Using Utility Computing
to provide
Mathematical Programming
Resources

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Agenda

- Introduction
- NEOS – Server for Optimization
  - Network.com (Sun)
- Azure Services Platform (Microsoft)
- Amazon Elastic Computing Cloud (EC2)
- Challenges and Conclusions
What is Utility Computing?

...the **packaging of computing resources**, such as computation and storage, as a **metered service** similar to a physical public utility...


→ Cloud Computing
<table>
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<tr>
<th>Aspects</th>
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<tr>
<td>• Service Provision Model: Maximize the efficient use of resources and minimize associated costs</td>
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<td>• Virtualization of Hardware</td>
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<td>• Unlimited computing resources and infrastructure available on demand</td>
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<td>• Pay as you go / No up-front commitment</td>
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Predecessors: Time Sharing Systems

- Sharing expansive computing resources
- Full service operations (Hard-&Software)
- Charges:
  - fixed rent
  - per usage
- Success of PC terminated businesses
Math. Programming Applications

Wide Range of possible Demands:

- Resources hungry (RAM / CPU)
- Parallel operation
- Off-line / Batch operations
- Delivery of Results time critical
- Interfaces and GUI application specific
- Confidentiality issues
- …
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NEOS – Server for Optimization

- Distributed (heterogeneous) computing environment
- Various interfaces, for modeling languages: Kestrel

```
gams transport lp=kestrel
  ...
  --- Executing KESTREL: elapsed 0:00:00.033

NEOS job#=1898119, pass=DdvyasMF

Check the following URL for progress report:
http://www-neos.mcs.anl.gov/cgi-bin/nph-neos-solver.cgi?admin=results&jobnumber=1898119&pass=DdvyasMF
  ...
  --- Reading solution for model transport
  *** Status: Normal completion
  --- Job transport.gms Stop 06/26/09 13:55:55 elapsed 0:00:34.037
```
NEOS – Server for Optimization

- Ready to use – service
- Free of charge
- Tailored for OR applications
- Simple interfaces (Web, Kestrel)
- Around for more than 10 years

- Performance
- Confidentiality?
- Scalable?
- Future?
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Network.com operated by Sun

- **On-demand grid** computing service
- A few hundred **identical computing nodes** (Opteron, 2 CPU, 2 *4 GB RAM, Solaris 10)
- **“Pay as you go”** - utility: 1 $ / CPU-hour
- **Web Interface** and **API**
- **Network of Service Provider**

→ No longer accessible (March 2010)
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Microsoft’s Azure Services Platform

- Application platform for different services
- Cloud Based (18 MS Datacenters world wide)
- Uses specialized OS (Windows Azure)
- Applications have to be customized for running on Windows Azure
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Amazon Elastic Computing Cloud

- Large number of **virtual machines** (instances)

- Hardware
  - 1-8 virtual CPU’s, ~1.7 - 68.4 GB RAM
  - Unlimited disk space
- OS: Microsoft 2008 Server, Linux, Solaris
- Cluster Compute Instances available

- Pay per Usage
  - Time (0.1 – 2.75+ $ uptime)
  - Disk space
  - Traffic
Using Amazon EC2..

- Signup with Amazon Account
- Payment via Credit Card

- Local Control: **Web Interfaces** and Batch Scripts
- Remote Desktop / Root access to virtual machines

- Companion Products: Storage Services, Flexible Payments, VPS, ..
- Large Network of Service Provider
Using Amazon EC2: Web

AWS Console
Using Amazon EC2: Shell.

c:\ec2>"c:\Program Files (x86)\Java\jre6\bin\java" -version
java version "1.6.0_20"
Java(TM) SE Runtime Environment (build 1.6.0_20-b02)
Java HotSpot(TM) Client VM (build 16.3-b01, mixed mode, sharing)
c:\ec2>ec2-describe-images -o amazon |grep -i windows
... IMAGE ami-f11ff098 amazon/Windows-Server2003R2-i386-Base-v109 amazon available public i386 machine
IMAGE ami-f31ff09a amazon/Windows-Server2003R2-i386-SqlExpress-v109 amazon available public
...
Using Amazon EC2: RDP / SSH
Amazon EC2: Usage

- No Restrictions

- Customized instances:
  - Evaluation / Support
  - Building and Testing Environment
  - Projects (CPU Bursts)
  - Grid Computing (e.g. Condor)
  - Value added Resellers
Amazon Elastic Computing Cloud

- Wide range of applications
- Business model!
- Simple Cost Structure
- Secured Environment (VPN!)
- Batch / API for Control

- Payments for Uptime
- Startup time
- Heterogeneous Hardware
- Fluctuations of Performance (IO)
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Challenges

- MP has **wide range of demands**
- Interfaces
- Reliability, **Scalability & Performance**
- **Portability** between different Service Providers
- Confidentiality
- **Business Models**
Conclusions

Still at a early stage, but will become more important?

• Offers lots of opportunities and promising developments

• **Lots of Challenges** ahead
The End

Thank you!

... Questions?
## Contacting GAMS

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