Internet evolution and misleading networking myths

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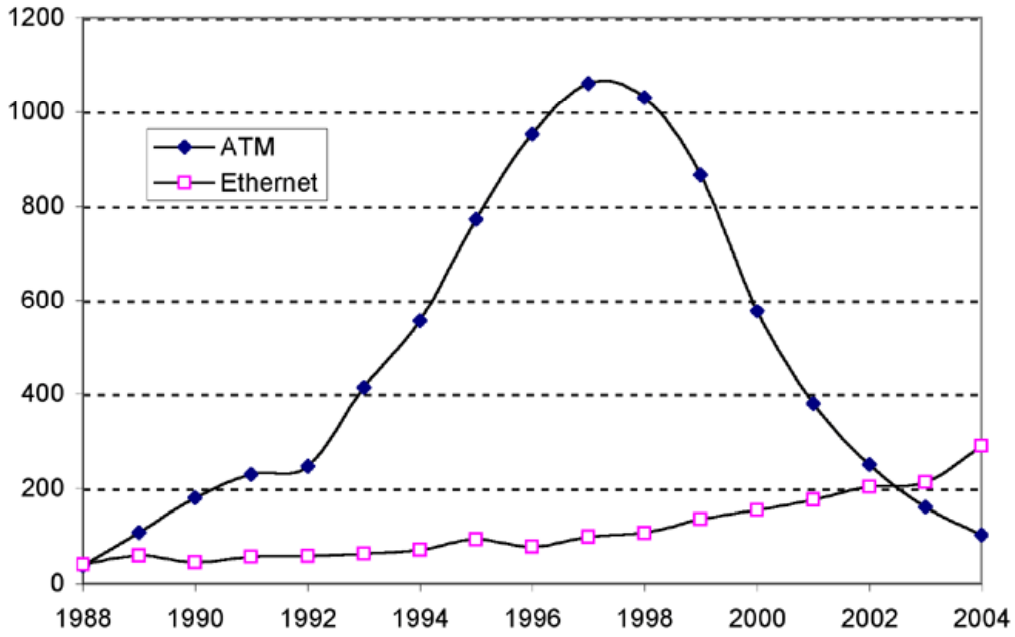
Frequent misplaced bets on technologies:



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

Being wrong is not a barrier to success:

The goals of the advertising business model do not always correspond to providing quality search to users. ... we expect that adertising funded search engines will be inherently biased towards the advertisers and away from the needs of the consumers. ... But we believe the issue of advertising causes enough mixed incentives that it is crucial to have a competitive search engine that is transparent and in the academic realm.

Overwhelming need for flexibility in technology and business plans:

The goals of the advertising business model do not always correspond to providing quality search to users. ... we expect that adertising funded search engines will be inherently biased towards the advertisers and away from the needs of the consumers. ... But we believe the issue of advertising causes enough mixed incentives that it is crucial to have a competitive search engine that is transparent and in the academic realm.

Sergey Brin and Larry Page, 1998

Misleading dogmas impeding reform and restructuring:

- Carriers can develop innovative new services
- Content is king
- Voice is passe
- Streaming real-time multimedia traffic will dominate
- There is an urgent need for new “killer apps”
- Death of distance
- QoS and measured rates

The Big Question:

Is the Internet threatened by

too much

or

too little

traffic?

Internet traffic as pulse of the Internet:

- Traffic growth slowing
- Hype accelerating
- Even very biased hype is occasionally correct: trustworthy data collection desirable
- There are huge sources of potential future traffic
- Future traffic levels result of interaction of complex feedback loops

MINTS News

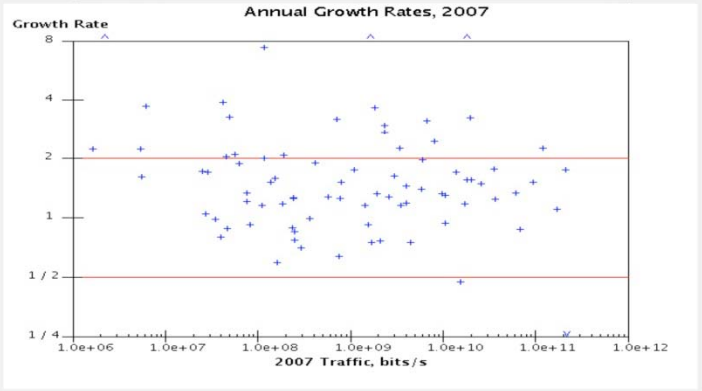
•Aug 11, 2008	A dramatic decline in traffic growth? Cogent reports absolute traffic decline, but other signs less dire.
•Jul 30, 2008	MINTS pages updated, RSS feed available
•Jun 25, 2008	Wireless traffic

More

Current (mid-2008) annual Internet traffic growth rates	
U.S.	50-60%
World	50-60%

Year-end 2007 monthly Internet traffic estimate	
U.S.	750-1250 PB (PetaByte = 10^{15} bytes)
World	3000-5000 PB (PetaByte = 10^{15} bytes)

Year-end 2007 estimates for monthly Internet traffic (GB per capita)	
Australia	1.0
Western Europe	2.3
Japan	2.6
U.S.	3.0
Hong Kong	17.0
South Korea	17.0



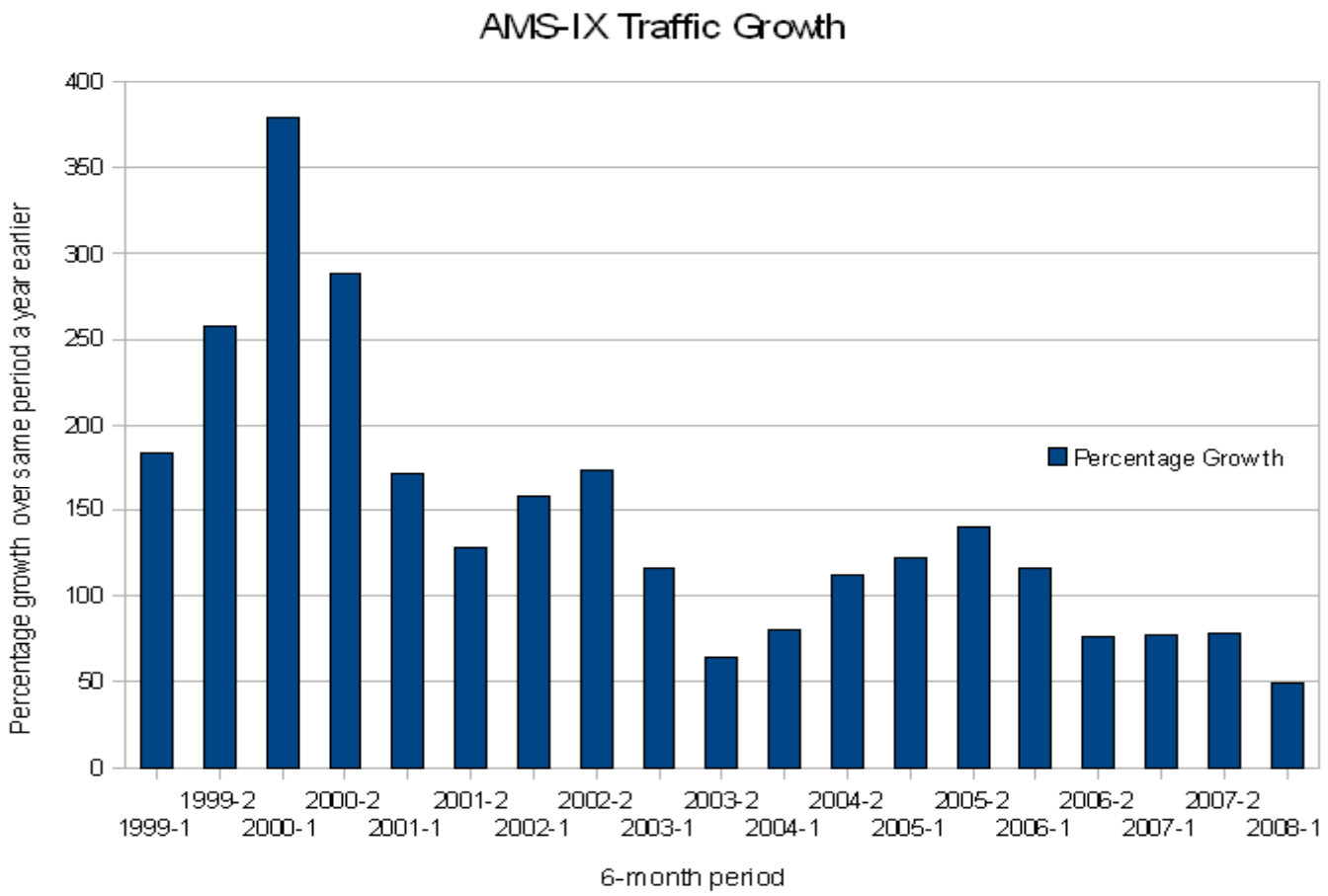
Traffic growth rates from publicly observed sites

http://www.dtc.umn.edu/mints

Current US and world Internet traffic:

- growth rates mostly in the 50-60% per year range
- Cisco white paper: 40% CAGR prediction
- Swanson-Gilder exaflood white paper: 55% CAGR prediction
- Nemertes white paper: about 100% CAGR prediction
- 50% growth rate in traffic only offsets 33% cost decline:
  - traffic: 100 $\Rightarrow$ 150
  - unit cost: 100 $\Rightarrow$ 67
  - total cost: 10,000 $\Rightarrow$ 10,050

General slowdown (world's largest exchange):



Hong Kong: extreme and intriguing slowdown

year	growth rate in Internet traffic over the previous year, for February of each year
2002	304%
2003	154
2004	431
2005	122
2006	61
2007	30
2008	11

Per-capita traffic intensity in Hong Kong is about 6x the U.S. level.

Huge potential sources of additional Internet traffic:

- Storage
  - Year-end 2006 worldwide digital storage capacity: 185,000 PB
  - Year-end 2006 worldwide Internet traffic: about 2,500 PB/month
- Broadcast TV
  - Year-end 2006 U.S. Internet traffic per capita: 2 GB/month
  - Year-end 2006 U.S. TV consumption per capita: 40 GB/month (soft figure, assumes 3 hr/day, at 1 Mbps, no HDTV, ...)

Cloud computing's limited prospects:

- cost, performance, and Moore's laws of computing, storage, and transmission
  - current growth rates of all 3 key technologies similar, ~50% per year
- transmission lagged historically, continues to do so
- residential users:
  - 3 Mb/s Internet downloads
  - 0.3 Mb/s Internet uploads
  - 0.5 Gb/s disks
  - 300 GB disk takes 3 months to upload at 0.3 Mb/s

Revenue per MB:

• SMS:	$1,000.00
• cellular calls:	1.00
• wireline voice:	0.10
• residential Internet:	0.01
• backbone Internet traffic:	0.0001

Volume is not value, but is an indicator of ecosystem health and growth!

Long-haul is not where the action is:

- 360networks transatlantic cable

Construction cost	**$850 M**
Sale price, 2003	**$18 M**
Annual operating cost	**$10 M**
Lit capacity, 2003	**192 Gb/s**
Design capacity	**1,920 Gb/s**
Transatlantic Internet capacity, 2008	**2,500 Gb/s**

Dominant types of communication: business and social, not content, in the past as well as today

Thirty years ago you left the city of Assur. You have never made a deposit since, and we have not recovered one shekel of silver from you, but we have never made you feel bad about this. Our tablets have been going to you with caravan after caravan, but no report from you has ever come here.

circa 2000 B.C.

A fine thing you did! You didn't take me with you to the city! If you don't want to take me with you to Alexandria, I won't write you a letter, I won't talk to you, I won't say Hello to you even. ... A fine thing you did, all right. Big gifts you sent me - chicken feed! They played a trick on me there, the 12th, the day you sailed. Send for me, I beg you. If you don't, I won't eat, I won't drink. There!

circa 200 A.D.

Human communication:

One picture is worth a thousand words

Human communication:

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

Harold Stark, 1970

Dreaming of streaming:

Key misleading myth: streaming real-time traffic

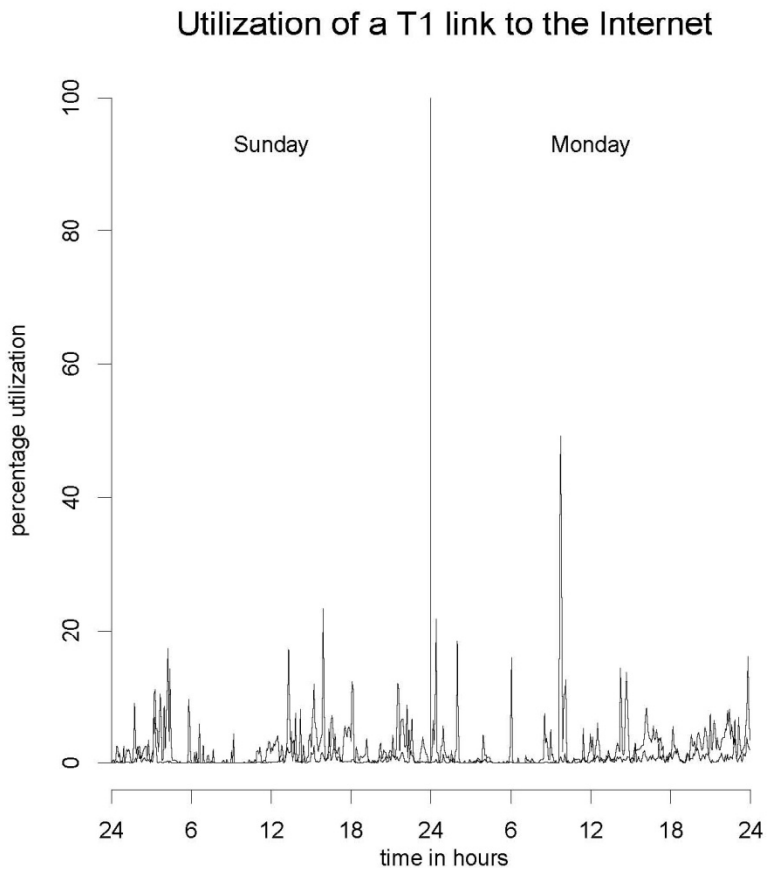
- Little demand for truly real-time traffic
- For most traffic, faster-than-real-time transfer wins:
  - far simpler network
  - enables new services
  - takes advantage of growing storage

Function of data networks:

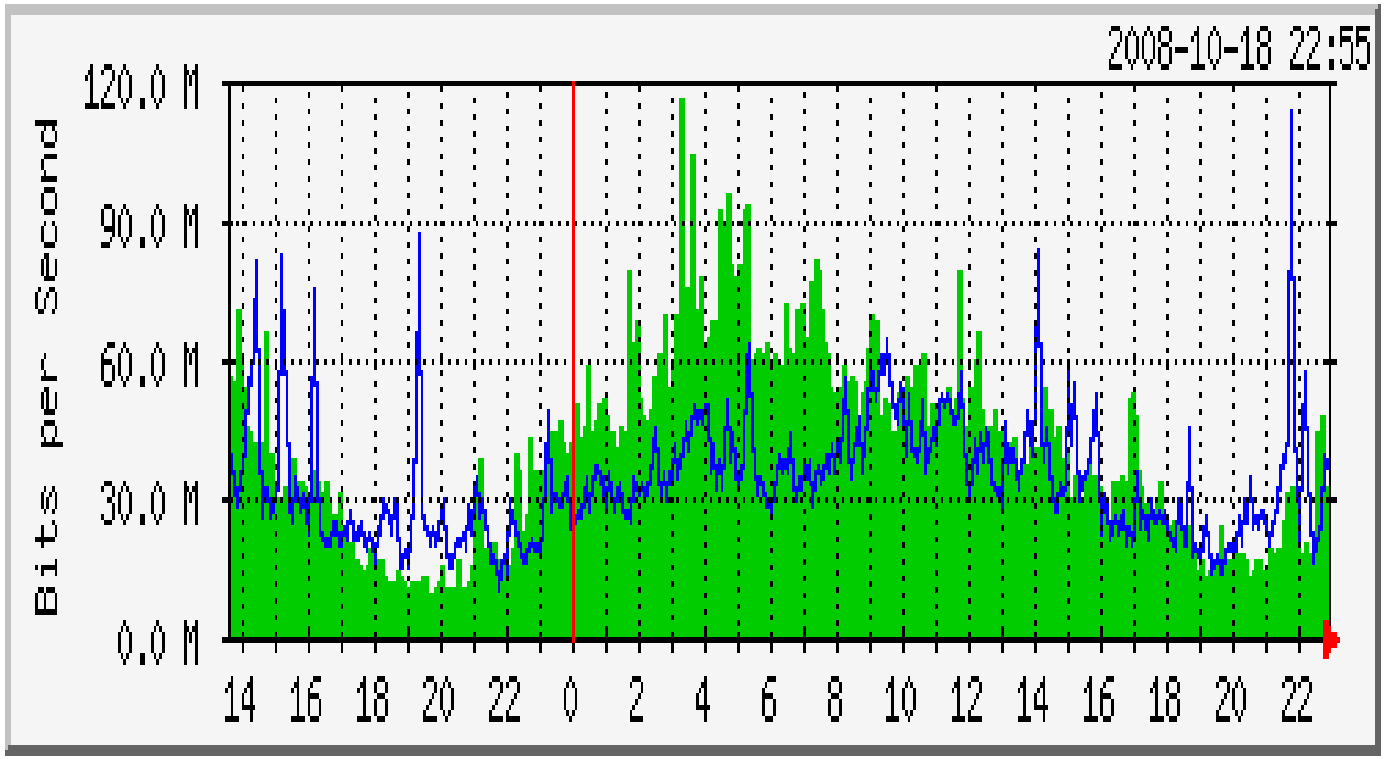
To satisfy human impatience

Human impatience has no limit:

Therefore there is no limit to bandwidth that might not be demanded eventually (and sold profitably).


Utilization of a T1 link to the Internet
Sunday
Monday
percentage utilization
0
20
40
60
80
100
24
6
12
18
24
6
12
18
24
time in hours

“Waste what is plentiful”



Predictions of future network:

- dumb pipes
- overprovisioned

  "Waste that which is plentiful"

  George Gilder
- dominated by cascades of computer-to-computer interactions, driven by human impatience
- horizontal layering, structural separation
- market segmented by size of (dumb) pipe

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

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