Smarter Workload Optimization – IBM Software And POWER Unleashed
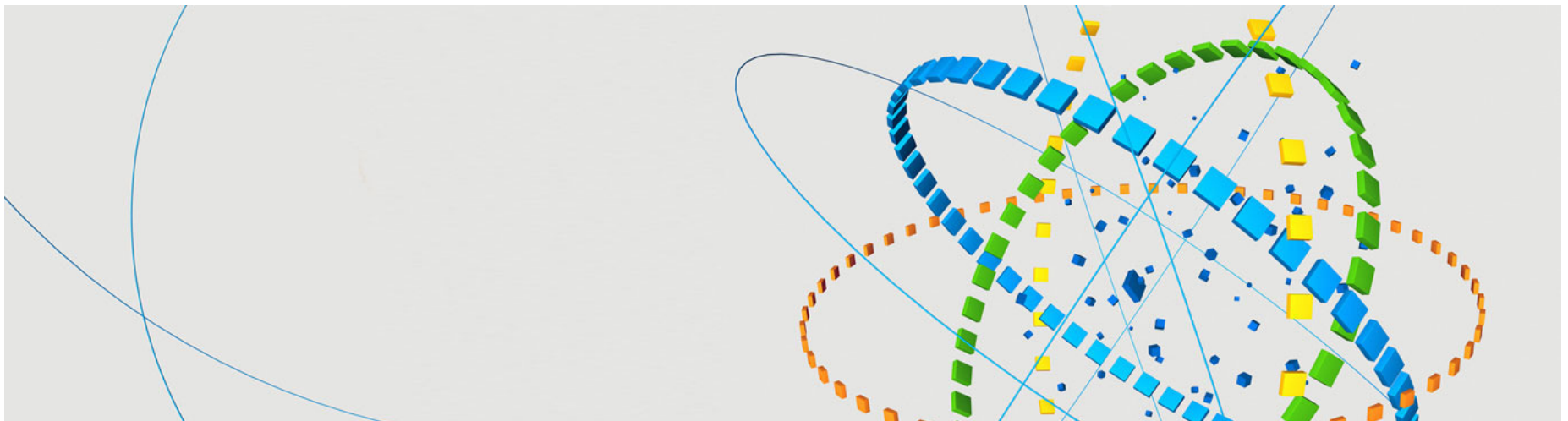
IBM

Analytics and OLTP On POWER – DB2 Engine Optimized for Smarter Computing

IBMDiscovery**Days**2011

Copies of Today's Presentations:
http://www.ibm.com/developerworks/offers/techbriefings/details/power.html

Efficient Data Processing And Analytics
To Handle Exploding Demand

Explosive Growth of Data

IBM Software
Designed to optimize IBM servers and storage for analytics and data management

Tivoli. software
Lotus. software
Rational software
WebSphere. software
Information Management

IBM Hardware Capabilities
IBM Power Systems, IBM Storage Systems – plus purpose-built innovations likeTurboCore, DB2 pureScale, Smart Analytics, and Easy Tier
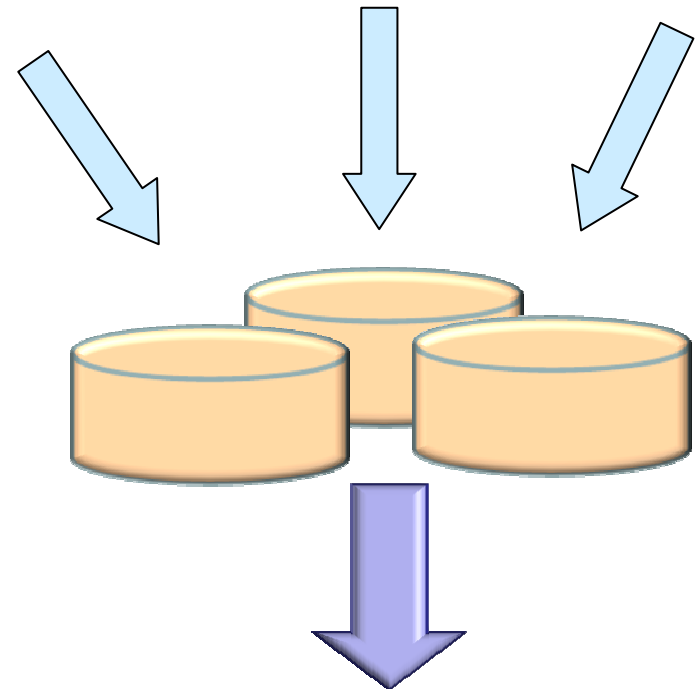
IBM Analytics and OLTP
Drive Business Success
Seize Opportunity!

Data Processing Workloads Have Different Characteristics

ONLINE TRANSACTION PROCESSING (OLTP)

Data Warehouse & Analytics

- Up to thousands of users

- Queries with quick response

- Smaller databases (up to terabytes)

- Mostly random I/O

- Fewer users

- Complex queries and reports

- Large databases (up to petabytes)

- Mostly sequential I/O

Different Requirements Demand Different Optimizations For Each Type Of Workload
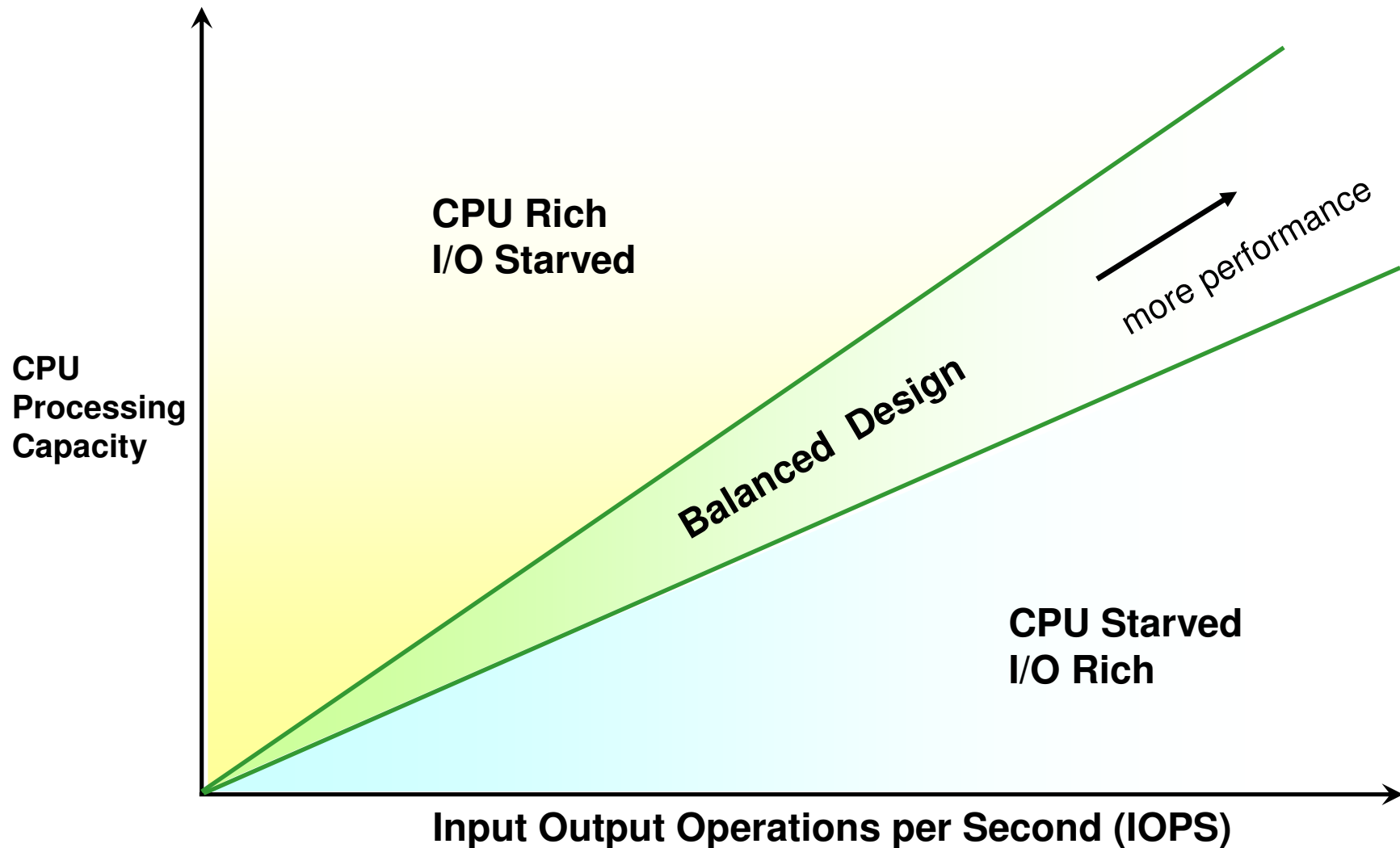
ONLINE TRANSACTION PROCESSING (OLTP)

Data Warehouse & Analytics

IBM Power Systems, DB2 and Storwize V7000

IBM Smart Analytics System 7700

Database OLTP Performance Is Bound By Two Key Capabilities

CPU Processing Capacity

CPU Rich
I/O Starved

Balanced Design

more performance

CPU Starved
I/O Rich

Input Output Operations per Second (IOPS)

Attributes Of Balanced Servers, Top 30% Of TPC-C Benchmark Servers

Balanced Systems - Top 30% TPC-C
CPU and IOPS used
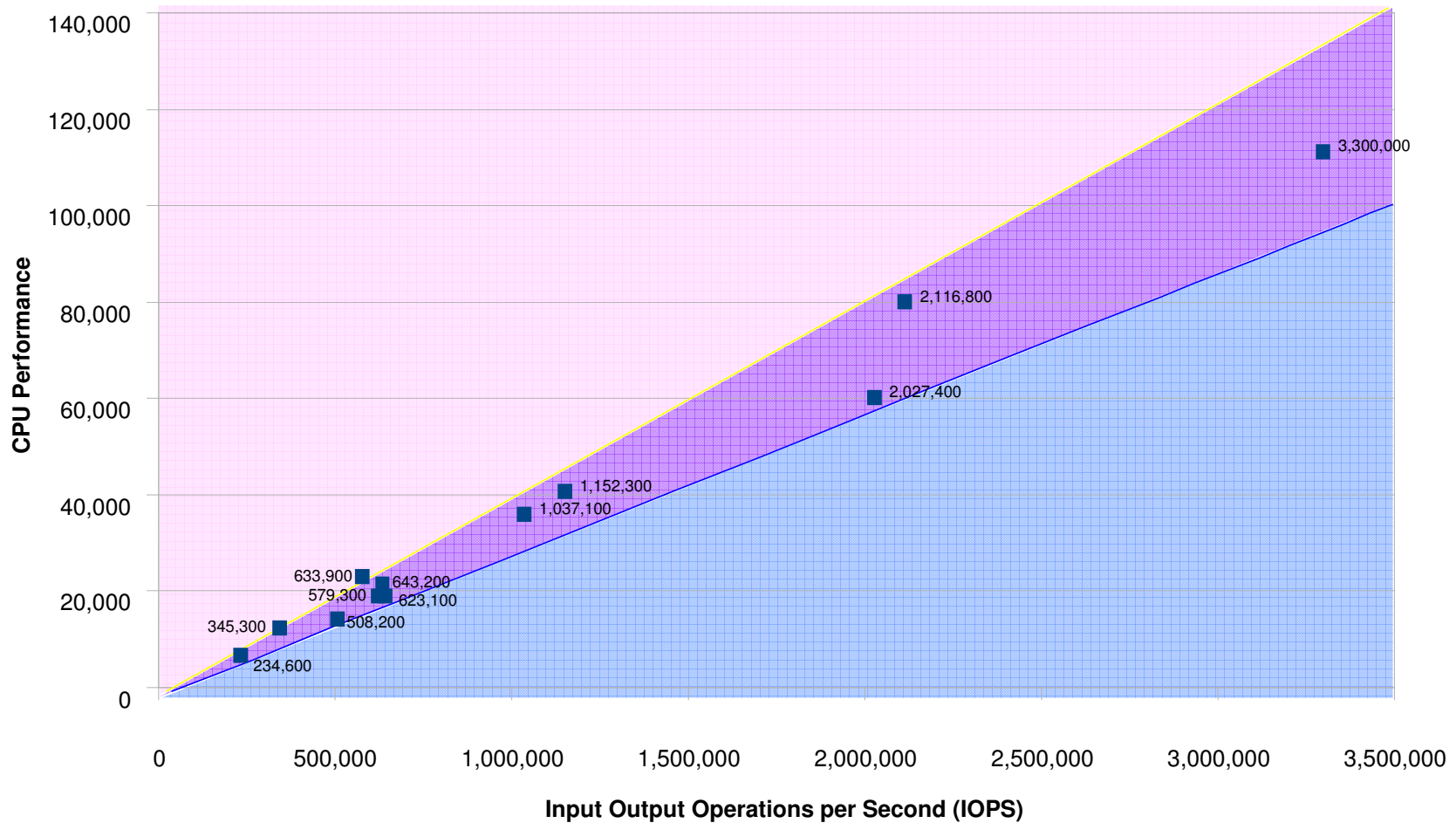
DB2 Is Optimized For POWER Architecture

- DB2 can scale by effectively utilizing the multiple threads available in Power SMP servers

- DB2 is tuned for the POWER architecture
  - ▶ Supports AIX 64KB, 16MB and 16GB large page sizes for buffer pools
  - ▶ Leverages POWER Hardware Decimal Floating Point
  - ▶ DB2 is integrated to work with AIX Workload Management (WLM)

- Storwize V7000 Solid State Storage with Easy Tier delivers more I/O bandwidth

Deep integration of software/hardware/storage is needed to take advantage of all available resources

POWER7 Hardware Can Be Optimized For Data Intensive Workloads
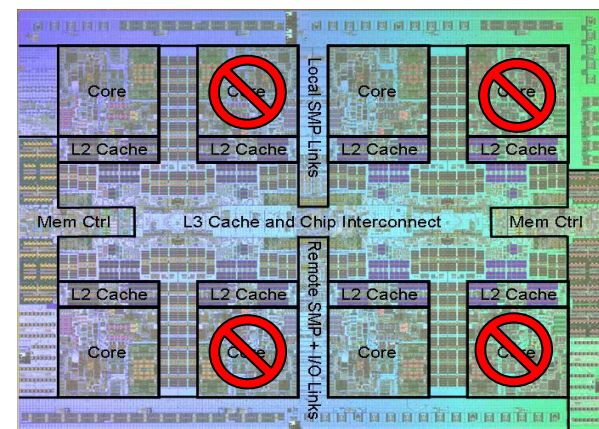
MAX CORE

- 8 cores share common 32MB of L3 cache

- Clock rate 3.8 GHz

- CPU intensive workloads have up to **20%** better price/performance running like this
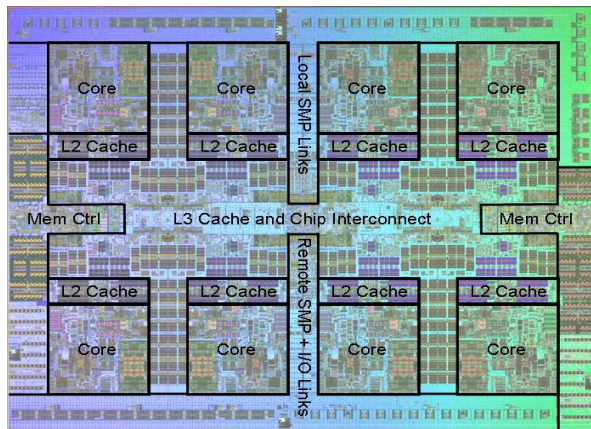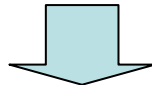
TURBO CORE

- 4 cores share same 32MB of L3 cache (turn off 4 cores)

- Clock rate 4.1 GHz (thermal reduction)

- Data intensive workloads have up to **7%** better price/performance running like this
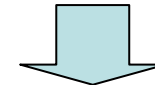
Optimized Database Performance – DB2 On Power 780 With TurboCore

DB2 efficiency leads in Performance Per Core which drives down cost.
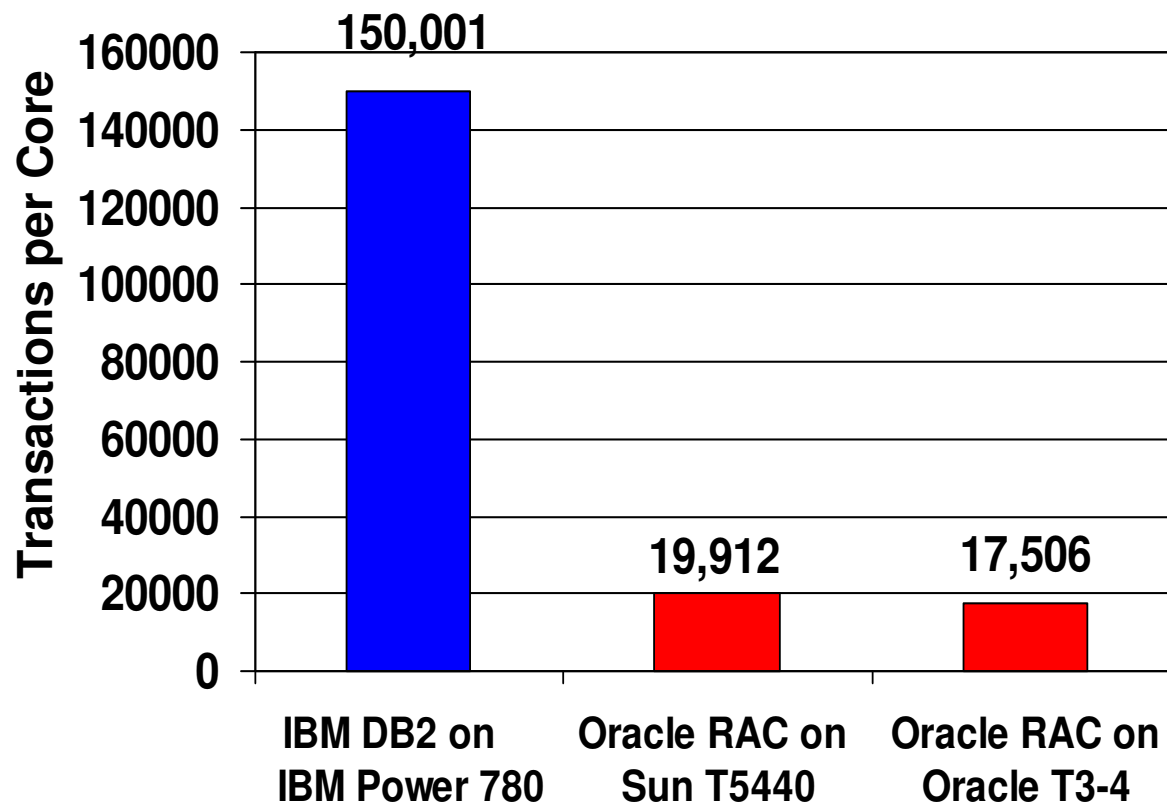
IBM DB2 can do more than 8x more transactions per core than Oracle

8 to 1

03 - Analytics & OLTP on POWER Q3.1

DB2 Clustering Provides Even More Processing Capacity

- DB2 pureScale is a cluster of DB2 servers supporting one logical database

- Design based on proven mainframe Parallel Sysplex design to achieve near linear scaling

High-speed centralized lock and cache management
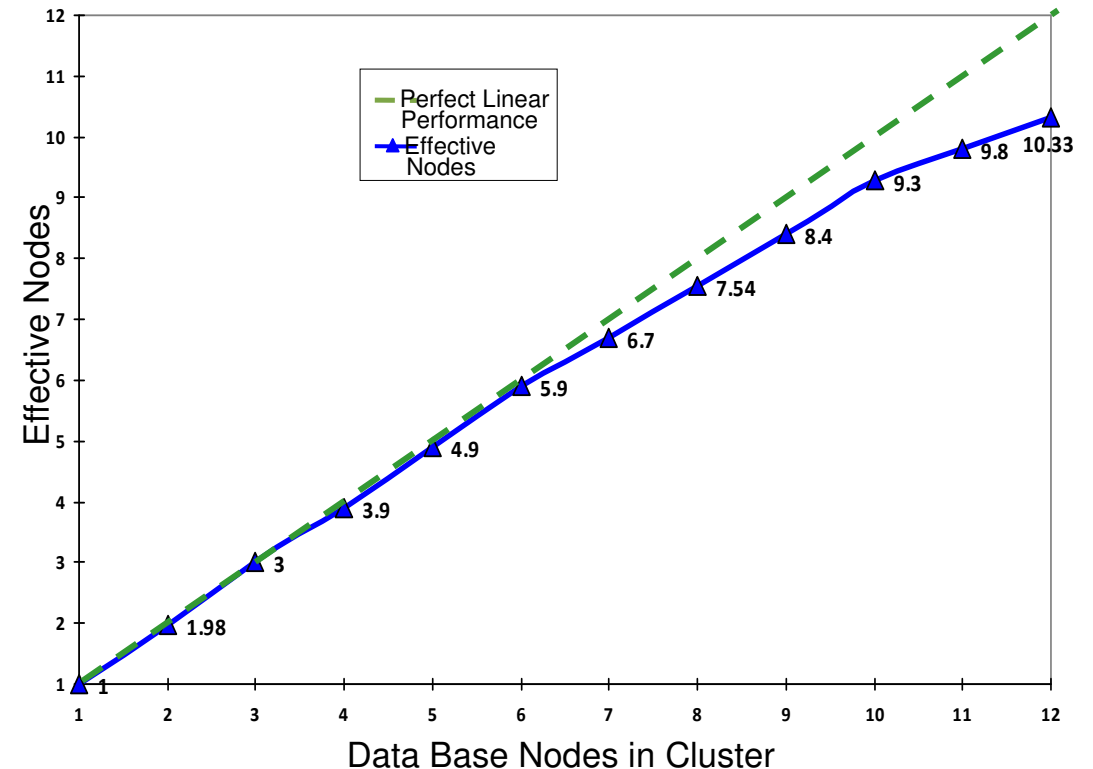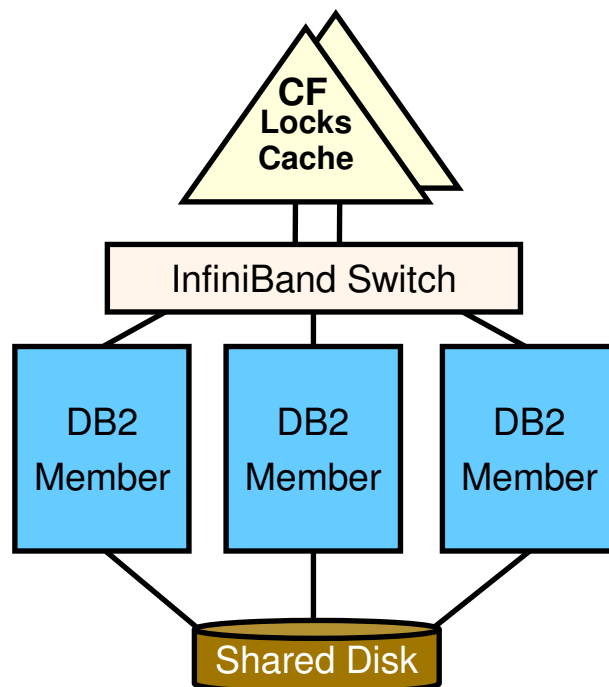
Source: IBM Software Group Internal Study

Without Application Changes And Extensive Database Tuning, Oracle RAC Does Not Scale

Oracle RAC
Distributed Design

| InfiniBand Switch |

Locks	Locks	Locks
Cache	Cache	Cache
Database Node	Database Node	Database Node

Shared Disk
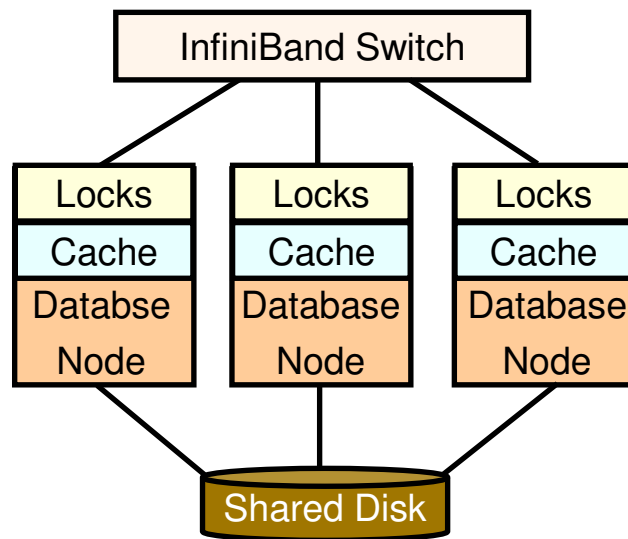
Inefficient distributed locking and buffer management limits scaling

Oracle RAC
Poor Scalability

Effective Nodes vs Data Base Nodes in Cluster

- Perfect Linear Performance
- Effective Nodes

1.69
2.44
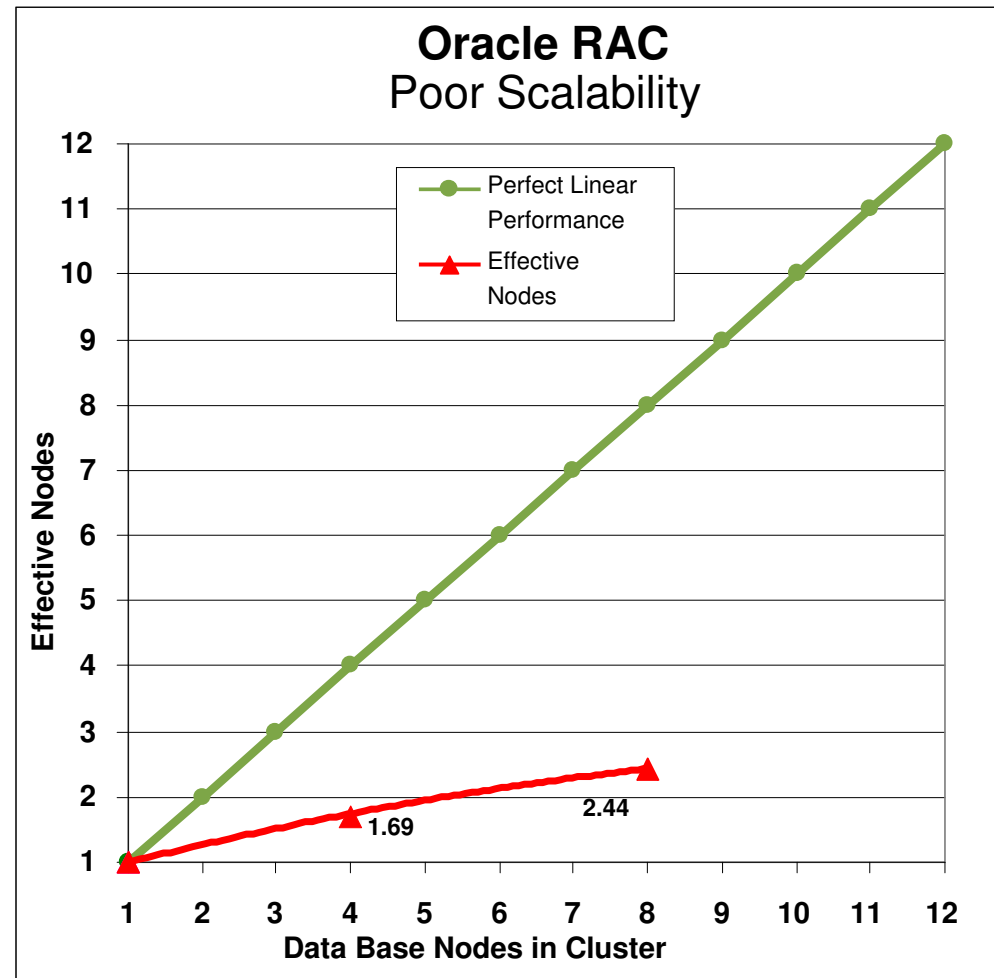
More Processing Power Requires More IOPS

CPU Processing Capacity

Balanced Design (Optimum price/performance)

Efficient use of fast processors

Efficient use of SSD storage and caching

IOPS (Input Output Operations per Second)
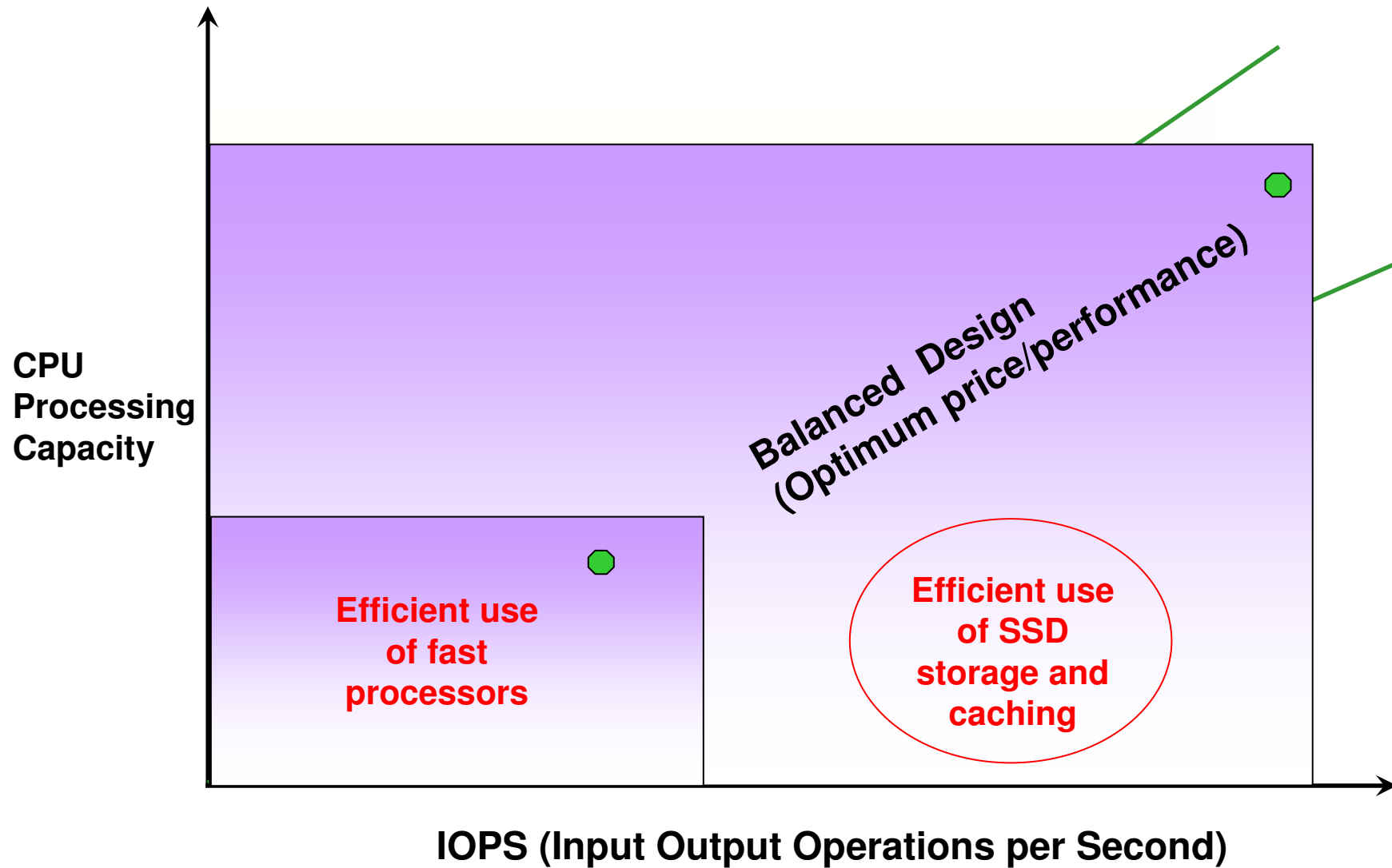
Solid State Drives Are Revolutionizing Storage Performance

Hard Disk Drives

SATA /SAS interface

200 IOP's

$0.73/GB

$7.5/IOPS

IBM 2TB SATA
3.5" LFF HDD
Cost: $1499.00

SAS interface

300 IOP's

$3.66/GB

$3.7/IOPS

IBM 300GB 10K SAS
2.5" SFF Slim-HS HDD
Cost: $1099.00

Solid State Storage

SAS interface

45,000 IOP's

$88.00/GB

$0.59/IOPS

SLC Durability

IBM 300GB
2.5" SFF SAS SSD
Cost: $26,399

PCIe interface

100,000 IOP's

$25.93/GB

$0.08/IOPS

MLC Durability

IBM 320GB HIGH IOP MS
CLASS SSD PCIe ADPT
Cost: $8,299

Easy Tier In Storwize V7000 Automatically Optimizes Use Of SSD

- Migrates data extents between SSD and HDD in same pool
  - ► Automatic hotspot detection
- Virtualized SSD is shared across all workloads using the pool
- More cost effective use of SSD versus ad hoc dedicated assignment
- Transparent to applications, no code changes required

SSD Array

Cold data migrates down   Hot data migrates up

HDD Array

Power 750

Overall Transactions per seconds

~9x tps improvement!!
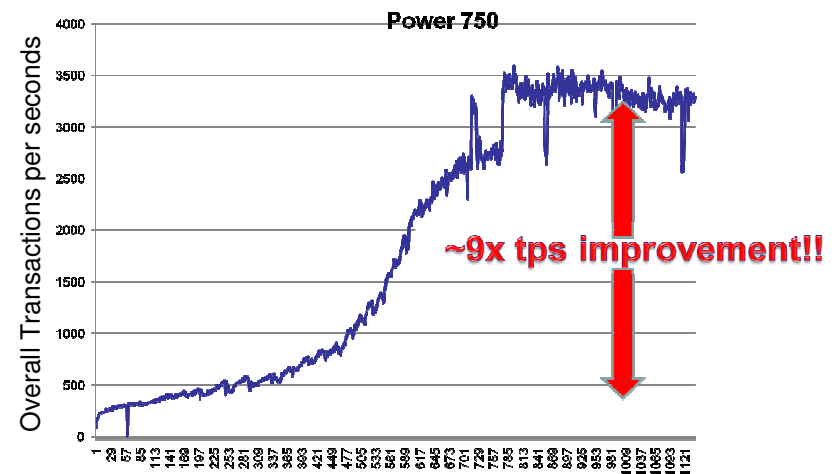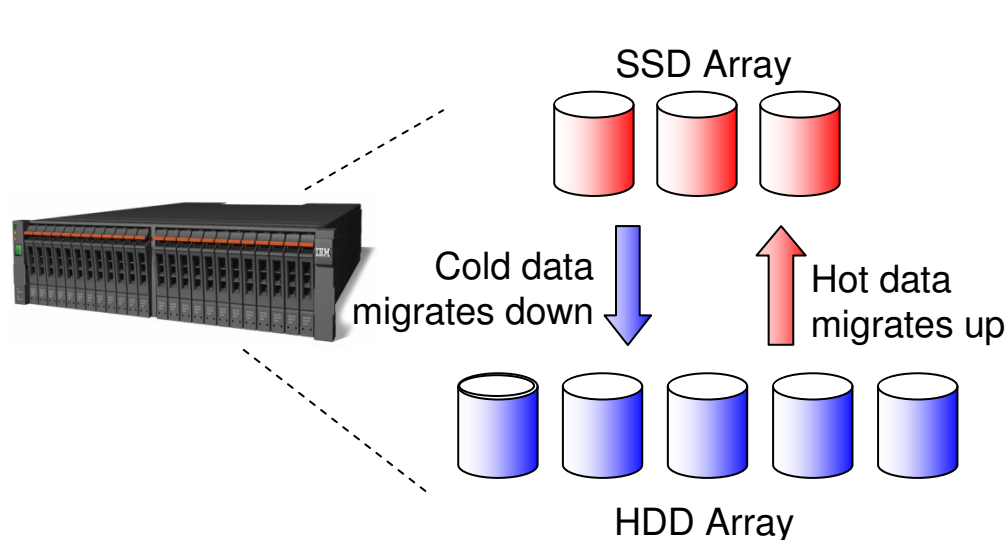
Example: Complex database transactional workload

System Comparison Of Competitor Versus IBM Power 740 + DB2 + Storwize V7000

Competitor Database Machine
(2 DBMS Nodes, 3 Storage Devices)
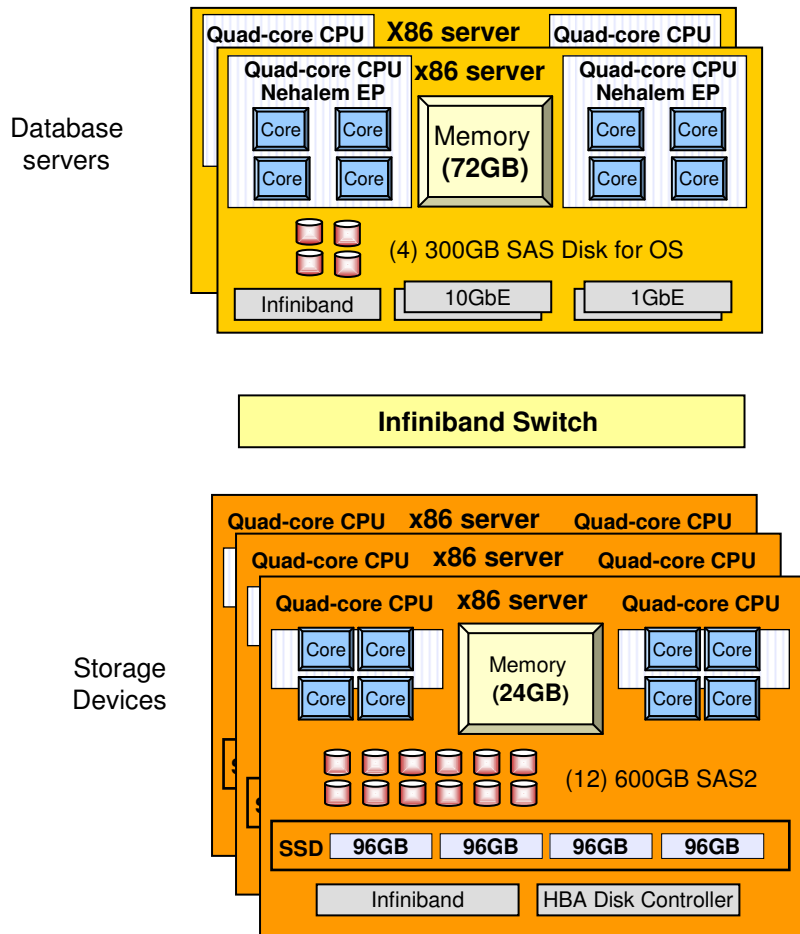
IBM POWER 740
16 cores (3.55 GHz)

Database servers

X86 server — Quad-core CPU / Quad-core CPU
x86 server — Quad-core CPU Nehalem EP (Core, Core, Core, Core) / Memory (72GB) / Quad-core CPU Nehalem EP (Core, Core, Core, Core)

(4) 300GB SAS Disk for OS

Infiniband | 10GbE | 1GbE

P740

Octa-core CPU (Core, Core, Core, Core, Core, Core, Core, Core)
Octa-core CPU (Core, Core, Core, Core, Core, Core, Core, Core)

Memory **(64 GB)**

(2) 146GB SAS 15K Disk for OS

Fibre HBA | Fibre HBA

Infiniband Switch

Storage Devices

x86 server — Quad-core CPU / Quad-core CPU
x86 server — Quad-core CPU / Quad-core CPU
x86 server — Quad-core CPU (Core, Core, Core, Core) / Memory (24GB) / Quad-core CPU (Core, Core, Core, Core)

(12) 600GB SAS2

SSD | 96GB | 96GB | 96GB | 96GB

Infiniband | HBA Disk Controller

SAN Switch (x2)

Storwize V7000

HDD

(36) 300 GB 10K RPM

SSD | 300 GB | 300 GB | 300 GB | 300 GB

POWER 740 with Storwize V7000 **Costs 61% Less**

3YR TCA = $2,230,481

3 YR TCA = $877,254

3 year total cost of acquisition includes hardware, software, service & support. Based on US list prices, prices will vary by country

Brokerage On-Line Transaction Processing Workload

- **More realistic OLTP workload models brokerage requirements**
  - ▶ Based on TPC-E but not a full implementation – so tpc-e "like"

- **Typical requirements**
  - ▶ Sub-second response times
  - ▶ Multiple systems with simultaneous access
    - – Customer/Client Access
    - – System updates (ingest stream)
    - – 3rd Party Access

- **Data Application Architecture**
  - ▶ Multiple tables, indexes, and data types
  - ▶ Requires referential integrity
  - ▶ Complex transactions
  - ▶ Multiple interacting subsystems

Customers

Stock Exchange

Brokerage House

System Under Test
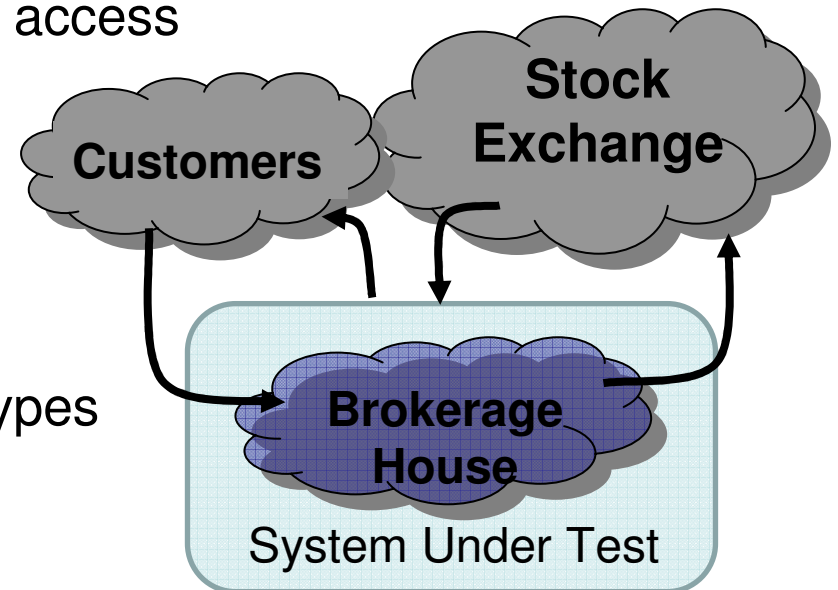
IBM Power 740 + DB2 + Storwize v7000 Delivers Better OLTP Throughput And Response Time

DB2 on Power 740 with Storwize V7000 vs. Competitor Transaction Throughput

DB2 on Power 740 with Storwize V7000 vs. Competitor Transaction Response Time

Transactions Per Second

- 4,000
- 3,500
- 3,000
- 2,500
- 2,000
- 1,500
- 1,000
- 500
- 0

3,406

1,982

■ Competitor ■ DB2 on Power
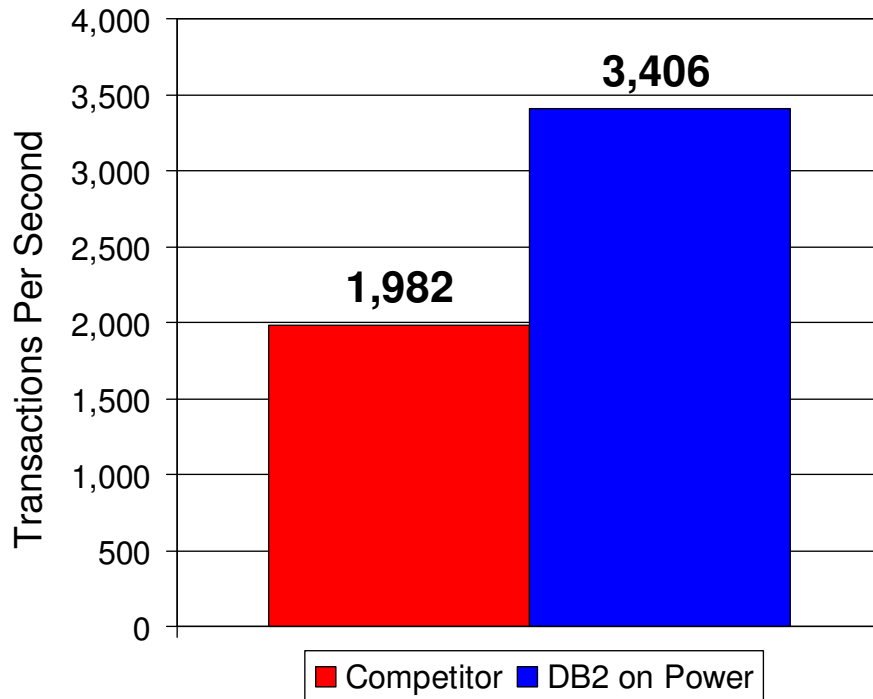
(Higher is Better)

1.7x more throughput

Transaction Average Response Time (ms)

- 50.0
- 40.0
- 30.0
- 20.0
- 10.0
- 0.0

40.5

20.6

■ Competitor ■ DB2 on Power
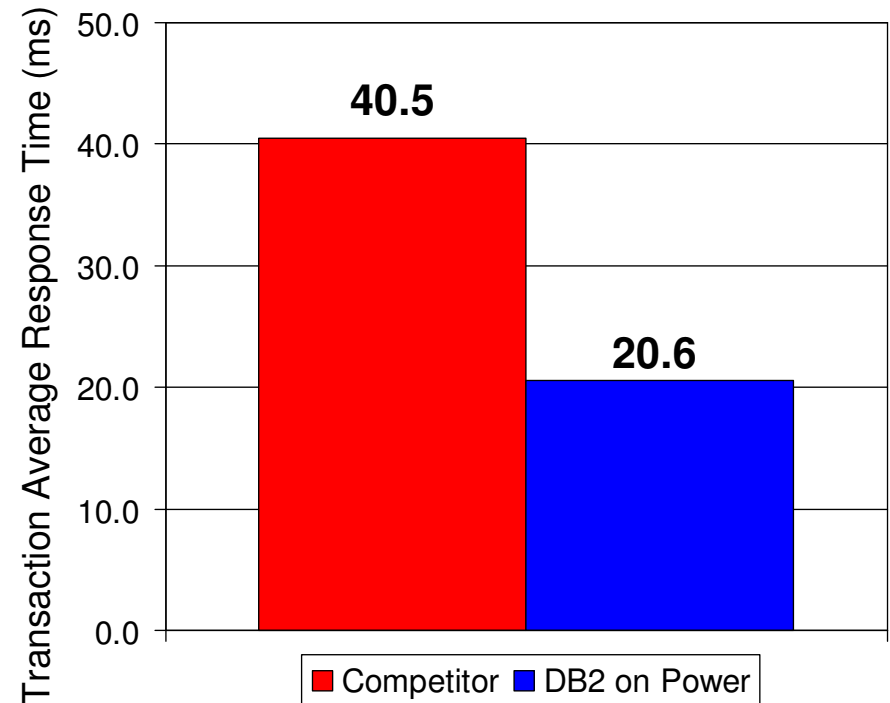
(Lower is Better)

2.0x faster response time

Performance numbers may vary based on workload profiles.

DB2 on Power 740 Delivers Even More Dramatic Savings

DB2 on Power 740 with Storwize V7000 vs.
Competitor Cost Per Transaction per second

Cost Per Transaction Per Second ($)

- Competitor: **$1,125**
- DB2 on Power: **$258**

Legend:
- 🟥 Competitor 🟦 DB2 on Power
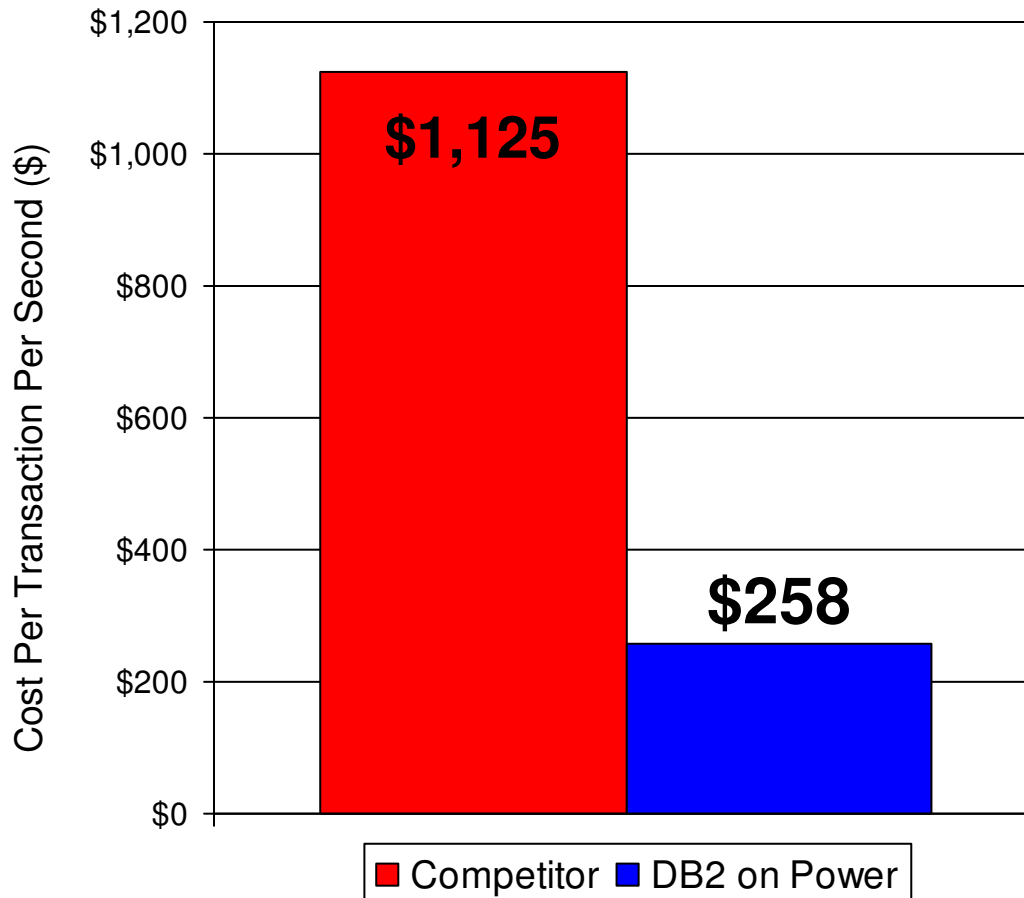
(Lower is better)

77%
lower cost
per transaction
per second
than competitor

Performance numbers may vary based on workload profiles.
3 year total cost of acquisition includes hardware,
software, service & support.
Based on US list prices, prices will vary by country.

… And DB2 Compression Gives An Additional 20% Performance Boost

- DB2 saves more space than the competition

- Compression can help performance by reducing I/O data traffic

- Enabling DB2 compression improved performance an additional 20% at no extra cost
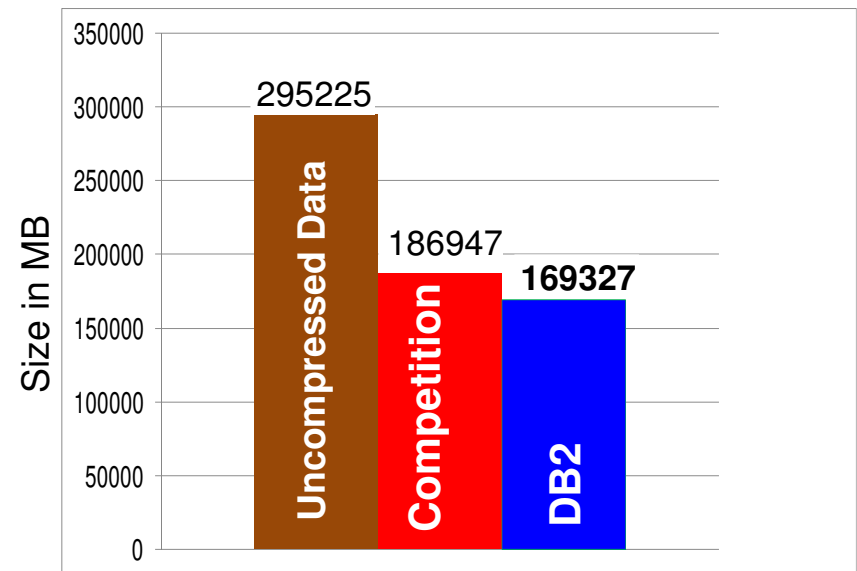
DB2, Power, And Storwize Beat The Competitor In OLTP

Evaluation Criteria	IBM	Competitor
DB2 and DB2 pureScale are optimized for Power architecture	Yes	No
DB2 pureScale scales much better than Oracle RAC at a lower cost of acquisition	Yes	No
DB2 on Power with Storwize V7000 provides better throughput and response than competitor	Yes	No
DB2 on Power with Storwize V7000 provides a lower cost per transaction (61% lower) than competitor	Yes	No
DB2 compresses data better than competitor at no additional cost	Yes	No

Characteristics Of Business Analytics Workload

ONLINE TRANSACTION PROCESSING (OLTP)

Data Warehouse & Analytics

- Up to thousands of users
- Queries with quick response
- Smaller databases (up to terabytes)
- Mostly random I/O

- Fewer users
- Complex queries and reports
- Large databases (up to petabytes)
- Mostly sequential I/O

Using Cognos Business Analytics To Improve Business Results

If we can identify our risky mortgage assets, we can work to remove them from our books.

We can identify risky mortgage customers by watching their activities in other business areas
- ▶ Bounced checks
- ▶ Missed credit card payments
- ▶ Missed loan payments.

Service Oriented Finance CIO

Mortgage Line of Business VP

Use Cognos To Unlock The Useful Insights In Your Data

- Predictive insight
- Consistent measurement of business performance
- Anticipate and explore new opportunities

With Cognos

Without Cognos

Without Cognos	With Cognos
Sense and respond	Predict and act
Instinct and intuition	Real-time, fact-driven
Skilled analytics experts	Everyone
Back office	Point of impact
Automated	Optimized

Increase Revenue

Increase Productivity

Reduce Costs

Reduce Risk
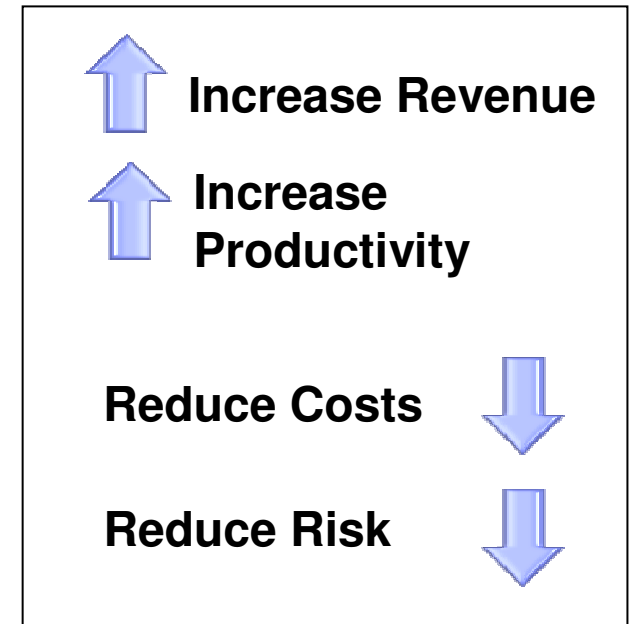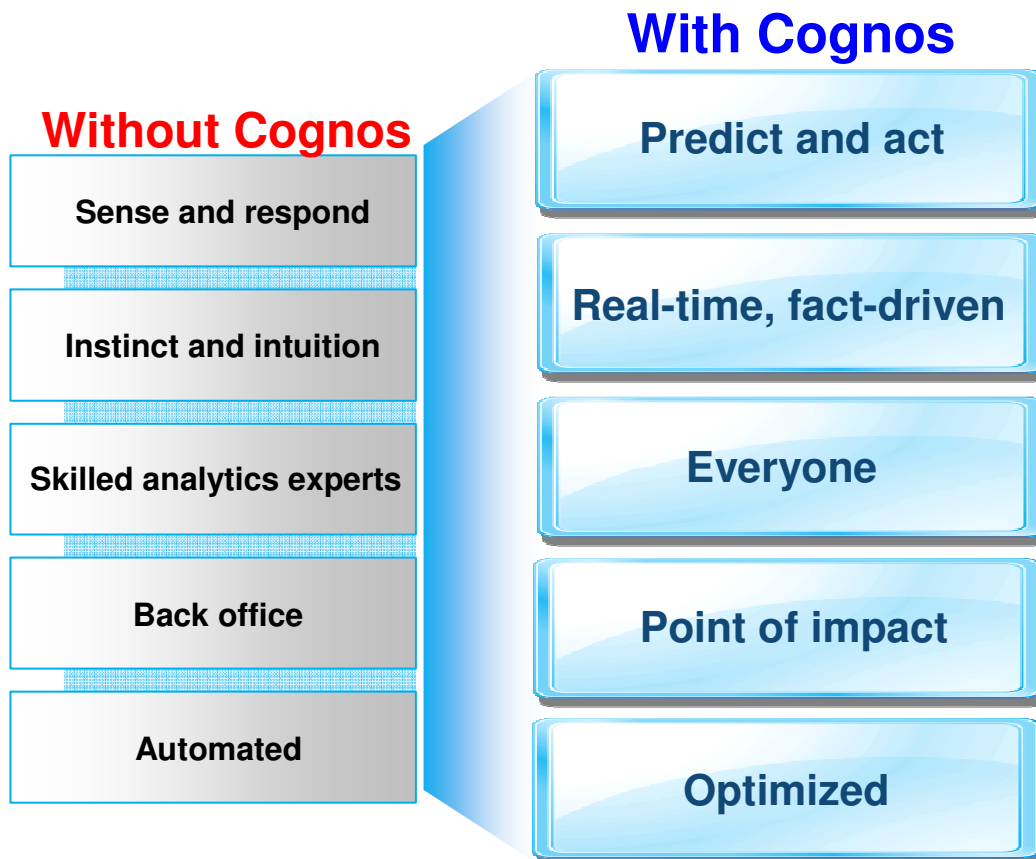
DEMO: Identify Risky Mortgage Accounts Using Cognos Business Intelligence

1. Show report generated in Cognos Report Studio in PDF format

2. Report identifies high-risk mortgages by looking at negative credit events in customers other SOF accounts (CC, Checking, etc…)

3. Report uses both structured and unstructured data (link to mortgage data stored in FileNet)
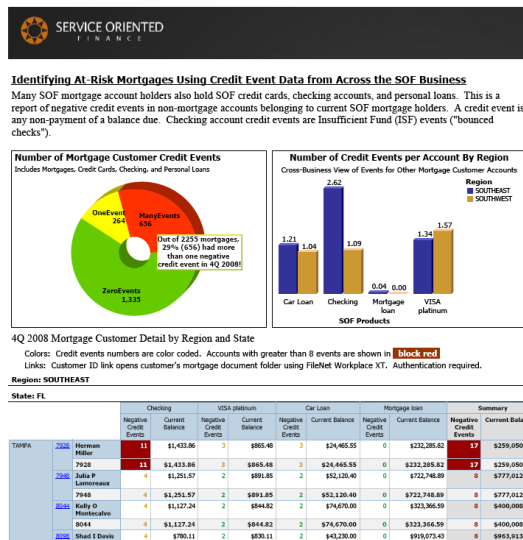
> That report is just what the executives wanted!

Mortgage Line of Business VP

- At risk customers are identified and contacted to refinance
- Risky mortgages can be sold

Business Analytic Assets Created By Cognos

Published Reports

HTML, PDF, Excel, CSV, email, mobile, ...more

Self-Service Report Specifications

Query Studio

Professional Report Specifications

Report Studio

Common Metadata Model

Data Warehouse

Analytic Report Specifications

Credit Events	Credit	Deposit	Loan
SOUTHEAST	1,107		Drill Down
SOUTHWEST	441		Drill Up

Analysis Studio

Dashboards

Go! Dashboard

Scorecard Specifications

Metric Studio

Mix and Match for Delivery To Employees

Report Specification Assets

IBM Smart Analytics System 7700 – A Complete Workload Optimized Analytics Solution

- **A pre-integrated and tuned solution containing Cognos and InfoSphere Warehouse software, Power hardware, and IBM storage**

Analytics
- ☑ Optional Cognos 8 BI
- ☑ Cubing Services
- ☑ Optional SPSS 19
- ☑ Text Analytics & Data Mining

Data Warehouse Software
- ☑ InfoSphere Warehouse
- ☑ Advanced Workload Management
- ☑ Tivoli System Automation

Hardware/OS and Storage
- ☑ AIX 6.1
- ☑ IBM Power 740
- ☑ IBM System Storage DS3500
- ☑ SSD standard in all configurations

Faster Time To Value
Deploy in days instead of months
Eliminates installation, integration, configuration, and tuning requirements

Costs less than building it yourself
Less staff and expertise required to implement, tune, and maintain

Unique offering
Modular for flexibility and growth
No competitor offers such an integrated analytics solution

Find out more: http://www.ibm.com/smart-analytics-system

IBM Smart Analytics System 7700 Configurations

7700 Capacity Sizes	XS	S	M	L	XL	XXL
# Data Modules	1	2	3	6	10	20
Spinning Disk (TB)	28.8	57.6	86.4	172.8	280	560
Space available for index, temp, logs, system (TB)	9.35	18.8	28.1	56.3	98	196
Solid State Device for temp (standard) (TB)	0.7	1.4	2.1	4.2	7	14
Additional Solid Device for temp (optional) (TB)	Up to 4.2	Up to 8.4	Up to 12.6	Up to 25.2	Up to 40.2	Up to 80.4

Each data module is a Power 740 server with 16 cores, 128GB memory, 96 300GB disk drives

IBM Smart Analytics System 7700 Capabilities

Modular architecture provides flexible growth pathway

Pre-configured for optimum tuning

Proven Warehouse Performance via Data Partition Facility

Cubing Services for modeling Dimensional Data

7700 Admin Node

2 POWER7 Chips
(8 cores per Chip)

7700 Data Node

2 POWER7 Chips
(8 cores per Chip)

800GB Per Node PCIe-attached SSD for temp space

Optional Integrated Business Intelligence (Cognos)

SAN SWITCH (2)

DS3500

(24) 300 GB
10K RPM
SAS

DS3500

(24) 300 GB
10K RPM
SAS

DS3500

(24) 300 GB
10K RPM
SAS

Extra Small IBM Smart Analytics System 7700

1 Admin Node

1 Data Node, 4 DS3500 Storage Servers Per Data Node

Efficient RAID6 Disk Redundancy

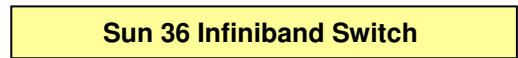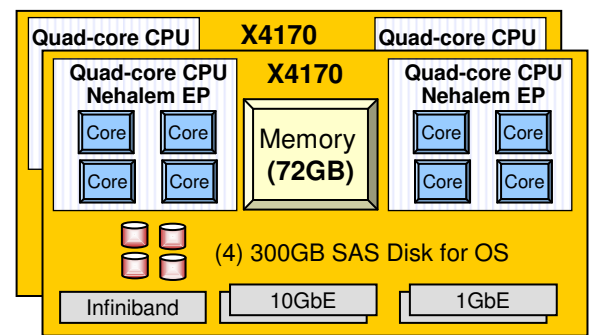Standard maintenance includes HW / SW support and software upgrades

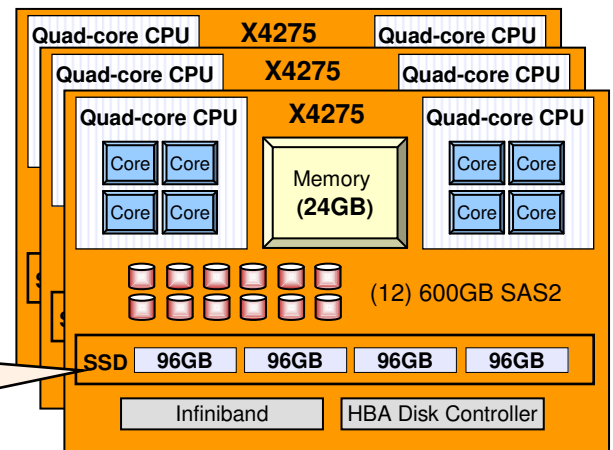# System Comparison Of Competitor With Smart Analytics 7700 R1 XS

Competitor V2 Database Machine ¼ Rack Size (2 DBMS Nodes, 3 Storage Cells)

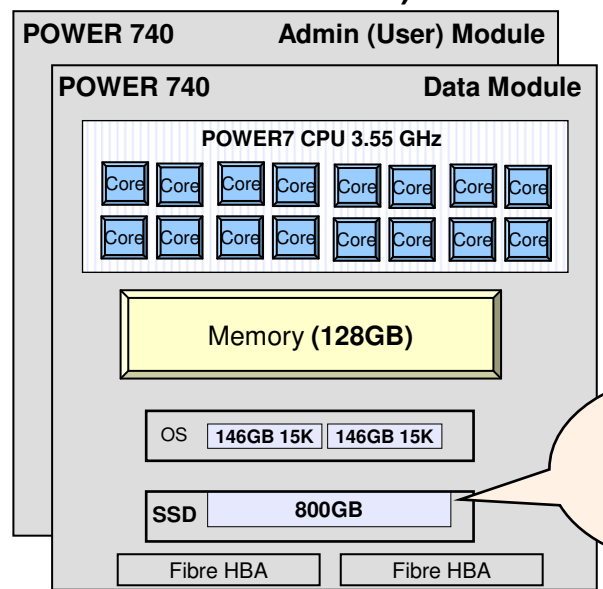**IBM Smart Analytic System 7700 R1 Extra Small Size (1 Admin Module, 1 Data Module)**
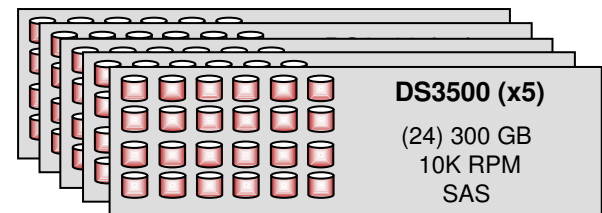
Oracle RAC DBMS

X4170
Quad-core CPU — Quad-core CPU
Quad-core CPU Nehalem EP — **X4170** — Quad-core CPU Nehalem EP
Core Core — Memory (72GB) — Core Core
Core Core — Core Core
(4) 300GB SAS Disk for OS
Infiniband — 10GbE — 1GbE

Sun 36 Infiniband Switch

Sandfly Storage Cells

X4275
Quad-core CPU — Quad-core CPU
Quad-core CPU — **X4275** — Quad-core CPU
Quad-core CPU — **X4275** — Quad-core CPU
Core Core — Memory (24GB) — Core Core
Core Core — Core Core
(12) 600GB SAS2
SSD — 96GB — 96GB — 96GB — 96GB
Infiniband — HBA Disk Controller

SSD used as cache

POWER 740 — Admin (User) Module

POWER 740 — Data Module

POWER7 CPU 3.55 GHz
Core Core Core Core Core Core Core Core
Core Core Core Core Core Core Core Core

Memory **(128GB)**

OS — 146GB 15K — 146GB 15K

SSD — 800GB

Fibre HBA — Fibre HBA

SSD used for temp space

SAN Switch (x2)

DS3500 (x5)
(24) 300 GB 10K RPM SAS

3YR TCA = $2,857,500

3 YR TCA = $2,817,500

Introducing BI Day Benchmark

- **BI Day Benchmark**
  - ▶ Based on a typical Cognos business analytics workload
  - ▶ Typical star schema data warehouse of 80 tables, ranging from 100GB to 10TB
  - ▶ Serial or concurrent test modes
  - ▶ Represents real world workloads

- **Industry benchmarks like TPC-H have lost relevance for customers**
  - ▶ Thousands of hours have been spent tuning TPC-H benchmarks (Real customers can't afford to do this)
  - ▶ Large benchmark results are achieved using unrealistic and impractical hardware configurations
  - ▶ TPC-H has only 8 tables and is not a star/snowflake schema

BI Day – Serial Test Mode

1 user executes
complex reports

…then... executes
intermediate reports

…then… executes
simple reports

1 User

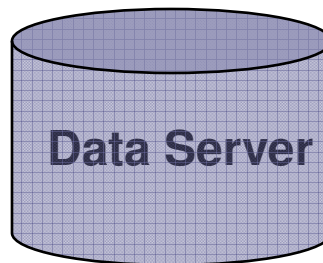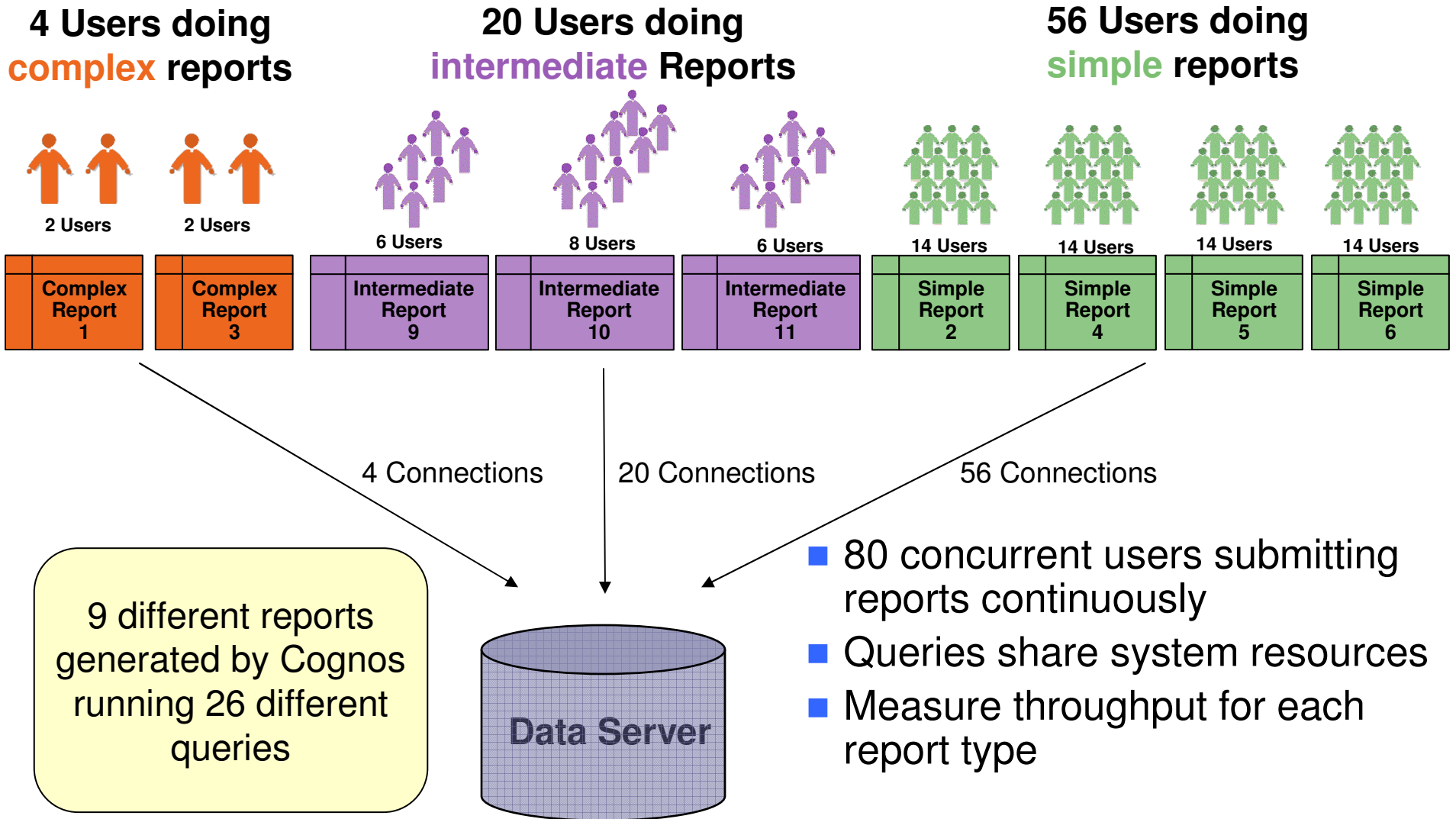| Complex Report 1 | Complex Report 3 | Intermediate Report 9 | Intermediate Report 10 | Intermediate Report 11 | Simple Report 2 | Simple Report 4 | Simple Report 5 | Simple Report 6 |

Single Connection

9 different reports generated by Cognos running 26 different queries

Data Server

- Single user serial execution test
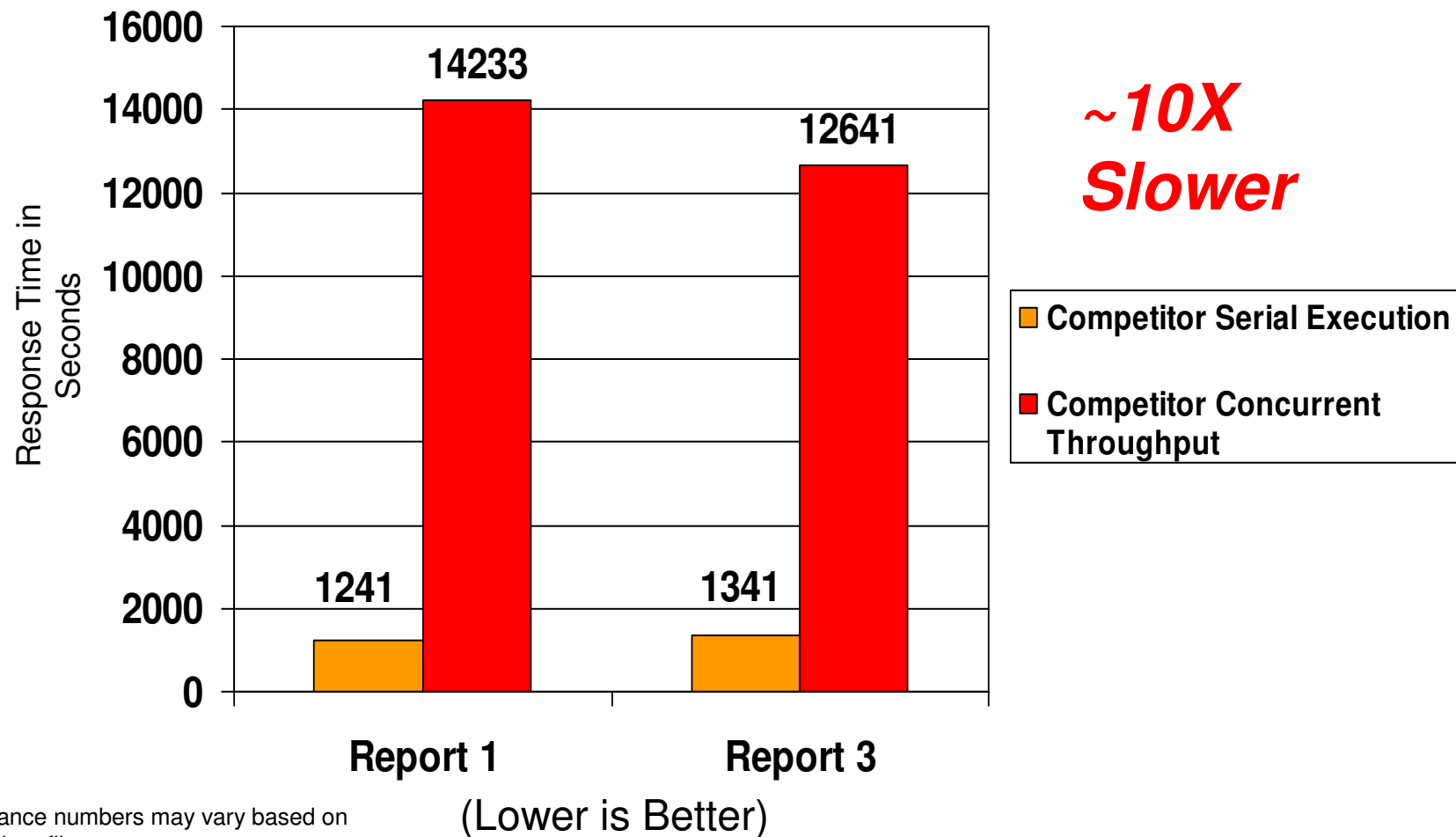- Each query gets all system resources
- Measure elapsed time for each report

BI Day – Concurrent Test Mode

4 Users doing
complex reports

2 Users   2 Users

Complex Report 1	Complex Report 3

20 Users doing
intermediate Reports

6 Users   8 Users   6 Users

Intermediate Report 9	Intermediate Report 10	Intermediate Report 11

56 Users doing
simple reports

14 Users   14 Users   14 Users   14 Users

Simple Report 2	Simple Report 4	Simple Report 5	Simple Report 6

4 Connections   20 Connections   56 Connections

9 different reports generated by Cognos running 26 different queries

Data Server

- 80 concurrent users submitting reports continuously
- Queries share system resources
- Measure throughput for each report type

Note: Distribution of complex, intermediate, and simple workloads based on Forrester Research, Profiling the Analytic End User for Business Intelligence, 2004

# Competitor Performance for Complex Reports Degrades When There Is Concurrent Work Going On

Competitor Complex Report Performance
Serial Execution versus Concurrent Throughput - 1TB

~10X Slower

Legend:
- ☐ Competitor Serial Execution
- ■ Competitor Concurrent Throughput

Chart data:
- Report 1: 1241 (Serial), 14233 (Concurrent)
- Report 3: 1341 (Serial), 12641 (Concurrent)

Y-axis: Response Time in Seconds (0 to 16000)

X-axis: Report 1, Report 3

(Lower is Better)

Performance numbers may vary based on workload profiles.

IBM Smart Analytics System 7700 Delivers More Throughput Concurrent Operational Reports

3.9X More Simple Reports
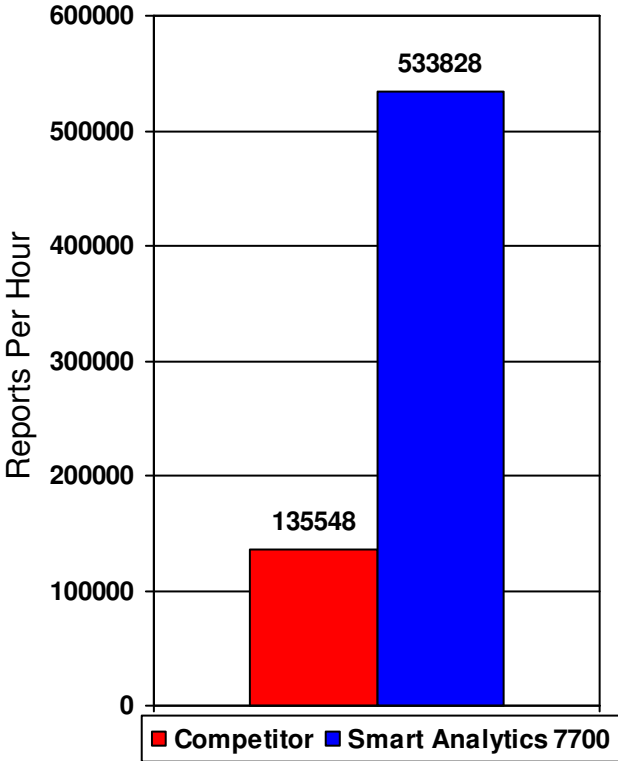
2X More Intermediate Reports
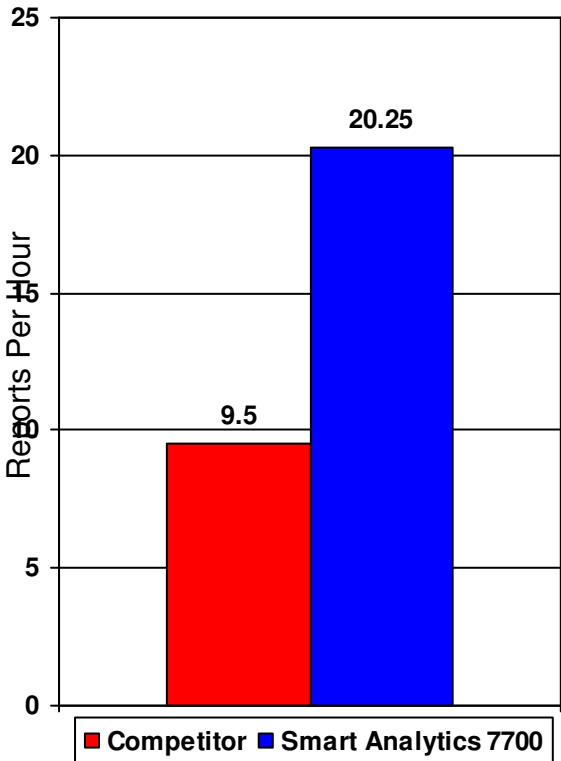
1.9x More Complex Reports

Reports Per Hour
at 10 TB data size

(Higher is Better)

Reports Per Hour
at 10 TB data size
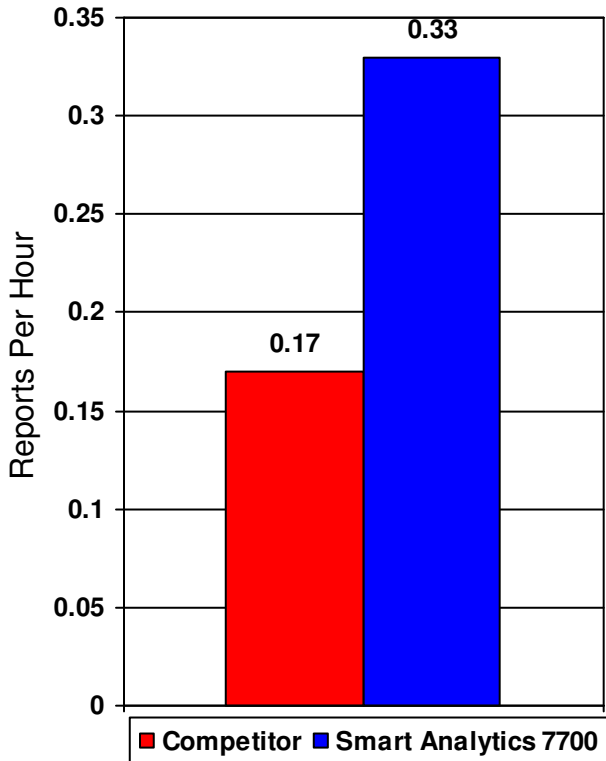
(Higher is Better)

Reports Per Hour
at 10 TB data size

(Higher is Better)
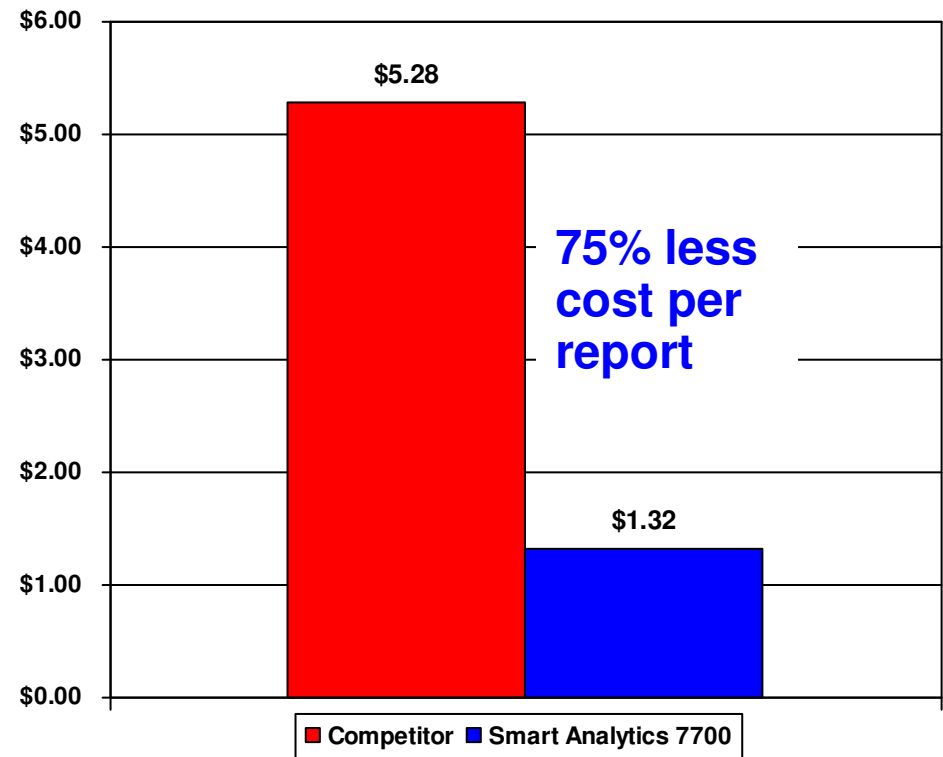
Performance numbers may vary
based on workload profiles.

Result: IBM 7700 Delivers More Aggregate Throughput And Lower Cost Per Report For Concurrent Operational Reports

Report Throughput at 10 TB

2,135,397

4x More Throughput

542,234

■ Competitor ■ Smart Analytics 7700
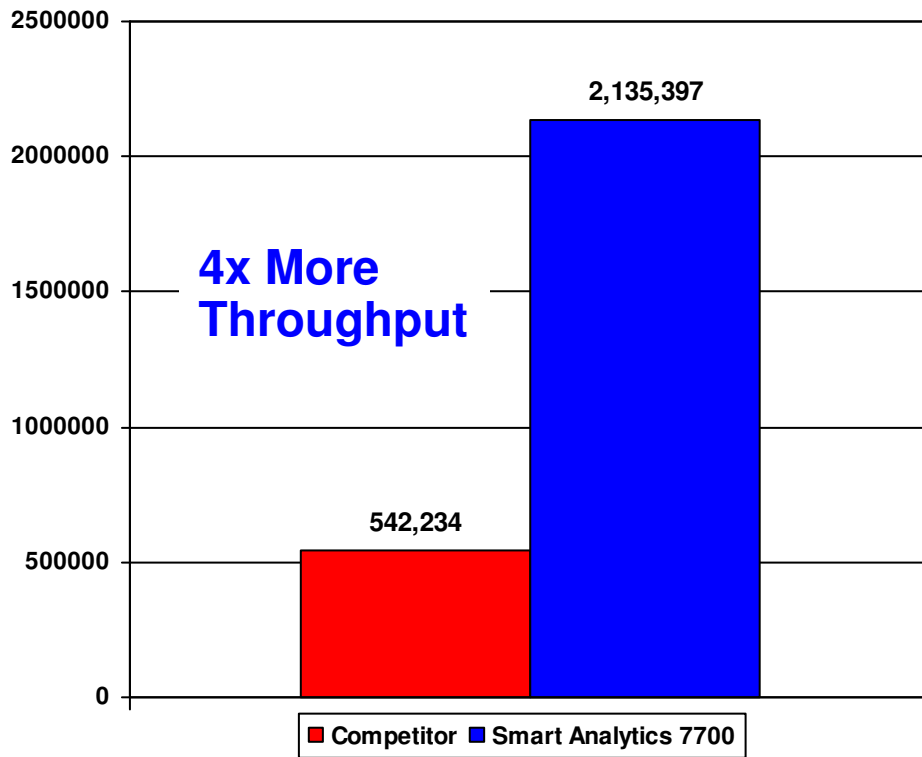
(Higher Throughput is Better)

Cost Per Report at 10 TB

$5.28

75% less cost per report

$1.32

■ Competitor ■ Smart Analytics 7700

(Lower Cost is Better)

Performance numbers may vary based on workload profiles. 3 year total cost of acquisition includes hardware, software, service & support. Based on US list prices, prices will vary by country.

IBM Smart Analytics System 7700 Beat The Competitor In Business Analytics

Evaluation Criteria	IBM	Competitor
OLAP, Data Mining, Text Mining included	Yes	No
Business Intelligence Software (Cognos) Integrated	Yes	No
Proven architecture for scalability	Yes	No
100% availability even in case of server failure	Yes	No
1st year software maintenance included (All IBM Software)	Yes	No
Software license costs per disk drive (Included) - $10,000 USD per Disk Drive for Oracle	Yes	No

Service Oriented Finance Needs To Find Good Future Customers

These reports are great! Can we take it a step further and be able to identify good future customers?

What you need is a Predictive Analysis tool. SPSS is an add-on to IBM Smart Analytics System that will help you do just that.
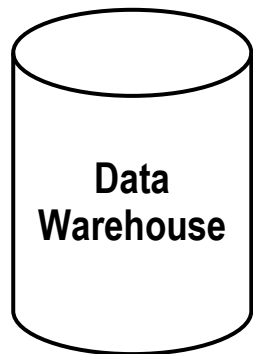
**Mortgage
Line of Business VP**

IBM

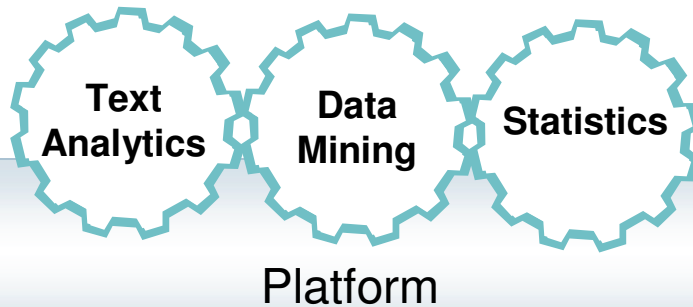# SPSS Helps Predict Future Events

Load

Data collection delivers an accurate view of customer attitudes and opinions

Predict

Predictive capabilities bring repeatability to ongoing decision making, and drive confidence in your results and decisions
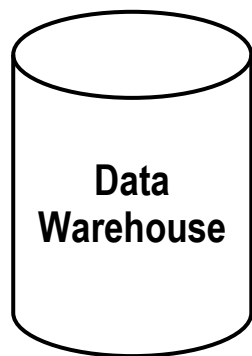
Act

Unique deployment technologies and methodologies maximize the impact of analytics in your operation

Data Warehouse

Load

Text Analytics

Data Mining

Statistics

Platform

Attract

Up-sell

Retain

. . .

Deployment Technologies

DEMO: Automate Analysis Rules For Identifying Risky Customers Using SPSS Statistics

1. Capture data from Data Warehouse on DB2 into SPSS Statistics

2. Pre-process the data to create new attributes for quantifying negative credit events across different product lines and create a risk flag for mortgage

3. Run Comparison of Means and Decision Tree to discover rules for characterizing risky customers

We can now identify the conditions that lead to risky mortgages!

Mortgage Line of Business VP

Summary – IBM Provides The Best Analytics And OLTP Solutions

- Different types of workloads have different data requirements which require different optimizations

- Oracle only offers Exadata as a "one size fits all" solution

- DB2 PureScale on Power Beats Exadata for Online Transaction Processing (OLTP) workloads

- IBM Smart Analytics System 7700 Beats Exadata for Business Analytics workloads

- Both provide a more scalable platform at a lower cost than Exadata

- IBM Smart Analytics System 7700 provides the most comprehensive Business Analytics solution in the industry
  - Includes Cognos and SPSS