Is Utility Computing suitable for providing Mathematical Programming Resources?

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Agenda

- Introduction
- Two different Approaches
- GAMS and Grid Computing
- Challenges and Conclusions
GAMS Development / GAMS Software

- Roots: **Research project**
  World Bank 1976
- Pioneer in **Algebraic Modeling Systems**
  used for economic modeling
- Went **commercial** in 1987
- **Offices** in Washington, D.C and Cologne

- Professional **software tool provider, not a consulting company**
- Operating in a **segmented niche market**
- Broad **academic & commercial** user base and network

General Algebraic Modeling System
What is Utility Computing?

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

… 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)
Predecessors: Time Sharing Systems

- Sharing expansive computing resources
- Full service operations
- Charges:
  - fixed rent
  - per usage
- Success of Personal Computer terminated businesses
Math Programming Applications

Wide Range of possible Demands:

- Lots of Memory and CPU time
- Off-line / Batch operations
- Parallel operations only sometimes possible

- Optimization may fail!
- Delivery of Results time critical (?)

- Confidentiality issues (?)
- GUI very application specific
- …
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Amazon Elastic Computing Cloud

- Access to an unlimited number of virtual machines
- Provides Hardware and OS
- Pay per Usage
Amazon EC2: Available Instances

- **Small**: 1.7 GB RAM, 1 virtual core, 160 GB HD ($0.1 per CPU h)
- **Large**: 7.5 GB RAM, 4 virtual cores, 850 GB HD ($0.4 per CPU h)
- **Extra Large**: 15 GB RAM, 8 virtual cores, 1690 HD ($0.8 per CPU h)
Using Amazon EC2....

• Growing Network of Service Provider
Network.com operated by Sun

- On-demand grid computing service
- A few hundred CPU’s (AMD Opteron, 2 CPU SMP, 2 *4 GB RAM, Solaris 10)
- Pay as you go utility: 1 $ / CPU-hour
- Network of Service Provider
Using Network.com...

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GRID Specific Enhancements

1. Submission of jobs

2. “Grid Middleware”
   – Distribution
   – Execution

3. Collection of solutions

4. Processing of results
GAMS & Grid 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
Using the GAMS GRID Facilities

Job Scheduling Host

Node 001

GAMS

Solve Loop

Model 1, Instance 001

Model 1, Instance ...

Model 1, Instance nnn

Output Job 1

Model 001

Job 1

Model 001
Advantages of Grid Computing

- Solve a certain number of scenarios faster:
  - sequential: 50 hours
  - parallel (200 CPUs): ~15 minutes

- Better results by running more scenarios*:

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Results for 4096 MIPS on Condor Grid

- 20 hours wall time
- 5000 CPU hours
- Peak number of CPU's: 500
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Challenges

- Interfaces
- Reliability, Scalability & Performance
- Confidentiality
- Business Models
Conclusions

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

• **Grid Computing** offers lots of promising developments

• **Algebraic Modeling Languages** are supporting parallel environments

• **Lots of Challenges** ahead
The End

Thank you!

… Questions?
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