EVASERVE

Module: Technical Risks

http://www.evaserve.fi

Evaluation of the reliability risks and availability of the technical system of a service product

Authors Pasi Valkokari, Helena Kortelainen, Susanna Kunttu

Revision history

Version	Date		Comments
0.1	8.6.2005	Helena Kortelainen	First draft. Module outline.
0.2	18.11.2005	Pasi Valkokari	Second draft.
1.0	23.12.2005	Pasi Valkokari	First Final version of reliability risk evaluation description
1.1	30.6.2006	Pasi Valkokari, Susanna Kunttu	References added, text edited and contents added
1.2	28.12.2007	Pasi Valkokari	Reliability viewpoint added, updates made

Contents

1 Evaluation goal

The object of the module is to evaluate the reliability and availability of the technical system supporting a service product as a part of the quality of the service. The technical system composes the base for services and thus operational malfunctions decrease the quality of the service or prevent service materialisation. High reliability of all the system components (terminals, data transfers etc.) is thus essential for the user of the service and the significance of the reliability of the technical system is emphasised on the applications critical for safety. The service ability concepts have been described in the standard International electro-technical vocabulary. Dependability and quality of service SFS-IEC 50(191) as shown in Figure 1.

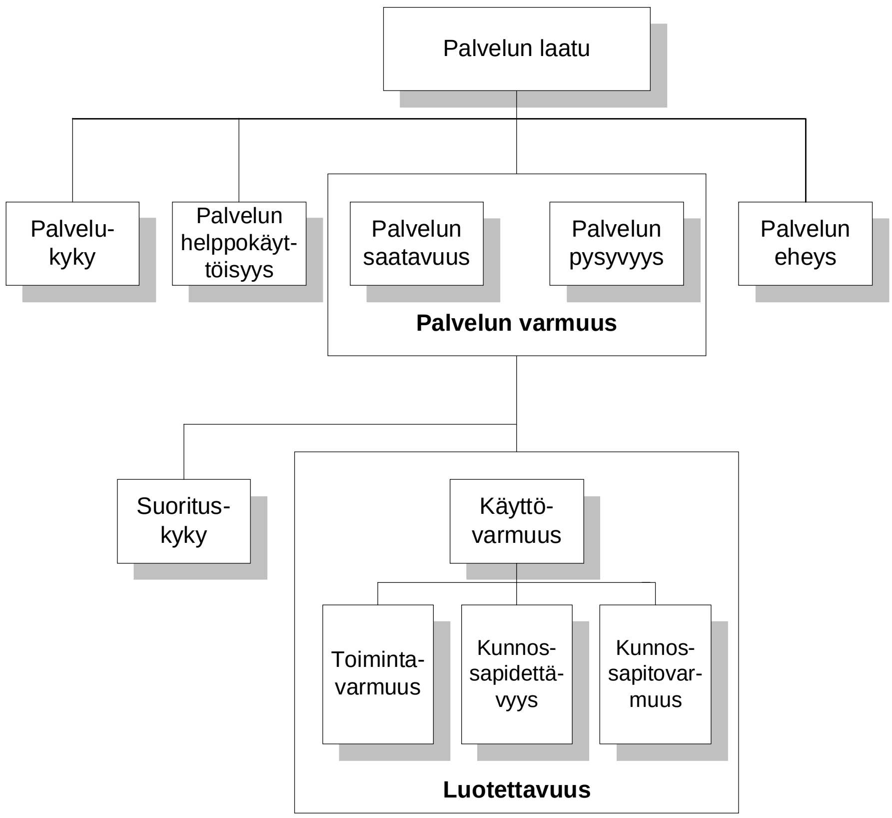

Figure 1. Service ability concepts (SFS-IEC 50(191) 1996).

Dependability is a general term spanning the aspects of the availability, reliability, maintainability and safety of the technical system. Reliability describes the ability of the system to operate in the desired manner for a desired period. Maintainability describes how fast the equipment can be repaired to operational state after a malfunction. Maintenance safety is not directly connected to the observed technical equipment but rather describes the ability of the maintenance organisation to carry out maintenance e.g. arrange the availability of spare parts and skilful personnel. The dependability issues often handle RAMS[1] aspects and requirements.

[1] **R**eliability, **A**vailability, **M**aintainability, **S**afety

The purpose of the reliability and availability analysis of a technical system is to study the possible disturbance and risk factors of the operation of the system. The analysis should be carried out as early in the lifespan of the system as possible as the reliability requirements can then be considered in the development stage. In the best cases the management of reliability risks of a technical system can be started at the conceptualisation phase of a service product. Risk analysis which incorporates not only identifying disturbance and risk factor but also evaluating their probability and consequences helps direct the development efforts to the objects most critical for the operation of the system. Systematic exploitation of reliability management tools decreases the need for redesign and testing of the technical system at the utilisation and later stages of the lifespan.

2 Description, definition and viewpoints of the evaluation process

The bases for system reliability evaluation are the obligations set for system providers by the international IEC standard (SFS-IEC 60300-1): *"The provider develops the reliability management plan as a part of the research and development or project plan. The reliability management plan is inspected and modified as required at project and product inspections. These inspections also verify that the reliability management plan and tasks, analyses and results correspond to the planned and specified reliability requirements. The provider creates and maintains directions ensuring the traceability of reliability requirements as defined by standard IEC 300-2.Reliability is an active component in product version management. Product version management is developed and maintained according to section 8.8 of standard ISO 9004."*

Tasks connected to system reliability management are e.g. (IEC 60300-2):

- reliability requirements
- analyses, prognosis and inspections
- verification, validation and testing
- planning use and maintenance safety

The technical system evaluation process can be based on the method described in the standard by employing the applicable elements. Approaches applicable for telematics system risk management have been presented also in other standards (e.g. EN50126 "Railway applications - the specification of Reliability, Availability, Maintainability and Safety"), in which the task differ a little from the tasks in the IEC standard but the basic principal is the same.

The most important phase of the lifespan of a system is the research, development and design phase during which the most important technical decisions are made. The tools used in the evaluation process ensure that the requirements connected to reliability, availability, safety and maintainability and possible orders of the authorities are transferred to the actual product at the different design phases. This decreases the need for redesign and testing.

3 Evaluation methods and instruments

Numerous methods, qualitative, quantitative and their combinations, are used in the reliability and availability analyses of technical systems. The selection and phasing of methods has to be based on the needs of the client. Method selection is also greatly affected by the quality and amount of reliability data available in the evaluated system. Figure 2 shows the typical sources of reliability data which can be combined to carry out comprehensive analyses of a technical system.

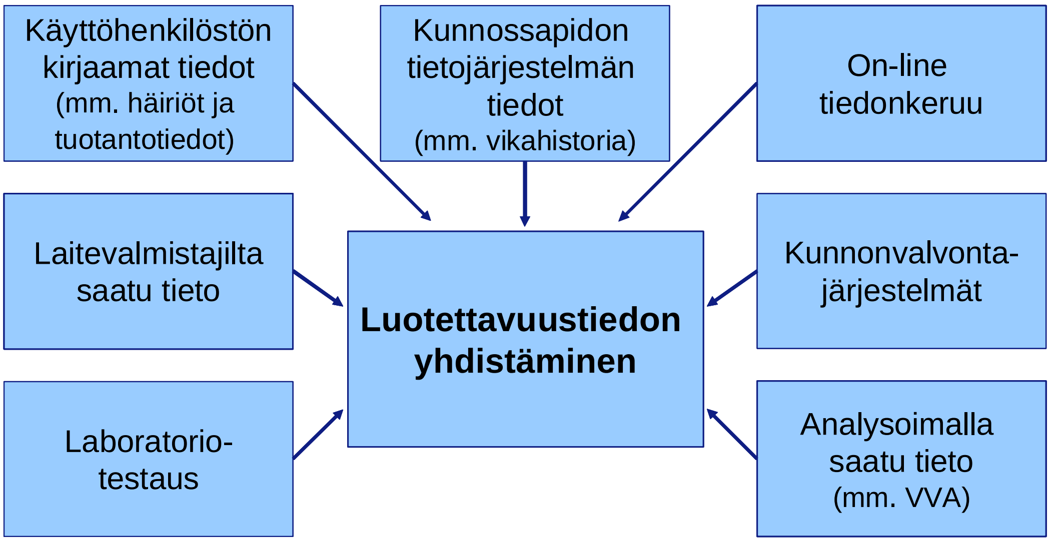

Figure 2. Sources of reliability data in a technical system.

It is justified to select the qualitative method for reliability risk evaluation if comprehensive fault statistics of the evaluated system is unavailable. Qualitative methods are based on operation experiences of malfunctions, usability and maintainability gathered from an expert work group. The analyses usually evaluate, quantify, the criticality of the identified types of malfunctions. Typical qualitative reliability management tools and risk analyse methods are Potential problem analysis (POA), Fault tree analysis (FTA), reliability flow charts, fault and impact analysis (VVA, FMECA), danger analysis (e.g. EN 1050 Check list) and maintenance analysis (e.g. RCM). Figure 3 shows the typical phases of reliability risk analysis.

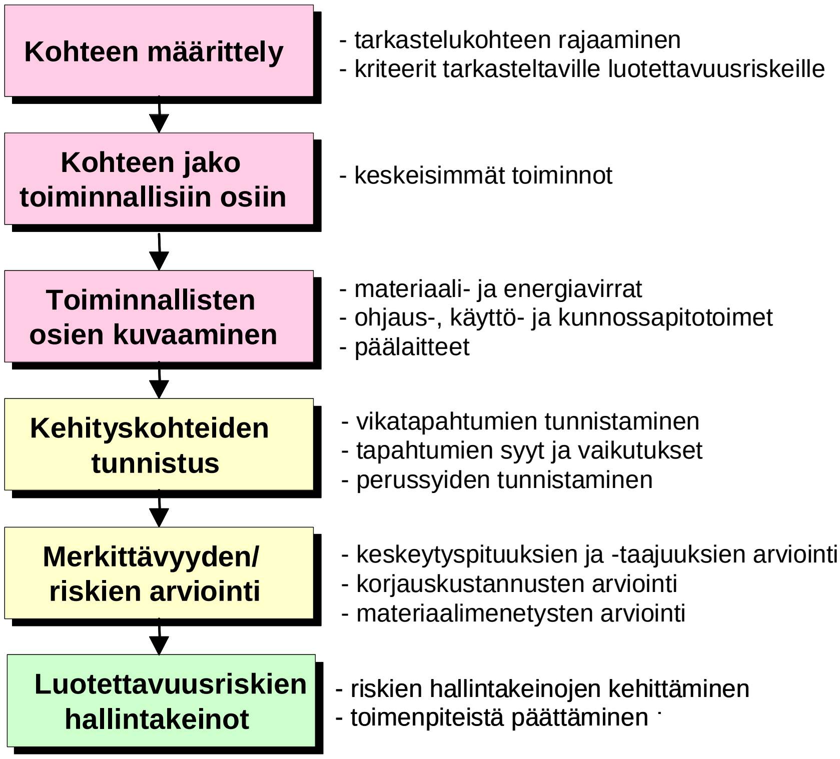

Figure 3. Typical phases of reliability analysis.

The resources required by the analyses are difficult to define precisely, the resourced are affected by the scale of the evaluated system and how exactly the reason behind faults are meant to be identify. The rule of thumb is that in most cases a comprehensive analyses requires four analyses meetings which in turn take about one month in time.

In addition to the qualitative tools there are several simulation programmes for quantitative modelling, usability and others that can be utilised in the evaluation of the reliability and availability of a technical system. The applied methods are selected according to the data available for the evaluated system. Data availability is affected by the phase of the system lifespan and the object of the analysis. Comprehensive data of a technical system has, however, usually not been gathered i.e. it is unavailable. Unavailable or deficient data can be complemented for calculation purposes with data from other different sources. The most important exploitable data sources are e.g.:

- expert evaluations at the same institution (use and maintenance personnel, see qualitative analyses)
- the base data from the possible availability analyses and evaluations executed at the design phase (see qualitative analyses)
- use experience data of (same or similar) equipment/hardware from other similar localities
- equipment manufacturer data (use experience data from different destinations or testing data)
- competing equipment manufacturer data (use experience data from different destinations or testing data)
- general fault information sources (databases, data books) data on failure rates and repairability (repair time) for different systems.

A list of different general data sources to be used in risk and reliability analyses can be found e.g. at http://www.ntnu.no/ross/info/data.php.

Life period cost and life period benefit analyses are vital in technical and economic risk management. These analyses can be used in evaluating the development of the most important costs and benefits of business investments during the entire life span of the investment and to calculate the profitability of the investment. The evaluation viewpoint is broader than traditional investment calculation because LCC/LCP (Life Cycle Cost / Life Cycle Profit) calculation accounts for the significance of indirect costs.

More detailed descriptions of risk analysis methods can be found at e.g. http://riskianalyysit.vtt.fi.

There are several instruments describing the dependability of a system or component. The IEC 50(191) standard from 1996 alone defines over 30 usability instruments. Typical instruments are

- Mean up time (MUT)
- Mean down time (MDT)
- Availability (A = (MUT / MUT+MDT) x 100%)
- Mean time to failure (MTTF)
- Mean time to restoration (MTTR)
- Fault frequency (number of faults during study period e.g. a year)

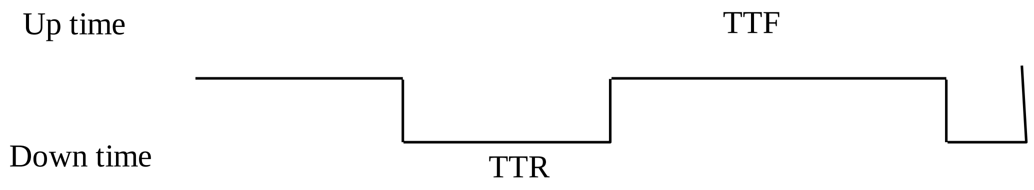

Figure 4. Presentation of availability instruments.

4 Results, conclusions, recommendations and reporting

The reporting format of risk analyses results varies greatly due to the methods used for the object of evaluation. The general goal is, however, to utilise the results during the design process in e.g. the selection of design alternatives. The following is a description of the general features of result reporting and utilisation.

Using the evaluation process the technical system client and provider can together define the dependability goals set for the system and monitor their realisation. The provider observes the requirements in the design process and possibly in the preceding development phase thus avoiding costly redesign and modifications. The need for testing is also reduced.

The client receives an evaluation of the dependability of the system and a maintenance plan as a result of the process. When the possible malfunction and risk factors are known the user can prepare e.g. with necessary spare parts and personnel training.

Quantitative methods can be used in modelling the impact of different implementation alternatives on the availability of an entire system.

LCC/LCP analyses produce calculation models for the cumulative costs and profits of different implementation alternatives. The models have been utilised in the management of business risks of technical systems and their service assemblies.

5 Connection to other modules

Reliability evaluation has a natural connection to three EVASERVE modules. The reliability and availability evaluation of the technical feasibility module produces additional information about e.g. system malfunctions and required maintenance. This is essential information also from the system profitability evaluation viewpoint e.g. in determining the lifespan cost and profit data. There is also a connection to the databases module if the service system is to incorporate fault and maintenance data acquisition features. This feature is required by system quality maintenance and development. The reliability and availability evaluation can produce the structure of the information required in the acquisition and a model about the methods with which the data is used in the development of system availability and maintenance.

6 References

The following is a list of references utilising reliability analysis methods. The reference descriptions aim to disclose how analysis method know-how has been used in the projects. Most of the references have been commissioned as confidential so additional information is unavailable. The references with available public material include a link to the material.

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