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(54) NETWORK LINK ENDPOINT CAPABILITY DETECTION

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(73) Assignee: **Negotiated Data Solutions LLC**, Chicago, IL (US)

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Related U.S. Patent Documents

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Filed: **Apr. 26, 1995**

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(51) **Int. Cl.**
H04L 12/413 (2006.01)

(52) **U.S. Cl.** **370/446**; 370/453; 370/465; 370/522

(58) **Field of Classification Search** 370/466, 370/453, 465, 522
See application file for complete search history.

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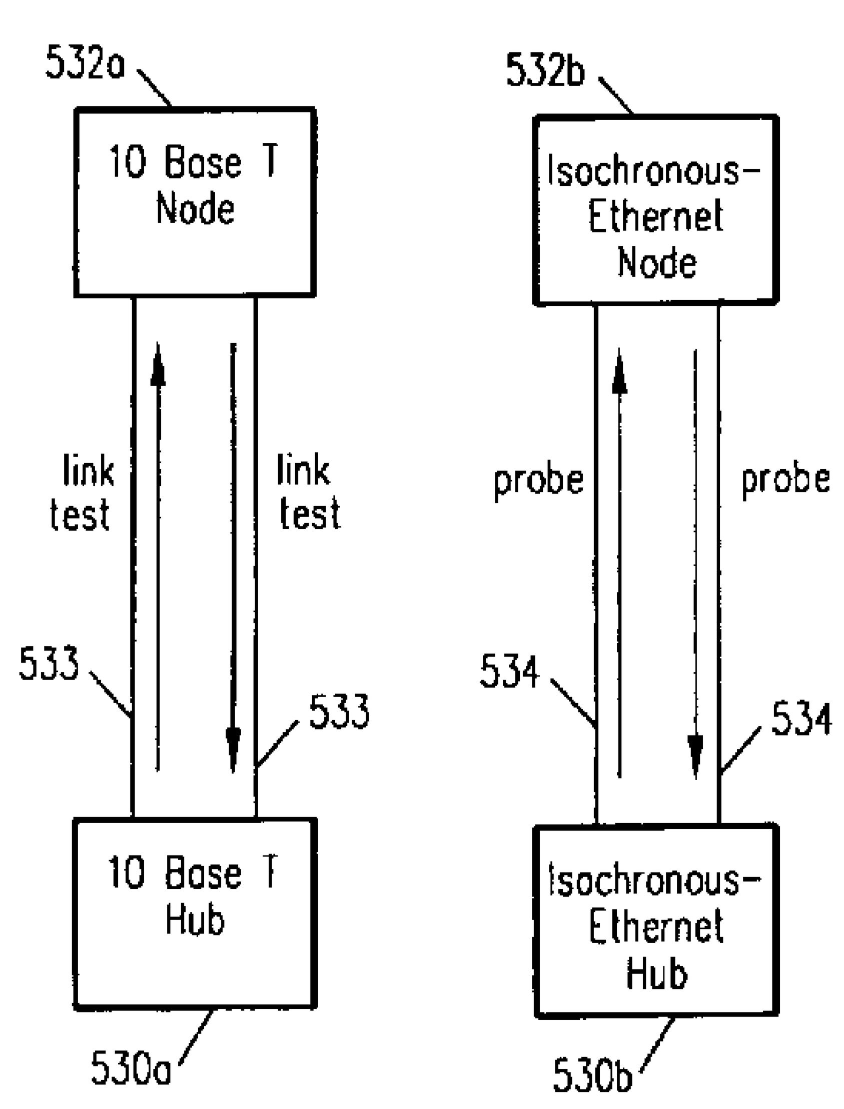
(57) **ABSTRACT**

Support for a mixed network environment is provided which can contain multiple isochronous and/or non-isochronous LAN protocols such as isochronous-ethernet, ethernet, isochronous-token ring, token ring, other isochronous-LAN or other LAN systems. Support for a mixed environment includes a protocol detection mechanism which is embodied in a handshaking scheme. This handshaking scheme determines the signalling capability at the end points of the link and implements the correct protocol. This enables isochronous nodes and hubs to automatically detect the presence of ethernet, token ring, or other LAN equipment at the other end of the network cable. If this detection occurs, the isochronous LAN equipment will fall-back to a LAN compliant mode of operation. Typically, only the hub will have the capability of operating in different networking modes, such as ethernet, Token Ring isochronous modes. The hub will listen for some form of identification from the attached nodes as to the type of service to provide—isochronous or non-isochronous; ethernet, token ring or other LAN service.

240 Claims, 9 Drawing Sheets



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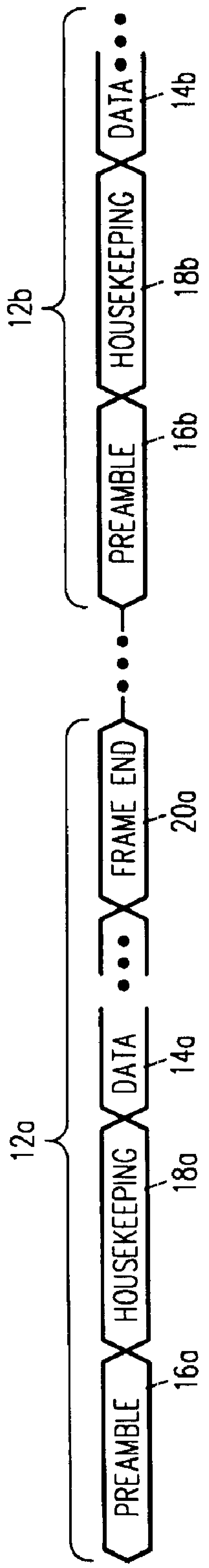

FIG. 1A

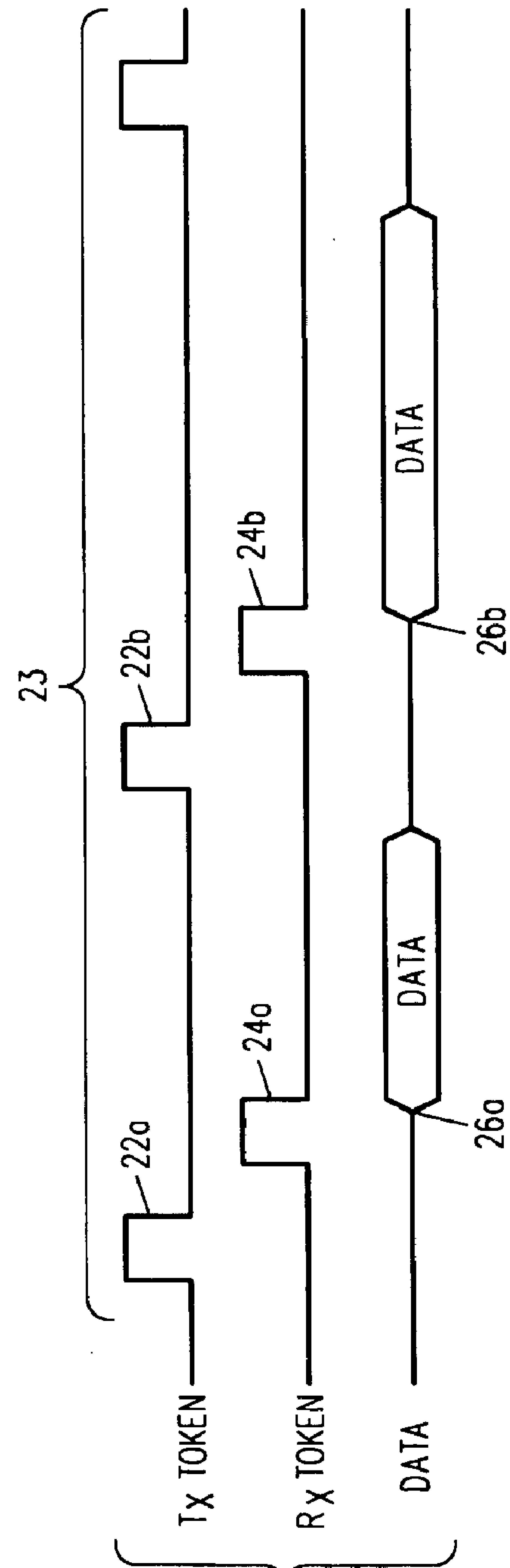

FIG. 1B

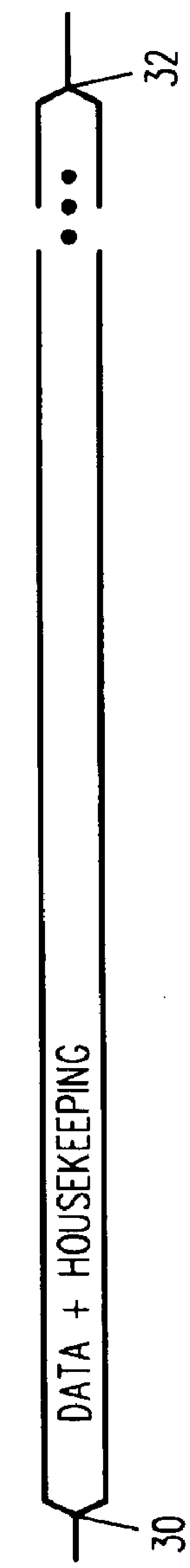

FIG. 1C

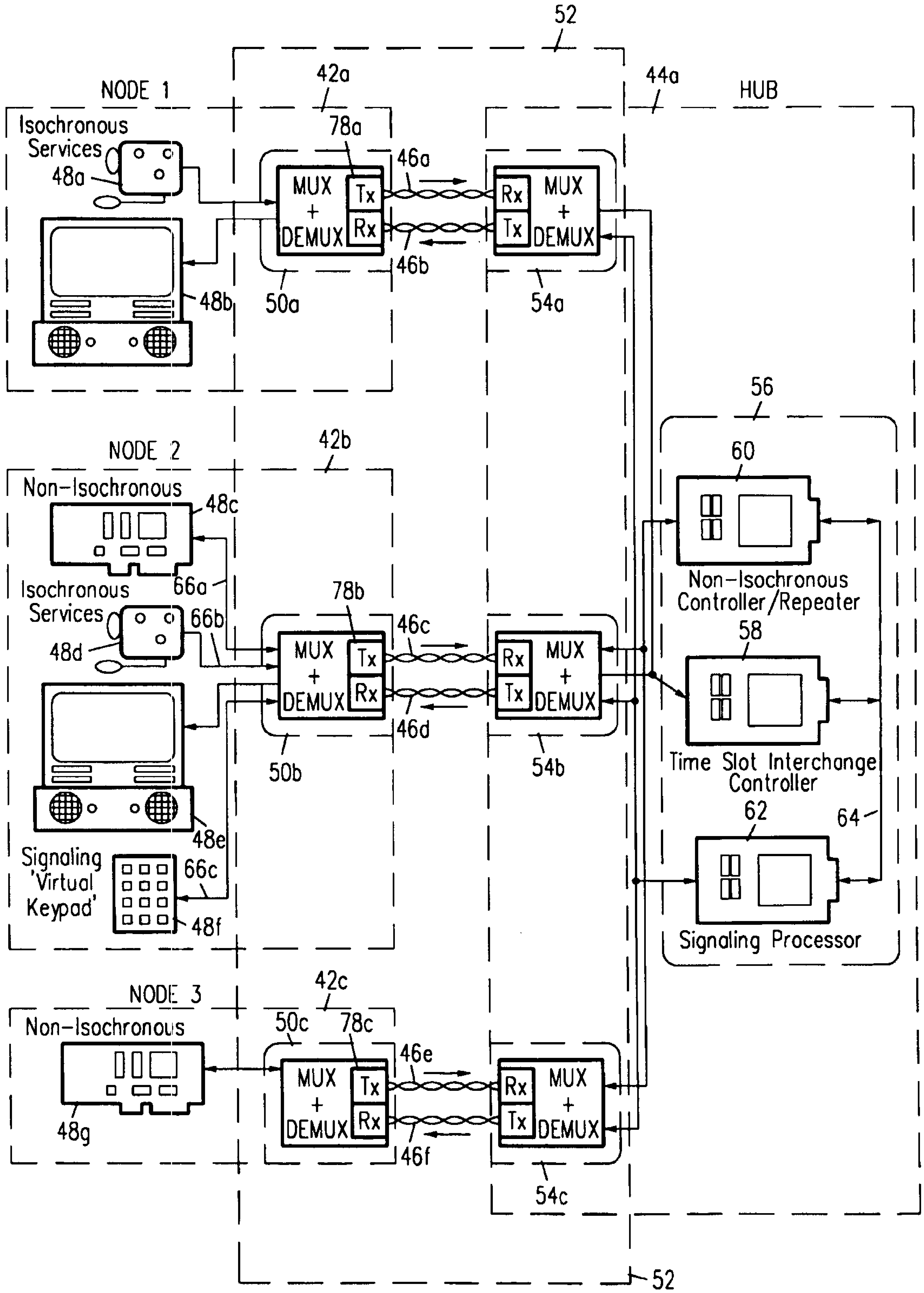
52
NODE 1
42a
44a
HUB
Isochronous
Services
48a
78a
46a
MUX
+
DEMUX
Tx
Rx
46b
50a
54a
48b
56
60
NODE 2
42b
Non-Isochronous
48c
66a
Isochronous
Services
66b
48d
78b
46c
46d
50b
54b
Non-Isochronous
Controller/Repeater
58
Time Slot Interchange
Controller
62
64
48e
Signaling
'Virtual
Keypad'
66c
48f
Signaling Processor
NODE 3
42c
Non-Isochronous
50c
78c
46e
46f
48g
54c
52

FIG. 2

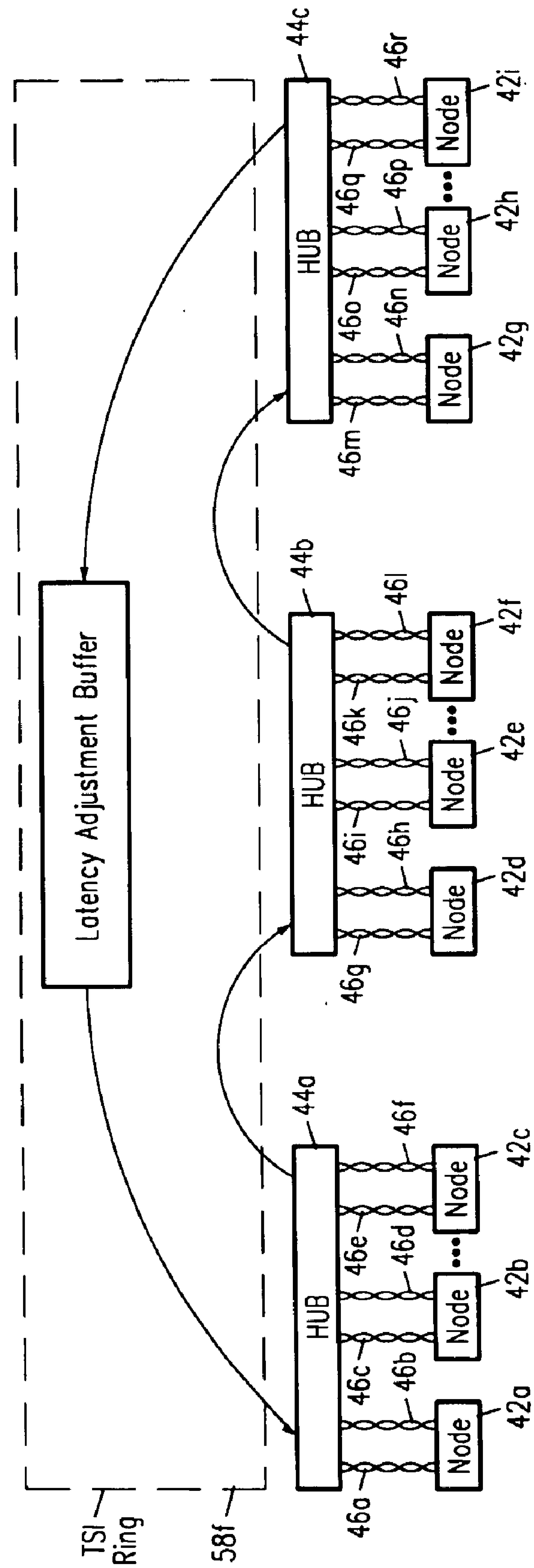
Latency Adjustment Buffer
HUB
HUB
HUB
Node
Node
Node
Node
Node
Node
Node
Node
Node
44a
44b
44c
42a
42b
42c
42d
42e
42f
42g
42h
42i
46a
46b
46c
46d
46e
46f
46g
46h
46i
46j
46k
46l
46m
46n
46o
46p
46q
46r
TSI Ring
58f

FIG. 3

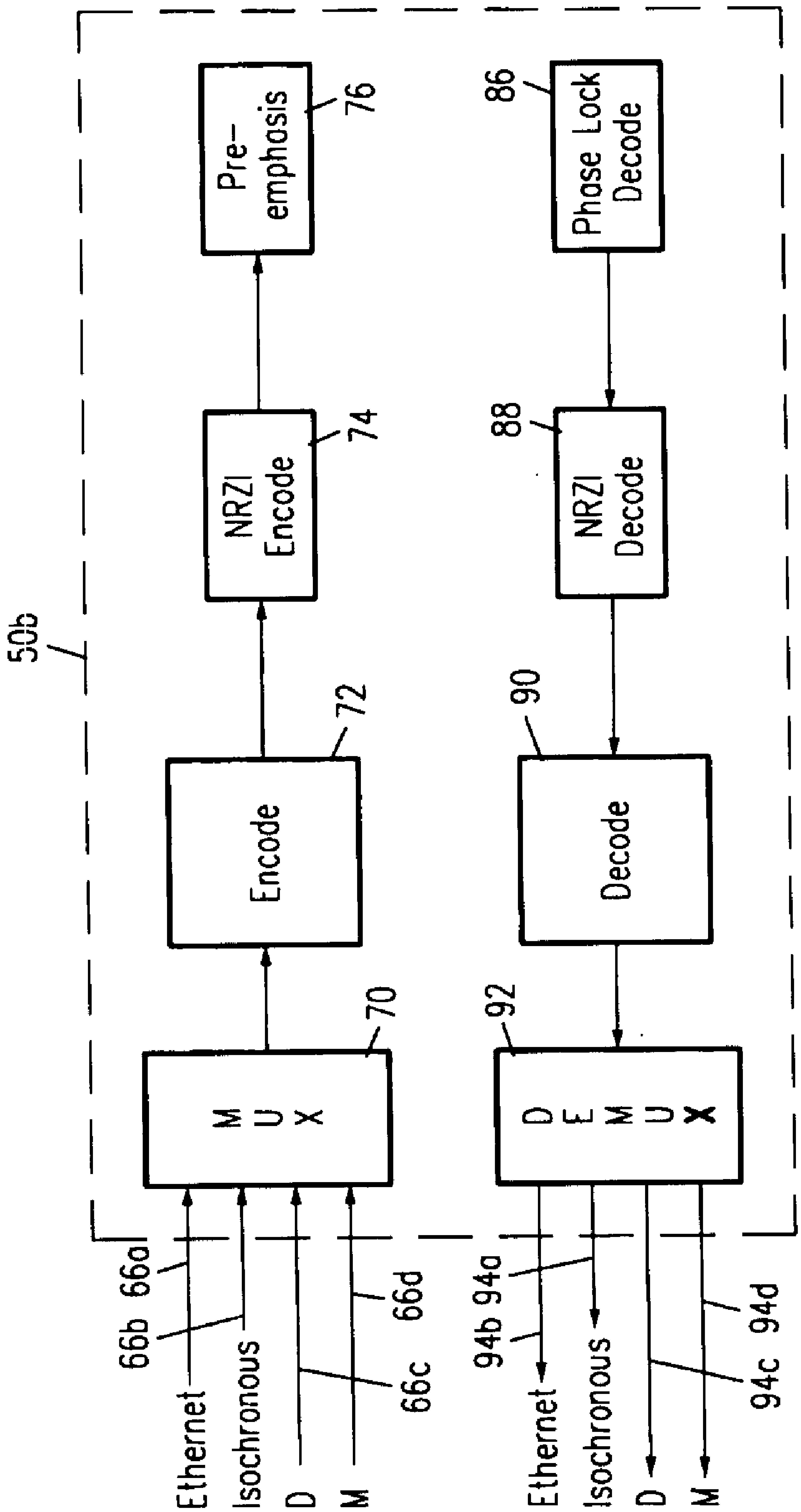
50b
Pre-emphasis
76
NRZI Encode
74
Encode
72
MUX
70
Phase Lock Decode
86
NRZI Decode
88
Decode
90
DEMUX
92
Ethernet
Isochronous
D
M
66a
66b
66c
66d
Ethernet
Isochronous
D
M
94a
94b
94c
94d

FIG. 4

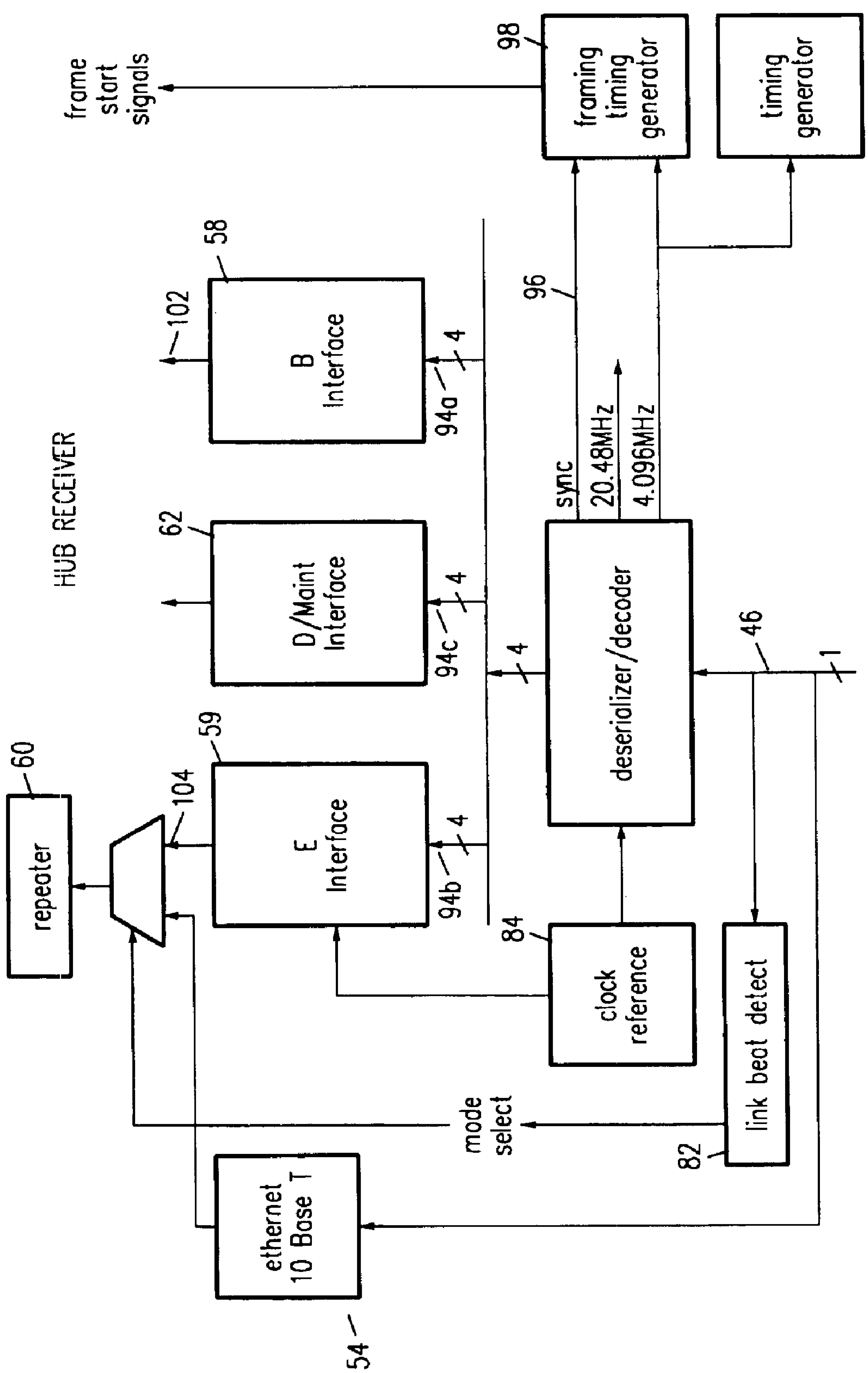
HUB RECEIVER
frame start signals
98
framing timing generator
timing generator
58
102
B Interface
94a
4
62
D/Maint Interface
94c
4
59
104
E Interface
94b
4
60
repeater
96
sync
20.48MHz
4.096MHz
deserializer/decoder
4
46
1
84
clock reference
link beat detect
82
mode select
ethernet 10 Base T
54

FIG. 5

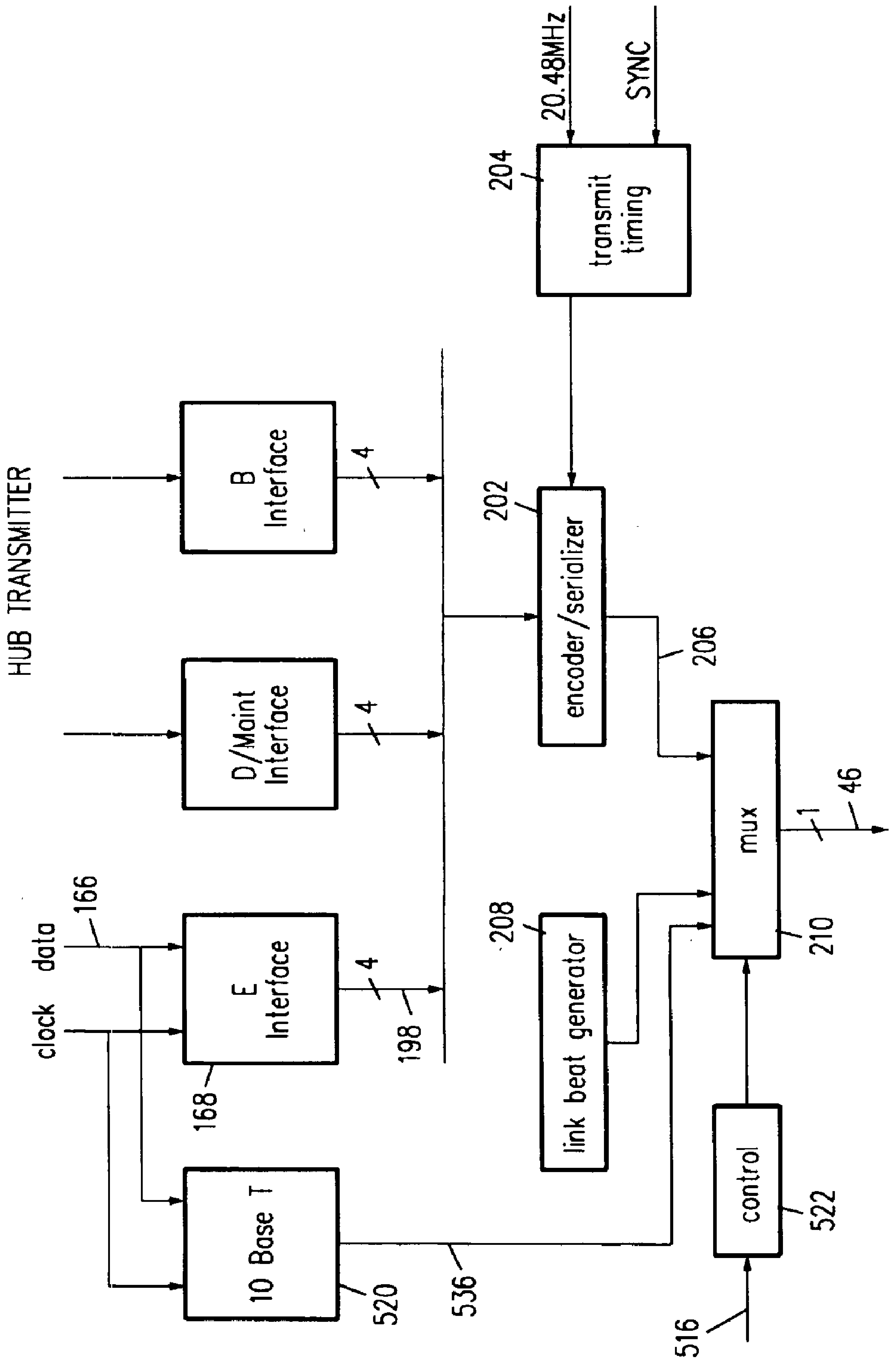
HUB TRANSMITTER
B Interface
D/Maint Interface
E Interface
10 Base T
clock
data
166
168
198
4
4
4
520
536
transmit timing
204
20.48MHz
SYNC
encoder/serializer
202
206
mux
1
46
210
link beat generator
208
control
522
516

FIG. 6

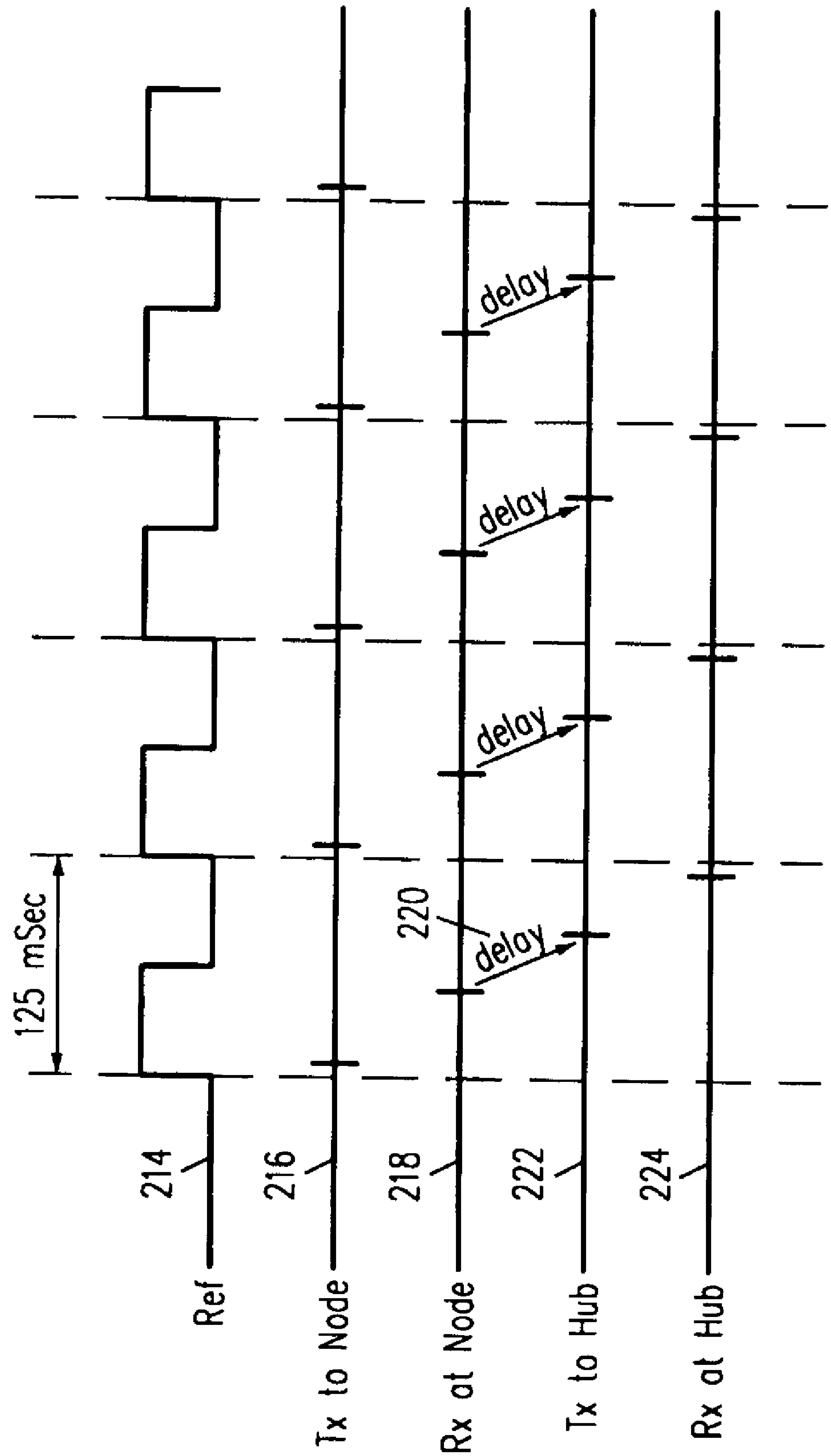
125 mSec
delay
delay
delay
delay
220
214
216
218
222
224
Ref
Tx to Node
Rx at Node
Tx to Hub
Rx at Hub

FIG. 7

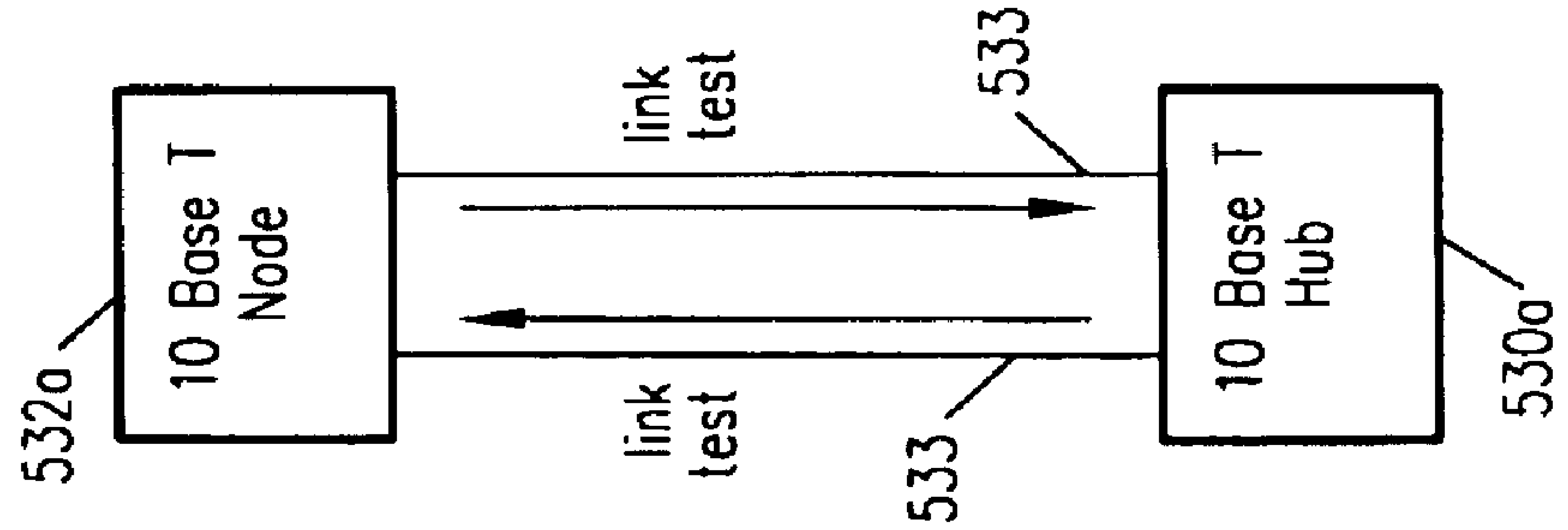

FIG. 8A

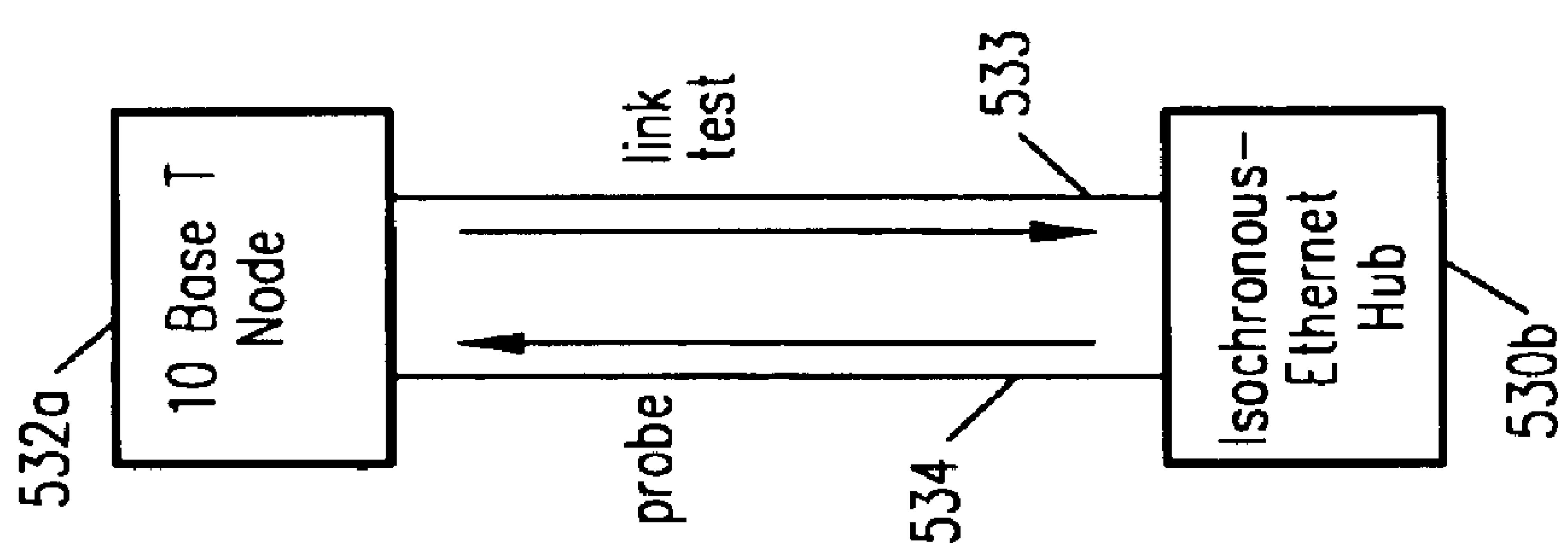

FIG. 8B

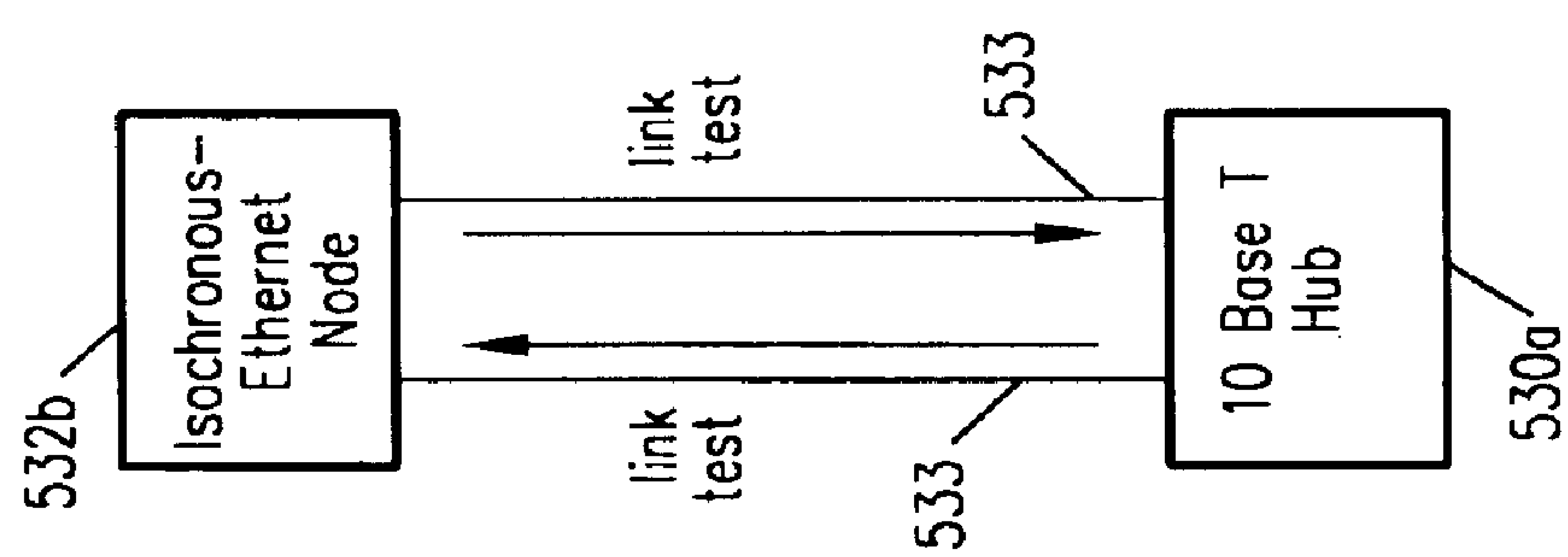

FIG. 8C

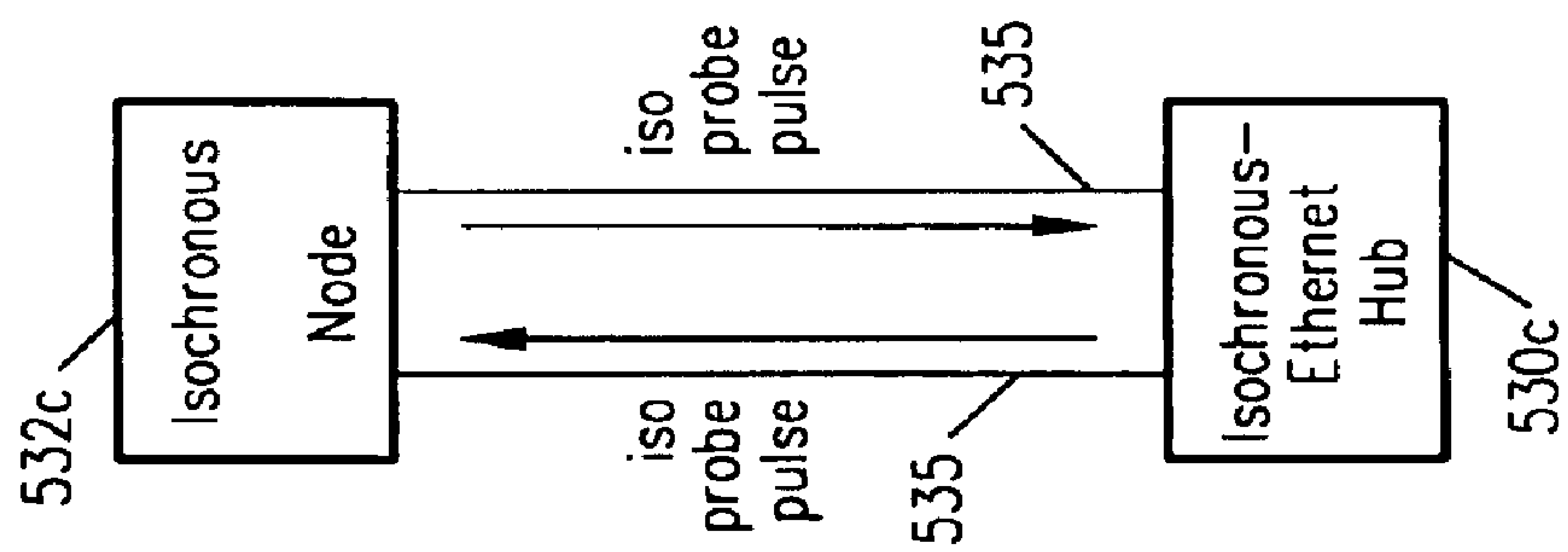

FIG. 8D

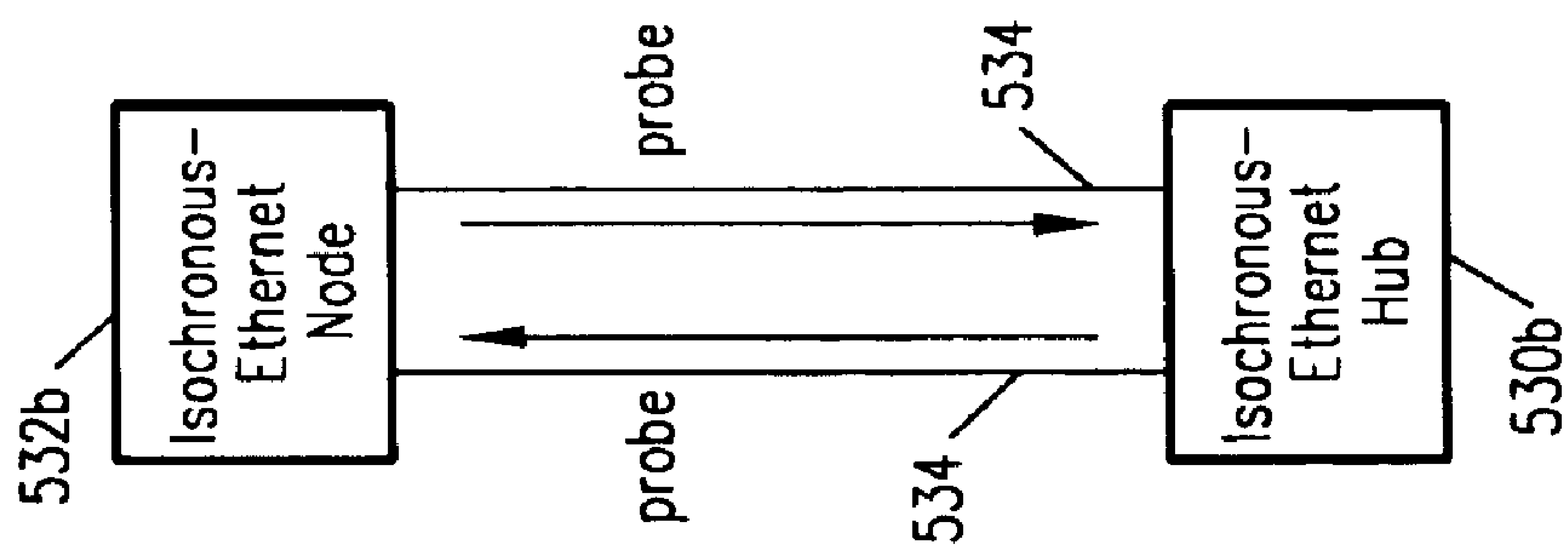

FIG. 8E

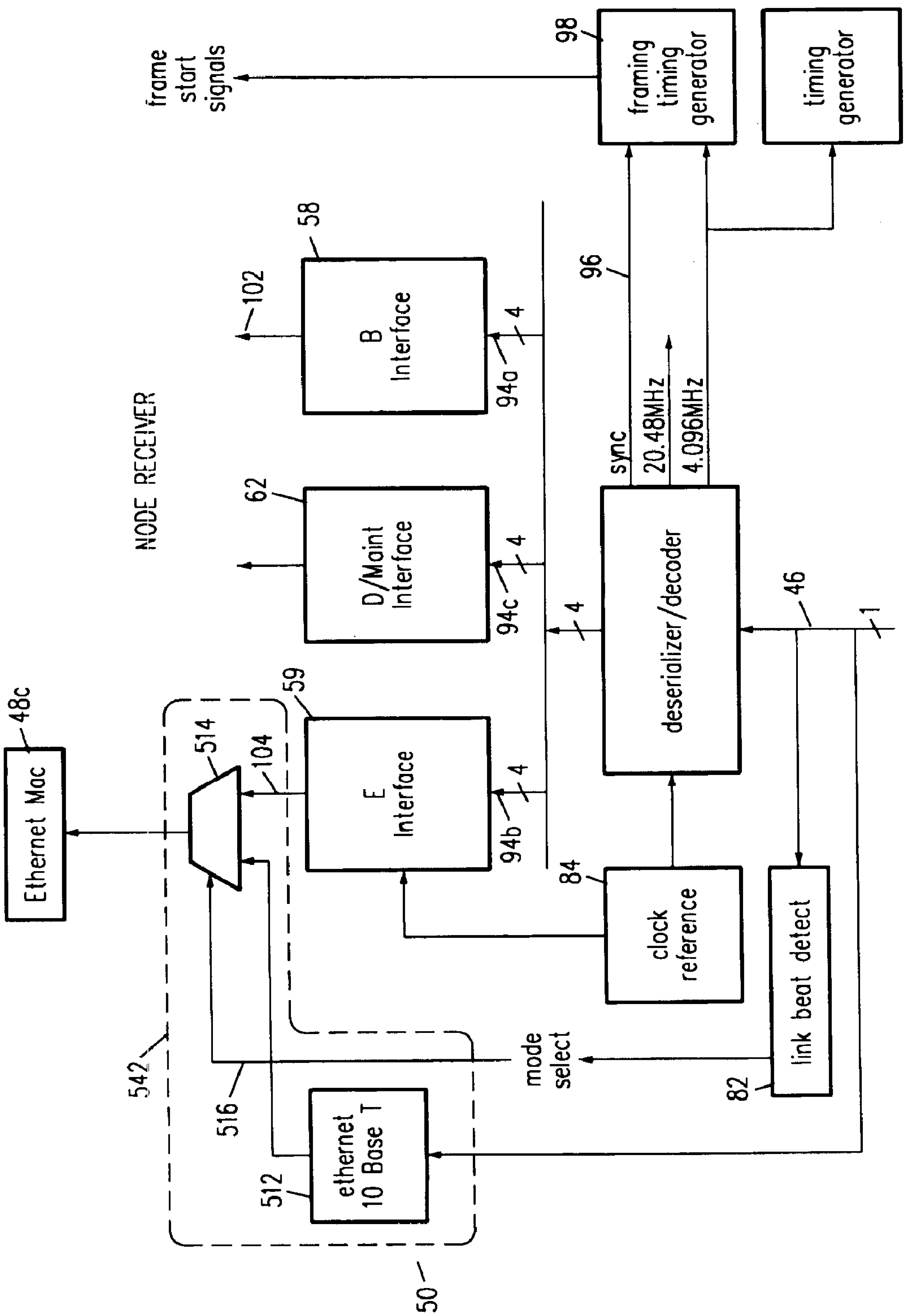
NODE RECEIVER
frame start signals
framing timing generator
98
timing generator
102
58
B Interface
4
94a
62
D/Maint Interface
4
94c
96
sync
20.48MHz
4.096MHz
deserializer/decoder
4
46
1
48c
Ethernet Mac
514
104
59
E Interface
4
94b
84
clock reference
link beat detect
82
mode select
542
516
ethernet 10 Base T
512
50

FIG. 9

NETWORK LINK ENDPOINT CAPABILITY DETECTION

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

This is a continuation of application Ser. No. 07/971,018, filed on Nov. 2, 1992 and now abandoned.

The present invention is directed to a method and apparatus for detecting, in a network, such as a local area network, the protocol capability of one or more endpoints of a data communication link, and in particular to a method and apparatus for determining whether a data source/sink at the end of a datalink has the capability of a first data communication protocol or a second data communication protocol.

BACKGROUND OF THE INVENTION

A typical data communication network is configured to operate according to a single predetermined protocol, e.g., an ethernet protocol, a token ring protocol, other LAN protocols, or an isochronous protocol. An example of an ethernet system is an implementation known as 10BASE-T which is described in the draft Nine supplement to IEEE standard 802.3, dated Nov. 15, 1989. Other examples of data communication protocols are X.25, and the Token Ring System, described for example, by IEEE Standard 802.5. Both ethernet and token ring systems convey data in packets but each uses a different media access method.

As shown in FIG. **1**A, in a packet system, data is transferred in a plurality of packets **12**a, **12**b which can be either constant-sized or variable-sized. Each packet includes a field of data **14**a, **14**b which may be preceded and/or followed by non-data information such as preamble information **16**a, **16**b housekeeping information such as data source information, data destination information, and the like **18**a, **18**b and a frame end marker **20**a. As seen in FIG. **1**A, because the fields provided for data **14**a, **14**b are not substantially continuous, the packetized scheme of FIG. **1**A is not isochronous but "bursty" in nature.

In a token ring system, a node is permitted to transmit data only after receipt of an electronic "token." as depicted in FIG. **1**B, a first station may transmit a token **22**a which is received **24**a by a second station whereupon the second station may begin transmission of data **26**a. After a period of data transmission, the second station transmits the token **22**b which is received by a third station **24**b that can then begin its own transmission of data **26**b. As seen in FIG. **1**B, because data transmission is synchronized with the occurrence of an event (the arrival of a token), the token ring system is not an isochronous data transfer system.

FIG. **1**C schematically depicts isochronous data transfer. In general terms, isochronous data is data which is non-packetized and of indeterminate, potentially continuous duration. In isochronous data transfer, the data transfer is initiated, such as by initiating a telephone conversation or beginning a video camera transmission **30**. After the data transfer or connection is initiated, transmission of the data, possibly accompanied by transmission of housekeeping information (such as destinations, audio or video timing, and the like) is provided substantially continuously for an indeterminate period, such as until termination of the connection **32**. Although it may be that not every bit transferred represents a data bit (since "housekeeping" bits may be also transferred), the transfer of data is substantially continuous in the sense that there are no substantial periods during which no data bits are transferred. It is possible that the data being transferred is "Null" data such as silence during a telephone conversation or transfer of a blank video image. One type of isochronous data transfer protocol is the Fiber Distributed Data Interface-II (FDDI-II) as described, for example, in FDDI-II Hybrid Multiplexer, Revision 2.4, dated Mar. 25, 1991.

Previous systems which were configured to use only a single-type protocol had the disadvantage that it was not possible to operate a mixed-protocol or "mixed-environment" system. Also, when upgrading a network system, it was necessary to upgrade the entire system and it was infeasible or wasteful to upgrade only part of the system (such as only some of the nodes or such as upgrading nodes without upgrading hubs or upgrading hubs without upgrading nodes). Additionally, when a system or system components were installed, or repaired it was necessary for the installing personnel to be familiar with the particular single protocol for which the network was configured and to make such installation, upgrade, or repair in accordance with such a single protocol. Furthermore, it was necessary that apparatus connected to the system be configured for exclusive operation in accordance with the predetermined single protocol.

SUMMARY OF THE INVENTION

The present invention includes a recognition of the problems found in previous devices. According to an embodiment of the present invention, apparatus connected to one endpoint of a network link is able to detect the protocol capability of the apparatus connected to the other end of the network link. Preferably, the first end of the network link has a capability of providing data communication under at least two different protocols and can select the appropriate protocol depending on what type of protocol capability is detected in the apparatus at the other end of the link.

Link endpoint capability detection takes advantage of the fact that different data communication protocols provide signals on the physical medium which have different characteristics. The various protocols can typically be detected by their unique timing and data patterns. According to one aspect of the invention, the network has a star topology with at least one hub and a plurality of nodes each node being connected to a hub by physical media constituting the link. The capability detection of the present invention can be performed by apparatus at either end of a link, and in particular, in a star topology network can be conducted by the hub or by any node. In one embodiment, capability detection is initiated by the hub. In a non-star topology at least one node can operate under two or more protocols and can detect the capability of another node with which it is connected.

The apparatus which initiates capability detection, according to one embodiment, transmits a signal onto the physical medium. In one embodiment, the apparatus at the far end of the link outputs, onto the physical medium, a second signal. Preferably, a second signal will be output from the apparatus at the far end of the link, regardless of whether the apparatus at the far end operates according to a first protocol or a second protocol. However, the second signal which is placed onto the physical medium at the far end of the link has either a first form or a second form, depending on whether the apparatus at the far end has a first protocol capability or a second protocol capability. This difference in signal is detected at the first end of the link and this could be used as a basis for determining the protocol capability at the far end of the link.

In another embodiment, the first apparatus outputs a first signal. The second apparatus outputs a response only if it has a first protocol capability. If no response is output, the first apparatus outputs a second signal in an attempt to elicit a response according to a second protocol. This process can be repeated until the first apparatus outputs a signal to which the second apparatus responds, thereby indicating a protocol capability of the second apparatus.

According to one embodiment, the first signal which is output, also carries information regarding the protocol capability of the first endpoint. That is, preferably, the first signal has a first form if the first endpoint has a first protocol capability and it has a second form if the first endpoint has a second protocol capability. Preferably, the apparatus at the far end of the link will respond to either of these forms in the manner described above.

In the preferred embodiment, the apparatus which has detected the capability at the far endpoint adjusts its operation to accommodate that capability. For example, when the first endpoint detects that the far endpoint has a first protocol capability, the first endpoint will configure itself to conduct subsequent communication using the first protocol. However, if the first endpoint detects that the far endpoint has a second protocol capability, the first endpoint is able to configure itself to accommodate the second protocol capability.

In one embodiment, the far endpoint will have only a single protocol capability. However, it is possible to configure a network in which both link endpoints have multiple protocol capabilities and both can detect one or more capabilities at the opposite endpoint. The endpoints can then configure themselves to operate at the best or most desired protocol level.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1**A, **1**B and **1**C of the timing of a packet transmission system, a token ring transmission system, and an isochronous transmission system respectively;

FIG. **2** is a schematic block diagram showing three nodes connecting to a hub card;

FIG. **3** is a schematic block diagram showing a number of hubs connected together using a ring structure;

FIG. **4**. is a schematic block diagram of node circuitry for multiplexing and preparing data for transmission over the media and for receiving information from the media and demultiplexing the data;

FIG. **5**. is a schematic block diagram of hub receiver circuitry according to an embodiment of the present invention;

FIG. **6** is a schematic block diagram of a hub transmitter circuitry;

FIG. **7** is a timing diagram showing the relative timing of transmissions and receptions at the hub and nodes;

FIGS. **8**A–**8**E are block diagrams depicting link endpoint capability detection for five different network configurations according to embodiments of the present invention; and

FIG. **9** is a block diagram of a node receiver, according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Before describing link endpoint capability detection, a general description of one type of network will be provided as one example of a data communication system in which the present invention can operate. A data communication system can be configured in a star-topology with a plurality of nodes **42**a, **42**b, **42**c, (FIG. **2**) each coupled to a hub **44**a by data links comprising physical data transmission media such as one-way twisted pair wires **46**a–**46**f. The number of nodes can be adjusted depending on the data transmission needs and objectives of the system. In one embodiment, each hub is configured to accommodate connection with up to 16 nodes. Each node **42**a, **42**b, **42**c includes circuitry **50**a, **50**b, **50**c for receiving data, converting it to a form suitable for transmission onto the physical media **46**a, **46**c, **46**e and receipt of signals from the physical media **46**b, **46**d, **46**f and conversion to a form suitable for use by the data sinks. Each of the nodes **42**a, **42**b, **42**c includes data sources and sinks **48**a–**48**g. The data sources and sinks can be isochronous sources and sinks such as video cameras **48**a, **48**d and monitors **48**b, **48**e, non-isochronous sources and sinks such as an ethernet media access controller **48**c, **48**g, and signaling or D channel sources and sinks such as an emulated or virtual key pad **48**f provided, for example, on a personal computer (PC) terminal.

Each of the nodes **42**a, **42**b, **42**c can include various types of sources and sinks such as strictly isochronous sources and sinks, such as depicted for node one **42**a, strictly non-isochronous sources/sinks as depicted for node three **42**c or both isochronous and non-isochronous sources and sinks as depicted for node two **42**b. The physical layer **52** of the network system depicted in FIG. **2** includes the node data receivers and converters **50**a, **50**b, **50**c, the physical media **46**a–**46**f and the hub components **54**a, **54**b, **54**c and **56**.

The hub **44**a includes circuitry **54**a, **54**b, **54**c for receiving data from the physical media **46**a, **46**c, **46**e separating the isochronous-sourced data from the non-isochronous-sourced data and the D channel and M channel data and converting separated data into a form suitable for handling by downstream hub circuitry **56**. In the depicted embodiment the separated isochronous-sourced data is provided to a time slot interchange controller **58** for placing the data on a high-bandwidth bus (e.g. the TSI bus) so that it can be transported to destination nodes on other TSI controllers in the hub or other hubs (as depicted, e.g. in FIG. **3**) and/or retrieved by hub circuitry **54**a, **54**b, **54**c for transmission to various destination nodes **42**a, **42**b, **42**c, e.g. by a local loopback capability. The separated non-isochronous data is provided to circuitry **60** configured to convey the non-isochronous data to one or more of the hub circuitry **54**a, **54**b, **54**c for transmission to destination nodes **42**a, **42**b, **42**c. In an embodiment in which non-isochronous-sourced data includes ethernet data, the hub circuitry **60** can be a standard ethernet repeater processor. In this way, the present invention can be at least partially backwards-compatible with previous ethernet hub systems. The D channel and M channel information is provided to a signaling processor **62** which performs various maintenance and control functions such as identifying and alerting users of error conditions, and setting up requested calls or connections, i.e. source/destination paths e.g. by communicating with the isochronous and non-isochronous controllers **58**, **60**, e.g. over data path **64**. As depicted in FIG. **3**, a number of star-topology systems can be interconnected by connecting hubs **44**a, **44**b, **44**c to one another, e.g. by a time slot interchange (TSI) ring.

According to the present invention, data communication can be provided according to one or more of a number of protocols. Those skilled in the art are familiar with protocols, but in general, a “protocol” includes a standard set of rules that specify the format, timing, sequencing and/or error checking for data transmission. Several network protocols are referenced above, including an ethernet protocol such as 10BASE-T, an isochronous protocol such as FDDI-II, and a token ring protocol. Another possible protocol is one in which both isochronous and non-isochronous data are combined into a frame structure for transmission across physical media. A frame-structure protocol of this type is described in greater detail in commonly-assigned application Ser. No. 07/969,916, titled “Network for Data Communication with Isochronous Capability”, now abandoned, filed on even date herewith and incorporated herein by reference. According to one such protocol, the incoming data from the various sources is provided to a multiplexer **70** (FIG. **4**) which performs time-division multiplexing on a four-bit basis. The pattern for the time division multiplexing is a repeating series of frames or templates. In this embodiment, the frames are repeated every 125 microseconds. The time division multiplexing is a multiplexing of isochronous-sourced data and non-isochronous-sourced data. The non-isochronous-sourced data can be data provided in accordance with a number of previously-available LAN systems and this protocol will be referred to, in general, as “isochronous-LAN” protocol. Several particular types of isochronous-LAN protocols are possible. When the isochronous data is multiplexed with LAN data which is provided decoding to an ethernet protocol, such as a 10BASE-T ethernet protocol, the resulting time-division multiplexed protocol will be referred to as an “isochronous-ethernet” protocol. When the isochronous data is multiplexed with LAN data which is provided according to a token ring protocol, the resultant time multiplexed protocol will be referred to as an “isochronous-token ring” protocol.

The present invention will be described below by way of a particular example in which one available protocol is an isochronous-ethernet protocol and another potentially available protocol is a 10BASE-T protocol. However, as will be clear to those skilled in the art, the present invention can also be used in connection with other combinations of protocols such as isochronous-token ring or other isochronous-LAN protocols, pure isochronous protocols such as FDDI-II, and can include three or more protocols.

Table I depicts the manner in which the various data streams, and additional data and control bytes are time-division multiplexed in an isochronous-ethernet protocol. Each symbol in Table I represents four bits of data so that every group of two symbols represents one 8-bit byte of data. In Table I, E represents four bits of data from the ethernet stream **66**b (FIG. **4**), B designates four bits of data from the isochronous stream **66**a. D represents four bits of data from the signaling or D channel stream **66**c, and M represents four bits of M channel data stream **66**d. In addition, certain byte-length patterns are provided. JK represents a frame synchronization pattern and EM (the first two bytes of block three in Table I) represents an ethernet “pad” followed by a maintenance byte. As seen in Table I, each frame contains 256 bytes which can be considered in thirty-two groups of eight bytes each, or four blocks of sixty-four bytes each. The frame structure is described more thoroughly in commonly-assigned application Ser. No. 07/969,911, Pat. No. 5,544,324, titled “Network for Transmitting Isochronous-Source Data with a Frame Structure”, filed on even date herewith and incorporated herein by reference.

TABLE I

BLOCK 0:																
J	K	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 0
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 1
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 2
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 3
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 4
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 5
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 6
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 7
BLOCK 1:																
M	M	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 8
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 9
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 10
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 11
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 12
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 13
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 14
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 15
BLOCK 2:																
D	D	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 16
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 17
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 18
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 19
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 20
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 21
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 22
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 23
BLOCK 3:																
E	M	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 24
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 25
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 26
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 27
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 28
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 29
E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 30

TABLE I-continued

E	E	E	B	E	B	E	B	E	B	E	B	E	B	E	E	Group 31

JK = Frame Synchronization Pattern
EM = Ethernet Fed & 4 Maintenance Bits
MM = 8 Maintenance Bits
E = Ethernet Packet Channel
D = D Channel
B = Isochronous Channel

The time-multiplexed data is then encoded by an encoder **72**. In the depicted embodiment, the encoder performs four/five encoding. One particular form of four/five encoding conforming partially to the ANSII X3T9.5 standard, is depicted in Table II. The encoding scheme depicted in Table II is described in greater detail in commonly-assigned application Ser. No. 970,329, titled "Frame-Based Transmission of Data", filed on even date herewith and incorporated herein by reference.

TABLE II

Symbol	Encoded (5 bit)	Decoded (4 bit)	Description
0	11110	0000	Data 0
1	01001	0001	Data 1
2	10100	0010	Data 2
3	10101	0011	Data 3
4	01010	0100	Data 4
5	01011	0101	Data 5
6	01110	0110	Data 6
7	01111	0111	Data 7
8	10010	1000	Data 8
9	10011	1001	Data 9
A	10100	1010	Data A
B	10111	1011	Data B
C	11010	1100	Data C
D	11011	1101	Data D
E	11100	1110	Data E
F	11101	1111	Data F
I	11111	1010	No Ethernet Carrier
S	11001	0111	No Ethernet Data
V	01100	0010	Unaligned Data
T	01101	0101	Unassigned
J	11000	1101	Frame Sync Part 1
K	10001	1101	Frame Sync Part 2
Q	00000	0010	Invalid
H	00100	0001	Invalid
R	00111	0110	Invalid
V	00001	0110	Invalid
V	00010	0010	Invalid
V	00011	0010	Invalid
V	00101	0010	Invalid
V	00110	0010	Invalid
V	01000	0010	Invalid
V	10000	0100	Invalid

The output from the encoding devices is sent to pre-emphasis circuitry **76**. The pre-emphasis circuitry compensates the signal transmitter onto the physical medium to reduce the jitter. The data output by the pre-emphasis circuitry **76** is sent to a transmitter or driver **78**b and the signal is transmitted over the physical medium **46**c. The physical medium **46**c can be any of a number of media types including twisted pair, coaxial or fiber optic cable.

The data sent over the physical media **46**a is received in the hub **44**a. The hub contains a plurality of circuit devices **54**a, **54**b, **54**c, each one coupled to one of the nodes **42**a, **42**b, **42**c by the physical media **46**. As depicted in FIG. **5**, the data transmitted over the physical media **46** arrives serially at a de-serializer/decoder **80**. Link detect circuitry **82** also receives the data from the physical media **46** for detection of the mode or protocol in which the node is operating as described more fully below. The de-serializer/decoder **80** receives a reference clock signal **84**. The de-serializer/decoder includes circuitry which is functionally an inverse Of the multiplexing/encoding circuitry described above. Referring to FIG. **4**, the de-serializer/decoder **80** includes phase lock decode circuitry **86**, the results of which are provided to NRZI decode circuitry **88** which, in turn, provides the decode results to four/five decode circuitry **90**, in turn providing results to a de-multiplexer **92** which separates the received data into the isochronous-sourced data **94**a the non-isochronous-sourced data **94**b and signaling data, such as D channel and M channel data **94**c. The de-serializer/decoder **80** also outputs a synchronization signal, derived from the JK frame synchronization symbols **96** for use by a framing timing generator **98**.

Both the non-isochronous-sourced data **94**b and the isochronous-sourced data **94**a are made available to the various hub circuitry components **54**a, **54**b, **54**c, as needed for transmission back to destination nodes. In one embodiment, the separated isochronous data **94**a and non-isochronous data **94**b are reconfigured by the respective interfaces **58**, **59** to provide isochronous output **102** and non-isochronous output **104** in a form suitable for processing so as to provide the data as needed for transmission to the destination nodes. In one embodiment, the non-isochronous data **94**b can be configured by the E interface **59** so that the output data **104** can be processed by a repeater device **60** for provision to hub circuitry **54** and eventual transmission to destination nodes. As an alternative to using a repeater for the non-isochronous data, packet connections may be linked through media access control layer bridges. Preferably, the output data **104** is in a form such that it can be handled by repeater circuitry of types previously available. For example, when the non-isochronous data **94**b is data which originated at the node **42**b from an ethernet MAC, the output data **104** is in a form such that it can be handled by a standard ethernet hub repeater **60** such as DP83950 "Repeater Interface Controller" (RIC) available from National Semiconductor Corporation, Santa Clara, Calif.

As shown in FIG. **5**, the data received over the physical link **46** is also provided to an additional interface for handling data according to a second protocol, as described more thoroughly below. For example, when the second protocol is an ethernet 10BASE-T protocol, a 10BASE-T interface **512** can be provided. The 10BASE-T receive interface **512** can be a standard 10BASE-T interface, such as model DP83922 Twisted Pair Transceiver Interface (TPI) available from National Semiconductor Corporation, Santa Clara, Calif. A multiplexer **514** determines whether the repeater **60** receives a data stream from the E interface **59** or the 10BASE-T interface **512**. This selection by the multiplexer **514** is controlled by a mode select signal output over control line **516** from the link beat detect circuit **82** as described more fully below.

The data **198** output from the E transmit interface **168** is provided along with isochronous data output **164** and M channel and D channel data **170** to encoder serializer circuitry **202**, as depicted in FIG. **6**. The encoder/serializer **202** is configured substantially like the encoding the circuitry found in the node and depicted in FIG. **4**. Specifically, the encoder/serializer **202** provides a multiplexer for combining the three streams of data **198**, **170**, **164**, a four/five encoder, an NRZI encoder, and pre-emphasis circuitry. The timing of transmission is controlled by transmit timing circuitry **204**. Output **206** from the encoder/serializer is selectively combined with link beats from a link beat generator **208** by multiplexer **210** for purposes of link end point detection, as described below. The clock signal and the data **166** from the repeater **60**, in addition to being provided to the E interface **168** is also provided to a second interface which operates according to a second protocol. When a second protocol is an ethernet 10BASE-T protocol, the interface is an ethernet 10BASE-T interface **520**. The ethernet 10BASE-T interface transmit **520** can be of a type substantially identical to 10BASE-T interfaces provided previously in apparatus such as model DP83922 Twisted Pair Transceiver Interface (TPI), available from National Semiconductor Corporation, Santa Clara, Calif. The output from the ethernet 10BASE-T interface **520** is provided to the multiplexer **210**. Multiplexer **210** is able to select, in response to a control signal **522**, whether to output data originating from the repeater **60** according to a first protocol determined by the E interface **168**, or according to a second protocol determined by the ethernet 10BASE-T interface **520**, as described more fully below. The data sent from the hub **44**a to the nodes **42** is sent in a frame format which is preferably substantially the same as the frame format used for the data sent from the nodes **48** to the hub **44**a as described above. At the nodes **42**, the circuitry **50** includes devices (FIG. **4**) for decoding and de-multiplexing data, similar to that described for performing these functions in the hub, mainly a phase lock decode **86**, and NRZI decode **88**, a four/five decode **90**, and a de-multiplexer **92**. Decoded and de-multiplexed data is then delivered to the various data sinks in the nodes **42**.

As shown in FIG. **7**, the timing of the system can be synchronized with a 125 microsecond reference clock signal **214**. In this example, the reference signal **214** provides an ascending clock edge every 125 microseconds. The reference signal can be provided by any of a number of sources. Preferably, an embodiment of the present invention is configured to permit a reference signal **214** to be synchronized to an external clock reference, such as a reference signal from a wide area network or from a FDDI-II ring. The reference signal can be supplied through one of the nodes and transmitted to the hub for distribution to the other nodes, or can be supplied directly to the hub for distribution.

FIG. **8**A depicts a network configuration in which the hub **530**a is a 10BASE-T hub and the node **532**a is a 10BASE-T node, both of which are found in previously-available devices. In this system, the 10BASE-T hub sends a hub protocal signal, specifically a link test pulse, in accordance with IEEE Standard 802.3, over the physical medium to a 10BASE-T node **532**a. In a typical system, the 10BASE-T hub outputs a hub protocal signal upon being powered-up. The link test pulse used in previous devices is described in IEEE Standard 802.3. Briefly, a link test pulse can be described as a series of single 100 nonosecond pulses occurring at a nominal 16 millisecond interval. The 10BASE-T node **532**a, typically in response to being powered-up, outputs onto the physical medium a node protocal signal, which, in accordance with IEEE 802.3, is substantially identical to the above-described link test pulse. This link test pulse is received by the 10BASE-T hub **530**a. At this point, a 10BASE-T hub proceeds to operate on the basis that it is connected to a 10BASE-T node (**532**a) and the node **532**a begins to operate on the basis that it is connected to a 10BASE-T hub (**530**a) and normal 10BASE-T communication proceeds.

FIG. **8**B depicts a configuration according to one embodiment of the present invention in which an isochronous-ethernet hub **530**b is connected to a 10BASE-T node **532**a. The isochronous-ethernet hub outputs a hub protocal signal, specifically a probe signal **534**. A probe signal differs from the link test pulse in that it has a faster link beat, for example having a beat period of less than about 2 milliseconds. The 10BASE-T node **532**a is configured substantially identically to previously available 10BASE-T nodes. Upon receipt of the probe pulse **534**, it continues to output a link test pulse onto the physical medium as its node protocal signal. The isochronous-ethernet hub **530**b, upon receiving a link test pulse (rather than a probe pulse) can determine, on that basis, that the apparatus connected to the far end of the physical medium is a 10BASE-T node **532**a (rather than, for example, an isochronous-ethernet node). Preferably, the isochronous-ethernet hub **530**b is capable of handling data either according to an isochronous-ethernet protocol or a 10BASE-T protocol. Upon receiving a link test pulse and determining that the node **532**a is a 10BASE-T node, the isochronous- ethernet hub **530**b will configure itself to conduct all future communications with node **532**a using a 10BASE-T protocol.

Although FIG. **8**B shows only a single node **532**a connected to the hub **530**b, in a typical configuration, a plurality of nodes will be connected to each hub. Preferably, the hub **530**b is capable of using different protocols with different nodes. Accordingly, an isochronous-ethernet hub which is connected to both a 10BASE-T node and an isochronous-ethernet node can determine the capability of each node which it is connected by observing the node protocal signal and can use the appropriate protocol for each node.

FIG. **8**C depicts a network configuration in which a 10BASE-T hub **530**a is connected to an isochronous-ethernet node **532**b. Upon initialization of the system the 10BASE-T hub outputs a link test pulse **533** as its hub protocal signal. In the depicted embodiment the isochronous-ethernet node **532**b can operate according to an isochronous-ethernet protocol. Therefore, upon receiving the link test pulse **533**, it outputs a link test pulse **533**. Accordingly, the 10BASE-T hub **530**a can only send ethernet data and no isochronous data.

FIG. **8**D depicts a network configuration in which an isochronous-ethernet hub **530**c is connected to an isochronous node **532**c. In the embodiment depicted in FIG. **8**D, the node **532**c only has isochronous protocol capability, but the hub **530**c has both an isochronous-ethernet protocol capability and an isochronous protocol capability. In this embodiment, upon initialization of the system, the hub **530**c outputs an isochronous probe pulse **535** as its hub protocal signal. The isochronous node **532**c, upon receiving the isochronous probe pulse **535**, can determine that the hub to which it is attached is an isochronous-capability hub and will configure itself to conduct all future communications with the hub **530**c according to an isochronous protocol. Thus, the isochronous node **532**c preferably contains isochronous apparatus similar to apparatus found in the hub **530**c for detecting circuitry at the other end of the link or physical medium and, thereafter, using the appropriate protocol. The isochronous node **532**c, in response to receipt of the iso probe pulse **535**, outputs an iso probe pulse **535** as its node protocal signal. The hub **530**c, upon receipt of the iso probe pulse, will commence normal isochronous hub operations.

FIG. **8**E depicts a configuration in which an isochronous-ethernet hub **530**b is connected to an isochronous-ethernet node **532**b. When the system is initialized the isochronous-ethernet hub **530**b outputs a probe signal such as an isoEnet probe, on the physical medium as its hub protocal signal. When the isochronous-ethernet node **532**b receives the isoEnet probe signal it is able to determine that the hub to which it is connected is an isochronous-ethernet hub. The isochronous-ethernet node **532**b then outputs an isoEnet probe signal **534** onto the physical medium as its node protocal signal which is received by the isochronous ethernet hub **530**b. When the isochronous-ethernet hub **530**b receives an isoEnet probe signal it can determine that the node **532**b to which it is connected is an isochronous-ethernet node and will conduct all future communications with this particular node according to the isochronous-ethernet protocol.

FIGS. **5** and **6** depict components in the hub which are used in connection with link endpoint capability detection. As depicted in FIG. **6**, a link beat generator **208** is provided for outputting the appropriate hub probe signal. A control signal **522** controls the multiplexer **210** so that the probe signal **208** is output onto the physical medium **46** at the appropriate time, e.g., upon initialization of the network system.

FIG. **9** depicts circuitry **50** in an isochronous-ethernet node. Circuitry **542** would be provided in a node which can operate in accordance with two protocols. Nodes which provide only a single protocol would not include circuitry **542** and the E interface **59** would be connected directly to the ethernet MAC **48**c. The node protocal signal received over the physical medium **46** is detected by the link beat detector circuitry **82**. Circuitry **82** can include, for example a state machine, for detecting the sequence and interval of the pulse or link test pulse. The link beat detector circuitry **82** outputs a mode select signal **516** for controlling the multiplexer **514**. The control signal **516** is configured to set the multiplexer **514** such that the ethernet MAC **48**C is connected to the output of the isochronous-ethernet interface **59** so that future data received over the physical medium **46** is treated in accordance with the isochronous-ethernet protocol. If the link beat detector **82** detects the link test pulse rather than an iso pulse signal, it outputs a mode select signal **516** which configures the multiplexer **514** to connect the ethernet MAC **48**C with the ethernet 10BASE-T interface **512** so that future data received over the physical medium is treated in accordance with ethernet 10BASE-T protocol. The mode select signal **516** also provides a signal to a control circuit in a node transmitter. The node transmitter is not separately depicted in detail since it is substantially identical to the hub transmitter depicted in FIG. **6**.

The node transmitter control **522** in response to the mode select signal **516** (indicating receipt of a link test pulse or other probe pulse) configures the multiplexer to output an appropriate node protocal signal from the link beat generator **208** onto the medium **46**. In some embodiments, nodes and/or hubs are configured to output a link test pulse or a probe pulse (depending on the capability of the hub or node), whenever the hub or node is powered-up. For embodiments in which the link beat detect **82** is able to discriminate between a link test pulse and a probe signal such as an iso probe pulse, the mode select **516** can configure the link beat generator **208** to output a link test pulse in response to a link test pulse and an iso probe pulse in response to a probe signal. The signal output by the node transmitter is received in the hub receiver **54** (FIG. **5**). The hub receiver link beat detect circuitry **82** detects the output of the node protocal signal from the node transmitter. When the signal is a probe signal, circuitry **82** outputs a mode select signal **516** which is effective to control the multiplexer **514** to connect the output from the E interface **59** to the repeater **60**. In this way, the hub receiver is now configured to process future signals received from the node over medium **46** according to an isochronous-ethernet protocol. The node select signal **516** also provides an input to control signal **522** which, in response, configures the multiplexer to place the output **206** from the encoder/serializer **202** onto the physical medium **46**, rather than using the output from the 10BASE-T interface **536**. In this way, the transmitter is now configured to output data according to the isochronous-ethernet protocol.

If the signal output from the node is a link test pulse rather than probe pulse, the link beat detector **82** outputs a mode select signal **516** which configures multiplexer **514** to connect the ethernet 10BASE-T interface **512** with repeater **60** and configures the multiplexer to send output **536** onto the physical medium **46**, rather than output **206**.

In view of the above description, a number of advantages of the present invention can be seen. The present invention allows a network to be configured in a mixed protocol or mixed environment, with, for example, a single hub connected to a plurality of nodes which operate according to different protocols, with the configuration being achieved automatically, without the need for manually establishing a predetermined protocol beforehand for each node. The present invention permits networks to be upgraded incrementally so that it is not necessary to upgrade all nodes at the same time. Furthermore, it is not, in general, necessary for service personnel to specifically configure nodes or hubs to accommodate particular protocols since the protocols are determined automatically and the nodes and hub configure themselves in accordance with the determined protocols.

A number of variations and modifications of the present invention can be used. Although an embodiment involving a 10BASE-T protocol and an isochronous-ethernet protocol was described, the present invention is equally applicable to other protocols including other LAN protocols such as a token ring protocol, an isochronous protocol and the like. Although the present invention described one particular signal characteristic used for determining the protocol, other characteristics could also be used. For example, a token ring connection could be detected by the presence of four or 16 Mbit/sec Manchester-encoded data. Other LANs can be detected by their unique timing and data patterns. Protocols could also be detected using such characteristics as the pattern of the presence or absence of a carrier, and the frequency spectrum of signals placed onto the physical medium. When a node has a capability of communicating under two or more protocols, e.g. either an isochronous-ethernet protocol or a pure ethernet protocol, it would be possible for a hub to use both capabilities of a node, i.e., to communicate according to a first protocol during a first time period and a second protocol during a second time period. Although the present invention has been described in the context of a star topology, the invention could also be used in a non-star topology, such as a ring topology or a tree topology. The present invention can be used in networks which do not have a hub, such as direct connections between two nodes with each node determining the protocol capabilities of the other node. As described above, the link test pulse and iso probe signals are related in that, for example, a 10BASE-T node will respond in the same fashion to receipt of either type of pulse. However, the test signals could be provided in forms which are unique to each type of protocol. In such a system, a data source/sink would output a first type of test pulse or other signal and, if no response was received, would output a second type of test pulse or signal, and so forth until a response was received indicating the protocol capability at the other end of the link. A data source/sink could be configured to determine all possible protocol capabilities of the apparatus at the other end of the link, rather than determining the "highest" or "best"capability available or using the first capability detected. The devices at each end could select a protocol capability other than the "highest" or "best" capability. It would be possible for a node to store an indication of its capabilities, such as in a table or other memory device, and to output the information upon receiving an inquiry. It would also be possible for a network to initialize in a common protocol, e.g., a 10BASE-T protocol, and, thereafter, exchange information, using that protocol, indicating additional protocol capabilities of the components of the system. Thereafter, the systems could reconfigure themselves to use desired ones of the available protocols.

Although the present invention has been described by way of preferred embodiments and certain variations and modifications, other variations and modifications can also be used, the invention being defined by the following claims.

What is claimed is:

1. In a data communication network comprising a hub coupled to at least one node, an apparatus for establishing communication between the hub and a node comprising:

a hub transmitter coupled to the hub for transmitting a hub protocol signal to the node, the hub protocol signal indicating a communication protocol, including a format for a data transmission, with which the hub is capable of communicating;

a node receiver coupled to the node for receiving the hub protocol signal;

a node transmitter coupled to the node for transmitting a node protocol signal to the hub, the node protocol signal indicating a communication protocol, including a format for a data transmission, with which the node is capable of communicating;

wherein the communication protocol indicated by the node protocol signal is different from the communication protocol indicated by the hub protocol signal;

a hub receiver coupled to the hub for receiving the node protocol signal;

a protocol identifying circuit coupled to the hub receiver for identifying the communication protocol indicated by the node protocol signal from among a plurality of possible communication protocols with which the hub is capable of communicating; and

wherein the hub transmitter includes a communication circuit for communicating with the node using the communication protocol indicated by the node protocol signal in response thereto.

2. The apparatus according to claim **1** wherein the hub receiver includes frame receiving circuitry for receiving data formatted in a frame structure, and packet receiving circuitry for receiving data formatted in a packet structure and wherein the received data formatted in the frame structure and the received data formatted in the packet structure are received over the same receiving communication path, and wherein the hub transmitter includes frame transmitting circuitry for transmitting data formatted in the frame structure, and packet transmitting circuitry for transmitting data formatted in the packet structure, wherein the data formatted in the frame structure and the data formatted in the packet structure are transmitted over the same transmitting communication path.

3. The apparatus according to claim **2** wherein the hub protocol signal comprises a signal indicating a protocol corresponding to data formatted in the frame structure, and wherein the node protocol signal comprises a signal indicating a protocol corresponding to data formatted in the packet structure.

4. The apparatus according to claim **2** wherein the node protocol signal indicates an ethernet protocol, and wherein the data formatted in the packet structure is formatted according to the ethernet protocol.

5. The apparatus according to claim **2** wherein the node protocol signal indicates a token-ring protocol, and wherein the data formatted in the packet structure is formatted according to the token-ring protocol.

6. The apparatus according to claim **2** wherein the frame receiving circuitry includes packet converting circuitry for converting received data formatted in the frame structure into data formatted in a packet structure.

7. The apparatus according to claim **6** wherein the node protocol signal indicates an ethernet protocol, and wherein the data formatted in the packet structure is formatted according to the ethernet protocol.

8. The apparatus according to claim **6** wherein the node protocol signal indicates a token-ring protocol, and wherein the data formatted in the packet structure is formatted according to the token-ring protocol.

9. The apparatus according to claim **1** wherein the hub receiver includes frame receiving circuitry for receiving data formatted in a frame structure, and isochronous receiving circuitry for receiving data formatted in an isochronous structure, wherein the received data formatted in a frame structure and the received data formatted in the isochronous structure are received over the same receiving communication path, and wherein the hub transmitter includes frame transmitting circuitry for transmitting data formatted in a frame structure, and isochronous transmitting circuitry for transmitting data formatted in an isochronous structure, wherein the data formatted in the isochronous structure and the data formatted in the frame structure are transmitted over the same transmitting communication path.

10. The apparatus according to claim **9** wherein the hub protocol signal comprises a signal indicating a protocol corresponding to data formatted in the frame structure, and wherein the node protocol signal comprises a signal indicating a protocol corresponding to data formatted in the isochronous structure.

11. The apparatus according to claim **9** wherein the node protocol signal indicates the isochronous protocol, and wherein the data formatted in the isochronous structure is communicated to the node according to the isochronous protocol.

12. The apparatus according to claim **9** wherein the frame receiving circuitry includes isochronous converting circuitry for converting received data formatted in the frame structure into data formatted in the isochronous structure.

13. The apparatus according to claim **12** wherein the node protocol signal indicates the isochronous protocol, and wherein the converted data formatted in the isochronous structure is communicated to the node according to the isochronous protocol.

14. The apparatus according to claim **9** wherein the frame receiving circuitry includes packet converting circuitry for converting received data formatted in the frame structure into data formatted in a packet structure.

15. An apparatus as set forth in claim **1** wherein said node transmitter transmits said node protocol signal responsive to said node receiver receiving said hub protocol signal.

16. In a data communication network comprising a hub coupled to at least one node, an apparatus for establishing communication between the hub and a node comprising:

a hub transmitter coupled to the hub for transmitting a hub protocol signal to the node, the hub protocol signal indicating a communication protocol, including a format for a data transmission, with which the hub is capable of communicating;

a protocol identifying circuit coupled to the node receiver for identifying the communication protocol indicated by the hub protocol signal from among a plurality of possible communication protocols with which the node is capable of communicating; and

a node transmitter coupled to the protocol identifying circuit for transmitting a node protocol signal, including a format for a data transmission, to the hub indicating that communication between the hub and the node will take place with the protocol indicated by the hub protocol signal.

17. The apparatus according to claim **16** wherein the node receiver includes frame receiving circuitry for receiving data formatted in a frame structure, and packet receiving circuitry for receiving data formatted in a packet structure, wherein the received data formatted in the frame structure and the received data formatted in the packet structure are received over the same receiving communication path, and wherein the node transmitter includes frame transmitting circuitry for transmitting data formatted in the frame structure, and packet transmitting circuitry for transmitting data formatted in the packet structure, wherein the data formatted in the frame structure and the data formatted in the packet structure are transmitted over the same transmitting communication path.

18. The apparatus according to claim **17** wherein the hub protocol signal indicates an ethernet protocol, and wherein the data formatted in the packet structure is formatted according to the ethernet protocol.

19. The apparatus according to claim **17** wherein the hub protocol signal indicates a token-ring protocol, and wherein the data formatted in the packet structure is formatted according to the token-ring protocol.

20. The apparatus according to claim **17** wherein the frame receiving circuitry includes packet converting circuitry for converting received data formatted in a frame structure into data formatted in a packet structure.

21. The apparatus according to claim **16** wherein the node receiver includes frame receiving circuitry for receiving data formatted in a frame structure, and isochronous receiving circuitry for receiving data formatted in an isochronous structure, wherein the received data formatted in the frame structure and the received data formatted in the isochronous structure are received over the same receiving communication path, and wherein the node transmitter includes frame transmitting circuitry for transmitting data formatted in the frame structure, and isochronous transmitting circuitry for transmitting data formatted in the isochronous structure, wherein the data formatted in the frame structure and the data formatted in the isochronous structure are transmitted over the same transmitting communication path.

22. The apparatus according to claim **21** wherein the hub protocol signal indicates an isochronous protocol, and wherein the transmitted data formatted in the isochronous structure is communicated to the hub according to the isochronous protocol.

23. The apparatus according to claim **21** wherein the frame receiving circuitry includes isochronous converting circuitry for converting received data formatted in the frame structure into data formatted in the isochronous structure.

24. In a data communication network comprising a hub coupled to at least one node, an apparatus for establishing communication between the hub and a node comprising:

a hub transmitter coupled to the hub for transmitting a hub protocol signal to the node, the hub protocol signal indicating one of a plurality of communication protocols, including a format for a data transmission, with which the hub is capable of communicating;

a node receiver coupled to the node for receiving the hub protocol signal;

a first protocol identifying circuit coupled to the node receiver for identifying the communication protocol indicated by the hub protocol signal from among a plurality of communication protocols with which the node is capable of communicating;

a node transmitter coupled to the node receiver for transmitting a node protocol signal to the hub, the node protocol signal indicating the communication protocol, including a format for a data transmission, indicated by the hub protocol signal if the communication protocol indicated by the hub protocol signal is a communication protocol with which the node is capable of communicating;

a hub receiver coupled to the hub for receiving the node protocol signal;

a second protocol identifying circuit coupled to the hub receiver for identifying the communication protocol indicated by the node protocol signal from among a plurality of communication protocols with which the hub is capable of communicating;

wherein the hub transmitter includes a communication circuit for communicating with the node using the communication protocol indicated by the node protocol signal in response thereto.

25. The apparatus according to claim **24** wherein said data communication network comprises a plurality of nodes and the data communication network is configured in a star topology.

26. The apparatus according to claim **24** wherein said data communication network comprises a plurality of hubs wherein the hubs are configured in a ring topology.

27. The apparatus according to claim **24** wherein said data communication network comprises a plurality of nodes and wherein the nodes are configured in a tree topology.

28. The apparatus according to claim **24** wherein the hub protocol signal comprises a series of 100 nanosecond pulses occurring at nominal 16 millisecond intervals.

29. The apparatus according to claim **24** wherein the hub receiver includes frame receiving circuitry for receiving data formatted in a frame structure, and packet receiving circuitry for receiving data formatted in an packet structure, wherein the received data formatted in a frame structure and the received data formatted in the packet structure are received over the same receiving communication path, and wherein the hub transmitter includes frame transmitting circuitry for transmitting data formatted in a frame structure, and packet transmitting circuitry for transmitting data formatted in a packet structure, wherein the transmitted data formatted in the frame structure and the transmitted data formatted in the packet structure are transmitted over the same transmitting communication path.

30. The apparatus according to claim 29 wherein the hub protocol signal comprises a signal indicating a protocol corresponding to data formatted in the frame structure, and wherein the node protocol signal comprises a signal indicating a protocol corresponding to data formatted in the frame structure.

31. The apparatus according to claim 29 wherein the hub protocol signal indicates an isochronous-ethernet protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-ethernet protocol.

32. The apparatus according to claim 29 wherein the hub protocol signal indicates an isochronous-token ring protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-token ring protocol.

33. The apparatus according to claim 29 wherein the hub protocol signal indicates an ethernet protocol, and wherein the transmitted data formatted in the packet structure is formatted according to the ethernet protocol.

34. The apparatus according to claim 29 wherein the hub protocol signal indicates a token-ring protocol, and wherein the transmitted data formatted in the packet structure is formatted according to the token-ring protocol.

35. The apparatus according to claim 29 wherein the frame receiving circuitry includes packet converting circuitry for converting received data formatted in the frame structure into data formatted in the packet structure.

36. The apparatus according to claim 35 wherein the hub protocol signal indicates an ethernet protocol, and wherein the transmitted data formatted in the packet structure is formatted according to the ethernet protocol.

37. The apparatus according to claim 35 wherein the hub protocol signal indicates a token-ring protocol, and wherein the transmitted data formatted in the packet structure is formatted according to the token-ring protocol.

38. The apparatus according to claim 35 wherein the hub protocol signal indicates an isochronous-ethernet protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-ethernet protocol.

39. The apparatus according to claim 35 wherein the hub protocol signal indicates an isochronous-token ring protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-token ring protocol.

40. The apparatus according to claim 29 wherein the frame receiving circuitry includes isochronous converting circuitry for converting received data formatted in a frame structure into data formatted in an isochronous structure.

41. The apparatus according to claim 40 wherein the hub protocol signal indicates an isochronous protocol.

42. An apparatus as set forth in claim 24 wherein said node transmitter transmits said node protocol signal responsive to said node receiver receiving said hub protocol signal.

43. The apparatus according to claim 24 wherein the hub receiver includes frame receiving circuitry for receiving data formatted in a frame structure, and isochronous receiving circuitry for receiving data formatted in an isochronous structure, wherein the received data formatted in a frame structure and the received data formatted in the isochronous structure are received over the same receiving communication path, and wherein the hub transmitter includes frame transmitting circuitry for transmitting data formatted in a frame structure, and isochronous transmitting circuitry for transmitting data formatted in an isochronous structure, wherein the transmitted data formatted in the frame structure and the transmitted data formatted in the isochronous structure are transmitted over the same transmitting communication path.

44. The apparatus according to claim 43 wherein the hub protocol signal indicates an isochronous protocol.

45. The apparatus according to claim 43 wherein the hub protocol signal indicates an isochronous-ethernet protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-ethernet protocol.

46. The apparatus according to claim 43 wherein the hub protocol signal indicates an isochronous-token ring protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-token ring protocol.

47. The apparatus according to claim 43 wherein the frame receiving circuitry includes isochronous converting circuitry for converting received data formatted in a frame structure into data formatted in an isochronous structure.

48. The apparatus according to claim 47 wherein the hub protocol signal indicates an isochronous protocol.

49. The apparatus according to claim [48] *47* wherein the hub protocol signal indicates an isochronous-ethernet protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-ethernet protocol.

50. The apparatus according to claim 47 wherein the hub protocol signal indicates an isochronous-token ring protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-token ring protocol.

51. The apparatus according to claim 47 wherein the frame receiving circuitry includes packet converting circuitry for converting received data formatted in a frame structure into data formatted in a packet structure.

52. The apparatus according to claim 51 wherein the hub protocol signal indicates an ethernet protocol, and wherein the transmitted data formatted in the packet structure is formatted according to the ethernet protocol.

53. The apparatus according to claim 51 wherein the hub protocol signal indicates a token-ring protocol, and wherein the transmitted data formatted in the packet structure is formatted according to the token-ring protocol.

54. The apparatus according to claim 51 wherein the hub protocol signal indicates an isochronous-ethernet protocol, and wherein the transmitted data formatted in the frame structure *is* formatted according to the isochronous-ethernet protocol.

55. The apparatus according to claim 51 wherein the hub protocol signal indicates an isochronous-token ring protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-token ring protocol.

56. The apparatus according to claim 51 wherein the hub protocol signal indicates an isochronous protocol.

57. In a data communication network comprising at least first and second communication endpoints, an apparatus for establishing communication between the first and second endpoints comprising:

a first endpoint transmitter coupled to the first endpoint for transmitting a first endpoint protocol signal to the second endpoint, the first endpoint protocol signal indicating a communication protocol, including a format for data transmission, with which the first endpoint is capable of communicating;

a second endpoint receiver coupled to the second endpoint for receiving the first endpoint protocol signal;

a second endpoint transmitter coupled to the second endpoint receiver for transmitting a second endpoint protocol signal to the first endpoint, the second endpoint protocol signal indicating a communication protocol, including a format for data transmission with which the second endpoint is capable of communicating;

a first endpoint receiver coupled to the first endpoint for receiving the second endpoint protocol signal;

a protocol identifying circuit coupled to the first endpoint receiver for identifying the communication protocol indicated by the second endpoint protocol signal from among a plurality of possible communication protocols with which the first endpoint is capable of communicating; and

a communication circuit in said first endpoint transmitter responsive to said protocol identifying circuit for communicating with the second endpoint using the communication protocol indicated by the second endpoint protocol signal.

58. The apparatus according to claim **57** wherein the communication circuit includes a first receiver sub-circuit in said first endpoint receiver and a first transmitter sub-circuit in said first endpoint transmitter for communicating using a first communication protocol and a second receiver sub-circuit in said first endpoint receiver and a second transmitter sub-circuit in said first endpoint transmitter for communicating using a second communication protocol, and wherein said communication circuit communicates with said second endpoint using one of said first receiver and transmitter sub-circuits and said second receiver and transmitter sub-circuits responsive to said second endpoint protocol signal.

59. The apparatus according to claim **58** wherein the first sub-circuit includes frame receiving circuitry for receiving data formatted in a frame structure, and the second sub-circuit includes packet receiving circuitry for receiving data formatted in a packet structure and wherein the received data formatted in the frame structure and the received data formatted in the packet structure are received over the same receiving communication path, and wherein the first sub-circuit further includes frame transmitting circuitry for transmitting data formatted in the frame structure, and the second sub-circuit includes packet transmitting circuitry for transmitting data formatted in the packet structure, wherein the data formatted in the frame structure and the data formatted in the packet structure are transmitted over the same transmitting communication path.

60. The apparatus according to claim **59** wherein the first endpoint protocol signal comprises a signal indicating a protocol corresponding to data formatted in the frame structure, and wherein the second endpoint protocol signal comprises a signal indicating a protocol corresponding to data formatted in the packet structure.

61. The apparatus according to claim **59** wherein the second endpoint protocol signal indicates an ethernet protocol, and wherein the data formatted in the packet structure is formatted according to the ethernet protocol.

62. The apparatus according to claim **59** wherein the second endpoint protocol signal indicates a token-ring protocol, and wherein the data formatted in the packet structure is formatted according to the token-ring protocol.

63. The apparatus according to claim **59** wherein the frame receiving circuitry includes packet converting circuitry for converting received data formatted in the frame structure into data formatted in the packet structure.

64. The apparatus according to claim **63** wherein the second endpoint protocol signal indicates an ethernet protocol and wherein the data formatted in the packet structure is formatted according to the ethernet protocol.

65. The apparatus according to claim **63** wherein the second endpoint protocol signal indicates a token-ring protocol, and wherein the data formatted in the packet structure is formatted according to the token-ring protocol.

66. The apparatus according to claim **58** wherein the first sub circuit includes frame receiving circuitry for receiving data formatted in a frame structure, and the second sub-circuit includes isochronous receiving circuitry for receiving data formatted in an isochronous structure, wherein the received data formatted in the frame structure and the received data formatted in the isochronous structure are received over the same receiving communication path, and wherein the first sub-circuit further includes frame transmitting circuitry for transmitting data formatted in a frame structure, and the second sub-circuit further includes isochronous transmitting circuitry for transmitting data formatted in an isochronous structure, wherein the data formatted in the isochronous structure and the data formatted in the frame structure are transmitted over the same transmitting communication path.

67. The apparatus according to claim **66** wherein the first endpoint protocol signal comprises a signal indicating a protocol corresponding to data formatted in the frame structure, and wherein the second endpoint protocol signal comprises a signal indicating a protocol corresponding to data formatted in the isochronous structure.

68. The apparatus according to claim **66** wherein the second endpoint protocol signal indicates the isochronous protocol, and wherein the data formatted in the isochronous structure is communicated to the second endpoint according to the isochronous protocol.

69. The apparatus according to claim **66** wherein the frame receiving circuitry includes isochronous converting circuitry for converting received data formatted in the frame structure into data formatted in the isochronous structure.

70. The apparatus according to claim **69** wherein the second endpoint protocol signal indicates the isochronous protocol, and wherein the converted data formatted in the isochronous structure is communicated to the second endpoint according to the isochronous protocol.

71. The apparatus according to claim **66** wherein the frame receiving circuitry includes packet converting circuitry for converting received data formatted in the frame structure into data formatted in the packet structure.

72. In a data communication network comprising at least first and second communication endpoints, an apparatus for establishing communication between the first and second endpoints comprising:

a first endpoint transmitter coupled to the first endpoint for transmitting a first endpoint protocol signal to the second endpoint, the first endpoint protocol signal indicating a communication protocol, including a format for data transmission, with which the first endpoint is capable of communicating;

a second endpoint receiver coupled to the second endpoint for receiving the first endpoint protocol signal;

a second endpoint transmitter coupled to the second endpoint receiver for transmitting a second endpoint protocol signal, responsive to receipt of said said first endpoint protocol signal, to the first endpoint, the second endpoint protocol signal indicating a communication protocol, including a format for data transmission with which the second endpoint is capable of communicating;

a first endpoint receiver coupled to the first endpoint for receiving the second endpoint protocol signal;

a protocol identifying circuit coupled to the first endpoint receiver for identifying the communication protocol indicated by the second endpoint protocol signal from among a plurality of possible communication protocols with which the first endpoint is capable of communicating; and

a communication circuit in said first endpoint transmitter responsive to said protocol identifying circuit for communicating with the second endpoint using the communication protocol indicated by the second endpoint protocol signal.

73. In a data communication network comprising at least a first endpoint coupled to at least a second endpoint, an apparatus for establishing communication between the first endpoint and the second endpoint comprising:

a first endpoint transmitter transmitting a first endpoint protocol signal to the second endpoint, the first endpoint protocol signal indicating a communication protocol, including a format for a data transmission, with which the first endpoint is capable of communicating;

a second endpoint receiver receiving the first endpoint protocol signal;

a second endpoint transmitter transmitting a second endpoint protocol signal to the first endpoint, the second endpoint protocol signal indicating a communication protocol, including a format for a data transmission, with which the second endpoint is capable of communicating;

wherein the communication protocol indicated by the second endpoint protocol signal is different from the communication protocol indicated by the first endpoint protocol signal;

a first endpoint receiver receiving the second endpoint protocol signal;

a first endpoint protocol identifying circuit coupled to the first endpoint receiver identifying the communication protocol indicated by the second endpoint protocol signal from among a plurality of possible communication protocols with which the first endpoint is capable of communicating; and

wherein the first endpoint transmitter includes a communication circuit for communicating with the second endpoint using the communication protocol indicated by the second endpoint protocol signal in response thereto.

74. The apparatus according to claim 73, wherein the first endpoint receiver includes frame receiving circuitry receiving data formatted in a frame structure, and packet receiving circuitry receiving data formatted in a packet structure and wherein the received data formatted in the frame structure and the received data formatted in the packet structure are received over the same receiving communication path, and wherein the first endpoint transmitter includes frame transmitting circuitry transmitting data formatted in the frame structure, and packet transmitting circuitry transmitting data formatted in the packet structure, wherein the data formatted in the frame structure and the data formatted in the packet structure are transmitted over the same transmitting communication path.

75. The apparatus according to claim 74, wherein the first endpoint protocol signal comprises a signal indicating a protocol corresponding to data formatted in the frame structure, and wherein the second endpoint protocol signal comprises a signal indicating a protocol corresponding to data formatted in the packet structure.

76. The apparatus according to claim 74, wherein the second endpoint protocol signal indicates an ethernet protocol, and wherein the data formatted in the packet structure is formatted according to the ethernet protocol.

77. The apparatus according to claim 74, wherein the second endpoint protocol signal indicates a token-ring protocol, and wherein the data formatted in the packet structure is formatted according to the token-ring protocol.

78. The apparatus according to claim 74, wherein the frame receiving circuitry includes packet converting circuitry converting received data formatted in the frame structure into data formatted in a packet structure.

79. The apparatus according to claim 78, wherein the second endpoint protocol signal indicates an ethernet protocol, and wherein the data formatted in the packet structure is formatted according to the ethernet protocol.

80. The apparatus according to claim 78, wherein the second endpoint protocol signal indicates a token-ring protocol, and wherein the data formatted in the packet structure is formatted according to the token-ring protocol.

81. The apparatus according to claim 73, wherein the first endpoint receiver includes frame receiving circuitry receiving data formatted in a frame structure, and isochronous receiving circuitry receiving data formatted in a isochronous structure, wherein the received data formatted in a frame structure and the received data formatted in the isochronous structure are received over the same receiving communication path, and wherein the first endpoint transmitter includes frame transmitting circuitry transmitting data formatted in a frame structure, and isochronous transmitting circuitry transmitting data formatted in an isochronous structure, wherein the data formatted in the isochronous structure and the data formatted in the frame structure are transmitted over the same transmitting communication path.

82. The apparatus according to claim 81, wherein the first endpoint protocol signal comprises a signal indicating a protocol corresponding to data formatted in the frame structure, and wherein the endpoint protocol signal comprises a signal indicating a protocol corresponding to data formatted in the isochronous structure.

83. The apparatus according to claim 81, wherein the second endpoint protocol signal indicates the isochronous protocol, and wherein the data formatted in the isochronous structure is communicated to the second endpoint according to the isochronous protocol.

84. The apparatus according to claim 81, wherein the frame receiving circuitry includes isochronous converting circuitry converting received data formatted in the frame structure into data formatted in the isochronous structure.

85. The apparatus according to claim 84, wherein the second endpoint protocol signal indicates the isochronous protocol, and wherein the converted data formatted in the isochronous structure is communicated to the second endpoint according to the isochronous protocol.

86. The apparatus according to claim 81, wherein the frame receiving circuitry includes packet converting circuitry converting received data formatted in the frame structure into data formatted in the packet structure.

87. An apparatus as set forth in claim 73, wherein the second endpoint transmitter transmits the second endpoint protocol signal responsive to the second endpoint receiver receiving the first endpoint protocol signal.

88. The apparatus of claim 73, wherein the first endpoint and the second endpoint are configured to operate in a best or desired manner.

89. The apparatus of claim 73, wherein the first endpoint and the second endpoint are coupled together over at least one physical medium.

90. The apparatus of claim 89, wherein the physical medium comprises one or more physical media selected from the group consisting of twisted pair media, coaxial cable media and fiber optic media.

91. The apparatus of claim 73, wherein the first endpoint and the second endpoint communicate in accordance with a first protocol at a first point in time, wherein the first endpoint and the second endpoint communicate in accordance with a second protocol at a second point in time.

92. The apparatus of claim 73, wherein the first endpoint and the second endpoint communicate in accordance with a communication protocol that is determined automatically.

93. The apparatus of claim 73, wherein data communicated between the first endpoint and the second endpoint include isochronous data.

94. The apparatus of claim 93, wherein the isochronous data comprises telephone data and/or video data.

95. In a data communication network comprising at least a first endpoint coupled to at least a second endpoint, an apparatus for establishing communication between the first endpoint and the second endpoint comprising:

a first endpoint transmitter transmitting a first endpoint protocol signal to a second endpoint receiver, the first endpoint protocol signal indicating a communication protocol, including a format for a data transmission, with which the first endpoint is capable of communicating;

a second endpoint protocol identifying circuit identifying the communication protocol indicated by the first endpoint protocol signal from among a plurality of possible communication protocols with which the second endpoint is capable of communicating; and

a second endpoint transmitter transmitting a second endpoint protocol signal to the first endpoint indicating that communication between the first endpoint and the second endpoint will take place with the protocol indicated by the first endpoint protocol signal.

96. The apparatus according to claim 95, wherein the second endpoint receiver includes frame receiving circuitry receiving data formatted in a frame structure, and packet receiving circuitry receiving data formatted in a packet structure, wherein the received data formatted in the frame structure and the received data formatted in the packet structure are received over the same receiving communication path, and wherein the second endpoint transmitter includes frame transmitting circuitry transmitting data formatted in the frame structure, and packet transmitting circuitry transmitting data formatted in the packet structure, wherein the data formatted in the frame structure and the data formatted in the packet structure are transmitted over the same transmitting communication path.

97. The apparatus according to claim 96, wherein the first endpoint protocol signal indicates an ethernet protocol, and wherein the data formatted in the packet structure is formatted according to the ethernet protocol.

98. The apparatus according to claim 96, wherein the first endpoint protocol signal indicates a token-ring protocol, and wherein the data formatted in the packet structure is formatted according to the token-ring protocol.

99. The apparatus according to claim 96, wherein the frame receiving circuitry includes packet converting circuitry converting received data formatted in a frame structure into data formatted in a packet structure.

100. The apparatus according to claim 95, wherein the second endpoint receiver includes frame receiving circuitry receiving data formatted in a frame structure, and isochronous receiving circuitry receiving data formatted in an isochronous structure, wherein the received data formatted in the frame structure and the received data formatted in the isochronous structure are received over the same receiving communication path, and wherein the second endpoint transmitter includes frame transmitting circuitry transmitting data formatted in the frame structure, and isochronous transmitting circuitry transmitting data formatted in the isochronous structure, wherein the data formatted in the frame structure and the data formatted in the isochronous structure are transmitted over the same transmitting communication path.

101. The apparatus according to claim 100, wherein the first endpoint protocol signal indicates an isochronous protocol, and wherein the transmitted data formatted in the isochronous structure is communicated to the first endpoint according to the isochronous protocol.

102. The apparatus according to claim 100, wherein the frame receiving circuitry includes isochronous converting circuitry converting received data formatted in the frame structure into data formatted in the isochronous structure.

103. The apparatus of claim 95, wherein the first endpoint and the second endpoint are configured to operate in a best or desired manner.

104. The apparatus of claim 95, wherein the first endpoint and the second endpoint are coupled together over at least one physical medium.

105. The apparatus of claim 104, wherein the physical medium comprises one or more physical media selected from the group consisting of twisted pair media, coaxial cable media and fiber optic media.

106. The apparatus of claim 95, wherein the first endpoint and the second endpoint communicate in accordance with a first protocol at a first point in time, wherein the first endpoint and the second endpoint communicate in accordance with a second protocol at a second point in time.

107. The apparatus of claim 95, wherein the first endpoint and the second endpoint communicate in accordance with a communication protocol that is determined automatically.

108. The apparatus of claim 95, wherein data communicated between the first endpoint and the second endpoint include isochronous data.

109. The apparatus of claim 108, wherein the isochronous data comprises telephone data and/or video data.

110. In a data communication network comprising at least a first endpoint coupled to at least a second endpoint, an apparatus for establishing communication between the first endpoint and a second endpoint comprising:

a first endpoint transmitter transmitting a first endpoint protocol signal to the second endpoint, the first endpoint protocol signal indicating one of a plurality of communication protocols, including a format for a data transmission, with which the first endpoint is capable of communicating;

a second endpoint receiver receiving the first endpoint protocol signal;

a second endpoint protocol identifying circuit identifying the communication protocol indicated by the first endpoint protocol signal from among a plurality of communication protocols with which the second endpoint is capable of communicating;

a second endpoint transmitter transmitting a second endpoint protocol signal to the first endpoint, the second endpoint protocol signal indicating the communication protocol indicated by the first endpoint protocol signal if the communication protocol indicated by the first endpoint protocol signal is a communication protocol, including a format for a data transmission, with which the second endpoint is capable of communicating;

a first endpoint receiver receiving the second endpoint protocol signal;

a first endpoint protocol identifying circuit identifying the communication protocol indicated by the second endpoint protocol signal from among a plurality of communication protocols with which the first endpoint is capable of communicating;

wherein the first endpoint transmitter includes a communication circuit communicating with the second endpoint using the communication protocol indicated by the second endpoint protocol signal.

111. The apparatus according to claim 110, wherein the data communication network comprises a plurality of second endpoints and the data communication network is configured in a star topology.

112. The apparatus according to claim 110, wherein the data communication network comprises a plurality of first endpoints wherein the first endpoints are configured in a ring topology.

113. The apparatus according to claim 110, wherein the data communication network comprises a plurality of second endpoints and wherein the second endpoints are configured in a tree topology.

114. The apparatus according to claim 110, wherein the first endpoint protocol signal comprises a series of 100 nanosecond pulses occurring at nominal 16 millisecond intervals.

115. The apparatus according to claim 110, wherein the first endpoint receiver includes frame receiving circuitry receiving data formatted in a frame structure, and packet receiving circuitry receiving data formatted in a packet structure, wherein the received data formatted in a frame structure and the received data formatted in the packet structure are received over the same receiving communication path, and wherein the first endpoint transmitter includes frame transmitting circuitry transmitting data formatted in a frame structure, and packet transmitting circuitry transmitting data formatted in a packet structure, wherein the transmitted data formatted in the frame structure and the transmitted data formatted in the packet structure are transmitted over the same transmitting communication path.

116. The apparatus according to claim 115, wherein the first endpoint protocol signal comprises a signal indicating a protocol corresponding to data formatted in the frame structure, and wherein the second endpoint protocol signal comprises a signal indicating a protocol corresponding to data formatted in the frame structure.

117. The apparatus according to claim 115, wherein the first endpoint protocol signal indicates an isochronous-ethernet protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-ethernet protocol.

118. The apparatus according to claim 115, wherein the first endpoint protocol signal indicates an isochronous-token ring protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-token ring protocol.

119. The apparatus according to claim 115, wherein the first endpoint protocol signal indicates an ethernet protocol, and wherein the transmitted data formatted in the packet structure is formatted according to the ethernet protocol.

120. The apparatus according to claim 115, wherein the first endpoint protocol signal indicates a token-ring protocol, and wherein the transmitted data formatted in the packet structure is formatted according to the token-ring protocol.

121. The apparatus according to claim 115, wherein the frame receiving circuitry includes packet converting circuitry converting received data formatted in the frame structure into data formatted in the packet structure.

122. The apparatus according to claim 121, wherein the first endpoint protocol signal indicates an ethernet protocol, and wherein the transmitted data formatted in the packet structure is formatted according to the ethernet protocol.

123. The apparatus according to claim 121, wherein the first endpoint protocol signal indicates a token-ring protocol, and wherein the transmitted data formatted in the packet structure is formatted according to the token-ring protocol.

124. The apparatus according to claim 121, wherein the first endpoint protocol signal indicates an isochronous-ethernet protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-ethernet protocol.

125. The apparatus according to claim 121, wherein the first endpoint protocol signal indicates an isochronous-token ring protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-token ring protocol.

126. The apparatus according to claim 115, wherein the frame receiving circuitry includes isochronous converting circuitry converting received data formatted in a frame structure into data formatted in an isochronous structure.

127. The apparatus according to claim 126, wherein the first endpoint protocol signal indicates an isochronous protocol.

128. An apparatus as set forth in claim 110, wherein the second endpoint transmitter transmits the second endpoint protocol signal responsive to the second endpoint receiver receiving the first endpoint protocol signal.

129. The apparatus according to claim 110, wherein the first endpoint receiver includes frame receiving circuitry receiving data formatted in a frame structure, and isochronous receiving circuitry receiving data formatted in an isochronous structure, wherein the received data formatted in a frame structure and the received data formatted in the isochronous structure are received over the same receiving communication path, and wherein the first endpoint transmitter includes frame transmitting circuitry transmitting data formatted in a frame structure, and isochronous transmitting circuitry transmitting data formatted in an isochronous structure, wherein the transmitted data formatted in the frame structure and the transmitted data formatted in the isochronous structure are transmitted over the same transmitting communication path.

130. The apparatus according to claim 129, wherein the first endpoint protocol signal indicates an isochronous protocol.

131. The apparatus according to claim 129, wherein the first endpoint protocol signal indicates an isochronous-ethernet protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-ethernet protocol.

132. The apparatus according to claim 129, wherein the first endpoint protocol signal indicates an isochronous-token ring protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-token ring protocol.

133. The apparatus according to claim 129, wherein the frame receiving circuitry includes isochronous converting circuitry converting received data formatted in a frame structure into data formatted in an isochronous structure.

134. The apparatus according to claim 133, wherein the first endpoint protocol signal indicates an isochronous protocol.

135. The apparatus according to claim 134, wherein the first endpoint protocol signal indicates an isochronous-ethernet protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-ethernet protocol.

136. The apparatus according to claim 133, wherein the first endpoint protocol signal indicates an isochronous-token ring protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-token ring protocol.

137. The apparatus according to claim 133, wherein the frame receiving circuitry includes packet converting circuitry converting received data formatted in a frame structure into data formatted in a packet structure.

138. The apparatus according to claim 137, wherein the first endpoint protocol signal indicates an ethernet protocol, and wherein the transmitted data formatted in the packet structure is formatted according to the ethernet protocol.

139. The apparatus according to claim 137, wherein the first endpoint protocol signal indicates a token-ring protocol, and wherein the transmitted data formatted in the packet structure is formatted according to the token-ring protocol.

140. The apparatus according to claim 137, wherein the first endpoint protocol signal indicates an isochronous-ethernet protocol, and wherein the transmitted data formatted in the frame structure formatted according to the isochronous-ethernet protocol.

141. The apparatus according to claim 137, wherein the first endpoint protocol signal indicates an isochronous-token ring protocol, and wherein the transmitted data formatted in the frame structure is formatted according to the isochronous-token ring protocol.

142. The apparatus according to claim 137, wherein the first endpoint protocol signal indicates an isochronous protocol.

143. The apparatus of claim 110, wherein the first endpoint and the second endpoint are configured to operate in a best or desired manner.

144. The apparatus of claim 110, wherein the first endpoint and the second endpoint are coupled together over at least one physical medium.

145. The apparatus of claim 144, wherein the physical medium comprises one or more physical media selected from the group consisting of twisted pair media, coaxial cable media and fiber optic media.

146. The apparatus of claim 110, wherein the first endpoint and the second endpoint communicate in accordance with a first protocol at a first point in time, wherein the first endpoint and the second endpoint communicate in accordance with a second protocol at a second point in time.

147. The apparatus of claim 110, wherein the first endpoint and the second endpoint communicate in accordance with a communication protocol that is determined automatically.

148. The apparatus of claim 110, wherein data communicated between the first endpoint and the second endpoint include isochronous data.

149. The apparatus of claim 148, wherein the isochronous data comprises telephone data and/or video data.

150. In a data communication network comprising at least first and second communication endpoints, an apparatus for establishing communication between the first and second endpoints comprising:

a first endpoint transmitter transmitting a first endpoint protocol signal to the second endpoint, the first endpoint protocol signal indicating a communication protocol, including a format for a data transmission, with which the first endpoint is capable of communicating;

a second endpoint receiver receiving the first endpoint protocol signal;

a second endpoint transmitter transmitting a second endpoint protocol signal to the first endpoint, the second endpoint protocol signal indicating a communication protocol, including a format for a data transmission, with which the second endpoint is capable of communicating;

a first endpoint receiver receiving the second endpoint protocol signal;

a first endpoint protocol identifying circuit identifying the communication protocol indicated by the second endpoint protocol signal from among a plurality of possible communication protocols with which the first endpoint is capable of communicating; and

a first endpoint communication circuit responsive to the first endpoint protocol identifying circuit for communicating with the second endpoint using the communication protocol indicated by the second endpoint protocol signal.

151. The apparatus according to claim 150, wherein the first endpoint communication circuit includes a first receiver sub-circuit in the first endpoint receiver and a first transmitter sub-circuit in the first endpoint transmitter for communicating using a first communication protocol and a second receiver sub-circuit in the first endpoint receiver and a second transmitter sub-circuit in the first endpoint transmitter for communicating using a second communication protocol, and wherein the communication circuit communicates with the second endpoint using one of the first receiver and transmitter sub-circuits and the second receiver and transmitter sub-circuits responsive to the second endpoint protocol signal.

152. The apparatus according to claim 151, wherein the first sub-circuit includes frame receiving circuitry receiving data formatted in a frame structure, and the second sub-circuit includes packet receiving circuitry receiving data formatted in a packet structure and wherein the received data formatted in the frame structure and the received data formatted in the packet structure are received over the same receiving communication path, and wherein the first sub-circuit further includes frame transmitting circuitry transmitting data formatted in the frame structure, and the second sub-circuit includes packet transmitting circuitry transmitting data formatted in the packet structure, wherein the data formatted in the frame structure and the data formatted in the packet structure are transmitted over the same transmitting communication path.

153. The apparatus according to claim 152, wherein the first endpoint protocol signal comprises a signal indicating a protocol corresponding to data formatted in the frame structure, and wherein the second endpoint protocol signal comprises a signal indicating a protocol corresponding to data formatted in the packet structure.

154. The apparatus according to claim 152, wherein the second endpoint protocol signal indicates an ethernet protocol, and wherein the data formatted in the packet structure is formatted according to the ethernet protocol.

155. The apparatus according to claim 152, wherein the second endpoint protocol signal indicates a token-ring protocol, and wherein the data formatted in the packet structure is formatted according to the token-ring protocol.

156. The apparatus according to claim 152, wherein the frame receiving circuitry includes packet converting cir-

cuitry converting received data formatted in the frame structure into data formatted in the packet structure.

157. The apparatus according to claim 156, wherein the second endpoint protocol signal indicates an ethernet protocol, and wherein the data formatted in the packet structure is formatted according to the ethernet protocol.

158. The apparatus according to claim 156, wherein the second endpoint protocol signal indicates a token-ring protocol, and wherein the data formatted in the packet structure is formatted according to the token-ring protocol.

159. The apparatus according to claim 151, wherein the first sub-circuit includes frame receiving circuitry receiving data formatted in a frame structure, and the second sub-circuit includes isochronous receiving circuitry receiving data formatted in an isochronous structure, wherein the received data formatted in the frame structure and the received data formatted in the isochronous structure are received over the same receiving communication path, and wherein the first sub-circuit further includes frame transmitting circuitry transmitting data formatted in a frame structure, and the second sub-circuit further includes isochronous transmitting circuitry transmitting data formatted in an isochronous structure, wherein the data formatted in the isochronous structure and the data formatted in the frame structure are transmitted over the same transmitting communication path.

160. The apparatus according to claim 159, wherein the first endpoint protocol signal comprises a signal indicating a protocol corresponding to data formatted in the frame structure, and wherein the second endpoint protocol signal comprises a signal indicating a protocol corresponding to data formatted in the isochronous structure.

161. The apparatus according to claim 159, wherein the second endpoint protocol signal indicates the isochronous protocol, and wherein the data formatted in the isochronous structure is communicated to the second endpoint according to the isochronous protocol.

162. The apparatus according to claim 159, wherein the frame receiving circuitry includes isochronous converting circuitry for converting received data formatted in the frame structure into data formatted in the isochronous structure.

163. The apparatus according to claim 162, wherein the second endpoint protocol signal indicates the isochronous protocol, and wherein the converted data formatted in the isochronous structure is communicated to the second endpoint according to the isochronous protocol.

164. The apparatus according to claim 159, wherein the frame receiving circuitry includes packet converting circuitry converting received data formatted in the frame structure into data formatted in the packet structure.

165. The apparatus of claim 150, wherein the first endpoint and the second endpoint are configured to operate in a best or desired manner.

166. The apparatus of claim 150, wherein the first endpoint and the second endpoint are coupled together over at least one physical medium.

167. The apparatus of claim 166, wherein the physical medium comprises one or more physical media selected from the group consisting of twisted pair media, coaxial cable media and fiber optic media.

168. The apparatus of claim 150, wherein the first endpoint and the second endpoint communicate in accordance with a first protocol at a first point in time, wherein the first endpoint and the second endpoint communicate in accordance with a second protocol at a second point in time.

169. The apparatus of claim 150, wherein the first endpoint and the second endpoint communicate in accordance with a communication protocol that is determined automatically.

170. The apparatus of claim 150, wherein data communicated between the first endpoint and the second endpoint include isochronous data.

171. The apparatus of claim 170, wherein the isochronous data comprises telephone data and/or video data.

172. In a data communication network comprising at least first and second communication endpoints, an apparatus for establishing communication between the first and second endpoints comprising:

- *a first endpoint transmitter transmitting a first endpoint protocol signal to the second endpoint, the first endpoint protocol signal indicating a communication protocol, including a format for a data transmission, with which the first endpoint is capable of communicating;*
- *a second endpoint receiver receiving the first endpoint protocol signal;*
- *a second endpoint transmitter transmitting a second endpoint protocol signal, responsive to receipt of the first endpoint protocol signal, to the first endpoint, the second endpoint protocol signal indicating a communication protocol, including a format for a data transmission, with which the second endpoint is capable of communicating;*
- *a first endpoint receiver receiving the second endpoint protocol signal;*
- *a first endpoint protocol identifying circuit identifying the communication protocol indicated by the second endpoint protocol signal from among a plurality of possible communication protocols with which the first endpoint is capable of communicating; and*
- *a first endpoint communication circuit communicating with the second endpoint using the communication protocol indicated by the second endpoint protocol signal.*

173. The apparatus of claim 172, wherein the first endpoint and the second endpoint are configured to operate in a best or desired manner.

174. The apparatus of claim 172, wherein the first endpoint and the second endpoint are coupled together over at least one physical medium.

175. The apparatus of claim 174, wherein the physical medium comprises one or more physical media selected from the group consisting of twisted pair media, coaxial cable media and fiber optic media.

176. The apparatus of claim 172, wherein the first endpoint and the second endpoint communicate in accordance with a first protocol at a first point in time, wherein the first endpoint and the second endpoint communicate in accordance with a second protocol at a second point in time.

177. The apparatus of claim 172, wherein the first endpoint and the second endpoint communicate in accordance with a communication protocol that is determined automatically.

178. The apparatus of claim 172, wherein data communicated between the first endpoint and the second endpoint include isochronous data.

179. The apparatus of claim 178, wherein the isochronous data comprises telephone data and/or video data.

180. In a data communication network comprising at least one first endpoint coupled to at least one second endpoint, a method in a system for establishing communication between a first endpoint and a second endpoint comprising the steps of:

- *transmitting a first endpoint protocol signal from a first endpoint transmitter to the second endpoint, the first* *endpoint protocol signal indicating a communication protocol, including a format for a data transmission, with which the first endpoint is capable of communicating;*

receiving the first endpoint protocol signal with a second endpoint receiver;

transmitting a second endpoint protocol signal from a second endpoint transmitter to the first endpoint, the second endpoint protocol signal indicating a communication protocol, including a format for a data transmission, with which the second endpoint is capable of communicating;

wherein the communication protocol indicated by the second endpoint protocol signal is different from the communication protocol indicated by the first endpoint protocol signal;

receiving the second endpoint protocol signal with a first endpoint receiver;

identifying the communication protocol indicated by the second endpoint protocol signal from among a plurality of possible communication protocols with which the first endpoint is capable of communicating; and

wherein the first endpoint transmitter communicates with the second endpoint using the communication protocol indicated by the second endpoint protocol signal.

181. The method of claim 180, wherein the first endpoint and the second endpoint are configured to operate in a best or desired manner.

182. The method of claim 180, wherein the first endpoint and the second endpoint are coupled together over at least one physical medium.

183. The method of claim 182, wherein the physical medium comprises one or more physical media selected from the group consisting of twisted pair media, coaxial cable media and fiber optic media.

184. The method of claim 180, wherein the first endpoint and the second endpoint communicate in accordance with a first protocol at a first point in time, wherein the first endpoint and the second endpoint communicate in accordance with a second protocol at a second point in time.

185. The method of claim 180, wherein the first endpoint and the second endpoint communicate in accordance with a communication protocol that is determined automatically.

186. The method of claim 180, wherein data communicated between the first endpoint and the second endpoint include isochronous data.

187. The method of claim 186, wherein the isochronous data comprises telephone data and/or video data.

188. The method of claim 180, wherein the first endpoint is coupled to a plurality of second endpoints through a plurality of physical media.

189. The method of claim 188, wherein the physical media comprises one or more physical media selected from the group consisting of twisted pair media, coaxial cable media and fiber optic media.

190. The method of claim 180, further comprising the step of establishing a direct connection between the first endpoint and the second endpoint.

191. The method of claim 180, wherein the first endpoint and the second endpoint communicate in accordance with one of a plurality of LAN protocols.

192. In a data communication network comprising at least one first endpoint coupled to at least one second endpoint, a method in a system for establishing communication between a first endpoint and a second endpoint comprising the steps of:

transmitting a first endpoint protocol signal from a first endpoint transmitter to the second endpoint, the first endpoint protocol signal indicating a communication protocol, including a format for a data transmission, with which the first endpoint is capable of communicating;

identifying the communication protocol indicated by the first endpoint protocol signal from among a plurality of possible communication protocols, including a format for a data transmission, with which the second endpoint is capable of communicating; and

transmitting a second endpoint protocol signal to the first endpoint indicating that communication between the first endpoint and the second endpoint will take place with the protocol indicated by the first endpoint protocol signal.

193. The method of claim 192, wherein the first endpoint and the second endpoint are configured to operate in a best or desired manner.

194. The method of claim 192, wherein the first endpoint and the second endpoint are coupled together over at least one physical medium.

195. The method of claim 194, wherein the physical medium comprises one or more physical media selected from the group consisting of twisted pair media, coaxial cable media and fiber optic media.

196. The method of claim 192, wherein the first endpoint and the second endpoint communicate in accordance with a first protocol at a first point in time, wherein the first endpoint and the second endpoint communicate in accordance with a second protocol at a second point in time.

197. The method of claim 192, wherein the first endpoint and the second endpoint communicate in accordance with a communication protocol that is determined automatically.

198. The method of claim 192, wherein data communicated between the first endpoint and the second endpoint include isochronous data.

199. The method of claim 198, wherein the isochronous data comprises telephone data and/or video data.

200. The method of claim 192, wherein the first endpoint is coupled to a plurality of second endpoints through a plurality of physical media.

201. The method of claim 200, wherein the physical media comprises one or more physical media selected from the group consisting of twisted pair media, coaxial cable media and fiber optic media.

202. The method of claim 192, further comprising the step of establishing a direct connection between the first endpoint and the second endpoint.

203. The method of claim 192, wherein the first endpoint and the second endpoint communicate in accordance with one of a plurality of LAN protocols.

204. In a data communication network comprising at least one first endpoint coupled to at least one second endpoint, a method in a system for establishing communication between a first endpoint and a second endpoint comprising the steps of:

transmitting a first endpoint protocol signal from a first endpoint to the second endpoint, the first endpoint protocol signal indicating one of a plurality of communication protocols, including a format for a data transmission, with which the first endpoint is capable of communicating;

receiving the first endpoint protocol signal with a second endpoint receiver;

identifying the communication protocol indicated by the first endpoint protocol signal from among a plurality of *communication protocols with which the second endpoint is capable of communicating;*

transmitting a second endpoint protocol signal to the first endpoint, the second endpoint protocol signal indicating the communication protocol indicated by the first endpoint protocol signal if the communication protocol indicated by the first endpoint protocol signal is a communication protocol, including a format for a data transmission, with which the second endpoint is capable of communicating;

receiving the second endpoint protocol signal with the first endpoint;

identifying the communication protocol indicated by the second endpoint protocol signal from among a plurality of communication protocols with which the first endpoint is capable of communicating; and

wherein the first endpoint transmitter communicates with the second endpoint using the communication protocol indicated by the second endpoint protocol signal.

205. The method of claim 204, wherein the first endpoint and the second endpoint are configured to operate in a best or desired manner.

206. The method of claim 204, wherein the first endpoint and the second endpoint are coupled together over at least one physical medium.

207. The method of claim 206, wherein the physical medium comprises one or more physical media selected from the group consisting of twisted pair media, coaxial cable media and fiber optic media.

208. The method of claim 204, wherein the first endpoint and the second endpoint communicate in accordance with a first protocol at a first point in time, wherein the first endpoint and the second endpoint communicate in accordance with a second protocol at a second point in time.

209. The method of claim 204, wherein the first endpoint and the second endpoint communicate in accordance with a communication protocol that is determined automatically.

210. The method of claim 204, wherein data communicated between the first endpoint and the second endpoint include isochronous data.

211. The method of claim 210, wherein the isochronous data comprises telephone data and/or video data.

212. The method of claim 204, wherein the first endpoint is coupled to a plurality of second endpoints through a plurality of physical media.

213. The method of claim 212, wherein the physical media comprises one or more physical media selected from the group consisting of twisted pair media, coaxial cable media and fiber optic media.

214. The method of claim 204, further comprising the step of establishing a direct connection between the first endpoint and the second endpoint.

215. The method of claim 204, wherein the first endpoint and the second endpoint communicate in accordance with one of a plurality of LAN protocols.

216. In a data communication network comprising at least first and second endpoints, a method in a system for establishing communication between the first and second endpoints comprising the steps of:

transmitting a first endpoint protocol signal from a first endpoint to the second endpoint, the first endpoint protocol signal indicating a communication protocol, including a format for a data transmission, with which the first endpoint is capable of communicating;

receiving the first endpoint protocol signal at the second endpoint;

transmitting a second endpoint protocol signal from the second endpoint to the first endpoint, the second endpoint protocol signal indicating a communication protocol, including a format for a data transmission, with which the second endpoint is capable of communicating;

receiving the second endpoint protocol signal at the first endpoint;

identifying the communication protocol indicated by the second endpoint protocol signal from among a plurality of possible communication protocols with which the first endpoint is capable of communicating; and

communicating between the first endpoint and the second endpoint using the communication protocol indicated by the second endpoint protocol signal.

217. The method of claim 216, wherein the first endpoint and the second endpoint are configured to operate in a best or desired manner.

218. The method of claim 216, wherein the first endpoint and the second endpoint are coupled together over at least one physical medium.

219. The method of claim 218, wherein the physical medium comprises one or more physical media selected from the group consisting of twisted pair media, coaxial cable media and fiber optic media.

220. The method of claim 216, wherein the first endpoint and the second endpoint communicate in accordance with a first protocol at a first point in time, wherein the first endpoint and the second endpoint communicate in accordance with a second protocol at a second point in time.

221. The method of claim 216, wherein the first endpoint and the second endpoint communicate in accordance with a communication protocol that is determined automatically.

222. The method of claim 216, wherein data communicated between the first endpoint and the second endpoint include isochronous data.

223. The method of claim 222, wherein the isochronous data comprises telephone data and/or video data.

224. The method of claim 216, wherein the first endpoint is coupled to a plurality of second endpoints through a plurality of physical media.

225. The method of claim 224, wherein the physical media comprises one or more physical media selected from the group consisting of twisted pair media, coaxial cable media and fiber optic media.

226. The method of claim 216, further comprising the step of establishing a direct connection between the first endpoint and the second endpoint.

227. The method of claim 216, wherein the first endpoint and the second endpoint communicate in accordance with one of a plurality of LAN protocols.

228. In a data communication network comprising at least first and second endpoints, a method in a system for establishing communication between the first and second endpoints comprising the steps of:

transmitting a first endpoint protocol signal from a first endpoint to the second endpoint, the first endpoint protocol signal indicating a communication protocol, including a format for a data transmission, with which the first endpoint is capable of communicating;

receiving the first endpoint protocol signal at the second endpoint;

transmitting a second endpoint protocol signal, responsive to receipt of the first endpoint protocol signal, from the second endpoint to the first endpoint, the second endpoint protocol signal indicating a communication *protocol, including a format for a data transmission, with which the second endpoint is capable of communicating;*

receiving the second endpoint protocol signal at the first endpoint;

identifying the communication protocol indicated by the second endpoint protocol signal from among a plurality of possible communication protocols with which the first endpoint is capable of communicating; and

communicating between the first endpoint and the second endpoint using the communication protocol indicated by the second endpoint protocol signal.

229. The method of claim 228, wherein the first endpoint and the second endpoint are configured to operate in a best or desired manner.

230. The method of claim 228, wherein the first endpoint and the second endpoint are coupled together over at least one physical medium.

231. The method of claim 230, wherein the physical medium comprises one or more physical media selected from the group consisting of twisted pair media, coaxial cable media and fiber optic media.

232. The method of claim 228, wherein the first endpoint and the second endpoint communicate in accordance with a first protocol at a first point in time, wherein the first endpoint and the second endpoint communicate in accordance with a second protocol at a second point in time.

233. The method of claim 228, wherein the first endpoint and the second endpoint communicate in accordance with a communication protocol that is determined automatically.

234. The method of claim 228, wherein data communicated between the first endpoint and the second endpoint include isochronous data.

235. The method of claim 234, wherein the isochronous data comprises telephone data and/or video data.

236. The method of claim 228, wherein the first endpoint is coupled to a plurality of second endpoints through a plurality of physical media.

237. The method of claim 236, wherein the physical media comprises one or more physical media selected from the group consisting of twisted pair media, coaxial cable media and fiber optic media.

238. The method of claim 228, further comprising the step of establishing a direct connection between the first endpoint and the second endpoint.

239. The method of claim 228, wherein the first endpoint and the second endpoint communicate in accordance with one of a plurality of LAN protocols.

240. In a data communication network comprising at least one first endpoint coupled to at least one second endpoint, a method in a system for establishing communication between a first endpoint and a second endpoint comprising the steps of:

transmitting a first endpoint protocol signal from a first endpoint transmitter to the second endpoint, the first endpoint protocol signal indicating a communication protocol, including a format for a data transmission, with which the first endpoint is capable of communicating;

identifying the communication protocol indicated by the first endpoint protocol signal from among a plurality of possible communication protocols with which the second endpoint is capable of communicating;

transmitting a second endpoint protocol signal to the first endpoint indicating that communication between the first endpoint and the second endpoint will take place with the protocol indicated by the first endpoint protocol signal;

the method further comprising the steps of:

transmitting the first endpoint protocol signal from the first endpoint to the second endpoint;

receiving the first endpoint protocol signal with a second endpoint receiver;

identifying the communication protocol indicated by the first endpoint protocol signal from among the plurality of communication protocols with which the second endpoint is capable of communicating;

transmitting the second endpoint protocol signal to the first endpoint, the second endpoint protocol signal indicating the communication protocol indicated by the first endpoint protocol signal if the communication protocol indicated by the first endpoint protocol signal is a communication protocol, including a format for a data transmission, with which the second endpoint is capable of communicating;

receiving the second endpoint protocol signal with the first endpoint;

identifying the communication protocol indicated by the second endpoint protocol signal from among a plurality of communication protocols with which the first endpoint is capable of communicating;

wherein the first endpoint transmitter communicates with the second endpoint using the communication protocol indicated by the second endpoint protocol signal;

the method further comprising the steps of:

transmitting the first endpoint protocol signal from the first endpoint to the second endpoint;

receiving the first endpoint protocol signal at the second endpoint;

transmitting the second endpoint protocol signal from the second endpoint to the first endpoint;

receiving the second endpoint protocol signal at the first endpoint;

identifying the communication protocol indicated by the second endpoint protocol signal from among a plurality of possible communication protocols with which the first endpoint is capable of communicating; and

communicating between the first endpoint and the second endpoint using the communication protocol indicated by the second endpoint protocol signal.

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