All I want you to tell me is what will be the networking technology in the year 1998.
Future

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Networking Trends
Impact of Networking
Current Research Topics
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
  \[\Rightarrow\] 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
Social Impact of Networking

- No need to get out for
  - Office
  - Shopping
  - Entertainment
  - Education

- Virtual Schools
- Virtual Cash
- Virtual Workplace
  (55 Million US workers will work remotely by 2000)
Cave Persons of 2050

The Ohio State University
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
Trends in Applications

- Little Voice
- AT&T: 125 to 130 M calls/day @ 5 min/call
  64 kbps/call \(\Rightarrow\) 28.8 Gbps = 1/1000 of one fiber
- 200 Million X 24 hr/day X 64 kbps = 12.8 Tbps

Percent of Voice on Private Nets

Life Cycles of Technologies

Number of Problems Solved

You are here

Research | Productization | Time
New Challenges: Exponential growth in number of users. Exponential growth in bandwidth per user. Traffic management, Security, Usability, ...
High Technology ≠ More vacation
Impact on R&D

- Too much growth in one year
  ⇒ Can't plan too much into long term
- Long term = 1\frac{1}{2} year or 10\frac{1}{2} 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
Impact on Education

- Technology is changing faster than our ability to learn
  - Your value (salary) decreases with experience (years out of college)
- Recent graduates know C++, HTML, Java, …
- A handheld device will have storage enough to carry a small library
- Computers have bigger memory than humans
  - Knowing where to find the information is more important than the information
- Human memory is pointer cache
New Challenges

- Networking is moving from specialists to masses ⇒ Usability (plug & play), security
- Exponential growth in number of users + Exponential growth in bandwidth per user ⇒ Traffic management
- Standards based networking for reduced cost ⇒ 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), …
Networking is the key to productivity
It is impacting all aspects of life ⇒ Networking Age
Profusion of Information
Collaboration between researchers and developers
Usability, security, traffic management
Key References

- See http://www.cis.ohio-state.edu/~jain/ref_trnd.htm
- T. Lewis, "The Next 10,000 years," IEEE Computer, April/May 1996