Speculative thoughts on future (and past) network architectures

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Outline:

- The hard-to-predict non-techie user is king
- Inertia more important than technology and economics
- Precise prediction impossible
- Flexibility, the main source of Internet's success, key (for even if you find the optimal solution, you won't convince decision makers in time)



Frequent misplaced bets on technologies:



Number of papers per year with ATM or Ethernet in the abstract, data from *IEEE Xplore* (2004) (estimated values for 2004).

Kalevi Kilkki, Sensible design principles for new networks and services, First Monday, Jan. 2005, http://www.firstmonday.org/issues/issue10_1/kilkki



Technologies often succeed in spite of their promoters' misconceptions:

Internet

 Railroads (freight vs. passengers, short vs. long haul, effect on demand for horses, ...)



Network technologies and architectures:

Irrelevant to users

 Cannot compensate completely for weaknesses of applications



Special report The digital home

Science fiction?

v entires: which protects such content against place of fiddling the copyright holders of content-film sud here ex. dice and record companies. In easerger, to

SAN FRANCISCO

Technology firms are pushing a futuristic vision of home entertainment not because consumers are desperate for it but because they themselves are





Technology:

- Many choices
- Drive for uniformity (converged network)
- Drive for diversity (walled gardens, security, redundancy, customer-owned networks, outsourcing, ...)
- ⇒ Likely outcome a multimodal telecom scene, unified by IP layer (in analogy with transportation sector, unified by container)



Primacy of user needs and user inertia:

Yellow pages example:

- Qwest sale of directory division in 2002 for approx. \$7 billion (annual revenues \$1.6 billion, margins 63%)
- Current (October 2005) market cap of Qwest: approx. \$7 billion

 \Rightarrow user inertia often most important factor in business success



Inertia:

- Standards that are still diffusing rapidly (e.g., IP) hard to undermine
- Comparison to standard gauge on railroads

Conclusion: You can tweak it, but it will be called IP, and will be very much like IP, however poor IP is



Hard to stop users from doing what they want, especially with broadband:

early 19th century "crossed-letter"





Long-haul is not where the	ne action is:
360networks transatlantic ca	able
Construction cost	\$850 M
Sale price	\$18 M
Annual operating cost	\$10 M
Lit capacity	192 Gb/s
Fully lit capacity	1,920 Gb/s
Ave. transatlantic Internet traffic	200 Gb/s
(mid-2005)	



General migration of costs to edges:

 US annual telecom spending \$300+ B
annual cost of running a backbone for all US traffic possibly just \$300 M



Implications of migration of costs to edges:

- Technology of the backbones does not matter much
- Architecture of the backbones does not matter much
- There could be many backbones, their economics don't matter much
- The most sensible strategy is to overprovision the core, confine what little QoS might be needed to the edges



Central technology trends:

- Rapid growth in processing power
- Rapid growth in storage
- Rapid growth in transmission
- Slow growth in resolution of display devices
- Imbalance, with far more storage than transmission



Implications of central technology trends:

- Most storage to stay local
- Transmission to be dominated by machine-to-machine file transfers, cascading from human demands
- Streaming real-time multimedia to be small



Main function of data networks:

Low transaction latency





Utilization of a T1 link to the Internet



Main function of data networks:

Low transaction latency

You waste that which is plentiful. — George Gilder



Tricky but central issue:

- Broadband is all the rage
- Voice is where the money comes from, and plays a uniquely vital role in human communication

Key issue: How to transition to an environment where the most valued feature can be delivered at trivial cost over a broadband connection?



Strong movement to control the Internet:

- extensive historical precedents for control
- main motivation economic
- extensive arguments for control from economics
- control move likely to fail because of special features of the Internet (migration of costs and intelligence to edges, connectivity and not content is king, ...), but the case is not clear cut, and so will not be decided for a long time



Absurdities of government regulation often rooted in corporate practices:

Cats is 'dogs' and rabbits is 'dogs' and so's Parrats, but this 'ere 'Tortis' is a insect, and there ain't no charge for it.

Punch, 1869





Open architecture vs. drive to price according to value:

[Alexander Graham] Bell should have anticipated Bill [Gates] and let someone else put in the phone infrastructure while he collected by the minute and distance (and even importance of the call if he could have figured a wait to monitor it) in perpetuity. email from Warren Buffett to Jeff Raikes of Microsoft, Aug. 21, 1997



Key question:

How much control over content should carriers exercise?

- Block video?
- Prevent WiFi hot spots?

Voice telephone content is private now, but:

In Britain in 1889, postal officials reprimanded a Leicester subscriber for using his phone to notify the fire brigade of a nearby conflagration. The fire was not on his premises, and his contract directed him to confine his telephone ``to his own business and private affairs.'' The Leicester Town Council, Chamber of Commerce, and Trade Protection Society all appealed to the postmaster-general, who ruled that the use of the telephone to convey intelligence of fires and riots would be permitted thenceforth.



18th Century: Beverley Beck Navigation

Cargo	Toll per Ton
Sand	2p
Timber, stone, salt	6р
Iron and lead	12p

There is extensive evidence that such practices often aid society's welfare, in accordance with standard economic doctrine.



What will consumers accept?

THE NEW YORK TIMES, MONDAY, JUNE 27, 2005

ALL CONSUMING

Airline Tickets Can Be More in June Than in January. But Soda? Forget It.

EMEMBER the plan to charge



"Where companies get in trouble is where they base it purely on supply and demand," said Mike Marn, director of pricing services at McKinsey & Company, the consulting firm. "Those are the situations where consumers really get up in arms. If you're going to take advantage of the demand, you have to be able to say with a straight face that there's a benefit that goes with it."

services at McKinsey & Company, the



Fundamental problems:

How to reconcile incentives to price discriminate with public loathing of such practices

Warning: better data collection and analysis tools are becoming available to customers



Likely outcome:

- explicit price disrimination for large and infrequent purchases
- simple (ideally flat rate) pricing for small and frequent purchases
 - extensive arguments based on advantages of bundling and behavioral economic factors (such as effect of flat rates in stimulating usage)



Walled garden attractions:

- Service providers like them
- Users might too, to save them the costs that the Internet has pushed onto them (incl. security)
 "AOL's missed opportunity"



Main imperative for service providers: increase usage

If they don't, their competitors will

- Provides one of the main incentives for flat rates
- Competition with wireless (and with each other) may force wireline carriers onto this course



Further data, discussions, and speculations in papers and presentation decks at:

http://www.dtc.umn.edu/~odlyzko

