

Measurement-Driven Protocol Engineering

IAB Technical Plenary, IETF 94 Yokohama
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Measurement-driven engineering

in one slide

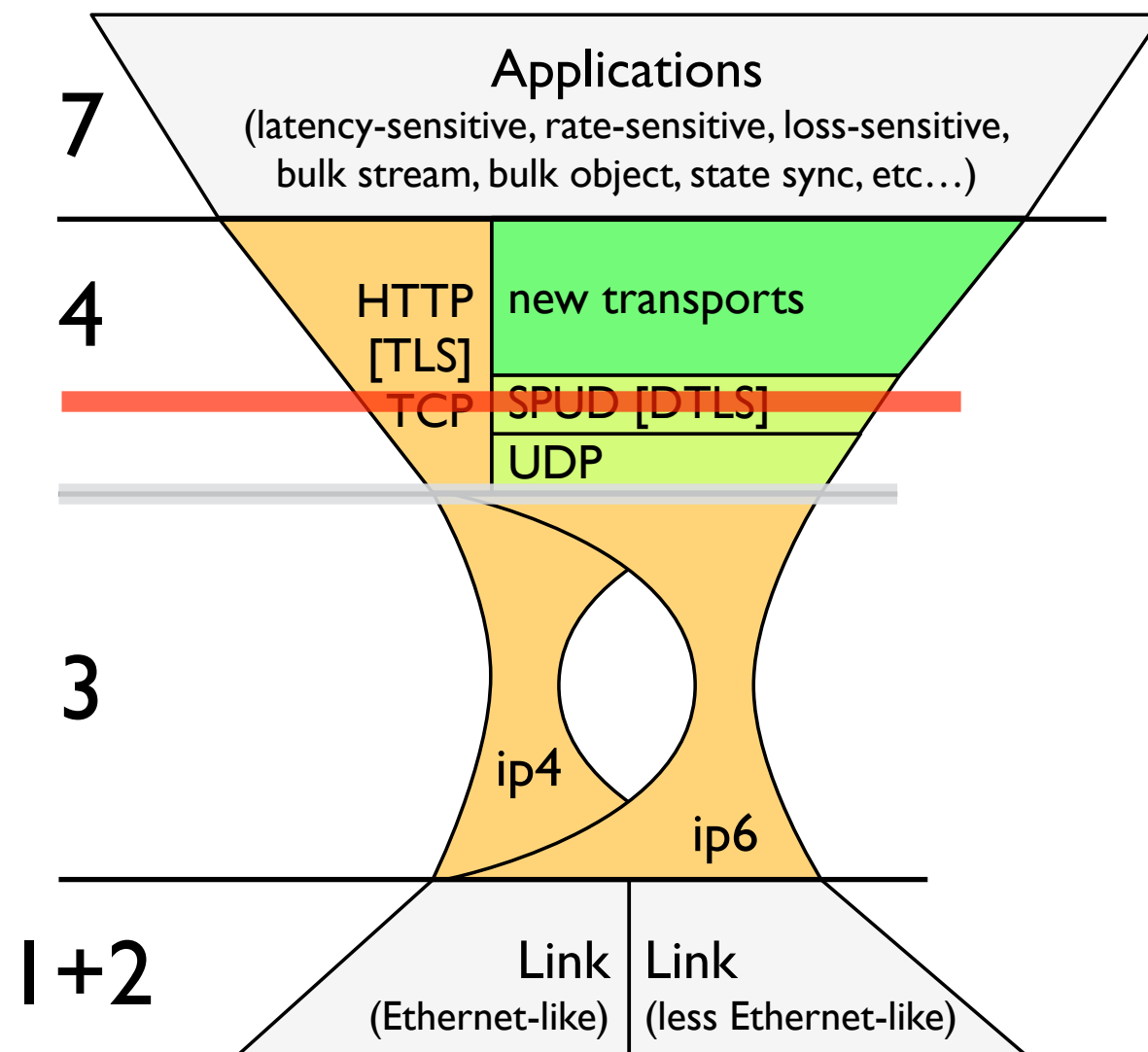
- Engineering decisions about protocols to deploy in the Internet should be based on **relevant data about the environment** they face.
 - Design for common occurrences.
 - Know the risks of uncommon ones.
 - Apply measurement liberally to know the difference. Maybe even at runtime.

Today's talks

- IP stack evolution and path impairment
 - **Can we run the Internet over UDP?**
Need more data.
- Understanding interdomain topology and **BGP dynamics**.
 - Need more data, better tools for data we have.
- Discussion:
*what can measurement do for you,
and what can you do for measurement?*

IP Stack Evolution and Path Impairment

Evolving the stack: explicit relayering and cooperation

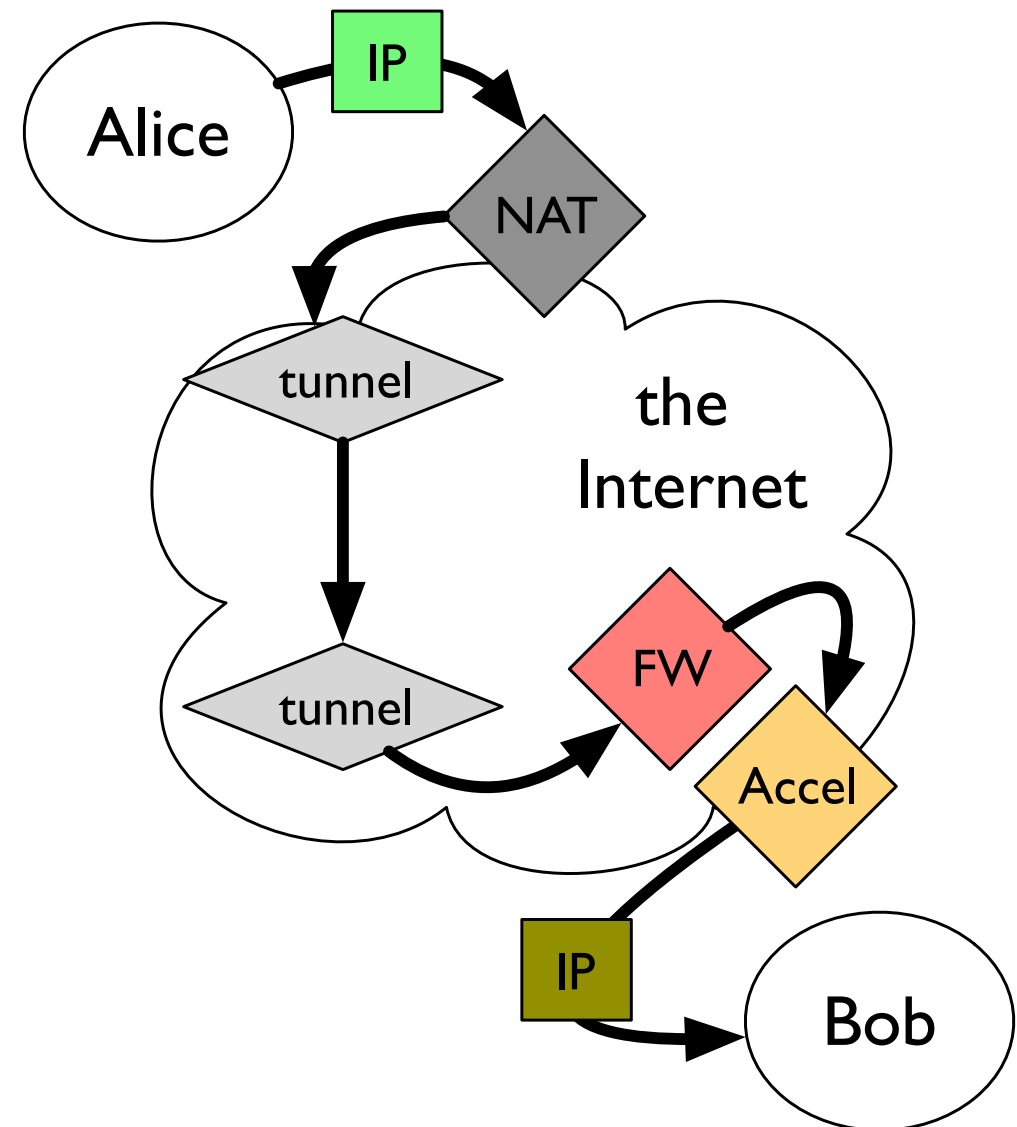


- Rethinking the layer boundary
 - UDP encapsulation (ports for NAT)
 - crypto (reinforce the boundary between endpoint and path visible headers)
 - explicit cooperation (give back transport and application semantics the path actually needs)

We assume that UDP works. Does it?

Measuring path impairment

- Path impairment: the likelihood that traffic with given characteristics will experience problems on a given path.
 - Increased latency, reordering
 - Increased loss/connectivity failure
 - "Bleaching" or selective disablement of features
- Utopian goals:
 - Given a proposed feature, how and how often does it break?
 - Given a path, what works over it?
- Specific question: can we run the Internet over UDP?
- First step: sharing what we know. **HOPSRG** (hops@ietf.org)



What can go wrong?

Modification	Planetlab	Ark
IP Address	74.9%	79.0%
ECN IP	13.7%	13.2%
TCP ISN	10.7%	1.8%
TCP MSS	10.8%	5.9%
TCP Ex.Opt.	8.8%	0.5%
MPCAPABLE	8.4%	0.3%
ECN TCP	0.6%	0.6%
TCP SackOK	0.3%	0.0%
TCP TS	0.3%	0.4%
TCP WScale	0.2%	0.2%

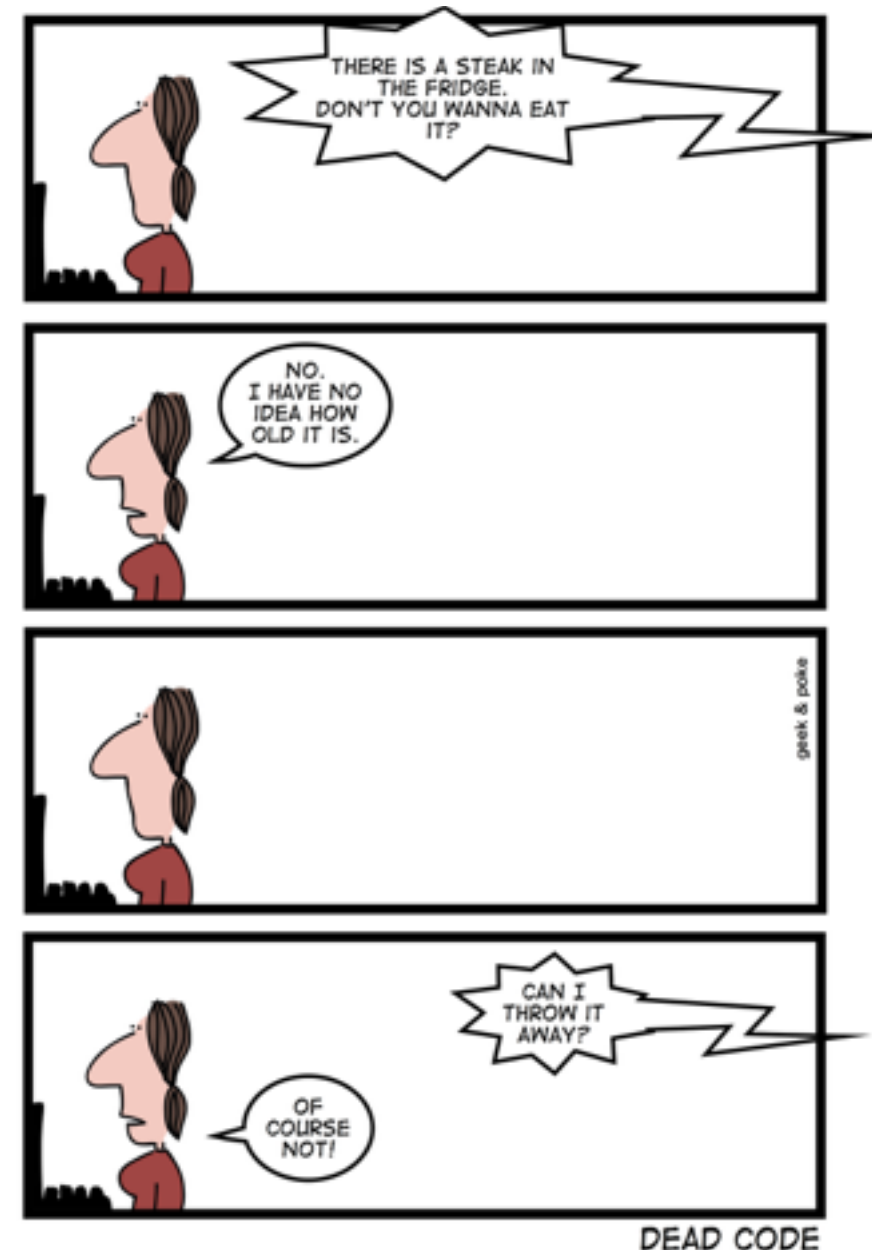
- **Best studies look at $O(10k)$ paths¹.**
- The Internet has billions and billions.
- Results highly dependent on vantage point.
- Need more diversity to answer the question.

Percentage of paths modifying selected packet feature on two research-oriented testbeds.

[1]: R. Craven, R. Beverly, M. Allman. **A Middlebox-Cooperative TCP for a non End-to-End Internet.** SIGCOMM, August 2014.

Application to Protocol Engineering

- We want our protocols to work when stuff breaks.
- Engineering tradeoff: robust code v. robustness against the path.
 - NAT? Design for it, even if it's hard.
 - Broken by operational practice? Depends if it's relevant.
 - Conflicts with a custom hack deployed in one network?
Write a polite email, but no code.
- We need data about prevalence to make informed decisions.



Measuring the Internet is hard

- Measurements often don't measure what you want.
 - e.g.: ICMP latency and connectivity correlate less than we'd like with application latency and connectivity.
- The Internet is not homogeneous.
 - e.g. how much crypto you see on a given link depends on application mix and the vagaries of CDN policy².
 - What is easy to measure not necessarily most relevant.
- Not enough data and too much data *at the same time*.

[2]: P. Richter et al. **Distilling the Internet's Application Mix from Packet-Sampled Traffic**. PAM, March 2015.

Measuring without measuring

- Lots of things that don't look like measurement are.
 - TCP
 - Version negotiation and fallback mechanisms
 - Platform-level diagnostics⁵
- **Vision:** Let's design protocols with this fact in mind.
 - Make instrumentation accessible.
 - Explicitly measure and react at runtime.

[5] e.g. telemetry.mozilla.org

Improving the best available data

- We have lots of **tools**...
 - platforms and testbeds (e.g. Atlas, mLab, Ark, BisMARK, SamKnows, PlanetLab...)
 - protocols (e.g. O/TWAMP, PSAMP, IPFIX, LMAP)
- ...but lack a framework to bring **comparability** and **repeatability** to their observations.
- Goal: combine measurements from different vantage points and data sources for wider and deeper insight.
 - Develop common information models and query sources³.
 - Common coordination and control protocols⁴.

[3] e.g. BGPstream (see next talk)

[4] e.g. mPlane, ict-mplane.eu, draft-trammell-mplane-protocol

Understanding real-world BGP Dynamics

Discussion

Ask what measurement can do for you...

- Questions to ask during protocol design:
 - What **assumptions** about the environment is protocol X based on? Do these hold?
 - What **sources** already exist that allow me to verify these assumptions?
 - What sources would help that **don't exist**?
 - What information does the protocol **generate** as a side effect that can lead to better insight? Can implementations use this at runtime?

...and what you can do for measurement

- There are many other insights to be gained from the Internet by measuring it in different ways.
- Integration of diverse measurements leads to better insight.
- Data generated as a side effect of a protocol's operation might be useful in other contexts.