NORTHROP GRUMMAN

Cross-Organization Coupling of Climate Models through ESMF

(A Prototype Over High-Speed Networks)

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- **Cluster system admin: K. Fisher (NASA GSFC)**
- **XCAT/Proteus: M. Govindaraju, K. Chiu, M. Head (SUNY, Binghampton)**
- **Models: J. Spahr, C. Mechoso (UCLA), C. Hill (MIT), P. Jones (LANL)**

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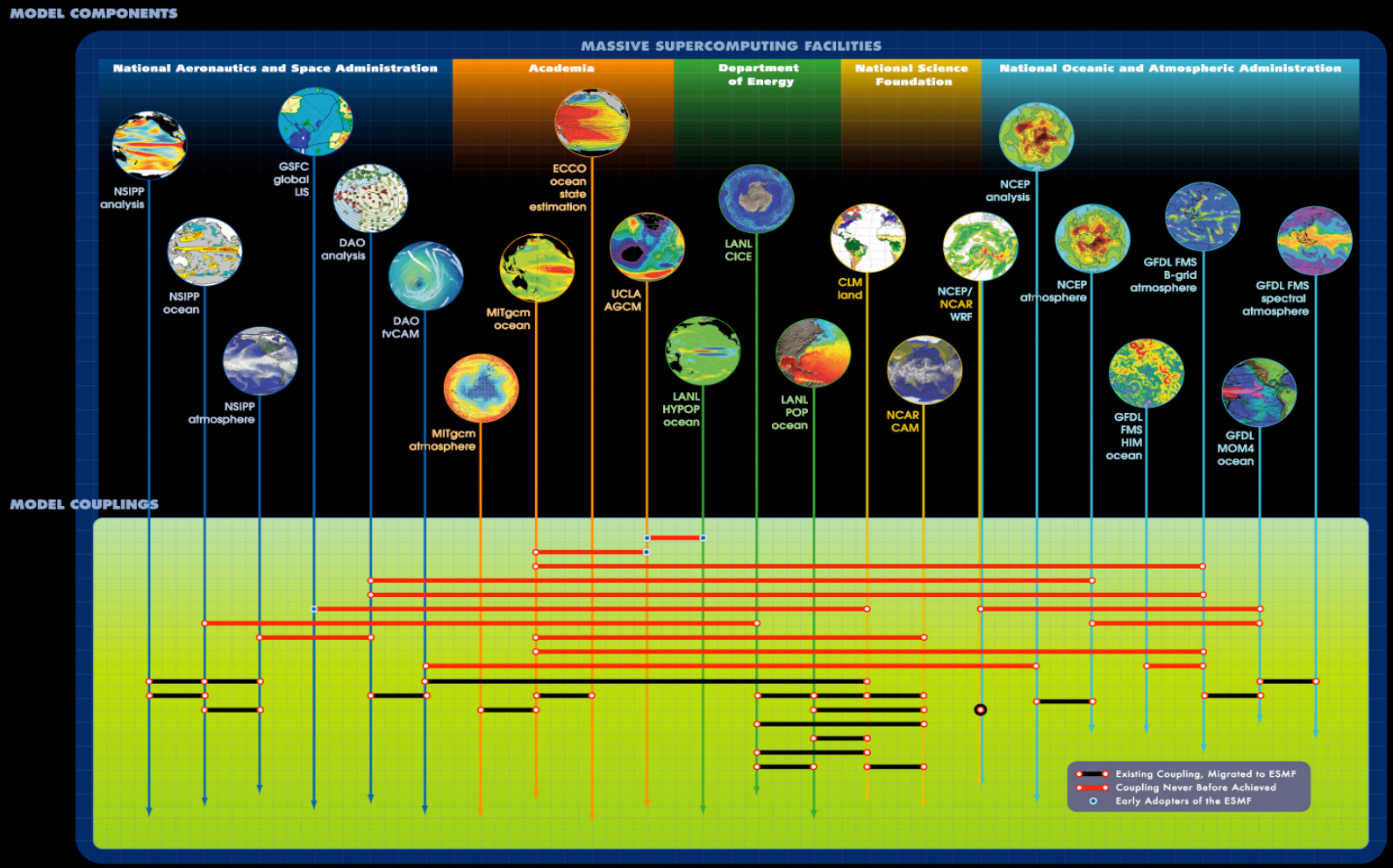
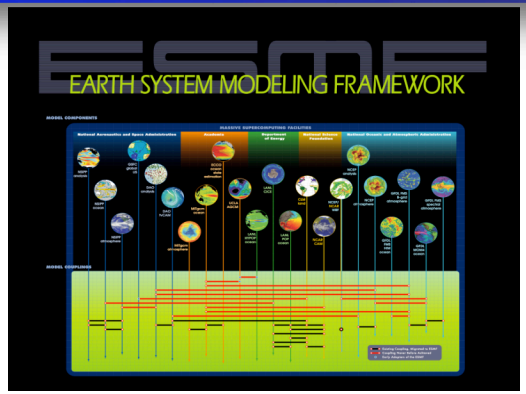
ESMF

EARTH SYSTEM MODELING FRAMEWORK



ESMF Enables Model Coupling

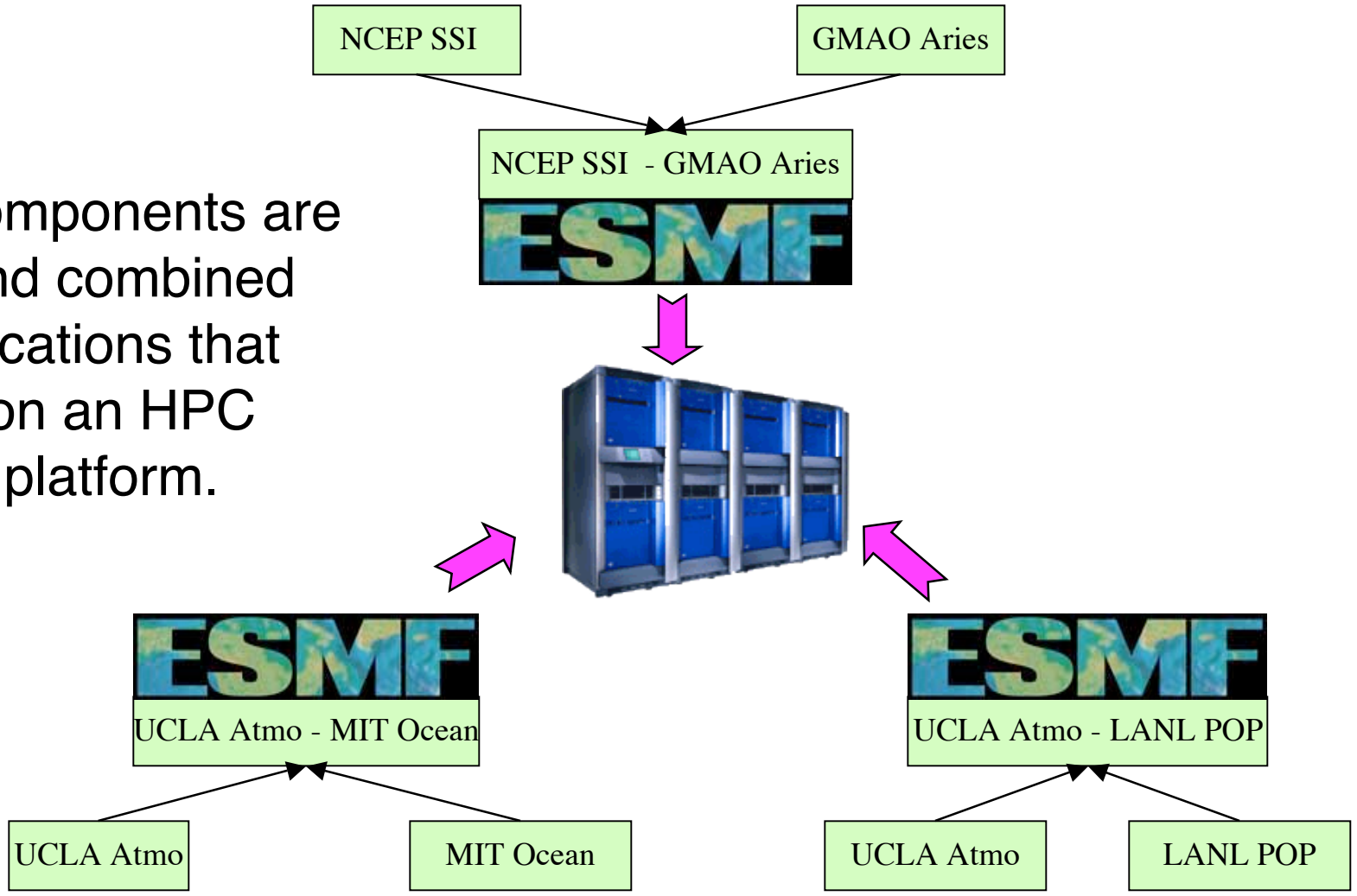


- ESMF defines:
  - An architecture for composing multi-component applications
  - Data structures and utilities for developing model components.
- Aims to create a framework usable by individual researchers as well as major operational and research centers

ESMF Enables Model Coupling

Applications Leave Their Institutions to Interact

ESMF components are ported and combined into applications that execute on an HPC compute platform.



ESMF Enables New Science

- ESMF is being used by researchers at:
  - National agencies like NASA, DOD, NSF/NCAR, and NOAA
  - Universities like MIT and UCLA
- ESMF provides a common standard that:
  - Simplifies creation of new scientific coupling experiments
  - Enhances opportunities for scientific collaboration

Examples of new ESMF interoperability experiments

NCEP SSI - GMAO Aries

UCLA Atmo - LANL POP

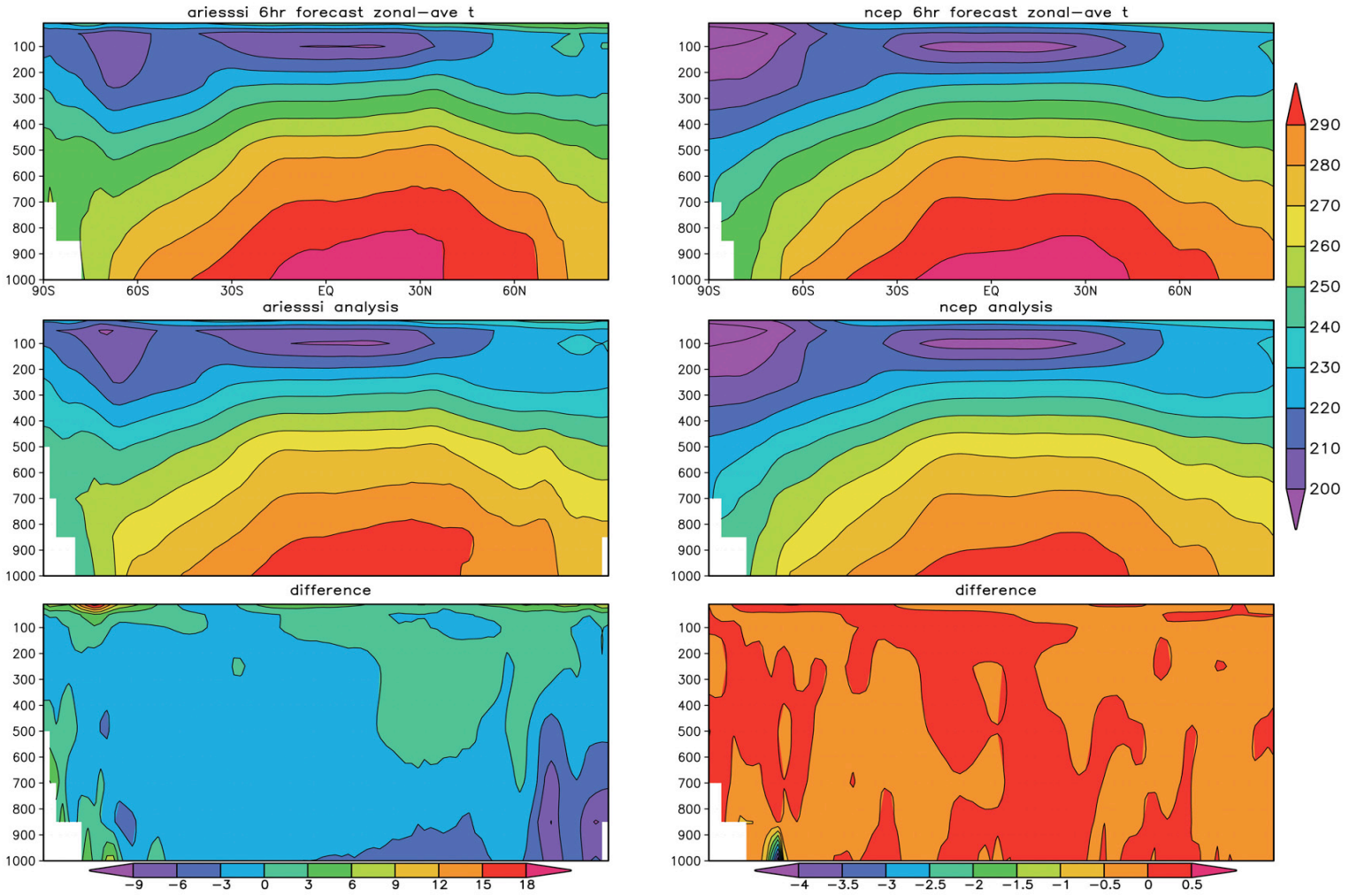
UCLA Atmo - MIT Ocean

NORTHROP GRUMMAN

ESMF Enables New Science

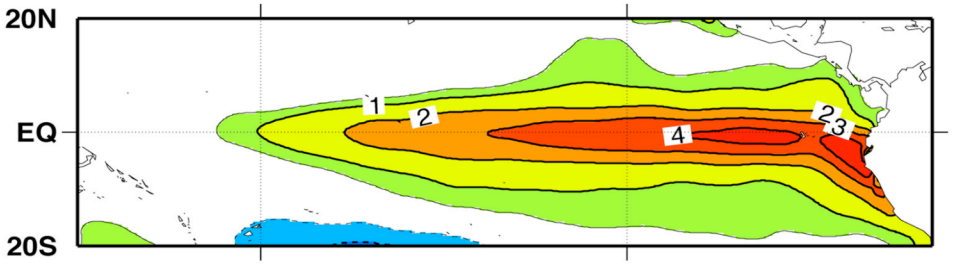
NCEP SSI - GMAO Aries

ESMF

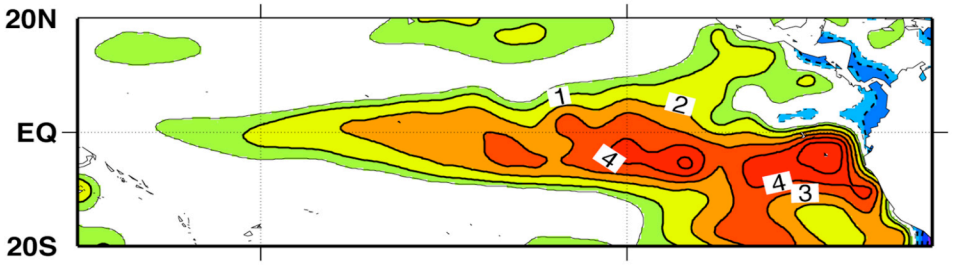


ESMF Enables New Science

Dec 1997-Feb 1998, SST anomaly, Reynolds Analysis



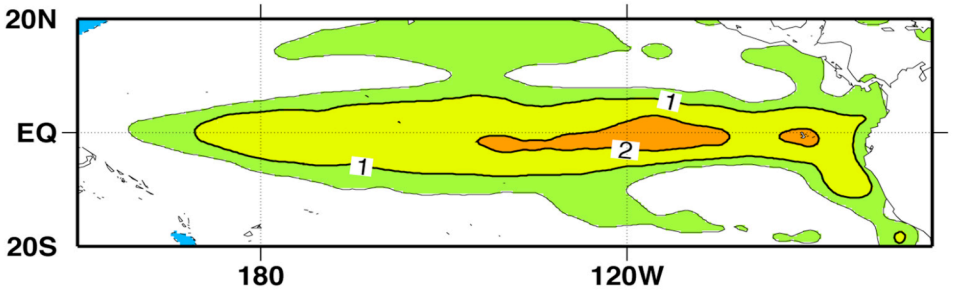
Dec 1997-Feb 1998, SST anomaly, forecast with MIT



UCLA Atmo - MIT Ocean

ESMF

Dec 1997-Feb 1998, SST anomaly, forecast with LANL POP



UCLA Atmo - LANL POP

ESMF

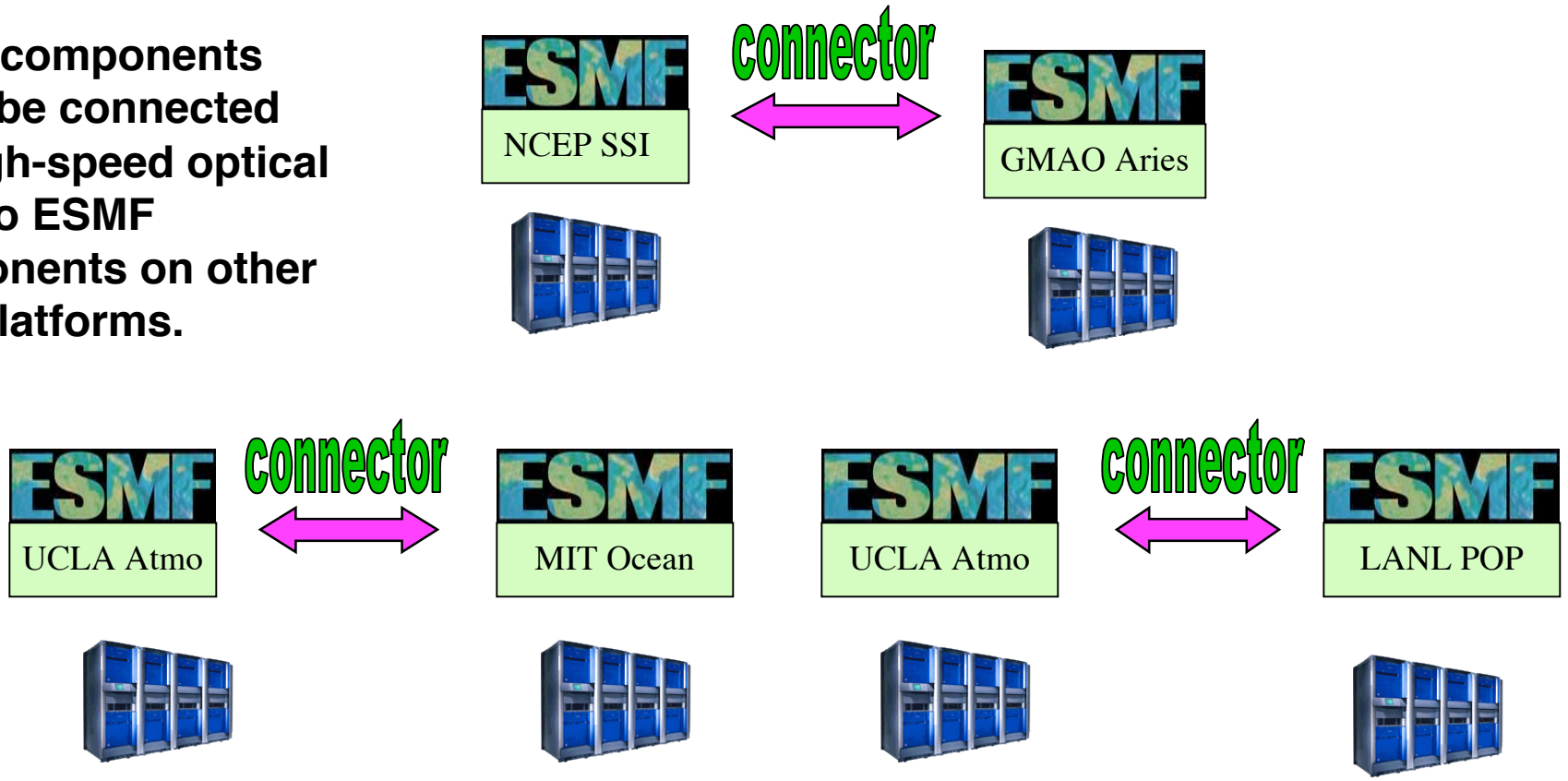
High Speed Networks Connect Centers

- The National LambdaRail and other optical networks are linking geographically distributed data and computing research centers.

Optical Networks Enable Distributed Experiments

Applications Stay at Their Institutions to Interact

ESMF components could be connected via high-speed optical links to ESMF components on other HPC platforms.



connector **will be based on distributed components using fast protocols**

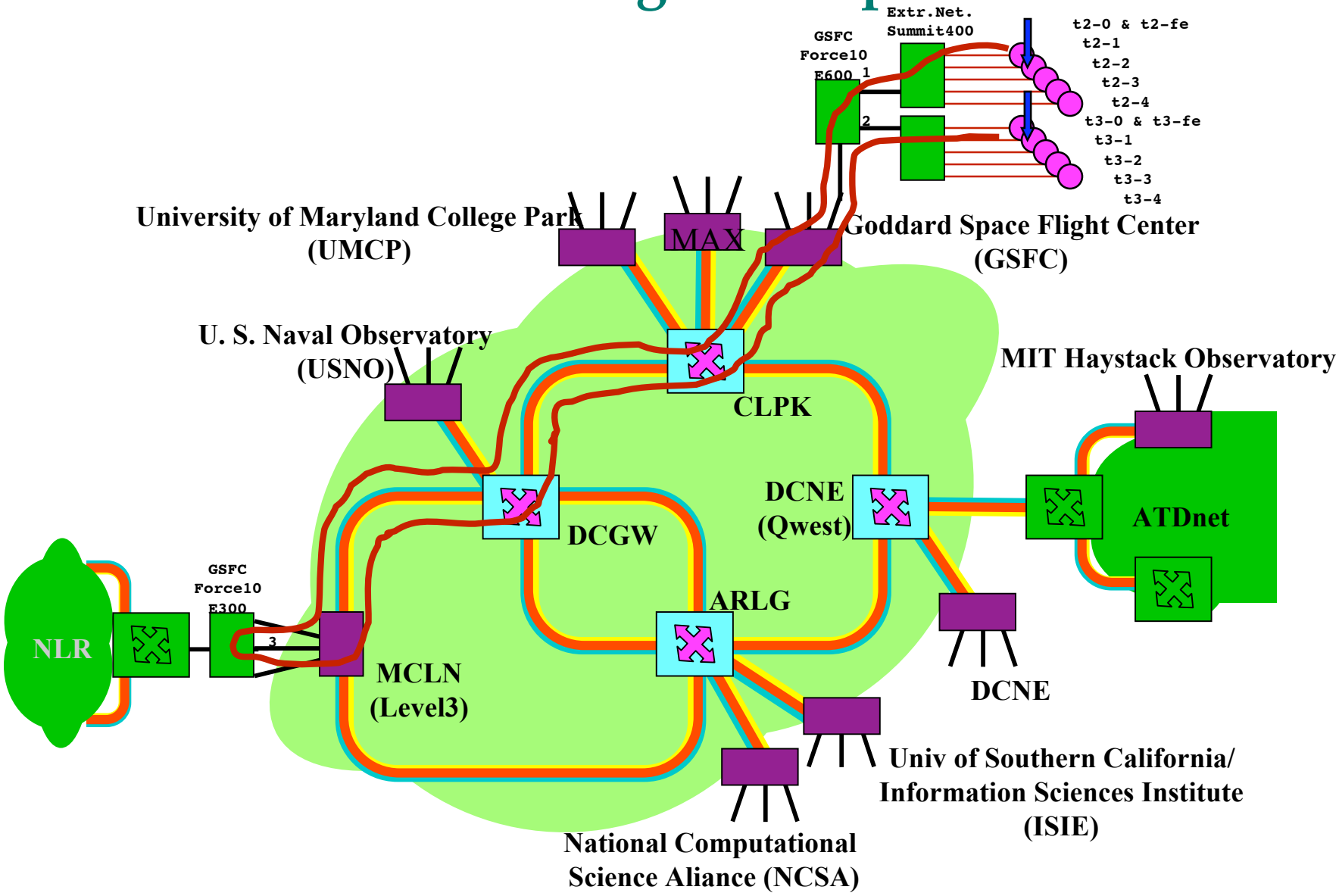
Northrop Grumman TASC High-Performance Network Research

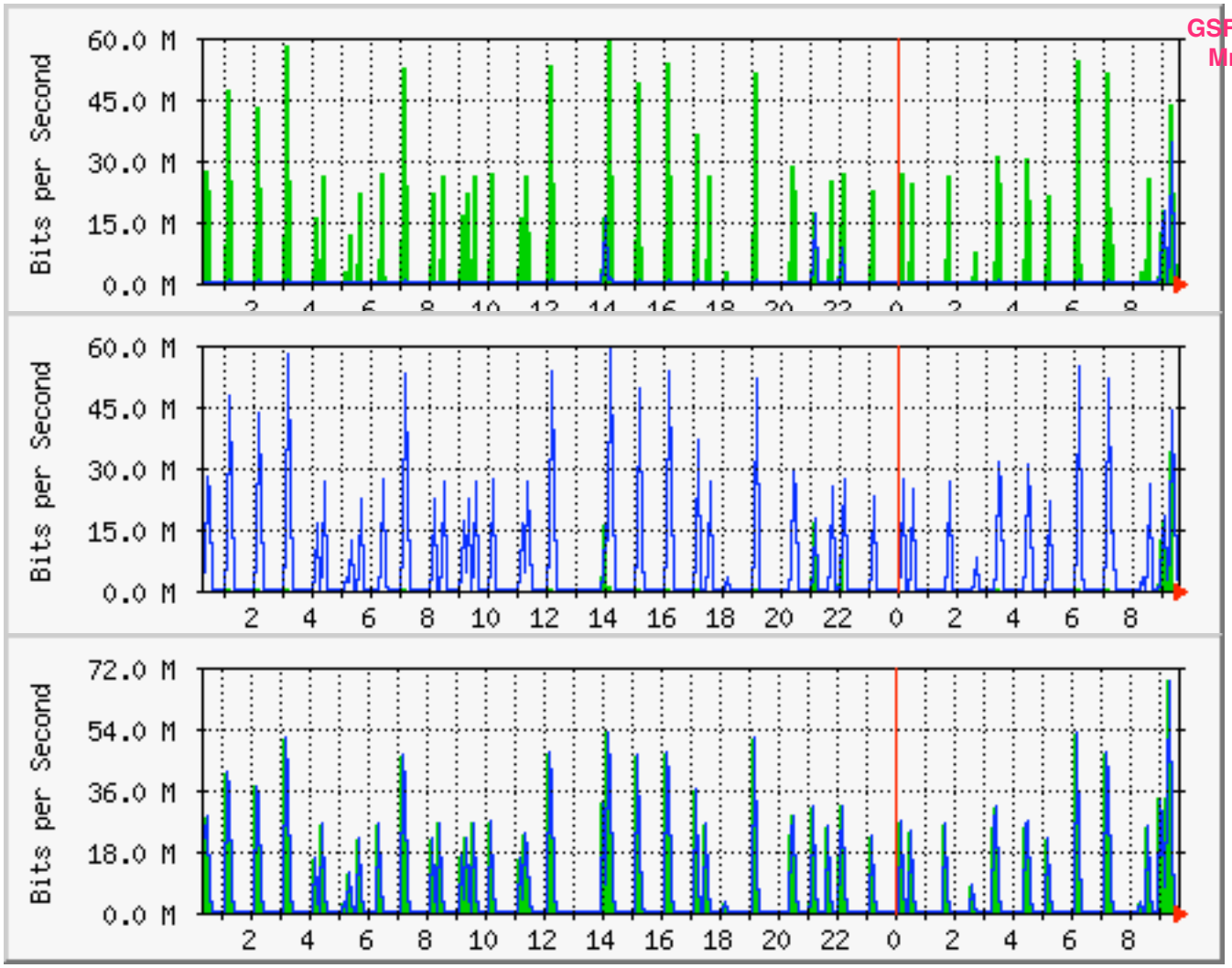
- Develop a framework for managing distributed data, applications, and users over a limited number of shared networks and computational resources
  - Transport of large data volumes over networks
  - Computationally intensive applications
  - Near real-time access to data products

A Prototype Over High-Speed Networks

- A high-speed network linking to National LambdaRail
- Multiple Linux clusters
- A connector software based on CCA-compliant and Grid-ready XCAT-C++/Proteus
  - Augment with fast communication protocols such as UDT
  - Support various data types, including 2D arrays

Thunder2-Thunder3 Looped Data Flows Across DRAGON Regional Optical Network





GSFC Scientific and Engineering Network (SEN)
Mrtg-based `Daily' Graph (5 Minute Average)
Bits per second In and Out
On Selected Interfaces

thunder2 10 GigE
7 November 2005

thunder3 10 GigE
7 November 2005

GSFC-McLean 10 GigE
"Lambda49" across DRAGON
7 November 2005

Max In:	68.5 Mb/s (0.7%)	Average In:	5527.8 kb/s (0.1%)	Current In:	472.0 b/s (0.0%)
Max Out:	68.3 Mb/s (0.7%)	Average Out:	5508.2 kb/s (0.1%)	Current Out:	624.0 b/s (0.0%)

Acknowledgements

- NASA's Earth-Sun System Technology Office/ Computational Technologies Project
- Northrop Grumman TASC IRAD