Networking: View from NASA

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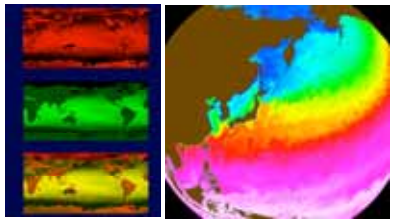
NASA High End Networking

Motivation

- NASA has fallen significantly behind the state of the art in advanced networks as indicated in figure 1
- With the introduction of NASA's newest supercomputer the lack of bandwidth is a significant barrier to collaboration and data sharing-2TByte per day data set cannot be effectively transferred between research teams
- Ames in conjunction with JPL and GSFC has completed a study on options for solving the problem
- Eventually the agency must solve this for all the centers and a preliminary analysis has been completed for the agency

ECCO Ocean Modeling



Run Requirements: (Ames – JPL)

–Nov 2003 = 340 GBytes / day

–Feb 2004 = 2000 GBytes /day

Conclusion

- Not enough bandwidth for distributed data intensive applications
- Opportunities exists to work with emerging NLR high bandwidth systems but Agency Infrastructure will not support this

Approach

- Ames High End Computers have been upgraded to 10Gbps capability
- Consortium formed and negotiations underway to extend Dark Fiber to Ames Site from local POP
- CENIC/National Lambda Rail NLR membership investigated-budget and plan developed. Anticipate 50-100x B/W improvement
- Design and Estimates for Router and Switch upgrades completed.

Research Network Capacity

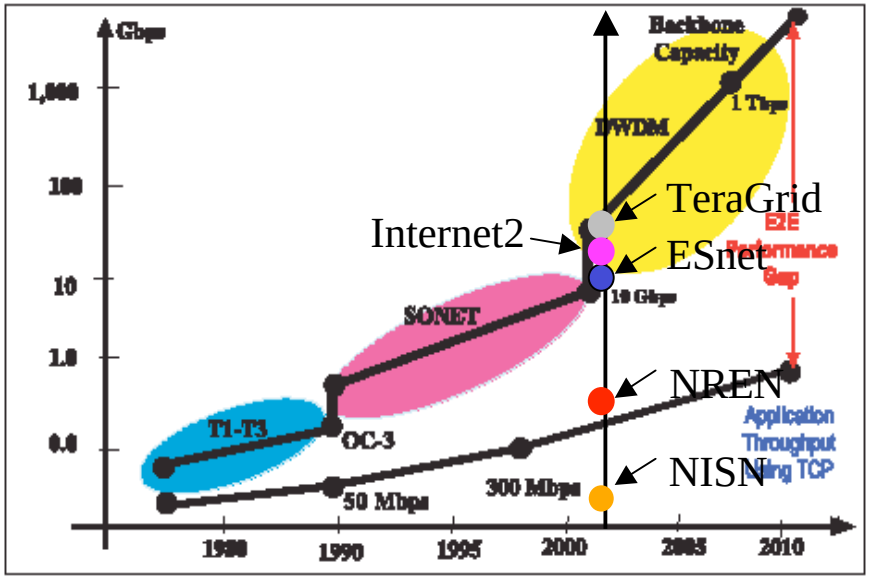


Figure 1

DoE Network Challenge, 2000

- Data Mission
- Data Service
- Data Grid

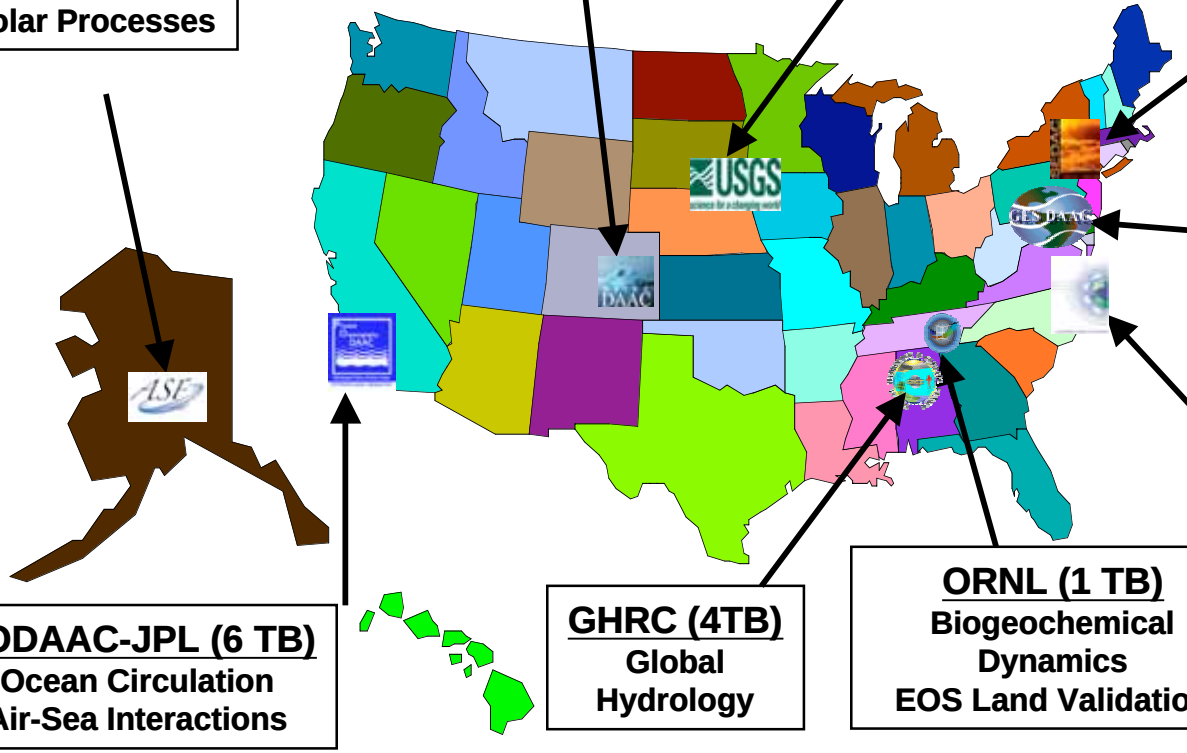
Earth System Enterprise-Data Lives in Distributed Active Archive Centers (DAAC)

NSIDC (67 TB)
Cryosphere
Polar Processes

LPDAAC-EDC (1143 TB)
Land Processes
& Features

ASF (256 TB)
SAR Products
Sea Ice
Polar Processes

SEDAC (0.1 TB)
Human Interactions in
Global Change



GES DAAC-GSFC (1334 TB)
Upper Atmosphere
Atmospheric Dynamics, Ocean Color, Global Biosphere, Hydrology, Radiance Data

ASDC-LaRC (340 TB)
Radiation Budget,Clouds
Aerosols, Tropospheric
Chemistry

ORNL (1 TB)
Biogeochemical
Dynamics
EOS Land Validation

GHRC (4TB)
Global
Hydrology

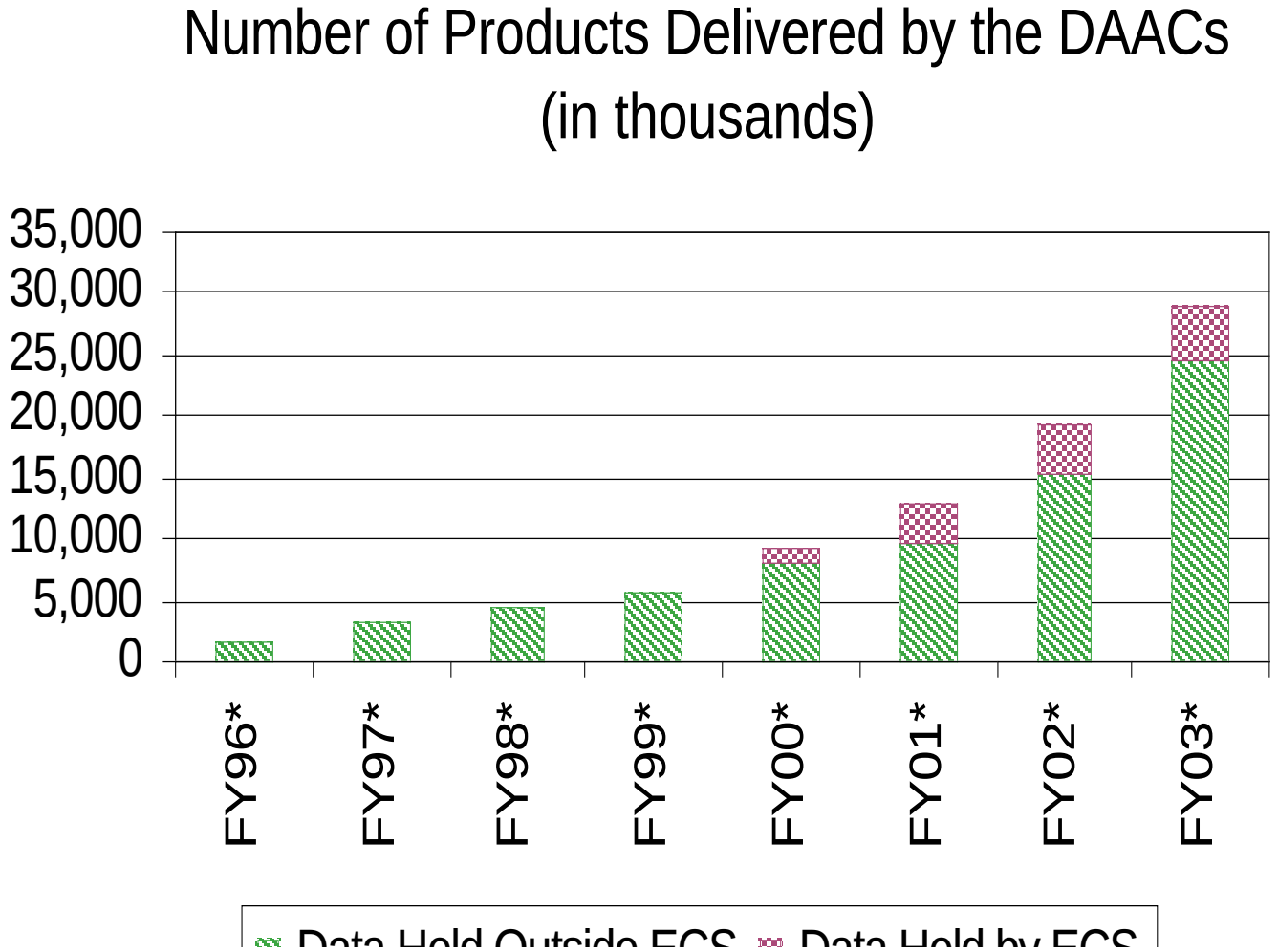
PODAAC-JPL (6 TB)
Ocean Circulation
Air-Sea Interactions

PI processing

Complexity
Heterogeneity

EOS Aura Satellite Will Be Launched Soon
Challenge is How to Evolve to New Technologies

Data Product Downloads from DAACs is Rapidly Increasing



ECS=EOSDIS Core System

Link to Operational Applications Community

In 1979: > 10 years

- Old way of doing business
  - Research Instrument → Demonstrate Impact → Develop operational instrument→ Operational Data System Infrastructure → Reproduce Impact in Operational/Applications Environment
- New way of doing business
  - Research Instrument → Research Demonstrates Impact (Anticipated and Unanticipated) → Move directly to Operational/Applications Environment

GOAL: < 2 years

- High End Computing (HEC)
- Common Center Architectures
- Link High End Computing Centers to the Data Mission

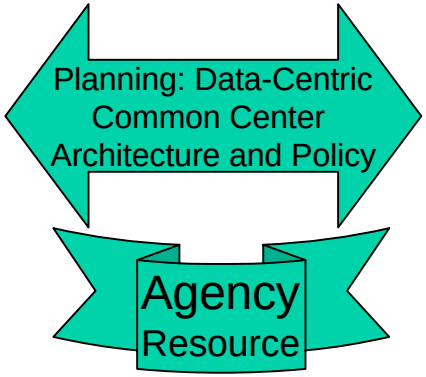
- Engineering, Science, and Exploration Mission

NASA's High-End Computing Resources

Goddard

1392 PE Compaq (2.2 TF)
640 PE SGI O3K (410 GF)
SUN QFS – 340 TB
SGI DMF 370 TB

Earth Science
Space Science



Ames

512 PE SGI Altix (2.3 TF)
1024 PE SGI O3K (850 GF)
SGI DMF 600 TB

Aerospace Eng
Earth Science

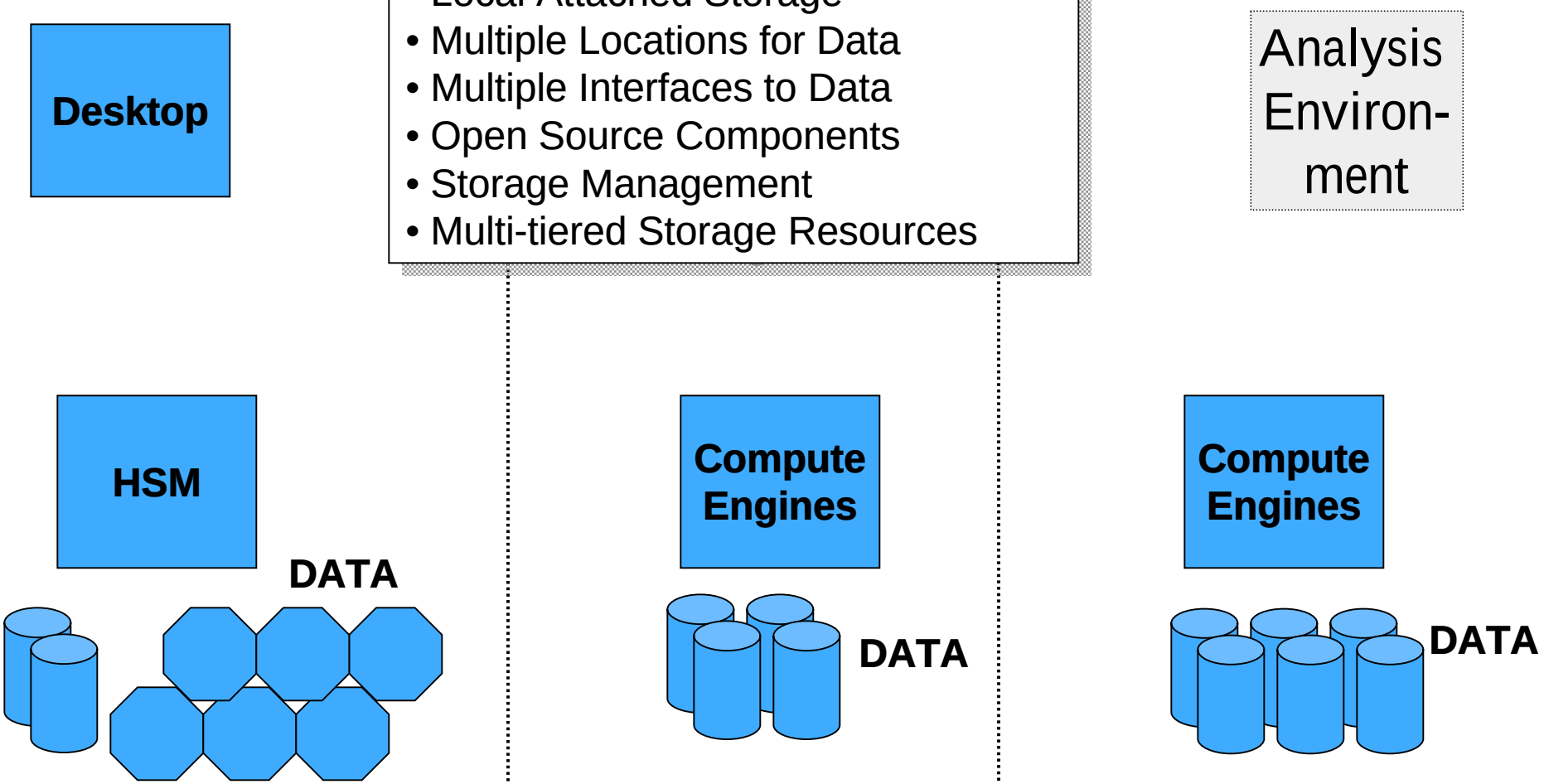
- Current Utilization:
  - Demand > 2 X Capacity: Stated Requirements > 4 X Capacity
  - Important Projects Delayed / Underserved
- Data Management and Transfer:
  - Move 300 TB archive from Ames to Goddard
  - Less than 10% supported network.

Goddard-Ames Collaboration Strongest Ever

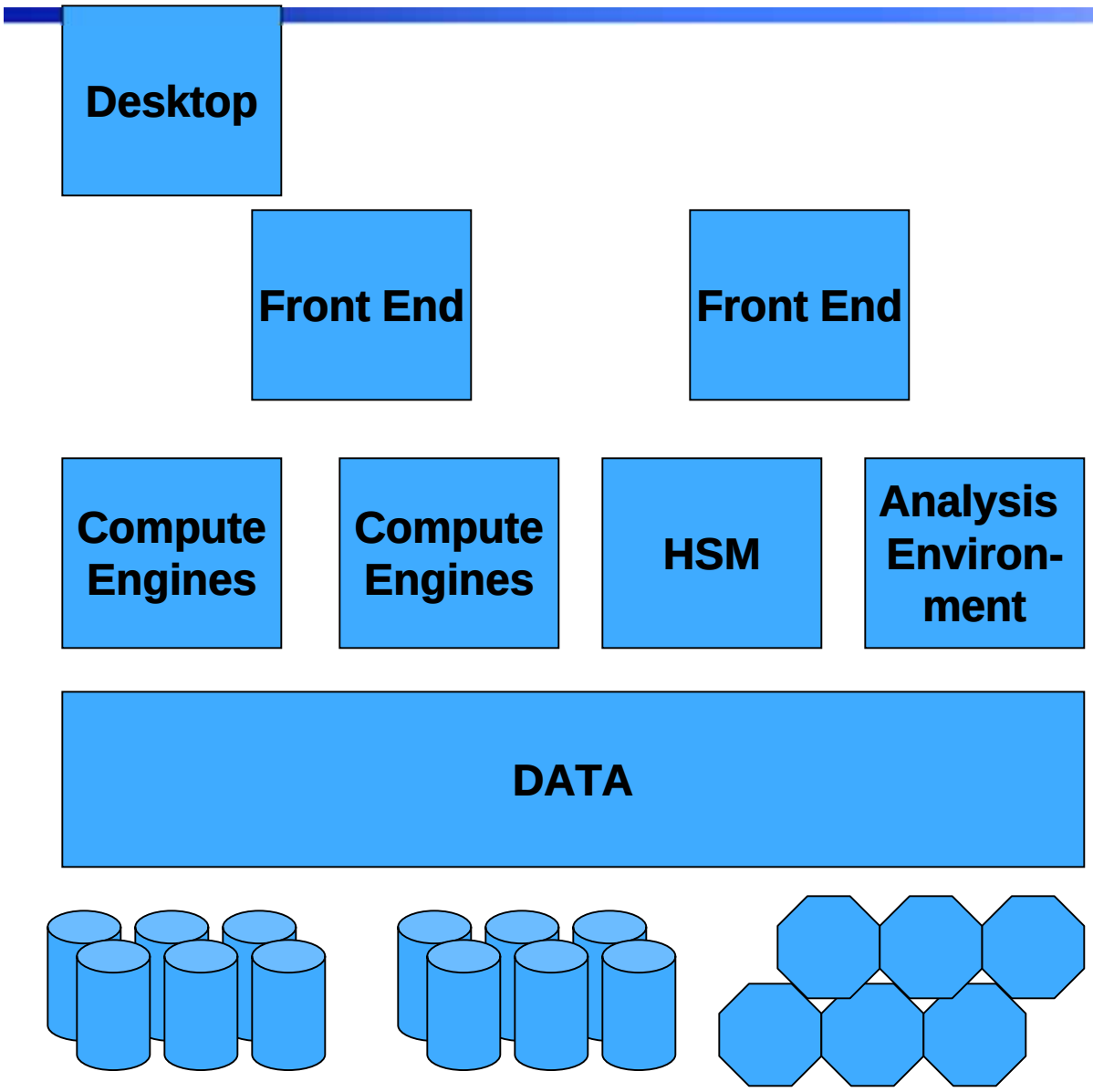
Current Goddard HEC Environment

- Vendor Specific
- Local Attached Storage
- Multiple Locations for Data
- Multiple Interfaces to Data
- Open Source Components
- Storage Management
- Multi-tiered Storage Resources

Analysis Environ-ment

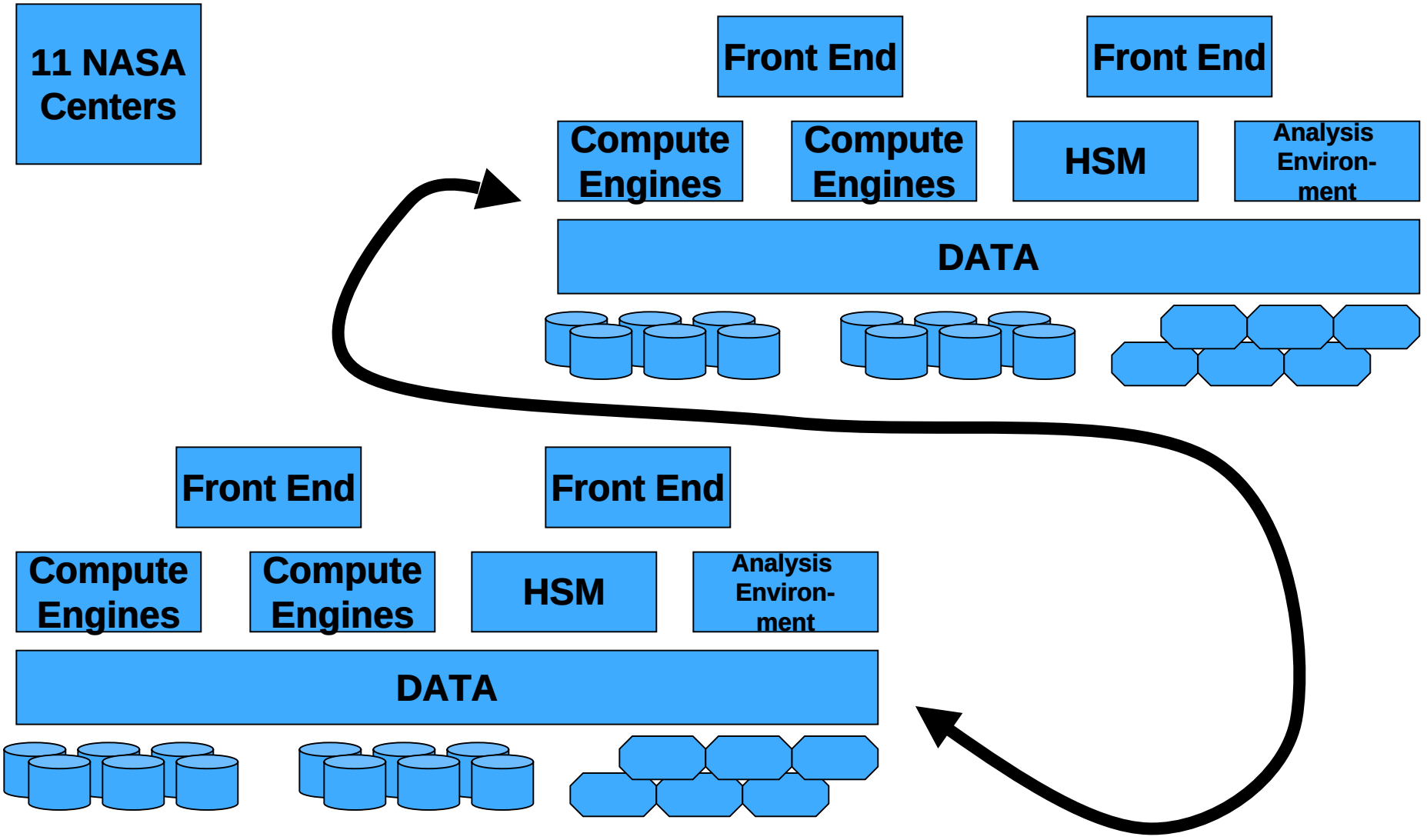


Goddard Architectural Vision



- Vendor Independent
- Interoperable
- Adaptable
- More Flexible
- Easy to Use and Access
- Open Source
- Standardized
- Common Front Ends
- Common Batch Queuing
- Load Balancing
- Common Interface to Data
- Storage Management
- Storage Area Network
- Multi-tiered Compute Engines
- Multi-tiered Storage Resources

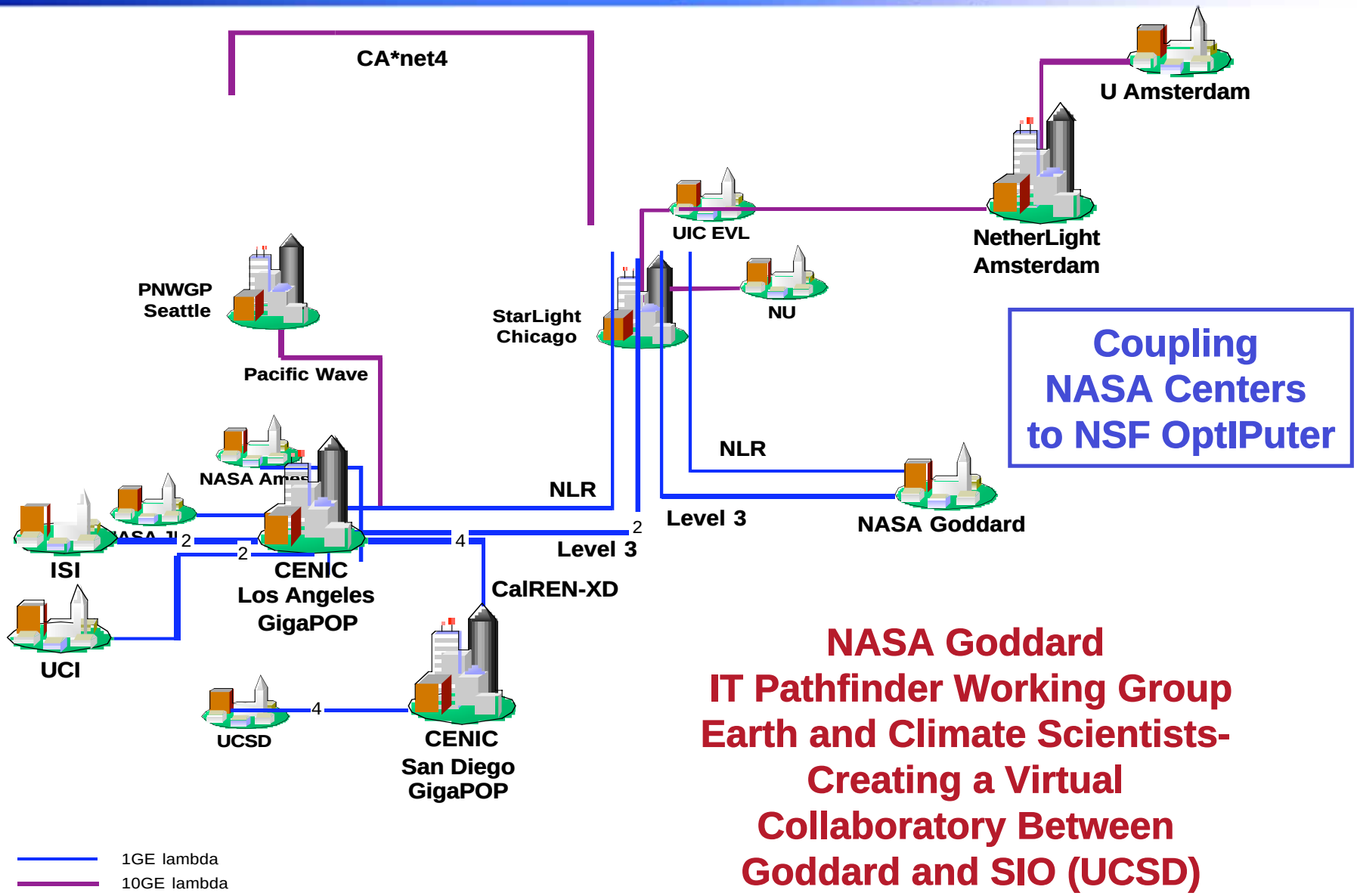
Common Center Architecture
Agency Mission



First Step on Networking

- Desire to link the NASA Centers
- Within Agency: Ames, Goddard, and JPL – the IT and Science Centers
- Prototype, Proof of Concept: Goddard and Scripps

Solution: Move to Internet Protocol Over Dedicated Optical Lightpaths



NASA Goddard
IT Pathfinder Working Group
Earth and Climate Scientists-
Creating a Virtual
Collaboratory Between
Goddard and SIO (UCSD)

Goddard-Scripps Project

- GSFC overall interest: Using new IT (e.g. optical networks, SAN's, compute/data grid software to improve collaborative research among Earth scientists)
- GSFC FY04 IRAD proposal recently approved for funding by GSFC's Director
- Current Issues and How Level(3) can help
  - Transcontinental Backbone Network
  - Regional Access Network for GSFC

GSFC FY04 IRAD Proposal "Preparing Goddard for Large Scale Team Science in the 21st Century: Enabling an All Optical Goddard Network Cyberinfrastructure"

Objectives Summary

- "…establish a "Lambda Network" (in this case using optical wavelength technology and 10 Gbps Ethernet per wavelength) from GSFC's Earth science Greenbelt facility in MD to the Scripps Institute of Oceanography (SIO) through the University of California, San Diego (UCSD) facility over the National Lambda Rail (NLR), a new national dark optical fiber infrastructure."
- "…make data residing on Goddard's high speed computer disks available to SIO with access speeds as if the data were on their own desktop servers or PC's."
- "…enable scientists at both institutions to share and use compute intensive community models, complex data base mining and multi-dimensional streaming visualization over this highly distributed, virtual working environment."

GSFC FY04 IRAD Proposal "Preparing Goddard for Large Scale Team Science in the 21st Century: Enabling an All Optical Goddard Network Cyberinfrastructure"

Examples of Initial Primary Users/Applications (1 of 2)

- Drs. Paul Houser and Mike Bosilovich of Code 970 are collaborating with Dr. John Roads of SIO on the Coordinated Earth Observing Program under GEWEX
- Dr. Roads with Dr. Max Suarez of Code 900.3, Mike Seablom of Code 560, and a UMBC graduate student working with Dr. Milton Halem, GSFC Emeritus, plan to run interactive distributed regional model forecasts using boundary forcing conditions from the Global Modeling and Assimilation Office (GMAO) global climate model
- Dr. Yoram Kaufman of Code 910 is collaborating with Dr. Ramanathan of SIO on an Aerosol project
- Dr. J. Herman of Code 910 is the Co–I with Dr. Francisco Valero of SIO who is the PI on the Triana mission

Examples of Initial Primary Users/Applications (2 of 2)

- Dr. Michelle Rienecker of Code 900.3 is collaborating with Dr. Tim Barnett of SIO on the assimilation of global sea height data from TOPEX and GRACE
- SIO's Prof. Richard Sommerville has one of his modelers remotely providing computational science support to the NCCS of Code 930
- Code 920 has collocated one of its geophysical scientists at SIO
- UCSD's Geosciences Network PI Dr. Dogan Seber has identified some of GSFC's solid earth research data sets and models for developing collaborative research efforts with Dr. Weijia Kuang and others from Code 920

GSFC FY04 IRAD Proposal "Preparing Goddard for Large Scale Team Science in the 21st Century: Enabling an All Optical Goddard Network Cyberinfrastructure"

Technical Approach

- Transcontinental, Regional, and Local Networking
  - Become a member of the NLR in partnership with the NREN Project, or directly through a Mid-Atlantic Terascale Partnership membership arrangement
  - Provision a lambda between GSFC and UCSD/SIO
  - Deploy Optical Add Drop Muxs at GSFC
  - Interconnect GSFC's *Thunderhead* cluster in building 28 to UCSD/SIO's OptIPuter network via this Lambda Network first at 1GigE, then 10GigE
- Application Development
  - Integrate Earth System Modeling Framework software with GRID middleware by constructing prototype interfaces between the components
  - Identify requirements for new methods and/or messages that would be desirable for supporting GSFC models and data assimilation

Additional Benefits of Having a Special Level(3) Lambda (vs Abilene or NLR)

- Starting Before September
  - Early end-to-end proof-of-concept tests affect direction of EOSDIS Evolution Tiger Team
  - Usage demos affect positive support for GSFC FY05 budget requests
- Continuing After September
  - Enables performance comparisons with Abilene and NLR transcontinental network approaches
  - Permits part of GSFC's FY04 funding for NLR membership and dedicated lambda implementation to be deferred and reallocated to implementing remaining network infrastructure, I.E. GSFC regional access and campus networks
- Important Issues:
  - Extending Networks into NASA Centers
  - Maintaining Carrier Independent Policy