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(54) **Method and apparatus for mapping fast ethernet packets in SONET containers over a radio-link system**

Verfahren und Gerät zur Einbindung von Fast Ethernet Paketen in SONET-Container über ein Funksystem

Méthode et dispositif pour associer des paquets d'ethernet à haute vitesse avec des contenants SONET à travers un système sans fil

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- **CARLISLE C J ET AL: "ARCHITECTURES AND FUNCTIONAL ASPECTS OF RADIO RELAY SYSTEMS FOR SDH NETWORKS" COUNTDOWN TO THE NEW MILENNIUM. PHOENIX, DEC. 2 - 5, 1991, PROCEEDINGS OF THE GLOBAL TELECOMMUNICATIONS CONFERENCE. (GLOBECOM), NEW YORK, IEEE, US, vol. 2, 2 December 1991 (1991-12-02), pages 856-860, XP000332795 ISBN: 0-87942-697-7**

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Description

[0001] The present invention relates to the field of telecommunications and in particular to the point-to-point radio-link communication systems. More in detail, it relates to a method and the respective apparatus for mapping Fast Ethernet interfaces (and possible data interfaces of different type) into a single Virtual Container of a STM-1 (or OC-3) payload transmitted to a point-to-point radio link system.

[0002] The present telecommunication networks try to maintain an optimized connection from the point of view of data and by an optimal exploitation of the available bandwidth in view of a geographical expansion of activities and the continuous increase of bit rates of IP (Internet Protocol) transmission. The bottleneck of the so-called "last mile" between the business LAN networks and the public networks is still limiting the business productivity and the profits of network service providers (NSP).

[0003] So far, the connection between local networks (LAN) and public networks was carried out substantially through optical fiber lines, dedicated lines or wireless systems designed to transmit voice signals. All these known connection systems have several disadvantages. For example, they provide high costs, delays in the physical cable laying, fees to be paid, contract restrictions and technical limitations reducing the business production capacity.

[0004] In addition to the traditional structures (Ethernet), based on a bus topology, utilized to interconnect computers in a local area network (LAN), it is well known the so-called "Fast Ethernet". The Fast Ethernet has now become a finally ratified Standard by the Institute of Electrical and Electronics Engineers (IEEE). To this Standard has been awarded the official name "802.3u" but it is more known with the name "100BASE-T" (it does not refer to the cable used but to the utilization manner of the cable itself). The 100BASE-T has a transmission bit-rate equivalent to 100 Mb/s and utilizes the CSMA/CD (Carrier Sense Multiple Access/Collision Detection) method to manage the access to the cable.

[0005] The existing solutions, both via cable and wireless, for interconnecting two LAN networks are considered as inadequate in particular in the presence of a 100 Mb/s transmission bit-rate.

[0006] EP-A-0 982 969 discloses a method of carrying frame based data, eg Ethernet data, over a synchronous digital hierarchy network in order to provide local area network type functionality over a wide area network coverage. Specific embodiments disclose methods of mapping Ethernet data frames into SDH virtual containers, and distinguishing start and end boundaries of the Ethernet data frames within the virtual container payloads, by a selection of encoding methods including a segmentation, pointer methods, bit stufifng methods and byte stuffing methods. Data frames are encoded with a code which designates a boundary of each frame, and the encoded frames are input into a synchronous data channel.

[0007] CARLISLE C J ET AL : "ARCHITECTURES AND FUNCTIONAL ASPECTS OF RADIO RELAY SYSTEMS FOR SDH NETWORKS" COUNTDOWN TO THE NEW MILLENIUM. PHOENIX, DEC. 2 - 5, 1991, PROCEEDINGS OF THE GLOBAL TELECOMMUNICATIONS CONFERENCE. (GLOBECOM), NEW YORK, IEEE, US, vol. 2, 2 December 1991 (1991-12-02), pages 856-860, XP000332795 ISBN: 0-87942-697-7 discloses the functionality of SDH radio and possible architectures for employing SDH radio in SDH networks. The SDH radio equipment is described in terms of functional blocks.

[0008] The object of the present invention is to offer a valid alternative to the existing solutions to implement an optimized LAN to LAN connection. In particular, the main object of the present invention is to provide a method for mapping Fast Ethernet data interfaces into a single Virtual Container of a STM-1/OC-3 payload transmitted to a radio-link system.

[0009] A further object is to let the Fast Ethernet signal of a first LAN, the Fast Ethernet signal being mapped and possibly transmitted through a SDH radio-link, travel within a SDH/SONET (ring) network so that it reaches a second LAN, possibly through another SDH radio-link.

[0010] The basic idea of the present invention is to encapsulate several data streams (Fast Ethernet (at 100 Mb/s) and low-level plesiochronous interfaces, namely E1 (at 2 Mb/s) or DS1 (at 1,5 Mb/s)) within the VC-4 of the payload of a STM-1 (or OC-3) signal and, in addition, to recover the clock signal at the receiver through information transmitted together with the same STM-1 frame.

[0011] According to the present invention, the (VC-4) Virtual Container is not created in a conventional manner but through a "packeting" step, as hereunder detailed.

[0012] The present invention will become clear thanks to the hereinafter detailed description, supplied by way of a non-limiting example, as set forth in the appended Figures, wherein:

- Fig. 1 illustrates a first network application of the present invention;
- Fig. 2 illustrates a second network application of the present invention;
- Fig 3 illustrates a schematical block diagram of a single wireless terminal implementing the present invention;
- Fig. 4 illustrates, schematically, a transmitter according to the present invention;
- Fig. 5 illustrates, schematically, a receiver according to the present invention;
- Fig. 6 illustrates how it could be mapped a single channel at 2 (or 1,5) Mb/s onto a Virtual Container of 36 bytes;

- Fig. 7 illustrates how it is possible to perform the packeting of channels at 2 (or 1,5) Mb/s;
- Fig. 8 illustrates a flow-chart of the various steps of the method carried out during the transmission; and
- Fig. 9 illustrates a flowchart of the various steps of the method carried out at the reception side.

[0013] Before describing the present invention, it is imperative to say that it is equally applicable to all the synchronous signals, such as SDH and SONET. Therefore, each reference made to the SDH domain is automatically understood as extended to the SONET world and *vice versa.*

[0014] Fig. 1 shows a first possible network application of the present invention to interconnect two local area networks, LAN1 and LAN2. A Fast Ethernet signal coming from a first local network (LAN1) is processed into a LAN Switch LANSW1, mapped (WTER1) into SDH/SONET Virtual Containers (VC4) and transmitted through a point-to-point SDH/SONET radio-link. At the reception side WTER2 of the radio-link, the frame created is inserted (NE1) and transported through a conventional (ring) SDH/SONET network, indicated by NTW. At node NE4 of the (ring) network, the frame is de-mapped and the signal is converted again into the original Fast Ethernet signal through a second LAN Switch LANSW2. Later, it is sent to the second local area network LAN2.

[0015] The application of Fig. 2 is very similar to the application of Fig. 1. The difference is in the fact that a second point-to-point SDH/SONET radio-link is implemented to accede to the second local area network LAN2. In each case, we could generically define both the applications as "LAN-to-LAN interconnections".

[0016] The problem that is addressed and solved by the present invention is transmitting a Fast Ethernet signal through a SDH/SONET radio-link. Since the Fast Ethernet signal has been properly "packeted" in order to be contained into the standard SDH/SONET Virtual Containers (VC-4), it can be easily transmitted through conventional (ring) SDH/SONET networks.

[0017] Fig. 3 illustrates a schematical block diagram of a single wireless terminal 10 implementing the present invention. Fig. 3 shows a first I/O interface 12 for Fast Ethernet (100BASE-T) signals and a plurality of I/O interfaces 14 for plesiochronous signals, typically E1 signals at 2 Mb/s or DS1 signals at 1,5 Mb/s. The maximum number of I/O interfaces 14 for plesiochronous signals is depending on which signal (E1, DS1) they are fit to receive and is limited only by the standardized capacity (149 Mb/s) of a VC-4 Virtual Container.

[0018] All the I/O interfaces 12, 14 are into a bidirectional communication with a packet building block 16 which acts as a "Round-Robin Scheduler". The packet building block 16 is in its turn connected to a block 18 for SDH/SONET frame processing and mapping. Conventionally, once the VC-4 Virtual Container has been built, SDH/SONET functional blocks are provided. In other words, all the termination sections of SDH/SONET are present, namely: POHT, the termination section of VC-4 POH; MSA, the section for adapting the AU-4 to the MS (Multiplex Section); MST, the MSOH termination section; and RST, the RSOH termination section. The radio terminal according to the present invention further comprises a system controller SYCTR and modulation blocks TXMOD (for transmission side) and demodulation blocks RXDEMOD (for reception side) which are connected to a conventional microwave transceiver (not shown). Possibly, a block SCHMN for the management of service channels and outer interfaces is provided.

[0019] The present invention is based on the principle of multiplexing data interfaces of different type into a single VC-4. The incoming signals (100BASE-T, E1, DS1) are divided into packets having a fixed length which are "stacked", that is temporary stored with a pre-established number. A time-division scheduler checks that the packet stacks from the sources be complete (in principle, the various signals could arrive with different bit rates). In the positive case, it is possible to build, that is to fill, a VC-4 Virtual Container. In the negative case, there are two alternatives: a VC-4 Virtual Container is constructed in any case by using "null" packets or the completion of the stack of valid packets is awaited.

[0020] Naturally, each packet stack from the same source is associated with a label or header identifying the source itself (for example 100BASE-T, first group of E1/DS1 signals or second group of E1/DS1 signals) in order to recover the original signal at the receiving side. The header, substantially, comprises a string for identifying the type of signal inserted into the VC-4.

[0021] In the preferred embodiment of the present invention, with a signal at 100 Mb/s and six signals at 2 (or 1,5) Mb/s, four different headers are foreseen: a first header for the source at 100 Mb/s, a second header for a first block of three signals at 2 (or 1,5) Mb/s, a third header for a second block of three signals at 2 (or 1,5) Mb/s and a fourth header to identify possible null packets. This because, as better explained hereinafter, the various signals at 2 (or 1,5) Mb/s are multiplexed at groups of three into a "super block ". After having identified the null packets by an appropriate header, they shall be easily eliminated during the reception without running the risk of loosing a part of the useful signal.

[0022] The present invention comprises the steps of dividing the signals (whichever the origin source could be) into packets having a pre-established length. The optimal packet length is equal to 28 bytes (27 bytes for information and 1 byte for header) for reasons that will become clear hereunder. Therefore, the maximum number of 28-bytes packets to be inserted into a VC-4 shall be 83. The residual 16 bytes of the VC-4 shall be utilized for clock recovery (the below described mechanism of time stamping).

[0023] The composition of a frame (single VC-4) in the case of a single source at 100 Mb/s will be as indicated in the below Table 1:

Table 1

Interface	No. of packets	No. bytes
100BASE-T	72÷73	1944÷1971
"Null" packets	10÷11	270÷297

[0024] The number of bytes reserved to the headers shall be 83, the ones reserved to the timestamp shall be 16.

[0025] The composition of a frame in the case of a Fast Ethernet source and of six sources at 2,0 (or 1,5) Mb/s will be as indicated in the below Table 2:

Interface	No. of packets	No. bytes
100BASE-T	72 ÷ 73	1944 ÷ 1971
1st block (3 X E1 or DS1)	4	108
2nd block (3 X E1 or DS1)	4	108
"Null" packets	2÷3	54÷81

Table 2

[0026] The number of bytes reserved to the headers shall be still 83, the ones reserved to the timestamp shall be 16.

[0027] For example, a signal at 2 (or 1,5) Mb/s is mapped onto a WST Virtual Container of 36 bytes as shown in Fig. 6, wherein:

BIP-2 contains a dedicated parity control;
Sg stn represents a negative stuffing signal;
Sg stp represents a positive stuffing signal;
Stn is a negative stuffing; and
Stp is a positive stuffing.

[0028] Three of these structures of 36 bytes are byte-by-byte multiplexed into a super block of 108 bytes (3X36 bytes) which, with the addition of the respective headers, are equivalent to four blocks of 28 bytes each.

[0029] Indeed, as the man skilled in the art will realize, a signal at 2 (or at 1,5) Mb/s could be contained also into 32 bytes only, notwithstanding the bytes of stuffing and parity control. Nevertheless, the same man skilled in the art shall recognize that 36 is also a multiple of the number of columns of a SDH/SONET frame and the multiplexing of three Virtual Containers of 36 bytes each (for a total of 108 bytes) is an exact multiple of four packets of 28 bytes as above defined and shown in Fig. 7; for sure, this fact is advantageous. In Fig. 7, the gray coloured byte indicates the packet header.

[0030] In the present invention, particular attention has been paid to the clock recovery since a source of asynchronous signals (100 Mb/s) is managed with the frame. The mechanism for recovering the synchronism signal is contained, as hereunder explained, in the SDH/SONET frame built through the packets from the various sources.

[0031] At the transmission side, a counter is provided for performing a sampling step and inserting, for instance at the end of the frame, an indicator (progressive number) proportional to the sampling frequency. At the reception side, this indicator is used for modifying the frequency of a voltage controlled oscillator (VCO) allowing to read the incoming data. Then, in each frame, a numerical indicator of the frequency by which the sampling has been carried out is contained.

[0032] In Fig. 4 a transmitter according to the present invention is schematically shown, the transmitter being able to receive signals of different type (100 BASE-T, E1, DS1) and to map them in an appropriate manner into a VC-4 of SDH/SONET frames. It is assumed that the incoming signals be a 100 BASE-T signal and six E1 (or DS1) signals.

[0033] The Time-Stamp is assigned (20) to the received 100 BASE-T signal in order to obtain the correct clock information at the receiving side. Packets having a fixed length are formed (22) and a header is added (24). The so formed packets are stacked into a buffer 34.

[0034] The signals E1, DS1 are received in groups of three signals. They are mapped (26) onto respective containers of 3X36 bytes. The containers of 108 bytes are multiplexed (28). As for the 100 BASE-T signal, packets are formed (30) and an appropriate header is added (32) to identify the origin source. Also in this case, the so formed packets are stacked (36) into a proper memory. Because of the above said reasons, void or null packets are formed (38) and also to these

null packets, having the same format of the valid packets, a proper header is added (40). A scheduler 42 forms a VC-4 Virtual Container, by utilizing the packets taken from the various buffers 34, 36 and possibly by using a certain number of null packets.

[0035] In Fig. 5 is schematically shown a receiver according to the present invention which is able to receive SDH/SONET frames and, from these, to extract the original signals (100 BASE-T, E1, DS1) transmitted through the radio link. The SDH/SONET frame is received through a proper input interface 50. From the received frame, the time stamp for clock recovery (54) is extracted (52). The so recovered clock signal is forwarded to a buffer (56) that stores the packets of the Fast Ethernet signals. The received frame is stored into a memory 58 and later processed by a block 60 for the identification of packet headers. The memory 58 is controlled by an appropriate controller 62, which is also in communication with the header identification block.

[0036] The block 60 for the header identification reads and identifies the headers of the packets contained in the payload of the frame. In the case of identification of a header of null packets, all the packets identified by this header shall be rejected (64). If a packet header of a 100BASE-T signal is identified, the packets identified by this header shall be sent (in the exact order of reception) to the buffer 56 and later to an output interface 66 for signals at 100 Mb/s. If a header of a first (or second) block of E1 or DS1 signals is identified, the packets identified by this header shall be sent to a first -68- (or second -74-) buffer of E1/DS1 signals to form a first -72-(or second -74-) container of 108 bytes (3X36 bytes). The respective first (or second) container of 108 bytes is demultiplexed (76, 78) and the E1/DS1 signals obtained shall be sent to the respective output interfaces 80.

[0037] The flowcharts of the Figures 8 and 9 summarize the various steps of the method of the present invention, for transmission and reception, respectively.

[0038] The transmission steps can be summarized as follows:

12: receiving signals from the first source (100 BASE-T),
26: receiving signals from the second/third source (first/second block of E1 or DS1 signals);
22, 30: building packets having pre-established sizes (27 bytes);
38: building null packets having pre-established sizes (27 bytes);
24, 32, 40: adding a proper header identifying the source;
34: forming packet stacks by storing them into a buffer;
42: when a stack of packets is ready, inserting them and building the VC-4, otherwise completing the VC-4 by null packets;
20: inserting a time stamping into the VC-4 after checking that the number of packets in the VC-4 is equal to 83 (if the number of packets is lower than 83, returning to the formed stacks of packets).

[0039] The reception steps can be summarized as follows:

50: receiving of SDH/SONET frames, STM-1 aligning, pointer interpreting and identifying the first packet of VC-4;
60: extracting a packet and reading the header thereof;
64: eliminating the packet if the header is invalid or in case a null packet is identified;
66: if the header identifies a packet coming from the first source (100 BASE-T), allocating the packet at the corresponding interface;
76, 78: if the header identifies a packet coming from the second/third source (first/second block of E1 or DS1 signals), demultiplexing the block of packets;
52: if the number of packets is equal to 83, extracting the time stamping, otherwise, if the number of packets is lower than 83, extracting a new packet (60), identifying the corresponding header and prosecuting as above said.

[0040] There have thus been shown and described a novel method and a novel apparatus which fulfill all the objects and advantages sought therefor. Many changes, modifications, variations and other uses and applications of the subject invention will, however, become apparent to those skilled in the art after considering the specification and the accompanying drawings which disclose preferred embodiments thereof.

Claims

1. Method for transmitting a Fast Ethernet (100 BASE-T) signal through a point-to-point radio link communication system, the method comprising the steps of

   a) receiving (12) Fast Ethernet (100 BASE-T) signals,
   b) packeting (18) such Fast Ethernet signals, wherein said step of packeting comprises forming (22) Fast

Ethernet signal packets having a same format,
characterized by
c) receiving (14) plesiochronous signals (E1, DS1) and forming (30) corresponding plesiochronous signal packets having a format which is the same as the format of said Fast Ethernet signal packets,
d) mapping (42) the Fast Ethernet signal packets and the plesiochronous signal packets into a single virtual container (VC-4) of a STM-1/OC-3 payload of a SDH/SONET frame signal, and
e) transmitting said frame signal through the point-to-point radio link, wherein said point-to-point radio link is a point-to-point SDH/SONET radio link.

2. Method according to claim 1, **characterized in that**

f) said step of mapping (42) comprises storing a number of packets (34, 36),
g) said step of mapping (42) further comprises forming at least one null packet having a format which is the same as said format of said Fast Ethernet signal packets;
h) said step of mapping (42) further comprises completely filling said virtual container with stored packets and with at least one null packet.

3. Method according to claim 1, **characterised in that** it comprises the further step of adding (32) a packet header to each of the Fast Ethernet signal packets and of the plesiochronous signal packets for identifying their origin source (100 BASE-T).

4. Method according to claim 3, **characterised in that** said step of forming packets having the same format comprises the step of forming packets of 27 bytes and said step of adding a packet header comprises the step of adding a 1-byte header.

5. Method according to claim 2, **characterised in that** it comprises the further step of adding (40) a corresponding header of null packet to each of the at least one null packet.

6. Method according to claim 5, **characterised in that** the step of forming at least one null packet comprises the step of forming at least one 27-bytes packet and the step of adding (40) a header of null packet comprises the step of adding a 1-byte header to each of the at least one null packet.

7. Method according to claim 1, **characterised in that** it comprises the further step of inserting a time stamping indicative of the sampling frequency and transmitting it together with the signal frame.

8. Apparatus for processing and transmitting a Fast Ethernet (100 BASE-T) signal through a point-to-point radio link communication system, the apparatus comprises:

i) an interface (12) for reception of Fast Ethernet (100 BASE-T) signals,
j) means (16, 18) for packeting said Fast Ethernet signal, wherein said means for packeting form Fast Ethernet signal packets having a same format,
characterized by further comprising
k) means (14) for receiving plesiochronous signals (E1, DS1) and forming (30) corresponding plesiochronous signal packets having a format which is the same as the format of said Fast Ethernet signal packets,
l) means (42) for mapping the Fast Ethernet signal packets and the plesiochronous signal packets into a single Virtual Container (VC-4) of a STM-1/OC-3 payload of a SDH/SONET signal frame, and
m) a transmitter that transmits said frame signal through the point-to-point radio link, wherein said point-to-point radio-link is a point-to-point SDH/SONET radio link.

9. Apparatus according to claim 9, **characterized in that** it further comprises

n) a buffer (34, 36) for storing a number of packets and **in that** said means for mapping further:
o) form at least one null packet having a format which is the same as said format of said Fast Ethernet signal packets, and
p) completely fill said single Virtual Container (VC-4) with stored packets and with at least one null packet.

10. Apparatus according to claim 8, **characterised in that** it further comprises means for adding a packet header to each of the Fast Ethernet signal packets and of the plesiochronous signal packets for identifying their origin source

(100 BASE-T).

11. Apparatus according to claim 8, **characterised by** further comprising means for inserting a time stamping indicating the sampling frequency and for transmitting it together with the signal frame.

Patentansprüche

1. Verfahren zur Übertragung eines Fast-Ethernet-(100 BASE-T) Signals über ein Punkt-zu-Punkt-Funkkommunikationssystem, wobei das Verfahren die Schritte umfasst des:

a) Empfangens (12) von Fast-Ethernet-(100 BASE-T) Signalen;
b) Paketierens (18) dieser Fast-Ethernet-Signale, wobei dieser Schritt des Paketierens das Bilden (22) von Fast-Ethernet-Signalpaketen umfasst, weiche dasselbe Format aufweisen;
gekennzeichnet durch
c) das Empfangen (14) plesiochroner Signale (E1, DS1) und das Bilden (30) entsprechender plesiochroner Signalpakete, die ein Format aufweisen, welches dasselbe, ist wie das Format der Fast-Ethernet-Singnalpakete ;
d) das Einbinden (42) der Fast-Ethernet-Signalpakete und der plesiochronen Signalpakete in einen einzigen virtuellen Container (VC-4) einer STM-1/OC-3-Nutzlast eines SDH/SONET-Rahmenssgnals; und
e) das Übertragen des Rahmensignals über die Punkt-zu-Punkt-Funkverbindung, wobei die Punkt-zu-Punkt-Funkverbindung eine Punkt-zu-Punkt-SDH/SONET-Funkverbindung ist

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass**

f) der Schritt des Einbindens (42) das Speichern einer Anzahl von Paketen (34, 36) umfasst;
g) der Schritt des Einbindens (42) weiterhin das Bilden von mindestens einem Nullpaket umfasst, welches ein Format aufweist, das dasselbe ist wie das Format der Fast-Ethernet-Signalpakete;
h) der Schritt des Einbindens (42) weiterhin das vollständige Auffüllen des virtuellen Containers mit gespeicherten Paketen und mit mindestens einem Nullpaket umfasst

3. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** es den weiteren Schritt des Hinzufügens (32) eines Paket-Headers zu jedem der Fast-Ethernet-Signalpakete und der plesiochronen Signalpakete zur Identifizierung ihrer ursprünglichen Quelle (100 BASE-T) umfasst.

4. Verfahren nach Anspruch 3, **dadurch gekennzeichnet, dass** der Schritt des Bildens von Paketen, welche dasselbe Format aufweisen, den Schritt des Bildens von Paketen mit 27 Bytes umfasst und dass der Schritt des Hinzufügens eines Paket-Headers den Schritt des Hinzufügens eines 1-Byte-Headers umfasst.

5. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass** er den weiteren Schritt des Hinzufügens (40) eines entsprechenden Nullpaket-Headers zu jedem der bzw. zu dem mindestens einen Nullpaket umfasst.

6. Verfahren nach Anspruch 5, **dadurch gekennzeichnet, dass** der Schritt des Bildens von mindestens einem Nullpaket den Schritt des Bildens von mindestens einem 27-Byte-Paket umfasst und der Schritt des Hinzufügens (40) eines Nullpaket-Headers den Schritt des Hinzufügens eines 1-Byte-Headers zu jedem der bzw. zu dem mindestens einen Nullpaket umfasst.

7. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** es den weiteren Schritt des Einfügens eines Zeitstempels umfasst, welcher einen Rückschluss auf die Abtastfrequenz zulässt, und des Übertragens dieses Zeitstempels zusammen mit dem Signalrahmen.

8. Gerät zum Verarbeiten und Übertragen eines Fast-Ethernet-(100 BASE-T) Signals über ein Punkt-zu-Punkt-Funkkommunikationssystem, wobei das Gerät umfasst:

i) eine Schnittstelle (12) zum Empfang von Fast-Ethernet-(100 BASE-T) Signalen;
j) Mittel (16, 18) zum Paketieren des Fast-Ethernet-Signals, wobei diese Mittel zum Paketieren Fast-Ethernet-Signalpakete bilden, welche dasselbe Format aufweisen;
dadurch gekennzeichnet, dass es weiterhin umfasst
k) Mittel (14) zum Empfangen plesiochroner Signale (E1, DS1) und zum Bilden (30) entsprechender plesio-

chroner Signalpakete, die ein Format aufweisen, welches dasselbe ist wie das Format der Fast-Ethernet-Signalpakete;
l) Mittel (42) zum Einbinden der Fast-Ethernet-Signalpakete und der plesiochronen Signalpakete in einen einzigen virtuellen Container (VC-4) einer STM-1/OC-3-Nutzlast eines SDH/SONET-Signalrahmens; und
m) einen Sender, der das Rahmensignal über die Punkt-zu-Punkt-Funkverbindung überträgt, wobei die Punkt-zu-Punkt-Funkverbindung eine Punkt-zu-Punkt-SDH/SONET-Funkverbindung ist.

9. Gerät nach Anspruch 9 **dadurch gekennzeichnet dass** es weiterhin umfasst:

n) einen Puffer (34, 36) zum Speichern einer Anzahl von Paketen (34, 36) und **dadurch**, dass das Mittel zum Einbinden weiterhin:
o) mindestens ein Nullpaket bildet, welches ein Format ausweist, das dasselbe ist wie das Format der Fast-Ethernet-Signalpakete; und
p) den einzigen virtuellen Container (VC-4) vollständig mit gespeicherten Paketen und mit mindestens einem Nullpaket auffüllt.

10. Gerät nach Anspruch 8, **dadurch gekennzeichnet, dass** es weiterhin Mittel zum Hinzufügen eines Paket-Headers zu jedem der Fast-Ethernet-Signalpakete und der plesiochronen Signalpakete zur Identifizierung ihrer ursprünglichen Quelle (100 BASE-T) umfasst.

11. Gerät nach Anspruch 8, **dadurch gekennzeichnet, dass** es weiterhin Mittel zum Einfügen eines Zeitstempels umfasst, welcher einen Ruckschluss auf die Abtastfrequenz zulässt, und zum Übertragen dieses Zeitstempels zusammen mit dem Signalrahmen.

Revendications

1. Procédé de transmission d'un signal Fast Ethernet (100 BASE-T) par le biais d'un système de communication par liaison radio point à point, le procédé comprenant les étapes de :

a) réception (12) de signaux Fast Ethernet (100 BASE-T),
b) paquétisation (18) de ces signaux Fast Ethernet, où ladite étape de paquétisation comprend la formation (22) de paquets de signaux Fast Ethernet ayant un même format,
caractérisé par :
c) la réception (14) de signaux plésiochrones (E1, DS1) et la formation (30) de paquets de signaux plésiochrones correspondants ayant un format qui est le même que le format desdits paquets de signaux Fast Ethernet,
d) la mise en correspondance (42) des paquets de signaux Fast Ethernet et des paquets de signaux plésiochrones avec un conteneur virtuel unique (VC-4) d'une charge utile STM-1/0C-3 d'un signal de trame SDH/SONET, et
e) la transmission dudit signal de trame par le biais de la liaison radio point à point, ou ladite liaison radio point à point est une liaison radio SDH/SONET point à point.

2. Procédé selon la revendication 1, **caractérisé en ce que**

f) ladite étape de mise en correspondance (42) comprend la mémorisation d'un nombre de paquets (34) 36),
g) ladite étape de mise en correspondance (42) comprend en outré la formation d'au moins un paquet nul ayant un format qui est le même que ledit format desdits paquets de signaux Fast Ethernet;
h) ladite étape de mise en correspondance (42) comprend en outré le remplissage complet dudit conteneur virtuel avec des paquets mémorisés et avec au moins un paquet nul.

3. Procédé selon la revendication 1, **caractérisé en ce qu'**il comprend l'étape supplémentaire d'ajout (32) d'un entete de paquet à chacun des paquets de signaux Fast Ethernet et des paquets de signaux plésiochrones pour identifier leur source d'origine (100 BASE-T).

4. Procédé selon la revendication 3, **caractérisé en ce que** ladite étape de formation de paquets ayant le même format comprend l'étape de formation de paquets de 27 octets et ladite étape d'ajout d'un en-tête de paquet comprend l'ajout d'un en-tête de 1 octet.

5. Procédé selon la revendication 2, **caractérisé en ce qu'**il comprend l'étape supplémentaire d'ajout (40) d'un en-tête correspondant de paquet nul à chacun de l'au moins un paquet nul.

6. Procédé selon la revendication 5, **caractérisé en ce que** l'étape de formation d'au moins un paquet nul comprend l'étape de formation d'au moins un paquet de 27 octets et l'étape d'ajout (40) d'un en-tête de paquet nul comprend l'étape d'ajout d'un en-tête d'1 octet à chacun de l'au moins un paquet nul.

7. Procédé selon la revendication 1, **caractérisé en ce qu'**il comprend l'étape supplémentaire d'insertion d'une estampille temporelle indicative de la fréquence d'échantillonnage et de sa transmission avec la trame de signal.

8. Appareil de traitement et de transmission d'un signal Fast Ethernet (100 BASE-T) par le biais d'un système de communication à liaison radio point à point, l'appareil comprenant ;

i) une interface (12) de réception de signaux Fast Ethernet (100 BASE-T),
j) des moyens (16, 18) de paquétisation dudit signal Fast Ethernet, où lesdits moyens de paquétisation forment des paquets de signaux Fast Ethernet ayant un même format,
caractérisé par le fait qu'il comprend en outre :
k) un moyen (14) de réception de signaux plésiochrones (E1, DS1) et de formation (30) de paquets de signaux plésiochrones correspondants ayant un format qui est le même que le format desdits paquets de signaux Fast Ethernet,
l) des moyens (42) de mise en correspondance des paquets de Signaux Fast Ethernet et des paquets de signaux plésiochrones avec un Conteneur virtuel unique (VC-4) d'une charge utile STM-1/0C-3 d'un signal de trame SDH/SONET, et
m) un émetteur qui transmet ledit signal de trame par le biais de la liaison radio point a point, où ladite liaison radio point à point est une liaison radio SDH/SONET point à point.

9. Appareil selon la revendication 9, **caractérisé en ce qu'**il comprend en outre

n) un tampon (34, 36) pour mémoriser un nombre de paquets et **en ce que** lesdits moyens de mise en correspondance en outre :
o) forment au moins un paquet nul ayant un format qui est le même que ledit format desdits paquets de signaux Fast Ethernet, et
p) remplissent complètement ledit Conteneur virtuel unique (VC-4) avec des paquets mémorisés et avec au moins un paquet nul.

10. Appareil selon la revendication 8, **caractérisé en ce qu'**il comprend en outre un moyen d'ajout d'un en-tête de paquet à chacun des paquets de signaux Fast Ethernet et des paquets de signaux plésiochrones pour identifier leur source d'origine (100 BASE-T).

11. Appareil selon la revendication 8, **caractérisé en ce qu'**il comprend en outre un moyen d'insertion d'une estampille temporelle indicative de la fréquence d'échantillonnage et de transmission de celle-ci avec la trame de signal.

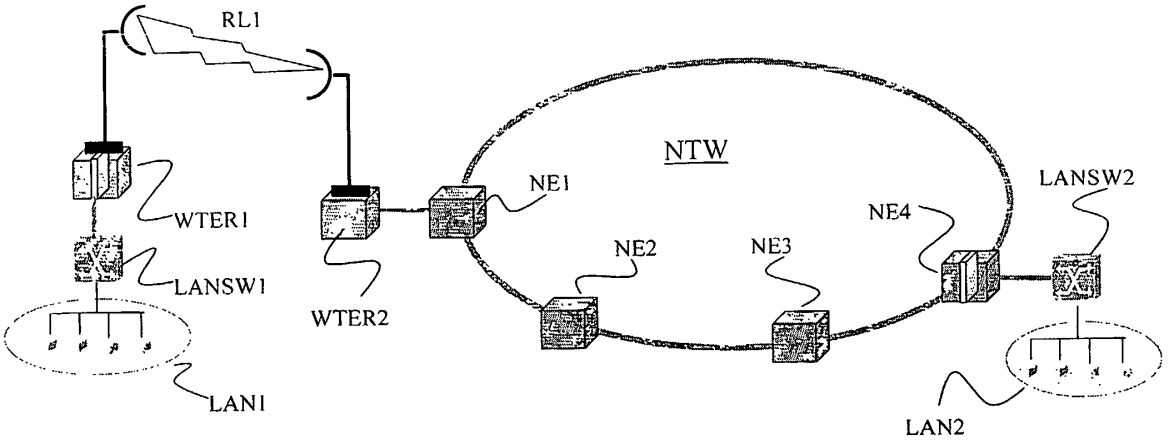
RL1
WTER1
LANSW1
LAN1
WTER2
NTW
NE1
NE2
NE3
NE4
LANSW2
LAN2

Fig. 1

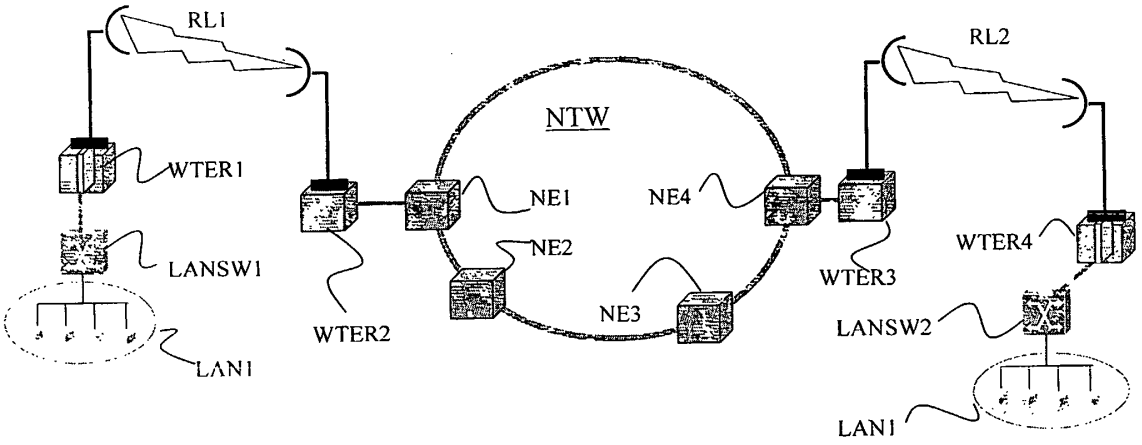
RL1
WTER1
LANSW1
LAN1
WTER2
NTW
NE1
NE2
NE3
NE4
RL2
WTER3
WTER4
LANSW2
LAN1

Fig. 2

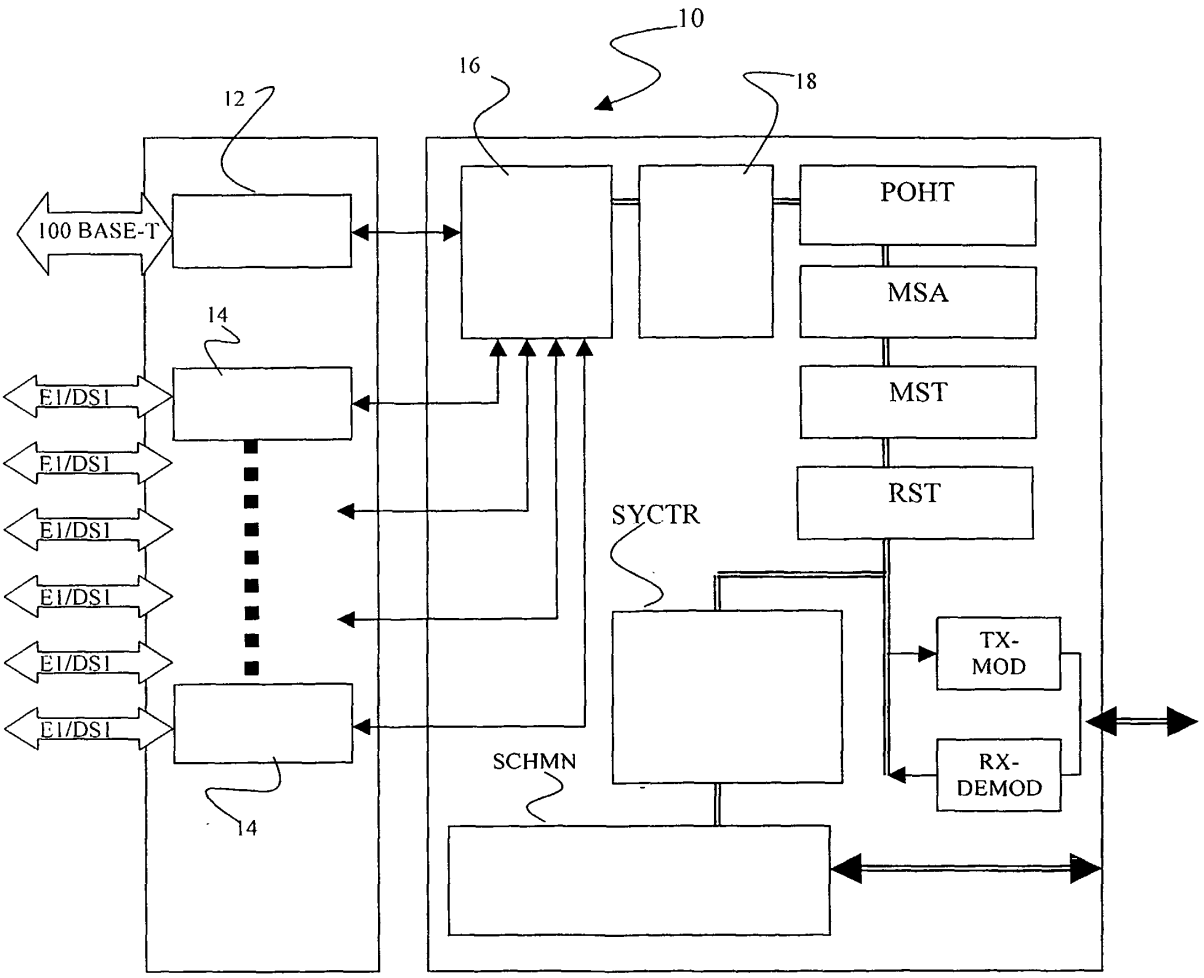
10
16
18
12
100 BASE-T
14
E1/DS1
E1/DS1
E1/DS1
E1/DS1
E1/DS1
E1/DS1
14
POHT
MSA
MST
RST
SYCTR
TX-
MOD
RX-
DEMOD
SCHMN

Fig. 3

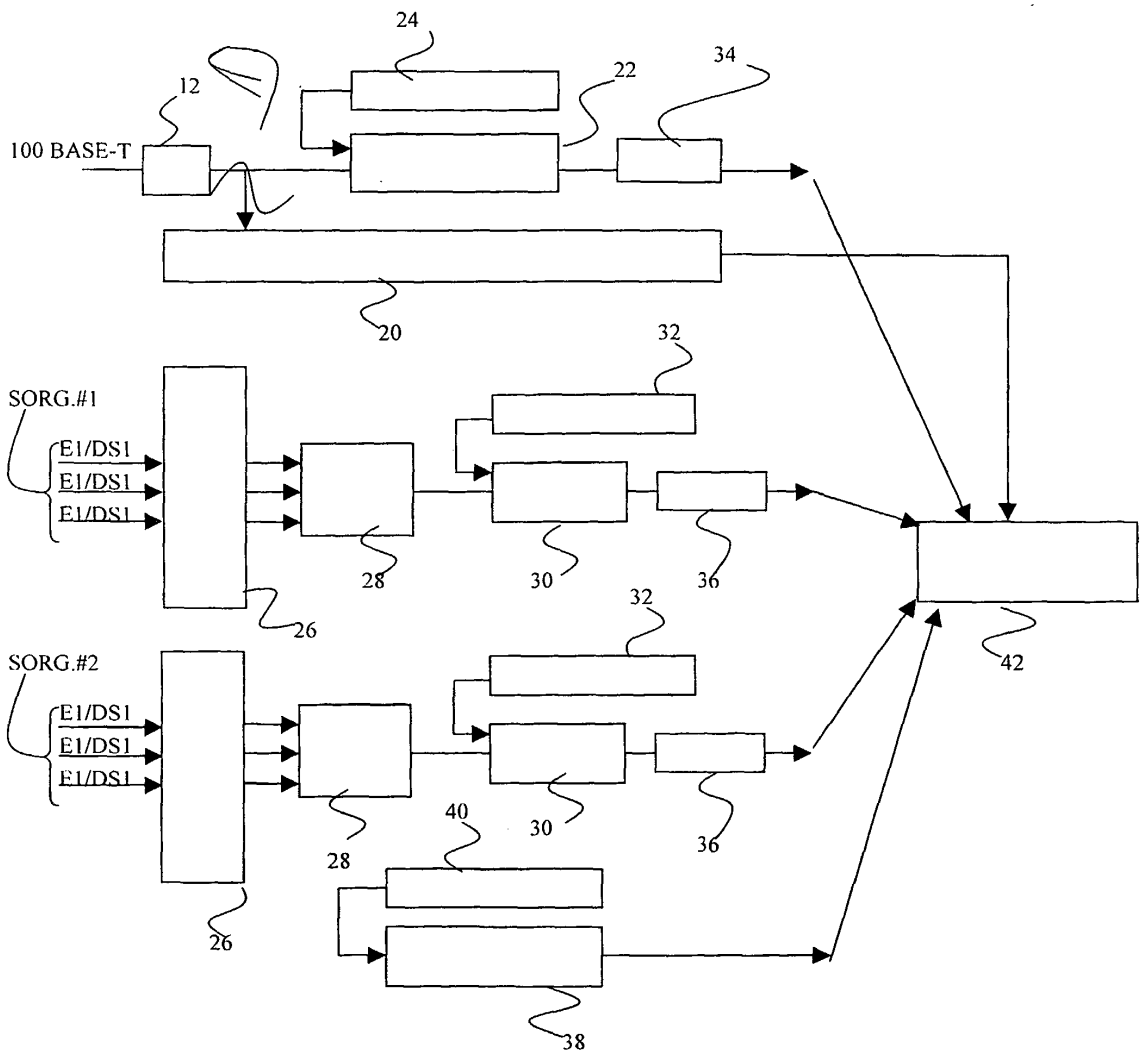
24
12
22
34
100 BASE-T
20
32
SORG.#1
E1/DS1
E1/DS1
E1/DS1
28
30
36
26
32
SORG.#2
E1/DS1
E1/DS1
E1/DS1
40
28
30
36
26
38
42

Fig. 4

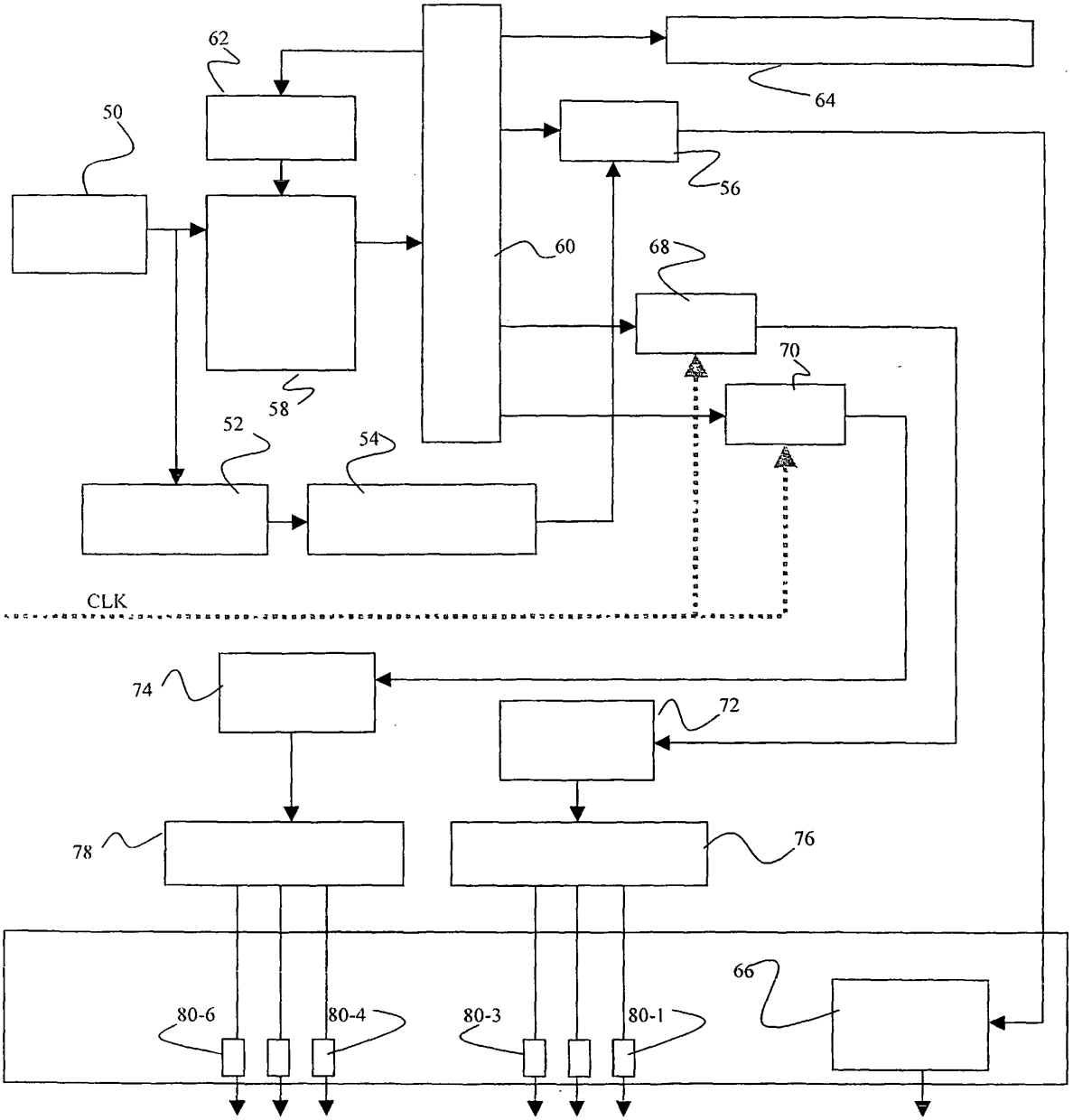

Fig. 5

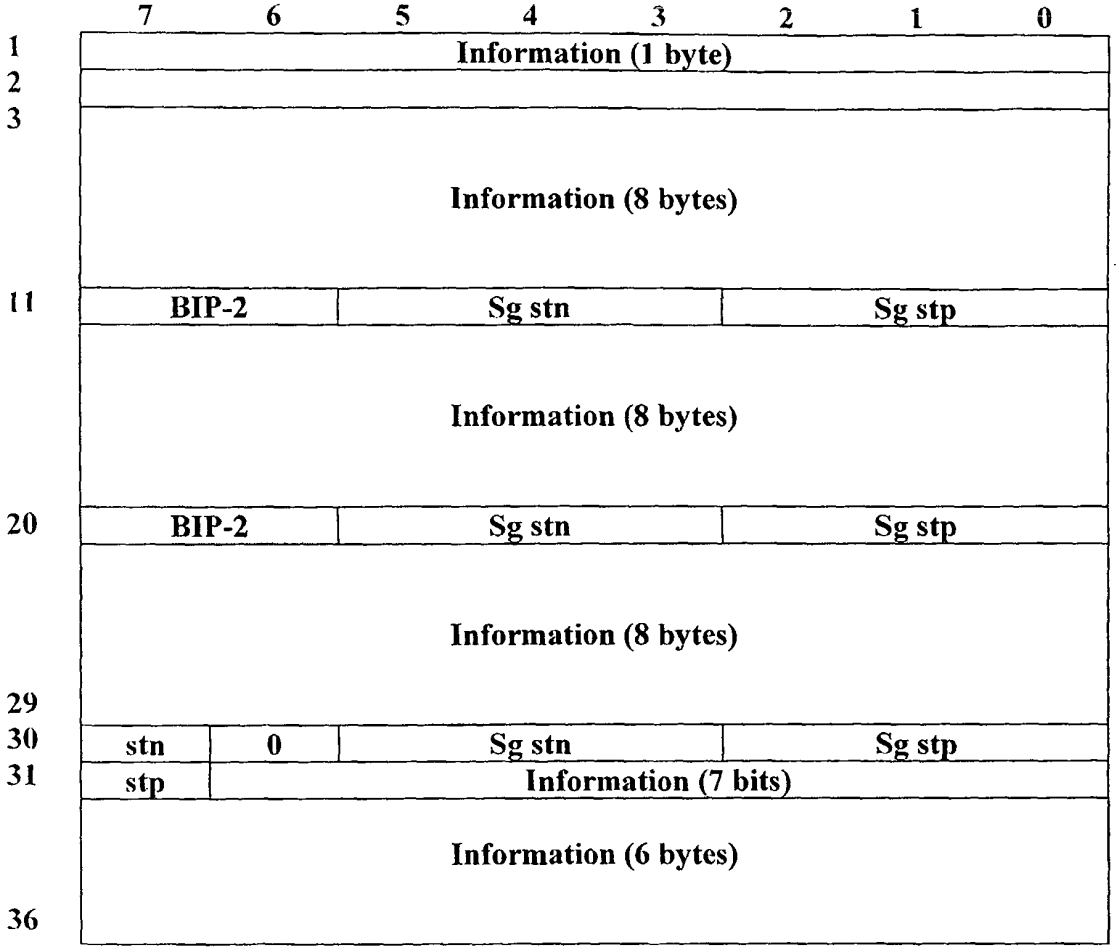
7 6 5 4 3 2 1 0
1
2
3
Information (1 byte)
Information (8 bytes)
11
BIP-2
Sg stn
Sg stp
Information (8 bytes)
20
BIP-2
Sg stn
Sg stp
Information (8 bytes)
29
30
stn
0
Sg stn
Sg stp
31
stp
Information (7 bits)
Information (6 bytes)
36

Fig. 6

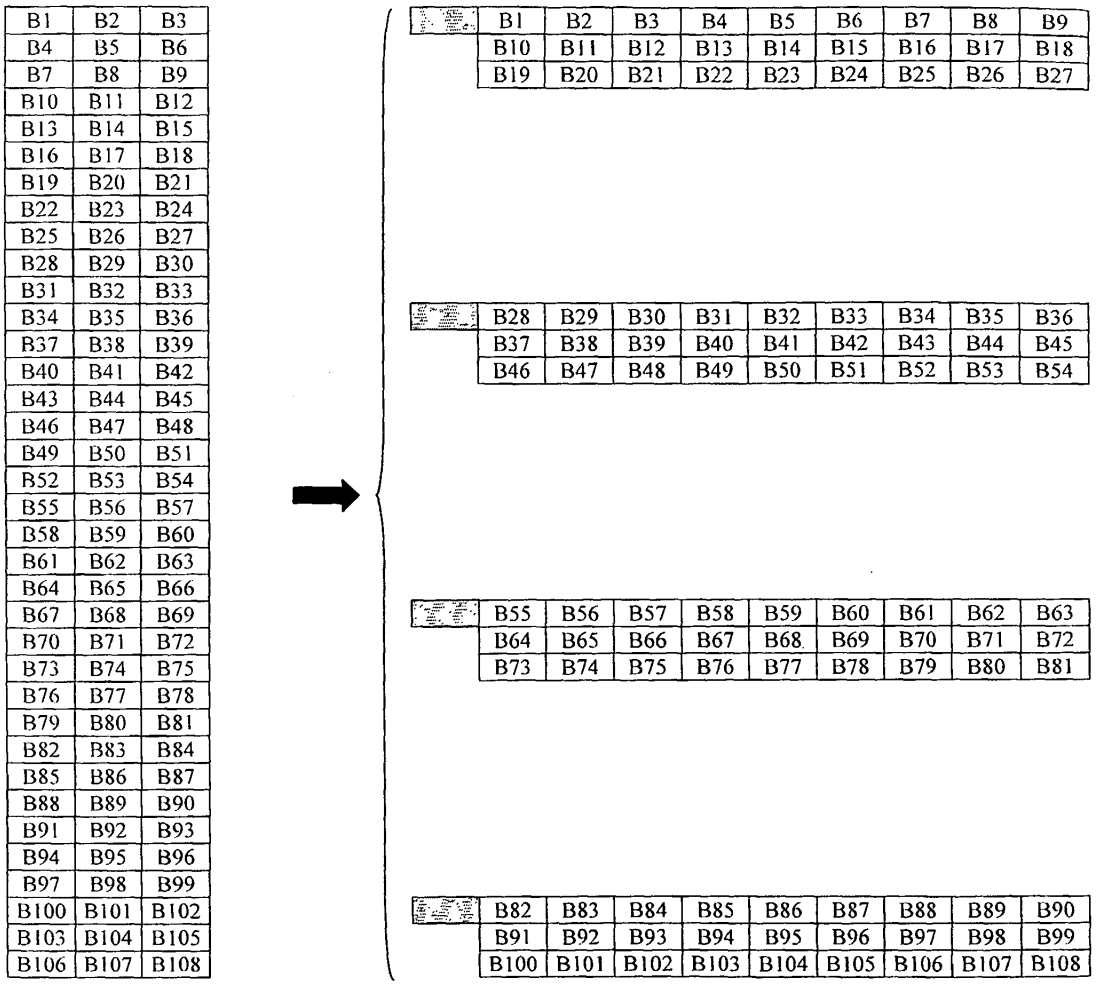
B1 B2 B3
B4 B5 B6
B7 B8 B9
B10 B11 B12
B13 B14 B15
B16 B17 B18
B19 B20 B21
B22 B23 B24
B25 B26 B27
B28 B29 B30
B31 B32 B33
B34 B35 B36
B37 B38 B39
B40 B41 B42
B43 B44 B45
B46 B47 B48
B49 B50 B51
B52 B53 B54
B55 B56 B57
B58 B59 B60
B61 B62 B63
B64 B65 B66
B67 B68 B69
B70 B71 B72
B73 B74 B75
B76 B77 B78
B79 B80 B81
B82 B83 B84
B85 B86 B87
B88 B89 B90
B91 B92 B93
B94 B95 B96
B97 B98 B99
B100 B101 B102
B103 B104 B105
B106 B107 B108
B1 B2 B3 B4 B5 B6 B7 B8 B9
B10 B11 B12 B13 B14 B15 B16 B17 B18
B19 B20 B21 B22 B23 B24 B25 B26 B27
B28 B29 B30 B31 B32 B33 B34 B35 B36
B37 B38 B39 B40 B41 B42 B43 B44 B45
B46 B47 B48 B49 B50 B51 B52 B53 B54
B55 B56 B57 B58 B59 B60 B61 B62 B63
B64 B65 B66 B67 B68 B69 B70 B71 B72
B73 B74 B75 B76 B77 B78 B79 B80 B81
B82 B83 B84 B85 B86 B87 B88 B89 B90
B91 B92 B93 B94 B95 B96 B97 B98 B99
B100 B101 B102 B103 B104 B105 B106 B107 B108

Fig. 7

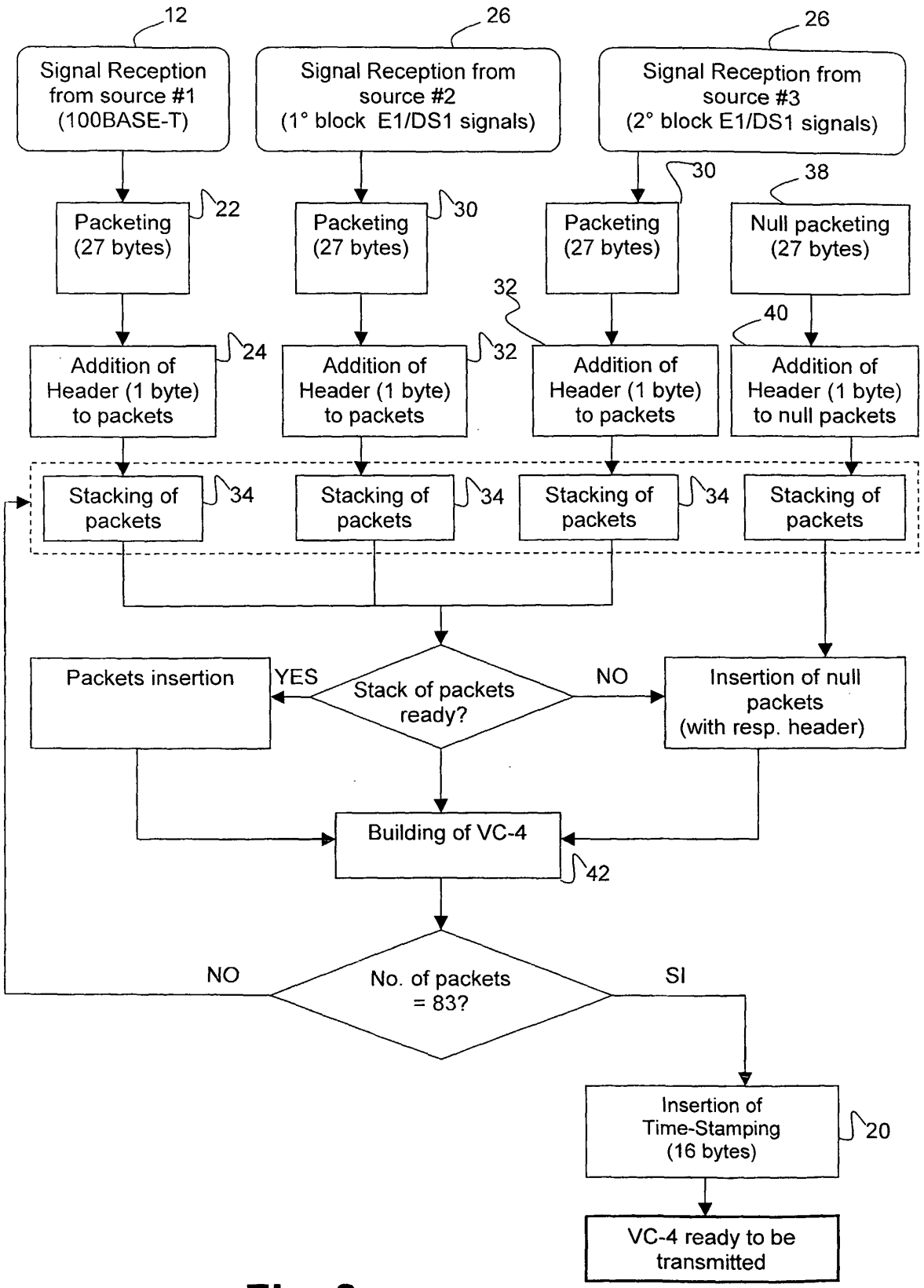
12
Signal Reception from source #1 (100BASE-T)
26
Signal Reception from source #2 (1° block E1/DS1 signals)
26
Signal Reception from source #3 (2° block E1/DS1 signals)
30
38
Packeting (27 bytes)
22
Packeting (27 bytes)
30
Packeting (27 bytes)
Null packeting (27 bytes)
32
40
Addition of Header (1 byte) to packets
24
Addition of Header (1 byte) to packets
32
Addition of Header (1 byte) to packets
Addition of Header (1 byte) to null packets
Stacking of packets
34
Stacking of packets
34
Stacking of packets
34
Stacking of packets
Packets insertion
YES
Stack of packets ready?
NO
Insertion of null packets (with resp. header)
Building of VC-4
42
NO
No. of packets = 83?
SI
Insertion of Time-Stamping (16 bytes)
20
VC-4 ready to be transmitted

Fig. 8

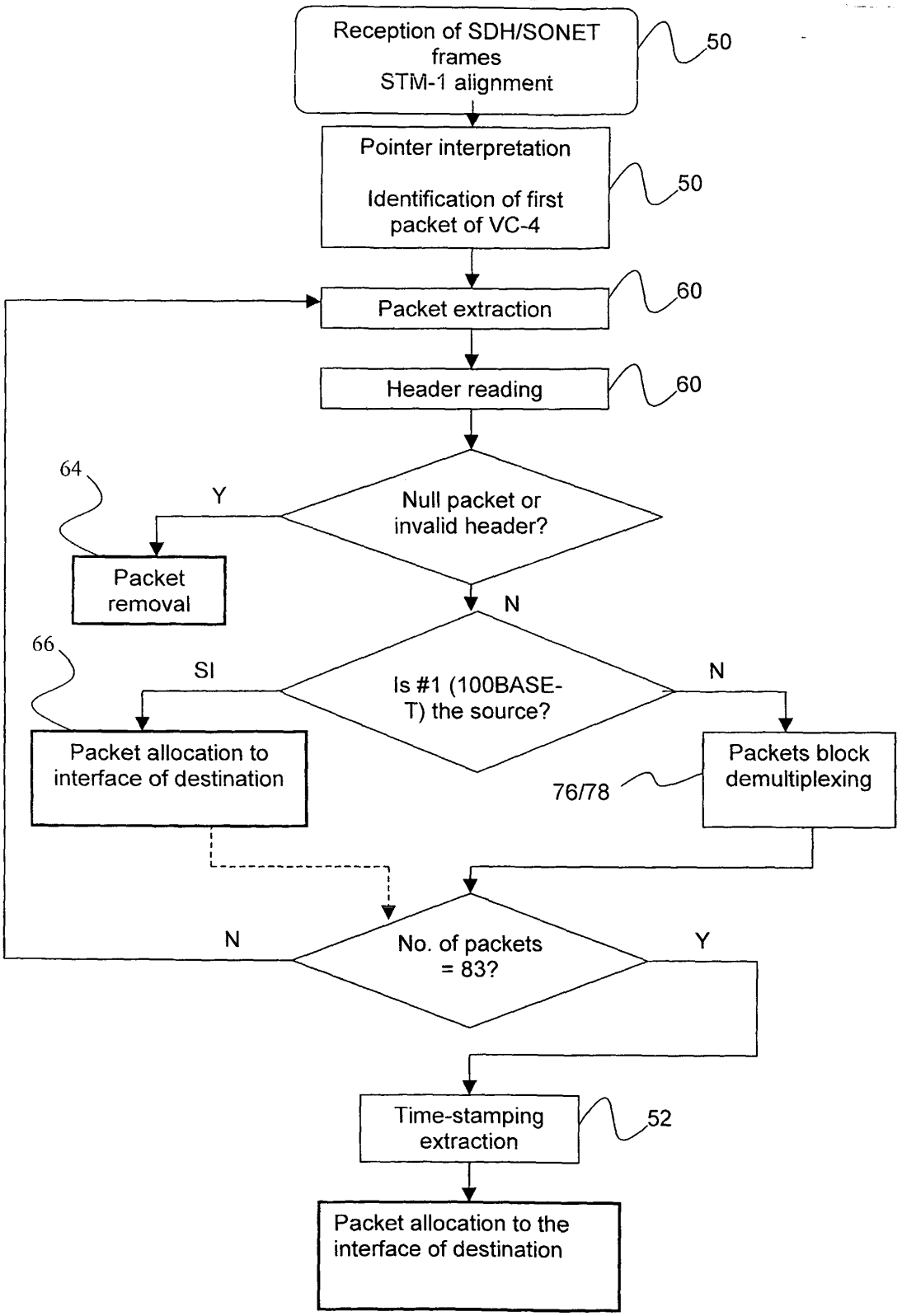
Reception of SDH/SONET frames
STM-1 alignment
50
Pointer interpretation
Identification of first packet of VC-4
50
Packet extraction
60
Header reading
60
64
Y
Null packet or invalid header?
Packet removal
N
66
SI
Is #1 (100BASE-T) the source?
N
Packet allocation to interface of destination
76/78
Packets block demultiplexing
N
No. of packets = 83?
Y
Time-stamping extraction
52
Packet allocation to the interface of destination

Fig. 9

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 0982969 A **[0006]**

Non-patent literature cited in the description

- ARCHITECTURES AND FUNCTIONAL ASPECTS OF RADIO RELAY SYSTEMS FOR SDH NETWORKS. **CARLISLE C J et al.** PROCEEDINGS OF THE GLOBAL TELECOMMUNICATIONS CONFERENCE. (GLOBECOM. IEEE, 02 December 1991, vol. 2, 856-860 **[0007]**