Software Engineering

The Software Process

SoftEng
http://softeng.polito.it

Version 2.0

Outline

- Activities
  - Production (requirements, design, implementation), verification, management
- Phases
  - Development, operation, maintenance
- Comparison with traditional engineering
- System and Software process
- SE approaches
- Recent trends

Software Engineering

Process
People
Tools
Techniques

Requirements

Software functions

Activities

Goal

Produce software

- documents, data, code

with defined, predictable process properties

- cost, duration

and product properties

- functionality, reliability, ..

How to achieve the goal?

Bottom Up

- We need the final thing
  - Executable code
- But we do not write the executable
  - We write the source code

Bottom Up - Code

- But the source code is large
  - Several physical units
    - Files and directories
  - Several logical units
    - Functions
    - classes
    - Packages
    - Subsystems
- So, which units? How do we define and organize them?

Bottom Up - Design

- But exactly, what the software should do?
  - Add numbers
  - Count cars
  - Forecast the weather
  - Control a cell phone
  - Support the administration of a company

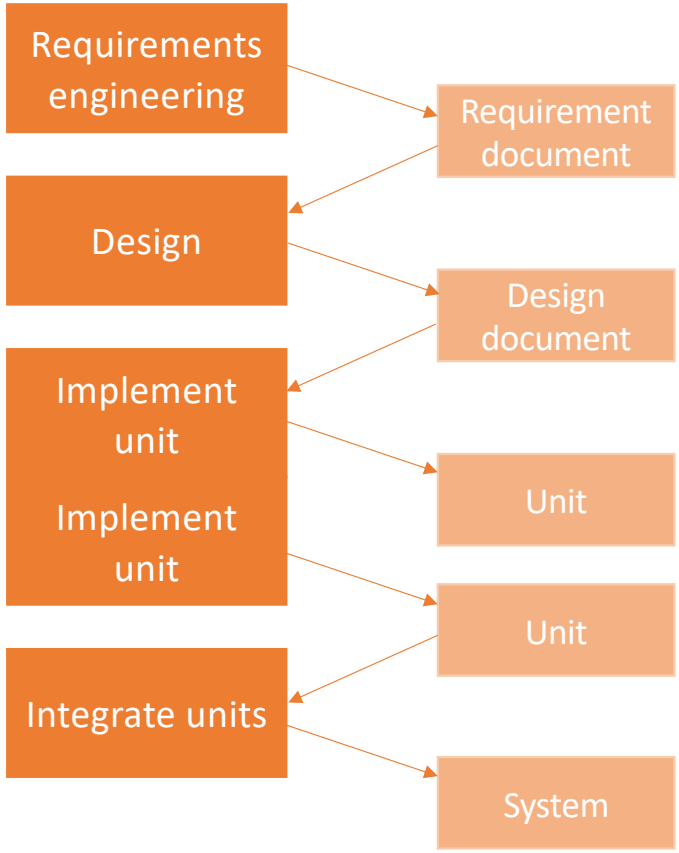
The Production activities

- Requirement engineering
  - What the software should do
- Architecture and design
  - Which units and how organized
- Implementation
  - Write source code, (executable code)
- Integrate units

The Production activities

- Logically, each activity depends on the previous one(s)
  - To design, one must know the requirements
  - To implement, one must know the design and the requirements
- First approach is to do these activities in sequence
  - See waterfall model later
- In practice feedbacks and recycles must be provided
- Requirements and design are written down in documents

The Production activities



The Production activities

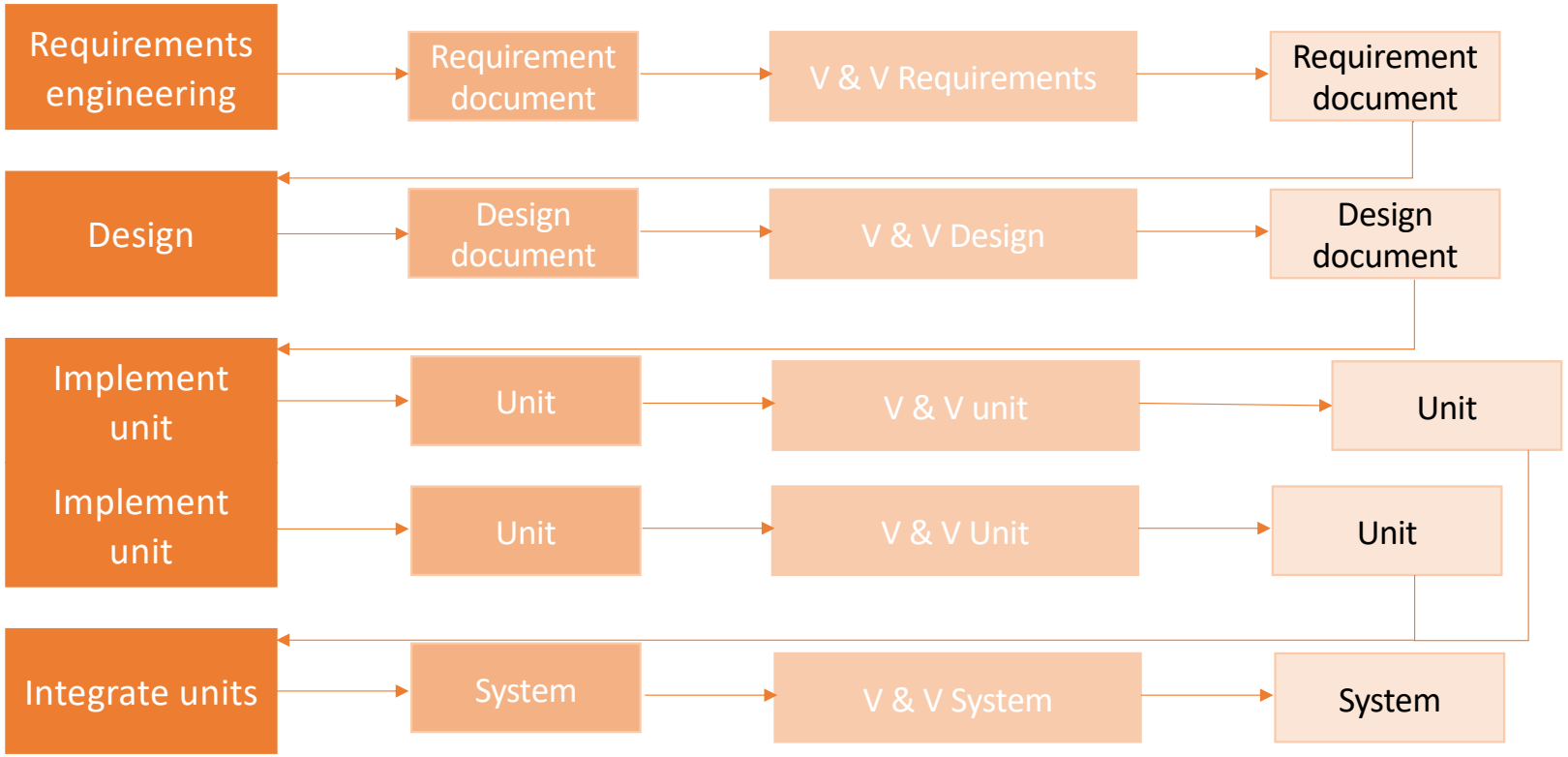
- Ok, we did it
  - Does it work?
  - Is it doing what it should do?

- Or
  - Did we understand the requirements correctly?
  - Did we implement the requirements correctly?

The Validation & Verification activities

- These activities are usually called V & V activities
- Control that the requirements are correct
  - Externally: did we understand what the customer/user wants?
  - Internally: is the document consistent?
- Control that the design is correct
  - Externally: is the design capable of supporting the requirements
  - Internally: is the design consistent?
- Control that the code is correct
  - Externally: is the code capable of supporting the requirements and the design?
  - Internally: is the code consistent (syntactic checks)

Production + V & V activities



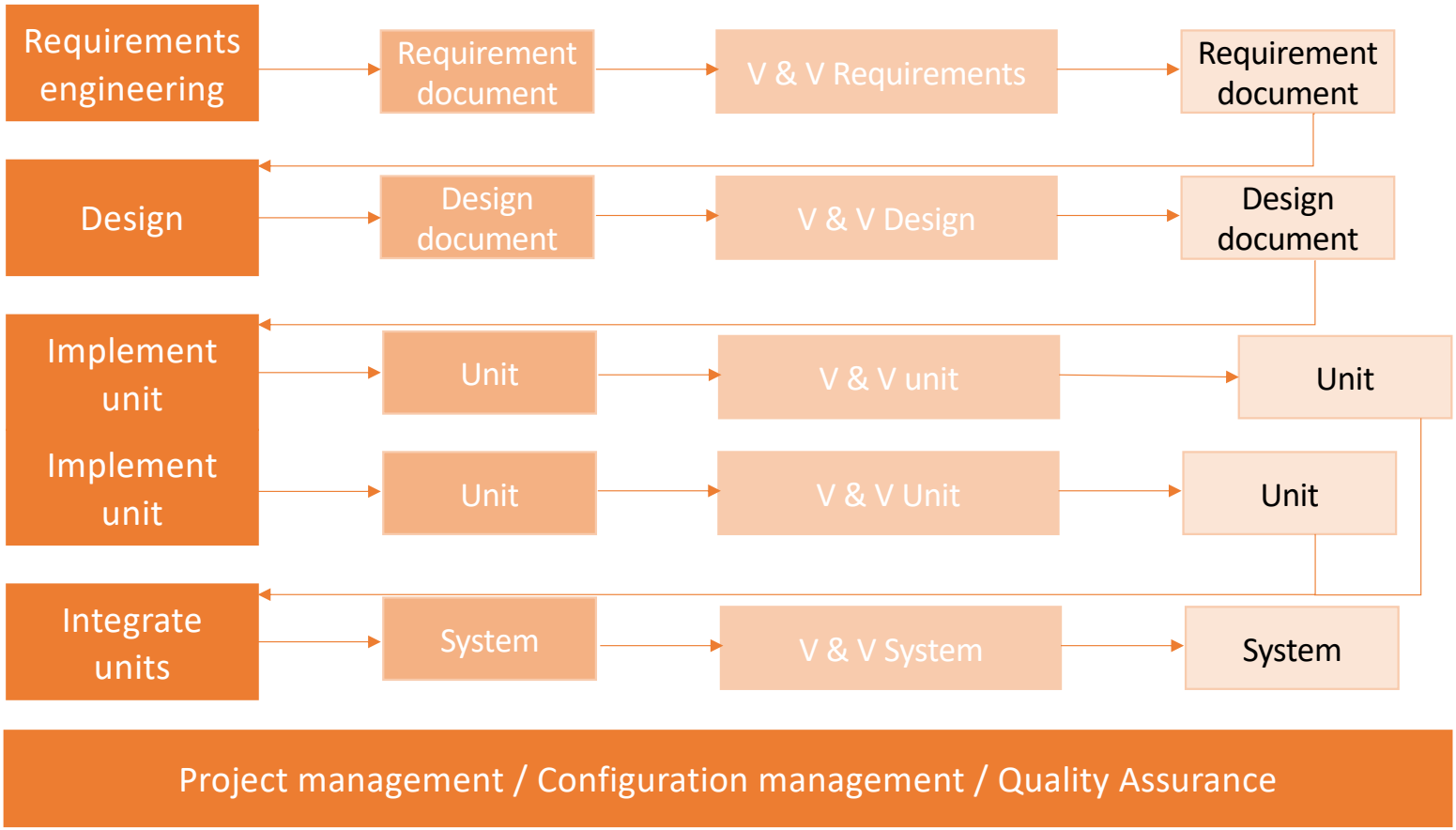
Production + V & V activities

- Well, seems a lot of work
  - Who does what, when?
  - With what resources?
  - How much will it cost, when will we finish?
  - Where are the documents and units? Who can modify what?
  - Are we doing it state of the art?

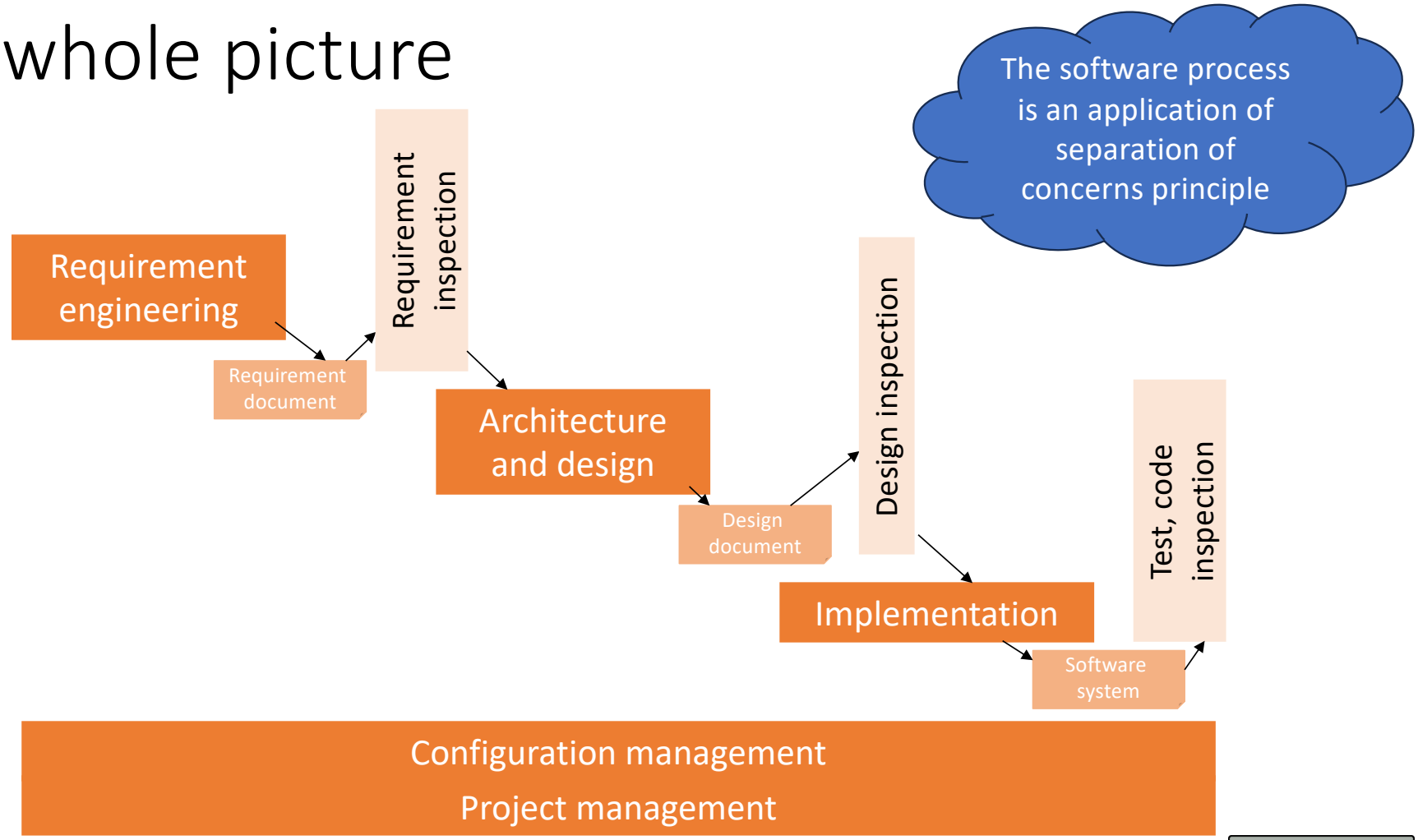
The management activities

- Project management
  - Assign work and monitor progress
  - Estimate and control budget
- Configuration management
  - Identify, store documents and units
  - Keep track of relationships and history
- Quality assurance
  - Define quality goals
  - Define how work will be done
  - Control results

The whole picture



The whole picture

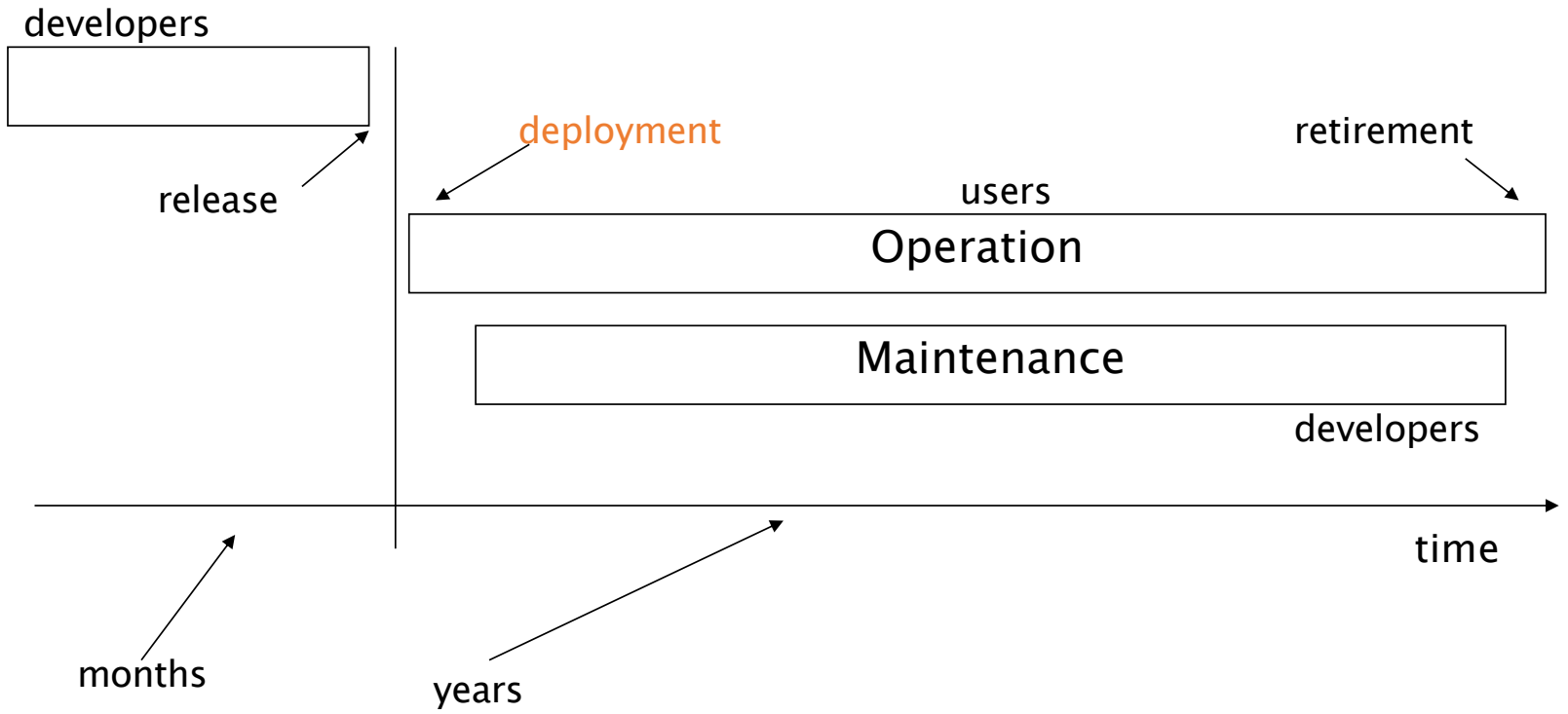


Phases

Beyond the code development

- Development is only the first part of the game
  - Operate the software
    - Deployment, operation
  - Modify the software
    - Maintenance
  - End up
    - retirement

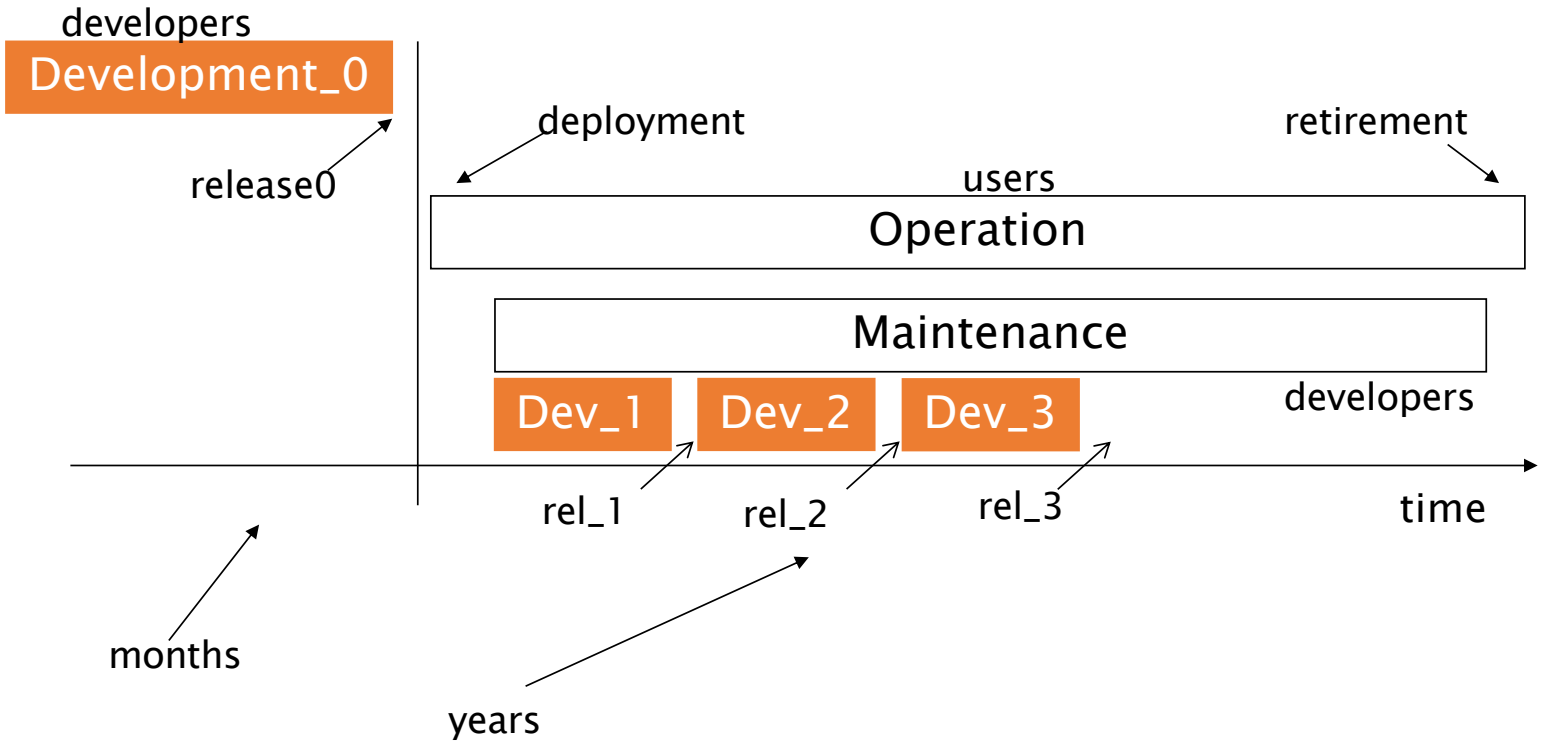
The main phases



Maintenance

- Can be seen as a sequence of developments
- First development usually longer
- Next developments constrained by previous ones and related choices
  - If dev_0 chooses Java, next developments are in Java
  - If dev_0 chooses client server model, next developments keep C/S

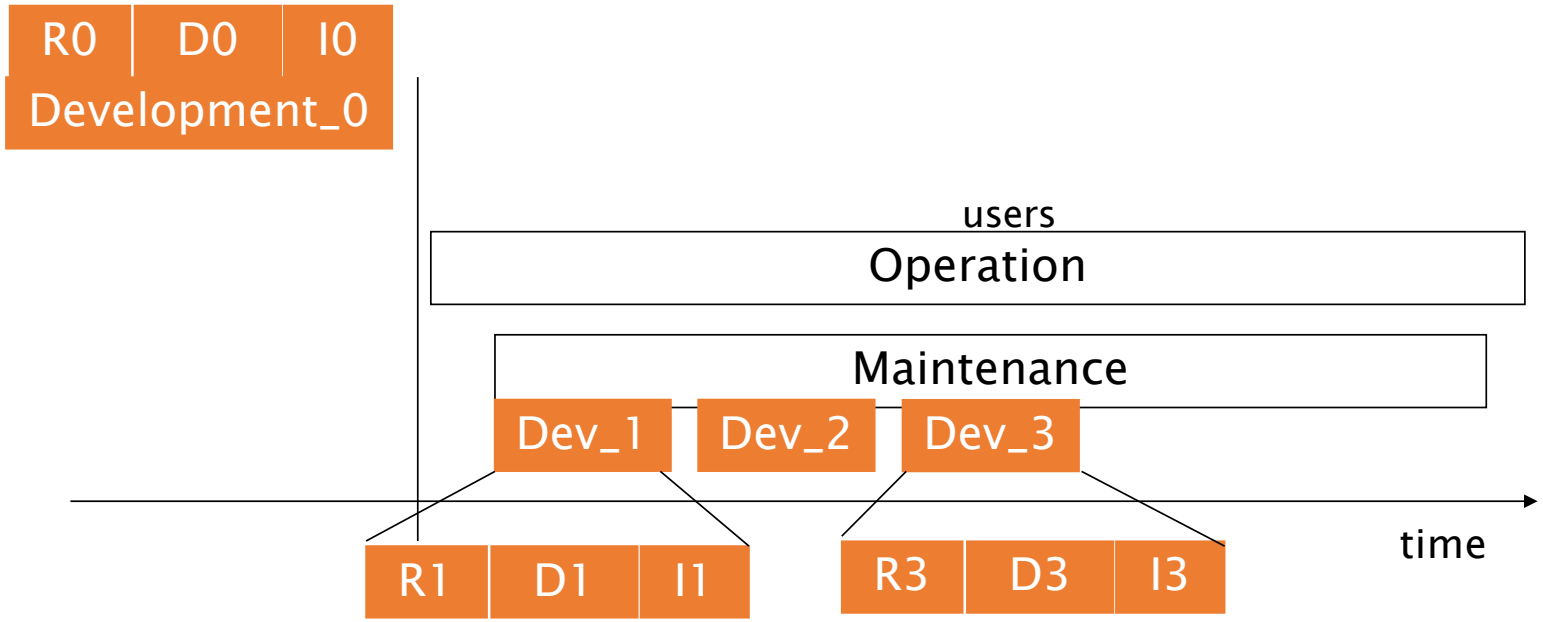
Maintenance



Maintenance

- Development and maintenance do the same activities (requirement, design, etc)
  - But in maintenance an activity is constrained by what has been done before
  - After years, the constraints are so many that changes become impossible

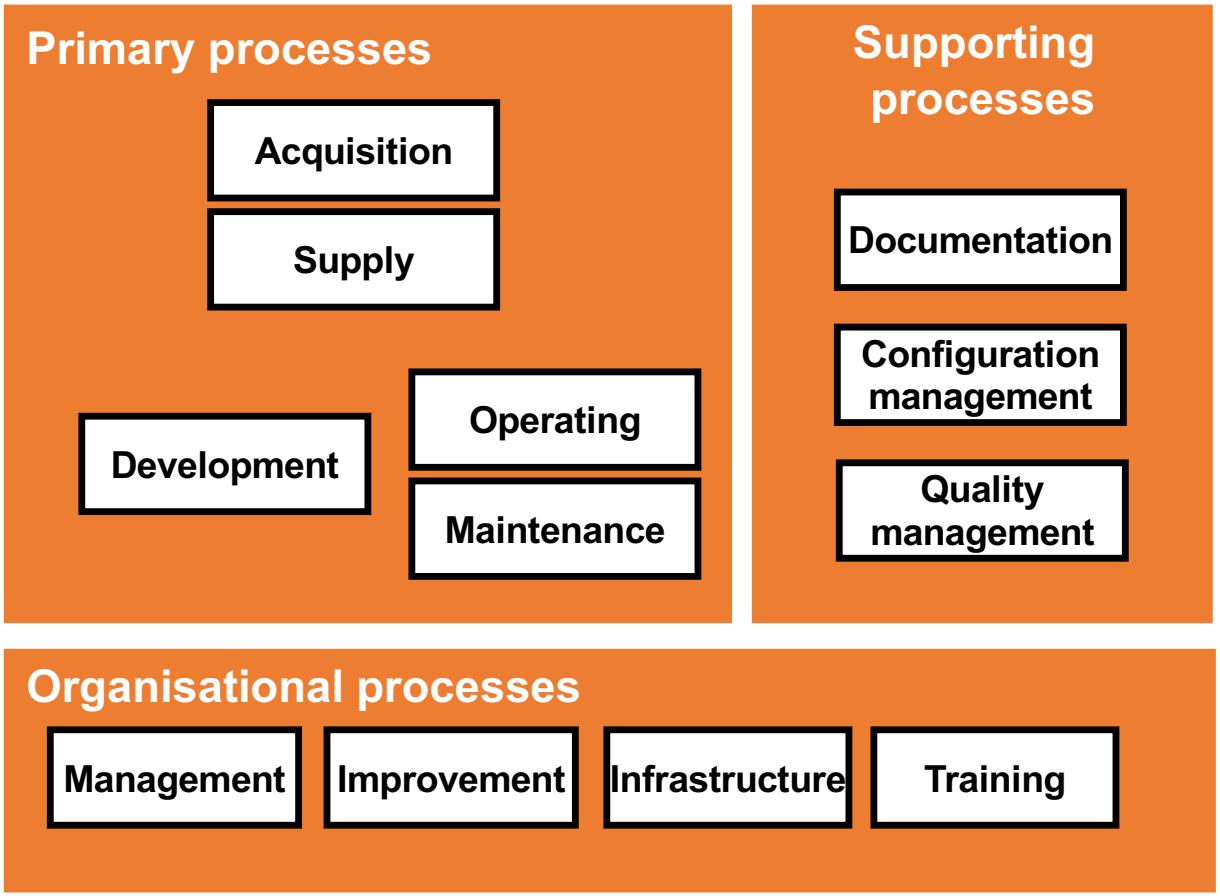
Maintenance



Maintenance

- Development_0
  - Req_0 developed from scratch
  - Design_0 developed from req_0
  - Impl_0 developed from design_0
- Development_1
  - Req_1 from Req_0 (and Des_0, Impl_0)
  - Des_1 from Req_1
  - Impl_1 from Des_1

ISO / IEC 12207



Scenarios in dev / maintenance / operation

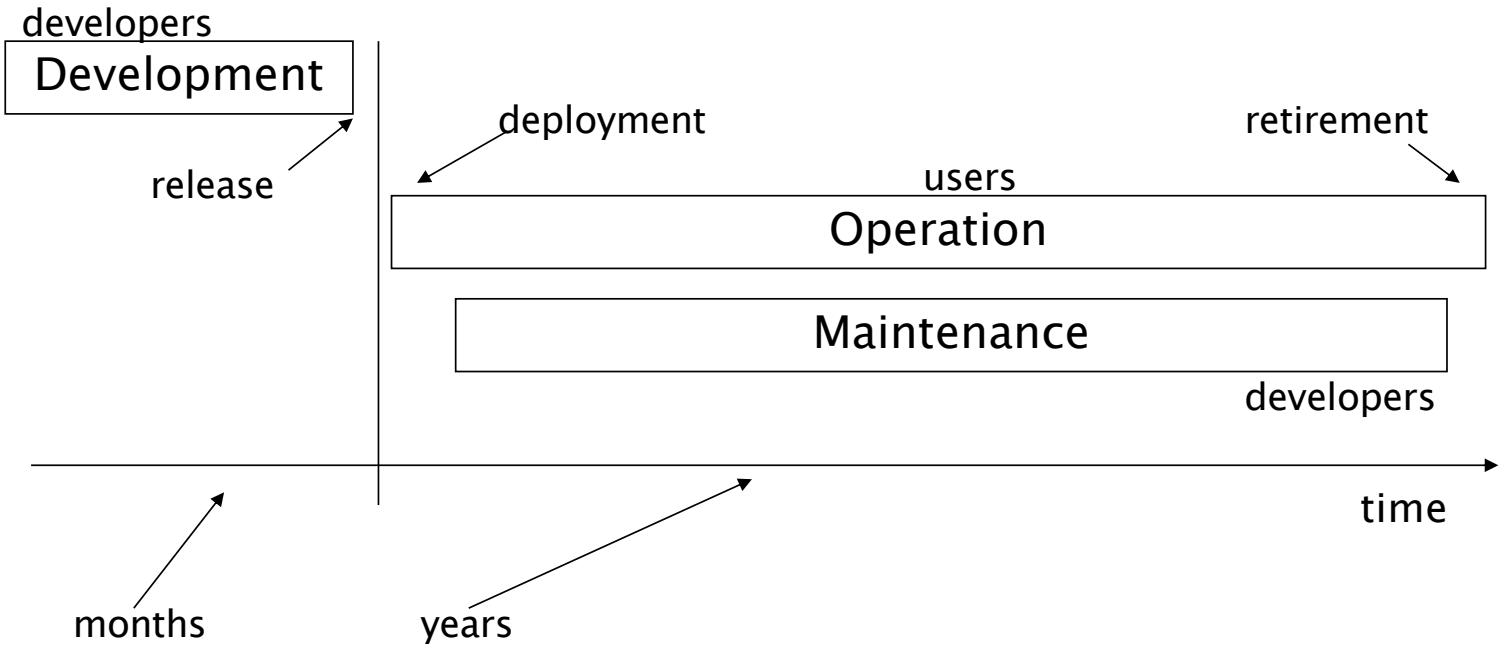
- Scenario 1: IT to support businesses
  - Development: several months
  - Operation: years
  - Maintenance: years, up to 60% of overall costs
- Scenario 2: consumer software (games)
  - Development: months
  - Operation: months (weeks)
  - Virtually no maintenance

Scenarios in dev / maintenance / operation

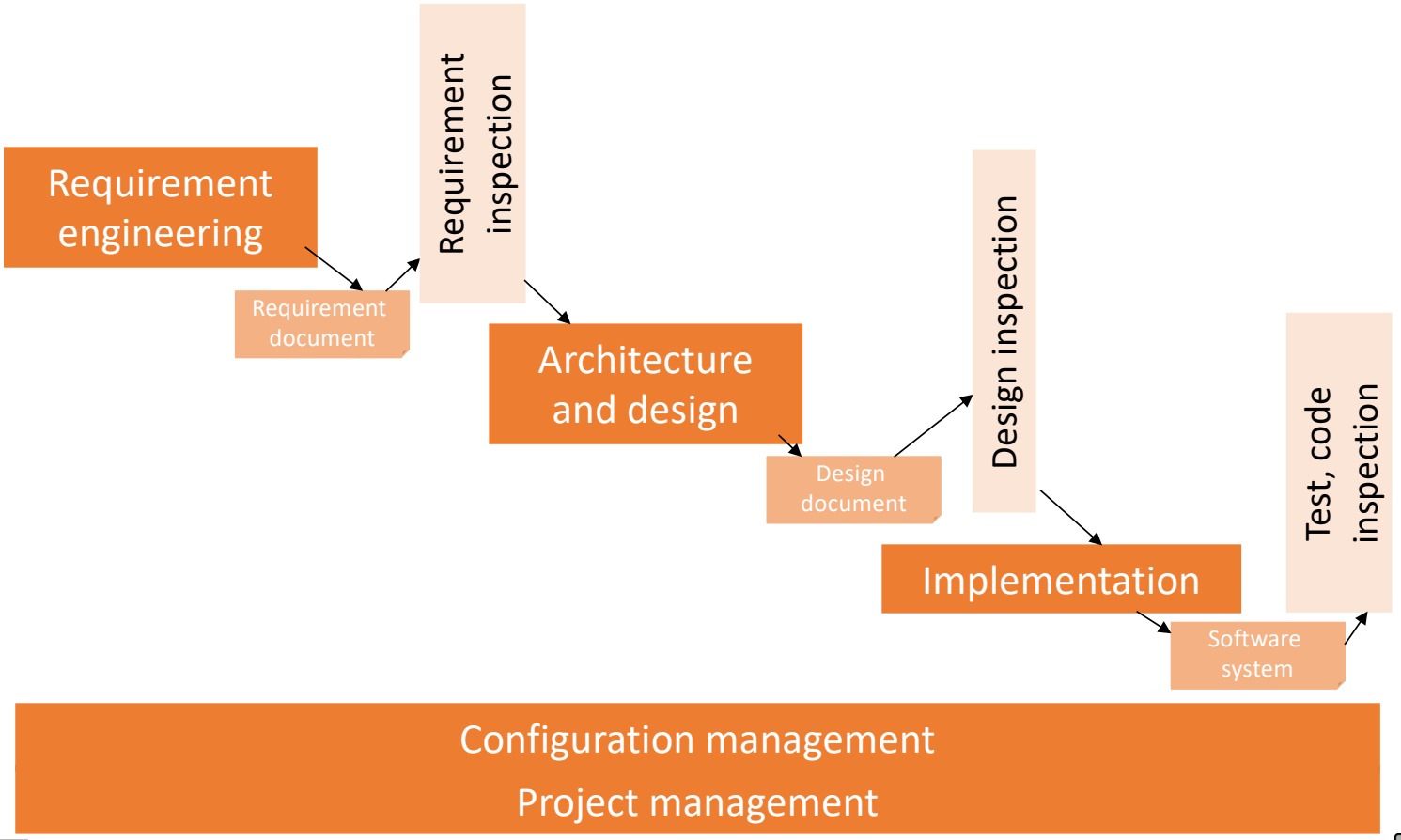
- Scenario 3: Operating System
  - Development: years
  - Operation: years
  - Maintenance: years, up to 60% of overall costs
- Scenario 3_1: Commercial OS (MS)
  - 2, 3 years to develop
  - Several years maintenance
  - Patches issued every day
  - Major releases (Service Pack) at long intervals
  - In parallel development of a new release
  - E.g. W95, NT, 2000, XP, Vista, 7, 10, 11

In summary, top down!

Phases



Development activities



Comparison with traditional engineering

The software process

- Not new
- Just applying engineering approach to software production
- What do aeronautics engineers do?

Production + test activities

- Requirement definition (“what”)
  - airplane, civil usage
  - capacity > 400 people
  - range > 12000km,
  - Noise level < xdB, consumption < .., acquisition cost < y$, operation cost < w $/year
- high level design (“how”)
  - Blueprints of the airplane
  - Definition of subsystems
    - Avionics, structure, engines
  - Mathematical models
    - Structural (wings and frame)
    - Thermodinamic + structural (engines)

Production + test activities

- Low level design
  - Further definition of subsystems
  - In several cases subcontracted or acquired (engine)
- Implementation
  - Implementation of each subsystem
- Unit test
  - Verification that subsystem complies to its specification

Production + test activities

- Integration
  - Put subsystems together (ex. wing + frame)
- Integration test
  - Test the assemblies
- Acceptance test
  - Does it fly?
- Certification
  - FAA (or other agency) tests that it flies and issues a certificate
  - (a defined and long list of checks)

Management activities

- project management
  - project planning
  - project tracking
  - budgeting, accounting
- configuration management
  - parts and assemblies
  - change control
- Quality management
  - Quality handbook
  - Quality plan
  - roles

Is there a difference?

Traditional engineering

- Hundreds of year old
- Theory from physics or other hard science, laws and mathematical models
- Maturity of customers and managers

Software engineering

- 54 years old
- Limited theories and laws. More a social science?
- Variable maturity of customers and managers

System and software process

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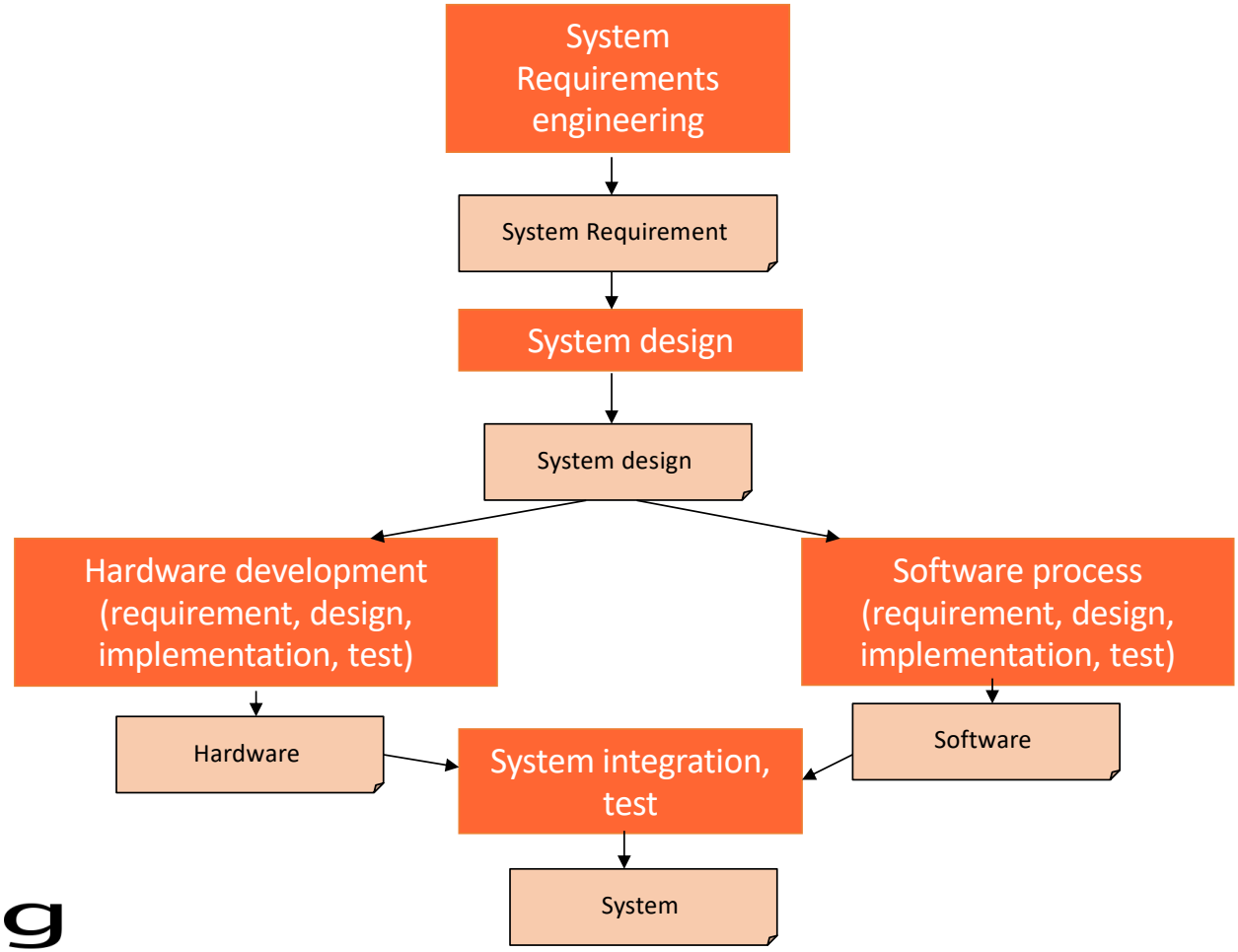
System vs. Software

- Different types of software require different processes
  - Stand alone software → software process
  - Embedded software → system process

The system process

- System requirements
- System design
- Software development
  - Requirements, design, implementation, test, integration
- System integration and test

The system process



Software Engineering approaches

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Software Engineering in one slide

- Activities
  - Production, VV, management
- Documents (and code)
  - To share and control information, decisions
- Techniques
  - To support activities
- Languages
  - To write documents (UML), code
- Models
  - To guide, support activities and the whole
  - CMM and CMM-I, ISO 9000-3, ISO 15504, ISO 12207, ISO 9126, IEEE, ..

Approaches

- There are many ways of putting everything together
- But at least 3 approaches can be recognized

Three basic approaches to SE

- Cow boy programming
  - Just code, all the rest is time lost and real programmers don't do it

1. Document based, semiformal, UML
   - Semiformal language for documents (UML), hand (human) based transformations and controls
2. Formal/model based
   - Formal languages for documents, automatic transformations and controls
3. Agile
   - Limited use of documents, emphasis on code and tests

Approaches, diffusion

- Cowboy programming

  Not un-applied ..

1. Document based, semiformal, UML
   - Standard industrial practice, especially on large projects and mature companies/domains
2. Formal
   - Limited application in critical domains, small part of projects, does not scale up in large projects
3. Agile
   - Latest approach, increasing usage

Approaches

- This course is focused on approach 1
- Specific lectures on approach 2 and 3
- Attend course Software Engineering 2 to apply approach 3 in practice

Recent trends in Software Engineering

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Trends - development

- Software as a service
- Cloud
- Devops
- Outsourcing
- Agile

Trends – business models

- ASP – pay per use
  - software is run on the provider's machines. Users use it through a network (Internet or Extranet). Users pay for using the software rather than purchasing it. E.g., mySAP.com.
- Freeware and pro versions
  - a light version of the software is distributed free of charge. The professional version is charged. E.g., RealPlayer.
- Shareware: software is distributed freely to facilitate trial use. Users pay for it if they decide to keep it and use it. E.g.,WinZIP.
- Adware: the software is free. The interface show advertisement banners refreshed via Intenet. E.g., Eudora

Summary

- Main phases are development, operation, maintenance
- Development has production, control and management activities
- The software process is the reference framework for techniques and tools
- For embedded software the software process is part of the system process
- Different categories of processes organize these activities in different ways