



Enabling Grids for E-scienceE

Web Services, WSRF and GT4

Mike Mineter

National e-Science Centre, Edinburgh

www.eu-egee.org

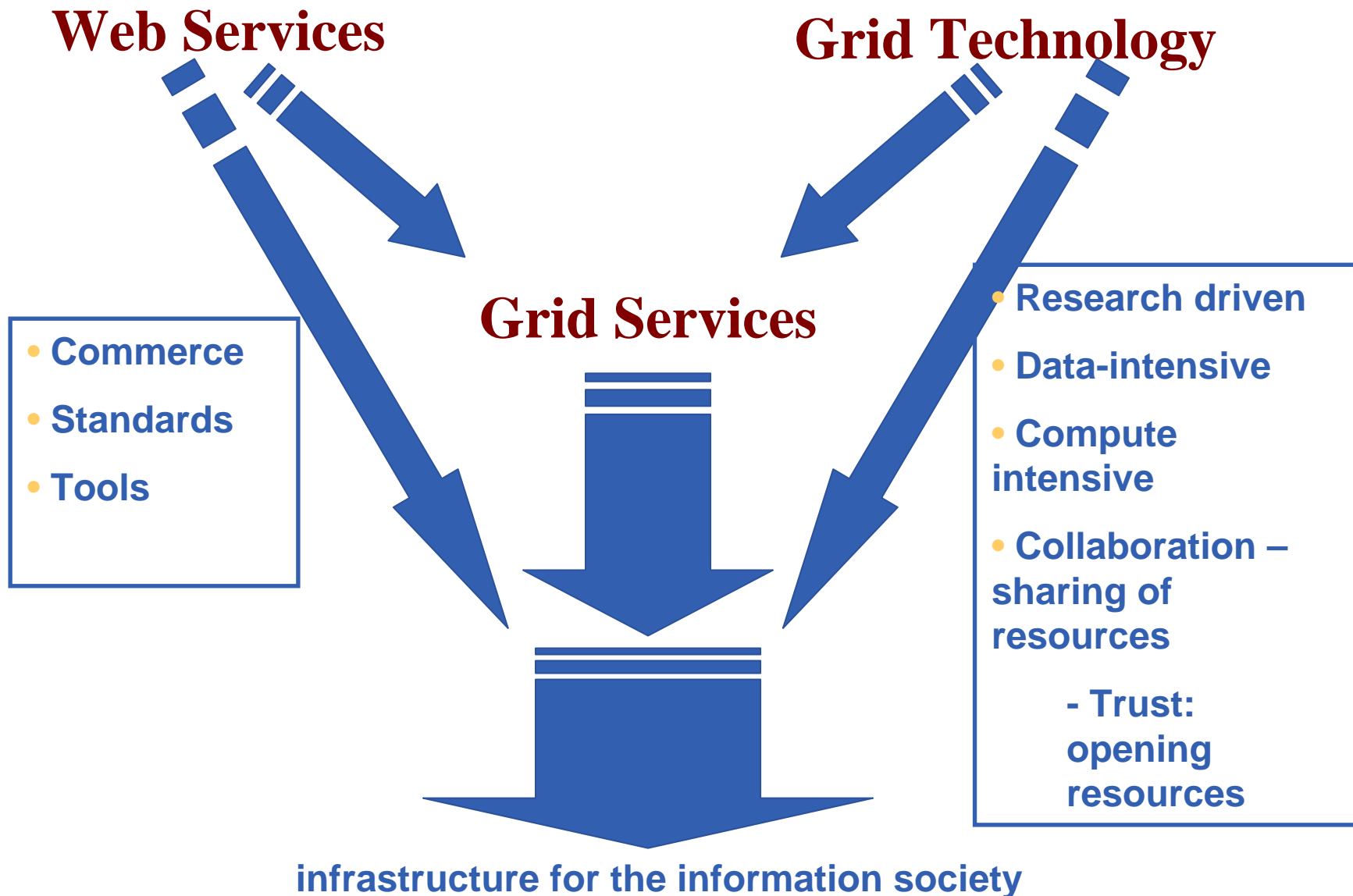


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- **An orientation to Web Services and to their role in Grid computing**
- **No prior knowledge assumed**

- “ Web Services are the way to build Grids”
- Web Services
- Relevance of Web Services to Grids
- Extending WS for grids
- So where are we now ?
- Where might we be going?!



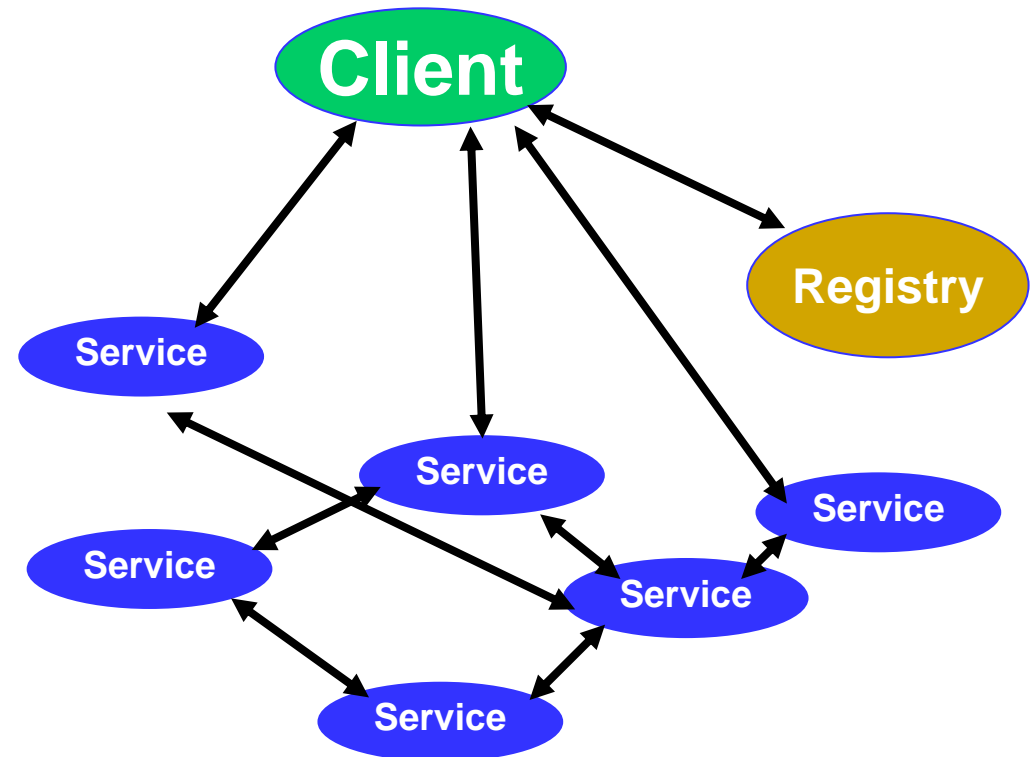


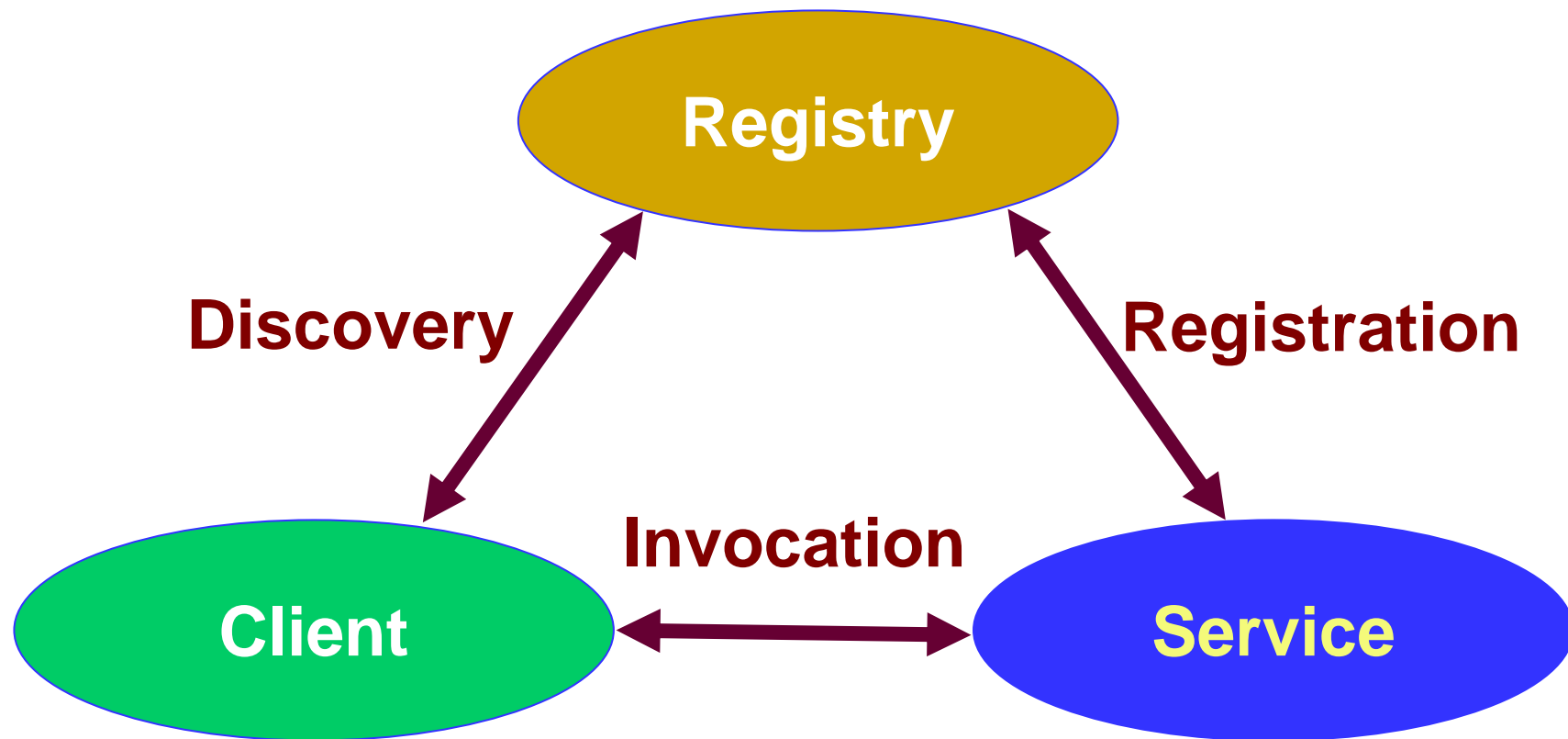
What are “Web Services?”

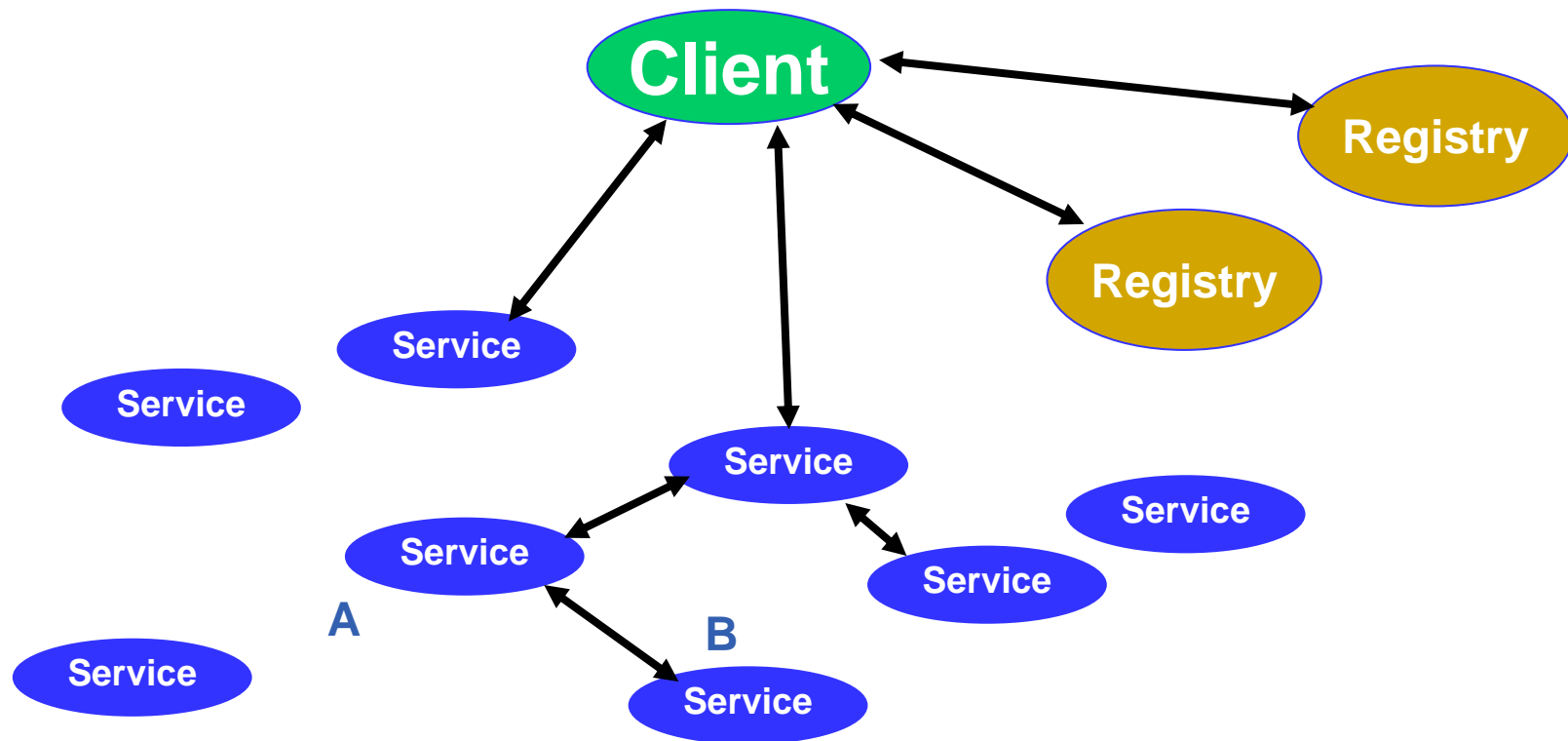
- **History**
 1. Web browsing
 2. Web pages with content from applications
 3. Applications that are useable by software clients
- **Web Services are software components that are..**
 - Accessible across a network
 - Loosely coupled
 - Defined by the messages they receive / send
 - Modular and self-contained
 - So can change service implementation without changing interfaces
 - Interoperable: each service has a description that is accessible and can be used to create software to invoke that service
- **... and based on standards**
 - Usually built on (extensions of) standards made ubiquitous by the Web: http(s), XML, ... and for which tools are already built.
 - Developed in anticipation of new uses – e.g. can compose workflow
 - Encouraging adoption

Service orientation – software components that are...

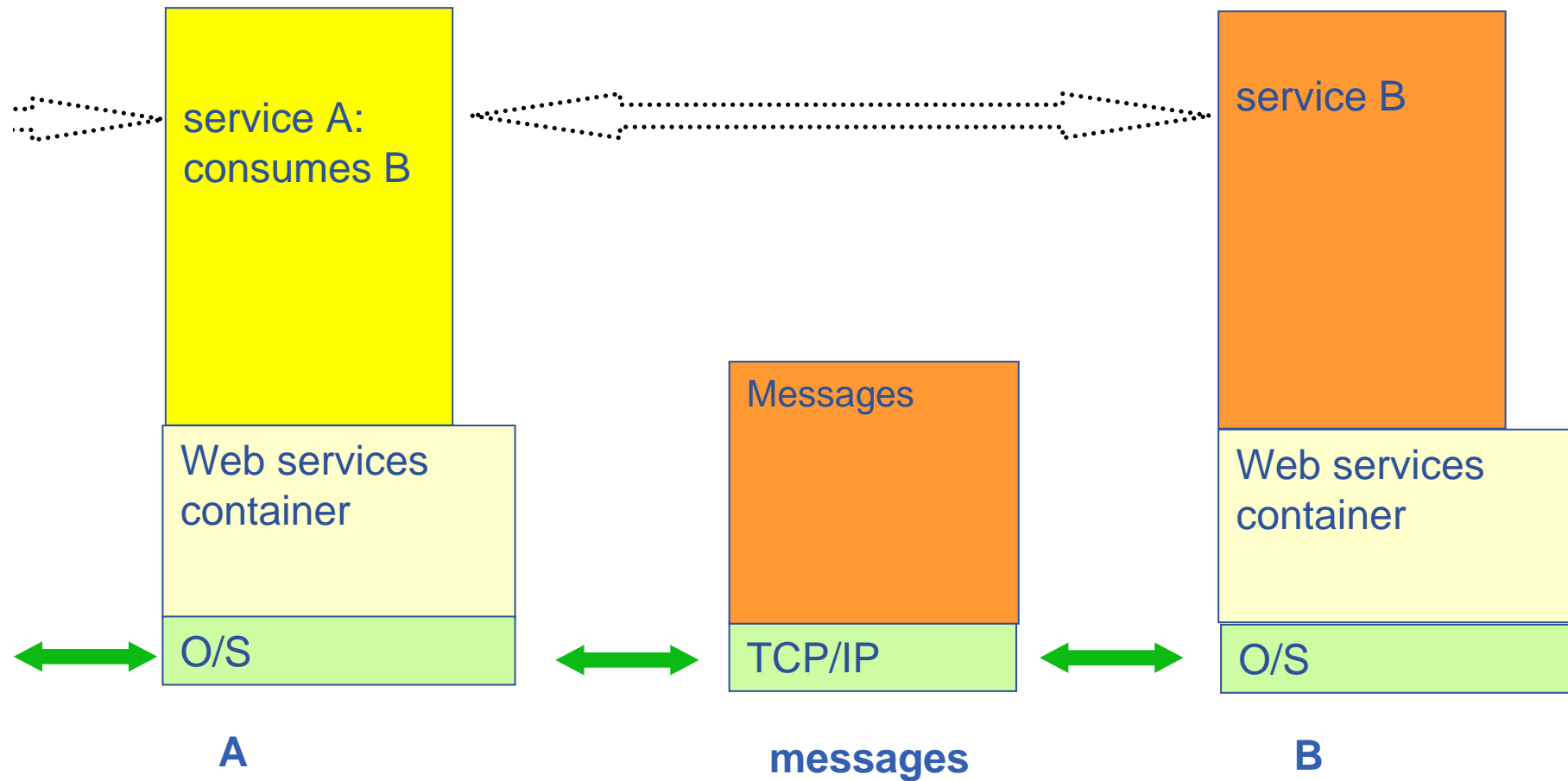
- Accessible across a network
- Loosely coupled, defined by the messages they receive / send
- Interoperable: each service has a description that is accessible and can be used to create software to invoke that service
- Based on standards (for which tools do / could exist)
- Developed in anticipation of new uses





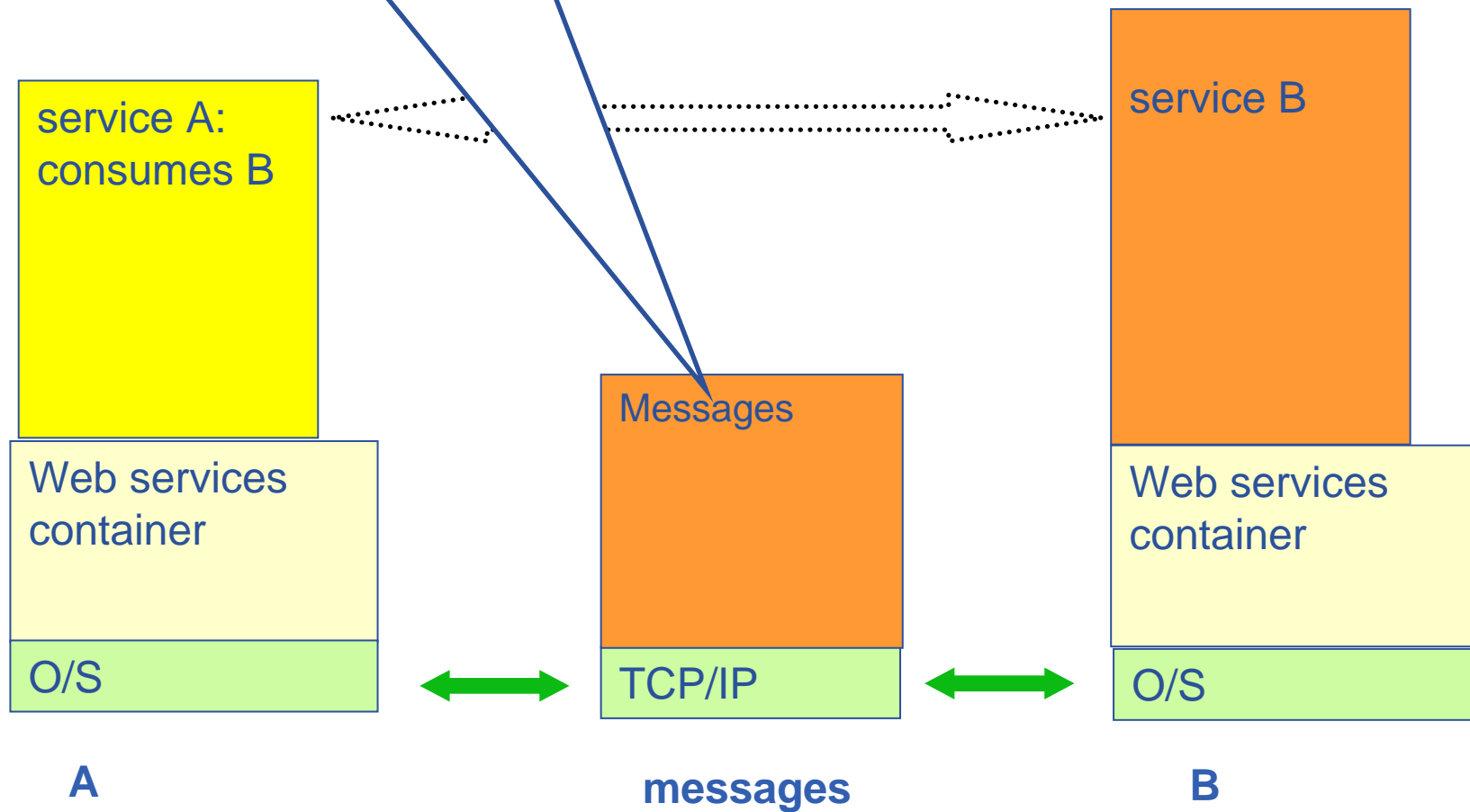


Using service B from service A

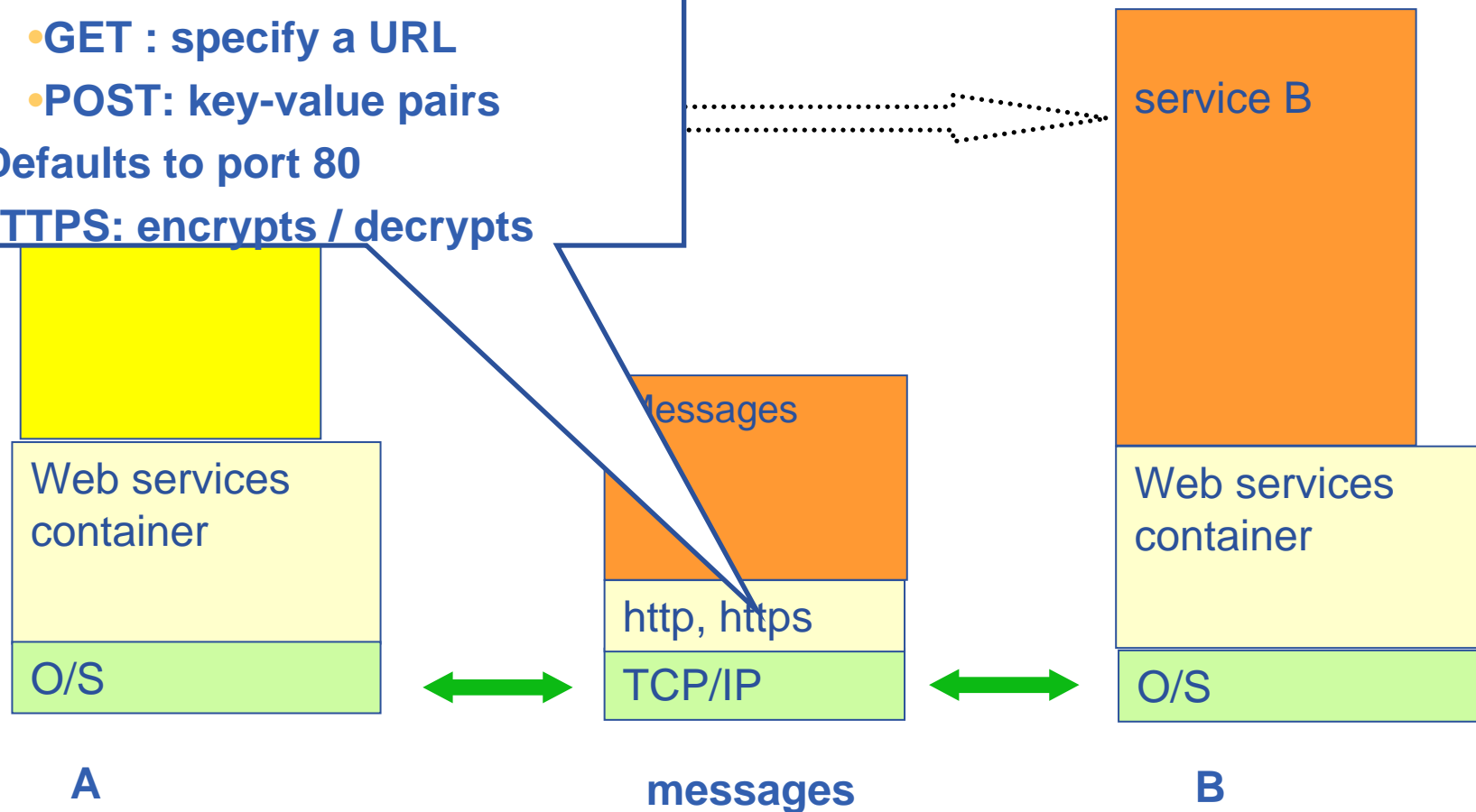


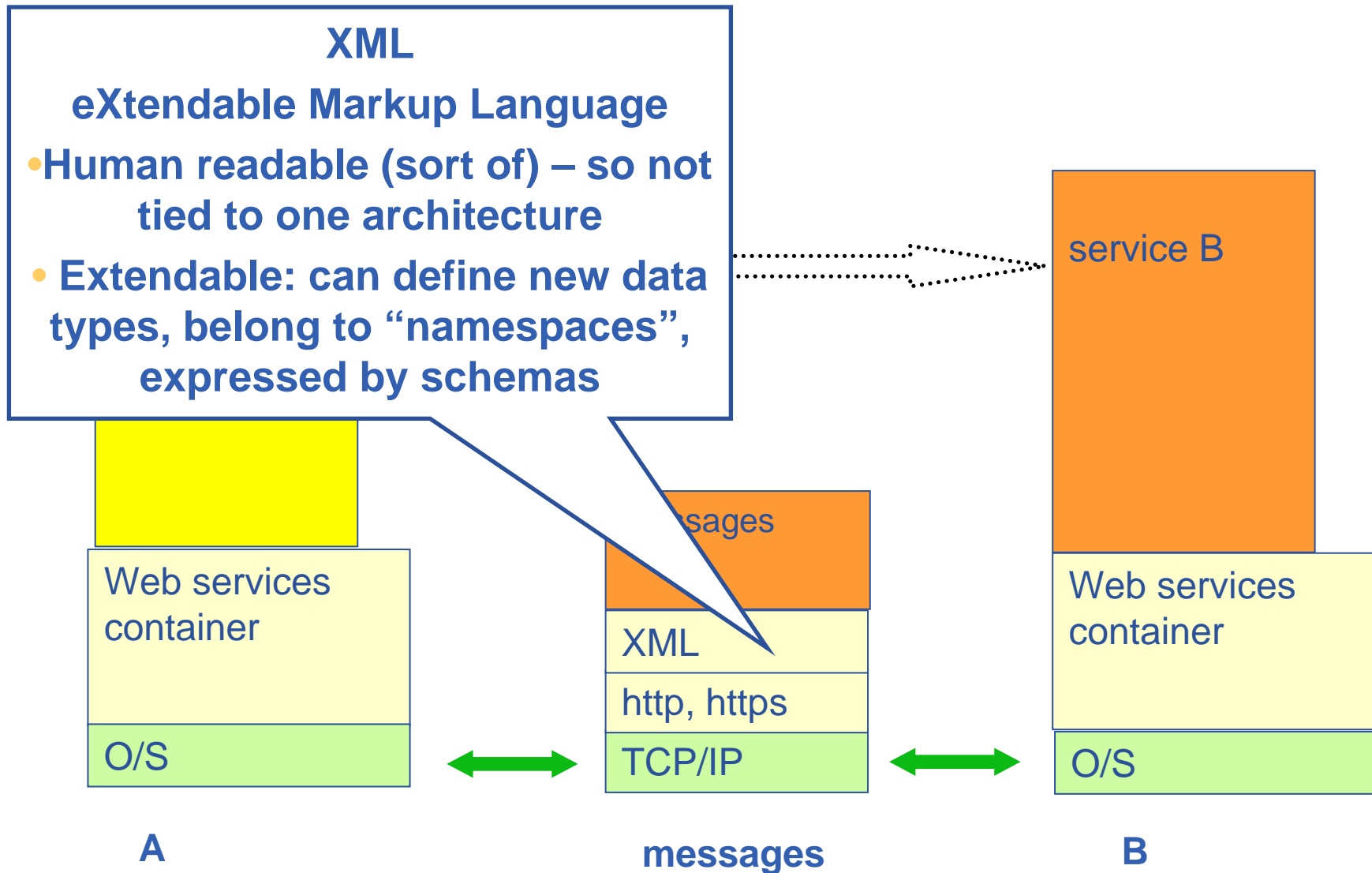
Using service B from service A

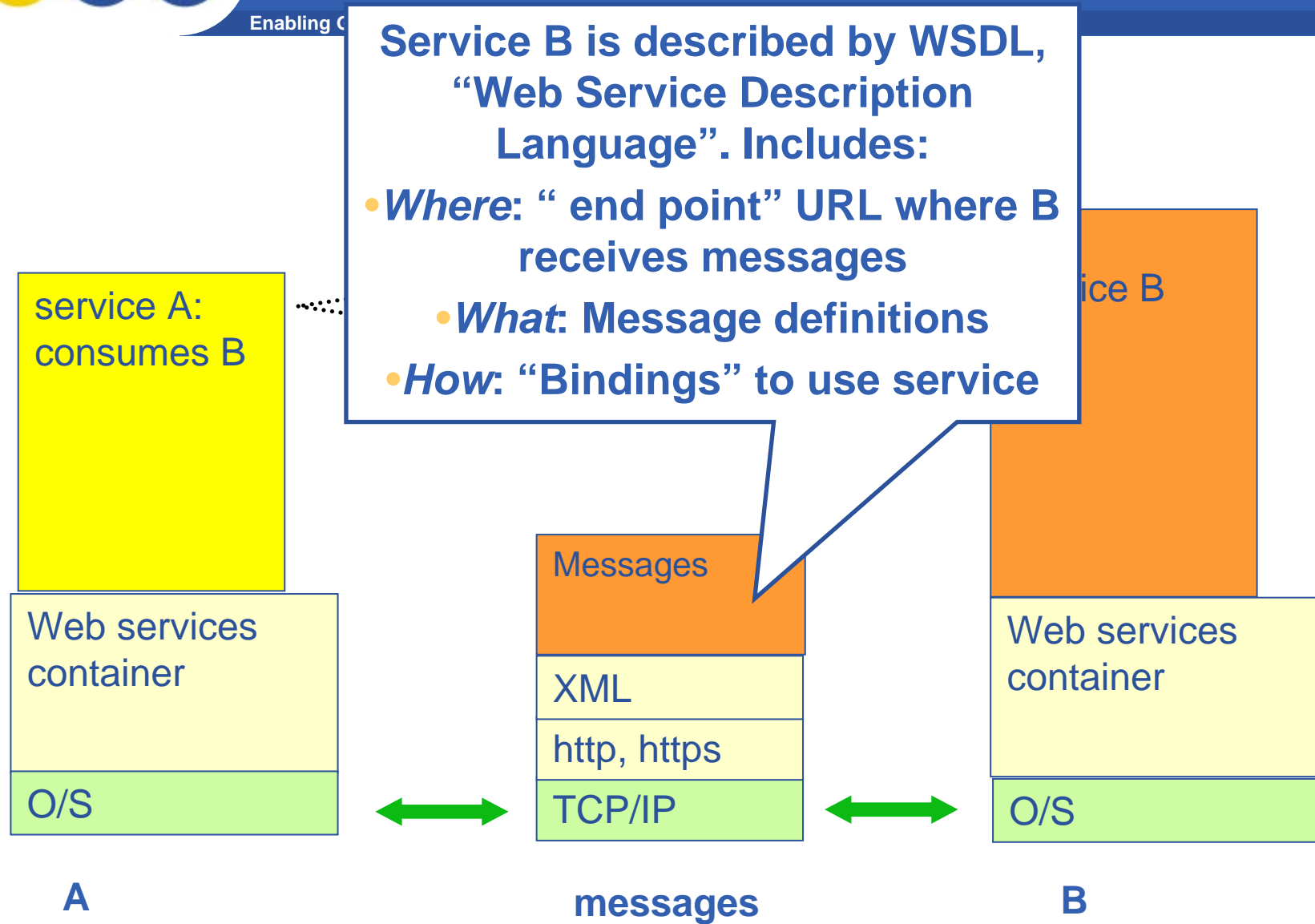
These messages define service B



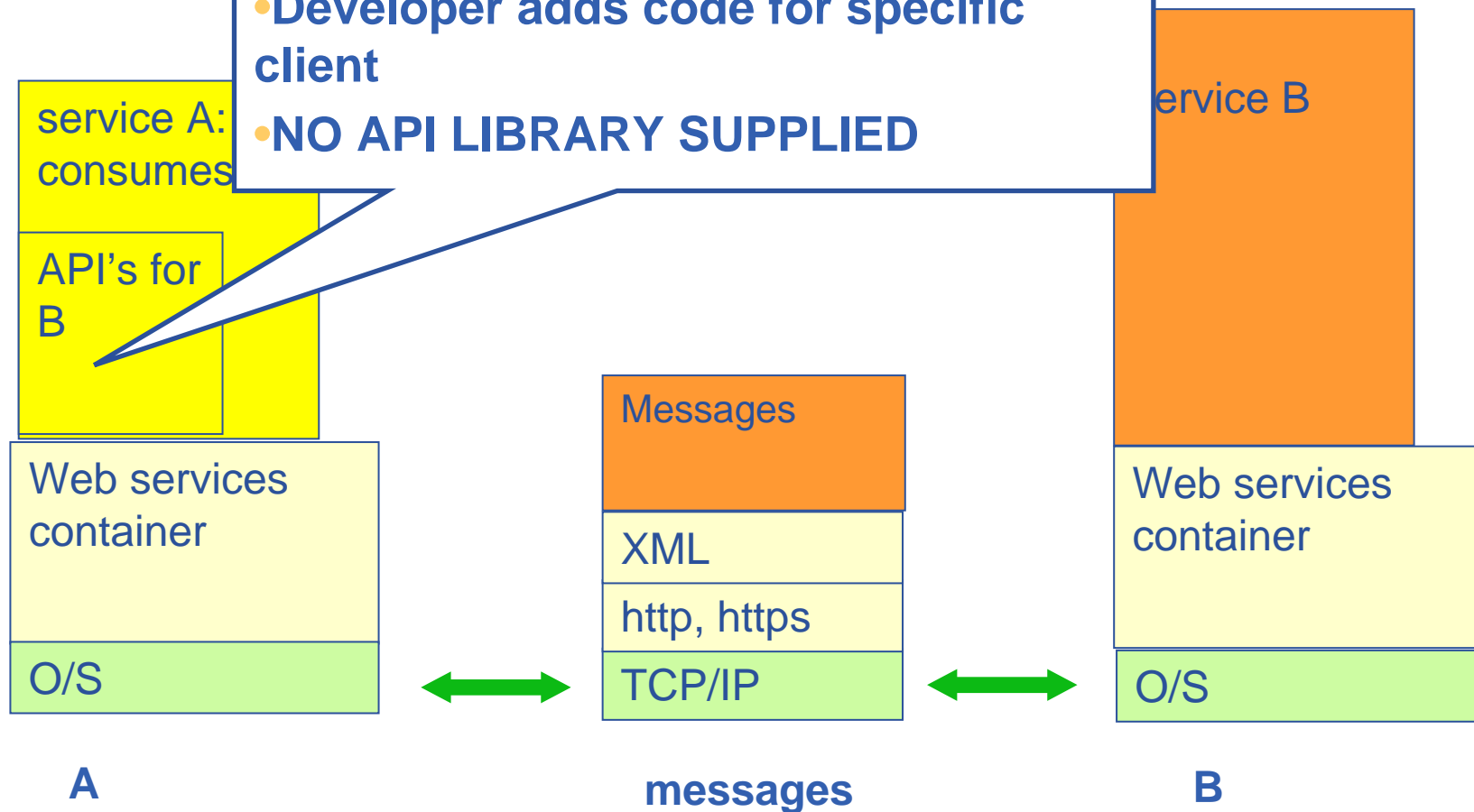
- Commonly used for WS - original purpose: carry HTML
- HTTP request methods
 - GET : specify a URL
 - POST: key-value pairs
- Defaults to port 80
- HTTPS: encrypts / decrypts

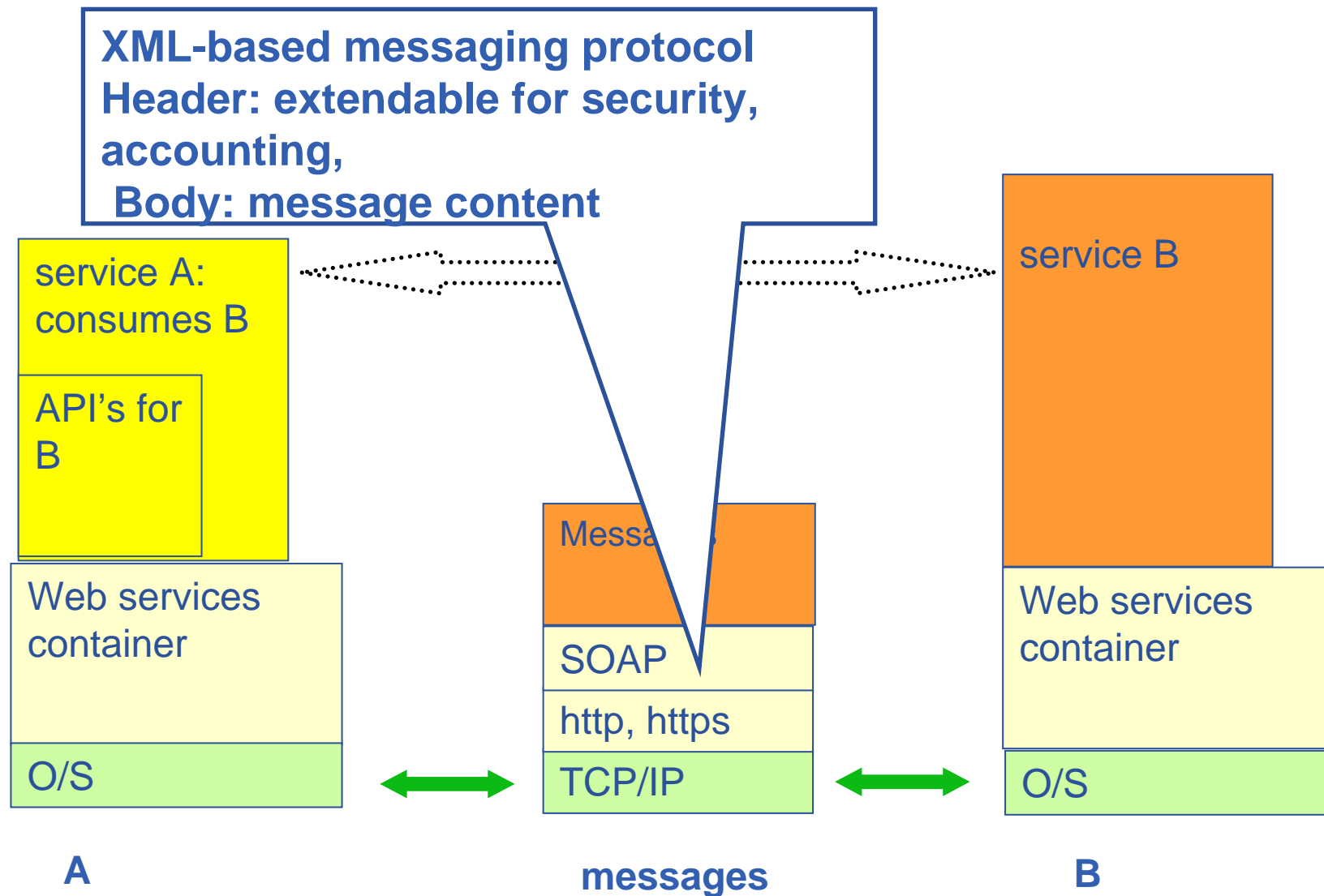


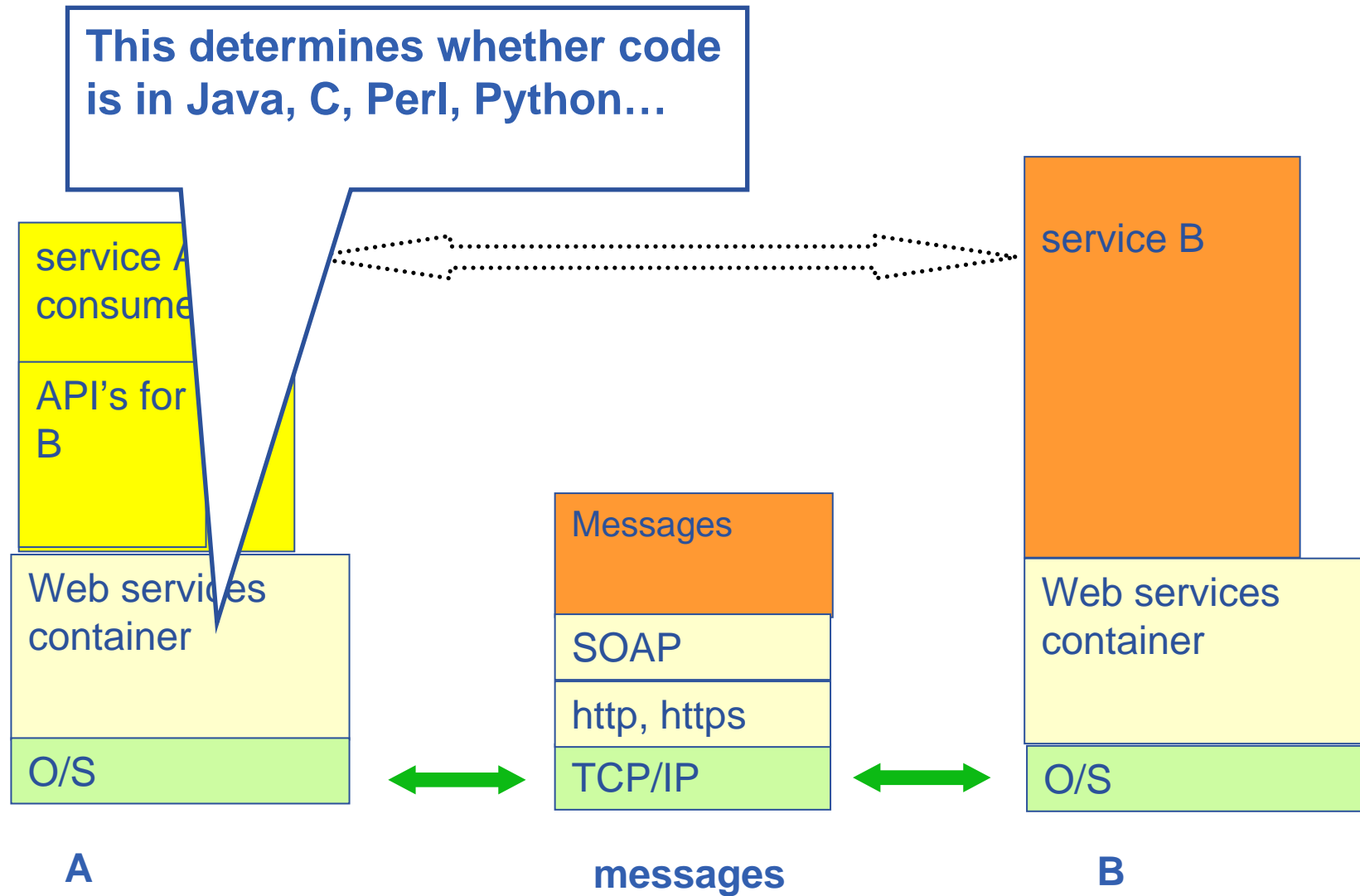




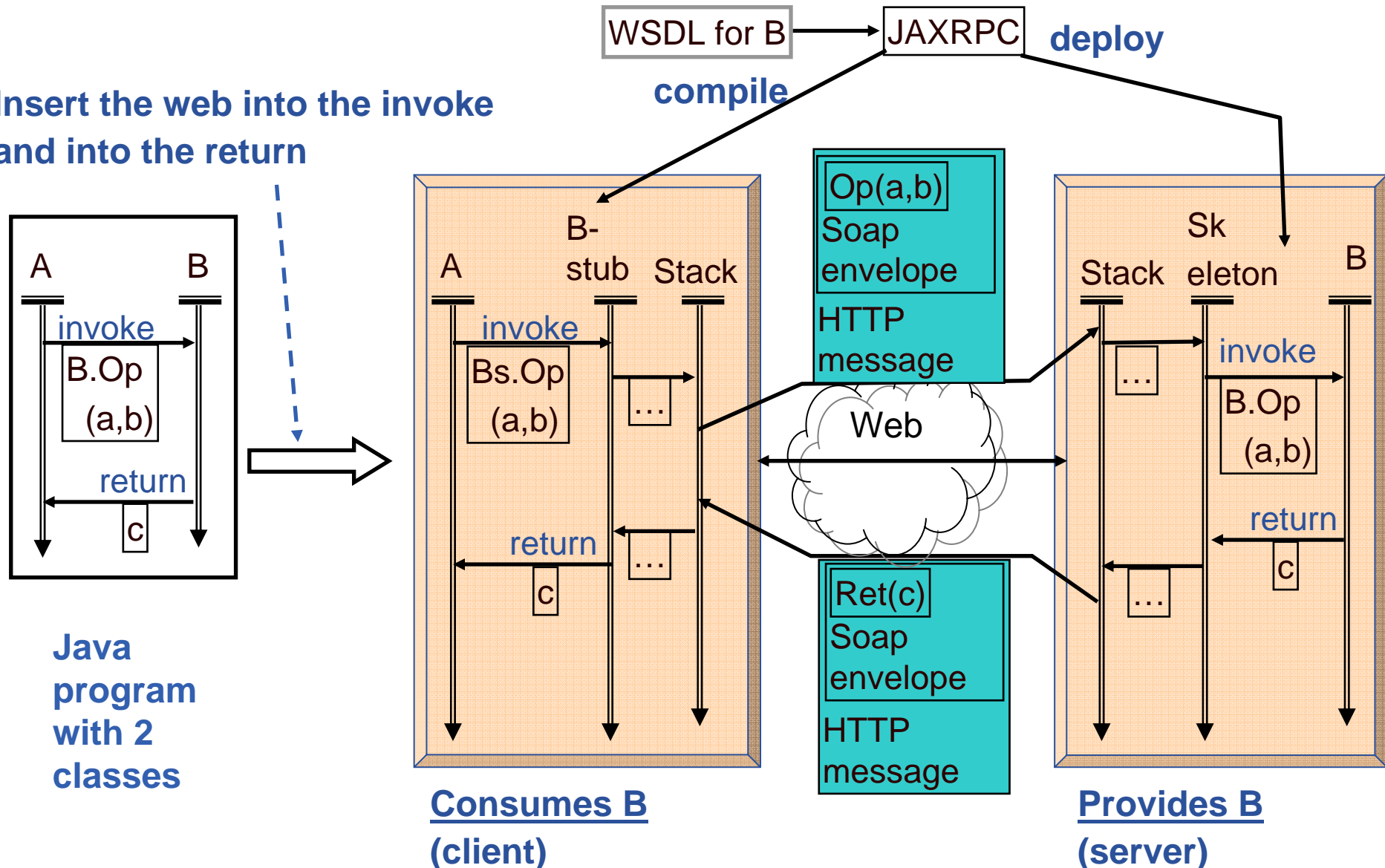
- API's are derived from the WSDL by tools
- Developer adds code for specific client
- **NO API LIBRARY SUPPLIED**







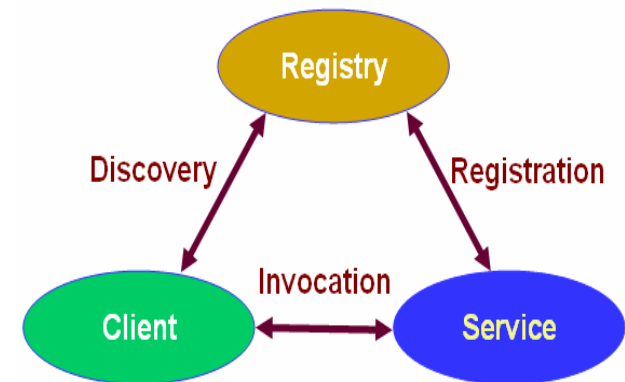
Insert the web into the invoke and into the return



- **WS-I (Interoperability)** delivers practical guidance, best practices and resources for developing interoperable Web services solutions.
- <http://www.ws-i.org/>

Open standards:

- **SOAP:** protocol for message passing
- **Web Service Description Language:** to describe services
- **UDDI:** Universal Description, Discovery and Integration
- **WS-Security:** incorporates security



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- So where are we now ?

- **Software components that are..**
 - Accessible across a network
 - Loosely coupled
 - Defined by the messages they receive / send
 - Modular and self-contained
 - So can change service implementation without changing interfaces
 - Interoperable: each service has a description that is accessible and can be used to create software to invoke that service
- **... and based on standards**
 - Tools, interoperability, ...
 - Developed in anticipation of new uses – e.g. can compose workflow
- **i.e. what web services exist for!**
- **So now building grid architecture based on WS**
- **But there are additional challenges!!!!**

Web Services

- **Goals**
 - Computational presentation & access of Enterprise services
 - Marketing integrated large scale software and systems
 - Model for independent development
 - Model for independent operation

Grids

- **Goals**
 - Inter-organisational collaboration
 - Sharing information and resources
 - Framework for collaborative development
 - Framework for collaborative operation

Web Services

- **Complex services created & delivered persistently by owner organisation**
- **Client interactions short-lived**
- **Multi-organisation integration responsibility of client**
 - Workflow enactment
 - Transaction coordination
 - May be by an intermediate service

Grid Services

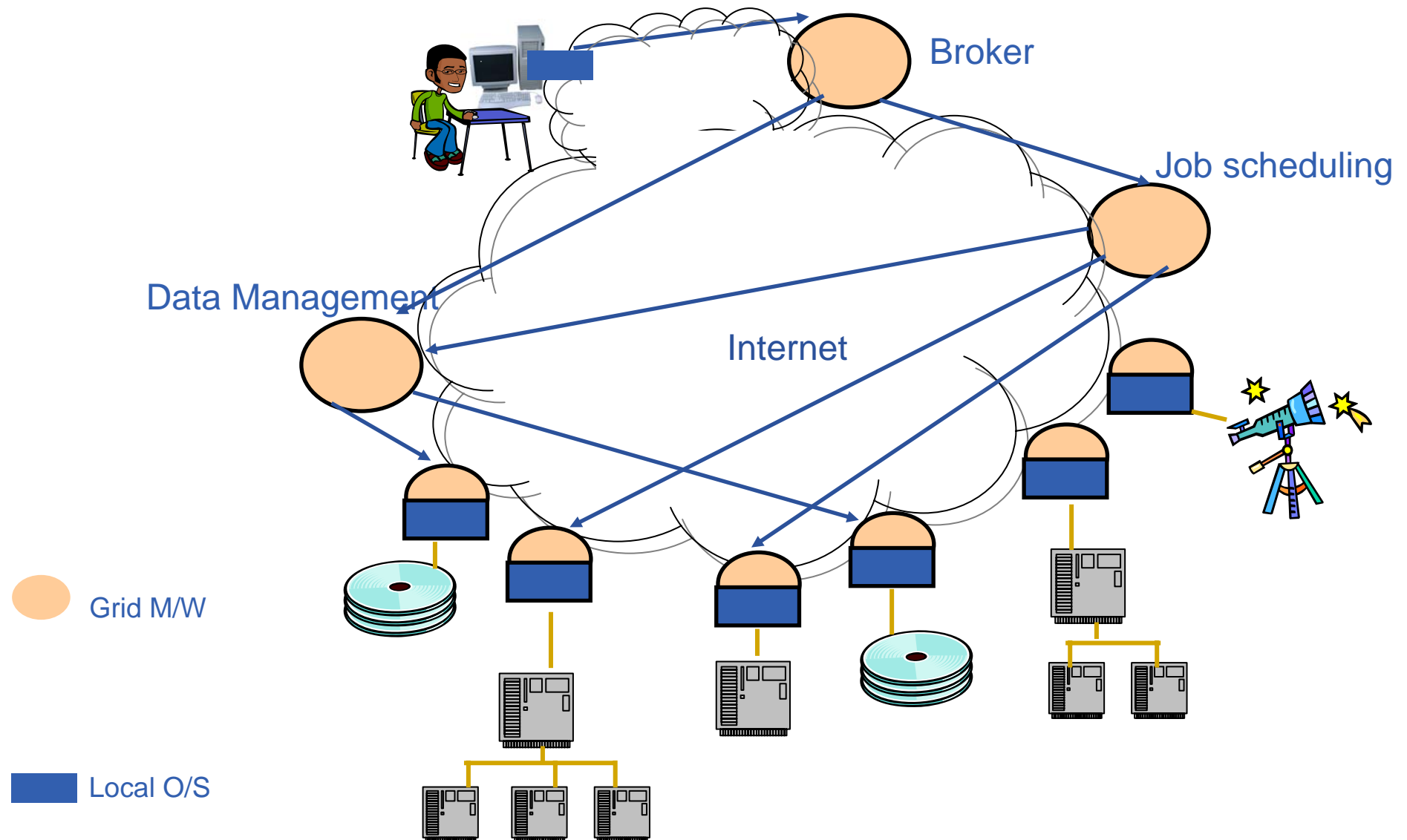
- **All of WS patterns +**
- **Dynamic services / resources**
- **Long-lived interactions**
- **Persistent computational integration**
 - Data management
 - Computation management
- **Persistent operational infrastructures**
 - EGEE managing European-scale grid
- **System organised optimisation**
- **End-to-end security (and non-repudiation)**
- **Virtual Organisations**
 - Establish multi-organisation security policies

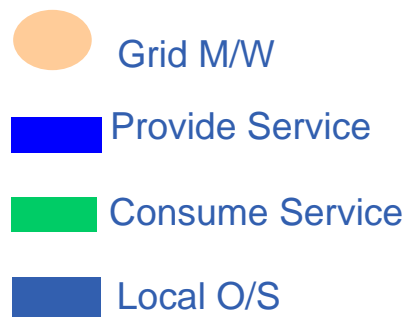
Web Services

- **Commercially successful operational applications**
- **Several good toolsets available**
 - Mostly costly to use outside academia
- **Workflow enactment**
 - BPEL4WS
- **Scale, usability & reliability problems in free-ware**
 - Many fixes were needed to Apache Tomcat
- **Much momentum**
 - Very high levels of investment

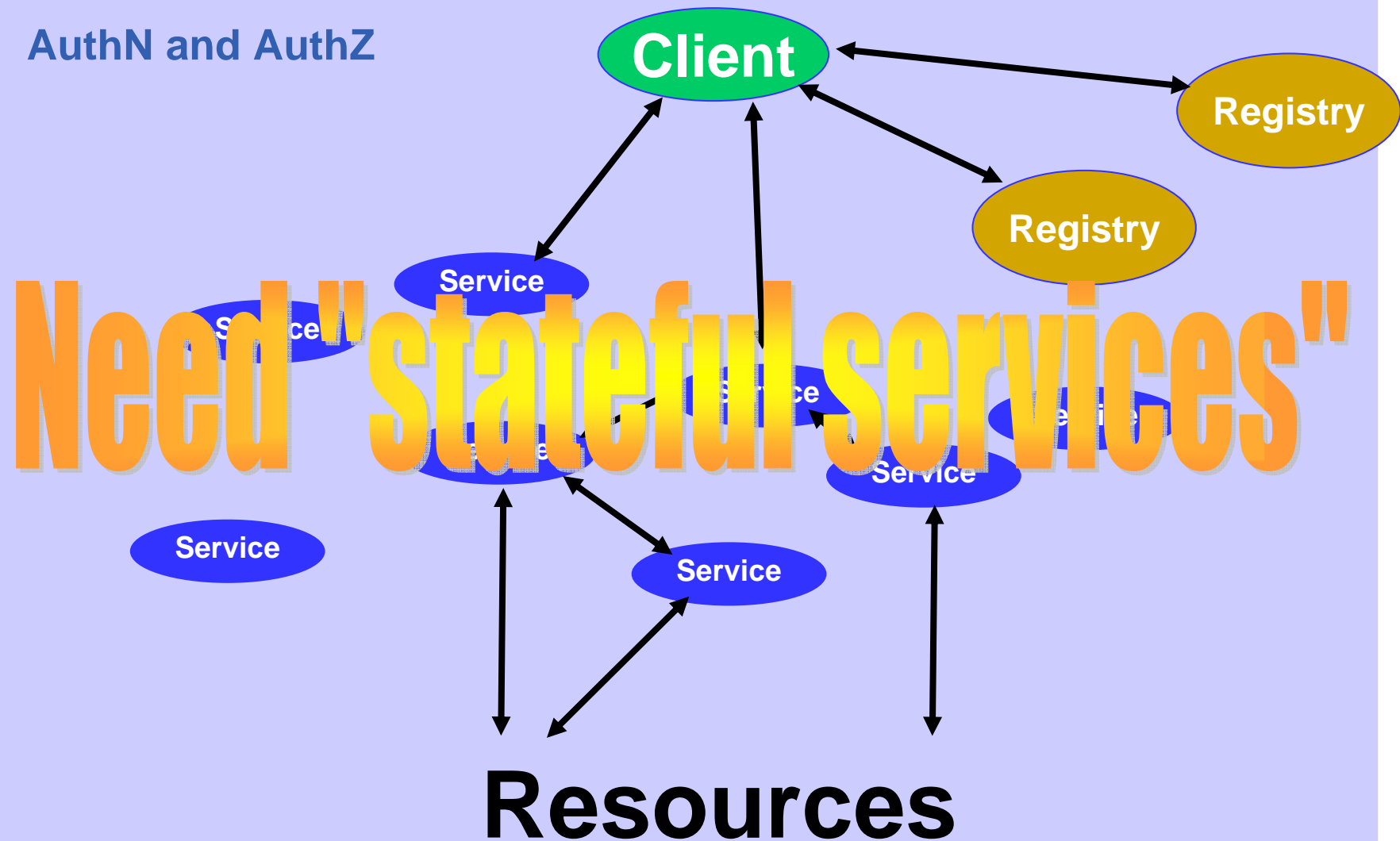
Grids

- **Operational research projects and grids**
 - >100 projects use GT2 or GT3
- **No toolsets**
- **Scientific workflow**
 - High-level work-load generators
 - Chimera, Pegasus, Taverna, ...
- **Some very robust and well tested technologies**
 - Condor, GT2, VDT, GT3.2, LCG2, EGEE1
- **All free-ware**
- **Performance, usability and reliability problems**
- **Much momentum**
- **High levels of investment**





AuthN and AuthZ



- **“Open grid services architecture” OGSA– proposed in 2001**
- **Open Grid Services Infrastructure**
 - Globus Toolkit 3 resulted
 - Specified in 2003
- **Then in January 2004**
 - OGSI to be replaced by emerging WS-RF (Web Services Resource Framework)
- **NOTE:**
 - OGSA still under development (GGF)
- **Imbalances in OGSI that are addressed by WS-RF (OASIS)**
 - Over O-O, megalithic, WS community not engaged
 - Focus onto state and resources

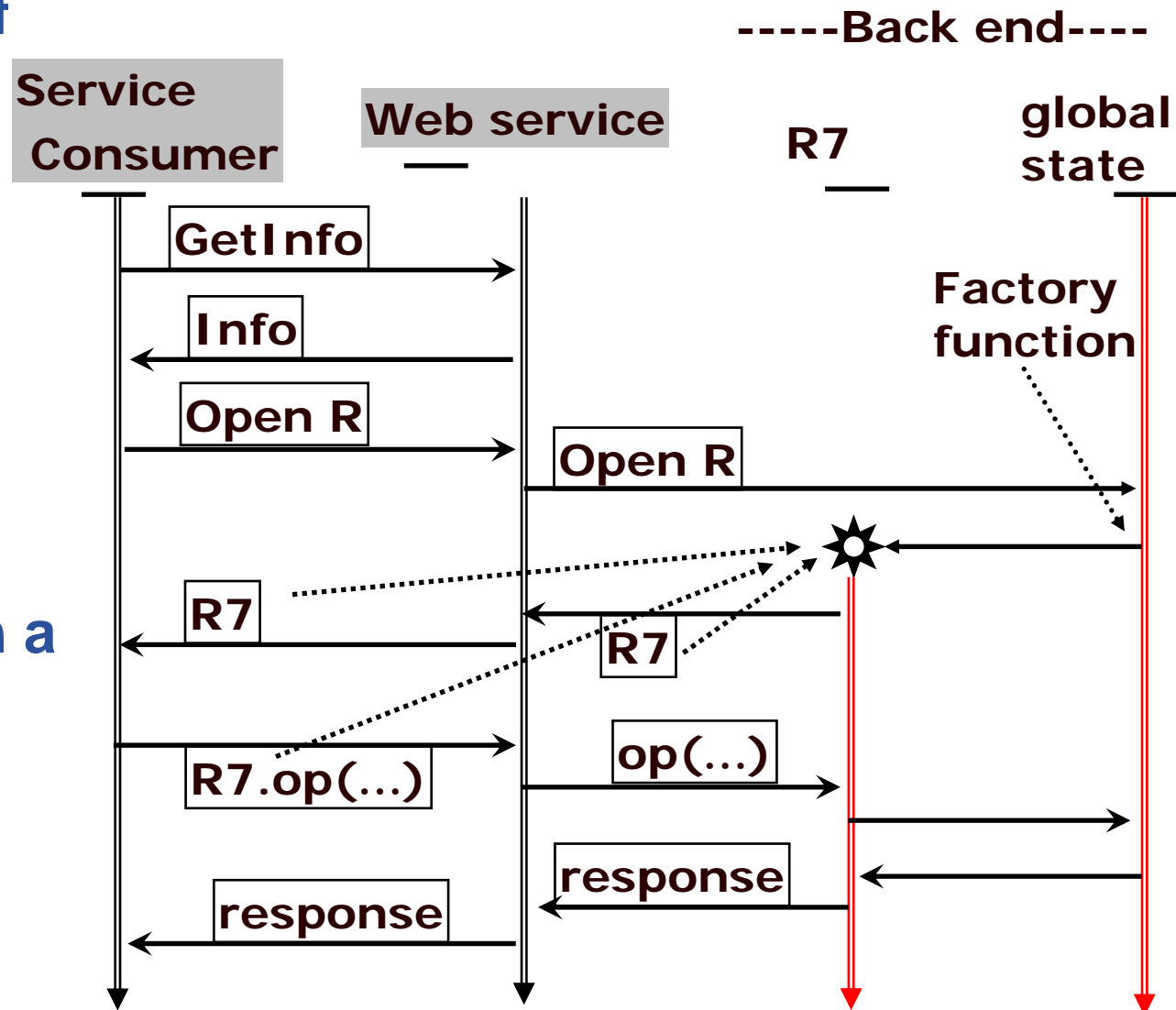
Web service itself

is stateless

Front end to multiple instances of back-end for each resource

Maintains state in a back-end

Service request identifies the specific resource



- **WSRF builds on**
 - WS-Addressing – W3C submission Aug 2004
 - WS-Notification
 - WS-BaseNotification
 - WS-BrockeredNotification
 - WS-Topics
- **WSRF comprises standards**
 - WS-ResourceLifetime
 - WS-ResourceProperties
 - WS-RenewableReferences
 - WS-ServiceGroup
 - WS-BaseFaults

Where are we now?!

- **Standards are emerging... some near acceptance and some being discarded**
 - Standards bodies:
 - W3C <http://www.w3c.org/>
 - GGF <http://www.ggf.org/>
 - OASIS <http://www.oasis-open.org/home/index.php>
 - IETF <http://www.ietf.org/>
 - For a summary see <http://www.innoq.com/soa/ws-standards/poster/>
- **Production grids are based on de-facto standards at present**
 - Inevitably!
 - GT2 especially
 - But locks a grid into one middleware stack unable to benefit from the diverse developments of new services
- **Some confusion remains after the OGSI era**
 - Many projects sidestepped this by using “pure” WS
- **Globus Toolkit 4 has been released**

- **HP-IBM-Intel-Microsoft Roadmap**
- **Globus comments:**
- **<http://www.globus.org/wsrf/convergence.php>**
 - “reconciling two similar but competing approaches”
 - the Web Services Distributed Management (WSDM) family of specifications (including Web Services Resource Framework (WSRF) and WS-Notification (WS-N))
 - IBM, HP, and others
 - WS-Management family of specifications (including WS-Transfer, WS-Eventing, and WS-Enumeration)
 - Microsoft, Intel, and others
 - “Globus will also work to provide a painless migration path for GT4-based services and clients”.
 - “While detailed specifications are not yet available, we are confident, based on knowledge of the existing specifications that are to be reconciled, and the published roadmap, that such a migration path will be easy to achieve”.

GT4-view of OGSA and WSRF -1

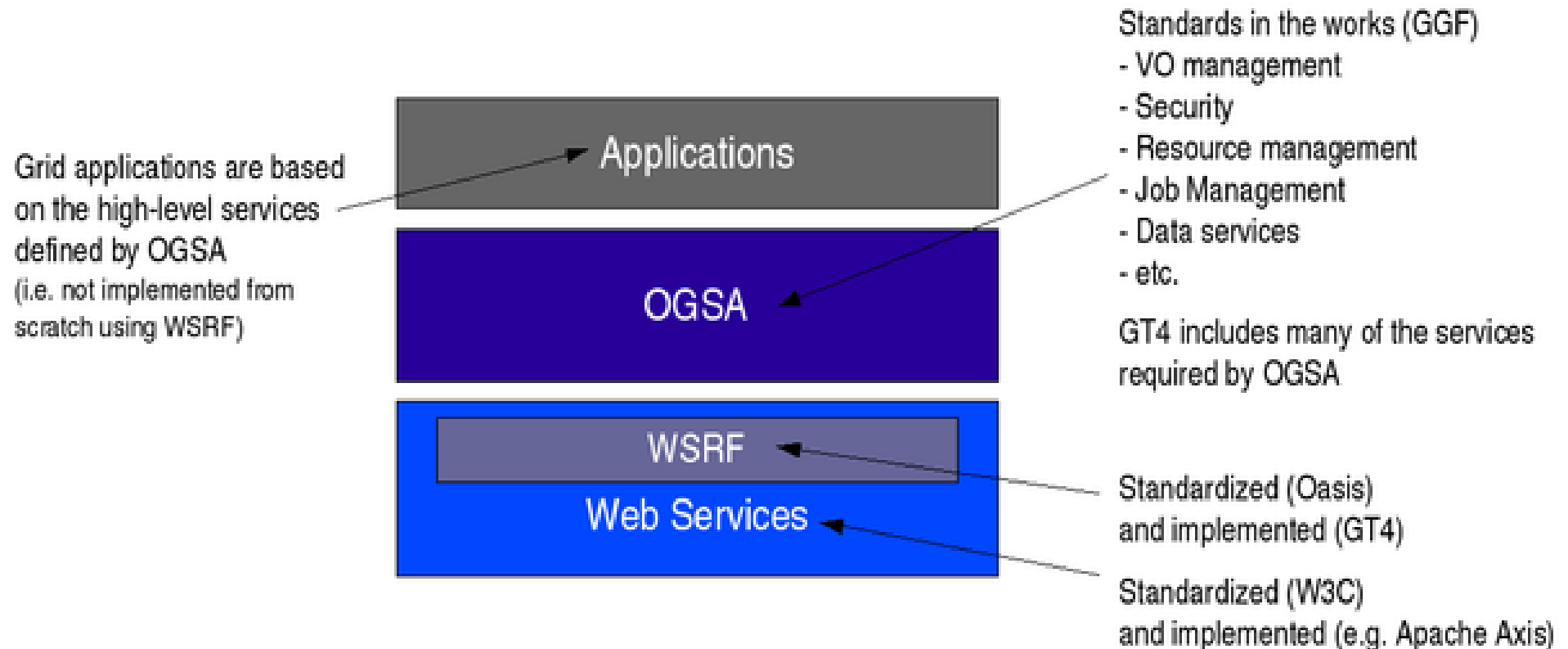


Diagram from Globus Alliance

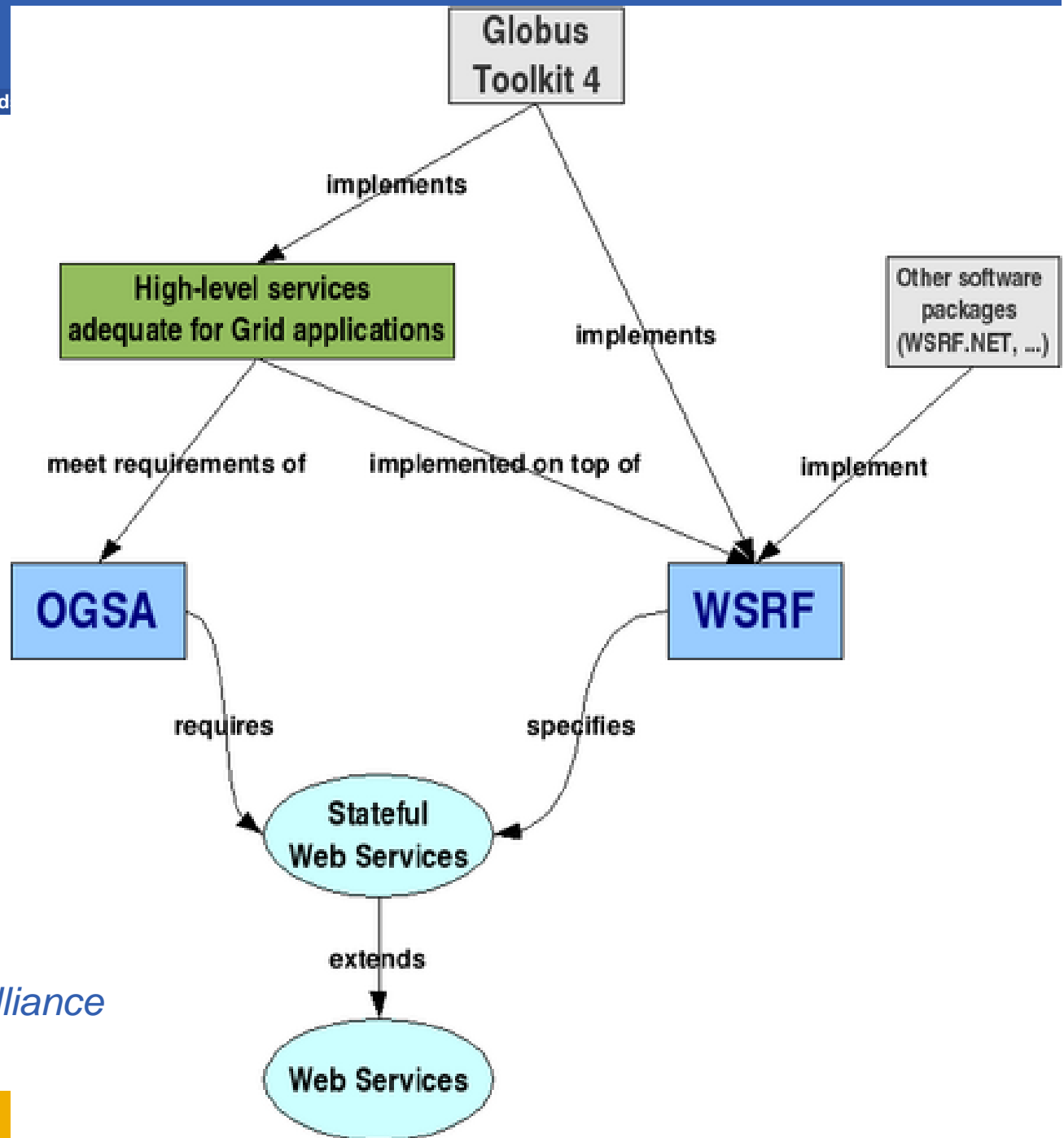


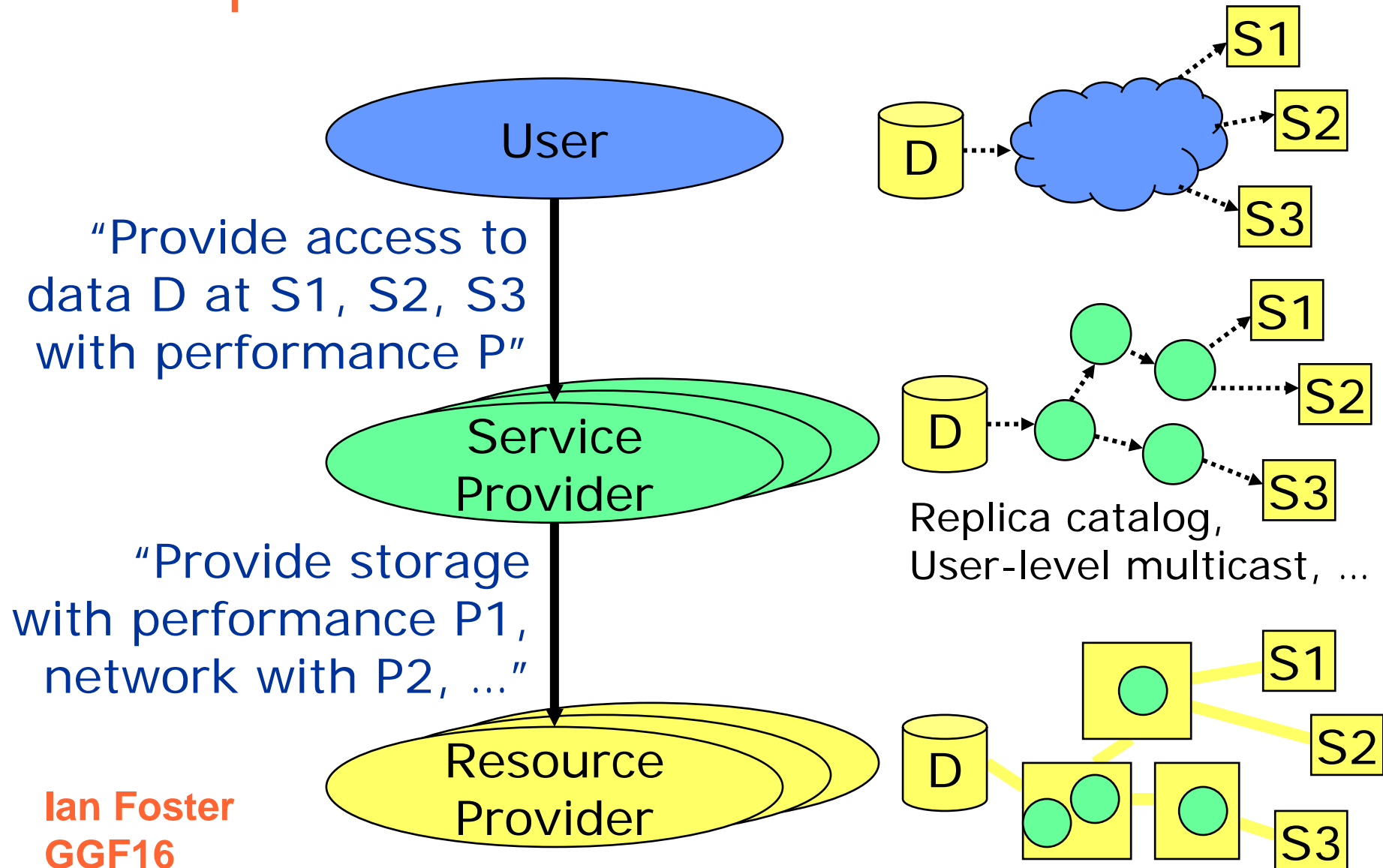
Diagram from Globus Alliance

- **VDT: Virtual Data Toolkit**
 - ensemble of grid middleware that can be easily installed and configured
 - Been used by LCG and EGEE with GT2, Condor, MyProxy,...
- **Pre-requisite for using GT4 in gLite and other production grids has been achieved:**
- **“VDT 1.3.7 introduces the Globus Toolkit 4.0 (GT4) series – both pre-web services and some web services.”**

http://vdt.cs.wisc.edu/globus_3.2_vs_4.0.html

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Decomposition Enables Separation of Concerns & Roles



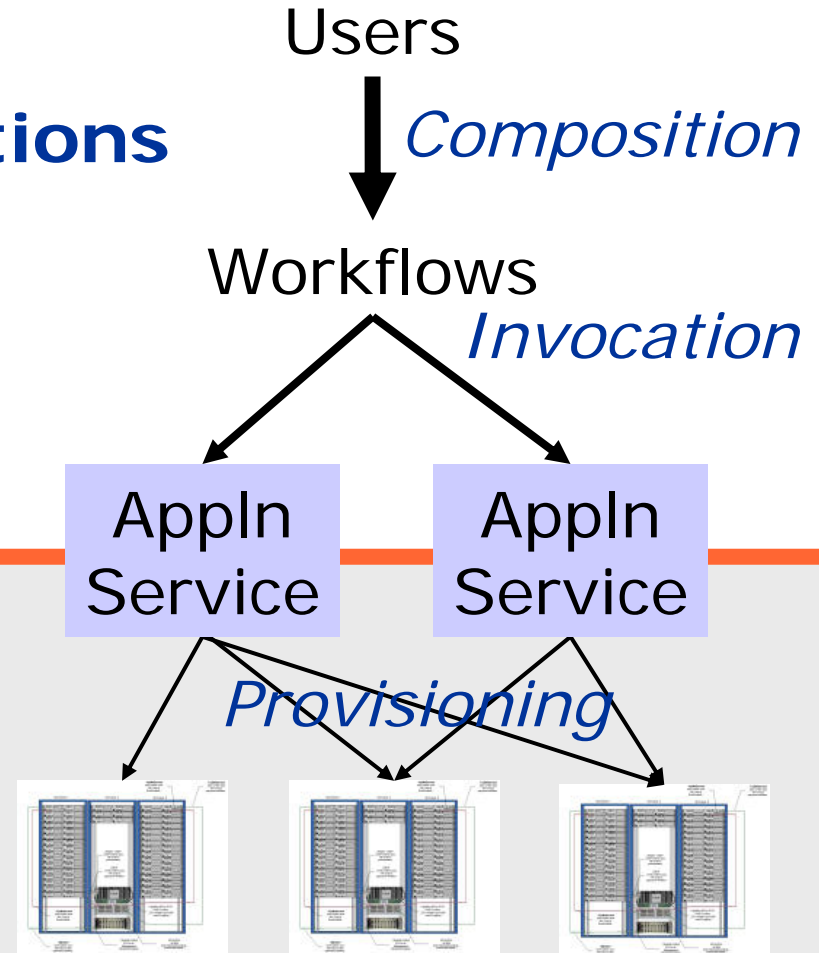
Service-Oriented Systems: The Role of Grid Infrastructure

- Service-oriented **applications**

- ◆ Wrap applications as services
- ◆ Compose applications into workflows

- Service-oriented **Grid infrastructure**

- ◆ Provision physical resources to support application workloads



Service-oriented research??

- “potential to increase individual and collective scientific productivity by making powerful information tools available to all”
- “Ultimately, we can imagine a future in which a community's shared understanding ... is documented also in the various databases and programs that represent—and automatically maintain and evolve—a collective knowledge base. ”

Ian Foster,

<http://www.sciencemag.org/cgi/content/full/308/5723/814?ijkey=aqCCmCFix8LI.&keytype=ref&siteid=sci>

Science 6 May 2005

- **Early grids**
 - Resource utilisation
 - A few big-science VOs
 - Trivial parallelism – many concurrent independent jobs
 - Data management – files only
- **Grid-enabling databases**
 - Pre-existing databases accessible from grids
 - Data integration
- **Service-oriented grid: possibilities for**
 - any collaborative research
 - International / national / university resources become accessible
 - With control and AA (authorisation and authentication)

- **The Grid Core Technologies, Maozhen Li and Mark Baker, Wiley, 2005**
- **The Globus Toolkit 4 Programmer's Tutorial**
Borja Sotomayor, Globus Alliance,
<http://gdp.globus.org/gt4-tutorial/multiplehtml/index.html>
- [The Web Services Grid Architecture \(WSGA\)](http://www.nesc.ac.uk/technical_papers/UKeS-2004-05.pdf)
www.nesc.ac.uk/technical_papers/UKeS-2004-05.pdf
- <http://java.sun.com/xml/webservices.pdf>

- **Current way people try to create grid middleware is using Service Oriented Architectures based on WS**
- **An abundance of standards is en route**
 - Extensions to manage resources are in WS-RF framework
 - Workflow – service composition
 - Also portals/portlets to expose services
- **Initial implementation based on WS-RF and OGSA is in Globus Toolkit 4**
- **Service-orientation is transforming business and research!**