Lessons from Two Decades of Networking

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NC State Class of 2001

Who is Andy Gospodarek?

- NC State class of 2001 (Computer Engineering)
- Open Source Expert/Enthusiast/Advocate/True Believer
- Spent entire career in computer networking:
 - Two Co-op terms at Cisco and one summer internship at SAS
 - Worked at 2 startups (LVL7 Systems and Cumulus Networks), one high-growth company (Red Hat), and one large company (Broadcom)
- Enjoy mountain biking, running, and Oxford commas
- Married to a NC State graduate (Class of 2001 in EE and Applied Math) and have 3 kids

What was happening in 2001?

Google was just starting to take off (Search was the only service)

It's hard to imagine life without Google's services...

...but many people wonder if that's a good thing?

2001: Smartphones were *rare*

Everyone has a smartphone including [sadly] many kids in elementary school...

...but more and more adults claim they are taking a break from their phones

Wireless networking hardware was extremely expensive

Wireless networking hardware is cheap...

...and service is so cheap that it is either free or practically free

Kevin Systrom, Yiming Zhang, and Mark Zuckerberg were all still living with their parents

Systrom, Zhang, and Zuckerberg can all buy their parents new houses

Internet was used for [illegally] sharing copyrighted images and music

Internet is used for everything

2000: NC State beat UNC-CH in football 38-20 in Chapel Hill

NC State beat UNC-CH in football 34-30 in Raleigh

I thought this was a talk about networking?

What enabled these changes to occur?

Networking was hard

Proprietary software dominated networking infrastructure

Networking vendors were extremely powerful and valuable

Networking and compute infrastructure has been commoditized

Open-source and standards-based software now dominate the networking industry

Data centers operators now extremely powerful and valuable

What software enabled this shift in power?

Linux Kernel contains ~4M LoC

Linux Kernel contains >30M LoC

Linux has more features and runs on more hardware than ever

2001: Version control software was terrible

2005: git was created

2008: GitHub was founded

2021: git is used by default for version control

High-speed network applications were custom to hardware running them

Packet processing frameworks like DPDK (userspace) or XDP (kernel) enable rapid, high-performance application development

What about protocol changes over the years?

When was TCP first proposed as a standard?

1974: TCP described by Vint Cerf and Bob Khan

2001: New TCP congestion algorithms begin to be developed to deal with growing scale of the Internet

2008: Cubic TCP released based on research done at NC State

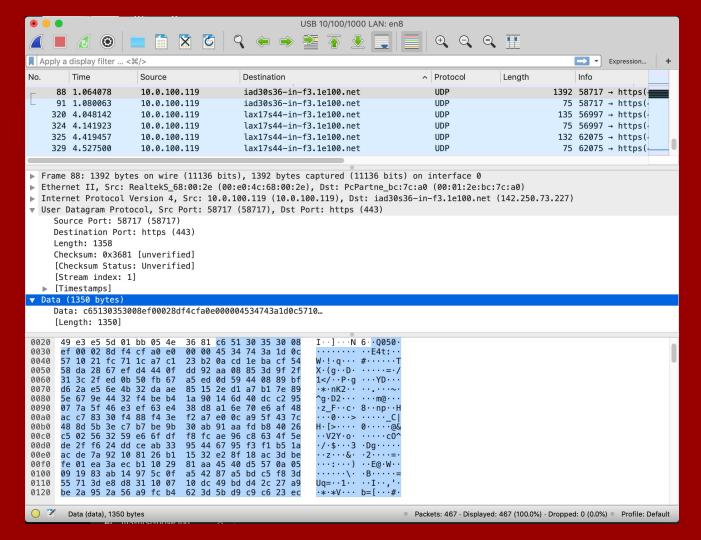
2010: Data Center TCP (DCTCP) research begins and continues today to boost network utilization

2011: TCP Fast Open introduced by Google to cut down on number of RTTs per session

2012: Google develops SPDY that serves as the basis for HTTP/2

2013: Google develops QUIC that will serve as the basis for HTTP/3, but will now be over UDP instead of TCP

2021: Google, YouTube, Facebook, and more all use QUIC/UDP by default instead of HTTPS/TCP



QUIC moves many features of TCP to userspace (client and server) rather than kernel

QUIC's main goal is to reduce latency of connection setup and retransmission

QUIC's secondary goal is to enable rapid protocol enhancement and development

Switch to UDP will impact every firewall product that exists today

Adoption of QUIC by IETF as standard *should* prevent a return to proprietary networking

2020: Everyone was online all the time for everything

2021: In-person work and school are back

Content providers do not want us to put down our devices

Providers and their algorithms know what we like...

...sometimes better than we know ourselves

Where do we go from here?

Humans still have the power to impact change

Value is created by people

Playing well with others is critical for success

"First I learned to read and write and then I conquered the world"

"First I learned to read and write **code** and then I conquered the world"

exit(0);

Commoditize?

To make the difference in quality between the most expensive and cheapest version of products in the same category virtually indistinguishable