Grid Computing

Globus Toolkit 4.0 – Part 1

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Fall 2006

Based on

Ian Foster, Globus Toolkit version 4
Tutorial, 1st Intl. Conf. on e-Science and Grid Computing,
Melbourne, Australia, December 12, 2005

The Globus Toolkit is a Collection of Components

- A set of loosely-coupled components, with:
  - Services and clients
  - Libraries
  - Development tools
- GT components are used to build Grid-based applications and services
  - GT can be viewed as a Grid SDK
- GT components can be categorized across two different dimensions
  - By broad domain area
  - By protocol support

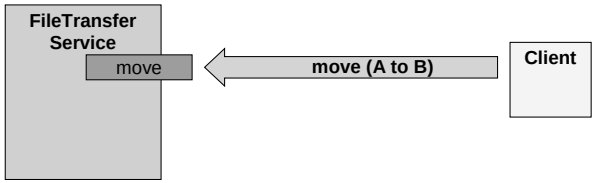
GT Domain Areas

- Core runtime
  - Infrastructure for building new services
- Security
  - Apply uniform policy across distinct systems
- Execution management
  - Provision, deploy, & manage services
- Data management
  - Discover, transfer, & access large data
- Monitoring
  - Discover & monitor dynamic services

GT Protocols

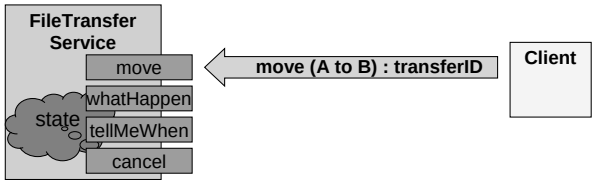
- Web service protocols
  - WSDL, SOAP
  - WS Addressing, WSRF, WSN
  - WS Security, SAML, XACML
  - WS-Interoperability profile
- Non Web service protocols
  - Standards-based, such as GridFTP
  - Custom

“Stateless” vs. “Stateful” Services



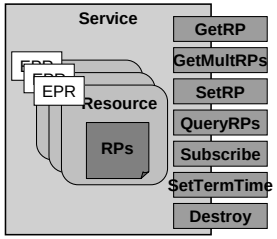
- Without state, how does client:
  - Determine what happened (success/failure)?
  - Find out how many files completed?
  - Receive updates when interesting events arise?
  - Terminate a request?
- Few useful services are truly “stateless”, but WS interfaces alone do not provide built-in support for state

FileTransferService (without WSRF)



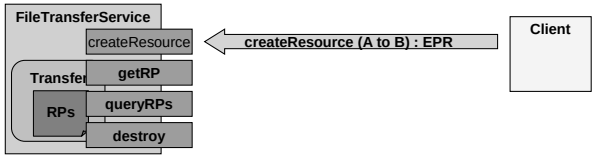
- Developer reinvents wheel for each new service
  - Custom management and identification of state: **transferID**
  - Custom operations to inspect state synchronously (**whatHappen**) and asynchronously (**tellMeWhen**)
  - Custom lifetime operation (**cancel**)

WSRF in a Nutshell



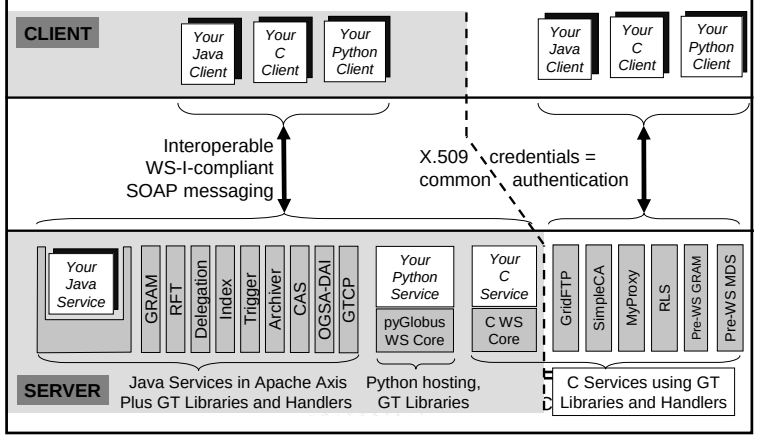
- Service
- State representation
  - Resource
  - Resource Property
- State identification
  - Endpoint Reference
- State Interfaces
  - GetRP, QueryRPs, GetMultipleRPs, SetRP
- Lifetime Interfaces
  - SetTerminationTime
  - ImmediateDestruction
- Notification Interfaces
  - Subscribe
  - Notify
- ServiceGroups

FileTransferService (w/ WSRF)



- Developer specifies custom method to createResource and leaves the rest to WSRF standards:
  - State exposed as Resource + Resource Properties and identified by Endpoint Reference (EPR)
  - State inspected by standard interfaces (GetRP, QueryRPs)
  - Lifetime management by standard interfaces (Destroy)

GT4 Components



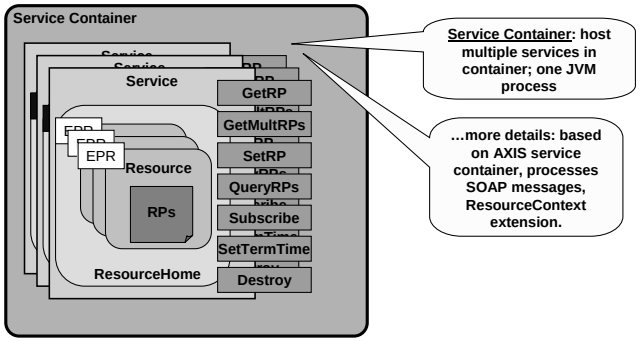
Goals for GT4

- Usability, reliability, scalability, …
  - Web service components have quality equal or superior to pre-WS components
  - Documentation at acceptable quality level
- Consistency with latest standards (WS-*, WSRF, WS-N, etc.) and Apache platform
  - WS-I Basic Profile compliant
  - WS-I Basic Security Profile compliant
- New components, platforms, languages
  - And links to larger Globus ecosystem
- See
  - http://www.globus.org/toolkit/docs/4.0/

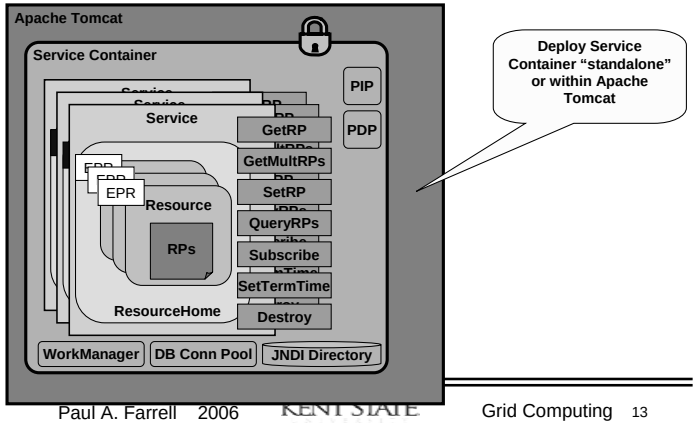
Hosting Environment

- Specific execution environment
- GT3 supports the following four Java hosting environments:
  - Embedded: embedded in any existing J2SE application.
  - Standalone: a lightweight J2SE server that hosts Grid services.
  - J2EE Web Container: an OGSI hosting environment inside a Web server that can be hosted by any Java Servlet-compliant engine, such as the Jakarta Tomcat.
  - J2EE EJB Container: a code generator to allow exposure of stateful J2EE Entity and Session Java Beans as OGSI-compliant Grid services.

GT4 WS Engine



GT4 WS Engine Hosting



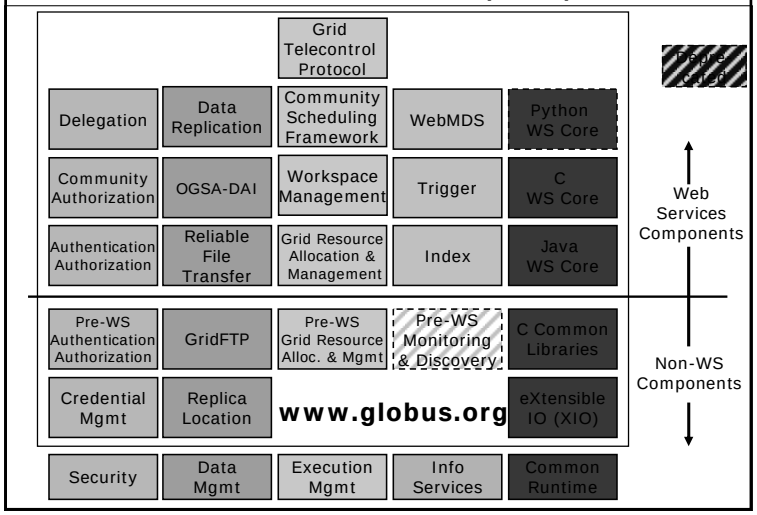
Software Required

- Required to install Globus 4.0.3
  - J2SE 1.4.2+ SDK from Sun, IBM, HP, or BEA (do not use GCJ).
  - Ant 1.6+ (1.6.1+ if using Java 1.5).
  - C compiler. If gcc, avoid version 3.2. 3.2.1 and 2.95.x are okay. gcc 4.1 has a bug
  - GNU tar, GNU sed, GNU Make
  - zlib 1.1.4+
  - Perl 5.005 or newer
  - sudo
  - JDBC compliant database. For instance, PostgreSQL 7.1+
  - gpt-3.2autotools2004 (shipped with the installers, but required if building standalone GPT bundles/packages)

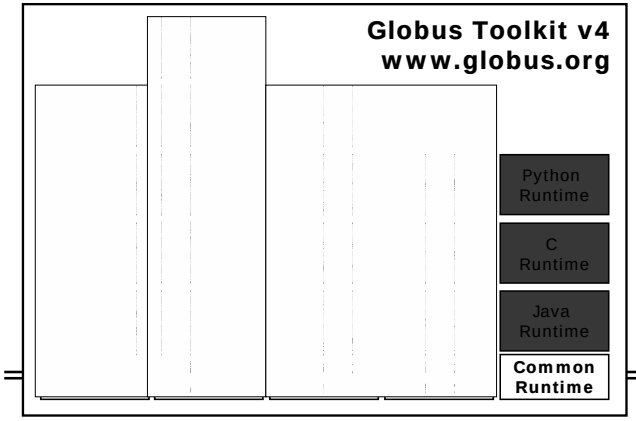
Optional Software

- IODBC (compile requirement for RLS)
- Tomcat (required by WebMDS, optional for other services
- gLite Java VOMS parsing libraries (compile requirement for Workspace Service)

Globus Toolkit version 4 (**GT4**)



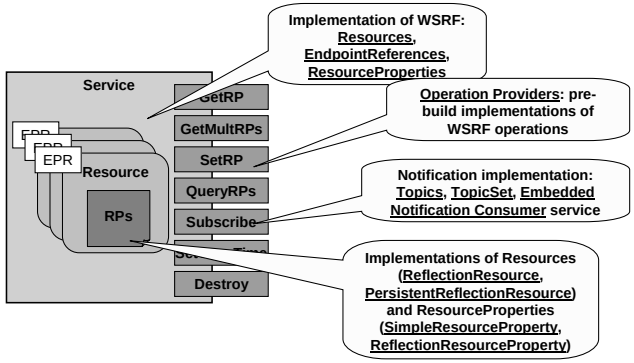
Globus Toolkit: Runtime



GT4 Web Services Runtime

- Supports both GT (GRAM, RFT, Delegation, etc.) & user-developed services
- Redesign to enhance scalability, modularity, performance, usability
- Leverages existing WS standards
  - WS-I Basic Profile: WSDL, SOAP, etc.
  - WS-Security, WS-Addressing
- Adds support for emerging WS standards
  - WS-Resource Framework, WS-Notification
- Java, Python, & C hosting environments
  - Java is standard Apache

GT4 WS Core in a Nutshell



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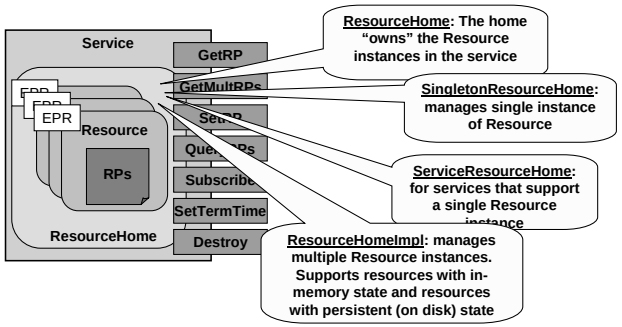

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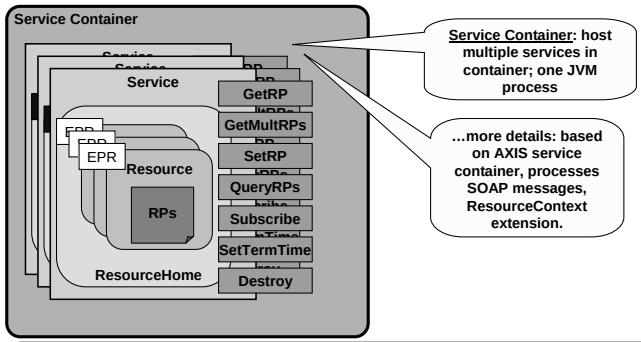

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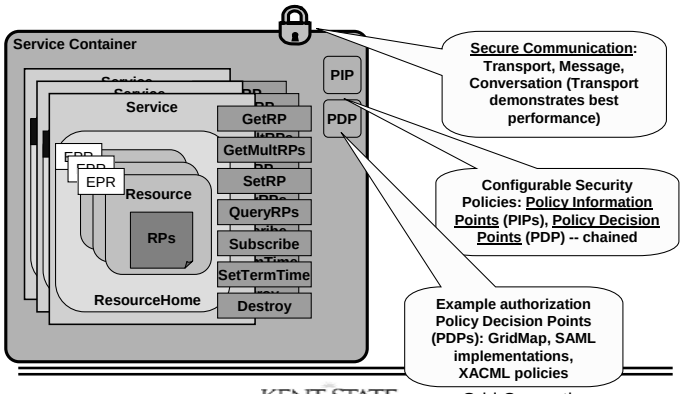

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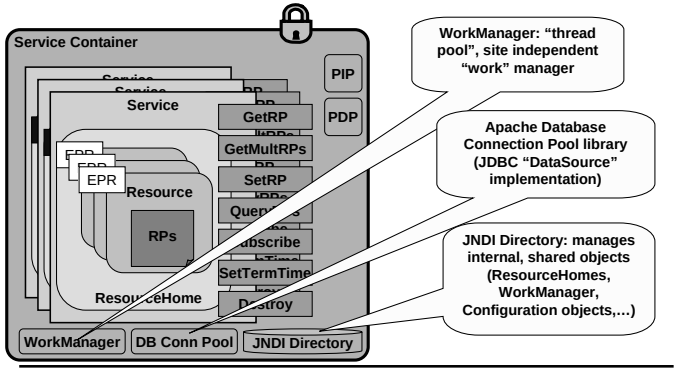

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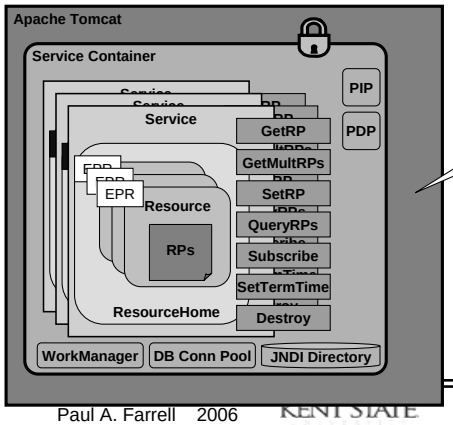

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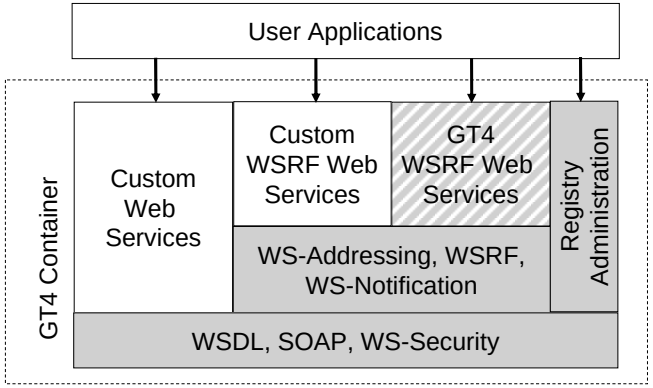
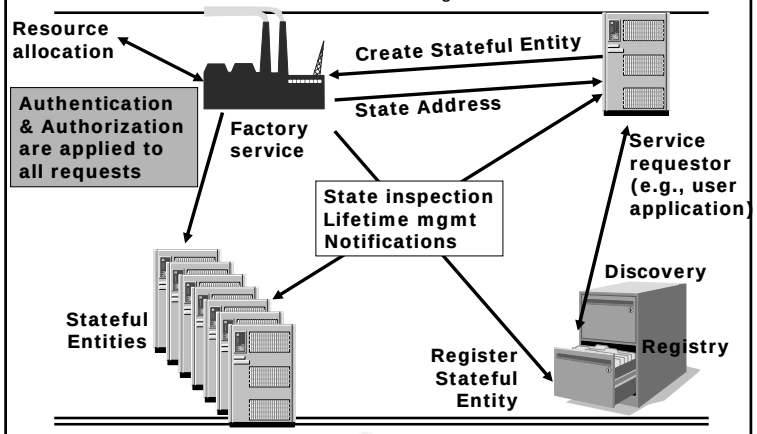
GT4 Web Services Runtime



Modeling State in Web Services

Interactions standardized using WSDL and SOAP



WSRF & WS-Notification

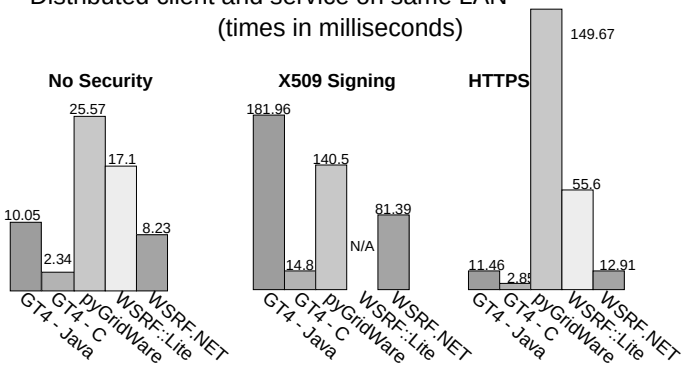
- **Naming and bindings** (basis for virtualization)
  - Every resource can be uniquely referenced, and has one or more associated services for interacting with it
- **Lifecycle** (basis for fault resilient state mgmt)
  - Resources created by services following factory pattern
  - Resources destroyed 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

WSRF/WSNs Compared (HPDC 2005)

	GT4-Java	GT4-C	pyGridWare	WSRF::Lite	WSRF.NET
Languages supported	Java	C	Python	Perl	C#/C++/VBasic, etc.
WS-Security password profile	Yes	No	In progress	In progress	Yes
WS-Security X.509 profile	Yes	In progress	Yes	In progress	Yes
WS-SecureConversation	Yes	No	Yes	No	Yes
TLS/SSL	Yes	Yes	Yes	Yes	Yes
Authorization	Multiple	Multiple	Callout	None	
Persistence of WS-Resources	Yes	Not default	Yes	Yes	Yes
Memory Footprint	JVM + 10M	22 KB	12 MB	12 MB	Depends
Memory size per WS-Resource	Depends on resource state	70B	Depends on resource state	0 (file/DB) or 10B (process)	Depends on resource state
Unmodified hosting environment	Yes	No	Yes	Yes (Apache)	Yes
Compliance with WS-I Basic Profile	Yes	Yes	Yes	In progress	Yes
Compliance with WS-I Basic Security Profile	Yes	Yes	Yes	No	Yes
Logging	Log4J	Yes	Yes	Yes	WSE diagnostics
WS-ResourceLifetime	Yes	Yes	Yes	Yes	Yes
WS-ResourceProperties	Yes	Yes	Yes	Yes	Yes
WS-ServiceGroup	Yes	Yes	Yes	Yes	Yes
WS-BaseFaults	Yes	Yes	Yes	Yes	Yes
WS-BaseNotification	Yes	Consumer	Yes	No	Yes
WS-BrokeredNotification	Partial	No	No	No	Yes
WS-Topics	Partial	Partial	Partial	No	Partial

GetRP Test

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



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GT4 WS Core Performance

(1) Message-level security (times in milliseconds)

	GT4 Java	GT4 C	GT4 Python	WSRF.NET
GetRP	181.96	14.77	140.50	81.39
SetRP	182.04	14.99	142.21	82.48
CreateR	188.46	14.98	132.26	96.22
DestroyR	182.03	15.76	136.12	86.89
Notify	219.51	N/A	244.93	101.57

(2) Transport-level security (times in milliseconds)

	GT4 Java	GT4 C	GT4 Python	WSRF.NET
getRP	11.46	2.85	149.67	12.91
setRP	11.47	2.86	150.79	12.3
createR	18.00	2.82	132.60	20.84
destroyR	14.92	2.71	149.21	16.05
Notify	29.26	9.67	169.07	45.0

"WSRF/WSNs Compared," HPDC 2005.