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Software Engineering
Fundamentals

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Agenda

1. Software engineering overview
    - Requirements
    - Design
    - Construction
    - Testing
    - Project management
2. Development methodologies overview
    - The Waterfall development process
    - Heavyweight methodologies
    - Agile methodologies and XP

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Software Engineering

Requirements, Design, Construction, Testing

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What is Software Engineering?

Software engineering **is the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software**

Definition by IEEE

Software Engineering

- **Software engineering is:**
  - **An engineering discipline that provides knowledge, tools, and methods for:**
    - **Defining software requirements**
    - **Performing software design**
    - **Software construction**
    - **Software testing**
    - **Software maintenance tasks**
    - **Software project management**

Software Development Activities

- Software development always includes the following activities (to some extent):
  - Requirements analysis
  - Design
  - Construction
  - Testing (sometimes)

  } Software Project Management

- These activities do not follow strictly one after another!
  - Often overlap and interact

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Software Requirements

Functional, Non-functional Requirements, SRS

Software Requirements

- ***Software requirements*** **define the functionality of the system**
  - **Answer the question "what?", not "how?"**
  - **Define constraints on the system**
- **Two kinds of requirements**
  - ***Functional*** **requirements**
  - ***Non-functional*** **requirements**

Requirements Analysis

- ***Requirements analysis*** **starts from a vision about the system**
  - **Customers don't know what they need!**
  - **Requirements come roughly and are specified and extended iteratively**
- ***Prototyping*** **is often used, especially for the user interface**
- **The outcome is the Software Requirements Specification (SRS)**

Software Requirements Specification (SRS)

- The ***Software Requirements Specification (SRS)*** is a formal requirements document
- It describes in details:
  - Functional requirements
    - Business processes
    - Actors and use-cases
  - Non-functional requirements
    - E.g. performance, scalability, etc.

Software Requirements

- It is always hard to describe and document the requirements in comprehensive and not ambiguous way
  - Good requirements save time and money
- Requirements always change during the project!
  - Good software requirements specification reduces the changes
  - Prototypes significantly reduce changes

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Software Requirements Specification and UI Prototype – Examples

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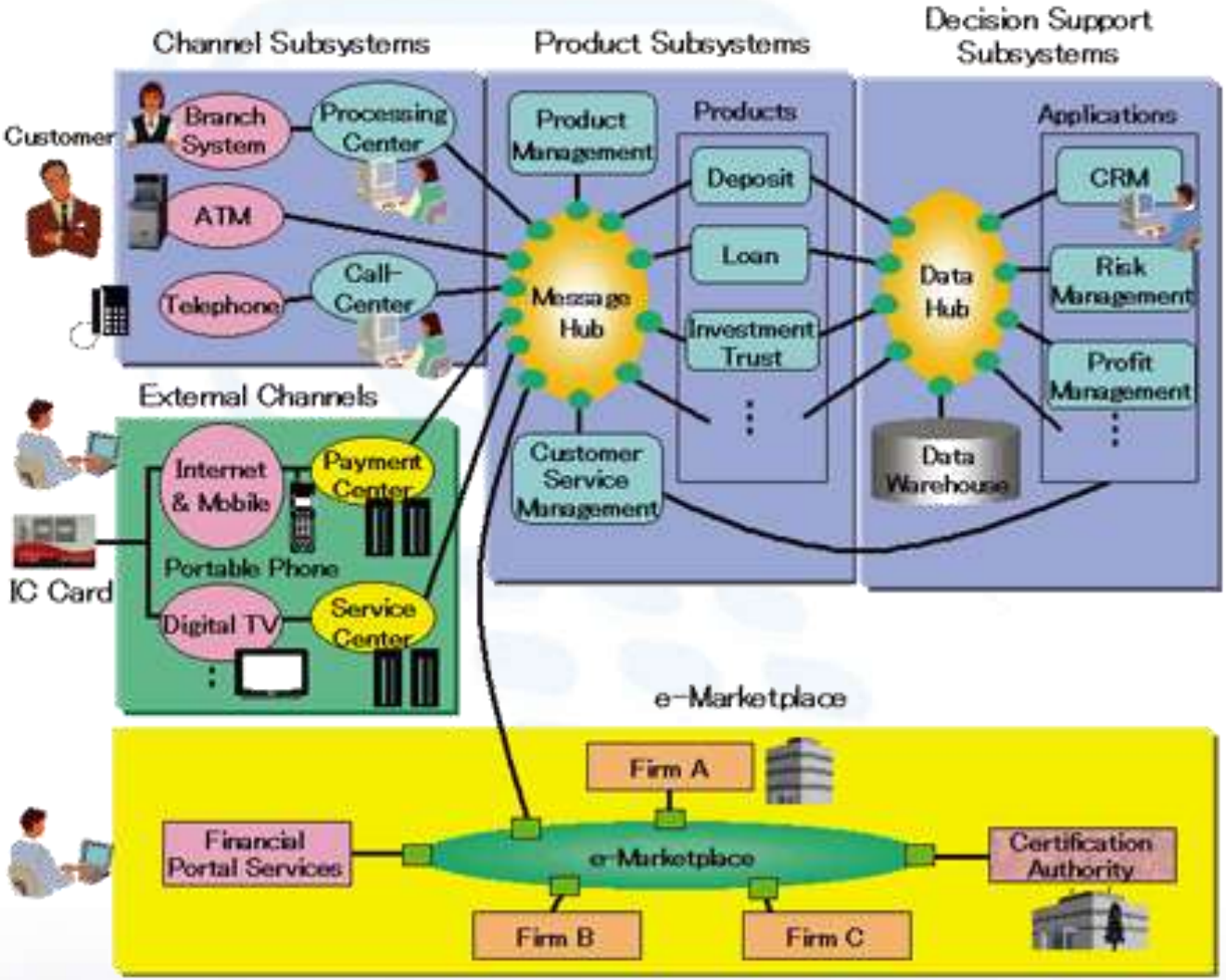
Software Architecture and Software Design

Software Architecture and Software Design

- ***Software design*** **is a technical description about how the system will implement the requirements**
- **The *system architecture* describes:**
  - **How the system will be decomposed into subsystems (modules)**
  - **Responsibilities of each module**
  - **Interaction between modules**
  - **Platforms and technologies**

System Architecture Diagram – Example



Software Design

- **Detailed Design**
  - **Describes the internal module structure**
  - **Interfaces, data design, process design**
- **Object-Oriented Design**
  - **Describes the classes, their responsibilities, relationships, dependencies, and interactions**
- **Internal Class Design**
  - **Methods, responsibilities, algorithms and interactions between them**

Software Design Document (SDD)

- The ***Software Design Document (SDD)*** is a formal description of the architecture and design of the system
- It contains:
  - Architecture design
    - Modules and their interaction (diagram)
  - For each module
    - Process design (diagrams)
    - Data design (E/R diagram)
    - Interfaces design (class diagram)

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Software Design Document – Example

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Software Construction

Implementation, Unit Testing, Debugging, Integration

Software Construction

- During the ***software construction*** phase developers create the software
  - Sometimes called ***implementation*** phase
- It includes:
  - Internal method design
  - Writing code
  - Writing unit tests (sometimes)
  - Testing and debugging
  - Integration

Writing the Code

- ***Coding*** **is the process of writing the programming code (the source code)**
  - **The code strictly follows the design**
  - **Developers perform *internal method design* as part of coding**
- **The *source code* is the output of the software construction process**
  - **Written by developers**
  - **Can include unit tests**

Testing the Code

- ***Testing*** **checks whether the developed software conforms to the requirements**
  - **Aims to identify defects (bugs)**
- **Developers test the code after write it**
  - **At least run it to see the results**
  - ***Unit testing*** **is even better**
    - **Units tests can be repeated many times**
- **System testing is done by QA engineers**
  - **Unit testing is done by developers**

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Debugging

- ***Debugging*** **aims to find the source of already identified defect and to fix it**
  - **Performed by developers**
- **Steps in debugging:**
  - **Find the defect in the code**
    - **Identify the source of the problem**
    - **Identify the exact place in code causing it**
  - **Fix the defect**
  - **Test to check if the fix is correct**

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Integration

- ***Integration*** **is putting all pieces together**
  - **Compile, run and deploy the modules as single system**
  - **Test to identify defects**
- **Integration strategies**
  - **Big bang, top-down and bottom-up**
  - **Continuous integration**

Coding != Software Engineering

- Inexperienced developers consider coding the core of development
  - In most projects coding is only 20% of the project activities!
  - The important decisions are taken during the requirements analysis and design
  - Documentation, testing, integration, maintenance, etc. are often disparaged
- Software engineering is not just coding!
  - ***Programmer*** != ***software engineer***

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Software Verification and Testing

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Software Verification

- What is ***software verification***?
  - It checks whether the developed software conforms to the requirements
  - Performed by the Software Quality Assurance Engineers (QA)
- Two approaches:
  - Formal ***reviews*** and ***inspections***
  - Different kinds of ***testing***
- Cannot certify absence of defects!
  - Can only decrease their rates

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Software Testing

- ***Testing*** **checks whether the developed software conforms to the requirements**
- **Testing aims to find defects (bugs)**
  - **Black-box and white-box tests**
  - **Unit tests, integration tests, system tests, acceptance tests**
  - **Stress tests, load tests, regression tests**
  - **Tester engineers can use automated test tools to record and execute tests**

Software Testing Process

- Test planning
  - Establish test strategy and test plan
  - During requirements and design phases
- Test development
  - Test procedures, test scenarios, test cases, test scripts
- Test execution
- Test reporting
- Retesting the defects

Test Plan and Test Cases

- The ***test plan*** is a formal document that describes how tests will be performed
  - List of test activities to be performed to ensure meeting the requirements
  - Features to be tested, testing approach, schedule, acceptance criteria
- Test scenarios and test cases
  - ***Test scenarios*** – stories to be tested
  - ***Test cases*** – tests of single function

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Test Plans and Test Cases – Example

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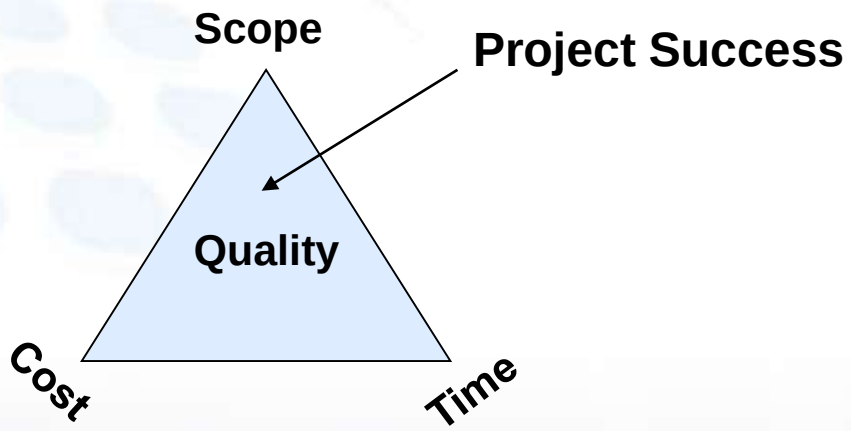
Software Project Management

What is Project Management?

- ***Project management*** **is the discipline of organizing and managing resources in order to successfully complete a project**
- **Successfully means within defined scope, quality, time and cost constraints**
- **Project constraints:**



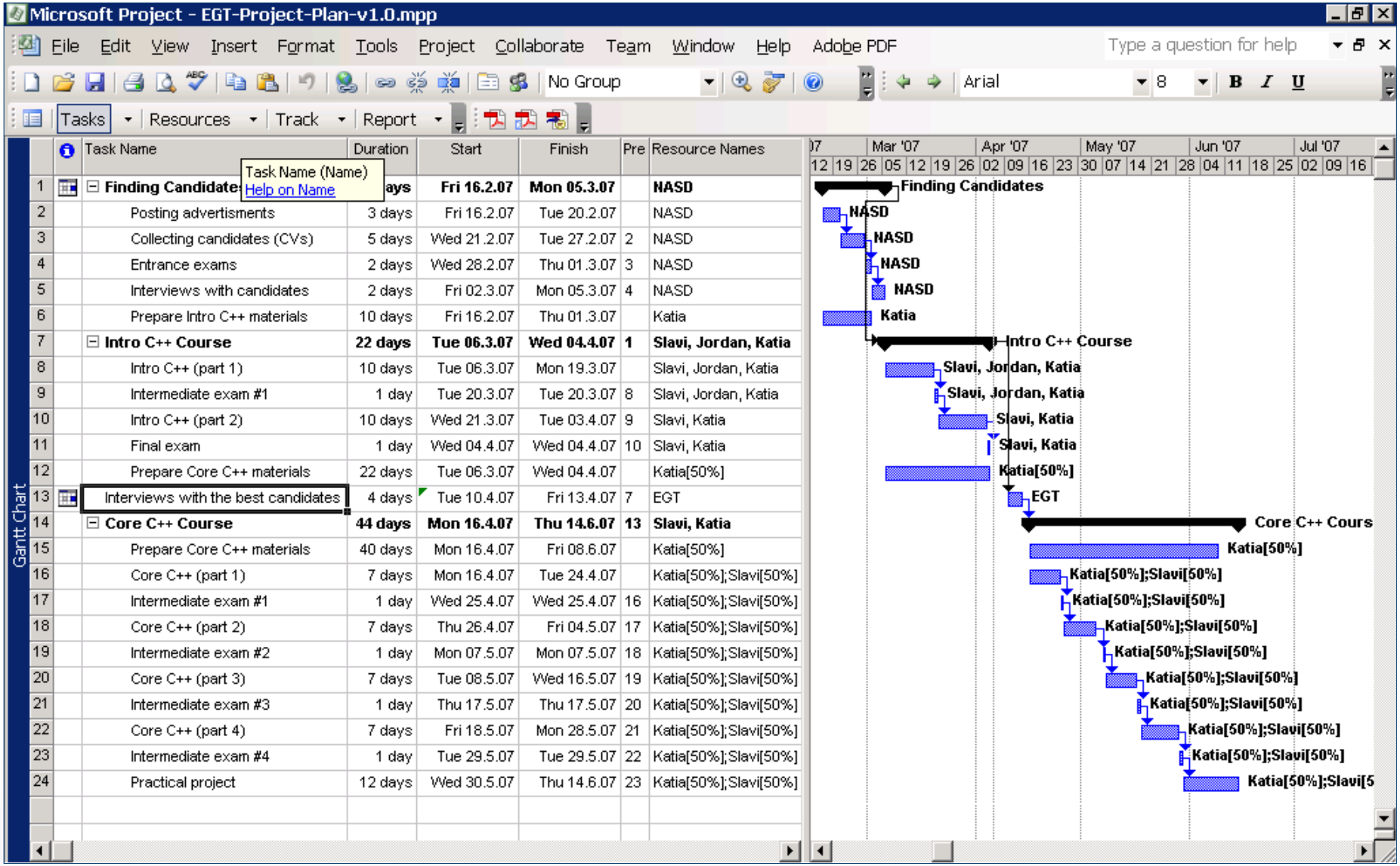
What is Software Project Management?

- ***Software project management***
  - Management discipline about planning, monitoring and controlling software projects
- ***Project planning***
  - Identify the scope, estimate the work involved, and create a project schedule
- ***Project monitoring and control***
  - Keep the team up to date on the project's progress and handle problems

What is Project Plan?

- The ***project plan*** is a document that describes how the work on the project will be organized
  - Contains tasks, resources, schedule, milestones, etc.
  - Tasks have start, end, assigned resources (team members), % complete, dependencies, nested tasks, etc.
- Project management tools simplify creating and monitoring project plans

Project Plan – Example



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Development Methodologies

What is a Development Methodology?

- A ***development methodology*** is a set of practices and procedures for creating software
  - A set of rules that developers have to follow
  - A set of conventions the organization decides to follow
  - A systematical, engineering approach for organizing software projects

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Development Methodologies

- The "Waterfall" Process
  - Old-fashioned, not used today
- Rational Unified Process (RUP)
  - Very formal, lots of documentation
- Microsoft Solutions Framework (MSF)
  - Formal heavyweight approach
- Agile Development Processes
  - E.g. Extreme Programming

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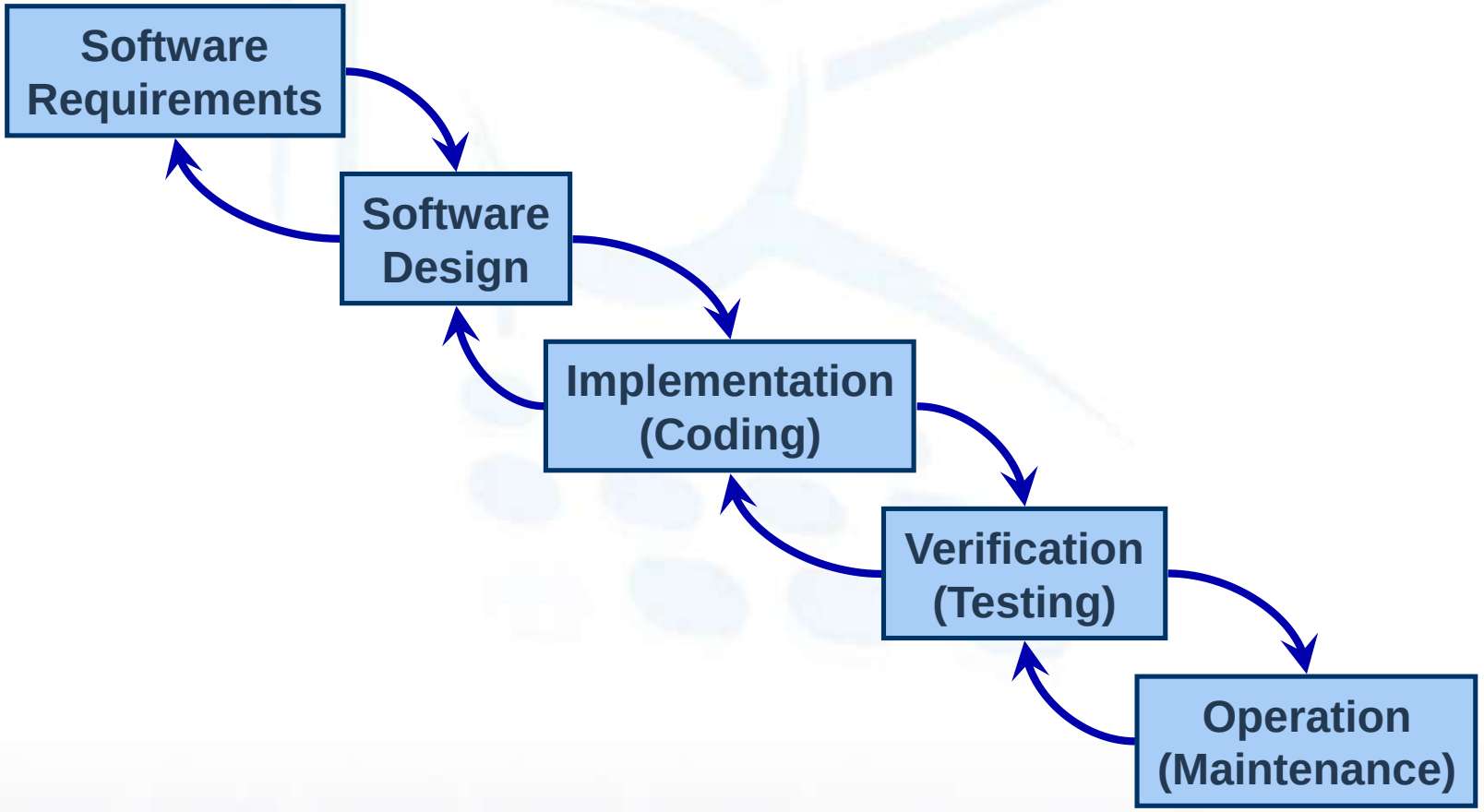
The Waterfall Development Process

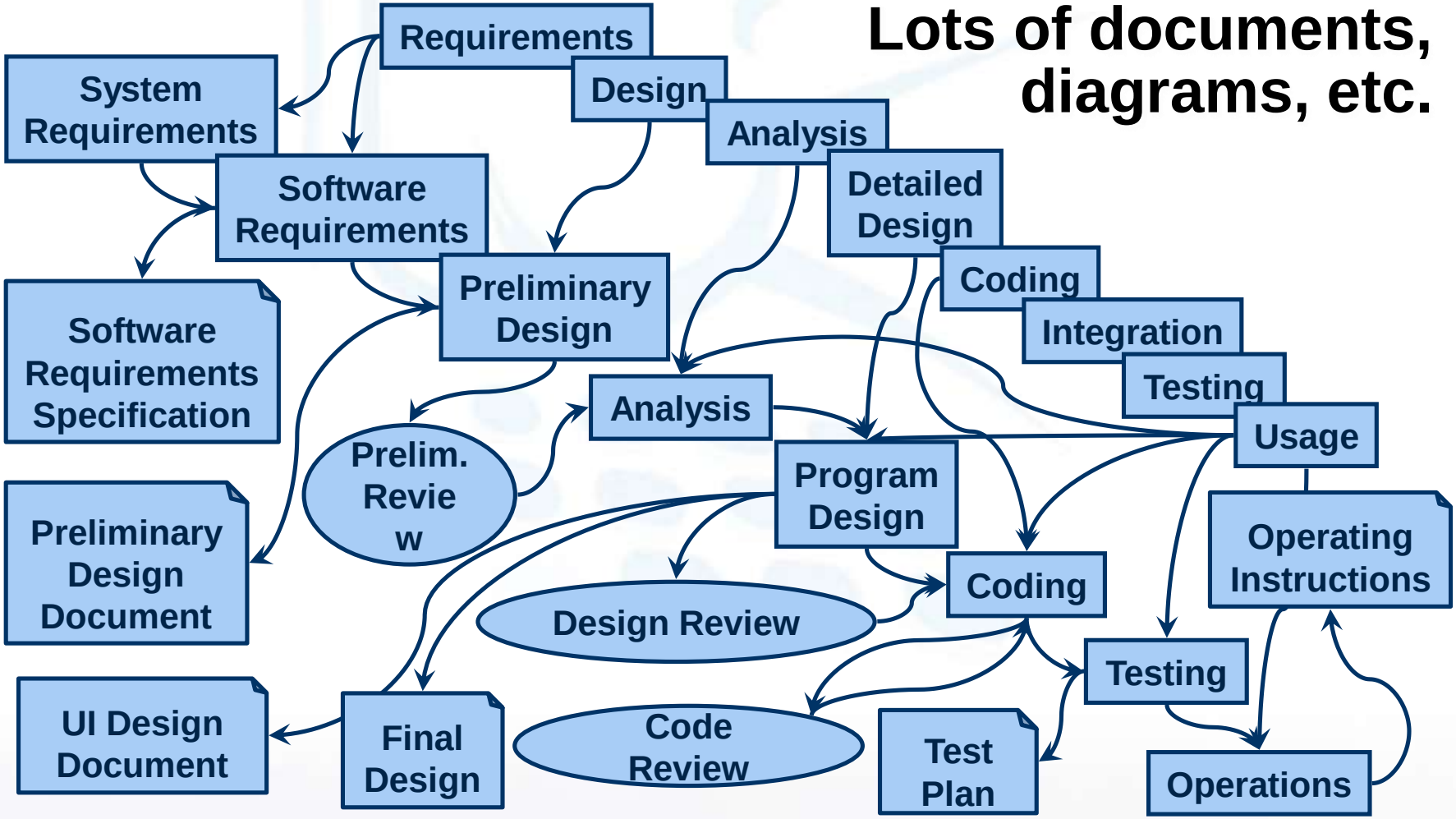
The Waterfall Process

- **The waterfall development process:**



Formal Methodologies

- **Formal methodologies are heavyweight!**



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Agile Development

The Agile Manifesto

“Our highest priority is to satisfy the customer through early and continuous delivery of valuable software“

Manifesto for Agile

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The Agile Spirit

- Incremental
  - ***Working software*** over comprehensive documentation
- Cooperation
  - ***Customer collaboration*** over contract negotiation
- Straightforward
  - ***Individuals and interactions*** over processes and tools
- Adaptive
  - ***Responding to change*** over following a plan

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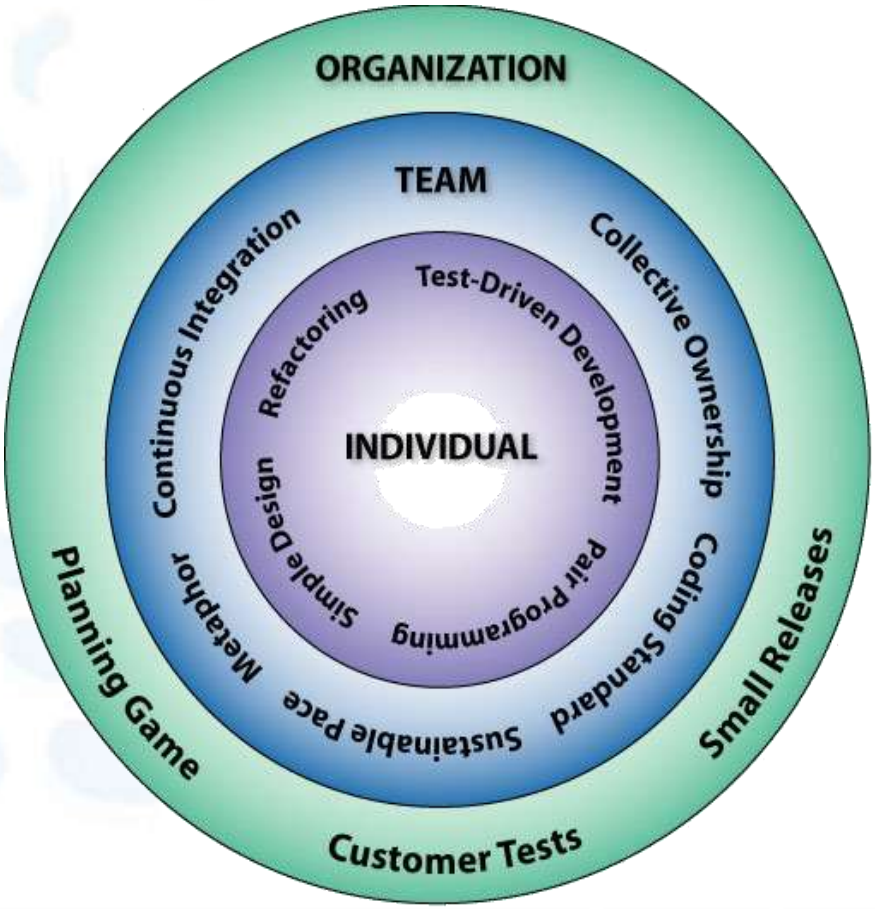
Agile Methodologies

- eXtreme Programming (XP)
- Scrum
- Crystal family of methodologies
- Feature-Driven Development (FDD)
- Adaptive Software Development (ASD)
- Dynamic System Development Model (DSDM)
- Agile Unified Process (AUP)

Extreme Programming: The 12 Key Practices

- The Planning Game
- Small Releases
- Metaphor
- Simple Design
- Test-Driven Development
- Refactoring
- Pair Programming
- Collective Ownership
- Continuous Integration
- 40-Hour Workweek
- On-site Customer
- Coding Standards



Questions?