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[Continued on next page]

(54) Title: METHOD FOR TRANSPORTING DATA OVER A DATA CONNECTION AND NETWORK COMPONENT

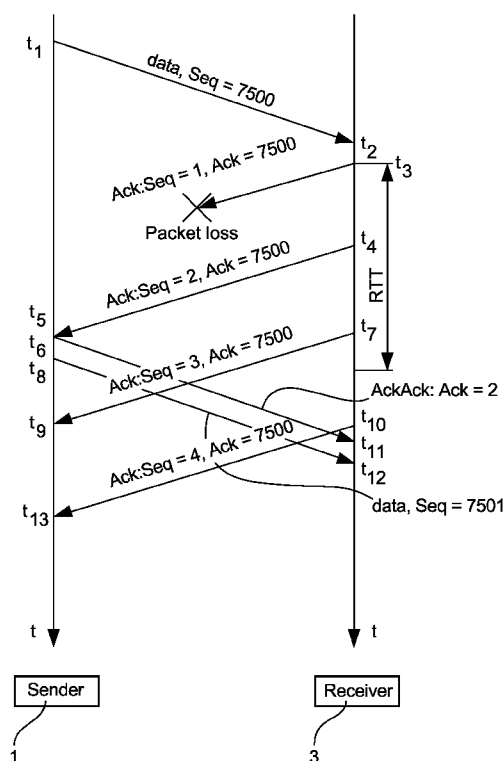


Fig. 5

(57) Abstract: The invention relates to a method for transporting data over a data connection between a sending network component (1) and a receiving network component (3) via a network (5), and a network component (3). The method solves a problem with the reliable data transport protocol according to which a number of data transport packets will be acknowledged in regular time intervals. When such an acknowledge message is get lost, the sending network component will have to keep the data for the purpose of retransmission and cannot free its sending buffer. The invention proposes to repeat such an acknowledge message as a precaution for the case that it gets lost after a short time. The time for repeating is set to be less than an RTT (round trip time for the connection). The solution therefore disregards the fact that no statement about the reception of the acknowledge message can get back to the receiver before the RTT has elapsed. For wide area connections in high bandwidth networks, where high RTT values exist, this has the advantage that significant delays in carrying on sending data or unnecessary retransmissions of significant amount of data can be avoided.



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MR, NE, SN, TD, TG).

Published:

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Method for transporting data over a data connection and network component

The invention relates to a method for transporting data over a data connection between a sending network component (1) and a receiving network component (3) via a network (5), and an adapted network component (3).

Background of the Invention

An important issue in networks connecting network components through data connections or data links relates to the optimized use of the data connections. Ideally, the utilized network protocol will provide for adjustment of transmission parameters for transmitting messages via the data connections in such a way, that the available bandwidth of the data connections are used fully, while avoiding a loss of data. This aim may be achieved by appropriate congestion control in order to estimate or calculate an optimal transmission parameter such as an optimal transmission rate with which data of a message are transmitted. If the transmission rate is too low, the bandwidth of the physical connection is not utilized fully. On the other hand, a transmission rate adjusted too high might lead to overflow of transmission buffers and eventually to data loss.

Transport protocol implementations for reliable data transmission based on an IP (Internet Protocol) stack provide for data packet acknowledgement in order to recognize data losses. In a reliable data transport protocol the lost packets will be retransmitted. The protocol implementations mostly handle acknowledge messages using byte sequencing or packet sequencing for data identification. After elapse of a certain time period the transmitting device interprets the

absence of such an acknowledge message for a certain time period as a packet loss. The respective data will then be retransmitted by the transmitter device. The waiting time period before retransmission is set to be at least the Round
5 Trip Time (RTT) between transmitting and receiving end plus some margin since no data acknowledge can occur in less than RTT since the sending time point.

The invention starts with the recognition that not only data packets can get lost in IP networks but also acknowledge
10 messages. In a reliable transport protocol like TCP (Transmission Control Protocol) the missing of an acknowledge message is interpreted by the data sender as a data packet loss, leading to a retransmission of the respective data, although they are already received by the receiver.

15 In more recent transport protocol proposals like UDT (UDP-based Data Transfer Protocol, where UDP stands for User Datagram Protocol) it is suggested to send also acknowledge packets to acknowledge messages - so called ACKACKs in order to avoid these unnecessary double data transmissions. It is
20 state-of-the art in this case at the data receiver side (this is the ACK-emitter) to wait also at least an RTT before issuing a retransmission of an acknowledge message.

It is important to know that the number of data packets that are acknowledged in one ACK message is subject to the proto-
25 col implementation or it is programmable. In the field of professional high speed networking, e.g. based on 10 GBit Ethernet technology an implementation can be that acknowledge messages are issued every 10 ms. This means that all the data packets received in that time period will be
30 checked in regard to one or more characteristic like the correct sequence numbering. If there is no violation of the

sequence numbering, the ACK message will be generated. The ACK message reports the correct reception of all the data packets received in the interval from the previous ACK message on. If there is a violation, it means that all the data
5 packets received in that period are not acknowledged and thus the sender needs to repeat them.

If the ACKACK message is missing, the receiver will generate an ACKACK message a second time after elapse of at least the RTT. Clearly it has the disadvantage that the sender can not
10 free the corresponding part of the protocol buffer before ACK has been received.

The Invention

The object of the invention is to provide a method and a network component in order to improve the transmission prop-
15 erties of a data transmission via a network.

This object is achieved by a method for transporting data over a data connection between a sending network component and a receiving network component according to claim 1 and a network component according to claim 8.

20 According to one aspect of the invention, the method comprises the following steps of sending a number of data transport messages to the receiving network component by the sending network component; receiving the number of data transport messages by the receiving network component; send-
25 ing an acknowledge message back to the sending network component by the receiving network component indicating correct reception of the number of data transport messages; wherein the method is characterized by the further step of repeating an acknowledge message by the receiving network component

after a time less than a round trip time for the communication between the sending network component and the receiving network component.

This has a substantial advantage in the following case. Considered is the situation that at least one acknowledge message has get lost and the receiver has not received further data for acknowledgement within an acknowledged timeout period of at least one RTT. Since the receiver will retransmit the acknowledge message in a time less than one RTT, the sender receives a retransmitted ACK earlier than in the state of the art implementation and so starts delivering further data packets earlier. The same effect could be observed, when the sender emits data within bursts instead of a constant data rate. The solution according the invention provides for a faster recognition that only the acknowledge message has get lost and thereby avoids retransmission of the data. The sender does not need to retransmit the data and it is possible to free the corresponding part of the sending buffer much earlier. In consequence the sender can carry on transmitting further data considerably faster. The overall performance of the data transport is increased.

Another preferred embodiment of the invention comprises the step of periodically repeating the acknowledge message with a time period being less than the round trip time until an acknowledge message is received back from the sending network component for indicating that the acknowledge message from the receiving network component has been correctly received. This embodiment provides even better reliability for the acknowledgement of data segments.

An advantageous embodiment of the invention comprises the step of coupling the time period for repeating the acknowl-

edge message from the receiving network component (3) to the selected acknowledge message sending interval which is less than the round trip time. It simplifies the algorithm for retransmission of lost data packets.

- 5 Corresponding advantageous embodiments for a network component adapted for the use in the method according to the invention, particularly for a receiving network component are apparent from the claims 8 to 11.

Drawings

- 10 Embodiments of the invention are depicted in the drawings and will be explained hereinafter. The drawings show in:
- Fig. 1 an arrangement of a sending component and a receiving component connected via a network;
- Fig. 2 the general three-way data and acknowledge model;
- 15 Fig. 3 a communication in which an ACK message for a first data sequence is get lost but implicitly acknowledged after transferral of a second data sequence;
- Fig. 4 a communication in which an ACK message is re-
- 20 transmitted after a regular timeout event;
- Fig. 5 a communication in which an ACK message for a first data sequence is get lost but repeated in short succession according to the invention, and;
- Fig. 6 an illustration of the involvement of the differ-
- 25 ent network protocol layers for the transfer of data packets.

Detailed Description of Embodiments according the Invention

The Internet Protocol (IP) is a widely utilized network protocol for data transport. IP delivers an unreliable connection service to upper layer protocols and to applications.

5 However, many applications, such as file transfer based applications and many peer-to-peer applications, require reliable and lossless connection oriented network services. The adoption of unreliable IP services to stream-oriented lossless reliable services is a major task of the transport
10 layer (layer four) of the Open Systems Interconnection Basic Reference Model or OSI Model. A well known transport protocol that delivers reliable connections over IP is the Transport Control Protocol (TCP), described in the publication ISI USC, *Transport Control Protocol*, Request for Comments.
15 IETF, September 1981.

However, due to limitations of TCP on high throughput long distance connections (so called Long Fat Pipes), many new approaches of alternative transport protocols have been revealed in the recent past, as described by C. Anglano and M.
20 Canonico in their publication *Performance analysis of high-performance file-transfer systems for Grid applications*, Concurrency and Computation: Practice & Experience, volume 18, pages 807-816 (2006).

Another protocol called UDT is described in a thesis from
25 the University of Illinois at Chicago made by Yunhong Gu with the title UDT: "A High Performance Data Transport Protocol" in 2005. These approaches and transport protocols derive their transmission data rate from the round-trip time (RTT) or from the one-way delay (OWD). Herein the OWD de-
30 notes the time it takes for a message, for example in form of a data packet, to travel from an origin or sending net-

work component to a destination or receiving network component, while the RTT is the time period starting when the sending network component sends out a message and ending when a reply to the sent message like ACK message, transmitted by the receiving network component is received by the sending network component. Further details on how to advantageously derive RTT or OWD values are disclosed in the parallel European Patent Application EP 08 101 897.0 of the applicant. The UDT protocol makes use of so-called ACKACK messages with which the sender acknowledges the reception of the acknowledge message from the data receiver.

Shown in the Fig. 1 are a sending component 1 and a further network component 3, which are each connected to a network 5 with wire or wireless connections. Via the network 5, the two network components 1 and 3 may communicate by first establishing a data connection. Depending on the complexity of the network 5, such a data connection may lead over one or several other components (not shown in Fig. 1) inside the network 5, including switches and routers, which direct messages from the sending network component 1 to the receiving network component 3 and vice versa.

When establishing a data connection between the two network components 1 and 3, the first message transmitted by the sending network component 1 and received by the receiving network component 3 is defined herein as the initiating message, because it initiates the data connection.

Congestion control includes a number of different implementations that may differ in which transmission parameters are adjusted and / or in how these parameters are estimated. For message transmission protocols such as the transmission con-

trol protocol (TCP) and variations thereof, an algorithm called "slow start" is widely used.

According to the slow start algorithm, a congestion window, corresponding to a buffer size at the sending network component 1 for the message to be transmitted, is set to an initial value depending on the TCP variation employed, such as TCP Reno, TCP Newreno, TCP Tahoe etc. After sending the initiating message to the receiving network component 3, the sending network component 1 will wait for an acknowledgement by the receiving network component 3. After receiving the initiating message acknowledgement, the sending network component 1 will transmit further messages and receive their respective message acknowledgements.

Fig. 2 illustrates the general three-way data and acknowledgement model. A sequence of data packets is transmitted by the sender 1 to receiver 3 over the network 5 at time t_1 . The sequence includes data packets with sequence numbers 1 to 7500. For clarification, only the transfer of the data packet with sequence number 7500 is illustrated in Fig. 2. At time point t_3 receiver 3 sends an ACK message back to the sender 1. This message may contain the quantified information which data packets with which range of sequence numbers have been correctly received. In the illustration it is indicated that the acknowledged sequence number range is up to the packet with sequence number 7500. So, all the packets with sequence numbers 1 to 7500 are acknowledged. In one transport protocol implementation for the 10 GBit Ethernet network technology an ACK message is periodically sent based on a 10 ms time period. This corresponds typically to the transfer of a few thousand transport packets. The amount of data sent in the 10 ms interval corresponds to ~12 Mbytes in total. Due to the fact that also such an ACK message can get

lost, the receiver generates a ACKACK message in response to the reception of the ACK message at time t_5 .

The corresponding part of the protocol buffer for sending data allocated in the sender 1 will be freed after the reception of the ACK message at time t_4 . The receiver 3 may indicate to the application in the device 3 that a new data segment is available for processing from the time t_3 on. It will however keep track of the response to the ACK message. When the ACKACK message is received at time t_6 , the data transfer is completed. If the ACKACK message is missing, the receiver 3 repeats the ACK message after a while so that the sender shall get a further chance to free its buffer.

This is illustrated in Fig. 3. Here, the timeout value is set to be equivalent to one RTT. As explained above, RTT is the round trip time for sending a message to a station and receiving back an immediate answer. Therefore, simply the answer is not expected earlier than that. In case the first ACK message gets lost on the data path as illustrated, the sender 1 cannot free the buffer until time point t_5 when the repeated ACK message is received. For the purpose of monitoring and managing the different ACK messages, they also come with sequence numbers. It is special in Fig. 3, that the sender stops sending further packets until the ACK message for packet 7500 is received. This will happen when e.g. the application in the sender does not deliver further data, or the buffer is completely filled with unacknowledged data which need to be kept for retransmission.

Fig. 4 illustrates a different situation. When the ACK message sent out at time t_3 gets lost, the sender continues sending data packets. When the data packet with sequence number 15000 is sent at time t_4 , which later is acknowledged

at time t_6 , the sender interprets this at time t_7 as an implicit acknowledgement of the data packets sent in the previous acknowledgement interval up to the packet with sequence number 7500. This is compliant to the acknowledgement system according to the TCP protocol.

Fig. 5 shows the same situation as in Fig. 3. The sender 1 again waits for the ACK message in order to be able to free its buffer. In the embodiment according to the invention the receiver 3 repeats the ACK message in shorter succession than in the embodiment of Fig. 3 as a precaution. It means that the receiver does not wait for one RTT at minimum before repeating the ACK message. The solution is taken due to the recognition of the inventor that lost acknowledge messages in a situation as considered here, can subjectively slow down the data transport process. It is illustrated that the first repetition of the ACK message is already correctly received at time t_5 . The sender can free its buffer at this time. This is substantially earlier than time t_5 in Fig. 3. Further repetitions of the ACK message follow at times t_7 and t_{10} . The repetition is stopped when the ACKACK message for the first repeated ACK message is received at time t_{11} at the receiver 3. After the sender 1 has cleared its buffer, and new data has been received from the application, the sender 1 continues sending data packets at time t_8 . Again, this is significantly earlier than in the embodiment of Fig. 3. In an advantageous embodiment of the invention the interval for repeating the ACK messages can be defined by the value RTT/n , where n is a real or natural number higher than 1.

In another embodiment of the invention the interval for repeating the ACK messages is coupled to the regular ACK mes-

sage sending period. The following outline explains when this should be taken:

In cases of sustained data transmission with a high data rate and in absence of acknowledge losses or with a reasonable low loss rate of acknowledge messages, data packets can be acknowledged periodically with a period duration much less than a RTT. A common acknowledge period is e.g. 10 milliseconds, while on a transcontinental network connection; RTT can have an amount of 100 ms and even higher. Is an acknowledge message lost, but the sender continues sending data packets, see Fig. 4, the sender 1 would receive after 10 ms waiting time the next ACK message, which implicitly acknowledges all data.

However, in case that a couple of consecutive acknowledges are lost, the sender 1 can mark all data emitted since the last received acknowledge as lost and try to retransmit them again. On a link with a RTT of 100 ms and a data rate of 8 Gbit/s, at least 100 Mbytes would be retransmitted unnecessarily if just the ACK messages are lost. The same effect could be observed, when the sender 1 emits data within bursts instead of a constant data rate.

It is therefore proposed to retransmit acknowledge messages earlier than after a RTT at least under the following condition:

- a) no new acknowledges have to be sent after a time period according to the applied protocol algorithm.

Preferably in case that condition a) is true, it is proposed to retransmit ACK messages after a period RTT/n , with n greater than 1, see above.

Another possibility if condition a) is true, is to retransmit acknowledges after a time period k whereby k is coupled to the ack sending period, so that the relation $k * T_{ACK} < RTT$ is met. T_{ACK} is the ACK sending period, e.g. 10 ms.

- 5 It is to be noted that also the ACKACK messages can get lost. The conception of an earlier repetition of an ACKACK message than after RTT can likewise be used and bring the advantage of reduced overhead in the sender 1 and receiver 3, for handling ACKACK messages.
- 10 Fig. 6 shows the involvement of the different network layers in the data transport between transmitter 1 and receiver 3. The depicted layers correspond to the layers defined in the ISO/OSI reference model for data communication. Physical layer 10 and link layer 20 might be in an 10 GBit Ethernet or Infiniband interface, implemented in hardware. The other layers, network layer 30, transport layer 40 and application layer 50 are preferably implemented with software means. Reference number 5 denotes the network components with e.g. switchers and routers. The buffer used for sending the data in sender 1 is allocated in the main memory but administered in the transport layer 4. A corresponding receiving buffer exists in the receiver 3.
- 15
- 20

The features of the invention as disclosed in the above description, in the claims and in the drawing may be of importance for the implementation of the various embodiments of the invention both individually and in any desired combination. The building blocks according the invention like the sending means and timing means, etc. can be implemented with hardware and/or software means.

25

Claims

1. Method for transporting data over a data connection between a sending network component (1) and a receiving network component (3) via a network (5), the method comprising the following steps:
- 5
- sending a number of data transport messages to the receiving network component (3) by the sending network component (1);
 - receiving the number of data transport messages by the
10 receiving network component (3);
 - sending an acknowledge message back to the sending network component (1) by the receiving network component (3) indicating correct reception of the number of data transport messages;
- 15 characterized by the further step of:
- repeating an acknowledge message by the receiving network component (3) after a time less than a round trip time for the communication between the sending network component (1) and the receiving network component (2).
- 20
2. Method according to claim 1, wherein, the acknowledge message is periodically repeated with a time period being less than the round trip time until an acknowledge message is received back from the sending network component for indicating that the acknowledge message from
25 the receiving network component has been correctly received.
3. Method according to claim 2, wherein the time period for repeating the acknowledge message from the receiving
30 network component (3) corresponds to a value RTT/n ,

where RTT is the estimated round trip time and n is a real or natural number greater than 1.

4. Method according to claim 2, wherein the time period for repeating the acknowledge message from the receiving network component (3) is coupled to the selected acknowledge message sending interval which is less than the round trip time.
5. Method according to one of the previous claims, further characterized by the step of commencing sending further data transport messages after receiving the acknowledge message from the receiving network component (3) by the sending network component (1).
6. Method according to one of the previous claims, characterized by that the data transport message and the further data transport message, comprise one or more data packets.
7. Method according to claim 6, characterized by that the data packets conform to the transmission control protocol (TCP) or the transmission control protocol in connection with the internet protocol (TCP/IP).
8. Network component (3) adapted for the use in a method according to one of the previous claims comprising:
 - receiving means configured to receive a data transport message from the sending network component (1);
 - sending means configured to send an acknowledge message back to the sending network component (1) in response to the reception of the data transport message;characterized in that

- the sending means are configured to repeat an acknowledge message, wherein the sending means include timing means that are configured to adjust the time for sending out the repeated acknowledge message to a value less than a round trip time for the acknowledge message.
- 5
9. Network component (3) according to claim 8, wherein, the sending means including the timing means are configured to periodically repeat an acknowledge message with a time interval being less than the round trip time for the acknowledge message until an acknowledge message is received back from the sending network component for indicating that the acknowledge message from the receiving network component (3) has been correctly received.
- 10
10. Network component (3) according to claim 9, wherein, the timing means determine the time interval for repeating the acknowledge message to be equal to RTT/n , wherein RTT means the round trip time for the acknowledge message and n is a real or natural number greater than 1.
- 15
11. Network component (3) according to claim 9, wherein, the timing means determine the time interval for repeating the acknowledge message to be in synchronization with the time interval for generating acknowledge messages during reception of a data stream.
- 20

AMENDED CLAIMS
received by the International Bureau on 30 July 2009 (30.07.09)

1. Method for transporting data over a data connection between a sending network component (1) and a receiving network component (3) via a network (5), the method comprising the following steps:
- sending a number of data packets to the receiving network component (3) by the sending network component (1);
 - receiving the number of data packets by the receiving network component (3);
 - sending an acknowledge message back to the sending network component (1) by the receiving network component (3) indicating correct reception of the number of data packets;
- characterized by the further step of:
- repeating the acknowledge message by the receiving network component (3) after a time period shorter than a round trip time for the communication between the sending network component (1) and the receiving network component (2), wherein the round trip time is the expected time period that, under normal conditions, lies between sending out a message and receiving an immediate reply to the sent message.
2. Method according to claim 1, wherein, the receiving network component periodically repeats sending the acknowledge message to the sending network component until it receives an acknowledge message that is sent by the sending network component and that acknowledges correct reception of the acknowledge message sent by the receiving network component, wherein the repetition is ef-

fectured with a time period being shorter than the round trip time.

3. Method according to claim 2, wherein the time period for repeating the acknowledge message from the receiving
5 network component (3) corresponds to a value RTT/n , where RTT is the estimated round trip time and n is a real or natural number greater than 1.
4. Method according to claim 2, wherein the time period for repeating the acknowledge message from the receiving
10 network component (3) is coupled to the selected acknowledge message sending interval which is less than the round trip time.
5. Method according to one of the previous claims, further characterized by the step of commencing sending further
15 data transport messages after receiving the acknowledge message from the receiving network component (3) by the sending network component (1).
6. Method according to one of the previous claims, characterized by that the data transport message and the further data transport message, comprise one or more data
20 packets.
7. Method according to claim 6, characterized by that the data packets conform to the transmission control protocol (TCP) or the transmission control protocol in connection with the internet protocol (TCP/IP).
25

8. Network component (3) adapted for the use in a method according to one of the previous claims comprising:

- receiving means configured to receive a data packet from a sending network component (1);
- 5 - sending means configured to send an acknowledge message to the sending network component (1) in response to the reception of the data packet;

characterized in that

- 10 - the sending means are configured to repeat the acknowledge message, wherein the sending means include timing means that are configured to adjust the time for sending out the repeated acknowledge message to a time period shorter than a round trip time for the communication between the sending network component
- 15 (1) and the receiving network component (2), wherein the round trip time is the expected time period that, under normal conditions, lies between sending out a message and receiving an immediate reply to the sent message.

- 20 9. Network component (3) according to claim 8, wherein, the sending means including the timing means are configured to periodically repeat the acknowledge message with a time interval being less than the round trip time for the acknowledge message until an acknowledge message is
- 25 received from the sending network component for indicating that the acknowledge message from the receiving network component (3) has been correctly received.

10. Network component (3) according to claim 9, wherein, the timing means determine the time interval for repeating
- 30 the acknowledge message to be equal to RTT/n , wherein

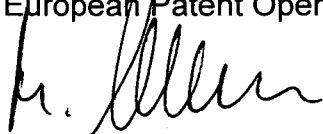
RTT means the round trip time for the acknowledge message and n is a real or natural number greater than 1.

11. Network component (3) according to claim 9, wherein, the timing means determine the time interval for repeating the acknowledge message to be in synchronization with the time interval for generating acknowledge messages during reception of a data stream.

Statement under Article 19 (1) PCT

Claim 1 has been amended, inter alia, by adding a definition of the term 'round trip time' as used in accordance with the invention. The amendment clearly and inventively distinguishes the claim over document D1, in which the TTI (transmission time interval) is mentioned. Generally TTI is the time that is required to transmit all bits of a message in serial form, and is also referred to as serialisation time. RTT (round trip time) not only includes the TTI of the original message, but also includes delays that may occur on the transmission path, e.g. in switches or routers, and the time for an acknowledge message issued by the receiver to arrive at the sender. Also, twice the TTI may be much longer than the RTT, since a long initial message having a rather long TTI may be acknowledged by a short ACK message having a comparatively short TTI.

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European Patent Operations



Robert Lindemann
European Patent Attorney

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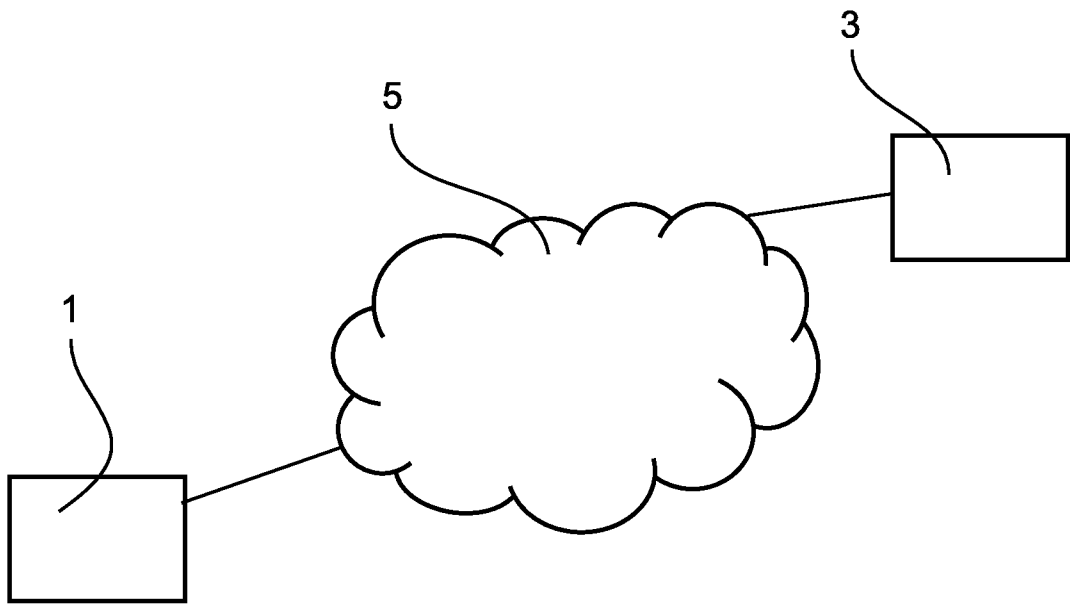


Fig. 1

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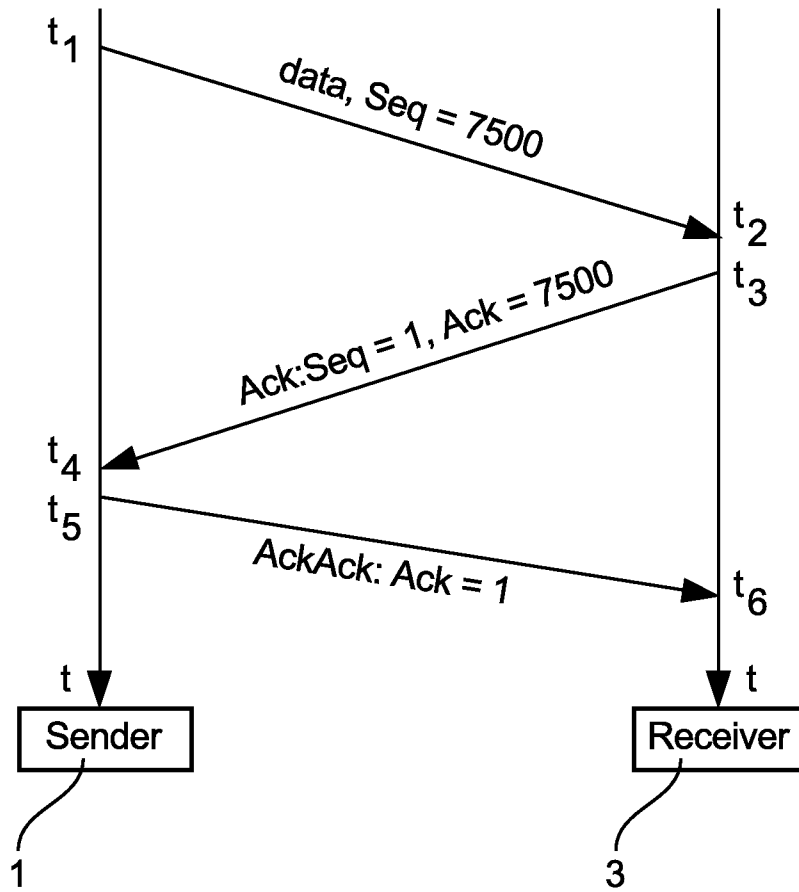


Fig. 2

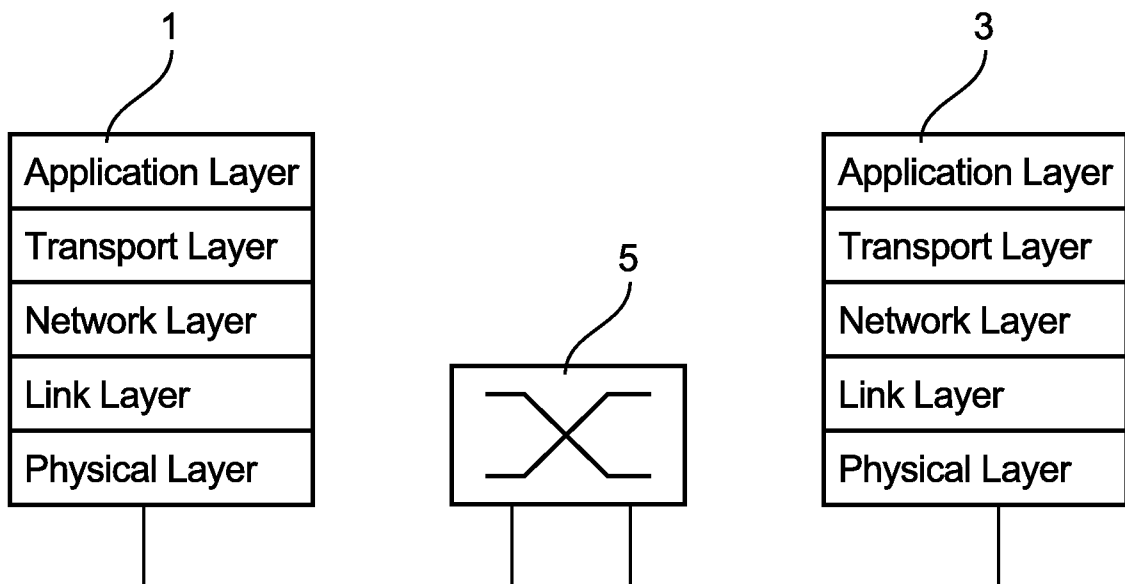
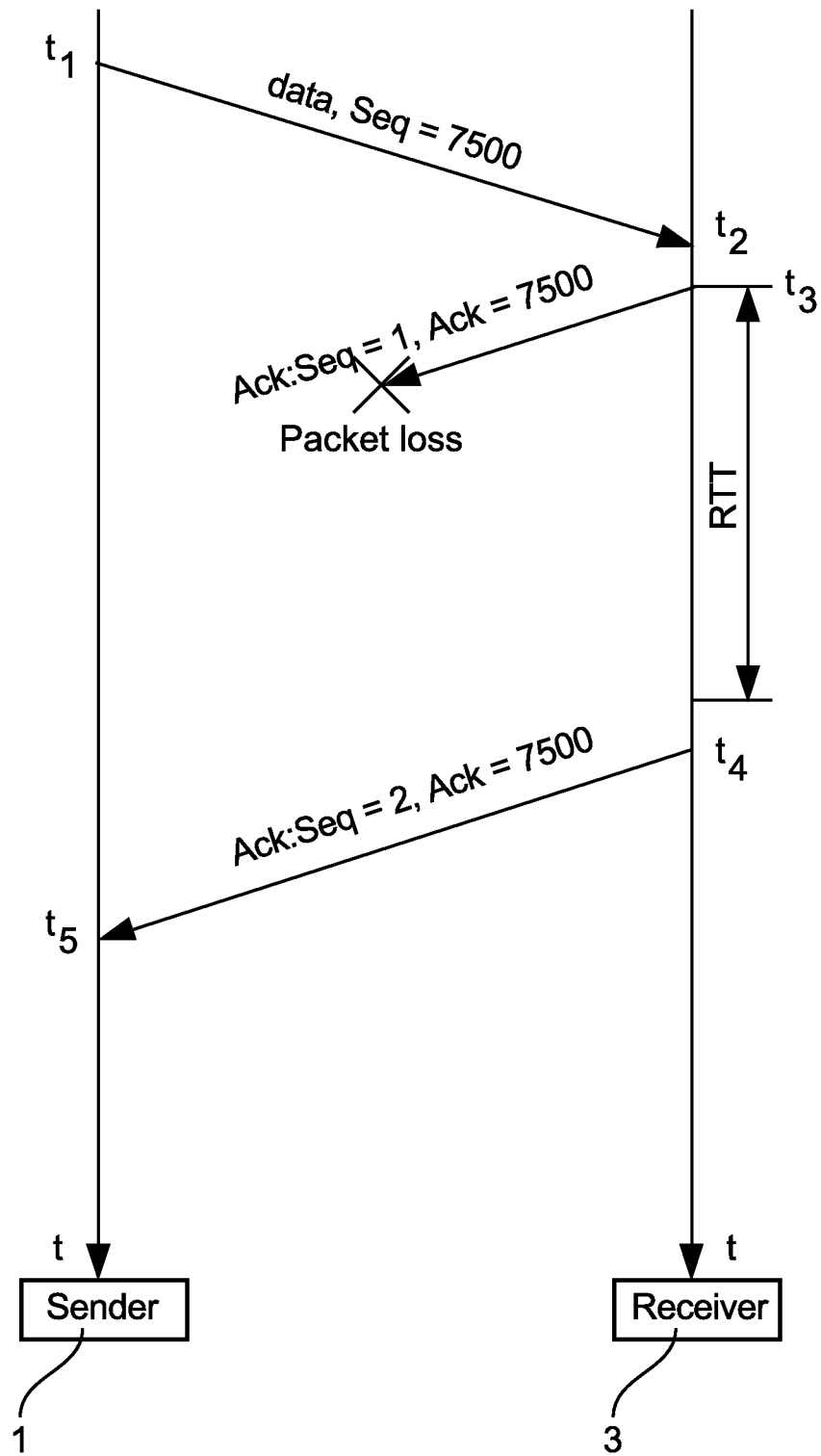
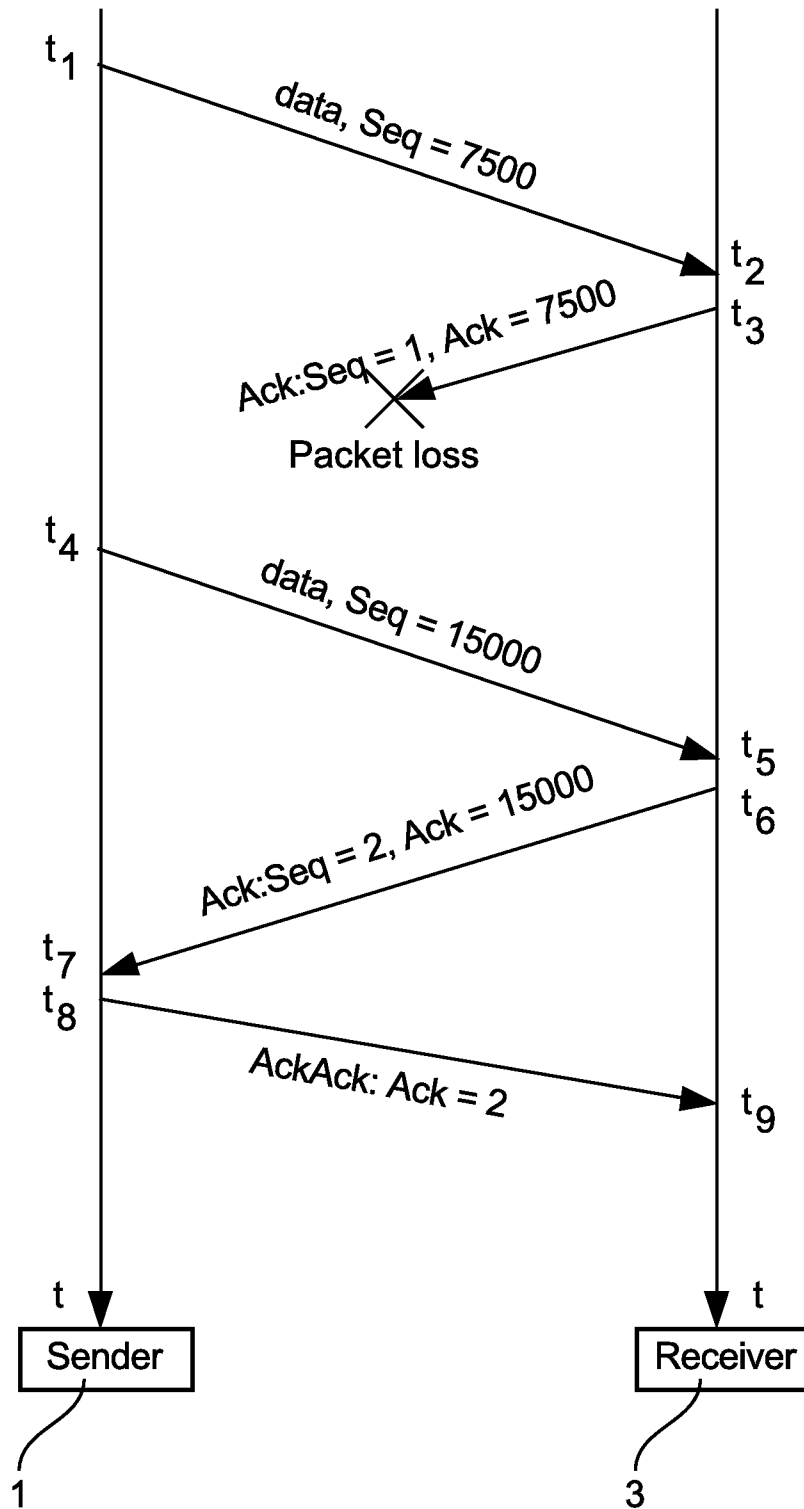


Fig. 6

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**Fig. 3**

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**Fig. 4**

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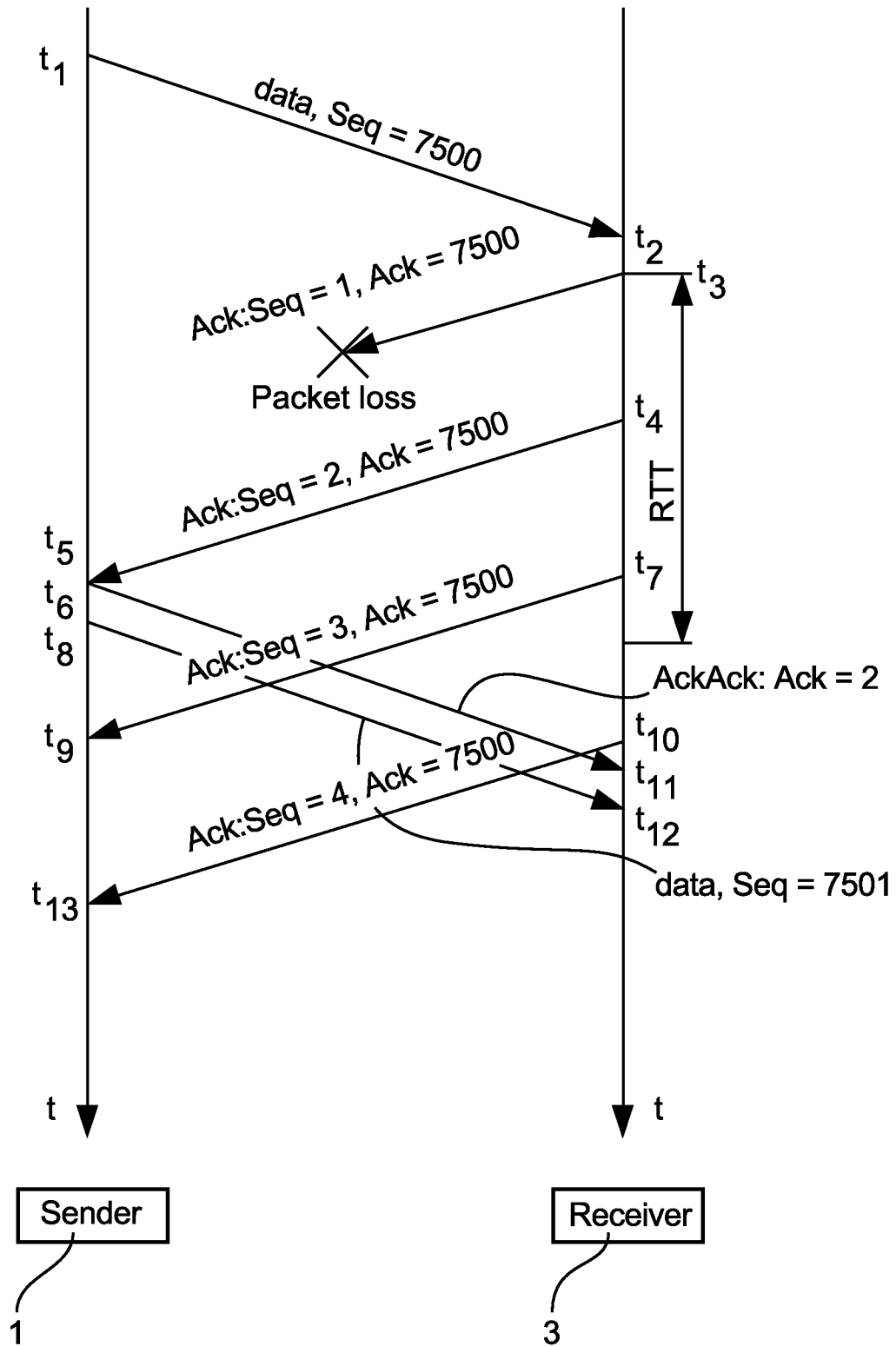


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2009/053630

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L1/16

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

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, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2008/039025 A (LG ELECTRONICS INC [KR]; JUNG IN JAE [KR]; KIM BONG HOE [KR]; KIM KI J) 3 April 2008 (2008-04-03) abstract page 10, line 12 - page 12, line 4 page 16, line 15 - page 18, line 20 -----	1,8
A	US 4 803 685 A (OGET CHRISTIAN [FR]) 7 February 1989 (1989-02-07) column 6, line 3 - line 11 -----	1-11

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

☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2008039025	A	03-04-2008	NONE
US 4803685	A	07-02-1989	BR 8701010 A 29-12-1987
		CA 1264875 A1 23-01-1990	
		DE 3766732 D1 31-01-1991	
		EP 0239453 A1 30-09-1987	
		FR 2595522 A1 11-09-1987	
		GR 3001549 T3 23-11-1992	
		IN 170913 A1 13-06-1992	
		JP 62277827 A 02-12-1987	
		SG 12792 G 16-04-1992	