Quality Attributes

Software Architecture
3rd Year – Semester 1
Lecture 11

Software Requirements

- Expectations from the Software/System
- Stakeholders/users/roles may have different requirements
  - End User: Needs the functionality work without issues, Wish the system to be easy to use
  - Project Manager: Low Cost
  - Admin/Security/Maintenance: May have their own specialized wishes
  - Sometimes there may be conflicts of requirements

Example: A manager wants low cost, but a user wants rich features

- Needs Vs. Wants

Requirements…

Q: When to identify requirements?
A: At the start of the Project

Q: Who is responsible for requirements?
A: Business Analyst + Architect

Software Architect must identify "Architectural Significant Requirements" (ASR)
Software Architect should find a balance between needs & wants

These are requirements that directly affect the system design or structure

Q: Why the Requirements should be clear?
A: Changes are costly, specially if the changes come in later stages

Types of Requirements

- Functional
  - What the system must do
  - How it must behave
  - How it must react
- Non-Functional
  - Quality Attributes
  - Business Requirements
  - Constraints

Exercise

- Write down the requirements for a Calculator on a Mobile Phone
- Functional
  - Basic + - * / operations
  - Support for Square root, etc…
  - Support for Brackets
- Non Functional
  - Should work for Android and iOS and later on Windows
  - Buttons should be placed in Number pad order
  - Support to add more operations later on (e.g. Log, Sin, Cos, …)
  - Landscape UI Support ??
  - How many digits to display on the UI ?? (e.g. 0.33333333333333333333)

Definition of Quality & Functionality

- Functionality: The capability of the software product to provide functions which meets stated and implied needs when software is used under specified conditions ability of the software to perform the functions required by the user under certain conditions.
- Quality: The extend to which a product satisfies stated and implied needs when used under specified conditions

How well the software satisfies user needs

Aspect	Functionality	Quality
Related to	Features and behavior	Performance, usability, reliability, etc.
Architecture Impact	Doesn't directly define architecture	**Big impact** on architecture
Type	Functional Requirement	**Non-Functional Requirement**

Functionality & Quality

- Functionality does not determine the Architecture
- For a given set of Functional Requirement you can create an endless amount of Architectures to Satisfy the requirements
- Functionality and Quality Attributes are Orthogonal (difference dimensions) independent but both are important.

Non-Functional Requirements

- Non-Functional requirements are not directly linked to any specific function
- They are qualifications that typically cover business and system quality requirements and have a big influence on the architecture
- When they are forgotten at the beginning of a project, it often results in major problems in later stages of the project

Quality Attributes (overview)

- Qualifications of the functional requirements or of the overall product
  - Runtime Qualities – Performance
  - User Qualities – User Friendliness / UX
- Measurable and Testable properties of the system that are used to indicate how well the system satisfies the needs of the stakeholders
- There are many Quality Attributes and the list keeps growing…

Business Requirements

- Business or strategic decisions
  - Cost
  - Time to Market
  - System Lifetime
- Strategic Trade-offs are made
  - E.g. Building Brand New Software Vs. Purchasing Existing Software

Constraints

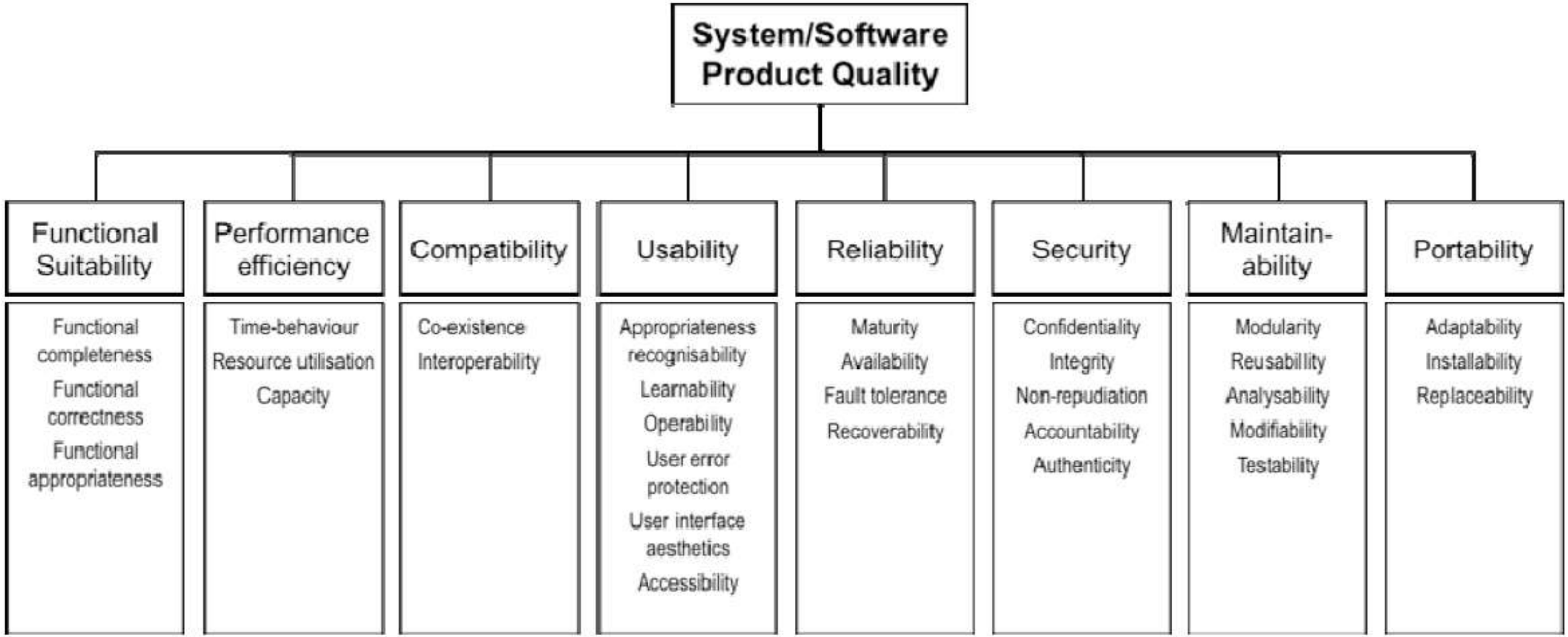
- Decisions/Agreements arrived beforehand
- No freedom to change and No Trade-offs can be made
  - E.g. Must use Open Source Software for Development

Software Architect has to make sure the Architecture Adheres to the constraints

Quality Attributes

Design Qualities	Run-time Qualities	System Qualities	User Qualities
• Modifiability • Reusability • Maintainability	• Performance • Reliability • Availability • Security • Scalability • Interoperability	• Testability • Supportability	• Usability • Accessibility

Quality Attribute – ISO 25010 Classification



Nature of Quality Attributes

- Quality Attributes may be related to one use case or part/module of the system or system as a whole
- Quality Attributes typically relate to different phases of the system life cycle such as design time and runtime qualities
- Quality Attributes may impact on each other
  - Performance is affected by almost all the other Quality Attributes

Role of an Architect on Quality Attributes

- Understand the Importance and Priority of the Quality Requirements of the System
- Evaluate and make Trade-Offs to meet the Quality Levels to satisfy the Stakeholders

Issues with Quality Attributes Definitions

- Grouped differently by different authors
- Overlapping (or Similar) Attributes
  - Integrity & Security
- Confusion with definition/meaning of Attributes
  - Performance: Responsiveness, Efficiency (CPU % Use)

Quality Attribute: Availability

- System Services are available when and where the users need to use them
- Proportion of time that the system is functional and working
- Affected by
  - System Errors
  - Maintenance Tasks
  - Infrastructure Failures
  - Malicious Attacks
  - System Load
  - Dependent Services
- Can be measured as a percentage of the total system downtime over a predefined period

Quality Attribute: Interoperability

- Ability of a system to exchange information successfully by communicating with other systems
- Interoperability Considerations
  - Syntactic: Ability to communicate between systems using specified data & communication protocols
  - Semantic: Ability to automatically interpret the information exchanged meaningfully and accurately in order to produce useful results

Quality Attribute: Modifiability

- Cost to make a change
  - Lower cost to change → higher in Modifiability
- Change Types
  - Functional Change
  - Environment Change (Host OS/Platform)
  - Protocols (Communication Protocols, etc…)
  - Dependencies (MySQL → Oracle Vs. MySQL → MongoDB)

Quality Attribute: Performance

- Performance is an indication of the responsiveness of a system to execute any action within a given time interval.
- It can be measured in terms of latency or throughput. Latency is the time taken to respond to any event.
- Throughput is the number of events that take place within a given amount of time.

Quality Attribute: Reliability

- Ability of a system to remain operational over time
- Probability that a system will not fail to perform its intended functions over a specified time interval
- How users and other systems can be dependable of a given software, protocol, hardware, etc...
- Affected by other attributes
  - Availability
  - Accuracy
  - Predictability

Quality Attribute: Reusability

- Capability for components and subsystems to be suitable for use in other applications and in other scenarios
- Minimizes the duplication of components and also the implementation time

- E.g. Software Libraries

Quality Attribute: Scalability

- Ability of a system to either handle increases in load without impact on the performance of the system, or the ability to be readily enlarged
  - Load
  - Functions
  - Geographic
- Methods
  - Horizontal: Add more Servers
  - Vertical: Add/Improve hardware (e.g. CPU) of the same Server

Quality Attribute: Security

- Capability of preventing Malicious Attacks
  - Virus
- Preventing unauthorized usage
- Protecting System Assets
  - Data
  - Hardware

Question:

Denial of Service: Is this a Security issue?

Is this only a Security issue?

No, it's also an availability issue (since it brings down the service).

Quality Attribute: Testability

- Create test criteria for the system and its components, and to execute these tests in order to determine if the criteria are met
  - How much can be tested?
  - How much time it takes to test?
- Testability makes it more likely that faults in a system can be isolated in a timely and effective manner

Quality Attribute: Usability

- How well the application meets the requirements of the user and consumer by being intuitive, easy to localize and globalize, providing good access for disabled users, and resulting in a good overall user experience.
- Usability Considerations
  - How easy it is to learn the features of the system
  - How efficiently the user can use the system
  - How well the system handles user errors
  - How well the system adapts to user needs
  - To what degree the system gives the user confidence in the correctness of its actions

Architectural Attributes & Considerations

- Architectural quality attributes are also similar to system quality attributes, but concerned with aspects of the architecture itself.
  - Conceptual integrity : The architecture should do similar things in similar ways.
  - Correctness and completeness : Concerned with checking the architecture for errors and omissions.
  - Buildability : Allows the system to be completed by the available team in a timely manner and to be open to certain changes as development progresses

Quality Attribute Scenarios (QAS)

- Universal for Formal way to express Quality Attributes
- The goal of QAS is to capture and document unambiguous and testable requirements
  - Document similar to Use Case scenarios

NEXT LECTURE:

Template to express Quality Attributes

How to apply it

Concrete System Specific Qualities

Tactics

- An architectural tactic is a means of satisfying a quality attribute response measure by manipulating some aspect of a quality attribute model through architectural decisions

NEXT LECTURE:

Ways to improve Quality Attributes

Tactics Framework