High Throughput, Low Impedance e-Science on Microsoft Azure

David Abramson & Blair Bethwaite

Monash e-Science and Grid Engineering Lab (MeSsAGE Lab)
Faculty of Information Technology
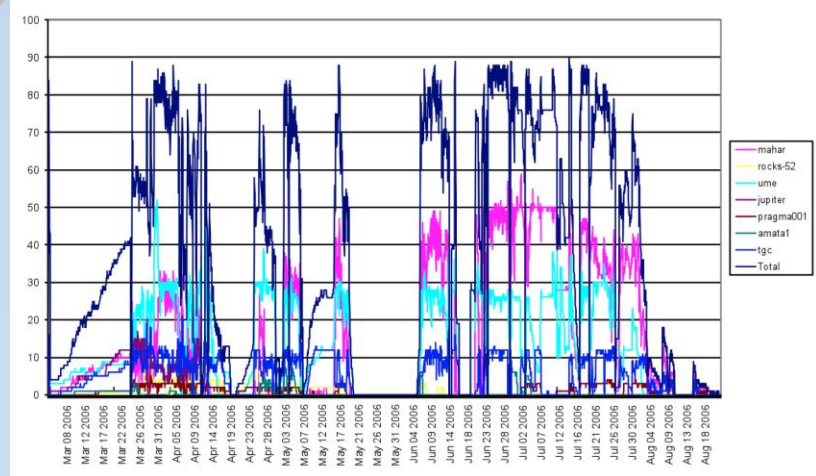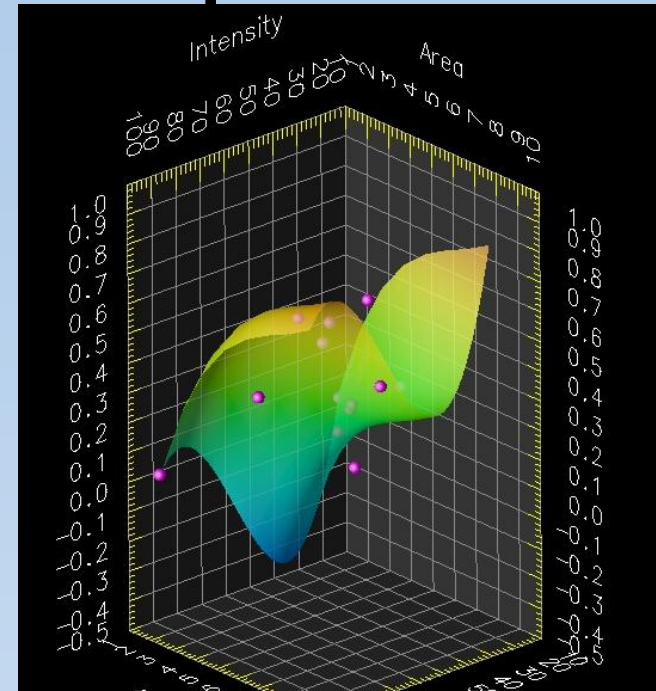
Monash e-Research Centre

Outline

- A new kind of science
    - When you get the tools right magic happens
    - Robust Science with Nimrod
    - Nimrod/K workflows
- From Clusters to Grids to Clouds
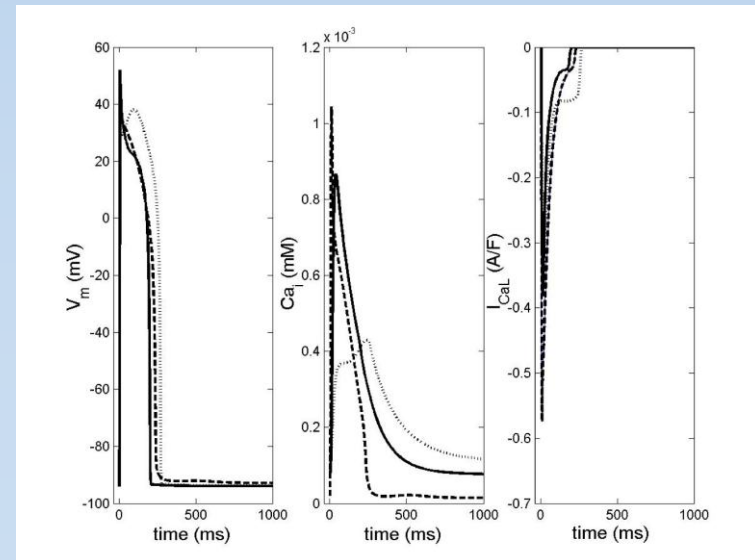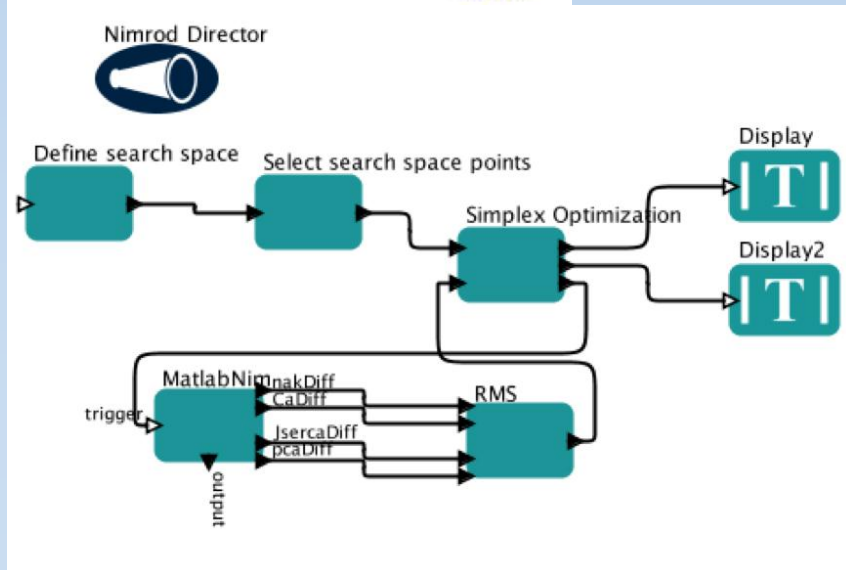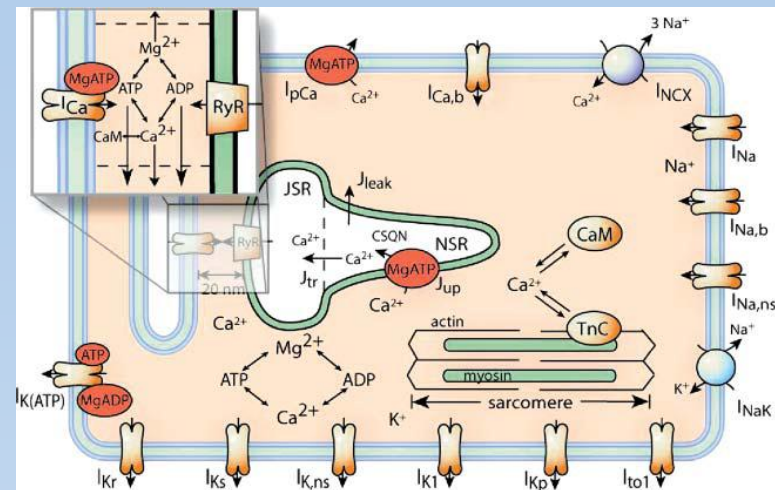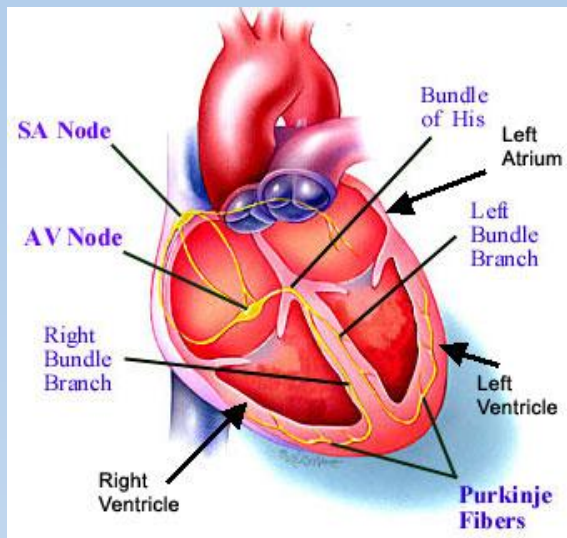- New Azure application drivers
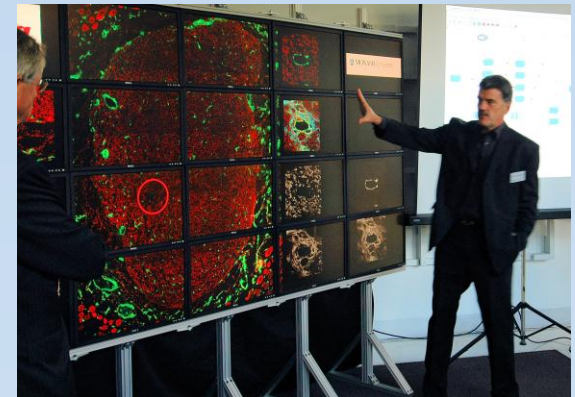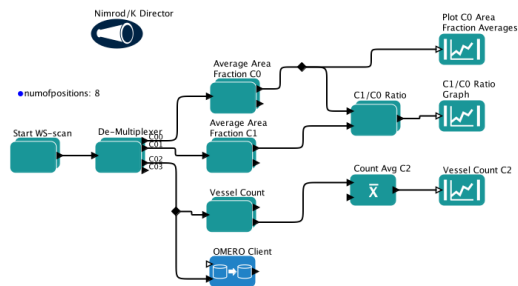- Conclusions

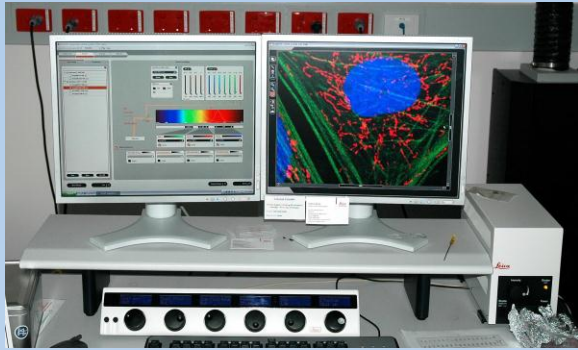When you get the tools right magic happens
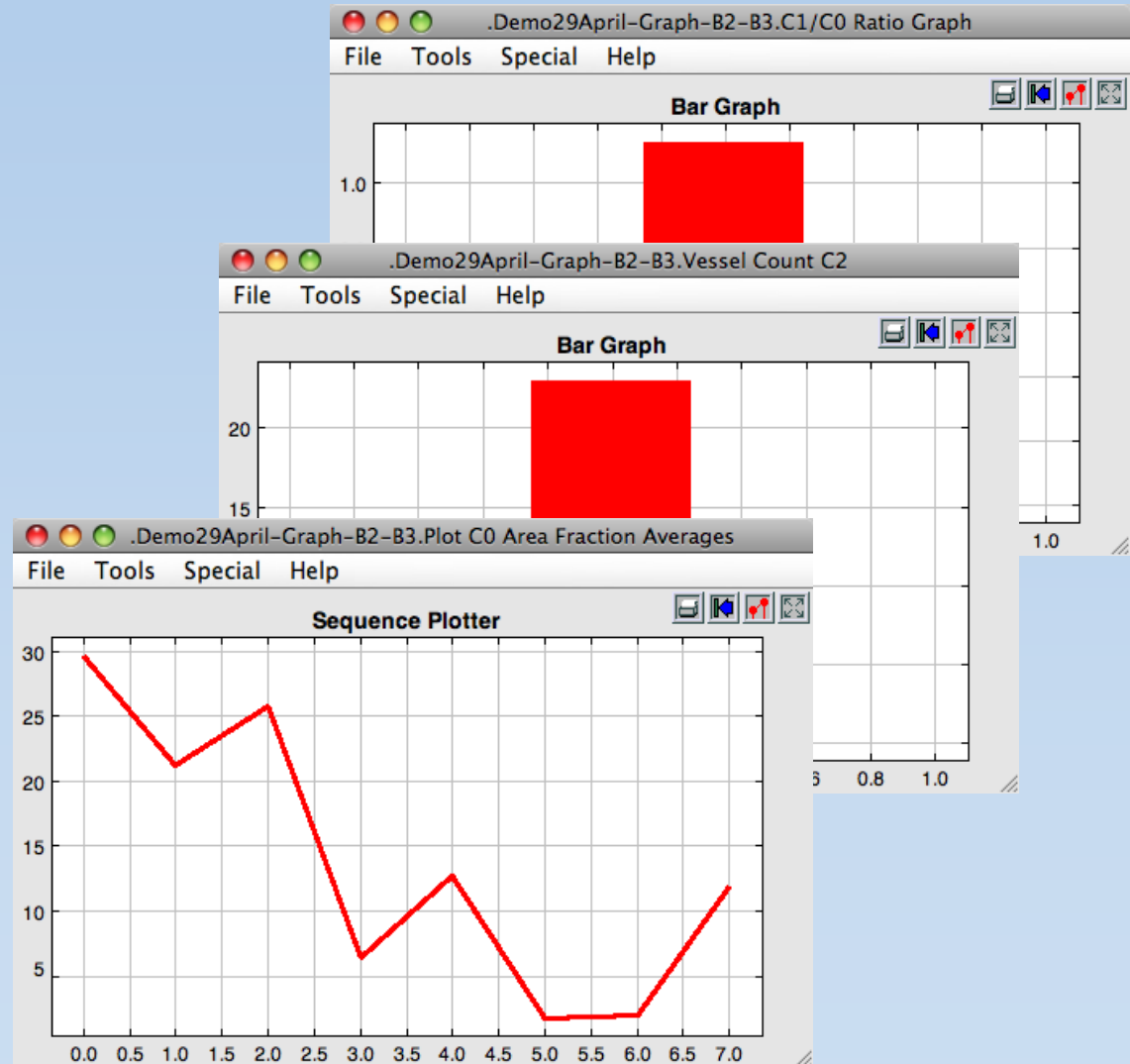
A new kind of science

Science that was impossible

New ways of thinking

New ways of thinking

New ways of thinking
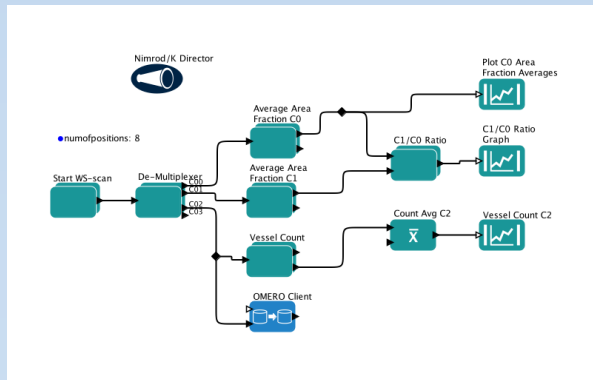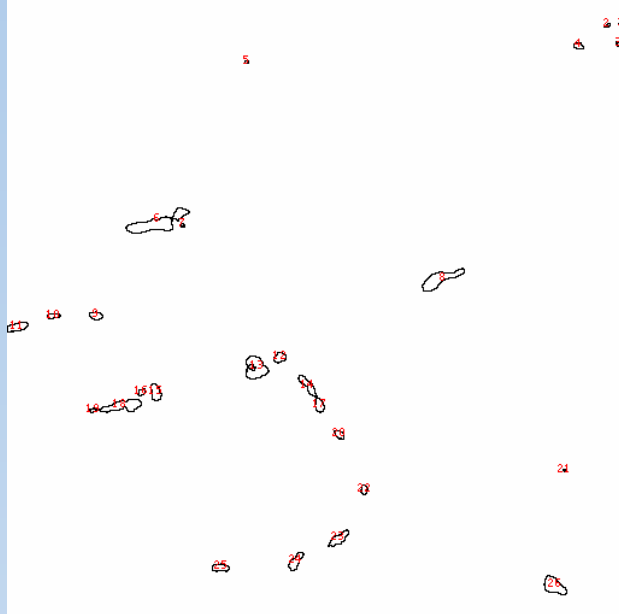
That work on other problems
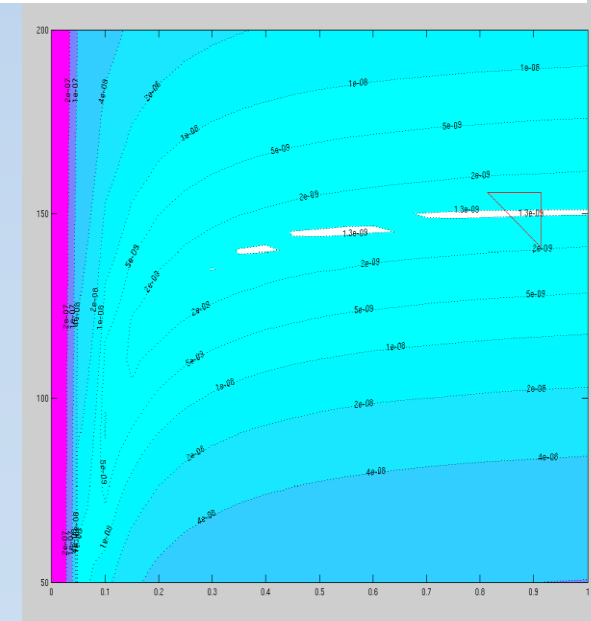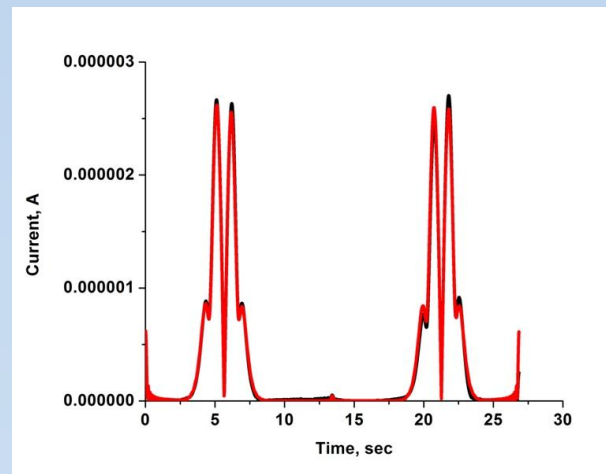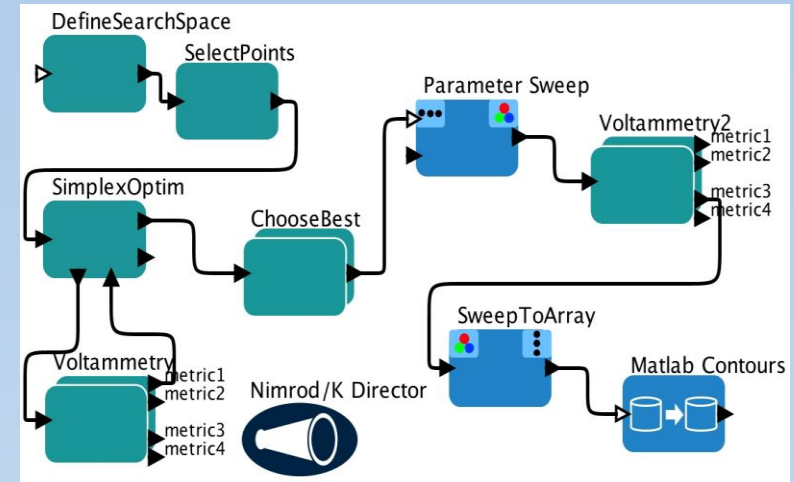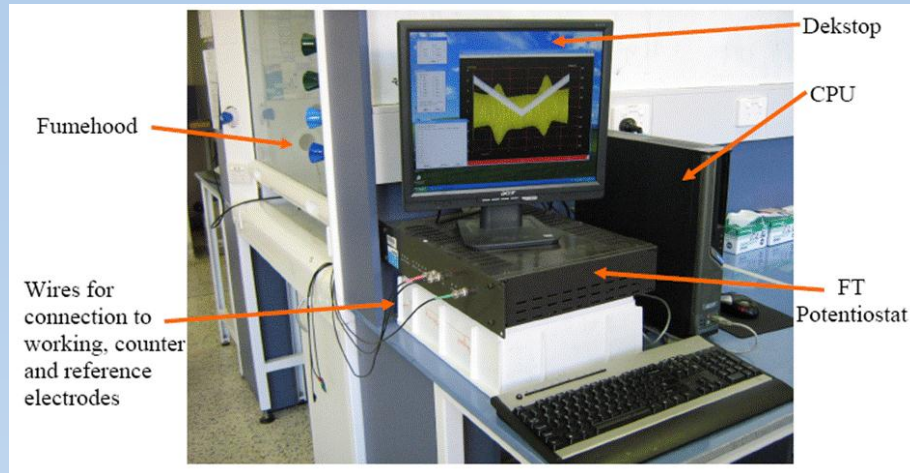
Robust science with Nimrod

A new kind of science

Robust science with Nimrod

- A full parameter sweep is the cross product of all the parameters (Nimrod/G)
- An optimization run minimizes some output metric and returns parameter combinations that do this (Nimrod/O)
- Design of experiments limits number of combinations (Nimrod/E)
- Workflows (Nimrod/K)

Nimrod/O   Results

Lenth Plot for Experiment 'Heart Cell Ca Dynamics'

The Nimrod family

Nimrod Development Cycle

Prepare Jobs using Portal

Sent to available machines

Jobs Scheduled Executed Dynamically

Results displayed & interpreted

Nimrod Portal

Peak: 8

Welcome Blair Bethwaite (you are an administrator)

Status of test

What's this?

The experiment has executed for 6mins and 0secs.

The experiment has started. 29 jobs have been completed, there are 23 jobs waiting, 38 jobs executing and 0 jobs failed.

Check for grid errors

Pause Experiment

Experiments
test
New experiment
Resource management
Administrative tools
Online Manual
Grid World
About
Logout

Plan file

What's this?

```
parameter x integer range from 7 to -1 step 1;
parameter y float range from 0.125 to 1.25 step 0.125;

task main
    copy work.py node:.
    node:execute /bin/chmod +x work.py
    node:execute /bin/hostname >> output
    node:execute /bin/date >> output
    node:execute /bin/pwd >> output
    node:execute /bin/echo "Working..." >> output
    node:execute ./work.py ${x} ${y} >> output
    copy node:output output.${jobname}.x${x}.y${y}
endtask
```

You cannot change the plan after execution has started.

Find: Previous   Next   Highlight all   Match case

Done   messagelab.monash.edu.au   Open Notebook   zotero

Nimrod Viewer for experiment test - Swiftfox

https://messagelab.monash.edu.au/NimrodARCS/cgi-bin/np-ml.cgi?page=nvapplet?param=test?window=main

- none
- nimrodtest.q@https://east-globus.enterprisegrid.edu.au:8443/SGE@
- cloud1://home1/blair/ec2/david-id:/home1/blair/ec2/david-secret2:5:m1.small:ami-0d729464

	Jobs	W	E	D
☐	0 (0%)	0	–	0
☐	67 (74%)	7	32	28
☐	23 (25%)	5	13	5
Total:	90	12	45	33

| Job: | 1 | Status: | Executing | ReQue... | Mark as Do... | Mark as Fail... |
| Time: | 0:00:00 | Parameters: | | | x "7" y "0.125" | |

Applet nimrodviewer.Applet started

messagelab.monash.edu.au   Open Notebook   zotero

Done   docs.google.com   Open Notebook   zotero

Sun VirtualBox

Details

General
Name
OS Ty
Base M
Video
Boot O
ACPI:
IO API
VT-x/A
Neste
PAE/N
3D Ac

Hard
IDE Pr

CD/DV
Image

Flopp
Not m

Audio
Host D
Contro

New   Settings   Show   Discard

Hardy
Saved

Intrepid
Powered Off

NG Dev
Powered Off

XPL (Pre SFU)
Running

File   Machine   Help

Applications   Places   System

1 GHz   13 °C   Wed Jul 29, 19:11:17

dmesg   WaspFactory.txt

gt4-test.sh   EVOPlayer.jnlp

pcm9_linux   e169g-switch_0.3 all.deb

linux-phc-0.3.0-pre1   temp

pslinuxv180

$6.29

13,908,855 People Online

nary phones

Nimrod/K Workflows

- Nimrod/K integrates Kepler with
  - Massively parallel execution mechanism
  - Transparent data transport
  - Robust design from Nimrod/G/O/E

Authentication			
GUI	…Kepler GUI Extensions…		
Vergil		Documentation	
Kepler Object Manager	SMS	Type System Ext	Smart Re-run / Failure Recovery	Provenance Framework
Kepler Core Extensions	Ptolemy			
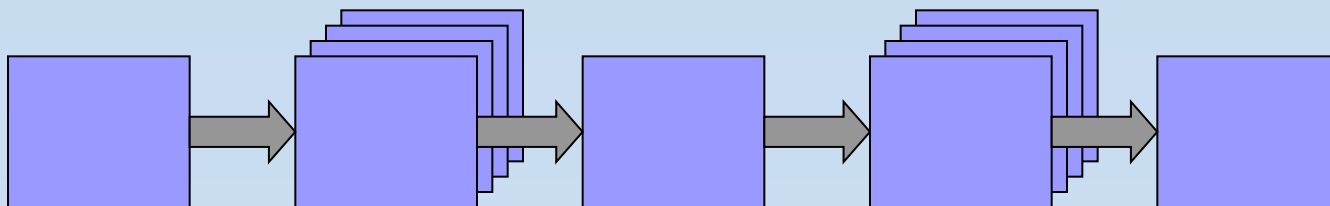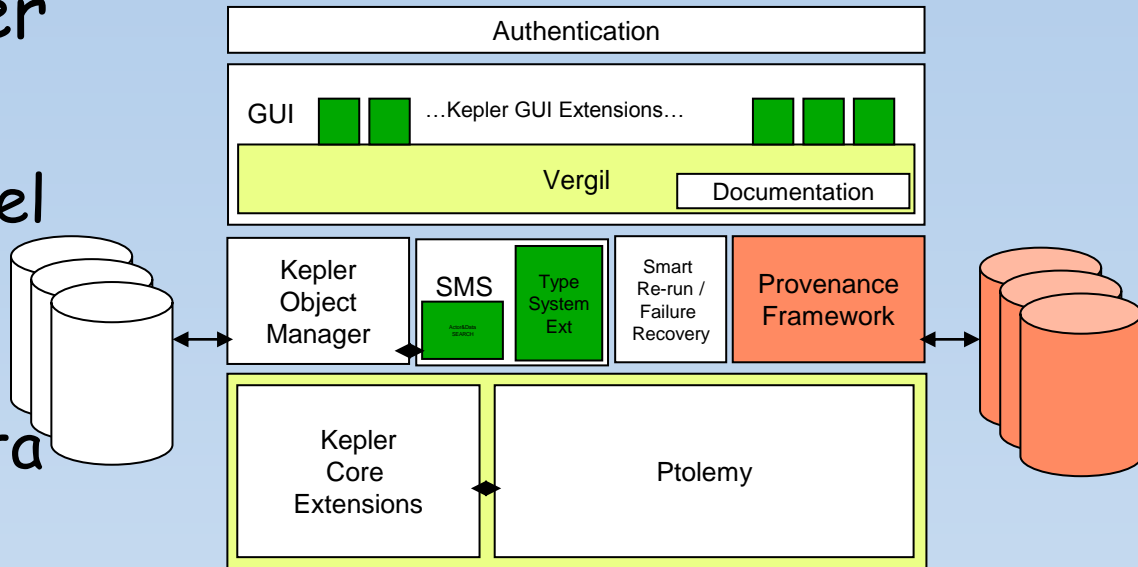
Complete Parameter Sweep
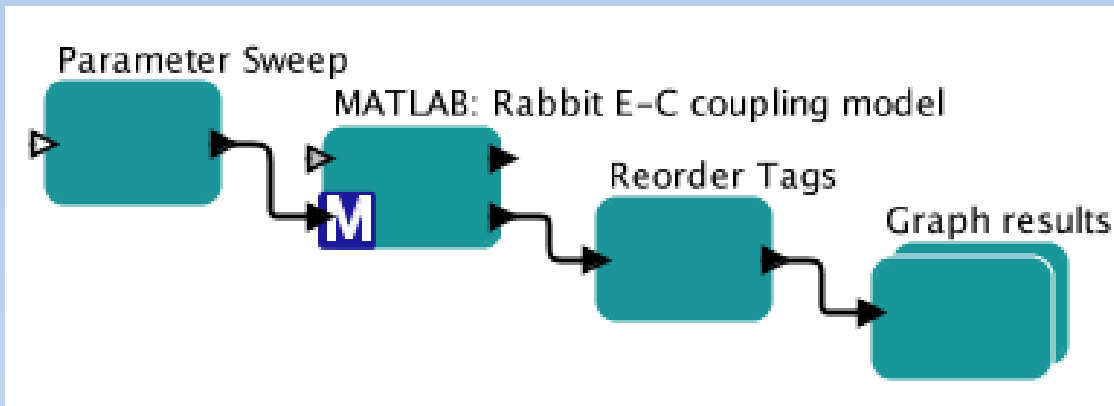
- Using a MATLAB actor provided by Kepler
- Local spawn
  - Multiple thread ran concurrently on a computer with 8 cores (2 x quads)
  - Workflow execution was just under 8 times faster
- Remote Spawn
  - 100's – 1000's of remote processes
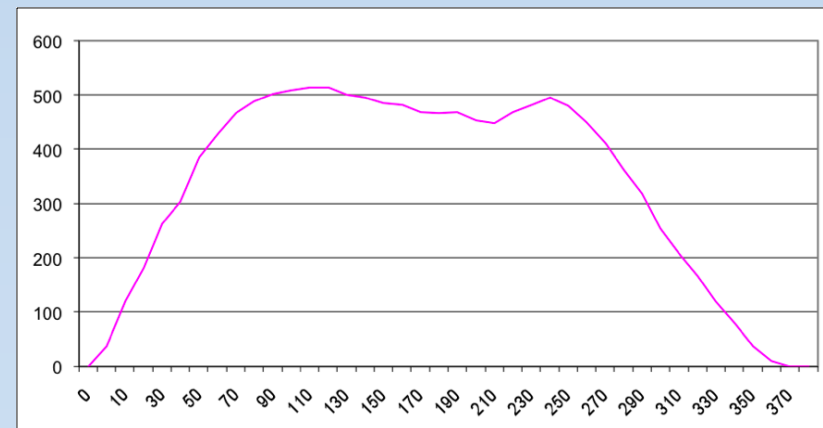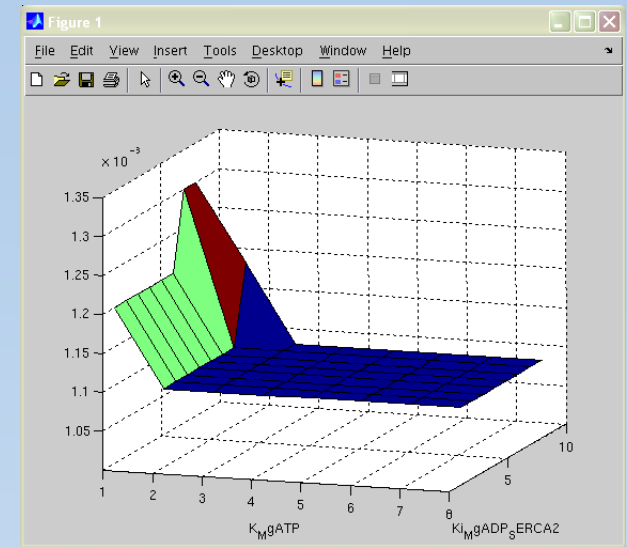
Nimrod/OK Workflows

- Nimrod/K supports parallel execution
- General template for search
  - Built from key components
- Can mix and match optimization algorithms
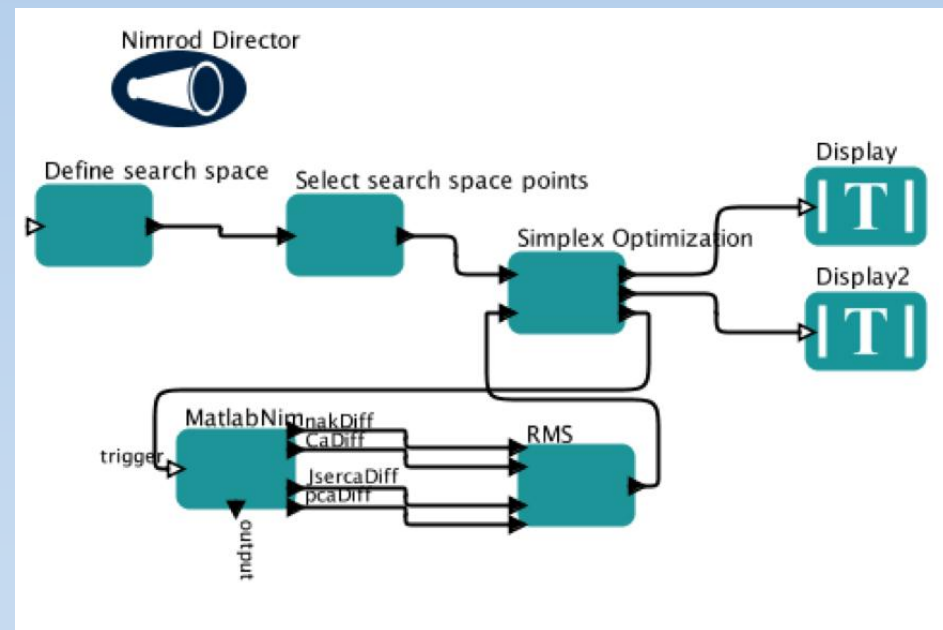
From Clusters, to Grids, to Clouds

Nimrod over Clusters

Jobs / Nimrod experiment

⬇

Nimrod
Actuator, e.g., SGE, PBS, LSF, Condor

⬇

Local Batch System

Nimrod over Grids

- Advantages
  - Wide area elastic computing
  - Portal based point-of-presence independent of location of computational resources
  - Grid level security
  - Computational economy proposed
    - New scheduling and data challenges
  - Virtualization proposed (Based on .NET!)

- Leveraged Grid middleware
  - Globus, Legion, ad-hoc standards

Leveraging Cloud Infrastructure

- **Centralisation is easier**
  - (Clusters vs Grid)
- **Virtualisation improves interoperability and scalability**
  - Build once, run everywhere
- **Computational economy, for real**
  - Deadline driven
    - "I need this finished by Monday morning!"
  - Budget driven
    - "Here's my credit card, do this as quickly and cheaply as possible."
- **Cloud bursting**
  - Scale-out to supplement locally and nationally available resources

Integrating Nimrod with IaaS

Portal $\rightarrow$ Jobs / Nimrod experiment $\leftarrow$ Nimrod-O/E/K

Nimrod/G

Actuator: Globus,... | Services | New actuators: EC2, Azure, IBM, OCCI?,...?

RESTful IaaS API

VM
Agents

VM
Agents

VM
Agents

Grid Middleware
Agents
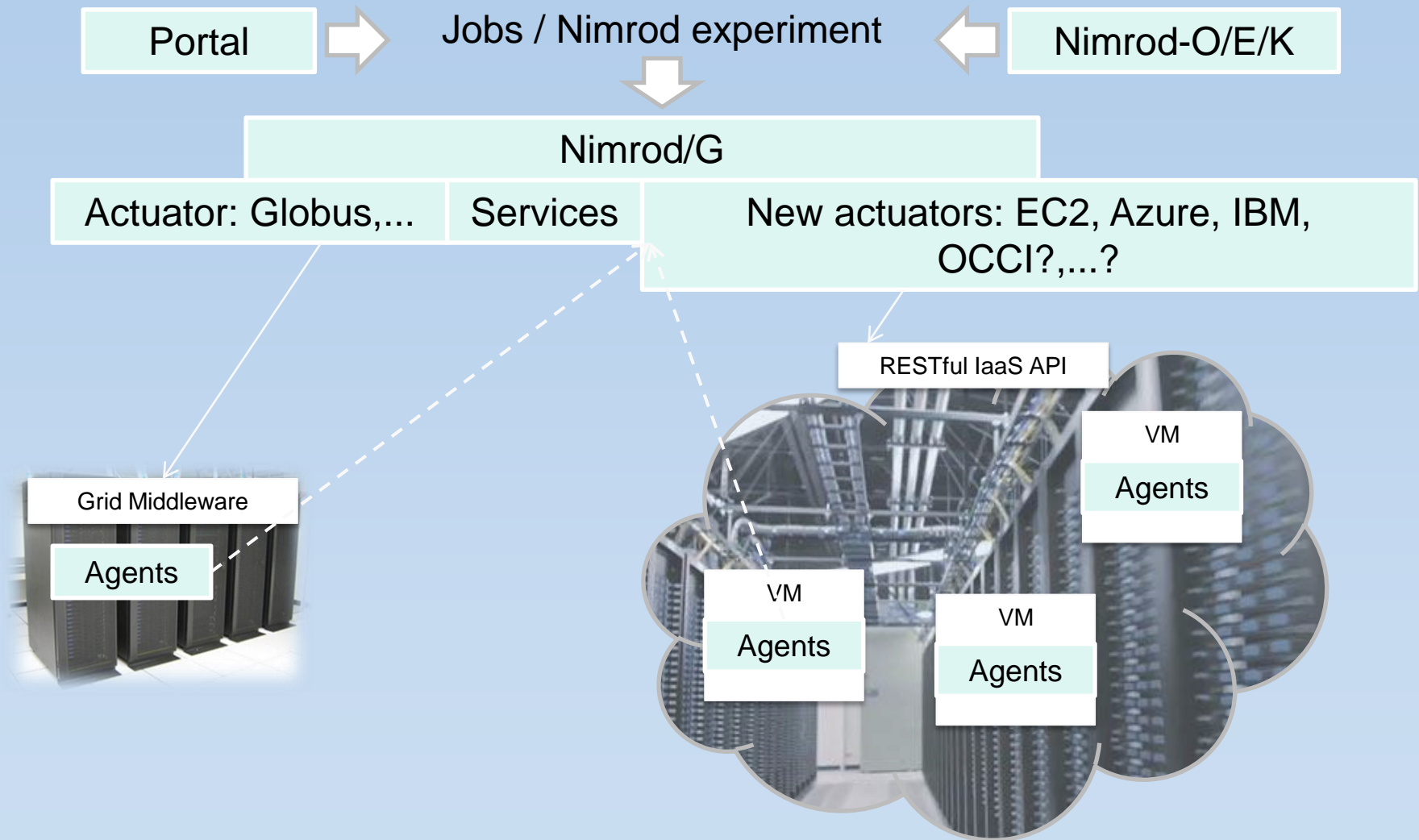
Integrating Nimrod with IaaS
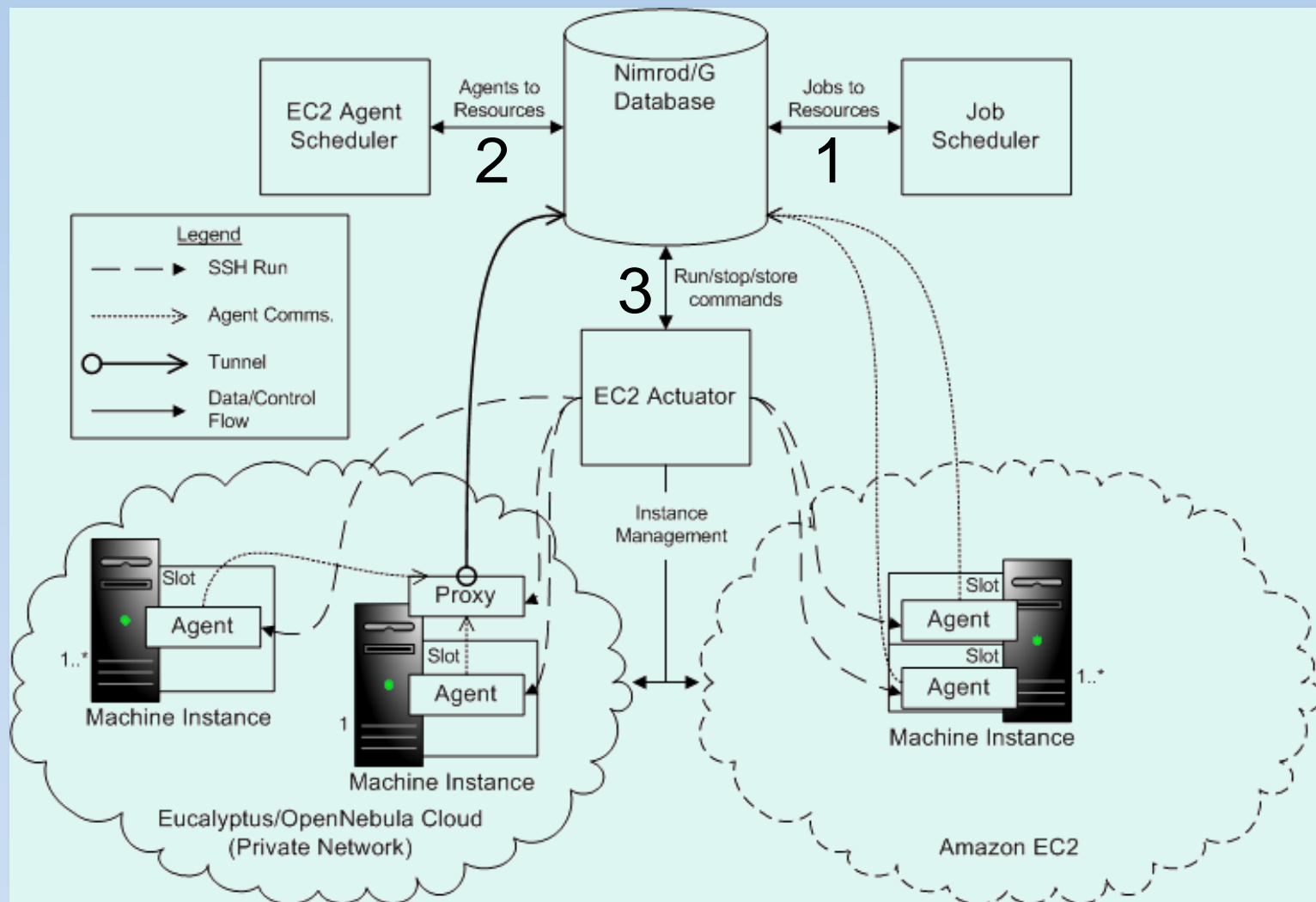
Cloud bursting

Resource	#jobs completed	Total job time (h:m:s)	μ / σ Job runtime (mins)
East	818	1245:37:23	91/5.7
EC2	613	683:34:05	67/14.2
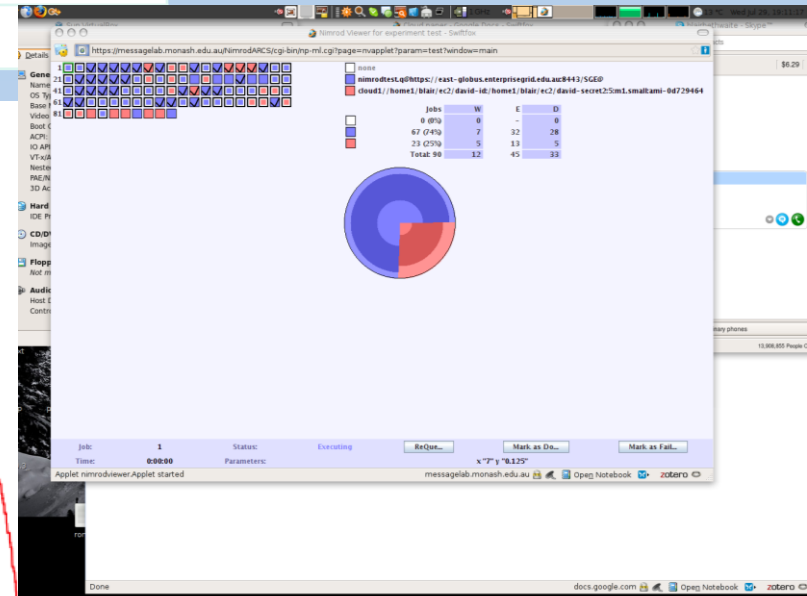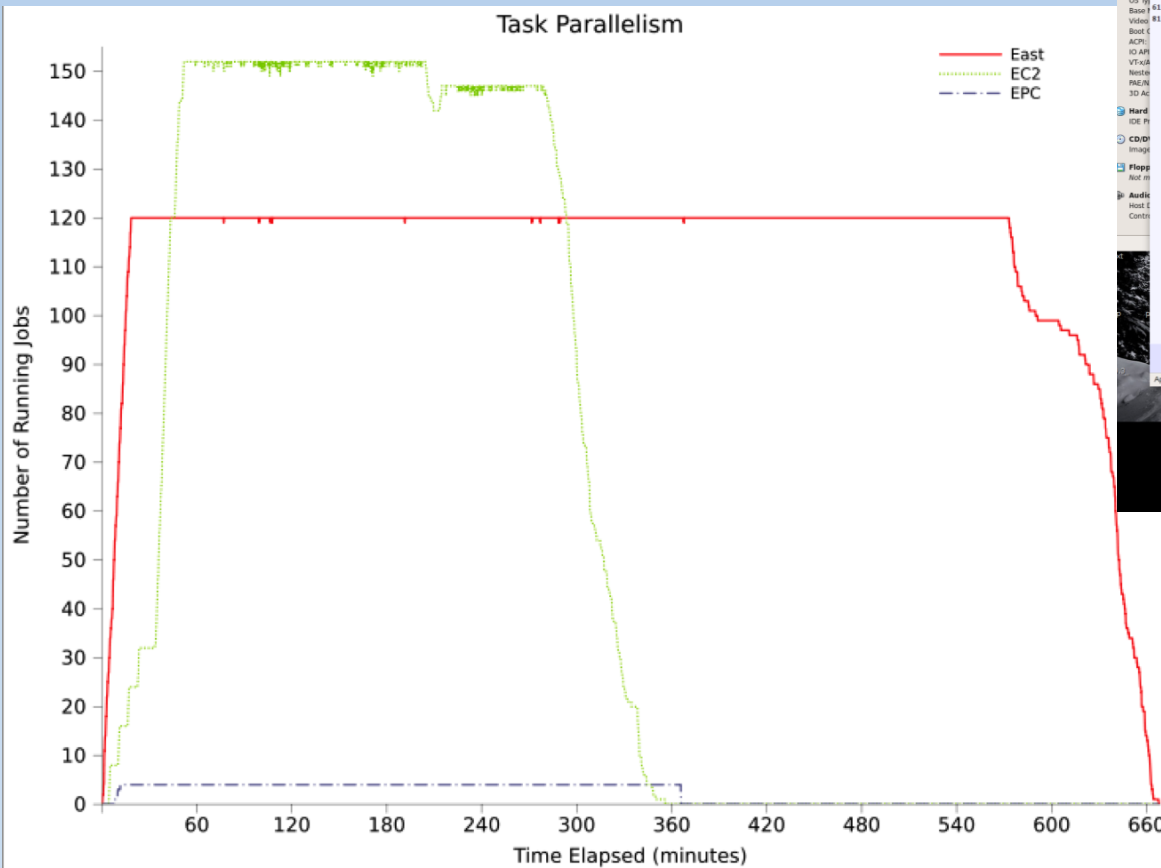
Progress to date

Azure implementation

PaaS is trickier...

- **More variety**
  - Azure vs AppEngine

- **Designed for web-app hosting**
  - Nimrod provides a generic execution framework

- **Higher level PaaS too prescriptive**
  - AppEngine: Python and Java only

Nimrod-Azure Mk.1

- Nimrod server runs on a Linux box external to Azure

- Nimrod-Azure actuator module contains the code for managing Nimrod agents on Azure

  - pre-defined minimal NimrodWorkerService cspkg;

  - library for speaking XML over HTTP with the Azure Storage and Management REST APIs

Integrating Nimrod with Azure

Azure

Queue

Blob

Agent

cspkg

Azure Actuator

Nimrod Server

Nimrod Experiment

30

Integrating Nimrod with Azure

Workers

Blob

Queue

Azure

Agent

User app/s

Agent params

Azure Actuator

Nimrod Server

32
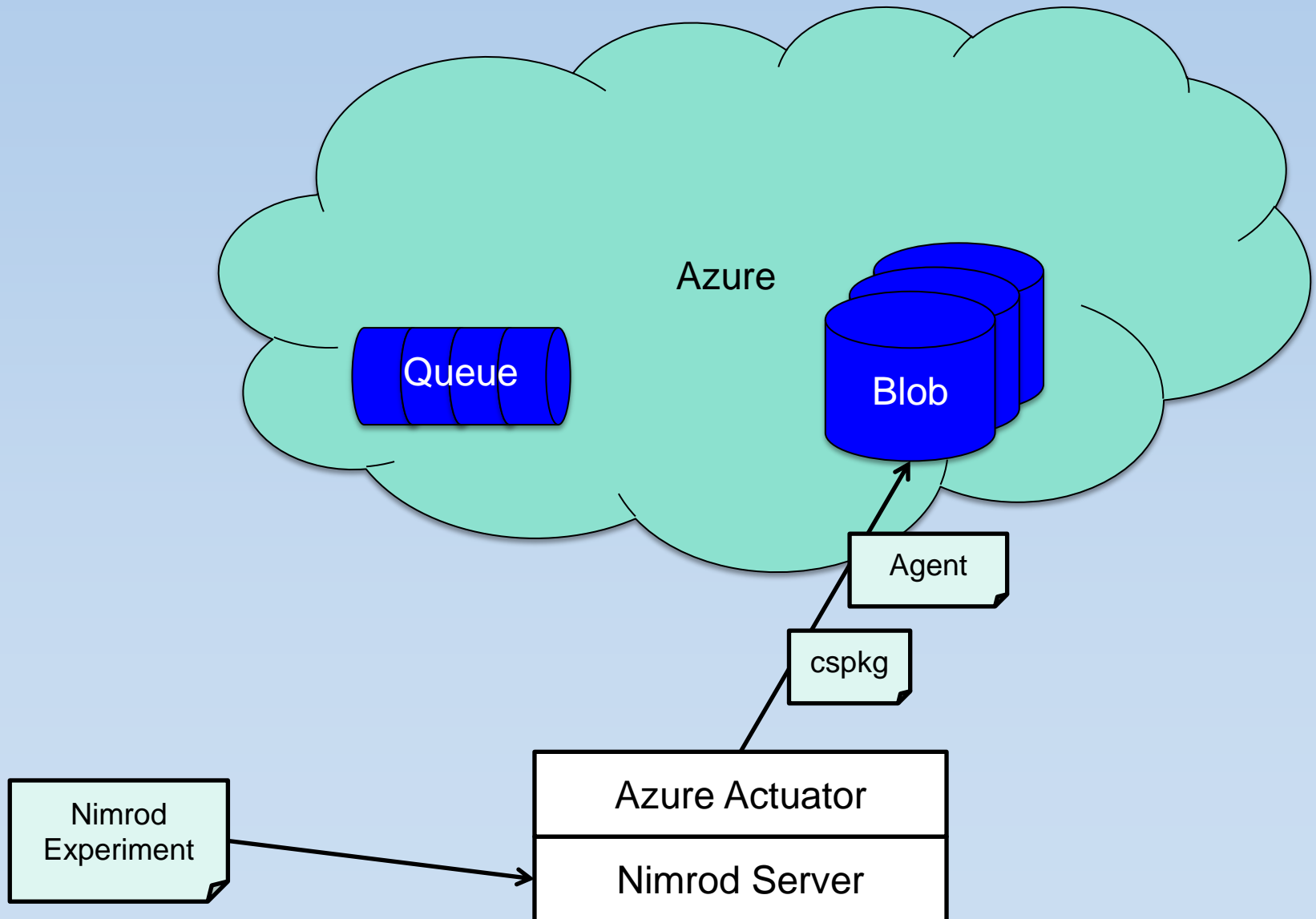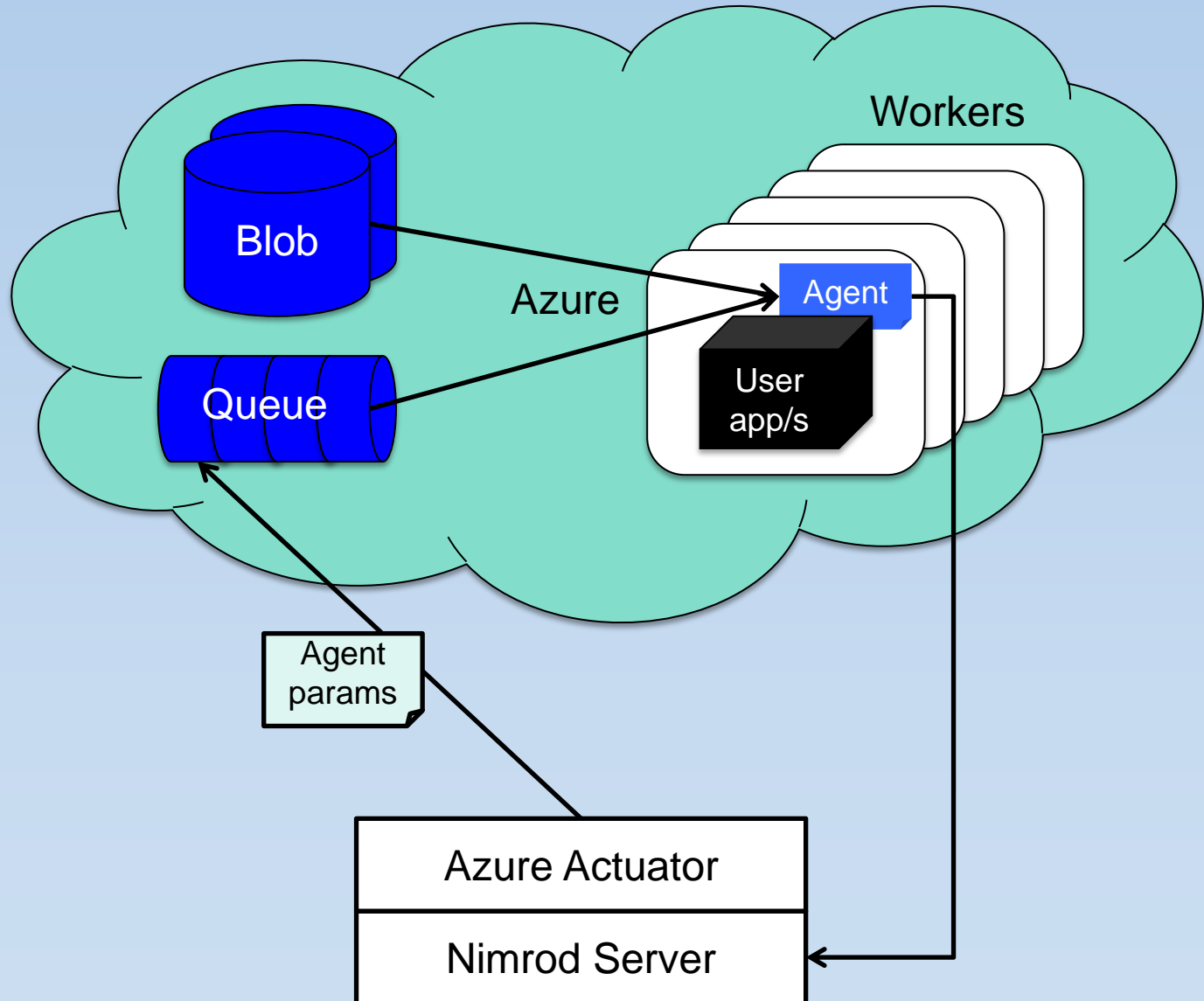
New Application Drivers

- Volcanic ash dispersion modelling
  - Pt.1 (NG-Tephra) completed with EC2
  - Pt.2 (Ceniza) to run on Azure
- Energy economics of distributed generation technology
  - to run on Azure

Smoke billows from an erupting volcano which seems to be close to the top of the Eyjafjalla glacier on April 14, 2010 near Reykjavik. All London flights, including those from Heathrow, will be suspended from noon (1100 GMT) today due to volcanic ash from Iceland that has already caused almost 300 cancellations here, officials said. (AFP/Getty Images)

Australian Energy Supply, Energy Flows 2007/2008
Sources: L.D. Wagner (2010), ABARE, ABS, AEMO, AER, ESAA

Acknowledgements
MeSsAGE Lab

- **Faculty Members**
  - Jeff Tan
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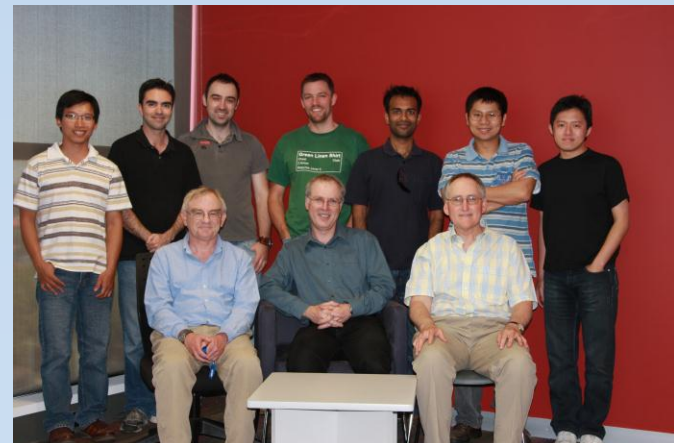- **Admin**
  - Rob Gray
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  - Shahaan Ayyub
  - Philip Chan
  - Colin Enticott
  - ABM Russell
  - Steve Quinette
  - Ngoc Dinh (Minh)
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  - Greg Watson
  - Rajkumar Buyya
  - Andrew Lewis
  - Nam Tran
  - Wojtek Goscinski
  - Aaron Searle
  - Tim Ho
  - Donny Kurniawan
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  - Microsoft
  - Sun Microsystems
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Questions?

More information:

> http://messagelab.monash.edu.au