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…*
(http://en.wikipedia.org/wiki/Utility_computing)

→ ***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

```
gams trnsport 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**?

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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

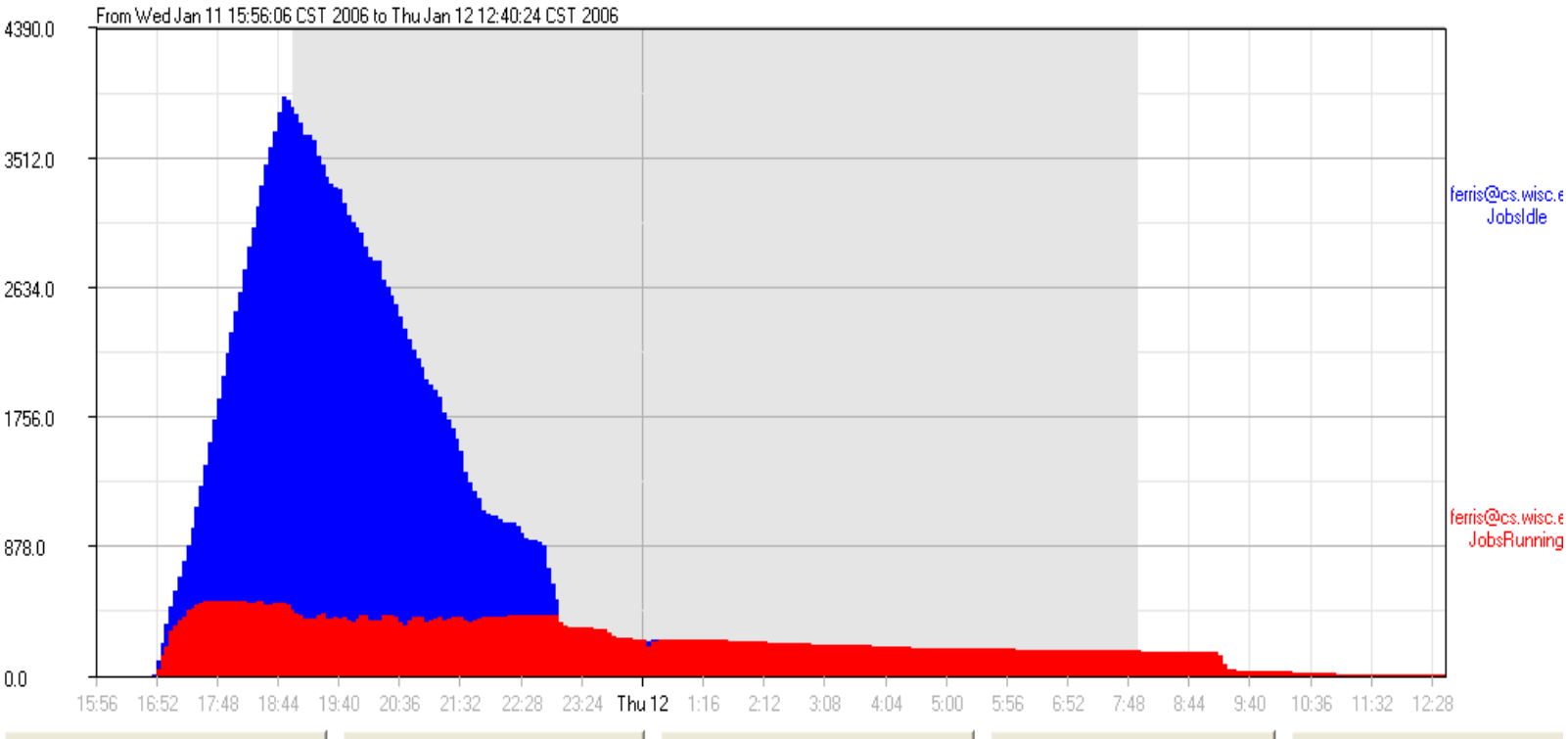
- **Divide and Conquer**
- Better results by running **more scenarios within a given time period**
- Solve a **certain number of scenarios faster**:
  - sequential: 50 hours
  - parallel (200 CPUs): ~15 minutes

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**)
  - 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,..
- 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 enviroments
- **Lots of Challenges** ahead

The End

Thank you!

… Questions?

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