BIG DATA

The Petabyte Age: More Isn't Just More — More Is Different

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Big Data, The Petabyte Age:

The biggest challenge of the Petabyte Age won't be storing all that data, it'll be figuring out how to make sense of it

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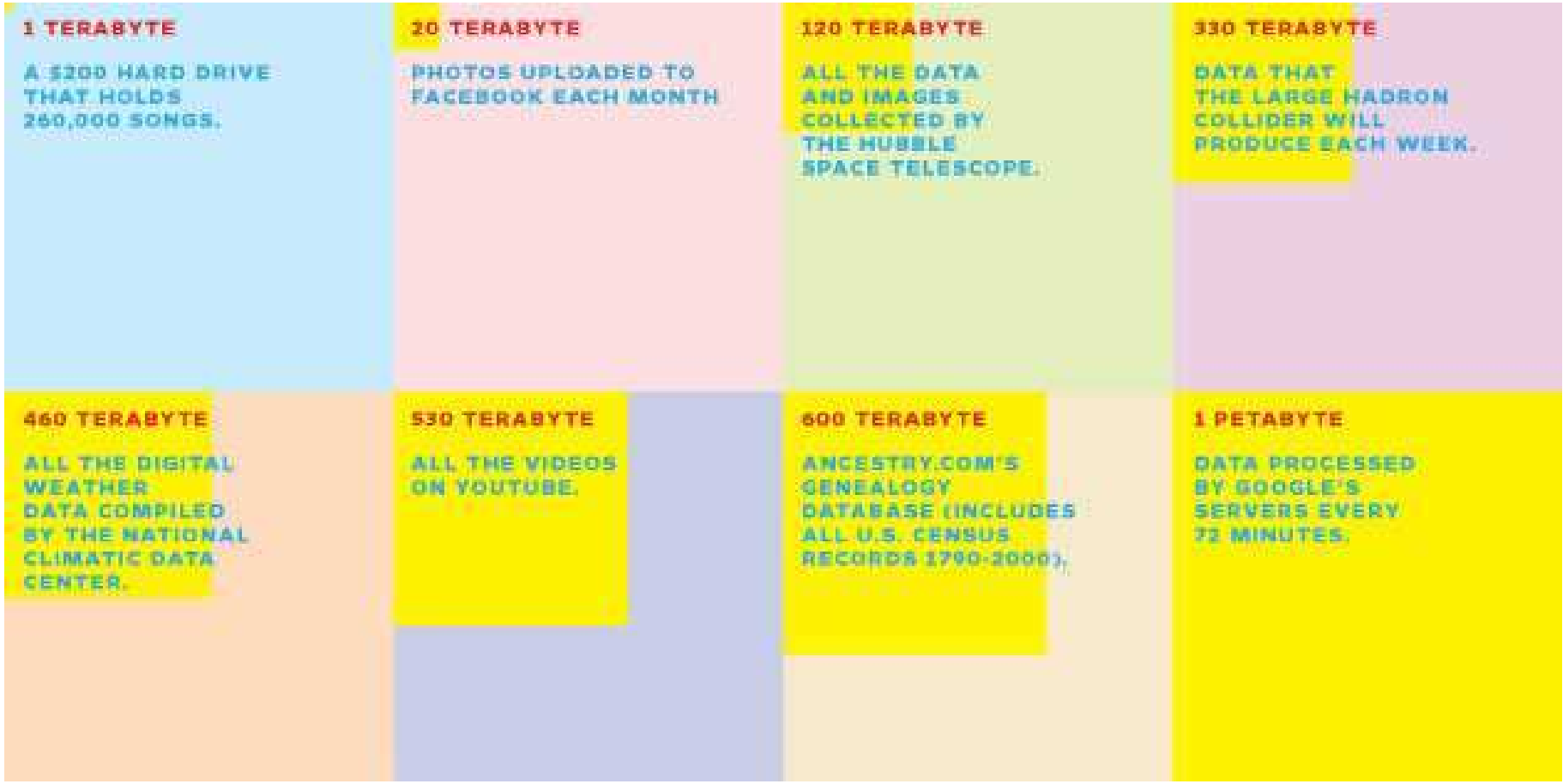
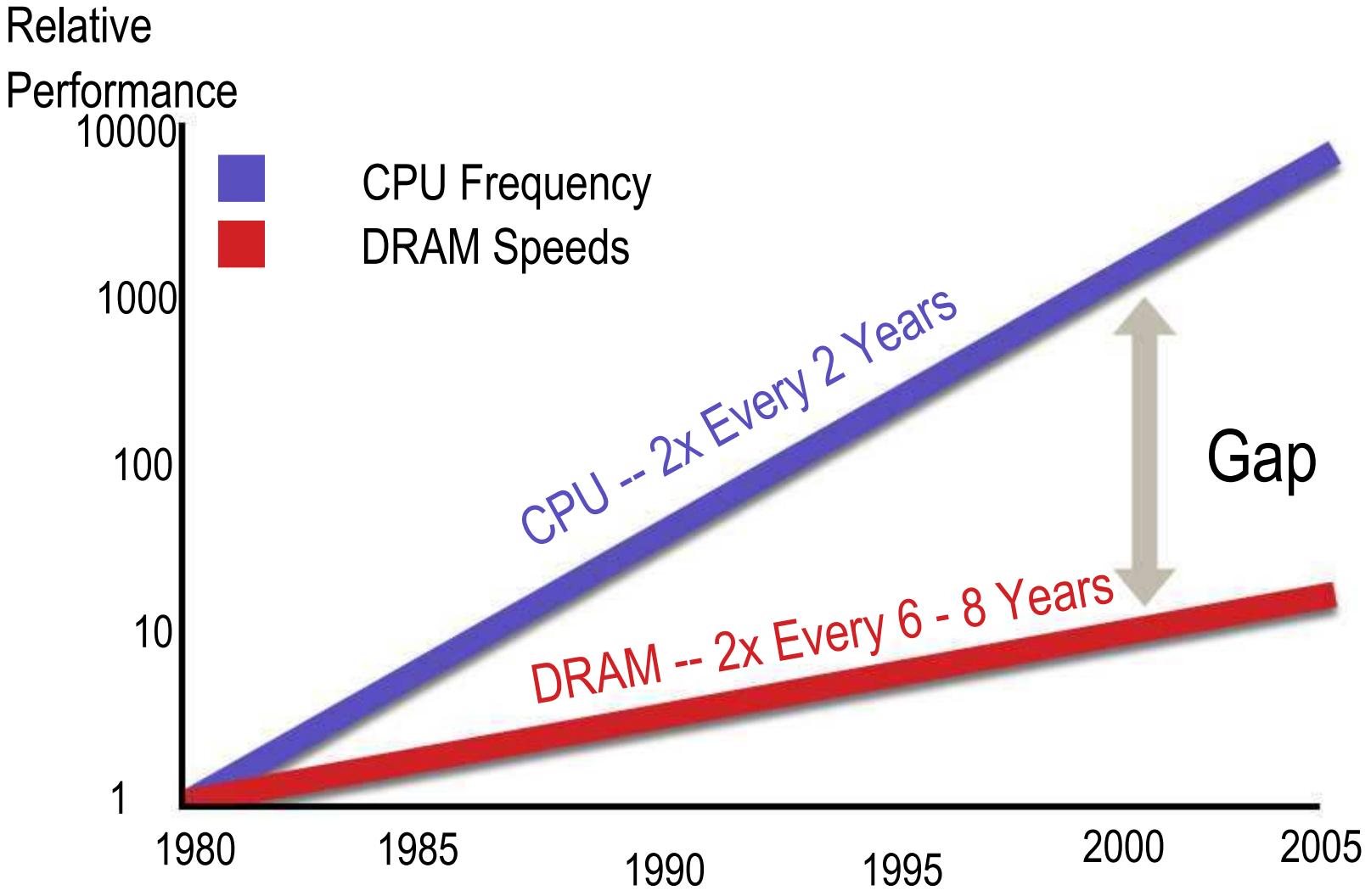
Big Data Key Trends



“Hitting walls” in Processor Design

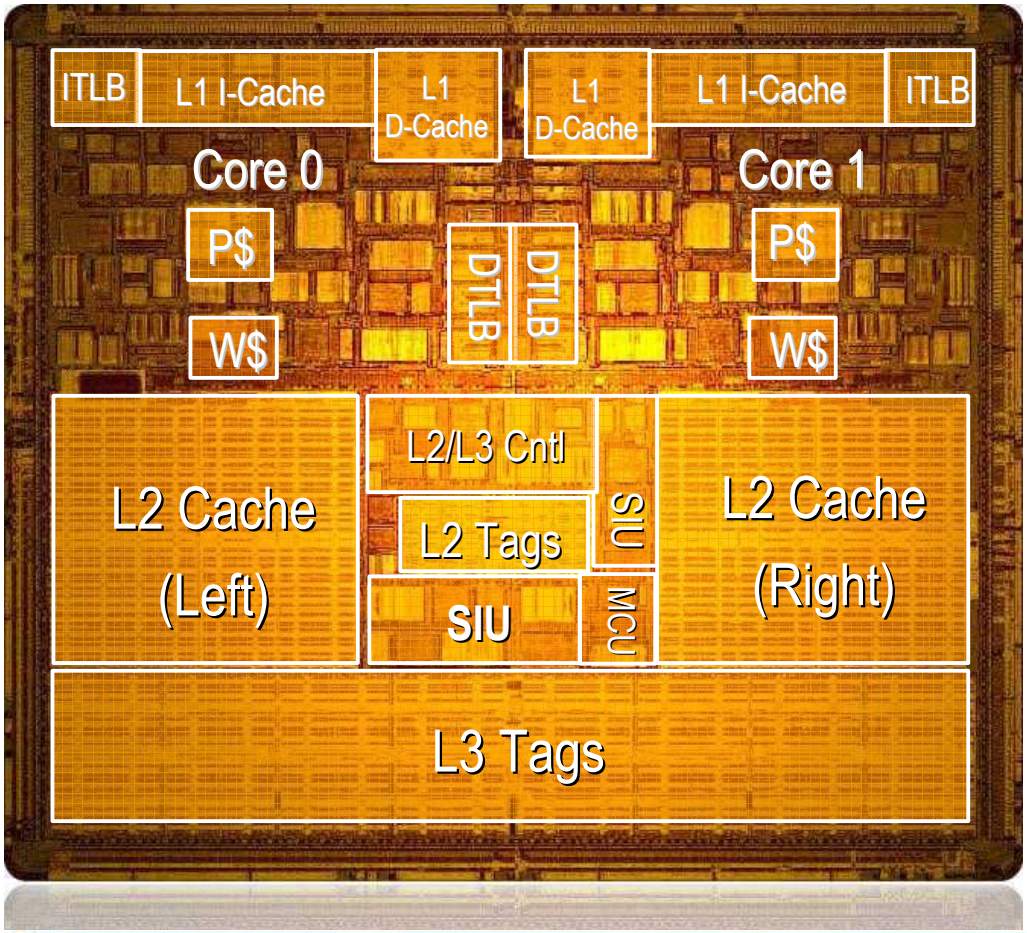
- Clock frequency
  - frequency increases tapering off, in new semiconductor processes
  - high frequencies => *power* issues
- Memory latency (not instruction execution speed) dominating most application times
- Processor designs for high single-thread performance are becoming *highly* complex, therefore:
  - expense and/or time-to-market suffer
  - verification increasingly difficult
  - more complexity => more circuitry => increased power ... for diminishing performance returns

Memory Bottleneck



Source: Sun World Wide Analyst Conference Feb. 25, 2003

How We Mask Memory Latency Today

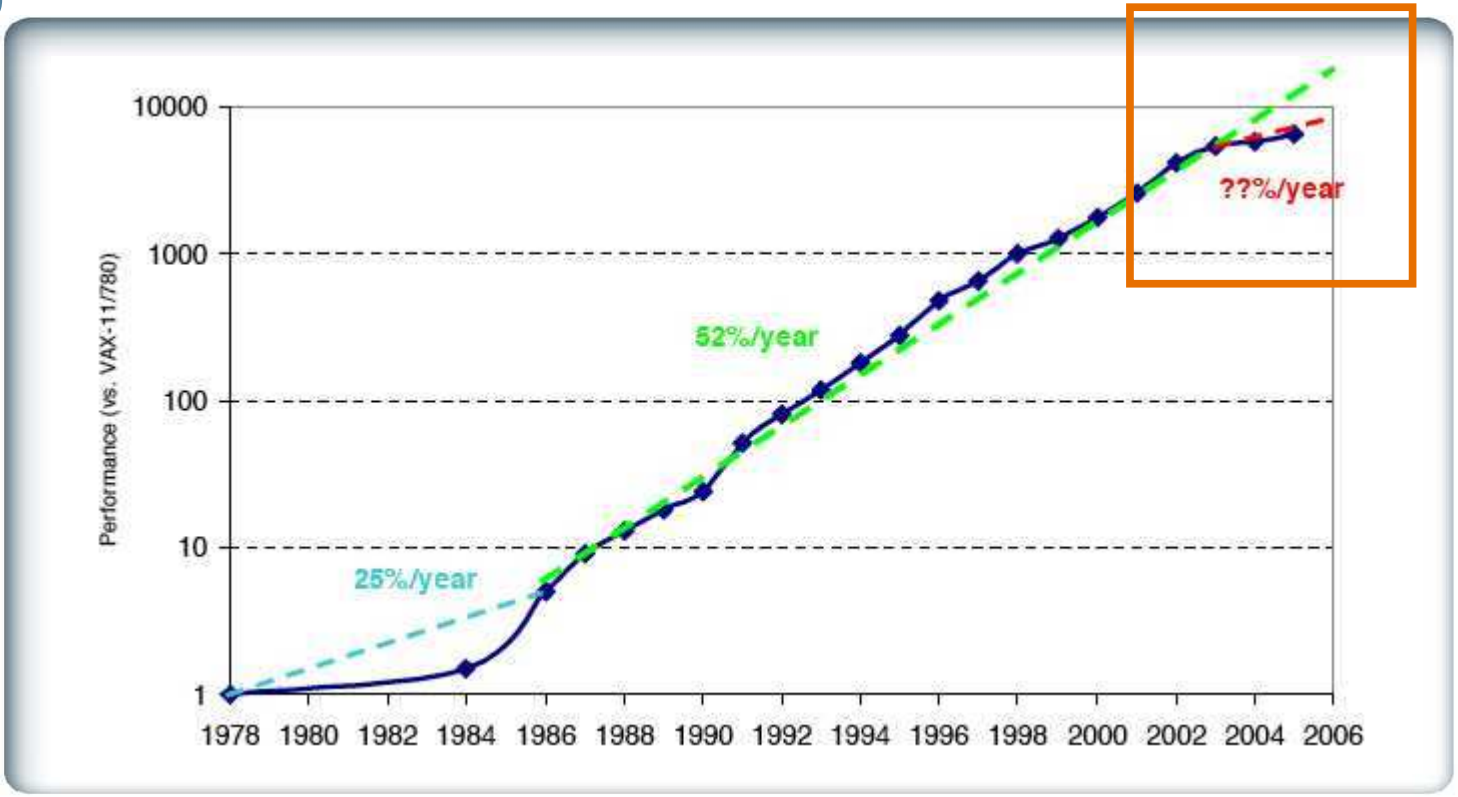


Great Big Caches

- of many different kinds
- that only mask memory latency
- and execute no code
- accessed one cache line at a time
- but require power and cooling to all lines all the time

Cache Logic Accounts for About 75% of the Chip Area

“Power Wall + Memory Wall + ILP Wall = Brick Wall”



“In 2006, performance is a factor of three below the traditional doubling every 18 months that we enjoyed between 1986 and 2002.

The doubling of uniprocessor performance may now take ***5 years***.” *

* “The Landscape of Parallel Computing Research: A View from Berkeley”, December 2006 (emphasis added)
http://www.eecs.berkeley.edu/Pubs/TechRpts/2006/EECS-2006-183.html

Single Threading

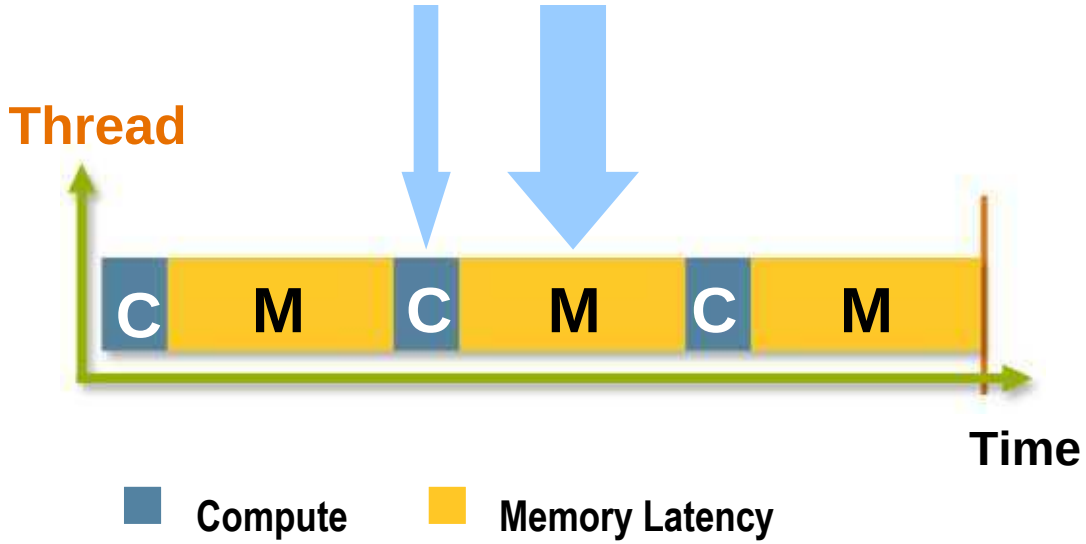
Up to 85% Cycles Spent Waiting for Memory

Hurry Up and WAIT

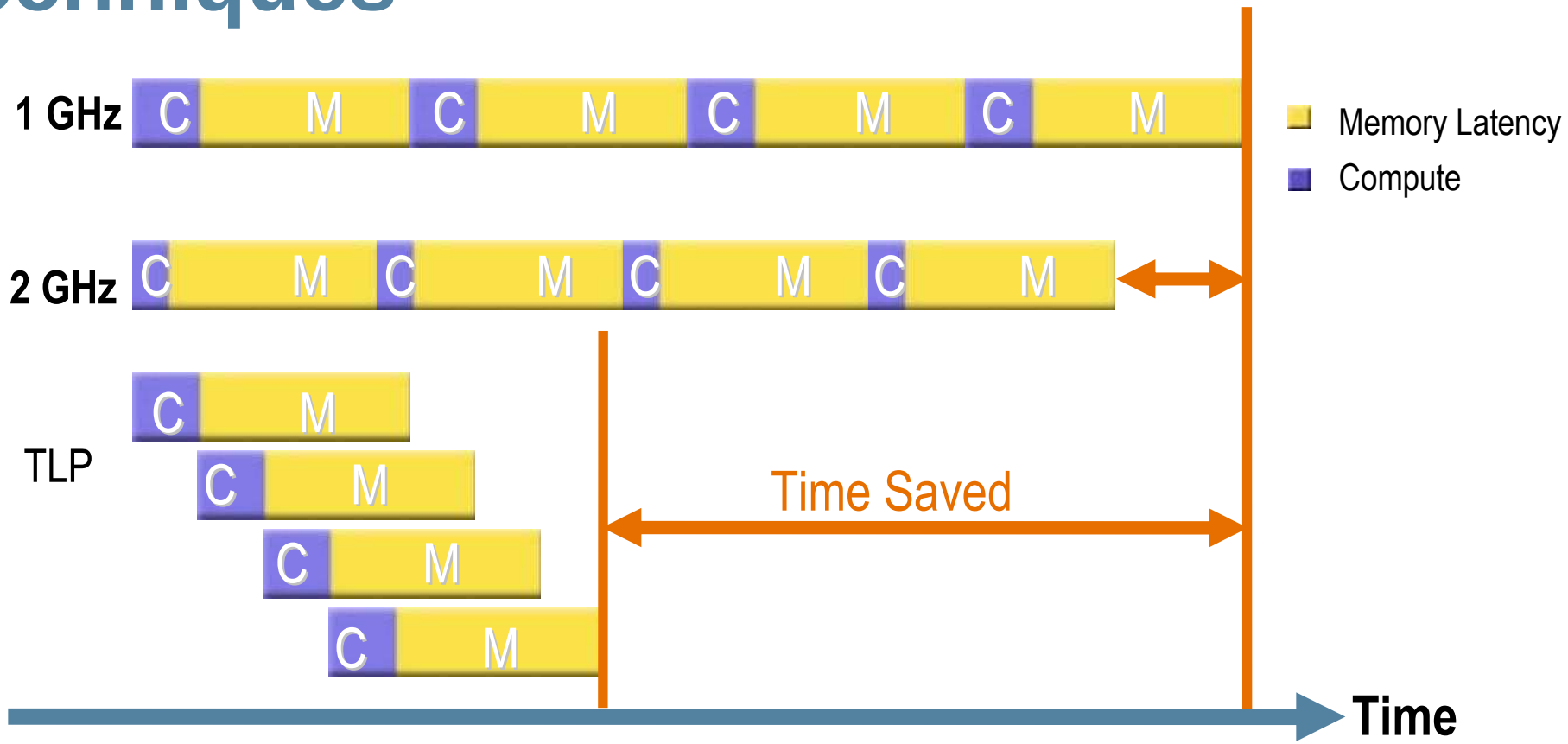
Single Threaded Performance

SPARC US-IV+ 25% 75%

Intel 15% 85%



Comparing Modern CPU Design Techniques

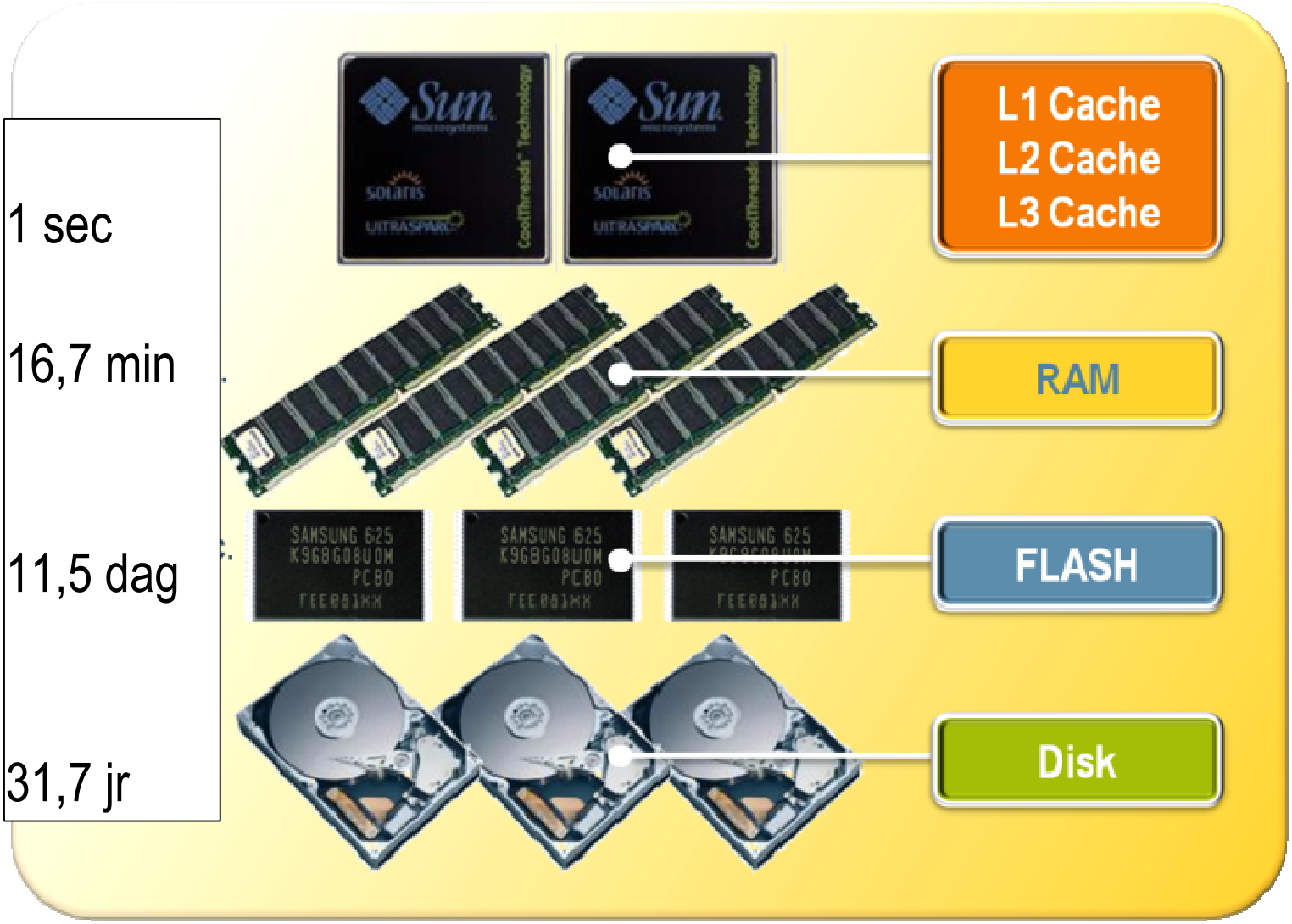


ILP Offers Limited Headroom
TLP Provides Greater Performance Efficiency

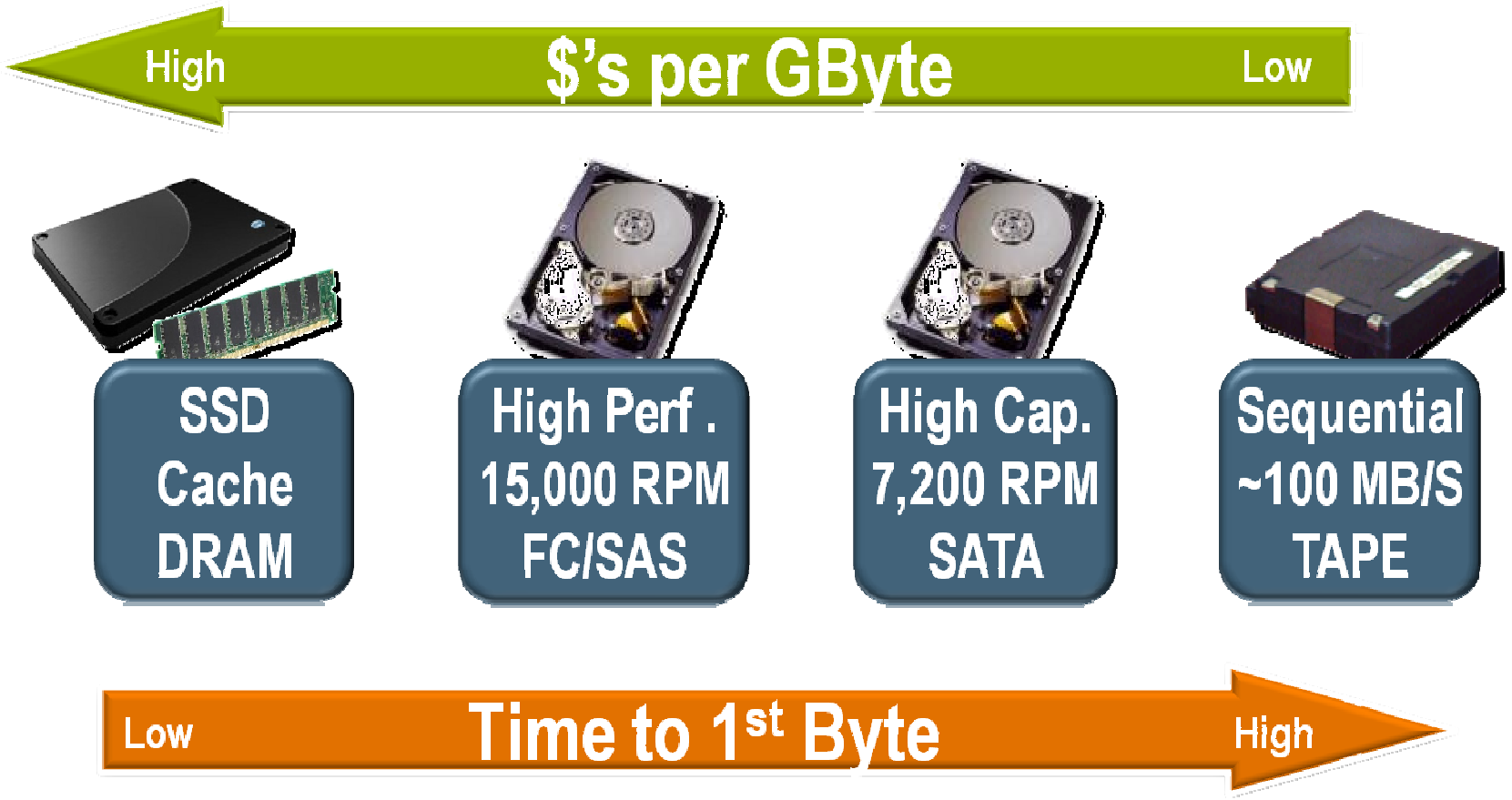
Chip Multi-Threading (CMT)
Utilization: Up to 85%*

* based on example of UltraSPARC T1

Enterprise Flash – Relative Perf



Where to Store Data?
Optimization Trade-Off

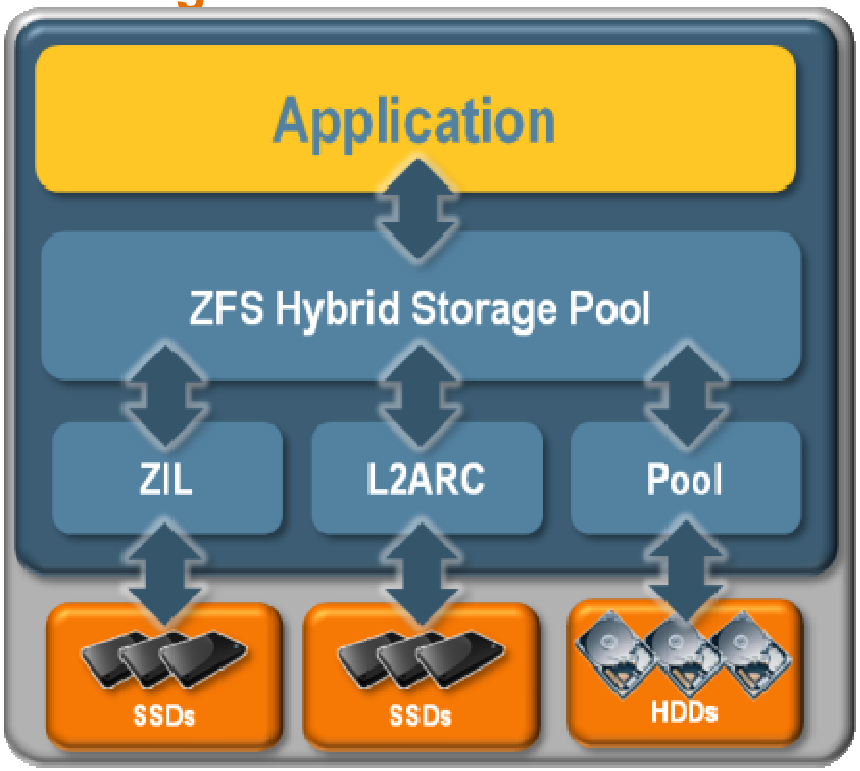


Data Retention Comparison

	DRAM	SSD	HDD
Budgetary Cost	$100/GB	$35/GB	$5/GB
Power Consumption	463 Watts	2.5 Watts	12 Watts
Random I/O	1,000,000 IOPS	50,000 IOPS	350 IOPS

ZFS Turbo Charges Applications

Hybrid Storage Pool Data Management on Solaris Systems, Open Storage



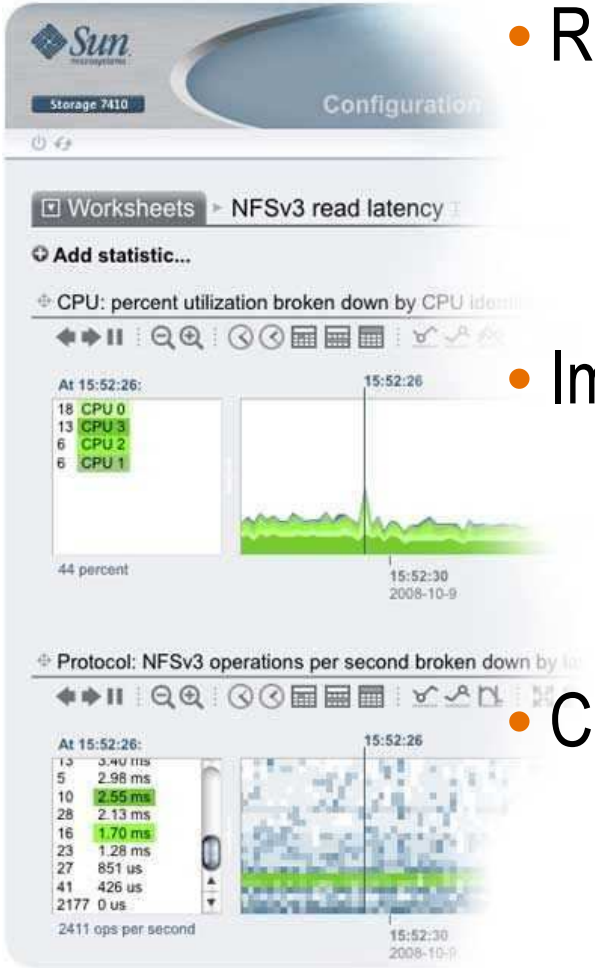
ZFS automatically:

- Writes new data to very fast SSD pool (ZIL)
- Determines data access patterns and stores frequently accessed data in the L2ARC
- Bundles IO into sequential lazy writes for more efficient use of low cost mechanical disks

solaris™

Unique Capabilities from Sun

Sun Storage 7000 Unified Storage Systems

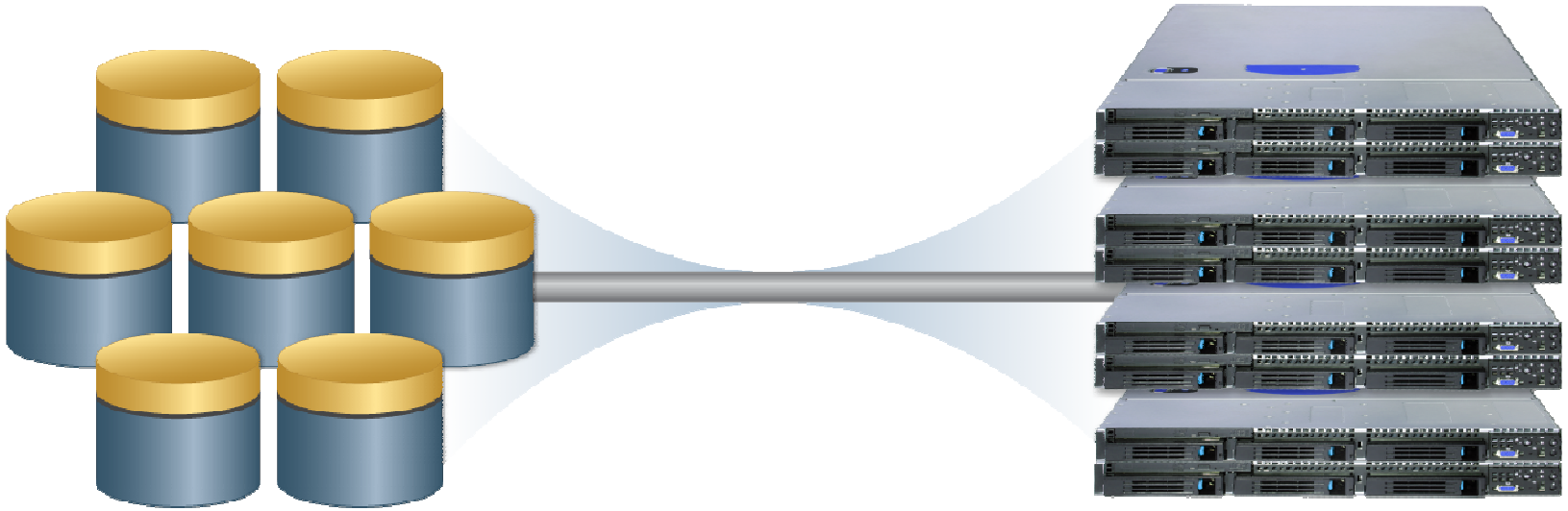


- Radical simplification
  - > Ready-to-go appliance – installs in minutes
  - > Extensive analytics and drill-down for rapid management of performance challenges
- Improved latency and performance
  - > Integrated flash drives
  - > Hybrid Storage Pools automates data placement on the best media
- Compelling value through standards
  - > Industry standard hardware and open source software vs. proprietary solution

Sun Oracle Database Machine

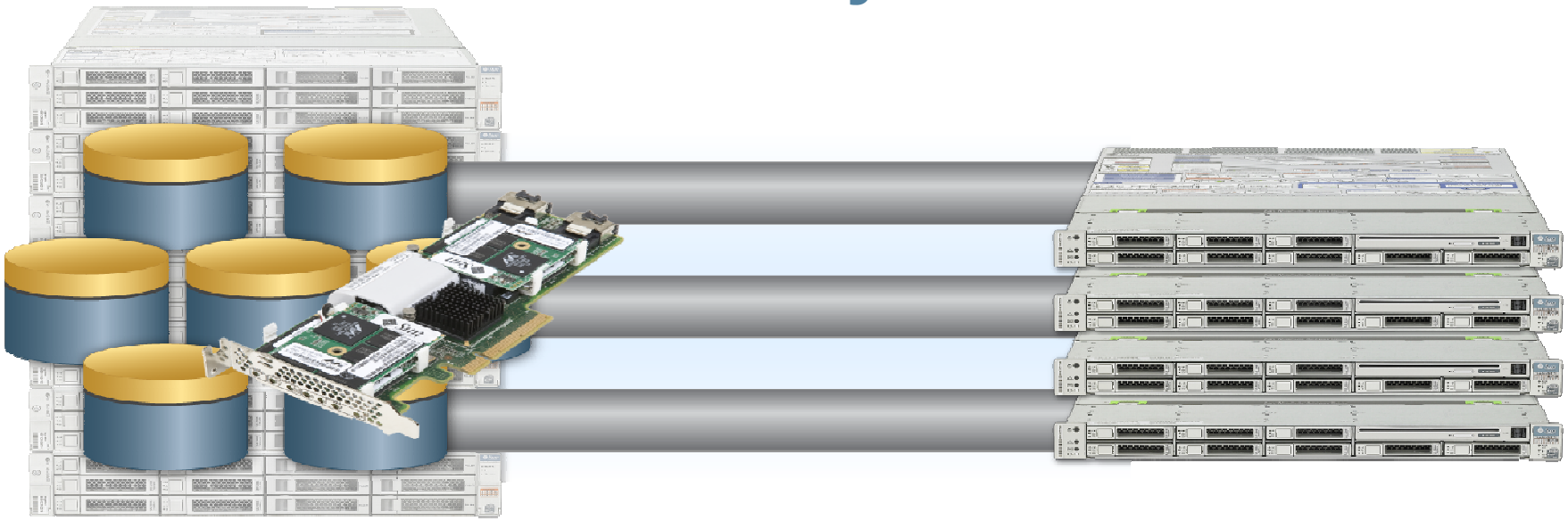
- Hardware by Sun, software by Oracle – Exadata Version 2
- Enhancements to Exadata Version 1 offering extreme performance
  - > Faster servers, storage, and network interconnects
  - > Flash acceleration
  - > Speedup at Oracle level of 20 times processing IOPS
  - > Extends Exadata to provide acceleration for OLTP
- Database aware storage
  - > Smart scans
  - > Storage indexes – eliminates a good deal of I/Os
- Massively parallel architecture
- Dynamic linear scaling
- Offering mission critical availability and protection of data

What Does Sun Oracle Database Machine Address?



- Current database deployments often have bottlenecks limiting the movement of data from disks to servers
  - > Storage Array internal bottlenecks on processors and Fibre Channel Architecture
  - > Limited Fibre Channel host bus adapters in servers
  - > Under configured and complex SANs
- Pipes between disks and servers are 10x to 100x too slow for data size

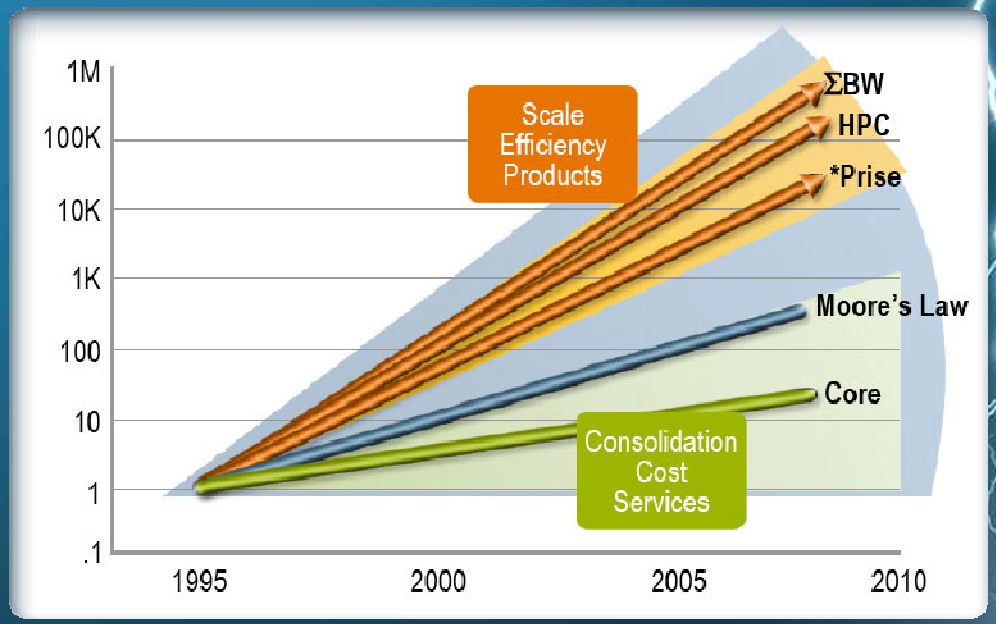
Sun Oracle Database Machine Solves the Bottleneck by



- Adding more pipes – Massively parallel architecture
- Make the pipes wider – 5X faster than conventional storage
- Ship less data through the pipes – Process data in storage
- Simplify the storage offering – eliminate the need of a SAN
- Allow for Ease of Growth
- Provide a Flash Cache for Rapid Response

HPC Market Trends

- It's a growing market, outpacing growth of many others
  - > $10B in 2008
  - > CAGR of 3.1% for 2007 to 2012*
- Clustering is now the dominant architecture
- HPC technologies now within reach of all organizations



* Source IDC (January 2009)

Sun Constellation System
Open Petascale Architecture

Eco-Efficient Building Blocks

Compute

Ultra-Dense Blade Platform

- Fastest processors: AMD Opteron, Intel Xeon
- Highest compute density
- Fastest host channel adaptor

Networking

Ultra-Dense Switch Solution

- 648 port InfiniBand switch
- Unrivaled cable simplification
- Most economical InfiniBand cost/port

Storage

Ultra-Dense Storage Solution

- Most economical and scalable parallel file system building block
- Up to 48 TB in 4RU
- Up to 2TB of SSD
- Direct cabling to IB switch

Software

DEVELOPER TOOLS
GRID ENGINE
PROVISIONING

solaris

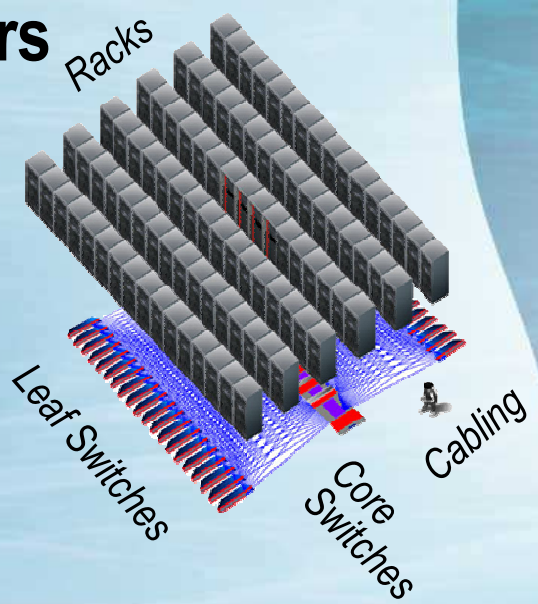
Comprehensive Software Stack

- Integrated developer tools
- Integrated Grid Engine infrastructure
- Provisioning, monitoring, patching
- Simplified inventory management

Sun Constellation System Open Petascale Architecture

Radical Simplicity, Faster Time to Deployment

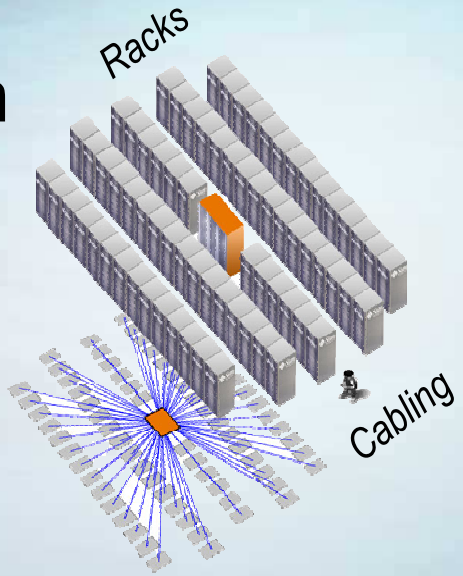
Competitors Compute Clusters



Competitors Cabling Infrastructure

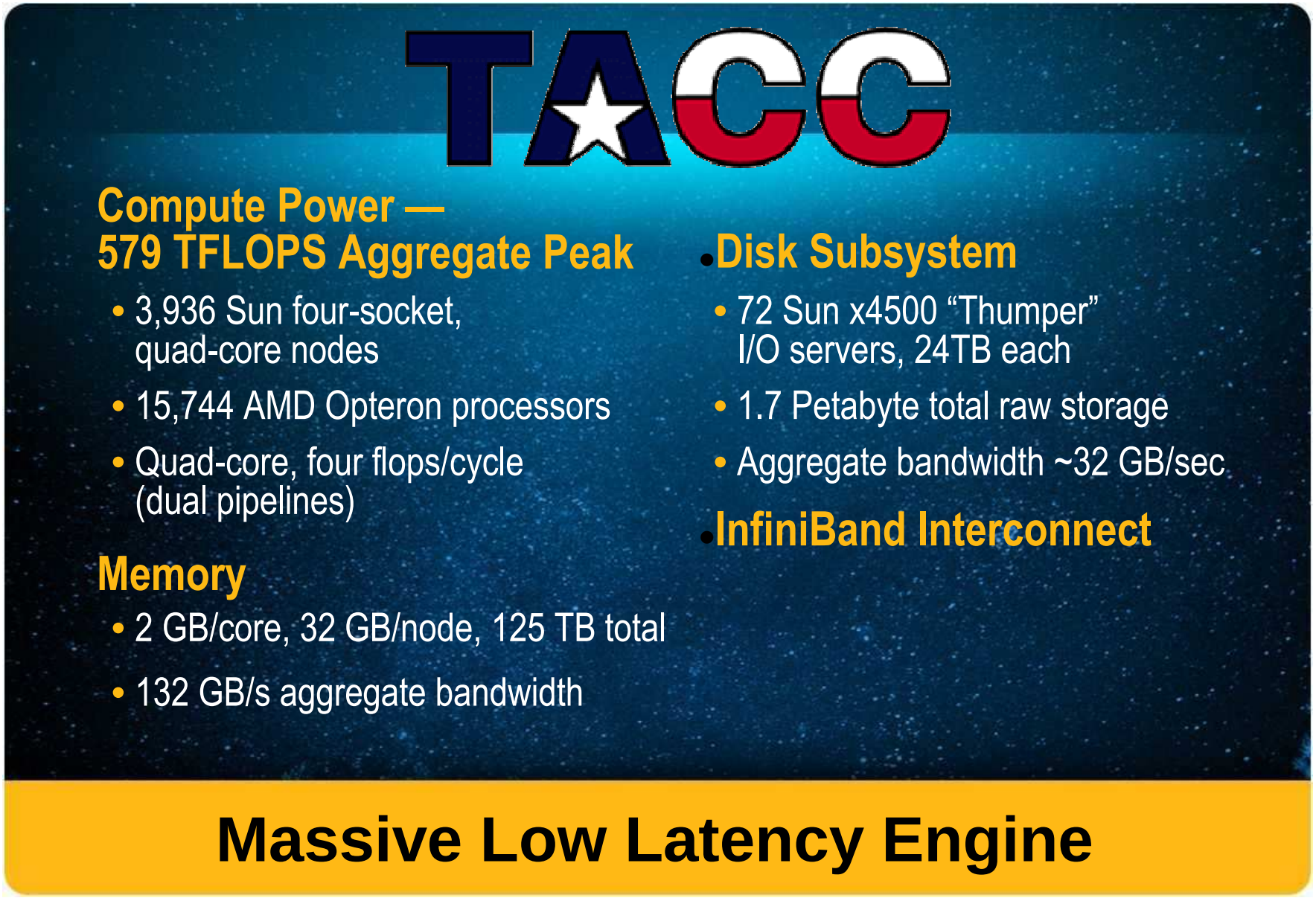
- **Alternative Open Standards Fabric**
- 300 switching elements
- 6912 cables
- 92 racks

Sun Constellation System Cluster



Reduced Cabling

- 1 switching element **300:1 reduction**
- 1152 cables **6:1 reduction**
- 74 racks **20% smaller footprint**

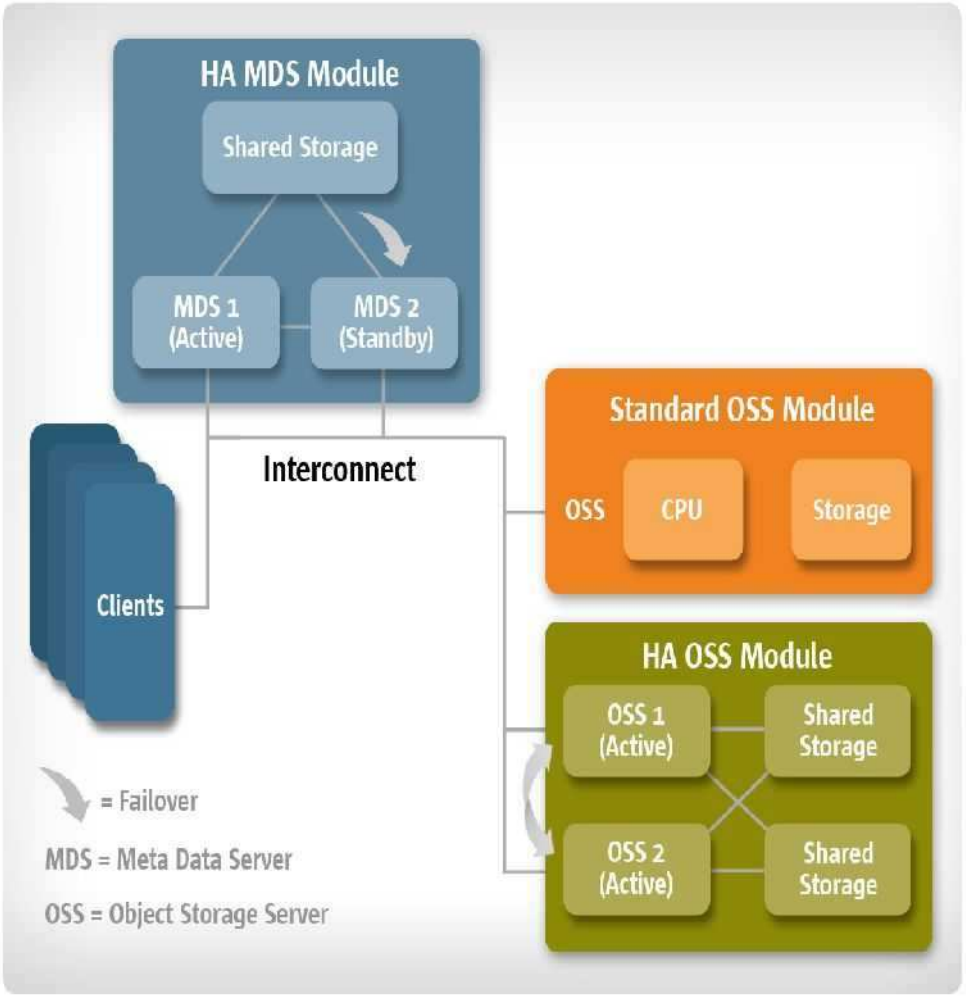

TACC
Compute Power —
579 TFLOPS Aggregate Peak
• 3,936 Sun four-socket, quad-core nodes
• 15,744 AMD Opteron processors
• Quad-core, four flops/cycle (dual pipelines)
Memory
• 2 GB/core, 32 GB/node, 125 TB total
• 132 GB/s aggregate bandwidth
Disk Subsystem
• 72 Sun x4500 "Thumper" I/O servers, 24TB each
• 1.7 Petabyte total raw storage
• Aggregate bandwidth ~32 GB/sec
InfiniBand Interconnect
Massive Low Latency Engine

The HPC Data I/O Challenge

- Compute power is scaling rapidly
  - Larger compute clusters
  - More sockets per server
  - More cores per CPU
- Compute advances far outpace those in I/O
  - Storage latency 12 orders of magnitude higher than compute
  - Compute Side developed Parallel Approaches sooner
- Need a better approach to feed compute
  - Cluster performance is often limited by data I/O
  - Need a parallel I/O approach to help balance things

Parallel Storage

Sun Storage Cluster



- Lustre and Open Storage providing a wide range of Scaling and Performance for a wide range of cluster sizes
- Breakthrough economics
  - > Up to 50% cost savings vs. competitors
- Simplified deployment and management of Lustre storage

Unique Capabilities from Sun lustre®

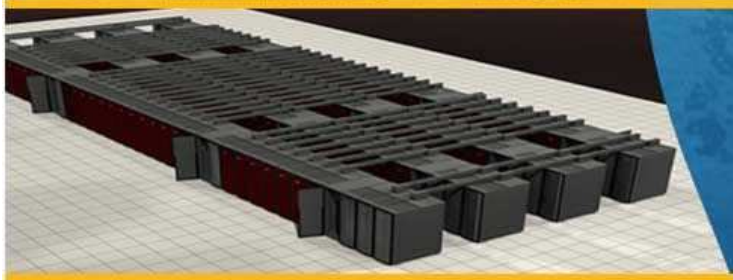
Sun Storage Cluster

- High performance and broad scaling
  - > From a few to over 100 GB/second
  - > From dozens to thousands of nodes
- Breakthrough economics, up to 50% savings
  - > Built with standardized hardware and open source software vs. proprietary products
- Simplifying Lustre for the mainstream
  - > Pre-defined modules speed deployment of parallel file system, available factory integrated
  - > Ease of use improvements – patchless clients, integrated driver stack, LNET self-test, mount-based cluster configuration, many more

Lustre in Action

TACC Ranger

1.73 PB storage, 35GB/s I/O throughput,
3,936 quad-core clients



Sandia Red Storm

340 TB Storage, 50GB/s I/O throughput,
25,000 clients

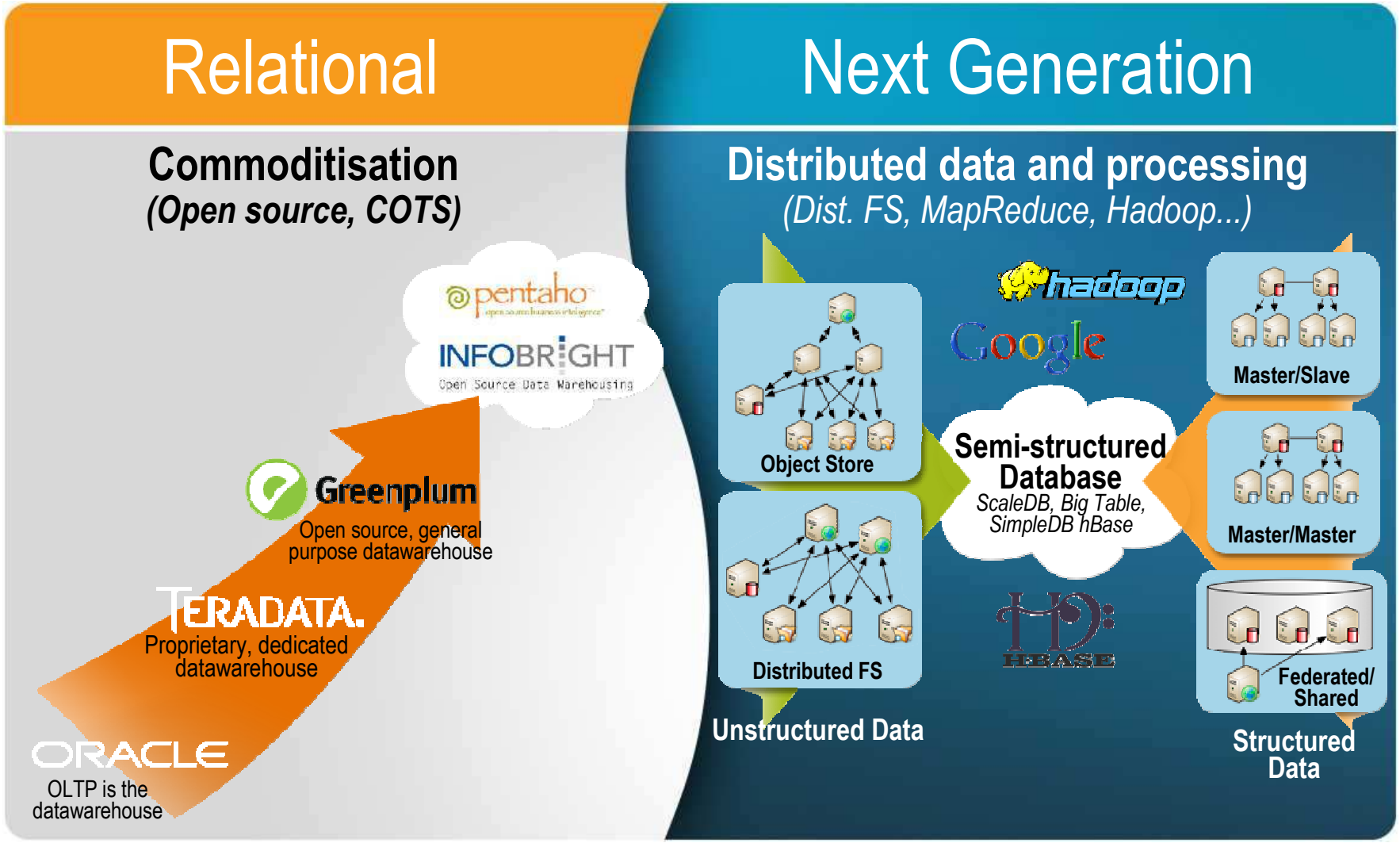
Framestore

"The Tale of Despereaux"
200TB Lustre file system – averaged 1.2GB/s in sustained reads,
peaks of 3GB/s, 5TB data generated per night from cluster
of 4,000 cores interfacing with Lustre file system

German Climate Research Data Centre (DKRZ)

272 TB, Lustre and Storage Archive Manager,
256 nodes with 1024 cores

Big Data Key Trends



Big Data

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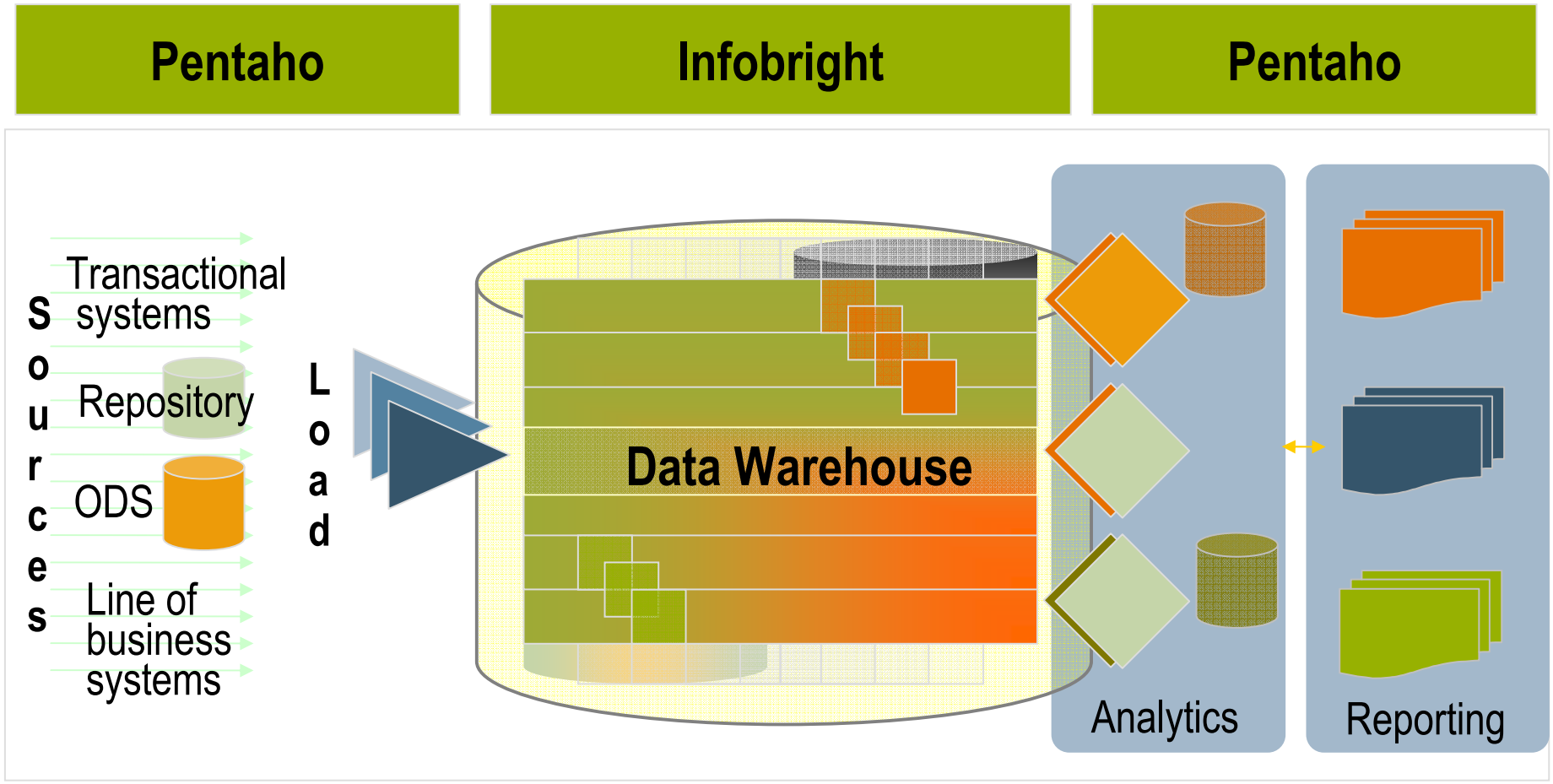
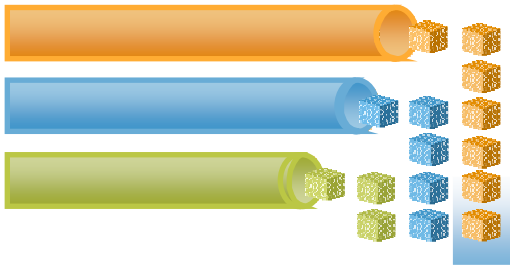
Typical BI/DW Components



Column-Orientation

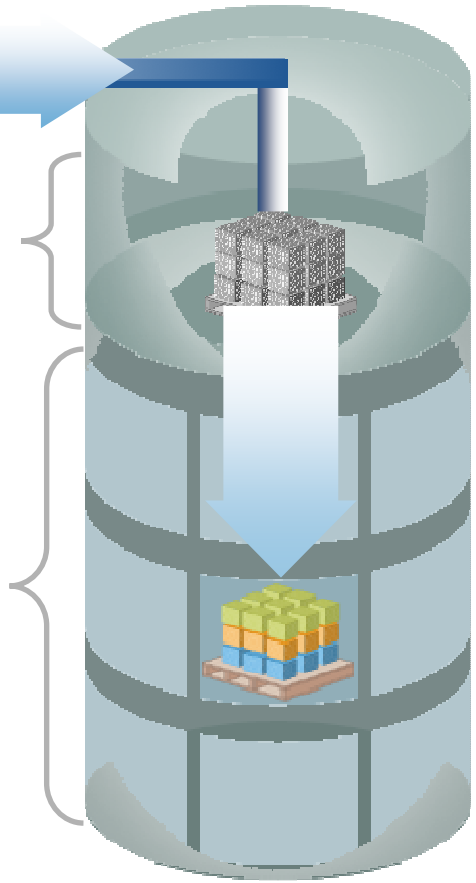
Exemplified by InfoBright's approach



Data Packs – data stored in manageably sized, highly **compressed data** packs

Knowledge Grid – statistics and metadata "describing" the super-compressed data which is automatically updated as data packs are created or updated

Infobright Optimizer iterates over the Knowledge Grid; only the data packs needed to resolve the query are decompressed

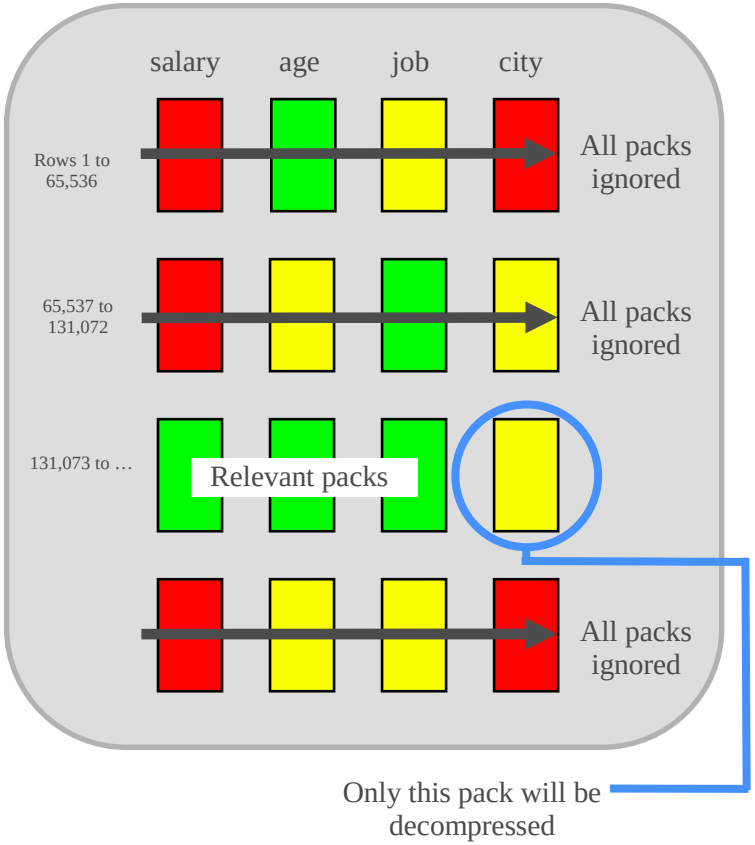


Smarter architecture

- Load data and go
- No indexes or partitions to build and maintain, no tuning
- Super-compact data foot- print leverages off-the-shelf hardware
- MySQL wrapper connects to BI and ETL tools

InfoBright Query Execution

`employees` records stored in Data Packs of 64k elements each




```
SELECT COUNT(*) FROM employees
 WHERE salary > 50000
 AND age < 65
 AND job = 'Shipping'
 AND city = 'TORONTO';
```

Using the Knowledge Grid, we verify, which packs are

- irrelevant (**no** values found that fit SELECT criteria)
- relevant (**all** values fit)
- suspect (**some** values fit)

Any row containing 1 or more irrelevant DP's is ignored.

Since we are looking for COUNT(*) in this case we do not need decompress relevant packs. COUNT information is kept in the Knowledge Grid in the Data Pack Nodes.

The suspect packs must be decompressed for detailed evaluation.