Development of the Transport Layer Scheduling Mechanism for the Onboard SpaceWire Networks

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Introduction (1/2)

Modern onboard networks need to schedule the traffic to avoid conflicts with simultaneous network resource usage and to reduce the network capacity.

Most of scheduling mechanisms for packet-switching and IP networks are implemented by means of store-and-forward switches.

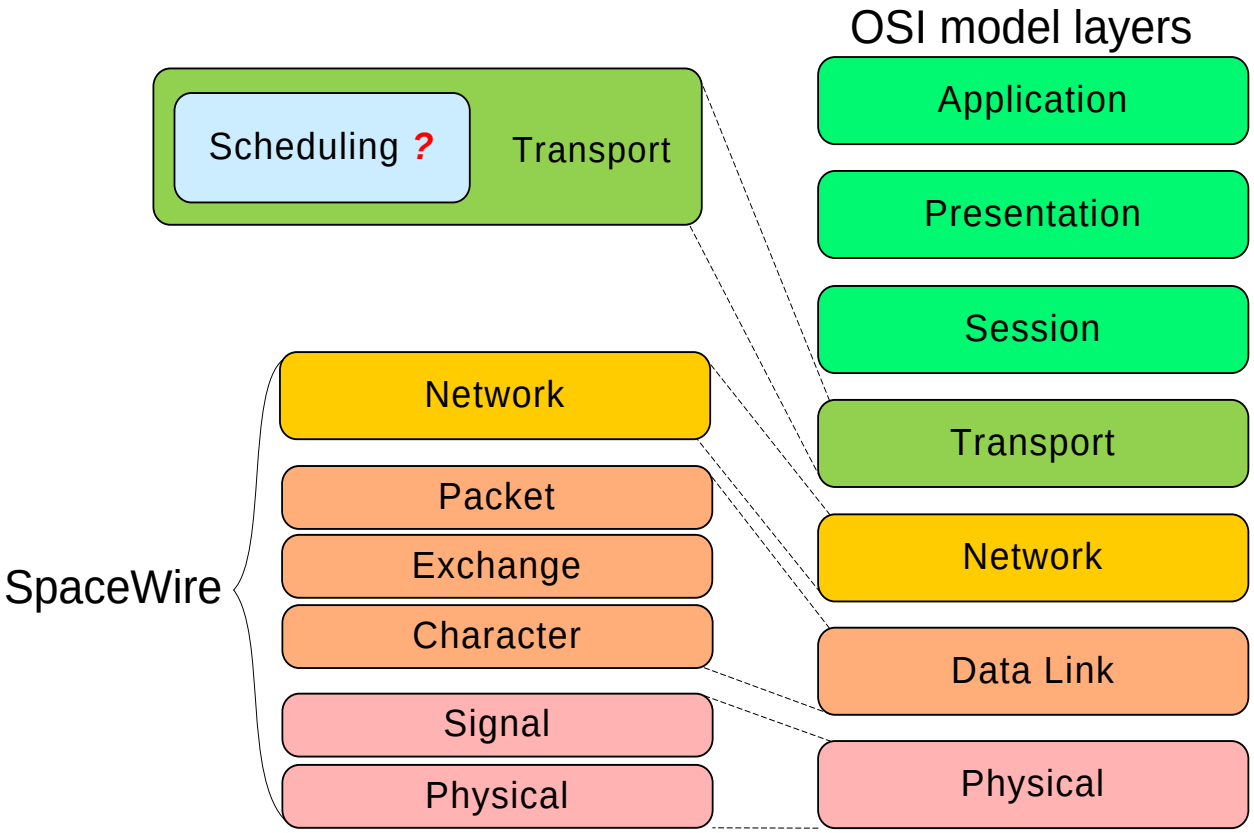
It is not suitable for SpaceWire networks.

According to SpaceWire standart, switches support wormhole routing without packet buffering.

Introduction (2/2)

There is no transport layer protocol officially released for SpaceWire that provides scheduling.

The SpaceWire-D protocol prototype has such a scheduling mechanism. But this protocol is not available for the public.



Scheduling

- Network should synchronize the schedule among all the nodes (by using SpaceWire time-codes);
- There should be a schedule for the whole SpaceWire network.

Slot	Nodes																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
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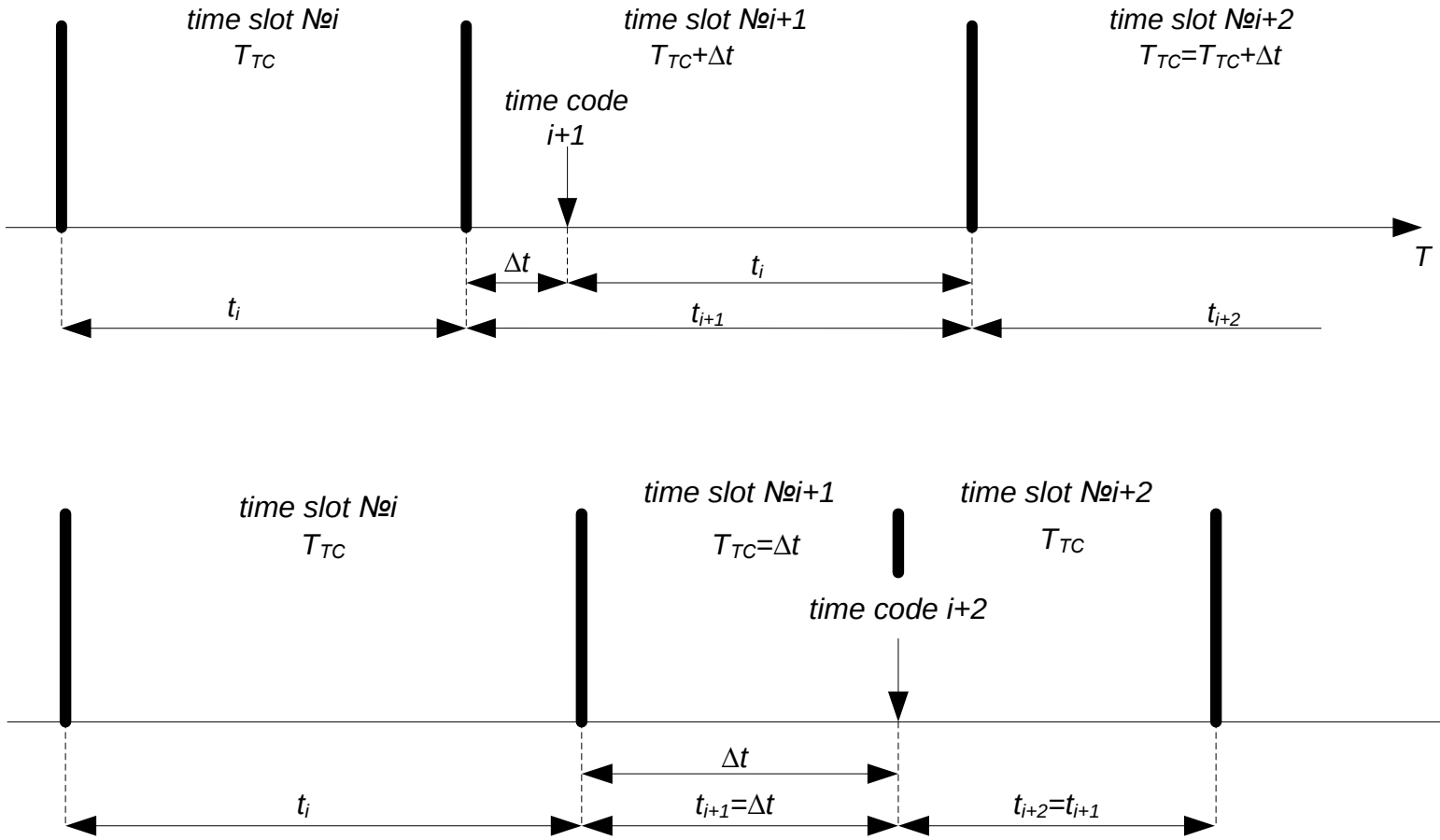
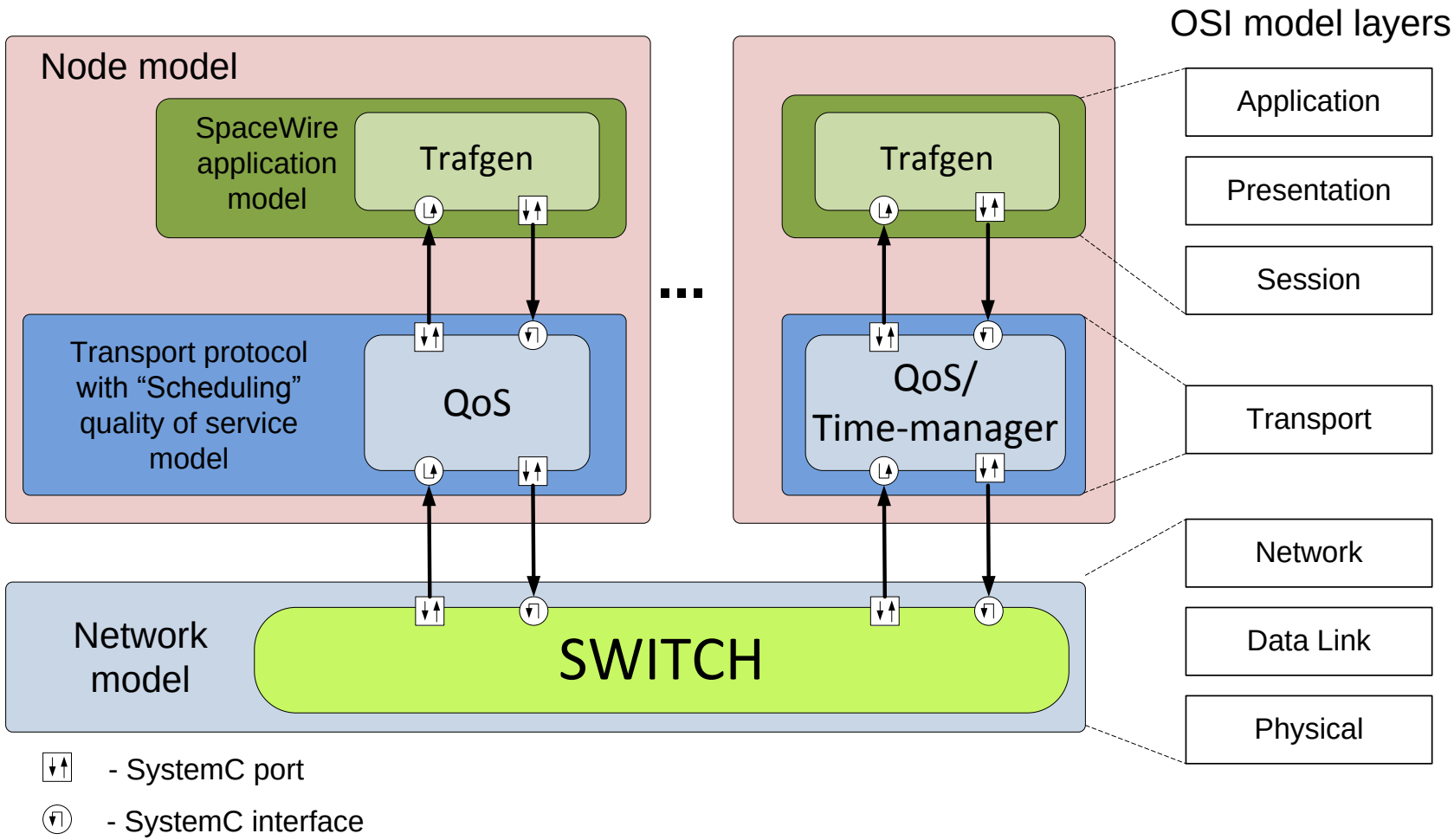
Scheduling mechanism based on the SpaceWire-D

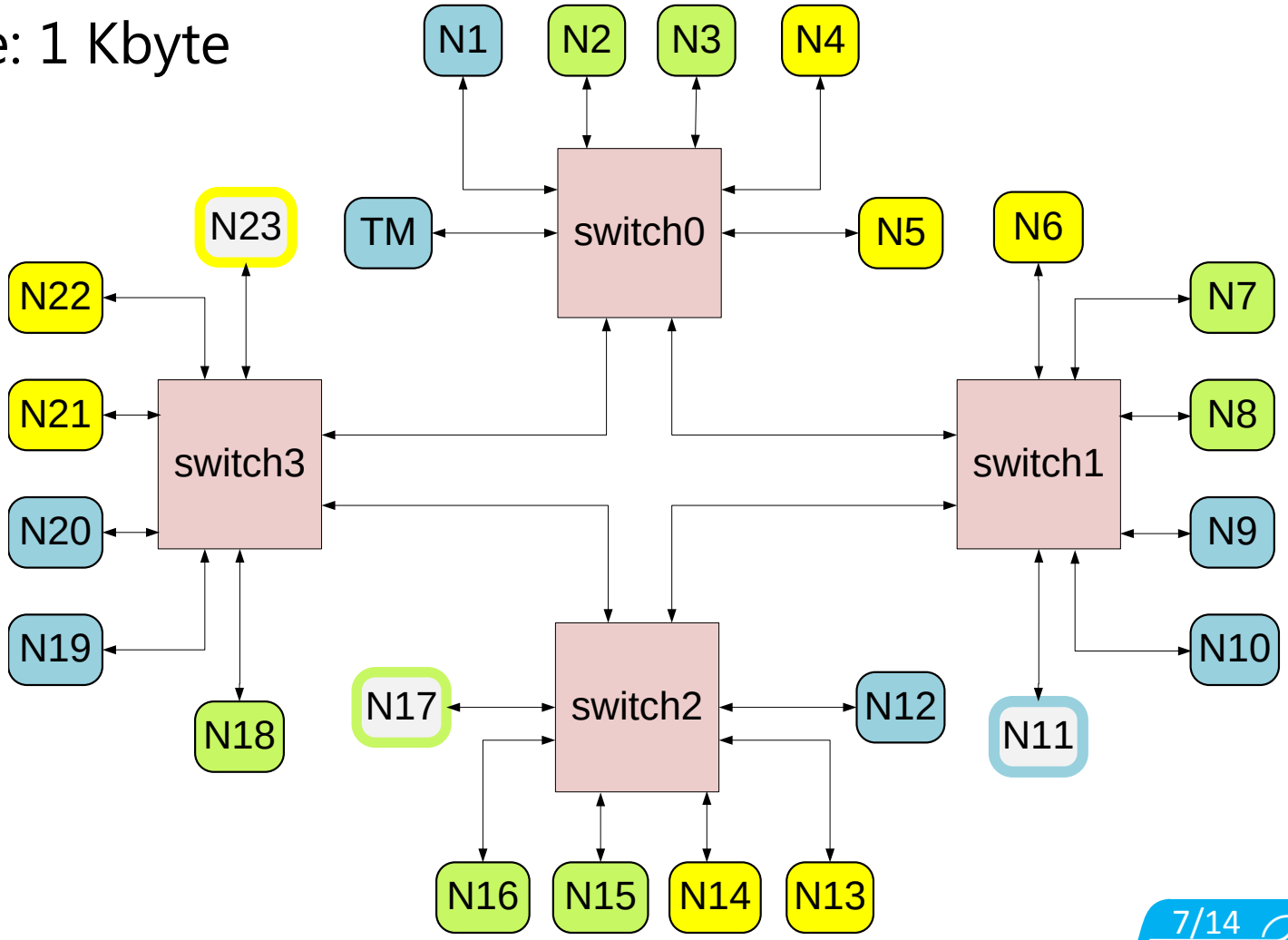


The simplified SpaceWire network model in SystemC

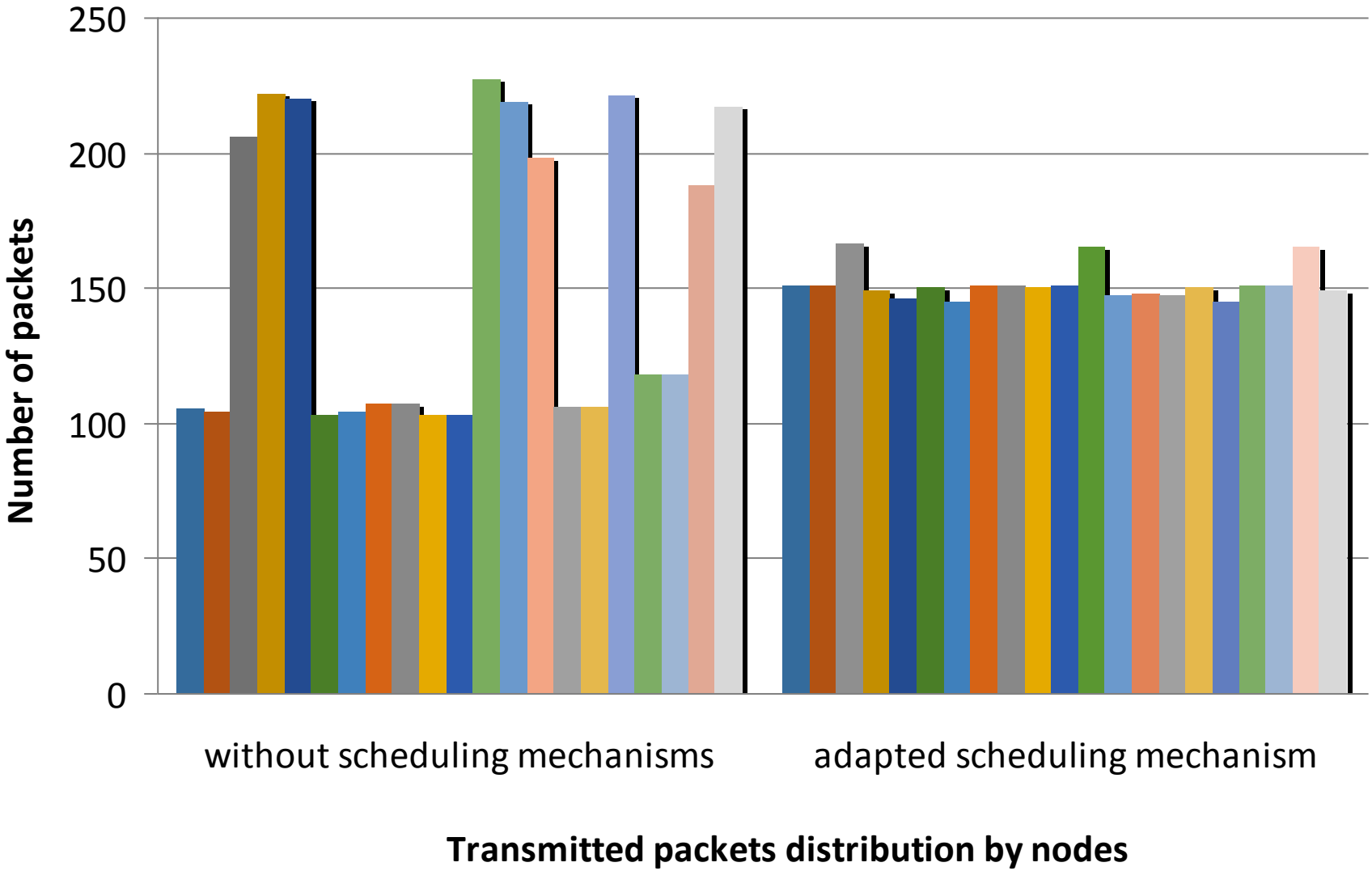


Simulation

- Data transmission speed: 200 Mbit/s;
- Time-slot: 500 μs;
- Packet size: 1 Kbyte



Comparison of data transmission results with scheduling mechanism and without it



Adapted scheduling mechanism disadvantages

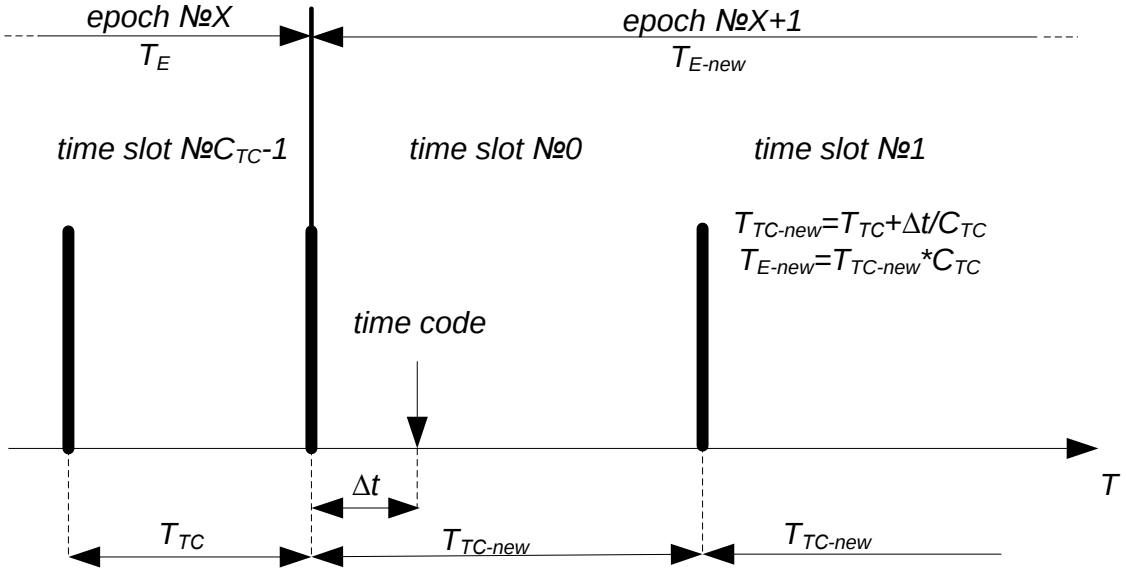
- It depends on a time-code number
  (SpaceWire-D – only 64 time-slots).
- Node synchronizes and updates time-slot timer too frequently.
  - additional computational resources from a node;
  - additional channel capacity;
  - slow down data transmission (and even block it) because time-codes have higher priority than data;
  - some satellite equipment has high-precision clocks that does not need frequent synchronization.

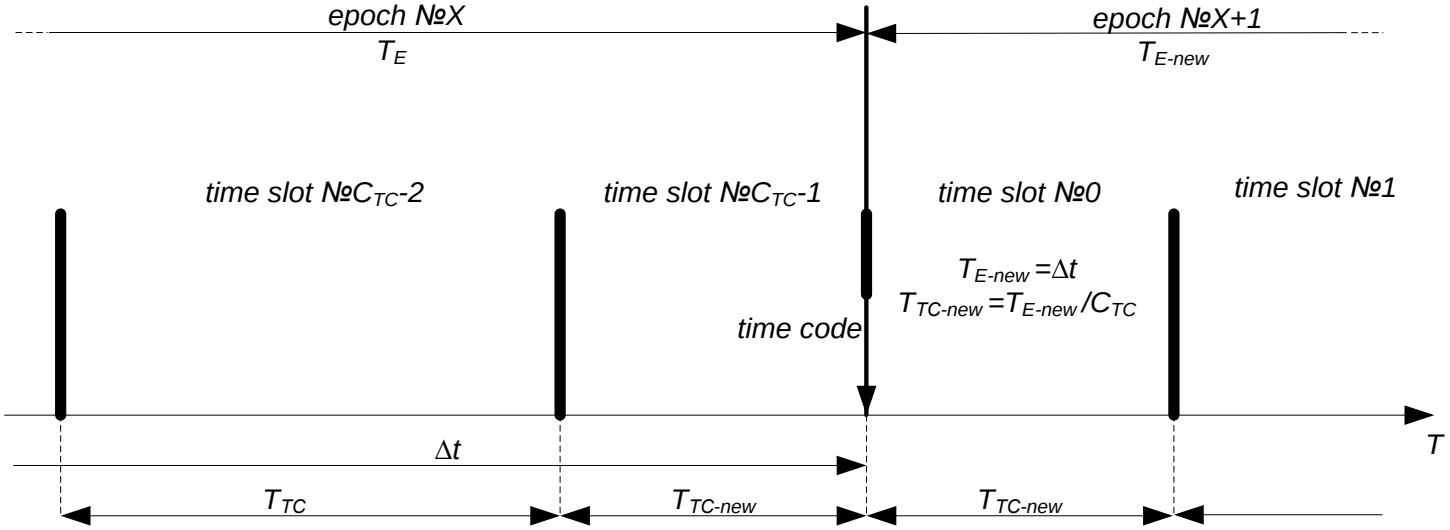
New version of scheduling mechanism (1/2)

New scheduling mechanism's distinctions:

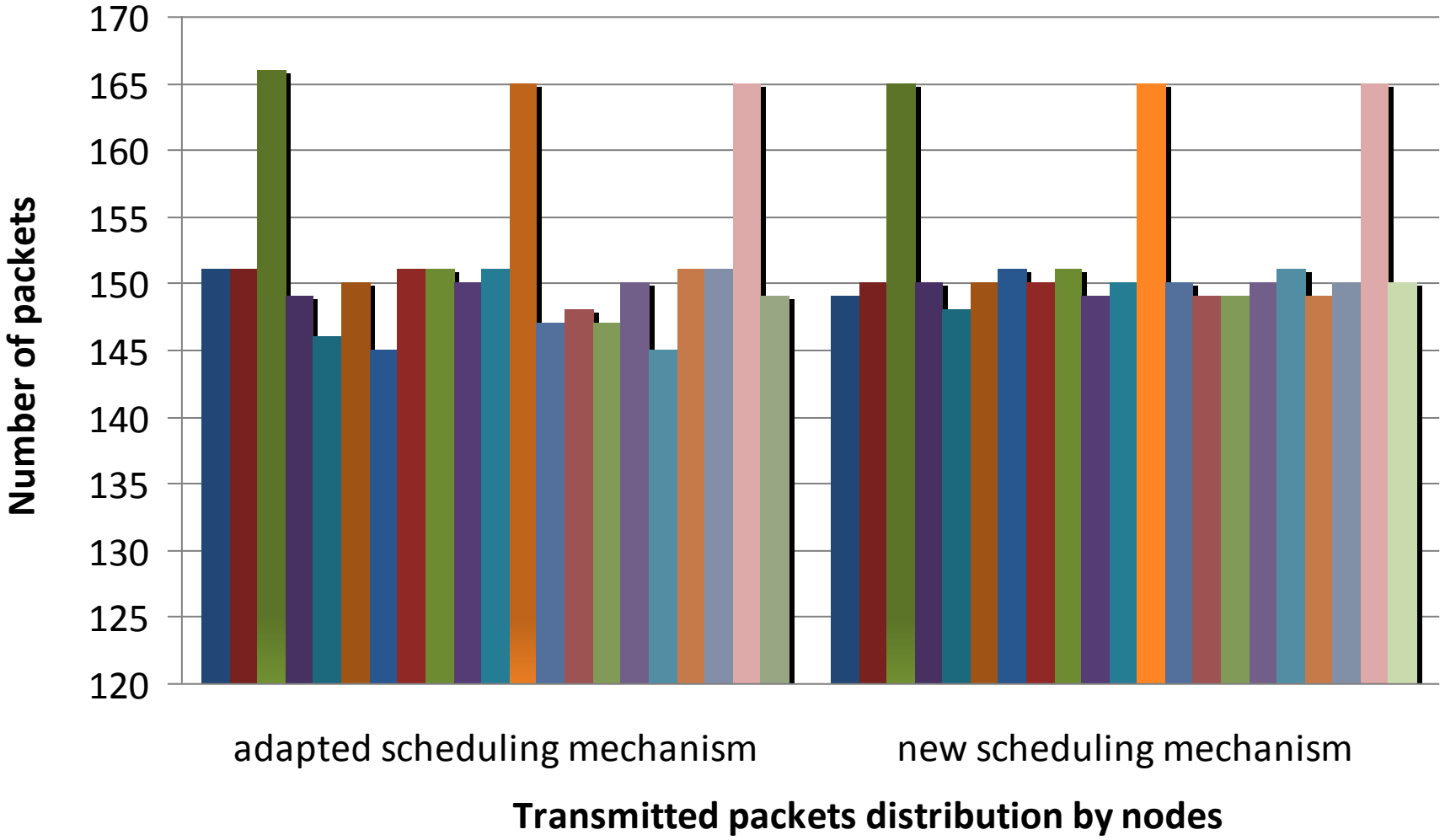
- synchronization is performed once in an *epoch*;
    - the epoch consists of N time-slots.
- new scheduling mechanism does not depend on a time-code number.

New version of scheduling mechanism (2/2)





Comparison of the simulation results for adapted scheduling mechanism modeling and new scheduling mechanism modeling



Conclusions

We got the new transport layer scheduling mechanism for the SpaceWire networks. This new scheduling mechanism has following advantages:

- it prevents conflicts of network resources usage;
- it decreases the network capacity;
  - *mean-square deviation of packets number decreases from 6.04 to 5.51*
- it allows to increase network bandwidth;
  - *number of transmitted time-codes decreases from 4224 to 34 (for 64 ms modeling)*
- it provides uniform data transmission;
- it gives more flexibility in schedule creation.
  - *It doesn't depend on a time-code numbers.*

The developed scheduling mechanism is planned to be included into the new transport protocol for the SpaceWire networks.

Thank you!

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