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

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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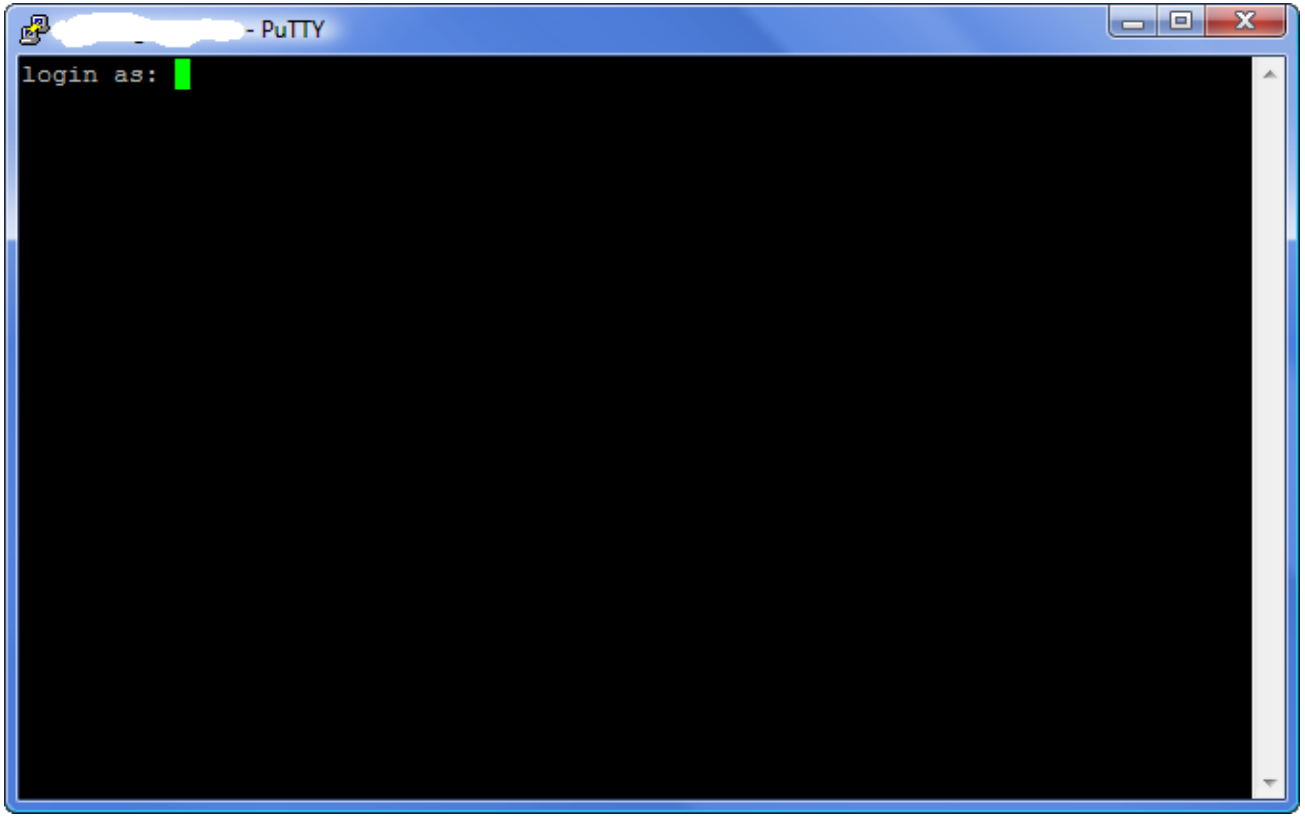
Amazon Elastic Computing Cloud

- 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….

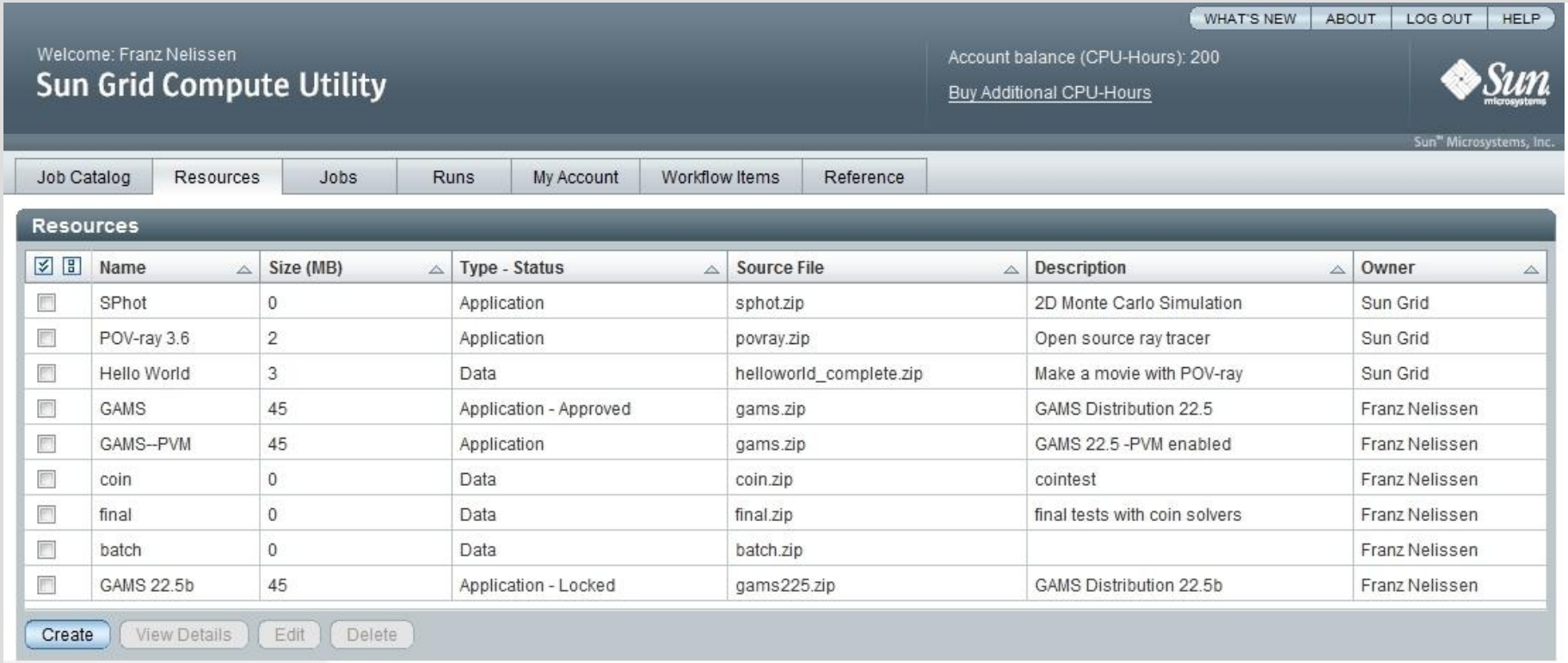


- Growing Network of Service Provider

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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Welcome: Franz Nelissen

Sun Grid Compute Utility

Account balance (CPU-Hours): 200

Buy Additional CPU-Hours

Sun Microsystems, Inc.

Job Catalog | Resources | Jobs | Runs | My Account | Workflow Items | Reference

Resources

Name	Size (MB)	Type - Status	Source File	Description	Owner
SPhot	0	Application	sphot.zip	2D Monte Carlo Simulation	Sun Grid
POV-ray 3.6	2	Application	povray.zip	Open source ray tracer	Sun Grid
Hello World	3	Data	helloworld_complete.zip	Make a movie with POV-ray	Sun Grid
GAMS	45	Application - Approved	gams.zip	GAMS Distribution 22.5	Franz Nelissen
GAMS--PVM	45	Application	gams.zip	GAMS 22.5 -PVM enabled	Franz Nelissen
coin	0	Data	coin.zip	cointest	Franz Nelissen
final	0	Data	final.zip	final tests with coin solvers	Franz Nelissen
batch	0	Data	batch.zip		Franz Nelissen
GAMS 22.5b	45	Application - Locked	gams225.zip	GAMS Distribution 22.5b	Franz Nelissen

Create | View Details | Edit | Delete

Total Resources Size (MB): 135.000

Account Storage limit (MB): 10240

→More Information at: http://www.gams.com/sungrid/

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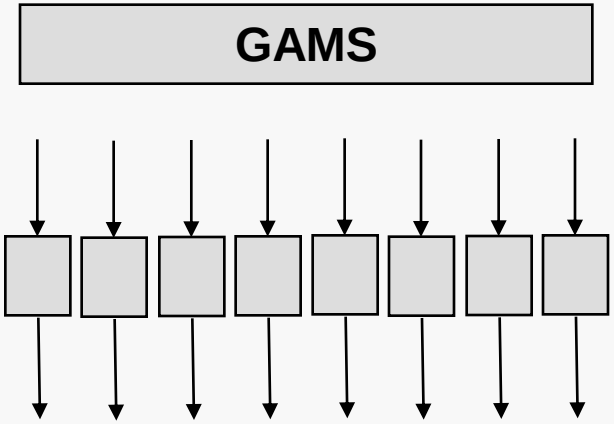
GRID Specific Enhancements

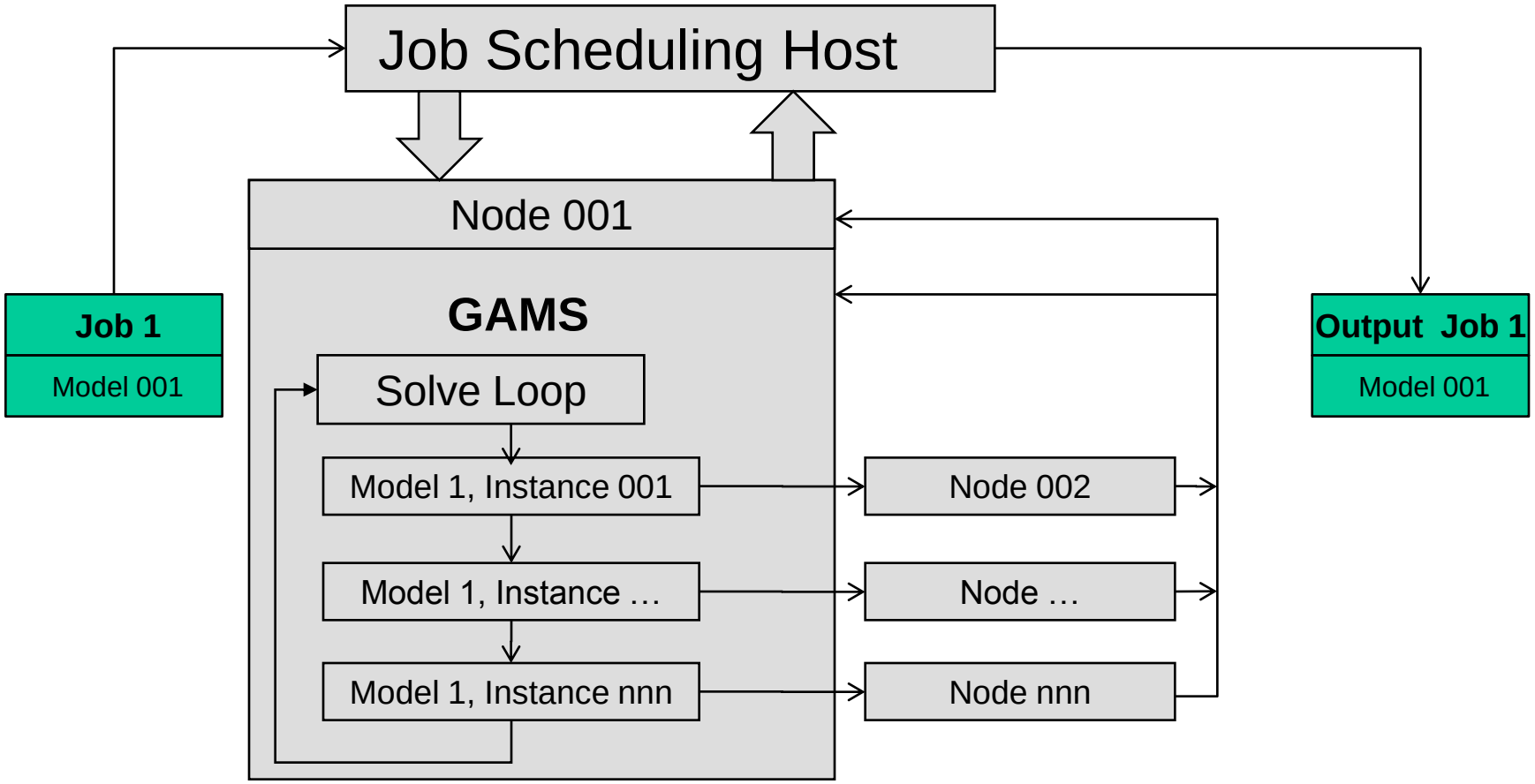
1. Submission of jobs
2. "Grid Middleware"
   - Distribution
   - Execution
3. Collection of solutions
4. Processing of results



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



Advantages of Grid Computing

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

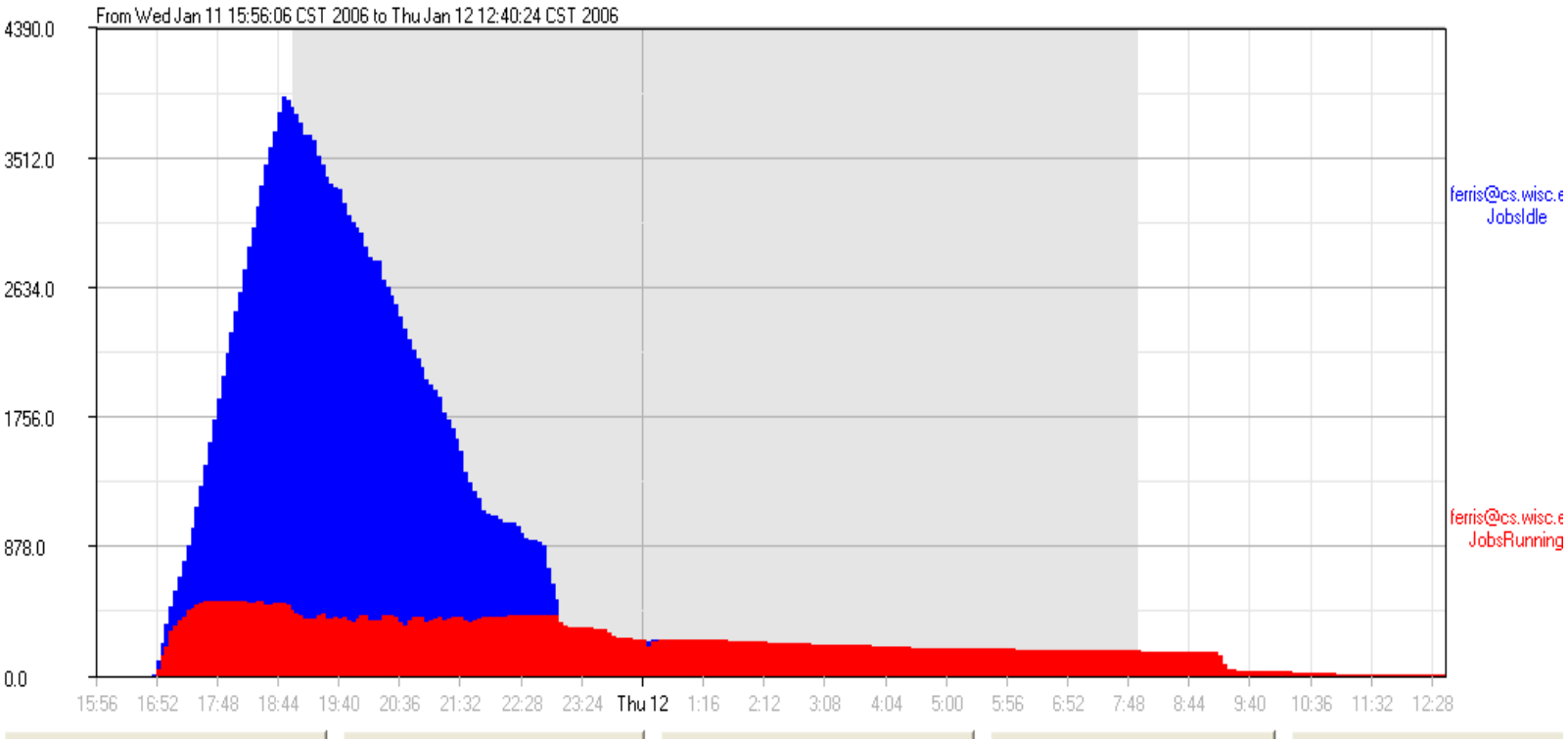
- Better results by running more scenarios*:

#SIM	VaR error	CVaR error
1000	5.42%	6.74%
20,000	1.21%	1.49%

* http://www.tc.cornell.edu/NR/shared/Presentations/24Feb04.Garp.pdf

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 enviroments**
- **Lots of Challenges** ahead

The End

Thank you!

… Questions?

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