My IBM Days

• Technical accomplishments in:
  – Power system modeling and control
  – Digital relaying / event location
  – Process control (Au “pot-line”)
  – Geo-data Analysis and Display System
  – Spatial operators in SQL
  – Decision Support Systems
  – Advanced Image Processing System (Hacienda / IBM 7350)
  – Prototype personal workstation / graphics display
  – Raster printing
  – “View and Shop”
  – Arithmetic coding
  – Image and record management / visual info ->”Content Manger”

• Others: hiring, managing lots of great people
Environment: 1970’s – 1980’s

- Storage Displays
- Raster Graphics
- Minicomputers
- Ethernet / Internet
- Geometry Engine
- VLSI
- microprocessors
- Memory price decline
Challenges in those “Old Days”

- Slow processors
- Multipliers slow and expensive
- Computer memory very expensive
- Storage = tape
- Very limited network bandwidth
- A to D converters (ADC) < ksp
The Computer Industry: A Look Back

IBM's First Commercial Computer
1955

Robert Noyce, Jack Kilby invent IC
1958-59

First DRAM
1970

Intel Founded
1968

Microsoft Founded, MITS Altair, First PC
1975

IBM PC
1981

Intel 486™ Processor
1989

Personal Conferencing
1994

Intel Pentium® processor with MMX™ technology
1997

Intel Pentium® II Processor
1995

Intel Pentium® Pro Processor
1992

EO Personal Communicator

Fairchild Semiconductor Founded
1957

DEC Minicomputer
1963

First Microprocessor First EPROM
1971

First Apple II PC
1977

Intel 386™ Processor
1985

Other brands and names are the property of their respective owners.
Technology Trends

<table>
<thead>
<tr>
<th>Year</th>
<th>CPU (mips)</th>
<th>LAN (Mbps)</th>
<th>Disk (PC -- MB)</th>
<th>Disk capacity increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>0.1</td>
<td>3</td>
<td>10</td>
<td>5000 : 1 for less $</td>
</tr>
<tr>
<td>1985</td>
<td>2</td>
<td>10</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>10</td>
<td>100</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td>300</td>
<td>1000</td>
<td>50000</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>1000</td>
<td>10000</td>
<td>500000</td>
<td></td>
</tr>
</tbody>
</table>

Disk (PC -- MB) 10 50 1000 50000

*Disk capacity increase 5000 : 1 for less $*

(40GBytes $89 at Fry’s 8/04/01)

(now get 250Gbytes for this price …)
Memory Price

(1 MByte)


$1M  $100K $50K $10K $2K $10 14c

7,140,000 : 1
over 30 years

128 MByte DiMM for $28
(Fry’s August 8/04/01)

today 2 GBytes for $150 or less
1960’s *Exciting* Applications

- Digital Control / Instrumentation
  - Audio and sub-audio
- Military (SAGE Air Defense)
- X-Y Digital Plotters (Bresenham)
- CAD for Automobile Design, Aerospace
  - IBM 2250 for GM
  - Sketchpad (Sutherland, MIT)
- Medical Applications (CAT, NMR)
- NASA Remote Sensing (ATS, GOES)
- Computer Games (e.g. Space War – MIT)
Technology: 1970’s – 1980’s

- Storage Displays
- Raster Graphics
- Minicomputers
- Ethernet / Internet
- Geometry Engine
- VLSI
1970’s – 1980’s

- Command and Control Systems
- Geographic Information Systems
- Decision Support Systems
- Computer Workstations
- Personal Computers
- Relational Database
Today

• Plenty of
  – Processor capacity
  – Memory
  – Disk storage
  – LAN bandwidth
• Scanners / digital cameras are inexpensive
• Dense packaging / portable devices
• Many more computer applications are economically feasible
CITRIS

• [http://www.citris-uc.org/about/mission](http://www.citris-uc.org/about/mission)

• (See this web site for current CITRIS information – following slides are a from the early proposal days – 2001)
CITRIS
The Center for Information Technology Research
In the Interest of Society

Core Technologies
- Distributed Info Systems
- Micro sensors and actuators
- Human-Computer Interaction
- Prototype Deployment

Foundations
- Security, Policy
- Probabilistic Systems
- Formal Techniques
- Data management
- Simulation

Applications
- Quality-of-Life Emphasis
- Initially Leverage Existing Expertise on campuses
Wireless Measurement, Diagnosis, and Cure

www.exploratorium.edu
The Best Technology for The World’s Biggest Challenges

• Education
• Emergency Response
• Land and Environment
Microair Vehicles and Smart Dust: Connecting Civil and Environmental Infrastructure
Dimensions of Multimedia

• Content Management / Storage
  – Database of text, image, audio, video, etc.
• Retrieval
• Image Query
• Display(s)
  – Multi/tiled
  – Large
  – Dynamics / sources / compatibilities
• Printing
• Networking
Telepresence - “Killer App” ??

Cisco Systems

Hewlett Packard (“Halo”)
• http://www.hp.com/halo/index.html

Microsoft (“ConferenceXP”)
• http://research.microsoft.com/conferencexp/
Test connection speed using: http://nitro.ucsc.edu/

UC Santa Cruz Web100 based Network Diagnostic Tool (NDT)
Located at Santa Cruz - CA; 1000 Mbps (Gigabit Ethernet) network connection

This java applet was developed to test the reliability and operational status of your desktop computer and network connection. It does this by sending data between your computer and this remote NDT server.

These tests will determine:
- The slowest link in the end-to-end path (Dial-up modem to 10 Gbps Ethernet/OC-192)
- The Ethernet duplex setting (full or half);
- If congestion is limiting end-to-end throughput.

It can also identify 2 serious error conditions:
- Duplex Mismatch
- Excessive packet loss due to faulty cables.

• Systems behind firewalls must permit TCP ports 3001, 3002, and 3003.
My DSL Performance from Home (Santa Cruz Mountains via Verizon)

TCP\Web100 Network Diagnostic Tool v5.4.12
click START to begin
Connected to: nitro.ucsc.edu -- Using IPv4 address
Checking for Middleboxes ................. Done
checking for firewalls .................... Done
running 10s outbound test (client-to-server [C2S]) ...... 733.0kb/s
running 10s inbound test (server-to-client [S2C]) ...... 2.88Mb/s
Your PC is connected to a Cable/DSL modem
TV

- NTSC (US “standard”) TV (4:3)
  - 30 frames/sec,
  - Analog uses ~ 6MHz bandwidth (includes 1MHz guard band)
  - ~525 lines (of ~ 720 pixels each)
  - Digitized (use 8 bits each for red, green, blue)
    - \(525 \times 720 \times 24 \times 30 = \sim \ 272,000,000 \ \text{bits/sec}\)
      - \(= 272 \ \text{Mbps} = 272,000,000 \ / 8 = 34 \ \text{Mbytes/sec}\)
  - MPEG compression (lossy) \sim 1-2 \ \text{Mbits/sec}
HDTV

- 16:9
- 1080p
  - 1080 lines of 1920 pixels
  - 30 frames/sec
  - Uncompressed is ~ 1,500,000,000 bps
    Or ~ 200 MBps
MPEG-2 compresses ~ 55:1

Still need ~ 30 Mbps

Tutorial: [http://www.pbs.org/opb/crashcourse/tv_grows_up/](http://www.pbs.org/opb/crashcourse/tv_grows_up/)
Conventional Video Conferencing

• H.263 etc.
  – 750Kbps to 2 Mbps (e.g. Polycom)

**Polycom® ViewStation® FX**

*Performance video communications for any conference or board room*

**Benefits**

- **Superior video quality** – Premium video from low bandwidth to high with support for standards-based H.264 and ITU 60 fields
- **Extensive viewing options** – Simultaneously supports up to four video monitors for near and multiple far side views plus a fifth XGA video output for high-resolution monitor or data projector
- **Maximum calling capability** – Embedded MP/PP connections to four video sites (IP, ISDN)

**ViewStation FX** is the highest performance, set-top video conferencing system in the Polycom ViewStation product line.

With integrated MP/PP, multipoint functionality. The ViewStation FX is available with the flexible...
Networks and Video

• Performance
  – Bandwidth
  – Low “jitter”
  – Minimal delay (for interactive videoconference / telepresence)

• Router / Network “Quality of Service”
Other Multimedia Research

• Joining all communications into home
  – TV, web, DVD, etc.
  – Any-to-any (display)
  – Multiple displays
    • pPaper
    • “smart wallpaper”
Web Performance

• Working within bandwidth limitations:
  – Video on demand (prefetch of “stubs”)
  – Caching

• User “pull” or “push” (subscription) to web sources

• Distance learning
  – Audio, “whiteboard”, limited video
Distance Learning

• Use of ConferenceXP – expand to multiple sites (solve scaling problem for bandwidth and CPU load for codex function)

• Tiled display for large classroom
  – Semi-automated note taking
  – Presentation of student work
  – Collaborative learning

• Conversion of document camera capture from video to vector order list (“ink”)