Software System Design - Architecture

Assignment1

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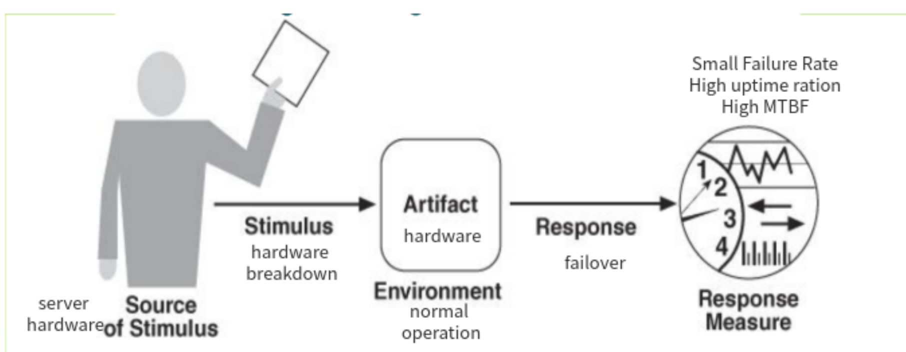
Task1: Quality Attribute Scenarios

Reliability & Recoverability

Reliability General Scenario

Portion of Scenario	**Possible Values**
Stimulus	Events that could potentially cause a system failure, such as invalid inputs, resource exhaustion, environmental changes.
Stimulus Source	Entities that generate failure-inducing stimuli, e.g. users, hardware, third-party systems.
Response	one or many of the following: 1. Failover: Switching to redundant components upon failure to maintain function. 2. Diagnosis: Investigating issues to determine root causes of problems. 3. Restart: Stopping and restarting malfunctioning software processes.
Response Measure	1. Uptime Ratio: the percentage of time that a system is functioning properly. 2. Mean Time Between Failure 3. Failure Rate: the frequency with which a system or component fails.
Environment	start up, normal operation, shutdown, overloaded operation
Artifact	Critical system components that need to function without failure.

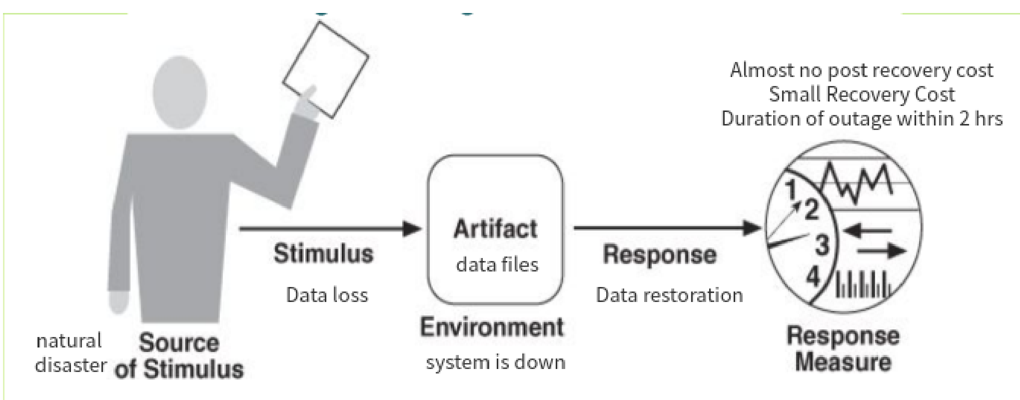
Reliability Concrete Scenario



Recoverability General Scenario

Portion of Scenario	Possible Values
Stimulus	The specific failure event, data corruption, infrastructure damage, etc.
Stimulus Source	An unforeseen failure or major system issue that compromises data or functionality, requiring recovery to restore service.
Response	one or many of the following: 1. Diagnosis 2. Repair 3. Data Restoration 4. Restart to a consistent state
Response Measure	1. Duration of Outage 2. Data/Functionality Loss 3. Mean Time to Recover 4. Recovery Cost 5. Post Recovery Defects
Environment	The system is in a malfunctioning state
Artifact	Critical System Component (may be code, hardware, data, service, etc) to be recovered.

Recoverability Concrete Scenario

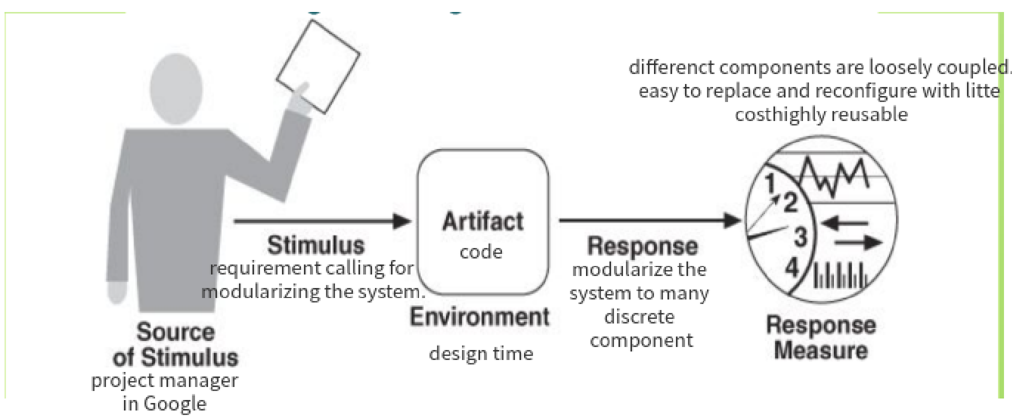


Modularity & Reusability

Modularity General Scenario

Portion of Scenario	Possible Values
Stimulus	The requirements that demand making the system modular.
Stimulus Source	The stakeholders that determine the requirements, such as customers, managers, end users, etc.
Response	Components are redesigned as loosely coupled modules focused on single capabilities.
Response Measure	1. The extent of coupling between different components. 2. The cose to modify, replace or reconfigure modules without major impact. 3. Reusability of modules in alternative configurations
Environment	Design time.
Artifact	Code

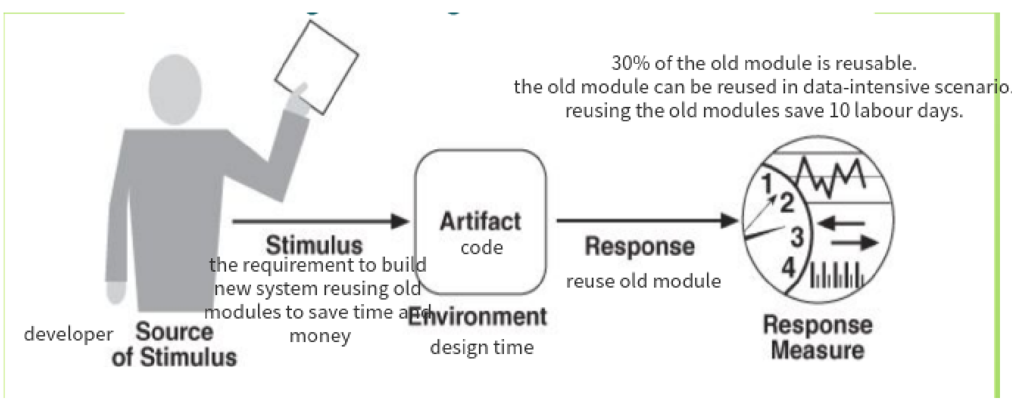
Modularity Concrete Scenario



Reusability General Scenario

Portion of Scenario	Possible Values
Stimulus	The need to reuse existing components instead of reinventing the wheel.
Stimulus Source	developer
Response	1. Analyzing the system, extract and modularize some parts which should be reusable and redesign the system. 2. reuse past code to build new modules.
Response Measure	1. Percentage of system composed of reusable elements 2. Number of contexts in which elements can be reused, that is, how well can this component to be reused. 3. Cost/time savings by reusing rather than rebuilding components.
Environment	design time
Artifact	Code

Reusability Concrete Scenario



Task2: Tactics

Strategy	Tactic	Impact on Reliability	Impact on Recoverability	Impact on Modularity	Impact on Reusability
Robustness Testing	Stress Test	Hardens system by exposing weaknesses.	N/A	N/A	N/A
	Worst Scenario Test	same as above	N/A	N/A	N/A
Redundancy	Backup Server	Prevents single points of failure.	Improve recovery speed.	N/A	N/A
	RAID Storage	same as above	same as above	N/A	N/A
Incremental Backups	Snapshots	Faster recovery, prevent data loss, etc	Allows granular restoration to recent working state.	N/A	N/A
	Replication	same as above	same as above	N/A	N/A
Disaster Recovery	Redundant data centers	maintain normal operation in disaster condition.	Gets system up quickly even after a crash to limit downtime.	N/A	N/A
	Failover procedures	same as above	same as above	N/A	N/A

Strategy	Tactic	Impact on Reliability	Impact on Recoverability	Impact on Modularity	Impact on Reusability
Loose Coupling	Abstraction	N/A	N/A	Changes to one module limit impact on others.	Easier to reuse.
	Standard interfaces	N/A	N/A	same as above	same as above
Segmentation	Microservices	prevent faliure in one microservices to propagate to others.	failure in a microservices does not entail the restart of the whole system, making recovery faster.	Units can be modified, replaced or scaled independently.	Fine grained units are easier to be reused.
	Componentization	N/A	N/A	same as above	same as above
Standardization	Style guides	N/A	N/A	N/A	New uses for existing standardized elements emerge.
	Use APIs	N/A	N/A	N/A	same as above

Strategy	Tactic	Impact on Reliability	Impact on Recoverability	Impact on Modularity	Impact on Reusability
Generalization	Promote polymorphism	N/A	N/A	N/A	Fewer variations needed and wider range of potential reuse.
	Interface Oriented Programming	N/A	N/A	easier to modularize due to low coupling.	same as above
	identify common requirements	N/A	N/A	easier to plan modularization.	same as above
Fault Detection	Exception handling	Problems can be addressed before causing significant disruption.	N/A	N/A	N/A
	Error logging	same as above	provide some information for recovery.	N/A	N/A

Task3: Quality Attribute Debate

Essay

> Identify the quality attributes that may relate to 'maintainability', such as (not limited to) 'testability', 'complexity', and 'reusability', and discuss their relationships with 'maintainability' based on your research. Describe the research you did on this task, and elaborate the reasons to support your
> argument.

Maintainability

Maintainability refers to the ease with which a system can be modified or adjusted to changes. From my perspective, maintainability is closely related to complexity, testability and extensibility - three quality attributes that impact software maintenance activities. This essay will explore how these quality attributes relate to maintainability.

Complexity and Maintainability
Complexity refers to the degree of interconnectivity and interdependence between components in a system. Complex systems are difficult to understand, which increases the cost of software maintenance. For example, complex code is hard to comprehend and debug, requiring more time, budget and effort to fix bugs - an important part of software maintenance. A study (*Banker, Rajiv D. and Datar, Srikant M., Software Complexity and Maintainability*) found that software complexity directly impacts maintenance costs. **In summary**, controlling complexity promotes maintainability by reducing maintenance costs.

Testability and Maintainability
Software testing is crucial to software maintenance. **Testability** refers to the degree to which a system supports testing. Highly testable systems enable developers to detect more bugs efficiently, reducing the cost and effort to fix them. Poorly testable systems require more time and resources to test and debug. **Therefore**, testability improves maintainability by decreasing the cost of resolving issues.

Extensibility and Maintainability
Extensibility refers to the ability to extend a system for future growth. Extending software is an important part of maintenance. Highly extensible systems are easy to extend without affecting other modules or requiring retesting, saving time and resources. Adding features to poorly extensible systems can impact other modules, requiring additional testing and maintenance. **In summary**, extensibility enhances maintainability by facilitating software extensions with minimal cost or effort.

In conclusion, complexity, testability and extensibility are quality attributes that significantly impact software maintenance activities. By controlling complexity, improving testability and extensibility, we can build highly maintainable software systems that can evolve and change efficiently.

Research Process Framework

Information was collected from Wikipedia, Google Scholar and additional scholarly sources on software quality attributes and maintainability. An analysis was conducted to examine how each quality attribute relates to and impacts maintainability.

References

[1]Banker, Rajiv & Datar, Srikant & Zweig, Dani. (1989). Software complexity and maintainability. 247-255. 10.1145/75034.75056.

[2] Wikipedia, "Complexity." https://en.wikipedia.org/wiki/Complexity.

[3] Wikipedia, "Extensibility." https://en.wikipedia.org/wiki/Extensibility.

[4] Wikipedia, "Testability." https://en.wikipedia.org/wiki/Testability.