Using Utility Computing to provide Mathematical Programming Resources

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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

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
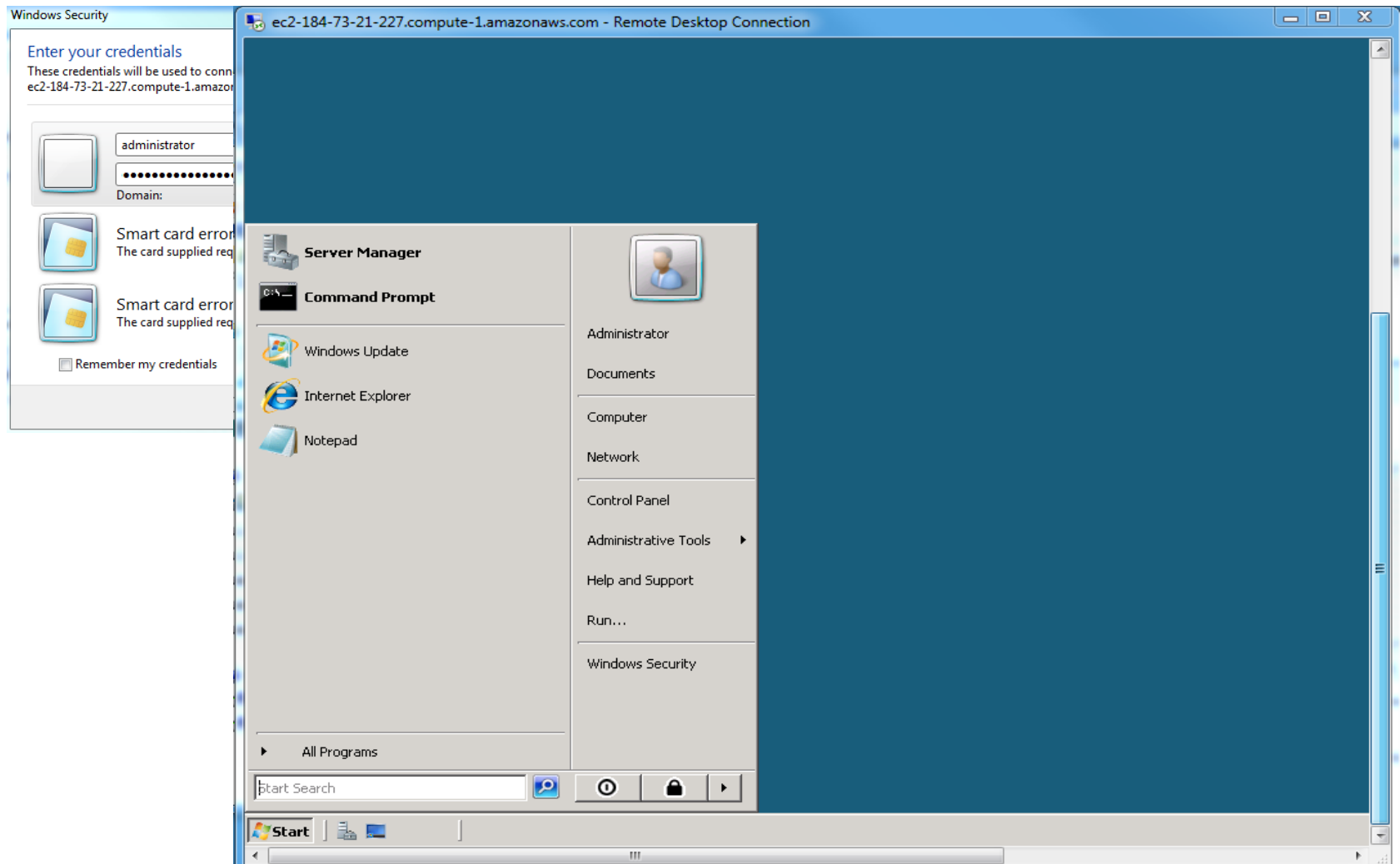
Amazon EC2: Usage

- 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?

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