Service Oriented Software Engineering

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Acknowledgments

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Your Answers Were Helpful for this Class

- Prof.Dr. Rosana Teresinha Vaccare Braga (Advisor)
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Required in this class

- Please pay attention on what is required in this class:
  - A sheet of paper;
  - A pen;
  - Preliminary Knowledge;
  - Even further attention!

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Required in this class

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  - Preliminary Knowledge;
  - Even further attention!

Important Question

- What do you expect from this course?
- This class:
  - Service Orientation introduction and application.

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The Most Important Thing in Reuse

Thanks to: Jon Whittle & John Hutchinson

Whittle et al. (2014). The State of Practice in Model-Driven Engineering.
http://doi.ieeecomputersociety.org/10.1109/MS.2013.65

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The Most Important Thing in Reuse

1. Abstraction.

Thanks to: Jon Whittle & John Hutchinson

Whittle et al. (2014). The State of Practice in Model-Driven Engineering.
http://doi.ieeecomputersociety.org/10.1109/MS.2013.65

Preliminary Knowledge

The Most Important Things in Reuse

1. Abstraction;
2. Abstraction;
3. Abstraction;
4. Abstraction.

Thanks to: Jon Whittle & John Hutchinson

Whittle et al. (2014). The State of Practice in Model-Driven Engineering.
http://doi.ieeecomputersociety.org/10.1109/MS.2013.65

Preliminary Knowledge

The Most Important Things in Reuse

1. Abstraction;
2. Abstraction;
3. Abstraction;
4. Abstraction.

Question to Ponder:

- Can we only reuse with abstraction?

Thanks to: Jon Whittle & John Hutchinson

Whittle et al. (2014). The State of Practice in Model-Driven Engineering.
http://doi.ieeecomputersociety.org/10.1109/MS.2013.65

Preliminary Knowledge

Abstraction

Abstract

Preliminary Knowledge

Abstraction

1. an abstract idea or term.

Abstract

Merriam-Webster (2017). English Dictionary.
https://www.merriam-webster.com/dictionary/

Preliminary Knowledge

Abstraction

Abstract

1. disassociated from any specific instance (abstract entity);
2. difficult to understand (abstruse, abstract problems);
3. insufficiently factual (formal).
4. expressing a quality apart from an object (the word poem is concrete, poetry is abstract)

Merriam-Webster (2017). English Dictionary.
https://www.merriam-webster.com/dictionary/

Preliminary Knowledge

Component

Standard

Pattern

Preliminary Knowledge

Component

- A software component is a **software element** that conforms to a **component model** and can be independently deployed and composed without modification according to a **composition standard**.

Standard

Pattern

Councill & T. Heineman (2001). Definition of a software component and its elements.
http://heim.ifi.uio.no/~frank/inf5040/CBSE/Component-Based_Software_Engineering_-_ch1.pdf

Preliminary Knowledge

Component

Standard

- A standard specification is an explicit set of **requirements** for an **item**, **material**, **component**, **system** or **service**. It is often used to **formalize** the technical aspects of a procurement agreement or **contract**.

Pattern

State of Oregon (2017). Standards Specifications.
http://www.oregon.gov/ODOT/Business/Pages/Standard_Specifications.aspx

Preliminary Knowledge

Component

Standard

Pattern

- form or model proposed for imitation;
- something designed or used as a model for making things;
- frequent or widespread incidence;
- (design pattern) A design pattern is the re-usable form of a solution to a design problem.

Merriam-Webster (2017). English Dictionary.
https://www.merriam-webster.com/dictionary/

Alexander et al. (1977). A Pattern Language: Towns, Buildings, Construction.
http://www.amazon.fr/exec/obidos/ASIN/0195019199/citeulike04-21

Preliminary Knowledge

Business

Process in Engineering

Process in Software Engineering

Process in Operating System

Preliminary Knowledge

Business

- Serious activity requiring time and effort.

Process in Engineering

Process in Software Engineering

Process in Operating System

Merriam-Webster (2017). English Dictionary.
https://www.merriam-webster.com/dictionary/

Preliminary Knowledge

Business

Process in Engineering

- a process is a series of interrelated **tasks** (or **activities**) that, together, **transform inputs** into **outputs**.

Process in Software Engineering

Process in Operating System

ANSI/EIA (1998). ANSI/EIA-632-1998: Processes for Engineering a System.
http://standards.sae.org/eia632/

Preliminary Knowledge

Business

Process in Engineering

Process in Software Engineering

- The process of dividing **software development work** into distinct phases to improve design, product management, and project management.

Process in Operating System

CMS (2008). Selecting a development approach..
https://www.cms.gov/Research-Statistics-Data-and-Systems/CMS-Information-Technology/XLC/Downloads/SelectingDevelopmentApproach.pdf

Preliminary Knowledge

Business

Process in Engineering

Process in Software Engineering

Process in Operating System

- A process is an **instance of a computer program** that is being executed. It contains the program code and its current activity.

Silberschatz et al. (2004). Operating system concepts with Java.
https://books.google.com.br/books?id=T4pQAAAAMAAJ

Preliminary Knowledge

Service

Remote

Preliminary Knowledge

Service

1. the work performed by one that serves;
2. help, use, benefit;
3. contribution to the welfare of others;
4. disposal for use (at your service);
5. useful labor that does not produce a tangible commodity;
6. serve.

Remote

Merriam-Webster (2017). English Dictionary.
https://www.merriam-webster.com/dictionary/

Preliminary Knowledge

Service

Remote

1. separated by an interval or space greater than usual;
2. controlled indirectly or from a distance;
3. not arising from a primary or proximate action.

Merriam-Webster (2017). English Dictionary.
https://www.merriam-webster.com/dictionary/

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Basic Service Example

- Objective: Identify a Good Services Example:
  - A survey with current/former graduate students;
  - *What is the most basic (or the first) services example you can "think of"?*

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Basic Service Example – Asking Professors & Students

de Sena (2009). Raciocinio Racional.
https://www.youtube.com/watch?v=fbVHK-34XyM

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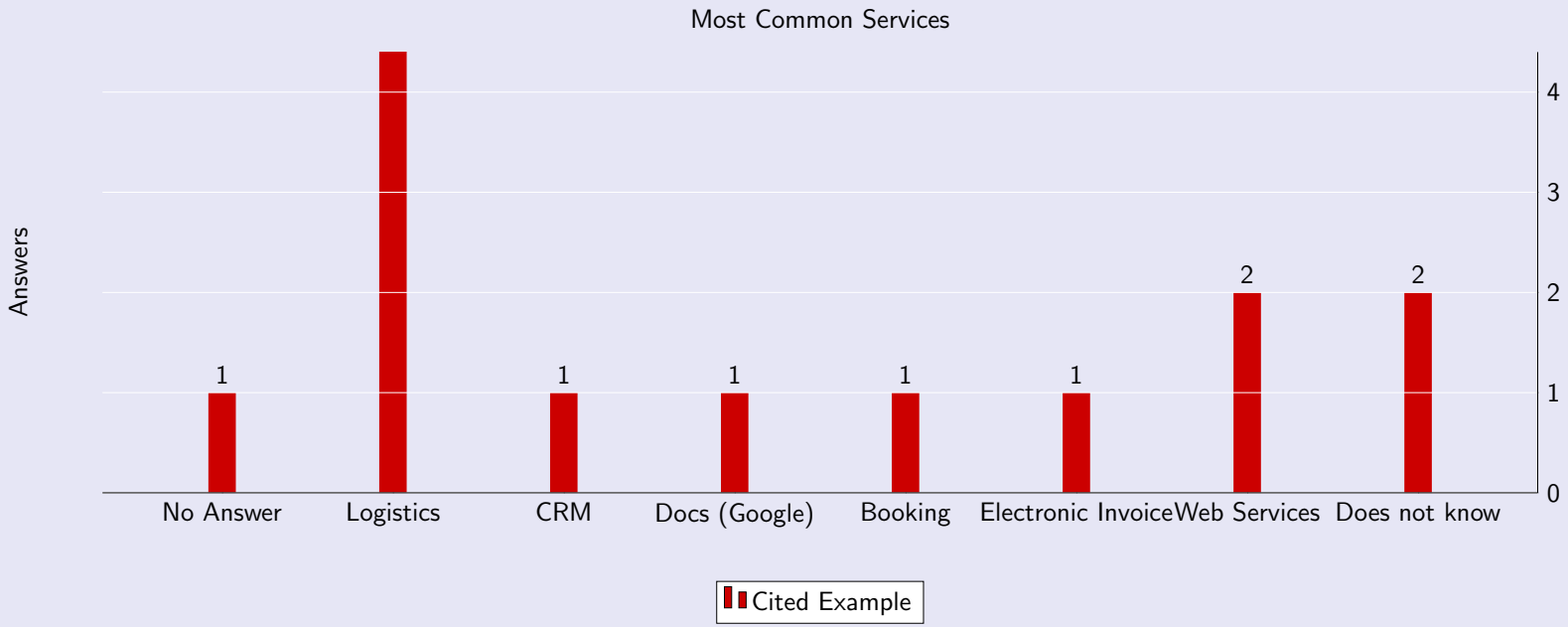
Basic Service Example –

Survey Results



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Motivating Example – Logistics System

Services

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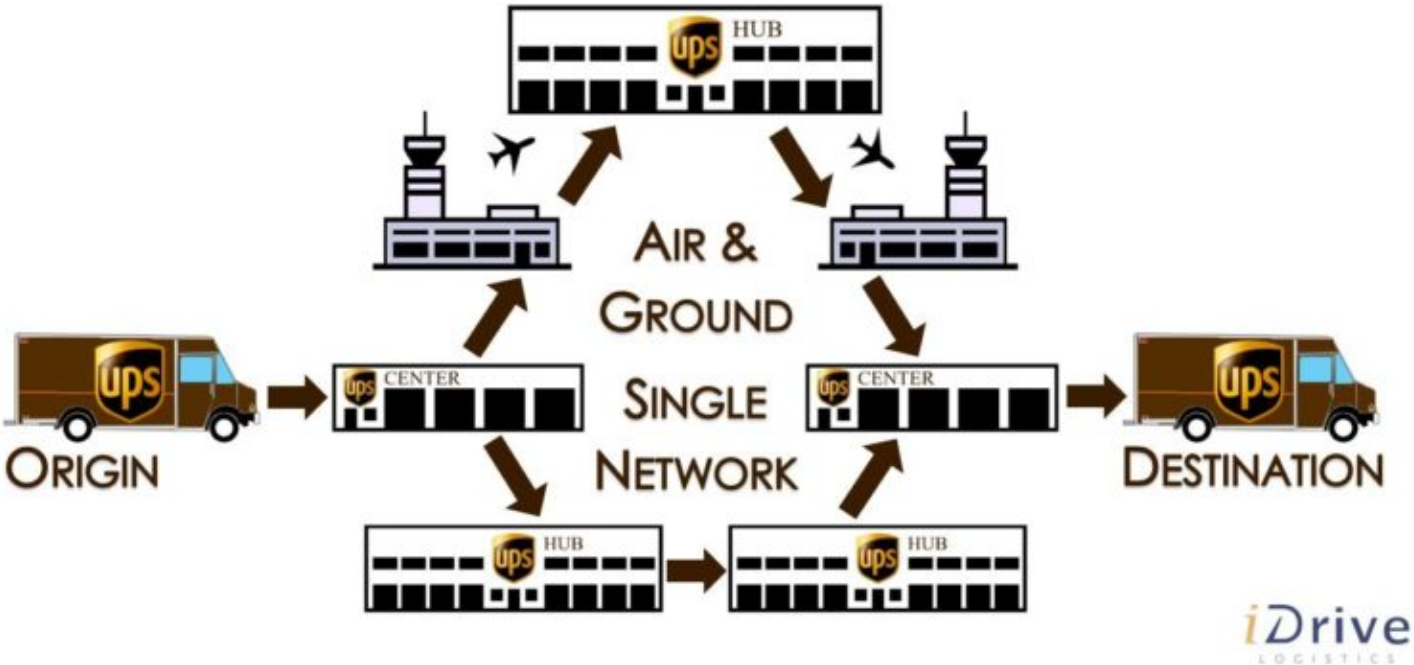
Address Search and Package Tracking

Design Systems inc. (2017). Logistics Planning.
http://www.dsi-solutions.com/manufacturing-industrial-logistics-planning.asp

Motivating Example – Logistics System



Address Search and Package Tracking

Jennings (2016). FedEx vs. UPS: Part 3 – Differences Between Networks.
http://idrivelogistics.com/fedex-vs-ups-part-3-differences-between-networks/

Motivating Example – Logistics System

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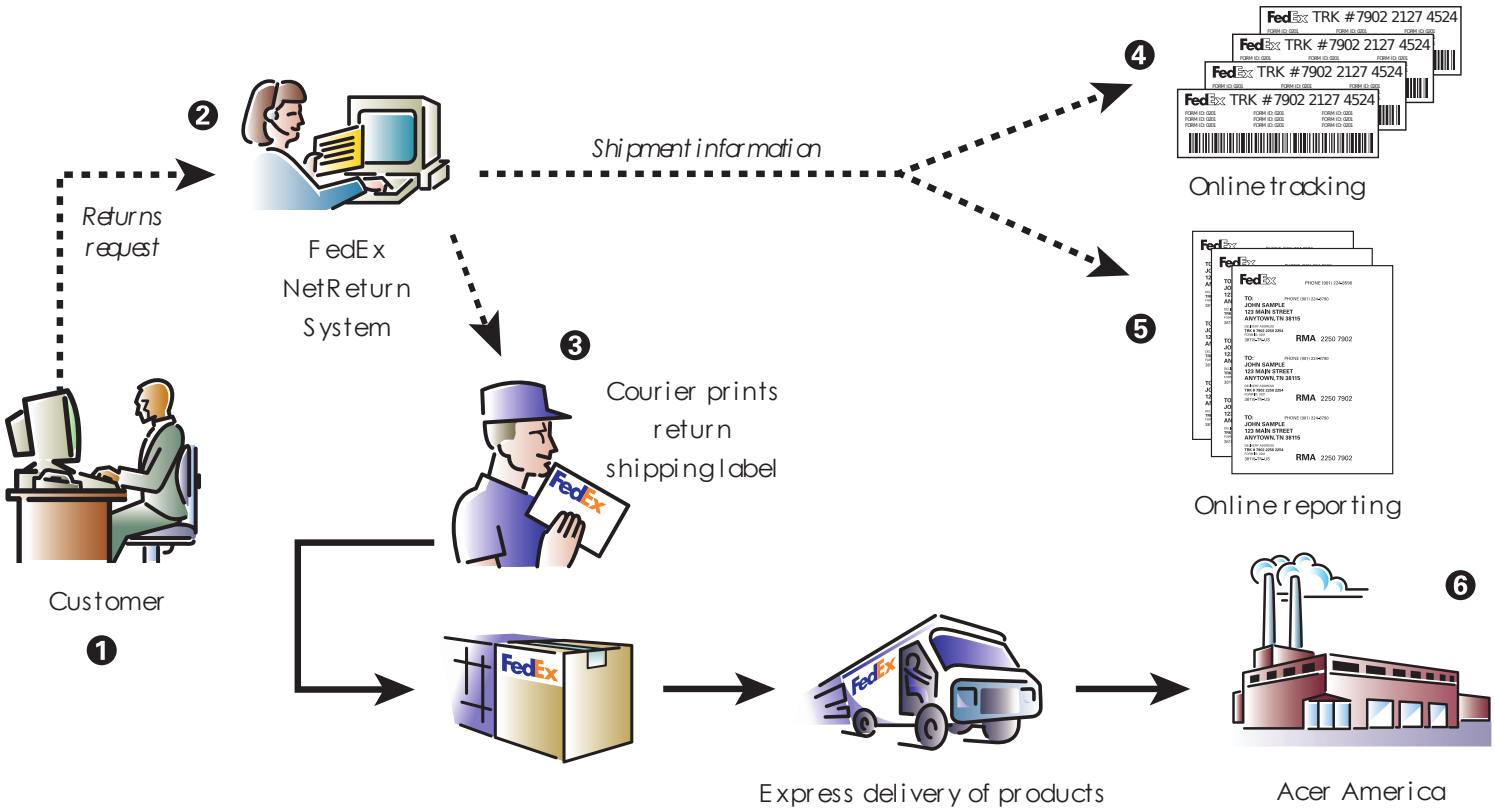

Address Search and Package Tracking

FedEx (2000). FedEx and Acer: Team to Streamline Returns.
http://www.fedex.com/us/solutions/downloads/acer.pdf

Motivating Example – Logistics System

Address Search and Package Tracking

Question to Ponder:

- Are services required for package tracking?

Motivating Example – Logistics System

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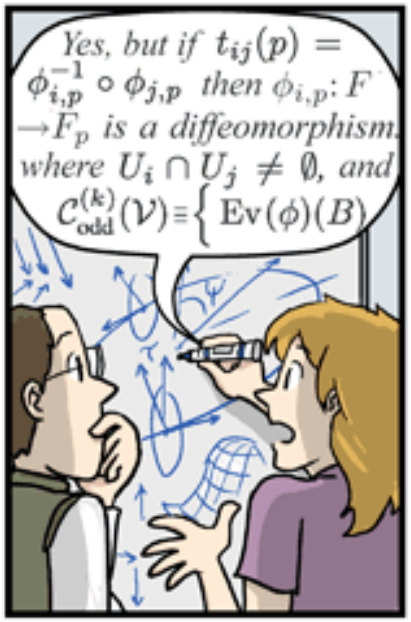
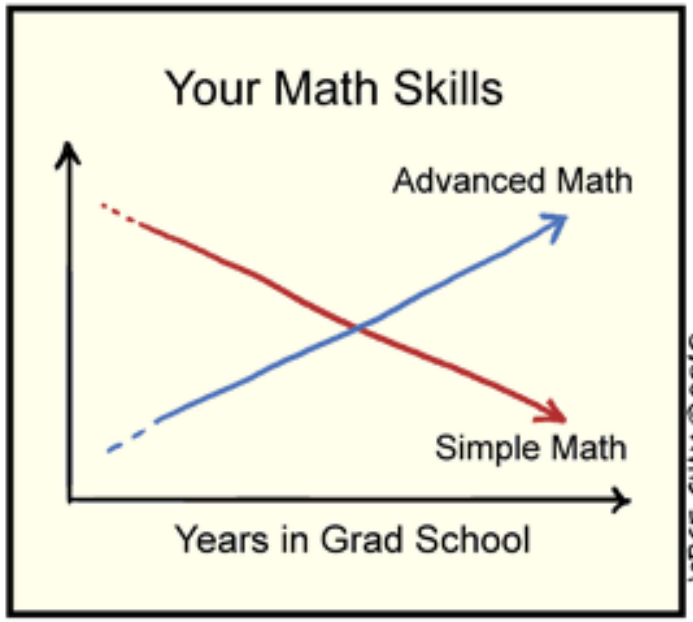
Basic Service Example is already too complex





Cham (2010). PhD Comics: Your Math Skills.
http://www.phdcomics.com/comics/archive.php?comicid=1356

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Service Definition (Repeat)

Motivating Example – Logistics System

Service Definition (Repeat)

1. the work performed by one that serves;
2. help, use, benefit;
3. contribution to the welfare of others;
4. disposal for use (at your service);
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6. serve.

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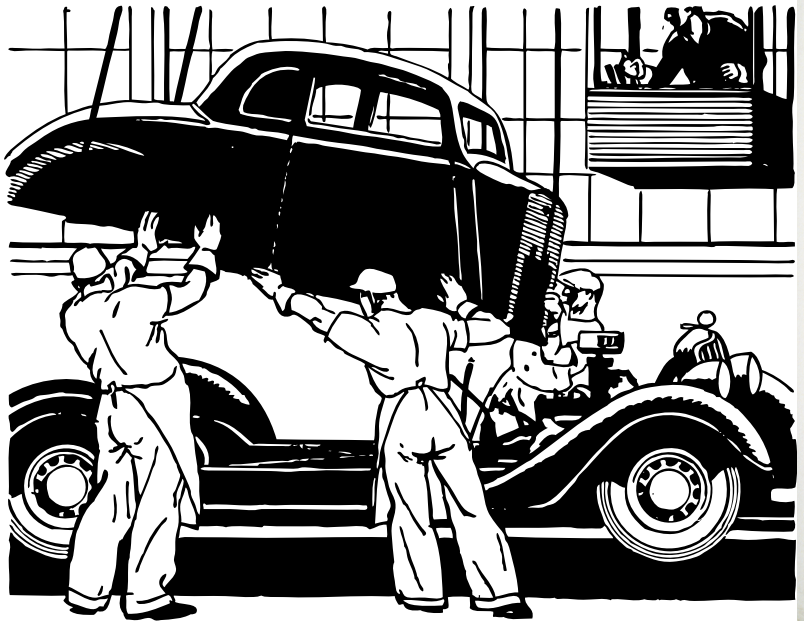
Economics

Economic Sectors

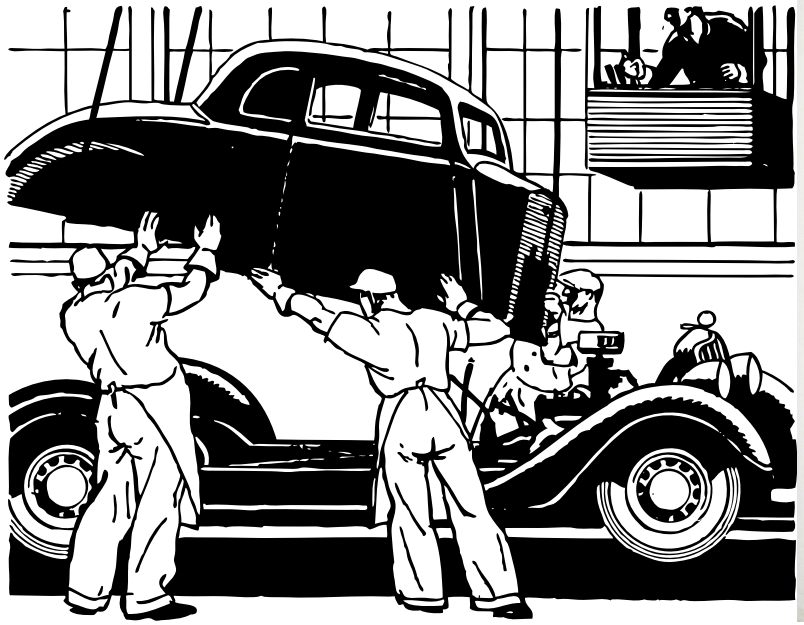
1. Primary Sector: Raw Materials;
2. Secondary Sector: Industry;
3. Tertiary Sector: Services.



Economics

Economic Sectors

1. Primary Sector: Raw Materials;
2. Secondary Sector: Industry;
3. Tertiary Sector: Services.
   Ex: Reuse of Waste $\Rightarrow$ Raw Material.



Economics

Tertiarization

1. Growth of Tertiary sector is called tertiarization;

> "In the United States 70 percent of the workforce works in the service sector; in Japan, 60 percent, and in Taiwan, 50 percent. These are not necessarily busboys and live-in maids. Many of them are in the professional category. **They are earning as much as manufacturing workers, and often more.**"

Ōmae (1990). The borderless world: power and strategy in the interlinked economy.
https://books.google.com.br/books?id=sznZAAAAIAAJ

Economics

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Tertiarization

1. In Software:
   1. Discussion Between **Software Industry** or **Software Service Provider**.
   2. Software Companies might make more profit as service providers instead of industrial production.

"In the United States 70 percent of the workforce works in the service sector; in Japan, 60 percent, and in Taiwan, 50 percent. These are not necessarily busboys and live-in maids. Many of them are in the professional category. **They are earning as much as manufacturing workers, and often more.**"

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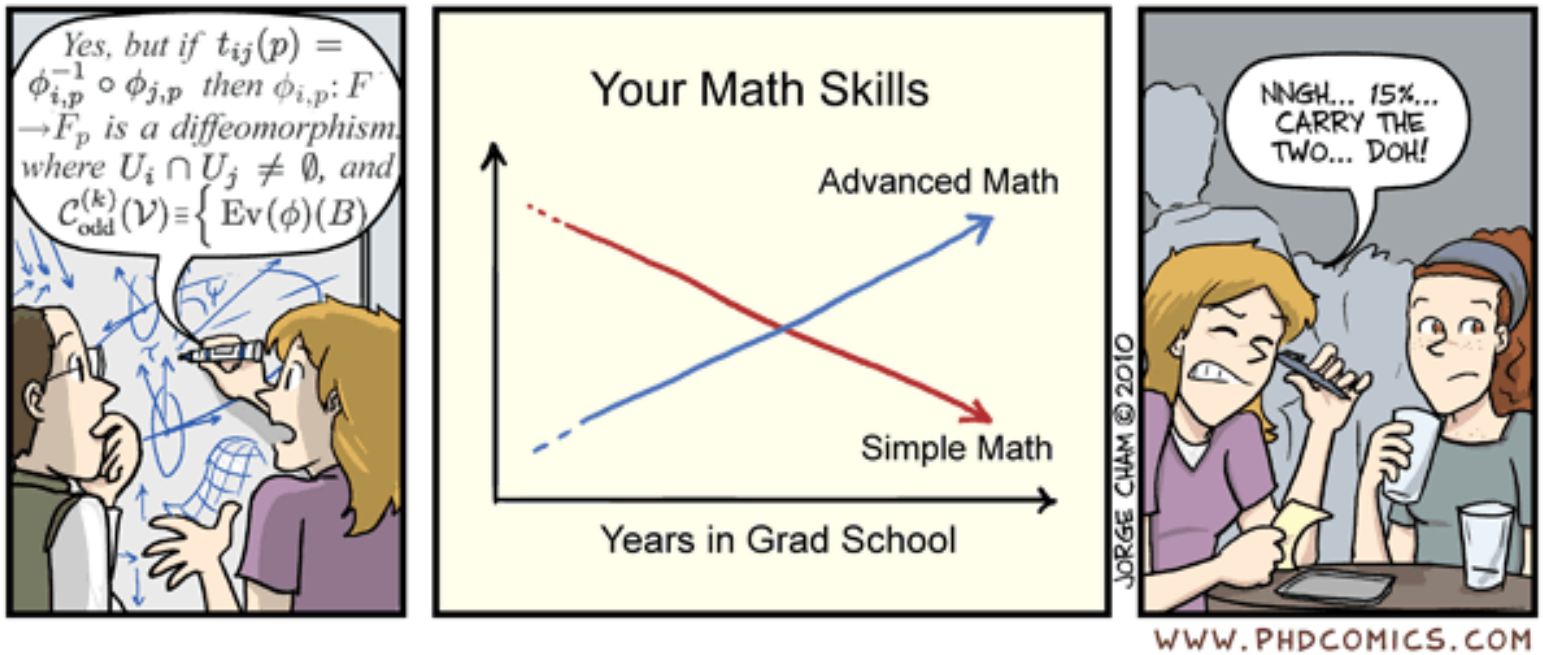
Basic Service Example



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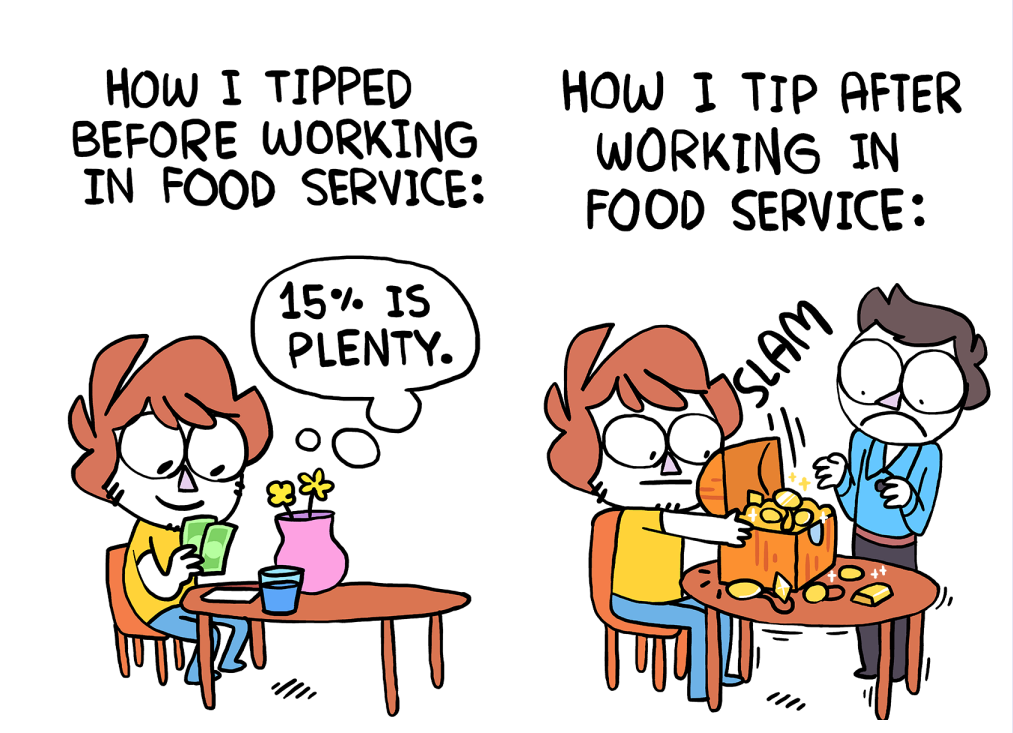
Basic Service Example



Protip: If you have not noticed, most concepts are inspired by economics and business.

Shenanigansen (2017). Owlturd Comix.
http://owlturd.com/post/162161101039

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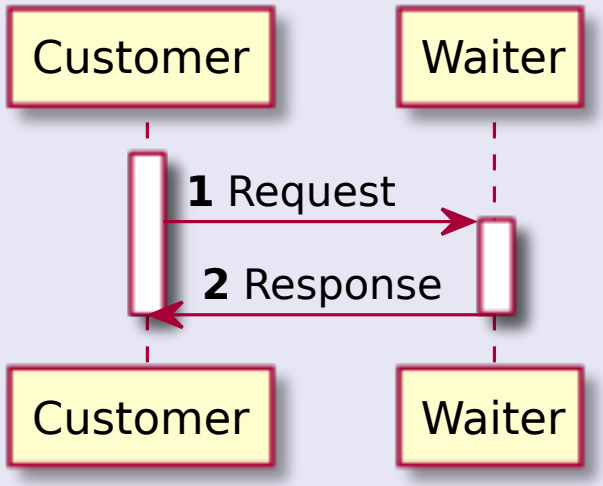
Basic Service Example – Food Service

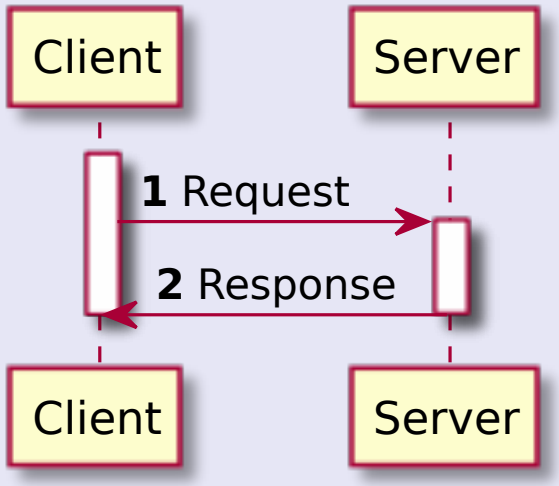
Service Examples

Basic Service Example – Food Service



Service Examples

Basic Service Example – Food Service



Service Examples

Basic Service Example

Question to Ponder:

- In computing: What is the difference between services and client-server architecture?

Service Examples

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Important Concepts

- Restaurant(s);
- Waiter(s);
- Customer(s);
- Recommended: Menu(s);
- Request/Response language and communication rules;
- Optional: Guide/Catalog/Survey of Restaurants.

- Service Type and Workflow;
  - Full/Customized Service;
  - Fast Service;
  - Self Service;
- Optional: Food Court.

Service Examples

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Guide

tripadvisor®

Service Examples

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Guide

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Service Examples

Basic SOA Concepts

Food Services	Software Services
Restaurant	Service Provider
Waiter	Server
Customer	Client
Menu	Interface Specification
Language and communication rules	Protocol
Guide/Catalog/Survey	UDDI
Service Type and Workflow	(Business) Process Model
Full/Customized Service	Stateful Service
Fast Service	Stateless Service
Self Service	Back-end Service
Food Court	Cloud Services

Service Examples

Basic SOA Concepts

Food Services	Software Services
Restaurant	Service Provider
Waiter	Server
Customer	Client
Menu	Interface Specification
Language and communication rules	Protocol
Guide/Catalog/Survey	UDDI
Service Type and Workflow	(Business) Process Model
Full/Customized Service	Stateful Service
Fast Service	Stateless Service
Self Service	Back-end Service
Food Court	Cloud Services

Question to Ponder:

- How a System-of-System would function in the context of Food Service?

Service Examples

Interface

1. Shared boundary across which two or more separate components of a computer system exchange information.
2. Information exchange can be between software, computer hardware, peripheral devices, humans and combinations of these.

of Electrical & Engineers (2000). IEEE 100: The Authoritative Dictionary of IEEE Standards Terms.
https://books.google.com.br/books?id=dYl2QgAACAAJ

Service Examples

Protocol

Service Examples

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Protocol

1. code prescribing strict adherence to correct etiquette and precedence;
2. a set of conventions (rules) governing the treatment and especially the formatting of data;
3. Must be agreed upon by the parties involved. Therefore, a protocol may be developed into a technical **standard**.

Merriam-Webster (2017). English Dictionary.
https://www.merriam-webster.com/dictionary/

Comer (2000). Internetworking with TCP/IP.
https://books.google.com.br/books?id=KW_xnQAACAAJ

Service Examples I

Hypertext Transfer Protocol (HTTP)

1. Used to transfer hypertext, may be used to transmit other data formats;
2. Most used transport protocol to transmit Web Services: a services model.

HTTP Concepts

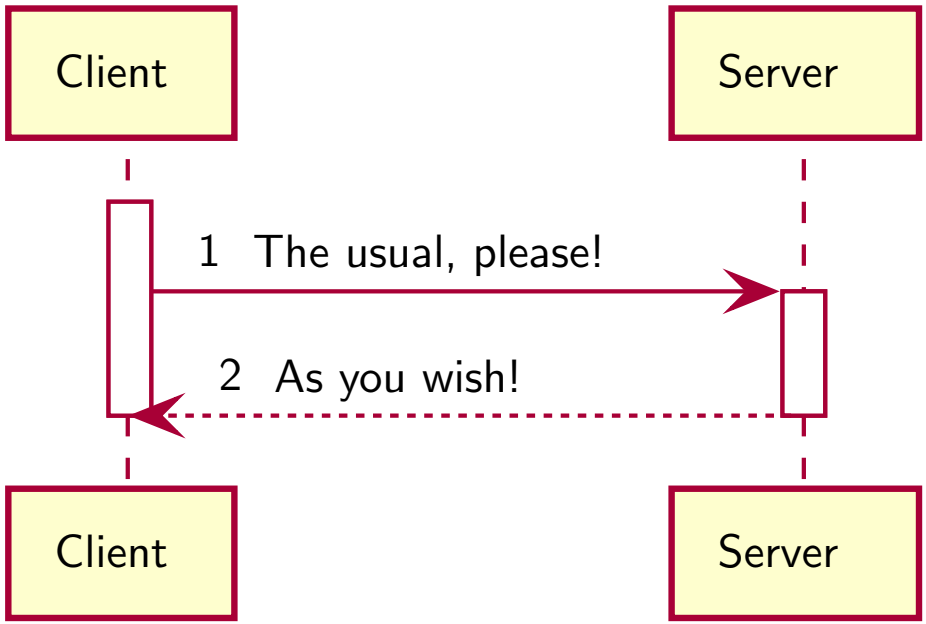
Concept	Description
Client Request	Client submits a request for a resource
Resource	Data hosted by server
Action Verb	Action to perform on Resource as requested by Client (e.g. GET or POST)
URL/URI	Universal Resource Location/Identifier
HTTP Version	Protocol Version to be **accepted** by parties
MIME	Multipurpose Internet Mail Extensions is a standard for data format specification
Server Header	Basic Information (Greeting) to Client

Fielding (2000). Architectural Styles and the Design of Network-based Software Architectures..
https://www.ics.uci.edu/~fielding/pubs/dissertation/top.htm

Service Examples

Stateful *(Full Service)*

1. The server must store a state.
   1. (e.g. the server must "remember" the client.)



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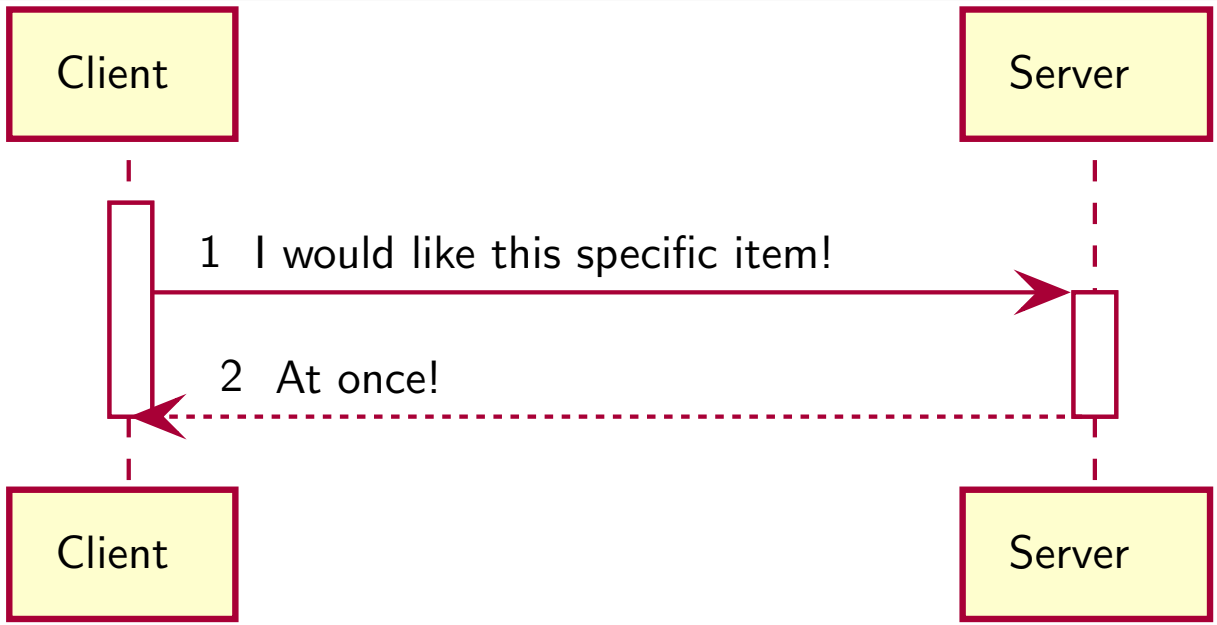
Stateless *(Fast Food)*

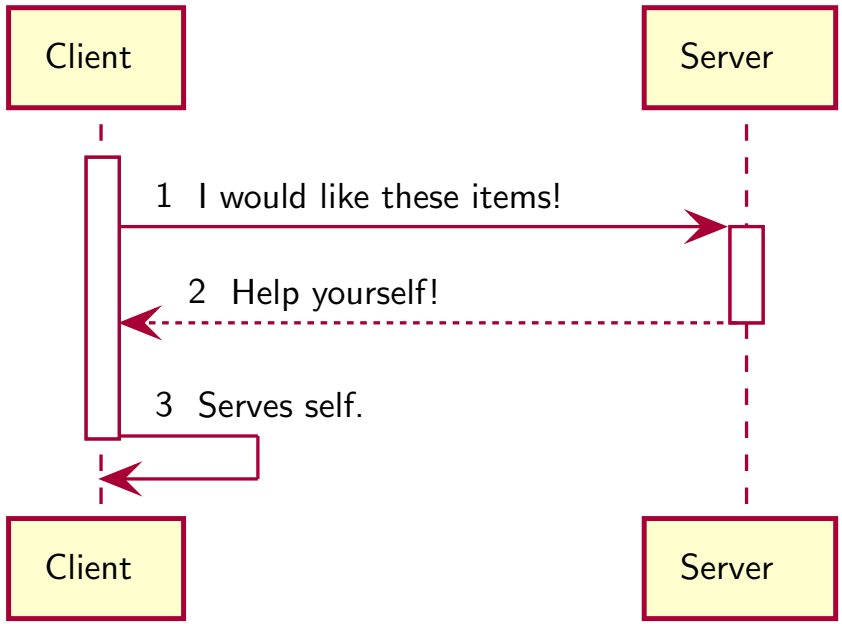
1. The server does not store any state.
   1. (e.g. the client must send **all** details for every request.)



Service Examples

Back-end Service *(Self Service)*

1. The server provides incomplete data that must be processed by the client.
   1. (e.g. the client must execute part of the work.)
2. This client might be an intermediary server (front-end) to the final client.



Service Examples

Question to Ponder:

- When is “Stateful” recommended?

Question to Ponder:

- When is “Stateless” recommended?

Question to Ponder:

- When is “Back-end” recommended?

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Motivating Example – 3

Bank System

- Data Processing Centers;
- Data Files.

Motivating Example – Banking System

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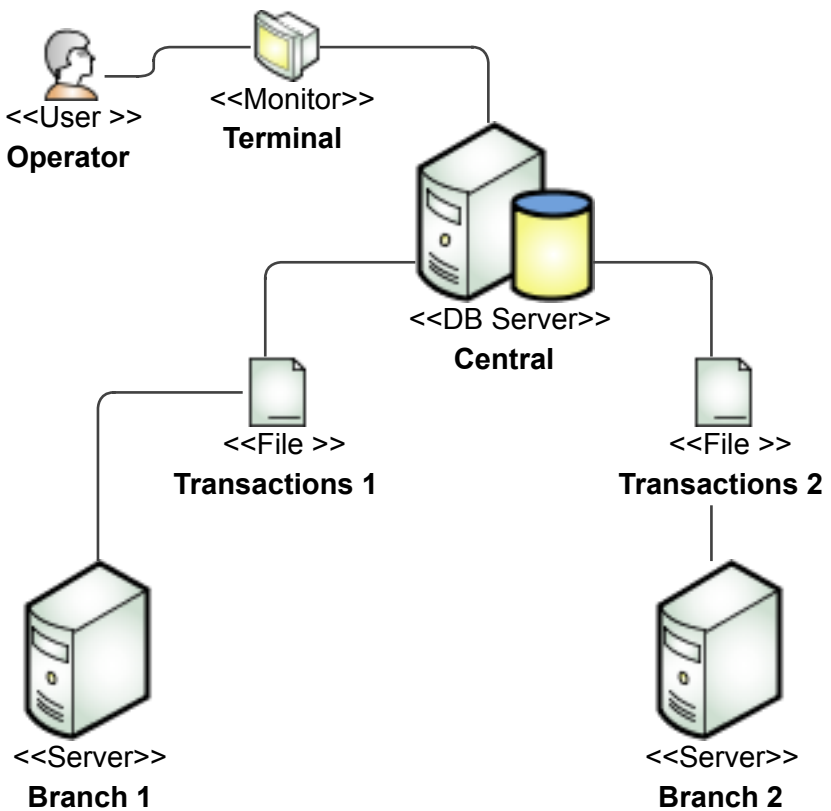

Bank Process Execution Evolution

Motivating Example – Banking System

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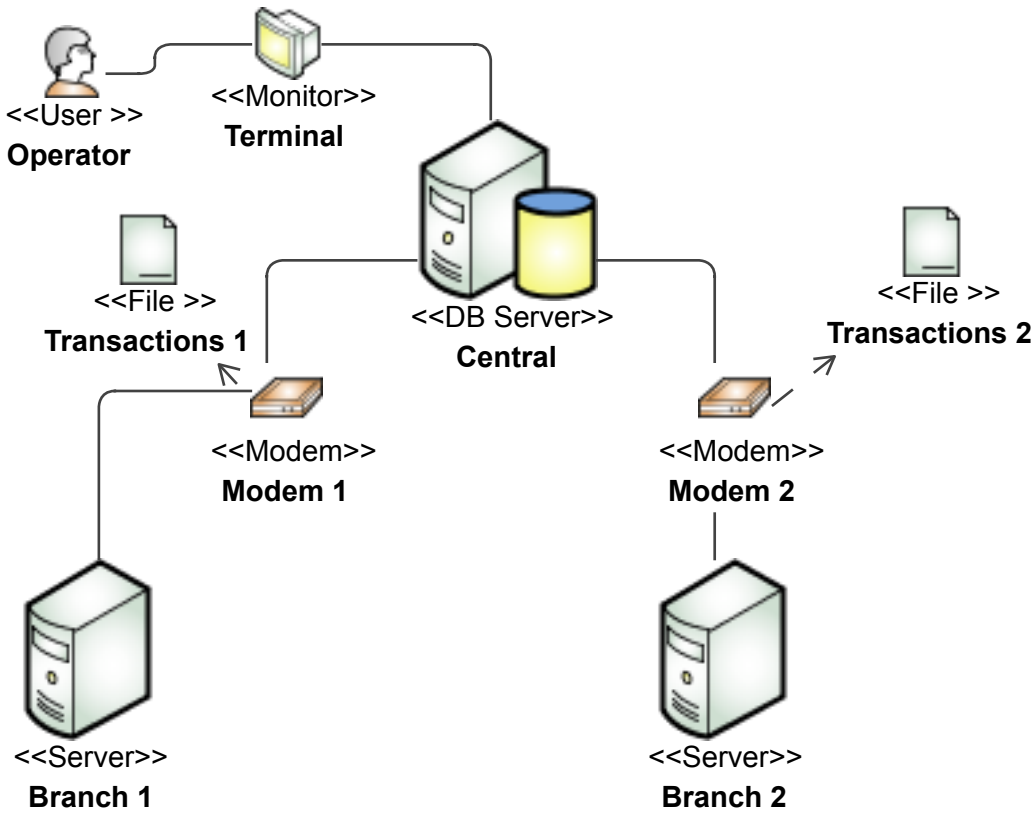

Bank Process Execution Evolution

Motivating Example – Banking System

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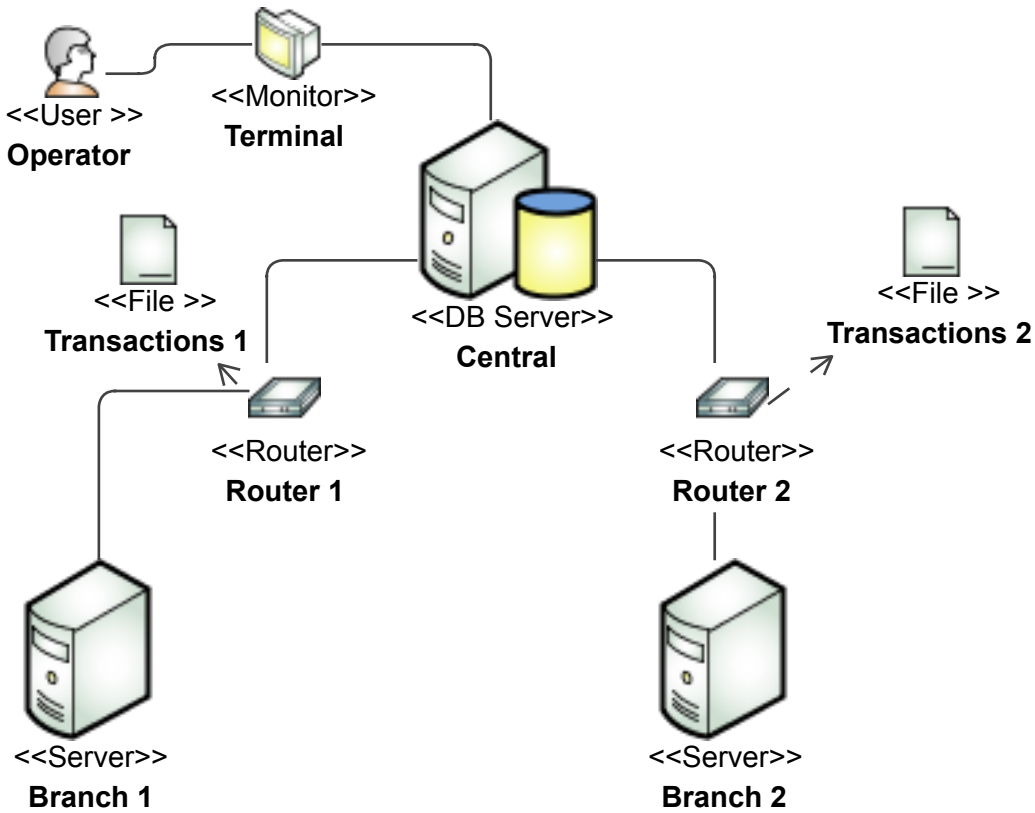

Bank Process Execution Evolution

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Services Implementations

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Blocking and Transparent

- Software/Computer calls remote procedures
  - Transparently;
  - Blocking (Synchronous);
  - Several Different Implementations that are not compatible.

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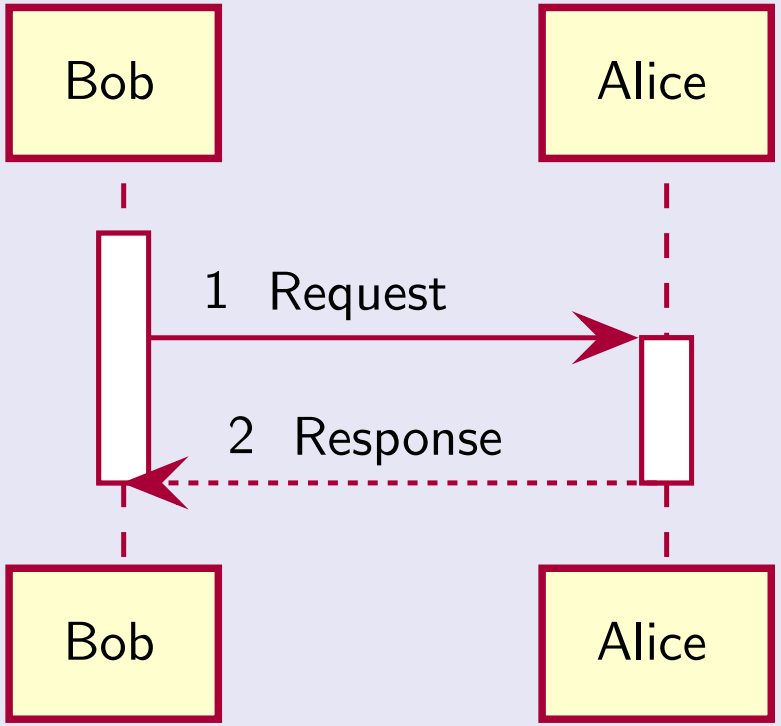

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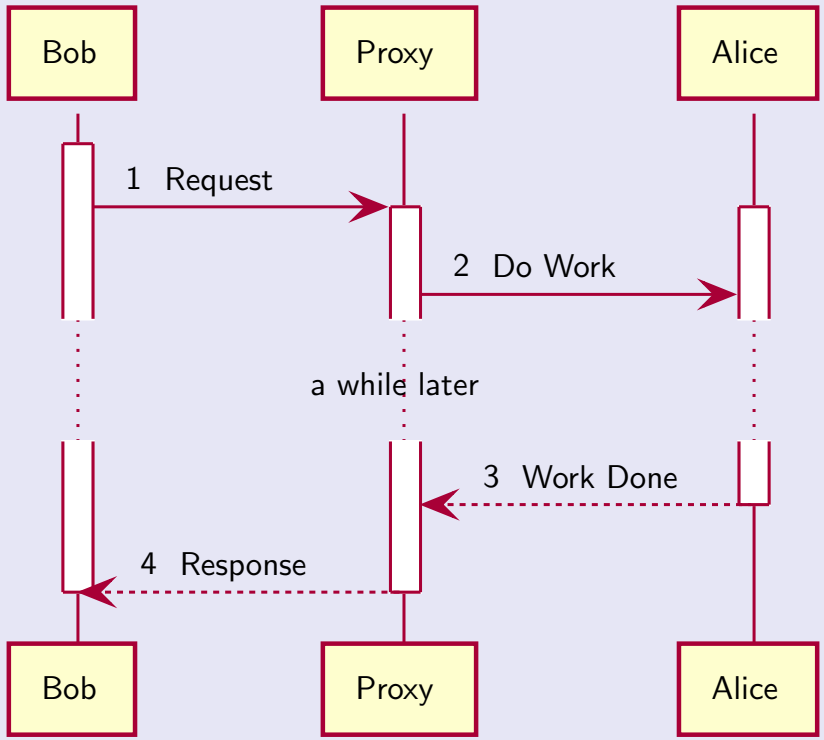

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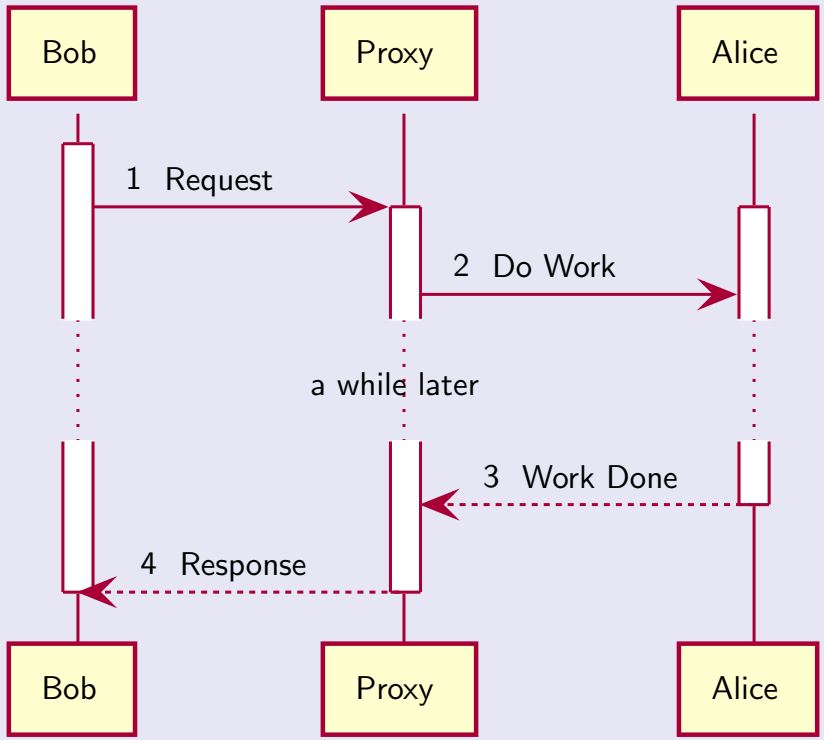

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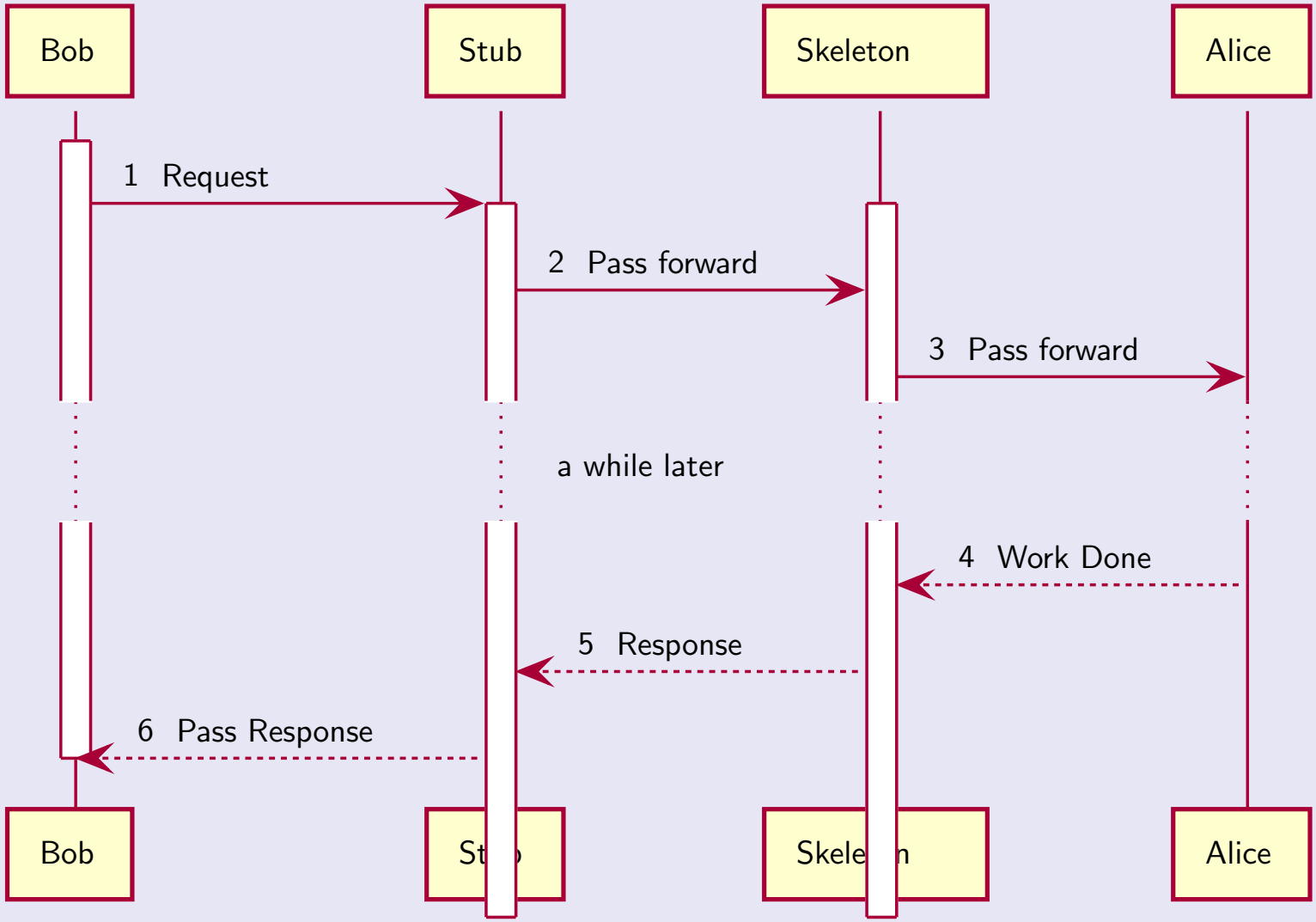
Blocking and Transparent

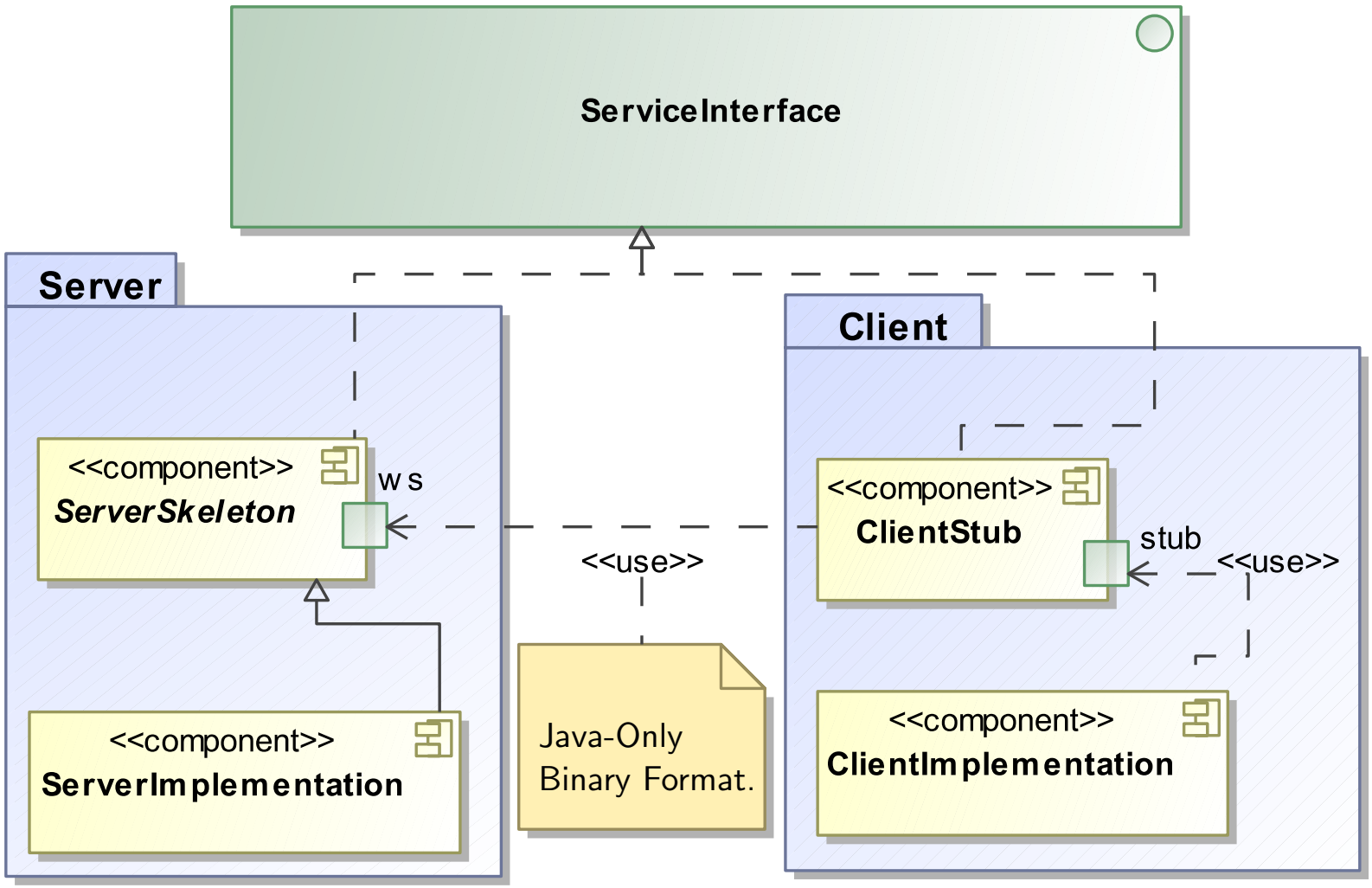


Services Implementations

Java Remote Method Invocation – RMI

- Adaptation of RPC for Java;
- Only for Java.

Services Implementations



Services Implementations

Common Object Request Broker Architecture – CORBA

- Platform independent format;
- Object-oriented;
- Custom format transfer.

Services Implementations

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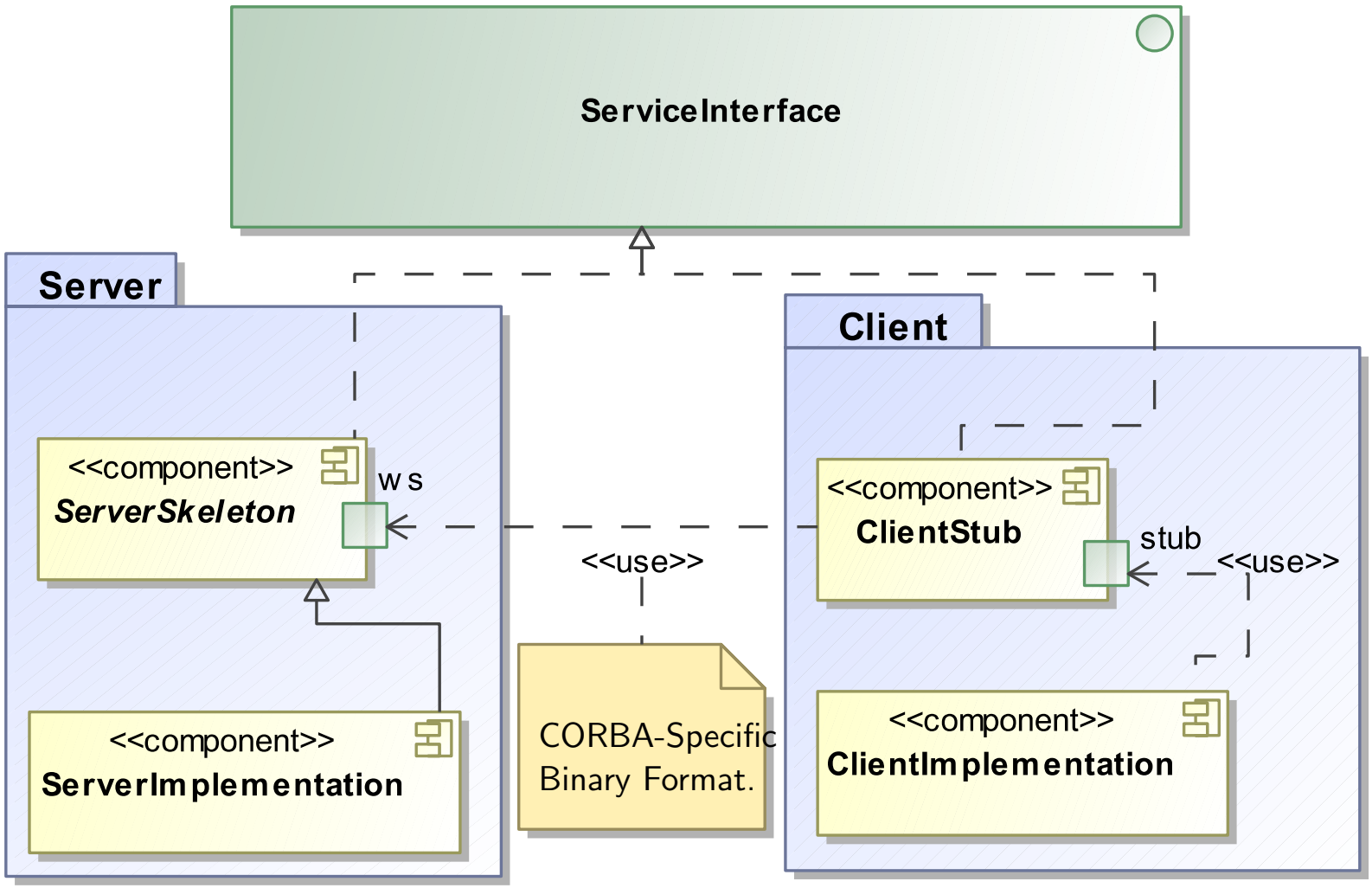

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Services Implementations I

Simple Object Access Protocol – SOAP

- Platform independent format;
- Object-Oriented;
- Recommends XML-based format transfer;
- Web Services Message Protocol.

Services Implementations II

SOAP Concepts

- Extensions:
  - WS-Security: Encryption and Authentication;
  - WS-Reliable Messaging: Message Delivery Reliability (Receipt).
- Process Model, e.g.:
  - WS-BPEL.
- Interface and Data Structure Specification, e.g.:
  - UDDI;
  - WSDL with XSD (XML Schema Specification – Data Structure).
- Message Protocols, e.g.:
  - SOAP.

Services Implementations III

SOAP Problems

- Heavy-weight protocol with strong rules;
- Hard to use for simple services;
- Large overhead for data transfer.

Sommerville (2015). Software Engineering, Tenth Edition.
https://www.pearson.com/us/higher-education/program/Sommerville-Software-Engineering-10th-Edition/PGM35255.html

Services Implementations I

Representative State Transfer – REST

- Light-weight alternative to SOAP;
- Not restricted to specific paradigms;
- Not tied to XML;
- Web Services Message Architectural Pattern.

Services Implementations II

REST Concepts

- RESTful is a system that intentionally complies to REST;
- Accidentally RESTful: a system that unintentionally complies to REST;
- Interface can be Specified with WADL;
- HTTP actions: e.g. GET, POST, PUT, PATCH, DELETE as methods;
- MIME types: the client may ask for a specific format per request.

Services Implementations III

REST Problems

- No standard for security;
- No standard for process model;
- No standard for data formats.

Fielding (2000). Architectural Styles and the Design of Network-based Software Architectures..
https://www.ics.uci.edu/~fielding/pubs/dissertation/top.htm

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Question to Ponder:

- Can you categorize: HTTP, RMI, CORBA, SOAP and REST in either Standard or Pattern?

Services Implementations

Question to Ponder:

- Can you categorize: HTTP, RMI, CORBA, SOAP and REST in either Standard or Pattern?

Question to Ponder:

- Which is better: Standard or Pattern?

Services Implementations

Question to Ponder:

- Can you categorize: HTTP, RMI, CORBA, SOAP and REST in either Standard or Pattern?

Question to Ponder:

- Which is better: Standard or Pattern?

Question to Ponder:

- When is it good to have more freedom?

Services Implementations

Question to Ponder:

- Can you categorize: HTTP, RMI, CORBA, SOAP and REST in either Standard or Pattern?

Question to Ponder:

- Which is better: Standard or Pattern?

Question to Ponder:

- When is it good to have more freedom?

Question to Ponder:

- When is it good to have less freedom?

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Motivating Example – Banking System

Control-M

BMC Software (New Dimension Software) (2017). Control-M.
http://www.bmcsoftware.com.br/it-solutions/control-m.html

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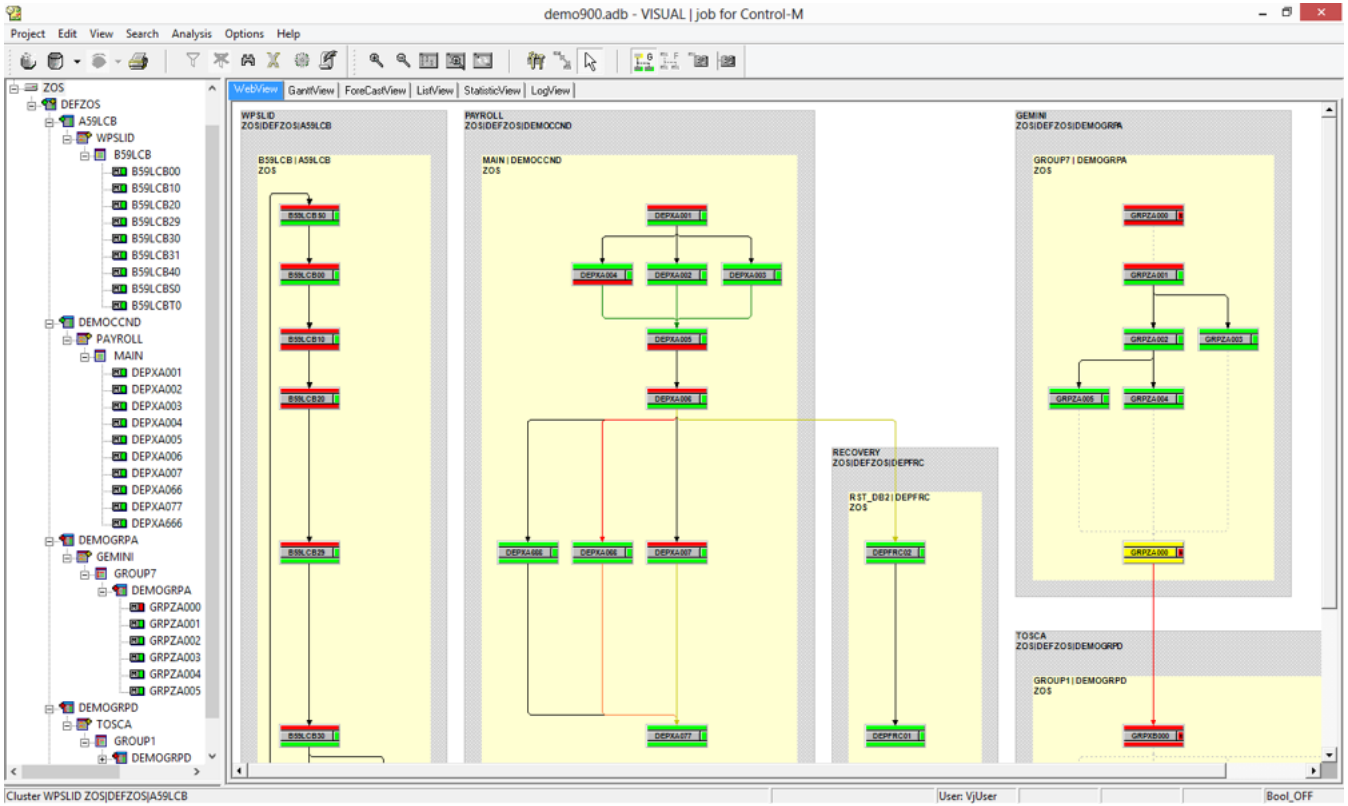

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Motivating Example – Banking System

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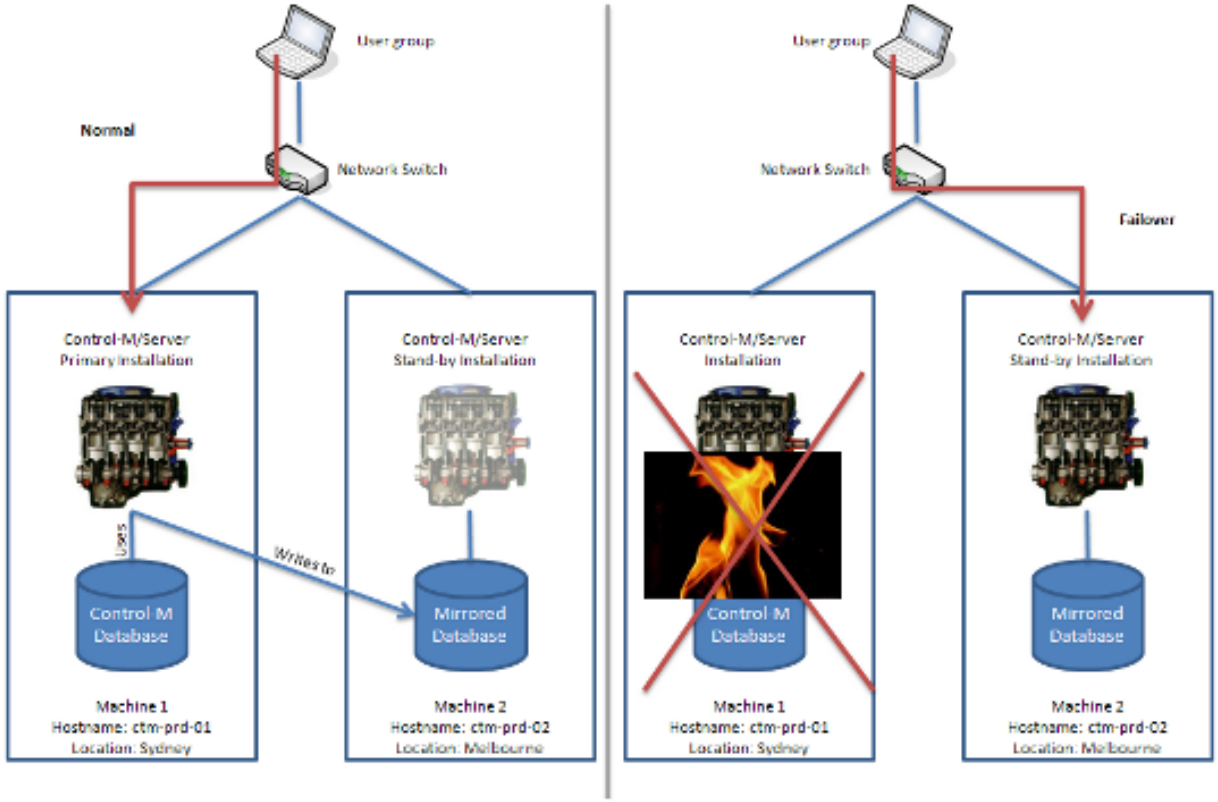


Control-M

BMC Software (New Dimension Software) (2017). Control-M.
http://www.bmcsoftware.com.br/it-solutions/control-m.html

Business Process Models

BPEL & BPMN

- Business Process Execution Language;
- Business Process Modeling Notation.

Sommerville (2015). Software Engineering, Tenth Edition.
https://www.pearson.com/us/higher-education/program/Sommerville-Software-Engineering-10th-Edition/PGM35255.html

OMG (2013). Business Process Model and Notation 2.0.2.
http://www.omg.org/spec/BPMN/

Business Process Models

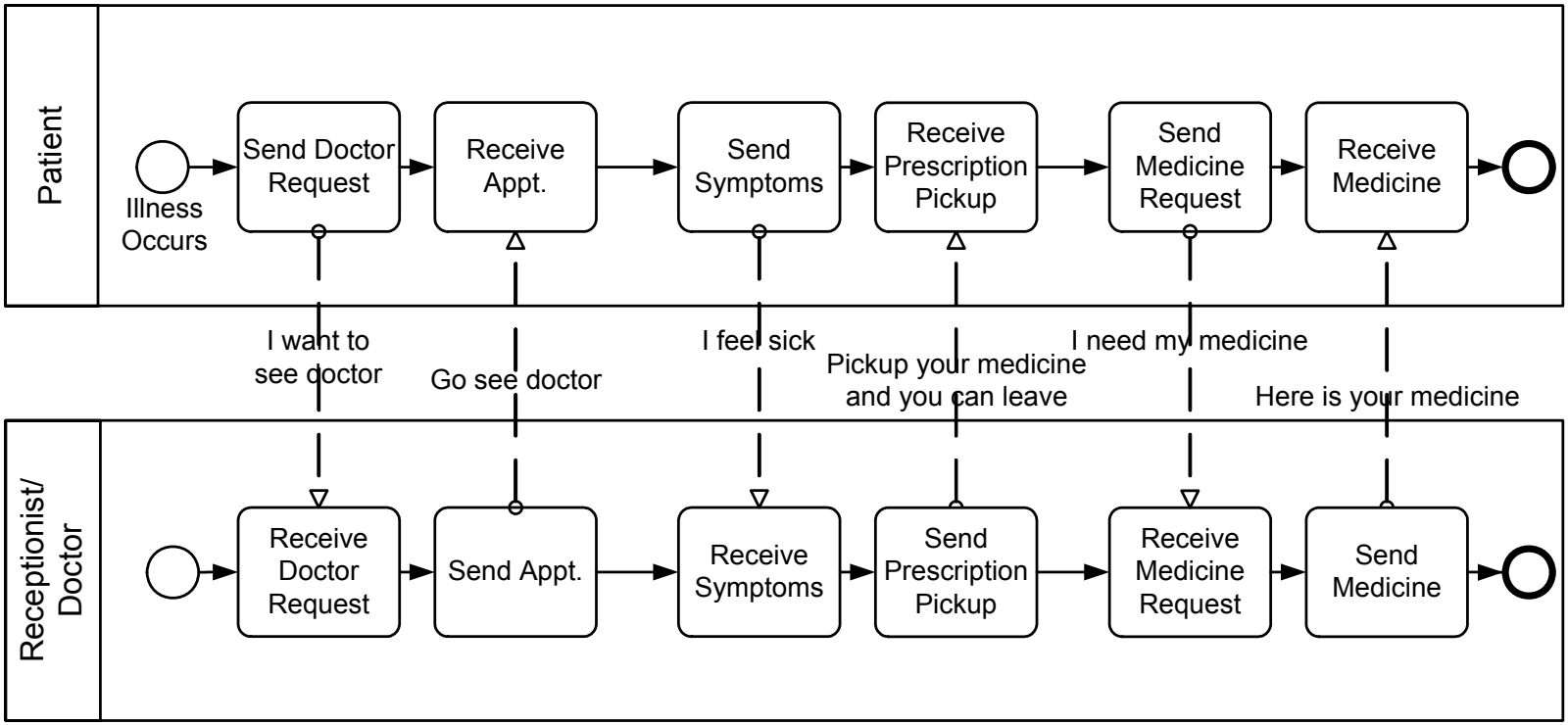
Question to Ponder:

- What is the difference between “Business Process” and “Protocol”?

Question to Ponder:

- How important is the “Business Process”?

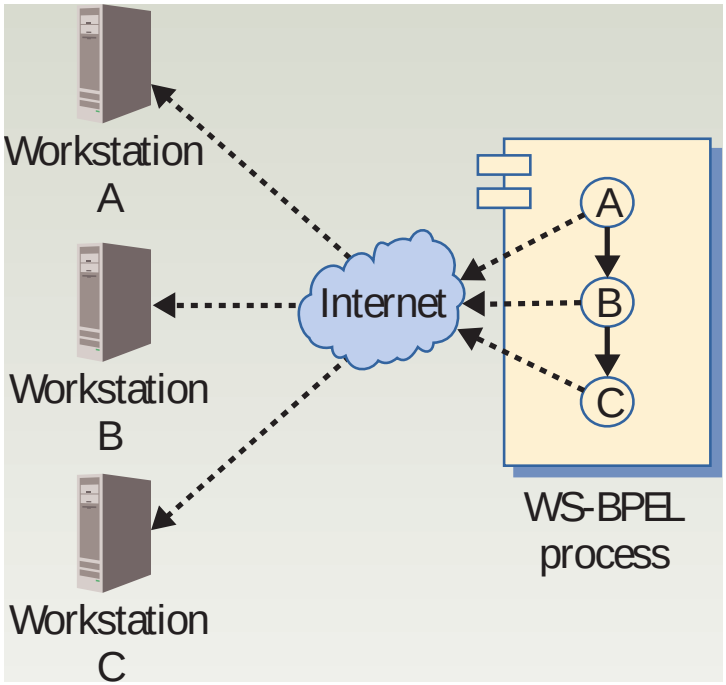
Business Process Models



BPMN Medical Example

OMG (2013). Business Process Model and Notation 2.0.2.
http://www.omg.org/spec/BPMN/

Business Process Models



BPEL to define execution order

Baresi et al. (2006). Toward Open-World Software: Issues and Challenges.
doi.ieeecomputersociety.org/10.1109/MC.2006.362

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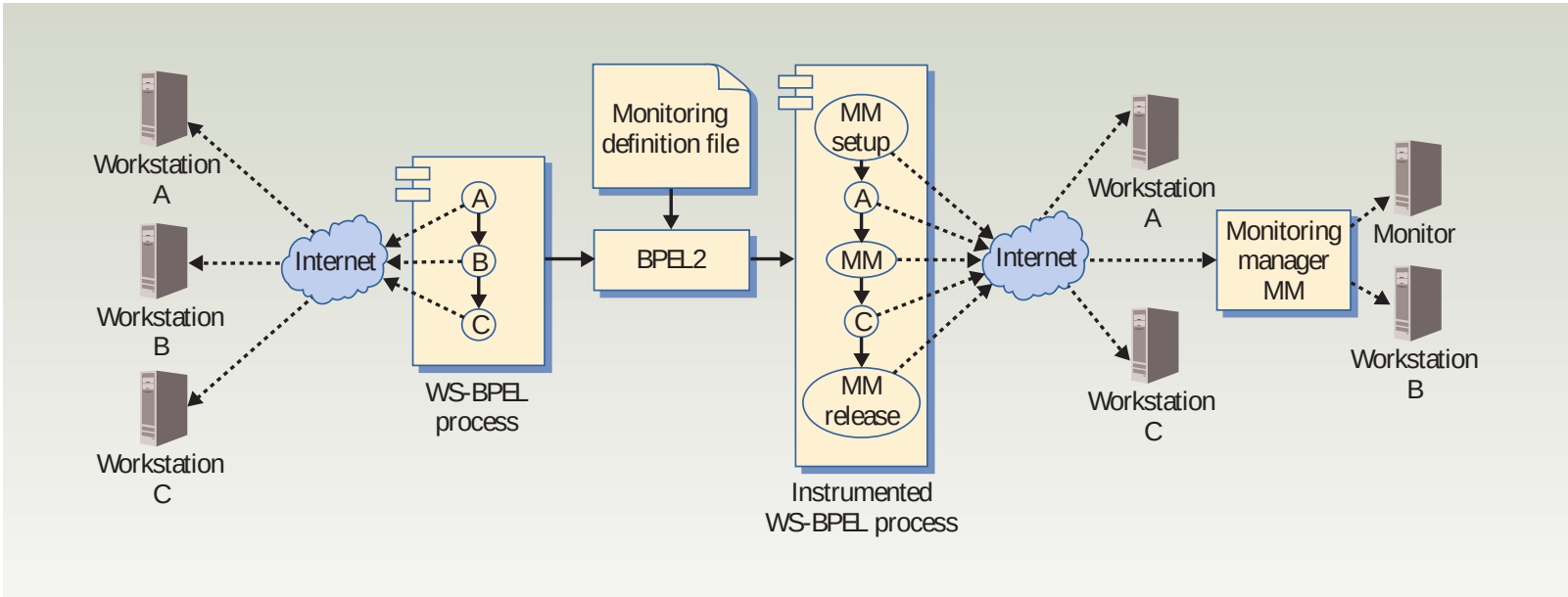
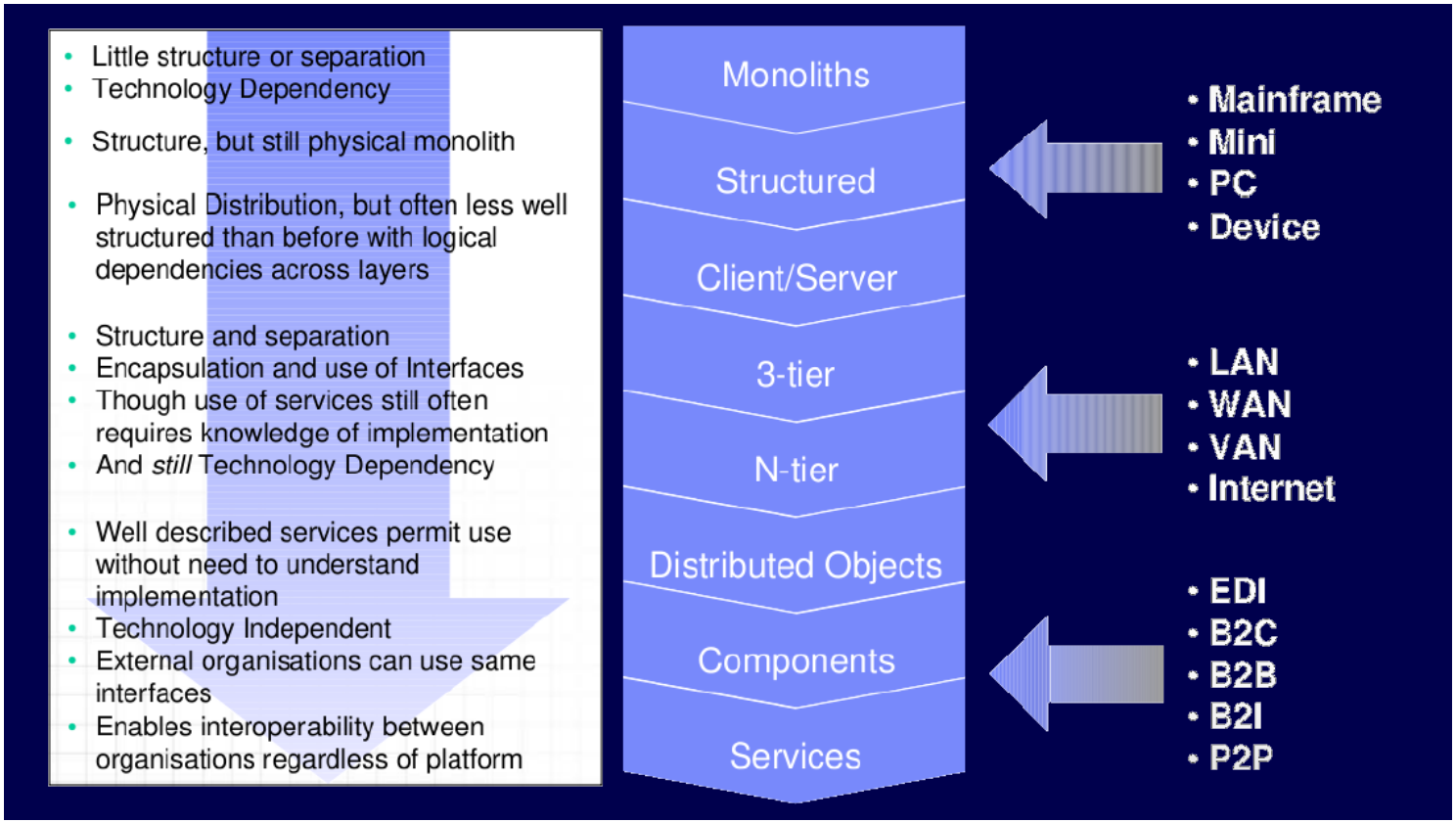


BPEL with instrumentation to add behavior

Baresi et al. (2006). Toward Open-World Software: Issues and Challenges.
doi.ieeecomputersociety.org/10.1109/MC.2006.362

Architectural Evolution



Architectural Evolution

Baresi et al. (2006). Toward Open-World Software: Issues and Challenges.
doi.ieeecomputersociety.org/10.1109/MC.2006.362

Architectural Evolution

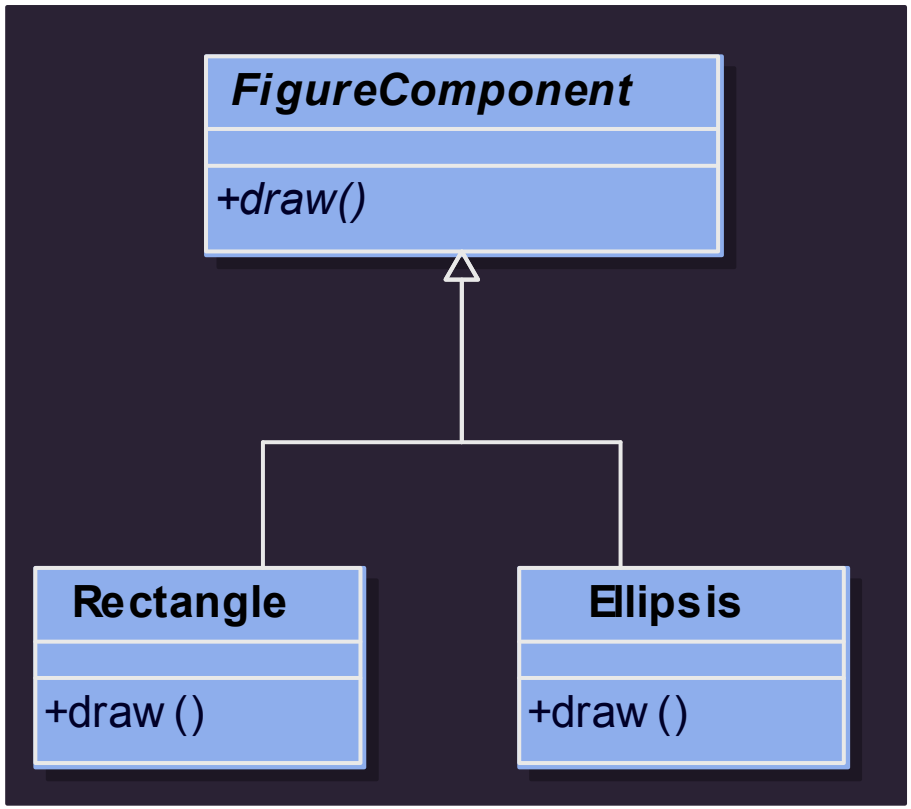
Question to Ponder:

- What is the most important: implementation or interface?

Question to Ponder:

- When is high dependency preferable?

Dynamic Calls



Overriding would be Completely Dynamic

Gamma et al. (1994). Design Patterns: Elements of Reusable Object-Oriented Software.
https://books.google.com.br/books?id=6oHuKQe3TjQC

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Service Oriented Architecture – SOA

- Architectural style recommended for developing software services;
- A "Service" according to SOA:
- Universal Description, Discovery and Integration (UDDI);
- 3 Degrees of Independence:

Sommerville (2015). Software Engineering, Tenth Edition.
https://www.pearson.com/us/higher-education/program/Sommerville-Software-Engineering-10th-Edition/PGM35255.html

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References

Service Oriented Architecture – SOA

- Architectural style recommended for developing software services;
- A "Service" according to SOA:
  - It logically represents a **business activity** with a specified outcome.
  - It is **self-contained**.
  - It is a **black box** for its consumers.
  - It may consist of other **underlying services**.
- Universal Description, Discovery and Integration (UDDI);
- 3 Degrees of Independence:

Open Group (2016). What is SOA?.
http://www.opengroup.org/soa/source-book/soa/soa.htm

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Service Oriented Architecture – SOA

- Architectural style recommended for developing software services;
- A "Service" according to SOA:
- Universal Description, Discovery and Integration (UDDI);
- 3 Degrees of Independence:
  - Platform;
  - Implementation;
  - Geographic.

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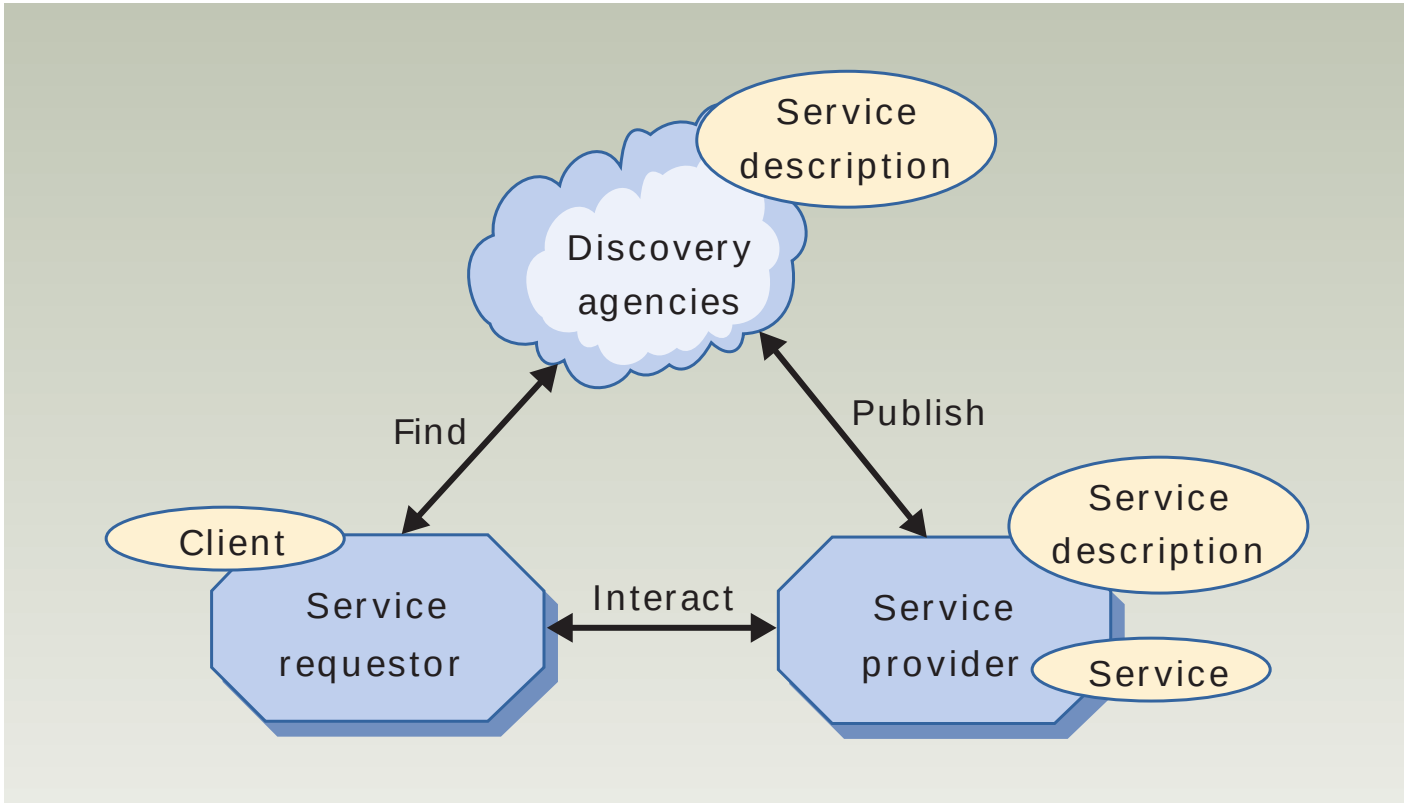

UDDI

Baresi et al. (2006). Toward Open-World Software: Issues and Challenges.
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Service Oriented Architecture – SOA

Description

Discover

Integrate

Merriam-Webster (2017). English Dictionary.
https://www.merriam-webster.com/dictionary/

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Description

1. a statement or account giving the characteristics of someone or something: a descriptive statement or account.

Discover

Integrate

Merriam-Webster (2017). English Dictionary.
https://www.merriam-webster.com/dictionary/

Service Oriented Architecture – SOA

Description

Discover

1. to make known or visible.

Integrate

Merriam-Webster (2017). English Dictionary.
https://www.merriam-webster.com/dictionary/

Service Oriented Architecture – SOA

Description

Discover

Integrate

1. to form, coordinate, or blend into a functioning or unified whole (unite);
2. to unite with something else;
3. to incorporate into a larger unit.

References

Merriam-Webster (2017). English Dictionary.
https://www.merriam-webster.com/dictionary/

Open Ended Process Models

Baresi et al. (2006). Toward Open-World Software: Issues and Challenges.
doi.ieeecomputersociety.org/10.1109/MC.2006.362

Open Ended Process Models

Question to Ponder:

- What is the difference between components and services?

Baresi et al. (2006). Toward Open-World Software: Issues and Challenges.
doi.ieeecomputersociety.org/10.1109/MC.2006.362

Open Ended Process Models

Question to Ponder:

- What is the difference between service oriented system and Service Oriented Architecture?

Baresi et al. (2006). Toward Open-World Software: Issues and Challenges.
doi.ieeecomputersociety.org/10.1109/MC.2006.362

Open Ended Process Models

Question to Ponder:

- What is the difference between SOA and SOAP?

Baresi et al. (2006). Toward Open-World Software: Issues and Challenges.
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Service Identification

- Three types of services should be identified:
  1. Utility Services: Generic behavior that are useful for varied systems;
  2. Business Services: Services that implement specific business activities;
  3. Coordination: Services that control a business process, often invoking other services.

Sommerville (2015). Software Engineering, Tenth Edition.
https://www.pearson.com/us/higher-education/program/Sommerville-Software-Engineering-10th-Edition/PGM35255.html

Service as Reusable Component

- Several techniques from Components are applicable:
  - Interface Design;
  - Interface Contracts;
  - Data Structures used for communication.

Sommerville (2015). Software Engineering, Tenth Edition.
https://www.pearson.com/us/higher-education/program/Sommerville-Software-Engineering-10th-Edition/PGM35255.html

Service Interface Design

Interface and Data Structure Specification

- How to call each service?
  - Create design models;
  - Select interfaces to be externalized;
  - Define data types to be transferred.

PIMServiceInterfaceTraditionalWS

+addContact(contact : Contact) : boolean
+retrieveContact(name : String) : Contact
+updateContact(contact : Contact, name : String) : boolean
+deleteContact(name : String) : boolean

Service Workflow Design I

Service Cooperation and Process Model

- How does the service invocations cooperate?
  - Create a process model with business activities;
  - Each business activity is implemented as a service;
  - Define contracts for each activity.
- Specify and Document Interfaces:
  - Write WSDL (SOAP) or WADL (REST);
  - Publish the interface for clients.

Service Workflow Design II

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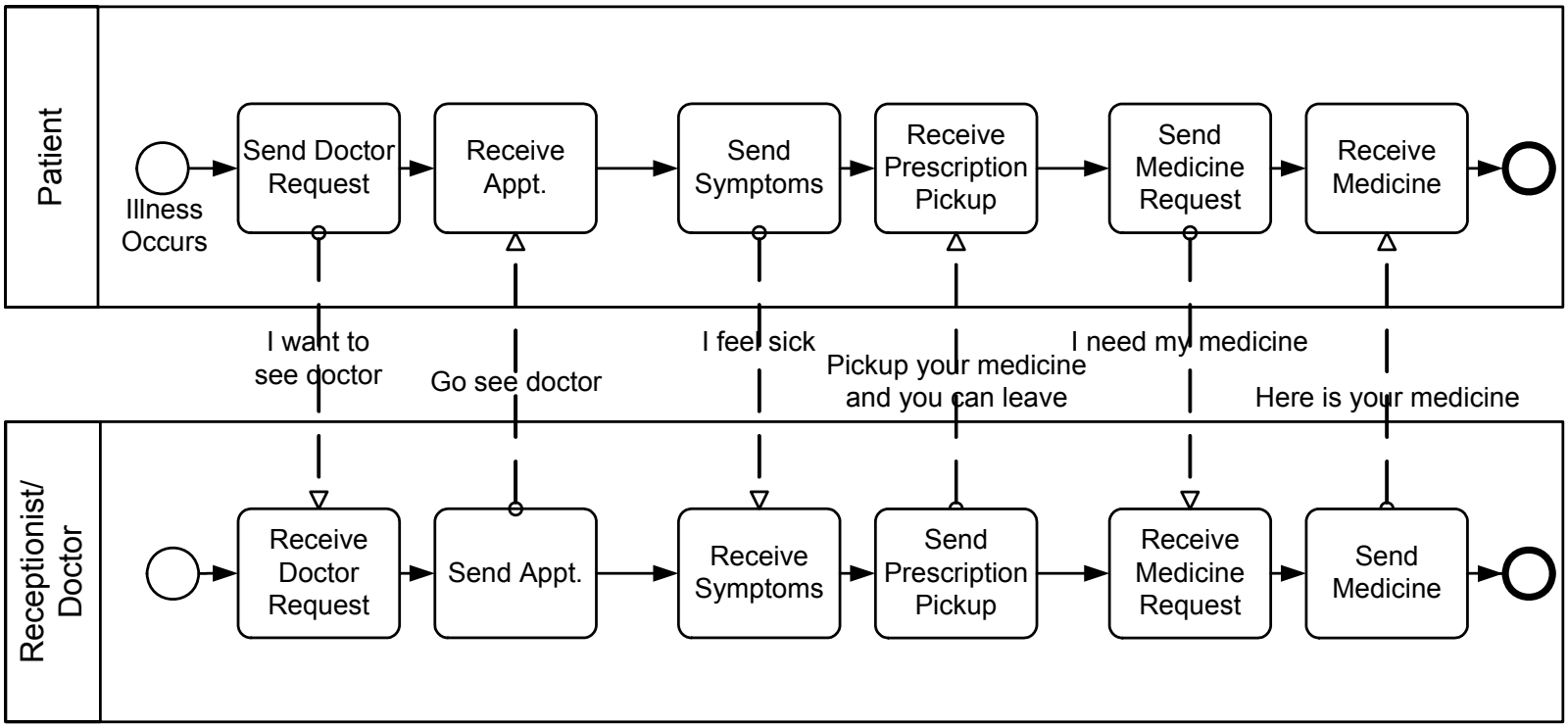

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Service Implementation

Service Coding

- Services may be written from scratch or by using frameworks;
- Frameworks are capable of following required standards;
- Some frameworks include compilers which parse and/or generate WSDL or WADL.

Sommerville (2015). Software Engineering, Tenth Edition.
https://www.pearson.com/us/higher-education/program/Sommerville-Software-Engineering-10th-Edition/PGM35255.html

Web Service Deployment

Web Services Installation/Deployment

- Web Services are often installed on top of Internet protocols, e.g.:
  - HTTP (Hypertext Transfer Protocol);
  - SMTP (Simple Mail Transfer Protocol);
  - XMPP (Extensible Message Passing Protocol).
- The server application may be standalone or run on top of a web server.

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https://www.pearson.com/us/higher-education/program/Sommerville-Software-Engineering-10th-Edition/PGM35255.html

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Web Services Installation/Deployment

- Web Services testing is an open issue;
- From the perspective of clients, it might be impossible to test all services;
- Different services providers might have different implementations for the same interface;
- Services might be changed dynamically.

Sommerville (2015). Software Engineering, Tenth Edition.
https://www.pearson.com/us/higher-education/program/Sommerville-Software-Engineering-10th-Edition/PGM35255.html

Development Sample

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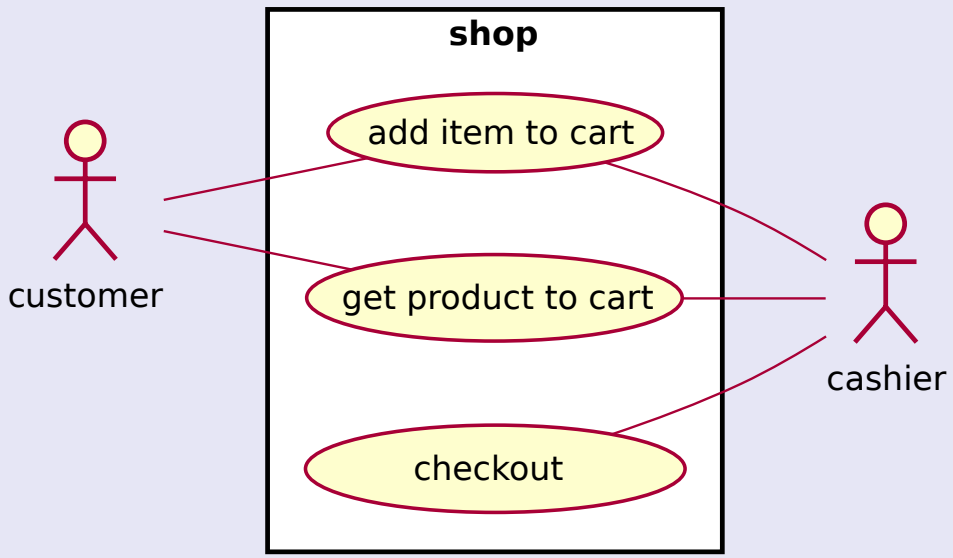
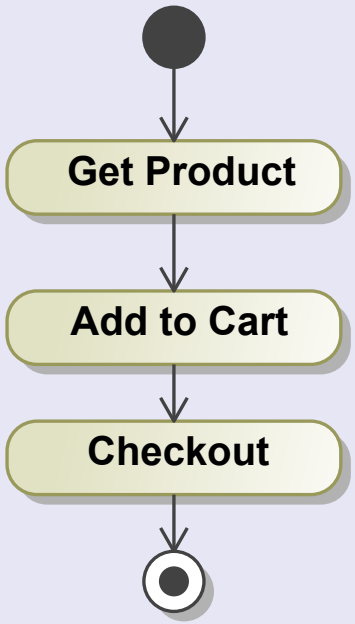
Use Case



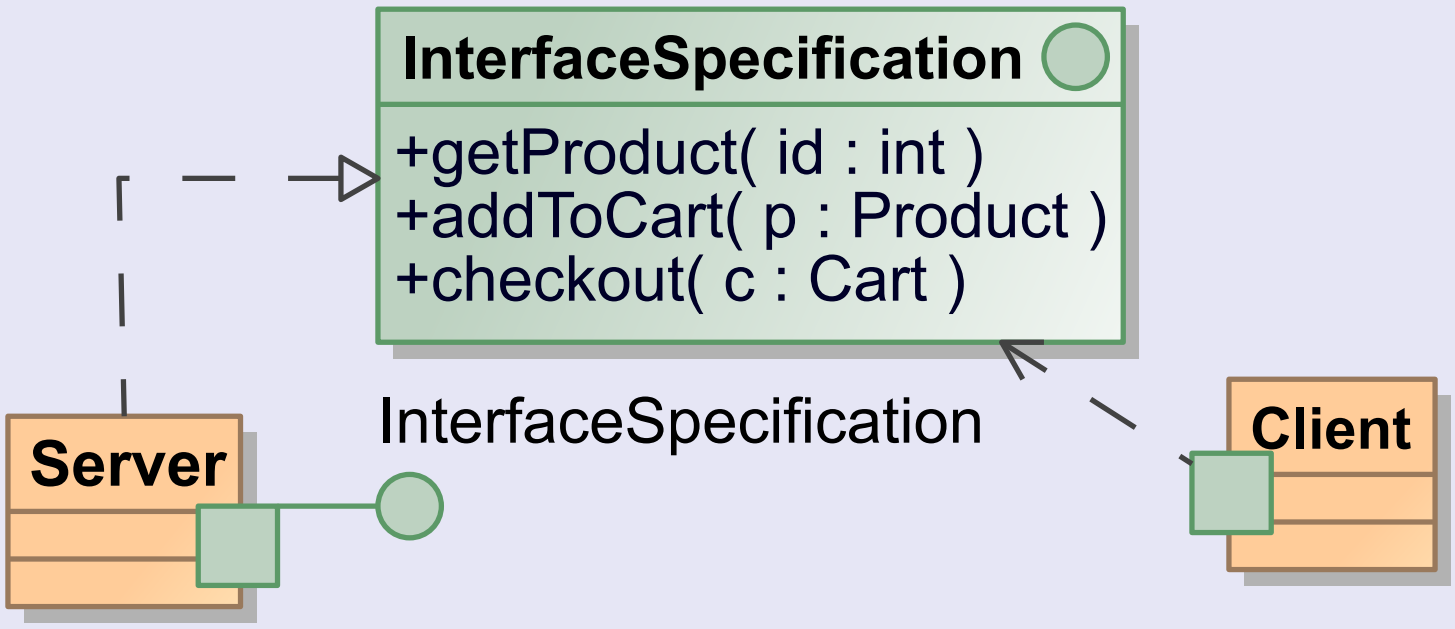
Development Sample

Use Case



Development Sample

Use Case



The End, for now...

Question to Ponder:

- Have you payed enough attention?

Thank You!

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