



Microsoft® Research

FacultySummit 2011

Cartagena, Colombia | May 18-20 | In partnership with COLCIENCIAS



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Scientific computing using Windows Azure

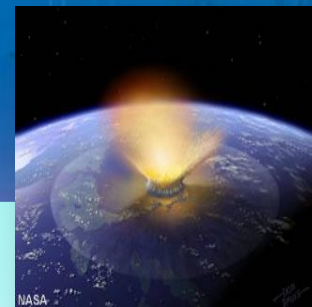
Steven Johnston (sjj698@zepler.org), Simon Cox,
University of Southampton, UK

Introduction

- Space Situational Awareness
- How are we using the cloud?
 - Cloud computing scenarios
 - Clouds in Space architecture
- Data visualisation
- Atmospheric Science Through Robotic Aircraft (ASTRA)
- Q&A

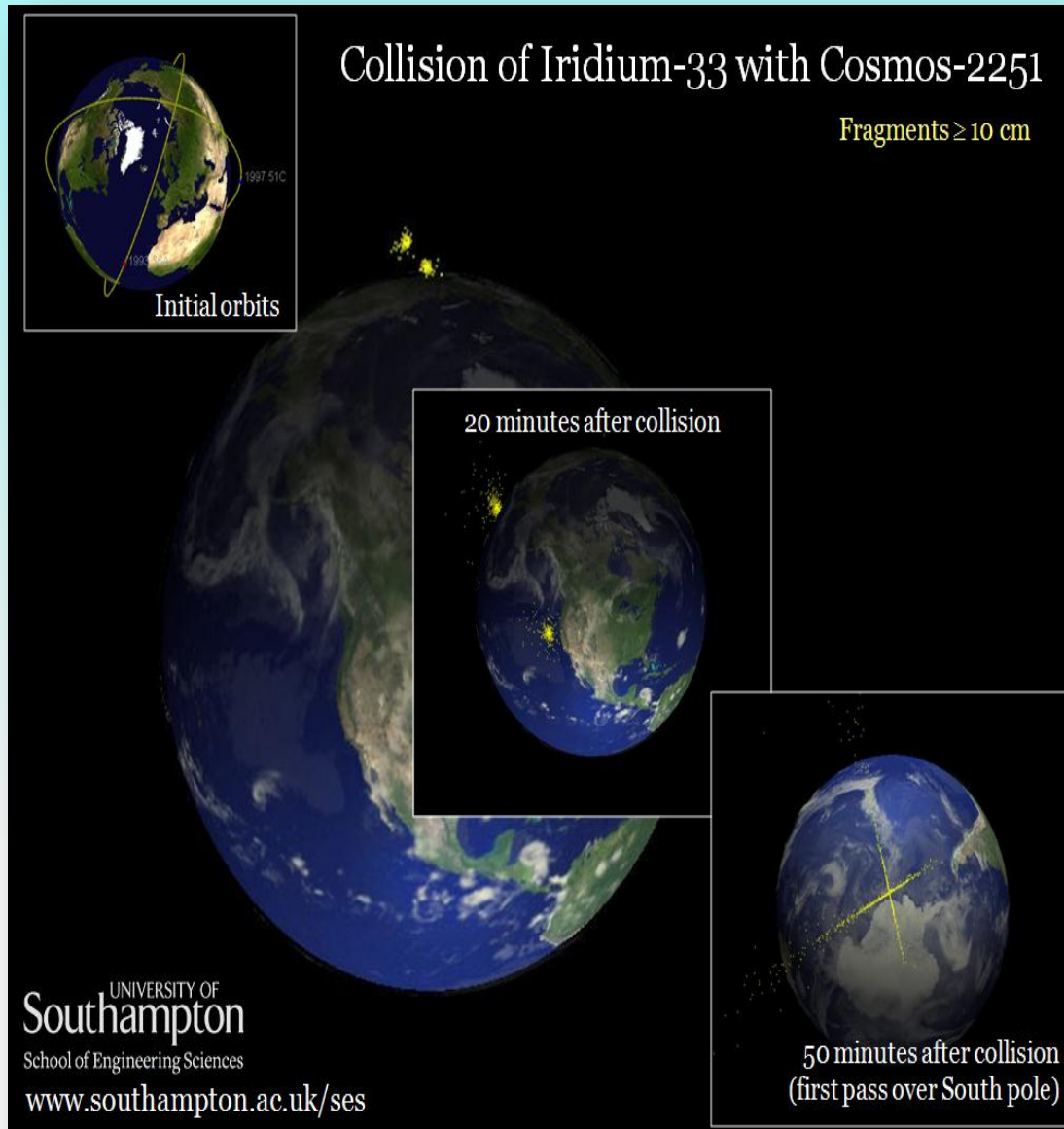


Space situational awareness



- Knowledge of space vehicle environment important
- Space debris increasingly problematic, e.g. Cosmos 2251 & Iridium-33 collision in February 2009
- **Near-earth objects (Apophis 2029-miss, 2036-hit)**
- Observation, data management, modelling, and operational tools. Global problem requires global IT infrastructure
- Southampton Space Situational Awareness Azure System
 - Processing and visualisation of tracked space objects, conjunction/impact analysis
 - Decision support system for space debris and NEO impacts
 - Debris removal

Iridium 33 and Cosmos 2251



Space debris

~20,000 objects (currently tracked)

~19,000 objects with a diameter over 10cm (not tracked)

~500,000 objects over 1cm (not tracked)

SPACE SURVEILLANCE SITES

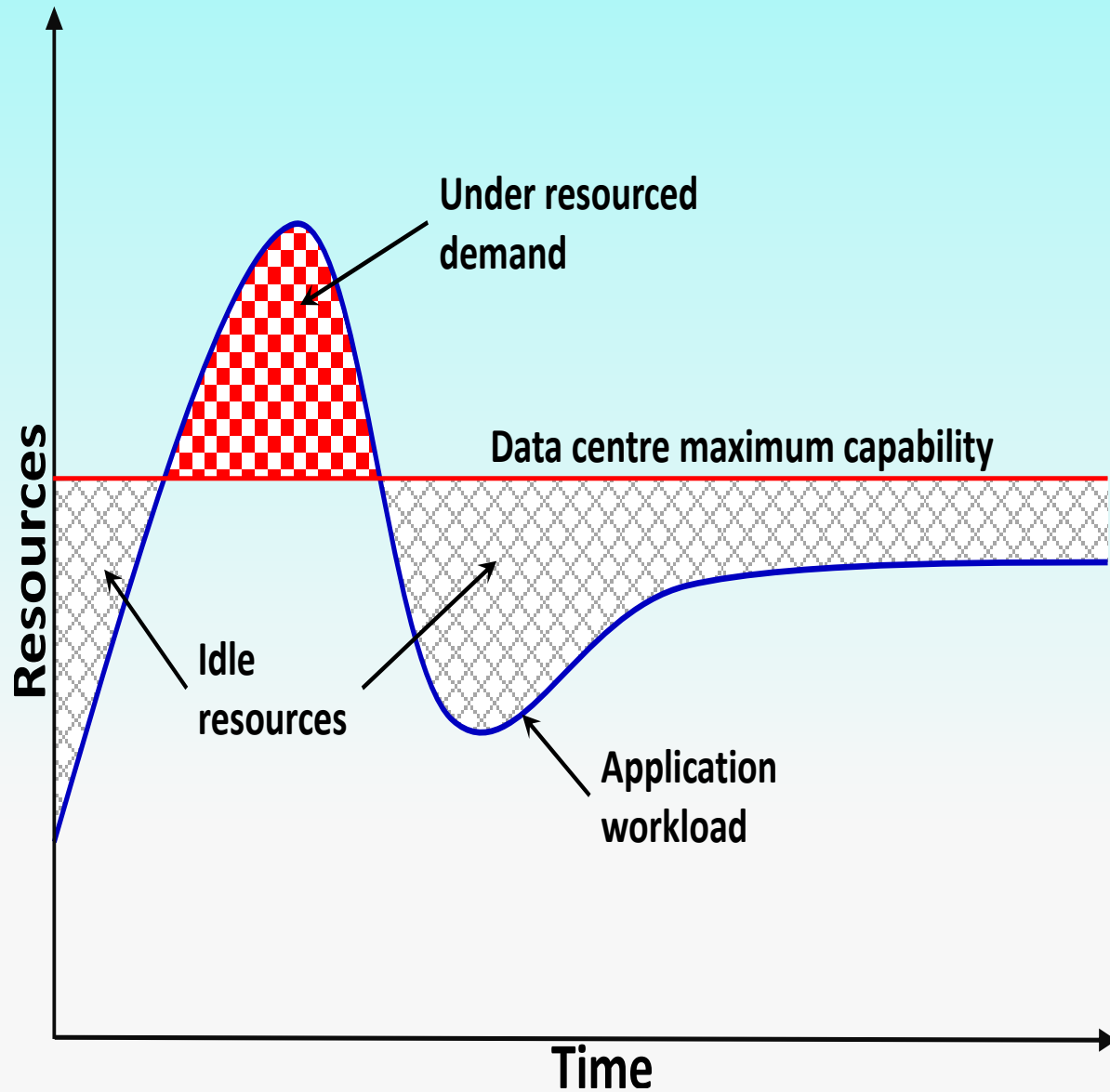


*Images from www.bbc.co.uk

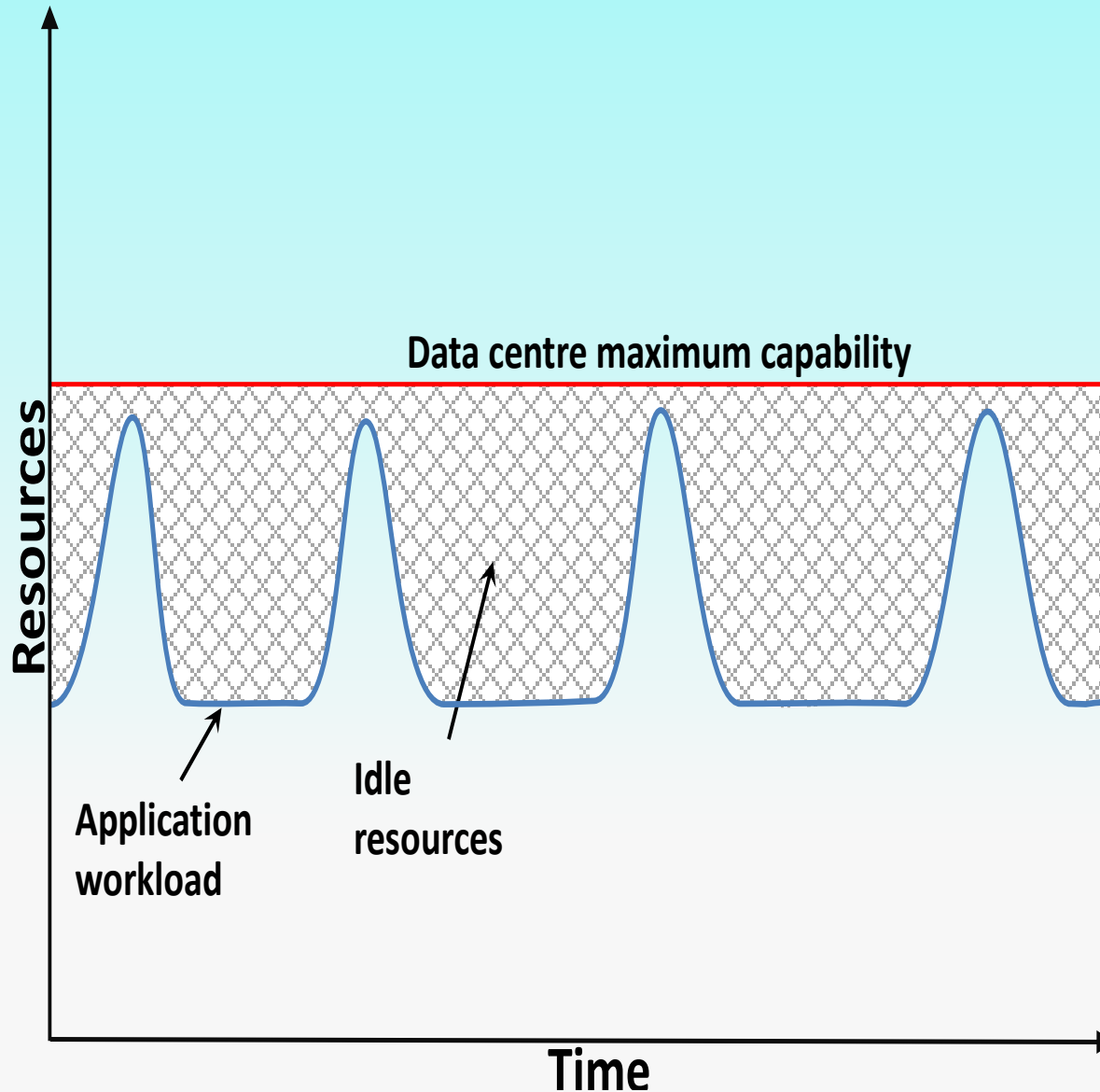
What is Cloud computing?

- Pay-per-use
- Quick provisioning
- Unlimited resources (\$)
- Compare with a datacentre or outsourcing
 - Bulk hardware purchase
 - Bulk admin
 - High utilisation
- No capital cost / lead time
- "Architect well and trade time for cost"

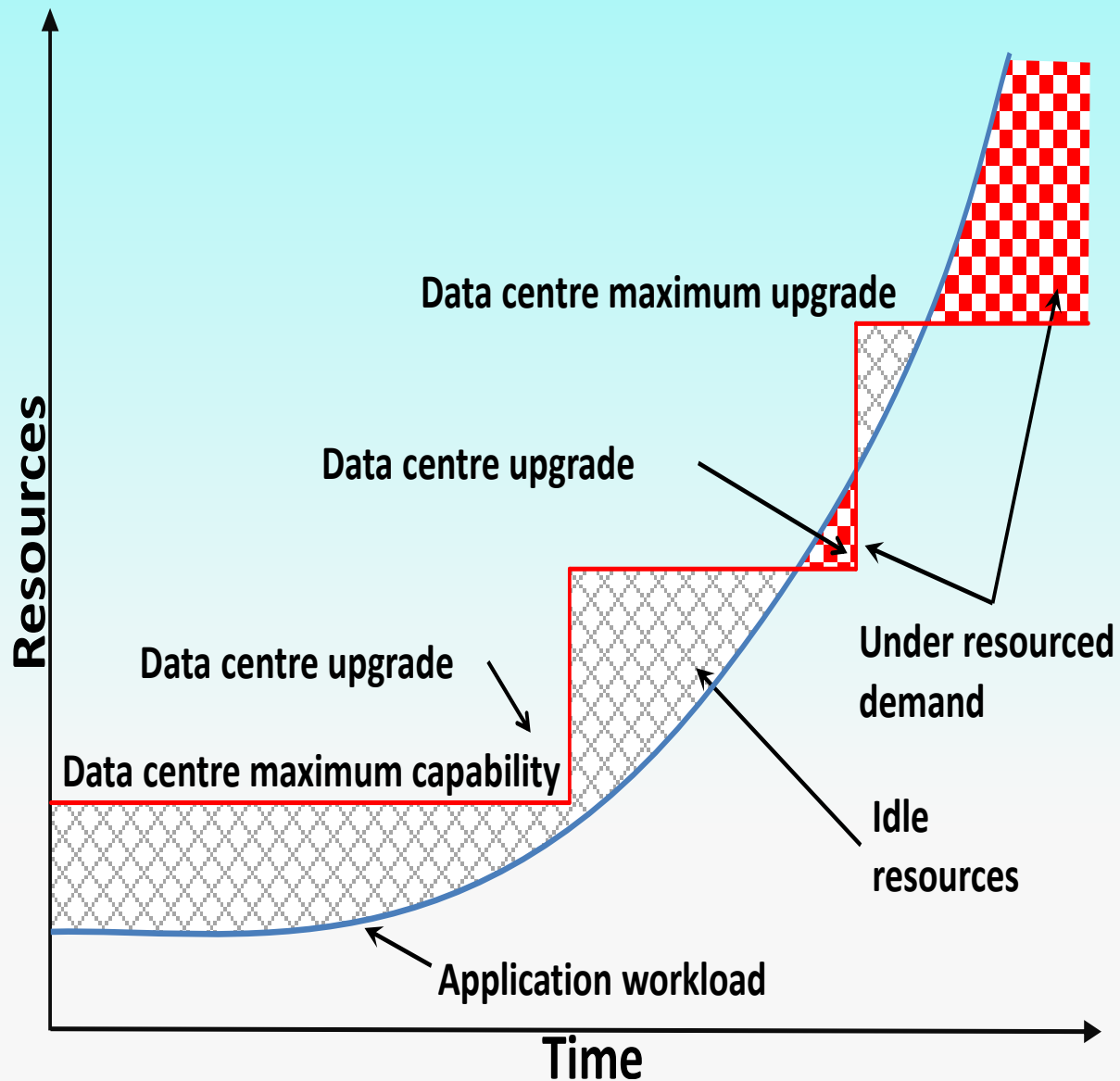
Hype curve



Burst capability (predictable and unpredictable)



(Super) - scalability



Data and algorithms

- Data dissemination
 - Co-locate data and processing power
 - Easier costing model for shared datasets.
 - DataMarket section of the Windows Azure Marketplace
- Algorithm development / validation
 - In general a serial task
 - Many require a large test dataset (large computation)
 - 'Rent' an appropriate machine for development tasks

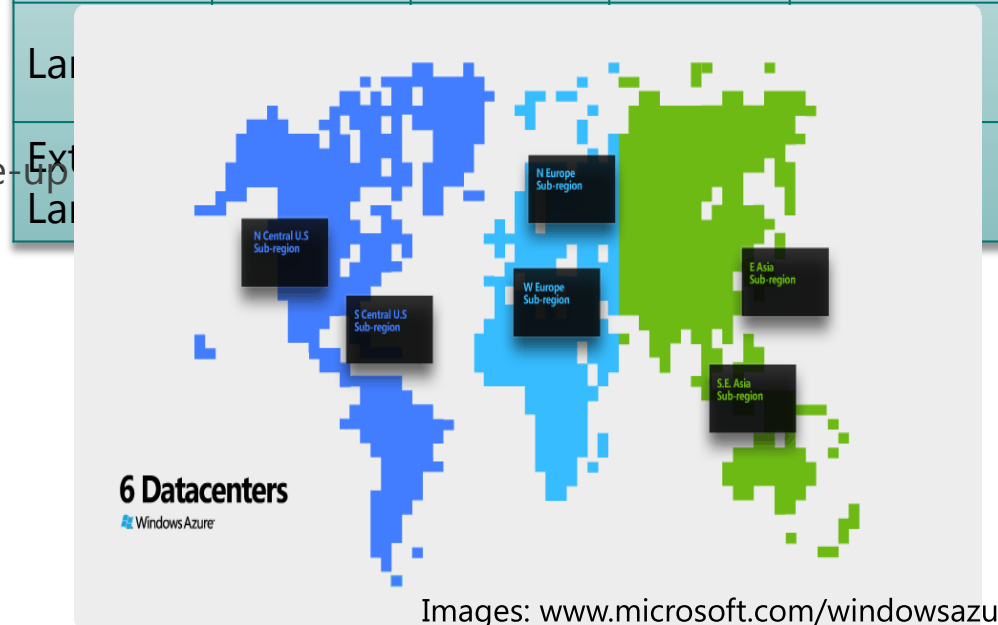
Cloud computing

- Infrastructure as a Service (IaaS)
 - Cloud IaaS sells/rents out infrastructure such as servers, virtual machines and networking and is an alternative to physically owning infrastructure.
 - For example renting a virtual machine on Amazon EC2
- Platform as a Service (PaaS)
 - Often build upon IaaS, cloud PaaS offerings include an Operating System and perhaps a software stack (.Net, Java).
 - For example Microsoft Windows Azure Workers
- Software as a Service (SaaS)
 - SaaS offers an end user application and can be built upon IaaS and PaaS.
 - For example Salesforce CRM

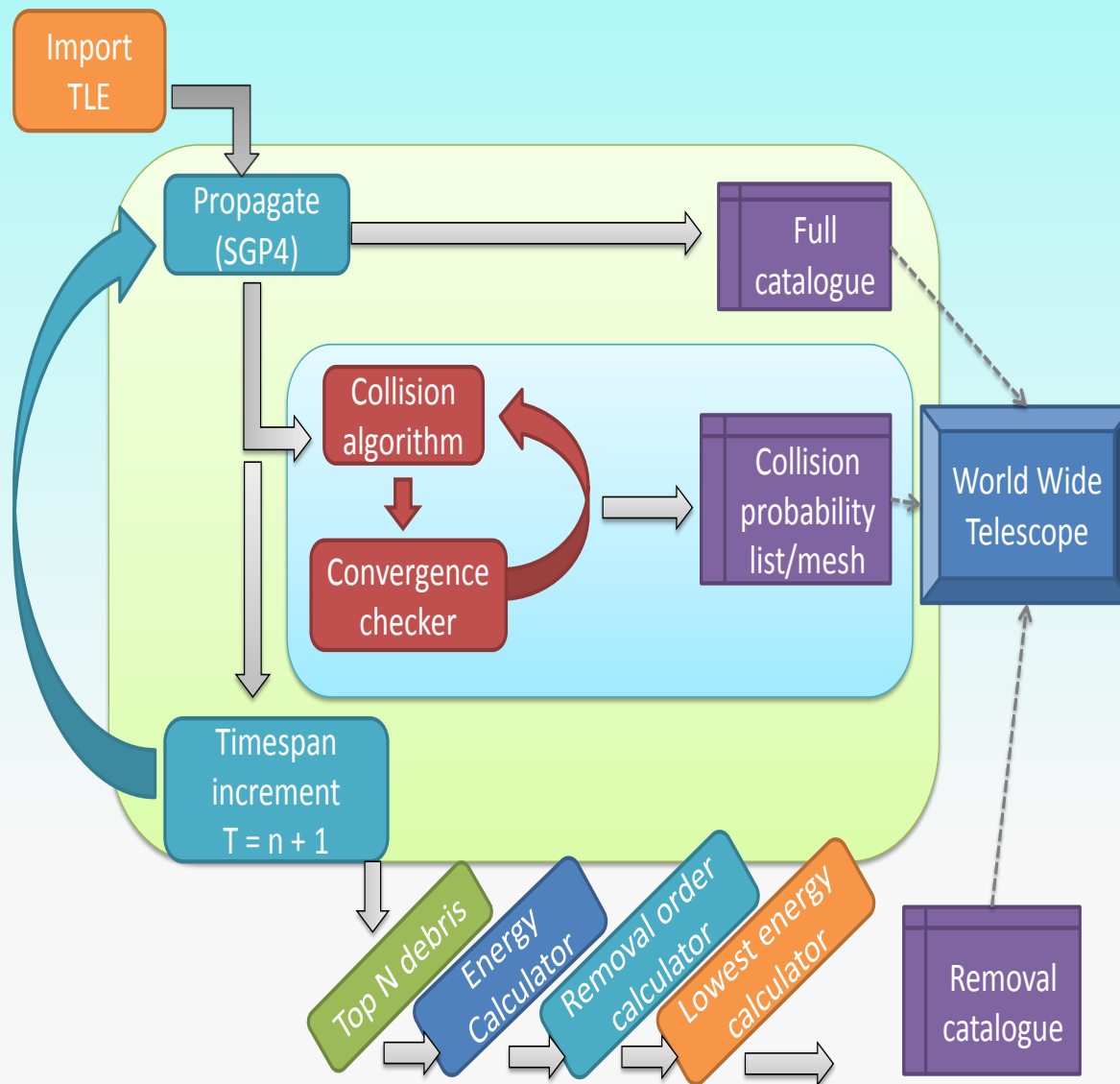
Windows Azure

- Azure Compute
 - Windows 2008 R2 (64 bit)
 - VM Role (build locally)
 - Scale out (more hardware)
 - Scale up (faster hardware)
 - Azure Storage
 - Blob
 - Table
 - Queue
 - SQL Azure
- Consider database sharding over scale-up

Compute Instance Size	CPU	Memory	Instance Storage	I/O Performance
Extra Small	1.0 GHz	768 MB	20 GB	Low
Small	1.6 GHz	1.75 GB	225 GB	Moderate
Medium	2 x 1.6 GHz	3.5 GB	490 GB	High

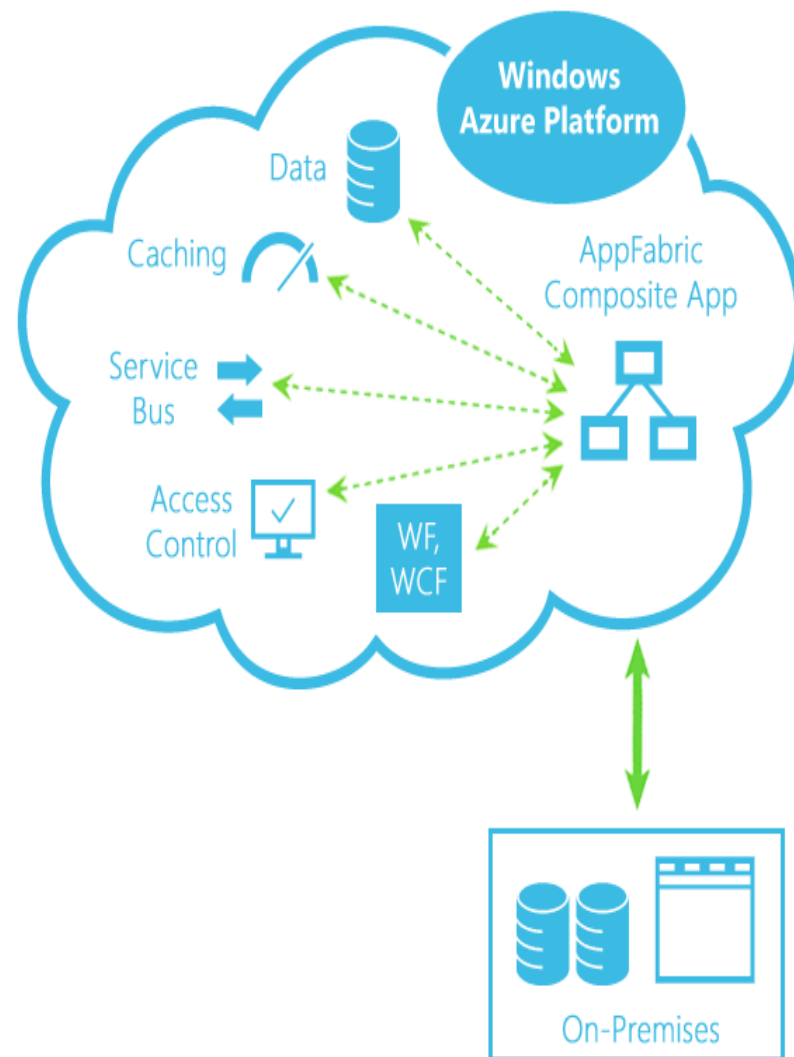


Clouds in space



Windows Azure

- **Compute**
- **Storage**
- Virtual Network
- Content Delivery Network
- AppFabric
 - Service Bus
 - Access control
 - Caching
 - Workflow
- Marketplace
- Appliance
-and more!



General considerations for Cloud compute

- Data storage policy (data export / local storage laws)
- There is a public network in-between (security/availability)
- SLA compensation policy
- Clouds are multi-tenanted (Security, Security, Security)
- Pricing (PAYG, Spot pricing, CPU units, offers.....) beware of direct comparisons
- Vendor roadmap (Lock-in)
- Use a flexible architecture (Pricing models change)
- Licensing (for example per core application licenses)

(Many issues are answered by current outsourcing scenarios)

World Wide Telescope (WWT)

The screenshot displays the Microsoft WorldWide Telescope (WWT) application interface. The main window shows a 3D visualization of the Earth with its orbital paths around the Sun. The interface includes a menu bar (Explore, Guided Tours, Search, Community, Telescope, View, Settings), a Collections bar with various astronomical categories, and a Layers panel on the left. The Layers panel shows a tree view of celestial objects, including the Sun, planets, and the Moon. A table below the Layers panel displays metadata for the selected object (Earth).

Name	Value
Lat	51.17263481
Long	-1.22694242
elevation	101.3989939
Fake Time	0001-01-01 00:00:00Z

At the bottom of the interface, there is a "Look At" section with a dropdown menu set to "SolarSystem" and "3D Solar System View". A "Tracking" section shows "Earth" is selected. A "Context Search Filter" is set to "All". A "Planet Size" slider is set to "Actual". A row of planet icons is visible, with "Earth" highlighted. The bottom right corner shows coordinates: "Loc: -150.9432" and "Lat: +46.2056".

Atmospheric Science Through Robotic Aircraft

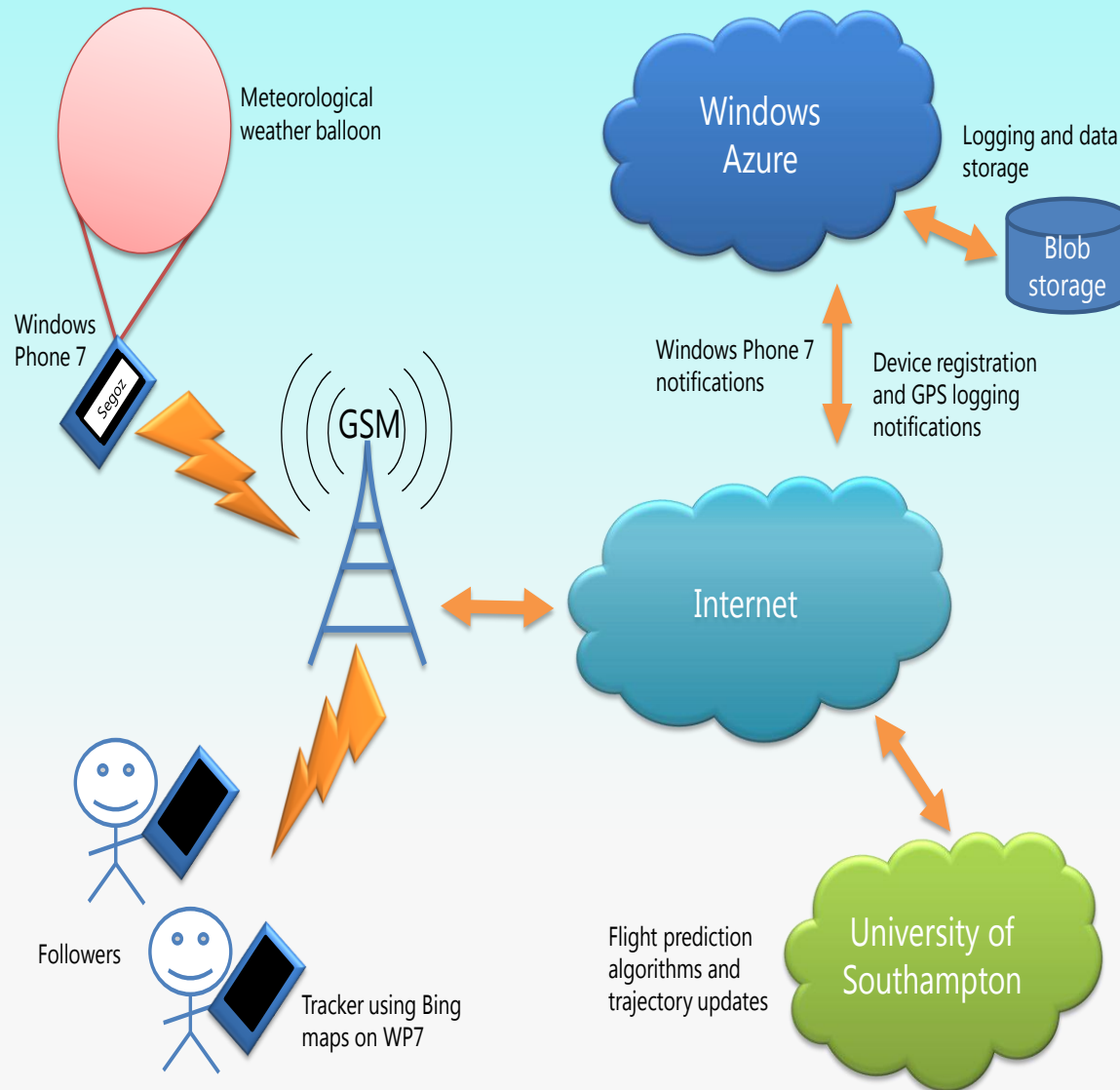
- Monitoring the atmosphere
 - Weather, pollution
 - Volcanic ash...
- Low cost metrological balloons
 - High altitude
- Instrument retrieval using WP7 + GPS
- Predicting the landing location with Azure

UNIVERSITY OF
Southampton



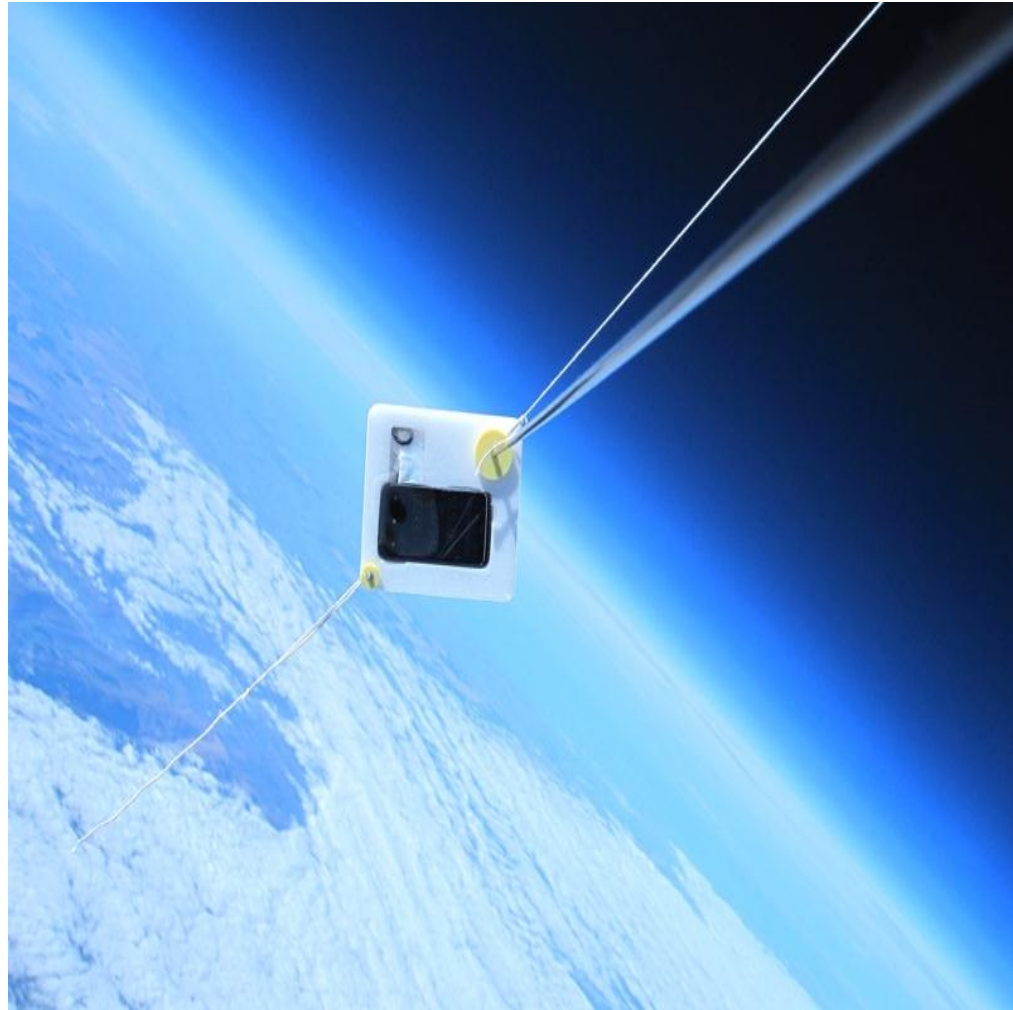
Segoz
co.uk

ASTRA architecture



ASTRA flights using WP7 and Windows Azure

- ASTRA 7
 - 18,237 meters (59,832 feet)
 - Top speed 145 km/h (90mph)
 - 1hr 16'
- ASTRA 8
 - 21,600 meters (71,000 feet)
 - Top speed 82 km/h (51mph)
 - 2hr 30'



Summary

- Cloud advantages

- Burst capability (predictable and unpredictable)
- Super-scalability
- Algorithm development
- Data dissemination
- 'Augmented processing'



Clouds in Space



ASTRA

Cloud computing is opening up new opportunities for science

Further information

- **Clouds in space**

G. Aloisio and S. Fiore, editors. Grid and Cloud Database Management, chapter Scientific computation and data management using Microsoft Azure. Springer.

<http://cmg.soton.ac.uk/research/projects/cloud-computing-for-planetary-defense/> (Previous version)

<http://cloudresearch.jiscinvolve.org/wp/category/projects/clouds-in-space/> (Blog)

- **Atmospheric Science Through Robotic Aircraft (ASTRA)**

<http://www.soton.ac.uk/~astra/> (Main page)

<http://segoz.co.uk/Stratosphericflight.aspx> (WP7 application)

<http://www.soton.ac.uk/~astra/diary.html>

<http://www.microsoft.com/showcase/en/us/details/da17789f-7914-4131-b7cb-91937be3d20a> (Video)

Further information

- Azure

<http://www.microsoft.com/windowsazure/> (Main page)

<http://www.microsoft.com/windowsazure/getstarted/> (Start here)

<http://www.microsoft.com/windowsazure/features/> (Features starting point)

<http://social.msdn.microsoft.com/Forums/en-US/category/windowsazureplatform> (Support forum)

<http://www.microsoft.com/windowsazure/whitepapers/> (Extra reading)

- Azure tools (\$)

<http://www.cerebrata.com/products/cloudstoragestudio/> (Data access)

<http://www.red-gate.com/search?fi=1&s=azure> (SQL Azure backup & admin)

Further information

- WP7

<http://watookitwp7.codeplex.com/> (Azure + WP7)

- WWT

<http://www.worldwidetelescope.org/> (Main page)

<http://www.worldwidetelescope.org/help/SupportHelp.aspx?Page=UserGuide> (User guide)

<http://www.worldwidetelescope.org/Authoring/Authoring.aspx?Page=DevelopersProgram> (Developer)

http://www.worldwidetelescope.org/Docs/WorldWideTelescope_Icapi.html (API)

<http://www.worldwidetelescope.org/ExcelPlugin.aspx> (Excel plugin)



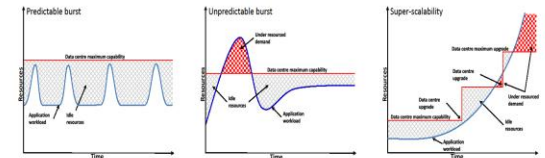
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 We gratefully acknowledge and thank Microsoft for their support.



Scientific computing using Windows Azure

Windows Azure, Windows Phone and WWT



Introduction

Cloud-based computing provides access to a utility style, on-demand compute resource, billed on a pay as you use basis. There are four key scenarios where cloud computing can prove advantageous, i) burst capability, ii) super scalability, iii) data dissemination and iv) algorithm development. We demonstrate each of these scenarios with the use of on-going projects, demonstrating the benefits gained by using Microsoft Windows Azure.

The 'Clouds in Space' project provides a cloud based plugin framework for satellite trajectory propagation and conjunction analysis and is aimed at improving Space Situational Awareness (SSA) by predicting potential satellite collisions. We are extending this to include Near Earth Objects (NEO) close approaches and calculate debris removal strategies to guide future billion dollar space missions. Debris removal requires optimising the removal of problematic debris with the cost and practicality of space technologies and mission capabilities.

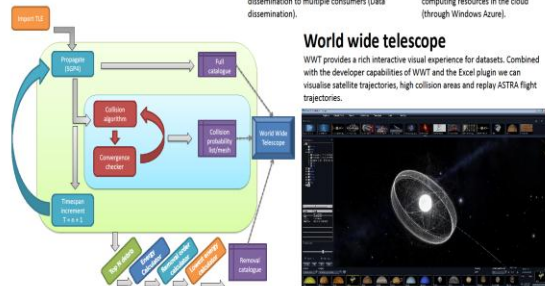
Clouds in Space

Clouds in Space demonstrates the key benefits of a cloud-based architecture.

- The satellite trajectories are updated twice a day and must be processed in a timely manner (predictable burst capability).
- In the event of a collision or future launch, additional load must be handled flexibly (unpredictable burst capability).
- New algorithms are required to understand propagation of space debris and collision events and to cope with scaling from tracking 20,000 objects (at 10cm resolution) to 500,000 (at 1 cm resolution), these can be developed and/or validated using the Clouds in space plugin framework (Algorithm development).
- Whilst the original source data is obtained from published sources, the resulting output data could be made available as a cloud data set for aggregation to multiple consumers (Data dissemination).

Atmospheric Science Through Robotic Aircraft

ASTRA investigates new technologies for making low cost observations of the physical parameters of the atmosphere. We develop and test platforms capable of delivering scientific instruments to altitudes ranging from the planetary boundary layer (hundreds of meters) to the upper stratosphere (up to 50km). ASTRA 7 was designed to demonstrate the feasibility of using a low-powered, lightweight commodity device (an HTC Trophy running Windows Phone 7) as a data logger, communications link and a portal to high performance computing resources in the cloud (through Windows Azure).



World wide telescope

WWT provides a rich interactive visual experience for datasets. Combined with the developer capabilities of WWT and the Excel plugin we can visualise satellite trajectories, high collision areas and replay ASTRA flight trajectories.



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