

Introduction to Networking and Systems Measurements

Device and System Characterization

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Make No Assumptions

What is the goal?

- Functional validation?
- Performance testing?
- Characterization?
- Comparison?
- Detecting problems?
- Finding the bottlenecks?

Different goals \Rightarrow different setup + experiments

What is the goal?

- Functional validation, e.g.,:
 - Can we send traffic from port A to port B?
- Performance testing, e.g.,:
 - What is the throughput of sending traffic from port A to port B?



OR

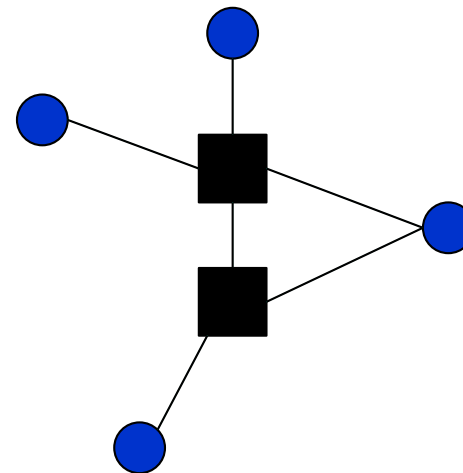
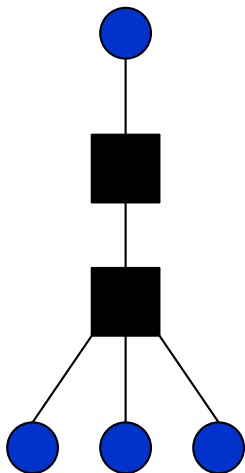


Vantage Points

- Characterisation is limited by vantage points
- Single vantage point:
 - Round trip measurements, topology measurements
 - OR
 - Passive measurements
- Two vantage points:
 - One way latency measurements, bandwidth measurements
+ everything a single vantage point can do
- Three vantage points?

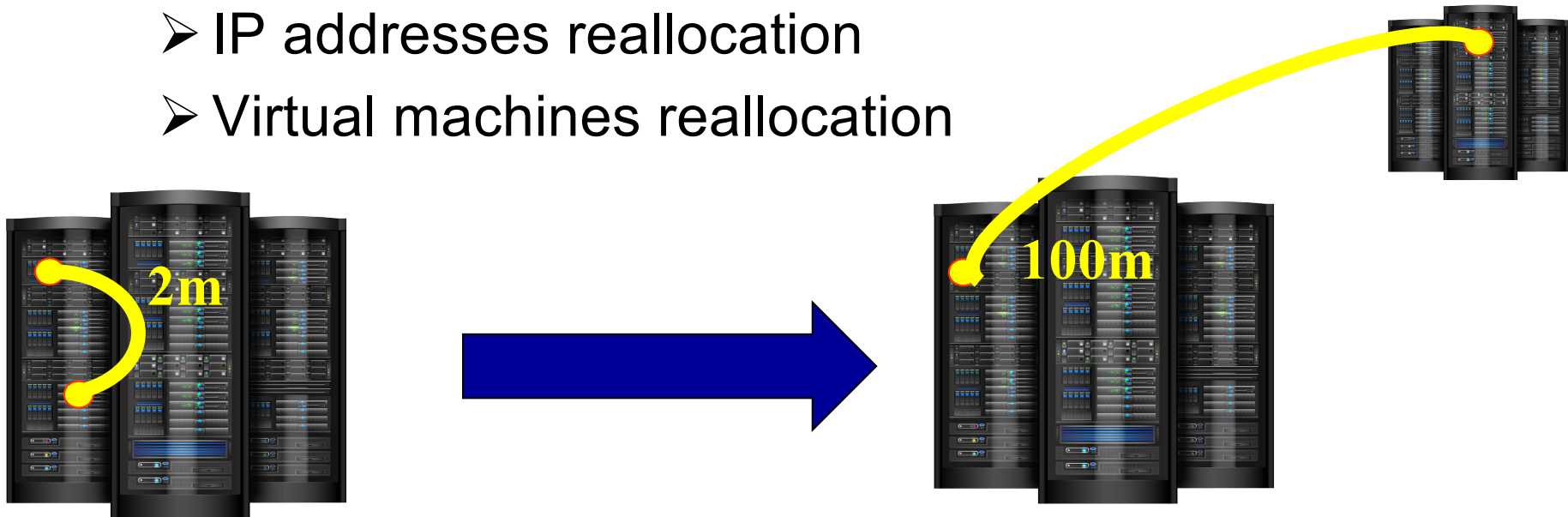
Vantage Points

- <Number> of vantage points is not sufficient
- <Location> of vantage points is important



Vantage Points

- Is your vantage point static?
- Mobile vantage points: Mobile phones, laptops
 - Sometimes good if you seek to increase coverage
- But also (for example):
 - IP addresses reallocation
 - Virtual machines reallocation



What is the workload?

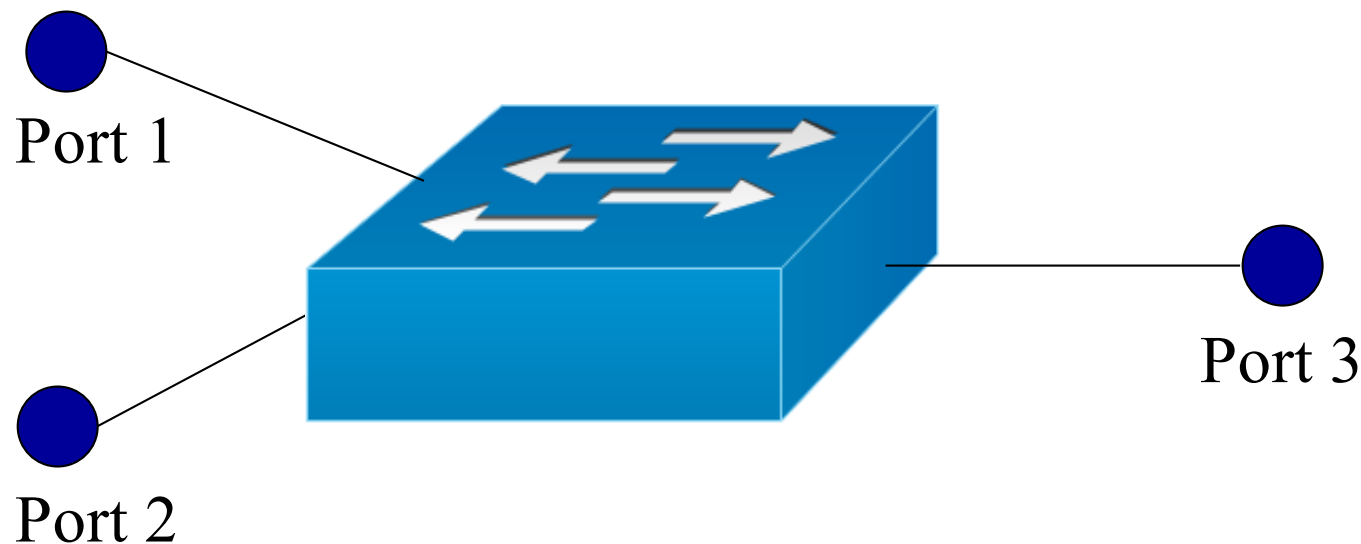
- Synthetically generated, e.g.,
 - 128B IPv4 Packets
- Protocol level, e.g.,
 - TCP flows
- Application level, e.g.,
 - Key-value store application

What is the workload?

- Everything matters!
- Packet size distribution
- Traffic rate
 - E.g., Average rate, peak rate,
- Traffic shape
 - E.g. bursts
- Payload
 - Some payloads are more likely to cause errors than others
- Protocol
-

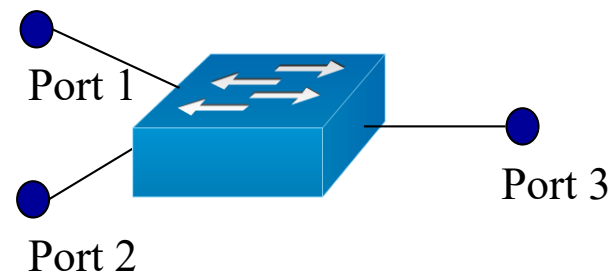
Example

- What can we learn about the internals of a switch using latency measurements and 3 vantage points?
- Assuming a sterile environment



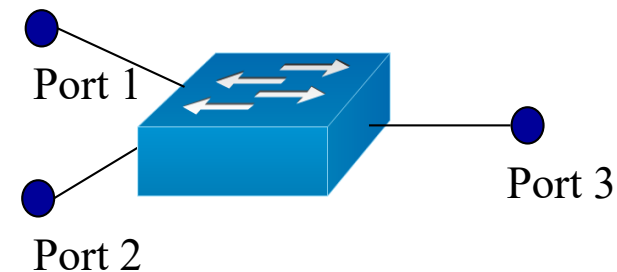
Example

- What is the basic latency of the switch?
 - Send packets from port 1 to port 2, measure the latency
- Is the switch design symmetric?
 - Send packets from port 2 to port 1, measure the latency
- Is the switch design identical for all ports?
 - Send packets from port X to port Y, measure the latency for all combinations



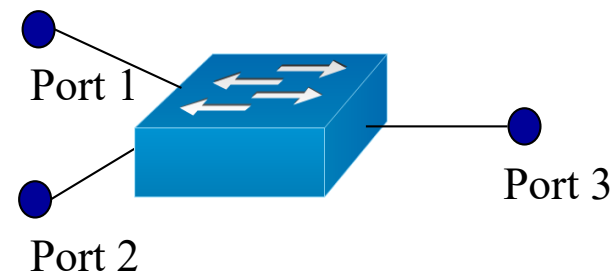
Example

- What type of switch is it?
 - Send packets of various sizes from port 1 to port 2, measure the latency
 - A cut-through switch will have the same latency for all packet sizes, a store-and-forward switch will have a higher latency for bigger packet sizes
- Is the switch sensitive to throughput?
 - Send packets at full line rate from port 1 to port 2, measure the latency
 - Do the results change over time?



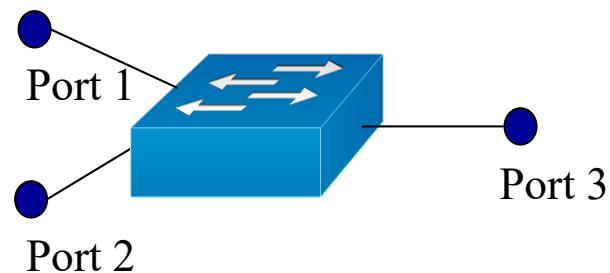
Example

- What can learn about the output queueing and output scheduling of the switch?
 - Send packets at port 1 to port 3, measure the latency
And at the same time
 - Send packets at port 2 to port 3, measure the latency
 - Vary the packet rate and discover more....



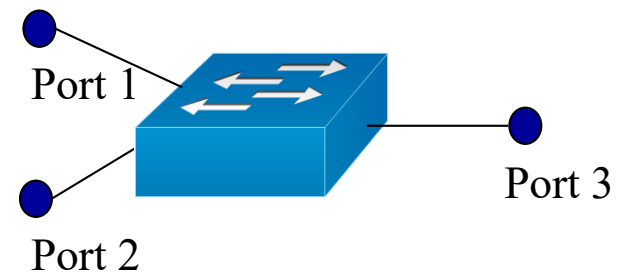
Example

- What can learn about the input queueing and input scheduling of the switch?
 - Send packets at port 1 to port 3, measure the latency
And at the same time
 - Send packets at port 2 to port 4
 - Vary the packet rate and discover more....
 - Why is sending from port 2 to port 1 a bad idea?



Example

- What can we learn about the internals of a switch using latency measurements and 3 vantage points?
- A lot!
- This was just a small subset



Example 2

- Mellanox Spectrum vs Broadcom Tomahawk
 - Tolly report, 2016
<http://www.mellanox.com/related-docs/products/tolly-report-performance-evaluation-2016-march.pdf>
- Bandwidth distribution, 3→1 scenario
 - Source ports 25,26,27, Destination port 31
33% BW from each port, on both devices
 - Source ports 24,25,26, Destination port 31
33% BW from each port, on Spectrum
25% from ports 25,26, **50%** from port 24 on Tomahawk
- What does it mean?

Synchronization

- Recall Lecture 3
- Synchronization of time between multiple machines
 - E.g., allow one-way latency measurements
- Synchronization of measurements
 - Can you trigger multiple vantage points to start an experiment at once?
 - E.g. what happens if you measure congestion effects without triggering at once?

Tools Selection

- When to use hardware tools? When to use software tools?
- You don't always have omniscient control over resources
 - You may not even have permissions for some basic tools
- What can you do?
 - Similar tools using different protocols
 - Write your own tools
 - Redesign your experiment



So lets start measuring!

- Wait!
- What is your goal?
- What do you know about your experimentation environment?
- Have you collected metadata?
- Are you aware of any limitations to the environment / tests / DUT / usage / ...?
- Is your experiment reproducible?

Advice

- Getting measurements right is *HARD*
- More isn't necessarily better.
- Prefer:
 - Fewer Measurements and Better methodology
 - Detailed measurements
 - Reproducibility
 - Understanding the results
 - Become an expert of your work