GARUDA - The National Grid Computing Initiative of India

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Outline

- **GARUDA Overview**
- **Communication Fabric**
- **Resources**
- **Partners**
- **Applications & User Groups**
- **Q & A**

Motivation for GARUDA

- Sharing of high-end computational resources with the larger scientific and engineering community across the country

- Emerging High Performance Computing (HPC) applications require integration of geographically distributed resources

- Collaborative Framework for solving applications which are interdisciplinary requiring experts from multiple domains and distributed locations

- Universal (location-independence, ubiquitous) access to resources

Computational Grids effectively address the above application requirements
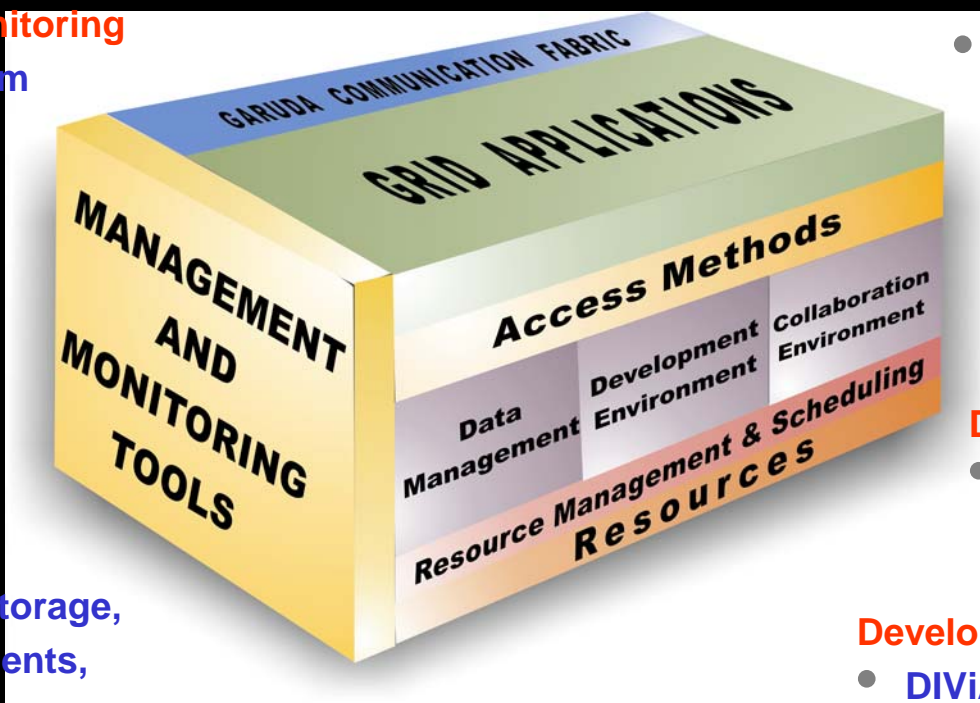
Project Overview

- Precursor to the National Grid Computing Initiative
  - Test Bed for grid technology/concepts and applications leading to the plan for the main grid initiative
- Project initiated by the Dept. of IT in November 2004
- Major Deliverables
  - Technologies, Architectures, Standards & Research Initiatives
  - Nation-wide high-speed communication fabric
  - Aggregation of Grid Resources
  - Deployment of Select applications of National Importance
  - Grid Strategic User Group
- High-speed Networking Component in collaboration with ERNET

Garuda Component Architecture

Application (PoC)
- Disaster Management
- Bioinformatics

Management & Monitoring
- Paryaveekshanam

Access Methods
- Access Portal
- Problem Solving Environments

Data Management
- Storage Resource Broker

Resources
- Compute, Data, Storage,
- Scientific Instruments,
- Softwares,..

Development Environment
- DIViA for Grid
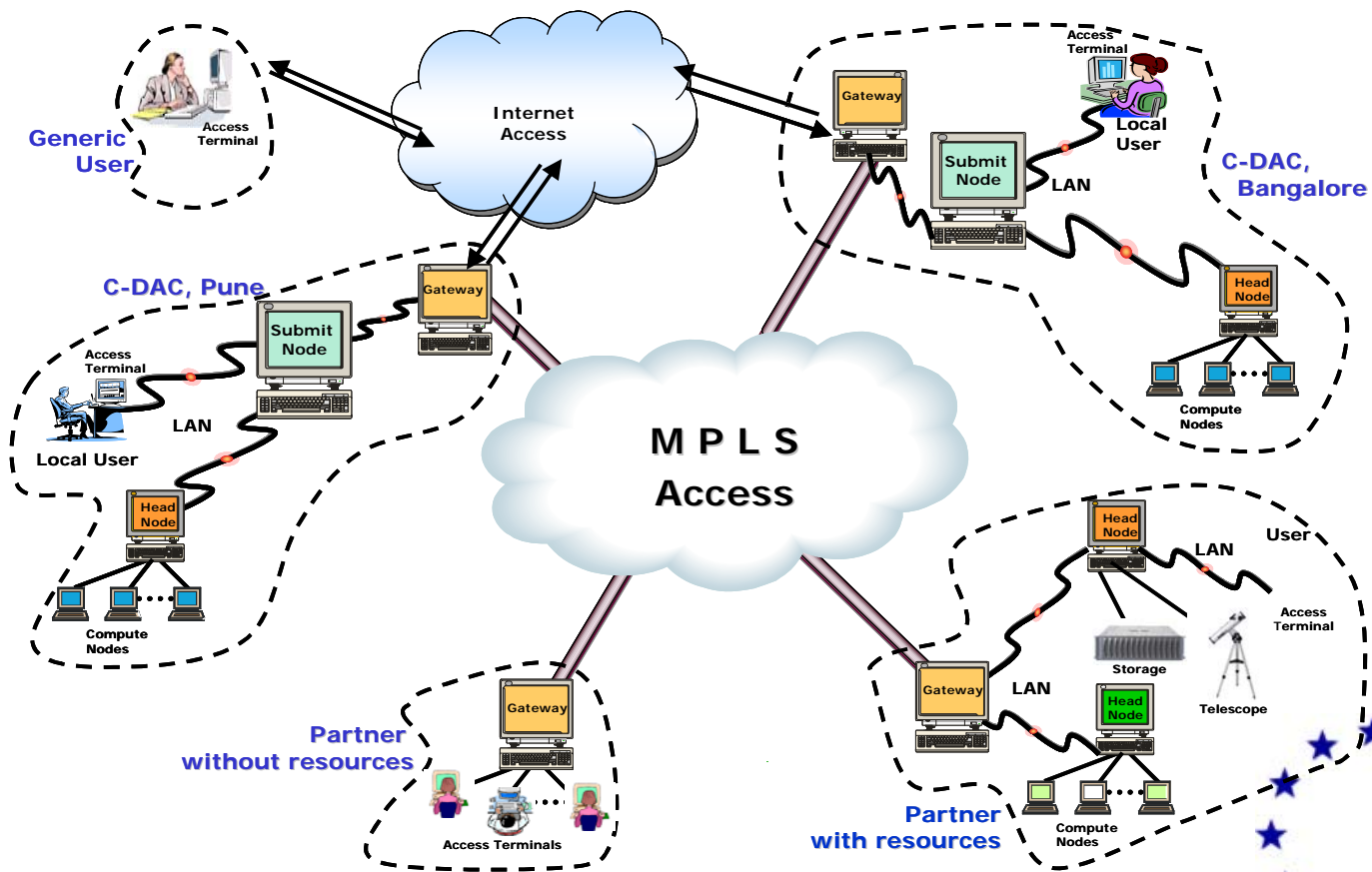
Resource Mgmt & Scheduling
- Moab from Cluster Resources
- Load Leveler, Torque
- Globus 2.x

Collaborative Environment
- Video Conferencing over IP
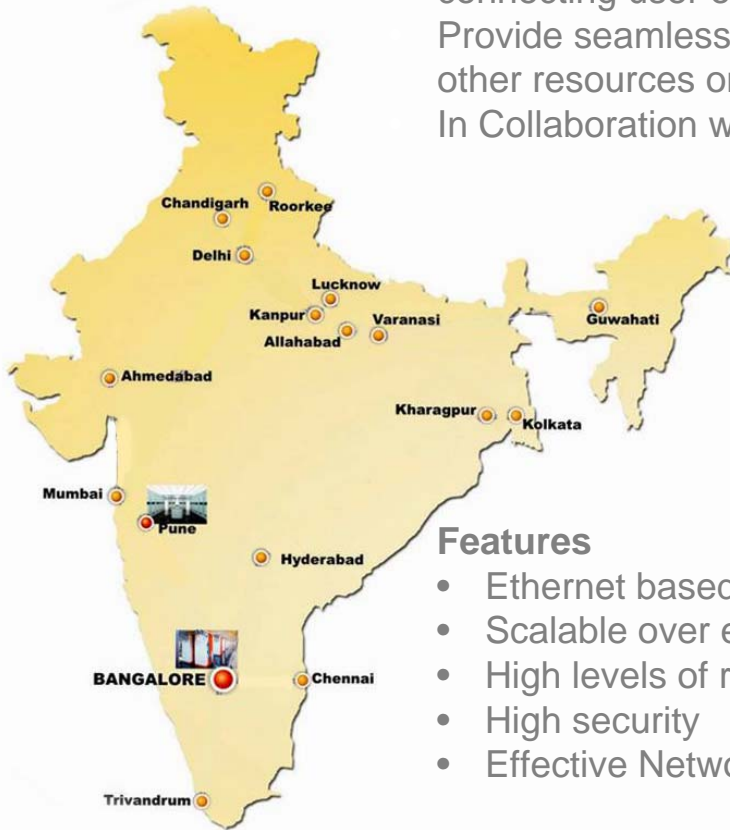- Access Grid

GARUDA Component Deployment Scenario`

GARUDA Communication Fabric

Objective

Provide an ultra-high speed multi services communication fabric connecting user organizations across 17 cities in the country
Provide seamless & high speed access to the compute, data & other resources on the Grid
In Collaboration with ERNET

Deliverables

High-speed Communication Fabric connecting 17 cities
Grid Management & Monitoring Centre
IP based Collaborative Environment among select centres

Features

- Ethernet based High Bandwidth capacity
- Scalable over entire geographic area
- High levels of reliability
- High security
- Effective Network Management

Chandigarh Roorkee
Delhi
Lucknow
Kanpur   Varanasi
Allahabad
Ahmedabad
Kharagpur   Kolkata
Guwahati
Mumbai
Pune
Hyderabad
BANGALORE   Chennai
Trivandrum

Characteristics

- Ethernet based High Bandwidth capacity
- Scalable over entire geographic area
- High levels of reliability
- Fault tolerance and redundancy
- Interference resilience
- High security
- Effective Network Management

Connectivity Details

- Each location in a city will connect through Ethernet-over-Fiber to the Provider Edge(PE) router located in the Service provider POP.

- Will be connected to layer 3 MPLS VPN from Service Provider's POP

- The access link for each location will be on a redundant/ring fiber link

- L2 VPN at 100 Mbps Connectivity between C-DAC, Pune and C-DAC, KP, Bangalore

Service Level Agreement (SLA)

- Operation of Network - 24x7x365 basis
- Latency – 80 ms (CPE – CPE)
- MTTR link failures – less than 3 hours
- Packet loss – less than 0.1 %
- Each Circuit Uptime % on Monthly basis-   99.5%
- Link fail over – within 50 ms
- Average Maintenance outage – 1 hour with prior notice

# Network Security & Management

- **Security**
  - Defined policies and procedures
  - Secure architecture
  - Authentication and Authorization mechanisms
  - Encryption of traffic
  - Usage of effective security solutions

- **Network Management**
  - Real time monitoring and offline analysis
  - Effective recovery mechanisms
  - Policies and procedures for configuration changes like Provisions for bandwidth variance, queuing, protocols, routing etc,
  - Usage of effective network management solutions

Garuda Network Connectivity Schema

Cisco 3750-24T L-3 switch

Internal sub-net
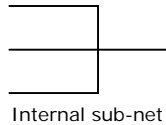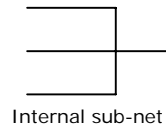
1Mbps Internet (1:1)

Cisco PIX 525 Firewall

100 Mbps

PNQ → BLR p2p link (Layer-2 VPN)

Cisco 3750-24T L-3 switch

Internal sub-net

1Mbps Internet (1:1)

Cisco PIX 525 Firewall

Cisco 2811 router with 2FE ports

GRID Globus node (connecting at 10Mbps)

MPLS 100 Mbps

MPLS 100 Mbps

MPLS 10 Mbps
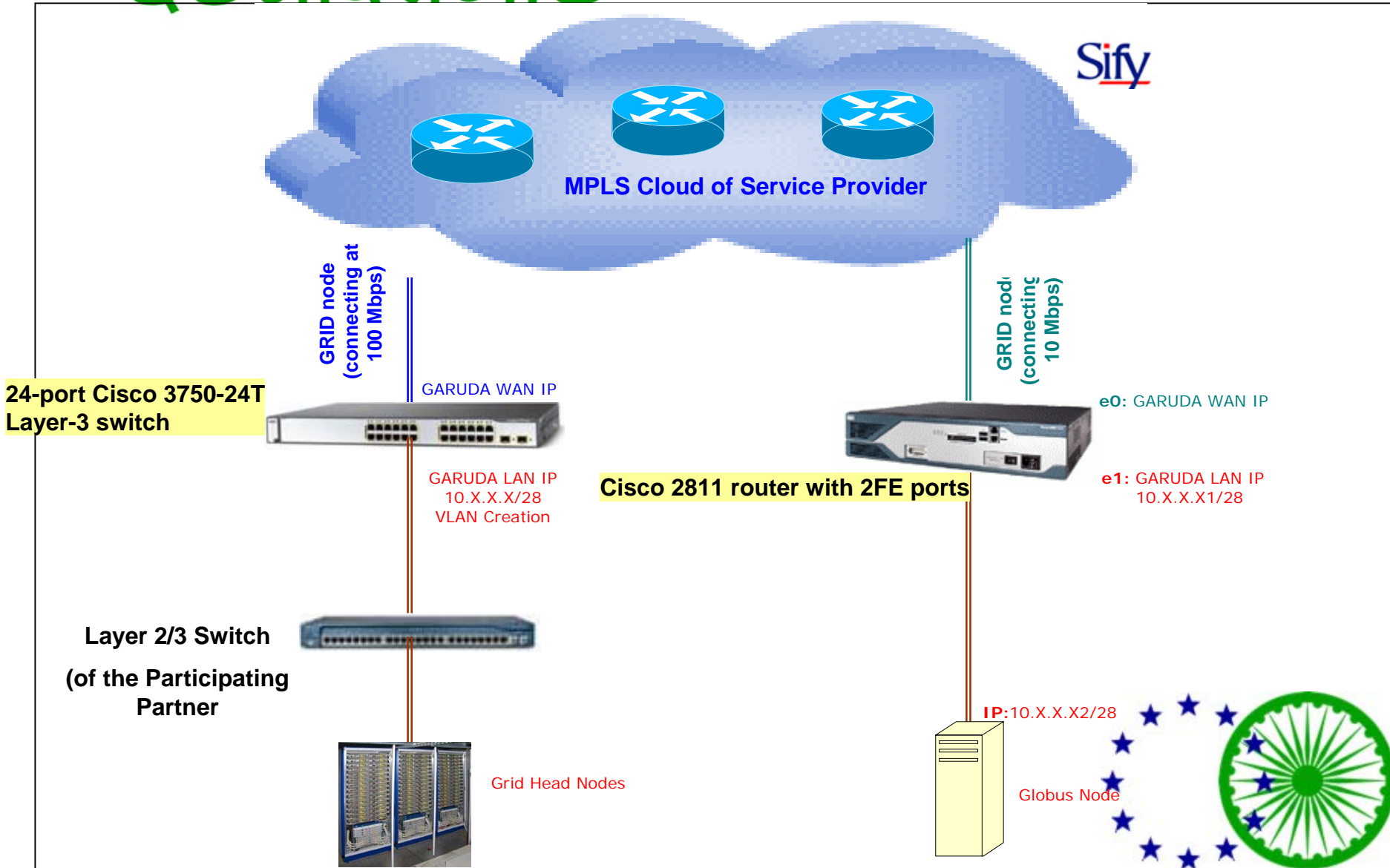
Aggregated MPLS BW: 2.43Gbps

PE (Provider Edge) Routers

MPLS Cloud of Service Provider

Sify

euindiagrid
इउभारतगीड

Sify

MPLS Cloud of Service Provider

GRID node (connecting at 100 Mbps)

GRID node (connecting 10 Mbps)

24-port Cisco 3750-24T Layer-3 switch

GARUDA WAN IP

e0: GARUDA WAN IP

GARUDA LAN IP 10.X.X.X/28 VLAN Creation

Cisco 2811 router with 2FE ports

e1: GARUDA LAN IP 10.X.X.X1/28

Layer 2/3 Switch

(of the Participating Partner

IP:10.X.X.X2/28

Grid Head Nodes

Globus Node

GARUDA Resources

- C-DAC centres at Bangalore, Pune, Hyderabad & Chennai will contribute a set percentage of their computing resources

- Grid Labs at Bangalore, Pune and Hyderabad have been set up

- The proposed 5TF system of C-DAC will also be available on the Grid
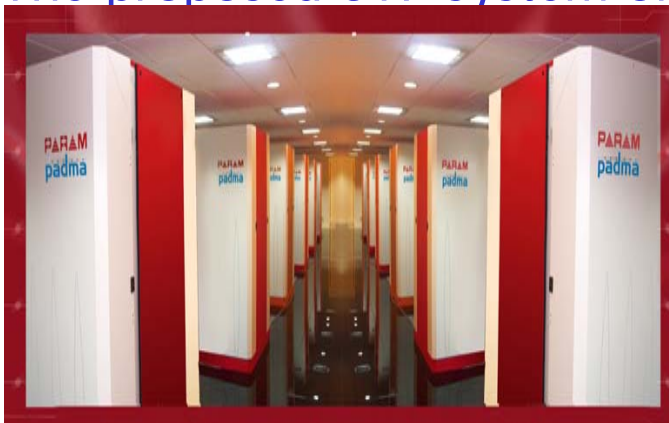
HPC Clusters & Storage from C-DAC (total 256 Processors)
- Bangalore   : 128 CPU AIX Cluster, 5 TB Storage
- Pune   :   64 CPU Solaris Cluster
                :   32 CPU Linux Cluster, 4 TB Storage
- Chennai   :   16 CPU Linux Cluster, 1 TB Storage
- Hyderabad   :   16 CPU Linux Cluster, 1 TB Storage

Resources from Partners

State-of-the-art High Performance Computing (HPC) Centre

- Satellite Terminals from SAC Ahmedabad
- Linux Clusters from (total 532 Processors)
  - PRL, Ahmedabad
  - IISc & RRI, Bangalore
  - IMTech, Chandigarh
  - MIT, Chennai
  - IGIB & IIT, Delhi
  - IIT, Guwahati
  - 32-way AIX SMP from University of Hyderabad

Resources

- HPC Clusters & Storage from C-DAC
  - Bangalore : 128 CPU AIX Cluster,5 TB Storage
  - Pune : 64 CPU Solaris Cluster
    : 16 CPU Linux Cluster, 4 TB Storage
  - Chennai : 16 CPU Linux Cluster, 2 TB Storage
  - Hyderabad : 16 CPU Linux Cluster, 2 TB Storage
  - The proposed 5 TF system to be part of the Grid
- Satellite Terminals from SAC Ahmedabad at Pune and Bangalore
- 64 CPU Xeon Computing Cycles from IGIB Delhi
- 32 way SMP from Univ. of Hyderabad
- 64 CPU cluster from MIT, Chennai
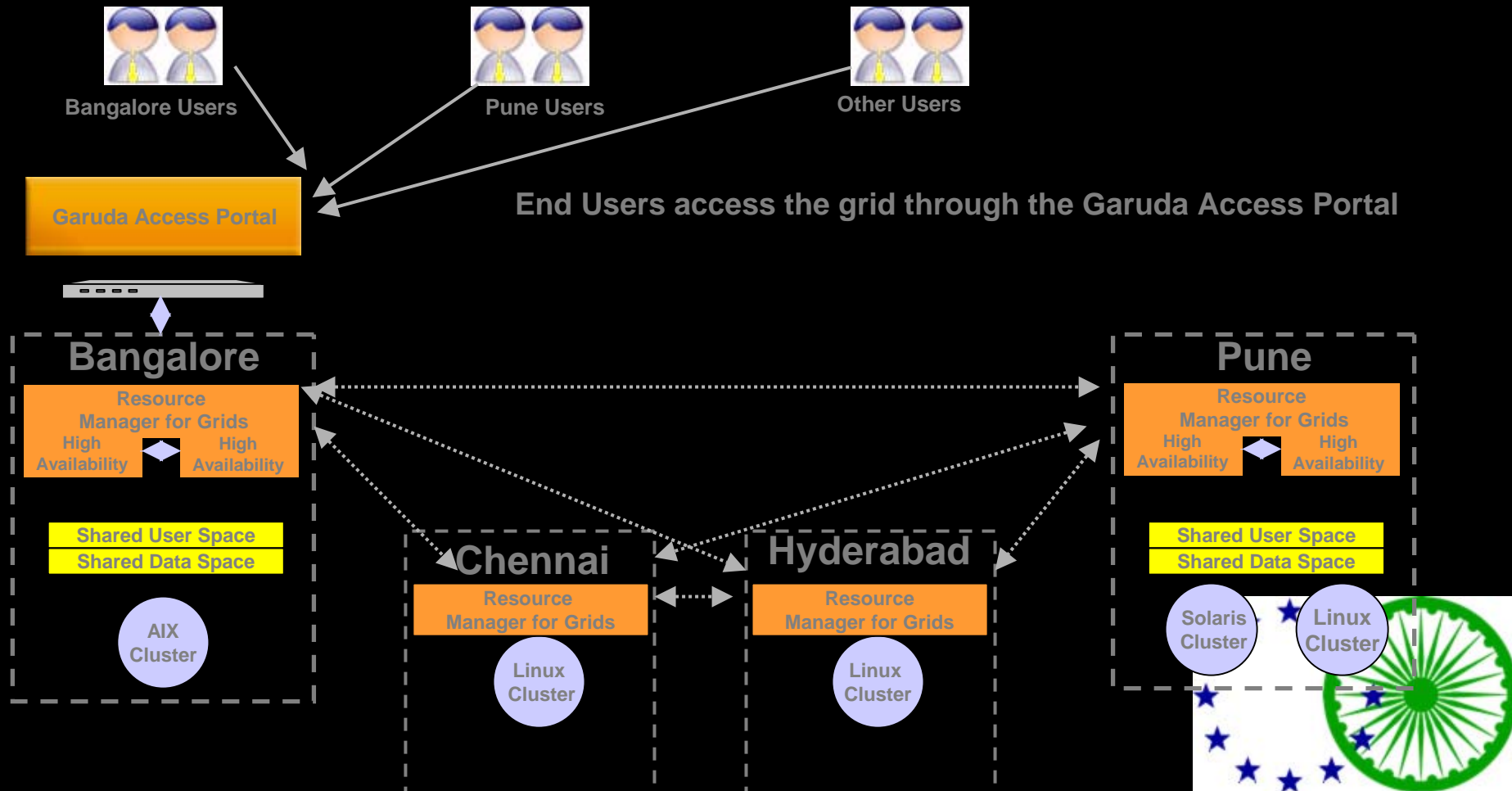- 64 CPU cluster from PRL, Ahmedabad

Resources

- 64 CPU POWER5 on Linux from IISc, Bangalore

- 32 CPU Opteron from RRI, Bangalore

- 16 CPU cluster from IMT, Chandigarh

- 32 CPU cluster from IIT, Delhi

- 128 CPU Cluster from IIT, Gwuahati

Resources at C-DAC centres

Bangalore Users

Pune Users

Other Users

Garuda Access Portal

End Users access the grid through the Garuda Access Portal

Bangalore

Resource Manager for Grids
High Availability   **High Availability**

Shared User Space
Shared Data Space

AIX Cluster

Pune

Resource Manager for Grids
High Availability   **High Availability**

Shared User Space
Shared Data Space

Solaris Cluster   **Linux Cluster**

Chennai

Resource Manager for Grids

Linux Cluster

Hyderabad

Resource Manager for Grids

Linux Cluster

Grid Management & Monitoring Centre

- An integrated Resource Management & Monitoring Framework

- Network Traffic Analysis and Congestion Management

- Help desk for Grid Users
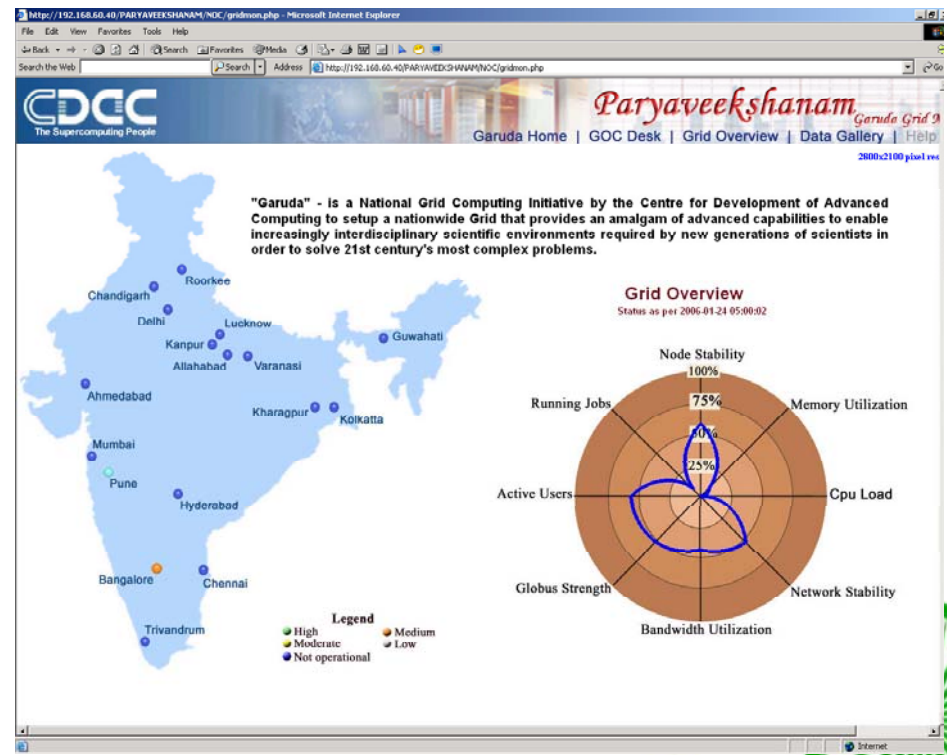
GARUDA Partners

- Motivation
  - To Collaborate on Research and Engineering of Technologies, Architectures, Standards and Applications in Grid Computing
  - To Contribute to the aggregation of resources in the Grid

- Current Participation
  - 36 research & academic institutions in the 17 cities
  - ERNET-HQ in Delhi
  - 8 centres of C-DAC
  - Total of 45 institutions

GARUDA Partners (contd..)

C-DAC Centres (8):
- Pune (2)
- Bangalore(2)
- Hyderabad
- Mumbai
- Chennai
- Thiruvananthapuram

Academia
- Motilal Nehru National Institute of Technology, Allahabad
- Indian Institute of Science, Bangalore
- Punjab Engineering College, Chandigarh
- Madras Institute of Technology, Chennai
- Jawaharlal Nehru University, Delhi
- Guwahati University, Guwahati
- University of Hyderabad, Hyderabad
- Indian Institute of Technology at :
  - Chennai
  - Delhi
  - Guwahati
  - Kanpur
  - Kharagpur
  - Mumbai
  - Roorkee
- University of Pune, Pune
- Institute of Technology, Banaras Hindu University, Varanasi

Government Collaborators
- ERNET India

GARUDA Partners (contd..)

Research Labs & Institutions
- Institute for Plasma Research, Ahmedabad
- Physical Research Laboratory, Ahmedabad
- Space Application Centre, Ahmedabad
- Harish Chandra Research Institute, Allahabad
- Indian Institute of Astrophysics, Bangalore
- National Centre for Biological Sciences, Bangalore
- Raman Research Institute, Bangalore
- Institute of Mathematical Sciences, Chennai
- Institute of Microbial Technology, Chandigarh
- Institute of Genomics and Integrative Biology, Delhi
- Centre for DNA fingerprinting and Diagnostics, Hyderabad
- Saha Institute of Nuclear Physics, Kolkatta
- Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow
- Bhabha Atomic Research Centre, Mumbai
- Tata Institute of Fundamental Research, Mumbai
- Inter-University Centre for Astronomy and Astrophysics, Pune
- National Chemical Laboratory, Pune
- National Centre for Radio Astrophysics, Pune
- Regional Cancer Centre, Thiruvananthapuram
- Vikram Sarabhai Space Centre, Thiruvananthapuram

Illustrative Applications

Objectives and Deliverables

- Objectives
    - Enable applications of national importance requiring aggregation of geographically distributed resources

- Deliverables
    - Grid enablement of illustrative applications and some demonstrations such as
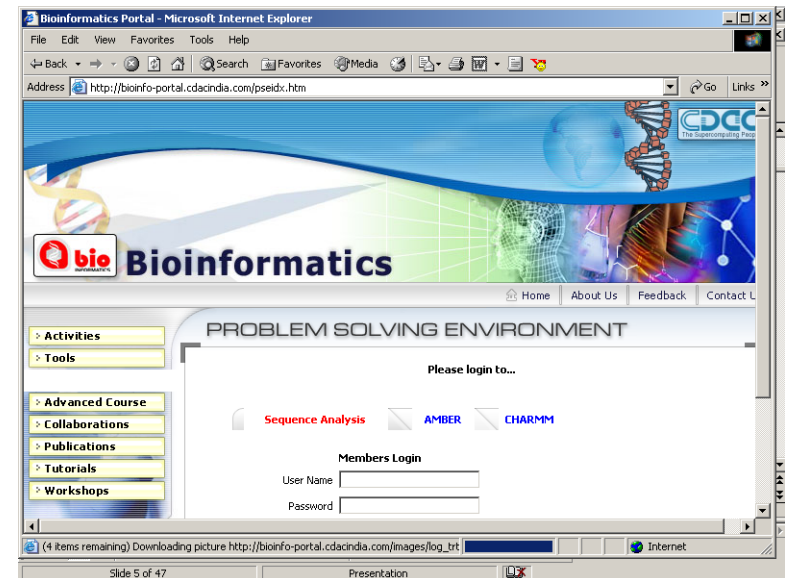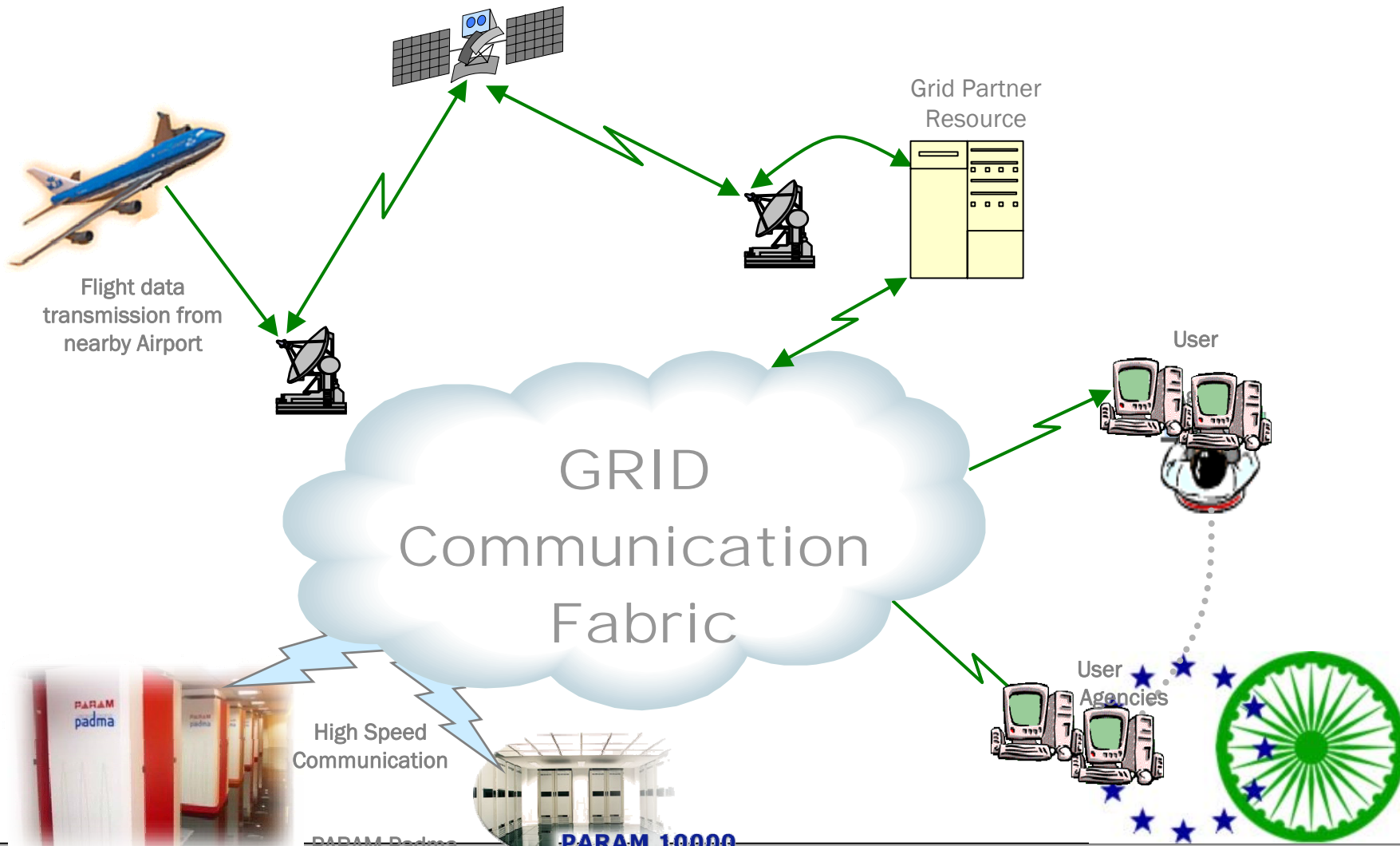   - Bioinformatics
        - Disaster Management
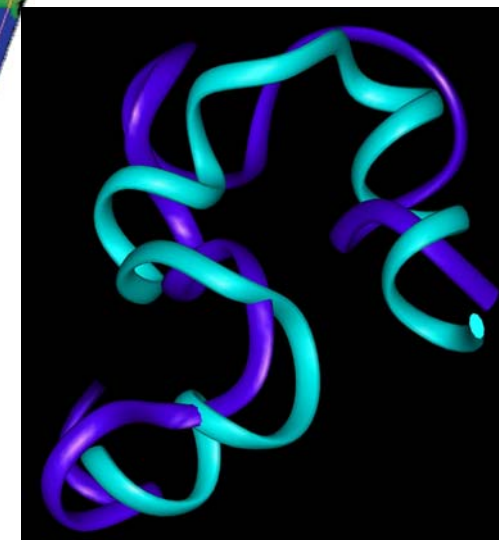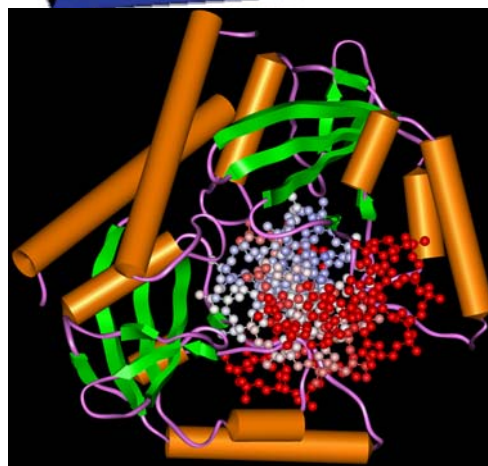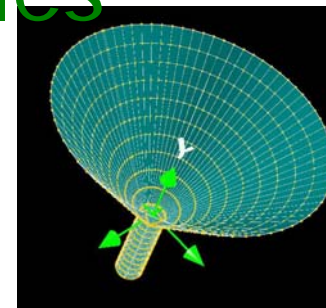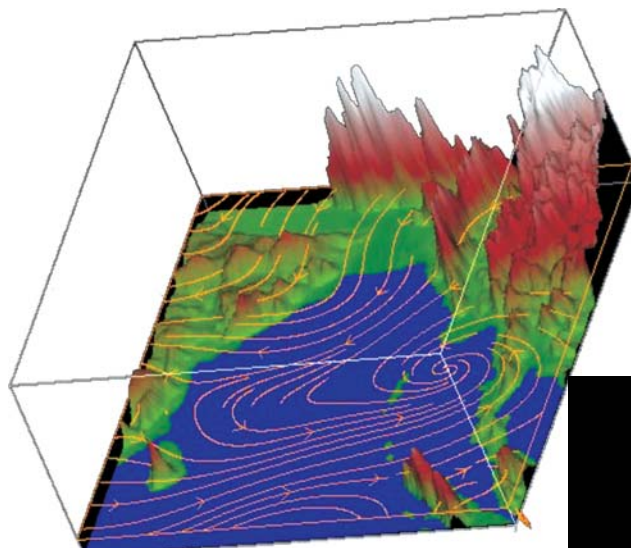
Bioinformatics

- Bioinformatics Resources & Applications Facility (BRAF) on PARAM Padma

- Supports highly optimized Bioinformatics codes on the PARAM Padma

- Web computing portal providing all computational facility to solve related problems

Disaster Management

GRID Communication Fabric

Flight data transmission from nearby Airport

Grid Partner Resource

User

User Agencies

High Speed Communication

PARAM Padma at Bangalore

PARAM 10000

Virtual User Community

- Astrophysics
- High Energy Physics & Astronomy
- Grid Technology
- Disaster Management
- Earth Science
- Bioinformatics (Genome)
- Network Technology

Thank you!

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