Traffic Growth and Network Spending: What's Ahead?

Andrew Odlyzko

UNIVERSITY OF MINNESOTA

odlyzko@umn.edu

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

Growth and Spending:

- **Internet traffic continues to about double each year (growth of 70-150% per year) as it has ever since 1997.**
- **Revenues: undermined by overcapacity**
- **Costs continue moving to the edges – backbone transport a commodity**
- **Budgets increasingly dominated by personnel costs**

Traffic on Internet backbones in U.S.

For each year, shows estimated traffic in terabytes during December of that year.

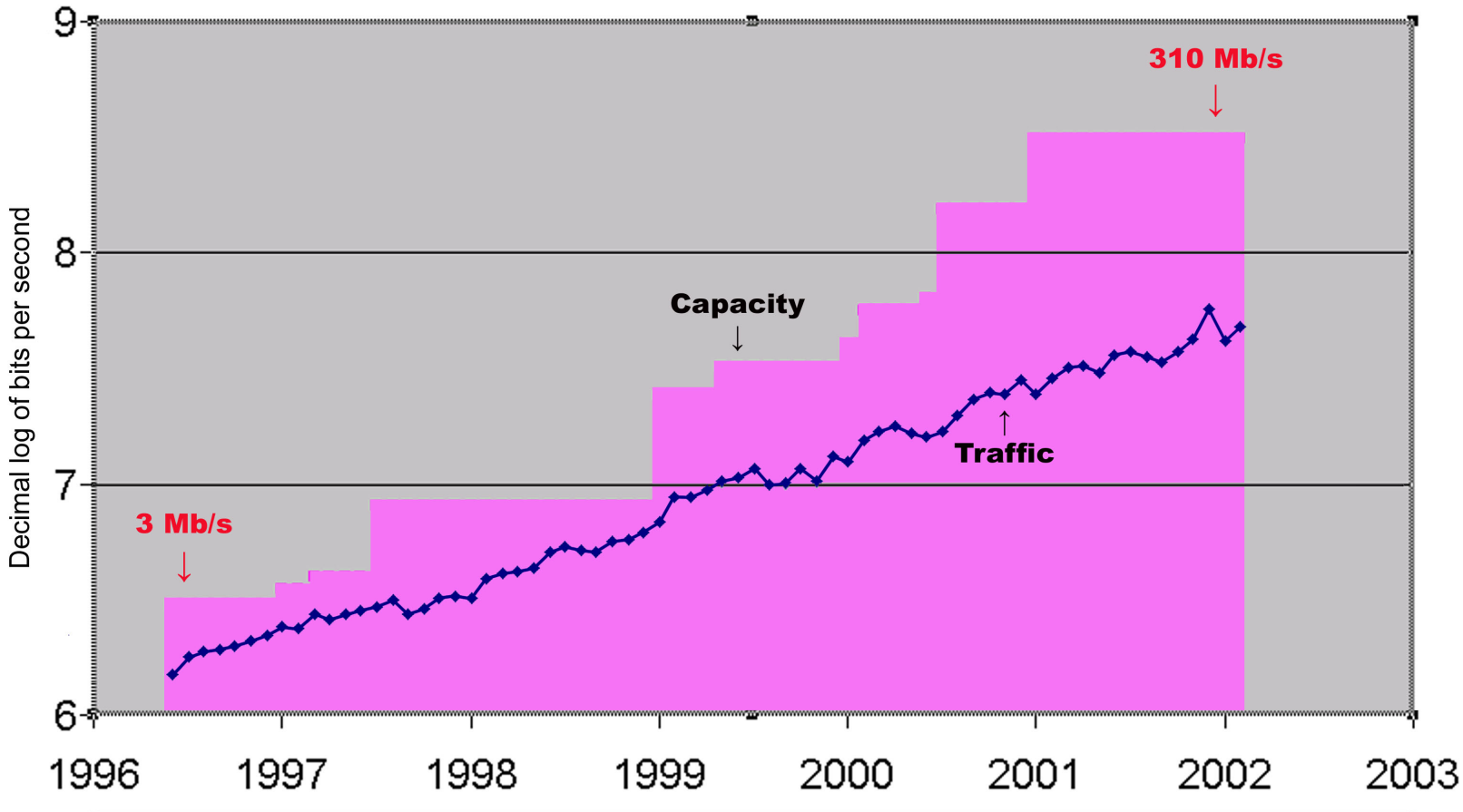
Year	TB/month
1990	1.0
1991	2.0
1992	4.4
1993	8.3
1994	16.3
1995	?
1996	1,500
1997	2,500 - 4,000
1998	5,000 - 8,000
1999	10,000 - 16,000
2000	20,000 - 35,000
2001	40,000 - 70,000

"Moore's Law" for data traffic:

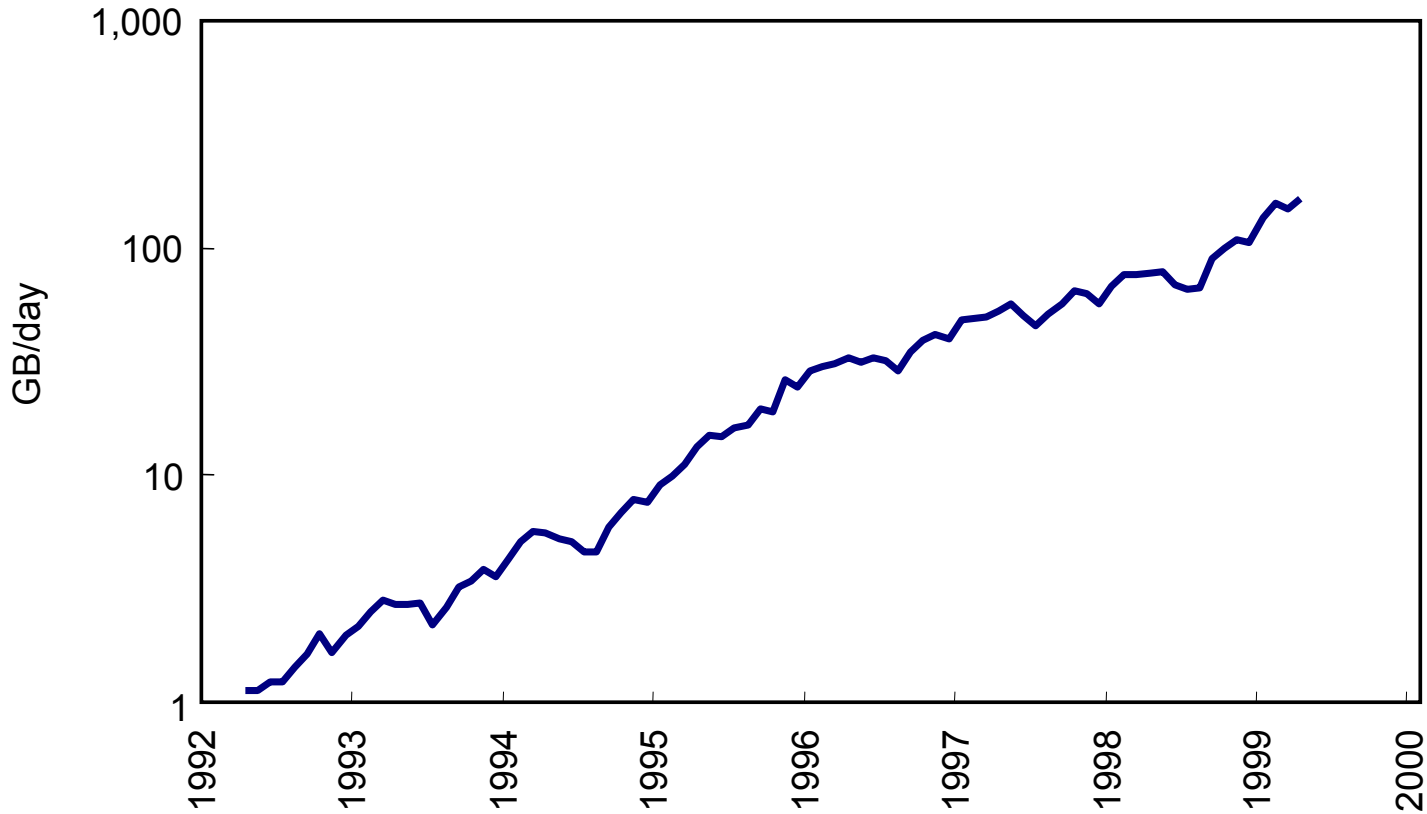
Usual pattern of large, well-connected institutions: approximate doubling of traffic each year

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

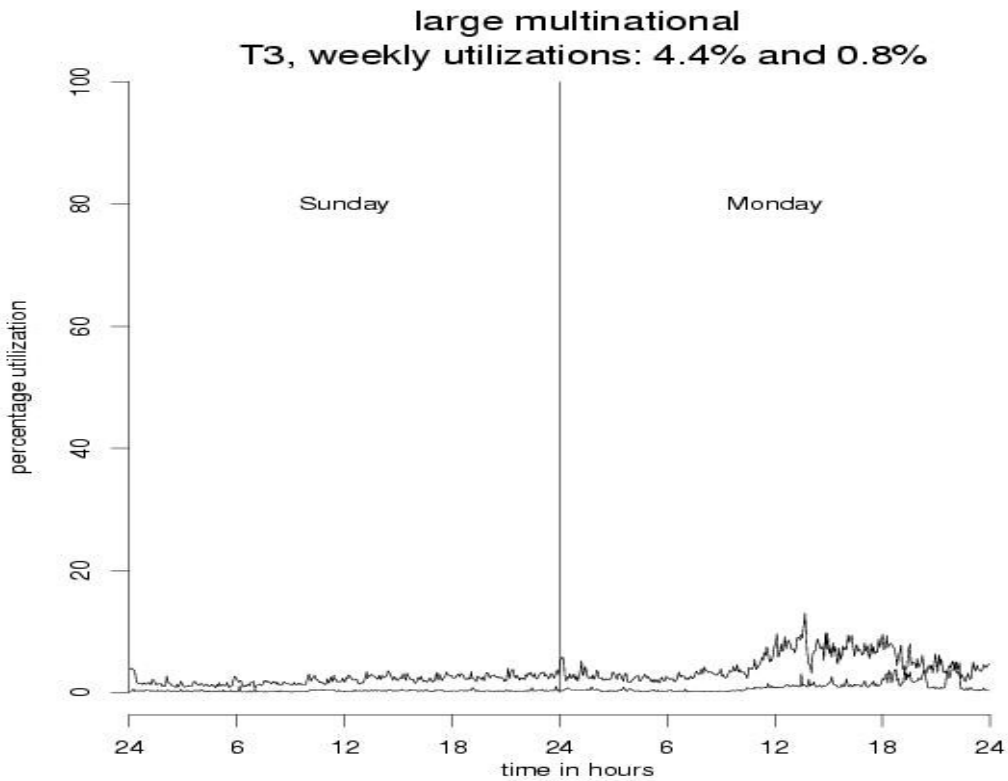
SWITCH traffic and capacity across the Atlantic



Traffic between the University of Minnesota and the Internet



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



Streaming multimedia vs. file transfers

File transfer for local storage and transfer to other devices the most natural evolution

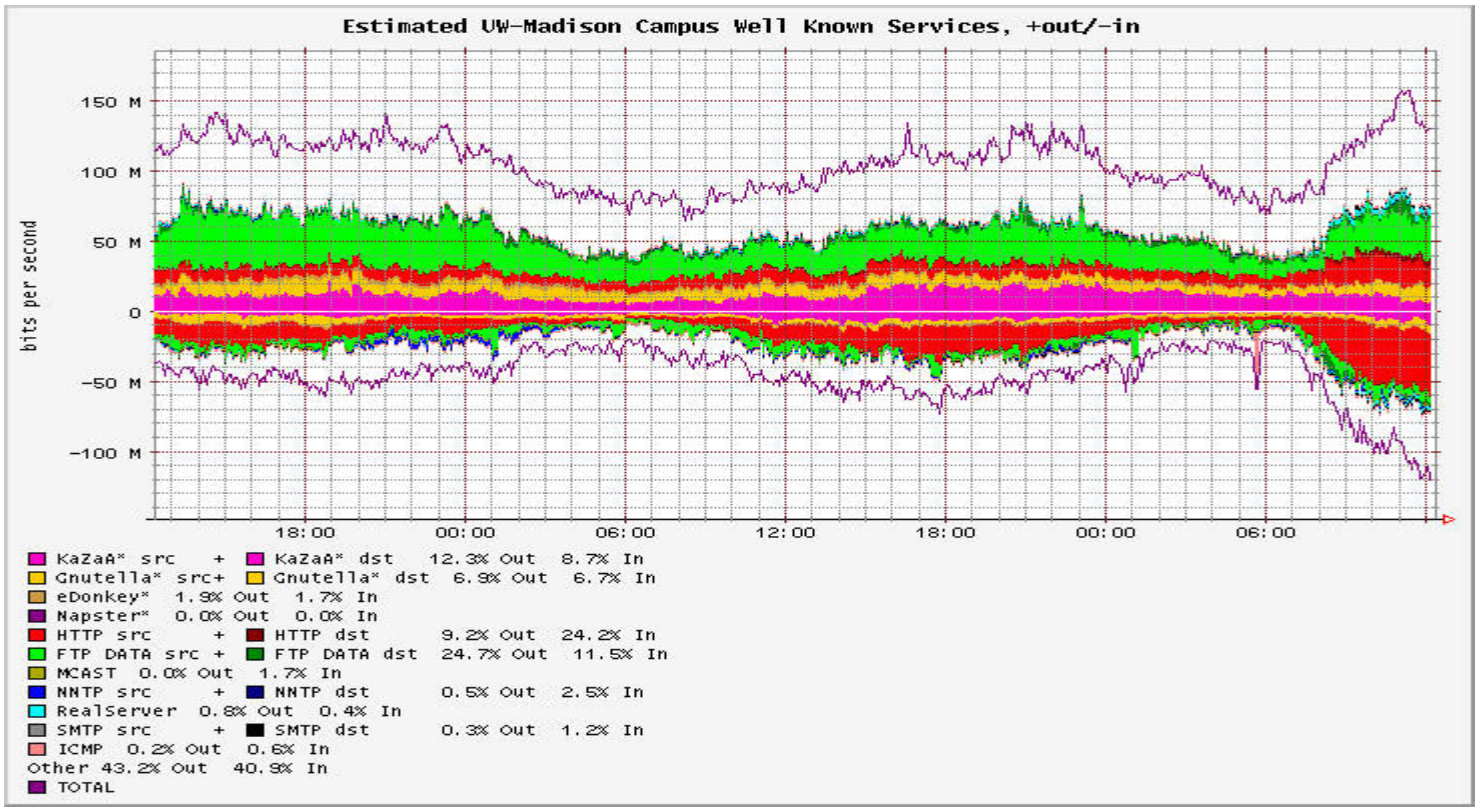
- **Predicted long ago**
- **Confirmed by Napster, . . .**
- **Want high bandwidth for faster-than-real-time**

We all have residential broadband (using conventional definition of broadband) courtesy of U.S. Postal Service!

Current Internet costs do not threaten Blockbuster

Multimedia file transfers a large portion of current traffic, streaming traffic in the noise

Internet traffic at the University of Wisconsin in Madison



Sources of traffic:

Current (October, 2002) traffic on U.S. backbones:
≈ 100,000 TB/month

<u>Very</u> generous upper bounds on residential traffic:

≤ 60 M dial subscribers at ≤ 100 MB/month:
≤ 6,000 TB/month
≤ 15 M broadband subscribers at ≤ 2,000 MB/month:
≤ 30,000 TB/month

Thus business use (including employee personal use) dominates

Distribution of Internet costs: almost all at edges

U.S. Internet connectivity market (excluding residential, web hosting, . . .) ≈ $15 billion/year

U.S. backbone traffic: ≈ 100,000 TB/month

Current transit costs (at OC3 bandwidth): ≈ $150/Mbps

Hence, if utilize purchased transit at 30% of capacity, cost for total U.S. backbone traffic: ≈$2 billion/year

Backbones are comparatively inexpensive and will stay that way!

Dominant source of innovation: Users

E-mail

WWW

Browser

Napster

The role of the Internet is to provide connectivity, not services!

The Internet succeeded by accident. Email, its "killer app," was not among the original design criteria:

The popularity of email was not foreseen by the ARPANET's planners. Roberts had not included electronic mail in the original blueprint for the network. In fact, in 1967 he had called the ability to send messages between users "not an important motivation for a network of scientific computers" . . . . Why then was the popularity of email such a surprise? One answer is that it represented a radical shift in the ARPANET's identity and purpose. The rationale for building the network had focused on providing access to computers rather than to people.

J. Abbate, *Inventing the Internet*

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

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

Conclusions:

The Internet is growing vigorously, but spending isn't

<u>Problem</u>: Overinvestment stimulated by business plans based on unrealistic expectations.

Need new business models based on providing services at the edges.

More data, analysis, and speculations at:

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