

Data Storage in the Internet Era

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Outline

- ★ *Internet Trends and Their Relationship to Data Storage Strategies*
 - ☞ *Server Storage*
 - ☞ *Client Storage*
 - ☞ *"Network Computers"*
- ★ *The Emergence of DVD*
 - ☞ *Impact on other disk and tape storage*
 - ☞ *What is it?*
 - ☞ *Some things other people don't tell you*

Data Storage on the Internet

- * Information is the reason the Internet exists*
- * The World Wide Web is like a massive disk drive*

Growth of the Internet

- * In 1969, 4 computers on the ARPAnet.*
- * In 1983, 200 computers on the Internet*
- * Today:*
 - ☞ Over 50 Million users*
 - ☞ Approximately 1 Terabyte per day is transmitted over the Internet*

Growth of the Internet

- *Fact:*

“Approximately 100% of Internet statistics are wrong.”

Trends and Predictions

- *Information is doubling electronically every year*
- *500 million people on the Internet by the year 2000*
- *Fiber and cable could amplify traffic by 100x*
- *Electronic commerce will become an even greater driver than it is today*

Storage Requirements

** Image and Multimedia have ravenous appetites for*

☞ Storage

☞ Network Bandwidth

☞ Processing Power

New Threshold

- ★ *Transition
from Ethernet Client/Server
to “Worldwide” Client/Server*
- ★ *Proximity is irrelevant*

Web Client/Server versus Traditional Client/Server

Application Characteristic	Ethernet Era Client/Server	Worldwide Client/Server
# clients per application	Less than 100	Millions
# servers per application	1 or 2	100,000+
Geography	Campus-based	Global
Server-to-server interactions	No	Yes

■ *Source: The Essential Client/Server Survival Guide*

Web Client/Server versus Traditional Client/Server (cont.)

Application Characteristic	Ethernet Era Client/Server	Worldwide Client/Server
Middleware	SQL and stored procedures	ORBs on top of Internet
Transactional updates	Very Infrequent	Pervasive
Multimedia content	Low	High
Time frames	1985 to present	Present to 2000+

How Much Bandwidth is Needed?

Content	Bandwidth Requirements	Remarks
Data requirements	2 Mbits/second	For LAN-speed responsiveness
Audio: - CD Quality	706 Kbits/sec	44,100 samples/sec, 16-bit/sample
-Digital Phone Quality	64 Kbits/sec	8000 samples/sec, 8-bit samples
Minimum quality, full motion video	566 Kbits/sec	1024 X 768 pixels, 30 frames/sec, 3 colors, 8 bits each
TV-quality, full motion video - Uncompressed	96 Mbits/sec	
- MPEG-2 compression	6 Mbits/sec	

LAN Transmission Technologies

LAN Type	Speed
Ethernet	10 Mbits /sec
Token Ring	4/16 Mbits/sec
Fast Ethernet	100 Mbits / sec
FDDI	100 Mbits / sec
ATM	25 Mbits/sec to 2.4 Gbits /sec

WAN Backbone: Physical Interconnect Technology

Line Type	Speed	Comments
T1 (or DS1)	1.54 Mbits / sec	North American standard
E1/E2/E3	2.04/8.4/34.4 Mbits/sec	European CCITT standard
T3 (or DS3)	44.73 Mbits / sec	North American standard
OC1 to OC48	51.8 Mbits/sec to 2.5 Gb/sec	Sonet fiber standard

WAN Backbone: The Packet Switching Alternatives

WAN Technology	Maximum Speed	Applications
Frame Relay	1-2 Mbits/sec (T1/E1)	Data
SMDS	45 Mbits/sec (T3)	Data
ATM	2.4 Gbits /sec	Data, Voice, and video

Home-to-WAN Connection

Connection Technology	Speed	When Available
V.32bis / V.34	14.4 / 28.8 Kbits/sec	Now
ISDN BRI / ISDN PRI	128 Kb/s / 1.54 Mb/sec	Now
T1	1.544 Mbits/sec	Now
HDSL	1.5 Mbits/sec	Late 1996
ADSL 3	6 Mb/s; 640 Kb/s (return)	1997
Cable Modem	10 Mbit/sec	1997
B-ISDN (ATM Sonet)	100 Mbit/sec (and up)	1999

Relationship of Bandwidth to Storage Requirements

- ★ *The “Client” connection is bottleneck*
- ★ *What is effect on:*
 - ☞ *Server and Client Storage requirements?*
 - ☞ *Software Distribution?*

However, what happens to Servers when the client bottleneck is solved?

Servers vs. Clients

FAT SERVERS

FAT CLIENTS

THIN CLIENTS

Internet Server Storage

- ★ *Servers must be scaleable and fault-resistant*
- ★ *Web Servers:*
 - ☞ *90/10 reads to writes*
 - ☞ *Relatively static data*
- ★ *E-mail Servers:*
 - ☞ *50/50 reads to writes*
 - ☞ *Dynamic data*

Critical Hardware Requirements for Servers

- * Keeps Running*
- * Grows Bigger and Fatter*
- * Thinner clients put more demand on servers*

Server Operating Systems

- ★ *Internet is a showcase of distributed UNIX technology*
- ★ *Rapid growth*
- ★ *Sun leads Internet server market with approximately 35%*

Client Storage

- ★ *Capacity of hard disks has risen as prices have fallen*
- ★ *Disk space is a concern if user is downloading lots of graphics or sound files*
- ★ *Bit Life / Shelf Life of data*
- ★ *Removable disk or tape storage is a partial answer*

Client Storage

- ★ *Many users do not want to “rent” space*
- ★ *Removable disk alternatives:*
 - ☞ *Zip*
 - ☞ *LS-120*
 - ☞ *JAZ*
 - ☞ *Syquest*
 - ☞ *PD*
 - ☞ *MO*
 - ☞ *DVD (in future)*

Another Answer: “Network Computers”

- ★ No local hard disk storage*
- ★ Software “Applets” are downloaded with the data*
- ★ User’s only storage would be on a distant server*
- ★ Again, increased demand on servers*

Demand for “Network Computers”?

When asked “If bandwidth were sufficiently wide that network access did not appear slower than accessing a hard drive, wouldn’t [customers] prefer a thinner, cheaper . . . client?”, Andy Grove (President and CEO of Intel) replied:

“If I could flap my hands strong enough and fly there would be no demand for airplanes.”

Red Herring Magazine, August 1996

What is DVD?

DVD-ROM:

4.7 GB (1 side, 1 layer)
up to 17 GB (2 sides,
2 layers per side)

DVD-R:

3.9 GB / side (proposed)

DVD-RAM:

2.6 GB / side (proposed)

DVD - When?

- ★ *DVD players available now*
- ★ *DVD-R - Late 1997 (?)*
- ★ *DVD-RAM: 1998 (?)*

DVD: Impact on other removable media

★ DVD-ROM

- ☞ Will eventually impact CD-ROM*
- ☞ Primarily for Software Distribution*

★ DVD-R

- ☞ Archival Storage*

★ DVD-RAM

- ☞ Slower than other removable discs*

DVD: Some things other people don't tell you

- ★ *CD-R discs not readable in many DVD-ROM players*
- ★ *DVD-R cannot be used for pre-mastering DVD-ROM*
- ★ *DVD-RAM disks will be housed in cartridges*
- ★ *DVD-RAM disks may not be readable in DVD-ROM drives*

CONCLUSIONS

- ★ *The Internet will have a significant impact on data storage*
- ★ *More networking means more storage*
- ★ *DVD impacts other forms of removable storage, but adoption may be slow*