

Software Reliability and Safety

CSE 8317 — Fall 2009

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OV.1. Overview

- Defining Quality, Reliability, and Safety
- SRE: Software Reliability Engineering
- SSE: Software Safety Engineering
- CSE 8317 Perspective and Common Analyses

Quality: Views and Aspects

View	Attribute	
	Correctness	Effectiveness
Customer (external)	Failures: reliability safety	Usability Maintainability Portability Performance Installability Readability
Developer (internal)	Faults: count distr class hazard	Design Size Change Complexity control data presentation

- 8317: Reliability/safety focus
- Things affect reliability/safety

Quality and Dependability

- ISO 9126 quality characteristics:
 - ▷ functionality, reliability, usability, efficiency, maintainability, portability
 - ▷ Characteristics into sub-characteristics (strict hierarchy)
 - ▷ customized for companies
 - e.g., IBM's CUPRIMDSO.
 - ▷ adapted to application domains
 - reliability, usability, security for Web

- Dependability: “The trustworthiness of a computing system which allows reliance to be justifiably placed on the services it delivers” (IFIP WG10.4).
 - ▷ reliability, availability, safety, security.
 - ▷ integrity and maintainability (?)
 - ▷ security sub-attributes:
 - availability, confidentiality, integrity

What Is Reliability?

- *Reliability*: Probability of failure-free operation for a specific time period or for a given set of input conditions under a specific environment
 - ▷ Probability: quantitative/statistical
 - ▷ Failure: behavioral deviations
 - ▷ Time vs. input measurement/sampling
 - ▷ Environment: OP and UBST
- Software reliability engineering (SRE):
 - ▷ Failure and other measurement/data
 - ▷ Reliability assessment
 - ▷ Reliability and other predictions
 - ▷ Decision making and management
 - ▷ Reliability and process improvement

What Is Safety?

- *Safety*: The property of being accident-free for (embedded) software systems.
 - ▷ Accident: failures with severe consequences
 - ▷ Hazard: condition for accident
 - ▷ Related to but distinct from reliability
 - ▷ Specialized techniques

- Software safety engineering (SSE):
 - ▷ Failure prevention and fault tolerance
 - ▷ Hazard identification/analysis techniques
 - ▷ Hazard resolution alternatives
 - ▷ Safety and risk assessment
 - ▷ Qualitative focus
 - ▷ Safety and process improvement

Reliability, Safety and Defects

- Defect/bug definition: SQE Ch.2
 - ▷ Failure: external behavior
 - deviation from expected behavior
 - ▷ Fault: internal characteristics
 - cause for failures
 - ▷ Error: missing/incorrect actions
 - ▷ Causal relation, but not necessarily 1-1
 - ▷ Safety-related: accident & hazard

- Defect and quality assurance: SQE Ch.3
 - ▷ Preventive actions based on analysis
 - ▷ Fault removal: insp./testing/verification
 - ▷ Fault tolerance (and safety assurance)

- Reliability/safety negatively correlated to defect (failure view).

Measurement, Analysis, & Modeling

- Measurements: SQE Ch.18
 - ▷ Result: success/failure/accident/etc.
 - ▷ Indirect measurements, as predictors:
 - activity/product internal/environment

- Analysis and modeling:
 - ▷ Model categories/context: SQE Ch.19
 - ▷ Defect analysis: SQE Ch.20
 - ▷ Risk identification: SQE Ch.21
 - ▷ Common basis for SRE & SSE
 - ▷ SRE/SSE models:
 - Data ⇒ reliability & safety

- 8317 focus: Analysis-based resolution for reliability/safety assurance and improvement

Reliability Analyses and Models

- SRE(.2).3: model = function relations
e.g., failure \sim time or input.

- Time domain approach
 - ▷ Failure arrival process
 - ▷ Statistical modeling
 - ▷ Failure count/interval/rate data
 - ▷ Time and other measurements
 - ▷ SRGMs: s/w reliability growth models
 - ▷ Assessment/prediction/decisions

- Input domain approach
 - ▷ Repeated random sampling
 - ▷ Related definitions and models
 - input domain reliability models
 - ▷ Fault seeding models

Reliability Analyses and Models

- TBRMs: tree-based reliability models
 - ▷ Both time/input domain info.
 - ▷ Additional benefit:
 - risk identification
 - guide for focused remedial actions
 - ▷ Technique: tree-based modeling
 - ▷ Development/application/SMU research
 - ▷ Major focus in 8317 (SRE.2)

- Other related issues: SRE.4
 - ▷ Implementation & applications
 - ▷ OP development & QA activities
 - ▷ Fault/defect modeling
 - ▷ Data treatment
 - ▷ Reliability composition, etc.

Safety Analysis & Improvement

- Hazard analysis and resolution (SSE.2)
 - ▷ Focus: accidents and pre-conditions (hazards), not other failures
 - ▷ “Safeware” Ch.13-16 & SQE Ch. 16.4
 - ▷ Identification and analysis
 - ▷ Resolution: elimination/reduction/control
 - ▷ Integration in development process
 - SSP (software safety program)
 - “Safeware”, Part IV (Ch.11-18)

- Formal verification related:
 - ▷ Main part: SSE.3, SQE Ch. 15.
 - ▷ PSC: SSE.4, SQE Ch. 16.5

Safety Analysis & Improvement

- Hazard analysis:
 - ▷ Fault trees: (static) logical conditions
 - ▷ Event trees: dynamic sequences
 - ▷ Other analyses
 - ▷ Generally qualitative
 - ▷ Related: hazard and risk assessment
- Hazard resolution (pre-accident)
 - ▷ Negate/block/mitigate/etc.
 - ▷ Hazard elimination/reduction/control
- Related: damage reduction (post-accident)

Safety Assurance & Improvement

- **Eliminate** identified hazard sources in material/component/software/etc.
- **Reduce** hazard likelihood/severity via:
 - ▷ Creating hazard barriers,
 - ▷ Minimizing failure probability, etc.
- **Control** hazard (after detection) via:
 - ▷ Isolation and containment,
 - ▷ Fail-safe design, etc.
- **Reduce** damage (post-accident, as compared to pre-accident for the above)

How CSE 8317 Fits In?

- Software reliability engineering (SRE):
 - ▷ SRGMs/IDRMs: assessment/prediction;
 - ▷ TBRMs and other recent development;
 - ▷ Focus: reliability analysis/improvement.

- Software safety engineering (SSE):
 - ▷ Fault/event tree analyses, etc.;
 - ▷ Hazard elimination/reduction/control;
 - ▷ Process integration, FV, FT, PSC, etc.

- Common analyses/techniques:
 - ▷ defect analysis (SQE Ch.20)
 - ▷ risk identification: SQE Ch.21