Repeatable research with open source platforms
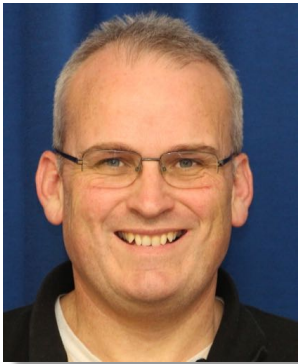

Andrew W. Moore, PhD CEng

Computer Laboratory

University of Cambridge

`http://www.cl.cam.ac.uk/~awm22/slides/2017-coseners.pptx`

Reproducibility in Science

- **Validate Correct Results**

    supporting the conclusions

    and

    compare with new ideas

- **Invalidate Incorrect results**

    refuting the conclusions

    and

    improve and refine

Reproducibility as validation

Reproducibility as invalidation

4

Reproducibility as invalidation

Once Again, Physicists Debunk Faster-Than-Light Neutrinos

By Adrian Cho | Jun. 8, 2012 , 3:39 PM

What do Linux apache MySQL Firefox BSD BIND

have in common with the resurgence in

Software Defined Networking (SDN)?

What do Linux apache MySQL Firefox BSD BIND

have in common with the resurgence in SDN?

Openly available source and open standards

And not just an implementation…

- OFLOPS – the OpenFlow performance tester

- OFtest – OpenFlow compliance tester

- OvS – software only implementation
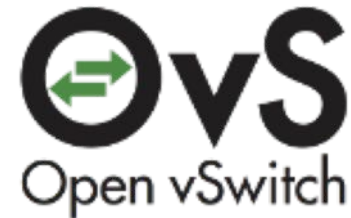
- Numerous OpenFlow controllers:

  From Ryu to OpenDaylight

Each a stabile platform
- enabling extension, and
- a process for adopting contributions and improvements

Because **network research**, and **education**

needs a good **platform**

`www.netfpga.org`

So what is NetFPGA?
NetFPGA = Networked FPGA platform

A line-rate, flexible, <u>open networking platform</u> for teaching and research

- Network Interface Card
- Hardware Accelerated Linux Router
- IPv4 Reference Router
- Traffic Generator
- Openflow Switch
- More Projects
- Add Your Project
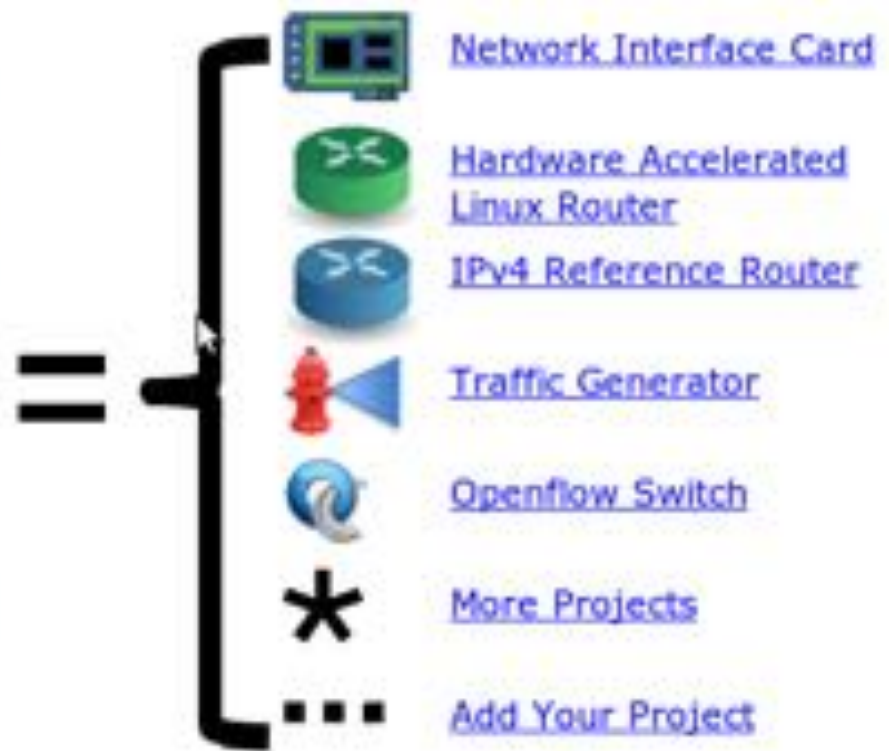
MIPS, RISC-V, Blueswitch, EMU, P4 FPGA…

Traffic Control – The Next Gen

- Latency injection – ns to seconds granularity

- Different latency distributions

- Rate control
  - Rate limiting
  - Shaping

- Per flow support

- Powered by **NetFPGA**
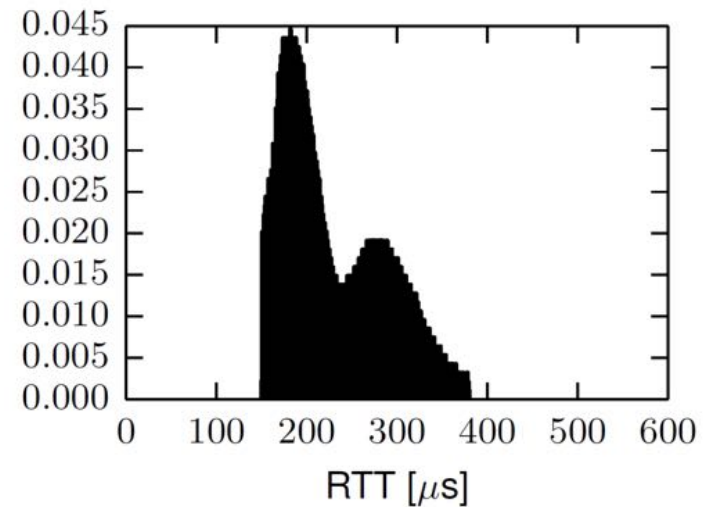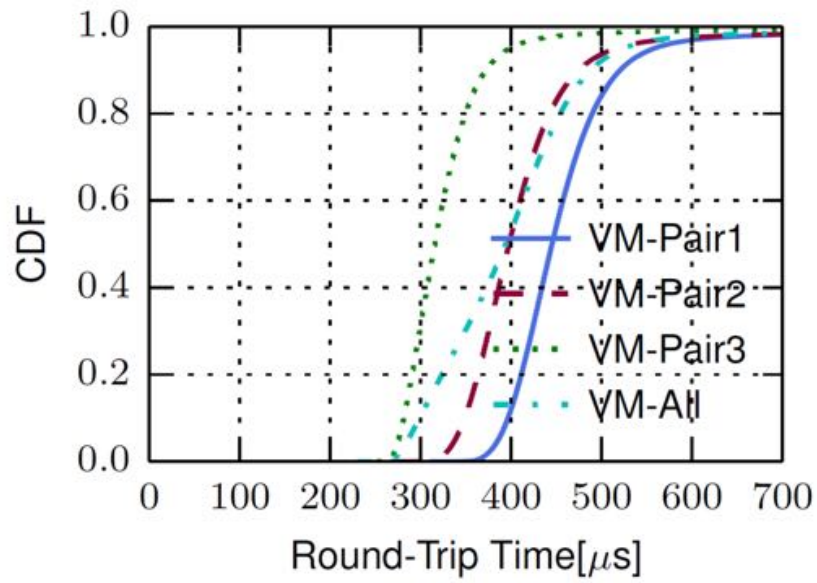
Datacentre Latency
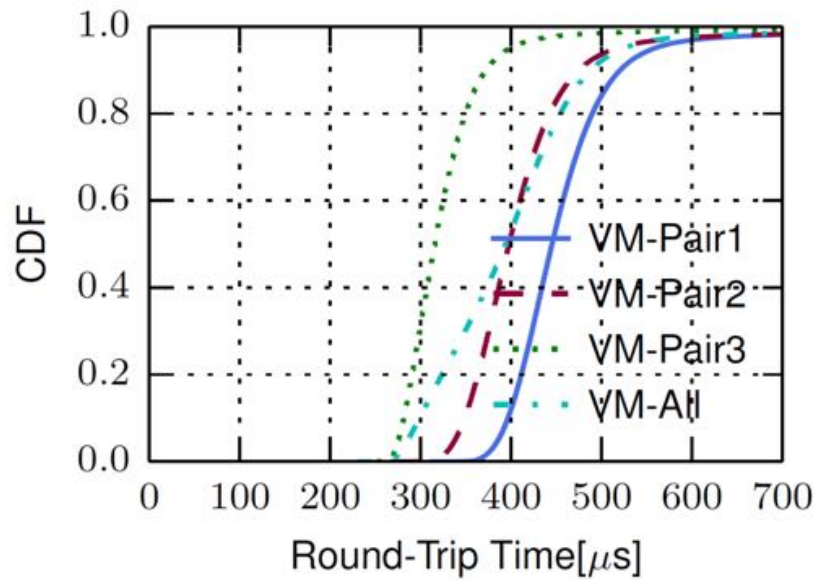
Datacentre Latency

Small latencies can still lead to significant performance loss

Measure the Application

- Packet Size

- Inter-Packet Gap

- Burst Size
    - Is congestion likely?

- Bandwidth – at different granularities

- Powered by NetFPGA

Bandwidth – 10ms granularity

Lasso (ML)

Memcached

Apache

18
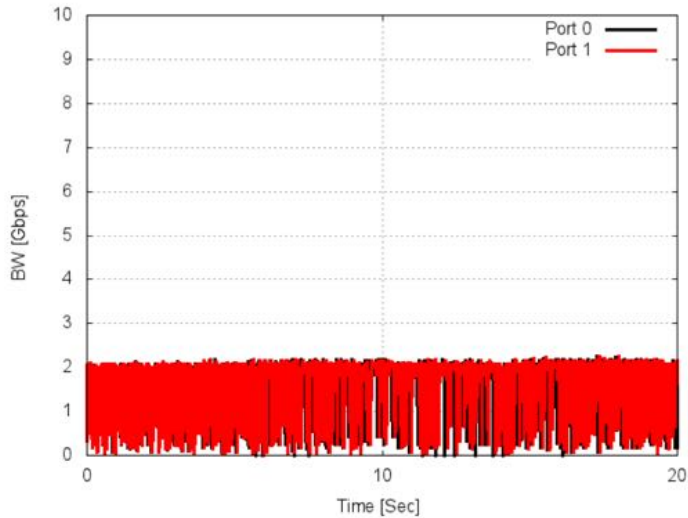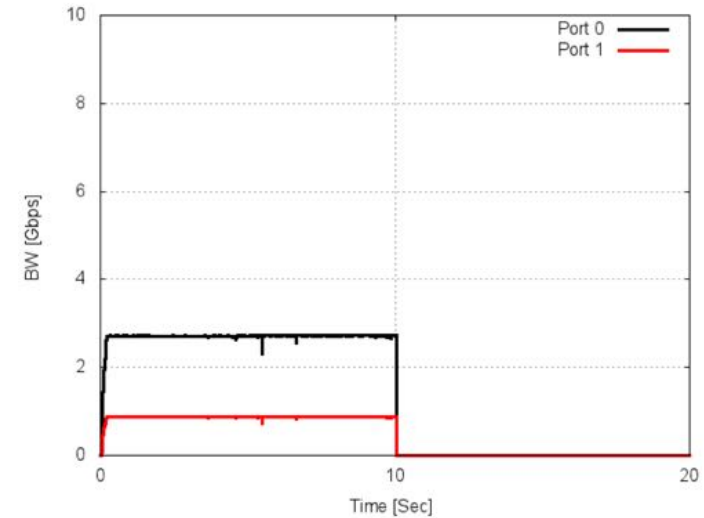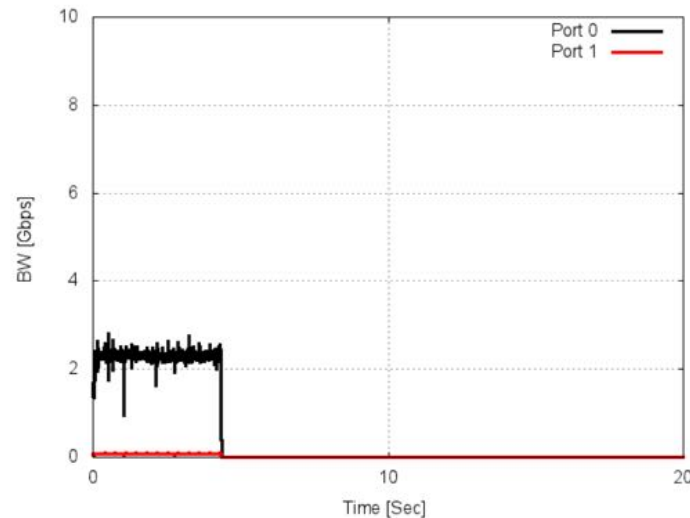
Bandwidth – 100us granularity

Lasso (ML)

Memcached
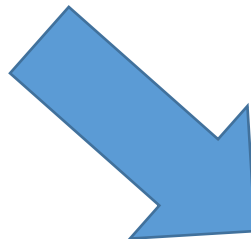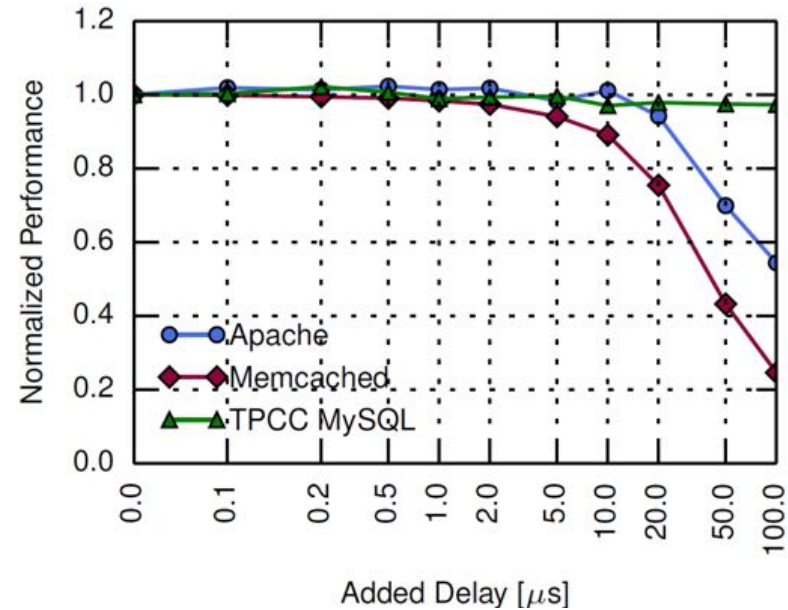
Apache

19
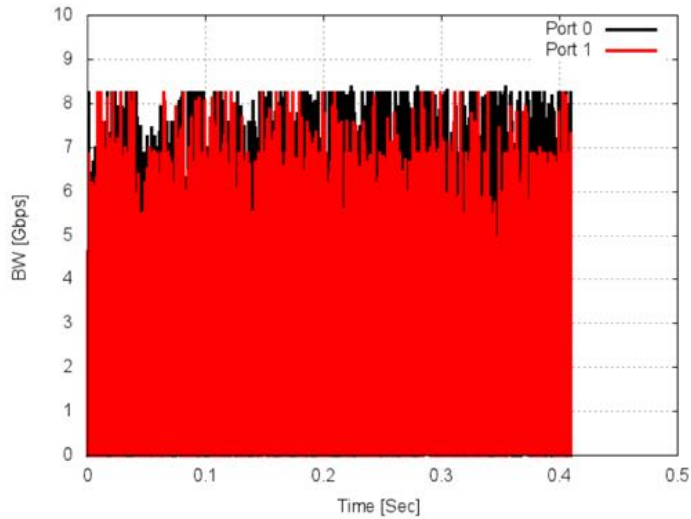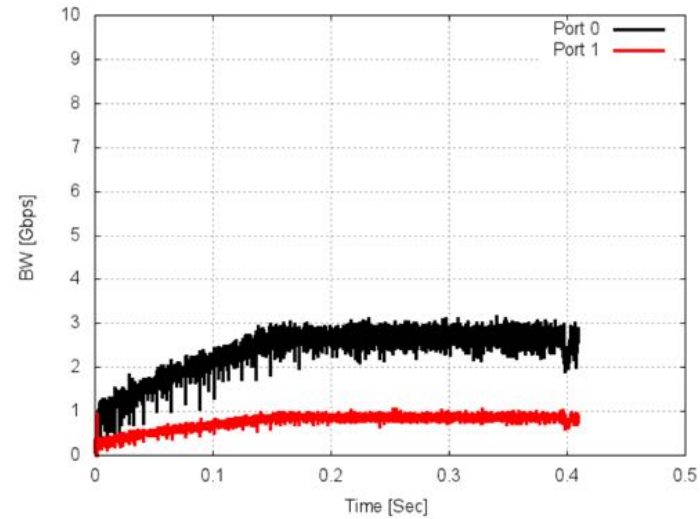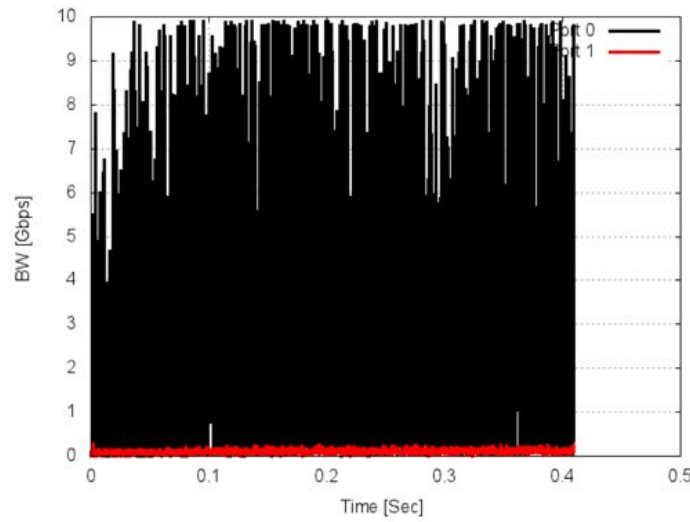
Emu : Accelerating Network Services

- The network library for Kiwi
- Compiling .Net programs
  - To x86
  - To simulation environment
  - To multiple FPGA targets

| (C#) | A1 Write | A2 Compile | (.NET CIL) | A3 Run | A4 Test |

Software development workflow

B1 Compile

(Verilog)

B2 Simulate

B3 Synthesis

Compiler Legend
A2 : Mono
B1 : Kiwi
B3 : Xilinx Vivado

(Bitstream)   C1 Run   C2 Test

Hardware development workflow
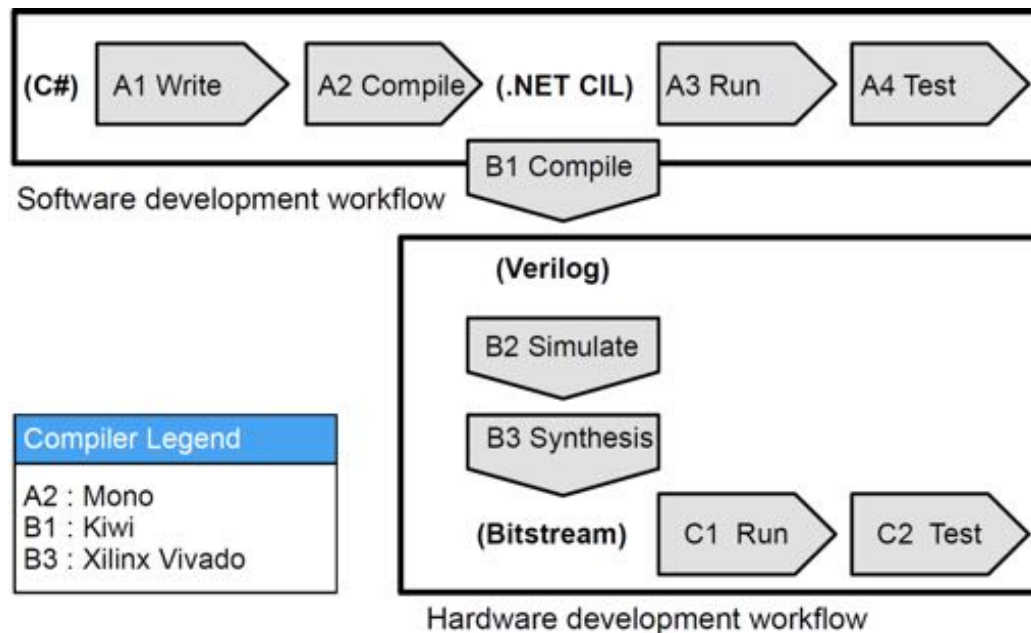
pcie-bench: an open source tool for benchmarking PCI Express

there is a limited understanding of PCIe functionality, nor the trade-offs that must be made to get best-performance from PCIe systems

- pcie-bench tool open source available
- It builds on NetFPGA and Netronome boards
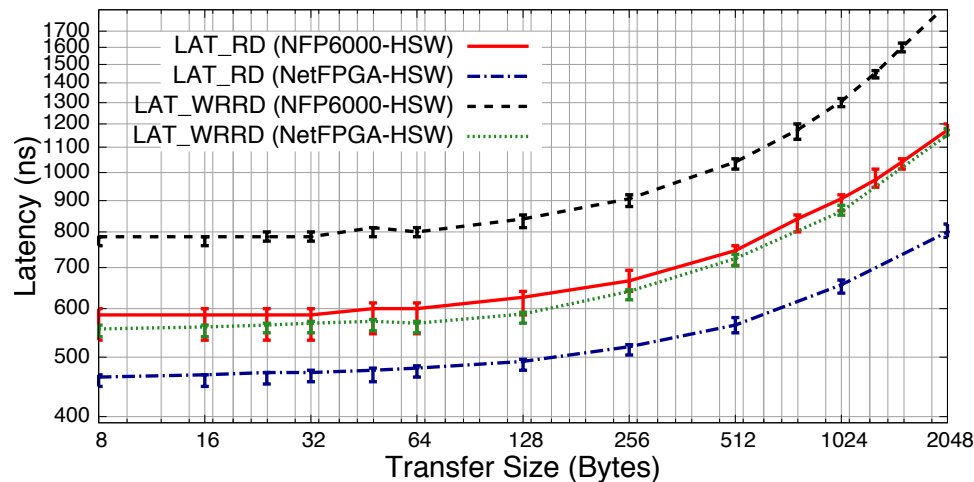
NetSoc: NetFPGA + Open Source Processors

- Open source, RISC based SoC architectures
- With high performance networking capabilities
- *RISC-V – RISC-V ISA soft processor, Linux OS*
- *CHERI – 64bit MIPS soft processor, BSD OS*
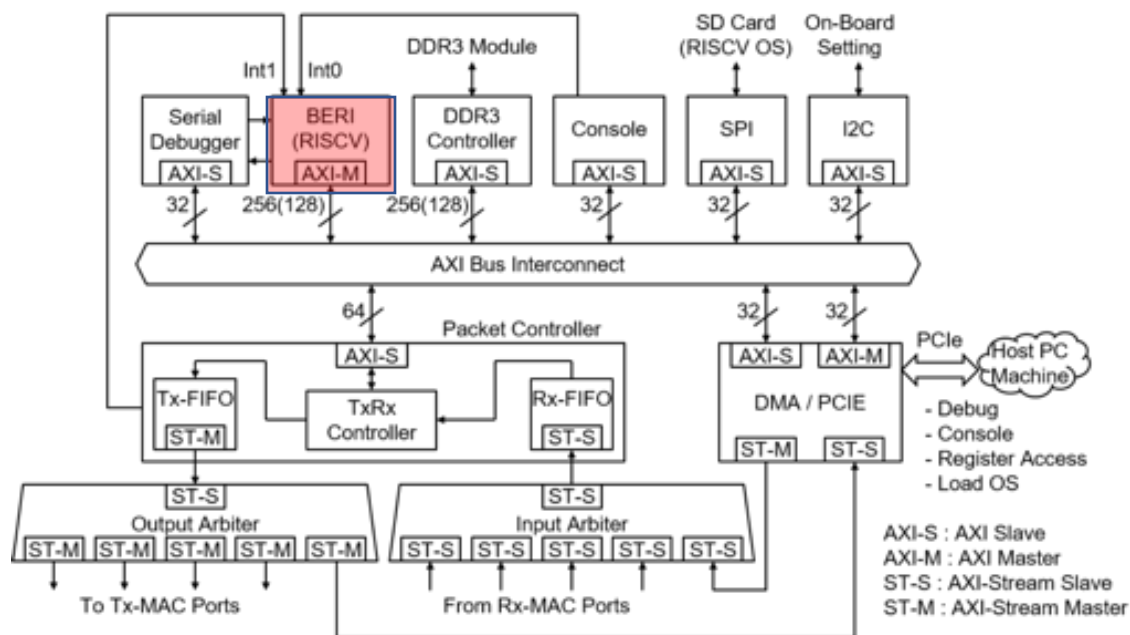
What can we do?

- Raise the bar on acceptable research
  - Insist on the artefacts being published
  - Insist on the results being available
  - Insist on the experiments being repeatable
  - Accept reproduction studies

- Enable Research Repeatability

Lead by example

Lead by example

Moore & Zuev 2005, we published the dataset

```
https://www.cl.cam.ac.uk/research/srg/
netos/projects/archive/nprobe/data/pap
ers/sigmetrics/index.html
```

In a form that was preserved anonymity and
1. Enabled reproducibility,
2. Enabled comparison against new algorithms, and
3. Actively encouraged others to create their own datasets

Lead by example

Queues don't matter when you can JUMP them!

Matthew P. Grosvenor   Malte Schwarzkopf   Ionel Gog   Robert N. M. Watson
Andrew W. Moore   Steven Hand   Jon Crowcroft

University of Cambridge Computer Laboratory

Simplicity is the shortest path to a solution.
– Ward Cunningham

Abstract

QJUMP is a simple and immediately deployable approach to controlling network interference in datacenter networks. Network interference occurs when congestion from throughput-intensive applications causes queueing that delays traffic from latency-sensitive applications. To mitigate network interference, QJUMP applies Internet

If memcached packets can somehow be prioritized to "jump-the-queue" over Hadoop's packets, memcached will no longer experience latency tails due to Hadoop. Of course, multiple instances of memcached may still interfere with *each other*, causing long queues or incast collapse [10]. However, if each memcached instance can be appropriately rate-limited at the origin, this too can be mitigated.

These observations are not new: QoS technologies like DiffServ [7] demonstrated that coarse-grained classification and rate-limiting can be used to control network in-

Lead by example

Queues don't matter when you can JUMP them!

http://www.camsas.org/qjump

Lead by example

Queues don't matter when you can JUMP **them!**

`http://www.camsas.org/qjump`

QJump   Learn   Publications   Download   Reproduce   About Us   CamSaS

Reproducing the QJump Experiments

As scientists and researchers we take the reproducibility of our work very seriously. We don't expect you to trust our results, in fact, we hope that you don't! On the following page we provide links to detailed descriptions the experiments behind each of the figures in our research publications. The full experimental descriptions include the precise configuration of our test equipment, links to the source code for our tools, patches that we made to other people's tools and original preprocessed data-sets that we gathered. Our hope is that anyone can use these descriptions re-run any of our experiments. We believe that this kind of openness is the way that all good, scholarly scientific research should be conducted.

For details of our publications including links to the manuscripts please see the publications page.

NSDI 2015 - Queues don't matter when you can

Enable others

Reproducible research needs,
widely available test-equipment

	Cost	Flexibility	Resolution	Line Rate
ixia SPIRENT endace power to see all	**$$$ $$$**	✗	✓	✓
DPDK, SW tools	**($)**	✓	✗	**(✓)**

Enable others

Reproducible research needs,
widely available test-equipment

	Cost	Flexibility	Resolution	Line Rate
ixia SPIRENT endace power to see all	$$$ $$$	✗	✓	✓
DPDK, SW tools	($)	✓	✗	(✓)
oSNt	($)	✓	✓	✓

Open-Source Network Tester

A platform for testing powered by

- Open source hardware and software platform for network test, publicly available

  https://osnt.org/

  https://github.com/NetFPGA/OSNT-Public/wiki

- Low cost, low jitter, flexible to update, scale-out, no CPU usage, nano-second resolution measurement

What can we do?

- Raise the bar on acceptable research
  - Insist on the artefacts being published
  - Insist on the results being available
  - Insist on the experiments being repeatable
  - Accept reproduction studies

- Enable Research Repeatability
  and then *Just Do It!* Everytime.

- Open-source (research) platforms ***work!***
  Build on platforms, and support platforms

What is the platform for machine-learning in networking?

Is the lack of an *active*-optical network due to a lack of platform?

(no one can make up their mind what it looks like...?)

What is the next software-platform to displace the current one?

(So what is Ion Stoica's next project ☺...?)

Acknowledgements