QoS in High Throughput Data Vortex Optical Interconnection Networks

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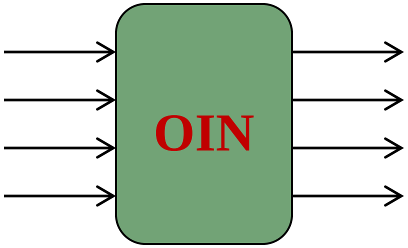
Outline

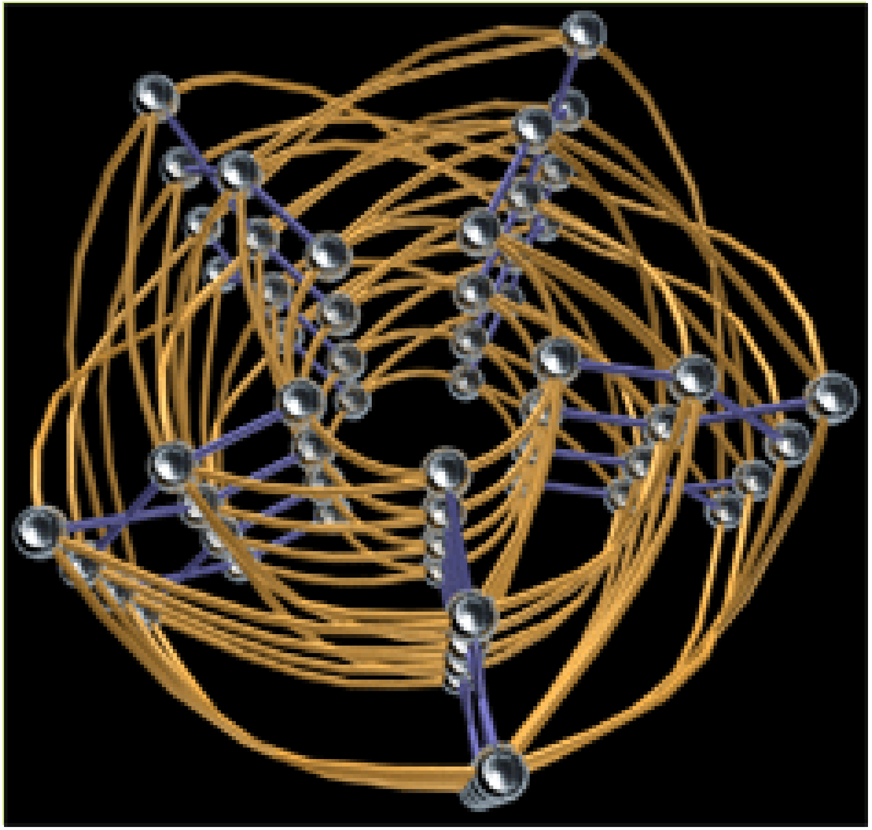
- Optical interconnection network
- Data Vortex network toplogy
- Modified high throughput implementations
- QoS support and implementation
- Performance evaluation
- Conclusion

Optical Interconnection Networks

- **High throughput**
- **Low latency**
- **Scalability**
- **Simple** routing arbitration
- **Contention resolution**/ optical buffering



Data Vortex network toplogy



Key features:

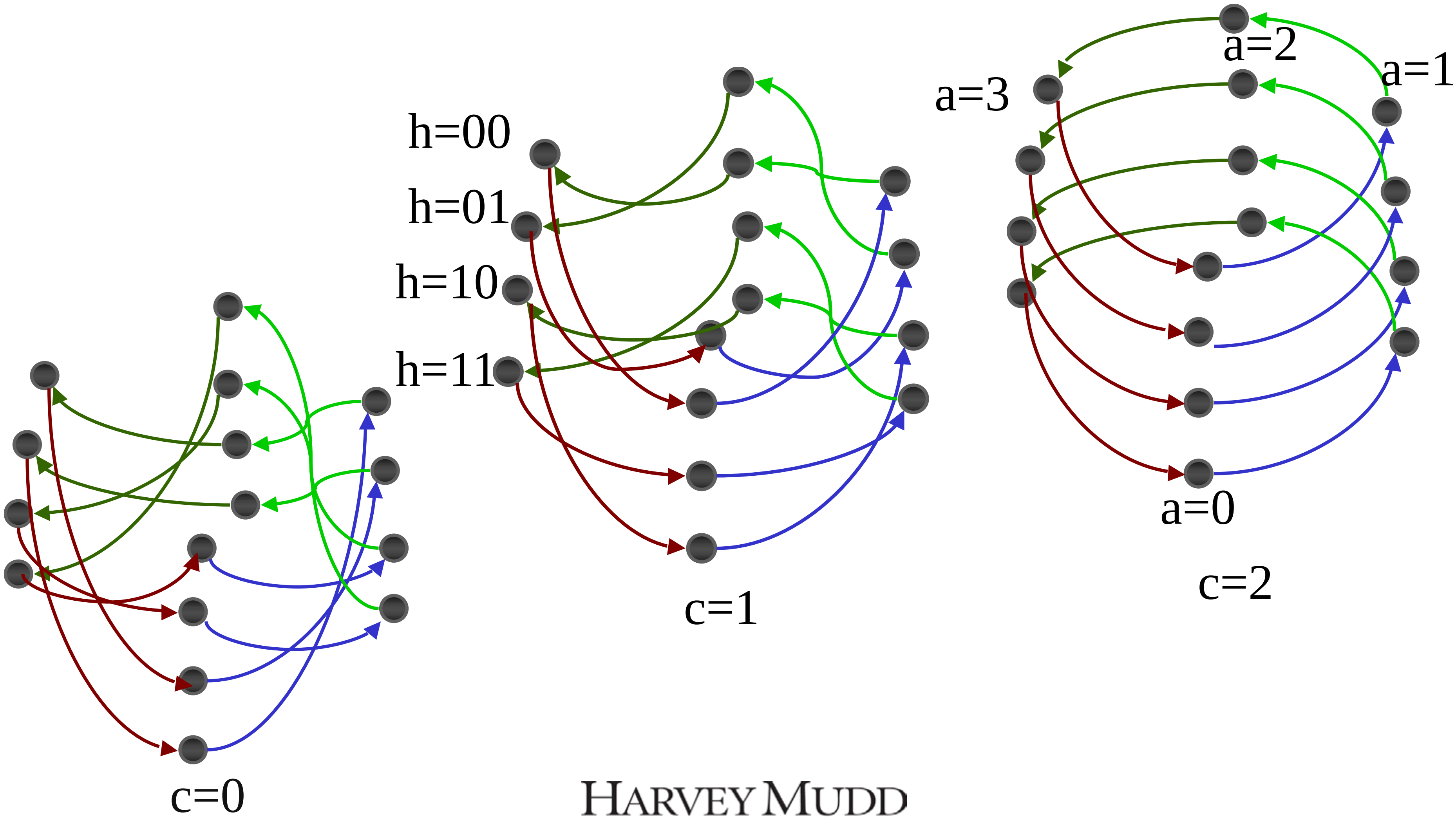
- •Packet switched
- •High throughput
- •Low latency
- •Simple node implementation
- •Non-blocking

- •Buffer-less/small buffer
- •WDM payload and header

Example: Data Vortex of **A=5, H=4**. C= $\log_2 H + 1$

http://lightwave.ee.columbia.edu/

Data Vortex network toplogy



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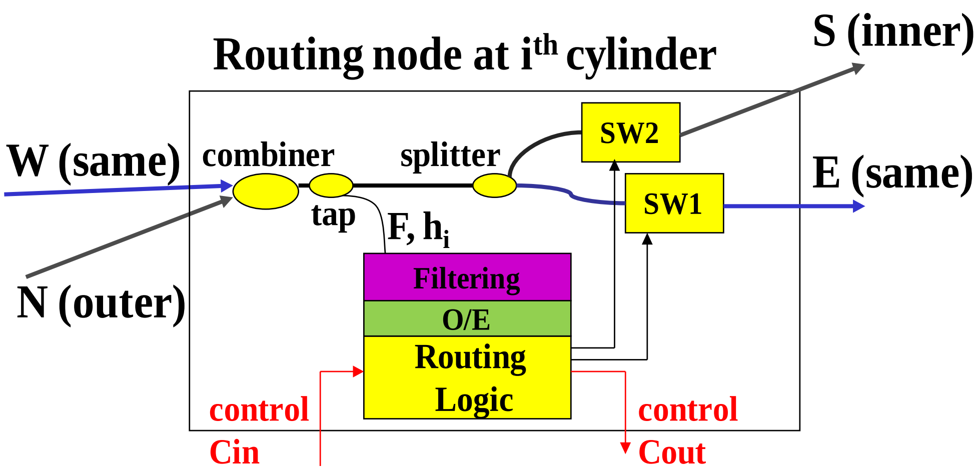
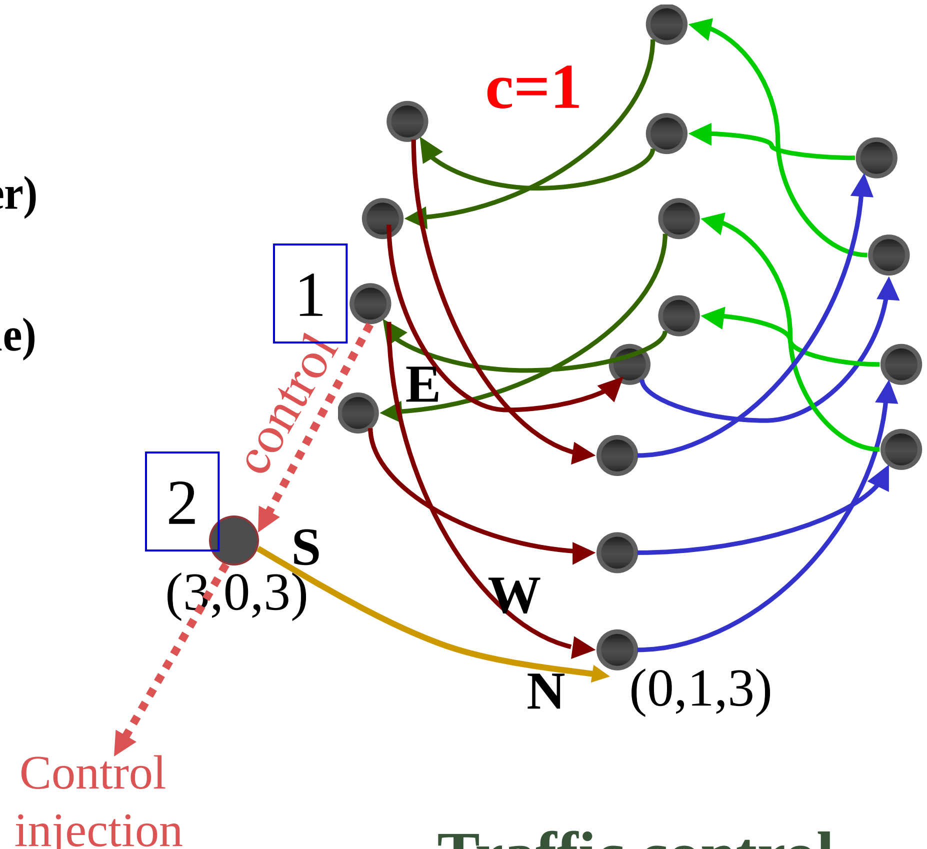
Original Routing and Traffic Control



Node implementation



Traffic control

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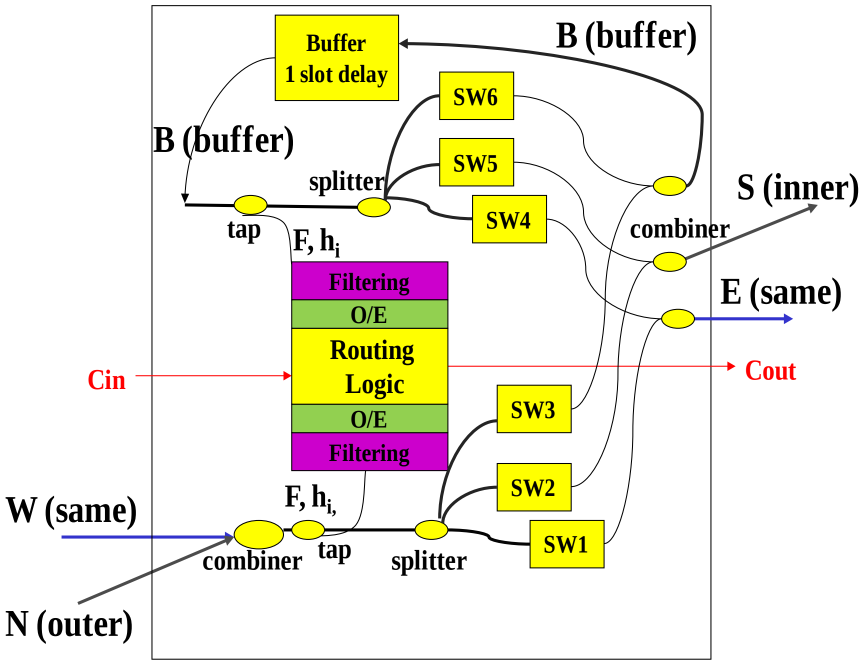
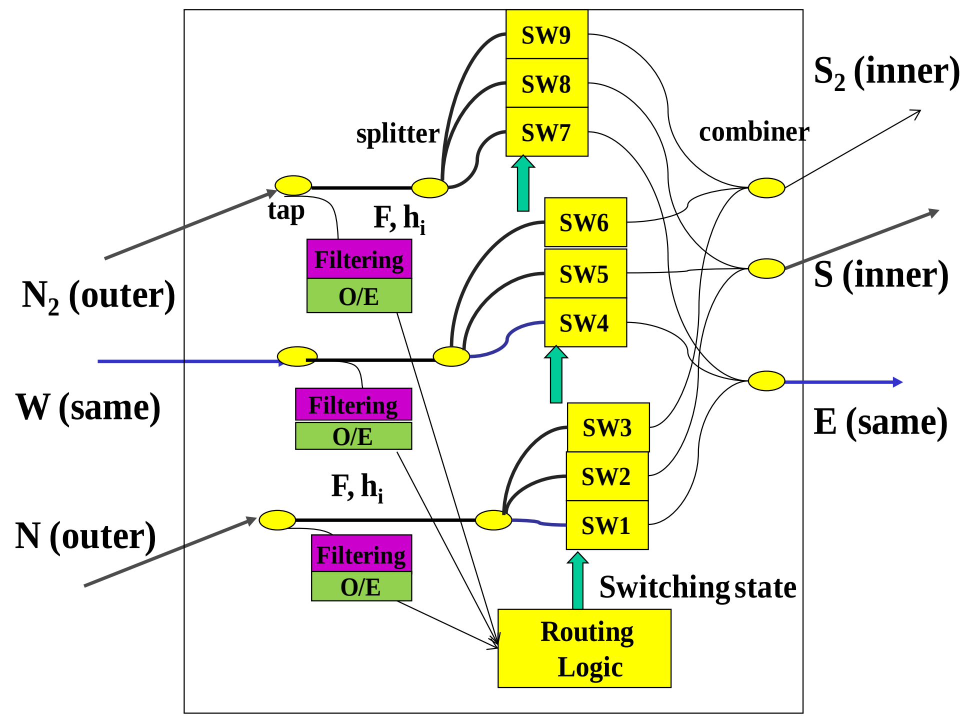
Alternatives:
Enhanced Node Implementation

2 input buffered node at i^{th} cylinder



3-input node at i^{th} cylinder



3 simultaneous input based inter-cylinder paths

Cases	W	N	N_2	Routing Table
1	0	0	0	$W\rightarrow S_2$, $N\rightarrow E$, drop N_2
2	0	0	1	$W\rightarrow S_2$, $N\rightarrow E$, $N_2\rightarrow S$
3	0	1	0	$W\rightarrow S_2$, $N_2\rightarrow E$, $N\rightarrow S$
4	0	1	1	$W\rightarrow S_2$, $N_2\rightarrow E$, $N\rightarrow S$,
5	1	0	0	$W\rightarrow S$, $N_2\rightarrow E$, $N\rightarrow S_2$
6	1	0	1	$W\rightarrow S$, $N_2\rightarrow E$, $N\rightarrow S_2$
7	1	1	0	$W\rightarrow S$, $N\rightarrow E$, drop N_2
8	1	1	1	$W\rightarrow S$, $N\rightarrow E$, drop N_2

TABLE 1: ROUTING TABLE FOR 3 SIMULTANEOUS INPUTS
1: Match or to maintain its height group
0: Not match, to switch its height group

QoS hardware requirement

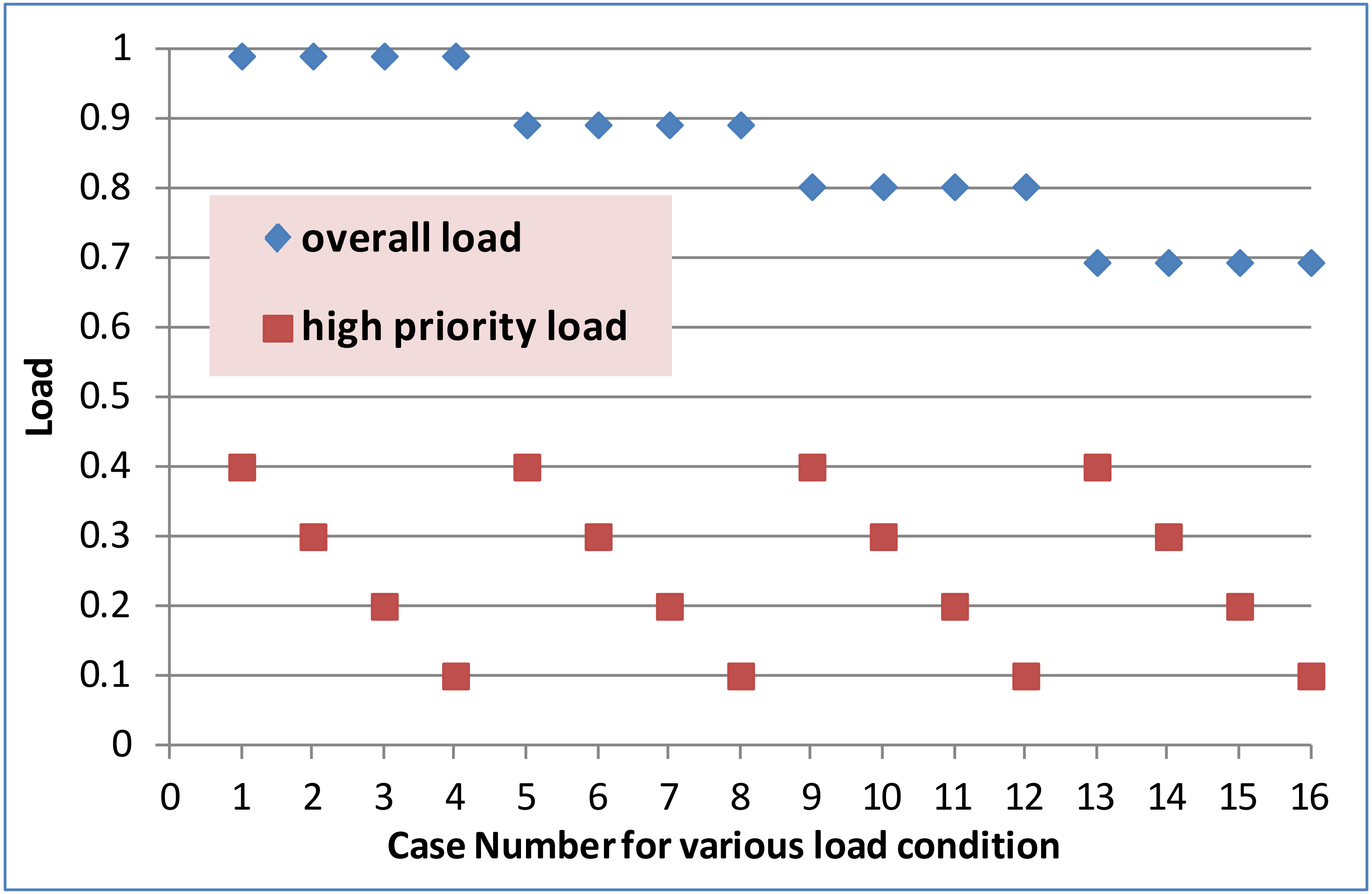
- Traffic class indicated by priority bit
- Priority bit detection at node
- Node routing logic slightly more complicated

TABLE 2: Routing Decision with all three incoming packets

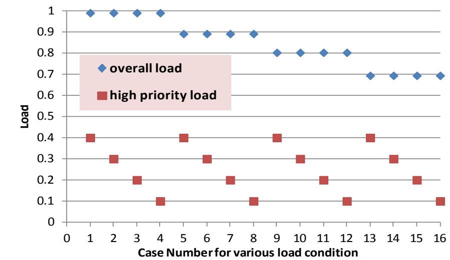
0: not match 1: match
H: high priority L: low priority

Input Case	P1	P2	P3	Routing Decision
1	L	L	L	Same routing logic as non-QoS
2	H	L	L	
	0	0	0	P1→S2, P2→E, P3→drop
	0	1	X	P1→S2, P2→S, P3→E
	1	0	0	P1→S, P2→S2, P3→E
	1	1	0/1	P1→S, P2→E, P3→S2/ →drop
3	H	H	L	
	0	0	0/1	P1→S2, P2→E, drop P3/P3→E
	0	1	0/1	P1→S2, P2→S, P3→E
	1	1	0/1	P1→S, P2→E, P3→S2/drop P3
4	H	H	H	Same routing logic as non-QoS

Performance Comparison



Performance Evaluation



A=5, H=256, Ain=3

Packet Drop Rate

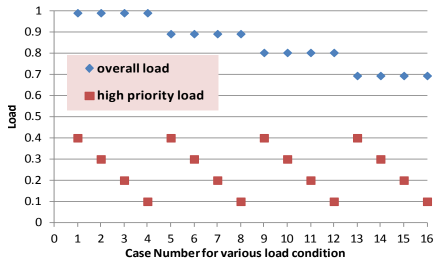
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0

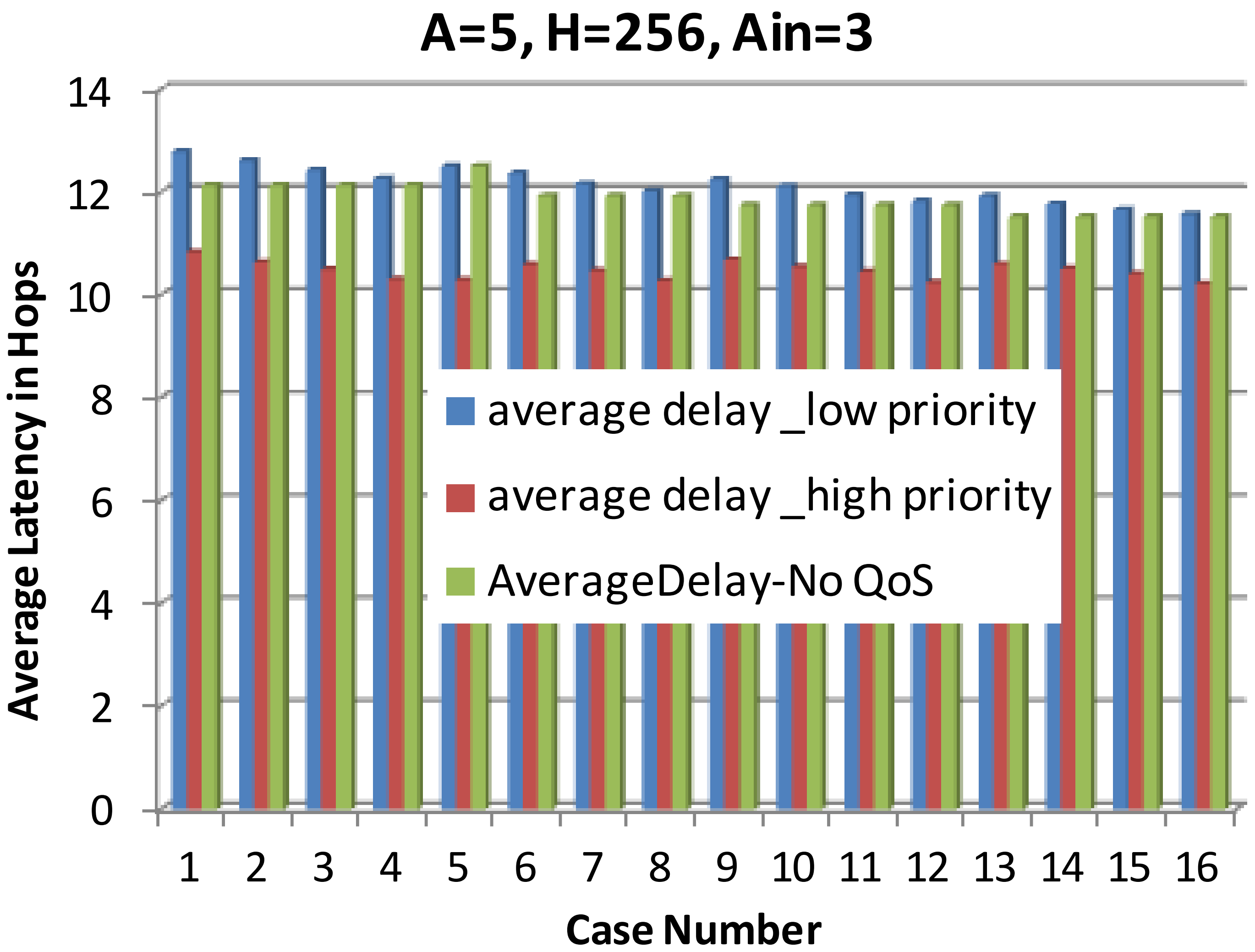
packet drop rate _low priority
packet drop rate _high priority
packet drop rate-No QoS

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

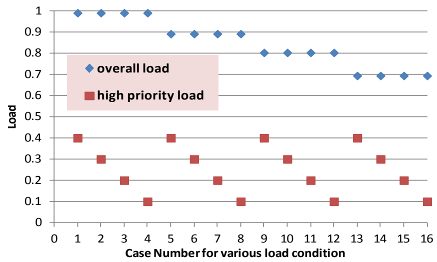
Case Number

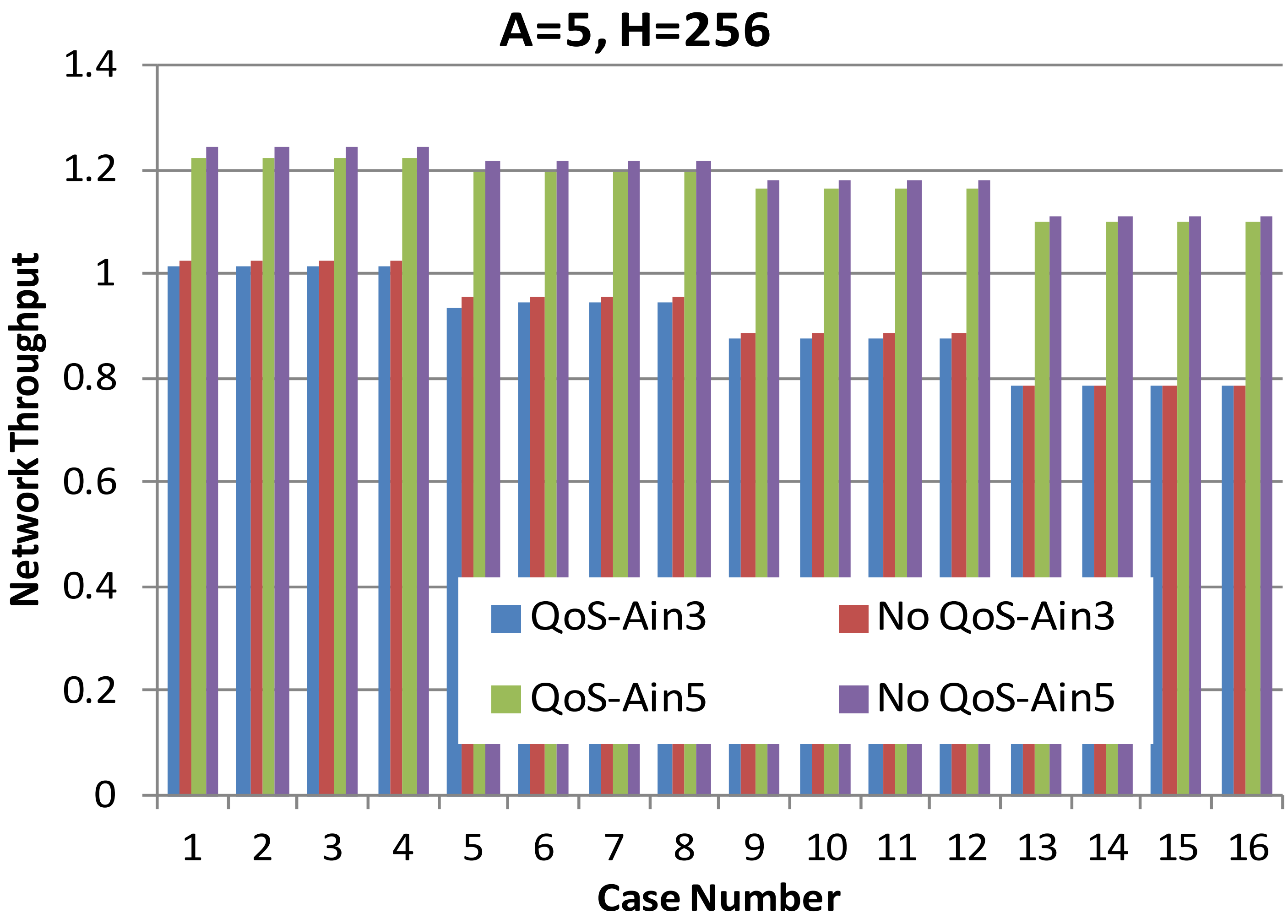
Performance Evaluation





Performance Evaluation





Conclusion

- QoS can be introduced in Data Vortex network.
- Hardware implementation should be small overhead.
- Overall performance is maintained to be at a similar level to non-QoS, while the high priority traffic achieves much better and optimized performance.
- QoS should be built in for future optical interconnection network.

Thank you ! Questions?

Reference:

[1] http://lightwave.ee.columbia.edu/data-vortex.php

[2] A. Shacham and K. Bergman, “On contention resolution in the data vortex optical interconnection network”, *Journal of Optical Networking*, vol. 6, No.6, pp.777–788, June 2007.

[3] Neha Sharma, D.Chadha, Vinod chandra, “The augmented data vortex switch fabric: An all-optical packet switched interconnection network with enhanced fault tolerance”, *Optical Switching and Networking, Elsevier*, **4,** 92-105 (2007).

[4] Qimin Yang, “Enhanced control and routing paths in data vortex interconnection networks”, *Journal of Optical Networking*, Vol. 6, No.12, pp. 1314-1322, December 2007.

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