SpW-D

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SpaceWire for Control Applications

- Determinism is essential
  - Determinism means
    - Predictable
    - Delivery within time constraints
  - Constrained Architecture
  - Time-slicing
- Determinism with constrained architecture
  - All communication initiated from data-handling computer
  - Single master architecture
  - Warm/cold redundancy

Simple link is deterministic

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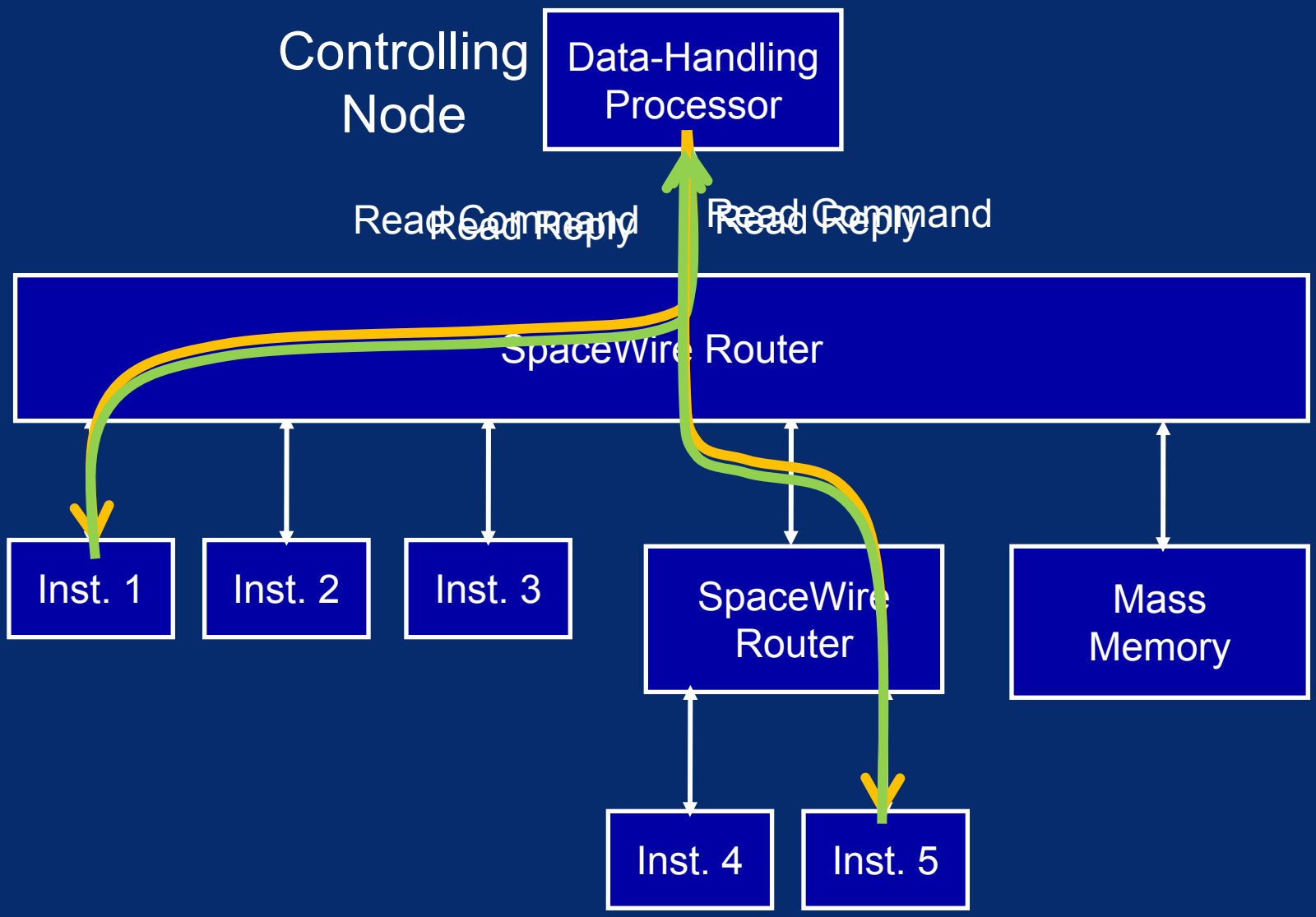
Determinism with Constrained Architecture



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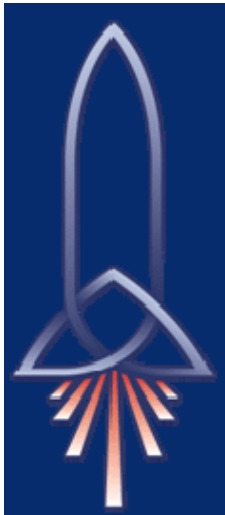
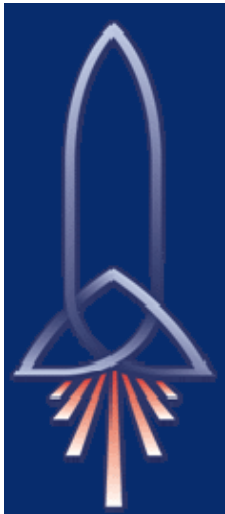


RMAP and Determinism

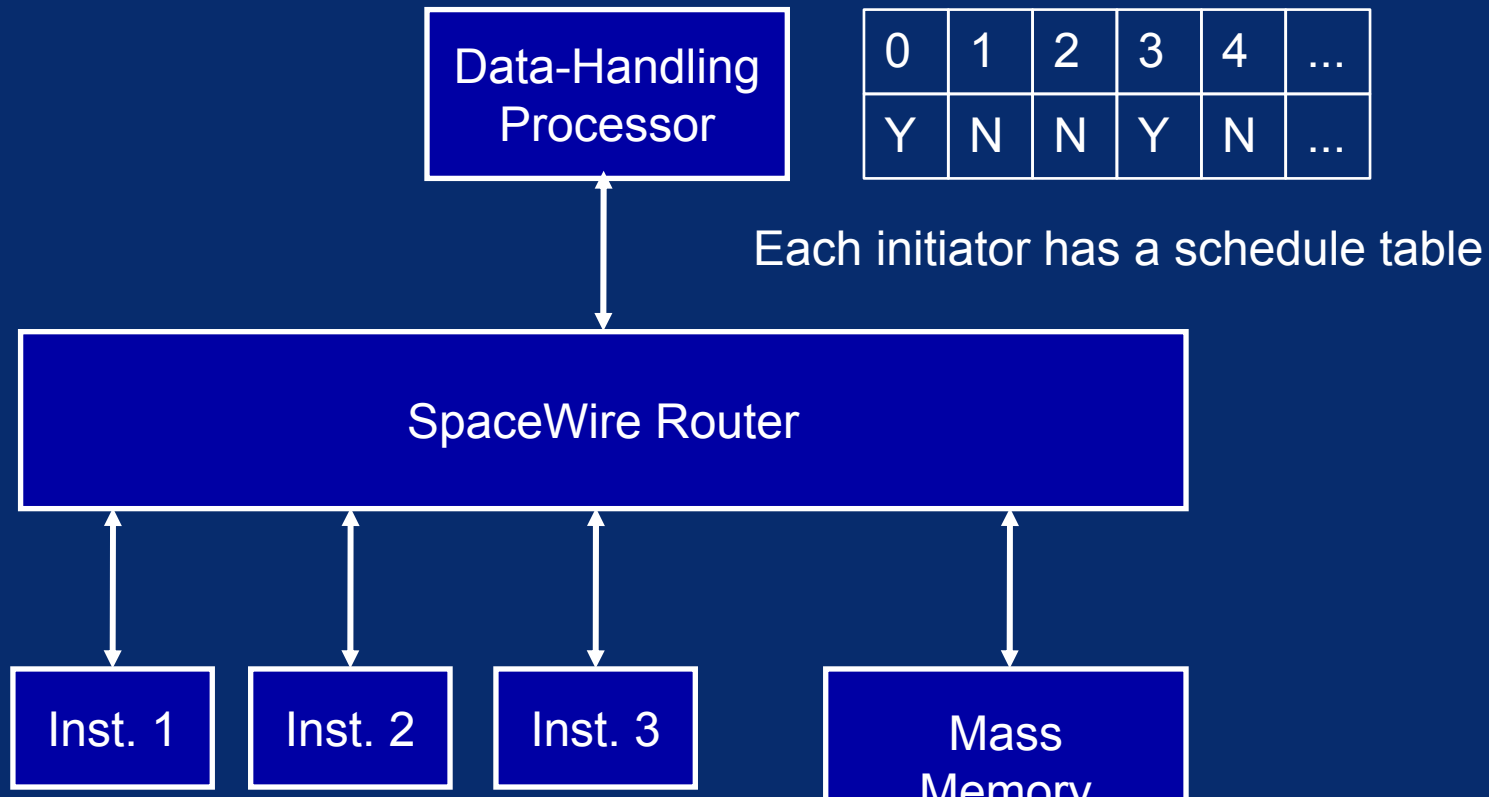
- Data-handling processor is the RMAP initiator
- RMAP targets are
  - Instruments
  - Mass memory
  - Telemetry
  - Etc
- RMAP initiator sends RMAP command
- RMAP target responds to command
  - Returns data/ack to initiator
- If expected reply not received
  - RMAP initiator can time-out and flag error



Determinism with Time-Slots

- Time-codes used to define time-slots
- Time-slot has same number as time-code that starts the time-slot
- 64 Time-slots
- For a 200 Mbits/s network
  - Time-slot around 30 µs
  - Epoch of 64 time-slots around 2 ms
- Sufficiently timely for avionics applications
- Fully deterministic to << 30 µs

Determinism with Time-Slots



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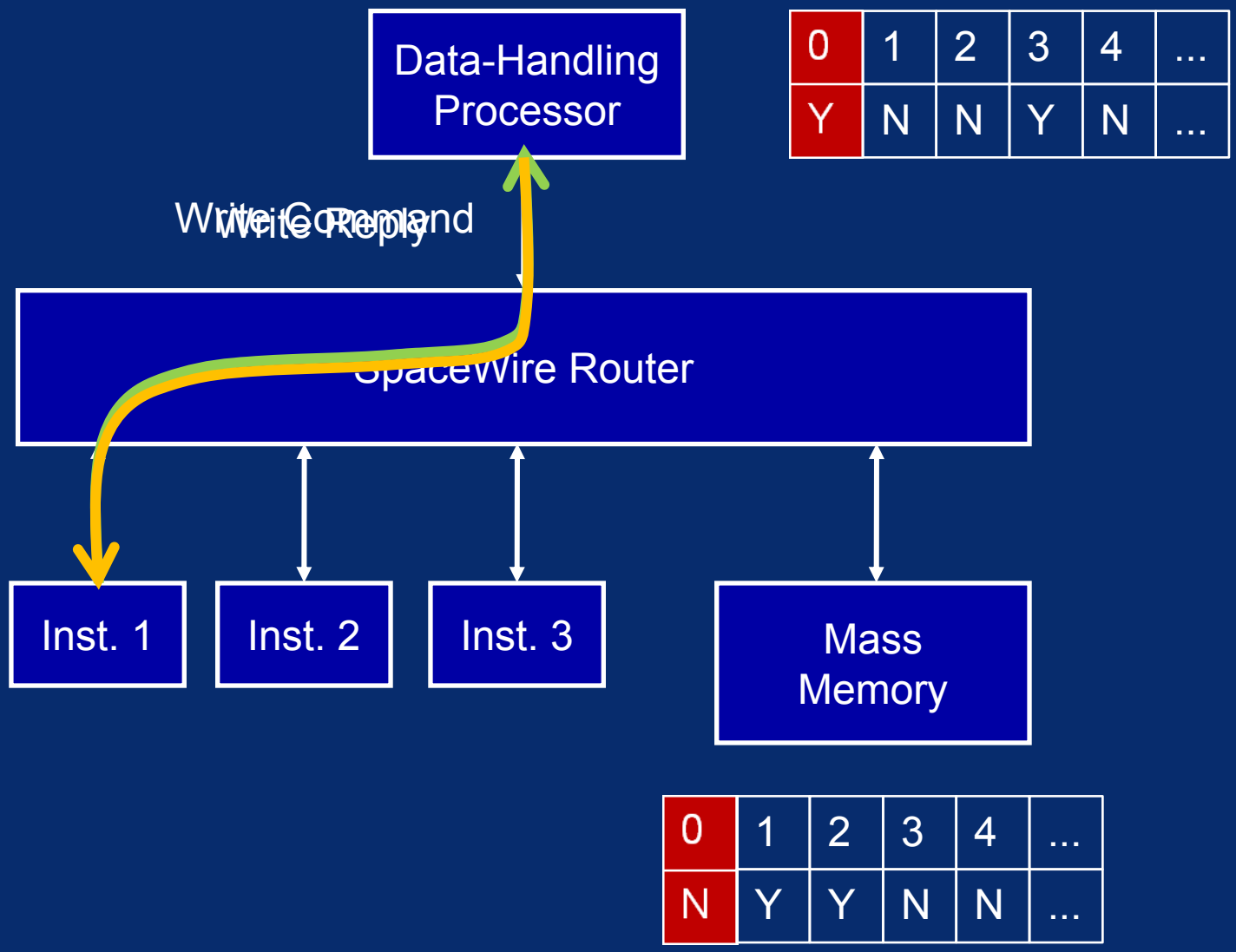
Time-Slot 0



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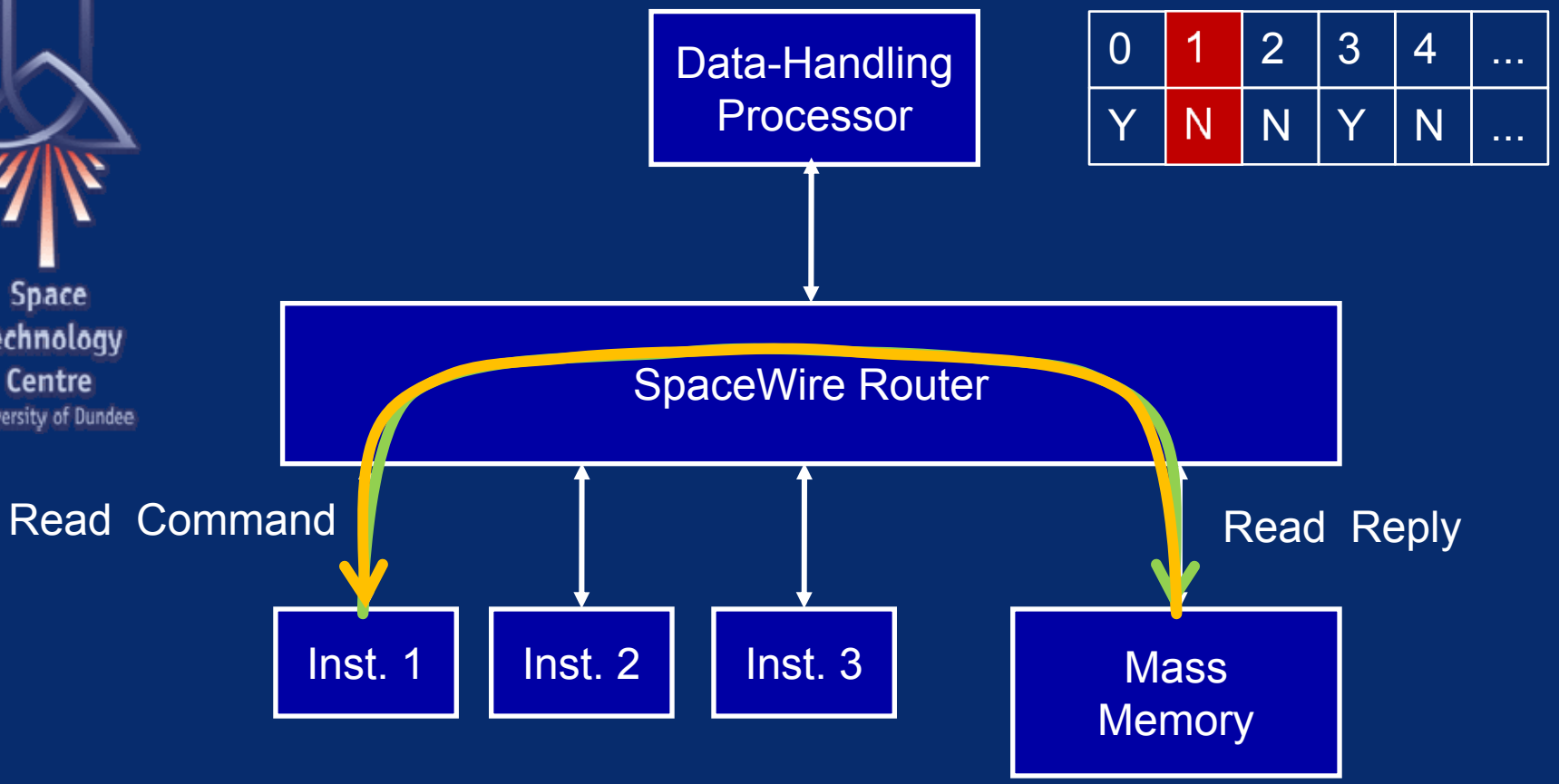
Time-Slot 1



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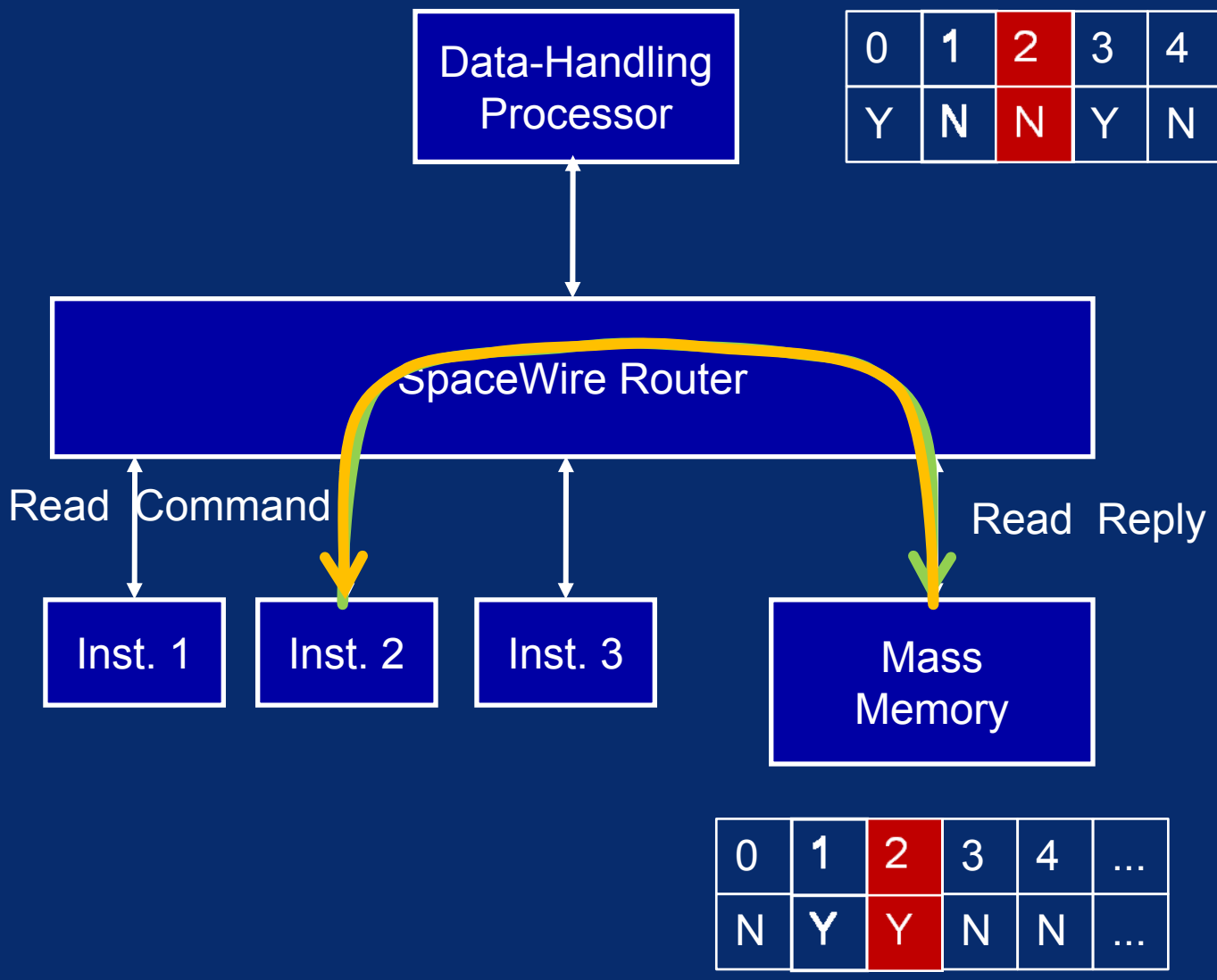
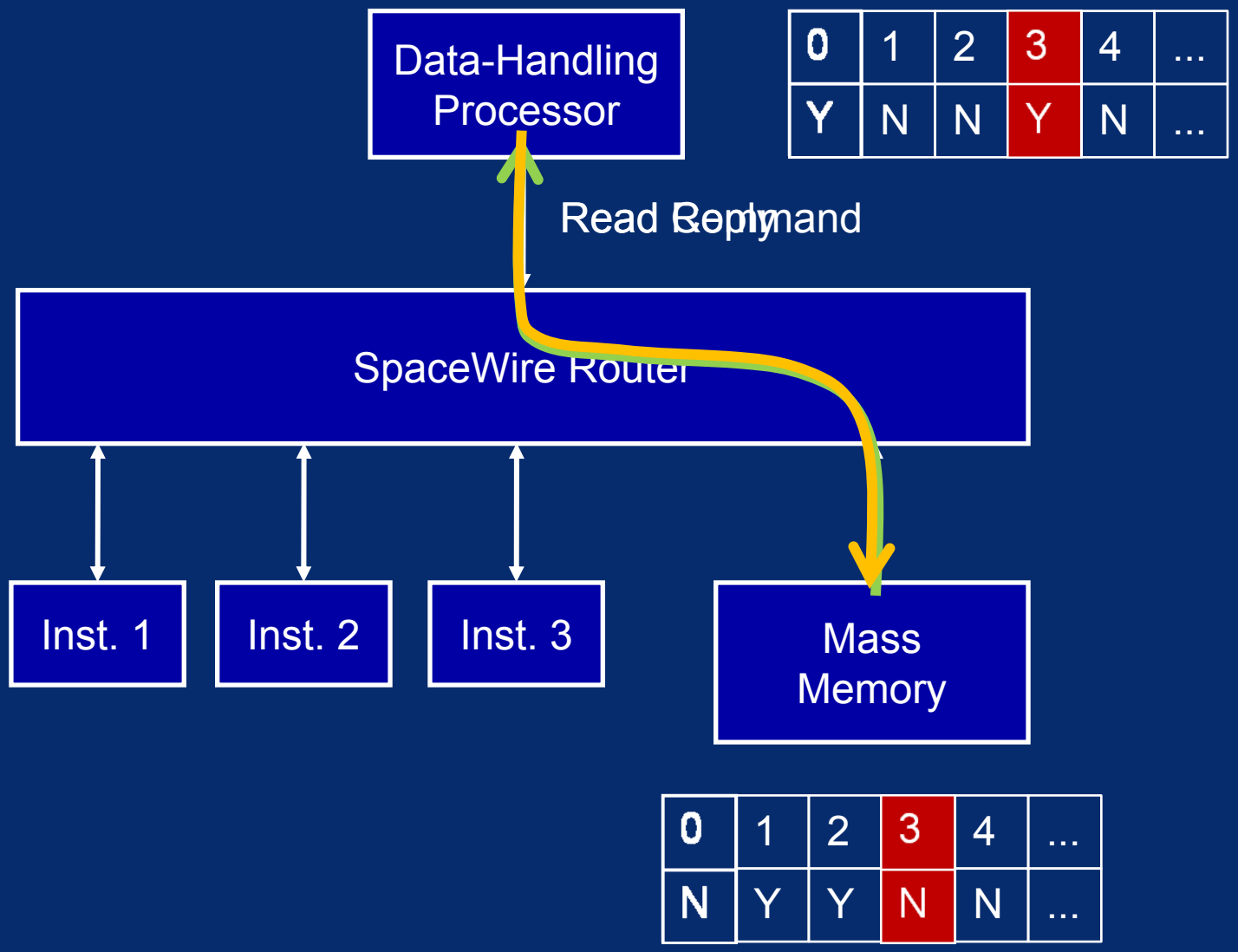
Time-Slot 2



Time-Slot 3



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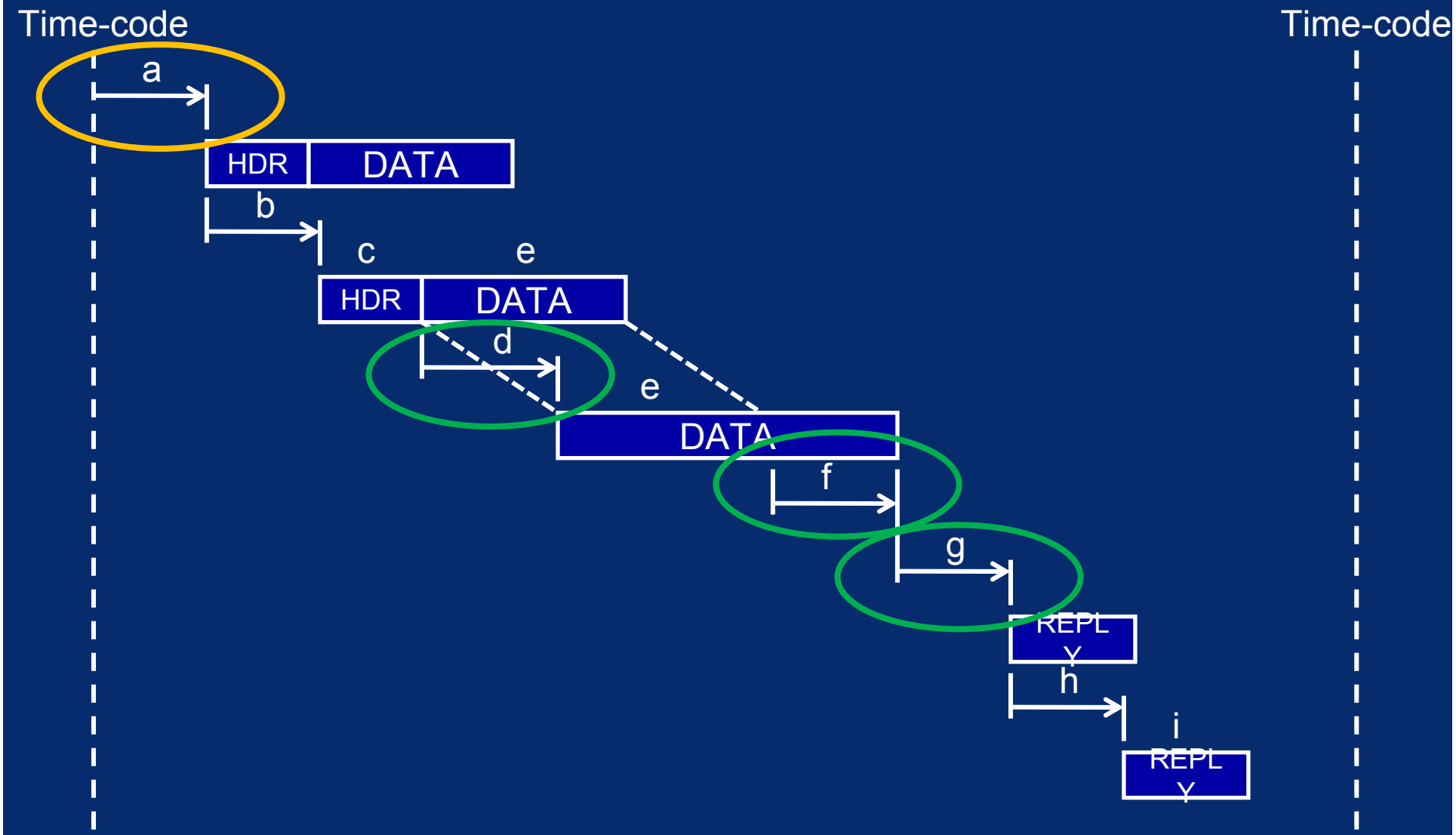
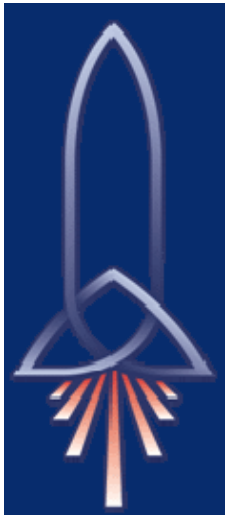
Assigning data to time-slots

- Different models can be used for assigning data to time-slots
- Simple queue
- Priority queue
- Queue for each time-slot that the node is allowed to send it
- Etc

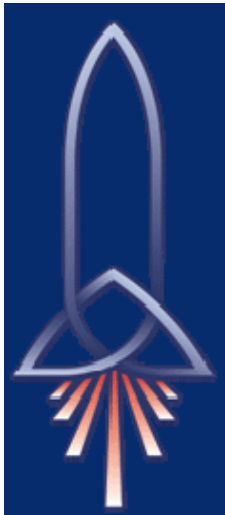
SpW-D Performance





Initiator Constraints

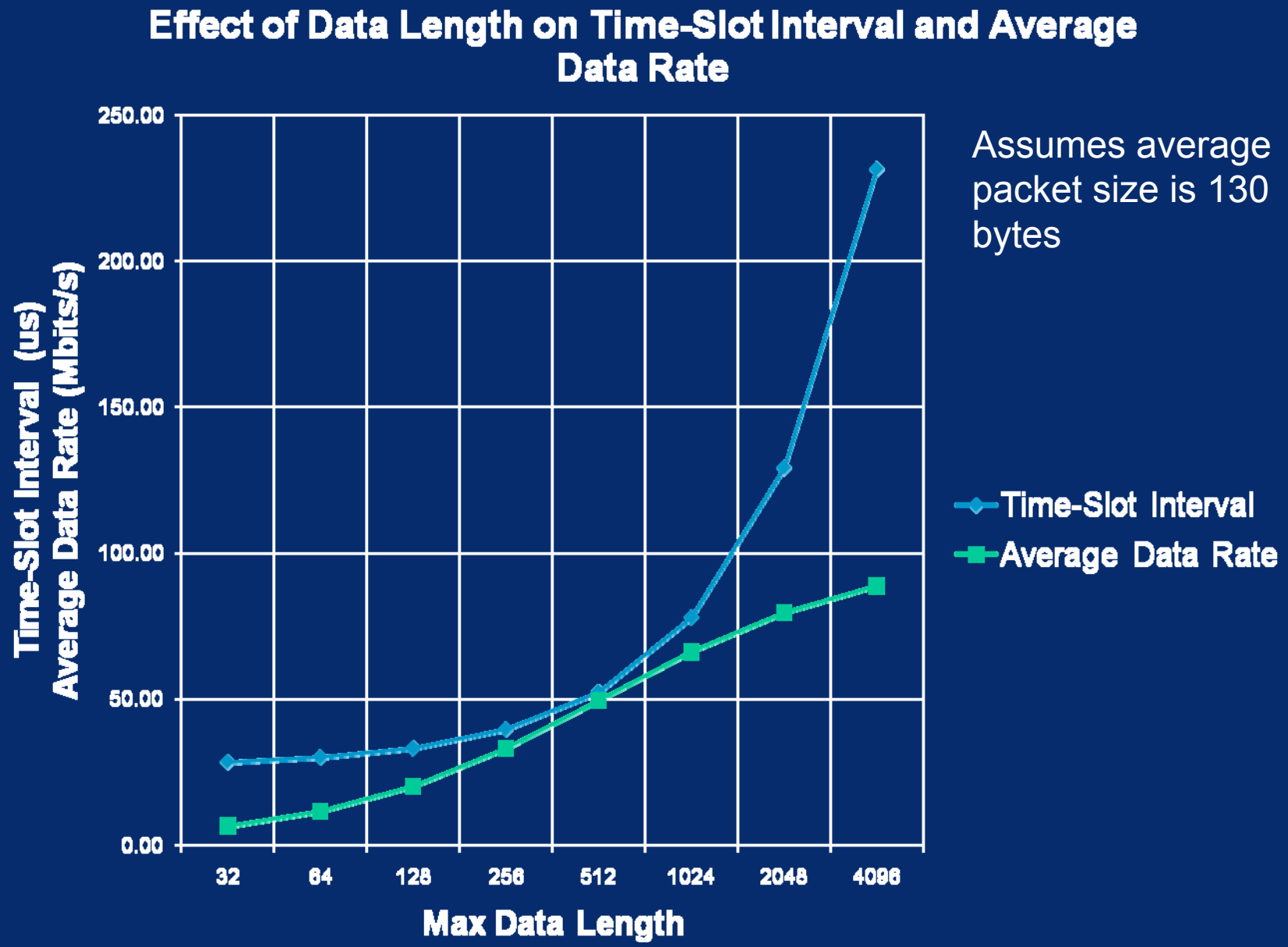
- Max data in RMAP read or write is 256 bytes (TBC)
- Must respond
  - Time-code to send RMAP command < 5 µs (a)



Target Constraints

- No modifications to RMAP target
- Must respond
  - End of header to authorisation: < 5 µs (d)
  - Read or Write at least as fast as SpaceWire link can handle data 20 Mbytes/s
  - Read or Write latency: < 5 µs (f)
  - Create reply: < 5 µs (g)

SpW-D Performance



Assumes average packet size is 130 bytes

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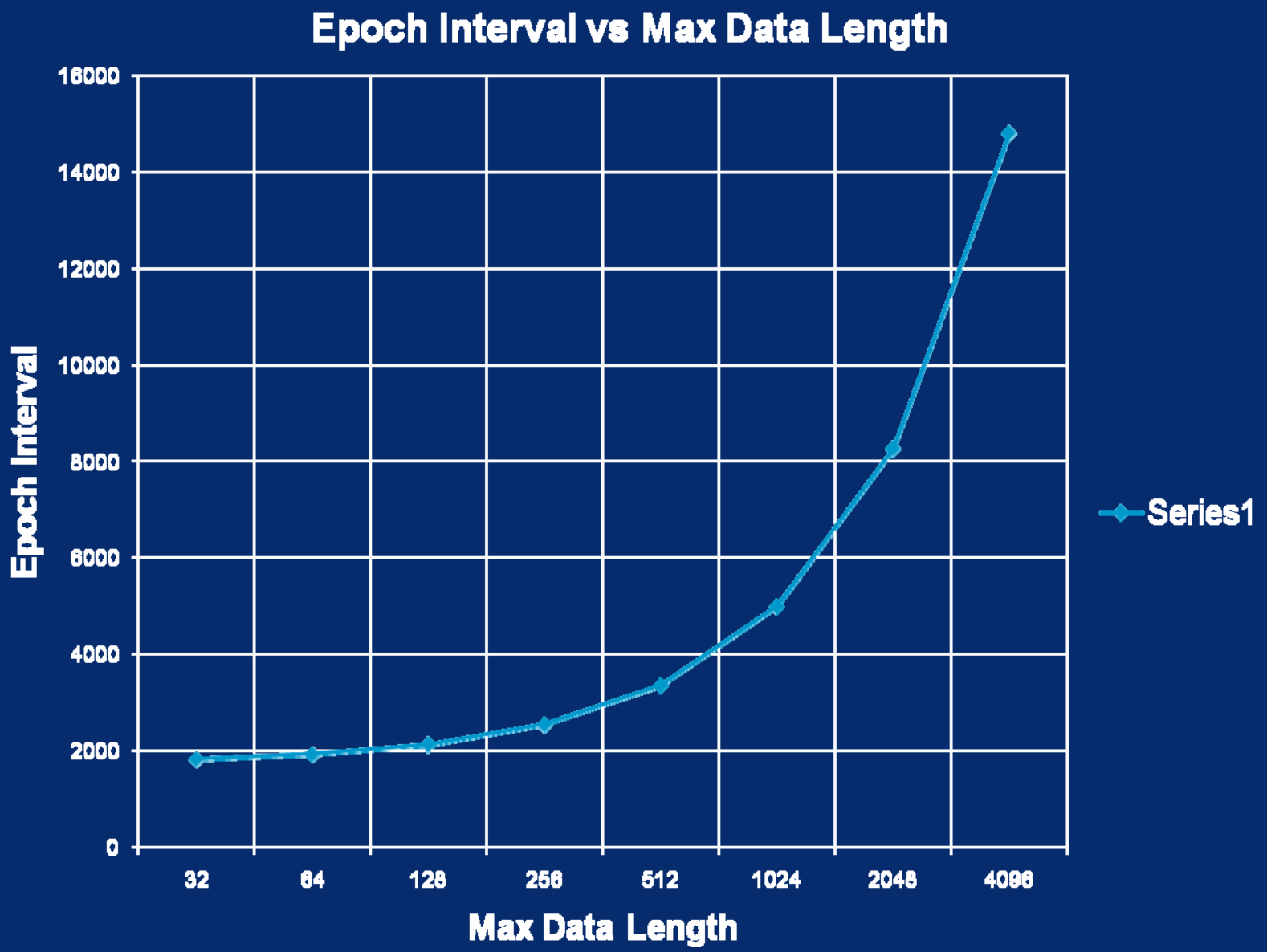
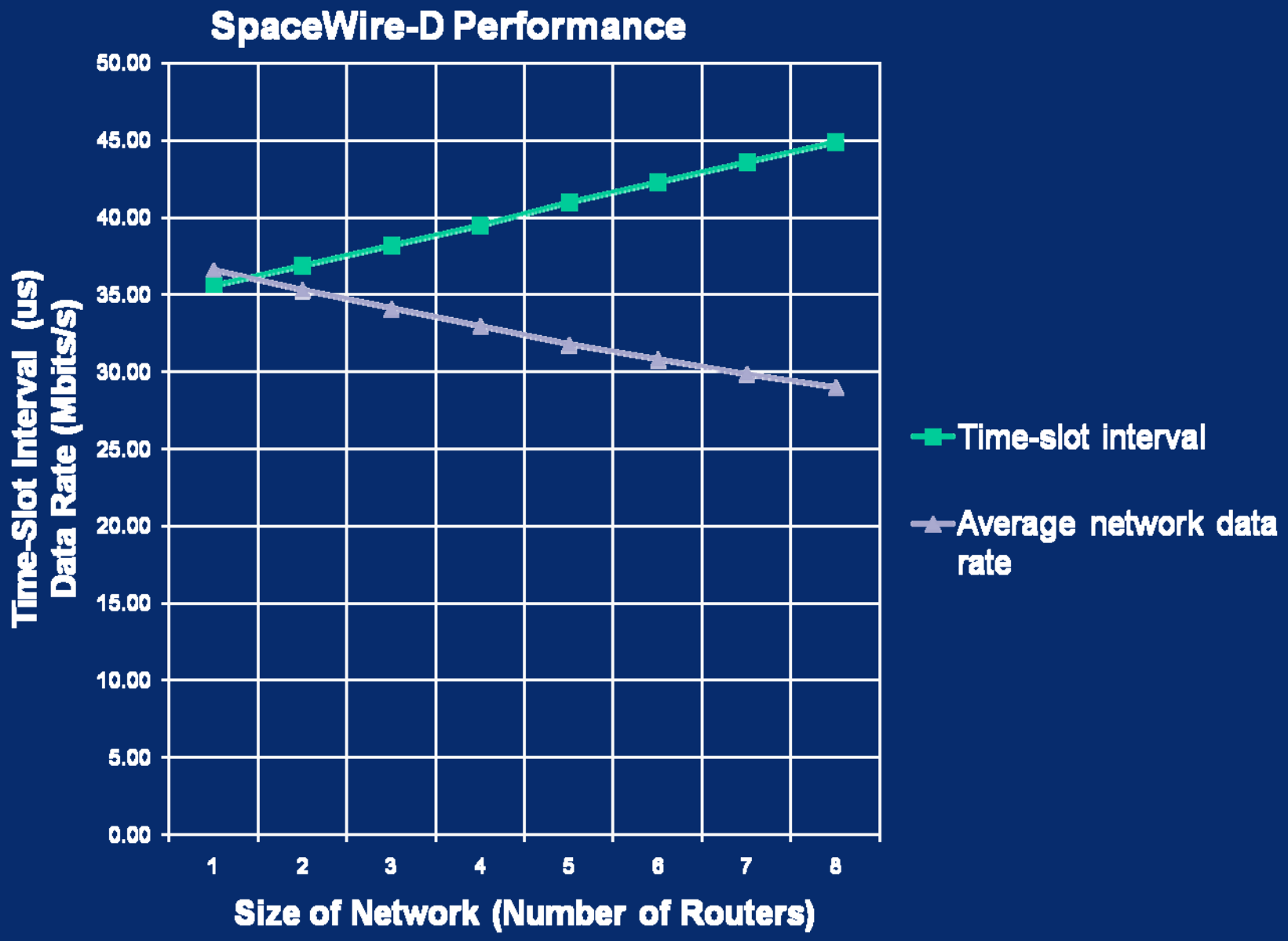
SpW-D Performance



SpW-D Performance



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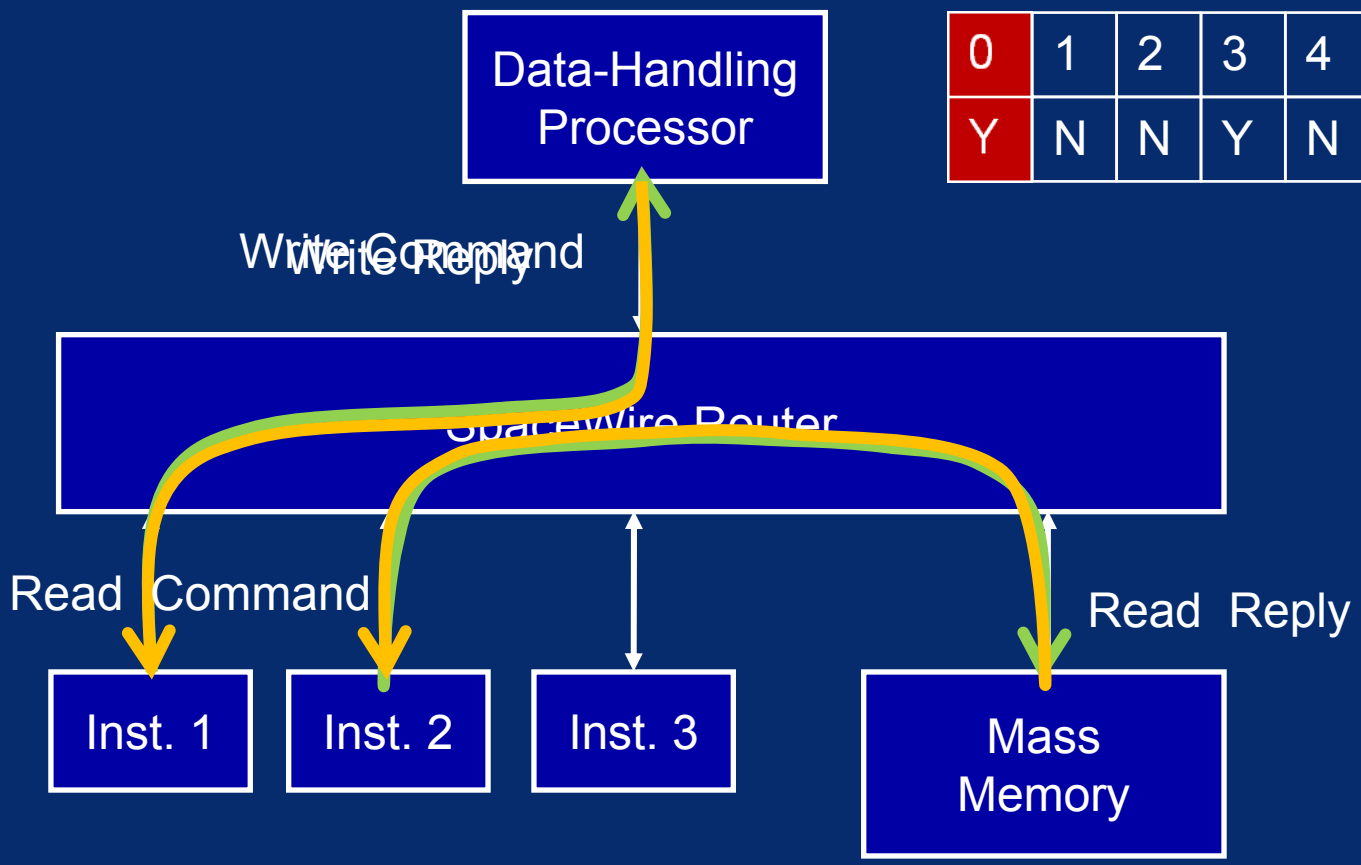
Time-Slot 0



0	1	2	3	4	...
Y	N	N	Y	N	...

0	1	2	3	4	...
Y	Y	Y	N	N	...

Conclusion

- Built on SpaceWire and RMAP standards
- Uses time-codes to produce time-slots
- Schedules communication in time-slots
- Uses RMAP transactions
- Can support FDIR
- Simple constraints:
  - RMAP target
    - Speed of response to RMAP commmand
  - RMAP initiator
    - Speed of response to time-code
    - Limit to size of RMAP data field
- Very simple to implement

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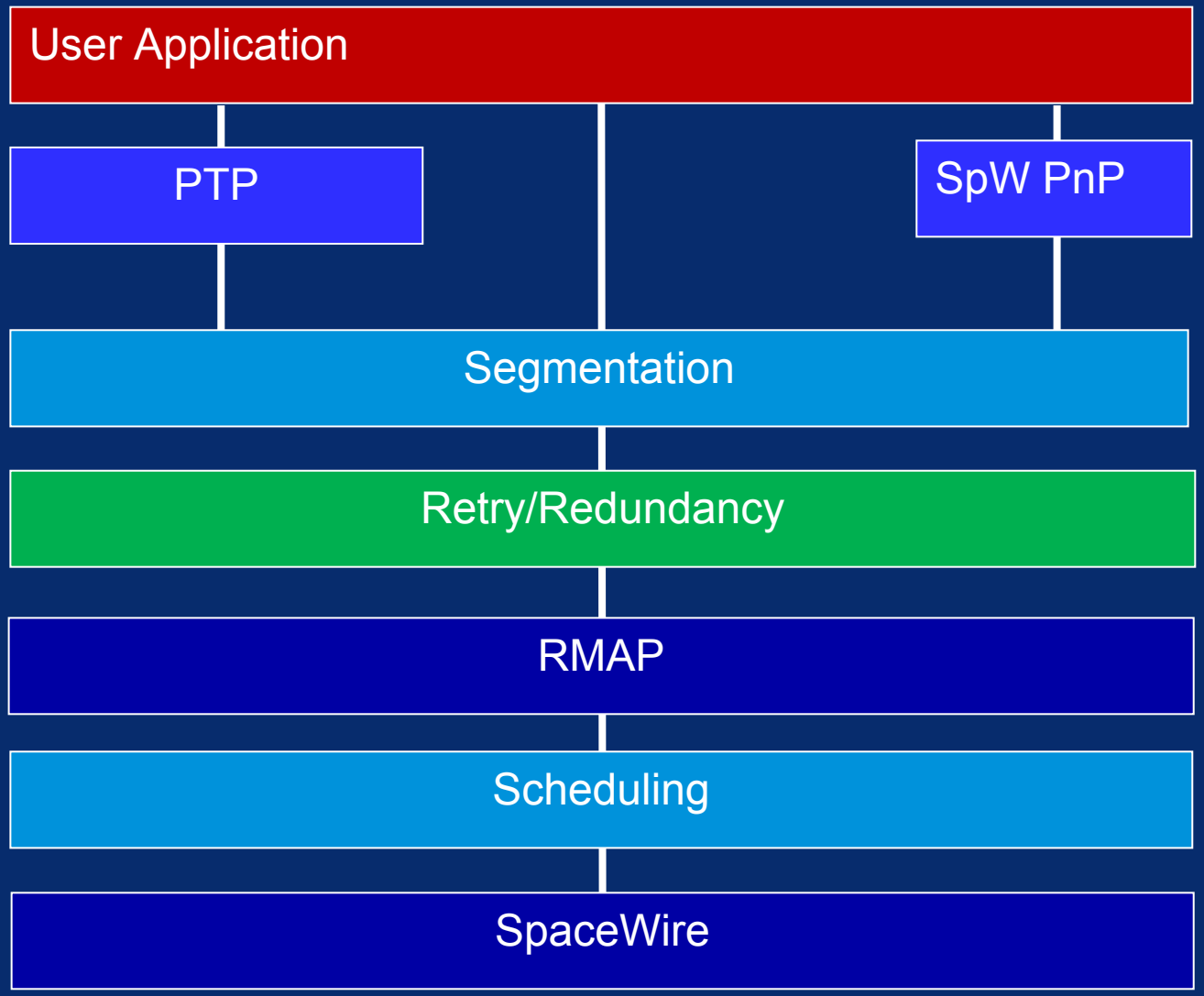
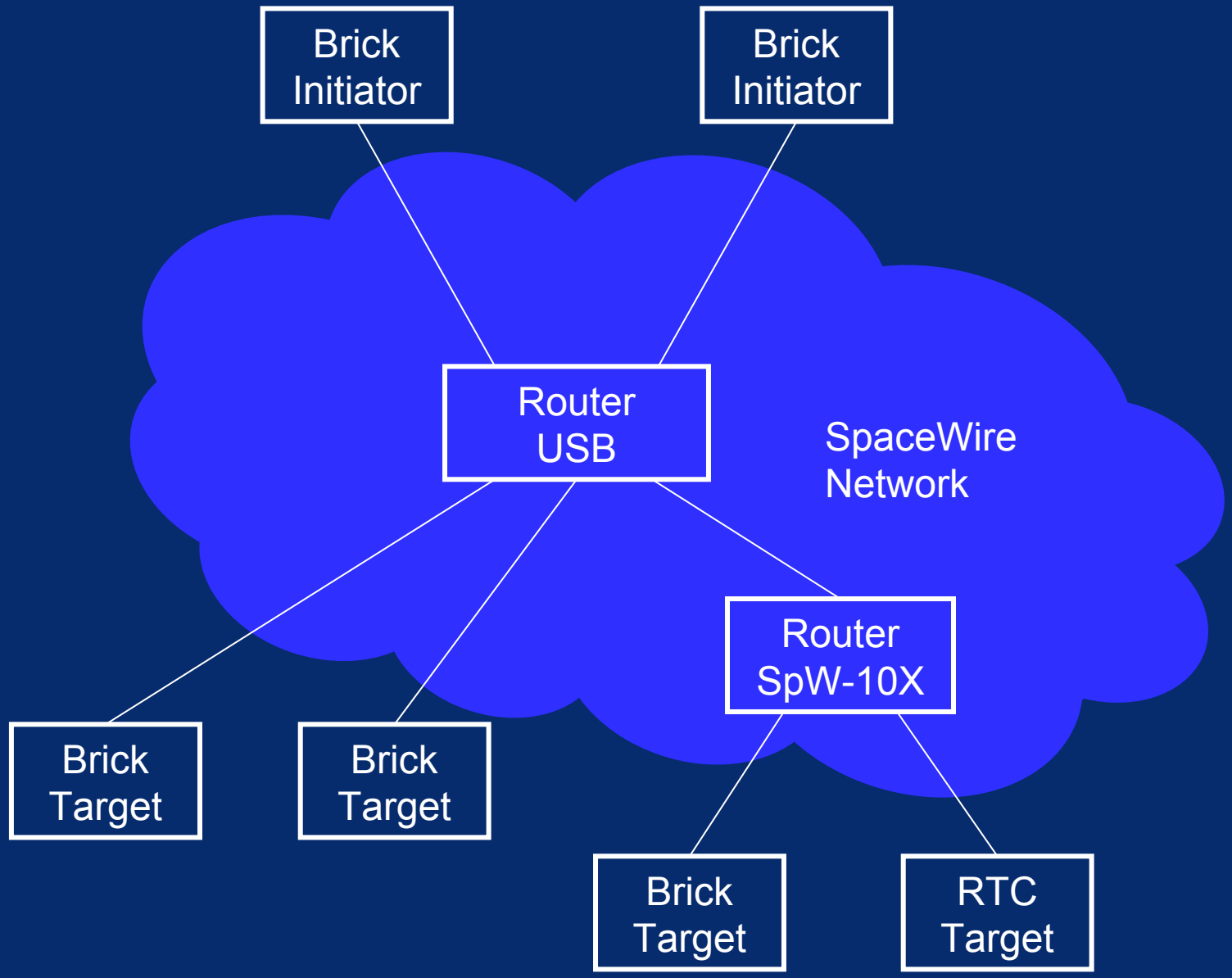
SpaceWire-D Protocol Stack



Demonstration



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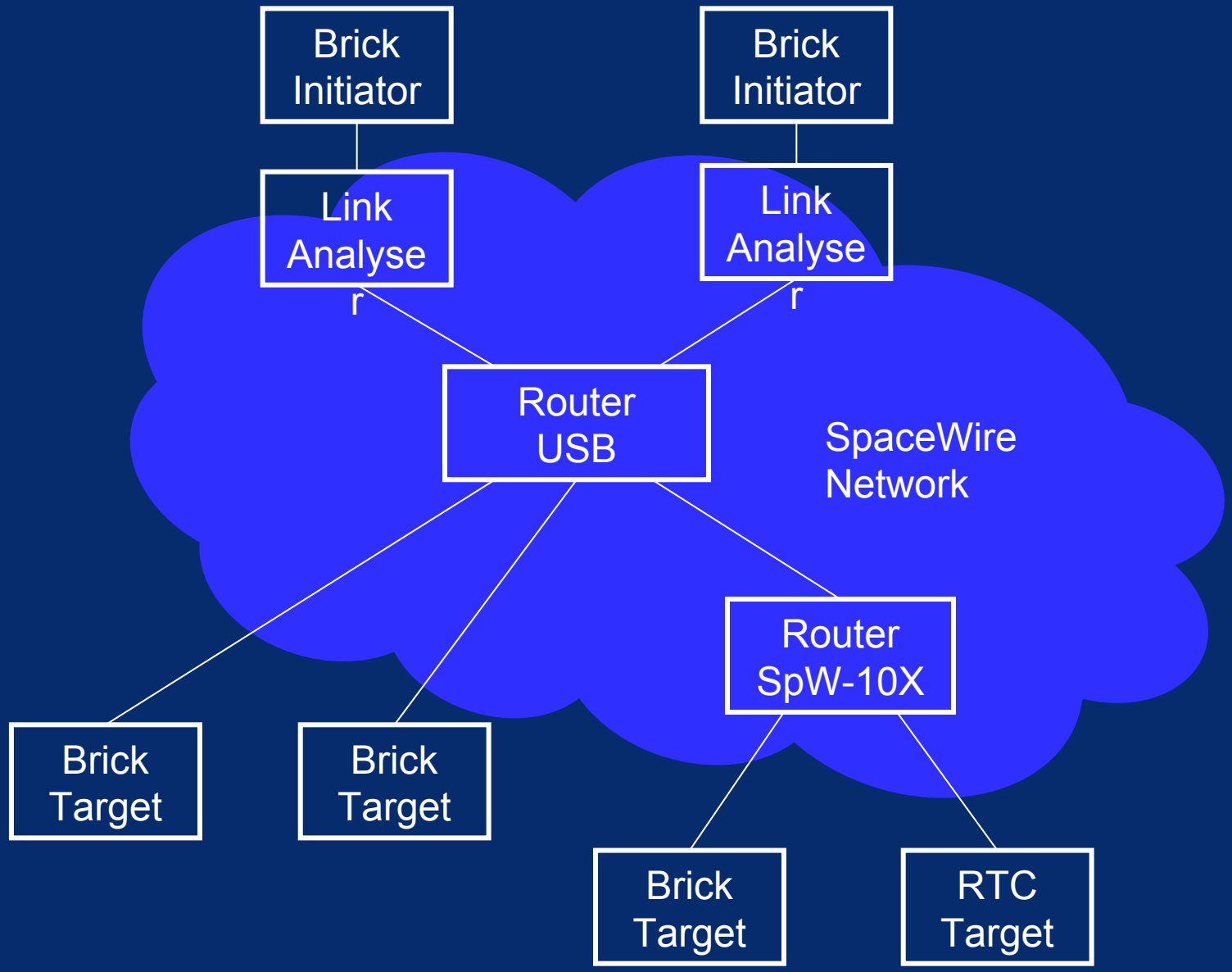
Demonstration



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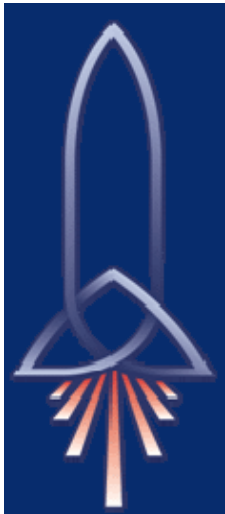
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