

Trends in Networking Research

Raj Jain

Raj Jain is now at
Washington University in Saint Louis
Jain@cse.wustl.edu
<http://www.cse.wustl.edu/~jain/>



- ❑ Technology Trends
- ❑ Impact on research
- ❑ Current Hot topics: A sample

Trends

- ❑ Communication is more critical than computing
 - Greeting cards contain more computing power than all computers before 1950.
 - Genesis's game has more processing than 1976 Cray supercomputer.
- ❑ Internet: 0.3 M hosts in Jan 91 to 9.5 M by Jan 96
⇒ More than 5 billion (world population) in 2003

Stone Age to Networking Age

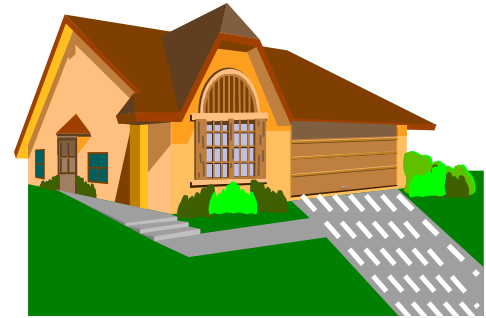
- ❑ Microwave ovens, stereo, VCRs, had some effect. But, Stone, iron, ..., automotive, electricity, telephone, jet plane, ..., networks caused a fundamental change in our life style
- ❑ In 1994, 9% of households with PC had Internet link. By 1997, 26%. Soon 98% ... like TV and telephone.
- ❑ URL is more important than a company's phone number. (54 URLs in first 20 pages of March '97 Good Housekeeping.)
- ❑ Email is faster than telegrams

Impact on R&D

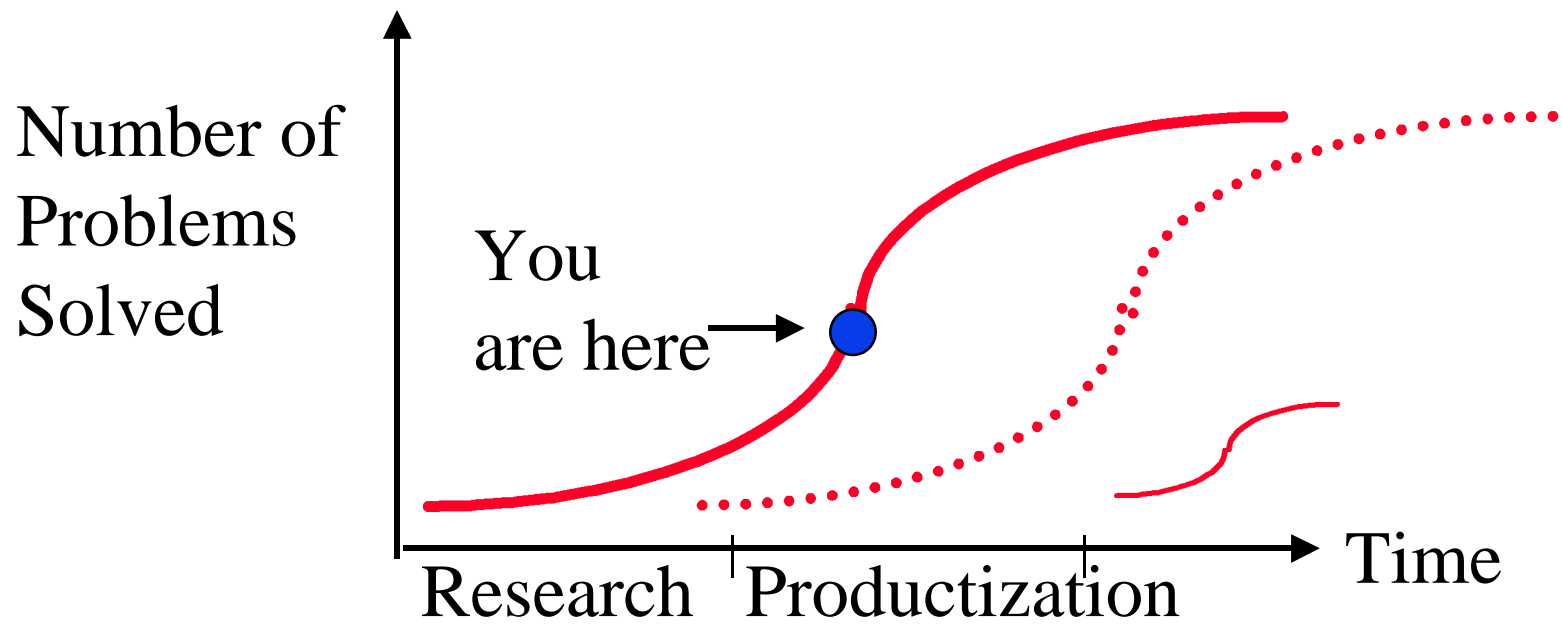
- ❑ Too much growth in one year
⇒ Can't plan too much into long term
- ❑ Long term = 1₂ year or 10₂ years at most
- ❑ Products have life span of 1 year, 1 month, ...
- ❑ Short product development cycles.
Chrysler reduced new car design time
from 6 years to 2.
- ❑ Distance between research and products has narrowed
⇒ Collaboration between researchers and developers
⇒ Academics need to participate in industry consortia

Garden Path to I-Way

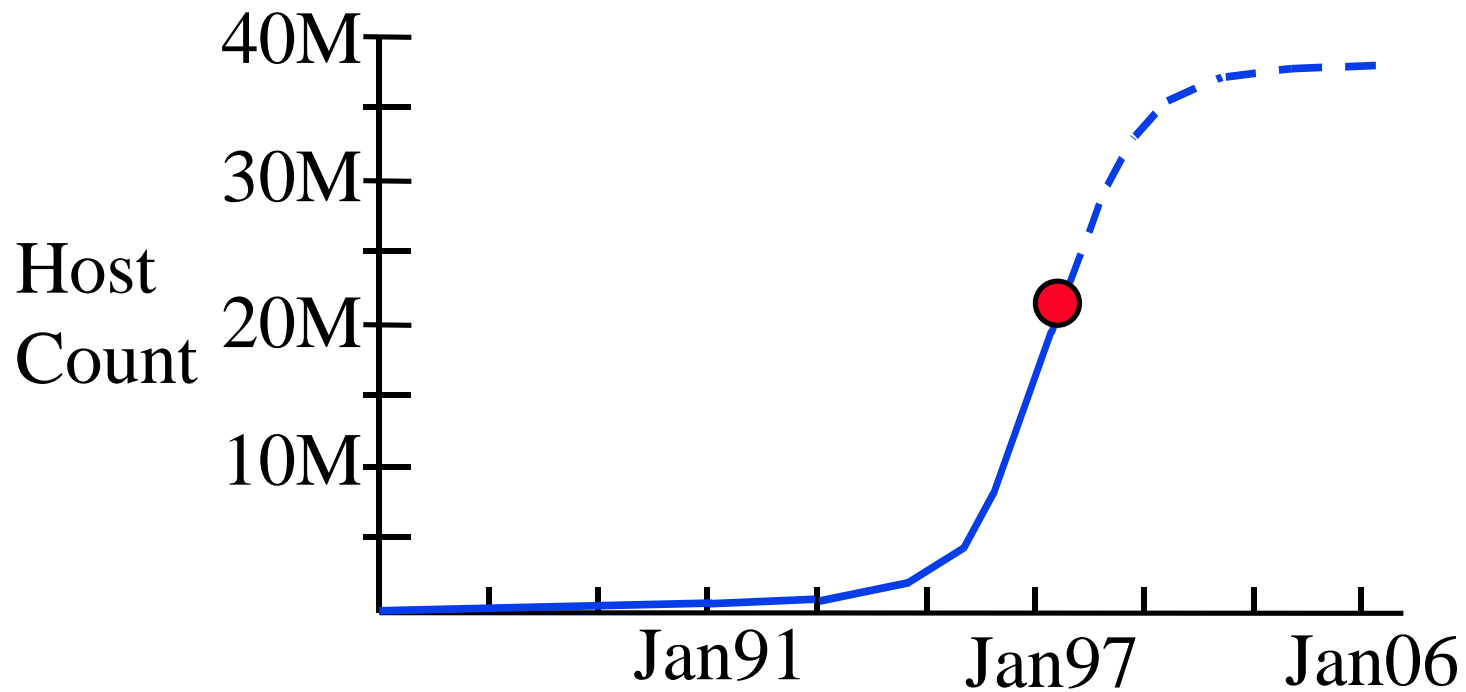
- ❑ Plain Old Telephone System (POTS)
= 64 kbps = 3 ft garden path
- ❑ ISDN = 128 kbps = 6 ft sidewalk
- ❑ T1 Links to Businesses = 1.544 Mbps
= 72 ft = 4 Lane roadway
- ❑ Cable Modem Service to Homes:
= 10 Mbps = 470 ft = 26 Lane Driveway
- ❑ OC3 = 155 Mbps = 1 Mile wide superhighway
- ❑ OC48 = 2.4 Gbps = 16 Mile wide superhighway



Life Cycles of Technologies



Internet Technology



New Challenges

- ❑ Networking is moving from specialists to masses \Rightarrow Usability (plug & play), security
- ❑ Exponential growth in number of users + Exponential growth in bandwidth per user \Rightarrow Traffic management,
- ❑ Standards based networking for reduced cost
 \Rightarrow Important to participate in standardization forums
ATM Forum, Frame Relay Forum, ...
Internet Engineering Task Force (IETF),
Institute of Electrical and Electronic Engineers (IEEE)
International Telecommunications Union (ITU), ...

Recent Trends

- ❑ Copper is still in.
6-27 Mbps on phone wire.
Fiber is being postponed.
- ❑ Shared LANs to Switched LANs
- ❑ Routing to Switching. Distinction is disappearing
- ❑ LANs and PBX's to Integrated LANs
- ❑ Bandwidth requirements are doubling every 4 months

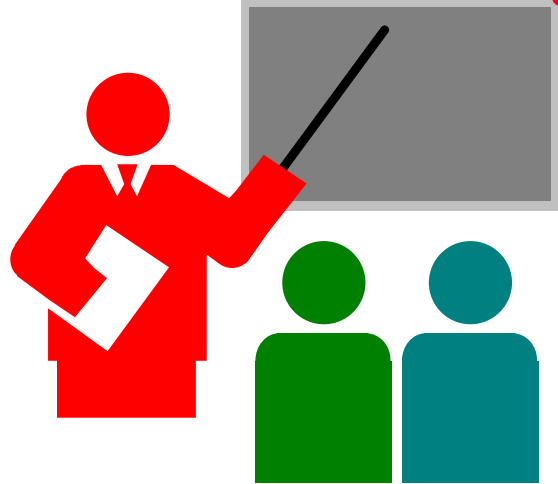
Hot Topics: A Sample

- ❑ Terabit networking: Wavelength division multiplexing, all-optical switching
- ❑ High-speed access from home
 - ⇒ Robust and high-bandwidth encoding techniques
- ❑ High-speed Wireless = More than 10 bit/Hz
28.8 kbps on 30 kHz cellular ⇒ 1 bit/Hz
- ❑ Traffic management, quality of service, multicasting:
 - Ethernet LANs, IP networks, ATM Networks
- ❑ Mobility
- ❑ Large network management Issues.

Hot Topics (Cont)

- ❑ Information Glut \Rightarrow Intelligent agents for searching, digesting, summarizing information
- ❑ Scalable Voice/Video compression:
2400 bps to 1.5 Mbps video, 8 kbps voice
- ❑ Electronic commerce \Rightarrow Security, privacy, cybercash
- ❑ Active Networks \Rightarrow A "program" in place of addresses

Summary



- ❑ Networking is the key to productivity
- ❑ It is impacting all aspects of life \Rightarrow Networking Age
- ❑ Profusion of Information
- ❑ Collaboration between researchers and developers
- ❑ Usability, security, traffic management

References

- All our ATM Forum contributions and papers are available **on-line** at <http://www.cis.ohio-state.edu/~jain/>
Specially see “Recent Hot Papers”
and “References on Recent Advances in Networking”

References (Cont)

- ❑ "The Next 50 years," Special issue of Communications of the ACM, Feb 1997.
- ❑ T.E. Bell and M.J. Riezenman, "Technology 1997: Communications," IEEE Spectrum, Jan 1997, pp. 27-37.
- ❑ N. Negroponte, "Being Digital," Vintage Books, 1995.
- ❑ D. Tapscott, "The Digital Economy: Promise and Peril in the Age of Networked Intelligence," McGraw-Hill, 1995.