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Benchmarking SpaceWire Networks

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The problem

- Multiple proposals for SpaceWire
- Vendors design new SpaceWire parts

- BUT …

- How can we evaluate proposals?
- How can we compare parts from different vendors?

Benchmark

Benchmark purposes

- Evaluate protocol proposals
- Compare network configurations
  - Cost
  - Performance
  - Reliability
- Compare components
- Formalize requirements
- Improve the standard

Benchmark Contents

- End units
  - Redundancy
- Traffic specifications
  - Unit X sends to unit Y
  - Quality of Service Requirements
    - Bandwidth, real time constraints, deadlines, Priorities, etc.
- Benchmark does NOT include implementation details
  - No topology, no specific components

End units (examples)

Unit	# Units	# Active Units
Data Handling System (DHS)	2	1
Reconfiguration Unit (RU)	1	1
Payload Sensor (Camera)	3	1
Downlink	2	1
Solar Cells Control	2	1
Star Tracker	3	3

Traffic matrix

From	To	Type	BW B/Sec	Cycle [Sec]	Latency	Control Loop	Priority
SENSOR	DHS		1,000	0.1			M
DHS	SENSOR		1,000		Low		H
STORAGE	DHS		1,000				M
DHS	STORAGE		1,000				M
SENSOR	STORAGE	Payload	100M				L
DHS	DOWNLINK		100				M
DOWNLINK	DHS		100				M
STORAGE	DOWNLINK	Payload	20M				L
DAP	DHS		500	0.1		Yes	H
DHS	DAP		200	0.1		Yes	H
DAS	DHS		1				M
DHS	DAS		1				M
DHS	TTCGCS		10K				M
TTCGCS	DHS		5K				M
TTCAP	DHS		500	0.1	Low	Yes	H
DHS	TTCAP		200	0.1		Yes	H
TTCAS	DHS		10				M

Traffic matrix (examples)

- High bandwidth

From	To	Type	BW B/sec	Latency	Recommended Priority
Sensor	Storage	Payload	100M		L

- Low bandwidth

DHS	Sensor	Control	1000	Low	H

Using the Benchmark

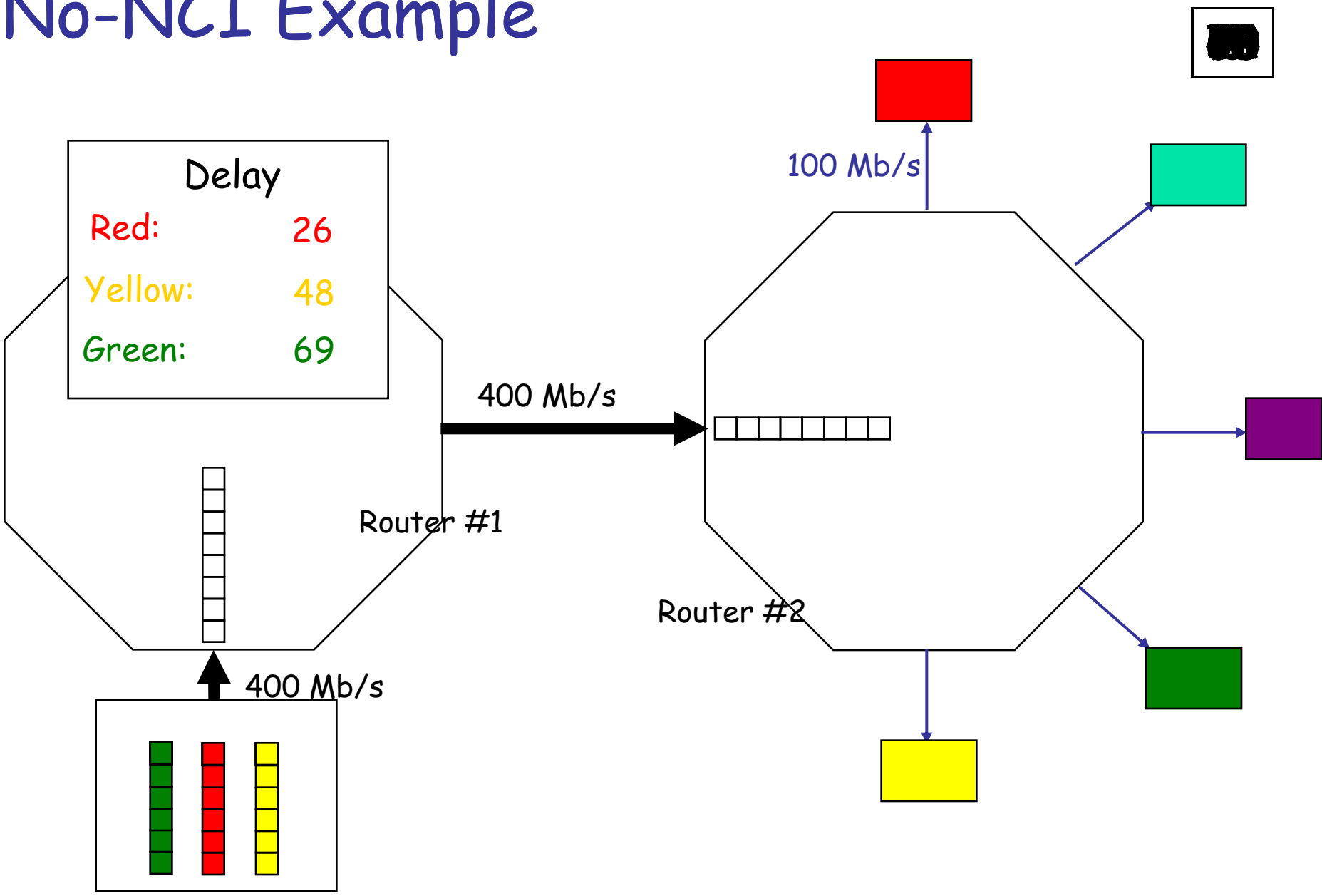
Evaluating SpaceWire features

- Standard: Packet-level priority (PLP)
- Non-Standard: N-Char interleaving (NCI)

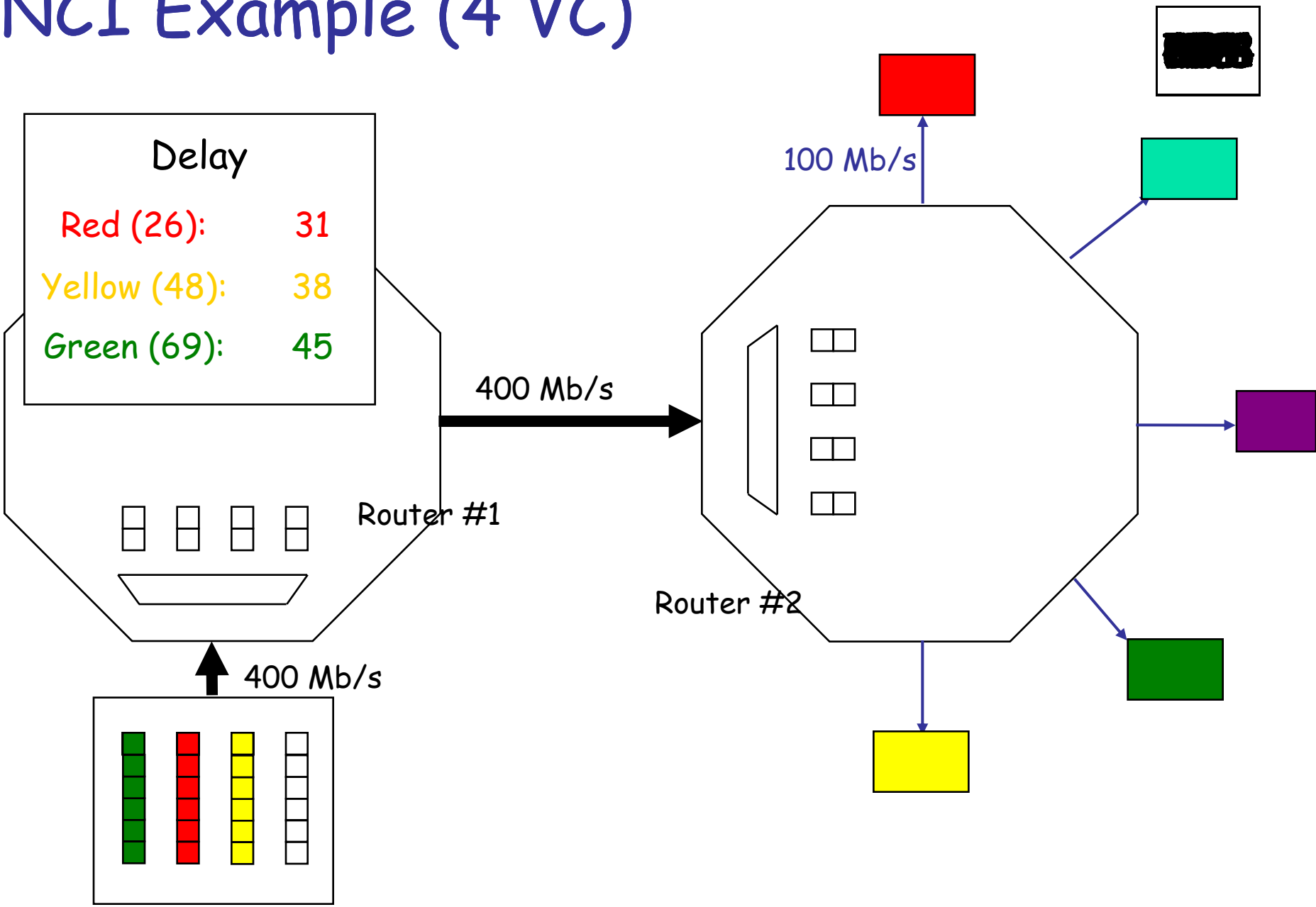
N-Char Interleaving

- Not in SpaceWire standard
- But, Very useful in Wormhole networks
- Requires multiple VCs
- VC code added to each N-Char
  - Ideally, SPW would allow longer flits

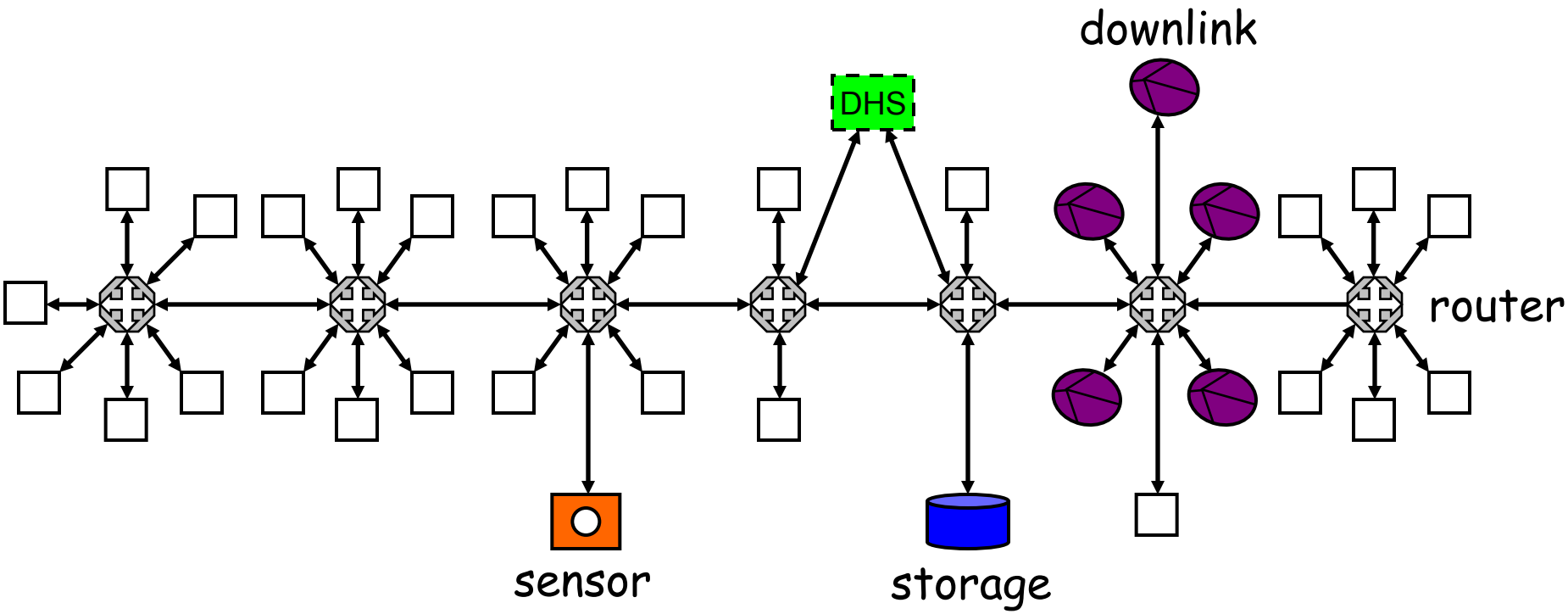
No-NCI Example



NCI Example (4 VC)



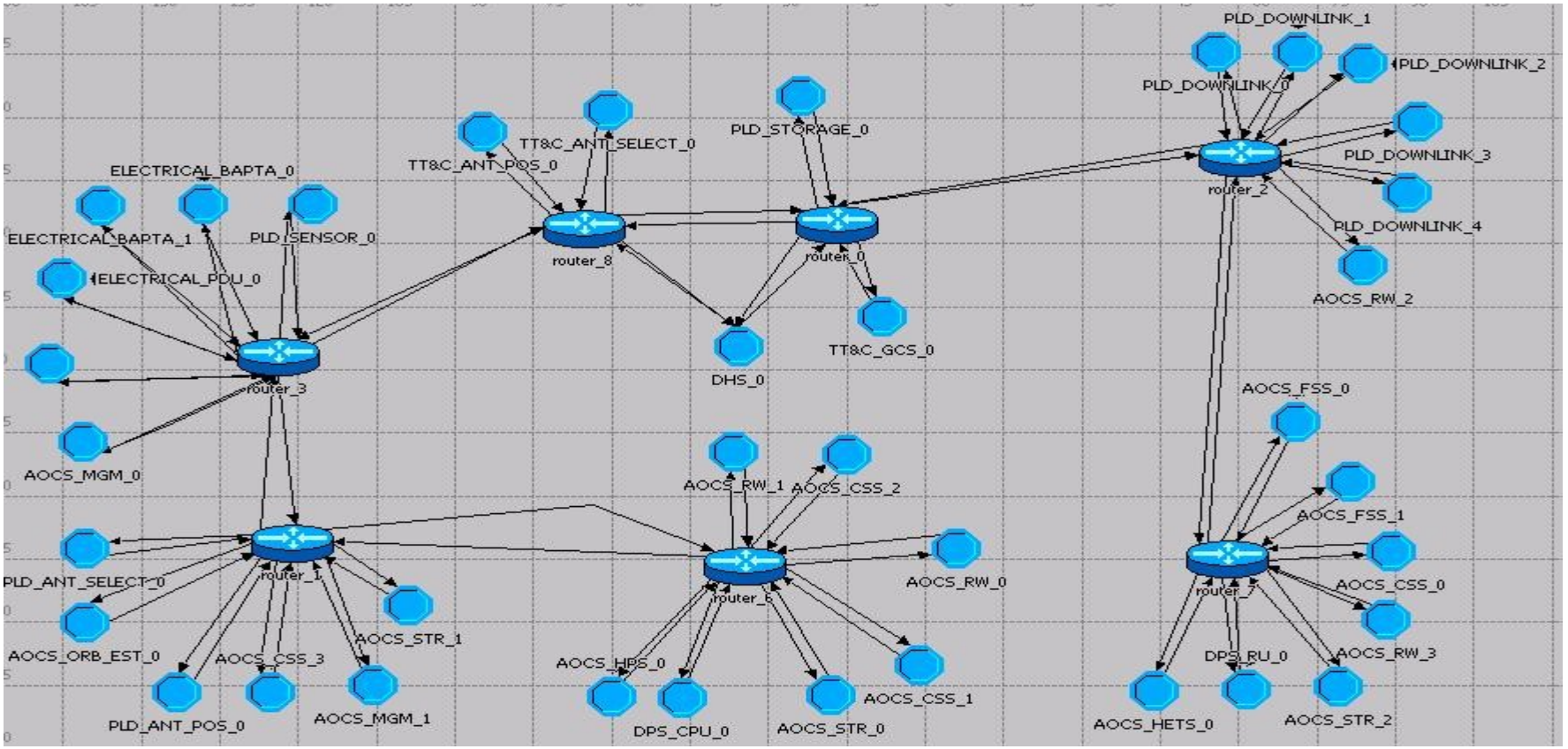
Network topology



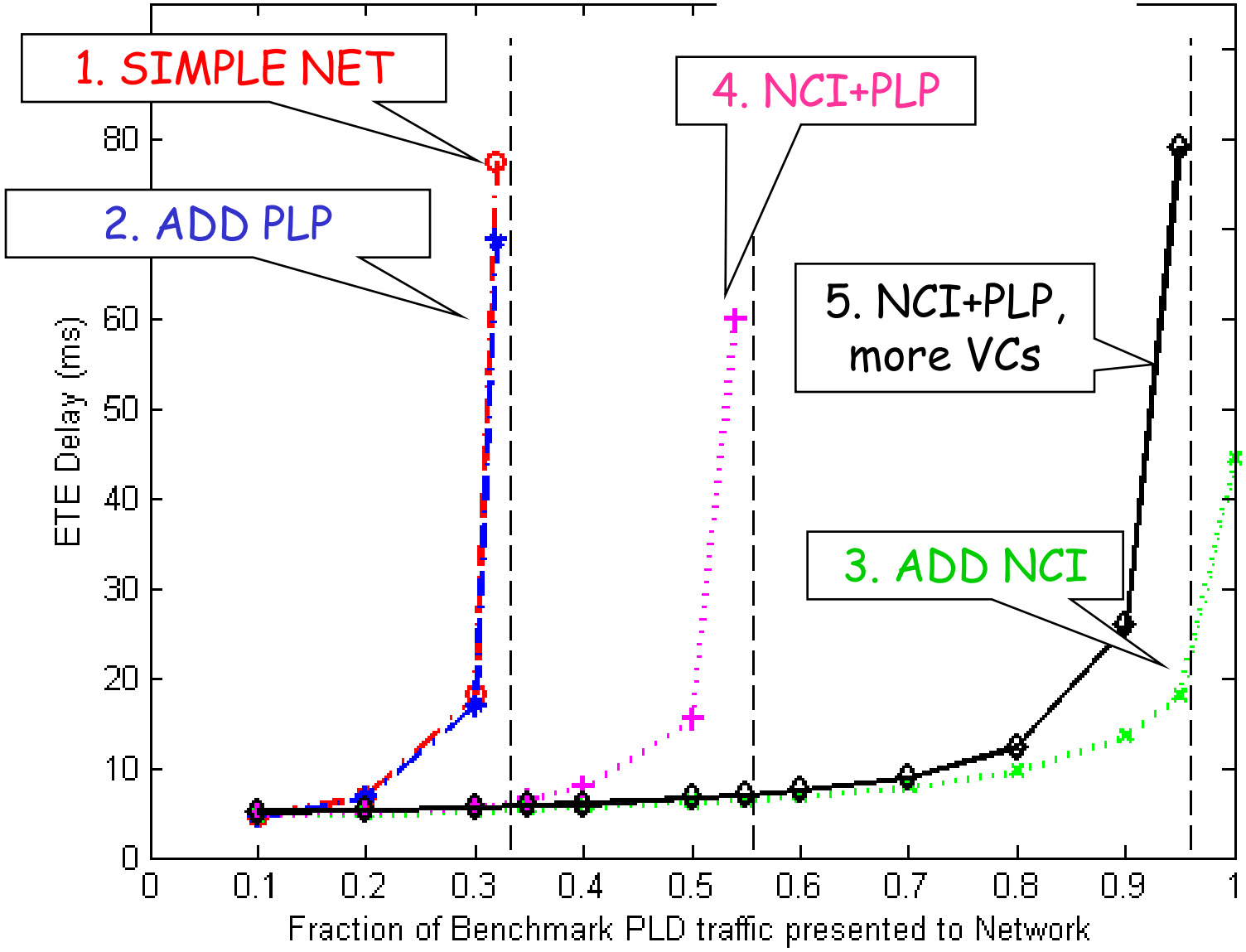
Only active units shown and simulated
Redundant units, routers, links hidden and ignored

Simulator display

- Simulated using OPNET
- A commercial simulator for networks

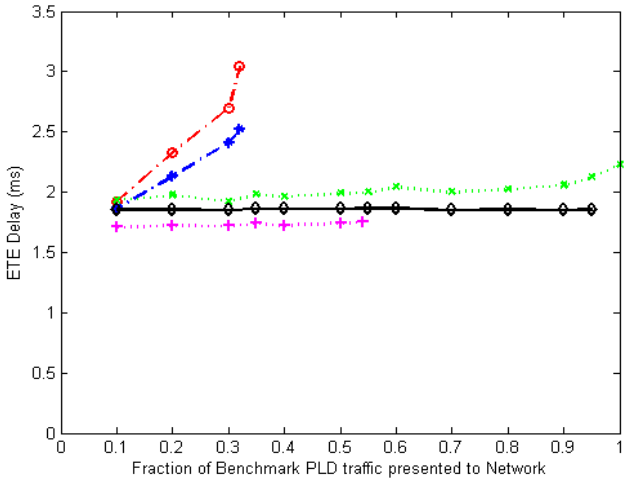


Simulations: Low priority payload traffic

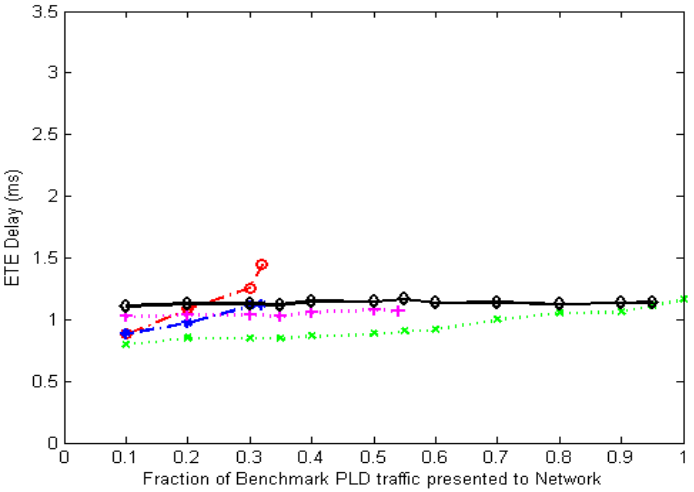


Simulations Results – Other Priorities

High Priority



Medium Priority



- NCI with PLP is beneficial
  - Low ETE delay of med+high priority packets
  - High ETE delay of low priority packets

Summary

- A new SpaceWire benchmark (open source)
- A new simulator for SpaceWire
- An example of using the benchmark
- Priorities help
- Non-standard NCI helps even more