08/276534 | 370 | 73 | Class | Subclass | ISSUE CLASSIFICATION

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5563883

UTILITY SERIAL NUMBER	PATENT DATE	PATENT NUMBER
08/ 276534	OCT 0 8 1995	5563883

SERIAL NUMBER	FILING DATE	CLASS	SUBCLASS	GROUP ART UNIT	EXAMINER
08/276,534	07/18/94	~~455~~ 370	095.200	~~2611~~ 2603	~~Fung~~

APPLICANTS

ALEXANDER L. CHENG, WHITE PLAINS, NY.

CONTINUING DATA******** None
VERIFIED

BVS

FOREIGN/PCT APPLICATIONS******** None
VERIFIED

BVS

FOREIGN FILING LICENSE GRANTED 08/15/94 ***** SMALL ENTITY *****

Foreign priority claimed / 35 USC 119 conditions met / Verified and Acknowledged	AS FILED	STATE OR COUNTRY	SHEETS DRWGS.	TOTAL CLAIMS	INDEP. CLAIMS	FILING FEE RECEIVED	ATTORNEY'S DOCKET NO.
☐ yes ☒ no / ☐ yes ☑ no / B.V.S. Examiner's initials	→	NY	14	10	4	$392.00	CHENG101

ADDRESS

ALEXANDER L. CHENG
11 SPRINGDALE AVENUE
WHITE PLAINS, NY 10604

TITLE

DYNAMIC CHANNEL MANAGEMENT AND SIGNALLING METHOD AND [illegible]

ISSUE FEE IN FILE

U.S. DEPT. of COMM.-Pat. & TM Office -- PTO-436L (rev. 10-78)

ISSUE [illegible] 12-12-95

PARTS OF APPLICATION FILED SEPARATELY

Applications Examiner

NOTICE OF ALLOWANCE MAILED		CLAIMS ALLOWED	
11-27-95	Assistant Examiner	Total Claims: 20	Print Claim: 6

ISSUE FEE		DRAWING		
Amount Due	Date Paid	Sheets Drwg.	Figs. Drwg.	Print Fig
$625.00	2-13-96	16/14	17/02	4

Label Area

Benedict V. Safourek 2603
BENEDICT V. SAFOUREK
PRIMARY EXAMINER
GROUP 263
Primary Examiner

ISSUE BATCH NUMBER: R-37

PREPARED FOR ISSUE

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Form PTO-436A
(Rev. 8/92)

(FACE)

08/ 276534

[redacted]

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AUG 089425
INITIALS

CONTENTS

Date Entered or Counted		Date Received or Mailed
	1. Application (Pat'd) papers.	
7-24	2. Rej (3 months)	8-4-95
	3. Amd't A	Oct 16 1995
11-27	4. Notice of Allowability	11-27-95
	5. Supplemental Allowability	12-21-95
3/13 6½	6. Issue Specification B	2/13/96
	7. Notice of Drawing Requirement	3/25/96
5/7	8. Formal Drawings (5 sh.) #2	4/22/96
	9. Notice of Drawing Requirement	5/13/96
	10. Issue Fee	2/13/96
	11. Notice of Entry (033111)	7-16-96
	12.	
	13. Petition 1.378c	01/02/10
	14. Pet. Granted	1/21/10
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SEARCHED

Class	Sub.	Date	Exmr.
348	6;9;12	7-12-95	
	13		
455	3.1;4.2		
	5.1;6.1		BS
	34.1		
379	71;73;76		
	80;853		
	85.7;858		
	95.1;95.2		
above to date		11-24-95	BUS

SEARCH NOTES

None	Date	Exmr.
	7-12-95	BU

INTERFERENCE SEARCHED

Class	Sub.	Date	Exmr.
370	69-78	11-24-95	BUS
455	1-12		
348	6-15		

(RIGHT OUTSIDE)

POSITION		ID NO.	DATE
CLASSIFIER		22	8/5/94
EXAMINER		313	8/12-94
TYPIST		384	8/15
VERIFIER			
CORPS CORR.			
SPEC. HAND			
FILE MAINT.			
DRAFTING			

INDEX OF CLAIMS

Claim Final	Claim Original	Date	Date
1	1	3/12/95	11/21/95
2	2		
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SYMBOLS

- ✓ ..... Rejected
- = ... Allowed
- - (Through numberal) Canceled
- + ... Restricted
- N ..... Non-elected
- I ..... Interference
- A ..... Appeal
- O ..... Objected

Claim Final	Claim Original	Date
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STAPLE AREA

☆U.S.G.P.O.: 1994 - 378-972

PATENT NUMBER

ORIGINAL CLASSIFICATION

CLASS	SUBCLASS
370	73

APPLICATION SERIAL NUMBER

08/276,534

CROSS REFERENCE(S)

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)			
348	12			
370	85.7	85.8		
455	4.2	5.1		

APPLICANT'S NAME (PLEASE PRINT)

Cheng

IF REISSUE, ORIGINAL PATENT NUMBER

INTERNATIONAL CLASSIFICATION cl 6

H	04	H		1/04

GROUP ART UNIT: 2603

ASSISTANT EXAMINER (PLEASE STAMP OR PRINT FULL NAME)

PRIMARY EXAMINER (PLEASE STAMP OR PRINT FULL NAME): Benedict V. Safourek

PTO 270 (REV. 5-91)

ISSUE CLASSIFICATION SLIP

U.S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

Final	Original	11/12/95	11/21/95
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SYMBOLS

- ✓ ..... Rejected
- = ... Allowed
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- O ..... Objected

Final	Original
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US005563883A

United States Patent [19]

Cheng

[11] Patent Number: 5,563,883

[45] Date of Patent: Oct. 8, 1996

[54] **DYNAMIC CHANNEL MANAGEMENT AND SIGNALLING METHOD AND APPARATUS**

[76] Inventor: **Alexander L. Cheng**, 11 Sprindale Ave., White Plains, N.Y. 10604

[21] Appl. No.: **276,534**

[22] Filed: **Jul. 18, 1994**

[51] **Int. Cl.**[6] **H04H 1/04**

[52] **U.S. Cl.** **370/73**; 348/12; 370/85.7; 370/85.8; 455/4.2; 455/5.1

[58] **Field of Search** 348/6, 9, 12, 13; 455/3.1, 4.2, 5.1, 6.1, 34.1; 379/71, 73, 76, 80, 85.3, 85.7, 85.8, 95.1, 95.2

[56] **References Cited**

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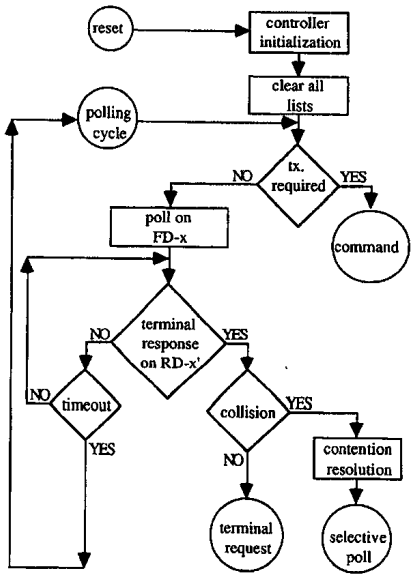
5,132,680	7/1992	Tezuka et al.	370/85.8
5,224,097	6/1993	Kaneshima	370/85.8
5,331,316	7/1994	Mestdagh	370/85.7
5,355,375	10/1994	Christensen	370/85.8
5,374,952	12/1994	Flohr	348/12
5,434,611	7/1995	Tamura	348/12

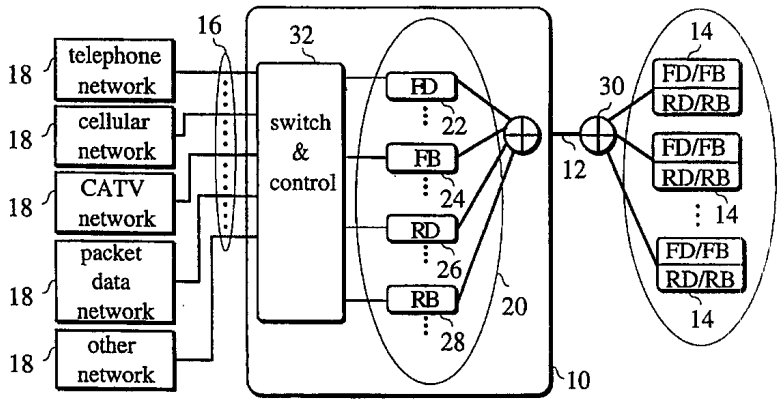
Primary Examiner—Benedict V. Safourek

[57] **ABSTRACT**

There is provided a dynamic and adaptable method and apparatus to support two-way multi-media communication services on a multiple access communication system, which comprises a central controller, a shared transmission media and a plurality of remote terminals dispersed throughout the network. The central controller comprises switch and control apparatus and a pool of transmitters and receivers. The communication channels between the central controller and remote terminals are arranged for signalling data and traffic bearer channels in the forward and reverse directions. The number of signalling data channels is adjusted to satisfy the traffic requirements and for redundancy purposes. The forward and reverse signalling data channels are coupled in different mappings to support terminal grouping. Multiple access of the remote terminals for the upstream traffic are mitigated by separating remote terminals in groups via the channel allocation and the terminal assignment process. Communication between the central controller and the remote terminals follows a multiple access scheme controlled by the central controller via polling procedure on each of the forward signalling data channels independently. In case of collision, the central controller engages the remote terminals in a selective polling process to resolve the contention. The overlapping polling method of the controlled access scheme increases the utilization of the signalling channel and reduces the time required to gain access to the shared transmission media. By dynamically adjusting the load on signalling data channels, the signalling process is greatly improved for efficiency and redundancy against anomalies with the added benefit of improved flexibility and extensibility. The system is especially useful in a two-way CATV network.

20 Claims, 16 Drawing Sheets





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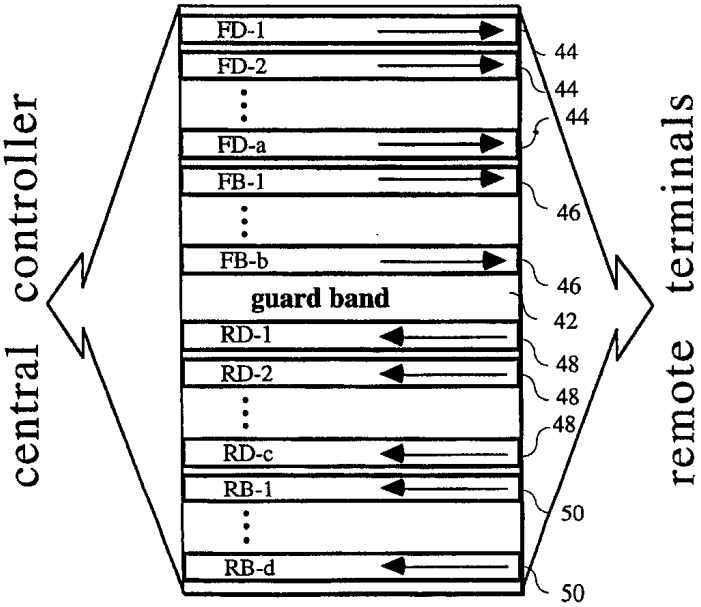


Figure 2

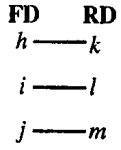


Figure 3a

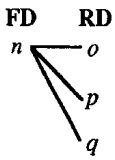


Figure 3b

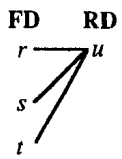


Figure 3c

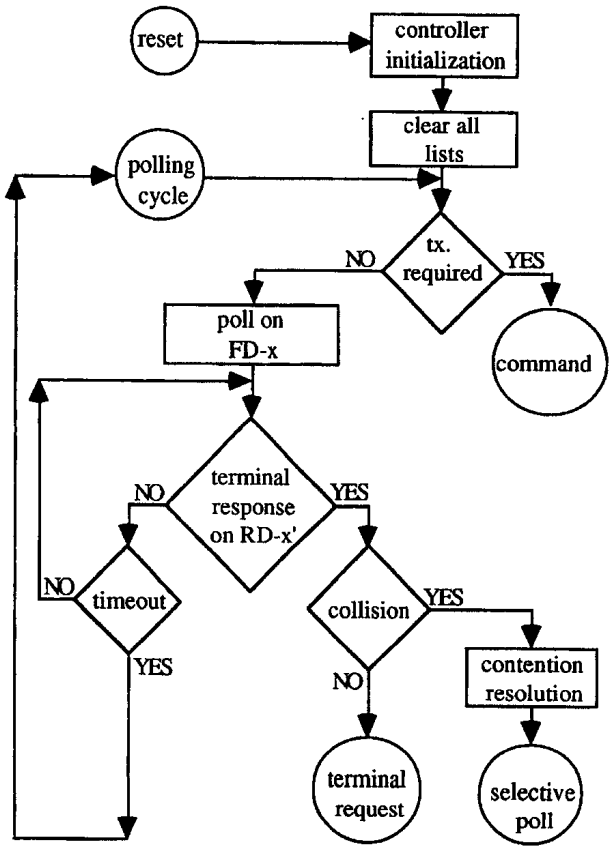


Figure 4

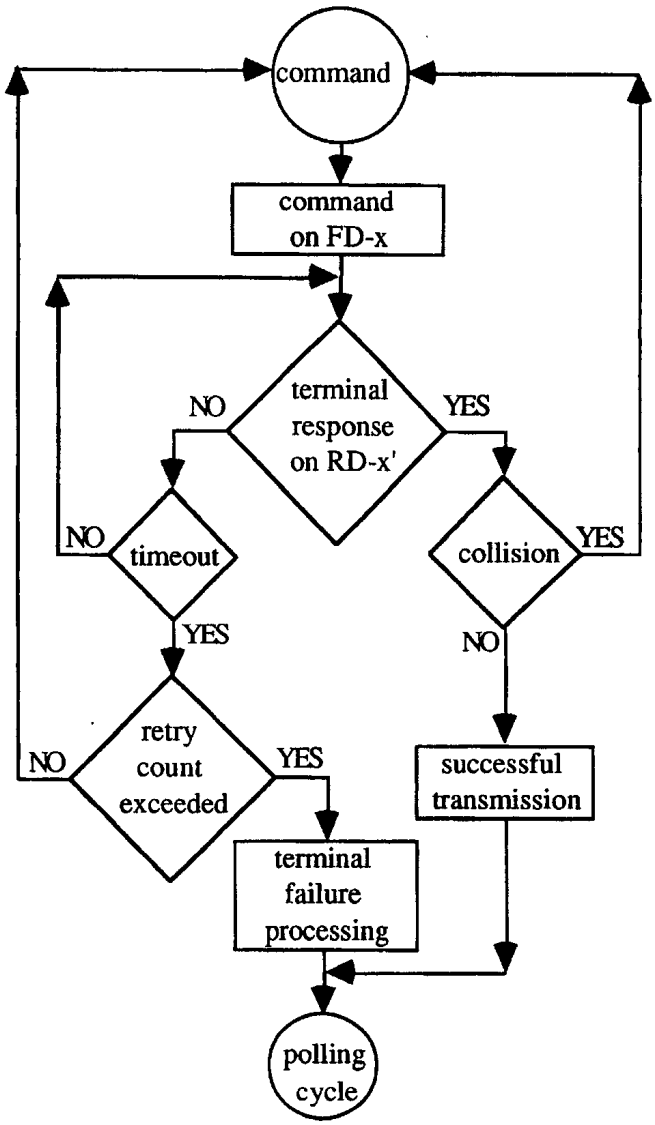

command
command on FD-x
terminal response on RD-x'
NO
YES
timeout
NO
YES
collision
YES
NO
retry count exceeded
NO
YES
successful transmission
terminal failure processing
polling cycle

Figure 5

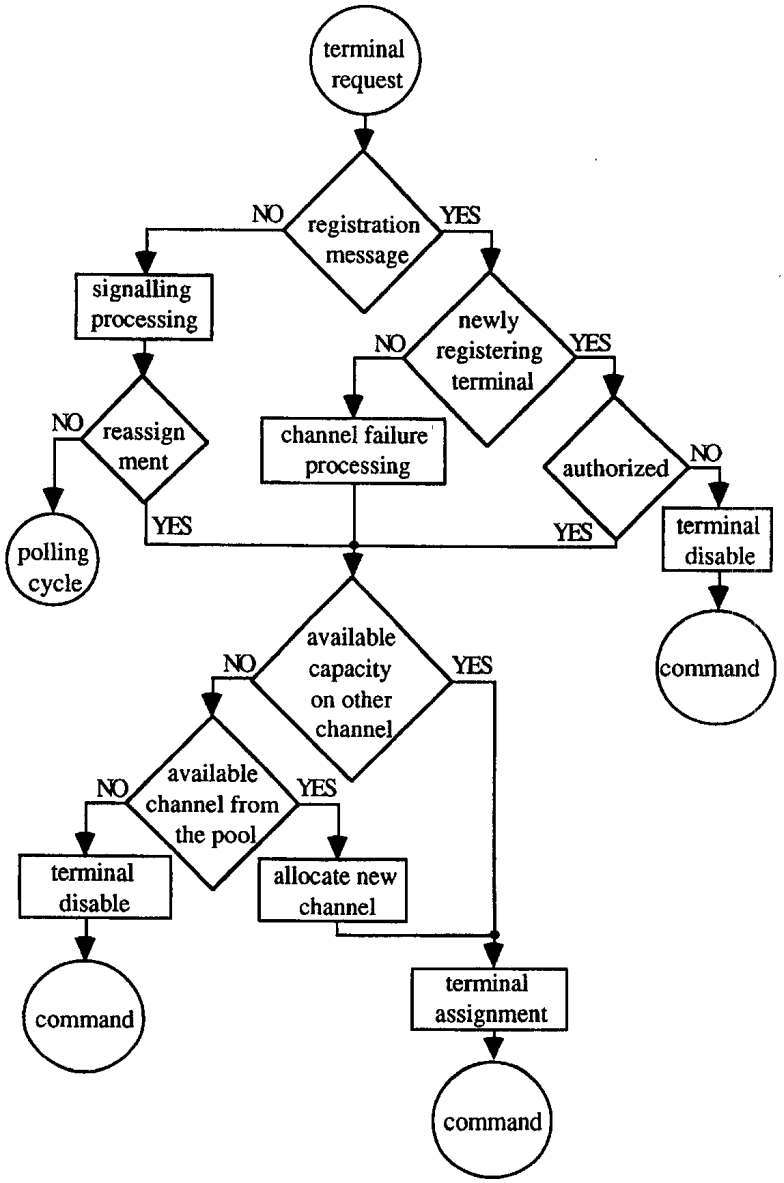

terminal request
registration message
NO
YES
signalling processing
newly registering terminal
NO
YES
reassign ment
NO
channel failure processing
authorized
NO
YES
YES
polling cycle
terminal disable
command
available capacity on other channel
NO
YES
available channel from the pool
NO
YES
terminal disable
allocate new channel
command
terminal assignment
command

Figure 6

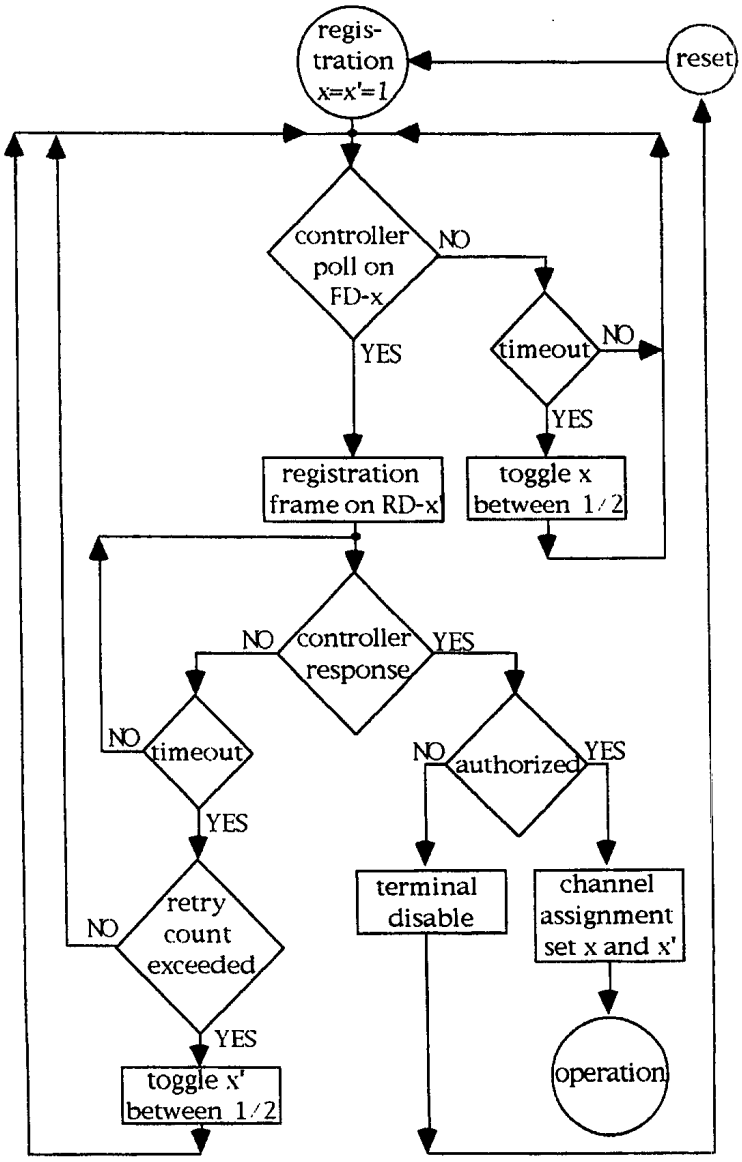

regis-
tration
x=x'=1
reset
controller
poll on
FD-x
NO
YES
timeout
NO
YES
registration
frame on RD-x'
toggle x
between 1/2
NO
controller
response
YES
NO
timeout
YES
NO
authorized
YES
retry
count
exceeded
NO
YES
terminal
disable
channel
assignment
set x and x'
toggle x'
between 1/2
operation

Figure 7

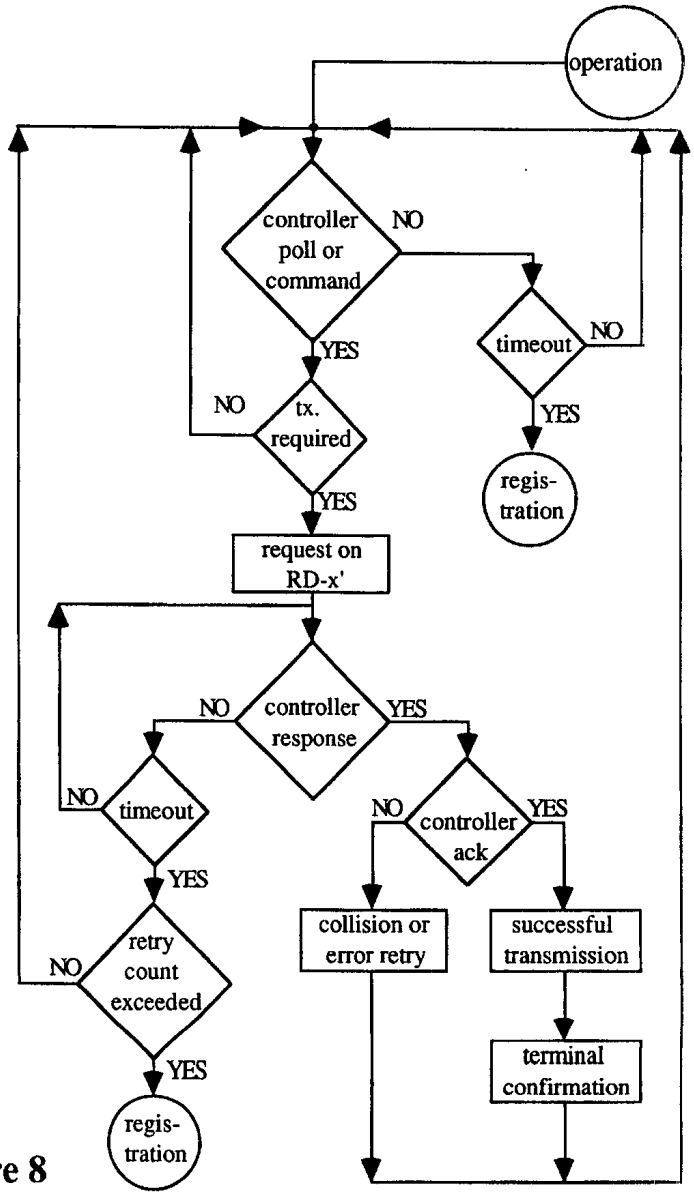

operation
controller poll or command
NO
YES
timeout
NO
YES
NO
tx. required
YES
regis-tration
request on RD-x'
NO
controller response
YES
NO
timeout
YES
NO
controller ack
YES
retry count exceeded
NO
YES
collision or error retry
successful transmission
terminal confirmation
regis-tration

Figure 8

Signalling data frame in the forward direction sent by central controller:

1	1	3	1
PMB	TID	SAT	FCS

Signalling data frame in the reverse direction sent by remote terminals:

1	1	3	1	bytes
PMB	TID	SRT	FCS	

preamble (PMB)
- sequence to indicate the start of message frame transmission and aid detection of collision

Terminal IDentifier (TID)
- terminal identifier for command
- lower TID of the range for the selective poll
- 0 (hexadecimal 00) is an invalid TID used for disabling terminal during the registration process (SAT/SRT contains the serial number)
- 255 (hex FF) for registration process (SAT/SRT contains the serial number)

Signalling Action Type (SAT)
- serial number of the remote terminal for channel assignment during registration process
- selective poll including higher TID of the range (used also for general/specific poll)
- selective poll with collision alert including higher range (used also for specific poll)
- in-coming call command on the indicated channel number
- release command
- disable command
- test command
- channel re-assignment command

Signalling Request Type (SRT)
- serial number of the remote terminal for terminal registration process
- on-hook
- off-hook
- switch-hook
- ringing
- release
- dial-digits
- incoming call blocking
- incoming call unblocking
- feature code (e.g., conference)
- test report
- alarm message (fault and fraud)
- multiple channel request (bandwidth-on-demand)
- channelized services (sub-rate & multiple channels)

Frame Check Sequence (FCS)
- protection, which covers TID and SAT/SRT fields, against transmission error or collision

Figure 9

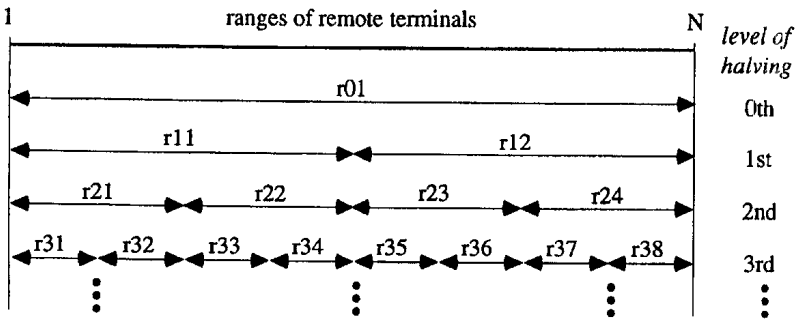


Figure 10

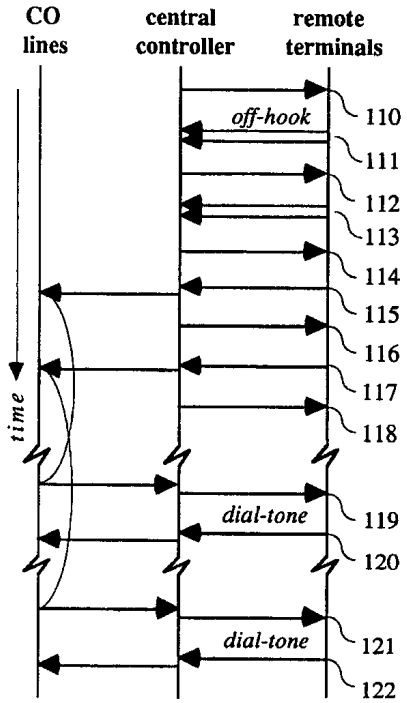


Figure 11

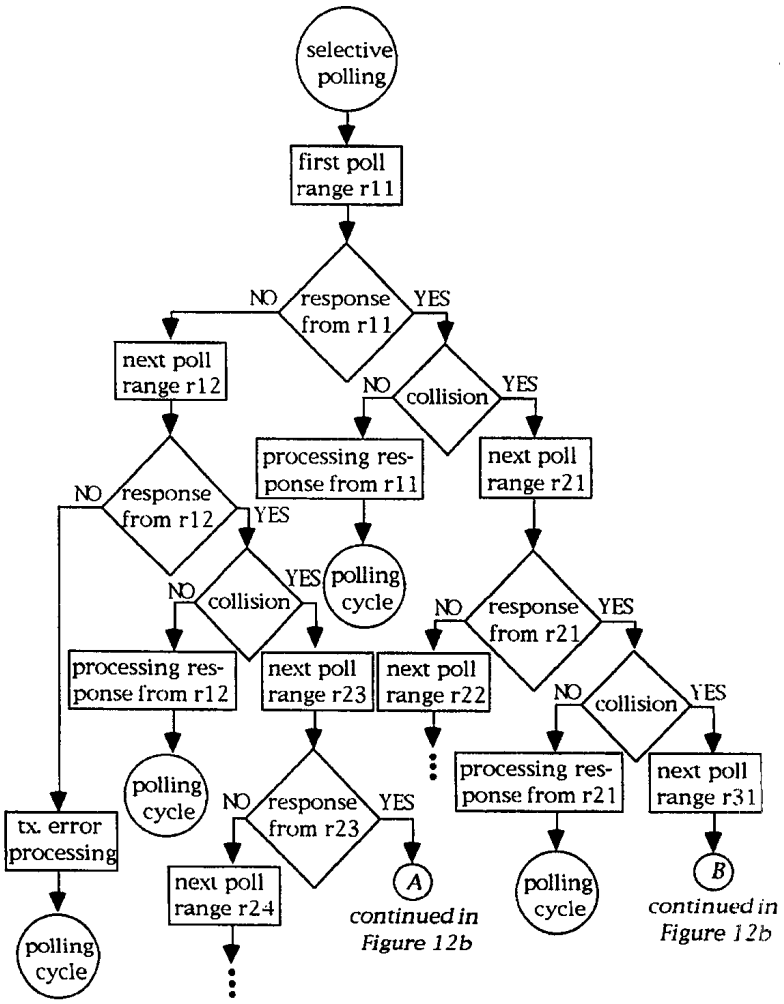

selective polling
first poll range r11
response from r11
NO
YES
next poll range r12
collision
NO
YES
processing response from r11
next poll range r21
response from r12
NO
YES
collision
YES
NO
polling cycle
response from r21
NO
YES
processing response from r12
next poll range r23
next poll range r22
collision
NO
YES
tx. error processing
polling cycle
response from r23
NO
YES
processing response from r21
next poll range r31
next poll range r24
A
continued in Figure 12b
polling cycle
B
continued in Figure 12b
polling cycle

Figure 12a

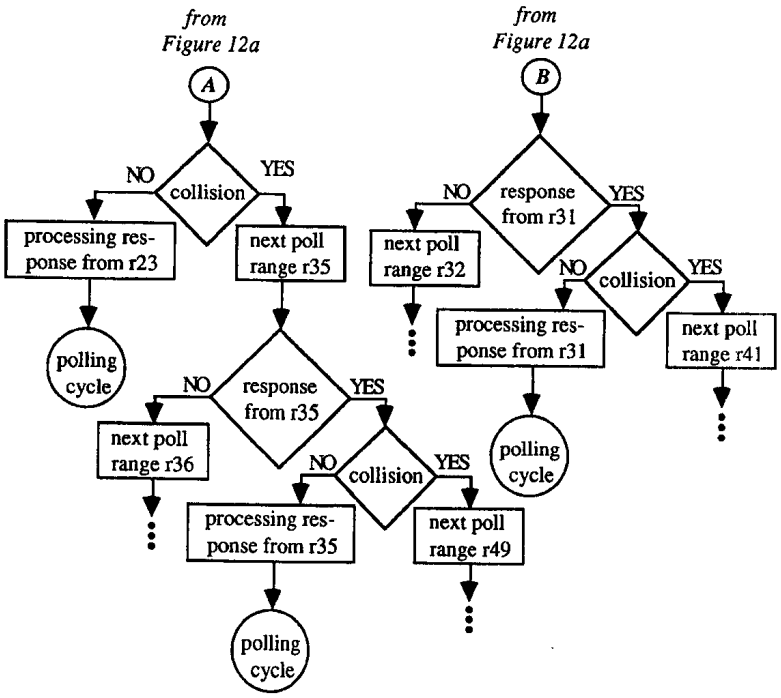

from Figure 12a
A
collision
NO
YES
processing response from r23
next poll range r35
polling cycle
response from r35
next poll range r36
collision
processing response from r35
next poll range r49
polling cycle
from Figure 12a
B
response from r31
next poll range r32
collision
processing response from r31
next poll range r41
polling cycle

Figure 12b

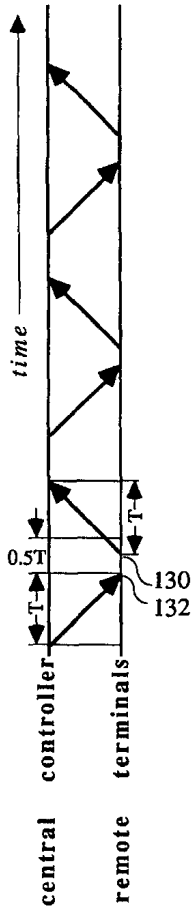


Figure 13a

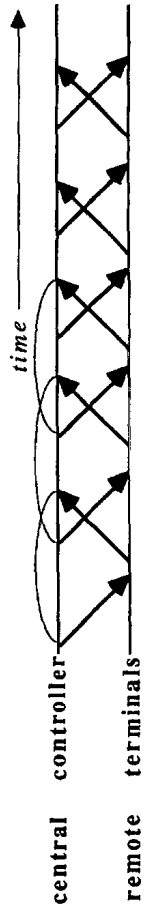


Figure 13b

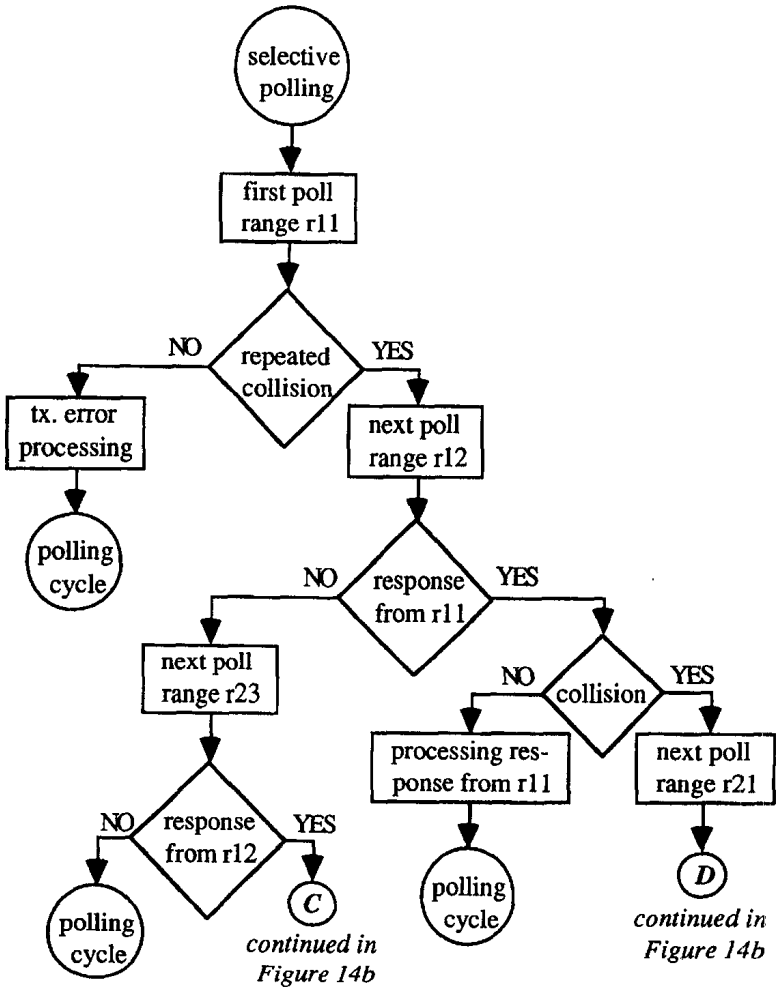

selective polling
first poll range r11
repeated collision
NO
YES
tx. error processing
polling cycle
next poll range r12
response from r11
NO
YES
next poll range r23
collision
NO
YES
processing response from r11
next poll range r21
response from r12
NO
YES
polling cycle
C
continued in Figure 14b
polling cycle
D
continued in Figure 14b

Figure 14a

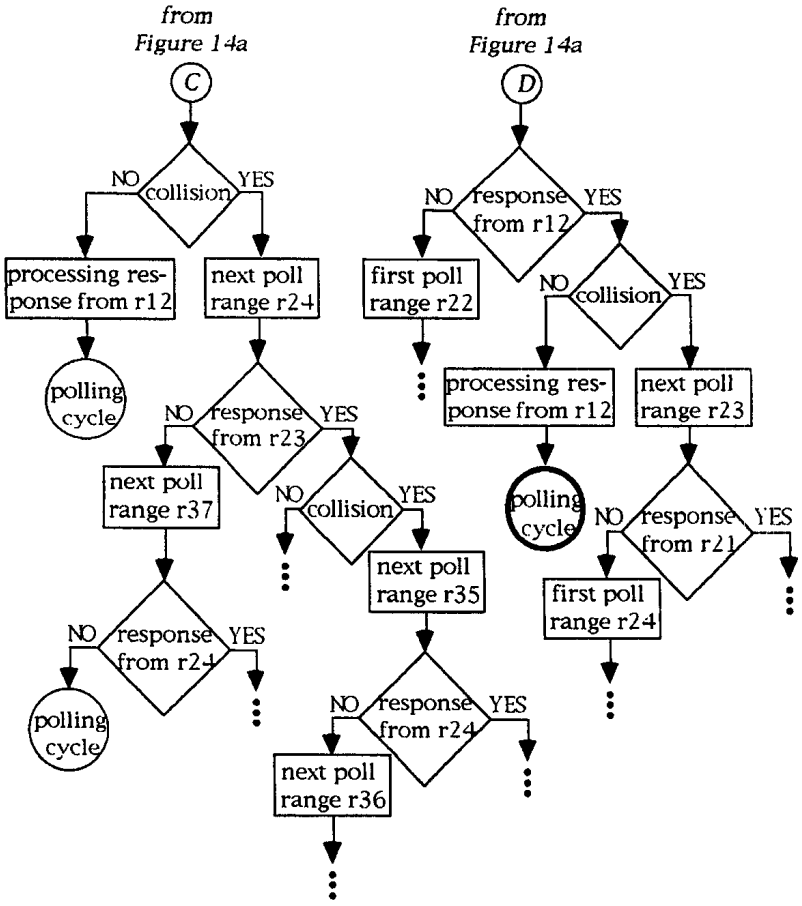
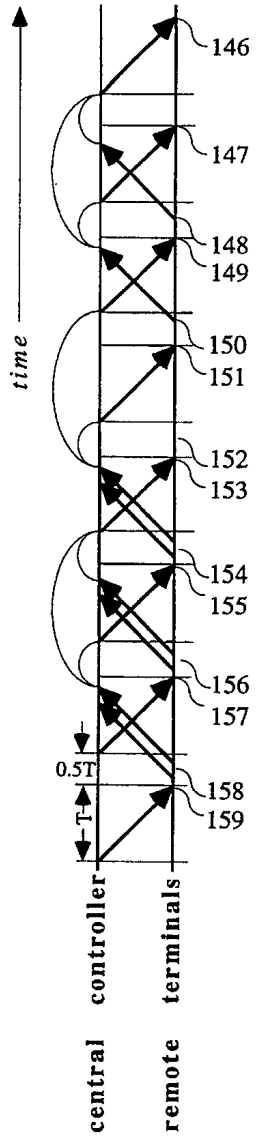

from Figure 14a
C
NO
collision
YES
processing response from r12
next poll range r24
polling cycle
NO
response from r23
YES
next poll range r37
NO
collision
YES
next poll range r35
NO
response from r24
YES
polling cycle
NO
response from r24
YES
next poll range r36
from Figure 14a
D
NO
response from r12
YES
first poll range r22
NO
collision
YES
processing response from r12
next poll range r23
polling cycle
NO
response from r21
YES
first poll range r24

Figure 14b


time
146
147
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0.5T
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central controller
remote terminals

Figure 15

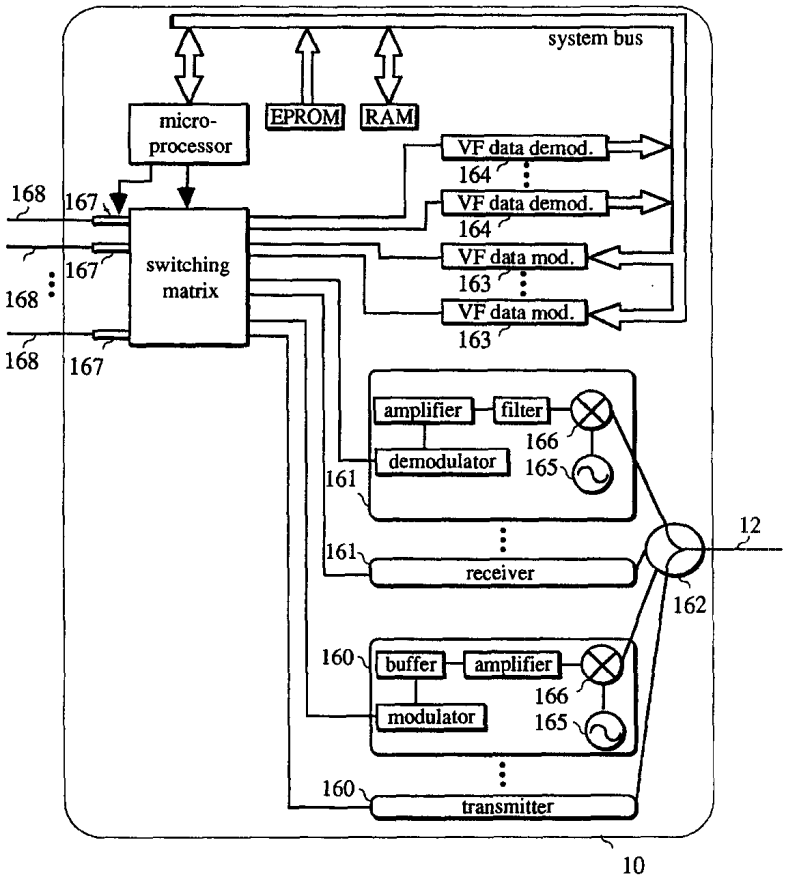
system bus
micro-processor
EPROM
RAM
VF data demod.
164
VF data demod.
164
VF data mod.
163
VF data mod.
163
168
167
168
167
168
167
switching matrix
amplifier
filter
166
demodulator
165
161
161
receiver
12
162
160
buffer
amplifier
166
modulator
165
160
transmitter
10

Figure 16

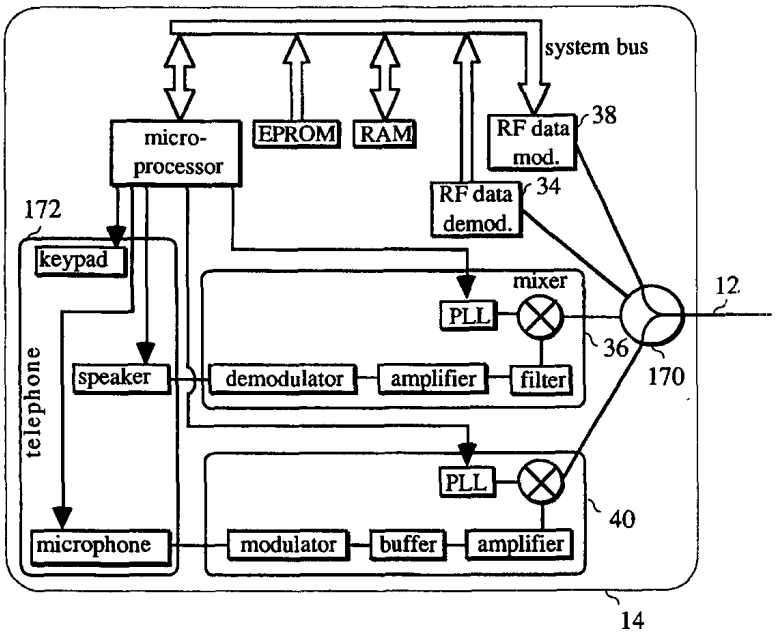
system bus
micro-processor
EPROM
RAM
RF data mod.
38
RF data demod.
34
172
keypad
mixer
PLL
12
36
170
speaker
demodulator
amplifier
filter
telephone
PLL
40
microphone
modulator
buffer
amplifier
14

Figure 17

DYNAMIC CHANNEL MANAGEMENT AND SIGNALLING METHOD AND APPARATUS

FIELD OF THE INVENTION

The present invention pertains generally to methods and apparatus for facilitating the two-way multi-media communication based on a shared transmission media such as coaxial cable-TV network, and more specifically to methods and apparatus for signalling channel management and protocol.

BACKGROUND OF THE INVENTION

A multiple access communication system comprises a central controller, a shared transmission media and a plurality of remote terminals dispersed geographically. To provide the means for multiple access is a classical problem in communication systems with a shared common transmission media. Some of the well known schemes are frequency division multiple access or FDMA, time division multiple access or TDMA, and code division multiple access or CDMA. These multiple access schemes deal with the techniques of separating the communication bandwidth into traffic-bearing channels. In a FDMA scheme, the communication bandwidth is divided into the frequency bands. The TDMA scheme separates the communication bandwidth into time slots. The traffic is encoded and then decoded using different code in a CDMA scheme.

In all these multiple access schemes the contention for access is resolved through signalling protocols on a predetermined and fixed signalling channel. There are proposals to dynamically allocate traffic-bearing channels to meet the service requirements in terms of lower blocking probability. However, in addition to availability, bandwidth and delay of the traffic-bearing channel, the traffic requirements should include responsiveness of the signalling process and the quality of the transmission means.

The signalling protocols for multiple access communication systems fall in two general categories for resolving the possible contention: scheduled access via polling or other means, and random access contention. In radiotelephony and local-area-network (CSMA/CD) environment, the contention is resolved by monitoring the signal during transmission, which requires synchronization and/or means to monitor activities amongst all remote terminals and the central controller. In the CATV network, remote terminals have different distance from the central controller making synchronization difficult. It is also not feasible to detect collision, i.e., multiple remote terminals transmit at the same time, on the CATV network since the remote terminals are attached to different branches of the network. The poll and response method is often used to schedule the multiple access from plurality of remote terminals, but it has the disadvantage of inefficiency due to wasteful interaction with remote terminals that are not in need of servicing.

DESCRIPTION OF THE RELATED ART

There are many proposals of means for dynamically adjusting the number of traffic-bearing channels according to varying traffic demands or the transmission quality in the radio telephony environment, e.g., U.S. Pat. Nos. 5,134,709, 5,235,631 and 5,276,908. In addition U.S. Pat. No. 4,868,811 discusses the protocol over the common signalling channel for allocation of traffic-bearing channels. U.S. Pat. No. 4,870,408 proposes a process of re-assigning subscriber units to balance the traffic load over the available channels. U.S. Pat. No. 5,010,329 discloses a method for dynamically grouping terminals in blocks for which the central unit performs block polling on a common data channel. The present invention presents a method to dynamically allocate both signalling data and traffic-bearing channels and to dynamically assign remote terminals to these channels.

The polling scheme is commonly used to resolve contention in a multiple access system. U.S. Pat. No. 4,385,314 proposes a system to sequentially poll all terminals. Due to the inherent inefficiency with sequential polling method, some proposals with the following variations for performance improvement have been presented. U.S. Pat. No. 4,754,426 proposes a two-level polling scheme with distributed control. U.S. Pat. No. 4,829,297 proposes use of a high priority group. U.S. Pat. No. 4,868,816 proposes a binary polling scheme, similar to the polling scheme in the present invention, with terminal address in each poll. U.S. Pat. No. 4,924,461 proposes a method to register other pending request on a second channel to interrupt sequential polling. U.S. Pat. No. 4,942,572 proposes a dual rate polling method using pseudo random sequence at high rate to poll all terminals resulting possibly in contention with a small number of terminals, and following the high rate poll by specific poll at lower rate in case of collision. This invention differs from the prior art in that multiple access is controlled through overlapping polling sequence executing on multiple channels in a parallel fashion. Only when collision occurs, this method will enter a selective polling sequence for contention resolution. The added benefit of this method is efficiency and redundancy against anomalies such as interference and component failure.

OBJECTS OF THE INVENTION

To overcome the problems mentioned above, the objective of the present invention is to present

- A flexible and extensible method for signalling channel management;
- A flexible and extensible method for assigning remote terminals to the signalling channels;
- An efficient asynchronous signalling protocol.

In the present invention, a dynamic process is disclosed to adjust the number of signalling channels to meet the requirements of varying traffic demand and the system growth. This is important in carrying multi-media traffic with different requirements in both the traffic-bearing channel bandwidth and the time required to setup a traffic-bearing channel. This dynamic signalling channel allocation and terminal assignment method also aids in system redundancy for anomalies such as interference and component failure. Integrated with the channel allocation and terminal assignment process, the present invention also presents an efficient controlled multiple access method. The central controller initiates the general polling on each signalling data channel in parallel to solicit request from all terminals assigned to the signalling data channel. Only when collision is detected, the central controller starts to poll selectively for resolution.

Further objects and advantages of my invention will become apparent from considerations of the drawings and ensuing description thereof.

BRIEF SUMMARY OF THE INVENTION

The multiple access communication system architecture depicted in FIG. 1 comprises a plurality of remote terminals, a common shared transmission media, a central controller

and interface to wide area networks. There are provided a number of communication channels (L) to the wide area networks, a number of communication channels (M) for supporting a plurality of remote terminals (N). The M number of channels to support communication between the central controller and the remote terminals are separated into four categories as depicted in FIG. 2, for carrying signalling data and user traffic in the forward and reverse directions, i.e., forward signalling data or FD channel, forward traffic bearer or FB channel, reverse signalling data or RD channel, and reverse traffic bearer or RB channel. All communication signals between the central controller and the remote terminals are multiplexed onto the shared transmission media.

The remote terminals are equipment supporting the users' communication need and are distributed throughout the network. For simplicity reason, the summing device for signals from remote terminals are shown as a single device in FIG. 1. Each of the remote terminals has one RF data demodulator capable of receiving data on the assigned FD channel, one frequency agile receiver capable of tuning to the assigned FB channel, one RF data modulator capable of transmitting data on the assigned RD channel, and one frequency agile transmitter capable of tuning to the assigned RB channel. The central controller comprises a switch and control mechanism, and a pool of transmitters and receivers for the communication channels. The central controller provides concentration and control function to meet the communication demand of the remote terminals much the same way as a Private Automated Branch eXchange or PABX. The central controller also translates the signalling information according to the requirement of the network. There are two levels of concentrations provided with this system: contention in the shared transmission media via the signalling protocol, and through the switching matrix of the central controller.

The signalling channels are dynamically adjusted for efficiency and redundancy. This also adds to the extensibility of the system for the increasing traffic load and system growth. The downstream traffic on these channels are scheduled by the central controller. Multiple access of the remote terminals for the upstream traffic are mitigated by separating remote terminals in groups via the channel allocation and the terminal assignment process. Prompted by the remote terminals at startup, or through the failure recovery procedure, or deemed necessary by the central controller, the channel allocation and terminal assignment process are initiated and controlled by the central controller. Through the registration process, the central controller assigns the remote terminal to a group supported by coupling of the specific forward and reverse signalling data channels. Afterwards, the communication between the central controller and the remote terminals follows a two-phase process. The controlled multiple access method is used, on each forward signalling data channel in parallel, for sporadic user data transfer or signalling purpose. The central controller either sends command to a specific remote terminal or solicits requests via a general poll from remote terminals assigned to the forward signalling data channel. The remote terminals respond to the controller's poll to request services. The selective polling process is used to identify the remote terminals involved in case of collision. The traffic bearer channel is used once the circuit is established via signalling protocol over the signalling data channels. The controlled multiple access scheme using overlapping polling method represents an efficient asynchronous signalling method and the decision process is designed to improve the effectiveness of the selective polling coverage during the contention resolution process.

Accordingly the achieved benefits of the present invention are:

- General communication channels management architecture;
- Flexible and extensible scheme for signalling channel management;
- Flexible and extensible scheme for assigning remote terminals to the signalling channels;
- Flexible and extensible scheme for supporting system growth and new services requirements;
- Improved system redundancy;
- Efficient asynchronous signalling protocol.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the invention will be apparent from the following Description of the Preferred Embodiment taken together with the accompanying drawings in which:

FIG. **1** is a illustration of a multiple access communication system architecture with interconnections between the remote terminals, the central controller which comprises the switch and control module and a number of transmitters and receivers, and the wide-area network.

FIG. **2** shows the channelization of the communication bandwidth of the shared transmission media between the central controller and the remote terminals for different functions.

FIG. **3** depicts the possible mappings of forward and reverse signalling data channels.

FIG. **4** depicts the logic flow diagram for polling and registration process at the central controller.

FIG. **5** depicts the logic flow diagram for command process at the central controller.

FIG. **6** is the logic flow diagram for registration, terminal reassignment, channel allocation, and terminal assignment process at the central controller.

FIG. **7** depicts the logic flow diagram for registration process at the remote terminals.

FIG. **8** depicts the logic flow diagram for signalling process at the remote terminals.

FIG. **9** details the message format for the signalling protocol between the central controller and the remote terminals.

FIG. **10** shows the ranges of remote terminals for selective polling during the contention resolution process.

FIG. **11** is a message exchange diagram for signalling protocol between the central controller and the remote terminals illustrating a scenario of collision and its resolution.

FIG. **12** is the decision graph for contention resolution process using polling ranges as defined in FIG. **10** using the regular polling method.

FIG. **13** contains signalling message exchange diagrams for comparison of two methods using the regular and the overlapping polling cycle.

FIG. **14** is the decision graph for contention resolution process using polling ranges as defined in FIG. **10** using the overlapping polling method.

FIG. **15** is a message exchange diagram using the overlapping polling method for signalling protocol between the central controller and the remote terminals illustrating a scenario of collision and its resolution.

FIG. **16** is the system block diagram of the central controller for supporting telephone services.

FIG. **17** is the system block diagram of a remote terminal for supporting telephone services.

DESCRIPTION OF PREFERRED EMBODIMENT

The multiple access communication system architecture as depicted in FIG. **1** comprises a central controller **10**, a shared transmission media **12**, and plurality of remote terminals **14** dispersed geographically throughout the network. A pool of communication channels **16** (L) are provided to the wide area networks **18**, a pool of communication channels **20** (M) for supporting a plurality of remote terminals **14** (N). The M number of channels to support communication between the central controller **10** and the remote terminals **1.4** are separated into four categories for carrying signalling data and user traffic in the forward and reverse directions, i.e., forward signalling data or FD channel **22**, forward traffic bearer or FB channel **24**, reverse signalling data or RD channel **26**, and reverse traffic bearer or RB channel **28**. All communication signals between the central controller **10** and the remote terminals **14** are multiplexed onto the shared transmission media **12**. All remote terminals **14** are equipment supporting the users' communication need and are distributed throughout the network. For simplicity reason, the summing device **30** for signals from remote terminals are shown as a single device in FIG. **1**. In a CATV network, this summing device **30** represents the splitters and taps connecting the branches that make up the network.

The central controller **10** comprises a switch and control mechanism **32**, and a pool of transmitters, called forward signalling data channel (FD) **22** and forward traffic bearer channel (FB) **24**, and a pool of receivers, called reverse signalling data channel (RD) **26** and reverse traffic bearer channel (RB) **28**. The central controller provides concentration and control function to meet the communication demand of the remote terminals much the same way as a Private Automated Branch exchange or PABX. The central controller also translates the signalling information according to the requirement of the network. In addition to concentration provided through the switching matrix of the central controller, contention in the shared transmission media via the signalling protocol provides another level of concentration with this system.

Each of the remote terminals has one radio frequency (RF) agile data demodulator capable of receiving on the assigned FD channel **34**, one RF agile receiver tuned to the assigned FB channel **36**, one RF agile data modulator capable of transmitting on the assigned RD channel **38**, and one RF agile transmitter tuned to the assigned RB channel **40**.

Although the present invention is useful for interworking with a variety of different wide area networks, the telephone network will be used hereinafter to illustrate the present invention.

As depicted in FIG. **2**, the bandwidth is channelized for carrying traffic in the forward and the reverse direction. Data channels are used for carrying signalling or data traffic while bearer channels are used for carrying user traffic similar to circuits in telephony. Therefore, there are altogether 4 types of channels as depicted in FIG. **2**. FD-x is the signalling data channel in the forward direction **44**, i.e., from the central controller to the remote terminals, numbered from 1 to a. FB-y is traffic bearer channel **46** in the forward direction numbered from 1 to b. RD-x' is signalling data channel **48** in the reverse direction, i.e., from the remote terminals to the central controller, numbered from 1 to c. RB-y' is traffic bearer channel **50** in the reverse direction numbered from 1 to d. A guard band **42** is also shown to separate the signals traveling in the forward and the reverse directions if they are to be put side-by-side. As explained later a and c should be greater than or equal to 2 for redundancy reason. Note that if the channels are of equal size, then a+b and c+d shall remain constant if all channels are available free of interference problem, i.e., there are a pool of channels from the central controller to the remote terminals, and a separate pool of channels from the remote terminals to the central controller. These pools are set aside for a flexible allocation scheme to be described in detail later.

Although it is not necessary to have all channel to have equal bandwidth, the communication process can be managed more easily if the channels have simplified structure with equal bandwidth. In case of equal size of the FD and FB channels, the management scheme can relocate the FD to a channel that is better suited for data transmission while FB channel carrying normal voice communication can tolerate a considerable more noisy channel than FD channel is able to. Similarly, the management process can take advantage of the flexibility afforded by the equal size of the RD and RB channels. If the bandwidth of the communication channels to the wide area network is equivalent to the channels of the shared transmission media, the number L is less than or equal to the number M, which in turn is less than or equal to the number N. In case of channels with different sizes the central controller needs to have the additional intelligence for managing these channels efficiently, and to perform segmentation and reassembly. Note that communication with asymmetric bandwidth requirement such as multi-cast can be efficiently supported in this system.

The FB-y and RB-y' channels are allocated according to the signalling protocol communicated over the FD-x and RD-x' channels. There is no contention in the forward direction, i.e., the traffic on each FD-x channel is scheduled independently. The number of signalling data channels are used to improve the efficiency servicing groups of remote terminals and the system redundancy. In case of transmission failure (detected through a number of retries without receiving acknowledgment), the central controller reverts back to FD-**1** and then FD-**2** for transmission to the specific remote terminal, while the remote terminals reverts back to RD-**1** and then RD-**2** for transmission and to FD-**1** and FD-**2** for reception. The FD-**1** and FD-**2** channels are called primary forward signalling data channel and backup forward signalling data channel respectively. These RD-**1** and RD-**2** channels are called primary reverse signalling data channel and backup reverse signalling data channel respectively.

With this general channelization architecture, a flexible management scheme is possible for channel arrangement and remote terminals grouping. For example, channel arrangement can be adjusted according to traffic pattern mix and/or more intelligent management scheme can be implemented with various priority lists. The channelization is shown to follow a FDMA scheme for ease of understanding, but this can also be easily adopted for TDMA or CDMA schemes.

Multiple access of the remote terminals for the upstream traffic are mitigated by separating remote terminals in groups via the channel allocation and the terminal assignment process to be described later. The contention among remote terminals in each group is resolved through a controlled multiple access followed by selective polling in case of collision on each of the signalling data channel. The

number of remote terminals assigned to each of the RD channel is to be evenly distributed according to the traffic demand. In the case of identical traffic requirements from all users, the number of remote terminals assigned to each of the RD channel will be equal.

The mapping of forward and reverse signalling data channels is under the control of the central controller dynamically. The mapping of part (a) of FIG. **3** depicts the simplest arrangement with each pair of forward and reverse signalling data channels forming a terminal group. For example, the terminal group receiving on FD-h channel will transmit on RD-k. The part (b) depicts the one-to-many mapping where the central controller transmits on one FD-n channel while the remote terminals belonging to the same group respond in their assigned RD-o, RD-p, and RD-q channel respectively. In part (c) with the many-to-one mapping shows that the central controller transmits on several FD (r, s and t) channels each reaching a subset of the group of the remote terminals, which respond in the same RD-u channel. Depending on the traffic pattern, some mapping will be more efficient in utilizing the bandwidth, e.g., the many-to-one mapping as depicted in part (b) of FIG. **3** is suitable for case where the traffic coming from the remote terminals far exceeds the traffic in the forward direction. Note that the mapping of part (c) can cause collision from remote terminals in different sub-sets of the same terminal group. This is the only mapping that will require the contention resolution process, described later, to be coordinated between multiple signalling data channels. Different types of mapping can be used at the same time (but not combined) for different segments of remote terminals when deemed appropriate by the central controller.

Prompted by the remote terminals at startup, or through the failure recovery procedure, or deemed necessary by the central controller, the channel allocation and terminal assignment process is initiated and controlled by the central controller. Through the registration process, the central controller assigns the remote terminal to a group corresponding to a specific set of signalling data channels. Afterwards, the communication between the central controller and the remote terminals follows a two-phase process. The controlled multiple access procedure is used on each of the signalling data channels in parallel, for sporadic user data transfer and for signalling purposes. The controller sends command to the remote terminal in case of request from the network while the remote terminals respond to the controller's poll to request services. If dedicated channel is required to meet the user's need, the traffic bearer channel is established via signalling protocol over the signalling data channels.

In FIG. **4**, the logic flow is shown for the central controller's initialization process and polling cycle. The polling process is executed in parallel for each of the FD-x in an independent fashion. After the system initialization, the central controller clears the channel allocation and terminal assignment lists and starts the polling cycle on FD-**1** and FD-**2**. If there is required transmission to the remote terminal, such as a incoming call, the central controller enters the command mode. Otherwise the central controller solicits for request from remote terminals assigned to the FD channel via a general poll. If there is no response from any of the remote terminal, the polling cycle repeats after a time-out period expires. If there is response from remote terminals without collision or transmission error, the central controller processes the request accordingly. In case of collision or transmission error, the central controller enters a selective polling cycle to identify the remote terminal(s) involved in the collision or caused the transmission error.

As depicted in FIG. **5**, the central controller in the command mode sends the message destined for a specific remote terminal. Normally only the addressed remote terminal will respond to the command, therefore, there is normally no need for collision processing except for transmission error. If the expected response is not received at the central controller from the addressed terminal after the time-out period expires, the central controller assumes that either FD-x or RD-x' channel is not usable by the addressed remote terminal. In this case, the central controller retries for a number of times, then proceeds with the terminal failure processing if there is still no response from the specific remote terminal. The terminal failure processing removes the failed remote terminal from the group and signals to the wide area network that connection is not possible.

In FIG. **6**, the logic flow diagram for the registration, channel allocation, terminal assignment and reassignment process is depicted. Upon receiving a registration message on RD-**1** or RD-**2**, the central controller checks if the remote terminal is a newly registering terminal. If the remote terminal is a newly registering terminal and is authorized, the central controller proceeds to check for available signalling data channels for the remote terminal. If the new remote terminal has not been authorized, the central controller will deny the remote terminal from entering the network by issuing a terminal disable command. If the remote terminal has been registered previously, the registration process is caused by channel failure recovery procedure sensed at the remote terminal, and the central controller will register the channel status and proceed to check for available signalling data channels for the remote terminal. At any time, the central controller can initiate the terminal re-assignment process if deemed appropriate for the varying traffic demand or other system dynamics.

The determining factors of signalling data channels availability include the number of remote terminals using the signalling data channel, the traffic requirements, past collision count, channel error status, and bandwidth of the signalling data channel. These factors will be calculated for each of the existing signalling data channels in consideration of the specific group mapping as depicted in FIG. **3**. If there are signalling data channels in the forward and the reverse direction, the registering remote terminal will be assigned to the group. If there is no available signalling data channel already in use, the central controller will check for available channel from the pool of transmitters and/or the poll of receivers, and proceeds with allocation if there is available channel from the pool (or a pair in case that neither the forward nor the reverse signalling data channels are available). If the signalling data channel is available, the central controller will complete the registration process by commanding the remote terminal to tune to the assigned channels. Otherwise, the central controller will deny the remote terminal from entering the network by issuing a terminal disable command.

In FIG. **7**, the logic flow of the remote terminals is shown for the channel registration process at startup or through failure recovery procedure. All of the remote terminals assigned to the same forward signalling data channel will receive the command or poll, but only the addressed remote terminals should respond. Initially the remote terminals will listen to a general poll on FD-**1** for registration. If the poll from the central controller is not receiving for an extended period of time, the remote terminal will try FD-**2** channel (toggling between FD-**1** and FD-**2**). Once a general poll is sensed on the forward signalling data channel, the remote terminal responds first on RD-**1** and then RD-**2** if there has

not been an acknowledgment from the central controller when the time-out period expires and retry count exceeded. Based on the central controller's command in response to the remoter terminal's registration message, the remote terminal either tunes to the assigned FD and RD channels or disables itself if not authorized.

Depicted in FIG. **8** is the signalling process at the remote terminals. Once the registration process is completed, the remote terminal will monitor the poll or command from the central controller on the assigned FD-x channel, and respond on the assigned RD-x' channel if needed. In case of failure, i.e., not receiving polls from the central controller for extended period of time, or no acknowledgment for the previous request, the remote terminal reverts back to FD-1 and RD-1 via the registration process. In case of collision with other remote terminals, the remote terminal follows the instruction from the central controller through selective polling process to resolve the contention.

The message format of the signalling protocol between the central controller and the remote terminals is depicted in FIG. **9**. The message frame starts with a one (1) byte preamble to indicate the start of message and to help detect collision. The Terminal Identifier (TID) field is one (1) byte long offering 256 possibility with the number 255 and 0 (hexadecimal FF and 00) set aside for registration purpose, i.e., maximum of 256–2=254 stations can be supported for each terminal group in this system.

The following field SAT or Signalling Action Type is three (3) bytes in length containing one of the listed commands. The SRT or Signalling Request Type field is also three (3) bytes in length containing one of the listed requests. Some of the commands and requests are included to illustrate possible features that can be supported in the system. For registration process, SAT and SRT fields contain the serial number of the remoter terminal, i.e., there are up to 2^{24}=16 million possible numbers. Note that there are two different types of polling message. The selective polling with collision alert is used to alert other remote terminals to avoid using the channel where collision occurred until the resolution is completed. The lower TID of the range in the TID field and the higher TID of the range as part of the SAT field determine the type of the poll: specific, selective, or general. The FCS or Frame Check Sequence field is one (1) byte long for protection against transmission error in the TID and SAT/SRT fields.

Collision and transmission error are detected by the following mechanisms:

invalid TID,

FCS error,

invalid frame length,

invalid frame format,

invalid SAT/SRT value.

In FIG. **10**, the remote terminals assigned to the same group are further separated in ranges during the selective polling process for resolving contention. This logic for resolving contention is contained in the central controller while the remote terminals follows the central controller's instructions. The naming of these ranges is as follows: the first digit of the subscript stands for the level, and the following number is used to sequentially designate from lower to higher TID (there are 2^n divisions at the n-th level). For example, at the 2nd level there are 2^2=4 ranges named r_{21}, r_{22}, r_{23}, and r_{24}. Note that a selective poll with range r_{01} is equivalent to a general poll.

In FIG. **11**, a scenario of message collision and the resolution process is illustrated. The collision is resolved using the selective polling approach which is similar in spirit to the binary search algorithm. Suppose there are N number of remote terminals in total, and two remote terminals, one numbered between 1 and N/4 and the other numbered between N/4 and N/2, go off-hook during the same polling cycle. These two remote terminals will respond to the general poll from the central controller **110** resulting in a collision **111**. Once the collision from two remote terminals is detected at the central controller, the next poll with collision alert covers the range r_{11} between 1 and N/2 **112**, which results in another collision **113**. After halving the range to r_{21} between 1 and N/4 **114**, the remote terminal numbered between 1 and N/4 responds without interference **115**. As soon as the first remote terminal involved in the collision is identified, the resolution process is deemed completed by the central controller. The central controller follows with a general poll without alert **116** that indicates the end of the contention resolution process and results in a response from the remote terminal in the range r_{22} between N/4 and N/2 **117**. The next general poll **118** from the central controller resumes normal operation. The dial tone is generated at the remote terminal when connection to the network is established. The central controller sends commands **119 121** to these two remote terminals respectively, and the remote terminals respond to the commands from the central controller with confirmations **120 122**.

The decision tree is depicted in FIG. **12***a* and FIG. **12***b* for the selective polling process to determine the remote terminal(s) involved in the collision or caused the transmission error. This diagram is to illustrate the process involved using the regular polling method with which the polling cycle repeats only after the response to the previous poll is received or time-out occurs. The idea is to systematically narrowing the scope based on the information available. This systematic approach follows the level as defined in FIG. **10**, i.e., orderly halving similar in spirit to the binary search algorithm.

Note that the contention process is deemed completed as soon as the first remote terminal involved in the collision is identified. Depending on the probability of the number of remote terminals involved in a collision and the error rate for the shared transmission media, i.e., if the transmission media has a high error rate and low collision probability, it is more beneficial to resume polling all remote terminals since the resolution process also accounts for the problem caused by transmission error. On the other hand if the collision probability is high and the transmission media is reliable, it is more efficient to continue the selective polling process until all remote terminals involved in the collision are identified.

Assume using the modest means of data transmission at rate of 9600 bits per second, to transmit 48 bits message the transmission delay T is approximately 48/9600=5 milliseconds. In the following discussion, assume 2.5 T is used for the time-out period for each polling cycle. The remote terminals shall start transmitting response message within the window of 0.5 T upon receiving the poll or the command from the central controller. One of the major benefit of fixed length messages is that it helps putting the time roughly into slots for efficiency improvement as explained in detail later.

To support 250 remote terminals in the system, the sequential polling scheme will incur the nominal delay of 250×2.5 T+2=1.5625 seconds, which is too long to be acceptable for most services. With the controlled multiple access method, the remote terminal will gain access at the earliest poll with T/2 delay on average, and in case of collision the number of selective polling cycles required to identify the first remote terminal involved in the collision is

$\log_2 250+1>9$, therefore, the maximum delay for the first terminal involved in a collision is 9×2.5 T×22.5 T=112.5 ms. If the decision tree in FIG. **12** is adhered to, i.e., the central controller declares the contention resolution is completed as soon as the first remote terminal is identified, the second terminal involved in the collision will take twice the amount of time and the third one takes three times the amount of time and so on, until the last one which takes one poll only. More importantly this method guarantees a deterministic approach if the grouping of remote terminals are properly selected to reduce the probability of collision. If the grouping is not done properly, the effect of increasing number of multiple collisions will put the system in constant mode of contention resolution.

With transmitting and receiving in two separate paths, it is possible to initiate a separate poll or command instead of waiting for the response from the remote terminals to the outstanding poll. This overlapping polling method deviates from the regular polling method by interleaving poll with response to the previous poll thereby taking full advantage of the bandwidth available. Similar to the spirit of instruction pipe-lining in the computer processor architecture, some of the polls may not be productive in the case of collision as evident by the example in FIG. **15** later, however, these polls do not cause any adverse effect. The central controller needs to make correlation between the poll and the response, and tries to optimize the time in resolution by anticipating the most profitable steps to take next.

In FIG. **13**, the message exchange diagrams of signalling protocols employing the regular polling cycle in FIG. **13***a* and the overlapping polling cycle in FIG. **13***b* are shown for comparison. In the ideal case with no collision, the controlled multiple access scheme using overlapping polling cycle represents an efficient asynchronous signalling method. In part (a) there are 3 polling cycles (response from remote terminal **130** to poll from the central controller **132**) within the time frame using the regular polling method versus 6 polling cycles using the overlapping polling method as shown in part (b). This example shows the maximum efficiency improvement that can be derived from the overlapping polling method over the regular polling method, i.e., in the order of **2**.

The decision tree is depicted in FIG. **14***a* and FIG. **14***b* for the selective polling process using the overlapping polling method to identify the remote terminal involved in the collision or caused the transmission error. The idea is to systematically narrowing the scope based on the information available and guided by the ranges of remote terminals at each advancing level as defined in FIG. **10**. Taking the advantage of the overlapping polling cycle, the polls is designed to anticipate the most probable range for maximum effect. The repeated collision in response to the overlapped general poll is used to determine whether the corrupted message is caused by the transmission error or collision. Similar to the decision tree in FIG. **12**, the resolution process is deemed complete as soon as the first remote terminal involved in the collision is identified.

In FIG. **15**, the message exchange diagram of the signalling protocol employing overlapping polling method dealing with the same scenario of collision as shown in FIG. **11** where the regular polling method is employed instead. Both remote terminals respond to the general poll from the central controller **159** resulting in a collision **158**. Since the central controller sends another general poll without waiting for response from the remote terminals **157**, both remote terminals respond again resulting in repeated collision **156**. The central controller next probe the remote terminals in the range r_{11} **155** resulting in second collision **154**. The central controller also sends out another probe with a selective poll for remote terminals in the range r_{12} **153** resulting in no response from these remote terminals **152**. When the central controller polls the remote terminals in the range r_{21} **151**, one of the terminals involved in the collision succeeds in responding to the poll without collision **150**. When the central controller polls the remote terminals in the range r_{22} **149**, the other terminal involved in the collision succeeds in responding to the poll without collision **148**. At this point, the central controller sends out general poll without alert **147** to end the collision processing. The next general poll without alert **146** from the central controller resumes the normal operation.

It takes the same amount of time (2 polling cycles in real time) to identify the first remote terminal involved in the collision for both methods. A number of reasons contribute to this situation. There are a few wasted effort as shown in the diagram, such as the repeated collision **156**, poll of remote terminals in the range r_{12} **153**, and poll of remote terminals in the range r_{11} **155**. Similar to the pipe-lining instruction architecture, this method is most productive when there is no "jump" in the line of instructions, i.e., no collision among the remote terminals. There are certainly instances where this method will produce more benefit than what is shown in FIG. **15**. For example, the overlapping polling method will be able to identify the transmission error in 1.5 polling cycle versus 3 in the worst case for the regular polling method. The decision tree in FIG. **14** can also be modified to take advantage of the available information that there might be more than 2 remote terminals involved in a collision at various points, e.g., the thickened circle to resume the polling cycle on the right side of FIG. **14** can be extended to improve the efficiency in case of three remote terminals in ranges r_{12}, r_{21} and r_{22} involved in a collision.

The block diagram of the apparatus to implement this signalling method for the telephone service is depicted in FIG. **16** for the central controller. There are a plurality of transmitters **160** and a plurality of receivers **161** for communication on the shared transmission media **12**. The duplexer **162** combines the transmitters' communication signals to be transmitted on the shared transmission media and duplicates the communication signals from the shared transmission media to each of these receivers. A number of voice frequency (VF) data modulators **163** and demodulators **164** similar to the conventional modem are provided for transmitting and receiving the signalling data. Each of the transmitters **160** and the receivers **161** has a oscillator **165** for tuning to the corresponding channels. The VF signal coming to the transmitter module **160** is first modulated, buffered, amplified and mixed with the oscillator's frequency to the RF channel. The RF signal coming to the receiver module **161** is translated to the intermediate frequency through the mixer **166**, then filtered, amplified, and finally demodulated back to the VF signal. The switching matrix under the control of the microprocessor, is used to connect VF signals between transmitters, receivers, interface to the telephone networks, VF data modulator and demodulator. The telephone interface module **167** under the control of the micro-processor performs the hybrid function to separate the signals in the transmit and receive direction (2-wire to 4-wire conversion), and the signalling function to/from the telephone network **168**. The Random Access Memory or RAM is used to store the dynamic information such as remote terminal and channel status. The Erasable Programmable Read Only Memory or EPROM is used to store the invariant information such as instructions to the

micro-processor at startup. The micro-processor communicates with EPROM, RAM, and the data modulators and demodulators via the system bus.

To allocate a forward signalling data channel, the central controller **10** determines an available VF data modulator **163**, a transmitter module **160**, and then commands the switching matrix to make the connection between the VF data modulator **163** and the RF transmitter **160**. The signalling information or sporadic user data will come from the micro-processor to the VF modulator **163** via the system bus, and then the modulated VF signal is fed to the input of the transmitter module **160** via the connection through the switching matrix before it is modulated to the RF channel. To allocate a reverse signalling data channel, the central controller determines an available VF data demodulator **164**, a receiver module **161**, and commands the switching matrix to make the connection between the VF data demodulator **164** and the RF receiver **161**. The signalling information or the sporadic user data follows the reverse direction as the forward direction. To establish a telephone connection, the central controller determines an available telephone interface module **167**, a transmitter module **160**, a receiver module **161**, and commands the switching matrix to make the connection between the telephone interface module **167** and the transmitter **160** and receiver modules **161**. The voice traffic is separated into the transmit and receive direction and connected through the switching matrix to the transmitter and receiver modules for modulating to and demodulating from the RF channels. Although the micro-processor needs to be involved in the path of data transfer, it is possible to establish a modem pool by setting aside a number of the VF data modulators and demodulators, and connecting them to the telephone interface module **167**. The data signal from the remote terminals are decoded by the VF data demodulator **164**, routed by the microprocessor, and then fed to the VF data modulator **163**. Through the connection between the VF data modulator **163** and telephone interface module **167**, the modulated data signal is transmitted to the telephone network. The data signal from the telephone network traverses in the reverse direction.

The apparatus to implement this signalling method for the telephone service is depicted in FIG. **17** for the remote terminals, which comprises a transmitter **40** and a receiver **36** for communication on the shared transmission media **12**, a RF data modulator **38** and a RF data demodulator **34** for signalling data channels. The transmitter **40**, the receiver **36**, the data modulator **38** and the data demodulator **34** are all capable of tuning to the assigned RF frequency. The duplexer **170** combines the transmitters' communication signals to be transmitted on the shared transmission media **12** and duplicates the communication signals from the shared transmission media to each of these receivers. The micro-processor communicates with EPROM, the RAM, and the data modulator and demodulator via the system bus. The keypad, the speaker, and the microphone make up the conventional telephone set **172**. The audio signal from the microphone feeds to the modulator to be transmitted on the assigned channel over the shared transmission media. Similarly the speaker gets the demodulated signal from the receiver tuned to the assigned channel. In this block diagram, sporadic user data shares the RF data modulator and demodulator with signalling information, while the telephone section provides voice traffic through the RF transmitter and receiver. If the data communication is to be supported using a dedicated circuit, the audio interface of a conventional modem can be connected to the input of the modulator of the transmitter and to the output of the demodulator of the receiver.

At startup, the modulator and the demodulator are tuned to the primary forward and reverse signalling data channels respectively. The micro-processor interprets the signalling command and instruct the Phased Lock Loop or PLL according to the command from the central controller. The transmitter and the receiver modules are enabled and tuned to the assigned channels when the connection is established. The micro-processor also controls the functioning of the microphone, the keypad and the speaker.

From the foregoing, it will be observed that numerous variations and modifications may be effected without departing from the true spirit and scope of the novel concept of the invention. It should be understood that no limitation with respect to the specific structure and circuit arrangements illustrated is intended or should be inferred. It is, of course, intended to cover by the appended claims all such modifications as fall within the scope of the claims.

Thus, in accordance with the invention, a Dynamic Channel Management And Signalling Method And Apparatus has been provided accomplishing all of the objects, and having the features and advantages specified at the beginning of this specification.

It is to be understood that the disclosed construction of the invention may be embodied in other forms within the scope of the claims.

What is claimed is:

1. In a multiple access communication system comprising a central controller, a shared transmission means for signalling data and user information, and a plurality of remote terminals, a method of allocating signalling data channels between said central controller and said plurality of remote terminals from a plurality of communication channels and of assigning remote terminals comprising the steps of:

(a) establishing communications between said central controller and said plurality of remote terminals via a plurality of signalling data channels, each of said remote terminals being initially assigned to a pair of predetermined signalling data channels;

(b) monitoring the status of a plurality of the signalling data channels in use between said central controller and said plurality of remote terminals for the usability of said signalling data channels;

(c) determining whether one of said plurality of remote terminals needs to be reassigned to a different signalling data channel other than said predetermined signalling data channel;

(d) determining whether a different and suitable signalling data channel is available other than said predetermined channel; and

(e) reassigning by said central controller said remote terminal to a different and suitable signalling data channel for communication henceforward.

2. In a multiple access communication system according to claim **1**, said step of establishing communications between said central controller and said plurality of remote terminals via a plurality of signalling data channels comprising the steps of:

(a) polling by said central controller said plurality of remote terminals on a pair of predetermined primary forward and backup forward signalling data channels for an activated remote terminal;

(b) sensing by an activated remote terminal for a polling message from said central controller on a predetermined backup forward signalling data channel if said predetermined primary forward signalling data channel is unavailable to said activated remote terminal because

of its failure to sense a polling message during a predetermined period of time;

(c) transmitting a registration message from said activated remote terminal to said central controller on a predetermined primary reverse signalling data channel; and

(d) retransmitting said registration message on a predetermined backup reverse signalling data channel if said primary reverse signalling data channel is unavailable to said activated :remote terminal because of its failure to sense a response from said central controller to said registration message after a predetermined period of time.

3. In a multiple access communication system according to claim **1**, said step of monitoring the status of a plurality of the signalling data channels in use between said central controller and said plurality of remote terminals for the usability of said signalling data channels comprising the steps of:

(a) calculating the aggregate traffic load requirements of said plurality of signalling data channels in use;

(b) monitoring the past collision count of said plurality of signalling data channels in use;

(c) monitoring the transmission error count of said plurality of signalling data channels in use; and

(d) sensing the status of said plurality of signalling data channels in use for failure.

4. In a multiple access communication system according to claim **1**, said step of determining whether one of said plurality of remote terminals needs to be reassigned to a different signalling data channel other than said predetermined signalling data channel comprising the steps of:

(a) sensing the status of said predetermined signalling data channel which said terminal has been assigned to for overloading to determine whether said terminal needs to be reassigned to a different signalling data channel because of overloading; and

(b) sensing the status of said predetermined signalling data channel which said terminal has been assigned to for failure to determine whether said terminal needs to be reassigned to a different signalling data channel because of failure.

5. In a multiple access communication system according to claim **1**, said step of determining whether a different and suitable signalling data channel is available other than said predetermined channel comprising the steps of:

(a) sensing the status of other signalling data channels other than said predetermined channel for spare capacity; and

(b) allocating a new signalling data channel if no signalling data channel has spare capacity and a new signalling data channel is available.

6. In a multiple access communication system comprising a central controller, a shared transmission means and a plurality of remote terminals, a method of controlled multiple access between said central controller and said plurality of remote terminals comprising the steps of:

(a) establishing communications between said central controller and each of said plurality of remote terminals via predetermined signalling data channels of a plurality of signalling data channels, each of said plurality of remote terminals can be assigned to any pair of said plurality of signalling data channels;

(b) polling a plurality of said plurality of remote terminals simultaneously by said central controller for determining whether there is any pending request from said plurality of remote terminals; and

(c) resolving contention among said plurality of remote terminals by said central controller if there is a pending request from more than one remote terminal on the same signalling data channel.

7. In a multiple access communication system according to claim **6**, said step of polling a plurality of said plurality of remote terminals simultaneously by said central controller for determining whether there is any pending request from said plurality of remote terminals comprising the steps of:

(a) polling said plurality of remote terminals by said central controller on one of said plurality of signalling data channels; and

(b) responding to said polling by said central controller by only those of said plurality of remote terminals which have a pending request.

8. In a multiple access communication system according to claim **6**, said step of resolving contention among said plurality of remote terminals if there is a pending request from more than one remote terminal on the same signalling data channel comprising the steps of:

(a) detecting data transmission errors due to collision of pending requests from said plurality of remote terminals;

(b) alerting a plurality of remote terminals assigned to a signalling data channel to avoid using said signalling data channel where collision occurred;

(c) polling said plurality of remote terminals by said central controller for identifying one of said plurality of remote terminals involved in the collision; and

(d) transmitting a signal from said central controller to said identified remote terminal indicating that said central controller will process its pending request.

9. In a multiple access communication system according to claim **8**, said step of polling said plurality of remote terminals by said central controller for identifying one of said plurality of remote terminals involved in the collision by continuing polling by said central controller before receiving any responses from said plurality of remote terminals.

10. The multiple access communication system of claim **6** further comprising the step of determining whether there is a command from said central controller to one or more of said plurality of remote terminals.

11. In the multiple access communication system of claim **6**, said step of polling a plurality of said plurality of remote terminals simultaneously by said central controller for determining whether there is any pending request from said plurality of remote terminals comprising the steps of:

(a) polling by said central controller said plurality of remote terminals in parallel on two or more of said plurality of signalling data channels; and

(b) responding to said polling by said central controller by only those of said plurality of remote terminals which have a pending request.

12. In a multiple access communication system according to claim **6**, said step of polling a plurality of said remote terminals simultaneously by said central controller for determining whether there is any pending request from said plurality of remote terminals by continuing polling by said central controller before receiving any responses from said plurality of remote terminals.

13. In a multiple access communication system according to claim **6**, said step of resolving contention among said plurality of remote terminals if there is a pending request from more than one remote terminal on the same signalling data channel further comprising the step of identifying one

of said more than one remote terminal that has a pending request by polling groups of said plurality of remote terminals.

14. In a multiple access communication system having a plurality of communication channels for communicating with a plurality of remote terminals, a central controller comprising:

(a) system controlling means for controlling the communication system comprising a micro-processor and associated EPROM and RAM;

(b) transmitting means for transmitting user traffic or signalling data on said communication channels;

(c) receiving means for receiving user traffic or signalling data on said communication channels;

(d) modulating means for modulating signalling data;

(e) demodulating means for demodulating signalling data;

(f) interfacing means for interfacing to a wide area network;

(g) switching means for making dynamic connections to switch signals among said transmitting means, said receiving means, said modulating

means, said demodulating means, and said interfacing means; and

(h) forward communication controlling means for selecting a forward signalling data channel via a dynamic connection between said transmitting means and said modulating means.

15. In a multiple access communication system having a plurality of communication channels for communicating with a plurality of remote terminals according to claim **14**, said central controller further comprising reverse communication controlling means for selecting a reverse signalling data channel via a dynamic connection between said receiving means and said demodulating means.

16. In a multiple access communication system having a plurality of communication channels for communicating with a plurality of remote terminals according to claim **15**, said central controller further comprising remote terminal communication controlling means for connecting a plurality of remote terminals via dynamic connections between said transmitting means and said receiving means.

17. In a multiple access communication system having a plurality of communication channels for communicating with a plurality of remote terminals according to claim **16**, said central controller further comprising wide area network communication controlling means for connecting a plurality of remote terminals to a plurality of wide area networks via dynamic connections among said transmitting means, said receiving means and said interfacing means.

18. In a multiple access communication system having a plurality of communication channels for communicating with a plurality of remote terminals according to claim **17**, said central controller further comprising modem communication controlling means for establishing a plurality of data modem connections to a wide area network via dynamic connections among said transmitting means, said receiving means, said modulating means, said demodulating means, and said intefacing means.

19. In a multiple access communication system having a central controller, a plurality of communication channels, and a plurality of remote terminals, each of said plurality of remote terminals comprising:

(a) user traffic transmitting means for transmitting user traffic on an assigned communication channel;

(b) user traffic receiving means for receiving user traffic on an assigned communication channel;

(c) signalling data transmitting means for transmitting signalling data on an assigned communication channel;

(d) signalling data receiving means for receiving signalling data on an assigned communication channel;

(e) user interfacing means comprising a telephone with a keypad;

(f) system controlling means for controlling the communication system comprising a micro-processor and associated EPROM and RAM and

(g) communication controlling means for tuning said signalling data transmitting means and for tuning said signalling data receiving means under control of said central controller a pair of assigned communication channels via said micro-processor and associated EPROM and RAM.

20. In a multiple access communication system according to claim **19**, said system controlling means further comprising a program for resolving contention in a multiple access system by responding to polling by said central controller.

* * * * *

PATENT APPLICATION SERIAL NO. 08/276534

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ABSTRACT of the Disclosure 08/270534

There is provided a dynamic and adaptable method and apparatus to support two-way multi-media communication services on a multiple access communication system, which comprises a central controller, a shared transmission media and a plurality of remote terminals dispersed throughout the network. The central controller comprises switch and control apparatus and a pool of transmitters and receivers. The communication channels between the central controller and remote terminals are arranged for signalling data and traffic bearer channels in the forward and reverse directions. The number of signalling data channels is adjusted to satisfy the traffic requirements and for redundancy purposes. The forward and reverse signalling data channels are coupled in different mappings to support terminal grouping. Multiple access of the remote terminals for the upstream traffic are mitigated by separating remote terminals in groups via the channel allocation and the terminal assignment process. Communication between the central controller and the remote terminals follows a multiple access scheme controlled by the central controller via polling procedure on each of the forward signalling data channels independently. In case of collision, the central controller engages the remote terminals in a selective polling process to resolve the contention. The overlapping polling method of the controlled access scheme increases the utilization of the signalling channel and reduces the time required to gain access to the shared transmission media. By dynamically adjusting the load on signalling data channels, the signalling process is greatly improved for efficiency and redundancy against anomalies with the added benefit of improved flexibility and extensibility. The system is especially useful in a two-way CATV network.

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APPLICATION FOR

UNITED STATES PATENT

TO WHOM IT MAY CONCERN:

Be it known that I, ALEXANDER L. CHENG, a citizen of the Republic of China (Taiwan), residing at 11 Springdale Avenue, White Plains, New York 10604, have invented new and useful improvements in a:

DYNAMIC CHANNEL MANAGEMENT AND

SIGNALLING METHOD AND APPARATUS

of which the following is the specification.

08/276534

DYNAMIC CHANNEL MANAGEMENT AND SIGNALLING METHOD AND APPARATUS

Field of the Invention

The present invention pertains generally to methods and apparatus for facilitating the two-way multi-media communication based on a shared transmission media such as coaxial cable-TV network, and more specifically to methods and apparatus for signalling channel management and protocol.

Background of the Invention

A multiple access communication system comprises a central controller, a shared transmission media and a plurality of remote terminals dispersed geographically. To provide the means for multiple access is a classical problem in communication systems with a shared common transmission media. Some of the well known schemes are frequency division multiple access or FDMA, time division multiple access or TDMA, and code division multiple access or CDMA. These multiple access schemes deal with the techniques of separating the communication bandwidth into traffic-bearing channels. In a FDMA scheme, the communication bandwidth is divided into the frequency bands. The TDMA scheme separates the communication bandwidth into time slots. The traffic is encoded and then decoded using different code in a CDMA scheme.

In all these multiple access schemes the contention for access is resolved through signalling protocols on a pre-determined and fixed signalling channel. There are proposals to dynamically allocate traffic-bearing channels to meet the service requirements in terms of lower blocking probability. However, in addition to availability, bandwidth and delay of the

traffic-bearing channel, the traffic requirements should include responsiveness of the signalling process and the quality of the transmission means.

The signalling protocols for multiple access communication systems fall in two general categories for resolving the possible contention: scheduled access via polling or other means, and random access contention. In radiotelephony and local-area-network (CSMA/CD) environment, the contention is resolved by monitoring the signal during transmission, which requires synchronization and/or means to monitor activities amongst all remote terminals and the central controller. In the CATV network, remote terminals have different distance from the central controller making synchronization difficult. It is also not feasible to detect collision, i.e., multiple remote terminals transmit at the same time, on the CATV network since the remote terminals are attached to different branches of the network. The poll and response method is often used to schedule the multiple access from plurality of remote terminals, but it has the disadvantage of inefficiency due to wasteful interaction with remote terminals that are not in need of servicing.

Description Of The Related Art

There are many proposals of means for dynamically adjusting the number of traffic-bearing channels according to varying traffic demands or the transmission quality in the radio telephony environment, e.g., U. S. Patent Nos. 5,134,709, 5,235,631 and 5,276,908. In addition U. S. Patent No. 4,868,811 discusses the protocol over the common signalling channel for allocation of traffic-bearing channels. U. S. Patent No. 4,870,408 proposes a process of re-assigning subscriber units to balance the traffic load over the available channels. U. S. Patent No. 5,010,329 discloses a method for dynamically grouping terminals in blocks for which the central unit performs

block polling on a common data channel. The present invention presents a method to dynamically allocate both signalling data and traffic-bearing channels and to dynamically assign remote terminals to these channels.

The polling scheme is commonly used to resolve contention in a multiple access system. U. S. Patent No. 4,385,314 proposes a system to sequentially poll all terminals. Due to the inherent inefficiency with sequential polling method, some proposals with the following variations for performance improvement have been presented. U. S. Patent No. 4,754,426 proposes a two-level polling scheme with distributed control. U. S. Patent No. 4,829,297 proposes use of a high priority group. U. S. Patent No. 4,868,816 proposes a binary polling scheme, similar to the polling scheme in the present invention, with terminal address in each poll. U. S. Patent No. 4,924,461 proposes a method to register other pending request on a second channel to interrupt sequential polling. U. S. Patent No. 4,942,572 proposes a dual rate polling method using pseudo random sequence at high rate to poll all terminals resulting possibly in contention with a small number of terminals, and following the high rate poll by specific poll at lower rate in case of collision. This invention differs from the prior art in that multiple access is controlled through overlapping polling sequence executing on multiple channels in a parallel fashion. Only when collision occurs, this method will enter a selective polling sequence for contention resolution. The added benefit of this method is efficiency and redundancy against anomalies such as interference and component failure.

Objects Of The Invention

To overcome the problems mentioned above, the objective of the present invention is to present

- A flexible and extensible method for signalling channel management;
- A flexible and extensible method for assigning remote terminals to the signalling channels;
- An efficient asynchronous signalling protocol.

In the present invention, a dynamic process is disclosed to adjust the number of signalling channels to meet the requirements of varying traffic demand and the system growth. This is important in carrying multi-media traffic with different requirements in both the traffic-bearing channel bandwidth and the time required to setup a traffic-bearing channel. This dynamic signalling channel allocation and terminal assignment method also aids in system redundancy for anomalies such as interference and component failure. Integrated with the channel allocation and terminal assignment process, the present invention also presents an efficient controlled multiple access method. The central controller initiates the general polling on each signalling data channel in parallel to solicit request from all terminals assigned to the signalling data channel. Only when collision is detected, the central controller starts to poll selectively for resolution.

Further objects and advantages of my invention will become apparent from considerations of the drawings and ensuing description thereof.

Brief Summary of the Invention

The multiple access communication system architecture depicted in Figure 1 comprises a plurality of remote terminals, a common shared transmission media, a central controller and interface to wide area networks. There are provided a number of communication channels (L) to the wide area networks, a number of communication channels (M) for supporting a plurality of remote terminals (N). The M number of channels to support

communication between the central controller and the remote terminals are separated into four categories as depicted in Figure 2, for carrying signalling data and user traffic in the forward and reverse directions, i.e., forward signalling data or FD channel, forward traffic bearer or FB channel, reverse signalling data or RD channel, and reverse traffic bearer or RB channel. All communication signals between the central controller and the remote terminals are multiplexed onto the shared transmission media.

The remote terminals are equipment supporting the users' communication need and are distributed throughout the network. For simplicity reason, the summing device for signals from remote terminals are shown as a single device in Figure 1. Each of the remote terminals has one RF data demodulator capable of receiving data on the assigned FD channel, one frequency agile receiver capable of tuning to the assigned FB channel, one RF data modulator capable of transmitting data on the assigned RD channel, and one frequency agile transmitter capable of tuning to the assigned RB channel. The central controller comprises a switch and control mechanism, and a pool of transmitters and receivers for the communication channels. The central controller provides concentration and control function to meet the communication demand of the remote terminals much the same way as a Private Automated Branch eXchange or PABX. The central controller also translates the signalling information according to the requirement of the network. There are two levels of concentrations provided with this system: contention in the shared transmission media via the signalling protocol, and through the switching matrix of the central controller.

The signalling channels are dynamically adjusted for efficiency and redundancy. This also adds to the extensibility of the system for the increasing traffic load and system growth. The downstream traffic on these

channels are scheduled by the central controller. Multiple access of the remote terminals for the upstream traffic are mitigated by separating remote terminals in groups via the channel allocation and the terminal assignment process. Prompted by the remote terminals at startup, or through the failure recovery procedure, or deemed necessary by the central controller, the channel allocation and terminal assignment process are initiated and controlled by the central controller. Through the registration process, the central controller assigns the remote terminal to a group supported by coupling of the specific forward and reverse signalling data channels. Afterwards, the communication between the central controller and the remote terminals follows a two-phase process. The controlled multiple access method is used, on each forward signalling data channel in parallel, for sporadic user data transfer or signalling purpose. The central controller either sends command to a specific remote terminal or solicits requests via a general poll from remote terminals assigned to the forward signalling data channel. The remote terminals respond to the controller's poll to request services. The selective polling process is used to identify the remote terminals involved in case of collision. The traffic bearer channel is used once the circuit is established via signalling protocol over the signalling data channels. The controlled multiple access scheme using overlapping polling method represents an efficient asynchronous signalling method and the decision process is designed to improve the effectiveness of the selective polling coverage during the contention resolution process.

Accordingly the achieved benefits of the present invention are:

- General communication channels management architecture;
- Flexible and extensible scheme for signalling channel management;

- Flexible and extensible scheme for assigning remote terminals to the signalling channels;
- Flexible and extensible scheme for supporting system growth and new services requirements;
- Improved system redundancy;
- Efficient asynchronous signalling protocol.

Brief Description Of The Drawings

Other objects, features and advantages of the invention will be apparent from the following Description of the Preferred Embodiment taken together with the accompanying drawings in which:

Figure 1 is a illustration of a multiple access communication system architecture with interconnections between the remote terminals, the central controller which comprises the switch and control module and a number of transmitters and receivers, and the wide-area network.

Figure 2 shows the channelization of the communication bandwidth of the shared transmission media between the central controller and the remote terminals for different functions.

Figure 3 depicts the possible mappings of forward and reverse signalling data channels.

Figure 4 depicts the logic flow diagram for polling and registration process at the central controller.

Figure 5 depicts the logic flow diagram for command process at the central controller.

Figure 6 is the logic flow diagram for registration, terminal reassignment, channel allocation, and terminal assignment process at the central controller.

Figure 7 depicts the logic flow diagram for registration process at the remote terminals.

Figure 8 depicts the logic flow diagram for signalling process at the remote terminals.

Figure 9 details the message format for the signalling protocol between the central controller and the remote terminals.

Figure 10 shows the ranges of remote terminals for selective polling during the contention resolution process.

Figure 11 is a message exchange diagram for signalling protocol between the central controller and the remote terminals illustrating a scenario of collision and its resolution.

Figure 12 is the decision graph for contention resolution process using polling ranges as defined in Figure 10 using the regular polling method.

Figure 13 contains signalling message exchange diagrams for comparison of two methods using the regular and the overlapping polling cycle.

Figure 14 is the decision graph for contention resolution process using polling ranges as defined in Figure 10 using the overlapping polling method.

Figure 15 is a message exchange diagram using the overlapping polling method for signalling protocol between the central controller and the remote terminals illustrating a scenario of collision and its resolution.

Figure 16 is the system block diagram of the central controller for supporting telephone services.

Figure 17 is the system block diagram of a remote terminal for supporting telephone services.

Description Of Preferred Embodiment

The multiple access communication system architecture as depicted in Figure 1 comprises a central controller **10**, a shared transmission media **12**, and a plurality of remote terminals **14** dispersed geographically throughout the network. A pool of communication channels **16** (*L*) are provided to the wide area networks **18**, a pool of communication channels **20** (*M*) for supporting a plurality of remote terminals **14** (*N*). The *M* number of channels to support communication between the central controller **10** and the remote terminals **14** are separated into four categories for carrying signalling data and user traffic in the forward and reverse directions, i.e., forward signalling data or FD channel **22**, forward traffic bearer or FB channel **24**, reverse signalling data or RD channel **26**, and reverse traffic bearer or RB channel **28**. All communication signals between the central controller **10** and the remote terminals **14** are multiplexed onto the shared transmission media **12**. All remote terminals **14** are equipment supporting the users' communication need and are distributed throughout the network. For simplicity reason, the summing device **30** for signals from remote terminals are shown as a single device in Figure 1. In a CATV network, this summing device **30** represents the splitters and taps connecting the branches that make up the network.

The central controller **10** comprises a switch and control mechanism **32**, and a pool of transmitters, called forward signalling data channel (FD) **22** and forward traffic bearer channel (FB) **24**, and a pool of receivers, called reverse signalling data channel (RD) **26** and reverse traffic bearer channel (RB) **28**. The central controller provides concentration and control function to meet the communication demand of the remote terminals much the same way as a Private Automated Branch eXchange or PABX. The central controller also translates the signalling information according to the requirement of the network. In addition to concentration provided through the switching matrix

of the central controller, contention in the shared transmission media via the signalling protocol provides another level of concentration with this system.

Each of the remote terminals has one radio frequency (RF) agile data demodulator capable of receiving on the assigned FD channel **34**, one RF agile receiver tuned to the assigned FB channel **36**, one RF agile data modulator capable of transmitting on the assigned RD channel **38**, and one RF agile transmitter tuned to the assigned RB channel **40**.

Although the present invention is useful for interworking with a variety of different wide area networks, the telephone network will be used hereinafter to illustrate the present invention.

As depicted in Figure 2, the bandwidth is channelized for carrying traffic in the forward and the reverse direction. Data channels are used for carrying signalling or data traffic while bearer channels are used for carrying user traffic similar to circuits in telephony. Therefore, there are altogether 4 types of channels as depicted in Figure 2. FD-x is the signalling data channel in the forward direction **44**, i.e., from the central controller to the remote terminals, numbered from 1 to *a*. FB-y is traffic bearer channel **46** in the forward direction numbered from 1 to *b*. RD-x' is signalling data channel **48** in the reverse direction, i.e., from the remote terminals to the central controller, numbered from 1 to *c*. RB-y' is traffic bearer channel **50** in the reverse direction numbered from 1 to *d*. A guard band **42** is also shown to separate the signals traveling in the forward and the reverse directions if they are to be put side-by-side. As explained later *a* and *c* should be greater than or equal to 2 for redundancy reason. Note that if the channels are of equal size, then $a+b$ and $c+d$ shall remain constant if all channels are available free of interference problem, i.e., there are a pool of channels from the central controller to the remote terminals, and a separate pool of channels from the

remote terminals to the central controller. These pools are set aside for a flexible allocation scheme to be described in detail later.

Although it is not necessary to have all channel to have equal bandwidth, the communication process can be managed more easily if the channels have simplified structure with equal bandwidth. In case of equal size of the FD and FB channels, the management scheme can relocate the FD to a channel that is better suited for data transmission while FB channel carrying normal voice communication can tolerate a considerable more noisy channel than FD channel is able to. Similarly, the management process can take advantage of the flexibility afforded by the equal size of the RD and RB channels. If the bandwidth of the communication channels to the wide area network is equivalent to the channels of the shared transmission media, the number L is less than or equal to the number M, which in turn is less than or equal to the number N. In case of channels with different sizes the central controller needs to have the additional intelligence for managing these channels efficiently, and to perform segmentation and reassembly. Note that communication with asymmetric bandwidth requirement such as multi-cast can be efficiently supported in this system.

The FB-y and RB-y' channels are allocated according to the signalling protocol communicated over the FD-x and RD-x' channels. There is no contention in the forward direction, i.e., the traffic on each FD-x channel is scheduled independently. The number of signalling data channels are used to improve the efficiency servicing groups of remote terminals and the system redundancy. In case of transmission failure (detected through a number of retries without receiving acknowledgment), the central controller reverts back to FD-1 and then FD-2 for transmission to the specific remote terminal. while the remote terminals reverts back to RD-1 and then RD-2 for transmission and to FD-1 and FD-2 for reception. The FD-1 and FD-2 channels

are called primary forward signalling data channel and backup forward signalling data channel respectively. These RD-1 and RD-2 channels are called primary reverse signalling data channel and backup reverse signalling data channel respectively.

With this general channelization architecture, a flexible management scheme is possible for channel arrangement and remote terminals grouping. For example, channel arrangement can be adjusted according to traffic pattern mix and/or more intelligent management scheme can be implemented with various priority lists. The channelization is shown to follow a FDMA scheme for ease of understanding, but this can also be easily adopted for TDMA or CDMA schemes.

Multiple access of the remote terminals for the upstream traffic are mitigated by separating remote terminals in groups via the channel allocation and the terminal assignment process to be described later. The contention among remote terminals in each group is resolved through a controlled multiple access followed by selective polling in case of collision on each of the signalling data channel. The number of remote terminals assigned to each of the RD channel is to be evenly distributed according to the traffic demand. In the case of identical traffic requirements from all users, the number of remote terminals assigned to each of the RD channel will be equal.

The mapping of forward and reverse signalling data channels is under the control of the central controller dynamically. The mapping of part (a) of Figure 3 depicts the simplest arrangement with each pair of forward and reverse signalling data channels forming a terminal group. For example, the terminal group receiving on FD-*h* channel will transmit on RD-*k*. The part (b) depicts the one-to-many mapping where the central controller transmits on one FD-*n* channel while the remote terminals belonging to the same group respond in their assigned RD-*o*, RD-*p*, and RD-*q* channel respectively. In part

(c) with the many-to-one mapping shows that the central controller transmits on several FD (r, s and t) channels each reaching a subset of the group of the remote terminals, which respond in the same RD-u channel. Depending on the traffic pattern, some mapping will be more efficient in utilizing the bandwidth, e.g., the many-to-one mapping as depicted in part (b) of Figure 3 is suitable for case where the traffic coming from the remote terminals far exceeds the traffic in the forward direction. Note that the mapping of part (c) can cause collision from remote terminals in different sub-sets of the same terminal group. This is the only mapping that will require the contention resolution process, described later, to be coordinated between multiple signalling data channels. Different types of mapping can be used at the same time (but not combined) for different segments of remote terminals when deemed appropriate by the central controller.

Prompted by the remote terminals at startup, or through the failure recovery procedure, or deemed necessary by the central controller, the channel allocation and terminal assignment process is initiated and controlled by the central controller. Through the registration process, the central controller assigns the remote terminal to a group corresponding to a specific set of signalling data channels. Afterwards, the communication between the central controller and the remote terminals follows a two-phase process. The controlled multiple access procedure is used on each of the signalling data channels in parallel, for sporadic user data transfer and for signalling purposes. The controller sends command to the remote terminal in case of request from the network while the remote terminals respond to the controller's poll to request services. If dedicated channel is required to meet the user's need, the traffic bearer channel is established via signalling protocol over the signalling data channels.

In Figure 4, the logic flow is shown for the central controller's initialization process and polling cycle. The polling process is executed in parallel for each of the FD-x in an independent fashion. After the system initialization, the central controller clears the channel allocation and terminal assignment lists and starts the polling cycle on FD-1 and FD-2. If there is required transmission to the remote terminal, such as a incoming call, the central controller enters the command mode. Otherwise the central controller solicits for request from remote terminals assigned to the FD channel via a general poll. If there is no response from any of the remote terminal, the polling cycle repeats after a time-out period expires. If there is response from remote terminals without collision or transmission error, the central controller processes the request accordingly. In case of collision or transmission error, the central controller enters a selective polling cycle to identify the remote terminal(s) involved in the collision or caused the transmission error.

As depicted in Figure 5, the central controller in the command mode sends the message destined for a specific remote terminal. Normally only the addressed remote terminal will respond to the command, therefore, there is normally no need for collision processing except for transmission error. If the expected response is not received at the central controller from the addressed terminal after the time-out period expires, the central controller assumes that either FD-x or RD-x' channel is not usable by the addressed remote terminal. In this case, the central controller retries for a number of times, then proceeds with the terminal failure processing if there is still no response from the specific remote terminal. The terminal failure processing removes the failed remote terminal from the group and signals to the wide area network that connection is not possible.

In Figure 6, the logic flow diagram for the registration, channel allocation, terminal assignment and reassignment process is depicted. Upon receiving a registration message on RD-1 or RD-2, the central controller checks if the remote terminal is a newly registering terminal. If the remote terminal is a newly registering terminal and is authorized, the central controller proceeds to check for available signalling data channels for the remote terminal. If the new remote terminal has not been authorized, the central controller will deny the remote terminal from entering the network by issuing a terminal disable command. If the remote terminal has been registered previously, the registration process is caused by channel failure recovery procedure sensed at the remote terminal, and the central controller will register the channel status and proceed to check for available signalling data channels for the remote terminal. At any time, the central controller can initiate the terminal re-assignment process if deemed appropriate for the varying traffic demand or other system dynamics.

The determining factors of signalling data channels availability include the number of remote terminals using the signalling data channel, the traffic requirements, past collision count, channel error status, and bandwidth of the signalling data channel. These factors will be calculated for each of the existing signalling data channels in consideration of the specific group mapping as depicted in Figure 3. If there are signalling data channels in the forward and the reverse direction, the registering remote terminal will be assigned to the group. If there is no available signalling data channel already in use, the central controller will check for available channel from the pool of transmitters and/or the poll of receivers, and proceeds with allocation if there is available channel from the pool (or a pair in case that neither the forward nor the reverse signalling data channels are available). If the signalling data channel is available, the central controller will complete the registration

process by commanding the remote terminal to tune to the assigned channels. Otherwise, the central controller will deny the remote terminal from entering the network by issuing a terminal disable command.

In Figure 7, the logic flow of the remote terminals is shown for the channel registration process at startup or through failure recovery procedure. All of the remote terminals assigned to the same forward signalling data channel will receive the command or poll, but only the addressed remote terminals should respond. Initially the remote terminals will listen to a general poll on FD-1 for registration. If the poll from the central controller is not receiving for an extended period of time, the remote terminal will try FD-2 channel (toggling between FD-1 and FD-2). Once a general poll is sensed on the forward signalling data channel, the remote terminal responds first on RD-1 and then RD-2 if there has not been an acknowledgment from the central controller when the time-out period expires and retry count exceeded. Based on the central controller's command in response to the remoter terminal's registration message, the remote terminal either tunes to the assigned FD and RD channels or disables itself if not authorized.

Depicted in Figure 8 is the signalling process at the remote terminals. Once the registration process is completed, the remote terminal will monitor the poll or command from the central controller on the assigned FD-x channel, and respond on the assigned RD-x' channel if needed. In case of failure, i.e., not receiving polls from the central controller for extended period of time, or no acknowledgment for the previous request, the remote terminal reverts back to FD-1 and RD-1 via the registration process. In case of collision with other remote terminals, the remote terminal follows the instruction from the central controller through selective polling process to resolve the contention.

The message format of the signalling protocol between the central controller and the remote terminals is depicted in Figure 9. The message

frame starts with a one (1) byte preamble to indicate the start of message and to help detect collision. The Terminal Identifier (TID) field is one (1) byte long offering 256 possibility with the number 255 and 0 (hexadecimal FF and 00) set aside for registration purpose, i.e., maximum of 256 - 2 = 254 stations can be supported for each terminal group in this system.

The following field SAT or Signalling Action Type is three (3) bytes in length containing one of the listed commands. The SRT or Signalling Request Type field is also three (3) bytes in length containing one of the listed requests. Some of the commands and requests are included to illustrate possible features that can be supported in the system. For registration process, SAT and SRT fields contain the serial number of the remoter terminal, i.e., there are up to 2^{24} = 16 million possible numbers. Note that there are two different types of polling message. The selective polling with collision alert is used to alert other remote terminals to avoid using the channel where collision occurred until the resolution is completed. The lower TID of the range in the TID field and the higher TID of the range as part of the SAT field determine the type of the poll: specific, selective, or general. The FCS or Frame Check Sequence field is one (1) byte long for protection against transmission error in the TID and SAT/SRT fields.

Collision and transmission error are detected by the following mechanisms:

- invalid TID,
- FCS error,
- invalid frame length,
- invalid frame format,
- invalid SAT/SRT value.

In Figure 10, the remote terminals assigned to the same group are further separated in ranges during the selective polling process for resolving

contention. This logic for resolving contention is contained in the central controller while the remote terminals follows the central controller's instructions. The naming of these ranges is as follows: the first digit of the subscript stands for the level, and the following number is used to sequentially designate from lower to higher TID (there are 2^n divisions at the n-th level). For example, at the 2nd level there are $2^2 = 4$ ranges named r_{21}, r_{22}, r_{23}, and r_{24}. Note that a selective poll with range r_{01} is equivalent to a general poll.

In Figure 11, a scenario of message collision and the resolution process is illustrated. The collision is resolved using the selective polling approach which is similar in spirit to the binary search algorithm. Suppose there are N number of remote terminals in total, and two remote terminals, one numbered between 1 and N/4 and the other numbered between N/4 and N/2, go off-hook during the same polling cycle. These two remote terminals will respond to the general poll from the central controller **110** resulting in a collision **111**. Once the collision from two remote terminals is detected at the central controller, the next poll with collision alert covers the range r_{11} between 1 and N/2 **112**, which results in another collision **113**. After halving the range to r_{21} between 1 and N/4 **114**, the remote terminal numbered between 1 and N/4 responds without interference **115**. As soon as the first remote terminal involved in the collision is identified, the resolution process is deemed completed by the central controller. The central controller follows with a general poll without alert **116** that indicates the end of the contention resolution process and results in a response from the remote terminal in the range r_{22} between N/4 and N/2 **117**. The next general poll **118** from the central controller resumes normal operation. The dial tone is generated at the remote terminal when connection to the network is established. The central controller sends commands **119** **121** to these two

remote terminals respectively, and the remote terminals respond to the commands from the central controller with confirmations 120 **122**.

The decision tree is depicted in Figure 12a and Figure 12b for the selective polling process to determine the remote terminal(s) involved in the collision or caused the transmission error. This diagram is to illustrate the process involved using the regular polling method with which the polling cycle repeats only after the response to the previous poll is received or time-out occurs. The idea is to systematically narrowing the scope based on the information available. This systematic approach follows the level as defined in Figure 10, i.e., orderly halving similar in spirit to the binary search algorithm.

Note that the contention process is deemed completed as soon as the first remote terminal involved in the collision is identified. Depending on the probability of the number of remote terminals involved in a collision and the error rate for the shared transmission media, i.e., if the transmission media has a high error rate and low collision probability, it is more beneficial to resume polling all remote terminals since the resolution process also accounts for the problem caused by transmission error. On the other hand if the collision probability is high and the transmission media is reliable, it is more efficient to continue the selective polling process until all remote terminals involved in the collision are identified.

Assume using the modest means of data transmission at rate of 9600 bits per second, to transmit 48 bits message the transmission delay T is approximately 48/9600 = 5 milli-seconds. In the following discussion, assume 2.5T is used for the time-out period for each polling cycle. The remote terminals shall start transmitting response message within the window of 0.5 T upon receiving the poll or the command from the central controller. One of the major benefit of fixed length messages is that it helps

putting the time roughly into slots for efficiency improvement as explained in detail later.

To support 250 remote terminals in the system, the sequential polling scheme will incur the nominal delay of $250 \times 2.5T \div 2 = 1.5625$ seconds, which is too long to be acceptable for most services. With the controlled multiple access method, the remote terminal will gain access at the earliest poll with T/2 delay on average, and in case of collision the number of selective polling cycles required to identify the first remote terminal involved in the collision is $\log_2 250 + 1 < 9$, therefore, the maximum delay for the first terminal involved in a collision is $9 \times 2.5T = 22.5T = 112.5$ ms. If the decision tree in Figure 12 is adhered to, i.e., the central controller declares the contention resolution is completed as soon as the first remote terminal is identified, the second terminal involved in the collision will take twice the amount of time and the third one takes three times the amount of time and so on, until the last one which takes one poll only . More importantly this method guarantees a deterministic approach if the grouping of remote terminals are properly selected to reduce the probability of collision. If the grouping is not done properly, the effect of increasing number of multiple collisions will put the system in constant mode of contention resolution.

With transmitting and receiving in two separate paths, it is possible to initiate a separate poll or command instead of waiting for the response from the remote terminals to the outstanding poll. This overlapping polling method deviates from the regular polling method by interleaving poll with response to the previous poll thereby taking full advantage of the bandwidth available. Similar to the spirit of instruction pipe-lining in the computer processor architecture, some of the polls may not be productive in the case of collision as evident by the example in Figure 15 later, however, these polls do not cause any adverse effect. The central controller needs to make

correlation between the poll and the response, and tries to optimize the time in resolution by anticipating the most profitable steps to take next.

In Figure 13, the message exchange diagrams of signalling protocols employing the regular polling cycle in Figure 13a and the overlapping polling cycle in Figure 13b are shown for comparison. In the ideal case with no collision, the controlled multiple access scheme using overlapping polling cycle represents an efficient asynchronous signalling method. In part (a) there are 3 polling cycles (response from remote terminal **130** to poll from the central controller **132**) within the time frame using the regular polling method versus 6 polling cycles using the overlapping polling method as shown in part (b). This example shows the maximum efficiency improvement that can be derived from the overlapping polling method over the regular polling method, i.e., in the order of 2.

The decision tree is depicted in Figure 14a and Figure 14b for the selective polling process using the overlapping polling method to identify the remote terminal involved in the collision or caused the transmission error. The idea is to systematically narrowing the scope based on the information available and guided by the ranges of remote terminals at each advancing level as defined in Figure 10. Taking the advantage of the overlapping polling cycle, the polls is designed to anticipate the most probable range for maximum effect. The repeated collision in response to the overlapped general poll is used to determine whether the corrupted message is caused by the transmission error or collision. Similar to the decision tree in Figure 12, the resolution process is deemed complete as soon as the first remote terminal involved in the collision is identified.

In Figure 15, the message exchange diagram of the signalling protocol employing overlapping polling method dealing with the same scenario of collision as shown in Figure 11 where the regular polling method is employed

instead. Both remote terminals respond to the general poll from the central controller **159** resulting in a collision **158**. Since the central controller sends another general poll without waiting for response from the remote terminals **157**, both remote terminals respond again resulting in repeated collision **156**. The central controller next probe the remote terminals in the range r_{11} **155** resulting in second collision **154**. The central controller also sends out another probe with a selective poll for remote terminals in the range r_{12} **153** resulting in no response from these remote terminals **152**. When the central controller polls the remote terminals in the range r_{21} **151**, one of the terminals involved in the collision succeeds in responding to the poll without collision **150**. When the central controller polls the remote terminals in the range r_{22} **149**, the other terminal involved in the collision succeeds in responding to the poll without collision **148**. At this point, the central controller sends out general poll without alert **147** to end the collision processing. The next general poll without alert **146** from the central controller resumes the normal operation.

It takes the same amount of time (2 polling cycles in real time) to identify the first remote terminal involved in the collision for both methods. A number of reasons contribute to this situation. There are a few wasted effort as shown in the diagram, such as the repeated collision **156**, poll of remote terminals in the range r_{12} **153**, and poll of remote terminals in the range r_{11} **155**. Similar to the pipe-lining instruction architecture, this method is most productive when there is no "jump" in the line of instructions, i.e., no collision among the remote terminals. There are certainly instances where this method will produce more benefit than what is shown in Figure 15. For example, the overlapping polling method will be able to identify the transmission error in 1.5 polling cycle versus 3 in the worst case for the regular polling method. The decision tree in Figure 14 can also be modified to

take advantage of the available information that there might be more than 2 remote terminals involved in a collision at various points, e.g., the thickened circle to resume the polling cycle on the right side of Figure 14 can be extended to improve the efficiency in case of three remote terminals in ranges r_{12}, r_{21} and r_{22} involved in a collision.

The block diagram of the apparatus to implement this signalling method for the telephone service is depicted in Figure 16 for the central controller. There are a plurality of transmitters **160** and a plurality of receivers **161** for communication on the shared transmission media **12**. The duplexer **162** combines the transmitters' communication signals to be transmitted on the shared transmission media and duplicates the communication signals from the shared transmission media to each of these receivers. A number of voice frequency (VF) data modulators **163** and demodulators **164** similar to the conventional modem are provided for transmitting and receiving the signalling data. Each of the transmitters **160** and the receivers **161** has a oscillator **165** for tuning to the corresponding channels. The VF signal coming to the transmitter module **160** is first modulated, buffered, amplified and mixed with the oscillator's frequency to the RF channel. The RF signal coming to the receiver module **161** is translated to the intermediate frequency through the mixer **166**, then filtered, amplified, and finally demodulated back to the VF signal. The switching matrix under the control of the micro-processor, is used to connect VF signals between transmitters, receivers, interface to the telephone networks, VF data modulator and demodulator. The telephone interface module **167** under the control of the micro-processor performs the hybrid function to separate the signals in the transmit and receive direction (2-wire to 4-wire conversion), and the signalling function to/from the telephone network **168**. The Random Access Memory or RAM is used to store the dynamic information such as remote terminal and channel

status. The Erasable Programmable Read Only Memory or EPROM is used to store the invariant information such as instructions to the micro-processor at startup. The micro-processor communicates with EPROM, RAM, and the data modulators and demodulators via the system bus.

To allocate a forward signalling data channel, the central controller **10** determines an available VF data modulator **163**, a transmitter module **160**, and then commands the switching matrix to make the connection between the VF data modulator **163** and the RF transmitter **160**. The signalling information or sporadic user data will come from the micro-processor to the VF modulator **163** via the system bus, and then the modulated VF signal is fed to the input of the transmitter module **160** via the connection through the switching matrix before it is modulated to the RF channel. To allocate a reverse signalling data channel, the central controller determines an available VF data demodulator **164**, a receiver module **161**, and commands the switching matrix to make the connection between the VF data demodulator **164** and the RF receiver **161**. The signalling information or the sporadic user data follows the reverse direction as the forward direction. To establish a telephone connection, the central controller determines an available telephone interface module **167**, a transmitter module **160**, a receiver module **161**, and commands the switching matrix to make the connection between the telephone interface module **167** and the transmitter **160** and receiver modules **161**. The voice traffic is separated into the transmit and receive direction and connected through the switching matrix to the transmitter and receiver modules for modulating to and demodulating from the RF channels. Although the micro-processor needs to be involved in the path of data transfer, it is possible to establish a modem pool by setting aside a number of the VF data modulators and demodulators, and connecting them to the telephone interface module **167**. The data signal from the remote

terminals are decoded by the VF data demodulator **164**, routed by the micro-processor, and then fed to the VF data modulator **163**. Through the connection between the VF data modulator **163** and telephone interface module **167**, the modulated data signal is transmitted to the telephone network. The data signal from the telephone network traverses in the reverse direction.

The apparatus to implement this signalling method for the telephone service is depicted in Figure 17 for the remote terminals, which comprises a transmitter **40** and a receiver **36** for communication on the shared transmission media **12**, a RF data modulator **38** and a RF data demodulator **34** for signalling data channels. The transmitter **40**, the receiver **36**, the data modulator **38** and the data demodulator **34** are all capable of tuning to the assigned RF frequency. The duplexer **170** combines the transmitters' communication signals to be transmitted on the shared transmission media **12** and duplicates the communication signals from the shared transmission media to each of these receivers. The micro-processor communicates with EPROM, the RAM, and the data modulator and demodulator via the system bus. The keypad, the speaker, and the microphone make up the conventional telephone set **172**. The audio signal from the microphone feeds to the modulator to be transmitted on the assigned channel over the shared transmission media. Similarly the speaker gets the demodulated signal from the receiver tuned to the assigned channel. In this block diagram, sporadic user data shares the RF data modulator and demodulator with signalling information, while the telephone section provides voice traffic through the RF transmitter and receiver. If the data communication is to be supported using a dedicated circuit, the audio interface of a conventional modem can be connected to the input of the modulator of the transmitter and to the output of the demodulator of the receiver.

At startup, the modulator and the demodulator are tuned to the primary forward and reverse signalling data channels respectively. The micro-processor interprets the signalling command and instruct the Phased Lock Loop or PLL according to the command from the central controller. The transmitter and the receiver modules are enabled and tuned to the assigned channels when the connection is established. The micro-processor also controls the functioning of the micro-phone, the keypad and the speaker.

From the foregoing, it will be observed that numerous variations and modifications may be effected without departing from the true spirit and scope of the novel concept of the invention. It should be understood that no limitation with respect to the specific structure and circuit arrangements illustrated is intended or should be inferred. It is, of course, intended to cover by the appended claims all such modifications as fall within the scope of the claims.

Thus, in accordance with the invention, a Dynamic Channel Management And Signalling Method And Apparatus has been provided accomplishing all of the objects, and having the features and advantages specified at the beginning of this specification.

It is to be understood that the disclosed construction of the invention may be embodied in other forms within the scope of the claims.

What is claimed is:

1. In a multiple access communication system comprising a central controller, a shared transmission means for signalling data and user information, and a plurality of remote terminals, a method of allocating signalling data channels between said central controller and said plurality of remote terminals from a plurality of communication channels and of assigning remote terminals comprising the steps of:

(a) establishing communications between said central controller and said plurality of remote terminals via a plurality of signalling data channels;

(b) monitoring the status of a plurality of the signalling data channels between said central controller and said plurality of remote terminals;

(c) determining whether one of said plurality of remote terminals needs to be assigned to a different signalling data channel;

(d) determining whether another and suitable signalling data channel is available; and

(e) assigning said remote terminal to said another and suitable signalling data channel for communication henceforward.

2. In a multiple access communication system according to claim 1, said step of establishing communications comprising the steps of:

(a) polling said plurality of remote terminals on a predetermined primary forward and backup forward signalling data channels for an activated remote terminal;

(b) sensing for a polling message from said central controller on a predetermined backup forward signalling data channel if said predetermined primary forward signalling data channel is unavailable;

(c) transmitting a registration message from said activated remote terminal to said central controller on a predetermined primary reverse signalling data channel; and

(d) providing a predetermined backup reverse signalling data channel if said primary reverse signalling data channel is unavailable.

3. In a multiple access communication system according to claim 1, said step of monitoring the status comprising the steps of:

(a) calculating the aggregate traffic load requirements of said signalling data channel;

(b) monitoring the past collision count of said signalling data channel;

(c) monitoring the transmission error count of said signalling data channel; and

(d) sensing the status of said signalling data channel assigned to one of said plurality of terminals for failure.

4. In a multiple access communication system according to claim 1, said step of determining whether one of said plurality of remote terminals needs to be assigned comprising the steps of:

(a) sensing for an activated remote terminal on predetermined primary reverse and backup reverse signalling data channels;

(b) sensing the status of said signalling data channel assigned to one of said plurality of terminals for overloading; and

(c) sensing the status of said signalling data channel assigned to one of said plurality of terminals for failure.

5. In a multiple access communication system according to claim 1, said step of determining whether another and suitable signalling data channel is available comprising the steps of:

(a) sensing the status of other signalling data channels for spare capacity;

(b) allocating a new signalling data channel if no signalling data channel has spare capacity and a new signalling data channel is available.

6. In a multiple access communication system comprising a central controller, a shared transmission means and a plurality of remote terminals, a method of controlled multiple access between said central controller and said plurality of remote terminals comprising the steps of:

(a) establishing communications between said central controller and said plurality of remote terminals via a plurality of signalling data channels;

(b) determining whether there is a command from said central controller to the said plurality of remote terminals;

(c) determining whether there is any pending request from said plurality of remote terminals; and

(d) resolving contention among said plurality of remote terminals or data transmission errors.

7. In a multiple access communication system according to claim 6, said step of determining whether there is any pending request from remote terminals comprising the steps of:

(a) polling in parallel on each of the said plurality of forward signalling data channels said plurality of remote terminals;

(b) responding from said plurality of remote terminals with any pending request; and

(c) interleaving polling messages with any responses from said plurality of remote terminals.

8. In a multiple access communication system according to claim 6, said step of resolving contention comprising the steps of:

(a) detecting corrupted messages due to collision or data transmission error from said plurality of remote terminals;

(b) alerting a plurality of remote terminals assigned to a signalling data channel to avoid using said signalling data channel where collision occurred;

(c) narrowing systematically the scope of said plurality of remote terminals via selective polling;

(d) interleaving the selective polling of probable range of said plurality of remote terminals with responses from said plurality of remote terminals;

(e) identifying a remote terminal involved in the collision;

(f) servicing said remote terminal involved in the collision; and

(g) resuming said controlled multiple access.

9. In a multiple access communication system having a plurality of communication channels, a central controller comprising:

(a) controlling means for controlling the communication system comprising a micro-process and associated EPROM and RAM;

(b) transmitting means for transmitting user traffic or signalling data on said communication channels;

(c) receiving means for receiving user traffic or signalling data on said communication channels;

(d) modulating means for modulating signalling data;

(e) demodulating means for demodulating signalling data;

(f) interfacing means for interfacing to a wide area network; and

(g) switching means for making dynamic connections between said transmitting means, said receiving means, said modulating means, said demodulating means, and said interfacing means;

(h) controlling means for selecting a forward signalling data channel via a dynamic connection between said transmitting means and said modulating means;

(i) controlling means for selecting a reverse signalling data channel via a dynamic connection between said receiving means and said demodulating means;

(j) controlling means for connecting a plurality of remote terminals via dynamic connections between said transmitting means and said receiving means; and

(k) controlling means for connecting a plurality of remote terminals to a plurality of wide area networks via dynamic connections between said transmitting means, said receiving means and said interfacing means; and

(l) controlling means for establishing a plurality of data modem connections to a wide area network via dynamic connections between said transmitting means, said receiving means, said modulating means, said demodulating means, and said interfacing means.

10. In a multiple access communication system having a plurality of communication channels, a remote terminal comprising:

(a) transmitting means for transmitting user traffic on an assigned communication channel;

(b) receiving means for receiving user traffic on an assigned communication channel;

~~(e) transmitting means for transmitting signalling data on an assigned~~ communication channel;

(d) receiving means for receiving signalling data on an assigned communication channel;

(e) interfacing means for interfacing to the user; and

(f) controlling means for interfacing to said assigned communication ~~channels via the micro-process and associated EPROM and RAM.~~

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor Alexander L. Cheng

For DYNAMIC CHANNEL MANAGEMENT AND SIGNALLING METHOD AND APPARATUS

Docket Cheng-101

1-00C

DECLARATION

I, ALEXANDER L. CHENG, hereby declare that I am a citizen of the Republic of China (Taiwan), residing at 11 Springdale Avenue, White Plains, New York 10604. NY

(1)

I believe that I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled

DYNAMIC CHANNEL MANAGEMENT AND SIGNALLING METHOD AND APPARATUS

described and claimed in the accompanying application.

I hereby state that I have reviewed and understand the contents of the specification.

I acknowledge the duty to disclose information which is material to the examination of the application in accordance with Title 37, Code of Federal Regulations, Section 1.56(a).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Dated: July 18, 1994

Alexander L. Cheng

08/276534

Attorney's Docket No. CHENG-101

Applicant ~~or Patentee:~~ Alexander L. Cheng

Serial or Patent No.: _____

Filed or Issued: _____

For: Dynamic Channel Management And Signalling Method And Apparatus

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) and 1.27(b))—INDEPENDENT INVENTOR

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled Dynamic Channel Management And Signalling Method And Apparatus described in

- ☑ the specification filed herewith.
- ☐ application serial no. _____, filed _____.
- ☐ patent no. _____, issued _____.

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- ☑ no such person, concern, or organization
- ☐ persons, concerns or organizations listed below*

*NOTE: *Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27).*

FULL NAME _____

ADDRESS _____

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

FULL NAME _____

ADDRESS _____

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

FULL NAME _____

ADDRESS _____

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b)).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Alexander L. Cheng
Name of Inventor

Signature of Inventor

July 18, 1994
Date

Name of Inventor

Signature of Inventor

Date

Name of Inventor

Signature of Inventor

Date

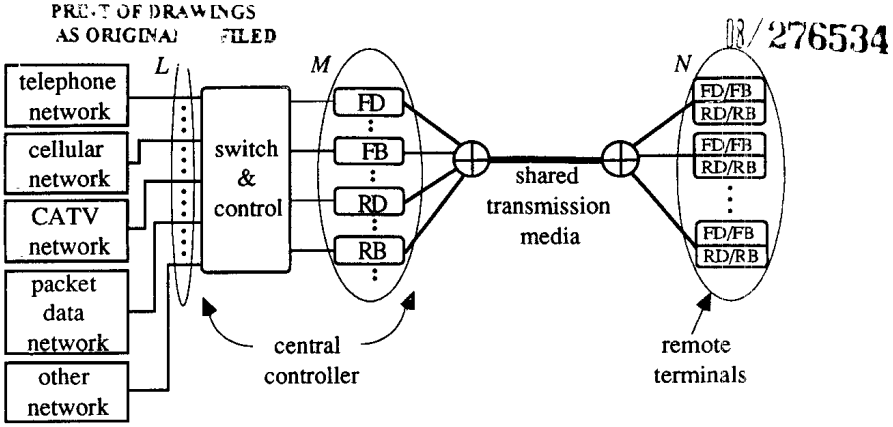
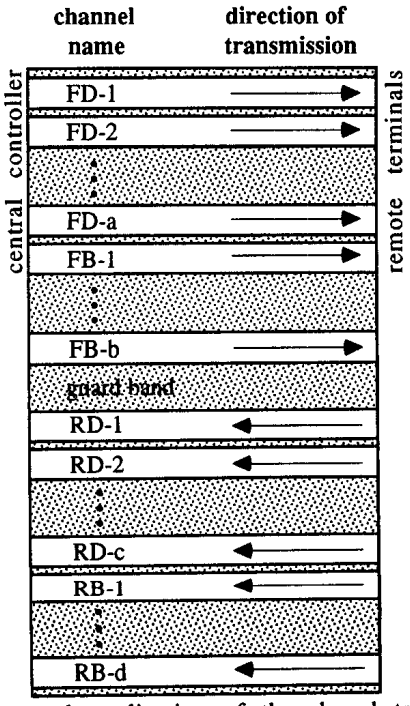


Figure 1: Multiple access communication system architecture



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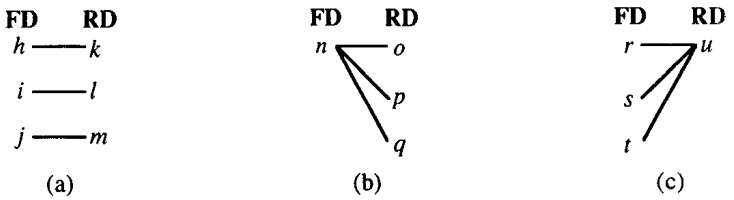

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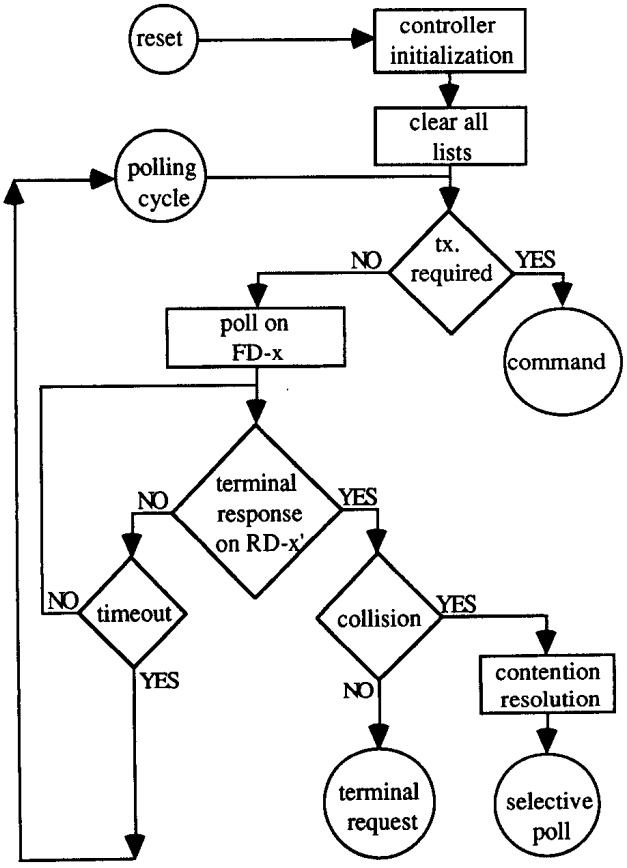

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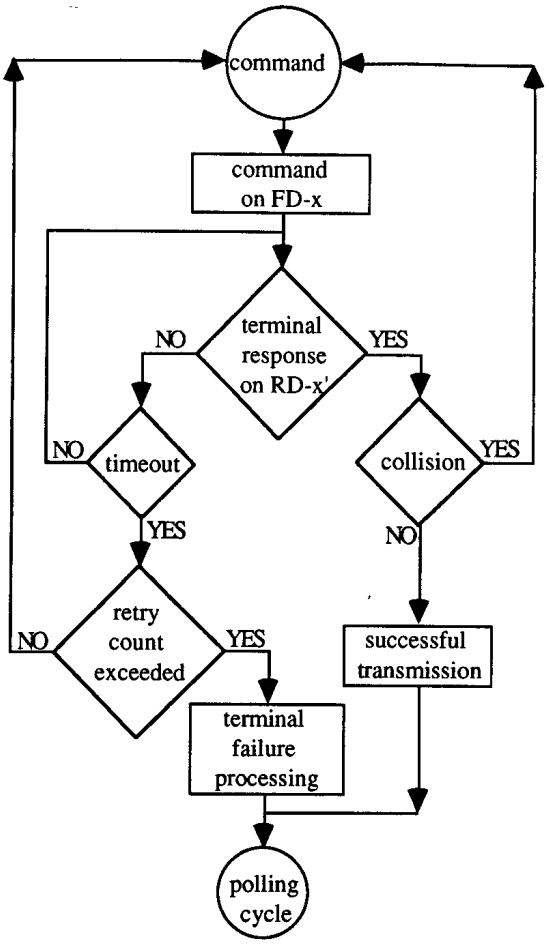

Figure 5: Flow diagram for command process at the central controller

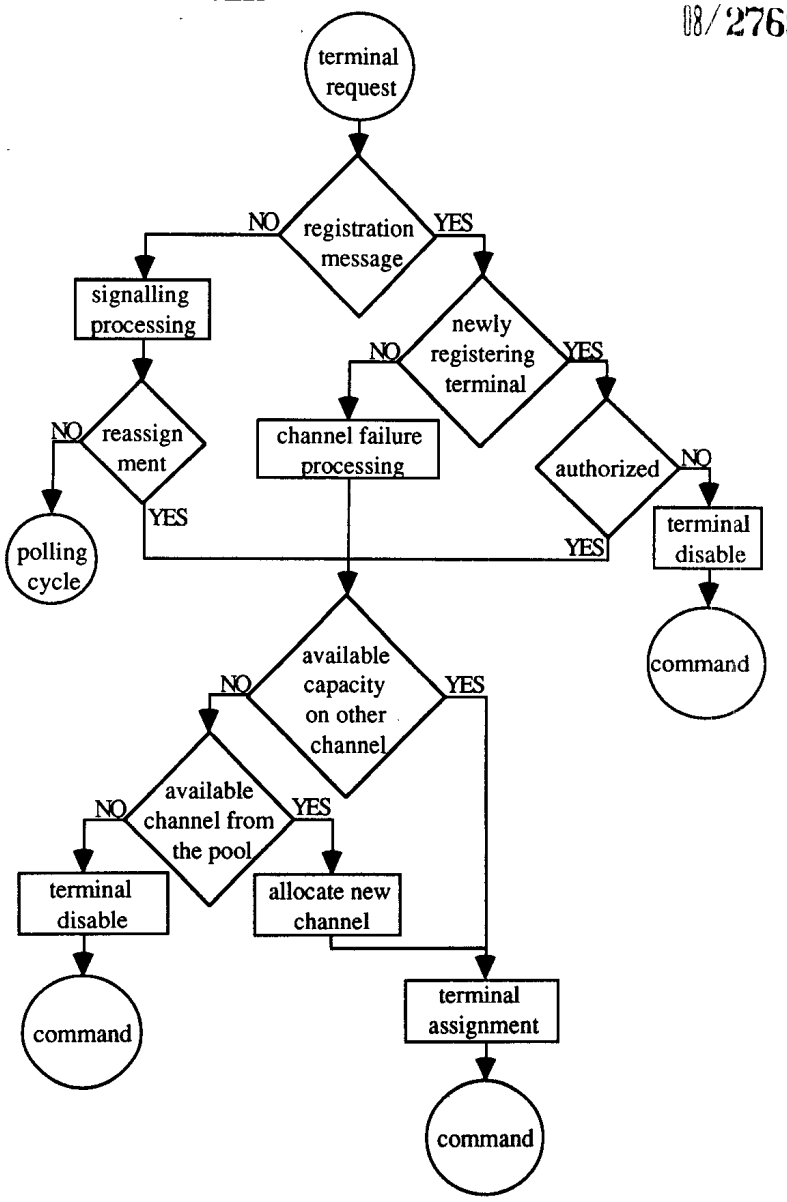

Figure 6: Flow diagram for registration, channel allocation and reassignment process at the central controller

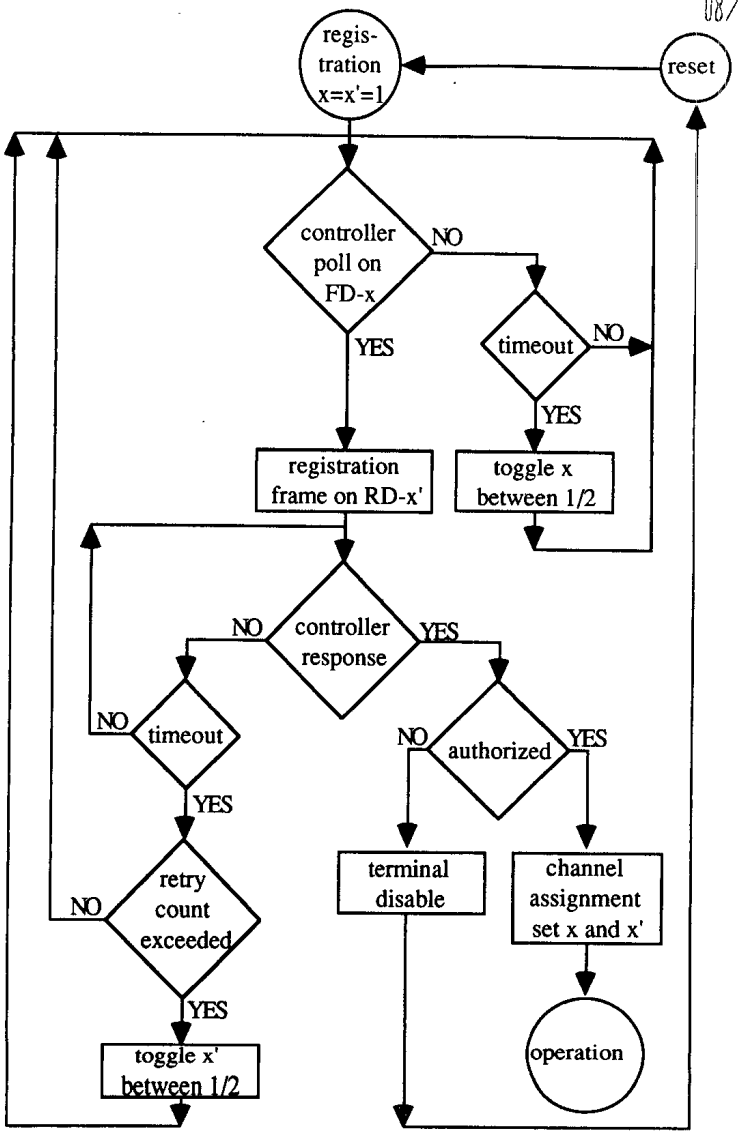

Figure 7: Flow diagram for registration process at the remote terminals

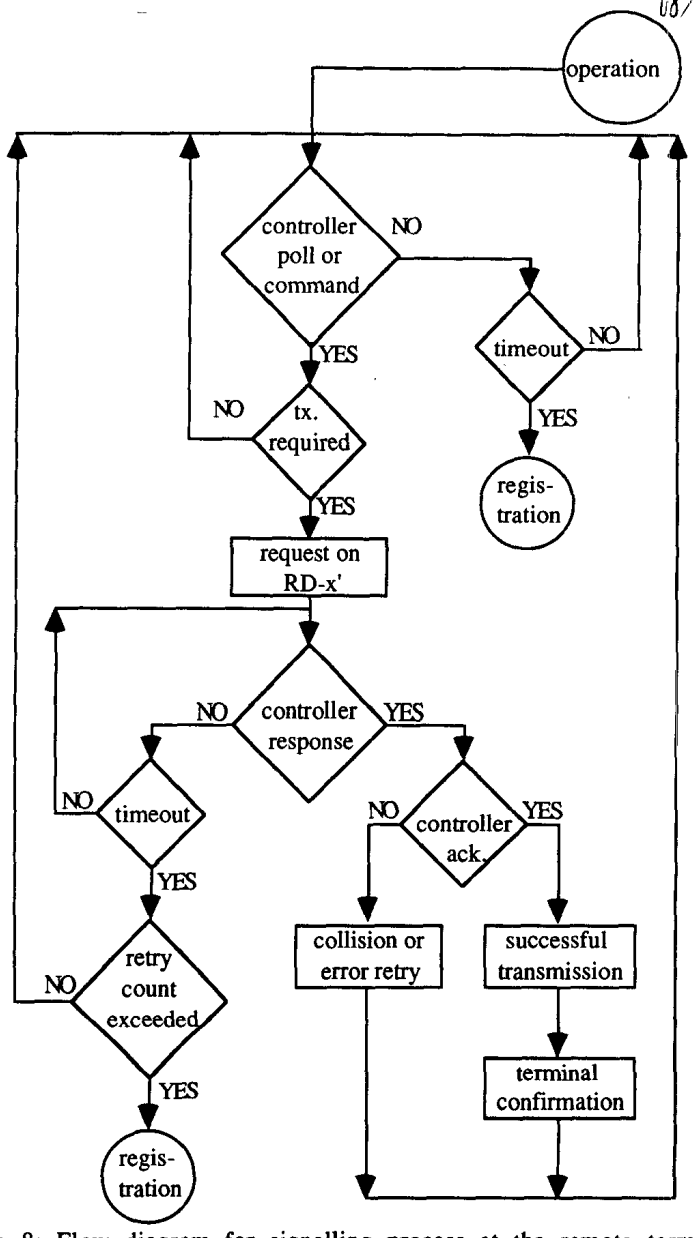

Figure 8: Flow diagram for signalling process at the remote terminals

Signalling data frame in the forward direction sent by central controller:

1	*1*	*3*	*1*	*bytes*
PMB	TID	SAT	FCS	

Signalling data frame in the reverse direction sent by remote terminals:

1	*1*	*3*	*1*	*bytes*
PMB	TID	SRT	FCS	

preamble (PMB)
- sequence to indicate the start of message frame transmission and aid detection of collision

Terminal IDentifier (TID)
- terminal identifier for command
- lower TID of the range for the selective poll
- 255 (hexadecimal FF) for registration process (SAT/SRT contains the serial number)
- 0 (hexadecimal 00) is an invalid TID used for disabling terminal during the registration process (SAT/SRT contains the serial number)

Signaling Action Type (SAT)
- serial number of the remote terminal for channel assignment during registration process
- selective poll including higher TID of the range (used also for general/specific poll)
- selective poll with collision alert including higher range (used also for specific poll)
- in-coming call command on the indicated channel number
- release command
- disable command
- test command
- channel re-assignment command

Signaling Request Type (SRT)
- serial number of the remote terminal for terminal registration process
- on-hook
- off-hook
- switch-hook
- ringing
- release
- dial-digits
- incoming call blocking
- incoming call unblocking
- feature code (e.g., conference)
- test report
- alarm message (fault and fraud)
- multiple channel request (bandwidth-on-demand)
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- protection, which covers TID and SAT/SRT fields, against transmission error or collision

Figure 9: Signalling protocol message format

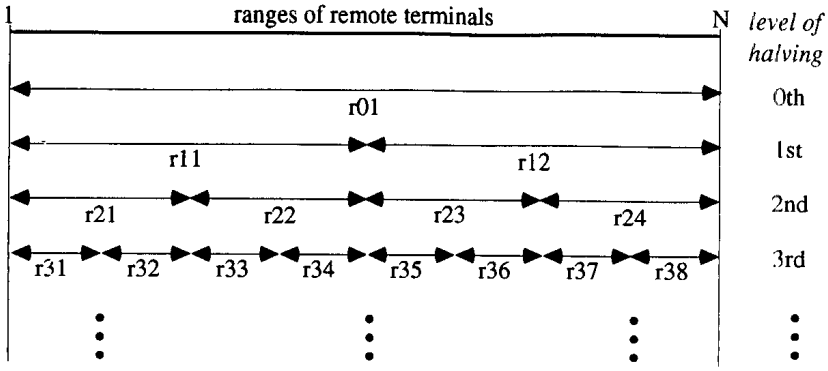


Figure 10: Ranges of remote terminals for contention resolution

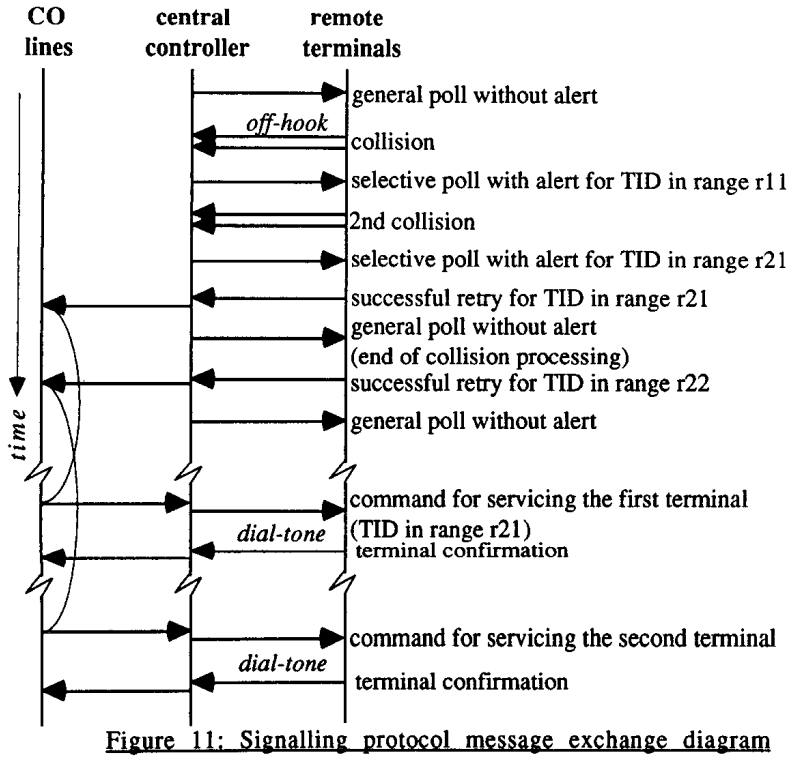


Figure 11: Signalling protocol message exchange diagram

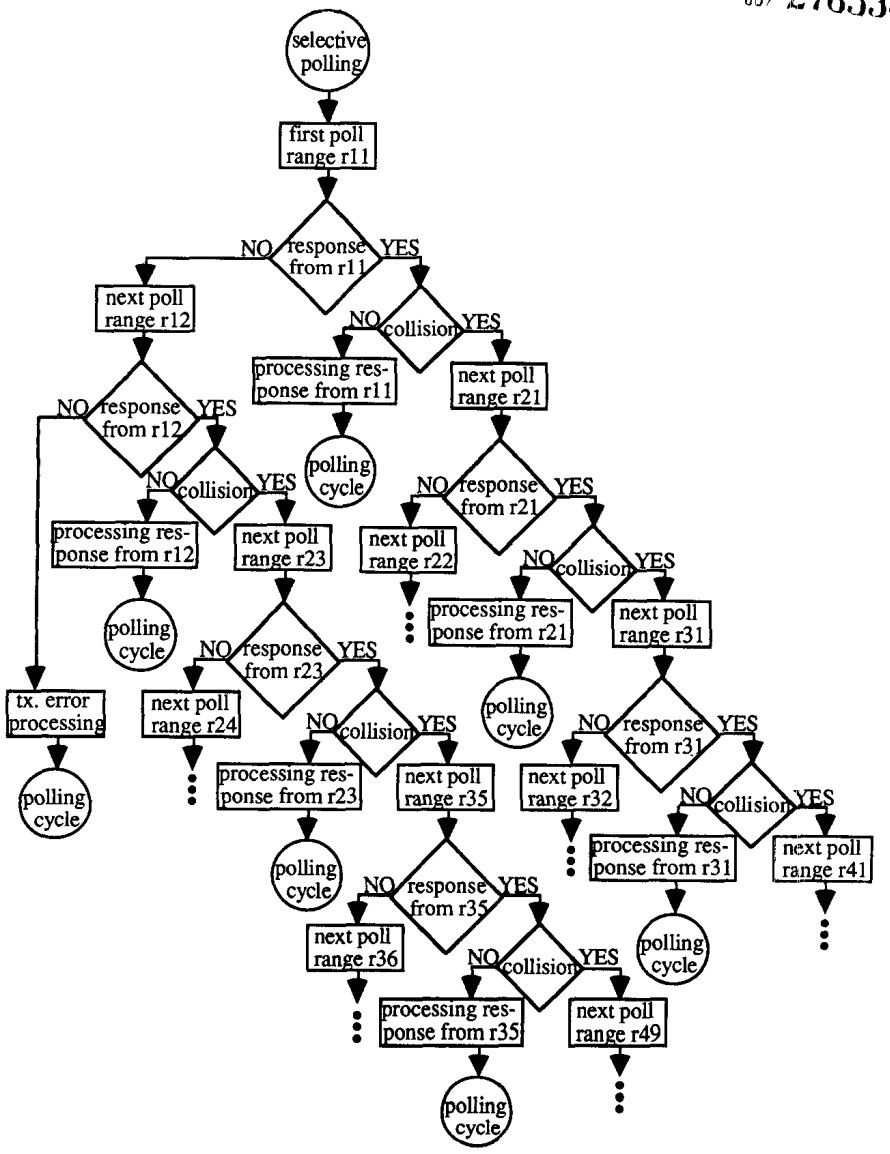
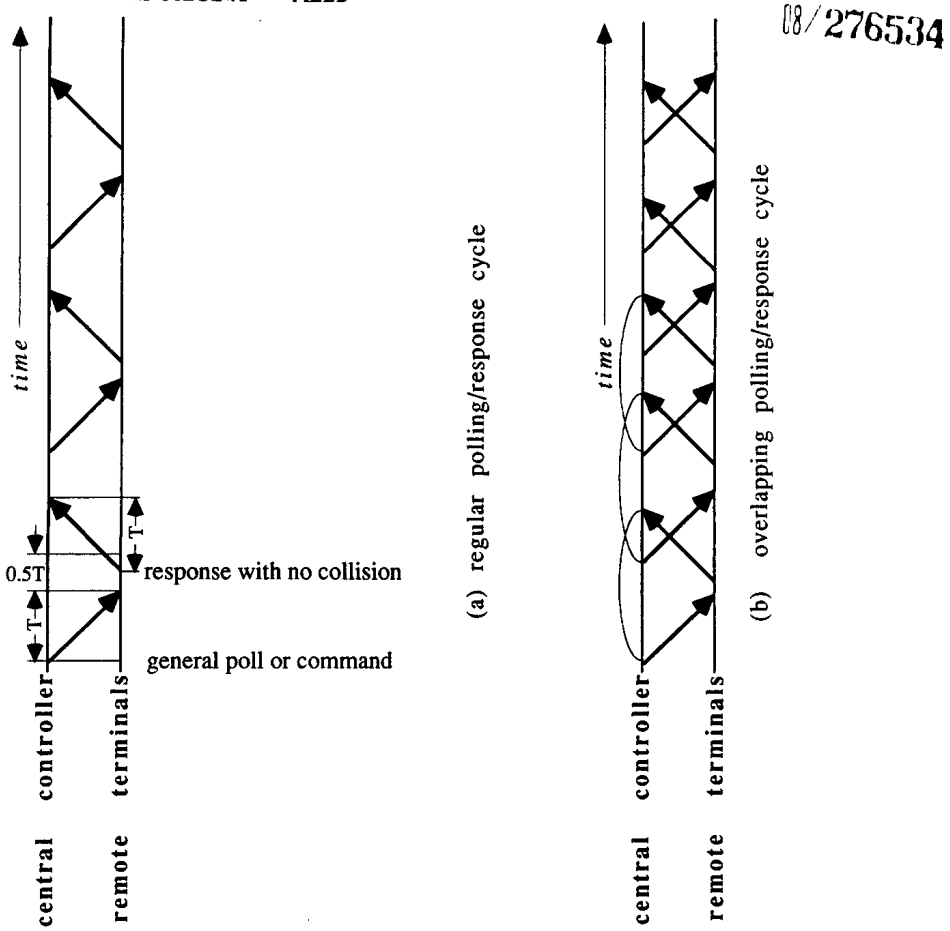


Figure 12: Decision tree for selective polling during contention resolution process using the regular polling method



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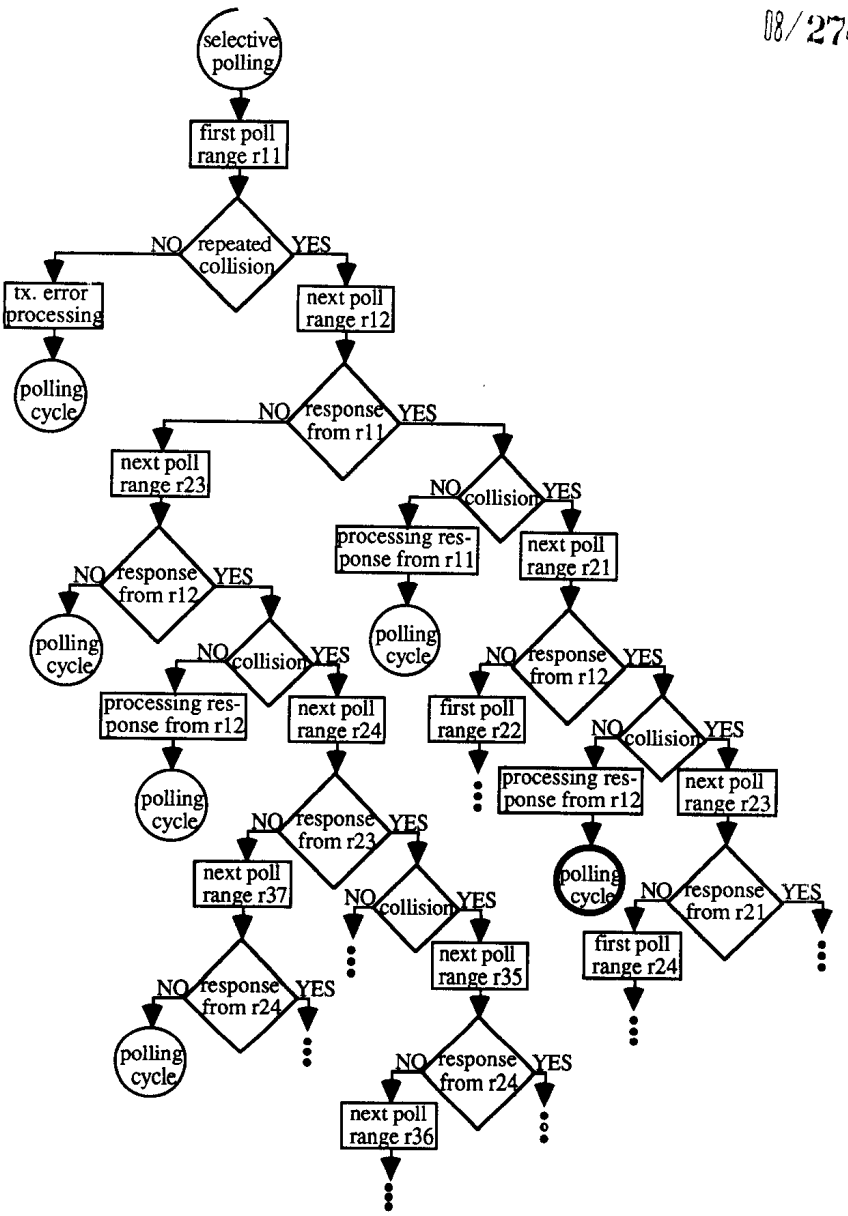

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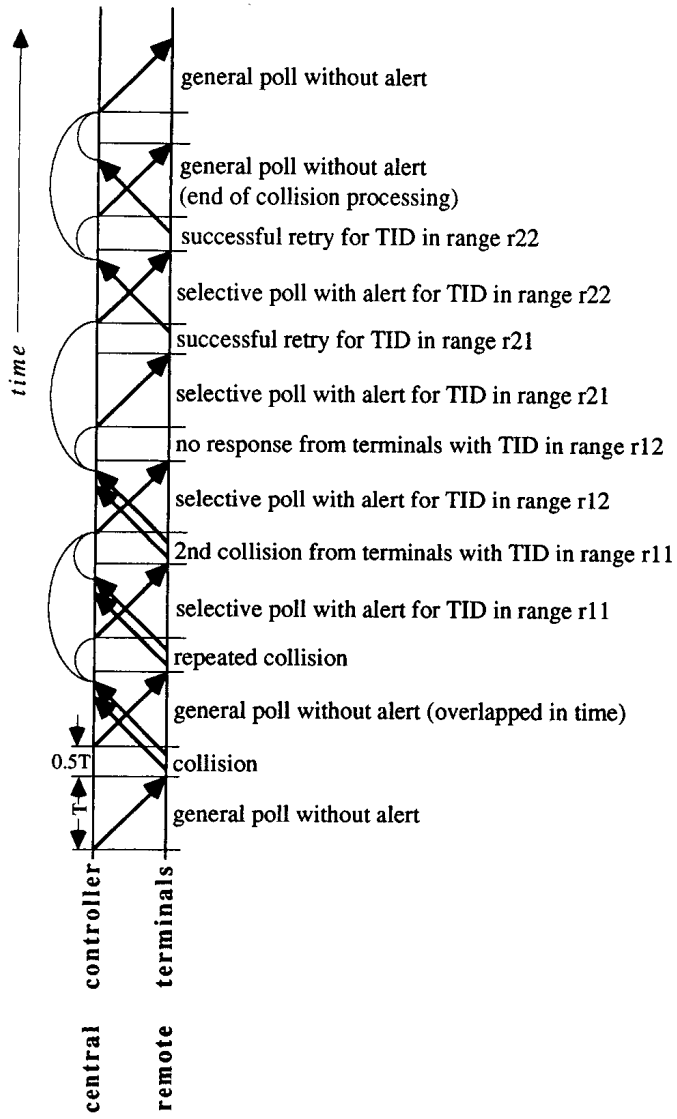

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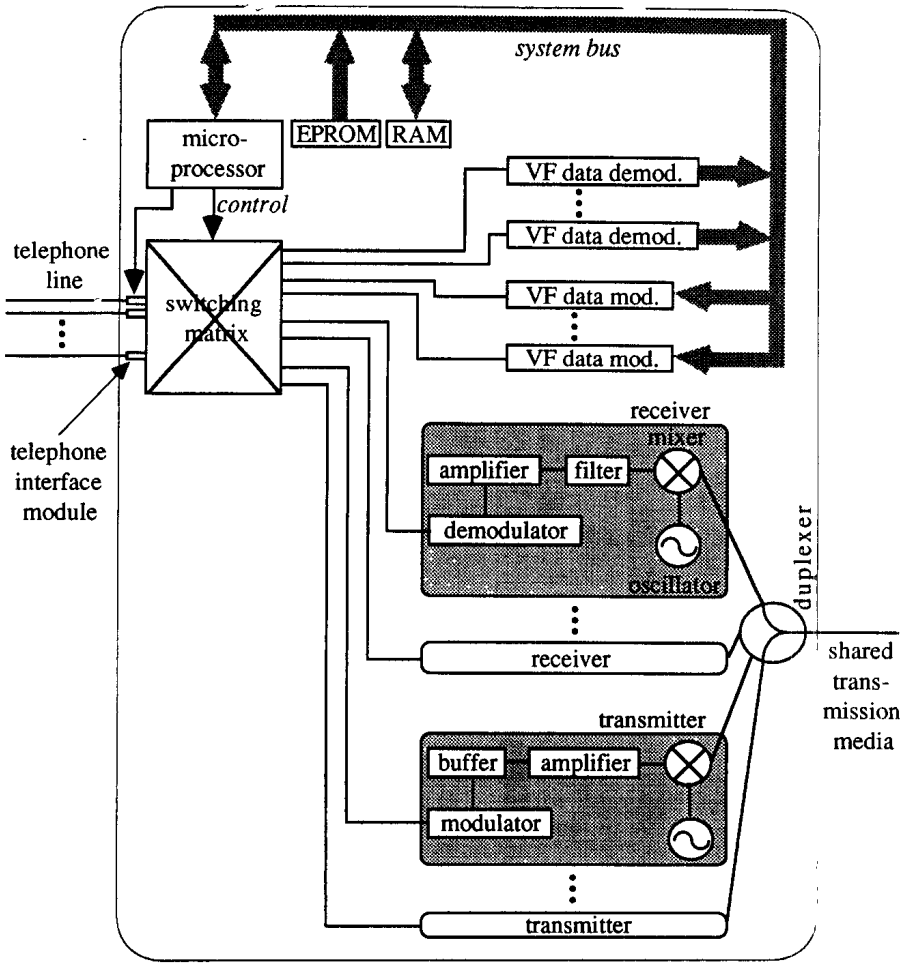

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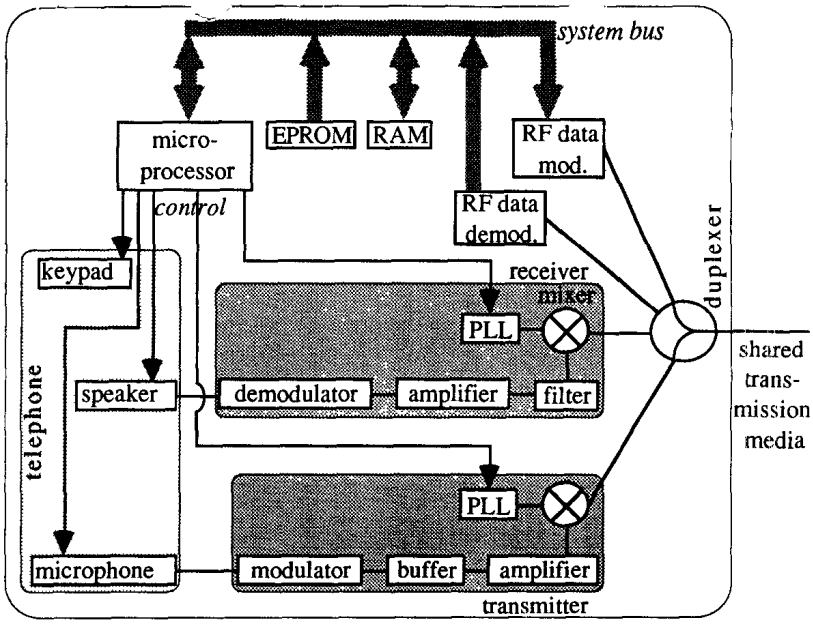
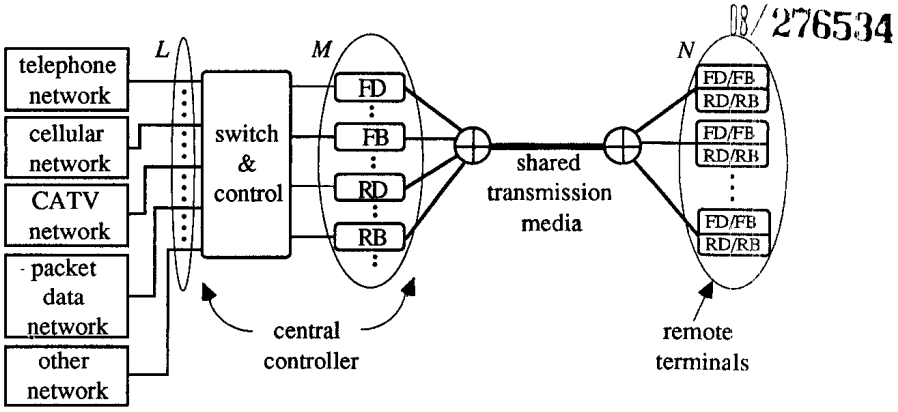


Figure 17: Block diagram of a remote terminal



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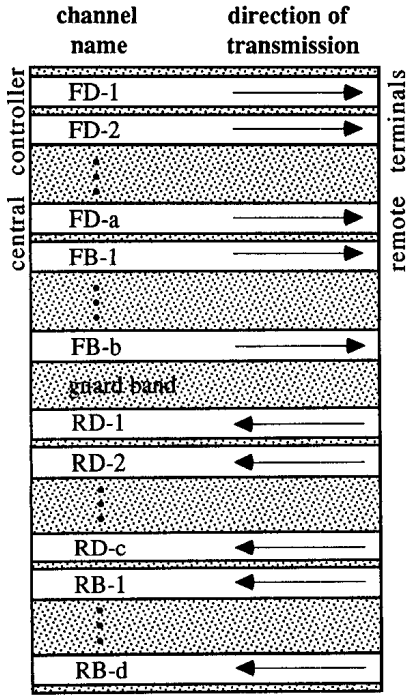

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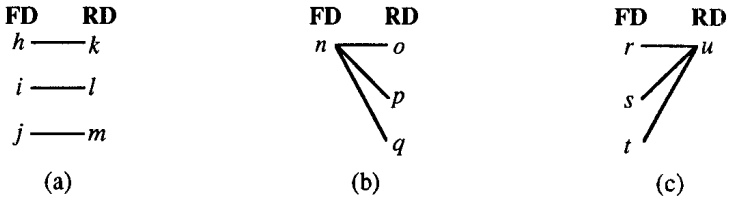
17-



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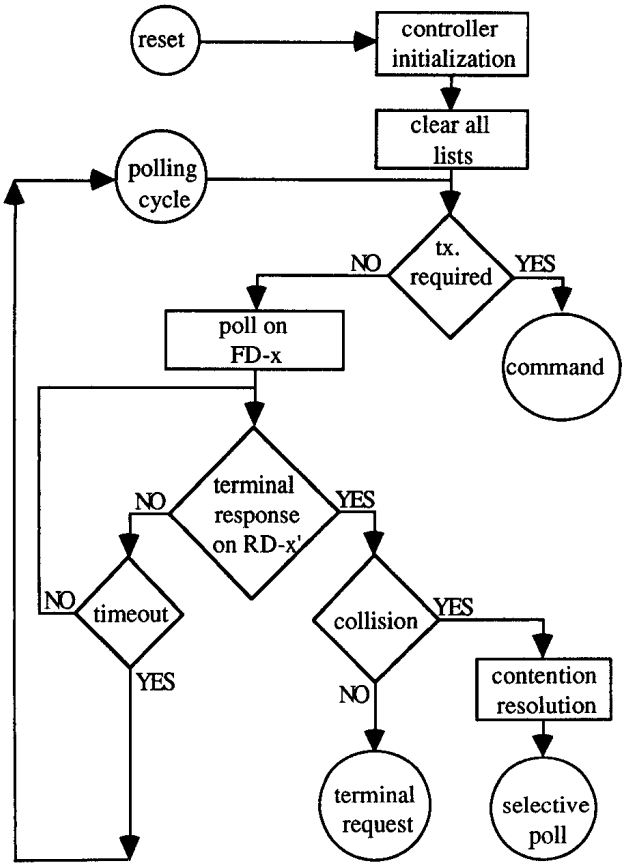

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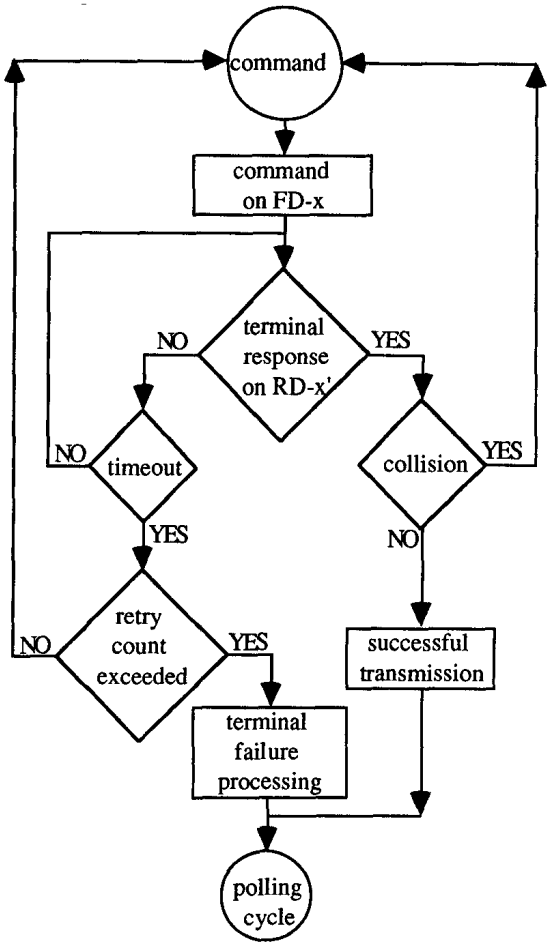

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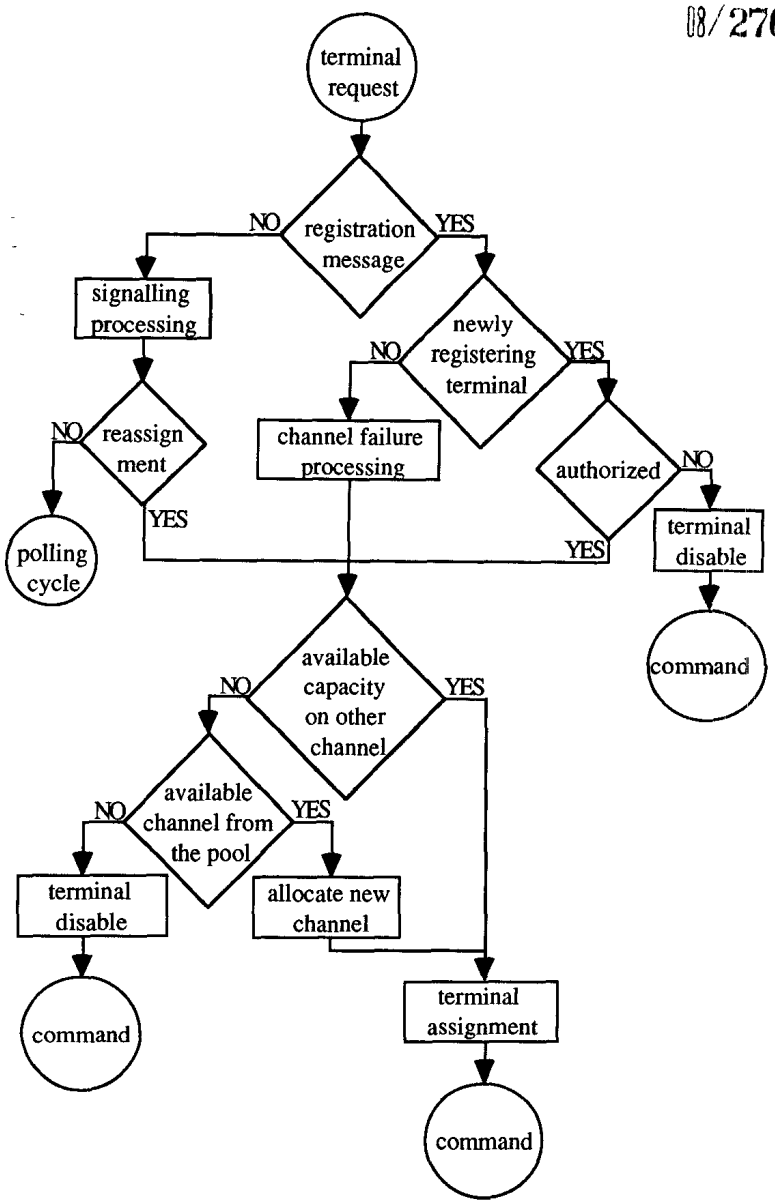

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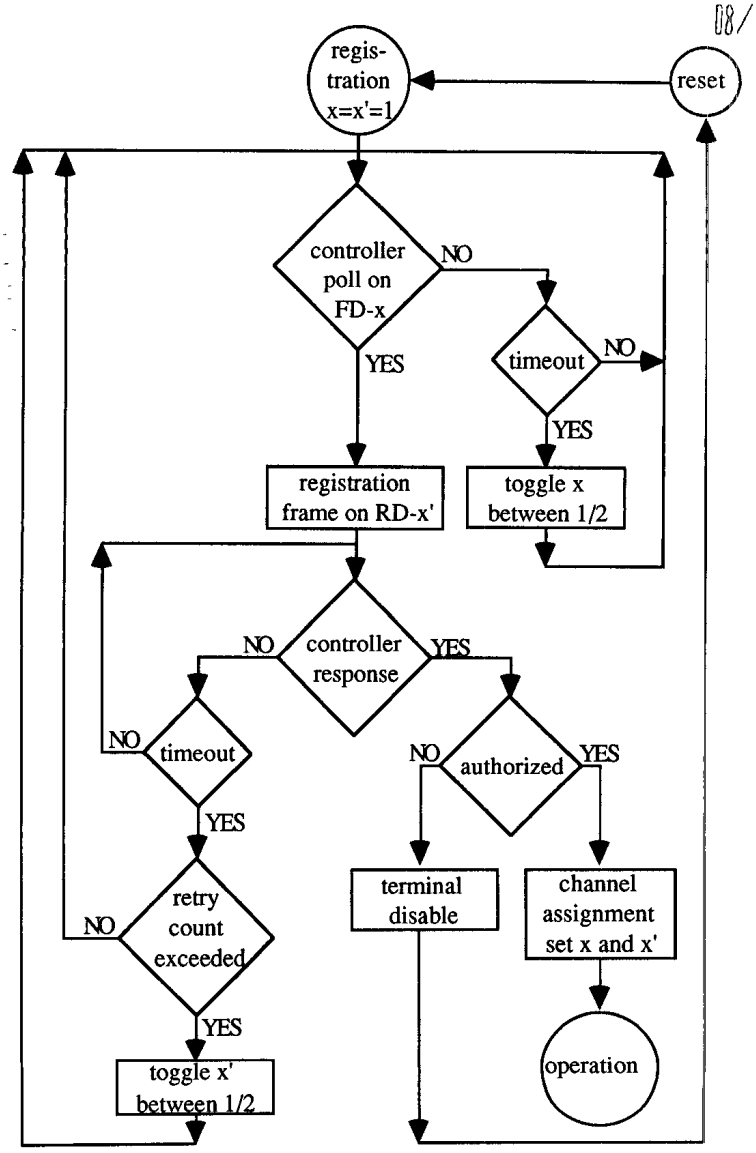

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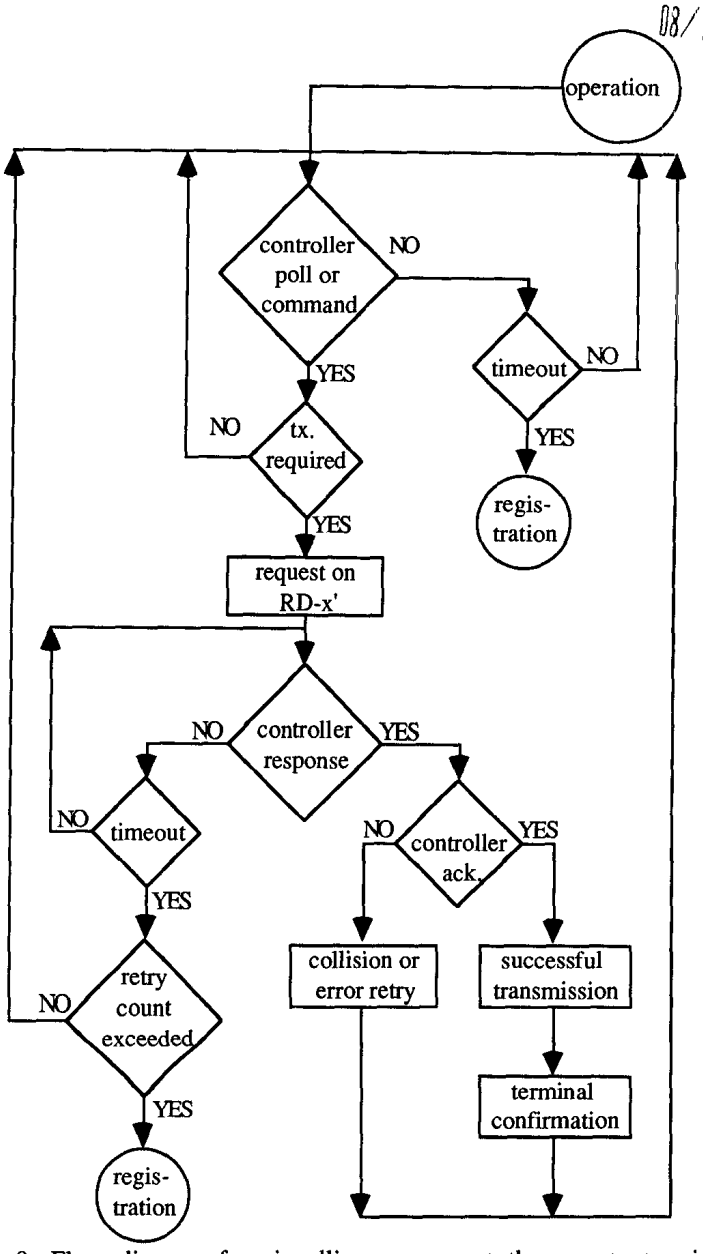

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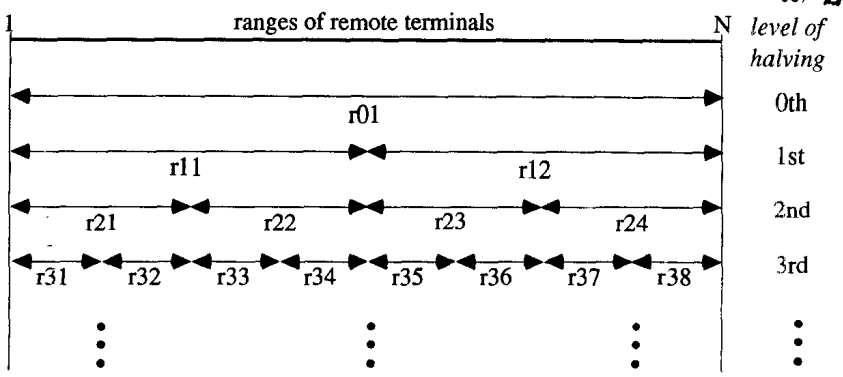

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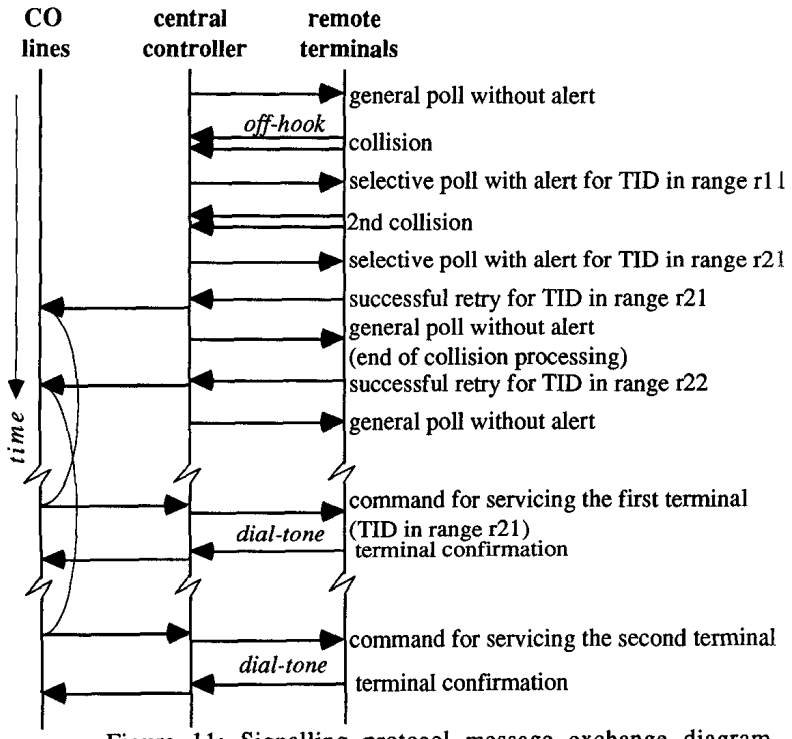

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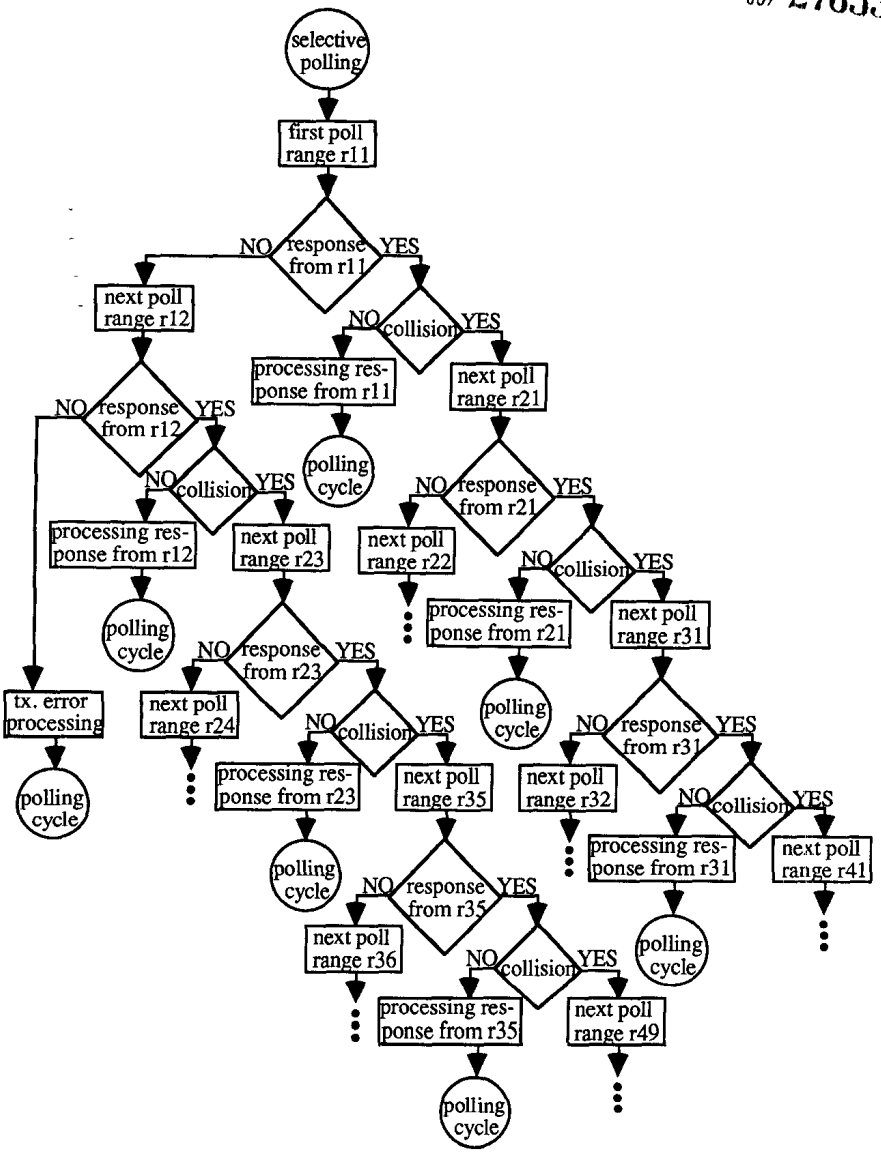

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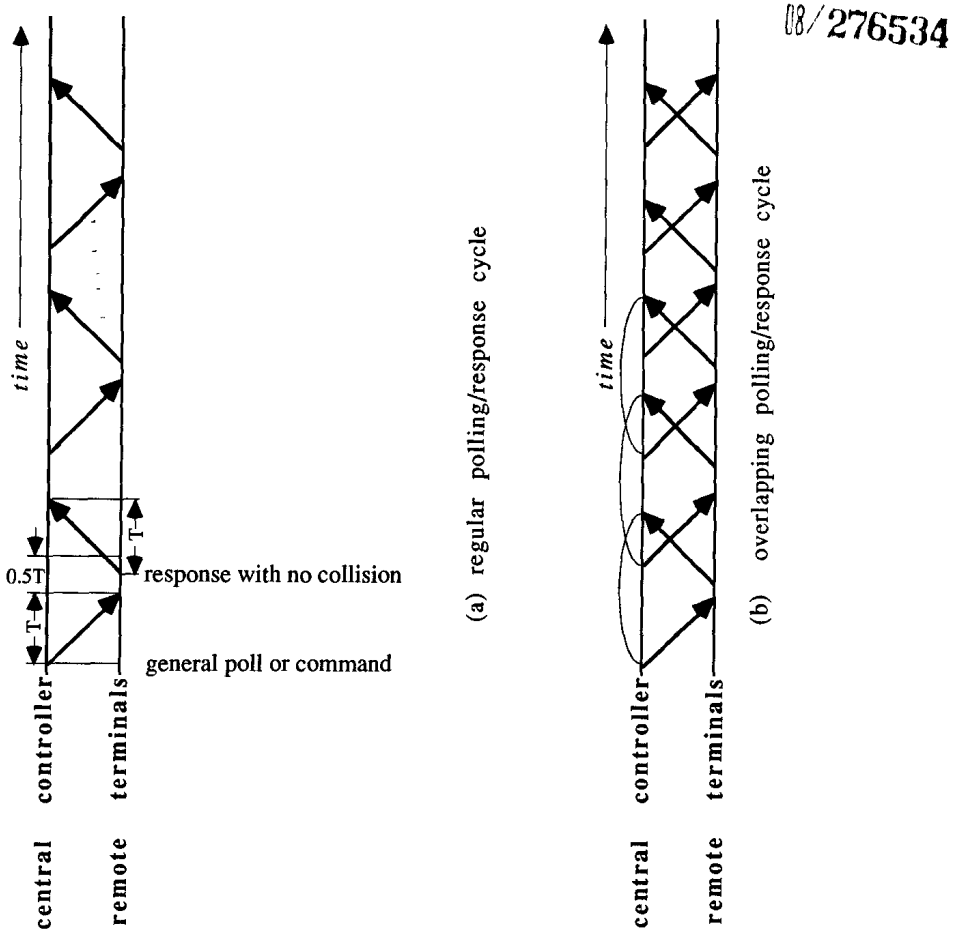

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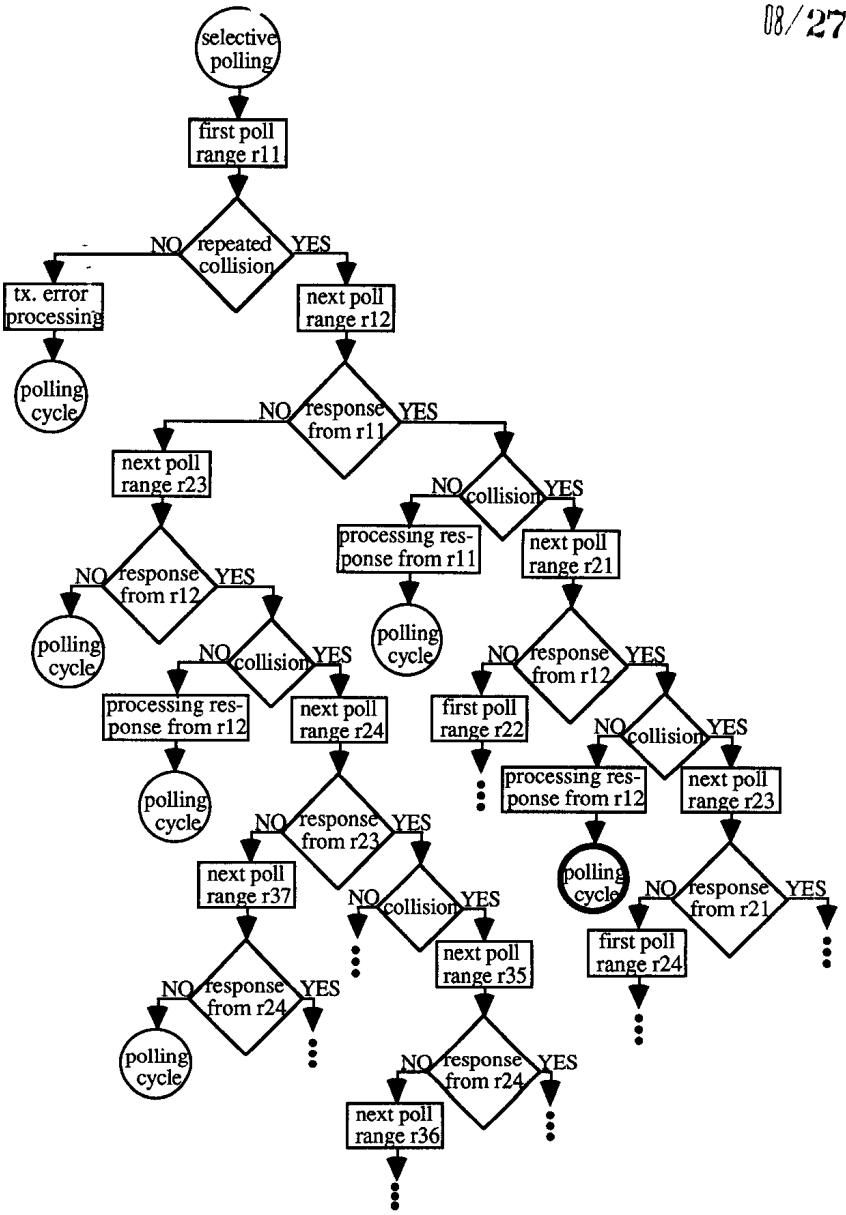

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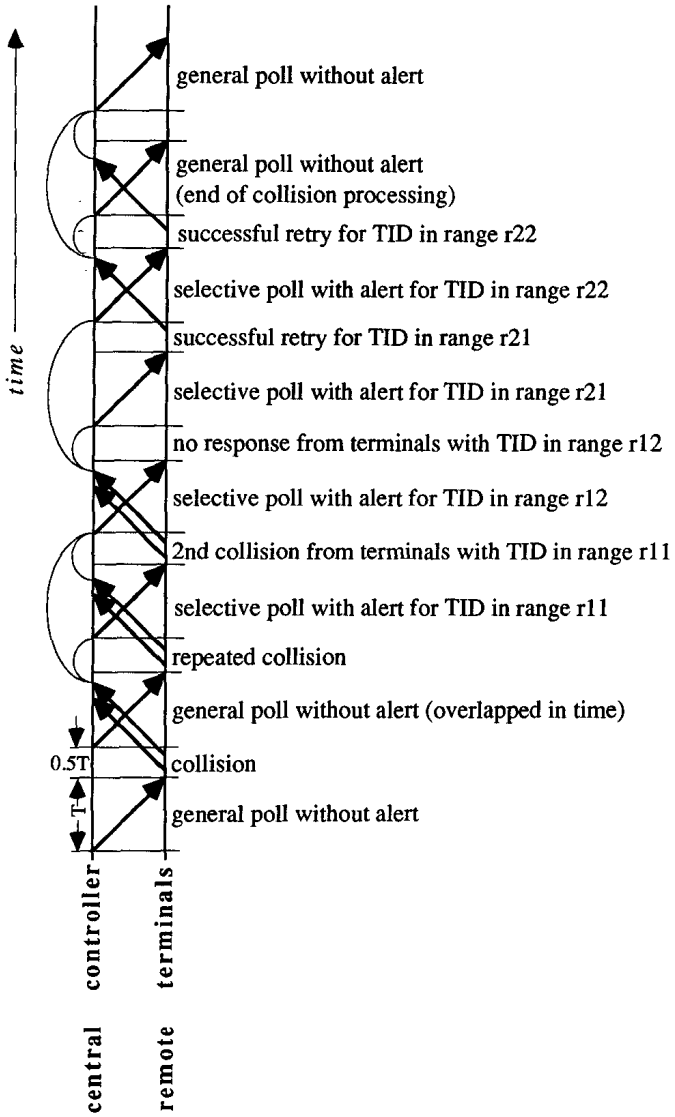

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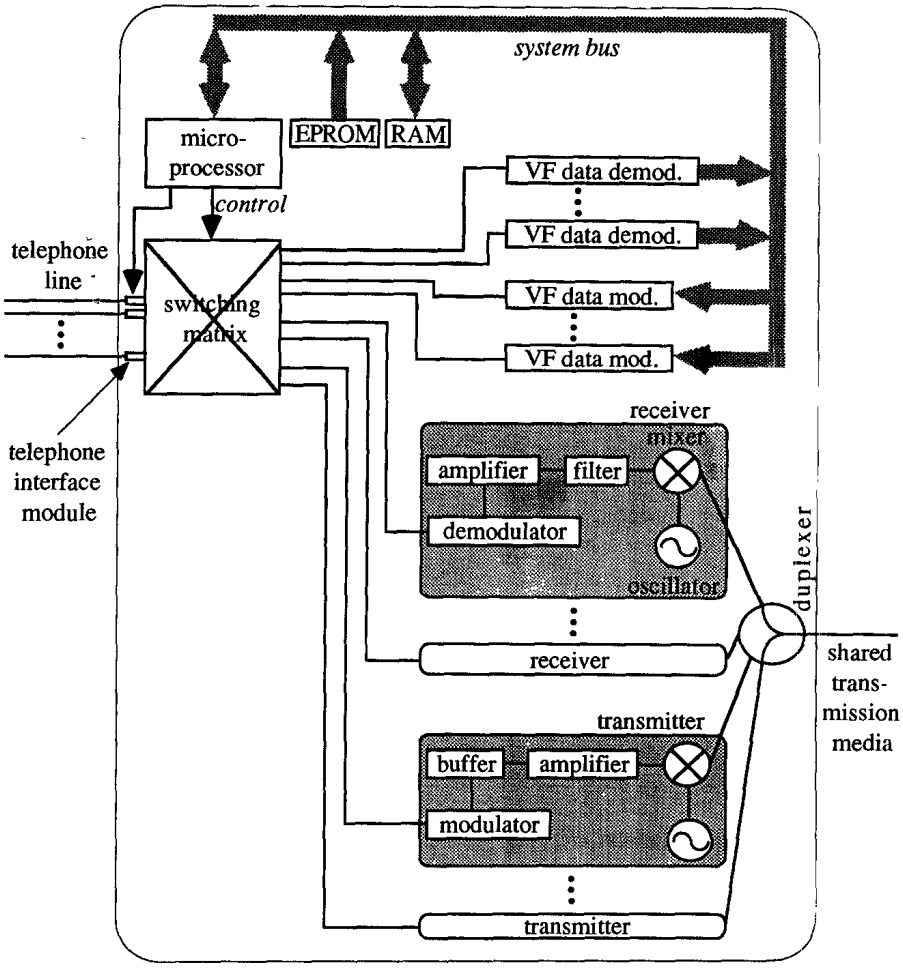

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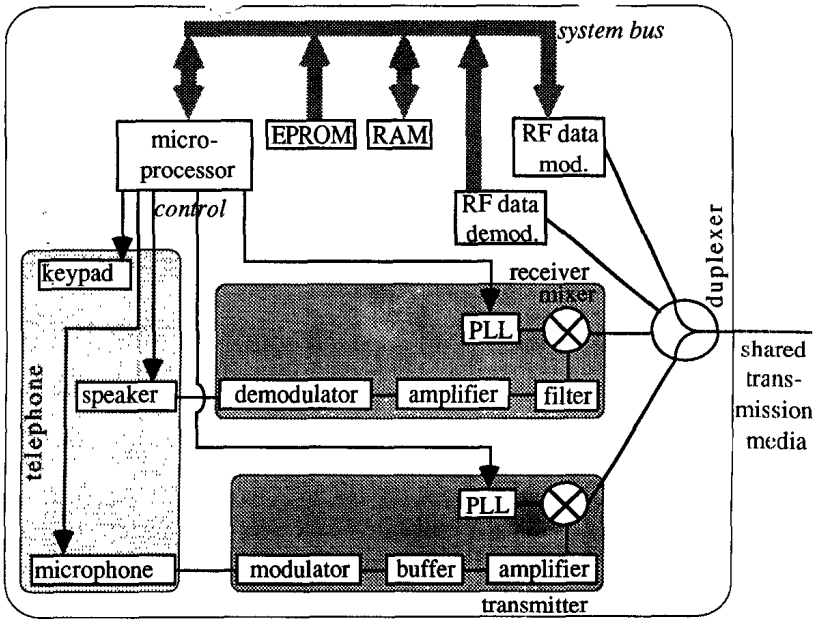


Figure 17: Block diagram of a remote terminal

08/276534

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Docket No. CHENG-101

NEW APPLICATION TRANSMITTAL

Commissioner of Patents and Trademarks
Washington, DC 20231

Sir:

Enclosed are:

(1) The papers required for a filing date under 37 CFR 1.53(b): (a) 33 pages of specification including 6 pages of claims with a total of 10 claims, with 4 independent and 6 dependent claims and (b) 14 sheets of informal drawing together with one page of abstract.

(2) Declaration.

(3) Small Entity Statement.

(4) Express Mail Certificate.

(5) A check in the amount of $392 payable to the Commissioner of Patents and Trademarks for the basic filing fee of $355 for a small entity plus $37 additional fee for 1 independent claims in excess of three independent claims at $37 per excess claim.

Please address all correspondence and telephone calls to the undersigned.

Respectfully submitted,

Dated: July 18, 1994

Alexander L. Cheng, Applicant
11 Springdale Avenue
White Plains, N.Y. 10604
914-428-0299

Enclosures

08/276534

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Re: Patent Application for

DYNAMIC CHANNEL MANAGEMENT AND
SIGNALLING METHOD AND APPARATUS

Docket: Cheng-101

Express Mail Label Number: HB114345407 US

Date of Deposit: July 18, 1994

CERTIFICATE OF MAILING UNDER 37 CFR 1.10

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

I hereby certify that the accompanying papers, namely:

Patent Application, Small Entity Statement and $392 Check

are being deposited with the United States Postal Service as "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above addressed to:

Commissioner of Patents and Trademarks
Washington, D.C. 20231.

Respectfully submitted,

Dated: July 18, 1994

Alexander L. Cheng, Applicant
11 Springdale Avenue
White Plains, N.Y. 10604
914-428-0299

Enclosures

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
08/276,534	07/18/94	CHENG	A CHENG101

EXAMINER
SAFOUREK, B

26M1/0804

ART UNIT	PAPER NUMBER
2603	2

ALEXANDER L. CHENG
11 SPRINGDALE AVENUE
WHITE PLAINS, NY 10604

DATE MAILED: 08/04/95

This is a communication from the examiner in charge of your application.
COMMISSIONER OF PATENTS AND TRADEMARKS

☑ This application has been examined ☐ Responsive to communication filed on _____ ☐ This action is made final.

A shortened statutory period for response to this action is set to expire 3 month(s), ~~_____ days~~ from the date of this letter.
Failure to respond within the period for response will cause the application to become abandoned. 35 U.S.C. 133

Part I THE FOLLOWING ATTACHMENT(S) ARE PART OF THIS ACTION:

1. ☑ Notice of References Cited by Examiner, PTO-892.
2. ☑ Notice of Draftsman's Patent Drawing Review, PTO-948.
3. ☐ Notice of Art Cited by Applicant, PTO-1449.
4. ☐ Notice of Informal Patent Application, PTO-152.
5. ☐ Information on How to Effect Drawing Changes, PTO-1474.
6. ☐ _____.

Part II SUMMARY OF ACTION

1. ☑ Claims 1-10 are pending in the application.

   Of the above, claims _____ are withdrawn from consideration.

2. ☐ Claims _____ have been cancelled.

3. ☐ Claims _____ are allowed.

4. ☑ Claims 1-10 are rejected.

5. ☐ Claims _____ are objected to.

6. ☐ Claims _____ are subject to restriction or election requirement.

7. ☑ This application has been filed with informal drawings under 37 C.F.R. 1.85 which are acceptable for examination purposes.

8. ☐ Formal drawings are required in response to this Office action.

9. ☐ The corrected or substitute drawings have been received on _____. Under 37 C.F.R. 1.84 these drawings are ☐ acceptable; ☐ not acceptable (see explanation or Notice of Draftsman's Patent Drawing Review, PTO-948).

10. ☐ The proposed additional or substitute sheet(s) of drawings, filed on _____. has (have) been ☐ approved by the examiner; ☐ disapproved by the examiner (see explanation).

11. ☐ The proposed drawing correction, filed _____, has been ☐ approved; ☐ disapproved (see explanation).

12. ☐ Acknowledgement is made of the claim for priority under 35 U.S.C. 119. The certified copy has ☐ been received ☐ not been received ☐ been filed in parent application, serial no. _____ ; filed on _____.

13. ☐ Since this application apppears to be in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under Ex parte Quayle, 1935 C.D. 11; 453 O.G. 213.

14. ☐ Other

EXAMINER'S ACTION

PTOL-326 (Rev. 2/93)

A. This application has been filed with informal drawings which are acceptable for examination purposes only. Formal drawings will be required when the application is allowed.

B. The Abstract of the Disclosure is objected to because it uses the term "means" in line 5. Correction is required. See M.P.E.P. § 608.01(b).

C. Claims 1-10 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. In lines 9-11 of claim 1 it is not clear if the channels in use are monitored and if so what for. The "said another" in line 16 of claim 1 lacks a good antecedent as lines 14 and 15 do not identify any special "another channel". The "A ... Channels" in lines 3-4 of claim 2 are confusing. It is not clear what the "unavailable" in line 9 of claim 2 refers to, the polling or sensing. There is no activated remote for lines 10 and 11 of claim 2. The data of lines 13-14 of claim 2 has already been sent on the primary channel. The "said signalling data channel" of claim 3, lines 3-4 lacks a definite antecedent. Also lines 5, 6 and 9. The channels are not assigned to terminals as in lines 9 and 10 of claim 3 but the terminals are assigned to channels. Also lines 6-7 of claim 4. Claim 4 has lots of sensing but no determining assignment. Should "assigned" in line 3 of claim 4 be -- reassigned --?

Claim 5 ignores the condition of the channel the terminal is on. In lines 5-7 of claim 6 are all terminals on all channels. The results of the steps of lines 8-11 of claim 7 are never used. What contention or errors are referred to in lines 12 and 13. What is the request of claims 6 and 7 a request for? Do the terminals also poll as lines 8 and 9 of claim 7 imply? There are no claimed messages to be detected in line 3 of claim 8. What scope is narrowed or probable range is polled in claim 8 cannot be determined. It takes two to have a collision and not one as in line 13 of claim 8. The controlling means, modulating, demodulating and interface of claim 9 are only connected by the switch of lines 12-14 and is so vague as not to be able to determine signal flow. The data channel is not between the modulator and transmitter as lines 15-17 imply. Lines 18-23 seem to have channels between the receiver and demodulator and transmitter and receiver and not the controller and remote terminals. There is no micro-process (or) EPROM and RAM as stated at lines 12 and 13 of claim 10. What is interfaced in line 11 of claim 10.

D. The following is a quotation of the appropriate paragraphs of 35 U.S.C. § 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless --
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

Claims 1 and 5 are rejected under 35 U.S.C. § 102(b) as being anticipated by Grauel et al.

E. Claim 6 is rejected under 35 U.S.C. § 102(e) as being anticipated by Christensen.

F. Claim 10 is rejected under 35 U.S.C. § 102(e) as being anticipated by Flohr.

G. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

H. Any inquiry concerning this communication or earlier communications from the examiner should be directed to B. V. Safourek whose telephone number is (703) 305-4364. The examiner can normally be reached on Monday - Friday from 6:30 to 4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Douglas Olm, can be reached on (703) 305-4703. The fax phone number for this Group is (703) 305-9508.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 305-4700.

B. V. Safourek/skf
July 27, 1995

Benedict V. Safourek

BENEDICT V. SAFOUREK
PRIMARY EXAMINER
GROUP 263

TO SEPARATE, HOLD TOP AND BOTTOM EDGES, SNAP--APART AND DISCARD CARBON

FORM PTO-892 (REV. 2-92) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

NOTICE OF REFERENCES CITED

SERIAL NO.	GROUP ART UNIT	ATTACHMENT TO PAPER NUMBER
276,534	2603	2

APPLICANT(S): Cheng

U.S. PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	NAME	CLASS	SUB CLASS	FILING DATE IF APPROPRIATE
	A	4573206	2/1986	Grauel et al.	455	34.1	—
	B	5132680	7/1992	Tezuka et al.	370	85.8	—
	C	5224097	6/1993	Kaneshima	370	85.8	—
	D	5331316	7/1994	Mestdagh	370	85.7	5-94
	E	5355375	10/1994	Christensen	370	85.8	3-93
	F	5374952	12/1994	Flohr	348	12	2-94
	G	5434611	7/1995	Tamura	348	12	12-92
	H						
	I						
	J						
	K						

FOREIGN PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUB-CLASS	PERTINENT SHTS. DWG.	PERTINENT PP. SPEC.
	L								
	M								
	N								
	O								
	P								
	Q								

OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)

R	
S	
T	
U	

EXAMINER	DATE
Safourek	7-13-95

* A copy of this reference is not being furnished with this office action.
(See Manual of Patent Examining Procedure, section 707.05 (a).)

2603

2

Form PTO 948 (Rev. 10-93) U.S. DEPARTMENT OF COMMERCE - Patent and Trademark Office Application No. 276534

NOTICE OF DRAFTSPERSON'S PATENT DRAWING REVIEW

PTO Draftpersons review all originally filed drawings regardless of whether they are designated as formal or informal. Additionally, patent Examiners will review the drawings for compliance with the regulations. Direct telephone inquiries concerning this review to the Drawing Review Branch, 703-305-8404.

The drawings filed (insert date) 7/18/94, are
A. ___ not objected to by the Draftsperson under 37 CFR 1.84 or 1.152
B. X objected to by the Draftsperson under 37 CFR 1.84 or 1.152 as indicated below. The Examiner will require submission of new, corrected drawings when necessary. Corrected drawings must be submitted according to the instructions on the back of this Notice.

1. DRAWINGS. 37 CFR 1.84(a): Acceptable categories of drawings: Black ink. Color.
   - ___ Not black solid lines. Fig(s)___
   - ___ Color drawings are not acceptable until petition is granted.

2. PHOTOGRAPHS. 37 CFR 1.84(b)
   - ___ Photographs are not acceptable until petition is granted.

3. GRAPHIC FORMS. 37 CFR 1.84 (d)
   - ___ Chemical or mathematical formula not labeled as separate figure. Fig(s)___
   - ___ Group of waveforms not presented as a single figure, using common vertical axis with time extending along horizontal axis. Fig(s)___
   - ___ Individuals waveform not identified with a separate letter designation adjacent to the vertical axis. Fig(s)___

4. TYPE OF PAPER. 37 CFR 1.84(e)
   - ___ Paper not flexible, strong, white, smooth, nonshiny, and durable. Sheet(s)___
   - ___ Erasures, alterations, overwritings, interlineations, cracks, creases, and folds not allowed. Sheet(s)___

5. SIZE OF PAPER. 37 CFR 1.84(f): Acceptable paper sizes:
   21.6 cm. by 35.6 cm. (8 1/2 by 14 inches)
   21.6 cm. by 33.1 cm. (8 1/2 by 13 inches).
   21.6 cm. by 27.9 cm. (8 1/2 by 11 inches)
   21.0 cm. by 29.7 cm. (DIN size A4)
   - ___ All drawing sheets not the same size. Sheet(s)___
   - ___ Drawing sheet not an acceptable size. Sheet(s) ___

6. MARGINS. 37 CFR 1.84(g): Acceptable margins:

Paper size			
21.6 cm. X 35.6 cm. (8 1/2 X 14 inches)	21.6 cm X 33.1 cm. (8 1/2 X 13 inches)	21 cm X 27.9 cm (8 1/2 X 11 inches)	21 cm. X 29 7 cm. (DIN Size A4)
T 5.1 cm. (2")	2.5 cm. (1")	2.5 cm (1")	2.5cm
L .64 cm. (1/4")	.64 cm. (1/4")	64 cm (1/4")	2 5 cm.
R .64 cm. (1/4")	64 cm (1/4")	64 cm (1/4")	1 5 cm.
B .64 cm (1/4")	.64 cm. (1/4")	.64 cm. (1/4")	1.0 cm

Margins do not conform to chart above.
Sheet(s) 1 - 10
X Top (T) ___ Left (L) ___ Right (R) ___ Bottom (B)

7. VIEWS. 37 CFR 1.84(h)
   REMINDER: Specification may require revision to correspond to drawing changes.
   - ___ All views not grouped together. Fig(s)___
   - ___ Views connected by projection lines. Fig(s)___
   - ___ Views contain center lines. Fig(s)___

Partial views. 37 CFR 1.84(h)(2)
   - ___ Separate sheets not linked edge to edge. Fig(s)___
   - ___ View and enlarged view not labeled separately. Fig(s)___
   - ___ Long view relationship between different parts not clear and unambiguous. 37 CFR 1.84(h)(2)(ii) Fig(s)___

Sectional views. 37 CFR 1.84(h)(3)
   - ___ Hatching not indicated for sectional portions of an object. Fig(s)___
   - ___ Hatching of regularly spaced oblique parallel lines not spaced sufficiently. Fig(s)___
   - ___ Hatching not at substantial angle to surrounding axes or principal lines. Fig(s)___
   - ___ Cross section not drawn same as view with parts in cross section with regularly spaced parallel oblique strokes. Fig(s)___
   - ___ Hatching of juxtaposed different elements not angled in a different way. Fig(s)___

Alternate position. 37 CFR 1.84(h)(4)
   - ___ A separate view required for a moved position Fig(s)___

Modified forms. 37 CFR 1.84(h)(5)
   - ___ Modified forms of construction must be shown in separate views Fig(s)___

8. ARRANGEMENT OF VIEWS. 37 CFR 1.84(i)
   - ___ View placed upon another view or within outline of another. Fig(s)___
   - ___ Words do not appear in a horizontal, left-to-right fashion when page is either upright or turned so that the top becomes the right side, except for graphs. Fig(s)___

9. SCALE. 37 CFR 1.84(k)
   - ___ Scale not large enough to show mechanism without crowding when drawing is reduced in size to two-thirds in reproduction. Fig(s)___
   - ___ Indication such as "actual size" or "scale 1/2" not permitted. Fig(s)___
   - ___ Elements of same view not in proportion to each other. Fig(s)___

10. CHARACTER OF LINES, NUMBERS, & LETTERS. 37 CFR 1.84(l)
   - ___ Lines, numbers & letters not uniformly thick and well defined, clean, durable, and black (except for color drawings). Fig(s)___

11. SHADING. 37 CFR 1.84(m)
   - ___ Shading used for other than shape of spherical, cylindrical, and conical elements of an object, or for flat parts. Fig(s)___
   - ___ Solid black shading areas not permitted. Fig(s)___

12. NUMBERS, LETTERS, & REFERENCE CHARACTERS. 37 CFR 1.84(p)
   - ___ Numbers and reference characters not plain and legible. 37 CFR 1.84(p)(1) Fig(s)___
   - ___ Numbers and reference characters used in conjuction with brackets, inverted commas, or enclosed within outlines. 37 CFR 1.84(p)(1) Fig(s)___
   - ___ Numbers and reference characters not oriented in same direction as the view. 37 CFR 1.84(p)(1) Fig(s)___
   - ___ English alphabet not used. 37 CFR 1.84(p)(2) Fig(s)___
   - ___ Numbers, letters, and reference characters do not measure at least .32 cm. (1/8 inch) in height. 37 CFR(p)(3) Fig(s)___

13. LEAD LINES. 37 CFR 1.84(q)
   - ___ Lead lines cross each other. Fig(s)___
   - ___ Lead lines missing. Fig(s)___
   - ___ Lead lines not as short as possible. Fig(s)___

14. NUMBERING OF SHEETS OF DRAWINGS. 37 CFR 1.84(t)
   - ___ Number appears in top margin. Fig(s)___
   - ___ Number not larger than reference characters. Fig(s)___
   - ___ Sheets not numbered consecutively, and in Arabic numerals, beginning with number 1 Sheet(s)___

15. NUMBER OF VIEWS. 37 CFR 1.84(u)
   - ___ Views not numbered consecutively, and in Arabic numerals, beginning with number 1. Fig(s)___
   - ___ View numbers not preceded by the abbreviation Fig. Fig(s)___
   - ___ Single view contains a view number and the abbreviation Fig.
   - ___ Numbers not larger than reference characters. Fig(s)___

16. CORRECTIONS. 37 CFR 1.84(w)
   - ___ Corrections not durable and permanent. Fig(s)___

17. DESIGN DRAWING. 37 CFR 1.152
   - ___ Surface shading shown not appropriate. Fig(s)___
   - ___ Solid black shading not used for color contrast. Fig(s)___

* Remove descriptive matter (next to Fig. legends)

ATTACHMENT TO PAPER NO. 2 REVIEWER A. Dean DATE 8/18/94

PTO Copy

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Serial No.	08/276,534
Filing Date	07/18/94
Applicant	Alexander L. Cheng
For	DYNAMIC CHANNEL MANAGEMENT AND SIGNALLING METHOD AND APPARATUS
Group Art Unit	2603
Primary Examiner	Benedict V. Safourek

AMENDMENT "A"

Commissioner of Patents and Trademarks
Washington, DC 20231

Sir:

In response to the Office Action dated 08/04/95 for the above-identified application, a shortened period of response being set to expire three months from that date, i.e., 11/04/95, please amend the above-identified application as follows:

IN THE ABSTRACT

Please amend the abstract as follows:

Line 5, change "means" to --apparatus--.

IN THE CLAIMS

1. (Amended) In a multiple access communication system comprising a central controller, a shared transmission means for signalling data and user information, and a plurality of remote terminals, a method of allocating signalling data channels

between said central controller and said plurality of remote terminals from a plurality of communication channels and of assigning remote terminals comprising the steps of:

(a) establishing communications between said central controller and said plurality of remote terminals via a plurality of signalling data channels, each of said remote terminals being initially assigned to a pair of predetermined signalling data channels;

(b) monitoring the status of a plurality of the signalling data channels in use between said central controller and said plurality of remote terminals for the usability of said signalling data channels;

(c) determining whether one of said plurality of remote terminals needs to be [assigned] reassigned to a different signalling data channel other than said predetermined signalling data channel;

(d) determining whether a different [another] and suitable signalling data channel is available other than said predetermined channel; and

(e) reassigning by said central controller [assigning] said remote terminal to a different [said another] and suitable signalling data channel for communication henceforward.

2. (Amended) In a multiple access communication system according to claim 1, said step of establishing communications between said central controller and said plurality of remote terminals via a plurality of signalling data channels comprising the steps of:

(a) polling by said central controller said plurality of remote terminals on a pair of predetermined primary forward and backup forward signalling data channels for an activated remote terminal;

(b) sensing by an activated remote terminal for a polling message from said central controller on a predetermined backup forward signalling data channel if said predetermined primary forward signalling data channel is unavailable to said activated remote terminal because of its failure to sense a polling message during a predetermined period of time;

(c) transmitting a registration message from said activated remote terminal to said central controller on a predetermined primary reverse signalling data channel; and

(d) retransmitting said registration message on [providing] a predetermined backup reverse signalling data channel if said primary reverse signalling data channel is unavailable to said activated remote terminal because of its failure to sense a response from said central controller to said registration message after a predetermined period of time.

3. (Amended) In a multiple access communication system according to claim 1, said step of monitoring the status of a plurality of the signalling data channels in use between said central controller and said plurality of remote terminals for the usability of said signalling data channels comprising the steps of:

(a) calculating the aggregate traffic load requirements of said plurality of signalling data channels in use;

(b) monitoring the past collision count of said plurality ~~of~~ signalling data channels in use;

(c) monitoring the transmission error count of said plurality of signalling data channels in use; and

(d) sensing the status of said plurality of signalling data channels in use [assigned to one of said plurality of terminals] for failure.

4. (Amended) In a multiple access communication system according to claim 1, said step of determining whether one of said plurality of remote terminals needs to be [assigned] reassigned to a different signalling data channel other than said predetermined signalling data channel comprising the steps of:

[(a) sensing for an activated remote terminal on predetermined primary reverse and backup reverse signalling data channels;]

(a) [(b)] sensing the status of said predetermined signalling data channel which [assigned to one of] said [plurality of terminals] terminal has been assigned to for overloading to determine whether said terminal needs to be reassigned to a different signalling data channel because of overloading; and

(b) [(c)] sensing the status of said predetermined signalling data channel which [assigned to one of] said [plurality of terminals] terminal has been assigned to for failure to determine whether said terminal needs to be reassigned to a different signalling data channel because of failure.

5. (Amended) In a multiple access communication system according to claim 1, said step of determining whether a different [another] and suitable signalling data channel is available other than said predetermined channel comprising the steps of:

(a) sensing the status of other signalling data channels other than said predetermined channel for spare capacity; and

(b) allocating a new signalling data channel if no signalling data channel has spare capacity and a new signalling data channel is available.

6. (Amended) In a multiple access communication system comprising a central controller, a shared transmission means and a plurality of remote terminals, a method of controlled multiple access between said central controller and said plurality of remote terminals comprising the steps of:

(a) establishing communications between said central controller and each of said plurality of remote terminals via predetermined signalling data channels of a plurality of signalling data channels, each of said plurality of remote terminals can be assigned to any pair of said plurality of signalling data channels;

[(b) determining whether there is a command from said central controller to one or more of the said plurality of remote terminals;]

(b) [(c)] polling a plurality of said plurality of remote terminals simultaneously by said central controller for determining whether there is any pending request from said plurality of remote terminals; and

(c) [(d)] resolving contention among said plurality of remote terminals by said central controller if there is a pending request from more than one remote terminal on the same signalling data channel [or data transmission errors].

7. (Amended) In a multiple access communication system according to claim 6, said step of polling a plurality of said plurality of remote terminals simultaneously by said central controller for determining whether there is any pending request from

said plurality of remote terminals comprising the steps of:

(a) polling [in parallel] said plurality of remote terminals by said central controller on one of [each of the] said plurality of [forward] signalling data channels [said plurality of remote terminals]; and

(b) responding to said polling by said central controller by only those of [from] said plurality of remote terminals which have a [with any] pending request.[; and]

[(c) interleaving polling messages with any responses from said plurality of remote terminals.]

8. (Amended) In a multiple access communication system according to claim 6, said step of resolving contention among said plurality of remote terminals if there is a pending request from more than one remote terminal on the same signalling data channel comprising the steps of:

(a) detecting data transmission errors [corrupted messages] due to collision of pending requests [or data transmission error] from said plurality of remote terminals;

(b) alerting a plurality of remote terminals assigned to a signalling data channel to avoid using said signalling data channel where collision occurred;

[(c) narrowing systematically the scope of said plurality of remote terminals via selective polling;]

[(d) interleaving the selective polling of probable range of said plurality of remote terminals with responses from said plurality of remote terminals;]

(c) [(e)] polling said plurality of remote terminals by said central controller for identifying one of said plurality of [a] remote terminals involved in the collision; and

(d) transmitting a signal from said central controller to said identified remote terminal indicating that said central controller will process its pending request.

[(f) servicing said remote terminal involved in the collision; and]

[(g) resuming said controlled multiple access.]

14
9. (Amended) In a multiple access communication system having a plurality of communication channels for communicating with a plurality of remote terminals, a central controller comprising:

(a) system controlling means for controlling the communication system comprising a micro-processor and associated EPROM and RAM;

(b) transmitting means for transmitting user traffic or signalling data on said communication channels;

(c) receiving means for receiving user traffic or signalling data on said communication channels;

(d) modulating means for modulating signalling data;

(e) demodulating means for demodulating signalling data;

(f) interfacing means for interfacing to a wide area network; [and]

(g) switching means for making dynamic connections to switch signals among [between] said transmitting means, said receiving means, said modulating means, said demodulating means, and said interfacing means; and

31

(h) forward communication controlling means for selecting a forward signalling data channel via a dynamic connection between said transmitting means and said modulating means.[;]

[(i) controlling means for selecting a reverse signalling data channel via a dynamic connection between said receiving means and said demodulating means;]

[(j) controlling means for connecting a plurality of remote terminals via dynamic connections between said transmitting means and said receiving means; and]

[(k) controlling means for connecting a plurality of remote terminals to a plurality of wide area networks via dynamic connections between said transmitting means, said receiving means and said interfacing means; and]

[(l) controlling means for establishing a plurality of data modem connections to a wide area network via dynamic connections between said transmitting means, said receiving means, said modulating means, said demodulating means, and said interfacing means.]

19

10. (Amended) In a multiple access communication system having a central controller, a plurality of communication channels, and a plurality of remote terminals, each of said plurality of [a] remote terminals comprising:

(a) user traffic transmitting means for transmitting user traffic on an assigned communication channel;

(b) user traffic receiving means for receiving user traffic on an assigned communication channel;

(c) signalling data transmitting means for transmitting signalling data on an assigned communication channel;

(d) signalling data receiving means for receiving signalling data on an assigned communication channel;

(e) user interfacing means [for interfacing to the user] comprising a telephone with a keypad; [and]

(f) system controlling means for controlling the communication system comprising a micro-processor and associated EPROM and RAM; and

(g) [(f)] communication controlling means for tuning said signalling data transmitting means and for tuning said signalling data receiving means under control of said central controller [interfacing] to a pair of [said] assigned communication channels via said [the] micro-processor and associated EPROM and RAM.

10

~~11.~~ (Added) The multiple access communication system of claim 6 further comprising the step of determining whether there is a command from said central controller to one or more of said plurality of remote terminals.

11

~~12.~~ (Added) In the multiple access communication system of claim 6, said step of polling a plurality of said plurality of remote terminals simultaneously by said central controller for determining whether there is any pending request from said plurality of remote terminals comprising the steps of:

(a) polling by said central controller said plurality of remote terminals in parallel on two or more of said plurality of signalling data channels; and

(b) responding to said polling by said central controller by only those of said plurality of remote terminals which have a pending request.

15
~~13~~. (Added) In a multiple access communication system having a plurality of communication channels for communicating with a plurality of remote terminals according to claim 14, said central controller further comprising reverse communication controlling means for selecting a reverse signalling data channel via a dynamic connection between said receiving means and said demodulating means.

16
~~14~~. (Added) In a multiple access communication system having a plurality of communication channels for communicating with a plurality of remote terminals according to claim 15, said central controller further comprising remote terminal communication controlling means for connecting a plurality of remote terminals via dynamic connections between said transmitting means and said receiving means.

17
~~15~~. (Added) In a multiple access communication system having a plurality of communication channels for communicating with a plurality of remote terminals according to claim 16, said central controller further comprising wide area network communication controlling means for connecting a plurality of remote terminals to a plurality of wide area networks via dynamic connections among said transmitting means, said receiving means and said interfacing means.

18
~~16~~. (Added) In a multiple access communication system having a plurality of communication channels for communicating with a plurality of remote terminals according to claim 17, said central controller further comprising modem communication controlling means for establishing a plurality of data modem

37

connections to a wide area network via dynamic connections among said transmitting means, said receiving means, said modulating means, said demodulating means, and said interfacing means.

12 ~~17~~. (Added) In a multiple access communication system according to claim 6, said step of polling a plurality of said remote terminals simultaneously by said central controller for determining whether there is any pending request from said plurality of remote terminals by continuing polling by said central controller before receiving any responses from said plurality of remote terminals.

13 ~~18~~. (Added) In a multiple access communication system according to claim 6, said step of resolving contention among said plurality of remote terminals if there is a pending request from more than one remote terminal on the same signalling data channel further comprising the step of identifying one of said more than one remote terminal that has a pending request by polling groups of said plurality of remote terminals.

9 ~~19~~. (Added) In a multiple access communication system according to claim 8, said step of polling said plurality of remote terminals by said central controller for identifying one of said plurality of remote terminals involved in the collision by continuing polling by said central controller before receiving any responses from said plurality of remote terminals.

20. (Added) In a multiple access communication system according to claim 19 ~~10~~, said system controlling means further comprising a program for resolving contention in a multiple access system by responding to polling by said central controller.

REMARKS

The claims pending are claims 1-20. Claims 1-10 have been amended to more definitely recite the claimed inventions. New claims 11-20 have been added to afford applicant additional protection to which he is entitled. It is noted that claims 2-4 and 7-9 are not rejected as anticipated.

For convenience applicant will respond to the Office Action of Primary Examiner Safourek in lettered sections corresponding to the letters in the Office Action.

A. The requirement for formal drawings is noted. Formal drawings will be filed after receipt of a Notice of Allowance.

B. The Abstract of the disclosure has been corrected to replace the word "means" with the word "apparatus."

C. Primary Examiner Safourek has rejected claims 1-10 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as his invention. Applicant has consulted a patent attorney and each of claims 1-10 has been amended in order to avoid each of Primary Examiner Safourek's objections. It is respectfully submitted that each of claims 1-10 as amended now complies with U.S.C. § 112, second paragraph.

D. Primary Examiner Safourek has rejected claims 1 and 5 under 35 U.S.C. § 102(b) as being anticipated by Grauel et al. (Grauel).

In order to explain the fundamental differences between the invention as defined by amended claim 1 and the cellular phone system disclosed by Grauel, applicant's invention will be briefly described.

Amended claim 1 defines a multiple access communication method of allocating a plurality of signalling data channels between a central controller and a plurality of remote terminals and of assigning remote terminals. Thus amended claim 1(a) recites "establishing communications between said central controller and said plurality of remote terminals via a plurality of signalling data channels, each of said remote terminals being initially assigned to a pair of predetermined signalling data channels."

Contrariwise, Grauel discloses a Method and Means For Allocating The Volume Of Traffic Over Different Control Channels Of A Cellular Radio System. Thus Grauel teaches that each cellular telephone is connected to the base radio station (Fig. 1) by a single signalling data channel. That single channel is shown by the unnumbered dashed line from his base radio station to his mobile radio station. That is, Grauel does not teach a plurality of signalling data channels as recited in amended claim 1(a).

Still further, amended claim 1(c) recites "determining whether one of said plurality of remote terminals needs to be reassigned to a different signalling data channel other than said predetermined signalling data channel." That step is clearly not shown by Grauel because he teaches that each control channel covers a range of the mobile radio stations with qualifying identifiers. Grauel's base radio station "meters" the aggregate traffic load of the control channels and adjusts the group codes of control channels for load

spreading. Therefore, it is not intended to select any individual mobile radio station for re-assignment.

Moreover, amended claim 1(d) recites "determining whether a different and suitable signalling data channel is available other than said predetermined channel." Grauel does not disclose that step. Only when traffic load is not balanced over the control channels, the base radio station is to rearrange the grouping of the mobile radio stations by changing the group codes of control channels. Or when failure occurs, the base station is to change a traffic channel to a control channel implying that every mobile radio station has to scan all data channel for this change. The step to allocate a new control channel by "changing the control channel code" is not disclosed.

Finally, amended claim 1(e) recites "reassigning by said central controller said remote terminal to a different and suitable signalling data channel for communication henceforward." Grauel does not disclose that step. Grauel does not allocate a signalling data channel and assign a remote cellular telephone to that channel. What Grauel teaches is a method of attaching group codes to control channels, each of which covers a range of cellular telephones with qualifying identifiers. Grauel's mobile stations need to monitor the changes of group codes of control channels and to assign themselves to the appropriate control channel.

Accordingly, it is respectfully submitted that amended claim 1 is clearly not anticipated by Grauel's cellular phone method. Further, the method defined by amended claim 1 is clearly nonobvious over Grauel and so is patentable for that reason.

Amended claim 5, which is dependent from claim 1, is allowable for the same reasons as amended claim 1 and because of the additional subject matter claimed. In

particular claim 5 recites the additional steps of: "(a) sensing the status of other signalling data channels other than said predetermined channel for spare capacity; and (b) allocating a new signalling data channel if no signalling data channel has spare capacity and a new signalling data channel is available." Grauel does not teach either of these steps.

So Claim 5 is allowable for these additional reasons.

E. Primary Examiner Safourek has rejected claim 6 under 35 U.S.C. § 102(e) as being anticipated by Christensen.

In order to explain the fundamental differences between the invention as defined by amended claim 6 and the hub controller system disclosed by Christensen, applicant's invention will be briefly described.

Amended claim 6 defines a controlled multiple access communication method, in which a plurality of signalling data channels is used to communicate with remote terminals. Thus amended claim 6(a) recites "establishing communications between said central controller and each of said plurality of remote terminals via predetermined signalling data channels of a plurality of signalling data channels, each of said plurality of remote terminals can be assigned to any pair of said plurality of signalling data channels."

Contrariwise, Christensen discloses a Method For Providing Deterministic Access To CSMA Local Area Network. Christensen's system conforms to the CSMA protocol using the same baseband media among all terminals for signalling data as well as normal user traffic. Furthermore there is no communication between Christensen's Hub

Controller and the terminals other than the "pseudo carrier" control signal in the baseband media to schedule the terminals for transmission.

Similarly amended claim 6(b) recites "polling a plurality of said remote terminals simultaneously by said central controller for determining whether there is any pending request from said plurality of remote terminals." That is, the central controller polls group of remote terminals instead of individual terminal for pending request. In contrary, Christensen's Hub Controller gives precedence to certain terminals by polling those terminals individually (Fig. 5a and 5b).

Moreover amended claim 6(c) recites "resolving contention among said plurality of remote terminals by said central controller if there is a pending request from more than one remote terminal on the same signalling data channel." Christensen's Hub Controller is not involved in contention resolution. Instead it lets the terminals follow the CSMA protocol in case of collision.

Accordingly, it is respectfully submitted that amended claim 6 is clearly not anticipated by Christensen's Method For Providing Deterministic Access To CSMA Local Area Network. Further, the method defined by amended claim 6 is clearly nonobvious over Christensen and so is patentable for that reason.

F. Primary Examiner Safourek has rejected claim 10 under 35 U.S.C. § 102(e) as being anticipated by Flohr.

In order to explain the fundamental differences between the invention as defined by amended claim 10 and the Videoconferencing System disclosed by Flohr, applicant's invention will be briefly described.

Amended claim 10 defines a remote terminal in a multiple access communication system where the central controller controls all communications in the system including relaying user traffic between remote terminals. Following a unique protocol, the remote terminal responds to the central controller's polls for control functions, e.g., to set up communication channel for user traffic, in a master-slave relationship. Each remote terminal is assigned to a pair of signalling data channels under the control of the central controller for redundancy.

Contrariwise, Flohr discloses a Videoconferencing System in which all terminals are equal in that these terminals are able to receive signals from other terminals directly over the transmission media. The control data follows the conventional LAN protocol (Fig. 1, 18A and 18B) while each terminal transmits on a fixed frequency band on the CATV cable.

Accordingly, it is respectfully submitted that amended claim 10 is clearly not anticipated by Flohr's Videoconferencing System. Further, the method defined by amended claim 10 is clearly nonobvious over Flohr and so is patentable for that reason.

In sum all of the pending claims are believed to be allowable.

Reconsideration of the rejected claims as amended and allowance of the application are respectfully requested.

October 1, 1995

Respectfully submitted,

Alexander L. Cheng
Applicant
11 Springdale Avenue
White Plains, NY 10604
914-428-0299

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO.
08/276,534	07/18/94	CHENG	A CHENG101

EXAMINER
SAFOUREK, B

ART UNIT	PAPER NUMBER
2603	4

26M1/1127

ALEXANDER L. CHENG
11 SPRINGDALE AVENUE
WHITE PLAINS, NY 10604

DATE MAILED: 11/27/95

NOTICE OF ALLOWABILITY

PART I.

1. ☑ This communication is responsive to amendment of 10-16-95
2. ☑ All the claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice Of Allowance And Issue Fee Due or other appropriate communication will be sent in due course.
3. ☑ The allowed claims are 1-20
4. ☐ The drawings filed on _____ are acceptable.
5. ☐ Acknowledgment is made of the claim for priority under 35 U.S.C. 119. The certified copy has [_] been received. [_] not been received. [ ] been filed in parent application Serial No. _____, filed on _____.
6. ☐ Note the attached Examiner's Amendment.
7. ☐ Note the attached Examiner Interview Summary Record, PTOL-413.
8. ☐ Note the attached Examiner's Statement of Reasons for Allowance.
9. ☐ Note the attached NOTICE OF REFERENCES CITED, PTO-892
10. ☐ Note the attached INFORMATION DISCLOSURE CITATION, PTO-1449

PART II.

A SHORTENED STATUTORY PERIOD FOR RESPONSE to comply with the requirements noted below is set to EXPIRE THREE MONTHS FROM THE "DATE MAILED" indicated on this form. Failure to timely comply will result in the ABANDONMENT of this application. Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

1. ☐ Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL APPLICATION, PTO-152, which discloses that the oath or declaration is deficient. A SUBSTITUTE OATH OR DECLARATION IS REQUIRED.
2. ☑ APPLICANT MUST MAKE THE DRAWING CHANGES INDICATED BELOW IN THE MANNER SET FORTH ON THE REVERSE SIDE OF THIS PAPER.
   a. ☑ Drawing informalities are indicated on the NOTICE RE PATENT DRAWINGS; PTO-948, attached hereto or to Paper No. 2. CORRECTION IS REQUIRED.
   b. ☐ The proposed drawing correction filed on _____ has been approved by the examiner. CORRECTION IS REQUIRED.
   c. ☐ Approved drawing corrections are described by the examiner in the attached EXAMINER'S AMENDMENT. CORRECTION IS REQUIRED.
   d. ☑ Formal drawings are now REQUIRED.

Any response to this letter should include in the upper right hand corner, the following information from the NOTICE OF ALLOWANCE AND ISSUE FEE DUE: ISSUE BATCH NUMBER, DATE OF THE NOTICE OF ALLOWANCE, AND SERIAL NUMBER.

Attachments:

- _ Examiner's Amendment
- _ Examiner Interview Summary Record, PTOL-413
- _ Reasons for Allowance
- _ Notice of References Cited PTO-892
- _ Information Disclosure Citation, PTO-1449
- _ Notice of Informal Application, PTO-152
- _ Notice re Patent Drawings, PTO-948
- _ Listing of Bonded Draftsmen
- _ Other

Benedict V. Safourek

BENEDICT V. SAFOUREK
PRIMARY EXAMINER
GROUP 263

PTOL-37 (REV. 4-89) ★

USCOMM-DC 89-3789

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

Address: Box ISSUE FEE
COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

26M1/1127

ALEXANDER L. CHENG
11 SPRINGDALE AVENUE
WHITE PLAINS, NY 10604

NOTICE OF ALLOWANCE AND ISSUE FEE DUE

☐ Note attached communication from the Examiner
☐ This notice is issued in view of applicant's communication filed _____

SERIES CODE/SERIAL NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP ART UNIT	DATE MAILED
08/276,534	07/18/94	020	SAFOUREK, B 2603	11/27/95

First Named Applicant: CHENG, ALEXANDER L.

TITLE OF INVENTION: DYNAMIC CHANNEL MANAGEMENT AND SIGNALLING METHOD AND APPARATUS

	ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
2	CHENG101	370-073.000	R37	UTILITY	YES	$625.00	02/27/96

THE APPLICATION IDENTIFIES ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED.

THE ISSUE FEE MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED.

HOW TO RESPOND TO THIS NOTICE:

I. Review the SMALL ENTITY Status shown above.
If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is changed, pay twice the amount of the FEE DUE shown above and notify the patent and Trademark Office of the change in status, or
B. If the Status is the same, pay the FEE DUE shown above.

If the SMALL ENTITY is shown as NO:
A. Pay FEE DUE shown above, or
B. File verified statement of Small Entity Status before, or with, pay of 1/2 the FEE DUE shown above.

II. Part B of this notice should be completed and returned to the Patent and Trademark Office (PTO) with your ISSUE FEE. Even if the ISSUE FEE has already been paid by charge to deposit account, Part B should be completed and returned. If you are charging the ISSUE FEE to your deposit account, Part C of this notice should also be completed and returned.

III. All communications regarding this application must give series code (or filing date), serial number and batch number. Please direct all communication prior to issuance to Box ISSUE FEE unless advised to contrary.

IMPORTANT REMINDER: Patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PTOL-85 (REV. 12-93) (0651-0033) 4. PATIENT AND TRADEMARK OFFICE COPY

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT		ATTORNEY DOCKET NO.
08/276,534	07/18/94	CHENG	A	CHENG101

SAFOUREK, EXAMINER

26M1/1221

ALEXANDER L. CHENG
11 SPRINGDALE AVENUE
WHITE PLAINS, NY 10604

ART UNIT	PAPER NUMBER
2603	5

DATE MAILED: 12/21/95

Supplemental NOTICE OF ALLOWABILITY

PART I.

1 ☑ This communication is responsive to amendment of 10-16-95

2 ☑ All the claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice Of Allowance And Issue Fee Due or other appropriate communication will be sent in due course.

3 ☑ The allowed claims are 1-20

4 ☐ The drawings filed on _____ are acceptable.

5. ☐ Acknowledgment is made of the claim for priority under 35 U.S.C. 119. The certified copy has [ ] been received [ ] not been received [ ] been filed in parent application Serial No. _____, filed on _____

6. ☐ Note the attached Examiner's Amendment.

7 ☐ Note the attached Examiner Interview Summary Record, PTOL-413.

8. ☐ Note the attached Examiner's Statement of Reasons for Allowance.

9. ☐ Note the attached NOTICE OF REFERENCES CITED, PTO-892

10 ☐ Note the attached INFORMATION DISCLOSURE CITATION, PTO-1449

PART II.

A SHORTENED STATUTORY PERIOD FOR RESPONSE to comply with the requirements noted below is set to EXPIRE THREE MONTHS FROM THE "DATE MAILED" indicated on this form. Failure to timely comply will result in the ABANDONMENT of this application. Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

1 ☑ Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL APPLICATION, PTO-152, which discloses that the oath or declaration is deficient ~~A SUBSTITUTE OATH OR DECLARATION IS REQUIRED~~

2 ☑ APPLICANT MUST MAKE THE DRAWING CHANGES INDICATED BELOW IN THE MANNER SET FORTH ON THE REVERSE SIDE OF THIS PAPER

a ☑ Drawing informalities are indicated on the NOTICE RE PATENT DRAWINGS, PTO-948, attached hereto or to Paper No. 2 CORRECTION IS REQUIRED

b. ☐ The proposed drawing correction filed on _____ has been approved by the examiner. CORRECTION IS REQUIRED

c ☐ Approved drawing corrections are described by the examiner in the attached EXAMINER'S AMENDMENT. CORRECTION IS REQUIRED

d ☑ Formal drawings are now REQUIRED

Any response to this letter should include in the upper right hand corner, the following information from the NOTICE OF ALLOWANCE AND ISSUE FEE DUE: ISSUE BATCH NUMBER, DATE OF THE NOTICE OF ALLOWANCE, AND SERIAL NUMBER.

Attachments:

- _ Examiner's Amendment
- _ Examiner Interview Summary Record PTOL-413
- _ Reasons for Allowance
- _ Notice of References Cited PTO-892
- _ Information Disclosure Citation, PTO-1449
- ☑ Notice of Informal Application, PTO-152
- _ Notice re Patent Drawings, PTO-948
- _ Listing of Bonded Draftsmen
- _ Other

A statement signed by applicant giving his complete post office address is required.

Benedict V. Safourek

BENEDICT V. SAFOUREK
PRIMARY EXAMINER
GROUP 263

PTOL-37 (REV. 4-89) ★

09/276,534

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTY DOCKET NO./TITLE

DATE MAILED:

NOTICE OF INFORMAL APPLICATION

(Attachment to Office Action)

This application does not conform with the rules governing applications for the reason(s) checked below. The period within which to correct these requirements and avoid abandonment is set in the accompanying Office action.

A. A new oath or declaration, identifying this application by the application number and filing date is required. The oath or declaration does not comply with 37 CFR 1.63 in that it:

1. ☐ does not identify the city and state or foreign country of residence of each inventor.
2. ☐ does not identify the citizenship of each inventor.
3. ☐ does not state whether the inventor is a sole or joint inventor.
4. ☐ does not state that the person making the oath or declaration:
   a. ☐ has reviewed and understands the contents of the specification, including the claims, as amended by any amendment specifically referred to in the oath or declaration.
   b. ☐ believes the named inventor or inventors to be the original and first inventor or inventors of the subject matter which is claimed and for which a patent is sought.
   c. ☐ acknowledges the duty to disclose information which is material to the examination of the application in accordance with 37 CFR 1.56(a).
5. ☐ does not identify the foreign application for patent or inventor's certificate on which priority is claimed pursuant to 37 CFR 1.55, and any foreign application having a filing date before that of the application on which priority is claimed, by specifying the application serial number, country, day, month, and year of its filing.
6. ☐ does not state that the person making the oath or declaration acknowledges the duty to disclose material information as defined in 37 CFR 1.56(a) which occurred between the filing date of the prior application and filing date of the continuation-in-part application which discloses and claims subject matter in addition to that disclosed in the prior application (37 CFR 1.63(d)).
7. ☐ does not include the date of execution.
8. ☐ does not use permanent ink, or its equivalent in quality, as required under 37 CFR 1.52(a).
9. ☐ contains non-initialed alterations (See 37 CFR 1.52(c)).
10. ☐ Other:

B. Applicant is required to provide:

1. ☐ A statement signed by applicant giving his or her complete name. A full name must include at least one given name without abbreviation as required by 37 CFR 1.41(a).
2. ☐ Proof of authority of the legal representative under 37 CFR 1.44.
3. ☐ An abstract in compliance with 37 CFR 1.72(b).
4. ☒ A statement signed by applicant giving his or her complete post office address (37 CFR 1.33(a)).
5. ☐ A copy of the specification written, typed, or printed in permanent ink, or its equivalent in quality as required by 37 CFR 1.52(a).
6. ☐ Other:

FORM PTO-152 (REV. 6-90)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Serial No.	08/276,534
Filing Date	07/18/94
Applicant	Alexander L. Cheng
For	DYNAMIC CHANNEL MANAGEMENT AND SIGNALLING METHOD AND APPARATUS
Group Art Unit	2603
Examiner	Benedict V. Safourek
Docket	CHENG101

DRAWINGS TRANSMITTAL LETTER

Drawing Review Board
Commissioner of Patents and Trademarks
Washington, DC 20231

Sir:

In response to the Notice of Draftsperson's Patent Drawing Review dated 08/18/94, enclosed are sixteen sheets of formal drawings in the subject application submitted within the three months shortened statutory period set in the Notice of Allowance dated 11/27/95.

Pursuant to 37 CFR § 1.84(c), placed on the back of each sheet is the application serial number, filing date, inventor's name, docket number, the name and telephone number of the person to call if the Office is unable to match the drawings to the proper application.

It is respectfully submitted that the formal drawings are acceptable so that the patent should issue.

January 13, 1996

Respectfully submitted,

Alexander L. Cheng
Applicant
11 Springdale Avenue
White Plains, NY 10604
914-428-0299

BY PRIORITY MAIL

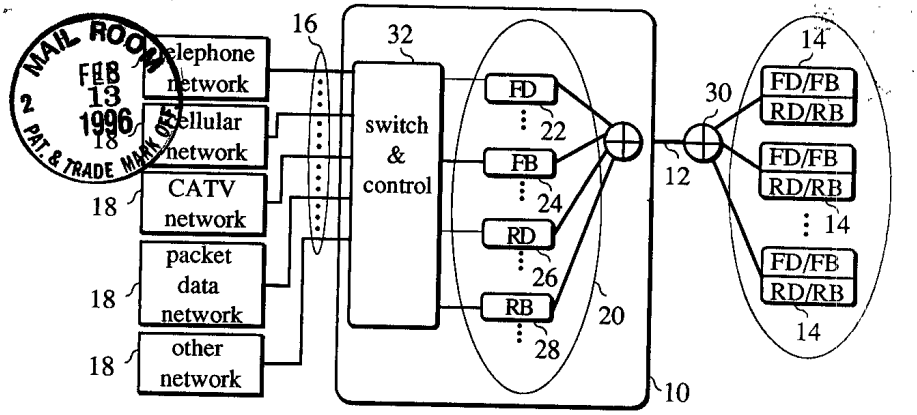


Figure 1

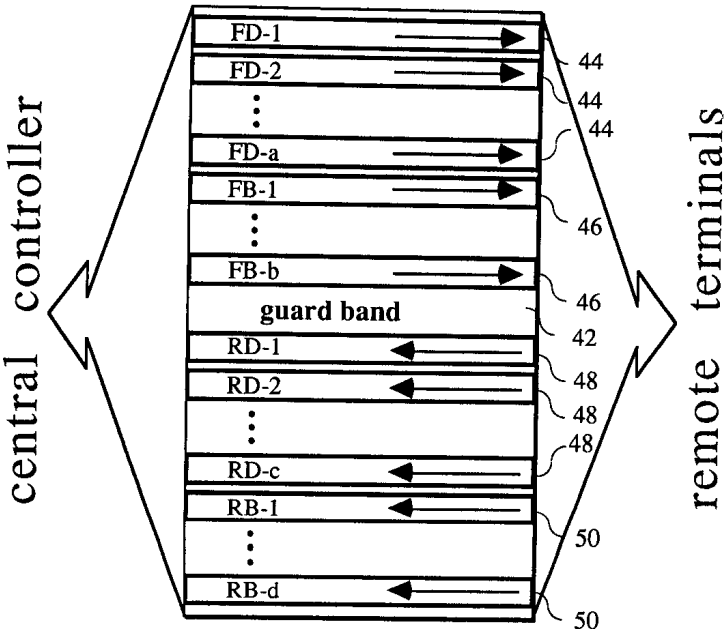


Figure 2

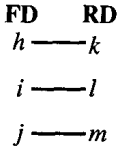


Figure 3a

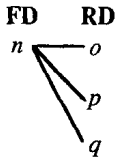


Figure 3b

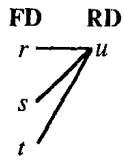


Figure 3c

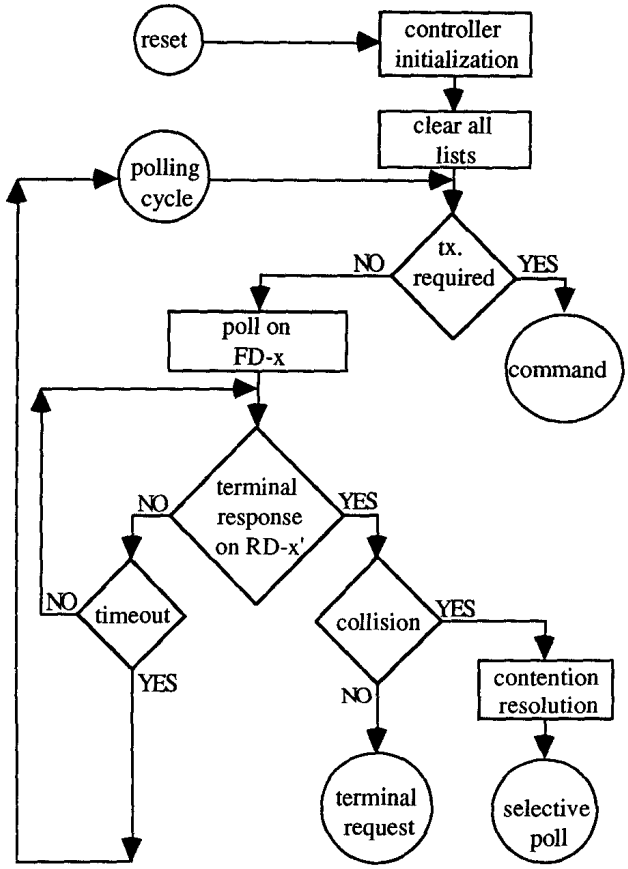


Figure 4

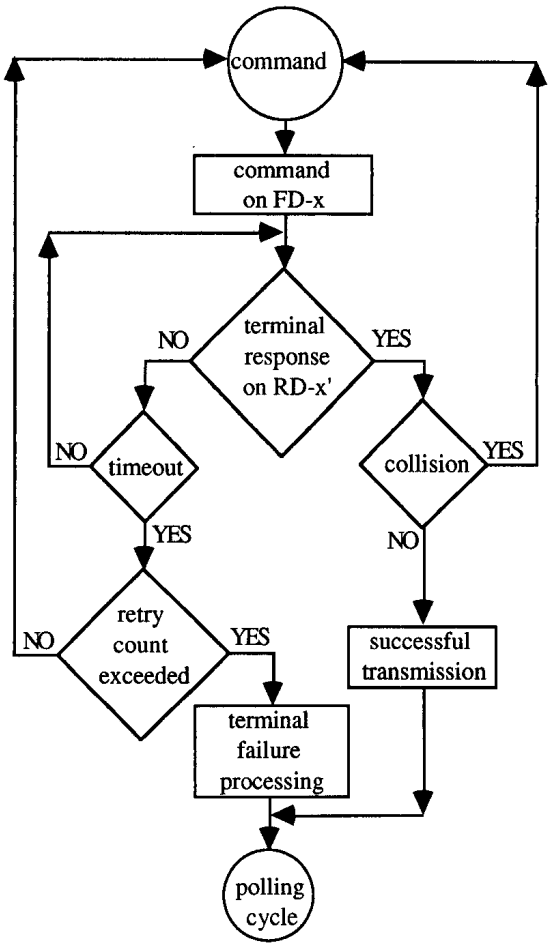

command
command on FD-x
terminal response on RD-x'
NO
YES
timeout
NO
YES
collision
YES
NO
retry count exceeded
NO
YES
successful transmission
terminal failure processing
polling cycle

Figure 5

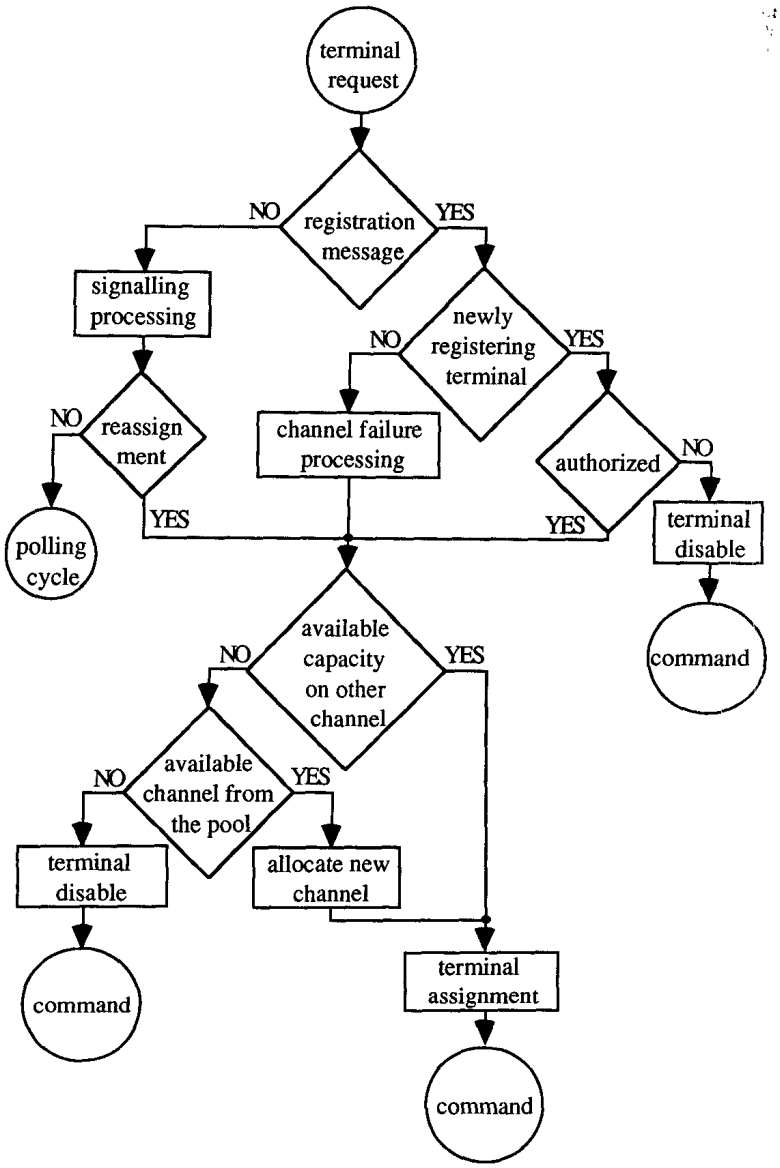

terminal request
registration message
NO
YES
signalling processing
newly registering terminal
NO
YES
reassign ment
NO
channel failure processing
authorized
NO
YES
YES
polling cycle
terminal disable
command
available capacity on other channel
NO
YES
available channel from the pool
NO
YES
terminal disable
allocate new channel
command
terminal assignment
command

Figure 6

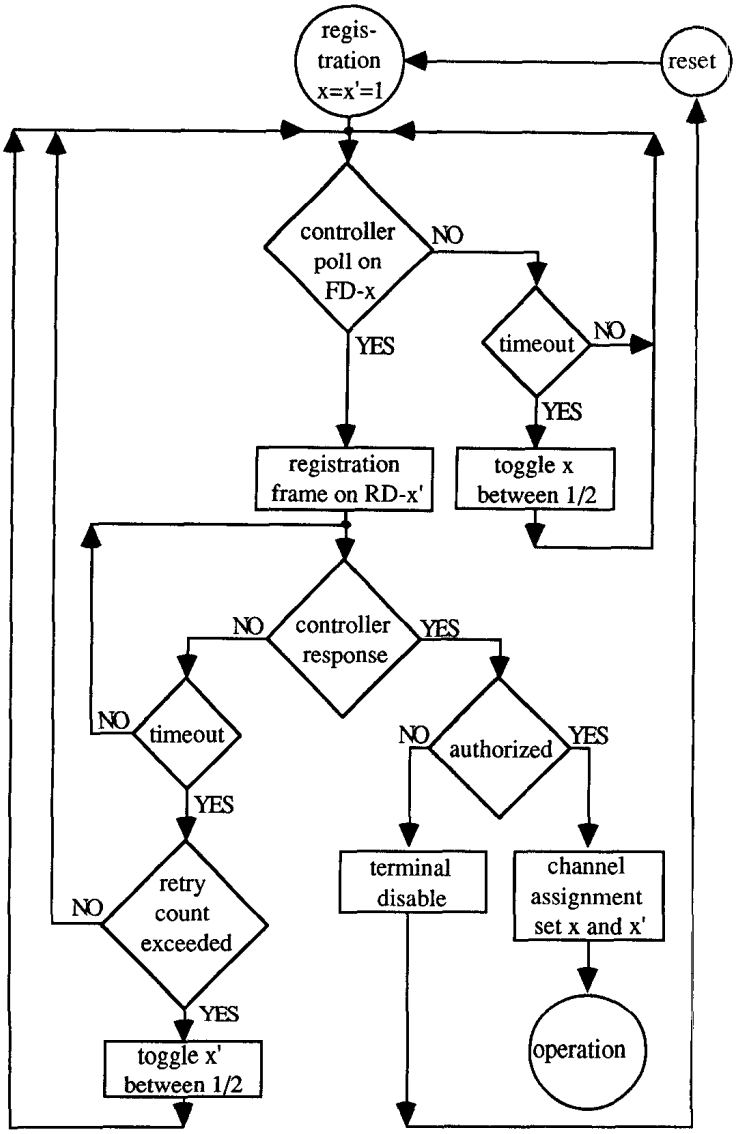

regis-
tration
x=x'=1
reset
controller
poll on
FD-x
NO
YES
timeout
NO
YES
registration
frame on RD-x'
toggle x
between 1/2
NO
controller
response
YES
NO
timeout
YES
NO
authorized
YES
retry
count
exceeded
NO
YES
terminal
disable
channel
assignment
set x and x'
toggle x'
between 1/2
operation

Figure 7

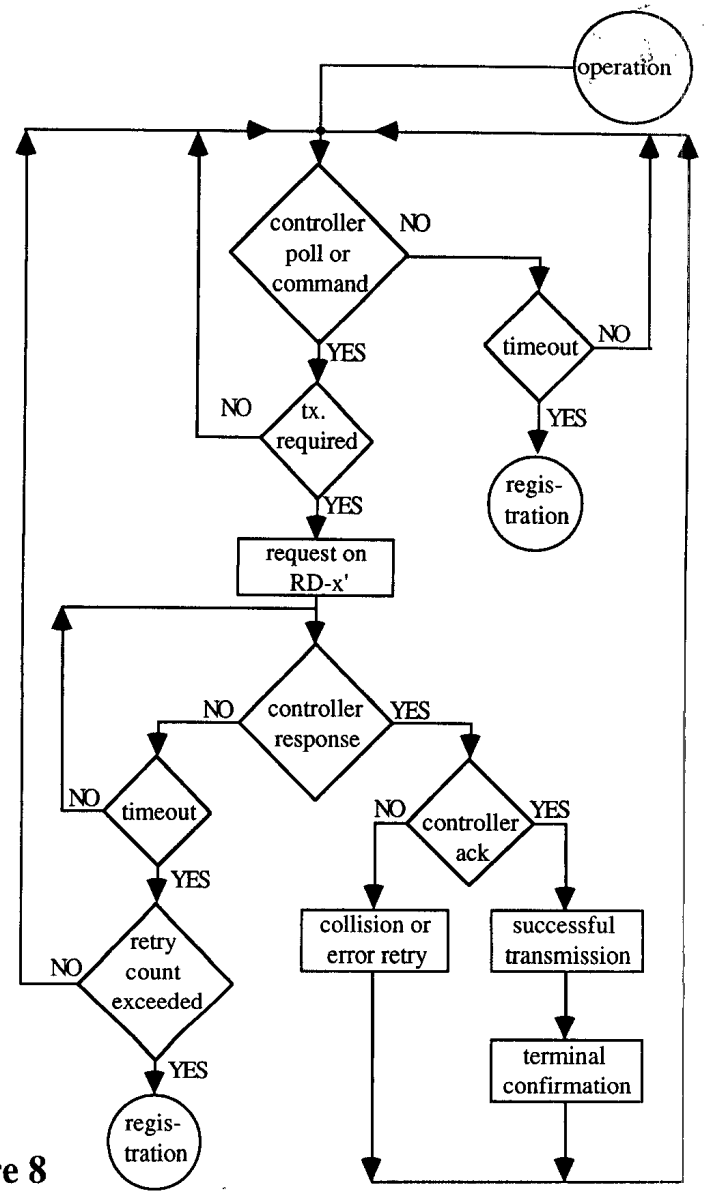


Figure 8

Signalling data frame in the forward direction sent by central controller:

1	1	3	1
PMB	TID	SAT	FCS

Signalling data frame in the reverse direction sent by remote terminals:

1	1	3	1	bytes
PMB	TID	SRT	FCS	

preamble (PMB)
- sequence to indicate the start of message frame transmission and aid detection of collision

Terminal IDentifier (TID)
- terminal identifier for command
- lower TID of the range for the selective poll
- 0 (hexadecimal 00) is an invalid TID used for disabling terminal during the registration process (SAT/SRT contains the serial number)
- 255 (hex FF) for registration process (SAT/SRT contains the serial number)

Signalling Action Type (SAT)
- serial number of the remote terminal for channel assignment during registration process
- selective poll including higher TID of the range (used also for general/specific poll)
- selective poll with collision alert including higher range (used also for specific poll)
- in-coming call command on the indicated channel number
- release command
- disable command
- test command
- channel re-assignment command

Signalling Request Type (SRT)
- serial number of the remote terminal for terminal registration process
- on-hook
- off-hook
- switch-hook
- ringing
- release
- dial-digits
- incoming call blocking
- incoming call unblocking
- feature code (e.g., conference)
- test report
- alarm message (fault and fraud)
- multiple channel request (bandwidth-on-demand)
- channelized services (sub-rate & multiple channels)

Frame Check Sequence (FCS)
- protection, which covers TID and SAT/SRT fields, against transmission error or collision

Figure 9

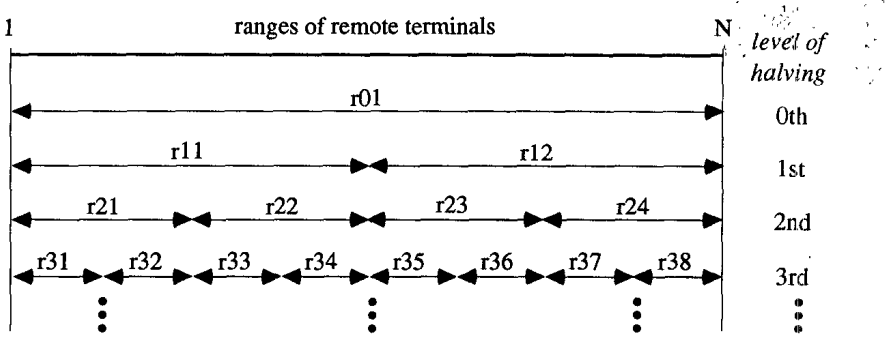


Figure 10

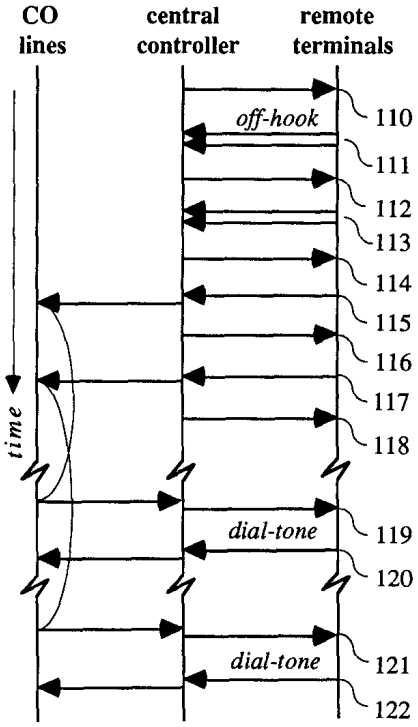


Figure 11

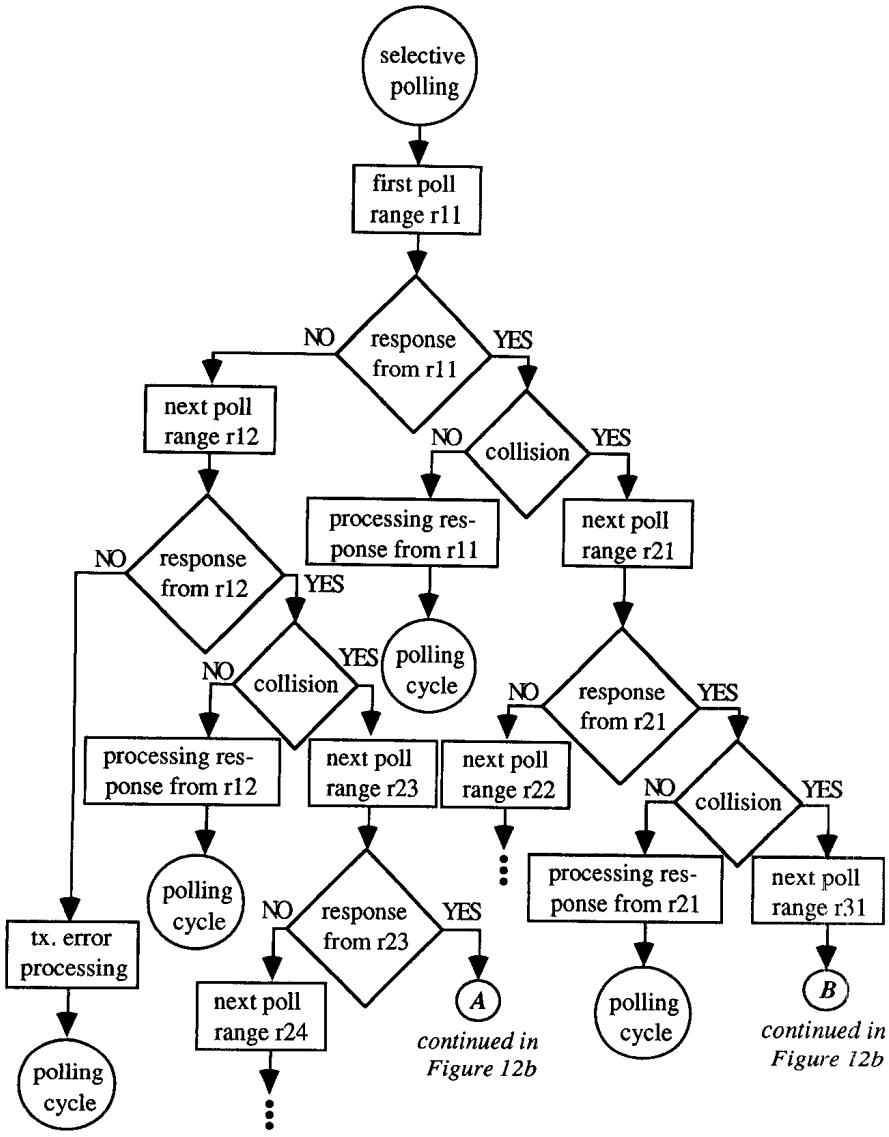

selective polling
first poll range r11
response from r11
NO
YES
next poll range r12
collision
NO
YES
processing response from r11
next poll range r21
response from r12
NO
YES
collision
NO
YES
polling cycle
response from r21
NO
YES
processing response from r12
next poll range r23
next poll range r22
collision
NO
YES
tx. error processing
polling cycle
response from r23
NO
YES
processing response from r21
next poll range r31
next poll range r24
A
B
polling cycle
polling cycle
continued in Figure 12b
continued in Figure 12b

Figure 12a

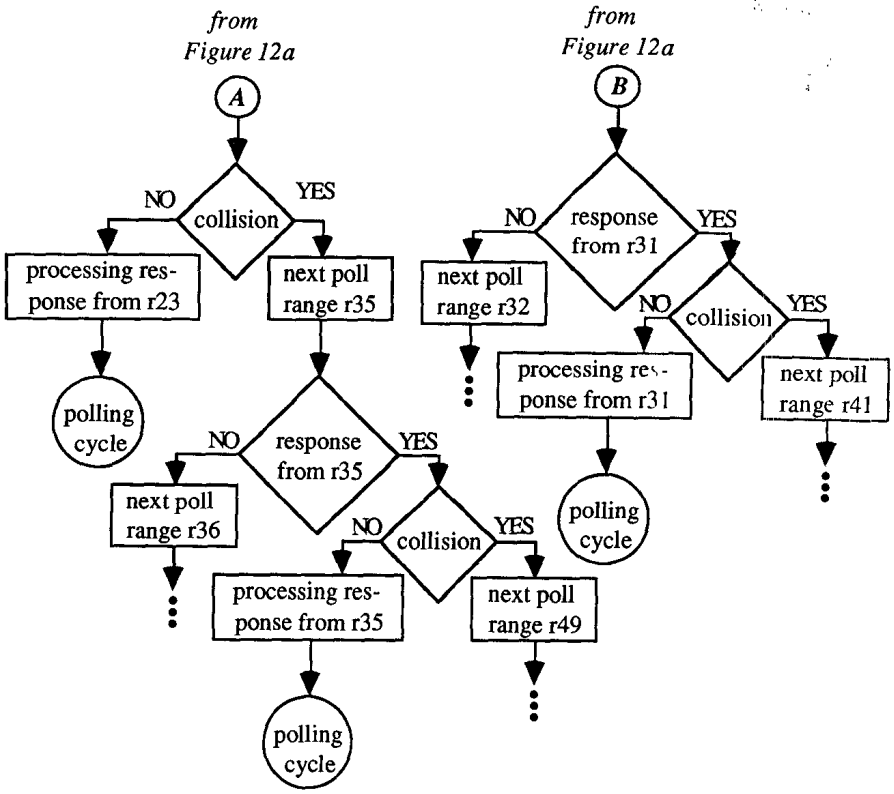


Figure 12b

10

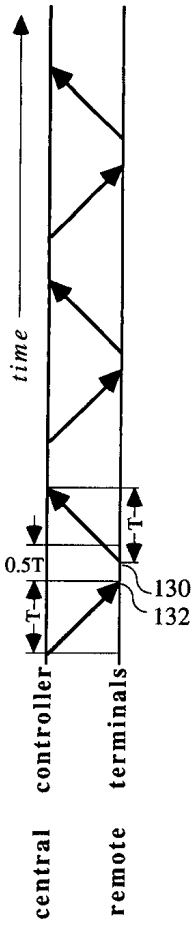


Figure 13a

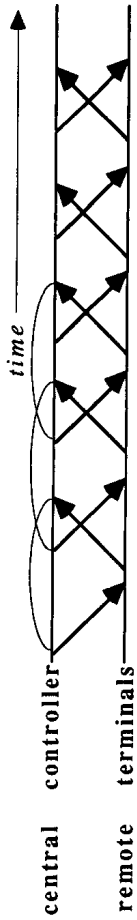


Figure 13b

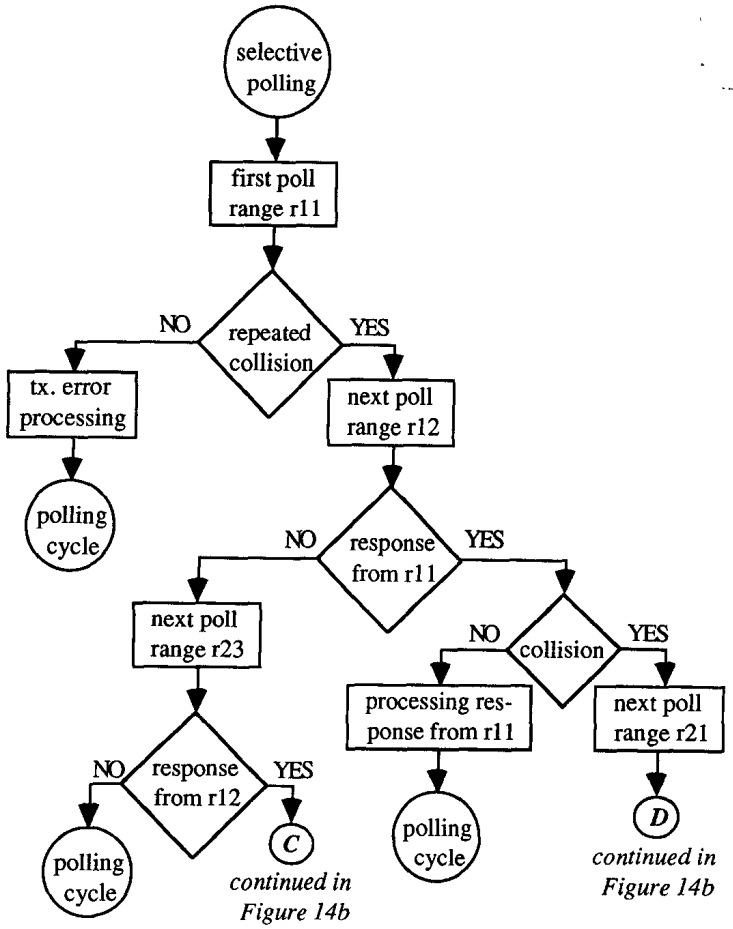


Figure 14a

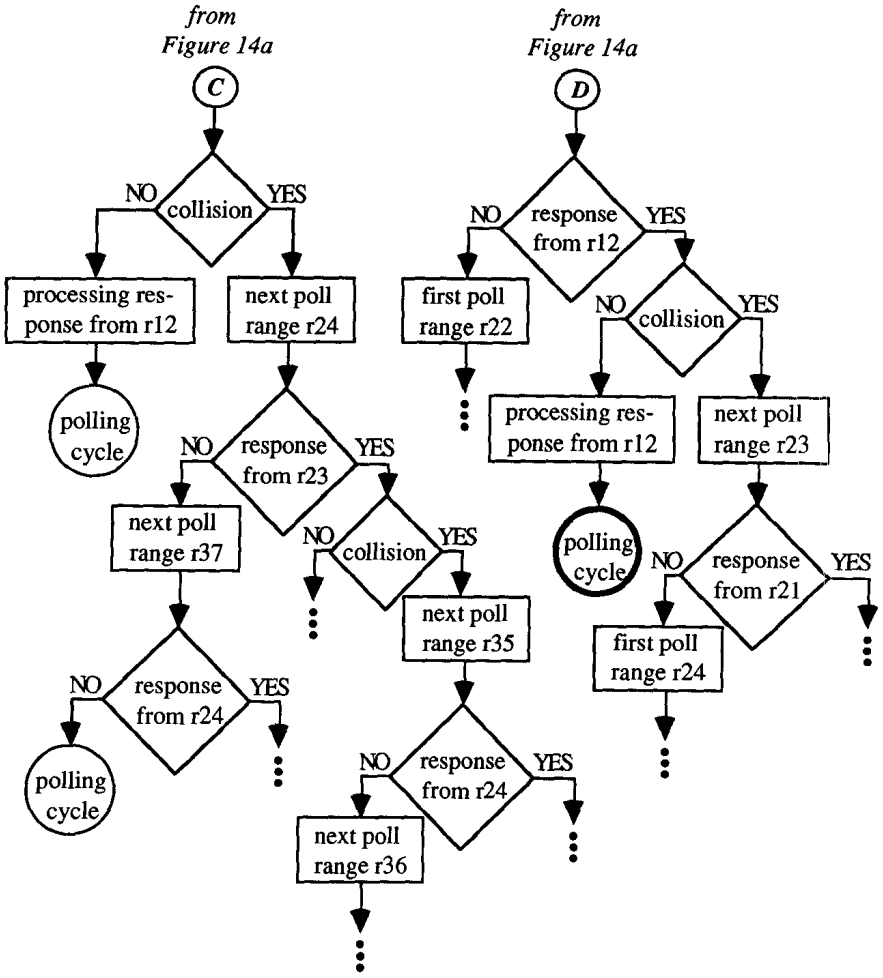

from Figure 14a
C
NO
collision
YES
processing response from r12
next poll range r24
polling cycle
NO
response from r23
YES
next poll range r37
NO
collision
YES
next poll range r35
NO
response from r24
YES
polling cycle
NO
response from r24
YES
next poll range r36
from Figure 14a
D
NO
response from r12
YES
first poll range r22
NO
collision
YES
processing response from r12
next poll range r23
polling cycle
NO
response from r21
YES
first poll range r24

Figure 14b

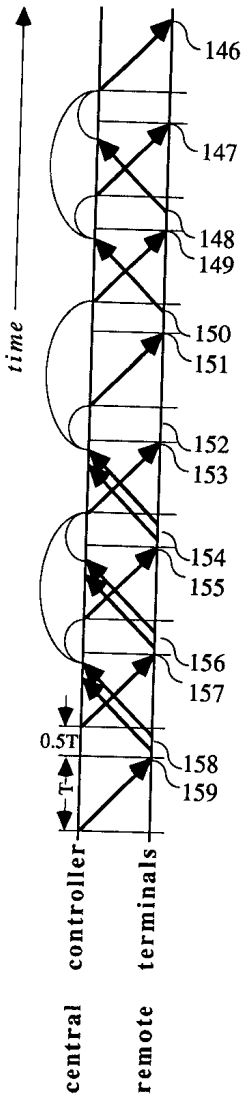

time
146
147
148
149
150
151
152
153
154
155
156
157
0.5T
T
158
159
central controller
remote terminals

Figure 15

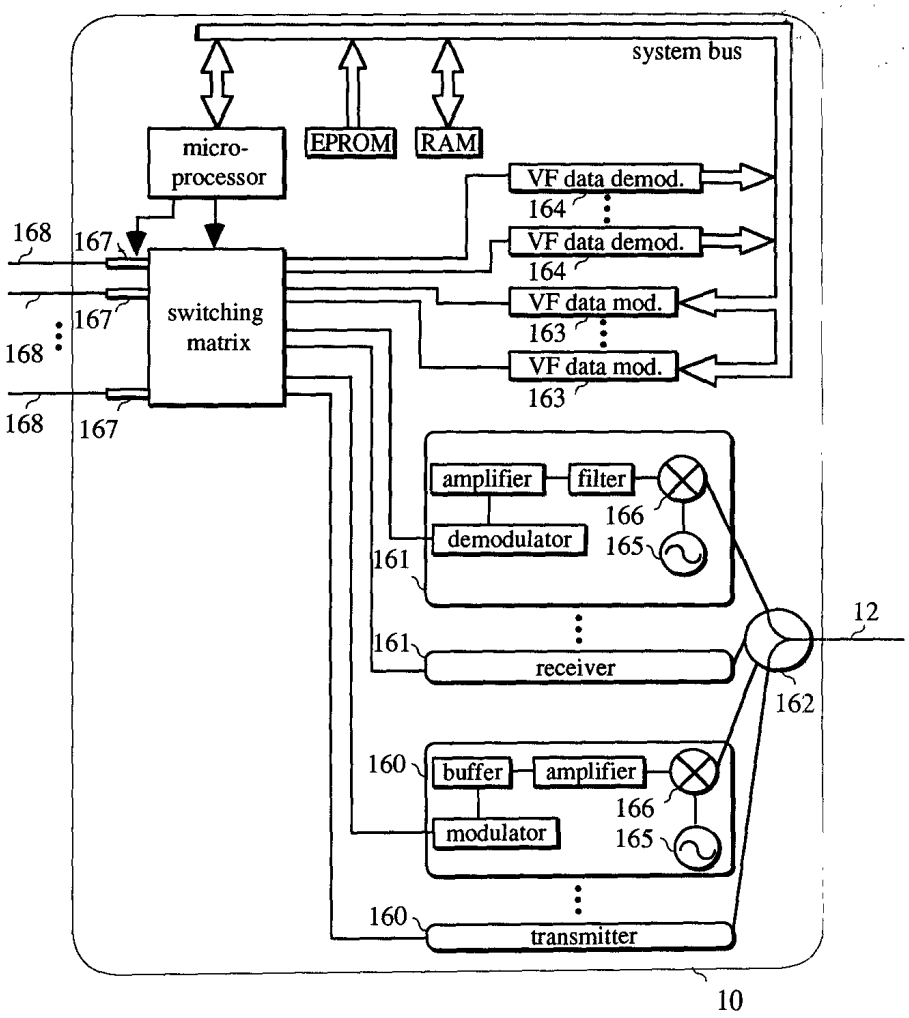


Figure 16

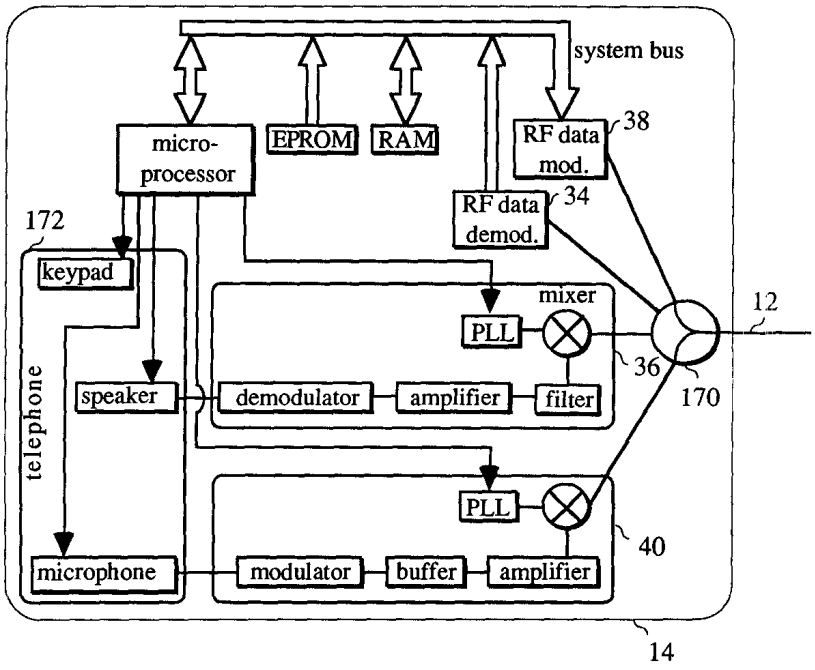


Figure 17

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Serial No.	08/276,534
Filing Date	07/18/94
Applicant	Alexander L. Cheng
For	DYNAMIC CHANNEL MANAGEMENT AND SIGNALLING METHOD AND APPARATUS
Group Art Unit	2603
Primary Examiner	Benedict V. Safourek

AMENDMENT "B" AFTER ALLOWANCE

Commissioner of Patents and Trademarks
Washington, DC 20231

Sir:

In response to the Notice of Informal Application dated 12/21/95, applicant hereby states that his complete post office address is: 11 Springdale Avenue, White Plains, NY 10604-2309, U.S.A.

Further, in the accompanying Drawings Transmittal Letter, applicant has filed formal drawings with added reference characters.

Accordingly, enclosed is substitute specification pages comprising the Description of Preferred Embodiment amended solely to recite the added reference characters.

Pages 10-27 Only
B. V. Safourek

February 13, 1996

Respectfully submitted,

Alexander L. Cheng
Applicant
11 Springdale Avenue
White Plains, NY 10604
914-428-0299

BY PRIORITY MAIL

B

Description Of Preferred Embodiment

The multiple access communication system architecture as depicted in Figure 1 comprises a central controller, a shared transmission media, and a plurality of remote terminals dispersed geographically throughout the network. A pool of communication channels (L) are provided to the wide area networks, a pool of communication channels (M) for supporting a plurality of remote terminals (N). The M number of channels to support communication between the central controller and the remote terminals are separated into four categories for carrying signalling data and user traffic in the forward and reverse directions, i.e., forward signalling data or FD channel, forward traffic bearer or FB channel, reverse signalling data or RD channel, and reverse traffic bearer or RB channel. All communication signals between the central controller and the remote terminals are multiplexed onto the shared transmission media. All remote terminals are equipment supporting the users' communication need and are distributed throughout the network. For simplicity reason, the summing device for signals from remote terminals are shown as a single device in Figure 1. In a CATV network, this summing device represents the splitters and taps connecting the branches that make up the network.

The central controller comprises a switch and control mechanism, and a pool of transmitters, called forward signalling data channel (FD) and forward traffic bearer channel (FB), and a pool of receivers, called reverse signalling data channel (RD) and reverse traffic bearer channel (RB). The central controller provides concentration and control function to meet the communication demand of the remote terminals much the same way as a Private Automated Branch eXchange or PABX. The central controller also translates the signalling information according to the requirement of the

network. In addition to concentration provided through the switching matrix of the central controller, contention in the shared transmission media via the signalling protocol provides another level of concentration with this system.

Each of the remote terminals has one radio frequency (RF) agile data demodulator capable of receiving on the assigned FD channel, one RF agile receiver tuned to the assigned FB channel, one RF agile data modulator capable of transmitting on the assigned RD channel, and one RF agile transmitter tuned to the assigned RB channel.

Although the present invention is useful for interworking with a variety of different wide area networks, the telephone network will be used hereinafter to illustrate the present invention.

As depicted in Figure 2, the bandwidth is channelized for carrying traffic in the forward and the reverse direction. Data channels are used for carrying signalling or data traffic while bearer channels are used for carrying user traffic similar to circuits in telephony. Therefore, there are altogether 4 types of channels as depicted in Figure 2. FD-x is the signalling data channel in the forward direction, i.e., from the central controller to the remote terminals, numbered from 1 to a. FB-y is traffic bearer channel in the forward direction numbered from 1 to b. RD-x' is signalling data channel in the reverse direction, i.e., from the remote terminals to the central controller, numbered from 1 to c. RB-y' is traffic bearer channel in the reverse direction numbered from 1 to d. A guard band is also shown to separate the signals traveling in the forward and the reverse directions if they are to be put side-by-side. As explained later a and c should be greater than or equal to 2 for redundancy reason. Note that if the channels are of equal size, then $a+b$ and $c+d$ shall remain constant if all channels are available free of interference problem, i.e., there are a pool of channels from the central controller to the

remote terminals, and a separate pool of channels from the remote terminals to the central controller. These pools are set aside for a flexible allocation scheme to be described in detail later.

Although it is not necessary to have all channel to have equal bandwidth, the communication process can be managed more easily if the channels have simplified structure with equal bandwidth. In case of equal size of the FD and FB channels, the management scheme can relocate the FD to a channel that is better suited for data transmission while FB channel carrying normal voice communication can tolerate a considerable more noisy channel than FD channel is able to. Similarly, the management process can take advantage of the flexibility afforded by the equal size of the RD and RB channels. If the bandwidth of the communication channels to the wide area network is equivalent to the channels of the shared transmission media, the number L is less than or equal to the number M, which in turn is less than or equal to the number N. In case of channels with different sizes the central controller needs to have the additional intelligence for managing these channels efficiently, and to perform segmentation and reassembly. Note that communication with asymmetric bandwidth requirement such as multi-cast can be efficiently supported in this system.

The FB-y and RB-y' channels are allocated according to the signalling protocol communicated over the FD-x and RD-x' channels. There is no contention in the forward direction, i.e., the traffic on each FD-x channel is scheduled independently. The number of signalling data channels are used to improve the efficiency servicing groups of remote terminals and the system redundancy. In case of transmission failure (detected through a number of retries without receiving acknowledgment), the central controller reverts back to FD-1 and then FD-2 for transmission to the specific remote terminal.

while the remote terminals reverts back to RD-1 and then RD-2 for transmission and to FD-1 and FD-2 for reception. The FD-1 and FD-2 channels are called primary forward signalling data channel and backup forward signalling data channel respectively. These RD-1 and RD-2 channels are called primary reverse signalling data channel and backup reverse signalling data channel respectively.

With this general channelization architecture, a flexible management scheme is possible for channel arrangement and remote terminals grouping. For example, channel arrangement can be adjusted according to traffic pattern mix and/or more intelligent management scheme can be implemented with various priority lists. The channelization is shown to follow a FDMA scheme for ease of understanding, but this can also be easily adopted for TDMA or CDMA schemes.

Multiple access of the remote terminals for the upstream traffic are mitigated by separating remote terminals in groups via the channel allocation and the terminal assignment process to be described later. The contention among remote terminals in each group is resolved through a controlled multiple access followed by selective polling in case of collision on each of the signalling data channel. The number of remote terminals assigned to each of the RD channel is to be evenly distributed according to the traffic demand. In the case of identical traffic requirements from all users, the number of remote terminals assigned to each of the RD channel will be equal.

The mapping of forward and reverse signalling data channels is under the control of the central controller dynamically. The mapping of part (a) of Figure 3 depicts the simplest arrangement with each pair of forward and reverse signalling data channels forming a terminal group. For example, the terminal group receiving on FD-*h* channel will transmit on RD-*k*. The part (b)

depicts the one-to-many mapping where the central controller transmits on one FD-n channel while the remote terminals belonging to the same group respond in their assigned RD-o, RD-p, and RD-q channel respectively. In part (c) with the many-to-one mapping shows that the central controller transmits on several FD (r, s and t) channels each reaching a subset of the group of the remote terminals, which respond in the same RD-u channel. Depending on the traffic pattern, some mapping will be more efficient in utilizing the bandwidth, e.g., the many-to-one mapping as depicted in part (b) of Figure 3 is suitable for case where the traffic coming from the remote terminals far exceeds the traffic in the forward direction. Note that the mapping of part (c) can cause collision from remote terminals in different sub-sets of the same terminal group. This is the only mapping that will require the contention resolution process, described later, to be coordinated between multiple signalling data channels. Different types of mapping can be used at the same time (but not combined) for different segments of remote terminals when deemed appropriate by the central controller.

Prompted by the remote terminals at startup, or through the failure recovery procedure, or deemed necessary by the central controller, the channel allocation and terminal assignment process is initiated and controlled by the central controller. Through the registration process, the central controller assigns the remote terminal to a group corresponding to a specific set of signalling data channels. Afterwards, the communication between the central controller and the remote terminals follows a two-phase process. The controlled multiple access procedure is used on each of the signalling data channels in parallel, for sporadic user data transfer and for signalling purposes. The controller sends command to the remote terminal in case of request from the network while the remote terminals respond to the

controller's poll to request services. If dedicated channel is required to meet the user's need, the traffic bearer channel is established via signalling protocol over the signalling data channels.

In Figure 4, the logic flow is shown for the central controller's initialization process and polling cycle. The polling process is executed in parallel for each of the FD-x in an independent fashion. After the system initialization, the central controller clears the channel allocation and terminal assignment lists and starts the polling cycle on FD-1 and FD-2. If there is required transmission to the remote terminal, such as a incoming call, the central controller enters the command mode. Otherwise the central controller solicits for request from remote terminals assigned to the FD channel via a general poll. If there is no response from any of the remote terminal, the polling cycle repeats after a time-out period expires. If there is response from remote terminals without collision or transmission error, the central controller processes the request accordingly. In case of collision or transmission error, the central controller enters a selective polling cycle to identify the remote terminal(s) involved in the collision or caused the transmission error.

As depicted in Figure 5, the central controller in the command mode sends the message destined for a specific remote terminal. Normally only the addressed remote terminal will respond to the command, therefore, there is normally no need for collision processing except for transmission error. If the expected response is not received at the central controller from the addressed terminal after the time-out period expires, the central controller assumes that either FD-x or RD-x' channel is not usable by the addressed remote terminal. In this case, the central controller retries for a number of times, then proceeds with the terminal failure processing if there is still no response from

the specific remote terminal. The terminal failure processing removes the failed remote terminal from the group and signals to the wide area network that connection is not possible.

In Figure 6, the logic flow diagram for the registration, channel allocation, terminal assignment and reassignment process is depicted. Upon receiving a registration message on RD-1 or RD-2, the central controller checks if the remote terminal is a newly registering terminal. If the remote terminal is a newly registering terminal and is authorized, the central controller proceeds to check for available signalling data channels for the remote terminal. If the new remote terminal has not been authorized, the central controller will deny the remote terminal from entering the network by issuing a terminal disable command. If the remote terminal has been registered previously, the registration process is caused by channel failure recovery procedure sensed at the remote terminal, and the central controller will register the channel status and proceed to check for available signalling data channels for the remote terminal. At any time, the central controller can initiate the terminal re-assignment process if deemed appropriate for the varying traffic demand or other system dynamics.

The determining factors of signalling data channels availability include the number of remote terminals using the signalling data channel, the traffic requirements, past collision count, channel error status, and bandwidth of the signalling data channel. These factors will be calculated for each of the existing signalling data channels in consideration of the specific group mapping as depicted in Figure 3. If there are signalling data channels in the forward and the reverse direction, the registering remote terminal will be assigned to the group. If there is no available signalling data channel already in use, the central controller will check for available channel from the pool of

transmitters and/or the poll of receivers, and proceeds with allocation if there is available channel from the pool (or a pair in case that neither the forward nor the reverse signalling data channels are available). If the signalling data channel is available, the central controller will complete the registration process by commanding the remote terminal to tune to the assigned channels. Otherwise, the central controller will deny the remote terminal from entering the network by issuing a terminal disable command.

In Figure 7, the logic flow of the remote terminals is shown for the channel registration process at startup or through failure recovery procedure. All of the remote terminals assigned to the same forward signalling data channel will receive the command or poll, but only the addressed remote terminals should respond. Initially the remote terminals will listen to a general poll on FD-1 for registration. If the poll from the central controller is not receiving for an extended period of time, the remote terminal will try FD-2 channel (toggling between FD-1 and FD-2). Once a general poll is sensed on the forward signalling data channel, the remote terminal responds first on RD-1 and then RD-2 if there has not been an acknowledgment from the central controller when the time-out period expires and retry count exceeded. Based on the central controller's command in response to the remoter terminal's registration message, the remote terminal either tunes to the assigned FD and RD channels or disables itself if not authorized.

Depicted in Figure 8 is the signalling process at the remote terminals. Once the registration process is completed, the remote terminal will monitor the poll or command from the central controller on the assigned FD-x channel, and respond on the assigned RD-x' channel if needed. In case of failure, i.e., not receiving polls from the central controller for extended period of time, or no acknowledgment for the previous request, the remote terminal reverts

back to FD-1 and RD-1 via the registration process. In case of collision with other remote terminals, the remote terminal follows the instruction from the central controller through selective polling process to resolve the contention.

The message format of the signalling protocol between the central controller and the remote terminals is depicted in Figure 9. The message frame starts with a one (1) byte preamble to indicate the start of message and to help detect collision. The Terminal Identifier (TID) field is one (1) byte long offering 256 possibility with the number 255 and 0 (hexadecimal FF and 00) set aside for registration purpose, i.e., maximum of 256 - 2 = 254 stations can be supported for each terminal group in this system.

The following field SAT or Signalling Action Type is three (3) bytes in length containing one of the listed commands. The SRT or Signalling Request Type field is also three (3) bytes in length containing one of the listed requests. Some of the commands and requests are included to illustrate possible features that can be supported in the system. For registration process, SAT and SRT fields contain the serial number of the remoter terminal, i.e., there are up to 2^{24} = 16 million possible numbers. Note that there are two different types of polling message. The selective polling with collision alert is used to alert other remote terminals to avoid using the channel where collision occurred until the resolution is completed. The lower TID of the range in the TID field and the higher TID of the range as part of the SAT field determine the type of the poll: specific, selective, or general. The FCS or Frame Check Sequence field is one (1) byte long for protection against transmission error in the TID and SAT/SRT fields.

Collision and transmission error are detected by the following mechanisms:

- invalid TID,

- FCS error,
- invalid frame length,
- invalid frame format,
- invalid SAT/SRT value.

In Figure 10, the remote terminals assigned to the same group are further separated in ranges during the selective polling process for resolving contention. This logic for resolving contention is contained in the central controller while the remote terminals follows the central controller's instructions. The naming of these ranges is as follows: the first digit of the subscript stands for the level, and the following number is used to sequentially designate from lower to higher TID (there are 2^n divisions at the n-th level). For example, at the 2nd level there are $2^2 = 4$ ranges named r_{21}, r_{22}, r_{23}, and r_{24}. Note that a selective poll with range r_{01} is equivalent to a general poll.

In Figure 11, a scenario of message collision and the resolution process is illustrated. The collision is resolved using the selective polling approach which is similar in spirit to the binary search algorithm. Suppose there are N number of remote terminals in total, and two remote terminals, one numbered between 1 and N/4 and the other numbered between N/4 and N/2, go off-hook during the same polling cycle. Once the collision from two remote terminals is detected at the central controller, the next poll with collision alert covers the range r_{11} between 1 and N/2, which results in another collision. After halving the range to r_{21} between 1 and N/4, the remote terminal numbered between 1 and N/4 responds without interference. As soon as the first remote terminal involved in the collision is identified, the resolution process is deemed completed by the central controller. The central controller follows with a general poll without alert

that indicates the end of the contention resolution process and results in a response from the remote terminal in the range r_{22} between N/4 and N/2. The dial tone is generated at the remote terminal when connection to the network is established.

The decision tree is depicted in Figure 12 for the selective polling process to determine the remote terminal(s) involved in the collision or caused the transmission error. This diagram is to illustrate the process involved using the regular polling method with which the polling cycle repeats only after the response to the previous poll is received or time-out occurs. The idea is to systematically narrowing the scope based on the information available. This systematic approach follows the level as defined in Figure 10, i.e., orderly halving similar in spirit to the binary search algorithm.

Note that the contention process is deemed completed as soon as the first remote terminal involved in the collision is identified. Depending on the probability of the number of remote terminals involved in a collision and the error rate for the shared transmission media, i.e., if the transmission media has a high error rate and low collision probability, it is more beneficial to resume polling all remote terminals since the resolution process also accounts for the problem caused by transmission error. On the other hand if the collision probability is high and the transmission media is reliable, it is more efficient to continue the selective polling process until all remote terminals involved in the collision are identified.

Assume using the modest means of data transmission at rate of 9600 bits per second, to transmit 48 bits message the transmission delay T is approximately 48/9600 = 5 milli-seconds. In the following discussion, assume 2.5T is used for the time-out period for each polling cycle. The

remote terminals shall start transmitting response message within the window of 0.5 T upon receiving the poll or the command from the central controller. One of the major benefit of fixed length messages is that it helps putting the time roughly into slots for efficiency improvement as explained in detail later.

To support 250 remote terminals in the system, the sequential polling scheme will incur the nominal delay of 250 × 2.5T ÷ 2 = 1.5625 seconds, which is too long to be acceptable for most services. With the controlled multiple access method, the remote terminal will gain access at the earliest poll with T/2 delay on average, and in case of collision the number of selective polling cycles required to identify the first remote terminal involved in the collision is $\log_2 250 + 1 < 9$, therefore, the maximum delay for the first terminal involved in a collision is 9 × 2.5T = 22.5T = 112.5 ms. If the decision tree in Figure 12 is adhered to, i.e., the central controller declares the contention resolution is completed as soon as the first remote terminal is identified, the second terminal involved in the collision will take twice the amount of time and the third one takes three times the amount of time and so on, until the last one which takes one poll only . More importantly this method guarantees a deterministic approach if the grouping of remote terminals are properly selected to reduce the probability of collision. If the grouping is not done properly, the effect of increasing number of multiple collisions will put the system in constant mode of contention resolution.

With transmitting and receiving in two separate paths, it is possible to initiate a separate poll or command instead of waiting for the response from the remote terminals to the outstanding poll. This overlapping polling method deviates from the regular polling method by interleaving poll with response to the previous poll thereby taking full advantage of the bandwidth

available. Similar to the spirit of instruction pipe-lining in the computer processor architecture, some of the polls may not be productive in the case of collision as evident by the example in Figure 15 later, however, these polls do not cause any adverse effect. The central controller needs to make correlation between the poll and the response, and tries to optimize the time in resolution by anticipating the most profitable steps to take next.

In Figure 13, the message exchange diagrams of signalling protocols employing the regular polling cycle and the overlapping polling cycle are shown for comparison. In the ideal case with no collision, the controlled multiple access scheme using overlapping polling cycle represents an efficient asynchronous signalling method. In part (a) there are 3 polling cycles within the time frame using the regular polling method versus 6 polling cycles using the overlapping polling method as shown in part (b). This example shows the maximum efficiency improvement that can be derived from the overlapping polling method over the regular polling method, i.e., in the order of 2.

The decision tree is depicted in Figure 14 for the selective polling process using the overlapping polling method to identify the remote terminal involved in the collision or caused the transmission error. The idea is to systematically narrowing the scope based on the information available and guided by the ranges of remote terminals at each advancing level as defined in Figure 10. Taking the advantage of the overlapping polling cycle, the polls is designed to anticipate the most probable range for maximum effect. The repeated collision in response to the overlapped general poll is used to determine whether the corrupted message is caused by the transmission error or collision. Similar to the decision tree in Figure 12, the resolution process is deemed complete as soon as the first remote terminal involved in the collision is identified.

In Figure 15, the message exchange diagram of the signalling protocol employing overlapping polling method dealing with the same scenario of collision as shown in Figure 11 where the regular polling method is employed instead. It takes the same amount of time (2 polling cycles in real time) to identify the first remote terminal involved in the collision for both methods. A number of reasons contribute to this situation. There are a few wasted effort as shown in the diagram, such as the repeated collision, poll of remote terminals in the range r_{12}, and poll of remote terminals in the range r_{33}. Similar to the pipe-lining instruction architecture, this method is most productive when there is no "jump" in the line of instructions, i.e., no collision among the remote terminals. There are certainly instances where this method will produce more benefit than what is shown in Figure 15. For example, the overlapping polling method will be able to identify the transmission error in 1.5 polling cycle versus 3 in the worst case for the regular polling method. The decision tree in Figure 14 can also be modified to take advantage of the available information that there might be more than 2 remote terminals involved in a collision at various points, e.g., the thickened circle to resume the polling cycle on the right side of Figure 14 can be extended to improve the efficiency in case of three remote terminals in ranges r_{12}, r_{21} and r_{22} involved in a collision.

The block diagram of the apparatus to implement this signalling method for the telephone service is depicted in Figure 16 for the central controller. There are a plurality of transmitters and a plurality of receivers for communication on the shared transmission media. The duplexer combines the transmitters' communication signals to be transmitted on the shared transmission media and duplicates the communication signals from the shared transmission media to each of these receivers. A number of voice

frequency (VF) data modulators and demodulators similar to the conventional modem are provided for transmitting and receiving the signalling data. Each of the transmitters and the receivers has a oscillator for tuning to the corresponding channels. The VF signal coming to the transmitter module is first modulated, buffered, amplified and mixed with the oscillator's frequency to the RF channel. The RF signal coming to the receiver module is translated to the intermediate frequency through the mixer, then filtered, amplified, and finally demodulated back to the VF signal. The switching matrix under the control of the micro-processor, is used to connect VF signals between transmitters, receivers, interface to the telephone networks, VF data modulator and demodulator. The telephone interface module under the control of the micro-processor performs the hybrid function to separate the signals in the transmit and receive direction (2-wire to 4-wire conversion), and the signalling function to/from the telephone network. The Random Access Memory or RAM is used to store the dynamic information such as remote terminal and channel status. The Erasable Programmable Read Only Memory or EPROM is used to store the invariant information such as instructions to the micro-processor at startup. The micro-processor communicates with EPROM, RAM, and the data modulators and demodulators via the system bus.

To allocate a forward signalling data channel, the central controller determines an available VF data modulator, a transmitter module, and then commands the switching matrix to make the connection between the VF data modulator and the RF transmitter. The signalling information or sporadic user data will come from the micro-processor to the VF modulator via the system bus, and then the modulated VF signal is fed to the input of the transmitter module via the connection through the switching matrix before it

is modulated to the RF channel. To allocate a reverse signalling data channel, the central controller determines an available VF data demodulator, a receiver module, and commands the switching matrix to make the connection between the VF data demodulator and the RF receiver. The signalling information or the sporadic user data follows the reverse direction as the forward direction. To establish a telephone connection, the central controller determines an available telephone interface module, a transmitter module, a receiver module, and commands the switching matrix to make the connection between the telephone interface module and the transmitter and receiver modules. The voice traffic is separated into the transmit and receive direction and connected through the switching matrix to the transmitter and receiver modules for modulating to and demodulating from the RF channels. Although the micro-processor needs to be involved in the path of data transfer, it is possible to establish a modem pool by setting aside a number of the VF data modulators and demodulators, and connecting them to the telephone interface module. The data signal from the remote terminals are decoded by the VF data demodulator, routed by the micro-processor, and then fed to the VF data modulator. Through the connection between the VF data modulator and telephone interface module, the modulated data signal is transmitted to the telephone network. The data signal from the telephone network traverses in the reverse direction.

The apparatus to implement this signalling method for the telephone service is depicted in Figure 17 for the remote terminals, which comprises a transmitter and a receiver for communication on the shared transmission media, a RF data modulator and a RF data demodulator for signalling data channels. The transmitter, the receiver, the data modulator and the data demodulator are all capable of tuning to the assigned RF frequency. The

duplexer combines the transmitters' communication signals to be transmitted on the shared transmission media and duplicates the communication signals from the shared transmission media to each of these receivers. The micro-processor communicates with EPROM, the RAM, and the data modulator and demodulator via the system bus. The keypad, the speaker, and the microphone make up the conventional telephone set. The audio signal from the microphone feeds to the modulator to be transmitted on the assigned channel over the shared transmission media. Similarly the speaker gets the demodulated signal from the receiver tuned to the assigned channel. In this block diagram, sporadic user data shares the RF data modulator and demodulator with signalling information, while the telephone section provides voice traffic through the RF transmitter and receiver. If the data communication is to be supported using a dedicated circuit, the audio interface of a conventional modem can be connected to the input of the modulator of the transmitter and to the output of the demodulator of the receiver.

At startup, the modulator and the demodulator are tuned to the primary forward and reverse signalling data channels respectively. The micro-processor interprets the signalling command and instruct the Phased Lock Loop or PLL according to the command from the central controller. The transmitter and the receiver modules are enabled and tuned to the assigned channels when the connection is established. The micro-processor also controls the functioning of the micro-phone, the keypad and the speaker.

From the foregoing, it will be observed that numerous variations and modifications may be effected without departing from the true spirit and scope of the novel concept of the invention. It should be understood that no limitation with respect to the specific structure and circuit arrangements

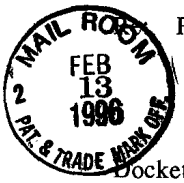
illustrated is intended or should be inferred. It is, of course, intended to cover by the appended claims all such modifications as fall within the scope of the claims.

Thus, in accordance with the invention, a Dynamic Channel Management And Signalling Method And Apparatus has been provided accomplishing all of the objects, and having the features and advantages specified at the beginning of this specification.

It is to be understood that the disclosed construction of the invention may be embodied in other forms within the scope of the claims.

What is claimed is:

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE



Patent Application for

DYNAMIC CHANNEL MANAGEMENT AND
SIGNALLING METHOD AND APPARATUS

Docket: Cheng-101

Express Mail Label Number: EG 587244152 US

Date of Deposit: February 13, 1996

CERTIFICATE OF MAILING UNDER 37 CFR 1.10

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

I hereby certify that the accompanying papers, namely:
Issue Fee Transmittal,
Patent Amendment "B",
Substitute Specification Pages,
Drawings Transmittal Letter,
Formal Drawings, and
$655 Check
are being deposited with the United States Postal Service as "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above addressed to:
Commissioner of Patents and Trademarks
Washington, D.C. 20231.

Respectfully submitted,

Dated: February 13, 1992

Alexander L. Cheng, Applicant
11 Springdale Avenue
White Plains, N.Y. 10604
914-428-0299

Enclosures

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SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO.

EXAMINER	
ART UNIT	PAPER NUMBER
	7

DATE MAILED:

NOTICE OF DRAWING REQUIREMENTS

☒ Corrected/substituted drawings for the above-identified application, received in the PTO on 2-13-96, are still considered informal for the reason(s) identified on the attached Form PTO-948.

☐ Applicant has the time remaining in the response period set in the Notice of Allowability or Notice of Drawing Requirements mailed _____ to overcome the objections raised in the attached Form PTO-948. This response period may be extended under the provisions of 37 CFR 1.136 (a) by filing the appropriate request and fee before the end of the six month statutory period for response.

☒ The PTO delayed in reviewing the corrected drawings. Applicant is given ONE month time limit from the date of this letter to provide corrected drawings. NO EXTENSION OF THIS TIME LIMIT MAY BE GRANTED UNDER EITHER 37 CFR 1.136(a) or (b). See MPEP 714.03. However, the response period set in the Notice of Allowability or Notice of Drawing Requirements mailed 11-27-95 may be extended under the provisions of 37 CFR 1.136(a) by filing the appropriate request and fee before the end of the six month statutory period for response.

☐ The PTO delayed in reviewing the corrected drawings. Applicant is given ONE month time limit from the date of this letter to provide corrected drawings. NO EXTENSION OF THIS TIME LIMIT MAY BE GRANTED UNDER EITHER 37 CFR 1.136(a) or (b). See MPEP 714.03

☒ ATTACHMENT: PTO-948

Bridget B Grady 3-19-96
PATENT AND TRADEMARK OFFICE DATE

FORM PTOL-455 (REV. 8-95)

Form PTO 948 (Rev. 10-94) U.S. DEPARTMENT OF COMMERCE - Patent and Trademark Office Application No. 276,534

NOTICE OF DRAFTSPERSON'S PATENT DRAWING REVIEW

PTO Draftpersons review all originally filed drawings regardless of whether they are designated as formal or informal. Additionally, patent Examiners will review the drawings for compliance with the regulations. Direct telephone inquiries concerning this review to the Drawing Review Branch, 703-305-8404.

The drawings filed (insert date) 2-13-96, are
A. ___ not objected to by the Draftsperson under 37 CFR 1.84 or 1.152.
B. ✓ objected to by the Draftsperson under 37 CFR 1.84 or 1.152 as indicated below. The Examiner will require submission of new, corrected drawings when necessary. Corrected drawings must be submitted according to the instructions on the back of this Notice.

1. DRAWINGS. 37 CFR 1.84(a): Acceptable categories of drawings: Black ink. Color.
   - ___ Not black solid lines. Fig(s)___
   - ___ Color drawings are not acceptable until petition is granted. Fig(s) ___
2. PHOTOGRAPHS. 37 CFR 1.84(b)
   - ___ Photographs are not acceptable until petition is granted. Fig(s) ___
   - ___ Photographs not properly mounted (must use brystol board or photographic double-weight paper). Fig(s)___
   - ___ Poor quality (half-tone). Fig(s)___
3. GRAPHIC FORMS. 37 CFR 1.84 (d)
   - ___ Chemical or mathematical formula not labeled as separate figure. Fig(s)___
   - ___ Group of waveforms not presented as a single figure, using common vertical axis with time extending along horizontal axis. Fig(s)___
   - ___ Individuals waveform not identified with a separate letter designation adjacent to the vertical axis. Fig(s)___
4. TYPE OF PAPER. 37 CFR 1.84(c)
   - ___ Paper not flexible, strong, white, smooth, nonshiny, and durable. Sheet(s)___
   - ___ Erasures, alterations, overwritings, interlineations, cracks, creases, and folds copy machine marks not accepted. Fig(s) ___
   - ___ Mylar, velum paper is not acceptable (too thin). Fig(s) ___
5. SIZE OF PAPER. 37 CFR 1.84(f): Acceptable sizes:
   - 21.6 cm. by 35.6 cm. (8 1/2 by 14 inches)
   - 21.6 cm. by 33.1 cm. (8 1/2 by 13 inches)
   - 21.6 cm. by 27.9 cm. (8 1/2 by 11 inches)
   - 21.0 cm. by 29.7 cm. (DIN size A4)
   - ___ All drawing sheets not the same size. Sheet(s)___
   - ___ Drawing sheet not an acceptable size. Sheet(s) ___
6. MARGINS. 37 CFR 1.84(g): Acceptable margins:

Paper size

21.6 cm. X 35 6 cm. (8 1/2 X 14 inches)	21.6 cm X 33.1 cm. (8 1/2 X 13 inches)	21 6 cm. X 27.9 cm (8 1/2 X 11 inches)	21.0 cm. X 29.7 cm (DIN Size A4)
T 5.1 cm. (2")	2.5 cm. (1")	2 5 cm. (1")	2.5cm.
L .64 cm. (1/4")	.64 cm (1/4")	.64 cm. (1/4")	2.5 cm.
R .64 cm. (1/4")	64 cm. (1/4")	.64 cm (1/4")	1.5 cm.
B .64 cm. (1/4")	.64 cm (1/4")	.64 cm. (1/4")	1.0 cm.

Margins do not conform to chart above. Sheet(s) ✓ Fig 1, Fig 7, Fig 12A, Fig 14B
✓ Top (T) ___ Left (L) ___ Right (R) ___ Bottom (B) Fig 15

7. VIEWS. 37 CFR 1.84(h)
   REMINDER: Specification may require revision to correspond to drawing changes.
   - ___ All views not grouped together. Fig(s)___
   - ___ Views connected by projection lines or lead lines. Fig(s)___
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   - ___ Cross section not drawn same as view with parts in cross section with regularly spaced parallel oblique strokes. Fig(s)___
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12. NUMBERS, LETTERS, & REFERENCE CHARACTERS. 37 CFR 1.84(p)
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    - ___ Numbers and reference characters not oriented in same direction as the view. 37 CFR 1.84(p)(l) Fig(s)___
    - ___ English alphabet not used. 37 CFR 1.84(p)(2) Fig(s)___
    - ___ Numbers, letters, and reference characters do not measure at least .32 cm. (1/8 inch) in height. 37 CFR(p)(3) Fig(s)___
13. LEAD LINES. 37 CFR 1.84(q)
    - ___ Lead lines cross each other. Fig(s)___
    - ___ Lead lines missing. Fig(s)___
14. NUMBERING OF SHEETS OF DRAWINGS. 37 CFR 1.84(t)
    - ___ Sheets not numbered consecutively, and in Arabic numerals, beginning with number 1. Sheet(s)___
15. NUMBER OF VIEWS. 37 CFR 1.84(u)
    - ___ Views not numbered consecutively, and in Arabic numerals, beginning with number 1. Fig(s)___
    - ___ View numbers not preceded by the abbreviation Fig. Fig(s)___
16. CORRECTIONS. 37 CFR 1.84(w)
    - ___ Corrections not made from prior PTO-948. Fig(s)___
17. DESIGN DRAWING. 37 CFR 1.152
    - ___ Surface shading shown not appropriate Fig(s)___
    - ___ Solid black shading not used for color contrast Fig(s)___

COMMENTS:

ATTACHMENT TO PAPER NO.___ REVIEWER Bridget Gray DATE 3-18-96

PTO Copy

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Serial No.	08/276,534
Filing Date	07/18/94
Applicant	Alexander L. Cheng
For	DYNAMIC CHANNEL MANAGEMENT AND SIGNALLING METHOD AND APPARATUS
Group Art Unit	2603
Examiner	Benedict V. Safourek
Docket	CHENG101

LETTER TO THE DRAFTSMAN

Sir/Madam:

In response to section 6 of the Office Action dated 03/25/96 for the above-identified application, please substitute the attached drawings, i.e., Fig. 1, Fig. 7, Fig. 12a, Fig. 14b and Fig. 15, for the filed drawings. While top margins of these drawings have been changed, it should be noted that no new matters has been added.

Pursuant to 37 CFR § 1.84(c), placed on the back of each sheet is the application serial number, filing date, inventor's name, docket number, the name and telephone number of the person to call if the Office is unable to match the drawings to the proper application.

It is respectfully submitted that the formal drawings are acceptable so that the patent should issue.

April 20, 1996

Respectfully submitted,

Alexander L. Cheng
Applicant
11 Springdale Avenue
White Plains, NY 10604
914-428-0299

BY PRIORITY MAIL

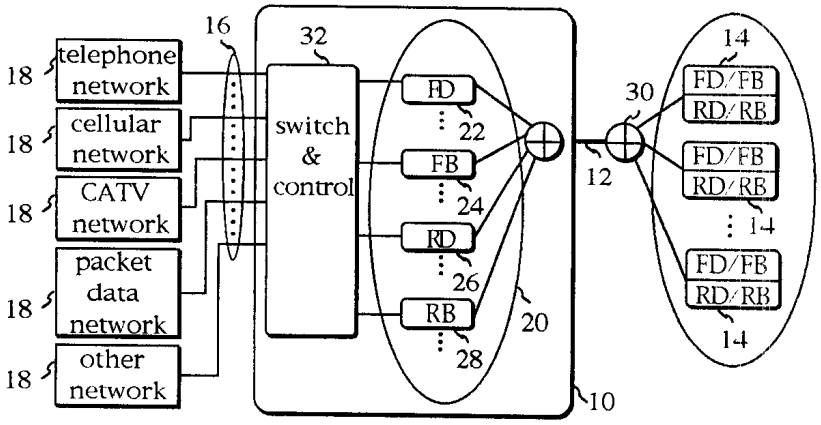

Figure 1

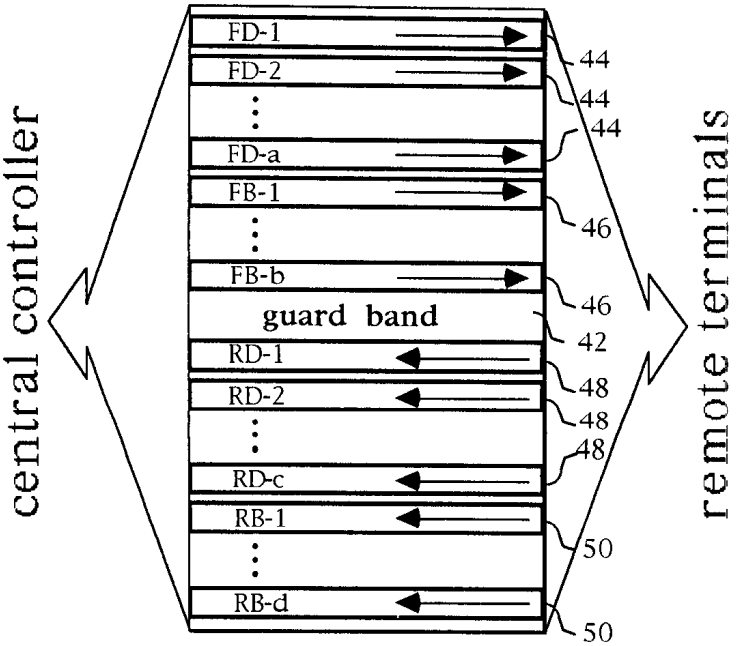

Figure 2

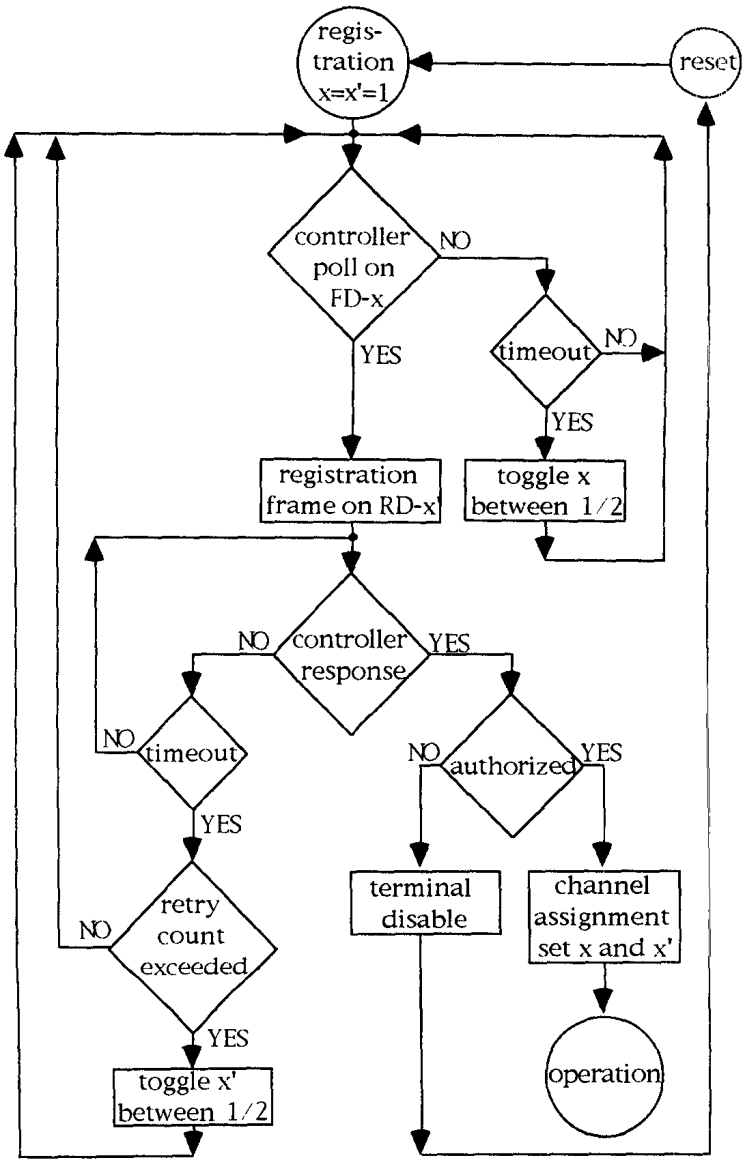
regis-
tration
x=x'=1
reset
controller
poll on
FD-x
NO
YES
timeout
NO
YES
registration
frame on RD-x'
toggle x
between 1/2
NO
controller
response
YES
NO
timeout
YES
NO
authorized
YES
retry
count
exceeded
NO
YES
terminal
disable
channel
assignment
set x and x'
toggle x'
between 1/2
operation

Figure 7

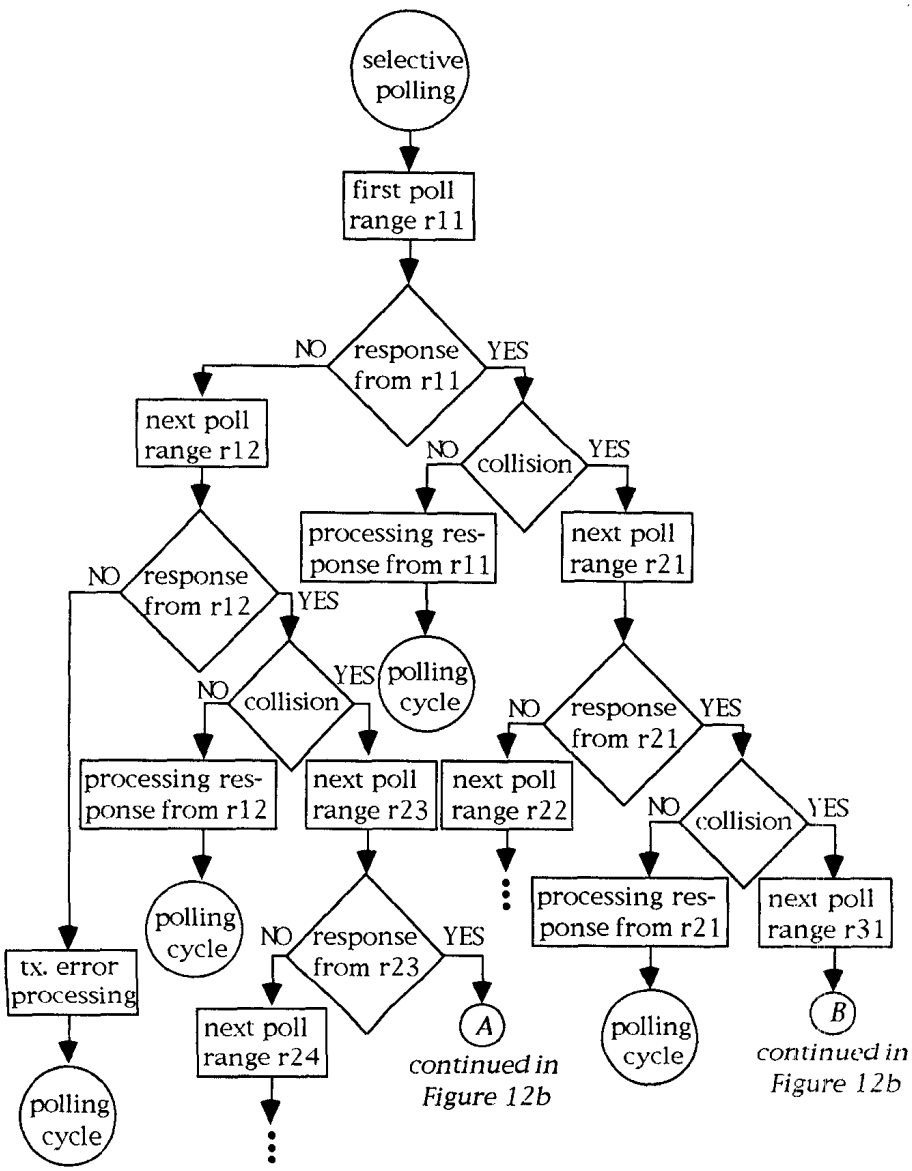
selective polling
first poll range r11
response from r11
NO
YES
next poll range r12
collision
NO
YES
processing response from r11
next poll range r21
response from r12
NO
YES
collision
NO
YES
polling cycle
response from r21
NO
YES
processing response from r12
next poll range r23
next poll range r22
collision
NO
YES
polling cycle
response from r23
NO
YES
processing response from r21
next poll range r31
tx. error processing
next poll range r24
A
B
continued in Figure 12b
polling cycle
polling cycle
continued in Figure 12b
polling cycle

Figure 12a

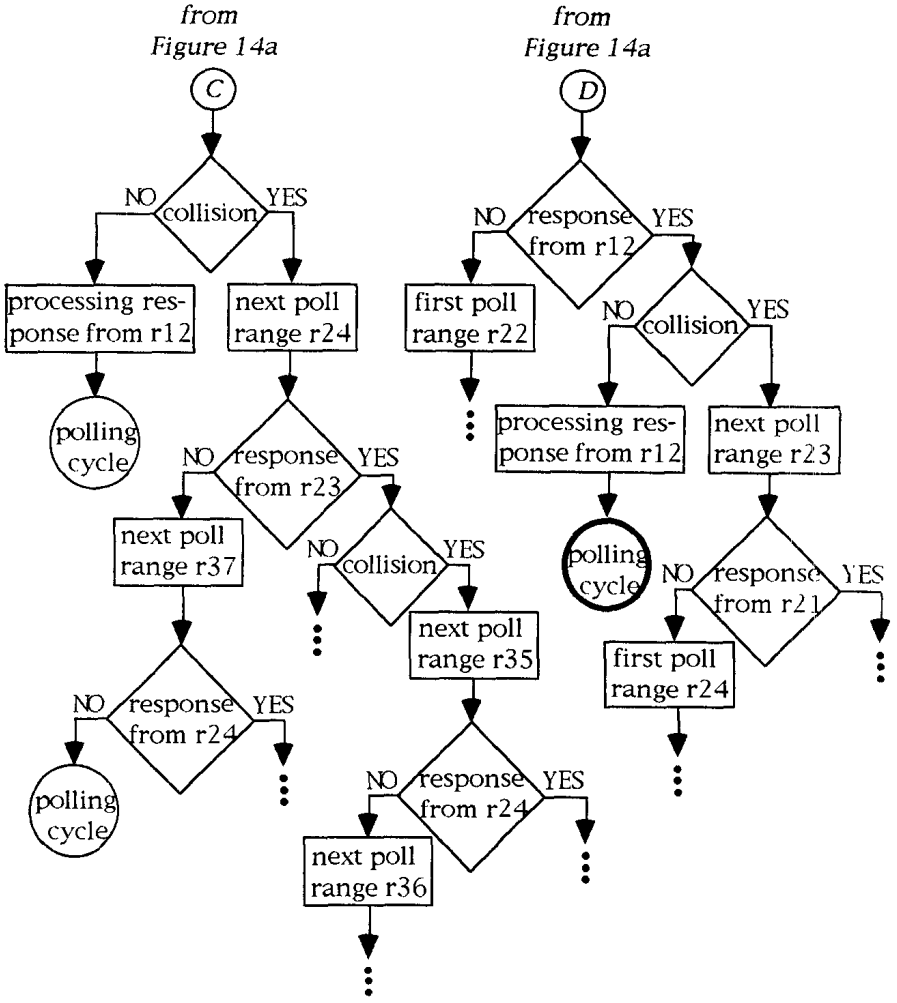
from Figure 14a
C
NO
collision
YES
processing response from r12
next poll range r24
polling cycle
NO
response from r23
YES
next poll range r37
NO
collision
YES
next poll range r35
NO
response from r24
YES
polling cycle
NO
response from r24
YES
next poll range r36
from Figure 14a
D
NO
response from r12
YES
first poll range r22
NO
collision
YES
processing response from r12
next poll range r23
polling cycle
NO
response from r21
YES
first poll range r24

Figure 14b

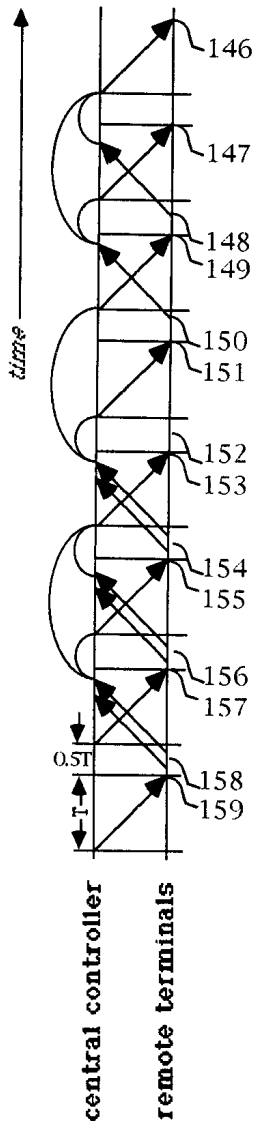
time
146
147
148
149
150
151
152
153
154
155
156
157
0.5T
T
158
159
central controller
remote terminals

Figure 15

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO.
08/276,534	07/18/94	CHENG A	CHENG101

4102/0513

ALEXANDER L. CHENG
11 SPRINGDALE AVENUE
WHITE PLAINS, NY 10604

EXAMINER	
SAE, B	
ART UNIT	PAPER NUMBER
2603	9

DATE MAILED: 05/13/96

NOTICE OF DRAWING REQUIREMENTS

☒ Corrected/substituted drawings for the above-identified application, received in the PTO on 4-22-96, are still considered informal for the reason(s) identified on the attached Form PTO-948.

☐ Applicant has the time remaining in the response period set in the Notice of Allowability or Notice of Drawing Requirements mailed _____ to overcome the objections raised in the attached Form PTO-948. This response period may be extended under the provisions of 37 CFR 1.136 (a) by filing the appropriate request and fee before the end of the six month statutory period for response.

☒ The PTO delayed in reviewing the corrected drawings. Applicant is given ONE month time limit from the date of this letter to provide corrected drawings. NO EXTENSION OF THIS TIME LIMIT MAY BE GRANTED UNDER EITHER 37 CFR 1.136(a) or (b). See MPEP 714.03. However, the response period set in the Notice of Allowability or Notice of Drawing Requirements mailed 11-27-95 may be extended under the provisions of 37 CFR 1.136(a) by filing the appropriate request and fee before the end of the six month statutory period for response.

☐ The PTO delayed in reviewing the corrected drawings. Applicant is given ONE month time limit from the date of this letter to provide corrected drawings. NO EXTENSION OF THIS TIME LIMIT MAY BE GRANTED UNDER EITHER 37 CFR 1.136(a) or (b). See MPEP 714.03

☐ ATTACHMENT: PTO-948

Joe Sams — PATENT AND TRADEMARK OFFICE

5-8-96 — DATE

FORM PTOL-455 (REV. 8-95)

Form PTO 948 (Rev. 10-94) U.S. DEPARTMENT OF COMMERCE - Patent and Trademark Office Application No. 08/276534

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Margins do not conform to chart above.
Sheet(s)____
___Top (T) ___ Left (L) ___Right (R) ___Bottom (B)

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17. DESIGN DRAWING. 37 CFR 1.152
    - ___ Surface shading shown not appropriate. Fig(s). ____
    - ___ Solid black shading not used for color contrast. Fig(s)____

COMMENTS:

ATTACHMENT TO PAPER NO.____ REVIEWER Jack Harris DATE 5-8-96

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$625 - 242 B
30 - 561

PART B—ISSUE FEE TRANSMITTAL

MAILING INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE. Blocks 2 through 6 should be completed where appropriate. All further correspondence including the Issue Fee Receipt, the Patent, advance orders and notification of maintenance fees will be mailed to addressee entered in Block 1 unless you direct otherwise, by: (a) specifying a new correspondence address in Block 3 below; or (b) providing the PTO with a separate "FEE ADDRESS" for maintenance fee notifications with the payment of Issue Fee or thereafter. **See reverse for Certificate of Mailing.**

1. CORRESPONDENCE ADDRESS	2. INVENTOR(S) ADDRESS CHANGE (Complete only if there is a change)
MAIL ROOM FEB 13 1996 PAT. & TM. OFFICE ALEXANDER L. CHENG [redacted] SPRINGDALE AVENUE WHITE PLAINS, NY 10604	INVENTOR'S NAME Street Address City, State and ZIP Code CO-INVENTOR'S NAME Street Address City, State and ZIP Code ☐ Check if additional changes are on reverse side

SERIES CODE/SERIAL NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP ART UNIT		DATE MAILED
08/276,534	07/18/94	020	SAFOUREK, B.	2603	11/27/95

First Named Applicant: ~~CHENG,~~ ~~ALEXANDER L.~~

TITLE OF INVENTION: DYNAMIC CHANNEL MANAGEMENT AND SIGNALLING METHOD AND APPARATUS

	ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
2	CHENG101	370-073.000	R37	UTILITY	YES	$625.00	02/27/96

3. Correspondence address change (Complete only if there is a change)

4. For printing on the patent front page, list the names of not more than 3 registered patent attorneys or agents OR, alternatively, the name of a firm having as a member a registered attorney or agent. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

DO NOT USE THIS SPACE

5. ASSIGNMENT DATA TO BE PRINTED ON THE PATENT (print or type)

(1) NAME OF ASSIGNEE:

(2) ADDRESS: (CITY & STATE OR COUNTRY)

A. ☑ This application is NOT assigned.
☐ Assignment previously submitted to the Patent and Trademark Office.
☐ Assignment is being submitted under separate cover. Assignments should be directed to Box ASSIGNMENTS.
PLEASE NOTE: Unless an assignee is identified in Block 5, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the PTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.

6a. The following fees are enclosed. $625 + $30 = $655
☑ Issue Fee ☐ Advance Order - # of Copies 10

6b. The following fees should be charged to:
DEPOSIT ACCOUNT NUMBER _____
(ENCLOSE PART C)
☐ Issue Fee ☐ Advance Order - # of Copies _____
☐ Any Deficiencies in Enclosed Fees

The COMMISSIONER OF PATENTS AND TRADEMARKS is requested to apply the Issue Fee to the application identified above.

(Authorized Signature) 1 541 625.00 CK CHENG101 30.00 CK CHENG101 (Date) 2/13/96

NOTE: The Issue Fee will not be accepted from anyone other than the applicant, a registered attorney or agent of the assignee or other party in interest as shown by the records of the Patent and Trademark Office

1. TRANSMIT THIS FORM WITH FEE-CERTIFICATE OF MAILING ON REVERSE

PTOL-85B (REV.12-93)(0651-0033)

BEST COPY

Certificate of Mailing

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to:

Box ISSUE FEE
Commissioner of Patents and Trademarks
Washington, D.C. 20231

on 2/13/96
(Date)

Alexander L. Cheng
(Name of person making deposit)

(Signature)

2/13/96
(Date)

Note: If this certificate of mailing is used, it can only be used to transmit the Issue Fee. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing.

Burden Hour Statement: This form is estimated to take .2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Office of Information Systems, Patent and Trademark Office, Washington, D.C. 20231, and to the Office of Information and Regulatory Affairs, Office of Management and Budget, (Project 0651-0033), Washington, D.C. 20503. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner of Patents and Trademarks, Box Issue Fee, Washington, DC 20231.

REVERSE PTOL-85B (REV. 12-93)(0651-0033)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Serial No.	08/276,534
Filing Date	07/18/94
Applicant	Alexander L. Cheng
For	DYNAMIC CHANNEL MANAGEMENT AND SIGNALLING METHOD AND APPARATUS
Group Art Unit	2603
Examiner	Benedict V. Safourek
Docket	Cheng101

LETTER TO THE DRAFTSMAN

Sir/Madam:

In response to section 10 of the Office Action date 05/13/96 for the above-identified application, please substitute the attached drawings, i.e., Fig. 2 and Fig 15, for the filed drawings. While letters of these drawings have been changed, it should be noted that no new matters has been added.

Pursuant to 37 CFR § 1.84(c), placed on the back of each sheet is the application serial number, filing date, inventor's name, docket number, the name and telephone number of the person to call if the Office is unable to match the drawings to the proper application.

It is respectfully submitted that the formal drawings are acceptable so that the patent should issue.

May 28, 1996

Respectfully submitted

Alexander L. Cheng
Applicant
11 Springdale Avenue
White Plain, NY 10604
914-428-0299

BY PRIORITY MAIL

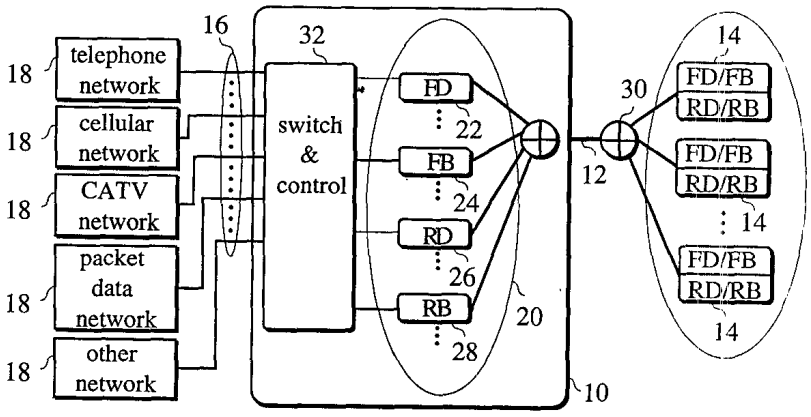


Figure 1

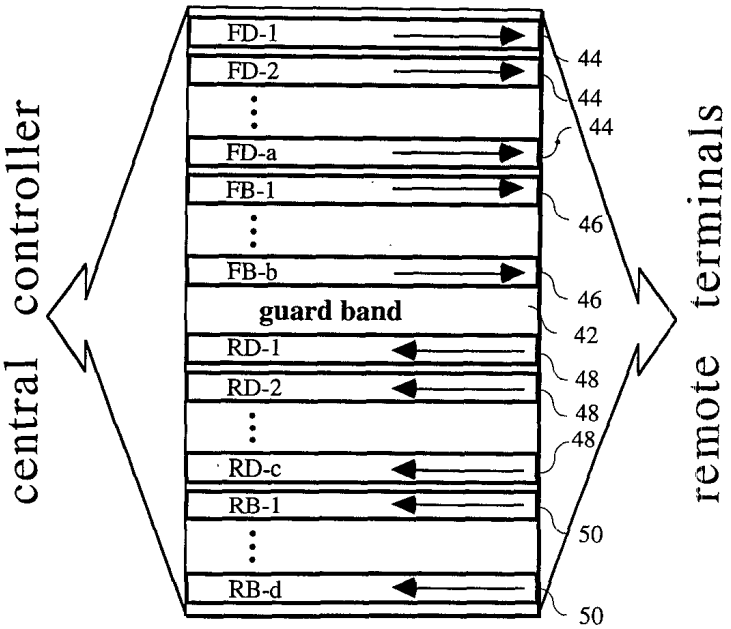


Figure 2

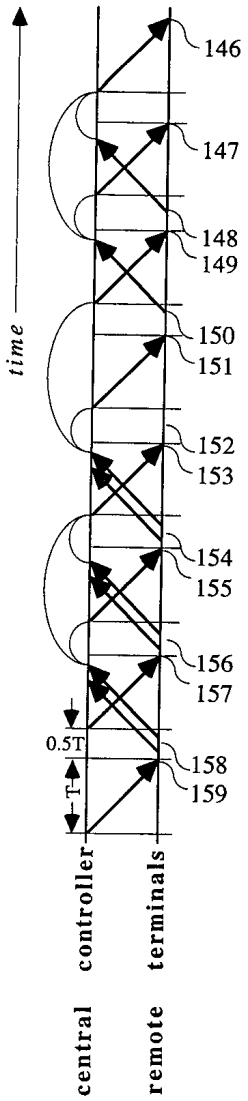

time
146
147
148
149
150
151
152
153
154
155
156
157
0.5T
T
158
159
central controller
remote terminals

Figure 15

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO
08/276,534	07/18/94	CHENG	4 CHENG 1 C

EXAMINER
SAFOUREK, B.

26M1/0716

ALEXANDER L. CHENG
11 SPRINGDALE AVENUE
WHITE PLAINS, NY 10604

ART UNIT	PAPER NUMBER
2603	11

DATE MAILED: 07/16/96

A. ☐ The petition filed _____ under 37 CFR 1.312(b) is granted.
The paper has been forwarded to the examiner for consideration on the merits.

B. ☑ The amendment filed Feb 13, 1996 under 37 CFR 1.312 has been considered, and has been:

1. ☐ entered
2. ☑ entered as directed to matters of form not affecting the scope of the invention (0.3311).
3. ☐ disapproved. A report appears below.
4. ☐ entered in part. A report appears below.

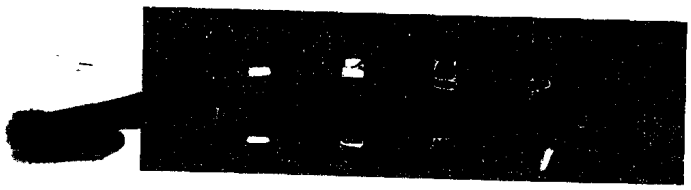
Report:

Benedict V. Safourek

BENEDICT V. SAFOUREK
PRIMARY EXAMINER
GROUP 263

PLEASE FURNISH YOUR ZIP CODE IN ALL CORRESPONDENCE

FORM PTOL-271 (REV. 7/89)



BEST COPY

PTO UTILITY GRANT
Paper Number 12

The Commissioner of Patents and Trademarks

Has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this

United States Patent

Grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America for the term set forth below, subject to the payment of maintenance fees as provided by law.

If this application was filed prior to June 8, 1995, the term of this patent is the longer of seventeen years from the date of grant of this patent or twenty years from the earliest effective U.S. filing date of the application, subject to any statutory extension.

If this application was filed on or after June 8, 1995, the term of this patent is twenty years from the earliest effective U.S. filing date of the application, subject to any statutory extension.

Bruce Lehman

Commissioner of Patents and Trademarks

Attest Melvinia Gary

The United States of America

PATENT AND TRADEMARK OFFICE
UNITED STATES OF AMERICA

Form PTO-1584 (Rev. 5/96)

FPI-LOM

(RIGHT INSIDE)

#13

M/ DAC

2010 JAN -6 PM 4:14

PTO/SB/66 (03-09)
Approved for use through 03/31/2012. OMB 0651-0016
U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PETITION TO ACCEPT UNINTENTIONALLY DELAYED PAYMENT OF MAINTENANCE FEE IN AN EXPIRED PATENT (37 CFR 1.378 (c))

Docket Number (Optional)

Mail to: Mail Stop Petition
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450
Fax: (571) 273-8300

NOTE: If information or assistance is needed in completing this form, please contact Petitions Information at (571) 272-3282.

Patent No. 5,563,883 Application Number 08/276,534

Issue Date October 8, 1996 Filing Date July 18, 1994

CAUTION: Maintenance fee (and surcharge, if any) payment must correctly identify: (1) the patent number (or reissue patent number, if a reissue) and (2) the application number of the actual U.S. application (or reissue application) leading to issuance of that patent to ensure the fee(s) is/are associated with the correct patent. 37 CFR 1.366(c) and (d).

Also complete the following information, if applicable

The above – identified patent

☐ is a reissue of original Patent No. _____ original issue date _____
original application number _____
original filing date _____

01/07/2010 DALLEN 00000081 5563883
01 FC:1599 3695.00 OP

☐ resulted from the entry into the U.S. under 35 U.S.C. 371 of international application _____
filed on _____

CERTIFICATE OF MAILING (37 CFR 1.89(a))

I hereby certify that this paper (*along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class main in an envelope addressed to Mail Stop Petition, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, or facsimile transmitted to the U.S. Patent and Trademark Office on the date shown below.

December 31 (AC), 2009
Date

Signature

Alexander L. Cheng
Typed or Printed Name of Person Signing Certificate

01/21/2010 CKHLOK 00000010 5563883
01 FC:2553 2055.00 OP
02 FC:1558 1640.00 OP

Adjustment date: 01/21/2010 CKHLOK
01/07/2010 DALLEN 00000081 5563883
01 FC:1599 -3695.00 OP

This collection of information is required by 37 CFR 1.378(c). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Mail Stop Petition, Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2

PTO/SB/66 (03-09)
Approved for use through 03/31/2012 OMB 0651-0016
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

1. SMALL ENTITY

☑ Patentee claims, or has previously claimed, small entity status See 37 CFR 1.27.

RECEIVED
JAN 11 2010
OFFICE OF PETITIONS

2. LOSS OF ENTITLEMENT TO SMALL ENTITY STATUS

☐ Patentee is no longer entitled to small entity status. See 37 CFR 1.27(g)

3. MAINTENANCE FEE (37 CFR 1.20(e)-(g))

The appropriate maintenance fee must be submitted with this petition, unless it was paid earlier.

NOT Small Entity			Small Entity		
Amount	Fee	(Code)	Amount	Fee	(Code)
☐ $ ____	3 ½ yr fee	(1551)	☐ $ ____	3 ½ yr fee	(2551)
☐ $ ____	7 ½ yr fee	(1552)	☐ $ ____	7 ½ yr fee	(2552)
☐ $ ____	11 ½ yr fee	(1553)	☐ $ 2,055.00	11 ½ yr fee	(2553)

MAINTENANCE FEE BEING SUBMITTED $ 2,055.00

4. SURCHARGE

The surcharge required by 37 CFR 1.20(i)(2) of $ 1,640.00 (Fee Code 1558) must be paid as a condition of accepting unintentionally delayed payment of a maintenance fee.

SURCHARGE FEE BEING SUBMITTED $ 1,640.00

5. MANNER OF PAYMENT

☑ Enclosed is a check for the sum of $ 3,695.00

☐ Please charge Deposit Account No. _____ the sum of $ _____

☐ Payment by credit card. Form PTO-2038 is attached.

6. AUTHORIZATION TO CHARGE ANY FEE DEFICIENCY

☐ The Director is hereby authorized to charge any maintenance fee, surcharge or petition deficiency to Deposit Account No. _____

7. OVERPAYMENT

As to any overpayment made please

OR

☐ Credit to Deposit Account No. _____.

☑ Send refund check

RECEIVED
JAN 11 2010
OFFICE OF PETITIONS

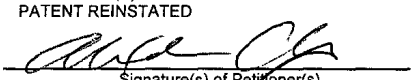
WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

8. STATEMENT

The delay in payment of the maintenance fee to this patent was unintentional.

9. PETITIONER(S) REQUEST THAT THE DELAYED PAYMENT OF THE MAINTENANCE FEE BE ACCEPTED AND THE PATENT REINSTATED



Signature(s) of Petitioner(s)

December 31, 2009
Date

Alexander L. Cheng
Typed or printed name(s)

Registration Number, if applicable

(914)-591-5939
Telephone Number

12 Hidden Glen Road, Scarsdale, NY 10583
Address

Address

37 CFR 1.378(d) states: "Any petition under this section must be signed by an attorney or agent registered to practice before the Patent and Trademark Office, or by the patentee, the assignee, or other party in interest."

ENCLOSURES

☑ Maintenance Fee Payment

☑ Surcharge under 37 CFR 1.20(i)(2) (fee for filing the maintenance fee petition)

☐ _____

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

#14

ALEXANDER L. CHENG
11 SPRINGDALE AVENUE
WHITE PLAINS NY 10604

MAILED

JAN 21 2010

OFFICE OF PETITIONS

In re Patent No. 5,563,883 :
Issue Date: October 8, 1996 :
Application No. 08/276,534 : DECISION ON PETITION
Filed: July 18, 1994 :
Attorney Docket No. CHENG101 :

This is a decision on the petition under 37 CFR 1.378(c), filed January 4, 2010 to accept the unintentionally delayed payment of a maintenance fee for the above-identified patent.

The petition is **GRANTED**.

This patent expired on October 9, 2008 for failure to pay the eleven and one-half year maintenance fee. Since this petition was submitted within twenty-four months after the six-month grace period provided in 37 CFR 1.362(c), the petition was timely filed under the provisions of 37 CFR 1.378(c).

The maintenance fee is hereby accepted and the above-identified patent is reinstated as of the mail date of this decision.

Additionally, the address given on the petition differs from the address of record. A courtesy copy of this decision is being mailed to the address given on the petition; however, the Office will mail all future correspondence solely to the address of record.

Telephone inquiries concerning this decision should be directed to the undersigned at (571) 272-7751.

Joan Olszewski
Petitions Examiner
Office of Petitions

cc: Alexander L. Cheng
12 Hidden Glen Road
Scarsdale, NY 10583

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

P75M

ALEXANDER L. CHENG
11 SPRINGDALE AVENUE
WHITE PLAINS NY 10604

DATE PRINTED
11/03/08

NOTICE OF PATENT EXPIRATION

According to the records of the U.S. Patent and Trademark Office (USPTO), payment of the maintenance fee for the patent(s) listed below has not been received timely prior to the end of the six-month grace period in accordance with 37 CFR 1.362(e). THE PATENT(S) LISTED BELOW HAS THEREFORE EXPIRED AS OF THE END OF THE GRACE PERIOD. 35 U.S.C. 41(b). Notice of the expiration will be published in the USPTO Official Gazette.

Expired patents may be reinstated in accordance with 37 CFR 1.378 if upon petition, the maintenance fee and the surcharge set forth in 37 CFR 1.20(i) are paid, AND the delay in payment of the maintenance fee is shown to the satisfaction of the Director to have been unavoidable or unintentional. 35 U.S.C. 41(c)(1).

If the Director accepts payment of the maintenance fee and surcharge upon petition under 37 CFR 1.378, the patent shall be considered as not having expired but would be subject to the intervening rights and conditions set forth in 35 U.S.C. 41(c)(2).

For instructions on filing a petition under 37 CFR 1.378 to reinstate an expired patent, customers should call the Office of Petitions Help Desk at 571-272-3282 or refer to the USPTO Web site at www.uspto.gov/web/offices/pac/dapp/petitionspractice.html. The USPTO also permits reinstatement under 37 CFR 1.378(c) by electronic petition (e-petition) using EFS-Web; e-petitions may be automatically granted if all the eligibility requirements are met. For further information on filing an e-petition, please call the Electronic Business Center (EBC) at 866-217-9197 (toll-free) or 571-272-4100 or refer to the EBC's e-petition guide at www.uspto.gov/ebc/portal/efs/petition_quickstart.pdf.

PATENT NUMBER	U.S. APPLICATION NUMBER	PATENT ISSUE DATE	APPLICATION FILING DATE	EXPIRATION DATE	ATTORNEY DOCKET NUMBER
5563883	08276534	10/08/96	07/18/94	10/08/08	CHENG101

NOTE: This notice was automatically generated based on the amount of time that elapsed since the date a patent was granted. It is possible that the patent term may have ended or been shortened due to a terminal disclaimer that was filed in the application. Also, for any patent that issued from an application filed on or after June 8, 1995 containing a specific reference to an earlier filed application or applications under 35 U.S.C. 120, 121, or 365(c), the patent term ends 20 years from the date on which the earliest such application was filed, unless the term was adjusted or extended under 35 U.S.C. 154 or 156.

MA441D (11/2006)

PATENT APPLICATION FEE DETERMINATION RECORD

Effective October 1, 1992

Application or Docket Number: 276534

CLAIMS AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA
BASIC FEE		
TOTAL CLAIMS	10 minus 20 =	* 0
INDEPENDENT CLAIMS	4 minus 3 =	* 1
MULTIPLE DEPENDENT CLAIM PRESENT		

* If the difference in column 1 is less then zero, enter "0" in column 2

SMALL ENTITY RATE	SMALL ENTITY FEE	OR	OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY FEE
	$355.00	OR		$710.00
x$11=		OR	x$22=	
x 37=	37	OR	x 74=	
+115=		OR	+230=	
TOTAL	392	OR	TOTAL	

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 20	Minus	** 20	= —
Independent	* 4	Minus	*** 4	= —
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				

SMALL ENTITY RATE	SMALL ENTITY ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY ADDITIONAL FEE
x$11=	—	OR	x$22=	
x 37=	—	OR	x 74=	
+ 115=		OR	+230=	
TOTAL ADDIT. FEE	—	OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
x$11=		OR	x$22=	
x 37=		OR	x 74=	
+ 115=		OR	+ 230=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
x$11=		OR	x$22=	
x 37=		OR	x 74=	
+115=		OR	+230=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875
(Rev.10-92)

Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Form PTO 1130
(REV 2/94)

U.S. DEPARTMENT OF COMMERCE
Patent and Trademark Office

PACE DATA ENTRY CODING SHEET

1ST EXAMINER	DATE
OT Quale	8-17-94
2ND EXAMINER	DATE

APPLICATION NUMBER	TYPE APPL	FILING DATE (MONTH DAY YEAR)	SPECIAL HANDLING	GROUP ART UNIT	CLASS	SHEETS OF DRAWING
08/276534	1	07 18 94	0	2611	455	14

TOTAL CLAIMS	INDEPENDENT CLAIMS	SMALL ENTITY?	FILING FEE	FOREIGN LICENSE	ATTORNEY DOCKET NUMBER
10	4	1	392	Y	CHEMG10.1

CONTINUITY DATA

CONT CODE	STATUS CODE	PARENT APPLICATION SERIAL NUMBER	PCT APPLICATION SERIAL NUMBER	PARENT PATENT NUMBER	PARENT FILING DATE (MONTH DAY YEAR)
			PCT/ /		
			PCT/ /		
			PCT/ /		
			PCT/ /		
			PCT/ /		

PCT/FOREIGN APPLICATION DATA

FOREIGN PRIORITY CLAIMED	COUNTRY CODE	PCT/FOREIGN APPLICATION SERIAL NUMBER	FOREIGN FILING DATE (MONTH DAY YEAR)

☆U.S.G.P.O. 1994 - 365-974

MPI Family Report (Family Bibliographic and Legal Status)

In the MPI Family report, all publication stages are collapsed into a single record, based on identical application data. The bibliographic information displayed in the collapsed record is taken from the latest publication.

Report Created Date: 2011-02-03

Name of Report:

Number of Families: 1

Comments:

Table of Contents

Family1

1 records in the family.

US5563883A 19961008

[no drawing available]

(ENG) Dynamic channel management and signalling method and apparatus

Assignee: CHENG; ALEXANDER L

Inventor(s): CHENG ALEXANDER L US

Application No: US 27653494 A

Filing Date: 19940718

Issue/Publication Date: 19961008

Abstract: (ENG) There is provided a dynamic and adaptable method and apparatus to support two-way multi-media communication services on a multiple access communication system, which comprises a central controller, a shared transmission media and a plurality of remote terminals dispersed throughout the network. The central controller comprises switch and control apparatus and a pool of transmitters and receivers. The communication channels between the central controller and remote terminals are arranged for signalling data and traffic bearer channels in the forward and reverse directions. The number of signalling data channels is adjusted to satisfy the traffic requirements and for redundancy purposes. The forward and reverse signalling data channels are coupled in different mappings to support terminal grouping. Multiple access of the remote terminals for the upstream traffic are mitigated by separating remote terminals in groups via the channel allocation and the terminal assignment process. Communication between the central controller and the remote terminals follows a multiple access scheme controlled by the central controller via polling procedure on each of the forward signalling data channels independently. In case of collision, the central controller engages the remote terminals in a selective polling process to resolve the contention. The overlapping polling method of the controlled access scheme increases the utilization of the signalling channel and reduces the time required to gain access to the shared transmission media. By dynamically adjusting the load on signalling data channels, the signalling process is greatly improved for efficiency and redundancy against anomalies with the added benefit of improved flexibility and extensibility. The system is especially useful in a two-way CATV network.

Priority Data: US 27653494 19940718 A Y;

IPC (International Class): H04N007173; H04M00700; H04H02042; H04N00710; H04H06097; H04H02038; H04H02079

ECLA (European Class): H04H02042; H04L01228B; H04M00700M; H04N00710; H04N007173C2

US Class: 370449; 348E07049; 348E07075; 370462; 725116; 725126

Publication Language: ENG

Filing Language: ENG

Examiner Primary: Safourek, Benedict V.

Legal Status:

Date	+/-	Code	Description
20081125	()	FP	Effective date: 20081008;
20100118	()	PRDP	Effective date: 20100121;

USPTO Maintenance Report

Patent Bibliographic Data					02/03/2011 08:15 AM
Patent Number:	5563883		Application Number:	08276534	
Issue Date:	10/08/1996		Filing Date:	07/18/1994	
Title:	DYNAMIC CHANNEL MANAGEMENT AND SIGNALLING METHOD AND APPARATUS				
Status:	4th, 8th and 12th year fees paid			Entity:	Small
Window Opens:	N/A	Surcharge Date:	N/A	Expiration:	N/A
Fee Amt Due:	Window not open	Surchg Amt Due:	Window not open	Total Amt Due:	Window not open
Fee Code:					
Surcharge Fee Code:					
Most recent events (up to 7):	01/21/2010 01/04/2010 12/31/2009 12/31/2009 10/08/2008 04/14/2008 02/13/2004	Petition Related to Maintenance Fees Granted. Petition Related to Maintenance Fees Filed. Surcharge, Petition to Accept Pymt After Exp, Unintentional. Payment of Maintenance Fee, 12th Yr, Small Entity. Patent Reinstated After Maintenance Fee Payment Confirmed. Maintenance Fee Reminder Mailed. Payment of Maintenance Fee, 8th Yr, Small Entity. --- End of Maintenance History ---			
Address for fee purposes:	ALEXANDER L. CHENG 11 SPRINGDALE AVENUE WHITE PLAINS, NY 10604				