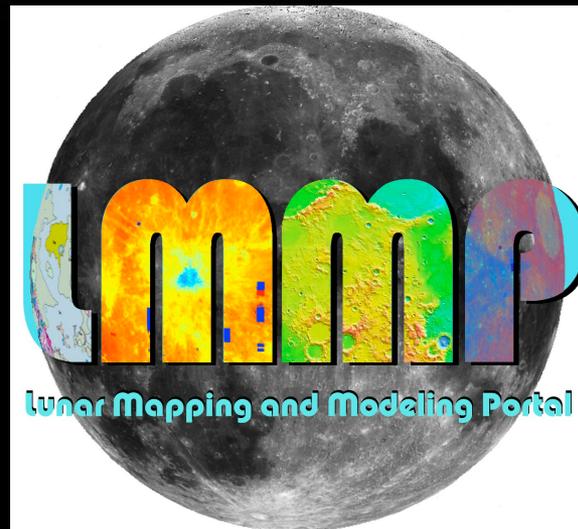


LUNAR MAPPING AND MODELING PORTAL



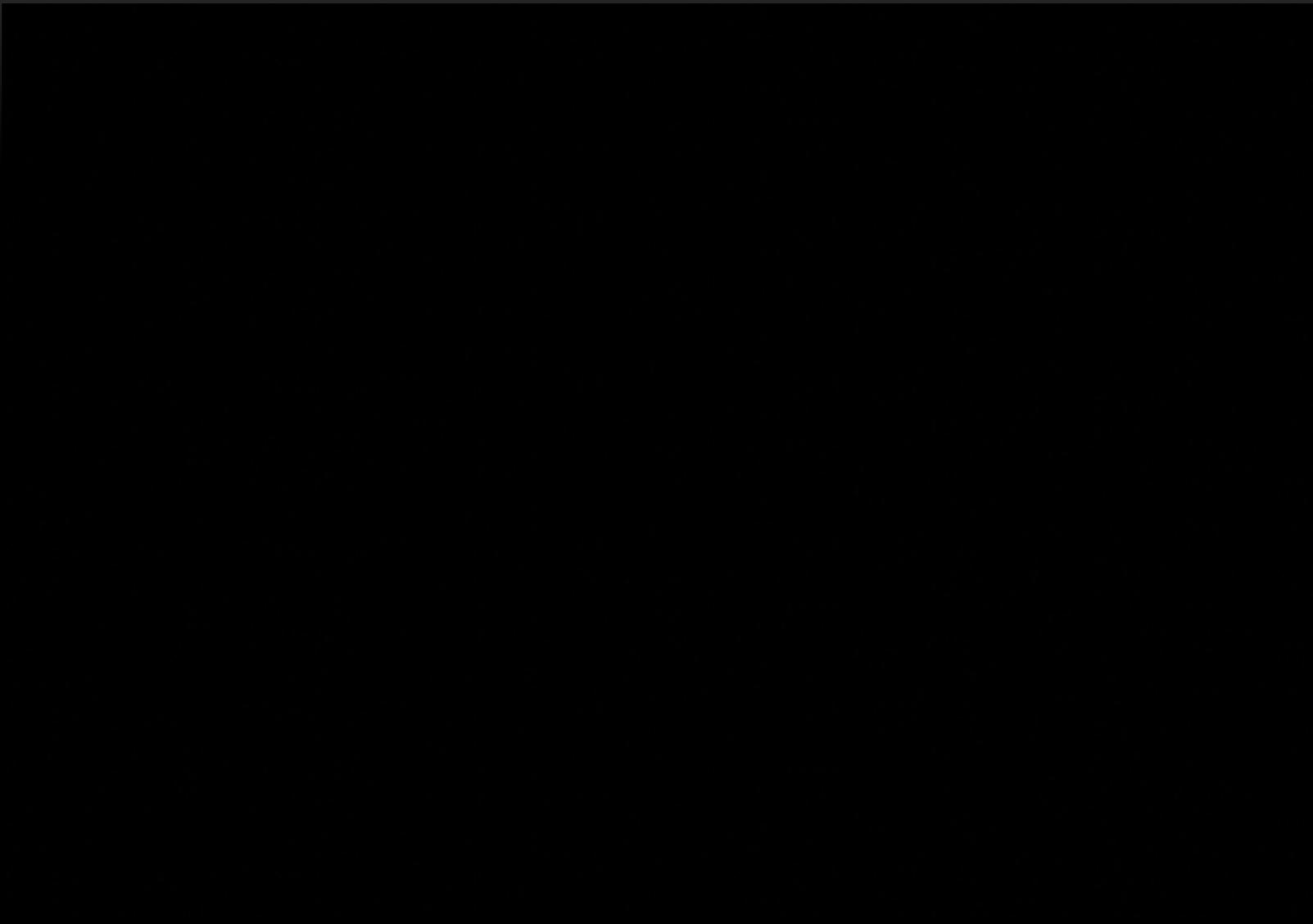
Lunar Science Forum
July 2012

Lunar Mapping and Modeling Portal



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California



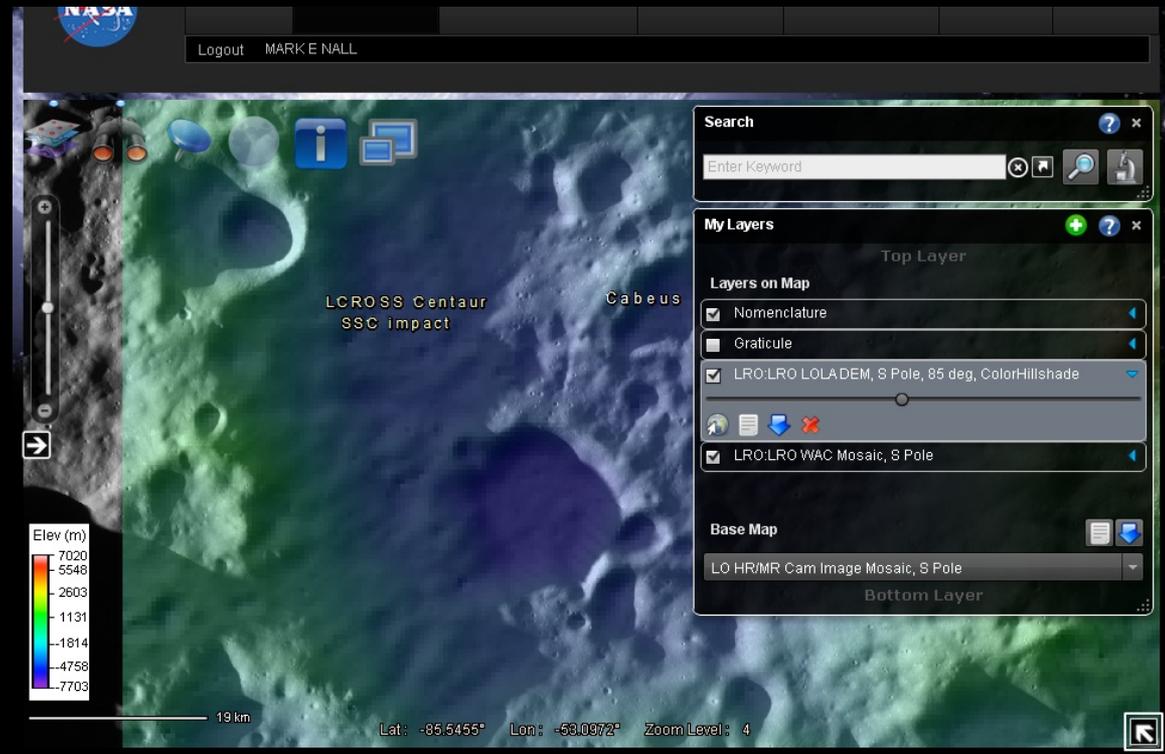


Summary and Objectives

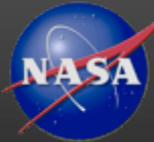
- LPRP/MSFC was tasked by the Advanced Capabilities Division in 2007 to make the expected results of the Lunar Reconnaissance Orbiter (LRO) easily accessible and usable by the Constellation Program (CxP)
 - Became known as LMMP
 - Managed under NPR 7120.8, as Technology Development Project
- Develop and integrate a suite of lunar mapping and modeling tools and products to support CxP and other lunar exploration activities
 - Include historical and international lunar mission data
 - Provide both public and restricted/authenticated user access
- Leverage products and expertise provided by the LRO Science Teams
- Identify and leverage other areas where NASA has made investments in relevant activities and expertise
 - ARC, Arizona State University, CRREL (Army Cold Regions Research & Engineering Laboratory), GSFC, JPL & USGS



- An operational integrated suite of lunar mapping and modeling tools and products to support lunar exploration activities



www.lmmp.nasa.gov



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USERS



- Wide utilization

- **NASA**

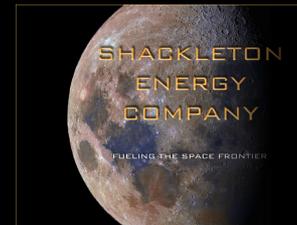
- RESOLVE mission planning
 - ALHAT maps & DEMs

- **Industry**

- Google Lunar X-Prize
 - SpaceMETA
 - EUROLUNA
 - Team FredNet
 - Shackleton Energy Company

- **Education**

- Hayden Planetarium





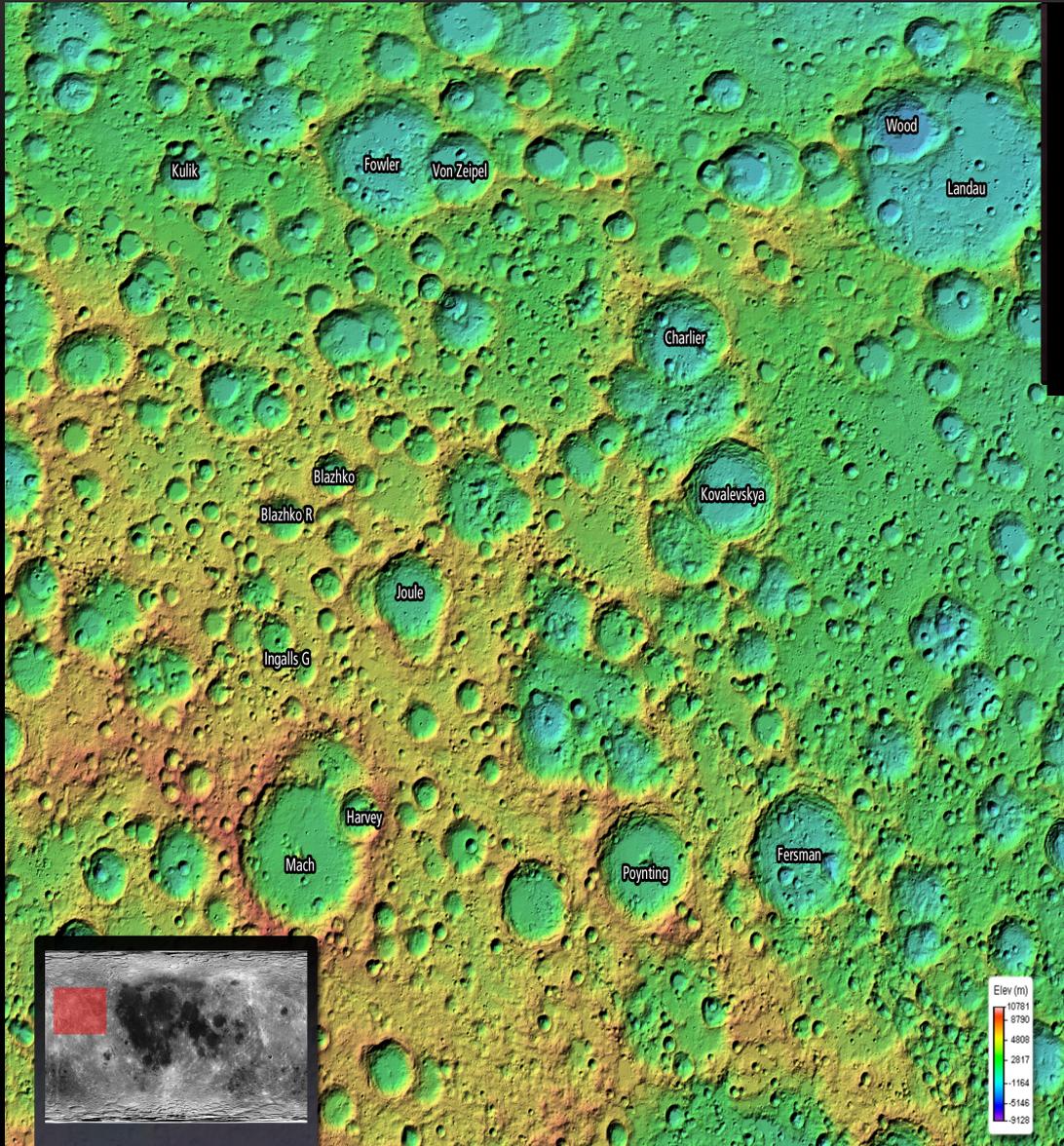
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LMMP DISPLAY ON THE HYPERWALL AT NASA HQ



Lunar Mapping and Modeling Portal



Lunar Mapping and Modeling Portal

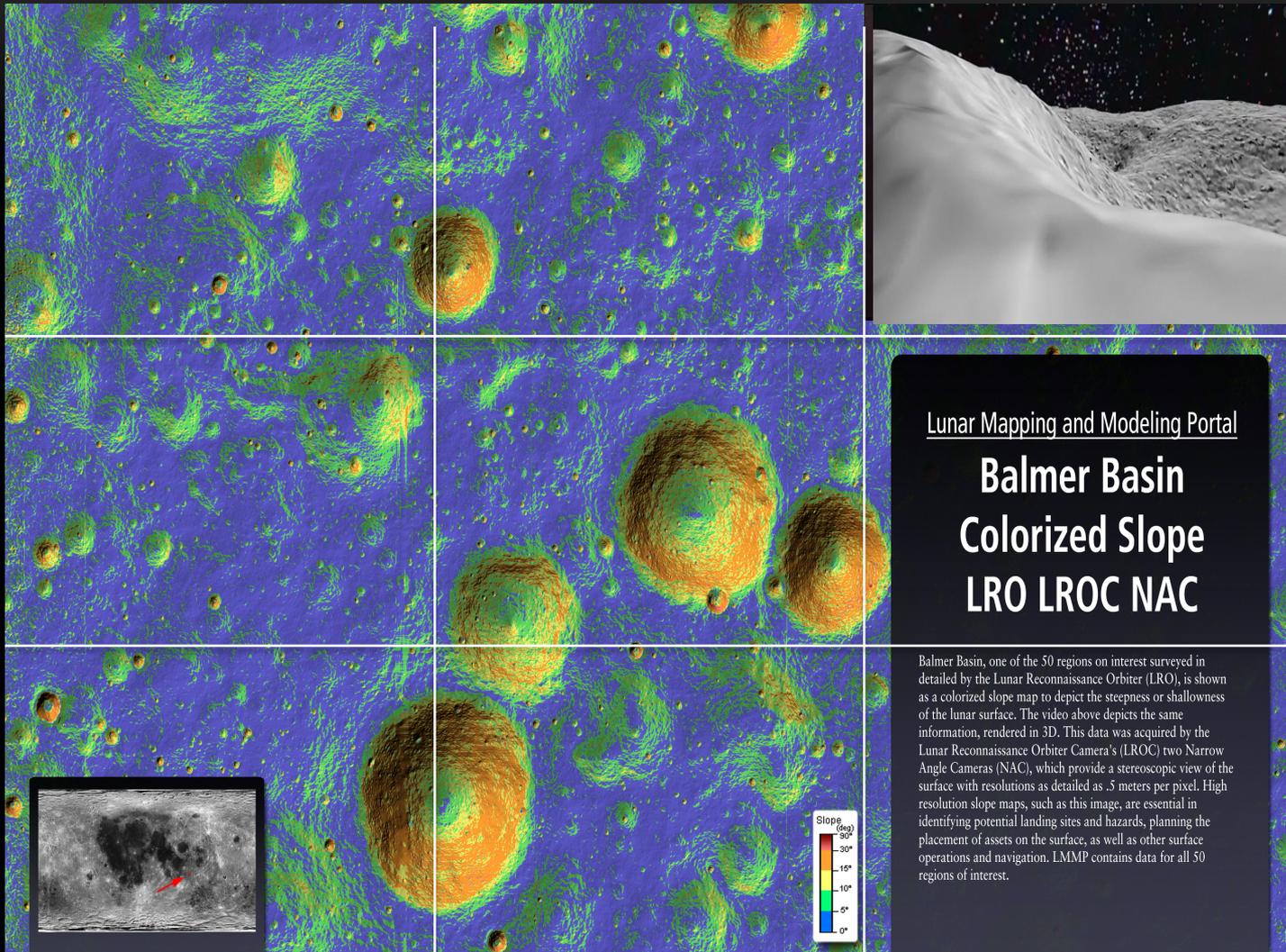
Colorized DEM LRO LOLA

This shows a colorized digital elevation map (DEM) of a region on the far side of the moon. Unlike the near side, the hemisphere that permanently faces the Earth, the far side has significantly more evidence of small and large crater impacts. This particular image was taken by the Lunar Reconnaissance Orbiter's (LRO) Lunar Orbiter Laser Altimeter in September 2011. The altimetry data acquired had a resolution of 128 pixels per degree and colorized to emphasize the varying elevations. LMMP contains a comprehensive nomenclature database is able to superimpose the names of the identified features on the projected map.



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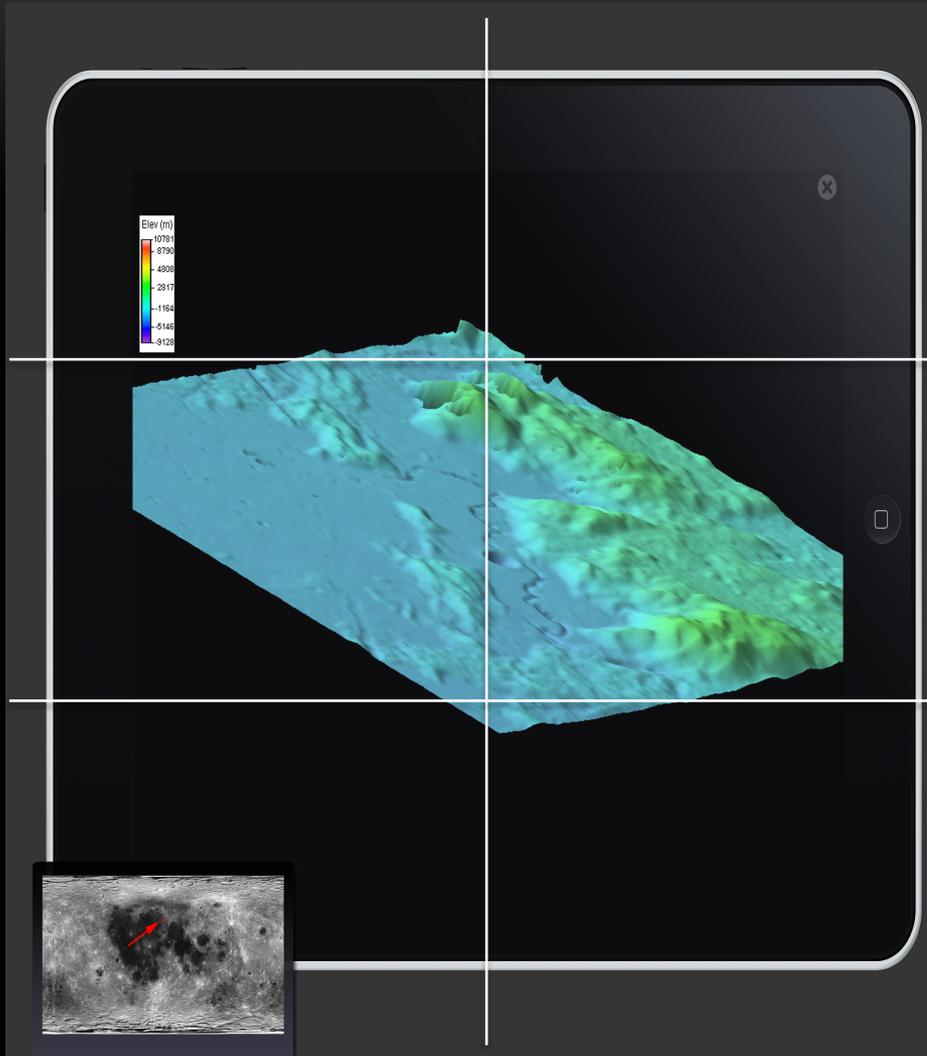
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Lunar Mapping and Modeling Portal

Balmer Basin
Colorized Slope
LRO LROC NAC

Balmer Basin, one of the 50 regions of interest surveyed in detail by the Lunar Reconnaissance Orbiter (LRO), is shown as a colorized slope map to depict the steepness or shallowness of the lunar surface. The video above depicts the same information, rendered in 3D. This data was acquired by the Lunar Reconnaissance Orbiter Camera's (LROC) two Narrow Angle Cameras (NAC), which provide a stereoscopic view of the surface with resolutions as detailed as .5 meters per pixel. High resolution slope maps, such as this image, are essential in identifying potential landing sites and hazards, planning the placement of assets on the surface, as well as other surface operations and navigation. LMP contains data for all 50 regions of interest.



Lunar Mapping and Modeling Portal
Rima Hadley
Apollo 15 Metric CAM

In addition to warehousing lunar data, LMMP also integrates existing lunar visualization tools, such as Lunar Mapper and ILIADS, as well as newly developed tools that work within a web browser or mobile device. The image shown is a three-dimensional rendering on an Apple iPad of the Rima Hadley area, Apollo 15's landing site, using the elevation data taken by the Apollo 15 Metric Camera. The accompanying video shows the same region rendered using OpenGL in Adobe Flash. LMMP has been shown on other devices such as Android mobile devices, large touchscreen displays, and immersive 3D apparatus. The rich dataset that is housed within LMMP lends itself to innovative interfaces to visualize and manipulate the data for scientific analysis or public curiosity.



PRODUCT SUMMARY (1 OF 2)



Image Mosaics

- Local: Cx Regions of Interest (35 LROC NAC Ortho-image mosaics & 3 Apollo PanCam Ortho-image Mosaics)
- Regional: Apollo Metric Camera Ortho-image Mosaics (4 – Apollo 15, 16, 17 and Integrated Zone)
- Regional: LROC NAC North and South Pole Ortho-image Mosaics
- Global: Lunar Orbiter HR/MR / Clementine UVVIS Hybrid Image Mosaic
- Global & Polar: LROC WAC Image Mosaic
- Global & Polar: Clementine UVVIS Image Mosaic
- Global & Polar: Lunar Orbiter HR/MR Camera Image Mosaic,
- DEM Products/Maps
 - Local: Cx Regions of Interest (41 LROC NAC-based DEMs & 3 Apollo PanCam-based DEMs)
 - DEM, Gray Scale, Hill Shade, Color Hill Shade, Slope, Confidence
 - Regional: Apollo Metric Camera Image DEMs (4 – Apollo 15, 16, 17 and Integrated Zone)
 - DEM, Gray Scale, Hill Shade, Color Hill Shade, Slope, Confidence, Precision
 - Global & Polar: LOLA DEMs (1 – Global, 2 – @ Each Pole)
- Hazards Products/Maps
 - Local: Cx Regions of Interest (25 - LROC NAC-based)
 - Rock & Crater Lists, Size-Frequency Distribution Plots, Density Maps, Cumulative Fractional Area Plots, Abundance Maps; Slope Hazard Maps; Roughness Hazard Maps

LMMP Developed Product	Historical/Other Product	Science Team Pass-through
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PRODUCT SUMMARY (2 OF 2)



- Lighting Models
 - JPL Developed Lighting Model Available Through Portal
 - SHADR – APL Developed Lighting Model Available within ILIADS
- Temperature Maps
 - Diviner: Average Regolith Surface Temperature & Normalized w/Latitude
- Gravity Models
 - Lunar Prospector 100K Spherical Harmonic (Coefficient & Covariance)
 - Lunar Prospector 150Q Spherical Harmonic (Coefficient & Covariance)
- Resource Maps
 - Silicate Mineralogy (Diviner): Christiansen Feature (Standard & Normalized Equatorial Noon)
 - Lyman Alpha Albedo (LAMP): North & South Pole
 - Mineralogy (Clementine): UVVIS FeO Wt-%, TiO₂ Wt-%, Optical Maturity, 3-Color Ratio
 - Mineralogy (Lunar Prospector): GRS Fe Abundance, K Abundance, Th Abundance
 - H Concentration (Lunar Prospector): NS H Abundance

LMMP Developed Product

Historical/Other Product

Science Team Pass-through

Lunar Mapping and Modeling Portal



CAPABILITIES SUMMARY



- User interface with access authentication (Registration)
- Data products Catalog, Browse, Search & Download (Metadata)
- PDS Integration
- Data annotation (Attach auxiliary data)
- Web Services
- Collaboration (Wiki, Workspace)
- Tools
 - Lighting (sun angle and lunar lighting over time)
 - Slope & Hazard (Rock density)
 - Pixel
 - Confidence
 - Subsetting
 - Distance
 - Terrain Viewer
 - ILIADS (Integrated Lunar Info Architecture & Decision Support)
 - Lunar Mapper
- Touch Screen, immersive media & Mobile Apps
- Online Help & Feedback



PLANS FOR FUTURE



- Increase user base of existing system
 - Better integrate with other AES activities; e.g., Morpheus
 - Investigating Education and Public Outreach opportunities through the NASA Lunar Science Institute & NASA Citizen Science efforts
- Plan for expansion to near Earth asteroids and other small bodies
 - MMSEV mission simulation support
 - JRPA & Mars mission support
- Continue to enhance system capabilities
- Continue to ingest additional LRO product updates as they become available



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ARCHITECTURAL PRINCIPLES

Principles

Usability

Scalability

Maintainability

Open

Data driven

Standardization

Reliability

Security

Implementation

Tiered Architecture

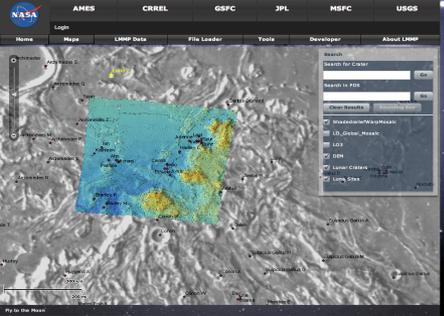
Service Oriented

Seamless Security

Cloud-enabled



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Web Client



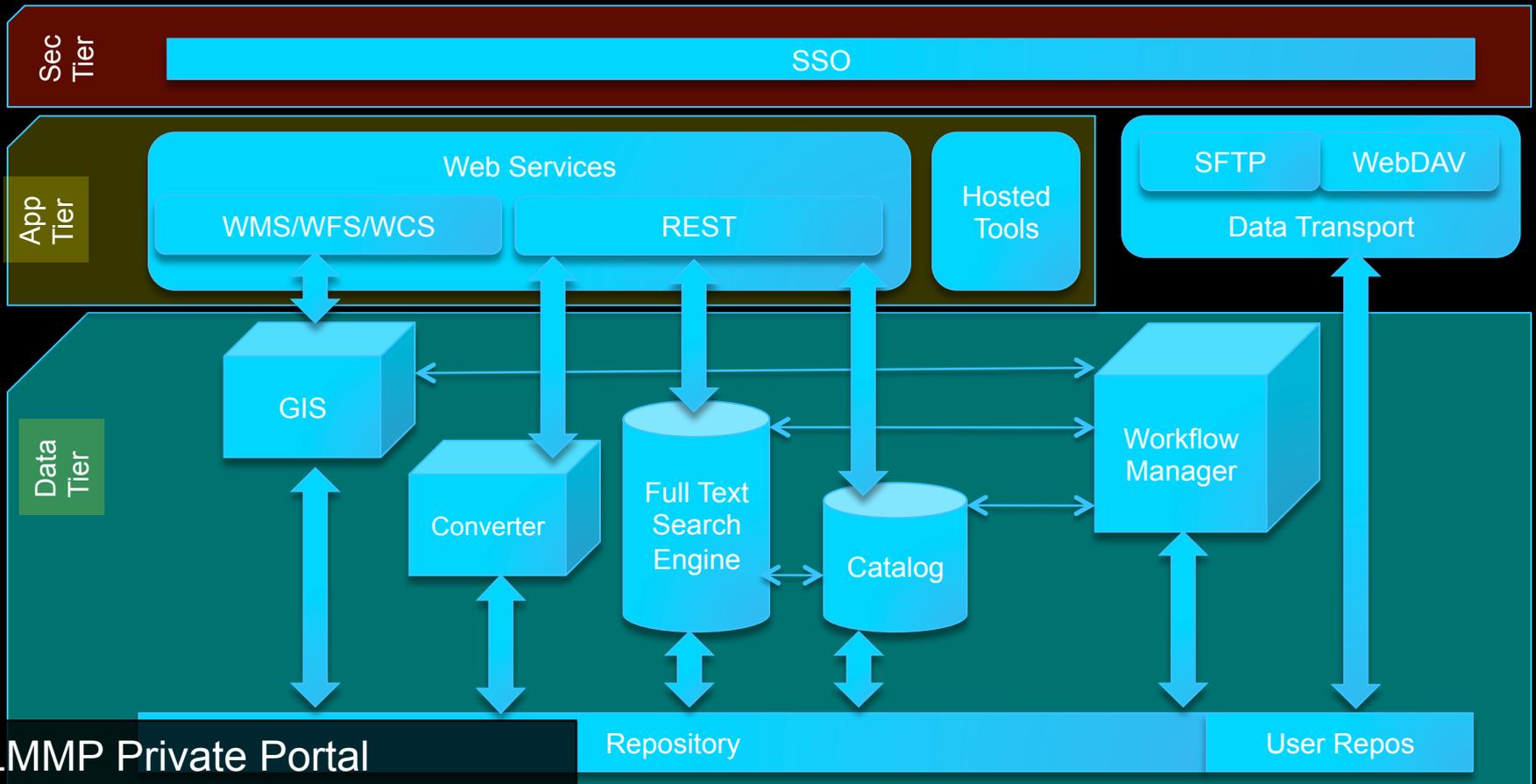
Mobile Client

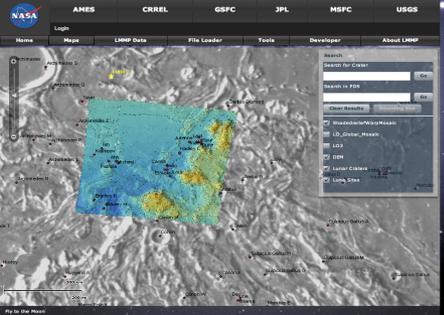


ESRI Client (ArcMap)



KML Client (Google Earth)





Web Client



Mobile Client



ESRI Client (ArcMap)

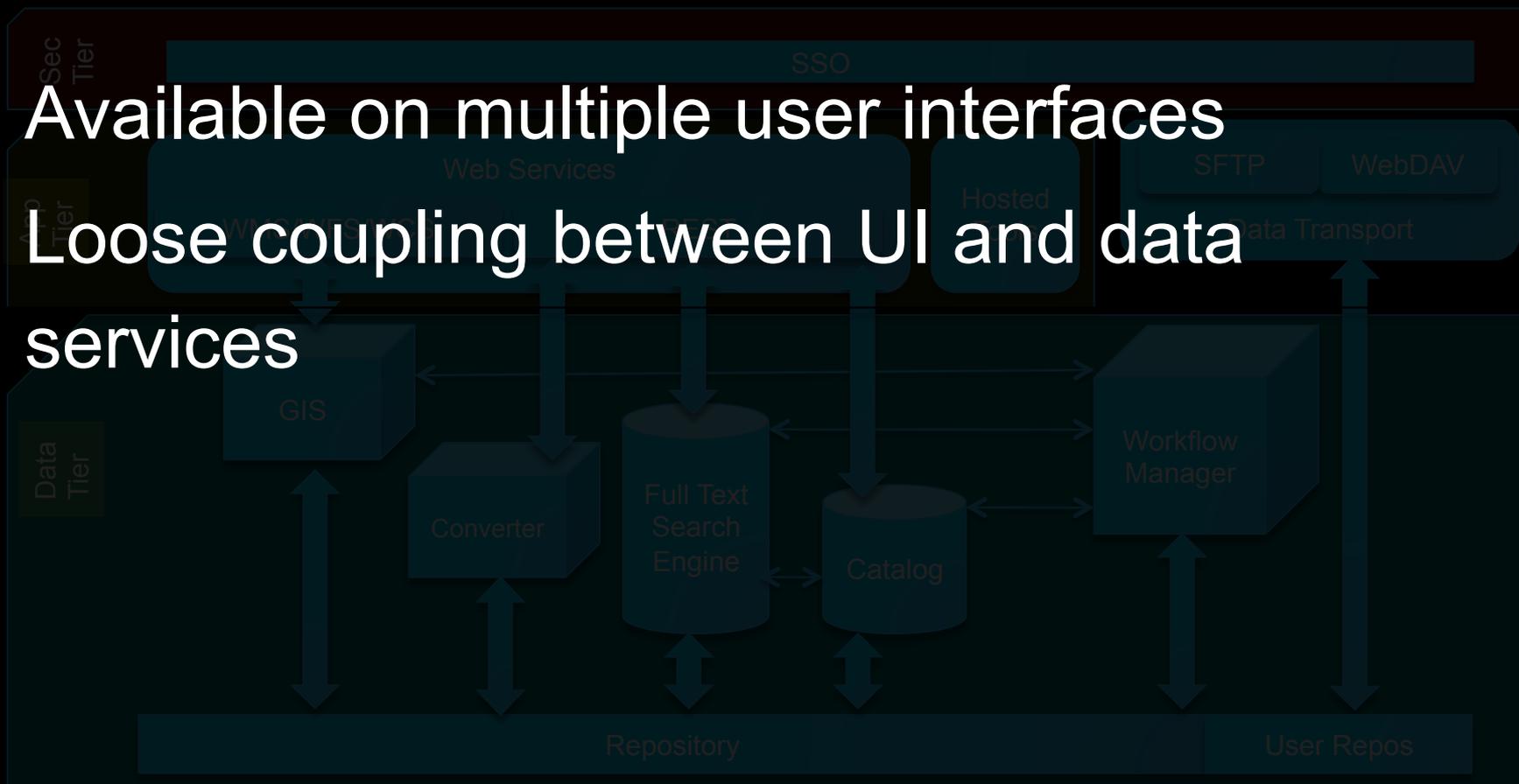


KML Client (Google Earth)



Available on multiple user interfaces

Loose coupling between UI and data services



Utilized Sun/Oracle OpenSSO Framework Single Sign-On Across All LMMP Domains

Sec
Tier

SSO

Multiple LDAP Sources
Exposes REST Wrappers

Login

Username :

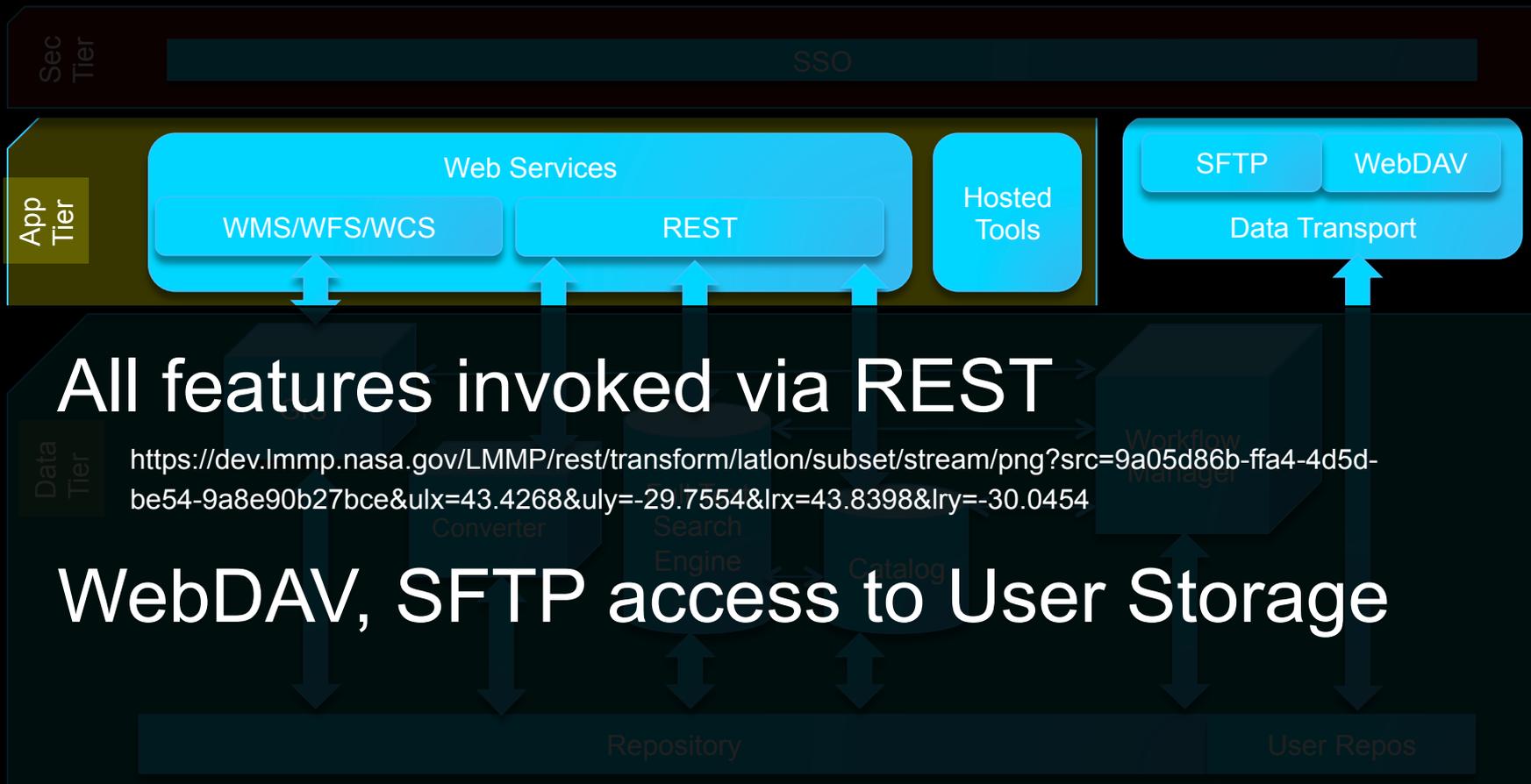
Password :

Account : NASA

LMM Registrations: NASA, JPL, LMMP

Login

GIS information provided by standard APIs, XML meta-catalog for GIS sources



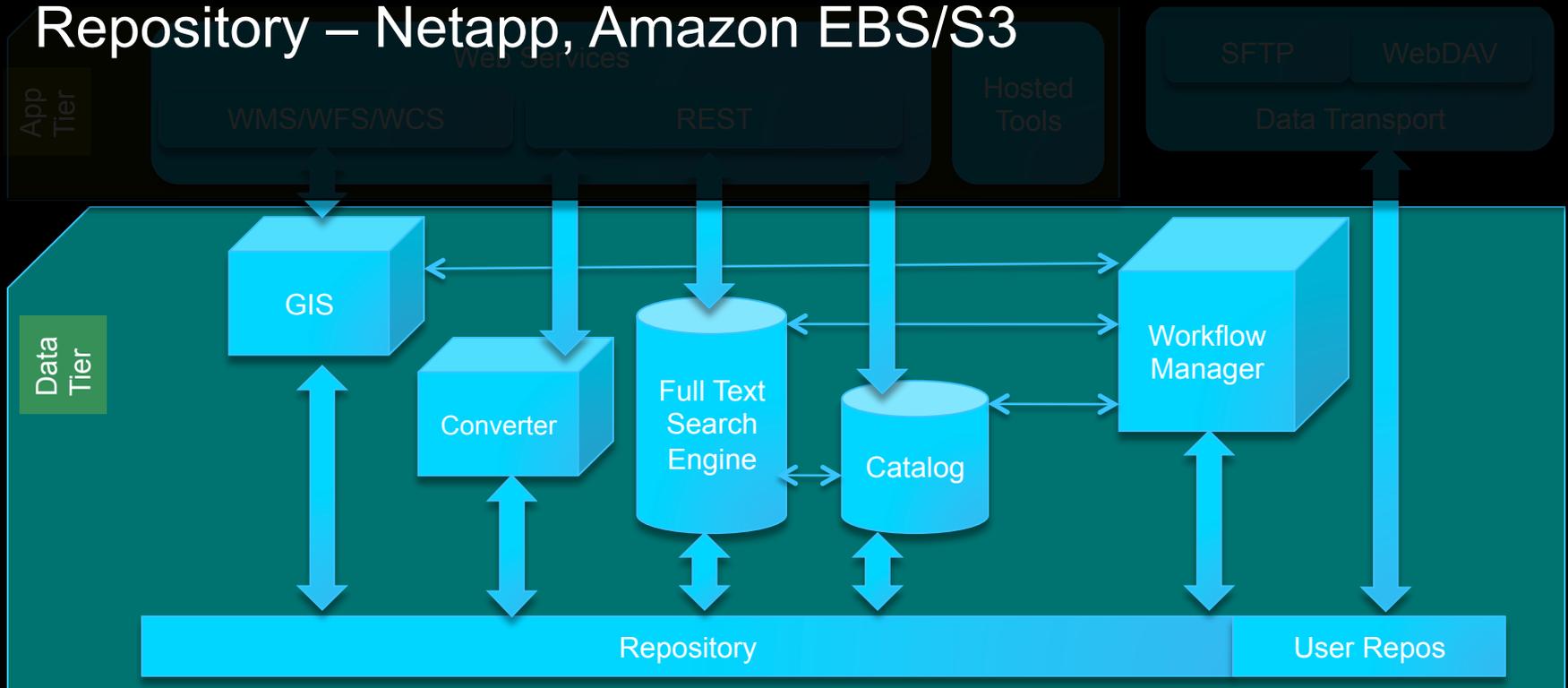
GIS Servers – JPL (T)WMS, ArcGIS

Data Converters – GDAL, Java ImageIO

Search Engine, Catalog – Solr, OODT, BerkeleyDBXML

Workflow – Jabber, Amazon SNS/SQS

Repository – Netapp, Amazon EBS/S3





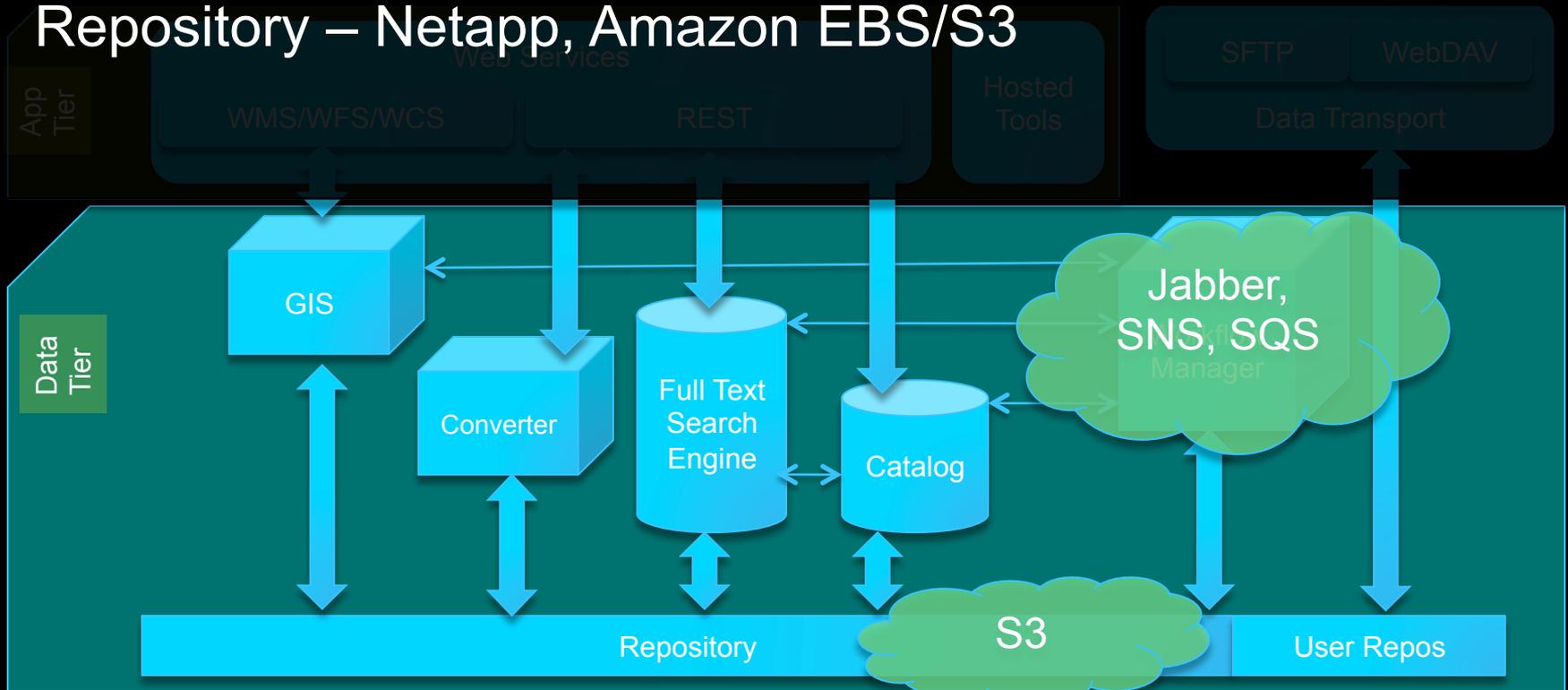
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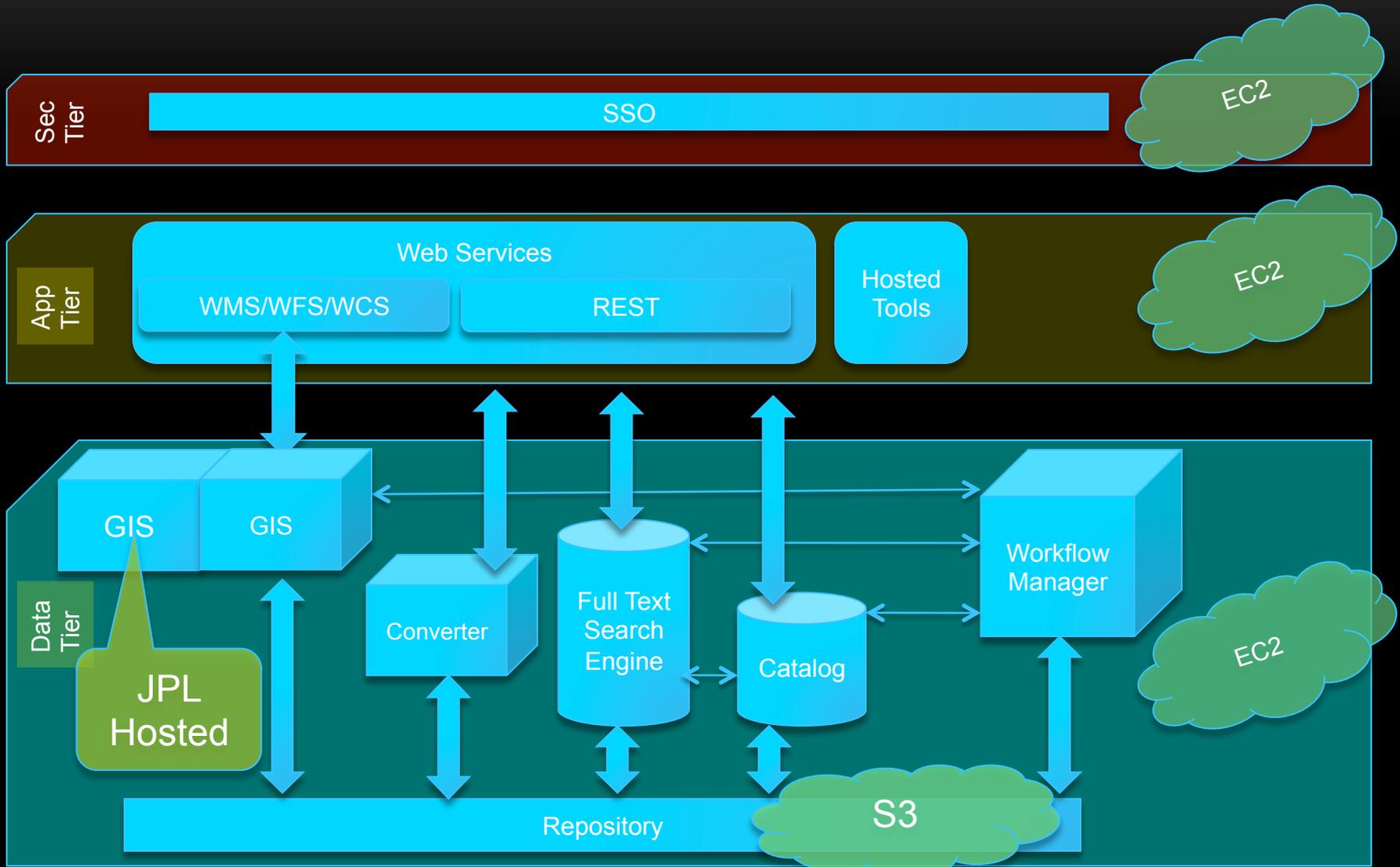
Workflow – Jabber, Amazon SNS/SQS

Repository – Netapp, Amazon EBS/S3





LMMP PUBLIC PORTAL





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Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California



- Additional Information & Presentations
 - Posters
 - Portal Demo
 - Contacts:
 - Emily Law emily.law@jpl.nasa.gov
 - Shan Malhotra shan.malhotra@jpl.nasa.gov
 - Bach Bui bach@jpl.nasa.gov

THANK YOU