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Grid Technology and Information Management for Command and Control

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The Tenth International Command and Control Research and Technology Symposium

June 14, 2005 1:00pm, Room 4

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Outline

Introduction

Architecture

- Sharing Resources
- Scalability
- Globus Grid Services
- Interactive Model

Net-Centricity

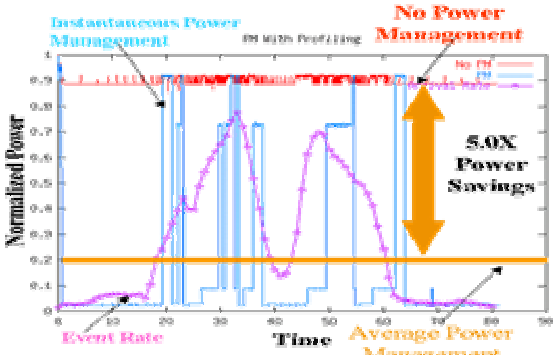
Security

Conclusion

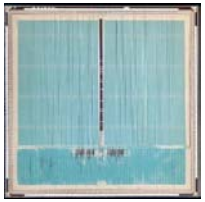
Emerging HW Architectures

DoD C2 SW requirements lag HW power

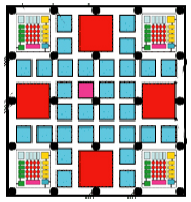
Adaptive/Reconfigurable Computing Systems (1991-2010)



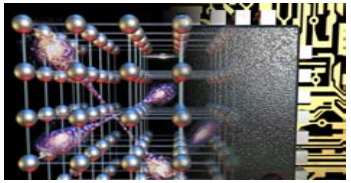
Power Aware Computing (1999-2006)



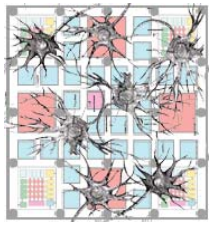
Data Intensive Computing (1998-2006)



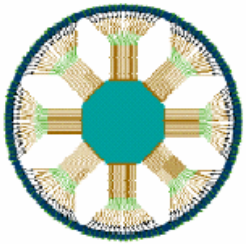
Polymorphous Computing Architectures (1999-2015)



High Productivity Computing Systems (2001-2012)



Cognitive Computing (2003-2023)



Peta-Scale Systems (2005-2018)

Hyperspectral Imaging Portfolio

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Objective: To develop a scalable, portable, high performance computing software framework with 8 algorithms for rapidly accessing and processing hyperspectral data.

Impact

- **Near Real-Time Access to Hyperspectral Imagery Data for Battlespace Awareness**
- **Imagery Products for Intelligence Analysts and Battlefield Decision Makers**

Approach

- **Leverage serial DoD hyperspectral imagery codes to rapidly process raw hyperspectral data to produce imagery products**
- **Client for JBI to provide rapid query, publish and subscribe with secure webserver application interface**

Status

- **8 Codes Tested and Integrated with Framework**
- **JBI Core Services Demonstrated**

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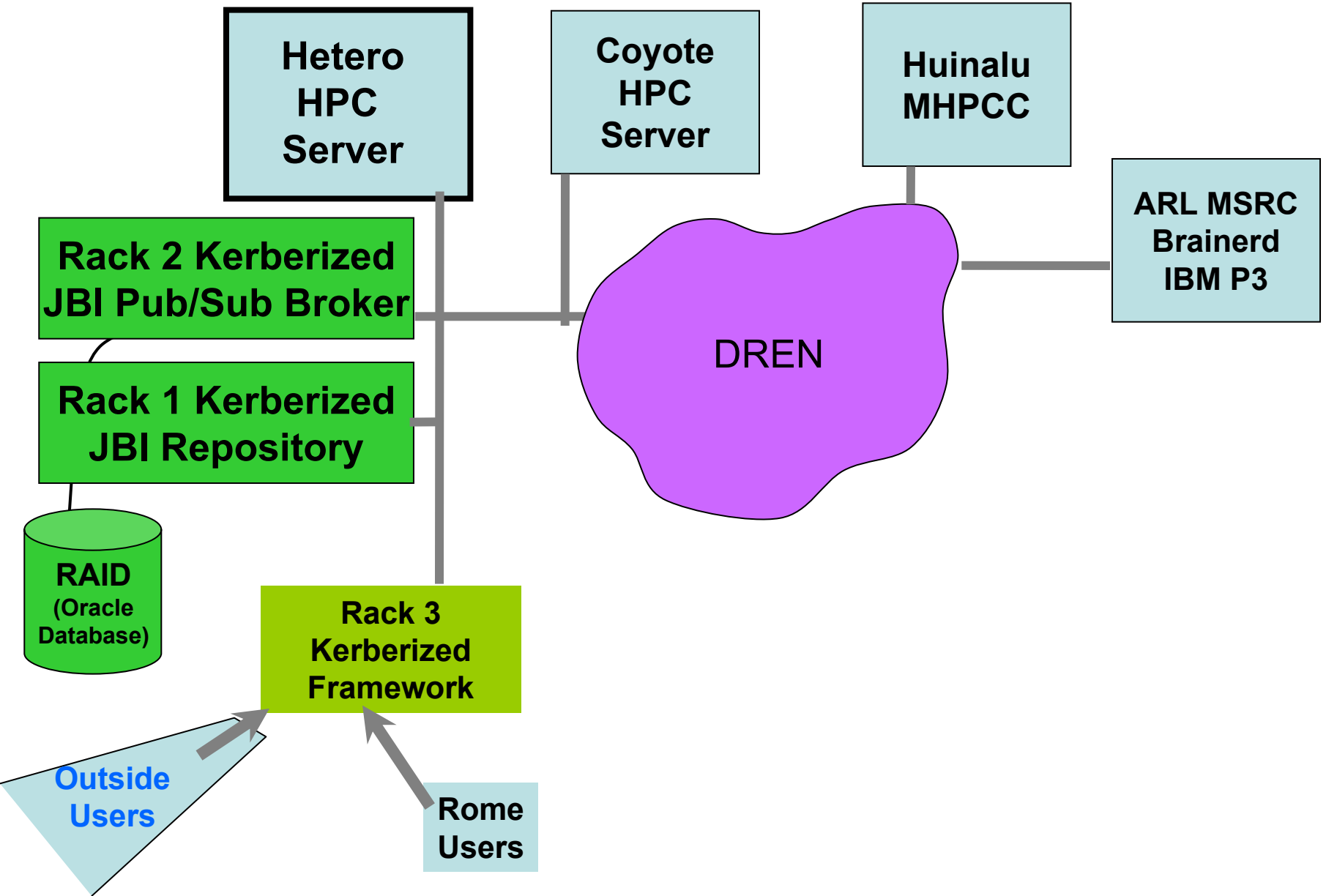
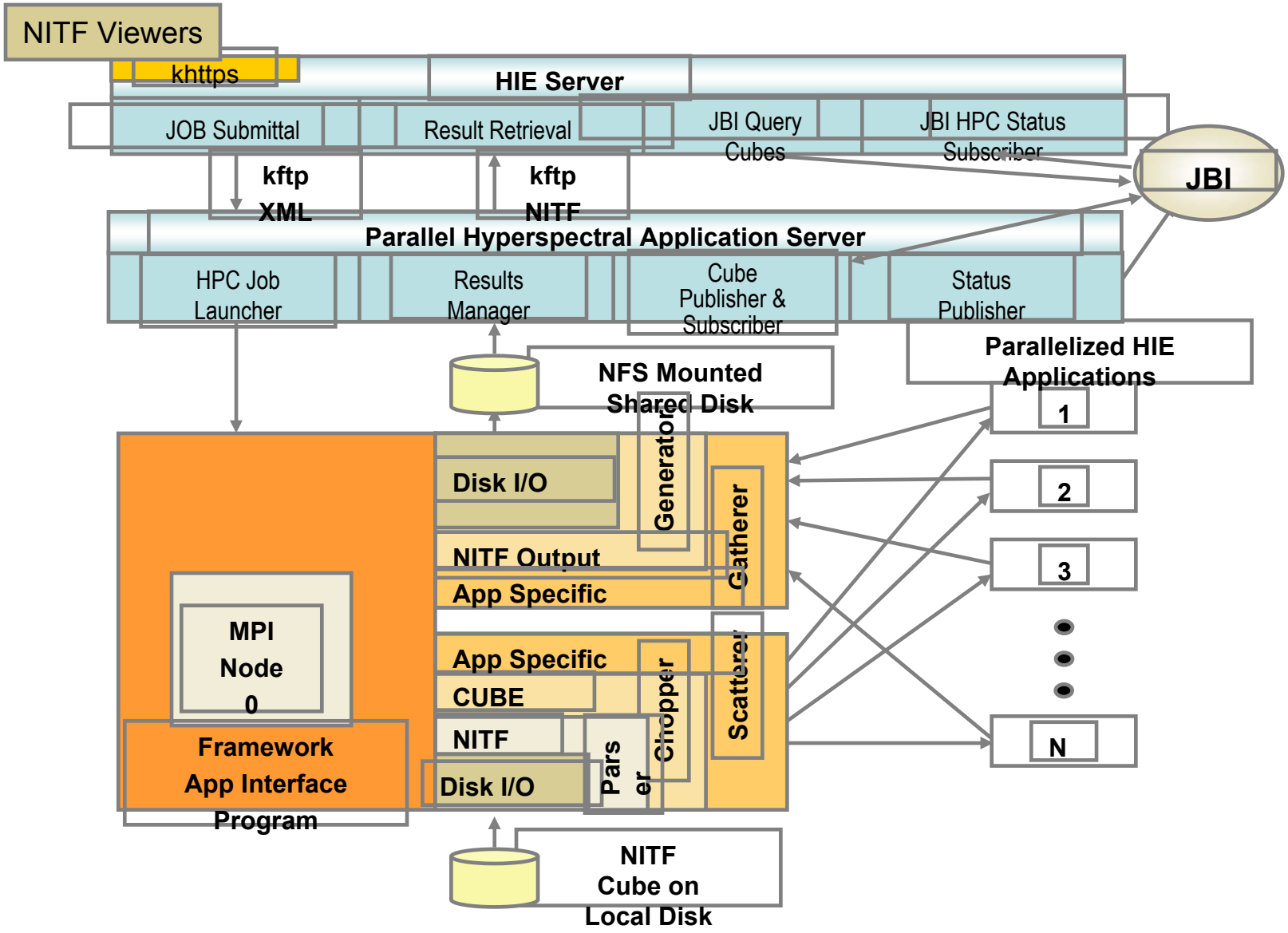
Hyperspectral Cubes

Cube Characteristics for Hyperspectral Image Exploitation						
	Sensor	Format	Size	Samples	Lines	Bands
Cuprite	Avaris	Bil	140MB	614	512	224
Jasper	Avaris	Bip	140MB	614	512	224
Virgin	Avaris	Bip	140MB	614	512	224
FortHill1	Nvis	Bip	181MB	256	6798	26
FortHill2	Nvis	Bip	172MB	256	6456	26
FortHill3	Nvis	Bip	138MB	256	5178	26
FortHill4	Nvis	Bip	165MB	256	6198	26
FortHill5	Nvis	Bip	128MB	256	4812	26
Terrain	Hydice	Bil	64MB	307	500	210
Urban	Hydice	Bil	40MB	307	307	210
Cube	Nvis	Bip	2GB	256	256	384

HIE Test Framework Grid

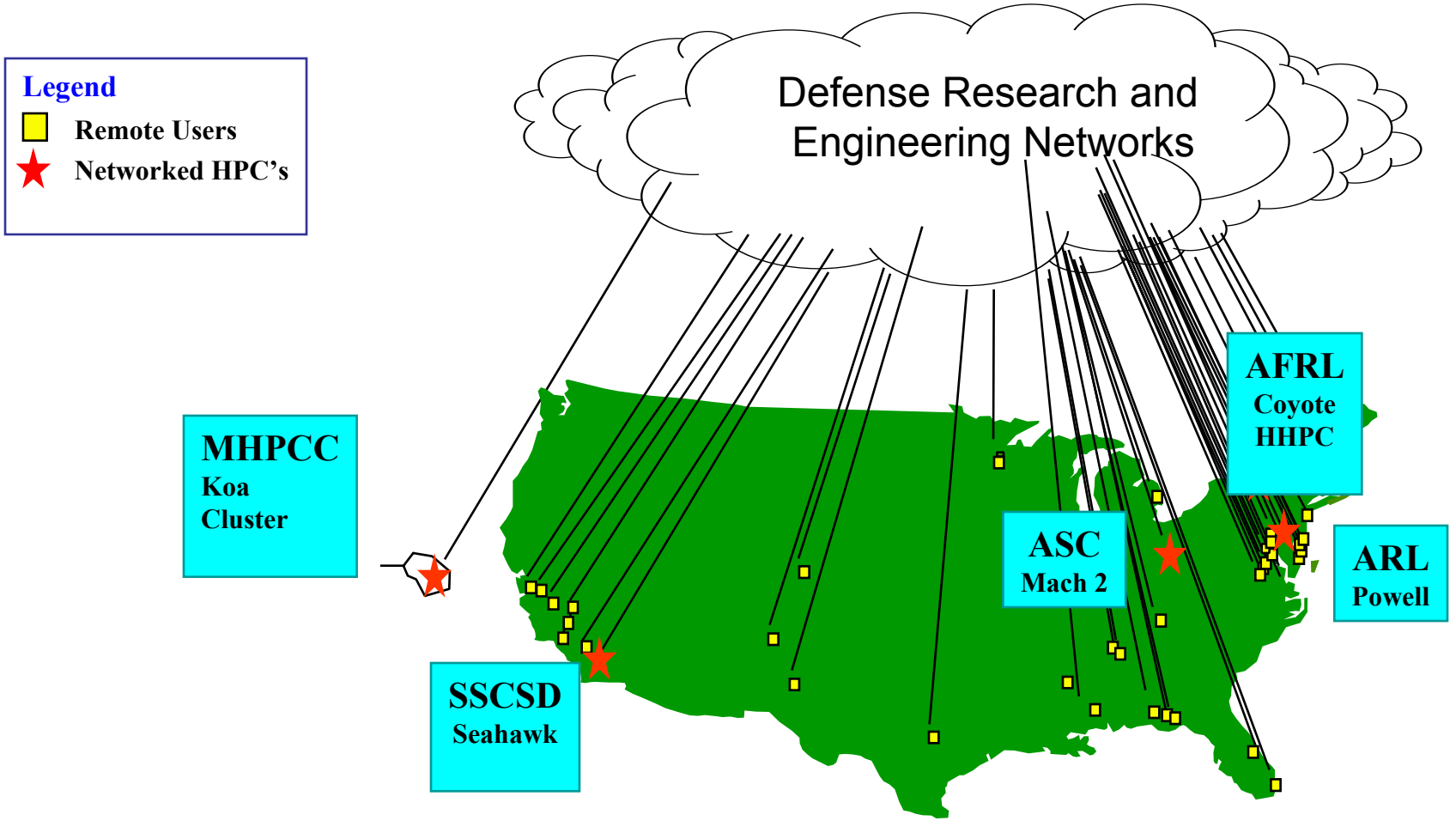


HPC/JBI/Server Interplay



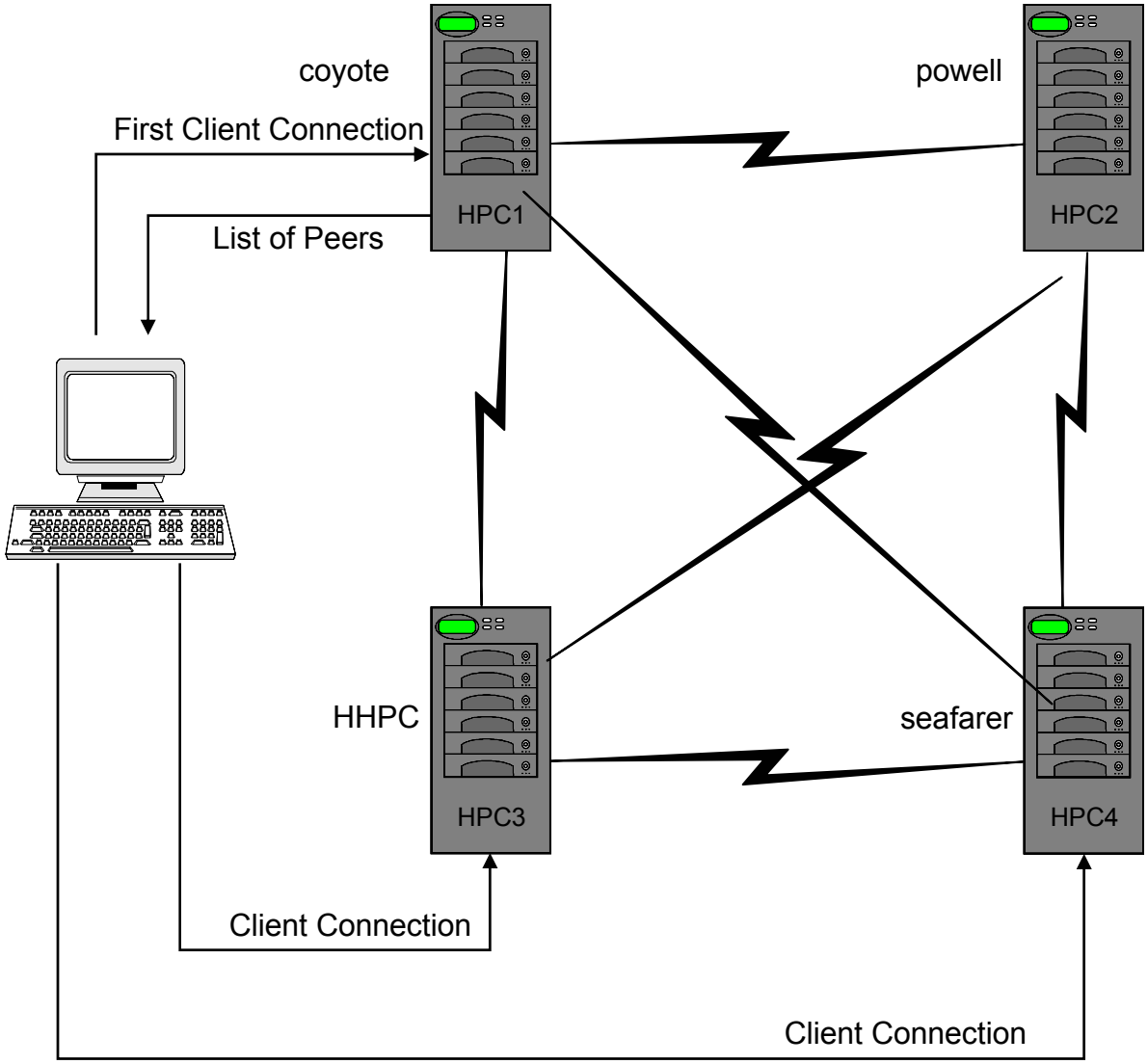
NSF TeraGrid

DPIM Testbed



- ✓Distributed HPC's
- ✓Accessed by authorized users anywhere on the DREN and Internet
- ✓Interactive and time critical problems

DPIM-DREN Interactive Network

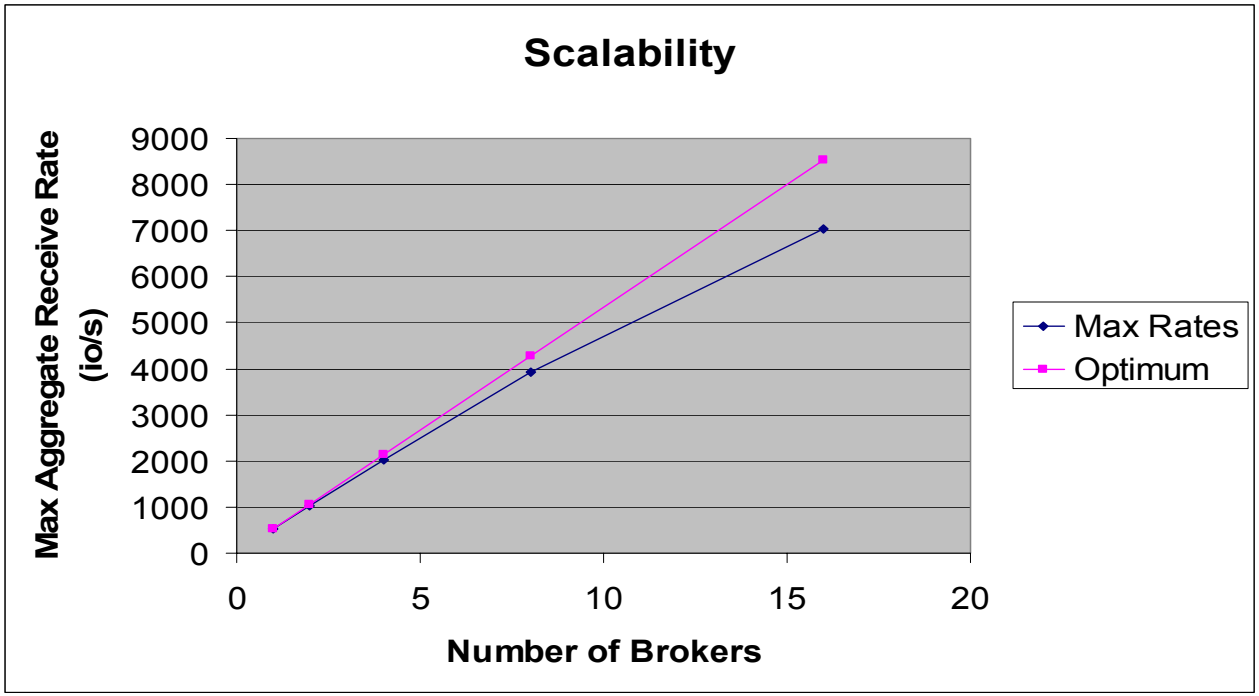


- HPCs are all interconnected
- Client gets list of HPCs from first connection
- Client maintains up to three connections
- Dynamic load balancing between HPCs based on I/O type and activity
- The client receives copies in triplicate of each publication

Joint Battlespace Infosphere

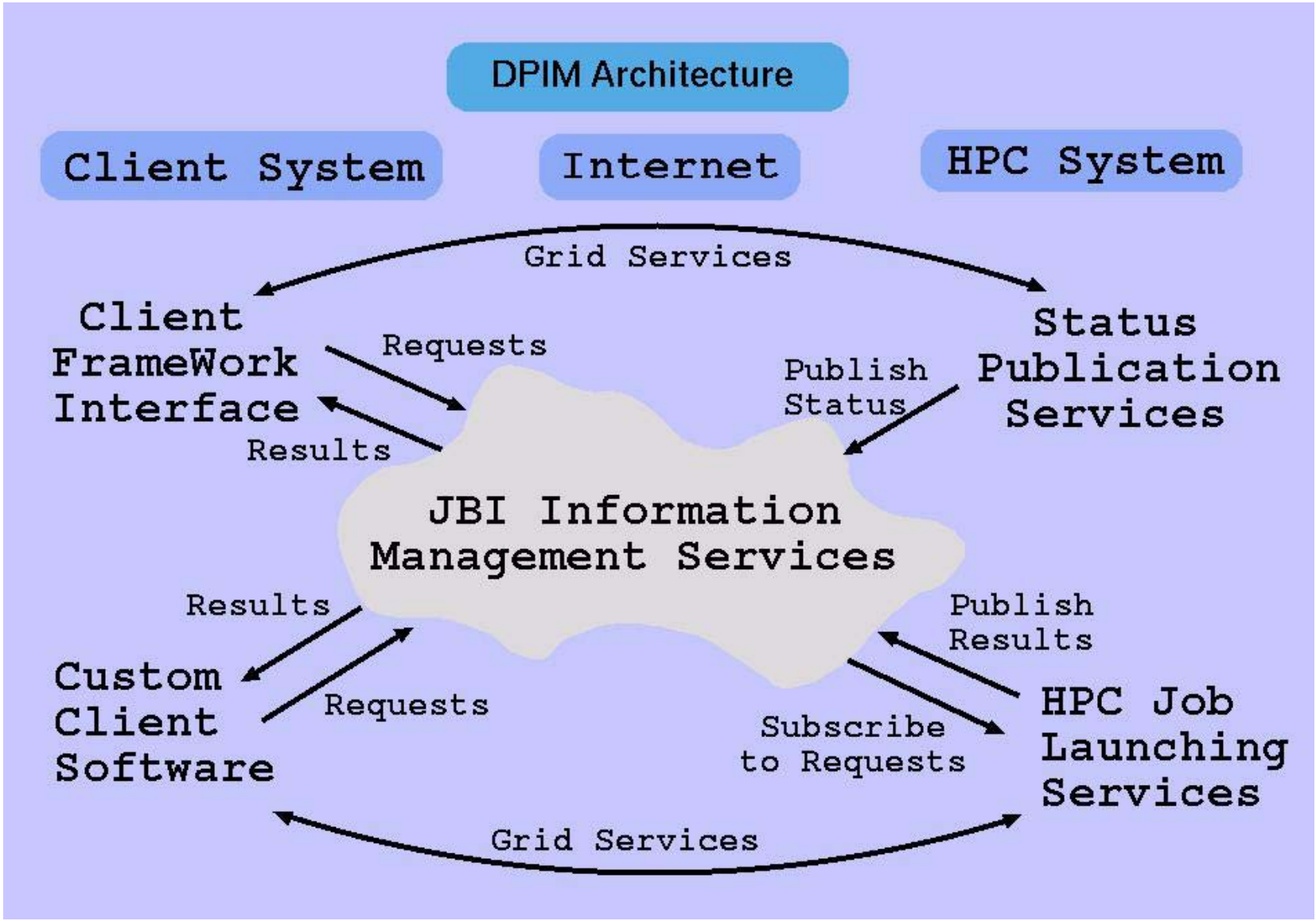
- Current JBI:
  - **Provide low latency and high capacity of the core services of a distributed, fault tolerant information management system**
- Goal:
  - **Use distributed interactive HPC resources on DREN**
  - **Fault tolerance**
  - **Scalability**

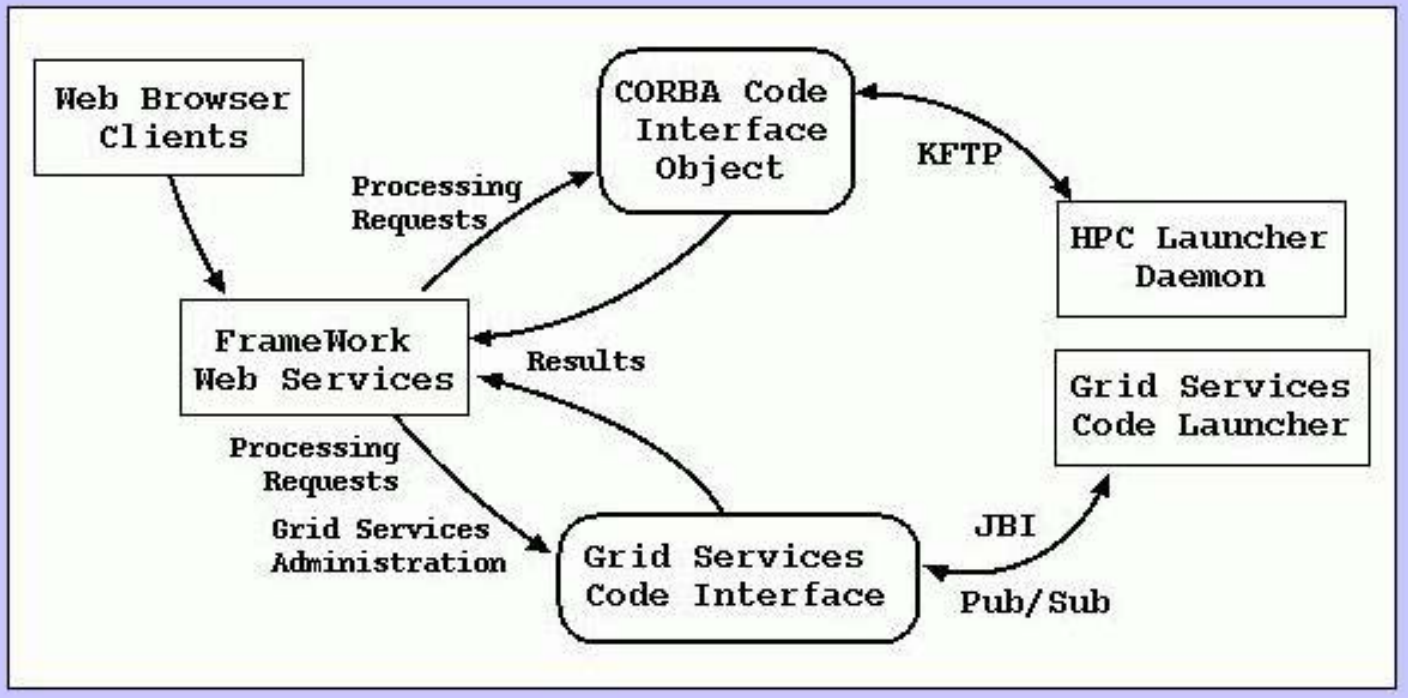
Scalability



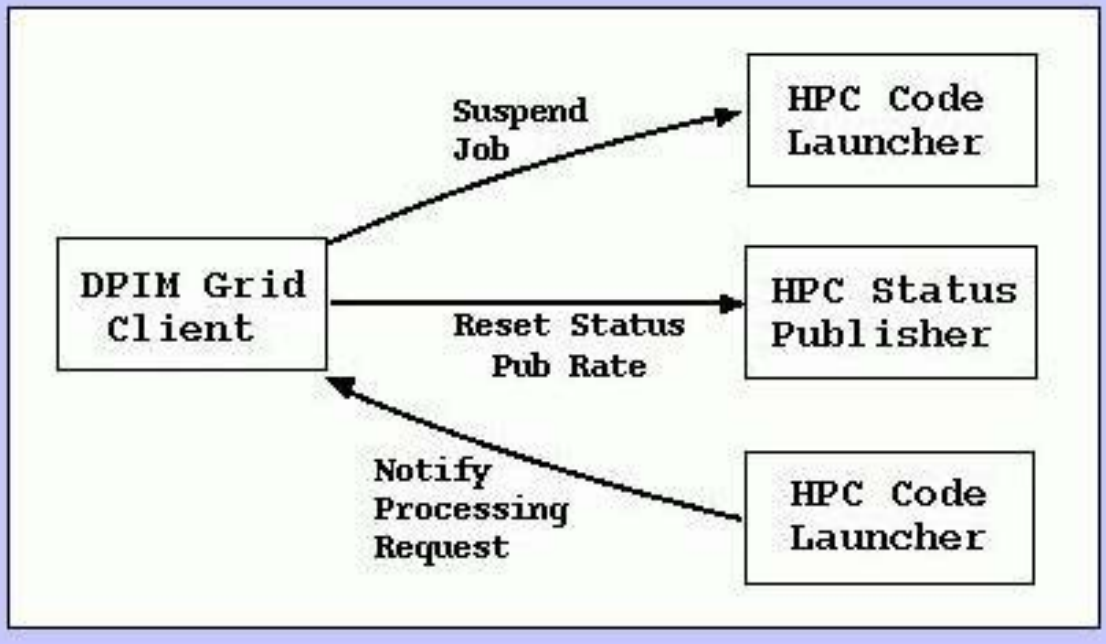
- 300 subscribers
- Predicate ensures that each publication is delivered to exactly one subscriber

- 300 Predicates
- 600 Clauses
- 0.3% hit ratio (1/300)
- 4-6 Publishers were used
- 2 KB IOs

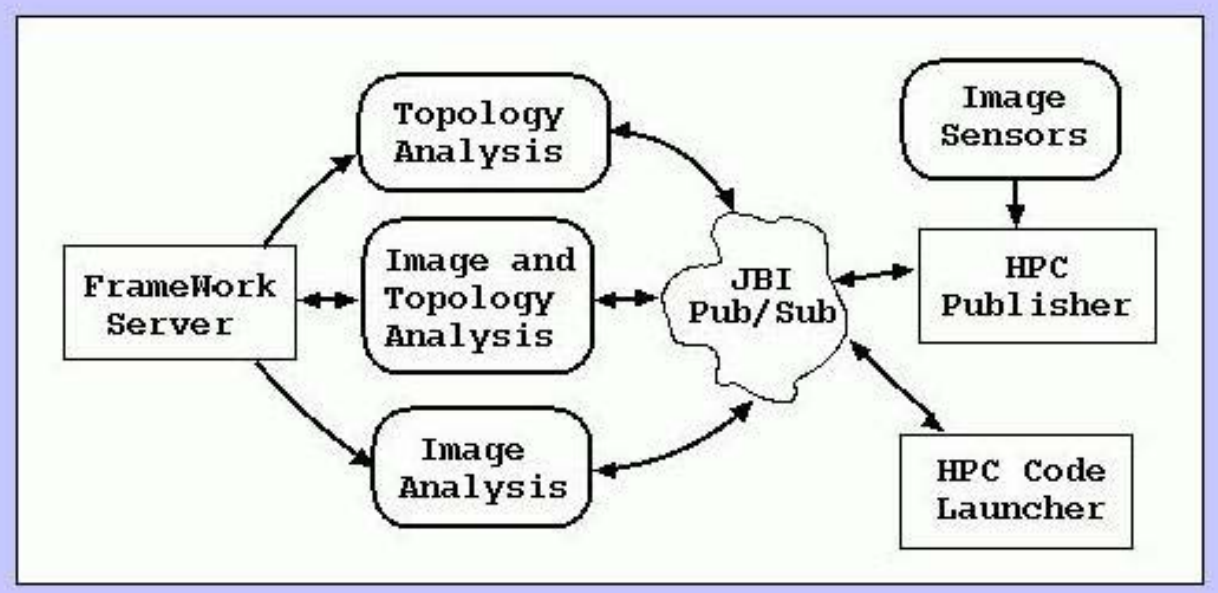

DPIM Architecture
Client System
Internet
HPC System
Grid Services
Client FrameWork Interface
Requests
Results
Publish Status
Status Publication Services
JBI Information Management Services
Results
Requests
Custom Client Software
Publish Results
Subscribe to Requests
HPC Job Launching Services
Grid Services



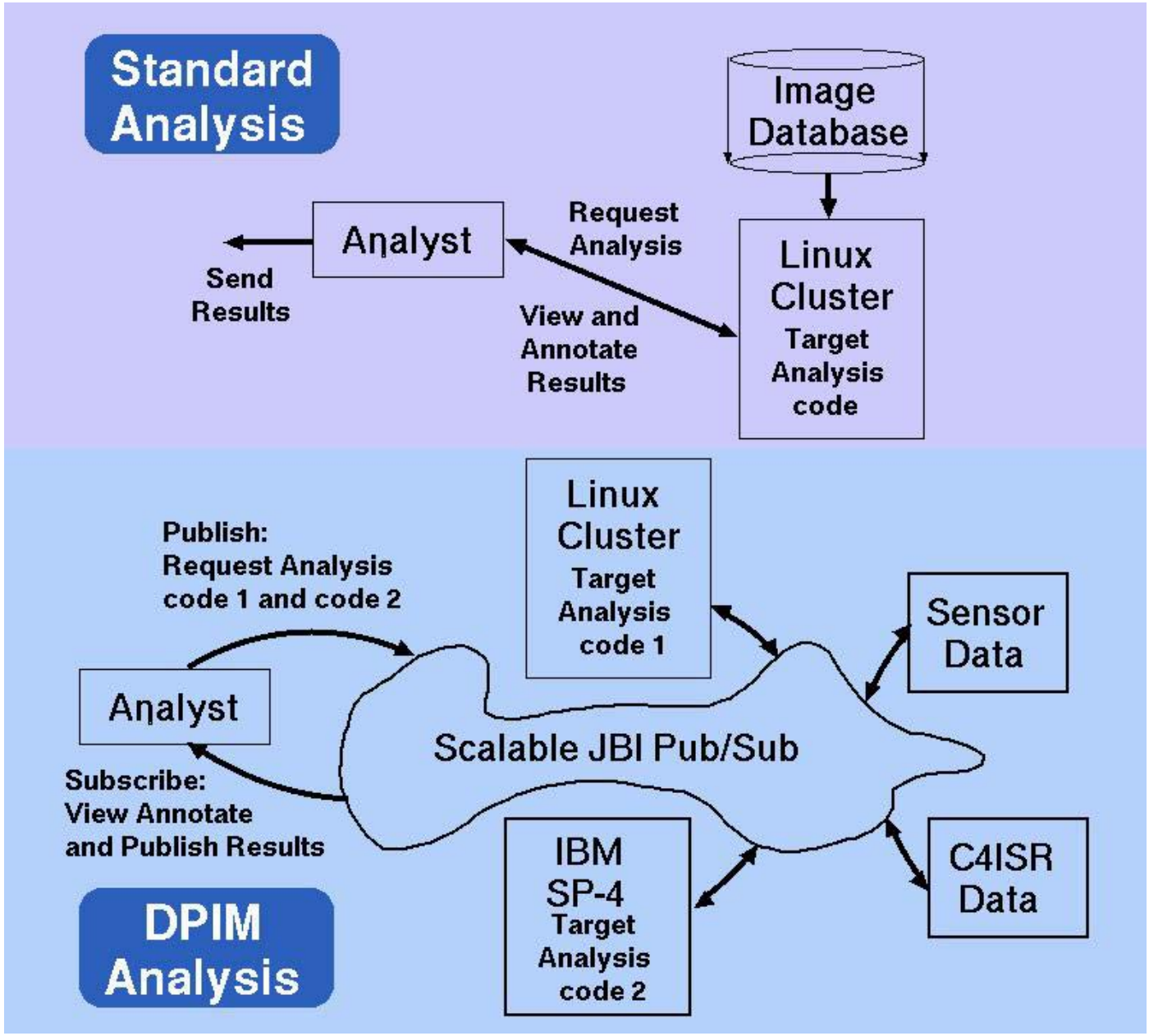
Replacing CORBA by Grid Services for Improved Control over Execution

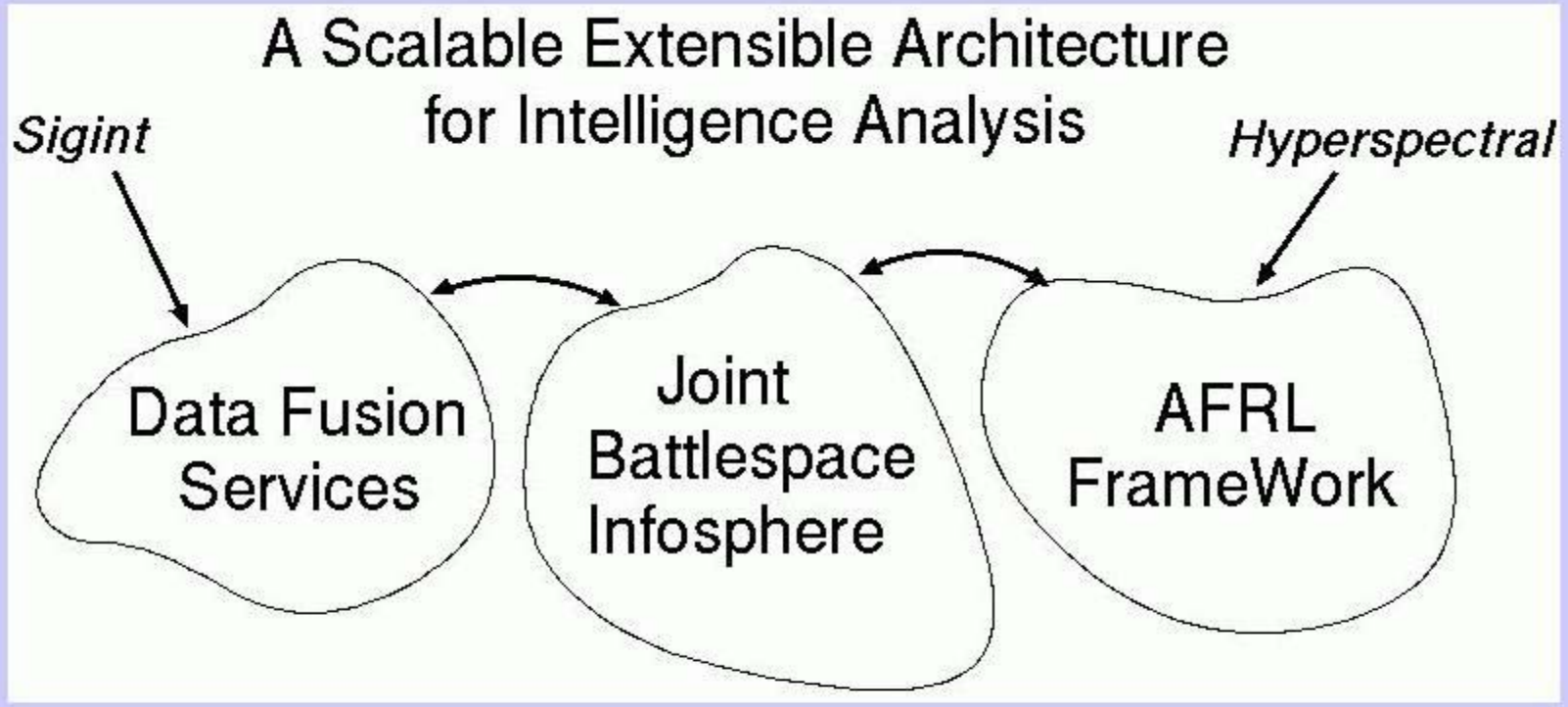


DPIM Grid Interface Used to Control Remote Operations

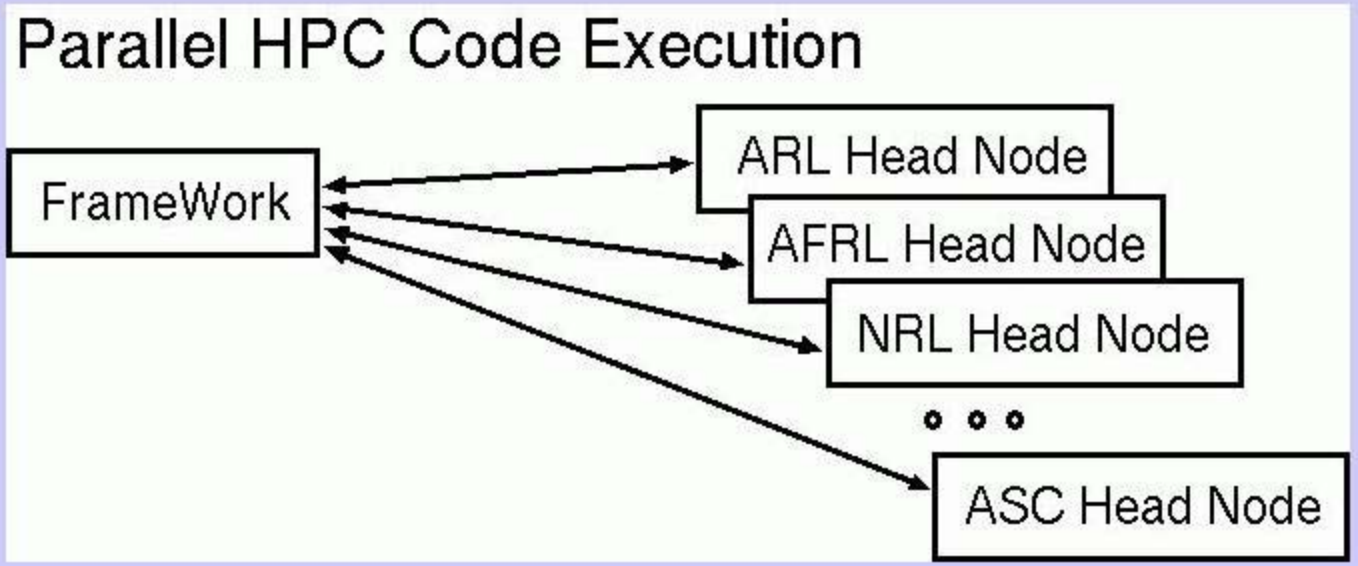


Communities of Interest Share Codes and HPC Resources to Improve Results


Standard Analysis
Image Database
Analyst
Request Analysis
Send Results
View and Annotate Results
Linux Cluster
Target Analysis code
Publish:
Request Analysis
code 1 and code 2
Linux Cluster
Target Analysis code 1
Sensor Data
Analyst
Scalable JBI Pub/Sub
Subscribe:
View Annotate
and Publish Results
IBM SP-4
Target Analysis code 2
C4ISR Data
DPIM Analysis



Additional Data Sources and Processing Codes can be Dynamically Configured



DPIM uses Status Publications and Resource Location Publications to Develop Execution Plan

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DPIM Machines File

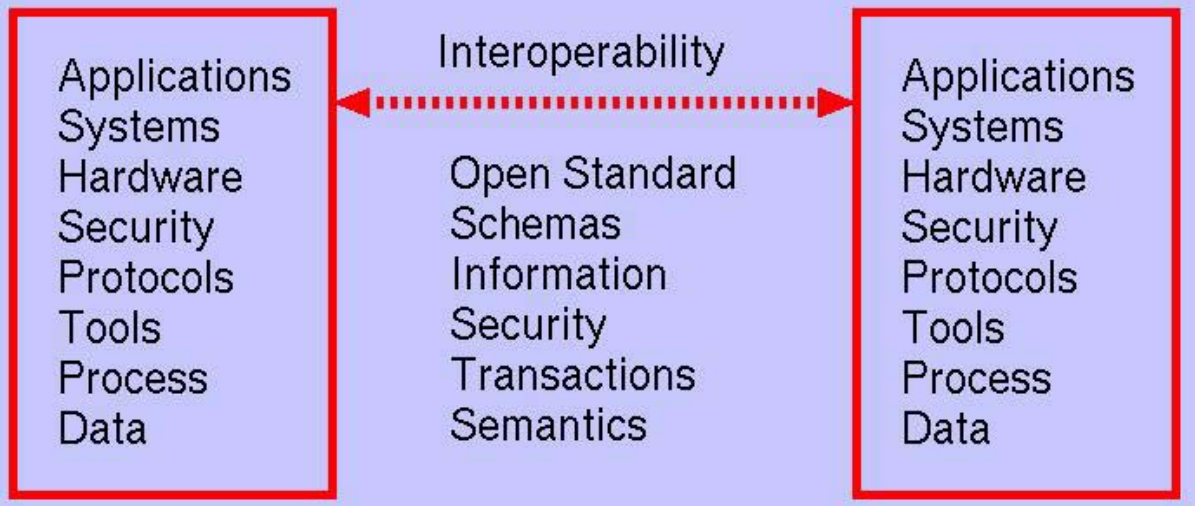
DPIM Machines File

```
http://grid.hpc.rl.af.mil/afrl/diht/coy0/launcher:20
http://grid.hpc.rl.af.mil/afrl/diht/hhpc0/launcher:24
http://grid.hpc.rl.af.mil/afrl/diht/mach2/launcher:32
http://grid.hpc.rl.af.mil/afrl/diht/seafarer/launcher:48
http://grid.hpc.rl.af.mil/afrl/diht/powell/launcher:48
```

DPIM Supports a Standard Grid Services Interface for the MPICH Globus Device

From: http://www.ncoic.org/download/NCOIC_Position_Paper_V21.pdf

Position Paper March 2005
An Introduction to the Network Centric Operations Industry Consortium (NCOIC")



"By using the open standards identified for use in the NCOIC architectural framework's lower (e.g., communications and **information services**) tiers, developers will be able to devote more time to the application development that provides greater value and return to the customer".

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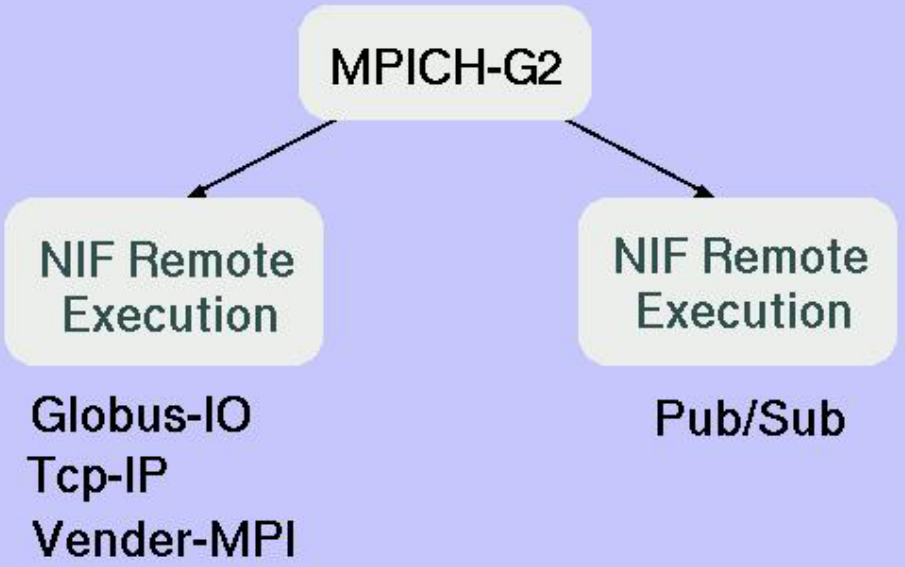
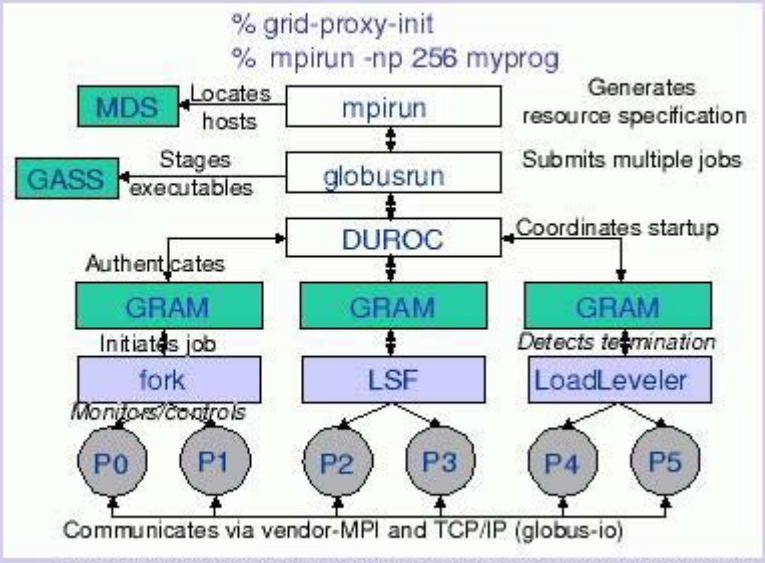
Net-Centric Issues

NCOIC NIF - Remote Execution Interface



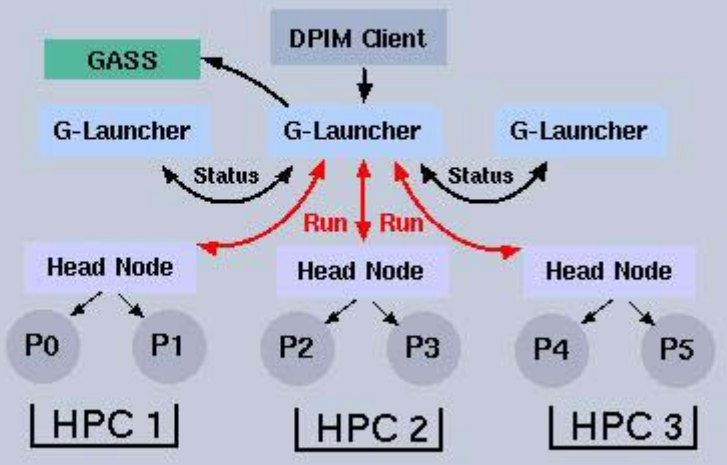
- Polling for inter-machine communication
- High-performance pub/sub
- Levels within communicator
- Transparent pub/sub



Above figure from: MPICH-G2: A Grid-Enabled Implementation of the Message Passing Interface.N. Karonis, B. Toonen, and I. Foster. Journal of Parallel and Distributed Computing, 2003.

GRID

- General Purpose Access to HPC Systems
  Low-level Batch Access



DPIM

- Interactive Access to HPC Systems
  Use of Grid Functions

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Security Issues

Traditional HPC Access

Kerberos HPC Security

Single Login

Admin Logs

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Other Work

Condor

Globus

Seti/Dnet

Community Framework

Nexus

GIG

JBI

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Conclusion

- Increasing Demand for Interactive Access to HPC Applications
- Make use of Open Source Standards
- High-Performance Information Management is key for Command and Control