Using Utility Computing to provide Mathematical Programming Resources

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Agenda

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

… a business model for computing in which resources are made available to the user on an as-needed basis…
(http://www.sun.com/service/sungrid/index.jsp)

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

→ Cloud Computing
Aspects

- *Unlimited* computing resources available on demand
- Pay as you go
- No up-front commitment
Predecessors: Time Sharing Systems

• Sharing expansive computing resources

• Full service operations

• Charges:
  – fixed rent
  – per usage

• Success of PC terminated businesses
Math. Programming Applications

Wide Range of potential Demands:

• Resources-hungry (Memory / CPU time)
• Parallel operation?

• Off-line / Batch operations
• Delivery of Results time critical

• Confidentiality issues
• GUI very application specific
• …
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NEOS – Server for Optimization

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

```plaintext
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 trnsport.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

- (Some) Important commercial solver missing
- Confidentiality?
- Scalable?
- Future?
### Agenda

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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

- Network of Service Provider

- **Web Interface** and **API**
Advantages of Grid Computing

• Divide and Conquer

• Better results by running more scenarios within a given time period

• Solve a certain number of scenarios faster:
  – sequential: 50 hours
  – parallel (200 CPUs): ~15 minutes
GAMS & Grid Computing

- Language Extensions to support distributed computing
- **Scalable** and **Platform independent**
  - massive grids
  - multi-cpu machines
  - “1 CPU - Grid”
- Only **minor changes** to model required
- **Separation** of model and solution method
Results for 4096 MIPS on Condor Grid

- 20 hours wall time
- 5000 CPU hours
- Peak number of CPUs: 500
Network.com operated by Sun

- **Uniform** Grid Structure
- Always on
- **Simple** Cost Structure
- **Secured** Environment

- **Interfaces**
- Limited **Resources** (CPUs, memory)
- Quality of service?
- **Business model?**
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Amazon Elastic Computing Cloud

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

- Provides
  - Hardware: 1-8 virtual CPU’s, ~1.7-16 GB RAM
  - Unlimited disk space (AWS S3)
  - MS 2003 Server, Linux, Solaris

- **Pay per Usage**
  - Time (0.1 – 1.2 $ hour **uptime**)
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,..
- Large Network of Service Provider
Amazon EC2: Usage

• No Restrictions

• Customized instances:
  • Grid Computing (e.g. Condor)
  • Projects (CPU Bursts)
  • Value added Resellers

• Builds and Tests
Amazon Elastic Computing Cloud

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

- Payment for Uptime
- Startup time
- Interfaces
- Heterogeneous Hardware
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Challenges

• MP has wide range of demands
• Interfaces
• Reliability, **Scalability & Performance**
• **Portability** between different Service Providers
• Confidentiality
• **Business Models**
• “Cloud Computing” **Hype**
Conclusions

• Utility computing still at a early stage, but will become more important

• Grid Computing offers lots of promising developments

• GAMS supports parallel environments

• Lots of Challenges ahead
The End

Thank you!

... Questions?
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