The Quantitative Analysis and Research of SpaceWire Delay Jitter

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Overview

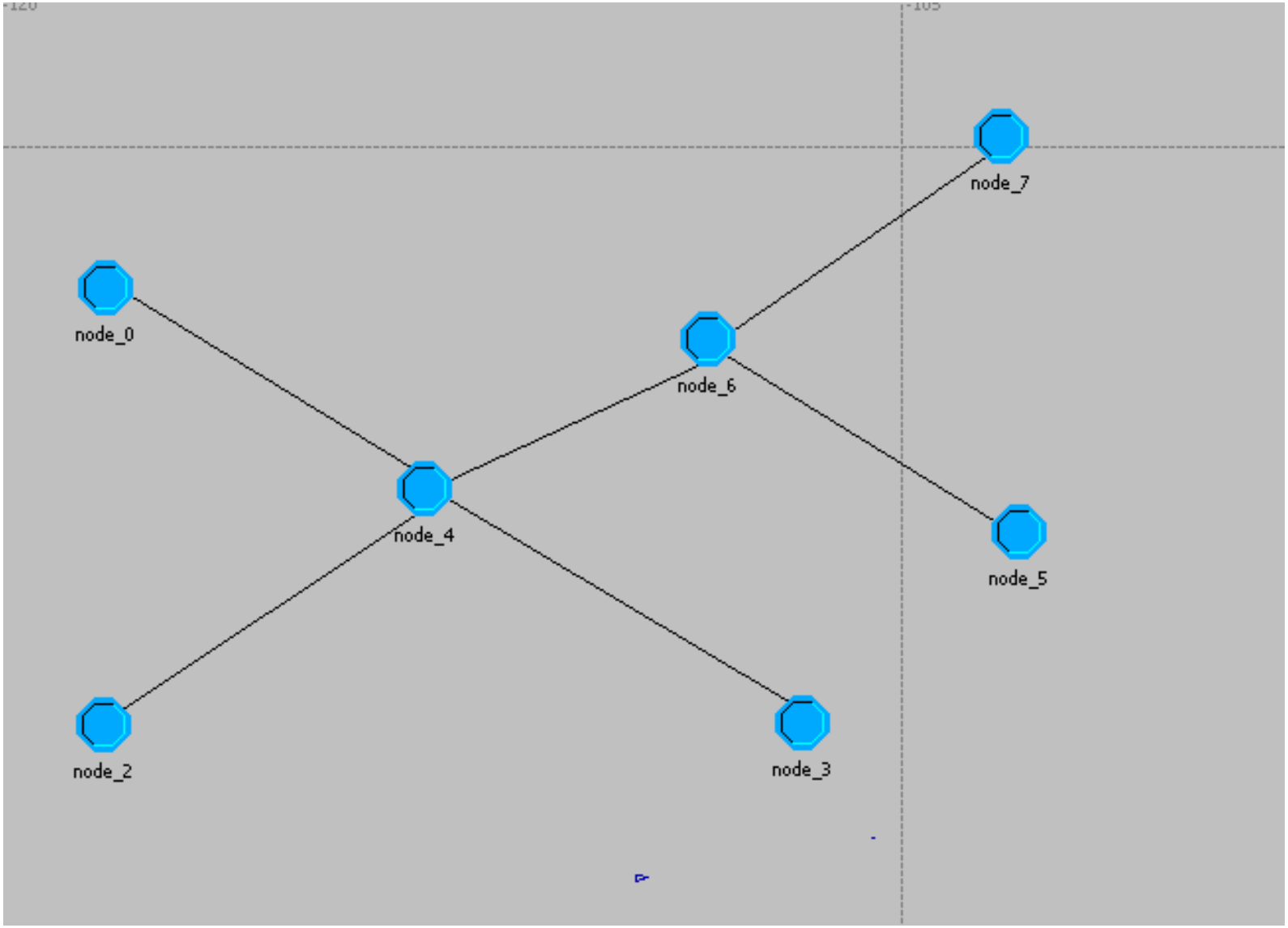
- Delay jitter is the key parameter to reflect network transmission performance, which measures the difference between the maximum transmission delay and the minimum transmission delay from end to end

large bandwidth traffic flow	• greater delay jitter requires larger cache for sending and receiving
real-time transmission	•if the maximum transmission delay is too long, the performance of the network will fall, causing the bus performance degradation
images and videos transmission	• Delay jitter performance has especially obvious impact on the quality of images and videos transmission with high bandwidth

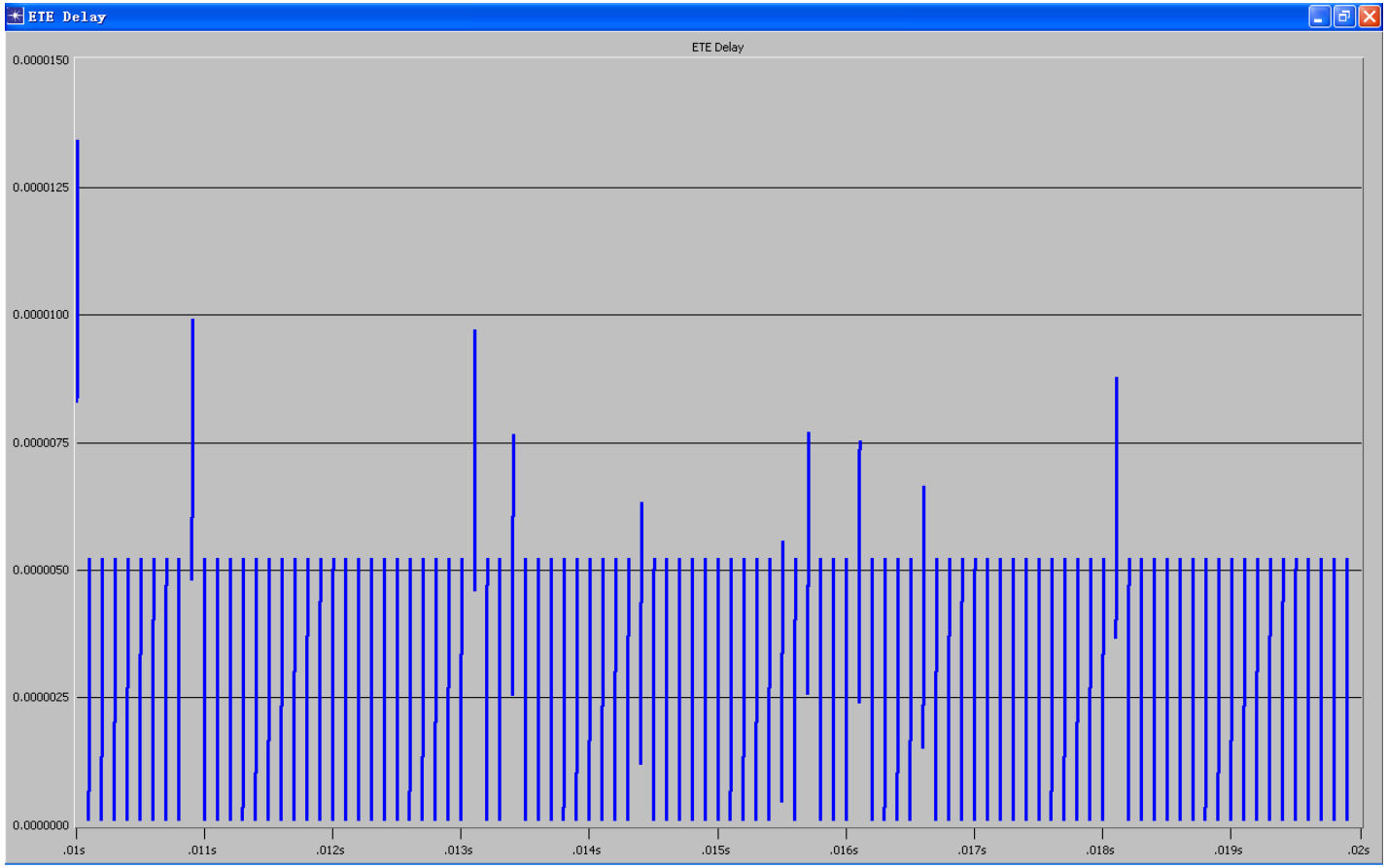
- This article carried out the quantitative analysis and research on the delay jitter of SpaceWire under specific application scenarios
- The research results of this article can provide a reference for designers to build a low delay jitter SpaceWire network

Simulation and Analysis

- We made the quantitative analysis through simulation with OPNET
- We first build a chain topology. Low-speed device node_0 and node_2, high-speed equipment node_5 is connected to the 4-port router node_4 and node_6. Node_7 is connected to a 4-port router which is a hot module (such as CPU, mass storage).

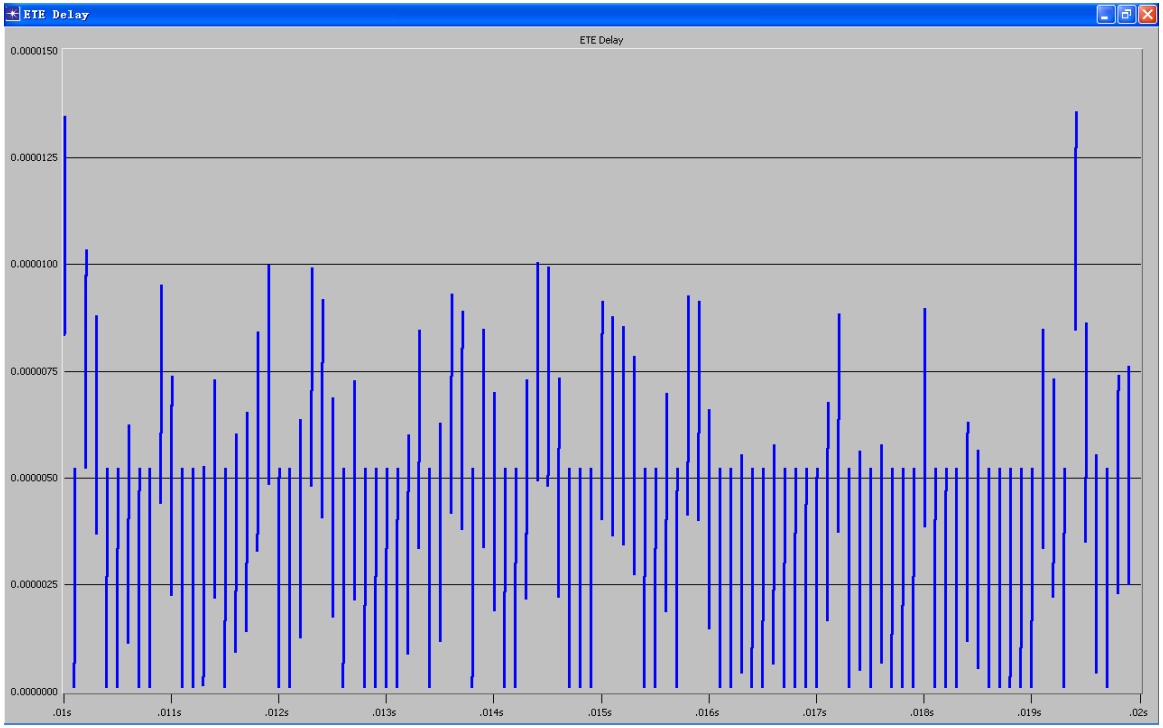

node_7
node_0
node_6
node_4
node_5
node_2
node_3

- We set node_0 to send packets at the simulation time of 0.01s, node_2 at 0.009998s and node_5 at 0.009999s
- The sending interval of node_0 is constantly 0.0001, and it send 100 packets in total. The sending intervals of node_2 and node_5 are random numbers between 0.0001 and 0.0002

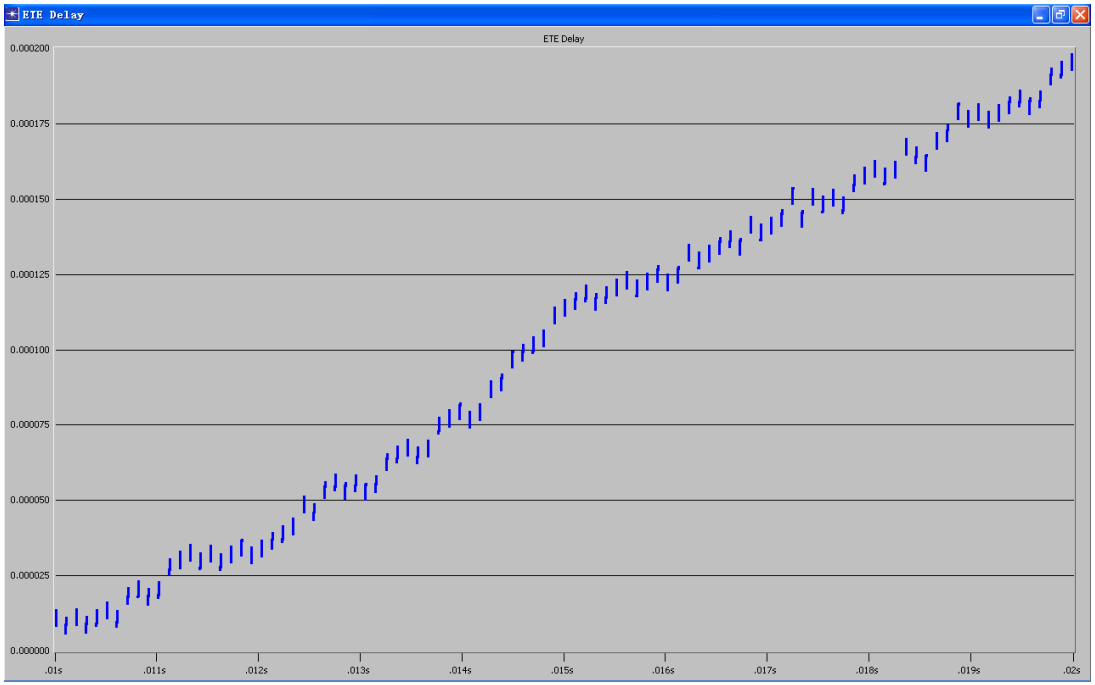

ETE Delay
ETE Delay
0.0000150
0.0000125
0.0000100
0.0000075
0.0000050
0.0000025
0.0000000
.01s
.011s
.012s
.013s
.014s
.015s
.016s
.017s
.018s
.019s
.02s

- Statistics in above chart are the end-to-end delays. Every line consists of 128 dots each of which represents an N-char delay
- In this simulation, the start time of end-to-end delay records from the creation of the package, and the ending time records from when each N-char is received

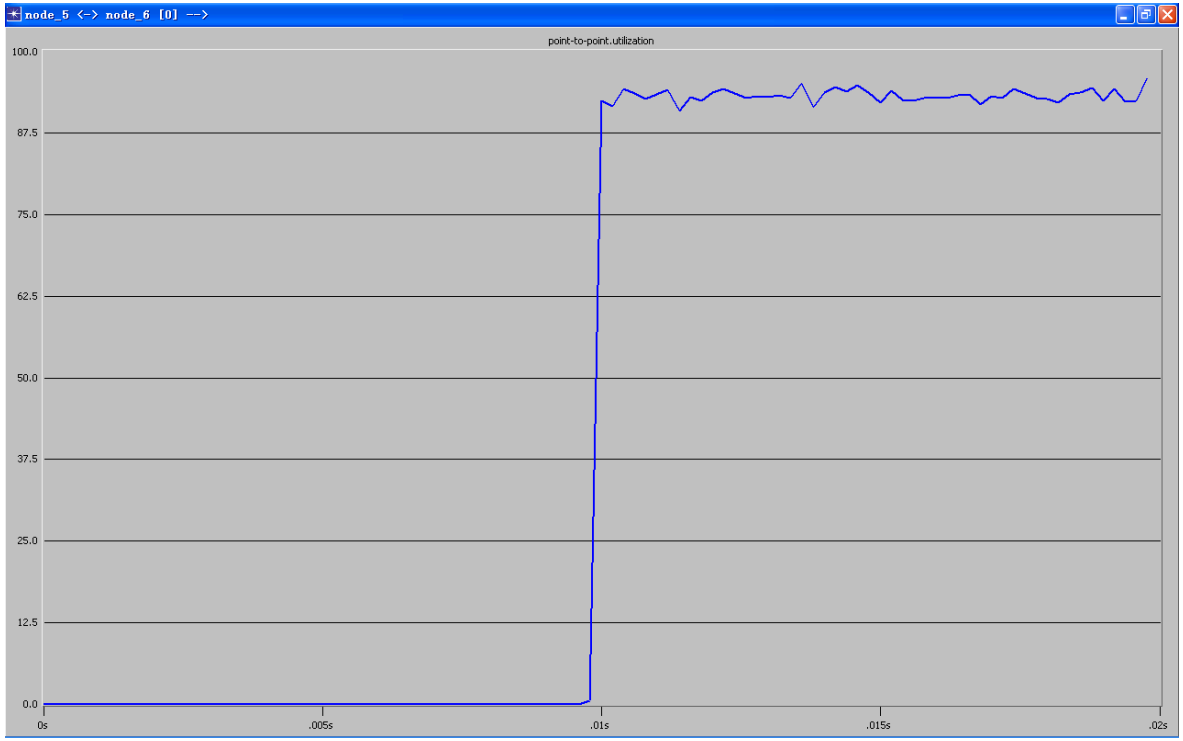
- When node_5 sending according to the function which is randomly distributed from 0.00001 to 0.00002 (that is 10 times larger than the above), we get the following results



- In extreme cases, node_5 sends packets according to the function which is randomly distributed from 0.000005 to 0.000006 (it is close to the total capacity of the link). We get the following results



- We can see link utilization of node_5-> node_6



Improvement

In the simulation we can see, real-time data may not arrive on time due to the lack of high-level agreements. if we want to effectively control the delay jitter of a source, here are two options

Division of Priority

Division of time fragment

Division of Priority

- When packets with high priority enter the route, sending of low-priority packets is immediately stopped and replaced with high-priority packets. Low-priority packets is put into cache and waits until high-priority data are finished

Division of time fragment

- Routing behaviour can be divided into multiple time fragments. Each fragment is allocated to different routing ports fairly. This is easy for implement, but will extend end-to-end delay of all packets

Conclusion

- This article carries out the quantitative and qualitative analysis on the delay jitter performance under different conditions, thereby providing a universally applicable method for designing the SpaceWire network and also the guidance for the design in the aspect of improving the delay jitter

Thanks