Challenges

Complex missions:
- data intensive
- CPU intensive
- processing context
Solutions

Different processing options:

- Local cluster
- Several independent processing centres
- GRID
- Cloud infrastructure
- Cloud infrastructure (commercial)

Access is better than ownership

(Kevin Kelly, Wired)
Different processing options:

- Local cluster
  
  e.g. ISDC services for INTEGRAL (see C. Ferrigno’s presentation)

- Several independent processing centres
  
  e.g. GAIA (S. Els’ presentation)

- GRID
  
  e.g. LHC (37 TByte/day → 11 Tier 1, 10-15 PByte/year), CTA

- Cloud infrastructure
  
  e.g. eLISA development (and SDC?)

- Cloud infrastructure (commercial)
  
  e.g. LHC for Higgs discovery, space?
• Several participating centres
• Same installation
• Middleware (e.g. gLite, EMI)
• High entry level
• EGI: Heavily supported by FP-6, FP-7, FP-8 (>100 M€ for EGEE and EGEE-II)
• Data intensive processing: needs dedicated infrastructure (e.g. LHC)
• Few, well connected large centres

EGI: European Grid Infrastructure
EGEE: Enabling Grids for E-Science in Europe (FP-6 / FP-7)
Cloud computing faces skepticism (Shane Canon, Lawrence Berkeley National Lab):

- Overhead to convert to Cloud environments
- Virtual instances underperform bare-metal systems
- Less cost effective than most large centers

Distinguish between

- Commercial cloud
- Cloud as a virtualised infrastructure
Overhead to convert to Cloud environments

Steps to be done

- Create a disk image of your operation system
- Upload it to cloud environment and set parameters of processing (#cores etc.)
- Install whatever s/w you like

Running your first task on the stratuslab cloud is not more challenging than to learn how to use the local cluster.

Disk images can be provided to consortium (e.g. Marketplace in stratuslab)
Cloud vs. Cluster

Virtual instances underperform bare-metal systems

How does the performance compare between a local cluster and a cloud environment?

<table>
<thead>
<tr>
<th>Description</th>
<th>StratusLab Cloud</th>
<th>Arago cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nodes</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Cores/node</td>
<td>24</td>
<td>16</td>
</tr>
<tr>
<td>Memory/node</td>
<td>36 GB</td>
<td>48 GB</td>
</tr>
<tr>
<td>Interconnexion network</td>
<td>1 GbE/s</td>
<td>10 GbE/s</td>
</tr>
</tbody>
</table>

Performance test

- Scaling: speedup, classical metric efficiency, Karp-Flatt metric efficiency
- Memory bandwidth
- I/O access
- Benchmarking: NASA parallel benchmark (NPB)
- High Performance Linpack (HPL)
Cloud & cluster both approach band-width saturation in a similar fashion.
Cloud vs. Cluster

Cloud environments under-perform for processes with large inter-node message transfer.
Cloud vs. Cluster

Table 3. Summary of processing resources on Amazon EC2.

<table>
<thead>
<tr>
<th>type</th>
<th>arch.</th>
<th>CPU</th>
<th>cores</th>
<th>memory (GB)</th>
<th>network</th>
<th>storage</th>
<th>price</th>
</tr>
</thead>
<tbody>
<tr>
<td>m1.small</td>
<td>32 bit</td>
<td>2.0–2.6 GHz Opteron</td>
<td>1/2</td>
<td>1.7</td>
<td>1 Gbps Ethernet</td>
<td>local</td>
<td>US$0.10 h⁻¹</td>
</tr>
<tr>
<td>m1.large</td>
<td>64 bit</td>
<td>2.0–2.6 GHz Opteron</td>
<td>2</td>
<td>7.5</td>
<td>1 Gbps Ethernet</td>
<td>local</td>
<td>US$0.40 h⁻¹</td>
</tr>
<tr>
<td>m1.xlarge</td>
<td>64 bit</td>
<td>2.0–2.6 GHz Opteron</td>
<td>4</td>
<td>15.0</td>
<td>1 Gbps Ethernet</td>
<td>local</td>
<td>US$0.80 h⁻¹</td>
</tr>
<tr>
<td>c1.medium</td>
<td>32 bit</td>
<td>2.33–2.66 GHz Xeon</td>
<td>2</td>
<td>1.7</td>
<td>1 Gbps Ethernet</td>
<td>local</td>
<td>US$0.20 h⁻¹</td>
</tr>
<tr>
<td>c1.xlarge</td>
<td>64 bit</td>
<td>2.0–2.66 GHz Xeon</td>
<td>8</td>
<td>7.5</td>
<td>1 Gbps Ethernet</td>
<td>local</td>
<td>US$0.80 h⁻¹</td>
</tr>
</tbody>
</table>

Table 4. Summary of processing resources on the Abe high-performance cluster.

<table>
<thead>
<tr>
<th>type</th>
<th>arch.</th>
<th>CPU</th>
<th>cores</th>
<th>memory (GB)</th>
<th>network</th>
<th>storage</th>
<th>storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>abe.local</td>
<td>64 bit</td>
<td>2.33 GHz Xeon</td>
<td>8</td>
<td>8</td>
<td>10 Gbps InfiniBand</td>
<td>local</td>
<td></td>
</tr>
<tr>
<td>abe.lustre</td>
<td>64 bit</td>
<td>2.33 GHz Xeon</td>
<td>8</td>
<td>8</td>
<td>10 Gbps InfiniBand</td>
<td>lustre</td>
<td></td>
</tr>
</tbody>
</table>

Berriman et al. 2013, « The application of cloud computing to scientific workflows: a study of cost and performance », Phil. Trans. R. Soc. A 2013 371
Cloud vs. Cluster

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Cloud environments perform similar for CPU- and memory-bound processes. Berriman et al. 2013
Science Clouds

Cloud computing skepticism (Shane Canon, Lawrence Berkeley National Lab):

- *Overhead to convert to Cloud environments*

Not more heavy than training colleagues on clusters (depends also on application)
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  True (especially for heavy i/o), but portability, collaboration in consortium, service, long-term possibility to process data (R. Rohlfs: “s/w must not include h/w specific routines”)

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- **Less cost effective than most large centers**
  Might be true when considering commercial clouds (again depends on application). Science cloud: in comparison with clusters, probably less costs for IT
Conclusion

Best solution depends on task + politics
GRID approach for heavy + long term + well financed tasks
Cloud environments can be a flexible solution for space projects
But: “The more communication, the worse the performance becomes” (Jackson et al. 2010)
Hybrid cloud solutions appear to satisfy many of the demands of space missions
Commercial cloud for temporary needs only

Read more:
• Berriman et al. 2013, Phil. Trans. R. Soc. A, 371
• Magellan report on Cloud Computing for Science, DoE, 2011
• Jackson et al. 2010, IEEE 2nd International Conf. on Cloud Comp. (Cloud Com)
See also presentation by Jorgo Bakker today!
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matériel supplémentaire
additional slides
noch mehr Folien
materiale aggiuntivo
aannullend materiaal
Cloud vs. Cluster
Cloud vs. Cluster

![Graph showing Bande passante (Gb/s) vs. Taille des messages (MB) for Arago and Virtuel]
Infrastructure

- Clusters, 620 CPU, 100 kW refroidissement, 100 TByte disque dur
- 10 Gbit/s connection
- 2 salles de conférence vidéo
- 2 salles de réunion
- Bureaux à la demande
- Support logiciel et matérielle
- Concurrent Design Facility