An ISO 9126-based Quality Model to Assess the Quality of TTCN-3 Test Specifications

Benjamin Zeiss[1], Diana Vega[2], Ina Schieferdecker[2], Helmut Neukirchen[1], Jens Grabowski[1]

[1] Software Engineering for Distributed Systems Group,
Institute for Computer Science, Georg-August-University of Göttingen

[2] ETS, Institute for Telecommunication Systems,
Technical University of Berlin

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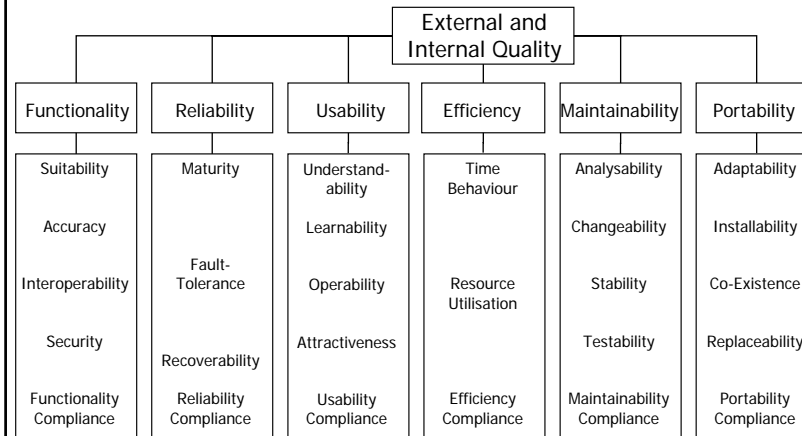
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1. Motivation

- Large and complex test specifications:
  - For example:
    The test suite Session Initiation Protocol (SIP)
    comprises more than 60.000 lines of TTCN-3 code.

- What is the "Quality of a Test Specification"?

  ⇒ **A quality model for test specifications is
  required!**

2. Software Quality Models

- Impartial assessment of software quality.
- Impartial objectives for software quality.

- ISO 9126-1:
  Software engineering – Product quality – Quality Model
  - Quality models for
    - internal quality,
    - external quality,
    - quality in use.

  Quality is composed of discrete characteristics, which
  may be structured into further sub-characteristcs.
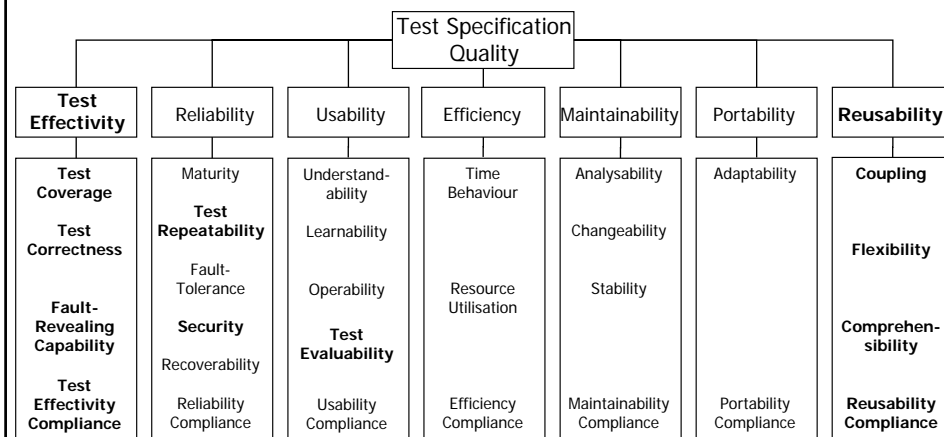
The ISO 9126 Model for Internal and external Quality

External and Internal Quality

Functionality	Reliability	Usability	Efficiency	Maintainability	Portability
Suitability	Maturity	Understand-ability	Time Behaviour	Analysability	Adaptability
Accuracy		Learnability		Changeability	Installability
Interoperability	Fault-Tolerance	Operability	Resource Utilisation	Stability	Co-Existence
Security		Attractiveness		Testability	Replaceability
	Recoverability				
Functionality Compliance	Reliability Compliance	Usability Compliance	Efficiency Compliance	Maintainability Compliance	Portability Compliance

3. A Quality Model for Test Specifications

Test Specification Quality

Test Effectivity	Reliability	Usability	Efficiency	Maintainability	Portability	Reusability
Test Coverage	Maturity	Understand-ability	Time Behaviour	Analysability	Adaptability	**Coupling**
Test Correctness	**Test Repeatability**	Learnability		Changeability		
	Fault-Tolerance		Resource Utilisation			**Flexibility**
Fault-Revealing Capability	**Security**	Operability		Stability		
		Test Evaluability				**Comprehen-sibility**
	Recoverability					
Test Effectivity Compliance	Reliability Compliance	Usability Compliance	Efficiency Compliance	Maintainability Compliance	Portability Compliance	**Reusability Compliance**

4. The Instantiation of Quality Models

- A quality model abstracts from
    - the test specification language and
    - project-specific requirements.

    ⇒ **An instantiation of a quality model is needed!**

- ISO 14598: Software engineering – Product evaluation
    1. Create the quality model.
    2. Select metrics for quality characteristics.
    3. Define threshold values for metrics.
    4. Weighing of quality characteristics.

An Instantitiation of the Test Quality Model for TTCN-3

- Testing and Test Control Notation version 3 (TTCN-3):

```
module exampleModule {
   ...
   type record IpAddressType { charstring ipAddress };
   template IpAddressType localhostTemplate := {
      ipAddress := "127.0.0.1"
   }
   testcase exampleTestCase() runs on ExampleComponent {
      portA.send(localhostTemplate);
      alt {
         [] portB.receive(localhostTemplate) {
               setverdict(pass);
            }
         [] portB.receive(IpAddressType:{*}) {
               setverdict(fail);
            }
      }
   }
}
```

Example: TTCN-3 Metrics for the Quality Characteristic Maintainability

- Maintainability:
  - Analysability:
    - *complexity violation* $\quad := 1 - \dfrac{\Sigma \text{ too complex behaviour definitions}}{\Sigma \text{ behaviour definitions}}$

  - Changeability:
    - *code duplication* $\quad := 1 - \dfrac{\Sigma \text{ duplicated code units}}{\Sigma \text{ code units}}$

  - Stability:
    - *parameter reassignment* $:= 1 - \dfrac{\Sigma \text{ out and inout formal parameters}}{\Sigma \text{ formal parameters}}$

- Range of metrics:
  0,0 (= worst quality) to 1,0 (= best quality).

5. Application

	SIP v2.20	SIP v2.24	SIP v3.01	SIP v3.06
Test cases	1068	1068	1412	1412
Behaviour definitions	1961	1971	2360	2369
Behaviour definitions with cyclomatic complexity > 10	27	30	51	51
Branches in alt-statements	1900	1958	2482	2534
Duplicated branches in alt-statements	1435	1471	1849	1879
Formal parameters	3175	3224	5062	5084
out und inout formal parameters	1237	1244	1617	1628
Analysability metric: *complexity violation* (cyclomatic complexity >10)	0.99	0.98	0.98	0.98
Changeability metric: *code duplication* (w.r.t. branches in alt-statements)	0.25	0.25	0.26	0.26
Stability metric: *parameter reassignment*	0.61	0.61	0.68	0.68

6. Summary and Outlook

- Summary:
    - Adaptation of the ISO 9126 quality model to test spezifications.
    - Instantiation of the model for TTCN-3.

- Outlook:
    - Consideration of external quality.
    - Adaptation to the revision of ISO 9126 & 14598: ISO 25000.
    - Instantiation for the UML testing profile.
    - Constitution of a working group for the quality of test specifications at the European Telecommunications Standards Institute (ETSI).

- # Thank you for your attention!