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Internet Protocols Laboratory

A Changing Internet in 2024

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Four Internet technology shifts

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#1 TCP/IP

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#1 TCP/IPv4

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Worldwide 45%

India 72%

Thailand 42%

Australia 30%

#1 TCP/IPv6

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HTTP

and other protocols

running over

TCP/IPv6

#1

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HTTP

and other protocols

running over

QUIC / IPv6

#1

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#2

HTTP displaces the other protocols

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HTTP moves to delivery via CDNs

#3

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#3

HTTP moves to delivery via **CDNs**

while other on-premise services

move to **cloud datacentres**

centralising the infrastructure

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#3

HTTP moves to delivery via **CDNs**

while other on-premise services

move to **cloud datacentres**

centralising the infrastructure

and encouraging direct interconnection to

hyper-giants and **the death of transit**

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#4

DNS provided by network operators
mapping of site names to IP, insecurely
and accidentally provides a control point

DoH per application
decoupled from operators
secure
and incidentally removes the control point

These changes are invisible

for the users of the network

What didn’t change?

Accessible infrastructure with a common protocol

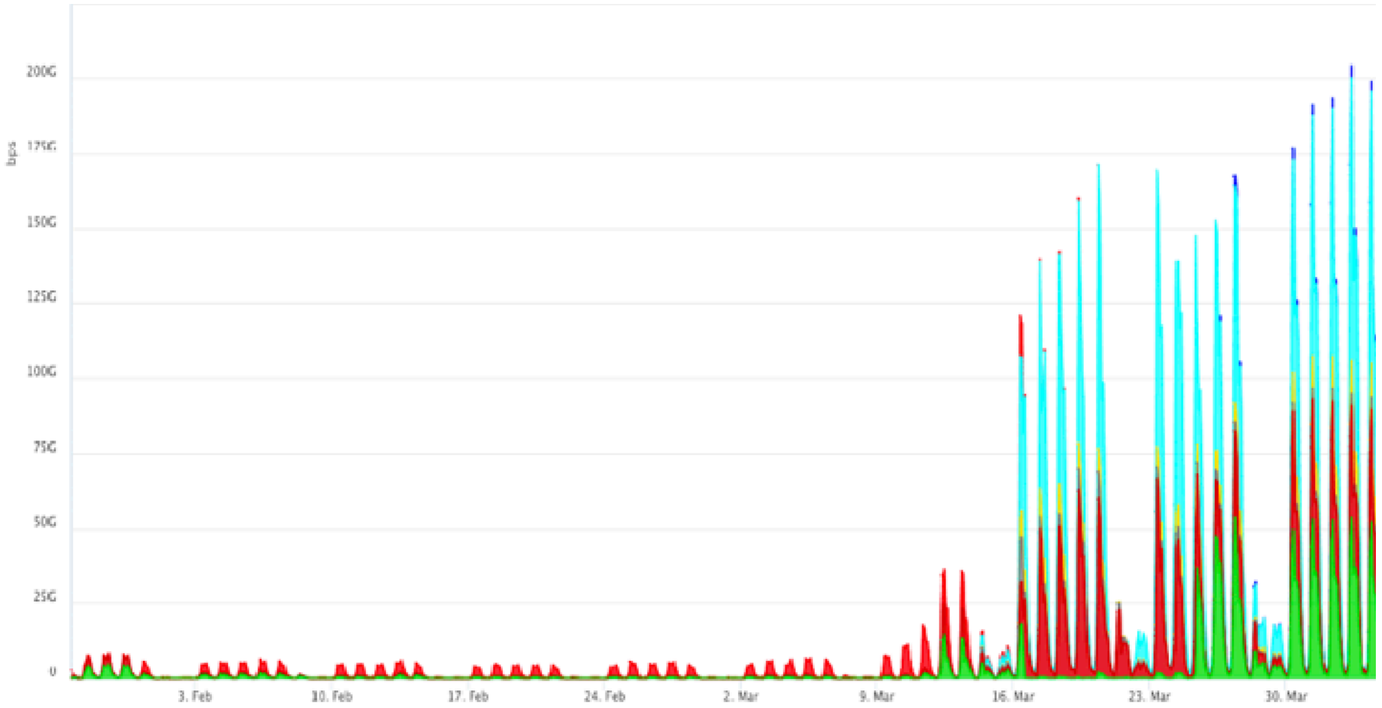
Open architecture of interoperable and reusable building blocks

Decentralised management

Common global identifiers

A technology neutral general-purpose network

Multistakeholder governance of the common infrastructure



25x traffic growth in 1 week

March 2020

Not hyper-optimised for any particular use case so had **flexibility to support the shift in use**

A technology neutral general-purpose network

Positives

Protocols have evolved, but we still (mostly) have a **common global infrastructure**

Performance, security, and privacy have all massively improved – due to centralisation or better protocols?

The infrastructure proved **flexible and secure enough** to support society during COVID lockdowns – design/policy lessons?

Challenges

Managing centralisation – hyper-giants have too much power; barriers to entry are high

Managing fragmentation to increase diversity of provision without splintering the network – there is value in having common infrastructure underlying content distribution

Balancing these with maintaining security and privacy – hyper-giants have too much visibility into data, but interoperability introduce security challenges

Challenges

Content moderation, taming social media, mis- and disinformation

Control points in the infrastructure ineffective – lead to ossification that hinders innovation and interoperability

Distinguish **uses of the Internet** from **the Internet**

Artificial intelligence

Distinguish AI using **training data from the Internet**; as a **network management** tool, as a **content moderation** tool, and **as an application** running over the Internet

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Uninteresting

uses of the Internet that don't change the Internet

Blockchain and web3 – a solution in search of a problem?

Metaverse, industrial IoT – can run on existing infrastructure; QoS requirements overblown

What can we learn?

The Internet is Continually Evolving

There is a steady flow of new work into IETF and IRTF

- New protocols are developed to address new challenges
- Existing protocols are extended and improved

This is normal work, **incremental continuous improvement**, unplanned and ad-hoc

Example: TCP was published as RFC 793 in 1981

- RFC 7414 (“A Roadmap for TCP Specification Documents”), from 2015, lists >100 RFCs that extend the original specification – and excludes more recent extensions like CUBIC and BBR congestion control and multi-path support
- The same type of evolution happens to **every** protocol

The Internet is Infrastructure

- Because the Internet is an infrastructure component, protocol evolution tends to happen in ways that are non-obvious to end-users
  - Over time, it just gradually appears to work better, to support new applications
  - Changes **are supposed** to be invisible to other parts of the system
  - The network architecture evolves – it is not designed

- Leads some to make claims of Internet stagnation – but today's Internet protocols are **far removed** from the original Internet protocol suite, even when they share a name

The Internet Was Not Designed

- Radical proposals are interesting to explore the design space, but **there is little top-down architecture or design in the Internet** – innovations succeed when co-opted into the network and incorporated in a bottom-up manner
  - The community is very good at incorporating new ideas into the network
  - Components can, and do, change in significant ways, but you don't notice and the network just works a little better
  - There are limits – not every idea can, or should, be incorporated into the network – but there are few design principles that are not violated somewhere in the Internet
- **Limited architectural vision is a strength** – it permits long-term evolution of the network

IETF Cannot Enact Radical Change

- The IETF has no mechanism to enact top-down architectural changes
- **This is a feature** – no-one controls the global Internet
- The only feasible route to change the network is incremental bottom-up deployment of new and updated protocols

distrust

those that suggest

radical change

without a deployment plan

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To sustain the Internet's value
we must let it develop while recognising and protecting what makes it unique

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