MonALISA

MONitoring Agents using a Large Integrated Services Architecture

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

ICFA WORKSHOP
Daegu, May 2005

Iosif Legrand
California Institute of Technology

1

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**

May 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**

May 2005   **Iosif Legrand**

The MonALISA Discovery System & Services
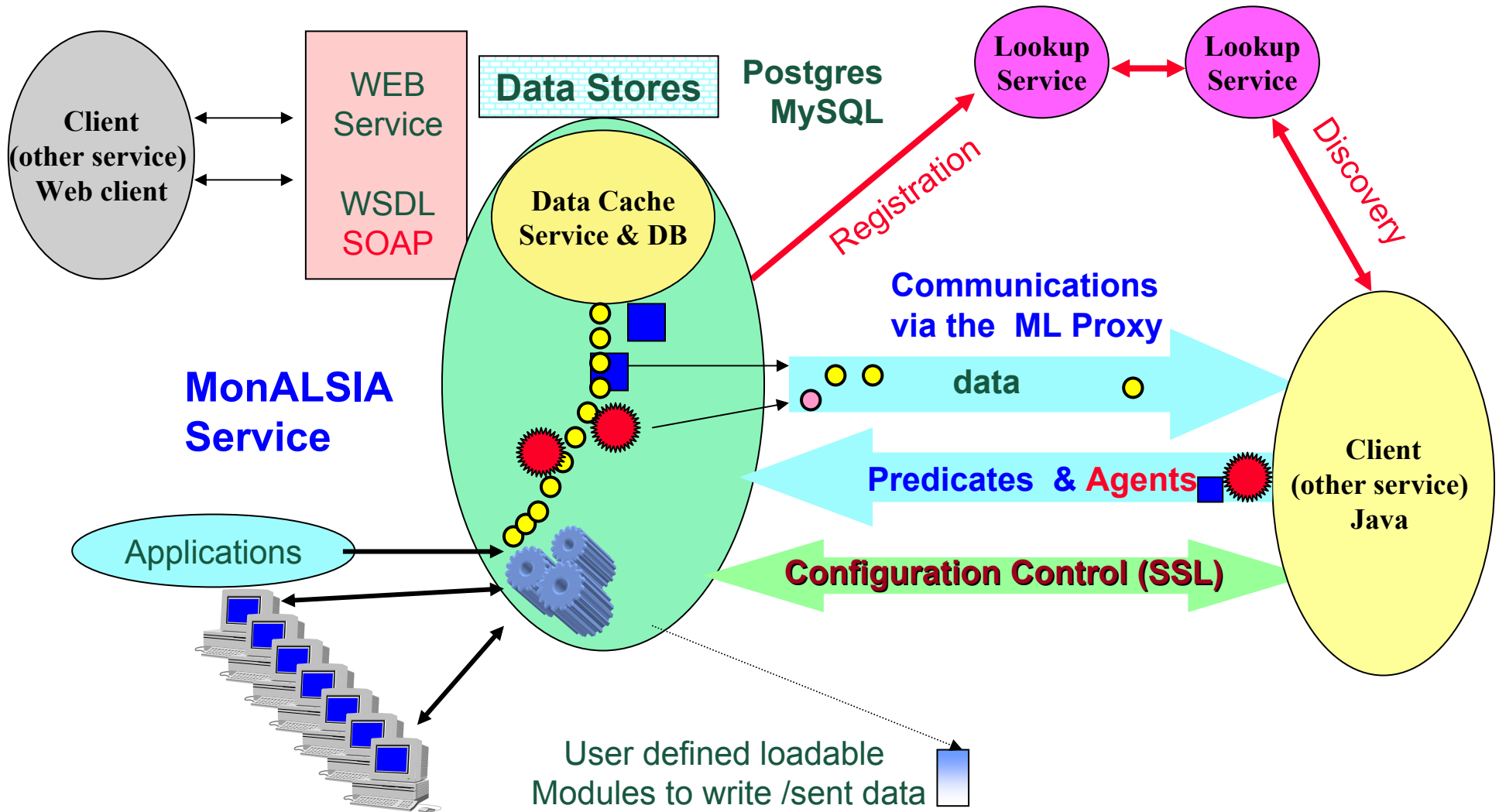
Fully Distributed System with no Single Point of Failure

Clients , HL services repositories
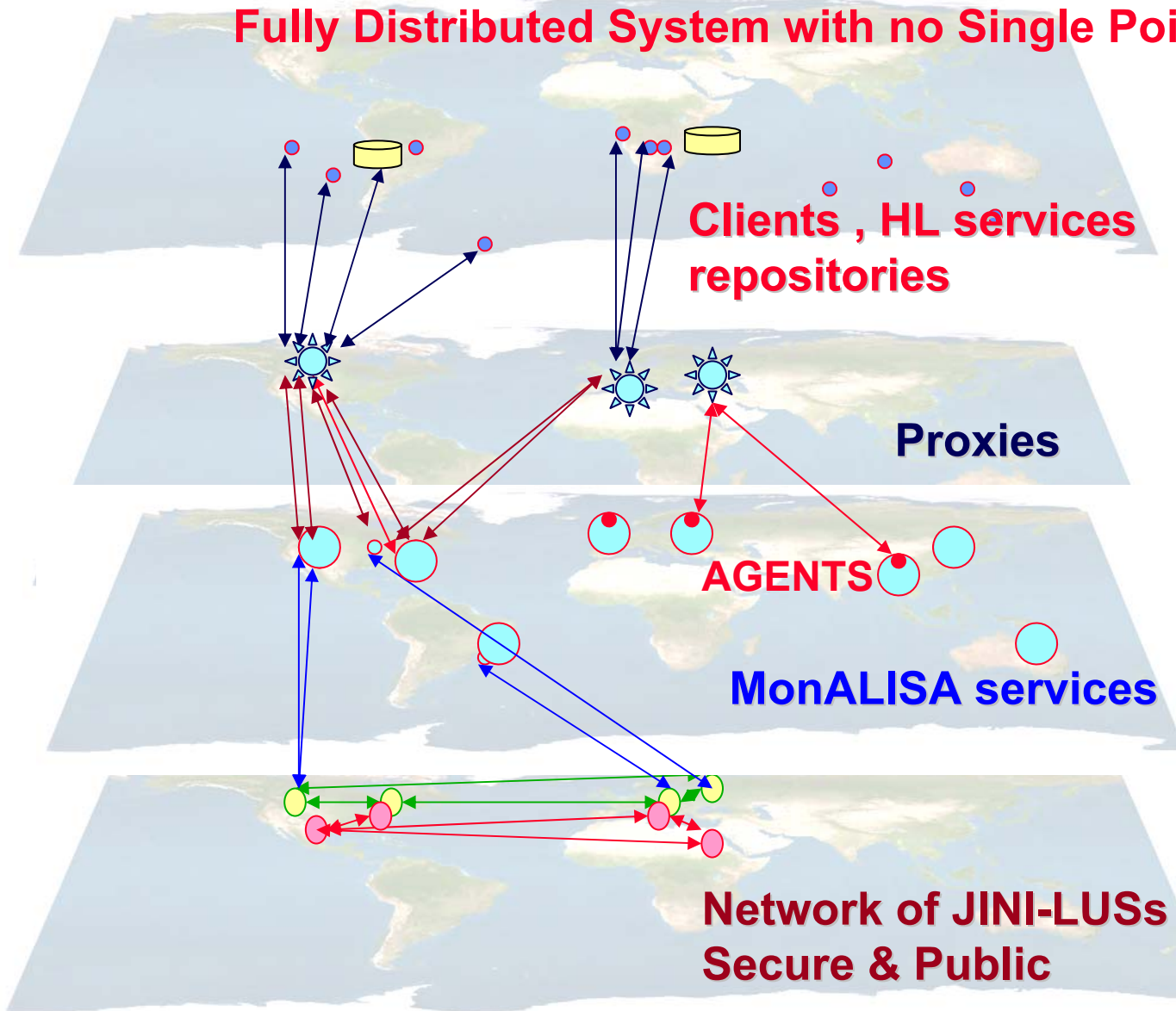
Global Services or Clients

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

Client (other service) Web client

WEB Service

WSDL SOAP

Data Stores

Postgres MySQL

Data Cache Service & DB

Lookup Service

Lookup Service

Registration

Discovery

MonALSIA Service

Communications via the ML Proxy

data

Predicates & Agents

Client (other service) Java

Applications

Configuration Control (SSL)

User defined loadable Modules to write /sent data

Registration (signed certificate)

Discovery

MonALISA Service

MonALISA Service

MonALISA Service

Trust keystore

Trust keystore

Lookup Service

Lookup Service

Services Proxy Multiplexer

Services Proxy Multiplexer

Client (other service)

Client (other service)

Data Filters & Agents

Client authentication

Admin SSL connection

AAA services

May   2005

Iosif Legrand

PROXY SERVICE NETWORK

Authorization Enforcement Point

Secure LUSs

Secure Registration

SSL/TLS, PKIX, GSS-API

Secure remote administration interface

AuthZ Queries

MonALISA Service Group

Clients: Repositories, WEB-Client

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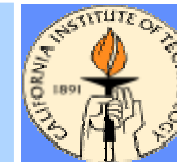
- Grid3
  ~40 sites in US and 1 Korea
- CMS-US sites
- CMS
- CDF
- D0 SAR
- ABILENE   backbone
- GLORIAD
- STAR
- ALICE
- VRVS System
- RoEduNET backbone
- INTERNET2 PIPES
- OSG
- LHCb

ABILENE

VRVS

It has been used for Demonstrations at:

- SC2003
- Telecom 2003
- WSIS 2003
- SC 2004
- I2 2005
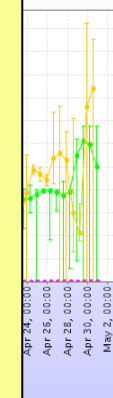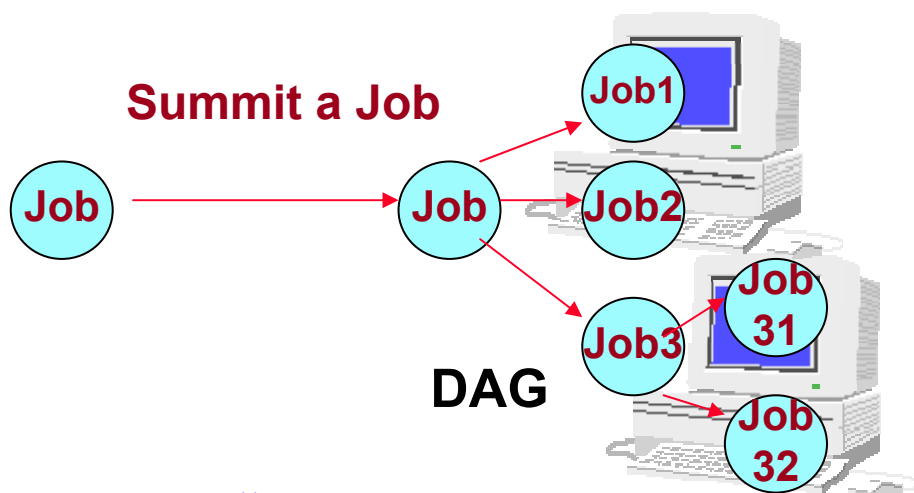
Monitoring Network Topology
Latency, Routers

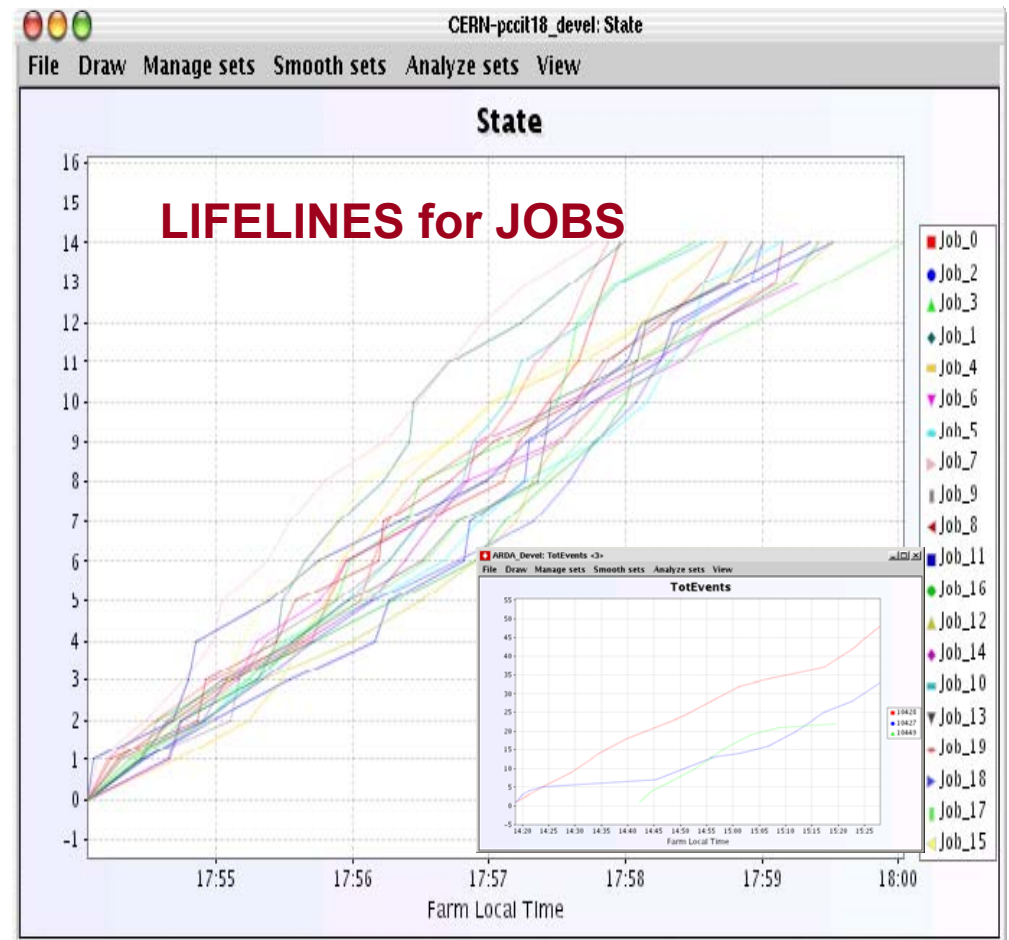**ROUTERS**

NETWORKS

AS

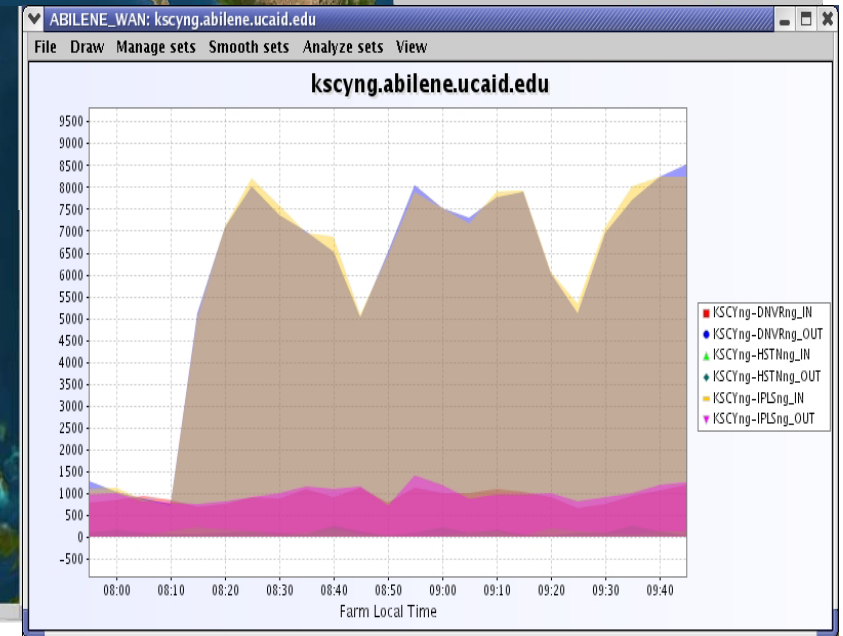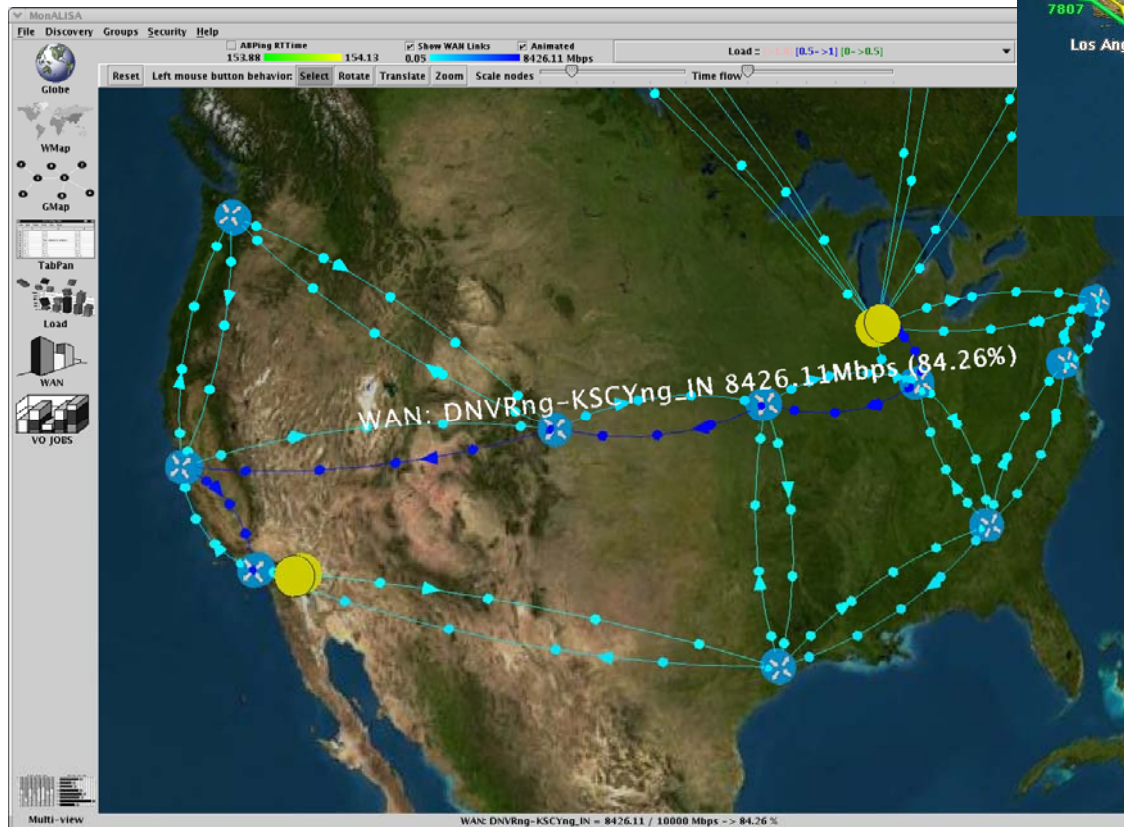May   2005   Iosif Legrand
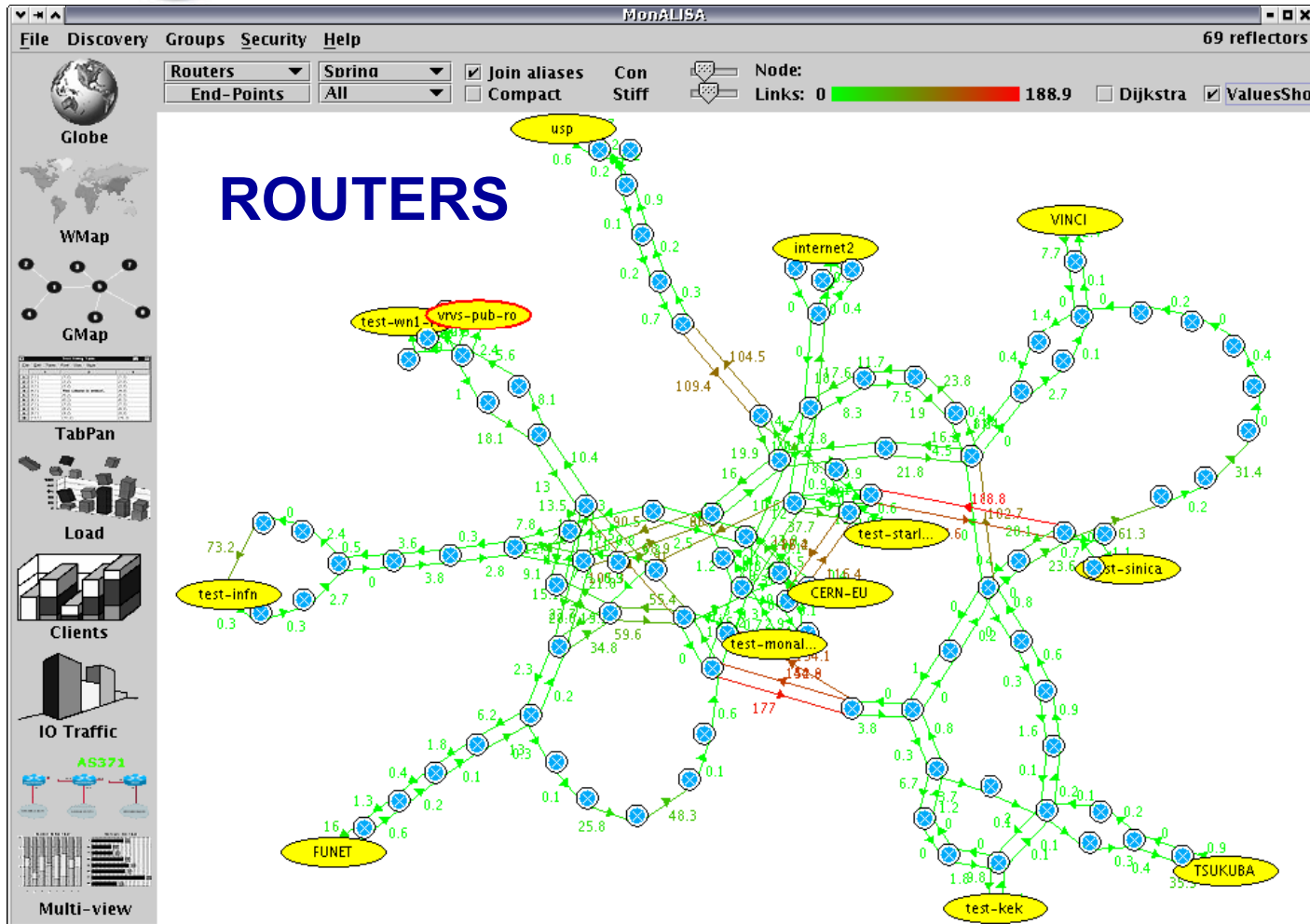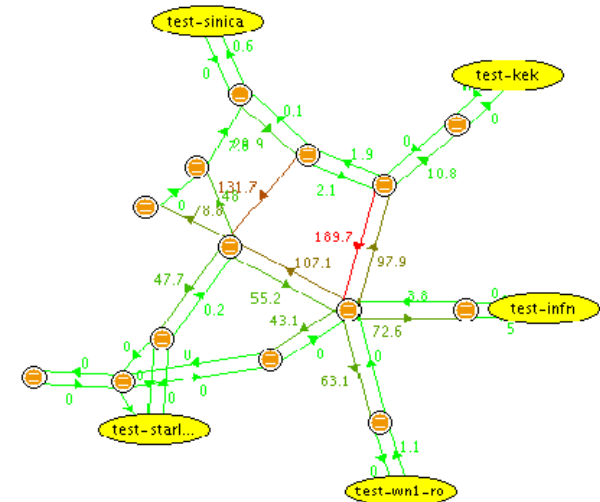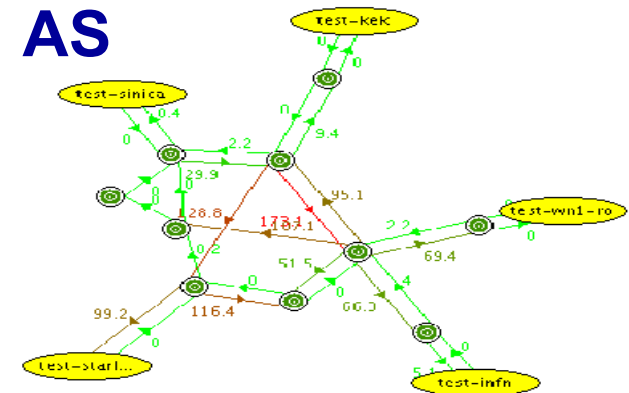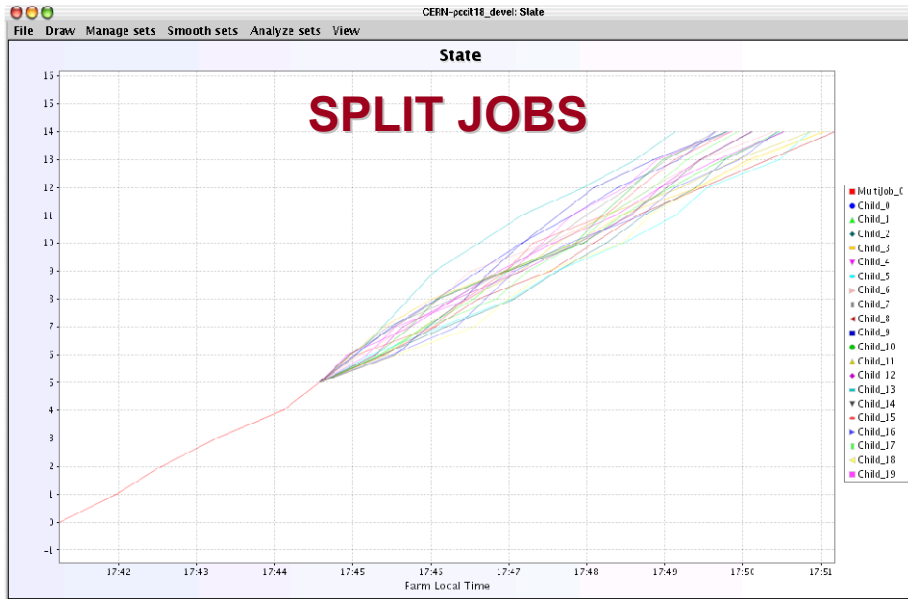
Monitoring ABILENE backbone Network

◆ **Test for a Land Speed Record**

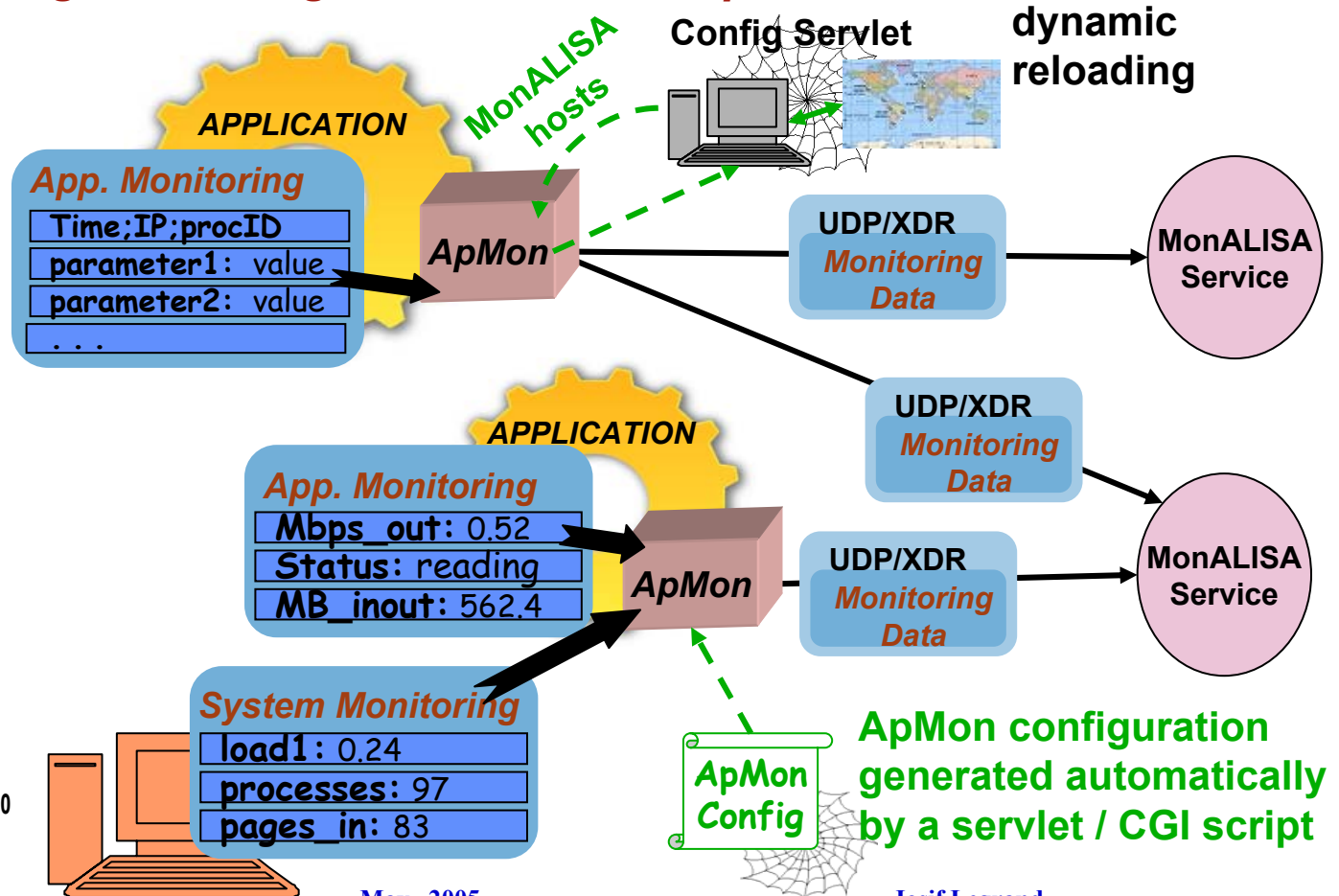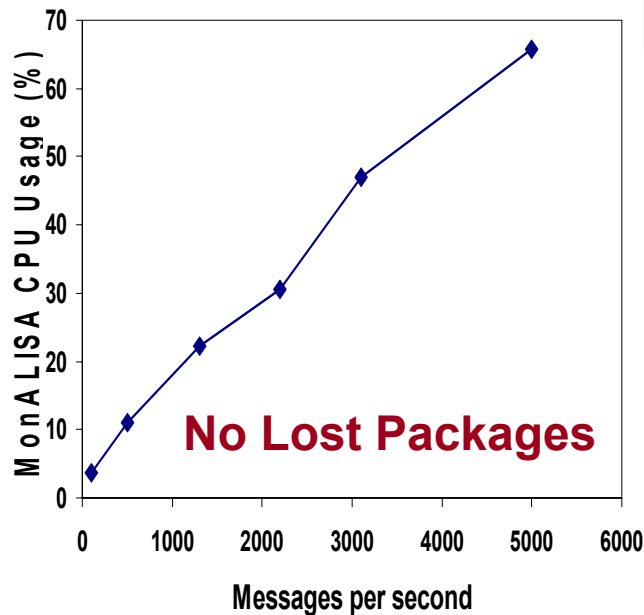◆ **~ 7 Gb/s in a single TCP stream from Geneva to Caltech**
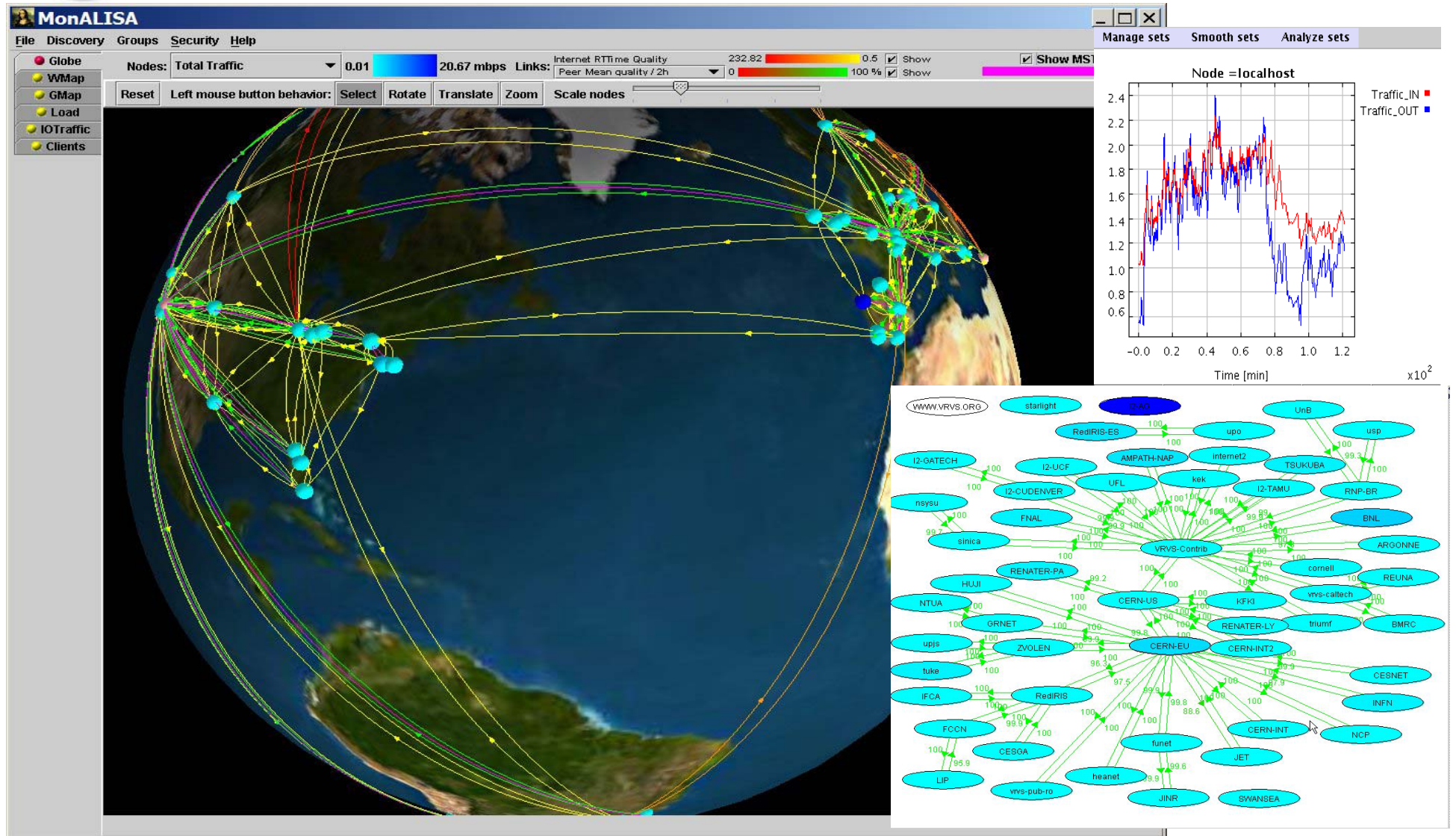
ApMon – Application Monitoring

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

No Lost Packages

MonALISA CPU Usage (%) vs Messages per second

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

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

UDP/XDR *Monitoring Data*

UDP/XDR *Monitoring Data*

MonALISA Service

ApMon Config

ApMon configuration generated automatically by a servlet / CGI script

14

May   2005

Iosif Legrand

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.

May 2005

Iosif Legrand
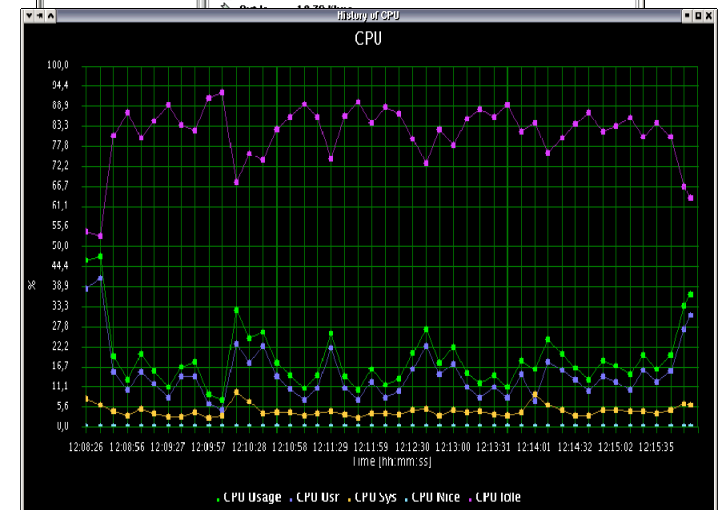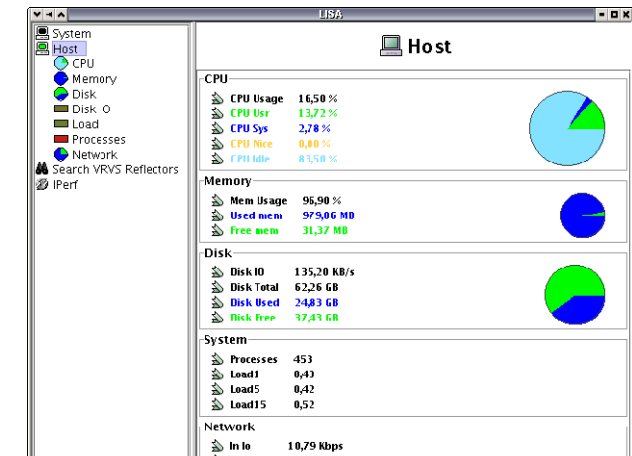
# LISA- Provides an Efficient Integration for Distributed Systems and Applications

◆ **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**

16
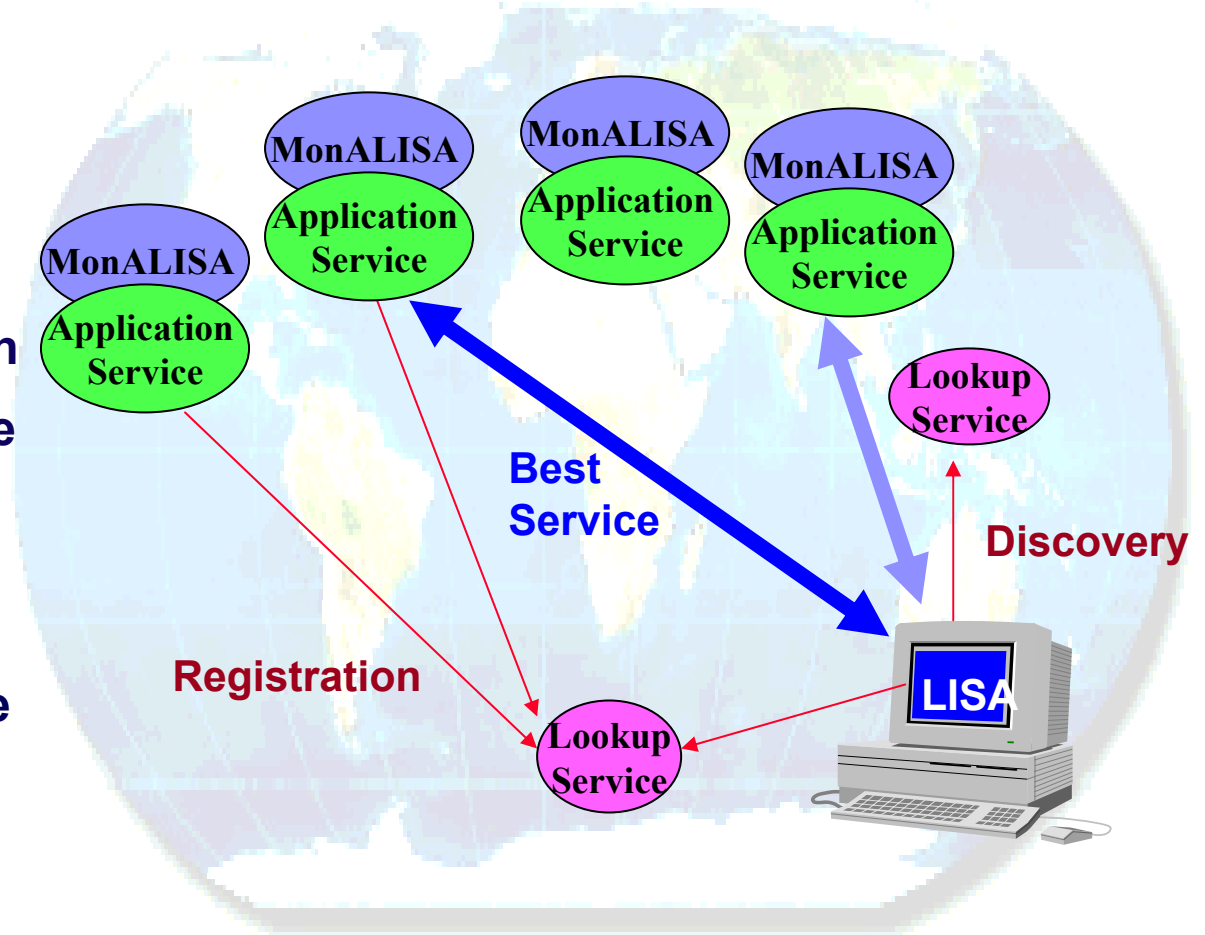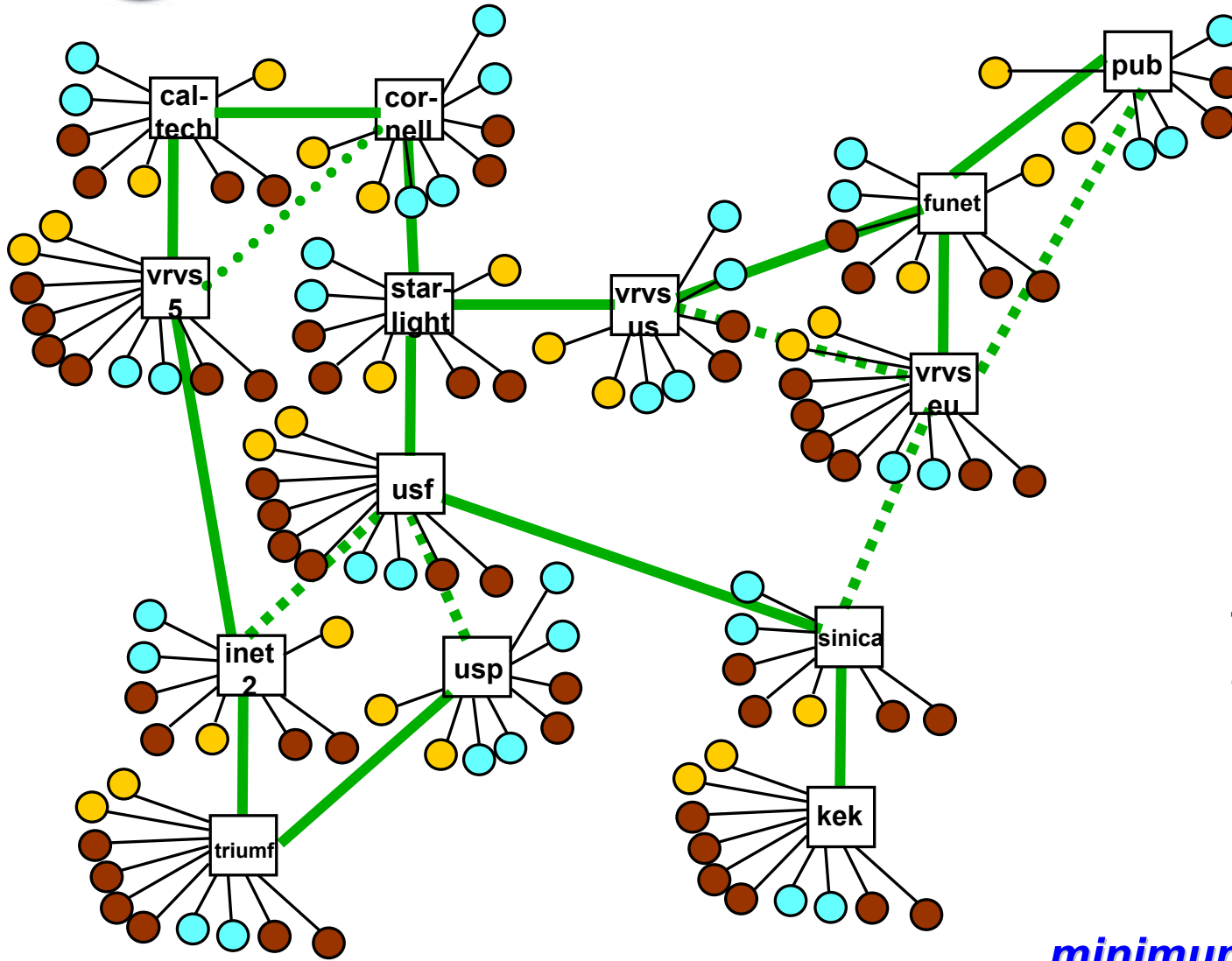
Reflectors are hosts that interconnect users by permanent IP tunnels.

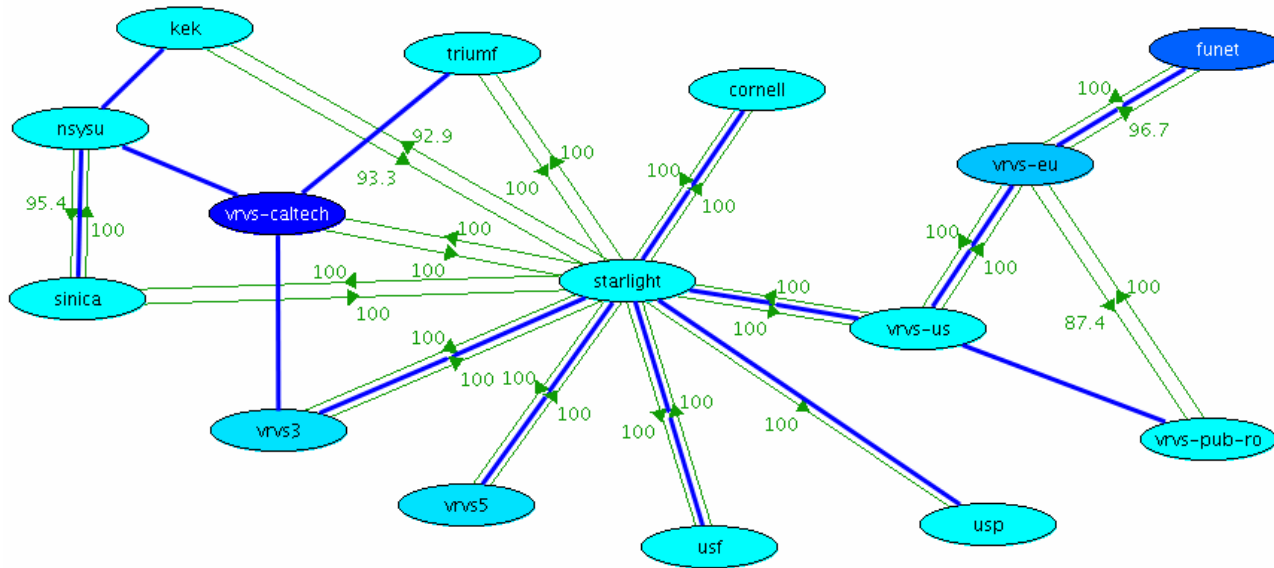The active IP tunnels must be selected so that there is no cycle formed.

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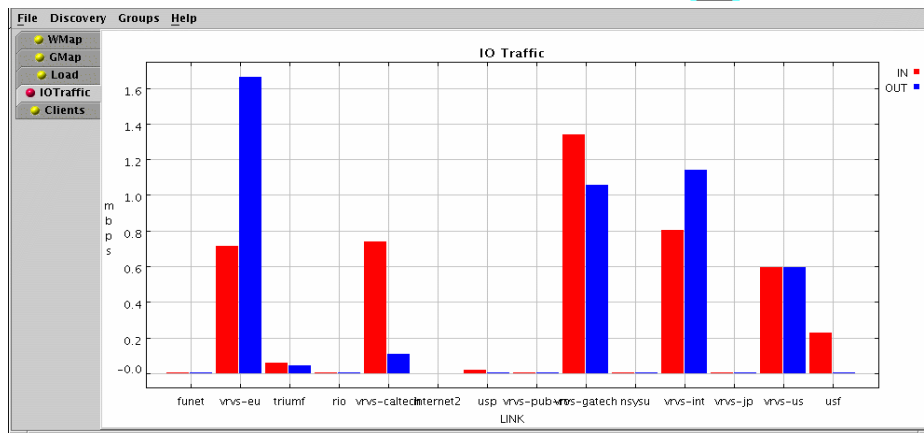
A weighted connected graph $G = (V,E)$ with n vertices and m edges. The quality of connectivity between any two reflectors is measured every 2s. Building in near real time a minimum-spanning tree T

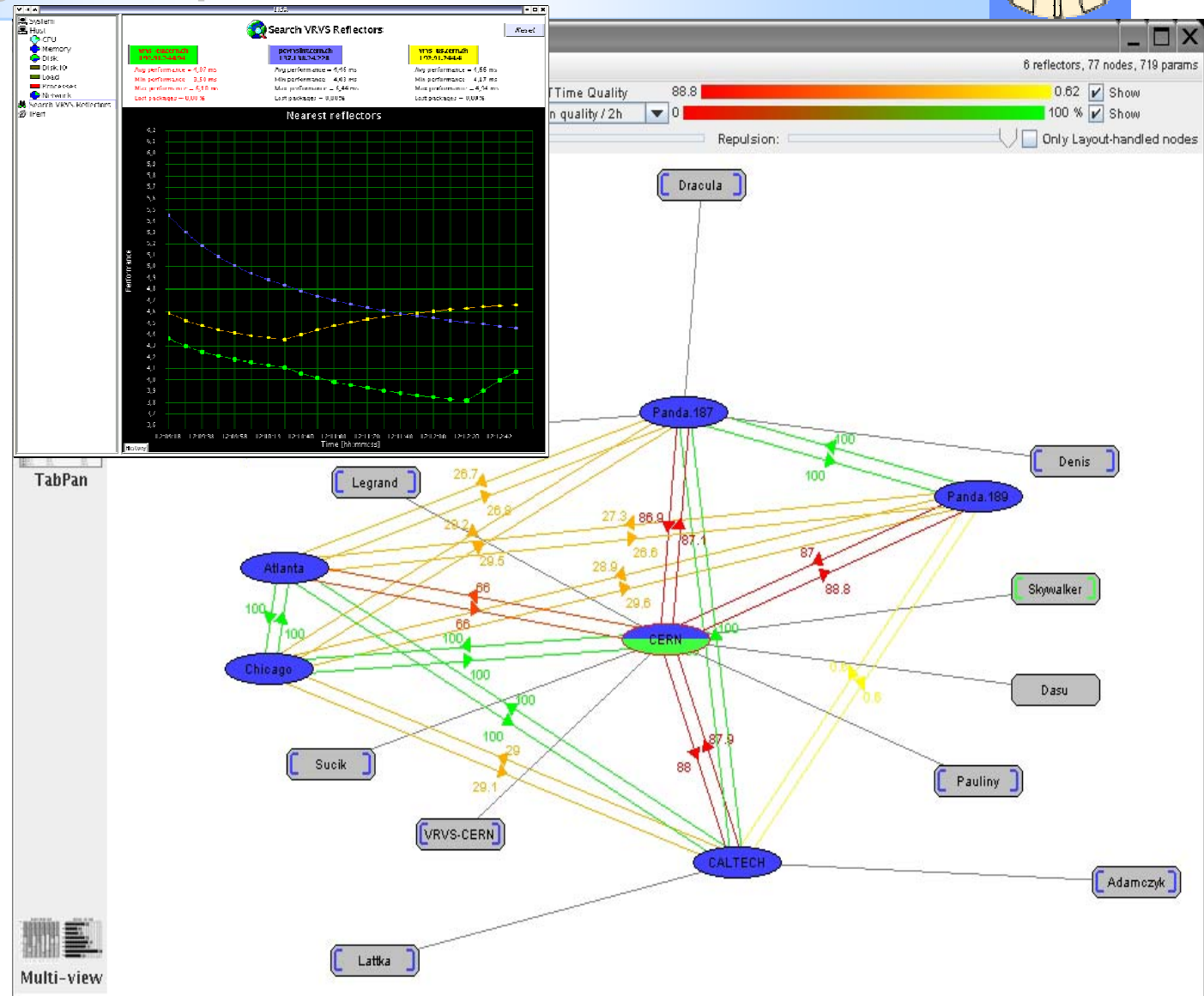$$w(T) = \sum_{(v,u) \in T} w((v,u))$$

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**

19

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

Discovery & Secure Connection

ML Demon

2

3

ML Agent
MonALISA

Optical Switch

Optical Switch

1

Control and Monitor the switch

ML Agent
MonALISA

Optical Switch

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

ML Agent
MonALISA

4

Runs a ML Demon

>*ml_path IP1 IP4 "copy file IP4"*

ML proxy services used in Agent Communication

May 2005

Iosif Legrand

May 2005   **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
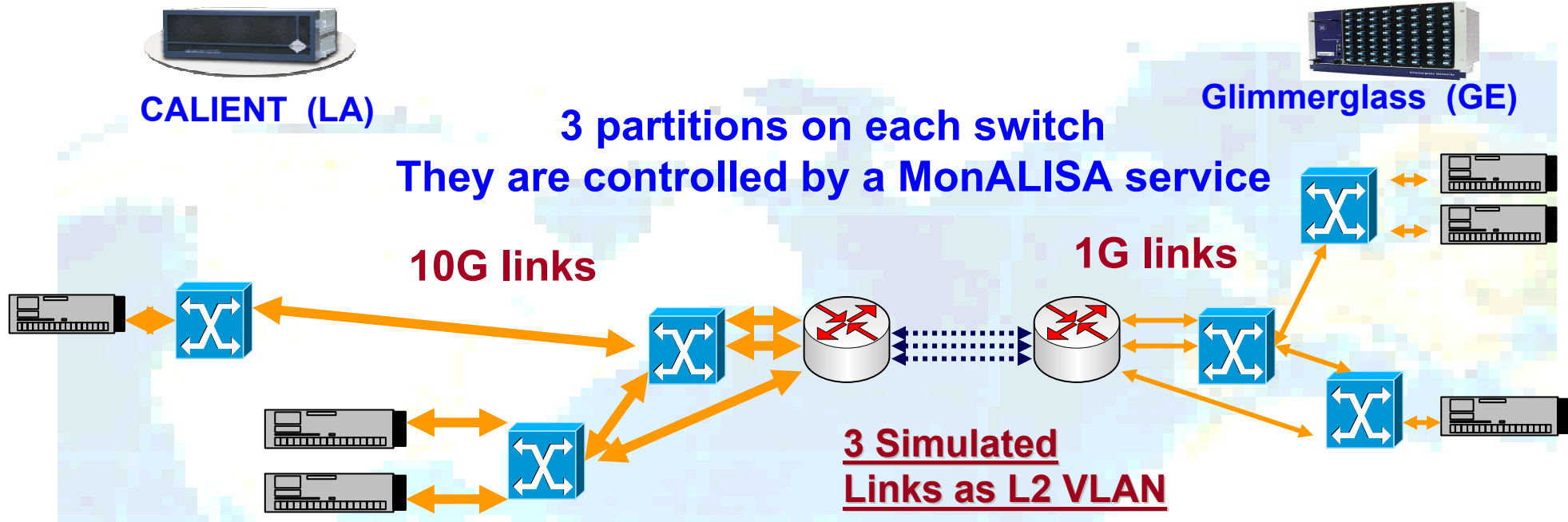
◆ **Monitor and control switches using TL1**
◆ **Interoperability between the two systems**

May   2005

Iosif Legrand

MonALISA is a framework to correlate information from different layers

Interface with GMPLS where available

Networking

GMPLS

Farms & Data Serv.

Job1

Job2

Job3

Job 31

Job 32

Job

Applications

Job

User

HELP to create Vertical Integration
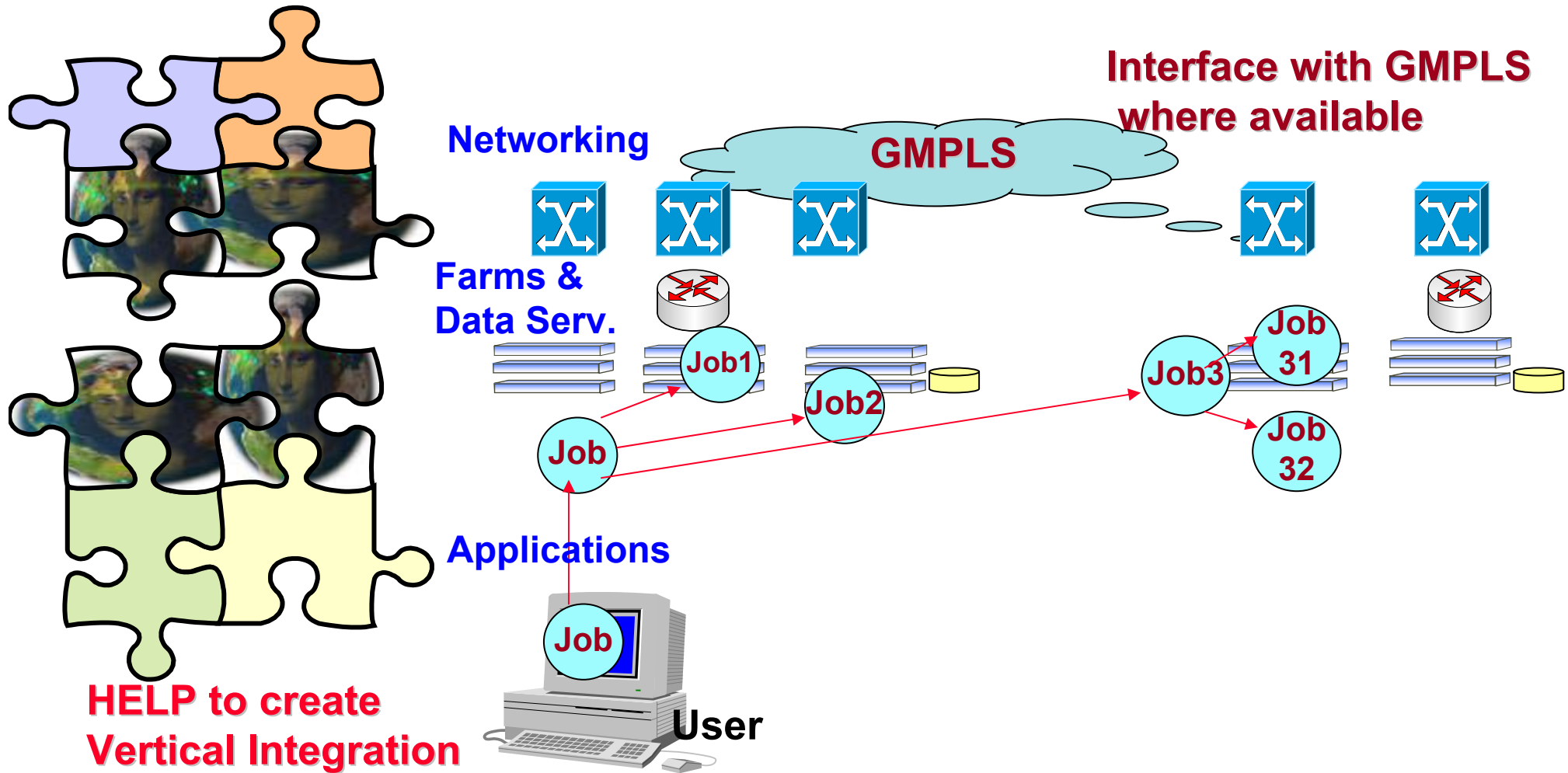
SUMMARY

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

May   2005   **Iosif Legrand**