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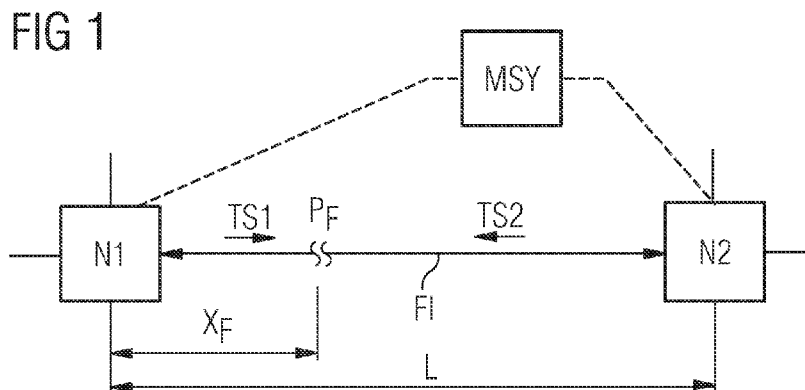
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(54) Title: LOCALISATION METHOD FOR BIDIRECTIONAL INTERRUPTIONS OF COMMUNICATION LINKS



(57) Abstract: Localisation method for bidirectional interruptions of communication links (FI) between nodes (N1, N2) in a communication network, comprising the steps of inserting time-stamps (TS1, TS2) into transmitted data signals, storing the last received time-stamp, supervising the connection and transmitting the last received time-stamps to a management system (MSY) and calculating the distance (XF) from a node (N1) to a failure point (Pf) according to the last received time-stamps (TS1, TS2).

LOCALISATION METHOD FOR BIDIRECTIONAL INTERRUPTIONS OF COMMUNICATION LINKS

FIELD OF THE INVENTION

5 The invention refers to a localisation method for bidirectional interruptions of communication links between nodes in a communication network.

10 BACKGROUND OF THE INVENTION

Communication networks comprise a plurality of nodes connected by links, e.g. optical fibers. The links are often bidirectional operated, whereas signals are transmitted in both directions between adjacent nodes over one single or
15 over two fibers in the same cable.

Several protection methods like e.g. 1:1, 1+1 protection and rerouting methods are known to maintain connectivity if a link is interrupted.

20 Nevertheless the disrupted link has to be repaired, the exact position of the failure has to be located.

Nowadays, repair teams need to visit the adjacent nodes of the interrupted link. Special measurement devices, e.g. Optical Time Domain Reflectometers (OTDR) for fiber networks,
25 have to be employed at least at one node adjacent to the incident.

30 OBJECTS AND SUMMARY OF THE INVENTION

Therefore it is an object of the present invention to provide a method for quick failure localization.

According to the present invention, there is provided a localisation method for bidirectional interruptions of communi-
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cation links between nodes in a communication network comprising the steps of
inserting time-stamps into the transmitted data,
storing the last received time-stamp,
5 supervising the connection and transmitting the last received time-stamps to a management system, and
calculating the distance from a node to an interruption point according to the last received time-stamps transmitted from the nodes (N1, N2) arranged on different sides of the inter-
10 ruption point (P_F).

This method allows a simple calculation of an interruption point and reduces the service expenses.

15 Signalling and calculation can be executed by methods according to the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

20 Examples of the invention including a presently preferred embodiment are described below with reference to accompanying drawings, where

FIG 1 shows a simplified bloc diagram of a network link and
25 FIG 2 shows a route-time diagram.

DETAILED DESCRIPTION OF THE INVENTION

30 **FIG 1** shows in a bloc diagram a section of a network with two adjacent nodes N1, N2 connected by a bidirectional link FI. Both nodes use the same exact timescale and the transmitters of both nodes inserts time-stamps TS1 and TS2 respectively in the transmitted data signals, e.g. as digital information or

any other defined metric. In addition e.g. byte boundaries can be used for fragmentation of the received time marks. The time synchronisation between the nodes could be realized by any synchronisation method exchanging information between the nodes or by special receivers for time signals, e.g. of the Global Positioning System.

The propagation time t_g of transmitted signals between two nodes is measured or calculated. It can also be helpful to know the distance between the nodes.

The location method is now explained with reference to **FIG 2**. Both nodes N1, N2 - adjacent nodes or any two nodes of a network, e.g. end nodes, exchanging data signals - are transmitting information comprising said time-stamps. If the data between the nodes is transmitted in data frames the time-stamps may be inserted at a certain data frame position. If the information is e.g. transmitted byte-by-byte the time-stamps are inserted periodically. The time-stamps can even be inserted in an alarm indication signal here also regarded as data signal.

The transmission of time-stamps is illustrated by continuous lines. The transmission of a new time-stamp is represented by a new line. The last received time stamps (or the time stamps of the last received complete data frames) are always stored. The time-stamps TS1 and TS2 shown in FIG 2 are the last received time-stamps before an interruption.

Now, the link is bidirectional interrupted at a "failure time" t_f (interruption time). The receivers of both nodes N1, N2 notice the interruption and signal it along with the last received time-stamps TS1, TS2 to a management system for interruption localisation (each entity designed for failure location is here referred to as management system). The last received time-stamps (or an even exacter calculated last successful transmission time) represent the emission times t_1 and t_2 .

The distance X_F to the failure point P_F can be calculated according

$$X_F = v_g(t_f - t_1) \quad (1)$$

with v_g = signal (group) velocity (calculated or measured),
 t_f - failure time.

The unknown failure time can be derived from

$$(t_f - t_1) + (t_f - t_2) = t_g \quad (2)$$

with

$$t_f = (t_g + t_1 + t_2)/2 \quad (3)$$

inserted in (1)

$$X_F = v_g(t_2 - t_1 + t_g)/2 \quad (4)$$

or avoiding v_g

$$X_F = L(t_2 - t_1 + t_g)/2t_g \quad (5)$$

with L - distance between the nodes N_1 , N_2 ;

Of course, discrete components causing an additional time delay can be considered by correction the time transmitted in the time-stamp and a more exact calculation of the interruption time is possible e.g. considering a time span between the last received time-stamp and the detected loss of signal, e.g. by counting the received bytes and transmitting a time span value together with the time-stamp to the management system.

For supervising reasons it may be advantageously to forward the time-stamps continuously to the management system or to transmit (additionally) the time-stamp of the last complete received data frame. These may be the time-stamps TS_1 , TS_2

shown in FIG 2 when the interruption occurred after the complete frames have passed the interruption point otherwise foregoing time stamps.

- 5 The present invention is not limited to the details of the above described principle. The scope of the invention is defined by the appended claims and all changes and modifications as fall within the equivalents of the scope of the claims are therefore to be embraced by the invention.

REFERENCE SIGNS

	$N1, N2$	nodes
	FI	link, fiber
5	MSY	management system
	$TS1, TS2$	time stamps
	P_F	interruption point
	X_F	distance to the interruption point
	t_F	failure time
10	$t1$	emission time of $TS1$
	$t2$	emission time of $TS2$
	L	distance between adjacent nodes

CLAIMS

1. Localisation method for bidirectional interruptions of communication links (FI) between two nodes N1 and N2 in a communication network, the two nodes N1 and N2 being located on different sides of an interruption point (P_F), the interruption point (P_F) being located at a distance (X_F) from the node N1, the communication network comprising a management system (MSY);

- 10 the method comprising the steps of
- inserting time-stamps (TS1, TS2) into transmitted data signals, the data signal including the time-stamps (TS1, TS2) being exchanged between the two nodes N1 and N2 in data frames and the time-stamps (TS1, TS2) being inserted at a
 - 15 certain data frame position,
 - receiving the transmitted data signals and storing a last received time-stamp, the last received time stamp (TS1, TS2) being the time stamp of the last complete data frame received by each node (N1, N2) before an interruption occurs,
 - 20 - transmitting the last received time-stamps (TS1, TS2) to the management system (MSY) when an interruption occurs, each node (N1, N2) transmitting its last received time stamp (TS1, TS2) to the management system (MSY),
 - calculating the distance (X_F) from a node (N1) to an interruption point (P_F) according to the last received time-stamps (TS1, TS2) transmitted from the nodes (N1, N2).
 - 25

2. Localisation method according to claim 1, further comprising the step of

- 30 - calculating the distance (X_F) from a node (N1) to the interruption point according to
- $$X_F = v_g(t_2 - t_1 + t_g)/2;$$

with v_g - signal velocity; t_g - propagation time from node to node; t_1 - time in which TS1 has been transmitted; t_2 - time in which TS2 has been transmitted.

- 5 3. Localisation method according to claim 1,
further comprising the step of
- calculating the distance (X_F) from a node (N1) to the interruption point (P_F) according to
$$X_F = L(t_2 - t_1 + t_g)/2t_g;$$
- 10 with L distance between the adjacent nodes N1, N2;
 t_g - propagation time from node to node; t_1 - time in which TS1 has been transmitted; t_2 - time in which TS2 has been transmitted.
- 15 4. Localisation method according to claim 1, 2 or 3,
further comprising the step of
wherein
- the time-stamps (TS1, TS2) are inserted into the transmitted data signals of adjacent nodes.
- 20 5. Localisation method according to claim 1, 2 or 3,
wherein
- the time-stamps (TS1, TS2) are inserted into the transmitted data signals of end nodes.
- 25 6. Localisation method according to one of the claims 1 - 4,
wherein
- the time-stamps (TS1, TS2) are continuously transmitted to the management system.

FIG 1

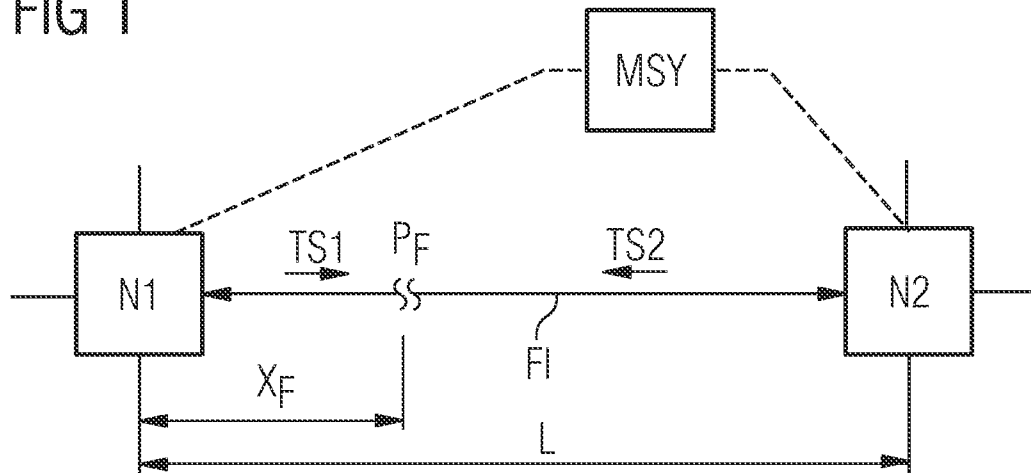
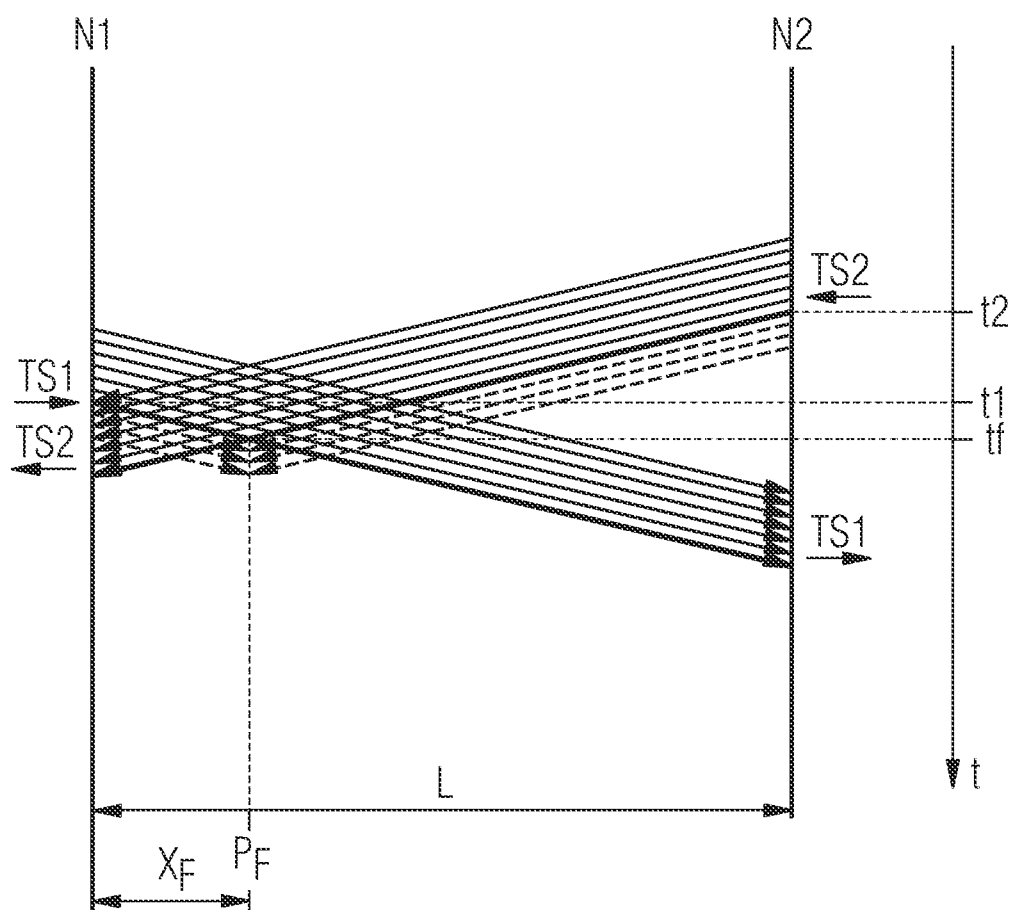


FIG 2



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2009/065324

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04L1/24 H04B10/08 H04L12/26
ADD. H04L1/00

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 H04B

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, COMPENDEX, INSPEC, IBM-TDB, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	JP 01 005147 A (NIPPON ELECTRIC CO) 10 January 1989 (1989-01-10) abstract	1-6
A	US 2008/232795 A1 (KLAR ANDREASR [DE] ET AL) 25 September 2008 (2008-09-25) claim 5	1-6
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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