(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
9 March 2006 (09.03.2006)

PCT

(10) International Publication Number
WO 2006/024889 A1

(51) International Patent Classification[7]: H04L 12/413

(21) International Application Number:
PCT/IB2004/002821

(22) International Filing Date: 31 August 2004 (31.08.2004)

(25) Filing Language: English

(26) Publication Language: English

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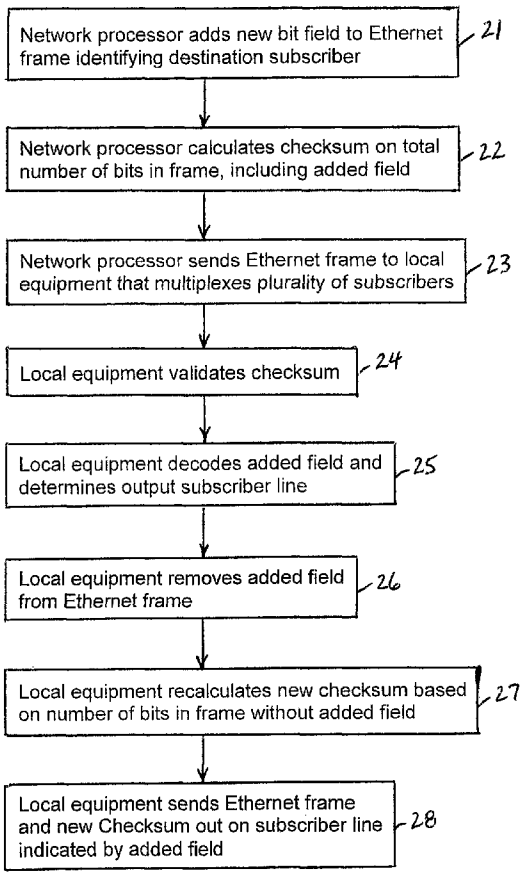
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: EXTRA INFORMATION IN ETHERNET FRAMES



(57) Abstract: In an Ethernet network (32), a system and method of controlling local equipment such as a multiplexer (33) that connects a plurality of subscriber lines to the network. A network processor (31) adds to an Ethernet frame, a new bit field identifying a selected subscriber line. The frame is sent to the multiplexer, which decodes and removes the new bit field, and switches the frame to the selected subscriber line. The network processor (31) may calculate a checksum (36) on the total number of bits in the Ethernet frame, including the new bit field. After removing the new bit field, the multiplexer then calculates a new checksum (43) on the bits remaining after the new bit field is removed. Alternatively, the network processor may calculate a checksum on the number of bits in the Ethernet frame, excluding the new bit field. In this case, the multiplexer switches the frame without altering the checksum.

WO 2006/024889 A1

EXTRA INFORMATION IN ETHERNET FRAMES

TECHNICAL FIELD OF THE INVENTION

The present invention relates generally to communications networks. More particularly, and not by way of limitation, the present invention is directed to a system and method of introducing extra information into an Ethernet bit stream for controlling local external equipments.

DESCRIPTION OF RELATED ART

Ethernet is a packet-based transmission protocol that is primarily used in local area networks (LANs). Ethernet is the common name for the IEEE 802.3 industry standard. Data is transmitted in Ethernet frames produced by a network processor. The structure of the Ethernet frames is defined in the IEEE 802.3 standard, incorporated herein by reference. According to the standard, each Ethernet frame includes a preamble with 64 bits utilized for synchronization. A Start of Frame Delimiter (SFD), a destination address, a source address, and a length/type identifier follow the preamble. Media Access Control (MAC) client data and a Packet Assembler/Disassembler (PAD) are next. A Frame Check Sequence (FCS) adds four more octets. The frame size is counted from the destination address to the FCS, inclusive, and thus may vary between 64 and 1518 octets, not including a Virtual Local Area Network (VLAN) tag, which adds 4 octets.

Local external equipments may be accessed through the LAN. To control these local external equipments, control commands must be included in the information carried by the Ethernet frames. The position and length of the blocks of the Ethernet frames are determined by the IEEE 802.3 standard, and cannot be changed. Therefore, when control commands for local external equipments are included in a frame, the amount of other data that can be carried is reduced.

Accordingly, there is a need for an improved system and method of controlling local external equipments utilizing an Ethernet bit stream.

SUMMARY OF THE INVENTION

In one aspect, the present invention is directed to a method of controlling local equipment on an Ethernet network in which a network processor produces and controls Ethernet frames. A new bit field is added to an Ethernet frame, indicating a function to be performed by the local equipment. Any type of hardware may add the new bit field, but in the currently preferred embodiment, the network processor adds the bit field. The network processor then sends the Ethernet frame to the local equipment. The local equipment decodes the new bit field and performs the indicated function.

In another aspect, the present invention is directed to a method of controlling a multiplexer that connects a plurality of subscriber lines to an Ethernet network. The method includes adding by the network processor, a new bit field into an Ethernet frame. The new bit field identifies a selected subscriber line from the plurality of subscriber lines to which the frame is to be switched by the multiplexer. The method also includes sending the Ethernet frame to the multiplexer; decoding the new bit field by the multiplexer; and switching the Ethernet frame to the selected subscriber line identified by the new bit field. The Ethernet frame includes an address field, and the multiplexer may decode the new bit field and switch the Ethernet frame without decoding the address field. The method may also include, after adding the new bit field into the Ethernet frame, the steps of: calculating by the network processor, a checksum on the total number of bits in the Ethernet frame, including the new bit field; sending the Ethernet frame to the multiplexer with the calculated checksum; and validating the checksum by the multiplexer. Additionally, the multiplexer may, after decoding the new bit field, restore the Ethernet frame to an original configuration by removing the new bit field. In this embodiment, the multiplexer then calculates a new checksum on the number of bits remaining in the Ethernet frame after the new bit field is removed, and switches the Ethernet frame with the new calculated checksum to the selected subscriber line.

In yet another aspect, the present invention is directed to a system for controlling local equipment on an Ethernet network. The system includes a network processor that produces and controls Ethernet frames. The network

processor includes means for adding a new bit field into an Ethernet frame that indicates a function to be performed by the local equipment, and means for sending the Ethernet frame over the network to the local equipment. The local equipment includes means for decoding the new bit field; and means for performing the function indicated by the new bit field. In one embodiment, the local equipment is a multiplexer that connects a plurality of subscriber lines to the network, and the function indicated by the new bit field is to switch the frame to a selected subscriber line.

In still yet another aspect, the present invention is directed to a method of controlling local equipment on an Ethernet network having a network processor that produces and controls Ethernet frames. The method includes receiving by the local equipment, an Ethernet frame that includes a new bit field indicating a function to be performed by the local equipment; decoding the new bit field by the local equipment; and performing by the local equipment, the function indicated by the new bit field. In one embodiment, the local equipment is a multiplexer that connects a plurality of subscriber lines to the Ethernet network, and the new bit field in the Ethernet frame identifies a selected subscriber line to which the multiplexer is to switch the received Ethernet frame.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a flow chart illustrating the general steps of the method of the present invention;

FIG. 2 is a flow chart illustrating the steps of an embodiment of the present invention in which a multiplexing function is performed in a local equipment; and

FIG. 3 is a simplified block diagram of an embodiment of the system of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

In a first embodiment of the present invention, a network processor produces and controls Ethernet frames addressed to a subscriber in a broadband network. The network processor may be, for example, a microprocessor capable of producing and controlling a bit stream comprising a plurality of Ethernet frames

containing messages for several subscribers. The processor is preferably controlled mainly by software, making it possible to rather easily change the functionality of the data exchange, compared to alternative ASIC-based hardware exchanges where changes in functionality are mainly limited to changes in register settings.

In an exemplary application of the invention, there is a need of dividing a single high-speed channel (100 Mbps, for example) to a number of channels with a lower data rate (10 Mbps, for example). In this particular case, the invention performs a multiplexing function, although the invention may also perform a number of other functions, and is not limited to multiplexing.

Each Ethernet frame has a destination address that can be used for controlling the destination of the message. However, testing on this address takes a long time and utilizes many resources in logic hardware. In the present invention, instead of using this method, the network processor adds a field to the standard Ethernet frame. Thereafter, the local equipment controlling the multiplexing functionality only has to decode this field to obtain the controlling instructions. This is a much simpler job, which can be performed more quickly utilizing fewer resources.

One output channel of the network processor may control, for example, ten subscribers. When the network processor sends a message to one of the ten subscribers, the processor adds a code field of at least four bits to the destination address field. At least four bits are added because this is the minimum number required for controlling ten separate channels. The total Ethernet frame is then sent to the local equipment, where the extra code field is decoded, telling the local equipment which of ten outputs to utilize for the message. The local equipment then performs this multiplexing function and sends the message to the addressed subscriber.

The network processor also delivers a checksum calculated on the total number of bits in the bit stream, including the extra bits of the code field. The checksum provides a method of indirectly validating the quality or correctness of a data transfer. By counting backwards in the receiver, the result should be zero or a pre-determined sum. A commonly used method is CRC32 (32-bit counting). If

the checksum does not match, the frame may be retransmitted. The local equipment uses the checksum to determine that the message was correctly received, but does not deliver the same checksum to the subscriber line. Instead, the local equipment removes the extra bit field and recalculates the checksum before sending it out on the subscriber line. In an alternative embodiment, the network processor delivers a checksum calculated on the number of bits in the bit stream, not including the extra bits. In this case, the local equipment uses the checksum to determine that the message was correctly received, and sends the same checksum out on the subscriber line. Thus, in this embodiment, the local equipment does not adjust the checksum.

FIG. 1 is a flow chart illustrating the general steps of the method of the present invention. The method may be utilized, for example, to control the destination of Ethernet frames in a broadband network. At step 11, a network processor adds a bit field to an Ethernet frame. Any type of hardware may add the new bit field, but in the currently preferred embodiment, the network processor adds the bit field. At step 12, the network processor sends the Ethernet frame with the added field to an external local equipment. The local equipment decodes the added field at step 13, and at step 14, performs the function indicated by the decoded field.

FIG. 2 is a flow chart illustrating the steps of an embodiment of the present invention in which a multiplexing function for a broadband network is performed in an external local equipment. At step 21, the network processor adds a bit field to an Ethernet frame identifying a destination subscriber. At step 22, the network processor calculates a checksum on the total number of bits in the frame, including the added field. At step 23, the network processor sends the Ethernet frame with the added field and the checksum to an external local equipment that multiplexes a plurality of output subscriber lines. At step 24, the local equipment validates the checksum. At step 25, the local equipment decodes the added field, and determines the output subscriber line indicated by the decoded field. At step 26, the local equipment removes the added field from the Ethernet frame. At step 27, the local equipment recalculates a new checksum based on the bits in the frame without the added field. At step 28, the local equipment sends the Ethernet

frame and new checksum out on the subscriber line indicated by the decoded field.

FIG. 3 is a simplified block diagram of an embodiment of the system of the present invention. The system includes a network processor 31, a broadband network 32, and a local equipment that functions as a multiplexer (MUX) 33. The network processor receives a message 34, which identifies a source, a destination subscriber (for example Subscriber D), and other known message components. An Ethernet frame producer 35, including checksum calculator 36, produces an Ethernet frame 38 from the message components. A bit field adder 37 adds a bit field to the Ethernet frame identifying destination Subscriber D. The checksum calculator then calculates a checksum on the total number of bits in the frame, including the added field. The Ethernet frame is then sent over the broadband network 32 to the MUX 33.

In the MUX 33, a checksum validater 39 validates the checksum. An added field decoder 41 decodes the added field, and determines the output Subscriber line D indicated by the decoded field. An added field remover 42 removes the added field from the Ethernet frame. A new checksum calculator 43 then recalculates a new checksum based on the bits in the frame without the added field. The MUX then sends the Ethernet frame and new checksum out on the Subscriber line D indicated by the decoded field.

The present invention may of course, be carried out in other specific ways than those herein set forth without departing from the essential characteristics of the invention. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

CLAIMS

1. A method of controlling local equipment on an Ethernet network having a network processor that produces and controls Ethernet frames, said method comprising:

adding a new bit field into an Ethernet frame, said new bit field indicating a function to be performed by the local equipment;

sending the Ethernet frame to the local equipment;

decoding the new bit field by the local equipment; and

performing by the local equipment, the function indicated by the new bit field.

2. The method of claim 1, wherein the step of adding the new bit field into the Ethernet frame is performed by the network processor.

3. The method of claim 1, wherein the Ethernet frame includes an address field, and the local equipment decodes the new bit field and performs the indicated function without decoding the address field.

4. The method of claim 3, further comprising:

restoring the Ethernet frame to an original configuration by removing the new bit field by the local equipment.

5. A system for controlling local equipment on an Ethernet network, said system comprising:

means for adding a new bit field into an Ethernet frame, said new bit field indicating a function to be performed by the local equipment;

means for sending the Ethernet frame over the network to the local equipment;

means within the local equipment for decoding the new bit field; and

means within the local equipment for performing the function indicated by the new bit field.

6. The system of claim 5, wherein the means for adding the new bit field into the Ethernet frame is in a network processor that produces and controls Ethernet frames.

7. The system of claim 5, wherein the Ethernet frame includes an address field, and the decoding means within the local equipment decodes the new bit field and performs the indicated function without decoding the address field.

8. The system of claim 5, further comprising:

means within the local equipment for restoring the Ethernet frame to an original configuration by removing the new bit field.

9. In an Ethernet network having a network processor that produces and controls Ethernet frames, a method of controlling a multiplexer that connects a plurality of subscriber lines to the network, said method comprising:

adding a new bit field into an Ethernet frame, said new bit field identifying a selected subscriber line from the plurality of subscriber lines to which the frame is to be switched by the multiplexer;

sending the Ethernet frame to the multiplexer;

decoding the new bit field by the multiplexer; and

switching the Ethernet frame to the selected subscriber line identified by the new bit field.

10. The method of claim 9, wherein the step of adding the new bit field into the Ethernet frame is performed by the network processor.

11. The method of claim 10, wherein the Ethernet frame includes an address field, and the multiplexer decodes the new bit field and switches the Ethernet frame without decoding the address field.

12. The method of claim 10, further comprising, after adding the new bit field into the Ethernet frame, the step of calculating by the network processor, a checksum on the total number of bits in the Ethernet frame, including the new bit field.

13. The method of claim 12, wherein the step of sending the Ethernet frame to the multiplexer includes sending the Ethernet frame to the multiplexer with the calculated checksum.

14. The method of claim 13, further comprising, prior to decoding the new bit field, the step of validating the checksum by the multiplexer.

15. The method of claim 9, further comprising, after decoding the new bit field, the step of restoring the Ethernet frame to an original configuration by removing the new bit field by the multiplexer.

16. The method of claim 15, wherein the step of restoring the Ethernet frame to an original configuration also includes calculating by the multiplexer, a new checksum on the number of bits remaining in the Ethernet frame after the new bit field is removed.

17. The method of claim 16, wherein the step of switching the Ethernet frame to the selected subscriber line includes switching the Ethernet frame with the new calculated checksum.

18. The method of claim 10, further comprising, after adding the new bit field into the Ethernet frame, the steps of:

calculating by the network processor, a checksum on the number of bits in the Ethernet frame, excluding the new bit field; and

sending the Ethernet frame to the multiplexer with the calculated checksum.

19. The method of claim 18, further comprising, after sending the Ethernet frame to the multiplexer with the calculated checksum, the steps of:

validating the checksum by the multiplexer;

restoring the Ethernet frame to an original configuration by removing the new bit field by the multiplexer; and

switching the Ethernet frame with the checksum to the selected subscriber line.

20. A system for controlling a multiplexer that connects a plurality of subscriber lines to an Ethernet network, said system comprising:

a network processor that produces and controls Ethernet frames, said network processor including:

means for receiving a message addressed to a selected subscriber line from the plurality of subscriber lines;

means for adding a new bit field into an Ethernet frame, said new bit field identifying the selected subscriber line to which the frame is to be switched by the multiplexer; and

means for sending the Ethernet frame over the network to the multiplexer;

means within the multiplexer for decoding the new bit field; and

means within the multiplexer for switching the Ethernet frame to the selected subscriber line identified by the new bit field.

21. The system of claim 20, wherein the Ethernet frame includes an address field, and the decoding means within the multiplexer decodes the new bit field without decoding the address field.

22. The system of claim 20, wherein the network processor also includes means for calculating a checksum on the total number of bits in the Ethernet frame, including the new bit field.

23. The system of claim 22, wherein the means for sending the Ethernet frame over the network to the multiplexer sends the Ethernet frame to the multiplexer with the calculated checksum.

24. The system of claim 23, further comprising means within the multiplexer for validating the checksum.

25. The system of claim 20, further comprising means within the multiplexer for restoring the Ethernet frame to an original configuration after decoding the new bit field, said restoring means removing the new bit field from the Ethernet frame.

26. The system of claim 25, wherein the restoring means within the multiplexer also includes means for calculating a new checksum on the number of bits remaining in the Ethernet frame after the new bit field is removed.

27. The system of claim 26, wherein the means for switching the Ethernet frame to the identified subscriber line switches the Ethernet frame with the new calculated checksum.

28. In an Ethernet network having a network processor that produces and controls Ethernet frames, a method of controlling a multiplexer that connects a plurality of subscriber lines to the network, said method comprising:

adding by the network processor, a new bit field into an Ethernet frame, said new bit field identifying a selected subscriber line from the plurality of subscriber lines to which the frame is to be switched by the multiplexer;

calculating by the network processor, a checksum on the total number of bits in the Ethernet frame, including the new bit field;

sending the Ethernet frame with the calculated checksum to the multiplexer;

validating the checksum by the multiplexer;

decoding the new bit field by the multiplexer without decoding an address field of the Ethernet frame;

restoring the Ethernet frame to an original configuration by removing the new bit field by the multiplexer;

calculating by the multiplexer, a new checksum on the number of bits remaining in the Ethernet frame after the new bit field is removed; and

switching the Ethernet frame with the new calculated checksum to the selected subscriber line identified by the new bit field.

29. A method of controlling local equipment on an Ethernet network having a network processor that produces and controls Ethernet frames, said method comprising:

receiving by the local equipment, an Ethernet frame that includes a new bit field indicating a function to be performed by the local equipment;

decoding the new bit field by the local equipment; and

performing by the local equipment, the function indicated by the new bit field.

30. The method of claim 29, wherein the local equipment is a multiplexer that connects a plurality of subscriber lines to the Ethernet network, and the new

bit field in the Ethernet frame identifies a selected subscriber line to which the multiplexer is to switch the received Ethernet frame.

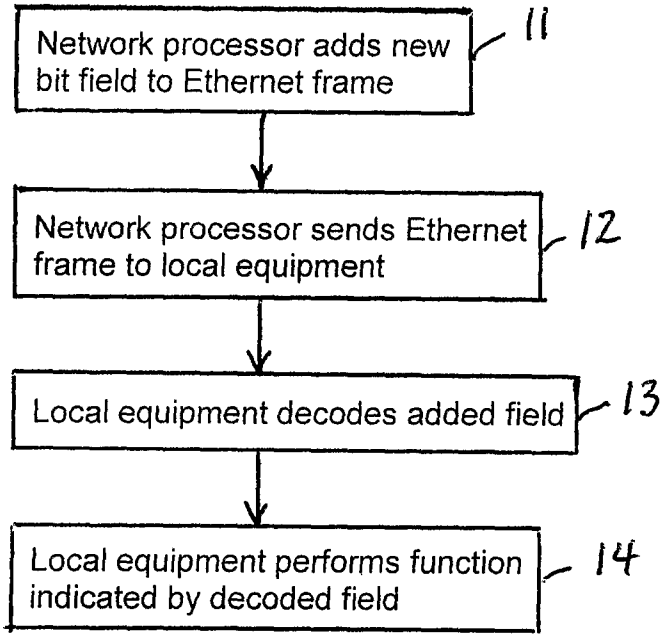

Network processor adds new bit field to Ethernet frame
11
Network processor sends Ethernet frame to local equipment
12
Local equipment decodes added field
13
Local equipment performs function indicated by decoded field
14

FIG. 1

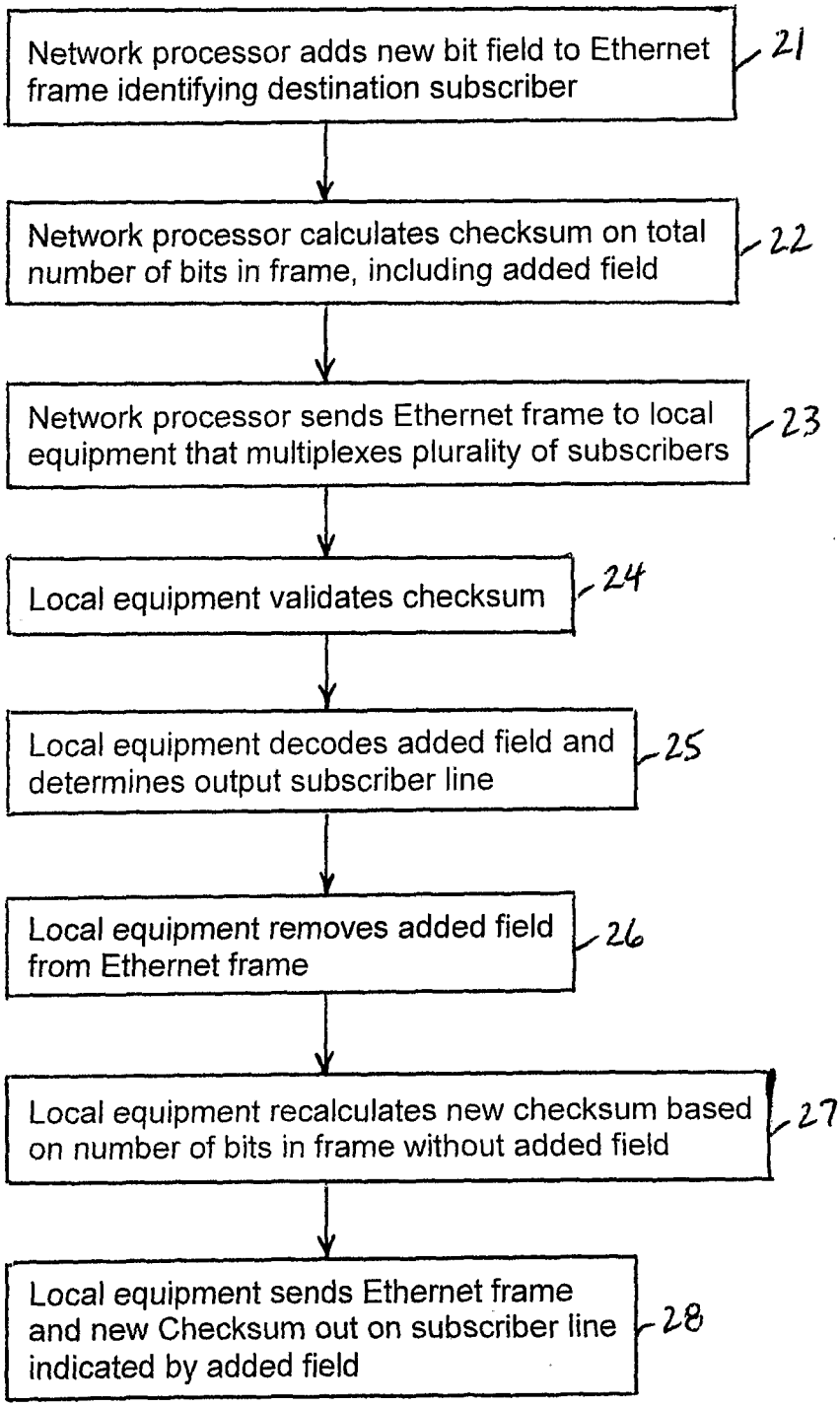

Network processor adds new bit field to Ethernet frame identifying destination subscriber
21
Network processor calculates checksum on total number of bits in frame, including added field
22
Network processor sends Ethernet frame to local equipment that multiplexes plurality of subscribers
23
Local equipment validates checksum
24
Local equipment decodes added field and determines output subscriber line
25
Local equipment removes added field from Ethernet frame
26
Local equipment recalculates new checksum based on number of bits in frame without added field
27
Local equipment sends Ethernet frame and new Checksum out on subscriber line indicated by added field
28

FIG. 2

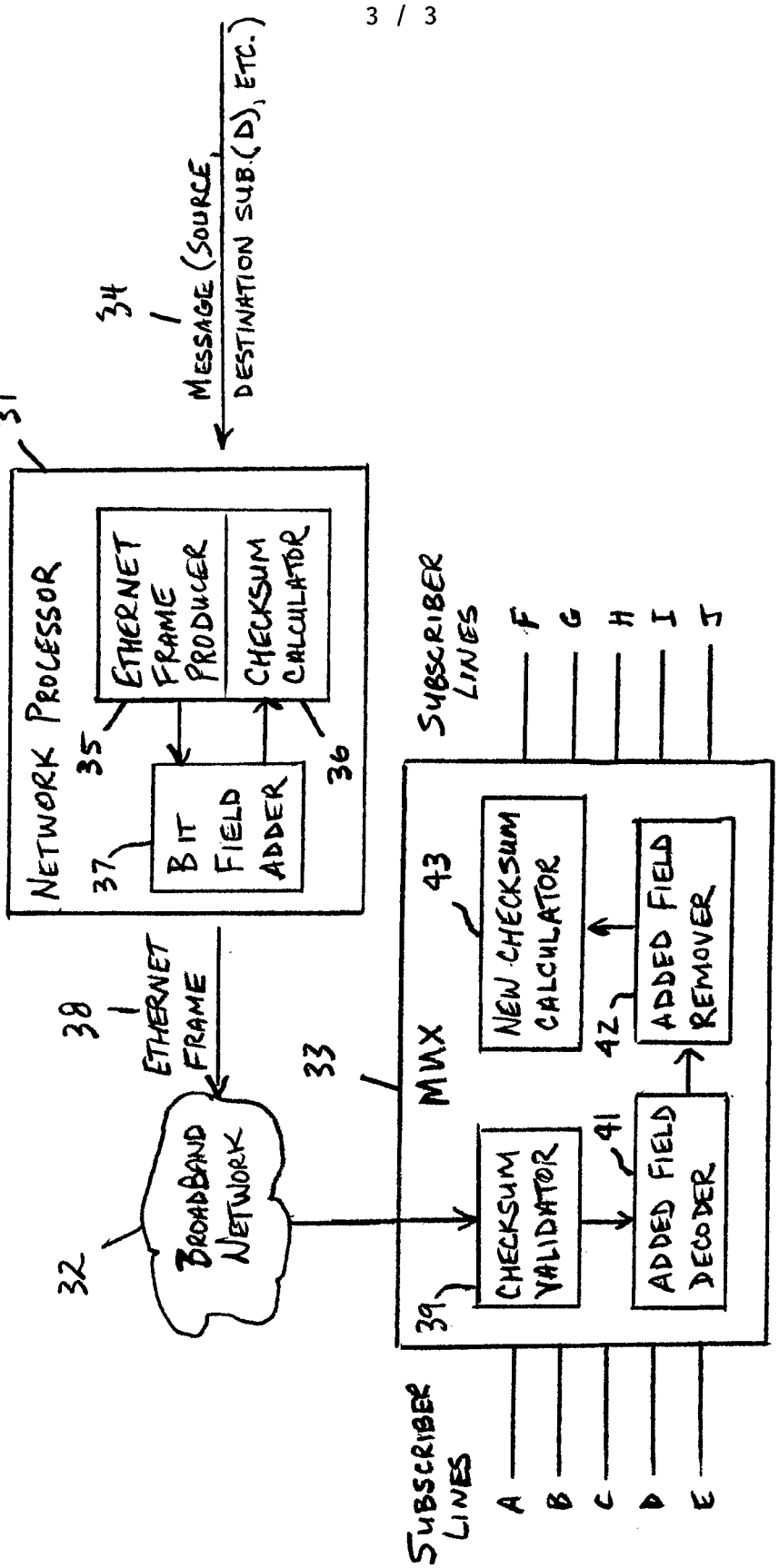

34
MESSAGE (SOURCE, DESTINATION SUB.(D), ETC.)
31
NETWORK PROCESSOR
ETHERNET FRAME PRODUCER
CHECKSUM CALCULATOR
35
36
37
BIT FIELD ADDER
38
ETHERNET FRAME
33
MUX
43
NEW CHECKSUM CALCULATOR
42
ADDED FIELD REMOVER
41
ADDED FIELD DECODER
39
CHECKSUM VALIDATOR
32
BROADBAND NETWORK
SUBSCRIBER LINES
A
B
C
D
E
SUBSCRIBER LINES
F
G
H
I
J

FIG. 3

INTERNATIONAL SEARCH REPORT

IB2004/002821

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04L12/413

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04L H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 351 449 A (SAMSUNG ELECTRONICS CO., LTD) 8 October 2003 (2003-10-08) abstract figures 8,9,12 paragraph '0015! paragraphs '0019! - '0033!	1-30
X	US 2003/152389 A1 (SALA DOLORS ET AL) 14 August 2003 (2003-08-14) abstract paragraphs '0009! - '0015!	1,5,29

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
10 May 2005	23/05/2005

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	DE LA PENA ALVAREZ

INTERNATIONAL SEARCH REPORT

IB2004/002821

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