Timing Analysis of SpaceWire using OMNeT++ based Simulator

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Agenda

01 Introduction to SpaceWire

02 Motivation for SpaceWire Simulation

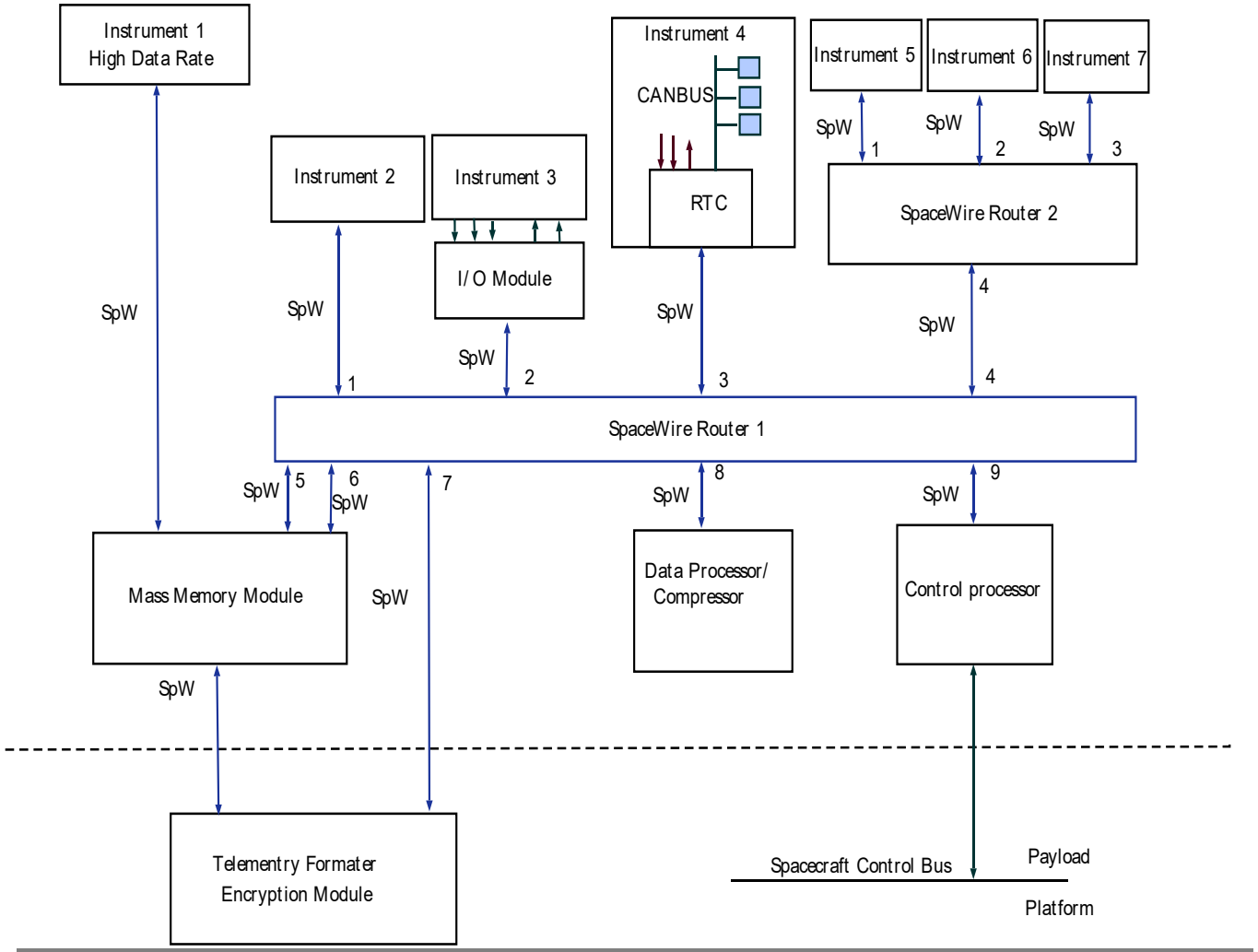
03 SpaceWire Simulation

04 Evaluation

05 Conclusion and Future work

SpaceWire Example

- Point to point
- With Routers

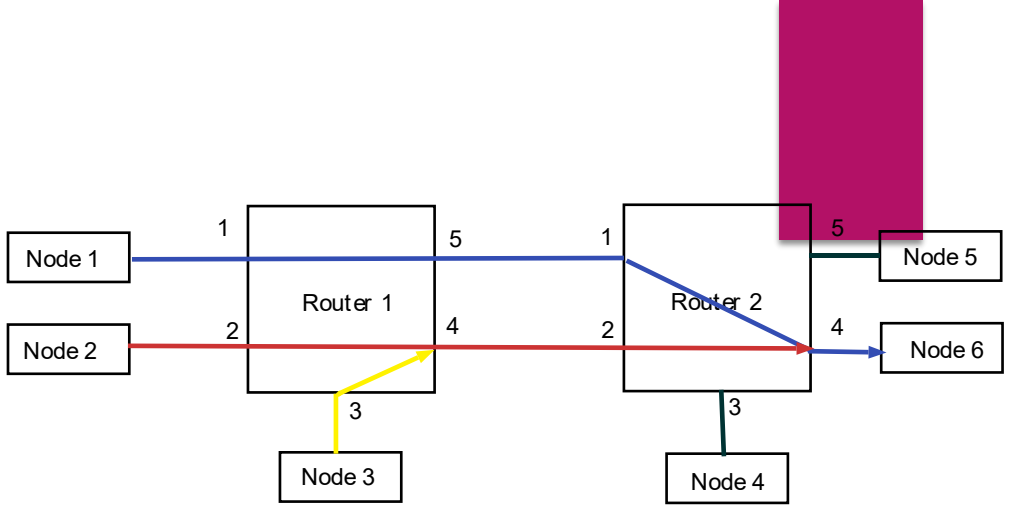


SpaceWire Example[1]

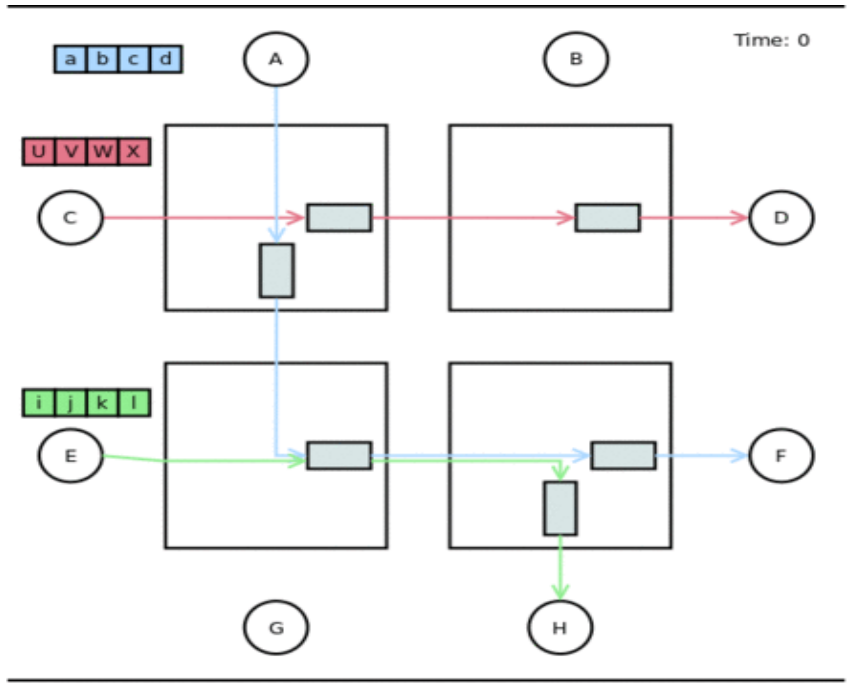
Wormhole Routing

- Wormhole Routing
- Small memory buffer
- No virtual channel support
- Arbitrarily large packets

No Real-time performance

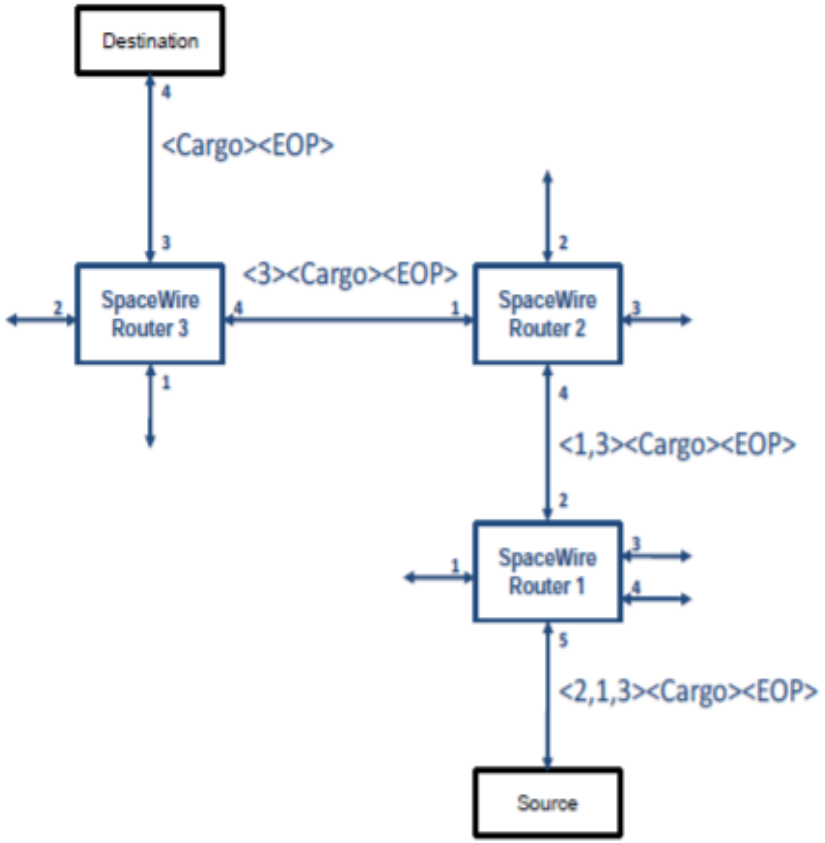


Wormhole Routing[1]

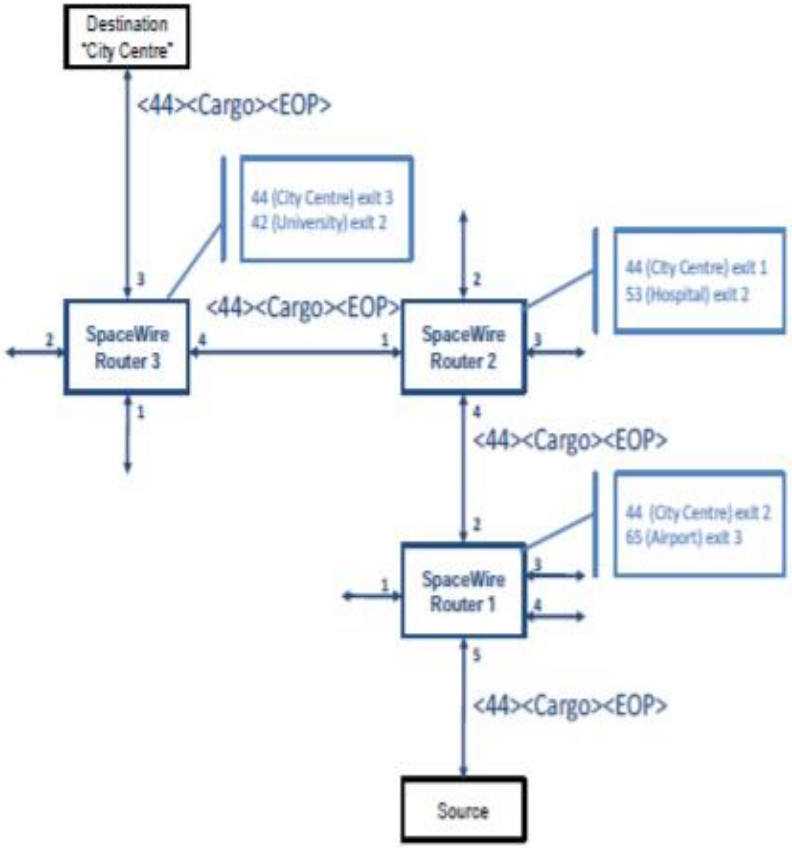


Wormhole Routing[Curtosy:Wikipedia]

SpaceWire Routing Strategies



Path Addressing[1]



Logical Addressing[1]

SpaceWire Simulation

1. Node
   - Source-node

   Random distribution to generate SpaceWire packets

   Packets of different size

   Queue to store messages

   - Destination-node

   Process the received SpaceWire packets
2. Router

   Fixed sized Queue to store messages

   Routing tables

1. Message(.msg)

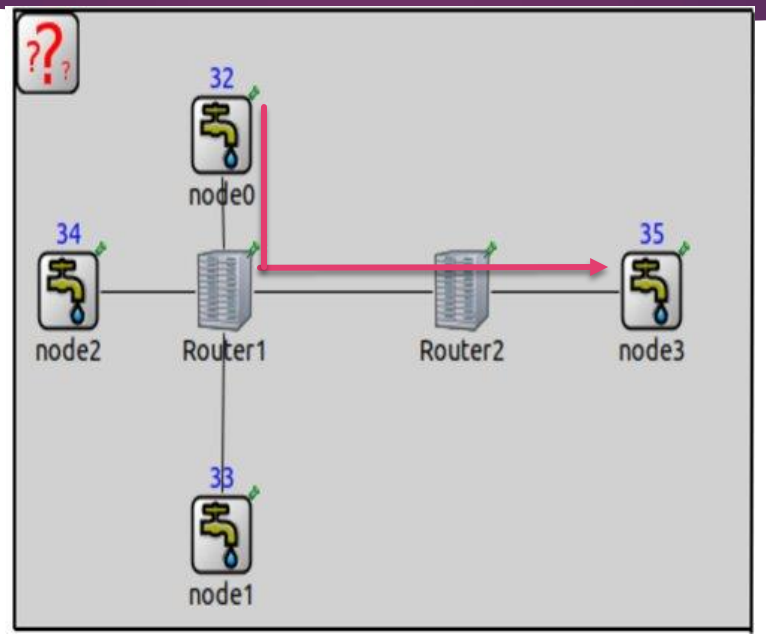
   SpaceWire packets Path & Logical addressing
2. Network.ned & Omnetpp.ini

   Setup network with modules and channels

   Configure parameters

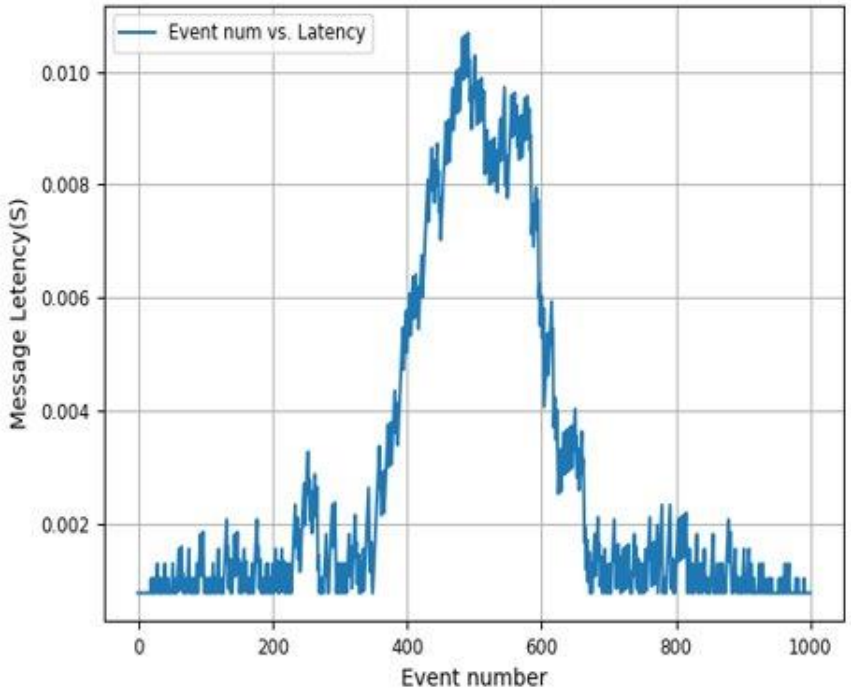
Experiment with different Packet Length

Num. Messages	1000
Distribution	Normal
Mean	1000 ms
Std.dev	100 ms
Packet length	64 Bytes
Channel data-rate	2 Mbps
Module-timer	0.01 ms

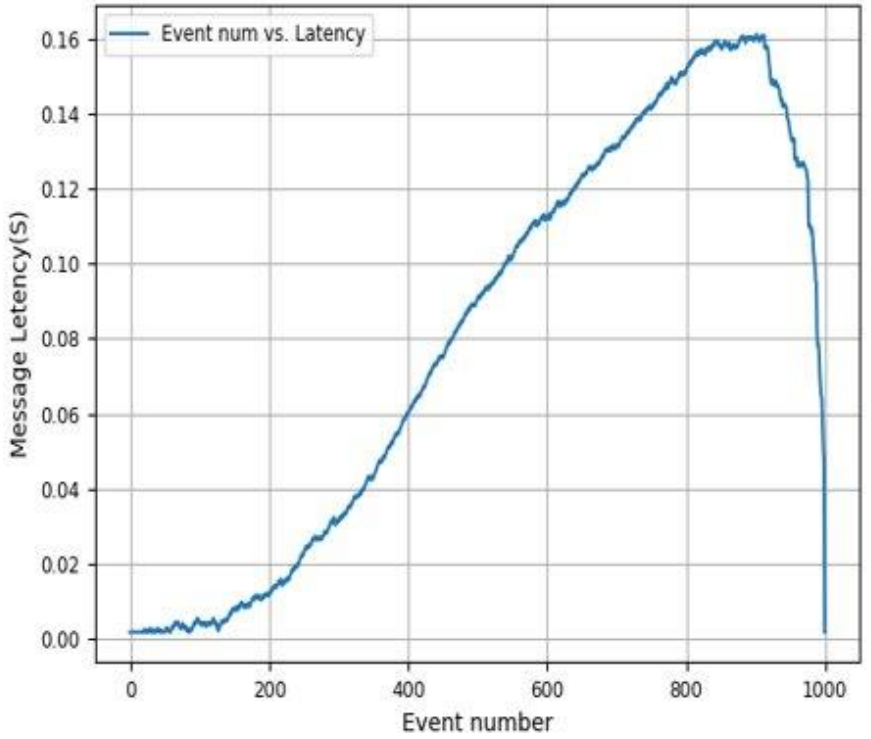


Num. Messages	1000
Distribution	Normal
Mean	1000 ms
Std.dev	100 ms
Packet length	128 Bytes
Channel data-rate	2 Mbps
Module-timer	0.01 ms

Key results

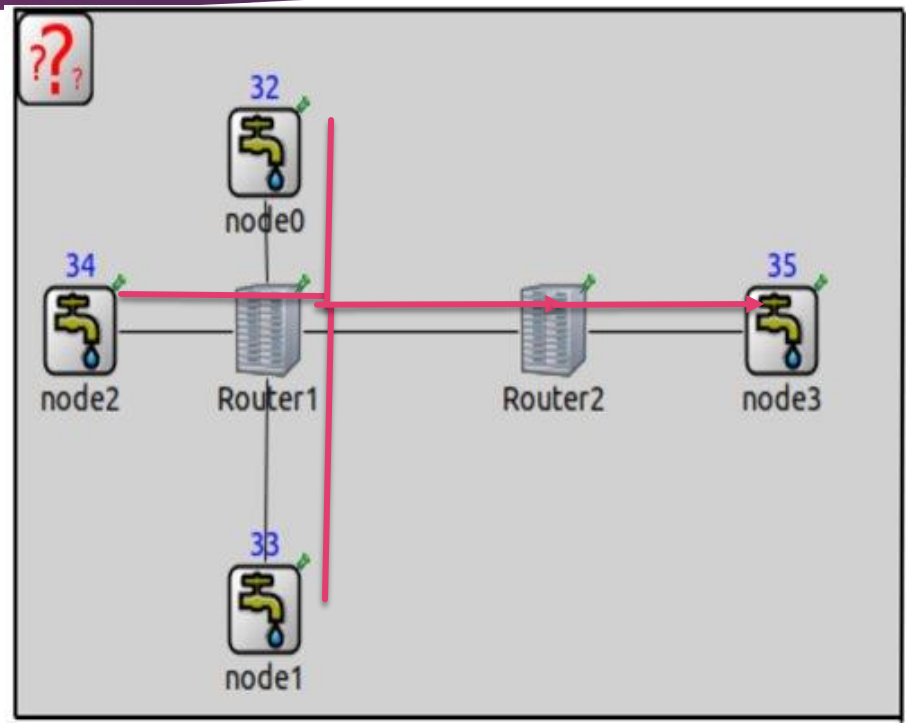


- Increase in end-to-end delay with increase in message length.
- Max.Latency increased 15times with doubled message length
- Min. latency observed as sum of channels delay.



Many source-node experiment

Num.Messages	333(each node)
Distribution	Normal
Mean	1000 ms
Std.dev	300,200& 100 ms
Packet length	128 Bytes
Channel data-rate	200 Mbps
Module-timer	Channeldatarate/5

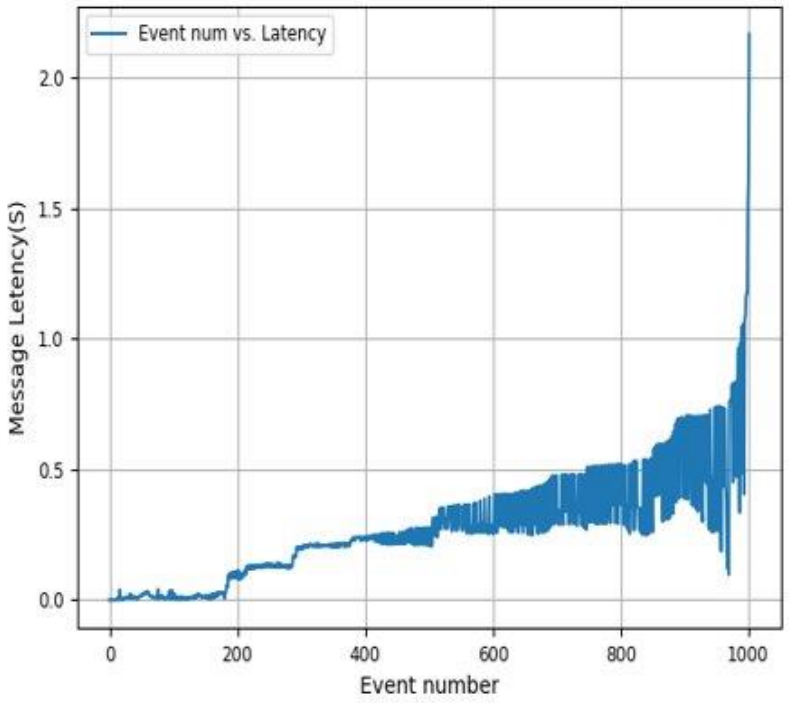


Key results

- Blocking inside a Router1

node0	node1	node2
193	261	396

- Increase in total simulation time and Max. Latency for the simulation.



Latency

Conclusion and future work

- End-to-end delay for different kinds of SpaceWire packets can be analyzed
- Blocking of packets can be analyzed in wormhole routing networks
- In future, simulation can be improved considering the following,
  - A bit level simulation of SpaceWire packets
  - Detail design of a SpaceWire router
  - Simulation performance and parameter configuration can be improved
- Network emulation with HiL or SiL.
- Testing and validation of instruments before integration into the mission payload.

Thank You

References

[1]"Steve Parkes", SpaceWire user’s guide, Isbn: 987-0-9573408-0-0.