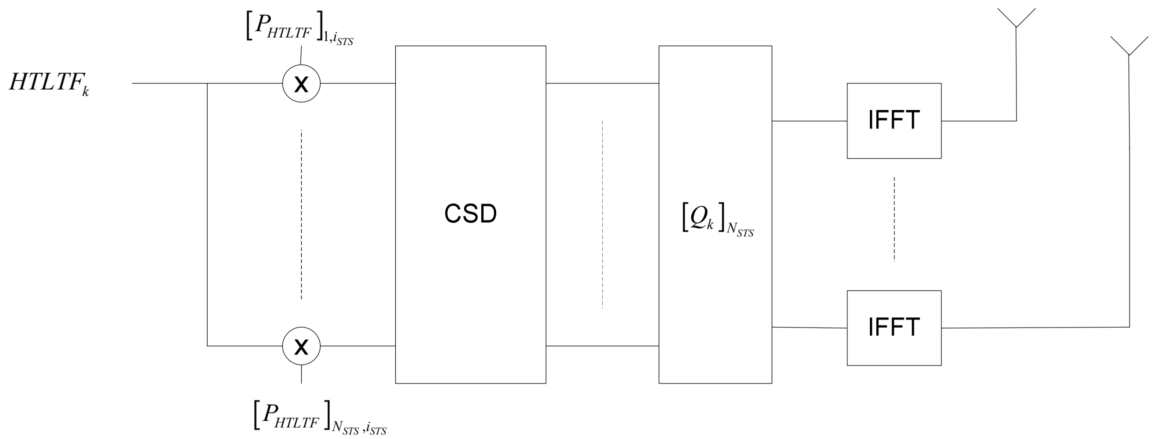

Figure 8 - Generation of data HT-LTFs

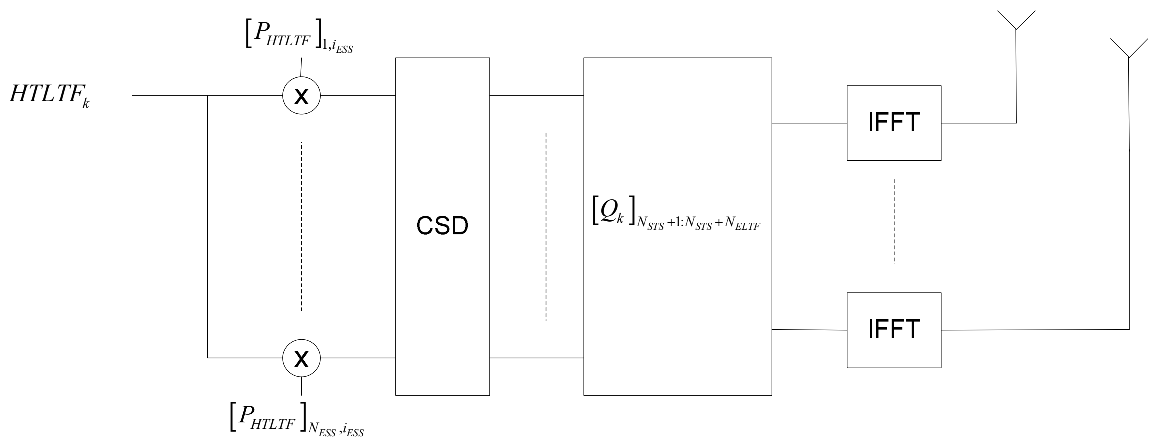

Figure 9 - Generation of the extension HT-LTFs

The mapping between space time streams and transmit chains is defined by the columns of an antenna map matrix Q_k for subcarrier k. The first N_{STS} columns define the space time streams used for data transmission, and the next N_{ESS} columns (up to $N_{TX} - N_{STS}$ columns) define the extension spatial streams. Thus, for the purpose of defining HT-LTFs, Q_k is an $N_{TX} \times N_{TX}$ dimension matrix. Columns $1 \cdots N_{STS}$ of Q_k are excited by the Data HT-LTFs and columns $N_{STS} + 1 \cdots N_{STS} + N_{ESS}$ are excited by the Extension HT-LTFs, where $N_{STS} + N_{ESS} \le N_{TX}$ is the total number of spatial streams being probed by the HT-LTFs. Q_k may be an identity matrix, in the case of direct-mapped MIMO. Q_k shall not be an indentity matrix when extension HT-LTFs are present ($N_{ESS} > 0$). Other limitations on Q_k are specified in sub clause 4.7.1

The time domain representation of the waveform transmitted in the i^{th} transmit chain during the n^{th} data HT-LTF ($1 \le n \le N_{DLTF}$) is:

$$r_{HT-LTF}^{n,i_{TX}}(t) = w_{T_{HT-LTFs}}(t)\sqrt{\frac{1}{N_{STS} \cdot N_{HT-LTF}^{Tone}}} \cdot$$

$$\left(\sum_{k=-N_{SR}}^{0} \sum_{i_{STS}=1}^{N_{STS}} [Q_k]_{i_{TX},i_{STS}} P_{HTLTF}(i_{STS},n) HTLTF(k) \exp\left(j2\pi k\Delta_F \left(t - \alpha T_{GI} - T_{CS}^{i_{STS}} \right) \right) + \Upsilon \sum_{k=1}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} [Q_k]_{i_{TX},i_{STS}} P_{HTLTF}(i_{STS},n) HTLTF(k) \exp\left(j2\pi k\Delta_F \left(t - \alpha T_{GI} - T_{CS}^{i_{STS}} \right) \right) \right)$$

and it is

$$r_{HT-LTF}^{n,i_{TX}}(t) = w_{T_{HT-LTFs}}(t)\sqrt{\frac{1}{N_{HT-LTF}^{Tone} N_{ESS}}} \cdot$$

$$\left(\sum_{k=-N_{SR}}^{0} \sum_{i_{ESS}=1}^{N_{ESS}} [Q_k]_{i_{TX},N_{STS}+i_{ESS}} P_{HTLTF}(i_{ESS},n-N_{DLTF}) HTLTF(k) \exp\left(j2\pi k\Delta_F \left(t - T_{GI} - T_{CS}^{i_{ESS}} \right) \right) + \Upsilon \sum_{k=1}^{N_{SR}} \sum_{i_{ESS}=1}^{N_{ESS}} [Q_k]_{i_{TX},N_{STS}+i_{ESS}} P_{HTLTF}(i_{ESS},n-N_{DLTF}) HTLTF(k) \exp\left(j2\pi k\Delta_F \left(t - T_{GI} - T_{CS}^{i_{ESS}} \right) \right) \right)$$

for the extension HT-LTFs $\left(N_{DLTF} < n \le N_{LTF} \right)$.

The HT-LTF mapping matrix P_{HTLTF} is:

$$P_{HTLTF} = \begin{pmatrix} 1 & -1 & 1 & 1 \\ 1 & 1 & -1 & 1 \\ 1 & 1 & 1 & -1 \\ -1 & 1 & 1 & 1 \end{pmatrix}$$

Where Υ is 1 for 20MHz and j in 40MHz. The value of α is 1 for mixed mode and 2 for the first HT-LTF in green field mode. The values for $T_{CS}^{i_{STS}}$ are given in Table 6. Q_k is defined in section 4.7.1.

4 The Data Field

The data field includes the service field, the PSDU, the pad bits, and the tail bits.

The number of symbols in the data field when BCC encoding is used is computed using the formula:

$$N_{SYM} = m_{STBC} \left\lceil \frac{8 \cdot length + 16 + 6 \cdot N_{ES}}{m_{STBC} \cdot N_{DBPS}} \right\rceil$$

Where m_{STBC} is 2 if STBC is used and 1 otherwise (making sure that the number of symbols is even when STBC is used.) The number of "zero" pad bits is thus $N_{SYM} \cdot N_{DBPS} - length \cdot 8 - 16 - 6N_{ES}$. The number of symbols in the data field when LDPCC encoding is used is described in section 4.3.3.4.

4.1 The service field

The service field is used for scrambler initialization. The service field will be composed of 16bits, all set to zero before scrambling. In legacy and legacy duplicate transmission the service field will be the same as in section 17.3.5.1 of the 11a standard. In HT modes, the service field is composed of 16 zeros bits, scrambled by the scrambler, as defined in the next section.

4.2 Scrambler

The data field is scrambled by the scrambler defined in section 17.3.5.4 of the 802.11a standard [1].

4.3 Coding

The data are encoded using the convolutional encoder defined in section 17.3.5.5 of the 802.11a standard [1]. A single FEC encoder is used when the PHY rate is less than or equal 300Mbps or when LDPCC ECC is used; When BCC FEC encoder is used, two encoders will be used when the PHY rate is greater than 300Mbps. The operation of the BCC FEC is described in sections 4.3.1 and 4.3.2. The operation of the LDPCC ECC is described in sections 4.3.3.

4.3.1 Encoder Parsing operation

If two encoders are used, the data scrambled bits are divided between the encoders by sending alternating bits to different encoders. The i^{th} bit to the j^{th} encoder, denoted $x_i^{(j)}$, is:

$$x_i^{(j)} = b_{N_{ES} \cdot i + j} \quad ; \quad 0 \le j \le N_{ES} - 1$$

Following the parsing operation, 6 scrambled "zero" bits following the end of the message bits in each FEC input sequence are replaced by unscrambled "zero" bits, as described in 17.3.5.2 of the 802.11a standard [1].

The replaced bits are:

$$x_i^{(j)} \quad : \qquad 0 \le j \le N_{ES} - 1 \quad ; \quad \frac{length \cdot 8 + 16}{N_{ES}} \le i \le \frac{length \cdot 8 + 16}{N_{ES}} + 5$$

4.3.2 Coding and puncturing

The encoder parser output sequences $\{x_i^0\}$ and $\{x_i^1\}$ where applicable will each be encoded by a rate ½ convolutional encoder defined in section 17.3.5.5 of the 802.11a standard [1]. After encoding, the encoded data will be punctured by the method defined in section 17.3.5.6 of the 802.11a standard to achieve the rate selected by the modulation and coding scheme.

In the case that rate 5/6 coding is selected, the puncturing scheme is as follows:

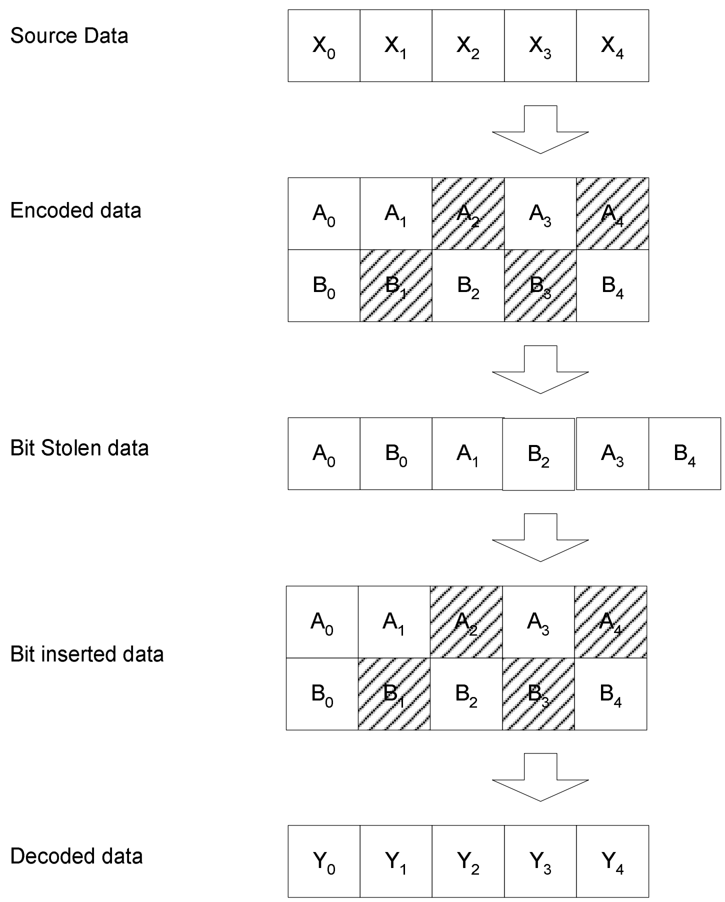

Figure 10 - Puncturing at rate 5/6

4.3.3 Low density parity check codes (optional ECC)

This subclause describes the LDPCCs to be optionally used in the HT system as high-performance ECC technique, instead of the convolutional code (4.3.2). The rate-dependent parameters in tables A1 through A15 in appendix A shall still apply.

4.3.3.1 LDPCC Code Rates and Codeword Block Lengths

The supported code rates, information block lengths, and codeword block lengths are described in Table 12.

Table 12 - LDPCC Parameters

Code rate (R)	LDPC information block length (bits)	LDPC codeword block length (bits)
1/2	972	1944
1/2	648	1296
1/2	324	648
2/3	1296	1944
2/3	864	1296
2/3	432	648
3/4	1458	1944
3/4	972	1296
3/4	486	648
5/6	1620	1944
5/6	1080	1296
5/6	540	648

4.3.3.2 LDPCC Encoder

For each of the three available codeword block lengths, the proposed LDPCC supports rate-1/2, rate-2/3, rate-3/4 and rate-5/6 encoding. The LDPCC encoder is systematic, i.e. it encodes an information block of size *k*, $\mathrm{I}=\left(i_0,i_1,\ldots i_{k-1}\right)$ into a codeword $\mathbf{c}$ of size n, $\mathbf{c}=(i_0, i_1, \ldots i_{k\text{-}1}, p_0, p_1, \ldots, p_{n\text{-}k\text{-}1})$, by adding $n-k$ parity bits obtained so that $\mathbf{H} \cdot \mathbf{c}^T = \mathbf{0}$, where $\mathbf{H}$ is an $(n-k)$ x n parity-check matrix. The selection of the codeword blocklength (n) is achieved via the LDPC PPDU encoding process described in subclause 1.1.

4.3.3.3 Parity check matrices

Each of the proposed parity-check matrices can be partitioned into square subblocks (submatrices) of size $Z \times Z$. These submatrices are either cyclic-permutations of the identity matrix or null submatrices.

The cyclic-permutation matrix P_i is obtained from the $Z \times Z$ identity matrix by cyclically shifting the columns to the right by *i* elements. The matrix P_0 is the $Z \times Z$ identity matrix. illustrates examples (for a subblock size of 8 x 8) of cyclic-permutation matrices P_i.

$$P_0 = \begin{bmatrix} 1&0&0&0&0&0&0&0 \\ 0&1&0&0&0&0&0&0 \\ 0&0&1&0&0&0&0&0 \\ 0&0&0&1&0&0&0&0 \\ 0&0&0&0&1&0&0&0 \\ 0&0&0&0&0&1&0&0 \\ 0&0&0&0&0&0&1&0 \\ 0&0&0&0&0&0&0&1 \end{bmatrix}, P_1 = \begin{bmatrix} 0&1&0&0&0&0&0&0 \\ 0&0&1&0&0&0&0&0 \\ 0&0&0&1&0&0&0&0 \\ 0&0&0&0&1&0&0&0 \\ 0&0&0&0&0&1&0&0 \\ 0&0&0&0&0&0&1&0 \\ 0&0&0&0&0&0&0&1 \\ 1&0&0&0&0&0&0&0 \end{bmatrix}, P_5 = \begin{bmatrix} 0&0&0&0&0&1&0&0 \\ 0&0&0&0&0&0&1&0 \\ 0&0&0&0&0&0&0&1 \\ 1&0&0&0&0&0&0&0 \\ 0&1&0&0&0&0&0&0 \\ 0&0&1&0&0&0&0&0 \\ 0&0&0&1&0&0&0&0 \\ 0&0&0&0&1&0&0&0 \end{bmatrix}$$

Figure 11 - Examples of cyclic-permutation matrices with Z=8. The matrix P_i is produced by cyclically shifting the columns of the identity matrix to the right by *i* places.

Table B.1 of Appendix B displays the "matrix prototypes" of parity-check matrices for all four code rates at block length n=648 bits. The integer i denotes the cyclic-permutation matrix P_i, as illustrated in . Vacant entries of the table denote null (zero) submatrices.

Table B.2 of Appendix B displays the matrix prototypes of parity-check matrices for blocklength n=1296 bits, in the same fashion.

Table B.3 of Appendix B displays the matrix prototypes of parity-check matrices for blocklength n=1944 bits, in the same fashion.

4.3.3.4 LDPCC PPDU encoding process

a) Compute the number of available bits in the minimum number of OFDM symbols in which the Data field of the packet may fit.

$$N_{pld} = \mathrm{LENGTH} \times 8 + 16 \quad (20)$$

$$N_{\mathrm{avbits}} = N_{\mathrm{CBPS}} \times (1 + U_{\mathrm{STBC}}) \times \mathrm{ceil}\left(\frac{N_{\mathrm{pld}}}{N_{\mathrm{CBPS}} \times \mathrm{R} \times (1 + U_{\mathrm{STBC}})} \right), \quad (21)$$

where U_{STBC} equals 1 when STBC is used and 0 otherwise.

b) Compute the integer number of LDPCC codewords to be transmitted, N_{CW} , and the length of the codewords to be used, L_{LDPC} from .

Table 13 - PPDU Encoding Parameters

N_{avbits} **Range (bits)**	**Number of LDPCC codewords N_{CW}**	**LDPC codeword length L_{LDPC} (bits)**
$N_{\mathrm{avbits}} \leq 648$	1	1296, if $N_{\mathrm{avbits}} \geq N_{\mathrm{pld}} + 912 \times (1-R)$ 648, otherwise
$648 < N_{\mathrm{avbits}} \leq 1296$	1	1944, if $N_{\mathrm{avbits}} \geq N_{\mathrm{pld}} + 1464 \times (1-R)$ 1296, otherwise
$1296 < N_{\mathrm{avbits}} \leq 1944$	1	1944
$1944 < N_{\mathrm{avbits}} \leq 2592$	2	1944, if $N_{\mathrm{avbits}} \geq N_{\mathrm{pld}} + 2916 \times (1-R)$ 1296, otherwise
$2592 < N_{\mathrm{avbits}}$	ceil(N_{pld} / (1944 × R))	1944

c) Compute the number of shortening bits to be padded to the N_{pld} data bits before encoding

$$N_{\text{shrt}} = (N_{\text{CW}} \times L_{\text{LDPC}} \times R) - N_{\text{pld}} \quad (19)$$

The shortening bits shall be equally distributed over all N_{CW} codewords with the first $\text{rem}(N_{\text{shrt}}, N_{\text{CW}})$ codewords being shortened one bit more than the remaining codewords. All shortened bits shall be set to 0 on the right of the data bits in the systematic portion of the codeword corresponding to their locations in the parity check matrix. These shortened bits shall be discarded after encoding.

d) Compute the number of bits to be punctured from the codewords after encoding

$$N_{\text{punc}} = \max(0, (N_{\text{CW}} \times L_{\text{LDPC}}) - N_{\text{avbits}} - N_{\text{shrt}}) \quad (20)$$

If $((N_{\text{punc}} > 0.1 \times N_{\text{CW}} \times L_{\text{LDPC}} \times (1-R)) \text{AND} (N_{\text{shrt}} < 1.2 \times N_{\text{punc}} \times R/(1-R)))$ is true OR if $(N_{\text{punc}} > 0.3 \times N_{\text{CW}} \times L_{\text{LDPC}} \times (1-R))$ is true, then increment N_{avbits} and recompute N_{punc} by the following:

$$N_{\text{avbits}} = N_{\text{avbits}} + N_{\text{CBPS}} \times (1 + U_{\text{STBC}}) \quad (21)$$

$$N_{\text{punc}} = \max(0, (N_{\text{CW}} \times L_{\text{LDPC}}) - N_{\text{avbits}} - N_{\text{shrt}}) \quad (22)$$

The punctured bits shall be equally distributed over all N_{CW} codewords with the first $\text{rem}(N_{\text{punc}}, N_{\text{CW}})$ codewords being punctured one bit more than the remaining codewords. These punctured bits shall be the right most parity portion of the codeword corresponding to their locations in the parity check matrix and shall be discarded after encoding. The number of OFDM symbols to be transmitted in the PPDU can be computed per:

$$N_{\text{SYM}} = N_{\text{avbits}} / N_{\text{CBPS}} \quad (23)$$

e) Compute the number of coded bits to be repeated

$$N_{\text{rep}} = \max(0, N_{\text{avbits}} - N_{\text{CW}} \times L_{\text{LDPC}} \times (1-R) - N_{\text{pld}}) \quad (24)$$

The number of coded bits to be repeated shall be equally distributed over all N_{CW} codewords with one more bit repeated for the first $\text{rem}(N_{\text{rep}}, N_{\text{CW}})$ codewords than for the remaining codewords. Note when puncturing occurs that coded bits are not repeated and vice versa. The coded bits to be repeated per codeword shall be copied (cyclically repeated when necessary) starting from the left most systematic data bits,continuing through the parity bits if necessary, all corresponding to their locations in the parity check matrix. These repeated bits are then concatenated to the codeword after the parity bits in their same order.

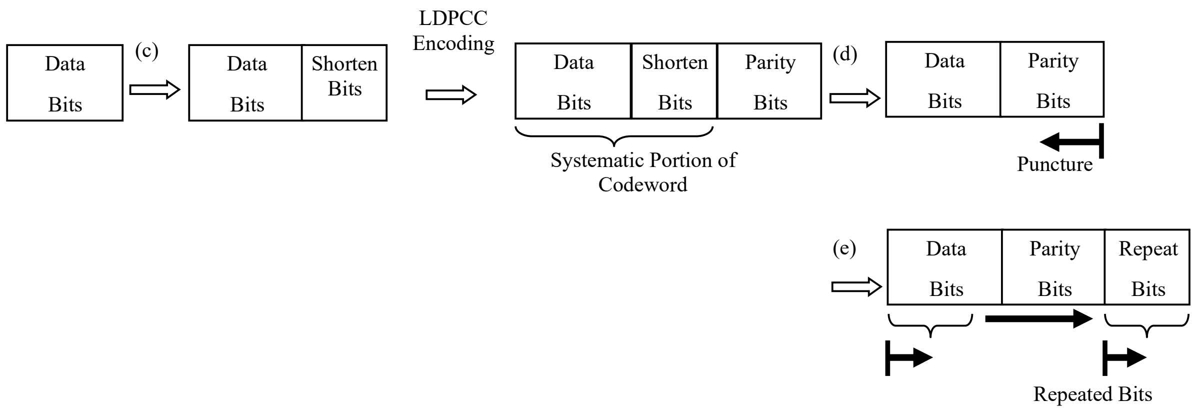

Figure 13 - LDPCC PPDU Encoding padding and puncturing of a single codeword

f) Encode the data per 4.3.3.2 and 4.3.3.3, using the number of shortening bits per codeword as computed in step c), and puncture or repeat bits per codeword as computed per step d) and e).

g) Aggregate all codewords and parse per 4.3.3.5.

4.3.3.5 LDPC Parser

The LDPC shortened and punctured codewords that result from the encoding process shall be outputted in sequential fashion starting from the i_0th bit of the systematic portion of each encoded codeword outputted first. The parsing of this encoded data stream into spatial streams shall follow exactly the parsing rules defined for the BCC encoder, as defined in clause 4.4.1.

4.4 Data Interleaver

After coding and puncturing, the data bit stream at the output of the FEC encoders are re-arranged into blocks of N_{CBPSS} bits. This operation is referred to as “stream parsing” and is described in 4.4.1 below. Each of these blocks is then interleaved by an interleaver that is a modification of the 802.11a interleaver.

4.4.1 Stream Parser

The number of bits assigned to a single axis (real or imaginary) in a constellation point in the i_{SS}^{th} spatial stream is denoted by $s(i_{SS}) = \max\left\{1, \frac{N_{BPSC}(i_{SS})}{2}\right\}$.

The sum of these over all streams is: $S = \sum_{i_{SS}=0}^{N_{SS}-1} s(i_{SS})$.

(Note that if equal MCS is used for all spatial streams this becomes $N_{SS} \cdot s$, where s is number of bits for an axis common to all streams).

Consecutive blocks of $s(i_{SS})$ bits are assigned to different spatial streams in a round robin fashion.

If two encoders are present, the output of each encoder is used alternately for each round robin cycle, i.e. at the beginning S bits from the output of first encoder are fed into all spatial streams, and then S bits from the output of second encoder are used and so on.

The k^{th} input to the i_{SS}^{th} spatial stream is $y_i^{(j)}$, which is the i^{th} output bit of the j^{th} encoder, where:

$$j = \left\lfloor \frac{k}{s(i_{SS})} \right\rfloor \oplus N_{ES}$$

and

$$i = \sum_{i'=0}^{i_{SS}-1} s(i') + S \cdot \left\lfloor \frac{k}{N_{ES} \cdot s(i_{SS})} \right\rfloor + k \oplus s(i_{SS})$$

4.4.2 Frequency interleaver

The bits at the output of the stream parser are divided into block of N_{CBPSS}, each block is interleaved by an interleaver based on the 802.11a interleaver. This interleaver, which is based on entering the data in rows, and reading it out in columns, has a different number of columns and rows when a 20MHz channel is used and when a 40MHz channel is used. The numbers are described in the table below:

Table 14 - Number of rows and columns in the interleaver

Parameter	20MHz	40MHz
N_{COL}	13	18
N_{ROW}	$4N_{BPSC}$	$6N_{BPSC}$
N_{ROT}	11	29

After the .11a like operations have been applied, if more than one spatial stream exists, a third operation called frequency rotation is applied to the additional spatial streams. The parameter for the frequency rotation is N_{ROT}.

An additional parameter is the spatial stream index i_{ss}=0,..,N_{SS}-1. The output of the third permutation is a function of the spatial stream index.

The interleaving is defined using three permutations. The first permutation is defined by the rule:

$$i = N_{ROW}\left(k \bmod N_{\mathrm{COL}}\right) + \mathrm{floor}\left(k / N_{\mathrm{COL}}\right) \qquad k = 0,1,\ldots,N_{\mathrm{CBPSS}}-1$$

The second permutation is defined by the rule

$$j = s \times \mathrm{floor}\left(i/s\right) + \left(i + N_{\mathrm{CBPSS}} - \mathrm{floor}\left(N_{\mathrm{COL}} \times i / N_{\mathrm{CBPSS}}\right)\right) \bmod s \qquad i = 0,1,\ldots,N_{\mathrm{CBPSS}}-1$$

The value of *s* is determined by the number of coded bits per sub carrier:

$$s = \max\left(N_{\mathrm{BPSC}}/2, 1\right)$$

If more that one spatial stream exists, a frequency rotation is applied to the output of the second permutation

$$r = \left(j - \left(\left(i_{ss} \times 2\right) \bmod 3 + 3 \times \mathrm{floor}\left(\frac{i_{ss}}{3}\right)\right) \times N_{ROT} \times N_{BPSC}\right) \bmod N_{CBPSS} \qquad j = 0,1,\ldots,N_{\mathrm{CBPSS}}-1$$

where $i_{ss} = 0,1,\ldots,N_{ss}-1$ is the index of the spatial steam on which this interleaver is operating.

The deinterleaver uses the following operations to perform the inverse rotation. We denote by *r* the index of the bit in the received block (per spatial stream). The first permutation reverses the third (frequency rotation) permutation of the interleaver

$$j = \left(r + \left(\left(i_{ss} \times 2\right) \bmod 3 + 3 \times \mathrm{floor}\left(\frac{i_{ss}}{3}\right)\right) \times N_{ROT} \times N_{BPSC}\right) \bmod N_{CBPSS} \qquad r = 0,1,\ldots,N_{\mathrm{CBPSS}}-1$$

The second permutation reverses the second permutation in the interleaver.

$$i = s \times \text{floor}\left(j/s\right) + \left(j + \text{floor}\left(N_{COL} \times j / N_{\text{CBPSS}}\right)\right) \bmod s \qquad j = 0,1,\ldots,N_{\text{CBPSS}} - 1$$

s is defined as above.

The third permutation reversed the first permutation of the interleaver:

$$k = N_{COL} \times i - \left(N_{CBPSS} - 1\right) \times \text{floor}\left(i / N_{ROW}\right) \qquad i = 0,1,\ldots,N_{CBPSS} - 1$$

4.5 QAM Mapping

The mapping between bits at the output of the interleaver and complex constellation points for BPSK, QPSK, 16-QAM and 64-QAM follows exactly the rules defined in section 17.3.5.7 of the 802.11a standard [1].

The streams of complex numbers should be denoted as $d_{k,l,n}$, $k = 0,1,\ldots,N_{\text{SD}} - 1$, $l = 1,\ldots,N_{\text{SS}}$, $n = 0,1,\ldots,N_{\text{SYM}} - 1$.

4.5.1 Space-Time-Block-Coding (STBC)

This subclause defines a set of optional robust transmission rates that are applicable only when N_{STS} is greater than N_{SS}. N_{SS} spatial streams are mapped to N_{STS} space time streams, which are mapped to N_{TX} transmit chains. These rates are based either on Space-Time Block Coding (STBC) or hybrid STBC / Spatial-Division-Multiplexing (SDM) schemes. When the use of STBC is indicated in HT-SIG STBC field, a symbol operation shall occur between the QAM mapper and the spatial mapper (see Figure 2) as defined in this clause.

Denote the complex modulator symbol transmitted on all data sub-carriers for stream *l* destined for the $(2n)^{\text{th}}$ and $(2n+1)^{\text{th}}$ OFDM symbol as $d_{k,l,2n}$ and $d_{k,l,2n+1}$ respectively where $n \in \{0,1,...\}$.

Table 15 indicates for each combination of N_{STS} and N_{SS} which modulator symbol shall be transmitted during OFDM symbol period $(2n)$ and $(2n+1)$ from space time stream $n_{\text{STS}} \in \{1,..,N_{\text{STS}}\}$ respectively and the MCS set with which this STBC coding may be combined.

Table 15 - QAM mapper output to spatial Mapper input for STBC

N_{STS}	Bits 0-6 in HT SIG1 (MCS index)	N_{SS}	Bits 4–5 in HT SIG2 (STBC index)	n_{STS}	space time stream in OFDM symbol (2*n*)	space time stream in OFDM symbol (2*n*+1)
2	0-7, 32	1	1	1	$d_{k,1,2n}$	$d_{k,1,2n+1}$
				2	$-d^*_{k,1,2n+1}$	$d^*_{k,1,2n}$
3	8-15, 33-38	2	1	1	$d_{k,1,2n}$	$d_{k,1,2n+1}$
				2	$-d^*_{k,1,2n+1}$	$d^*_{k,1,2n}$
				3	$d_{k,2,2n}$	$d_{k,2,2n+1}$
4	8-15	2	2	1	$d_{k,1,2n}$	$d_{k,1,2n+1}$
				2	$-d^*_{k,1,2n+1}$	$d^*_{k,1,2n}$
				3	$d_{k,2,2n}$	$d_{k,2,2n+1}$
				4	$-d^*_{k,2,2n+1}$	$d^*_{k,2,2n}$
4	16-23, 39, 41, 43, 46, 48, 50	3	1	1	$d_{k,1,2n}$	$d_{k,1,2n+1}$
				2	$-d^*_{k,1,2n+1}$	$d^*_{k,1,2n}$
				3	$d_{k,2,2n}$	$d_{k,2,2n+1}$
				4	$d_{k,3,2n}$	$d_{k,3,2n+1}$

The l'th space time stream for the k'th data subcarrier of symbol n shall be denoted $\tilde{d}_{k,l,n}$. If no space time block coding is applied $\tilde{d}_{k,l,n} = d_{k,l,n}$ and $N_{STS}=N_{SS}$.

Note that the specific STBC schemes for single spatial streams N_{SS}=1 with N_{TX}=3 or N_{TX}=4 are not detailed in this section since they are covered through the use of spatial expansion as detailed section 4.7.1.

4.6 Pilot Subcarriers

In the case of 20MHz 4 pilot tones are inserted, pilot signals are inserted in the same sub-carriers used in 802.11a standard, i.e. in sub-carriers -21, -7, 7 and 21; the pilot sequence for the n^{th} symbols and $i_{STS}{}^{th}$ space time stream is defined as follows:

$$P_{(i_{STS},n)}^{-28,28} = \{0,0,0,0,0,0,0,\Psi_{i_{STS},n\oplus 4}^{(N_{STS})},0,0,0,0,0,0,0,0,0,0,0,0,0,\Psi_{i_{STS},(n+1)\oplus 4}^{(N_{STSI})},0,0,0,0,0,0,0,\\ 0,0,0,0,0,0,\Psi_{i_{STS},(n+2)\oplus 4}^{(N_{STS})},0,0,0,0,0,0,0,0,0,0,0,0,0,\Psi_{i_{STS},(n+3)\oplus 4}^{(N_{STS})},0,0,0,0,0,0,0\}, \qquad (22)$$

In the case of 40MHz transmission pilot signals are inserted in sub-carriers -53, -25, -11, 11, 25, 53; the pilot sequence for the n^{th} symbols and $i_{STS}{}^{\text{th}}$ space time stream is defined as follows:

$$P_{i_{STS}}^{(-58..58,n)} = \{0,0,0,0,0,\Psi_{i_{STS},n\oplus 6}^{(N_{STS})},0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,\\ \Psi_{i_{STS},(n+1)\oplus 6}^{(N_{STS})},0,0,0,0,0,0,0,0,0,0,0,0,0,\Psi_{i_{STS},(n+2)\oplus 6}^{(N_{STS})},0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,\\ 0,\Psi_{i_{STS},(n+3)\oplus 6}^{(N_{STS})},0,0,0,0,0,0,0,0,0,0,0,0,0,0,\Psi_{i_{STS},(n+4)\oplus 6}^{(N_{STS})},0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,\\ 0,0,0,0,0,0,0,0,0,\Psi_{i_{STS},(n+5)\oplus 6}^{(N_{STS})},0,0,0,0,0\}$$

, (23)

Where $n \oplus 4$ indicates symbol number modulo 4;

Note that for each space time stream there is a different pilot pattern and the pilot patterns are cyclically rotated over symbols.

The basic patterns are also different according to the total number of space time streams for the packet.

The patterns $\Psi_{i_{STS},n}^{(N_{STS})}$ are defined in the following tables The first table (Table 16) defines the values for 20MHz transmission and the second table (Table 17) defines the values for 40MHz transmission

Table 16 - pilot values for 20MHz transmission

N_{STS}	i_{STS}	$\Psi_{i_{STS},0}^{(N_{STS})}$	$\Psi_{i_{STS},1}^{(N_{STS})}$	$\Psi_{i_{STS},2}^{(N_{STS})}$	$\Psi_{i_{STS},3}^{(N_{STS})}$
1	0	1	1	1	-1
2	0	1	1	-1	-1
2	1	1	-1	-1	1

3	0	1	1	-1	-1
3	1	1	-1	1	-1
3	2	-1	1	1	-1
4	0	1	1	1	-1
4	1	1	1	-1	1
4	2	1	-1	1	1
4	3	-1	1	1	1

Table 17 - Pilots values for 40MHz transmission

NSTS	iSTS	$\Psi_{i_{STS},0}^{(N_{STS})}$	$\Psi_{i_{STS},1}^{(N_{STS})}$	$\Psi_{i_{STS},2}^{(N_{STS})}$	$\Psi_{i_{STS},3}^{(N_{STS})}$	$\Psi_{i_{STS},4}^{(N_{STS})}$	$\Psi_{i_{STS},5}^{(N_{STS})}$
1	0	1	1	1	-1	-1	1
2	0	1	1	-1	-1	-1	-1
2	1	1	1	1	-1	1	1
3	0	1	1	-1	-1	-1	-1
3	1	1	1	1	-1	1	1
3	2	1	-1	1	-1	-1	1
4	0	1	1	-1	-1	-1	-1
4	1	1	1	1	-1	1	1
4	2	1	-1	1	-1	-1	1
4	3	-1	1	1	1	-1	1

In the duplicate mode there are 8 pilots in the bins -53, -39, -25, -11, 11, 25, 39, 53.

The pilot values are the same as the values on bins -21, -7, 7, 21 in the 20MHz mode, repeated on the negative and positive bins and rotated in the upper bins.

4.7 OFDM Modulation

The time domain signal is composed from the stream of complex numbers

$\tilde{d}_{k,l,n},\ k = 0,1,\ldots,N_{\mathrm{SD}}-1,\ l = 1,\ldots,N_{\mathrm{STS}},\ n = 0,1,\ldots,N_{\mathrm{SYM}}-1$

and from the pilot signals. In the case of 40MHz transmission the upper sub-carriers are rotated 90° relative to the lower subcarriers

4.7.1 Spatial Mapping

The transmitter may choose to rotate and/or scale the space time block coder output vector (or the QAM mapper output vector if no space time block coding was applied). This is useful in the following cases:

- There are more transmit chains than space time streams. $N_{STS} < N_{TX}$
- As part of (an optional) sounding packet.
- As part of (an optional) calibration procedure
- When the packet is in (an optional) beam forming mode.

If the data to be transmitted on subcarrier k on space time stream i_{STS} is $X_k^{i_{STS}}$ then the transmitted data on the i_{TX}'th transmit chain shall be.

$$r_{Field}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{Field}^{Tone}}} w_{T_{Field}}(t) \sum_{k} \sum_{i_{STS}=1}^{N_{STS}} \left[Q_k\right]_{i_{TX} i_{STS}} X_k^{(i_{STS})} \exp\left(j 2\pi k \Delta_F \left(t - T_{CS}^{i_{STS}} \right)\right)$$

where $\left[Q_k\right]_{i_{TX}, i_{STS}}$ is the element in the i_{TX}'th row and i_{STS}'th column in a matrix Q_k with N_{TX} rows and N_{STS} columns. Q_k may be frequency dependent.

There are several typical matrices that can be used:

- Direct mapping – in this case Q_k is a diagonal matrix of unit magnitude complex values that can take two forms:
  - $Q_k = \mathbf{I}$, the identity matrix
  - A CSD matrix in which the diagonal elements represent cyclic shift in the time domain: $\left[Q_k\right]_{i,i} = \exp(-j 2\pi k \Delta_F \tau_{CS}^{i})$
- Spatial Expansion – In this case Q_k is the product of a CSD matrix and a square matrix formed of orthogonal columns. As an illustration:
  - Q_k may be the product of a CSD matrix and a square unitary matrix such as the Hadamard matrix or the Fourier matrix. Sounding PPDUs using spatial expansion shall use unitary Q_k.
  - the spatial expansion may be performed by duplicating some of the N_{STS} streams to form the N_{TX} streams, each stream being scaled by the following normalization factor $\sqrt{\frac{N_{STS}}{N_{TX}}}$ by using for instance one of the following matrices multiplied by a CSD matrix and possibly by any square unitary matrix:

- N_{TX}=2, N_{STS}=1 $\left[Q_k\right]_{N_{STS}} = \frac{1}{\sqrt{2}}\begin{bmatrix}1 & 1\end{bmatrix}^T$
- N_{TX}=3, N_{STS}=1 $\left[Q_k\right]_{N_{STS}} = \frac{1}{\sqrt{3}}\begin{bmatrix}1 & 1 & 1\end{bmatrix}^T$
- N_{TX}=4, N_{STS}=1 $\left[Q_k\right]_{N_{STS}} = \frac{1}{2}\begin{bmatrix}1 & 1 & 1 & 1\end{bmatrix}^T$
- N_{TX}=3, N_{STS}=2 $\left[Q_k\right]_{N_{STS}} = \sqrt{\frac{2}{3}}\begin{bmatrix}1 & 0\\ 0 & 1\\ 1 & 0\end{bmatrix}$
- N_{TX}=4, N_{STS}=2 $\left[Q_k\right]_{N_{STS}} = \frac{1}{\sqrt{2}}\begin{bmatrix}1 & 0\\ 0 & 1\\ 1 & 0\\ 0 & 1\end{bmatrix}$
- N_{TX}=4, N_{STS}=3 $\left[Q_k\right]_{N_{STS}} = \frac{\sqrt{3}}{2}\begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\\ 1 & 0 & 0\end{bmatrix}$

- Different Spatial Expansions over sub-carriers – in which case the smoothing bit should be set to 0 and used in MM only:
  - N_{TX}=2, N_{STS}=1 $\left[Q_k\right]_{N_{STS}} = \begin{bmatrix}1 & 0\end{bmatrix}^T \; or \; \left[Q_k\right]_{N_{STS}} = \begin{bmatrix}0 & 1\end{bmatrix}^T$
  - N_{TX}=3, N_{STS}=2 $\left[Q_k\right]_{N_{STS}} = \begin{bmatrix}1 & 0\\ 0 & 0\\ 0 & 1\end{bmatrix}, \begin{bmatrix}1 & 0\\ 0 & 1\\ 0 & 0\end{bmatrix} or \begin{bmatrix}0 & 0\\ 1 & 0\\ 0 & 1\end{bmatrix}$
  - N_{TX}=4, N_{STS}=2 $\left[Q_k\right]_{N_{STS}} = \begin{bmatrix}1 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 1\end{bmatrix}, \begin{bmatrix}1 & 0\\ 0 & 0\\ 0 & 1\\ 0 & 0\end{bmatrix}, \begin{bmatrix}0 & 0\\ 1 & 0\\ 0 & 0\\ 0 & 1\end{bmatrix} or \begin{bmatrix}0 & 0\\ 1 & 0\\ 0 & 1\\ 0 & 0\end{bmatrix}$
  - N_{TX}=4, N_{STS}=3 $\left[Q_k\right]_{N_{STS}} = \begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 0\\ 0 & 0 & 1\end{bmatrix} or \begin{bmatrix}1 & 0 & 0\\ 0 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\end{bmatrix}$

- Beam Forming Steering Matrix – In this case Q_k is any matrix that improves the reception in the receiver based on some knowledge of the channel between the transmitter and the receiver. In explicit feedback BF the matrix Q_k is supplied by feedback from the station to which the beamformed packet is directed.

In the case where there are fewer space time streams than transmit chains, the first N_{STS} columns of the square matrices above can be used.

The same matrix Q_k shall be applied to subcarrier k during any part of the packet in GF mode and any part of the packet following and including the HT-STF field in a mixed mode packet. This operation is transparent to the receiver.

If the smoothing bit in the HT-SIG is not set to 0, the time domain channel between any space time stream and any transmit chain input, induced by the frequency dependence in the matrix Q_k, and the CSD added according to Table 6, shall not exceed 600ns.

When spatial expansion is applied to the transmission, allowing more transmit chains to be used than spatial streams, the additional CSD value for each TX chain shall not exceed 200 nsec.

If no spatial mapping is applied, the matrix Q_k is equal to the identity matrix and $N_{STS} = N_{TX}$.

4.7.2 20MHz HT transmission

The signal from the i_{TX}'th transmit chain $i_{TX} = 1,\ldots,N_{TX}$ is:

$$r_{HT-DATA}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{HT-DATA}^{Tones}}} \sum_{n=0}^{N_{SYM}-1} w_{T_{SYM}}(t - nT_{SYM}) \left(\sum_{k=0}^{N_{SD}-1} \sum_{i_{STS}=1}^{N_{STS}} \left[Q_{M(k)} \right]_{i_{TX}, i_{STS}} \tilde{d}_{k, i_{STS}, n} \exp\left(j2\pi M(k) \Delta_F \left(t - T_{GI} - nT_{SYM} - T_{CS}^{i_{STS}} \right) \right) + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} \left[Q_k \right]_{i_{TX}, i_{STS}} P_{i_{STS}}^{(k,n)} \exp(j2\pi k \Delta_F \left(t - T_{GI} - nT_{SYM} - T_{CS}^{i_{STS}} \right) \right)$$

z is 3 in a mixed mode packet and 2 in a Green Field Packet. p_n is defined in section 17.3.5.9 of the 802.11a standard.

M(k) in the 20MHz case is

$$M(k)=\begin{cases} k-28 & 0\le k\le 6 \\ k-27 & 7\le k\le 19 \\ k-26 & 20\le k\le 25 \\ k-25 & 26\le k\le 31 \\ k-24 & 32\le k\le 44 \\ k-23 & 45\le k\le 51 \end{cases}, \quad (24)$$

$P_{i_{Tx}}^{(k,n)}$ are defined in equation (22) above.

4.7.3 Transmission in 40MHz HT mode

In the case of 40MHz, the signal from the i_{TX} th transmit chain is:

$$\begin{aligned} r_{HT-DATA}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{STS}N_{HT-DATA}^{Tones}}} \sum_{n=0}^{N_{SYM}-1} w_{T_{SYM}}(t-nT_{SYM}) \cdot \\ \left(\sum_{k=0}^{N_{SD}/2-1} \sum_{i_{STS}=1}^{N_{STS}} \left[Q_{M(k)}\right]_{i_{TX},i_{STS}} \tilde{d}_{k,i_{STS},n} \exp\left(j2\pi M(k)\Delta_F\left(t-T_{GI}-nT_{SYM}-T_{CS}^{i_{STS}}\right)\right)+ \right. \\ p_{n+z}\sum_{k=-N_{SR}}^{0} \sum_{i_{STS}=1}^{N_{STS}} \left[Q_k\right]_{i_{TX},i_{STS}} P_{i_{STS}}^{(k,n)} \exp\left(j2\pi k\Delta_F\left(t-T_{GI}-nT_{SYM}-T_{CS}^{i_{STS}}\right)\right)+ \\ j\sum_{k=N_{SD}/2}^{N_{SD}-1} \sum_{i_{STS}=1}^{N_{STS}} \left[Q_{M(k)}\right]_{i_{TX},i_{STS}} \tilde{d}_{k,i_{STS},n} \exp\left(j2\pi M(k)\Delta_F\left(t-T_{GI}-nT_{SYM}-T_{CS}^{i_{STS}}\right)\right)+ \\ \left. jp_{n+z}\sum_{k=1}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} \left[Q_k\right]_{i_{TX},i_{STS}} P_{i_{STS}}^{(k,n)} \exp\left(j2\pi k\Delta_F\left(t-T_{GI}-nT_{SYM}-T_{CS}^{i_{STS}}\right)\right)\right) \end{aligned}$$

Where $M(k)$ is given below:

$$M(k)=\begin{cases} k-58 & 0\le k\le 4 \\ k-57 & 5\le k\le 31 \\ k-56 & 32\le k\le 44 \\ k-55 & 45\le k\le 53 \\ k-52 & 54\le k\le 62 \\ k-51 & 63\le k\le 75 \\ k-50 & 76\le k\le 102 \\ k-49 & 103\le k\le 107 \end{cases}$$

- The pilot sequence $P_{i_{SMI}}^{(k,n)}$ is defined in equation (23) for 40MHz.

It should be noted that the 90º rotation that is applied to the upper part of the 40MHz channel is applied in the same way to the HT-STF, HT-LTF and HT-SIG. The rotation applies to both pilots and the data in upper part of the 40MHz channel.

4.7.4 Transmission in HT duplicate mode.

HT duplicate mode provides the lowest transmission rate in 40MHz. It may only be used for one spatial stream and only with BPSK coding and rate ½ coding.

Under HT duplicate mode, the following equation defines the signal:

$$\begin{aligned} r_{HT-DATA}^{i_{TX}}(t) &= \frac{1}{\sqrt{N_{Duplicate}^{Tones}}}\sum_{n=0}^{N_{SYM}-1} w_{T_{SYM}}\left(t-nT_{SYM}\right) \\ &\left(\sum_{k=0}^{47}\left[Q_{M(k)-32}\right]_{i_{TX},1} d_{k,n}\exp\left(j2\pi\left(M(k)-32\right)\Delta_F\left(t-nT_{SYM}-T_{GI}\right)\right)+\right. \\ &j\sum_{k=0}^{47}\left[Q_{M(k)+32}\right]_{i_{TX},1} d_{k,n}\exp\left(j2\pi\left(M(k)+32\right)\Delta_F\left(t-nT_{SYM}-T_{GI}\right)\right)+ \\ &p_{n+z}\sum_{k=-N_{SR}}^{N_{SR}}\left[Q_{k-32}\right]_{i_{TX},1} P_k\exp\left(j2\pi(k-32)\Delta_F\left(t-nT_{SYM}-T_{GI}\right)\right)+ \\ &\left. jp_{n+z}\sum_{k=-N_{SR}}^{N_{SR}}\left[Q_{k+32}\right]_{i_{TX},1} P_k\exp\left(j2\pi(k+32)\Delta_F\left(t-nT_{SYM}-T_{GI}\right)\right)\right) \end{aligned}$$

z is defined in section 4.7.2. *M(k), P_k* is defined in section 17.3.5.9 of the 802.11a standard [1]. N_{SR} has the value defined for legacy 20MHz transmission. $\left[Q_k\right]_{i_{TX}}$ is an element from a vector of length N_{TX}, which may be frequency dependent.

The rules of spatial expansion CSD limitation, as specified in section 4.7.1, shall apply to $\left[Q_k\right]_{i_{TX}}$

4.7.5 Transmission with a short guard interval

Short guard interval is used in the data field of the packet, when the Short GI field in the HT-SIG is set to 1. When it is used, the same formula for the formation of the signal is used as in sections 14.7.2 and 4.7.3 with the exception of T_{GI} replaced by T_{GIS} and T_{SYM} is replaces with T_{SYMS}. Short GI shall not be used in GF mode when the MCS indicates a single spatial stream.

4.8 Legacy duplicate transmission

Legacy duplicate transmission is used to transmit to legacy 802.11a devices that may be present in either the upper and lower channels of the 40MHz channel. The L-STF, L-LTF and L-SIG are transmitted in the same way as in the HT 40MHz transmission. There is no HT-SIG, HT-STF or HT-LTF. Data transmission is defined in the following equation:

$$
\begin{aligned}
r_{LEG-DUP}^{i_{TX}}\left(t-nT_{SYM}\right) = {} & \frac{1}{\sqrt{N_{Duplicate}^{Tones}}} w_{TSYM}\left(t-nT_{SYM}\right) \\
& \left(\sum_{k=0}^{47}\left[Q_{M(k)-32}\right]_{i_{TX},1} d_{k,n} \exp\left(j2\pi\left(M\left(k\right)-32\right)(\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{TX}}\right)\right)+ \right. \\
& j\sum_{k=0}^{47}\left[Q_{M(k)+32}\right]_{i_{TX},1} d_k \exp\left(j2\pi\left(M\left(k\right)+32\right)(\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{TX}}\right)\right)+ \\
& p_n \sum_{k=-N_{SR}}^{N_{SR}}\left[Q_{k-32}\right]_{i_{TX},1} P_k \exp\left(j2\pi(k-32)\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{TX}}\right)\right)+ \\
& \left. jp_n \sum_{k=-N_{SR}}^{N_{SR}}\left[Q_{k+32}\right]_{i_{TX},1} P_k \exp\left(j2\pi(k+32)\Delta_F\left(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{TX}}\right)\right)\right)
\end{aligned}
$$

$P_k, M(k)$ are the ones defined at 11a standard at section 17.3.5.9.

$T_{CS}^{i_{TX}}$ are defined in Table 4. $\left[Q_k\right]_{i_{TX}}$ is an element from a vector of length N_{TX}, which may be frequency dependent. The rules of spatial expansion CSD limitation, as specified in section 4.7.1, shall apply to $\left[Q_k\right]_{i_{TX}}$

5 Channel Numbering and Channelization

The device operates both in the 5GHz band and 2.4GHz band. When using 20MHz channels it uses the same channels as in the 11a/11g. When using the 40MHz channel, it can operate in the channels defined in sections 5.1 and 5.2.

5.1 Channel Allocation in the 5 GHz Band

Channel center frequencies are defined at every integral multiple of 5 MHz above 5 GHz (for 20 MHz channels). The relationship between center frequency and channel number is given by the following equation:

Channel center frequency = 5000 + 5 · n_{ch} (MHz), Where n_{ch} = 0,1,…200.

The 40MHz channels in 5GHz are specified by two fields: ($N_{control\_ch}$, extension). The first field represents the channel number of the control channel, and the second one indicates whether the extension channel is above or below the control channel (1 -> above, -1 -> below). For example, a 40MHz channel consisting of channel 36 and 40 where channel 36 is the control channel shall be specified as (36,1).

The following table lists the valid settings of these two fields in the 5 GHz band.

Table 18 - 40MHz channel allocation in the 5GHz band

Regulatory domain	Band (GHZ)	$N_{control\_ch}$		Center Frequency (MHz)
		Extension=1	Extension=-1	
United States	U-NII lower band (5.15-5.25)	36 44	40 48	5190 5230
United States	U-NII middle band (5.25-5.35)	52 60	56 64	5270 5310
Europe	ETSI (5.5-5.7)	100 108 116 124 132	104 112 120 128 136	5510 5550 5590 5630 5670
United States	U-NII upper band (5.725-5.825)	149 157	153 161	5755 5795

5.2 Channel Allocation in the 2.4 GHz Band

Channel center frequencies are defined at every integral multiple of 5 MHz in the 2.4 GHz band. The relationship between center frequency and channel number is given by the following equation: Channel center frequency = 2407 + 5 · n_{ch} (MHz), Where n_{ch} = 1,2,…11.

The 40MHz channels in 2.4GHz are specified in the same way as in 5GHz: ($N_{control\_ch}$, extension). The first field represents the channel number of the control channel, and the second one indicates whether the extension channel is above or below the control channel (1 -> above, -1 -> below). For example, a 40MHz channel consisting of channel 2 and channel 6 where channel 6 is the control channel shall be specified as (6, -1).

The following table lists the valid settings of these two fields in the 2.4 GHz band.

Table 19 - 40Mhz channel alocation in the 2.4GHz and

Regulatory domain	$N_{control\_ch}$		Center Frequency (MHz)
	Extension=1	Extension=-1	
	1	5	2422
	2	6	2427
United States	3	7	2432
Canada	4	8	2437
Europe	5	9	2442
	6	10	2447
	7	11	2452

6 Transmit Spectrum Mask

When transmitting in a 20MHz channel, the transmitted spectrum shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18 MHz, –20 dBr at 11 MHz frequency offset, –28 dBr at 20 MHz frequency offset and –45 dBr at 30 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 15. The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth.

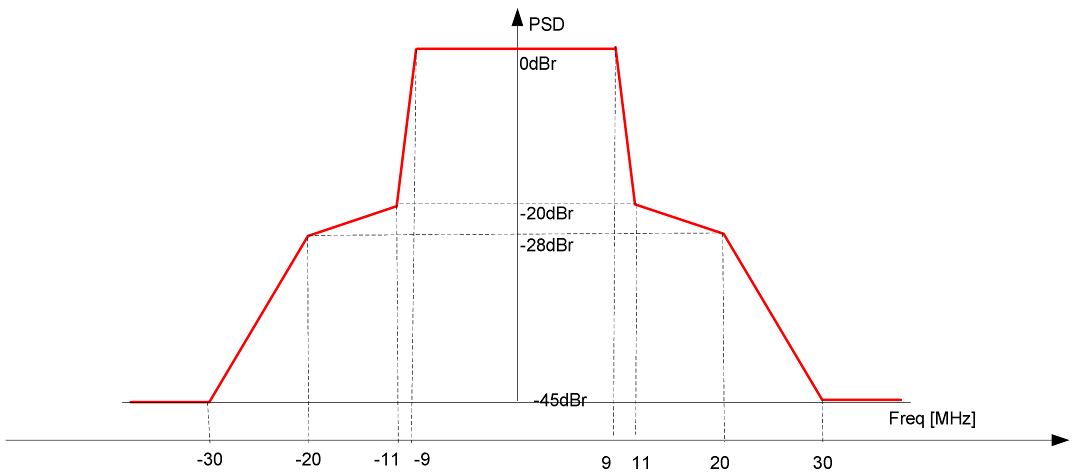

Figure 14 - Transmit spectral mask for 20MHz Transmission

When transmitting in a 40MHz channel, the transmitted spectrum shall have a 0 dBr bandwidth not exceeding 38 MHz, –20 dBr at 21 MHz frequency offset, -28 dBr at 40 MHz offset and –45 dBr at 60 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 16.

The transmit spectral mask for 20MHz transmission in upper or lower 20Mhz channels of a 40MHz is the same mask as that used for the 40MHz channel.

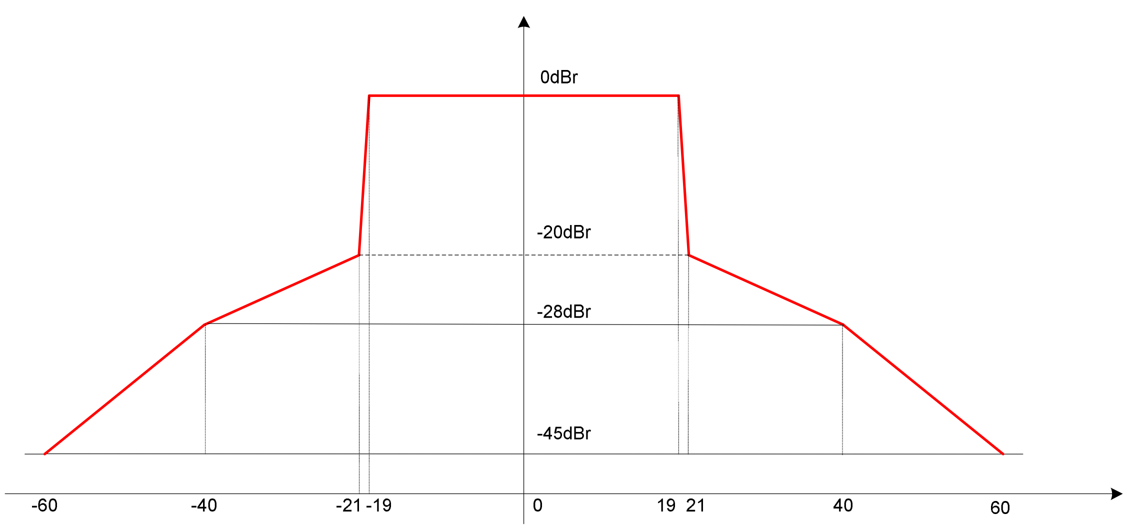

Figure 15 - Transmit spectral mask for a 40MHz channel

6.1 Spectral Flatness

In a 20MHz channel and in corresponding 20MHz transmission in a 40MHz channel, the average energy of the constellations in each of the spectral lines –16 to –1 and +1 to +16 shall deviate no more than ± 2 dB from their average

energy. The average energy of the constellations in each of the spectral lines –28 to –17 and +17 to +28 will deviate no more than +2/–4 dB from the average energy of spectral lines –16 to –1 and +1 to +16.
In a 40 MHz transmission the average energy of the constellations in each of the spectral lines –42 to –2 and +2 to +42 shall deviate no more than ± 2 dB from their average energy. The average energy of the constellations in each of the spectral lines –43 to –58 and +43 to +58 shall deviate no more than +2/–4 dB from the average energy of spectral lines –42 to –2 and +2 to +42.
The data for this test will be based on the channel estimate step.

6.2 Transmit Power

The maximum allowable output power of the device is the same as in legacy 802.11a or 802.11g transmitter. If more than one transmit chain is used, the total power in all transmit chains shall be equal to the total power possible for a legacy 802.11a/g transmitter. If a 40MHz channel is used, the total transmitted power in the 40MHz bandwidth shall be equal to the total transmitted power allowed for a legacy 802.11a transmitter in a 20MHz channel.

6.3 Transmit center frequency tolerance

The transmitter center frequency tolerance shall be ±20 ppm maximum. The different transmit chain center frequencies (LO) and each transmit chain symbol clock frequency shall all be derived from the same reference oscillator.

7 Packet alignment

7.1 Packet alignment

The receiver will assert PHY-CCA.indicate(idle).(12.3.5.10) at the 4μsec boundary following the reception of the last symbol of the packet.

The transmitter will assert PHY-TXEND.confirm (12.3.5.7) at the trailing boundary of the last symbol of the packet on the air.

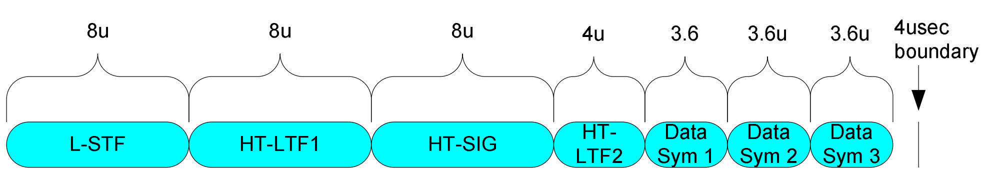

Figure 16 - Packet alignment example - GF packet with short GI

7.2 Reduced Interframe Space (RIFS)

The transmitter shall be able to transmit a packet 2usec after PHY-TXEND.confirm is asserted. The receiver shall be able to decode a packet if it starts 2µsec after PHY-RXEND.indication is asserted for the previous packet. RIFS timing accuracy is ±10%.

8 Beamforming

Beamforming is a technique in which the transmitter utilizes the knowledge of the MIMO channel to generate a spatial mapping matrix Q_k that will improve reception in the receiver.

The MIMO channel model is one in which when a vector $\mathbf{x}_k = \left[x_1, x_2, \ldots, x_{N_{TX}}\right]^T$ is transmitted in subcarrier k the received vector $\mathbf{y}_k = \left[y_1, y_2, \ldots, y_{N_{RX}}\right]^T$ is modeled as:

$$\mathbf{y}_k = H_k \mathbf{x}_k + \mathbf{n}$$

Where H_k is the channel matrix $\left(N_{RX}, N_{TX}\right)$ and $\mathbf{n}$ is white (spatial and temporally) Gaussian noise.

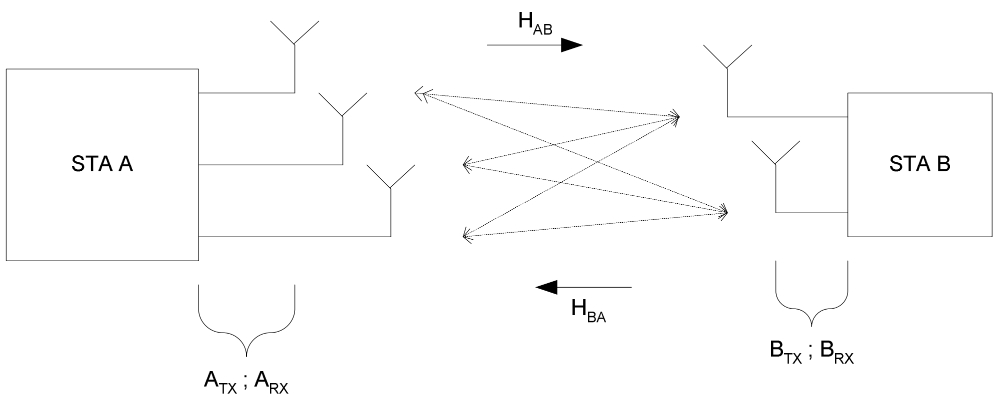

Figure 17 - The beamforming MIMO channel model

When beamforming is used, the transmitter replaces $\mathbf{x}_k$ with $Q_k \mathbf{x}_k$ so that the received vector is $\mathbf{y}_k = H_k Q_k \mathbf{x}_k + \mathbf{n}$

There are several methods of beam forming, differing in the way the transmitter acquires the knowledge of the channel matrices H_k and on whether the transmitter or the receiver generates Q_k .

In implicit beam forming the transmitter uses the fact that the channel between antenna i at STA A and antenna l at STA B, is the same as the channel measured at antenna i of STA A when antenna l at STA B is transmitting.

Using a matrix representation of the channel, it means that the channel between STA A and STA B is the transpose of the channel between STA B and STA A. This is true for the channels between the antennas. Since the actual channel includes the transmit chain in STA A and receive chain in STA B, there is the need for a calibration procedure to correct for the difference in the measured channel, due to the difference between the combinations of STA A transmitter and STA B receiver ($B_{RX}H_{AB}A_{TX}$) vs. STA B transmitter and STA A receiver ($A_{RX}H_{BA}B_{TX}$). (A_{TX} is the diagonal matrix modeling the attenuation and delay in each of STA A transmit chains, similarly B_{TX} and A_{RX}, B_{RX} with receiver chains).

In explicit beamforming, in order for STA A to transmit a beamformed packet to STA B, STA B measures the channel matrices and sends STA A either the mapping matrices Q_k to uses, or the channel matrices H_k .

8.1 CSI Matrices Feedback

In the CSI matrices feedback the transmitting STA receives an action frame containing the quantized MIMO channel matrix, H , from the receiving STA. The transmitting station then may use this matrix to compute a set of transmit spatial mapping matrices, Q_k .

The matrix H (of a specific subcarrier) shall be encoded as follows:

- The maximum of the real part of and the maximum of the imaginary part of each element of the matrix is found and the maximum of these is taken:
$$m_H = \max\left\{\max\left\{\left|\Re H_{k,l}\right|\right\}_{k,l=1}^{k=N_{TX},l=N_{RX}}, \max\left\{\left|\Im H_{k,l}\right|\right\}_{k,l=1}^{k=N_{TX},l=N_{RX}}\right\}$$
- Each element in the matrix $H_{k,l}$ is quantized to Nb bits in two's complement notation according to the formula: $H^Q_{k,l} = round\left(\frac{H_{k,l}}{m_H}\left(2^{N_b}-1\right)\right)$.
- The ratio between $\max\left\{m_H\left(k\right)\right\}_{k=-N_{SR}}^{N_{SR}}$ and $m_H\left(k\right)$ of subcarrier k in decibel units is encoded in 3 bits using one's complement notation.

Therefore each matrix is encoded using $3 + 2 \times Nb \times N_{TX} \times N_{RX}$ bits.

Nb may have the value of 4, 5, 6, 8 bits.

8.2 Non Compressed Steering Matrix Feedback

In non compressed steering matrix feedback, the receiving station computes a set of matrices for feedback to the transmitter. These matrices are assembled into an action frame as described in MAC section "Steering Matrices Feedback Frame". The transmitter can then apply these matrices directly as the spatial mapping matrices Q_k .

The encoding of these matrices is identical to the encoding of the CSI matrices. The dimensions of the steering matrices is $N_{TX} \times N_{SS}$.

8.3 Compressed Steering Matrix Feedback

In compressed steering matrix feedback, the receiving station computes a set of compressed unitary matrices for feedback to the transmitter. These compressed matrices are assembled into an action frame as described in MAC section "Compressed Steering Matrices Feedback Frame ".

The transmitter can then apply these matrices, or a function of them, as the spatial mapping matrices Q_k . The matrix compression is defined as follows. The unitary matrix V shall be represented as:

$$V = \prod_{i=1}^{\min(N-1,M)} \left[D_i \left(1_{i-1} \quad e^{j\phi_{i,i}} \quad \ldots \quad e^{j\phi_{N-1,i}} \quad 1 \right) \prod_{l=i+1}^{N} G_{li}^T \left(\psi_{li} \right) \right] \times \tilde{I}_{N \times M}$$

The matrix $D_i \left(x_1 \quad \cdots \quad x_n \right)$ is an n by n diagonal matrix with elements x_1 to x_n on the diagonal. Note that there will be the first i elements, x_1 to x_i of D_i will be 1. The matrix $G_{li}(\psi)$ is an n by n Givens rotation matrix:

$$G_{li}(\psi) = \begin{bmatrix} I_{i-1} & 0 & 0 & 0 & 0 \\ 0 & \cos(\psi) & 0 & \sin(\psi) & 0 \\ 0 & 0 & I_{l-i-1} & 0 & 0 \\ 0 & -\sin(\psi) & 0 & \cos(\psi) & 0 \\ 0 & 0 & 0 & 0 & I_{N-l} \end{bmatrix}$$

where each I_m is an m by m identity matrix, and $\cos(\Psi)$ and $\sin(\Psi)$ are located at lth and ith row and column. $\tilde{I}_{NxM}$ is an identity matrix padded with zeros to fill the additional rows or columns when $N \neq M$.

For example, a 4x2 V matrix has the following representation:

$$V=\begin{bmatrix}1&0&0&0\\0&e^{j\phi_{21}}&0&0\\0&0&e^{j\phi_{31}}&0\\0&0&0&e^{j\phi_{41}}\end{bmatrix}\times G_{21}^{T}(\psi_{21})G_{31}^{T}(\psi_{31})G_{41}^{T}(\psi_{41})\times\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&e^{j\phi_{32}}&0\\0&0&0&e^{j\phi_{42}}\end{bmatrix}\times$$
$$\times G_{32}^{T}(\psi_{32})G_{42}^{T}(\psi_{42})\times\begin{bmatrix}1&0\\0&1\\0&0\\0&0\end{bmatrix}$$

$$V=\begin{bmatrix}1&0&0&0\\0&e^{j\phi_{21}}&0&0\\0&0&e^{j\phi_{31}}&0\\0&0&0&e^{j\phi_{41}}\end{bmatrix}\times\begin{bmatrix}\cos\psi_{21}&\sin\psi_{21}&0&0\\-\sin\psi_{21}&\cos\psi_{21}&0&0\\0&0&1&0\\0&0&0&1\end{bmatrix}^{T}\begin{bmatrix}\cos\psi_{31}&0&\sin\psi_{31}&0\\0&1&0&0\\-\sin\psi_{31}&0&\cos\psi_{31}&0\\0&0&0&1\end{bmatrix}^{T}\begin{bmatrix}\cos\psi_{41}&0&0&\sin\psi_{41}\\0&1&0&0\\0&0&1&0\\-\sin\psi_{41}&0&0&\cos\psi_{41}\end{bmatrix}^{T}$$
$$\times\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&e^{j\phi_{32}}&0\\0&0&0&e^{j\phi_{42}}\end{bmatrix}\times\begin{bmatrix}1&0&0&0\\0&\cos\psi_{32}&\sin\psi_{32}&0\\0&-\sin\psi_{32}&\cos\psi_{32}&0\\0&0&0&1\end{bmatrix}^{T}\begin{bmatrix}1&0&0&0\\0&\cos\psi_{42}&0&\sin\psi_{42}\\0&0&1&0\\0&-\sin\psi_{42}&0&\cos\psi_{42}\end{bmatrix}^{T}\times\begin{bmatrix}1&0\\0&1\\0&0\\0&0\end{bmatrix}$$

This is a description of a method for finding a compressed V matrix using Givens Rotation.

$$V=\left[\prod_{i=1}^{\min(M,N-1)}\left[D_i\left(1_{i-1}\quad e^{j\phi_{i,i}}\quad \ldots\quad e^{j\phi_{N-1,i}}\quad 1\right)\prod_{l=i+1}^{N}G_{li}^{T}(\psi_{li})\right]\right]\tilde{I}_{N\times M}$$

A unitary NxM beamforming matrix V is column-wise phase invariant because the steering matrix needs a reference in phase per each column. This means V may be equivalent to $\tilde{V}\tilde{D}$, where $\tilde{D}$ is a column-wise phase shift matrix such as $\tilde{D}=diag(e^{j\theta_1},.e^{j\theta_2},..,e^{j\theta_M})$. When the beamformee estimates the channel, it may find $\tilde{V}$ for the beamforming matrix for the beamformer, but it may send $\tilde{V}\tilde{D}$ back to the beamformer, where $V=\tilde{V}\tilde{D}$. θ_i in $\tilde{D}$ is found to make the last row of $\tilde{V}\tilde{D}$ to be real numbers.

When the beamformee finds V matrix, all of elements in V may be complex numbers. The angles $\phi_{1,1}$, …, $\phi_{N-1,1}$ in the diagonal matrix $D_1\left(e^{j\phi_{11}}\quad \ldots\quad e^{j\phi_{N-1,1}}\quad 1\right)^{*}$ may be found to make the first column of $V\widetilde{D}$ to all be real numbers. Now, the first column of $\left(G_{41}G_{31}G_{21}D_1^*\right)\times V$ can be $[1\ 0\ \ldots\ 0]^T$ by Givens rotation G_{l1}'s such as

$$\begin{bmatrix} \cos\psi_{N1} & 0 & 0 & \sin\psi_{N1} \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -\sin\psi_{N1} & 0 & 0 & \cos\psi_{N1} \end{bmatrix} \begin{bmatrix} \cos\psi_{31} & 0 & \sin\psi_{31} & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\psi_{31} & 0 & \cos\psi_{31} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\psi_{21} & \sin\psi_{21} & 0 & 0 \\ -\sin\psi_{21} & \cos\psi_{21} & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e^{j\phi_{11}} & 0 & 0 & 0 \\ 0 & \ddots & 0 & 0 \\ 0 & 0 & e^{j\phi_{N-1,1}} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}^* \times V = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & & & \\ 0 & & V_2 & \\ 0 & & & \end{bmatrix}$$

For new (N-1) x (M-1) submatrix V_2, this process may be applied in the same way. Then, the angles $\phi_{2,2}, \ \ldots, \phi_{N-1.2}$ in the diagonal matrix $D_2\left(1 \quad e^{j\phi_{22}} \quad e^{j\phi_{32}} \quad 1\right)^*$ may be found to make the first column of V_2 to be all real numbers. Now, the first two columns of $\left(G_{42}G_{32}D_2^*\right)\left(G_{41}G_{31}G_{21}D_1^*\right)\times V$ can be $\widetilde{I}_{Nx2}$ by Givens rotation G_{l2}'s such as

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\psi_{N2} & 0 & \sin\psi_{21} \\ 0 & 0 & 1 & 0 \\ 0 & -\sin\psi_{N2} & 0 & \cos\psi_{N2} \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\psi_{32} & \sin\psi_{32} & 0 \\ 0 & -\sin\psi_{32} & \cos\psi_{32} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & e^{j\phi_{22}} & 0 & 0 \\ 0 & 0 & e^{j\phi_{N-1,2}} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}^* \times G_{41}G_{31}G_{21}D_1^{**}V = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & & \\ 0 & 0 & V_3 & \end{bmatrix}$$

This process may keep going until the first M columns of right side matrix becomes $\widetilde{I}_{NxM}$. When M < N, this process does not have to go on because V_{M+1} will be nulled out by $\widetilde{I}_{NxM}$. Then, by multiplying the conjugate transpose of product of series of D_i's and G_{li}'s on the left, V can be expressed as

$$V = \left[\prod_{i=1}^{\min(M,N-1)} \left[D_i\left(1_{i-1} \quad e^{j\phi_{i,i}} \quad \ldots \quad e^{j\phi_{N-1,i}} \quad 1\right)\prod_{l=i+1}^{N} G_{li}^T\left(\psi_{li}\right)\right]\right]\widetilde{I}_{N\times M},$$

9 High Throughput Preamble Format for Sounding PPDUs

MIMO channel measurement takes place in every PPDU as a result of transmitting the HT-LTFs as part of the PLCP preamble. At a minimum, the number of HT-LTFs transmitted must be equal to the number of space time streams transmitted, and these are transmitted using the same spatial transformation that is used for the HT-Data. This enables the computation of the spatial equalization at the receiver.

When the number of space time streams, N_{STS}, is less than the number of transmit antennas, or less than $\min(N_{TX}, N_{RX})$, sending only N_{STS} HT-LTFs does not allow the receiver to recover a full characterization of the MIMO channel, even though the resulting MIMO channel measurement is sufficient for receiving the HT-Data.

However, there are several cases where it is desirable to obtain as full a characterization of the channel as is possible, thus requiring the transmission of a sufficient number of HT-LTFs to sound the full dimensionality of the channel, which is in some cases N_{TX}, and in other cases $\min(N_{TX}, N_{RX})$. We refer to these cases of MIMO channel measurement as MIMO channel sounding. A sounding packet may be used to probe available channel dimensions. A sounding PPDU is identified by setting the sounding bit in HT-SIG to zero. A sounding PPDU may have any allowed number of HT-LTFs satisfying $N_{LTF} \geq N_{STS}$ (A sounding packet may have $N_{STS} = N_{LTF}$). In general, if the sounding bit in the HT-SIG is set to zero, when $N_{LTF} > N_{STS}$, segmented HT-LTFs are used, except for the case where $N_{SS} = 3$ and $N_{LTF} = 4$ or in a zero length packet.

Even if N_{ESS} =0 in a sounding packet, the sounding bit shall be set to zero.

9.1 Sounding with a zero length packet

An STA may sound the channel using a zero length packet (indicated by zero in the Length field in the HT-SIG) with the sounding bit set. The number of LTF's is the number implied by the MCS. No data field will follow the last HT-LTF or the HT-SIG (see Figure 19).

It is optional for an STA to process a zero length packet.

Figure 18 -An example of a zero length packet used for sounding

9.2 Sounding PPDU for calibration

In the case of a bidirectional calibration exchange, two STAs exchange sounding PPDUs enabling the receiving STA to compute an estimate of the MIMO channel matrix, H_k, for each subcarrier. In general, in an exchange of calibration messages, the number of spatial streams will be less than the number of transmit antennas, necessitating the use of segmented HT-LTFs. In the case of sounding PPDUs for calibration, the antenna mapping matrix shall be

$$Q_k = \mathbf{C}_{CSD}(k) P_{HTLTF},$$

where $\mathbf{C}_{CSD}(k)$ is a diagonal cyclic shift matrix, where the diagonal elements carry frequency-domain representation of the cyclic shifts given in Table 4, and $\mathbf{P}_{HTLTF}$ is the unitary matrix given in 3.6.5.

9.3 Sounding PPDU for channel quality assessment (informative)

A MIMO channel with N_{TX} transmit antennas and N_{RX} receive antennas can support a maximum of $N_{STS,\max} = \min(N_{TX}, N_{RX})$ space time streams. In order for a receiving STA to obtain a channel quality assessment for all $N_{STS,\max}$ available spatial streams, so that it can respond to an MRQ, when using a transmit steering matrix Q_k, it needs an estimate of the effective channel $H_k Q_k$, where Q_k is in this case a $N_{TX} \times N_{STS,\max}$ orthonormal steering matrix. This requires the transmitting STA to send HT-LTFs to sound the $N_{STS,\max}$ available space time streams. The number of HT-LTFs can be determined from HT-SIG fields of MCS and STBC as shown in Table 10. STAs supporting the transmission of segmented HT-LTFs can send a sounding PPDU using extension HT-LTFs as necessary. STAs that don't support transmission of segemented PPDUs may only send a sounding PPDU when $N_{SS} = N_{STS,\max}$.

10 Optional Features

This section assembles the main features that are optional

- Green Field mode is optional at both receive and transmit
- Short GI is optional at both receive and transmit
- STBC is optional at both receive and transmit
- Beam Forming is optional at both receive and transmit
- 40MHz Channel processing is optional at both transmit and receive.

11 References

[1] IEEE Std 802.11a-1999 – Part 11 Wireless Land Medium Access control (MAC) and Physical Layer (PHY) specification: High Speed Physical Layer in the 5 GHZ Band.

[2] IEEE Std 802.11b-1999 – Part 11 Wireless Land Medium Access control (MAC) and Physical Layer (PHY) specification: Higher-Speed Physical Layer Extension in the 2.4 GHz Band.

[3] IEEE Std 802.11g-1999 – Part 11 Wireless Land Medium Access control (MAC) and Physical Layer (PHY) specification: Amendment 4: Further Higher Data Rate Extension in the 2.4 GHz Band

Appendix A: Rate Dependent Parameters for High Throughput Modulation and Coding Schemes (MCS)

Table A-1 – rate dependent parameters for mandatory 20 MHz, N_{SS} =1 modes

MCS Index	Modulation	R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mbps)	
								800ns GI	400ns GI[1]
0	BPSK	½	1	52	4	52	26	6.5	7.2
1	QPSK	½	2	52	4	104	52	13.0	14.4
2	QPSK	¾	2	52	4	104	78	19.5	21.7
3	16-QAM	½	4	52	4	208	104	26.0	28.9
4	16-QAM	¾	4	52	4	208	156	39.0	43.3
5	64-QAM	2/3	6	52	4	312	208	52.0	57.8
6	64-QAM	¾	6	52	4	312	234	58.5	65.0
7	64-QAM	5/6	6	52	4	312	260	65.0	72.2

[1]Support of 400 ns guard interval is optional on transmit and receive.

Table A-2—Rate-dependent parameters for optional 20 MHz, N_{SS} = 2 modes

MCS Index	Modulation	R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mbps)	
								800ns GI	400ns GI
8	BPSK	½	1	52	4	104	52	13.0	14.444
9	QPSK	½	2	52	4	208	104	26.0	28.889
10	QPSK	¾	2	52	4	208	156	39.0	43.333
11	16-QAM	½	4	52	4	416	208	52.0	57.778
12	16-QAM	3/4	4	52	4	416	312	78.0	86.667
13	64-QAM	2/3	6	52	4	624	416	104.0	115.556
14	64-QAM	¾	6	52	4	624	468	117.0	130.000
15	64-QAM	5/6	6	52	4	624	520	130.0	144.444

[1]Support of 400 ns guard interval is optional on transmit and receive.

Table A-3—Rate-dependent parameters for optional 20 MHz, N_{SS} = 3 modes

MCS Index	Modulation	R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mbps)	
								800 ns GI	400ns GI
16	BPSK	½	1	52	4	156	78	19.5	21.7
17	QPSK	½	2	52	4	312	156	39.0	43.3
18	QPSK	¾	2	52	4	312	234	58.5	65.0
19	16-QAM	½	4	52	4	624	312	78.0	86.7
20	16-QAM	3/4	4	52	4	624	468	117.0	130.0
21	64-QAM	2/3	6	52	4	936	624	156.0	173.3
22	64-QAM	¾	6	52	4	936	702	175.5	195.0
23	64-QAM	5/6	6	52	4	936	780	195.0	216.7

Table A-4—Rate-dependent parameters for optional 20 MHz, N_{SS} = 4 modes

MCS Index	Modulation	R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mbps)	
								800 ns GI	400ns GI[1]
24	BPSK	½	1	52	4	208	104	26.0	28.9
25	QPSK	½	2	52	4	416	208	52.0	57.8
26	QPSK	¾	2	52	4	416	312	78.0	86.7
27	16-QAM	½	4	52	4	832	416	104.0	115.6
28	16-QAM	3/4	4	52	4	832	624	156.0	173.3
29	64-QAM	2/3	6	52	4	1248	832	208.0	231.1
30	64-QAM	¾	6	52	4	1248	936	234.0	260.0
31	64-QAM	5/6	6	52	4	1248	1040	260.0	288.9

Table A-5—Rate-dependent parameters for optional 40 MHz, N_{SS} = 1 modes

MCS Index	Modulation	R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mbps)	
								800 ns GI	400ns GI
0	BPSK	½	1	108	6	108	54	13.5	15.0
1	QPSK	½	2	108	6	216	108	27.0	30.0
2	QPSK	¾	2	108	6	216	162	40.5	45.0
3	16-QAM	½	4	108	6	432	216	54.0	60.0
4	16-QAM	3/4	4	108	6	432	324	81.0	90.0
5	64-QAM	2/3	6	108	6	648	432	108.0	120.0
6	64-QAM	¾	6	108	6	648	486	121.5	135.0
7	64-QAM	5/6	6	108	6	648	540	135.0	150.0

Table A-6—Rate-dependent parameters for optional 40 MHz, N_{SS} = 2 modes

MCS Index	Modulation	R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mbps)	
								800 ns GI	400ns GI
8	BPSK	½	1	108	6	216	108	27.0	30.0
9	QPSK	½	2	108	6	432	216	54.0	60.0
10	QPSK	¾	2	108	6	432	324	81.0	90.0
11	16-QAM	½	4	108	6	864	432	108.0	120.0
12	16-QAM	3/4	4	108	6	864	648	162.0	180.0
13	64-QAM	2/3	6	108	6	1296	864	216.0	240.0
14	64-QAM	¾	6	108	6	1296	972	243.0	270.0
15	64-QAM	5/6	6	108	6	1296	1080	270.0	300.0

Table A-7—Rate-dependent parameters for optional 40 MHz, N_{SS} = 3 modes

MCS Index	Modulation	R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mbps)	
								800 ns GI	400ns GI
16	BPSK	½	1	108	6	324	162	40.5	45.0
17	QPSK	½	2	108	6	648	324	81.0	90.0
18	QPSK	¾	2	108	6	648	486	121.5	135.0
19	16-QAM	½	4	108	6	1296	648	162.0	180.0
20	16-QAM	3/4	4	108	6	1296	972	243.0	270.0
21	64-QAM	2/3	6	108	6	1944	1296	324.0	360.0
22	64-QAM	¾	6	108	6	1944	1458	364.5	405.0
23	64-QAM	5/6	6	108	6	1944	1620	405.0	450.0

Table A-8—Rate-dependent parameters for optional 40 MHz, N_{SS} = 4 modes

MCS Index	Modulation	R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mbps)	
								800 ns GI	400ns GI
24	BPSK	½	1	108	6	432	216	54.0	60.0
25	QPSK	½	2	108	6	864	432	108.0	120.0
26	QPSK	¾	2	108	6	864	648	162.0	180.0
27	16-QAM	½	4	108	6	1728	864	216.0	240.0
28	16-QAM	3/4	4	108	6	1728	1296	324.0	360.0
29	64-QAM	2/3	6	108	6	2592	1728	432.0	480.0
30	64-QAM	¾	6	108	6	2592	1944	486.0	540.0
31	64-QAM	5/6	6	108	6	2592	2160	540.0	600.0

Table A-9—Rate-dependent parameters for optional 40 MHz HT duplicate mode, N_{SS} = 1

MCS Index	Modulation	R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mbps)	
								800 ns GI	400ns GI
32	BPSK	½	1	96	8	48	24	6.0	6.7

Table A-10—Rate-dependent parameters for optional 20 MHz, N_{SS} = 2 modes

MCS Index	Modulation		R	N_{TBPS}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mbps)	
	Stream 1	Stream 2							800 ns GI	400ns GI
33	16-QAM	QPSK	½	6	52	4	312	156	39	43.3
34	64-QAM	QPSK	½	8	52	4	416	208	52	57.8
35	64-QAM	16-QAM	½	10	52	4	520	260	65	72.2
36	16-QAM	QPSK	3/4	6	52	4	312	234	58.5	65.0
37	64-QAM	QPSK	¾	8	52	4	416	312	78	86.7
38	64-QAM	16-QAM	3/4	10	52	4	520	390	97.5	108.3

Table A-11 – rate dependent parameters for optional 20MHz, N_{SS} = 3 modes

MCS Index	Modulation			R	N_{TBPS}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mbps)	
	Stream 1	Stream 2	Stream 3							800 ns GI	400ns GI
39	16-QAM	QPSK	QPSK	½	8	52	4	416	208	52	57.8
40	16-QAM	16-QAM	QPSK	½	10	52	4	520	260	65	72.2
41	64-QAM	QPSK	QPSK	½	10	52	4	520	260	65	72.2
42	64-QAM	16-QAM	QPSK	½	12	52	4	624	312	78	86.7
43	64-QAM	16-QAM	16-QAM	½	14	52	4	728	364	91	101.1
44	64-QAM	64-QAM	QPSK	½	14	52	4	728	364	91	101.1
45	64-QAM	64-QAM	16-QAM	½	16	52	4	832	416	104	115.6
46	16-QAM	QPSK	QPSK	¾	8	52	4	416	312	78	86.7
47	16-QAM	16-QAM	QPSK	¾	10	52	4	520	390	97.5	108.3
48	64-QAM	QPSK	QPSK	¾	10	52	4	520	390	97.5	108.3
49	64-QAM	16-QAM	QPSK	¾	12	52	4	624	468	117	130.0
50	64-QAM	16-QAM	16-QAM	¾	14	52	4	728	546	136.5	151.7
51	64-QAM	64-QAM	QPSK	¾	14	52	4	728	546	136.5	151.7
52	64-QAM	64-QAM	16-QAM	¾	16	52	4	832	624	156	173.3

Table A-12—Rate-dependent parameters for optional 20 MHz, N_{SS} = 4 modes

MCS Index	Modulation				R	N_{TBPS}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mbps)	
	Stream 1	Stream 2	Stream 3	Stream 4							800 ns GI	400ns GI
53	16-QAM	QPSK	QPSK	QPSK	½	10	52	4	520	260	65	72.2
54	16-QAM	16-QAM	QPSK	QPSK	½	12	52	4	624	312	78	86.7
55	16-QAM	16-QAM	16-QAM	QPSK	½	14	52	4	728	364	91	101.1
56	64-QAM	QPSK	QPSK	QPSK	½	12	52	4	624	312	78	86.7
57	64-QAM	16-QAM	QPSK	QPSK	½	14	52	4	728	364	91	101.1
58	64-QAM	16-QAM	16-QAM	QPSK	½	16	52	4	832	416	104	115.6
59	64-QAM	16-QAM	16-QAM	16-QAM	½	18	52	4	936	468	117	130.0
60	64-QAM	64-QAM	QPSK	QPSK	½	16	52	4	832	416	104	115.6

61	64-QAM	64-QAM	16-QAM	QPSK	½	18	52	4	936	468	117	130.0
62	64-QAM	64-QAM	16-QAM	16-QAM	½	20	52	4	1040	520	130	144.4
63	64-QAM	64-QAM	64-QAM	QPSK	½	20	52	4	1040	520	130	144.4
64	64-QAM	64-QAM	64-QAM	16-QAM	½	22	52	4	1144	572	143	158.9
65	16-QAM	QPSK	QPSK	QPSK	¾	10	52	4	520	390	97.5	108.3
66	16-QAM	16-QAM	QPSK	QPSK	¾	12	52	4	624	468	117	130.0
67	16-QAM	16-QAM	16-QAM	QPSK	¾	14	52	4	728	546	136.5	151.7
68	64-QAM	QPSK	QPSK	QPSK	¾	12	52	4	624	468	117	130.0
69	64-QAM	16-QAM	QPSK	QPSK	¾	14	52	4	728	546	136.5	151.7
70	64-QAM	16-QAM	16-QAM	QPSK	¾	16	52	4	832	624	156	173.3
71	64-QAM	16-QAM	16-QAM	16-QAM	¾	18	52	4	936	702	175.5	195.0
72	64-QAM	64-QAM	QPSK	QPSK	¾	16	52	4	832	624	156	173.3
73	64-QAM	64-QAM	16-QAM	QPSK	¾	18	52	4	936	702	175.5	195.0
74	64-QAM	64-QAM	16-QAM	16-QAM	¾	20	52	4	1040	780	195	216.7
75	64-QAM	64-QAM	64-QAM	QPSK	¾	20	52	4	1040	780	195	216.7
76	64-QAM	64-QAM	64-QAM	16-QAM	¾	22	52	4	1144	858	214.5	238.3

Table A-13—Rate-dependent parameters for optional 40 MHz, N_{SS} = 2 modes

MCS Index	Modulation		R	N_{TBPS}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mbps)	
	Stream 1	Stream 2							800 ns GI	400ns GI
33	16-QAM	QPSK	½	6	108	6	648	324	81	90
34	64-QAM	QPSK	½	8	108	6	864	432	108	120
35	64-QAM	16-QAM	½	10	108	6	1080	540	135	150
36	16-QAM	QPSK	3/4	6	108	6	648	486	121.5	135
37	64-QAM	QPSK	¾	8	108	6	864	648	162	180
38	64-QAM	16-QAM	3/4	10	108	6	1080	810	202.5	225

Table A-14 - Rate-dependent parameters for optional 40 MHz, N_{SS} = 3 modes

MCS Index	Modulation			R	N_{TBPS}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mbps)	
	Stream 1	Stream 2	Stream 3							800 ns GI	400ns GI
39	16-QAM	QPSK	QPSK	½	8	108	6	864	432	108	120
40	16-QAM	16-QAM	QPSK	½	10	108	6	1080	540	135	150
41	64-QAM	QPSK	QPSK	½	10	108	6	1080	540	135	150
42	64-QAM	16-QAM	QPSK	½	12	108	6	1296	648	162	180
43	64-QAM	16-QAM	16-QAM	½	14	108	6	1512	756	189	210
44	64-QAM	64-QAM	QPSK	½	14	108	6	1512	756	189	210
45	64-QAM	64-QAM	16-QAM	½	16	108	6	1728	864	216	240
46	16-QAM	QPSK	QPSK	¾	8	108	6	864	648	162	180
47	16-QAM	16-QAM	QPSK	¾	10	108	6	1080	810	202.5	225
48	64-QAM	QPSK	QPSK	¾	10	108	6	1080	810	202.5	225
49	64-QAM	16-QAM	QPSK	¾	12	108	6	1296	972	243	270
50	64-QAM	16-QAM	16-QAM	¾	14	108	6	1512	1134	283.5	315
51	64-QAM	64-QAM	QPSK	¾	14	108	6	1512	1134	283.5	315
52	64-QAM	64-QAM	16-QAM	¾	16	108	6	1728	1296	324	360

Table A-15—Rate-dependent parameters for optional 40 MHz, N_{SS} = 4 modes

MCS Index	Modulation				R	N_{TBPS}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mbps)	
	Stream 1	Stream 2	Stream 3	Stream 4							800 ns GI	400ns GI
53	16-QAM	QPSK	QPSK	QPSK	½	10	108	6	1080	540	135	150
54	16-QAM	16-QAM	QPSK	QPSK	½	12	108	6	1296	648	162	180
55	16-QAM	16-QAM	16-QAM	QPSK	½	14	108	6	1512	756	189	210
56	64-QAM	QPSK	QPSK	QPSK	½	12	108	6	1296	648	162	180
57	64-QAM	16-QAM	QPSK	QPSK	½	14	108	6	1512	756	189	210
58	64-QAM	16-QAM	16-QAM	QPSK	½	16	108	6	1728	864	216	240
59	64-QAM	16-QAM	16-QAM	16-QAM	½	18	108	6	1944	972	243	270
60	64-QAM	64-QAM	QPSK	QPSK	½	16	108	6	1728	864	216	240

61	64-QAM	64-QAM	16-QAM	QPSK	½	18	108	6	1944	972	243	270
62	64-QAM	64-QAM	16-QAM	16-QAM	½	20	108	6	2160	1080	270	300
63	64-QAM	64-QAM	64-QAM	QPSK	½	20	108	6	2160	1080	270	300
64	64-QAM	64-QAM	64-QAM	16-QAM	½	22	108	6	2376	1188	297	330
65	16-QAM	QPSK	QPSK	QPSK	¾	10	108	6	1080	810	202.5	225
66	16-QAM	16-QAM	QPSK	QPSK	¾	12	108	6	1296	972	243	270
67	16-QAM	16-QAM	16-QAM	QPSK	¾	14	108	6	1512	1134	283.5	315
68	64-QAM	QPSK	QPSK	QPSK	¾	12	108	6	1296	972	243	270
69	64-QAM	16-QAM	QPSK	QPSK	¾	14	108	6	1512	1134	283.5	315
70	64-QAM	16-QAM	16-QAM	QPSK	¾	16	108	6	1728	1296	324	360
71	64-QAM	16-QAM	16-QAM	16-QAM	¾	18	108	6	1944	1458	364.5	405
72	64-QAM	64-QAM	QPSK	QPSK	¾	16	108	6	1728	1296	324	360
73	64-QAM	64-QAM	16-QAM	QPSK	¾	18	108	6	1944	1458	364.5	405
74	64-QAM	64-QAM	16-QAM	16-QAM	¾	20	108	6	2160	1620	405	450
75	64-QAM	64-QAM	64-QAM	QPSK	¾	20	108	6	2160	1620	405	450
76	64-QAM	64-QAM	64-QAM	16-QAM	¾	22	108	6	2376	1782	445.5	495

Appendix B – LDPC Matrix Definitions

(normative)

Table B.1
Matrix prototypes of parity-check matrices for codeword block length *n*= 648 bits.
Subblock size is *Z*= 27 bits.

(a)
Code rate *R*= 1/2.

0	-	-	-	0	0	-	-	0	-	-	0	1	0	-	-	-	-	-	-	-	-	-	-
22	0	-	-	17	-	0	0	12	-	-	-	-	0	0	-	-	-	-	-	-	-	-	-
6	-	0	-	10	-	-	-	24	-	0	-	-	-	0	0	-	-	-	-	-	-	-	-
2	-	-	0	20	-	-	-	25	0	-	-	-	-	-	0	0	-	-	-	-	-	-	-
23	-	-	-	3	-	-	-	0	-	9	11	-	-	-	-	0	0	-	-	-	-	-	-
24	-	23	1	17	-	3	-	10	-	-	-	-	-	-	-	-	0	0	-	-	-	-	-
25	-	-	-	8	-	-	-	7	18	-	-	0	-	-	-	-	-	0	0	-	-	-	-
13	24	-	-	0	-	8	-	6	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-
7	20	-	16	22	10	-	-	23	-	-	-	-	-	-	-	-	-	-	-	0	0	-	-
11	-	-	-	19	-	-	-	13	-	3	17	-	-	-	-	-	-	-	-	-	0	0	-
25	-	8	-	23	18	-	14	9	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
3	-	-	-	16	-	-	2	25	5	-	-	1	-	-	-	-	-	-	-	-	-	-	0

(b)

Code rate *R*= 2/3.

25	26	14	-	20	-	2	-	4	-	-	8	-	16	-	18	1	0	-	-	-	-	-	-
10	9	15	11	-	0	-	1	-	-	18	-	8	-	10	-	-	0	0	-	-	-	-	-
16	2	20	26	21	-	6	-	1	26	-	7	-	-	-	-	-	-	0	0	-	-	-	-
10	13	5	0	-	3	-	7	-	-	26	-	-	13	-	16	-	-	-	0	0	-	-	-
23	14	24	-	12	-	19	-	17	-	-	-	20	-	21	-	0	-	-	-	0	0	-	-
6	22	9	20	-	25	-	17	-	8	-	14	-	18	-	-	-	-	-	-	-	0	0	-
14	23	21	11	20	-	24	-	18	-	19	-	-	-	-	22	-	-	-	-	-	-	0	0
17	11	11	20	-	21	-	26	-	3	-	-	18	-	26	-	1	-	-	-	-	-	-	0

(c)

Code rate *R*= 3/4.

16	17	22	24	9	3	14	-	4	2	7	-	26	-	2	-	21	-	1	0	-	-	-	-
25	12	12	3	3	26	6	21	-	15	22	-	15	-	4	-	-	16	-	0	0	-	-	-
25	18	26	16	22	23	9	-	0	-	4	-	4	-	8	23	11	-	-	-	0	0	-	-
9	7	0	1	17	-	-	7	3	-	3	23	-	16	-	-	21	-	0	-	-	0	0	-
24	5	26	7	1	-	-	15	24	15	-	8	-	13	-	13	-	11	-	-	-	-	0	0
2	2	19	14	24	1	15	19	-	21	-	2	-	24	-	3	-	2	1	-	-	-	-	0

(d)

Code rate *R*= 5/6.

17	13	8	21	9	3	18	12	10	0	4	15	19	2	5	10	26	19	13	13	1	0	-	-
3	12	11	14	11	25	5	18	0	9	2	26	26	10	24	7	14	20	4	2	-	0	0	-
22	16	4	3	10	21	12	5	21	14	19	5	-	8	5	18	11	5	5	15	0	-	0	0
7	7	14	14	4	16	16	24	24	10	1	7	15	6	10	26	8	18	21	14	1	-	-	0

Table B.2
Matrix prototypes of parity-check matrices for codeword block length *n*= 1296 bits.
Subblock size is *Z*= 54 bits.

(a)

Code rate *R*= 1/2.

40	-	-	-	22	-	49	23	43	-	-	-	1	0	-	-	-	-	-	-	-	-	-	-
50	1	-	-	48	35	-	-	13	-	30	-	-	0	0	-	-	-	-	-	-	-	-	-
39	50	-	-	4	-	2	-	-	-	-	49	-	-	0	0	-	-	-	-	-	-	-	-
33	-	-	38	37	-	-	4	1	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-
45	-	-	-	0	22	-	-	20	42	-	-	-	-	-	-	0	0	-	-	-	-	-	-
51	-	-	48	35	-	-	-	44	-	18	-	-	-	-	-	-	0	0	-	-	-	-	-
47	11	-	-	-	17	-	-	51	-	-	-	0	-	-	-	-	-	0	0	-	-	-	-
5	-	25	-	6	-	45	-	13	40	-	-	-	-	-	-	-	-	-	0	0	-	-	-
33	-	-	34	24	-	-	-	23	-	-	46	-	-	-	-	-	-	-	-	0	0	-	-
1	-	27	-	1	-	-	-	38	-	44	-	-	-	-	-	-	-	-	-	-	0	0	-
-	18	-	-	23	-	-	8	0	35	-	-	-	-	-	-	-	-	-	-	-	-	0	0
49	-	17	-	30	-	-	-	34	-	-	19	1	-	-	-	-	-	-	-	-	-	-	0

(b)

Code rate *R*= 2/3.

39	31	22	43	-	40	4	-	11	-	-	50	-	-	-	6	1	0	-	-	-	-	-	-
25	52	41	2	6	-	14	-	34	-	-	-	24	-	37	-	-	0	0	-	-	-	-	-
43	31	29	0	21	-	28	-	-	2	-	-	7	-	17	-	-	-	0	0	-	-	-	-
20	33	48	-	4	13	-	26	-	-	22	-	-	46	42	-	-	-	-	0	0	-	-	-
45	7	18	51	12	25	-	-	-	50	-	-	5	-	-	-	0	-	-	-	0	0	-	-
35	40	32	16	5	-	-	18	-	-	43	51	-	32	-	-	-	-	-	-	-	0	0	-
9	24	13	22	28	-	-	37	-	-	25	-	-	52	-	13	-	-	-	-	-	-	0	0
32	22	4	21	16	-	-	-	27	28	-	38	-	-	-	8	1	-	-	-	-	-	-	0

(c)

Code rate *R*= 3/4.

39	40	51	41	3	29	8	36	-	14	-	6	-	33	-	11	-	4	1	0	-	-	-	-
48	21	47	9	48	35	51	-	38	-	28	-	34	-	50	-	50	-	-	0	0	-	-	-
30	39	28	42	50	39	5	17	-	6	-	18	-	20	-	15	-	40	-	-	0	0	-	-
29	0	1	43	36	30	47	-	49	-	47	-	3	-	35	-	34	-	0	-	-	0	0	-
1	32	11	23	10	44	12	7	-	48	-	4	-	9	-	17	-	16	-	-	-	-	0	0
13	7	15	47	23	16	47	-	43	-	29	-	52	-	2	-	53	-	1	-	-	-	-	0

(d)

Code rate *R*= 5/6.

48	29	37	52	2	16	6	14	53	31	34	5	18	42	53	31	45	-	46	52	1	0	-	-
17	4	30	7	43	11	24	6	14	21	6	39	17	40	47	7	15	41	19	-	-	0	0	-
7	2	51	31	46	23	16	11	53	40	10	7	46	53	33	35	-	25	35	38	0	-	0	0
19	48	41	1	10	7	36	47	5	29	52	52	31	10	26	6	3	2	-	51	1	-	-	0

Table B.3
Matrix prototypes of parity-check matrices for codeword block length *n*=1944 bits.
Subblock size is *Z* = 81 bits.

(a)
Code rate *R*= 1/2.

57	-	-	-	50	-	11	-	50	-	79	-	1	0	-	-	-	-	-	-	-	-	-	-
3	-	28	-	0	-	-	-	55	7	-	-	-	0	0	-	-	-	-	-	-	-	-	-
30	-	-	-	24	37	-	-	56	14	-	-	-	-	0	0	-	-	-	-	-	-	-	-
62	53	-	-	53	-	-	3	35	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-
40	-	-	20	66	-	-	22	28	-	-	-	-	-	-	-	0	0	-	-	-	-	-	-
0	-	-	-	8	-	42	-	50	-	-	8	-	-	-	-	-	0	0	-	-	-	-	-
69	79	79	-	-	-	56	-	52	-	-	-	0	-	-	-	-	-	0	0	-	-	-	-
65	-	-	-	38	57	-	-	72	-	27	-	-	-	-	-	-	-	-	0	0	-	-	-
64	-	-	-	14	52	-	-	30	-	-	32	-	-	-	-	-	-	-	-	0	0	-	-
-	45	-	70	0	-	-	-	77	9	-	-	-	-	-	-	-	-	-	-	-	0	0	-
2	56	-	57	35	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	0	0
24	-	61	-	60	-	-	27	51	-	-	16	1	-	-	-	-	-	-	-	-	-	-	0

(b)

Code rate *R*= 2/3.

61	75	4	63	56	-	-	-	-	-	-	8	-	2	17	25	1	0	-	-	-	-	-	-
56	74	77	20	-	-	-	64	24	4	67	-	7	-	-	-	-	0	0	-	-	-	-	-
28	21	68	10	7	14	65	-	-	-	23	-	-	-	75	-	-	-	0	0	-	-	-	-
48	38	43	78	76	-	-	-	-	5	36	-	15	72	-	-	-	-	-	0	0	-	-	-
40	2	53	25	-	52	62	-	20	-	-	44	-	-	-	-	0	-	-	-	0	0	-	-
69	23	64	10	22	-	21	-	-	-	-	-	68	23	29	-	-	-	-	-	-	0	0	-
12	0	68	20	55	61	-	40	-	-	-	52	-	-	-	44	-	-	-	-	-	-	0	0
58	8	34	64	78	-	-	11	78	24	-	-	-	-	-	58	1	-	-	-	-	-	-	0

(c)

Code rate *R*= 3/4.

48	29	28	39	9	61	-	-	-	63	45	80	-	-	-	37	32	22	1	0	-	-	-	-
4	49	42	48	11	30	-	-	-	49	17	41	37	15	-	54	-	-	-	0	0	-	-	-
35	76	78	51	37	35	21	-	17	64	-	-	-	59	7	-	-	32	-	-	0	0	-	-
9	65	44	9	54	56	73	34	42	-	-	-	35	-	-	-	46	39	0	-	-	0	0	-
3	62	7	80	68	26	-	80	55	-	36	-	26	-	9	-	72	-	-	-	-	-	0	0
26	75	33	21	69	59	3	38	-	-	-	35	-	62	36	26	-	-	1	-	-	-	-	0

(d)

Code rate *R*= 5/6.

13	48	80	66	4	74	7	30	76	52	37	60	-	49	73	31	74	73	23	-	1	0	-	-
69	63	74	56	64	77	57	65	6	16	51	-	64	-	68	9	48	62	54	27	-	0	0	-
51	15	0	80	24	25	42	54	44	71	71	9	67	35	-	58	-	29	-	53	0	-	0	0
16	29	36	41	44	56	59	37	50	24	-	65	4	65	52	-	4	-	73	52	1	-	-	0

Appendix C – Acronyms

BPSK	Binary Phase Shift Keying
CS	Cyclic Shift
CSD	Cyclic Shift Diversity
ECC	Error Correcting Code
EPP	Extended Phy Protection
FEC	Forward Error Correction
GF	Green Field
GI	Guard Interval
HT	High Throughput
LDPC	Low Density Parity Check
LDPCC	Low Density Parity Check Codes
LSB	Least Significant Bit
LTF	Long Training Field
MCS	Modulation and Coding Scheme
MIMO	Multiple Input Multiple Output
MM	Mixed Mode
MSB	Most Significant Bit
OFDM	Orthogonal Frequency Division Multiplexing
PAPR	Peak to Average Power Ratio
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
STA	Station
STBC	Space Time Block Codes
STF	Short Training Field
TxBF	Transmit Beam Forming

APPENDIX G

Documents

Join group

Everything 2006 TGn (inactive)
37

Created (ET) ▼	Year	DCN	Rev	Group	Title	Author (Affiliation)	Uploaded (ET)	Actions
23-Jan-2006 ET	2006	37	0	TGn	Tgn Minutes January 2006 Meeting	Garth Hillman (Advanced Micro Devices)	23-Jan-2006 00:00:00 ET	Download

Join group

APPENDIX H

IEEE P802.11
Wireless LANs

[Minutes of High Throughput Task Group .11n Session]				
Date: 2006-1-16				
Author(s):				
Name	**Company**	**Address**	**Phone**	**email**
Garth Hillman	Advanced Micro Devices	5204 East Ben White Austin TX 78741 MS: 625	(512) 602-7869	Garth.hillman @amd.com

Abstract

Cumulative minutes of the High Throughput Task Group meetings held during the IEEE 802.11 Interim session in Hawaii from January 16 through 20, 2006. The session was chaired by TGn chair Bruce Kraemer from Conexant.

Executive Summary (also see Chairs' meeting doc 11-05-1249r5 and closing report doc. 11-06-0222r0):

1. **TGn Joint Proposal team presented their complete proposal to the IEEE 802.11TGn body as contained in documents:**
   - **11-05-1095r5 [MAC]**
   - **11-05-1102r4 [PHY]**
2. **The JP proposal overview was presented to the body in documents:**
   - **11-06-0045r0 - Overview**
   - **11-05-1161r2 – Phy Details**
   - **11-05-1165r5 – MAC Details**
3. **Ample time was made available for Q&A**
4. **Confirmation vote on adopting the JP as the TGn baseline document was held and the body approved it unanimously (184,0,4)**
5. **A Technical Editor Election was held and Adrian Stephens from Intel was elected by acclamation.**
6. **An ad hoc committee was formed to develop a PICS and MIB in time for the March meeting; Adrian Stephens volunteered to chair this committee; first conference call set for Feb 20 at 11 AM EST**
7. **An ad hoc committee was formed to develop a Coexistence Assurance document; Sheung Li volunteered to chair this committee; first conference call set for Feb 20 at 4 PM EST**
8. **Plans for March meeting were discussed and included:**
   - **Presentation of draft & discussion**
   - **Presentation of CA; discussion; joint meeting with .19; vote?**
   - **Presentation of MIB & PICS; discussion; vote to incorporate in draft?**
   - **Review timeline**
   - **Set logistics for TGn peer review of draft before going to first LB**

Note: Relative to presentations, these minutes are intended to offer a brief summary (including document number) of each of the presentations to facilitate review and recall without having to read each of the presentations. Most of the 'presentation related' minutes are built directly from selected slides and therefore are not subjective. An effort was made to note obscure acronyms. As always Q&A is somewhat subjective/interpretive on my part and therefore subject to question.

****

Detailed cumulative minutes follow:

Monday; January 16, 2006; 10:30 AM – 3:30 PM [~ 175 attendees; 9 new]

1. Meeting was called to order by Task Group chair at 10:30PM
2. Chairs' Meeting Doc 11-05-1249rx

3. Chair read IEEE-SA Standards Board Bylaws on Patent Policy and additional Pat Com Guidance; chair noted change to 2006 version!
4. Chair reviewed topics NOT to be discussed during the meeting including – licensing, pricing, litigation, market share
5. Letters of Assurance (LOA) can be sent to Pat Com but details should not be discussed here
6. Attendance reminder – for this meeting attendance will be manual (IEEE registration desk) and on an honour system
7. Now is the time to confirm your voting status especially in view of the likely confirmation vote later this week – see Harry if you are unsure
8. Reminders:
   8.1. Make sure your badges are visible especially when voting
   8.2. No company logos on presentations
9. Chair reviewed history of .11n in order to provide the background to set the agenda for this meeting:
   9.1. HTSG formed in 9-11-02
   9.2. TGn formed 9-15-03
   9.3. Mar 05 1st confirm vote which failed
   9.4. July 05 formed JP
   9.5. Jan 06 JP proposal made to .11n
   9.6. Goal remains a ratified standard in April 2007
10. Nov proposal for January's Agenda reviewed and noted that it was based on JP proposal put on server by Jan 9, 2006
11. Exec Summary from Nov minutes 11-05-1148r0 presented
12. **Motion by Amer Hassan to approve Nov minutes, 11-05-1148r0, was seconded by Jon Rosdahl and approved unanimously**
13. Chair listed doc numbers posted by JP prior to this meeting as:
    13.1. 11-05-1095-04-000n Joint Proposal MAC Specification
    13.2. 11-05-1102-04-000n Joint Proposal PHY Specification
    13.3. 11-05-1268-01-000n TGn Joint Proposal MAC1 Results
    13.4. 11-05-1267-01-000n TGn Joint Proposal MAC Simulation Methodology
    13.5. 11-05-1266-01-000n TGn Joint Proposal MAC Results
14. Chair listed doc numbers of JP supporting documents
    14.1. 11-05-1269-00-000n TGn Joint Proposal MAC2 Results
    14.2. 11-05-1270-00-000n TGn Joint Proposal MAC3 Results
    14.3. 11-06-0046-00-000n TGn Joint Proposal FRCC Compliance
    14.4. 11-06-0067-00-000n TGn Joint Proposal PHY Results
    14.5. 11-06-0045-00-000n Joint Proposal Opening Report
15. Changes to Chair's list?
    15.1. 11-05-0067r0 to r1
    15.2. add new doc from Institute for Infocom Research, 11-06-0084r0
    15.3. add 11-05-1165r5, Joint Proposal MAC Detail which will be posted before lunch
16. Chair proposed an agenda for this meeting (granted 16 hours total) which was modified; the modified agenda is shown in the following table which is followed by a description of how the acceptance of the modifications were achieved:

	Jan 16	Jan 17	Jan 18	Jan 19	
Time	Monday	Tuesday	Wednesday	Thursday	Frid
8:00-10:00	⊘	⊘	⊘	First Confirmation vote at 9:00 AM	
10:30-12:30	Opening JP Overview	⊘	⊘	Comment Resolution	
13:30-15:30	PHY Rationale and Q & A	⊘	⊘	Second Confirmation vote	
16:00-18:00	⊘	MAC Rationale and Q&A	⊘	Technical editor Coexistence Plans for March	
19:30-21:30	⊘	Q & A	⊘	⊘	

17. Agenda overview
    17.1. Monday – AM2 admin and JP presentation, PM1 Q&A
    17.2. Tuesday 4 hours for Q&A
    17.3. Wednesday – no time allocated
    17.4. Thursday – AM1 Q&A, AM2 confirmation vote special order, PM1 Technical editor election (Sean Coffey has withdrawn his candidacy leaving only Adrian Stephens but nominations are still open), PM2 plans for Mar
18. Recommended change – Monday PM1 devoted to PHY presentation and MAC presentation Tuesday PM2 and evening was accepted
19. Other presentations? A – none
20. Other agenda items? A – none
21. Suggested 9 AM confirmation vote as special order on Thursday with a 2nd confirm vote if needed for Thursday PM1 was accepted
22. Confirmation vote procedure alternatives
    22.1. Show of hands
    22.2. Verbal but recorded
    22.3. Paper process
23. Discussion – our process calls for a roll call vote
24. OK - verbal or paper?
25. No objection to a verbal roll call vote
26. Note that the agenda can be changed with 2/3 majority; e.g., not use 2nd roll call vote

27. Need to change dates on columns of agenda from 9-12 to 16-20
28. **Motion to approve agenda on slide 22 with amendments by John Barr and seconded by Jim Petranovich was accepted without objection**
29. Presentation "JP Opening Report" 11-06-0045r0 Introduction by Jon Rosdahl
    29.1. JP has completed and is READY
    29.2. 300 meeting hours by JP since July
    29.3. JP team is united in its support of this proposal
30. Phy summary by Aon Mujtaba
    30.1. High Level changes since Nov
        30.1.1. Mandatory ~150 Mbps -> ~600 Mbps with Optional features (slide 17)
        30.1.2. Number of encoders: 1 below 300 Mbps and 2 above (added 5/6 coding)
        30.1.3. Parser – Group wise
        30.1.4. Antenna mapper – TX Beam Forming (BF) option
        30.1.5. GI – 400 ns optional
        30.1.6. Short MIMO preamble – Green Field optional
        30.1.7. HT-SIG modulation – 2 symbol 90 degree rotated Q-BPSK
        30.1.8. Scrambler initialization – Service Field in MAC Header
        30.1.9. MCS set – asymmetric MCS sets (for STBC and TxBF)
        30.1.10. Advanced Coding - LDPC
        30.1.11. Sounding packet Format – staggered preamble & zero-length Frame (both optional)
        30.1.12. STBC – 3x1 and 4x1 added as optional
31. MAC summary by Adrian Stephens
    31.1. High Level Changes since Nov
        31.1.1. Added new features
            31.1.1.1. PCO 20/40 MHz operation
            31.1.1.2. Greenfield & RIFS operation
            31.1.1.3. MIMO power saving
        31.1.2. A-MPDU – about 2.5 x Data/ACK (aggregation at bottom of MAC)
        31.1.3. A-MSDU - ~20% on top of A-MPDU (aggregation at top of MAC)
        31.1.4. Reverse Direction - ~25% benefit
        31.1.5. Enhanced Block ACK - ~5-10% benefit
        31.1.6. PSMP/MTBA – VoIP call density increase of up to 2x non-PSMP (power save multi-poll)
32. Final Thoughts by Jon Rosdahl
    32.1. complete
    32.2. Recommend body approve 11-05-1095r4 and 11-05-1102r4 as baseline in confirmation vote
33. Bruce presented changed agenda (see above) and noted we have 45 min remaining this AM; how to use this time?
34. Phy team preferred to wait until PM1 session at 1:30 PM before starting PHY details
35. Questions/Comments on Opening presentations
    35.1. really a home coming week for .11n
    35.2. proposal looks very good
36. Session was recessed at 11:45 AM until 1`:30 PM today

37. Session was reconvened at 1:32 PM by the Chair

38. JP PHY Overview, 11-05-1161r2 by Jim Petranovich and Aon Mujtaba
    38.1. What's New, Basic – Jim Petranovich
        38.1.1. Spatial Division Multiplexing through MIMO (most basic is # SS= # TX antennas)
        38.1.2. Bandwidth Expansion
        38.1.3. New MCS Sets
            38.1.3.1. Note – symmetrical indicates each spatial stream uses the same MCS
        38.1.4. Higher Rate Binary Convolutional Code
        38.1.5. New Frame Formats
        38.1.6. RIFS (Reduced Inter-frame Spacing)
    38.2. What's New, Advanced by Aon Mujtaba (Motivation was increased robustness and performance)
        38.2.1. Short GI option
        38.2.2. Spatial Expansion (all are linear transformations unlike SDM)
        38.2.3. Space-Time Block Codes (good for single stream devices)
        38.2.4. Channel Sounding (antenna to antenna sounding)
        38.2.5. Transmit Beam Forming (complex - affects virtually everything in PHY spec; due to loss of reciprocity over time use reciprocity with care)
        38.2.6. Low Density Parity Check Code (systematic =>input data + redundancy is transmitted)
        38.2.7. Synopsis – took Shannon's law and used every trick known to get as close as possible to it
    38.3. Conclusion
        38.3.1. JP PHY submission is a good basis for the 802.11n PHY specification
            38.3.1.1. Standardizes use of SDM and bandwidth expansion
            38.3.1.2. Provides for data rates up to 600 Mbps
                38.3.1.2.1. Includes state-of-the-art techniques to enhance throughput, including TxBF, STBC, and LDPC
            38.3.1.3. Extensible architecture meets the needs of many segments of the industry
                38.3.1.3.1. One spatial stream in clients and STBC support for hand-held segment
                38.3.1.3.2. Multiple spatial streams, TxBF, and channel sounding for CE segment
39. Chair asked for Questions from the floor
    39.1. PAR specs at least a 100 Mbps mode? A - yes but <100 Mbps modes are permitted and AP always supports >100 Mbps since 2 SS supported
    39.2. Options typically are not implemented? A – disagree in this case since options are NOT redundant and will be essential for some features
    39.3. The confluence of many markets drove this spec and precipitated the wide range of options and performance levels
40. If no more Qs now remember that email Qs can be submitted this week
41. Recall that we need a CA doc to go to LB; tomorrow 1:30 PM .19 TAG will review methodologies to analyze co-existence
42. We have 45 minutes remaining, should we start MAC? A – will require more than 1 hour so would rather not
43. **Motion to recess until Tuesday at 4:00 PM by Jon Rosdahl and seconded by Jim Petranovich passed unanimously**
44. Chair recessed the session at 2:38 PM until 4 PM tomorrow

Tuesday January 17, 2006; 4:00 – 9:30 PM

1. Chair called session to order at 4:01 PM
2. Adrian Stephens presented doc 11-05-1165r5, Joint Proposal MAC Detail; Part A up to slide 33
    a. Primary function of the MAC is aggregation
        i. A-MPDU (bottom of MAC)
        ii. A-MSDU (top of MAC)
        iii. Little benefit for fragmentation within Aggregation
        iv. Power Save Multi-poll (PSMP)/Multi-TID Block Ack (MTBA)
        v. Reverse Direction (RD)
        vi. High Throughput Control Bit
        vii. MIMO Power Save
        viii. Link Management
        ix. Implicit Channel Feedback
        x. Explicit Channel Feedback
3. Matt Fischer presented Part B of doc 11-05-1165r5; slide 33 to end
    a. Zero Length Frame
    b. Transmit Antenna Selection
    c. Coexistence Mechanisms
        i. PCO= Phased Coexistence Operation
    d. RIFs ~ 2 usec
    e. MAC Capabilities
    f. PHY Capabilities
    g. Summary of Value of Features
4. Questions
    a. MCS Request Feedback, is it in the HT control field? A – MCS is only a recommendation; end point will monitor carefully; no calibration testing
    b. Length information included? A – no
    c. MIMO Power Save; what does it mean? A – allows Rx to shut down all but one receiver until multiple Rx needed
    d. How much power saving? A – difficult to simulate; a mechanism to ensure not disadvantaged wrt SISO device
    e. A-MSDU mandatory? A – yes
    f. Will you always have QOS control field? A – no
    g. Slide 52; differences between 2nd and 3rd rows? A – simulation scenarios
    h. Non-QOS? A – QOS references VoIP and video, non-QOS does not
    i. Ratio? A – BW delivered vs. BW offered; QOS and non-QOS flows are simultaneously offered and load sized to be impossible to meet; measures how close a system can come
    j. Slide 20; is TID set a bit map? A – yes, EDCA only has 8 bits
    k. Slide 71; AS criteria time durations for sounding frames? A – 16 usec between frames and updating of selection info is implementation specific
    l. Slide 56; who should I talk to? A – Adrian re: Table 43 in spec
    m. Similar to clause in 7.2.2 in current standard; question use of BSS ID in address fields? A – sub frame header contains src and des; multiple src addresses are possible now so we choose BSSID; refer to Figure 28
    n. Text not clear? A – may need to clarify
    o. Note: A-MSDU is always a single hop frame and not forwarded

5. Are there enough questions (MAC or PHY) to justify using the evening session? No response
6. Comments from Floor
    a. Use reflector or directly email authors
    b. Also we have the Thursday 8:00 AM hour
7. Chair reviewed agenda for the rest of the week, namely:
    a. Confirmation Special Order at 9 AM on Thursday
    b. Technical Editor Election on Thursday
    c. Planning for March on Thursday
8. Chair noted that there still was only one nominee for editor, Adrian Stephens, and there is still time for additional nominations; sooner the better!!!
9. **Motion to recess until Thursday morning at 8:00AM by Jim Petranovich and seconded by Assaf Kasher passed unanimously**
10. Chair recessed session at 5:42 PM

Thursday January 19, 2006; 8:00 AM – 6:00 PM

1. Chair called the session to order at 8:04 AM
2. Chair reviewed plan for the day:
    a. 8-9AM – Q&A
    b. PHY doc now at rev 2 as two new companies have contributed to the sim results
    c. 9 AM – special order verbal roll call vote
    d. Comments or questions?
    e. Could we bring forward other topics to be addressed today? A - yes
3. Jon Rosdahl – spoke to encourage the membership to confirm the JP proposal as the baseline for TGn and noted that this does not mean it is accepted but rather that it is just the start of the amendment development process
4. **Motion by Jon Rosdahl and seconded by Adrian Stephens to "Conduct a confirmation vote on the existing proposal of record, the Joint Proposal, in 802.11-05/1095r5 and 802.11-05/1102r4 pursuant to the selection process step 17 (802.11-03/0665r9)" passed without objection**
5. Sheung Li gave TGn an update on the .19 as follows:
    a. PAR & 5C was created in .19 on Tuesday to form a coexistence recommended practice Task Group
    b. Need volunteers from .11n to join the task group when it is approved
    c. Coexistence with cordless phones and BT for example
    d. Pending confirmation of the JP Sheung will make a formal motion to form a .11n ad hoc group to develop a coexistence analysis which will comply with the recommended practice
    e. Document will be a PHY level analysis – e.g., if within x meters of a y radio you can expect z degradation
6. Only one nomination for Tech Editor has been received but floor is still open
7. Again chair asked for Questions? A – none
8. No objection to terminating Q&A
9. Chair recessed the session at 8:22 AM until 9 AM

10. Chair reconvened the session at 8:58 AM
11. **The verbal roll call confirmation vote was held and counted by WG executive**

12. **Confirmation vote results were (184,0,4); a 100% confirmation result which certainly exceeds the required 75% threshold!!!!!!!**
13. **At 9:45 a motion was made by Jim Petranovich and seconded by Adrian Stephens to recess until 10:30 AM passed unanimously**

14. Chair reconvened the session at 10:34
15. Technical Editor Election
    a. No new nominations
    b. Adrian Stephens accepted the nomination and made a presentation 11-05-0287r2 (his candidacy speech updated from last year)
    c. Still plans on forming a team of editors at 1 PM
    d. Goal - Initial Draft by March 2006
    e. What needs to be done before March?
        i. Planning meeting today in Kings 1 room
    f. Adrian Stephens was unanimously confirmed as Technical Editor
16. There will therefore be an editor planning meeting at 1 PM
17. **Motion by Jim Petranovich and seconded by Dave Andrus for TGn to instruct the TGn technical editor to include the text from**
    a. 11-05-1095-05-000n Joint Proposal MAC Specification
    b. 11-05-1102-04-000n Joint Proposal PHY Specification
    c. and prepare draft 0.01.
18. **JP Specs have been on the server for 4 hours**
19. **Motion passed unanimously**
20. Note that existing docs do not contain a MIB and PICS
21. Chair proposed that an ad hoc committee be formed to create the MIB and PICS and would meet between now and the March meeting
22. The earliest possible date given the 3 week notification period would be Feb 20
23. Would someone be willing to volunteer as chair of the ad hoc group?
24. Adrian Stephens volunteered, no one else volunteered
25. **Motion by Jim Petranovich and seconded by Eric Tokubo to Form an ad-hoc committee to create MIB and PICS documents for review during the March 2006 TGn meeting. Telecons to be held Feb 20 & 27 at 11:00 am EST passed unanimously**
26. Adrian Stephens was confirmed as the chair of the PICS/MIB ad hoc committee
27. Coexistence Committee ad hoc formation topic was introduced by the chair
28. Sheung Li volunteered to chair this ad hoc group should the members approve
29. **Motion by Tom Siep and seconded by Joe Levy to Form an ad-hoc committee to create a CA document for review during the March 2006 TGn meeting. Telecons to be held Feb 20 & 27 at 4pm EST.(Call coordinates to be distributed via WG reflector) passed unanimously**
30. Sheung was confirmed as CA ad hoc task group chair
31. Floor – add joint session with .19 to the March agenda? Chair agreed to do that.
32. Chair suggested the comments on existing technical docs be emailed to the TGn reflector between now and the March meeting
33. Chair reviewed a proposed agenda for the March meeting as follows:
    a. Between now and March
        i. Prepare specification for letter ballot
        ii. Prepare MIB , PICS & CA
        iii. Post by 1 week prior to meeting (Feb 27)

   b. March Meeting Plan (3 hours ad hoc + 16 hours)
      i. Presentation of draft & discussion
      ii. Presentation of CA discussion, vote?
      iii. Presentation of MIB & PICS; discussion, vote to incorporate in draft?
      iv. Review timeline
      v. Ready to release draft to letter ballot or steps remaining

34. Alternative suggestions?
    a. How have other groups proceeded, what is history
35. Editor is aware of next steps
36. CA never been done before
37. The TGr History was recounted
    a. 2 meetings to tune up initial draft
    b. Internal comment period
    c. CR on internal review
    d. 1st LB then submitted
    e. Note that TG must generate a voting pool
    f. 1st LB is 40 days
    g. Most comments came in the last 2 days
    h. So, 4 months between 1st and 2nd LB is likely
38. So let's consider an internal comment period after first draft prepared in March and have a LB release planned for May at the earliest?
39. Straw Poll to have an internal TG peer review before going to LB? (Y=32, N=1)
40. Floor comments
    a. draft needs much work and will likely take more than 2 months to complete a peer review
    b. may have draft before March meeting
    c. Editor job is to simply restructure document and not introduce any new tech content
    d. With draft will come a list of incomplete items as determined by editorial team
    e. Draft will not likely be available much before the March meeting; Adrian trying to control expectations
41. Chair stated he has enough guidance to create a March agenda proposal
42. Should we formally review time line now? A- no, chair should do it informally and address it formally in March
43. **Motion to adjourn by Jon Rosdahl and seconded by Jim Petranovich was passed unanimously**
44. Chair adjourned the meeting at 11:21 AM

APPENDIX I

OFFICIAL IEEE 802.11 WORKING GROUP PROJECT TIMELINES - 2023-11-21

IN PROCESS - Standards, Amendments, and Recommended Practices

IEEE Project and Final Document	Final Doc Type	Project Authorization Request (PAR)	Task Group and Activity	Documentation Session End Snapshot: Format & Version	Documentation Session End Snapshot: Incorporated Baselines	Current Status	PAR Approved, Modified, or Extended [Expires]	WG Letter Ballots: Draft / Predicted Initial	WG Letter Ballots: Date	WG Letter Ballots: Result / Predicted Recirc	Form Standards Association (SA) Ballot Pool / Reform	MEC / MDR Done	IEEE SA Ballots: Draft / Predicted Initial	IEEE SA Ballots: Date	IEEE SA Ballots: Result / Predicted Recirc	Final 802.11 WG Approval	Final or Conditional 802 EC Approval	RevCom & Standards Board Final or Continuous Process Approval	ANSI Approved	Superseded or Withdrawn by Standards Board
IEEE Std P802.11bn	A	Ultra High Reliability	TGbn		802.11-2020 802.11ax-2021 802.11ay-2021 802.11ba-2021 802.11-2020/Cor1-2022 802.11az-2022 802.11bd-2022 802.11bb-2023 802.11bc 802.11-2020/Cor2 802.11me 802.11bh 802.11be 802.11bk 802.11bf 802.11bi	Actual	2023-09-21 [2027-12-31]													
						Predicted	C	May 2025		May 2026	Mar 2027	May 2027	May 2027		Jul 2027	Mar 2028	Mar 2028	May 2028	N/A	
IEEE Std P802.11-2020/Cor2	COR	Correct 802.11bc identifer of EBCS ANQP element	WG Tech Ed	PDF D1.00	802.11-2020 802.11ax-2021 802.11ay-2021 802.11ba-2021 802.11-2020/Cor1-2022 802.11az-2022 802.11bd-2022 802.11bb-2023 802.11bc	Actual	2023-07-20 [2024-07-20]	D1.0	2023-10-25	100%										
						Predicted	C	C		Nov 2023	Oct 2023	Nov 2023	Nov 2023		Nov 2023	Nov 2023	Nov 2023	Jan 2024	N/A	
IEEE Std P802.11bk	A	320 MHz Positioning	TGbk	PDF D0.80	802.11-2020 802.11ax-2021 802.11ay-2021 802.11ba-2021 802.11-2020/Cor1-2022 802.11az-2022 802.11bd-2022 802.11bb-2023 802.11bc 802.11-	Actual	2022-12-03													
						Predicted	C	Nov 2023		Jan 2024	Jan 2024	Aug 2024	Mar 2024		May 2024	Sep 2024	Nov 2024	Nov 2024	N/A	

IEEE Project and Final Document	Final Doc Type	Project Authorization Request (PAR)	Task Group and Activity	Documentation Session End Snapshot: Format & Version	Documentation Session End Snapshot: Incorporated Baselines	Current Status	PAR Approved, Modified, or Extended [Expires]	WG Letter Ballots: Draft / Predicted Initial	WG Letter Ballots: Date / Predicted Recirc	WG Letter Ballots: Result	Form Standards Association (SA) Ballot Pool / Reform	MEC / MDR Done	IEEE SA Ballots: Draft / Predicted Initial	IEEE SA Ballots: Date / Predicted Recirc	IEEE SA Ballots: Result	Final 802.11 WG Approval	Final or Conditional 802 EC Approval	RevCom & Standards Board Final or Continuous Process Approval	ANSI Approved	Superseded or Withdrawn by Standards Board
					2020/Cor2 802.11me 802.11bh 802.11be															
IEEE Std P802.11bi	A	Enhanced Data Privacy	TGbi		802.11-2020 802.11ax-2021 802.11ay-2021 802.11ba-2021 802.11-2020/Cor1-2022 802.11az-2022 802.11bd-2022 802.11bb-2023 802.11bc 802.11-2020/Cor2 802.11me 802.11bh 802.11be 802.11bk 802.11bf	Actual	2021-02-10 [2025-12-31]													
						Predicted	C	May 2024	Dec 2024		Jan 2025	Jan 2025	May 2025	Jul 2025		Jan 2026	Jan 2026	Mar 2026	N/A	
IEEE Std P802.11me	A	802.11 Accumulated Maintenance Changes	TGme	PDF D4.10	802.11-2020 802.11ax-2021 802.11ay-2021 802.11ba-2021 802.11-2020/Cor1-2022 802.11az-2022 802.11bd-2022 802.11bb-2023 802.11bc 802.11-2020/Cor2	Actual	2021-02-10 [2025-12-31]	D1.0 D2.0 D3.0 D4.0	2022-01-10 2022-11-11 2023-05-07 2023-08-30	84% 87% 93% 96%	2023-05-01	2023-07-01	D4.0	2023-10-10	85%					
						Predicted	C	C	C		C	C	C	Feb 2024		Sep 2024	Sep 2024	Sep 2024	N/A	
IEEE Std P802.11bh	A	Randomized and Changing MAC Addresses	TGbh	PDF D1.00	802.11-2020 802.11ax-2021 802.11ay-2021 802.11ba-2021 802.11-2020/Cor1-2022 802.11az-2022 802.11bd-2022 802.11bb-2023 802.11bc 802.11-2020/Cor2 802.11me	Actual	2021-02-10 [2025-12-31]	D1.0	2023-07-01	92%										
						Predicted	C	C	Nov 2023		Jan 2024	Mar 2024	Mar 2024	May 2024		Jul 2024	Jul 2024	Sep 2024	N/A	
IEEE Std P802.11bf	A	WLAN Sensing	TGbf	PDF D2.10	802.11-2020 802.11ax-2021 802.11ay-	Actual	2020-09-25 [2024-12-31]	D1.0 D2.0	2023-03-02 2023-08-20	78% 86%										

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					2021 802.11ba-2021 802.11-2020/Cor1-2022 802.11az-2022 802.11bd-2022 802.11bb-2023 802.11bc 802.11-2020/Cor2 802.11me 802.11bh 802.11be 802.11bk	Predicted	C	C	C		Jan 2024	Jul 2024	May 2024	Sep 2024		Mar 2025	Mar 2025	May 2025	N/A	
IEEE Std P802.11be	A	Extremely High Throughput	TGbe	PDF D4.10	802.11-2020 802.11ax-2021 802.11ay-2021 802.11ba-2021 802.11-2020/Cor1-2022 802.11az-2022 802.11bd-2022 802.11bb-2023 802.11bc 802.11-2020/Cor2 802.11me 802.11bh	Actual	2019-03-21 [2025-12-31]	D2.0 D3.0 D4.0	2022-07-04 2023-03-02 2023-08-13	64% 80% 90%	2023-10-01	2023-09-01								
						Predicted	C	C	C		C	C	Jan 2024	Mar 2024		Sep 2024	Oct 2024	Dec 2024	N/A	
IEEE Std P802.11bc	A	Enhanced Broadcast Service	TGbc	PDF D7.00	802.11-2020 802.11ax-2021 802.11ay-2021 802.11ba-2021 802.11-2020/Cor1-2022 802.11az-2022 802.11bd-2022 802.11bb-2023	Actual	2018-12-05 [2022-12-31]	D1.0 D2.0 D3.0 D4.0	2020-12-20 2021-10-28 2022-04-28 2022-08-25	83% 90% 92% 95%	2022-09-01	2022-07-01	D4.0 D5.0 D6.0 D7.0	2022-11-04 2023-01-13 2023-02-21 2023-03-13	92% 97% 100% 100%	2023-03-01	2023-03-01			
						Predicted	C	C	C		C	C	C	C		C	C	Jun 2023	N/A	

PUBLISHED - Standards, Amendments, and Recommended Practices

IEEE Project and Final Document	Final Doc Type	Project Authorization Request (PAR)	Task Group and Activity	Documentation Session End Snapshot Format & Version	Documentation Session End Snapshot Incorporated Baselines	Current Status	PAR Approved, Modified, or Extended [Expires]	WG Letter Ballots Draft / Predicted Initial	WG Letter Ballots Date / Predicted Recirc	WG Letter Ballots Result	Form SA Ballot Pool / Reform	MEC / MDR Done	IEEE SA Ballots Draft / Predicted Initial	IEEE SA Ballots Date / Predicted Recirc	IEEE SA Ballots Result	Final 802.11 WG Approval	Final or Conditional 802 EC Approval	RevCom & Standards Board Final or Continuous Process Approval	ANSI Approved	Published
IEEE Std P802.11bb-	A	Light Communications	TGbb	PDF D7.00	802.11-2020 802.11ax-	Actual	2018-03-09 [2022-12-31]	D1.0 D2.0	2022-01-12 2022-04-22	87% 94%	2022-03-01	2022-03-01	D4.1 D5.0	2022-11-07 2023-01-14	91% 92%	2023-03-01	2023-03-01	2023-06-01		2023-11-11

IEEE Project and Final Document	Final Doc Type	Project Authorization Request (PAR)	Task Group and Activity	Documentation Session End Snapshot Format & Version	 Incorporated Baselines	Current Status	PAR Approved, Modified, or Extended [Expires]	WG Letter Ballots Draft	 Date Predicted Initial	 Result Predicted Recirc	Form SA Ballot Pool / Reform	MEC / MDR Done	IEEE SA Ballots Draft	 Date Predicted Initial	 Result Predicted Recirc	Final 802.11 WG Approval	Final or Conditional 802 EC Approval	RevCom & Standards Board Final or Continuous Process Approval	ANSI Approved	Published
2023					2021 802.11ay-2021 802.11ba-2021 802.11-2020/Cor1-2022 802.11az-2022 802.11bd-2022			D3.0 D4.0	2022-08-31 2022-10-01	95% 99%			D6.0 D7.0	2023-02-21 2023-03-14	96% 100%					
IEEE Std P802.11bd-2022	A	Enhancements for Next Generation V2X	TGbd	PDF D8.00	802.11-2020 802.11ax-2021 802.11ay-2021 802.11ba-2021 802.11-2020/Cor1-2022 802.11az-2022	Actual	2018-12-05 [2022-12-31]	D1.0 D2.0 D3.0 D4.0	2020-11-18 2021-08-01 2021-12-16 2022-03-30	82% 88% 94% 99%	2021-12-02	2022-03-01	D4.0 D5.0 D6.0 D7.0 D8.0	2022-05-09 2022-07-05 2022-08-30 2022-09-30 2022-10-14	92% 93% 95% 97% 97%	2022-09-16	2022-10-04	2022-12-01		2023-03-10
IEEE Std P802.11az-2022	A	Next Generation Positioning	TGaz	PDF D7.00	802.11-2020 802.11ax-2021 802.11ay-2021 802.11ba-2021 802.11-2020/Cor1-2022	Actual	2015-09-03 [2023-12-31]	D1.0 D2.0 D3.0 D4.0 D4.0	2019-03-09 2020-01-03 2021-02-10 2021-09-07 2021-10-01	79% 87% 88% 95% 98%	2021-08-01	2021-07-01	D4.0 D5.0 D6.0 D7.0	2021-11-05 2022-06-09 2022-09-07 2022-09-29	93% 94% 99% 100%	2022-09-16	2022-10-04	2022-12-01		2023-03-03
IEEE Std P802.11-2020/Cor1-2022	COR	Correct 802.11ay Assignment of Protected Announce Support Bit	WG Tech Ed	PDF D2.10	802.11-2020 802.11ax-2021 802.11ay-2021 802.11ba-2021	Actual	2022-02-23 [2026-12-31]	D1.0 D2.1	2022-04-14 2022-06-01	99% 100%	2022-05-01	2022-06-01	D2.1	2022-07-08	100%	2022-07-01	2022-07-01	2022-09-21		2022-12-27
IEEE Std P802.11ba-2021	A	Wake Up Radio	TGba	PDF D8.00	802.11-2020 802.11ax-2021 802.11ay-2021	Actual	2016-12-07 [2020-12-31]	D1.0 D2.0 D3.0 D4.0 D5.0 D6.0	2018-10-24 2019-03-03 2019-06-18 2019-10-15 2019-12-17 2020-02-01	72% 82% 84% 90% 96% 99%	2019-08-01	2019-11-01	D6.0 D7.0 D8.0	2020-03-18 2020-10-01 2020-12-21	91% 95% 98%	2020-11-01	2020-11-01	2021-03-01		2021-10-08
IEEE Std P802.11ay-2021	A	Next Generation 60GHz	TGay	PDF D7.00	802.11-2020 802.11ax-2021	Actual	2015-03-26 [2021-12-31]	D1.0 D2.0 D3.0 D4.0 D5.0	2018-01-07 2018-08-31 2019-02-28 2019-07-08 2019-11-08	74% 93% 93% 98% 99%	2019-06-01	2019-07-16	D5.0 D6.0 D7.0	2020-01-09 2020-09-29 2020-12-20	89% 92% 98%	2020-11-01	2020-11-01	2021-03-01		2021-07-28
IEEE Std P802.11ax-2021	A	High Efficiency WLAN	TGax	PDF D8.00	802.11-2020	Actual	2014-03-27 [2020-12-31]	D1.0 D2.0 D3.0 D4.0 D5.0 D6.0	2017-01-08 2017-11-04 2018-07-01 2019-02-25 2019-10-24 2019-12-11	58% 63% 87% 92% 94% 97%	2019-09-01	2019-05-01	D6.0 D7.0 D8.0	2020-01-24 2020-09-17 2020-11-27	82% 88% 95%	2020-09-01	2020-11-01	2021-02-01		2021-05-19
IEEE Std P802.11-2020	STD	802.11 Accumulated Maintenance Changes	TGmd	PDF D5.00	802.11-2016	Actual	2017-03-23 [2021-12-31]	D1.0 D2.0 D3.0	2018-03-17 2019-01-10 2019-10-30	85% 93% 96%	2019-09-01	2019-05-01	D3.0 D4.0 D5.0	2019-12-15 2020-09-04 2020-10-04	83% 91% 97%	2020-09-01	2020-10-01	2020-12-01		2021-02-26

SUPERSEDED OR WITHDRAWN - Standards, Amendments, and Recommended Practices

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IEEE Std P802.11aq-2018	A	Pre-Association Discovery	TGaq	PDF D14.00	802.11-2016 802.11ai-2016 802.11-2020 802.11ah-2016 802.11aj-2018 802.11ak-2018	Actual	2012-12-05 [2018-12-31]	D1.0 D3.0 D4.0 D5.0 D6.0 D7.0	2015-03-04 2015-11-07 2016-04-21 2016-07-19 2016-08-19 2016-09-25	73% 93% 93% 93% 96% 97%	2016-08-01	2016-06-01	D7.0 D8.0 D9.0 D10.0 D12.0 D13.0 D14.0 D14.0	2016-11-04 2017-03-18 2017-06-23 2017-07-29 2017-10-01 2017-10-30 2018-01-04 2018-01-31	88% 91% 94% 98% 97% 97% 98% 99%	2018-03-07	2018-03-09	2018-06-14		2018-08-31
IEEE Std P802.11ak-2018	A	General Link	TGak	PDF D6.00	802.11-2016 802.11ai-2016 802.11-2020 802.11ah-2016 802.11aj-2018	Actual	2012-12-05 [2018-12-31]	D1.0 D2.0 D3.0 D4.0	2015-05-06 2016-03-10 2017-01-10 2017-03-30	85% 91% 94% 95%	2016-11-01	2016-11-01	D4.0 D5.0 D6.0	2017-05-11 2017-11-09 2018-01-01	90% 93% 97%	2018-01-19	2018-01-31	2018-03-08		2018-06-14
IEEE Std P802.11aj-2018	A	China Millimeter Wave	TGaj	PDF D9.00	802.11-2016 802.11ai-2016 802.11-2020 802.11ah-2016	Actual	2012-08-01 [2018-12-31]	D1.0 D2.0 D3.0 D4.0 D5.0	2016-01-20 2016-06-30 2016-08-30 2016-12-21 2017-03-04	88% 89% 89% 92% 95%	2017-01-01	2016-11-01	D6.0 D7.0 D8.0 D9.0 D14.0	2017-06-25 2017-08-04 2017-08-24 2017-12-17 2018-01-04	98% 100% 100% 100% 98%	2017-11-10	2017-11-10	2018-01-24		2018-04-18
IEEE Std P802.11-2016	STD	802.11 Accumulated Maintenance Changes	TGmc	PDF D8.00	802.11-2012 802.11ae-2012 802.11aa-2012 802.11ad-2012 802.11ac-2013 802.11af-2013	Actual	2012-08-30 [2016-12-31]	D1.0 D2.0 D3.0 D4.0 D4.0	2013-03-02 2013-10-23 2014-06-23 2015-02-17 2015-03-26	88% 90% 90% 94% 96%	2014-09-01	2014-07-01	D4.0 D5.0 D6.0 D7.0 D8.0	2015-04-26 2016-01-26 2016-06-30 2016-08-20 2016-09-08	88% 90% 93% 97% 99%	2016-09-01	2016-10-01	2016-12-07		2017-12-31
IEEE Std P802.11ah-2016	A	Sub 1 GHz	TGah	PDF D10.00	802.11-2016 802.11ai-2016 802.11-2020	Actual	2010-10-04 [2016-12-31]	D1.0 D2.0 D3.0 D4.0 D5.0 D5.0	2013-11-04 2014-07-05 2014-10-25 2015-02-14 2015-04-16 2015-10-03	73% 83% 90% 93% 93% 98%	2015-04-01	2016-02-01	D5.0 D6.0 D7.0 D8.0 D9.0 D10.0	2015-11-05 2016-03-02 2016-04-14 2016-05-17 2016-09-09 2016-09-30	91% 91% 92% 95% 95% 96%	2016-09-01	2016-10-01	2016-12-07		2017-05-10
IEEE Std P802.11ai-2016	A	Fast Initial Link Setup	TGai	PDF D11.00	802.11-2016	Actual	2010-12-08 [2016-12-31]	D1.0 D2.0 D3.0 D4.0 D5.0 D6.0	2013-09-12 2014-05-07 2014-10-14 2015-02-24 2015-06-26 2015-07-31	74% 85% 88% 90% 92% 97%	2015-03-01	2014-11-01	D6.0 D7.0 D8.0 D9.0 D9.0 D11.0	2015-09-15 2016-03-30 2016-07-13 2016-08-06 2016-09-09 2016-09-30	90% 89% 93% 95% 97% 95%	2016-09-01	2016-10-01	2016-12-07		2016-12-31
IEEE Std P802.11af-2013	A	TV White Spaces	TGaf	PDF D6.00	802.11-2012 802.11ae-2012 802.11aa-2012 802.11ad-2012 802.11ac-2013	Actual	2009-12-09 [2013-12-31]	D1.0 D2.0 D3.0 D4.0 D5.0 D5.0	2011-02-24 2012-08-19 2013-02-08 2013-04-17 2013-06-14 2013-08-01	62% 79% 87% 92% 94% 99%	2013-06-01	2013-11-01	D5.0 D6.0 D6.0	2013-09-11 2013-10-19 2013-10-30	97% 99% 99%	2013-11-01	2013-11-01	2013-12-11		2014-02-21
IEEE Std P802.11ac-2013	A	Very High Throughput 6GHz	TGac	PDF D7.00	802.11-2012 802.11ae-2012 802.11aa-2012 802.11ad-2012	Actual	2008-09-26 [2012-12-31]	D1.0 D2.0 D3.0 D4.0 D5.0 D5.0	2011-06-25 2012-02-18 2012-06-25 2012-11-01 2013-02-01 2013-04-04	74% 89% 91% 94% 95% 96%	2013-01-01	2013-01-01	D5.0 D6.0 D7.0	2013-05-05 2013-08-03 2013-10-23	93% 97% 99%	2013-11-01	2013-11-01	2013-12-09		2013-12-18
IEEE Std P802.11ad-2012	A	Very High Throughput 60GHz	TGad	PDF D9.00	802.11-2012 802.11ae-2012 802.11aa-2012	Actual	2008-12-10 [2012-12-31]	D1.0 D2.0 D3.0 D4.0 D5.0 D5.0	2010-10-24 2011-04-05 2011-06-01 2011-08-09 2011-10-06 2011-11-24	87% 88% 92% 95% 94% 95%	2011-09-01	2011-07-01	D5.0 D6.0 D7.0 D8.0 D9.0 D9.0	2012-01-05 2012-03-30 2012-05-11 2012-06-16 2012-07-28 2012-08-12	86% 90% 95% 97% 98% 98%	2012-07-01	2012-07-01	2012-10-23		2012-12-28
IEEE Std P802.11aa-2012	A	Video Transport Streams	TGaa	Word / PDF D9.00	802.11-2012 802.11ae-2012	Actual	2008-03-27 [2012-12-31]	D1.0 D2.0 D3.0 D4.0 D5.0	2010-07-10 2010-12-08 2011-02-24 2011-04-09 2011-06-17	78% 79% 81% 85% 90%	2011-06-30	2011-06-16	D6.0 D7.0 D8.0 D9.0	2011-10-12 2011-11-26 2012-01-02 2012-01-27	93% 96% 99% 100%	2012-01-28	2012-02-17	2012-06-01		2012-05-29

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								D6.0 D6.0	2011-08-09 2011-08-31	94% 95%										
IEEE Std P802.11ae-2012	A	Prioritization of Management Frames	TGae	PDF D8.00	802.11-2012	Actual	2009-12-09 [2010-10-15]	D1.0 D2.0 D3.0 D4.0 D5.0	2010-10-27 2011-02-18 2011-04-26 2011-06-18 2011-08-04	81% 86% 89% 96% 96%	2011-07-01	2011-05-01	D5.0 D6.0 D7.0 D8.0	2011-09-09 2011-10-29 2011-12-13 2012-01-04	95% 96% 100% 100%	2012-01-20	2012-02-17	2012-03-01		2012-04-06
IEEE Std P802.11-2012	STD	802.11 Accumulated Maintenance Changes	TGmb	Frame / PDF D9.01	802.11-2007 802.11k-2008 802.11r-2008 802.11y-2008 802.11w-2009 802.11n-2009 802.11p-2010 802.11z-2010 802.11v-2011 802.11u-2011 802.11s-2011	Actual	2007-03-22 [2011-12-31]	D1.0 D2.0 D3.0 D4.0 D5.0	2009-06-27 2010-01-08 2010-04-25 2010-06-25 2010-08-19	87% 89% 89% 89% 92%	2010-09-14	2010-09-01	D6.0 D7.0 D8.0 D9.0 D10.0 D11.0 D12.0	2010-11-05 2011-02-18 2011-04-14 2011-06-22 2011-09-07 2011-10-22 2011-11-13	87% 90% 92% 93% 92% 94% 97%	2011-11-11	2011-11-11	2012-03-01		2012-03-29
IEEE Std P802.11s-2011	A	Mesh Networking	TGs	PDF	802.11-2007 802.11k-2008 802.11r-2008 802.11y-2008 802.11w-2009 802.11n-2009 802.11p-2010 802.11z-2010 802.11v-2011 802.11u-2011	Actual	2004-05-13 [2010-12-31]	D1.0 D2.0 D3.0 D4.0 D5.0 D6.0 D7.0	2007-01-06 2008-05-03 2009-05-04 2010-01-08 2010-04-15 2010-06-28 2010-08-13	48% 61% 79% 85% 89% 89% 95%	2010-09-12	2010-09-29	D7.0 D8.0 D9.0 D10.0 D11.0	2010-11-01 2011-01-10 2011-03-05 2011-04-09 2011-05-07	95% 96% 95% 97% 97%	2011-07-01	2011-07-01	2011-08-01		2012-03-01
IEEE Std P802.11u-2011	A	InterWorking with External Networks	TGu	Frame / PDF D13.00	802.11-2007 802.11k-2008 802.11r-2008 802.11y-2008 802.11w-2009 802.11n-2009 802.11p-2010 802.11z-2010 802.11v-2011	Actual	2004-12-08 (02/05/2008) [2010-12-31]	D1.0 D2.0 D3.0 D4.0 D5.0 D6.0 D7.0 D8.0	2007-07-08 2008-03-15 2008-07-12 2008-10-08 2009-02-20 2009-04-24 2009-06-19 2009-08-18	64% 70% 77% 78% 82% 90% 88% 93%	2009-06-01	2009-07-12	D8.0 D9.0 D10.0 D11.0 D12.0 D13.0	2009-11-07 2010-04-23 2010-07-08 2010-08-13 2010-09-12 2010-11-21	90% 92% 94% 96% 98% 99%	2010-11-01	2010-11-01	2011-02-25		2012-03-01
IEEE Std P802.11v-2011	A	Wireless Network Management	TGv	Frame / PDF D16.00	802.11-2007 802.11k-2008 802.11r-2008 802.11y-2008 802.11w-2009 802.11n-2009 802.11p-2010 802.11z-2010	Actual	2004-12-08 [2010-12-31]	D1.0 D2.0 D3.0 D4.0 D5.0 D6.0 D7.0	2007-08-30 2008-03-15 2008-07-13 2008-12-19 2009-04-04 2009-06-12 2009-08-07	63% 67% 69% 81% 83% 90% 92%	2009-06-01	2009-07-12	D7.0 D9.0 D10.0 D11.0 D12.0 D13.0 D14.0 D15.0 D15.0 D16.0	2009-11-07 2010-02-17 2010-04-13 2010-06-10 2010-07-07 2010-07-28 2010-08-25 2010-10-18 2010-09-30 2010-11-15	81% 84% 87% 92% 94% 98% 98% 98% 98% 98%	2010-11-01	2010-11-01	2011-02-09		2012-03-01
IEEE Std P802.11z-2010	A	Extensions to Direct Link Setup	TGz	Word / PDF D13.00	802.11-2007 802.11k-2008 802.11r-2008 802.11y-2008 802.11w-2009 802.11n-2009 802.11p-2010	Actual	2007-08-22	D1.0 D2.0 D3.0 D4.0 D5.0 D6.0	2008-05-03 2008-08-20 2008-12-18 2009-03-05 2009-06-23 2009-08-26	64% 66% 84% 88% 92% 96%	2009-06-01	2009-06-18	D6.0 D7.0 D8.0 D9.0 D11.0 D13.0	2009-11-07 2010-02-27 2010-05-04 2010-06-10 2010-08-04 2010-08-29	87% 87% 94% 95% 95% 98%	C	C	2010-10-01		2012-03-01
IEEE Std P802.11p-2010	A	Wireless Access for the Vehicular Environment	TGp	N/A	802.11-2007 802.11k-2008 802.11r-2008 802.11y-2008 802.11w-2009 802.11n-2009	Actual	2004-09-23	D1.0 D2.0 D3.0 D4.0 D5.0 D6.0 D7.0 D8.0 D9.0	2006-04-11 2007-01-05 2007-09-12 2008-05-03 2008-12-05 2009-03-31 2009-06-13 2009-08-05 2009-10-10	59% 67% 74% 79% 85% 89% 85% 89% 93%	2009-06-01	2008-06-19	D9.0 D10.0 D11.0	2009-11-22 2010-02-16 2010-04-07	93% 96% 99%	C	C	2010-07-15		2012-03-01
IEEE Std P802.11w-2009	A	Protected Management Frames	TGw	N/A	802.11-2007 802.11k-2008 802.11r-2008 802.11y-2008	Actual	2005-03-20	D1.0 D2.0 D3.0 D4.0 D5.0 D6.0	2006-11-19 2007-05-02 2007-10-19 2008-01-05 2008-02-20 2008-04-18	86% 89% 92% 92% 95% 97%	2007-11-13		D6.0 D7.0 D9.0 D10.0 D11.0	2008-09-24 2009-01-18 2009-05-23 2009-06-14 2009-06-28	86% 88% 92% 93% 95%	C	C	2009-09-11		2012-03-01

IEEE Project and Final Document	Final Doc Type	Project Authorization Request (PAR)	Task Group and Activity	Documentation: Session End Snapshot: Format & Version	Documentation: Session End Snapshot: Incorporated Baselines	Current Status	PAR Approved, Modified, or Extended [Expires]	WG Letter Ballots: Draft	WG Letter Ballots: Date (Predicted Initial)	WG Letter Ballots: Result (Predicted Recirc)	Form SA Ballot Pool / Reform	MEC / MDR Done	IEEE SA Ballots: Draft	IEEE SA Ballots: Date (Predicted Initial)	IEEE SA Ballots: Result (Predicted Recirc)	Final 802.11 WG Approval	Final or Conditional 802 EC Approval	RevCom & Standards Board Final or Continuous Process Approval	ANSI Approved	Superseded or Withdrawn by Standards Board
IEEE Std P802.11n-2009	A	High Throughput	TGn		802.11-2007 802.11k-2008 802.11r-2008 802.11y-2008 802.11w-2009	Actual	2003-09-11 [2007-09-27]	D1.0 D2.0 D3.0 D4.0 D5.0 D6.0 D7.0 D7.0	2006-04-29 2007-03-09 2007-10-27 2008-04-12 2008-06-12 2008-08-05 2008-09-30 2008-12-02	47% 83% 85% 88% 90% 91% 94% 95%	2008-12-11	2008-12-11	D7.0 D8.0 D9.0 D10.0 D11.0 D11.0	2009-01-10 2009-03-06 2009-04-04 2009-05-30 2009-07-03 2009-06-20	78% 80% 81% 88% 91% 90%	C	C	2009-09-11		2012-03-01
IEEE Std P802.11y-2008	A	3650-3700 MHz Operation in USA	TGy	N/A	802.11-2007 802.11k-2008 802.11r-2008	Actual	2006-03-16	D1.0 D2.0 D3.0 D4.0 D5.0 D6.0	2007-01-07 2007-05-05 2007-06-20 2007-08-21 2007-10-13 2007-12-08	76% 84% 91% 94% 96% 99%	2007-06-20	2007-07-28	D7.0 D8.0 D9.0 D10.0 D11.0	2008-01-30 2008-03-08 2008-03-27 2008-03-18 2008-06-20	93% 93% 96% 97% 97%	C	C	2008-11-06		2012-03-01
IEEE Std P802.11r-2008	A	Fast Roaming	TGr	N/A	802.11-2007 802.11k-2008	Actual	2006-05-25	D1.0 D2.0 D3.0 D4.0 D5.0 D6.0	2006-01-04 2006-04-04 2006-10-14 2006-12-04 2007-04-04 2007-06-13	81% 88% 86% 92% 95% 97%		2007-04-11	D7.0 D8.0 D9.0 D9.0	2007-08-30 2007-10-07 2008-02-01 2008-01-17	86% 90% 97% 96%	C	C	2008-05-09		2012-03-01
IEEE Std P802.11k-2008	A	Radio Resource Measurement	TGk	N/A	802.11-2007	Actual	2002-12-11	D1.0 D2.0 D3.0 D4.0 D5.0 D6.0 D7.0 D7.0	2007-09-11 2008-01-05 2004-09-11 2005-03-15 2005-11-12 2006-03-31 2006-09-16 2006-11-16 2007-02-13 2007-05-05	90% 100% 95% 86% 80% 81% 85% 91% 92% 93%		2007-04-10	D8.0 D9.0 D10.0 D11.0 D12.0 D12.0 D13.0	2007-08-13 2007-10-04 2007-12-08 2008-01-17 2008-02-14 2008-02-01 2008-03-18	90% 89% 91% 95% 95% 95% 97%	C	C	2008-05-09		2012-03-01
IEEE Std P802.11-2007	STD	802.11 Standard Maintenance Revision	TGma	N/A	802.11-1999 802.11c 802.11a-1999 802.11b-1999 802.11b Cor1-2001 802.11d-2001 802.11g-2003 802.11h-2003 802.11i-2004 802.11j-2004 802.11e-2005	Actual	2003-03-20 [2003-03-20]	D1.0 D2.0 D3.0 D4.0	2005-05-08 2005-07-17 2005-08-19 2005-09-19	91% 94% 95% 96%	2005-08-21	2005-08-21	D5.0 D6.0 D7.0 D8.0 D9.0	2005-11-20 2006-05-10 2006-07-11 2006-09-09 2006-11-07	86% 90% 91% 96% 96%	2006-11-08	2006-11-08	2007-03-08		2012-03-01
IEEE Std P802.11.2	RP	Wireless Performance	TGt			Actual	2008-12-31	D1.0	2007-05-16	76%										2008-05-14
IEEE Std P802.11e-2005	A	MAC Enhancements QoS	TGe	N/A	802.11-1999 802.11c 802.11a-1999 802.11b-1999 802.11b Cor1-2001 802.11d-2001 802.11g-2003 802.11h-2003 802.11i-2004 802.11j-2004	Actual	2000-03-30	D4.0 D5.0 D6.0 D7.0 D8.0	2001-05-15 2002-01-16 2002-07-02 2003-01-08 2003-08-22 2003-12-20 2004-02-15 2004-03-10	0% 55% 49% 83% 97% 89% 93% 94%			D8.0 D9.0 D10.0 D11.0 D12.0 D13.0 D13.0	2004-05-30 2004-08-31 2004-10-08 2004-11-11 2004-12-23 2005-04-16 2005-02-18	85% 87% 92% 95% 96% 99% 96%	2005-07-22	2005-07-22	2005-09-22		2007-03-08
IEEE Std P802.11j-2004	A	4.9 GHz-5 GHz Operation in Japan	TGj	N/A	802.11-1999 802.11c 802.11a-1999 802.11b-1999 802.11b Cor1-2001 802.11d-2001 802.11g-2003 802.11h-2003 802.11i-2004	Actual	2002-12-11	D1.0 D1.2 D1.3 D1.4	2003-05-12 2004-01-14 2004-03-11 2004-04-20	68% 89% 94% 95%	2004-05-13		D1.5 D1.6	2004-07-02 2004-08-14	88% 96%	C	C	2004-09-23	2005-02-02	2007-03-08
IEEE Std P802.11i-2004	A	MAC Security Enhancements	TGi	N/A	802.11-1999 802.11c 802.11a-1999	Actual	2001-05-30	D3.0 D4.0	2002-05-04 2003-01-12 2003-06-06	77% 76% 78%	2003-08-10		D7.0 D8.0	2003-12-20 2004-03-12	89% 92%	C	C	2004-06-24	2005-02-14	2007-03-08

IEEE Project and Final Document	Final Doc Type	Project Authorization Request (PAR)	Task Group and Activity	Documentation Session End Snapshot Format & Version	Incorporated Baselines	Current Status	PAR Approved, Modified, or Extended [Expires]	WG Letter Ballots Draft	Date Predicted Initial	Result Predicted Recirc	Form SA Ballot Pool / Reform	MEC / MDR Done	IEEE SA Ballots Draft	Date Predicted Initial	Result Predicted Recirc	Final 802.11 WG Approval	Final or Conditional 802 EC Approval	RevCom & Standards Board Final or Continuous Process Approval	ANSI Approved	Superseded or Withdrawn by Standards Board
					802.11b-1999 802.11b Cor1-2001 802.11d-2001 802.11g-2003 802.11h-2003			D5.0 D6.0 D7.0	2003-08-19 2003-10-09 2003-11-04	87% 92% 95%			D9.0 D10.0	2004-04-10 2004-05-08	98% 98%					
IEEE Std P802.11h-2003	A	Spectrum and Transmit Power Management Extensions in the 5 GHz Band in Europe	TGh	N/A	802.11-1999 802.11c 802.11a-1999 802.11b-1999 802.11b Cor1-2001 802.11d-2001 802.11g-2003	Actual	2000-12-07	D2.2	2001-09-03 2002-05-05 2002-09-01 2002-11-01	0% 76% 90% 97%	2002-07-25		D3.0 D3.11 D3.6	2003-02-06 2003-06-26 2003-04-30	92% 98% 96%	C	C	2003-09-11	2003-12-29	2007-03-08
IEEE Std P802.11g-2003	A	Further Higher Data Rate Extension in the 2.4 GHz Band	TGg	N/A	802.11-1999 802.11c 802.11a-1999 802.11b-1999 802.11b Cor1-2001 802.11d-2001	Actual	2000-09-21	D5.0 D4.0 D6.1	2002-03-11 2002-09-01 2003-01-08 2002-11-01 2003-02-04	45% 83% 88% 87% 89%	2002-07-25		D6.2 D7.1 D8.2	2003-03-09 2003-04-08 2003-05-14	84% 85% 96%	C	C	2003-06-12	2003-10-20	2007-03-08
IEEE Std P802.11b Cor1-2001	COR	Corrigenda to IEEE 802.11b-1999	TGb-Cor1		802.11-1999 802.11c 802.11a-1999	Actual	1999-11-27						D1.5	2001-04-13	98%	C	C	2001-10-10	2002-01-30	2007-03-08
IEEE Std P802.11d-2001	A	Operation in Additional Regulatory Domains	TGd	N/A	802.11-1999 802.11c 802.11a-1999 802.11b-1999 802.11b Cor1-2001	Actual	1999-06-26		2000-04-04 2000-06-26	0% 0%	2001-11-29		D2.0 D3.0	2001-03-01 2001-04-13	93% 100%	C	C	2001-06-14	2001-10-25	2007-03-08
IEEE Std P802.11b-1999	A	Higher Speed PHY Extension in the 2.4 GHz Band	TGb	N/A	802.11-1999 802.11c 802.11a-1999	Actual	1997-12-09		1998-11-09	0%						C	C	1999-09-16		2007-03-08
IEEE Std P802.11a-1999	A	Higher Speed PHY Extension in the 5GHz Band	TGa	N/A	802.11-1999	Actual	1997-09-16									C	C	1999-09-16	2000-02-04	2007-03-08
IEEE Std P802.11f-2003	RP	Inter-Access Point Protocol Across Distribution Systems Supporting IEEE 802.11 Operation	TGf	N/A		Actual	2000-03-30		2001-05-15 2001-09-03 2002-03-10 2002-06-16	0% 0% 82% 96%	2002-07-27		D4.0 D4.1 D5.0 D6.0	2002-10-28 2002-12-19 2003-02-17 2003-04-08	88% 95% 97% 98%	C	C	2003-06-12		2006-02-03
IEEE Std P802.11-1999	STD	Part II Wireless LAN Medium Access Control MAC and Physical Layer PHY Specifications	MAC/PHY	N/A		Actual	1997-12-09							2003-01-07 2003-04-09 2003-02-02	99% 99% 99%	C	C	1999-03-18	1999-07-15	2005-09-30
IEEE Std P802.11-1997	STD	IEEE Standard for Wireless LAN Medium Access Control MAC and Physical Layer PHY Specifications	MAC/PHY	N/A		Actual	1991-03-21									C	C	1997-06-26		1999-07-15
IEEE Std P802.11c	A	Media Access Control MAC Bridges - Supplement for Support by IEEE 802.11 [Rolled into IEEE 802.1D]	TGc	N/A	802.11-1999	Actual	1997-12-09													

Timeline Chart Notes:

C	=	Stage Completed or Currently In-Process	N/A	=	Not Applicable	MEC	=	IEEE-SA Mandatory Editorial Coordination	MDR	=	802.11 WG Mandatory Draft Review
A / COR	=	Amendment / Corrigendum	RP	=	Recommended Practice	Final 802.11 WG	=	Approval by 802.11 WG - Current WG Calendar			
Predicted	=	Current Date Estimate	SB	=	SA Ballot	Final or Conditional 802 EC	=	Approval by 802 EC at Plenary Session - Current 802 EC Plenary Calendar			
Date	=	Actual or Start Date	STD	=	Standard and/or Revision	RevCom/Standards Board	=	Approval of RevCom / IEEE-SA Standards Board in Normal Session - Current IEEE-SA Calendar			
LB	=	Letter Ballot	TG	=	Task Group	ANSI	=	American National Standards Institute			

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APPENDIX J

IEEE 802.11 FUTURE SESSION PLANS

IEEE 802.11 WLAN WORKING GROUP SESSIONS

All interested parties are welcome to attend our open Public meetings of the IEEE 802.11 Working Group, you do not have to be an IEEE member to attend. There is a registration fee, to defray the cost of the session. At Plenary sessions these are administered by the IEEE 802 LMSC organization. Interim sessions are administered by the IEEE 802.11/15 Working Groups. This is in-addition to your individual hotel accommodation, and travel expenses. Click here to view an Example Plenary and Interim Session Agenda, or review the latest Combined Tentative Agenda for the next IEEE 802.11 WG Session below.

For Year 2024			
January 14-19	Hilton Panama, Panama City, Panama (Re-booked from January 2022) Paid registration is required	203	Interim*
March 10-15	Hyatt Regency Denver at Colorado Convention Center, Denver, Co, USA (Re-booked from March 2021)	204	Plenary
May 12-17	Warsaw Marriott Hotel, Warsaw, Poland (Re-book from May 2020 and May 2022)	205	Interim*
July 14-19	Sheraton Le Centre Montreal, Montreal, Quebec, Canada (Re-booked from July 2020)	206	Plenary
September 8-13	Hilton Waikoloa Village, Waikoloa, Hawaii, USA	207	Interim*
November 10-15	Hyatt Regency Vancouver, Vancouver, British Columbia Canada	208	Plenary
For Year 2025			
January	Kobe Japan (TBC)	209	Interim*
March 9-14	Hilton Atlanta, Atlanta GA, USA (2 of 2 re-booked from March 2020)	210	Plenary
May 11-16	Hilton Prague, Prague (TBC)	211	Interim*
July 13-18	Melia Castilla Madrid, Madrid Spain (TBC)	212	Plenary
September 9-14	Hilton Waikoloa Village, Waikoloa, Hawaii, USA	213	Interim*
November 8-14	Marriott Marquis Queen's Park, Bangkok Thailand	214	Plenary
For Year 2026			
January 11-16	TBD	215	Interim*

March 7-13	Hyatt Regency Vancouver, Vancouver Canada	216	Plenary
May 10-15	TBD (Europe)	217	Interim*
July	TBD	218	Plenary
September 13-18	Hilton Waikoloa Village, Waikoloa, Hawaii, USA	219	Interim*
November 8-13	Marriott Marquis Queen's Park, Bangkok Thailand	220	Plenary
For Year 2027			
January 10-15	TBD	221	Interim*
March	Hilton Atlanta, Atlanta Georgia, USA	222	Plenary
May 9-14	TBD (Asia)	223	Interim*
July 10-16	Gothia Towers, Gothenburg, Sweden (TBC)	224	Plenary
September 12-17	Grand Hyatt Atlanta Buckhead, Atlanta Georgia, USA (TBC)	225	Interim*
November 14-19	Hilton Waikoloa Village, Waikoloa, Hawaii, USA	226	Plenary

NOTES

* *Denotes* - The IEEE 802.11 Working Group for Wireless Area Networks (WLANs) session is co-located with the IEEE 802.15 Working Group for Wireless Personal Area Networks (WPANs), IEEE 802.18 Technical Advisory Group for Radio Regulatory (R-REG), IEEE 802.19 Technical Advisory Group for Wireless Coexistence (COEX), and IEEE 802.24 Vertical Applications Technical Advisory Group session. A joint opening session with the Working Groups and the Technical Advisory Groups takes place at Interim sessions.

GENERAL SESSION INFORMATION

- New attendees should check the agenda file for any new members orientation session. This session typically takes place on Monday, and is intended to bring new attendees rapidly up to speed with how to operate effectively within the group.
- The Online Tentative Session Agenda displayed is always subject to change, after review at the start of the Full Working Group session for each meeting, and may be revised during the week to incorporate any necessary work.
- All Working Group sessions start promptly on time, as detailed in the session agenda.

- Attendees should bring a Laptop computer (or other small form factor computing device) equipped with 802.11 connectivity for use at the meetings. This is needed to access meeting documents and draft standards and to record meeting attendance.

- The Working Group operates under a hierarchy of IEEE, IEEE-SA, IEEE LMSC and 802.11 policies and procedures as described in http://www.ieee802.org/11/Rules/rules.shtml. You are deemed to be aware of and compliant to these rules by your participation in an 802.11 meeting.

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APPENDIX K

SUMMARY REPORT OF THE JANUARY 2006 MEETING OF IEEE 802.11:

Our January 2006 meeting was held at the Hilton Waikoloa Village, Kona, Hawaii. As of this meeting, the 802.11 membership consists of 519 voting members.

These **Ballots** were conducted in the weeks preceding this meeting:

- Letter Ballot 79 of **P802.11r**-D1.0 was conducted November 25, 2005 through Jan 4, 2006. It passed with 268 approve, 64 disapprove, and 72 abstain; an 81% approval. The return rate was 78%.

- Sponsor Ballot of **P802.11REV-ma**-D5.0 ran October 21 through November 20, 2005. It passed with 86 approve, 14 disapprove, and 8 abstain; an 86% approval. The return rate was 75%.

New Ballots from this meeting**:**

- The working group approved conducting a 15 day letter ballot to approve sending 802.11p draft 0.26 to letter ballot. If the 15 day ballot passes, then 802.11p draft 0.26 will be sent to a 40 day letter ballot as **P802.11p**-D1.0.

Other WG activities:

- The PAR and Five Criteria for 802.11Y (Contention Based Protocols) were approved by ExCom in November. However the item did not get on the NesCom agenda for their approval, so the group will continue to operate as the CBP SG through March 2006.
- Document 11-06-0154-01 was approved as a summary of the position of the IEEE 802.11 Working Group in regard to WAPI. Document 11-06-0149-02 was approved as the IEEE 802.11 Working Group general comments in regard to ISO/IEC JTC1 document 1N7904, supplementing the detailed comments in 11-05-1205-00
- Upcoming **Interim** **meeting locations** were discussed:
  - May 14 – 19, 2006 : Hyatt Regency in Jacksonville, FL.
  - September 17 - 21, 2004: Melbourne, Australia
  - January 14-19 2007: Hilton London Metropole
  - May 2007: Considering Cancun, Mexico and Montreal, Canada

The consolidated working group and task group **minutes** for this meeting are available here.

The reports for the individual task groups are linked below:

- **Project 802.11k, Radio Resource Measurement of Wireless LANs**
- **Project 802.11m, Maintenance PAR**
- **Project 802.11n, High Throughput**

- **Project 802.11p**, **Wireless Access in the Vehicular Environment**
- **Project 802.11r**, **Fast Roaming Fast Handoff**
- **Project 802.11s**, **Mesh Networking**
- **Project 802.11T**, **Wireless Performance Prediction**
- **Project 802.11u**, **Wireless Interworking With External Networks**
- **Project 802.11v**, **Wireless Network Management**
- **Project 802.11w**, **Protected Management Frames**
- **CBP SG** **(soon to be 802.11y),** **Contention Based Protocol Study Group**
- **WNG**, **Wireless LAN Next Generation Standing Committee**

Meeting Schedule:

The next meeting of 802.11 will take place March 5th-10th, 2006 at the Hyatt Regency Denver at CC Center, CO, USA. -See IEEE 802.11 Meeting Plan for details.

USEFUL LINKS TO OTHER SITES:

IEEE P802.11 WLANs RELATED

- FTP Site Archive
- E-mail Reflectors Archives (Members Only)

OTHER SITES

- IEEE P802 LAN/MAN Standards Committee (LMSC)
- IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)
- IEEE P802.18 Regulatory TAG
- IEEE P802.19 Coexistence TAG

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APPENDIX L

IEEE STANDARDS ASSOCIATION

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802.15.4-2015.pdf	3,568
802.1D-2004.pdf	2,563
802.3bw-2015.pdf	2,351
802.11ac-2013.pdf	2,303
802.3by-2016.pdf	2,085
802.1AB-2005.pdf	1,870

802.3bp-2016.pdf	1,856
802.11ad-2012.pdf	1,564
802.3.1-2013.pdf	1,400
802.1X-2010.pdf	1,366
802-1Q-2014_mibs.zip	1,336
802.11-2007.pdf	1,315
802.3bq-2016.pdf	1,307
802.15.1-2005.pdf	1,262
802.11i-2004.pdf	1,208
802.1AE-2006.pdf	1,193

New Program Entries

Standards added into program Since Jan 2017

802.11-2016.pdf	6,300
802.3by-2016.pdf	2,085
802.3bp-2016.pdf	1,856
802.3bq-2016.pdf	1,307
802.3bz-2016.pdf	1,060
802.11ai-2016_errata.zip	975
802.3bn-2016.pdf	823
802.3br-2016.pdf	646
802.1Qbu-2016.zip	575
802.15.3-2016.pdf	573
802.15.9-2016.pdf	395
802.1BA-2011_Cor_1-2016.pdf	334
802-1Qbz-2016.pdf	247

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Public network service provider	645
Standards developer	586
Systems administrator	485
Unknown	8
TOTAL	10,977

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Network silicon manufacturer	190
Network software developer	436
Other	1134
Private network service Provider	96
Public network service Provider	352
Standards developer	203
Systems administrator	235
Unknown	3
TOTAL	5,289

Thank You