MonALISA

MONitoring Agents using a Large Integrated Services Architecture

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

TERENA

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MonALISA is A Dynamic, Distributed Service Architecture

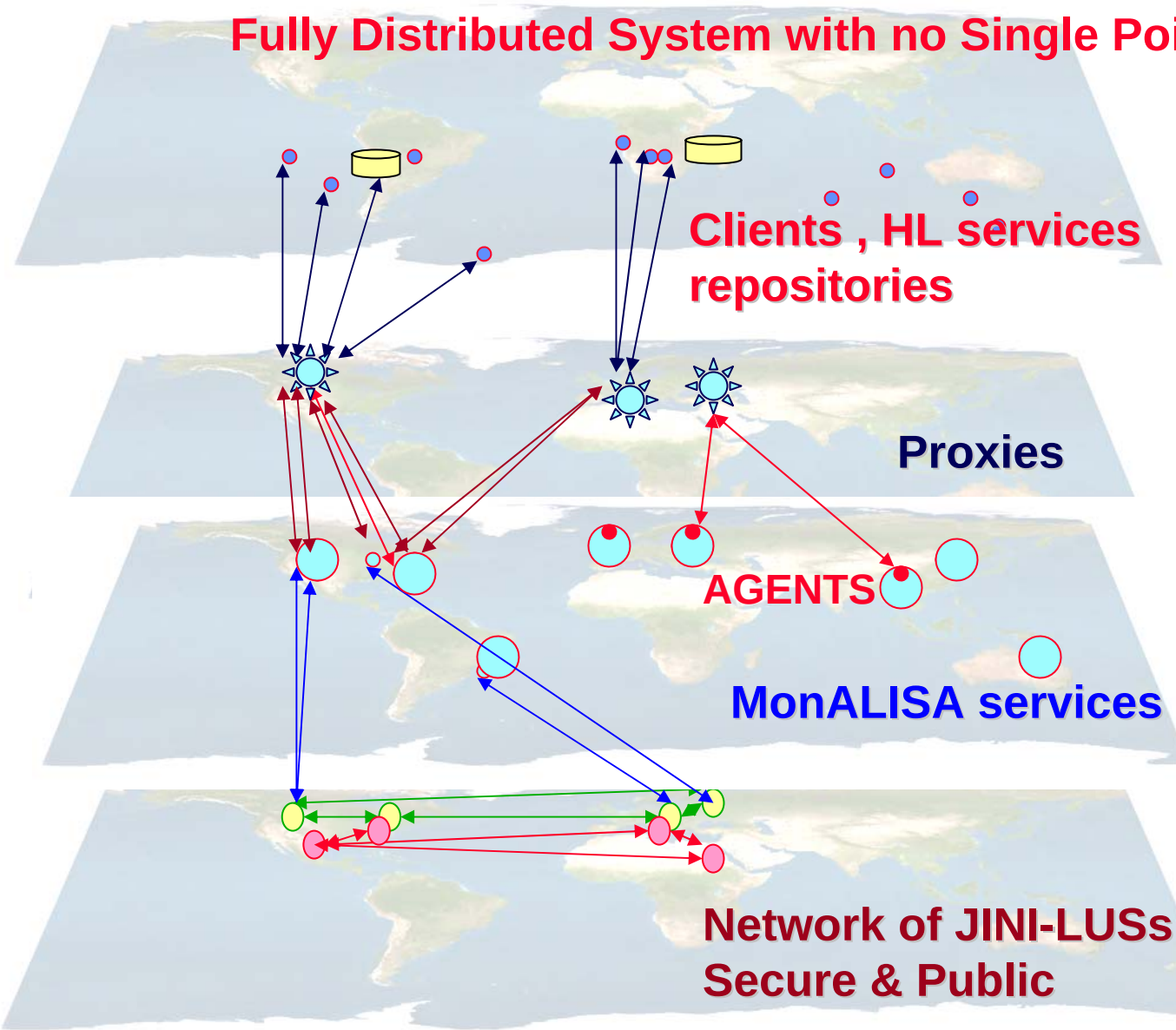
- **Real-time monitoring is an essential part of managing distributed systems. The monitoring information gathered is necessary for developing higher level services, and components that provide automated decisions, to help operate and optimize the workflow in complex systems.**
- **The MonALISA system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

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

The MonALISA Discovery System & Services

Fully Distributed System with no Single Point of Failure



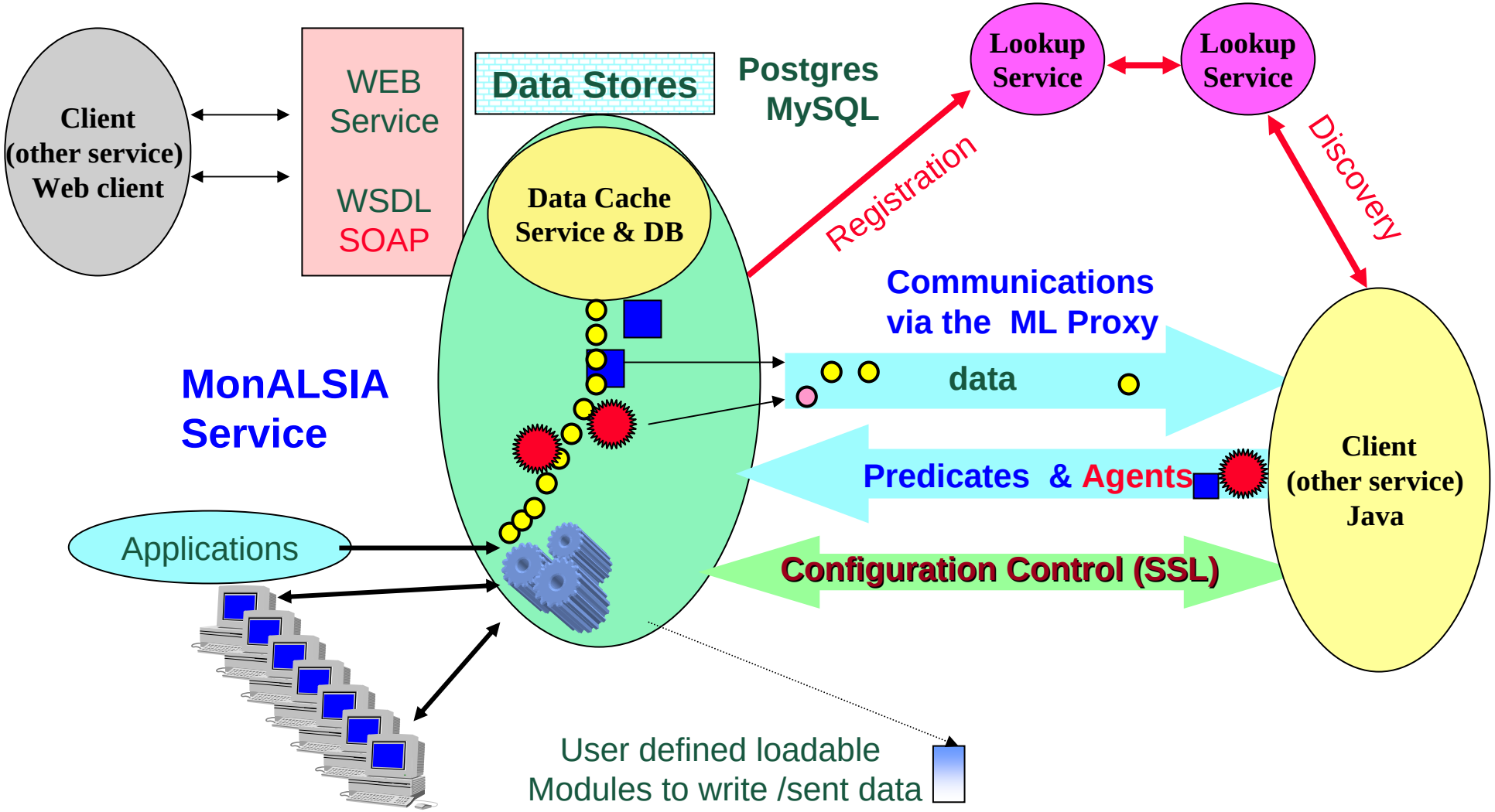
Global Services or Clients

Dynamic load balancing
Scalability & Replication
Security AAA for Clients

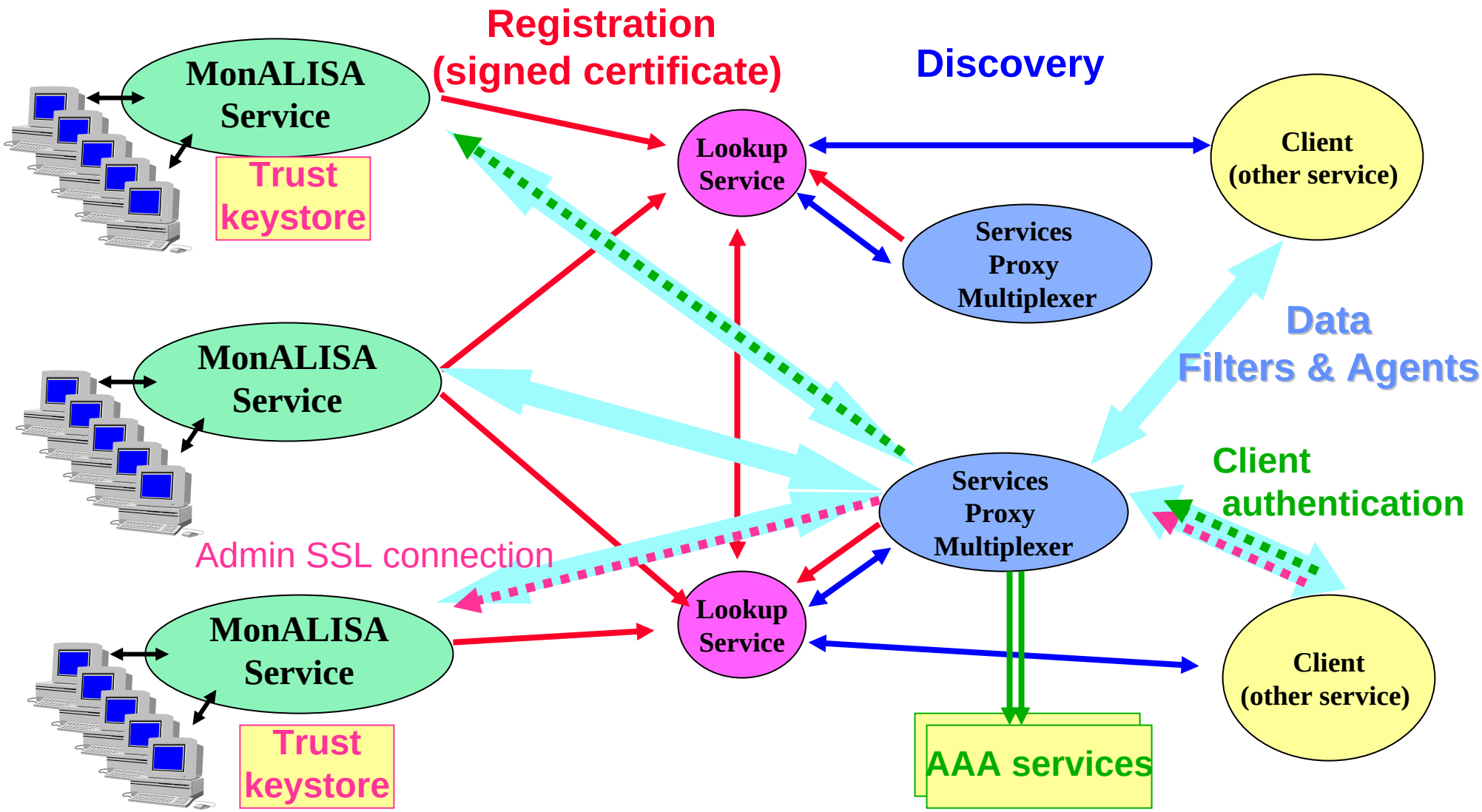
Distributed System for gathering and Analyzing Information.

Distributed Dynamic Discovery- based on a lease Mechanism and REN

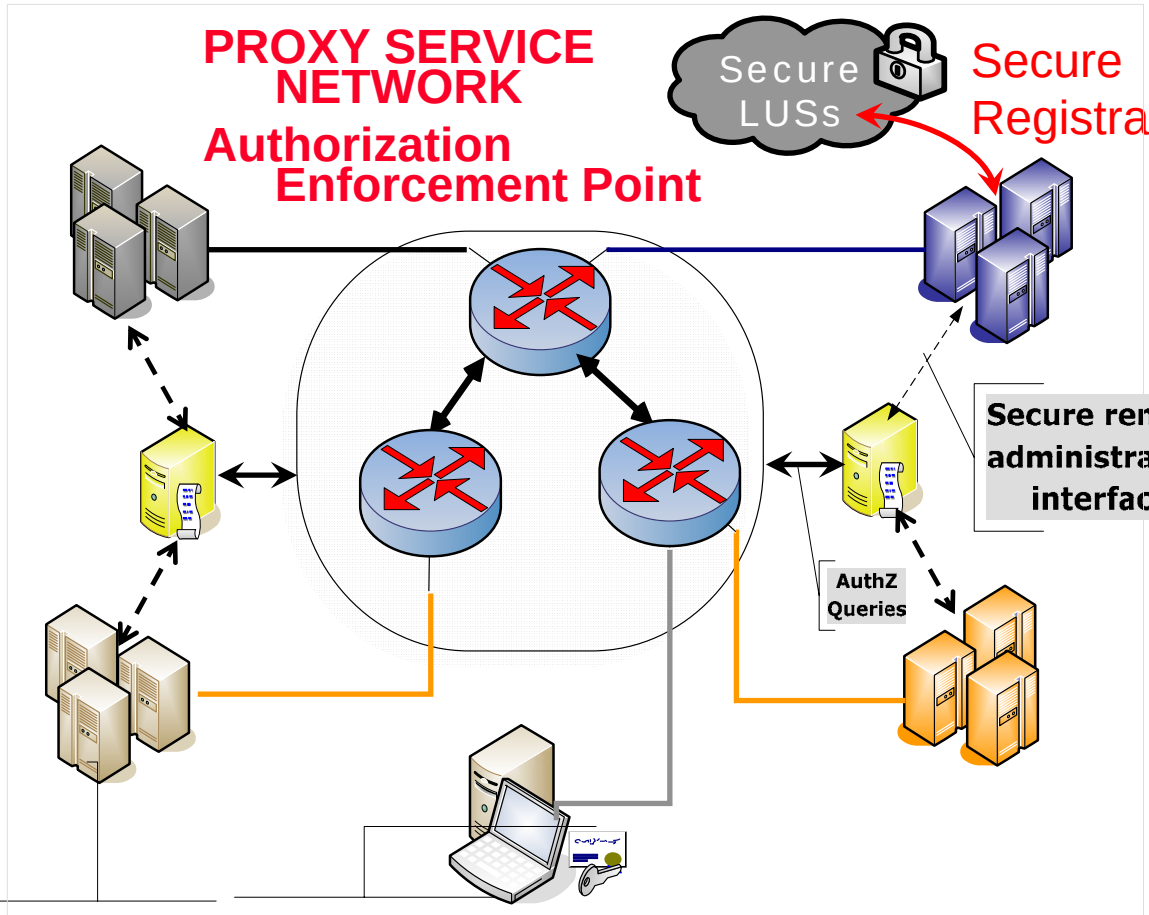
MonALISA service & Data Handling



Registration / Discovery
Admin Access and AAA for Clients



Security in the MonALSIA System



SSL/TLS, PKIX, GSS-API

1) ***Community-based trust relationships.***
Multiple MonaLisa services may be operated by a community. The community memberships is maintained in specialized Authorization Services

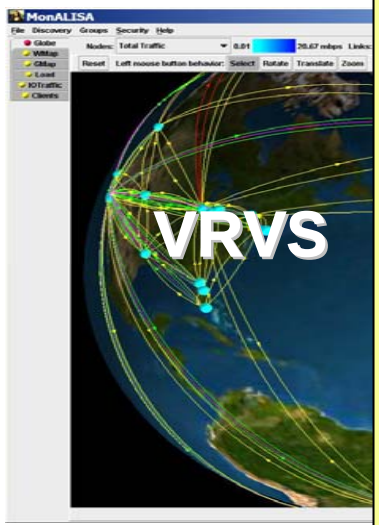
2) ***Flexible communication protection***

3) **Secure registration in LUSs based on an X.509 host or site certificate**

4) ***Auditing***

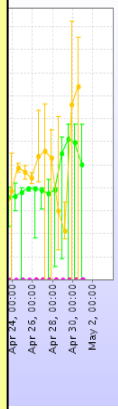
Communities using MonALISA

- Grid3
  ~40 sites in US and 1 Korea
- CMS-US sites
- CMS
- CDF
- D0 SAR
- ABILENE backbone
- GLORIAD
- STAR
- ALICE
- VRVS System
- RoEduNET backbone
- INTERNET2 PIPES
- OSG
- LHCb

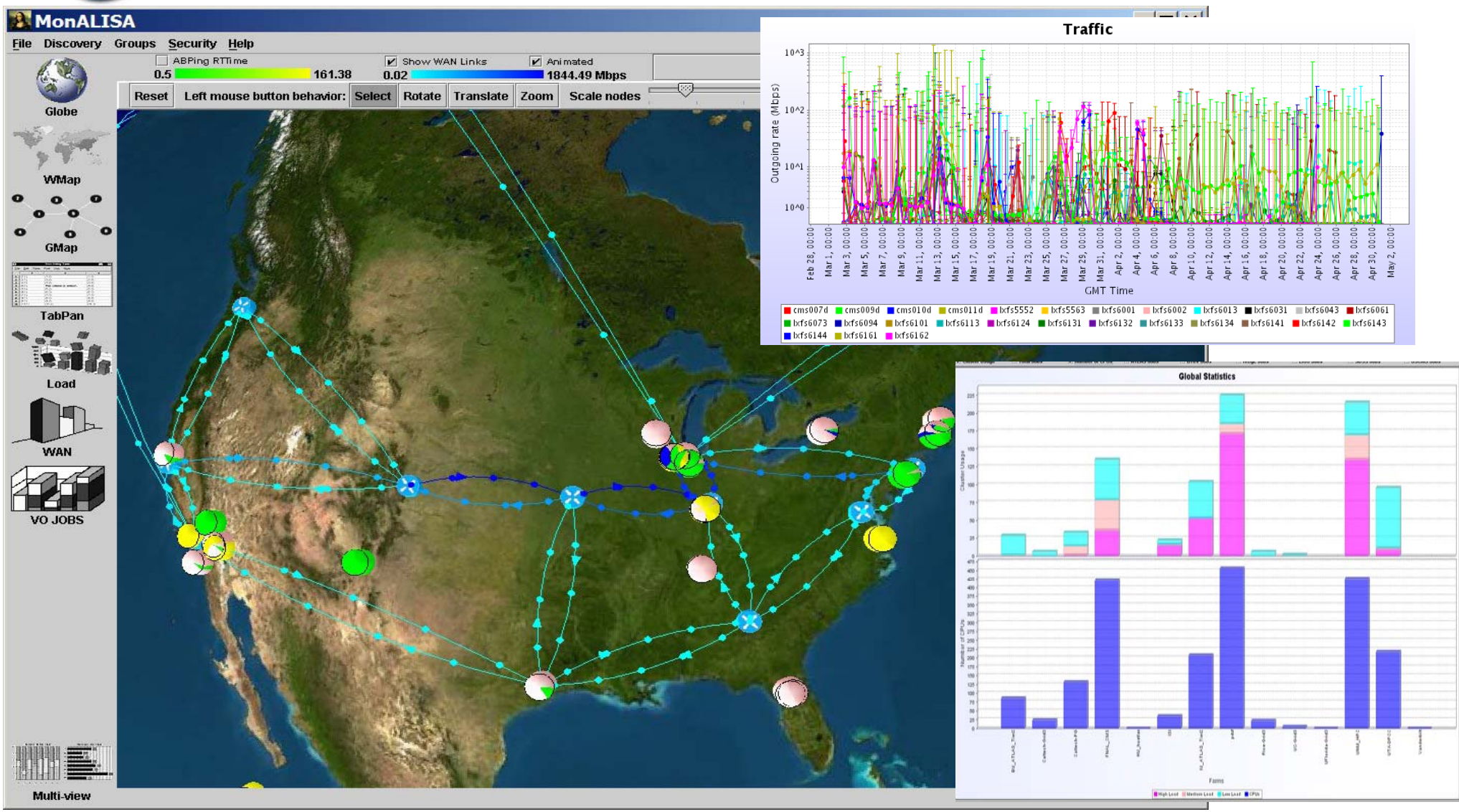


It has been used for Demonstrations at:

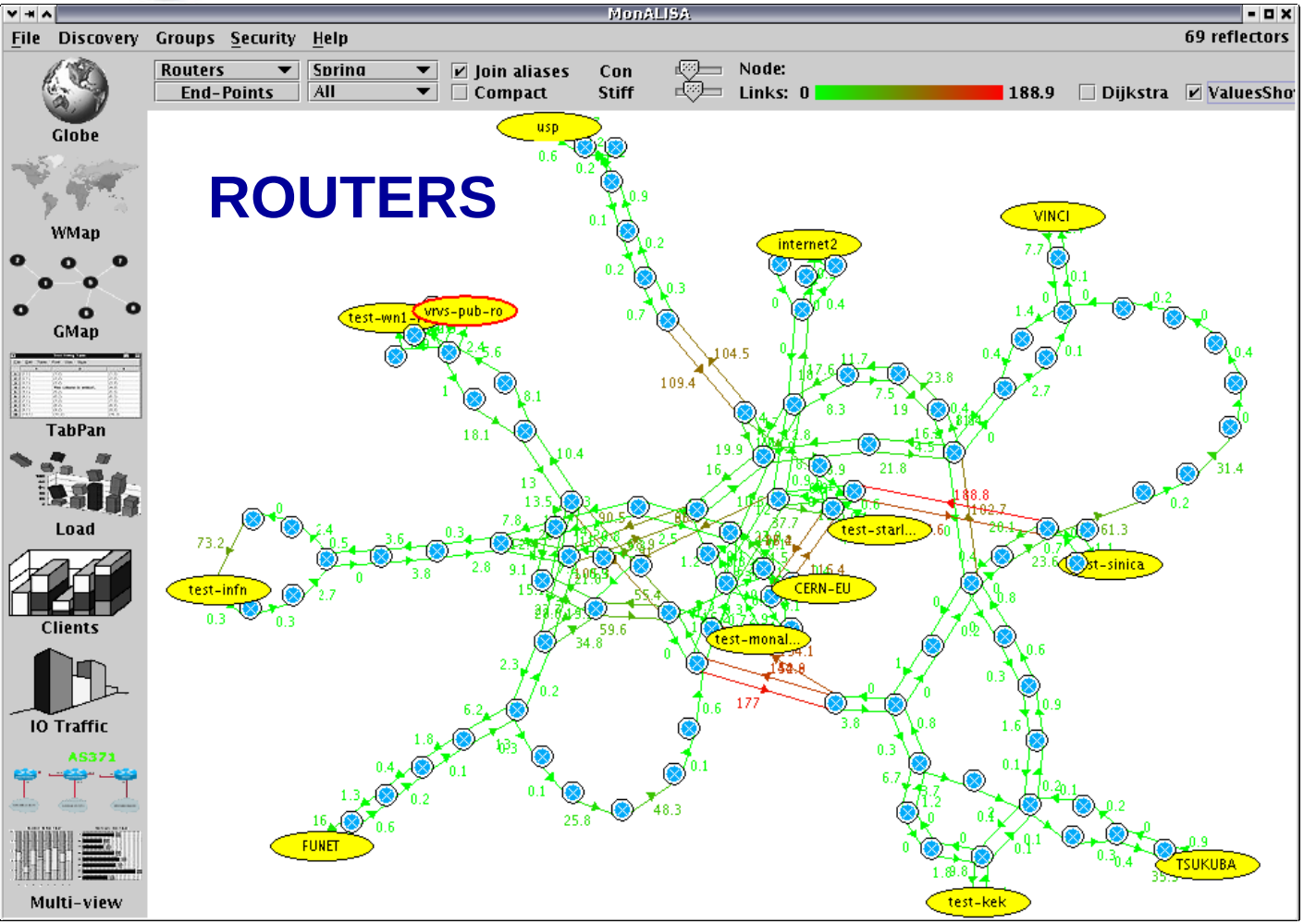
- SC2003
- Telecom 2003
- WSIS 2003
- SC 2004
- I2 2005



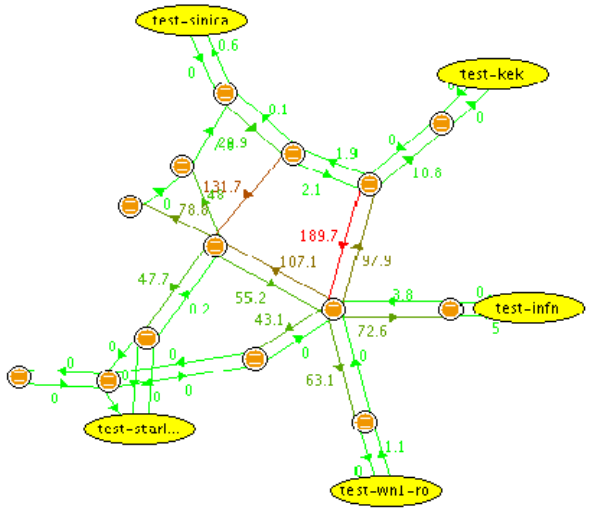
Monitoring I2 Network Traffic, Grid03 Farms and Jobs



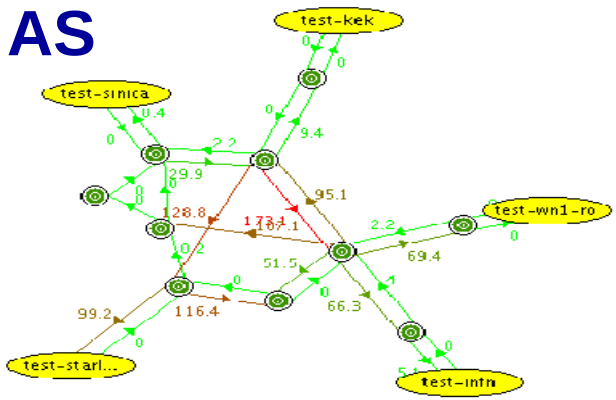
Monitoring Network Topology
Latency, Routers



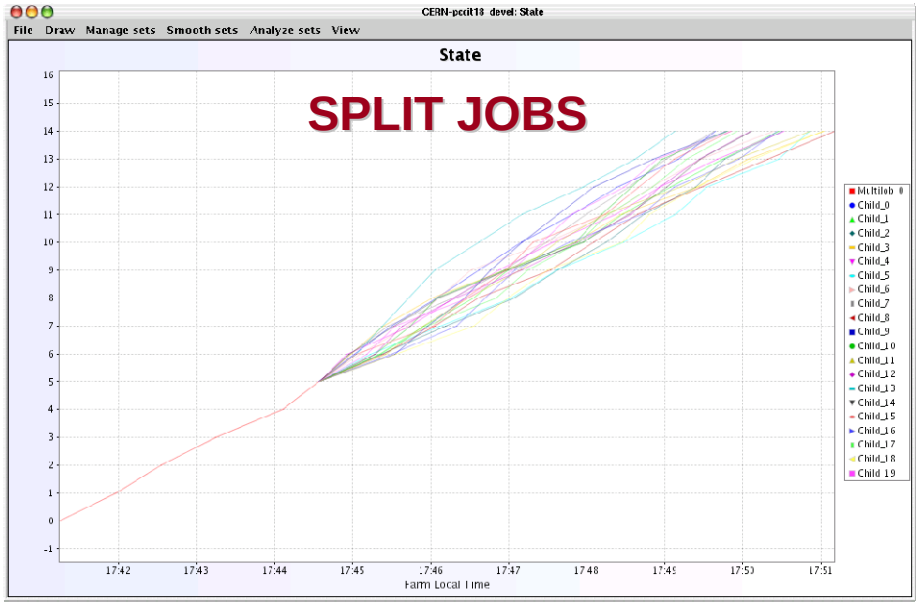
NETWORKS

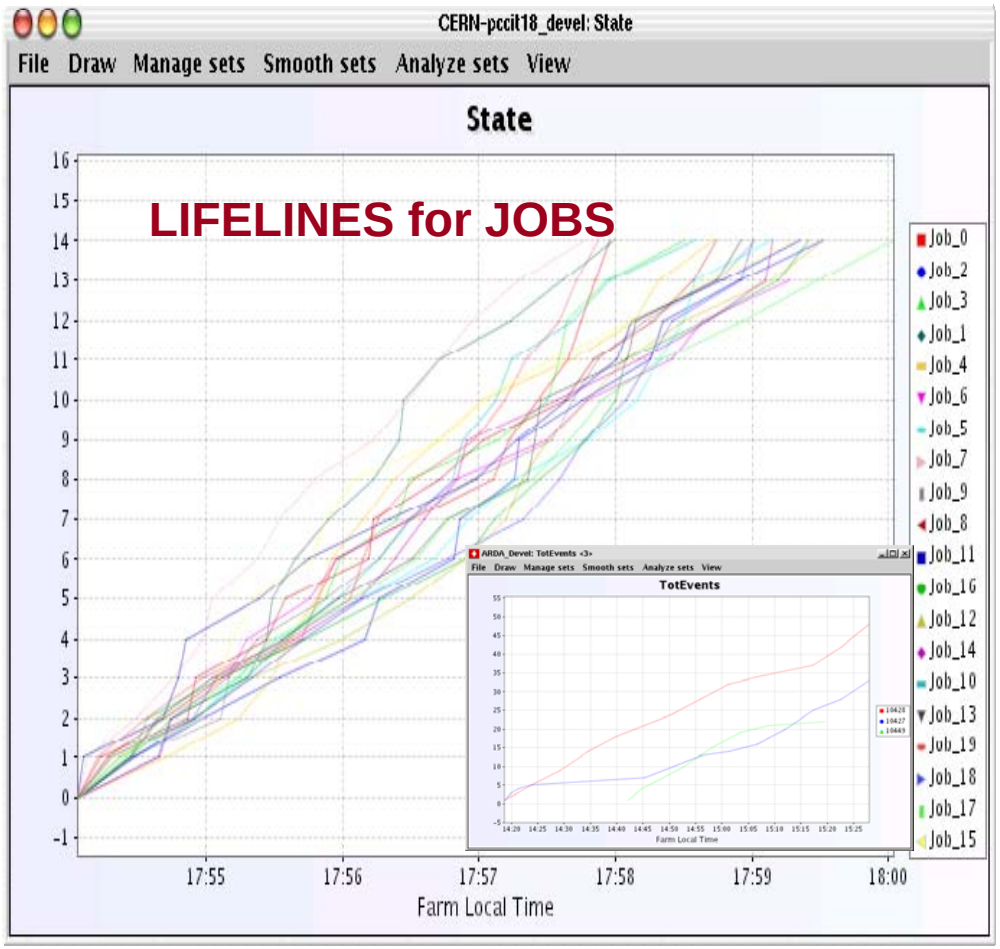


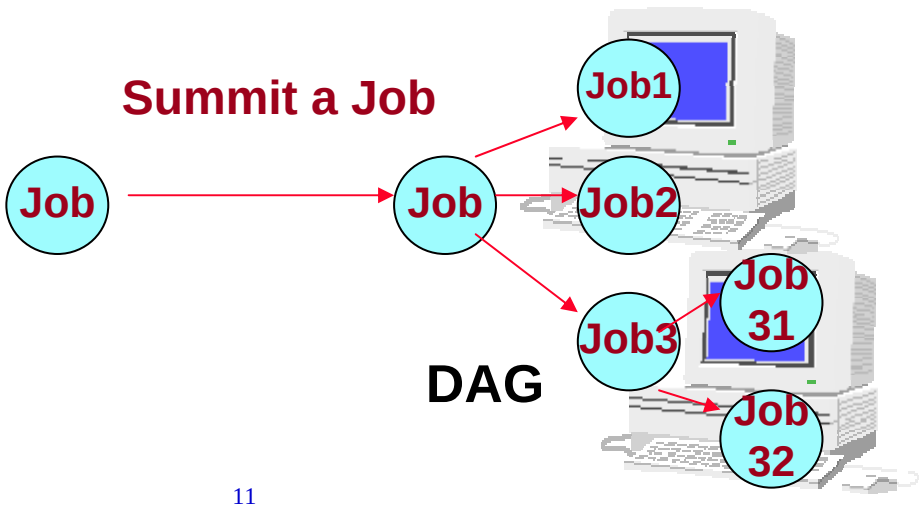
AS



Monitoring the Execution of Jobs and the Time Evolution

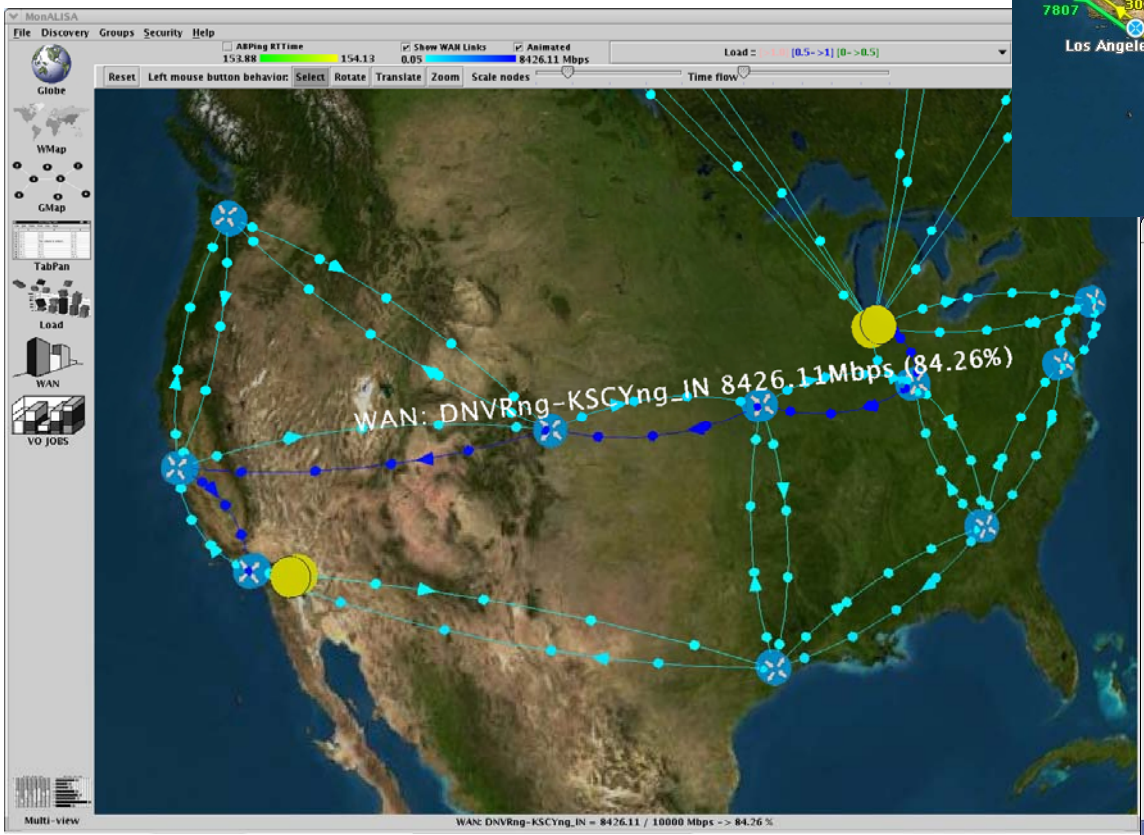


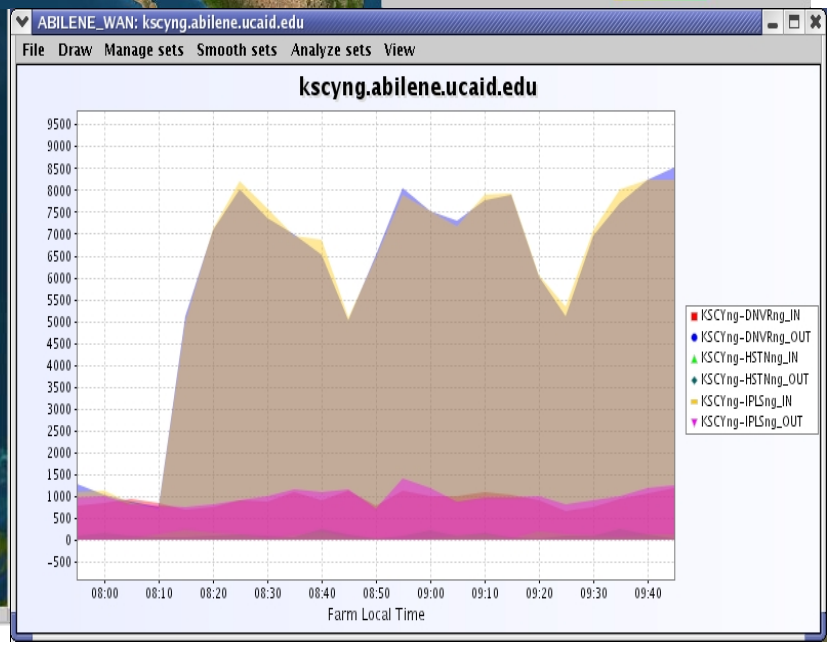




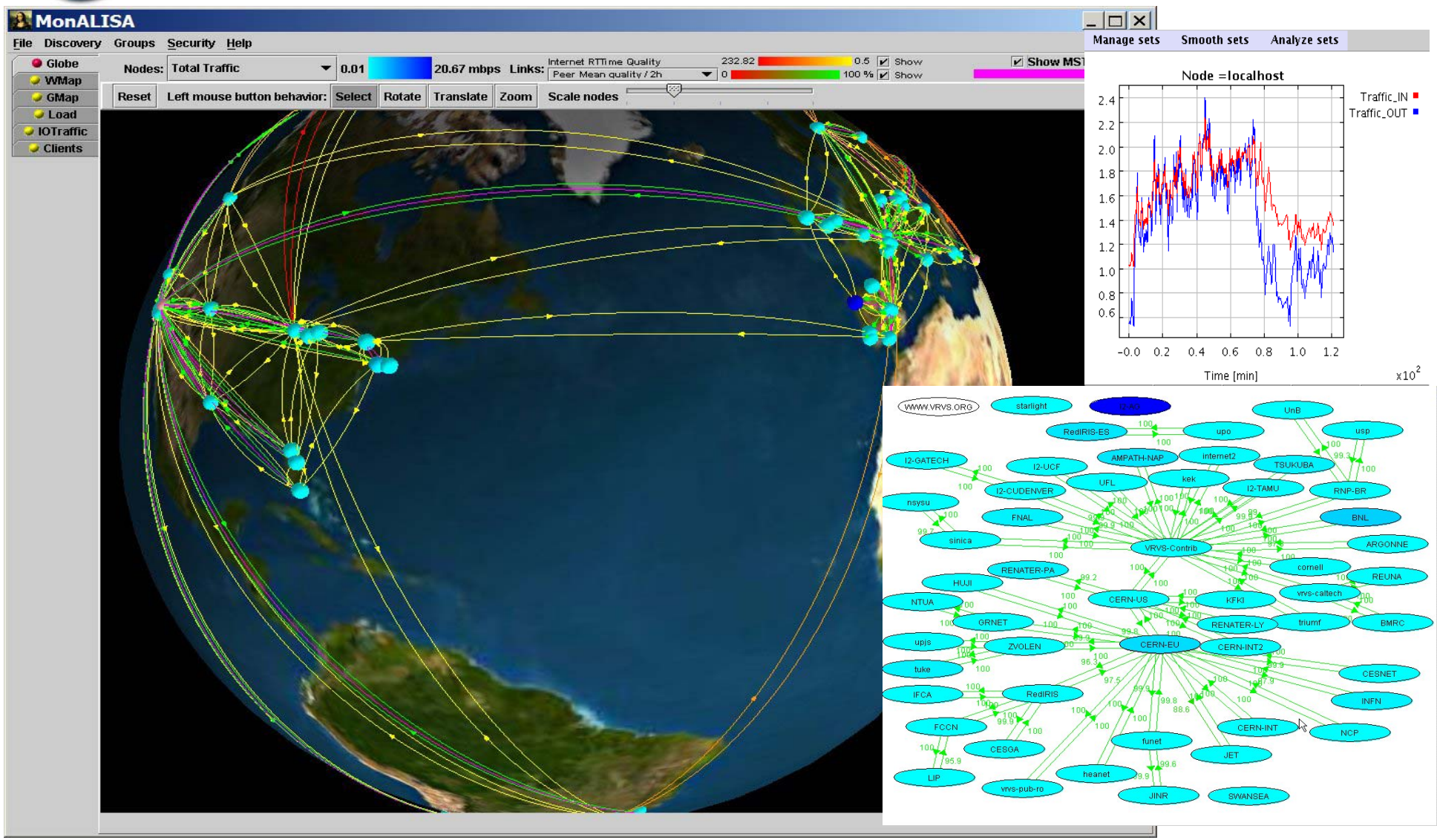
Monitoring ABILENE backbone Network

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





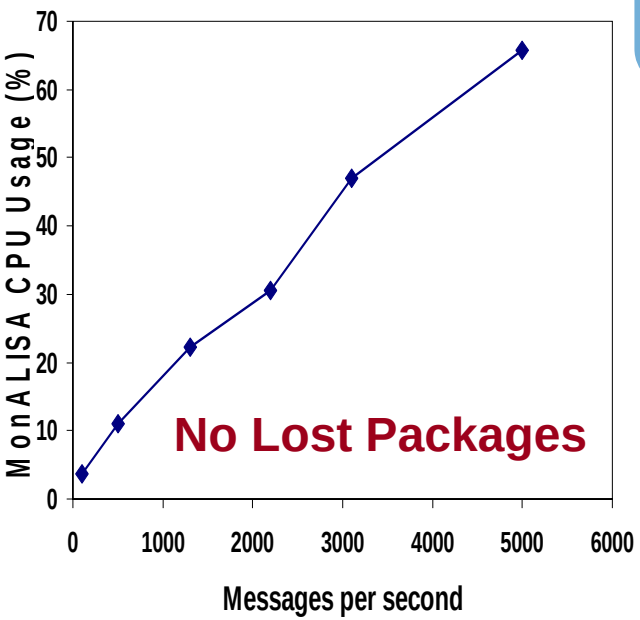
Monitoring VRVS Reflectors and Communication Topology

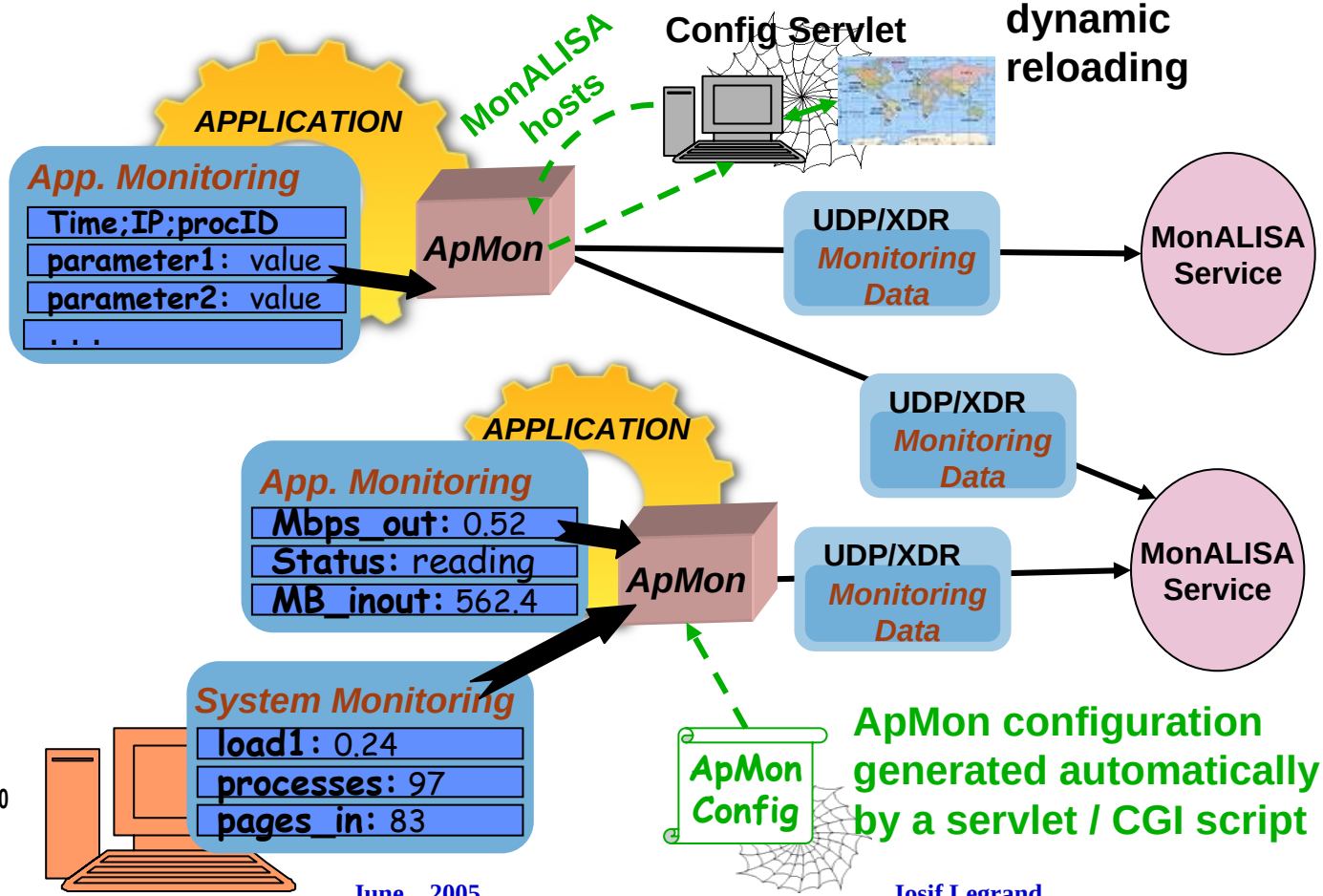


ApMon – Application Monitoring

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**

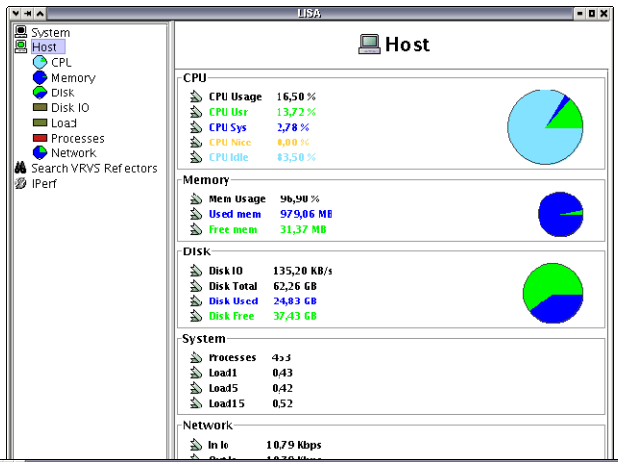


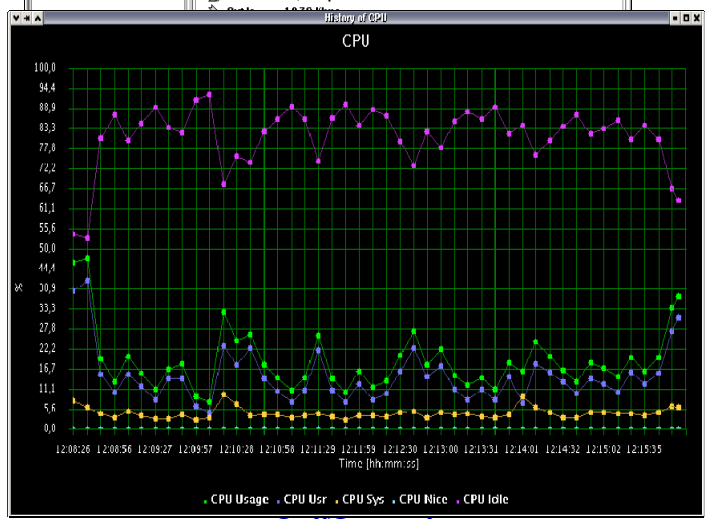


LISA- Localhost Information Service Agent
End To End Monitoring Tool

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

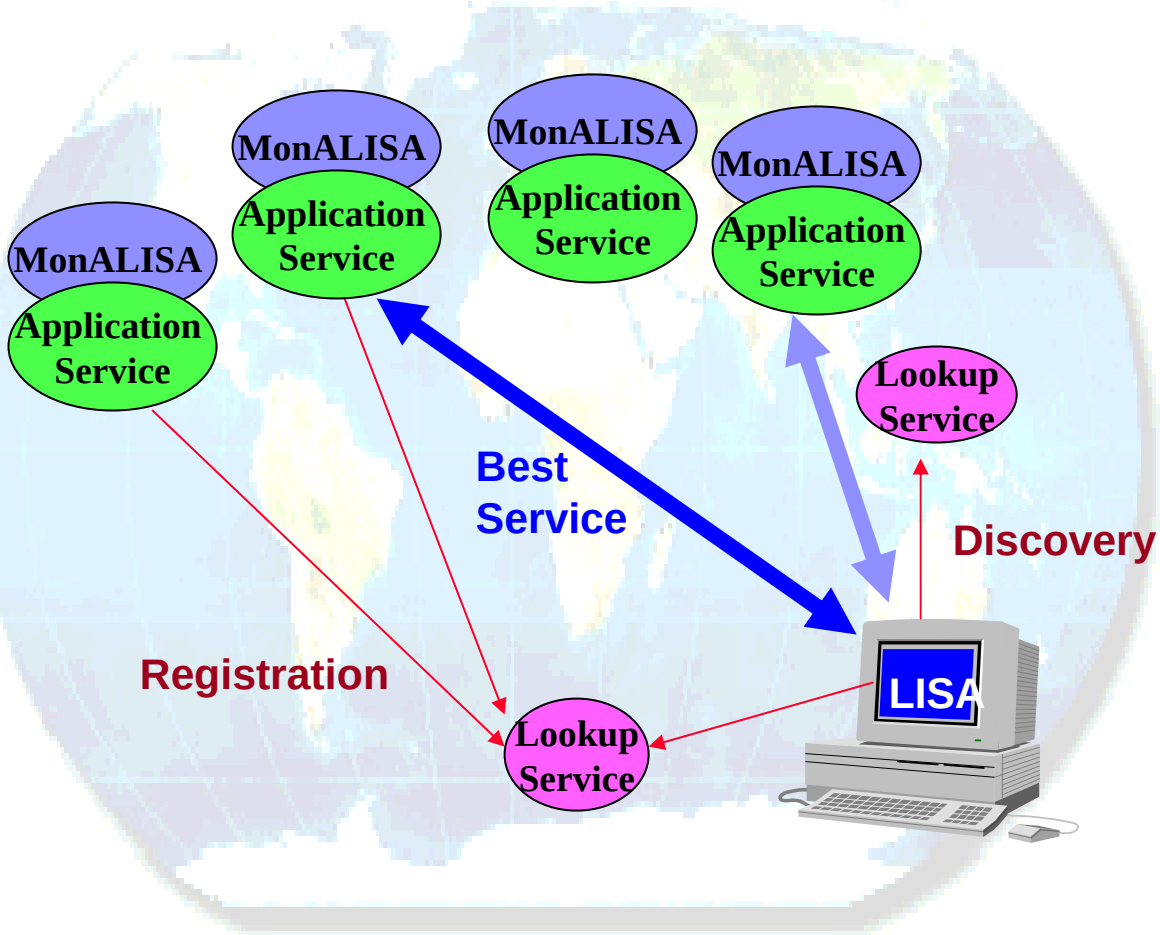
- It is very easy to deploy and install by simply using any browser.
- It detects the system architecture, the operating system and selects dynamically the binary parts necessary on each system.
- It can be easily deployed on any system. It is now used on all versions of Windows, Linux, Mac.
- It provides 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.



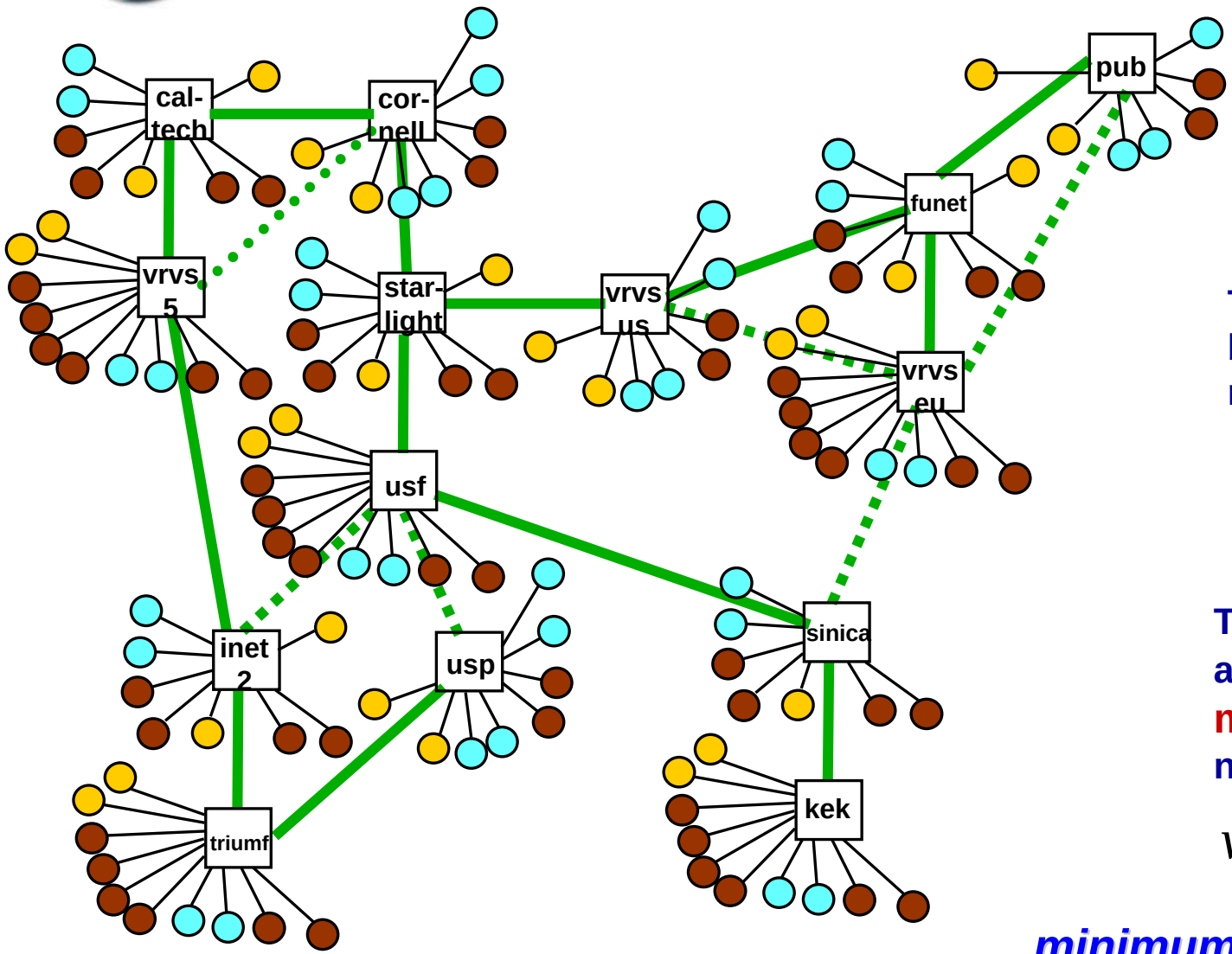


LISA- Provides an Efficient Integration for Distributed Systems and Applications

- 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



Communication in the Distributed Collaborative System



Reflectors are hosts that interconnect users by permanent IP tunnels.

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

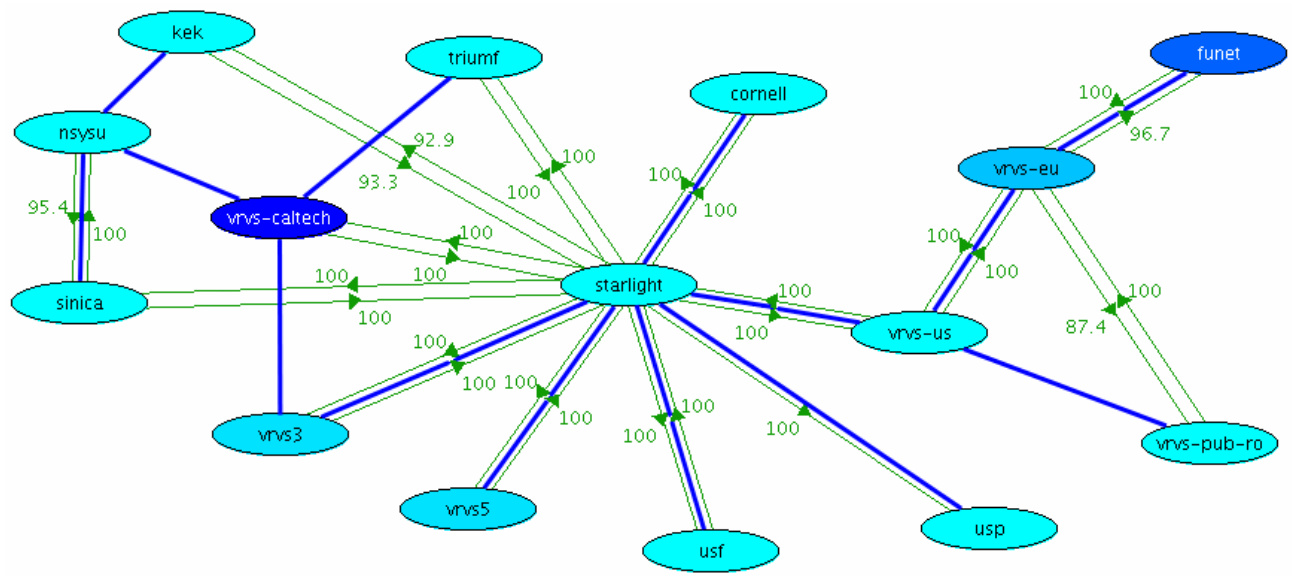
Tree

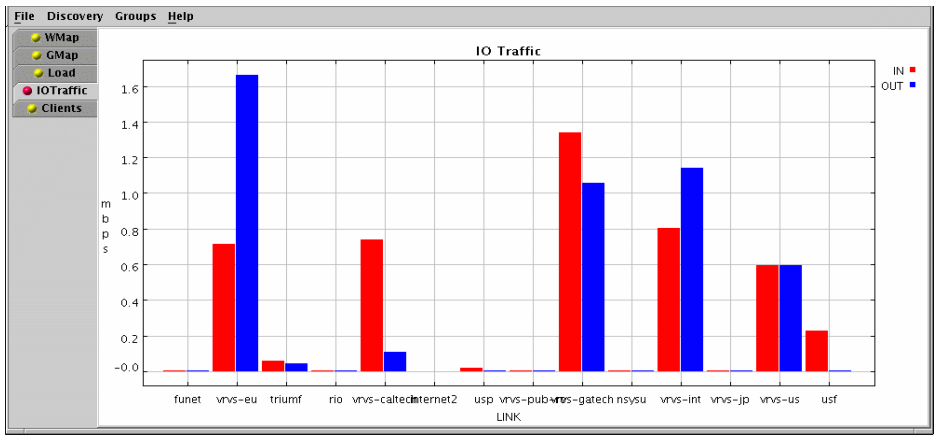
The selection is made according to the **real-time measurements** of the network performance.

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

minimum-spanning tree (MST)

Creating a Dynamic, Global, Minimum Spanning Tree to optimize the connectivity



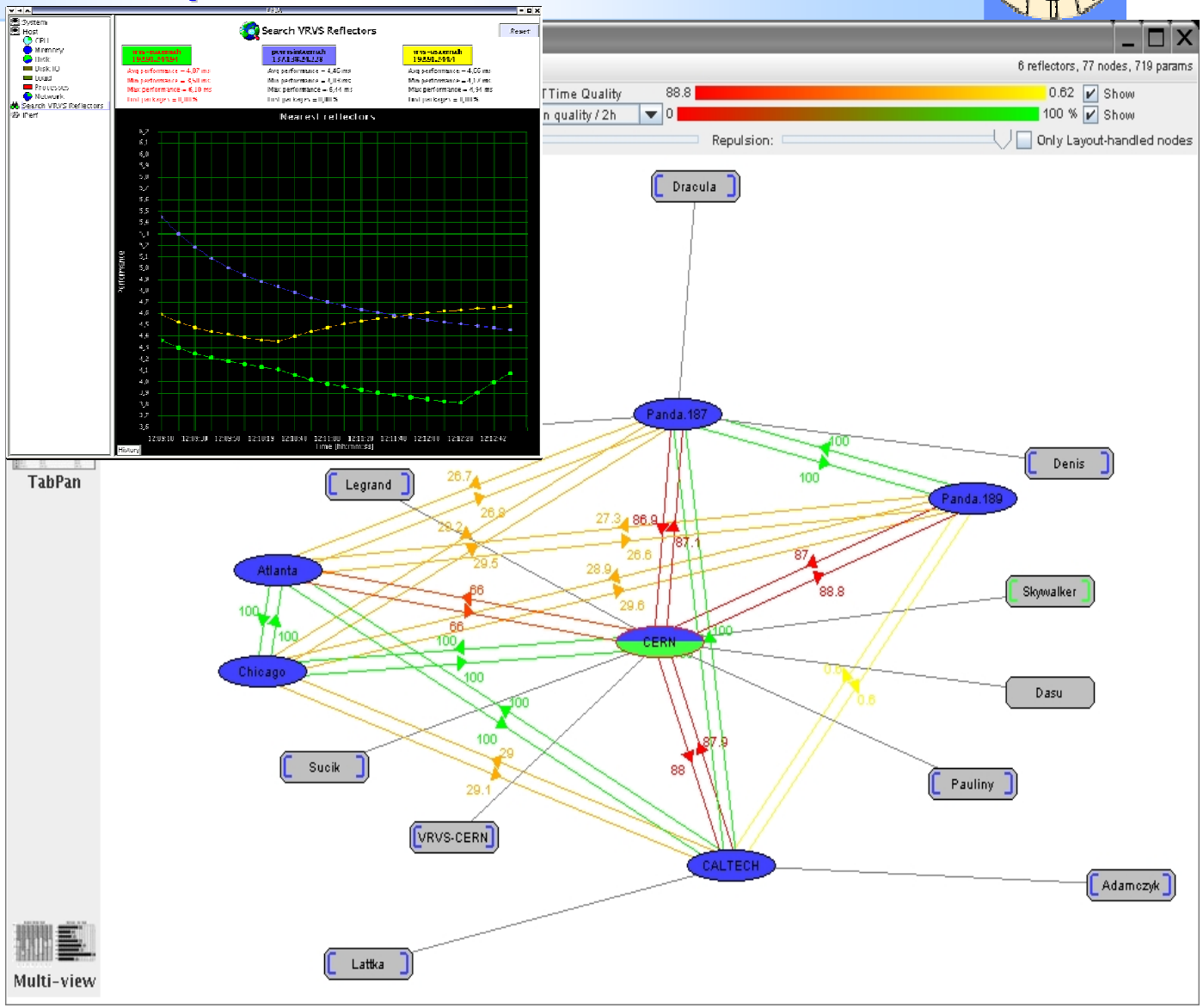


A weighted connected graph $G = (V,E)$ with n vertices and m edges. The quality of connectivity between any two reflectors is measured every 2s. Building in near real time a minimum-spanning tree T

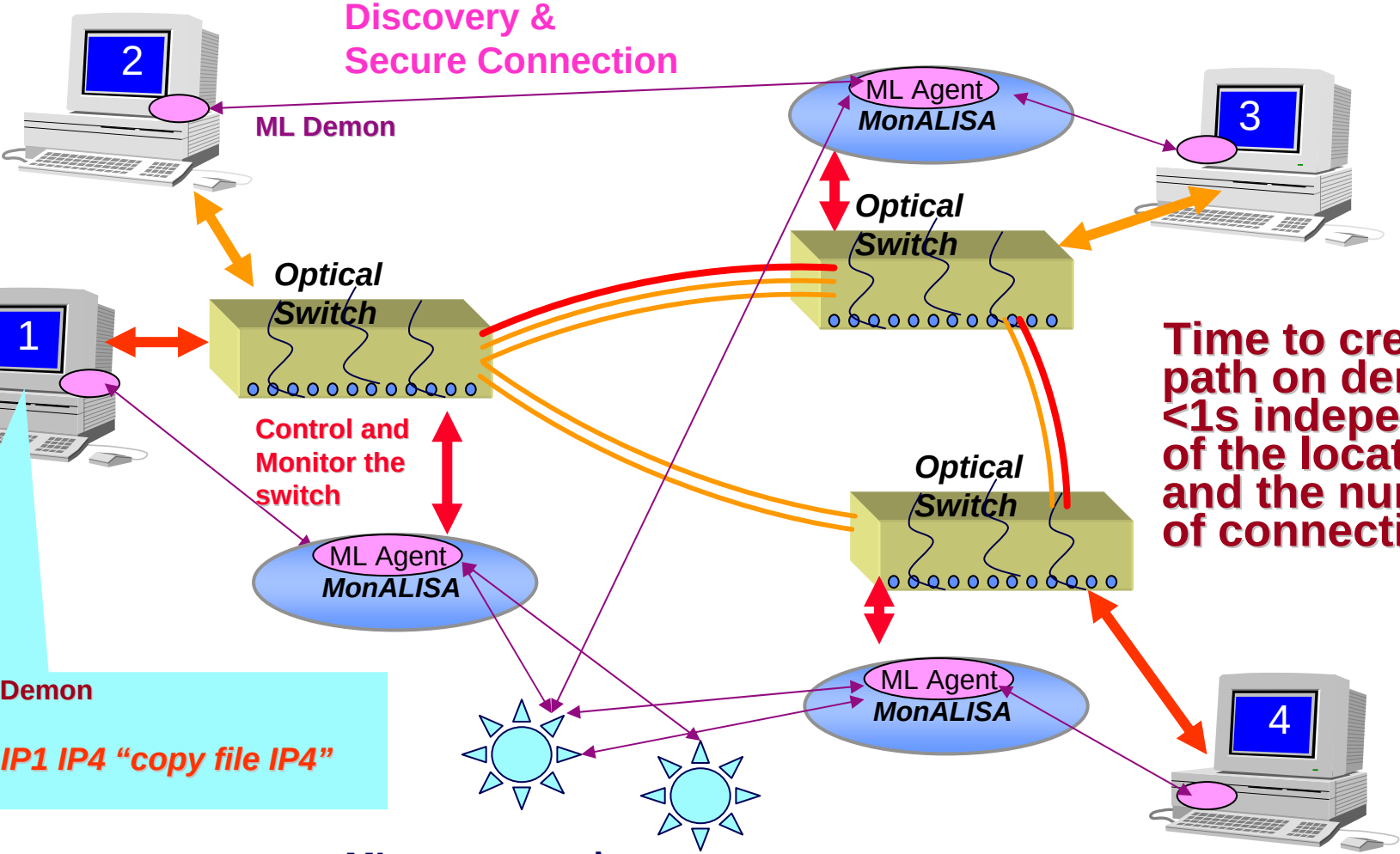
$$w(T) = \sum_{(v,u)\in T} w((v,u))$$

EVO: LISA Detects the Best Reflector for each Client and MonALISA Agents keep the reflectors connected in a MST

- 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

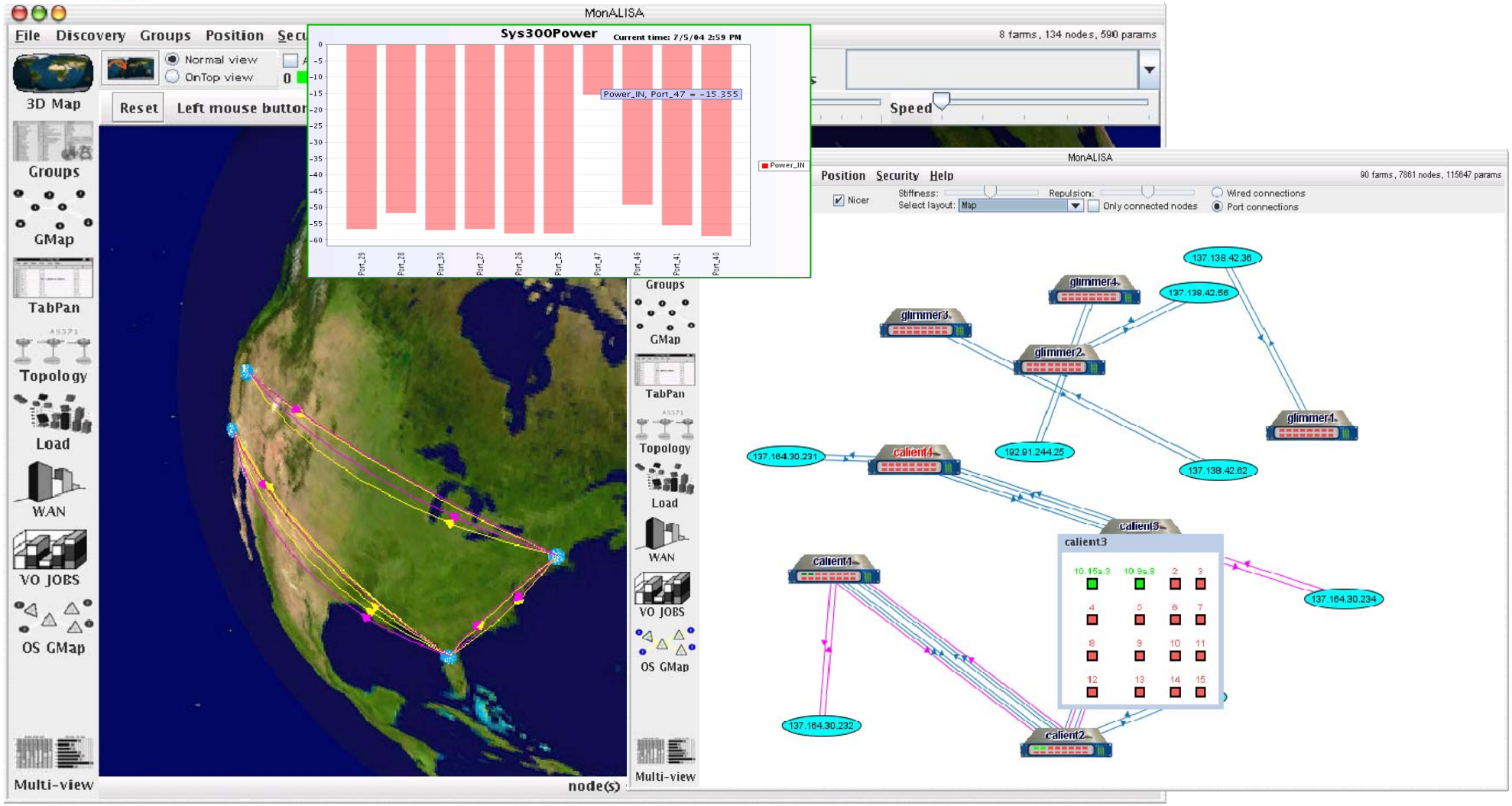


MonALISA agents to create on demand on an optical path or tree



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

Monitoring Optical Switches
Agents to Create on Demand an Optical Path

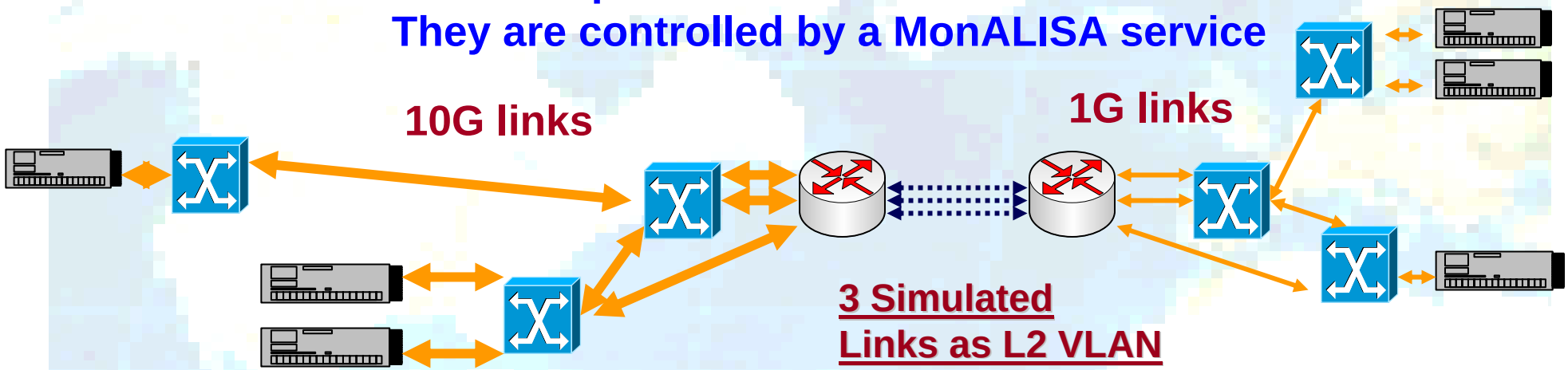


Test Setup for Controlling Optical Switches

CALIENT (LA)

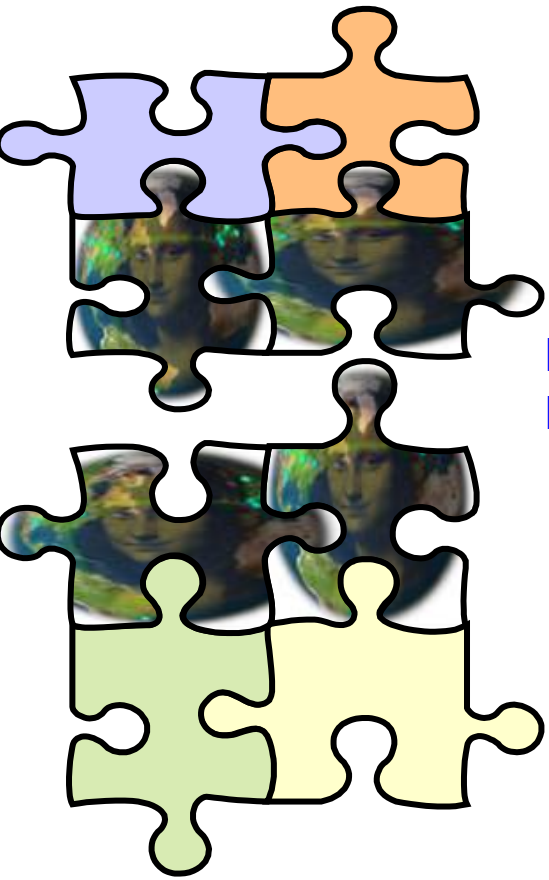
Glimmerglass (GE)

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

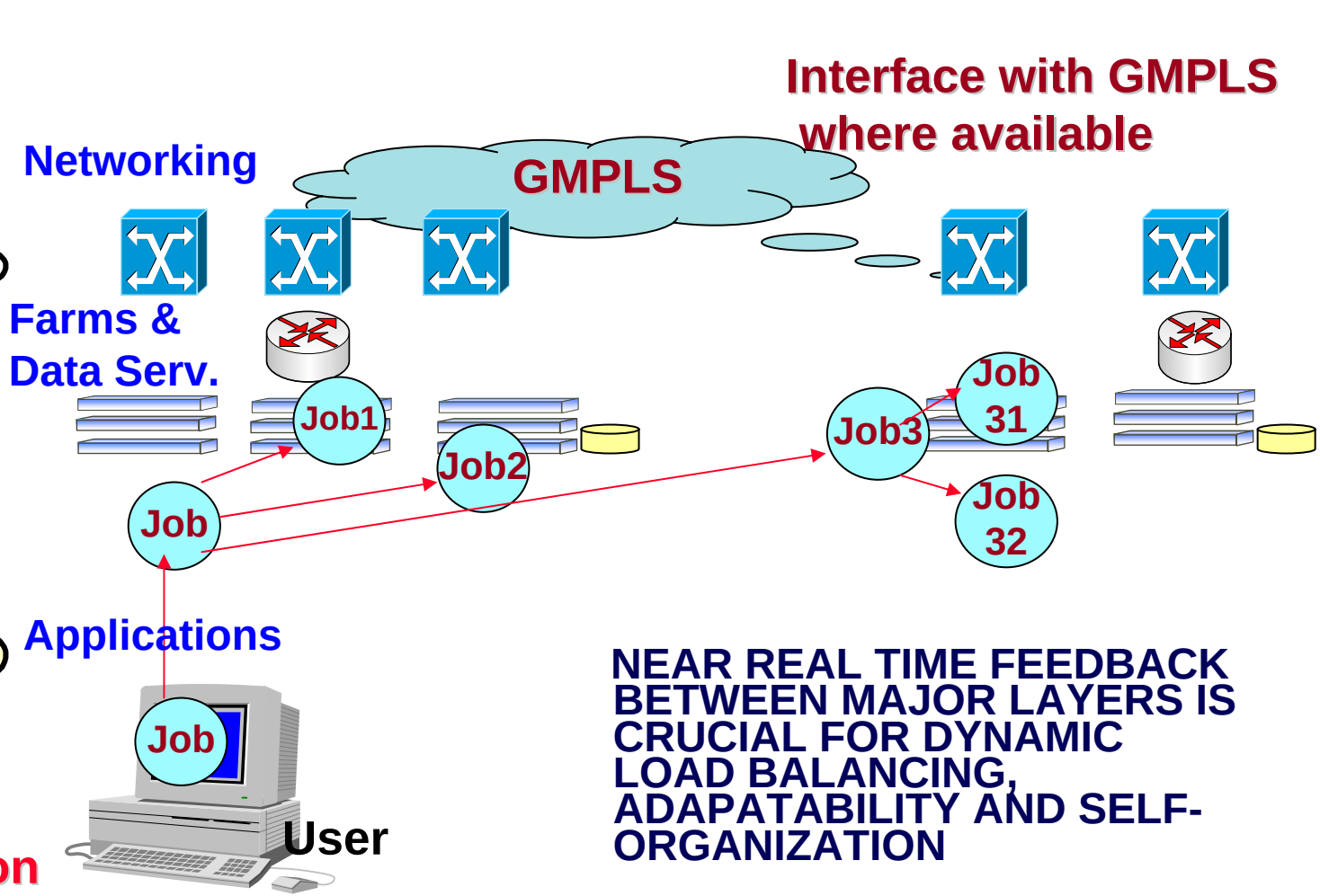


- Monitor and control switches using TL1
- Interoperability between the two systems
- End User access to service

MonALISA is a framework to correlate information from different layers



HELP to create Vertical Integration



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

SUMMARY

MonaLISA is a fully distributed service system with no single point of failure. It provides reliable registration and discovery.

- MonALISA is interfaced with many monitoring tools and is capable to collect any information from different applications
- It allows to analyze and process information in real time, locally, using Filters or Agents that are dynamically deployed.
- Can be used to control and monitor any other applications. Agents can be used to supervise applications, to restart or reconfigure them, and to notify other services when certain conditions are detected.
- Provides a secure administration interface which allows to remotely control (start / stop/ reconfigure / upgrade) distributed services or applications.
- The Agent system in the MonALISA framework can be used to develop higher level services, implemented as a distributed network of communicating agents, to perform global optimization tasks.

It proved to be a stable and reliable distributed service system

~200 Sites running MonALISA

http://monalisa.caltech.edu