Middleware and Web Services

Lecture 2: Service Architecture

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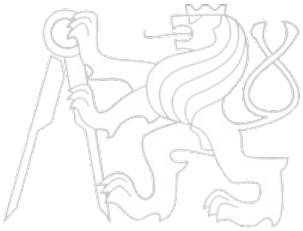

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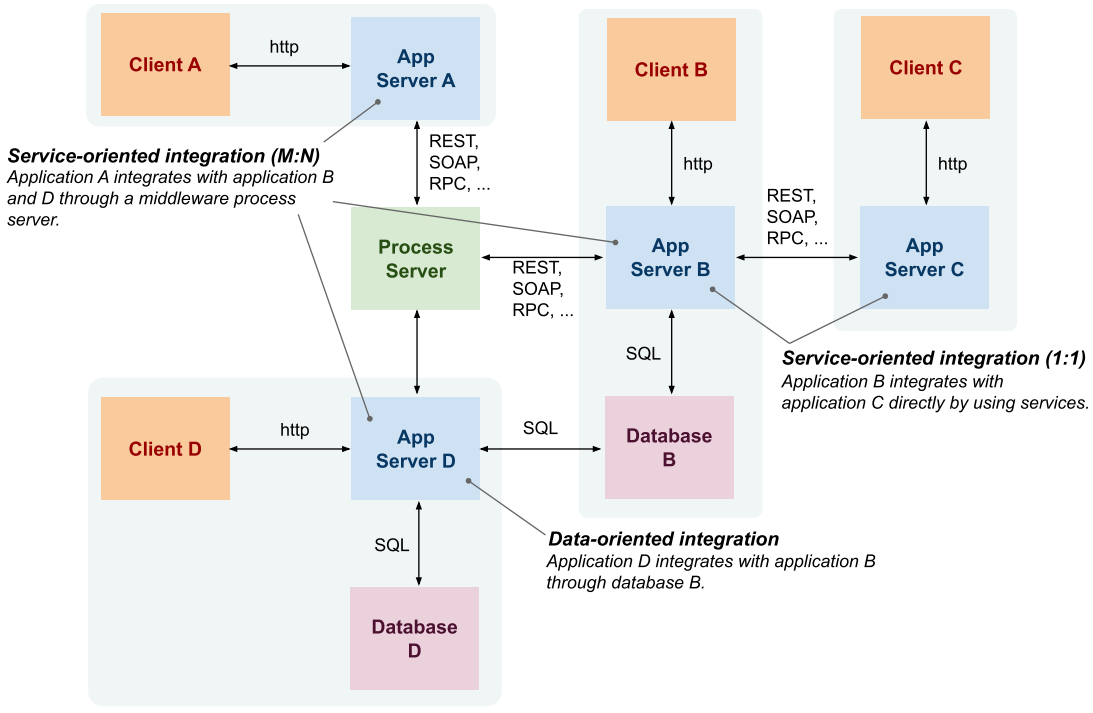
Overview

- Integrating Applications
- Service Definition
- Service Communication

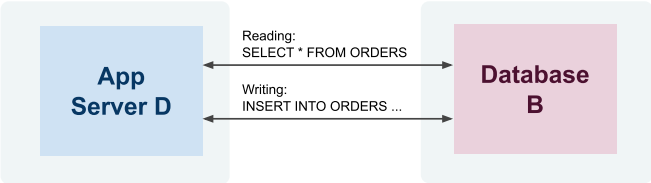
Integration and Interoperability

- Integration
  - *A process of connecting applications so that they can exchange and share capabilities, that is — information and functionalities.*
  - *Includes methodological approaches as well as technologies*
- Interoperability
  - *Ability of two or more applications to understand each other*
  - *Interoperability levels*
    - → *Data – syntax/structure and semantics*
    - → *Functions/Processes – syntax and semantics*
    - → *Technical aspects – protocols, network addresses, etc.*

Integration Approaches Overview

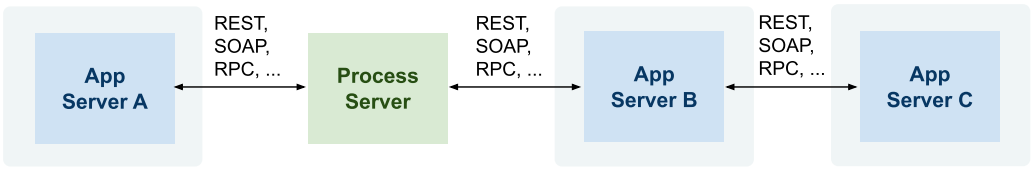


Data-oriented Integration



- Third-party database access
  - *Application D accesses a database of application B directly by using SQL and a knowledge of database B structure and constraints*
  - *In the past: monolithic and two-tier client/server architectures*
  - *Today: ETL (Extract, Transform, Load) technologies*
- Problems
  - *App D must understand complex structures and constraints*
    - → *Data – very complex, includes structure and integrity constraints*
    - → *Functions/processes – hidden in integrity constraints*
    - → *Technical – access mechanisms can vary*

Service-oriented Integration



- Integration at the application layer
  - *Application exposes services that other applications consume*
  - *Services hide implementation details but only define interfaces for integration*
- Problems
  - *Can become unmanageable if not properly designed*
  - *Interoperability*
    - → *Data – limited to input and output messages only*
    - → *Functions/processes – limited to semantics of services*
    - → *Technical – access mechanisms can vary*

Integration and Types of Data

- Real-time data – Web services
  - *Service-oriented integration*
  - *online, realtime communication between a client and a service*
  - *Usually small data and small amount of service invocation in a process*
- Bulk data – ETL
  - *Data-oriented integration*
  - *processing of large amount of data in batches*
  - *Sometimes required for reconciliation across apps*
    → *when real-time integration fails and there is poor error handling*
- **SOA provides both Web service and ETL capabilities**

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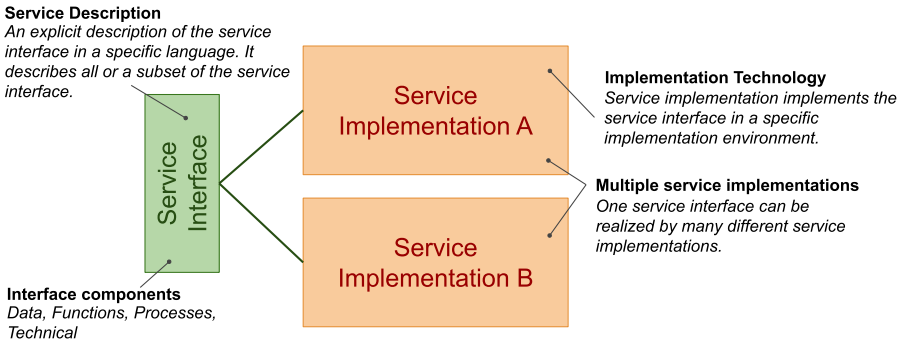
Web Service Architecture

- Web Service Architecture
  - *Defined by W3C in Web Service Architecture Working Group Note*
  - *Defines **views***
    - → *message-oriented view (WSDL and SOAP)*
    - → *resource-oriented view (REST and HTTP)*
  - *Defines **architecture entities** and their **interactions***
    - → *Abstraction over underlying technology*
    - → *Basis for service usage processes and description languages*
- Service Oriented Architecture
  - *Collection of tools, methods and technologies*
  - *There is some implicit understanding of SOA in the community such as*
    - → *SOA provides advances over Enterprise Application Integration*
    - → *SOA is realized by using SOAP, WSDL, (and UDDI) technologies*
    - → *SOA utilizes Enterprise Service Bus (ESB)*
  - ⇒ *~ a realization of Web Service Architecture message-oriented view*

Service

- Difficult to agree on one definition
- Business definition
  - *A service realizes an effect that brings a business value to a service consumer*
    - → *for example, to pay for and deliver a book*
- Conceptual definition
  - *service characteristics*
    - → *encapsulation, reusability, loose coupling, contracting, abstraction, discoverability, composability*
- Logical definition
  - *service interface, description and implementation*
  - *service usage process*
    - → *service use tasks, service types*
- Architectural definition
  - *business service (also application service)*
    - → *external, exposed functionality of an application*
  - *infrastructure service*
    - → *internal/technical, supports processing of requests*

Interface, Description and Implementation



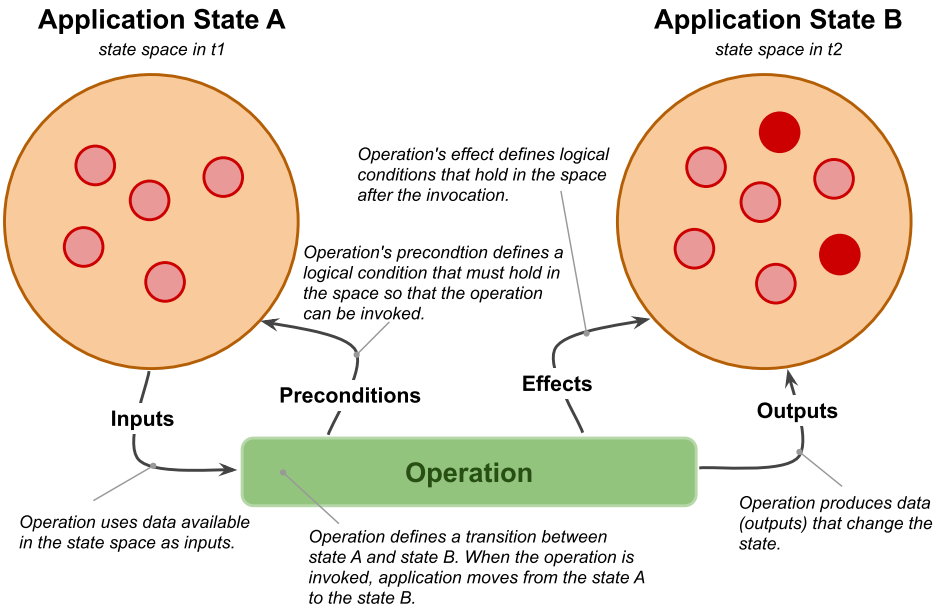
- Terminology clarification
  - *service ~ service interface + service implementation*
  - *WSDL service ~ service description in WSDL language*
  - *SOAP service ~ a service interface is possible to access through SOAP protocol; there is a WSDL description usually available too.*
  - *REST/RESTful service ~ service interface that conforms to REST architectural style and HTTP protocol*

Service Interface

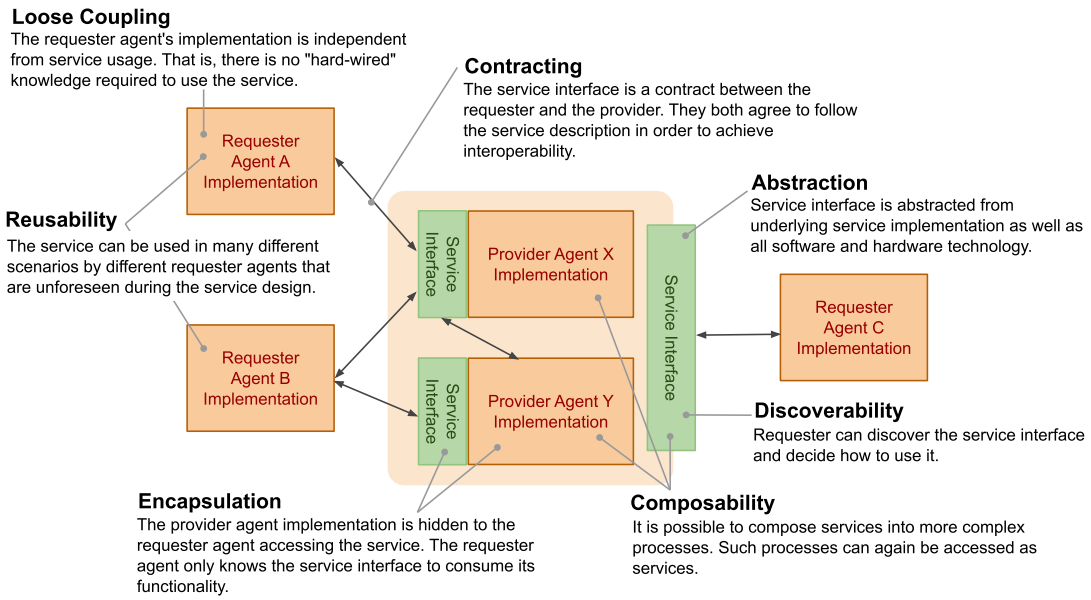
- Service interface components
  - *Data*
    - *→ Data model definition used by the service*
    - *→ for example, input and output messages, representation of resources*
  - *Functions*
    - *→ operations and input and output data used by operations*
  - *Process*
    - *→ public process: how to consume the service's functionality*
    - *→ orchestration: realization of the service's functionality by its implementation*
  - *Technical*
    - *→ security, usage aspects (SLA-Service Level Agreement)*
    - *→ other technical details such as IP addresses, ports, protocols, etc.*

Public Process

- A state diagram
  - *operation of a service defines a **state transition** between two states.*



Service Characteristics



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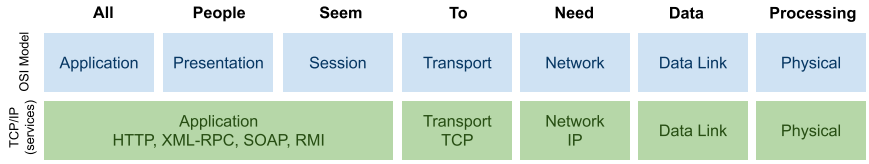
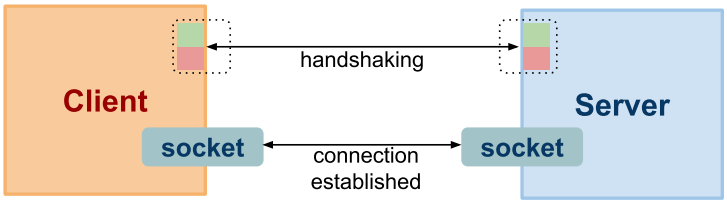
Application Protocols

- Remember this



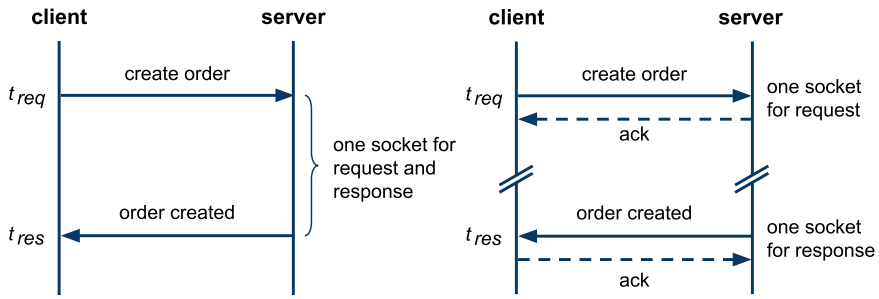
- App protocols mostly on top of the TCP Layer
  - *use TCP socket for communication*
- Major protocols
  - *HTTP – most of the app protocols layered on HTTP*
    → wide spread, but: implementors often break HTTP semantics
  - *RMI – Remote Method Invocation*
    → Java-specific, rather interface
    → may use HTTP underneath (among other things)
  - *XML-RPC – Remote Procedure Call and SOAP*
    → Again, HTTP underneath
  - *WebSocket – new protocol part of HTML5*

Socket



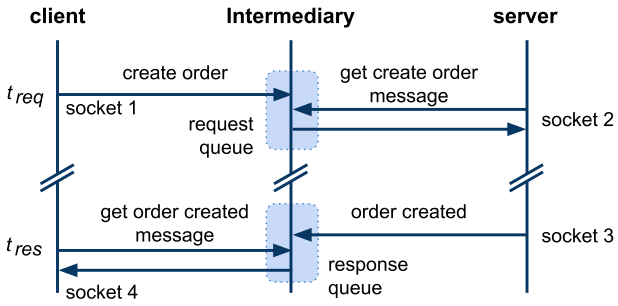
- Handshaking (connection establishment)
  - *The server listens at* `[dst_ip,dsp_port]`
  - *Three-way handshake:*
    - → *the client at* `[src_ip,src_port]` *sends a connection request*
    - → *the server responds*
    - → *the client acknowledges the response, can send data along*
  - *Result is a socket (virtual communication channel) with unique identification:* `socket=[src_ip,src_port;dst_ip,dst_port]`
- Data transfer (resource usage)
  - *Client/server writes/reads data to/from the socket*
  - *TCP features: reliable delivery, correct order of packets, flow control*
- Connection close

Synchronous and Asynchronous Communication



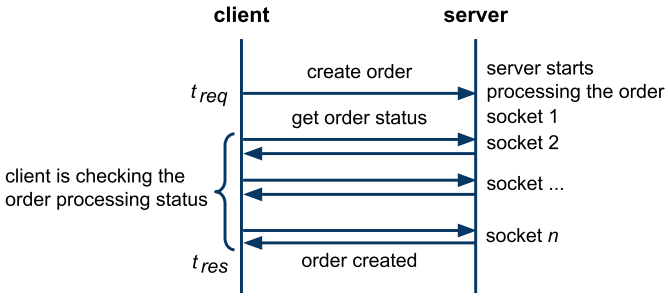
- Synchronous
  - *one socket,* $|t_{req} - t_{res}|$ *is small*
  - *easy to implement and deploy, only standard firewall config*
  - *only the server defines endpoint*
- Asynchronous
  - *request, response each has socket, client and server define endpoints*
  - $|t_{req} - t_{res}|$ *can be large (hours, even days)*
  - *harder to do across network elements (private/public networks issue)*

Asynchronous via Intermediary



- Intermediary
  - *A component that decouples a client-server communication*
  - *It increases reliability and performance*
    - → *The server may not be available when a client sends a request*
    - → *There can be multiple servers that can handle the request*
- Further Concepts
  - *Message Queues (MQ) – queue-based communication*
  - *Publish/Subscribe (P/S) – event-driven communication*

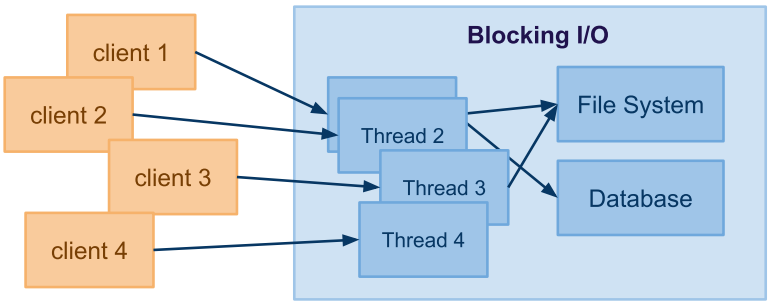
Asynchronous via Polling



- Polling – only clients open sockets
  - *A client performs multiple request-response interactions*
    - → *The first interaction initiates a process on the server*
    - → *Subsequent interactions check for the processing status*
    - → *The last interaction retrieves the processing result*
- Properties of environments
  - *A server cannot open a socket with the client (network restrictions)*
  - *Typically on the Web (a client runs in a browser)*

Blocking I/O Model

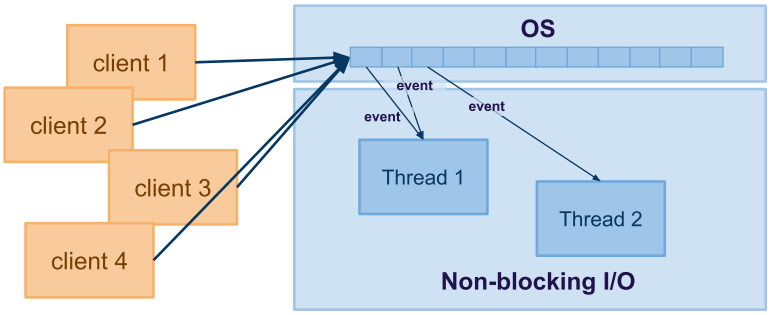
- The server creates a thread for every connection
  - *For example, 1K connections = 1K threads, big overhead*



- Characteristics
  - *the thread is reserved for the connection*
  - *When processing of the request requires other interactions with DB/FS or network communication is slow*
    → scales very bad as the thread's execution is "blocked"

Non-Blocking I/O Model

- Connections maintained by the OS, not the Web app
  - *The Web app registers events, OS triggers events when occur*



- Characteristics
  - *Event examples: new connection, read, write, closed*
  - *The app may create working threads and controls their number*
    → less number of working threads as opposed to blocking I/O
  - *On the outbound calls, there can still be blocking I/O*
    → this depends on the implementation framework