TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

CEN/CLC/TR 17602-80-04

October 2021

ICS 49.140; 35.240.99

English version

Space product assurance - Software metrication programme definition and implementation

Assurance produit des projets spatiaux - Guide de métrologie du logiciel

Raumfahrtproduktsicherung - Softwaremetrikhandbuch

This Technical Report was approved by CEN on 13 September 2021. It has been drawn up by the Technical Committee CEN/CLC/JTC 5.

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Table of contents

Figures

Tables

European Foreword

This document (CEN/CLC/TR 17602-80-04:2021) has been prepared by Technical Committee CEN/CLC/JTC 5 "Space", the secretariat of which is held by DIN.

It is highlighted that this technical report does not contain any requirement but only collection of data or descriptions and guidelines about how to organize and perform the work in support of EN 17602-80.

This Technical report (CEN/CLC/TR 17602-80-04:2021) originates from ECSS-Q-HB-80-04A.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document has been developed to cover specifically space systems and has therefore precedence over any TR covering the same scope but with a wider domain of applicability (e.g.: aerospace).

Introduction

This Handbook describes the approach to be taken for the definition and implementation of an effective and efficient metrication programme for the development of software in a space project.

This Handbook provides guidelines and examples of software metrics that can be used in space system developments, in line with the requirements defined by [ECSS-E-40] and [ECSS-Q-80], given guidelines and examples to provide a coherent view of the software metrication programme definition and implementation.

This Handbook is intended to help customers in formulating their quality requirements and suppliers in preparing their response and implementing the work. This Handbook is not intended to replace textbook material on computer science or technology and software metrics, so repeating such material is avoided in this Handbook. The readers and users of this Handbook are assumed to posse's general knowledge of computer science and software engineering.

In space projects, the demand of high quality software to be developed within allocated budget and time is a priority objective, particularly in presence of dependability requirements. Also the size of the operational software has increased significantly due to the increase in functionality to allow new challenging missions and to reply to increasingly sophisticated and demanding user requirements.

The space software development is therefore characterized by:

- High dependability of the software products, in both space and ground segments;
- Stringent schedule and cost estimates that are more and more accurate to enable reliable cost estimates for the overall project;
- Demand of high quality software, and
- Increasing productivity requirements.

To improve, suppliers should know what can be done better, and also what to look at in order to understand where lessons learnt can be applied to support the improvement.

Measurements are the only way to quantitatively assess the quality of a process or a product.

In presence of complex software projects reliable measures of both processes and products provide a powerful tool to software management for keeping the project in track and preserve the intended quality of the software product. Improvement of both the space software product and its development processes depends upon improved ability to identify, measure, and control essential parameters that affect software product and its development processes. This is the goal of any software metrication programme.

The main reasons for measuring software processes and products are:

— **To characterize** the existing processes and the status of products under development or operations, in order to gain a better understanding and support the overall verification of the software, as well as to acquire data/information for future assessments of similar processes/products.

— **To evaluate** the status of the project to determine its status and possible deviation from the established plans, and to support identification of actions to bring it back under control; the evaluation includes an assessment of an achievement of quality goals and an assessment of the impacts of technology and process improvements on products and processes.

— **To predict**, with the aim to improve the ability to plan. Measuring for prediction involves gaining understanding of relationships among processes and products and building models of these relationships, so that the observed values for some attributes can be used to predict others. The reason for that is to establish achievable goals for cost, schedule, and quality—so that appropriate resources can be applied. Predictive measures are also the basis for extrapolating trends, so estimates for cost, time, and quality can be updated based on current evidence. Projections and estimates based on historical data also help to analyse risks and make design/cost tradeoffs.

— **To improve**. Gathering quantitative information helps to identify roadblocks, root causes, inefficiencies, and other opportunities for improving product quality and process performance. Measures also help to plan and track improvement efforts.

Measures of current performance give baselines to compare against, so that it can be possible to judge whether or not the improvement actions are working as intended and what the side effects can be. Good measures also help to communicate goals and convey reasons for improving. This helps engage and focus the support of those who work within the processes to make them successful.

1 Scope

The scope of this Handbook is the software metrication as part of a space project, i.e. a space system, a subsystem including hardware and software, or ultimately a software product. It is intended to complement the [ECSS-Q-80] with specific guidelines related to use of different software metrics including their collection, analysis and reporting. Tailoring guidelines for the software metrication process are also provided to help to meet specific project requirements.

This Handbook provides recommendations, methods and procedures that can be used for the selection and application of appropriate metrics, but it does not include new requirements with respect to those provided by ECSS-ST-Q-80C Standard.

The scope of this Handbook covers the following topics:

- Specification of the goals and objectives for a metrication programme.
- Identification of criteria for selection of metrics in a specific project / environment (goal driven).
- Planning of metrication in the development life cycle.
- Interface of metrication with engineering processes.
- Data collection aspects (including use of tools).
- Approach to the analysis of the collected data.
- Feedback into the process and product based on the analysis results.
- Continuous improvement of measurement process.
- Use of metrics for process and product improvement.

This Handbook is applicable to all types of software of all major parts of a space system, including the space segment, the launch service segment and the ground segment software.

2 References

For each document or Standard listed, a *mnemonic* (used to refer to that source throughout this document) is proposed in the left side, and then the *complete reference* is provided in the right one.

ECSS Standards		
EN Reference	**Reference in text**	**Title**
EN 16601-00-01	[ECSS-S-ST-00-01]	ECSS-S-ST-00-01C, ECSS - Glossary of terms
EN 16602-80	[ECSS-Q-80]	ECSS-Q-ST-80C, Space Product Assurance – Software Product Assurance
EN 16603-40	[ECSS-E-40]	ECSS-E-ST-40C, Space Engineering – Software

ISO/IEC Standards	
ISO 9126	ISO/IEC 9126 Software engineering - Product quality, Parts 1 to 4 (complete series)
ISO 9126-1	ISO/IEC 9126-1:2001 Part 1: Quality model
ISO 9126-2	ISO/IEC TR 9126-2:2003 Part 2: External metrics
ISO 9126-3	ISO/IEC TR 9126-3:2003 Part 3: Internal metrics
ISO 9126-4	ISO/IEC TR 9126-4:2004 Part 4: Quality in use metrics
ISO 12207	ISO/IEC 12207:2008 Information Technology - Software life cycle processes.
ISO 14143	ISO/IEC 14143 Information technology - Software measurement, Parts 1 to 6 (complete series)
ISO 14598	ISO/IEC 14598 Software engineering - Product evaluation, Parts 1 to 6 (complete series)
ISO 14598-1	ISO/IEC 14598-1:1999 Part 1: General overview
ISO 24765	ISO/IEC 24765, Systems and Software Engineering Vocabulary
ISO 15939	ISO/IEC 15939:2007 Software Engineering - Software Measurement Process
ISO 17799	ISO/IEC 17799:2005 Information technology - Code of practice for information security management
ISO 25000	ISO/IEC 25000:2005 Ed. 1 Software Engineering - Software product Quality Requirements and Evaluation (SQuaRE) - Guide to SQuaRE
Other ESA documents	
SPEC	ESTEC Contract No. 12650/97/NL/NB(SC) - SPEC – Software Product Evaluation and Certification (complete series)

SPEC-I	ESTEC Contract No. 20421/06/NL/PA - SPEC Method Improvement
SPEC-I-QM	SPEC/QM SPEC Method improvement - Quality Model – Issue 1.F
SPEC-I-TN1	SPEC-I/TN1 SPEC Analysis results - Issue 1.F
SPEC-I -TN2	SPEC-I/TN2 Concept for Space Software Product Evaluation for Conformity WP4 - part 2- Issue 3.B
SPEC-I –TN3	SPEC-I/TN3 Concept for Space Software Product Evaluation for Conformity WP4 - part 3- Issue 3.2
SPEC-TN3	SPEC/TN3 Space Domain Specific Software Product Quality Models, Requirements and Related Evaluation Methods - Issue 3.4
SPEC-TN4.1	SPEC/TN4 part 1 Overview of existing software certification schemes - Issue 2
SPEC-TN4.2	SPEC/TN4 part 2 Concept for Space Software Product Evaluation and Certification - Issue 2
SPEC-TN4.3	SPEC/TN4 part 3 Concept for Space Software Product Evaluation and Certification - Issue 2
Reports and articles	
CHALMERS	Chalmers University of Technology Presentation - Department of Computer Engineering - Dependability and Security Modelling and Metrics
EADS-ST	Astrium-ST- Astrium ST internal documents
FENTON	"Software Metrics - A Rigorous & Practical Approach" (second edition) Norman E. Fenton, Shari Lawrence Pfleeger
NASA-1740	NSS 1740.13 "NASA Software Safety Standard" February 1996
NASA-8719	NASA-STD-8719.13A Software Safety, 15 September 1997
NIAC	Common Vulnerability Scoring System - Final Report and Recommendations by the Council, 12 October 2004
NIST-1	NIST and Federal Computer Security Program Managers Forum IT Security Metrics Workshop - A Practical Approach to Measuring Information Security: Measuring Security at the System Level, 21 May 2002
NIST-2	NIST Special Publication 800-55 Security Metrics Guide for Information Technology Systems, July 2003
NIST-3	NIST Special Publication 800-35 Guide to Information Technology Security Services, October 2003
SANS-1	SANS Institute - A Guide to Security Metrics - SANS Security Essentials GSEC Practical Assignment, Version 1.2, 11 July 2001
SANS-2	SANS Institute - Systems Maintenance Programs - The Forgotten Foundation and Support of the CIA Triad, GSEC v1.3, 10 January 2002
SEC-FIN	VTT Technical Research Centre of Finland Publications 544 Process Approach to Information Security Metrics in Finnish Industry and State Institutions, 2004
SUN-JAVA	SUN Java Coding Conventions

Websites	
ISECOM	The Institute for Security and Open Methodologies (security) http://www.isecom.org/securitymetrics.shtml
EDUCAUSE	http://www.educause.edu
SEC-METRICS	Community website http://www.securitymetrics.org
SW-METRICS	International Software Metrics Organization http://www.swmetrics.org
SEC-DOCS	Security white papers and documents http://www.securitydocs.com
IEEE	http://www.ieee.com
IEEE-CS	http://www.computer.org
NIST	NIST Computer Security Resource Centre http://csrc.nist.gov/ispab/
COSMICON	The Common Software Measurement International Consortium http://www.cosmicon.com/
UKSMA	The UK Software Metrics Association http://www.uksma.co.uk/?action=0&what=90
ARMY-METRICS	Army Software Metrics Office http;//www.armysoftwaremetrics.org
PSSM	Practical Software & Systems Measurement http://www.psmsc.com