Software Platform

Lecture 2

Emanuele Di Buccio

01/03/2024

Master Degree in Computer Engineering, A.A. 2023/2024

In the previous lecture . . .

Previous lecture topics

- Definitions of **Software Platform**
- Software Engineering
- Software Processes, Paradigms and Architecture
- Patterns
- A scenario for supporting the adoption of Microservices

Previous lecture topics

https://app.wooclap.com/HHRZHD

Software platform

- “an operating environment upon which applications can execute and which provides reusable capabilities” [Bottcher, 2018]
- other systems the software interfaces with and make up the environment in which the software will execute [Sommerville, 2016]
- “a collection of services that help companies get their software running in front of their customers” [Salatino, 2023]
- “foundation of self-service APIs, tools, services, knowledge and support which are arranged as a compelling internal product” [Bottcher, 2018]

Monolith Architecture Advantages

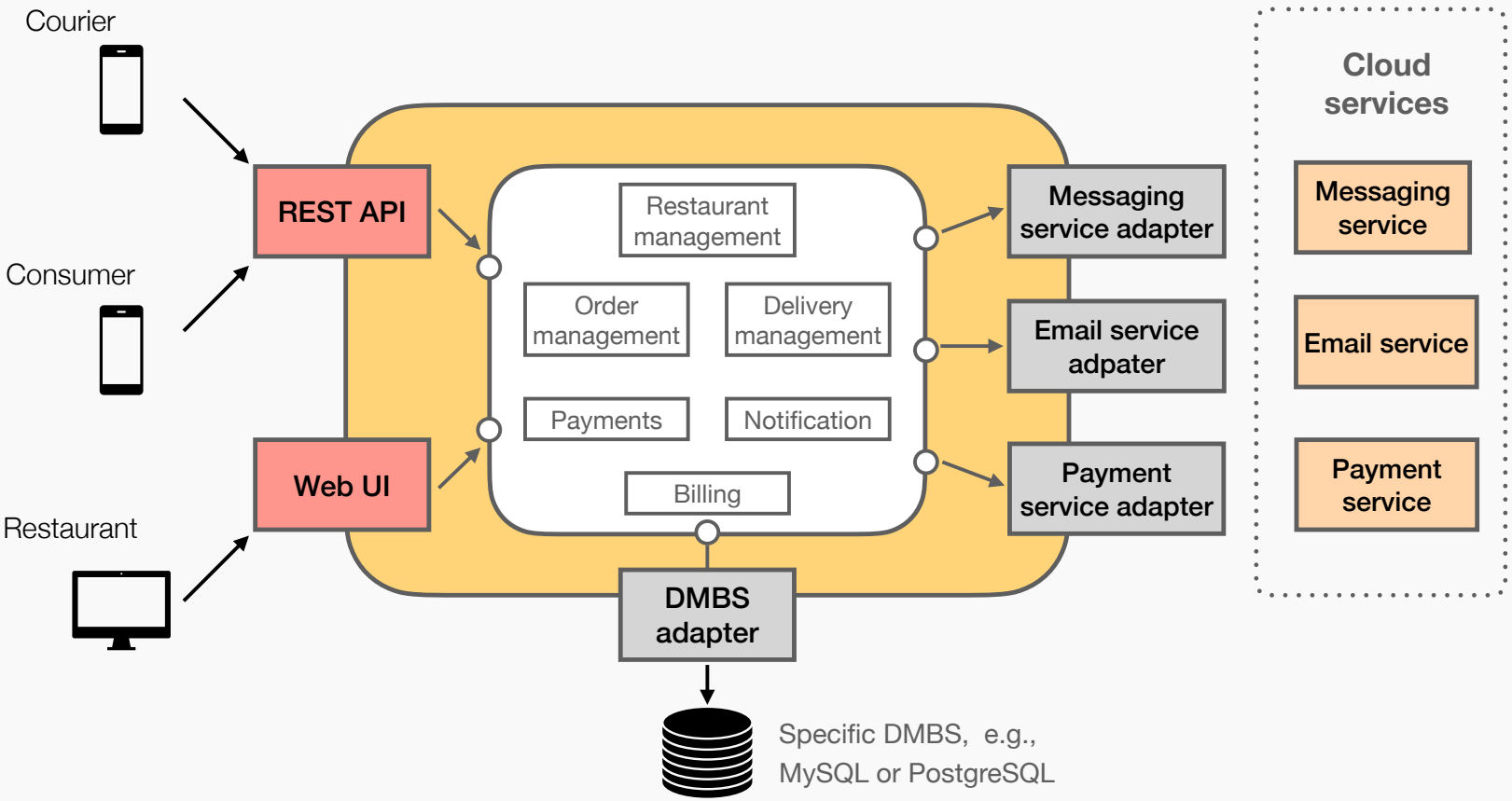
Should I stay always away from **monolithic** architectures? **No!**

Some **advantages**:

- “Simple” to develop
- Easy to make radical changes to the application
- Straightforward to test
- Straightforward to deploy
- Easy to scale

More on Course Topics

Why Microservices?



Based on Figure 1.1 from [Richardson, 2019], accessible here

What are microservices? (1)

Possible definition (by Adrian Cockcroft here)

- “Loosely coupled service-oriented architecture with bounded context”

Let us “unpack” it:

- Loosely coupled
- service-oriented architecture
- bounded context

What are microservices? (2)

- Loosely coupled
  - no need to update every service at the same time
- service-oriented architecture
  - “a specific type of distributed system framework that maintains agents that act as “software services,” performing well-defined operations” [Joseph et al., 2004]
  - note: we will discuss SOA vs Microservices
- bounded context
  - no need to know too much about the surrounding services
  - single function that does one thing and can be modified quite easily
  - understand easily downstream and upstream dependencies

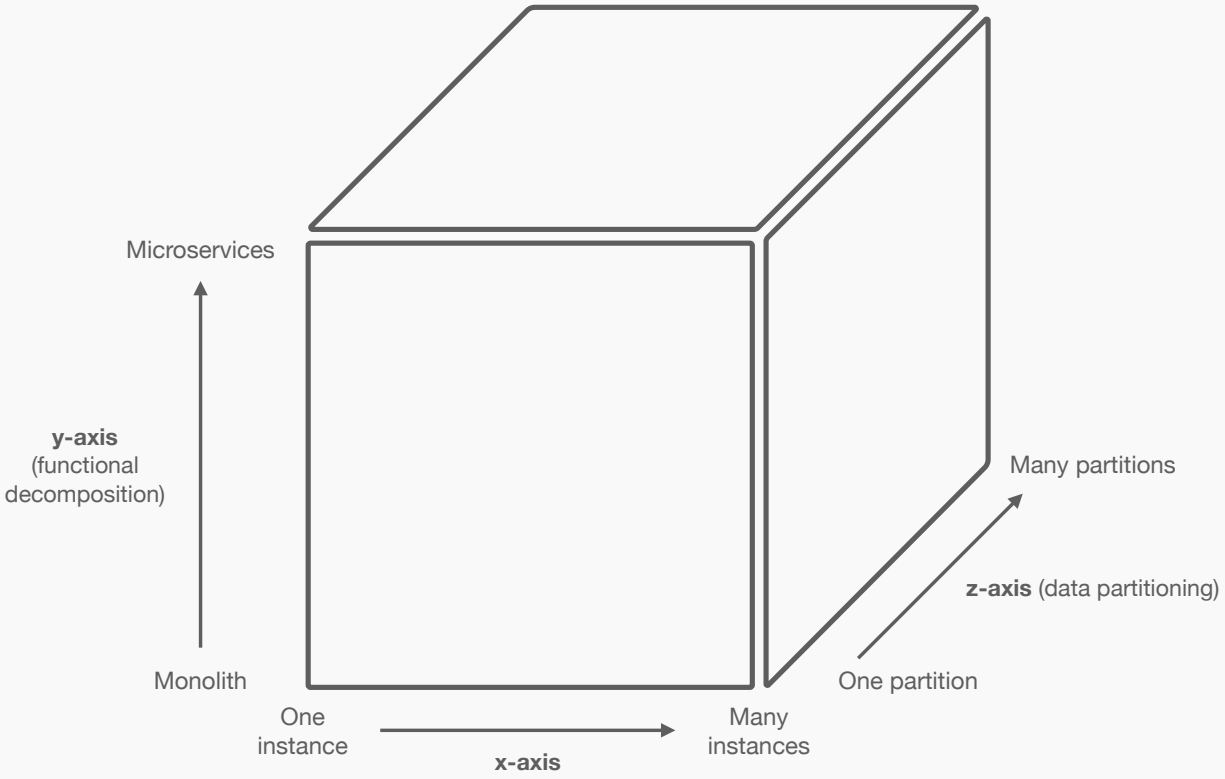
What are microservices? (3)

From [Tanenbaum and Steen, 2023]:

- Essential property that each microservice runs as a separate (network) process
- Does *micro* require service to be small? How small?
  $\Rightarrow$ no agreement on the size

What are microservices? (4)

- We will elaborate more on this definition as in [Richardson, 2019]
- the Scale Cube [Abbott and Fisher, 2009]



What are microservices? (5)

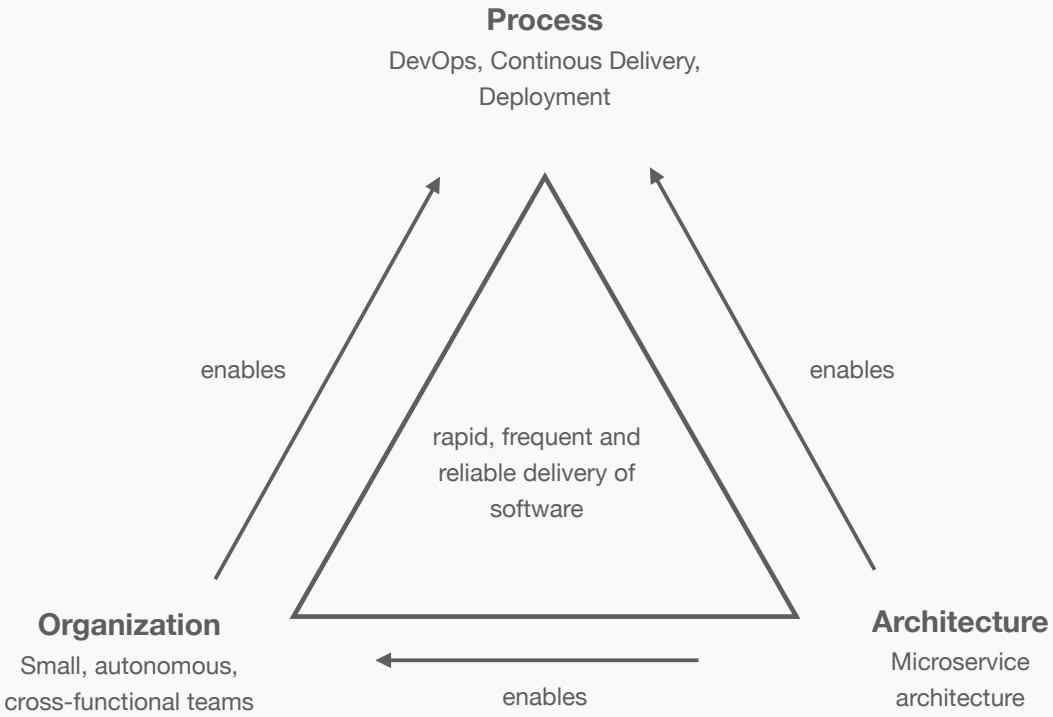
Microservices

- functional decomposition (y-axis), where the application is split in a set of **services**
- services as **unit of modularity**
- each service has **its own datastore**

Process and organization (1)

Is it just a matter of architecture? No! In addition to the architecture

- organization
- development and delivery



Java for Complex Software Platforms

- Main programming language of the course: Java
- A framework that can help in developing software platforms: Spring
- What is Spring?
  - open-source application framework
  - original form introduced in [Johnson, 2003]; history here
  - provides several modules for a range of services
  - “offers a container [. . .] that creates and manages application components. These components [. . .] are wired together inside [the container] to make a complete application, much like bricks, mortar, timber, nails, plumbing, and wiring are bound together to make a house.” [Walls, 2022]

Cloud Computing (1)

From IBM article "What is Cloud Computing?"

> *Cloud computing is* **on-demand access**, *via the internet,* **to computing resources** – *applications, servers (physical servers and virtual servers), data storage, development tools, networking capabilities, and more* – **hosted at a remote data center managed by a cloud services provider** *(or CSP). The CSP makes these resources available for a monthly subscription fee or bills them according to usage.*

Cloud Computing (2)

What is cloud computing? [Tanenbaum and Steen, 2023]

- organizations running data centers opening up their resources to customers $\rightarrow$ **utility computing**
  - customer could upload tasks to a data center and be charged on a per-resource basis
  - basis for cloud computing
- **cloud computing**
  - characterized by easily usable and accessible pool or *virtualized* resources
  - *dynamic configuration* of which and how resources are used
  - need to scale? acquire more resources!
  - generally cloud computing based on a *pay-per-use* model

Cloud Computing (3)

Cloud organized in four layers:

- Hardware
  - processors, routers, power and cooling systems
- Infrastructure
  - virtual storage and computing resources
- Platform
  - vendor-specific API
  - includes calls to upload and execute a program in the vendor's cloud
  - higher-level abstractions, e.g., Amazon S3 for storage
- Application
  - *examples*: applications found in office suites

Cloud Computing (4)

Services offered through various interfaces:

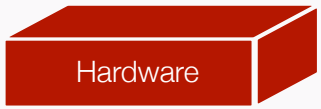
Type of service	Resource managed at the layer		Examples
Software as a Service (SaaS)		Web services, multimedia, business app	Google docs, Gmail, Flickr
Platform as a Service (PaaS)		Software framework (Java), Storage (databases)	MS Azure, Google App engine
Infrastructure as a Service (IaaS)		Computation (VM), storage (block, file)	Amazon S3, Amazon EC2
		CPU, memory, disk, bandwidth	Datacenters

Image adapted from [Zhang et al., 2010] and [Tanenbaum and Steen, 2023]

Cloud Computing (5)

Serverless and Function-as-as-Service (FaaS)

- “In serverless, the cloud provider manages the provisioning of resources for a service in a transparent, auto-scaling manner, without the developer in the loop” [Shahrad et al., 2019]
- “[FaaS] is a way to scale the execution of simple, standalone, developer-written functions, where state is not kept across function invocations” [Shahrad et al., 2019]

Cloud Computing (6)

Possible benefits (from “What is Cloud Computing?”)

- Lower IT costs
- Improve agility and time-to-value
- Scale more easily and cost-effectively

Software Engineering

Software Processes and Paradigms

Software processes

- “A software process is a set of related activities that leads to the production of a software system” [Sommerville, 2016]
- “A *process* is a collection of activities, actions, and tasks that are performed when some work product is to be created” [Pressman, 2009]
- Real software processes are interleaved sequences of diverse activities:
  - technical
  - collaborative
  - managerial

Process Activities

Fundamental activities is a software process [Sommerville, 2016]

1. Software specification
   → definition of software functionality and constraints
2. Software development
   → software to meet the specification is designed and programmed
3. Software validation
   → ensure that the software is what the customer requires
4. Software evolution
   → changes software to reflect changing customer and market requirements

Process Activities - Software specification (1)

Software specification

- process of
  - understanding and defining what services are required from the system
  - identifying the constraints on the system's operation and development
- mistakes made at this stage inevitably lead to later problems in subsequent stages

Process Activities - Software specification (2)

- May be preceded by feasibility or marketing study to assess
  - whether or not there is a need or a market for the software
  - whether or not it is technically and financially realistic to develop the software required
- Result of the activity: an **agreed requirements document** that specifies a system satisfying stakeholder requirements
- What is a stakeholder?
  - every person or group that will be affected by the system

Process Activities - Software specification (3)

- Requirements:
  - descriptions of the services that a system should provide
  - constraints on its operation
- Requirement Engineering:
  - finding out
  - analyzing
  - documenting
  - checking

  services and constraints

Process Activities - Software specification (4)

Possible classification of requirements

- functional requirements
- non-functional requirements

Process Activities - Software specification (5)

Functional requirements

- statements of services the system should provide
- how the system should react to particular inputs
- how the system should behave in particular situations

Process Activities - Software specification (6)

Non-functional requirements

- constraints on the services or functions offered by the system
- timing constraints
- constraints on the development process
- constraints imposed by standards

Process Activities - Software specification (7)

Main activities in software specification:

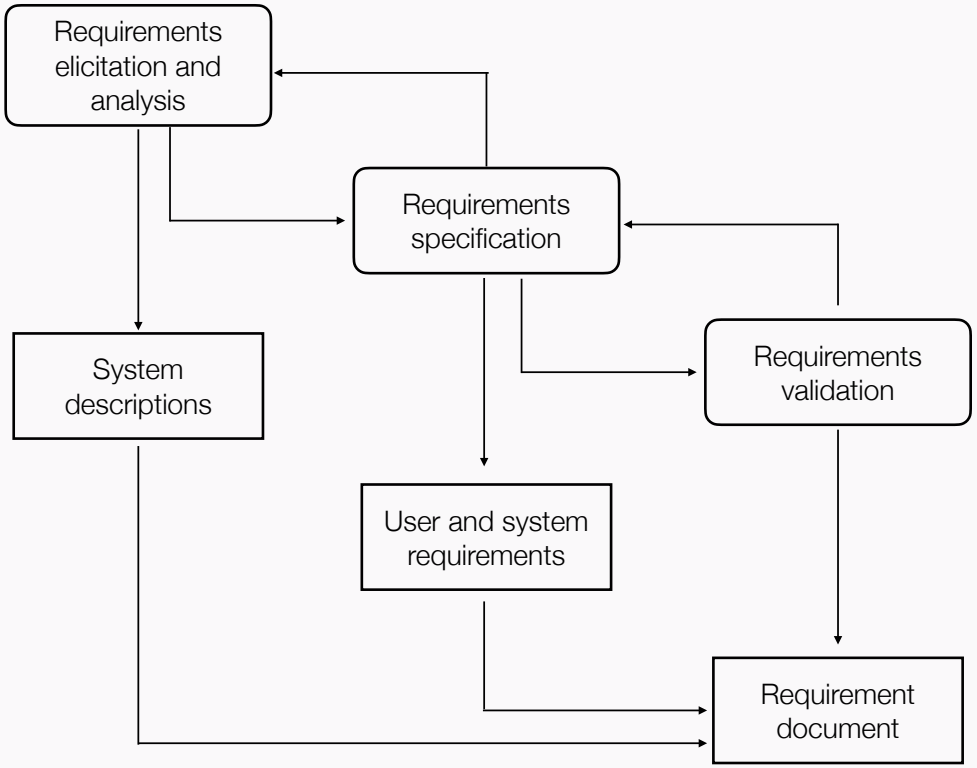


Figure from [Sommerville, 2016]

Process Activities - Software specification (8)

Main activities in software specification:

1. **Requirement elicitation and analysis**
   - observation of existing systems
   - discussions with potential users
   - task analysis
   - development of one or more system models and prototypes
2. **Requirement specification**
   - user requirements (high-level description for customer/end-user)
   - system requirements (a more detailed description)
3. **Requirement validation**
   - checking requirements for realism, consistency, and completeness
   - fix error in the requirement document, if any

Process Activities - Software design and implementation (1)

- **Goal**: developing an executable system for delivery to the customer
- may include two separate activities:
  - design
  - implementation
- **software design**: description of
  - structure of the software
  - data models and structures used by the system
  - interfaces between system components
  - (sometimes) algorithms used

Process Activities - Software design and implementation (2)

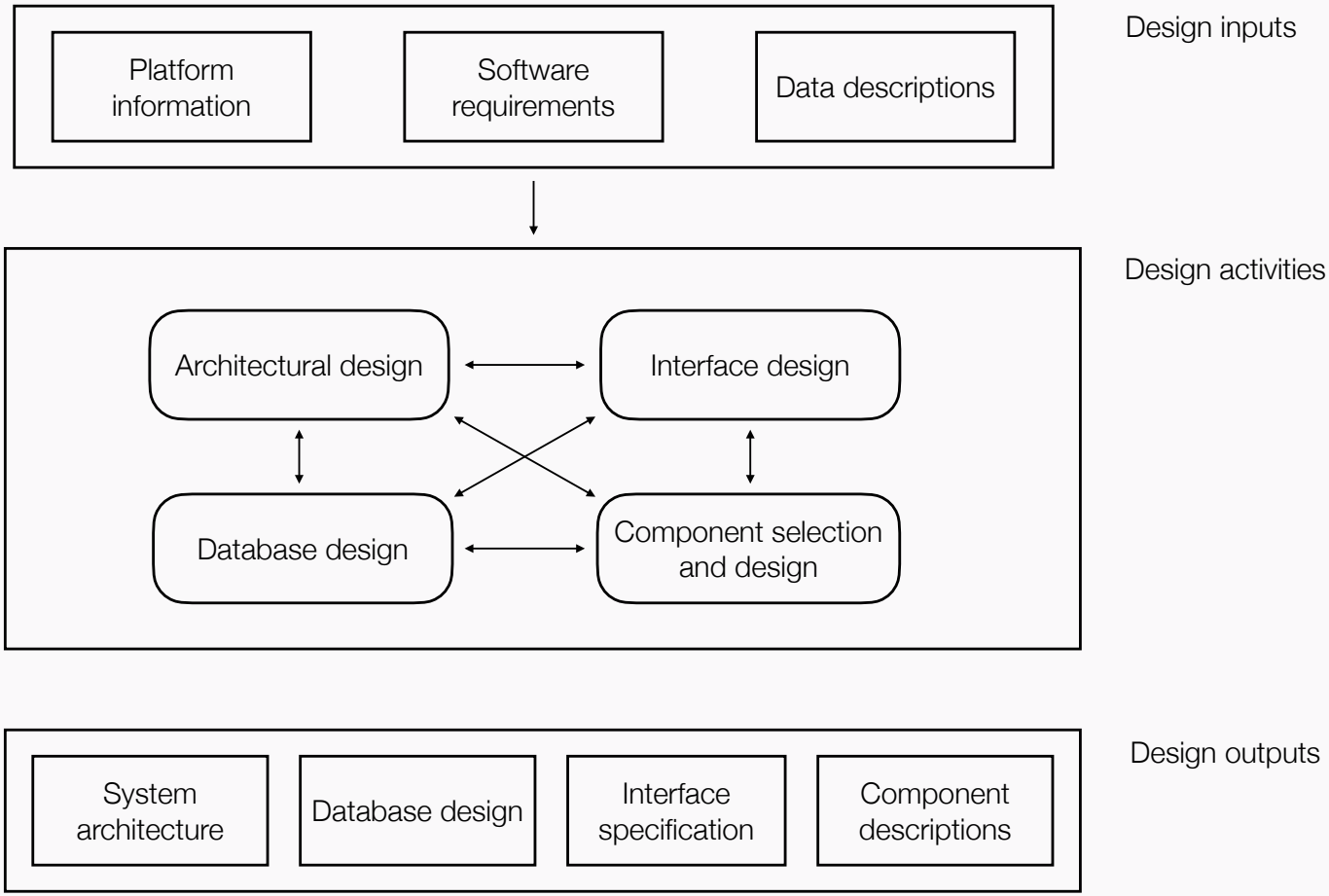


Figure from [Sommerville, 2016]

Process Activities - Software design and implementation (3)

- Architectural design
  - overall structure of the system
  - principal components (subsystems/modules)
  - components relationships and distribution
- Database design
  - system data structures and their representation in a database
- Interface design
  - interfaces (non-ambiguous) between system components
  - (then) components can be separately designed and developed
- Component selection and design
  - search for reusable components (list of changes, if necessary)
  - design new software components

Process Activities - Software design and implementation (4)

Design outputs:

- detailed design documents (for critical systems)
- design diagrams (for a model-driven approach)
- outputs represented in the code (agile methods)

Process activities: Software validation (1)

Software Verification and Validation (V & V)

- **goal**: show that a system both conforms to its specification and meets the expectations of the system customer
- principal validation technique: program testing with simulated data
- may involve checking processes, such as **inspections** and **reviews**

Process activities: Software validation (2)

Testing process stages

1. **Component testing**
   - components: simple entities (e.g., functions or object classes) or coherent groupings of entities
   - components tested independently by developers
2. **System testing**
   - components are integrated to create a complete system
   - may reveal errors from unanticipated interactions between components and component interface problems
   - (sometimes) multistage process: components integrated to form subsystems, individually tested and then integrated
3. **Customer testing**
   - final stage before the system is accepted for operational use
   - tested by the customer with real data

Process activities: Software validation (3)

- Normally, component testing is part of the development process
  - programmers make up their own test data
  - programmers incrementally test the code as it is developed
- Why programmers?
  - knows the component
  - (therefore) is the best person to generate test cases

Process activities: Software evolution (1)

- Flexibility of software (when compared to hardware)
- Historically, a split between the process of software development and the process of software evolution
- distinction increasingly irrelevant

$\Rightarrow$ software engineering as an evolutionary process

More on Software processes (1)

Description of a process must include:

1. **people involved in the process**
   - specification of the roles, and therefore of the responsibilities
   - *examples*: project manager, configuration manager, and programmer

2. **products or deliverables**
   - outcomes are not only software
   - *example*: architectural design $\Rightarrow$ software architecture model

3. **conditions** affecting the sequence of activities:
   - *pre-conditions*, e.g., approval of the requirements by the consumer before architecture design
   - *post-conditions*, e.g., update, if necessary, of the models describing the architecture

More on Software processes (2)

In professional software development **planning** is an inherent part of all processes.

Possible categorization:

- **Plan-driven** processes
  - all the process activities are planned in advance
  - progress **measured** against the plan
- **Agile** processes
  - **incremental** and continual planning
  - easier to change the process to reflect changing requirements

Note: can be a compromise between the two

Process Paradigms

- General process models
- High-level, abstract descriptions of software processes
- Process frameworks that may be extended/adapted to create more specific software engineering processes
- Also called **Software Development Life Cycle models**
- Examples:
  - Waterfall model
  - Incremental development
  - Integration and configuration

References

References (1)


Abbott, M. L. and Fisher, M. T. (2009).

The Art of Scalability: Scalable Web Architecture, Processes, and Organizations for the Modern Enterprise.

Addison-Wesley Professional, 1st edition.


Bottcher, E. (2018).

What i talk about when i talk about platforms.

https://martinfowler.com/articles/talk-about-platforms.html.


Johnson, R. (2003).

Expert One-on-one J2EE Design and Development.

Wiley & Sons, erste edition.

References (2)

Joseph, J., Ernest, M., and Fellenstein, C. (2004).

Evolution of grid computing architecture and grid adoption models.

IBM Systems journal, 43(4):624–645.

Pressman, R. (2009).

Software Engineering: A Practitioner's Approach.

McGraw-Hill, Inc., USA, 7 edition.

Richardson, C. (2019).

Microservices Patterns: With examples in Java.

Manning.

References (3)


Salatino, M. (2023).

Platform Engineering on Kubernetes.

Manning.


Shahrad, M., Balkind, J., and Wentzlaff, D. (2019).

Architectural implications of function-as-a-service computing.

pages 1063–1075. ACM.


Sommerville, I. (2016).

Software Engineering.

Pearson, 10th - global edition edition.


Tanenbaum, A. S. and Steen, M. v. (2023).

"Distributed Systems (4th edition).

Maarten van Steen.

References (4)

Walls, C. (2022).

***Spring in Action, Sixth Edition*.**

Manning.

Zhang, Q., Cheng, L., and Boutaba, R. (2010).

Cloud computing: state-of-the-art and research challenges.

Journal of Internet Services and Applications, 1(1):7–18.

Questions?