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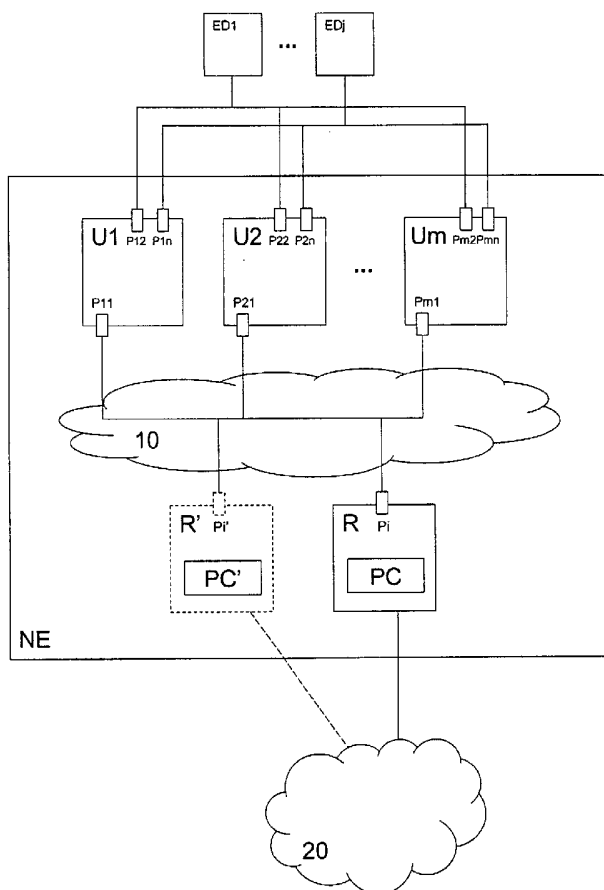
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(54) Title: LAN-BASED INTER-UNIT COMMUNICATION



(57) Abstract: The present invention relates to a network element and an associated method, which facilitates communication of data frames between elemental devices (U1-Um) of a network element by using an LAN-based link system. Data applied to a port of a multi-port interface converter is formatted into a data frame which may selectively include a Q Tag Prefix populated with a VID (Virtual LAN Identifier) defined in the IEEE 802.1Q standard. If the data to be communicated by the multi-port interface converter is originated at the converter, the data is formatted into a data frame, but the prefix structure is not included, and therefore the frame is not populated with the VID. When the data frame is received at the router device, detection is made as to whether the data frame includes a prefix structure. Routing of the data of the data frame is made responsive to whether the prefix structure is formed of a VID contained in the data frame. Furthermore, an activity state of active and non-active units can be signaled using the proposed LAN-based link system. Thereby, communication between elemental devices of a network element can be facilitated and complexity can be reduced.

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LAN-based Inter-Unit CommunicationFIELD OF THE INVENTION

The present invention relates to a network element having at least two elemental devices connected to a link system to selectively communicate a payload data stream and a management data stream upon a common transport stream.

- 5 Furthermore, the present invention relates to a corresponding method of communication.

BACKGROUND OF THE INVENTION

- 10 Network elements like routers, transport engines, e.g. base stations of cellular networks, or the like of communication or data networks may be of a multiple-device architecture comprising several internal units, subunits or elemental devices, such as forming parts of their internal architecture.
- 15 Conventionally, several backplane connections have been provided for interconnecting the elemental devices of such network elements to transmit payload-controlling and management data between the elemental devices. The transmission interface device comprises an interface converter having external ports to which data is applied. Data generated external to the elemental devices
- 20 and applied thereto as well as data generated internal to the elemental devices might need to be communicated between the elemental devices. Both the externally-generated data like payload from and to a user terminal and the internally-generated data, such as data used for management purposes, have to be exchanged between the elemental devices of the network element. When a
- 25 common interface is used for all kinds of data, each of the elemental devices must

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be able to determine whether the data transmitted via the common interface is externally-generated data or internally-generated data. While proprietary interfaces and protocols can be provided by which to facilitate the determination, such use typically would increase the cost and complexity of the system.

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Network elements also sometimes utilize redundant elemental devices when operations performed at such units are essential for element operation. Intelligent routers in network elements, for instance, are essential to operation of the network element and are installed in the network element. In the event of failure of a primary router, an alternate router is used to perform the operations normally performed by the primary router. Thereby, operation of the network continues. The term "protection" is sometimes utilized to indicate that a network service is ensured to continue even if a portion of the network which provides the service is not working properly. Use of redundant components, such as a redundant router, provides such protection.

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Equipment protection treats defects that are localized in a node or network element. The use of redundant, spare circuitry, compensates for, or replaces, failed components and protect equipment.

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Network elements operable in a telecommunication network are constructed to meet operational standards, defined in terms of availability and mean time between failures. The requirements are generally fairly strict. For instance, network operators of public networks regularly require system availability around 99.99 percent of the time. Redundant devices are used to fulfill such requirements. One elemental device, referred to as an active device, is normally working, and another device, referred to as a redundant device, merely controls, or monitors, the active device while the active device is operable. If the redundant device unit determines that the active device is not working well enough, the redundant device becomes the active device and takes over the functionality of the active unit. Protection

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switching is involved in the changeover of operations from the active device to the redundant device. Protection switching occurs, normally, very quickly and does not have any impact on the overall functionality of the functional operations performed by the active and redundant devices. Conventionally, physically-separated
5 signaling cables are used for communication between the active and redundant devices. However, the use of such separate cables, in addition to a payload link, or other network path, increases hardware costs as a result of use of a non-standardized connecting device, and associated implementing apparatus.

10 SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a network element and an associated method, by which communication of data between elemental
15 devices can be facilitated.

This object is achieved by a network element having a first elemental device and at least a second elemental device, said first and second elemental devices being connected together via a link system to selectively communicate a payload data stream and a management data stream upon a common transport stream, said first
20 elemental device comprising:

- frame encapsulating means arranged to receive data to be communicated to a selected one of said at least one second elemental device, and to format said received data into frames related to said common transport stream; and
- communication means coupled to said frame encapsulating means to receive
25 said common transport stream, said communication means being arranged to use a device-specific address for forwarding frames received from said frame encapsulating means to said selected elemental device via said link system.

Furthermore, the above object is achieved by a network element having a first
30 elemental device set into an active state, and a second elemental device set into

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an inactive state, said first and second elemental devices being connected to a link system used for selectively communicating a payload data stream and a management data stream upon a common transport stream, said second elemental device comprising:

- 5 - detecting means arranged to detect whether said first elemental device (R) is working properly;
- protection control means coupled to said detecting means and arranged to set said second elemental device into the active state in response to an output of said detecting means; and
- 10 - signaling means for signaling an information indicating said active state via said link system using said common transport stream.

Additionally, the above object is achieved by a method for communicating in a network element having a first elemental device and at least second elemental

- 15 device, said first and at least second elemental devices being connected together via a link system, said method comprising the steps of:
 - receiving data to be communicated to a selected one of said at least one second elemental device, and formatting said received data into frames related to a common transport stream used on said link system; and
 - 20 - using a device-specific address for forwarding frames to said selected elemental device via said link system.

Accordingly, a manner is provided by which to form a known standard compliant Ethernet point-to-point link for communication between two, or more, elemental

- 25 devices of the multiple-device network element. A standard Ethernet protocol, e.g. as defined in the IEEE 802.3 standard, can thus be utilized which permits the multi-device network element to be of reduced complexity and cost in contrast to a corresponding network element which utilizes common backplane links. Because a standard, rather than proprietary protocol is utilized, the multi-device network

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element can be of reduced cost and complexity relative to a corresponding network element utilizing a proprietary protocol and interface.

- 5 Data to be communicated by a first elemental device to a second elemental device by way of an Ethernet connection is encapsulated in different Ethernet frames. For complete device communication the elemental devices may only be connected via standard compliant Ethernet point-to-point links, using a unique Ethernet MAC (Media Access Control) address for each device.
- 10 The Ethernet connection may transmit both as Ethernet frames for exchanging common payload data and as special Ethernet frames for exchanging management information to avoid separate management network connections. To distinguish between data originated from or destined during communication, the network element may be arranged as a complete Virtual Local Area Network
- 15 (VLAN) with Ethernet or other LAN links. Each elemental device may thus contain VLAN processor means with a frame encapsulator for inserting a tag control information field, e.g. a so-called Q Tag Prefix, in the header of such frames originated from or destined to different physical interfaces. The Q Tag Prefix may include a VID (Virtual LAN Identifier) that identifies the origin of the data
- 20 encapsulated into the frame defined pursuant to the IEEE 802.1Q standard.

- Furthermore, the data encapsulated into the frame may be originated at one of the elemental devices. In this case, it is not necessary to insert the Q Tag Prefix, or analogous structure, with the VID into the frame. A conventional non-tagged frame
- 25 can be used for transmission of that data. When received at an elemental device, a detector may search for the Q Tag Prefix, or analogous structure. When analysis detects the absence of the Q Tag Prefix, the second elemental device may determine the data contained in the frame to have been originated at the first elemental device. When frames are communicated pursuant to an inter unit

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communication, the Q Tag Prefix with the VID is not necessarily available for examination. Such frames may be used directly for management purposes.

Conversely, when the data encapsulated into the frame is generated external to the first elemental device and, for instance, applied thereto by way of an external port of an elemental device, the Q Tag Prefix, or other tag header field, can be populated with a value of a VID. The value may be selected to correspond with the external port at which the data is applied to the first elemental device. The data frame is communicated upon the internal LAN connection to the second elemental device. When received at the second elemental device, analysis may be made of the Q Tag Prefix to determine whether the field is populated with the value of the VID. When detected, this value indicates the data to define the destination interface. The VID thus identifies the external port at which the data is applied to the elemental device.

When the data frame is received at the destination device, analysis of the frame structure regarding a Q Tag Prefix is made. If the frame contains a Q Tag Prefix populated with a VID, the data contained in the frame may be passed on to the corresponding destination point.

Communication may be effectuated between a multi-port interface converter and a router provided in the network element. External data is selectably applied to external ports of the multi-port interface converter. And, internally-generated data, such as management information, may be generated at the interface converter. A VLAN processor of the interface converter encapsulates data into a data frame and selectably populates a Q Tag Prefix, e.g., defined by the IEEE 802.1Q standard, with a VID, defined by the IEEE 802.1Q standard. A VID is associated with each of the external ports to which external data is selectably applied to the converter. When the data encapsulated into a data frame is externally-generated data, the Q Tag Prefix is populated with the VID associated with the external port at which the

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data is applied. If, conversely, the data is internally-generated, the Q Tag Prefix may not be populated with a VID or in a specific advantageous embodiment of invention conventionally Ethernet frames, e.g. according IEEE 802.3, are used. The prefix structure not necessarily has to be removed in cases of internal traffic. It
5 may as well be left empty or it may indicate other addresses used for internal forwarding and/or processing. Once encapsulated into a data frame, the data frame is communicated upon an LAN connection to the router, and the Q Tag Prefix is analyzed to determine the origination and destination of the data of the data frame. Data originated at, or applied to, the router is analogously
10 encapsulated and communicated to the converter.

Because a standard LAN protocol, the IEEE 802.1Q protocol, can be utilized, a proprietary protocol and corresponding interface need not be developed and used. A network element formed of elemental devices, can therefore be constructed less
15 expensively and with less complexity than would otherwise be required of a corresponding element.

In another aspect of the present invention, a manner is provided by which to signal the protection state of redundant units to indicate the status of individual ones of
20 the redundant units. The signaling is generated to indicate whether a unit is on active status or is in a stand-by status. The signaling information flows are generated by way of the same internal link system, e.g. local area network (LAN) such as Ethernet, or any other network pathway, between the redundant units. Periodic, added message frames, e.g. Ethernet frames, are used. When the
25 redundant units are formed of an active router unit and a stand-by router unit in an IP network, separate multi-interface units have an LAN connection, e.g. an Ethernet connection.

In these and other aspects, therefore, apparatus, and an associated method, is
30 provided for a network element having several elemental devices. At least two

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elemental devices, respectively, are connected together by a link system or structure. A frame encapsulator receives data to be communicated to the other elemental device. The frame encapsulator frame-formats the data into a data frame. The data frame has a header portion and a data portion. To identify
5 different data sources the header portion includes a prefix structure, such as a Q Tag Prefix, populated with a tag header. The tag header field formed of a Q Tag Prefix is not a specific, reserved field, but rather is a prefix inserted at a well defined location of the header portion. The data frame, once formed, is for communication via the link system to the second elemental device. The prefix
10 structure may as well be omitted for internal data traffic.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described on the basis of preferred embodiments
15 with reference to the accompanying drawings, in which:

Fig. 1 shows a schematic functional block diagram of a network element with elemental devices, according to first and second embodiments of the present invention;
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Fig. 2 shows a schematic functional block diagram of an elemental device according to the first preferred embodiment;

Fig. 3 shows a representation of a tagged frame structure of a frame formed
25 pursuant to IEEE 802.1Q;

Fig. 4 shows a schematic functional block diagram of representative of a protection switching function between an active device and a spare device; and

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Fig. 6 shows a schematic flow diagram of the protection switching function according to the second preferred embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

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The preferred embodiments relate to traffic communication between internal elemental devices (Units) of a multiple-devices network element NE, like an intelligent router, and at least one transport engine or other external entity ED1 to EDj, e.g. a base station.

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Fig. 1 shows a schematic block diagram of such a network element NE according to the first preferred embodiment. For the internal data flow, the network element NE comprises an Ethernet LAN structure 10. From IP (Internet Protocol) point of view, this LAN 10 will be regarded as a single IP sub-net. According the invention, all elemental devices U1 to Um are only connected via standard compliant Ethernet point-to-point links, e.g. standardized fast Ethernet or G bit/s Ethernet, for complete communication between the elemental devices U1-Um. Thereby, the use of additional dedicated links performing a separate management network can be avoided.

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A dedicated MAC address unique for each of the elemental device U1-Um is used to exchange every kind of information via this links of the LAN 10. Especially, control packets, e.g. Inter Unit (Device) Communication and Network Management Information, are combined with payload traffic originated and addressed to entities, e.g. the external entities ED1 to EDn, connected via a bus system or other network system, or to an IP network 20, external to the multiple-devices network element NE to one common transport stream between each device pair. Each of the elemental devices U1 to Um comprises a plurality of addressable ports Pi1-Pin to enable dedicated data flows via the LAN 10 or to the external entities ED1 to EDj, respectively. In the preferred embodiments, the elemental devices U1 to Um can

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be regarded as interface units or multi-interface converters connected optically or electrically at their external ports P12-P1n, P22-P2n and Pm2-Pmn via respective links, e.g. SDH lines, to the external entities ED1 to EDj which may be base stations, radio stations or transceivers for RF transmission links, private sub-
5 networks connected via E1 or E3 lines, or Wireless LANs.

Furthermore, the multiple-device network element NE comprises an active unit R and a corresponding optional inactive unit R' in a stand-by state, each connected via at least one addressable port Pi and Pi', respectively, to said LAN 10. The
10 active and inactive units R, R' are identical or replaceable versions of a critical unit, e.g. a router unit, which has to be protected and is thus duplicated for redundancy reasons. It is noted that with respect to the data communication over the LAN 10, the active and inactive devices R, R' can be regarded as elemental devices similar to the elemental devices U1 to Um but with a specific function, e.g. a routing
15 function.

Fig. 2 shows a schematic block diagram of the elemental device U1 of Fig. 1, which structure corresponds to all other elemental devices U2 to Um. The elemental device U1 comprises an adding functionality 150 for adding information
20 packets generated by an internal information source 170 to an externally originated information. Furthermore, an extracting functionality 110 is provided for extracting a received information and forwarding it to different internal or external reception points 140. Especially, when the multiple-devices network element NE has an equipment protection by redundant units, such as the active and inactive units R,
25 R', all traffic between the protected active unit R and the other inactive stand-by unit R' can be exchanged without requiring any additional links.

In other words, the LAN 10 provides a kind of multiplexing functionality for data traffic originated in different external and internal entities. Additional to payload
30 traffic, control traffic such as Inter Device Communication and Management

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information can be exchanged internally between the elemental devices U1-Um and/or redundant units R, R'. All traffic can be exchanged in both directions.

5 In the preferred embodiments, an Ethernet LAN 10 is used which provides only unique Ethernet MAC addresses for each port of the elemental devices U1-Um and redundant units R, R'.

10 This addressing mechanism enables the IP layer or network layer to distinguish between different interfaces during communication. E.g., when a multi-interface converter of a base station communicates with several networks.

15 In particular, a VLAN (virtual LAN) architecture known from IEEE 802.1Q standard can be 'misused' as a multiplex layer. Known VLANs use frames containing a tag header field with VLAN IDs (VIDs). For data transmission on a single Ethernet link the VID is used to address different IP data stream packets. Each stream is originated from or destined to a different physical interface or port on a unit, as determined by its own unique MAC address. An assigned VID determines each logical interface on a Unit. Logical interfaces can be an SDH (Synchronous Digital Hierarchy) interface or a single PDH (Plesiochronous Digital Hierarchy) interface.

20 In these cases it is also a physical interface with PPP (Point-to-Point Protocol) as layer 2, or it can be an ATM PVC (Asynchronous Transfer Mode Permanent Virtual Circuit) or a couple of PDH interfaces bound together by Multi link-PPP.

25 Furthermore, an encapsulating functionality 160 in each elemental device U1-Um encapsulates all data to be transmitted via the Ethernet link into an Ethernet frame using the destination MAC Address of the selected destination unit. The elemental devices U1-Um add at least in all frames of data assigned to an external interface the mentioned tag headers with VIDs according IEEE 802.1Q.

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Additionally, each of the elemental device U1-U_m contains an analyzing functionality 120 for analyzing and reading the header of data frames received via an interface functionality 130. After recognition of a tagged frame the analyzing functionality 120 reads the VID. Based on the VID the associated port will be used
5 for forwarding these frames to the destination points to further processing.

In the preferred embodiment, untagged frames can be used for traffic between communicating unit pairs itself. In such case the data stream on the Ethernet link of the LAN 10 contains tagged and non-tagged Ethernet frames. Data transmitted
10 with a non-tagged Ethernet frame can be directly passed to the next layer indicating that it has been originated in the sending unit itself and was received via the Ethernet link. The unit software will interpret a non-tagged frame as inter-unit communication directly used for management purposes. This is advantageous in that when the respective elemental device is connected with a conventional unit
15 without VLAN it works limited by using the inter-unit communication feature only. The presence of a so-called QTag prefix is already indicating, that the data has been received via an external interface. The VID in the QTag prefix is used to define the destination interface. Neither the existence of the QTag prefix nor the VID give any information related to the originating layer of the data.
20 However, internal generated data, e.g. management data of the originating device, can have a QTag prefix. But, it is advantageous if they are non-tagged. Ethernet frames do not have a specific field reserved for the QTag prefix. It is inserted at a well defined place into the Ethernet header. A tagged frame is thus larger than a non- tagged one transporting the same data.

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The ports P₁₁-P_{m1} of the elemental devices U1 to U_m and the port P_i of the router unit R are connecting ports for forming an Ethernet connection e.g. with a corresponding port P_i of the router unit R. The frame format used on the Ethernet connection is Ethernet, specified by the IEEE 802.3 standard specification. The
30 ports P₁₂-P_{1n}, P₂₂-P_{2n} and P_{m2}-P_{m_n} form external data ports permitting

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exchange of data with the external entities ED1-EDj external of the network element NE. According the preferred embodiments, each elemental device includes a VLAN processor which provides the functionalities indicated in Fig. 2.

The VLAN processor can be implemented in any desired manner. For instance, the
5 VLAN processor can be implemented alternately as a hardware device, a software device, or a combination of both devices. The processor is coupled to each of the ports P_{i1} - P_{in} ($i=1$ to m) and P_i .

The VLAN processor is further coupled to receive internally-generated data
10 generated within each elemental device and which is also frame-formatted to be encapsulated in frames different from the remaining data traffic thereby.

Each of the external ports P_{12} - P_{1n} , P_{22} - P_{2n} and P_{m2} - P_{mn} is identified with a VID. When data is applied to any of these ports, the data is encapsulated into a
15 frame format by the frame encapsulating functionality 160 of the VLAN processor. The identity of the port at which the data is applied, in terms of the VID, is also provided to the VLAN processor. To identify the different frames of the external ports P_{12} - P_{1n} , P_{22} - P_{2n} and P_{m2} - P_{mn} in the data stream between the elemental devices U_1 to U_m , the frame encapsulating functionality 160 tags the
20 corresponding frames and inserts the VID allocated to the origin source in the Q-tag prefix.

All kinds of data frames encapsulated by the frame encapsulating functionality 160 are provided to a respective port and communicated upon the Ethernet connection
25 to the router unit R. The router unit R also includes a VLAN processor to which the data frames are applied. The analyzing functionality 120 of the router unit R searches for tagged frames and reads the VID contained within the header portion of the frame to determine to which logical layer 3 interface the frame should be routed. Here, the data destination can be for the router unit R itself, to another
30 location within the network element NE, or the frame is to be forwarded to another

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external location, here indicated by the external entities ED1-EDj and the IP network 20. A forwarding decision to forward the data frame is made, for instance, responsive to the VID contained in a tagged frame, and the frame is thereafter sent by way of another interface (not shown). And, once delivered to the appropriate
5 layer 3 interface element, routing of forwarding decisions are made responsive to information, here VID, within the received data.

As two-way communication is permitted between the respective devices, each VLAN processor includes the frame encapsulating functionality 160 and also the
10 analyzing functionality 120.

Fig. 3 shows a frame structure of a data frame into which data is frame-formatted by the frame encapsulating functionality 160 (shown in Fig. 2). The data frame, shown generally at 102, is exemplary of a tagged data frame according IEEE
15 802.1Q formed of externally-generated data applied to the transport element device to use in a VLAN . The data frame is formatted to include a header portion having after a preamble, not shown, a destination MAC address field 104, a source MAC address field 106, an Ether-type field 108, a tag control information field 112, and a MAC (Media Access Control) length/type field 114. A payload portion
20 includes a data field 116, a PAD field 118 and an Frame Check Sequence FCS field 122. The data format corresponds to a format set forth in the IEEE 802.1Q standard protocol.

The tag control information field 112 includes a Q Tag Prefix 124 at which a VLAN
25 identifier is selectively inserted pursuant to the preferred embodiment of the present invention. Here, when the data encapsulated by the frame encapsulating functionality 160 is originated external to the network element NE at one of the ports P12-P1n, P22-P2n and Pm2-Pmn thereof, the frame encapsulating functionality 160 populates the tag header field 124 with the VID associated with
30 the port at which the data is received.

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According to the preferred embodiments, when the data encapsulated into the frame is exchanged internally, i.e. internal management information, the frame should advantageously not include the Q Tag Prefix or not be populated with a VID
5 value. Subsequent to communication of the data frames to the router unit R, the analyzation functionality 120 thereof searches in each received data frame for a Q Tag Prefix to determine the origin of the data frame. If the received data are not tagged or a Q Tag Prefix is not populated with a VID, the data contained in the frame is known, thereby, to have been originated at the respective elemental
10 device for use by the router unit R.

In other words, data received at the ports P12-P1n, P22-P2n and Pm2-Pmn of an elemental device are encapsulated into a tagged Ethernet frame by the frame encapsulating functionality 160 of the respective VLAN processor. The destination
15 address field is populated with the MAC address of the router unit R and a VLAN Q Tag Prefix is inserted into an added tag control information field 112 according to the IEEE 802.1Q protocol utilizing the VID associated with the appropriate port of the elemental device. The Ethernet frame is then communicated upon the Ethernet connection from the respective transmitting port.

20 Conversely, data which is generated at the internal information source 170 of an elemental device is formatted by the frame encapsulating function 160 into a data frame and communicated upon the Ethernet connection from the transmitting port without a VLAN Q Tag Prefix in a "non-tagged" frame. When the Q Tag Prefix of
25 the data frame is not populated with the VID, any other device, which is unaware of any special functionality of the originating device, considers the device to behave as an ordinary device.

When a data frame is detected at the router unit R, whether a tagged or a non-tagged frame, analysis is made to determine whether the Q Tag Prefix includes a
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VID. If the data frame is a non-tagged frame, the data contained therein is directly passed to a next-higher layer, as the data frame is indicated to have been received at the port P_i . If the data frame is a tagged data frame, noted to have been received at the port P_i , then the value of the VID is analyzed. Depending upon the value of the VID, the associated external port P_{12-P1n} , P_{22-P2n} and P_{m2-Pmn} at which the data contained in the data frame is originated is determined, and the data contained in the frame is passed on to a next-higher layer indicating on which port of the originating elemental device the data was received.

10 Communication of data is analogously effectuated at the routing unit R. Data is available in a higher-level layer, here designated as logical layer 3 data. Frame formatting is performed on the data by operation of the VLAN processor and all data frames are communicated from a data port of the device, such as the data port P_i , to a specific destination device, i.e. one of the elemental devices U_1 to U_m .

15 If the destination of data frames originated at the router unit R is one of the elemental devices U_1 to U_m , the data frames are communicated by way of a respective Ethernet connection of the LAN 10 subsequent to frame formatting operations at the VLAN processor. The Q Tag Prefix of the data frame is not populated with a VID, or the frame encapsulating functionality 160 of the router unit R generates a non-tagged frame. In another implementation, the data frame can be populated with a VID which identifies the transport element device. When the data frame is received at the selected elemental device, detection by the analyzing functionality 120 is utilized at the VLAN processor to determine whether a tag header field was inserted and is populated with a VID. If determination is made that the data frame forms a non-tagged data frame, the data is passed on to a higher logic level layer of the selected elemental device for further processing. If, conversely, the destination of the data frame is to a device coupled to the external ports P_{12-P1n} , P_{22-P2n} and P_{m2-Pmn} , then the tag header field is populated with a VID associated with the intended destination.

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The VID is of characteristics specified pursuant to the IEEE 802.1Q standard. The VID is, therefore, of a 12-bit length and is positioned within the tag control information portion of the data frame set forth in the IEEE 802.1Q standard.

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The data contained in the data frames is originated beyond the external interfaces P12-P1n, P22-P2n and Pm2-Pmn, and the Q Tag Prefix is populated with a corresponding VID. Higher-level logical layer data is communicated to the router unit R. As the Q Tag Prefix is populated with a VID, and the data frame is passed
10 on to the higher-level logical layers of the router unit R for further processing thereat.

In the second preferred embodiment, the proposed LAN-based inter-unit communication architecture is used for providing a protection switching
15 functionality. Here, signaling can also be effectuated between redundant elemental devices, formed of an active device, e.g. the router unit R and at least one stand-by device indicated in Fig. 1 as a dotted additional or redundant router unit R'. In particular, the protection or activity state of the redundant devices R, R' is signaled via the LAN 10 to indicate their respective status, i.e., active or stand-by. The
20 signaling information flows by way of the internal Ethernet LAN 10 formed to extend between the redundant devices using periodic, added message Ethernet frames. It is however noted that the protection switching function can be provided for any other critical unit or elemental device of the network element NE.

25 Fig. 4 shows a schematic functional block diagram of the protection switching functionality according to the second preferred embodiment. In order to quickly activate the stand-by router unit R', a protection controller PC' in the stand-by router unit R' controls the active router unit R. Both devices utilize the same MAC- and the same IP-addresses by way of identical ports Pi, Pi' of the respective,
30 connected devices. Both connections are terminated in each multi-interface unit of

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the elemental devices U1 to Um at the same port. If the stand-by router unit R' determines that the active router unit R is not operating adequately, the stand-by router unit R' becomes active and takes over the functions of the active router unit R. That is, the stand-by router unit R' becomes the active unit. A defect of the first
5 active router unit R could affect both of the units, i.e., both the active and stand-by router units, being simultaneously active and the first unit sends incorrect traffic data. Appropriate indication of the correctly working unit in each multi-interface unit is thus needed to execute a protected switchover on its port.

10 Within selected time intervals, all active units send status messages by way of the standardized Ethernet connection of the LAN 10 to indicate their states. The messages are sent in an additional, specific Ethernet frame, different from other data frames. Each message contains a device-related ranking number. A communication between the active router unit R and the stand-by router unit R'
15 performed before the occurrence of a unit defect or mis-operation adjusts the ranking number of the stand-by router unit R' in such a way that the stand-by router unit R' starts sending a ranking number higher than that of the active router unit R when the stand-by router unit R becomes active. If a protected switchover between the redundant units occurs, the multi-interface elemental devices U1 to
20 Um are thus enabled to identify the value traffic from both active units based on the ranking numbers.

Similar to the first preferred embodiment, the signaling information flows also via the internal Ethernet LAN 10 between the units using periodical added message
25 Ethernet frames.

According to Fig. 4, each of the elemental devices U1 to Um is coupled to the router units R, R' by way of Ethernet links L1 and L2, respectively. The Ethernet links L1, L2 are commonly coupled e.g. at the port P11 of the elemental device U1.

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During operation, a message frame comparison functionality 230 of VLAN processor at the respective elemental device U1 must determine which of the Ethernet links L1 or L2 extends to the active router unit R. The determination is made responsive to data received from both of the router units R, R'.

5

In regular time intervals, the active router unit R sends special messages indicating its status as the active router unit. The messages are sent in an Ethernet frame of a different type than that is used to send normal data. The separate data types, therefore, do not interfere. The messages sent by the active router unit R in the Ethernet frame of the different type contain a ranking number RN as a parameter.

10

The comparison functionality 230 determines which of the router units is the active router unit in a two-step procedure. First, the comparison functionality 230 determines whether the special messages that are received are generated by only one of the router units R, R'. If only one of the router units R, R' is sending the special messages, that router unit forms the active router unit. If, however, messages are received from both of the router units R, R' within a common time period, then the active unit to be used for communication is determined to be the router unit that sends a message containing a higher value, or other rated, number in its message. Both router units may send messages when the stand-by router unit R' becomes the active router unit while the previously-active router unit R might well continue to attempt to function as the active router unit.

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When the active router unit R forms the initially-active router device, the stand-by router unit R' acts in a stand-by mode and forms the stand-by router unit. The stand-by router unit R' operates in the stand-by mode to monitor operation of the active router unit R to ensure its proper functioning. The stand-by router unit R' also maintains an awareness of the value of the number in the indication messages sent by the active router unit R. If the stand-by router unit R' determines the active router unit R not to be operating properly, the stand-by router unit R'

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- 20 -

becomes active and takes over operation of the active router functions. The previous stand-by router unit R' indicates its status as the new active router unit by sending indication messages generated by a message generation functionality 210' and added to a data stream generated in a MAC signaling unit 220' to the comparison functionality 230. An updated ranking number RN with a value greater than the value of the number utilized by the previously-active router R is obtained from the protection controller PC' and is added by the message generation functionality 210' to the indication message. If the previously-active router unit R is still sending indication messages, the comparison functionality 230 is still able to determine that the newly-active router unit R' is the active router unit due to the higher value of the ranking number RN in the message.

When the previously-active router unit R is replaced and becomes the new stand-by router unit, the formerly active router unit R becomes operable as the stand-by router unit. If again a protection switching is required, the same procedure is again effectuated.

Fig. 5 shows a schematic flow diagram of the protection switching functionality according to the second preferred embodiment.

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In step 301, the state indication message of the active router unit R is checked by the protection controller PC' of the stand-by router unit R'. If it is determined in step 302 that the active router unit R is working or functioning properly, e.g. without any parameter in a non-admissible range, the stand-by router R' maintains its inactive state. On the other hand, if it is determined in sep 302 that the active router unit R is not working properly, the protection controller PC' of the stand-by router unit R' sets the stand-by router unit R' into the active state and generates a ranking number higher than the ranking number RN of the active router unit R. Based on this higher ranking number RN, the state indication message of the former stand-by router unit R' is generated by the message generation functionality

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210' and added to the signaling stream supplied via the respective Ethernet links to the elemental device U1 and the other elemental devices U2 to Um.

It is noted that the present invention is not restricted to the above preferred
5 embodiments, but can be used in any network element having elemental devices,
to thereby facilitate inter-unit communication. Moreover, any kind of frame-based
network structure can be used as a link system for routing the common transport
stream between the elemental devices, router units, and the like. In particular,
other LAN-standards such as polling-based or token-passing architectures may be
10 used. The preferred embodiments may thus vary within the scope of the attached
claims.

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Claims

1. A network element having at least two elemental device (U1-U_m, R, R'),
said elemental devices being connected together via a link system (10) to
5 selectively communicate a payload data stream and a management data stream
upon a common transport stream, each of said elemental devices comprising:
 - a) frame encapsulating means (160) arranged to receive data to be
communicated to a selected one of said at least two elemental device (U2-U_n), and
to format said received data into frames related to said common transport stream;
10 and
 - b) communication means (130) coupled to said frame encapsulating means
(160) to receive said common transport stream, said communication means being
arranged to use a device-specific address for forwarding frames received from said
frame encapsulating means (160) to said selected elemental device via said link
15 system (10).
2. A network element according to claim 1, further comprising frame analyzing
means (120) coupled to said link system to receive said common-transport-stream
related frames, said frame analyzing means (120) being arranged for recognizing
said device-specific addresses and for selectively forwarding said common-
20 transport-stream related frames responsive thereto.
3. A network element according to claim 1 or 2, wherein said frame
encapsulating means (160) is arranged to generate data frames having a header
portion and a data portion, said header portion selectively including a prefix
structure identifying an entity (ED1-ED_j) which has generated the data of said data
25 frames.

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4. A network element according to claim 3, wherein said link system (10) to which said elemental devices (U1-U_m, R, R') are connected forms a standard-compliant LAN point-to-point link and wherein the data frames into which said frame encapsulating means (160) encapsulates the data comprises LAN frames.

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5. A network element according to claim 4, wherein said standard-complaint LAN is an Ethernet.

6. A network element according to any one of claims 3 to 5, wherein said prefix structure comprises an identifier (VID) of a Virtual Local Area Network.

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7. A network element according to any one of claims 3 to 6, wherein said prefix structure is of a length corresponding to a VID field defined pursuant to an IEEE 802.1Q standard, and wherein said VID comprises an IEEE 802.1Q-defined VID.

15

8. A network element according to any one of claims 3 to 7, wherein said elemental devices (U1-U_m, R, R') comprise at least a first external port (P12-P1_n, P22-P2_n, P_m2-P_m_n) and wherein said entity (ED1-ED_j) is positioned external to said elemental devices (U1-U_m) and coupled to said first external port (P12-P1_n, P22-P2_n and P_m2-P_m_n) thereof, and wherein said prefix structure identifies said first external port (P12-P1_n, P22-P2_n and P_m2-P_m_n) to which said entity is coupled.

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9. A network element according to claim 8, wherein said elemental devices (U1-U_m, R, R') comprise a packet-data interface conversion means (130), wherein said entity comprises a packet data source, and wherein said prefix structure identifies said first external port (P12-P1_n, P22-P2_n and P_m2-P_m_n) as a configuration parameter.

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10. A network element according to any one of claims 8 or 9, wherein said frame encapsulating means (160) is embodied in a Virtual LAN processor.

11. A network element according to any one of claims 3 to 10, wherein the data
5 of said data frames is defined in terms of logical layers comprising at least one lower-level logical layer and at least one higher-level logical layer, and wherein the data formatted by said frame encapsulating means (160) comprises data formed of said at least one higher-level logical layer

10 12. A network element according to any one of claims 3 to 11, wherein said elemental devices (U1-U_m, R, R') comprise an output port (P₁₁-P_{m1}, P_i, P_{i'}) coupled to said link system (10), wherein said elemental devices (U1) comprise an input port (P₁₁-P_{m1}, P_i, P_{i'}) coupled to said link system (10), and wherein said data frames formed by said frame encapsulating means (160) are provided to said
15 output port (P₁₁-P_{m1}, P_i, P_{i'}) of said elemental devices (U1-U_m, R, R').

13. A network element according to any one of claims 3 to 12, further comprising an additional data entity (170) positioned internal to said elemental devices (U1-U_m) and wherein the prefix structure of the header portion of a data
20 frame comprising data generated by said additional entity remains unpopulated such that said data frame forms a non-tagged frame.

14. A network element according to claim 13, wherein said elemental devices (U1-U_m, R, R') comprise at least a first external port (P₁₂-P_{1n}, P₂₂-P_{2n} and P_{m2}-
25 P_{mn}), wherein said entity (ED1-ED_j) is positioned external to said first elemental device (U1) and coupled to said first external port (P₁₂-P_{1n}, P₂₂-P_{2n} and P_{m2}-P_{mn}) thereof, and wherein said data frames generated by said frame encapsulating means (160) are selectively formed of data generated by said external entity and data generated by said internal entity (170).

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15. A network element according to claim 13 or 14, wherein the data generated by said internal entity (170) comprises management data and the data generated by said external entity (ED1-EDj) comprises payload data, and wherein said header field is populated with said prefix structure when the data frame is formed
5 of the data generated by said external entity.
16. A network element according to any one of claims 3 to 15, further comprising detecting means (120) positioned at said elemental devices (U1-Um, R, R') and coupled to receive indications of the data frame communicated between
10 said elemental devices (U1), said detecting means (120) being arranged to detect whether said prefix structure is included as part of said header portion.
17. A network element according to claim 16, wherein said detecting means (120) is arranged to indicated a data frame merely to be received at said elemental
15 devices (U1-Um, R, R') if said detecting means (120) fails to detect the prefix structure in the header portion.
18. A network element according to claim 17, wherein said elemental devices (U1-Um, R, R') comprises at least a first external port (P12-P1n, P22-P2n and
20 Pm2-Pmn), and wherein said detecting means (120) is arranged to identify a first data port coupled to said first external port (P12-P1n, P22-P2n and Pm2-Pmn) as being associated with the data frame, when said detecting means (120) detects said prefix structure.
- 25 19. A network element having a first elemental device (R) set into an active state, and a second elemental device (R') set into an inactive state, said first and second elemental devices being connected to a link system (10) used for selectively communicating a payload data stream and a management data stream upon a common transport stream, said second elemental device (R') comprising:

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- a) detecting means (PC') arranged to detect whether said first elemental device (R) is working properly;
- b) protection control means (PC') coupled to said detecting means and arranged to set said second elemental device into the active state in response to
5 an output of said detecting means; and
- c) signaling means (210) for signaling an information indicating said active state via said link system (10) using said common transport stream.
20. A network element according to claim 19, wherein said link system (10)
10 forms a standard-compliant LAN point-to-point link.
21. A network element according to claim 20, wherein said standard-complaint LAN is an Ethernet.
- 15 22. A network element according to any one of claims 19 to 21, wherein said protection state information is signaled in a predetermined data frame different from other data frames of said common transport stream.
- 20 23. A network element according to claim 22, wherein said protection state information is signaled as a ranking number, said active protection state being indicated by the highest ranking number.
24. A method for communicating in a network element having at least two elemental devices (U1-Um, R, R'), said elemental devices being connected
25 together via a link system (10), said method comprising the steps of:
- a) receiving data to be communicated to a selected one of said elemental devices (U1-Um, R, R'), and formatting said received data into frames related to a common transport stream used on said link system (10); and
- b) using a device-specific address for forwarding frames to said selected
30 elemental device via said link system (10).

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25. A method according to claim 24, further comprising the step of detecting, once the data frame is delivered to said second elemental device, whether a header portion includes a prefix structure.
26. A method according to claim 25, wherein said prefix structure is selectively
5 inserted into said header portion and comprises a Virtual LAN Identifier (VID).
27. A method according to claim 25 or 26, wherein said prefix structure corresponds to a VID field defined pursuant to an IEEE 802.1Q standard, and wherein said VID comprises an IEEE 802.1Q-defined VID.
- 10 28. A method according to claim 24, wherein a first one (R) of said elemental devices is set into an active state and a second one (R') of said elemental devices is set into an inactive state, and wherein said communication method is used to signal said active state via said link system (10).

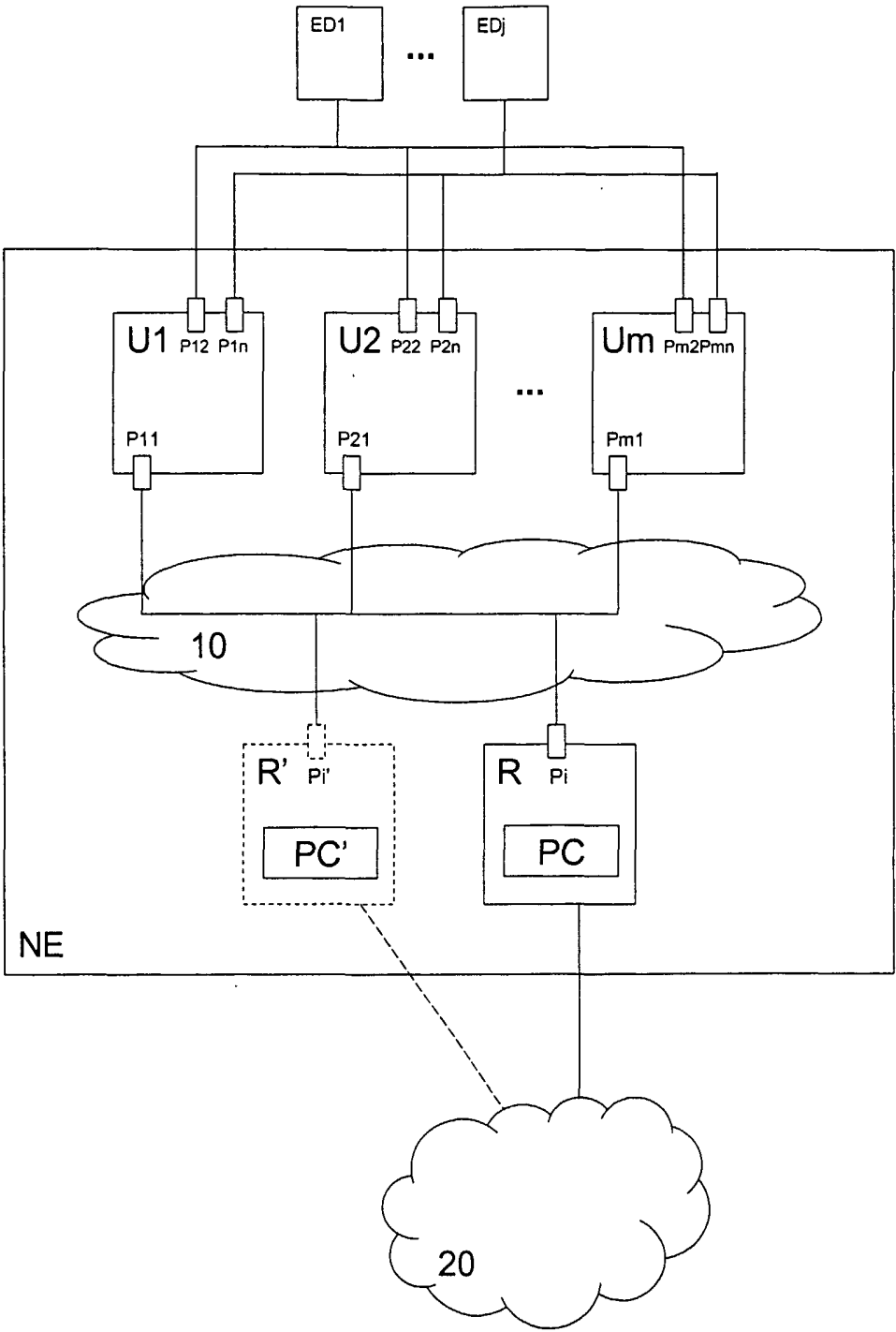


Fig. 1

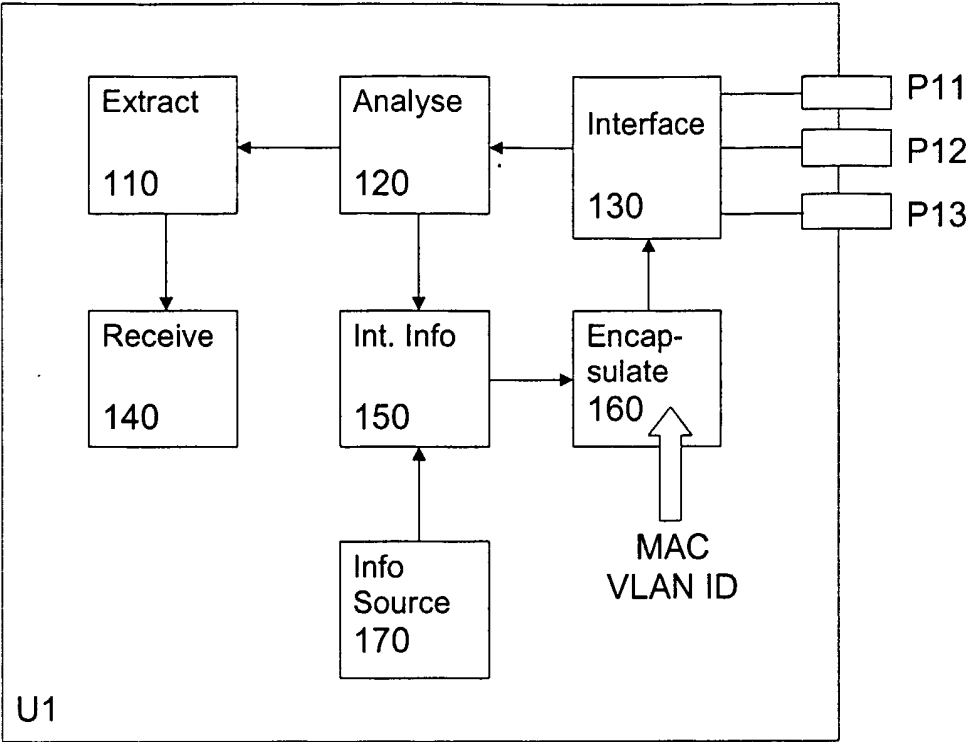


Fig. 2

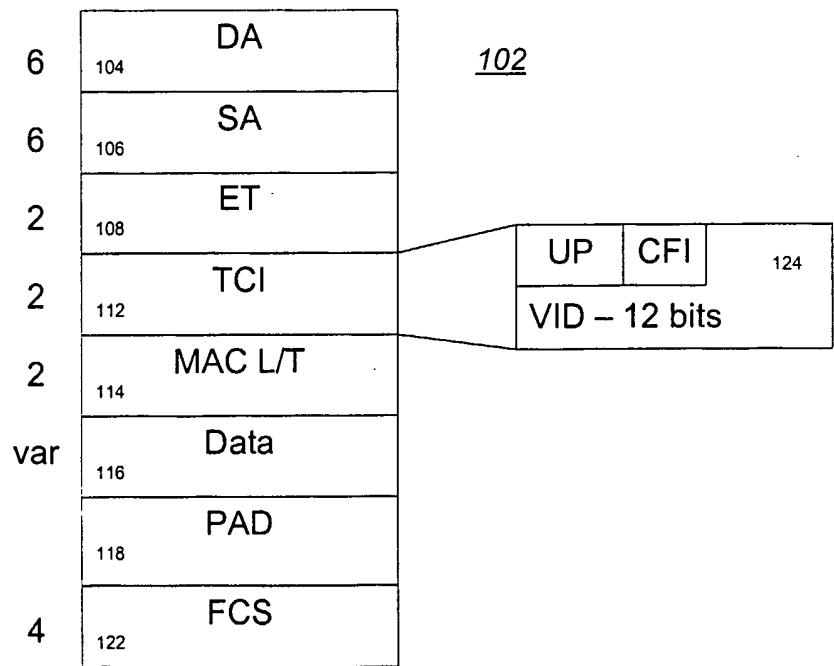
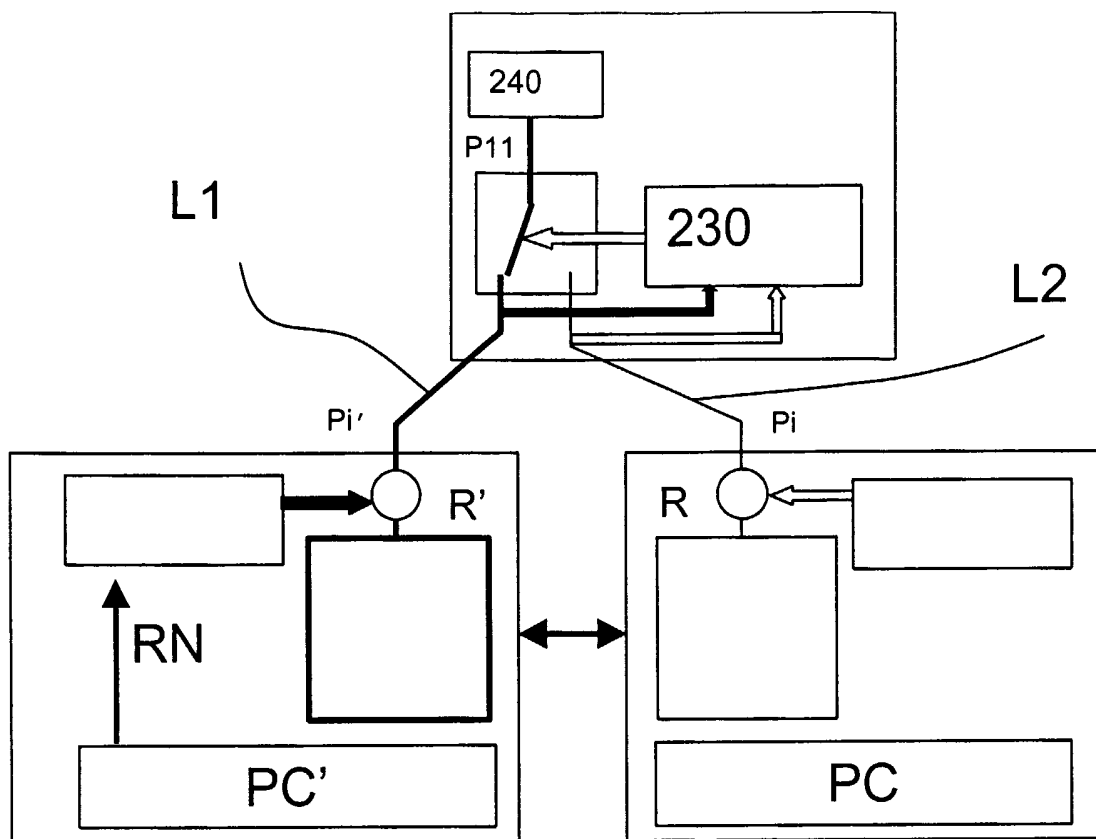
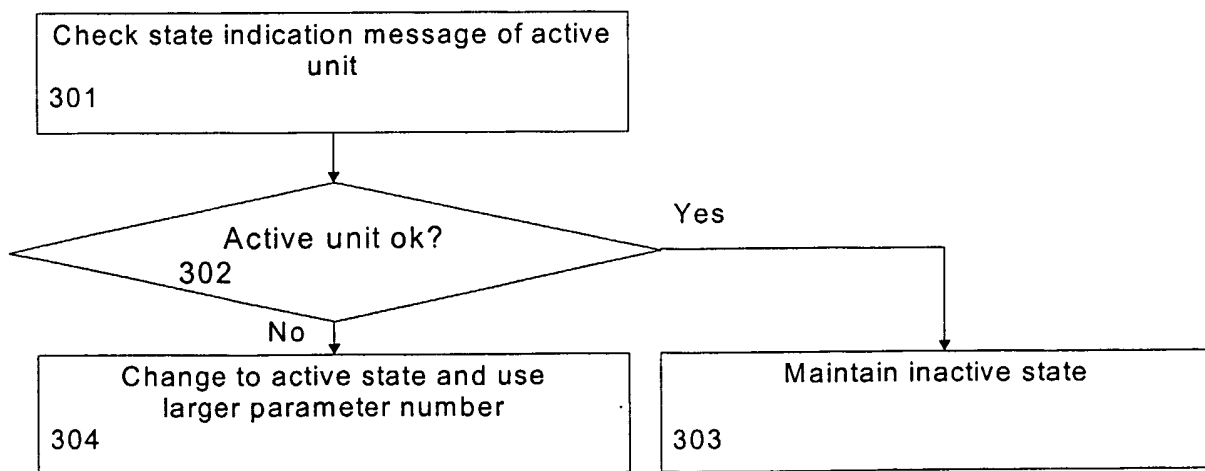


Fig. 3

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**Fig. 4****Fig. 5**