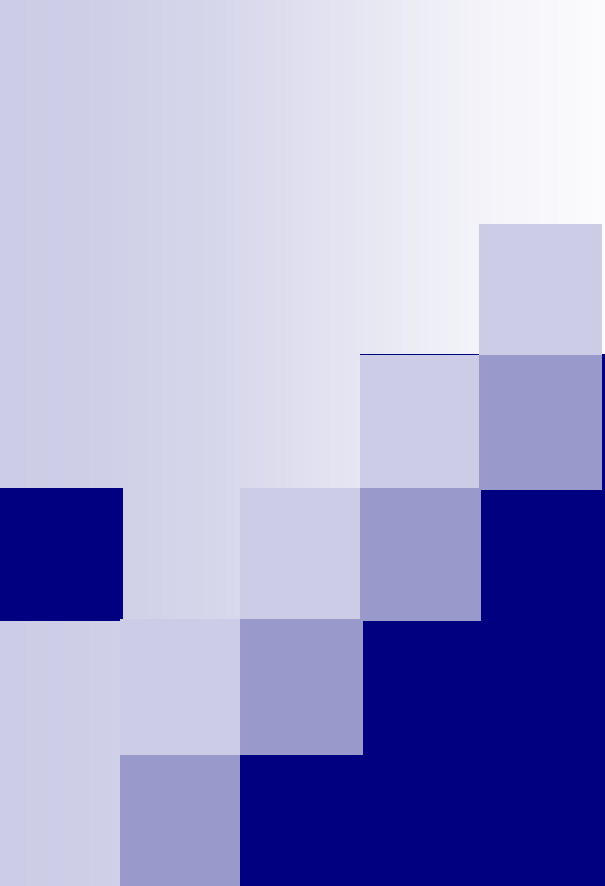




Network Computing

Lecture 18

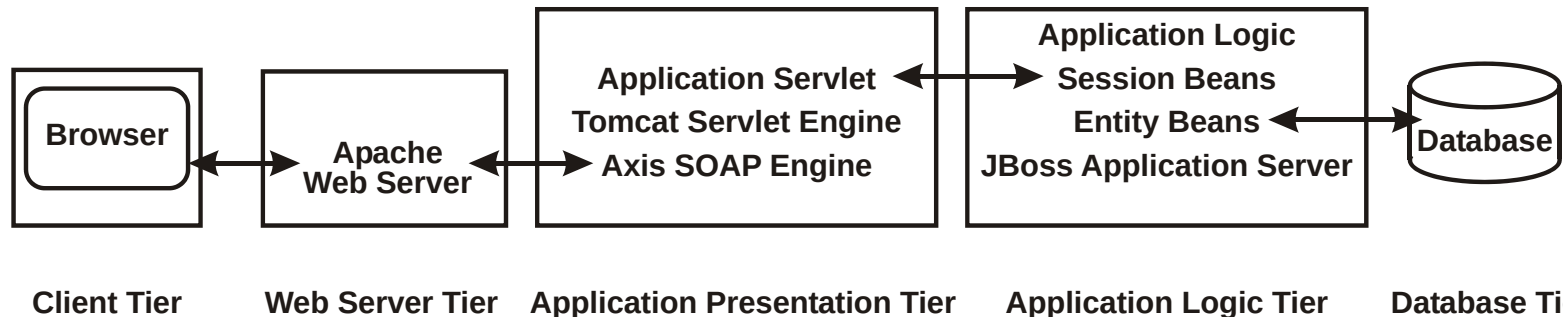
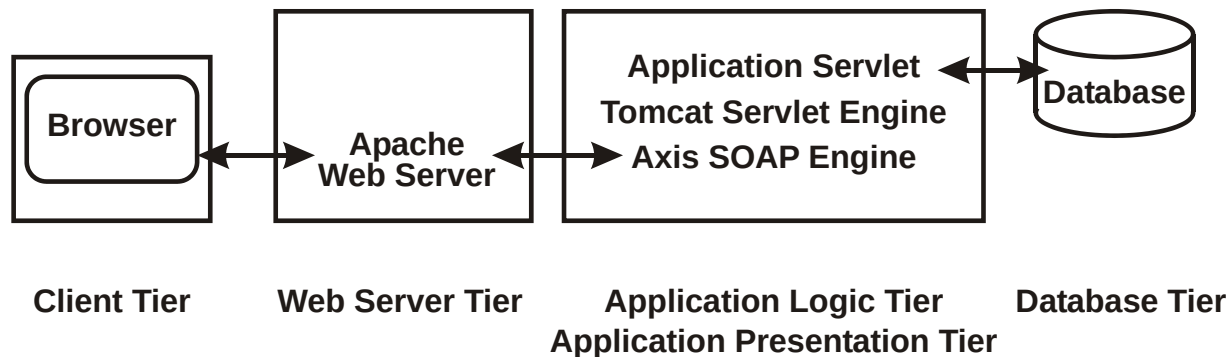
Professor Louise E. Moser
Spring 2012

Web Services

- A **Web Service** is a service offered by one application to other applications on the World Wide Web
- A **Web Service** is software designed to support interoperable machine-to-machine interactions over the Internet
- **Two major classes of Web Services**
 - **Simple Object Access Protocol (SOAP)** – Service is exposed via an arbitrary set of operations, which are conveyed in XML-formatted SOAP messages over HTTP
 - **REpresentational State Transfer (REST)** – Service uses a uniform set of stateless operations (HTTP methods) to manipulate XML representations of Web resources, which are conveyed directly over HTTP
- **Examples**
 - Financial – Banking, Investing, Stock Trading, etc.
 - Travel – Airline Reservation, Hotel Reservation, Car Rental, etc.
 - Healthcare – Appointments, Access to Health Records, Health Insurance, etc.

Web Services

- A Web Service is a **server-side application** that implements procedures that clients can call
- A Web Service is deployed in a **service-side container** that is either a Servlet container in the Apache Tomcat servlet engine, or an EJB container in an EJB/J2EE application server, e.g., JBoss

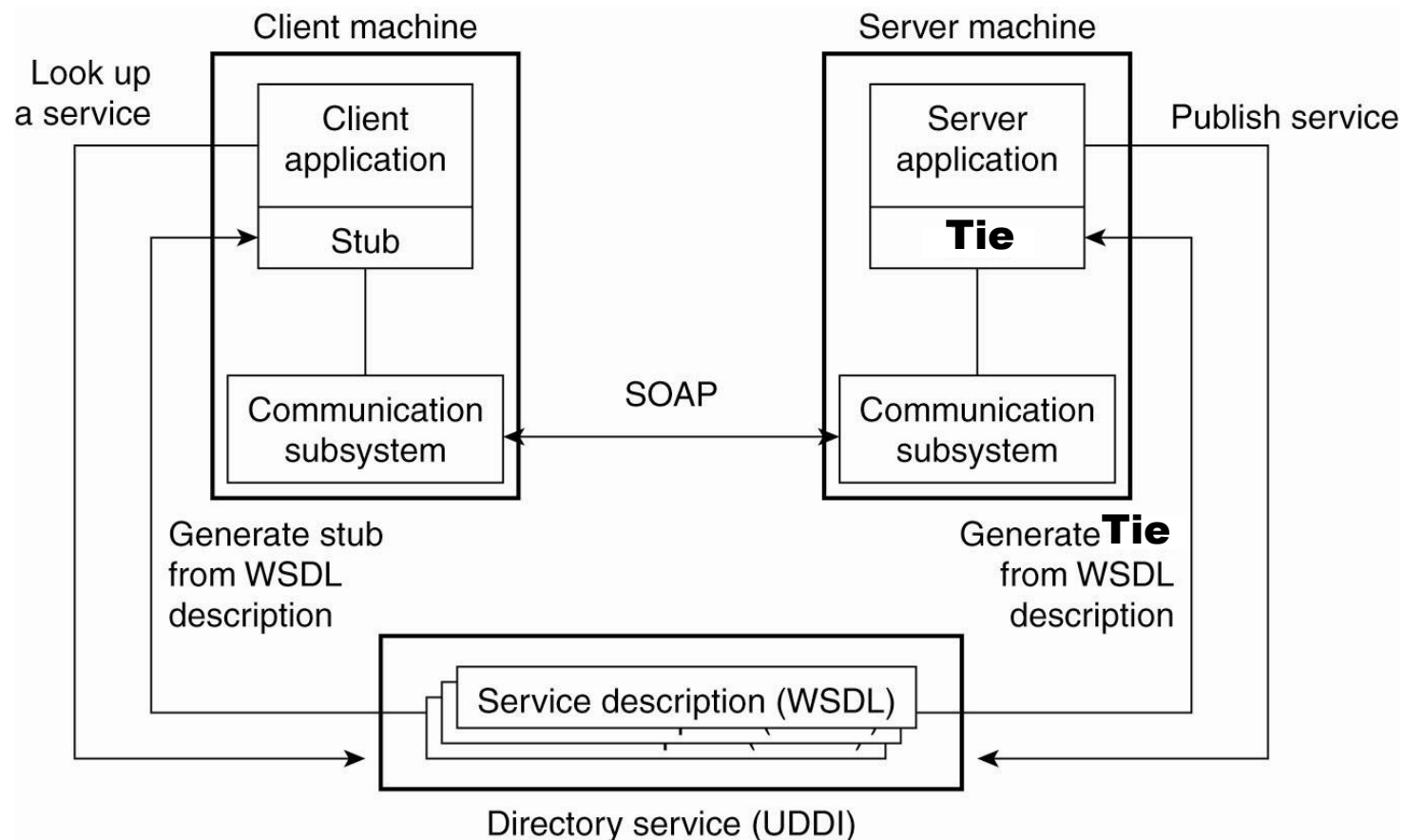


Web Services Standards

- **Web Services** are based on the following standards
 - **eXtensible Markup Language (XML)** - Defines the syntax of Web Services documents so that the information in those documents is self-describing
 - **Simple Object Access Protocol (SOAP)** - Provides a standard way to encode different protocols and interaction mechanisms in XML, so that XML documents can be easily exchanged across the Internet
 - **Web Services Description Language (WSDL)** - An advanced form of Interface Definition Language (IDL) that has been augmented to define additional aspects of a service description
 - **Universal Description Discovery and Integration (UDDI)** - Used by a Service Registry where service providers publish and advertise available services, and service consumers query and search for services

Web Services Standards

- The organization of a Web Service, based on the XML, SOAP, WSDL, and UDDI standards



Web Services Atomic Transactions

- **Web Services Atomic Transactions (WS-AT)**

- Built on the Web Services Coordination framework

- **Two Protocols**

- **Two Phase Commit (2PC)**

- **Completion and Distributed Commit Protocol**

- **Set of Services at the Participants, Initiator, Coordinator**

- At a Participant, the service comprises:

- **Participant Service** – Used by the Coordinator to solicit votes from, and to send the transaction outcome to, the Participant

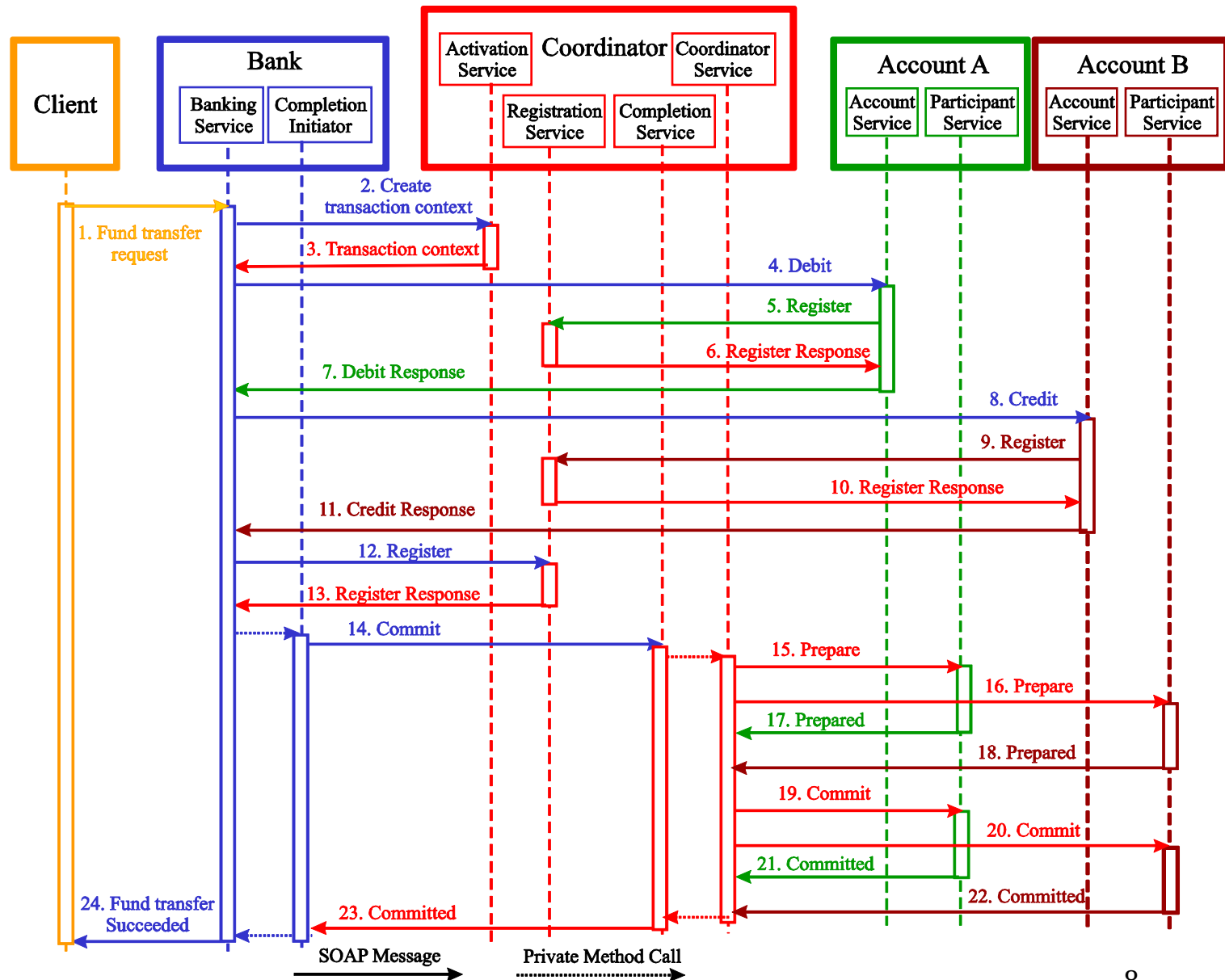
- At the Initiator, the service comprises:

- **CompletionInitiator Service** – Used by the Coordinator to inform the Initiator of the final outcome of the transaction

Web Services Atomic Transactions

- At the Coordinator, the services comprise:
 - **Activation Service** – Creates a Coordinator object and a transaction context for a distributed transaction
 - **Registration Service** – Allows the Initiator and the Participants to register their endpoint references
 - **Completion Service** – Enables the Initiator to signal the start of the distributed commit
 - **Coordinator Service** – Coordinates the Participants using the 2PC protocol to ensure atomic commitment of the distributed transaction

Banking Example



Web Services Business Activities

■ Web Services Business Activity (WS-BA) Specification

- Describes how to coordinate long-running Business Activities, where Atomic Transactions are not appropriate
 - With long-running Business Activities, transactions can lock up resources, so other transactions cannot access them
 - Use of **Compensations** can make Business Activities more adaptive
- Standardizes the Activation, Registration and Coordinator Services for Web Services Business Activities

■ Web Services Business Activity Initiator (WS-BA-I) Protocol

- Standardizes communication between the Initiator of a Business Activity and the Coordinator, which WS-BA does not do
- Enables interoperability between the Initiators and the Coordinators of different vendors

Web Services Business Activity Specification

- Built on the Web Services Coordination framework
- **Two Coordination Types**
 - **Atomic Outcome** – All Participants must reach agreement on the outcome of the Business Activity (**Close** or **Compensate**)
 - **Mixed Outcome** – Some Participants are directed to Close while others are directed to Compensate
- **Two Coordination Protocols**
 - **Business Agreement with Participant Completion (BAwPC)**
 - When a Participant has finished its work, it sends a **Completed** message to the Coordinator
 - The Coordinator responds with either a **Close** message or a **Compensate** message
 - If the Participant receives a Compensate message, it undoes its completed work and restores the data it recorded at the start of the Business Activity
 - **Business Agreement with Coordinator Completion (BAwCC)**
 - The Coordinator sends a **Complete** message to the Participants, informing them to complete their processing
 - If a Participant has successfully finished its work, it sends a **Completed** message to the Coordinator

WS-BA Roles and Interactions

■ Initiator

- Starts the Business Activity by requesting the Activation Service to generate a Coordination context (Coordination id and Registration Service ref)
- Propagates the Business Activity to the Participants using the Coordination context
- Determines the outcome of the Business Activity according to the business logic and then terminates the Business Activity

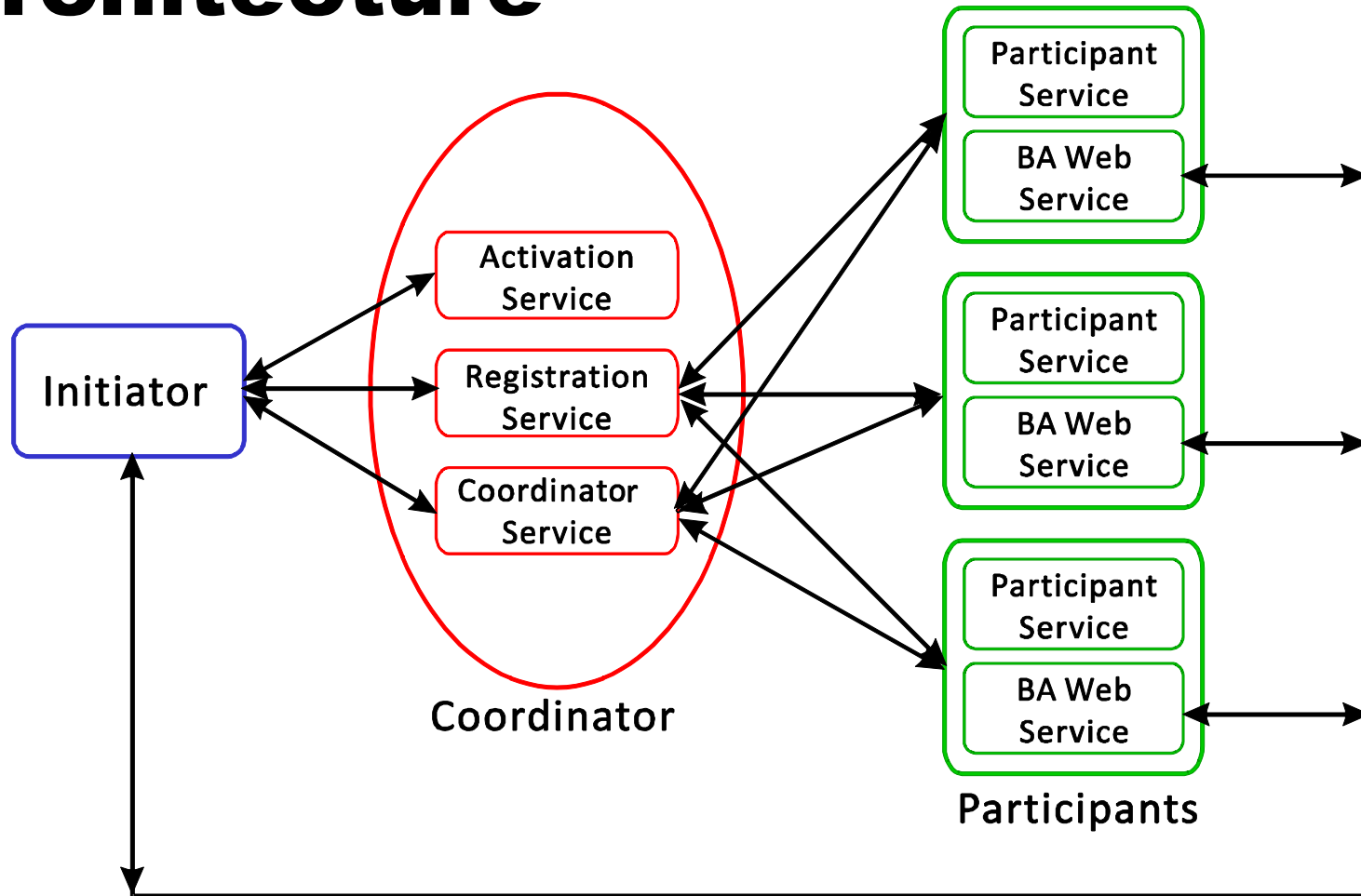
■ Coordinator

- **Activation Service** used by the Initiator to create a Coordination context and Coordinator object, which provides the Registration and Coordinator Services
- **Registration Service** used by the Initiator to register the Business Activity, and by the Participants to register one of the two Coordination Protocols
- **Coordinator Service** interacts with the Initiator via WS-BA-I and with the Participants via one of the two Coordination Protocols

■ Participant

- Performs specific work for the Business Activity

Web Services Business Activity Architecture

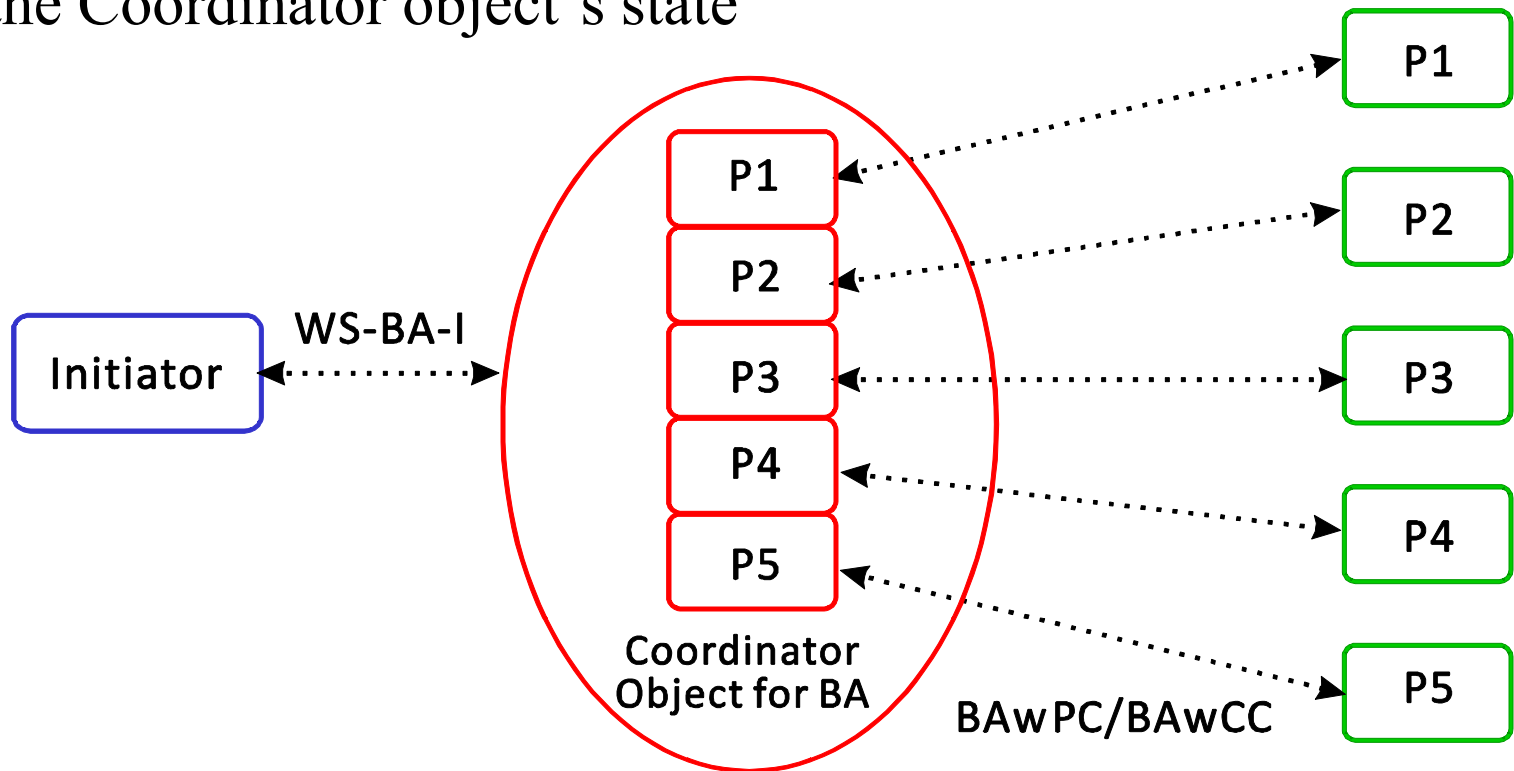


Web Services Business Activity Initiator Protocol (WS-BA-I)

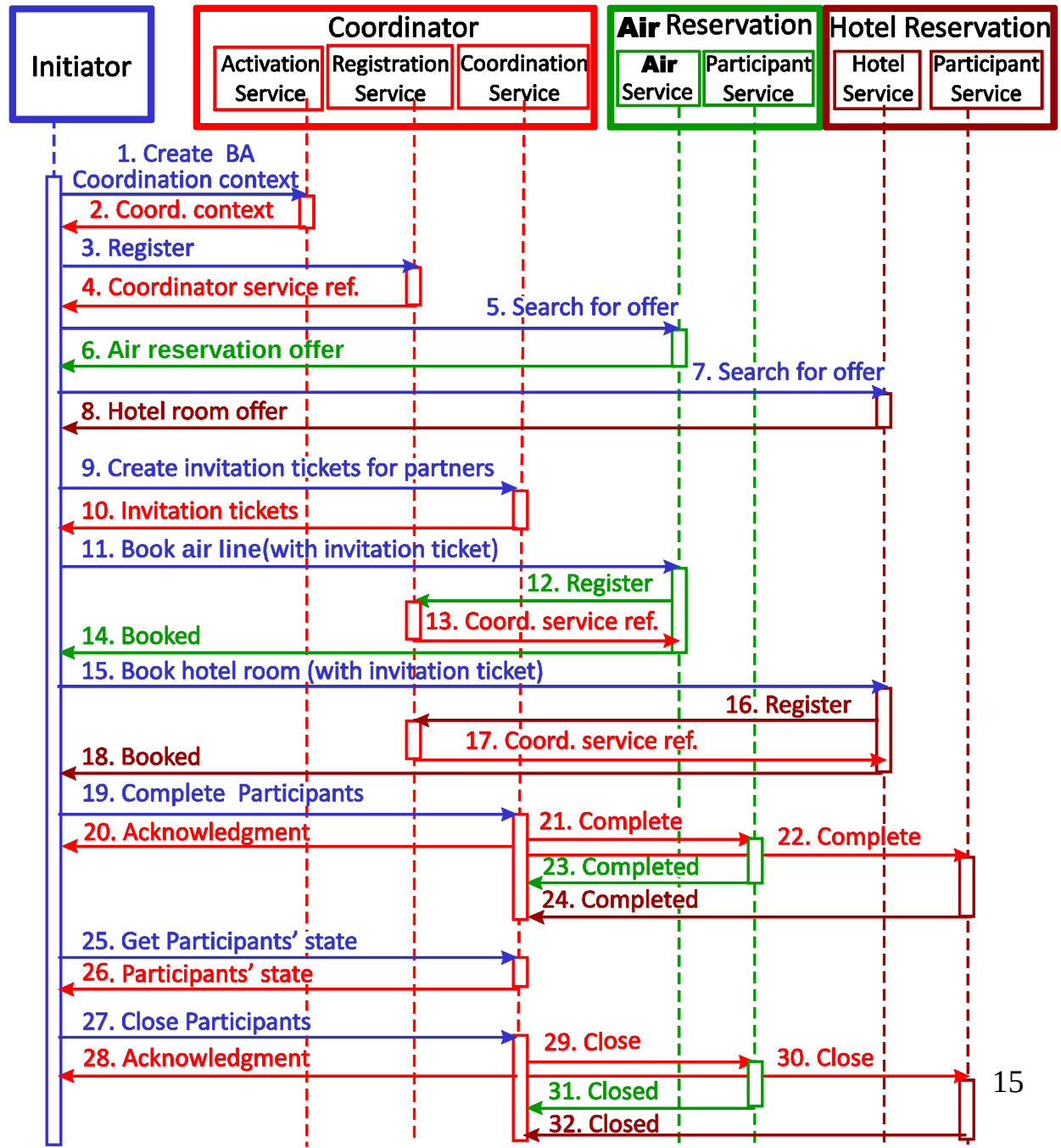
- Standardizes the interactions between the Initiator and the Coordinator (like the Completion protocol in WS-AT)
- Allows the Initiator to
 - Query the state of the Business Activity
 - Create **Invitation Tickets**
 - Initiator uses an Invitation Ticket to propagate the Business Activity to a remote Web Service
 - The remote Web Service then registers with the Coordinator using the Invitation Ticket
 - Instruct the Coordinator to Complete (for BA_wCC), Close, Compensate, or Cancel the Business Activity
- Uses the Pull model, which allows the Initiator to
 - Operate through a firewall or a NAT box
 - Poll the Coordinator to get the state of the Business Activity

State Model for WS-BA with WS-BA-I

- The Coordinator object keeps track of each Participant's state
- Requests sent by a Participant modify only its part of the Coordinator object's state



Travel Reservation Example



Future Trends and Issues

- **Performance** - XML documents can consume large amounts of network bandwidth, memory space, and processing cycles
 - **Special hardware**, e.g., new types of routers and accelerators, might offset the adverse performance impacts
 - **Binary attachments** might address the performance issue, but they lose the self-describing, interoperability advantages of XML

Future Trends and Issues

- **Reliability** is a major concern for Web Services
 - End-to-end reliable message delivery requires that the intended destination applications receive the messages **exactly once** and in the **correct order**
 - Long-running business transactions must provide **data consistency** and **protection against faults**
- W3C and OASIS have developed several specifications related to reliability
 - **WS-Reliability** and **WS-ReliableMessaging**
 - **WS-Coordination**, **WS-AtomicTransactions**, **WS-BusinessActivity**
- In our research, we have enhanced WS-AtomicTransactions and WS-BusinessActivity to protect them against Byzantine (arbitrary) faults

Future Trends and Issues

- **Security** is a major concern when software applications in one enterprise invoke software applications in another enterprise over the Internet
- **Security breaches** that can occur
 - **Identity-based attacks**, where a hacker poses as an authorized user to access a Web Service, but actually is not authorized to do so
 - **Malicious content attacks**, where an intruder forces a Web server to perform an unauthorized activity
 - **Operational attacks**, where a hacker manipulates an XML message to tie up server resources
- **Security measures** that can be employed
 - **HTTPS**
 - **IP filtering**
 - **WS-Security standard**
 - **Security appliances** that authenticate XML messages

Future Trends and Issues

- The ultimate goal of Web Services
 - **Dynamic interaction** among businesses in an open community
 - **Automated clients** that browse service registries, find services and service providers, discover how to interact with those services, and invoke those services without human intervention
- Currently, the Web and Web Services specifications focus primarily on the **syntactic** aspects of representing and communicating information
- The **Semantic Web** aims for complete automation of Web Services, by standardizing the representation and handling of **semantic metadata** to describe Web Services and how to use them
 - Requires major advances in the automated analysis of semantic information (which is currently research rather than practice)

For More Information on Web Services

- Java Technology and Web Services
<http://java.sun.com/webservices/index.html>
- Java API for XML-based RPC (JAX-RPC) Specification
<http://java.sun.com/xml/downloads/jaxrpc.html>
- JAX-RPC Website
<http://java.sun.com/xml/jaxrpc/index.html>
- Simple Object Access Protocol (SOAP) Specification
<http://www.w3.org/TR/SOAP/>
- SOAP with Attachments API for Java (SAAJ) Specification
<http://java.sun.com/xml/downloads/saaj.html>
- SAAJ Website
<http://java.sun.com/xml/saaj/>
- Web Services Description Language (WSDL)
<http://www.w3.org/TR/wsdl>
- Java API for XML (JAXM) Website
<http://java.sun.com/jaxm>