Service-oriented Architectures for Distributed Cooperative Instrumentation Grids

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Outline

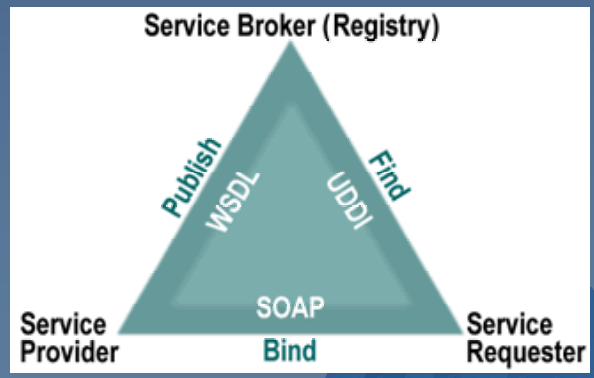
- Service Oriented Architectures
- From Service Oriented Architectures to Grid frameworks
- Grid and Instruments
- A Grid-based distributed measurement system
- Conclusions

Goals

- To extend the concept of distributed cooperating resources and to manage measurement instrumentation, low-cost nodes, control processes and computing facilities in a uniform way
- To propose a service oriented architecture for distributed measurement systems
- To evaluate Grid frameworks for instrumentation control and distributed measurement systems set-up
- To apply the proposed service oriented architecture in setting up an educational laboratory on electronics

SOA (Service Oriented Architecture)

- A design model to link computational resources, under the control of different ownership domains, on demand.
- SOA provides a uniform means to offer, discover, interact with and use capabilities to produce desired effects consistent with measurable preconditions and expectations.
- SOA paradigm can be described as “publish, find and bind” model.
- Web services are ideal for implementing a SOA.
- Web services are software system designed to support interoperable machine-to-machine interaction over a network.
- Interfaces are described in a machine-processable format (XML based).
- Interactions use SOAP messages, typically on HTTP, with an XML serialization.



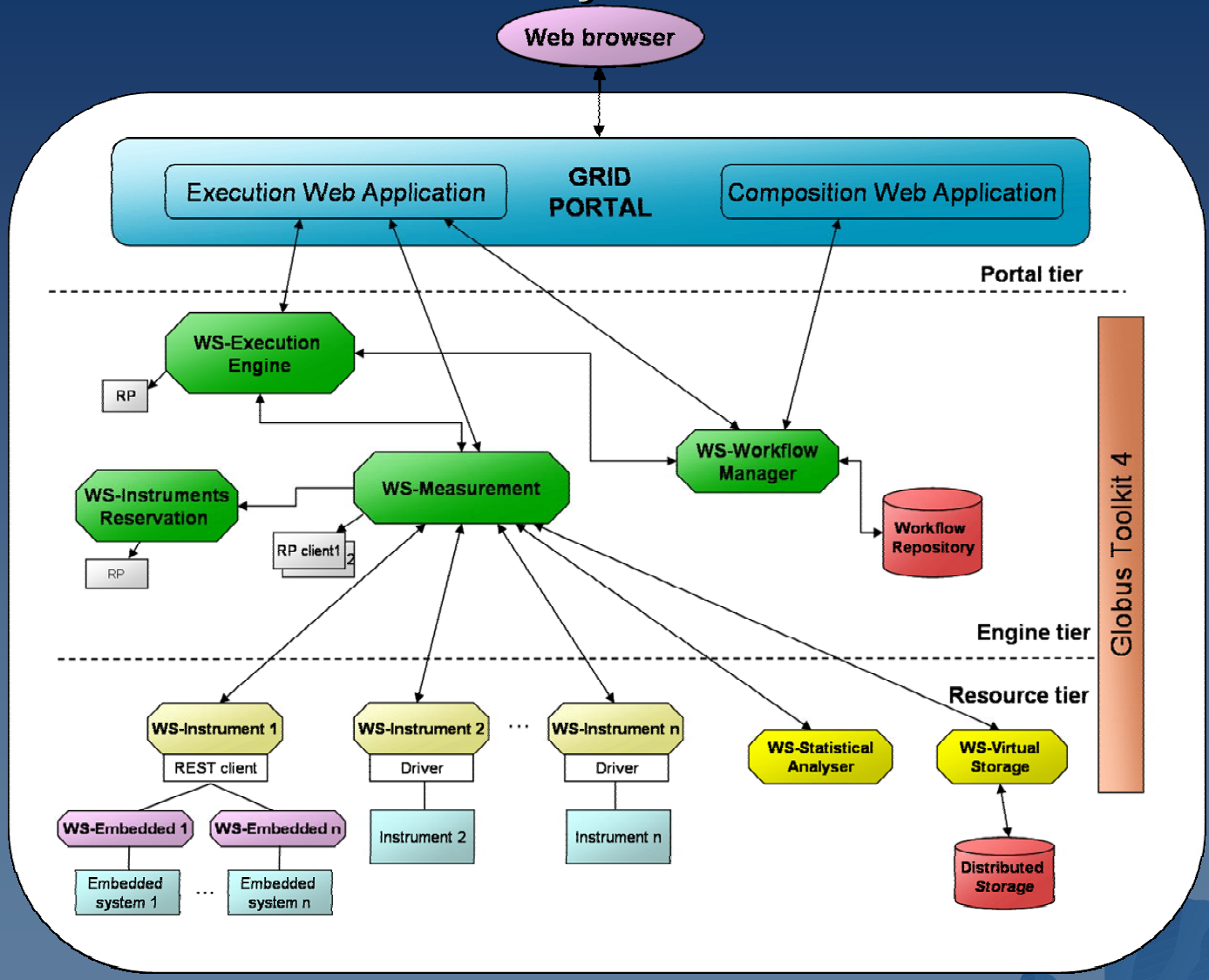
From SOA to Grid frameworks

- Grid emerged as a key infrastructure for “flexible, secure, coordinated resource sharing among dynamic collections of individuals and institutions” to create Virtual Organizations.
- Growing interest in the scientific community in extending Grid approach to measurement and control field.
- Distributed measurement systems need to merge specialized devices, sensor networks and processing units.
- The target is to use Grid frameworks facilities for sharing and integrating instruments with computing and storage capability.

Grid and Instruments

- Integration of instruments with the Grid requires mechanisms to register, locate and control them.
- It is feasible to develop Grid services that expose instruments functionalities and implement a standard communication model. Instrument services are the first *brick* to build Grid based measurement systems.
- Workflows allow aggregating and coordinating dynamically heterogeneous instruments. They describe measurement processes.

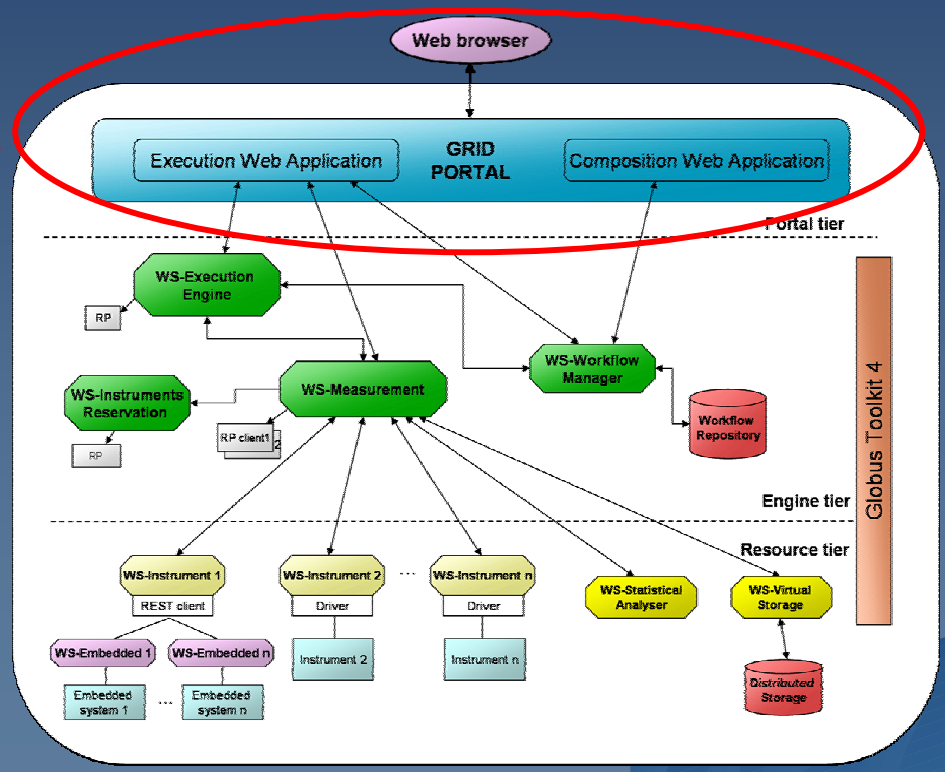
A Grid-based laboratory architecture



A Grid-based laboratory architecture

A multi-tier architecture able to manage multi-user and concurrent accesses on resources.

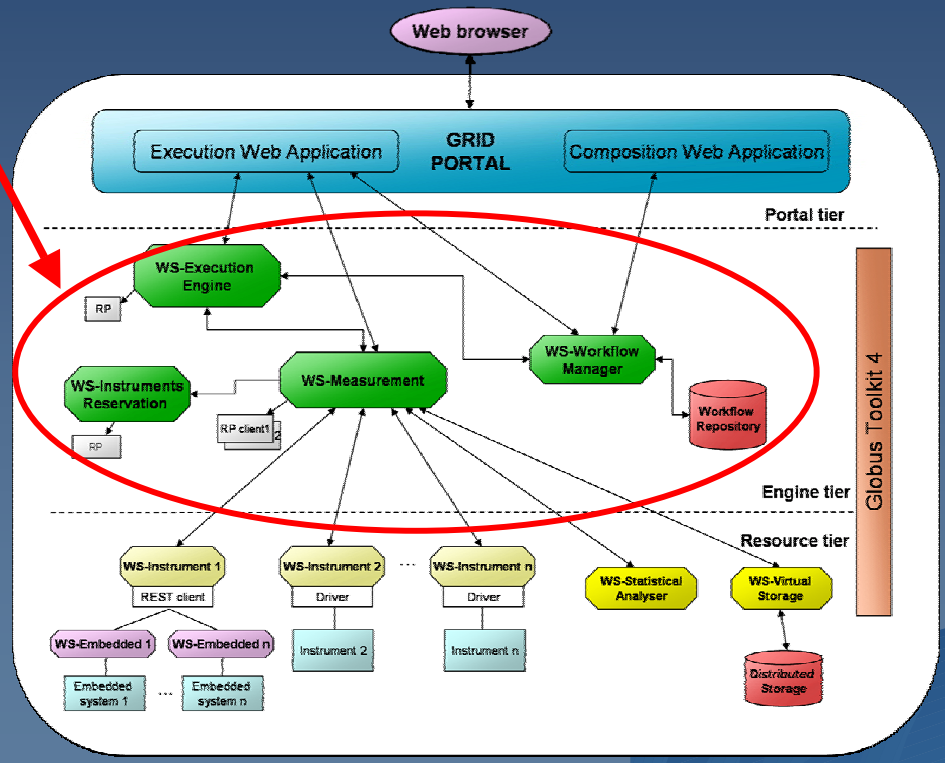
End users run measurement processes that require controlling instruments or acquiring data from networks of low cost nodes, and set up new measurement processes based on the functionalities exposed by the controlled resources.



A Grid-based laboratory architecture

The middleware services

- control real distributed resources (instrumentation, devices under test, data acquisition nodes) combining them with storage and computing facilities in a secure environment;
- manage concurrent accesses to the real devices and interactive work sessions.

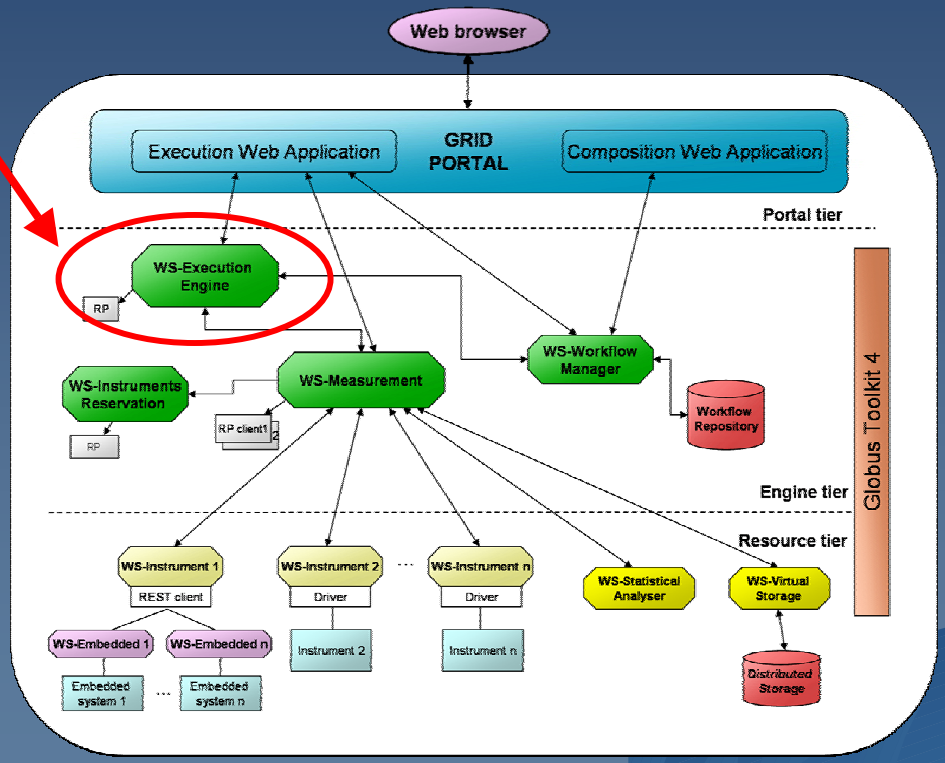


A Grid-based laboratory architecture

The WS-ExecutionEngine is a stateful service.

It manages the users work sessions and creates an instance of the WS-Measurement service for each measurement process according to the selected workflow.

It stores session related information.

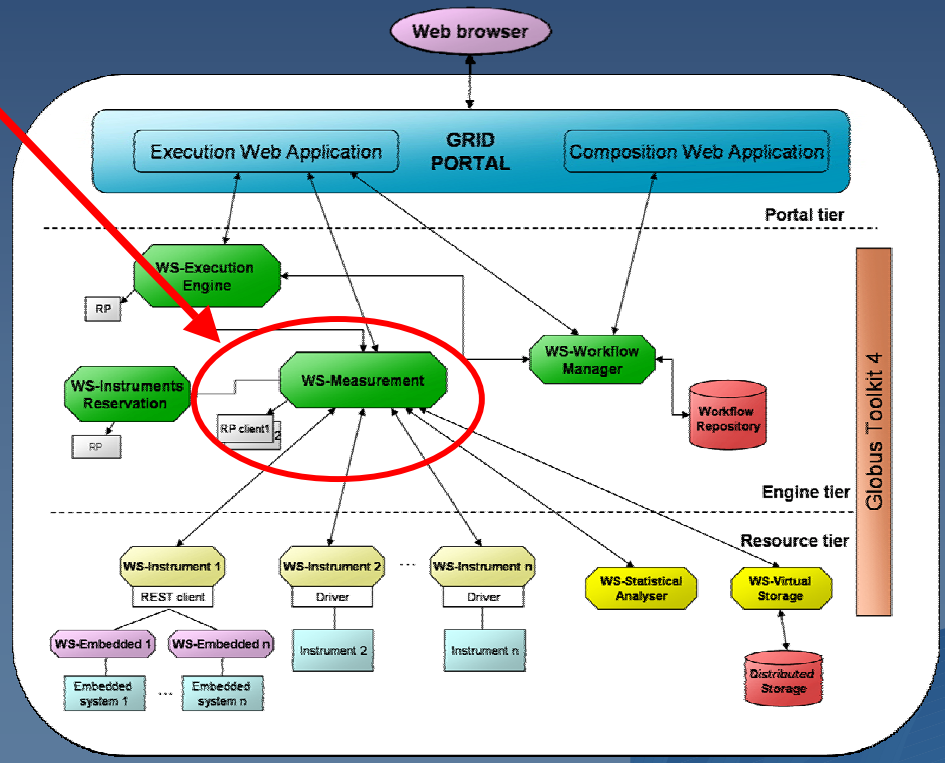


A Grid-based laboratory architecture

The WS-Measurement service is stateful service.

It is a generic service able to run any measurement and works on the base of the workflow assigned to it at invocation time .

It maintains workflow specific information.

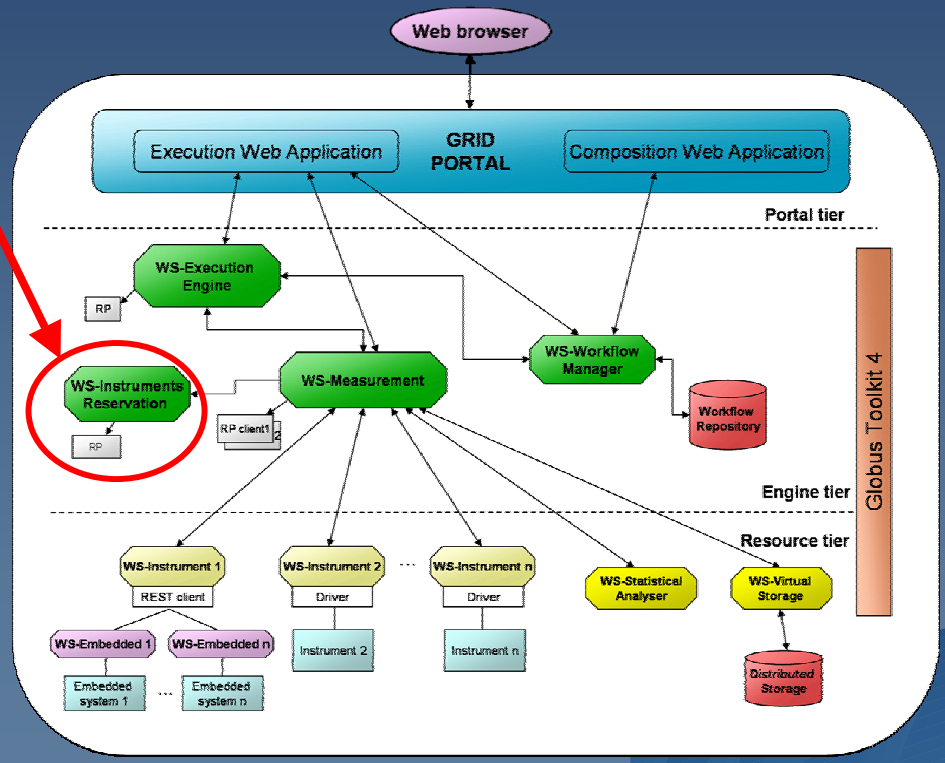


A Grid-based laboratory architecture

The WS-Instruments Reservation is a stateful service.

It maintains the state of the devices of the Resource tier, and checks their availability.

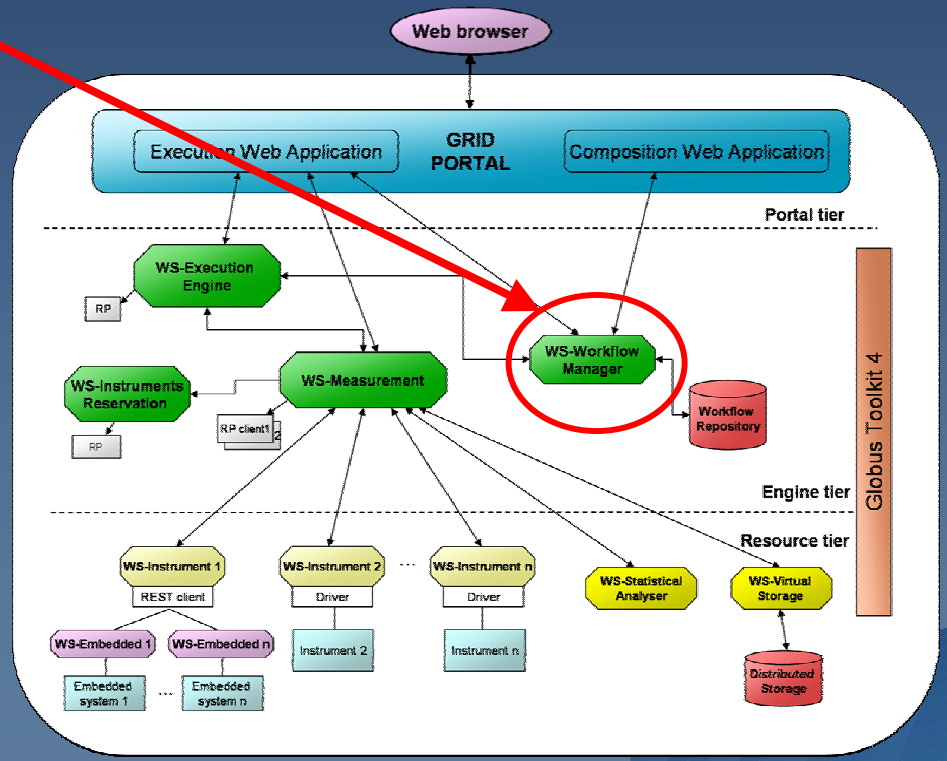
It reserves the resources present in the workflows for the time required to complete the measurement processes.



A Grid-based laboratory architecture

The WS-WorkflowManager service exposes functionalities for the management of the workflow repository: store, update, delete and load workflows.

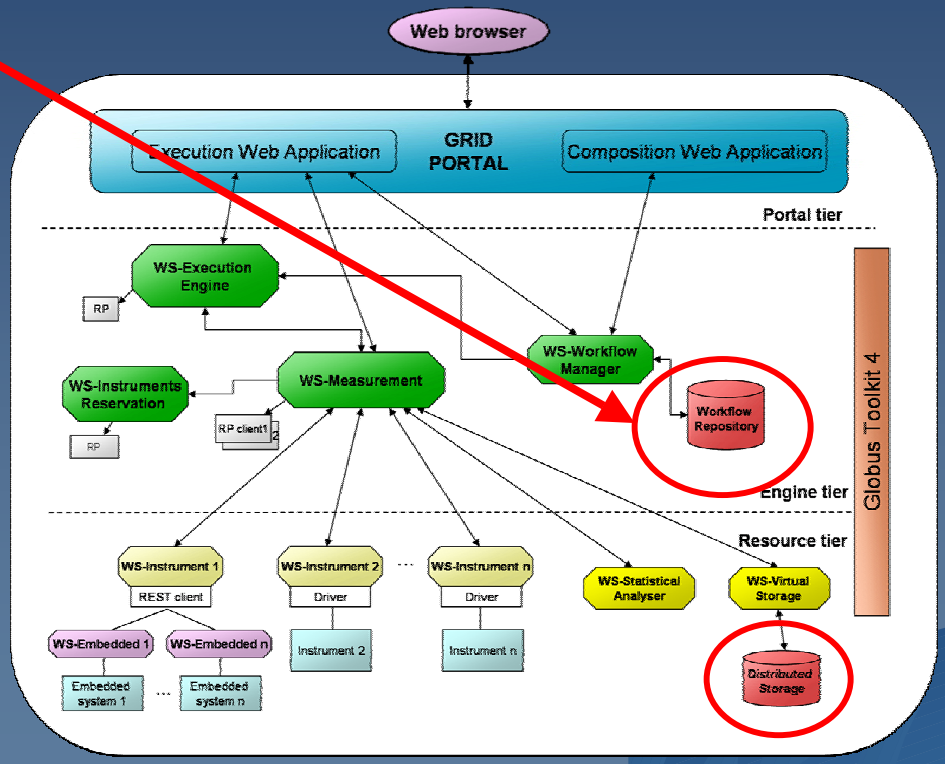
It is a stateless service.



A Grid-based laboratory architecture

The WorkflowRepository is a container of workflows.

It can be implemented in different ways: a directory in a file system, a database, a WebDav repository or a distributed storage system provided by Grid frameworks.

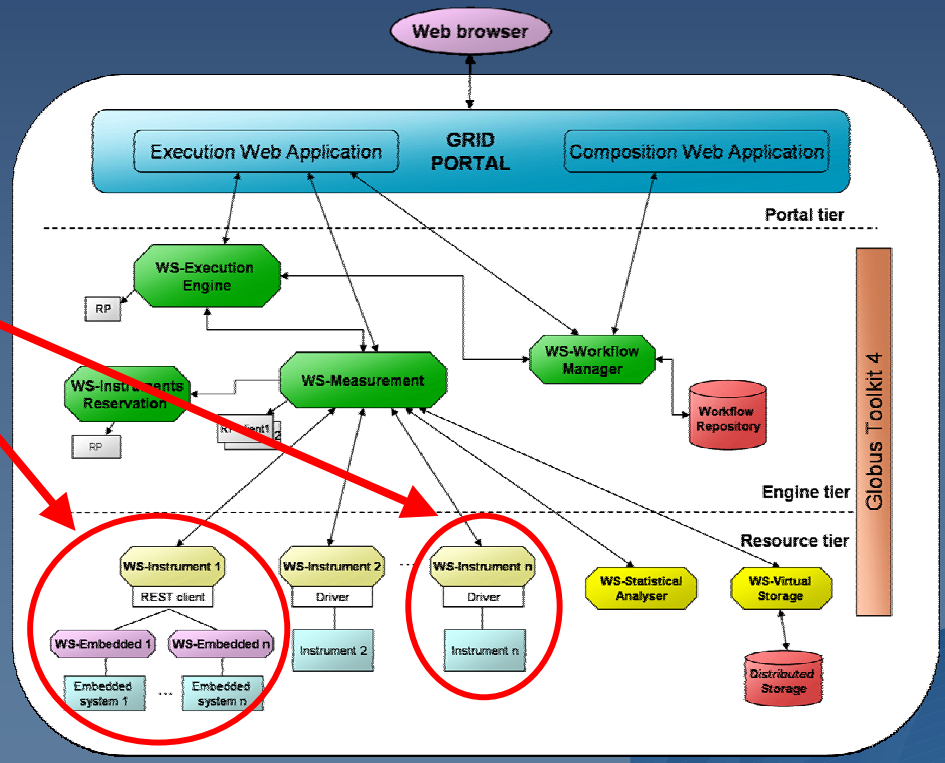


A Grid-based laboratory architecture

The WS-Instrument services are in charge of communicating with the real devices.

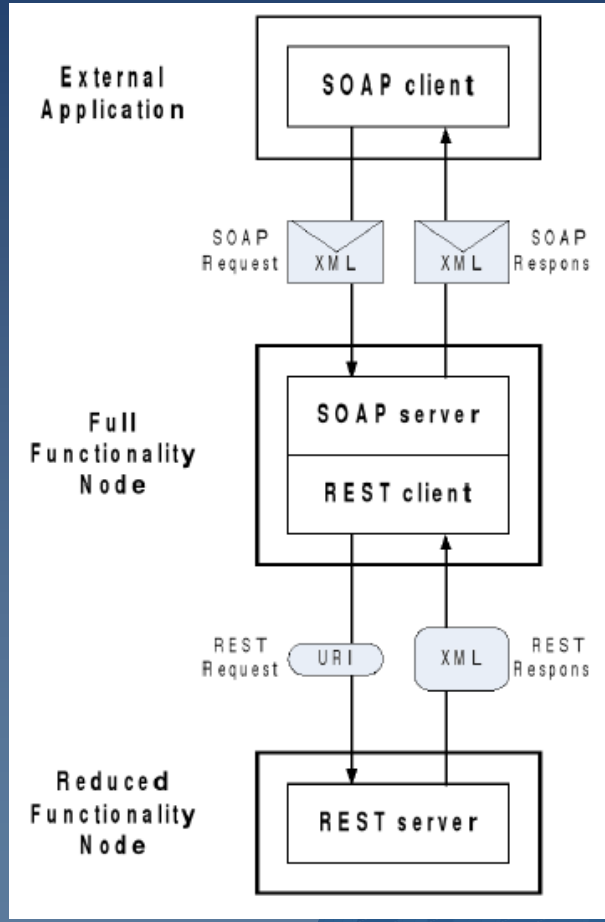
Two kinds of WS-Instrument services:

- wrappers to the instrument drivers;
- embedded systems control.



Web Services for embedded systems

- Embedded systems are special-purpose systems in which the computer is completely encapsulated by or dedicated to the device or system they control.
- REST (REpresentational State Transfer) is a light-weight solution adopted for accessing embedded devices as services.
- The RESTful implementation of a service uses the standard HTTP primitives for service access: URIs provide unique, uniform and universal addressing mechanism.
- A two layers SOA can merge small devices (i.e. for environmental sensing and conditioning) and nodes that offer more complex services on the base of the collected results.



Conclusions

- The architectural model has been validated setting up an educational laboratory on electronics for supporting courses of the curricula in Information Engineering at the University of Genoa.

Thank you for your attention

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