

It is obvious, that whenever two threads are working at the same memory area, coordination is required to avoid race conditions. Otherwise there is the danger of having conflicting memory accesses such that data which is to be read by the sending thread is already overwritten by the application thread which is delivering the data into the sending buffer or vice versa that data which is to be sent over the network is not even delivered to the buffer memory so that outdated data will be send instead.

Lock free data structures for data transport systems are proposed in prior art. Particularly, WO 2009/043712 A1 describes a memory buffer model for a data transport system, which is designed to work in a point-to-point mode.

From WO 03/069836 A1 it is known a method of transmitting data packets over network from a sending station to a plurality of receiving stations in a multicast communication mode. This method involves receiving acknowledgment messages from each of the plurality of receivers. The method also involves a step of combining each received acknowledgment message with a data structure in which information for each transmitted packet is recorded. Retransmission is performed for a packet for which it is indicated in the data structure that a receiver in the plurality of receivers has not yet acknowledged receipt of the data packet.

The invention

The inventors recognized that the lock free data structure as disclosed in WO 2009/043712 A1 is not appropriate for the high-speed point-to-multipoint communication mode. It is therefore an object of the invention to provide a solution with a lock-free data structure for the case of a point-to-multipoint data transmission.

Having a point-to-multipoint data transfer system means on the networking level a necessity for a more complex ARQ management scheme (at the sender site) than in case of the point-to-point mode, where a decision on buffer clean-up can be taken instantly upon reception of a confirmation for a certain data packet in the form of an ACK packet. A variant of the Automatic Repeat Request Protocol ARQ is also used in the Transmission Control Protocol to ensure reliable transmission of data

Claims

1. A method for operating a memory buffer system implemented at a sender station (10) connectable to a communication network (30) for the fast data transport over the communication network (30) with a reliable transport protocol working in a point-to-multipoint data transfer mode, wherein the memory buffer system comprises a send buffer (40) comprising data cells in which the data units ready to be sent over the communication network (30) are stored and in which the data units are stored which have been sent over the communication network (30) with corresponding data packets but not being completely acknowledged by the receiving stations (21, 22, 23) of said point-to-multipoint data communication mode, wherein the memory buffer system further comprises a meta-storage buffer (50) comprising cells in which the meta-data in the form of protocol-dependent parameters for the data packets which have been sent over the communication network (30) but not being completely acknowledged are stored, the method being characterized by:
- with a sending thread (70) which is responsible for sending data packets to a multipoint receiver group, adding the meta-data for a sent data packet into a next free cell of the meta-storage buffer (50), thereby shifting a first descriptor (ActiveCellsEndDescr) pointing to the end of the occupied cells range in the meta-storage (50) forward;
 - with a receiver servicing thread (90) which is responsible for the adding of meta-data into the meta-storage buffer (50) removing a cell from the range of occupied cells in the meta-storage buffer (50) in the case that it is found that the corresponding data packet has been completely acknowledged by all active receivers (21, 22, 23) in the point-to-multipoint communication mode, thereby shifting a second descriptor

- (ActiveCellsBeginDescr) pointing to the beginning of the occupied cells range in the meta-storage (50) forward; and in the receiver servicing thread (90) checking whether an acknowledgment message from the multipoint receivers (21, 22, 23) is missing for the corresponding data packet thereby checking if the receiver from which an acknowledgement message is missing is in an inactive state, wherein in case the missing acknowledgment message is not from an inactive receiver, declaring the data packet to be a candidate for retransmission over the communication network (30) to at least the multipoint receiver (21, 22, 23) from which the acknowledgment message is missing.
2. Method according to claim 1, wherein the occupied cells in the meta-storage buffer (50) comprise a field (MASK) with mask information reflecting for each of the receiving stations (21, 22, 23) of a data transfer session in the point-to-multipoint mode, the state whether or not an acknowledgment message has been received back from the respective receiving station (21, 22, 23) for the corresponding data packet being sent over the communication network (30).
3. Method according to claim 2, comprising after receiving an acknowledge message from a receiving station (21, 22, 23) updating said mask information in the occupied cell for the corresponding sent data packet by the receiver servicing thread (90).
4. Method according to one of the claims 2 or 3, wherein the receiver servicing thread (90) comprises checking the entries in the field (MASK) with mask information, whereby the cell will be declared to be allowed to be removed in the removal process if the mask information reflects that the acknowledgment messages for the corresponding data packet have

been received from all active receivers (21, 22, 23) involved in the point-to-multipoint communication mode.

5. Method according to one of the claims 2 to 4, wherein said mask information (MASK) is implemented in the form of a binary mask with a binary information item for each of the participating receiving stations (21, 22, 23) in said point-to-multipoint communication mode.

10 6. Method according to one of the previous claims, wherein checking for an inactive receiver involves comparing the mask information of the corresponding cell in the meta storage buffer (50) with a protocol object list in which it is recorded if any one of the multipoint receivers (21, 22, 23) is inactive in the current data transfer session.

7. Method according to one of the previous claims, wherein the checking whether acknowledgment messages are missing comprises comparing the amount of occupied cells in the meta-storage buffer (50) with a threshold value (LRST) and taking further action in the step of checking only if the amount of occupied cells in the meta-storage buffer (50) exceeds the threshold value (LRST).

25 8. Method according to claim 7, wherein the threshold value (LRST) is estimated at the beginning of a data transfer session.

9. Method according to claim 8, wherein estimating the threshold value (LRST) comprises:

- measuring the round trip time values RTT in milliseconds between the sending station (10) and any one of the multipoint receiver stations (21, 22, 23)
- selecting the highest round trip time value RTT measured in the previous step;

35

- calculating the threshold value LRST according to the formula:

$$LRST = \left(\frac{\frac{DataRate * 1E6}{PacketSize * 8}}{\frac{1E3}{RTT}} \right) + B \quad \text{where}$$

- DataRate - is the maximum sending data rate in [Mbit/s]
- PacketSize - is the maximum packet size in [bytes]
- RTT - is the highest measured RTT value selected in the step before in [ms]
- B - is a correction coefficient.

10

10. Method according to claim 9, wherein the correction coefficient B is calculated according to the formula:

$$B = \left(\frac{\frac{DataRate * 1E6}{PacketSize * 8}}{\frac{1E3}{RTT}} \right) * 0.5$$

with the DataRate, PacketSize and RTT value being the same as defined in claim 10.

15

11. Method according to one of the previous claims, comprising maintaining a third descriptor (NextRetransmissionDescr) pointing to the next most expected position of a cell which contains the meta-data of the data packet stored in the send buffer (40) which is expected to be retransmitted at the next retransmission request.

20

12. Apparatus adapted to perform the method according to one of the previous claims.

25

13. Computer program product having stored thereon program code which when run in a computing system performs the method according to one of the claims 1 to 11.

30

14. Computer program comprising executable program code which when run in a computing system performs the method according to one of the claims 1 to 11.