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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

(54) Title: METHOD FOR DISCONTINUOUSLY TRANSFERRING DATA IN A POINT-TO-MULTIPOINT ACCESS NETWORK, CENTRAL UNIT, AND NETWORKING TERMINATION UNIT

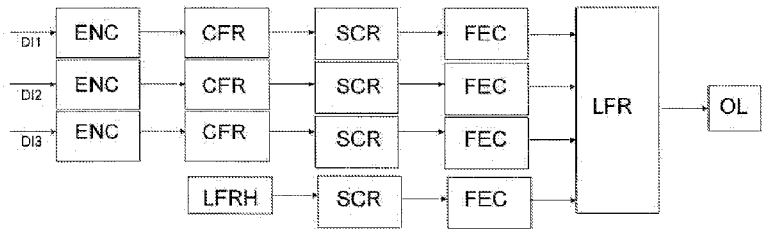

Fig. 4

(57) Abstract: The invention relates to a method for discontinuously transferring data (DI1, DI2, DI3) in a point- to-multipoint access network from a central unit to a subscriber- sided network termination unit via a distribution network, that connects the central unit with this subscriber-sided network termination unit and with a multiple of like other subscriber-sided network termination units, in which measures tor serving correct data transmission, like scrambling (SCR) or error correccion (FEC), are applied to the data (DI1, DI2, DI3) for this single subscriber-sided network termination unit before they are combined with data for other subscriber-sided network termination units, to a central unit, and to a subscriber-sided network termination unit.

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Method for discontinuously transferring Data in a Point-to-Multipoint Access Network, Central Unit, and Network Termination Unit

The invention relates to a method for discontinuously transferring data in a point-to-multipoint access network from a central unit to a subscriber-sided network termination unit via a distribution network, that connects the central unit with this subscriber-sided network termination unit and with a multiple of like other subscriber-sided network termination units, according to the preamble of claim 1, to a central unit for a point-to-multipoint access network with the central unit, a distribution network and a multiple of subscriber-sided network termination units, according to the preamble of claim 3, and to a subscriber-sided network termination unit, for a point-to-multipoint access network with a central unit, a distribution network, this subscriber-sided network termination unit and a multiple of like other subscriber-sided network termination units, according to the preamble of claim 4.

Point-to-multipoint techniques more and more replace legacy point-to-point techniques in telecommunication, especially in the access area. In the direction versus the end users, the downstream direction, data for the different end users are time division multiplexed (TDM), whereas in the direction starting from the end users, the upstream direction, data from the different end users are combined in time division multiple

access technique (TDMA technique). Data transfer originating from and destined for either of the end users thus is a discontinuous data transfer, irrespective of the fact that such data transfer is embedded in a continuous data flow on one and the same medium.

One way of increasing the capacity of such point-to-multipoint access network (also radio connections are considered to be such "network") is to increase the bit rate. Starting in the range of 144 to 155 Mb/s in the 1990s, at the moment we are dealing with upcoming 10 Gb/s. For point-to-point applications even 100 Gb/s at the moment is under development.

A problem is that the energy consumption of the affected apparatus basically is rising with rising bit rate. For different reasons energy consumption should be kept low:

- Equipment sometimes is located remotely and works battery-backed with solar energy.
- During times of power outage a battery-backed operation might be foreseen.
- Waste heat may be disturbing.
- Environmental concerns like carbon footprint more and more play a role.

This problem according to the invention is solved by a method for discontinuously transferring data in a point-to-multipoint access network according to the teaching of claim 1, by a central unit according to the teaching of claim 3, and by a subscriber-sided network termination unit according to the teaching of claim 4.

The basic idea behind is to on the one hand put out of operation such part of a subscriber-sided network termination unit that is adapted to handle received data intended for the

subscriber-sided network termination unit until such data really are foreseen to be received, and on the other hand to take measures that such subscriber-sided network termination unit can operate without prior reception of data foreseen for other subscriber-sided network termination units.

It is to be mentioned that measures for ensuring privacy, namely encrypting and decrypting, necessarily have to be done and are being done individually. In US 2005/135803 A1 as accompanying measure to encrypting and decrypting the use of error correction codes for error recognition is suggested. There, of course, the measures for error recognition necessarily have to be individual as well.

Further embodiments of the invention can be found in the subclaims and in the accompanying description.

The invention will be described based on an example lying in the field of gigabit passive optical networks with 10 Gb/s or 10G PON.

In the following the invention will be described with the aid of the accompanying drawings:

Figure 1 shows a typical passive optical network, in which the method according to the invention can be applied.

Figure 2 shows a typical data frame as used in passive optical networks.

Figure 3 shows a simplified block diagram of a central unit for such passive optical network according to the state of the art.

Figure 4 shows a corresponding block diagram of a central unit

according to the invention.

Figure 5 shows a simplified block diagram of an optical network termination unit as an example of a subscriber-sided network termination unit according to the invention.

As shown in figure 1 a typical passive optical network PON as an example of a point-to-multipoint access network is considered in this invention.

Figure 1 shows a central unit, here called optical line termination OLT, a distribution network DN, and a multiple of, here three, subscriber-sided network termination units, here called optical network termination units ONT1, ONT2, and ONTn.

The distribution network DN shows a common optical link, not referenced here, reaching from the optical line termination OLT to an optical splitter SP and a multiple of separate optical links, also not referenced here, from the splitter to one of the optical network termination units ONT1, ONT2, and ONTn each. What is referenced here as optical splitter SP normally is a passive optical element that functions as splitter in the downlink direction towards the end users assigned to the optical network termination units ONT1, ONT2, and ONTn, and as a combiner in the uplink direction from the end users towards the optical line termination OLT.

It is to be clearly seen here that each optical network termination unit ONT1, ONT2, and ONTn receives all data destined for all optical network termination units ONT1, ONT2, and ONTn, including the other ones. So actually it has to cope with a continuous data stream though only a discontinuous, bursty data stream is destined for it.

Receiving continuous data streams eases coping with ordinary transmission technological functions like keeping synchronization, error correction or reducing steady components by means of scrambling and is therefore willingly used in legacy applications. Where, as proposed in this invention, such continuous data stream is no longer dealt with continuously, but only in a bursty manner, a remedy for anyway coping with such transmission technological functions has to be foreseen. Of course some transmission technological functions like error correction are not absolutely necessary because they only have to improve but not really enable data transfer, but others like synchronization are basic.

Figure 2 shows a typical data frame as used in passive optical networks.

Such data frames practically are periodical and a frame length of 125 microseconds is widely used in telecommunication. A frame starts with a frame header FHD and is followed by consecutive payload sections each consisting of a payload header PLH and a payload body PLn, here shown the payload bodies PL1, PL2, PL3, and PL4. Whereas the payload headers PLH all have a fixed length and a standardized structure, depending on the used standard or protocol, the payload bodies' contents are free and sometimes, also depending on the used standard or protocol, even the lengths are variable. In the latter case following a frame header FHD a remainder of a payload section started in the previous frame may be completed. Not used capacity normally leads to filler bits or dummy payload sections at the end of a frame. In any event a continuous bit clock is used for synchronization purposes. There is no systematic assignment between payload bodies PLi and optical network termination units ONTk.

Figure 3 shows the conditioning of data streams like such shown in figure 2, as known from the state of the art.

Figure 3 shows three encoders ENC, three channel framing units CFR, a line framing header unit LFRH, a line framing unit LFR, a scrambler unit SCR, a forward error correction unit FEC, and a box OL representing an optical line.

A multiple of, here three, independent data input streams DI1, DI2, and DI3 pass assigned encoders ENC and channel framing units CFR, before they are forwarded together with the output data of the line framing header unit LFRH to the line framing unit LFR, and from there a multiplexed signal is transferred via the scrambler unit SCR and the forward error correction unit FEC to the optical line OL.

A multiple of, here three, independent data input streams DI1, DI2, and DI3 first is encoded in respective encoders ENC, one per data stream. This ensures privacy, because as already mentioned and as seen in figure 1, every optical network termination unit ONT1, ONT2, and ONTn receives all data destined for all destinations.

The independent data input streams DI1, DI2, and DI3 are considered here as representing the contents of one connection or channel each. Such content has to be transferred transparently from this input to a respective output of an assigned optical network termination unit ONT. Normally at the output of such optical network termination unit ONT the terminal of a single subscriber or similar equipment is connected, but principally even a further distribution network could be connected.

Either of the data input streams DI1, DI2, and DI3 might be a continuous or a discontinuous one; and the different data streams might even be out of synchronism with respect to one another. The first step towards multiplexing is the unification and synchronization of the different data streams. At least before multiplexing a common data clock is necessary. For achieving such purposes each of the data input streams DI1, DI2, and DI3 after being encoded undergoes a channel framing in separate channel framing units CFR. Here the data units of the data input streams DI1, DI2, and DI3 are processed each into a payload header PLH and a payload body like PL1, PL2, PL3, or PL4 as already mentioned in the description of figure 2.

In most of the known exemplary networks here at the latest the data streams are filled with filler bits or dummy data units to ensure a continuous data stream also for data streams not utilizing the full provided capacity.

Together with frame headers FHD, as shown in figure 2, these encoded and framed data input streams are input to the line framing unit LFR, where they are multiplexed, normally in an asynchronous manner, to a common data frame, as shown in figure 2. In such networks normally the capacity of the common link is less than the sum of the capacities of the data input streams. So first filler bits or dummy data units coming from the different data input streams are omitted and at the end of a frame either new filler bits or dummy data units are inserted or remainders are forwarded to the next frame.

In order to improve the quality of data transmission various measures are known to be applied in addition to the mere framing. Here two such examples are scrambling and forward error

correction. Other kinds of error correction or mere error recognition are other such examples. Such measures imply reversing at the receiving side, here the respective optical network termination unit ONT1, ONT2, to ONTn.

As the latter measures are applied on the framed signal as a whole, their reversing also implies the application on the framed signal as a whole. This hinders the processing of only those signal parts that belong to the data streams intended for reception at the respective optical network termination unit ONT1, ONT2, to ONTn.

To overcome this problem, according to the invention the measures exceeding the combination of data for different optical network termination units ONT1, ONT2, and ONTn are applied to the data of either of the data input streams DI1, DI2, and DI3 and thus are applied before such data are combined with data of the respective other data streams. In the given example this means that scrambling and forward error correction is applied prior to combining the data input streams DI1, DI2, and DI3 to the data stream to be sent towards the optical line OL.

This results in a corresponding block diagram of a central unit as shown in figure 4.

Figure 4 shows three encoders ENC, three channel framing units CFR, a line framing header unit LFRH, four scrambler units SCR, four forward error correction units FEC, a line framing unit LFR, and a box OL representing an optical line.

The functions performed here are principally the same as already described based on figure 3 in connection with the prior art description of a central unit as known. The difference is

that the measures exceeding the combination of data for different optical network termination units ONT1, ONT2, and ONTn are applied to the data of either of the data input streams DI1, DI2, and DI3 and thus are applied before such data are combined with data of the respective other data streams, as already mentioned. To reversing such measures therefor the other parts of the transferred signal are not needed.

It is to be mentioned here that measures like scrambling or error correction use some kind of coding schemes and normally need blocks of fixed lengths. To ensure this the payloads have to be filled with filler bits to reach such block lengths, if they do not anyway work with fixed blocks. This is considered to be only a minor disadvantage because the additional load is negligible. The use of codes with shorter run lengths could reduce this additional load at the cost of reduced transmission quality, if acceptable.

It is further to be mentioned here that the realization of the different blocks shown in figures 3 and 4 may be achieved by using separate hardware for each and every block, by hardware common to some or all blocks, by software individual to each and every block or by software common to some or all blocks.

As a consequence there is no longer a need to completely process the transferred signal at each and every optical network termination unit ONT1, ONT2, to ONTn.

As a consequence figure 5 shows a simplified block diagram of an example of an optical network termination unit that according to the invention is adapted to not continuously processing an incoming data stream.

Figure 5 shows an optical network termination unit ONT, that includes a transmission function part TFP and a clock CL.

The transmission function part TFP is adapted to cooperate with the forward error correction unit FEC, the scrambler unit SCR, the channel framing unit CFR, and the encoder ENC processing the data input stream DI1, DI2, or DI3 associated to this optical network termination unit ONT. To this end may be it also needs information from the line framing header unit LFRH. To this end it needs to work only when such data arrive at its input and according to the invention it is adapted to be put out of operation controlled by the clock CL.

The clock CL has to maintain synchronization in times the transmission function part TFP is out of operation, is adapted to put out of operation such part, when applicable, and is adapted to reverse such putting out of operation when data income is expected.

Depending on the protocol and standard used, the times when data income is to be expected, may be fixed while putting such optical network termination unit ONT into operation, when establishing a connection to this optical network termination unit ONT, or may be reported once per frame in the frame header FHD or even in subsequent reports within the different payload headers PLH.

Depending on the way of reporting the transmission times to the optical network termination unit ONT and its clock CL the sleep times of the transmission function part TFP may be longer or shorter and the reduction in energy consumption may be higher or lower. In order to ensure correct operation, a timely wake up for re-synchronization and re-alignment may be necessary. But this is not a principle problem.

Similar putting out of operation of not continuously used parts of an optical network termination unit ONT may be applied to those parts of the unit that apply to data sent in the opposite direction, here the upstream direction.

Claims

1. Method for discontinuously transferring data (DI1, DI2, DI3) in a point-to-multipoint access network (figure 1) from a central unit (OLT) to a subscriber-sided network termination unit (ONT1, ONT2, ONTn) via a distribution network (DN), that connects the central unit (OLT) with this subscriber-sided network termination unit (ONT1, ONT2, ONTn) and with a multiple of like other subscriber-sided network termination units (ONT1, ONT2, ONTn), **characterized in, that** all measures exceeding the combination (LFR) with data (DI1, DI2, DI3) for other subscriber-sided network termination units (ONT1, ONT2, ONTn), like scrambling (SCR) or error correction (FEC), are performed individually prior to such combination (LFR) and that measures other than error recognition are included.

2. Method according to claim 1, characterized in, that timing data relating to an upcoming transfer of data are available (CL) within this subscriber-sided network termination unit (ONT1, ONT2, ONTn) beforehand and that at the receiving side of this subscriber-sided network termination unit (ONT1, ONT2, ONTn) until an upcoming transfer of data at least a minimum operation is to be performed in order to be ready for the upcoming transfer of data.

3. Central unit (OLT) for a point-to-multipoint access network with the central unit (OLT), a distribution network (DN) and a multiple of subscriber-sided network termination units (ONT1, ONT2, ONTn), **characterized in, that** the central unit (OLT) includes transmission function means (SCR, FEC) and a multiplexer (LFR), where the transmission function means (SCR, FEC) are adapted to serving the transfer of data, like scrambling (SCR) and error correction (FEC), and where the multiplexer (LFR) is adapted to combining data (DI1, DI2, DI3) for a certain subscriber-sided network termination unit (ONT1, ONT2, ONTn) with data (DI1, DI2, DI3) for other subscriber-sided network termination units (ONT1, ONT2, ONTn), and that the transmission function means (SCR, FEC) and the multiplexer (LFR) are arranged in such a consecutive manner that first all transmission function measures for data for this subscriber-sided network termination unit (ONT1, ONT2, ONTn) are carried out and after that the combining of data (LFR) for this subscriber-sided network termination unit (ONT1, ONT2, ONTn) with data for other subscriber-sided network termination units (ONT1, ONT2, ONTn), and that the transmission function means (SCR, FEC) include means other than for performing measures for error recognition.

4. Subscriber-sided network termination unit (ONT1, ONT2, ONTn), for a point-to-multipoint access network with a central unit (OLT), a distribution network (DN), this subscriber-sided network termination unit (ONT1, ONT2, ONTn) and a multiple of like other subscriber-sided network termination units (ONT1, ONT2, ONTn), with means for performing transmission

function measures like scrambling (SCR) and error correction (FEC), **characterized in, that** the subscriber-sided network termination unit (ONT1, ONT2, ONTn) at least functionally is separated into at least a first part (TFP) and a second part (CL), such that the first part (TFP) can be put out of operation independent from the second part (CL), and that the second part (CL) includes a clock that is adapted to reverse the putting out of operation of the first part (TFP) at a specified upcoming time, and that the transmission function means (SCR, FEC) include means other than for performing measures for error recognition.

5. Subscriber-sided network termination unit (ONT1, ONT2, ONTn) according to claim 4, characterized in, that the first part (TFP) is adapted to perform such functions (SCR, FEC) that relate to transmission function measures for serving the transfer of data for this subscriber-sided network termination unit (ONT1, ONT2, ONTn), like scrambling (SCR) and error correction (FEC).

6. Software program product for performing the method according to claim 1, when loaded into a central unit (OLT) according to claim 3.

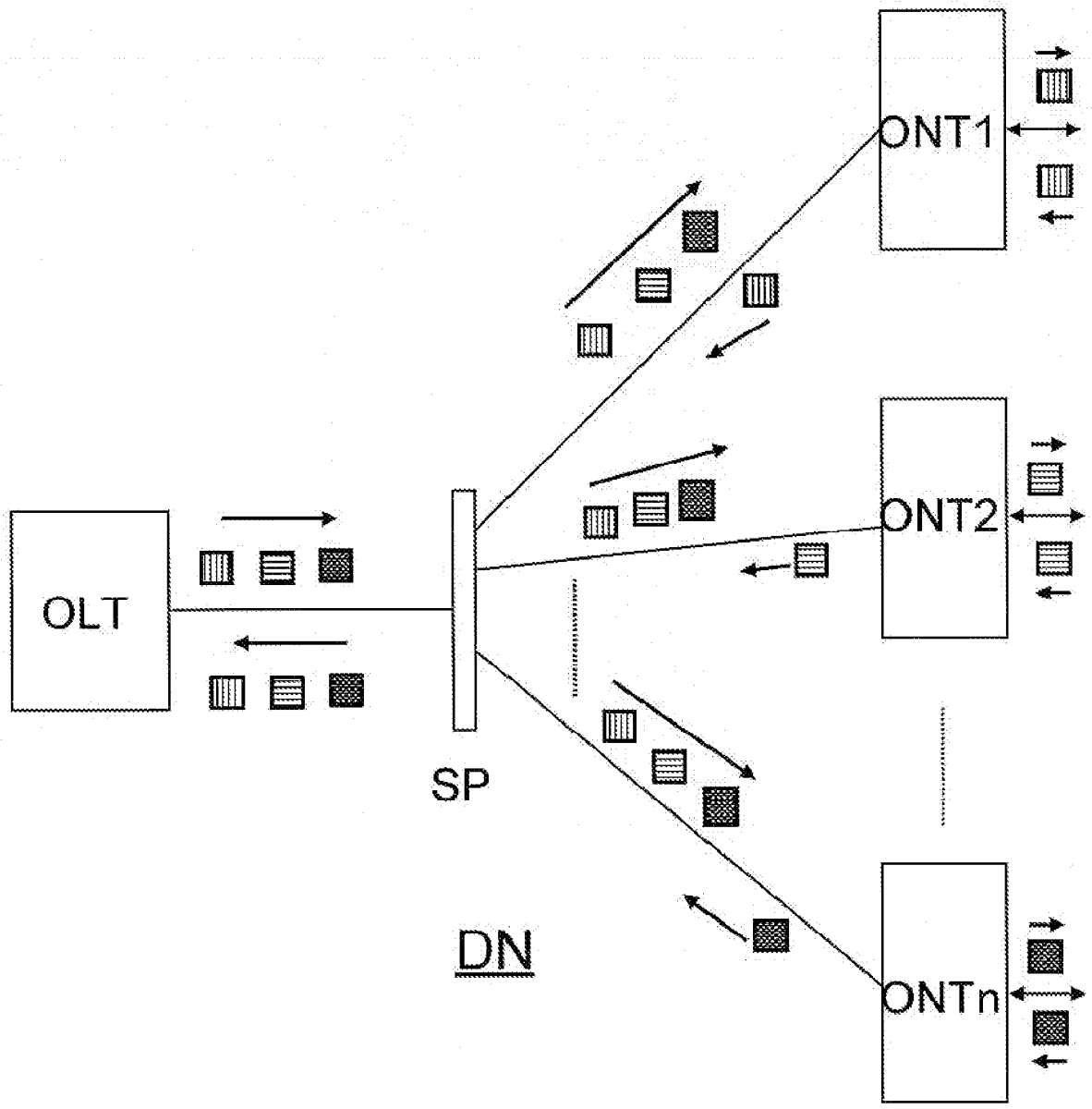

Fig. 1

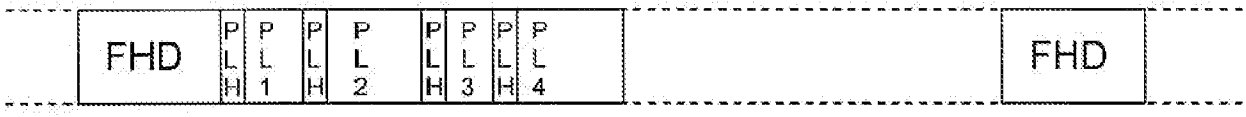

Fig. 2

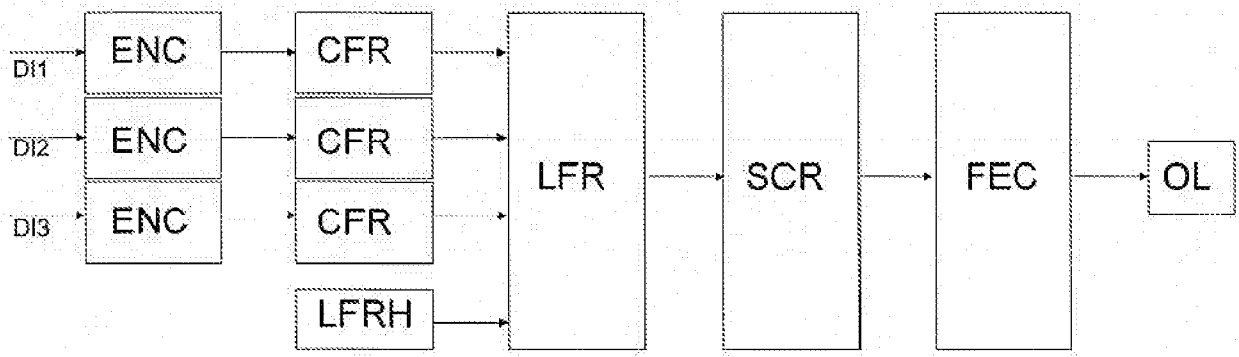

Fig. 3

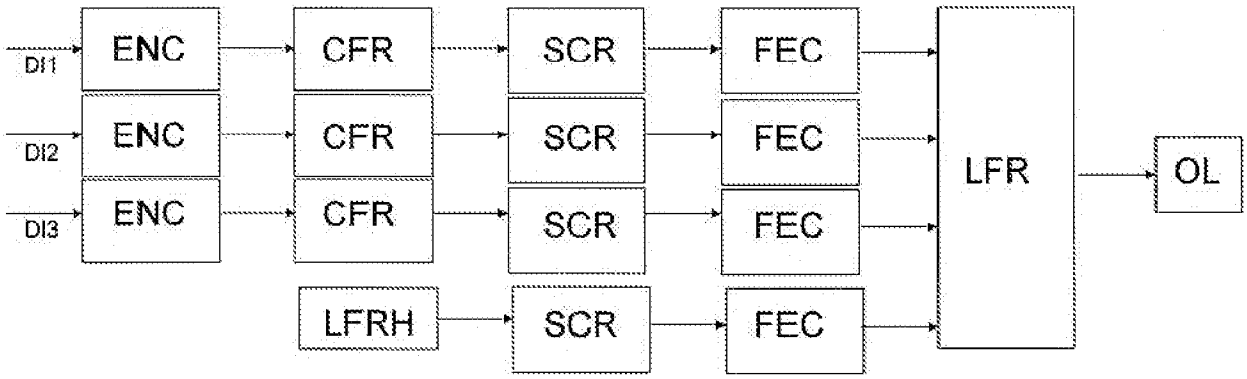

Fig. 4

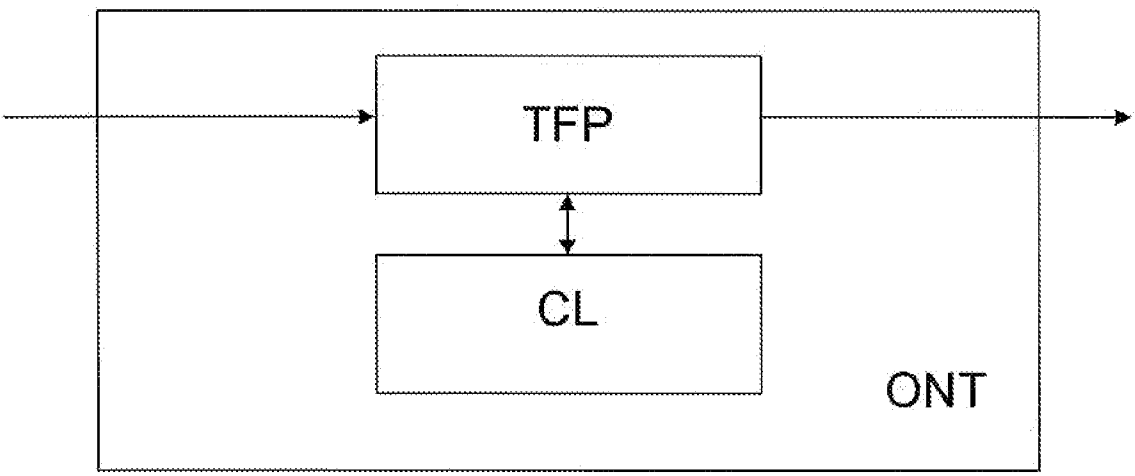

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/056167

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L12/28

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L H04Q H04N

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005/135803 A1 (LEE HAK-PHIL [KR] ET AL) 23 June 2005 (2005-06-23) abstract paragraph [0003] - paragraph [0014] paragraph [0021] paragraph [0023] paragraph [0028] - paragraph [0029] paragraph [0072] claim 1 figures 1-7	1-3,6

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 July 2010	20/09/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Lai, Cristiana

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/056167

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 02/35906 A (ACTELIS NETWORKS LTD [IL]; BARLEV TUVIA [IL]; MOLEV SHTAYMAN ARKADY [I) 10 May 2002 (2002-05-10) abstract page 4, line 6 - page 5, line 3 page 23, line 23 - page 25, line 5 page 56, line 8 - page 60, line 3 page 61, line 11 - page 63, line 19 figures 1,2,16,17,19-21	1-3,6
A	US 7 171 121 B1 (SKARICA CHRISTOPHER M [CA] ET AL) 30 January 2007 (2007-01-30) abstract column 3, line 58 - column 5, line 3 figures 1-4	1-3,6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2010/056167

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-3, 6

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-3, 6

Method , central unit and software program, for individually applying measures exceeding the combinationof data, prior to such combination.

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2. claims: 4, 5

Subscriber-sided network termination unit involving reversing the putting out of operation of the first part.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2010/056167

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005135803 A1	23-06-2005	JP 2005184811 A	07-07-2005
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US 7171121 B1	30-01-2007	NONE	