Technology Adoption and the Internet

Geoff Huston
Chief Scientist
APNIC Labs
Why?

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When?
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Will this “transition” ever end?

When?

Or has it already ended and the mess we have today is the mess we are going to have to live with for a few more decades until the Internet crumbles into chaos?
More Whys?

Are we still using BGP?
It’s a 65 year old network routing protocol that creaks and groans! Haven’t we had better ideas since then?

And what about TCP, HTTP, DNS, SMTP?
None of these protocols are recent inventions either
We seem to spend most of our time tweaking around the edges and avoiding fundamental changes these days
What's happening?

Is there any appetite left for technical innovation in the internet, or is the internet entering a terminal phase of sclerotic dotage?

We’re not making changes because what we have is perfect. Far from it.

But despite many issues we are still slow to adopt changes

So why does today’s Internet actively resist change?
The Pace of Consumer Technology Adoption

CONSUMPTION SPREADS FASTER TODAY

PERCENT OF U.S. HOUSEHOLDS

100%

80

60

40

20

ELECTRICITY

TELEPHONE

AUTO

REFRIGERATOR

STOVE

COLOR TV

CLOTHES WASHER

CLOTHES DRYER

AIR CONDITIONING

COMPUTER

VCR

INTERNET

MICROWAVE

CELLPHONE


SOURCE NICHOLAS FELTON, THE NEW YORK TIMES

HBR.ORG
A Conventional View of Progress

This view sees progress as progressive refinement.

Adopted technologies build on existing capabilities.

Progress is largely deterministic.
Example: IEEE 802.3 GigE

Ethernet Speed Evolution Summary

- 2.5 GE and 5 GE is coming soon for higher speed Cat 5e/6 applications
- 10 GE is being widely deployed in every part of the network
- 25 GE is coming soon for server and ToR applications
- 40 GE is increasingly deployed in data center networks
  - Popular for 40 GE and 4 x 10 GE breakout
- 100 GE has transitioned to 2nd generation technology with CFP2, CFP4 and QSFP28
  - Still at least one generation away from 100 Gb/s serial signaling
- 400 GE development is well under way and will leverage 100 GE technology
- Ethernet at Terabit speeds is still unfeasible in the near future, but we’ll get there eventually (2020+)

2016 Ethernet Alliance Road Map
http://ethernetalliance.org/roadmap

Greg Hankins, NANOG 64, Evolution of Ethernet Speeds: What’s New and What’s Next
June 2015
Example: IEEE 802.3 Clos

ETHERNET APPLICATIONS

AUTOMOTIVE and Enterprise applications drive the bulk of Ethernet port shipments with hundreds of millions of ports shipped per year. Ethernet is now in enterprise local area networks (LANs) where the entire Ethernet family, including the AVB (media) and services, can be found. Ethernet is also in a computer where over 70% of malware samples have been identified over the past 10 years. Ethernet data center networks are very well suited and fundamental to the data center of today and will continue to be as the traffic density and demand continue to grow.

SERVICE PROVIDERS have driven higher speeds through fiber solutions. Backhaul, core connections, LSPs, client core systems, and optical transport networks (OTNs) are prominent in very long distance backbones. In particular, the $10 million deployment of subsea dramatic increases in bandwidth and cellular applications and continues to push Ethernet to higher speeds and longer distances, as the world demands it for the billions of devices and services.

To get high-speed versions of the roadmap and to learn more about the roadmap, please go to http://www.ethernetalliance.org/roadmap/

Greg Hankins, NANOG 64, Evolution of Ethernet Speeds: What's New and What's Next
June 2015
Reality is often messier!

This view sees progress as a random outcome of an underlying chaotic set of circumstances.

We have no real concept of any long term objective, and just shift from state to state in random directions.
What is this telling us?

It appears that technology evolutionary process is like a biological process – pretty much random!

But the filter of natural selection has no clear analogue in technology

- Sometimes completely broken technologies gain market ascendency
- Sometimes we accidently make good choices for all the wrong reasons at the time!
We can't all decide on the same thing at the same time

Sometimes we just can’t choose, and then we pick both
  Household power: 110v vs 240v, 50Hz vs 60Hz?
  Driving vehicles: on the left or on the right?

Closer to home - Telephony:
  μ-Law or A-Law voice encoding?
  T vs E multiplexing?

Computing technology is not immune
  what’s a ‘word’ – 6 bits, 8 bits, 16 bits, 32 bits, 36 bits, 60 bits?
  big endian vs little endian?
Success!

Some technology platforms have been completely revolutionary in their impacts through widespread adoption:

• The IP packet switched model
• The browser application
• Mobile devices
• Social Media
Examples of Transformational Technologies

Circuits to Packets
- 100x unit cost reduction in network service
- The change was large enough to destroy the incumbent telco market

Hardware to Cloudware
- 2x – 4x unit cost reduction
- Moderate pace of change that has allowed some incumbents to ride the change while others have had a harder time
Failure!

Other technologies appear to fall far short of their intended adoption trajectory:

- OSI
- ATM
- SMS
- IPv6
- “New IP”
Failure Examples

IPv6
- No marginal unit cost improvement
- Incumbents feel no major pressure to adopt
- 25 year transition with no end in sight

DNSSEC
- Increased unit cost without clear incremental benefits
- Another protracted transition with no end in sight

Circuits to Packets
- True stateless packet switched networks exist only in textbooks these days
- With MPLS and its variants we’ve back to virtual circuits again!
What's going on?

• Why was IPv4 fast-paced success while IPv6 has been a slow motion train wreck of prevarication and delay?
• Why is security a market failure?
• Is Google now so entrenched that it is beyond all but the most disruptive of competitive technology pressures?
What drives change?

Market motivations:

• Incumbency breeds risk aversion and increasing inertia

• Breeds erection of increasing barriers to market entry by competitive actors

• The cost of risk rises
  • Venture capital funds increasingly uninterested in small cap ventures – it's either billions or nothing, because underfunded exercises in disruptive competition are increasingly likely to fail
Economics of Innovation

Unit Cost Reduction

Adoption pressure

incumbent Resistance

incumbent Replacement

Market Destruction!
Economics of Innovation

- Adoption pressure vs. Unit Cost Reduction
- Open markets vs. incumbent Resistance
- "incumbent entrenchment" level vs. incumbent Replacement
- Monopolies vs. Market Destruction!
Some Examples
IPv6 adoption - 2012 to Today

26% of the Internet’s user base have IPv6 today
And is very diverse in Europe

IPv6 is deployed in Central Europe and Greece, but not in the North, South or East.
DNSSEC adoption
Same (but different) diversity

DNSSEC is deployed in Northern Europe, but not as much in Central, Southern or Eastern Europe.
Why is there such diversity in deployment?
Challenges for adoption:

1. This is a deregulated and highly competitive environment

   There are many different players
   Each with their own perspective

   And all potential approaches will be explored!
Challenges for adoption:

2. The myth of long-term planning

"IPv6 Transition will take many years...

5 years, maybe 10 years, maybe longer" 

Are we still firmly committed to the plans we had 5 years ago? How about our 10-year-old plans?

The longer the period of transition, the higher the risk of completely losing the plot and heading into other directions!
Challenges for adoption:

3. The environment keeps changing

Today's Internet Architecture
Some Providers see advantage in early adoption

• Competitive positioning in a diverse market
• Early adoption of future mainstream technologies (first user advantage)
• Perception of enhanced utility, security and safety in these more recent technologies
Other Providers see compelling reasons to wait ...

• **IPv6** is a 1990’s technology solution to a 1980’s networking architectural challenge – CDN feeder networks do not need globally unique address plans across every device all of the time

• **DNSSEC** is merely a pantomime of secure DNS. If we pushed DNSSEC validation to the edges of the network where it truly matters we’re scared that the DNS will slow down to unacceptable levels. DANE’s demise is a good example of this DNS paranoia!

• **RPKI Route Origin Validation** is also a thin veneer of supposed security. It makes routing attacks ever so slightly harder. More moving parts can introduce fragility, and not necessarily enhance operating stability
What drives change?

This is a market, like any other
And consumers of goods and services make choices
These user choices are what drives the market
What resists change?

• Volume tends to increase inertial resistance
  • And the digital world has massive volume

• Incumbency resists change
  • And the digital world is now dominated by a small set of incumbents

• The emergence of large scale digital incumbents creates its own challenges
Change and Monopolies

• We are now communicating with a computer-mediated environment rather than with each other

• The network itself is largely incidental to this evolving story, and this is not really about the Internet any more

• It’s about a set of revolutionary social changes on a par with the industrial revolution that have been triggered by abundant computing, storage and comms

• And its dominated by a very small cartel of monopolists
The Gilded Age in the United States

During latter part of the 19th century in the United States the dominant position within industry and commerce was occupied by a very small number of players who were moving far faster than the regulatory measures of the day.

The resulting monopolies took the US decades to dismember, and even today many of these gilded age companies remain dominant in their field.
The Internet’s Gilded Age

At some point in the past decade or so the dominant position across the entire Internet has been occupied by a very small number of players who are moving far faster than the regulatory measures that were intended to curb the worst excesses of market dominance by a small clique of actors.
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WASHINGTON — Faced with the growing possibility of antitrust actions and legislation to curb their power, four of the biggest technology companies are amassing an army of lobbyists as they prepare for what could be an epic fight over their futures.
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“Every monopoly and all exclusive privileges are granted only at the expense of the public interest”

Andrew Jackson, 1830

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Incumbency Rewards

Gittes: How much are you worth?
Cross: I've no idea. How much do you want?
Gittes: I just want to know what you're worth. Over ten million?
Cross: Oh my, yes!
Gittes: Why are you doing it? How much better can you eat? What can you buy that you can't already afford?
Cross: The future, Mr. Gittes – the future!

Chinatown (1974)
Where does all this head?

*For our society, this rapid market-driven digitisation of our world has the potential to be incredibly empowering or incredibly threatening*

*Or both at the same time!*
Wherever we're heading...

• It’s not the Internet any more
• That has already died and gone to silicon heaven!
Sic transit gloria mundi

In 1776 English historian Edward Gibbon published a mighty 6 volume work tracing the Roman Empire (and Western Civilisation) from the height of Empire to the fall of Byzantium.

The seeds of the empire’s eventual decline and fall were sown early in its rise.
Thanks!