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Cloud. Data. Mobile. Open Source.

APRIL 29-30, 2013

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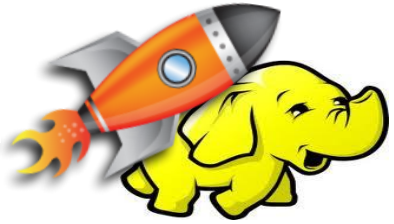
Turbo-Charging Open Source Hadoop for Faster, more Meaningful Insights



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Agenda

- Some Context – IBM Platform Computing
- Low-latency scheduling meets open-source
- Breakthrough performance
- Multi-tenancy (*for real!*)
- Cluster-sprawl - The *elephant* in the room
- Side step the looming challenges

IBM Platform Computing

- Acquired by IBM in 2012
- 20 year history in high-performance computing
- 2000+ global customers
- 23 of 30 largest enterprises
- High-performance, mission-critical, extreme scale
- Comprehensive capability

De facto standard for commercial high-performance computing

Powers financial analytics grids for 60% of top investment banks

Over 5 million CPUs under management

Breakthrough performance in Big Data analytics

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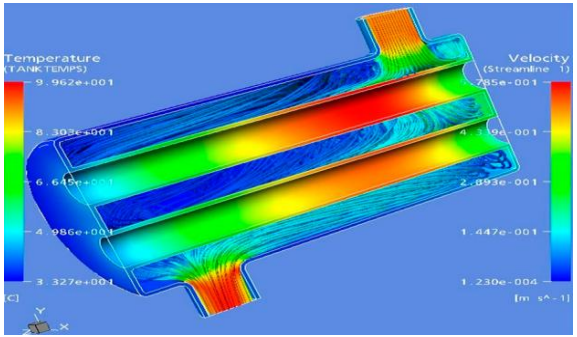
Technical Computing - HPC



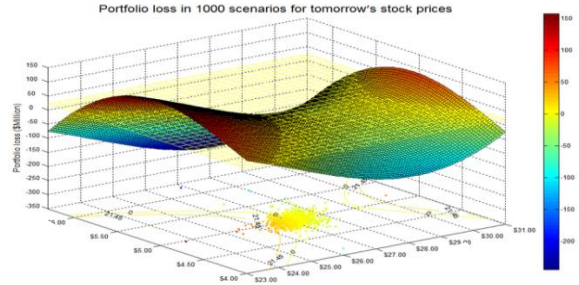
Platform LSF Family

Platform HPC

Scalable, comprehensive workload management for demanding heterogeneous environments

Simplified, integrated HPC management software bundled with systems

Analytics Infrastructure Software



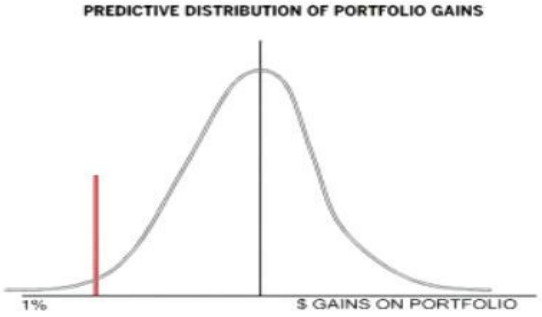
Platform Symphony Family

High-throughput, low-latency compute and data intensive analytics

- An SOA infrastructure for analytics
- Extreme performance and scale
- Complex Computations (i.e., risk)
- Big Data Analytics via MapReduce

Our worldview – shaped by time critical analytics

- Financial firms compete on the their ability to maximize use of capital
- Monte-Carlo simulation is a staple technique for simulating market outcomes
- Underlying instruments are increasingly complex
- A crush of new regulation



$$\sigma_\Lambda^2 = \sum_{i=1}^{N} L_i^2 \cdot E[(D_i^2 - 2D_i \cdot p_i + p_i^2)] + \sum_{i=1}^{N} \sum_{\substack{j=1 \\ j \neq i}}^{N} L_i \cdot L_j \cdot E[(D_i D_j - p_i D_j - p_j D_i + p_i p_j)]$$

$$= \sum_{i=1}^{N} L_i^2 \cdot p_i \cdot (1 - p_i) + \sum_{i=1}^{N} \sum_{\substack{j=1 \\ j \neq i}}^{N} L_i \cdot L_j \cdot [E(D_i D_j) - p_i p_j] \text{ because } D_i \in \{0; 1\} \text{ and hence } D_i^2 = D_i$$

$$= \sum_{i=1}^{N} L_i^2 \cdot p_i \cdot (1 - p_i) + \sum_{i=1}^{N} \sum_{\substack{j=1 \\ j \neq i}}^{N} L_i \cdot L_j \cdot \left[Pr(D_i = 1 \cap D_j = 1) - p_i p_j \right] \text{ because of (2)}$$

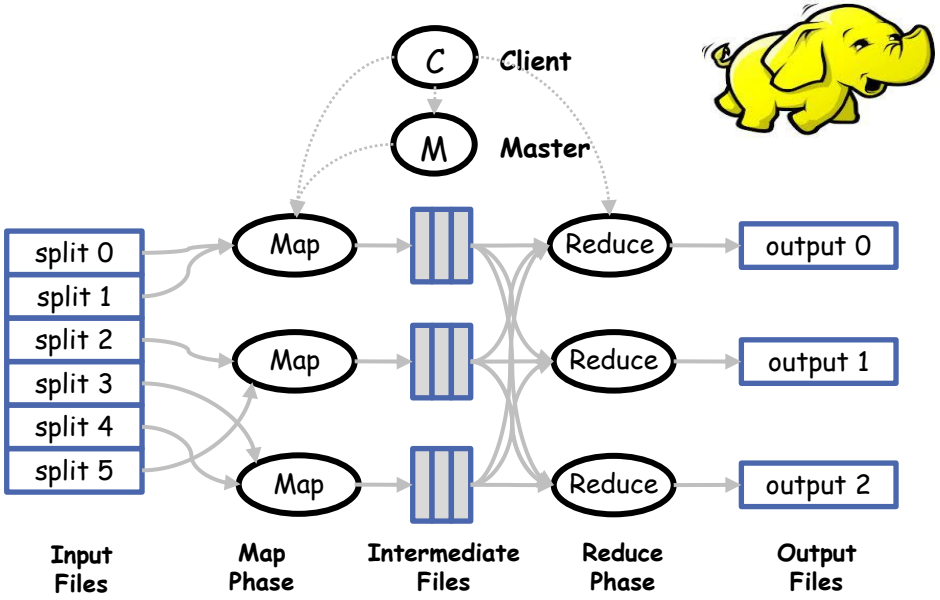
$$\sum_{i=1}^{N} L_i^2 \cdot p_i \cdot (1 - p_i) + \sum_{i=1}^{N} \sum_{\substack{j=1 \\ j \neq i}}^{N} L_i \cdot L_j \cdot (\Phi^{(2)}(\tau_i, \tau_j; w_i w_j) - p_i p_j) \text{ as in (6)}$$

Compute this over 5,000 market scenarios comprised of 200 risk factors over 10 years for all instruments and all portfolios – NOW!

IBM Platform Symphony

- A heterogeneous grid management platform
- A high-performance SOA middleware environment
- Supports diverse compute & data intensive applications
  - ISV applications – Many applications in this space are open source
  - In-house developed applications (C/C++, C#/.NET, Java, Excel, R etc)
  - Support for Linux / Power Linux, Windows + other OS
- React instantly to time critical-requirements
- A multi-tenant shared services platform
- Implements a fully compatible MapReduce run-time for open-source Hadoop

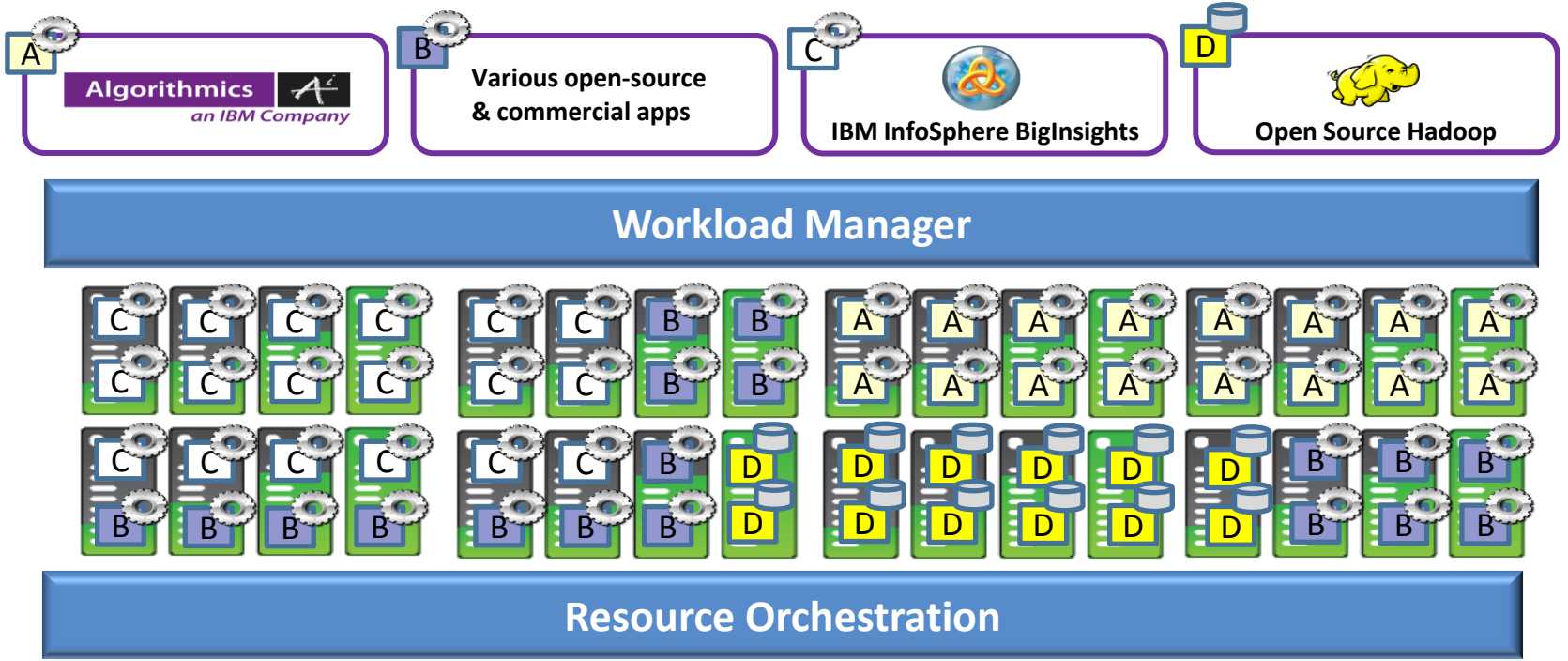
Hadoop MapReduce



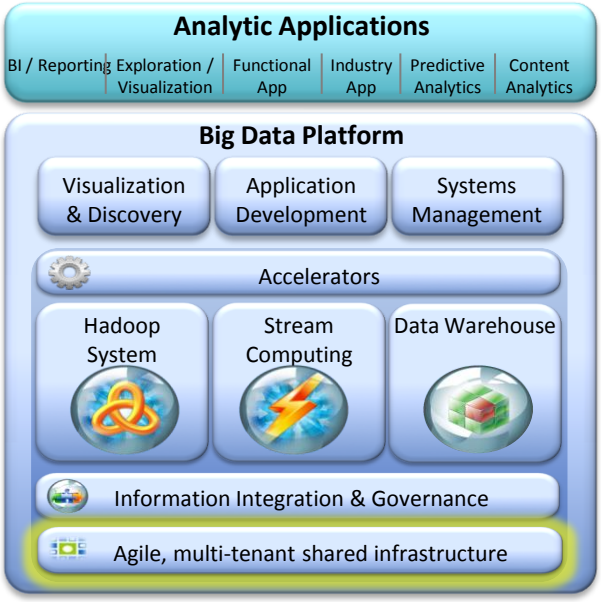
De-facto "Big Data" standard

- Pioneered at Google / Yahoo!
- Framework for writing applications to rapidly process vast datasets
- More cost effective than traditional data warehouse / BI infrastructure
- Dramatic performance gains
- Java based
- From our perspective: *Just another distributed computing problem*

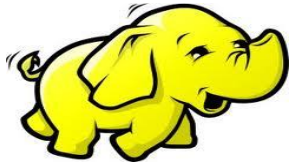
IBM Platform Symphony



IBM InfoSphere BigInsights & Platform Symphony



- Comprehensive platform
- Data at rest, data in motion
- Extensive library of data connectors
- Rich development tools
- Application accelerators
- Web-based management console



Big problems demand big infrastructure

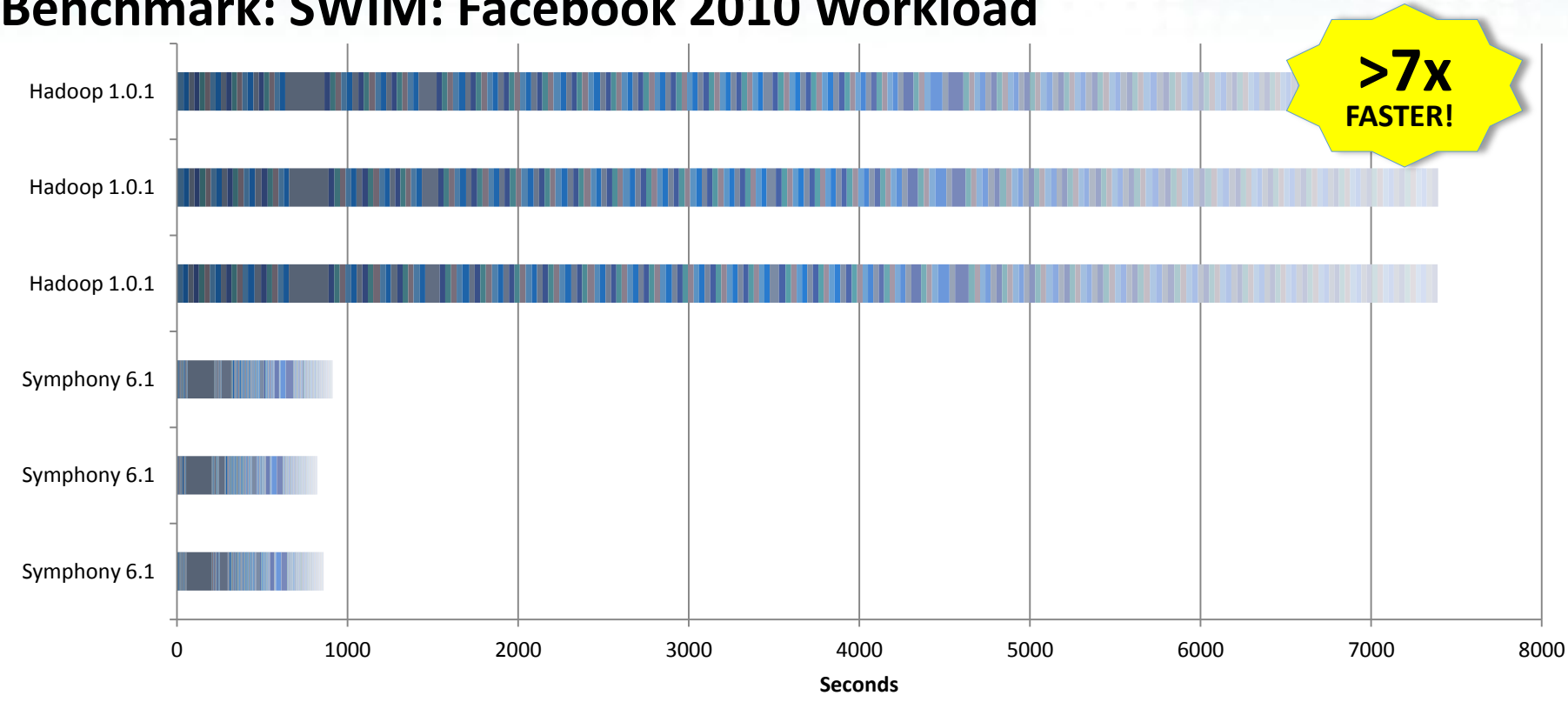
- **Exploit threads**
  - Power 7+ - 2 threads per core vs. 2 threads per core
- **High Throughput**
  - Extreme memory and I/O bandwidth
- **Better Java implementation**
  - Optimized JVM on Power 7+
- **Superior I/O**
  - Massive I/O bandwidth
- **Parallel file system**
  - Your choice of HDFS or GPFS
- **Ideal match for Apache Hadoop MapReduce framework**
  - Massively parallel processing across Linux clusters

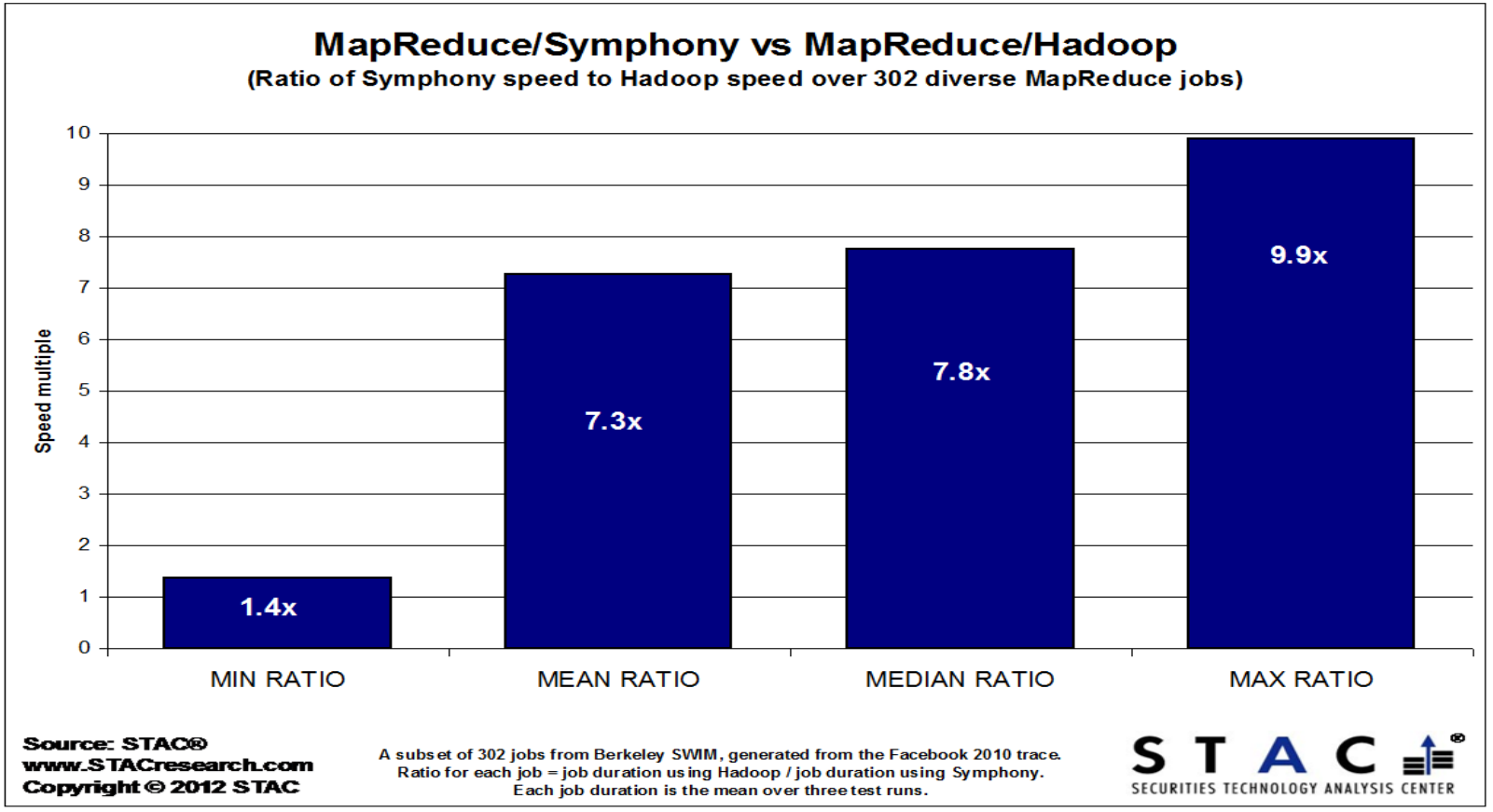
PERFORMANCE

Berkley SWIM

- “Real-world” MapReduce benchmark – synthesize and replay captured *real-world* workloads
- Developed by Yanpei Chen and others at @ UCB - https://github.com/SWIMProjectUCB/SWIM/wiki
- Viewed as an advance over existing synthetic MapReduce benchmarks including GridMix2, PigMix, Hive BM etc.
- Represents workloads comprised of short, large and huge jobs stressing disk, network IO, CPU and memory
- Promoted by Cloudera – advantages of SWIM promoted at Hadoop World 2011 - http://www.slideshare.net/cloudera/hadoop-world-2011-hadoop-and-performance-todd-lipcon-yanpei-chen-cloudera

Benchmark: SWIM: Facebook 2010 Workload




MapReduce/Symphony vs MapReduce/Hadoop
(Ratio of Symphony speed to Hadoop speed over 302 diverse MapReduce jobs)
Speed multiple
10
9
8
7
6
5
4
3
2
1
0
1.4x
7.3x
7.8x
9.9x
MIN RATIO
MEAN RATIO
MEDIAN RATIO
MAX RATIO
Source: STAC®
www.STACresearch.com
Copyright © 2012 STAC
A subset of 302 jobs from Berkeley SWIM, generated from the Facebook 2010 trace.
Ratio for each job = job duration using Hadoop / job duration using Symphony.
Each job duration is the mean over three test runs.
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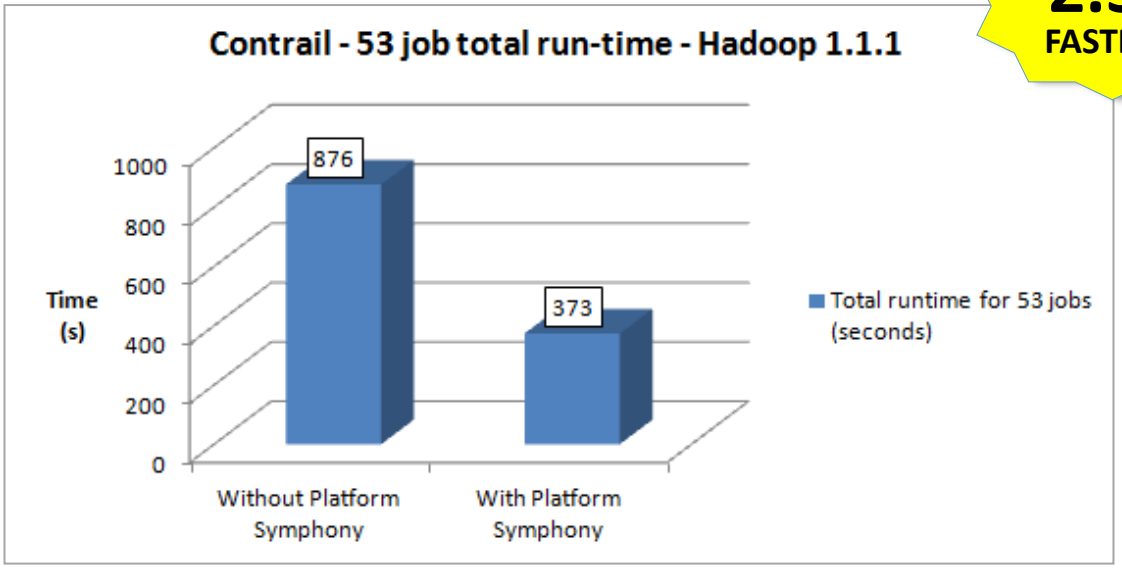
Benchmark: Contrail

- Open-source software for De Novo Genome Assembly – key contributors are Jeremy Lewi, Avijit Gupta, Ruschil Gupta, Michael Schatz and others
- Sequencing large genomes is too large a problem for conventional algorithms
- It turns out that the *deBrujin graph* fundamental to genome sequencing is readily represented as key-value pairs – ideal for processing with MapReduce
- Contrail runs a pipeline where each pipeline stage is implemented as a MapReduce job to exploit parallelism

http://sourceforge.net/apps/mediawiki/contrail-bio/index.php?title=Contrail

Benchmark: Contrail



2.3x FASTER!

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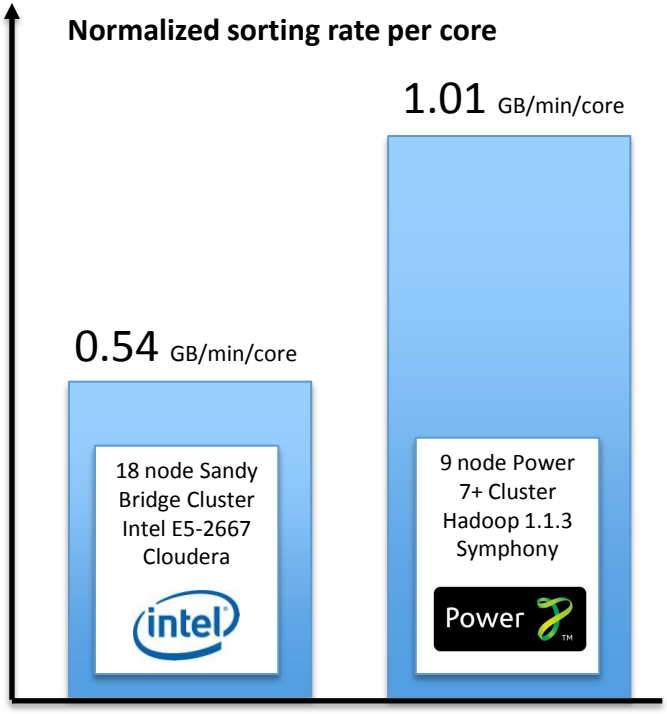
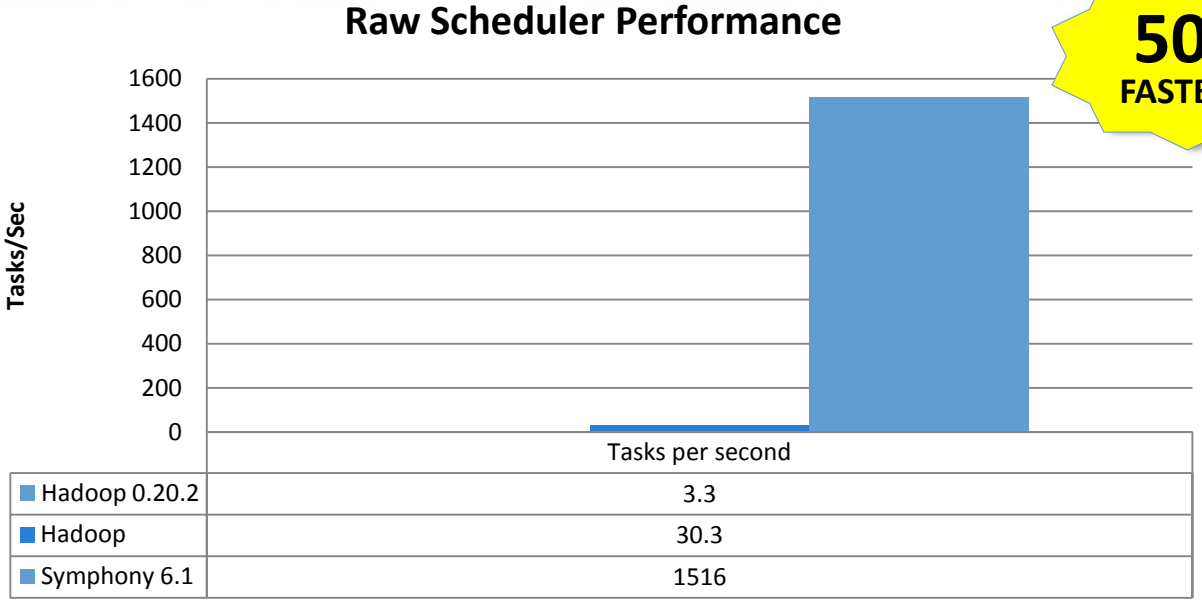
Record Terasort results on Power 7+

Hardware	
Cluster	1 PowerLinux P7+ Master Node 9 PowerLinux P7+ Slave Nodes
CPU	16 processor cores per server (128 total)
Memory	128 GB per server (1280 total)
Internal Storage	6 600GB internal SAS drivers per server (36 TB total)
Storage Expansion	24 600GB SAS drives in IBM EXP24S SFF Gen2-bay Drawer, per server(144 TB total)
Network	2 10Gbe connections per server
Switch	BNT BLACE RackSwitch G8264
Software	
OS	Red Had Enterprise Linux 6.2
Java	IBM Java 64bit Version 7 SR1
HDFS	Hadoop v1.1.3 (1 node as NameNode and 9 nodes as DataNode)
Platform Symphony MapReduce	Advanced Edition 6.1.0.1 1 node as Management Host and 9 nodes as Compute Hosts



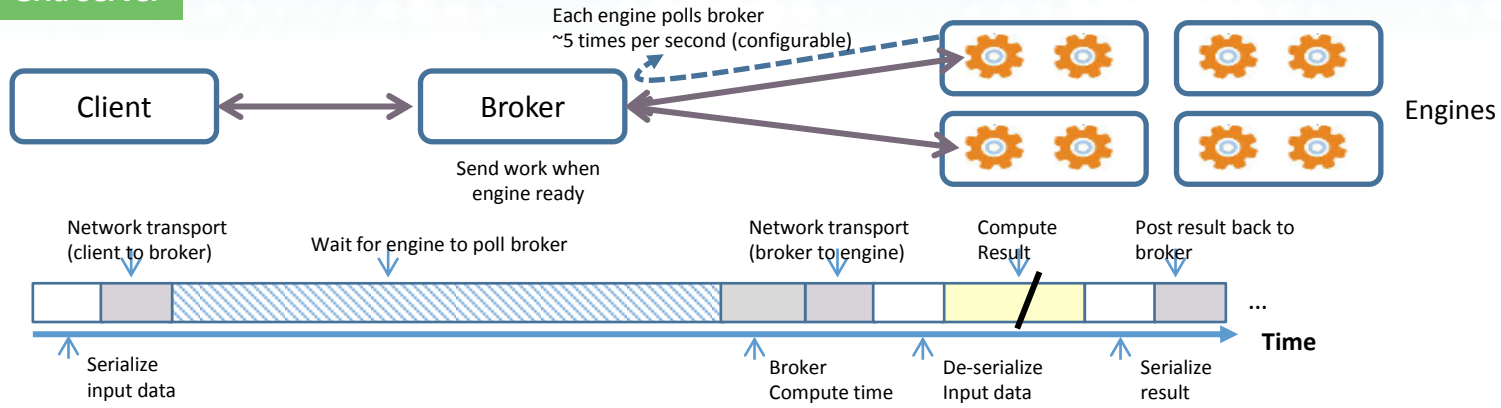
IBM internal unaudited result – details of Intel system benchmark at http://www.hp.com/hpinfo/newsroom/press_kits/2012/HPDiscover2012/Hadoop_Appliance_Fact_Sheet.pdf

Understanding the advantage



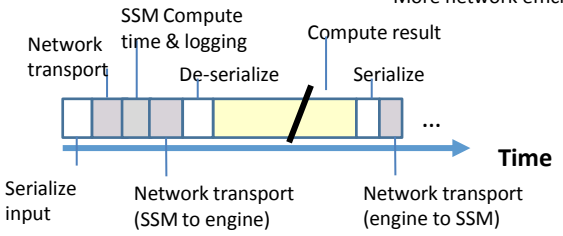
- Symphony 6.1 can schedule ~50x more tasks per second
- Hadoop results taken from Hadoop World 2011 performance presentation, Lipcon & Chen

Other Grid Server



Platform Symphony

No wait time due to polling, faster serialization/de-serialization, More network efficient protocol

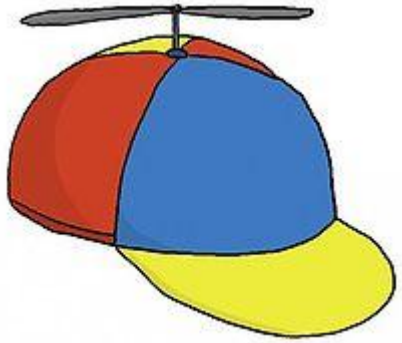


IBM Platform Symphony is (much) faster because:

- Efficient C language routines use CDR (common data representation) and IOCP rather than slow, heavy-weight XML data encoding)
- Network transit time is reduced by avoiding text based HTTP protocol and encoding data in more compact CDR binary format
- Processing time for all Symphony services is reduced by using a native HPC C/C++ implementation for system services rather than Java
- Platform Symphony has a more efficient “push model” that avoids entirely the architectural problems with polling

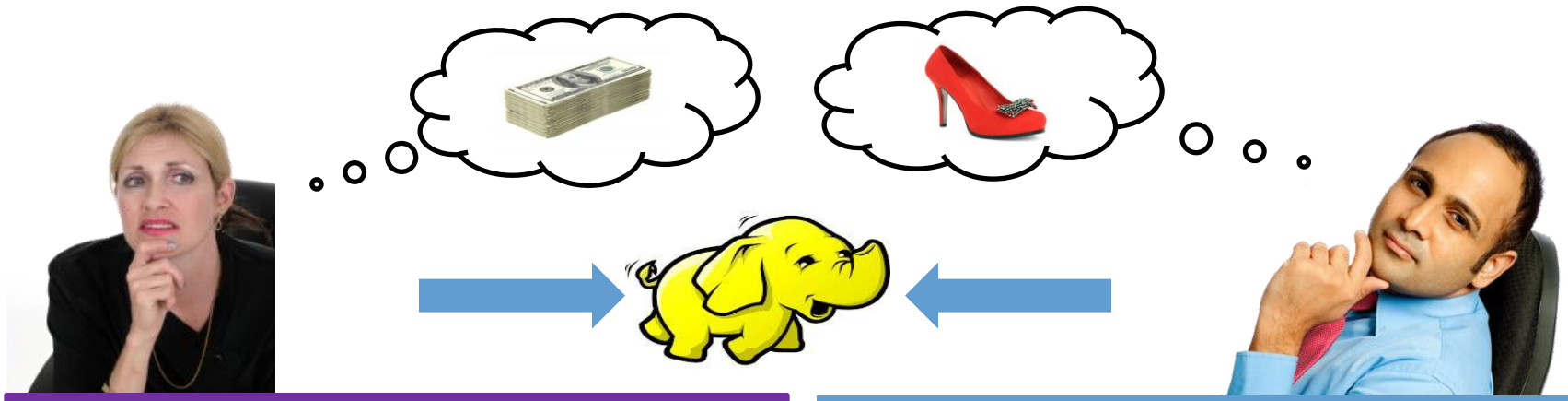
Many performance optimizations

- C++ native code
- Optimized binary network protocols
- Fast object serialization
- JVM pre-start & re-use
- Generic slots enabling full cluster utilization
- Efficient push-based scheduling model
- Uses Symphony common data for JAR transport
- Shuffle-stage optimizations
- Intelligent pre-emption



MULTITENANCY

Different workloads demand different SLAs



"I need an updated counterparty credit risk analysis for the final earnings report by 2:00 pm"

"I wonder if teenagers in California still think red shoes are cool?"

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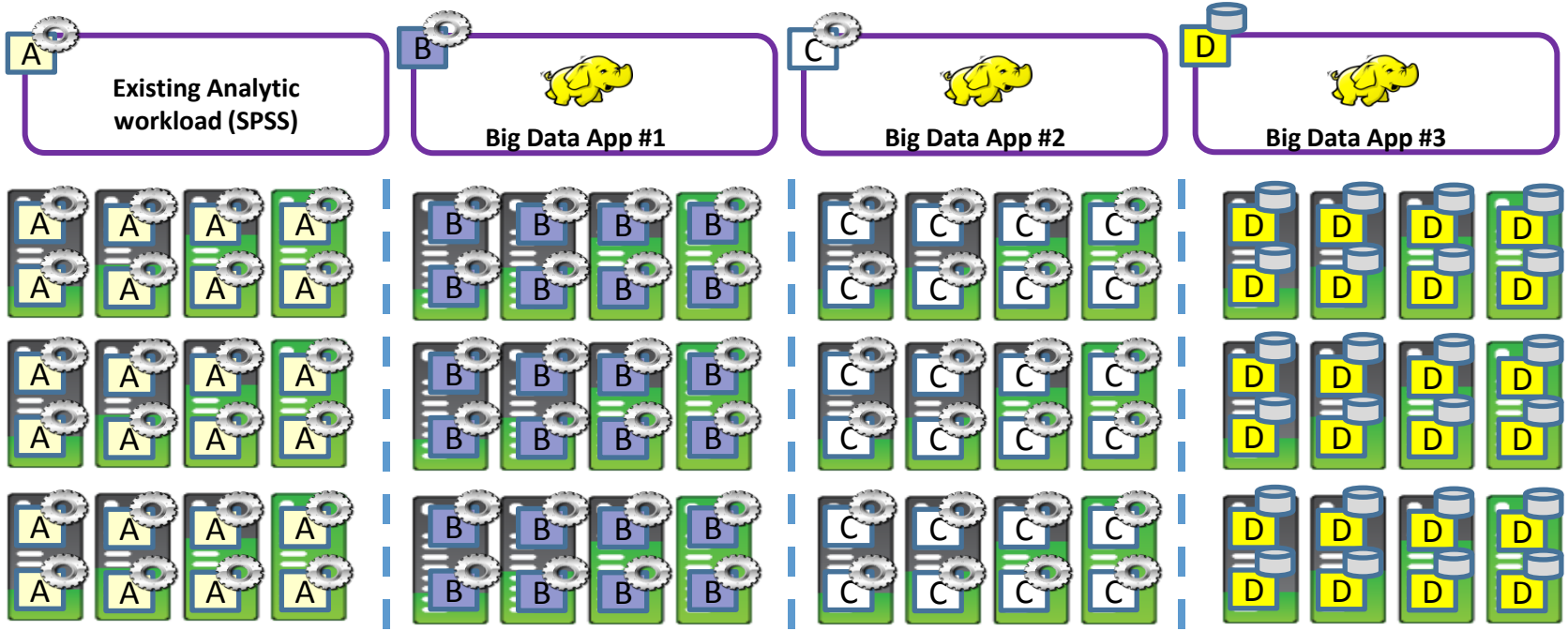
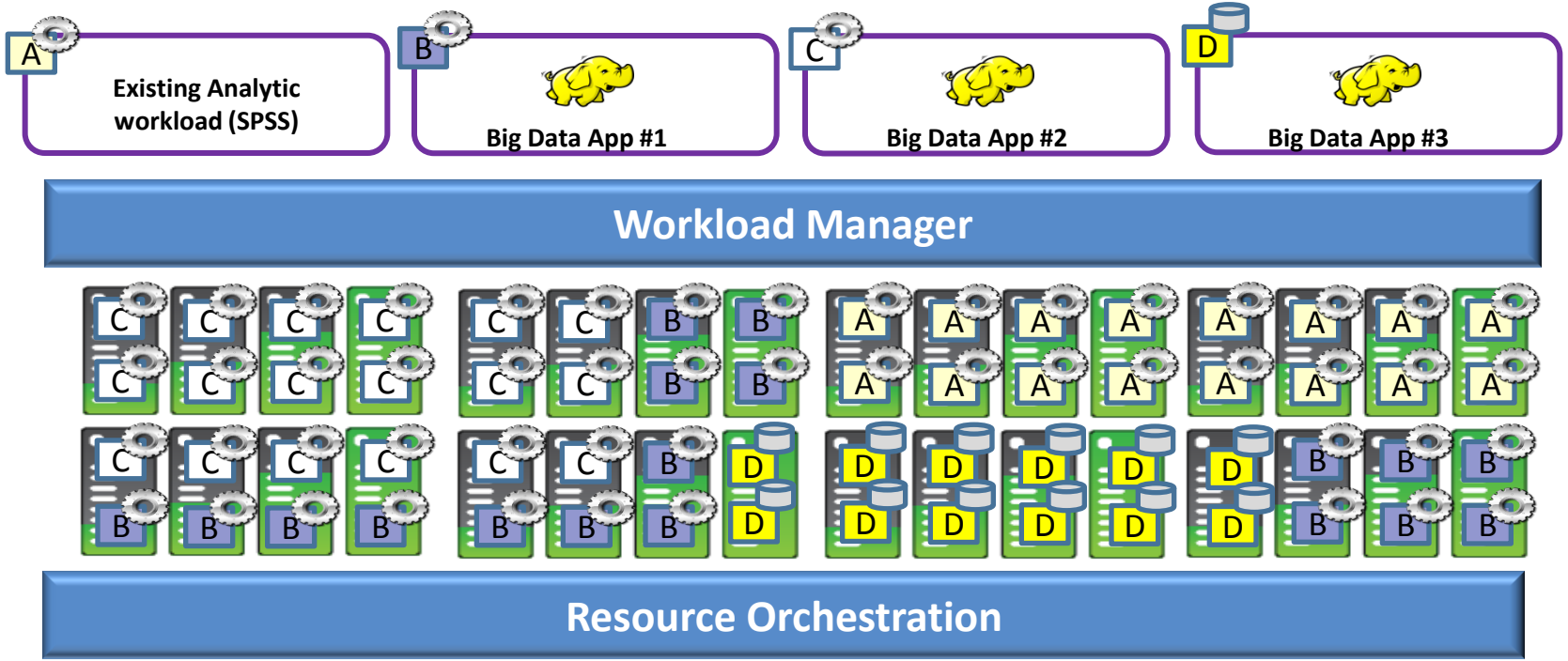
Cluster Sprawl - Silos of underutilized, incompatible clusters



Dynamic resource sharing among heterogeneous tenants



Ensuring SLAs is critical

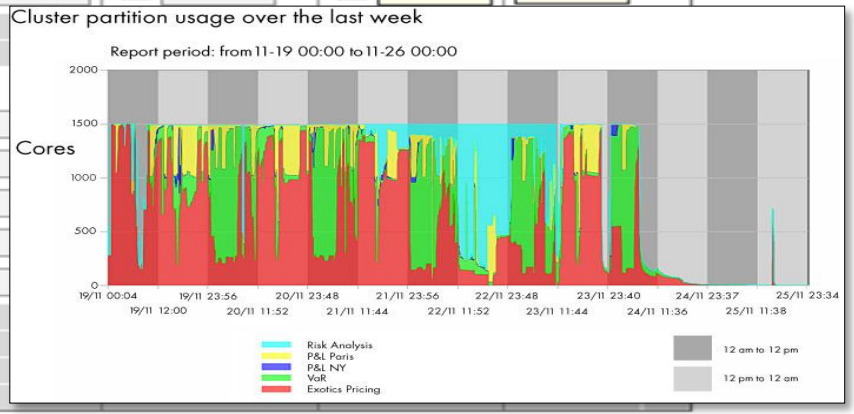
Consumers | Resource Distribution Plan

Resource Group: Management | Time Intervals and Settings

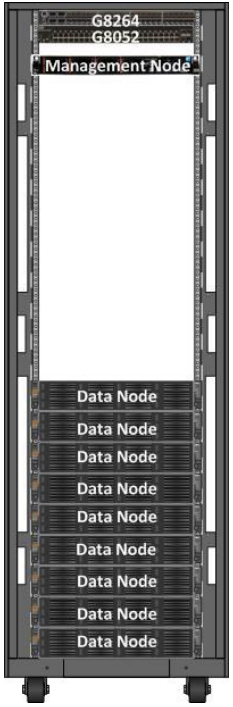
00:00
18:00

Consumer	Ownership: Owned Slots	Consumer Rank	Lend	Limit	Borro
demo2	24				
System	10	10			
Extended	4	70			
Standard	6	70			1
Total	10	-	-		
Balance	0	-	-		
Application	10	5			
Payroll	1	30			
SymSOATest	3	30			
StoreFront	2	30			
Risk	1	30			
Tibco	3	30			
Total	10	-	-		
Balance	0	-	-		
Total	20	-	-		
Balance	4	-	-		

Agile sharing at run-time while preserving ownership and application SLAs



Multiple deployment options

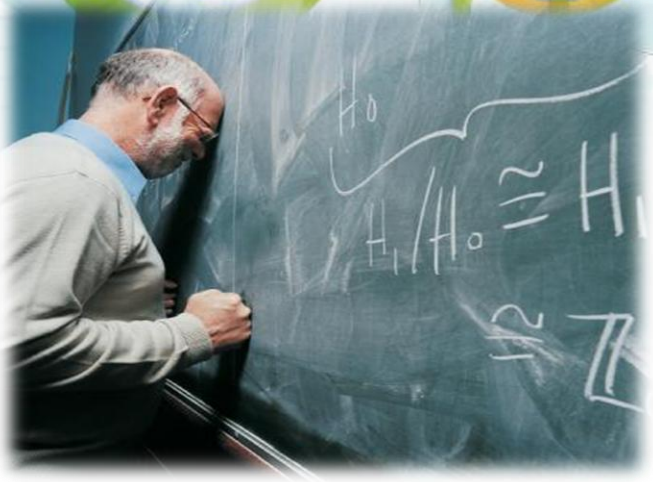


- Pure Data for Hadoop appliances
- Power and Intel based Big Data Reference Architectures
- Your choice of distribution

  IBM BigInsights, Cloudera, MAPR, Apache, Hortonworks etc..
- Your choice of file system

  HDFS or GPFS

Summing up



A unique solution for open-source Big Data Analytics

- Exceptional performance
- Lower infrastructure cost
- Multiple Hadoop distributions
- Simplified application life cycle management
- Sophisticated multi-tenancy
- Optional GPFS file system

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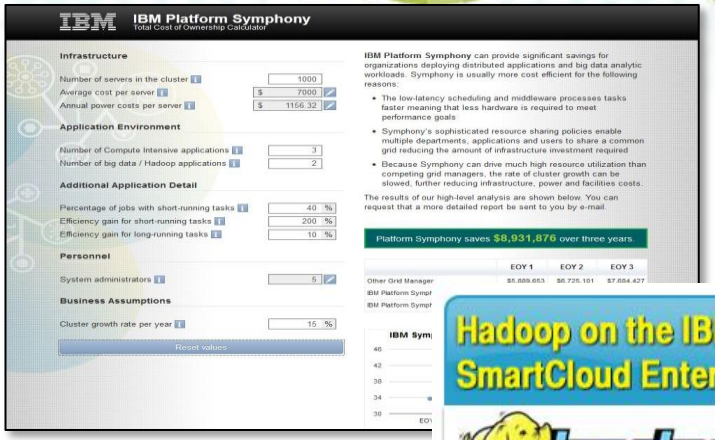
Next steps

- Review the benchmarks
- Take the TCO challenge
- Contact us



http://www.ibm.com/platformcomputing/products/symphony/

http://www.ibm.com/platformcomputing/products/symphony/highperfhadoop.html

http://www-03.ibm.com/systems/power/software/linux/powerlinux/

http://bigdatauniversity.com

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