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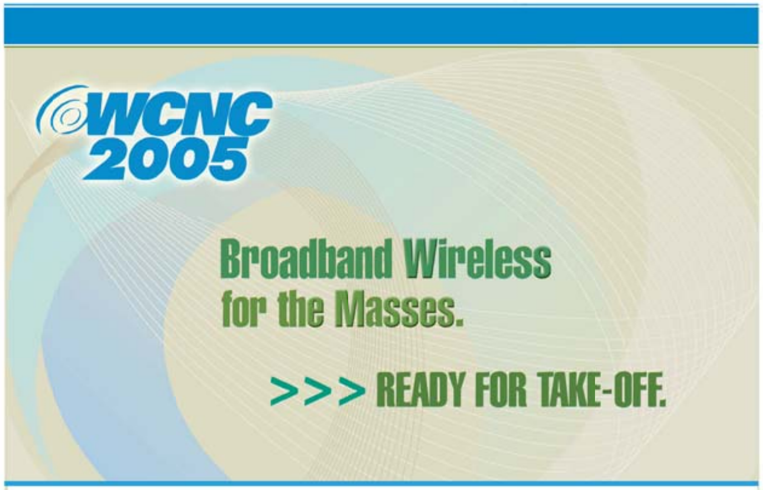

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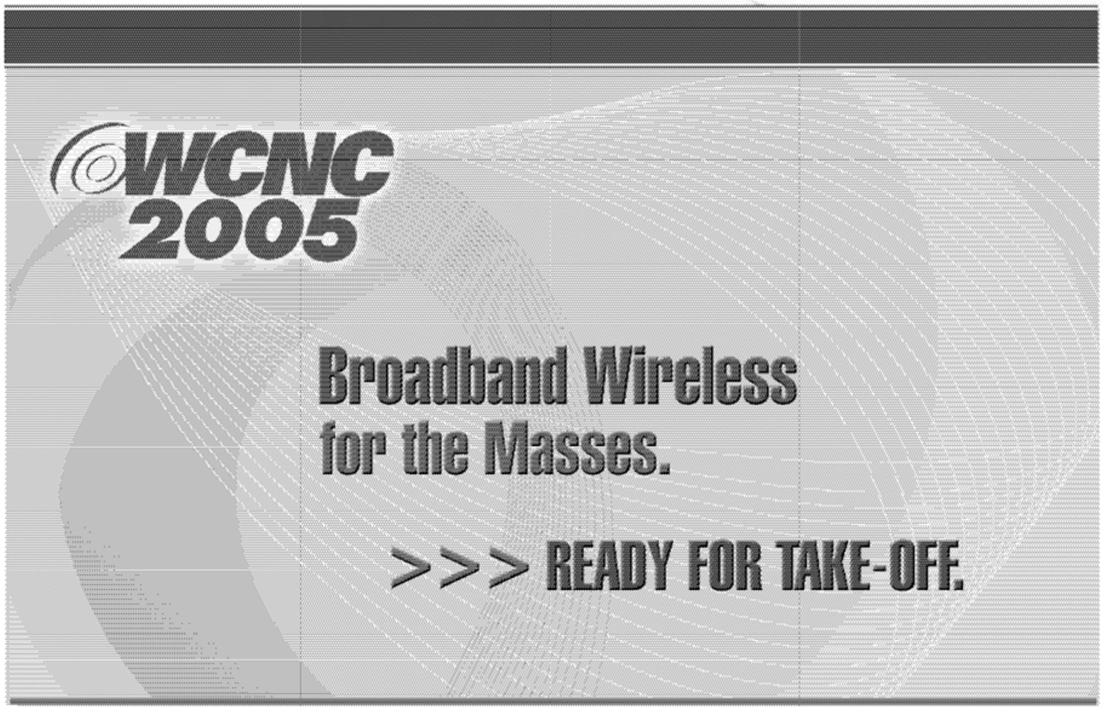

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Contents

Volume 1

Phy/MAC Symposium

PHY01: MIMO-OFDM Signal Processing

PHY01-1 Training Signal Design for MIMO OFDM Channel Estimation in the Presence of Frequency Offsets 1
Hlaing Minn (The University of Texas at Dallas, USA), Naofal Al-Dhahir (The University of Texas at Dallas, USA)

PHY01-2 Frequency Offset Tracking for MIMO OFDM Systems Using Pilots 7
Magnus Sandell (Toshiba Research Europe Ltd, UK), Darren McNamara (Toshiba Research Europe Ltd, UK), Steve Parker (Toshiba Research Europe Ltd, UK)

PHY01-3 Design of Optimal Pilot-Tones for Channel Estimation in MIMO-OFDM Systems 12
Zhongshan Wu (Louisiana State University, USA), Jianqiang He (Louisiana State University, USA), Guoxiang Gu (Louisiana State University, USA)

PHY01-4 Synchronization Algorithms for MIMO OFDM Systems 18
En Zhou (Beijing University of Posts & Telecommunications, China), Xing Zhang (Beijing University of Posts & Telecommunications, China), Hui Zhao (Beijing University of Posts & Telecommunications, China), Wenbo Wang (Beijing University of Posts & Telecommunications, China)

PHY02: OFDM I

PHY02-1 Subspace-based Noise Variance and SNR Estimation for OFDM Systems 23
Xiaodong Xu (Southeast University, P.R. China), Ya Jing (Southeast University, P.R. China), Xiaohu Yu (Southeast University, P.R. China)

PHY02-2 OFDM Phase Noise Cancellation via Approximate Probabilistic Inference 27
Darryl Dexu Lin (University of Toronto, Canada), Yi Zhao (University of Toronto, Canada), Teng Joon Lim (University of Toronto, Canada)

PHY02-3 A Programmable Baseband Receiver Platform for WCDMA/OFDM Mobile Terminals 33
Lasse Harju (Tampere University of Technology, Finland), Jari Nurmi (Tampere University of Technology, Finland)

PHY03: OFDM II

PHY03-1 Techniques for Suppression of Intercarrier Interference in OFDM Systems 39
Tiejun Wang (University of California, San Diego, USA), John G. Proakis (University of California, San Diego, USA), James R. Zeidler (University of California, San Diego, USA)

PHY03-2 A New Multicarrier Transceiver Based on the Discrete Cosine Transform 45
Naofal Al-Dhahir (The University of Texas at Dallas, USA), Hlaing Minn (The University of Texas at Dallas, USA)

PHY03-3 Antenna-Selective Transmit Diversity Technique for OFDM-based WLANs with Dual-Band Printed Antenna 51
Ichiro Seto (Toshiba Corporation, Japan), Takahiro Sekiguchi (Toshiba Corporation, Japan), Hidehiro Matsuoka (Toshiba Corporation, Japan), Akihiro Tsujimura (Toshiba Corporation, Japan), Syuichi Sekine (Toshiba Corporation, Japan), Kazumi Sato (Toshiba Corporation, Japan), Hiroshi Yoshida (Toshiba Corporation, Japan), Minoru Namekata (Toshiba Corporation, Japan)

PHY04: 802.11 MAC I

PHY04-1 A Throughput Optimization and Transmitter Power Saving Algorithm for IEEE 802.11b Links 57
Tianmin Mo (Virginia Polytechnic Institute and State University, USA), Charles W. Bostian (Virginia Polytechnic Institute and State University, USA)

PHY04-2 Adaptive IEEE 802.11 DCF Scheme with Knowledge-based Backoff 63
Srikant Kuppa (The University of Texas at Dallas, USA), Ravi Prakash (The University of Texas at Dallas, USA)

PHY04-3 Achieving Scalable Performance in Large-Scale IEEE 802.11 Wireless Networks 69
Chung Ng Ping (The Chinese University of Hong Kong, Hong Kong), Chang Liew Soung (The Chinese University of Hong Kong, Hong Kong), Bin Jiang Li (The Chinese University of Hong Kong, Hong Kong)

PHY04-4 Implementing a Low Power TDMA Protocol over 802.11 75
Jim Snow (Portland State University, USA), Wu-chi Feng (Portland State University, USA), Wu-chang Feng (Portland State University, USA)

PHY05: 802.11 MAC II

PHY05-1 Why RTS-CTS Is Not Your Ideal Wireless LAN Multiple Access Protocol ... 81
João Luís Sobrinho (Instituto de Telecomunicacões, Portugal), Roland de Haan (Instituto de Telecomunicacões, Portugal), José Manuel Brâzio (Instituto de Telecomunicacões, Portugal)

PHY05-2 Macrodiversity Packet Combining for the IEEE 802.11a Uplink ... 88
Shi Cheng (West Virginia University, USA), Matthew C. Valenti (West Virginia University, USA)

PHY05-3 Effects of Contention Window and Packet Size on the Energy Efficiency of Wireless Local Area Network ... 94
Xiaodong Wang (University of Cincinnati, USA), Jun Yin (University of Cincinnati, USA), Dharma P. Agrawal (University of Cincinnati, USA)

PHY05-4 Towards the Performance Analysis of IEEE 802.11 in Multihop Ad Hoc Networks ... 100
Yawen Barowski (Auburn University, USA), Saâd Biaz (Auburn University, USA), Prathima Agrawal (Auburn University, USA)

PHY06: 802.11 MAC III

PHY06-1 Evaluation of Contention Free Bursting in IEEE 802.11e Wireless LANs ... 107
Atul Salhotra (Marvell Semiconductor, Inc., USA), Ravi Narasimhan (University of California, Santa Cruz, USA), Rahul Kopikare (Marvell Semiconductor, Inc., USA)

PHY06-2 An Analytic Model for Infrastructure WLAN Capacity with Bidirectional Frame Aggregation ... 113
Changwen Liu (Intel R&D, USA), Adrian P. Stephens (Intel R&D, USA)

PHY06-3 A Link Adaptation Strategy for QoS Support in IEEE 802.11e-based WLANs ... 120
Matteo Bandinelli (University of Florence, Italy), Francesco Chiti (University of Florence, Italy), Romano Fantacci (University of Florence, Italy), Daniele Tarchi (University of Florence, Italy), Gianluca Vannuccini (University of Florence, Italy)

PHY06-4 Improving the Reliability of IEEE 802.11 Broadcast Scheme for Multicasting in Mobile Ad Hoc Networks ... 126
Jiawei Xie (Nanyang Technological University, Singapore), Amitabha Das (Nanyang Technological University, Singapore), Sukumar Nandi (Indian Institute of Technology, Guwahati, India), Anil K. Gupta (Nanyang Technological Univerisity, Singapore)

PHY07: Wireless Transmission Enhancements

PHY07-1 On the Advantages of Multihop Extensions to IEEE 802.11 Infrastructure Mode ... 132
Sathya Narayanan (Panasonic, USA), Pei Liu (Polytechnic University, USA), Shivendra S. Panwar (Polytechnic University, USA)

PHY07-2 Energy Efficient Channel Coding Based on Position Awareness and Radio Link Budget Estimation ... 139
M. Fresia (University of Genoa, Italy), A. Iscra (University of Genoa, Italy), F. Lavagetto (University of Genoa, Italy)

PHY07-3 MEOW with CATS: Multimedia Extensions over Wireless with CTS-assisted Transmission Scheme ... 145
Martin Kappes (Avaya Labs, Germany), A. S. Krishnakumar (Avaya Labs, USA), P. Krishnan (Avaya Labs, USA)

PHY07-4 Scheduling Algorithm Based on Sender Buffer Backlog for Real–Time Application in Mobile Packet Networks ... 151
Hideyuki Koto (KDDI R&D Laboratories, Inc., Japan), Masaki Fukushima (KDDI R&D Laboratories, Inc., Japan), Shinichi Nomoto (KDDI R&D Laboratories, Inc., Japan), Fumio Takahata (Waseda University, Japan)

PHY08: CDMA Link Design

PHY08-1 Throughput Analysis of Multirate VSG CDMA Wireless Packet Communication Systems in Rayleigh Fading Environment ... 158
Pongsatorn Sedtheetorn (The University of Manchester, UK), Khairi Ashour Hamdi (The University of Manchester, UK)

PHY08-2 Serial Block Processing for Multicode WCDMA Frequency Domain Equalization ... 164
Daniele Lo Iacono (STMicroelectronics, Italy), Ettore Messina (STMicroelectronics, Italy), Costantino Volpe (STMicroelectronics, Italy), Arnaldo Spalvieri (Politecnico di Milano, Italy)

PHY08-3 A Frequency-Domain Approach for Estimating Frequency Offset and Speed in 3G WCDMA Systems ... 171
M. Karthik (STMicroelectronics, Singapore), Kwok H. Li (Nanyang Technological University, Singapore), Ser W. Oh (STMicroelectronics, Singapore)

PHY08-4 A New Approach to Study the Effect of Carrier Frequency Offset on the BER Performance of Asynchronous MC-CDMA Systems ... 177
Xiaoyu Hu (Institute for Infocomm Research, Singapore, National University of Singapore, Singapore), Yong Huat Chew (Institute for Infocomm Research, Singapore)

PHY09: CDMA I

PHY09-1 Performance Evaluation of WCDMA High Speed Downlink Packet Access/Frequency Division Duplex Mode ... 183
Mahmoud H. Ismail (The University of Mississippi, USA), Mustafa M. Matalgah (The University of Mississippi, USA)

PHY09-2 Multihop Mobile Communications System using MC-CDMA in Forward Links 189
Takeo Ohseki (KDDI R&D Laboratories, Inc., Japan), Naoki Fuke (KDDI R&D Laboratories, Inc., Japan), Osamu Maeshima (KDDI R&D Laboratories, Inc., Japan), Hisato Iwai (KDDI R&D Laboratories, Inc., Japan), Keizo Sugiyama (KDDI R&D Laboratories, Inc., Japan), Mitsuo Nohara (KDDI R&D Laboratories, Inc., Japan)

PHY09-3 Reverse Link Capacity of the WCDMA System Using High Altitude Platform Stations 195
Tae Chul Hong (Electronics and Telecommunications Research Institute, Korea), Bon-Jun Ku (Electronics and Telecommunications Research Institute, Korea), Jong-Min Park (Electronics and Telecommunications Research Institute, Korea), Do-Seob Ahn (Electronics and Telecommunications Research Institute, Korea)

PHY09-4 Impacts of Imperfect Channel Estimation and Multipath Fading on Forward-Link Performance in CDMA Distributed Antenna Systems 201
Peng Chen (Beijing University of Posts and Telecommunications, China), Wei-ling Wu (Beijing University of Posts and Telecommunications, China)

PHY10: CDMA II

PHY10-1 Multicode CDMA Transmission over Time-Varying Multipath Channels 206
Yanxin Na (The University of Texas at Dallas, USA), Mohammad Saquib (The University of Texas at Dallas, USA), Giridhar Mandyam (Nokia Research Center, USA)

PHY10-2 Complete Analytical Framework for Throughput Calculation in WCDMA Downlink TDD Mode 212
Mahmoud H. Ismail (The University of Mississippi, USA), Mustafa M. Matalgah (The University of Mississippi, USA)

PHY10-3 Reverse-Link Performance Analysis in CDMA Distributed Antenna Systems 218
Peng Chen (Beijing University of Posts and Telecommunications, China), Wei-ling Wu (Beijing University of Posts and Telecommunications, China)

PHY10-4 BER Performance of Multicarrier Spread Spectrum Chip-Level Differential Detection in Multipath Fading Channels 222
Lijun Song (University of Electronic Science and Technology of China, China), Youxi Tang (University of Electronic Science and Technology of China, China), Shaoqian Li (University of Electronic Science and Technology of China, China)

PHY11: CDMA III

PHY11-1 Adaptive Soft-Input Soft-Output Multiuser Detection for Asynchronous Coded DS-CDMA Systems 227
Wei Zhang (University of Ottawa, Canada), Claude D'Amours (University of Ottawa, Canada), Abbas Yongaçoğlu (University of Ottawa, Canada)

PHY11-2 A Robust Linearly Constrained CMA for Adaptive Blind Multiuser Detection 233
Ayman Elnashar (MobiNil, Egypt), Said Elnoubi (Alexandria University, Egypt), Hamdi Elmikati (Mansoura University, Egypt)

PHY11-3 DS-CDMA SIR Estimation with Bias Removal 239
Carmela Cozzo (Ericsson Research, USA), Gregory E. Bottomley (Ericsson Research, USA)

PHY11-4 Effects of Noise-like Ultrawideband Emissions on cdma2000 Forward Link Performance 244
Marilynn P. Wylie-Green (Nokia Research Center, USA), Peter Wang (Nokia Research Center, USA)

PHY12: CDMA IV

PHY12-1 On the Spectral Efficiency of DS-CDMA with Higher Order Modulation in Presence of Fading 249
Oliver Prätor (Dresden University of Technology, Germany), Gerhard P. Fettweis (Dresden University of Technology, Germany)

PHY12-2 Delay and DOA Estimation for Chip-Asynchronous DS-CDMA Systems Using Reduced Rank Space–Time Processing 255
Chiao-Yao Chuang (University of Southern California, USA), Xiaoli Yu (University of Southern California, USA), C.-C. Jay Kuo (University of Southern California, USA)

PHY12-3 Efficient Minimum Probability of Error Demodulation for DS-CDMA Systems 261
Mohit Garg (Indian Institute of Technology, Mumbai, India), Umesh D. Nimbhorkar (Indian Institute of Technology, Mumbai, India), U. B. Desai (Indian Institute of Technology, Mumbai, India), S. N. Merchant (Indian Institute of Technology, Mumbai, India)

PHY13: Multiuser DS-CDMA

PHY13-1 Iterative Group Blind Multiuser Detection and Decoding for Asynchronous CDMA Systems 267
Shahram Talakoub (University of Windsor, Canada), Behnam Shahrrava (University of Windsor, Canada)

PHY13-2 Blind Adaptive Multiuser Detection for Periodically Time Varying Interference Suppression 273
James Whitehead (Eskom Group, South Africa), Fambirai Takawira (University of KwaZulu-Natal, South Africa)

PHY13-3 Low-Complexity Performance Optimization for MIMO CDMA Systems 280
Chun-Hung Liu (The University of Texas at Austin, USA)

PHY13-4 A Novel Segment-Level MMSE-MUD Design for Rapidly Time-Varying Channel Conditions in TD-SCDMA Down-Lnk Channel 286
Wan Lei (Ericsson, China), Tomas Sundin (Ericsson AB, Sweden)

PHY14: CDMA Systems

PHY14-1 Signal Detection and Interference Cancellation for TD-SCDMA Downlink in Fast Time-Varying Environment..291
Yuhong Wang (ST Microelectronics, Singapore), Ying-Chang Liang (Insitute for Infocomm Research, Singapore), Wing Seng Leon (Institute for Infocomm Research, Singapore)
PHY14-2 Interference Whitening Receivers for Bandlimited DS-CDMA Systems in Nakagami Fading...297
K. Sivanesan (University of Alberta, Canada), Norman C. Beaulieu (University of Alberta, Canada)
PHY14-3 Peak Power Reduction in SCS-MC-CDM System...302
Noboru Izuka (Japan Telecom, Japan), Atsushi Nagate (Japan Telecom, Japan), Hiroyoshi Masui (Japan Telecom, Japan), Teruya Fujii (Japan Telecom, Japan)
PHY14-4 Diversity Combining Options for Spread Spectrum OFDM Systems in Frequency Selective Channels..308
Robert Novak (University of Alberta, Canada), Witold A. Krzymień (University of Alberta, Canada)

PHY15: Iterative Multiuser Receivers

PHY15-1 Design of Turbo-MUD Receivers with Density Evolution in Overloaded CDMA Systems 315
Simone Morosi (University of Florence, Italy), Enrico Del Re (University of Florence, Italy), Romano Fantacci (University of Florence, Italy), Angela Chiassai (University of Florence, Italy)
PHY15-2 An Iterative Receiver for Layered Space-Time MIMO DS-CDMA Uplink Using Turbo Trellis-Coded Modulation 320
J. H. Jeong (The Pennsylvania State University, USA), M. Kavehrad (The Pennsylvania State University, USA)
PHY15-3 Convergence Behavior of Iterative Turbo Multiuser Detection Algorithms..326
Mehdi Hedjazi Moghari (University of Windsor, Canada), Behnam Shahrrava (University of Windsor, Canada)
PHY15-4 Group-Blind Turbo Multiuser Detection for CDMA Using a Gaussian Approximation..333
Mehdi Hedjazi Moghari (University of Windsor, Canada), Behnam Shahrrava (University of Windsor, Canada)

PHY16: 3G Networks I

PHY16-1 Adaptive Block-Equalizers for the UTRA-FDD Downlink..340
Mauro Pesce (Swiss Federal Institute of Technology, Switzerland), Dirk Dahlhaus (Swiss Federal Institute of Technology, Switzerland), Heino Gerlach (Siemens AG, Germany), Wen Xu (Siemens AG, Germany)
PHY16-2 Whitened Matched Filter for Attenuating Frequency Selectively Faded Interferers in GSM 346
Hartmut Wilhelm (Siemens AG, Germany)
PHY16-3 Improved Convolutional Code Design for 3GPP TDD Systems...353
Gang Wu (Philips Research East Asia, P.R. China), Yueheng Li (Philips Research East Asia, P.R. China)
PHY16-4 cdma2000 Packet Data Throughput Improvements Provided by Handset Dual Antenna Diversity..359
Levent Aydin (Qualcomm Incorporated, USA), Samir Ginde (Qualcomm Incorporated, USA), Walid Hamdy (Qualcomm Incorporated, USA)

PHY17: 3G Networks II

PHY17-1 An Efficient Radio Resource Management Technique for the Reverse Link in cdma2000 1xEV-DV...364
Hwanjoon Kwon (Samsung Electronics Co., Ltd., Korea), Younsun Kim (Samsung Electronics Co., Ltd., Korea), Jin-kyu Han (Samsung Electronics Co., Ltd., Korea), Donghee Kim (Samsung Electronics Co., Ltd., Korea)
PHY17-2 In Search of Lost Capacity Non-effective Load in UMTS Radio Interface (Uplink) 369
Krzysztof Kordybach (VTT Information Technology, Finland), Sami Nousiainen (VTT Information Technology, Finland)
PHY17-3 On Link Budget of cdma2000 1x EV-DV Forward Link 375
Jian Gu (Nokia China Investment Co., P.R. China), Xiangguang Che (Nokia China Investment Co., P.R. China)
PHY17-4 A Macroanalysis of Hsdpa Receiver Models 380
Ahmet Baştuğ (Philips Semiconductors, France), Dirk T. M. Slock (Eurecom Institute, France)

PHY18: MIMO Systems I

PHY18-1 On the Asymptotic Behavior of the Outage Probability for MIMO Systems 386
Hao Shen (Concordia University, Canada), Ali Ghrayeb (Concordia University, Canada)
PHY18-2 Investigation of Diversity Techniques Considering Receiver Structure in MIMO Systems 391
Yutaka Murakami (Matsushita Electric Industrial Co., Ltd., Japan), Kiyotaka Kobayashi (Matsushita Electric Industrial Co., Ltd., Japan), Masayuki Orihashi (Matsushita Electric Industrial Co., Ltd., Japan), Takashi Matsuoka (Matsushita Electric Industrial Co., Ltd., Japan)

PHY18-3 Analytical Approach of V-BLAST Performance with Two Transmit Antennas 396
R. T. Xu (Hong Kong Polytechnic University, Hong Kong), Francis C. M. Lau (Hong Kong Polytechnic University, Hong Kong)
PHY18-4 Tight Upper Bound on the Ergodic Capacity of the Ricean Fading MIMO Channels 402
Shi Jin (Southeast University, P.R. China), Xiqi Gao (Southeast University, P.R. China)

PHY19: MIMO Systems II

PHY19-1 A Comparative Study of MIMO Detection Algorithms for Wideband Spatial Multiplexing Systems 408
Jingming Wang (University of California, Los Angeles, USA), Babak Daneshrad (University of California, Los Angeles, USA)
PHY19-2 Fading and Interference Mitigation in Multi-antenna Wireless Transmission 414
Oghenekome Oteri (Stanford University, USA), Arogyaswami Paulraj (Stanford University, USA)
PHY19-3 Decoupling Method for Low Complexity Turbo Equalization of Frequency-Selective MIMO Wireless Systems 420
Yongfang Guo (University of California, Davis, USA), Bernard C. Levy (University of California, Davis, USA)
PHY19-4 Space-Time-Frequency Coded Multiband UWB Communication Systems 426
W. Pam Siriwongpairat (University of Maryland, USA), Weifeng Su (University of Maryland, USA), Masoud Olfat (University of Maryland, USA), K. J. Ray Liu (University of Maryland, USA)

PHY20: MIMO Systems III

PHY20-1 Construction and Capacity Analysis of High-Rank Line-of-Sight MIMO Channels 432
Frode Bøhagen (UniK/Nera Research, Norway), Pål Orten (UniK/NERA, Norway), Geir E. Øien (NTNU, Norway)
PHY20-2 Multiuser Detection in OFDM Space-Time Block Code for High Rate Uplink Application 438
Mohamad Jamalulil Syed (University of Limoges - ENSIL, France), Vahid Meghdadi (University of Limoges, France), Ferré Guillaume (University of Limoges, France), Jean Pierre Cances (University of Limoges, France), Reza Mohammad Khani (CNRS/LSS, France), Jean-Michel Dumas (University of Limoges, France)
PHY20-3 Interference Cancellation for Space-Frequency OFDM MIMO Systems: Iterative Decoding 444
L.-Y. Song (The University of York, UK), Alister G. Burr (The University of York, UK)

PHY21: MIMO Coding I

PHY21-1 A Closed-Form Result for the Average Pairwise Error Probability of $t = 2$, $r = 1$ Differential Cyclic Unitary Space-Time Modulation 449
Zheng Du (University of Alberta, Canada), Norman C. Beaulieu (University of Alberta, Canada), Jinkang Zhu (University of Alberta, Canada)
PHY21-2 Diagonal Space-Time Hadamard Codes with Erasure Decoding Algorithm 455
Domenico Giustiniano (Università di Palermo, Italy), Paul Lusina (University of Ulm, Germany), Giovanni Garbo (Università di Palermo, Italy)
PHY21-3 Generalized Block Space-Time Trellis Codes: Set-Partitioning and Code Design 461
Mohammad Janani (The University of Texas at Dallas, USA), Aria Nosratinia (The University of Texas at Dallas, USA)
PHY21-4 Improved Tomlinson-Harashima Precoding for the Downlink of Multiple Antenna Multiuser Systems 466
Jia Liu (University of Alberta, Canada), Witold A. Krzymień (University of Alberta, Canada)

PHY22: MIMO Coding II

PHY22-1 Effective Design of Recursive Convolutional Space-Time Codes with an Arbitrary Number of Transmit Antennas 473
Ying Li (Xidian University, China), Xudong Guo (Xidian University, China), Xin-mei Wang (Xidian University, China)
PHY22-2 A New Two-Level Differential Unitary Space-Time Modulation 479
Zheng Du (University of Alberta, Canada), Norman C. Beaulieu (University of Alberta, Canada)
PHY22-3 Quasi-Orthogonal STBC with Minimum Decoding Complexity: Further Results 483
Chau Yuen (Nanyang Technological University, Singapore), Yong Liang Guan (Nanyang Technological University, Singapore), Tjeng Thiang Tjhung (Institute for Infocomm Research, Singapore)
PHY22-4 On the Design of Linear Precoders for Orthogonal Space-Time Block Codes with Limited Feedback 489
Shahab Sanayei (The University of Texas at Dallas, USA), David J. Love (Purdue University, USA), Aria Nosratinia (The University of Texas at Dallas, USA)

PHY23: MIMO Coding III

PHY23-1 A New Differential Monomial Space-Time Code 494
Zheng Du (University of Alberta, Canada), Norman C. Beaulieu (University of Alberta, Canada)
PHY23-2 Performance of Alamouti Space-Time Code in Time-Varying Channels with Noisy Channel Estimates 498
Jittra Jootar (University of California, San Diego, USA), James R. Zeidler (University of California, San Diego, USA), John G. Proakis (University of California, San Diego, USA)

PHY23-3 An Adaptive Power Allocation Scheme for Space-Time Block Coded MIMO Systems 504
Liang Xian (Oregon State University, USA), Huaping Liu (Oregon State University, USA)

PHY23-4 Error Probability of Orthogonal Space-Time Block Codes over Correlated Rayleigh and Rician Channels 509
Hao Zhang (University of Victoria, Canada), Wei Li (University of Victoria, Canada), T. Aaron Gulliver (University of Victoria, Canada)

PHY24: MIMO Transceiver Designs I

PHY24-1 Symbol by Symbol Soft-Input Soft-Output Multiuser Detection for Frequency Selective MIMO Channels 515
Sara Bavarian (Simon Fraser University, Canada), Jim K. Cavers (Simon Fraser University, Canada)

PHY24-2 An Iterative Interference Cancellation Scheme for STBC Multirate Multiuser Systems 521
The-Hanh Pham (National University of Singapore, Singapore), A. Nallanathan (National University of Singapore, Singapore), B. Kannan (Institute for Infocom Research, Singapore)

PHY24-3 Software-Defined Radio Implementation of Multiple Antenna Systems using Low-Density Parity-Check Codes 527
Nicolae Chiurtu (Ecole Polytechnique Fédérale de Lausanne, Switzerland), Linus Gasser (Ecole Polytechnique Fédérale de Lausanne, Switzerland), Philippe Roud (Ecole Polytechnique Fédérale de Lausanne, Switzerland), Bixio Rimoldi (Ecole Polytechnique Fédérale de Lausanne, Switzerland)

PHY24-4 Single-Block Differential Transmit Scheme for Frequency Selective MIMO-OFDM Systems 532
Thanongsak Himsoon (University of Maryland, USA), Weifeng Su (University of Maryland, USA), K. J. Ray Liu (University of Maryland, USA)

PHY25: MIMO Transceiver Designs II

PHY25-1 The Sorted-QR Chase Detector for Multiple-Input Multiple-Output Channels 538
Deric W. Waters (Georgia Institute of Technology, USA), John R. Barry (Georgia Institute of Technology, USA)

PHY25-2 Space-Time Signaling in Correlated Channels 544
Ahmadreza Hedayat (The University of Texas at Dallas, USA), Harsh Shah (The University of Texas at Dallas, USA), Aria Nosratinia (The University of Texas at Dallas, USA)

PHY25-3 Joint Optimization of Rate Allocation and BLAST Ordering to Minimize Outage Probability 550
Arumugam Kannan (Georgia Institute of Technology, USA), Badri Varadarajan (Georgia Institute of Technology, USA), John R. Barry (Georgia Institute of Technology, USA)

PHY25-4 Design and Implementation of a 5.25 GHz Radio Transceiver for a MIMO Testbed 556
Stephan Lang (University of California, Los Angeles, USA), Babak Daneshrad (University of California, Los Angeles, USA)

PHY26: Wireless Circuits I

PHY26-1 A High-Precision AFC Circuit Applied to 64 QAM Point-to-Multipoint Burst Communications 562
Yosuke Akimoto (NTT Corporation, Japan), Yushi Shirato (NTT Corporation, Japan), Kazuji Wantanabe (NTT Corporation, Japan)

PHY26-2 An Effort Reduced Five-Port Direct Conversion Receiver and Its Calibration 568
Marko Mailand (Dresden University of Technology, Germany), Hans-Joachim Jentschel (Dresden University of Technology, Germany)

PHY26-3 Development of a PC Card Using Planar Antennas for Wireless LAN on 2.4/5 GHz Bands 573
Hidehiro Matsuoka (Toshiba Corporation, Japan), Ichiro Seto (Toshiba Corporation, Japan), Takahiro Sekiguchi (Toshiba Corporation, Japan), Hiroshi Yoshida (Toshiba Corporation, Japan), Akihiro Tsujimura (Toshiba Corporation, Japan), Minoru Namekata (Toshiba Corporation, Japan)

PHY26-4 A Novel Timing Recovery Circuit with High Tracking Ability for Burst-mode Multilevel QAM Transmission 578
Yushi Shirato (NTT Corporation, Japan), Hiroshi Yoshioka (NTT Corporation, Japan), Kazuji Watanabe (NTT Corporation, Japan)

PHY27: Wireless Circuits II

PHY27-1 The Research on the Design of Filter Banks in Filtered Multitone Modulation 584
Youjun Gao (Shandong University, P.R. China), Zhenming Gao (Shandong University, P.R. China), Weihong Zhu (Shandong University, P.R. China), Xinghai Yang (Shandong University, P.R. China)

PHY27-2 Efficient VLSI Architectures for Recursive Vandermonde QR Decomposition in Broadband OFDM Pre-Distortion 589
Yuanbin Guo (Nokia Research Center, USA)

PHY27-3 The Use of Hybrid Logarithmic Arithmetic for Root Raised Cosine Matched Filters in WCDMA Downlink Receivers 596
Charan Litchfield (University of Kent at Canterbury, UK), R. J. Langley (University of Kent at Canterbury, UK), Peter Lee (University of Kent at Canterbury, UK), John Batchelor (University of Kent at Canterbury, UK)

PHY27-4 Continuous Modulation from a Single-Bit DSP Output 601
Oliver M. Collins (University of Notre Dame, USA), Jagadish Venkataraman (University of Notre Dame, USA)

PHY28: Ad-Hoc Networks I

PHY28-1 A Non-Cooperative Power Control Game for Multicarrier CDMA Systems 606
Farhad Meshkati (Princeton University, USA), Mung Chiang (Princeton University, USA), Stuart C. Schwartz (Princeton University, USA), H. Vincent Poor (Princeton University, USA), Narayan B. Mandayam (Rutgers University, USA)
PHY28-2 Exploiting Processing Gain in Wireless Ad Hoc Networks Using Synchronous Collision Resolution Medium Access Control Schemes 612
John A. Stine (The Mitre Corportation, USA)
PHY28-3 Transmission Power Control for Ad Hoc Wireless Networks:Throughput, Energy, and Fairness 619
Lujun Jia (Northeastern University, USA), Xin Liu (Northeastern University, USA), Guevara Noubir (Northeastern University, USA), Rajmohan Rajaraman (Northeastern University, USA)
PHY28-4 Optimal Channel Utilization Ratio in Ad Hoc Wireless Networks 626
G. Ferrari (Carnegie Mellon University, USA, University of Parma, Italy), O. K. Tonguz (Carnegie Mellon University, USA)

PHY29: Ad-Hoc Networks II

PHY29-1 On the Capacity of Ad Hoc Networks with Clustering 632
Eugene Perevalov (Lehigh University, USA), Rick Blum (Lehigh University, USA), Danny Safi (Lehigh University, USA)
PHY29-2 A Clock-Sampling Mutual Network Time-Synchronization Algorithm for Wireless Ad Hoc Networks 638
Carlos H. Rentel (Carleton University, Canada), Thomas Kunz (Carleton University, Canada)
PHY29-3 A MAC Technique for CDMA-based Ad Hoc Networks 645
Romano Fantacci (University of Florence, Italy), Angela Ferri (University of Florence, Italy), Daniele Tarchi (University of Florence, Italy)
PHY29-4 Performance Analysis of Variable Bit Rate Multiclass Services in a Multitime-Hopping Pulse Position Modulation UWB System 651
T. C. Wong (Institute for Infocomm Research, Singapore), J. W. Mark (University of Waterloo, Canada), K. C. Chua (National University of Singapore, Singapore)

Author Index

Volume 2

PHY30: Sensor Networks

PHY30-1 Using Frequency Division to Reduce MAI in DS-CDMA Wireless Sensor Networks 657
Bao Hua Liu (The University of New South Wales, Australia), Chun Tung Chou (The University of New South Wales, Australia), Justin Lipman (The University of New South Wales, Australia), Sanjay Jha (The University of New South Wales, Australia)
PHY30-2 Does Proper Coding Make Single Hop Wireless Sensor Network Reality: The Power Consumption Perspective 664
Lizhi Charlie Zhong (University of California, Berkeley, USA), Jan M. Rabaey (University of California, Berkeley, USA), Adam Wolisz (Technische Universitaet Berlin, Germany)
PHY30-3 Low Power Synchronization for Wireless Sensor Network Modems 670
Josephine Ammer (University of California, Berkeley, USA), Jan Rabaey (University of California, Berkeley, USA)
PHY30-4 Energy and Latency Control in Low Duty Cycle MAC Protocols 676
Yuan Li (University of Southern California, USA), Wei Ye (University of Southern California, USA), John Heidemann (University of Southern California, USA)

PHY31: Wireless MAC Protocols

PHY31-1 Balancing the Hidden and Exposed Node Problems with Power Control in CSMA/CA-based Wireless Networks 683
Yihong Zhou (The University of Texas at Austin, USA), Scott M. Nettles (The University of Texas at Austin, USA)
PHY31-2 Towards Better Understanding of Medium Access Control for Multiuser Beamforming Systems 689
Slawomir Stańczak (Fraunhofer German-Sino Lab for Mobile Communications, Germany), Holger Boche (Fraunhofer German-Sino Lab for Mobile Communications, Germany), Marcin Wiczanowski (Technical University of Berlin, Germany)

PHY31-3 Admission Control for Maximal Throughput in Power Limited CDMA Systems 695
Zory Marantz (Polytechnic University, USA), Penina Orenstein (Polytechnic University, USA), David J. Goodman (Polytechnic University, USA)
PHY31-4 Frame Level Control for Collision Mitigation in Orthogonal Code Hopping Multiplexing 701
Sung Ho Moon (Korea Advanced Institute of Science and Technology, Korea), Jae Kyun Kwon (Electronics and Telecommunications Research Institute, Korea), Dan Keun Sung (Korea Advanced Institute of Science and Technology, Korea)

PHY32: Wireless MAC Analysis

PHY32-1 On the Performance of Randomized Power Control Algorithms in Multiple Access Wireless Networks 707
Arash Behzad (University of California, Los Angeles, USA), Izhak Rubin (University of California, Los Angeles, USA), Julan Hsu (University of California, Los Angeles, USA)
PHY32-2 A New Fairness Index for Radio Resource Allocation in Wireless Networks 712
Mehrdad Dianati (University of Waterloo, Canada), Xeumin Shen (University of Waterloo, Canada), Sagar Naik (University of Waterloo, Canada)
PHY32-3 Linear and Successive Predistortion in the Frequency Domain: Performance Evaluation in SDMA Systems 718
Christoph Degen (RWTH Aachen University, Germany), Lars Brühl (RWTH Aachen University, Germany)

PHY33: Coexistence & Spectrum Utilization

PHY33-1 Cognitive Radio—An Adaptive Waveform with Spectral Sharing Capability 724
Vasu D. Chakravarthy (Air Force Research Laboratory, USA), Arnab K. Shaw (Wright State University, USA), Michael A. Temple (Air Force Institute of Technology, USA), James P. Stephens (Air Force Research Laboratory, USA)
PHY33-2 Interference Avoidance in Spectrally Encoded Multiple Access Communications Using MPSK Modulation 730
A. S. Nunez (Air Force Institute of Technology, USA), M. A. Temple (Air Force Institute of Technology, USA), R. F. Mills (Air Force Institute of Technology, USA), R. A. Raines (Air Force Institute of Technology, USA)
PHY33-3 Spectrum Load Smoothing for Optimized Spectrum Utilization—Rationale and Algorithm 735
Lars Berlemann (RWTH Aachen University, Germany), Bernhard Walke (RWTH Aachen University, Germany)
PHY33-4 Spectral-Efficiency Analysis in Noncooperative Interference Environments 741
Fredrik Berggren (Royal Institute of Technology, Sweden)

PHY34: UWB I

PHY34-1 Receiver Improvement for Ultra-Wideband Transmitted-Reference Systems 746
Meng-Hsuan Chung (University of Southern California, USA), Robert A. Scholtz (University of Southern California, USA)
PHY34-2 Acquisition of Direct-Sequence Ultra-Wideband Signals 752
Iyappan Ramachandran (University of Washington, USA), Sumit Roy (University of Washington, USA)
PHY34-3 A Study of Low-Power Ultra Wideband Radio Transceiver Architectures 758
Payam Heydari (University of California, Irvine, USA)
PHY34-4 Design of UWB Pulses by Spline Approximation 764
Mitsuhiro Matsuo (Ibaraki University, Japan), Masaru Kamada (Ibaraki University, Japan), Hiromasa Habuchi (Ibaraki University, Japan)

PHY35: UWB II

PHY35-1 Signal Design for Non-coherent UWB with PPM Modulation in Fading Channels 770
Sudharman K. Jayaweera (Wichita State University, USA)
PHY35-2 The Effect of Receiver Front-End Non-Linearity on DS-UWB Systems Operating in the 3 to 4 Ghz Band 776
Ivan Siu-Chuang Lu (University of New South Wales, Australia), Neil Weste (Macquarie University, Australia), Sri Parameswaran (University of New South Wales, Australia)
PHY35-3 Ultra-Wideband Multicarrier Communication Receiver Based on Analog to Digital Conversion in the Frequency Domain 782
Sebastian Hoyos (University of California, Berkeley, USA), Brian M. Sadler (Army Research Laboratory, USA), Gonzalo R. Arce (University of Delaware, USA)
PHY35-4 Optimum and Sub-Optimum Detection of Physics-based Ultra-Wideband Signals in Presence of Inter-Symbol Interference 788
Robert C. Qiu (Tennessee Tech University, USA)

PHY36: UWB III

PHY36-1 On Medium Access Control for High Data Rate Ultra-Wideband Ad Hoc Networks 795
Kejie Lu (University of Florida, USA), Dapeng Wu (University of Florida, USA), Yuguang Fang (University of Florida, USA), Robert C. Qiu (Tennessee Technological University, USA)

PHY36-2 Exact Modeling of Multiple Access Interference and BER Derivation for TH-PPM UWB 801
S. Niranjayan (Institute for Infocomm Research, Singapore), A. Nallanathan (National University of Singapore, Singapore), B. Kannan (Institute for Infocomm Research, Singapore)

PHY36-3 Orthogonal Variable Spreading Factor Codes with Zero-Correlation Zone for TS-UWB 807
Di Wu (Rutgers University, USA), Predrag Spasojević (Rutgers University, USA), Ivan Seskar (Rutgers University, USA)

PHY36-4 Energy-Efficient Resource Allocation for Multiband UWB Communication Systems 813
W. Pam Siriwongpairat (University of Maryland, USA), Zhu Han (University of Maryland, USA), K. J. Ray Liu (University of Maryland, USA)

PHY37: Communications Signal Processing

PHY37-1 Wireless Local Positioning System via DS-CDMA and Beamforming: A Perturbation Analysis 819
Hui Tong (Michigan Technological University, USA), Seyed A. Zekavat (Michigan Technological University, USA)

PHY37-2 Computing Location from Ambient FM Radio Signals 824
Adel Youssef (University of Maryland, USA), John Krumm (Microsoft Corporation, USA), Ed Miller (Microsoft Corporation, USA), Gerry Cermak (Microsoft Corporation, USA), Eric Horvitz (Microsoft Corporation, USA)

PHY37-3 On the Statistics of the Residual Frequency Error for Frequency Estimators 830
Tao Luo (Qualcomm Inc., USA), Young-Chai Ko (Korea University, Korea)

PHY37-4 An Investigation of Phase Pulse Shape Diversity to Generate Parallel Branches, Increase Data Rate, and Reduce the Complexity of CPM Modulation 836
James A. Norris (Harris Corporation, USA)

PHY38: Diversity I

PHY38-1 A Practical RAKE Combining Scheme for Synchronous CDMA Systems 843
Wei Li (University of Victoria, Canada), Hong-Chuan Yang (University of Victoria, Canada), T. Aaron Gulliver (University of Victoria, Canada)

PHY38-2 Performance Analysis of Combining Techniques with Correlated Diversity 849
Eduard A. Jorswieck (Fraunhofer Institute for Telecommunications, Germany), Tobias J. Oechtering (Technical University Berlin, Germany), Holger Boche (Technical University Berlin, Germany)

PHY38-3 Performance of Rake-MMSE-Equalizer for UWB Communications 855
Mohsen Eslami (University of Alberta, Canada), Xiaodai Dong (University of Alberta, Canada)

PHY38-4 Optimal and Suboptimal Finger Selection Algorithms for MMSE Rake Receivers in Impulse Radio Ultra-Wideband Systems 861
Sinan Gezici (Princeton University, USA), Mung Chiang (Princeton University, USA), H. Vincent Poor (Princeton University, USA), Hisashi Kobayashi (Princeton University, USA)

PHY39: Diversity II

PHY39-1 Moment based Analysis of Equal Gain Combiner in Equally Correlated Nakagami-*m* Fading Channels 867
Yunxia Chen (University of California, Davis, USA), Chintha Tellambura, (University of Alberta, Canada),

PHY39-2 Postdetection Switch-and-Stay Diversity in Rician Fading 872
Sasan Haghani (University of Alberta, Canada), Norman C. Beaulieu (University of Alberta, Canada)

PHY39-3 Error Probability Analysis of TAS/MRC-based Scheme for Wireless Networks 877
Jia Tang (Texas A&M University, USA), Xi Zhang (Texas A&M University, USA)

PHY39-4 Optimum Selection Combining for *M*-QAM on Fading Channels 883
M. Surendra Raju (Insilica Semiconductors India Pvt. Ltd, India), Ramesh Annavajjala (University of California, San Diego, USA), A. Chockalingam (Indian Institute of Science, Bangalore, India)

PHY40: Communication Systems Performance Analysis I

PHY40-1 Error Performance of Coherent High Dimensional Signaling in Nakagami Fading Channels with Diversity Reception 888
Lei Xiao (University of Alberta, Canada), Xiaodai Dong (University of Alberta, Canada)

PHY40-2 Performance of MC CDMA RAKE Systems in Generalized Nakagami-*m* Multipath Fading Channel 894
Abdel-Awal Hashem (Alcatel Egypt, Egypt), Said Elnoubi (University of Alexandria, Egypt), Hamdi Elmikati (University of Mansoura, Egypt)

PHY40-3 Theoretical Analysis of BER in DPSK/OFDM Systems with Postdetection Diversity Reception 900
Yuki Mitsu (Shinshu University, Japan), Fumihito Sasamori (Shinshu University, Japan), Shiro Handa (Shinshu University, Japan), Shinjiro Oshita (Shinshu University, Japan)

PHY40-4 Optimization of Delay Diversity for Linear Equalization 905
S. Yiu (University of British Columbia, Canada), R. Schober (University of British Columbia, Canada), W. Gerstacker (University of Erlangen-Nürnberg, Germany)

PHY41: Communication Systems Performance Analysis II

PHY41-1 Sample Rejection for Efficient Simulation of Intersymbol Interference Channels with MLSD 911
Pavel Loskot (University of Alberta, Canada), Norman C. Beaulieu (University of Alberta, Canada)

PHY41-2 A Threshold-based Linear Parallel Interference Canceller on Fading Channels 917
V. Tikiya (Indian Institute of Science, Bangalore, India), A. Chockalingam (Indian Institute of Science, Bangalore, India)

PHY41-3 Robust Structured Interference Rejection Combining 922
Erik G. Larsson (The George Washington University, USA)

PHY41-4 Adaptive Modulation and Coding with Multicodes over Nakagami Fading Channels 927
Raymond Kwan (The University of British Columbia, Canada), Cyril Leung (The University of British Columbia, Canada)

PHY42: Wireless Channel Models

PHY42-1 Modelling and Performance Prediction for Multiple Antenna Systems using Enhanced Ray Tracing 933
K. H. Ng (University of Bristol, UK), E. K. Tameh (University of Bristol, UK), A. R. Nix (University of Bristol, UK)

PHY42-2 A 3D Correlation Model for MIMO Non-Isotropic Scattering with Arbitrary Antenna Arrays 938
Hamidreza Saligheh Rad (Queen's University, Canada), Saeed Gazor (Queen's University, Canada)

PHY42-3 Statistical Characterization of the UWB Propagation Channel in Various Types of High-Rise Apartments 944
Chia-Chin Chong (Samsung Advanced Institute of Technology, Korea), Youngeil Kim (Samsung Advanced Institute of Technology, Korea), Seong-Soo Lee (Samsung Advanced Institute of Technology, Korea)

PHY42-4 Characterization of Ultra-Wideband Channels for Outdoor Office Environment 950
C. W. Kim (National University of Singapore, Singapore), X. Sun (National University of Singapore, Singapore), L. C. Chiam (National University of Singapore, Singapore), B. Kannan (Institute for Infocomm Research, Singapore), F. P. S. Chin (Institute for Infocomm Research, Singapore), H. K. Garg (National University of Singapore, Singapore)

PHY43: Communication Systems Performance Analysis III

PHY43-1 Accurate BER Analysis of Bandlimited DS-CDMA System with EGC and SC Diversity over Nakagami Fading Channels 956
K. Sivanesan (University of Alberta, Canada), Norman C. Beaulieu (University of Alberta, Canada)

PHY43-2 Optimal Realizable MMSE Linear and Decision Feedback Equalizers: Time Domain Results 961
Jianqiang He (Louisiana State University, USA), Zhongshan Wu (Louisiana State University, USA), Guoxiang Gu (Louisiana State University, USA),

PHY43-3 Exact BERs for *M*-QAM with MRC and Channel Estimation Errors in Rician Channels 967
Yao Ma (Iowa State University, USA), Robert Schober (University of British Columbia, Canada), Dongbo Zhang (Iowa State University, USA)

PHY43-4 On the Performance of Hybrid Macro/Microdiversity in the Reverse-Link Microcellular Networks 973
A. Adinoyi (Carleton University, Canada), H. Yanikomeroglu (Carleton University, Canada)

PHY44: Multiuser Communications I

PHY44-1 Exploiting Multiuser Diversity with Only 1-bit Feedback 978
Shahab Sanayei (The University of Texas at Dallas, USA), Aria Nosratinia (The University of Texas at Dallas, USA)

PHY44-2 SER Performance Analysis and Optimum Power Allocation for Decode-and-Forward Cooperation Protocol in Wireless Networks 984
Weifeng Su (University of Maryland, USA), Ahmed K. Sadek (University of Maryland, USA), K. J. Ray Liu (University of Maryland, USA)

PHY44-3 On the Distributed Space-Time Signal Design for a Large Number of Relay Terminals 990
Murat Uysal (University of Waterloo, Canada), Onur Canpolat (University of Waterloo, Canada)

PHY44-4 Adaptive Resource Allocation Scheme for 2-hop Non-regenerative MIMO Relaying System 995
Zhang Qi (Beijing University of Posts and Telecommunications, China), Wang Ying (Beijing University of Posts and Telecommunications, China), Zhang Ping (Beijing University of Posts and Telecommunications, China)

PHY45: Multiuser Communications II

PHY45-1 Cooperative Coding using Serial Concatenated Convolutional Codes 1001
Yang Cao (The George Washington University, USA), Branimir Vojcic (The George Washington University, USA)
PHY45-2 Combined Opportunistic Beamforming and Receive Antenna Selection 1007
Lei Zan (University of California, Irvine, USA), Syed Ali Jafar (University of California, Irvine, USA)
PHY45-3 A Simple Cooperative Diversity Scheme Based on Orthogonal Signaling 1012
V. Mahinthan (University of Waterloo, Canada), J. W. Mark (University of Waterloo, Canada)

PHY46: Multiuser Communications III

PHY46-1 Multiuser Zero Forcing Relaying with Noisy Channel State Information 1018
Armin Wittneben (Swiss Federal Institute of Technology, Switzerland), Ingmar Hammerström (Swiss Federal Institute of Technology, Switzerland)
PHY46-2 Performance Analysis of Reliability Filling on Quasi-Static Fading Channels 1024
Arun Avudainayagam (University of Florida, USA), John M. Shea (University of Florida, USA)
PHY46-3 Energy-Efficient Cooperation Transmission over Multiuser OFDM Networks: Who Helps Whom and How to Cooperate 1030
Zhu Han (University of Maryland, USA), Thanongsak Himsoon (University of Maryland, USA), W. Pam Siriwongpairat (University of Maryland, USA), K. J. Ray Liu (University of Maryland, USA)

PHY47: Coding Principles I

PHY47-1 Quasi-Cyclic Codes from Extended Difference Families 1036
Tao Xia (University of Arizona, USA), Bo Xia (Intel Corporation, USA)
PHY47-2 Unequal Protection with Turbo Decoding for High-Order Modulated Signaling 1041
Charles C. Wang (The Aerospace Corporation, USA), Quang Vo (Northrop Grumman Space Technology, USA)
PHY47-3 An Algorithm for the Estimation of the Minimum Distance of LDPC Codes 1046
Fred Daneshgaran (California State University Los Angeles, USA), Massimiliano Laddomada (Politecnico di Torino, Italy), Marina Mondin (Politecnico di Torino, Italy)

PHY48: Coding Principles II

PHY48-1 Constrained Decoding for Turbo-CRC Code with High Spectral Efficient Modulation 1050
Huijun Chen (University of Mississippi, USA), Lei Cao (University of Mississippi, USA), Chang Wen Chen (Florida Institute of Technology, USA)
PHY48-2 Performance of Hamming Codes in Systems Employing Different Code Symbol Energies 1055
Wenhui Xiong (Ohio University, USA), David W. Matolak (Ohio University, USA)
PHY48-3 Unquantized and Uncoded Channel State Information Feedback on Wireless Channels 1059
Dragan Samardzija (Bell Laboratories, Lucent Technologies, USA), Narayan Mandayam (Rutgers University, USA)
PHY48-4 Constellations Design for Multiple Transmissions: Maximizing the Minimum Squared Euclidean Distance 1066
Leszek Szczeciński (INRS Energy, Canada), Marcos Bacic (Universidad Técnica Federico Santa María, Chile)

PHY49: Communication Theory I

PHY49-1 On the Use of Orthogonal Signals to Generate Parallel Branches and Improve the Spectral Efficiency of CPM and TCM Modulation 1072
James A. Norris (Harris Corporation, USA)
PHY49-2 Iterative Decoding for Joint Source-Channel Coding using Combined TCQ/CPM 1079
Zihuai Lin (Chalmers University of Technology, Sweden), Tor Aulin (Chalmers University of Technology, Sweden)
PHY49-3 Capacity and Coding of Flat Fading Channels without Channel State Information 1085
Teng Li (University of Notre Dame, USA), Oliver M. Collins (University of Notre Dame, USA)
PHY49-4 Time-Selective Signaling for Turbo-Equalization 1091
Mehdi Hedjazi Moghari (University of Windsor, Canada), Behnam Shahrrava (University of Windsor, Canada)

PHY50: Communication Theory II

PHY50-1 Turbo Equalization with Iterative Online SNR Estimation 1097
Shahram Talakoub (University of Windsor, Canada), Behnam Shahrrava (University of Windsor, Canada)
PHY50-2 Novel Performance Upper Bounds for Space-Time Trellis Codes over Quasi-Static Fading Channels 1103
Jingyu Hu (The University of Texas at Austin, USA), Scott L. Miller (Texas A&M University, USA)

PHY50-3 On an Optimum Algorithm for Waveform Synthesis and Its Applications to Digital Transmitters 1108
RaviKiran Gopalan (University of Notre Dame, USA), Oliver M. Collins (University of Notre Dame, USA)
PHY50-4 Relaxed Bandwidth Sharing with Space Division Multiplexing™ 1114
V. Guruprasad (Inspired Research LLC, USA)

PHY51: 4G Wireless Networks Concepts

PHY51-1 Downlink Multicell MIMO-OFDM: An Architecture for Next Generation Wireless Networks 1120
Lei Shao (Intel Corporation, USA), Sumit Roy (University of Washington, USA)
PHY51-2 Link-Adaptation-Enhanced Dynamic Channel Allocation for MIMO-OFDM Wireless Networks 1126
Jia Tang (Texas A&M University, USA), Xi Zhang (Texas A&M University, USA)
PHY51-3 A Performance Analysis of Coded Frequency-Hopped OFDMA....1132
Kostas Stamatiou (University of California, San Diego, USA), John G. Proakis (University of California, San Diego, USA)
PHY51-4 Performance Studies of a VSF-OFCDM System using a Symbol Relocated Scheme during Retransmission 1138
Xiaoming Peng (Institute for Infocomm Research, Singapore), Francois P. S. Chin (Institute for Infocomm Research, Singapore), A. S. Madhukumar (Nanyang Technological University, Singapore)

PHY52: Wireless Network Optimization

PHY52-1 Optimal Allocation of Bandwidth for Minimum Battery Consumption 1144
Qinghua Zhao (University of California, San Diego, USA), Pamela C. Cosman (University of California, San Diego, USA), Laurence B. Milstein (University of California, San Diego, USA)
PHY52-2 Power Cost of Mobility in Cellular Systems with Closed-Loop Power Control 1150
In-Ho Lee (University of Hanyang, Korea), Dongwoo Kim (University of Hanyang, Korea)
PHY52-3 Fast Near-Optimal Energy Allocation for Multimedia Loading on Multicarrier Systems 1155
Michael A. Enright (University of Southern California, USA), C.-C. Jay Kuo (University of Southern California, USA)
PHY52-4 Traffic Engineering for Wireless Mobile Networks Supporting Heterogeneous Traffic....1161
Leila Z. Ribeiro (Virginia Polytechnic Institute and State University, USA; CelPlan Technologies, Inc., USA), Luiz A. DaSilva (Virginia Polytechnic Institute and State University, USA)

PHY53: Wireless Security (Invited Papers)

PHY53-1 A Covert Channel in MAC Protocols Based on Splitting Algorithms 1168
Song Li (University of Maryland, USA), Anthony Ephremides (University of Maryland, USA)
PHY53-2 Client Assisted Location Data Acquisition Scheme for Secure Enterprise Wireless Networks 1174
Santosh Pandey (Auburn University, USA), Byungsuk Kim (Telcordia Technologies, Inc., USA), Farooq Anjum (Telcordia Technologies, Inc., USA), Prathima Agrawal (Auburn University, USA)
PHY53-3 Authenticated Key Exchange for Wireless Security 1180
Hideki Imai (University of Tokyo, Japan), SeongHan Shin (University of Tokyo, Japan), Kazukuni Kobara (University of Tokyo, Japan)
PHY53-4 Enhancing Wireless Location Privacy Using Silent Period....1187
Leping Huang (Nokia Research Center, Japan, University of Tokyo, Japan), Kanta Matsuura (University of Tokyo, Japan), Hiroshi Yamane (University of Tokyo, Japan), Kaoru Sezaki (University of Tokyo, Japan)
PHY53-5 Preventing Wormhole Attacks on Wireless Ad Hoc Networks: A Graph Theoretic Approach....1193
L. Lazos (University of Washington, USA), R. Poovendran (University of Washington, USA), C. Meadows (Naval Research Laboratory, USA), P. Syverson (Naval Research Laboratory, USA), L. W. Chang (Naval Research Laboratory, USA)
PHY53-6 A Combinatorial Approach to Key Predistribution for Distributed Sensor Networks 1200
Jooyoung Lee (University of Waterloo, Canada), Douglas R. Stinson (University of Waterloo, Canada)

Networks Symposium

NET01: Scheduling

NET01-1 (invited) Opportunistic Downlink Scheduling for Multiuser OFDM Systems 1206
Zhi Zhang (Colorado State University, USA), Ying He (University of Maryland, College Park, USA), Edwin K. P. Chong (Colorado State University, USA)
NET01-2 Mobility Assisted Opportunistic Scheduling for Downlink Transmissions in Cellular Data Networks 1213
Syed Hussain Ali (The University of British Columbia, Canada), Victor C. M. Leung (The University of British Columbia, Canada)
NET01-3 An Adaptive Round Robin Scheduler for Head-of-Line-Blocking Problem in Wireless LANs 1219
Bin Jiang Li (The Chinese University of Hong Kong, Hong Kong), Chang Liew Soung (The Chinese University of Hong Kong, Hong Kong)
NET01-4 Improving Wireless Local Area Networks Goodput Through Link Adaptation and Scheduling 1225
Lau-yung Hung (The Hong Kong University of Science and Technology, Hong Kong), Brahim Bensaou (The Hong Kong University of Science and Technology, Hong Kong)

NET02: Quality of Service

NET02-1 A Statistical Measurement Model for the 3G Networks QoS Evaluation 1231
I. Cotanis (Ericsson NetQual Inc., USA)
NET02-2 QoS-driven Rate Control Strategies for W-CDMA Systems 1236
Tracy Tung (University of Technology, Sydney, Australia), Abbas Jamalipour (University of Sydney, Australia)
NET02-3 Supporting QoS in Wireless MAC by Fuzzy Control 1242
Chao-Lieh Chen (Kun-Shan University of Technology, Taiwan), Po-Chien Hsiao (Kun-Shan University of Technology, Taiwan)
NET02-4 Quality-of-Service Management for IP-based Mobile Networks 1248
Joachim Hillebrand (DoCoMo Laboratories Europe, Germany), Christian Prehofer (DoCoMo Laboratories Europe, Germany), Roland Bless (University of Karlsruhe, Germany), Martina Zitterbart (University of Karlsruhe, Germany)

NET03: Call Admission Control

NET03-1 A Practical Method for Estimating Performance Metrics of Call Admission Control Schemes in Wireless Mobile Networks 1254
Emre A. Yavuz (The University of British Columbia, Canada), Victor C. M. Leung (The University of British Columbia, Canada)
NET03-2 Adaptive Prioritized Admission over CDMA 1260
Oliver Yu (University of Illinois at Chicago, USA), Emir Saric (University of Illinois at Chicago, USA), Anfei Li (University of Illinois at Chicago, USA)
NET03-3 Admission Control for Realtime Traffic: Improving Performance of Mobile Networks by Operating on Actual Throughput 1266
Andreas Brandt (Humbold Universität zu Berlin, Germany), Manfred Brandt (Konrad-Zuse-Zentrum für Informationstechnik Berlin, Germany), Stefan Rugel (Siemens AG, Germany), Dietmar Weber (Siemens AG, Germany)

Author Index

Volume 3

NET04: Cellular Network Performance

NET04-1 A Statistical Estimation of Average IP Packet Delay in Cellular Data Networks 1273
Hubert Graja (University College Dublin, Ireland), Philip Perry (University College Dublin, Ireland), John Murphy (University College Dublin, Ireland)
NET04-2 Unifying View on Min–Max Fairness and Utility Optimization in Cellular Networks 1280
Holger Boche (Technical University of Berlin, Germany), Marcin Wiczanowski (Technical University of Berlin, Germany), Slawomir Stanczak (Mobile Communications Institute, Germany)
NET04-3 Modeling and Performance Analysis of Future Generation Multimedia Wireless and Mobile Networks Using Smart Antennas 1286
Huazhou Liu (University of Cincinnati, USA), Yong Xu (University of Cincinnati, USA), Qing-An Zeng (University of Cincinnati, USA)

NET04-4 Throughput Optimization in multiCell CDMA Networks 1292
Robert Akl (University of North Texas, USA), Mort Naraghi-Pour (Louisiana State University, USA), Manju Hegde (Ageia Technologies, Inc., USA)

NET05: Radio Resource Management

NET05-1 (invited) Dynamic Downlink OFDM Resource Allocation with Interference Mitigation and Macro Diversity for Multimedia Services in Wireless Cellular Systems 1298
Navid Damji (McGill University, Canada), Tho Le-Ngoc (McGill University, Canada)
NET05-2 Resource Management for Service Providers in Heterogeneous Wireless Networks 1305
Xu Yang (London of University, UK), John Bigham (London of University, UK), Laurie Cuthbert (London of University, UK)
NET05-3 An Efficient Resource Reservation Scheme Based on Gray-Cell in Wireless Mobile Networks 1311
Moonjeong Chang (Ewha Womans University, Korea), Meejeong Lee (Ewha Womans University,Korea), Hyunjeong Lee (University of Nevada, Reno, USA)
NET05-4 Performance Modelling of GSM/GPRS Cells with Different Radio Resource Allocation Strategies 1317
Hamza Dahmouni (France Telecom, France), Bertrand Morin (France Telecom, France), Sandrine Vaton (ENST Bretagne, France)

NET06: Multimedia over Wireless Networks

NET06-1 Dynamic Resource Allocation for Video Traffic over Time-varying CDMA Wireless Channels 1323
Hai Jiang (University of Waterloo, Canada), Weihua Zhuang (University of Waterloo, Canada), Xuemin Shen (University of Waterloo, Canada)
NET06-2 Efficient Real-Time Video Transmission in OVSF-CDMA System 1329
Jun Xu (University of Waterloo, Canada), Xuemin Shen (University of Waterloo, Canada), Jon W. Mark (University of Waterloo, Canada), Jun Cai (University of Waterloo, Canada)
NET06-3 Predictive Rate Control for Real-Time Video Streaming with Network triggered Handover 1335
Susumu Ishihara (Shizuoka University, Japan), Kenji Koyama (Shizuoka University, Japan), Goh Miyamoto (National Institute of Information and Communications Technology, Japan), Masahiro Kuroda (National Institute of Information and Communications Technology, Japan)
NET06-4 Robust Transmission of JPEG-2000 Images over Peer-to-Peer Mixed Wired and Wireless Links 1341
Ming Zhao (National University of Singapore, Singapore), Thinh M. Le (National University of Singapore, Singapore)

NET07: Location Management and Paging

NET07-1 Pipeline Paging for Wireless Systems 1347
Yang Xiao (The University of Memphis, USA), Hui Chen (The University of Memphis, USA), Mohsen Guizani (Western Michigan University, USA)
NET07-2 Practical Approach to Optimize Paging Success Rate in CDMA Network 1353
Jey Veerasamy (Samsung Telecommunications America, USA), John Jubin (Samsung Telecommunications America, USA), Sanjay Kodali (Samsung Telecommunications America, USA)
NET07-3 Efficient Location Management for Fast Call Setup 1359
Sanjay Kodali (Samsung Telecommunications America, USA), Jey Veerasamy (Samsung Telecommunications America, USA), John Jubin (Samsung Telecommunications America, USA)
NET07-4 An Intelligent Location Management Strategy for Next Generation Wireless Networks: A Rule Base Approach 1365
Madhubanti Maitra (Jadavpur University, India), Partha S. Bhattacharjee (Calcutta Telephones, India), Debashis Saha (Indian Institute of Management, Calcutta, India), Amitava Mukherjee (Royal Institute of Technology, Sweden)

NET08: Handoff Management

NET08-1 An Improved Location-based Handover Algorithm for GSM Systems 1371
Rong-Terng Juang (National Taipei University of Technology, Taiwan), Hsin-Piao Lin (National Taipei University of Technology, Taiwan), Ding-Bing Lin (National Taipei University of Technology, Taiwan)
NET08-2 SMART-FRX: A Novel Error-Recovery Scheme to Improve Performance of Mobile SCTP during WLAN to Cellular Forced Vertical Handover 1377
Li Ma (The University of British Columbia, Canada), Fei Yu (The University of British Columbia, Canada), Victor C. M. Leung (The University of British Columbia, Canada)
NET08-3 Active Application oriented Vertical Handoff in Next Generation Wireless Networks 1383
Wen-Tsuen Chen (National Tsing-Hua University, Republic of China), Yen Yuan Shu (National Tsing-Hua University, Republic of China)

NET08-4 Handover Latency Analysis on Mobile Ethernet 1389
Tetsuya Aoyama (Shizuoka University, Japan), Koichi Ishibashi (Mitsubishi Electric Corporation, Japan), Masaki Bandai (Shizuoka University, Japan), Masahiro Kuroda (National Institute of Information and Communications Technology, Japan), Takashi Watanabe (Shizuoka University, Japan)

NET09: IP Mobility

NET09-1 (invited) Mobility Analysis for all-IP Networks 1395
Ramy Farha (University of Toronto, Canada), Alberto Leon-Garcia (University of Toronto, Canada)
NET09-2 Implementation and Evaluation of a Network-controlled Mobility Management Protocol (IP^{2}MM): Performance Evaluation Compared with Mobile IPv6 1402
Katsutoshi Nishida (NTT DoCoMo Inc., Japan), Shin-ichi Isobe (NTT DoCoMo Inc., Japan), Tomohiko Yagyu (NEC Corporation, Japan), Ippei Akiyoshi (NEC Corporation, Japan)
NET09-3 Inter-domain Handover Scheme Based on Forwarding Router Discovery for Mobile IP Networks 1409
Takeshi Takahashi (Waseda University, Japan), Jarmo Harju (Tampere University of Technology, Finland), Koichi Asatani (Kogakuin University, Japan), Hideyoshi Tominaga (Waseda University, Japan)
NET09-4 A Comparative Analysis on Signaling Cost of Mobile IP Regional Registration with Paging Support 1415
Tanapong Poungkong (Chulalongkorn University, Thailand), Watit Benjapolakul (Chulalongkorn University, Thailand)

NET10: IPv6 Mobility

NET10-1 Adaptive Local Route Optimization in Hierarchical Mobile IPv6 Networks 1421
Sangheon Pack (Seoul National University, Korea), Taekyoung Kwon (Seoul National University, Korea), Yanghee Choi (Seoul National University, Korea)
NET10-2 Mobile 4-in-6: A Novel IPv4 / IPv6 Transitioning Mechanism for Mobile Hosts 1427
Joe Finney (Lancaster University, UK), Stefan Schmid (Lancaster University, UK), Andrew Scott (Lancaster University, UK)
NET10-3 Mobility Anchor Point Selection Based on User Mobility in HMIPv6 Integrated with Fast Handover Mechanism 1434
E. Natalizio (University of Calabria, Italy), A. Scicchitano (University of Calabria, Italy), S. Marano (University of Calabria, Italy)
NET10-4 Early Binding Updates for Mobile IPv6 1440
Christian Vogt (University of Karlsruhe, Germany), Roland Bless (University of Karlsruhe, Germany), Mark Doll (Univerity of Karlsruhe, Germany), Tobias Kuefner (University of Karlsruhe, Germany)

NET11: Wireless Metropolitan Area Networks

NET11-1 (invited) Mobility Support for IEEE 802.16d Wireless Networks 1446
Kin K. Leung (Imperial College, UK), Sayandev Mukherjee (Bell Labs, Lucent Technologies, USA), George E. Rittenhouse (Bell Labs, Lucent Technologies, USA)
NET11-2 On the Performance of Metro-Scale Ad Hoc Networks 1453
Rajendra V. Boppana (The University of Texas at San Antonio, USA), Zhi Zheng (The University of Texas at San Antonio, USA)
NET11-3 Constructing Collocated Non-Interfering Wireless Meshes with Beam-Crossing Grids 1459
Pai-Hsiang Hsiao (Harvard University, USA), H. T. Kung (Harvard University, USA)
NET11-4 A Link Adaptation Algorithm for IEEE 802.16 1466
Shyamal Ramachandran (MeshNetworks Inc., USA), Charles W. Bostian (Virginia Polytechnic Institute and State University, USA), Scott F. Midkiff (Virginia Polytechnic Institute and State University, USA)

NET12: Satellite Networks

NET12-1 (invited) Broadband Satellite Networks: Trends and Challenges 1472
Sastri L. Kota (Harris Corporation, USA)
NET12-2 Fast and Accurate Canceller on Carrier Super-positioning for VSAT Frequency Re-use 1479
Michihiro Ichikawa (Nara Institute of Science and Technology, Japan), Takao Hara (Nara Institute of Science and Technology, Japan), Minoru Okada (Nara Institute of Science and Technology, Japan), Heiichi Yamamoto (Nara Institute of Science and Technology, Japan), Kiyotake Ando (JSAT Corporation, Japan)
NET12-3 An Enhanced QoS Routing Algorithm for Provision of End-to-End Delay Guarantee in Low Earth Orbit Satellite Networks 1485
Qijie Huang (Institute for Infocomm Research, Singapore, National University of Singapore, Singapore), Boon Sain Yeo (Institute for Infocomm Research, Singapore), Peng-Yong Kong (Institute for Infocomm Research, Singapore)
NET12-4 An Experimental Evaluation of a Novel Acknowledgment Scheme over GEO-Satellite Links 1491
Ru H. Wang (Lamar University, USA), Satinderbir Singh (Lamar University, USA), Sreelakshmi Bonasu (Lamar University, USA), Guangbin Fan (University of Mississippi, USA)

NET13: TCP over Wireless

NET13-1 TCP Congestion Control with ACK-Pacing for Vertical Handover 1497
Yosuke Matsushita (Osaka University, Japan), Takahiro Matsuda (Osaka University, Japan), Miki Yamamoto (Osaka University, Japan)

NET13-2 TCP/IP Analysis and Optimization over a Precommercial Live UMTS Network 1503
M. Catalan (Technical University of Catalonia, Spain), C. Gomez (Technical University of Catalonia, Spain), D. Viamonte (Technical University of Catalonia, Spain), J. Paradells (Technical University of Catalonia, Spain), A. Calveras (Technical University of Catalonia, Spain), F. Barcelo (Technical University of Catalonia, Spain)

NET13-3 Modeling Split-TCP Latency and Buffering Requirements in GEO Satellite Networks 1509
M. Karaliopoulos (University of Surrey, UK), R. Tafazolli (University of Surrey, UK), B. Evans (University of Surrey, UK)

NET13-4 Quality of Service for TCP over Satellite Links in Congested Networks 1515
Unghee Lee (Virginia Polytechnic Institute and State University, USA), Scott F. Midkiff (Virginia Polytechnic Institute and State University, USA)

NET14: Wireless Network Security

NET14-1 DoS-resistant Access Control Protocol with Identity Confidentiality for Wireless Networks 1521
Zhiguo Wan (National University of Singapore, Singapore), Bo Zhu (National University of Singapore, Singapore), Robert H. Deng (Singapore Management University, Singapore), Feng Bao (Institute for Infocomm Research, Singapore), Akkihebbal L. Ananda (National University of Singapore, Singapore)

NET14-2 Access Control for Future Mobile Devices 1527
Hongyuan Chen (Nokia Research Center, Japan), T. V. L. N Sivakumar (Nokia Research Center, Japan)

NET14-3 Mobile IPv4 Secure Firewall Traversal with Deployment of Foreign Agents 1533
Jin Tang (Georgia Institute of Technology, USA), John A. Copeland (Georgia Institute of Technology, USA)

NET15: Multihop and Ad Hoc WLANs

NET15-1 Effect of Relaying on Capacity Improvement in Wireless Local Area Networks 1539
Aaron So (University of Toronto, Canada), Ben Liang (University of Toronto, Canada)

NET15-2 The Impact of Lossy Links on TCP Performance in IEEE 802.11 based Ad Hoc Networks 1545
Xia Li (National University of Singapore, Singapore, Institute for Infocomm Research, Singapore), KeeChaing Chua (National University of Singapore, Singapore), Peng-Yong Kong (Institute for Infocomm Research, Singapore), ShengMing Jiang (Institute for Infocomm Research, Singapore)

NET15-3 Proportional Fairness in Wireless LANs and Ad Hoc Networks 1551
Bin Jiang Li (The Chinese University of Hong Kong, Hong Kong), Chang Liew Soung (The Chinese University of Hong Kong, Hong Kong)

NET15-4 BLAM: An Energy-Aware MAC Layer Enhancement for Wireless Ad Hoc Networks 1557
Sameh Gobriel (University of Pittsburgh, USA), Rami Melhem (University of Pittsburgh, USA), Daniel Mossé (University of Pittsburgh, USA)

NET16: Mobility over WLANs/WLAN Deployment

NET16-1 QoS for Inter-WLAN IP Mobility with High Speed Accessed Network Server 1564
Moshiur Rahman (AT&T Labs, USA), Fotios Harmantzis (Stevens Institute of Technology, USA), Vinoth Gunasekaran (Stevens Institute of Technology, USA)

NET16-2 Roaming Key based Fast Handover in WLANs 1570
A. R. Prasad (DoCoMo Communications Laboratories Europe GmbH, Germany), H. Wang (DoCoMo Communications Laboratories Europe GmbH, Germany)

NET16-3 A Network Layer Seamless Handover Scheme Based on Xcast for Wireless LANs 1577
Lei Li (The Graduate University for Advanced Studies, Japan), Shinji Abe (National Institute of Informatics, Japan)

NET16-4 Joint Access Point Placement and Channel Assignment for 802.11 Wireless LANs 1583
Xiang Ling (University of Electronic Science and Technology of China, China), Kwan Lawrence Yeung (University of Hong Kong, Hong Kong)

NET17: Real-time Traffic over WLAN

NET17-1 (invited) Using Dynamic PCF to Improve the Capacity for VoIP Traffic in IEEE 802.11 Networks 1589
Takehiro Kawata (NTT, Japan), Sangho Shin (Columbia University, USA), Andrea G. Forte (Columbia University, USA), Henning Schulzrinne (Columbia University, USA)

NET17-2 Wireless LAN Resource Management Mechanism Guaranteeing Minimum Available Bandwidth for Real-Time Communication 1596
Toshihiko Tamura (NTT Corporation, Japan), Tadashi Ito (NTT Corporation, Japan)

NET17-3 Optimization of a Link Adaptation Algorithm for Voice over Wireless LAN Applications 1602
Tony Braskich (Motorola Labs, USA), Nattavut Smavatkul (Motorola Labs, USA), Steve Emeott (Motorola Labs, USA)
NET17-4 Effect of Packet Size on Loss Rate and Delay in Wireless Links 1608
Jari Korhonen (National University of Singapore, Singapore), Ye Wang (National University of Singapore, Singapore)

NET18: WLAN Performance

NET18-1 (invited) A Methodology for the Energy Efficiency Performance Evaluation of Tree-search Contention Resolution Algorithms 1614
Chatschik Bisdikian (IBM T. J. Watson Research Center, USA)
NET18-2 Enhancing 802.11 DCF MAC for TCP/IP Communication 1620
Yoshifumi Nishida (Sony Computer Science Laboratories, Inc., Japan)
NET18-3 SCW: Sliding Contention Window for Efficient Service Differentiation in IEEE 802.11 Networks 1626
Abdelhamid Nafaa (University of Versailles, France), Adlen Ksentini (University of Cergy-Pontoise, France), Ahmed Mehaoua (University of Versailles, France)
NET18-4 A Technical and Micro-Economic Analysis of Wireless LANs 1632
Leonardo Badia (University of Ferrara, Italy), Michele Zorzi (University of Padova, Italy)

NET19: Mobility Models and Effects

NET19-1 The Influence Mobility Model: A Novel Hierarchical Mobility Modeling Framework 1638
Muhammad U. Ilyas (Michigan State University, USA, Lahore University of Management Sciences, Pakistan), Hayder Radha (Michigan State University, USA)
NET19-2 Using Delaunay Triangulation to Construct Obstacle Detour Mobility Model 1644
Dijiang Huang (University of Missouri–Kansas City, USA)
NET19-3 Impact of Mobility on Connection Stability in Ad Hoc Networks 1650
Sungsoon Cho (University of Michigan, USA), John P. Hayes (University of Michigan, USA)
NET19-4 HSDPA Flow Level Performance and the Impact of Terminal Mobility 1657
Remco Litjens (TNO Telecom, The Netherlands)

NET20: Experimental Evaluations

NET20-1 (invited) Overview of the ORBIT Radio Grid Testbed for Evaluation of Next-Generation Wireless Network Protocols 1664
D. Raychaudhuri (Rutgers University, USA), I. Seskar (Rutgers University, USA), M. Ott (Rutgers University, USA), S. Ganu (Rutgers University, USA), K. Ramachandran (Rutgers University, USA), H. Kremo (Rutgers University, USA), R. Siracusa (Rutgers University, USA), H. Liu (Rutgers University, USA), M. Singh (Rutgers University, USA)
NET20-2 GPRS Measurement Methodologies and Performance Characterization for the Railway Environment 1670
Dirk Michel (Bechtel Telecommunications, UK), Nathan Ramasarma (Bechtel Telecommunications, USA)
NET20-3 Empirical Observations on Wireless LAN Performance in Vehicular Traffic Scenarios and Link Connectivity based Enhancements for Multihop Routing 1676
Jatinder Pal Singh (Stanford University, USA), Nicholas Bambos (Stanford University, USA), Bhaskar Srinivasan (Robert Bosch Corporation, USA), Detlef Clawin (Robert-Bosch-Strasse 200, Germany), Yonchun Yan (University of Cincinnati, USA)
NET20-4 Implementation of a Cellular Framework for Spontaneous Network Establishment 1683
Marc Danzeisen (University of Berne, Switzerland, Swisscom AG, Switzerland), Torsten Braun (University of Berne, Switzerland), Simon Winiker (University of Berne, Switzerland), Daniel Rodellar (Swisscom AG, Switzerland)

NET21: Cellular WLAN Interworking

NET21-1 An Improved Interworking Architecture for UMTS–WLAN Tight Coupling 1690
Chunming Liu (Florida International University, USA), Chi Zhou (Florida International University, USA)
NET21-2 Incentive Scheduling for Cooperative Relay in WWAN/WLAN Two-Hop-Relay Network 1696
Hung-Yu Wei (NEC Labs America, USA, Columbia University, USA), Richard D. Gitlin (Columbia University, USA)
NET21-3 Practical Considerations on End-to-End Cellular/PWLAN Architecture in Support of Bilateral Roaming 1702
Jenq-Shiou Leu (National Tsing Hua University, Taiwan), Rong-Horng Lai (Mobitai Communications, Taiwan), Hsin-I Lin (Mobitai Communications, Taiwan), Wei-Kuan Shih (National Tsing Hua University, Taiwan)
NET21-4 WRN: Improving System Performance in 3G Networks Through Fixed multiHop Relay Nodes 1708
Shamik Sengupta (University of Central Florida, USA), Mainak Chatterjee (University of Central Florida, USA), Samrat Ganguly (NEC Laboratories America, USA), Rauf Izmailov (NEC Laboratories America, USA)

NET22: Cellular Network Engineering

NET22-1 Geographic Load Balancing for WCDMA Mobile Networks Using a Bubble Oscillation Algorithm 1714
Lin Du (Philips Research East Asia, P.R. China), John Bigham (University of London, UK), Laurie Cuthbert (University of London, UK)

NET22-2 Dynamic Inter-Operator Spectrum Sharing for UMTS FDD with Displaced Cellular Networks 1720
M. K. Pereirasamy (Siemens AG, Germany), J. Luo (Siemens AG, Germany), M. Dillinger (Siemens AG, Germany), C. Hartmann (Technical University of Munich, Germany)

NET22-3 Novel Algorithms for Reducing Cell Sites during a Technology Upgrade and Network Overlay 1726
David Abusch-Magder (Bell Labs, Lucent Technology, USA)

NET22-4 A Simple and Accurate Linear Solver for Hyperbolic Localization 1733
Haoyun Wu (Sensis Corporation, USA), I-tai Lu (Polytechnic University, USA)

NET23: End-to-End Performance

NET23-1 Latency Analysis of WAP 2.0 for Short-Lived Flows 1737
Humphrey Rutagemwa (University of Waterloo, Canada), Xuemin Shen (University of Waterloo, Canada), Jon W. Mark (University of Waterloo, Canada)

NET23-2 Using Network Tomography for Dynamic Path Adaptation 1743
Hazar Aouad (Ecole Nationale Supérieure des Télécommunications, France), Samir Tohme (Versailles St Quentin University, France)

NET23-3 Local Restoration for Bandwidth Guaranteed Connections in Mobile Optical Backbone Networks 1749
Fangting Sun (University of Maryland, USA), Mark Shayman (University of Maryland, USA)

NET23-4 Load Balancing in Distributed Computing over Wireless LAN: Effects of Network Delay 1755
S. Dhakal (University of New Mexico, USA), M. M. Hayat (University of New Mexico, USA), M. Elyas (University of New Mexico, USA), J. Ghanem (University of New Mexico, USA), C. T. Abdallah (University of New Mexico, USA)

NET24: Wireless Network Performance 1

NET24-1 Multicast Streaming over 3G Cellular Networks through multiChannel Transmissions: Proposals and Performance Evaluation 1761
Michele Rossi (University of Ferrara, Italy), Paolo Casari (University of Padova, Italy), Marco Levorato (University of Padova, Italy), Michele Zorzi (University of Padova, Italy)

NET24-2 Comparison of Signaling Performance in the UMTS Radio Access Network and a Merged Radio Access Network Architecture 1767
Andreas Mitschele-Thiel (Technical University of Ilmenau, Germany), Peter Schefczik (Lucent Technologies, Germany), Anja Wiedemann (University of Duisburg-Essen, Germany)

NET24-3 Retransmission Strategies for MBMS over GERAN 1773
Hrvoje Jenkač (Munich University of Technology, Germany), Günther Liebl (Munich University of Technology, Germany), Thomas Stockhammer (Siemens AG, Germany), Wen Xu (Siemens AG, Germany)

NET24-4 Multicast Optimization in Broadband Adaptive Optical Wireless Networks 1780
Ahmed M. Mahdy (University of Nebraska–Lincoln, USA), Jitender S. Deogun (University of Nebraska–Lincoln, USA)

NET25: Wireless Network Performance 2

NET25-1 Locality-based Techniques for Computationally Simplifying Wireless Network Optimization 1786
R. Kang-Xing Jin (Bell Labs, Lucent Technologies, USA), Jeffrey Brian Arnold (Bell Labs, Lucent Technologies, USA), David Abusch-Magder (Bell Labs, Lucent Technology, USA)

NET25-2 Cell Stay Time Prediction for Mobility Independent Predictive Services in Wireless Networks 1792
F. De Rango (University of Calabria, Italy), P. Fazio (University of Calabria, Italy), S.Marano (University of Calabria, Italy)

NET25-3 TCP Traffic in Bluetooth 1.2: Performance and Dimensioning of Flow Control 1798
Jelena Mišić (University of Manitoba, Canada), Ka Lok Chan (The Hong Kong University of Science and Technology, China), Vojislav Mišić (University of Manitoba, Canada)

NET25-4 Permeable-Layer Receiver for Reliable Multicast Transmission in Wireless Systems 1805
Hrvoje Jenkač (Munich University of Technology, Germany), Thomas Stockhammer (Siemens AG, Germany), Wen Xu (Siemens AG, Germany)

NET26: Sensor Network Protocols

NET26-1 A Cross-layer Approach for Efficient Flooding in Wireless Sensor Networks 1812
Xiaodong Wang (University of Cincinnati, USA), Jun Yin (University of Cincinnati, USA), Qi Zhang (University of Cincinnati, USA), Dharma P. Agrawal (University of Cincinnati, USA)

NET26-2 A State-free Data Delivery Protocol for Multihop Wireless Sensor Networks 1818
Dazhi Chen (Syracuse University, USA), Jing Deng (University of New Orleans, USA), Pramod K. Varshney (Syracuse University, USA)

NET26-3 A Distributed Protocol for Query Execution in Sensor Networks 1824
Jang-Ping Sheu (National Central University, Taiwan), Chia-Hao Yu (National Central University, Taiwan), Tu Shin-Chih (University of National Central, Taiwan)

NET26-4 Analysis of Hierarchical Algorithms for Wireless Sensor Network Routing Protocols 1830
Kevin Sean Chan (Georgia Institute of Technology, USA), Hossein Pishro-Nik (Georgia Institute of Technology, USA), Faramarz Fekri (Georgia Institute of Technology, USA)

NET27: Sensor Network: Node Placement and Localization

NET27-1 (invited) Towards Optimal Sensor Placement with Hypercube Cutting Planes 1836
Siddhartha Chaudhuri (Indian Institute of Technology, Kanpur, India), R. K. Ghosh (Indian Institute of Technology, Kanpur, India), Sajal K. Das (The University of Texas at Arlington, USA)

NET27-2 Sensor Networks over Information Fields: Optimal Energy and Node Distributions 1842
Hithesh Nama (Rutgers University, USA), Narayan Mandayam (Rutgers University, USA)

NET27-3 Density-Aware Hop-Count Localization (DHL) in Wireless Sensor Networks with Variable Density 1848
Sau Yee Wong (Institute of Infocomm Research, Singapore, National University of Singapore, Singapore), Joo Ghee Lim (Institute for Infocomm Research, Singapore), S. V. Rao (Institute for Infocomm Research, Singapore), Winston K. G. Seah (Institute for Infocomm Research, Singapore)

NET27-4 A Distributed Algorithm for Logical Location Estimation in Speckled Computing 1854
R. McNally (University of Edinburgh, Scotland), K. J. Wong (University of Edinburgh, Scotland), D. K. Arvind (University of Edinburgh, Scotland)

NET28: Sensor Network: Energy Efficiency 1

NET28-1 (invited) Energy Aware Routing for Spatio-Temporal Queries in Sensor Networks 1860
Neha Jain (University of Cincinnati, USA), Ratnabali Biswas (University of Cincinnati, USA), Nagesh Nandiraju (University of Cincinnati, USA), Dharma P. Agrawal (University of Cincinnati, USA)

NET28-2 Energy and Mobility Aware Geographical Multipath Routing for Wireless Sensor Networks 1867
Qilian Liang (University of Texas at Arlington, USA), Qingchun Ren (University of Texas at Arlington, USA)

NET28-3 Energy Efficient Clustering in Sensor Networks with Mobile Agents 1872
Mahdi Lotfinezhad (University of Toronto, Canada), Ben Liang (University of Toronto, Canada)

NET28-4 Energy-Aware, Collaborative Tracking with Ad Hoc Wireless Sensor Networks 1878
Sanjeevi Balasubramanian (Wichita State University, USA), Sudharman K. Jayaweera (Wichita State University, USA), Kameswara R. Namuduri (Wichita State University, USA)

NET29: Sensor Network: Energy Efficiency 2

NET29-1 (invited) Towards a Model of Energy Complexity for Algorithms 1884
Ravi Jain (DoCoMo USA Laboratories, USA), David Molnar (University of California, Berkeley, USA), Zulfikar Ramzan (DoCoMo USA Laboratories, USA)

NET29-2 Lifetime Maximization under Reliability Constraint via Cross-Layer Strategy in Wireless Sensor Networks 1891
Hojoong Kwon (Seoul National University, Korea), Tae Hyun Kim (Seoul National University, Korea), Sunghyun Choi (Seoul National University, Korea), Byeong Gi Lee (Seoul National University, Korea)

NET29-3 A Minimum-Power Wireless Sensor Network Self-Deployment Scheme 1897
Wei Li (Boston University, USA), Christos G. Cassandras (Boston University, USA)

NET29-4 Fuzzy Optimization for Distributed Sensor Deployment 1903
Haining Shu (University of Texas at Arlington, USA), Qilian Liang (University of Texas at Arlington, USA)

Author Index

Volume 4

NET30: Sensor Network: Security

NET30-1 Securing Sensor Networks with Location-based Keys 1909
Yanchao Zhang (University of Florida, USA), Wei Liu (University of Florida, USA), Wenjing Lou (Worcester Polytechnic Institute, USA), Yuguang Fang (University of Florida, USA)

NET30-2 A Robust Group-based Key Management Scheme for Wireless Sensor Networks 1915
Zhen Yu (Iowa State University, USA), Yong Guan (Iowa State University, USA)

NET30-3 LLK: A Link-Layer Key Establishment Scheme for Wireless Sensor Networks 1921
Yun Zhou (University of Florida, USA), Yanchao Zhang (University of Florida, USA), Yuguang Fang (University of Florida, USA)

NET30-4 The New Intrusion Prevention and Detection Approaches for Clustering-based Sensor Networks 1927
Chien-Chung Su (National Cheng Kung University, Taiwan), Ko-Ming Chang (National Cheng Kung University, Taiwan), Yau-Hwang Kuo (National Cheng Kung University, Taiwan), Mong-Fong Horng (Shu-Te University, Taiwan)

NET31: Sensor Network Design

NET31-1 Critical Area Attention in Traffic Aware Dynamic Node Scheduling for Low Power Sensor Networks 1933
Mostafa Ghannad Rezaie (University of Tehran, Iran), Vahid Shah Mansouri (Shrift University of Technology, Iran), Mehdi Mani (Institut National des Telecommunications, France)

NET31-2 Distributed Source Coding in Wireless Sensor Networks using LDPC Coding: The Entire Slepian-Wolf Rate Region 1939
Mina Sartipi (Georgia Institute of Technology, USA), Faramarz Fekri (Georgia Institute of Technology, USA)

NET31-3 Self-Organizing Redundancy-Cellular Architecture for Wireless Sensor Networks 1945
Xiaofei Wang (Cornell University, USA), Toby Berger (Cornell University, USA)

NET31-4 A Study into the Practical Issues Related to a Deployed Ad Hoc Wireless Sensor Network 1952
E. L. Kuan (Multiple Access Communications Limited, UK)

NET32: MANET Routing 1

NET32-1 Multipath Fresnel Zone Routing for Wireless Ad Hoc Networks 1958
Yibin Liang (Virginia Polytechnic Institute and State University, USA), Scott F. Midkiff (Virginia Polytechnic Institute and State University, USA)

NET32-2 Neighbor Stability Routing in MANETs 1964
Lei Chen (Auburn University, USA), Chung-wei Lee (Auburn University, USA)

NET32-3 Node Caching Enhancement of Reactive Ad Hoc Routing Protocols 1970
Sunsook Jung (Georgia State University, USA), Nisar Hundewale (Georgia State University, USA), Alex Zelikovsky (Georgia State University, USA)

NET32-4 A Cross-Layer Approach for Designing Directional Routing Protocol in MANETs 1976
Hrishikesh Gossain (University of Cincinnati, USA), Tarun Joshi (University of Cincinnati, USA), Carlos Cordeiro (Philips Research, USA), Dharma P. Agrawal (University of Cincinnati, USA)

NET33: MANET Routing 2

NET33-1 Adaptive Load Balancing in Mobile Ad Hoc Networks 1982
Shouyi Yin (Tsinghua University, P.R. China), Xiaokang Lin (Tsinghua University, P.R. China)

NET33-2 Routing with Congestion Awareness and Adaptivity in Mobile Ad Hoc Networks 1988
Duc A. Tran (University of Dayton, USA), Harish Raghavendra (University of Dayton, USA)

NET33-3 Dynamic NIx-Vector Routing for Mobile Ad Hoc Networks 1995
Young J. Lee (Georgia Institute of Technology, USA), George F. Riley (Georgia Institute of Technologh, USA)

NET33-4 A Workload-based Adaptive Load-Balancing Technique for Mobile Ad Hoc Networks 2002
Young J. Lee (Georgia Institute of Technology, USA), George F. Riley (Georgia Institute of Technologh, USA)

NET34: MANET Routing 3

NET34-1 Improving the Efficiency and Reliability of the Route Discovery Process in On-demand Routing Protocols 2008
Marco Aurélio Spohn (University of California at Santa Cruz, USA), J. J. Garcia-Luna-Aceves (University of California at Santa Cruz, USA)

NET34-2 Path Verification for Robust, Instantaneous Loop-free Routing in Ad Hoc Networks 2014
Hari Rangarajan (University of California, Santa Cruz, USA), J. J. Garcia-Luna-Aceves (University of California at Santa Cruz, USA)

NET34-3 Establishing Measurement-based Reliable Path in Mobile Ad Hoc Networks 2020
Ki-Il Kim (Chungnam National University, Korea), Sang-Ha Kim (Chungnam National University, Korea)

NET34-4 On-Line Disjoint Path Routing for Network Capacity Maximization in Ad Hoc Networks 2026
Weifa Liang (Australian National University, Australia), Yuzhen Liu (Wuhan University, P.R. China), Xiaoxing Guo (Australian National University, Australia)

NET35: MANET Routing 4

NET35-1 Experimental Evaluation of LANMAR, a Scalable Ad Hoc Routing Protocol 2032
Yeng-Zhong Lee (University of California at Los Angeles, USA), Jason Chen (University of California at Los Angeles, USA), Xiaoyan Hong (The University of Alabama, USA), Kaixin Xu (University of California at Los Angeles, USA), Teresa Breyer (University of California at Los Angeles, USA), Mario Gerla (University of California at Los Angeles, USA)

NET35-2 Ferry Replacement Protocols in Sparse MANET Message Ferrying Systems 2038
Jeonghwa Yang (Georgia Institute of Technology, USA), Yang Chen (Georgia Institute of Technology, USA), Mostafa Ammar (Georgia Institute of Technology, USA), Chungkee Lee (Georgia Institute of Technology, USA)

NET35-3 Route Reservation in Ad Hoc Networks: Is It a Good Idea? 2045
Sooksan Panichpapiboon (Carnegie Mellon University, USA), Gianluigi Ferrari (Carnegie Mellon University, USA), Nawaporn Wisitpongphan (Carnegie Mellon University, USA), Ozan K. Tonguz (Carnegie Mellon University, USA)

NET35-4 Routing and Interface Assignment in multiChannel multiInterface Wireless Networks 2051
Pradeep Kyasanur (University of Illinois at Urbana–Champaign, USA), Nitin H. Vaidya (University of Illinois at Urbana–Champaign, USA)

NET36: MANET Power Efficient Broadcasting

NET36-1 The Minimum Power Broadcast Problem in Wireless Networks: A Simulated Annealing Approach 2057
Roberto Montemanni (Istituto Dalle Molle di Studi sull'Intelligenza Artificiale, Switzerland), Luca Maria Gambardella (Istituto Dalle Molle di Studi sull'Intelligenza Artificiale, Switzerland), Arindam K. Das (University of Washington, USA)

NET36-2 Scalable Power-Efficient Broadcast over Densely Deployed Wireless Ad Hoc Networks 2063
Intae Kang (University of Washington, USA), Radha Poovendran (University of Washington, USA)

NET36-3 Local Versus Global Power Adaptive Broadcasting in Ad Hoc Networks 2069
Kyriakos Karenos (University of California, Riverside, USA), Asheq Khan (University of California, Riverside, USA), Srikanth Krishnamurthy (University of California, Riverside, USA), Michalis Faloutsos (University of California, Riverside, USA), Xiaohu Chen (University of California, Riverside, USA)

NET36-4 NB-TRACE: Network-Wide Broadcasting Through Time Reservation Using Adaptive Control for Energy Efficiency 2076
Bulent Tavli (University of Rochester, USA), Wendi B. Heinzelman (University of Rochester, USA)

NET37: MANET Key Management

NET37-1 Analysis of a Hybrid Key Management Solution for Ad Hoc Networks 2082
Aruna Balasubramanian (University at Buffalo, USA), Sumita Mishra (CompSys Technologies Inc., USA), Ramalingam Sridhar (University at Buffalo, USA)

NET37-2 An Improved Authenticated Key Agreement Protocol with Perfect Forward Secrecy for Wireless Mobile Communication 2088
Ai-fen Sui (The University of Hong Kong, Hong Kong), Lucas C. K. Hui (The University of Hong Kong, Hong Kong), S. M. Yiu (The University of Hong Kong, Hong Kong), K. P. Chow (The University of Hong Kong, Hong Kong), W. W. Tsang (The University of Hong Kong, Hong Kong), C. F. Chong (The University of Hong Kong, Hong Kong), K. H. Pun (The University of Hong Kong, Hong Kong), H. W. Chan (The University of Hong Kong, Hong Kong)

NET37-3 PGSP: A Protocol for Secure Communication in Peer-to-Peer System 2094
Neelima Arora (Intel Technologies Pvt. Ltd., India), R. K. Shyamasundar (Tata Institute of Fundamental Research, India)

NET37-4 An Authenticated Group Key Agreement for Wireless Networks 2100
Chik How Tan (Nanyang Technological University, Singapore), Joseph Chee Ming Teo (Nanyang Technological University, Singapore)

NET38: MANET Security

NET38-1 Detecting and Locating Wormhole Attacks in Wireless Ad Hoc Networks through Statistical Analysis of Multipath 2106
Lijun Qian (Prairie View A&M University, USA), Ning Song (Prairie View A&M University, USA), Xiangfang Li (WRutgers University, USA)

NET38-2 Mitigating Malicious Control Packet Floods in Ad Hoc Networks 2112
Saman Desilva (The University of San Antonio, USA), Rajendra V. Boppana (The University of Texas at San Antonio, USA)

NET38-3 Resource-Aware Self-Adaptive Security Provisioning in Mobile Ad Hoc Networks 2118
Chunxiao Chigan (Michigan Technological University, USA), Leiyuan Li (Michigan Technological University, USA), Yinghua Ye (Nokia Research Center, USA)

NET38-4 Piconet Security in IEEE 802.15.3 WPAN 2125
Zhihua Tao (Microsoft Research Asia, P.R. China), Zihua Guo (Microsoft Research Asia, P.R. China), Richard Yao (Microsoft Research Asia, P.R. China)

NET39: MANET Fairness

NET39-1 A Self-Learning Repeated Game Framework for Optimizing Packet Forwarding Networks 2131
Zhu Han (University of Maryland, College Park, USA), Charles Pandana (niversity of Maryland, College Park, USA), K. J. Ray Liu (University of Maryland College Park, USA)

NET39-2 TWOACK: Preventing Selfishness in Mobile Ad Hoc Networks 2137
Kashyap Balakrishnan (Deloitte & Touche LLP, USA), Jing Deng (University of New Orleans, USA), Pramod K. Varshney (Syracuse University, USA)

NET39-3 Towards Cooperation Fairness in Mobile Ad Hoc Networks 2143
Haijin Yan (The University of Georgia, USA), David Lowenthal (The University of Georgia, USA)

NET39-4 Improving Per-Flow Fairness in Wireless Ad Hoc Networks 2149
Oyunchimeg Shagdar (ATR Adaptive Communications Research Laboratories, Japan), Bing Zhang (ATR Adaptive Communications Research Laboratories, Japan)

NET40: MANET Multicast Routing

NET40-1 On-Demand Overlay Multicast in Mobile Ad Hoc Networks 2155
Oliver Stanze (University of Karlsruhe, Germany), Martina Zitterbart (University of Karlsruhe, Germany)

NET40-2 On Demand Multicast Routing with Unidirectional Links 2162
Mario Gerla (University of California at Los Angeles, USA), Yeng-Zhong Lee (University of California at Los Angeles, USA), Joon-Sang Park (University of California, Los Angeles, USA), Yunjung Yi (University of California at Los Angeles, USA)

NET40-3 CQMP: A Mesh-based Multicast Routing Protocol with Consolidated Query Packets 2168
Harleen Dhillon (State University of New York at Buffalo, USA), Hung Q. Ngo (State University of New York at Buffalo, USA)

NET40-4 Enhancing Cellular Multicast Performance Using Ad Hoc Networks 2175
Jun Cheol Park (University of Utah, USA), Sneha Kumar Kasera (University of Utah, USA)

NET41: MANET Cross-Layer Design

NET41-1 Does Relay of Corrupted Packets Increase Capacity? 2182
S. S. Karande (Michigan State University, USA), H. Radha (Michigan State University, USA)

NET41-2 Multiuser Diversity Forwarding in Multihop Packet Radio Networks 2188
Peter Larsson (Ericsson Research, Sweden), Niklas Johansson (Ericsson Research, Sweden)

NET41-3 Distributed Channel Assignment Protocols: A Cross-Layer Approach 2195
Michelle X. Gong (Virginia Polytechnic Institute and State University, USA), Scott F. Midkiff (Virginia Polytechnic Institute and State University, USA)

NET41-4 Cross-Layer Optimization of Multihop Radio Networks with Multiuser Detectors 2201
Simone Loretti (Royal Institute of Technology, Sweden), Pablo Soldati (Royal Institute of Technology, Sweden), Mikael Johansson (Royal Institute of Technology, Sweden)

NET42: MANET Connectivity

NET42-1 Multirate Aware Topology Control in Multihop Ad Hoc Networks 2207
Shihong Zou (Beijing University of Posts and Telecommunications, China), Shiduan Cheng (Beijing University of Posts and Telecommunications, China), Yu Lin (Beijing University of Posts and Telecommunications, China)

NET42-2 Performance Evaluation of Topology Management in Multirate Ad Hoc Networks 2213
Haixia Tan (University of California, Irvine, USA), Weilin Zeng (University of California, Irvine, USA), Lichun Bao (University of California, Irvine, USA)

NET42-3 Asymptotic Critical Transmission Ranges for Connectivity in Wireless Ad Hoc Networks with Bernoulli Nodes 2219
Peng-Jun Wan (Illinois Institute of Technology, USA), Chih-Wei Yi (Illinois Institute of Technology, USA)

NET42-4 Connectivity in the Presence of Shadowing in 802.11 Ad Hoc Networks ... 2225

Patrick Stuedi (Swiss Federal Institute of Technology, Switzerland), Oscar Chinellato (Swiss Federal Institute of Technology, Switzerland), Gustavo Alonso (Swiss Federal Institute of Technology, Switzerland)

NET43: MANET Service Provisioning

NET43-1 *Random* and *Linear* Address Allocation for Mobile Ad Hoc Networks ... 2231

Nakjung Choi (Seoul National University, Korea), C. K. Toh (University of London, UK), Yongho Seok (Seoul National University, Korea), Dongkyun Kim (Kyungpook National University, Korea), Yanghee Choi (Seoul National University, Korea)

NET43-2 Adaptive QoS Provisioning in Wireless Ad Hoc Networks: A Semi-MDP Approach ... 2238

Daniel Yagan (National University of Singapore, Singapore), Chen-Khong Tham (National University of Singapore, Singapore)

NET43-3 Error Recovery for Multicast Conversational Video over Error-Prone Networks (with Application to Ad Hoc WLANs) ... 2245

Matías Freytes (Universidad Nacional de Córdoba, Argentina), Carlos A. Marqués (Universidad Nacional de Córdoba, Argentina)

NET43-4 Broadcast Methods for Inter-Vehicle Communications System ... 2252

T. Fukuhara (KDDI R&D Laboratories Inc., Japan), T. Warabino (KDDI R&D Laboratories Inc., Japan), T. Ohseki (KDDI R&D Laboratories, Inc., Japan), K. Saito (KDDI R&D Laboratories Inc., Japan), K. Sugiyama (KDDI R&D Laboratories Inc., Japan), T. Nishida (NiCT, Japan), K. Eguchi (NiCT, Japan)

NET44: MANET Architecture and Performance

NET44-1 Accurate and Energy-efficient Congestion Level Measurement in Ad Hoc Networks ... 2258

Jaewon Kang (Rutgers University, USA), Yanyong Zhang (Rutgers University, USA), Badri Nath (Rutgers University, USA)

NET44-2 Rate-based Transport Control for Mobile Ad Hoc Networks ... 2264

Hongqiang Zhai (University of Florida, USA), Xiang Chen (University of Florida, USA), Yuguang Fang (University of Florida, USA)

NET44-3 Service Architecture for Integrating MANETs with Heterogeneous IP Networks ... 2270

Joe C. Chan (University of Technology, Sydney, Australia), Doan B. Hoang (University of Technology, Sydney, Australia)

NET44-4 Minimizing Average Network Delay for Ultra-Wideband Wireless Networks ... 2276

Christopher S. Taggart (North Carolina State University, USA), Yannis Viniotis (North Carolina State University, USA), Mihail L. Sichitiu (North Carolina State University, USA)

Services & Applications Symposium

SA01: Mobile Ad Hoc Networks

SA01-1 (invited) Fault and Intrusion Tolerance in Wireless Ad Hoc Networks ... 2281

N. A. Boudriga (University of 7th of November, Carthage, Tunisia), M. S. Obaidat (Monmouth University, USA)

SA01-2 A Novel Signaling System for Multiparty Sessions in Peer-to-Peer Ad Hoc Networks ... 2287

Chunyan Fu (Concordia University, Canada), Roch H. Glitho (Ericsson, Canada, Concordia University, Canada), Rachida Dssouli (Concordia University, Canada)

SA01-3 Distributed Multicast Grouping for Publish/Subscribe over Mobile Ad Hoc Networks ... 2293

Eiko Yoneki (University of Cambridge, UK), Jean Bacon (University of Cambridge, UK)

SA01-4 A Service Continuity Layer for Mobile Services ... 2300

Ivar Jørstad (Norwegian University of Science and Technology, Norway), Do Van Thanh (Telenor R&D, Norway), Schahram Dustdar (Vienna University of Technology, Austria)

SA02: Voice over IP

SA02-1 A Study on SIP Session Timer for Wireless VoIP ... 2306

Ai-Chun Pang (National Taiwan University, Republic of China), Chih-Hsiao Liu (National Taiwan University, Republic of China), Shu Ping Liu (National Taiwan University, Republic of China), Hui-Nien Hung (National Chiao Tong University, Republic of China)

SA02-2 Performance Evaluation of VoIP over 3G-WLAN Interworking System ... 2312

R. Rajavelsamy (Samsung India Software Operations, India), Jeedigunta Venkateswar (Samsung India Software Operations, India), Balaji Holur (Samsung India Software Operations, India), Manoj Choudhary (Samsung India Software Operations, India), Osok Song (Samsung Electronics Co. Ltd., Korea)

SA02-3 SIP-based Mobile VPN for Real-Time Applications ... 2318

Shun-Chao Huang (National Tsing Hua University, Taiwan), Zong-Hua Liu (National Tsing Hua University, Taiwan), Jyh-Cheng Chen (National Tsing Hua University, Taiwan)

SA02-4 Toll-Free IP (TIP): Architecture and Implementation 2324
Tao Zhang (Telcordia Technologies, USA), Sunil Madhani (Telcordia Technologies, USA), Miriam Tauil (Telcordia Technologies, USA)

SA03: Wireless LAN

SA03-1 (invited) A Comparative Performance Evaluation of RSS-based Positioning Algorithms Used in WLAN Networks 2331
Ahmad Hatami (Worcester Polytechnic Institute, USA), Kaveh Pahlavan (Worcester Polytechnic Institute, USA)

SA03-2 TDOA Location System for IEEE 802.11b WLAN 2338
Ryota Yamasaki (Hitachi, Ltd., Japan), Atsushi Ogino (Hitachi, Ltd., Japan), Tsuyoshi Tamaki (Hitachi, Ltd., Japan), Takaki Uta (Hitachi, Ltd., Japan), Naoto Matsuzawa (Hitachi, Ltd., Japan), Takeshi Kato (Hitachi, Ltd., Japan)

SA03-3 Minimizing Re-Authentication Overheads in Infrastructure IEEE 802.11 WLAN Networks 2344
Anindo Mukherjee (University of Cincinnati, USA), Tarun Joshi (University of Cincinnati, USA), Dharma P. Agrawal (University of Cincinnati, USA)

SA03-4 Received Signal Strength based Location Estimation of a Wireless LAN Client 2350
Michael Robinson (McGill University, Canada), Ioannis Psaromiligkos (McGill University, Canada)

SA04: Sensor Networks

SA04-1 Safety Warning Based on Roadway Sensor Networks 2355
Kai Xing (The George Washington University, USA), Min Ding (The George Washington University, USA), Xiuzhen Cheng (The George Washington University, USA), Shmuel Rotenstreich (The George Washington University, USA)

SA04-2 Fault-Tolerant Target Detection in Sensor Networks 2362
Min Ding (The George Washington University, USA), Dechang Chen (Uniformed Services University of the Health Sciences, USA), Andrew Thaeler (The George Washington University, USA), Xiuzhen Cheng (The George Washington University, USA)

SA04-3 Sensor Data Aggregation for Resource Inventory Applications 2369
Tsung-Han Lin (National Taiwan University, Taiwan), Polly Huang (National Taiwan University, Taiwan)

SA04-4 Supporting Group Communication among Interacting Agents in Wireless Sensor Networks 2375
Jaewon Shin (Stanford University, USA), Anthony Man–Cho So (Stanford University, USA), Leonidas Guibas (Stanford University, USA)

SA05: Traffic Engineering

SA05-1 Simulation of Teletraffic Variables in UMTS Networks: Impact of Lognormal Distributed Call Duration 2381
Antonietta Spedalieri (Technical University of Catalonia, Spain), Israel Martin-Escalona (Technical University of Catalonia, Spain), Francisco Barcelo (Technical University of Catalonia, Spain)

SA05-2 Performance Implications of Pareto-distributed Cell Residual Time in Distributed Admission Control Scheme (DACS) 2387
S. Thajchayapong (Carnegie Mellon University, USA), O. K. Tonguz (Carnegie Mellon University, USA)

SA05-3 Dynamic Packet Scheduling for cdma2000 1xEV-DO Broadcast and Multicast Services 2393
Kyungtae Kang (Seoul National University, Korea), Jinsung Cho (Kyung Hee University, Korea), Heonshik Shin (Seoul National University, Korea)

SA05-4 A Dummy Segment based Bandwidth Probing Technique to Enhance the Performance of TCP over Heterogeneous Networks 2400
Tarik Taleb (Tohoku University, Japan), Kenichi Kashibuchi (Tohoku University, Japan), Nei Kato (Tohoku University, Japan), Yoshiaki Nemoto (Tohoku University, Japan)

SA06: Network Architecture Design

SA06-1 A Consolidated Architecture for 4G/B3G Networks 2406
M. Rubaiyat Kibria (The University of Sydney, Australia), Vinod Mirchandani (The University of Sydney, Australia), Abbas Jamalipour (The University of Sydney, Australia)

SA06-2 A Lightweight Pervasive Architecture for Fieldwork Environments 2412
Thienne Johnson (Universidade Federal de Pernambuco, Brazil), Djamel Sadok (Universidade Federal de Pernambuco, Brazil)

SA06-3 Design and Implementation of an Architecture Supporting Mobile CORBA Servants under Intermittent Connectivity Environment 2418
Mayank Mishra (Persistent Systems Private Ltd., India), Sanjay Chaudhary (Dhirubhai Ambani Institute of Information and Communication Technology, India)

SA06-4 Integrated Networking Technologies for a Survivable Network 2424
J. Chennikara-Varghese (Telcordia Technologies, Inc., USA), A. Dutta (Telcordia Technologies, USA), A. Cheng (Telcordia Technologies, USA), D. Chee (Telcordia Technologies, Inc., USA), M. Elaoud (Telcordia Technologies, USA), T. McAuley (Telcordia Technologies, USA), I. Sebuktekin (Telcordia Technologies, USA), B. Kim (Telcordia Technologies, USA), K. D. Wong (Telcordia Technologies, USA), J. Burns (Telcordia Technologies, USA), M. Yajnik (Telcordia Technologies, USA), L. Wong (Telcordia Technologies, USA), K. Young (Telcordia Technologies, USA), Henning Schulzrinne (Columbia University, USA)

SA07: Service Accountability

SA07-1 An AAA based Service Customization Framework for Public WLANs 2430
Farooq Bari (AT&T Wireless Services, USA)
SA07-2 Sequential Aggregate Signatures for Wireless Routing Protocols 2436
Huafei Zhu (Institute for Infocomm Research, Singapore), Feng Bao (Institute for Infocomm Research, Singapore), Tieyan Li (Institute for Infocomm Research, Singapore), Yongdong Wu (Institute for Infocomm Research, Singapore)
SA07-3 A Simple Approach to Charging and Billing of Packetized Applications 2440
Gülfem Işiklar (Boğaziçi University, Turkey), Ayşe Başar Bener (Boğaziçi University, Turkey)
SA07-4 Service Survivability in Wireless Networks via Multi-Layer Self-Healing 2446
Latha Kant (Telcordia Technologies Inc., USA), Wai Chen (Telcordia Technologies Inc., USA)

SA08: Cellular System Services

SA08-1 Mapping of File-Sharing onto Mobile Environments: Feasibility and Performance of eDonkey with GPRS 2453
Tobias Hoßfeld (University of Würzburg, Germany), Kurt Tutschku (University of Würzburg, Germany), Frank-Uwe Andersen (Siemens AG, Germany)
SA08-2 Access to IP Multimedia Subsystem of UMTS via PacketCable Network 2459
Mehdi Mani (Institut National des Telecommunications, France), Noël Crespi (Institut National des Telecommunications, France)
SA08-3 A Proxy-based Framework to Enhance User Level Performance of GPRS/UMTS Networks 2466
Yue Wang (Tsinghua University, P.R. China), Junxiu Lu (Tsinghua University, P.R. China), Yong Ren (Tsinghua University, P.R. China), Xiuming Shan (Tsinghua University, P.R. China), Yonghua Song (Brunel University, UK)
SA08-4 IMS-based Push-to-Talk over GPRS/UMTS 2472
Peter Kim (Siemens AG, Germany), Andras Balazs (Siemens AG, Germany), Eddy van den Broek (Siemens AG, Germany), Gerhard Kieselmann (Siemens AG, Germany), Wolfgang Böhm (Siemens AG, Germany)

SA09: Personal and Indoor Services

SA09-1 (invited) A Novel Scheduling Scheme and MAC Enhancements for IEEE 802.15.3 High-Rate WPAN 2478
RanRan Zeng (Beijing University of Posts and Telecommunications, China), Geng-Sheng Kuo (National Chengchi University, Taiwan)
SA09-2 Practical Device Association Protocols for Wireless enabled Personal Devices 2484
A. Lakshminarayanan (Institute for Infocomm Research, Singapore), Huafei Zhu (Institute for Infocomm Research, Singapore)
SA09-3 Map-aided Indoor Mobile Positioning System using Particle Filter 2490
Frédéric Evennou (France Telecom R&D, France), François Marx (France Telecom R&D, France), Emil Novakov (IMEP, France)
SA09-4 HTTP Compression Techniques 2495
Zhigang Liu (Nokia Research Center, USA), Yousuf Saifullah (Nokia Research Center, USA), Marc Greis (Nokia Research Center, USA), Srinivas Sreemanthula (Nokia Research Center, USA)

SA10: Wireless Services

SA10-1 Implementing a Wireless Application in a Developing Country 2501
J. G. McDaniel (University of Victoria, Canada), E. Slawecki (Canadian Society for International Health, Canada)
SA10-2 Aerouter™—A Graphical Simulation Tool for Routing in Aeronautical Systems 2506
Ehssan Sakhaee (The University of Sydney, Australia), Abbas Jamalipour (The University of Sydney, Australia)
SA10-3 Dynamic End-to-End Image Adaptation for Guaranteed Quality of Service in Wireless Image Data Services 2512
Dong-Gi Lee (University of California, San Diego, USA), Sujit Dey (University of California, San Diego, USA)
SA10-4 On the Use of Notch Filters and Ordered Co-channel TDMA Slots Strategies to the TDMA and CDMA Overlaid Systems 2519
Josefina Castañeda-Camacho (CINVESTAV-IPN, Mexico), Domingo Lara-Rodríguez (CINVESTAV-IPN, Mexico)

SA11: Location and Mobility Tracking

SA11-1 An Enhanced Received Signal Level Cellular Location Determination Method via Maximum Likelihood and Kalman Filtering 2524
Ioannis G. Papageorgiou (University of Cyprus, Cyprus), Charalambos D. Charalambous (University of Cyprus, Cyprus), Christos Panayiotou (University of Cyprus, Cyprus)

SA11-2 Analysis and Implementation of a Novel Single-Channel Direction-Finding Method 2530
Nathan Harter (Virginia Polytechnic Institute and State University, USA), John J. Keaveny (Virginia Polytechnic Institute and State University, USA), Swaroop Venkatesh (Virginia Polytechnic Institute and State University, USA), R. Michael Buehrer (Virginia Polytechnic Institute and State University, USA)

SA11-3 Rate Control for Streaming Services Based on Mobility Prediction in Wireless Mobile Networks 2534
Chunglae Cho (Electronics and Telecommunications Research Institute, Korea), Sun-mi Jun (Electronics and Telecommunications Research Institute, Korea), Euihyun Paik (Electronics and Telecommunications Research Institute, Korea), Kwang-Roh Park (Electronics and Telecommunications Research Institute, Korea)

SA11-4 Selection of Diversity and Modulation Parameters for Nakagami Fading Channels to Jointly Satisfy Outage and Bit Error Requirements 2540
P. Sharma (University at Buffalo, USA)

Author Index 2547

Aerouter™ - A Graphical Simulation Tool for Routing in Aeronautical Systems

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***Abstract*—The enormous growth and demand of in-flight Internet access has driven the need for producing effective simulation tools in order to effectively identity best resources such as satellites and gateways for routing in these large-scale systems. In this paper we will introduce a simple simulation tool called Aerouter, which can assist in identifying best satellites and gateways for routing in aeronautical applications. The proposed simulation tool will include new routing techniques as well as taking Doppler and atmospheric attenuations into account in its automatic calculations. Preliminary results illustrate the effectiveness and usefulness of Aerouter for future in-flight Internet access networks.**

***Index Terms* —In-flight Internet Access, aeronautical routing, routing tools, simulation tools**

I. INTRODUCTION

In recent years, there has been much advancement in providing consumers with mobile Internet technologies, spanning not only single user systems in the case of cellular technologies, but also taking us higher into the sky in the case of in-flight broadband Internet, as offered by Connexion by Boeing [1], and similar high speeds by Tenzing [2]. However there are inherent issues associated with this kind of system such as rain and atmospheric attenuation (with the use of much higher frequency bands such as the *Ku* and *Ka*), increased handoffs, and changing network topologies.

In most cases it is desirable to visually analyze such systems, and be able to change parameters in real-time whilst observing the effects of these changes. This will further simplify the task of management of these systems. Hence complexity is dramatically reduced for those responsible for managing resources in aeronautical systems. Thus, a user-friendly tool for effectively analyzing routing in aeronautical applications is essential in this fast growing industry. Resource selection is an important task for airline companies and choosing the right resources is vital when considering the high costs, and hence there is little room for errors. Leasing satellite services in particular is not cheap and there is great importance in choosing the right satellites for optimized solutions for in-flight Internet access. By having a tool which can identify best satellites and gateways for routing in a flight route, an airline company could make better resource selections that best meet their needs. It is also a useful and effective method of selecting optimum paths that can provide the best and most cost effective Internet experience for on-board Internet users.

We have implemented the Aerouter™ System, which is a simple tool that can be used for simulating such systems. Aerouter™ System provides an effective way to graphically demonstrate how an aircraft routes to different satellites and gateways as it travels from its source to destination in real-time. In Aerouter™ parameters can also be altered in real-time via user-input, allowing the users to see the effect of changes in these parameters, visually.

In this paper, we introduce many of the features of Aerouter™ and how it can be used for simulating aeronautical routing. We will also introduce the idea of using the Doppler shift caused by high speed mobile systems such as the airplane and thresholds in producing more efficient routing, and prove their effectiveness using simple Aerouter™ simulations.

II. BACKGROUND

A. Current State-of-the-Art Inflight Broadband Internet

During the past two to three years, we have seen leading airline companies begin to expand the horizons of Internet access by introducing broadband Internet inside airplanes. The technology's main basis is the use of geostationary satellite systems, and also the use of the higher frequency *Ku* band (12-18 GHz) [3, 4], which allows the possibility of achieving high speed data transfers. However, there are inherent problems with such a model, such as lag or transmission delay in using geostationary earth orbit (GEO) satellites due to their long distance (36000 km) from the earth and the atmospheric attenuation caused by using the higher frequency bands [3]. Despite these minor setbacks, in-flight Internet has been around for a few years now, and recently Lufthansa has taken the lead by being the first to commercially introduce broadband Internet on their flights using the Connexion by Boeing service [1]. Many other major airlines have signed definite agreements with Connexion by Boeing to install these technologies [1], and

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although it was initially estimated that this market would grow to around $70 billion over the next 10 years [5], more recently this has been reduced due to the decline in air travel market, to a more revised figure of 2.5 billion by 2007, by the Northern Sky Research in October 2001 [6]. Tenzing associated with Airbus also provides solid speeds with its Swift64 services, which are expected to reach data rates of up to 432 Kbps with the use of Inmarsat 4s, and Inmarsat's Broadband Global Area Network (BGAN) planned for launch in 2005, and expected to begin services by 2006 [2, 7, 8].

B. *Existing Simulation Tools*

Simulation tools for satellite telecommunications systems have been developed, yet there are minor set-backs such as the need to supplement mobile systems, which rapidly change their position and hence have a changing network topology. Several simulation tools are in existence including Matlab [9], OPNET [10], and NS2 [11]. Although widely used, these simulation tools are very generic and sophisticated for non-technical people, and the need to develop a dedicated simulation software for routing in aeronautical applications is required to visually analyze their routing in real-time, supplemented by a simplified and effective interactive functionality that allows customization of routing preferences according to Quality of Service (QoS) and cost parameters. There are also several parameters, which are inherent in mobile systems, specifically linear fast-moving mobile systems such as the airplane. In order to cater for these parameters, a specialized routing simulator is required for such systems. This simulator should ideally be user-friendly and acceptable to both technical and non-technical people, who are concerned both with the commercial and technical side of aeronautical systems.

III. THE AEROUTER™ SYSTEM

The Aerouter™ System is developed in order to offer simplicity in finding better ways of routing in aeronautical and similar fast-moving linear mobile systems. Parameters can be inputted into the system in real-time and their effects visually analyzed. A standalone command based Aerouter Optimizer supplements Aerouter™ and outputs routing information onto a file, which can effectively be used to graph results, and find optimal parameters. Real information such as satellite and gateway positions and routing parameters can be inputted into this system. Furthermore, new routing parameters are introduced into this system to make aeronautical routing as efficient as possible, with high quality of service, and least number of handoffs. These parameters will be discussed throughout this paper.

The Aerouter™ system consists of two main calculative blocks: The first one finds paths and their costs, and the other block does the routing decision (choosing the best path for routing).

The Graphical User Interface (GUI) of the Aerouter™ consists of three parts: Part 1 takes user input of parameters, such as speed of airplane, threshold, time, and Doppler parameters. Part 2 consists of the graphical representation of the system, and how an aircraft (or mobile system) is moving

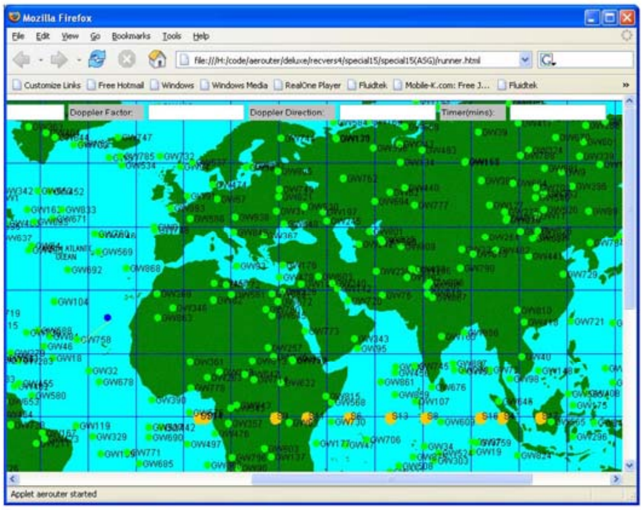

Figure 1. The Aerouter™ GUI.

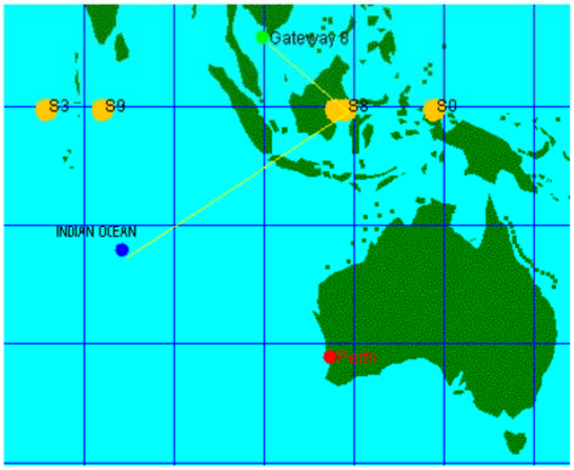

Figure 2. An Example of Routing in Aerouter™.

```
Number of handoffs: 3

Average Link Cost: 0.42695214384859353

vlon: -0.20773217903319843
vlat: 0.09872862702438033
Aircraft Latitude: -38.167259786476876

Threshold: 0.5
Speed: 5.0


Smallest Bandwidth: 2.1458396049772013
Largest Delay: 1.0000492174380993
Largest Power: 1.0000984372985549
Largest P3: 2.0
Average Bandwidth: 2.3622504692881483
Average Delay: 0.9606587241361448
Average Power: 0.9230805796148807
Average P3: 2.0
```

Figure 3. Aerouter™ Routing Information.

and routing. It shows how the aircraft routes as it moves from its source to its destination from a "birds-eye" perspective, and simulates the way the aircraft would route to satellites and gateways in reality. Part 3 is an interface showing routing information such as number of handoffs, average link cost, and other routing values in real-time. Figures 1, 2 and 3 demonstrate these features, respectively.

During the course of the simulation, the user can change routing parameters such as the threshold, speed of aircraft, and visually see its effect on the total system. In order to find the optimal routing parameters, one can use the Aerouter™ Optimizer, which is the command based counterpart simulator to Aerouter™ that runs the simulation with variable parameters, and outputs the routing results onto a file. The optimal values can be extracted from these files and tested using the Aerouter™. The Aerouter™ provides means for sanity checking the results obtained from the Aerouter™ Optimizer, visually. The Aerouter Optimizer provides a fast way of obtaining results, by simulating the scenario with different parameters and rapidly outputting them onto a file, without the need of visually checking it (this will be done in the Aerouter™).

All the routing parameters and positions (in latitude/longitude format) for all satellites and gateways are read from files (or databases). Information about the source and destination of flight is also obtained in a similar fashion. In future versions of Aerouter™, live weather information could also be inputted into the system in order to cater for atmospheric and rain attenuations, which are especially significant in the case of using broadband, as higher frequencies are used.

For the first analysis, we will consider the *link cost*, which is a measure of the quality of the link, affected by such things as distance (medium path loss [12]), attenuation and congestion in the network, and other static and variable QoS and cost-related parameters related to the link and the nodes (satellites and gateways). For the initial calculation we associate link cost with QoS for simplicity.

For initial calculations, we calculate link costs using a single mixed metric (SMM), calculated from the weighted sum of the QoS and cost related parameters for the link as shown in (1), where w_i is the weight of the ith normalized parameter p_i , and n is the total number of parameters in the link cost. The weight w_i represents how important parameter p_i is to our routing. We make an assumption that the link cost is proportional to the inverse of link quality. Hence as the link quality deteriorates, the link cost increases. This assists in performing QoS routing [13, 14, 15] with respect to link cost as a single mixed metric, which reduces the complexity by avoiding the use of multiple metrics in our routing.

$$Link\,Cost = \sum_{i=0}^{n} w_i \cdot p_i \tag{1}$$

In the real scenario the link quality is measured as the QoS parameters related to the link. This is specified by the on-board application, since different applications have different level of QoS needs. For example some applications are delay sensitive whilst others are bandwidth sensitive. In Aerouter we consider several parameters which can be defined by the network administrator. Aerouter™ will use a normalized value between 0 and 1 for each of the cost parameters. Additionally we can incorporate random attenuation to cater for atmospheric attenuations (e.g. rain), and distance related parameters such as power and delay. Effectively fixed and variable QoS and cost parameters are used to determine link quality and link cost. Some of the parameters that can affect the link cost (again this is application specific) are but not limited to bandwidth, delay, delay jitter, power, security, and attenuation parameters. We will deal with these parameters in future simulations.

A. Routing Algorithm

There are many routing algorithms that are used for both static and dynamic systems; more suitably are QoS routing algorithms, which supplement mobile and ad-hoc systems [16]. However we devise a unique algorithm suitable for mobile routing, specifically for use with airplanes using the satellite system to route to ground stations.

We explain the nature of the routing algorithm as it could be used in a real system, and how the Aerouter™ System adapts this algorithm. For our example we will look at how an aircraft routes to ground stations using satellites in a real world scenario. The nodes sending the "hello" message become the *parent* of the receiving nodes. Thus the *child* node of the previous parent node yet becomes the parent of the next set of nodes. The routing algorithm works as follows:

1) *The Airplane (Master Parent) sends a hello message to all nodes within the line-of-sight(LOS)*
2) *The nodes do the same if they are satellites*
3) *If the node is a gateway(child) it will produce a reply*
4) *The (parent) node that receives the replies works out the link cost for all the replies, and evaluates the best replying (child) node*
5) *It will then send this detail along with the received hello from the previous node back to the previous (parent) node*
6) *This continues until the original node receives the replies within a predefined time*

In the Aerouter™ System, a recursive route discovery algorithm is devised which allows the aircraft to either directly communicate to gateways on ground, or through satellite to gateway. This is an effective extension to the existing aeronautical architecture which only consists of aircraft – satellite – gateway links. By allowing the airplane to directly communicate to ground stations, we can decrease delay for delay sensitive applications, and reduce satellite service costs at some instances. The routing algorithm adapted in Aerouter™ does not exchange messages (conserving time), since this is happening at a much smaller scale. The algorithm finds all existing paths and sorts them according to their link cost as defined in (1).

New routing decisions need to be made in the case when:

1) A direct neighbor node goes out of line of sight

2) The threshold value is compromised

3) When a node fails.

Each time one of the above cases becomes true, a new routing decision needs to be made, where a new path is chosen.

B. Threshold

Threshold is our first introduced parameter that will assist in reducing the number of handoffs, at the price of reduced average link quality. The threshold value is directly related to the link cost (and link quality). The higher the threshold value, the more relaxed the link cost (and QoS) constraint. A smaller threshold value puts a higher constraint on link cost and thus the smaller the link cost needs to be to satisfy QoS/cost requirements.

A new routing decision is made once the threshold is compromised (i.e. once the link quality goes below the threshold value). In Aerouter™ this corresponds to a link cost going above the threshold value, for our initial assumptions. Figure 4 illustrates this idea. It is important to note that if the threshold value is met, it is the *single-mixed metric* QoS requirement that is met. The fewer the number of parameters in the single mixed metric, the more likely each individual parameter constraint will be met. We will investigate this in future simulations.

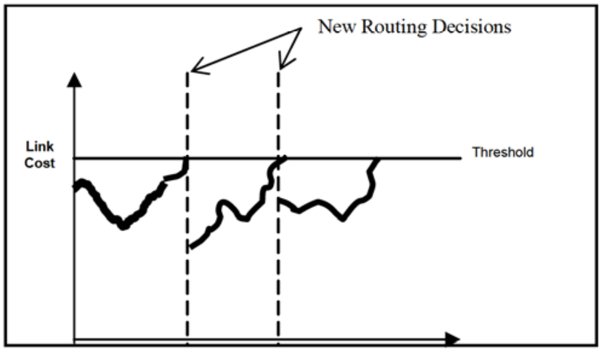

Figure 4: Routing using thresholds.

Currently, the Aerouter™ works on a single threshold basis. However in the future we will introduce the concept of *temporal hysteresis*, which allows a time *t* for the link quality to be below a threshold, before it makes a new routing decision. We also introduce another threshold: the *critical threshold*.

Temporal Hysteresis is a scheme proposed to avoid unnecessary handoffs caused by temporary link degradation such as brief obstacles (e.g. buildings), brief attenuations (e.g. cloud patches), shadowing and diffraction [17], and similar degradation caused by aircraft maneuvers. This scheme becomes very effective when we introduce the use of non-GEO satellite systems in the Aerouter™ System, which require more frequent handoffs.

The Critical Threshold, on the other hand, would cause a routing decision be made instantaneously once it is compromised. This threshold is below the temporal threshold.

C. A New Paradigm – Using the Doppler Factor in Routing

The Doppler Factor is introduced to further produce efficient routing by reducing the total number of handoffs during a flight journey. By introducing the Doppler factor into our system, an airplane (or a mobile system) would be able to route to nodes it is approaching rather than nodes it is receding from. Nodes having higher Doppler factors are approaching the aircraft, whilst nodes receding have larger negative Doppler factors. Approaching nodes are within Line-Of-Sight of the airplane for a longer period of time. Consequently, the time taken for the next handoff is increased, and effectively the total number of handoffs during the whole journey is decreased. As explained in [17], the Doppler Effect is particularly noticeable in aeronautical systems, due to their high speeds.

The Doppler shift is the apparent change in the frequency of a (electromagnetic) signal caused by the relative motion of the transmitter and receiver. This property has many uses in real-world applications ranging from astronomy (Red Shift) to its use by police in determining how fast a car is moving [18]; and now its use in routing is introduced.

Equation (2) and (3) are adapted from [17] for this approach. The Doppler shift frequency is calculated in hertz. V_d is the Doppler velocity, c is the speed of light (3.0×10^8m/s) and the carrier frequency is taken as 20 GHz.

$$f_{doppler} = \frac{v_d}{c} . f_{carrier} \qquad (2)$$

$$v_d = \frac{v_z.[r_p - r_s.\cos\alpha.\cos\beta] - v_{lat}.[r_s.\sin\beta] - v_{long}.[r_s.\cos\beta.\sin\alpha]}{\sqrt{r_p - 2\cos\alpha.\cos\beta.r_p.r_s + r_s{}^2}} \qquad (3)$$

r_s : Radius of the satellite orbit (42000km)

r_p : Radius of airplane (from centre of earth)

α : Latitude of airplane

β : Longitude difference

v_z : Vertical velocity of the airplane

v_{lat} : Airplane velocity in latitude direction

v_{long} : Airplane velocity in longitude direction

We further see the effect of using the Doppler factor in routing in Figure 5. The thick black line represents the direct path of the aircraft. In Figure 5, assume all satellites meet the threshold value (QoS/cost constraint); however Satellite 2 provides a slightly better link cost than Satellite 3. For the first case of Figure 5, at the initial position of aircraft, the aircraft first routes to Satellite 1 until it reaches position A where Satellite 1 is either out of line-of-sight of the airplane or the threshold value is compromised. At this point the aircraft can either route to Satellite 2 or Satellite 3. If the Doppler factors of the satellites are not considered, the aircraft would route to Satellite 2, since it provides a smaller link cost. However at point B, Satellite 2 would go out of line-of-sight, and thus a new handoff must take place, to Satellite 3. Ultimately there are 2 handoffs for the first case. Had the aircraft used the Doppler factors of the satellites, it could have routed to Satellite 3 at position A, reducing the number of handoffs to one, as shown in the second case of Figure 5. Of course, the link quality may (or may not) have been reduced. However if the threshold (QoS/cost) is met in both scenarios, the Doppler scenario would be superior as it provides a better routing scheme by reducing the number of handoffs. We will investigate the use of the Doppler factors in more detail in the simulations of Section IV.

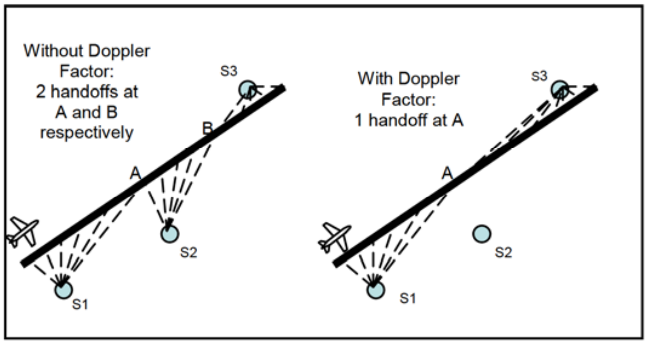

Figure 5. The effect of using Doppler parameters in routing.

In the real-world scenario, the Doppler factor can be calculated using radio signals sent and received from the aircraft and the satellites (during data transmission and reception or in a form of beacons). By comparing the expected frequency and the actual frequency of the signal, the Doppler factor can be calculated. The larger the (positive) Doppler factor, the closer the approaching node is to the direct path of aircraft (assuming a straight path); hence the longer the period of time the node remains within line-of-sight (LOS) of aircraft. The great thing about this new application is that no new hardware technology is necessary to be implemented. By utilizing the technology already on-board, a more efficient routing can be achieved.

IV. AEROUTER SIMULATION: DOPPLER & THRESHOLD PARAMETER FOR ROUTING

In our first attempt of demonstrating the effect of Doppler factor and showing how the Aerouter™ simulator works, we will run a simulation involving the threshold variable and the Doppler factors relating to the nodes within LOS of the aircraft and investigate the effect it has on the number of handoffs during the flight. The threshold value is directly related to the cost and QoS constraint. However at the same time it will define how much the Doppler factor affects which nodes are chosen. As the threshold value approaches zero, the QoS requirements approach infinity, thus the smallest cost links are selected for routing without regard to looking at the Doppler factors. As the threshold value increases, the QoS requirements are relaxed and the route selection will begin looking at all nodes and links satisfying the threshold (QoS/cost) value and selecting the one with the largest positive Doppler factor for routing. Hence we have met our QoS/cost constraints, whilst selecting nodes which will be within LOS for a greater period of time. Effectively this should reduce the total number of handoffs for the journey. We consider a return trip journey between two destinations: namely Melbourne to New York, with randomly generated GEO satellites and gateways (Actual position of all satellites and gateways are not yet known but will be used in future calculations, however for the purpose of demonstrating Doppler routing, actual position of nodes is deemed unnecessary). For our initial simulations we will consider only bandwidth as our QoS parameter, and assume zero attenuation and zero weight for other parameters in (1), whilst setting the weight for bandwidth to one. Effectively this can be a routing scheme for bandwidth sensitive applications. We assume that each selected link provides a constant level of bandwidth.

To further demonstrate the effect of Doppler, we need to create a scenario where frequent handoffs are necessary. This could be smaller satellite spot beams, or frequent compromises of threshold (due to link QoS degradation), where new paths need to be discovered on a frequent basis. However in this simulation QoS is not degraded, as we assume each link will provide a constant bandwidth. Thus the only time handoffs could occur in this scenario is when a node goes out of LOS (we assume no node failure). In order to supplement frequent handoffs in this simulation we will make the primary means of communication, aircraft to ground station, since ground stations would only stay within line-of-sight of aircraft for a short period of time. At the edge of line-of-sight of aircraft-to-ground station, a new handoff must take place. The aircraft will look first for available ground stations which may exist within LOS. If there are no ground stations in sight, the aircraft will proceed to use the satellite system.

We note that this is a bandwidth routing scheme, such that in any case, either the best bandwidth path is chosen (in the case of using close-to-zero threshold) or the "best" (Doppler-bandwidth combination) path that satisfies the threshold (QoS/cost) is chosen in the simulation.

We note that a threshold value of zero (infinite QoS requirement) would correspond to finding the best bandwidth path regardless of the Doppler factors, and as the threshold value increases (i.e. link cost and QoS constraints are relaxed), the Doppler factors of nodes become more dominant.

The bandwidth (QoS) requirement for the link would simply be the inverse of the threshold. We will analyze the average bandwidth of the whole journey with regard to the QoS constraint bandwidth. It is important to note that at any one time, there may be no nodes satisfying the required bandwidth constraint, in which case the smallest cost bandwidth (largest bandwidth) path is selected.

V. NUMERICAL RESULTS AND DISCUSSIONS

The simulation results are shown in Figure 6 and Table I. . As shown in the graph, the smaller threshold values (corresponding to very high bandwidth requirements) yield greater number of handoffs. However when the threshold is increased and QoS requirements relaxed, fewer numbers of handoffs occur. This can be explained as at the lower threshold values, the path selection is restricted by the high level of QoS requirement, and hence there are fewer options of selecting nodes with higher Doppler factors that also meet the QoS requirement. Table I further supports this statement. We note that these values are strictly relative values. Actual bandwidth requirements depend on application.

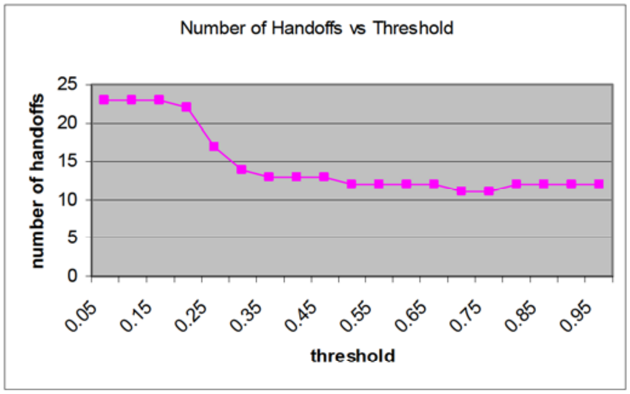

Figure 6. number of handoffs vs. threshold.

TABLE I. SAMPLE SIMULATION RESULTS

Thresh	Routing Information			
	Bandwidth (BW) Requirement	*Av. BW*	***No. of Handoffs***	***Av. Link Cost***
0.2	5	6.06	22	0.18
0.25	4	5.77	17	0.19
0.5	2	3.82	12	0.31
0.7	1.43	2.10	11	0.52

VI. CONCLUSIONS AND FUTURE WORKS

From the simulation results, we can see that by introducing the Doppler factor into routing decision, we reduce the number of handoffs, at the price of slightly lowering the link quality (in this case bandwidth). By increasing the threshold, we relax the QoS constraint, and allow more optional nodes for routing, hence when using the Doppler factor, nodes that both satisfy the minimum constraint and have larger Doppler factors are selected for routing, and since these nodes are within LOS for a greater period of time, the total number of handoffs during the whole journey is reduced.

The Aerouter™ System is still a very young system, and there are many improvements that need to be incorporated. In the near future we will further implement new parameters and rectify existing functions to better resemble as much as possible the real-world scenario. Attenuation parameters, both random, and weather attenuation parameters will be implemented in future versions of Aerouter™ System. Also the concept of ad-hoc networking between aircrafts, as a means of sharing cached data, and support for non-GEO satellite systems is currently being implemented in the Aerouter™ System.

REFERENCES

[1] Connexion By Boeing Website: http://www.connexionbyboeing.com.

[2] "Commercial satcoms take centre stage", Aircraft Technology Engineering & Maintenance, April/May 2004.

[3] M. Holzbock and C. Senninger, "An aeronautical multimedia service demonstration at high frequencies," IEEE Multimedia, vol.6, no. 4, pp. 20-29, 1999.

[4] S. Karlin, "Take off, plug in, dial up," IEEE Spectrum, vol. 38, no. 2, pp. 52-59, 2001.

[5] Connexion By Boeing, News Release, April 27, 2000. http://www.boeing.com/news/releases/2000/news_release_000427a.html

[6] M. Holzbock, *et. al*, "Evolution of aeronautical communications for personal and multimedia services" IEEE Communications Magazine, vol. 41, no. 7, pp. 36-43, July 2003.

[7] J. Descaillot, *SITA Network Deployment and Plans*, Datalink Users Forum, San Francisco, February 2004.

[8] Official Inmarsat Website: http://aero.inmarsat.com/.

[9] Official Matlab Website: http://www.matlab.com.

[10] Official OPNET Website: http://www.opnet.com.

[11] Network Simulator Website: http://www-mash.cs.berkeley.edu/ns.

[12] S. Haykin and M.Moher, *Modern Wireless Communications*, International Edition Prentice Hall, 2005.

[13] M. Rafter, "Performance of packet switched radio networks using combined parameter routing metrics" IEEE Military Communications Conference, MILCOM 91', Military Communications in a Changing World, McLean, VA USA, 1991.

[14] Z. Wang and J. Crowcroft, "Quality-of-service routing for supporting multimedia applications" *IEEE Journal on Selected Areas in Communications*, vol. 14, pp. 1228-1234, 1996.

[15] P. Khadivi, S. Samavi, T. D. Todd, H. Saidi. "Multi-constraint QoS routing using a new single mixed metric", 2004 IEEE International Conference on Communications, vol. 4, pp. 2042-2046, June 2004.

[16] S. Chen and K. Nahrstedt, "An overview of quality of service routing for next-generation high-speed networks: problems and solutions," IEEE Network, vol.12, no. 6, pp. 64-79, Nov/Dec 1998.

[17] M. Holzbock, M. Werner, A. Jahn, and E. Lutz, "Future broadband communications for airliners," Proceedings of the 4th European Workshop on Mobile/Personal Satcoms (EMPS 2000), pp. 221-226, 2000.

[18] D. Halliday, R. Resnick, and J. Walker, *Fundamentals of Physics*, 4th Edition, Wiely, 1993.