Scalable Enterprise Data Processing for the Cloud
With Oracle Grid Engine

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Program Agenda

• The new data landscape
• Data-oriented computing
• Data infrastructure
• Compute infrastructure
• Data-oriented computing revisited
• Additional resources
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The Data Landscape

• Structured data
  - Relational data, XML, etc.
  - Well-defined data structure – e.g. Schema, DTD
    • Facilitates automated analysis – e.g. SQL, XSLT
  - Managed life cycle

• Unstructured data
  - Everything that's not structured
  - No predictable or useful structure
    • Somewhat subjective
  - Analysis requires customization and manual intervention
  - No clear life cycle because no clear classification
Unstructured Data

• Documents, logs, records, dumps, etc.
  − Distributed across files across machines across the network
• Growing rapidly
  − 85% of enterprise data
  • Growing at 61.7% compounded annually
• Expensive to store it all
  − How to decide what to keep?
• Potentially massive source of business value
  − Business value locked behind lack of structure
The Data Landscape

- NYSE is generating 1TB per day
- Facebook is generating 20TB per day
  - Compressed!
- CERN is generating 40TB per day
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Data-Oriented Computing

• Compute is now cheap; moving data is still expensive
  – Big change from a decade ago
  – More CPU cores than can be used effectively
  – More data than can be processed

• Do the work close to the data
  – “What to run” → “What data to process”

• Data no longer assumed to float in a SAN
  – Data locality is a core concept
  – The network is the data
Structured Versus Unstructured
Structured Versus Unstructured

Compute

Database
Structured Versus Unstructured

Compute

Database Cluster
Structured Versus Unstructured

Compute

Local Disk
Data-Oriented Computing and the Cloud

• Public clouds rapidly becoming the dominant storage vehicle
• Large data analytics fits well with private or public clouds
  − Mind the transfer!
• Bandwidth and latency issues make hybrid cloud solutions unfavorable

Worldwide Enterprise Disk Storage Consumption Model Capacity Shipment Share by Segment, 2005–2014 (%)
Typical Data-Oriented Computing Use Cases

• Large data files
  – Implicitly chunked across network
  – Process massively in parallel

• Fragmented data records
  – Process in place
  – Aggregation implicit in the computation

• Hacking by determined developers
  – Now called “Data Science”

• Streaming data
  – Dump into storage and proceed as above
Basic Data-Oriented Computing Building Blocks

• Data Infrastructure
  – Massively scalable
    • Also in terms of cost
  – Network-centric
  – Data locality

• Compute Infrastructure
  – Highly scalable management of compute resources
  – Support for multi-tenancy
    • Users & applications
  – Support for accounting and billing
    • Fundamental to cloud model
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Oracle Coherence

• Highly-scalable in-memory data grid
  – Aggregates total memory of nodes into a single cache
    • More nodes = more cache space
  – Coherency maintained through extremely optimized protocol
  – No single point of failure
• Object oriented
  – Every object lives on a particular node
  – Objects replicated for redundancy
• Can be backed by a traditional data store
  – Write ahead, write behind, etc.
Oracle Coherence Embedded Data Grid
Apache Hadoop HDFS

• Highly-scalable on-disk data grid
  – Aggregates assigned disk space of nodes into a single pool
    • More nodes = more storage space
  – Data locations maintained by a master node

• File oriented
  – Every file is broken into data blocks
  – Every block lives on a particular node
  – Blocks replicated for redundancy

• Core component of Hadoop
  – Powerful marriage of compute with data
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Oracle Grid Engine
Business-driven Workload Management

• Powerful workload manager
  - Efficiently match workload to available resources
  - Schedule according to business policies
  - Aggregate user and uses onto a set of resource pools
  - Extreme scalability
  - Full accounting

• Flexible resource broker
  - Share resources among services according to SLOs
  - Lease additional capacity from the cloud on demand
  - Set idle/underutilized machines into reduced power mode
Award-winning Sun Grid Engine
Thousands of Successful Grids

Excellence in Cluster Technology

2004
Frost & Sullivan
Excellence in Technology Award

ClusterWorld
Redefining High Performance Computing
Excellence in Cluster Technology
Redefining the Enterprise Data Center

• Tear down application resource silos
  – Resource sharing according to needs and policies
• Reduce the cost of data center ownership
  – More efficient use of resources
    – Idle or underused machines powered down until needed
• On-demand scale-out to cloud resources
  – Insulates applications from cloud service providers
    – Facilitates private cloud model
• Support for data-oriented compute models
  – Apache Hadoop
  – Oracle Coherence
Common Use Cases

Modeling/Processing

Streaming

Monte Carlo

Validation
Map/Reduce

- Defined in a paper from Google in 2004
  - Apache Hadoop is the best known implementation
- Data processing in two steps
  - Map: process input data across network
  - Reduce: assemble intermediate results into final result
- Example: counting words in a book
  - Map: for each page, emit every word into a giant hash table
  - Reduce: merge all hash tables together and count the number of values for each key
- Massively parallel processing – *embarrassingly parallel*
  - Inherently data aware
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Rethinking Unstructured Data With Hadoop

- MapReduce provides unified interface
  - Rich ecosystem of tools for data analysis
    - Hive, Pig, et al → Cloudera Distribution of Hadoop
  - Almost as accessible as structured data

- HDFS is a *low-cost* distributed file system
  - Adding capacity means just adding (cheap) nodes
  - Changes the economies of data storage

- Possible to extract the value from unstructured data and feasible to keep large amounts of it around
  - Tremendous opportunity for discovered knowledge
“Hadoop is a key ingredient in allowing LinkedIn to build many of our most computationally difficult features, allowing us to harness our incredible data about the professional world for our users”

Jay Kreps, Principal Engineer
Word Count Example Revisited

Word Count Algorithm

- Store data in HDFS
- Map phase: count words per data block
- Shuffle
- Reduce phase: aggregate counts
- Extract results from HDFS

capacity: 14334
intellect: 12377
mind: 9574
money: 5967
truth: 5868...

China

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Word Count Algorithm
Unstructured Enterprise Data Analytics

• Not all necessarily Hadoop
  – MPI, Java, legacy, or even different Hadoop versions
• Grid Engine unifies the workload across the resources
  – Better efficiency
  – Lower cost of management
  – Cross-domain workflows
• Plus enterprise class features:
  – Demand-driven cloud connectivity and power management
  – Advanced scheduling policies
    • Advance resource reservations
  – Full accounting and reporting suite
“The Oracle Grid Engine 6.2 software has dramatically lowered for us the cost of data intensive, Hadoop centered, computing. Oracle Grid Engine allows us to run Hadoop jobs within exactly the same scheduling and submission environment we use for traditional scalar and parallel loads.”

Gianluigi Zanetti
Director, Biomedical Applications, CRS4
Word Count Example Re-Revisited

Map/Reduce: Word Count

Map/Reduce

OpenMPI

Java

Oracle Grid Engine

HDFS

ORACLE
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References For Getting Started

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• Cloudera:
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