Lecture 12

PROCESSES AND ADVANCED TECHNIQUES

PB007 Software Engineering I
Faculty of Informatics, Masaryk University

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Topics covered

- ✧ Summary of covered topics
- ✧ Software process models
- ✧ Outline of advanced techniques
- ✧ Tool support
- ✧ Course follow-up

Summary of Covered Topics

Lecture 12/Part 1

Covered topics

1. **Software development**, UML Use Case diagram.
2. **Requirements specification**, UML Activity diagram.
3. System analysis and design, structured vs. object-oriented A&D.
4. **Object oriented analysis**, UML Class, Object and State diagram.
5. **Structured analysis**, data modelling, ERD.
6. **High-level design**, UML Class diagram in design.
7. **Low-level design and implementation**, UML Interaction diagrams
8. **Architecture design**, UML Package, Component and Deployment diagram.
9. **Testing**, verification and validation.
10. **Operation**, maintenance and system evolution.
11. Software development **management**.

Software Process Models

Lecture 12/Part 2

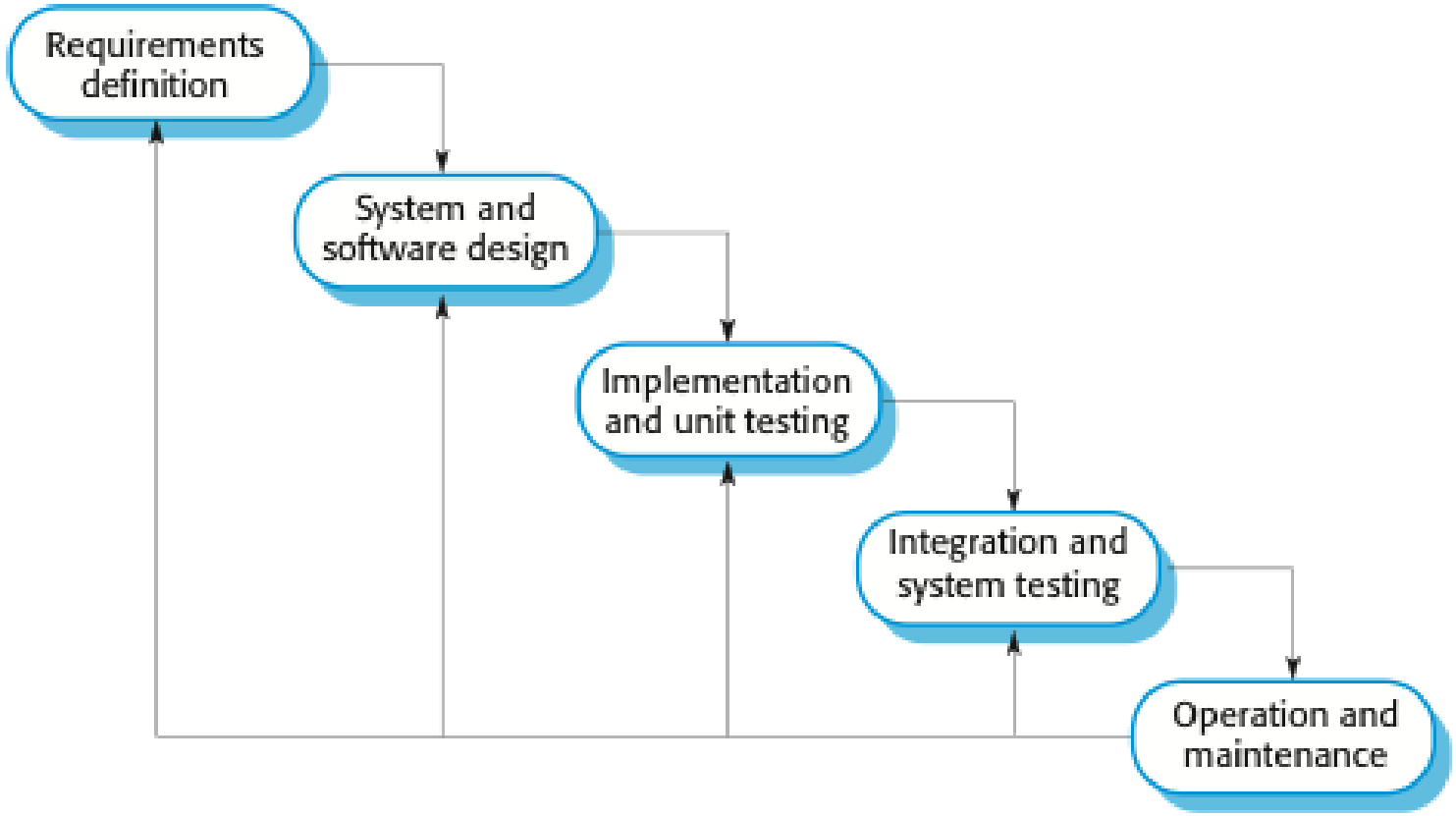
Software process models

- **The waterfall model**
  - Plan-driven model. Separate and distinct phases of specification and development.
- **Incremental development**
  - Specification, development and validation are interleaved. May be plan-driven or agile.
- **Reuse-oriented software engineering**
  - The system is assembled from existing components. May be plan-driven or agile.
- In practice, most large systems are developed using a process that incorporates elements **from many different models**.

Plan-driven and agile development

- Plan-driven development
  - A plan-driven approach to software engineering is based around separate development stages with the **outputs** to be produced at each of these stages **planned in advance**.
  - Not necessarily waterfall model – plan-driven, incremental development is possible
- Agile development
  - Specification, design, implementation and testing are inter-leaved and the **outputs** from the development process are **decided through a process of negotiation** during the software development process.

The waterfall model



Waterfall model benefits and problems

- The waterfall model is mostly used for **large system engineering projects** where a system is developed at several sites.
  - In those circumstances, the plan-driven nature of the waterfall model helps coordinate the work.
- Suitable for new versions of **generic products.**
  - Well understood context, stable requirements.
- The process makes it difficult to respond to **changing customer requirements**.
  - Therefore, this model is only appropriate when the requirements are well-understood and changes can be limited.

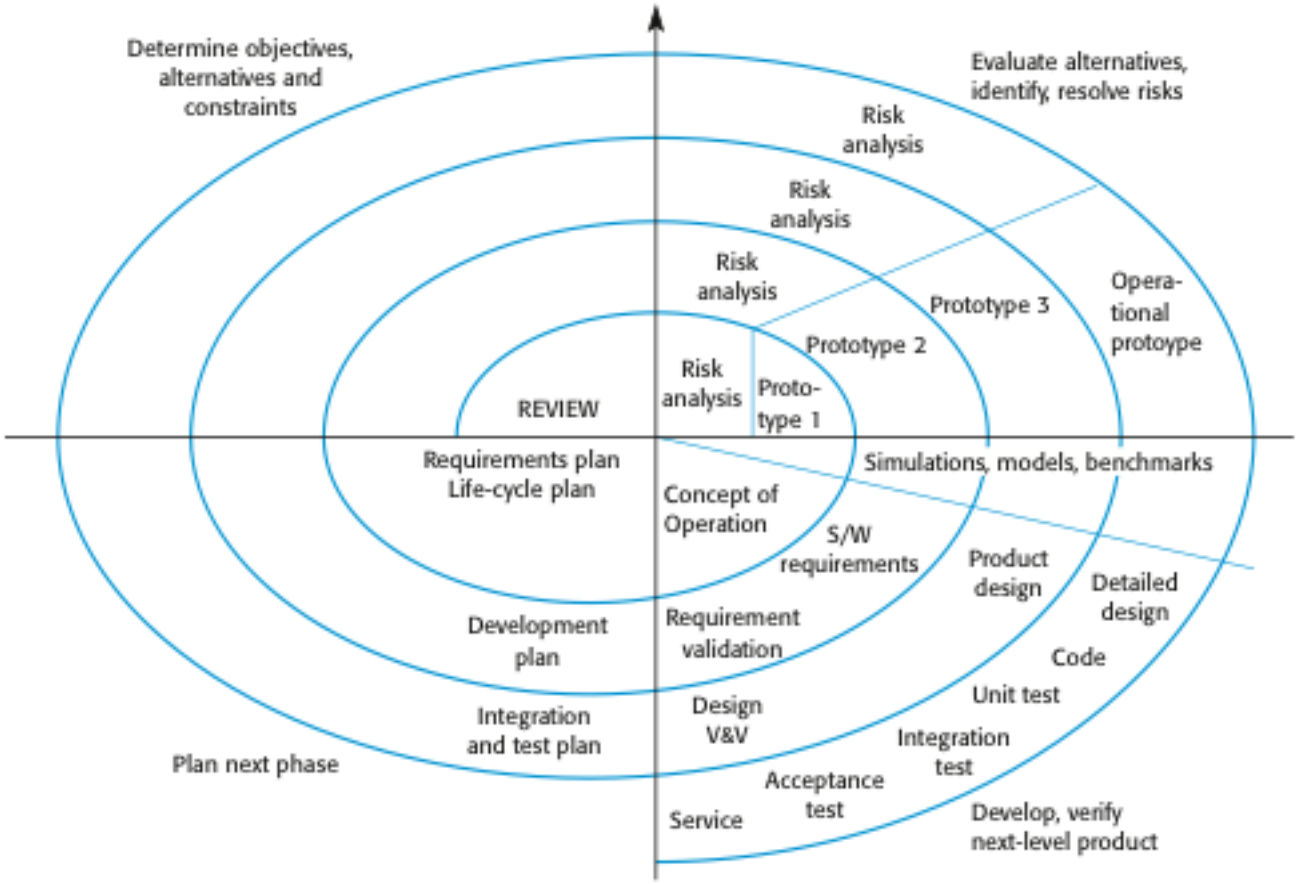
Software prototyping

- A prototype is an initial version of a system used to demonstrate concepts and try out design options.
- A prototype can be used in:
  - The requirements engineering process to help with **requirements elicitation**, consistency checking and validation;
  - In design processes to **explore design options** and develop a **UI design**;
- Prototypes often have **poor internal structure** and thus should not become the foundation of the final system.

Boehm's spiral model

- **Process is represented as a spiral** rather than as a sequence of activities with backtracking.
- Each loop in the spiral represents a phase in the process.
- **No fixed phases** such as specification or design - loops in the spiral are chosen depending on what is required.
- **Risks** are explicitly assessed and resolved throughout the process.

Boehm's spiral model of the software process



Spiral model sectors

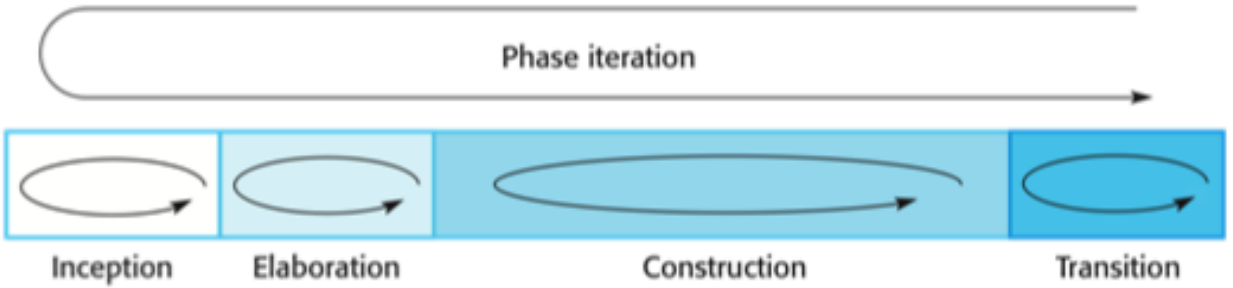
- ✧ Objective setting
  - Specific objectives for the phase are identified.
- ✧ Risk assessment and reduction
  - Risks are assessed and activities put in place to reduce the key risks.
- ✧ Development and validation
  - A development model for the system is chosen which can be any of the generic models.
- ✧ Planning
  - The project is reviewed and the next phase of the spiral is planned.

The Rational Unified Process

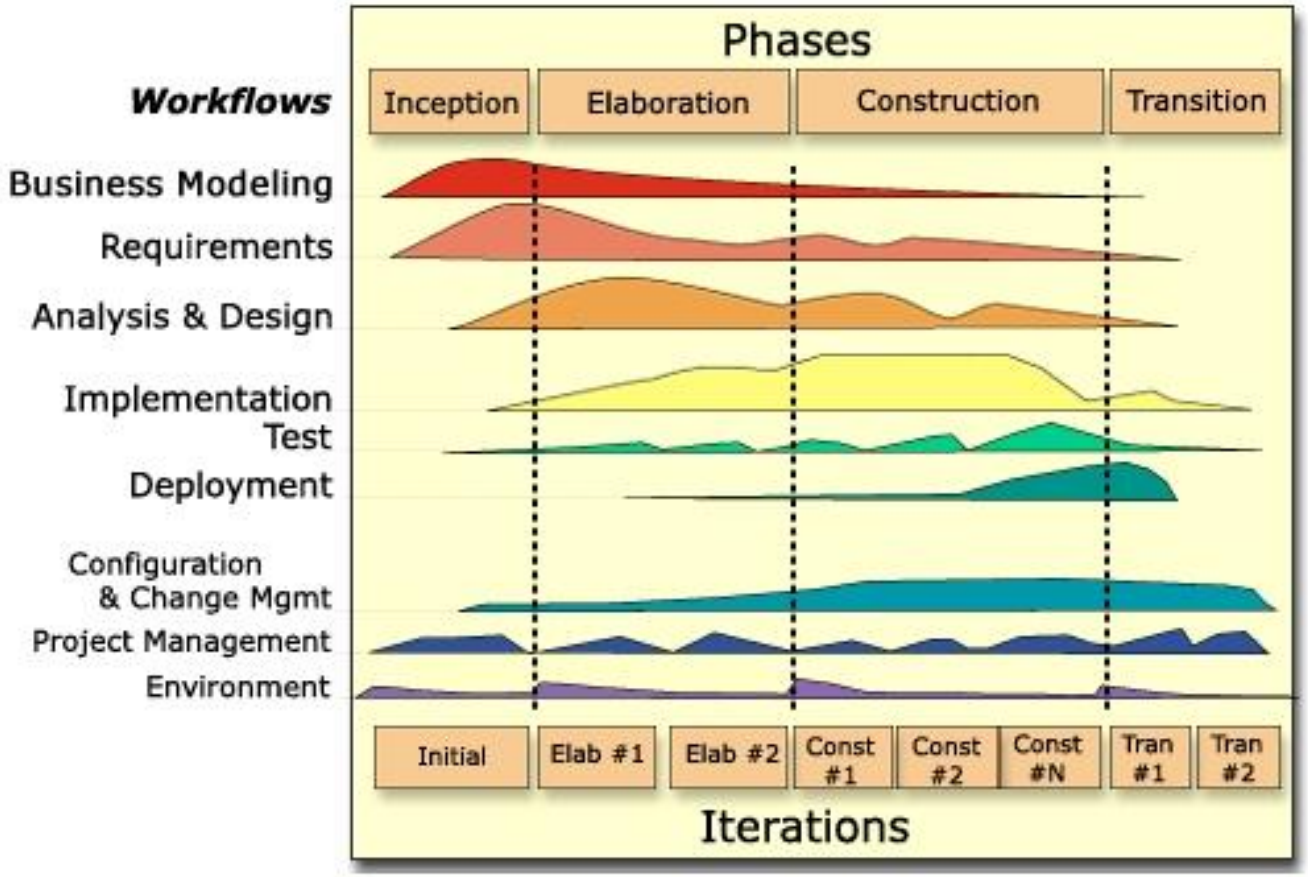
- A modern generic process commonly associated with the Unified Modeling Language (UML).
- Brings together aspects of a number of generic process models discussed in this lecture. Which ones?
- Normally described from 3 perspectives
  - A **dynamic perspective** that shows phases over time;
  - A **static perspective** that shows process activities;
  - A **practice perspective** that suggests good practices to be used during the process.

Phases in the Rational Unified Process

- Inception
  - Establish the business case for the system.
- Elaboration
  - Develop understanding of the problem domain and system architecture.
- Construction
  - System design, programming and testing.
- Transition
  - Deploy the system in its operating environment.

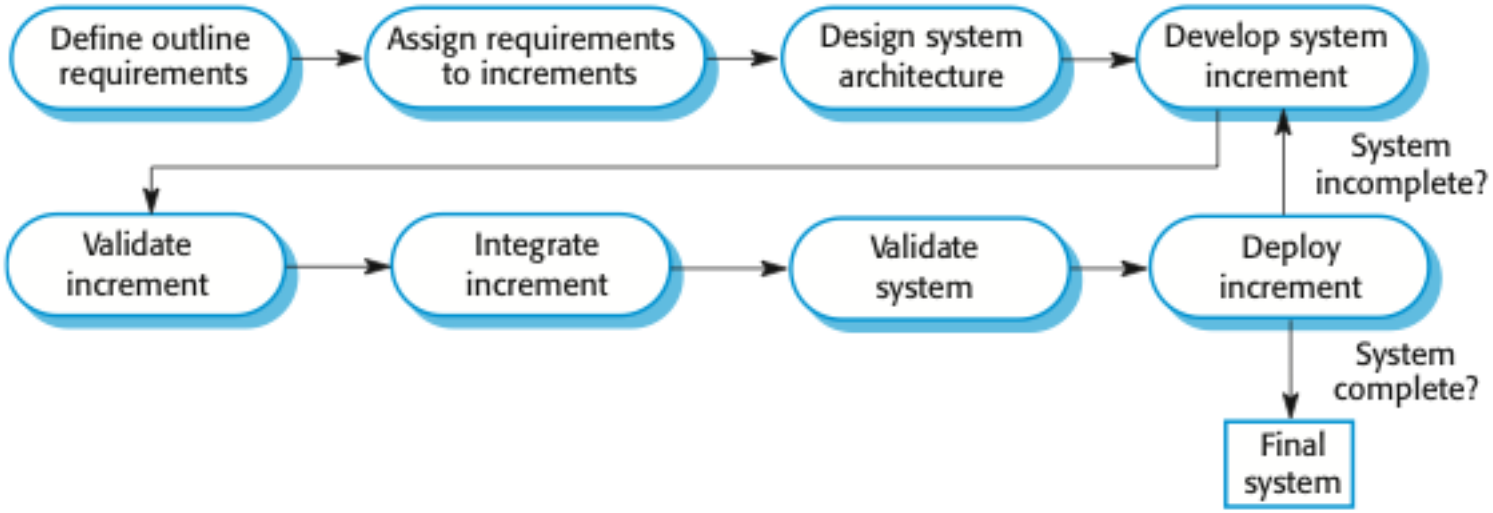


RUP process architecture



Iterative and incremental development

✧ What is the difference between the two?



Incremental delivery

- Rather than deliver the system as a single delivery, the development and delivery is broken down into increments with **each increment delivering part of the required functionality**.
- User requirements are **prioritised** and the highest priority requirements are included in early increments.
- Once the development of an increment is started, the requirements are frozen though requirements for later increments can continue to evolve.

Incremental development benefits

- **Customer value** can be delivered with each increment so system functionality is available earlier.
- Early increments act as a **prototype** to help elicit requirements for later increments.
- **Lower risk** of overall project failure.
- The **highest priority** system services tend to receive the most attention (design, testing, etc.).

Incremental development problems

- The **complete specification** is hard to foresee.
  - This becomes problematic when complete specification is required in contract negotiation.
- System **structure tends to degrade** as new increments are added.
  - Unless time and money is spent on extensive **refactoring**, regular changes tend to **corrupt system structure** and increase the cost of incorporating further changes.
- It is hard to identify and effectively design basic **facilities shared** by different parts of the system.
- The process is not visible, **progress is hard to trace**.

Agile methods

- Agile methods:
  - Focus on the **code** rather than the design
  - Are based on an **iterative approach** to software development
  - Are intended to deliver working software quickly and evolve this quickly to **meet changing requirements**.
- The aim of agile methods is to **reduce overheads in the software process** (e.g. by limiting documentation) and to be able to **respond quickly to changing requirements** without excessive rework.

The principles of agile methods

Principle	Description
Customer involvement	Customers should be closely involved throughout the development process. Their role is provide and prioritize new requirements and to evaluate the iterations of the system.
Incremental delivery	The software is developed in increments with the customer specifying the requirements to be included in each increment.
People not process	The skills of the development team should be recognized and exploited. Team members should be left to develop their own ways of working without prescriptive processes.
Embrace change	Expect the system requirements to change and so design the system to accommodate these changes.
Maintain simplicity	Focus on simplicity in both the software being developed and in the development process. Wherever possible, actively work to eliminate complexity from the system.

Problems with agile methods

- It can be difficult to **keep the interest of customers** who are involved in the process.
- Because of their focus on small, tightly-integrated teams, one needs to be careful when **scaling agile methods** to large systems.
- **Prioritizing changes** can be difficult where there are **multiple stakeholders**.
- Maintaining **simplicity** requires extra work.
- **Contracts** may be a problem as with other approaches to iterative development.

Extreme programming

- Perhaps the best-known and most widely used agile method.
- Extreme Programming (XP) takes an ‘extreme’ approach to iterative development.
  - New versions may be built several times per day;
  - Increments are delivered to customers every 2 weeks;
  - All tests must be run for every build and the build is only accepted if tests run successfully.

XP and agile principles

- Incremental development is supported through small, regular, **frequent system releases**.
- Customer involvement means **full-time customer engagement** with the team.
- People not process through **pair programming**, **collective ownership** and a process that avoids long working hours.
- Maintaining simplicity through **constant refactoring** of code.

Reuse-oriented software engineering

- Based on **systematic reuse** where systems are integrated from existing components or COTS (Commercial-off-the-shelf) systems.
- Process stages
  - Component analysis;
  - Requirements modification;
  - System design with reuse;
  - Development and integration.
- Reuse is now the standard approach for building many types of business system

Key points

- General process models describe the organization of software processes.
  - Examples of general models include the ‘waterfall’ model, incremental development, and reuse-oriented development.
- Processes should include activities to cope with change.
  - This may involve **prototyping** and **incremental delivery**, which help to avoid poor early decisions on requirements and design.
- Agile methods are incremental development methods that focus on frequent releases, reducing process overheads and emphasize customer involvement.

Outline of Advanced Techniques

Lecture 12/Part 3

Distributed systems

- Virtually all large computer-based systems are now distributed systems.

  "… a collection of independent computers that appears to the user as a single coherent system."

- Distributed systems issues
  - Distributed systems are **more complex** than systems that run on a single processor.
  - Complexity arises because different parts of the system are **independently managed** as is the network.
  - There is **no single authority** in charge of the system so top-down control is impossible.

Service-oriented architectures

- A means of developing distributed systems where the components are stand-alone services
- Services may execute on different computers from different service providers
- Standard protocols have been developed to support service communication and information exchange
- Benefits of SOA:
  - Services can be provided **locally** or **outsourced** to ext. providers
  - Services are **language-independent**
  - Investment in **legacy systems** can be preserved
  - Inter-organisational computing is facilitated through **simplified information exchange**

Mobile applications

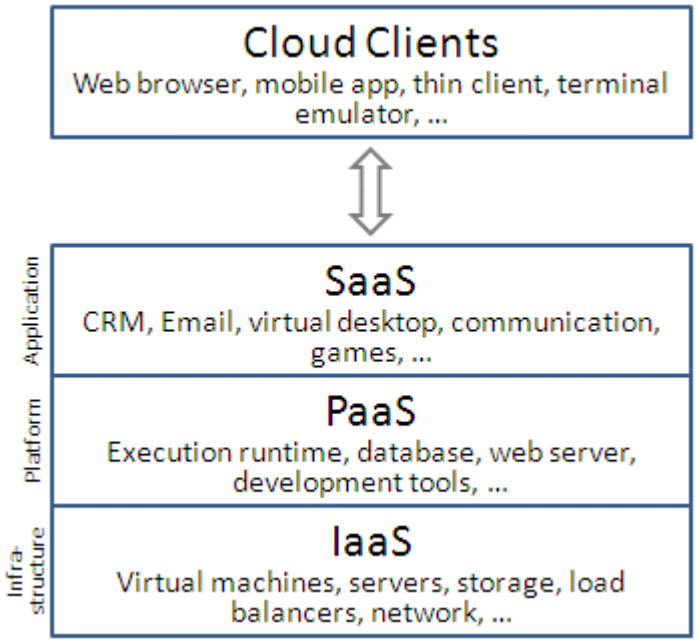
- A mobile applications include apps designed to run on smartphones, tablet computers and other mobile devices.
- They are usually available through application distribution platforms, operated by the owner of the mobile operating system, such as the Apple App Store, Google Play, and Windows Phone Store.
- Mobile apps were originally offered for general productivity and information retrieval, including email, calendar, contacts and weather information.
- However, public demand drove rapid expansion into many other categories, including banking, order-tracking, or medical apps.

Embedded systems

- Computers are used to control a wide range of systems from **simple domestic machines**, through **games controllers**, to entire **manufacturing plants**.
- Their software must react to events generated by the hardware and, often, issue control signals in response to these events.
- The software in these systems is **embedded in system hardware**, often in **read-only memory**, and usually responds, in **real time**, to events from the system's environment.
- Issues of **safety** and **reliability** may dominate the system design.

Cloud computing

- Cloud computing is computing in which large groups of remote servers are networked to allow **centralized data storage** and online **access to computer services** or **resources**.
- Service models
  - Infrastructure as a service (IaaS)
  - Platform as a service (PaaS)
  - Software as a service (SaaS)
- Moreover, **big data and its processing** is a topic on its own



Tool Support

Lecture 12/Part 4

SE tasks commonly supported by tools

- Plan and schedule software development project
- Specify, manage and trace requirements
- Model and analyze business processes
- Create design and deployment models
- Create, edit, compile and debug code in different languages
- Generate and import database schema
- Track changes
- Manage tests
- Document software development
- Communicate and develop team based projects

Most popular tools

- Requirements analysis and design modeling tools
- Programming environments that automate parts of program construction processes (e.g., automated builds)
- Software configuration management and version control
- Testing tools including static and dynamic analysis tools
- Continuous integration and release management
- Issue tracking
- Project management tools
- Tool integration concepts and mechanisms

Integrated development environments (IDEs)

- Software development **tools are often grouped** to create an integrated development environment (IDE).
- An IDE is a set of software tools that supports different aspects of software development, within some **common framework** and user interface.
- IDEs are created to support development in a **specific programming language** such as Java. The language IDE may be developed specially, or may be an instantiation of a general-purpose IDE, with specific language-support tools.

Key points

- Software engineering process can be supported by a large variety of tools.
- The specific tools are often integrated into a single environment or framework, which assists the developers through integrated support on one place.

Course Follow-up

Lecture 12/Part 5

Course finalization

- ✧ Seminar projects
  - Assessment
  - “Seminar completion / Absolvování cvičení“ notebook in IS
- ✧ Exam
  - Number of exam dates
  - Reservation/cancelation policies
  - Legth of the exam
  - Form of the exam – test part and UML modelling part
  - Results and their viewing
- ✧ Opinion poll
  - Do not forget to give us your feedback! ☺

Follow-up and related courses

- **PA017 Softwarové inženýrství II**
- **PA103 Objektové metody návrhu informačních systémů**
- **PV167 Projekt z objektového návrhu inf. Systémů**
- **PV260 Software Quality**
- PA104 Vedení týmového projektu
- PV207 Business Process Management
- PV165 Procesní řízení
- PV045 Management informačního systému
- PA189 Agile Management in IT
- PV028 Aplikační informační systémy

Follow-up and related courses

- PV043 Informační systémy podniků
- PV230 Podnikové portály
- PV019 Geografické informační systémy I, II
- PV058 Informační systémy ve veřejné a státní správě
- PV213 Enterprise Information Systems in Practice
- PV098 Řízení implementace IS
- PB168 Základy databázových a informačních systémů
- PB114 Datové modelování I
- SSME Courses

Thanks

Thank you for your attention

and good luck with the exam!