Internet Futures

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There are just far too many ways to be an Internet Oracle:

- Applications Futures
- Service Futures
- Business Futures
- Political Futures
- Social Futures

. . .

So I’d better stick to talking about what I am familiar with:

The future of the Internet, from the general perspective of its **Technology Base**

The HOW of Internet Futures

Futures are often an outcome of current pressure points

So what's broken in today's Internet?

. . . The Internet

A Fine Thing in practice...

But in theory it just won't work!

The Technology Top 10

My Top 10 list of Internet failures

Who's in charge?

- Vint Cerf?
- ICANN?
- US Commerce
- ITU

and in Australia...

- Telstra?
- ACCC?
- Minister of Communications?

10. Nobody is in charge

- There is no cohesive plan for the Internet evolution
- Progress is made through chaotic interaction
- Technology evolution is not a rational ordered process!

‘Internet Governance’ is becoming an increasingly hot issue as more and more neophytes join in the fun

Where’s the money?

- Content Providers?
- Software publishers?
- Hardware manufacturers?
- Carriage providers?
- Internet Service Providers?

9. An Internet Economy ?

- Financial models of service provision are widely divergent
- No evidence that there is any convergence yet
- 22 of the top 25 Internet companies are still operating in the red
- IP packet carriage is a low margin commodity market
- Applications services occur edge-to-edge, beyond the network boundary

Internet service provision will rewrite carrier economics. Current share market e*hysteria will eventually blow out, and a new, and far smaller, commodity service structure will emerge.

Who's listening on the wire?

- Privacy and authenticity are fundamental to confidence in communications
- E-Commerce needs robustness
- Privacy of communications is necessary
  - although how much privacy is 'enough' remains undetermined

8. The Internet needs Security

- Way too many applications and services still do not embed secure communications
- Authentication mechanisms are not widely used
  - The SPAM bombardment is a failure of the security model
- E-Commerce needs widely deployed secure authentication tools to confirm validity of the transaction

Widespread adoption of security mechanisms is still some decades away.

Where do I get it?

- There is no directory of
  - people
  - services
  - resources

which spans the entire Internet

7. There is no Directory

- Bug or Feature?
- Directory Lookup or Service Discovery?
- Who populates and maintains the directory?
- How to generate unique entries for unambiguous automated lookup
- Not for want of trying....

Discarded directory technologies are the road fill of the information superhighway.

What are you reading?

- The model of content creation and circulation on the Internet poses new challenges to copyright owners, publishers, media owners, governments.

6. There is no Content Control

- Content can be easily duplicated and recirculated
- How does a content owner preserve value in the content given a lack of control over republication on the net?
- How can a community express baseline standards of acceptability to protect its minors?

It’s a bird, … no it’s a plane…

- The Internet does not have a single service model
  - email, web, commerce, voice, ...???

5. No single Internet Service Model

- The underlying engineering model cannot be readily tuned to the characteristics of every particular service or application
  - The principle of generality may then apply - the engineering of the network is liable to be equally unsuitable for all potential applications!
  - The Internet platform continues to evolve to accommodate an ever broader end system application family
  - The dynamic engineering model is an inhibitor to broad-scale platform investment

THE Internet?

- There are some 60,000 constituent networks
  - Who offer a differing range of services
  - Who attempt to interconnect in various inventive ways
  - Who contribute to a routing soup which borders on chaotic instability

- Many operators, many policies,

one service?

4. Too Many Operators

- No stable scaleable architecture of interconnection
- No financial model to underpin interconnection
- No economies of scale achievable
- This mess is sustained only by aggressive growth in market demand and poor regulatory understanding

Consolidation of backbone operators is underway, leading to over-compensation into a global cartel in the Internet Service Market

Internet Performance is...

- an oxymoron?
- All in the mind?
- Un-measureable?

3. Quality of Service is a Myth

- Data is adaptive, not predictable
  - This results in a dynamic equilibrium of shared use, where the network's resources are shared equally to all active sessions
- No application can count on a fixed network performance environment

Data and Voice carriage will remain distinct engineering environments

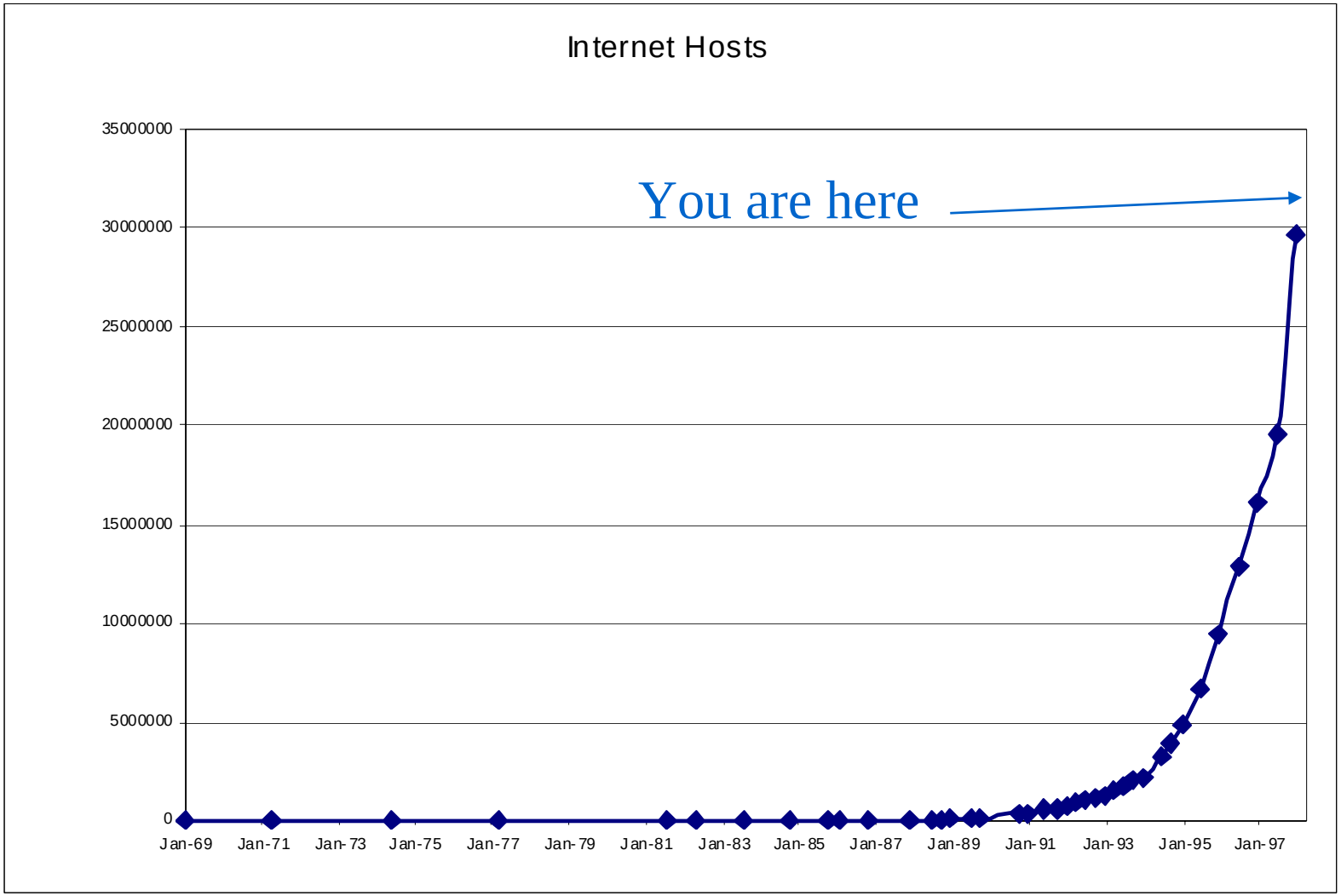
Data over Voice

- Voice was provisioned using extravagant margins of supply
  - this is sustainable as the historical service price of Voice is well in excess of network carriage costs for Voice
- Data has been provisioned on these margins of oversupply of Voice networks
- These oversupply stocks are now exhausted…

2. No More Data over Voice

- Voice traffic will decline in total wire use to less than 0.01% in the next decade
- Data service markets are very low margin basic commodity markets
  - network size and efficiency are the competitive edges in this new market
  - Transition to a high efficiency data carriage environment calls for re-engineering of the entire service network as a data platform
  - Who will undertake this investment quickly enough?

Scale


Internet Hosts
35000000
30000000
25000000
20000000
15000000
10000000
5000000
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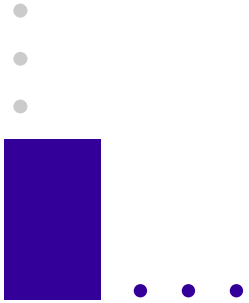
You are here
Jan-69
Jan-71
Jan-73
Jan-75
Jan-77
Jan-79
Jan-81
Jan-83
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97

1. Scale

- Almost every major Internet challenge is an aspect of scaling the network to meet explosive demand:
  - access infrastructure
  - trunk bandwidth
  - routing stability
  - quality of service
  - application support infrastructure



So why does the Internet work at all?

The Edge Service Model

- Network Services
  - switching
  - transmission
- **User Controlled Services**
  - delivery models
  - content
  - services
  - …

The Internet Service Model

- Edge distributed services are easy to scale
  - email
  - web content
  - e-commerce
- centralised services are difficult to scale
  - identity authentication
  - domain name management
  - registries and directories

Challenges

- Growth is a forgiving environment
- When growth levels decline it will herald:
  - destruction of the small to medium size ISP market
  - regulatory confusion
  - service provider aggregation in global markets
  - investment tension between telco investment and new private investment channels
  - crash of profitability in voice
  - high value service markets appearing in the service sectors, not the communications sector

A changing world...

Communications technologies define the business and social structure of our environment

Fundamental changes in communications technology and communications service economics always have a massive long term impact on business and social structures

The Internet will drive such a change

The Internet is **not** a solved problem

- Technology development is still necessary
- There is so much yet to construct
- There are so many potential uses that can be tapped

Key Future IP Technologies

- Quality of Service support
- Multicast
- Directories
- Content Indexing and Caching
- Mobility and Wireless transmission
- Gigabit switches and transmission
- Internet Utility Appliance technologies

Lots of theory - but little practice so far..

Quality of Service Support

- Embedded network mechanisms to support managed expectations of
  - end to end delay management
  - throughput
  - loss rates
- Introduce robust expectation setting into the Internet environment

Quality of Service Support

- Improving the network
  - Random Early Deletion and Early Congestion Notification to improve congestion onset signaling
  - Weighted Fair Queuing to provide fair resource allocation and bounded delay
  - Admission Control traffic shaping
  - Uncoupling the management of network rate controlled and external rate controlled data flows
  - Differentiated Service management structures

Multicast

- group communications support
- provides efficient push content support infrastructure
- support for collaborative tools

Multicast Issues

- routing and switching support
- multicast traffic shaping
- real time adaptive rate controls
- reliable multicast transport signaling structures

Directories

- Evolving models
  - central data repository vs distributed data elements
  - application specific vs universal schema
  - information scoping
- No shortage of contenders for an Internet directory service!

Directories

- Directory operator models
  - service provider?
  - described entity?
  - content provider?
  - dedicated directory service provider?

Directories in the Network

- Directory Enabled Networks?
  - I know who you are
  - I know where you want to go today

Content Indexing

- Current indexing:
  - web trawlers
  - content word-by-word indexing

- Maybe this is finally **THE** application for all that natural language research!

Content Caching

- Just in Time vs Just in Case
- Caching
  - browser selected caching
  - transparent caching
- Caching Tools:
  - local content delivery
  - referral directed back to content originator
  - active caching as a network function

Speed and Volume

- Switched Gigabit Ethernet as a successor to Ethernet and FDDI LANs
- IP over ATM
- IP over SDH
  - bedding down deeper into the communications infrastructure for higher speed and greater reliability
- IP over WDM

Switching and Routing

- IP switching technology evolution
  - capability to create multiple segmented network overlays on a single network substrate
    - multiple routing families
    - differentiated service levels per segment
    - Service Level Guarantee support

Mobility and Wireless

- The technology base is now well understood
- The economics of spectrum exploitation for wireless are still an open issue
- Uptake will be based on availability of useable spectrum space within an already populated environment

The Appliance World

- Internet telephones and videophones are already here.
- shrinking the Internet communications function to the lower left corner of the ASIC
  - well connected coffee makers?
  - smart per appliance electricity meters?
  - really clever garden sprinklers?

But remember...

massive deployment acts as inertial brake to continued innovation of the base technologies

Will the Ubiquitous Internet of 2008 be as exciting as the Evolving Internet of 1998?