# Structural Organization of the Router for the Multi-channel Computer Systems

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**Abstract.** *In this paper we suggest a specialized router for distributed computer systems, which has the internal multichannel links. This router allows to eliminate the deadlocks in the routed data flows for the various routing mechanisms that supports a variety of simultaneous secured communication channels and allow to improve the functioning of the computer systems and security of the processed data there.*

## Keywords

Data flow, router, multichannel links.

## 1 Introduction. The statement of the problem

There is an effective mechanism to improve the data security in the distributed computer systems (DCS) – the directed routing, which provides the transfer of data on a communication channel with the criterion of the maximum safety for the transmitted data by each constituent sub-channels between the nodes. The safety criterion is defined as the probability of threats realization for the transmitted data security on a particular sub-channel. This probability is functionally related to the trust level to the node actions in the DCS.

Let us consider the case where the trust level parameter to nodes is varied in the range from 0 to 1. Let us show the certain topology of the distributed computer system with the predefined trust levels for the nodes action in DSC (Fig. 1).

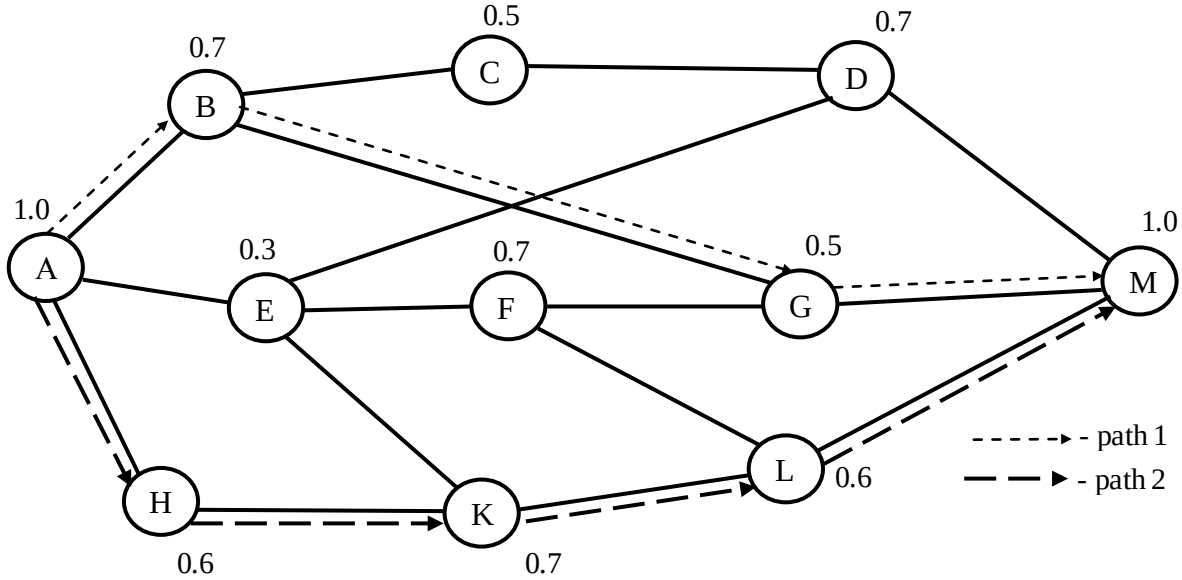



**Fig. 1.** The topology of the DCS with the predefined trust levels for nodes actions

When the data is transmitted from the node A to the node M then there multiple paths are available. Thus, the data transmission is safe in case only if the trust level to the all nodes on the packets route must not fall lower than 0.6, then the data can be transmitted over a shorter path 1. In case if the requirement is that the trust level must not fall lower than 0.55, then the data transmission must pass through path 2, which is not the most optimal in terms of distance of the data

transfers. Thus, there is the need to develop a special mechanism for the data routing along a predetermined path that will allow to transmit the data with the criterion of trust level to the nodes actions in the DCS, which is functionally linked to the safety of the data transmission.

When we are implementing the directed routing there is raised another related problem. The directed routing means that the data are transmitted by a certain communication channel, which is formed by the criterion of the maximum data transfers safety. Let us want to send a message from the node A to the node M by the safest route: A – F – G – L – M (Fig. 2).

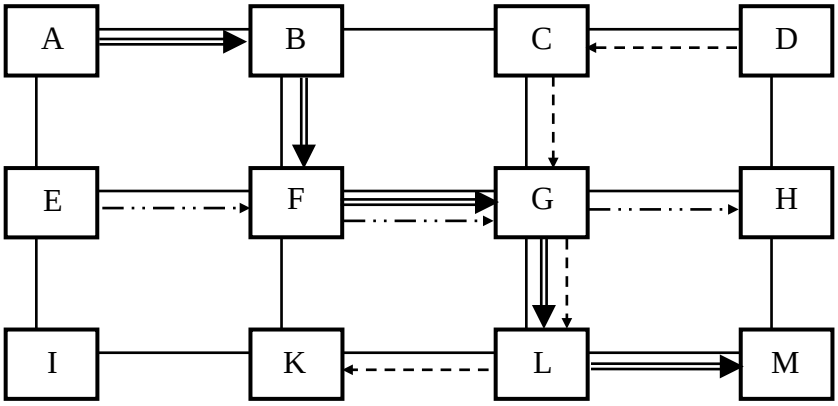



**Fig. 2.** The multiple data flows, which are intersecting in the topology of a distributed computer system

As a result there is formed a temporary channel A – F – G – L – M, which for certain period closes the possibility of transfer data by the other communication channels in a given topology, such as the channels D – C – G – L – K or E – F – G – H. In fact, there is a classical data interlocking that significantly increases the time of the data transmission. Furthermore, the heavy traffic recall the high probability that a packet will be blocked in the buffer, taking a number of buffers on his route, which in turn causes the increasing the time of the data packages transmission. The problem of channels interlocking also arises when there is implemented the routing mechanism based on the virtual channels. Thus, the actual problem is the implementation of a specialized router for distributed computer systems, allowing serve the multiple concurrent data flows.

## 2 The analysis of recent results and publications

The theory of the routers design is sufficiently developed. There are known a number of publications in this field, in particular [1,2].

The generalized structure of classical router for DCS and switched networks is shown in Fig . 3 .

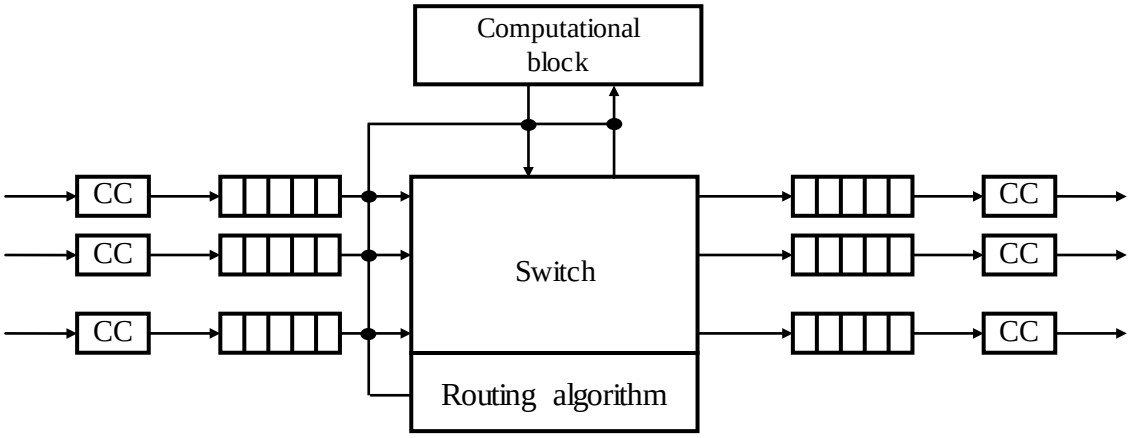
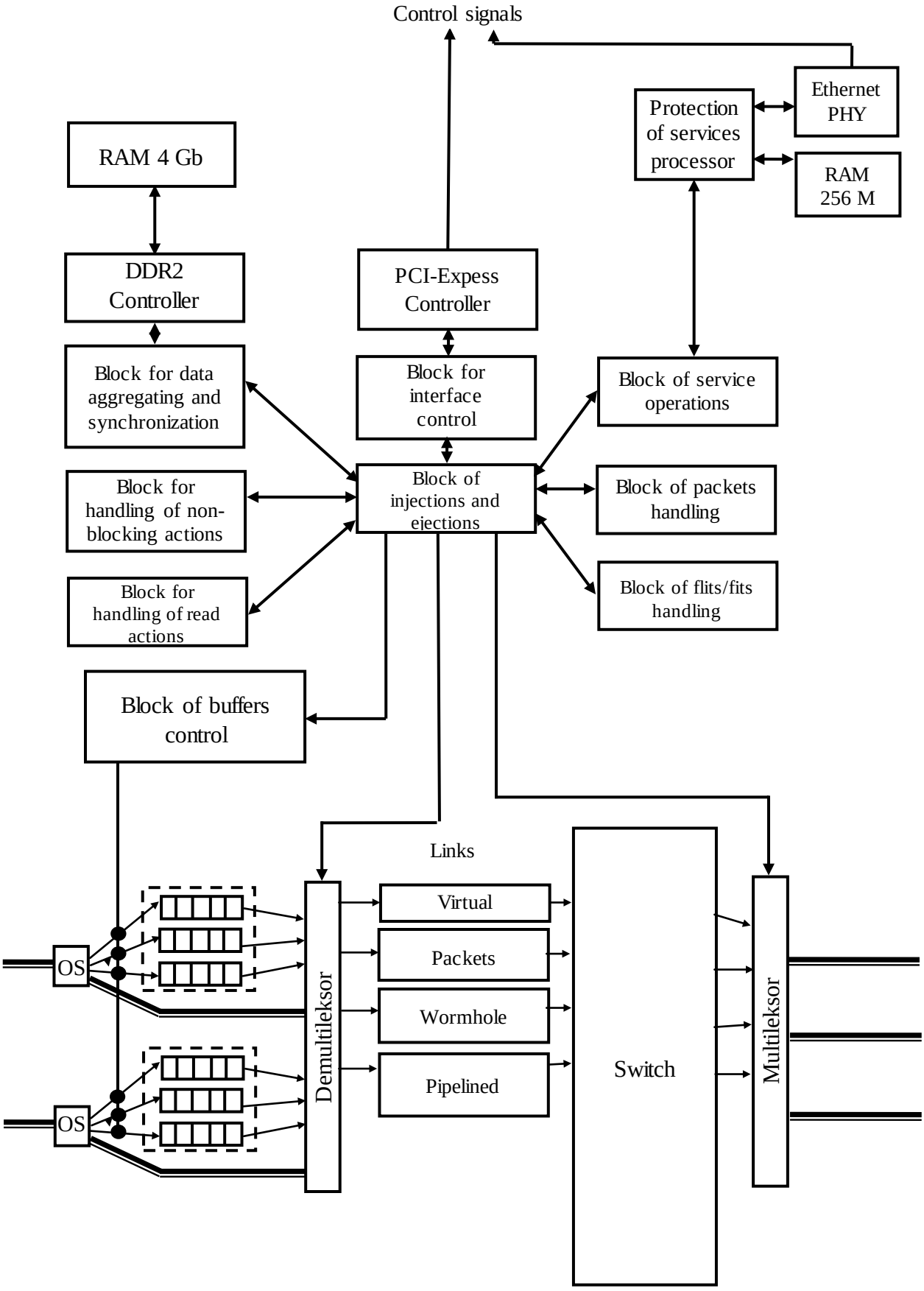



**Fig. 3.** The generalized structure of a router for the distributed computer systems and switched networks

This router performs the data processing and transmitting in 4 phases [3,4]:

- the input buffering: the data arrives in the input buffer;
- the forming of the routing paths: based on the destination address is determined the output port of the router ;
- the bits transmission through the router: the data passes through the router to the output buffer;
- the bits transmission over the communication channel (CC): the data are transmitted over the communication channel to the next router.




OS - optical splitter

**Fig. 4.** The structure of a router with internal multi-channel communications

# 3 The router for distributed computer systems with the internal multi-channel links

To solve the problems discussed above on the data flows interlocking we propose to apply the mechanism of the multi-channel communications. Instead a single channel with the buffer in router we suggest to set a number of buffers which are operating with the parallel multi-channel links, so there the data are split for a certain number of sub-channels, and these sub-channels are independent and the data transmission on them can be performed in parallel, thereby eliminating the data transfers delays, associated with interlocking, which is caused by the capture of the packet buffers or the link.

The structure of the router with internal multi-channel communications is shown on Fig. 4.

For the channels multiplexing for the data transfers are may be used the protocols of the Time Division Multiple Access (TDMA) or the Frequency Division Multiple Access (FDMA). At the inputs of the router there is a buffer memory for the intermediate data storage. The choice of data to send is implemented in accordance with the routing algorithm. In the multi-channel communications there is a division of data between the multiple sources. To support the multi-channel mechanism are used the special data transfer protocols with the fixed or random access, which are realizing the certain scheme for channels division.

One of the most effective protocols to support multi-channel communication is ALOHA, which enables the communication between the source and the receiver in the multi-channel environment. The classic one, the ALOHA protocol without the time slots is rather difficult to manage, as packets can be transmitted at any time and are independent from each other.

The modifying one is a protocol Slotted ALOHA (S-ALOHA) which implements the traffic division by the slots and all packets are sent entirely within the slot, and this allows increased the throughput in comparing to the classical ALOHA protocol by reducing the number of conflicting packages due to the prohibiting the data transfer in next slot in case if there is a conflict and there is no partial overlap of conflicting packages.

It should be noted that the number of simultaneously used channels on the buffer level can be different, but a fixed number of channels is simplified the control mechanism for the multi-channeled transmission. The number of channels is determined by the traffic intensity, which in turn determines the number of required virtual channels, which are formed simultaneously. In the practice, the actual number of channels should be equal to the number of source nodes which are generate and transmit packets with a high intensity. Also, in case if the traffic intensity is increased the data interlocking may occur, but the number of the data locking cases is reduced substantially.

Thus, the suggested multi-channel mechanism allows to solve the problem of the channels interlocking and the buffers blocking, which allow increase the efficiency of routing mechanism in distributed computer systems. As a result, we may realize a number of the simultaneously operating secured sub-channel for the critical data transmission and the open communication channels for the open data transfers without any interlocking, which increases the data transfer efficiency and their security in the distributed computer systems.

# 4 Conclusion

There is suggested the internal multi-channel links mechanism in the routers to solve the problem of mutual blocking of data flows. The main idea is that instead of a single-channel communication buffer in the router are installed a number of parallel operating buffers and multi-links, which are divided the data channel on a certain number of sub-channels. Sub-channels are independent between themselves and the data on them is transferred in parallel, thereby eliminating the time delays associated with the interlocking, which are caused by the capture of packet buffers or links. The result is formed a number of simultaneously operating secured channel for the critical data transmission and the open communication channels for open data transmitting without any interlocking, which increases the efficiency and security for the data processing in the distributed computer systems.

# References

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