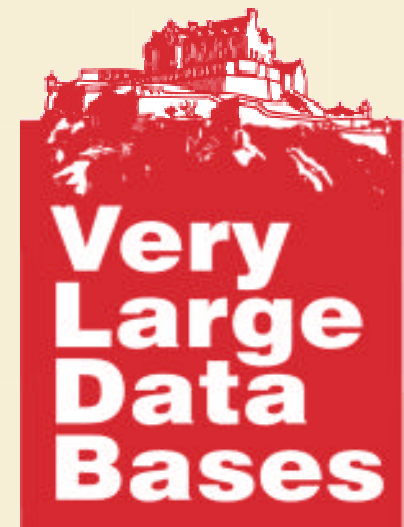
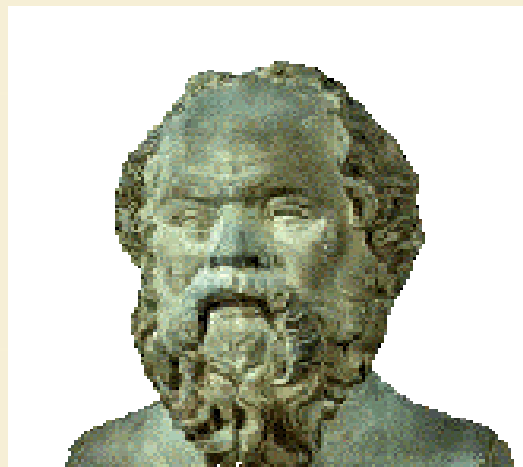


Active Storage Hierarchy, Database Systems and Applications



Socratic Exegesis

VLDB '99 Panel

Why This Panel?

■ Database Systems & Storage

- ◆ Interesting Research & Business Opportunities
- ◆ New Engineering & Performance Frontiers
- ◆ Applications - Sky (actually Space) is the Limit

■ Prevailing Zeitgeist

*“I don’t care where I store and query my data
as long it is on disk”*

■ Why VLDB?

- ◆ Jim Gray’s 1998 10-year best paper (Disk Shadowing) talk future of Disk Technology
- ◆ Put Everything in Future (Disk) Controllers (it’s not “if”, it’s “when”)
 - <http://www.nsic.org/nasd/1998-jun/gray.pdf>



Panelists

John Burgess - FileTek

Felipe Carino - FileTek

Ted Johnson - AT&T Labs

Bill O'Connell - IBM

**Joel Saltz - John Hopkins &
Univ. of Maryland**

Talk Slides: www.FileTek.com

John Burgess



**FileTek - Co-Founder, Chief Technical Officer
Co-Inventor Storage Machine & StorHouse Product
BS in Electrical Engineering, Virginia Tech**

Active Storage; StorHouse/RM & Storage Systems

Dr. Ted Johnson



Principal Member Technical Staff - **AT&T Labs**
Ph.d Computer Science, **New York University**, 1990

Storage Systems & Storage Trends

Dr. Joel Saltz



**Professor Computer Science, University of Maryland, College Park
Director of the Division of Informatics, Department of Pathology
Professor Pathology, John Hopkins University (Medical School)**

Applications & Storage Needs

Felipe Carino, Jr.



FileTek, Director New Business Development
Executive MBA **USC** 1995
M.S. in Computer Science, **NYU**, 1979

Database Trends & Storage Needs Road To Yottabytes

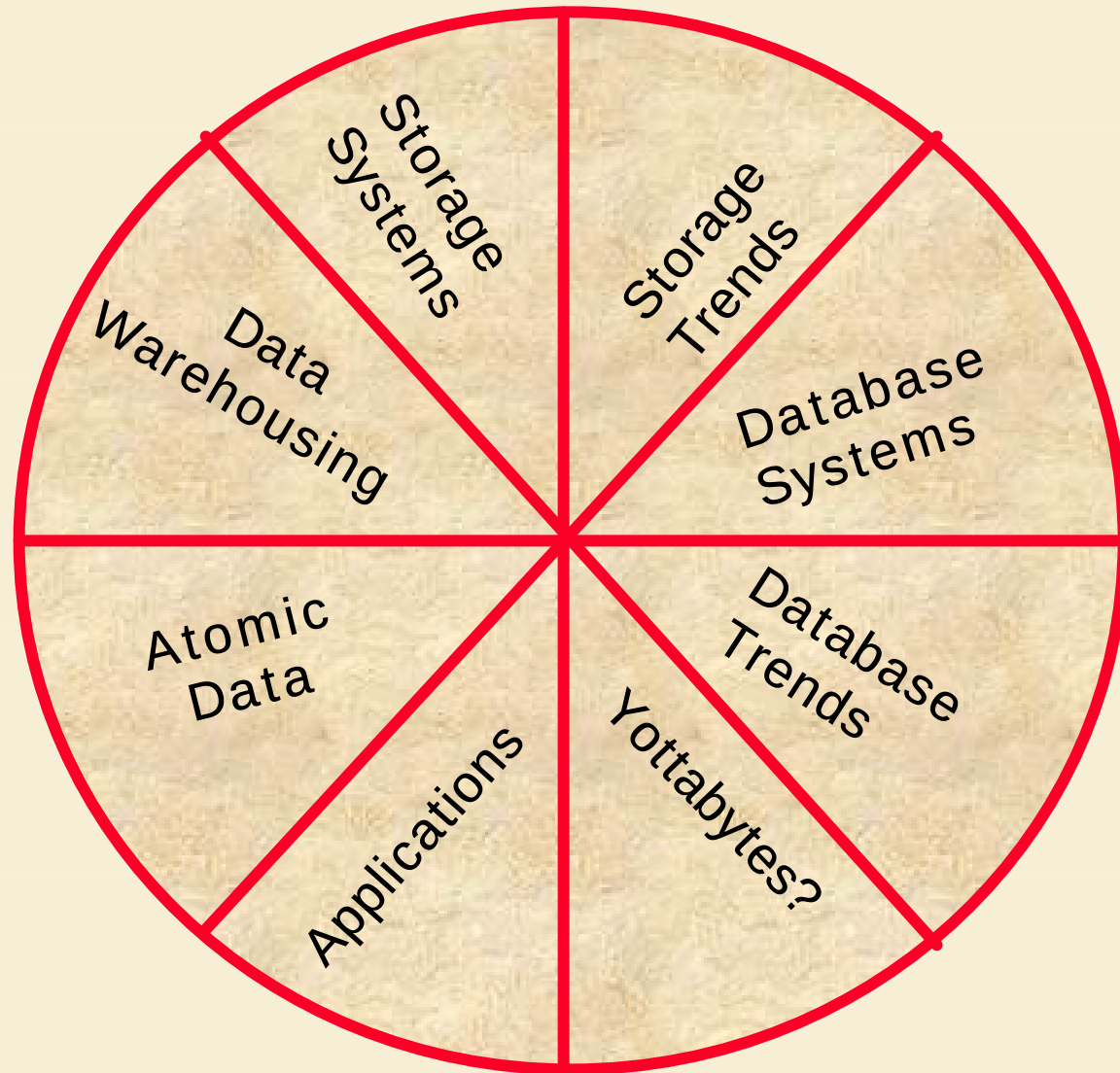
Wild Bill ..

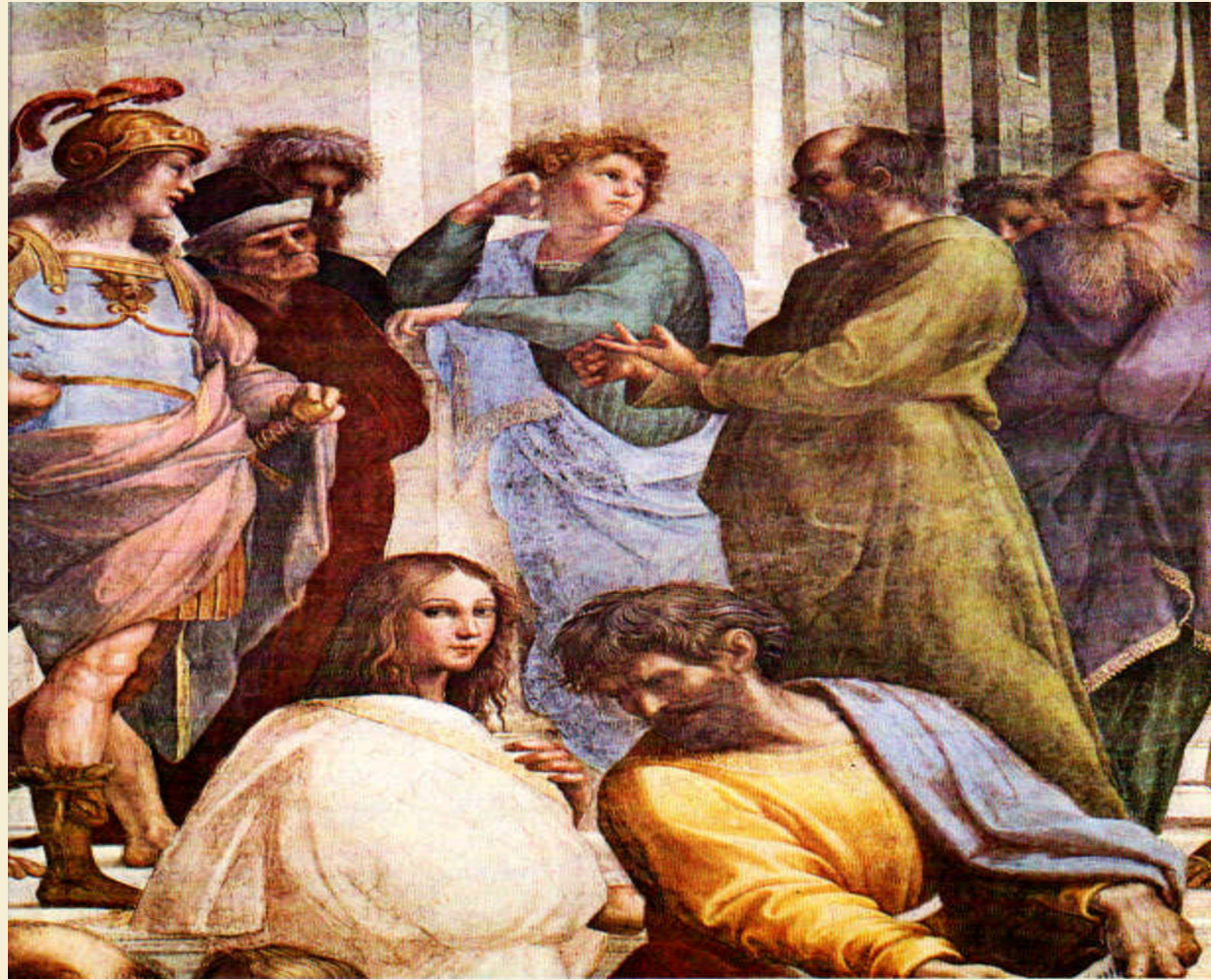


IBM Toronto - Manager Optimizer Group
Ph.d Illinois Institute of Technology

Database Systems & Storage Needs

Panel Topics

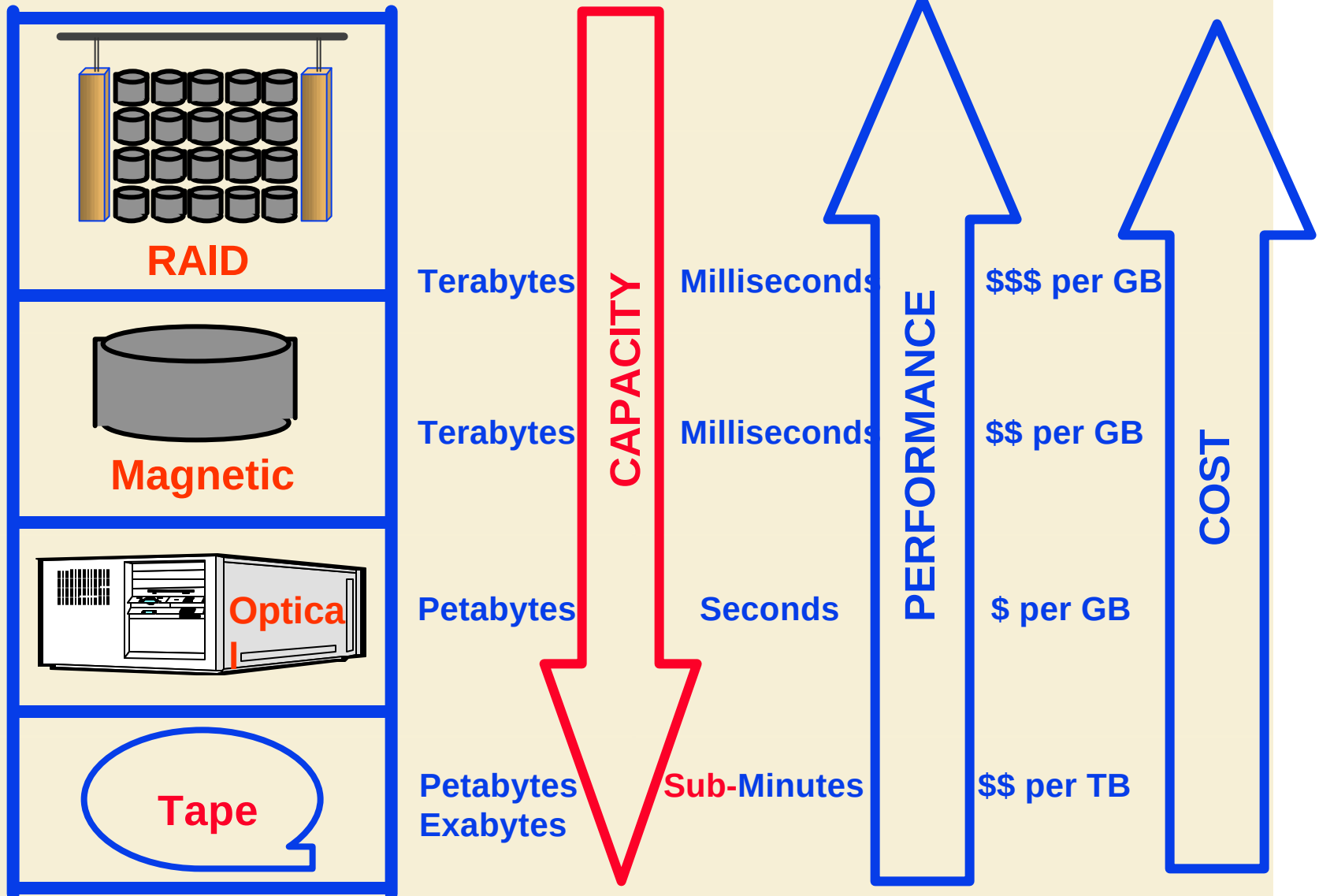




Socrates in the Marketplace

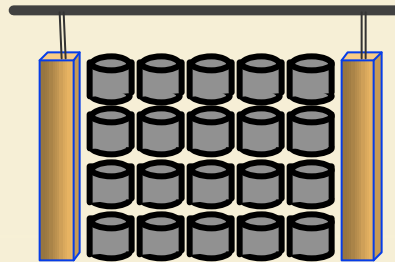
for Database & Storage Systems

Capacity, Cost & Performance Tradeoffs



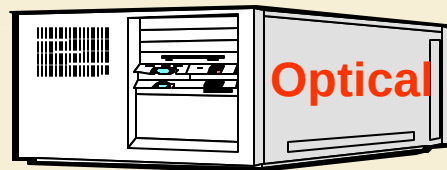
Storage Media

Cost



RAID

**100% of
Disk Dollar**



Optical

**43% of
Disk Dollar**

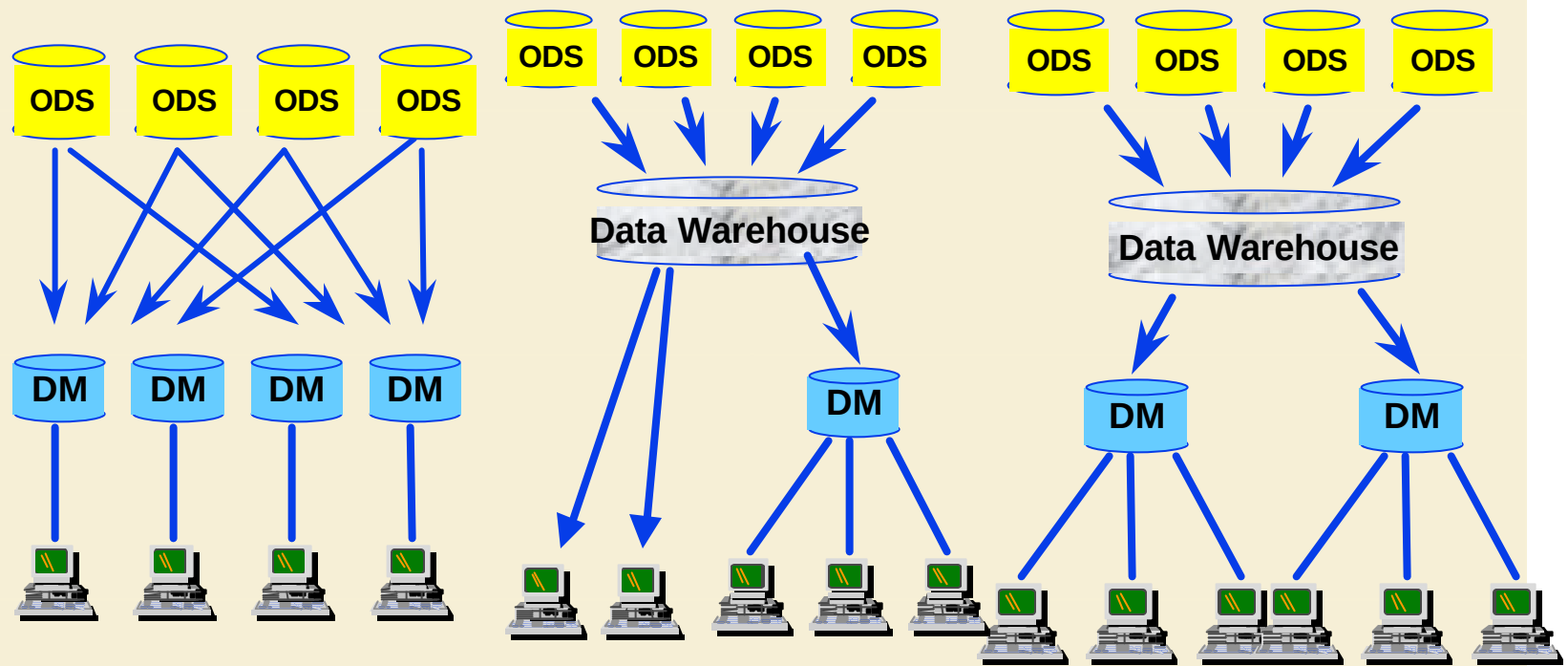


Tape

**7% of
Disk Dollar**

A 100TB Example

ACCESS TIME		RELATIVE HRDWR \$/MB
8-80 NS	DRAM	400-750
.2-.3 MS	Solid State Memory	10-50
4-10 MS	Performance Disk (RAID)	.60-1.00
5-20 MS	Capacity Disk (DASD)	.20-.60
5-10 Sec	Optical Disk	.10-.50
5-60 Sec	Tape	.05-.07



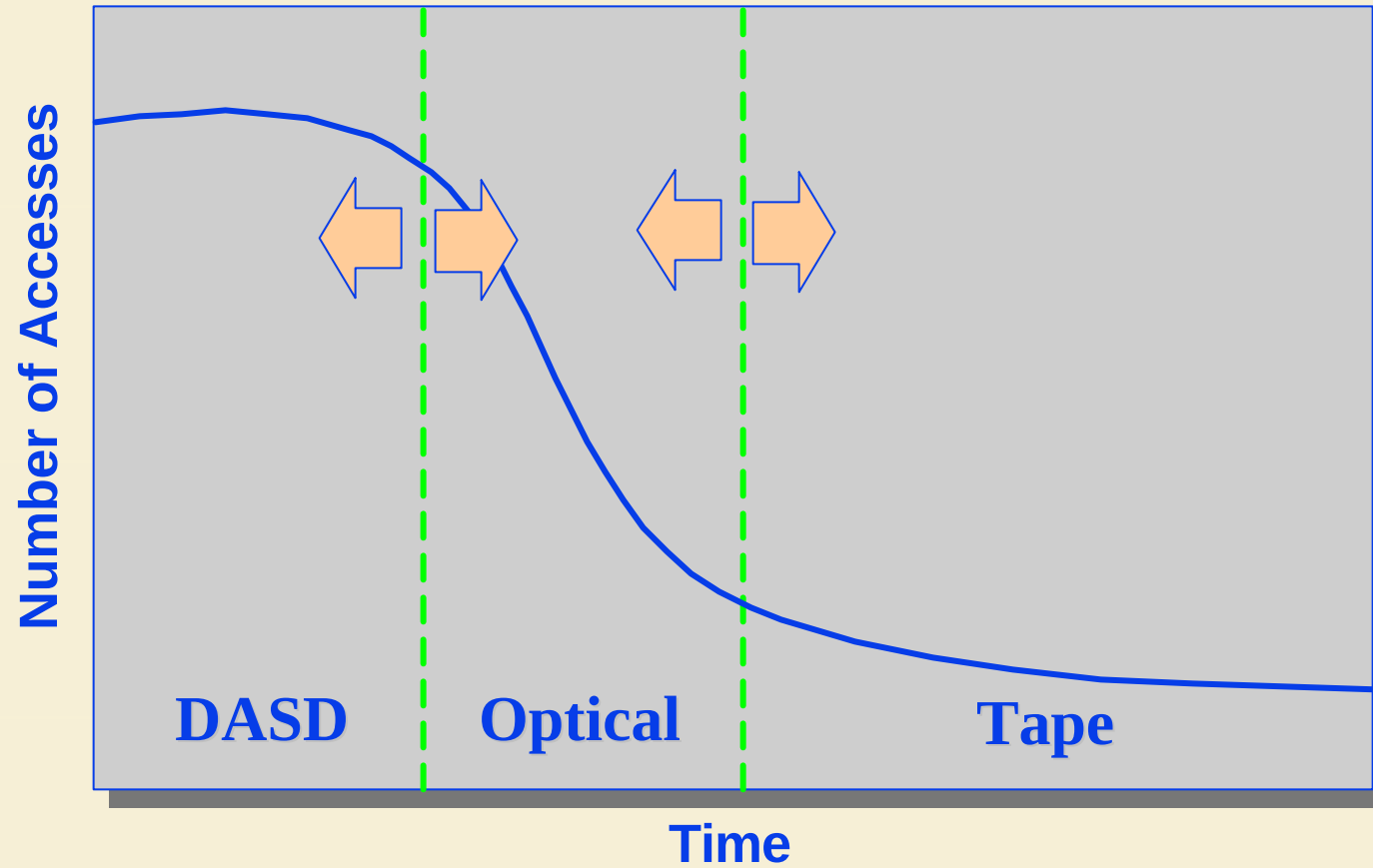
**Independent
Data Mart**

**Dependent
Data Mart**

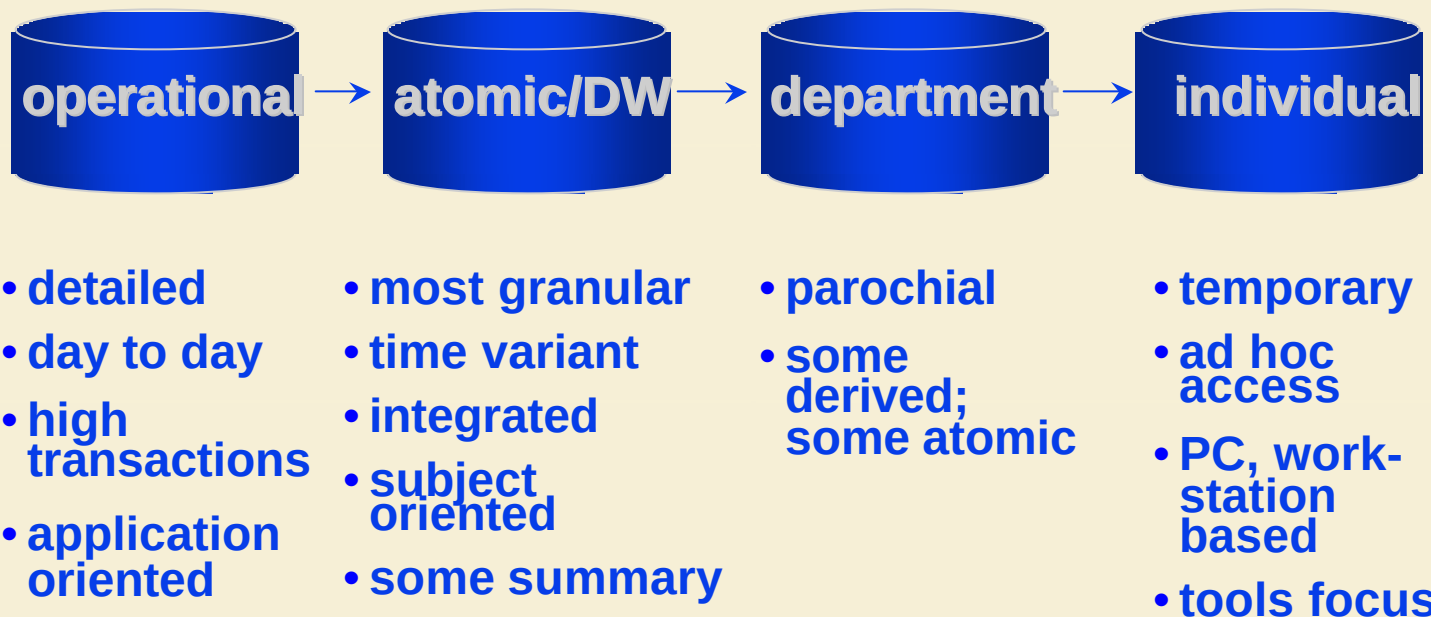
**Enterprise-Wide
Data Warehouse**

Data Warehouse & Data Mart Architectures

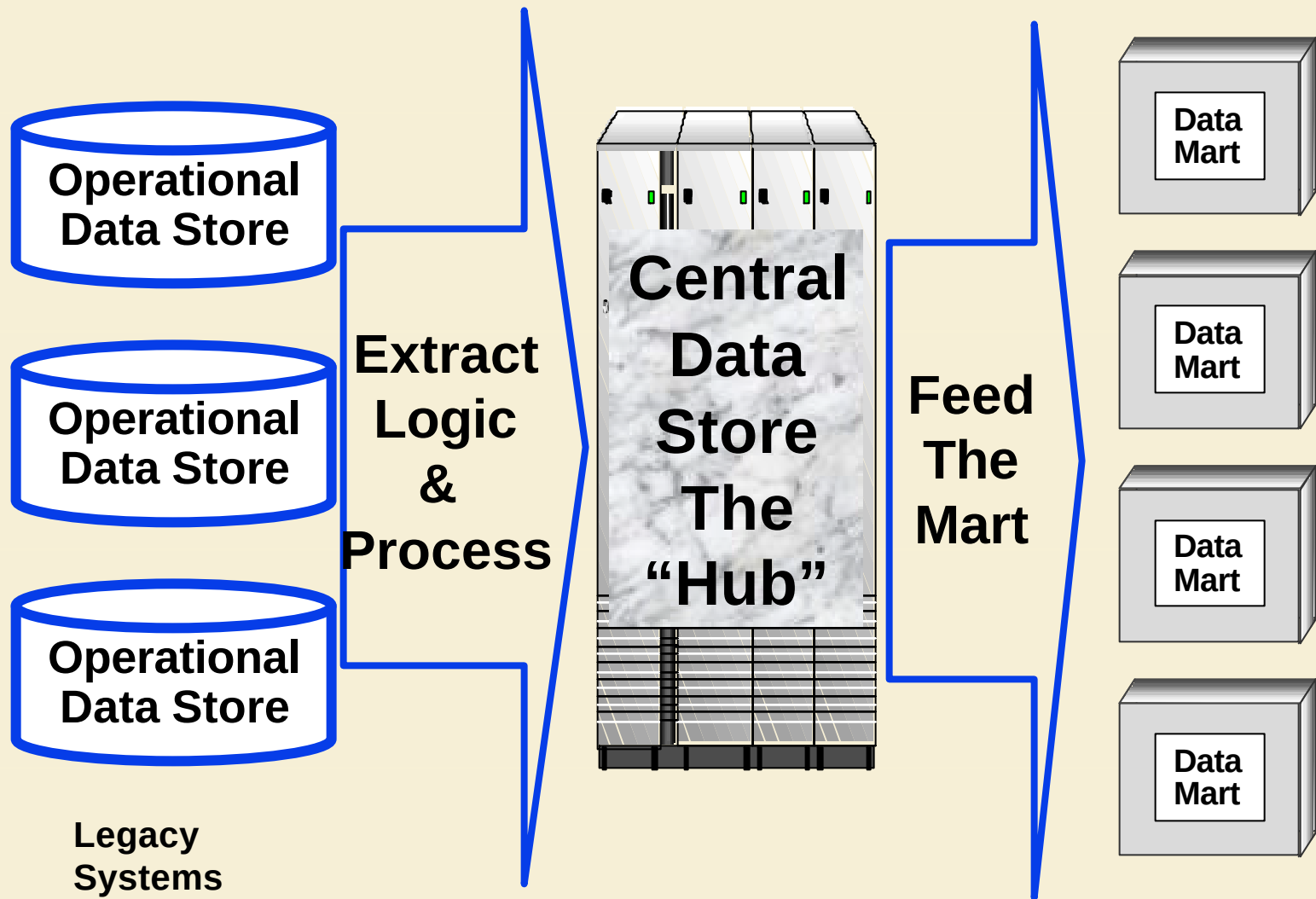
A Place for Everything . . .



What is Atomic-Level Data?



VALUE OF DETAIL **ATOMIC DATA** (NOT SUMMARIES)

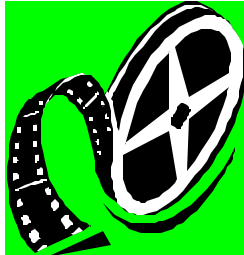
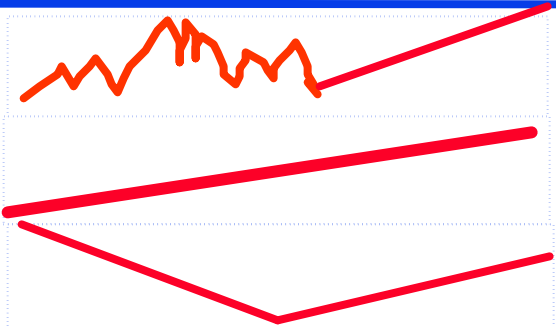


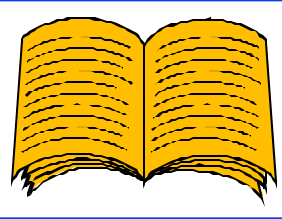
DATABASE TRENDS: SQL-99

UDT (Objects) & UDFs (Functions)

```
SELECT Stock, Price, Video, PlotDailyValues(History)
FROM   StockHistory
WHERE  MovingAverage (History, 30) /
       LastPrice (History) < .8;
```



Stock	Price	Video	PlotDailyValues
Felipe.com Art.com Pekka.com	500 75 100		



TEXT

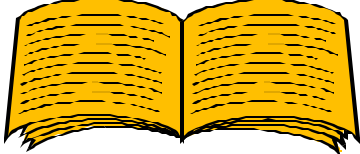
■ **TEXT**: Includes Many Data Types

- ◆ ASCII & EBCDIC Text
- ◆ Word & Framemaker Documents
- ◆ PDF Files, etc.

SELECT
WHERE

*** FROM ProductTable**
FindText (Literature, “Yellow Sticky”);



PRODUCT	PICTURE	LITERATURE
Yellow Sticky		



AUDIO



VIDEO

■ AUDIO & VIDEO: Many Uses

- ◆ Product Information
- ◆ Advertisement (for Web Apps)
- ◆ Customer Interactions
 - Financial Transactions
 - Insurance Claims, etc.

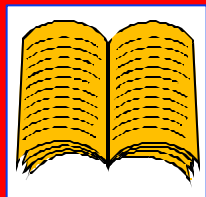
SCALAR DATA	AUDIO	VIDEO
...		

VLDB Sizes: Cost-Effective System Needs

LOGICAL DATABASE INFORMATION BACKPLANCE



IMAGE



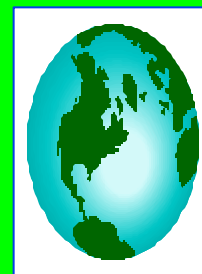
TEXT



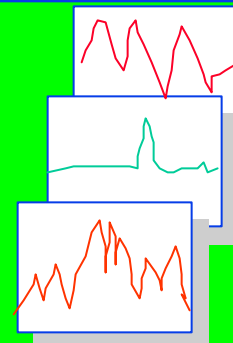
AUDIO



VIDEO

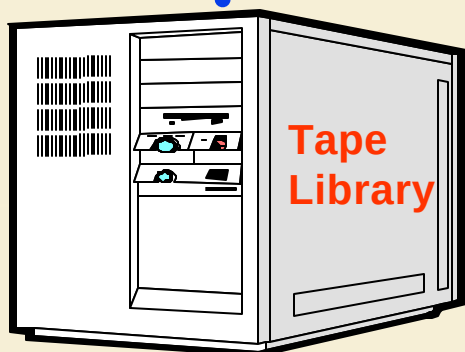


SPATIAL

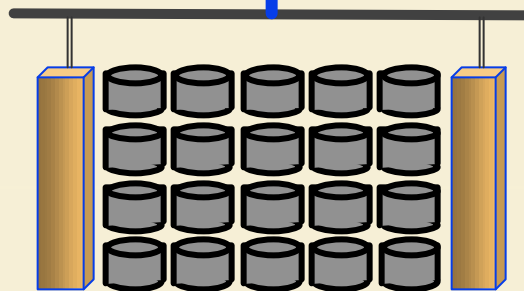


Stock
Time-Series

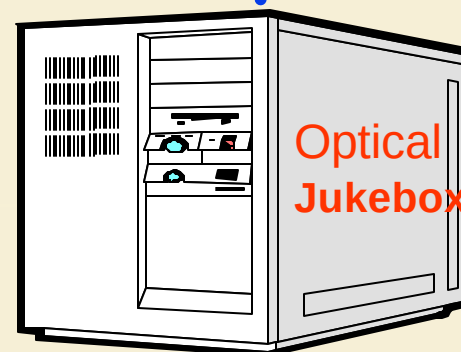
OBJECT/RELATIONAL DATABASES



Tape
Library



Disks

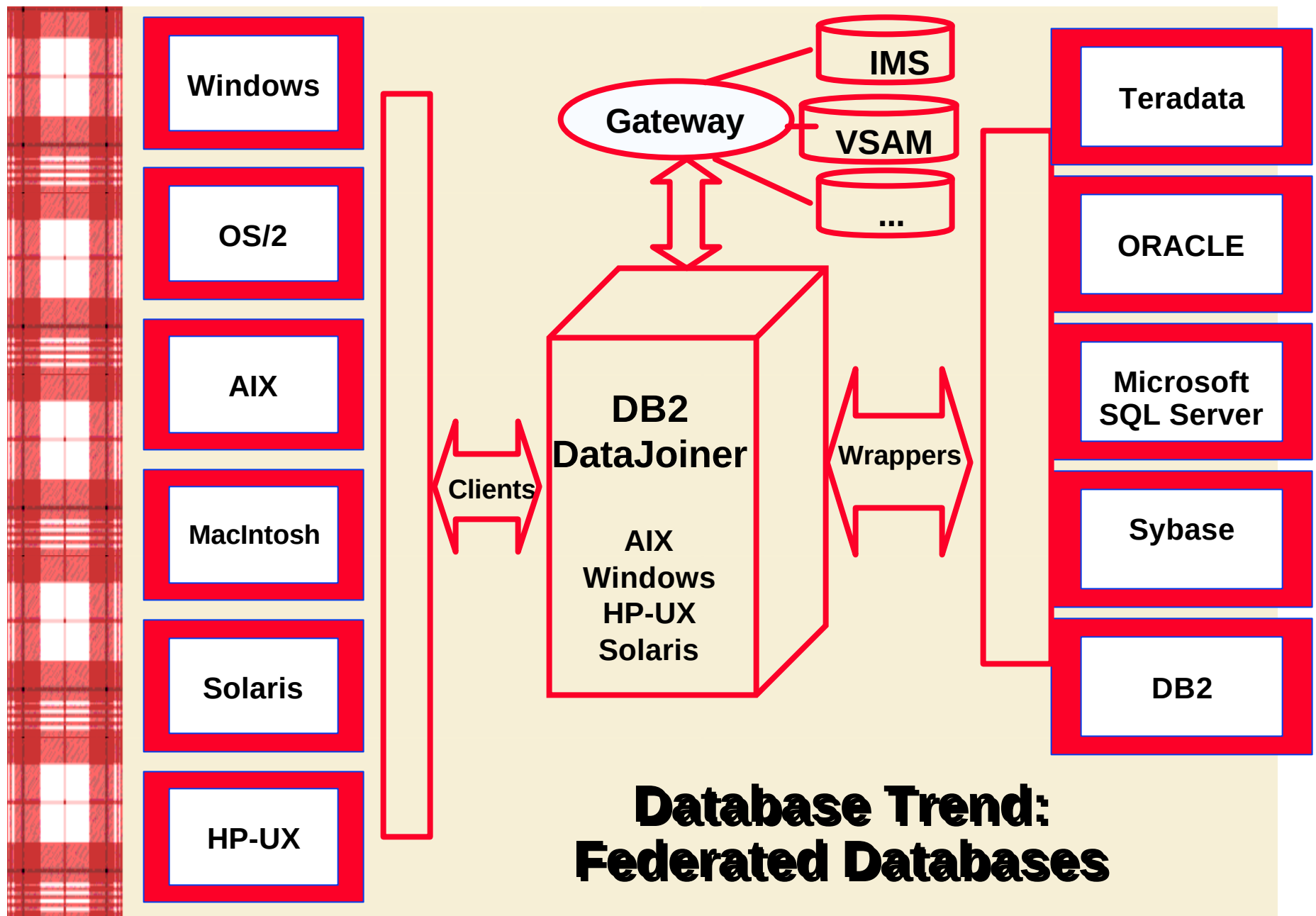


Optical
Jukebox



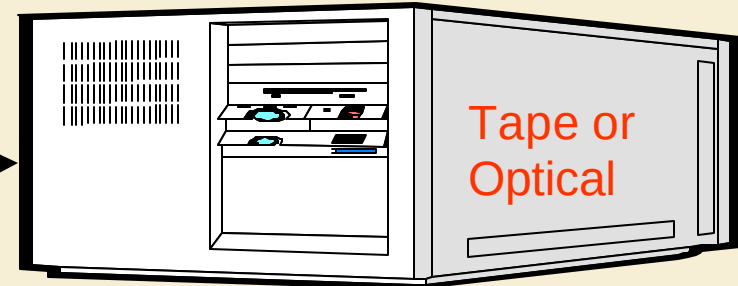
Federated Databases-- The Players

- **IBM DB2 Data Joiner**
- **Merant Data Direct**
- **Cohera Data Federation System**
- **Sybase ACA**
- **IBI EDA/ SQL**
- **SolutionsIQ CONNX**
- **B2 SQL Integrator**



Logical Horizontal Partitioning (LHP)

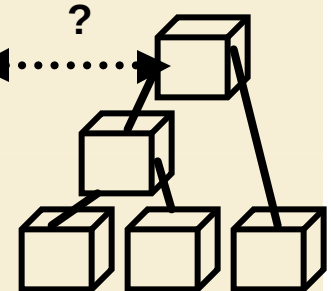
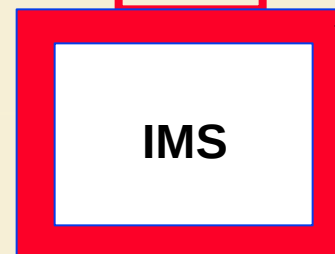
Item	Product	Price



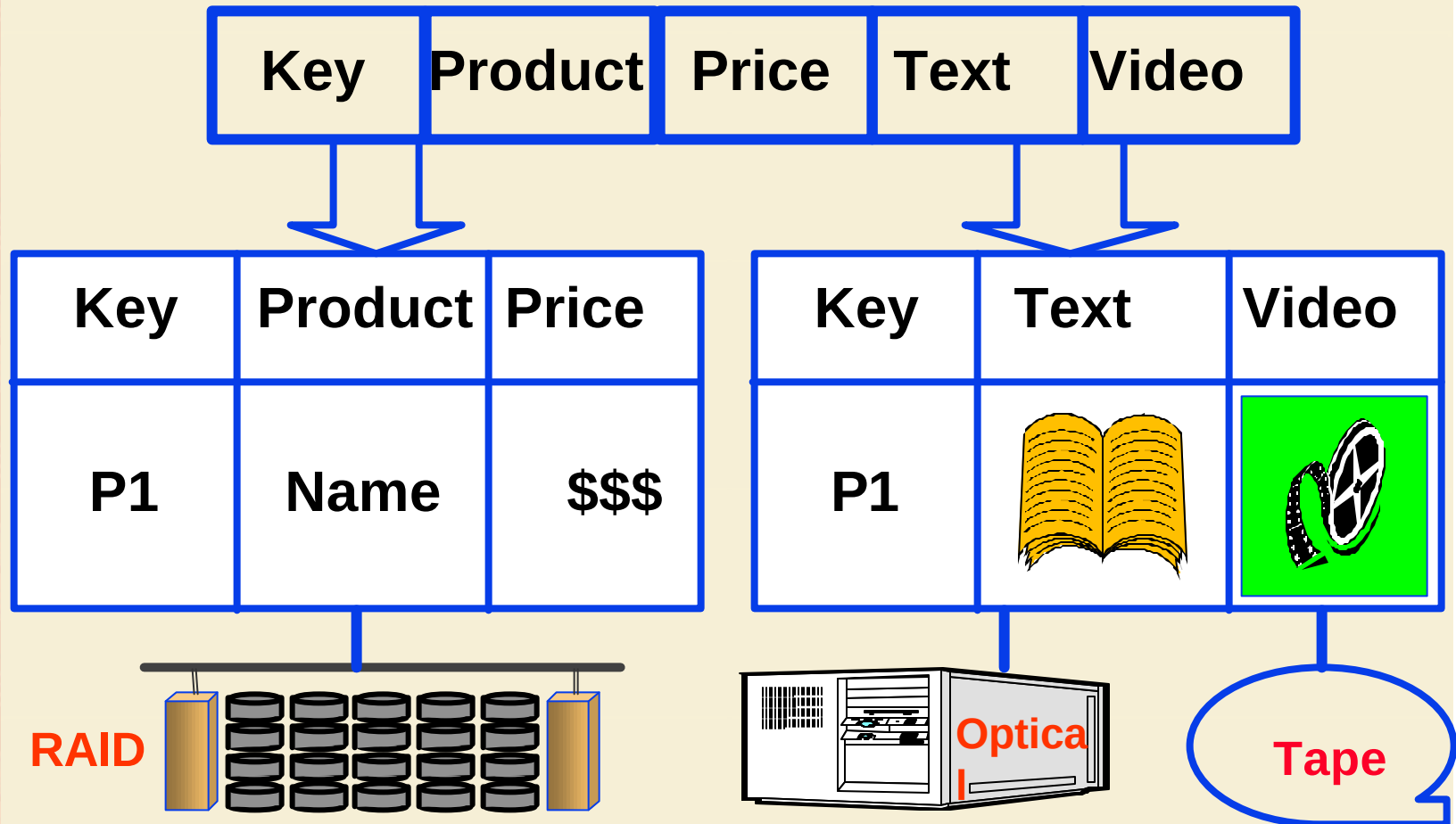
MIGRATE

Migration Rules
[1] Aging Strategy or [2] Predicates

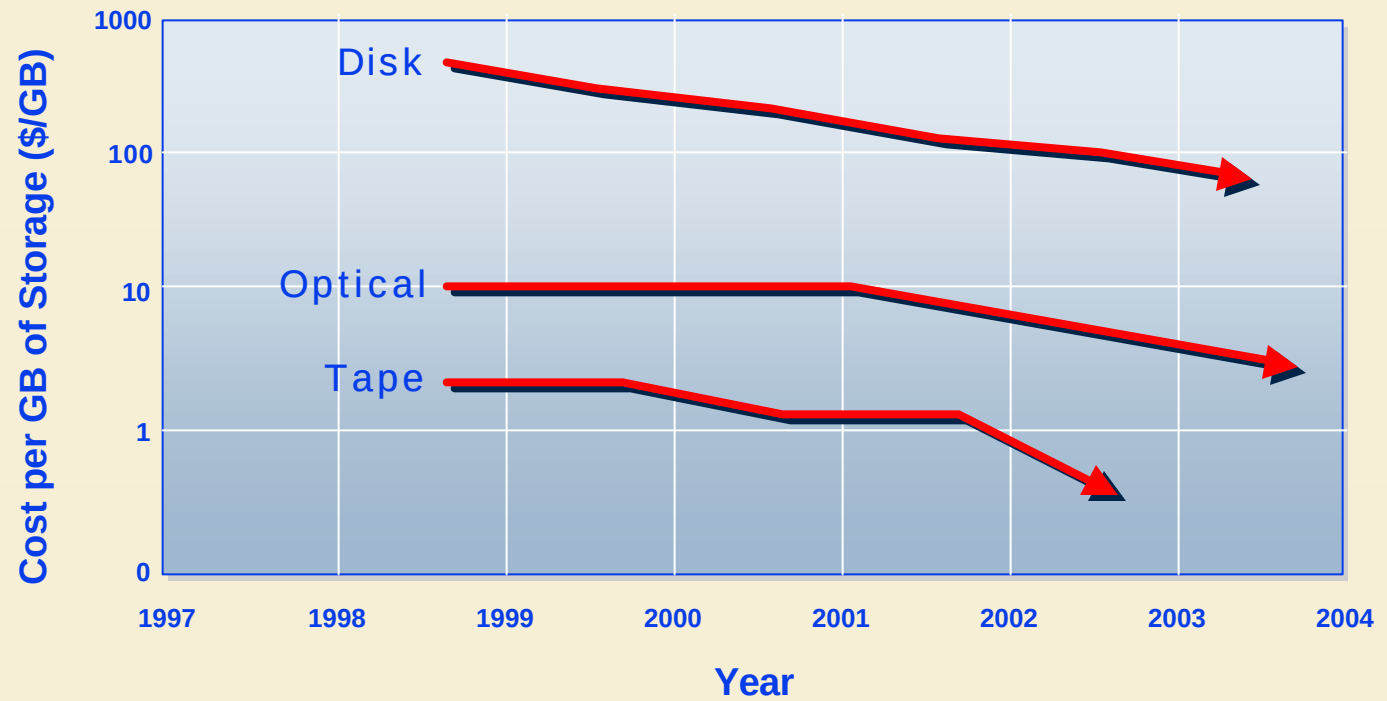
Item	Product	Price



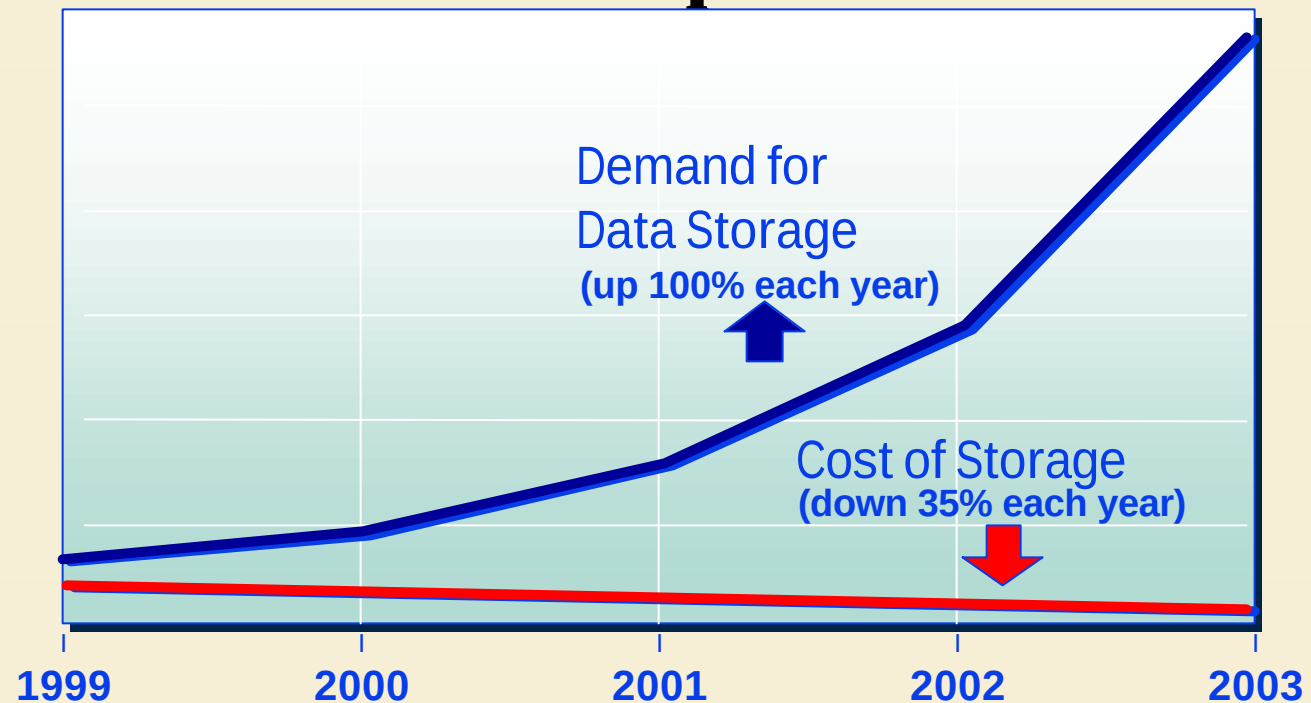
Logical Vertical Partitioning (LVP)



Storage Cost Trends



Information Explosion



Therefore, it doesn't matter what the price of RAID/DASD does -- the customer's data needs will continue to outpace price decreases!

DATABASE SIZES

VERY LARGE DATABASES (VLDB) SCALAR DATA

■ Terabyte (10^{12})

- ◆ National Retail Point-Of-Sale Data (~30TB)
- ◆ Telecommunications Call Detail Warehouse (~200TB)

■ Growth To {PETA, EXA, ZETTA, YOTTA}

◆ Disk-Only Solution:

- Not Cost-Effective (requires \$\$\$)
- If You Choose Disk-Based Solution

Then Contact Felipe (can use Stock Tip)

Very Large Databases - Definitions

*LARGE OBJECTS,
USER-DEFINED TYPES,
“MUCHO” SCALAR DATA*

■ Petabyte (10^{15})

- ◆ Text
- ◆ Image Data
- ◆ Audio
- ◆ Video

Very VLDB - Six/Seven Commas

- **Exabyte (10^{18}) - Six Commas**
 - ◆ US National Medical Insurance Records
 - ◆ Human Genome (US Population)
 - ◆ Yes: Image, Audio & Video (Again?)

- **Zettabyte (10^{21}) - Seven Commas**
 - ◆ Spatial & Terrestrial Data
 - ◆ Video & Audio Archives

The Big One - Yottabyte or Bust!

■ Yottabyte (10^{24}) - **Eight** Commas

◆ By Moore's Law:

➤ Year 2050 Database Size

➤ Math Sizing Source: Pekka Kostamaa

—pkostamaa@filetek.com



Socratic Exegesis - VLDB Style

And Now Here's ...

- **Ted Johnson - Storage Trends**
- **John Burgess - StorHouse/RM**
- **Bill O'Connell - Database Systems (@IBM)**
- **Joel Saltz - Applications & Tools**
 - ◆ **Road to Yottabytes (Today?)**

Felipe's Socratic Exegesis

- Jim Gray: Correct
 - ◆ Disk Storage Trends
 - ◆ Smarter Disks
 - ◆ Service More DB Functionality
 - For **SOME** Applications: Think of Disks as Shared-Nothing Single-CPU Nodes
 - ◆ Missing/Un-emphasized Point (Annual Growth)
 - Disk Improvement 35%
 - Data Growth 100%
- Database Growth Enablers
 - ◆ Federated, Object/Relational (UDT/UDFs)
- How Big? Yottabyte by 2050
- Finally
 - ◆ Remember what happened to Socrates Disciple