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Software Engineering Fundamentals

Software Development Practices and Methodologies

Telerik Software Academy

Learning & Development

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Software Engineering

Requirements, Design, Construction, Testing

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 (depends on the methodology)!
  - Often overlap and interact

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Software Requirements

Functional & Non-functional Requirements, SRS, User Story Cards

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
- The outcome is the Software Requirements Specification (SRS) or set of User Stories
- Prototyping is often used, especially for the user interface (UI)

Software Requirements Specification (SRS)

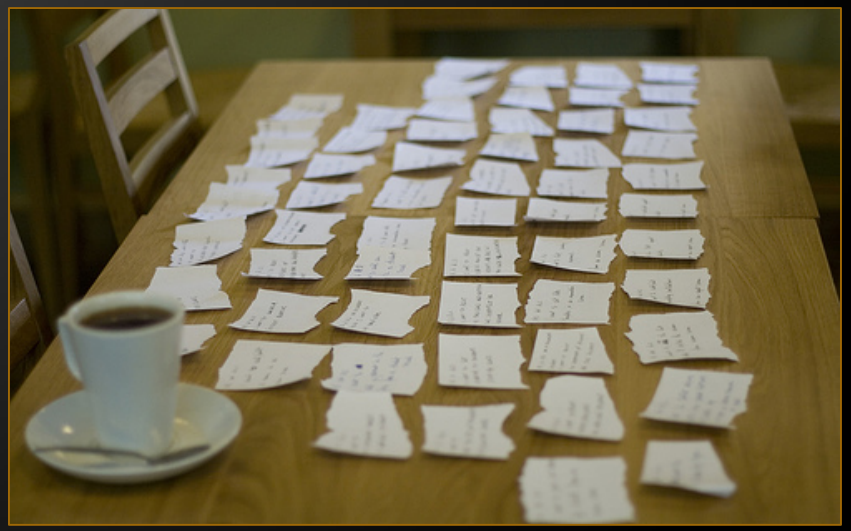
- The Software Requirements Specification (SRS) is a formal requirements document
- It describes in details:
  - Functional requirements
    - Business processes
    - Actors and use-cases
  - Non-functional requirements
    - E.g. performance, scalability, constraints, etc.

Agile Requirements and User Stories

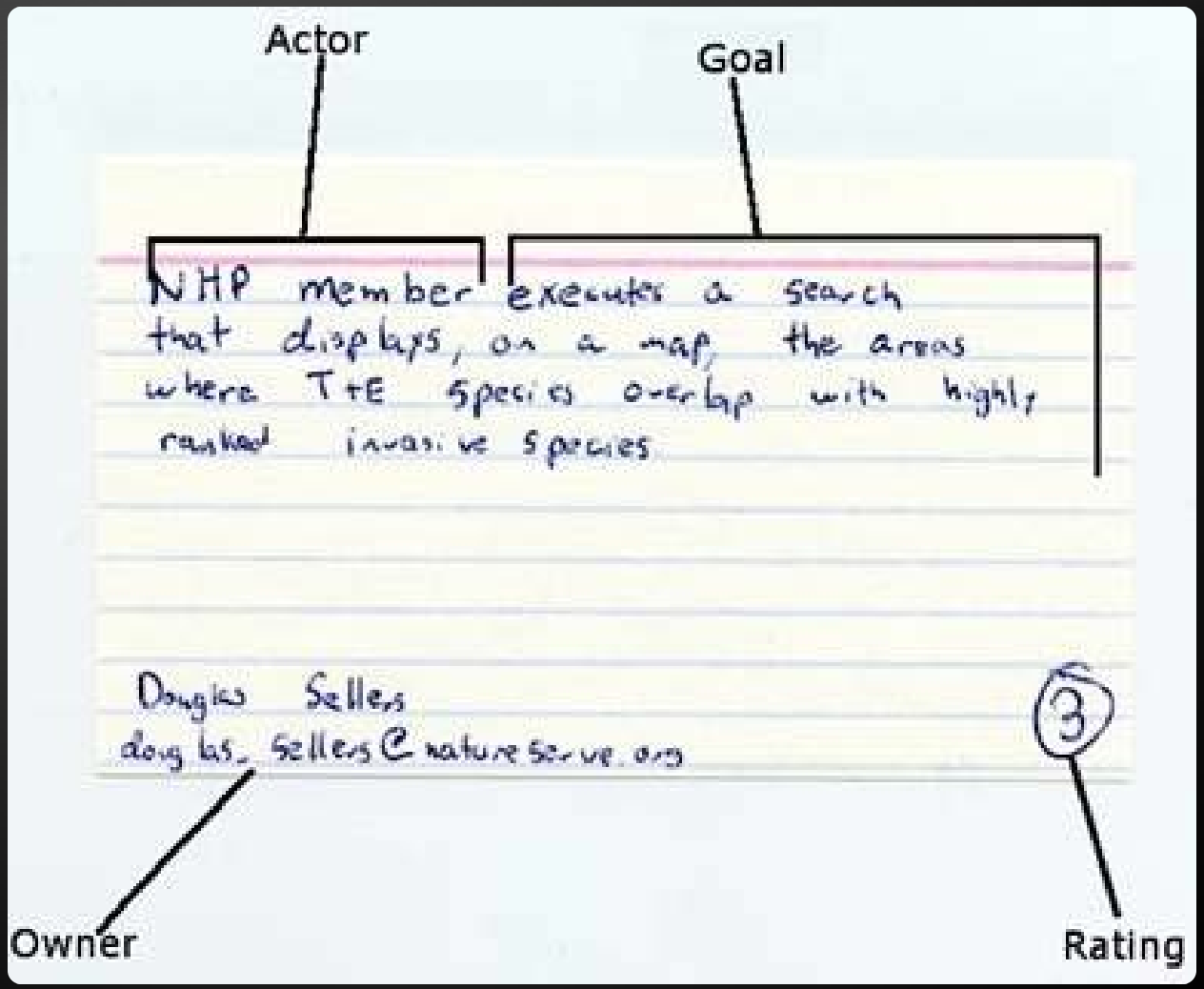
- Requirements specifications are too heavy
  - Does not work well in dynamic projects that change their requirements every day
- Agile development needs agile requirements
  - Split into small iterations
- How to split the requirements?
  - Use simple, informal requirements description
  - User story: a small feature that brings some value to the end-user

What is User Story?

- User story
  - User needs to accomplish something
  - Written informal (in words / images / sketches)
  - Looks like use-case but is different (less formal)
- User stories have
  - Actor (who?)
  - Goal (what?, why?)
  - Other info
    - Owner, estimate, …



User Story – Example



Software Requirements

- It is always hard to describe and document the requirements in comprehensive way
  - Good requirements save time and money
- Requirements always change during the project!
  - Good requirements reduces the changes
  - Prototypes significantly reduce changes
  - Agile methodologies are flexible to changes
    - Incremental development in small iterations

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Software Requirements Specifications (SRS), User Stories and UI Prototypes

Live Demo

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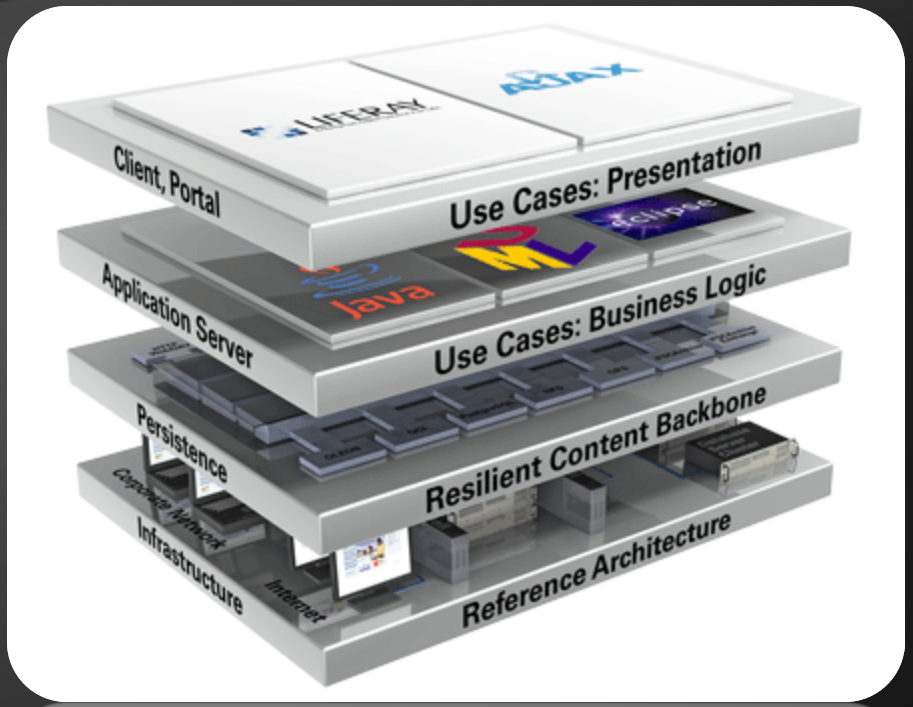
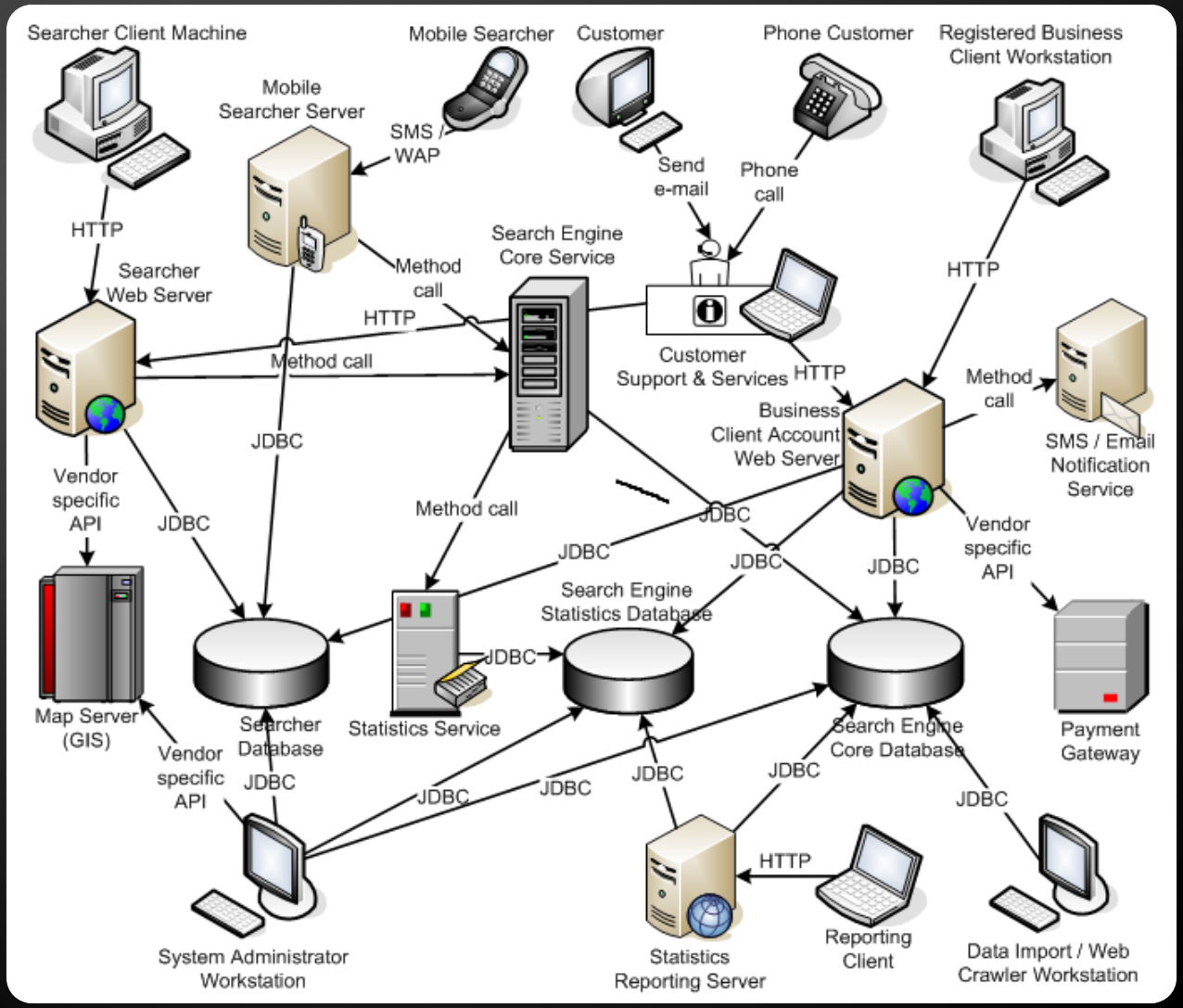


Software Architecture and Software Design

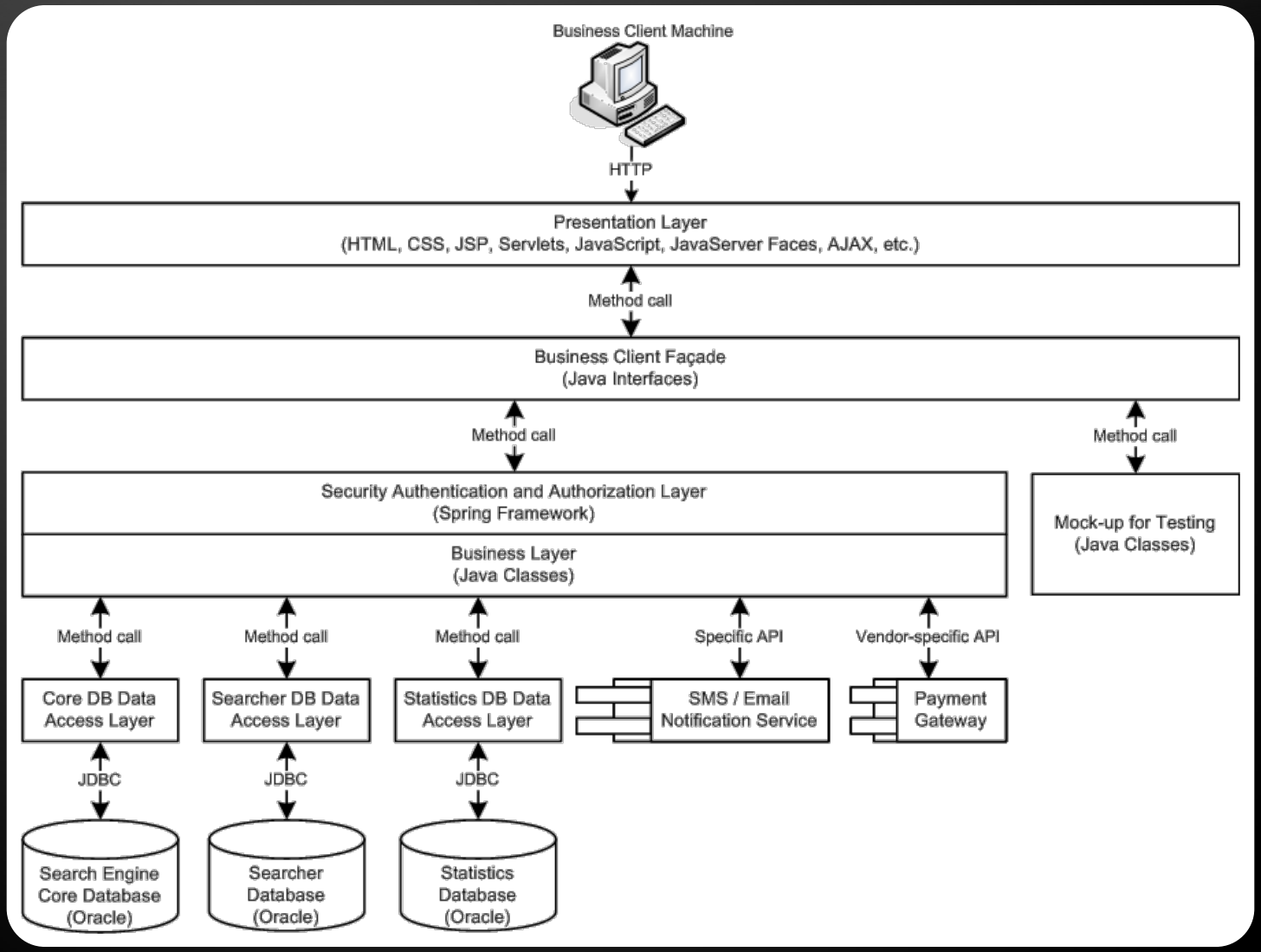
Software Architecture and Software Design

- Software design is a technical description (blueprints) 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 the modules
  - Platforms and technologies

System Architecture Diagram – Example



Software 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)
  - Formal description of the architecture and design of the system
- It contains:
  - Architectural 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

Live Demo

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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 the source code
  - Writing unit tests (optionally)
  - 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 writing it
  - At least run it to see the results
  - Unit testing works better
    - Units tests can be repeated many times

- System testing is done by the QA engineers
  - Unit testing is done by developers

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 the code causing it
  - Fix the defect
  - Test to check if the fix is working correctly

Integration

- Integration is putting all pieces together
  - Compile, run and deploy the modules as a 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

Software Verification

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

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

Live Demo

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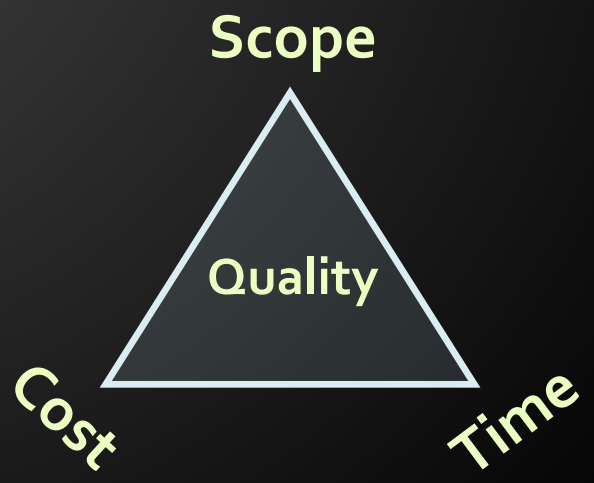
Software Project Management

What is Project Management?

- Project management is the discipline of organizing and managing work and 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, cost, etc.
- Project management tools simplify creating and monitoring project plans

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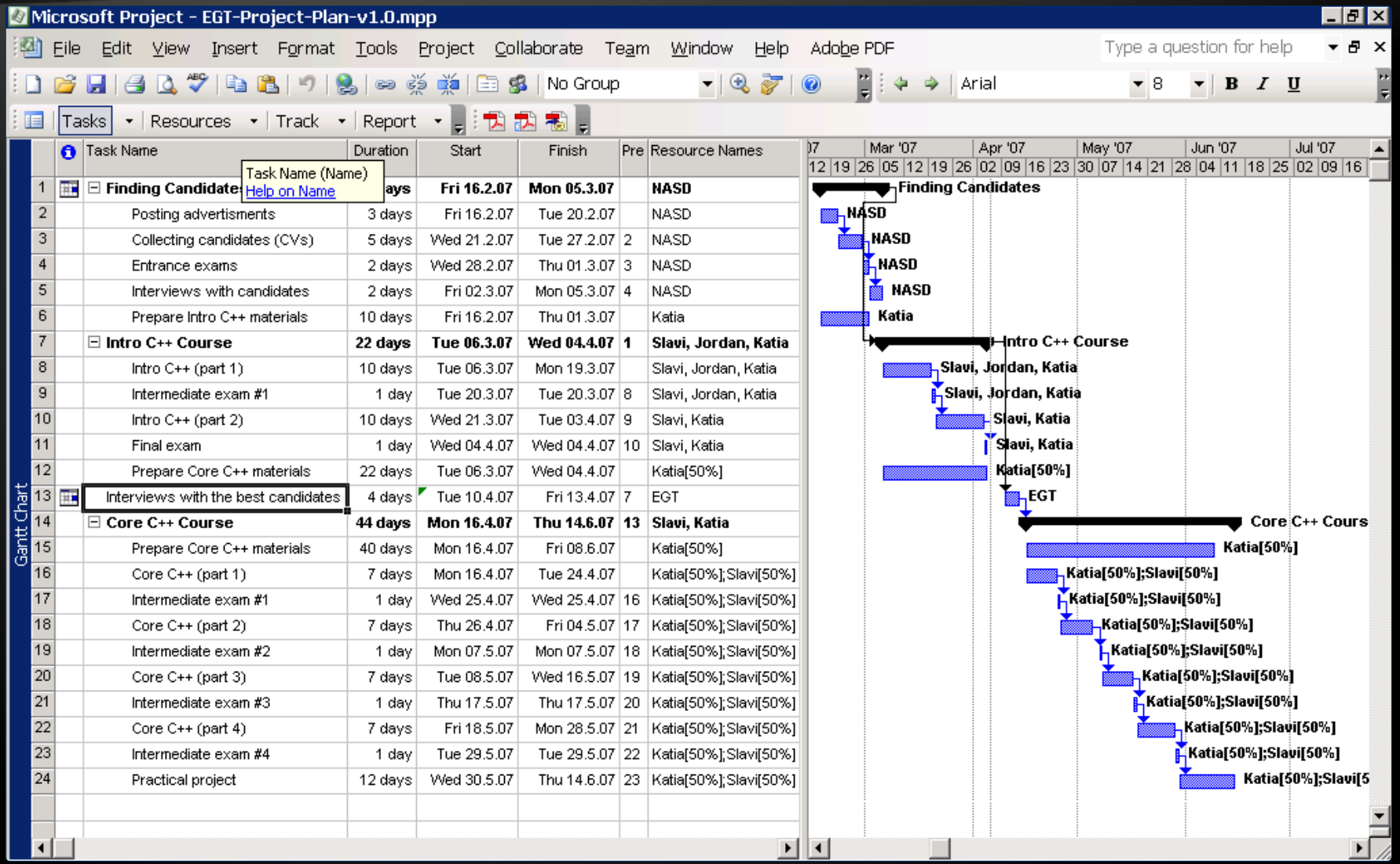
Project Plan – Example



	Task Name	Duration	Start	Finish	Pre	Resource Names
1	**Finding Candidates**	**days**	**Fri 16.2.07**	**Mon 05.3.07**		**NASD**
2	Posting advertisments	3 days	Fri 16.2.07	Tue 20.2.07		NASD
3	Collecting candidates (CVs)	5 days	Wed 21.2.07	Tue 27.2.07	2	NASD
4	Entrance exams	2 days	Wed 28.2.07	Thu 01.3.07	3	NASD
5	Interviews with candidates	2 days	Fri 02.3.07	Mon 05.3.07	4	NASD
6	Prepare Intro C++ materials	10 days	Fri 16.2.07	Thu 01.3.07		Katia
7	**Intro C++ Course**	**22 days**	**Tue 06.3.07**	**Wed 04.4.07**	**1**	**Slavi, Jordan, Katia**
8	Intro C++ (part 1)	10 days	Tue 06.3.07	Mon 19.3.07		Slavi, Jordan, Katia
9	Intermediate exam #1	1 day	Tue 20.3.07	Tue 20.3.07	8	Slavi, Jordan, Katia
10	Intro C++ (part 2)	10 days	Wed 21.3.07	Tue 03.4.07	9	Slavi, Katia
11	Final exam	1 day	Wed 04.4.07	Wed 04.4.07	10	Slavi, Katia
12	Prepare Core C++ materials	22 days	Tue 06.3.07	Wed 04.4.07		Katia[50%]
13	Interviews with the best candidates	4 days	Tue 10.4.07	Fri 13.4.07	7	EGT
14	**Core C++ Course**	**44 days**	**Mon 16.4.07**	**Thu 14.6.07**	**13**	**Slavi, Katia**
15	Prepare Core C++ materials	40 days	Mon 16.4.07	Fri 08.6.07		Katia[50%]
16	Core C++ (part 1)	7 days	Mon 16.4.07	Tue 24.4.07		Katia[50%];Slavi[50%]
17	Intermediate exam #1	1 day	Wed 25.4.07	Wed 25.4.07	16	Katia[50%];Slavi[50%]
18	Core C++ (part 2)	7 days	Thu 26.4.07	Fri 04.5.07	17	Katia[50%];Slavi[50%]
19	Intermediate exam #2	1 day	Mon 07.5.07	Mon 07.5.07	18	Katia[50%];Slavi[50%]
20	Core C++ (part 3)	7 days	Tue 08.5.07	Wed 16.5.07	19	Katia[50%];Slavi[50%]
21	Intermediate exam #3	1 day	Thu 17.5.07	Thu 17.5.07	20	Katia[50%];Slavi[50%]
22	Core C++ (part 4)	7 days	Fri 18.5.07	Mon 28.5.07	21	Katia[50%];Slavi[50%]
23	Intermediate exam #4	1 day	Tue 29.5.07	Tue 29.5.07	22	Katia[50%];Slavi[50%]
24	Practical project	12 days	Wed 30.5.07	Thu 14.6.07	23	Katia[50%];Slavi[50%]

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Development Methodologies

Waterfall, Scrum, Lean Development, Kanban, Extreme Programming

What is a Development Methodology?

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

Development Methodologies

- Back in history
  - The "Waterfall" Process
    - Old-fashioned, not used today
  - Rational Unified Process (RUP)
  - Microsoft Solutions Framework (MSF)

- Modern development methodologies
  - Agile development processes
  - Scrum, Kanban, Lean Development, Extreme Programming (XP), etc.

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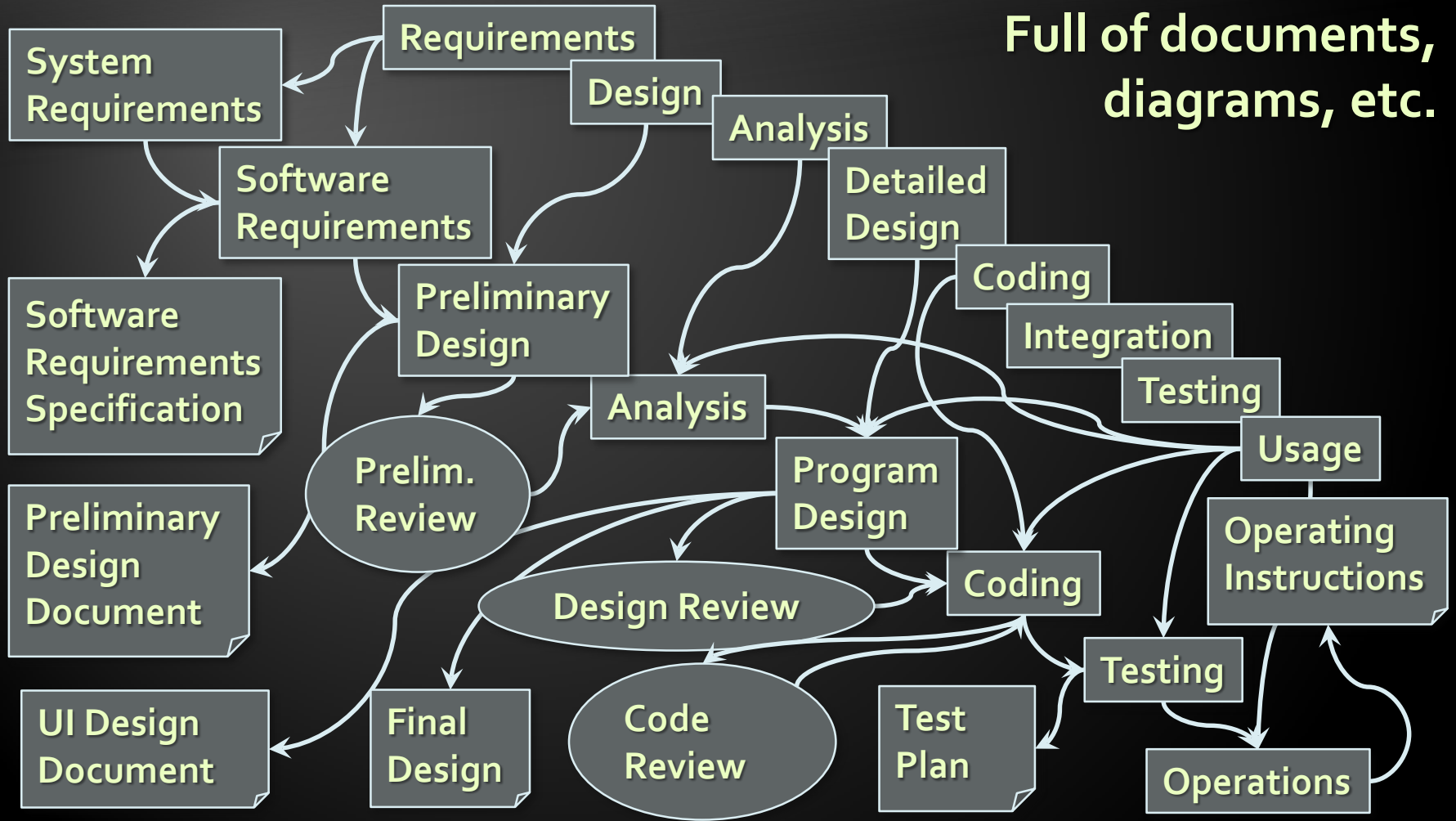
The Waterfall Development Process

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

The Agile Spirit

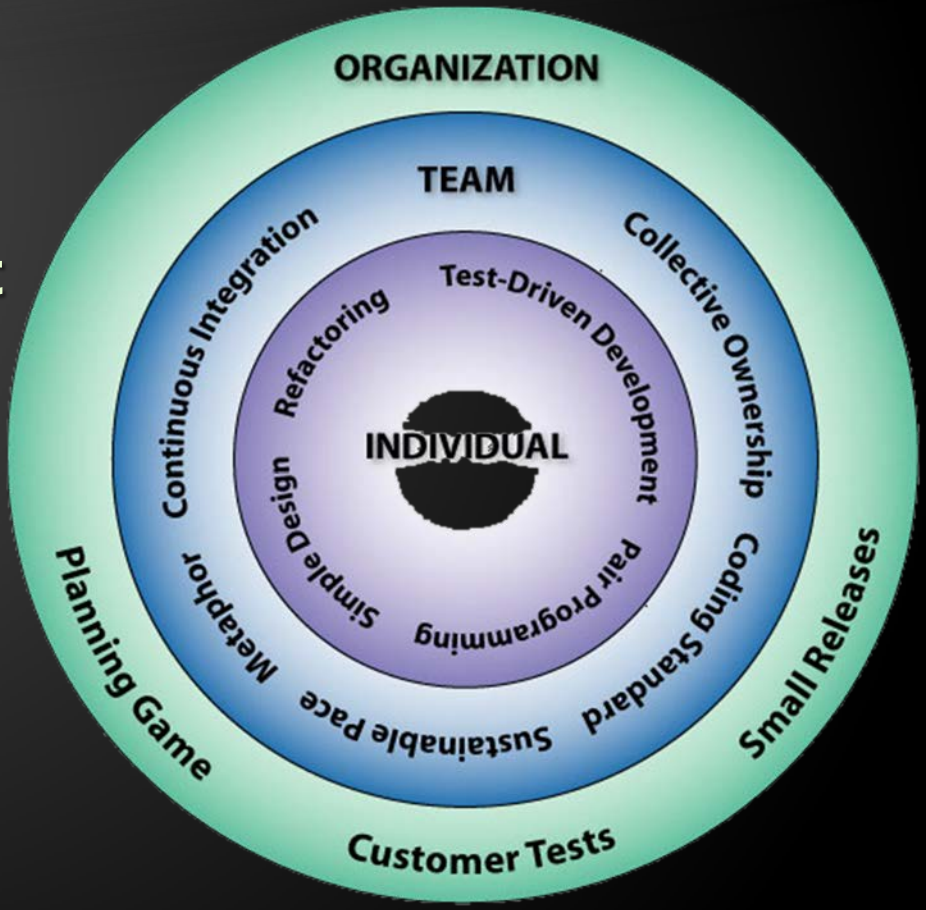
- Incremental
  - Working software over comprehensive documentation
- Cooperation
  - Customer collaboration over contract negotiation
- Straightforward
  - Individuals and interactions over processes and tools
- Adaptive
  - Responding to change over following a plan

Agile Methodologies

- Scrum
- Kanban
- Lean Software Development
- eXtreme Programming (XP)
- Feature-Driven Development (FDD)
- Crystal family of methodologies
- 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



Scrum

- Scrum is an iterative incremental framework for managing complex projects

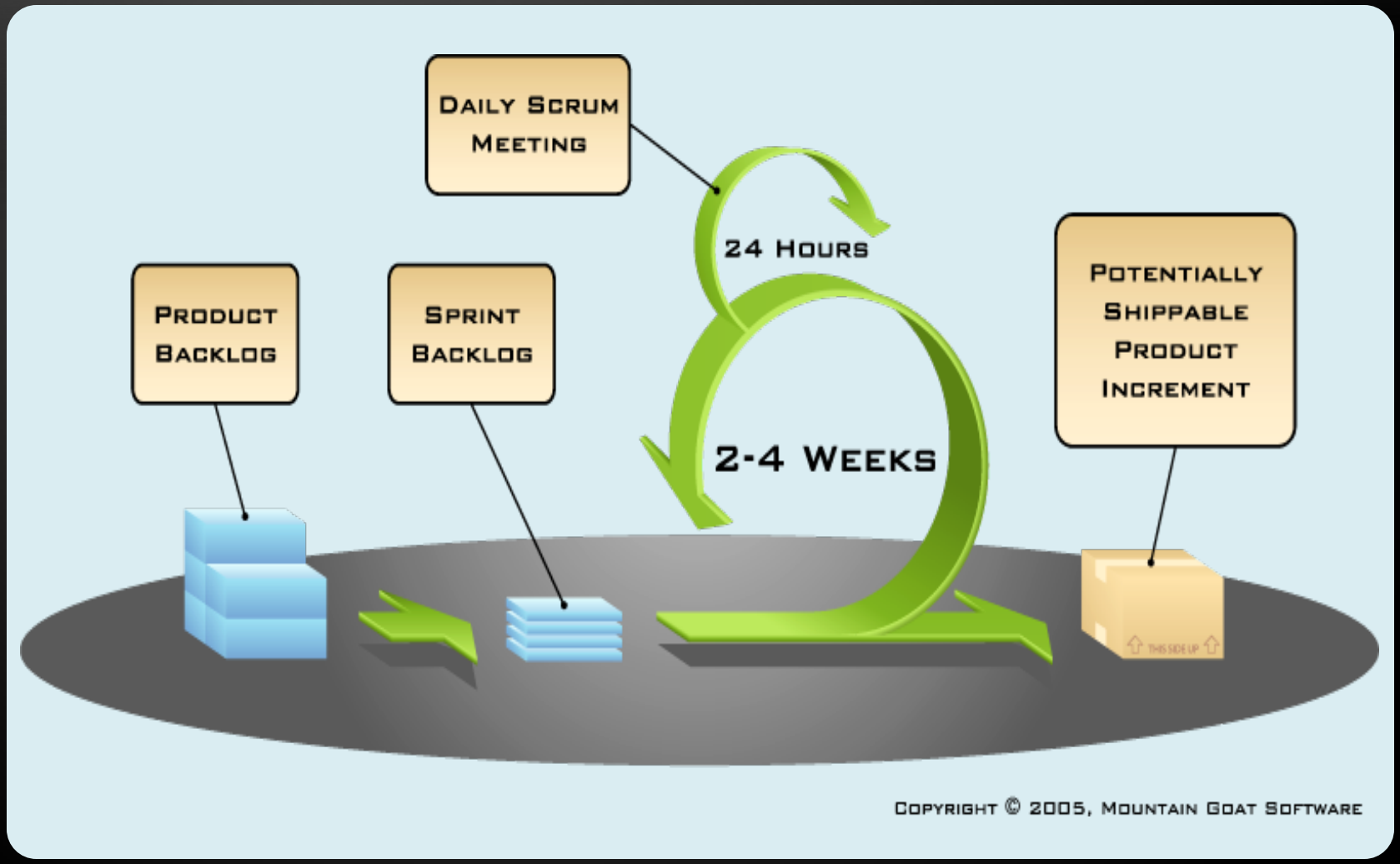
- Scrum roles:
  - Scrum Master – maintains the Scrum processes
  - Product Owner – represents the stakeholders
  - Team – a group of about 7 people
    - The team does the actual development: analysis, design, implementation, testing, etc.

Scrum Terminology

- Sprint
  - An iteration in the Scrum development
  - Usually few weeks

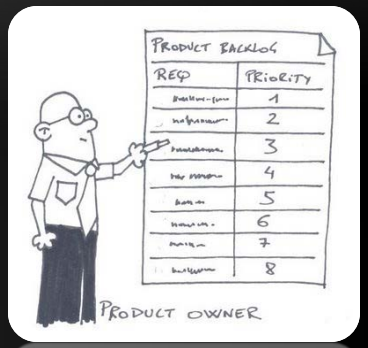
- Product Backlog
  - All features that have to be developed
- Sprint Backlog
  - All features planned for the current sprint

The Scrum Process Framework



Scrum Practices

- Sprint Planning Meeting
  - At the beginning of the sprint cycle
  - Establish the Sprint backlog



- Daily Scrum stand-up meeting
  - Each day during the sprint – project status from each team member
  - Timeboxed to 15 minutes
- Sprint Review Meeting
  - Review the work completed / not completed

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