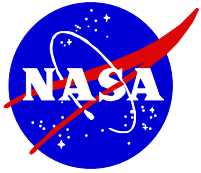


ISS Space-based Science Operations Grid for the Ground Systems Architecture Workshop (GSAW)



Technology Trends



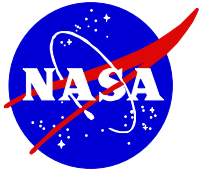
- **Three growth “areas”**
 - Storage (doubles every 12 months).
 - Networks (doubles every 9 Months).
 - Compute Power (doubles every 18 months).
- **Implications**
 - Larger volumes of data demanding more analysis.
 - Larger bandwidth producing more collaboration, communication, and video.
 - Increasing use of remote compute power.
 - (Ian Foster, “The Grid: A New Infrastructure for 21st Century Science”, Physics Today, February, 2002.



What is a grid?



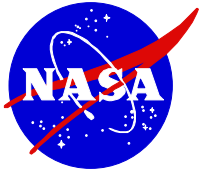
- “A Grid is a system that:
 - 1) coordinates resources that are **not** subject to **centralized control**
 - 2) using **standard**, open general-purpose **protocols and interfaces**
 - 3) to deliver **nontrivial** qualities of service.”
 - **(Source: Ian Foster, “What is a Grid? A Three Point Checklist”, July 20,2002).**



What a Grid Is / Is Not



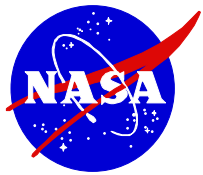
- The World Wide **Web**.
- **Entropia**TM
- Ames Information Power Grid (**IPG**).
- **Peer-to-Peer** (P2P) Computing.
- A source of **free cycles**.
- A Virtual Machine or a distributed operating system. (note: architecture defines protocols that make up Grid-speak).



Candidate Grid Applications



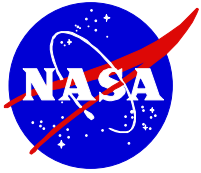
- **Unsuitable:**
 - Applications that run quickly and easily on one machine
 - “Indivisible” data sets
 - One machine device drivers
- **Suitable:**
 - Decentralized *virtual organizations* requiring distinct services



Grid-enabling Space-based Science Operations



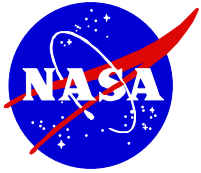
- **Increase access**, by the science community, to:
 - Computational resources, in real-time, from their own workstation
 - Related and collaborative data from other remote sources
 - High volume data storage
- **Simplify access** to payload operations services.
 - Single sign on (one username/password)
 - Transparency to networked services



The Security Question



- **Security**
 - Fundamental aspect of Grid technology
 - Covers all areas of security (except physical security) by using existing computer and network security and security **designed into** grid technology
 - Areas being addressed:
 - ◆ Certificate based authentication
 - ◆ Authorization
 - ◆ Virtual Private Network (VPN) utilization



Technical Objectives



- **Short Term:**

- Analyze and then demonstrate the technical **feasibility** of grid technology applied to space-based science operations from a national and global perspective
- **Identify existing ISS ground systems suitable for grid applications** and identify any system enhancements needed
- **Build a prototype** that incorporates needed services
 - NOTE: Results will be reported through the NSF National Middleware Initiative as a case study.

- **Long Term:**

- Determine application to ISS payload community
- Determine application to other NASA programs/projects e.g. free flyers



Space-based Services Required for Remote Operations



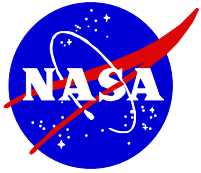
Service:

Wide Area Networking
Local Area Networking
International WAN
Telemetry (data) Management

Commanding
Voice
Video
Planning
Security

Purpose:

Provide connectivity to your instrument
Provide “first mile and last mile” connectivity
Provide Connectivity worldwide
Receive, process, store and display science or operations data
Change an instrument’s state
Coordinate operations and science activities
View experiment activities or specimens
Plan the activities of science and operations
Confidentiality, integrity and accessibility



New Services Enabled By A Grid



Service:

Videoconferencing

Data Storage

Visualization*

Collaboration tools

Text messaging

Instant messaging

High End Processing

Outreach

Purpose:

Reduce travel costs

Add to storage capacity

Enhance understanding of science
& engineering problems

Enhance planning and science operations
(application sharing)

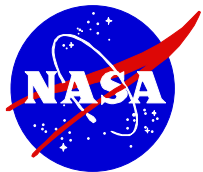
Enhance communication

Enhance communication

Provide near real time processing of user
telemetry data

Provide educational and public access to space
based science

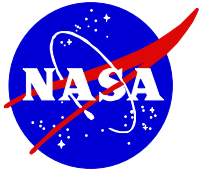
* Under consideration



Scope of *Prototype* Grid Services



- Verify Technology exceeds current capabilities
 - i.e., Telescience Resource Kit (**TReK**), Internet Voice Distribution System (**IVoDS**) and WAN service
- Verify new capabilities such as videoconferencing can be realized
- Ensure Grid Security Infrastructure meets NASA requirements
- Determine cost savings
- Establish relationships with participants
- Ensure ease of use and transparency to users



Participants and Resources for Prototype Grid



- **Participants**

- One or more current ISS Principal Investigator (PI) sites
- Marshall Space Flight Center's Flight Project Directorate's Ground Systems Department (GSD)
- University of Alabama in Huntsville (UAH)
- Ames Research Center's (ARC) NASA Information Power Grid
- Stanford University Video Auditorium
- University of Chile at Santiago

- **Potential Resources**

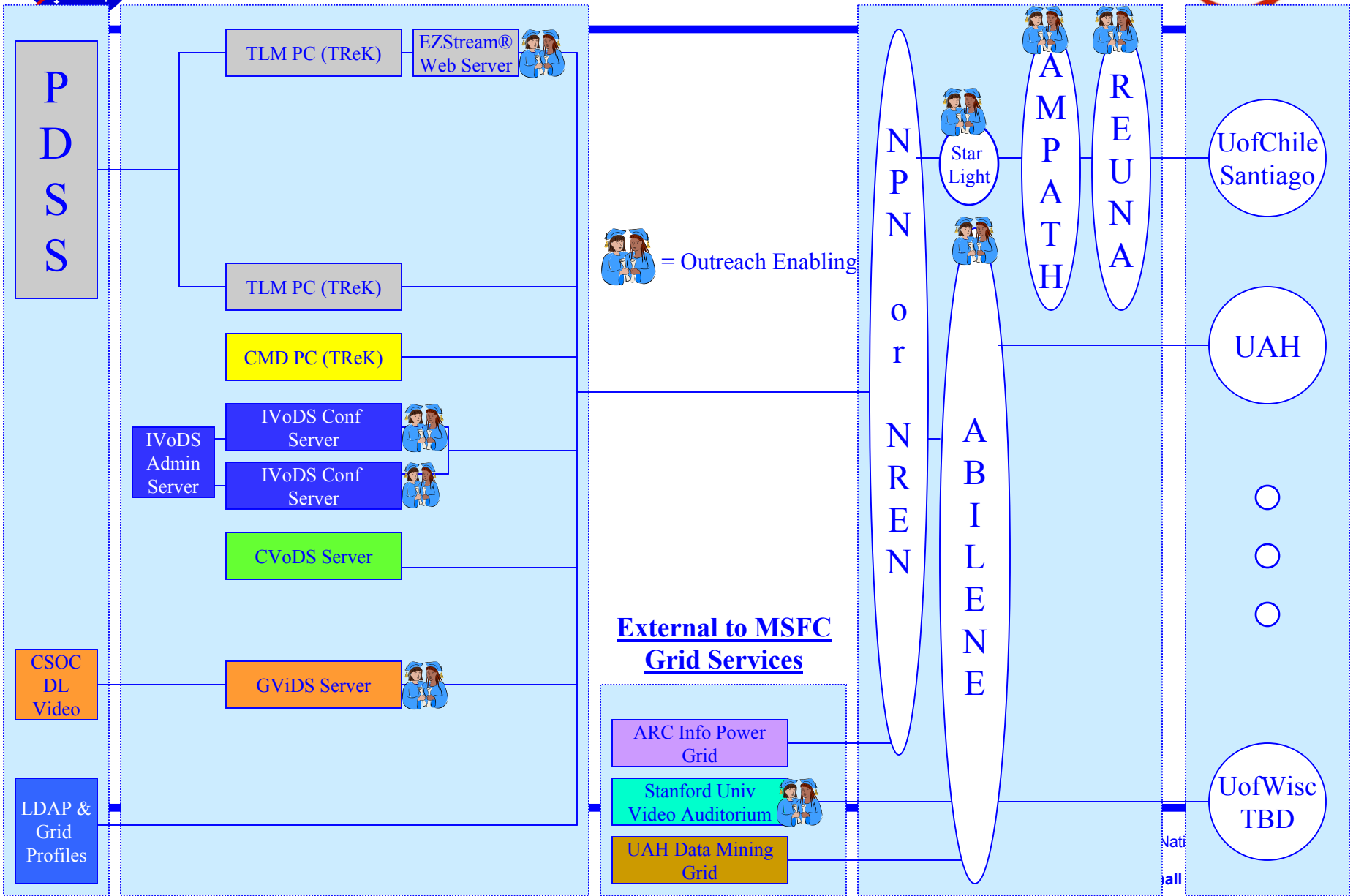
- NASA Research and Education Network (NREN) or NASA Prototype Network (NPN)
- Internet2/Abilene
- Star Light
- America's Pathway (AMPath)
- REUNA (Spanish acronym for Chilean Research & Education Network)

Draft Space-based Science Operations Grid - Phase 1 Prototype



Grid Services in MSFC B4207 Annex

Network Services

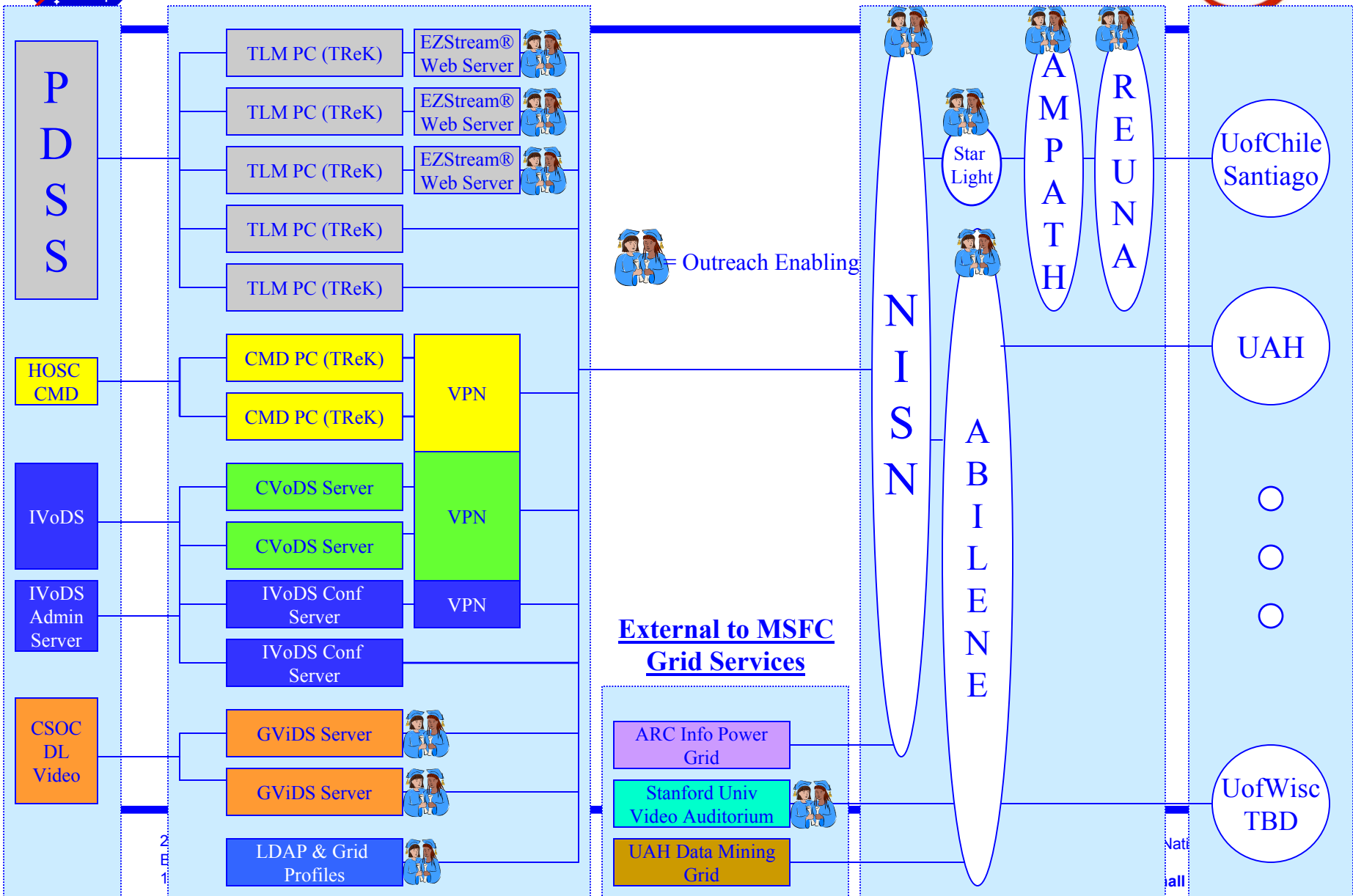


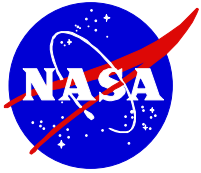
Draft Space-based Science Operations Grid - Phase 2



Grid Services in MSFC B4207 Annex

Network Services





Annotated Bibliography



- Ian Foster, Carl Kesselman, Steven Tuecke, “The Anatomy of the Grid.” <http://www.globus.org/research/papers/anatomy.pdf> (Somewhat Academic, but the definitive guide)
- Cade Metz, “Power Grids.” http://www.pcmag.com/print_article/0,3048,a=30701,00.asp (Consumers Guide to Grid Computing).
- Ian Foster, “The Grid: A New Infrastructure for 21st Century Science,” Physics Today, February 2002. <http://www.aip.org/pt/vol-55/iss-2/p42.html>
- Mark Baker, “Web Services and the Eight Fallacies,” <http://www.oreillynet.com/lpt/wlg/1681> (Fallacies of Distributed Computing)
- Venu Vasudevan, “A Web Services Primer,” XML.COM <http://www.xml.com/pub/a/ws/2001/04/04/webservices/index.html>