Crisis and Mythology in the Telecom World

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Current state:

- Vigorous traffic growth
- Service revenues pretty healthy
- Supplier sector crashed, slow recovery
- Voice is still where the money is

Projections/speculations:

- Continuing strong traffic growth
- Resumption of service revenue growth
- Faster growth on supplier side
- Restructuring of the industry
- Long haul to stay small
- More to be done with voice
- Simplicity wins!

Telecom industry restructuring and myths that are in the way:

- Main problems:
  - short term: coping with massive overinvestment of the bubble years
  - medium term: restructuring of the industry
- Myths impeding correct action:
  - content is king
  - telecom industry can create innovative new services
  - voice is passe
  - streaming real-time multimedia traffic to dominate
  - QoS is needed

Broadband vs. narrowband: How are people voting with their pocketbooks?

U.S. data for December, 2001

broadband lines	**12.8M**
cell phones	**128.4M**

Narrowband mobility beat stationary broadband 10:1, even though prices were comparable

Deployment is not the big issue. Adoption rates matter far more

Adoption rates suggest broadband beats cell telephony in attractiveness:

U.S. Broadband Lines		U.S. Cell Phones	
Dec 1999	2.8M	Dec 1989	3.5M
Dec 2000	7.1M	Dec 1990	5.3M
Dec 2001	12.8M	Dec 1991	7.6M
Dec 2002	19.9M	Dec 1992	11.0M
Dec 2003	27.0M (est)	Dec 1993	16.0M
		Dec 1994	24.1M

Thus broadband growth in three years equals that of cell phones in five years

→ **cannot ignore technology adoption rates**

Internet time is a dangerous myth

US Telecom Revenues

Year	Revenue (billions)	Increase (percent)
1995	$190	
1996	$212	11.6
1997	$231	9.0
1998	$246	6.5
1999	$269	9.3
2000	$293	8.9
2001	$302	3.0
2002	$294	-2.7

Last 150 years: Growth 2 percent per year faster than GDP

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 for various services

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

One picture is worth a thousand words

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

Harold Stark, 1970

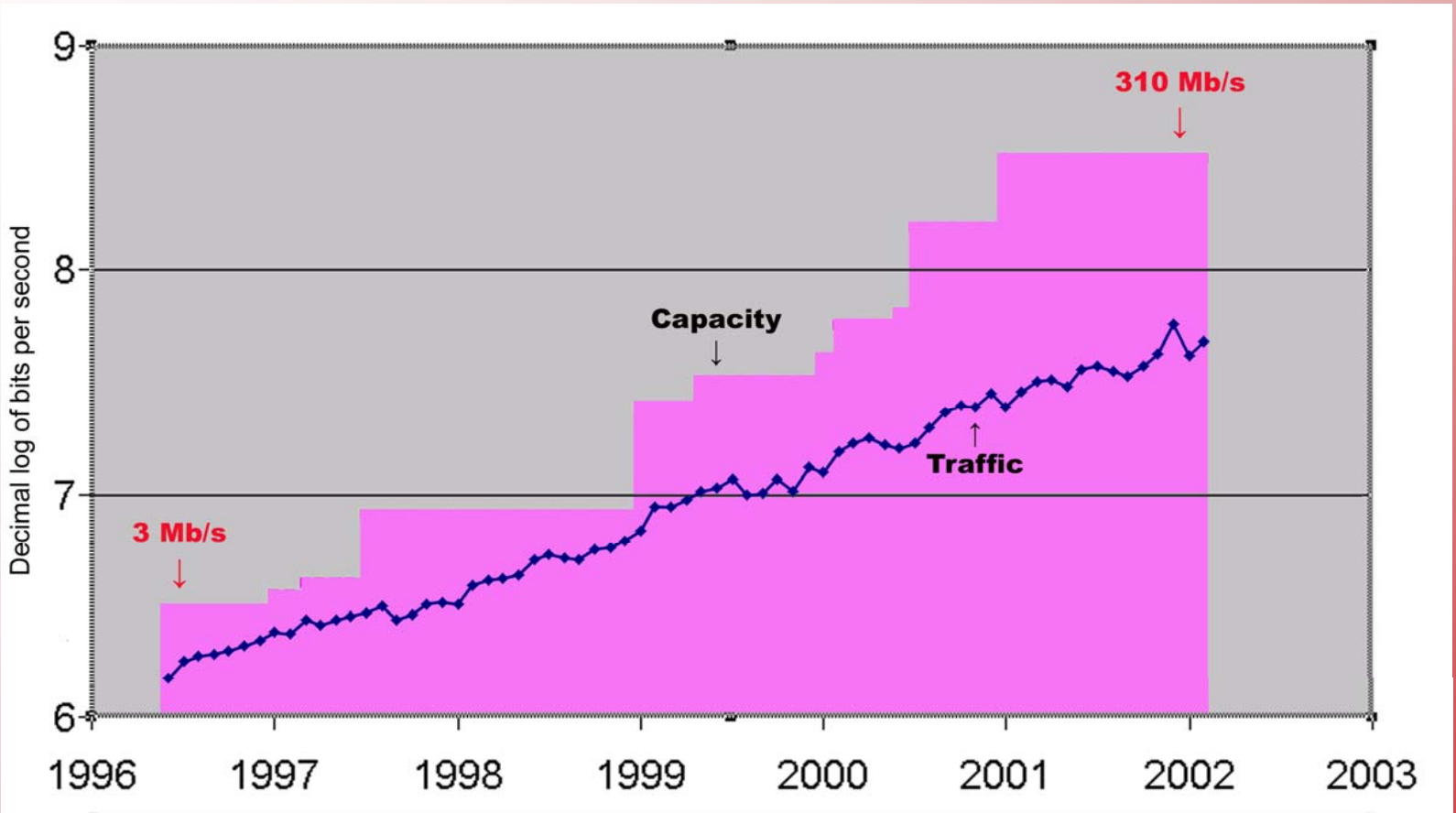
There are still unexploited opportunities in voice, especially in 3G (with differentiated voice quality levels, etc.). The success of Nextel's push-to-talk should not have been a surprise (nor SMS).

"Moore's Law" for data traffic:

Usual pattern of large, well-connected institutions: approximate doubling of traffic each year

Note: Some large institutions report growth rates of 30-40% per year, the historical pre-Internet data traffic growth rate

SWITCH traffic and capacity across the Atlantic



Internet growth hype:

"… bandwidth … will be chronically scarce. Capacity actually creates demand in this business…bandwidth-centric names are good values at any price since nobody can predict the true demand caused by growth."

-- Jack Grubman, April 1988

"Over the past five years, Internet usage has doubled every three months."

-- Kevin Boyne-UUNET COO, Sept. 2000

"If you are not scared, you do not understand"

-- Mike O'Dell -UUNET Chief Scientist, May 2000

Never any "insatiable demand" for communications

British "Penny Post" reform of 1840

Year	*Millions Letters*	*Revenue (Millions £)*	*Profit (Millions £)*
1839	75.9	2.4	1.6
1840	168.8	1.4	0.5
1841	195.5	1.5	0.6
1842	208.4	1.6	0.6
1843	220.5	1.6	0.6
1844	242.1	1.7	0.7

1851	360.6	2.4	1.1

Importance of pricing:

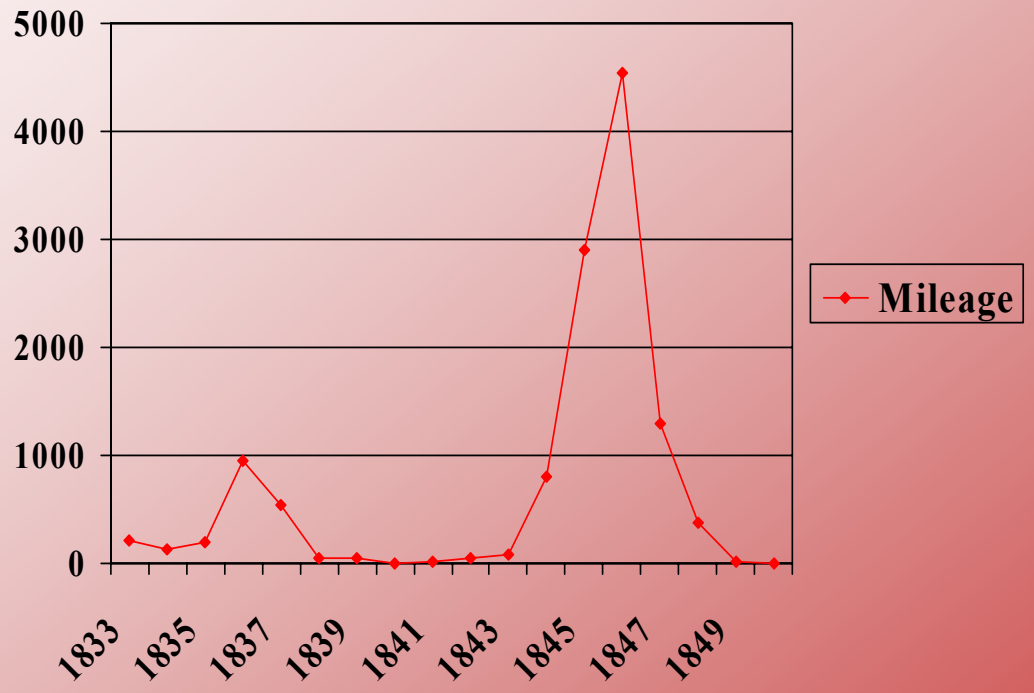
After decades of stagnation, postal traffic started to grow vigorously once low and simple distance-insensitive rates were introduced in 1840

Long history of techno bubbles and associated promoters

Between 1837 and 1845 inclusive, there were gentlemen who rode in their carriages and kept fine establishments, who were called ‘traffic takers’. He stumbled over one of these gentlemen in 1844, who was sent to take the traffic on a railway called the Manchester and Southampton. It did not go to Manchester and it did not go to Southampton; but it was certainly an intermediate link between these places. This gentleman went to a place in Wilts where there was a fair, and there took the number of sheep on the fair day, and assuming that there would be the same number all the days of the year, he doubled or trebled the amount for what he called ‘development’ and the result was that he calculated that by sheep alone the Manchester and Southampton line would pay 15 percent.

Long history of technology leading to overinvestment and crashes

Railways authorized by British Parliament (not necessarily built)



Power of new technology:

- In spite of the crash of late 1840s, traffic (freight-miles and passenger trips) as well as revenues all grew 10x between 1850 and 1900

- Railway mileage growth 1850-1900: 3x

Traffic on Internet backbones in U.S.

For each year, shows December estimated traffic in terabytes

Year	TB/month
1990	1.0
1991	2.0
1992	4.4
1993	8.3
1994	16.3
1995	?
1996	1,500
1997	2,500 - 4,000
1998	5,000 - 8,000
1999	10,000 - 16,000
2000	20,000 - 35,000
2001	40,000 - 70,000
2002	80,000 - 140,000
2003	140,000 – 250,000

Long-haul is not where the action is:

- 360networks 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**

Internet bandwidth vs. potential fiber capacity:

100,000 TB/month ≈ 300 Gbps

80–wavelength OC192 DWDM system → 800 Gbps/fiber

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

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

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**

Migration of Costs to Edges
→ *New Business Models*

- Customer-owned networks
- Outsourcing
- Analogies with multi-modal transportation model

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

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

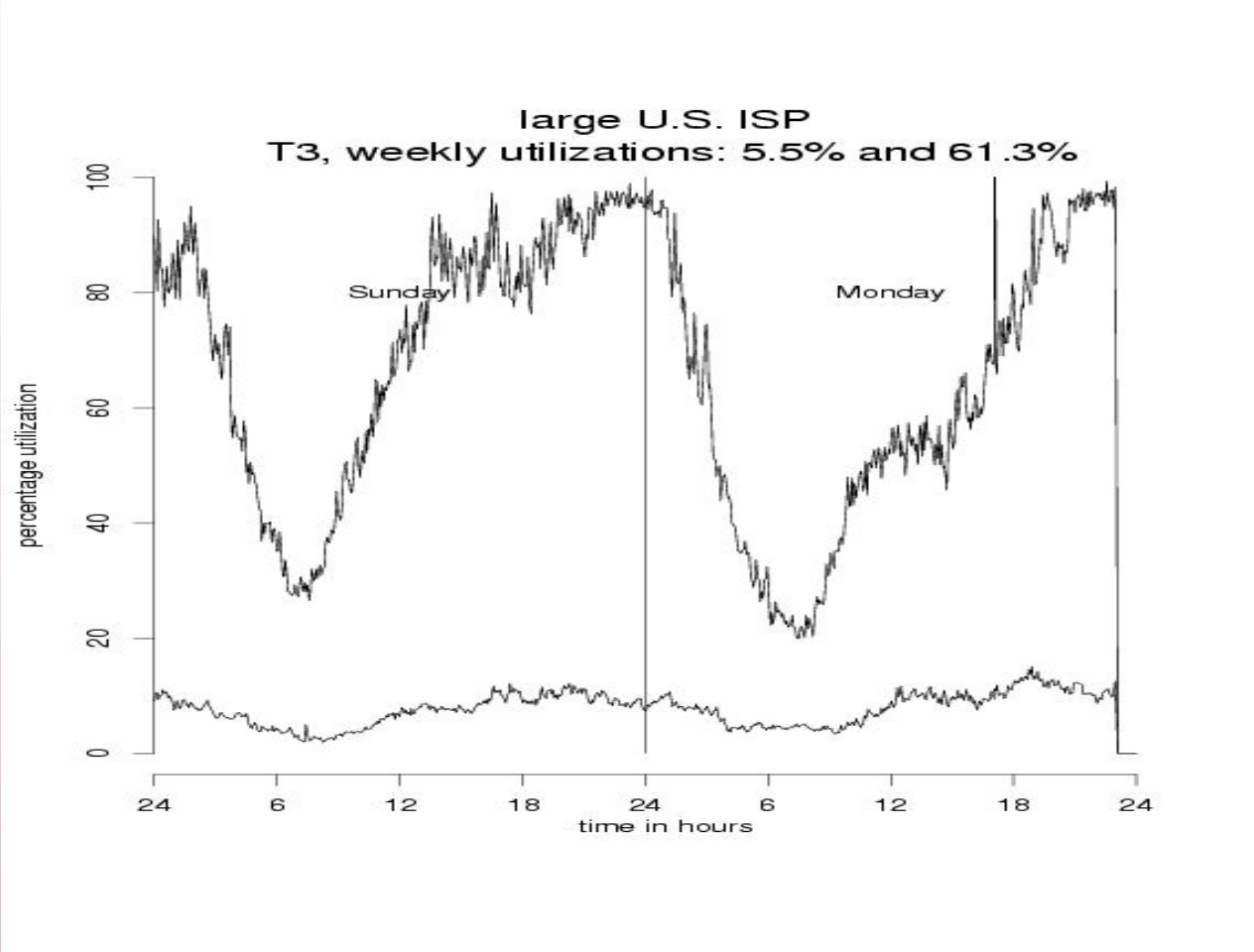
And (largely encompassing all of these): QoS

All technical successes, but failures in the marketplace

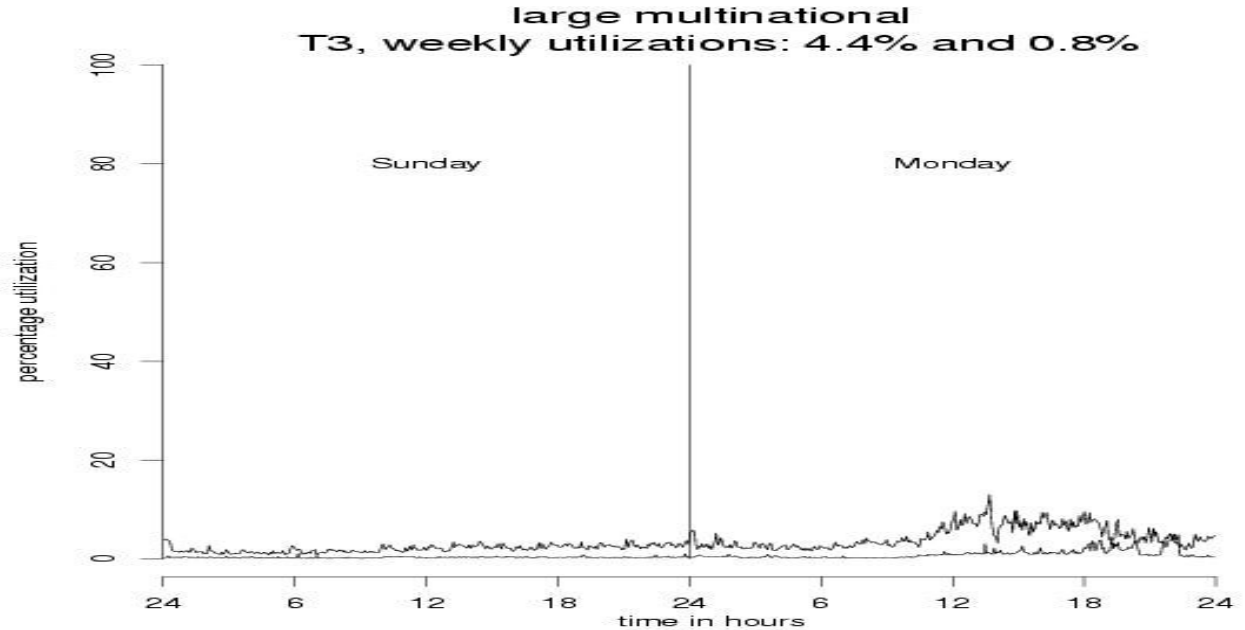
All recent "killer apps" created by users, not carriers

- email
- World Wide Web
- browser
- search engines
- Napster

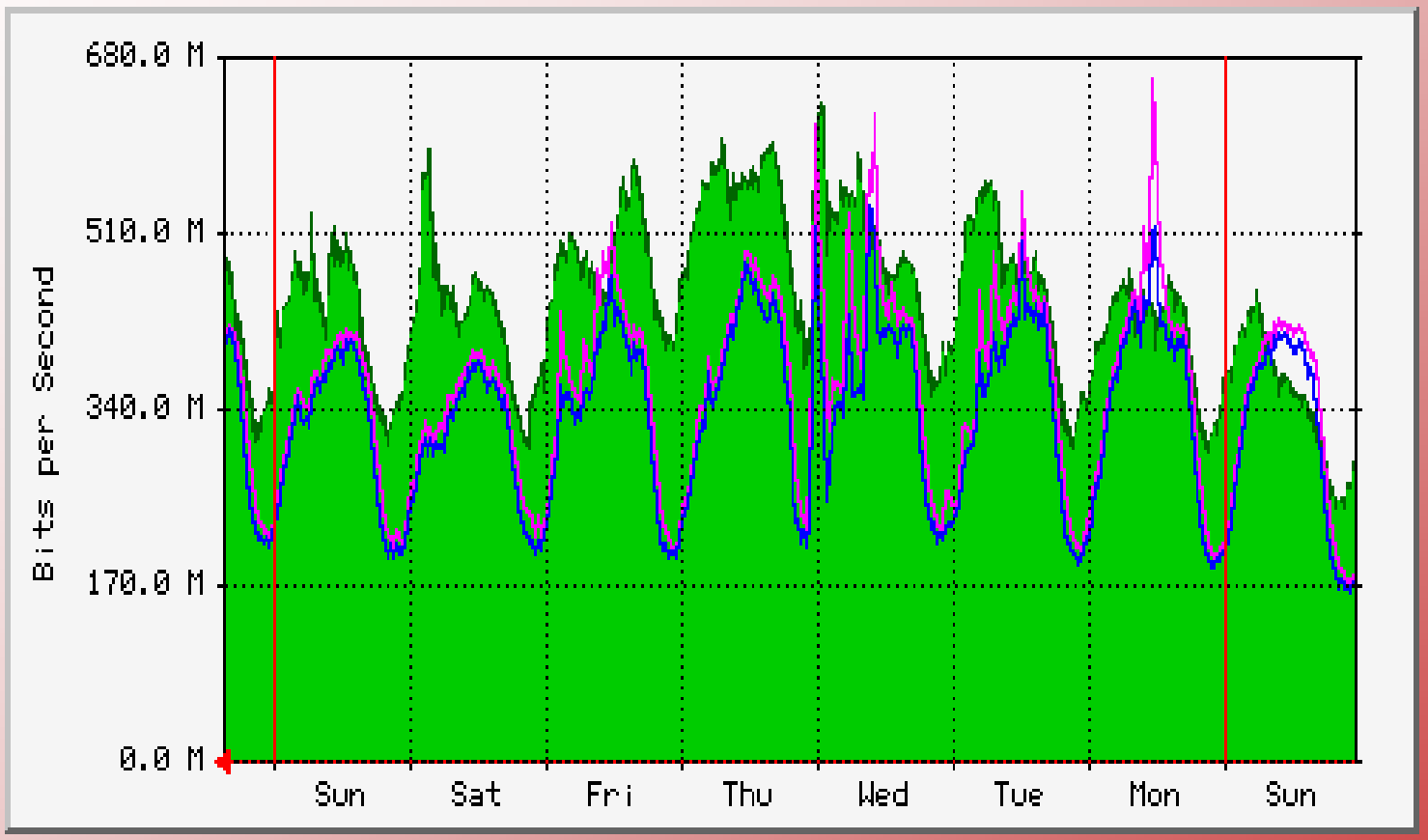
The dominant and seriously misleading view of data network utilization



Typical enterprise traffic profile: Demolishes myth of insatiable demand for bandwidth and many (implicit) assumptions about nature of traffic



Weekly traffic profile on an AboveNet OC192 link from Washington, DC to New York City:



Streaming multimedia vs. file transfers

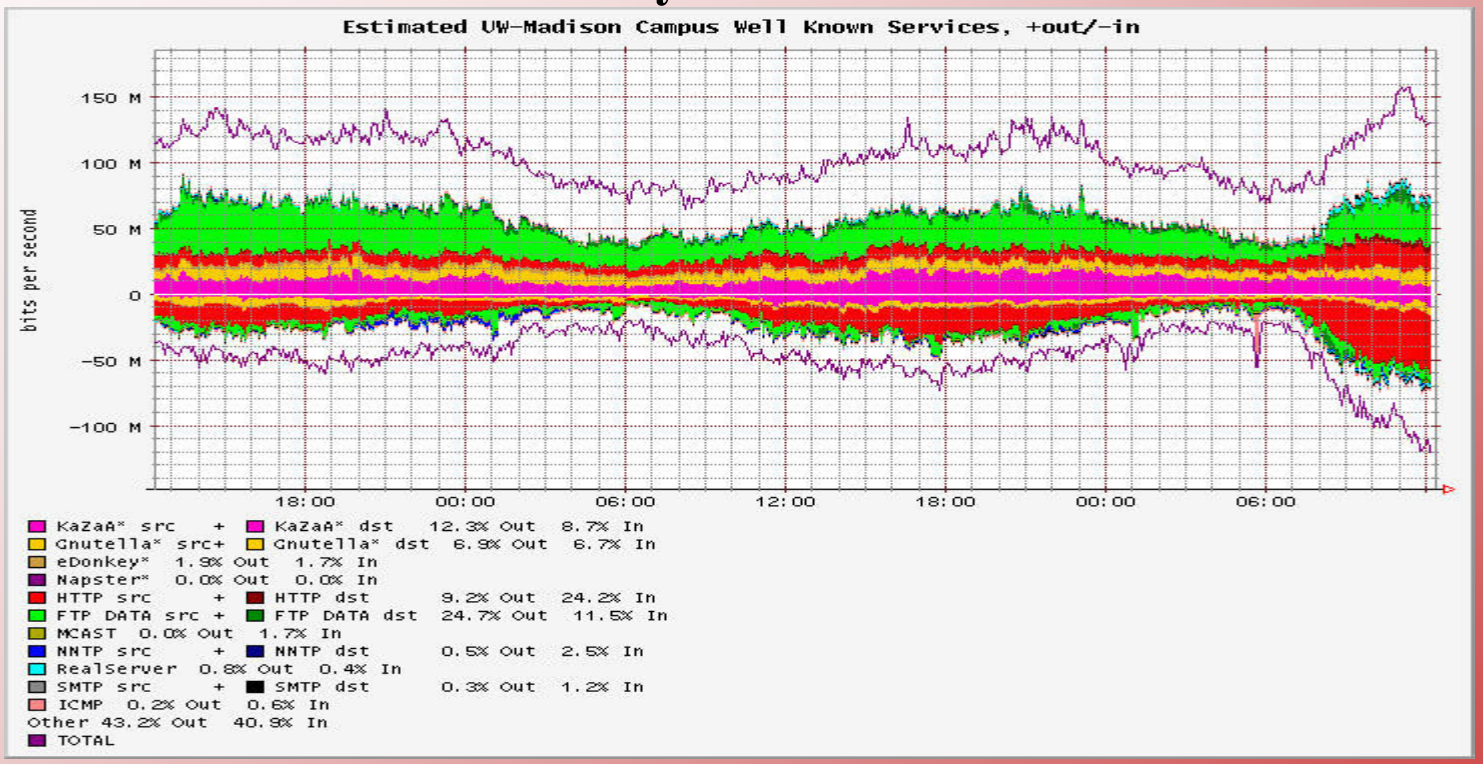
File transfer for local storage and transfer to other devices the most natural evolution (giving edge to Ethernet)

- **Predicted long ago**
- **Confirmed by Napster, . . .**
- **Want high bandwidth for faster-than-real-time**

We all have residential broadband (using conventional definition of broadband) courtesy of regular mail!

Multimedia File Transfers A Large Portion Of Current Traffic, Streaming Traffic In The Noise

Internet traffic at the University of Wisconsin in Madison



First mile turmoil:

- **Rising competition**

  ILECs vs. Cable

- **Potential spoiler:**

  Fixed wireless

  (Not burdened by $1,500 cost per household for wiring, may make FTTH irrelevant)

Conclusions

- Healthy traffic growth
- Gross overcapacity in some sectors
- Need for industry restructuring
- Healthy future for telecom in the long run
- Considerable turmoil for rest of decade
- Simplicity wins!

Additional data and speculations:

www.dtc.umn.edu/~odlyzko

Especially in the papers:

"The many paradoxes of broadband"

"Internet traffic growth: Sources and implications"

"Pricing and architecture of the Internet"