One must learn by doing the thing; for though you think you know it, you have no certainty until you try. ” - Sophocles
• JPL is a Federally Funded Research and Development Center (FFRDC) Managed by CalTech for NASA
• NASA’s lead center for robotic exploration of the solar system. Have 19 spacecraft and 9 instruments across the solar system and beyond
• $1.7B contract per year, ~ 5,000 employees; 177 acre facility located in Pasadena, CA, with 670K sq.ft of office space and 900K sq.ft. of labs

• Manages worldwide Deep Space Network
  – 3 Locations - Goldstone CA, Madrid Spain, Canberra Australia
  – Spacecraft Command & Control - Recording scientific data
• 50+ years experience in spacecraft design, production, operation
• JPL spacecraft have visited all planets in our solar system except Pluto!
Upcoming Mars & Solar System Exploration Events

- **EPOXI Comet Flyby**
  - November 2010

- **Dawn Vesta Arrival**
  - August 2011 (Ceres, February 2011)

- **Stardust-NExT Comet Flyby**
  - February 2011

- **GRAIL**
  - September 2011

- **Aquarius**
  - April 2011

- **Juno**
  - August 2011

- **Mars Science Laboratory**
  - November 2011

- **NuSTAR**
  - January 2012
PEARL STREET STATION
Mission Operations
Computers
Traditional Approach to Infrastructure
Replace Every Procurement Screen with a Provisioning Screen.
Jim Rinaldi - CIO JPL
What Compute Capacity means to JPLers
Here comes the rain...
But how?

- Focus on real business problems
- Early hands-on prototypes of enabling capabilities in every promising cloud
- Avoid analysis paralysis, but be safe
- Educate, communicate, influence, elaborate
- Keep it real
- Pro-active partnering
Let’s Move to the Cloud!
Contract Negotiations!
First to Sign!
Fostering the IT Consumers’ Ingenuity

INGENUITY
Because One Just Isn't Enough

IT ➔ “Innovating Together”
Keep it real

JPL Partners
Cloud Computing Concepts

1. Cloud Application Suitability Model (CASM)

2. Wheel of Security

3. Cloud Readiness Levels (CRL) (Institution, Apps, Dev)

4. Cloud Oriented Architecture (CIOA)

Public and Non-Sensitive data can be accessed in the Cloud today

NASA Technology Readiness Level
Cloud App Suitability Model determines application location

App Req’ts: Security, ITAR, app type, bandwidth, uptime, etc

<table>
<thead>
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<th>Score</th>
<th>Cloud Type</th>
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<td>Public</td>
<td>Recommends one of several</td>
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<tr>
<td>50-75</td>
<td>Community or Hybrid</td>
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<tr>
<td>0-49</td>
<td>Private or Hybrid</td>
<td>Recommendation</td>
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Private Clouds
Community Cloud
Public Cloud

Private Clouds
Community Clouds
Public Clouds

Private Clouds
Community Clouds
Public Clouds

Today
Within 2 Years
Future

➡ We’ll become faster, cheaper, greener, more flexible, and a partner of choice
Data in Cloud ≠ Public Data
JPL Cloud Uses: Outreach for Citizen Scientists

BeaMartian.jpl.nasa.gov
Reaches MS Cloud developers / citizen scientists of all ages
At EclipseCon 2010, a competition to drive a “Mars rover”

- Innovative concepts. Great programs. Exciting and fun
- It was all in Amazon’s Cloud (no JPL computing resources)
Mars-2-Earth
Mars-2-Earth
JPL Cloud Uses: Amazon HPC usage for Athlete
MER Image Processing

Embarrassingly parallel application
Process and deliver from Cloud
Streamlined image processing through Cloud Computing
Better situational awareness, better science, better safety
Maestro for MER
POLYPHONY

IMAGE PROCESSING ON CLOUD
~ Quarter Million Images
Quarter of a *day*
< $200

Weeks ✗ Days
Physical Control
Who Do We Already Trust?
Can Clouds Be Safer?
Security through Uniformity
A few examples of prototyped benefits so far:
• From weeks to hours to process Saturn images
• 15% more time for scientists world wide on Mars rovers
• From days to hours to model computations (e.g. DSN)
• Can reduce ops costs
• Can reduce risk
• Can speed experiments
• Augments JPL resources
• Partnering pays off!
JPL Cloud Strategy: What’s next

Cloud is THE enabler... if we continue to Keep it Real
We transition from understanding the Cloud to working in the Cloud to partnering in the Cloud

The Cloud enables everything … if we let it (e.g. PC 3.0)

Specialized Clouds become the Operating System

JPL will advance the Cloud Readiness Levels (CRL) and Cloud Oriented Architecture (COA)

Transition Cloud from Pilot to Operational mode

Spin the Wheel of Security and evaluate more Use Cases

Automate the Cloud Application Suitability Model (CASM)

Continue to keep it real and benefit from employees’ and partners’ ingenious usage of Clouds

Take full advantage of the Pervasive Cloud
Can we live without making IT rain?
What can YOU do about Cloud computing?

- Get started now with low sensitivity data
- Focus on new capabilities
- Prototype under the radar screen
- Communicate it as a business initiative (ROA)
- Partner with everyone
- Use the 3-floor elevator test
- Create a cross-functional leadership team focused on the concept (legal, procurement, security, facilities, business leaders, IT)
- Expect license agreement to take time
- Keep it real