

Some Thoughts on Internet Infrastructure

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It used to be so simple...

1980's:

- The network was the transmission fabric for computers
- It was just a packet transmission facility
- Every other function was performed by attached mainframe computers



Then we went client/server

1990's:

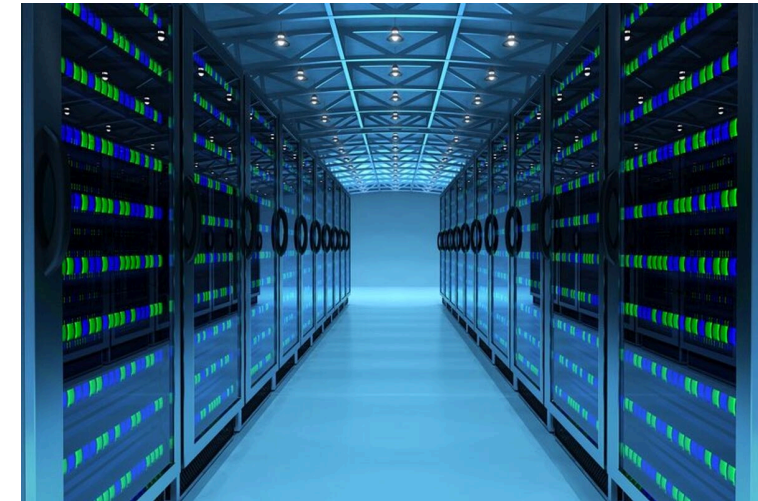
- The rise of the Personal Computer as the “customer’s computer”
- We started to make a distinction between “customers” and “network”
 - The naming system was pulled into the network
 - The routing system was pulled into the network
 - Messaging, content and services were pulled into the network
- We created the asymmetric client/server network architecture for the Internet



Internet Infrastructure of 2000

Rapid expansion of infrastructure in many directions:

- Exchanges, Peering Points and Gateways
- Tier 1 ISPs
- Transit and Traffic Engineering
- Data Centres and Service “Farms”
- Quality of Service Engineering
- MPLS, VPNs and related network segmentation approaches
- Customer Access Networks
- Content Distribution Networks



What's driving change today?

- Bigger
- Faster
- Better
- Cheaper

Bigger



- Increasing **transmission capacity** by using photonic amplifiers and wavelength multiplexing for fibre cables
- Adding **link aggregation** capability
- Serving content and service transactions by distributing the load across many individual platforms through **server and content aggregation**
- The rise of high capacity mobile edge networks and mobile platforms add massive volumes to content delivery
- To manage this load we've stopped pushing content and transactions across the network and instead **we serve from the edge**

Faster



- Reduce latency - stop pushing content and transactions across the network and instead **serve from the edge**
- The rise of CDNs serve (almost) all Internet content and services from massively scaled distributed delivery systems.
- “Packet Miles” to deliver content to users has shrunk - that’s faster!
- The development of high frequency cellular data systems (4G/5G) has resulted in a highly capable last mile access network with Gigabit capacity
- Applications are being re-engineered to meet faster response criteria
- Compressed interactions across shorter distances using higher capacity circuitry result in a faster Internet

Better



- If “better” means “more trustworthy” and “more privacy” then we are making progress at last!
 - Encryption is close to ubiquitous in the world of web services
 - TLS 1.3 is moving to seal up the last open TLS porthole, the SNI field
 - Oblivious DNS and Oblivious HTTP is moving to isolate knowledge of the querier from the name being queried
 - The content, application, and platform sectors have all taken the privacy agenda up with enthusiasm, to the extent that whether networks are trustable or not doesn’t matter any more – all network infrastructure is uniformly treated as untrustable!

Cheaper



- We are living in a world of abundant comms and computing capacity
- And working in an industry when there are significant economies of scale
- And being largely funded by capitalising a collective asset that is infeasible to capitalise individually
- The result is that a former luxury service accessible to just a few has been transformed into an affordable mass-market commodity service available to all

So it's all good!

Right?

Some questions to think about

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- Or Peering? Or Exchanges? Or Gateways?
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- What is left of our former public communications infrastructure?
 - And does anyone care any more?
- **Are these changes resistible in any way?**
 - What's the cost to a national economy in driving away digital services?
 - Or trying to enforce national adherence to compromised and useless crypto models?
 - Or trying to isolate points of foreign dependence in the delivery of Internet services?

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 - Or are all these infrastructure elements heading inexorably towards irrelevance?
- In a world of application-based computing and end-to-end encryption, are there any inspection and interception control points left?
 - Or is the entire Internet vanishingly opaque in a diverse ways that it can now resist the attempt to impose any such control?
- **Once you pass the entire global communications endeavour to a market-based private sector regime then it takes on a momentum of its own that places it outside of historic forms of national regulation and control**
- Are these changes resistible in any way?
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Thanks!