MonALISA
MONitoring Agents using a Large Integrated Services Architecture

End User Agents: extending the "intelligence" to the edge in Distributed Service Systems

Internet2 Meeting
September 2005

Iosif Legrand
California Institute of Technology

◆ **MonALISA (Monitoring Agents using a Large, Integrated Services Architecture)**

   An Agent Based, Dynamic Service System able to Monitor, Control and Optimize Distributed Systems

◆ **LISA (Localhost Information Service Agent)**
   End User Agent, capable to effectively integrate user applications with Service Oriented Architectures.

◆ **Examples :**

   EVO system: a distributed videoconferencing system

   Data transfers: creating on demand an optical path

MonALISA is A Dynamic, Distributed Service Architecture

➢ **Real-time monitoring is an essential part of managing distributed systems. The monitoring information gathered is necessary for developing higher level services, and components that provide automated decisions, to help operate and optimize the workflow in complex systems.**

➢ **The MonALISA system is designed as an ensemble of autonomous multi-threaded, self-describing agent-based subsystems which are registered as dynamic services, and are able to collaborate and cooperate in performing a wide range of monitoring tasks. These agents can analyze and process the information, in a distributed way, to provide optimization decisions in large scale distributed applications.**

➢ **An agent-based architecture provides the ability to invest the system with increasing degrees of intelligence; to reduce complexity and make global systems manageable in real time**

September   2005   Iosif Legrand

The MonALISA Architecture Provides:

➢ **Distributed Registration and Discovery for Services and Applications.**

➢ **Monitoring all aspects of complex systems :**

  ❑ **System information for computer nodes and clusters**

  ❑ **Network information : WAN and LAN**

  ❑ **Monitoring the performance of Applications, Jobs or services**

  ❑ **The End User Systems, its performance**

➢ **Can interact with any other services to provide in near real-time customized information based on monitoring data**

➢ **Secure, remote administration for services and applications**

➢ **Agents to supervise applications, to restart or reconfigure them, and to notify other services when certain conditions are detected.**

➢ **The MonALISA framework can be used to develop higher level decision services, implemented as a distributed network of communicating agents, to perform global optimization tasks.**

➢ **Graphical User Interfaces to visualize complex information**

September 2005   Iosif Legrand

The MonALISA Discovery System & Services

Fully Distributed System with no Single Point of Failure

Clients , HL services repositories
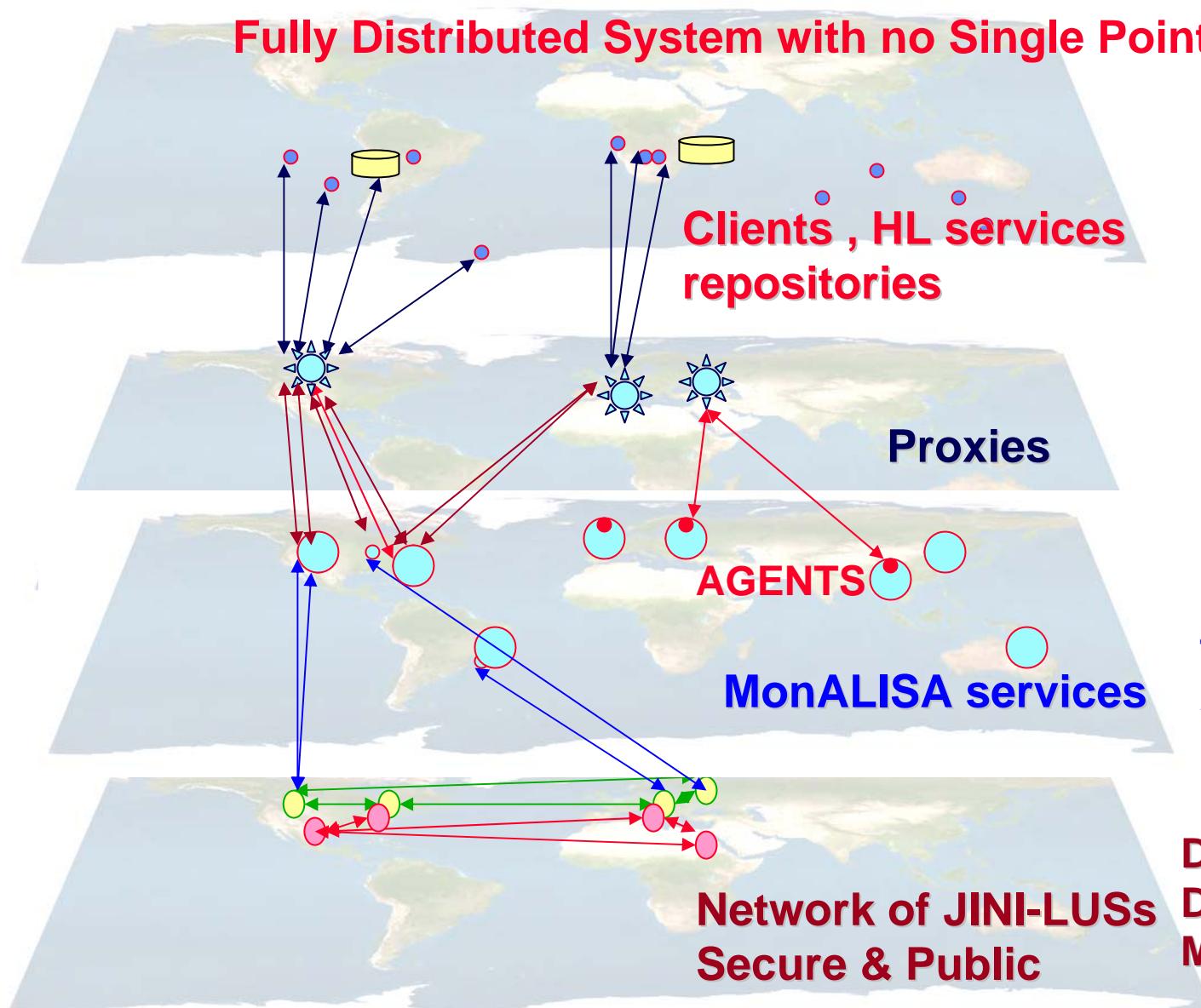
Global Services or Clients

Proxies

Dynamic load balancing Scalability & Replication Security AAA for Clients

AGENTS

MonALISA services

Distributed System for gathering and Analyzing Information.

Network of JINI-LUSs Secure & Public

Distributed Dynamic Discovery- based on a lease Mechanism and REN

Iosif Legrand

MonALISA service & Data Handling

September 2005

Iosif Legrand
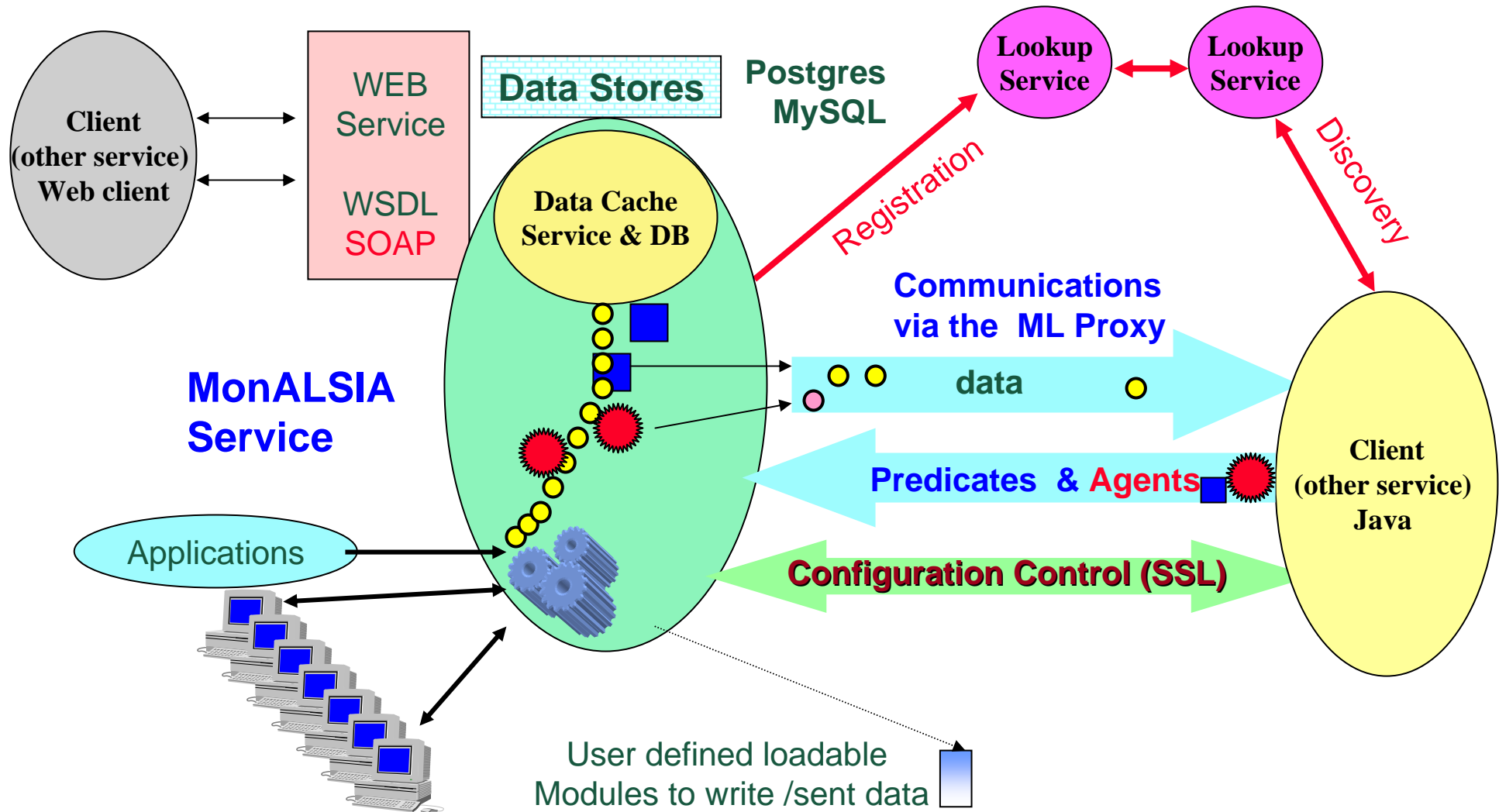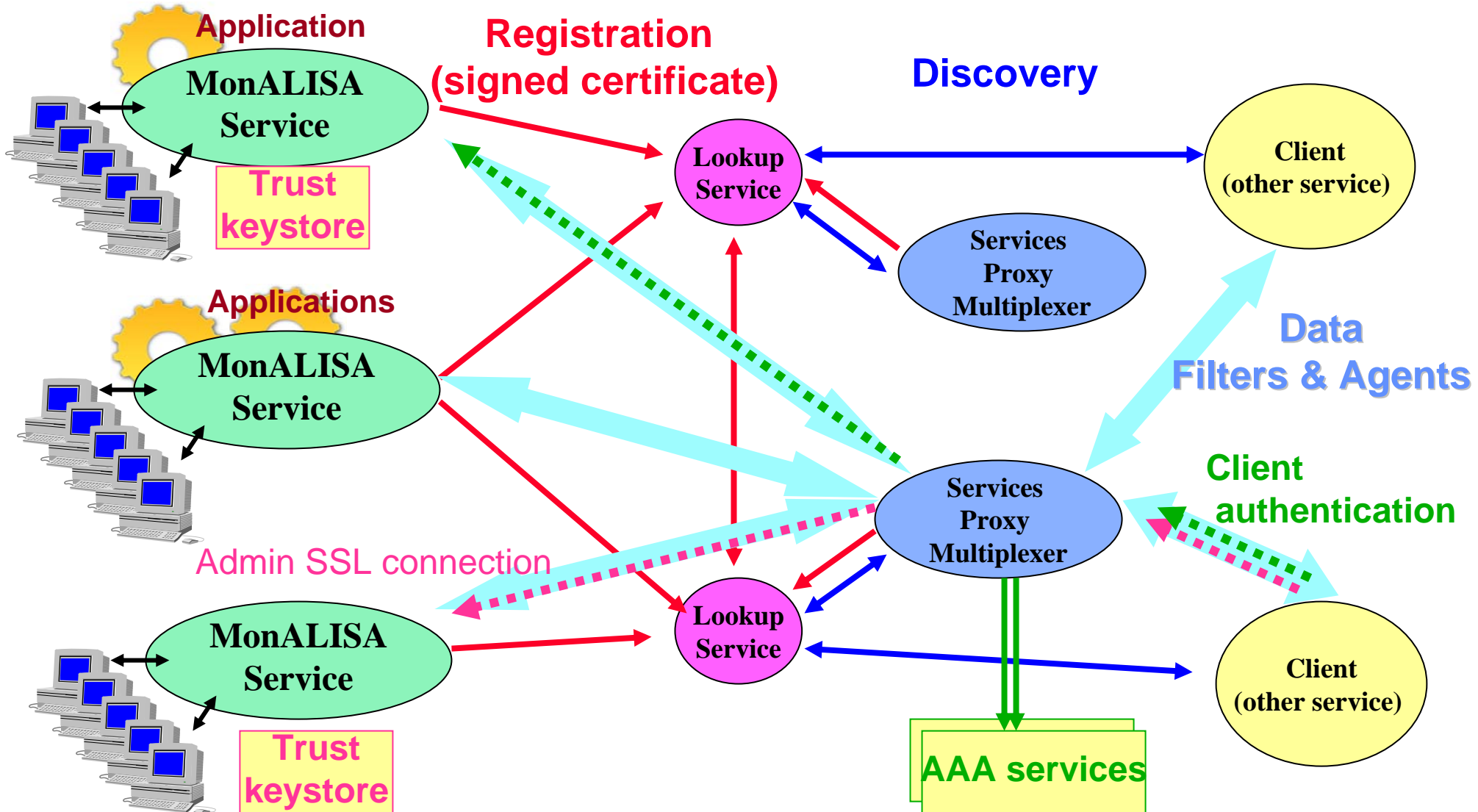
Communities using MonALISA

- OSG
- Grid3
- CMS
- ALICE
- VRVS System
- STAR
- D0
- ABILENE
- GLORIAD

More than 200 Sites running MonALISA and it monitors more than 12 000 nodes, more than 60 WAN links and Collects ~ 200 000 parameters /min
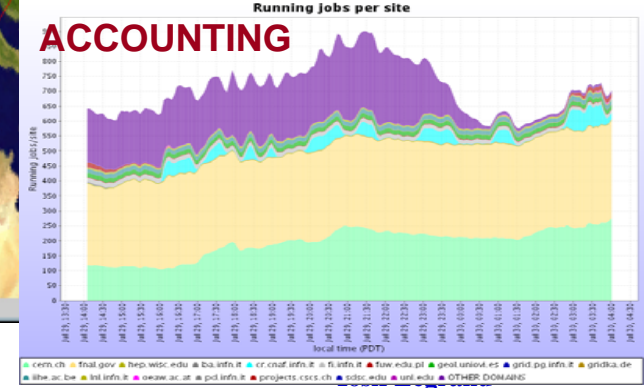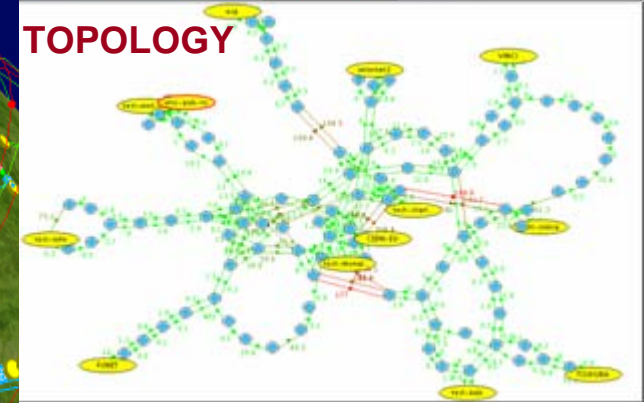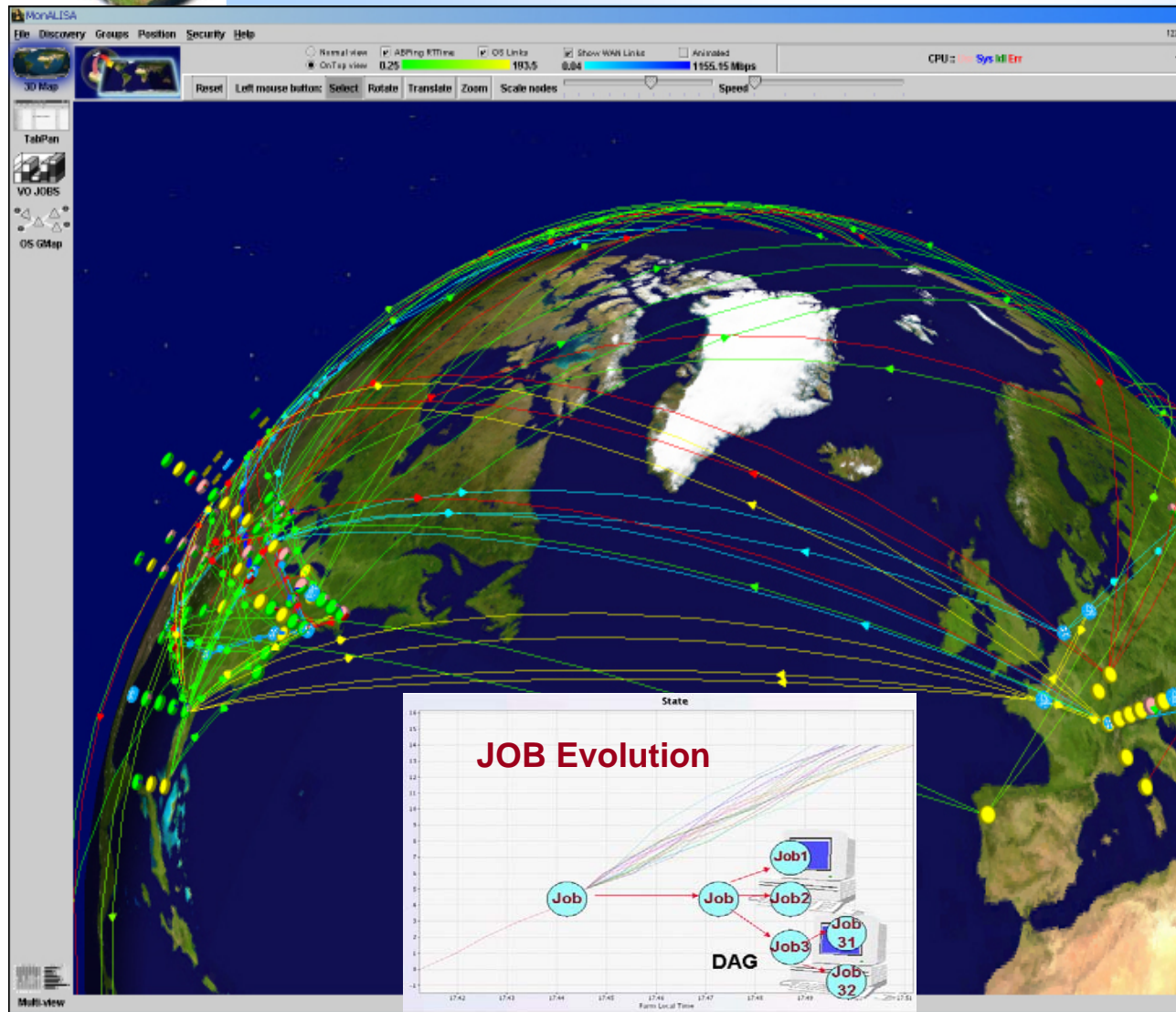
It has been used for Demonstrations at:

- SC2003
- Telecom 2003
- WSIS 2003
- SC 2004
- I2 2005
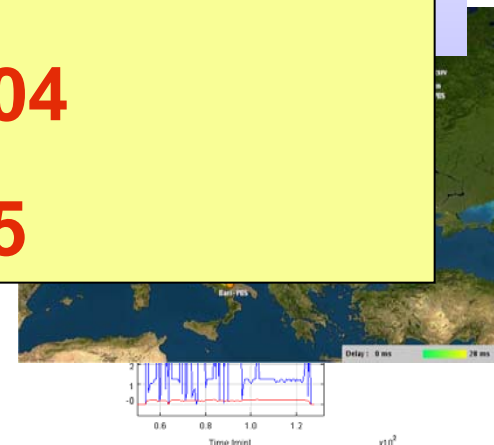
http://monalisa.caltech.edu

JOBS

Global Statistics

TOPOLOGY

JOB Evolution

State

Job → Job → Job1
Job → Job → Job2
Job → Job3 → Job 31
Job3 → Job 32

DAG

ACCOUNTING

Running jobs per site

September 2005

9

September 2005

Iosif Legrand
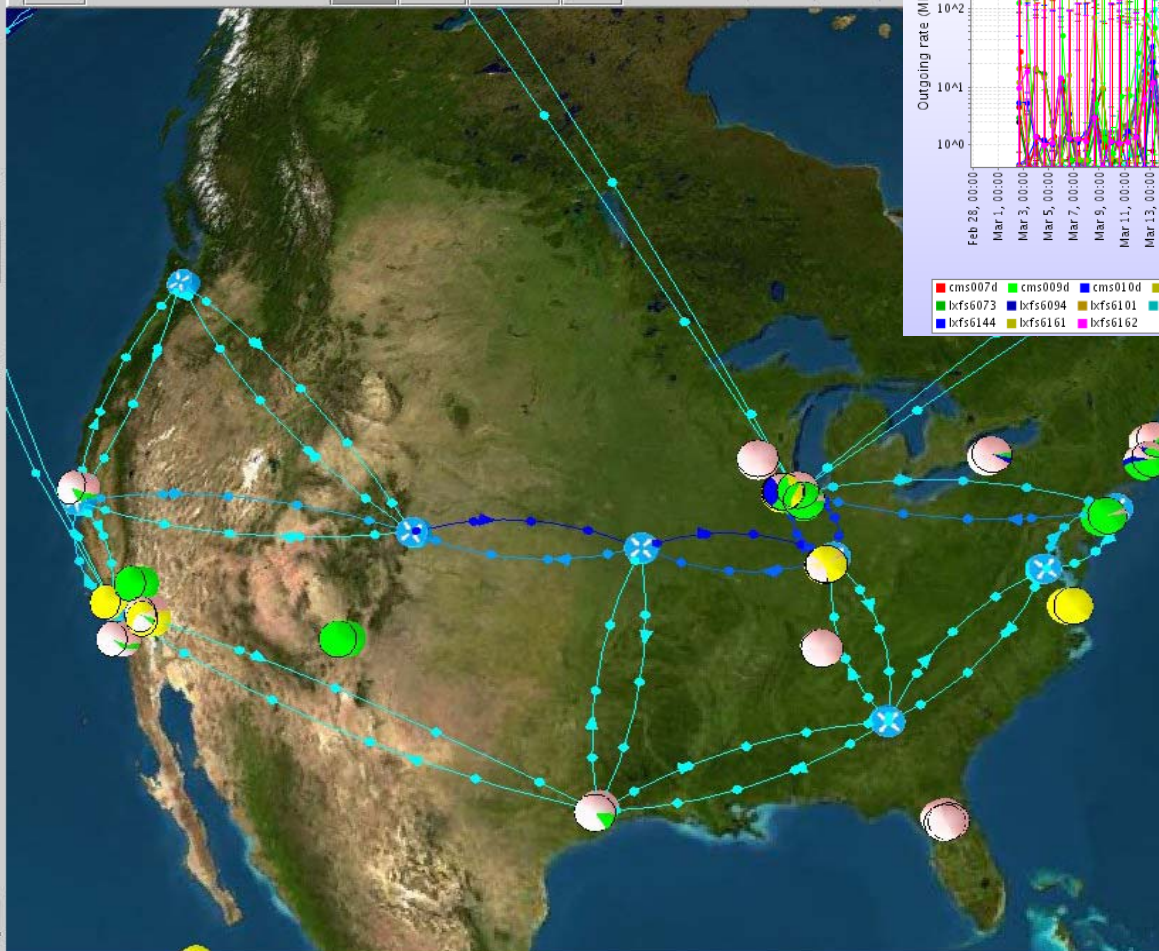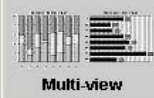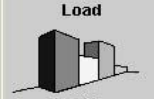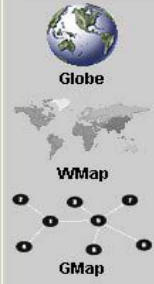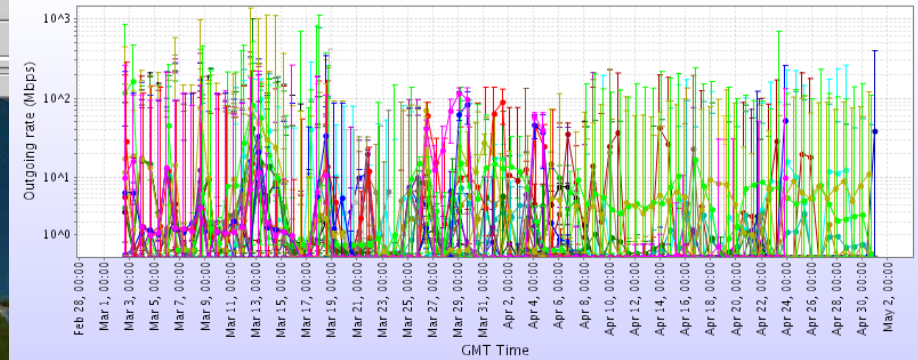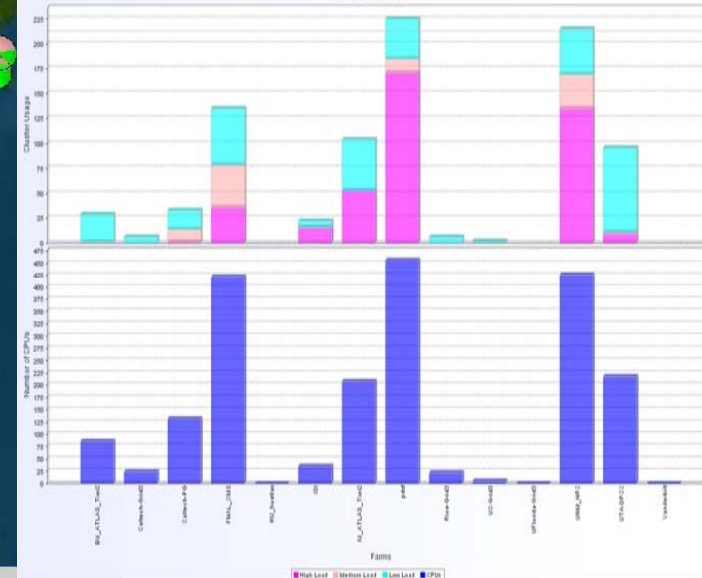
Monitoring Network Topology
Latency, Routers
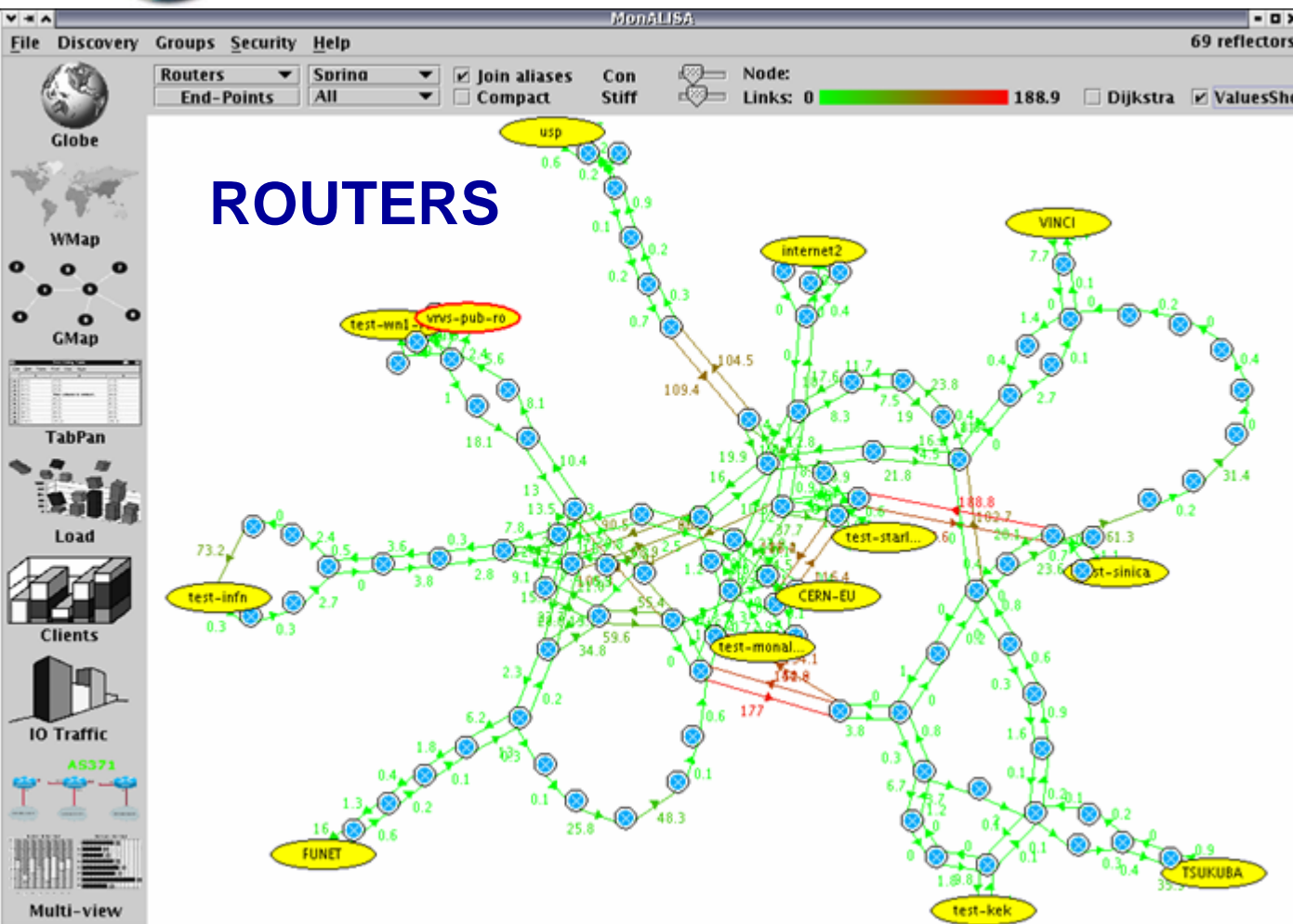
NETWORKS

ROUTERS
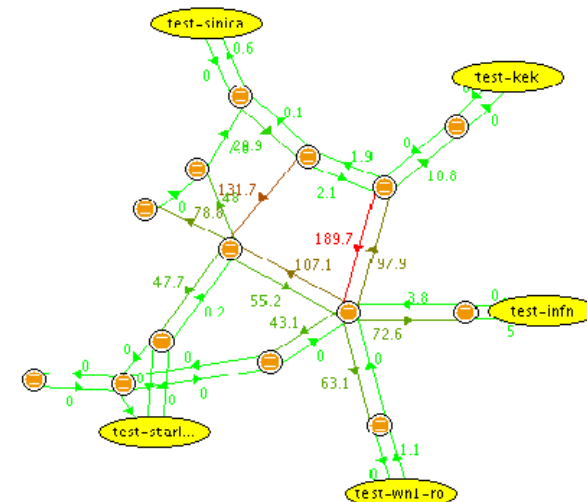
AS
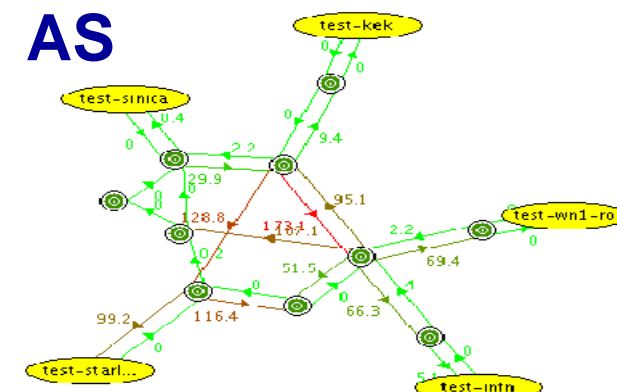
ApMon – Application Monitoring

Library of APIs (C, C++, Java, Perl. Python) that can be used to send any information to MonALISA services

> *Flexibility, dynamic configuration, high communication performance*

- Automated system monitoring
- Accounting information

Config Servlet

dynamic reloading

APPLICATION

App. Monitoring
- Time;IP;procID
- parameter1: value
- parameter2: value
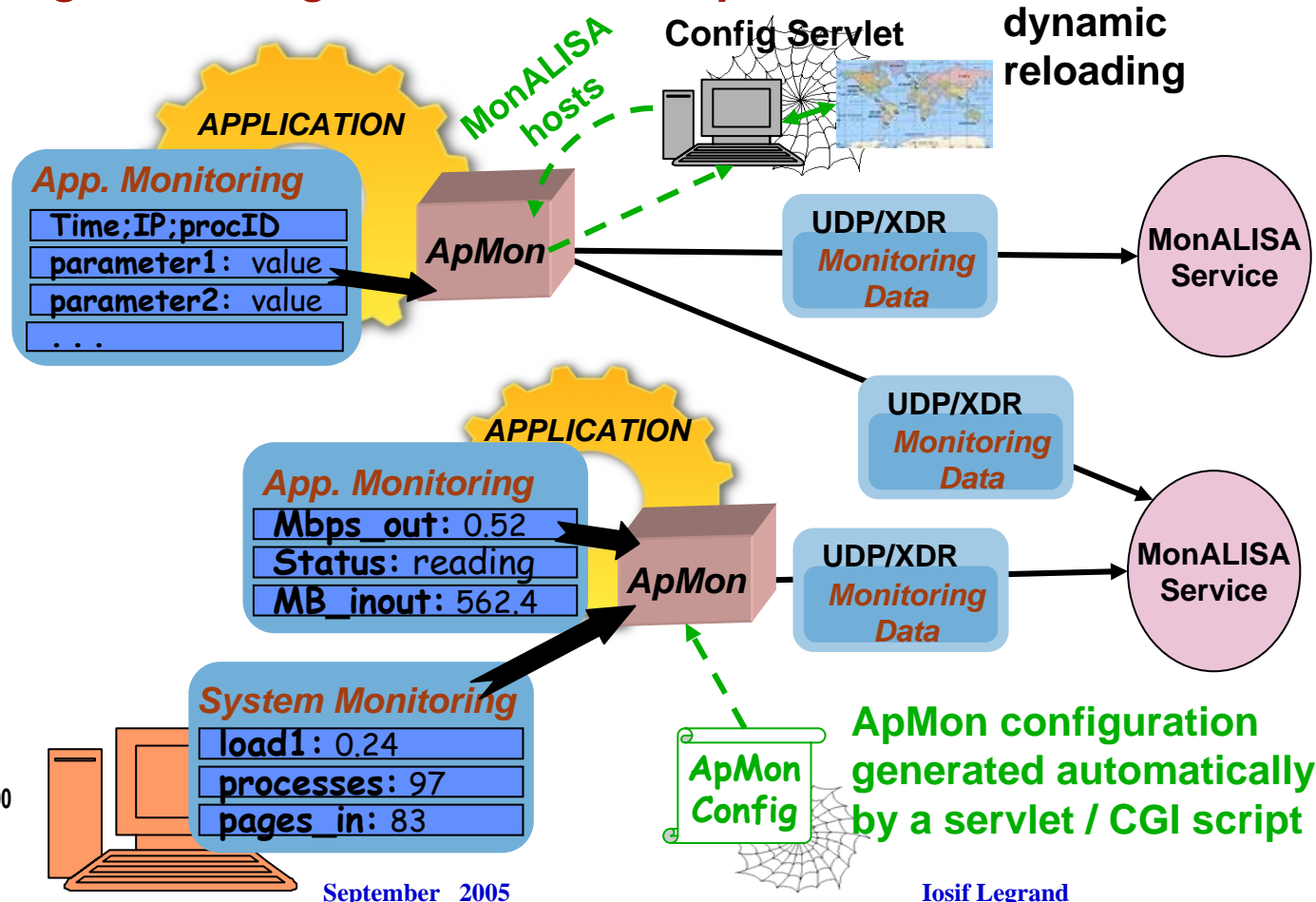- . . .

MonALISA hosts

ApMon

UDP/XDR *Monitoring Data*

MonALISA Service

APPLICATION

App. Monitoring
- Mbps_out: 0.52
- Status: reading
- MB_inout: 562.4

ApMon

UDP/XDR *Monitoring Data*

UDP/XDR *Monitoring Data*

MonALISA Service

System Monitoring
- load1: 0.24
- processes: 97
- pages_in: 83

ApMon Config

ApMon configuration generated automatically by a servlet / CGI script

No Lost Packages

Graph: MonALISA CPU Usage (%) vs Messages per second

MonALISA CPU Usage (%): 0, 10, 20, 30, 40, 50, 60, 70

Messages per second: 0, 1000, 2000, 3000, 4000, 5000, 6000

September   2005

Iosif Legrand

SPLIT JOBS

LIFELINES for JOBS

Summit a Job

Job → Job → Job1, Job2

Job3 → Job 31, Job 32

DAG

September   2005   Iosif Legrand

Monitoring ABILENE backbone Network

- **Test for a Land Speed Record**
- **~ 7 Gb/s in a single TCP stream from Geneva to Caltech**

September 2005   **Iosif Legrand**

September 2005

Iosif Legrand
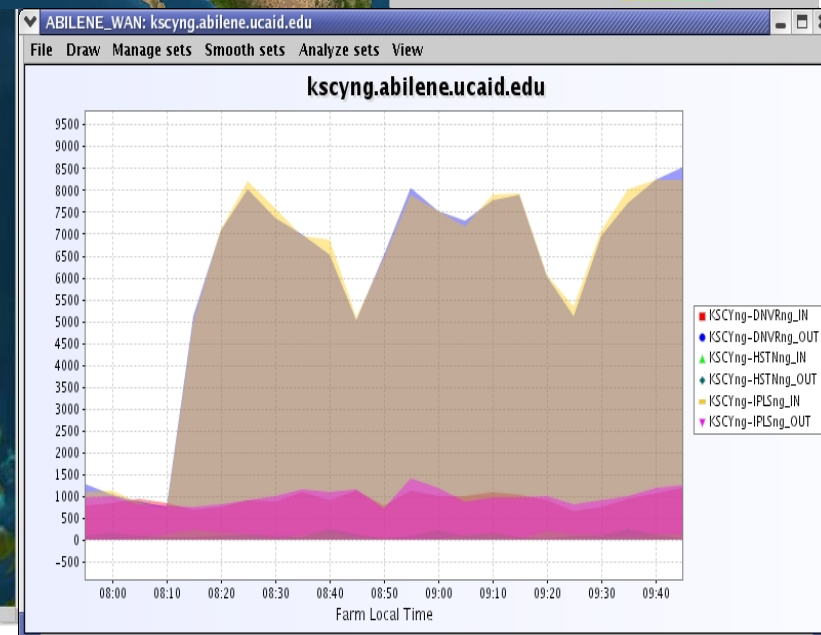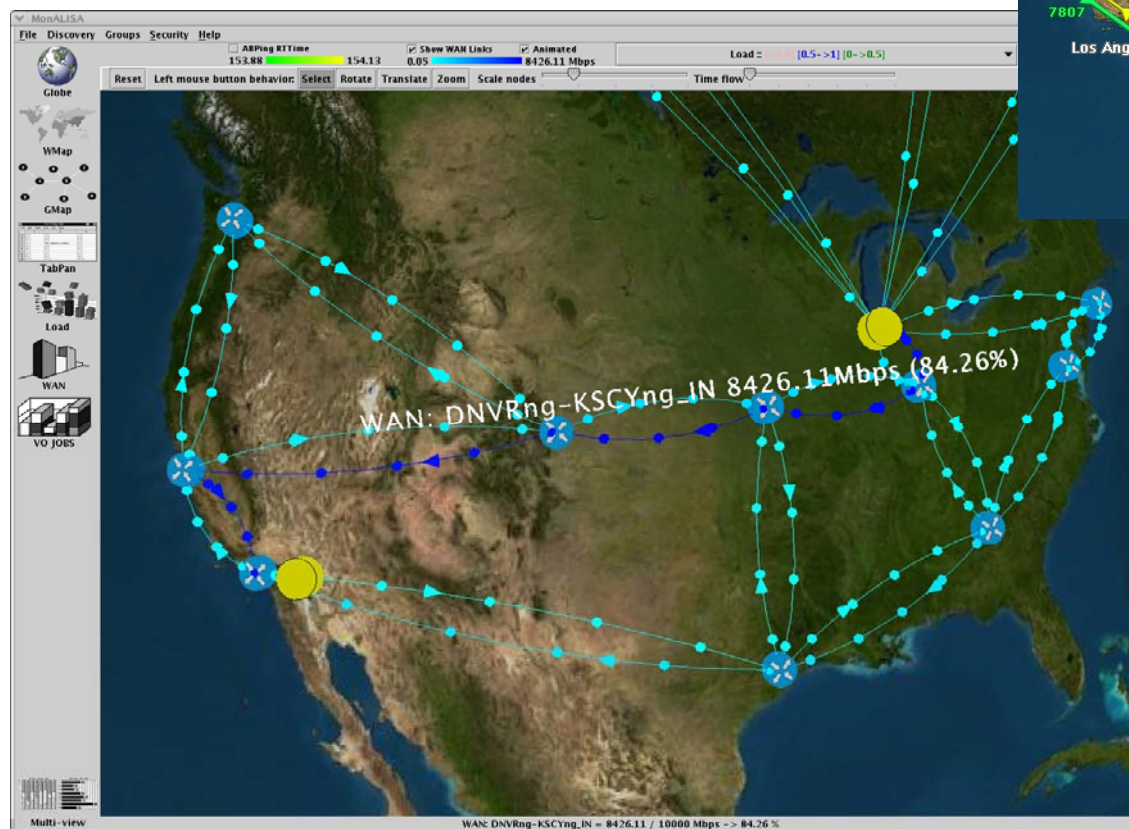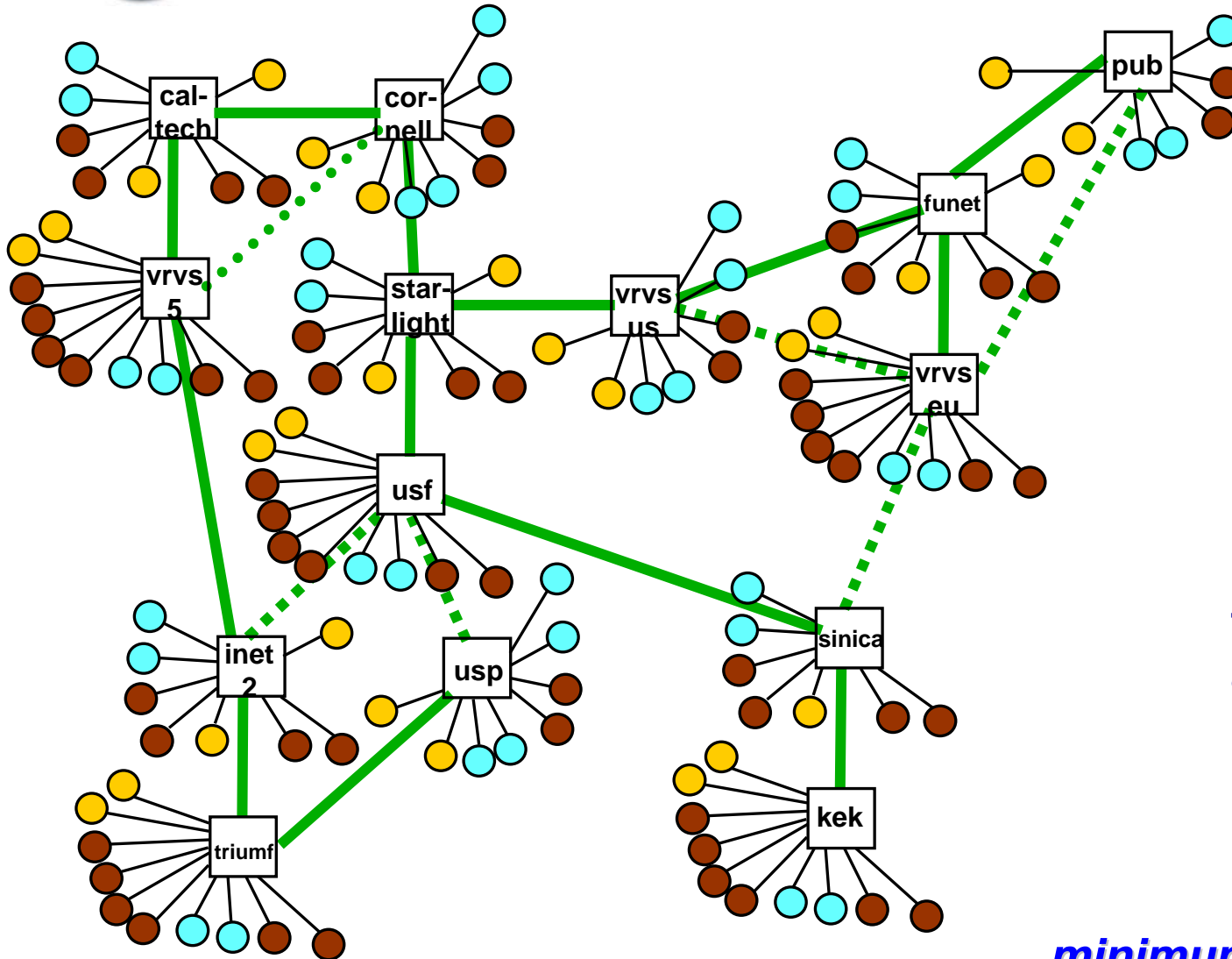
Reflectors are hosts that interconnect users by permanent IP tunnels.

The active IP tunnels must be selected so that there is no cycle formed.

Tree

The selection is made according to the **real-time measurements** of the network performance.

$$w(T) = \sum_{(v,u) \in T} w((v,u))$$

minimum-spanning tree (MST)

A weighted connected graph $G = (V,E)$ with n vertices and m edges. The quality of connectivity between any two reflectors is measured every 2s. Building in near real time a minimum-spanning tree T

$$w(T) = \sum_{(v,u) \in T} w((v,u))$$

LISA- Localhost Information Service Agent
End To End Monitoring Tool

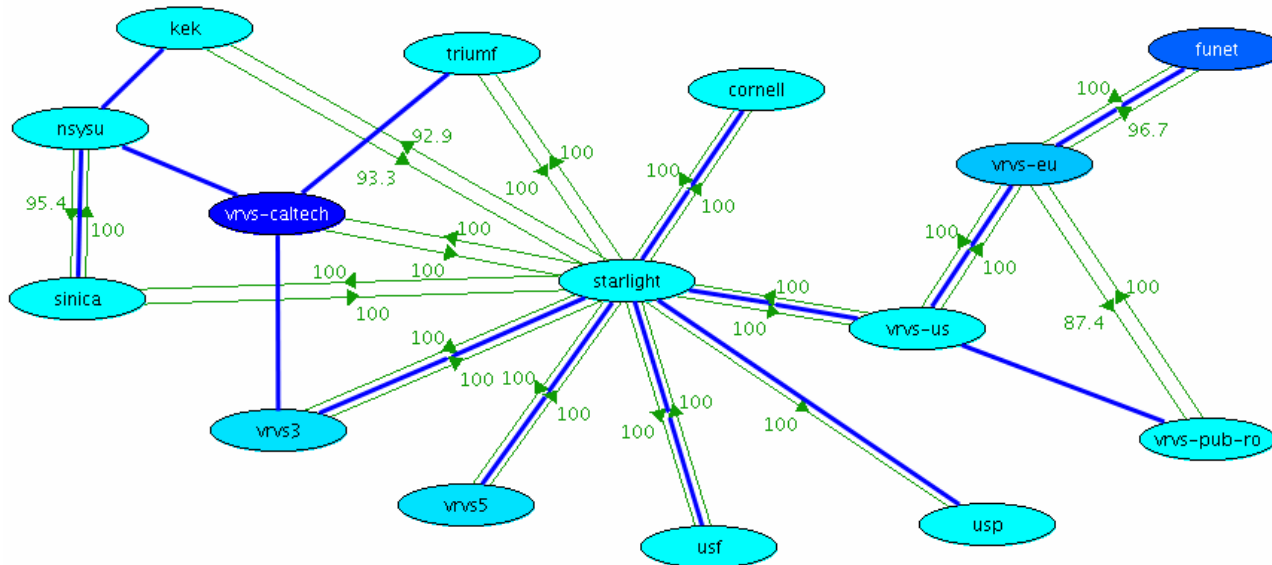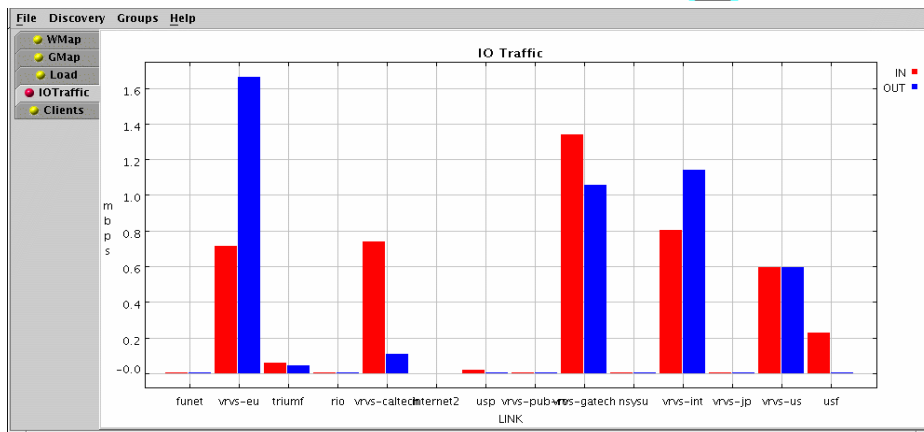**A lightweight Java Web Start application that provides complete monitoring of the end user systems, the network connectivity and can use the MonALISA framework to optimize client applications**

◆ **It is very easy to deploy and install by simply using any browser.**

◆ **It detects the system architecture, the operating system and selects dynamically the binary parts necessary on each system.**

◆ **It can be easily deployed on any system. It is now used on all versions of Windows, Linux, Mac.**

◆ **It provides complete system monitoring of the host computer:**

◆ **CPU, memory, IO, disk, …**

◆ **Hardware detection**

◆ **Main components, Audio, Video equipment,**

◆ **Drivers installed in the system**

◆ **Provides embedded clients for IPERF (or other network monitoring tools, like Web 100)**

◆ **A user friendly GUI to present all the monitoring information.**

18
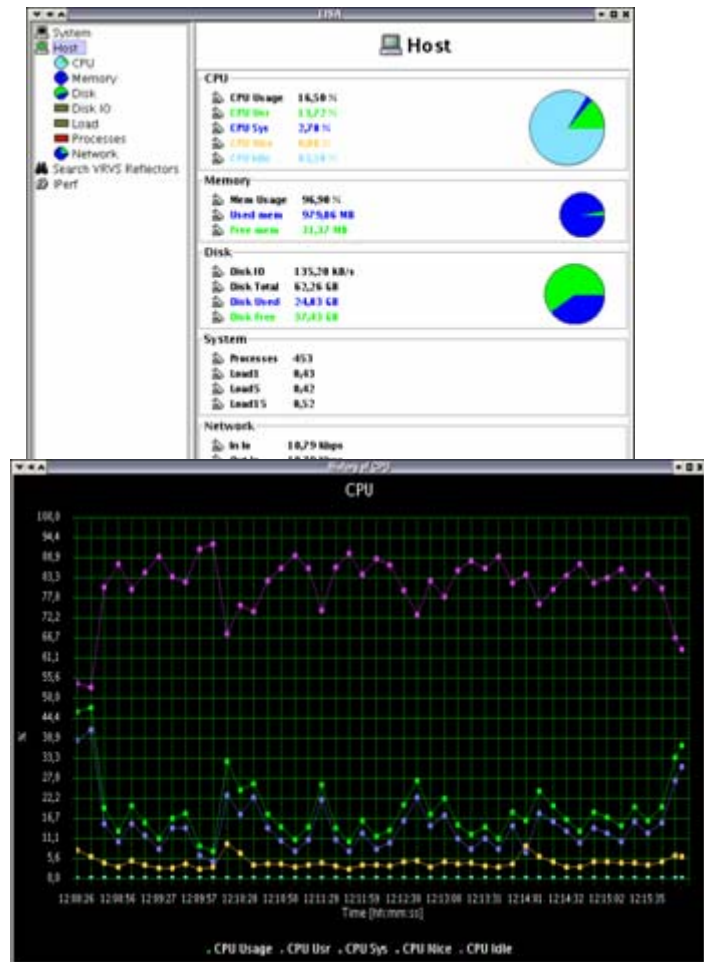
LISA- Provides an Efficient Integration for Distributed Systems and Applications

◆ **It is using external services to identify the real IP of the end system, its network ID and AS**

◆ **Discovers MonALISA services and can select, based on service attributes, different applications and their parameters (location, AS, functionality, load …)**

➔ **Based on information such as AS number or location, it determines a list with the best possible services.**

➔ **Registers as a listener for other service attributes (eg. number of connected clients).**

➔ **Continuously monitors the network connection with several selected services and provides the best one to be used from the client's perspective.**

➔ **Measures network quality, detects faults and informs upper layer services to take appropriate decisions**

19

- ➤ **Dynamic Discovery of Reflectors**

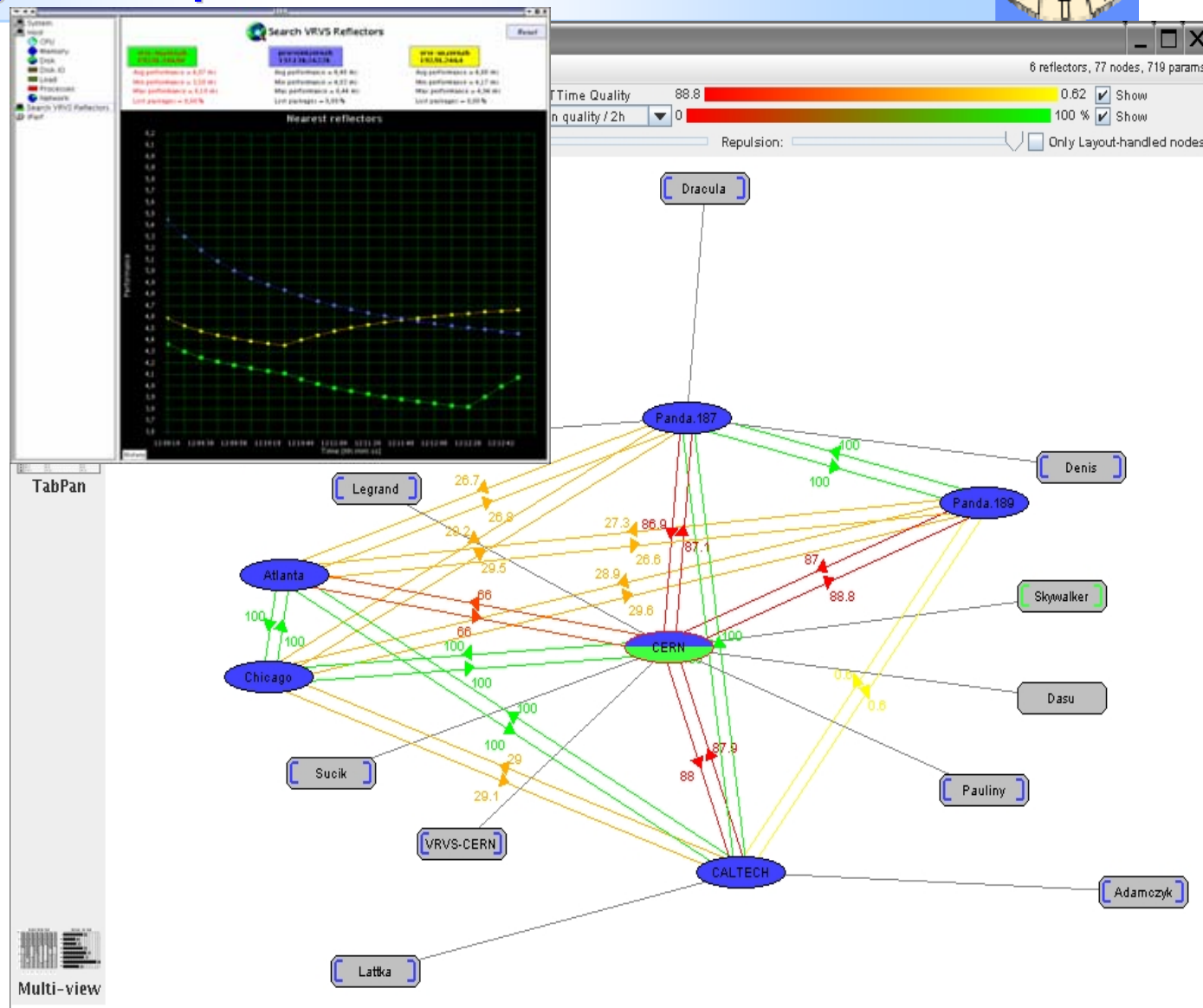- ➤ **Creates and maintains, in real-time, the optimal connectivity between reflectors (MST) based on periodic network measurements.**

- ➤ **Detects and monitor the User configuration, its hardware, the connectivity and its performance.**

- ➤ **Dynamically connects the client to the best reflector**

- ➤ **Provides secure administration.**

- ➤ **It is using alarm triggers to notify unexpected events**

20

MonALISA agents to create on demand on an optical path or tree

Discovery & Secure Connection

ML Agent *MonALISA*

ML Demon

Optical Switch

Optical Switch

Time to create a path on demand <1s independent of the location and the number of connections

Optical Switch

Control and Monitor the switch

ML Agent *MonALISA*

Runs a ML Demon

>ml_path IP1 IP4 "copy file IP4"

ML Agent *MonALISA*

ML proxy services used in Agent Communication

Iosif Legrand

Test Setup for Controlling Optical Switches

CALIENT (LA)

Glimmerglass (GE)

3 partitions on each switch
They are controlled by a MonALISA service
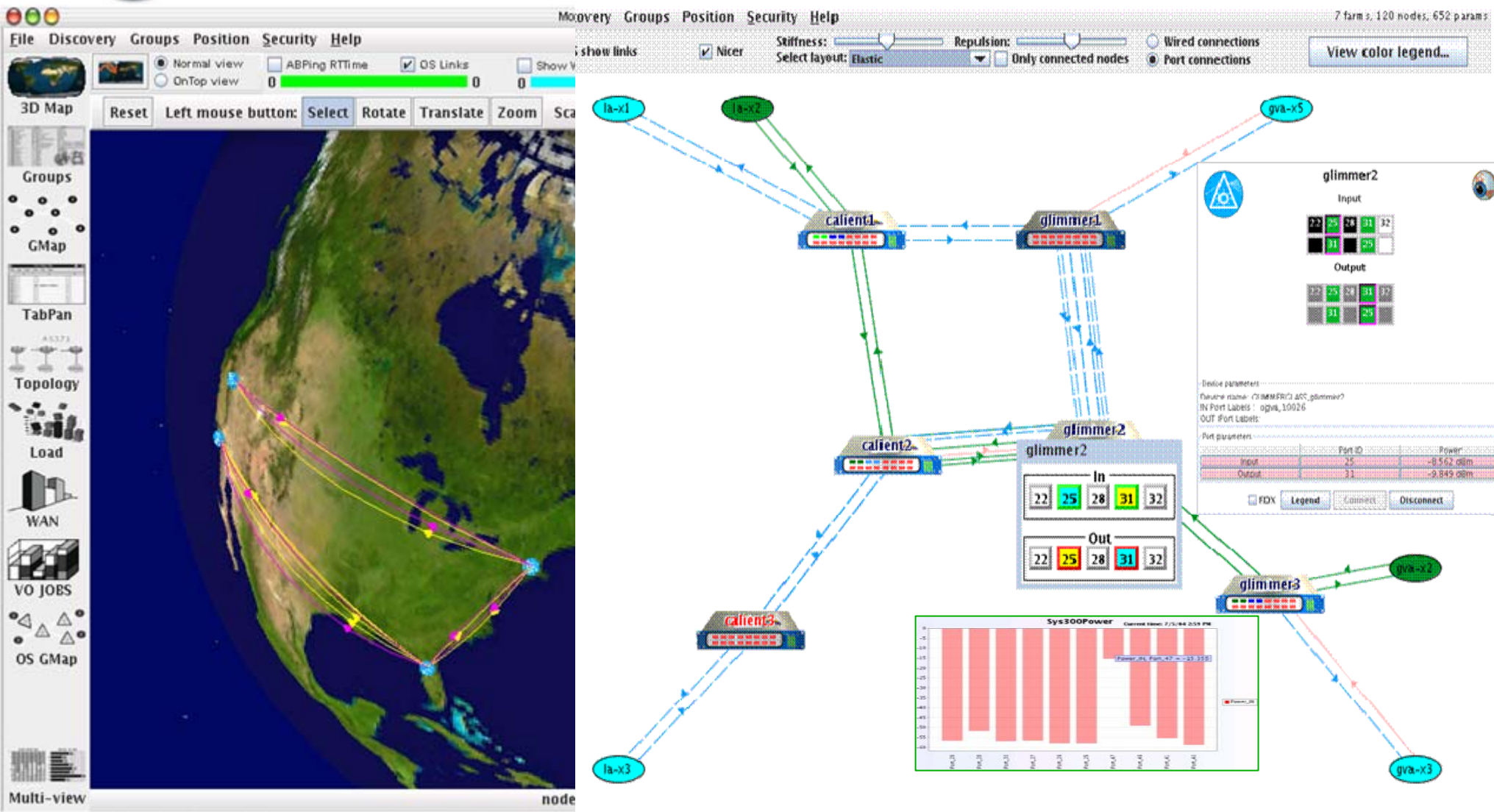
10G links

1G links

3 Simulated
Links as L2 VLAN

◆ **Monitor and control switches using TL1**
◆ **Interoperability between the two systems**
◆ **End User access to service**

September   2005   Iosif Legrand

September 2005   Iosif Legrand

MonALISA is a framework capable to correlate information from different layers

Networking

Farms & Data Serv.

Job1

Job2

Job

Job3

Job 31

Job 32

Applications

Job

User

HELP to create Vertical Integration

NEAR REAL TIME FEEDBACK BETWEEN MAJOR LAYERS IS CRUCIAL FOR DYNAMIC LOAD BALANCING, ADAPATABILITY AND SELF-ORGANIZATION

September 2005   **Iosif Legrand**