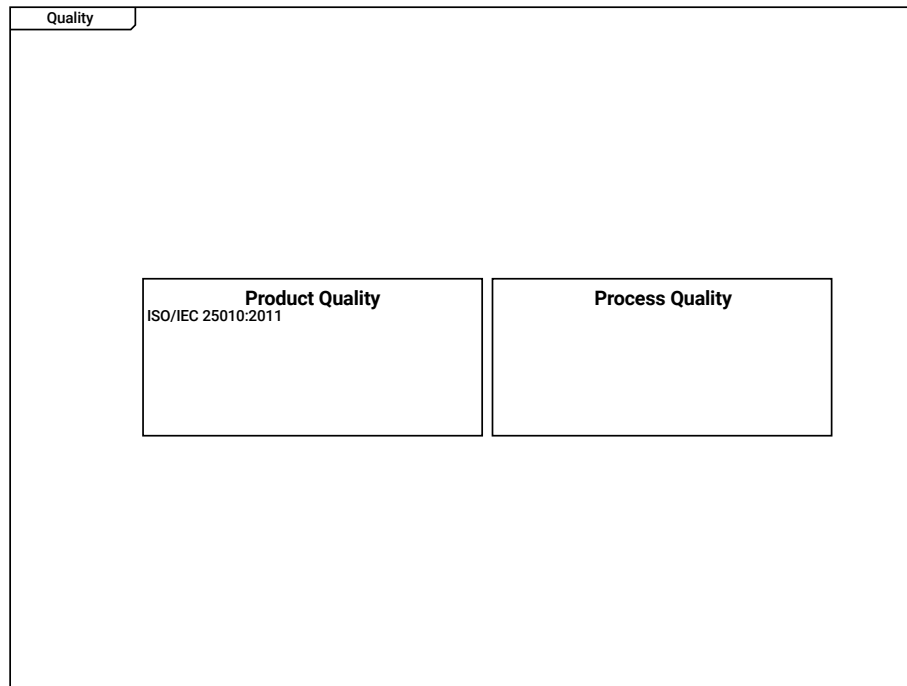


1 Quality Example

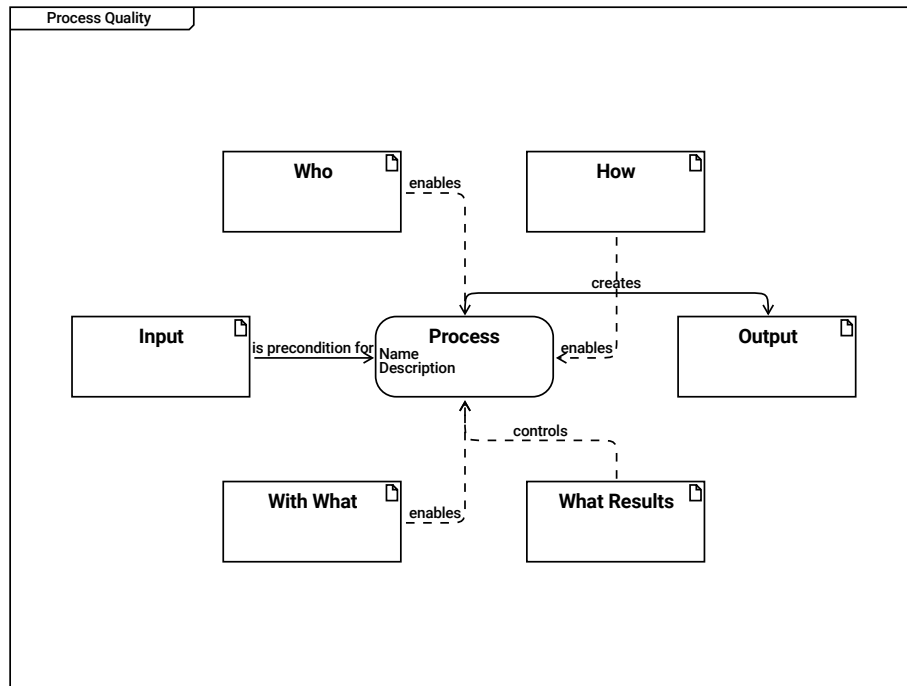


Quality

Product Quality
ISO/IEC 25010:2011

Process Quality

2 Process Quality



Process Quality

| The turtle diagram shows the elements of a process.

Who

| Roles,
| Skills, Knowledge,
| Trainings
enables --> Process

How

| Guidelines, Checklists,
| Templates
enables --> Process

Input

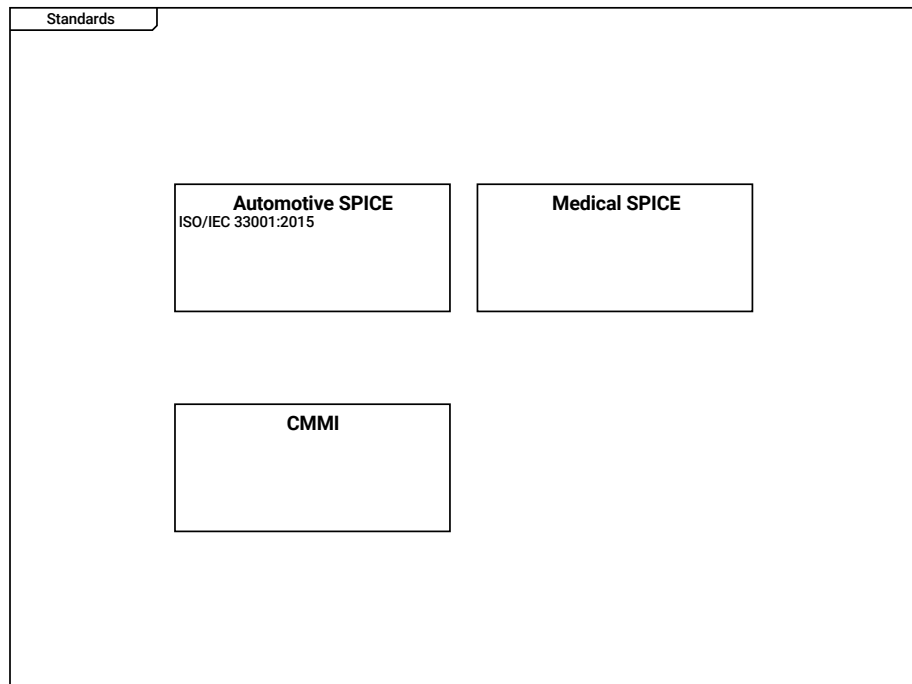
is precondition for --> Process

Process
Name
Description
creates --> Output

Output
| Process output,
| Evidence on performed process

With What
enables --> Process

What Results
controls --> Process

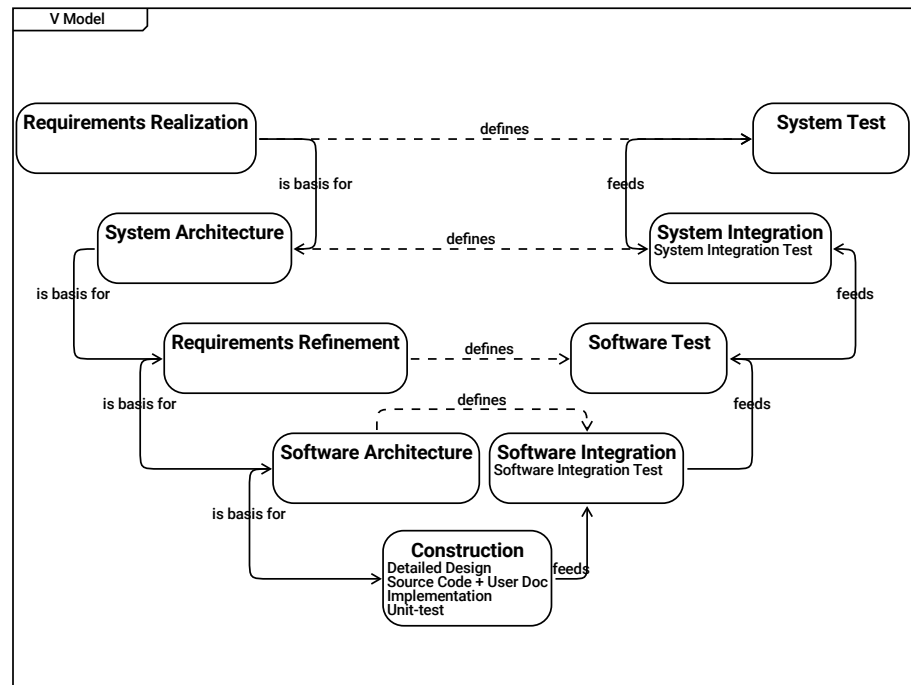


Standards

Automotive SPICE
ISO/IEC 33001:2015

Medical SPICE

CMMI



V Model

Requirements Realization
is basis for --> System Architecture
defines --> System Test

System Test

System Architecture
is basis for --> Requirements Refinement
defines --> System Integration

System Integration
System Integration Test

feeds --> System Test

Requirements Refinement
is basis for --> Software Architecture
defines --> Software Test

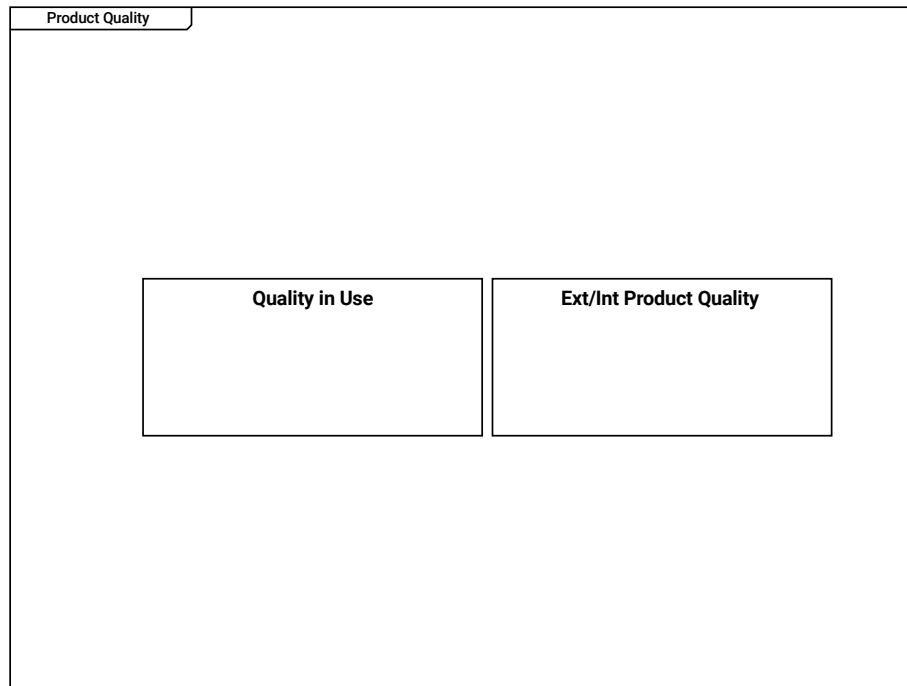
Software Test
feeds --> System Integration

Software Architecture
defines --> Software Integration
is basis for --> Construction

Software Integration
Software Integration Test
feeds --> Software Test

Construction
Detailed Design
Source Code + User Doc
Implementation
Unit-test
feeds --> Software Integration

3 Product Quality



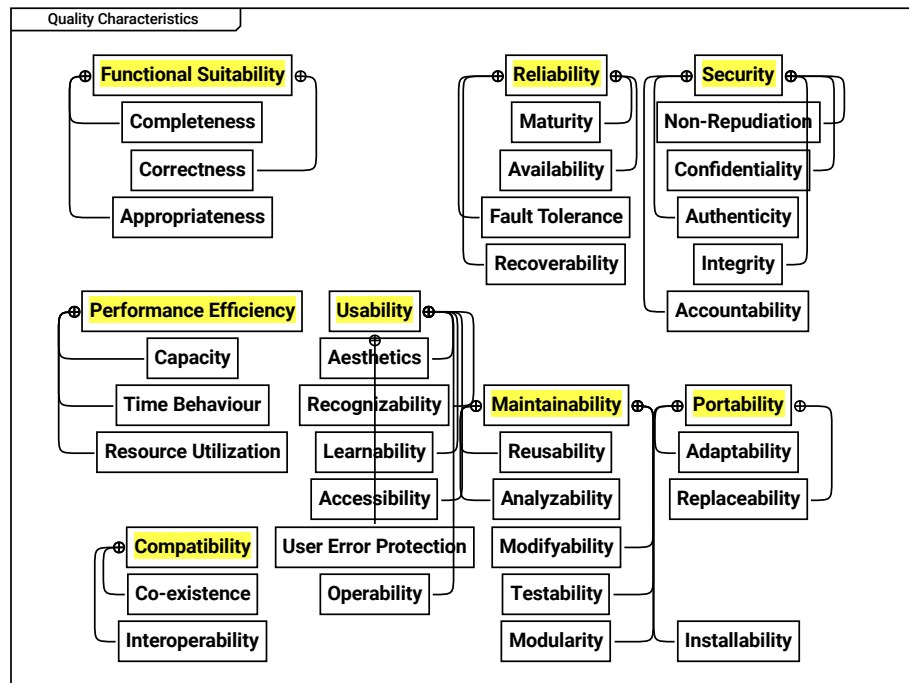
Product Quality

Quality in Use

- | Quality in use can be measured when the product is already in use,
- | e.g. the percentage of satisfied customers can be determined.

Ext/Int Product Quality

- | Product quality are internal and externally visible qualities,
- | such as memory consumption or startup timings.



Quality Characteristics
| according to ISO 25010

Functional Suitability

- > Completeness
- > Correctness
- > Appropriateness

Reliability

- > Maturity
- > Availability
- > Fault Tolerance
- > Recoverability

Security

- > Authenticity
- > Non-Repudiation
- > Accountability
- > Integrity
- > Confidentiality

Completeness

Maturity

Non-Repudiation

Correctness

Availability

Confidentiality

Appropriateness

Fault Tolerance

Authenticity

Recoverability

Integrity

Performance Efficiency

- > Time Behaviour
- > Resource Utilization
- > Capacity

Usability

- > Recognizability
- > Learnability
- > Operability
- > User Error Protection

- > Aesthetics
- > Accessibility

Accountability

Capacity

Aesthetics

Time Behaviour

Recognizability

- Maintainability
- > Testability
 - > Modifyability
 - > Analyzability
 - > Reusability
 - > Modularity

- Portability
- > Adaptability
 - > Installability
 - > Replaceability

Resource Utilization

Learnability

Reusability

Adaptability

Accessibility

Analyzability

Replaceability

Compatibility

--> Co-existence

--> Interoperability

User Error Protection

Modifyability

Co-existence

Operability

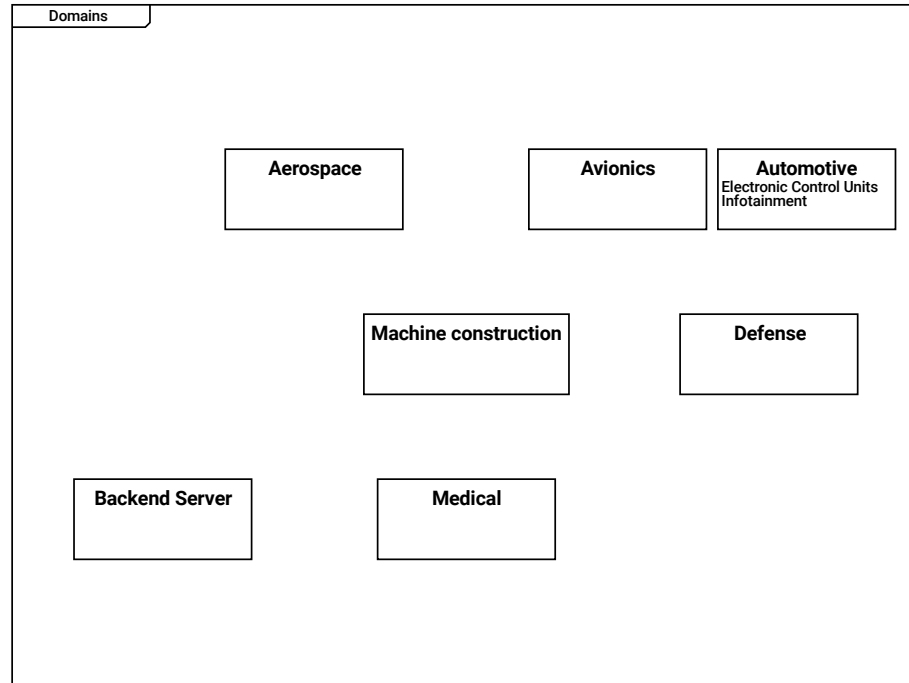
Testability

Interoperability

Modularity

Installability

3.1 Product Quality Measures



Domains

Aerospace

Avionics

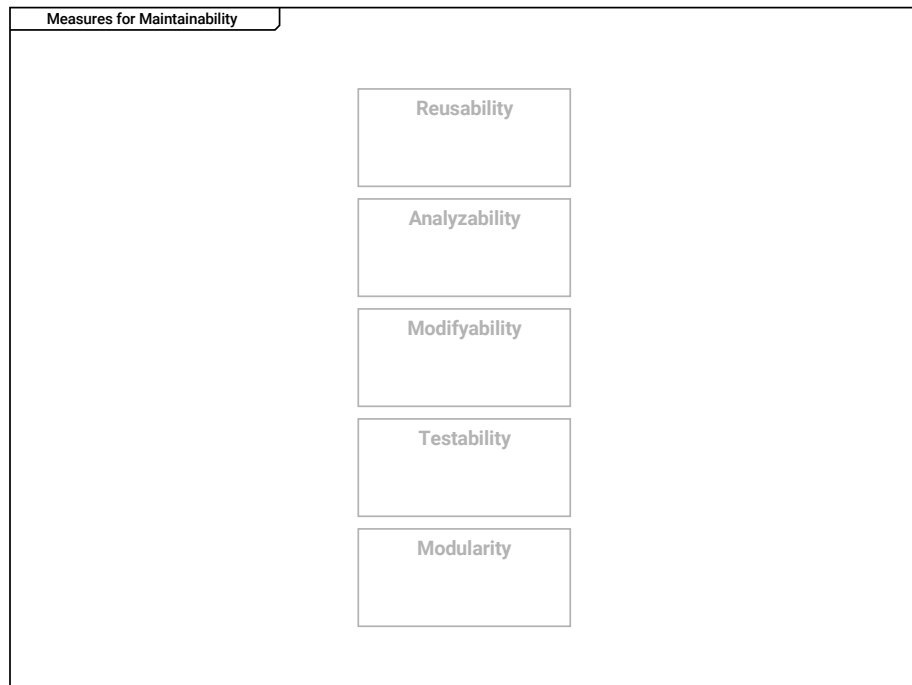
Automotive
Electronic Control Units
Infotainment

Machine construction

Defense

Backend Server

Medical



Measures for Maintainability

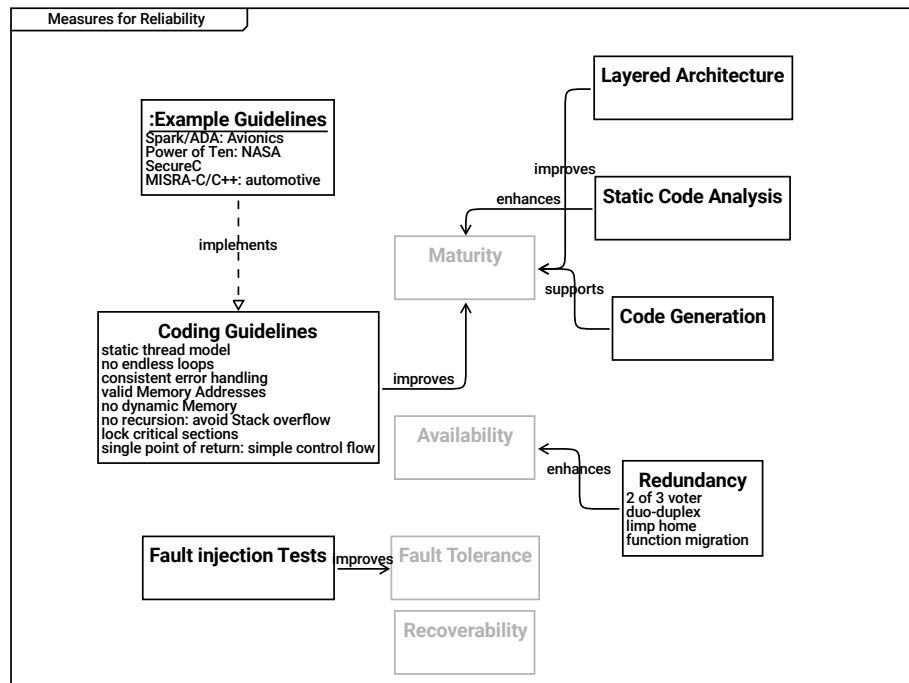
Reusability

Analyzeability

Modifyability

Testability

Modularity



Measures for Reliability

Layered Architecture
improves --> Maturity

Example Guidelines
Spark/ADA: Avionics
Power of Ten: NASA
SecureC
MISRA-C/C++: automotive
implements --> Coding Guidelines

Static Code Analysis
enhances --> Maturity

Maturity

Code Generation

- | An understandable model and a small code generator
- | allow to generate mature software.
- supports --> Maturity

Coding Guidelines

- static thread model
 - | Execution threads shall not be started/stopped dynamically
- no endless loops
 - | Every loop shall have a counter to ensures that
 - | after a predefined maximum value the loop is definitely quit
- consistent error handling
 - | Inconsistencies in error handling make
 - | bugs in error handling more likely
- valid Memory Addresses
 - | Only valid memory addresses may be read/written.
 - | E.g. Java solves this by prohibiting pointers,
 - | In C/C++, check pointers and array indices before usage
- no dynamic Memory
 - | When the program is running,
 - | - it must not fail due to
 - | - memory fragmentation (virtual addresses/physical pages)
 - | - out of memory situations
 - | - it shall have a defined timing (which new/malloc cannot provide)
- no recursion: avoid Stack overflow
- lock critical sections
 - | Always lock critical sections.
 - | Exceptions to locking are a nightmare.
- single point of return: simple control flow
 - | Simple control flow is key to understandable code
- improves --> Maturity

Availability

Redundancy

- 2 of 3 voter
- duo-duplex
- limp home
- function migration
- enhances --> Availability

Fault injection Tests

- improves --> Fault Tolerance

Fault Tolerance

Recoverability