XLDB’11 Cloud Computing at Scale

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Microsoft Research
Framing Questions for Presentation(s)

Does it make sense for large-scale (many terabytes, petabytes), data-intensive projects to consider using public cloud?

Many of the claims being made about cloud computing for research have lead some to the point of “irrational exuberance” and unrealistic expectations…

• Issues and observations on when public clouds are not a great fit…

What is the reasonable scale, and how to decide when it is better to use a public cloud or a cluster?

Realistic expectations and opportunities to create sources of value.
Cloud Computing for Research Program, MSR
~100 Projects and growing...

Selected Projects
Penn
Louisiana
Washington
New York
New Mexico
North Dakota
California
Colorado
Michigan
Texas

National Science Foundation
Florida
Georgia
Mass.
Virginia
North Carolina
South Carolina
Indiana
Delaware

Europe
Brussels
Venus-C
England - University of Nottingham
Inria in France
Plus Italy, Spain, Greece, Denmark, Switzerland, Germany

China

Japan
InfoPlosion
- Tokyo
- Kyoto

Taiwan- starting

Australia
Partners
- NICTA
- ANU
- CSIRO
It is hard to compete with a fully utilized cluster on cost alone:

- Cost comparison for DOE lab performing metagenomics, assuming cluster utilization of 80% or higher, private cluster (container) was a clear winner;
- Possible to fine tune a cluster for a specific workload, further increasing the amount of work performed per dollar spent.

Most organizations do not have to fully account for the cost of running a cluster or compute facility, with the institution carrying cost for infrastructure, electricity, etc…
Cost prohibitive for petascale projects (and likely to remain so for the foreseeable future…)

Economics of Cloud Storage

- Hard Drive Storage (per gigabyte): $44.56
- Web Storage (per gigabyte): $1,250

2000
Economics of Cloud Storage

2010

Hard Drive Storage (per gigabyte) $0.07

Web Storage (per gigabyte) $0.15

Cost prohibitive for petascale projects (and likely to remain so for the foreseeable future...)

BackBlaze Blog Sept 2009

<table>
<thead>
<tr>
<th>COST OF A PETABYTE</th>
<th>BackBlaze Blog Sept 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAW DRIVES</td>
<td>$81,000</td>
</tr>
<tr>
<td>BACKBLAZE</td>
<td>$117,000</td>
</tr>
<tr>
<td>DELL MD1000</td>
<td>$826,000</td>
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<tr>
<td>SUN X4550</td>
<td>$1,000,000</td>
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<tr>
<td>NetApp FAS-6000</td>
<td>$1,714,000</td>
</tr>
<tr>
<td>amazon S3</td>
<td>$2,806,000</td>
</tr>
<tr>
<td>EMC NS-960</td>
<td>$2,860,000</td>
</tr>
</tbody>
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* Amazon S3 Storage over three years (minus electricity, co-location and administration).
Realities of Networking both to and within Cloud Platforms

- Latency and throughput from lab to cloud (datacenter) limited by weakest link.
- Measure the time to transfer a terabyte, even on research networks (NLR and/or I2);
- Groups facing issues scaling a compute facility unable to get sufficient throughput;
- Limited network bandwidth within the datacenter, largely commodity hardware

Simply put, data intensive research applications were not the primary target customer for first generation cloud providers...
Lack of Broad Access – how the other half live…

Actually the other 80%, as only a fraction of scientists and researchers enjoy regular access to required computational and data-intensive resources…
What Researchers Need Today, and Trends Looking Ahead...

Data Analysis Services

I’ve got data, what can I do with it?
- Most researchers struggle with 50GB to 100GB for their research;
- Analysis can be compute intensive, intermediate data products large;

Research projects are more diverse, more collaborative
- Push towards community reference data collections, up to 5TB to 10TB;
- Shared, community built and supported research services;

Software services are becoming a new type of instrument (A Szalay)
- Analysis involves personal research data plus community reference data;
- Ability to curate, share, and collaborate over data is game changing;

A common pattern across many scientific disciplines
R. palustris as a platform for H2 production*

Identify key drivers for producing hydrogen, promising alternative fuel – understand R. palustris well enough to be able to improve its H2 production;

Characterize a population of strains and use integrative genomics approaches to dissect the molecular networks of H2 production;

BLAST to query 16 strains to sort out genetic relationships
- Each strain, estimated ~5,000 proteins (700,000 sequence)
- Jobs kicked off of NCBI clusters before completion
- Using AzureBLAST against NCBI NREF complete in ~30 min.
- Against ~5,000 proteins from another strain less than 30 sec.
- Publishable result in one day for roughly $150.

NCBI reference data for complete BLAST suite, roughly 50GB

Eric Schadt, Pac Bio and Sam Phattarasukol Harwood Lab, UW
AzureMODIS – Computing Evapotranspiration (ETP)

Two MODIS satellites
- Terra, launched 12/1999
- Aqua, launched 05/2002
- Near polar orbits
- Global coverage two days
- Sensitive in 36 spectral bands

Catharine van Ingen (MSR), Jie Li, Marty Humphrey (UVA), Youngryel Ryu (UCB), Deb Agarwal (BWC/LBL), Keith Jackson (BL), Jay Borenstein (Stanford), Team SICT: Vlad Andrei, Klaus Ganser, Samir Selman, Nandita Prabhu (Stanford), Team Nimbus: David Li, Sudarshan Rangarajan, Shantanu Kurhekar, Riddhi Mittal (Stanford)
Computing Evapotranspiration for One US Year

**Data Collection Stage**
- Source Imagery Download Sites
- 400-500 GB
- 60K files
- $50 upload
- 10 MB/sec
- $225 storage
- 11 hours
- <10 workers

**Reprojection Stage**
- 400 GB
- 45K files
- 3500 hours
- $420 cpu
- $60 download

**Derivation Reduction Stage**
- 5-7 GB
- 5.5K files
- 1800 hours
- 100 workers
- $216 cpu

**Analysis Reduction Stage**
- <10 GB
- ~15K files
- 1800 hours
- $216 cpu

**Reduction #1 Queue**
- 400-500 GB
- 60K files
- 11 hours
- <10 workers

**Reduction #2 Queue**
- 400 GB
- 45K files
- 1800 hours
- 100 workers

**Total cost $1,800, where all storage costs assume 3 month project duration;**
Excel DataScope

Cloud Scale Data Analytics from Excel

Bringing the power of the cloud to the laptop

- Data sharing in the cloud, with annotations to facilitate discovery and reuse;
- Sample and manipulate extremely large data collections in the cloud;
- Data analytics algorithms, through Excel ribbon running on Azure;
- Invoke models, to process and refine data;
- Machine learning over large data sets to discover correlations;
- Publish data collections and visualizations to the cloud;

Researchers use familiar tools, familiar but differentiated.
The Cloud Opportunity: Democratizing Access to Resources

**Today**

**Majority of Researchers**
- Use laptops and desktop computers
- Overwhelmed by data
- Doing analysis difficult; sharing even harder

**Supercomputing Users**
- Those with small clusters or servers

**A Unified Research Community**

**Tomorrow**

**Paradigm Shift**
- Powerful Tools
  - Data and analysis tools in the cloud
  - Cycles, storage, support
  - Building communities around research results
  - The ability to marshal needed resources on demand
  - Without caring or knowing how it gets done...
- Accelerating Discovery