SpaceWire Network Performance Evaluation During the Streaming STP Data ransmission

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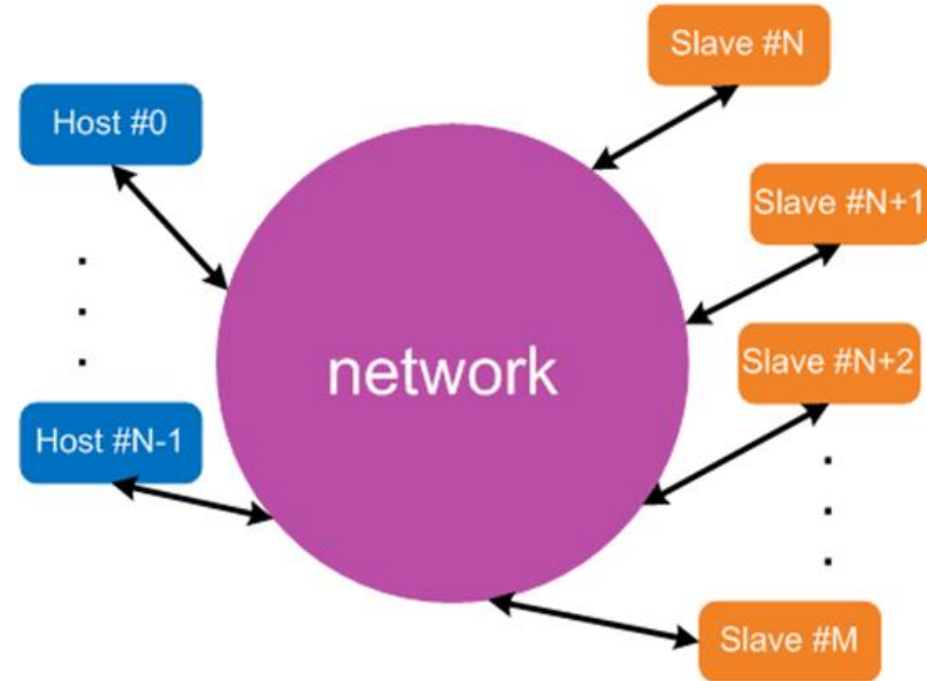
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SpaceWire Network Structure
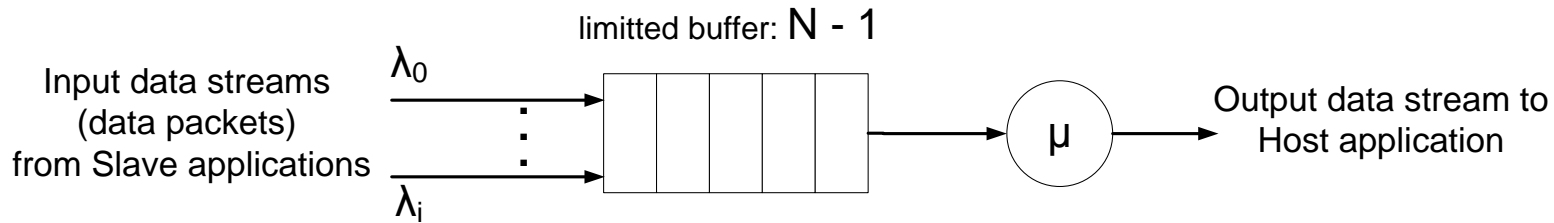
Multiple streaming coherent SpaceWire applications

Parameters:

▸ Channel speed of data transmission (2-400 Mbps)

▸ Network Load

▸ Bit error rate (BER = 10^{-12})

▸ Number of Slave applications

▸ Size of data payload

▸ Buffer's size of network equipment

Mathematical model (1/2)

Queue system with a limited size of buffer:

limited buffer: N - 1

Input data streams
(data packets)
from Slave applications

λ_0

λ_i

μ

Output data stream to
Host application

Assumption (1/2):

▸ time intervals between arrivals of data packets and time service are distributed according to the Poisson Law

Erlang's formula of **probability of K packets being in the queue system**:

$$p_{k=n+s} = \frac{\frac{Z^n}{n!}\left(\frac{Z}{n}\right)^s}{\sum_{j=0}^{n}\frac{Z^j}{j!} + \frac{Z^n}{n!}\sum_{j=1}^{N-1}\left(\frac{Z}{n}\right)^j},$$

$Z = \dfrac{\lambda}{\mu}$ – reduced density of packets

n – number of process units

s – amount of data packets in a buffer

Mathematical model (2/2)

Assumption (2/2):

▸ n=1 – number of Host applications **=>** $$p_{k=1+s} = Z^k \frac{1-Z}{1-Z^{N+1}}$$

Probability of packet loss performs if two events occur: the system got N packets and N+1 packet comes to the input:

$$p_B = p_N p^{(N+1)} = \frac{Z^N(1-Z)}{1-Z^{N+1}}$$

Quantity of dropped packets per time unit:

$$p_B = \frac{R}{\lambda} => R = p_B \lambda$$

Parameters for performance evaluation of SpaceWire Network

▸ Channel Speed of data transmission = 40 Mbps

▸ Network Load = 60%

▸ Number of Slave applications – up to 32

▸ Total data transfer time = 60 ms

▸ Size of data packet payload = 1014 bytes

▸ Buffer size of network equipment varies from 1 to 128 data packets (full data packet size = 1024 bytes)

▸ Max upper bottom of packet loss percentage is 1%
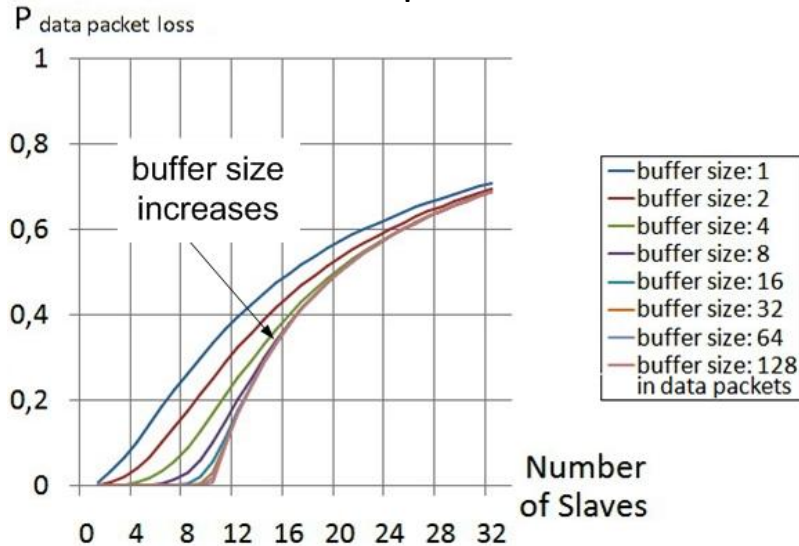
Results (1/2)

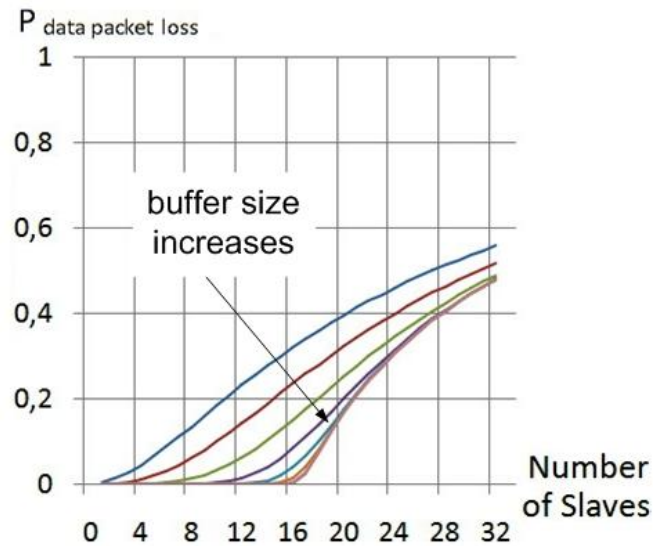slave/host: 40/**40** Mbps, 60%

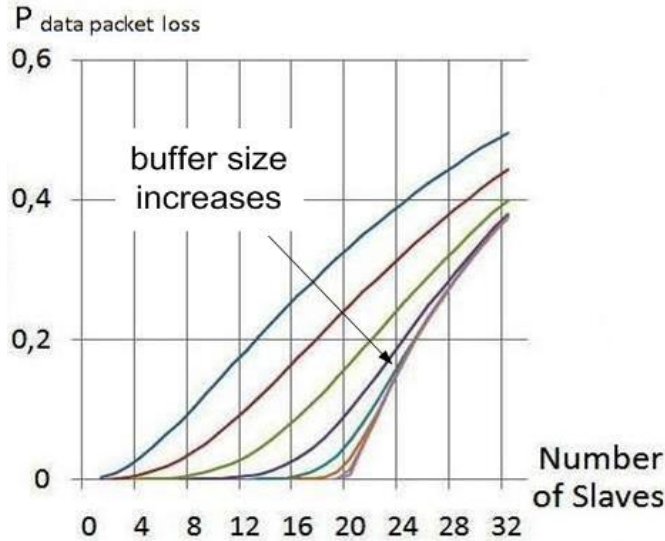slave/host: 40/**160**, 60%
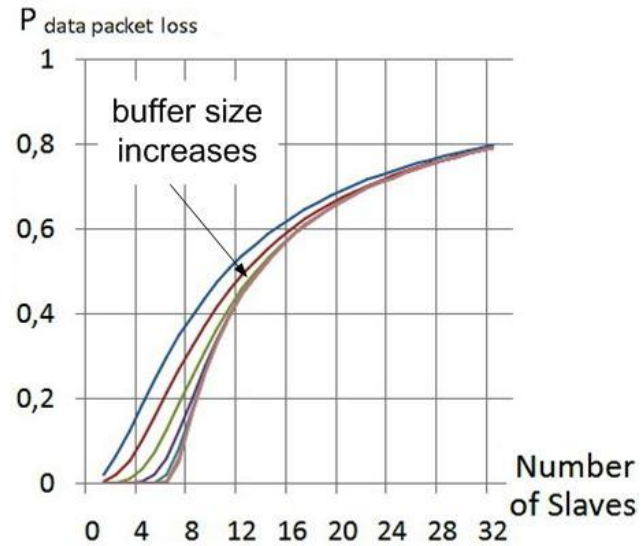
slave/host: 40/**240** Mbps, 60%

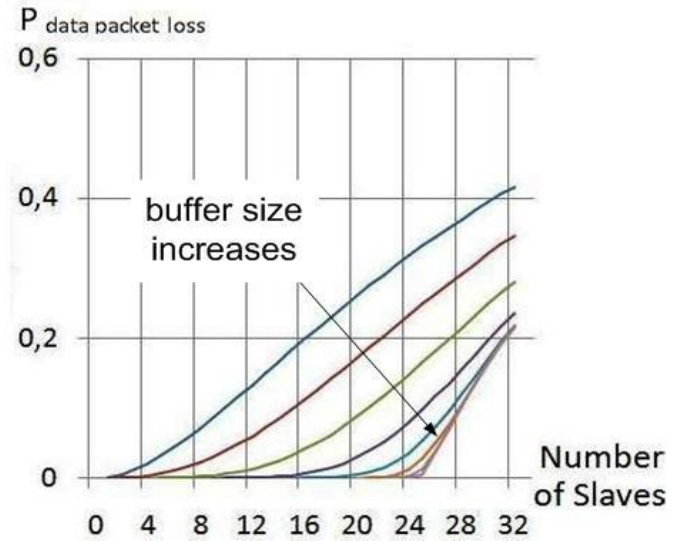

slave/host: 40/**400**, 60%
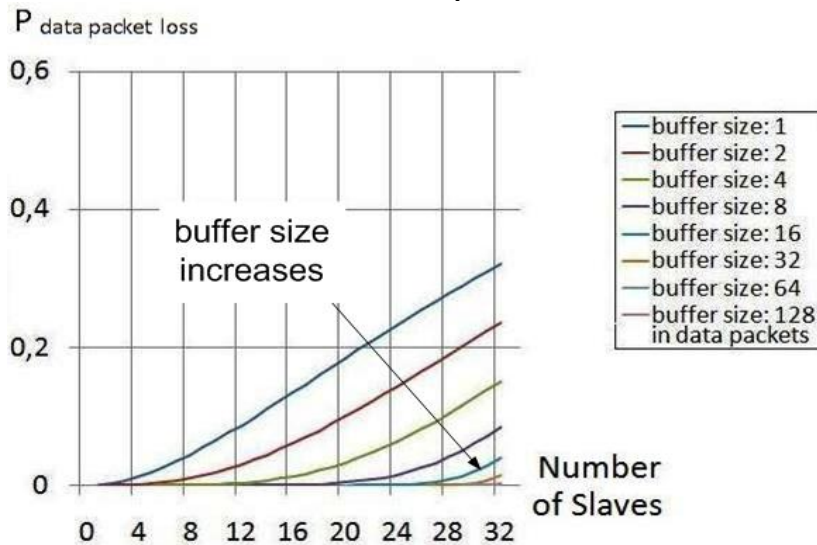
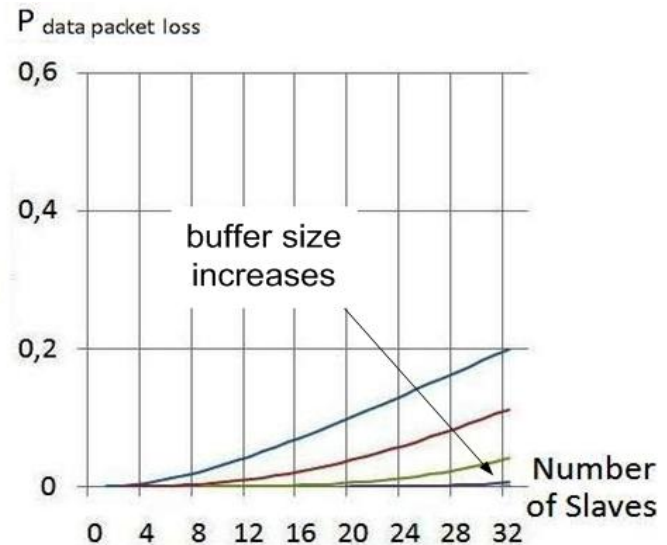# Results (2/2)

slave/host: 40/400 Mbps, **50**%

slave/host: 40/40, **40**%

slave/host: 40/400 Mbps, **30**%

slave/host: 40/400, **20**%

Conclusion

▸ Probability of packet loss has an exponential trend

▸ Increasing of buffer size more than 8 times is undesirable

▸ Rate of data packets service should be compared with total incoming packets rate

Evaluation of various network parameters and its combinations is essential in the development process of the network equipment

THANK YOU

for questions
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