

# *Data Storage in the Internet Era*

***David J. Kalstrom***

*DeLaLuz Technologies, Inc*

*740 Tabor Dr, Scotts Valley CA 95066*

*Phone: +1-408-461-1163; Fax: +1-408-481-1432*

*dkalstrom@aol.com*

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*Fairfax VA 22043*

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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*

<b>Application Characteristic</b>	<b>Ethernet Era Client/Server</b>	<b>Worldwide Client/Server</b>
# 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.)*

<b>Application Characteristic</b>	<b>Ethernet Era Client/Server</b>	<b>Worldwide Client/Server</b>
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?*

<b>Content</b>	<b>Bandwidth Requirements</b>	<b>Remarks</b>
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*

<b>LAN Type</b>	<b>Speed</b>
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*

<b>Line Type</b>	<b>Speed</b>	<b>Comments</b>
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*

<b>WAN Technology</b>	<b>Maximum Speed</b>	<b>Applications</b>
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*

<b>Connection Technology</b>	<b>Speed</b>	<b>When Available</b>
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*

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*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*