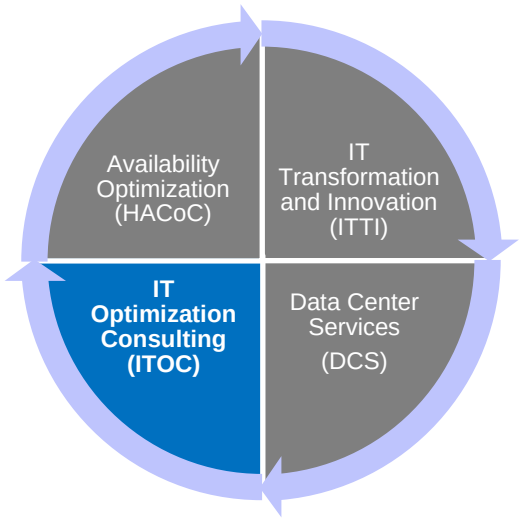
TCA / TCO Advantages of using POWER8

Competitive Analysis – DB2 BLU Lightning

May 20, 2014



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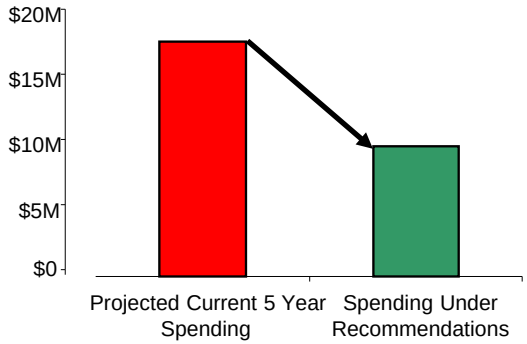
The IT Optimization Consulting Team has a long history of helping clients to leverage transformational technologies in support of continuous optimization, innovation and improved economics

- **Who we are**
  - IBM Systems & Technology Group (STG) - Lab Services Executive Consulting - IT Optimization Consulting Team (a.k.a the **"Scorpion"** team)
  - Team of highly experienced IBM technical and financial modeling experts who have performed 1100+ of studies over the past thirteen years

- **What we do**
  - Provide a view of IT systems infrastructure and associated costs via a variety of engagement options
  - Produce first-pass strategic systems optimization recommendations that focus on cost reduction, environmental savings, system efficiencies and operational performance improvements
  - Highlight areas of opportunity for savings
    - ***Average*** 45% savings in annual operating costs
    - Typical energy (Systems kW) savings from 60-80%
    - 60-90% reduction in CPU cores and associated S/W costs

Proof Point: Average annual operating savings of 45%



Source: IBM Scorpion Studies

- **Why consider an engagement with us?** We have deep consulting experience across a broad set of industries to help address current IT organization challenges such as:

New Kind of Server Sprawl
15% average annual growth and 4X more required floor space over the next 10 years to keep pace with compute capacity needs - ***Gartner Data Center Summit, 2013***

Spiraling Staff Costs
Staff costs are now outpacing all other IT-related budget items - ***Forrester's Forrsights Budget and Priorities Tracker, Q412***

Energy Efficiency
The problem lies in the amount of power and cooling that new high density infrastructures require.- ***Gartner Data Center Summit, 2013***

Storage Growth
Average annual external storage capacity growth over the next 3 years of 35-40% - ***IDC, Q2 2013 Forecast***

IBM STG Lab Services – IT Optimization Consulting Team Offerings

Value to Customer: Studies and assessments produce strategic systems optimization recommendations that focus on cost reduction, environmental savings, system efficiencies and operational performance improvements. Recommendations and supporting business cases highlight the impact of new technologies and strategies to optimize an environment.

Engagement Offering	Consider this offering if you want to…
IT Systems Rationalization Study (Scorpion Study): Get an accurate and detailed view of IT systems architectures and associated costs. Based on financial and technological data, we'll evaluate the feasibility of implementing advanced IBM technologies. Server or server/storage.	▪ View a cross-platform comparison of your entire environment - what is installed and the associated costs ▪ Review optimization recommendations and supporting business cases across all platforms ▪ Evaluate new IT technologies/strategies
IT Optimization Assessment (ITOA): Quickly identify optimization opportunities for a subset of your environment (250 logical servers or more).	▪ Enhance or expand your virtualization technologies ▪ Optimize a particular platform ▪ Eliminate or add a hardware platform
Cloud IT Optimization Assessment (CITOA): Evaluate the feasibility and expected costs and benefits of implementing private cloud technologies. Server or server/storage.	▪ Understand the financial impact of moving to Cloud ▪ Identify workloads to target for Cloud ▪ Evaluate key Cloud management practices and determine where your current environment stands to support Cloud
Fit For Purpose (F4P): A platform selection process that relies on four key IT elements: 1) unique application requirements, 2) a cost model, 3) an infrastructure service delivery comparison, and 4) IT goals and objectives.	▪ Participate in a client centric thought process that can help you make infrastructure architecture decisions ▪ Evaluate platforms based on the fundamental principles that "one size does not fit all" and that "local factors matter".
IT Systems Energy Efficiency Assessment (ITEEA): Reduce the environmental demand of IT systems and achieve more with less power. Server, storage and networking devices.	▪ Understand how systems optimization can reduce power ▪ Improve the ability of your data center to deliver workload and performance while using fewer resources

To discuss an engagement contact the IT Optimization Consulting Team

Opportunity Manager: US West, Canada	Opportunity Manager: US East, Federal & WW
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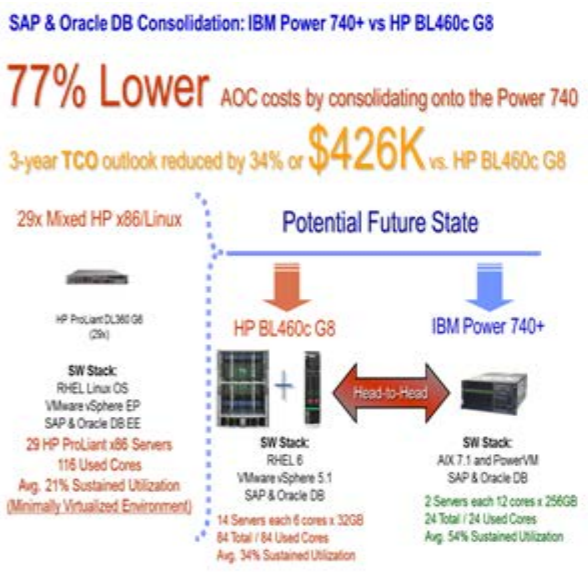
Sales Teams’ Next Steps: • Contact an Opportunity Manager to discuss a customer’s situation, pain points and challenges. • Opportunity Manager will work with you to scope an appropriate engagement and help plan a course of action to present the engagement to the customer.	

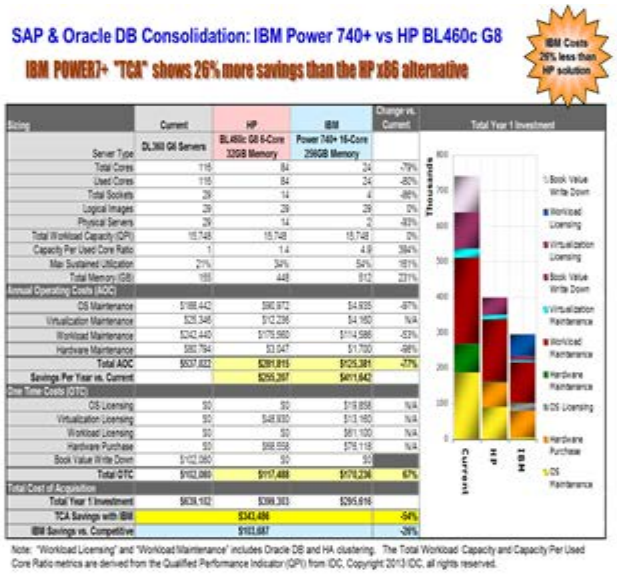
Purpose of this document:

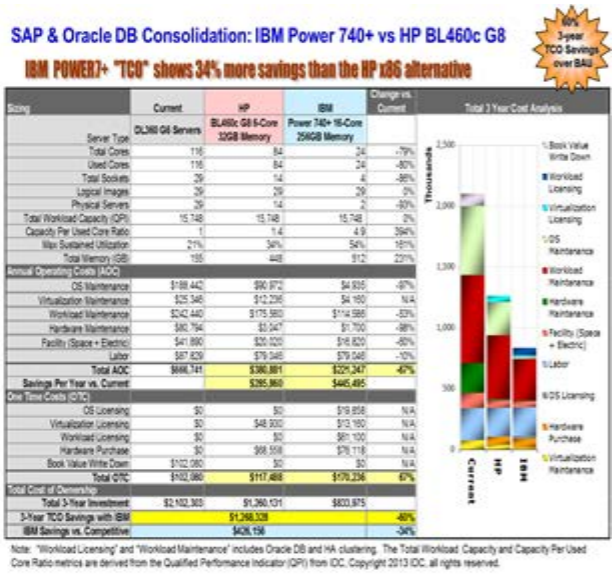
Use with clients to illustrate the value of POWER8 Systems with full stack TCA/TCO examples. Do not leave behind.

- TCA / TCO scenario showing advantages of POWER8 vs the competition
- Full stack scenarios, including servers, virtualization, OS and software
- " *TCA / TCO Advantages of using POWER8* "
- " *TCA / TCO Advantages of using POWER7+* " (**IBM SSI, IBM SDA, BP**)

Sample TCA / TCO Outputs







Cost analysis assumptions and parameters

TCA = HW (server w/o external storage) & SW One Time Licensing including: O/S, virtualization s/w, workload s/w (application s/w + middleware s/w) + year 1 7x24 Support (HWMA and SWMA)

TCO = Cost of acquisition (HW & SW) plus + 3 year projection of annual HW/SW maintenance + Labor + Facility Costs (energy and space costs at average commercial rates). We did not model migration or transition costs.

Key Modeling Assumptions:

1. Sizing for each of the scenarios was performed using IBM internal benchmark results for the configurations and workloads specified.
2. The baseline for any threshold CPU utilization values (where shown) were derived based on stated vendor models, workload type, and inputs from "*2012 Solitaire Interglobal virtualization capacity study*: http://www.sil-usa.com/pub_papers/QR2012A672.pdf "
3. TCO models use a 3-year business case timeline. Growth/inflation was not modeled.
4. HBAs and network adapters were included in the IBM and competitive configurations. External storage was not factored into any of the comparisons. Actual configurations may vary based on the specific client requirements.
5. Hardware purchase costs and SW Initial License costs are capital expenditures assumed to be written off in "year 1." HW depreciation, SW amortization and lease purchase options were, therefore, not modeled.
6. Hardware maintenance targets a 24x7, 4hr response SLA. It is calculated by blending the warranty and any necessary warranty or post-warranty cost uplifts to arrive at the 3-year support term shown
7. Staff costs were calculated using an observed industry average for managing the in scope servers. A ratio of 40 servers to 1 FTE was applied. We assumed an observed industry average of $80,000 per yr. plus a 38% uplift for "burden" as a baseline labor cost. Migration, transition and installation services are not included in our analysis.
8. Annual energy costs are calculated using an observed industry average of $ 0.12 / KwHr. (USEIA value) as applied to the "typical" power draw for the systems configured.
9. Space costs are calculated using an observed industry average of $1,200 per a standard 42U rack footprint of 2M^2. (The footage of the rack is assumed to be approx. 21.5 ft^2).
10. All scenarios are figured at "list price" levels.
11. All future state solutions are assumed to have no cores virtualized.

POWER8 2-Socket vs HP x86 2-Socket

Workload: Database BI

(Modeled with List Pricing)

Database BI (BLU Lightning) Summary: IBM POWER8 vs. HP x86

136 Times Better TCA "Cost per Transaction" with POWER8 ($3.3K for P8 vs $451.5K for x86) [1]

152 Times Better TCO "Cost per Transaction" with POWER8 ($4.6K for P8 vs $700.2K for x86) [1]

The IBM POWER8 two socket servers address the need for a low cost solution, while offering superior price performance and innovative features. POWER8 servers running DB2 and Cognos showed a 82 to 1 transaction rate advantage (2) over similarly configured x86 two socket offerings

x86 Ivy Bridge v2 DB	Feature	POWER8 DB
12	Cores per Chip	12
24	Threads per Chip	96
30MB (L3)	Cache per Chip	96MB (L3) / 128MB (L4)
60GB / sec	Memory Bandwidth	230GB / sec

HP DL380p 24 cores 256GB
DB Server

HP DL380p 16 cores 384GB
Cognos Server

Head-to-Head

IBM P8 S824 24 cores 256GB
DB Server

IBM P8 S822L 20 cores 384GB
Cognos Server

SW Stack:
SUSE 11.3
"Other" DB

SW Stack:
SUSE 11.3
Cognos Business View 10.2.1

SW Stack:
AIX 7.1
DB2 10.5

SW Stack:
SUSE 11.3
Cognos Business View 10.2.1

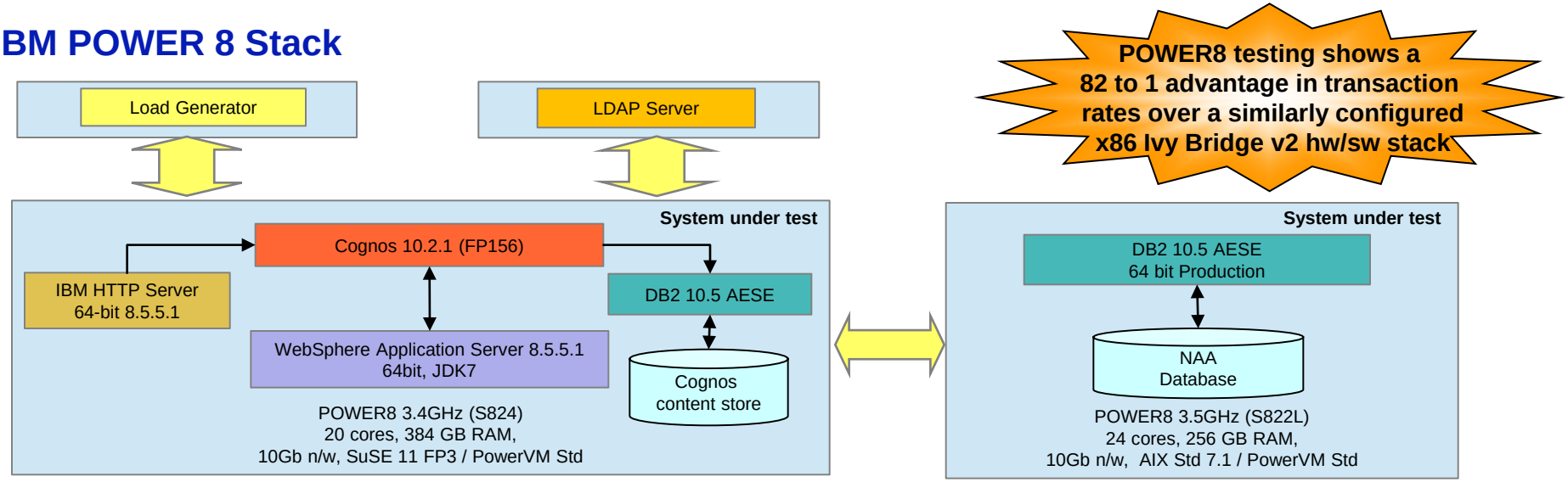
- ✓ **~$3.3K per transaction for POWER8 TCA as compared to $451.5K per transaction for x86**
- ✓ **~$4.6K per transaction for POWER8 TCO as compared to $700.2K per transaction for x86**

(1) Values shown are normalized to 82 to 1 xaction ratio for POWER8 and x86 Ivy Bridge v2

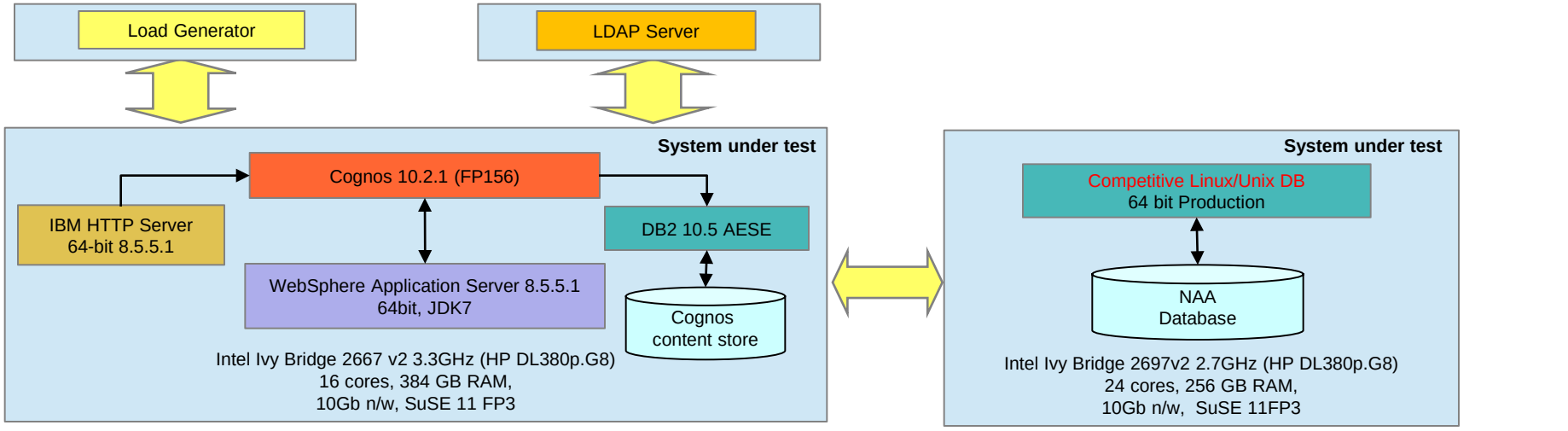
(2) 82x is based on IBM Internal Testing of sample analytic workloads; current as of May 20, 2014. Performance improvement figures are cumulative of all queries in the workload. Individual results will vary depending on individual workloads, configurations and conditions

Database BI (BLU Lightning) Stack: IBM POWER8 vs. HP x86

IBM POWER 8 Stack



HP x86 Stack



Database BI (BLU Lightning) TCA: IBM POWER8 vs. HP x86

IBM POWER8 is 136 Times Better TCA per transaction than the HP x86 alternative!

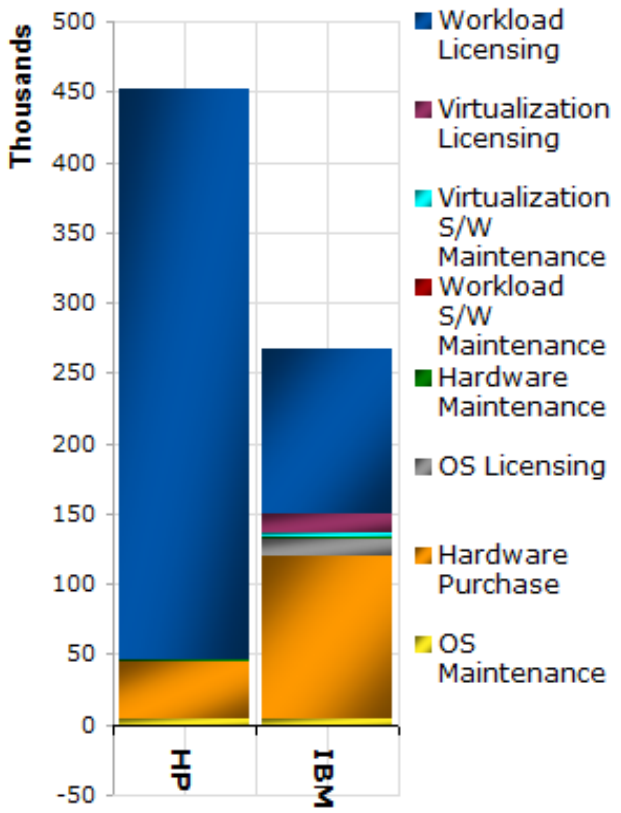
[$ 3.3K per xaction (P8) vs $ 451.5K per xaction (x86)] [1]

136 Times Better TCA per Transaction with POWER8

Business Case Summary

	2x DL380.G8(40x640)	2x P8 S8XX(44x640)	
Sizing	**HP**	**IBM**	**Change**
Server Type	2x DL380 G8 40-Core 640GB Memory	2x P8 S8xx 44-Core 640GB Memory	
Total Cores	40	44	10%
Used Cores	40	44	10%
Total Sockets	4	4	10%
Logical Images	2	2	0%
Physical Servers	2	2	0%
Total Workload Capacity Ratio	1	82	8100%
Capacity Per Used Core Ratio	1.0	74.5	7355%
Total Memory (GB)	640	640	0%
Pre-paid Yr 1 Maint Costs (OTC)			
OS Maintenance	$3,780	$4,594	22%
Virtualization S/W Maintenance	$0	$3,080	--
Workload S/W Maintenance	$0	$0	--
Hardware Maintenance	$914	$1,588	74%
Total Year 1 Op. Costs	**$4,694**	**$9,262**	**97%**
One Time Costs (OTC)			
OS Licensing	$0	$12,000	--
Virtualization S/W Licensing	$0	$12,320	--
Workload S/W Licensing	$405,380	$117,460	-71%
Hardware Purchase	$41,392	$115,768	180%
Total OTC	**$446,772**	**$257,548**	**-42%**
Total Cost of Acquisition			
Total Year 1 Investment	**$451,466**	**$266,810**	
TCA Savings with IBM	**$184,656**		**-41%**

Total Year 1 Investment



The "Total Workload Capacity" and "Capacity Per Used Core Ratio" metrics derived from internal IBM performance projections for P8 system vs x86 (82 to 1 transaction ratio)

(1) Values shown are normalized to 82 to 1 xaction ratio for POWER8 and x86 Ivy Bridge v2

Database BI (BLU Lightning) TCO: IBM POWER8 vs. HP x86

IBM POWER8 is 152 Times Better TCO per transaction than the HP x86 alternative!

[$ 4.6K per xaction (P8) vs $ 700.2K per xaction (x86)] [1]

152 Times Better TCO per Transaction with POWER8

Business Case Summary

	2x DL380.G8(40x640)	2x P8 S8XX(44x640)	
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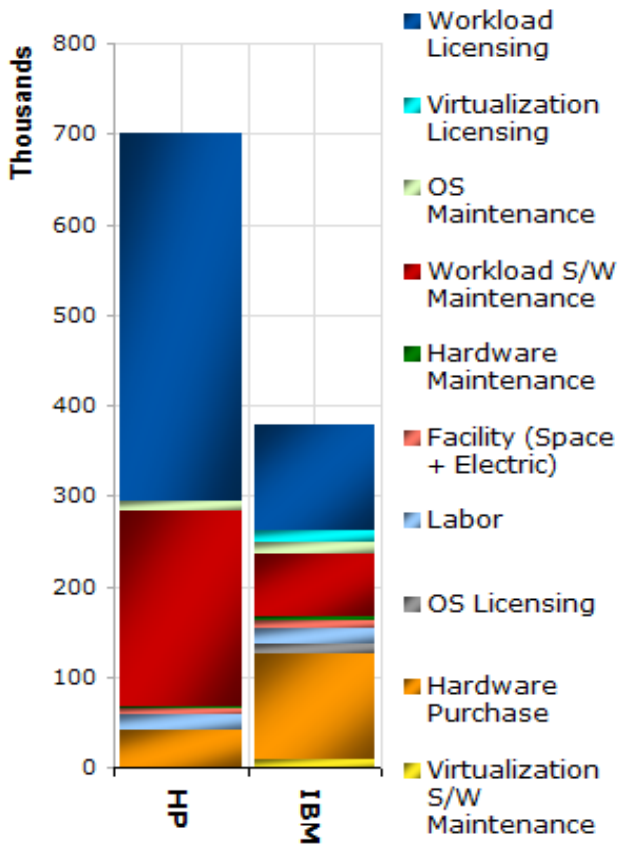
Capacity Per Used Core Ratio	1.0	74.5	7355%
Total Memory (GB)	640	640	0%
Annual Operating Costs (AOC)			
OS Maintenance	$3,780	$4,594	22%
Virtualization S/W Maintenance	$0	$3,080	--
Workload S/W Maintenance	$71,929	$22,876	-68%
Hardware Maintenance	$914	$1,588	74%
Facility (Space + Electric)	$2,328	$2,801	20%
Labor	$5,520	$5,520	0%
Total AOC	**$84,471**	**$40,459**	**-52%**
One Time Costs (OTC)			
OS Licensing	$0	$12,000	--
Virtualization S/W Licensing	$0	$12,320	--
Workload S/W Licensing	$405,380	$117,460	-71%
Hardware Purchase	$41,392	$115,768	180%
Total OTC	**$446,772**	**$257,548**	**-42%**
Total Cost of Ownership			
Total 3-Year CapEx and Op. Costs	**$700,184**	**$378,925**	
3-Year TCO Savings with IBM	**$321,259**		**-46%**

Total 3 Year Cost Analysis



The "Total Workload Capacity" and "Capacity Per Used Core Ratio" metrics derived from internal IBM performance projections for P8 system vs x86 (82 to 1 transaction ratio)

(1) Values shown are normalized to 82 to 1 xaction ratio for POWER8 and x86 Ivy Bridge v2

Database BI (BLU Lightning) Background Details: IBM POWER8 vs. HP x86

More transactions per core, means fewer cores and/or systems and lower software costs

IBM POWER8

- DB Server – S824
  - 2 procs, 24-cores: POWER8 3.5GHz
  - 256 GB memory, 2000GB internal storage
- Cognos Server – S822L
  - 2 procs, 20-cores: POWER8 3.4GHz
  - 384 GB memory, 2000GB internal storage

HP x86 Ivy Bridge v2

- DB Server – DL380p G8
  - 2 procs, 24-cores: Xeon E5-2697 v2 2.7GHz
  - 256 GB memory, 1200GB internal storage
- Cognos Server – DL380p G8
  - 2 procs, 16-cores: Xeon E5-2667 v2 3.3GHz
  - 384 GB memory, 1200GB internal storage

Proof Point	IBM POWER8		HP x86 Ivy Bridge v2	
	Values Used	Obtained From	Values Used	Obtained From
HW Costs	DB Server $82,495 Cognos Server $33,273	IBM eConfig	DB Server $23,085 Cognos Server $18,307	HP Online Pricing
HWMA Costs (24x7, 4hr)	DB Server $1,055 Per Year Cognos Server $ 533 Per Year	IBM eConfig	DB Server $457 Per Year Cognos Server $457 Per Year	HP Online Pricing
OS Costs (AIX and SUSE)	DB Server (AIX Std) $12,000 Cognos Server (SUSE) $0	IBM eConfig (AIX) SUSE Pricing (SUSE)	DB Server (SUSE) $0 Cognos Server (SUSE) $0	SUSE Pricing (SUSE) SUSE Pricing (SUSE)
Virtualization (PowerVM)	DB Server (PowerVM Std) $6,720 Cognos Server (PowerVM Std) $5,600	IBM Distributed Software Price List	Not Applicable	Not Applicable
Database OTC Costs	IBM DB2 BLU AESE - $56,700 per TB (includes 1st yr S&S, 20% for yrs 2 & 3)	IBM Distributed Software Price List	"Other" DB EE NUP Pricing $950 / NUP (S&S – 22% of List NUP Pricing)	"Other" DB on-line pricing
Cognos OTC Costs	IBM Cognos Analytic Server for Business Intelligence - Processor Value Unit (PVU) License. MSRP $51.50/PVU. (S&S – 1ST Yr. included, 16% per yr. after)	IBM On-line pricing	IBM Cognos Analytic Server for Business Intelligence - Processor Value Unit (PVU) License. MSRP $51.50/PVU. (S&S – 1ST Yr. included, 16% per yr. there after)	IBM On-line pricing
Transaction Ratio	82 xactions for every 1 x86 xaction	IBM Internal Testing	1 xaction for every 82 POWER8 xactions	IBM Internal Testing
Transaction Ratio Rationale	The "Total Workload Capacity" and "Capacity Per Used Core" ratios derived from internal IBM testing for P8 versus x86 configurations The 82 to 1 projection is based on testing of sample analytic serial and concurrent workloads and is current as of May 20, 2014. Performance improvement figures are cumulative of all queries in the workload. Individual results will vary depending on, configurations and conditions.			
Power	DB Server 616 Watts @ $0.12 kWhr Cognos Server 543 Watts @ $0.12 kWhr	IBM Internal Specs	DB Server 503 Watts @ $0.12 kWhr Cognos Server 415 Watts @ $0.12 kWhr	HP Power Advisor

Database BI (BLU Lightning): IBM POWER8 vs x86 Benchmark Notes

Summary Results - 82 to 1 projected advantage based on testing of sample serial/concurrent workloads (as of May 20, 2014)

- Serial execution test
  - Mix of 100 simple, intermediate, and complex reports executed serially
  - **46x** average improvement in report execution time
  - Maximum single report improvement of more than **518x**
- Concurrent throughput test
  - 60 concurrent users running a 70%/25%/5% split of simple/intermediate/complex reports
  - Consistent and fast results from the IBM Stack, more variable and lengthy results from the Competitive Stack
  - **82x** more reports per hour (RPH) based on geomean calculation across report types
    - **747x** more complex reports, **40x** more intermediate reports, **18x** more simple reports

Benchmark Description

- BI DAY 2.0 consists of 16 Cognos reports and dashboards.
- Two modes of execution – (1) Serial Execution Test (2) Concurrent Throughput Test
  - Each report consists of one or more SQL queries
  - Each report from, or inspired by, Network Analytics Accelerator product
  - Each report scans a fact table and joins one or more dimension tables
- Reports are categorized into:
  - Simple: Few # of SQL, small range (week) of data
  - Intermediate: Moderate # of SQL, moderate range (quarter/year) of data
  - Complex: Large # of SQL, majority of queries on full fact table
- BI Day 2.0 contains 5 star schemas with a shared set of 23 dimension tables (a total of 28 tables)
  - Each star schema/fact table maps to a different dynamic cube definition
  - Total raw data size: 2.6 TB
  - Three largest star schemas are accessed by the BI Day 2.0 reports
  - Intermediate and Complex reports access Voice Summary and Voice Detail cubes
  - Simple reports access Data Detail and Voice Detail cubes

Influence of Cognos BI versus Database on results

- All Cognos in-memory caches are filled with database queries
  - Member cache has dimension table attributes
  - Query data cache contains previous query results
- Each report is answered by Cognos with fastest access to data
  - Look for data in-memory in the query data cache before querying data warehouse
  - If data in query data cache, no database access required

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