



Using Utility Computing to provide Mathematical Programming Resources

Franz Nelißen
FNelissen@gams.com
GAMS Software GmbH



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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...*

http://en.wikipedia.org/wiki/Utility_computing

→ Cloud Computing



Aspects

- Service Provision Model: Maximize the efficient use of resources and minimize associated costs
- Virtualization of Hardware
- Unlimited computing resources and infrastructure available on demand
- Pay as you go / No up-front commitment



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 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

- 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

Amazon S3 **Amazon EC2** Amazon Elastic MapReduce Amazon CloudFront Amazon RDS

Navigation
Region: US East

> EC2 Dashboard

INSTANCES
> Instances
> Spot Requests

IMAGES
> AMIs
> Bundle Tasks

ELASTIC BLOCK STORE
> Volumes
> Snapshots

NETWORKING & SECURITY
> Elastic IPs
> Security Groups
> Placement Groups
> Load Balancers
> Key Pairs

My Instances

Launch Instance Instance Actions Reserved Instances Show/Hide Refresh Help

Viewing: All Instances All Instance Types 1 to 13 of 13 Instances

	Instance	AMI ID	Root Device	Type	Status	Lifecycle	Security Groups	Key Pair Name	Monitoring	Virtuali
<input type="checkbox"/>	i-fdbe8494	ami-3c47a355	instance-store	m1.small	● running	normal	All Incoming, defau	mc-keypair	disabled	paravirtu
<input type="checkbox"/>	i-49fcb421	ami-4042a029	ebs	m1.large	● running	normal	default	mc-keypair	disabled	paravirtu
<input type="checkbox"/>	i-9bf816f0	ami-86db39ef	ebs	m1.large	● running	normal	default	mc-keypair	disabled	paravirtu
<input type="checkbox"/>	i-5b628930	ami-9903e2f0	instance-store	m1.large	● running	normal	default	mc-keypair	disabled	paravirtu
<input type="checkbox"/>	i-cb9b2aa0	ami-45c22e2c	ebs	c1.medium	● stopped	normal	All Incoming, defau	mc-keypair	disabled	hvm
<input type="checkbox"/>	i-e744f58c	ami-cdc22ea4	ebs	m2.4xlarge	● stopped	normal	All Incoming	mc-keypair	disabled	hvm
<input type="checkbox"/>	i-23bf3848	ami-cdc22ea4	ebs	m2.4xlarge	● stopped	normal	All Incoming	mc-keypair	enabled	hvm
<input type="checkbox"/>	i-719afc1a	ami-2bd33d42	ebs	c1.xlarge	● stopped	normal	All Incoming, defau	mc-keypair	disabled	hvm
<input type="checkbox"/>	i-f1d0b89a	ami-7906e810	ebs	m1.large	● running	normal	All Incoming, defau	mc-keypair	disabled	paravirtu
<input type="checkbox"/>	i-85ef9bee	ami-f715fb9e	ebs	c1.xlarge	● running	normal	All Incoming, defau	mc-keypair	disabled	hvm
<input type="checkbox"/>	i-99d5a1f2	ami-f715fb9e	ebs	c1.xlarge	● running	normal	All Incoming, defau	mc-keypair	disabled	hvm
<input type="checkbox"/>	i-22a9ad49	ami-3b836a52	ebs	m1.large	● running	normal	All Incoming, defau	mc-keypair	disabled	hvm
<input type="checkbox"/>	i-cb1cc6a1	ami-c8c42fa1	ebs	m1.small	● running	normal	All Incoming, defau	mc-keypair	disabled	paravirtu

0 EC2 Instances selected



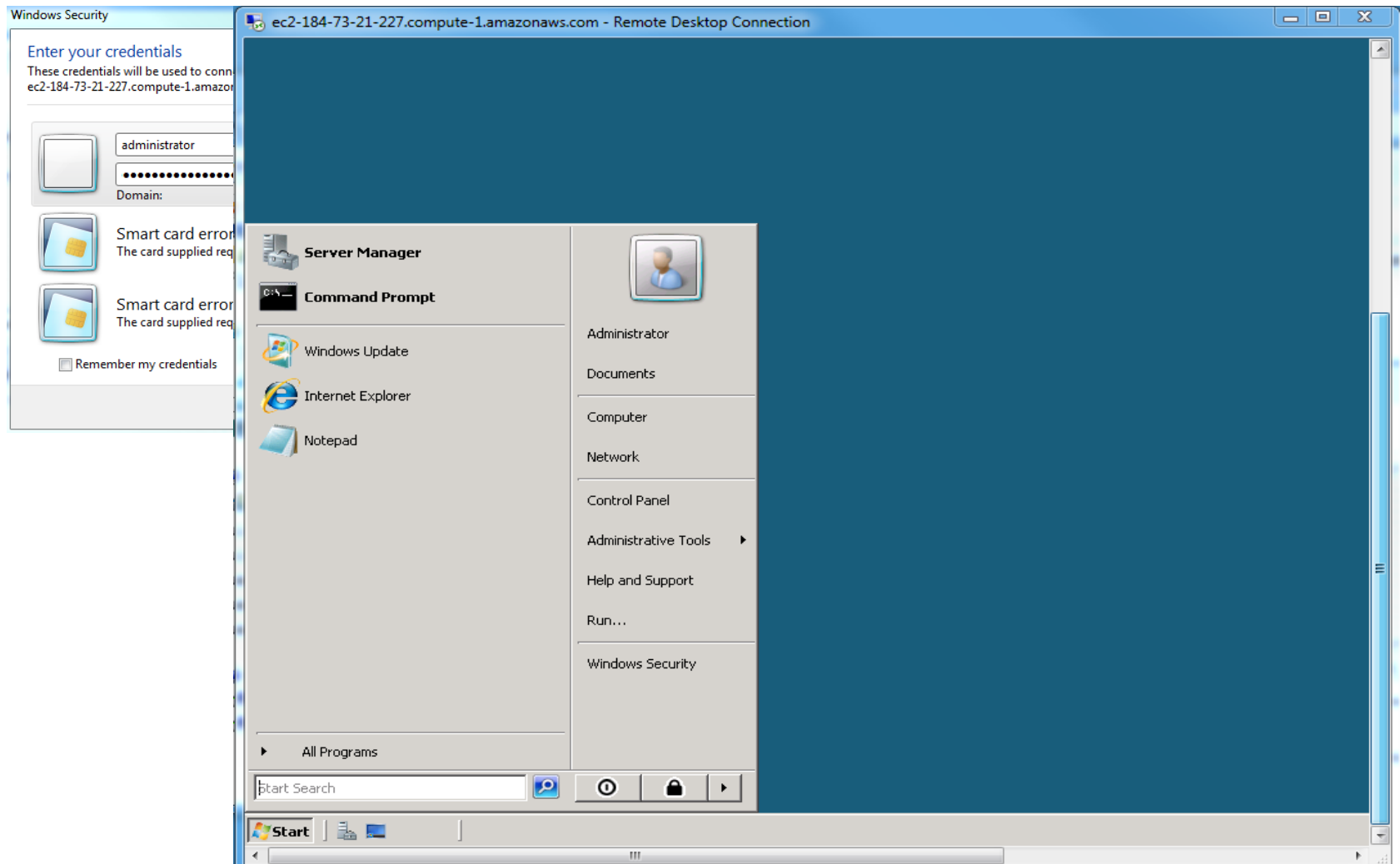
Using Amazon EC2: Shell.

```
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

Europe:

GAMS Software GmbH
Eupener Str. 135-137
50933 Cologne
Germany
Phone: +49 221 949 9170
Fax: +49 221 949 9171
<http://www.gams.com>

USA:

GAMS Development Corp.
1217 Potomac Street, NW
Washington, DC 20007
USA
Phone: +1 202 342 0180
Fax: +1 202 342 0181
<http://www.gams.com>