



# Grid Technologies for Netted Sensors

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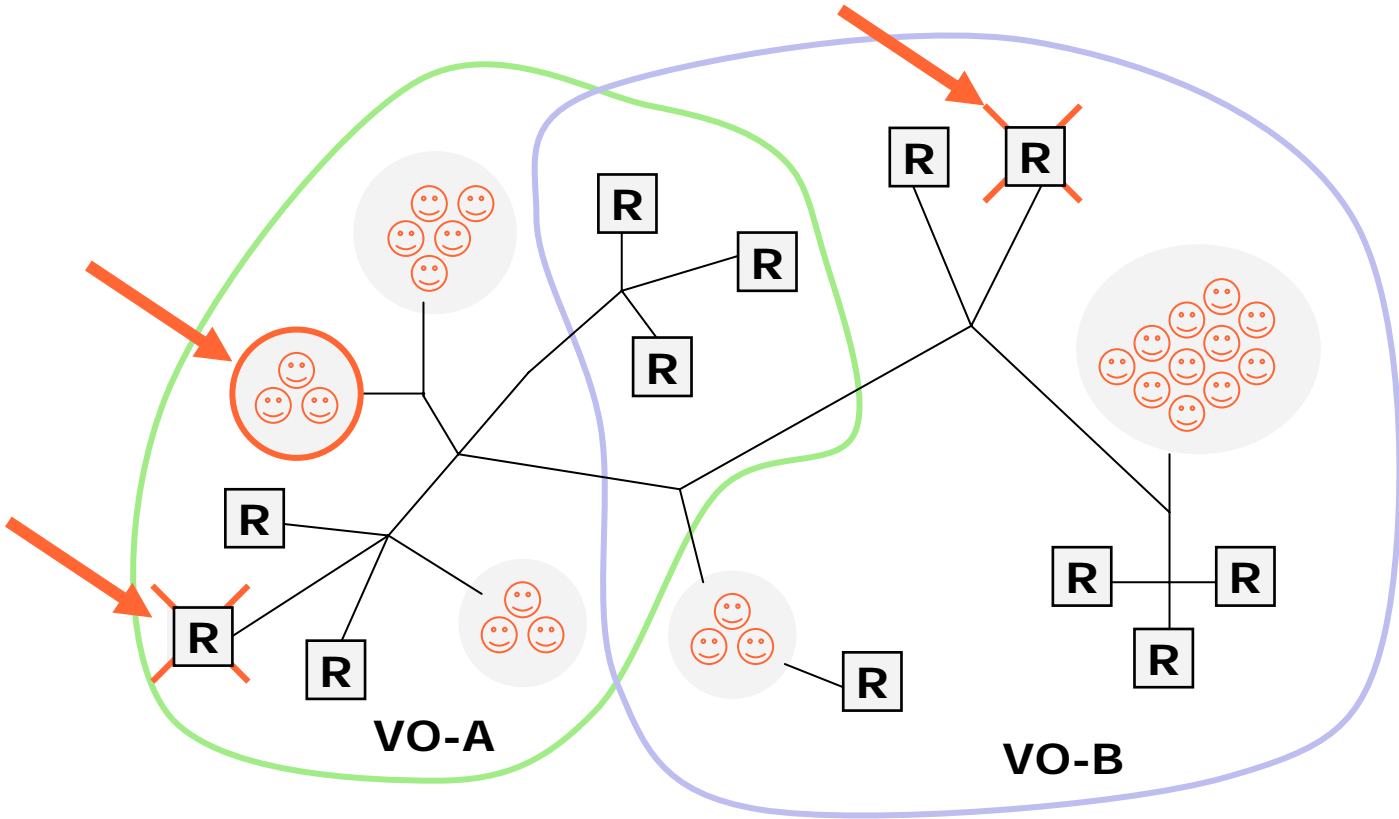


# Overview

- The role of Grid infrastructure
- Web services as a technology base
- Globus as open source implementation
- Example applications

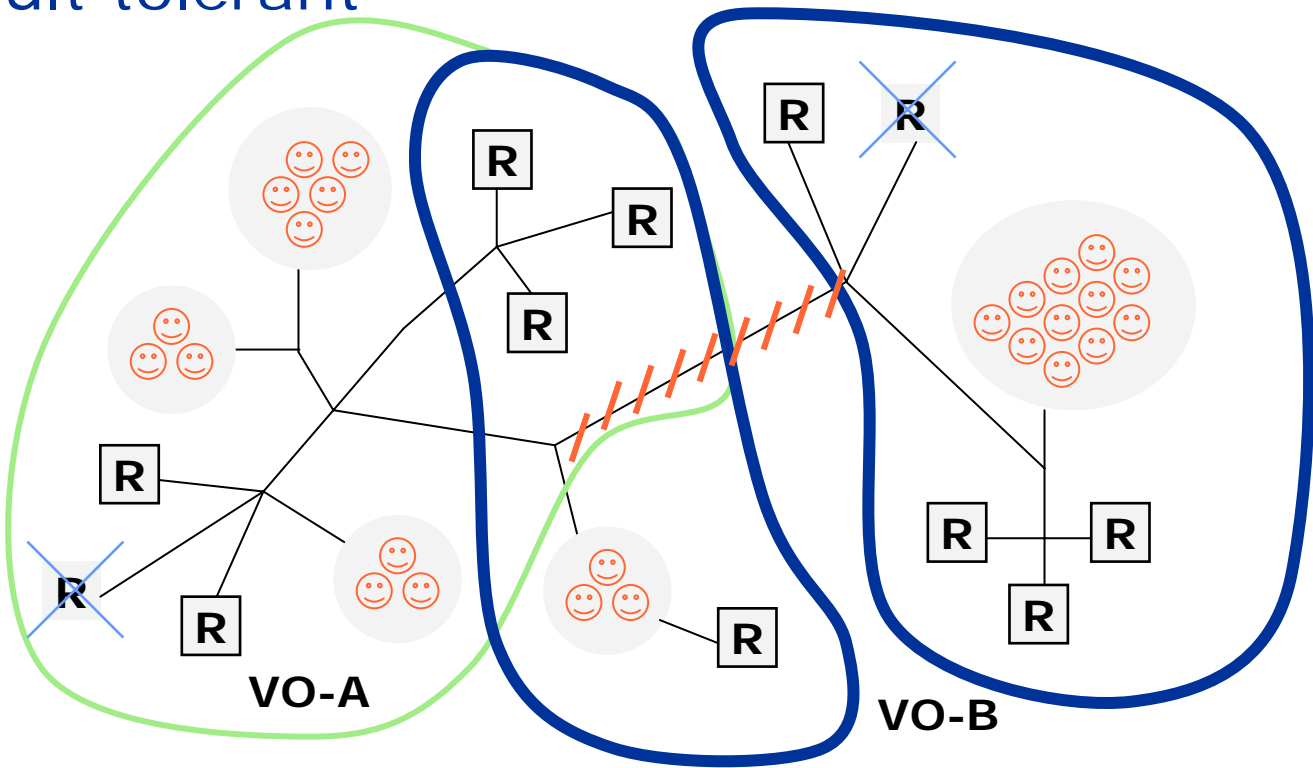
# Grid Infrastructure: Aggregation in Virtual Organizations

- Distributed resources and people
- Linked by networks, crossing admin domains
- Sharing resources, common goals
- Dynamic behaviors



# Grid Infrastructure: Aggregation in Virtual Organizations

- Distributed resources and people
- Linked by networks, crossing admin domains
- Sharing resources, common goals
- Dynamic behaviors
- Fault tolerant



# Grid Infrastructure: Take Services Seriously

- Model the world as a collection of services
  - ◆ Computations, computers, instruments, storage, data, communities, agreements, ...
- Focus on what these things have in common
  - ◆ E.g., **state modeling & lifecycle**: Negotiation, deployment/creation, modeling, monitoring, management, termination
  - ◆ E.g., **security**: Authentication, authorization, audit, ...
- ➔ Result is **Grid infrastructure**
  - ◆ Using Web services as a platform

# Web Services and Stateful Resources

- “State” appears in almost all applications
  - ◆ Data in a purchase order
  - ◆ Current usage agreement for resources
  - ◆ Metrics associated with work load on a server
- Web services can model, access and manage state in many different ways
  - ◆ Ad-hoc, per-application approaches
  - ◆ WS-Resource Framework (WSRF) & WS-Notification propose a standard approach

# WSRF & WS-Notification

- **Naming and bindings** (basis for virtualization)
  - ◆ Every resource can be uniquely referenced, and has one or more associated services for interacting with it
- **Lifecycle** (basis for fault resilient state mgmt)
  - ◆ Resources created by services following factory pattern
  - ◆ Resources destroyed immediately or scheduled
- **Information model** (basis for monitoring, discovery)
  - ◆ Resource properties associated with resources
  - ◆ Operations for querying and setting this info
  - ◆ Asynchronous notification of changes to properties
- **Service groups** (basis for registries, collective svcs)
  - ◆ Group membership rules & membership management
- **Base Fault type**

# Grid Infrastructure: Open Standards

Applications of the framework  
(Compute, network, storage provisioning,  
job reservation & submission, data management,  
application service QoS, ...)

WS-Agreement  
(Agreement negotiation)

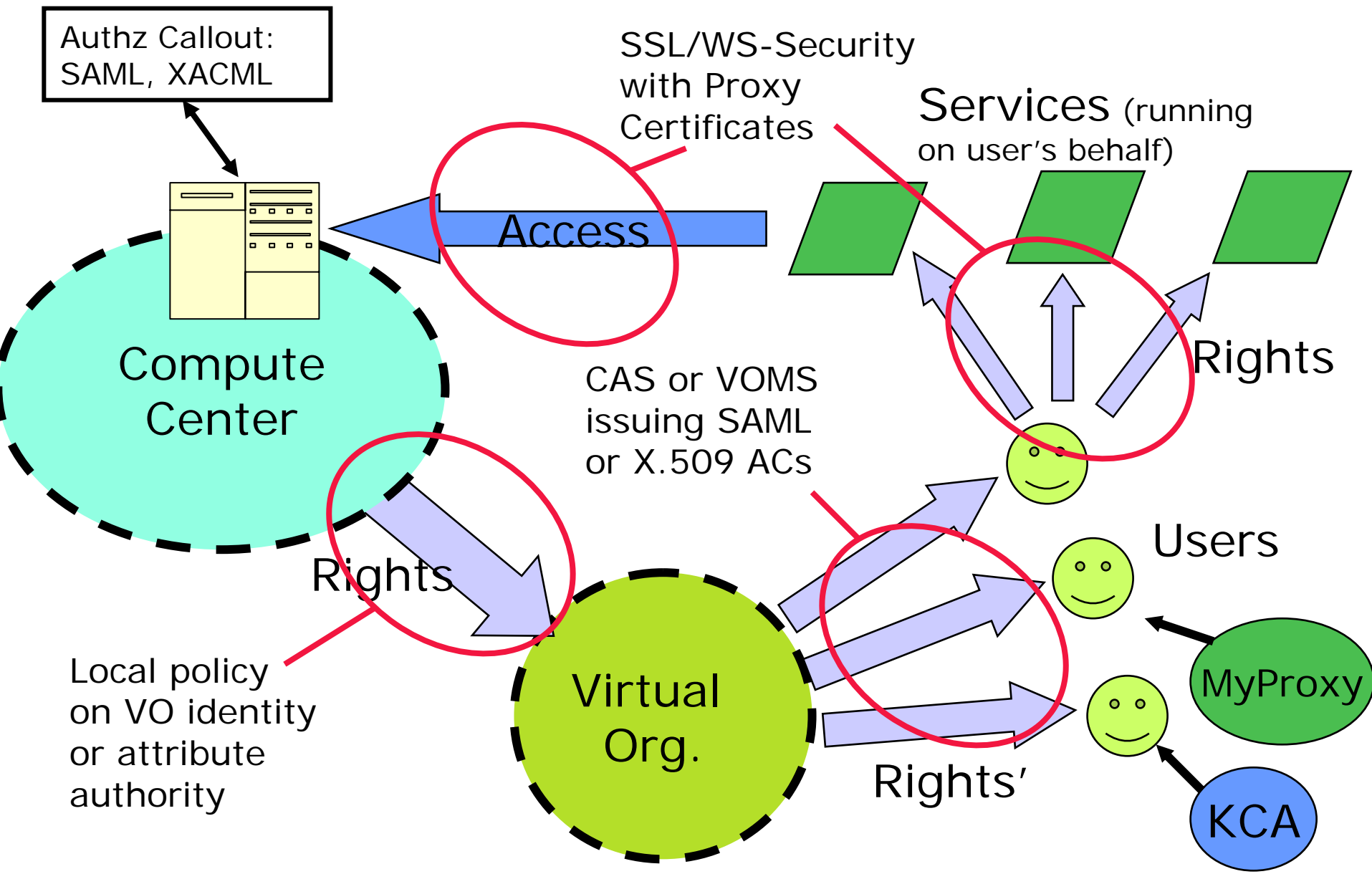
WS Distributed Management  
(Lifecycle, monitoring, ...)

WS-Resource Framework & WS-Notification\*  
(Resource identity, lifetime, inspection, subscription, ...)

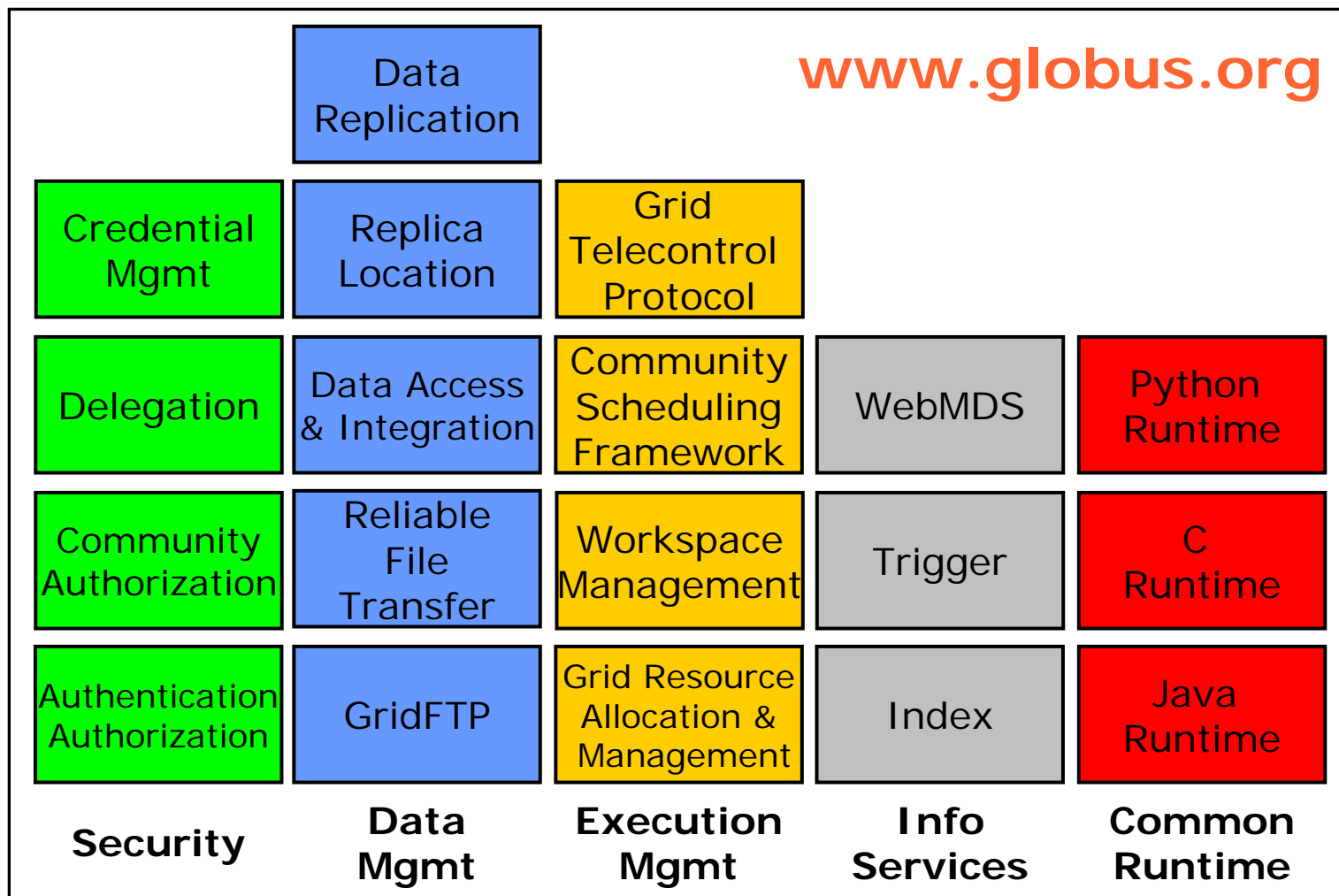
Web services  
(WSDL, SOAP, WS-Security, WS-ReliableMessaging, ...)

\*WS-Transfer, WS-Enumeration, WS-Eventing, WS-Management define similar functions

# Grid Infrastructure: Authentication & Authorization

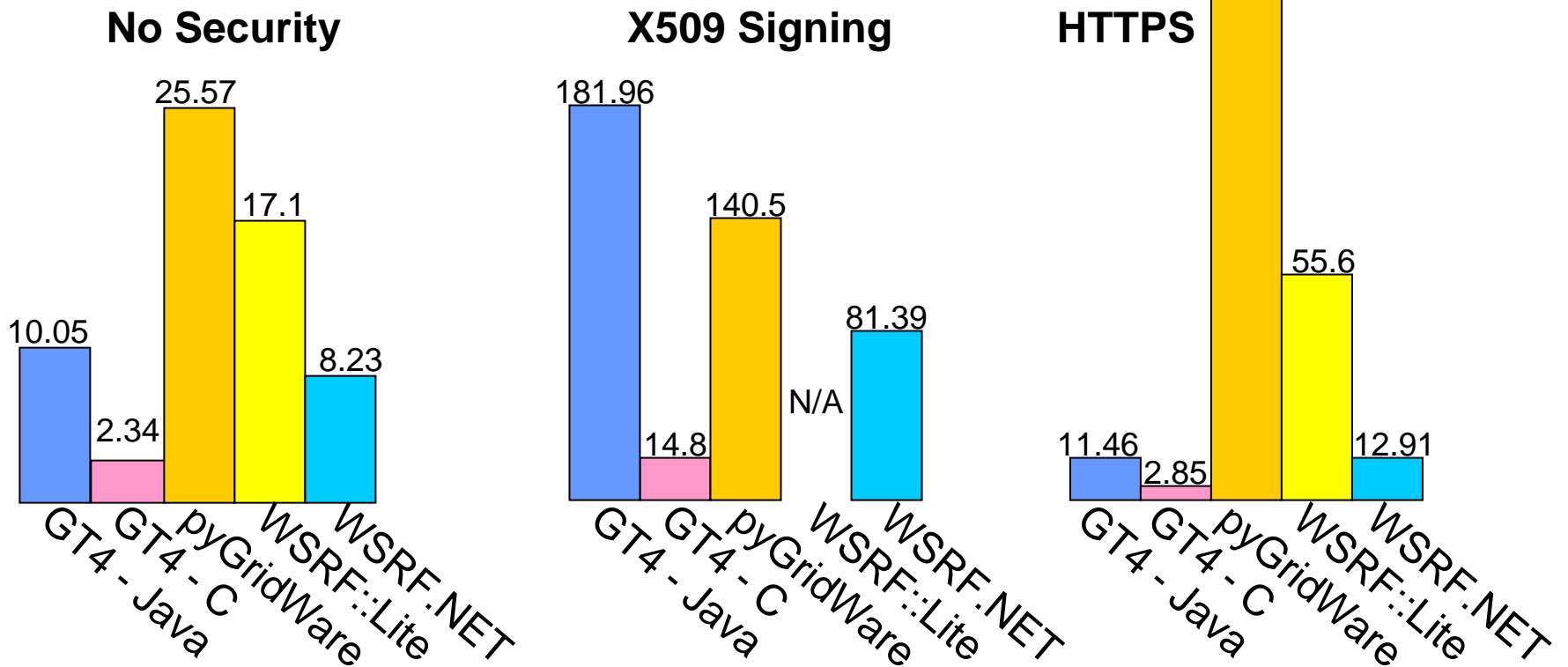


# Globus Toolkit: Open Source Grid Infrastructure



# WS-RF Performance (GetRP)

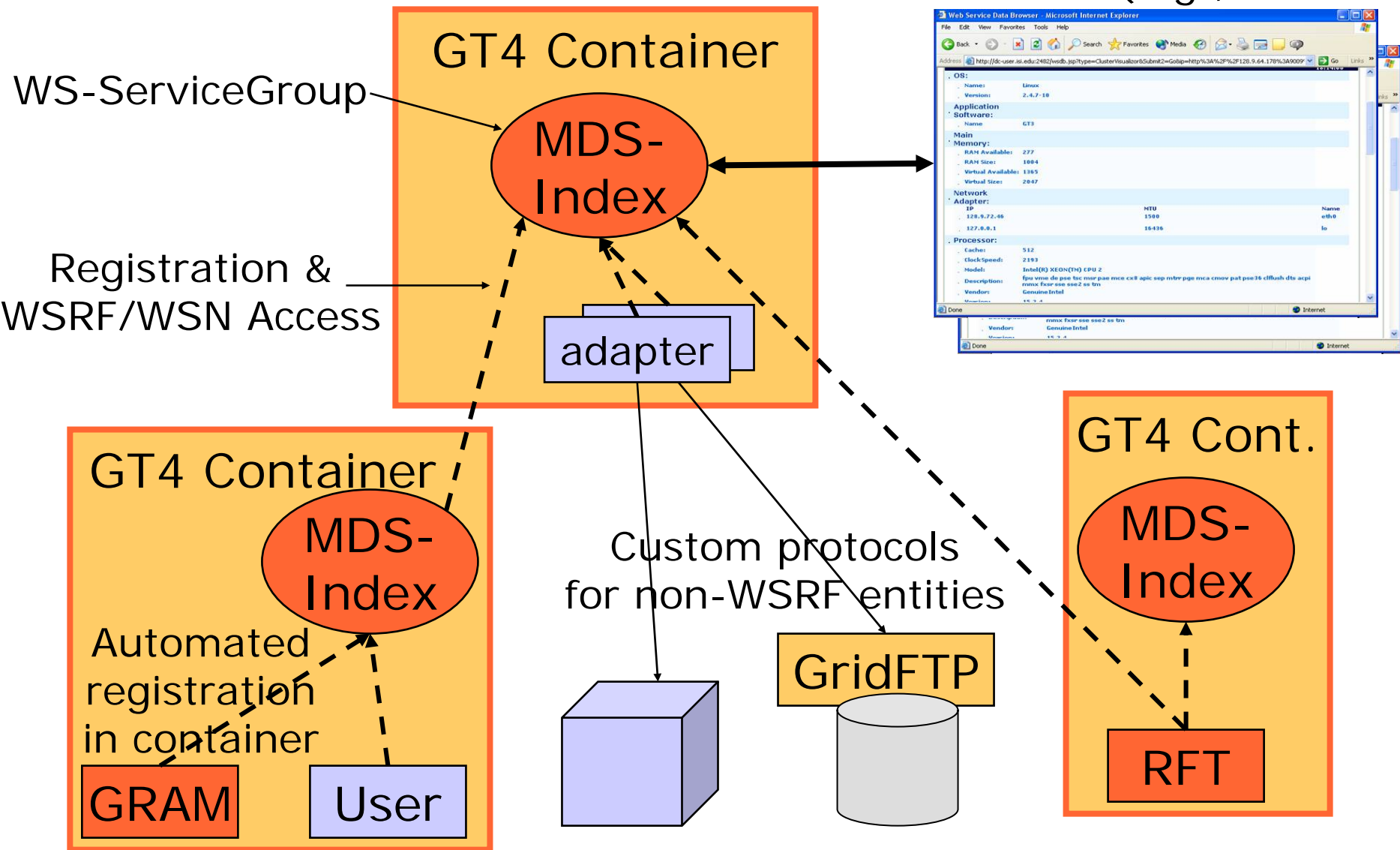
Distributed client and service on same LAN  
(times in milliseconds)



# GT4


## Monitoring & Discovery

Clients  
(e.g., WebMDS)





# A Typical eScience Use of Globus: Network for Earthquake Eng. Simulation

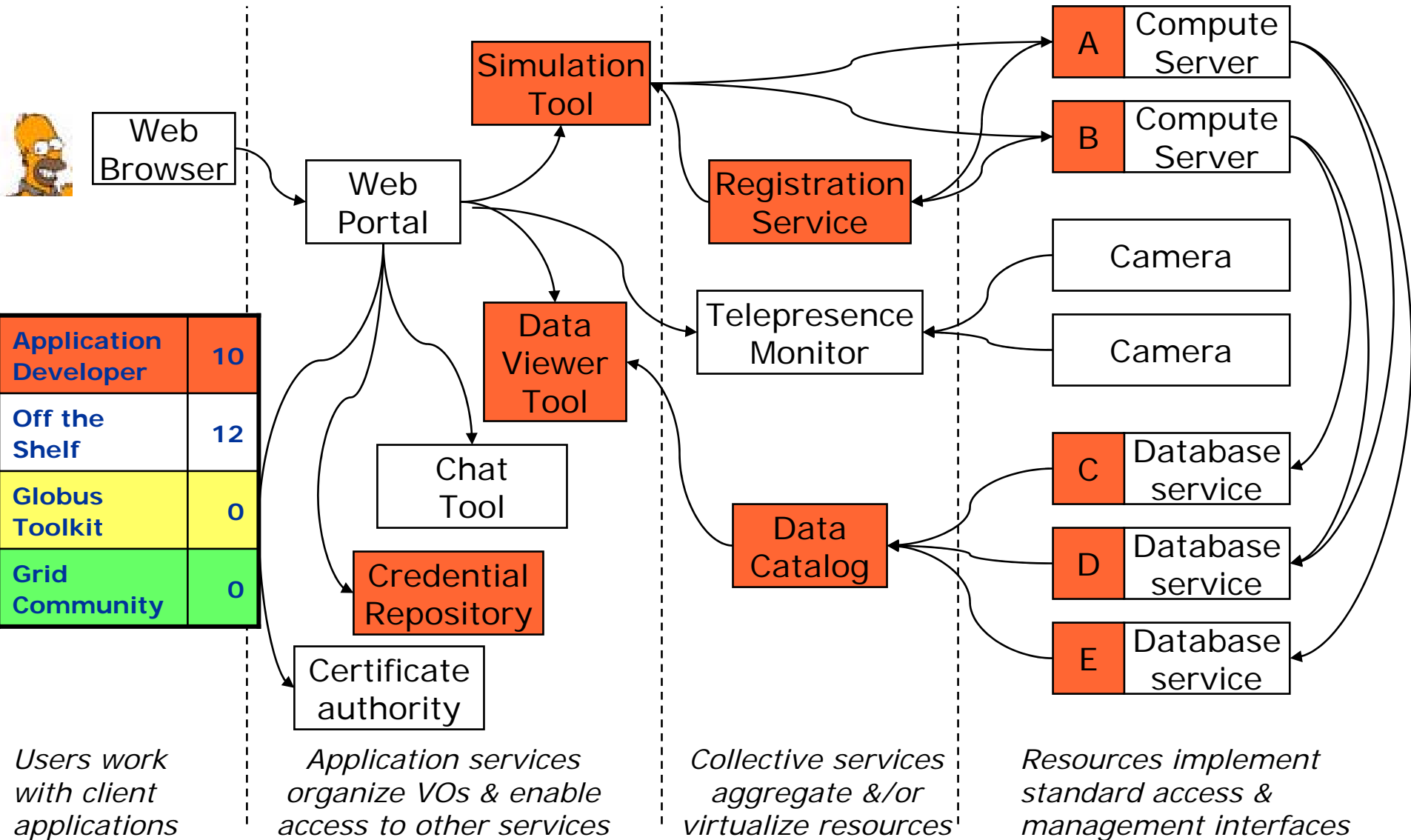


The figure illustrates a network of earthquake engineering simulation facilities across the United States. Key components include:

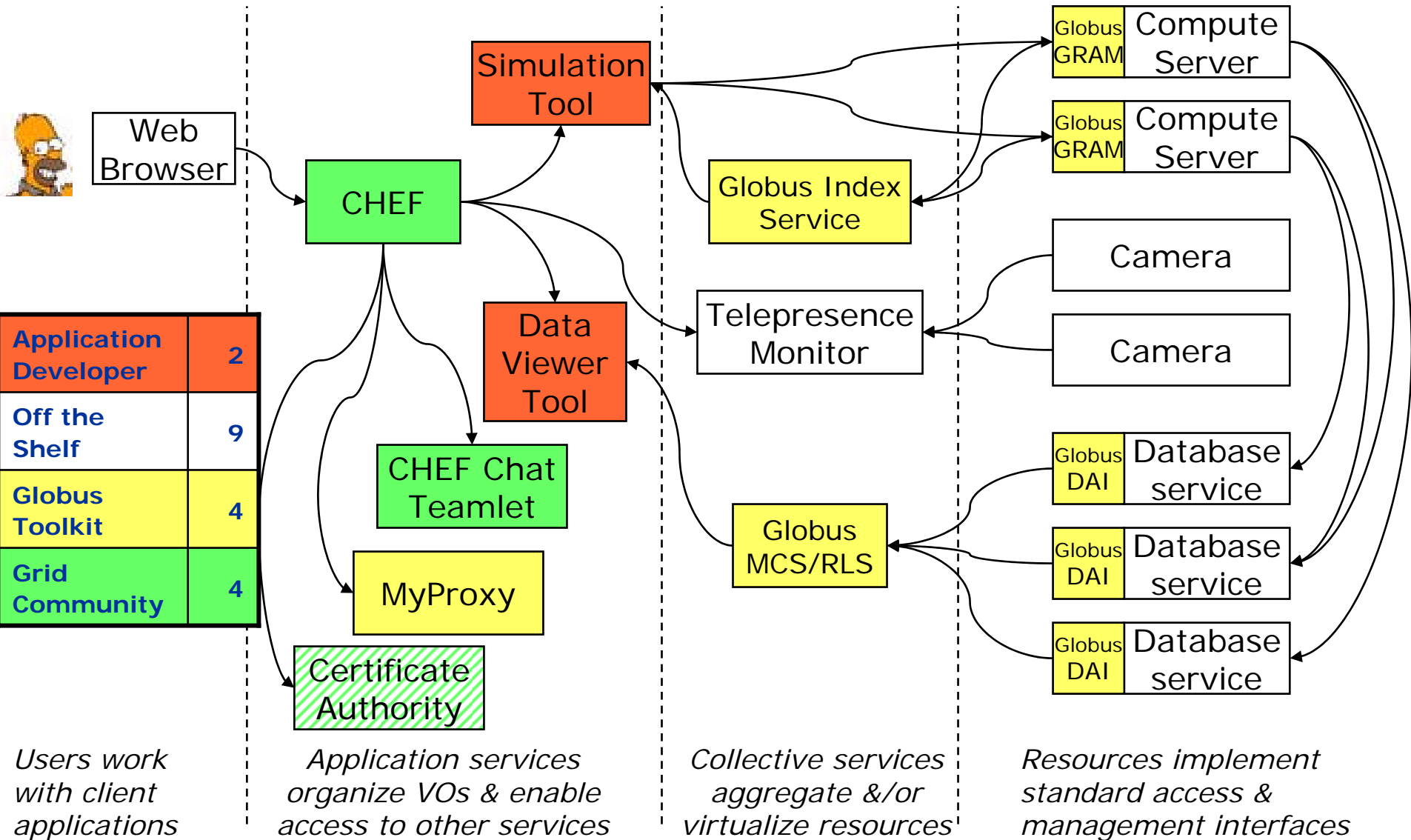
- Physical Facilities:** Images of large-scale shake tables (e.g., Multiple Shake Table Research Facility at UC Berkeley, UCSD, and UCIR), computer models of structures, and specialized testing equipment like the MTS Civil Engineering System (METS) at UC Berkeley.
- Data and Simulation:** A screenshot of a web browser displaying a data viewer for a simulation, showing displacement of a model over time and a circular pattern of data points.
- Network Infrastructure:** A diagram showing a wireless IP cloud connecting various sites, including a concentration point and a command center for data acquisition and control.
- Human Interaction:** A photograph of a control room where researchers are monitoring the simulation.

Links instruments, data,  
computers, people

# Without the Globus Toolkit



# With the Globus Toolkit



Application Developer	2
Off the Shelf	9
Globus Toolkit	4
Grid Community	4

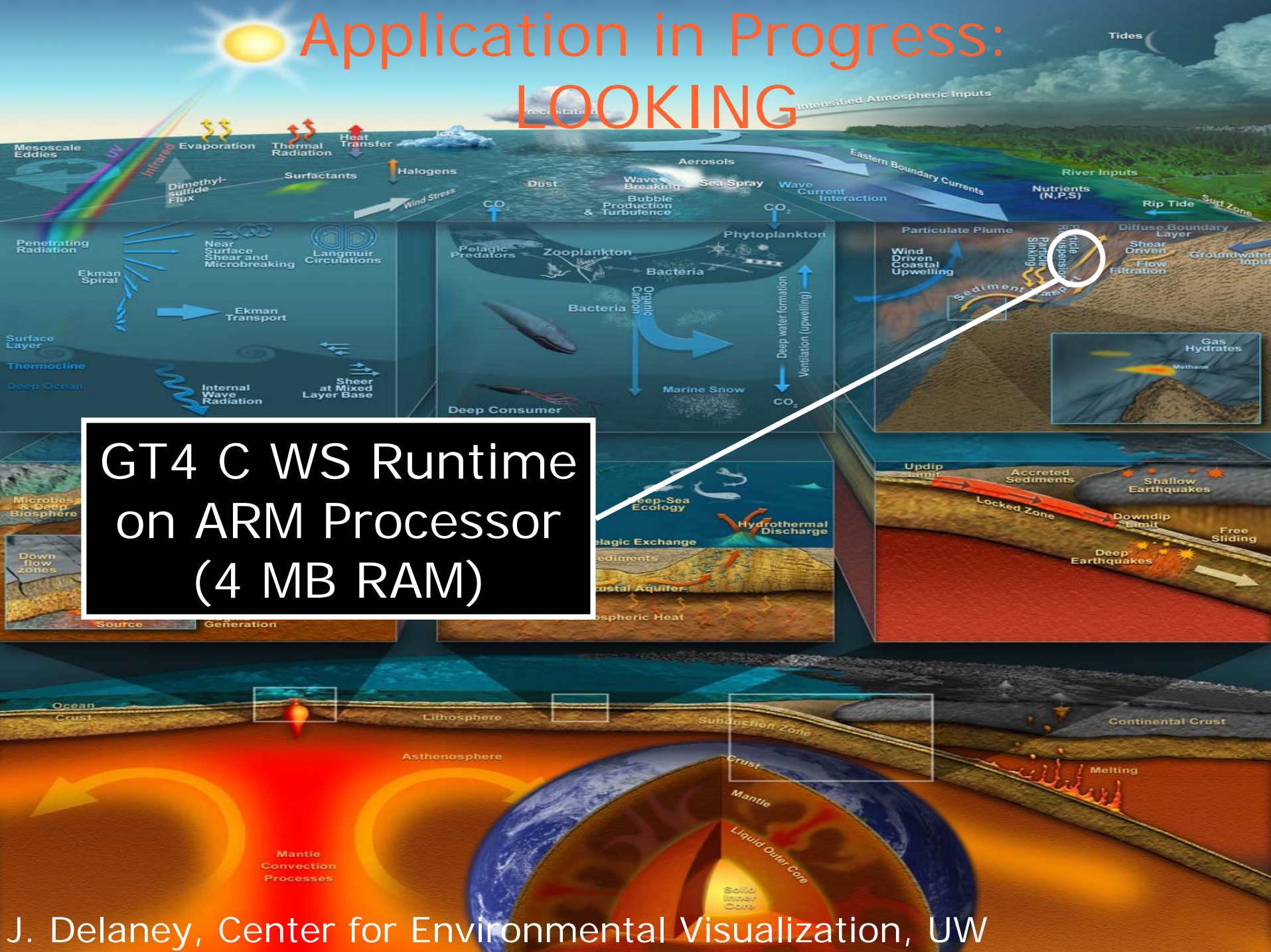
Users work with client applications

Application services organize VOs & enable access to other services

Collective services aggregate &/or virtualize resources

Resources implement standard access & management interfaces

# Application in Progress: LOOKING



GT4 C WS Runtime  
on ARM Processor  
(4 MB RAM)

# Summary

- Grids & netted sensors share concerns
  - ◆ Federation, modeling, management, security, dynamics, ...
- Common technology base has advantages
  - ◆ Enables sharing of infrastructure & code
  - ◆ Enables interoperability & embedding
- Service-oriented architecture as foundation
  - ◆ Web services base extended via Grid
  - ◆ Open source implementation: Globus

## For More Information

- Globus Alliance
  - ◆ [www.globus.org](http://www.globus.org)
- Global Grid Forum
  - ◆ [www.ggf.org](http://www.ggf.org)
- NEES
  - ◆ [www.nees.org](http://www.nees.org)
- Background information
  - ◆ [www.mcs.anl.gov/~foster](http://www.mcs.anl.gov/~foster)

