National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Cloud Computing @ JPL Science Data Systems

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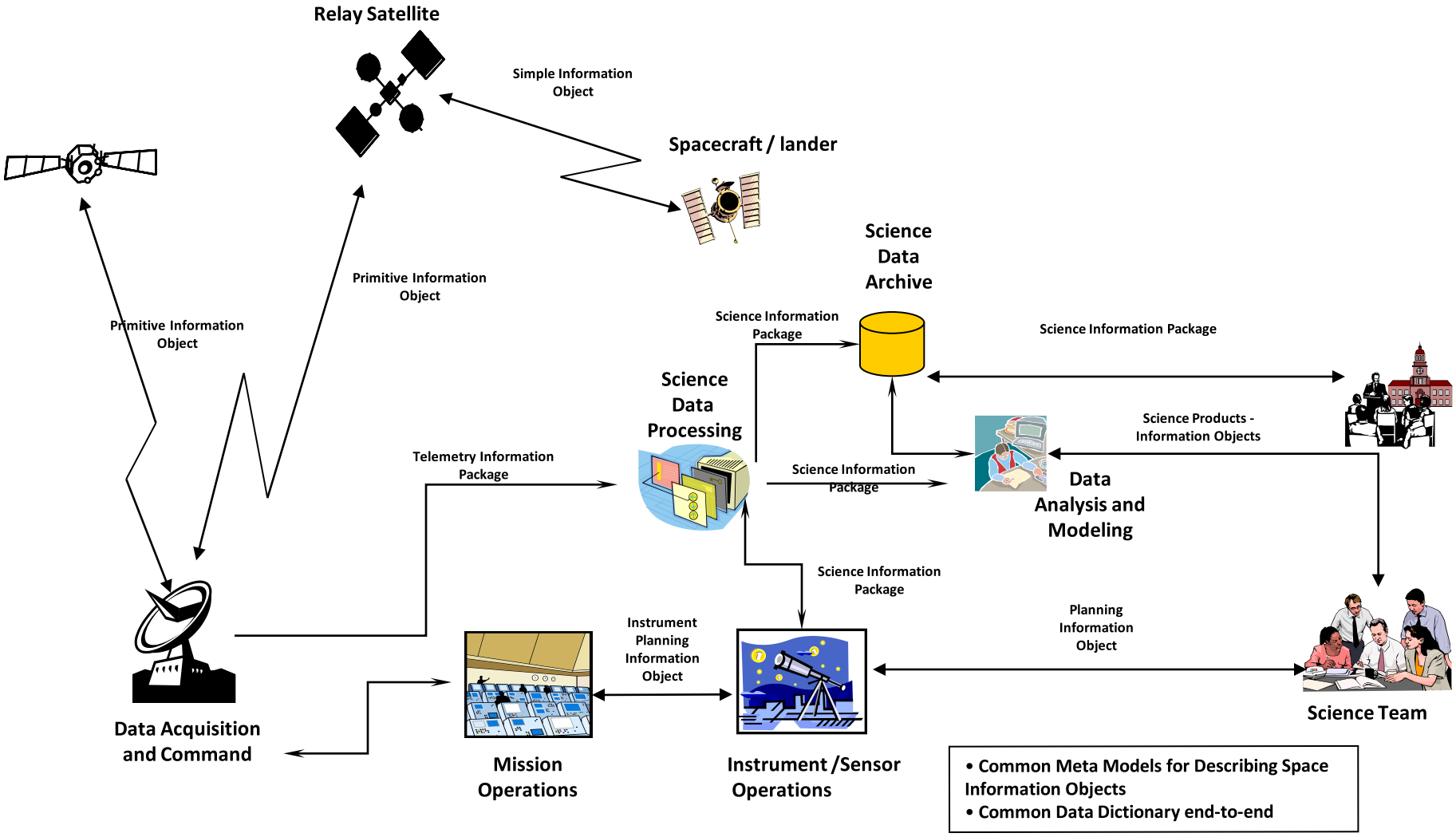
Outline

- Science Data Systems (SDS)
- Space & Earth SDSs
- SDS Common Components
- Components using Cloud Computing
- Use Case 1: LMMP
- Use Case 2: ACCE
- Strategy

Science Data Systems (SDS)

- Cover a wide variety of domain disciplines
  - Solar system exploration, Astrophysics, Earth science, Biomedicine, etc,…
- Each has its own communities, standards and systems
- But, there is a set of common components
- Some can greatly benefit from proven cloud computing technologies

Space Science Data Systems



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Earth Science Data Systems

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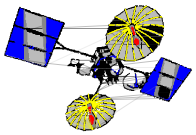
SDS Architectural Components View

Users



Ground Processing Center

WebService / API

Analysis | Visualization | Tools

Portal

Search | Transformation | Transport

Data Processing

Ingest | File Manager | Resource Manager | Data Distribution

System Resources | Catalog Metadata | Data Repository

Workflow | Tracking | Monitoring | Security

Client

Presentation

Application Service

Data Processing

Data Management

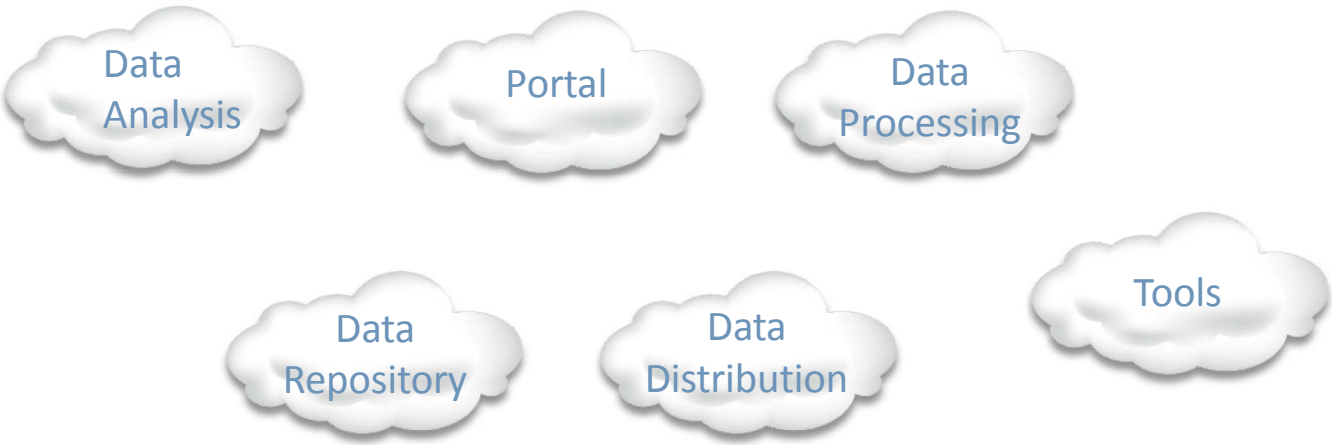
Resource

System Service

Legends:

- System Layer
- Data System Component
- External Entity
- Interface

Components using Cloud Computing



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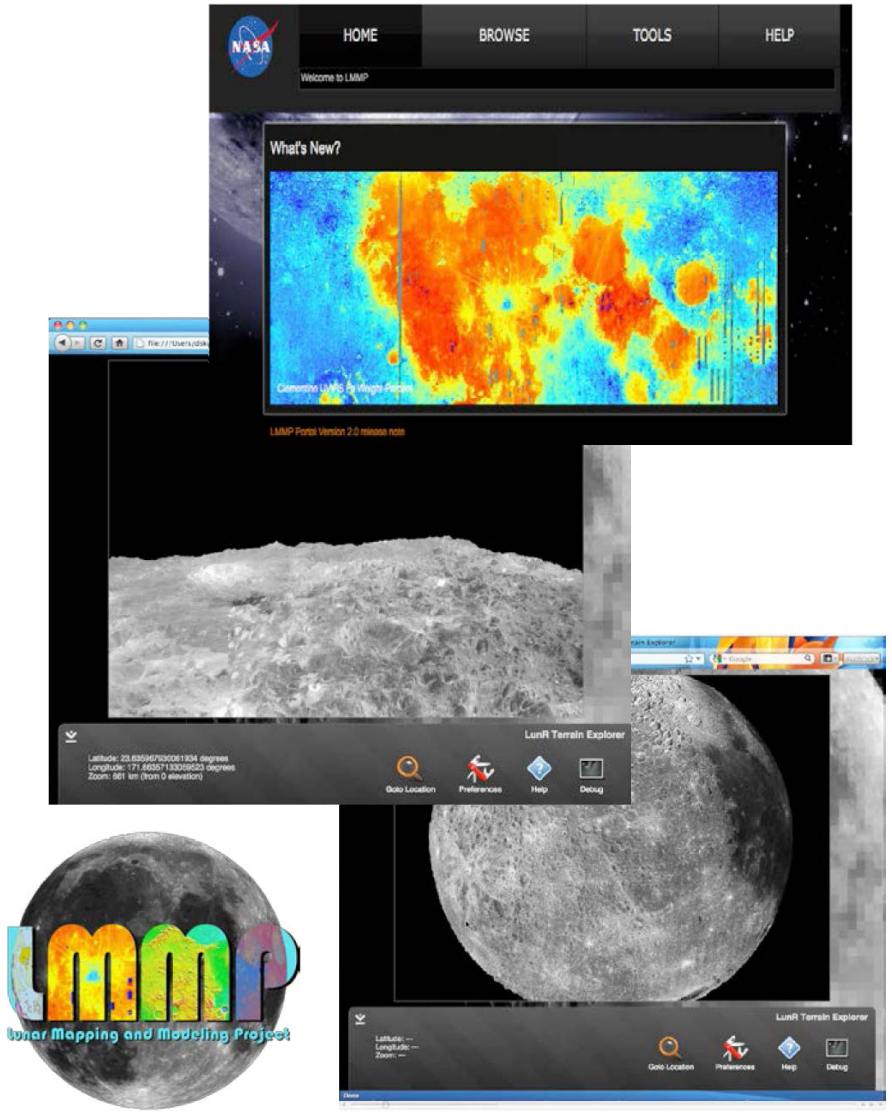
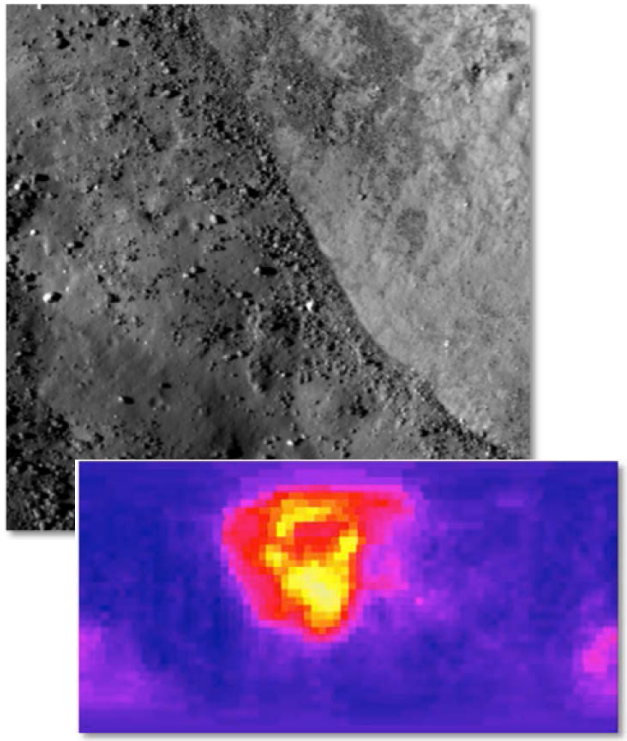
Use Case 1: Lunar Mapping & Modeling Project (LMMP)

- Provide science and exploration community a suite of lunar mapping and modeling tools and products that support the lunar exploration activities
- The tools and products are made available through a common, intuitive NASA portal
- Publicly available since March 2012
- http://lmmp.nasa.gov



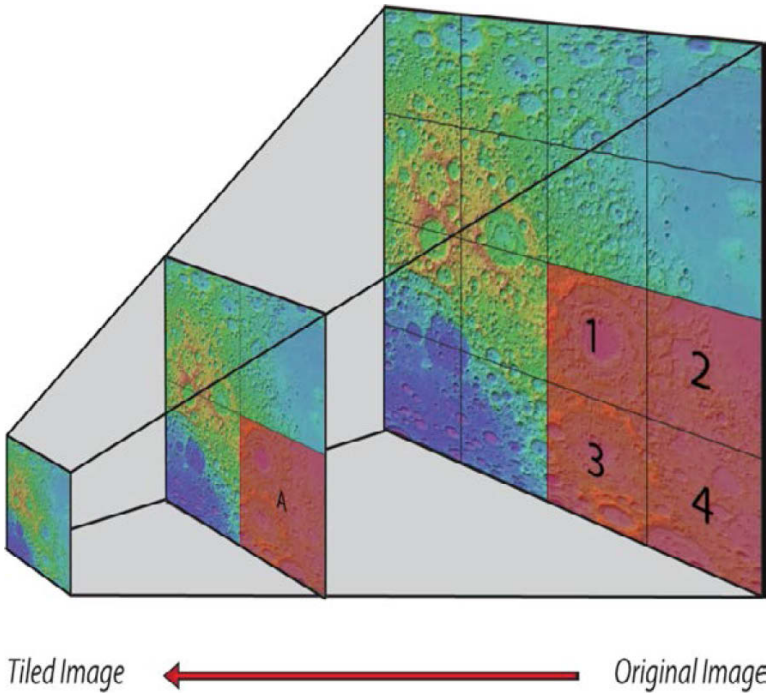
Challenge

- The image files LMMP manages range from a few gigabytes to hundreds of gigabytes in size with new data arriving every day
- Lunar surface images are too large to efficiently load and manipulate in memory
- LMMP must make the data readily available in a timely manner for users to view and analyze
- LMMP needs to accommodate large numbers of users with minimal latency



Cloud Computing Solutions

- Slice a large image into many small images and to merge and resize until the last merge and reduce yields a reasonably sized image that depicts the entire image
- Amazon E2C/S3
- Used distributed approach with Elastic MapReduce to tile images
- Developed a hybrid solution (multi-tiered data access approach) to serve images to users by cloud storage

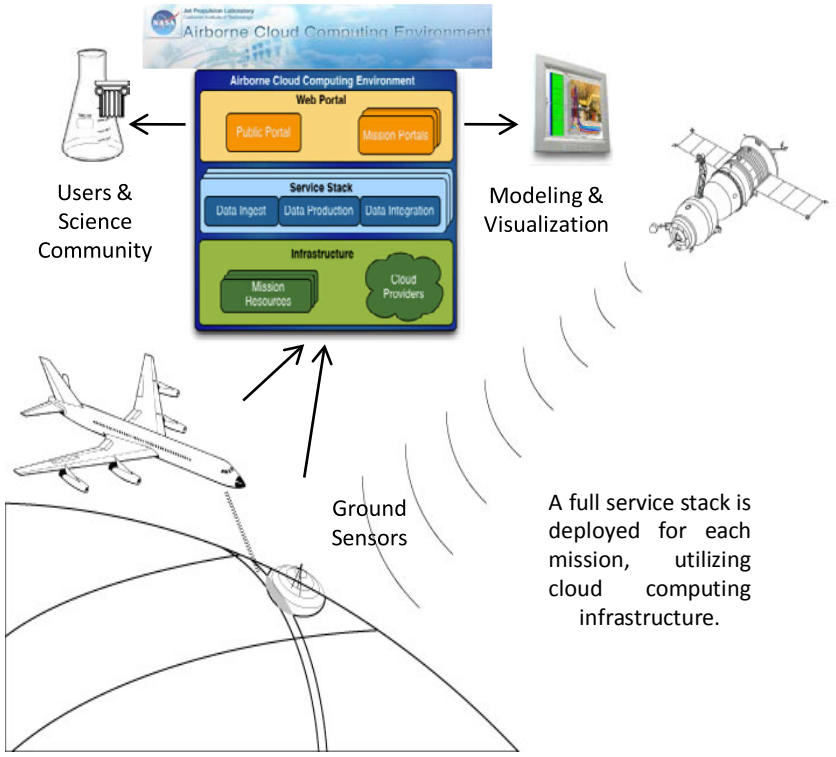


Findings

- Computing performance
  - Comparable especially for the new machines with significant processing capability
  - EC2's "rental" model offers better performance per dollar than having to purchase and maintain local servers
- Storage
  - Pay for just the bandwidth consumed
  - Eliminate the need to purchase extra hardware and bandwidth to handle the occasional spikes in usage
- Cloud Deployment
  - Increase latency
  - Enable fault tolerance

Use Case 2: Airborne Cloud Computing Environment (ACCE)

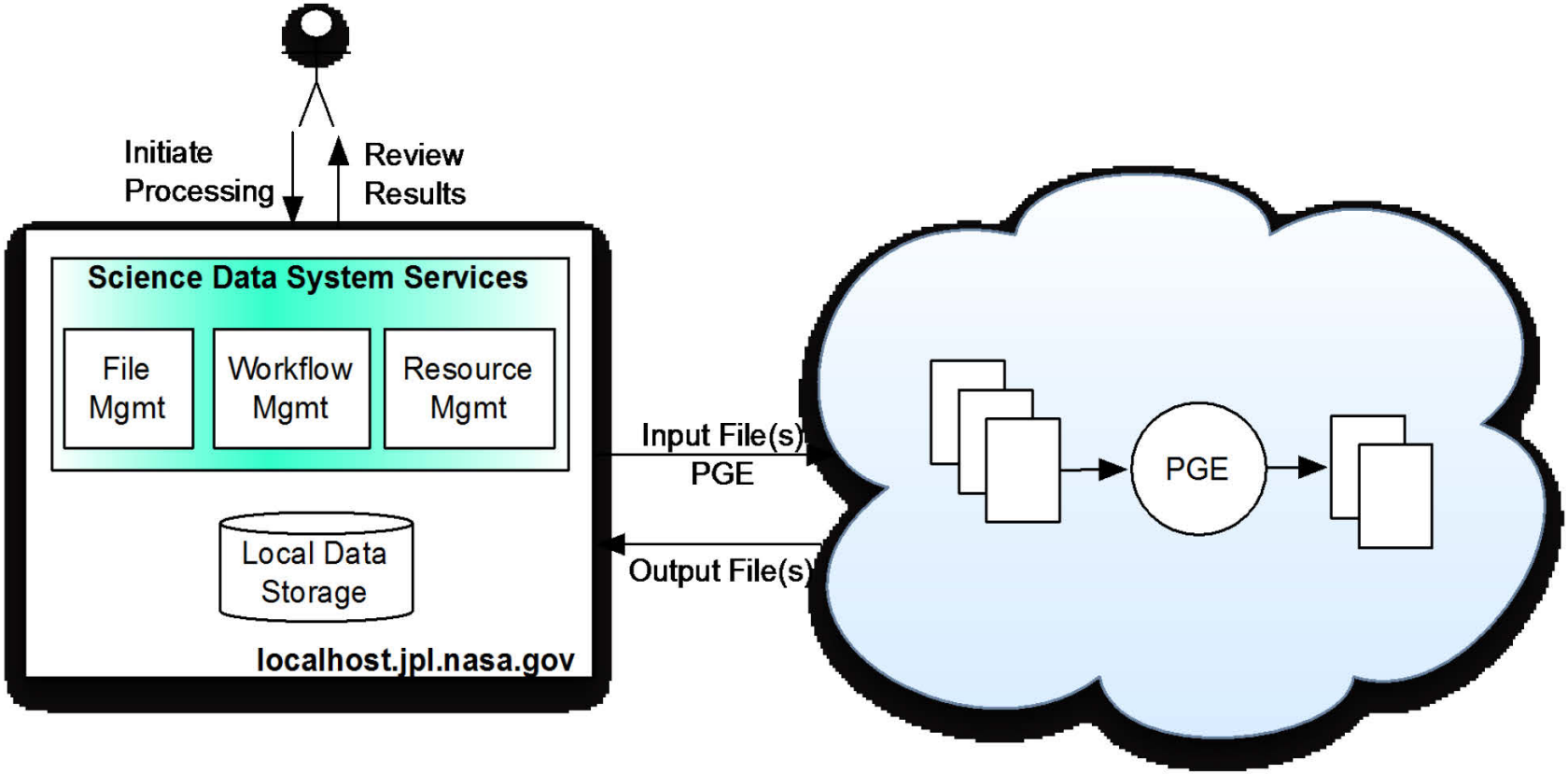
- Multi-mission capability providing distributed SDS services applicable to space-borne missions
  - File Management
  - Workflow Management
  - Resource Management
- Extend the existing services to utilize cloud services, commercial, community and private
  - Storage
  - Compute Resources



Approach

- Explore the benefits of performing science data processing for airborne missions in the cloud
- Evaluate different cloud technologies
  - Amazon EC2/S3
    - Elastic compute resources and on-demand storage
  - Eucalyptus
    - Infrastructure software for establishing a private cloud
  - Hadoop – Distributed File System (DFS) and MapReduce
    - Increased processing performance on large data sets

Cloud deployment



Findings

- Processing cost reduction
  - No investment in capital required (upfront or refresh costs)
  - Pay only for what you use
- Challenge
  - Host Environment
  - Support for ITAR-sensitive data
  - Data transfer rates between JPL and commercial cloud
  - JPL Firewall

Take Away

- Many benefits
  - Accessible from anywhere
  - Increase/decrease number of machines based on user defined parameters
  - Resizable compute capacity for unlimited growth
  - Utility Computing, pay by the drink, rapidly provisioned
- But….
  - Complexity
  - Security
  - Reliability
  - Feasibility
  - Standards

Strategy

- Cloud computing is an approach and tool to support “Big Data”
- Cloud Computing Working Groups
  - Common architecture
  - Common cloud framework
  - Lessons Learned
  - Best Practices
- Further benchmarking, optimization, research
- Collaboration

Thank You