



PERFORMANCE ANALYSIS OF OPENFLOW HARDWARE

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AGENDA

- Experiments
 - Installing flows
 - Performance overhead
 - Lookup procedure
 - Failover speed
 - DoS controller
- Conclusion
- Questions
- Presentation approximately 20 minutes
- Questions approximately 5 minutes
- 21 slides

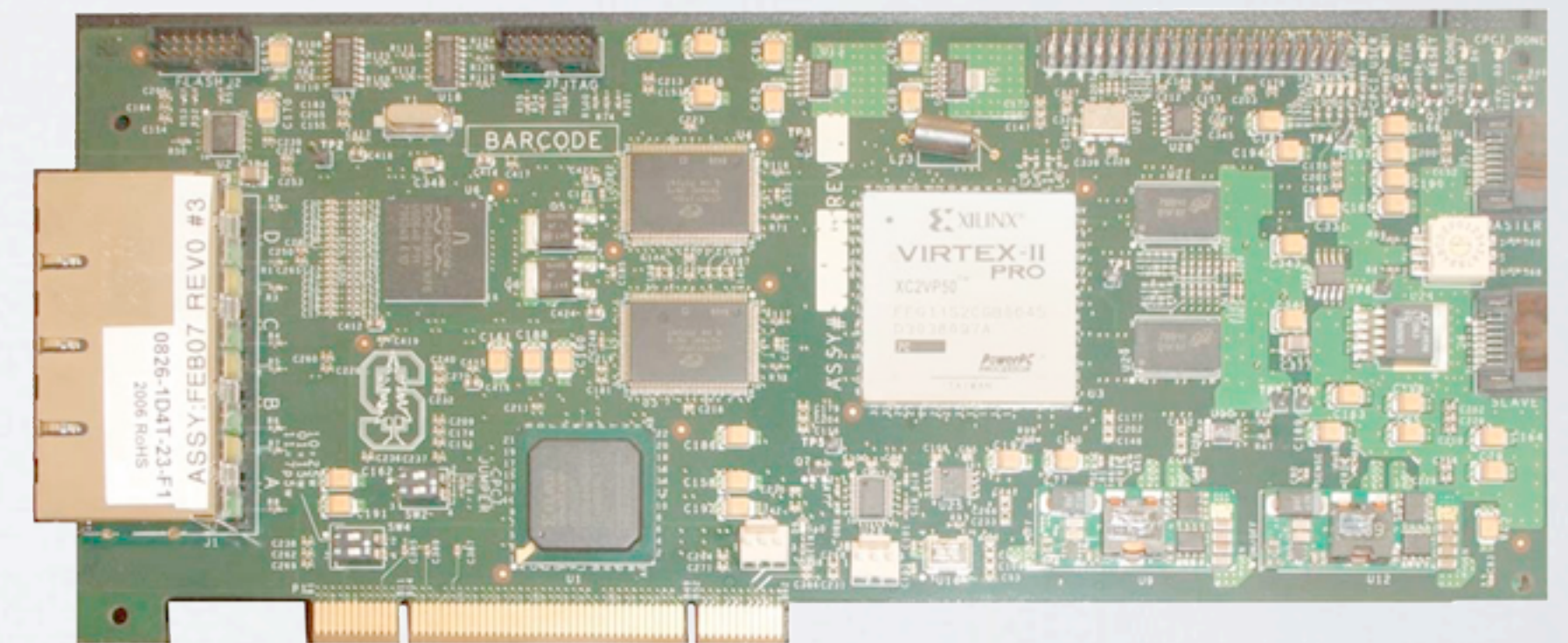
RESEARCH QUESTION

“How can the scalability of OpenFlow switches be explained by their hardware design?”

EXPERIMENTS

Hardware

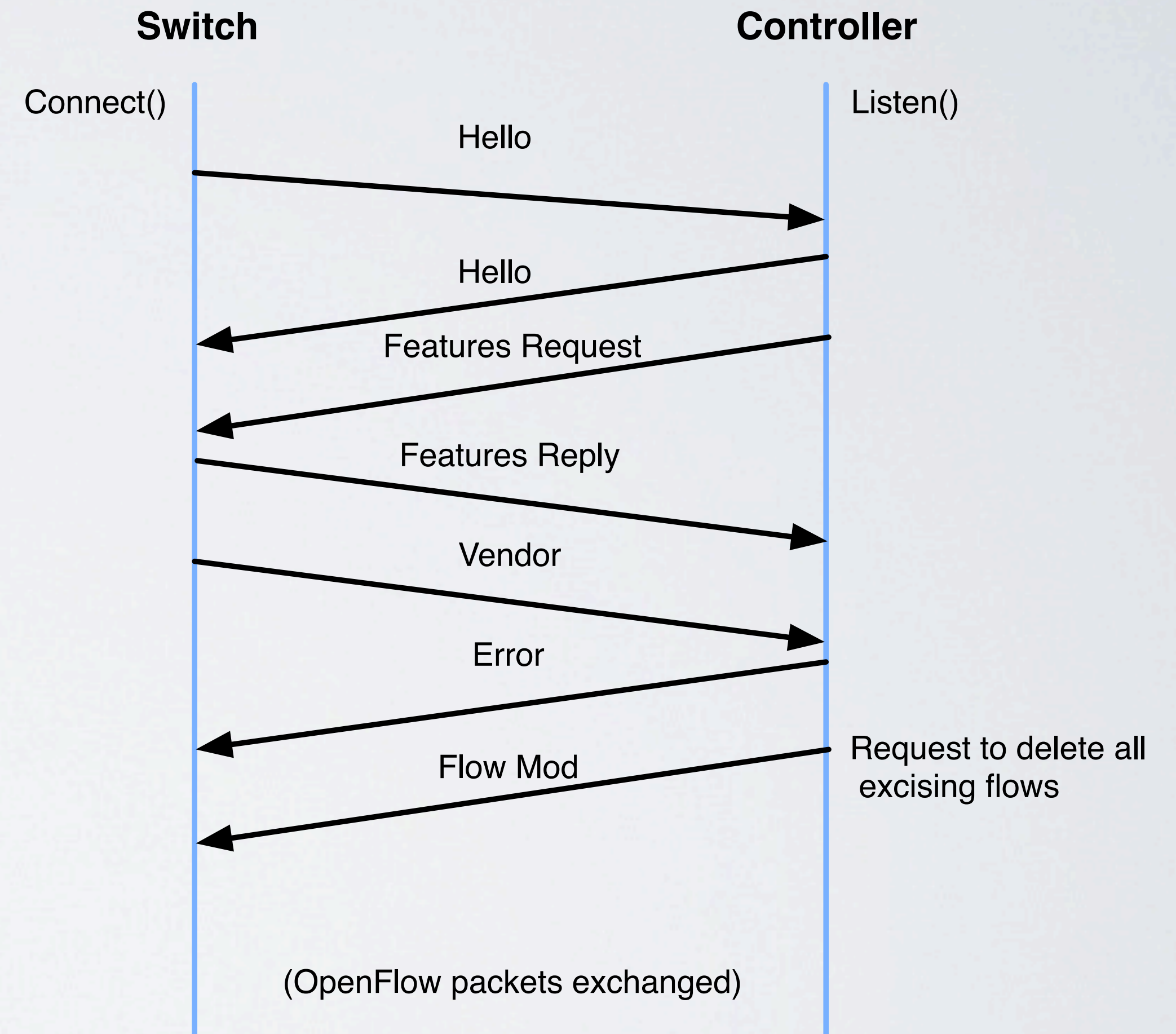
- Pronto 3290
- Xorplus
- Pica8
- Open vSwitch
- NetFPGA Gigabit Card
- Anritsu MDI 230A Ethernet Traffic Tester



EXPERIMENTS

Installing flows

- Types of flows
- Initial hand-shake
- Install flows rapidly



EXPERIMENTS

Installing flows

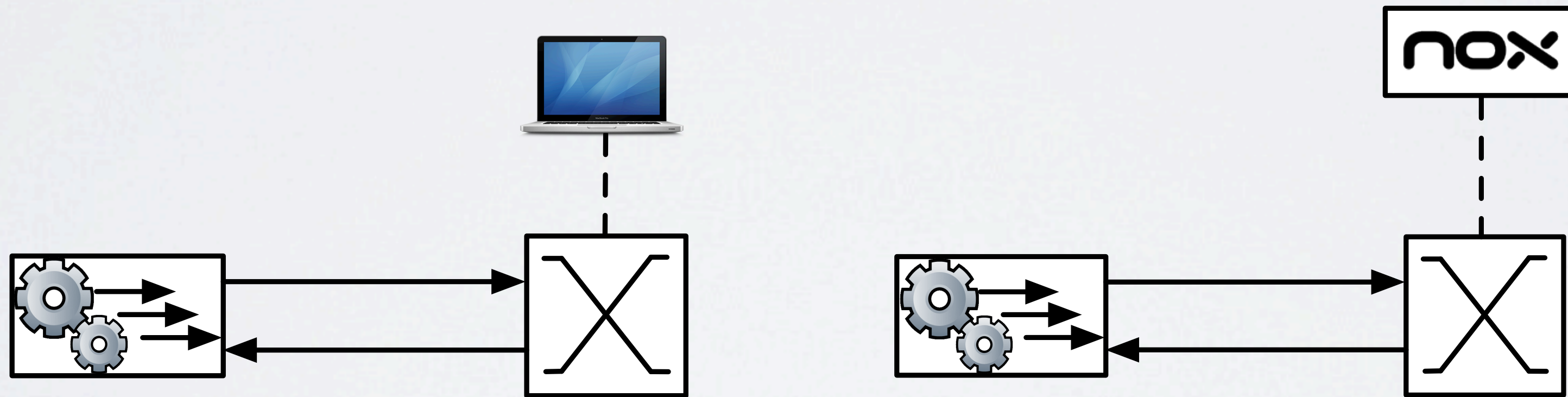
Three tries installing the maximum amount of flows

	Pica8 OpenFlow	NetFPGA
Install 1 linear flow	4.3 ms	0.8 ms
Install 1 hash flow	2.0 ms	6.1 ms

EXPERIMENTS

Performance overhead

- Does OpenFlow add a big amount of latency when switching?



EXPERIMENTS

Performance overhead

	Port 4 to port 3	Port 3 to port 4
Max	7.1 μ s	7.7 μ s
Min	6.4 μ s	7.1 μ s

EXPERIMENTS

Performance overhead

- Test packet send from Anritsu is not recognized

- 4 bytes are added

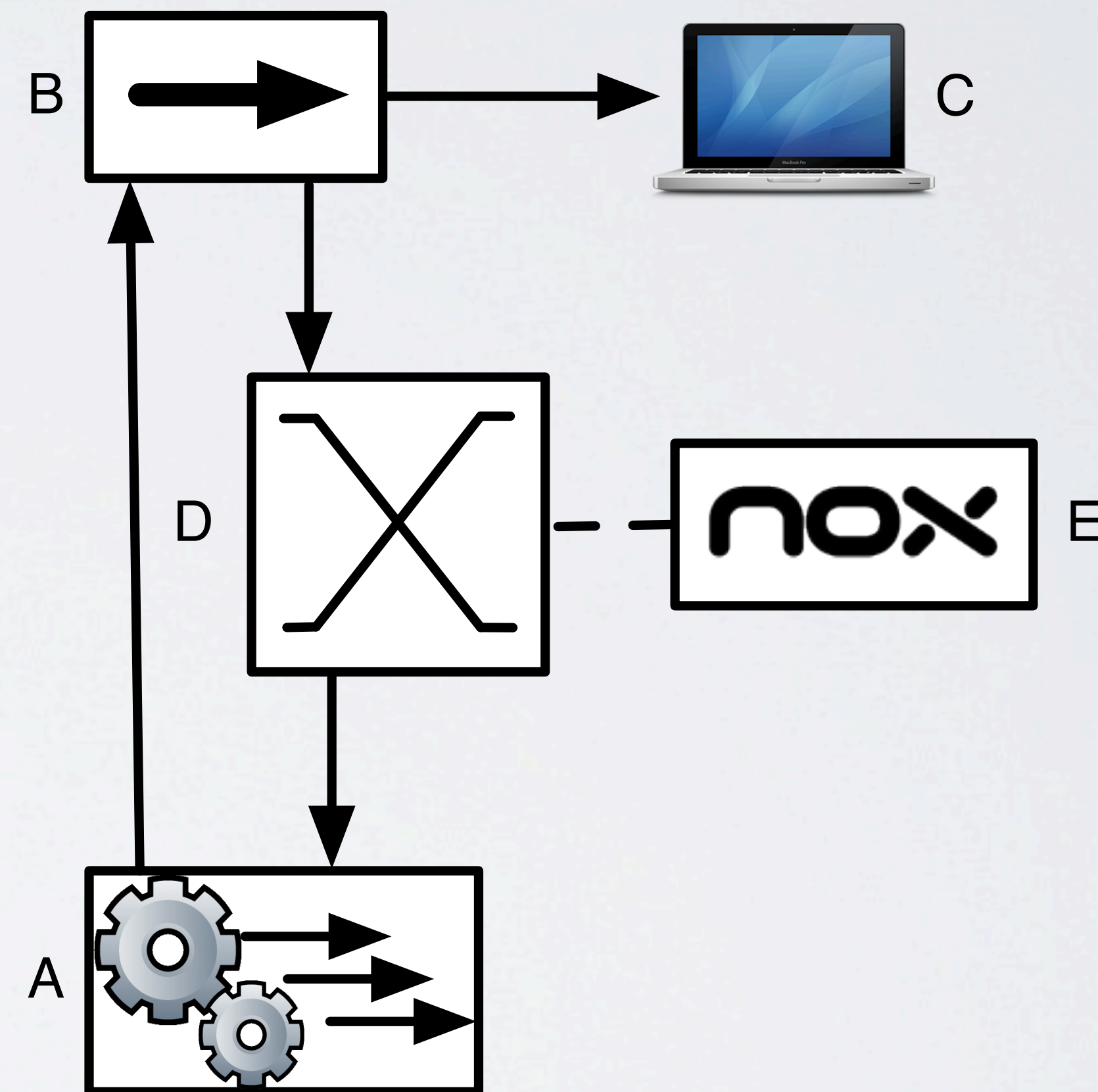
A) Anritsu

B) Ethernet hub

C) Laptop running Wireshark

D) OpenFlow switch

E) OpenFlow controller



EXPERIMENTS

Performance overhead

Send from Anritsu

```
Frame 2: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)
Ethernet II, Src: Beckhoff_03:00:00 (00:01:05:03:00:00), Dst:
Beckhoff_04:00:00 (00:01:05:04:00:00)
Internet Protocol Version 4, Src: 10.1.5.3 (10.1.5.3), Dst: 10.1.5.4
(10.1.5.4)
Data (26 bytes)
```

```
0000  00 01 05 04 00 00 00 01 05 03 00 00 08 00 45 00
0010  00 2e 00 00 40 00 40 00 1c c8 0a 01 05 03 0a 01
0020  05 04 f6 f6 28 28 00 0c ff 83 df 17 32 09 4e d1
0030  e7 cd d6 31 00 dc 8c 70 00 01 9c 89
```

EXPERIMENTS

Performance overhead

Received at laptop

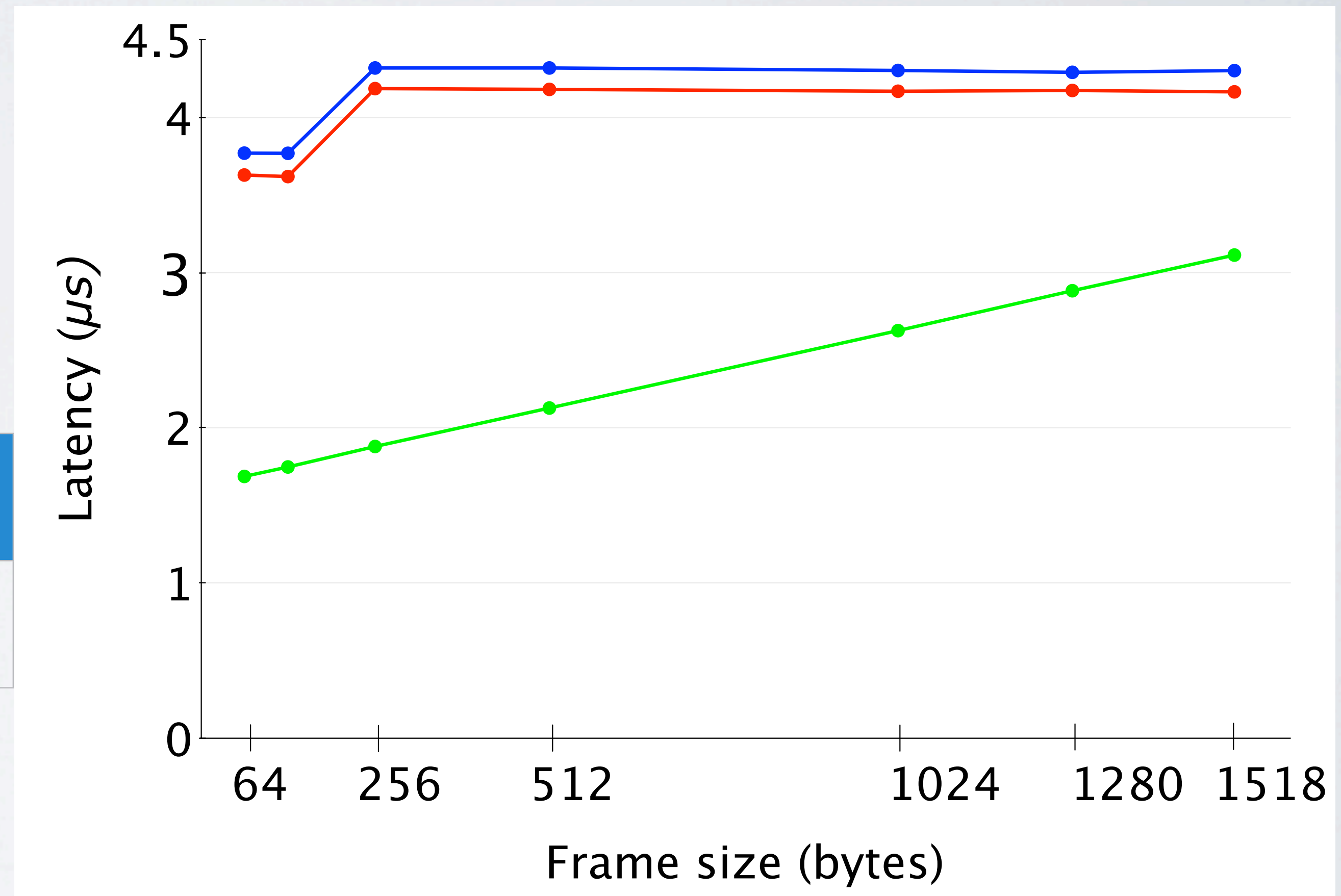
```
Frame 3: 68 bytes on wire (544 bits), 68 bytes captured (544 bits)
Ethernet II, Src: Beckhoff_03:00:00 (00:01:05:03:00:00), Dst:
Beckhoff_04:00:00 (00:01:05:04:00:00)
Internet Protocol Version 4, Src: 10.1.5.3 (10.1.5.3), Dst: 10.1.5.4
(10.1.5.4)
Data (26 bytes)
0000 00 01 05 04 00 00 00 01 05 03 00 00 08 00 45 00
0010 00 2e 00 00 40 00 40 00 1c c8 0a 01 05 03 0a 01
0020 05 04 f6 f6 28 28 00 0c ff 83 df 17 32 09 4e d1
0030 e7 cd d6 31 00 dc 8c 70 00 01 9c 89 30 6a da fd
0040 1c df 44 21
```

EXPERIMENTS

Lookup procedure

- Throughput and latency with different frame sizes

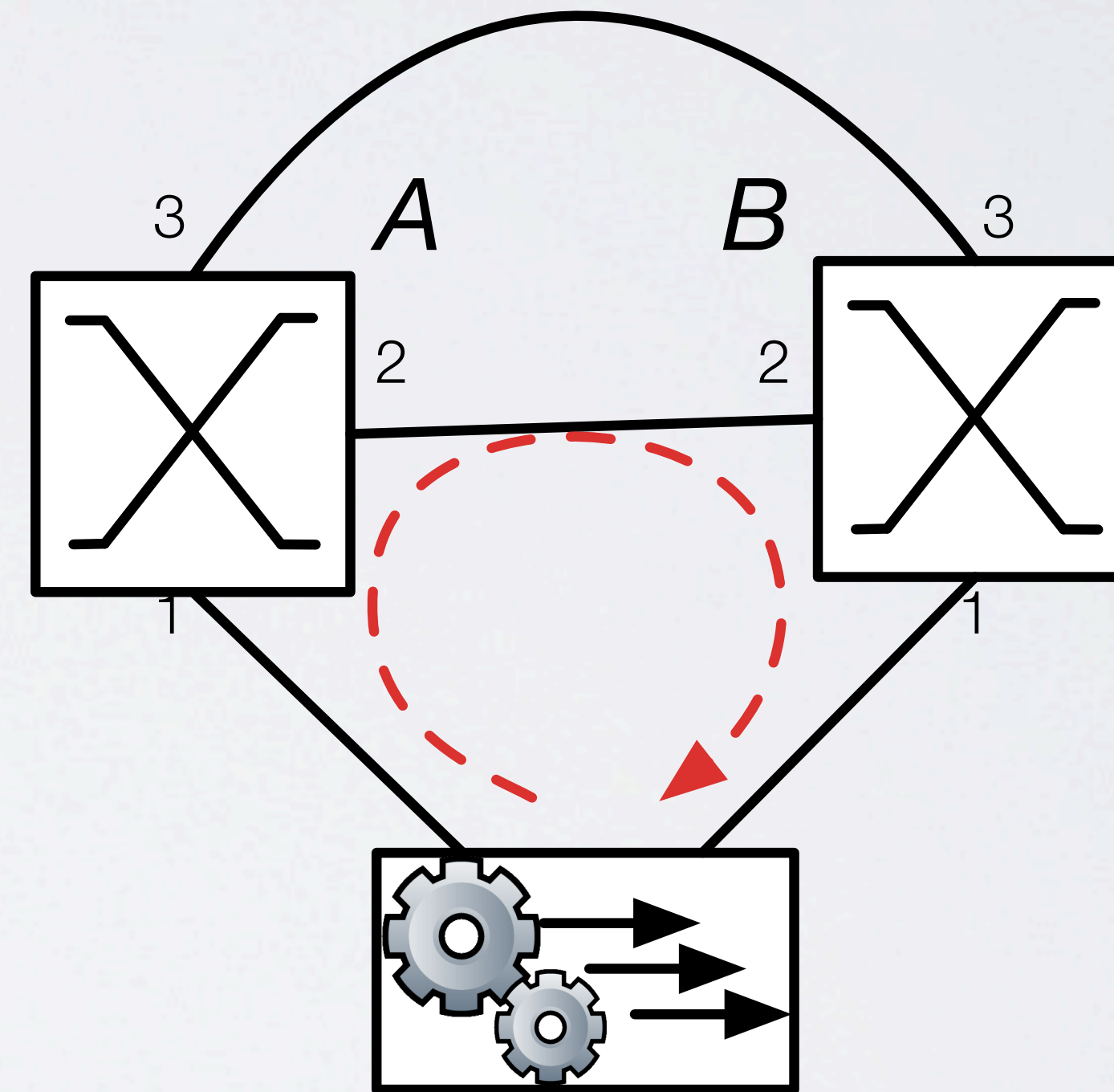
NetFPGA	Pica8	Open vSwitch
99.9%	100.0%	100.0%



EXPERIMENTS

Failover speed

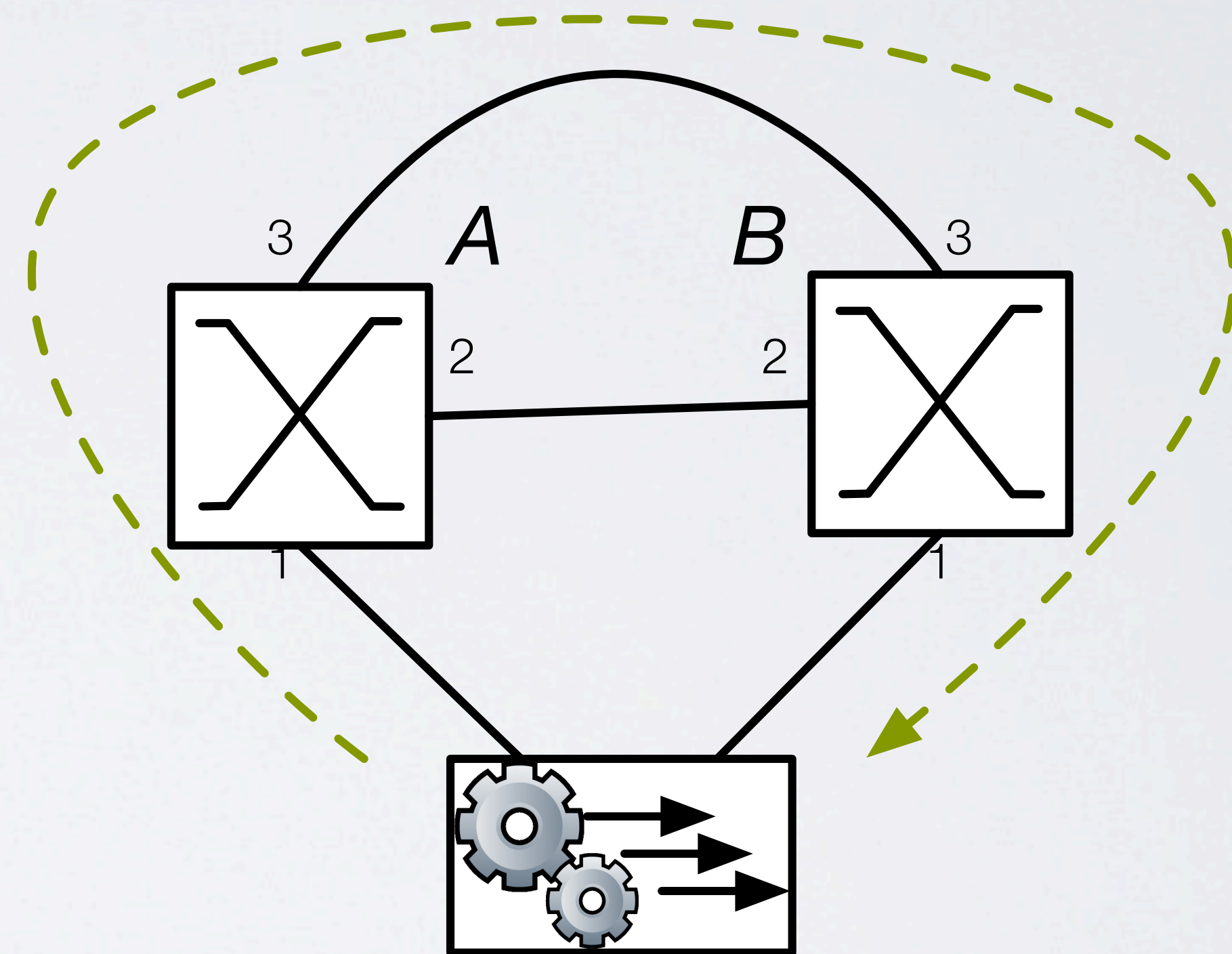
- Mid-stream path switch
- Implications
 - ✓ Frame loss
 - ✓ Latency
 - One measurement per second...



EXPERIMENTS

Failover speed

- Mid-stream path switch
- Implications
 - ✓ Frame loss
 - ✓ Latency
 - One measurement per second...



EXPERIMENTS

Failover speed

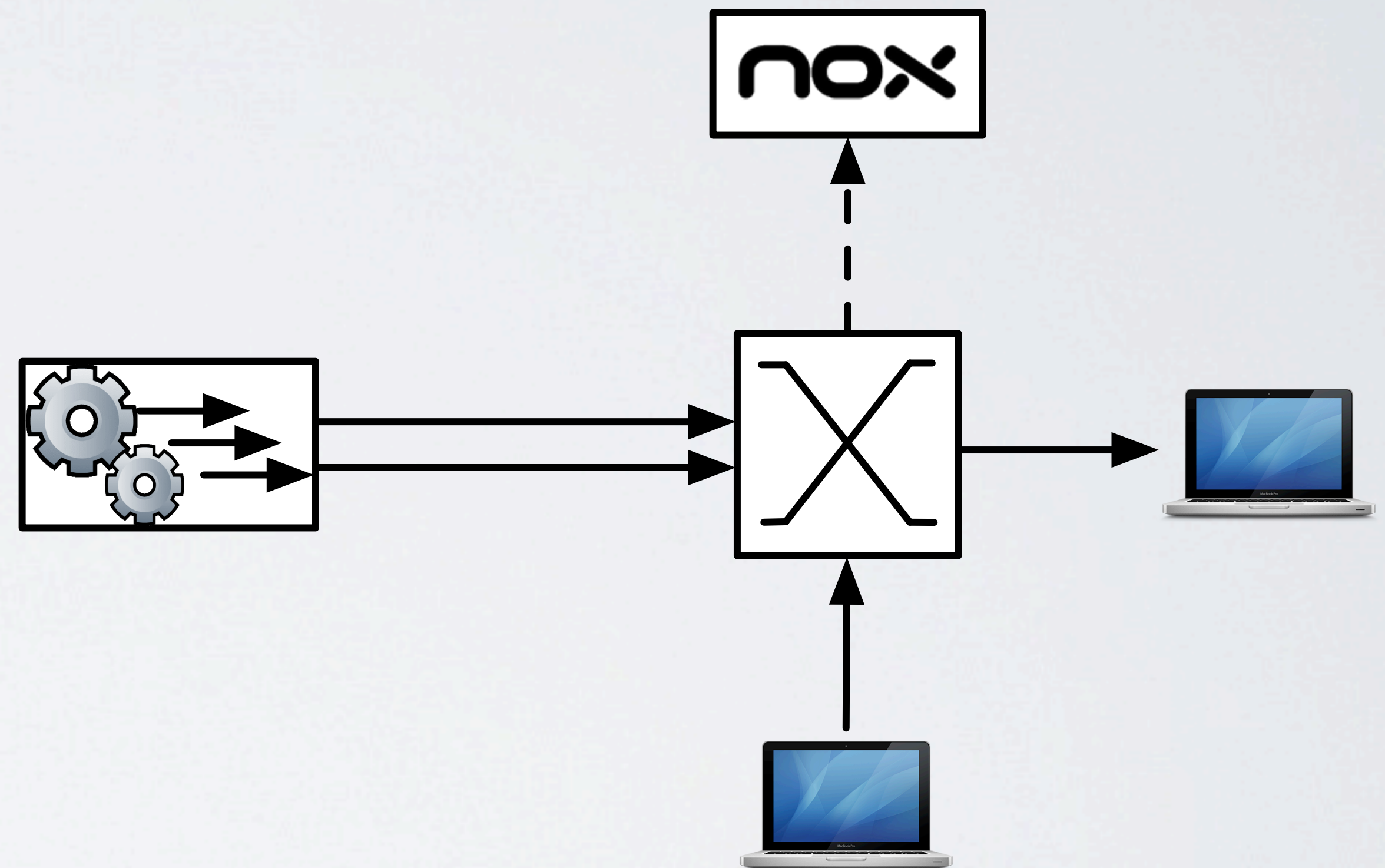
100,000,000 frames sent at supported line rate

	NetFPGA	Pronto Pica8	Pronto Open vSwitch
Frame loss	0	122	-1,740 – 1,898
Sequence errors	0	1	7.952

EXPERIMENTS

DoS controller

- The controller becomes a critical and maybe vulnerable component
- Is it possible to flood the controller?



EXPERIMENTS

DoS controller

	NetFPGA	ProntoPica8
No traffic	1.37 ms	8.50 ms
Random stream	16.74 ms	N/A

CONCLUSION

Results

1. Hardware design of ToR switches not yet optimized for OpenFlow
2. Pronto adds unnecessary Ethernet trailer to frame
3. Pronto unable to forward ARP when flooded with unknown flows

CONCLUSION

Recommendations

- Development ongoing
- Interoperability between versions an issue
- Benchmarking not an easy task...

QUESTIONS?