

The Economics of the Internet

Andrew Odlyzko

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

Outline and main points:

- ◆ technology has outrun demand
- ◆ economics (and to some extent regulation) dominant factor
- ◆ awkward transition: voice network ⇒
voice one of many services on top of broadband
- ◆ problem: voice is still where the money is and will continue to be for some time
- ◆ wealth of technological choices: winners hard to predict, may be determined by strategic decisions, as well as regulation
- ◆ FTTH may never be big in residential broadband
- ◆ fixed wireless access may play a key role

Outline and main points (cont'd):

Key underappreciated elements:

- ◆ move of costs and revenue opportunities to edges
- ◆ low transaction latency main driver of data networks
- ◆ content is not king
- ◆ streaming real-time multimedia traffic likely to be small
- ◆ increasing usage key imperative for service providers
- ◆ behavioral economic issues central (user preferences in pricing, etc.)

Hype and reality:

“Over the last five years, Internet usage has doubled every three months.”

Kevin Boyne, UUNET COO, Sept. 2000

with such growth rates, any new technological improvements could produce untold wealth and justify crazy valuations (such as JDS Uniphase at over \$100 B)

Reality:

U.S. Internet backbone traffic at year-end 2003: 130 - 250 PB/month could fit on a single fiber (but about 3x voice traffic)

Internet Bandwidth vs. Potential Fiber Capacity

100 PB/month \approx 300 Gbps

80-wavelength OC192 DWDM system \rightarrow 800 Gbps/fiber

**Telegeography 2002: in mid-2002, highest capacity
Internet route (NYC – Washington): \approx 140 Gbps**

**9/11 disaster reports: Verizon central office at 140 West Street
in NYC had capacity of 3.6 million VGE \approx 200 Gbps**

Basic telecom statistics:

U.S. service providers' annual revenues, 2003

total telecom	\$300 B
cellular	80
Internet	35
dedicated access	15
residential dial	10
residential broadband	10

voice is still where the money is (and will continue to be for quite a while)

Volume and value only weakly related:

Revenue per MB

Service	Typical monthly bill	Revenue per MB
Cable	\$40	\$0.00012
Broadband Internet	50	0.025
Phone	70	0.08
Dial Internet	20	0.33
Cell phone	50	3.50
SMS		3000.00

One picture is worth a thousand words, provided one uses another thousand words to justify the picture.

Harold Stark, 1970

There are still unexploited opportunities in voice, especially in 3G (with differentiated voice quality levels, etc.). The success of Nextel's push-to-talk should not have been a surprise (nor SMS).

Price discrimination, cross-subsidies, and regulation:

Wide dispersion in valuation of bit valuations

⇒ price discrimination (via regulatory fiat or through competitive market dynamics)

Much of current telecom turmoil driven by collapsing system of taxes and cross-subsidies

VoIP: negligible network operations savings (VoIP usually does not compress much, and instead transforms mostly local calls into long distance ones), but bypasses established regulatory regime

Price discrimination incentives:

growing

appear to explain much of drive for new Internet architecture with more control for carriers (contrary to historical precedents from telecom)

A depressing litany of duds among major recent networking research initiatives:

- ◆ ATM
- ◆ RSVP
- ◆ Smart markets
- ◆ Active networks
- ◆ Multicasting
- ◆ Streaming real time multimedia
- ◆ 3G

And (largely encompassing all of these): QoS

All technical successes, but failures in the marketplace

Key question:

How much control over content should carriers exercise?

- ◆ **Block video?**
- ◆ **Prevent WiFi hot spots?**
- ◆ **Block VoIP?**

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: Berkeley Beck Navigation

<u>Cargo</u>	<u>Toll per ton</u>
Salt	2p
Iron or lead	8p
Timber or stone	2p
Hemp, lime and flax	7p

historical pattern in transportation: charge according to nature of cargo, contrary to the end-to-end principle that is the foundation of Internet's success

Telecom vs. transportation: Which precedents will prevail?

several key differences between the two

one of the most important:

- ◆ telecom: costs and revenue opportunities at edges
- ◆ transportation: core network expensive

general facts about telecom:

- ◆ basic network costs low
- ◆ complexity, not efficiency of utilization is what matters

Long-haul is not where the action is:

▶ 360 networks transatlantic cable

Construction cost	\$850 M
Sale price	\$18 M
Annual operating cost	\$10 M
Lit capacity	192 Gb/s
Ave. transatlantic Internet traffic	70 Gb/s

Residential broadband costs:

DSL and cable modem users: average data flow around 10Kb/s per user

If provide 20 Kb/s per user, at current costs for backbone transit of \$100 per Mb/s per month, each user will cost around \$2/month for Internet connectivity.

→ Most of the cost at edges, backbone transport almost negligible

Evolution of telecom hobbled by several misconceptions:

- ◆ content is not king (connectivity is valued more highly)
- ◆ streaming real time multimedia likely to be a small fraction of total traffic (file transfers for local storage, transfer, and replay are the natural evolution)
- ◆ misunderstanding of what broadband is (desire for low transaction latency is the key element)

The open architecture and end-to-end principle are likely to survive if these misconceptions are dispelled.

Behavioral economics important:

- ◆ constrains overt price discrimination
- ◆ promotes flat rate pricing
- ◆ promotes open networks

Conclusions

Telecom industry: painful transition, and economics and regulation are likely to be more important than technology

Much more measurement, modeling, and analysis of the Internet is needed, especially in areas neglected so far:

- ◆ user behavior and needs:
 - what happens to demand as capacity rises
 - response to pricing
- ◆ industry structure

More information:

◆ papers at

<http://www.dtc.umn.edu/~odlyzko/doc/networks.html>

◆ especially:

“The economics of the Internet: Utility, utilization, pricing, and Quality of Service,” unpublished 1998 manuscript

“The many paradoxes of broadband,” 2003

“Internet traffic growth: Sources and implications,” 2003

“Pricing and architecture of the Internet: Historical perspectives from telecommunications and transportation,” recent preprint