Automotive SPICE®

Process Reference Model

Process Assessment Model

Version 4.0

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Automotive SPICE®

过程参考模型

过程评估模型

版本 4.0

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本文档是对 Automotive SPICE 过程评估模型和过程参考模型 3.1 版本 的修订，该模型由德国汽车工业协会质量管理中心 (QMC) 的第 13 工作组制订。

本文复制的相关资料来自于：

- **ISO/IEC 33020:2019**
  信息技术--过程评估--评估过程能力的过程度量框架

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Document history

Version	Date	By	Notes
2.0	2005-05-04	AutoSIG / SUG	DRAFT RELEASE, pending final editorial review
2.1	2005-06-24	AutoSIG / SUG	Editorial review comments implemented Updated to reflect changes in FDIS 15504-5
2.2	2005-08-21	AutoSIG / SUG	Final checks implemented: FORMAL RELEASE
2.3	2007-05-05	AutoSIG / SUG	Revision following CCB: FORMAL RELEASE
2.4	2008-08-01	AutoSIG / SUG	Revision following CCB: FORMAL RELEASE
2.5	2010-05-10	AutoSIG / SUG	Revision following CCB: FORMAL RELEASE
3.0	2015-07-16	VDA QMC WG13	Changes: See release notes
3.1	2017-11-01	VDA QMC WG13	Changes: See www.automotivespice.com
4.0	**2023-10-20**	**VDA QMC WG13**	**Complete revision of PAM**

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文档历史

版本	日期	作者	记录
2.0	2005-05-04	AutoSIG / SUG	初版发布，未实施最终评审
2.1	2005-06-24	AutoSIG / SUG	实施评审意见，FDIS 15504-5 中反映变更
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4.0	**2023-10-20**	**VDA QMC WG13**	**对 PAM 全面修订**

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Table of contents

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目录结构

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PUBLIC

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List of Figures

List of Tables

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图清单

表清单

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1. Introduction

1.1. Scope

Process assessment is a disciplined evaluation of an organizational unit's processes against a process assessment model.

The Automotive SPICE process assessment model (PAM) is intended for use when performing conformant assessments of the process capability on the development of embedded automotive systems. It was developed in accordance with the requirements of ISO/IEC 33004:2015.

Automotive SPICE has its own process reference model (PRM), which was developed based on the Automotive SPICE process reference model 4.5. It was further developed and tailored considering the specific needs of the automotive industry. If processes beyond the scope of Automotive SPICE are needed, appropriate processes from other process reference models such as ISO/IEC 12207 or ISO/IEC/IEEE 15288 may be added based on the business needs of the organization.

The PRM is incorporated in this document and is used in conjunction with the Automotive SPICE process assessment model when performing an assessment.

This Automotive SPICE process assessment model contains a set of indicators to be considered when interpreting the intent of the Automotive SPICE process reference model. These indicators may also be used when implementing a process improvement program.

1.2. Terminology

Automotive SPICE follows the following precedence for use of terminology:

- ISO/IEC 33001 for assessment related terminology
- ISO/IEC/IEEE 24765, ISO/SAE 21434 and ISO/IEC/IEEE 29119 terminology (as contained in Annex C)
- Terms introduced by Automotive SPICE (as contained in Annex C)
- PMBOK® Guide – Fourth Edition
- PAS 1883:2020

Term	Origin	Description
Activity	Automotive SPICE V4.0	Execution of a task by a stakeholder or an involved party.

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1. 介绍

1.1. 范围

过程评估是依照过程评估模型对组织单位的过程进行规范化的评估。

Automotive SPICE 过程评估模型（PAM）旨在为嵌入式车载系统开发执行过程能力符合性评估时使用。

该模型是根据 ISO/IEC 33004:2015 的需求所开发的。

Automotive SPICE 有其本身的过程参考模型(PRM)，是基于 Automotive SPICE 过程参考模型 4.5 所开发。另外考虑汽车行业的特定需要，对该模型进行了进一步的开发和剪裁。如果需要有超出 Automotive SPICE 范围的过程，可基于组织的业务需要增加来自于其他过程参考模型（例如：ISO/IEC 12207 或 ISO/IEC/IEEE 15288）的适当过程。

该 PRM 被包含在本文中，并与 Automotive SPICE 过程评估模型一起在执行评估时使用。

Automotive SPICE 过程评估模型包含在诠释 Automotive SPICE 过程参考模型的意图时应考虑的一系列的指标。这些指标也可用于过程改进项目的实施。

1.2.术语

Automotive SPICE 对术语的使用，遵循以下的优先顺序：

- ISO/IEC 33001 关于评估相关的术语
- ISO/IEC/IEEE 24765、ISO/SAE 21434 和 ISO/IEC/IEEE 29119 术语（包含在附录 C）
- Automotive SPICE 所引入的术语（包含在附录 C）
- PMBOK® 指南 – 第四版
- PAS 1883:2020

术语	来源	描述
活动	Automotive SPICE V4.0	由利益相关方或参与方执行的任务

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Application parameter	Automotive SPICE V4.0	An application parameter is a software variable containing data that can be changed at the system or software levels; they influence the system's or software behavior and properties. The notion of application parameter is expressed in two ways: • The specification (including variable names, the domain value range, technical data types, default values, physical unit (if applicable), the corresponding memory maps, respectively). • The actual quantitative data value it receives by means of data application. Application parameters are not requirements. They are a technical implementation solution for configurability-oriented requirements.
Approval	Automotive SPICE V4.0	Written statement that a deliverable is fit for its intended use, and compliant with defined criteria.
Baseline	Automotive SPICE V4.0	A defined and coherent set of read-only information, serving as an input information the for affected parties.
Deliverable	PMBOK® Guide – Fourth Edition	Any unique and verifiable product, result, or capability to perform a service that must be produced to complete a process, phase, or project. Often used more narrowly in reference to an external deliverable, which is a deliverable that is subject to approval by the project sponsor or customer.
Functional requirement	ISO/IEC/IEEE 24765	A statement that identifies what a product or process must accomplish to produce required behavior and/or results.
Hardware	intacs® working group HW PAM	Assembled and interconnected electrical or electronic hardware components or parts which perform analog or digital functions or operations.
Hardware component	intacs® working group HW PAM	Logical (e.g., functional block) or physical group of hardware parts realizing a functionality, which • cannot be realized by any of its hardware parts alone, e.g., voltage monitoring, power supply. • may be organized hierarchically, i.e., a hardware component can contain lower-level hardware components. *NOTE: Depending on the application, e.g., the populated PCB, a system-on-chip, a microcontroller, or an SBC can be considered a HW component.*
Hardware element	intacs® working group HW PAM	Generic term; can represent a hardware component, a hardware part, a hardware interface, or the hardware.
Hardware part	Automotive SPICE V4.0	Fundamental HW element the purpose and functionality of which cannot be further subdivided or separated. *NOTE: Examples are transistors, resistors, diodes, non-populated PCB* *NOTE: Depending on the application, e.g., a system-on-chip, a microcontroller or an SBC can be considered a HW part.* *NOTE: the term 'unit' is considered to apply to the software domain only. The term 'hardware part' can be viewed as the hardware counterpart of 'software unit'.*

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用参数	Automotive SPICE V4.0	应用参数是包含了在系统或软件层级可被更改的数据的软件变量，他们影响系统或软件的行为和属性。 应用参数的概念有两种表达方式： • 规范（分别包括变量名称、值域范围、技术数据类型、默认值、物理单位（如适用）、对应的内存映射）。 • 通过数据应用收到的实际定量数据值。 应用参数不是需求，而是面向可配置性需求的一种技术实现方案。
批准	Automotive SPICE V4.0	表明交付成果适合其预期用途并符合既定准则的书面声明。
基线	Automotive SPICE V4.0	一组已定义且连贯的只读信息，作为受影响方的输入信息。
交付物	PMBOK® 指南 – 第四版	为完成某个过程、阶段或项目而必须产出的任何独特且可验证的产品、结果或执行服务的能力。通常更狭义地指代对外交付物，即需要项目赞助方或客户批准的交付成果。
功能性需求	ISO/IEC/IEEE 24765	识别产品或过程对于产生所需的行为和/或结果所必须完成的内容的陈述。
硬件	intacs® 工作组 HW PAM	被装配和互连的电子电气硬件组件或元器件，用于执行模拟或数字的功能或操作。
硬件组件	intacs® 工作组 HW PAM	为实现某一功能的硬件元器件逻辑性组合（例如功能块）或物理性组合，且： • 此功能无法由该组件的任何硬件元器件单独实现，例如电压监控、电源供电。 • 此功能可以分层构建，即硬件组件可以包含较低层级的硬件组件。 *注：根据应用的不同，可以将集成电路板（PCB）、片上系统、微控制器或系统基础芯片（SBC）视为硬件组件。*
硬件要素	intacs® 工作组 HW PAM	通用术语，可以表示硬件组件、硬件部件、硬件接口或硬件。
硬件元器件	Automotive SPICE V4.0	基本硬件要素，其用途和功能不可进一步细分或切割。 *注：例如晶体管、电阻器、二极管、未集成的 PCB* *注：根据不同的应用，可以将片上系统，微控制器或系统基础芯片（SBC）视为是硬件元器件。* *注：术语“单元”仅适用于软件领域。术语“硬件元器件”可以被看作是“软件单元”的硬件对应物。*

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Hyperparameter	Automotive SPICE V4.0	In machine learning, a hyperparameter is a parameter whose value is used to control the training of the ML model. Its value must be set between training iterations. Examples: learning rate, loss function, model depth, regularization constants.
Information need	Automotive SPICE V4.0	The need for characterizing process or product related effectiveness and efficiency (used by MAN.6 and PA 4.1).
Machine Learning (ML)	Automotive SPICE V4.0	In Automotive SPICE Machine Learning (ML) describes the ability of software to learn from specific training data and to apply this knowledge to other similar tasks.
Measure	Automotive SPICE V4.0	An activity to achieve a certain intent.
Measurement	Oxford Dictionary	“The activity to find the size, quantity or degree of something”.
Metric	Automotive SPICE V4.0	A quantitative or qualitative measurable indicator that matches defined information needs.
Operational Design Domain	PAS 1883:2020	Operational Design Domain (ODD) is operating conditions under which a given overall system or feature thereof is specifically designed to function. This includes, but is not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics.
Project	ISO/IEC/IEEE 24765	Endeavor with defined start and finish dates undertaken to create a product or service in accordance with specified resources and requirements.
Release	Automotive SPICE V4.0	A physical product delivered to a customer, including a defined set of functionalities and properties.
Regression verification	Automotive SPICE V4.0	Selective re-verification of elements to verify that modifications have not caused unintended effects.
Risk	ISO/IEC/IEEE 24765	The combination of the probability of occurrence and the consequences of a given future undesirable event.
Software component	Automotive SPICE V4.0	Software component in design and implementation-oriented processes: The software architecture decomposes the software into software components across appropriate hierarchical levels down to the lowest-level software components in a conceptual model. Software component in verification-oriented processes: The implementation of a SW component under verification is represented e.g., as source code, object files, library file, executable, or executable model.
Software element	Automotive SPICE V4.0	Refers to software component or software unit

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超参数	Automotive SPICE V4.0	在机器学习中，超参数是一类参数，参数值用于控制机器学习模型的训练。其值必须在训练迭代之间设置。例如：学习率，损失函数，模型深度，正则化常数。
信息需要	Automotive SPICE V4.0	用以表征与过程或产品相关的有效性和效率的需要（用于 MAN.6 和 PA 4.1）。
机器学习（ML）	Automotive SPICE V4.0	在 Automotive SPICE 中，机器学习(ML)描述了软件从特定训练数据中学习并将这些知识应用于其他类似任务的能力。
措施	Automotive SPICE V4.0	为达成某种意图的活动。
测量	牛津字典	“发现事物的大小、数量或程度的活动”。
度量	Automotive SPICE V4.0	与既定的信息需要相匹配的定量或定性的可衡量指标。
运行设计域	PAS 1883:2020	运行设计域（ODD）是一个给定的整体系统或其功能被专门设计用于工作的运行条件。 这包括但不限于环境、地理和时间限制，和/或某些交通或道路特征的必要存在与否。
项目	ISO/IEC/IEEE 24765	依据特定的资源和需求，努力在既定开始和完成日期之内创建产品或服务。
发布	Automotive SPICE V4.0	交付给客户的物理产品，其中包括一组定义的功能和属性。
回归验证	Automotive SPICE V4.0	对要素进行选择性的重新验证，以验证修改没有造成意外的影响。
风险	ISO/IEC/IEEE 24765	某一在未来不希望发生的事件发生的可能性与后果的结合。
软件组件	Automotive SPICE V4.0	面向设计和实现过程的软件组件： 软件架构将软件分解为跨适当层级结构的软件组件，直至概念模型中的最低级别软件组件。 面向验证过程的软件组件： 被验证的软件组件的实现表现为源代码、目标文件、库文件、可执行文件或可执行模型等。
软件要素	Automotive SPICE V4.0	参见软件组件或软件单元

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Software unit	Automotive SPICE V4.0	Software unit in design and implementation-oriented processes: As a result of the decomposition of a software component, the software is decomposed into software units which are a representation of a software element, which is decided not to be further subdivided and that is a part of a software component at the lowest level, in a conceptual model. Software unit in verification-oriented processes: An implemented SW unit under verification is represented e.g., as source code files, or an object file.
Stakeholder requirements	Automotive SPICE V4.0	Any type of requirement for the stakeholders in the given context, e.g., customer requirement, supplier internal requirements (product-specific, platform etc.), legal requirements, regulatory requirements, statutory requirements, industry sector requirements, international standards, codes of practice etc. …
System Element	Automotive SPICE V4.0	System elements can be: • Logical and structural objects at the architectural and design level. System elements can be further decomposed into more fine-grained system elements of the architecture or design across appropriate hierarchical levels. • Physical representations of these objects, or a combination, e.g., peripherals, sensors, actuators, mechanical parts, software executables.
Task	Automotive SPICE V4.0	A definition, but not the execution, of a coherent and set of atomic actions.
Validation measure	Automotive SPICE V4.0	Validation measure can be: • Operational use case testing under real-life conditions • Highly accelerated life testing (HALT) • Simulations under real-life conditions • End user trials • Panel or blind tests • Expert panels
Verification	Automotive SPICE V4.0	Verification is confirmation through the provision of objective evidence that an element fulfils the specified requirements.
Verification measure	Automotive SPICE V4.0	Verification measure can be: • Test cases • Measurements • Calculations • Simulations • Reviews • Analyses Note, that in particular domains certain verification measures may not be applicable, e.g., software units generally cannot be verified by means of calculations or analyses.

Table 1 — Terminology

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软件单元	Automotive SPICE V4.0	面向设计和实现过程的软件单元： 作为软件组件分解的结果，软件被分解为软件单元，软件单元是软件要素的一种表现，在概念模型中软件单元作为最低级别软件组件的一部分不可被进一步细分。 面向验证过程的软件单元： 被实现的需要验证的软件单元表现为源代码文件、目标文件等。
利益相关方需求	Automotive SPICE V4.0	在给定环境下利益相关方任何类型的需求，例如客户需求、供应商内部需求（特定产品、平台等）、法律需求、监管需求、法规需求、行业部门需求、国际标准、行为准则等。
系统要素	Automotive SPICE V4.0	系统要素可以是： • 架构和设计层级的逻辑和结构对象。系统要素可以跨适当层级结构被进一步分解为架构或设计的更细粒度的系统要素。 • 某些对象的物理变现或组合，例如外围设备、传感器、制动器、机械零件、软件可执行文件。
任务	Automotive SPICE V4.0	对一组连贯的原子行动的定义，不包括执行。
确认措施	Automotive SPICE V4.0	确认措施可以是： • 真实条件下的操作用例测试 • 高加速寿命测试(HALT) • 真实条件下的模拟 • 终端用户试用 • 小组测试或盲测 • 专家小组
验证	Automotive SPICE V4.0	验证是通过提供客观证据来确认一个要素满足规定的需求。
验证措施	Automotive SPICE V4.0	验证措施可以是： • 测试用例 • 测量 • 计算 • 模拟 • 评审 • 分析 注意，在特定的领域中，某些验证措施可能不适用，例如软件单元通常不能通过计算或分析来验证。

表 1 — 术语

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1.3. Abbreviations

BP	**B**ase **P**ractice
CAN	**C**ontroller **A**rea **N**etwork
CASE	**C**omputer-**A**ided **S**oftware **E**ngineering,
CCB	**C**hange **C**ontrol **B**oard
CPU	**C**entral **P**rocessing **U**nit
ECU	**E**lectronic **C**ontrol **U**nit
EEPROM	**E**lectrically **E**rasable **P**rogrammable **R**ead **O**nly **M**emory
EOL	**E**nd-**o**f-**L**ine
FMEA	**F**ailure **M**ode and **E**ffect **A**nalysis
FTA	**F**ault **T**ree **A**nalysis
GP	**G**eneric **P**ractice
GR	**G**eneric **R**esource
IEC	**I**nternational **E**lectrotechnical **C**ommission
IEEE	**I**nstitute of **E**lectrical and **E**lectronics **E**ngineers
I/O	**I**nput / **O**utput
ISO	**I**nternational **O**rganization for **S**tandardization
LIN	**L**ocal **I**nterconnect **N**etwork
MISRA	**M**otor **I**ndustry **S**oftware **R**eliability **A**ssociation
MOST	**M**edia **O**riented **S**ystems **T**ransport
ODD	**O**perational **D**esign **D**omain
PA	**P**rocess **A**ttribute
PAM	**P**rocess **A**ssessment **M**odel
PRM	**P**rocess **R**eference **M**odel

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1.3.缩略语

BP	**B**ase **P**ractice 基本实践
CAN	**C**ontroller **A**rea **N**etwork 控制器局域网络
CASE	**C**omputer-**A**ided **S**oftware **E**ngineering, 计算机辅助软件工程
CCB	**C**hange **C**ontrol **B**oard 变更控制委员会
CPU	**C**entral **P**rocessing **U**nit 中央处理器
ECU	**E**lectronic **C**ontrol **U**nit 电子控制单元
EEPROM	**E**lectrically **E**rasable **P**rogrammable **R**ead **O**nly **M**emory 电子可擦写编程只读内存
EOL	**E**nd-**o**f-**L**ine 下线
FMEA	**F**ailure **M**ode and **E**ffect **A**nalysis 失效模式及影响分析
FTA	**F**ault **T**ree **A**nalysis 故障树分析
GP	**G**eneric **P**ractice 通用实践
GR	**G**eneric **R**esource 通用资源
IEC	**I**nternational **E**lectrotechnical **C**ommission 国际电工学委员会
IEEE	**I**nstitute of **E**lectrical and **E**lectronics **E**ngineers 电气与电子工程师协会
I/O	**I**nput / **O**utput 输入 / 输出
ISO	**I**nternational **O**rganization for **S**tandardization 国际标准化组织
LIN	**L**ocal **I**nterconnect **N**etwork 内部互联网络
MISRA	**M**otor **I**ndustry **S**oftware **R**eliability **A**ssociation 汽车产业软件可靠性协会
MOST	**M**edia **O**riented **S**ystems **T**ransport 多媒体定向系统传输
ODD	**O**perational **D**esign **D**omain 运行设计域
PA	**P**rocess **A**ttribute 过程属性
PAM	**P**rocess **A**ssessment **M**odel 过程评估模型
PRM	**P**rocess **R**eference **M**odel 过程参考模型

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PWM	**P**ulse **W**idth **M**odulation
RAM	**R**andom **A**ccess **M**emory
ROM	**R**ead **O**nly **M**emory
SPICE	**S**ystems **P**rocess **I**mprovement and **C**apability d**E**termination
SUG	**S**pice **U**ser **G**roup
USB	**U**niversal **S**erial **B**us
WP	**W**ork **P**roduct
WPC	**W**ork **P**roduct **C**haracteristic

Table 2 — Abbreviation List

2. Statement of compliance

The Automotive SPICE process reference model and process assessment model are conformant with the ISO/IEC 33004:2015 and can be used as the basis for conducting an assessment of process capability.

An ISO/IEC 33003:2015 compliant Measurement Framework is defined in section 5.

A statement of compliance of the process assessment model and process reference model with the requirements of ISO/IEC 33004:2015 is provided in Annex A.

A statement of compliance of the measurement framework with the requirements of ISO/IEC 33003:2015 is provided in Annex A.

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PWM	**P**ulse **W**idth **M**odulation 脉冲宽度调制
RAM	**R**andom **A**ccess **M**emory 随机存取内存
ROM	**R**ead **O**nly **M**emory 只读内存
SPICE	**S**ystems **P**rocess **I**mprovement and **C**apability d**E**termination 系统过程改进和能力确定
SUG	**S**pice **U**ser **G**roup **S**pice 用户群体
USB	**U**niversal **S**erial **B**us 通用串行总线
WP	**W**ork **P**roduct 工作产品
WPC	**W**ork **P**roduct **C**haracteristic 工作产品特性

表 2 — 缩略语清单

2. 符合性声明

Automotive SPICE 过程参考模型及过程评估模型符合ISO/IEC 33004:2015，可作为实施过程能力评估的基础来使用。
符合 ISO/IEC 33003:2015 标准的度量框架在第 5 章节定义。

附录 A 提供过程评估模型及过程参考模型对于 ISO/IEC 33004:2015 要求的符合性声明。

附录 A 提供度量框架对于 ISO/IEC 33003:2015 要求的符合性声明。

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3. Process capability determination

The concept of process capability determination by using a process assessment model is based on a two-dimensional framework. The first dimension is provided by processes defined in a process reference model (process dimension). The second dimension consists of capability levels that are further subdivided into process attributes (capability dimension). The process attributes provide the measurable characteristics of process capability.

The process assessment model selects processes from a process reference model and supplements with indicators. These indicators support the collection of objective evidence which enable an assessor to assign ratings for processes according to the capability dimension.

The relationship is shown in Figure 1.

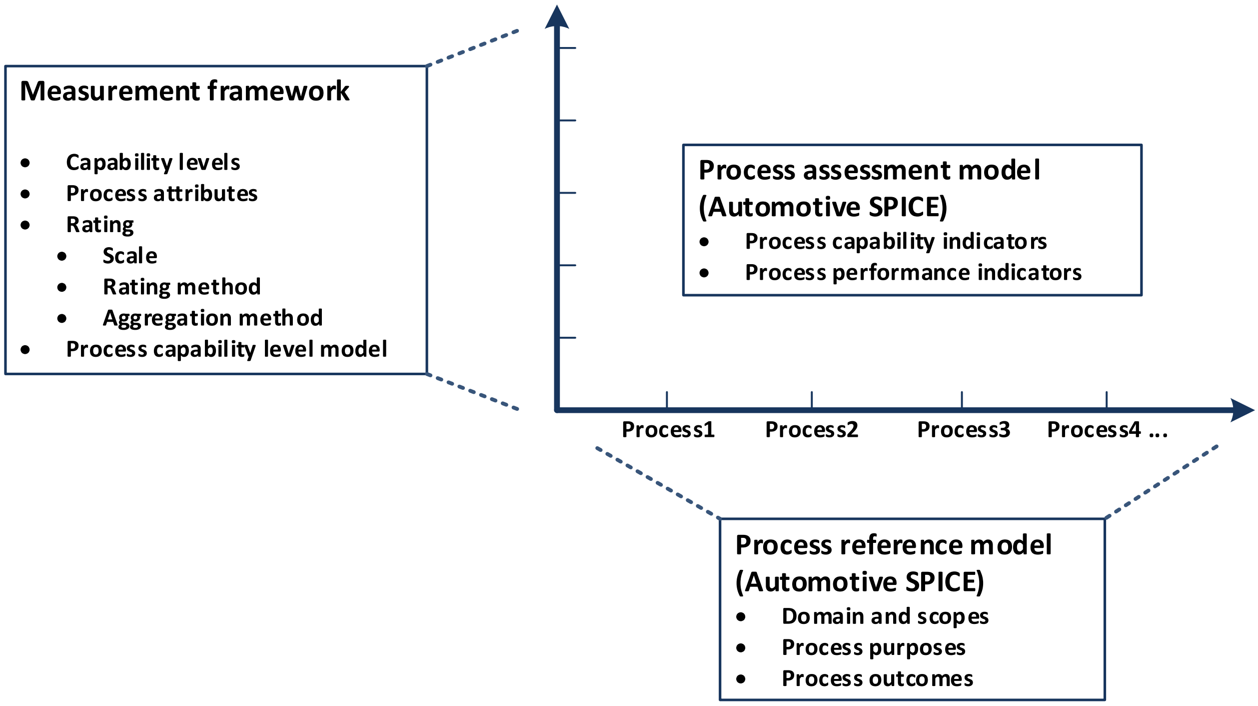

Figure 1 — Process assessment model relationship

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3. 过程能力确定

使用过程评估模型来确定过程能力的概念是基于一个二维框架。第一个维度是由过程参考模型（过程维度）定义的过程来提供。第二个维度是由进一步细分到过程属性的能力等级（能力维度）所构成。过程属性提供了过程能力可度量的特性。

过程评估模型从过程参考模型中选择过程并增补了指标。这些指标支持收集客观证据，使评估师能够根据能力维度对过程进行评定。
关系如 图 1 所示：

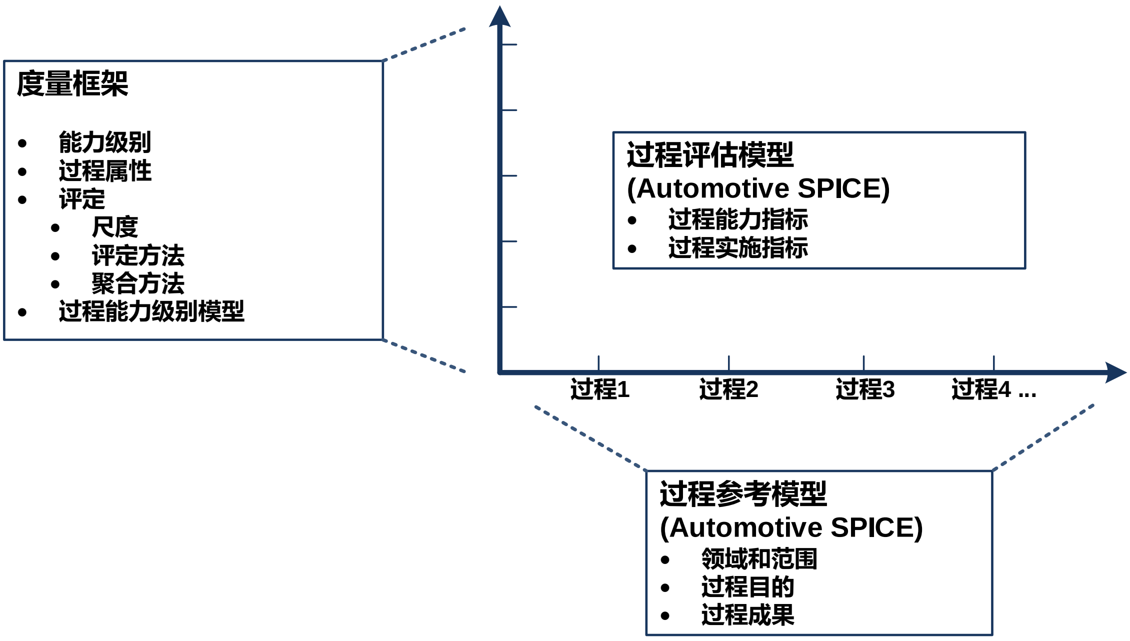

图 1 — 过程评估模型关系

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3.1. Process reference model

Processes are collected into process groups according to the domain of activities they address.

These process groups are organized into 3 process categories: Primary life cycle processes, Organizational life cycle processes and Supporting life cycle processes.

For each process a purpose statement is formulated that contains the unique functional objectives of the process when performed in a particular environment. For each purpose statement a list of specific outcomes is associated, as a list of expected positive results of the process performance.

For the process dimension, the Automotive SPICE process reference model provides the set of processes shown in Figure 2.

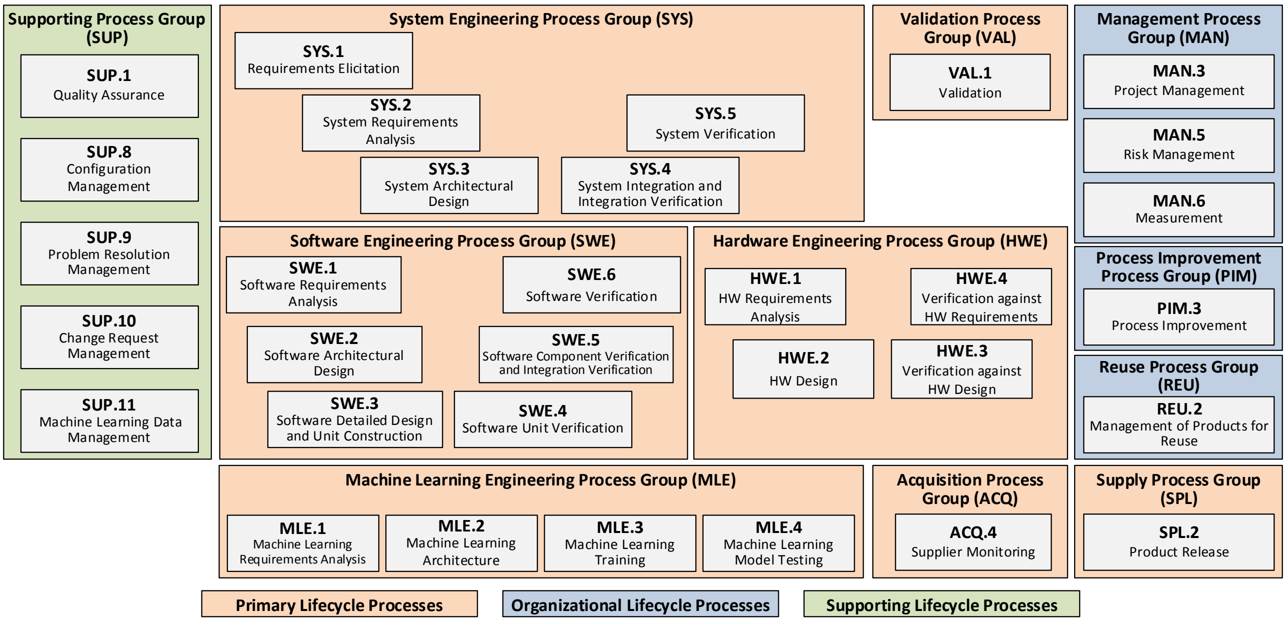

Figure 2 — Automotive SPICE process reference model - Overview

3.1.1. Primary life cycle processes category

The primary life cycle processes category consists of processes that may apply for an acquirer of products from a supplier or may apply for product development when responding to stakeholder needs and delivering products including the engineering processes needed for specification, design, implementation, integration and verification.

The primary life cycle processes category consists of the following groups:

- the Acquisition process group
- the Supply process group
- the System engineering process group
- the Validation process group
- the Software engineering process group

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3.1.过程参考模型

根据所涉及的活动领域，这些过程被收集到各个过程组中。

这些过程组被划分成 3 个过程类别：主要生命周期过程、组织生命周期过程和支持生命周期过程。

对于每个过程，都制定了目的陈述，其中包含在特定环境下执行过程的特有功能性目标。针对每个目的陈述，都有一个相关联的特定成果清单，作为过程实施的预期正面结果的清单。

针对过程维度，Automotive SPICE 过程参考模式提供了过程集合 如 图 2。

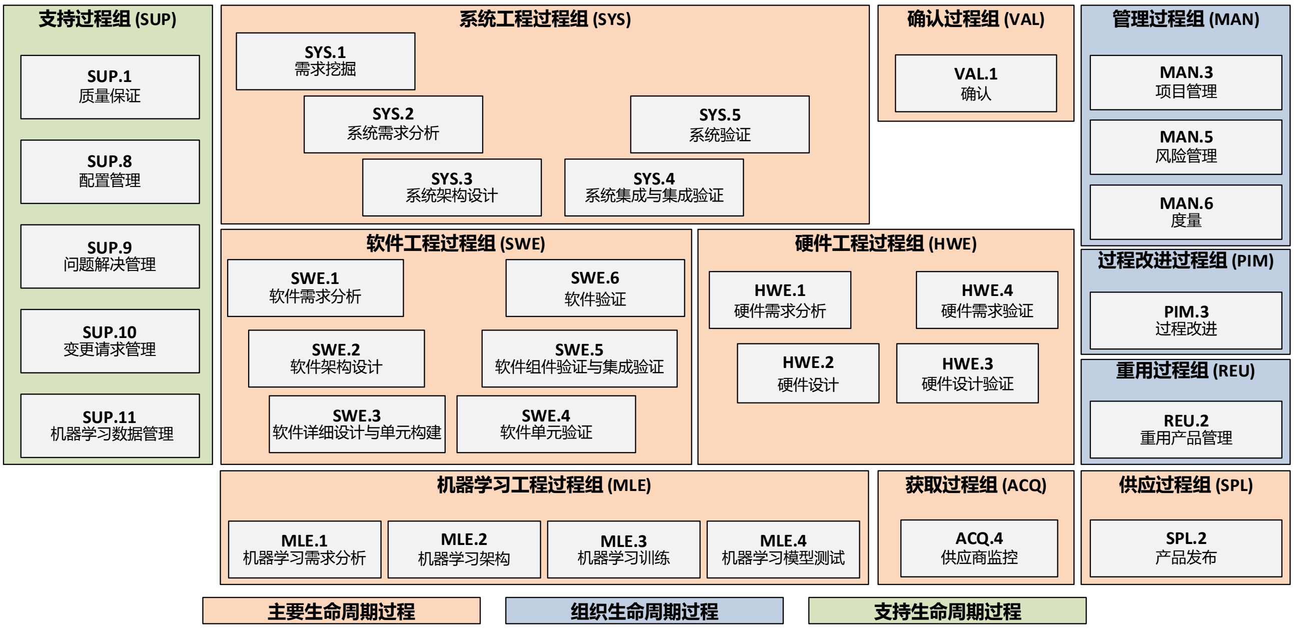

图 2 — Automotive SPICE 过程参考模型– 概览

3.1.1. 主要生命周期过程类别

主要生命周期过程类别是由适用于从供应商处获取产品的过程，或者适用于在响应利益相关方需要和交付产品时产品开发的过程所组成，包括规范、设计、开发、集成和验证所需的工程过程。
主要生命周期过程类别包括下列组：

- 获取过程组
- 供应过程组
- 系统工程过程组
- 确认过程组
- 软件工程过程组

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- the Machine learning engineering process group
- the Hardware engineering process group

The Acquisition process group (ACQ) consists of one process that is performed by the customer, or by the supplier when acting as a customer for its own suppliers, in order to acquire a product and/or service.

ACQ.4	Supplier Monitoring

Table 3 — Primary life cycle processes – ACQ process group

The Supply process group (SPL) consists of one process performed by the supplier in order to supply a product and/or a service.

SPL.2	Product Release

Table 4 — Primary life cycle processes – SPL process group

The System Engineering process group (SYS) consists of processes addressing the elicitation and management of customer and internal requirements, the definition of the system architecture and the integration and verification on the system level.

SYS.1	Requirements Elicitation
SYS.2	System Requirements Analysis
SYS.3	System Architectural Design
SYS.4	System Integration and Integration Verification
SYS.5	System Verification

Table 5 — Primary life cycle processes – SYS process group

The Validation process group (VAL) consists of one process that is performed to provide evidence that the product to be delivered satisfies the expectations for its intended use.

VAL.1	Validation

Table 6 — Primary life cycle processes – VAL process group

The Software Engineering process group (SWE) consists of processes addressing the management of software requirements derived from the system requirements, the development of the corresponding software architecture and design as well as the implementation, integration and verification of the software.

SWE.1	Software Requirements Analysis
SWE.2	Software Architectural Design
SWE.3	Software Detailed Design and Unit Construction
SWE.4	Software Unit Verification
SWE.5	Software Component Verification and Integration Verification

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- 机器学习工程过程组
- 硬件工程过程组

获取过程组（ACQ）包括客户执行的过程，或者当供应商为了获取产品或服务而作为其供应商的客户时所执行的过程。

ACQ.4	供应商监控

表 3 —主要生命周期过程 –获取过程组

供应过程组（SPL）包括供应商为了供应产品和/或服务所执行的过程。

SPL.2	产品发布

表 4 — 主要生命周期过程 – SPL 过程组

系统工程过程组（SYS）由多个过程组成，这些过程用于管理客户和内部需求的挖掘和管理、系统架构的定义以及在系统级别的集成和验证。

SYS.1	需求挖掘
SYS.2	系统需求分析
SYS.3	系统架构设计
SYS.4	系统集成与集成验证
SYS.5	系统验证

表 5 —主要生命周期过程 – SYS 过程组

确认过程组（VAL）由一个过程组成，执行该过程提供证据，来证明待交付产品满足其预期用途的期望。

VAL.1	确认

表 6 —主要生命周期过程 – VAL 过程组

软件工程过程组（SWE）由多个过程组成，这些过程用于管理源自系统需求的软件需求的管理、相应软件架构的开发和设计以及软件实现、集成和验证。

SWE.1	软件需求分析
SWE.2	软件架构设计
SWE.3	软件详细设计与单元构建
SWE.4	软件单元验证
SWE.5	软件组件验证与集成验证

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SWE.6	Software Verification

Table 7 — Primary life cycle processes – SWE process group

The Machine Learning Engineering process group (MLE) consists of processes addressing the management of ML requirements derived from the software requirements, the development of the corresponding ML architecture, the training of ML model, and testing of ML model against ML requirements.

MLE.1	Machine Learning Requirements Analysis
MLE.2	Machine Learning Architecture
MLE.3	Machine Learning Training
MLE.4	Machine Learning Model Testing

Table 8 — Primary life cycle processes – MLE process group

The Hardware Engineering process group (HWE) consists of processes addressing the management of hardware requirements derived from the system requirements, the development of the corresponding hardware architecture and design as well as the verification of the hardware.

HWE.1	Hardware Requirements Analysis
HWE.2	Hardware Design
HWE.3	Verification against Hardware Design
HWE.4	Verification against Hardware Requirements

Table 9 — Primary life cycle processes – HWE process group

3.1.2. Supporting life cycle processes category

The supporting life cycle processes category consists of processes that may be employed by any of the other processes at various points in the life cycle.

SUP.1	Quality Assurance
SUP.8	Configuration Management
SUP.9	Problem Resolution Management
SUP.10	Change Request Management
SUP.11	Machine Learning Data Management

Table 10 — Supporting life cycle processes - SUP process group

3.1.3. Organizational life cycle processes category

The organizational life cycle processes category consists of processes that develop process, product,

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SWE.6 软件验证

表 7 —主要生命周期过程 – SWE 过程组

机器学习工程过程组（MLE）由多个过程组成，这些过程用于管理源自软件需求的 ML 需求、开发相应的 ML 架构、训练 ML 模型以及根据 ML 需求测试 ML 模型。

MLE.1 机器学习需求分析

MLE.2 机器学习架构

MLE.3 机器学习训练

MLE.4 机器学习模型测试

表 8 —主要生命周期过程 – MLE 过程组

硬件工程过程组（HWE）由多个过程组成，这些过程用于管理从系统需求中衍生出来的硬件需求、相应硬件架构开发和设计以及硬件的验证。

HWE.1 硬件需求分析

HWE.2 硬件设计

HWE.3 硬件设计验证

HWE.4 硬件需求验证

表 9 —主要生命周期过程 – HWE 过程组

3.1.2. 支持生命周期过程类别

支持生命周期过程类别包括可由其他任何过程在生命周期内的多个节点使用的过程。

SUP.1 质量保证

SUP.8 配置管理

SUP.9 问题解决管理

SUP.10 变更请求管理

SUP.11 机器学习数据管理

表 10 —支持生命周期过程 - SUP 过程组

3.1.3. 组织生命周期过程类别

组织生命周期过程类别是由开发过程以及产品和资源资产的过程所组成。这些过程、产品和资源资

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and resource assets which, when used by projects in the organization, may help the organization achieve its business goals.

The organizational life cycle processes category consists of the following groups:

- the Management process group;
- the Process Improvement process group;
- the Reuse process group.

The Management process group (MAN) consists of processes that may be used by anyone who manages any type of project or process within the life cycle.

MAN.3	Project Management
MAN.5	Risk Management
MAN.6	Measurement

Table 11 — Organizational life cycle processes - MAN process group

The Process Improvement process group (PIM) covers one process that contains practices to improve the processes performed in the organizational unit.

PIM.3	Process Improvement

Table 12 — Organizational life cycle processes - PIM process group

The Reuse process group (REU) covers one process to systematically exploit reuse opportunities in organization's product portfolio.

REU.2	Management of Products for Reuse

Table 13 — Organizational life cycle processes - REU process group

3.2. Measurement framework

The measurement framework provides the necessary requirements and rules for the capability dimension. It defines a schema which enables an assessor to determine the Capability Level of a given process. These capability levels are defined as part of the measurement framework.

To enable the rating, the measurement framework provides process attributes defining a measurable property of process capability. Each process attribute is assigned to a specific capability level. The extent of achievement of a certain process attribute is represented by means of a rating based on a defined rating scale. The rules from which an assessor can derive a final capability level for a given process are represented by a process capability level model.

Automotive SPICE defines its own measurement framework.

> *Note: The Automotive SPICE measurement framework is an adaption of ISO/IEC 33020:2019. Text incorporated from ISO/IEC 33020 within this chapter is written in italic font and marked with a left side bar.*

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产在组织内的项目中使用时，以帮助组织实现其业务目标。

组织生命周期过程类别包括以下组：

- 管理过程组
- 过程改进过程组
- 重用过程组

管理过程组（MAN）是由在生命周期内管理任何类型的项目或过程的任何人可使用的过程所组成。

MAN.3	项目管理
MAN.5	风险管理
MAN.6	度量

表 11 —组织生命周期过程 - MAN 过程组

过程改进过程组（PIM）涵盖一个过程，该过程包含在组织单位中改进已执行过程的实践。

PIM.3	过程改进

表 12 —组织生命周期过程 - PIM 过程组

重用过程组（REU）涵盖了一个过程，用于系统化地在组织的产品组合中开拓重用机会。

REU.2	重用产品管理

表 13 —组织生命周期过程 - REU 过程组

3.2.度量框架

度量框架为能力维度提供了必要的需求和规则。它定义了一个可使评估人员确定对象过程的能力级别的模式。这些能力等级被定义为度量框架的一部分。

为了能够进行评定，度量框架提供了定义过程能力的有可度量特性的过程属性。每个过程属性被分配到特定的能力等级。某个过程属性达成的程度是基于已定义的评定尺度的评定方式来表示。评估师对给定过程的最终能力等级的导出规则是由过程能力等级模型来表示。

Automotive SPICE 定义了自己的度量框架。

> *注: Automotive SPICE 的度量框架是对 ISO/IEC 33020:2019 的适配。本章中从 ISO/IEC 33020 中引入的文本以斜体字书写，并在左侧用竖线标记。*

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3.2.1. Process capability levels and process attributes

The process capability levels, and associated process attributes are described in detail in chapter 5.

Process attributes are features of a process that can be evaluated on a scale of achievement, providing a measurement of the capability of the process. They are applicable to all processes.

A capability level is characterized by one or more process attributes whose implementation result in a significant improvement in the capability to perform a process. Each attribute addresses a specific aspect of the capability level. The levels constitute a rational way of progressing through improvement of the capability of any process.

There are six capability levels as listed in Table 14, incorporating nine process attributes:

Level 0: Incomplete process	*The process is not implemented or fails to achieve its process purpose.*
Level 1: Performed process	*The implemented process achieves its process purpose*
Level 2: Managed process	*The previously described performed process is now implemented in a managed fashion (planned, monitored and adjusted) and its work products are appropriately established, controlled and maintained.*
Level 3: Established process	*The previously described managed process is now implemented using a defined process that is capable of achieving its process outcomes.*
Level 4: Predictable process	*The previously described established process now operates predictively within defined limits to achieve its process outcomes. Quantitative management needs are identified, measurement data are collected and analyzed to identify assignable causes of variation. Corrective action is taken to address assignable causes of variation.*
Level 5: Innovating process	*The previously described predictable process is now continually improved to respond to organizational change.*

Table 14 — Process capability levels

Within this process assessment model, the determination of capability is based upon the nine process attributes (PA) as listed in Table 15 — Process attributes.

Attribute ID	Process Attributes
Level 0: Incomplete process	
Level 1: Performed process	
PA 1.1	*Process performance process attribute*

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3.2.1. 过程能力等级和过程属性

过程能力等级和相关的过程属性在第 5 章详细描述。

过程属性是通过提供过程能力的度量，对达成程度进行评估的过程特征。过程属性适用于所有的过程。
能力等级表征为一个或多个过程属性，这些过程属性的实施可使执行过程能力显著提升。每个属性都说明能力等级的某个特定方面。

这些能力等级总体上构成了一套合理的改进方法，旨在提升任一过程能力。

共有 6 个能力等级，包含 9 个过程属性，如表 14 所示：

等级0 级: 不完整的过程	*过程未实施或未能实现其过程目的。*
等级1 级: 已执行的过程	*已执行的过程实现其过程目的。*
等级2 级: 已管理的过程	*以管理的方式（计划，监控和调整）来实施前述的已执行的过程，并且适当的建立、控制和维护该过程工作产品。*
等级3 级： 已建立的过程	*前述的已管理的过程，由能实现其过程成果的已定义过程来实施。*
等级4 级： 可预测的过程	*前述的已建立的过程，在定义的限值内可预测地运作以达成其过程成果。识别量化管理需要，收集和分析度量数据，以识别波动的可查明原因。采取纠正措施来解决波动的可查明原因。*
等级5 级： 创新的过程	*前述的可预测的过程得到不断地改进，以适应组织的变化。*

表 14 —过程能力等级

在此过程评估模型中，能力的确定是基于表 15 所定义的 9 个过程属性。

属性 ID	*过程属性*
等级 0 级:不完整的过程	
等级 1 级:已执行的过程	
PA 1.1	*过程实施过程属性*

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Level 2: Managed process	
PA 2.1	*Performance management process attribute*
PA 2.2	*Work product management process attribute*
Level 3: Established process	
PA 3.1	*Process definition process attribute*
PA 3.2	*Process deployment process attribute*
Level 4: Predictable process	
PA 4.1	*Quantitative analysis process attribute*
PA 4.2	*Quantitative control process attribute*
Level 5: Innovating process	
PA 5.1	*Process innovation process attribute*
PA 5.2	*Process innovation implementation process attribute*

Table 15 — Process attributes

3.2.2. Process attribute rating

To support the rating of process attributes, the measurement framework provides a defined rating scale with an option for refinement, different rating methods and different aggregation methods depending on the class of the assessment (e.g., required for organizational maturity assessments).

3.2.2.1. Rating scale

> *Within this process measurement framework, a process attribute is a measureable property of process capability. A process attribute rating is a judgement of the degree of achievement of the process attribute for the assessed process.*

The rating scale is shown in Table 16 — Rating scale.

Note. The rating scale is identical to ISO/IEC 33020:2019

N	*Not achieved*	*There is little or no evidence of achievement of the defined process attribute in the assessed process.*
P	*Partially achieved*	*There is some evidence of an approach to, and some achievement of, the defined process attribute in the assessed process. Some aspects of achievement of the process attribute may be unpredictable.*

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等级 2 级:已管理的过程	
PA 2.1	*实施管理过程属性*
PA 2.2	*工作产品管理过程属性*
等级 3 级：已建立的过程	
PA 3.1	*过程定义过程属性*
PA 3.2	*过程部署过程属性*
等级 4 级：可预测的过程	
PA 4.1	*定量分析过程属性*
PA 4.2	*定量控制过程属性*
等级 5 级：创新的过程	
PA 5.1	*过程创新过程属性*
PA 5.2	*过程创新实施过程属性*

表 15 —过程属性

3.2.2. 过程属性评定

为支持过程属性评定，度量框架提供了一个已定义的评定尺度（可选择更细化的评定尺度），以及基于评估类型（例如，组织成熟度评估所需的）的不同评定方法和聚合方法。

3.2.2.1. 评定尺度

> *在这个过程度量框架中，过程属性是过程能力的可度量特性。过程属性评定是对被评估过程的过程属性达成程度的判断。*

评定尺度见**错误!未找到引用源。**

注：此评定尺度与 ISO/IEC 33020:2019 一致

N	*没有达成*	*在被评估的过程中，有很少或没有证据表明定义的过程属性得到了达成。*
P	*部分达成*	*在被评估的过程中，有一些证据表明对定义的过程属性进行了执行，并得到一些达成。过程属性的达成在某些方面可能是不可预测的。*

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L	*Largely achieved*	*There is evidence of a systematic approach to, and significant achievement of, the defined process attribute in the assessed process. Some weaknesses related to this process attribute may exist in the assessed process.*
F	*Fully achieved*	*There is evidence of a complete and systematic approach to, and full achievement of, the defined process attribute in the assessed process. No significant weaknesses related to this process attribute exist in the assessed process.*

Table 16 — Rating scale

The ordinal scale defined above shall be understood in terms of percentage achievement of a process attribute. The corresponding percentages shall be:

N	*Not achieved*	*0 to ≤ 15% achievement*
P	*Partially achieved*	*> 15% to ≤ 50% achievement*
L	*Largely achieved*	*> 50% to ≤ 85% achievement*
F	*Fully achieved*	*> 85% to ≤ 100% achievement*

Table 17 — Rating scale percentage values

The ordinal scale may be further refined for the measures P and L as defined below.

P-	*Partially achieved:*	*There is some evidence of an approach to, and some achievement of, the defined process attribute in the assessed process. Many aspects of achievement of the process attribute may be unpredictable.*
P+	*Partially achieved:*	*There is some evidence of an approach to, and some achievement of, the defined process attribute in the assessed process. Some aspects of achievement of the process attribute may be unpredictable.*
L-	*Largely achieved:*	*There is evidence of a systematic approach to, and significant achievement of, the defined process attribute in the assessed process. Many weaknesses related to this process attribute may exist in the assessed process.*
L+	*Largely achieved:*	*There is evidence of a systematic approach to, and significant achievement of, the defined process attribute in the assessed process. Some weaknesses related to this process attribute may exist in the assessed process.*

Table 18 — Refinement of rating scale

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L	主要达成	在被评估的过程中，有证据表明对定义的过程属性有系统地执行，并得到显著的达成。过程属性相关的一些弱点可存在于被评估的过程中。
F	全部达成	在被评估的过程中，有证据表明对定义的过程属性有完整地和系统地执行，并得到充分的达成。没有过程属性相关的显著的弱点存在于被评估的过程中。

表 16 —评定尺度

以上所定义的顺序尺度应以过程属性达成的百分比来理解。对应的百分比应是：

N	没有达成	0 ~ ≤ 15% 达成
P	部分达成	> 15% ~ ≤ 50%达成
L	主要达成	> 50% ~ ≤ 85%达成
F	完全达成	> 85% ~ ≤ 100%达成

表 17 —评定尺度的百分比值

针对 P 和 L 的度量，顺序尺度可进一步细化如下。

P-	部分达成:	在被评估的过程中，有一些证据表明对定义的过程属性进行了执行，并得到一些达成。过程属性的达成在很多方面可能是不可预测的。
P+	部分达成:	在被评估的过程中，有一些证据表明对定义的过程属性进行了执行，并得到一些达成。过程属性的达成在某些方面可能是不可预测的。
L-	主要达成:	在被评估的过程中，有证据表明对定义的过程属性有系统地执行，并得到显著的达成。过程属性相关的很多弱点可存在于被评估的过程中。
L+	主要达成:	在被评估的过程中，有证据表明对定义的过程属性有系统地执行，并得到显著的达成。过程属性相关的一些弱点可存在于被评估的过程中。

表 18 —评定尺度的细化

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The corresponding percentages shall be:

P-	*Partially achieved -*	*> 15% to ≤ 32.5% achievement*
P+	*Partially achieved +*	*> 32.5 to ≤ 50% achievement*
L-	*Largely achieved -*	*> 50% to ≤ 67.5% achievement*
L+	*Largely achieved +*	*> 67.5% to ≤ 85% achievement*

Table 19 — Refined rating scale percentage values

3.2.3. Rating and aggregation method

Rating and aggregation methods are taken from ISO/IEC 33020:2019, which provides the following definitions:

> *A process outcome is the observable result of successful achievement of the process purpose.*
>
> *A process attribute outcome is the observable result of achievement of a specified process attribute.*
>
> *Process outcomes and process attribute outcomes may be characterised as an intermediate step to providing a process attribute rating.*
>
> *When performing rating, the rating method employed shall be specified relevant to the class of assessment. The following rating methods are defined.*
>
> *The use of rating method may vary according to the class, scope and context of an assessment. The lead assessor shall decide which (if any) rating method to use. The selected rating method(s) shall be specified in the assessment input and referenced in the assessment report.*

ISO/IEC 33020:2019 provides the following 3 rating methods:

> ***Rating method R1***
>
> *The approach to process attribute rating shall satisfy the following conditions:*
>
> *a) Each process outcome of each process within the scope of the assessment shall be characterized for each process instance, based on validated data;*
>
> *b) Each process attribute outcome of each process attribute for each process within the scope of the assessment shall be characterized for each process instance, based on validated data;*
>
> *c) Process outcome characterizations for all assessed process instances shall be aggregated to provide a process performance attribute achievement rating;*
>
> *d) Process attribute outcome characterizations for all assessed process instances shall be aggregated to provide a process attribute achievement rating.*
>
> ***Rating method R2***
>
> *The approach to process attribute rating shall satisfy the following conditions:*

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对应的百分比应是：

P-	*部分达成-*	*> 15% ～ ≤ 32.5% 达成*
P+	*部分达成+*	*> 32.5 ～ ≤ 50% 达成*
L-	*主要达成-*	*> 50% ～ ≤ 67.5% 达成*
L+	*主要达成+*	*> 67.5% ～ ≤ 85% 达成*

表 19 —细化的评定尺度的百分比值

3.2.3. 评定和聚合的方法

评定和聚合的方法采自于 ISO/IEC 33020:2019，其提供了如下定义：

> *过程成果是过程目的成功达成的可观测的结果。*
>
> *过程属性成果是特定的过程属性成功达成的可观测的结果。*
>
> *过程成果和过程属性成果可表示为中间步骤的特性以提供过程属性的评定。*
>
> *在执行评定时，采用的评定方法应明确与评估的类型相关联。下列评定方法被定义。*
>
> *评定方法的使用可根据评估的类型、范围和环境的不同而不同。主评估师应决定使用哪种评定方法。选定的评定方法应定义在评估输入中，并在评估报告中提及。*

ISO/IEC 33020:2019 提供如下 3 种评定方法：

> ***评定方法 R1***
>
> *过程属性评定的方法应满足以下条件：*
>
> *a)在评估范围内，每个过程的各过程成果应基于经过验证的数据为每个过程实例进行特征描述；*
>
> *b) 在评估范围内，每个过程的各过程属性的各过程属性成果应基于经过验证的数据为每个过程实例进行特征描述；*
>
> *c) 应对所有被评估的过程实例的过程成果特性进行聚合，以提供过程实施属性达成的评定。*
>
> *d) 应对所有被评估的过程实例的过程属性成果特性进行聚合，以提供过程属性达成的评定。*
>
> ***评定方法 R2***
>
> *过程属性评定的方法应满足以下条件：*

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a) Each process attribute for each process within the scope of the assessment shall be characterized for each process instance, based on validated data;

b) Process attribute characterizations for all assessed process instances shall be aggregated to provide a process attribute achievement rating.

Rating method R3

Process attribute rating across assessed process instances shall be made without aggregation.

In principle the three rating methods defined in ISO/IEC 33020:2019 depend on

a) whether the rating is made only on process attribute level (Rating method 3 and 2) or – with more level of detail – both on process attribute and process attribute outcome level (Rating method 1); and
b) the type of aggregation ratings across the assessed process instances for each process

If a rating is performed for both process attributes and process attribute outcomes (Rating method 1), the result will be a process performance attribute outcome rating on level 1 and a process attribute achievement rating on higher levels.

Depending on the class, scope and context of the assessment an aggregation within one process (one-dimensional, vertical aggregation), across multiple process instances (one-dimensional, horizontal aggregation) or both (two-dimensional, matrix aggregation) is performed.

ISO/IEC 33020:2019 provides the following examples:

When performing an assessment, ratings may be summarized across one or two dimensions.

For example, when rating a

- *process attribute for a given process, one may aggregate ratings of the associated process (attribute) outcomes – such an aggregation will be performed as a vertical aggregation (one dimension).*
- *process (attribute) outcome for a given process attribute across multiple process instances, one may aggregate the ratings of the associated process instances for the given process (attribute) outcome such an aggregation will be performed as a horizontal aggregation (one dimension)*
- *process attribute for a given process, one may aggregate the ratings of all the process (attribute) outcomes for all the processes instances – such an aggregation will be performed as a matrix aggregation across the full scope of ratings (two dimensions)*

The standard defines different methods for aggregation. Further information can be taken from ISO/IEC 33020:2019.

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> *a) 在评估范围内，每个过程的过程属性应基于经过验证的数据为每个过程实例进行特征描述。*
>
> *b) 应对所有被评估的过程实例的过程属性特性进行聚合，以提供过程属性达成的评定。*
>
> ***评定方法 R3***
>
> *跨（被评估的）过程实例的过程属性评定不应进行聚合。*

原则上，ISO/IEC 33020 中定义的三种评定方法依赖于

a) 是否只对过程属性级别（评定方法3 和2）进行评定，或者更加详细地对过程属性和过程属性成果的两者都进行评定（评定方法1）；

b) 对每个过程进行跨（被评估的）过程实例聚合评定的类型

如果对过程属性和过程属性成果都执行评定（评定方法1），评定结果为在1 级对过程实施属性成果的评定和在更高级别对过程属性达成成果的评定。
依赖于评估的类型、范围和背景，在一个过程内（一个维度，垂直聚合）、跨多个过程实例（一个维度，横向聚合）或两者（两个维度，矩阵聚合）进行聚合。

ISO/IEC 33020:2019 提供如下示例：

> *当执行评估时，评定可跨一或两个维度进行汇总：*
>
> *例如，*
>
> - *评定某过程的过程属性时，可以聚合相关过程（属性）成果的评定-这样的聚合将作为垂直聚合来执行（一个维度）。*
> - *评定跨多个过程实例的某过程属性的过程（属性）成果时，可以聚合该过程（属性）成果相关过程实例的评定 – 这样的聚合是作为横向聚合来执行（一个维度）。*
> - *评定某过程的过程属性时，可以聚合所有过程实例的所有过程（属性）成果的评定 – 这样的聚合将作为遍及整个评定范围的矩阵聚合来执行（两个维度）。*

标准定义了不同的聚合方法。可以从 ISO/IEC 33020:2019 获取更详细的信息。

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3.2.4. Process capability level model

The process capability level achieved by a process shall be derived from the process attribute ratings for that process according to the process capability level model defined in Table 20 — Capability levels.

The process capability level model defines the rules how the achievement of each level depends on the rating of the process attributes for the assessed and all lower levels.

As a general rule the achievement of a given level requires a largely or fully achievement of the corresponding process attributes and a full achievement of any lower lying process attribute.

Scale	Process attribute	Rating
Level 1	PA 1.1: Process performance process attribute	Largely or fully
Level 2	PA 1.1: Process performance process attribute PA 2.1: Process performance management process attribute PA 2.2: Work product management process attribute	Fully Largely or fully Largely or fully
Level 3	PA 1.1: Process performance process attribute PA 2.1: Process performance management process attribute PA 2.2: Work product management process attribute PA 3.1: Process definition process attribute PA 3.2: Process deployment process attribute	Fully Fully Fully Largely or fully Largely or fully
Level 4	PA 1.1: Process performance process attribute PA 2.1: Process performance management process attribute PA 2.2: Work product management process attribute PA 3.1: Process definition process attribute PA 3.2: Process deployment process attribute PA 4.1: Quantitative analysis process attribute PA 4.2: Quantitative control process attribute	Fully Fully Fully Fully Fully Largely or fully Largely or fully
Level 5	PA 1.1: Process performance process attribute PA 2.1: Process performance management process attribute PA 2.2: Work product management process attribute PA 3.1: Process definition process attribute PA 3.2: Process deployment process attribute PA 4.1: Quantitative analysis process attribute PA 4.2: Quantitative control process attribute PA 5.1: Process innovation process attribute PA 5.2: Process innovation implementation process attribute	Fully Fully Fully Fully Fully Fully Fully Largely or fully Largely or fully

Table 20 — Capability levels and corresponding process attribute ratings

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3.2.4. 过程能力等级模型

根据**错误!未找到引用源。** 所定义的过程能力等级模型，过程所达到的过程能力等级应从该过程的过程属性评定中导出。
依赖于评估对象等级及在所有更低等级的过程属性的评定，过程能力等级模型定义了如何达成各等级的规则。
作为一般规则，达成某等级需要主要达成该等级对应过程属性，并且完全达成更低等级的过程属性。

级别	过程属性	评定
等级 1 级	PA 1.1:过程实施	主要或完全
等级 2 级	PA 1.1: 过程实施 PA 2.1: 实施管理 PA 2.2:工作产品管理	完全 主要或完全 主要或完全
等级 3 级	PA 1.1: 过程实施 PA 2.1: 实施管理 PA 2.2: 工作产品管理 PA 3.1: 过程定义 PA 3.2: 过程部署	完全 完全 完全 主要或完全 主要或完全
等级 4 级	PA 1.1:过程实施 PA 2.1: 实施管理 PA 2.2:工作产品管理 PA 3.1: 过程定义 PA 3.2: 过程部署 PA 4.1: 定量分析 PA 4.2:定量控制	完全 完全 完全 完全 完全 主要或完全 主要或完全
等级 5 级	PA 1.1: 过程实施 PA 2.1: 实施管理 PA 2.2:工作产品管理 PA 3.1: 过程定义 PA 3.2: 过程部署 PA 4.1: 定量分析 PA 4.2:定量控制 PA 5.1: 过程创新 PA 5.2: 过程创新实施	完全 完全 完全 完全 完全 完全 完全 主要或完全 主要或完全

表 20 —能力等级及相应的过程属性评定

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3.3. Process assessment model

The process assessment model offers indicators in order to identify whether the process outcomes and the process attribute outcomes (achievements) are present or absent in the instantiated processes of projects and organizational units. These indicators provide guidance for assessors in accumulating the necessary objective evidence to support judgments of capability. They are not intended to be regarded as a mandatory set of checklists to be followed.

3.3.1. Assessment indicators

According to ISO/IEC 33004, a process assessment model needs to define a set of assessment indicators:

> ***Assessment Indicators***
>
> *A process assessment model shall be based on a set of assessment indicators that:*
>
> *a) explicitly address the purpose and process outcomes, as defined in the selected process reference model, of each of the processes within the scope of the process assessment model;*
>
> *b) demonstrate the achievement of the process attributes within the scope of the process assessment model;*
>
> *c) demonstrate the achievement (where relevant) of the process quality levels within the scope of the process assessment model.*
>
> *The assessment indicators generally fall into three types:*
>
> *a)* ***practices*** *that support achievement of either the process purpose or the specific process attribute.*
>
> *b)* ***information items*** *and their characteristics that demonstrate the respective achievements.*
>
> *c) resources and infrastructure that support the respective achievements.*
>
> *[ISO/IEC 33004:2015, 6.3.1]*

In this assessment model, only practices and information items are used.

Practices are representing activity-oriented indicators, where information items are representing result-oriented indicators. Both practices and information items are used for judging objective evidence to be collected and accumulated in the performance of an assessment.

As a first type of assessment indicator, practices are provided, which can be divided into two types:

1. **Base practices (BP), applying to capability level 1**

   They provide an indication of the extent of achievement of the process outcomes. Base practices relate to one or more process outcomes, thus being always process-specific and not generic.

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3.3. 过程评估模型

过程评估模型提供了指标，以识别过程成果和过程属性成果（成就）在项目和组织单位的实例化过程中是存在还是缺失的。这些指标为评估师收集必要的客观证据提供了指导，以支持能力的判定。这些指标不应被视为必须遵循的检查单集。

3.3.1. 评估指标

根据 ISO/IEC 33004，过程评估模型需要定义一套评估指标：

> ***评估指标***
>
> *过程评估模型须基于一组评估指标，这些指标：*
>
> *a) 在过程评估模型的范围内，明确阐明所选过程参考模型中各过程所定义的目的和过程成果；*
>
> *b) 在过程评估模型的范围内，证明过程属性的达成；*
>
> *c) 在过程评估模型的范围内，证明过程质量级别的达成（如相关）。*
>
> *评估指标一般分为三类：*
>
> *a) 支持过程目标或特定过程属性达成的**实践**。*
>
> *b) 能表明各自达成的**信息项**及其特性。*
>
> *c) 支持各自达成的资源和基础设施。*
>
> *[ISO/IEC 33004:2015, 6.3.1]*

在本评估模型中，只有实践和信息项被使用。

实践是指面向活动的指标，而信息项则是指面向结果的指标。实践和信息项都用于判断在评估执行过程中收集和积累的客观证据。

作为第一类评估指标，提供的实践可以分为两类：

1. **基本实践（BP）适用于能力等级 1 级**

   基本实践提供了关于过程成果的达成程度的指标。

   基本实践与一个或多个过程成果相关，因此总是特定于过程的，而不是通用的。

2. Generic practices (GP), applying to capability levels 1 to 5

They provide an indication of the extent of process attribute achievement. Generic practices relate to one or more process attribute achievements, thus applying to any process.

As a second type of assessment indicators, **information items (II)** including their **characteristics (IIC)** are provided in Annex B.

These are meant to offer a good practice and state-of-the-art knowledge guide for the assessor. Therefore, information items including their characteristics are supposed to be a quickly accessible information source during an assessment.

Information item characteristics shall not be interpreted as a required structure of a corresponding work products, which is defined by the project and organization, respectively.

Please refer to chapter 3.3.2 for understanding the difference between information items and work products.

ISO 33004:2015 requires the mapping of assessment indicators to process attributes as shown in figure 3.

The capability of a process on level 1 is only characterized by the measure of the extent to which the process outcomes are achieved. According to ISO 33003:2015, a measurement framework requires each level to reveal a process attribute. Therefore, the only process performance attribute for capability Level 1 (PA.1.1) has a single generic practice (GP 1.1.1) pointing as an editorial reference to the respective process performance indicators (see figure 3 and chapter 4).

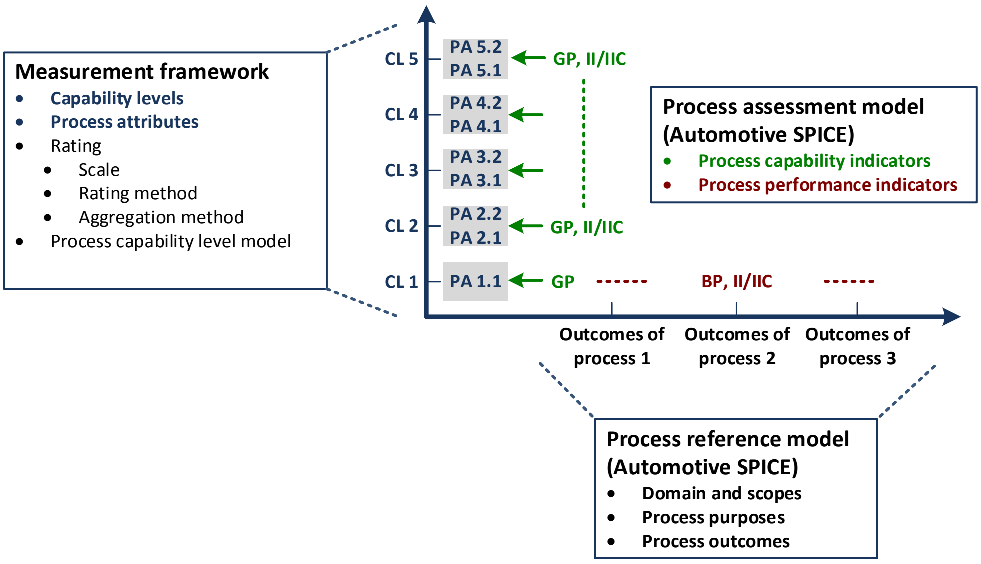

Figure 3 — Relationship between assessment indicators and process capability

The detailed mapping of base practices / indicators and generic practices / indicators to process outcomes and achievements, is provided in corresponding tables in chapter 4 and 5, respectively.

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2. 通用实践（GP）适用于能力等级 2 级到 5 级

通用实践提供了关于过程属性达成程度的指标。通用实践与一个或多个过程属性的实现相关，因此适用于任何过程。

作为第二类评估指标，信息项（II）及其特性（IIC）在附件 B 中得以展示。

这些旨在为评估师提供良好的实践和最先进的知识指南。因此，信息项（包括其特性）被认为是在评估中可快速访问的信息源。

信息项特性不应被解释为相应工作产品的必需结构，工作产品是由项目和组织分别定义的。

请参阅第**错误!未找到引用源。**章节，了解信息项和工作产品之间的区别。

ISO 33004:2015 要求将评估指标映射到过程属性，如图 3 所示。

过程的能力等级 1 级只是对过程成果达成程度的度量的特性。

根据 ISO 33003:2015，度量框架要求每个级别都要展现一个过程属性。因此，仅有能力等级 1 级的过程实施属性（PA.1.1）具有单一的通用实践（GP 1.1.1），作为编辑参考引用各个过程实施指标（见图 3 和第 4 章）。

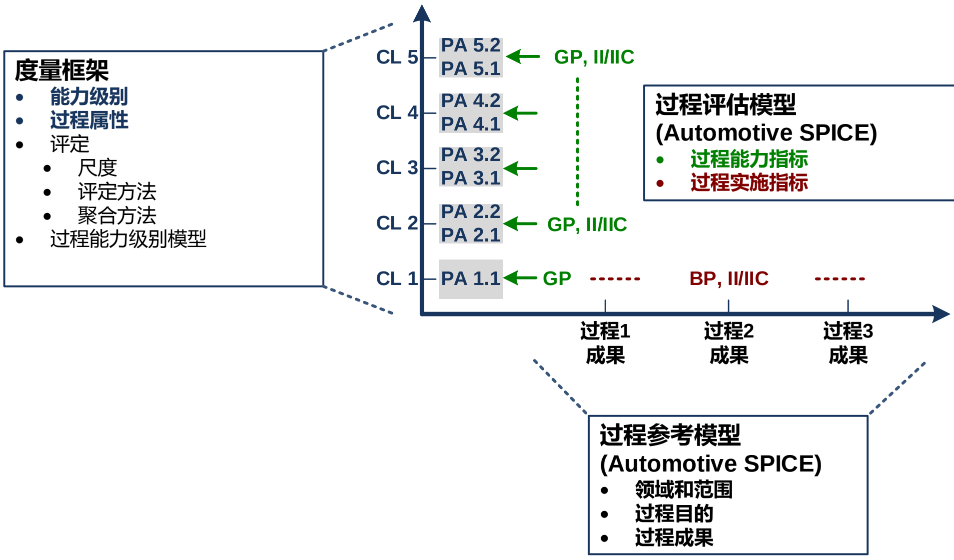

图 3 —评估指标与过程能力的关系

第 4 章和第 5 章的相应表格分别提供了基本实践/指标和通用实践/指标与过程成果和成就的详细对应关系。

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3.3.2. Understanding information Items and work products

In order to judge the presence or absence of process outcomes and process attribute achievements an assessment obtains objective evidence. All such evidence comes either from the examination of work products related to a specific output of the processes assessed, or from statements made by the performers and managers of the processes. Sources for such evidence is either repository content of the assessed processes, or testimony provided by the performers and managers of the assessed processes.

As described in chapter 3.3.1, this process assessment model provides information items serving as indicators to guide the assessor when judging a process attribute achievement.

3.3.2.1. Information items versus work products

ISO/IEC 33001 provides the following definition of the term “information item”:

> ***information item***
>
> *separately identifiable body of information that is produced, stored, and delivered for human use*
>
> *Note 1 to entry: An information item can be produced in several versions during a system, software, or service life cycle. Syn: information product.*
>
> *[ISO/IEC 33001:2015, 3.1.4]*

Note: Human use includes the information stored, managed and processed by a tool.

One common definition of the term “work product” is:

> ***work product***
>
> *artifact resulting from the execution of a process*
>
> *[ISO/IEC/IEEE 24765:2017]*

Both terms are used in different context in an assessment:

- Information items are defining relevant pieces of information used by the assessors to judge the achievement of process attributes.
- Work products are produced by the organization assessed when performing, managing, establishing, analyzing and innovating processes.

Information items (together with their characteristics) are provided as guidance for “what to look for” when examining the work products available in the assessed organization. The extent of implementation of an information item (in line with its defined characteristics) in a related work product serves as objective evidence supporting the assessment of a particular process. A documented process and assessor judgment is needed to ensure that the process context (application domain, business purpose, development methodology, size of the organization, etc.) is considered when using this information.

Information items shall therefore not be mistaken for the work product generated by the assessed organization itself. There is no 1:1 relationship between an information item and the work product taken as sample evidence by the assessor when assessing the achievement of a process outcome and process attribute achievements. An output generated by a process may comprise multiple information item characteristics and multiple outputs may also contain the same information item characteristics.

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3.3.2. 理解信息项和工作产品

为了判断过程成果和过程属性成就的存在或缺失，评估需要获取客观证据。所有这些证据或者来自对工作产品（与被评价过程的特定输出相关的）的检查，或者来自过程执行者和管理者的陈述。这些证据的来源可以是被评估过程的存储内容，也可以是被评估过程的执行者和管理者提供的证词。

如 3.3.1 节所述，本过程评估模型提供了信息项，作为指导评估师判断过程属性达成情况的指标。

3.3.2.1. <u>信息项与工作产品</u>

ISO/IEC 33001 对术语“信息项”提供了如下定义：

> ***信息项***
>
> *为人类使用而产生、存储和传递的可被单独识别的信息主体*
>
> *注 1：在系统、软件或服务的生命周期中，一个信息项可以产生多个版本。同：信息产品。*
>
> *[ISO/IEC 33001:2015, 3.1.4]*

注：人类使用包括由工具存储、管理和处理的信息。

术语“工作产品”的一个常用定义为：

> ***工作产品***
>
> *过程执行所产生的制品*
>
> *[ISO/IEC/IEEE 24765:2017]*

这两个术语在评估中的不同环境中使用：

- 信息项定义了评估师用来判断过程属性达成情况的相关信息片段。
- 工作产品是被评估组织在执行、管理、建立、分析和创新过程时产出的。

在检查被评估组织中可用的工作产品时，信息项（及其特性）作为指南以指示“寻找什么”。信息项（根据其定义的特性）在相关工作产品中的实现程度被用作客观证据，以支持对特定过程的评估。在使用这些信息时需要有文档化的过程和评估师的判断，以确保过程上下文（应用领域、业务目的、开发方法、组织规模等）得以考虑。

因此，信息项不应被误认为是被评估组织自己生成的工作产品。在对过程成果和过程属性的达成情况进行评估时，信息项和被评估师采为样本证据的工作产品之间没有 1:1 的对应关系。某个由过程产生的输出可以包含多个信息项特性，同时多个输出也可以包含相同的信息项特性。

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Information item characteristics should be considered as indicators when considering whether, given the context, a work product is contributing to the intended purpose of the process. Context-sensitivity means that assessor judgment is needed to ensure that the actual context (application domain, business purpose, development methodology, size of the organization, etc.) is considered when using the information items.

3.3.2.2. Types of work products

A work product to be considered as evidence when rating a process attribute may not necessary be outputs from the processes assessed but can also be originated from other processes of the organization. Once such a work product is used in the performance of a process under assessment, it may be considered by the assessor as objective evidence.

In a lot of cases work products are comprising documentation aspects, such as specifications, reports, records, architectural designs, software code etc.

Examples of work products not comprising any documentation aspects are software binaries, raw data, or a physical electronic hardware.

3.3.3. Understanding the level of abstraction of a PAM

The term "process" can be understood at three levels of abstraction. Note that these levels of abstractions are not meant to define a strict black-or-white split, nor is it the aim to provide a scientific classification schema – the message here is to understand that, in practice, when it comes to the term "process" there are different abstraction levels, and that a PAM resides at the highest.

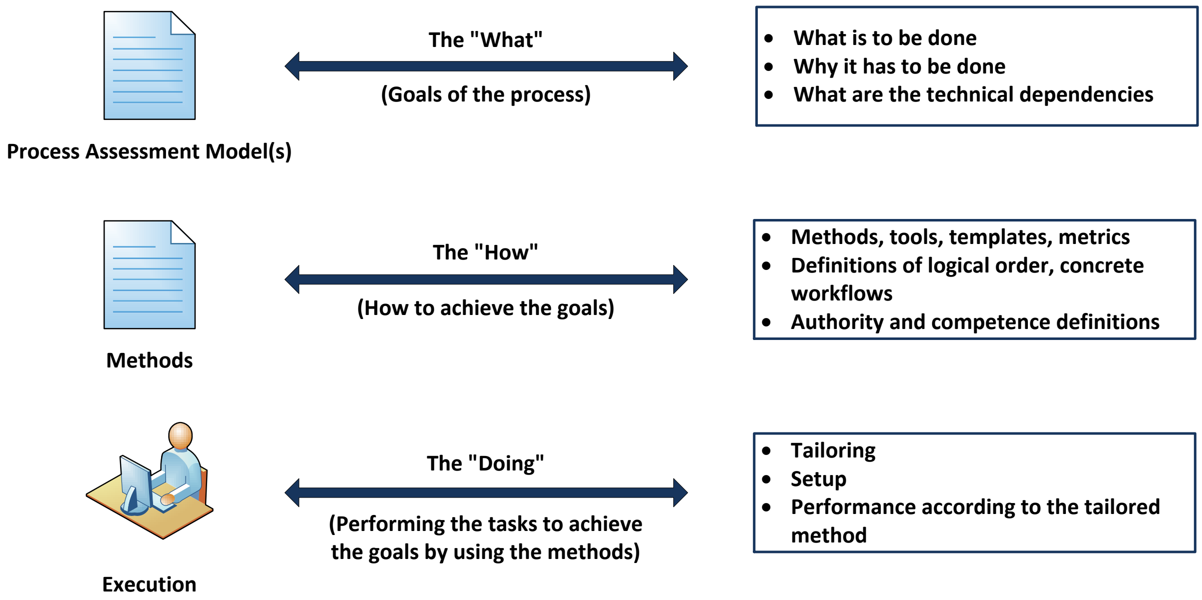

Figure 4 — Possible levels of abstraction for the term "process"

Capturing experience acquired during product development (i.e., at the DOING level) in order to share this experience with others means creating a HOW level. However, a HOW is always

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当考虑一个工作产品在给定的上下文中是否对过程的预期目的有帮助时，信息项特性应被当作衡量指标。上下文敏感意味着评估师需要进行判断，以确保在使用信息项时考虑到实际上下文（应用领域、业务目的、开发方法、组织规模等）。

3.3.2.2. 工作产品类型

在对过程属性进行评级时，作为证据的工作产品不一定是所评估过程的输出，也可以是源于组织其它过程的输出。一旦这样的工作产品被用于被评估过程的实施中，它就可以被评估师认定为客观证据。

在很多情况下，工作产品是由文档形式构成的，如规范、报告、记录、架构设计、软件代码等。

不包括任何文档形式的工作产品的示例如，软件二进制文件、原始数据或物理电子硬件。

3.3.3. 理解 PAM 的抽象级别

术语“过程”可在三个抽象层面上理解。注意这些抽象层面并不是为了定义一个严格的“非黑即白”的分层，也不是为了提供一个科学的分类模式 – 而是为便于理解，在实践中，当涉及到术语“过程”时，这个词有不同的抽象层面，并且PAM 属于最高层。

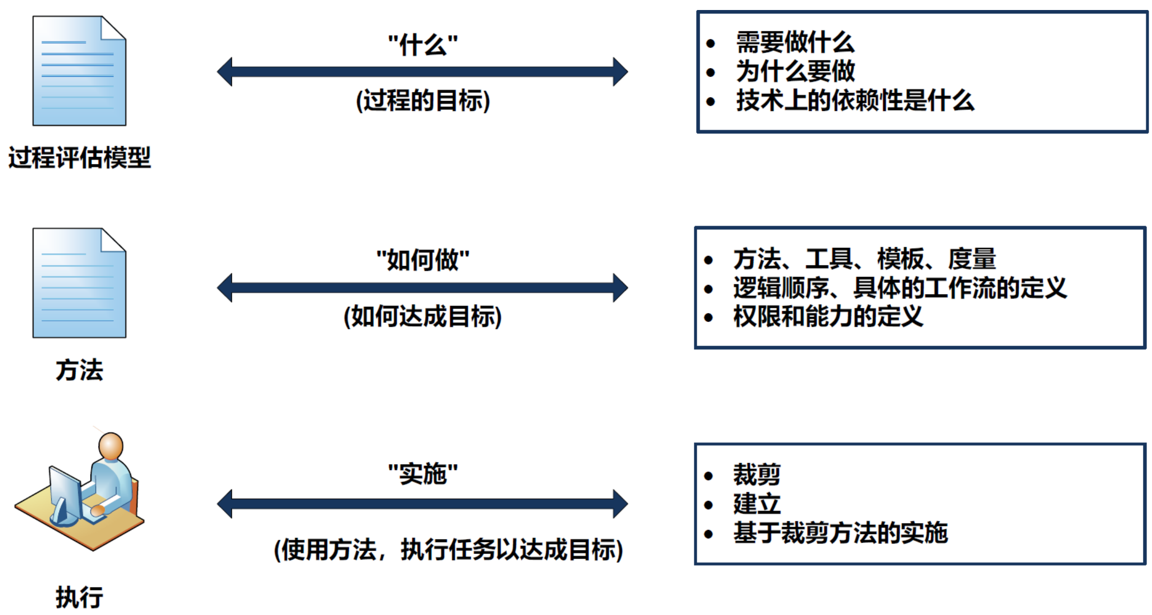

图 4 —关于术语“过程”的可能的抽象层面

获取在产品开发过程中获取的经验（即在”实施”层面）以便与他人分享，这意味着创建一个”如何做”级别。然而，”如何做”总是特定于一个特定环境，如某个公司、某个组织单位、或者某个产品线。例如，项目、组织单位或公司A 的”如何做”可能不适用于项目、组织单位或公司B。然而，

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specific to a particular context such as a company, an organizational unit, or a product line. For example, the HOW of a project, organizational unit, or company A is potentially not applicable as is to a project, organizational unit, or company B. However, both might be expected to adhere the principles represented by PAM indicators for process outcomes and process attribute achievements. These indicators are at the WHAT level while deciding on solutions for concrete templates, proceedings, and tooling etc. is left to the HOW level.

3.3.4. Why a PRM and PAM are not a lifecycle model or development process blueprint

A lifecycle model defines phases and activities in a logical timely order, possibly including cycles or loops, and parallelization. For example, some standards such as ISO 26262 or ISO/SAE 21434 are centered around a lifecycle model (neither of these standards in fact represents a PRM according to ISO/IEC 33004). Companies, organizational units, or projects will interpret such general lifecycle models given in standards, and then detail it out into roles, organizational interactions and interfaces, tools or tool chains, work instructions, and artifacts. Lifecycle models therefore are a concept at the HOW level (see Section 3.3.3).

In contrast, a PRM/PAM according to ISO/IEC 33004 (formerly ISO/IEC 15504-2) is at the level of the WHAT by abstracting from any HOW level, see Figure 4 in Section 3.3.3. In Automotive SPICE®, this has been, and is, indicated by the process MAN.3 Project Management requiring in BP2 “Define project life cycle”. A PRM/PAM groups a set of coherent and related characteristics of a particular technical topic and calls it ‘process’. In different terms, a process in a PRM represents a ‘distinct conceptual silo’. In this respect, a PRM/PAM

- neither predefines, nor discourages, any order in which PRM processes or Base Practices are to be performed. Ultimately, in Automotive SPICE consistency must be fulfilled as required by the traceability/consistency Base Practices in MAN.3 or SYS.x, SWE.x, and HWE.x;
- does not predefine any particular work product structure, or work product blueprints. For example, the process SYS.2 does not mean that there shall be exactly one system requirements specification containing everything provided by the stakeholders.

As a consequence, it is the assessor’s responsibility to perform a mapping of elements in such a HOW level to the Assessment Indicators in the PAM, see Figure 5.

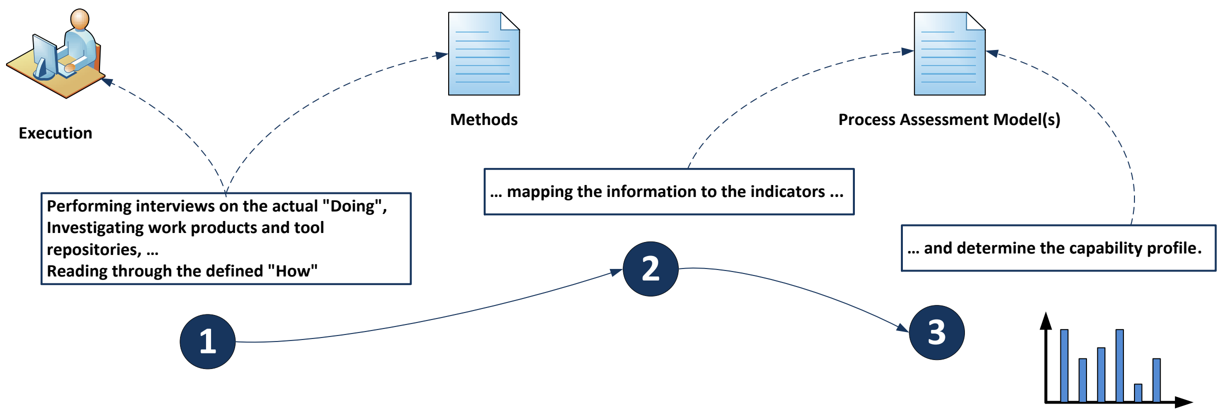

Figure 5 — Performing a process assessment for determining process capability

In this respect, a PRM or PAM further is not supposed to represent a product element hierarchy either.

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两者都可能会遵循PAM 指标所代表的原则，以达成过程成果和过程属性。这些指标是在”什么”的层面，而具体的模板、规程和工具等解决方案的确定则是归属于”如何做”层面。

3.3.4. 为什么 PRM 和 PAM 不是生命周期模型或开发过程蓝图

生命周期模型以逻辑时间顺序定义阶段和活动，可能包括周期或循环以及并行化。例如，某些标准（如 ISO 26262 或 ISO/SAE 21434）是以生命周期模型为中心的（事实上，这两个标准都不代表符合 ISO/IEC 33004 的 PRM）。公司、组织单位或项目将解释标准中给出的这种通用生命周期模型，然后将其细化至角色、组织交互和接口、工具或工具链、工作指导和制品。因此，生命周期模型是一个“如何做”层面的概念（见 3.3.3 节）。

相反，符合 ISO/IEC 33004（以前的 ISO/IEC 15504-2）的 PRM/PAM 通过从任何“如何做”层面进行抽象而处于“什么”层面，参见第 3.3.3 节中的图 4。在 Automotive SPICE®中，MAN.3 项目管理过程所要求 BP2“定义项目生命周期”已经表明这一点。PRM/PAM 将特定技术主题下的一组相关且连贯的特征组合在一起，并将其称为“过程”。用另一种表述方式，PRM 中的过程表示“不同的概念筒仓”。从这个方面讲，PRM/PAM 具备如下特点：

- 既不预先定义，也不阻碍 PRM 过程或基本实践的执行顺序。最终，对于 Automotive SPICE®的一致性要求，必须按照 MAN.3 或 SYS.x、SWE.x 和 HWE.x 中的基本实践所要求的可追溯性/一致性来满足；
- 不预定义任何特定的工作产品结构，或工作产品蓝图。例如，过程 SYS.2 并不意味着必须只有一个包含利益相关方提供的所有内容的系统需求规范。

因此，评估师有责任将这种“如何做”级别的要素映射到 PAM 中的评估指标，见图 5。

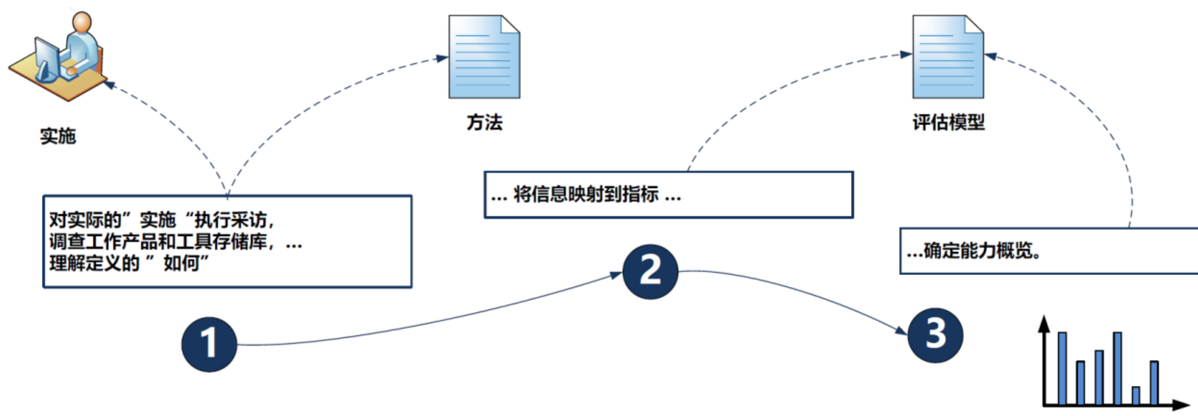

图 5 —执行确定过程能力的过程评估

从这个方面讲， PRM 或 PAM 也不应该表示产品要素的层次结构。

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4. Process reference model and performance indicators (Level 1)

The processes in the process dimension can be drawn from the Automotive SPICE process reference model, which is incorporated in the tables below indicated by a red bar at the left side.

Each table related to one process in the process dimension contains the process reference model (indicated by a red bar) and the process performance indicators necessary to define the process assessment model. The process performance indicators consist of base practices (indicated by a green bar) and output information items (indicated by a blue bar).

Process reference model	**Process ID** **Process name** **Process purpose** **Process outcomes**	The individual processes are identified with a unique process identifier and a process name. A process purpose statement is provided, and process outcomes are defined to represent the process dimension of the Automotive SPICE process reference model. The background coloring of process ID's and names are indicating the assignment to the corresponding process group.
Process performance indicators	**Base Practices**	A set of base practices for the process providing a definition of the activities to be performed to accomplish the process purpose and fulfill the process outcomes. The base practice headers are summarized at the end of a process to demonstrate their relationship to the process outcomes.
	Output information items	The output information items that are relevant to accomplish the process purpose and fulfill the process outcomes summarized at the end of a process to demonstrate their relationship to the process outcomes. *Note: Refer to Annex B for the characteristics of each information item.*

Table 21 — Template for the process description

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4. 过程参考模型和实施指标（等级 1 级）

过程维度中的过程可取自Automotive SPICE 过程参考模型，该内容包含在下表中由左侧红色竖线表示的部分。

与过程维度中各个过程相关的表包含过程参考模型（由红色栏表示）和定义过程评估模型所需的过程实施指标。过程实施指标是由基本实践（由绿色栏表示）和输出工作产品（由蓝色栏表示）所构成。

过程参考模型	**过程 ID** **过程名称** **过程目的** **过程成果**	每个过程由唯一的过程 ID 和过程名称所标识。提供了过程目的声明，并定义了过程成果以表示 Automotive SPICE 过程参考模型的过程维度。过程 ID 和过程名称的背景颜色表示该过程被分配的相应过程组别。
过程实施指标	**基本实践**	过程的一组基本实践提供了实现过程目的和满足过程成果所需执行的活动的定义。 基本实践标题在过程末尾处进行汇总，以说明它们与过程成果的关系。
	输出信息项	与实现过程目的和满足过程成果相关的输出信息项，在过程末尾进行汇总，以说明它们与过程成果的关系。 • *注：各信息项特性见附录 B。*

表 21 —过程描述的模板

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4.1. Acquisition process group (ACQ)

4.1.1. ACQ.4 Supplier Monitoring

Process ID
ACQ.4
Process name
Supplier Monitoring
Process purpose
The purpose is to track and assess the performance of an external contract-based supplier company against agreed commitments.
Process outcomes
1) Joint activities, as agreed between the customer and the supplier, are performed. 2) All information, agreed upon for exchange, is communicated regularly between the customer and the supplier. 3) Performance of the supplier is monitored against the agreements. 4) Changes to the agreement, if needed, are negotiated between the customer and the supplier and documented in the agreement.

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4.1. 获取过程组(ACQ)

4.1.1. ACQ.4 供应商监控

过程 ID
ACQ.4
过程名称
供应商监控
过程目的
其目的是：根据约定的承诺，跟踪和评估外部合同供应商公司的实施情况。
过程成果
1) 根据客户和供应商的约定，实施了联合活动。 2) 在供应商和客户之间定期沟通了所有约定交换的信息; 3) 依照协议，监控了供应商的实施情况; 4) 根据需要，客户和供应商对协议的变更进行了协商，并将变更记录在协议中。

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Base Practices
ACQ.4.BP1: Agree on and maintain joint activities, joint interfaces, and information to be exchanged. Establish and maintain an agreement on information to be exchanged, on joint activities, joint interfaces, responsibilities, type and frequency of joint activities, communications, meetings, status reports, and reviews.
ACQ.4.BP2: Exchange all agreed information. Use the defined joint interfaces between customer and supplier for the exchange of all agreed information.
ACQ.4.BP3: Review development work products with the supplier. Review development work products with the supplier on the agreed regular basis, covering technical aspects, problems and risks. Track open measures. *Note 1: see SUP.9 for management of problems*
ACQ.4.BP4: Review progress of the supplier. Review progress of the supplier regarding schedule, quality, and cost on the agreed regular basis. Track open measures to closure and perform risk mitigation activities. *Note 2: see MAN.5 for management of risks*
ACQ.4.BP5: Act to correct deviations. Take action when agreed objectives are not achieved. Negotiate changes to objectives and document them in the agreements.

ACQ.4 Supplier Monitoring	Outcome 1	Outcome 2	Outcome 3	Outcome 4
Output Information Items				
02-01 Commitment/Agreement	X	X	X	X
13-52 Communication evidence	X	X	X	
13-09 Meeting support evidence	X	X		
13-14 Progress status		X	X	
13-16 Change request				X
13-19 Review evidence		X		
14-02 Corrective action				X
15-51 Analysis results			X	

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基本实践
ACQ.4.BP1: 约定并维护联合活动、联合接口及需要交换的信息。建立并维护协议，包括交换信息、联合活动、联合接口、职责以及联合活动、沟通、会议、状态汇报、评审的类别和频率。
ACQ.4.BP2: 交换所有约定的信息。使用客户和供应商之间定义的联合接口交换所有约定的信息。
ACQ.4.BP3: 与供应商评审开发工作产品。按照约定定期与供应商评审开发工作产品，包括技术方面、问题和风险。跟踪未完成的措施。 • *注 1:问题管理参见 SUP.9。*
ACQ.4.BP4: 评审供应商进展。按照约定定期评审供应商在进度、质量和成本方面的进展。跟踪未完成的措施直到关闭，并实施风险缓解活动。 • *注 2：风险管理参见 MAN.5。*
ACQ.4.BP5: 纠正偏差。当约定的目标没有达成时，采取行动。就目标的变更进行协商，并记录在协议中。

ACQ.4 供应商监控	成果 1	成果 2	成果 3	成果 4
输出信息项				
02-01 承诺/协议	X	X	X	X
13-52 沟通证据	X	X	X	
13-09 会议支持证据	X	X		
13-14 进展状态		X	X	
13-16 变更请求				X
13-19 评审证据		X		
14-02 纠正措施				X
15-51 分析结果			X	

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Base Practices				
BP1: Agree on and maintain joint processes, joint interfaces, and information to be exchanged	X	X		X
BP2: Exchange all agreed information	X	X	X	
BP3: Review development work products with the supplier	X		X	X
BP4: Review progress of the supplier	X		X	X
BP5: Act to correct deviations			X	X

4.2. Supply process group (SPL)

4.2.1. SPL.2 Product Release

Process ID
SPL.2
Process name
Product Release
Process purpose
The purpose is to control the release of a product to the intended customer.
Process outcomes
1) The contents of the product releases are determined. 2) The release package is assembled from configured items. 3) The release documentation is defined and produced. 4) Release approval is performed against defined criteria. 5) The release package is made available to the intended customer.

Base Practices
SPL.2.BP1: Define the functional content of releases. Define the functionality to be included and the release criteria for each release. *Note 1: This may include the hardware elements, software elements, and extra application parameter files (influencing the identified system functionality) that are needed for the release.*

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基本实践				
BP1: 约定并维护联合活动、联合接口及需要交换的信息	X	X		X
BP2: 交换所有约定的信息	X	X	X	
BP3: 与供应商评审开发工作产品	X		X	X
BP4: 评审供应商进展	X		X	X
BP5: 纠正偏差			X	X

4.2.供应过程组 (SPL)

4.2.1. SPL.2 产品发布

过程 ID
SPL.2
过程名称
产品发布
过程目的
其目的是：控制对目标客户的产品发布。
过程成果
1) 确定了产品发布的内容； 2) 发布包由被配置的项构建； 3) 定义并生成了发布文档； 4) 依照定义的准则，批准了发布； 5) 提供了发布包给目标客户。

基本实践
SPL.2.BP1: 定义发布的功能性内容。定义各发布所包含的功能和发布准则。 • *注 1: 可包括发布所需的硬件要素、软件要素和额外的应用参数文件（影响已识别的系统功能）。*

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SPL.2.BP2: Define release package. Define the release as well as supporting tools and information. *Note 2: The release package may include also programming tools.*
SPL.2.BP3: Ensure unique identification of releases. Ensure a unique identification of the release based upon the intended purpose and expectations of the release. *Note 3: Unique identification may be realized by a classification and numbering scheme for product releases.*
SPL.2.BP4: Build the release from items under configuration control. Build the release from items under configuration control to ensure integrity. *Note 4: This practice may be supported by the SUP.8 Configuration Management Process.*
SPL.2.BP5: Ensure release approval before delivery. Criteria for the release are satisfied before delivery takes place.
SPL.2.BP6: Provide a release note. A release is accompanied by information detailing key characteristics of the release. *Note 5: The release note may include information about legal aspects like relevant target markets, legislation that is considered etc. See also VAL.1 Validation.*
SPL2.BP7: Communicate the type, service level and duration of support for a release. Identify and communicate the type, service level and duration of support for a release.
SPL.2.BP8: Deliver the release package to the intended customer. Deliver the release package to the intended customer. *Note 6: The intended customer may be an internal organizational unit or an external organization.*

SPL.2 Product Release	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5
Output Information Items					
11-03 Release note	X		X	X	X
11-04 Product release package		X	X		
13-06 Delivery evidence			X		X
13-13 Product release approval				X	X
18-06 Product release criteria	X	X		X	
Base Practices					
BP1: Define the functional content of releases	X				

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SPL.2.BP2:定义发布包。定义发布以及支持工具和信息。 • *注 2: 发布包还可包括编程工具。*
SPL.2.BP3: 确保发布的唯一标识。根据发布的目的和期望，确保发布的唯一标识。 • *注 3: 唯一标识可通过产品发布的分类和编号方式来实现。*
SPL.2.BP4: 从配置控制项构建发布。从纳入配置控制的项构建发布以确保完整性。 • *注 4: 该实践可通过 SUP.8 配置管理过程支持。*
SPL.2.BP5: 确保交付前对发布的批准。在发布前，发布准则得到满足。
SPL.2.BP6: 提供发布说明。 发布时附带该发布关键特性的详细信息。 • *注 5: 发布说明可包括有关法律方面的信息，如相关目标市场、考虑的法规等。另请参见 VAL.1 确认。*
SPL2.BP7: 沟通发布的类型、服务级别和提供支持的持续时间。识别和沟通发布的类型、服务级别和提供支持的持续时间。
SPL.2.BP8: 交付发布包给目标客户。交付发布包给目标客户。 • *注 6: 目标客户可以是内部组织单位或外部组织。*

SPL.2 产品发布	成果 1	成果 2	成果 3	成果 4	成果 5
输出信息项					
11-03 发布说明	X		X	X	X
11-04 产品发布包		X	X		
13-06 发布证据			X		X
13-13 产品发布批准				X	X
18-06 产品发布准则	X	X		X	
基本实践					
BP1: 定义发布的功能性内容	X				

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BP2: Define release package	X				
BP3: Establish a product release classification and numbering scheme			X		
BP4: Build the release from configured items		X			
BP5: Ensure product release approval before delivery				X	
BP6: Provide a release note			X		X
BP7: Communicate the type, service level and duration of support for a release			X		X
BP8: Deliver the release package to the intended customer					X

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BP2: 定义发布包	X				
BP3: 确保发布的唯一标识			X		
BP4: 从配置控制项构建发布		X			
BP5: 确保交付前对发布的批准				X	
BP6: 提供发布说明			X		X
BP7: 沟通发布的类型、服务级别和提供支持的持续时间			X		X
BP8: 交付发布包给目标客户					X

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4.3. System engineering process group (SYS)

4.3.1. SYS.1 Requirements Elicitation

Process ID
SYS.1
Process name
Requirements Elicitation
Process purpose
The purpose is to gather, analyze, and track evolving stakeholder needs and requirements throughout the lifecycle of the product and/or service to establish a set of agreed requirements.
Process outcomes
1) Continuing communication with the stakeholder is established. 2) Stakeholder expectations are understood, and requirements are defined and agreed. 3) Stakeholder requirements changes arising from stakeholder needs are analyzed to enable associated risk assessment and impact management. 4) Determination of stakeholder requirements status is ensured for all affected parties.

Base Practices
SYS.1.BP1: Obtain stakeholder expectations and requests. Obtain and define stakeholder expectations and requests through direct solicitation of stakeholder input, and through review of stakeholder business proposals (where relevant) and other documents containing inputs to stakeholder requirements, and consideration of the target operating and hardware environment. *Note 1: Documenting the stakeholder, or the source of a stakeholder requirement, supports stakeholder requirements agreement and change analysis (see BP2 and BP3).*
SYS.1.BP2: Agree on requirements. Formalize the stakeholder's expectations and requests into requirements. Reach a common understanding of the set of stakeholder requirements among affected parties by obtaining an explicit agreement from all affected parties. *Note 2: Examples of affected parties are customers, suppliers, design partners, joint venture partners, or outsourcing parties.* *Note 3: The agreed stakeholder requirements may be based on feasibility studies and/or cost and schedule impact analysis.*

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4.3.系统工程过程组 (SYS)

4.3.1. SYS.1 需求挖掘

过程 ID
SYS.1
过程名称
需求挖掘
过程目的
其目的是：在产品和/或服务的整个生命周期内收集、分析和跟踪不断变化的利益相关方的需要和需求，建立一组约定的需求。
过程成果
1) 建立了与利益相关方的持续沟通； 2) 理解了利益相关方的期望，定义和约定了需求； 3) 分析了因利益相关方需要的变化而引发的利益相关方需求变更，便于相关的风险评估和影响管理； 4) 确保了所有受影响方能够确定利益相关方需求的状态。

基本实践
SYS.1.BP1: 获得利益相关方期望和要求。通过直接征求利益相关方意见、评审利益相关方业务提案（相关部分）及其它包含利益相关方需求输入的文档，并考虑目标运行和硬件环境，获得并定义利益相关方期望和要求。 • *注 1: 记录利益相关方或利益相关方需求来源，支持利益相关方需求协议和变更分析（参见 BP2 和 BP3）。*
SYS.1.BP2: 达成需求共识。将利益相关方期望和要求正式化，形成需求。通过获得所有受影响方的明确协议，在受影响方之间达成对利益相关方需求的共识。 • *注 2: 受影响方的示例如，客户、供应商、设计合作伙伴、合资公司或外包方。* • *注 3: 约定的利益相关方需求可基于可行性研究和/或成本和进度影响分析。*

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SYS.1.BP3: Analyze stakeholder requirements changes. Analyze all changes made to the stakeholder requirements against the agreed stakeholder requirements. Assess the impact and risks, and initiate appropriate change control and mitigation actions.

Note 4: Requirements changes may arise from different sources as for instance changing technology, stakeholder needs, or legal constraints.

Note 5: Refer to SUP.10 Change Request Management, if required.

SYS.1.BP4: Communicate requirements status. Ensure all affected parties can be aware of the status and disposition of their requirements including changes and can communicate necessary information and data.

SYS.1 Requirements Elicitation	Outcome 1	Outcome 2	Outcome 3	Outcome 4
Output Information Items				
15-51 Analysis Results			X	
13-52 Communication Evidence	X	X		
17-00 Requirement		X		
17-54 Requirement Attribute		X	X	X
Base Practices				
BP1: Obtain stakeholder expectations and requests	X			
BP2: Agree on requirements		X		
BP3: Analyze stakeholder requirements changes			X	
BP4: Communicate requirements status	X			X

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SYS.1.BP3:分析利益相关方需求变更。 依照约定的利益相关方需求，分析利益相关方需求的所有变更。评估影响和风险，并启动适当的变更控制和缓解措施。

- *注 4: 需求变更可能有不同的来源，例如技术变化、利益相关方需要变化、法律约束。*
- *注 5: 如有需要，参见 SUP.10 变更请求管理。*

SYS.1.BP4: 沟通需求状态。确保所有受影响方都能了解其需求的状态和处置结果，包括变更，并沟通必要的信息和数据。

SYS.1 需求挖掘	成果 1	成果 2	成果 3	成果 4
输出信息项				
15-51 分析结果			X	
13-52 沟通证据	X	X		
17-00 需求		X		
17-54 需求属性		X	X	X
基本实践				
BP1: 获得利益相关方期望和要求	X			
BP2: 达成需求共识		X		
BP3: 分析利益相关方需求变更			X	
BP4: 沟通需求状态	X			X

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4.3.2. SYS.2 System Requirements Analysis

Process ID
SYS.2
Process name
System Requirements Analysis
Process purpose
The purpose is to establish a structured and analyzed set of system requirements consistent with the stakeholder requirements.
Process outcomes
1) System requirements are specified. 2) System requirements are structured and prioritized. 3) System requirements are analyzed for correctness and technical feasibility. 4) The impact of system requirements on the operating environment is analyzed. 5) Consistency and bidirectional traceability are established between system requirements and stakeholder requirements. 6) The system requirements are agreed and communicated to all affected parties.

Base Practices
SYS.2.BP1: Specify system requirements. Use the stakeholder requirements to identify and document the functional and non-functional requirements for the system according to defined characteristics for requirements. *Note 1: Characteristics of requirements are defined in standards such as ISO IEEE 29148, ISO 26262-8:2018, or the INCOSE Guide For Writing Requirements.* *Note 2: Examples for defined characteristics of requirements shared by technical standards are verifiability (i.e., verification criteria being inherent in the requirements text), unambiguity/comprehensibility, freedom from design and implementation, and not contradicting any other requirement).*
SYS.2.BP2: Structure system requirements. Structure and prioritize the system requirements. *Note 3: Examples for structuring criteria can be grouping (e.g., by functionality) or product variants identification.* *Note 4: Prioritization can be done according to project or stakeholder needs via e.g., definition of release scopes. Please refer to SPL.2.BP1.*

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4.3.2. SYS.2 系统需求分析

过程 ID
SYS.2
过程名称
系统需求分析
过程目的
其目的是：建立一组已结构化和已分析的系统需求，与利益相关方需求相一致。
过程成果
1) 定义了系统需求； 2) 结构化了系统需求并进行优先级排序； 3) 分析了系统需求的正确性和技术可行性； 4) 分析了系统需求对运行环境的影响； 5) 建立了系统需求与利益相关方需求之间的一致性和双向可追溯性； 6) 约定了系统需求，并与所有受影响方沟通。

基本实践
SYS.2.BP1: 定义系统需求。根据定义的需求特性，使用利益相关方需求来识别和文档化系统的功能性和非功能性需求。 • *注 1:需求特性在一些标准中有定义，诸如 ISO IEEE 29148、ISO/IEC IEEE 24765、ISO 26262-8:2018 或 INCOSE 需求编写指南等。* • *注 2:上述标准共有的关于已定义的需求特性的示例如，可验证的 (即：需求文本中固有的验证准则)、无歧义的/可理解的，无设计和实现限制的，以及不与任何其他需求相矛盾的。*
SYS.2.BP2: 结构化系统需求。结构化系统需求并进行优先级排序。 • *注 3: 结构化准则的示例如，分组（如按功能）或产品变体识别。* • *注 4: 可以根据项目或利益相关方需要(如发布范围的定义)，来进行优先级排序。参见 SPL.2.BP1。*

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SYS.2.BP3: Analyze system requirements. Analyze the specified system requirements including their interdependencies to ensure correctness, technical feasibility, and to support project management regarding project estimates.

Note 5: See MAN.3.BP3 for project feasibility and MAN.3.BP5 for project estimates.

Note 6: Technical feasibility can be evaluated based on e.g., platform or product line, or by means of prototype development or product demonstrators.

SYS.2.BP4: Analyze the impact on the system context. Analyze the impact that the system requirements will have on elements in the relevant system context.

SYS.2.BP5: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability between system requirements and stakeholder requirements.

Note 7: Bidirectional traceability supports consistency, facilitates impact analyses of change requests, and supports the demonstration of coverage of stakeholder requirements. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.

Note 8: There may be non-functional stakeholder requirements that the system requirements do not trace to. Examples are process requirements. Such stakeholder requirements are still subject to verification.

SYS.2.BP6: Communicate agreed system requirements and impact on the system context. Communicate the agreed system requirements, and results of the impact analysis on the system context, to all affected parties.

SYS.2 System Requirements Analysis	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6
Output Information Items						
17-00 Requirement	X	X				
17-54 Requirement Attribute		X	X			
15-51 Analysis Results			X	X		
13-51 Consistency Evidence					X	
13-52 Communication Evidence						X
Base Practices						
BP1: Specify system requirements	X					
BP2: Structure system requirements		X				

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SYS.2.BP3: 分析系统需求。分析已定义的系统需求（包括它们的相互依赖关系），以确保正确性、技术可行性，并支持项目管理的项目估算。 • *注 5: 项目可行性参见 MAN.3.BP3，项目估算参见 MAN.3.BP5。* • *注 6:技术可行性评估可基于平台或产品、通过原型开发或产品演示。*
SYS.2.BP4: 分析对系统环境的影响。分析系统需求对相关系统环境中的要素产生的影响。
SYS.2.BP5: 确保一致性和建立双向可追溯性。确保系统需求与利益相关方需求之间的一致性并建立双向可追溯性。 • *注 7: 双向可追溯性支持一致性，有助于对变更请求的影响分析，并支持利益相关方需求覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。* • *注 8: 可能存在系统需求无法追溯的非功能性利益相关方需求，例如过程需求。这些利益相关方需求仍然需要验证。*
SYS.2.BP6: 沟通约定的系统需求和对系统环境的影响。与所有受影响方沟通约定的系统需求，以及对系统环境影响分析的结果。

SYS.2 系统需求分析	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6
输出信息项						
17-00 需求	X	X				
17-54 需求属性		X	X			
15-51 分析结果			X	X		
13-51 一致性证据					X	
13-52 沟通证据						X
基本实践						
BP1: 定义系统需求	X					
BP2: 结构化系统需求		X				

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BP3: Analyze system requirements			X			
BP4: Analyze the impact on the system context				X		
BP5: Ensure consistency and establish bidirectional traceability					X	
BP6: Communicate agreed system requirements and impact on the system context						X

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BP3: 分析系统需求			X			
BP4: 分析对系统环境的影响				X		
BP5: 确保一致性和建立双向可追溯性					X	
BP6: 沟通约定的系统需求和对系统环境的影响						X

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4.3.3. SYS.3 System Architectural Design

Process ID
SYS.3
Process name
System Architectural Design
Process purpose
The purpose is to establish an analyzed system architecture, comprising static and dynamic aspects, consistent with the system requirements.
Process outcomes
1) A system architecture is designed including a definition of the system elements with their behavior, their interfaces, their relationships, and their interactions. 2) The system architecture is analyzed against defined criteria, and special characteristics are identified. 3) Consistency and bidirectional traceability are established between system architecture and system requirements. 4) The agreed system architecture and the special characteristics are communicated to all affected parties.

Base Practices
SYS.3.BP1: Specify static aspects of the system architecture. Specify and document the static aspects of the system architecture with respect to the functional and non-functional system requirements, including external interfaces and a defined set of system elements with their interfaces and relationships.
SYS.3.BP2: Specify dynamic aspects of the system architecture. Specify and document the dynamic aspects of the system architecture with respect to the functional and non-functional system requirements including the behavior of the system elements and their interaction in different system modes. *Note 1: Examples of interactions of system elements are timing diagrams reflecting inertia of mechanical components, processing times of ECUs, and signal propagation times of bus systems.*

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4.3.3. SYS.3 系统架构设计

过程 ID
SYS.3
过程名称
系统架构设计
过程目的
其目的是：建立与系统需求一致的，经过分析的系统架构（包括静态和动态方面）。
过程成果
1) 设计了系统架构，包括系统要素及其行为、接口、关系和交互的定义； 2) 根据已定义的准则分析了系统架构，并识别了特殊特性； 3) 建立了系统架构与系统需求之间的一致性和双向可追溯性； 4) 将约定的系统架构和特殊特性与所有受影响方沟通。

基本实践
SYS.3.BP1: 定义系统架构的静态方面。根据功能和非功能的系统需求，定义和文档化系统架构的静态方面，包括外部接口和一组已定义的系统要素及其接口和关系。
SYS.3.BP2: 定义系统架构的动态方面。根据功能和非功能系统需求，定义并文档化系统架构的动态方面，包括系统要素的行为及其在不同系统模式下的交互。 • *注 1:系统要素相互作用的示例如，反映机械组件惯性、ECU 的处理时间、总线系统的信号传播时间的时序图。*

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SYS.3.BP3: Analyze system architecture. Analyze the system architecture regarding relevant technical design aspects related to the product lifecycle, and to support project management regarding project estimates, and derive special characteristics for non-software system elements. Document a rationale for the system architectural design decisions.

Note 2: See MAN.3.BP3 for project feasibility and MAN.3.BP5 for project estimates.

Note 3: Examples for product lifecycle phases are production, maintenance & repair, decommissioning.

Note 4: Examples for technical aspects are manufacturability for production, suitability of pre-existing system elements to be reused, or availability of system elements.

Note 5: Examples for methods being suitable for analyzing technical aspects are prototypes, simulations, and qualitative analyses (e.g., FMEA approaches)

Note 6: Examples of design rationales are proven-in-use, reuse of a product platform or product line), a make-or-buy decision, or found in an evolutionary way (e.g., set-based design).

SYS.3.BP4: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability between the elements of the system architecture and the system requirements that represent properties or characteristics of the physical end product.

Note 7: Bidirectional traceability further supports consistency, and facilitates impact analysis of change requests, and demonstration of verification coverage. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.

Note 8: There may be non-functional requirements that the system architectural design does not trace to. Examples are do not address, or represent, direct properties or characteristics of the physical end product. Such requirements are still subject to verification.

SYS.3.BP5: Communicate agreed system architecture. Communicate the agreed system architecture, including the special characteristics, to all affected parties.

SYS.3 System Architectural Design	Outcome 1	Outcome 2	Outcome 3	Outcome 4
Output Information Items				
04-06 System Architecture	X			
13-51 Consistency Evidence			X	
13-52 Communication Evidence				X
15-51 Analysis Results		X		
17-57 Special Characteristics		X		
Base Practices				
BP1: Specify static aspects of system architecture	X			
BP2: Specify dynamic aspects of system architecture	X			

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SYS.3.BP3: 分析系统架构。基于产品生命周期相关的技术方面，来分析系统架构，并支持项目管理的项目估算，以及导出非软件系统要素的特殊特性。文档化系统架构设计决策的依据。

- *注 2: 项目可行性参见 MAN.3.BP3，项目估算参见 MAN.3.BP5。*
- *注 3: 产品生命周期阶段的示例如，生产、维护和维修、报废。*
- *注 4: 技术方面的示例如，生产的可制造性、被重用的既有系统要素的适用性，或系统要素的可用性。*
- *注 5: 适合分析技术方面方法的示例如，原型、仿真和定性分析(例如 FMEA 方法)*
- *注 6:设计依据的示例如，在用证明、产品平台或产品线的重用、自制或外购（make-or-buy）的决策、或以演变的方式进行呈现(如集合设计)。*

SYS.3.BP4: 确保一致性和建立双向可追溯性。确保系统架构要素与表示最终实物产品属性或特性的系统需求之间的一致性并建立双向可追溯性。

- *注 7: 双向可追溯性支持一致性，并有助于对变更请求的影响分析和验证覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。*
- *注 8: 可能存在系统架构设计无法追溯的肺功能性要求。例如不涉及或代表物实际产品的直接属性或特征。这些需求仍有待延证。*

SYS.3.BP5: 沟通约定的系统架构。与所有受影响方沟通约定的系统架构，包括特殊特性。

SYS.3 系统架构设计	成果 1	成果 2	成果 3	成果 4
输出信息项				
04-06 系统架构	X			
13-51 一致性证据			X	
13-52 沟通证据				X
15-51 分析结果		X		
17-57 特殊特性		X		
基本实践				
BP1: 定义系统架构的静态方面	X			
BP2: 定义系统架构的动态方面	X			

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BP3: Analyze the system architecture		X		
BP4: Ensure consistency and establish bidirectional traceability			X	
BP5: Communicate agreed system architecture				X

4.3.4. SYS.4 System Integration and Integration Verification

Process ID
SYS.4
Process name
System Integration and Integration Verification
Process purpose
The purpose is to integrate systems elements and verify that the integrated system elements are consistent with the system architecture.
Process outcomes
1) Verification measures are specified for system integration verification of the integrated system elements based on the system architecture, including the interfaces of, and interactions between, system elements. 2) System elements are integrated up to a complete integrated system consistent with the release scope. 3) Verification measures are selected according to the release scope considering criteria, including criteria for regression verification. 4) Integrated system elements are verified using the selected verification measures, and the results of the system integration verification are recorded. 5) Consistency and bidirectional traceability are established between verification measures and the elements of the system architecture. 6) Bidirectional traceability between verification results and verification measures is established. 7) Results of the system integration and integration verification are summarized and communicated to all affected parties.

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BP3: 分析系统架构		X		
BP4: 确保一致性和建立双向可追溯性			X	
BP5: 沟通约定的系统架构				X

4.3.4. SYS.4 系统集成与集成验证

过程 ID
SYS.4
过程名称
系统集成与集成验证
过程目的
其目的是：集成系统要素，并验证集成的系统要素与系统架构相一致。
过程成果
1) 基于系统架构，包括系统要素之间的接口和交互，为集成的系统要素定义了系统集成验证的验证措施； 2) 将系统要素集成为与发布范围一致的完整的集成系统； 3) 根据发布范围并考虑准则（包括回归验证准则），选择了验证措施； 4) 使用选定的验证措施验证了集成的系统要素，并记录了系统集成验证结果； 5) 建立了验证措施与系统架构要素之间的一致性和双向可追溯性； 6) 建立了验证结果与验证措施之间的双向可追溯性； 7) 总结了系统集成与集成验证结果，并与所有受影响方沟通。

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Base Practices
SYS.4.BP1: Specify verification measures for system integration. Specify the verification measures, based on a defined sequence and preconditions for the integration of system elements against the system static and dynamic aspects of the system architecture, including • techniques for the verification measures, • pass/fail criteria for verification measures, • a definition of entry and exit criteria for the verification measures, and • the required verification infrastructure and environment setup. *Note 1: Examples on what a verification measure may focus are the timing dependencies of the correct signal flow between interfacing system elements, or interactions between hardware and software, as specified in the system architecture. The system integration test cases may focus on* • *the correct signal flow between system items,* • *the timeliness and timing dependencies of signal flow between system items,* • *the correct interpretation of signals by all system items using an interface, and/or* • *the dynamic interaction between system items.*
SYS.4.BP2: Select verification measures. Document the selection of verification measures for each integration step considering selection criteria including criteria for regression verification. The documented selection of verification measures shall have sufficient coverage according to the release scope. *Note 2: Examples for selection criteria can be prioritization of requirements, the need for regression verification (due to e.g., changes to the system architectural design or to system components), or the intended use of the delivered product release (e.g., test bench, test track, public road etc.)*
SYS.4.BP3: Integrate system elements and perform integration verification. Integrate the system elements until the system is fully integrated according to the specified interfaces and interactions between the system elements, and according to the defined sequence and defined preconditions. Perform the selected system integration verification measures. Record the verification measure data including pass/fail status and corresponding verification measure data. *Note 3: Examples for preconditions for starting system integration can be successful system element verification or qualification of pre-existing system elements.* *Note 4: See SUP.9 for handling verification results that deviate from expected results*
SYS.4.BP4: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability between verification measures and the system architecture. Establish bidirectional traceability between verification results and verification measures. *Note 5: Bidirectional traceability supports consistency, and facilitates impact analysis of change requests, and demonstration of verification coverage. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.*

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基本实践
SYS.4.BP1: 定义系统集成的验证措施。依照系统架构的静态和动态方面，基于已定义的系统要素集成顺序和前提条件，定义验证措施，包括： • 验证措施技术 • 验证措施通过/失败准则 • 验证措施准入和准出准则 • 所需的验证基础设施和环境设置 • *注 1: 验证措施可关注的示例包括接口系统要素之间正确信号流的时序依赖性，或系统架构中定义的硬件和软件交互。系统集成验证措施可关注：* • *系统要素之间正确信号流* • *系统要素之间信号流的时效性和时序依赖性* • *所有系统要素对使用接口的信号的正确解释，和/或* • *系统要素之间的动态交互*
SYS.4.BP2: 选择验证措施。考虑选择准则（包括回归验证准则），记录每个集成步骤的验证措施选择。所记录的验证措施选择应根据发布范围具备足够的覆盖率。 • *注 2: 选择准则的示例如，需求优先级、回归验证需要（如由于系统架构设计或系统组件变更）、或交付产品发布的预期用途（例如测试台架、测试跑道、公共道路等）。*
SYS.4.BP3: 集成系统要素并执行集成验证。根据系统要素之间定义的接口和交互，以及定义的顺序和定义的前提条件，将系统要素集成为完整系统。执行选定的系统集成验证措施。记录验证结果，包括通过/失败状态和相应验证措施数据。 • *注 3: 开始系统集成的前提条件的示例可以是成功完成系统要素的验证或既有系统要素的鉴定。* • *注 4: 对与预期结果不符的验证结果的处理，参见 SUP.9。*
SYS.4.BP4: 确保一致性和建立双向可追溯性。确保验证措施与系统架构之间的一致性并建立双向可追溯性。建立验证结果与验证措施之间的双向可追溯性。 • *注 5: 双向可追溯性支持一致性，并有助于对变更请求的影响分析和验证覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。*

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SYS.4.BP5: Summarize and communicate results. Summarize the system integration and integration verification results and communicate them to all affected parties.

Note 6: Providing all necessary information from the test case execution in a summary enables other parties to judge the consequences.

SYS.4 System Integration and Integration Verification	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6	Outcome 7
Output Information Items							
08-60 Verification Measure	X						
06-50 Integration Sequence Instruction		X					
03-50 Verification Measure Data				X			
08-58 Verification Measure Selection Set			X				
15-52 Verification Results				X			
13-51 Consistency Evidence					X	X	
13-52 Communication Evidence							X
11-06 Integrated System		X					
Base Practices							
BP1: Specify verification measures for system integration	X						
BP2: Select verification measures			X				
BP3: Integrate system elements and perform integration verification**.**		X		X			
BP4: Ensure consistency and establish bidirectional traceability					X	X	
BP5: Summarize and communicate results							X

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SYS.4.BP5: 总结和沟通结果。总结系统集成与集成验证结果，并与所有受影响方沟通。

- *注 6: 在总结中提供来自测试用例执行的所有必要信息，以便其他方可以判断结果。*

SYS.4 系统集成与集成验证	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6	成果 7
输出信息项							
08-60 验证措施	X						
06-50 集成顺序指导		X					
03-50 验证措施数据				X			
08-58 验证措施选择集			X				
15-52 验证结果				X			
13-51 一致性证据					X	X	
13-52 沟通证据							X
11-06 集成系统		X					
基本实践							
BP1: 定义系统集成的验证措施	X						
BP2: 选择验证措施			X				
BP3: 集成系统要素并执行集成验证		X		X			
BP4: 确保一致性和建立双向可追溯性					X	X	
BP5: 总结和沟通结果							X

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4.3.5. SYS.5 System Verification

Process ID
SYS.5
Process name
System Verification
Process purpose
The purpose is to ensure that the system is verified to be consistent with the system requirements.
Process outcomes
1) Verification measures are specified for system verification of the system based on the system requirements. 2) Verification measures are selected according to the release scope considering criteria, including criteria for regression verification. 3) The integrated system is verified using the selected verification measures and the results of system verification are recorded. 4) Consistency and bidirectional traceability are established between verification measures and system requirements. 5) Bidirectional traceability is established between verification results and verification measures. 6) Verification results are summarized and communicated to all affected parties.

Base Practices
SYS.5.BP1: Specify verification measures for system verification. Specify the verification measures for system verification suitable to provide evidence for compliance with the functional and non-functional information in the system requirements, including • techniques for the verification measures, • pass/fail criteria for verification measures, • a definition of entry and exit criteria for the verification measures, • necessary sequence of verification measures, and • the required verification infrastructure and environment setup. *Note 1: The system verification measures may cover aspects such as thermal, environmental, robustness/lifetime, and EMC.*

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4.3.5. SYS.5 系统验证

过程 ID
SYS.5
过程名称
系统验证
过程目的
其目的是：确保系统得到验证，与系统需求相一致。
过程成果
1) 基于系统需求，定义了系统验证的验证措施； 2) 根据发布范围并考虑准则（包括回归验证准则），选择了验证措施； 3) 使用选定的验证措施验证了集成系统，并记录了系统验证结果； 4) 建立了验证措施与系统需求之间的一致性和双向可追溯性； 5) 建立了验证结果与验证措施之间的双向可追溯性； 6) 总结了验证结果，并与所有受影响方沟通。

基本实践
SYS.5.BP1: 定义系统验证的验证措施。定义系统验证的验证措施，以适于提供符合系统需求中功能性和非功能性信息的证据，包括： • 验证措施技术， • 验证措施通过/失败准则， • 验证措施准入和准出准则， • 验证措施的必要顺序， • 所需的验证基础设施和环境设置。 *注 1: 系统验证可覆盖热、环境、鲁棒性/寿命、EMC 等方面。*

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SYS.5.BP2: Select verification measures. Document the selection of verification measures considering selection criteria including criteria for regression verification. The selection of verification measures shall have sufficient coverage according to the release scope. *Note 2: Examples for criteria for selection can be prioritization of requirements, the need for regression verification (due to e.g., changes to the system requirements), the intended use of the delivered product release (test bench, test track, public road etc.)*
SYS.5.BP3: Perform verification of the integrated system. Perform the verification of the integrated system using the selected verification measures. Record the verification results including pass/fail status and corresponding verification measure data. *Note 3: See SUP.9 for handling verification results that deviate from expected results*
SYS.5.BP4: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability between verification measures and system requirements. Establish bidirectional traceability between verification results and verification measures. *Note 4: Bidirectional traceability supports consistency, and facilitates impact analysis of change requests, and demonstration of verification coverage. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.*
SYS.5.BP5: Summarize and communicate results. Summarize the system verification results and communicate them to all affected parties. *Note 5: Providing all necessary information from the test case execution in a summary enables other parties to judge the consequences.*

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SYS.5.BP2: 选择验证措施。考虑选择准则（包括回归验证准则），记录验证措施选择。所记录的验证措施选择应根据发布范围具备足够的覆盖率。 • *注 2: 选择准则的示例可以是需求优先级，回归验证需要（例如由于系统需求变更），或交付产品发布的预期用途（例如，测试台架、测试跑道、公共道路等）。*
SYS.5.BP3: 执行集成系统验证。使用选定的验证措施执行集成系统验证。记录验证结果，包括通过/失败状态和相应验证措施数据。 • *注 3: 与预期结果不符的验证结果处理，参见 SUP.9。*
SYS.5.BP4: 确保一致性和建立双向可追溯性。确保验证措施与系统需求之间的一致性并建立双向可追溯性。建立验证结果与验证措施之间的双向可追溯性。 • *注 4: 双向可追溯性支持一致性，并有助于变更请求的影响分析和验证覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。*
SYS.5.BP5: 总结和沟通结果。总结系统验证结果，并与所有受影响方沟通。 • *注 5:在总结中提供来自测试用例执行的所有必要信息，以便其他方可以判断结果。*

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SYS.5 System Verification	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6
Output Information Item						
08-60 Verification Measure	X					
03-50 Verification Measure Data			X			
08-58 Verification Measure Selection Set		X				
15-52 Verification Results			X			
13-51 Consistency Evidence				X	X	
13-52 Communication Evidence						X
Base Practices						
BP1: Specify verification measures for system verification	X					
BP2: Select verification measures		X				
BP3: Perform verification of the integrated system			X			
BP4: Ensure consistency and establish bidirectional traceability.				X	X	
BP5: Summarize and communicate results						X

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SYS.5 系统验证	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6
输出信息项						
08-60 验证措施	X					
03-50 验证措施数据			X			
08-58 验证措施选择集		X				
15-52 验证结果			X			
13-51 一致性证据				X	X	
13-52 沟通证据						X
基本实践						
BP1: 定义系统验证的验证措施	X					
BP2: 选择验证措施		X				
BP3: 执行集成系统验证			X			
BP4: 确保一致性和建立双向可追溯性				X	X	
BP5: 总结和沟通结果						X

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4.4. Software engineering process group (SWE)

4.4.1. SWE.1 Software Requirements Analysis

Process ID
SWE.1
Process name
Software Requirements Analysis
Process purpose
The purpose is to establish a structured and analyzed set of software requirements consistent with the system requirements, and the system architecture.
Process outcomes
1) Software requirements are specified. 2) Software requirements are structured and prioritized. 3) Software requirements are analyzed for correctness and technical feasibility. 4) The impact of software requirements on the operating environment is analyzed. 5) Consistency and bidirectional traceability are established between software requirements and system requirements. 6) Consistency and bidirectional traceability are established between software requirements and system architecture. 7) The software requirements are agreed and communicated to all affected parties.

Base Practices

SWE.1.BP1: Specify software requirements. Use the system requirements and the system architecture to identify and document the functional and non-functional requirements for the software according to defined characteristics for requirements.

Note 1: Characteristics of requirements are defined in standards such as ISO IEEE 29148, ISO 26262-8:2018, or the INCOSE Guide for Writing Requirements.

Note 2: Examples for defined characteristics of requirements shared by technical standards are verifiability (i.e., verification criteria being inherent in the requirements text), unambiguity/comprehensibility, freedom from design and implementation, and not contradicting any other requirement).

Note 3: In case of software-only development, the system requirements and the system architecture refer to a given operating environment. In that case, stakeholder requirements can be used as the basis for identifying the required functions and capabilities of the software.

Note 4: The hardware-software-interface (HSI) definition puts in context hardware and therefore it is an interface decision at the system design level. If such a HSI exists, then it may provide input to software requirements.

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4.4. 软件工程过程组 (SWE)

4.4.1. SWE.1 软件需求分析

过程 ID
SWE.1
过程名称
软件需求分析
过程目的
其目的是：建立一组已结构化和已分析的软件需求，与系统需求和系统架构相一致。
过程成果
1) 定义了软件需求； 2) 结构化了软件需求并进行优先级排序； 3) 分析了软件需求的正确性和技术可行性； 4) 分析了软件需求对运行环境的影响； 5) 建立了软件需求与系统需求之间的一致性和双向可追溯性； 6) 建立了软件需求与系统架构之间的一致性和双向可追溯性； 7) 约定了软件需求，并与所有受影响方沟通。

基本实践
SWE.1.BP1: 定义软件需求。根据定义的需求特性，使用系统需求和系统架构来识别和文档化软件的功能性和非功能性需求。 *注 1: 需求特性在一些标准中有定义，诸如 ISO IEEE 29148、ISO/IEC IEEE 24765、ISO 26262-8:2018 或 INCOSE 需求编写指南等。* *注 2: 上述标准共有的关于已定义的需求特性的示例如，可验证的 (即：需求文本中固有的验证准则)、无歧义的/可理解的，无设计和实现限制的，以及不与任何其他需求相矛盾的。* *注 3: 如果只有软件开发，系统需求和系统架构是指给定的运行环境。在这种情况下，可将利益相关方需求作为识别软件所需功能和能力的基础。* *注 4: 软硬件接口（HSI）定义将硬件置于上下文中，因此它是系统设计级别的接口决策。如果存在这类 HSI，可为软件需求提供输入。*

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SWE.1.BP2: Structure software requirements. Structure and prioritize the software requirements. *Note 5: Examples for structuring criteria can be grouping (e.g., by functionality) or expressing product variants.* *Note 6: Prioritization can be done according to project or stakeholder needs via e.g., definition of release scopes. Refer to SPL.2.BP1.*
SWE.1.BP3: Analyze software requirements. Analyze the specified software requirements including their interdependencies to ensure correctness, technical feasibility, and to support project management regarding project estimates. *Note 7: See MAN.3.BP3 for project feasibility and MAN.3.BP5 for project estimates.* *Note 8: Technical feasibility can be evaluated based on e.g., platform or product line, or by prototyping.*
SWE.1.BP4: Analyze the impact on the operating environment. Analyze the impact that the software requirements will have on elements in the operating environment.
SWE.1.BP5: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability between software requirements and system architecture. Ensure consistency and establish bidirectional traceability between software requirements and system requirements. *Note 9: Redundant traceability is not intended.* *Note 10: There may be non-functional system requirements that the software requirements do not trace to. Examples are process requirements or requirements related to later software product lifecycle phases such as incident handling. Such requirements are still subject to verification.* *Note 11: Bidirectional traceability supports consistency, and facilitates impact analysis of change requests, and demonstration of verification coverage. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.* *Note 12: In case of software development only, the system requirements and system architecture refer to a given operating environment. In that case, consistency and bidirectional traceability can be ensured between stakeholder requirements and software requirements.*
SWE.1.BP6: Communicate agreed software requirements and impact on the operating environment. Communicate the agreed software requirements, and the results of the analysis of impact on the operating environment, to all affected parties.

SWE.1 Software Requirements Analysis	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6	Outcome 7
Output Information Items							
17-00 Requirement	X	X					
17-54 Requirement Attribute		X					
15-51 Analysis Results			X	X			
13-51 Consistency Evidence					X	X	

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SWE.1.BP2: 结构化软件需求。结构化软件需求并进行优先级排序。

注 5: 结构化准则的示例如，分组（如按功能）或产品变体识别。

注 6: 可以根据项目或利益相关方需要(如发布范围的定义)，来进行优先级排序。参见 SPL.2.BP1。

SWE.1.BP3: 分析软件需求。分析已定义的软件需求（包括它们的相互依赖关系），以确保正确性、技术可行性，并支持项目管理的项目估算。

注 7: 项目可行性参见 MAN.3.BP3，项目估算参见 MAN.3.BP5。

注 8: 技术可行性评估可基于平台或产品，或通过原型开发。

SWE.1.BP4: 分析对运行环境的影响。分析软件需求对运行环境中的要素产生的影响。

SWE.1.BP5: 确保一致性和建立双向可追溯性。确保软件需求与系统架构之间的一致性并建立双向可追溯性。确保软件需求与系统需求之间的一致性并建立双向可追溯性。

注 9: 冗余的可追溯性是非意图的。

注 10: 可能存在软件需求无法追溯的非功能性系统需求，例如过程需求或与后续软件产品生命周期阶段相关的需求，如事件处理。这些需求仍然需要验证。

注 11: 双向可追溯性支持一致性，并有助于变更请求的影响分析和验证覆盖率的证明。仅有追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。

注 12: 在只有软件开发的情况下，系统需求和系统架构是指给定的运行环境。在这种情况下，可确保利益相关方需求与软件需求之间的一致性和双向可追溯性。

SWE.1.BP6: 沟通约定的软件需求和对运行环境的影响。与所有受影响方沟通约定的软件需求，以及对运行环境影响分析的结果。

SWE.1 软件需求分析	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6	成果 7
输出信息项							
17-00 需求	X	X					
17-54 需求属性		X					
15-51 分析结果			X	X			
13-51 一致性证据					X	X	

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13-52 Communication Evidence							X
Base Practices							
BP1: Specify software requirements	X						
BP2: Structure software requirements		X					
BP3: Analyze software requirements			X				
BP4: Analyze the impact on the operating environment				X			
BP5: Ensure consistency and establish bidirectional traceability					X	X	
BP6: Communicate agreed software requirements and impact on the operating environment							X

4.4.2. SWE.2 Software Architectural Design

Process ID
SWE.2
Process name
Software Architectural Design
Process purpose
The purpose is to establish an analyzed software architecture, comprising static and dynamic aspects, consistent with the software requirements.
Process outcomes
1) A software architecture is designed including static and dynamic aspects. 2) The software architecture is analyzed against defined criteria. 3) Consistency and bidirectional traceability are established between software architecture and software requirements. 4) The software architecture is agreed and communicated to all affected parties.

Base Practices
SWE.2.BP1: Specify static aspects of the software architecture. Specify and document the static aspects of the software architecture with respect to the functional and non-functional software requirements, including external interfaces and a defined set of software components with their interfaces and relationships. *Note 1: The hardware-software-interface (HSI) definition puts in context the hardware design and therefore is an aspect of system design (SYS.3).*

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13-52 沟通证据							X
基本实践							
BP1: 定义软件需求	X						
BP2: 结构化软件需求		X					
BP3: 分析软件需求			X				
BP4: 分析对运行环境的影响				X			
BP5: 确保一致性和建立双向可追溯性					X	X	
BP6: 沟通约定的软件需求和对运行环境的影响							X

4.4.2. SWE.2 软件架构设计

过程 ID
SWE.2
过程名称
软件架构设计
过程目的
其目的是：建立与软件需求一致的，经过分析的软件架构（包括静态和动态方面）。
过程成果
1) 设计了软件架构，包括静态和动态两个方面； 2) 根据已定义的准则分析了软件架构； 3) 建立了软件架构与软件需求之间的一致性和双向可追溯性； 4) 约定了软件架构，并与所有受影响方沟通。

基本实践
SWE.2.BP1: 定义软件架构的静态方面。针对功能性和非功能性的软件需求，定义和文档化软件架构的静态方面，包括外部接口和一组已定义的软件组件及其接口和关系。 • *注 1: 硬件-软件-接口(HSI)定义是在硬件设计上下文中给出，因此是系统设计的一部分 (SYS.3)。*

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SWE.2.BP2: Specify dynamic aspects of the software architecture. Specify and document the dynamic aspects of the software architecture with respect to the functional and non-functional software requirements, including the behavior of the software components and their interaction in different software modes, and concurrency aspects.

Note 2: Examples for concurrency aspects are application-relevant interrupt handling, preemptive processing, multi-threading.

Note 3: Examples for behavioral descriptions are natural language or semi-formal notation (e.g, SysML, UML).

SWE.2.BP3: Analyze software architecture. Analyze the software architecture regarding relevant technical design aspects and to support project management regarding project estimates. Document a rationale for the software architectural design decision.

Note 4: See MAN.3.BP3 for project feasibility and MAN.3.BP5 for project estimates.

Note 5: The analysis may include the suitability of pre-existing software components for the current application.

Note 6: Examples of methods suitable for analyzing technical aspects are prototypes, simulations, qualitative analyses.

Note 7: Examples of technical aspects are functionality, timings, and resource consumption (e.g, ROM, RAM, external / internal EEPROM or Data Flash or CPU load).

Note 8: Design rationales can include arguments such as proven-in-use, reuse of a software framework or software product line, a make-or-buy decision, or found in an evolutionary way (e.g, set-based design).

SWE.2.BP4: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability between the software architecture and the software requirements.

Note 9: There may be non-functional software requirements that the software architectural design does not trace to. Examples are development process requirements. Such requirements are still subject to verification.

Note 10: Bidirectional traceability supports consistency, and facilitates impact analysis of change requests, and demonstration of verification coverage. Traceability alone, e.g, the existence of links, does not necessarily mean that the information is consistent with each other.

SWE.2.BP5: Communicate agreed software architecture. Communicate the agreed software architecture to all affected parties.

SWE.2 Software Architectural Design	Outcome 1	Outcome 2	Outcome 3	Outcome 4
Output Information Items				
04-04 Software Architecture	X			
13-51 Consistency Evidence			X	
13-52 Communication Evidence				X
15-51 Analysis Results		X		

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SWE.2.BP2: 定义软件架构的动态方面。针对功能和非功能的软件需求，定义并文档化软件架构的动态方面，包括软件组件的行为及其在不同软件模式下的交互，以及并发性方面。

- *注 2: 并发性方面的示例如，应用程序相关的中断处理、抢占式处理、多线程。*
- *注 3: 行为描述的示例如，自然语言或半形式化记法 (如 SysML, UML)。*

SWE.2.BP3: 分析软件架构。就相关技术设计方面分析软件架构，并支持项目管理的项目估算。文档化软件架构设计决策的依据。

- *注 4: 项目可行性参见 MAN.3.BP3，项目估算参见 MAN.3.BP5。*
- *注 5: 分析可包括现有软件组件对既有应用的适用性。*
- *注 6: 适用于分析技术方面的方法的示例如，原型、仿真、定性分析。*
- *注 7: 技术方面的示例如，功能、时间和资源消耗(例如 ROM、RAM、外部/内部 EEPROM 或数据 Flash 或 CPU 负载)。*
- *注 8: 设计依据可以包括一些论据，如在用证明、软件框架或软件产品线的重用、自制或外购（make-or-buy）的决策、或以演变的方式进行呈现(如集合设计)。*

SWE.2.BP4: 确保一致性和建立双向可追溯性。确保软件架构与软件需求之间的一致性并建立双向可追溯性。

- *注 9: 可能存在软件架构设计无法追溯的非功能性软件需求。例如开发过程需求。这些需求仍然需要验证。*
- *注 10: 双向可追溯性支持一致性，并有助于对变更请求的影响分析和验证覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。*

SWE.2.BP5: 沟通约定的软件架构。与所有受影响方沟通约定的软件架构。

SWE.2 软件架构设计	成果 1	成果 2	成果 3	成果 4
输出信息项				
04-04 软件架构	X			
13-51 一致性证据			X	
13-52 沟通证据				X
15-51 分析结果		X		

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Base Practices				
BP1: Specify static aspects of software architecture	X			
BP2: Specify dynamic aspects of software architecture	X			
BP3: Analyze software architecture		X		
BP4: Ensure consistency and establish bidirectional traceability			X	
BP5: Communicate agreed software architecture				X

4.4.3. SWE.3 Software Detailed Design and Unit Construction

Process ID
SWE.3
Process name
Software Detailed Design and Unit Construction
Process purpose
The purpose is to establish a software detailed design, comprising static and dynamic aspects, consistent with the software architecture, and to construct software units consistent with the software detailed design.
Process outcomes
1) A detailed design is specified including static and dynamic aspects. 2) Software units as specified in the software detailed design are produced. 3) Consistency and bidirectional traceability are established between software detailed design and software architecture; and consistency and bidirectional traceability are established between source code and software detailed design; and consistency and bidirectional traceability are established between the software detailed design and the software requirements. 4) The source code and the agreed software detailed design are communicated to all affected parties.

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基本实践				
BP1: 定义软件架构的静态方面	X			
BP2: 定义软件架构的动态方面	X			
BP3: 分析软件架构		X		
BP4: 确保一致性和建立双向可追溯性			X	
BP5: 沟通约定的软件架构				X

4.4.3. SWE.3 软件详细设计与单元构建

过程 ID
SWE.3
过程名称
软件详细设计和单元构建
过程目的
其目的是：建立与软件架构相一致的软件详细设计，包括静态和动态方面，并构建与软件详细设计相一致的软件单元。
过程成果
1) 定义了详细设计，包括静态和动态两个方面； 2) 产出了软件详细设计中定义的软件单元； 3) 建立了软件详细设计与软件架构之间的一致性和双向可追溯性; 建立了源代码与软件详细设计之间的一致性和双向可追溯性; 建立了软件详细设计与软件需求之间的一致性和双向可追溯性； 4) 与所有受影响方沟通了源代码和达成一致的软件详细设计。

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Base Practices
SWE.3.BP1: Specify the static aspects of the detailed design. For each software component specify the behavior of its software units, their static structure and relationships, their interfaces including • valid data value ranges for inputs and outputs (from the application domain perspective), and • physical or measurement units applicable to inputs and outputs (from the application domain perspective). *Note 1: The boundary of a software unit is independent from the software unit's representation in the source code, code file structure, or model-based implementation, respectively. It is rather driven by the semantics of the application domain perspective. Therefore, a software unit may be, at the code level, represented by a single subroutine or a set of subroutines.* *Note 2: Examples of valid data value ranges with applicable physical units from the application domain perspective are '0..200 [m/s]', '0..3.8 [A]' or '1..100 [N]'. For mapping such application domain value ranges to programming language-level data types (such as unsigned Integer with a value range of 0..65535) refer to BP2.* *Note 3: Examples of a measurement unit are '%' or '‰'.* *Note 4: A counter is an example of a parameter, or a return value, to which neither a physical nor a measurement unit is applicable.* *Note 5: The hardware-software-interface (HSI) definition puts in context the hardware design and therefore is an aspect of system design (SYS.3).*
SWE.3.BP2: Specify dynamic aspects of the detailed design. Specify and document the dynamic aspects of the detailed design with respect to the software architecture, including the interactions between relevant software units to fulfill the component's dynamic behavior. *Note 6: Examples for behavioral descriptions are natural language or semi-formal notation (e.g, SysML, UML).*
SWE.3.BP3: Develop software units. Develop and document the software units consistent with the detailed design, and according to coding principles. *Note 7: Examples for coding principles at capability level 1 are not to use implicit type conversions, only one entry and one exit point in subroutines, and range checks (design-by-contract, defensive programming). Further examples see e.g, ISO 26262-6 clause 8.4.5 together with table 6.*
SWE.3.BP4: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability between the software detailed design and the software architecture. Ensure consistency and establish bidirectional traceability between the developed software units and the software detailed design. Ensure consistency and establish traceability between the software detailed design and the software requirements. *Note 8: Redundancy should be avoided by establishing a combination of these approaches.* *Note 9: Examples for tracing a software unit in the detailed design to a software requirement directly are communication matrices or basis software aspects such as a list of diagnosis identifiers inherent in an Autosar configuration.* *Note 10: Bidirectional traceability supports consistency, and facilitates impact analysis of change requests, and demonstration of verification coverage. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.*

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基本实践
SWE.3.BP1: 定义详细设计的静态方面。 为每个软件组件定义其软件单元的行为、其静态结构和关系，及其接口，包括： • 输入和输出的有效数据值域 (从应用领域的角度来看)，以及 • 用于输入和输出的物理或计量单位 (从应用领域的角度来看)。 • *注 1: 软件单元的边界分别独立于软件单元在源代码、代码文件结构或基于模型的实现中的表示。它是由应用领域视角的语义驱动的。因此，在代码层次上，一个软件单元可以由单个子程序或一组子程序表示。* • *注 2: 从应用领域的角度来看，具有适用物理单位的有效数据值域的示例如，“0..200 [m/s]'，'0..3.8 [A] '或' 1..100[N]”。要将这种应用领域的值域映射到编程语言级别的数据类型(例如取值范围为 0..65535 的无符号整数)，请参考 BP2。* • *注 3: 计量单位的示例如，“%”或“‰”。* • *注 4: 计数器是一个参数或返回值的示例，既不适用物理单位，也不适用计量单位。* • *注 5:硬件-软件-接口(HSI)定义是在硬件设计上下文中给出，因此是系统设计的一部分(SYS.3)。*
SWE.3.BP2:定义详细设计的动态方面。 定义并文档化关于软件架构的详细设计的动态方面，包括相关软件单元之间的交互以实现组件的动态行为。 • *注 6: 行为描述的示例如，自然语言或半形式化记法 (如 SysML, UML)。*
SWE.3.BP3:开发软件单元。 根据编码原则，开发并文档化与详细设计一致的软件单元。 • *注 7: 能力等级 1 级的编码原则示例是不使用隐式类型转换，在子程序中只有一个入口和一个出口，以及范围检查(契约式设计，防御性编程)。进一步的示例参见 ISO 26262-6 条款 8.4.5 和表 6。*
SWE.3.BP4: 确保一致性和建立双向可追溯性。 确保软件详细设计与软件架构之间的一致性并建立双向可追溯性。确保开发的软件单元与软件详细设计之间的一致性并建立双向可追溯性。确保软件详细设计与软件需求之间的一致性并建立双向可追溯性。 • *注 8: 宜通过建立这些方法的组合来避免冗余。* • *注 9: 在详细设计中直接追溯到软件需求的软件单元的示例如，通信矩阵或基础软件方面，例如 Autosar 配置中固有的诊断标识符列表。* • *注 10: 双向可追溯性支持一致性，并有助于变更请求的影响分析和验证覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。*

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SWE.3.BP5: Communicate agreed software detailed design and developed software units. Communicate the agreed software detailed design and developed software units to all affected parties.

SWE.3 Software Detailed Design and Unit Construction	Outcome 1	Outcome 2	Outcome 3	Outcome 4
Output Information Items				
04-05 Software Detailed Design	X			
11-05 Software Unit	X	X		
13-51 Consistency Evidence			X	
13-52 Communication Evidence				X
Base Practices				
BP1: Specify the static aspects of the detailed design	X			
BP2: Specify the dynamic aspects of the detailed design	X			
BP3: Develop software units		X		
BP4: Ensure consistency and establish bidirectional traceability			X	
BP5: Communicate agreed software detailed design and developed software units				X

4.4.4. SWE.4 Software Unit Verification

Process ID
SWE.4
Process name
Software Unit Verification
Process purpose
The purpose is to verify that software units are consistent with the software detailed design.

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SWE.3.BP5: 沟通约定的软件详细设计和已开发的软件单元。与所有受影响方沟通约定的软件详细设计和已开发的软件单元。

SWE.3 软件详细设计和单元构建	成果 1	成果 2	成果 3	成果 4
输出信息项				
04-05 软件详细设计	X			
11-05 软件单元	X	X		
13-51 一致性证据			X	
13-52 沟通证据				X
基本实践				
BP1: 定义详细设计的静态方面	X			
BP2: 定义详细设计的动态方面	X			
BP3 开发软件单元		X		
BP4: 确保一致性和建立双向可追溯性			X	
BP5: 沟通约定的软件详细设计和已开发的软件单元				X

4.4.4. SWE.4 软件单元验证

过程 ID
SWE.4
过程名称
软件单元验证
过程目的
其目的是：验证软件单元与软件详细设计相一致。

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Process outcomes
1) Verification measures for software unit verification are specified. 2) Software unit verification measures are selected according to the release scope, including criteria for regression verification. 3) Software units are verified using the selected verification measures, and results are recorded. 4) Consistency and bidirectional traceability are established between verification measures and software units; and bidirectional traceability is established between verification results and verification measures. 5) Results of the software unit verification are summarized and communicated to all affected parties.

Base Practices
SWE.4.BP1: Specify software unit verification measures. Specify verification measures for each software unit defined in the software detailed design, including • pass/fail criteria for verification measures, • entry and exit criteria for verification measures, and • the required verification infrastructure. *Note 1: Examples for unit verification measures are static analysis, code reviews, and unit testing.* *Note 2: Static analysis can be done based on MISRA rulesets and other coding standards.*
SWE.4.BP2: Select software unit verification measures. Document the selection of verification measures considering selection criteria including criteria for regression verification. The documented selection of verification measures shall have sufficient coverage according to the release scope.
SWE.4.BP3: Verify software units. Perform software unit verification using the selected verification measures. Record the verification results including pass/fail status and corresponding verification measure data. *Note 3: See SUP.9 for handling of verification results that deviate from expected results.*
SWE.4.BP4: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability between verification measures and the software units defined in the detailed design. Establish bidirectional traceability between the verification results and the verification measures. *Note 4: Bidirectional traceability supports consistency, and facilitates impact analysis of change requests, and demonstration of verification coverage. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.*
SWE.4.BP5: Summarize and communicate results. Summarize the results of software unit verification and communicate them to all affected parties. *Note 5: Providing all necessary information from the test case execution in a summary enables other parties to judge the consequences.*

过程成果

1) 定义了软件单元验证的验证措施；
2) 根据发布范围并考虑准则（包括回归验证准则），选择了软件单元验证措施；
3) 使用选定的验证措施验证了软件单元，并记录了验证结果；
4) 建立了验证措施与软件单元之间的一致性和双向可追溯性；建立了验证结果与验证措施之间的双向可追溯性；
5) 总结了软件单元验证结果，并与所有受影响方沟通。

基本实践

SWE.4.BP1: 定义软件单元验证措施。为软件详细设计定义的每个软件单元定义验证措施，包括：

- 验证措施通过/失败准则
- 验证措施准入和准出准则
- 所需的验证基础设施
  - *注 1: 单元验证措施的示例包括静态分析、代码评审、单元测试。*
  - *注 2: 静态分析可基于 MISRA 规则集和其它编码标准。*

SWE.4.BP2: 选择软件单元验证措施。考虑选择准则（包括回归验证准则），记录验证措施选择。所记录的验证措施选择应根据发布范围具备足够的覆盖率。

SWE.4.BP3: 验证软件单元。使用选定的验证措施执行软件单元验证。记录验证结果，包括通过/失败状态和相应验证措施数据。

- *注 3: 与预期结果不符的验证结果处理，参见 SUP.9。*

SWE.4.BP4: 确保一致性和建立双向可追溯性。确保验证措施与软件详细设计中软件单元之间的一致性并建立双向可追溯性。建立验证结果与验证措施之间的双向可追溯性。

- *注 4: 双向可追溯性支持一致性，并有助于变更请求的影响分析和验证覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。*

SWE.4.BP5: 总结和沟通结果。总结软件单元验证结果，并与所有受影响方沟通。

- *注 5:在总结中提供来自测试用例执行的所有必要信息，以便其他方可以判断结果。*

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SWE.4 Software Unit Verification	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5
Output Information Items					
08-60 Verification Measure	X				
03-50 Verification Measure Data			X		
08-58 Verification Measure Selection Set		X			
15-52 Verification Results			X		
13-51 Consistency Evidence				X	
13-52 Communication Evidence					X
Base Practices					
BP1: Specify software unit verification measures	X				
BP2: Select software unit verification measures		X			
BP3: Verify software units			X		
BP4: Ensure consistency and establish bidirectional traceability for software unit verification				X	
BP5: Summarize and communicate results					X

4.4.5. SWE.5 Software Component Verification and Integration Verification

Process ID
SWE.5
Process name
Software Component Verification and Integration Verification
Process purpose
The purpose is to verify that software components are consistent with the software architectural design, and to integrate software elements and verify that the integrated software elements are consistent with the software architecture and software detailed design.

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SWE.4 软件单元验证	成果 1	成果 2	成果 3	成果 4	成果 5
输出信息项					
08-60 验证措施	X				
03-50 验证措施数据			X		
08-58 验证措施选择集		X			
15-52 验证结果			X		
13-51 一致性证据				X	
13-52 沟通证据					X
基本实践					
BP1: 定义软件单元验证措施	X				
BP2: 选择软件单元验证措施		X			
BP3: 验证软件单元			X		
BP4: 确保一致性和建立双向可追溯性				X	
BP5: 总结和沟通结果					X

4.4.5. SWE.5 软件组件验证与集成验证

过程 ID
SWE.5
过程名称
软件组件验证与集成验证
过程目的
其目的是：验证软件组件与软件架构设计相一致，集成软件要素，并验证集成的软件要素与软件架构和软件详细设计相一致。

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Process outcomes
1) Verification measures are specified for software integration verification of the integrated software elements based on the software architecture and detailed design, including the interfaces of, and interactions between, the software components. 2) Verification measures for software components are specified to provide evidence for compliance of the software components with the software components' behavior and interfaces. 3) Software elements are integrated up to a complete integrated software. 4) Verification measures are selected according to the release scope considering criteria, including criteria for regression verification. 5) Software components are verified using the selected verification measures, and the results of the integration verification are recorded. 6) Integrated software elements are verified using the selected verification measures, and the results of the integration verification are recorded. 7) Consistency and bidirectional traceability are established between verification measures and the software architecture and detailed design; and bidirectional traceability is established between verification results and verification measures. 8) The results of software component verification and software elements integration verification are summarized and communicated to all affected parties

Base Practices
SWE.5.BP1: Specify software integration verification measures. Specify verification measures, based on a defined sequence and preconditions for the integration of software elements, against the defined static and dynamic aspects of the software architecture, including • techniques for the verification measures, • pass/fail criteria for verification measures, • entry and exit criteria for verification measures, and • the required verification infrastructure and environment setup. *Note 1: Examples on which the software integration verification measures may focus on are the correct dataflow and dynamic interaction between software components together with their timing dependencies, the correct interpretation of data by all software components using an interface, and the compliance to resource consumption objectives.* *Note 2: The software integration verification measure may be supported by using hardware debug interfaces or simulation environments (e.g, Software-in-the-Loop-Simulation).*

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过程成果

1) 基于软件架构和详细设计，包括软件组件之间的接口和交互，为集成的软件要素定义了软件集成验证的验证措施；
2) 为软件组件定义验证措施，以提供软件组件符合其行为和接口的证据；
3) 将软件要素集成为完整的集成软件；
4) 根据发布范围并考虑准则（包括回归验证准则），选择了验证措施；
5) 使用选定的验证措施验证了软件组件，并记录了集成验证结果；
6) 使用选定的验证措施验证了集成的软件要素，并记录了集成验证结果；
7) 建立了验证措施与软件架构和详细设计之间的一致性和双向可追溯性；建立了验证结果与验证措施之间的双向可追溯性；
8) 总结了软件组件验证和软件要素集成验证结果，并与所有受影响方沟通。

基本实践

SWE.5.BP1: 定义软件集成验证措施。依照软件架构已定义的静态和动态方面，基于已定义的软件要素集成顺序和前提条件，定义验证措施，包括：

- 验证措施技术
- 验证措施通过/失败准则
- 验证措施准入和准出准则
- 所需的验证基础设施和环境设置

- *注 1: 软件集成验证措施可关注的示例包括软件组件之间正确数据流和动态交互以及它们的时序依赖性，所有软件组件接口的数据正确解释，以及资源消耗目标的符合性。*
- *注 2: 可以使用硬件调试接口或仿真环境（例如软件在环仿真）支持软件集成验证措施。*

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SWE.5.BP2: Specify verification measures for verifying software component behavior. Specify verification measures for software component verification against the defined software components' behavior and their interfaces in the software architecture, including

- techniques for the verification measures,
- entry and exit criteria for verification measures,
- pass/fail criteria for verification measures, and
- the required verification infrastructure and environment setup.

Note 3: Verification measures are related to software components but not to the software units since software unit verification is addressed in the process SWE.4 Software Unit Verification.

SWE.5.BP3: Select verification measures. Document the selection of integration verification measures for each integration step considering selection criteria including criteria for regression verification. The documented selection of verification measures shall have sufficient coverage according to the release scope.

Note 4: Examples for selection criteria can be the need for continuous integration /continuous development regression verification (due to e.g, changes to the software architectural or detailed design), or the intended use of the delivered product release (e.g, test bench, test track, public road etc.).

SWE.5.BP4: Integrate software elements and perform integration verification. Integrate the software elements until the software is fully integrated according to the specified interfaces and interactions between the Software elements, and according to the defined sequence and defined preconditions. Perform the selected integration verification measures. Record the verification measure data including pass/fail status and corresponding verification measure data.

Note 5: Examples for preconditions for starting software integration are qualification of pre-existing software components, off-the-shelf software components, open-source-software, or auto-code generated software.

Note 6: Defined preconditions may allow e.g, big-bang-integration of all software components, continuous integration, as well as stepwise integration (e.g, across software units and/or software components up to the fully integrated software) with accompanying verification measures.

Note 7: See SUP.9 for handling deviations of verification results deviate expected results.

SWE.5.BP5: Perform software component verification. Perform the selected verification measures for verifying software component behavior. Record the verification results including pass/fail status and corresponding verification measure data.

Note 8: See SUP.9 for handling verification results that deviate from expected results.

SWE.5.BP6: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability between verification measures and the static and dynamic aspects of the software architecture and detailed design. Establish bidirectional traceability between verification results and verification measures.

Note 9: Bidirectional traceability supports consistency, and facilitates impact analysis of change requests, and demonstration of verification coverage. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.

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SWE.5.BP2: 定义验证软件组件行为的验证措施。依照软件架构已定义的软件组件行为和接口，定义软件组件验证的验证措施，包括：

- 验证措施技术
- 验证措施准入和准出准则
- 验证措施通过/失败准则
- 所需的验证基础设施和环境设置

注 3: 验证措施与软件组件相关但不与软件单元相关，因为软件单元验证已在过程 SWE.4 软件单元验证中处理。

SWE.5.BP3: 选择验证措施。考虑选择准则（包括回归验证准则），记录每个集成步骤的验证措施选择。所记录的验证措施选择应根据发布范围具备足够的覆盖率。

注 4: 选择准则的示例如，持续集成/持续开发回归验证需要（如由于软件架构或详细设计变更）、或交付产品发布的预期用途（如测试台架、测试跑道、公共道路等）。

SWE.5.BP4: 集成软件要素并执行集成验证。根据软件要素之间定义的接口和交互，以及定义的顺序和定义的前提条件，将软件要素集成为完整软件。执行选定的集成验证措施。记录验证结果，包括通过/失败状态和相应验证措施数据。

注 5: 开始软件集成的前提条件的示例可以是现有软件组件、现成软件组件、开源软件或自动生成代码软件的鉴定。

注 6: 定义的前提条件可允许所有软件组件的大爆炸集成、持续集成以及逐步集成（例如跨软件单元和/或软件组件直到完整集成软件），并伴随验证措施。

注 7: 与预期结果不符的验证结果处理，参见 SUP.9。

SWE.5.BP5: 执行软件组件验证。执行选定的验证软件组件行为的验证措施。记录验证结果，包括通过/失败状态和相应验证措施数据。

注 8: 与预期结果不符的验证结果处理，参见 SUP.9。

SWE.5.BP6: 确保一致性和建立双向可追溯性。确保验证措施与软件架构和详细设计的静态和动态方面之间的一致性并建立双向可追溯性。建立验证结果与验证措施之间的双向可追溯性。

注 9: 双向可追溯性支持一致性，并有助于变更请求的影响分析和验证覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。

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SWE.5.BP7: Summarize and communicate results. Summarize the software component verification and the software integration verification results and communicate them to all affected parties.

Note 10: Providing all necessary information from the test case execution in a summary enables other parties to judge the consequences.

SWE.5 Software Component Verification and Integration Verification	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6	Outcome 7	Outcome 8
Output Information Items								
08-60 Verification Measure	X	X						
06-50 Integration Sequence Instruction			X					
03-50 Verification Measure Data					X			
08-58 Verification Measure Selection Set				X				
15-52 Verification Results					X	X		
13-51 Consistency Evidence							X	
13-52 Communication Evidence								X
01-03 Software Component			X					
01-50 Integrated Software			X					
Base Practices								
BP1: Specify software integration verification measures	X							
BP2: Specify verification measures for verifying software component behavior		X						
BP3: Select verification measures				X				
BP4: Integrate software elements and perform integration verification			X			X		
BP5: Perform software component verification					X			
BP6: Ensure consistency and establish bidirectional traceability							X	
BP7: Summarize and communicate results								X

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SWE.5.BP7: 总结和沟通结果。总结软件组件验证和软件集成验证结果，并与所有受影响方沟通。

- *注 10: 在总结中提供来自测试用例执行的所有必要信息，以便其他方可以判断结果。*

SWE.5 软件组件验证与集成验证	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6	成果 7	成果 8
输出信息项								
08-60 验证措施	X	X						
06-50 集成顺序指导			X					
03-50 验证措施数据					X			
08-58 验证措施选择集				X				
15-52 验证结果					X	X		
13-51 一致性证据							X	
13-52 沟通证据								X
01-03 软件组件			X					
01-50 集成软件			X					
基本实践								
BP1: 定义软件集成验证措施	X							
BP2: 定义验证软件组件行为的验证措施		X						
BP3: 选择验证措施				X				
BP4: 集成软件要素并执行集成验证			X			X		
BP5: 执行软件组件验证					X			
BP6: 确保一致性和建立双向可追溯性							X	
BP7: 总结和沟通结果								X

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4.4.6. SWE.6 Software Verification

Process ID
SWE.6
Process name
Software Verification
Process purpose
The purpose of the Software Verification process is to ensure that the integrated software is verified to be consistent with the software requirements.
Process outcomes
1) Verification measures are specified for software verification of the software based on the software requirements. 2) Verification measures are selected according to the release scope considering criteria, including criteria for regression verification. 3) The integrated software is verified using the selected verification measures and the results of software verification are recorded. 4) Consistency and bidirectional traceability are established between verification measures and software requirements; and bidirectional traceability is established between verification results and verification measures. 5) Results of the software verification are summarized and communicated to all affected parties.

Base Practices

SWE.6.BP1: Specify verification measures for software verification. Specify the verification measures for software verification suitable to provide evidence for compliance of the integrated software with the functional and non-functional information in the software requirements, including

- techniques for the verification measures,
- pass/fail criteria for verification measures,
- a definition of entry and exit criteria for the verification measures,
- necessary sequence of verification measures, and
- the required verification infrastructure and environment setup.

Note 1: The selection of appropriate techniques for verification measures may depend on the content of the respective software requirement (e.g, boundary values and equivalence classes for data range-oriented requirements, positive/sunny-day-test vs. negative testing such as fault injection), or on requirements-based testing vs. “error guessing based on knowledge or experience”.

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4.4.6. SWE.6 软件验证

过程 ID
SWE.6
过程名称
软件验证
过程目的
其目的是：确保集成软件得到验证，与软件需求相一致。
过程成果
1) 基于软件需求，定义了软件验证的验证措施； 2) 根据发布范围并考虑准则（包括回归验证准则），选择了验证措施； 3) 使用选定的验证措施验证了集成软件，并记录了软件验证结果； 4) 建立了验证措施与软件需求之间的一致性和双向可追溯性；建立了验证结果与验证措施之间的双向可追溯性； 5) 总结了软件验证结果，并与所有受影响方沟通。

基本实践
SWE.6.BP1:定义软件验证的验证措施。定义软件验证的验证措施，以适于提供符合软件需求中功能性和非功能性信息的证据，包括： • 验证措施技术， • 验证措施通过/失败准则， • 验证措施准入和准出准则， • 验证措施的必要顺序， • 所需的验证基础设施和环境设置。 *注 1: 适当验证措施技术的选择可取决于软件需求的内容（例如面向数据范围需求的边界值和等价类，正测试 vs 负测试，如故障注入），或基于需求的测试 vs 基于知识或经验的错误猜测。*

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SWE.6.BP2: Select verification measures. Document the selection of verification measures considering selection criteria including criteria for regression verification. The documented selection of verification measures shall have sufficient coverage according to the release scope.

Note 2: Examples for selection criteria can be prioritization of requirements, continuous development, the need for regression verification (due to e.g., changes to the software requirements), or the intended use of the delivered product release (test bench, test track, public road etc.)

SWE.6.BP3: Verify the integrated software. Perform the verification of the integrated software using the selected verification measures. Record the verification results including pass/fail status and corresponding verification measure data.

Note 3: See SUP.9 for handling verification results that deviate from expected results.

SWE.6.BP4: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability between verification measures and software requirements. Establish bidirectional traceability between verification results and verification measures.

Note 4: Bidirectional traceability supports consistency, and facilitates impact analysis of change requests, and demonstration of verification coverage. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.

SWE.6.BP5: Summarize and communicate results. Summarize the software verification results and communicate them to all affected parties.

Note 5: Providing all necessary information from the test case execution in a summary enables other parties to judge the consequences.

SWE.6 Software Verification	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5
Output Information Items					
08-60 Verification Measure	X				
03-50 Verification Measure Data			X		
08-58 Verification Measure Selection Set		X			
15-52 Verification Results			X		
13-51 Consistency Evidence				X	
13-52 Communication Evidence					X
Base Practices					
BP1: Specify verification measures for software verification	X				
BP2: Select verification measures		X			

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SWE.6.BP2: 选择验证措施。考虑选择准则（包括回归验证准则），记录验证措施选择。所记录的验证措施选择应根据发布范围具备足够的覆盖率。

- *注 2: 选择准则的示例可以是需求优先级，持续开发，回归验证需要（例如由于软件需求变更），或交付产品发布的预期用途（例如，测试台架、测试跑道、公共道路等）。*

SWE.6.BP3: 验证集成软件。使用选定的验证措施执行集成软件验证。记录验证结果，包括通过/失败状态和相应验证措施数据。

- *注 3: 与预期结果不符的验证结果处理，参见 SUP.9。*

SWE.6.BP4: 确保一致性和建立双向可追溯性。确保验证措施与软件需求之间的一致性并建立双向可追溯性。建立验证结果与验证措施之间的双向可追溯性。

- *注 4: 双向可追溯性支持一致性，并有助于变更请求的影响分析和验证覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。*

SWE.6.BP5: 总结和沟通结果。总结软件验证结果，并与所有受影响方沟通。

- *注 5: 在总结中提供来自测试用例执行的所有必要信息，以便其他方可以判断结果。*

SWE.6 软件验证	成果 1	成果 2	成果 3	成果 4	成果 5
输出信息项					
08-60 验证措施	X				
03-50 验证措施数据			X		
08-58 验证措施选择集		X			
15-52 验证结果			X		
13-51 一致性证据				X	
13-52 沟通证据					X
基本实践					
BP1: 定义软件验证的验证措施	X				
BP2: 选择验证措施		X			

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BP3: Verify the integrated software			X		
BP4: Ensure consistency and establish bidirectional traceability.				X	
BP5: Summarize and communicate results					X

4.5. Validation process group (VAL)

4.5.1. VAL.1 Validation

Process ID
VAL.1
Process name
Validation
Process purpose
The purpose is to provide evidence that the end product, allowing direct end user interaction, satisfies the intended use expectations in its operational target environment.
Process outcomes
1) Validation measures are selected considering criteria for regression verification. 2) The product is validated using the selected validation measures and the results of validation are recorded. 3) Consistency and unidirectional traceability are established between validation measures and stakeholder requirements; and consistency and bidirectional traceability is established between validation results and validation measures. 4) Results of the validation are summarized and communicated to all affected parties.

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BP3: 验证集成软件			X		
BP4: 确保一致性和建立双向可追溯性				X	
BP5: 总结和沟通结果					X

4.5.确认过程组 (VAL)

4.5.1. VAL.1 确认

过程 ID
VAL.1
过程名称
确认
过程目的
其目的是：提供证据证明允许直接与最终用户交互的最终产品，在其运行目标环境中满足使用期望。
过程成果
1) 考虑回归确认准则，选择了确认措施； 2) 使用选定的确认措施确认了产品，并记录了确认结果； 3) 建立了确认措施与利益相关方需求之间的一致性和单向可追溯性；建立了确认结果与确认措施之间的双向可追溯性； 4) 总结了确认结果，并与所有受影响方沟通。

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Base Practices
VAL.1.BP1: Specify validation measures for product validation. Specify the validation measures for the end product based on the stakeholder requirements to provide evidence that it fulfills its intended use expectations in its operational target environment, and • techniques for the validation measures, • pass/fail criteria for validation measures, • a definition of entry and exit criteria for the validation measures, • necessary sequence of validation measures, and • the required validation infrastructure and environment setup. *Note 1: An example for validation-relevant stakeholder requirements are homologation or legal type approval requirements. Further examples of sources of intended use expectations are technical risks (see MAN.5, SYS.3.BP4, SWE.2.BP3, HWE.2.BP6).* *Note 2: Where stakeholder requirements cannot be specified comprehensively or change frequently, repeated validation of (often rapidly developed) increments in product evolution may be employed to refine stakeholder requirements, and to mitigate risks in the correct identification of needs.* *Note 3: Validation may also be conducted to confirm that the product also satisfies the often less formally expressed, but sometimes overriding, attitudes, experience, and subjective tests that comprise stakeholder or end user satisfaction.*
VAL.1.BP2: Select validation measures. Document the selection of validation measures considering selection criteria including criteria for regression validation. The documented selection of validation measures shall have sufficient coverage according to the release scope. *Note 4: Examples for criteria for selection can be the release purpose of the delivered product (such as test bench, test track, validation on public roads, field use by end users), homologation/ type approval, confirmation of requirements, or the need for regression due to e.g., changes to stakeholder requirements and needs.*
VAL.1.BP3: Perform validation and evaluate results. Perform the validation of the integrated end product using the selected validation measures. Record the validation results including pass/fail status. Evaluate the validation results. *Note 5: Validation results can be used as a means for identifying stakeholder or system requirements e.g, in the case of mock-ups or concept studies.* *Note 6: See SUP.9 for handling verification results that deviate from expected results*
VAL.1.BP4: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability from validation measures to the stakeholder requirements from which they are derived. Establish bidirectional traceability between validation results and validation measures. *Note 7: Examples of sources of validation measures from which they can be derived are legal requirements, homologation requirements, results of technical risk analyses, or stakeholder and system requirements (see SYS.1 and SYS.2).* *Note 8: If sources of validation measures are e.g., legal or homologation requirements, then direct bidirectional traceability from those sources to the validation measures are not possible. In such a case, unidirectional traceability is sufficient.* *Note 9: Bidirectional traceability supports consistency, and facilitates impact analyses of change requests, and demonstration of verification coverage. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.*

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基本实践

VAL.1.BP1: 定义产品确认的确认措施。基于利益相关方需求，定义最终产品的确认措施，以提供其在运行目标环境下实现了使用期望的证据，包括：

- 确认措施技术
- 确认措施通过/失败准则
- 确认措施准入和准出准则
- 确认措施的必要顺序
- 所需的确认基础设施和环境设置

注 1: 确认相关的利益相关方需求的示例如，认证或法律型式批准需求。使用期望来源的示例如，技术风险（参见 MAN.5、SYS.3.BP3、SWE.2.BP3、HWE.2.BP4）。

注 2: 如果利益相关方需求无法全面定义或频繁变化，则可以对产品演化中的增量进行重复确认（通常快速开发），以完善利益相关方需求并缓解正确识别需要的风险。

注 3: 确认还可用于确认产品是否满足通常不正式表达但有时更重要的态度、体验和主观评测，而这些包含了利益相关方或最终用户的满意度。

VAL.1.BP2: 选择确认措施。考虑选择准则（包括回归确认准则），记录确认措施选择。所记录的确认措施选择应根据发布范围具备足够的覆盖率。

注 4: 选择准则的示例可以是交付产品的发布目的（例如测试台架、试车场、公共道路、最终用户现场使用等），认证/型式批准，需求确认，或由于利益相关方需求和需要的变更而进行回归。

VAL.1.BP3: 执行确认并评估结果。使用选定的确认措施执行最终产品的确认。记录确认结果，包括通过/失败状态。评估确认结果。

注 5: 确认结果可用作识别利益相关方需求或系统需求的手段，例如实物模型或概念研究情况下。

注 6: 与预期结果不符的验证结果处理，参见 SUP.9。

VAL.1.BP4: 确保一致性和建立双向可追溯性。确保确认措施与利益相关方需求之间的一致性并建立双向可追溯性。建立确认结果与确认措施之间的双向可追溯性。

- *注 7: 确认措施来源的示例如，法律需求、认证需求、技术风险分析结果或利益相关方和系统需求（参见 SYS.1 和 SYS.2）。*
- *注 8: 如果确认措施的来源是法律或认证需求，那么从这些来源到确认措施之间不可能存在直接双向可追溯性。在这种情况下，单向可追溯性就足够了。*
- *注 9: 双向可追溯性支持一致性，并有助于变更请求的影响分析和验证覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。*

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VAL.1.BP5: Summarize and communicate results. Summarize the validation results and communicate them to all affected parties. *Note 10: Providing all necessary information from the test case execution in a summary enables other parties to judge the consequences.*

VAL.1 Validation	Outcome 1	Outcome 2	Outcome 3	Outcome 4
Output Information Items				
08-59 Validation Measure	X			
08-57 Validation Measure Selection Set	X			
13-24 Validation Results		X		
13-51 Consistency Evidence			X	
13-52 Communication Evidence				X
Base Practices				
BP1: Specify validation measures	X			
BP2: Select validation measures	X			
BP3: Perform validation and evaluate results		X		
BP4: Ensure consistency and establish traceability.			X	
BP5: Summarize and communicate results				X

4.6. Machine Learning Engineering process group (MLE)

4.6.1. MLE.1 Machine Learning Requirements Analysis

Process ID
MLE.1
Process name
Machine Learning Requirements Analysis
Process purpose
The purpose is to refine the machine learning-related software requirements into a set of ML requirements.
Process outcomes

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VAL.1.BP5: 总结和沟通结果。 总结确认结果，并与所有受影响方沟通。

- *注 10:在总结中提供来自测试用例执行的所有必要信息，以便其他方可以判断结果。*

VAL.1 确认	成果 1	成果 2	成果 3	成果 4
输出信息项				
08-59 确认措施	X			
08-57 确认措施选择集	X			
13-24 确认结果		X		
13-51 一致性证据			X	
13-52 沟通证据				X
基本实践				
BP1: 定义产品确认的确认措施	X			
BP2: 选择确认措施	X			
BP3: 执行确认并评估结果		X		
BP4: 确保一致性和建立双向可追溯性			X	
BP5: 总结和沟通结果				X

4.6.机器学习工程过程组（MLE）

4.6.1. MLE.1 机器学习需求分析

过程 ID
MLE.1
过程名称
机器学习需求分析
过程目的
其目的是：将与机器学习相关的软件需求细化为一组 ML 需求。
过程成果

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1) The ML requirements including ML data requirements are identified and specified based on the software requirements and the components of the software architecture.
2) ML requirements are structured and prioritized.
3) ML requirements are analyzed for correctness and verifiability.
4) The impact of ML requirements on the ML operating environment is analyzed.
5) Consistency and bidirectional traceability are established between ML requirements and software requirements, and between ML requirements and software architecture.
6) The ML requirements are agreed and communicated to all affected parties.

Base Practices

MLE.1.BP1: Specify ML requirements. Use the software requirements and the software architecture to identify and specify functional and non-functional ML requirements, as well as ML data requirements specifying data characteristics (e.g., gender, weather conditions, street conditions within the ODD) and their expected distributions.

Note 1: Non-functional requirements may include relevant characteristics of the ODD and KPIs as robustness, performance, and level of trustworthiness.

Note 2: The ML data requirements are input for SUP.11 Machine Learning Data Management but also for other MLE processes.

Note 3: In case of ML development only, stakeholder requirements represent the software requirements.

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过程成果

1) 基于软件需求和软件架构的组件，识别和定义了包括 ML 数据需求在内的 ML 需求；
2) 结构化了 ML 需求并进行优先级排序；
3) 分析了 ML 需求的正确性和可验证性；
4) 分析了 ML 需求对 ML 运行环境的影响；
5) 建立了 ML 需求与软件需求之间，以及 ML 需求与软件架构之间的一致性和双向可追溯性；
6) 约定了 ML 需求，并与所有受影响方沟通。

基本实践

MLE.1.BP1: 定义 ML 需求。使用软件需求和软件架构来识别和定义功能性和非功能性 ML 需求，以及定义了数据特征（例如：性别、天气条件、ODD 内的街道条件）及其预期的分布的 ML 数据需求。

注 1：非功能性需求可能包括 ODD 和 KPIs 的相关特性，如鲁棒性、性能和可信度。

注 2：机器学习数据需求是 SUP.11 机器学习数据管理过程的输入，也是其他 MLE 过程的输入。

注 3：在只有 ML 开发的情况下，利益相关方需求代表软件需求。

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MLE.1.BP2: Structure ML requirements. Structure and prioritize the ML requirements.

Note 4: Examples for structuring criteria can be grouping (e.g., by functionality) or variants identification.

Note 5: Prioritization can be done according to project or stakeholder needs via e.g., definition of release scopes. Refer to SPL.2.BP1.

MLE.1.BP3: Analyze ML requirements. Analyze the specified ML requirements including their interdependencies to ensure correctness, technical feasibility, and ability for machine learning model testing, and to support project management regarding project estimates.

Note 6: See MAN.3.BP3 for project feasibility and MAN.3.BP5 for project estimates.

MLE.1.BP4: Analyze the impact on the ML operating environment. Analyze the impact that the ML requirements will have on interfaces of software components and the ML operating environment.

Note 7: The ML operating environment is defined as the infrastructure and information which both the trained ML model and the deployed ML model need for execution.

MLE.1.BP5: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability between ML requirements and software requirements and between ML requirements and the software architecture.

Note 8: Bidirectional traceability supports consistency, facilitates impact analyses of change requests, and verification coverage demonstration. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.

Note 9: Redundant traceability is not intended, but at least one out of the given traceability paths.

MLE.1.BP6: Communicate agreed ML requirements and impact on the operating environment. Communicate the agreed ML requirements, and the results of the impact analysis on the ML operating environment to all affected parties.

MLE.1 Machine Learning Requirements Analysis	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6
Output Information Items						
17-00 Requirement	X	X				
17-54 Requirement attribute		X	X			
13-52 Communication evidence						X

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MLE.1.BP2: 结构化 ML 需求。结构化 ML 需求并进行优先级排序。

- *注 4：结构化准则的示例如，分组（如按功能）或变体识别。*
- *注 5：可以根据项目或利益相关方需要(如发布范围的定义)，来进行优先级排序。参见 SPL.2.BP1。*

MLE.1.BP3: 分析 ML 需求。分析已定义的 ML 需求（包括它们的相互依赖关系），以确保正确性、技术可行性和机器学习模型测试能力，并支持项目管理的项目估算。

- *注 6：项目可行性参见 MAN.3.BP3，项目估算参见 MAN.3.BP5。*

MLE.1.BP4: 分析对 ML 运行环境的影响。分析 ML 需求对软件组件接口和 ML 运行环境的影响。

- *注 7：ML 运行环境被定义为已训练的 ML 模型和已部署的机器学习模型在执行过程中所需的基础设施和信息。*

MLE.1.BP5: 确保一致性和建立双向可追溯性。确保 ML 需求与软件需求之间，以及 ML 需求与软件架构之间的一致性并建立双向可追溯性。

- *注 8：双向可追溯性支持一致性，并有助于对变更请求的影响分析和验证覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。*
- *注 9：冗余的可追溯性是非意图的，但在给定的可追溯性路径中至少要有一条。*

MLE.1.BP6: 沟通约定的 ML 需求和对运行环境的影响。与所有受影响方沟通约定的 ML 需求，以及对 ML 运行环境影响分析的结果。

MLE.1 机器学习需求分析	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6
输出信息项						
17-00 需求	X	X				
17-54 需求属性		X	X			
13-52 沟通证据						X

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13-51 Consistency evidence					X	
15-51 Analysis results			X	X		
Base Practices						
BP1: Specify ML requirements	X					
BP2: Structure ML requirements		X				
BP3: Analyze ML requirements			X			
BP4: Analyze the impact on the ML operating environment				X		
BP5: Ensure consistency and establish bidirectional traceability					X	
BP6: Communicate agreed ML requirements						X

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13-51 一致性证据					X	
15-51 分析结果			X	X		
基本实践						
BP1: 定义 ML 需求	X					
BP2: 结构化 ML 需求		X				
BP3: 分析 ML 需求			X			
BP4: 分析对 ML 运行环境的影响				X		
BP5: 确保一致性和建立双向可追溯性					X	
BP6: 沟通约定的 ML 需求和对运行环境的影响						X

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4.6.2. MLE.2 Machine Learning Architecture

Process ID
MLE.2
Process name
Machine Learning Architecture
Process purpose
The purpose is to establish an ML architecture supporting training and deployment, consistent with the ML requirements, and to evaluate the ML architecture against defined criteria.
Process outcomes
1) A ML architecture is developed. 2) Hyperparameter ranges and initial values are determined as a basis for the training. 3) Evaluation of ML architectural elements is conducted. 4) Interfaces of the ML architectural elements are defined. 5) Resource consumption objectives for the ML architectural elements are defined. 6) Consistency and bidirectional traceability are established between the ML architectural elements and the ML requirements. 7) The ML architecture is agreed and communicated to all affected parties.

Base Practices
MLE.2.BP1: Develop ML architecture. Develop and document the ML architecture that specifies ML architectural elements including details of the ML model, pre- and postprocessing, and hyperparameters which are required to create, train, test, and deploy the ML model. *Note 1: Necessary details of the ML model may include layers, activation functions, and backpropagation. The level of detail of the ML model may not need to cover aspects like single neurons.* *Note 2: The details of the ML model may differ between the ML model used during training and the deployed ML model.*
MLE.2.BP2: Determine hyperparameter ranges and initial values. Determine and document the hyperparameter ranges and the initial values as a basis for the training.
MLE.2.BP3: Analyze ML architectural elements. Define criteria for analysis of the ML architectural elements. Analyze ML architectural elements according to the defined criteria. *Note 3: Trustworthiness and explainability might be criteria for the analysis of the ML architectural elements.*

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4.6.2. MLE.2 机器学习架构

过程 ID
MLE.2
过程名称
机器学习架构
过程目的
其目的是：建立 ML 架构，可以支持训练和部署且和 ML 需求保持一致，并依照定义的准则来评估 ML 架构设计。
过程成果
1) 开发了 ML 架构； 2) 确定了超参数的范围和初始值, 以作为训练的基础； 3) 对 ML 架构要素进行了评估； 4) 定义了 ML 架构要素的接口； 5) 定义了 ML 架构要素的资源消耗目标； 6) 建立了 ML 架构要素与 ML 需求之间的一致性和双向可追溯性； 7) 约定了 ML 架构，并与所有受影响方沟通。

基本实践
MLE.2.BP1: 开发 ML 架构。开发并记录 ML 架构，其中定义了 ML 架构的要素，包括创建、训练、测试和部署 ML 模型所需的 ML 模型、预处理和后处理以及超参数的细节。 • *注 1：ML 模型的必要细节可包括层、激活函数和反向传播。 ML 模型的详细程度可不覆盖单个神经元这个层面。* • *注 2：训练期间使用的 ML 模型和已部署的 ML 模型之间，在细节上可能有所不同。*
MLE.2.BP2: 确定超参数范围和初始值。确定并记录超参数范围和初始值，以作为训练的基础。
MLE.2.BP3: 分析 ML 架构要素。定义分析 ML 架构要素的准则。根据定义的准则分析 ML 架构的要素。 • *注 3：可信度和可解释性可以是 ML 架构要素分析的准则。*

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MLE.2.BP4: Define interfaces of the ML architectural elements. Determine and document the internal and external interfaces of each ML architectural element including its interfaces to related software components.

MLE.2.BP5: Define resource consumption objectives for the ML architectural elements. Determine and document the resource consumption objectives for all relevant ML architectural elements during training and deployment.

MLE.2.BP6: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability between the ML architectural elements and the ML requirements.

Note 4: Bidirectional traceability supports consistency, and facilitates impact analyses of change requests, and verification coverage demonstration. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.

Note 5: The bidirectional traceability should be established on a reasonable level of abstraction to the ML architectural elements.

MLE.2.BP7: Communicate agreed ML architecture. Inform all affected parties about the agreed ML architecture including the details of the ML model and the initial hyperparameter values.

MLE.2 Machine Learning Architecture	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6	Outcome 7
Output Information Items							
04-51 ML architecture	X	X	X	X	X		
13-52 Communication evidence							X
13-51 Consistency evidence						X	
01-54 Hyperparameter	X	X					
15-51 Analysis results	X		X				
Base Practices							
BP1: Develop ML architecture	X						
BP2: Determine hyperparameter ranges and initial values.		X					
BP3: Evaluate ML architectural elements			X				
BP4: Define interfaces of the ML architectural elements				X			
BP5: Define resource consumption objectives for the ML architectural elements					X		

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MLE.2.BP4: 定义 ML 架构要素的接口。确定和记录每个 ML 架构要素的内部和外部接口，包括其与相关软件组件的接口。
MLE.2.BP5: 定义 ML 架构要素的资源消耗目标。确定并记录所有相关 ML 架构要素在训练和部署过程中的资源消耗目标。
MLE.2.BP6: 确保一致性和建立双向可追溯性。确保 ML 架构要素与 ML 需求之间的一致性并建立双向可追溯性。 • *注 4：双向可追溯性支持一致性，并有助于对变更请求的影响分析和验证覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。* • *注 5：双向可追溯性应该建立在对 ML 架构要素的合理抽象级别上。*
MLE.2.BP7: 沟通约定的 ML 架构。通知所有受影响方已约定的 ML 架构，包括 ML 模型的细节和超参数的初始值。

MLE.2 机器学习架构	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6	成果 7
输出信息项							
04-51 ML 架构	X	X	X	X	X		
13-52 沟通证据							X
13-51 一致性证据						X	
01-54 超参数	X	X					
15-51 分析结果	X		X				
基本实践							
BP1: 开发 ML 架构	X						
BP2: 确定超参数范围和初始值		X					
BP3: 分析 ML 架构要素			X				
BP4: 定义 ML 架构的要素的接口				X			
BP5: 定义 ML 架构要素的资源消耗目标					X		

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BP6: Ensure consistency and establish bidirectional traceability						X	
BP7: Communicate agreed ML architecture							X

4.6.3. MLE.3 Machine Learning Training

Process ID
MLE.3
Process name
Machine Learning Training
Process purpose
The purpose is to optimize the ML model to meet the defined ML requirements.
Process outcomes
1) A ML training and validation approach is specified. 2) The data set for ML training and ML validation is created. 3) The ML model, including hyperparameter values, is optimized to meet the defined ML requirements. 4) Consistency and bidirectional traceability are established between the ML training and validation data set and the ML data requirements. 5) Results of optimization are summarized, and the trained ML model is agreed and communicated to all affected parties.

Base Practices

MLE.3.BP1: Specify ML training and validation approach. Specify an approach which supports the training and validation of the ML model to meet the defined ML requirements. The ML training and validation approach includes

- entry and exit criteria of the training and validation,
- approaches for hyperparameter tuning / optimization,
- approach for data set creation and modification, and
- training and validation environment

Note 1: The ML training and validation approach may include random dropout and other robustification methods.

Note 2: ML validation is the optimization of the hyperparameters during Machine Learning Training (MLE.3). The term "validation" has a different meaning than VAL.1.

Note 3: The training environment should reflect the environment of the deployed model.

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BP6: 确保一致性和建立双向可追溯性						X	
BP7: 沟通约定的 ML 架构							X

4.6.3. MLE.3 机器学习训练

过程 ID
MLE.3
过程名称
机器学习训练
过程目的
其目的是：优化 ML 模型以满足已定义的 ML 需求。
过程成果
1) 定义了 ML 的训练和验证方法； 2) 创建了用于 ML 训练和 ML 验证的数据集； 3) 对包括超参数值在内的 ML 模型进行了优化，以满足已定义的 ML 需求； 4) 建立了 ML 训练和验证数据集与 ML 数据需求之间的一致性和双向可追溯性； 5) 总结了优化结果，并与所有受影响方沟通约定的已训练的 ML 模型。

基本实践

MLE.3.BP1：定义 ML 训练和验证方法。定义支持训练和验证 ML 模型的方法，以满足已定义的 ML 需求。ML 训练和验证方法包括

- 训练和验证的准入和准出准则，
- 超参数调整/优化的方法，
- 数据集创建和修改的方法，以及
- 训练和验证环境。

注 1：ML 的训练和验证方法可包括随机丢弃和其他稳定化方法。

注 2：ML 验证是指在 ML 训练（MLE.3）过程中优化超参数。术语 "验证（validation） "的含义与 VAL.1 不同。

注 3：训练环境应反映出对模型部署环境的考虑。

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MLE.3.BP2: Create ML training and validation data set. Select data from the ML data collection provided by SUP.11 and assign them to the data set for training and validation of the ML model according to the specified ML training and validation approach.

Note 4: The ML training and validation data set may include corner cases, unexpected cases, and normal cases depending on the ML requirements.

Note 5: A separated data set for training and validation might not be required in some cases (e.g., k-fold cross validation, no optimization of hyperparameters).

MLE.3.BP3: Create and optimize ML model. Create the ML model according to the ML architecture and train it, using the identified ML training and validation data set according to the ML training and validation approach to meet the defined ML requirements, and training and validation exit criteria.

MLE.3.BP4: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability between the ML training and validation data set and the ML data requirements.

Note 6: Bidirectional traceability supports consistency and facilitates impact analyses of change requests. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.

MLE.3.BP5: Summarize and communicate agreed trained ML model. Summarize the results of the optimization and inform all affected parties about the agreed trained ML model.

MLE.3 Machine Learning Training	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5
Output Information Items					
08-65 ML training and validation approach	X				
03-51 ML data set		X			
01-53 Trained ML model			X		
01-54 Hyperparameter			X		
13-51 Consistency evidence				X	
13-52 Communication evidence					X

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MLE.3.BP2: 创建 ML 的训练和验证数据集。从 SUP.11 提供的 ML 数据集中选择数据，并按照指定的 ML 训练和验证方法将其分配到数据集中，用于训练和验证 ML 模型。 • *注 4：取决于 ML 需求，ML 训练和验证数据集可包括边角案例、意外案例和正常案例。* • *注 5：在某些情况下（如 K 折交叉验证、无需优化超参数），可能不需要单独的训练和验证数据集。*
MLE.3.BP3: 创建和优化 ML 模型。根据 ML 架构创建 ML 模型，并根据 ML 训练和验证方法使用已明确的 ML 训练和验证数据集进行训练，以满足定义的 ML 需求以及训练和验证的准出准则。
MLE.3.BP4: 确保一致性和建立双向可追溯性。确保 ML 训练和验证数据集与 ML 数据需求之间的一致性并建立双向可追溯性。 • *注 6：双向可追溯性支持一致性，并有助于对变更请求进行影响分析。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。*
MLE.3.BP5: 总结和沟通约定的已训练的 ML 模型。总结优化的结果，并与所有受影响方沟通约定的已训练的 ML 模型。

MLE.3 机器学习训练	成果 1	成果 2	成果 3	成果 4	成果 5
输出信息项					
08-65 ML 训练和验证方法	X				
03-51 ML 数据集		X			
01-53 已训练的 ML 模型			X		
01-54 超参数			X		
13-51 一致性证据				X	
13-52 沟通证据					X

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Base Practices					
BP1: Specify ML training and validation approach	X				
BP2: Create ML training and validation data set		X			
BP3: Create and optimize ML model			X		
BP4: Ensure consistency and establish bidirectional traceability				X	
BP5: Summarize and communicate agreed trained ML model					X

4.6.4. MLE.4 Machine Learning Model Testing

Process ID
MLE.4
Process name
Machine Learning Model Testing
Process purpose
The purpose is to ensure compliance of the trained ML model and the deployed ML model with the ML requirements.
Process outcomes
1) A ML test approach is defined. 2) A ML test data set is created. 3) The trained ML model is tested. 4) The deployed ML model is derived from the trained ML model and tested. 5) Consistency and bidirectional traceability are established between the ML test approach and the ML requirements, and the ML test data set and the ML data requirements; and bidirectional traceability is established between the ML test approach and ML test results. 6) Results of the ML model testing are summarized and communicated with the deployed ML model to all affected parties.

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基本实践					
BP1: 定义 ML 训练和验证方法	X				
BP2: 创建 ML 训练和验证数据集		X			
BP3: 创建和优化 ML 模型			X		
BP4: 确保一致性和建立双向可追溯性				X	
BP5: 总结和沟通约定的已训练的 ML 模型					X

4.6.4. MLE.4 机器学习模型测试

过程 ID
MLE.4
过程名称
机器学习模型测试
过程目的
其目的是：确保已训练的模型和已部署的模型符合 ML 需求。
过程成果
1) 定义了 ML 测试方法； 2) 创建了 ML 测试数据集； 3) 测试了已训练的 ML 模型； 4) 由已训练的 ML 模型导出已部署的 ML 模型，并进行了测试； 5) 建立了 ML 测试方法与 ML 需求之间，以及 ML 测试数据集与 ML 数据需求之间的一致性和双向可追溯性；建立了 ML 测试方法与 ML 测试结果之间的双向可追溯性； 6) 总结了 ML 模型测试的结果，并与所有受影响方沟通了已部署的 ML 模型。

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Base Practices
MLE.4.BP1: Specify an ML test approach. Specify an ML test approach suitable to provide evidence for compliance of the trained ML model and the deployed ML model with the ML requirements. The ML test approach includes • ML test scenarios with distribution of data characteristics (e.g., gender, weather conditions, street conditions within the ODD) defined by ML requirements, • distribution and frequency of each ML test scenario inside the ML test data set, • expected test result per test datum, • entry and exit criteria of the testing, • approach for data set creation and modification, and • the required testing infrastructure and environment setup. *Note 1: Expected test result per test datum might require labeling of test data to support comparison of output of the ML model with the expected output.* *Note 2: Test datum is the smallest amount of data which is processed by the ML model into only one output. E.g., one image in photo processing or an audio sequence in voice recognition.* *Note 3: Data characteristic is one property of the data that may have different expressions in the ODD. E.g., weather condition may contain expressions like sunny, foggy or rainy.* *Note 4: An ML test scenario is a combination of expressions of all defined data characteristics e.g., weather conditions = sunny, street conditions = gravel road.*
MLE.4.BP2: Create ML test data set. Create the ML test data set needed for testing of the trained ML model and testing of the deployed ML model from the ML data collection provided by SUP.11 considering the ML test approach. The ML test data set shall not be used for training. *Note 5: The ML test data set for the trained ML model might differ from the test data set of the deployed ML model.* *Note 6: Additional data sets might be used for special purposes like assurance of safety, fairness, robustness.*
MLE.4.BP3: Test trained ML model. Test the trained ML model according to the ML test approach using the created ML test data set. Record and evaluate the ML test results. *Note 7: Evaluation of test logs might include pattern analysis of failed test data to support e.g., trustworthiness.*

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基本实践
MLE.4.BP1: 定义 ML 测试方法。 定义 ML 测试方法，以适于提供已训练的 ML 模型和已部署的 ML 模型符合 ML 需求的证据。ML 测试方法包括： • ML 测试场景以及 ML 需求所定义的数据特性分布（例如：ODD 中的性别、天气条件、街道条件等）， • ML 测试数据集中各 ML 测试场景的分布和频率， • 每个测试数据点的预期测试结果， • 测试的准入和准出准则， • 数据集创建和修改的方法，以及 • 所需测试基础设施和环境搭建。 *注 1：各测试数据点的预期结果可能需要对测试数据进行标注，以支持 ML 模型输出和预期结果的比较。* *注 2：测试数据点是由 ML 模型单次输出所需处理的最小数据量。例如，照片处理中的一张图像或语音识别中的音频序列。* *注 3：数据特征是数据的一个属性，在 ODD 中可能具有不同的表达式。例如，天气条件可能包含诸如晴天、雾天或雨天等表达方式。* *注 4：ML 测试场景是所有已定义数据特征的表达式的组合，例如，天气条件 = 晴天，街道条件 = 碎石路。*
MLE.4.BP2: 创建 ML 测试数据集。根据 ML 测试方法，从 SUP.11 提供的 ML 数据集合创建测试已训练的 ML 模型和已部署的 ML 模型的 ML 测试数据集。ML 测试数据集不得用于训练。 *注 5：用于已训练的 ML 模型的 ML 测试数据集可不同于已部署的 ML 模型的 ML 测试数据集。* *注 6：附加的数据集可用于特殊目的，例如安全保证、公平性、鲁棒性。*
MLE.4.BP3: 测试已训练的 ML 模型。 根据 ML 测试方法，使用创建的 ML 测试数据集来测试已训练的 ML 模型。记录并评估 ML 测试结果。 *注 7：测试日志的评估可包括对失败测试数据的模式分析，以支持可信度等。*

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MLE.4.BP4: Derive deployed ML model. Derive the deployed ML model from the trained ML model according to the ML architecture. The deployed ML model shall be used for testing and delivery to software integration.

Note 8: The deployed ML model will be integrated into the target system and may differ from the trained ML model which often requires powerful hardware and uses interpretative languages.

MLE4.BP5: Test deployed ML model. Test the deployed ML model according to the ML test approach using the created ML test data set. Record and evaluate the ML test results.

MLE.4.BP6: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability between the ML test approach and the ML requirements, and the ML test data set and the ML data requirements; and bidirectional traceability is established between the ML test approach and ML test results.

Note 9: Bidirectional traceability supports consistency, and facilitates impact analyses of change requests, and verification coverage demonstration. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.

MLE.4.BP7: Summarize and communicate results. Summarize the ML test results of the ML model. Inform all affected parties about the agreed results and the deployed ML model.

MLE.4 Machine Learning Model Testing	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6
Output Information Items						
08-64 ML test approach	X					
03-51 ML data set		X				
13-50 ML test results			X	X		
11-50 Deployed ML model				X		
13-51 Consistency evidence					X	
13-52 Communication evidence						X
Base Practices						
BP1: Specify an ML test approach	X					
BP2: Create ML test data set		X				

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MLE.4.BP4: 导出已部署的 ML 模型。根据 ML 架构，从已训练的 ML 模型导出已部署的 ML 模型。已部署的 ML 模型须被用于软件集成的测试和交付。 • *注 8：已部署的 ML 模型将被集成到目标系统，并且可能与已训练的 ML 模型不同，后者通常需要强大的硬件并使用解释性语言。*
MLE4.BP5: 测试已部署的 ML 模型。根据 ML 测试方法，使用创建的 ML 测试数据集来测试已部署的 ML 模型。记录并评估 ML 测试结果。
MLE.4.BP6: 确保一致性和建立双向可追溯性。确保 ML 测试方法与 ML 需求之间，以及 ML 测试数据集与 ML 数据需求之间的一致性并建立双向可追溯性。建立 ML 测试方法与 ML 测试结果之间的双向可追溯性。 • *注 9：双向可追溯性有助于一致性，并有助于对变更请求的影响分析和验证覆盖率的证明。仅可追溯性，例如链接的存在，并不一定意味着信息彼此一致。*
MLE.4.BP7: 总结和沟通结果。总结 ML 模型的 ML 测试结果。通知所有受影响方有关约定的结果和已部署的 ML 模型。

MLE.4 机器学习模型测试	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6
输出信息项						
08-64 ML 测试方法	X					
03-51 ML 数据集		X				
13-50 ML 测试结果			X	X		
11-50 已部署的 ML 模型				X		
13-51 一致性证据					X	
13-52 沟通证据						X
基本实践						
BP1: 定义 ML 测试方法	X					
BP2: 创建 ML 测试数据集		X				

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BP3: Test trained ML model			X			
BP4: Derive deployed ML model				X		
BP5: Test deployed ML model				X		
BP6: Ensure consistency and establish bidirectional traceability					X	
BP7: Summarize and communicate results						X

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BP3: 测试已训练的 ML 模型			X			
BP4: 导出已部署的 ML 模型				X		
BP5: 测试已部署的 ML 模型				X		
BP6: 确保一致性和建立双向可追溯性					X	
BP7: 总结和沟通结果						X

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4.7. Hardware Engineering process group (HWE)

4.7.1. HWE.1 Hardware Requirements Analysis

Process ID
HWE.1
Process name
Hardware Requirements Analysis
Process purpose
The purpose is to establish a structured and analyzed set of hardware requirements consistent with the system requirements, and the system architectural design.
Process outcomes
1) Hardware requirements are specified. 2) Hardware requirements are structured and prioritized. 3) Hardware requirements are analyzed for correctness and technical feasibility. 4) The impact of hardware requirements on the operating environment is analyzed. 5) Consistency and bidirectional traceability are established between hardware requirements and system requirements. 6) Consistency and bidirectional traceability are established between hardware requirements and system architectural design. 7) The hardware requirements are agreed and communicated to all affected parties.

Base Practices

HWE.1.BP1: Specify hardware requirements. Use the system requirements, and the system architecture including interface definitions, to identify and document the functional and non-functional requirements of the hardware according to defined characteristics for requirements.

Note 1: Characteristics of requirements are defined in standards such as ISO IEEE 29148, ISO/IEC IEEE 24765, ISO 26262-8:2018, or the INCOSE Guide For Writing Requirements.

Note 2: Examples for defined characteristics of requirements shared by the above-mentioned standards are verifiability (i.e., verification criteria being inherent in the requirements text), unambiguity/comprehensibility, freedom from design and implementation, and not contradicting any other requirement).

Note 3: In case of hardware-only development, the system requirements and the system architecture refer to a given operating environment. In that case, stakeholder requirements can be used as the basis for identifying the required functions and capabilities of the hardware.

Note 4: The hardware-software-interface (HSI) definition puts in context software and therefore is an interface decision at the system design level. If such a HSI exists, then it may provide input to hardware requirements.

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4.7.硬件工程过程组(HWE)

4.7.1. HWE.1 硬件需求分析

过程 ID
HWE.1
过程名称
硬件需求分析
过程目的
其目的是：建立一套与系统需求以及系统架构设计相一致的结构化和已分析的硬件需求。
过程成果
1) 定义了硬件需求； 2) 结构化了硬件需求并进行优先级排序； 3) 分析了硬件需求的正确性和技术可行性； 4) 分析了硬件需求对运行环境的影响； 5) 建立了硬件需求与系统需求之间的一致性和双向可追溯性； 6) 建立了硬件需求与系统架构设计之间的一致性和双向可追溯性； 7) 约定了硬件需求并与所有受影响方沟通。

基本实践
HWE.1. BP1: 定义硬件需求。根据已定义的需求特性，使用系统需求和系统架构(包括接口定义)来识别并文档化硬件的功能性和非功能性需求。 *注 1: 需求特性在一些标准中有定义，诸如 ISO IEEE 29148、ISO/IEC IEEE 24765、ISO 26262-8:2018 或 INCOSE 需求编写指南等。* *注 2: 上述标准共有的关于已定义的需求特性的示例如，可验证的 (即：需求文本中固有的验证准则)、无歧义的/可理解的，无设计和实现限制的，以及不与任何其他需求相矛盾的。* *注 3:在只有硬件开发的情况下，系统需求和系统架构参考给定的操作环境。在这种情况下，利益相关方的需求应该被作为识别硬件所需功能和能力的基础。* *注 4:硬件-软件-接口(HSI)定义是在软件上下文中给出的，因此它是系统设计级别的接口决策。如果存在这样的 HSI，那么它可以为硬件需求提供输入。*

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HWE.1.BP2: Structure hardware requirements. Structure and prioritize the hardware requirements.

Note 5: Examples for structuring criteria can be grouping (e.g., by functionality) or variants identification.

Note 6: Prioritization can be done according to project or stakeholder needs via e.g., definition of release scopes. Refer to SPL.2.BP1.

HWE.1.BP3: Analyze hardware requirements. Analyze the specified hardware requirements including their interdependencies to ensure correctness, technical feasibility, and to support project management regarding project estimates.

Note 7: See MAN.3.BP3 for project feasibility and MAN.3.BP5 for project estimates.

Note 8: The analyses of technical feasibility can be done based on a given hardware design (e.g., platform) or by prototype development.

HWE.1.BP4: Analyze the impact on the operating environment. Identify the interfaces between the specified hardware and other elements of the operating environment. Analyze the impact that the hardware requirements will have on these interfaces and the operating environment.

HWE.1.BP5: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish traceability between hardware requirements and the system architecture. Ensure consistency and establish traceability between hardware requirements and system requirements.

Note 9: Redundant traceability is not intended.

Note 10: There may be non-functional hardware requirements that the hardware design does not trace to. Examples are development process requirements. Such requirements are still subject to verification.

Note 11: Bidirectional traceability supports consistency, and facilitates impact analysis of change requests, and demonstration of verification coverage. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.

Note 12: In case of hardware development only, the system requirements and system architecture refer to a given operating environment. In that case, consistency and bidirectional traceability can be ensured between stakeholder requirements and hardware requirements.

HWE.1.BP6: Communicate agreed hardware requirements and impact on the operating environment. Communicate the agreed hardware requirements and results of the analysis of impact on the operating environment to all affected parties.

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HWE.1. BP2:结构化硬件需求。结构化硬件需求并进行优先级排序。

- *注 5: 结构化准则的示例如，分组（如按功能）或变体识别。*
- *注 6: 可以根据项目或利益相关方需要(如发布范围的定义)，来进行优先级排序。参见 SPL.2.BP1。*

HWE.1. BP3: 分析硬件需求。分析已定义的硬件需求（包括它们的相互依赖性），以确保正确性、技术可行性，并支持项目管理的项目估算。

- *注 7:项目可行性参见 MAN.3.BP3，项目估算参见 MAN.3.BP5。*
- *注 8:技术可行性分析可基于给定的硬件设计(如平台)或原型件开发来进行。*

HWE.1. BP4: 分析对运行环境的影响。识别指定硬件和运行环境的其他要素之间的接口。分析硬件需求对这些接口和运行环境的影响。

HWE.1. BP5：确保一致性和建立双向可追溯性。确保硬件需求与系统架构之间的一致性并建立可追溯性。确保硬件需求与系统需求之间的一致性并建立可追溯性。

- *注 9: 冗余的可追溯性是非意图的。*
- *注 10:可能存在硬件设计无法追溯的非功能性硬件需求。例如开发过程需求。这些需求仍然需要验证。*
- *注 11: 双向可追溯性支持一致性，并有助于对变更请求的影响分析和验证覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。*
- *注 12:如果只有硬件开发，系统需求和系统架构是指给定的运行环境。在这种情况下，可以确保利益相关方的需求和硬件需求之间的一致性和双向可追溯性。*

HWE.1. BP6: 沟通约定的硬件需求和对运行环境的影响。与所有受影响方沟通约定的硬件需求，以及对运行环境影响分析的结果。

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HWE.1 Hardware Requirements Analysis	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6	Outcome 7
Output Information Items							
13-52 Communication Evidence							X
13-51 Consistency Evidence					X	X	
17-00 Requirement	X	X	X				
17-54 Requirement Attribute		X					
15-51 Analysis Results			X	X			
Base Practices							
BP1: Specify hardware requirements	X						
BP2: Structure hardware requirements		X					
BP3: Analyze hardware requirements			X				
BP4: Analyze the impact on the operating environment				X			
BP5: Ensure consistency and establish bidirectional traceability					X	X	
BP6: Communicate agreed hardware requirements							X

4.7.2. HWE.2 Hardware Design

Process ID
HWE.2
Process name
Hardware Design
Process purpose

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HWE.1 硬件需求分析	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6	成果 7
输出信息项							
13-52 沟通证据							X
13-51 一致性证据					X	X	
17-00 需求	X	X	X				
17-54 需求属性		X					
15-51 分析结果			X	X			
基本实践							
BP1: 定义硬件需求	X						
BP2: 结构化硬件需求		X					
BP3: 分析硬件需求			X				
BP4: 分析对运行环境的影响				X			
BP5: 确保一致性和建立双向可追溯性					X	X	
BP6: 沟通约定的硬件需求和对运行环境的影响							X

4.7.2. HWE.2 硬件设计

过程 ID
HWE.2
过程名称
硬件设计
过程目的

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The purpose is to provide an analyzed design, including dynamic aspects, that is consistent with the hardware requirements and suitable for manufacturing, and to derive production-relevant data.
Process outcomes
1) A hardware architecture and hardware detailed design is developed that identifies the elements of the hardware and describes their behavior as well as their interfaces, and the dynamic interactions of the hardware elements. 2) The hardware architecture and the hardware detailed design is analyzed, and special characteristics are identified. 3) Consistency and bidirectional traceability are established between hardware requirements and hardware design. 4) Hardware production data is derived from the hardware detailed design and communicated to all affected parties. 5) Information for production test is derived from the hardware detailed design and communicated to all affected parties. 6) The hardware architecture and hardware detailed design and the special characteristics are agreed and communicated to all affected parties.

Base Practices
HWE.2.BP1: Specify the hardware architecture. Develop the hardware architecture that identifies the hardware components. Document the rationale for the defined hardware architecture. *Note 1: Examples for aspects reflected in the hardware architecture are ground concept, supply concept, EMC concept.* *Note 2: Examples for a design rationale can be implied by the reuse of a standard hardware, platform, or product line, respectively, or by a make-or-buy decision, or found in an evolutionary way.*
HWE.2.BP2: Specify the hardware detailed design. Based on components identified in the hardware architecture, specify the detailed design description and the schematics for the intended hardware variants, including the interfaces between the hardware elements. Derive the hardware layout, the hardware bill of materials, and the production data. *Note 3: The identification of hardware parts and their suppliers in the hardware bill of materials may be subject to a pre-defined repository (see also IATF 16949:2016, clause 8.4.1.2.).* *Note 4: Hardware detailed design may be subject to constraints such as availability of hardware parts on the market, hardware design rules, layout rules, creepage and clearance distances, compliance of HW parts with industry standards such as AEC-Q, REACH.*
HWE.2.BP3: Specify dynamic aspects. Evaluate and document the dynamic behavior of the relevant hardware elements and the interaction between them. *Note 5: Not all hardware elements have dynamic behavior that needs to be described.*

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其目的是：提供已分析的（包括动态方面），与硬件需求一致且适合制造的设计，并导出生产相关的数据。
过程成果
1) 开发了硬件架构与硬件详细设计，确定了硬件要素、并描述了它们的行为和接口，以及硬件要素之间的动态交互； 2) 分析了硬件架构和硬件详细设计，并识别了其特殊特性； 3) 建立了硬件需求与硬件设计间的一致性与双向可追溯性； 4) 根据硬件详细设计导出了硬件的生产数据，并与所有受影响方进行了沟通； 5) 根据硬件详细设计导出了产品测试信息，并与所有受影响方进行了沟通； 6) 与所有受影响方沟通了约定的硬件架构、硬件详细设计及特殊特性。

基本实践
HWE.2.BP1:定义硬件架构。开发硬件架构，其中识别硬件组件。记录已定义硬件架构的依据。 *注 1：能反映硬件架构层面的示例包括接地概念、供电概念，EMC 概念。* *注 2：设计依据的示例可以分别蕴含于标准硬件、平台或产品线的重用，或由自制或外购（make-or-buy）的决策，或以演变的方式进行呈现。*
HWE.2.BP2:定义硬件详细设计。 基于硬件架构中识别的组件，定义预期硬件变体的详细设计与原理图，包括硬件要素之间的接口。导出硬件布局图、硬件物料清单及生产数据。 *注 3：硬件物料清单中硬件元器件及其供应商的识别可能受预定义库的影响。（另见 IATF 16949:2016 第 8.4.1.2 条）。* *注 4：硬件详细设计可能会受到一些限制，诸如市场上硬件元器件的可用性、硬件设计规则、布局规则、爬电距离及电气间隙、硬件元器件是否符合诸如 AEC-Q, REACH 等行业标准。*
HWE.2.BP3:定义动态的方面。评估并文档化相关硬件要素的动态行为及各要素间的交互作用。 *注 5：不是所有的硬件要素都有需要被描述的动态行为。*

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HWE.2.BP4: Analyze the hardware architecture and the hardware detailed design. Analyze the hardware architecture and hardware detailed design regarding relevant technical aspects, and support project management regarding project estimates. Identify special characteristics. *Note 6: Examples for technical aspects are manufacturability for production, suitability of pre-existing hardware components to be reused, or availability of hardware elements.* *Note 7: Examples of methods suitable for analyzing technical aspects are simulations, calculations, quantitative or qualitative analyses such as FMEA.*
HWE.2.BP5: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish traceability between hardware elements and hardware requirements. Ensure consistency and establish traceability between the hardware detailed design and components of the hardware architecture. *Note 8: There may be non-functional hardware requirements that the hardware design does not trace to. Examples are development process requirements. Such requirements are still subject to verification.* *Note 9: Bidirectional traceability further supports consistency, and facilitates impact analysis of change requests, and demonstration of verification coverage. Traceability alone, e.g, the existence of links, does not necessarily mean that the information is consistent with each other.*
HWE.2.BP6: Communicate agreed hardware architecture and hardware detailed design. Communicate the agreed hardware architecture and the hardware detailed design, including the special characteristics and relevant production data, to all affected parties.

HWE.2 Hardware Design	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6
Output Information Items						
04-52 Hardware Architecture	X					
04-53 Hardware Detailed Design	X					
15-51 Analysis Results		X				
13-51 Consistency Evidence			X			
17-57 Special Characteristics		X				
13-52 Communication Evidence						X
04-54 Hardware Schematics	X			X	X	
14-54 Hardware Bill of Materials	X			X	X	
04-55 Hardware Layout	X			X	X	
03-54 Hardware Production Data	X			X	X	

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HWE.2.BP4: 分析硬件架构和硬件详细设计。就相关技术方面分析硬件架构和硬件详细设计，并支持项目管理的项目估算。识别特殊特性。

- *注 6：技术方面的示例如，生产的可制造性、被重用的既有硬件组件的适用性、或硬件元器件的可用性。*
- *注 7：适用于分析技术方面的方法的示例如，仿真、计算、定量或定性分析，如 FMEA。*

HWE.2.BP5:确保一致性和建立双向可追溯性。确保硬件要素与硬件需求之间的一致性并建立可追溯性。确保硬件详细设计与硬件架构中的组件之间的一致性并建立可追溯性。

- *注 8:可能存在硬件设计无法追溯的非功能性硬件需求。例如开发过程需求。这些需求仍然需要验证。*
- *注 9：双向可追溯性支持一致性，并有助于对变更请求的影响分析和验证覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。*

HWE.2.BP6:沟通约定的硬件架构和硬件详细设计。与所有受影响方沟通约定的硬件架构和硬件详细设计，包括特殊特性和相关生产数据。

HWE.2 硬件设计	成果 1	成果 12	成果 3	成果 4	成果 5	成果 6
输出信息项						
04-52 硬件架构	X					
04-53 硬件详细设计	X					
15-51 分析结果		X				
13-51 一致性证据			X			
17-57 特殊特性		X				
13-52 沟通证据						X
04-54 硬件原理图	X			X	X	
14-54 硬件物料清单	X			X	X	
04-55 硬件布局图	X			X	X	
03-54 硬件生产数据	X			X	X	

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04-56 Hardware Element Interface	X					
Base Practices						
BP1: Specify the hardware architecture	X			X	X	
BP2: Specify the hardware detailed design	X			X	X	
BP3: Specify dynamic aspects	X					
BP4: Analyze the hardware architecture and the hardware detailed design		X				
BP5: Ensure consistency and establish bidirectional traceability			X			
BP6: Communicate agreed hardware architecture and hardware detailed design				X	X	X

4.7.3. HWE.3 Verification against Hardware Design

Process ID
HWE.3
Process name
Verification against Hardware Design
Process purpose
The purpose is to ensure that the production data compliant hardware is verified to provide evidence for compliance with the hardware design.
Process outcomes
1) Verification measures are specified for verification of the hardware against the hardware design, including the interfaces between hardware elements and the dynamic aspects. 2) Verification measures are selected according to the release scope-considering criteria, including criteria for regression verification. 3) Verification is performed on production data compliant samples using the selected verification measures, and verification results are recorded. 4) Consistency and bidirectional traceability are established between hardware elements and verification measures. 5) Bidirectional traceability is established between verification measures and verification results. 6) Verification results are summarized and communicated to all affected parties.

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04-56 硬件要素接口	X					
基本实践						
BP1: 定义硬件架构	X			X	X	
BP2: 定义硬件详细设计	X			X	X	
BP3: 定义动态的方面	X					
BP4: 分析硬件架构和硬件详细设计		X				
BP5: 确保一致性和建立双向可追溯性			X			
BP6: 沟通约定的硬件架构和硬件详细设计				X	X	X

4.7.3. HWE.3 硬件设计验证

过程 ID
HWE.3
过程名称
硬件设计验证
过程目的
其目的是：确保符合生产数据的硬件得到验证，以提供符合硬件设计的证据。
过程成果
1) 定义了依照硬件设计对硬件进行验证的验证措施，包括硬件要素间接口以及动态方面； 2) 根据发布范围并考虑准则（包括回归验证准则），选择了验证措施； 3) 使用选定的验证措施对符合生产数据的样件进行了验证，并记录了验证结果； 4) 建立了硬件要素与验证措施之间的一致性和双向可追溯性； 5) 建立了验证措施与验证结果之间的双向可追溯性； 6) 总结了验证结果，并与所有受影响方沟通。

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Base Practices

HWE.3.BP1: Specify verification measures for the verification against hardware design. Specify the verification measures suitable to provide evidence for compliance of the hardware with the hardware design and its dynamic aspects. This includes

- techniques for the verification measures,
- pass/fail criteria for the verification measures,
- a definition of entry and exit criteria for the verification measures,
- necessary sequence of the verification measures, and
- the required verification infrastructure and environment setup.

Note 1: Examples on what a verification measure may focus on are the timeliness and timing dependencies of the correct signal flow between interfacing hardware elements, interactions between hardware components.

Note 2: Measuring points can be used for stepwise testing of hardware elements.

HWE.3.BP2: Ensure use of compliant samples. Ensure that the samples used for verification against hardware design are compliant with the corresponding production data, including special characteristics. Ensure that deviations are documented and that they do not alter verification results.

Note 3: Examples of compliance are sample reports, record of visual inspection, ICT report.

HWE.3.BP3: Select verification measures. Document the selection of verification measures considering selection criteria including regression criteria. The documented selection of verification measures shall have sufficient coverage according to the release scope.

Note 4: Examples for selection criteria can be prioritization of requirements, the need for regression due to changes to the hardware design, or the intended use of the delivered hardware release (e.g., test bench, test track, public road etc.)

HWE.3.BP4: Verify hardware design. Verify the hardware design using the selected verification measures. Record the verification results including pass/fail status and corresponding verification measure output data.

Note 5: See SUP.9 for handling of non-conformances.

HWE.3.BP5: Ensure consistency and establish bidirectional traceability. Ensure consistency and establish bidirectional traceability between hardware elements and the verification measures. Establish bidirectional traceability between the verification measures and verification results.

Note 6: Bidirectional traceability supports consistency, and facilitates impact analysis of change requests, and demonstration of verification coverage. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.

HWE.3.BP6: Summarize and communicate results. Summarize the verification results and communicate them to all affected parties.

Note 7: Providing all necessary information from the test case execution in a summary enables other parties to judge the consequences.

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基本实践
HWE.3.BP1: 依照硬件设计，定义验证的验证措施。定义验证措施，以适于提供硬件符合硬件设计及其动态方面的证据。包括： • 验证措施的技术， • 验证措施的通过/失败准则， • 验证措施的准入和准出准则， • 验证措施的必要顺序， • 所需的验证基础设施和环境搭建。 *注 1: 验证措施可能关注的示例包括硬件要素接口之间正确信号流的时效和时序依赖性，以及硬件组件之间的交互。* *注 2: 测量点可用于硬件要素的逐步测试。*
HWE.3.BP2: 确保使用符合要求的样件。确保用于验证硬件设计的样件符合相应的生产数据，包括特殊特性。确保偏差得到记录，并且不会改变验证结果。 *注 3: 符合性的示例如，样件报告、目视检测记录、ICT 报告。*
HWE.3.BP3: 选择验证措施。考虑选择准则（包括回归验证准则），记录验证措施选择。所记录的验证措施选择应根据发布范围具备足够的覆盖率。 *注 4: 选择准则的示例可以是需求优先级，由于硬件设计更改而导致的回归验证需要，或交付硬件发布的预期用途（例如，测试台架、测试跑道、公共道路等）。*
HWE.3.BP4: 验证硬件设计。使用选定的验证措施来验证硬件设计。记录验证结果，包括通过/失败状态以及相应验证措施的输出数据。 *注 5: 不符合项的处理，参见 SUP.9。*
HWE.3.BP5: 确保一致性和建立双向可追溯性。确保硬件要素与验证措施之间的一致性并建立双向可追溯性。建立验证措施与验证结果之间的双向可追溯性。 *注 9：双向可追溯性支持一致性，并有助于对变更请求的影响分析和验证覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。*
HWE.3.BP6: 总结和沟通结果。总结验证结果，并与所有受影响方沟通。 *注 7：在总结中提供来自测试用例执行的所有必要信息，以便其他方可以判断结果。*

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HWE.3 Verification against Hardware Design	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6
Output Information Items						
08-60 Verification Measure	X					
03-50 Verification Measure Data			X			
08-58 Verification Measure Selection Set		X				
15-52 Verification Results			X			
13-51 Consistency Evidence				X	X	
13-52 Communication Evidence						X
Base Practices						
BP1: Specify verification measures for the verification against hardware design	X					
BP2: Ensure use of compliant samples			X			
BP3: Select verification measures		X				
BP4: Verify hardware design			X			
BP5: Ensure consistency and establish bidirectional traceability				X	X	
BP6: Summarize and communicate results						X

4.7.4. HWE.4 Verification against Hardware Requirements

Process ID
HWE.4
Process name
Verification against Hardware Requirements
Process purpose
The purpose is to ensure that the complete hardware is verified to be consistent with the hardware requirements.

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HWE.3 硬件设计验证	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6
输出信息项						
08-60 验证措施	X					
03-50 验证措施数据			X			
08-58 验证措施选择集		X				
15-52 验证结果			X			
13-51 一致性证据				X	X	
13-52 沟通证据						X
基本实践						
BP1: 依照硬件设计，定义验证的验证措施	X					
BP2: 确保使用符合要求的样件			X			
BP3: 选择验证措施		X				
BP4: 验证硬件设计			X			
BP5: 确保一致性和建立双向可追溯性				X	X	
BP6: 总结和沟通结果						X

4.7.4. HWE.4 硬件需求验证

过程 ID
HWE.4
过程名称
硬件需求验证
过程目的
其目的是：确保完成的硬件得到验证且与硬件需求相一致。

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Process outcomes
1) Verification measures are specified for verification of the hardware against the hardware requirements. 2) Verification measures are selected considering criteria, including criteria for regression verification. 3) Verification is performed, if applicable on production data compliant samples, using the selected verification measures, and verification results are recorded. 4) Consistency and bidirectional traceability are established between verification measures and hardware requirements. 5) Bidirectional traceability is established between verification measures and verification results. 6) Verification results are summarized and communicated to all affected parties.

Base Practices
HWE.4.BP1: Specify verification measures for the verification against hardware requirements. Specify the verification measure to provide evidence for compliance with the hardware requirements. This includes • techniques for the verification measures, • pass/fail criteria for the verification measures, • a definition of entry and exit criteria for the verification measures, • necessary sequence of verification the measures, and • the required verification infrastructure and environment setup *Note 1: The verification measures may cover aspects such as thermal, environmental, robustness/lifetime, and EMC.*
HWE.4.BP2: Ensure use of compliant samples. Ensure that the samples used for the verification against hardware requirements are compliant with the corresponding production data, including special characteristics, provided by hardware design. *Note 2: Examples of compliance are sample reports, record of visual inspection, ICT report.*
HWE.4.BP3: Select verification measures. Document the selection of verification measures considering selection criteria including regression criteria. The documented selection of verification measures shall have sufficient coverage according to the release scope. *Note 3: Examples for selection criteria can be prioritization of requirements, the need for regression due to changes to the hardware requirements, or the intended use of the delivered hardware release (e.g, test bench, test track, public road etc.).*
HWE.4.BP4: Verify the compliant hardware samples. Verify the compliant hardware samples using the selected verification measures. Record the verification results including pass/fail status and corresponding verification measure output data. *Note 4: See SUP.9 for handling of non-conformances.*

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过程成果
1) 定义了硬件需求验证的验证措施； 2) 选择了验证措施，考虑包括回归验证准则的准则； 3) 使用选定的验证措施对符合生产数据的样件（如适用）执行了验证，并记录了验证结果； 4) 建立了验证措施与硬件需求之间的一致性和双向可追溯性； 5) 建立了验证措施与验证结果之间的双向可追溯性； 6) 总结了验证结果，并与所有受影响方沟通。

基本实践
HWE.4. BP1:定义硬件需求验证的验证措施。定义验证措施，以提供符合硬件需求的证据。该验证措施包括： • 验证措施的技术 • 验证措施的通过/失败准则 • 验证措施准入和准出准则 • 验证措施的必要顺序 • 所需的验证基础设施和环境搭建 *注 1: 验证措施可能覆盖例如热能，环境，鲁棒性/寿命，和 EMC。*
HWE.4.BP2:确保使用符合要求的样件。确保用于验证硬件需求的样件符合相应的生产数据，包括硬件设计提供的特殊特性。 *注 2: 符合性的示例如，样品报告，目视检查记录，ICT 报告。*
HWE.4.BP3:选择验证措施。文档化验证措施的选择，考虑包括回归准则的选择准则。文档化了的验证措施的选择应根据发布范围具备足够的覆盖度。 *注 3: 选择准则的示例可以是需求的优先级、由于硬件需求更改而导致的回归的要求或交付硬件发布的预期用途（例如，测试台架、测试跑道、公共道路等）*
HWE.4.BP4:验证符合要求的硬件样件。使用选定的验证措施来验证符合的硬件样件。记录验证结果，包括通过/失败状态以及相应验证措施的输出数据。 *注 4:不符合项的处理，参见 SUP.9。*

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HWE.4.BP5: Ensure consistency and establish bidirectional traceability. Ensure consistency between hardware requirements and verification measures. Establish bidirectional traceability between hardware requirements and verification measures. Establish bidirectional traceability between verification measures and verification results.

Note 5: Bidirectional traceability supports consistency, and facilitates impact analysis of change requests, and demonstration of verification coverage. Traceability alone, e.g., the existence of links, does not necessarily mean that the information is consistent with each other.

HWE.4.BP6: Summarize and communicate results. Summarize the verification results and communicate them to all affected parties.

Note 6: Providing all necessary information from the test case execution in a summary enables other parties to judge the consequences.

HWE.4 Verification against Hardware Requirements	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6
Output Information Items						
08-60 Verification Measure	X					
03-50 Verification Measure Data			X			
08-58 Verification Measure Selection Set		X				
15-52 Verification Results			X			
13-51 Consistency Evidence				X	X	
13-52 Communication Evidence						X
Base Practices						
BP1: Specify verification measures for the verification against hardware requirements	X					
BP2: Ensure use of compliant samples			X			
BP3: Select verification measures		X				
BP4: Verify hardware			X			
BP5: Ensure consistency and establish bidirectional traceability				X	X	
BP6: Summarize and communicate results						X

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HWE.4.BP5:确保一致性和建立双向可追溯性。确保硬件需求与验证措施之间的一致性。建立硬件需求与验证措施之间的双向可追溯性。建立验证措施与验证结果之间的双向可追溯性。

注 5:双向可追溯性支持一致性，并有助于对变更请求的影响分析和验证覆盖率的证明。仅有可追溯性本身（如存在两者之间的链接），并不一定意味着两者之间的信息是一致的。

HWE.4.BP6:总结和沟通结果。总结验证结果，并与所有受影响方沟通。

注 6:在总结中提供来自测试用例执行的所有必要信息，以便其他方可以判断结果。

HWE.4 硬件需求验证	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6
输出信息项						
08-60 验证措施	X					
03-50 验证措施数据			X			
08-58 验证措施选择集		X				
15-52 验证结果			X			
13-51 一致性证据				X	X	
13-52 沟通证据						X
基本实践						
BP1: 定义硬件需求验证的验证措施	X					
BP2: 确保使用符合要求的样件			X			
BP3: 选择验证措施		X				
BP4: 验证符合要求的硬件样件			X			
BP5: 确保一致性和建立双向可追溯性				X	X	
BP6: 总结和沟通结果						X

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4.8. Supporting process group (SUP)

4.8.1. SUP.1 Quality Assurance

Process ID
SUP.1
Process name
Quality Assurance
Process purpose
The purpose of the Quality Assurance Process is to provide independent and objective assurance that work products and processes comply with defined criteria and that non-conformances are resolved and further prevented.
Process outcomes
1) Quality assurance is performed independently and objectively without conflicts of interest. 2) Criteria for the quality of work products and process performance are defined. 3) Conformance of work products and process performance with the defined criteria and targets is verified, documented and communicated to the relevant parties. 4) Non-conformances are tracked, resolved, and further prevented. 5) Non-conformances are escalated to appropriate levels of management. 6) Management ensures that escalated non-conformances are resolved.

Base Practices
SUP.1.BP1: Ensure independence of quality assurance. Ensure that quality assurance is performed independently and objectively without conflicts of interest. *Note 1: Possible inputs for evaluating the independence may be assignment to financial and/or organizational structure as well as responsibility for processes that are subject to quality assurance (no self-monitoring).*
SUP.1.BP2: Define criteria for quality assurance. Define quality criteria for work products as well as for process tasks and their performance. *Note 2: Quality criteria may consider internal and external inputs such as customer requirements, standards, milestones, etc.*
SUP.1.BP3: Assure quality of work products. Identify work products subject to quality assurance according to the quality criteria. Perform appropriate activities to evaluate the work products against the defined quality criteria and document the results. *Note 3: Quality assurance activities may include reviews, problem analysis and lessons learned that improve the work products for further use.*

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4.8. 支持过程组（SUP）

4.8.1. SUP.1 质量保证

过程 ID
SUP.1
过程名称
质量保证
过程目的
其目的是：提供独立且客观的保证，使工作产品和过程符合已定义的准则，并使不符合项得到解决和进一步的预防。
过程成果
1) 独立且客观地执行了质量保证，没有利益冲突； 2) 定义了工作产品和过程实施的质量准则； 3) 验证、文档化并与相关方沟通了工作产品与过程活动与已定义准则的符合性； 4) 跟踪、解决并进一步预防了不符合项； 5) 将不符合项升级到了适当的管理层； 6) 管理层确保升级的不符合项得到了解决。

基本实践
SUP.1.BP1: 确保质量保证的独立性。确保独立且客观地执行了质量保证，没有利益冲突。 *注 1：对财务和/或组织架构，以及需要质量保证的过程（无自我监控）的职责的分配可作为评估独立性的输入。*
SUP.1.BP2: 定义质量保证准则。定义工作产品以及过程任务和其实施的质量准则。 *注 2：质量准则可考虑内部和外部的输入，例如，客户需求、标准、里程碑等。*
SUP.1.BP3: 确保工作产品的质量。根据质量准则，识别需要进行质量保证的工作产品。依照定义的质量准则，执行适当的活动，并记录结果。 *注 3：质量保证活动可包括评审、问题分析和以供后续工作产品改进使用的经验教训总结。*

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SUP.1.BP4: Assure quality of process activities. Identify processes subject to quality assurance according to the quality criteria. Perform appropriate activities to evaluate the processes against their defined quality criteria and associated target values and document the results.

NOTE 4: Quality assurance activities may include process assessments, problem analysis, regular check of methods, tools, and the adherence to defined processes, and consideration of lessons learned.

SUP.1.BP5: Summarize and communicate quality assurance activities and results. Regularly report performance, non-conformances, and trends of quality assurance activities to all affected parties.

SUP.1.BP6: Ensure resolution of non-conformances. Analyze, track, correct, resolve, and further prevent non-conformances found in quality assurance activities.

NOTE 5: Non-conformances detected in work products may be entered into the problem resolution management process (SUP.9).

NOTE 6: Non-conformances detected in the process definition or implementation may be entered into a process improvement process (PIM.3).

SUP.1.BP7: Escalate non-conformances. Escalate relevant non-conformances to appropriate levels of management and other relevant stakeholders to facilitate their resolution.

NOTE 7: The decision whether to escalate non-conformances may be based on criteria such as delay of resolution, urgency, and risk.

SUP.1 Quality Assurance	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6
Output Information Items						
16-50 Organizational structure	X				X	
18-52 Escalation path					X	X
18-07 Quality criteria		X	X	X		
13-52 Communication evidence			X	X	X	
13-18 Quality conformance evidence			X	X		
13-19 Review evidence			X	X		
14-02 Corrective action				X		X
Base Practices						
BP1: Ensure independence of quality assurance.	X					

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SUP.1.BP4: 确保过程活动的质量。根据质量准则，识别需要进行质量保证的过程。依照定义的质量准则和相关目标值，执行适当的活动以评估过程，并记录结果。

注 4：质量保证活动可包括过程评估、问题分析、对方法/工具/已定义过程遵守情况的定期检查，以及对经验教训的考虑。

SUP.1.BP5:总结和沟通质量保证活动和结果。定期向受影响方汇报质量保证活动的实施、不符合项和趋势。

SUP.1.BP6: 确保不符合项的解决。分析、跟踪、纠正、解决以及进一步预防质量保证活动中所发现的不符合项。

注 5：工作产品中识别的不符合项可以纳入问题解决管理过程（SUP.9）。

注 6：过程定义或实施中识别的不符合项可以纳入过程改进过程（PIM.3）。

SUP.1.BP7: 升级不符合项。升级相关的不符合项到适当的管理层和其他利益相关方，以促进其得到解决。

注 7：决定是否需要升级不符合项可基于诸如解决延迟、紧急性及风险的准则。

SUP.1 质量保证	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6
输出信息项						
16-50 组织架构	X				X	
18-52 升级路径					X	X
18-07 质量准则		X	X	X		
13-52 沟通证据			X	X	X	
13-18 质量符合性证据			X	X		
13-19 评审证据			X	X		
14-02 纠正措施				X		X
基本实践						
BP1: 确保质量保证的独立性	X					

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BP2: Define criteria for quality assurance.		X				
BP3: Assure quality of work products.			X	X		
BP4: Assure quality of process activities.			X	X		
BP5: Summarize and communicate quality assurance activities and results.			X	X	X	
BP6: Ensure resolution of non-conformances.				X		X
BP7: Escalate non-conformances.					X	X

4.8.2. SUP.8 Configuration Management

Process ID
SUP.8
Process name
Configuration Management
Process purpose
The purpose of the Configuration Management Process is to establish and maintain the integrity of relevant configuration items and baselines, and make them available to affected parties.
Process outcomes
1) Selection criteria for configuration items are defined and applied. 2) Configuration item properties are defined. 3) Configuration management is established. 4) Modifications are controlled. 5) Baselining is applied. 6) The status of the configuration items is recorded and reported. 7) The completeness and consistency of the baselines is ensured. 8) The availability of backup and recovery mechanisms is verified.

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BP2: 定义质量保证准则		X				
BP3: 确保工作产品的质量			X	X		
BP4: 确保过程活动的质量			X	X		
BP5: 总结和沟通质量保证活动和结果			X	X	X	
BP6: 确保不符合性的解决				X		X
BP7: 升级不符合项					X	X

4.8.2. SUP.8 配置管理

过程 ID
SUP.8
过程名称
配置管理
过程目的
其目的是：建立和维护相关配置项和基线的完整性，并使其对受影响方可用。
过程成果
1) 定义和应用了配置项的挑选准则； 2) 定义了配置项的属性； 3) 建立了配置管理； 4) 控制了修改； 5) 应用了基线； 6) 记录和汇报了配置项的状态； 7) 确保了基线的完整性和一致性； 8) 验证了备份和恢复机制的可用性。

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Base Practices
SUP.8.BP1: Identify configuration items. Define selection criteria for identifying relevant work products to be subject to configuration management. Identify and document configuration items according to the defined selection criteria. *NOTE 1: Configuration items are representing work products or group of work products which are subject to configuration management as a single entity.* *NOTE 2: Configuration items may vary in complexity, size, and type, ranging from an entire system including all system, hardware, and software documentation down to a single element or document.* *NOTE 3: The selection criteria may be applied to single work products or a group of work products.*
SUP.8.BP2: Define configuration item properties. Define the necessary properties needed for the modification and control of configuration items. *NOTE 4: The configuration item properties may be defined for single configuration items or a group of items.* *NOTE 5: Configuration item properties may include a status model (e.g., Under Work, Tested, Released, etc.), storage location, access rights, etc.* *NOTE 6: The application of properties may be implemented by attributes of configuration items.*
SUP.8.BP3: Establish configuration management. Establish configuration management mechanisms for control of identified configuration items including the configuration item properties, including mechanisms for controlling parallel modifications of configuration items. *NOTE 7: This may include specific mechanisms for different configuration item types, such as branch and merge management, or checkout control.*
SUP.8.BP4: Control modifications. Control modifications using the configuration management mechanisms. *NOTE 8: This may include the application of a defined status model for configuration items.*
SUP.8.BP5: Establish baselines. Define and establish baselines for internal purposes, and for external product delivery, for all relevant configuration items.
SUP.8.BP6: Summarize and communicate configuration status. Record, summarize, and communicate the status of configuration items and established baselines to affected parties in order to support the monitoring of progress and status. *NOTE 9: Regular communication of the configuration status, e.g., based on a defined status model supports project management, quality activities, and dedicated project phases such as software integration.*
SUP.8.BP7: Ensure completeness and consistency. Ensure that the information about configuration items is correct and complete including configuration item properties. Ensure the completeness and consistency of baselines. *NOTE 10: Completeness and consistency of a baseline means that all required configuration items are included and consistent, and have the required status. This can be used to support e.g., project gate approval.*

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基本实践
SUP.8.BP1: 识别配置项。定义选择准则，用于识别需要进行配置管理的相关工作产品。根据定义的选择准则，识别和记录配置项。 *注 1：配置项是代表工作产品或工作产品组，需要进行配置管理的单一实体。* *注 2：配置项在复杂度、大小和类型方面可能不同，范围从包含所有系统、硬件和软件文档的完整系统到单个要素或文档。* *注 3：选择准则可以应用于单个工作产品或一组工作产品。*
SUP.8.BP2: 定义配置项属性。定义配置项修改和控制的所需的必要属性。 *注 4：可以为单个配置项或一组配置项定义配置项属性。* *注 5：配置项属性可包括一个状态模型（例如，工作中、已测试、已发布等）、存储位置、访问权限等。* *注 6：属性的应用可以通过配置项属性来实施。*
SUP.8.BP3: 建立配置管理。建立配置管理机制（包括控制配置项并行修改的机制），用于控制已识别的配置项（含配置项属性）。 *注 7：这可能包括不同配置项类型的特定机制，例如，分支和合并管理，或检出控制。*
SUP.8.BP4: 控制修改。使用配置管理机制控制修改。 *注 8：这可能包括定义的配置项状态模型的应用。*
SUP.8.BP5:建立基线。对所有关连的配置项，定义和建立用于内部目的和外部产品交付的基线。
SUP.8.BP6: 总结和沟通配置状态。记录、总结和与受影响方沟通配置项和已建立基线的状态，以支持进展和状态的监控。 *注 9：配置状态（例如，基于定义的状态模型）的定期沟通支持项目管理、质量活动和特定的项目阶段（如软件集成）。*
SUP.8.BP7: 确保完整性和一致性。确保配置项相关信息（包括配置项属性）是正确的和完整的。确保基线的完整性和一致性。 *注 10：基线的完整性和一致性意味着所有所需的配置项都包括在内并保持一致，并且具备所需的状态。这可用于支持，例如，项目阀点审批。*

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SUP.8.BP8: Verify backup and recovery mechanisms availability. Verify the availability of appropriate backup and recovery mechanisms for the configuration management including the controlled configuration items. Initiate measures in case of insufficient backup and recovery mechanisms.

NOTE 11: Backup and recovery mechanisms may be defined and implemented by organizational units outside the project team. This may include references to corresponding procedures or regulations.

SUP.8 Configuration Management	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6	Outcome 7	Outcome 8
Output Information Items								
18-53 Configuration item selection criteria	X							
01-52 Configuration item list	X	X					X	
16-03 Configuration management system			X	X	X			
13-08 Baseline					X		X	
14-01 Change history			X	X		X		
15-56 Configuration status						X		
13-51 Consistency Evidence							X	
06-52 Backup and recovery mechanism information								X
Base Practices								
BP1: Identify configuration items	X							
BP2: Define configuration item properties		X						
BP3: Establish configuration management			X	X				
BP4: Control modifications				X				
BP5: Establish baselines					X			
BP6: Summarize and communicate configuration status						X		
BP7: Ensure completeness and consistency							X	
BP8: Verify backup and recovery mechanisms availability								X

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SUP.8.BP8: 验证备份和恢复机制的可用性。验证配置管理（包括受控的配置项）适当的备份和恢复机制的可用性。在备份和恢复机制不充分时采取措施。

注 11：备份和恢复机制可能由项目外的组织单位进行定义和实施。这可包括对相关程序和法规的引用。

SUP.8 配置管理	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6	成果 7	成果 8
输出信息项								
18-53 配置项选择准则	X							
01-52 配置项清单	X	X					X	
16-03 配置管理系统			X	X	X			
13-08 基线					X		X	
14-01 变更历史			X	X		X		
15-56 配置状态						X		
13-51 一致性证据							X	
06-52 备份和恢复机制信息								X
基本实践								
BP1: 识别配置项	X							
BP2: 定义配置项属性		X						
BP3: 建立配置管理			X	X				
BP4: 控制修改				X				
BP5: 建立基线					X			
BP6: 总结和沟通配置状态						X		
BP7: 确保完整性和一致性							X	
BP8: 验证备份和恢复机制的可用性								X

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4.8.3. SUP.9 Problem Resolution Management

Process ID
SUP.9
Process name
Problem Resolution Management
Process purpose
The purpose of the Problem Resolution Management Process is to ensure that problems are identified, recorded, analyzed, and their resolution is managed and controlled.
Process outcomes
1) Problems are uniquely identified, recorded and classified. 2) Problems are analyzed and assessed to determine an appropriate solution. 3) Problem resolution is initiated. 4) Problems are tracked to closure. 5) The status of problems including trends identified are reported to stakeholders.

Base Practices
SUP.9.BP1: Identify and record the problem. Each problem is uniquely identified, described and recorded**.** A status is assigned to each problem to facilitate tracking. Supporting information is provided to reproduce and diagnose the problem. *NOTE 1: Problems may relate to e.g., product, resources, or methods.* *NOTE 2: Example values for the problem status are "new", "solved", "closed", etc.* *NOTE 3: Supporting information may include e.g, the origin of the problem, how it can be reproduced, environmental information, by whom it has been detected.* *NOTE 4: Unique identification supports traceability to changes made as needed by the change request management process (SUP.10).*
SUP.9.BP2: Determine the cause and the impact of the problem. Analyze the problem, determine its cause, including common causes if existing, and impact. Involve relevant parties. Categorize the problem. *NOTE 5: Problem categorization (e.g., light, medium, severe) may be based on severity, criticality, urgency, etc.*
SUP.9.BP3: Authorize urgent resolution action. Obtain authorization for immediate action if a problem requires an urgent resolution according to the categorization.

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4.8.3. SUP.9 问题解决管理

过程 ID
SUP.9
过程名称
问题解决管理
过程目的
其目的是：确保问题被识别、记录、分析、并对其解决进行管理和控制。
过程成果
1) 对问题进行了唯一标识、记录和分类； 2) 分析和评估了问题以确定适当的解决方案； 3) 启动了问题解决； 4) 跟踪了问题直至关闭； 5) 向利益相关方报告了问题的状态，包括所识别的趋势。

基本实践
SUP.9.BP1: 识别和记录问题。每个问题都被唯一识别、描述和记录。 给每个问题分配状态以便跟踪。提供支持信息以重现和诊断问题。 *注 1：问题可能与例如产品、资源或方法有关。* *注 2：问题状态的示例值如，"新建"、"已解决"、"已关闭"等。* *注 3：支持信息可包括例如问题的起源、问题如何重现、环境信息、问题发现者等。* *注 4：唯一标识有助于变更请求管理过程（SUP.10）所需的变更追溯性。*
SUP.9.BP2: 确定问题的原因和影响。分析问题，确定其原因，包括共性原因（如果存在）和影响。让相关方参与进来。对问题进行分类。 *注 5：可基于严重度、关键性、紧急性等，对问题分类（例如：轻度、中度、重度）。*
SUP.9.BP3: 授权紧急解决行动。根据分类，如果问题需要进行紧急解决，获得立即采取行动的授权。

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SUP.9.BP4: Raise alert notifications. If according to the categorization the problem has a high impact on other systems or other affected parties, an alert notification needs to be raised accordingly.

SUP.9.BP5: Initiate problem resolution. Initiate appropriate actions according to the categorization to resolve the problem long-term, including review of those actions or initiate a change request. This includes synchronization and consistency with short-term urgent resolution actions, if applicable.

SUP.9.BP6: Track problems to closure. Track the status of problems to closure including all related change requests. The closure of problems is accepted by relevant stakeholders.

SUP.9.BP7: Report the status of problem resolution activities. Collect and analyze problem resolution management data, identify trends, and initiate related actions. Regularly report the results of data analysis, the identified trends and the status of problem resolution activities to relevant stakeholders.

NOTE 6: Collected data may contain information about where the problems occurred, how and when they were found, what their impacts were, etc.

SUP.9 Problem Resolution Management	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5
Output Information Items					
13-07 Problem	X	X	X	X	
15-55 Problem analysis evidence		X			
15-12 Problem status					X
Base Practices					
BP1: Identify and record the problem	X			X	
BP2: Determine the cause and the impact of the problem	X	X			
BP3: Authorize urgent resolution action			X		
BP4: Raise alert notifications			X		
BP5: Initiate problem resolution			X		
BP6: Track problems to closure				X	X
BP7: Report the status of problem resolution activities					X

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SUP.9.BP4: 发出警报通知。根据分类，如果问题对于其他系统或其他受影响方有较大的影响，则需要相应地发出警报通知。
SUP.9.BP5: 启动问题解决。根据分类发起适当的行动 (包括对行动的评审或发起变更请求) 以长期解决问题。这包括与短期紧急解决行动的同步和一致性（如适用）。
SUP.9.BP6: 跟踪问题直至关闭。跟踪问题的状态（包括所有相关的变更请求）直至关闭。相关的利益相关方接受问题的关闭。
SUP.9.BP7: 报告问题解决活动的状态。收集和分析问题解决管理数据，识别趋势，并发起相关的行动。定期向相关的利益相关方报告数据分析的结果、识别的趋势和问题解决活动的状态。 *注 6：收集的数据可以包含的信息有：问题是在哪里发生的、是如何及何时被发现的、有什么影响等。*

SUP.9 问题解决管理	成果 1	成果 2	成果 3	成果 4	成果 5
输出信息项					
13-07 问题	X	X	X	X	
15-55 问题分析证据		X			
15-12 问题状态					X
基本实践					
BP1: 识别和记录问题	X			X	
BP2: 确定问题的原因和影响	X	X			
BP3: 授权紧急解决行动			X		
BP4: 发出警报通知			X		
BP5: 启动问题解决			X		
BP6: 跟踪问题直至关闭				X	X
BP7: 报告问题解决活动的状态					X

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4.8.4. SUP.10 Change Request Management

Process ID
SUP.10
Process name
Change Request Management
Process purpose
The purpose of the Change Request Management Process is to ensure that change requests are recorded, analyzed, tracked, approved, and implemented.
Process outcomes
1) Requests for changes are recorded and identified. 2) Change requests are analyzed, dependencies and relationships to other change requests are identified, and the impact is estimated. 3) Change requests are approved before implementation and prioritized accordingly. 4) Bidirectional traceability is established between change requests and affected work products. 5) Implementation of change requests is confirmed. 6) Change requests are tracked to closure and status of change requests is communicated to affected parties.

Base Practices
SUP.10.BP1: Identify and record the change requests. The scope for application of change requests is identified. Each change request is uniquely identified, described, and recorded, including the initiator and reason of the change request. A status is assigned to each change request to facilitate tracking. *NOTE 1: Change requests may be used for changes related to e.g., product, process, methods.* *NOTE 2: Example values for the change request status are "open", "under investigation", "implemented", etc.* *NOTE 3: The change request handling may differ across the product life cycle e.g., during prototype construction and series development*
SUP.10.BP2: Analyze and assess change requests. Change requests are analyzed by relevant parties according to analysis criteria. Work products affected by the change request and dependencies to other change requests are determined. The impact of the change requests is assessed. *NOTE 4: Examples for analysis criteria are: resource requirements, scheduling issues, risks, benefits, etc.*
SUP.10.BP3: Approve change requests before implementation. Change requests are prioritized and approved for implementation based on analysis results and availability of resources. *NOTE 5: A Change Control Board (CCB) is an example mechanism used to approve change requests.* *NOTE 6: Prioritization of change requests may be done by allocation to releases.*

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4.8.4. SUP.10 变更请求管理

过程 ID
SUP.10
过程名称
变更请求管理
过程目的
其目的是：确保变更请求被记录、分析、跟踪、批准和实施。
过程成果
1) 记录和识别了变更请求； 2) 分析了变更请求，识别了与其它变更请求之间的依赖与关系，并估算了影响； 3) 在实施前批准了变更请求并相应地确定了优先级； 4) 建立了变更请求与受影响工作产品之间的双向可追溯性； 5) 确认了变更请求的实施； 6) 跟踪了变更请求直至关闭，并与受影响方沟通了变更请求的状态。

基本实践
SUP.10.BP1: 识别和记录变更请求。对变更请求的适用范围进行了识别。每个变更请求被唯一标识、描述和记录，包括变更请求的发起者和原因。为每个变更请求分配一个状态以便于跟踪。 *注 1：变更请求可用于例如与产品、过程、方法等相关的变更。* *注 2：变更请求状态的示例如，“未解决”、“调查中”、“已实施”等。* *注 3：变更请求的处理可在产品生命周期中有所不同，例如，在原型构建和量产开发中*
SUP.10.BP2: 分析和评估变更请求。相关方根据分析准则对变更请求进行分析。确定受变更请求影响的工作产品以及对其他变更请求的依赖关系。评估变更请求的影响。 *注 4：分析准则的示例如，资源需求、时间进度问题、风险、收益等。*
SUP.10.BP3: 在实施前批准变更请求。基于分析结果和资源可用性，确定变更请求的优先级并批准实施。 *注 5：通过变更控制委员会（CCB）批准变更请求是一种示例机制。* *注 6：变更请求的优先级可通过分配变更到不同的发布来体现。*

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SUP.10.BP4: Establish bidirectional traceability. Establish bidirectional traceability between change requests and work products affected by the change requests. In case that the change request is initiated by a problem, establish bidirectional traceability between change requests and the corresponding problem reports.

SUP.10.BP5: Confirm the implementation of change requests. The implementation of change requests is confirmed before closure by relevant stakeholders.

SUP.10.BP6: Track change requests to closure. Change requests are tracked to closure. The status of change requests is communicated to all affected parties.

NOTE 7: Examples for informing affected parties can be daily standup meetings or tool-supported workflows.

SUP.10 Change Request Management	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6
Output Information Items						
18-57 Change analysis criteria		X				
13-16 Change request	X	X	X		X	X
13-51 Consistency evidence				X		
Base Practices						
BP1: Identify and record the change requests	X					
BP2: Analyze and assess change requests		X				
BP3: Approve change requests before implementation			X			
BP4: Establish bidirectional traceability				X		
BP5: Confirm the implementation of change requests					X	
BP6: Track change requests to closure						X

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SUP.10.BP4: 建立双向可追溯性。建立变更请求与受变更请求影响的工作产品之间的双向可追溯性。如果变更请求是由问题所导致的，在变更请求与对应的问题报告之间建立双向可追溯性。
SUP.10.BP5: 确认变更请求的实施。在关闭前，由相关的利益相关方确认变更请求的实施。
SUP.10.BP6: 跟踪变更请求直至关闭。跟踪变更请求直至关闭。与所有受影响方沟通变更请求的状态。 *注 7：通知受影响方的示例可以是每日站会或工具支持的工作流程。*

SUP.10 变更请求管理	成就 1	成就 2	成就 3	成就 4	成就 5	成就 6
输出信息项						
18-57 变更分析准则		X				
13-16 变更请求	X	X	X		X	X
13-51 一致性证据				X		
基本实践						
BP1: 识别和记录变更请求	X					
BP2: 分析和评估变更请求		X				
BP3: 在实施前批准变更请求			X			
BP4: 建立双向可追溯性				X		
BP5: 确认变更请求的实施					X	
BP6: 跟踪变更请求直至关闭						X

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4.8.6. SUP.11 Machine Learning Data Management

Process ID
SUP.11
Process name
Machine Learning Data Management
Process purpose
The purpose is to define and align ML data with ML data requirements, maintain the integrity and quality of the ML data, and make them available to affected parties.
Process outcomes
1) A ML data management system including an ML data lifecycle is established. 2) A ML data quality approach is developed including ML data quality criteria. 3) Collected ML data are processed for consistency with ML data requirements. 4) ML data are verified against defined ML data quality criteria and updated as needed. 5) ML data are agreed and communicated to all affected parties.

Base Practices
SUP.11.BP1: Establish an ML data management system. Establish an ML data management system which supports • ML data management activities, • relevant sources of ML data, • ML data life cycle including a status model, and • interfaces to affected parties. *Note 1: Supported ML data management activities may include data collection, labeling/annotation, and structuring.*

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4.8.6. SUP.11 机器学习数据管理

过程 ID
SUP.11
过程名称
机器学习数据管理
过程目的
其目的是：定义机器学习数据并与机器学习数据需求相一致，维护机器学习数据的完整性和质量，并提供给受影响方。
过程成果
1) 建立了 ML 数据管理系统，包括 ML 数据生命周期； 2) 开发了 ML 数据质量方法，包括 ML 数据质量准则； 3) 处理了收集的 ML 数据，使其与 ML 数据需求相一致； 4) 根据定义的 ML 数据质量准则，验证了 ML 数据，并根据需要对其进行了更新； 5) 约定了 ML 数据，并与所有受影响方沟通。

基本实践
SUP.11.BP1:建立 ML 数据管理系统。建立 ML 数据管理系统，其支持 • ML 数据管理活动， • ML 数据相关来源， • ML 数据生命周期，包括状态模型和 • 受影响方接口。 *注 1: 支持的 ML 数据管理活动可包含数据收集，标签/标注和结构化。*

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SUP.11.BP2: Develop an ML data quality approach. Develop an approach to ensure that the quality of ML data is analyzed based on defined ML data quality criteria and activities are performed to support avoidance of biases of data. *Note 2: Examples of ML data quality criteria are relevant data sources, reliability and consistency of labelling, completeness against ML data requirements.* *Note 3: The ML data management system should support the quality criteria and activities of the ML data quality approach.* *Note 4: Biases to avoid may include sampling bias (e.g., gender, age) and feedback loop bias.* *Note 5: For creation of ML data sets see MLE.3.BP2 and MLE.4.BP2.*
SUP.11.BP3: Collect ML data. Relevant sources for raw data are identified and continuously monitored for changes. The raw data is collected according to the ML data requirements. *Note 6: The identification and collection of ML data might be an organizational responsibility.* *Note 7: Continuous monitoring should include the ODD and may lead to changes of the ML requirements.*
SUP.11.BP4: Process ML data. The raw data are processed (annotated, analyzed, and structured) according to the ML data requirements.
SUP.11.BP5: Assure quality of ML data. Perform the activities according to the ML data quality approach to ensure that the ML data meets the defined ML data quality criteria. *Note 8: These activities may include sample-based reviews or statistical methods.*
SUP.11.BP6: Communicate agreed processed ML data. Inform all affected parties about the agreed processed ML data and provide them to the affected parties.

SUP.11 Machine Learning Data Management	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5
Output Information Items					
16-52 ML data management system	X				
19-50 ML data quality approach		X			
03-53 ML data			X	X	
13-52 Communication evidence					X

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SUP.11.BP2:开发 ML 数据质量方法。

开发一种方法，以确保基于定义的 ML 数据质量准则对 ML 数据的质量进行分析，以及支持避免数据偏差的活动得到执行。

- *注 2: ML 数据质量准则的示例如，相关数据来源，标签的可靠性和一致性，相对于 ML 数据需求的完整性。*
- *注 3: ML 数据管理系统应支持质量准则和 ML 数据质量方法的活动。*
- *注 4: 需避免的偏差包括采样偏差（例如：性别，年龄）和反馈环偏差。*
- *注 5: ML 数据集的创建，见 MLE.3.BP2 和 MLE.4.BP2。*

SUP.11.BP3:收集 ML 数据。识别原始数据相关来源，并持续监控变更。根据 ML 数据需求，收集原始数据。

- *注 6: ML 数据的识别和收集可以是组织上的职责。*
- *注 7: 持续监控应包括 ODD，并且可能导致对 ML 需求的变更。*

SUP.11.BP4: 处理 ML 数据。根据 ML 数据需求，对原始数据进行处理（标注，分析和结构化）。

SUP.11.BP5: 保证 ML 数据质量。根据 ML 数据质量方法，执行活动以确保 ML 数据符合 ML 数据质量准则。

- *注 8: 这些活动可包括基于样品的评审或者统计学方法。*

SUP.11.BP6: 沟通约定的已处理的 ML 数据。通知并提供给所有受影响方约定的已处理的 ML 数据。

SUP.11 机器学习数据管理		成果 2	成果 3	成果 4	成果 5
输出信息项					
16-52 ML 数据管理系统	X				
19-50 ML 数据质量方法		X			
03-53 ML 数据			X	X	
13-52 沟通证据					X

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Base Practices					
BP1: Establish an ML data management system	X				
BP2: Develop an ML data quality approach		X			
BP3: Collect ML data			X		
BP4: Process ML data			X		
BP5: Assure quality of ML data				X	
BP6: Communicate agreed processed ML data					X

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基本实践					
BP1: 建立 ML 数据管理系统	X				
BP2: 开发 ML 数据质量方法		X			
BP3: 收集 ML 数据			X		
BP4: 处理 ML 数据			X		
BP5: 保证 ML 数据质量				X	
BP6: 沟通约定的已处理的 ML 数据					X

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4.9. Management process group (MAN)

4.9.1. MAN.3 Project Management

Process ID
MAN.3
Process name
Project Management
Process purpose
The purpose is to identify and control the activities, and establish resources necessary for a project to develop a product, in the context of the project's requirements and constraints.
Process outcomes
1) The scope of the work for the project is defined. 2) The feasibility of achieving the goals of the project with available resources and constraints is evaluated. 3) The activities and resources necessary to complete the work are sized and estimated. 4) Interfaces within the project, and with other projects and organizational units, are identified and monitored. 5) Plans for the execution of the project are developed, implemented and maintained. 6) Progress of the project is monitored and reported. 7) Adjustment is performed when project goals are not achieved.

Base Practices
MAN.3.BP1: Define the scope of work. Identify the project's goals, motivation and boundaries.
MAN.3.BP2: Define project life cycle. Define the life cycle for the project, which is appropriate to the scope, context, and complexity of the project. Define a release scope for relevant milestones. *Note 1: This may include the alignment of the project life cycle with the customer's development process.*
MAN.3.BP3: Evaluate feasibility of the project. Evaluate the feasibility of achieving the goals of the project with respect to time, project estimates, and available resources. *Note 2: The evaluation of feasibility may consider technical constraints of the project.*

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4.9.管理过程组（MAN）

4.9.1. MAN.3 项目管理

过程 ID
MAN.3
过程名称
项目管理
过程目的
其目的是：在项目需求和约束的背景下，为项目开发产品，识别和控制活动，以及建立必需的资源。
过程成果
1) 定义了项目的工作范围； 2) 在可用资源和约束条件下，评估了实现项目目标的可行性； 3) 评估了完成工作所必需的活动和资源的规模，并进行了估算； 4) 识别和监控了项目内部、与其他项目以及组织单位间的接口； 5) 制订、实施和维护了项目执行的计划； 6) 监控和汇报了项目的进展； 7) 当项目目标没有达成时，执行了调整。

基本实践
MAN.3.BP1:定义工作范围。识别项目的目标，动机和边界。
MAN.3.BP2: 定义项目生命周期。定义符合项目范围、背景和复杂度的项目生命周期。定义相关里程碑的发布范围。 *注 1: 这可能需要包括项目的生命周期与客户的开发过程对齐。*
MAN.3.BP3: 评估项目的可行性。从时间、项目估算和可用的资源来评估项目目标达成的可行性。 *注 2：可行性的评估可考虑项目的技术约束。*

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MAN.3.BP4: Define and monitor work packages. Define and monitor work packages and their dependencies according to defined project life cycle and estimations.

Note 3: The structure and the size of the work packages support an adequate progress monitoring.

Note 4: Work packages may be organized in a work breakdown structure.

MAN.3.BP5: Define and monitor project estimates and resources. Define and monitor project estimates of effort and resources based on project's goals, project risks, motivation and boundaries.

Note 5: Examples of necessary resources are budget, people, product samples, or infrastructure

Note 6: Project risks (using MAN.5) may be considered.

Note 7: Estimations and resources may include engineering, management and supporting processes.

MAN.3.BP6: Define and monitor required skills, knowledge, and experience. Identify and monitor the required skills, knowledge, and experience for the project in line with the estimates and work packages.

Note 8: Training, mentoring or coaching of individuals may be applied to resolve deviations from required skills and knowledge.

MAN.3.BP7: Define and monitor project interfaces and agreed commitments. Identify and agree interfaces of the project with affected stakeholders and monitor agreed commitments. Define an escalation mechanism for commitments that are not fulfilled.

Note 9: Affected stakeholders may include other projects, organizational units, sub-contractors, and service providers.

MAN.3.BP8: Define and monitor project schedule. Allocate resources to work packages and schedule each activity of the project. Monitor the performance of activities against schedule.

MAN.3.BP9: Ensure consistency. Regularly adjust estimates, resources, skills, work packages and their dependencies, schedules, plans, interfaces, and commitments for the project to ensure consistency with the scope of work.

Note 10: This may include the consideration of critical dependencies, that are an input for risk management.

MAN.3.BP10: Review and report progress of the project. Regularly review and report the status of the project and the fulfillment of work packages against estimated effort and duration to all affected parties. Prevent recurrence of identified problems.

Note 11: Project reviews may be executed at regular intervals by the management. Project reviews may contribute to identify best practices and lessons learned.

Note 12: Refer to SUP.9 for resolution of problems

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MAN.3.BP4: 定义和监控工作包。根据已定义的项目生命周期和估算，定义和监控工作包以及它们之间的依赖关系。

注 3：工作包的结构和规模有助于适当的进展监控。

注 4：工作包可以按照工作分解结构来组织。

MAN.3.BP5: 定义和监控项目估算和资源。基于项目的目标、风险、动机和边界，定义和监控项目工作量和资源的估算。

注 5：必要的资源的示例如，预算、人员、产品样件或基础设施。

注 6：可考虑项目风险（使用 MAN.5）。

注 7：估算和资源可能包括工程、管理和支持相关过程。

MAN.3.BP6: 定义和监控所需的技能、知识和经验。为项目识别和监控与估算和工作包相匹配的所需的技能、知识和经验。

注 8：可能需要对个人进行培训、指导和辅导，以解决与所需技能和知识的偏差。

MAN.3.BP7: 定义和监控项目接口和约定的承诺。识别和约定项目与受影响方的接口，并监控约定的承诺。定义未达成承诺时的升级机制。

注 9：受影响方可能包括其他项目，组织单位，分包商和服务提供方。

MAN.3.BP8:定义和监控项目进度计划。为工作包分配资源，并为项目的每一个活动排进度计划。基于进度计划监控活动的实施。

MAN.3.BP9: 确保一致性。定期调整项目的估算、资源、技能、工作包及其依赖关系、进度计划、计划、接口和承诺，以确保与工作范围的一致性。

注 10：这可能包括对关键依赖关系的考虑，可作为风险管理的输入。

MAN.3.BP10: 评审和报告项目进展。依照估算的工作量和工期，定期与所有受影响方评审和报告项目状态和工作包完成情况。预防已识别问题的重复发生。

注 11：项目评审可以由管理层定期执行。项目评审有助于识别最佳实践和经验教训。

注 12：问题的解决参见 SUP.9。

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MAN.3 Project Management	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6	Outcome 7
Output Information Items							
08-53 Scope of work	X						
08-54 Feasibility analysis		X		X			
14-10 Work package			X	X	X		
13-52 Communication evidence		X	X				
13-16 Change request							X
13-51 Consistency evidence		X					X
14-02 Corrective action						X	X
18-52 Escalation path				X		X	X
08-56 Schedule			X		X		X
14-50 Stakeholder groups list				X			
15-06 Project status				X		X	
Base Practices							
BP1: Define the scope of work	X						
BP2: Define project life cycle	X	X					
BP3: Evaluate feasibility of the project		X					
BP4: Define and monitor work packages			X	X	X		X
BP5: Define and monitor project estimates and resources		X	X				X
BP6: Define and monitor required skills, knowledge, and experience			X				X
BP7: Define and monitor project interfaces and agreed commitments			X		X		X
BP8: Define and monitor project schedule						X	X
BP9: Ensure consistency			X	X	X		X
BP10: Review and report progress of the project						X	X

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MAN.3 项目管理	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6	成果 7
输出信息项							
08-53 工作范围	X						
08-54 可行性分析		X		X			
14-10 工作包			X	X	X		
13-52 沟通证据		X	X				
13-16 变更请求							X
13-51 一致性证据		X					X
14-02 纠正措施						X	X
18-52 升级路径				X		X	X
08-56 进度计划			X		X		X
14-50 利益相关方群组清单				X			
15-06 项目状态				X		X	
基本实践							
BP1: 定义工作范围	X						
BP2: 定义项目生命周期	X	X					
BP3: 评估项目的可行性		X					
BP4: 定义和监控工作包			X	X	X		X
BP5: 定义和监控项目估算和资源		X	X				X
BP6: 定义和监控所需的技能、知识和经验			X				X
BP7: 定义和监控项目接口和约定的承诺			X		X		X
BP8: 定义和监控项目进度计划						X	X
BP9: 确保一致性			X	X	X		X
BP10: 评审和报告项目进展						X	X

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4.9.2. MAN.5 Risk Management

Process ID
MAN.5
Process name
Risk Management
Process purpose
The purpose is to Regularly identify, analyze, treat and monitor process related risks and product related risks.
Process outcomes
1) The sources of risks are identified and regularly updated. 2) Potential undesirable events are identified as they develop during the conduct of the project. 3) Risks are analyzed and the priority in which to apply resources to treatment of these risks is determined. 4) Risk measures are defined, applied, and assessed to determine changes in the status of risk and the progress of the risk treatment activities. 5) Appropriate treatment is taken to correct or avoid the impact of risk based on its priority, probability, and consequence or other defined risk threshold.

Base Practices
MAN.5.BP1: Identify sources of risks. Identify and regularly update the sources of risks with affected parties. *Note 1: Risks may include technical, economical, and schedule risks.* *Note 2: Risks may include the suppliers' deliverables and services.* *Note 3: The risk sources may vary across the entire project life cycle.*
MAN.5.BP2: Identify potential undesirable events. Identify potential undesirable events within the scope of the risk management for the project.
MAN.5.BP3: Determine risks. Determine the probability and severity of the undesirable events to support priorities for the mitigation of the risks. *Note 4: Different methods may be used to analyze technical risks of a system, for example, functional analysis, simulation, FMEA, FTA etc.*
MAN.5.BP4: Define risk treatment options. For each risk select a treatment option to accept, mitigate, avoid, or share (transfer) the risk.

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4.9.2. MAN.5 风险管理

过程 ID
MAN.5
过程名称
风险管理
过程目的
其目的是：定期识别、分析、处理和监控过程相关的风险和产品相关的风险。
过程成果
1) 识别并定期更新了风险源； 2) 识别了项目实施过程中产生的潜在不良事件； 3) 分析了风险，并确定了风险的优先级按其使用资源处理这些风险； 4) 定义、应用和评估了风险应对措施，以确定风险的状态变化和风险处理活动的进展； 5) 基于风险的优先级、概率、后果或其他定义的风险阈值，采取了适当的处理措施来纠正或避免风险的影响。

基本实践
MAN.5.BP1: 识别风险源。识别并定期与受影响方更新风险源。 *注 1：风险可能包括技术，经济和时间进度风险。* *注 2：风险可能包括供应商的交付物及服务。* *注 3：风险源可能在整个项目生命周期中变化。*
MAN.5.BP2: 识别潜在不良事件。在项目的风险管理范围内，识别潜在不良事件。
MAN.5.BP3: 确定风险。确定不良事件的发生概率和严重度，以支持风险减缓的优先级。 *注 4：可以使用不同的方法来分析系统的技术风险。例如，功能分析，仿真，FMEA，FTA 等。*
MAN.5.BP4: 定义风险处理方案。针对各风险，选择处理方案以接受、减缓、规避或分担（转移）风险。

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MAN.5.BP5: Define and perform risk treatment activities. Define and perform risk activities for risk treatment options.

MAN.5.BP6: Monitor risks. Regularly re-evaluate the risk related to the identified potential undesirable events to determine changes in the status of a risk and to evaluate the progress of the risk treatment activities.

Note 5: Risks of high priority may need to be communicated to and monitored by higher levels of management.

MAN.5.BP7: Take corrective action. When risk treatment activities are not effective, take appropriate corrective action.

Note 6: Corrective actions may involve reevaluation of risks, developing and implementing new mitigation concepts or adjusting the existing concepts.

MAN.5 Risk Management	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5
Output Information Items					
15-51 Analysis results	X	X	X		X
15-09 Risk status	X		X	X	X
08-55 Risk measure				X	X
14-02 Corrective action				X	X
Base Practices					
BP1: Identify sources of risks	X				
BP2: Identify potential undesirable events		X			
BP3: Determine risks			X		
BP4: Define risk treatment options				X	X
BP5: Define and perform risk treatment activities.				X	X
BP6: Monitor risks				X	
BP7: Take corrective action					X

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MAN.5.BP5: 定义和执行风险处理活动。基于风险处理方案，定义和执行风险处理活动。

MAN.5.BP6: 监控风险。定期重新评估与已识别的潜在不良事件相关的风险，以确定风险状态的变化，并评估风险处理活动的进展。

- *注 5：高优先级风险可能需要与更高级别的管理层进行沟通，并由其进行监控。*

MAN.5.BP7: 采取纠正措施。当风险的处理活动无效时，采取适当的纠正措施。

- *注 6：纠正措施可能涉及到风险的再评估，制订和实施新的缓解方案或调整现有方案。*

MAN.5 风险管理	成果 1	成果 2	成果 3	成果 4	成果 5
输出信息项					
15-51 分析结果	X	X	X		X
15-09 风险状态	X		X	X	X
08-55 风险措施				X	X
14-02 纠正措施				X	X
基本实践					
BP1: 识别风险源	X				
BP2: 识别潜在不良事件		X			
BP3: 确定风险			X		
BP4: 定义风险处理方案				X	X
BP5: 定义和执行风险处理活动				X	X
BP6: 监控风险				X	
BP7: 采取纠正措施					X

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4.9.3. MAN.6 Measurement

Process ID
MAN.6
Process name
Measurement
Process purpose
The purpose is to Collect and analyze data relating to the development results and processes implemented within the organization and its projects, to support effective management of the processes.
Process outcomes
1) The measurement information needs that are necessary to evaluate the achievement of process objectives and the achievement of desired work products are identified. 2) An appropriate set of metrics, driven by the information needs are identified and/or developed. 3) Measurement activities are identified and performed. 4) The required metrics are collected, stored, analyzed, and the results interpreted. 5) Metrics are used to support decisions and provide an objective basis for communication.

Base Practices
MAN.6.BP1: Identify information needs. Identify the measurement information needs that are necessary to evaluate the achievement of process objectives and work products. *Note 1: Information needs may change over time. Therefore, the measurement process may be used in an iterative way.*
MAN.6.BP2: Specify metrics. Identify and develop an appropriate set of metrics based on measurement information needs. *Note 2: Metrics may be related to processes or development results.*
MAN.6.BP3: Collect and store metrics. Collect and store both base and derived metrics, including any context information necessary to verify and understand the metrics. *Note 3: Base metrics in the context of this process are directly gathered metrics like "number of defects found" or "number of lines of code", where derived metrics are two or more metrics that are brought in relation to each other like "number of defects found per line of code".*
MAN.6.BP4: Analyze collected metrics. Analyze, interpret and review measured values to support decision-making.

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4.9.3. MAN.6 度量

过程 ID
MAN.6
过程名称
度量
过程目的
其目的是：收集和分析组织及其项目内的开发结果和过程实施相关的数据，以支持过程的有效管理。
过程成果
1) 识别了用于评估过程目标达成情况和期望的工作产品的达成情况所需的度量信息需要； 2) 识别和/或制订了由信息需要驱动的一组适当的度量项； 3) 识别和执行了度量活动； 4) 收集、存储和分析了所需的度量项，并对结果进行了解释； 5) 使用了度量项来支持决策，并为沟通提供了客观基础。

基本实践
MAN.6.BP1: 识别信息需要。识别用于评估过程目标和工作产品达成情况所必要的度量信息需要。 *注 1：信息需要可能会随着时间而改变，因此，可以以迭代的方式使用度量过程。*
MAN.6.BP2: 定义度量项。基于度量信息需要，识别和制订一组适当的度量项。 *注 2：度量项可能是过程或开发结果相关的。*
MAN.6.BP3: 收集并存储度量项。收集并存储基础及衍生度量项，包括任何必要的背景信息来验证和理解度量项。 *注 3：本过程中所涉及的基础度量项是指直接收集到的度量数据，如“发现缺陷的数量”或“代码行的数量”，衍生度量项是两个或多个相关联的度量项，如“每行代码发现缺陷的数量”。*
MAN.6.BP4: 分析收集的度量项。分析、解释和评审度量值，以支持决策。

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MAN.6.BP5: Communicate analysis results. Communicate analysis results to all affected parties.
MAN.6.BP6: Use metrics for decision-making. Make accessible and use information from collected metrics and analysis results for any decision-making process for which it is relevant.

MAN.6 Measurement	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5
Output Information Items					
03-03 Benchmarking data				X	X
03-04 Customer satisfaction data				X	X
03-06 Process performance information				X	X
07-51 Measurement result		X	X	X	X
15-51 Analysis results	X			X	X
Base Practices					
BP1: Identify information needs	X				
BP2: Specify metrics		X	X		
BP3: Collect and store metrics			X	X	
BP4: Analyze collected metrics				X	X
BP5: Communicate measurement information					X
BP6: Use metrics for decision-making					X

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MAN.6.BP5: 沟通分析结果。与所有受影响方沟通分析结果。

MAN.6.BP6: 使用度量项进行决策。使收集到的度量项和分析结果中的信息可用于任何相关的决策过程。

MAN.6 度量	成果 1	成果 2	成果 3	成果 4	成果 5
输出信息项					
03-03 基准数据				X	X
03-04 客户满意度数据				X	X
03-06 过程实施信息				X	X
07-51 度量结果		X	X	X	X
15-51 分析结果	X			X	X
基本实践					
BP1: 识别信息需要	X				
BP2: 定义度量项		X	X		
BP3: 收集并存储度量项			X	X	
BP4: 分析收集的度量项				X	X
BP5: 沟通分析结果					X
BP6: 使用度量项进行决策					X

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4.10. Process improvement process group (PIM)

4.10.1. PIM.3 Process Improvement

Process ID
PIM.3
Process name
Process Improvement
Process purpose
The purpose is to continually improve the organization’s effectiveness and efficiency through the processes used and ensure alignment of the processes with the business needs.
Process outcomes
1) Commitment is established to provide resources to sustain improvement measures. 2) Issues arising from the organization's internal or external environment are identified as improvement opportunities and justified as reasons for change. 3) Analysis of the current status of the existing process is performed. 4) Improvement goals are identified and prioritized, and consequent changes to the process are defined, documented and implemented. 5) The effects of process implementation are monitored, measured and confirmed against the identified improvement goals. 6) Knowledge gained from the improvement is communicated within the organization.

Base Practices
PIM.3.BP1: Establish commitment. Establish commitment to support the process improvement staff, to provide resources and further enablers to sustain improvement actions. *Note 1: The process improvement process is a generic process, which can be used at all levels (e.g, organizational level, process level, project level, etc.) and which can be used to improve all processes.* *Note 2: Commitment at all levels of management may support process improvement.* *Note 3: Enablers for improvement measures may include trainings, methods, infrastructure, etc.*

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4.10. 过程改进过程组（PIM）

4.10.1. PIM.3 过程改进

过程 ID
PIM.3
过程名称
过程改进
过程目的
其目的是：通过使用的过程持续改进组织的有效性和效率，并且确保过程与业务需求保持一致。
过程成果
1) 建立了承诺以提供资源用于支持持续改进措施； 2) 识别了由组织内部或外部环境引发的问题，作为改进机会和改变的合理理由； 3) 实施了对现有过程当前状态的分析； 4) 识别了改进目标，并对其进行优先级排序，定义、记录和实施了过程的后续变更； 5) 依照已识别的改进目标，监控、度量和确认了过程实施的效果； 6) 在组织内沟通了从改进中获得的知识。

基本实践
PIM.3.BP1: 建立承诺。建立承诺以支持过程改进人员，提供资源和进一步的助力来持续推进改进活动。 *注 1: 过程改进过程是一个通用的过程，可以在所有层级（例如组织级、过程级、项目级等）使用，并且可以用于改进所有过程。* *注 2：各级管理层的承诺有助于过程改进。* *注 3：改进措施的助力可包括培训、方法、基础设施等。*

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PIM.3.BP2: Identify improvement measures. Identify issues from the analysis of process performance and derive improvement opportunities with justified reasons for change.

Note 4: Analysis may include problem report trend analysis (see SUP.9), analysis from Quality Assurance and Verification results and records (see SUP.1), validation results and records, and product quality metrics like defect rate.

Note 5: Issues and improvement suggestions may be addressed by the customer.

Note 6: Sources for identification of issues may include: process assessment results, audits, customer's satisfaction reports, measurements of organizational effectiveness/efficiency, costs of quality.

PIM.3.BP3: Establish process improvement goals. Analyze the current status of the existing processes and establish improvement goals.

Note 7: The current status of processes may be determined by process assessment.

PIM.3.BP4: Prioritize improvements. Prioritize the improvement goals and improvement measures.

PIM.3.BP5: Define process improvement measures. Process improvement measures are defined.

Note 8: Improvements may be documented in incremental steps.

PIM.3.BP6: Implement process improvement measures. Implement and apply the improvements to the processes. Update the Process documentation and train people as needed.

Note 9: Process application can be supported by establishing policies, adequate process infrastructure, process training, process coaching and tailoring processes to local needs.

Note 10: Improvements may be piloted before roll out within the organization.

PIM.3.BP7: Confirm process improvement. The effects of process implementation are monitored and measured, and the achievement of defined improvement goals is confirmed.

PIM.3.BP8: Communicate results of improvement. Knowledge gained from the improvements and progress of the improvement implementation is communicated to affected parties.

PIM.3 Process Improvement	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6
Output Information Items						
02-01 Commitment/agreement	X					
06-04 Training material				X		X
07-04 Process metric					X	X

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PIM.3.BP2: 识别改进措施。从过程绩效的分析中识别问题，以导出改进机会，并给出合理的变更理由。

注 4：分析可能包括问题报告趋势分析（见 SUP.9），质量保证和验证的结果及记录（见 SUP.1）、确认结果及记录以及产品质量度量项（如缺陷率）的分析。

注 5：问题和改进建议可以是客户提出的。

注 6：问题识别的来源可包括：过程评估结果、审核、客户满意度报告、组织有效性/效率的度量和质量成本。

PIM.3.BP3: 建立过程改进目标。分析已有过程的当前状态，并建立改进目标。

注 7：过程的当前状态可通过过程评估确定。

PIM.3.BP4: 对改进进行优先级排序。对改进目标和改进措施进行优先级排序。

PIM.3.BP5: 定义过程改进措施。定义过程改进措施。

注 8：改进可以以递进的步骤进行记录。

PIM.3.BP6: 实施过程改进措施。实施并应用过程改进。根据需要更新过程文档并对人员进行培训。

注 9：可以通过建立政策、适当的过程基础设施、过程培训、过程辅导和基于本地需要剪裁过程来支持过程应用。

注 10： 改进可以在组织内推行前进行试点。

PIM.3.BP7: 确认过程改进。监控和度量过程实施的效果，并确认定义的改进目标的达成情况。

PIM.3.BP8: 沟通改进结果。将从改进中获得的知识以及改进实施进展与受影响方进行沟通。

PIM.3 过程改进	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6
输出信息项						
02-01 承诺/协议	X					
06-04 培训材料				X		X
07-04 过程度量项					X	X

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10-00 Process description				X		
13-52 Communication evidence						X
13-16 Change request		X				
15-51 Analysis result		X	X	X	X	
15-13 Assessment/audit report			X		X	
15-16 Improvement opportunity		X	X	X		
16-06 Process repository				X		
Base Practices						
BP1: Establish commitment	X					
BP2: Identify improvement measures		X	X			
BP3: Establish process improvement goals				X		
BP4: Prioritize improvements				X		
BP5: Define process improvement measures				X		
BP6: Implement process improvement measures				X		
BP7: Confirm process improvement					X	
BP8: Communicate results of improvement						X

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10-00 过程描述				X		
13-52 沟通证据						X
13-16 变更请求		X				
15-51 分析结果		X	X	X	X	
15-13 评估/审核报告			X		X	
15-16 改进机会		X	X	X		
16-06 过程库				X		
基本实践						
BP1: 建立承诺	X					
BP2: 识别改进措施		X	X			
BP3: 建立过程改进目标				X		
BP4: 对改进进行优先级排序				X		
BP5: 定义过程改进措施				X		
BP6: 实施过程改进措施				X		
BP7: 确认过程改进					X	
BP8: 沟通改进结果						X

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4.11. Reuse process group (REU)

4.11.1.REU.2 Management of Products for Reuse

Process ID
REU.2
Process name
Management of Products for Reuse
Process purpose
The purpose is to ensure that reused work products are analyzed, verified, and approved for their target context.
Process outcomes
1) Products for reuse are selected using defined criteria. 2) Products for reuse are analyzed for portability and interoperability. 3) Limitations for reuse are defined and communicated. 4) Products for reuse are verified. 5) Products for reuse are provided to affected parties. 6) Communication mechanism is established with the reuse product provider.

Base Practices
REU.2.BP1: Select products for reuse. Select the products to be reused using defined criteria. *Note 1: Products for reuse may be systems, hardware or software components, third party components or legacy components.*
REU.2.BP2: Analyze the reuse capability of the product. Analyze the designated target architecture and the product to be reused to determine its applicability in the target architecture according to relevant criteria. *Note 2: Examples for criteria can be requirements compliance, verifiability of the product to be reused in the target architecture, or portability/interoperability.*
REU.2.BP3: Define limitations for reuse. Define and communicate limitations for the products to be reused. *Note 3: Limitations may address parameters of operational environment.*

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4.11. 重用过程组(REU)

4.11.1. REU.2 重用产品管理

过程 ID
REU.2
过程名称
重用产品管理
过程目的
其目的是：确保重用产品被分析、验证，并批准应用于目标环境。
过程成果
1) 基于已定义的准则选择了重用产品； 2) 分析了重用产品的可移植性及互操作性； 3) 定义和沟通了重用的限制条件； 4) 验证了重用产品； 5) 提供了重用产品给受影响方； 6) 建立了与重用产品提供方之间的沟通机制。

基本实践
REU 2.BP1: 选择重用产品。 基于已定义的准则选择重用产品。 *注 1：重用产品可以是系统、硬件、软件组件、第三方组件或者遗留组件。*
REU 2.BP2: 分析产品的重用适用性。 根据相关准则，分析指定目标架构和待重用产品以确认其在目标架构的适用性。 *注 2：分析准则示例如，需求符合性，重用产品在目标架构的可验证性，或者可移植性及互操作性。*
REU 2.BP3: 定义重用限制条件。定义并沟通对于重用产品的限制条件。 *注 3：限制条件可包括操作环境参数。*

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REU.2.BP4: Ensure qualification of products for reuse. Provide evidence that the product for reuse is qualified for the intended use of the deliverable.

Note 4: Qualification may be demonstrated by verification evidence.

Note 5: Verification may include the appropriateness of documentation.

REU.2.BP5: Provide products for reuse. Make available the product to be reused to affected parties.

Note 6: Refer to HWE.3, SWE.5 or SYS.4 for more information on integration of hardware, software, or system components.

REU.2.BP6: Communicate information about effectiveness of reuse activities. Establish communication and notification mechanism about experiences and technical outcomes to the provider of reused products.

Note 7: The communication with the provider of a reused product may depend on whether the product is under development or not.

REU.2 Management of Products for Reuse	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6
Output Information Items						
04-02 Domain architecture		X	X			
12-03 Reuse candidate	X				X	
13-52 Communication evidence						X
15-07 Reuse analysis evidence		X	X			
13-53 Qualification evidence				X		
Base Practices						
BP1: Select products for reuse	X					
BP2: Analyze the reuse capability of the product		X				
BP3: Define limitations for reuse			X			
BP4: Ensure qualification of products for reuse				X		
BP5: Provide products for reuse					X	
BP6: Communicate information about effectiveness of reuse activities						X

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REU 2.BP4: 确保重用产品合格。提供证据以证明重用产品达到交付物预期用途的标准。

注 4：合格性可通过验证证据来证明。

注 5：验证可包含记录的适当性。

REU.2.BP5: 提供重用产品。为受影响方提供重用产品。

注 6：关于硬件、软件及系统组件集成的更多信息，参见 HWE.3, SWE.5 和 SYS.4。

REU.2.BP6: 沟通重用活动有效性信息。与重用产品提供方就经验及技术成果建立沟通及通知机制。

注 7：与重用产品提供方之间的沟通可能依赖于产品是否在开发中。

REU.2 重用产品管理	成果 1	成果 2	成果 3	成果 4	成果 5	成果 6
输出信息项						
04-02 领域架构		X	X			
12-03 重用候补	X				X	
13-52 沟通证据						X
15-07 重用分析证据		X	X			
13-53 合格性证据				X		
基本实践						
BP1：选择重用产品	X					
BP2：分析产品的重用适用性		X				
BP3：定义重用限制条件			X			
BP4：确保重用产品合格				X		
BP5：提供重用产品					X	
BP6：沟通重用活动有效性信息						X

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5. Process capability levels and process attributes

The definition of process capability indicators for each process attribute is an integral part of a measurement framework. Process capability indicators such as generic practices and information items are the means to support the judgment of the degree of achievement of the associated process attribute.

This chapter defines the generic practices and information items and their mapping to the process attributes for each capability level defined in the measurement framework [3.2].

Note: Due to lack of a defined process attribute for process capability level 0, no generic practices and information items are defined.

Process capability level	**Process attribute ID** **Process attribute name** **Process attribute scope** **Process achievements**	Each process attribute is identified with a unique identifier and name. A process attribute scope statement is provided, and process achievements are defined.
Process attribute acievement indicators	**Generic practices**	A set of generic practices for the process attribute providing a definition of the activities to be performed to accomplish the process attribute scope and fulfill the process achievements. The generic practice headers are summarized at the end of a process to demonstrate their relationship to the process attribute achievements.
	Output information items	The output information items that are relevant to accomplish the process attribute scope and fulfill the process achievements are summarized at the end of a process attribute section to demonstrate their relationship to the process achievements. *Note: Refer to Annex B for the characteristics of each information item.*

Table 22 — Template for the process description

5.1. Process capability level 0: Incomplete process

The process is not implemented or fails to achieve its process purpose. At this level there is little or no evidence of any systematic achievement of the process purpose.

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5. 过程能力等级与过程属性

为每个过程属性定义的过程能力指标，是度量框架不可或缺的一部分。如通用实践、信息项等过程能力指标是支持判断相关的过程属性达成程度的方式。

本章为度量框架[3.2]中的各能力等级定义了通用实践和信息项，以及它们与过程属性的映射关系。

注：由于没有为过程能力等级 0 定义过程属性，因此没有定义通用实践和信息项。

<table>
<tr><td>过程能力等级</td><td>过程属性 ID
过程属性名称
过程属性范围
过程成就</td><td>每个过程属性都标明了唯一标识符和名称，并提供了过程属性范围声明，定义了过程成就。</td></tr>
<tr><td rowspan="2">过程属性达成指标</td><td>通用实践</td><td>过程属性的一组通用实践提供了需执行活动的定义，以实现过程属性范围和过程成就。
通用实践标题信息在过程的最后进行了总结，以展示它们与过程属性成就之间的关系。</td></tr>
<tr><td>输出信息项</td><td>与完成过程属性范围和实现过程成就相关的输出信息项总结在过程属性部分的末尾，以证明它们与过程成就的关系。
• 注：每个信息项的特性见附录 B.</td></tr>
</table>

表 22 — 过程描述模板

5.1. 过程能力等级 0 级：不完整的过程

过程未实施、或未能实现其过程目的。在这个等级只有很少或没有系统化实现过程目的的证据。

5.2. Process capability Level 1: Performed process

The implemented process achieves its process purpose. The following process attribute demonstrates the achievement of this level.

5.2.1. PA 1.1 Process performance process attribute

Process attribute ID
PA 1.1
Process attribute name
Process performance process attribute
Process attribute scope
The process performance process attribute is a measure of the extent to which the process purpose is achieved.
Process attribute achievements
1) The process achieves its defined outcomes.

Generic practices
GP 1.1.1 Achieve the process outcomes Achieve the intent of the base practices. Produce work products that evidence the process outcomes.

PA 1.1 **Process performance process attribute**	Achievement a
Output Information Items	
Process specific information items, as described in chapter 4	X
Generic practices	
GP 1.1.1 Achieve the process outcomes	X

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5.2.过程能力等级 1 级：已执行的过程

已执行的过程实现其过程目的。以下过程属性证明达成该等级。

5.2.1. PA 1.1 过程实施过程属性

过程属性 ID
PA1.1
过程属性名称
过程实施过程属性
过程属性范围
过程实施过程属性是：衡量过程目的达成程度的一种度量。
过程属性成就
1) 过程达成其定义的成果。

通用实践
GP 1.1.1 达成过程成果 达成基本实践的意图。 生成证明过程成果的工作产品。

PA 1.1 **过程实施过程属性**	成就 a
输出信息项	
过程特定信息项，如第 4 章所述	X
通用实践	
GP 1.1.1 达成过程成果	X

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5.3. Process capability Level 2: Managed process

The following process attributes, together with the previously defined process attribute, demonstrate the achievement of this level.

5.3.1. PA 2.1 Process performance management process attribute

Process attribute ID
PA 2.1
Process attribute name
Process performance management process attribute
Process attribute scope
The performance management process attribute is a measure of the extent to which the performance of the process is managed.
Process attribute achievements
1) Strategy for the performance of the process is defined based on identified objectives. 2) Performance of the process is planned. 3) Performance of the process is monitored and adjusted to meet the planning. 4) Needs for human resources including responsibilities and authorities for performing the process are determined. 5) Needs for physical and material resources are determined. 6) Persons performing the process are prepared for executing their responsibilities. 7) Physical and material resources for performing the process are identified, made available, allocated and used. 8) Interfaces between the involved parties are managed to ensure both effective communication and the assignment of responsibilities.

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5.3.过程能力等级 2 级：已管理的过程

以下过程属性结合先前已定义的过程属性，证明达成该等级。

5.3.1. PA 2.1 过程实施管理过程属性

过程属性 ID
PA2.1
过程属性名称
过程实施管理过程属性
过程属性范围
实施管理过程属性是：对过程实施进行管理的程度的度量
过程属性成就
1) 基于已识别的目标定义了过程实施策略。 2) 计划了过程的实施。 3) 监控和调整了过程的实施以满足计划。 4) 确定了人力资源需求，包括执行过程的职责和权限。 5) 确定了对实物和物料资源的需求。 6) 准备了执行过程的人员以履行其职责。 7) 识别、提供、分配并使用了执行过程所需的实物和物料资源。 8) 管理了参与方之间的接口以确保有效的沟通和职责的分配。

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Generic practices
GP 2.1.1: Identify the objectives and define a strategy for the performance of the process. The scope of the process activities including the management of process performance and the management of work products are determined. Corresponding results to be achieved are determined. Process performance objectives and associated criteria are identified. *Note 1: Budget targets and delivery dates to the customer, targets for test coverage and process lead time are examples for process performance objectives.* *Note 2: Performance objectives are the basis for planning and monitoring.* Assumptions and constraints are considered when identifying the performance objectives. Approach and methodology for the process performance is determined. *Note 3: A process performance strategy may not necessarily be document-ed specifically for each process. Elements applicable for multiple processes may be documented jointly, e.g, as part of a common project handbook or in a joint test strategy.*
GP 2.1.2: Plan the performance of the process. The planning for the performance of the process is established according to the defined objectives, criteria, and strategy. Process activities and work packages are defined. Estimates for work packages are identified using appropriate methods. *Note 4: Schedule and milestones are defined.*
GP 2.1.3: Determine resource needs. The required amount of human resources, and experience, knowledge and skill needs for the for process performance are determined based on the planning. The needs for physical and material resources are determined based on the planning. *Note 5: Physical and material resources may include equipment, laboratories, materials, tools, licenses etc.* Required responsibilities and authorities to perform the process, and to manage the corresponding work products are determined. *Note 6: The definition of responsibilities and authorities does not necessarily require formal role descriptions.*

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通用实践

GP 2.1.1: 识别目标并定义过程实施策略。

确定过程活动的范围，包括过程实施管理和工作产品管理。

确定要达成的相应结果。

识别过程实施目标和相关准则。

注 1：向客户提供预算目标和交付日期、测试覆盖率目标和过程实施周期是过程实施目标的示例。

注 2：实施目标是计划和监控的基础。

在识别实施目标时考虑假设和约束。

确定过程实施方法和方法论。

注 3：过程实施策略不一定专门针对每个过程进行记录。适用于多个过程的要素可以联合记录，例如，作为通用项目手册的一部分或联合测试策略。

GP 2.1.2: 计划过程的实施。

根据定义的目标、准则和策略建立过程实施计划。

定义过程活动和工作包。

使用适当的方法识别工作包的估算。

注 4：定义进度计划和里程碑。

GP 2.1.3: 确定资源需求。

根据计划确定过程实施所需的人力资源、经验、知识和技能需求。

根据计划确定实物和物料资源需求。

注 5：实物和物料资源需求可包括设备、实验室、材料、工具、许可证等。

确定执行过程和管理相应工作产品所需的职责和权限。

注 6：职责和权限的定义不一定需要正式的角色描述。

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GP 2.1.4: Identify and make available resources.

The individuals performing and managing the process are identified and allocated according to the determined needs.

The individuals performing and managing the process are being qualified to execute their responsibilities.

Note 7: Qualification of individuals may include training, mentoring, or coaching.

The other resources, necessary for performing the process are identified, made available, allocated and used according to the determined needs.

GP 2.1.5: Monitor and adjust the performance of the process.

Process performance is monitored to identify deviations from the planning.

Appropriate actions in case of deviations from the planning are taken.

The planning is adjusted as necessary.

GP 2.1.6: Manage the interfaces between involved parties.

The individuals and groups including required external parties involved in the process performance are determined.

Responsibilities are assigned to the relevant individuals or parties.

Communication mechanisms between the involved parties are determined.

Effective communication between the involved parties is established and maintained.

PA 2.1 Process Performance Management	Achievement 1	Achievement 2	Achievement 3	Achievement 4	Achievement 5	Achievement 6	Achievement 7	Achievement 8
Output Information Items								
19-01 Process performance strategy	X							
18-58 Process performance objectives	X							
14-10 Work package		X						
08-56 Schedule		X	X					
13-14 Progress status			X					
17-55 Resource needs				X	X			

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GP 2.1.4: 识别并提供资源。

根据确定的需求，识别和分配执行和管理过程的人员

执行和管理过程的人员具备执行其职责的资质。

注 7：人员获得资质的方法可包括培训、指导或辅导。

根据确定的需求，识别、提供、分配和使用执行过程所需的其他资源。

GP 2.1.5: 监控和调整过程的实施。

监控过程实施以识别与计划的偏差。

如果偏离计划，采取适当的行动。

必要时调整计划。

GP 2.1.6: 管理参与方之间的接口。

确定过程实施中涉及的人员和群体，包括所需的外部方。

分配职责给相关个人或各方。

确定参与方之间的沟通机制。

建立和维护参与方之间的有效沟通。

PA 2.1 过程实施管理	成就 1	成就 2	成就 3	成就 4	成就 5	成就 6	成就 7	成就 8
输出信息项								
19-01 过程实施策略	X							
18-58 过程实施目标	X							
14-10 工作包		X						
08-56 进度计划		X	X					
13-14 进展状态			X					
17-55 资源需求				X	X			

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08-61 Resource allocation						X	X	
08-62 Communication matrix								X
13-52 Communication evidence								X
Generic Practices								
GP 2.1.1: Identify the objectives and define a strategy for the performance of the process	X							
GP 2.1.2: Plan the performance of the process		X						
GP 2.1.3: Determine resource needs				X	X			
GP 2.1.4: Identify and make available resources						X	X	
GP 2.1.5: Monitor and adjust the performance of the process			X					
GP 2.1.6: Manage the interfaces between involved parties								X

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08-61 资源分配						X	X	
08-62 沟通矩阵								X
13-52 沟通证据								X
通用实践								
GP 2.1.1: 识别目标并定义过程实施策略	X							
GP 2.1.2: 计划过程的实施		X						
GP 2.1.3: 确定资源需求				X	X			
GP 2.1.4: 识别并提供资源						X	X	
GP 2.1.5: 监控和调整过程的实施			X					
GP 2.1.6: 管理参与方之间的接口								X

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5.3.2. PA 2.2 Work product management process attribute

Process attribute ID
PA 2.2
Process attribute name
Work product management process attribute
Process attribute scope
The work product management process attribute is a measure of the extent to which the work products produced by the process are appropriately managed.
Process attribute achievements
1) Requirements for the work products of the process are defined. 2) Requirements for storage and control of the work products are defined. 3) The work products are appropriately identified, stored, and controlled. 4) The work products are reviewed and adjusted as necessary to meet requirements.

Generic practices
GP 2.2.1 Define the requirements for the work products. The requirements for the content and structure of the work products to be produced are defined. Quality criteria for the work products are identified. Appropriate review and approval criteria for the work products are defined. *Note 1: Possible sources of documentation requirements may be e.g., best practices or lessons learned from other projects, standards, organization requirements, customer requirements, etc.* *Note 2: There may be types of work products for which no review or approval is required, thus then there would be no need to define the corresponding criteria.*

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5.3.2. PA 2.2 工作产品管理过程属性

过程属性 ID
PA2.2
过程属性名称
工作产品管理过程属性
过程属性范围
工作产品管理过程属性是：对过程生成的工作产品进行适当管理的程度的度量。
过程属性成就
1) 定义了过程工作产品的需求。 2) 定义了工作产品的存储和控制需求。 3) 适当地识别、存储和控制了工作产品。 4) 评审了工作产品，并根据需要调整了工作产品以符合需求。

通用实践

GP 2.2.1 定义工作产品的需求。

定义需要生成的工作产品的内容和结构的需求。

识别工作产品的质量准则。

定义工作产品的适当的评审和批准准则。

注 1：文档化要求的来源可能是从其他项目中吸取的最佳实践或经验教训、标准、组织要求、客户要求等。

注 2：可能存在不需要审核或批准的工作产品类型，因此无需定义相应的准则。

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GP 2.2.2 Define the requirements for storage and control of the work products. Requirements for the storage and control of the work products are defined, including their identification and distribution. *Note 3: Possible sources for the identification of requirements for storage and control may be e.g., legal requirements, data policies, best practices from other projects, tool related requirements, etc.* *Note 4: Examples for work product storage are files in a file system, ticket in a tool, Wiki entry, paper documents etc.* *Note 5: Where status of a work product is required in base practices, this should be managed via a defined status model.*
GP 2.2.3 Identify, store and control the work products. The work products to be controlled are identified. The work products are stored and controlled in accordance with the requirements. Change control is established for work products. Versioning and baselining of the work products is performed in accordance with the requirements for storage and control of the work products. The work products including the revision status are made available through appropriate mechanisms.
GP 2.2.4 Review and adjust work products. The work products are reviewed against the defined requirements and criteria. Resolution of issues arising from work products reviews is ensured.

PA 2.2 Work product management process attribute	Achievement 1	Achievement 2	Achievement 3	Achievement 4
Output Information Items				
17-05 Requirements for work products	X	X		
18-59 Review and approval criteria for work products	X			
18-07 Quality criteria	X			
13-19 Review evidence				X

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GP 2.2.2 定义工作产品存储和控制的需求。

定义工作产品的存储和控制需求，包括它们的标识和分发。

注 3：存储和控制要求识别的来源可以是法律要求、数据政策、其他项目的最佳实践、工具相关需求等。

注 4：工作产品存储的示例包括文件系统中的文件、工具中的票单、Wiki 条目、纸质文档等。

注 5：如果基本实践中需要工作产品的状态，则宜通过定义的状态模型进行管理。

GP 2.2.3 识别、存储和控制工作产品。

识别需要控制的工作产品。

依据需求存储和控制工作产品。

建立工作产品的变更控制。

根据工作产品的存储和控制需求执行工作产品的版本控制和基线化。

通过适当的机制提供工作产品，包括修订状态。

GP 2.2.4 评审和调整工作产品。

根据定义的需求和准则评审工作产品。

确保解决工作产品评审中出现的问题。

PA 2.2 工作产品管理过程属性	成就 1	成就 2	成就 3	成就 4
输出信息项				
17-05 工作产品需求	X	X		
18-59 工作产品评审和审批准则	X			
18-07 质量准则	X			
13-19 评审证据				X

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13-08 Baseline			X	
16-00 Repository			X	
Generic Practices				
GP 2.2.1 Define the requirements for the work products	X			
GP 2.2.2 Define the requirements for storage and control of the work products		X		
GP 2.2.3 Identify, store and control the work products			X	
GP 2.2.4 Review and adjust work products.				X

5.4. Process capability Level 3: Established process

The following process attributes, together with the previously defined process attributes, demonstrate the achievement of this level.

5.4.1. PA 3.1 Process definition process attribute

Process attribute ID
PA 3.1
Process attribute name
Process definition process attribute
Process attribute scope
The process definition process attribute is a measure of the extent to which a standard process is maintained to support the deployment of the defined process.
Process attribute achievements
1) A standard process is developed, established, and maintained that describes the fundamental elements that must be incorporated into a defined process. 2) The required inputs and the expected outputs for the standard process are defined. 3) Roles, responsibilities, authorities, and required competencies for performing the standard process are defined. 4) Tailoring guidelines for deriving the defined process from the standard process are defined. 5) Required physical and material resources and process infrastructure needs are determined as part of the standard process. 6) Suitable methods and required activities for monitoring the effectiveness, suitability and adequacy of the process are determined.

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13-08 基线			X	
16-00 存储库			X	
通用实践				
GP 2.2.1 定义工作产品的需求	X			
GP 2.2.2 定义工作产品存储和控制的需求		X		
GP 2.2.3 识别、存储和控制工作产品			X	
GP 2.2.4 评审和调整工作产品				X

5.4.过程能力等级 3 级：已建立的过程.

以下过程属性结合先前已定义的过程属性，证明达成该等级。

5.4.1. PA 3.1 过程定义过程属性

过程属性 ID
PA 3.1
过程属性名称
过程定义过程属性
过程属性范围
过程定义过程属性是：对标准过程的维护程度的度量，以支持已定义过程的部署。
过程属性成就
1) 制订、建立和维护了标准过程，该过程描述了必须合并到已定义过程中的基本要素。 2) 定义了标准过程所需的输入和预期输出。 3) 定义了实施标准过程的角色、职责、权限和所需的能力。 4) 定义了从标准过程导出已定义过程的裁剪指南。 5) 作为标准过程的一部分，确定了实施过程所需的实物和物料资源工作环境。 6) 确定了监控过程有效性、适用性和充分性的适当方法和所需活动。

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Generic practices

GP 3.1.1 Establish and maintain the standard process.

A suitable standard process is developed including required activities and their interactions.

Inputs and outputs of the standard process are defined including the corresponding entry and exit criteria to determine the interactions and sequence with other processes.

Process performance roles are identified and assigned to the standard process activities including their type of involvement, responsibilities, and authorities.

Note 1: An example for describing the involvement of the process roles in the activities is a RASI/RASIC representation.

Suitable guidance, procedures, and templates are provided to support the execution of the process as needed.

Note 2: Procedures may also include description of specific methods to be used.

Appropriate tailoring guidelines including predefined unambiguous criteria as well as predefined and unambiguous proceedings are defined based on identified deployment needs and context of the standard process.

The standard process is maintained according to corresponding feedback from the monitoring of the deployed processes.

Note 3: For guidance on how to perform process improvements see the Process Improvement process (PIM.3).

GP 3.1.2 Determine the required competencies.

Required competencies, skills, and experience for performing the standard process are determined for the identified roles.

Appropriate qualification methods to acquire the necessary competencies and skills are determined, maintained, and made available for the identified roles.

Note 4: Qualification methods are e.g., trainings, mentoring, self-study.

Note 5: Preparation includes e.g., identification or definition of trainings, mentoring concepts, self-learning material.

GP 3.1.3 Determine the required resources.

Required physical and material resources and process infrastructure needs for performing the standard process are determined.

Note 6: This may include e.g., facilities, tools, licenses, networks, services, and samples supporting the establishment of the required work environment.

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通用实践
GP 3.1.1 建立和维护标准过程。 制订适当的标准过程，包括其所需的活动及其相互作用。 定义了标准过程的输入和输出，包括相应的准入和准出准则，以确定与其它过程的交互作用和顺序。 识别过程实施角色，并将其分配给标准过程中的活动，包括其参与类型、职责和权限。 *注 1：描述过程中参与活动的角色示例是 RASI/RASIC。* 根据需要，提供适当的指导、程序和模板以支持过程的执行。 *注 2：程序还可能包括要使用的具体方法的说明。* 根据已识别的部署需要和标准过程的背景，定义适当的剪裁指南，包括预先定义的明确准则以及预先定义的明确程序。 根据已部署的过程监控中的相应反馈，对标准过程进行维护。 *注 3：有关如何实施过程改进的指导，参见过程改进过程（PIM.3）。*
GP 3.1.2 确定所需的能力。 为已识别的角色确定实施标准过程所需的能力、技能和经验。 为已识别的角色确定、维护并提供适当的资质鉴定方法，以获得必要的能力和技能。 *注 4：资质鉴定方法包括例如：培训、辅导、自学。* *注 5：准备工作包括识别或定义培训、指导概念、自学材料等。*
GP 3.1.3 确定所需的资源。 确定了实施标准过程需要的实物和物料资源以及过程基础设施需求。 *注 6：这可能包括例如：支持建立所需工作环境的设施、工具、许可证、网络、服务和样件。*

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GP 3.1.4 Determine suitable methods to monitor the standard process.

Methods and required activities for monitoring the effectiveness and adequacy of the standard process are determined.

Note 7: Methods and activities to gather feedback regarding the standard process may be lessons learned, process compliance checks, internal audits, management reviews, change requests, reflection of state-of-the-art such as applicable international standards, etc.

Appropriate criteria and information needed to monitor the standard process are defined.

Note 8: Information about process performance may be of qualitative or quantitative nature.

PA 3.1 Process definition process attribute	Achievement 1	Achievement 2	Achievement 3	Achievement 4	Achievement 5	Achievement 6
Output Information Items						
06-51 Tailoring guideline				X		
08-63 Process monitoring method						X
10-00 Process description	X	X				
10-50 Role description			X			
10-51 Qualification method description			X			
10-52 Process resource and infrastructure description					X	
Generic Practices						
GP 3.1.1 Establish and maintain the standard process	X	X	X	X		
GP 3.1.2 Determine the required competencies			X			
GP 3.1.3 Determine the required resources					X	
GP 3.1.4 Determine suitable methods to monitor the standard process						X

5.4.2. PA 3.2 Process deployment process attribute

Process attribute ID
PA 3.2

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GP 3.1.4 确定适当的方法来监控标准过程。

确定了监控标准过程有效性和充分性的方法和所需活动。

注 7：收集有关标准过程的反馈的方法和活动，可以是经验教训、过程合规性检查、内部审核、管理评审、变更请求、反映最先进技术（如适用的国际标准）等。

定义了监控标准过程所需的适当准则和信息。

注 8：过程绩效的信息可能是定性的或定量的。

PA 3.1 过程定义过程属性	成就 1	成就 2	成就 3	成就 4	成就 5	成就 6
输出信息项						
06-51 裁剪指南				X		
08-63 过程监控方法						X
10-00 过程描述	X	X				
10-50 角色描述			X			
10-51 资质鉴定方法说明			X			
10-52 过程资源和基础设施描述					X	
通用实践						
GP 3.1.1 建立和维护标准过程	X	X	X	X		
GP 3.1.2 确定所需的能力			X			
GP 3.1.3 确定所需的资源					X	
GP 3.1.4 确定适当的方法来监控标准过程						X

5.4.2. PA 3.2 过程部署过程属性

过程属性 ID
PA3.2

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Process attribute name
Process deployment process attribute
Process attribute scope
The process deployment process attribute is a measure of the extent to which the standard process is deployed as a defined process to achieve its process outcomes.
Process attribute achievements
1) A defined process is deployed based upon an appropriately selected and/or tailored standard process. 2) Assignment of persons necessary for performing the defined process to roles is performed and communicated. 3) Required education, training and experience is ensured and monitored for the person(s) assigned to the roles. 4) Required resources for performing the defined process are made available, allocated, and maintained. 5) Appropriate information is collected and analyzed as a basis for understanding the behavior of the process.

Generic practices
GP 3.2.1 Deploy a defined process that satisfies the context specific requirements of the use of the standard process. The defined process is appropriately selected and/or tailored from the standard process. Conformance of defined process with standard process requirements and tailoring criteria is verified. The defined process is used as managed process to achieve the process outcomes. *Note 1: Changes in the standard process may require updates of the defined process.*
GP 3.2.2 Ensure required competencies for the defined roles. Human resources are allocated to the defined roles according to the required competencies and skills. Assignment of persons to roles and corresponding responsibilities and authorities for performing the defined process are communicated. Gaps in competencies and skills are identified, and corresponding qualification measures are initiated and monitored. Availability and usage of the project staff are measured and monitored.
GP 3.2.3 Ensure required resources to support the performance of the defined process. Required information to perform the defined process is made available, allocated and used. Required physical and material resources, process infrastructure and work environment are made available, allocated and used.

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过程属性名称
过程部署过程属性
过程属性范围
过程部署过程属性是：对标准过程作为已定义过程进行部署而实现其过程成果的程度的度量。
过程属性成就
1) 基于适当的已选择的 和/或 裁剪的标准过程部署了已定义过程 2) 实施并沟通了执行已定义过程所需人员的角色分配 3) 确保并监控所分配到该角色的人员所需的教育、培训和经验。 4) 提供、分配和维护实施已定义过程所需的资源 5) 收集和分析适当的信息，作为理解过程行为的基础。

通用实践
GP 3.2.1 部署已定义过程，该已定义过程满足使用标准过程的背景特定需求。 从标准过程中适当地选择 和/或 裁剪出已定义过程. 验证已定义过程与标准过程需求和裁剪准则的一致性。 已定义过程用作已管理的过程，以实现过程成果。 *注 1:标准过程的变更可能需要更新已定义过程。*
GP 3.2.2 确保已定义角色所需的能力。 根据所需的能力和技能，将人力资源分配给已定义的角色。 为实施已定义过程，对人员的角色分配以及相应的职责和权限进行沟通。 识别能力和技能方面的差距，并启动和监控相应的资质相关措施。 度量和监控项目人员的可用性和使用情况。
GP 3.2.3 确保所需的资源以支持已定义过程的实施。 提供、分配和使用执行已定义过程所需的信息。 提供、分配和使用所需的实物和物料资源、过程基础设施和工作环境。

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Availability and usage of resources are measured and monitored.
GP 3.2.4 Monitor the performance of the defined process. Information is collected and analyzed according to the determined process monitoring methods to understand the effectiveness and adequacy of the defined process. Results of the analysis are made available to all effected parties and used to identify where continual improvement of the standard and/or defined process can be made. *Note 2: For guidance on how to perform process improvements see the Process Improvement process (PIM.3).*

PA 3.2 Process deployment process attribute	Achievement 1	Achievement 2	Achievement 3	Achievement 4	Achievement 5
Output Information Items					
10-00 Process description	X				
15-54 Tailoring documentation	X				
14-53 Role assignment		X	X		
13-55 Process resource and infrastructure documentation				X	
03-06 Process performance information					X
Generic Practices					
GP 3.2.1 Deploy a defined process	X				
GP 3.2.2 Ensure required competencies		X	X		
GP 3.2.3 Ensure required resources				X	
GP 3.2.4 Monitor the performance of the defined process					X

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度量和监视资源的可用性和使用情况。
GP 3.2.4 监控已定义过程的绩效。 根据确定的过程监控方法收集和分析信息，以理解已定义过程的有效性和充分性。 提供分析结果给所有受影响方，并识别对标准和/或已定义过程的持续改进。 *注 2:关于如何实施过程改进的指导，参见过程改进过程(PIM.3)。*

PA 3.2 过程部署过程属性	成就 1	成就 2	成就 3	成就 4	成就 5
输出信息项					
10-00 过程描述	X				
15-54 裁剪文档	X				
14-53 角色分配		X	X		
13-55 过程资源和基础设施文档				X	
03-06 过程实施信息					X
通用实践					
GP 3.2.1 部署已定义过程	X				
GP 3.2.2 确保所需的能力		X	X		
GP 3.2.3 确保所需的资源				X	
GP 3.2.4 监控已定义过程的绩效					X

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5.5. Process capability Level 4: Predictable process

The following process attributes, together with the previously defined process attributes, demonstrate the achievement of this level.

5.5.1. PA 4.1 Quantitative analysis process attribute

Process attribute ID
PA 4.1
Process attribute name
Quantitative analysis process attribute
Process attribute scope
The quantitative analysis process attribute is a measure of the extent to which information needs are defined, relationships between process elements are identified and data are collected.
Process attribute achievements
1) Process information needs in support of relevant defined quantitative business goals are established. 2) Measurable relationships between process elements that contribute to the process performance, and data collection techniques and data collection frequency, are identified. 3) Process measurement objectives are derived from process information needs. 4) Techniques for analyzing the collected data are selected. 5) Quantitative control limits for process performance in support of relevant business goals are established. 6) Results of measurement are collected, validated and reported in order to monitor the extent to which the quantitative targets/objectives for process performance are met. *Note: Information needs typically reflect management, technical, project, process or product needs.*

Generic practices
GP 4.1.1 Identify business goals. Business goals are identified that are supported by the quantitatively measured process.
GP 4.1.2 Establish process information needs. Stakeholders of the identified business goals and the quantitatively measured process are identified, and their information needs are defined and agreed.

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5.5.过程能力等级 4 级：可预测的过程

以下过程属性结合先前已定义的过程属性，证明达成该等级。

5.5.1. PA 4.1 定量分析过程属性

过程属性 ID
PA 4.1
过程属性名称
定量分析过程属性
过程属性范围
定量分析过程的属性是：定义信息需要、识别过程要素之间的关系以及收集数据的程度的度量。
过程属性成就
1) 建立了过程信息需要，以支持相关已定义的量化业务目标。 2) 确定有助于过程绩效的过程要素之间的可度量关系，以及数据收集技术和数据收集频率。 3) 从过程信息需要导出了过程度量目标。 4) 选择了分析收集数据的技术。 5) 为支持相关业务目标，建立了过程绩效的定量控制限值。 6) 收集、确认和报告了度量结果，以监控过程绩效达成定量目标的程度。 *注 1 信息需要通常反映了管理、技术、项目、过程或产品的需要。*

通用实践
GP 4.1.1 识别业务目标。 识别业务目标，其目标由定量度量过程所支持。
GP 4.1.2 建立过程信息需要。 识别已确定的业务目标和定量度量过程的利益相关方，并定义他们的信息需要/需要且达成一致。

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GP 4.1.3 Identify measurable relationships between process elements. Identify the relationships between process elements, or sets of process elements, which contribute to the process information needs. *Note 1: Examples of process elements are work products, activities, tasks.*
GP 4.1.4 Derive process measurement approach and select analysis techniques. Based on the measurable relationships of process elements, or set of process elements, the process measurement metrics are derived to satisfy the established process information needs. Frequency of data collection is defined. Select analysis techniques, appropriate to collected data. Algorithms and methods to create derived measurement results from base measures are defined, as appropriate. Verification mechanism for base and derived measures is defined. *Note 2: Typically, the standard process definition is extended to include the collection of data for process measurement.*
GP 4.1.5 Establish quantitative control limits. Establish quantitative control limits for the derived metrics. Agreement with process stakeholders is established.
GP 4.1.6 Collect product and process measurement results through performing the defined process. Data collection mechanisms are created for all identified metrics. Required data is collected across process instances of within the defined frequency and recorded. Measurement results are analyzed and reported to the identified stakeholders. *Note 3: A product measure can contribute to a process measure, e.g., the productivity of testing characterized by the number of defects found in a given timeframe in relation to the product defect rate in the field.*

PA 4.1 Quantitative analysis process attribute	Achievement 1	Achievement 2	Achievement 3	Achievement 4	Achievement 5	Achievement 6
Output Information Items						
18-70 Business goals	X	X				
07-61 Quantitative process metric		X	X			
07-62 Process analysis techniques				X		

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GP 4.1.3 识别过程要素之间的度量关系。

识别过程要素或过程要素集之间的关系，有助于建立过程信息需要。

注 1:过程要素的示例如，工作产品、活动、任务。

GP 4.1.4 推导过程度量方法并选择分析技术。

基于过程要素或过程要素集之间的可度量关系，推导出过程度量的度量项 ，以满足已建立的过程信息需要。

定义数据收集的频率。

为所收集的数据选择合适的分析技术。

定义从基础度量导出衍生度量结果的适当的算法和方法。

定义基本度量和衍生度量的验证机制。

注 2: 通常，对标准过程定义范围进行扩展，以包含过程度量的数据收集。

GP 4.1.5 建立定量控制限值。

建立衍生度量项的定量控制限值。与过程利益相关方达成一致。

GP 4.1.6 通过执行已定义过程来收集产品和过程的度量结果。

为所有已识别的指标创建数据收集机制。

按照所定义的频率，收集并记录跨过程示例所需的数据。

分析度量结果并报告给已识别的利益相关方。

注 3：产品度量有助于过程度量，例如：以给定时间范围内发现的缺陷数量为特征的测试生产率与现场的产品缺陷率有关

PA 4.1 定量分析过程属性	成就 1	成就 2	成就 3	成就 4	成就 5	成就 6
输出信息项						
18-70 业务目标	X	X				
07-61 定量过程度量		X	X			
07-62 过程分析技术				X		

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07-63 Process control limits					X	
07-64 Process measurement data						X
Generic Practices						
GP 4.1.1 Identify business goals	X					
GP 4.1.2 Establish process information needs	X					
GP 4.1.3 Identify measurable relationships between process elements		X				
GP 4.1.4 Derive process measurement approach and select analysis techniques			X	X		
GP 4.1.5 Establish quantitative control limits					X	
GP 4.1.6 Collect product and process measurement results through performing the de-fined process						X

5.5.2. PA 4.2 Quantitative control process attribute

Process attribute ID
PA 4.2
Process attribute name
Quantitative control process attribute
Process attribute scope
The quantitative control process attribute is a measure of the extent to which objective data are used to manage process performance that is predictable.
Process attribute achievements
1) Variations in process performance are identified. 2) Assignable causes of process variation are determined through analysis of the collected quantitative data. 3) Distributions that characterize the performance of the process are established. 4) Corrective actions are taken to address assignable causes of variation.

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07-63 过程控制限值					X	
07-64 过程度量数据						X
通用实践						
GP 4.1.1 识别业务目标	X					
GP 4.1.2 建立过程信息需要	X					
GP 4.1.3 识别过程要素之间的度量关系		X				
GP 4.1.4 推导过程度量方法并选择分析技术			X	X		
GP 4.1.5 建立定量控制限值					X	
GP 4.1.6 通过执行已定义过程来收集产品和过程的度量结果						X

5.5.2. PA 4.2 定量控制过程属性

过程属性 ID
PA 4.2
过程属性名称
定量控制过程属性
过程属性范围
定量控制过程属性是：将客观数据用于管理可预测的过程绩效的程度的度量。
过程属性成就
1) 识别过程绩效的波动 2) 通过分析收集到的定量数据，确定了过程波动的可查明原因 3) 建立了表征过程的绩效的分布。 4) 采取了纠正措施以解决波动的可查明原因；

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Generic practices
GP 4.2.1 Identify variations in process performance. Deviations in the performance of process instances from the established quantitative control limits are determined based on the collected quantitative measurement data.
GP 4.2.2 Identify causes of variation. The determined deviations in process performance are analyzed to identify potential cause(s) of variation using the defined analysis techniques. Distributions are used to quantitatively understand the variation of process performance under the influence of potential causes of variation. Consequences of process variation are analyzed.
GP 4.2.3 Identify and implement corrective actions to address assignable causes. Results are provided to those responsible for taking action. Corrective actions are determined and implemented to address each assignable cause of variation. Corrective action results are monitored and evaluated to determine their effectiveness. *Note 1: Assignable cause may indicate a possible problem in the defined process.*

PA 4.2 Quantitative control process attribute	Achievement 1	Achievement 2	Achievement 3	Achievement 4
Output Information Items				
15-57 Quantitative process analysis results	X	X	X	
08-66 Measures against deviations in quantitative process analysis				X
Generic Practices				
GP 4.2.1 Identify variations in process performance	X			
GP 4.2.2 Identify causes of variation		X	X	
GP 4.2.3 Identify and implement corrective actions to address assignable causes				X

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通用实践
GP 4.2.1 识别过程绩效的波动 基于所收集的定量度量数据，确定过程绩效的定量控制限值的偏差。
GP 4.2.2 识别波动的原因 使用已定义的分析技术对过程绩效中确定的偏差进行分析，以识别波动的潜在原因。 了解过程绩效在潜在原因影响下的定量分布变化。 分析了过程波动的后果。
GP 4.2.3 识别和实施纠正措施以解决可查明原因 提供结果给负责采取行动的人。 确定并实施纠正措施，以解决每个波动的可查明原因。 监控和评估纠正措施的结果，以确定其有效性。 *注 1:可查明的原因可能表明所定义的过程中可能存在的问题。*

PA 4.2 定量控制过程属性	成就 1	成就 2	成就 3	成就 4
输出信息项				
15-57 定量过程分析结果	X	X	X	
08-66 在定量过程分析中防止偏差的措施				X
通用实践				
GP 4.2.1 识别过程绩效的波动	X			
GP 4.2.2 识别波动的原因		X	X	
GP 4.2.3 识别和实施纠正措施以解决可查明原因				X

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5.6. Process capability Level 5: Innovating process

The following process attributes, together with the previously defined process attributes, demonstrate the achievement of this level.

5.6.1. PA 5.1 Process innovation process attribute

Process attribute ID
PA 5.1
Process attribute name
Process innovation process attribute
Process attribute scope
The process innovation process attribute is a measure of the extent to which changes to the process are identified from investigations of innovative approaches to the definition and deployment of the process.
Process attribute achievements
1) Process innovation objectives are defined that support the relevant business goals. 2) Quantitative data are analyzed to identify opportunities for innovation. 3) Innovation opportunities derived from new technologies and process concepts are identified.

Generic practices
GP 5.1.1 Define the process innovation objectives for the process that support the relevant business goals. New business visions and goals are analyzed to give guidance for new process objectives and potential areas of process innovation. Quantitative and qualitative process innovation objectives are defined and documented.
GP 5.1.2 Analyze quantitative data of the process. Common causes of variation in process performance across process instances are identified and analyzed to get a quantitative understanding of their impact.

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5.6.过程能力等级 5 级: 创新的过程

以下过程属性结合先前已定义的过程属性，证明达成该等级。

5.6.1. PA 5.1 过程创新过程属性

过程属性 ID
PA 5.1
过程属性的名称
过程创新过程属性
过程属性范围
过程创新过程的过程属性是：从过程的定义和部署的创新方法的调查中识别过程变化的程度的度量。
过程属性成就
1) 定义了支持相关业务目标的过程创新目标 2) 分析了定量数据，以识别创新机会。 3) 识别了来自新技术和过程概念的创新机会

通用实践
GP 5.1.1 定义支持相关业务目标的过程创新目标。 分析新的业务愿景和目标，以指导新的过程目标和过程创新的潜在领域。 定义并记录定量和定性的过程创新目标.
GP 5.1.2 分析过程的定量数据。 识别和分析跨过程绩效波动的共性原因，以定量地理解其影响。

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GP 5.1.3 Identify innovation opportunities.
Identify opportunities for innovation based on the quantitative understanding of the analyzed data. Industry best practices, new technologies and process concepts are identified and evaluated. Feedback on opportunities for innovation is actively sought. Emergent risks are considered in evaluating improvement opportunities.

PA 5.1 Process innovation process attribute	Achievement 1	Achievement 2	Achievement 3
Output Information Items			
18-80 Improvement opportunity	X		X
15-58 Common cause of variation analysis results		X	
Generic Practices			
GP 5.1.1 Define the process innovation objectives for the process that support the relevant business goals	X		
GP 5.1.2 Analyze quantitative data of the process		X	
GP 5.1.3 Identify innovation opportunities			X

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GP 5.1.3 识别创新机会。 基于对分析数据的定量理解，识别创新机会。 识别并评价行业最佳实践、新技术和过程概念，并积极寻求创新机会的反馈。 在评估改进机会时考虑紧急风险。

PA 5.1 过程创新过程属性	成就 1	成就 2	成就 3
输出信息项			
18-80 改进机会	X		X
15-58 波动分析结果的共性原因		X	
通用实践			
GP 5.1.1 定义支持相关业务目标的过程创新目标	X		
GP 5.1.2 分析过程的定量数据		X	
GP 5.1.3 识别创新机会			X

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5.6.2. PA 5.2 Process innovation implementation process attribute

Process attribute ID
PA 5.2
Process attribute name
Process innovation implementation process attribute
Process attribute scope
The process innovation process implementation attribute is a measure of the extent to which changes to the definition, management and performance of the process achieves the relevant process innovation objectives.
Process attribute achievements
1) Impact of all proposed changes is assessed against the objectives of the defined process and standard process. 2) Implementation of all agreed changes is managed to ensure that any disruption to the process performance is understood and acted upon. 3) Effectiveness of process change on the basis of quantitative performance and innovation feedback is evaluated.

Generic practices
GP 5.2.1 Define and assess the impact of proposed changes. Specified changes are assessed against product quality and process performance requirements and goals. Impact of changes to other defined and standard processes is considered. Objective priorities for process innovation are established. Commitment to innovation is demonstrated by organizational management including other relevant stakeholders.
GP 5.2.2 Implement agreed process changes. A mechanism is established for incorporating accepted changes into the defined and standard process(es) effectively and completely. Process changes are implemented and effectively communicated to all affected parties.

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5.6.2. PA 5.2 过程创新实施过程属性

过程属性 ID
PA 5.2
过程属性名称
过程创新实施过程属性
过程属性范围
过程创新实施过程属性是：对过程的定义、管理和绩效的变化达成相关过程创新目标的程度的度量。
过程属性成就
1) 依据已定义过程和标准过程的目标，对所有提议的变更的影响进行了评估。 2) 管理了所有约定的变更的实施，以确保理解过程实施的任何干扰，并采取了行动。 3) 基于量化绩效和创新反馈评估了过程变更的有效性。

通用实践
GP 5.2.1 定义并评估提议变更的影响。 依据产品质量、过程绩效需求和目标，评估特定的变更。 考虑变更对其它已定义过程和标准过程的影响。 为过程创新建立目标的优先级。 组织的管理层包括其他利益相关方证明对创新的承诺。
GP 5.2.2 实施约定的过程变更。 建立机制，以有效地和完全地将接受的变更纳入已定义过程和标准过程中。 实施过程变更，并与所有受影响方进行有效沟通。

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GP 5.2.3 Evaluate the effectiveness of process change. Performance and capability of the changed process are measured and compared with historical data. Performance and capability of the changed process are analyzed to determine whether the process performance has improved with respect to common causes of variations. Other feedback is recorded, such as opportunities for further innovation of the standard process. A mechanism is available for documenting and reporting analysis results to stakeholders of standard and defined process.

PA 5.2 Process innovation implementation attribute	Achievement a	Achievement b	Achievement c
Output Information Items			
18-81 Improvement evaluation results	X		X
08-66 Measures against deviations in quantitative process analysis		X	X
Generic Practices			
GP 5.2.1 Define and assess the impact of proposed changes	X		
GP 5.2.2 Implement agreed process changes		X	
GP 5.2.3 Evaluate the effectiveness of process change			X

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GP 5.2.3 评估过程变更的有效性。

对变更过程的实施和能力进行度量，并与历史数据进行比较。

对变更过程的实施和能力进行分析，以确定过程实施是否根据波动的常见原因得到了改进。

记录其它反馈，例如：进一步创新标准过程的机会。

有记录和报告分析结果给标准过程和已定义过程的利益相关方的机制。

PA 5.2 过程创新实施过程属性	成就 a	成就 b	成就 c
输出信息项			
18-81 改进评价结果	X		X
08-66 在定量过程分析中防止偏差的措施		X	X
通用实践			
GP 5.2.1 定义并评估提议变更的影响	X		
GP 5.2.2 实施约定的过程变更		X	
GP 5.2.3 评估过程变更的有效性			X

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Annex A Conformity statements

Annex A.1 Introduction

The Automotive SPICE process assessment and process reference model are meeting the requirements for conformance defined in ISO/IEC 33004:2015. The process assessment model can be used in the performance of assessments that meet the requirements of ISO/IEC 33002:2015.

This clause serves as the statement of conformance of the process assessment and process reference models to the requirements defined in ISO/IEC 33004:2015.

[ISO/IEC 33004:2015, 5.5 and 6.4]

Due to copyright reasons each requirement is only referred by its number. The full text of the requirements can be drawn from ISO/IEC 33004:2015.

Annex A.2 Conformance to the requirements for process reference models

<u>Clause 5.3, "Requirements for process reference models"</u>

The following information is provided in chapter 1 and 3 of this document:

- the declaration of the domain of this process reference model;
- the description of the relationship between this process reference model and its intended context of use; and
- the description of the relationship between the processes defined within this process reference model.

The descriptions of the processes within the scope of this process reference model meeting the requirements of ISO/IEC 33004:2015 clause 5.4 is provided in chapter 4 of this document.

[ISO/IEC 33004:2015, 5.3.1]

The relevant communities of interest and their mode of use and the consensus achieved for this process reference model is documented in the copyright notice and the scope of this document.

[ISO/IEC 33004:2015, 5.3.2]

The process descriptions are unique. The identification is provided by unique names and by the identifier of each process of this document.

[ISO/IEC 33004:2015, 5.3.3]

<u>Clause 5.4, "Process descriptions"</u>

These requirements are met by the process descriptions in chapter 4 of this document.

[ISO/IEC 33004:2015, 5.4]

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Annex A 符合性声明

Annex A.1 介绍

Automotive SPICE 过程评估模型和过程参考模型满足 ISO/IEC 33004:2015 中所定义的符合性要求。该过程评估模型可用来实施满足 ISO/IEC 33002:2015 所要求的评估。

本条款作为过程评估模型与过程参考模型对于 ISO/IEC33004:2015 中所定义的要求的符合性声明。

> *[ISO/IEC 33004:2015, 5.5 和 6.4]*

由于版权原因，每条要求仅通过其编号来引用。 具体要求的全文可参见 ISO/IEC 33004:2015。

Annex A.2 对于过程参考模型的要求的符合性

条款 5.3，“过程参考模型的要求”

以下信息由本文的第 1 章和第 3 章提供：

- 本过程参考模型领域的声明。
- 本过程参考模型和其预期使用背景之间的关系的说明。
- 本过程参考模型内所定义的过程之间的关系的说明。

满足 ISO/IEC 33004:2015 条款 5.4 要求的过程参考模型范围内的过程描述在本文第 4 章中提供。

> *[ISO/IEC 33004:2015, 5.3.1]*

本过程参考模型的相关利益团体，使用方式以及达成的共识被记录在本文档的版权公告和文档范围中。

> *[ISO/IEC 33004:2015, 5.3.2]*

过程描述是唯一的。本文中每个过程的标识是由唯一的名称和 ID 所提供。

> *[ISO/IEC 33004:2015, 5.3.3]*

条款 5.4，“过程描述”

在本文第 4 章节中的过程描述满足了这些要求。

> *[ISO/IEC 33004:2015, 5.4]*

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Annex A.3 Conformance to the requirements for process assessment models

Clause 6.1, "Introduction"

The purpose of this process assessment model is to support assessment of process capability within the automotive domain using the defined process measurement framework.

[ISO/IEC 33004:2015, 6.1]

Clause 6.2, "Process assessment model scope"

The process scope of this process assessment model is defined in the process reference model included in chapter 3.1 of this document. The Automotive SPICE process reference model is satisfying the requirements of ISO/IEC 33004:2015, clause 5 as described in Annex A.2.

The process capability scope of this process assessment model is defined in the process measurement framework, which defines a process measurement framework for process capability satisfying the requirements of ISO/IEC 33003:2015.

[ISO/IEC 33004:2015, 6.2]

Clause 6.3, "Requirements for process assessment models"

The Automotive SPICE process assessment model is related to process capability.

[ISO/IEC 33004:2015, 6.3.1]

This process assessment model incorporates the defined process measurement framework, which satisfies the requirements of ISO/IEC 33003:2015.

[ISO/IEC 33004:2015, 6.3.2]

This process assessment model is based on the Automotive SPICE Reference Model included in this document.

This process assessment model is based on the defined Measurement Framework.

[ISO/IEC 33004:2015, 6.3.3]

The processes included in this process assessment model are identical to those specified in the Process Reference Model

[ISO/IEC 33004:2015, 6.3.4]

For all processes in this process assessment model all levels defined in the process measurement framework are addressed.

[ISO/IEC 33004:2015, 6.3.5]

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Annex A.3 对于过程评估模型的要求的符合性

条款 6.1，“介绍”

本过程评估模型的目的是：使用已定义的过程度量框架，以支持在汽车领域的过程能力的评估。

> *[ISO/IEC 33004:2015, 6.1]*

条款 6.2，“过程评估模型范围”

本过程评估模型的过程范围是定义在本文第 3.1 章节所包含的过程参考模型中。Automotive SPICE 过程参考模型满足 ISO/IEC 33004:2015 条款 5 的要求，如附录 A.2 所描述。

本过程评估模型的过程能力范围定义在过程度量框架内，定义了满足 ISO/IEC 33003:2015 要求的过程能力的度量框架。

> *[ISO/IEC 33004:2015, 6.2]*

条款 6.3，“过程评估模型的要求”

Automotive SPICE 过程评估模型与过程能力相关联。

> *[ISO/IEC 33004:2015, 6.3.1]*

本过程评估模型满足 ISO/IEC 33003 要求的过程度量框架。

> *[ISO/IEC 33004:2015, 6.3.2]*

本过程评估模型是基于本文中的 Automotive SPICE 参考模型。

本过程评估模型是基于定义的度量框架。

> *[ISO/IEC 33004:2015, 6.3.3]*

本过程评估模型所包含的过程与过程参考模型所定义的过程一致。

> *[ISO/IEC 33004:2015, 6.3.4]*

对于本过程评估模型中的所有过程，过程度量框架中所定义的所有级别都得到表述。

> *[ISO/IEC 33004:2015, 6.3.5]*

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This process assessment model defines

- the selected process quality characteristic;
- the selected process measurement framework;
- the selected process reference model(s);
- the selected processes from the process reference model(s)

in chapter 3 of this document.

[ISO/IEC 33004:2015, 6.3.5 a-d]

In the capability dimension, this process assessment model addresses all of the process attributes and capability levels defined in the process measurement framework.

[ISO/IEC 33004:2015, 6.3.5 e]

Clause 6.3.1, "Assessment indicators"

Note: Due to an error in numbering in the published version of ISO/IEC 33004:2015 the following reference numbers are redundant to those stated above. To refer to the correct clauses from ISO/IEC 33004:2015, the text of clause heading is additionally specified for the following three requirements.

The Automotive SPICE process assessment model provides a two-dimensional view of process capability for the processes in the process reference model, through the inclusion of assessment indicators as defined in chapter 3.3. The assessment indicators used are:

- Base practices and information items

[ISO/IEC 33004:2015, 6.3.1 a, "Assessment indicators"]

- Generic practices and information items

[ISO/IEC 33004:2015, 6.3.1 b, "Assessment indicators"]

Clause 6.3.2, "Mapping process assessment models to process reference models"

The mapping of the assessment indicators to the purpose and process outcomes of the processes in the process reference model is included in the tables for each process in chapter 4.

The mapping of the assessment indicators to the process attributes in the process measurement framework including all of the process attribute achievements is included in the tables for each process attribute in chapter 5.

[ISO/IEC 33004:2015, 6.3.2, "Mapping process assessment models"]

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在本文的第 3 章中，本过程评估模型定义：

- 选定的过程质量特性
- 选定的过程度量框架
- 选定的过程参考模型
- 从过程参考模型选定的过程

> *[ISO/IEC 33004:2015, 6.3.5 a-d]*

在能力维度，本过程评估模型表述了定义的过程度量框架中的所有的过程属性和能力等级。

> *[ISO/IEC 33004:2015, 6.3.5 e]*

条款 6.3.1，“评估指标”

注：由于 ISO/IEC 33004:2015 发布版本的编号错误，以下引用编号与上述重复。为了引用 ISO/IEC 33004:2015 中的正确条款，对以下的三条要求在条款标题中做了补充定义。

Automotive SPICE 过程评估模型通过包含定义在第 3.3 章节的评估指标， 为过程参考模型中的过程的过程能力提供了一个二维视图。使用的评估指标是：

- 基本实践和信息项

> *[ISO/IEC 33004:2015, 6.3.1 a, “评估指标”]*

- 通用实践和信息项

> *[ISO/IEC 33004:2015, 6.3.1 b, “评估指标”]*

条款 6.3.2, “过程评估模型到过程参考模型的映射”

评估指标到过程参考模型中的过程目的及过程成果的映射是被包含在第 4 章的每个过程的表格中。

评估指标到过程度量框架（包含所有过程属性成就）中的过程属性的映射是被包含在第 5 章的每个过程属性的表格中。

> *[ISO/IEC 33004:2015, 6.3.2, “映射过程评估模型”]*

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Clause 6.3.3, "Expression of assessment results"

The process attributes and the process attribute ratings in this process assessment model are identical to those defined in the measurement framework. As a consequence, results of assessments based upon this process assessment model are expressed directly as a set of process attribute ratings for each process within the scope of the assessment. No form of translation or conversion is required.

> *[ISO/IEC 33004:2015, 6.3.3, "Expression of assessment results"]*

Annex A.4 Conformance to the requirements for measurement frameworks

The measurement framework defined in Automotive SPICE 4.0 is an adaption of the measurement framework defined in ISO/IEC 33020:2019. The following modifications have been performed:

- Renaming of the Process attribute titles.
- Changes in the generic practices.
- Assignments of indicators to process attribute achievements.

Conceptualization, Construct definition and Operationalization relevant for conformity to ISO/IEC 33003:2015 has been adopted from ISO/IEC 33020:2019.

The conformity of the Automotive SPICE Measurement Framework is thereby confirmed based on the existing conformance statement of 33020:2019.

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条款 6.3.3，“评估结果的表示形式”

过程评估模型中的过程属性和过程属性评定与度量框架中所定义内容一致。作为结果，基于本过程评估模型的评估结果是直接被表示为评估范围内每个过程的一组过程属性的评定。不需要任何形式翻译或转换。

> *[ISO/IEC 33004:2015, 6.3.3, “评估结果的表示形式”]*

Annex A.4 对于度量框架的要求的符合性

Automotive SPICE 4.0 中定义的度量框架采自 ISO/IEC 33020:2019 中定义的度量框架，并进行了以下的修改：

- 对过程属性标题进行了重命名。
- 通用实践中的变化。
- 关于过程属性达成指标的分配。

与 ISO/IEC 33003:2015 符合性相关的概念化、结构定义和操作化已从 ISO/IEC 33020:2019 中采用。

根据现有的 ISO/IEC 33020:2019 的符合性声明，Automotive SPICE 度量框架的符合性也因此得到了确认。

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Annex B Information Item Characteristics

Characteristics of information items are defined using the schema in table B.1. See Section 3.3.2 on the definition and explanation on how to interpret information items and their characteristics.

Information item identifier	An identifier number for the information item which is used to reference the information item.
Information item name	Provides an example of a typical name associated with the information item characteristics. This name is provided as an identifier of the type of information item the practice or process might produce. Organizations may call these information items by different names. The name of the information item in the organization is not significant. Similarly, organizations may have several equivalent information items which contain the characteristics defined in one information item type. The formats for the information items can vary. It is up to the assessor and the organizational unit coordinator to map the actual information items produced in their organization to the examples given here.
Information item characteristics	Provides examples of the potential characteristics associated with the information item types. The assessor may use these in evaluating the samples provided by the organizational unit. It is not intended to use the listed characteristics as a checklist. Some characteristics may be contained in other work products, as it would be found appropriate in the assessed organization.

Table B.1 — Structure of information item characteristics (IIC) table

ID	Name	Characteristics
01-03	Software component	• Software element in the software architecture above the software unit level. • Represented by a design model element or executable code such as libs or scripts and a configuration description, if applicable.
01-50	Integrated software	• Software executable (e.g, simulator with stubbing, debug-able, object code) including: - application parameter files (being a technical implementation solution for configurability-oriented requirements) - all configured software elements
01-52	Configuration item list	• Items under configuration control • The name of work products and an associated reference (to file, to tool artifact) • Configuration item attributes and properties
01-53	Trained ML model	• The trained ML model is the output of the training process. It consists of the software representing the ML architecture, the set of weights which were optimized during the training, and the final set of hyperparameters.

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Annex B 信息项特性

信息项特性使用表 B.1 模式进行定义。详见 3.3.2 章节中关于如何诠释信息项, 及其特性的定义和解释。

信息项 ID	用于引用信息项的标识编号。
信息项名称	提供与信息项特性相关联的典型名称的示例。 此名称是由实践或过程可产出的信息项的类型的标识。 组织可使用其他名称来命名这些信息项。 在组织中信息项的名称并不重要。同样，组织可有多个等效的信息项而包含一个信息项类型中所定义的特性。 信息项的格式可多种多样。由评估师和组织单位协调员，将其组织所产出的实际信息项映射到这里给出的示例。
信息项特性	提供与信息项类型相关联的潜在特性的示例。评估师可在评估组织单位所提供的样例的过程中使用这些特性。其意图并不是将所罗列的特性作为检查单进行使用。在被评估的组织中，可能发现某些特性被包含在其他工作产品中是恰当的。

表 B.1 —信息项特性（IIC）表的结构

ID	名称	特性
01-03	软件组件	• 软件架构中，在软件单元层级之上的软件要素。 • 如适用，由设计模型要素，或可执行代码（例如库或脚本）以及配置描述所表示。
01-50	集成软件	• 软件可执行文件（例如，带有打桩、可调试的目标代码的模拟程序）包含： - 应用参数文件（作为面向可配置性需求的技术实施方案) - 所有已配置的软件要素
01-52	配置项清单	• 处于配置控制的项 • 工作产品名称及关联的引用（文件，工具制品） • 配置项属性和特性
01-53	已训练的 ML 模型	• 已训练的 ML 模型是训练过程的输出。由代表 ML 架构的软件、在训练过程中优化的权重集、以及最终的超参数集所组成。

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01-54	Hyperparameter	• Hyperparameters are used to control the ML model which has to be trained, e.g.: - Learn rate of training - Scaling of network (number of layers or neurons per layer) - Loss function • Minimum characteristics: - Description - Initial value - Final value upon communicating the results of the ML training
02-01	Commitment / agreement	• Signed off by all parties involved in the commitment/agreement • Establishes what the commitment is for • Establishes the resources required to fulfill the commitment, such as: - time - people - budget - equipment - facilities

03-06	Process performance information	• Measurements about defined quantitative or qualitative measurable indicators, that match defined information needs.
		• Measurement metrics for the calculation of the quantitatively or qualitatively measurable indicators
		• Data comparing process performance against expected levels
		• Examples for project performance information:
		- resource utilization against established target
		- time schedule against established target
		- activity or task completion criteria met
		- defined input and output work products available
		- process quality against quality expectations and/or criteria
		- product quality against quality expectations and/or criteria
		- highlight product performance issues, trends
		• Examples for service level performance information:
		- references any goals established
		- real time metrics related to aspects such as:
		    - capacity
		    - throughput
		    - operational performance
		    - operational service
		    - service outage time
		    - up time
		    - job run time

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01-54	超参数	• 超参数用于控制需要训练的 ML 模型, 例如: - 训练的学习率 - 网络的缩放（层的数量或各层的神经元数） - 损失函数 • 最小特性: - 描述 - 初始值 - 传递 ML 训练结果后的最终值
02-01	承诺/协议	• 由承诺/协议的所有参与方签署 • 建立对什么的承诺 • 建立为满足承诺所需的资源，例如： - 时间 - 人 - 预算 - 设备 - 设施
03-06	过程实施信息	- 关于已定义的定量或定性的可度量指标的度量，与已定义的信息需要相匹配。 - 用于计算定量或定性的可度量指标的度量项 - 将过程实施与预期水平进行比较的数据 - 项目实施信息的示例: - 依照已确立目标的资源使用 - 依照已确立目标的时间进度 - 活动或任务的完成准则得到满足 - 定义的输入以及输出工作产品是可用的 - 依照质量预期和/或准则的过程质量 - 依照质量预期和/或准则的产品质量 - 强调的产品性能问题、趋势 - 服务级别实施信息的示例： - 引用所有已建立的目标 - 实时度量相关方面，例如: - 能力 - 生产能力 - 运行性能 - 运行服务 - 服务中断时间 - 可服务时间 - 工作运行时间

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03-50	Verification Measure data	• Verification measure data are data recorded during the execution of a verification measure, e.g.: - for test cases: raw data, logs, traces, tool generated outputs - measurements: values - calculations: values - simulations: protocol - reviews such as optical inspections à findings record - analyses: values
03-51	ML data set	• Selection of ML Data for e.g., ML model training (ML Training and Validation Data Set) or test of the trained and deployed ML model (ML Test Data Set).
03-53	ML data	• Datum to be used for Machine Learning. The datum has to be attributed by metadata, e.g., unique ID and data characteristics. Examples: - Visual data like a photo or videos (but a video could also be considered as sequence of photos depending on the intended use) - Audio recording - Sensor data - Data created by an algorithm - Data might be processed to create additional data. E.g., processing could add noise, change colors or merge pictures.
03-54	Hardware production data	• Consists of bill of materials • Consists of layout e.g, GERBER data • Specifies requirements for EOL test e.g.: - Test type (AOI, ICT, boundary scan) - Test coverage - Electrical loads - Acceptance criteria • In case of semiconductor development: mask data (GDS2)

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03-50	验证措施数据	• 验证措施数据是在执行验证措施中记录的数据，例如: - 关于测试用例：原始数据，日志，记录，工具生成的输出 - 测量：值 - 计算: 值 - 仿真: 协议 - 评审例如光学检测，评审记录 - 分析: 值
03-51	ML 数据集	• 选择 ML 数据，例如，为了训练 ML 模型（ML 训练和验证数据集）或为了测试训练后和部署后的 ML 模型（ML 测试数据集）。
03-53	ML 数据	• 用于机器学习的数据点。数据点必须由元数据进行属性化，例如，唯一 ID 和数据特性。示例: - 视觉数据，如照片或视频（但根据预期用途，视频也可以被视为照片序列） - 录音 - 传感器数据 - 由算法创建的数据 - 也可能通过处理数据以创建其他数据。例如，处理可以添加噪音、更改颜色或合并图片。
03-54	硬件生产数据	• 包含物料清单（BOM） • 包含布局，例如： GERBER 数据 • EOL 测试的特定需求，例如： - 测试类型（AOI、ICT、边界扫描） - 测试覆盖率 - 电气负载 - 验收准则 • 如果是半导体开发：掩模数据（GDS2）

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04-04	Software architecture	• A justifying rationale for the chosen architecture. • Individual functional and non-functional behavior of the software component • Settings for application parameters (being a technical implementation solution for configurability-oriented requirements) • Technical characteristics of interfaces for relationships between software components such as: - Synchronization of Processes and tasks - Programming language call - APIs - Specifications of SW libraries - Method definitions in an object- oriented class definitions or UML/SysML interface classes - Callback functions, "hooks" • Dynamics of software components and software states such as: - Logical software operating modes (e.g, start-up, shutdown, normal mode, calibration, diagnosis, etc.) - intercommunication (processes, tasks, threads) and priority - time slices and cycle time - interrupts with their priorities - interactions between software components • Explanatory annotations, e.g, with natural language, for single elements or entire diagrams/models.
04-05	Software detailed design	• Elements of a software detailed design: - Control flow definition - Format of input/output data - Algorithms - Defined data structures - Justified global variables - Explanatory annotations, e.g, with natural language, for single elements or entire diagrams/models • Examples for expression languages, depending on the complexity or criticality of a software unit: - natural language or informal languages - semi-formal languages (e.g, UML, SysML) - formal languages (e.g, model-based approach)

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04-04	软件架构	• 所选架构的合理依据 • 软件组件的单独功能性和非功能性行为 • 应用参数的设置（作为面向配置需求的技术实现方案） • 软件组件间关联接口的技术特性，例如： - 进程和任务的同步 - 编程语言调用 - API 函数 - 软件库的规范 - 面向对象类定义中的方法定义或者 UML/SysML 接口类 - 回调函数，“钩子函数（Hooks）” • 软件组件以及软件状态的动态，例如： - 逻辑软件运行模式（例如:启动、关机、正常模式、标定和诊断等） - 内部通信（进程，任务，线程）以及优先级 - 时间片和周期时间 - 中断及其优先级 - 软件组件间交互 • 解释性注释，例如，使用自然语言，用于单个要素或整个图表/模型。
04-05	软件详细设计	• 软件详细设计的要素： - 控制流定义 - 输入/输出数据格式 - 算法 - 定义的数据结构 - 合理的全局变量 - 解释性注释，例如，使用自然语言，用于单个要素或整个图表/模型。 • 表达式语言的示例，取决于软件单元的复杂性或关键性： - 自然语言或非正式语言 - 半形式语言（例如，UML、SysML） - 形式语言（例如，基于模型的方法）

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04-06	System architecture	• A justifying rationale for the chosen architecture.
		• Individual behavior of system elements
		• Interrelationships between system elements
		Settings for system parameters (such as application parameters)
		Manual/human control actions, e.g., according to STPA
		• Interface Definitions:
		- Technical characteristics of interfaces for relationships between two system elements
		• Interfaces between system elements e.g.:
		- bus interfaces (CAN, MOST, LIN, Flexray etc.)
		- thermal influences
		- hardware-software-interfaces (HSI), see below
		- electromagnetic interfaces
		- optical interfaces
		- hardware-mechanical-interfaces (e.g., a cable satisfying both mechanical and electrical requirements, housing interface to a PCB)
		- hardware-mechanical interconnection technology such as connectors, pressfit
		- creepage and clearance distances
		• Fixations such as adhesive joints, screw bolts/fitting, riveted bolts, welding
		• System interfaces related to EE Hardware e.g.:
		- analogue or digital interfaces (PWM, I/O) and their pin configurations
		- SPI bus, I2C bus, electrical interconnections
		- placement, e.g., thermal interfaces between hardware elements (heat dissipation)
		- soldering
		- creepage and clearance distances
		• Interfaces for mechanical engineering e.g.:
		- friction
		- thermal influences
		- tolerances
		- clutches
		- fixations such as adhesive joints, screw bolts/fitting, riveted bolts, welding
		- forces (as a result of e.g., vibrations or friction)
		- placement
		- shape
		- A hardware-software interface, e.g.:
		    - connector pin configurations and floating IOs for µCs/MOSFETs
		    - signal scaling & resolution to be reflected by the application software

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04-06	系统架构	• 所选架构的合理依据
		• 系统要素的单独行为
		• 系统要素间的关联关系
		系统参数的设置（例如应用参数）
		手动/人工控制操作，例如：按照 STPA
		• 接口定义
		- 两个系统要素间关联接口的技术特性
		• 系统要素间接口，例如：
		- 总线接口 (CAN, MOST, LIN, Flexray 等)
		- 热影响
		- 软硬件接口(HSI), 见下文
		- 电磁接口
		- 光接口
		- 硬件-机械接口（例如：同时满足机械和电气需求的线束, PCB 的外壳接口）
		- 硬件-机械互连技术，如接插件，无焊压接
		- 爬电距离和电气间隙
		• 固定装置，如粘接接头、螺钉螺栓/配件、铆接螺栓、焊接
		• 电子电气硬件相关系统接口 ，例如：
		- 模拟或数字接口（PWM, I/O）及其引脚配置
		- SPI 总线, I2C 总线, 电气互连
		- 放置，例如：硬件要素间的热接口（散热）
		- 软焊
		- 爬电距离和电气间隙
		• 机械工程的接口，例如：
		- 摩擦
		- 热影响
		- 公差
		- 离合器
		- 固定装置，如粘接接头、螺钉螺栓/配件、铆接螺栓、焊接
		- 力（例如振动或摩擦造成的力）
		- 放置
		- 形状
		- 软硬件接口，例如：
		  - 用于 µCs/MOSFET 的连接器的引脚配置和浮接输入输出
		  - 由应用软件所反映的信号缩放和分辨率

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		• Mechanical-hardware interfaces e.g. - such as mechanical dimensioning - positioning of connectors - positioning of e.g., hall sensors in relation to the bus-bar - tolerances • Dynamics of system elements and system states: - Description of the system states and operation modes (startup, shutdown, sleep mode, diagnosis/calibration mode, production mode, degradation, emergency such as “limp-home”, etc.) - Description of the dependencies among the system components regarding the operation modes - Interactions between system elements such as inertia of mechanical components to be reflected by the ECU, signal propagation and processing time through the hardware and software and e.g., bus systems • Explanatory annotations, e.g., with natural language, for single elements or entire diagrams/models.
04-51	ML architecture	• An ML architecture is basically a special part of a software architecture (see 04-04). Additionally - ML architecture describes the overall structure of the ML-based software element - ML architecture specifies ML architectural elements including an ML model and other ML architectural elements, provided to train, deploy, and test the ML model. - describes interfaces within the ML-based software element and to other software elements - ML architecture describes details of the ML model like used layers, activation functions, loss function, and backpropagation - ML architecture contains defined hyperparameter ranges and initial values for training start - resource consumption objectives are defined - ML architecture contains allocated ML requirements
04-52	Hardware architecture	• Describes the initial floorplan and the overall hardware structure • Identifies the required hardware components • Includes the rationale for chosen options of hardware architecture • Identifies own developed and supplied hardware components • Identifies the required internal and external hardware component interfaces • Specifies the interfaces of the hardware components • Specifies the dynamic behavior • Identifies the relationship and dependency between hardware components • Describes all hardware variants to be developed • Describes power supply, thermal and grounding concepts

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		• 机械-硬件接口，例如 - 如机械尺寸 - 接插件位置 - 位置，例如:霍尔传感器相对于母线的定位 - 公差 • 系统要素以及系统状态的动态： - 描述系统状态和运行模式（启动、关机、休眠模式、诊断/标定模式、生产模式、降级、紧急如“跛行”等） - 描述关于运行模式的系统组件间依赖关系 - 系统要素间的交互，例如由 ECU 所反映的机械组件的惯性、信号传播以及通过硬件和软件（例如总线系统）的处理时间 • 解释性注释，例如，使用自然语言，用于单个要素或整个图表/模型。
04-51	ML 架构	• ML 架构基本上是软件架构(见 04-04)的特殊部分。此外 - ML 架构描述基于 ML 的软件要素的整体结构 - ML 架构定义了 ML 架构要素，其中包括 ML 模型和其他的 ML 架构要素。这些要素用于训练、部署和测试 ML 模型。 - 描述基于 ML 软件内部接口以及和其他软件要素间的接口 - ML 描述 ML 模型的细节，如使用的层级、激活函数、损失函数和反向传播 - ML 架构包含定义的超参数范围和训练开始时的初始值 - 资源消耗目标得到定义 - ML 架构包含分配的 ML 需求
04-52	硬件架构	• 描述初始平面图和整体硬件结构 • 识别所需的硬件组件 • 包含所选硬件架构选项的依据 • 识别自主开发和被提供的硬件组件 • 识别所需的内部和外部硬件组件的接口 • 定义硬件组件的接口 • 定义动态行为 • 识别硬件组件间的关系和依赖关系 • 描述需要开发的所有硬件的变体 • 描述电源，热和接地概念设计

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04-53	Hardware detailed design	• Describes the interconnections between the hardware parts • Specifies the interfaces of the hardware parts • Specifies the dynamic behavior (examples are: transitions between electrical states of hardware parts, power-up and power-down sequences, frequencies, modulations, signal delays, debounce times, filters, short circuit behavior, self-protection) • Describes the conclusions and decisions based on e.g., analysis reports, datasheets, application notes • Describes the constraints for layout
04-54	Hardware Schematics	• Identifies the hardware parts • Specifies the connections of the hardware parts • Specifies the unique identification of all hardware parts • Specifies unique variant identification
04-55	Hardware Layout	• Specifies the placement of the hardware parts and labels • Specifies manufacturing data e.g., circuit paths (width, routing), vias, testing points, number of layers, drillings, material of the PCB, shape, soldering resist mask, PCB coating • Specifies a unique layout identification
04-56	Hardware element interface	• is defined by output, input, type, and electrical characteristics including signal tolerances. • Examples of interfaces are - high level interfaces like SPI, I2C, CAN, LIN, Ethernet - electrical interconnections - thermal interfaces between hardware elements (heat dissipation)
06-04	Training material	• Updated and available for new releases • Coverage of system, application, operations, maintenance as appropriate to the application • Course listings and availability
06-50	Integration sequence instruction	• Identification of required physical elements (e.g., hardware, mechanical, wiring elements), and software executables and application parameters (being a technical implementation solution for configurability-oriented requirements) • necessary sequence or ordering of integration • preconditions for starting system integration
06-51	Tailoring guideline	• Criteria for tailoring, • Proceeding of tailoring describing how to derive and document the defined process from the standard process including responsibility for tailoring and corresponding approval • Requirements for the defined process to ensure integrity and consistency of the defined process • Subset of process assets that is essential for the defined process

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04-53	硬件详细设计	• 描述硬件元器件间的关连 • 定义硬件元器件的接口 • 定义动态行为（例如：硬件元器件电气状态之间的迁移、上电和下电时序、频率、调制、信号延迟、去抖动时间、滤波器、短路行为、自我保护） • 描述基于例如分析报告、数据表、应用说明等的结论和决策 • 描述布局的约束
04-54	硬件原理图	• 识别硬件元器件 • 定义硬件元器件的连接 • 定义所有硬件元器件的唯一标识 • 定义唯一的变体标识
04-55	硬件布局	• 定义硬件元器件和标签的位置 • 定义制造数据，例如电路路径（宽度、布线）、通孔、测试点、层数、钻孔、PCB 材料、形状、阻焊阻掩模、PCB 涂层 • 定义唯一的布局标识
04-56	硬件要素接口	• 由输出、输入、类型以及电气特性（包括信号容差）来定义。 • 接口示例： - SPI、I2C、CAN、LIN、以太网等高级别的接口 - 电气互连 - 硬件要素间的热接口（散热）
06-04	培训资料	• 新发布的培训资料得到更新并可用 • 根据应用，适当地覆盖系统、应用、操作和维护的范围 • 课程列表及可用性
06-50	集成顺序操作指导	• 识别所需的物理要素（例如硬件、机械、布线要素），以及软件可执行文件和应用参数（作为面向可配置性需求的技术实现解决方案） • 集成的必要顺序或排序 • 开始系统集成的前置条件
06-51	裁剪指南	• 裁剪的准则， • 实施裁剪描述如何从标准过程推导出和记录已定义过程，包括裁剪和相应审批的职责 • 对已定义过程的需求，以确保已定义过程的完整性和一致性 • 已定义过程至关重要的过程资产子集

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06-52	Backup and recovery mechanism information	• Description / confirmation of existing backup and recovery mechanisms • References to corresponding procedures or regulations
07-04	Process metric	• Measurements about the process' performance: - ability to produce sufficient work products - adherence to the process - time it takes to perform process - defects related to the process • Measures the impact of process change • Measures the efficiency of the process
07-05	Project metric	• Monitors key processes and critical tasks, provides status information to the project on: - project performance against established plan - resource utilization against established plan - time schedule against established plan - process quality against quality expectations and/or criteria - product quality against quality expectations and/or criteria - highlight product performance problems, trends • Measures the results of project activities: - tasks are performed on schedule - product's development is within the resource commitments allocated • References any goals established
07-06	Quality metric	• Measures quality attributes of the work products defined: - functionality - reliability - usability - efficiency - maintainability - portability • Measures quality attributes of the "end customer" quality perception *Note: Refer ISO/IEC 25010 for detailed information on measurement of product quality.*

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06-52	备份和恢复机制信息	• 当前备份/恢复机制的描述/确认 • 引用对应的规程或法规
07-04	过程度量项	• 关于过程实施的度量 - 产生足够的工作产品的能力 - 对过程的遵循度 - 执行过程需要的时间 - 过程相关的缺陷 • 度量过程变更的影响 • 度量过程的效率
07-05	项目度量项	• 监控重要过程和关键任务，为项目提供以下状态信息： - 依照已建立计划的项目实施 - 依照已建立计划的资源使用 - 依照已建立计划的时间进度 - 依照质量预期和/或准则的过程质量 - 依照质量预期和/或准则的产品质量 - 强调的产品性能问题、趋势 • 度量项目活动的结果： - 任务按进度执行 - 产品开发在资源分配承诺范围内 • 引用所有已建立的目标
07-06	质量度量项	• 度量定义的工作产品的质量属性： - 功能性 - 可靠性 - 可用性 - 效率 - 可维护性 - 可移植性 • 度量“最终用户“质量感知的质量属性 *注：关于产品质量度量的详细信息参见 ISO/IEC 25010。*

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07-08	Service level metric	• Real time metrics taken while a system is operational, it measures the system's performance or expected service level • Identifies aspects such as: - capacity - throughput - operational performance - operational service - service outage time - up time - job run time

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07-08	服务级别度量项	• 系统运行时所得到的实时度量项是对系统性能或预期服务级别进行度量 • 识别以下方面，例如： - 能力 - 生产能力 - 运行性能 - 运行服务 - 服务中断时间 - 可服务时间 - 工作运行时间

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07-51	Measurement result	Result of gathering qualitative or quantitative data, e.g., Process metric • Measurements about the process' performance: - ability to produce sufficient work products - adherence to the process - time it takes to perform process - defects related to the process • Measures the impact of process change • Measures the efficiency of the process Project metric • Monitors key processes and critical tasks, provides status information to the project on: - project performance against established plan - resource utilization against established plan - time schedule against established plan - process quality against quality expectations and/or criteria - product quality against quality expectations and/or criteria - highlight product performance problems, trends • Measures the results of project activities: • tasks are performed on schedule • product's development is within the resource commitments allocated • References any goals established Quality metric • Measures quality attributes of the work products defined: - functionality - reliability - usability - efficiency - maintainability - portability • Measures quality attributes of the "end customer" quality perceptionService level metric • Benchmarking data • Customer satisfaction survey

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7-51	度量结果	定量或定性数据收集的结果，例如： 过程度量项 • 关于过程实施的度量 - 产生足够的工作产品的能力 - 对过程的遵循度 - 执行过程需要的时间 - 过程相关的缺陷 • 度量过程变更的影响 • 度量过程的效率 项目度量项 • 监控重要过程和关键任务，为项目提供以下状态信息： - 依照已建立计划的项目实施 - 依照已建立计划的资源使用 - 依照已建立计划的时间进度 - 依照质量预期和/或准则的过程质量 - 依照质量预期和/或准则的产品质量 - 强调的产品性能问题、趋势 • 度量项目活动的结果： • 任务按时执行 • 产品开发在资源分配承诺范围内 • 引用所有已建立的目标 质量度量项 • 度量定义的工作产品的质量属性： - 功能性 - 可靠性 - 可用性 - 效率 - 可维护性 - 可移植性 • 度量“最终用户“质量感知服务水平指标的质量属性 • 对标数据 • 客户满意度调查

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07-61	Quantitative process metric	• Quantitatively measurable indicators that match information needs derived from business goals • Relation of the quantitatively measurable indicators to process elements in process descriptions or repositories and tools • Process measurement metrics for the calculation of the quantitatively measurable indicators, based on data from related process elements, repositories, or tools
07-62	Process analysis technique	• Methods for statistical analysis of process data • Frequency of data collection.
07-63	Process control limits	• Quantitative control limits for the quantitative process metrics
07-64	Process measurement data	• Data collected across process instances • Attributes of data, e.g., timestamps • Relation to process measurement metrics • Storage and retrieval • Effective controls over access
15-57	Quantitative process analysis results	• Deviations, and distributions, of the quantitative performance of individual process instances performance from the established quantitative control limits (special causes of variations)
08-66	Measures against deviations in quantitative process analysis	• Definition of counter measures actions to address each assignable cause of special causes of variation, or common causes of variation • Effective implementation of these counter measures
15-58	Common cause of variation analysis results	• Identification of common causes - deviations of the quantitative performance of all process instances from the established quantitative control limits - distributions of the quantitative performance of all process instances within established quantitative control limits
08-53	Scope of work	• Summary of deliverables for a project • Intended use for the deliverables • Main functions to be realized • Target delivery date and major milestones • Work products and activities that are not in scope of the project as needed • Target markets • Applicable standards and legal requirements • Reuse options • Integration of third party deliveries
08-54	Feasibility analysis	• Statement about the ability of the project to achieve the project objectives with available resources

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07-61	定量过程度量项	• 可定量度量的指标，与业务目标导出的信息相符合 • 可定量度量的指标与过程描述或储存库及工具中的过程要素的关系。 • 基于相关过程要素、储存库或工具的数据的过程度量项被用于计算可定量度量的指标
07-62	过程分析技术	• 过程数据统计分析的方法 • 数据收集的频率
07-63	过程控制限值	• 定量过程度量项的定量控制限值
07-64	过程度量数据	• 跨过程实例收集的数据 • 数据的属性，例如时间戳 • 与过程度量指标的关系 • 存储和检索 • 对访问的有效控制
15-57	定量过程分析结果	• 单独过程实例的定量绩效与既定定量控制限值的偏差和分布（波动的特定原因）
08-66	应对定量过程分析中偏差的措施	• 定义应对措施行动以解决波动的可查明原因，或波动的共同原因 • 有效执行这些应对措施
15-58	波动的共同原因的分析结果	• 识别共同原因 - 所有过程实例的定量绩效与既定定量控制限值的偏差 - 在既定定量控制限值内所有过程实例的定量绩效的分布
08-53	工作范围	• 项目交付物总结 • 交付物的预期用途 • 需实现的主要功能 • 目标交付日期和主要里程碑 • 根据需要项目范围外的工作产品和活动 • 目标市场 • 适用的标准和法规要求 • 重用选项 • 第三方交付的集成
08-54	可行性分析	• 关于项目利用可用资源达成项目目标的能力的声明

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08-55	Risk measure	• Identifies - the risk to be mitigated, avoided, or shared (transferred) - the activities to mitigate, avoid, or share (transfer) the risk - the originator of the measure - criteria for successful implementation - criteria for cancellation of activities - frequency of monitoring • Risk treatment alternatives: - treatment option selected- avoid/reduce/transfer - alternative descriptions - recommended alternative(s) - justifications
08-56	Schedule	• Identifies the activities to be performed • Identifies the expected, and actual, start and completion date for required activities against progress/completion of activities • Identifies dependencies between activities and critical path • Has a mapping to scheduled resources and input data • Identifies resource allocation, resource workload, and critical resources *NOTE: A schedule is consistent with the defined work packages, see 14-10*
08-57	Validation Measure Selection Set	• Include criteria for re-validation in the case of changes (regression). • Identification of validation measures, also for regression
08-58	Verification Measure Selection Set	• Include criteria for re-verification in the case of changes (regression). • Identification of verification measures, also for regression testing
08-59	Validation Measure	• A validation measure can be a test case, a measurement, a simulation, an emulation, or an end user survey • The specification of a validation measure includes - pass/fail criteria for validation measures (completion and end criteria) - a definition of entry and exit criteria for the validation measures, and abort and re-start criteria • Techniques • Necessary validation environment & infrastructure • Necessary sequence or ordering
08-60	Verification Measure	• A verification measure can be a test case, a measurement, a calculation, a simulation, a review, an optical inspection, or an analysis • The specification of a verification measure includes - pass/fail criteria for verification measures (test completion and ending criteria) - a definition of entry and exit criteria for the verification measures, and abort and re-start criteria • Techniques (e.g., black-box and/or white-box-testing, equivalence classes and boundary values, fault injection for Functional Safety, penetration testing for Cybersecurity, back-to- back testing for model-based development, ICT)

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08-55	风险措施	• 识别 - 需要缓解、避免或分担（转移）的风险 - 缓解、避免或分担（转移）风险的活动 - 措施的发起人 - 成功实施的准则 - 取消活动的准则 - 监测频率 • 风险处理备选方案: - 选择处理方案-避免/降低/转移 - 备选方案描述 - 推荐的备选方案 - 理由
08-56	进度计划	• 识别要执行的活动 • 依据活动的进度/完成，识别所需活动的预期和实际开始和完成日期 • 能识别活动间依赖关系和关键路径 • 具有对计划资源和输入数据的映射 • 识别资源分配、资源工作负荷以及关键资源 *注：进度计划与定义的工作包一致，见 14-10*
08-57	确认措施选择集	• 包括在发生变更（回归）情况下的重新确认的准则。 • 识别确认措施，也适用回归
08-58	验证措施选择集	• 包括在发生变更（回归）情况下的重新验证的准则。 • 识别验证措施，也适用回归测试
08-59	确认措施	• 确认措施可以为测试用例、测量、仿真、模拟或最终用户调查 • 确认措施的规范包含 - 确认措施的通过/失败准则(完成和结束准则) - 确认措施的准入和准出准则，以及中止和重启的准则的定义 • 技术 • 必要的确认环境和基础设施 • 必要的顺序或排序
08-60	验证措施	• 验证措施可以为测试用例、测量、计算、仿真、评审、光学检测或分析 • 验证措施的规范包含 - 验证措施的通过/失败准则(完成和结束准则) - 验证措施的准入和准出准则，以及中止和重启的准则的定义 • 技术（例如黑盒 和/或 白盒测试、等价类和边界值、功能安全的故障注入，网络安全的渗透测试、基于模型开发的背靠背测试、ICT）

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		• Necessary verification environment & infrastructure • Necessary sequence or ordering
08-61	Resource allocation	• Detailed / named resources are allocated to process tasks • Overall resource workload is considered (e.g., allocation of resources to multiple projects) *NOTE: Work breakdown structure may be used to refine the detailed resource allocation* *NOTE: A resource allocation may be integrated in a/ be a part of the schedule, see 08-56* *NOTE: Resources to be allocated are e.g., personnel/human resources for project roles and physical and material resources such as (special/limited) equipment, tool, licenses, test hardware, test vehicle, climate chambers etc.*
08-62	Communication matrix	• List of relevant process internal / external stakeholders • Roles and contact information of the parties involved • Definition of required interfaces between stakeholders • Communication subject • Communication means and frequency • Documentation needs of the communication (e.g., type of communication record)
08-63	Process Monitoring Method	• Measures including criteria for monitoring effectiveness, suitability, and adequacy of the standard process • Method for collecting and analyzing the monitoring measures
08-64	ML test approach	• The ML test approach describes - ML test scenarios with distribution of data characteristics (e.g., gender, weather conditions, street conditions within the ODD) defined by ML requirements - quantity of each ML test scenario inside the test data set - expected test result per test datum - pass/fail criteria for the ML testing - entry and exit criteria for the ML testing - the required ML testing infrastructure and environment configuration
08-65	ML training and validation approach	• The ML Training and Validation approach describes at least: - entry and exit criteria of the ML training - approaches for hyperparameter tuning / optimization to be used in the training - approach for data set creation and modification - training environment, including required training hardware (e.g., GPU, or supercomputer to be used) - interface adapter for provision of input data and storage of output data - if required, actions to organize the data set and training environment • The ML training and validation approach may additionally include robustification methods like random dropout

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		• 必要的验证环境和基础设施 • 必要的顺序或排序
08-61	资源分配	• 详细的/指定的资源分配给过程任务 • 整体资源的工作负荷得到考虑 (例如将资源分配给多个项目) *注：工作分解结构可用于细化详细的资源分配* *注：资源分配可以集成在进度计划的一部分中，参见 08-56* *注：需分配的资源，包括项目角色的人员/人力资源以及实物和物料资源，例如（特殊/有限）设备、工具、许可证、测试硬件、测试车辆、气候室等。*
08-62	沟通矩阵	• 相关过程内部/外部利益相关方清单 • 参与方的角色和联系信息 • 定义利益相关方之间所需的接口人 • 沟通主题 • 沟通方式和频率 • 沟通的文档化需要（例如，沟通记录的类型）
08-63	过程监控方法	• 措施，包括监控标准过程有效性、适用性和充分性的准则 • 收集和分析监控措施的方法
08-64	ML 测试方法	• ML 测试方法描述 - ML 测试场景，具有 ML 需求所定义的数据特征分布（例如，性别、天气条件、ODD 内的街道条件） - 测试数据集中各机器学习测试场景的数量 - 各测试数据点的预期测试结果 - ML 测试的通过/失败准则 - ML 测试的准入和准出准则 - 所需的 ML 测试基础设施和环境配置
08-65	ML 训练和验证方法	• ML 训练和确认方法至少描述： - ML 训练的准入和准出准则 - 训练中使用的超参数调整/优化方法 - 数据集创建和修改的方法 - 训练环境，包括所需的训练硬件（例如要使用的 GPU 或超级计算机） - 用于提供输入数据和存储输出数据的接口适配 - 如果需要，组织数据集以及训练环境的行动 • ML 训练和验证方法可能还包括鲁棒性方法，例如随机丢弃法

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10-00	Process description	• Process description of a standard or defined process (e.g., after tailoring), including: - scope and the intended use of the process - process activities including description and dependencies - entry and exit criteria such as input information needed and expected outputs for activities - Roles assigned to process activities (e.g., as RASIC) or work products - guidelines - templates - specific methods/work instructions
10-50	Role description	• Name/identifier (unique within the organization) • Assigned activities (e.g., as RASIC) • Responsibilities and authorities • Required competencies, skills, and experience
10-51	Qualification method description	• Training courses • Training materials • Mentoring/coaching concepts • Self-learning material
10-52	Process resource and infrastructure description	• Required facilities • Required tools and corresponding licenses • Required networks • Required services • Required samples
11-03	Release note	• Coverage for key elements (as appropriate to the application): • Description of what is new or changed (including features removed) • System information and requirements • Identification of conversion programs and instructions • Release numbering implementation may include: - the major release number - the feature release number - the defect repair number - the alpha or beta release; and the iteration within the alpha or beta release • Identification of the component list (version identification included): - hardware / software / product elements, libraries, etc. - associated documentation list • New/changed parameter information (e.g., for application parameters or global variables) and/or commands. Note that application parameters are a technical implementation solution for configurability-oriented requirements) • Backup and recovery information

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10-00	过程描述	• 标准过程或已定义过程（例如，经过裁剪后）的过程描述，包括： - 过程的范围和预期用途 - 过程活动包括描述以及依赖关系 - 准入和准出准则，例如活动所需的输入信息以及期待的输出 - 分配给过程活动（例如，作为 RASIC）或工作产品的角色 - 指南 - 模板 - 特定方法/工作指导
10-50	角色描述	• 名称/标识（在组织内是唯一的） • 分配的活动（例如，作为 RASIC） • 职责和权限 • 所需的能力、技能和经验
10-51	资质鉴定方法说明	• 培训课程 • 培训材料 • 指导/辅导概念 • 自学材料
10-52	过程资源和基本设施描述	• 所需设施 • 所需工具和相应的许可证 • 所需网络 • 所需服务 • 所需样件
11-03	发布说明	• 关键要素覆盖率（酌情适用）： • 新增的或变更的内容描述（包括删除的功能） • 系统信息和需求 • 识别转换程序和操作指导 • 发布编号方式的实施可包括： - 主要发布号 - 功能发布号 - 缺陷修复号 - alpha 或 beta 版本，以及 alpha 或 beta 版本中的迭代 • 识别组件清单（包括版本标识）： - 硬件/软件/产品要素、库等 - 相关的文档清单 • 新的/变更的参数信息(如应用参数或全局变量)和/或指令。注意：应用参数为面向可配置性需求的技术实现解决方案。 • 备份和恢复信息

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		• List of open known problems, faults, warning information, etc. • Identification of verification and diagnostic procedures • Technical support information • Copyright and license information • The release note may include an introduction, the environmental requirements, installation procedures, product invocation, new feature identification and a list of defect resolutions, known defects and workarounds
11-04	Product release package	• Includes the hardware/software/product • Includes and associated release elements such as: - system hardware/software/product elements - associated customer documentation - application parameter definitions defined - command language defined - installation instructions - release letter
11-05	Software Unit	Can be • a representation of a software element at the lowest level in a conceptual model, which is decided not to be further subdivided and that is a part of a software component, or • a representation of a software unit under verification such as commented source code, auto-code, an object file, a library, an executable, or an executable model as input to verification
11-06	Integrated System	• Integrated product • Application parameter files (being a technical implementation solution for configurability-oriented requirements) • All configured elements for the product release are included
11-50	Deployed ML model	• It is derived from the trained ML model (see 01-53) and is to be integrated into the target system. • It may differ from the trained ML model which often requires powerful hardware and uses interpretative languages.
12-03	Reuse candidate	• Identifies the product to be reused • Identifies the responsible person for the products to be reused • Identifies the reuse goals and objectives • Identifies the list of reuse assets • Identifies the issues/risks of reusing the component including specific requirements (hardware, software, resource and other reuse components) • Identifies the person who will be qualifying the reuse candidate

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	• 未解决的已知问题、故障、警告信息等清单 • 识别验证和诊断程序 • 技术支持信息 • 版权和许可证信息 • 发布说明可以包括介绍、环境要求、安装规程、产品调用、新功能标识和缺陷解决清单、已知缺陷和变通方法
11-04	产品发布包	• 包括硬件/软件/产品 • 包含相关的发布要素，如： - 系统硬件/软件/产品要素 - 相关的客户文档 - 已定义的应用参数定义 - 已定义的指令语言 - 安装操作指导 - 发布信函
11-05	软件单元	可为： • 在概念模型中最低层级的软件要素的表示形式，该要素被决定不进一步细分，并且是软件组件的一部分。或， • 正在验证的软件单元的表示形式，例如注释的源代码、自动代码、目标文件、库、可执行文件或作为验证输入的可执行模型
11-06	集成的系统	• 集成的产品 • 应用参数文件（作为面向可配置性需求的技术实现解决方案） • 包含产品发布的所有配置的要素
11-50	已部署的 ML 模型	• 它源于已训练的 ML 模型（见 01-53），并将集成到目标系统中。 • 它可能与已训练的 ML 模型不同，后者通常需要强大的硬件并使用解释性语言。
12-03	重用候补	• 识别重用产品 • 识别重用产品的负责者 • 识别重用的目的和目标 • 识别重用资产清单 • 识别重用组件的问题/风险，包括特定需求（硬件、软件、资源和其他重用组件） • 识别重用候补的资质鉴定者

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13-06	Delivery evidence	• Evidence of items shipped/delivered electronically to customer • Identification of: - to whom it was sent - address, where delivered - delivery date - receipt of delivered product
13-07	Problem	• Identifies the submitter of the problem • Identifies the group/person(s) responsible for providing problem resolution • Includes a description of the problem • Identifies classification of the problem (criticality, urgency, relevance etc.) • Identifies the status of the problem - States such as “open”, “in review”, “in implementation”, “closed”, “rejected”, “cancelled”, … - Transitions between states with conditions and authorities • Identifies the expected closure date
13-08	Baseline	• Identifies a state of one or a set of work products and artifacts which are consistent and complete • Basis for next process steps and/or delivery • Is unique and may not be changed *NOTE: This should be established before a release to identify consistent and complete delivery*
13-09	Meeting support evidence	• Agenda and minutes that are records that define: - purpose of meeting - attendees - date, place held - reference to previous minutes - what was accomplished - identifies issues raised - any open issues - next meeting if any
13-13	Product release approval	• Content information of what is to be shipped or delivered • Identification of: - for whom it is intended - the address where to deliver - the date released - Evidence of supplier approval

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13-06	交付证据	• 以电子方式向客户运送/递送交付物的证据 • 识别： - 发送给谁 - 交付到什么地址 - 交付日期 - 记录交付产品的凭据
13-07	问题	• 识别问题的提交者 • 识别负责提供问题解决措施的小组/人员 • 包含问题的描述 • 识别问题的分类（关键性、紧迫性、相关性等） • 识别问题的状态 - 状态如："新建"、"评审中"、"实施中"、"关闭"、"拒绝"、"取消"等 - 状态间迁移条件以及批准者 • 识别预期的关闭日期
13-08	基线	• 识别一个或一组一致的和完整的工作产品和制品的状态 • 后续过程步骤 和/或 交付的基础 • 是唯一的和可能不变的 *注：这应该在发布之前建立，以识别一致和完整的交付*
13-09	会议支持证据	• 记录议程和会议记录是定义： - 会议目的 - 与会者 - 日期，举办地 - 引用先前的会议记录 - 完成了什么 - 识别提出的问题 - 任何未解决问题 - 后续会议，如有
13-13	产品发布批准	• 确认需运送或交付的内容信息 • 识别： - 对象 - 交付到什么地址 - 发布日期 - 供应商批准证据

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13-14	Progress status	• Status of a plan(s) (actual against planned) such as: - status of actual activities/work packages against planned activities/work package - status of actual results against established objectives/goals - status of actual resources allocation against planned resources - status of actual cost against budget estimates - status of actual time against planned schedule - status of actual quality against planned quality • Record of any deviations from planned activities and reason why
13-16	Change request	• Identifies purpose of change • Identifies requester contact information • Impacted system(s) • Impact to operations of existing system(s) defined • Impact to associated documentation defined • Criticality of the request, due date • Information supporting the tracking of change requests to closure - progress status attribute (e.g., open, allocated, implemented, closed) - time stamp of status change - person who changed a status - rationale for changing a status
13-18	Quality conformance evidence	• Identifies what tasks/activities/process produce the information • Identifies when the data was collected • Identifies source of any associated data • Identifies the associated quality criteria • Identifies any associated measurements using the information
13-19	Review evidence	• Provides the context information about the review: - what was reviewed - lists reviewers who attended and their area of responsibility - status of the review • Provides information about the scope of the review: - checklists - review criteria - requirements - compliance to standards • Effort information about: - preparation time spent for the review - time spent in the review

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13-14	进展状态	• 计划的状态（实际的对计划的），如： - 实际活动/工作包状态与计划活动/工作包的对比情况 - 实际结果状态与既定目的/目标的对比情况 - 实际资源分配状态与计划资源的对比情况 - 实际费用状态与预算估算的对比情况 - 实际时间状态与计划进度表的对比情况 - 实际质量状态与计划质量的对比情况 • 记录任何与计划活动的偏差和原因所在
13-16	变更请求	• 识别变更的目的 • 识别请求者联系信息 • 受影响的系统 • 对定义的现有系统的操作的影响 • 对定义的相关文档的影响 • 请求的关键性，期限 • 支持跟踪变更请求至关闭的信息 - 进展状态属性（例如：新建、已分配、已实施、已关闭） - 状态变更的时间戳 - 状态变更者 - 状态变更依据
13-18	质量符合性证据	• 定义哪些任务/活动/过程产生信息 • 定义什么时候收集数据 • 定义任何相关数据的来源 • 识别相关的质量准则 • 识别任何相关的使用信息的度量
13-19	评审证据	• 提供有关评审的背景信息： - 评审什么 - 列出参加的评审人以及他们的职责范围 - 评审的状态 • 提供有关评审覆盖范围的信息： - 检查表 - 评审准则 - 需求 - 符合标准 • 工作量信息，关于: - 准备评审所花费的时间 - 评审所花费的时间

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		• Review findings: - non-conformances - improvement suggestions
13-24	Validation results	• Validation data, logs, feedback, or documentation • Validation measure passed • Validation measure not passed • Validation measure not executed, and a rationale • Information about the validation execution (date, participants etc.) • Abstraction or summary of validation results
13-25	Verification results	• Verification data and logs • Verification measure passed • Verification measure not passed • Verification measure not executed, and a rationale • Information about the verification execution (date, “object-under-verification”, etc.) • Abstraction or summary of verification results
13-50	ML test results	• Test data and logs • Test data with correct results • Test data with incorrect results • Test data not executed, and a rationale • Information about the test execution (date, participants, model version etc.) • Abstraction or summary of ML test results
13-51	Consistency Evidence	• Demonstrates bidirectional traceability between artifacts or information in artifacts, throughout all phases of the life cycle, by e.g., - tool links - hyperlinks - editorial references - naming conventions • Evidence that the content of the referenced or mapped information coheres semantically along the traceability chain, e.g., by - performing pair working or group work - performing by peers, e.g., spot checks - maintaining revision histories in documents - providing change commenting (via e.g., meta-information) of database or repository entries *Note: This evidence can be accompanied by e.g., Definition of Done (DoD) approaches.*

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		• 评审发现：
		  - 不符合项
		  - 改进建议

13-24	确认结果	• 确认数据、日志、反馈或文档 • 通过的确认措施 • 未通过的确认措施 • 未执行的确认措施和依据 • 关于确认的执行信息（日期，参与者等） • 确认结果的摘要或总结
13-25	验证结果	• 验证数据和日志 • 通过的验证措施 • 未通过的验证措施 • 未执行的验证措施和依据 • 关于验证的执行信息（日期，“验证对象”等） • 验证结果的摘要或总结
13-50	ML 测试结果	• 测试数据和日志 • 具有正确结果的测试数据 • 具有不正确结果的测试数据 • 未执行的测试数据和依据 • 关于测试的执行信息（日期，参与者，模型版本等） • ML 测试结果的摘要或总结

13-51	一致性证据	• 在生命周期的所有阶段，通过以下方式展示制品或制品中信息之间的双向可追溯性
		  - 工具链接
		  - 超链接
		  - 编辑参考文献
		  - 命名规则
		• 所引用或映射的信息内容在语义上与追溯链上的信息一致的证据，例如
		  - 执行分组工作或小组工作
		  - 由同行执行，例如抽查
		  - 维护文档中的修订历史
		  - 提供数据库或存储库条目的更改注释（例如，通过元信息）
		注意：此证据可以伴随例如完成定义（DoD）方法。

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13-52	Communication Evidence	• All forms of interpersonal communication such as - e-mails, also automatically generated ones - tool-supported workflows - meeting, verbally or via meeting minutes (e.g., daily standups) - podcast - blog - videos - forum - live chat - wikis - photo protocol
13-55	Process resource and infrastructure documentation	• Information on availability, allocation, and usage of - Facilities - Tools and corresponding licenses - Networks - Services - Samples • for non-standard and critical resources and infrastructure.
14-01	Change history	• Historical records of all changes made to an object (document, file, software component, etc.): - description of change - version information about changed object - date of change - change requester information - change control record information
14-02	Corrective action	• Identifies the initial problem • Identifies the ownership for completion of defined action • Defines a solution (series of actions to fix problem) • Identifies the open date and target closure date • Contains a status indicator • Indicates follow up audit actions

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13-52	沟通证据	• 所有形式的人际沟通，如： - 电子邮件，同样适用自动生成的 - 工具支持的工作流 - 会议，口头或会议记录(例如：每日站会) - 播客 - 博客 - 视频 - 论坛 - 即时聊天 - 维基 - 照片协议
13-55	过程资源和基础设施文档	• 有关可用性、分配和使用情况的信息 - 设施 - 工具和相应的许可证 - 网络 - 服务 - 样件 • 用于非标准和关键资源和基础设施。
14-01	变更历史	• 对对象（文档、文件、软件组件等）所做的所有变更的历史记录： - 变更描述 - 变更对象的版本信息 - 变更日期 - 变更请求者信息 - 变更控制记录信息
14-02	纠正行动	• 识别初始问题 • 识别已定义行动完成的所有权 • 定义解决方案（解决问题的一系列行动） • 识别提出日期和目标关闭日期 • 包含状态指示器 • 指示后续审核行动

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14-10	Work package	• Defines activities to be performed • Documents ownership for activities e.g., by domains • Documents critical dependencies to other work packages • Documents input and output work products • Documents the critical dependencies between defined work products • Information needed to perform these activities • Estimates of effort, duration *NOTE: The work package descriptions may be integrated into the/be a part of a schedule, see 08-56*
14-50	Stakeholder groups list	• Identifies: • involved parties • weight/importance of each stakeholder group • representative(s) for each stakeholder group • information needs of each stakeholder group
14-53	Role Assignment	• Assignment of person(s) to roles - required competencies vs existing competencies - required skills vs existing skills - required experience and trainings based on identified competencies / skills gap
14-54	Hardware Bill of materials	• Uniquely identifies type, supplier, and amount of the complete set of all hardware parts of the hardware
15-06	Project status	• Status of in regards to progress and consistency of schedule, work item content, tasks, resources (human resources, infrastructure, hardware/materials, budget), skills and competence of human resources • planned progress and expenditure against dates/deadlines and actual expenditure • reasons for variance from planned progress • threats to continued progress • issues which may affect the ability of the project to achieve its goals • contingency actions
15-07	Reuse analysis evidence	• Identification of reuse opportunities • Identification of constraints for reuse • Identification of regression test cases • Identification of reuse infrastructure • Identification of known defects
15-09	Risk status	• Identifies the status, or the change, of an identified risk: - risk statement - risk source - risk impact and risk probability

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14-10	工作包	• 定义要执行的活动 • 记录活动的所有权，例如：按领域 • 记录对于其他活动的关键依赖关系 • 记录输入和输出工作产品 • 记录定义的工作产品之间的关键依赖关系 • 执行这些活动所需的信息 • 估算工作量和工期 • *注：工作包的描述可以整合到进度表，或是进度表的一部分，见 08-56*
14-50	利益相关方群组清单	• 识别： • 参与方 • 各利益相关方群组的权重/重要性 • 各利益相关方群组的代表 • 各利益相关方群组的信息需要
14-53	角色分配	• 对于角色的人员分配 - 所需能力 vs 现有能力 - 所需技能 vs 现有技能 - 基于已确定的能力/技能差距所需的经验和培训
14-54	硬件物料清单	• 硬件中整套的所有硬件元器件的唯一标识的类型、供应商和数量
15-06	项目状态	• 关于进度计划、工作项内容、任务、资源（人力资源、基础设施、硬件/材料、预算）、人力资源的技能和能力的进展和一致性的状况 • 计划进展和计划支出与实际日期/期限和实际支出的对比 • 与计划进展不一致的原因 • 对持续进展的威胁 • 可能影响项目达成目标的能力的问题 • 应急行动
15-07	重用分析证据	• 识别重用机会 • 识别重用约束 • 识别回归测试用例 • 识别重用基础设施 • 识别已知缺陷
15-09	风险状态	• 识别已识别风险的状态，或者变化: - 风险陈述 - 风险源 - 风险影响和风险概率

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		- categories and risk thresholds, e.g., for prioritization or setting a status - risk treatment activities in progress
15-12	Problem status	• Indicates progress of problem resolution • Status of problem e.g., - by problem categories/classification - by problem resolution stage
15-13	Assessment/audit report	• States the purpose of assessment • Method used for assessment • Requirements used for the assessment • Assumptions and limitations • Identifies the context and scope information required: - date of assessment - organizational unit assessed - sponsor information - assessment team - attendees - scope/coverage - assesses and information - assessment tool used • Records the result: - Data - identifies the gaps, potentials, weaknesses or non-conformances that require corrective actions
15-16	Improvement opportunity	• Identifies what the problem is • Identifies what the cause of a problem is • Suggest what could be done to fix the problem • Identifies the value (expected benefit) in performing the improvement • Identifies the penalty for not making the improvement
15-51	Analysis Results	• Identification of the object under analysis. • The analysis criteria used, e.g.: - selection criteria or prioritization scheme used - decision criteria - quality criteria • The analysis results, e.g.: - what was decided/selected - reason for the selection

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		- 归类和风险阈值，例如：优先级排序或状态设定 - 正在进行的风险处理活动
15-12	问题状态	• 显示问题解决的进展 • 问题的状态，例如： - 按照问题类别/分类 - 按照问题解决阶段
15-13	评估/审核报告	• 陈述评估目的 • 用于评估的方法 • 用于评估的要求 • 假设和限制 • 识别所需的背景和范围信息: - 评估日期 - 被评估的组织单位 - 赞助者信息 - 评估小组 - 与会者 - 范围/覆盖率 - 被评估者的信息 - 评估使用的工具 • 记录结果： - 数据 - 识别需要纠正行动的差距、潜力、弱点或不符合项
15-16	改进机会	• 识别问题是什么 • 识别问题的原因是什么 • 建议为解决问题可以做什么 • 识别在执行改进中的价值（预期的利益） • 识别不实施改进的弊端
15-51	分析结果	• 识别分析对象。 • 使用的分析准则，例如： - 使用的选择准则或优先级排序方式 - 决策准则 - 质量准则 • 分析结果，例如： - 决定/选择的是什么 - 选择理由

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		- assumptions made - potential negative impact • Aspects of the analysis may include - correctness - understandability - verifiability - feasibility - validity
15-52	Verification Results	• Verification data and logs • Verification measure passed • Verification measure not passed • Verification measure not executed • information about the test execution (date, tester name etc.) • Abstraction or summary of verification results
15-54	Tailoring documentation	• Applied criteria for tailoring, • Evidence that the defined process is tailored from the standard process according to the defined criteria
15-55	Problem analysis evidence	• Author and involved parties • Date of the analysis • Context and root cause of the problem • Analysis result may include - Impact - Potential negative impact - Affected parties - Potential solution (if known)
15-56	Configuration status	• Summary of configuration management records including relevant status • Analysis of the configuration management overall state • Identification of baselines made
16-03	Configuration management system	• Supports the configuration management for the scope of the configuration item list contents • Correct configuration of products • Can recreate any release or test configuration • Ability to report configuration status • Has to cover all relevant tools
16-06	Process repository	• Contains process descriptions • Supports multiple presentations of process assets

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		- 所作的假设 - 潜在负面影响 • 分析方面可能包括 - 正确性 - 可理解性 - 可验证性 - 可行性 - 有效性
15-52	验证结果	• 验证数据和日志 • 通过的验证措施 • 未通过的验证措施 • 未执行的验证措施和理由 • 关于验证的执行信息（日期，测试人员姓名等） • 验证结果的概述或总结
15-54	裁剪文档	• 裁剪的适用准则 • 证明已定义过程是根据已定义准则对标准过程进行的裁剪
15-55	问题分析证据	• 作者和参与方 • 分析日期 • 问题背景和根本原因 • 分析结果可能包含 - 影响 - 潜在负面影响 - 受影响方 - 潜在的解决方案（如已知）
15-56	配置状态	• 包含相关状态在内的配置管理记录的总结 • 配置管理整体情况的分析 • 已建立基线的识别
16-03	配置管理系统	• 支持配置项清单内容范围的配置管理 • 产品的正确配置 • 能够重新创建任何发布或测试配置 • 能够报告配置状态 • 须覆盖所有相关工具
16-06	过程库	• 包含过程描述 • 支持过程资产的多种展示形式

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16-50	Organizational structure	• Disciplinary reporting line • Organizational units and sub-units, if applicable
16-52	ML data management system	• The ML data management system is part of the configuration management system (see 16-03) and • Supports data management activities like data collection, description, ingestion, exploration, profiling, labeling/annotation, selection, structuring and cleansing • Provides the data for different purposes, e.g., training, testing • Supports the relevant sources of ML data
17-00	Requirement	• An expectation of functions and capabilities (e.g., non-functional requirements), or one of its interfaces • from a black-box perspective • that is verifiable, does not imply a design or implementation decision, is unambiguous, and does not introduce contradictions to other requirements. • A requirements statement that implies, or represents, a design or implementation decision is called “Design Constraint”. • Examples for requirements aspects at the system level are thermal characteristics such as - heat dissipation - dimensions - weight - materials • Examples of aspects related to requirements about system interfaces are - connectors - cables - housing • Examples for requirements at the hardware level are - lifetime and mission profile, lifetime robustness - maximum price - storage and transportation requirements - functional behavior of analog or digital circuits and logic - quiescent current, voltage impulse responsiveness to crank, start-stop, drop-out, load dump - temperature, maximum hardware heat dissipation - power consumption depending on the operating state such as sleep-mode, start-up, reset conditions - frequencies, modulation, signal delays, filters, control loops - power-up and power-down sequences, accuracy and precision of signal acquisition or signal processing time - computing resources such as memory space and CPU clock tolerances - maximum abrasive wear and shearing forces for e.g., pins or soldering joints - requirements resulting from lessons learned - safety related requirements derived from the technical safety concept
17-05	Requirements for work products	• Requirements for content and structure, storage and control - Identifies documentation specific meta data, such as id, date, author information, ownership, access rights, review and approval

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16-50	组织架构	• 科室汇报线 • 组织单位和次级单位（如适用）
16-52	ML 数据管理系统	• ML 数据管理系统是配置管理系统的一部分（参见 16-03） • 支持数据管理活动，如数据收集、描述、接入、探索、概要分析、标记/注释、选择、结构化和清洗 • 为不同目的提供数据，例如：训练、测试 • 支持 ML 数据相关来源
17-00	需求	• 对功能以及能力（例如：非功能性需求），或其接口之一的期待 • 从黑盒的视角 • 可被验证的，不暗示设计或实现决策的，无歧义的，并和其他需求无矛盾。 • 暗示或表示设计或实现决策的需求陈述称为“设计约束”。 • 系统层级需求方面的示例如热特性，如 - 散热 - 尺寸 - 重量 - 材料 • 关于系统接口方面的需求示例如 - 接插件 - 线束 - 外壳 • 硬件层级需求的示例 - 寿命和任务剖面，寿命可靠性 - 最高价格 - 存储和运输需求 - 模拟或数字电路和逻辑的功能行为 - 静态电流，电压脉冲对点火、启停、压差，负荷突降的响应 - 温度，最大硬件散热 - 依赖于工作状态的功耗，如睡眠模式、启动、复位条件 - 频率、调制、信号延迟、滤波器、控制环路 - 上电和断电时序、信号采集或信号处理时间的准确度和精度 - 计算资源，如内存空间和 CPU 时钟容差 - 最大磨料磨损和剪切力，例如引脚或焊点 - 从经验教训中得出的需求 - 从技术安全概念推导出的安全相关需求
17-05	工作产品需求	• 对内容和结构、存储和控制的需求

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		status with, where applicable, status model and workflow, or others - Identifies requirements on documentation structure, e.g., table of content or figures or other formal aspects - May be provided by documentation templates - May be based on tool specific templates - Defines the storage location such as data repository, tool, versioning system - Requirements for versioning - Requirements for baselining - Distribution of the documents - Maintenance and disposal of the documents - May be specific for certain types of documents
17-54	Requirement Attribute	• Meta-attributes that support structuring and definition of release scopes of requirements. • Can be realized by means of tools. *NOTE: usage of requirements attributes may further support analysis of requirements.*
17-55	Resource needs	• Identification of required resources for process performance • Staff including competencies, skills and authorities needs • Material, equipment, and infrastructure • Time and budget *NOTE: Needs are derived from Work Breakdown structure and schedule*
17-57	Special Characteristics	• Special Characteristics in terms of relevant standards such as IATF 16949, VDA 6.x Guidelines, ISO 26262. • Special Characteristics according to IATF 16949:2016-10 [15], Chapters 8.3.3.3, are product characteristics or production process parameters that may have an impact on safety or compliance with official regulations, the fit, the function, the performance or further processing of the product. • Special characteristics shall be verifiable according to VDA vol. 1 *NOTE: A typical method for identifying and rate special characteristics is an FMEA.*
18-00	Standard	• Identification of to whom/what they apply • Expectations for conformance are identified • Conformance to requirements can be demonstrated • Provisions for tailoring or exception to the requirements are included
18-06	Product release criteria	• Defines expectations for product release: - release type and status - required elements of the release - product completeness including documentation - adequacy and coverage of testing - limit for open defects

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		- 识别文档化特定的元数据，例如 ID、日期、作者信息、所有权、访问权限、评审和批准状态（如适用）、状态模型和工作流等 - 识别文档化结构的需求，例如目录或图表或其他形式方面 - 可由文档模板提供 - 可能基于工具特定模板 - 定义存储位置，例如数据存储库、工具、版本系统 - 版本控制需求 - 基线化要求 - 文档的分发 - 文档的维护和处置 - 可能特定于某些类型的文档
17-54	需求属性	• 支持需求发布范围的结构化和定义的元属性（Meta-attributes）。 • 可以通过工具实现。 *注意：使用需求属性可以进一步支持需求分析。*
17-55	资源需要	• 识别过程实施所需的资源 • 工作人员，包括能力、技能和权限的需要 • 材料、设备和基础设施 • 时间和预算 *注意：需求由工作分解结构和进度计划导出*
17-57	特殊特性	• IATF 16949、VDA 6.x 指南、ISO 26262 等相关标准的特殊特性。 • 根据 IATF 16949：2016-10 [15] 第 8.3.3.3 章，特殊特性是指可能影响安全或官方法规合规性、适合性、功能、性能或进一步产品加工的产品特性或生产工艺参数。 • 特殊特性须按照 VDA vol. 1 进行验证 *注意：识别和评级特殊特性的典型方法是 FMEA.*
18-00	标准	• 适用对象和内容的识别 • 对符合性的期望得到识别 • 对需求的符合性可得到证明 • 包含对需求的裁剪或例外情况的规定
18-06	产品发布准则	• 定义产品发布的期望： - 发布类型和状态 - 所需的发布要素 - 产品完整性（包括文档） - 测试的充分性和覆盖率

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		- change control status
18-07	Quality criteria	• Defines the expectations for work products and process performance • Including thresholds/tolerance levels, required measurements, required checkpoints • Defines what is an adequate work product (required elements, completeness expected, accuracy, etc.) • Defines what constitutes the completeness of the defined tasks • Defines what constitutes the performance of the defined tasks • Establishes expected performance attributes
18-52	Escalation path	• Defined mechanisms to report and confirm escalation relevant issues • Identifies stakeholders to be included in the escalation path • Identifies levels of escalation
18-53	Configuration item selection criteria	• Identify types of work products to be subject to configuration control
18-57	Change analysis criteria	• Defines analysis criteria, such as - resource requirements - scheduling issues - risks - benefits
18-58	Process performance objectives	• Objectives for the process of creating the process outcomes and capability level 2 achievements, and corresponding evaluation criteria • Assumptions and constraints, if applicable • Used as the basis for deriving a detailed planning • Examples: - Effort, costs, or budget targets (e.g., min/max limits) - Process-specific deadlines in line with milestones, or frequency of activities (o e.g., dates for deliveries to the customer, quality gates) - Metrics (e.g., max. number of open change requests per release, max. ratio of configuration items in status “in work” at certain milestones before next delivery / release date)
18-59	Review and approval criteria for work products	• Specifies for each type of work products review and approval needs - If and when a review is required - Who shall review it - Who shall approve it - Review method(s) to be used - Criteria for approval

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		- 未解决缺陷的限制 - 变更控制状态
18-07	质量准则	• 定义对工作产品和过程实施的期待 • 包括阈值/容忍级别，所需度量，所需检查点 • 定义什么是完整的工作产品（所需的要素、预期的完整性、准确性等） • 定义什么是构成了已定义任务的完整性 • 定义什么是构成了已定义任务的绩效 • 建立预期的绩效属性
18-52	升级路径	• 定义汇报以及确认升级相关问题的机制 • 识别升级路径中需包含的利益相关方 • 识别升级的级别
18-53	配置项选择准则	• 识别要受配置控制的工作产品类型
18-57	变更分析准则	• 定义分析准则，如 - 资源需求 - 日程安排问题 - 风险 - 益处
18-58	过程实施目标	• 创建过程成果和能力等级 2 级的成就的过程目标，以及相应评估准则 • 假设以及约束，如适用 • 被用于推导详细计划的基础 • 示例： - 工作量，费用或预算目标 （例如：下限/上限) - 符合里程碑的过程特定期限或活动频率（例如，交付给客户的日期、质量阀） - 度量项（例如，每次发布的最多未关闭状态变更请求数量，在下一个交付/发布日期之前的某些里程碑上处于 “工作中” 状态的配置项的最大比率）
18-59	过程产品的评审和批准准则	• 定义各类型过程产品评审和批准的需要 - 是否以及什么时候需要评审 - 谁应评审 - 谁应审批 - 要采用的评审方法 - 批准的准则

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18-70	Business goals	• Explanation of the business goals • Requirements for the business needs • Associations to other goals • Reasons for the existence of the goals and needs, level of degree of the need and effect on the business not having that need • Conditions, constraints, assumptions • Timeframe for achievement • Authorization at the highest level
18-80	Improvement opportunity	• Cause of the improvement need, e.g., - from qualitative or quantitative process performance analysis, evaluations, and monitoring - industry best practice review, state-of-the-art observations, market studies etc. • Improvement objectives derived from organizational business goals and improvement needs • Organizational scope • Process scope • Activities to be performed to keep all those affected by the improvement informed • Priorities
18-81	Improvement evaluation results	• Operational impacts of identified changes on the product(s) and processes • Expected benefit • Conditions, constraints, assumptions
19-01	Process performance strategy	• The operational approach to achieve the process outcomes, consistent with the Process Performance Objectives (18-58), e.g.: - proceedings, including the monitoring of the performance of the process - methodology • scope(s) of the strategy within the process, e.g.: - development sites - application domain-specific differences (e.g., software drivers versus. powertrain software) - disciplines (e.g., different configuration management approaches for software and hardware, or combined approaches) - options due to socio-cultural differences
19-50	ML data quality approach	• The ML data quality approach • Defines Quality criteria (see 18-07) e.g., the relevant data sources, reliability and consistency of labelling, completeness against ML data requirementsv • Describes analysis activities of the data • Describes activities to ensure the quality of the data to avoid issues e.g., data bias, bad labeling

Table B.2 — Information Item Characteristics

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18-70	业务目标	• 业务目标的解释 • 业务需要的需求 • 与其他目标的关联 • 目标和需要的存在原因、需要程度的级别以及如无该需要而对商业造成的影响 • 条件、约束、假设 • 实现目标的时限 • 最高级别的授权
18-80	改进机会	• 改进需要的原因，例如： - 定量或定性过程实施分析，评估以及监控 - 行业最佳实践评审，最新的观察，市场调研等。 • 由组织业务目标和改进需求推导出的改进目标 • 组织范围 • 过程范围 • 为通知所有受改进影响方而执行的活动 • 优先级
18-81	改进评估结果	• 已识别的变更对产品和过程的运营影响 • 预期收益 • 条件、约束、假设
19-01	过程实施策略	• 达成过程成果的运行方法，与过程实施目标保持一致 (18-58)， 例如： - 程序，包括对过程执行情况的监控 - 方法论 • 过程内策略的范围，例如： - 开发基地 - 应用领域特有的差异（例如，软件驱动程序 vs 动力总成软件） - 专业 （例如，软件和硬件不同的配置管理方法，或者组合方法） - 社会文化差异的选项
19-50	ML 数据质量方法	• ML 数据质量方法 • 定义质量准则（参见 18-07），例如相关数据源、标签的可靠性和一致性、符合 ML 数据需求的完整性 • 描述数据的分析活动 • 描述确保数据质量的活动，以避免数据偏差、标签错误等问题

表 B.2—信息项特性

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Annex C Key concepts and guidance

The following sections describe the key concepts that have been introduced in the Automotive SPICE PRM resp. PAM 3.1. They relate to the terminology described in Annex C Terminology.

Annex C.1 The "Plug-in" concept

The following figure shows the basic principle of the "plug-in" concept. The top-level comprises all system engineering processes organized in a system "V". Depending on the product to be developed the corresponding engineering disciplines with their domain-specific processes (e.g., hardware engineering HWE or software engineering SWE) can be added to the assessment scope. All other processes such as management processes and supporting processes are domain-independent and are therefore designed in a way that they can be applied to both the system level and the domain levels.

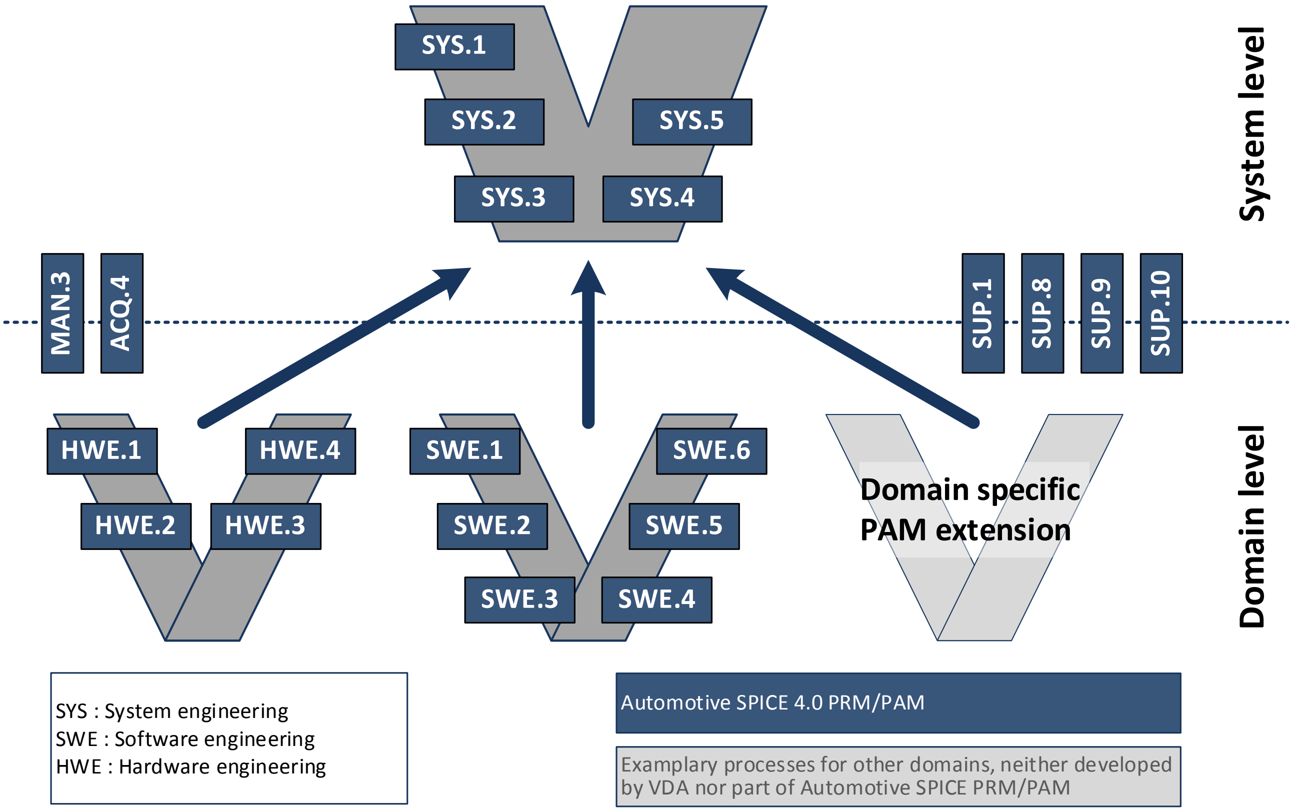

Figure C.1 — The "Plug-in" concept

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Annex C 关键概念与指南

以下章节描述在 Automotive SPICE PRM 及 PAM 3.1 中所引入的关键概念。它们与附录 C 术语中的术语描述相关联。

Annex C.1 “插件” 的概念

下图展示“插件”概念的基本原理。顶层包含所有以系统"V"字模型组织的系统工程过程。取决于所开发的产品 ，可以将相应工程域的特定过程（例如硬件工程 HWE 或软件工程 SWE）添加到评估范围中。其他的所有过程（例如管理过程和支持过程）都是独立于具体工程过程领域的，因此它们可以被同时应用于系统级别以及领域级别的工程过程。

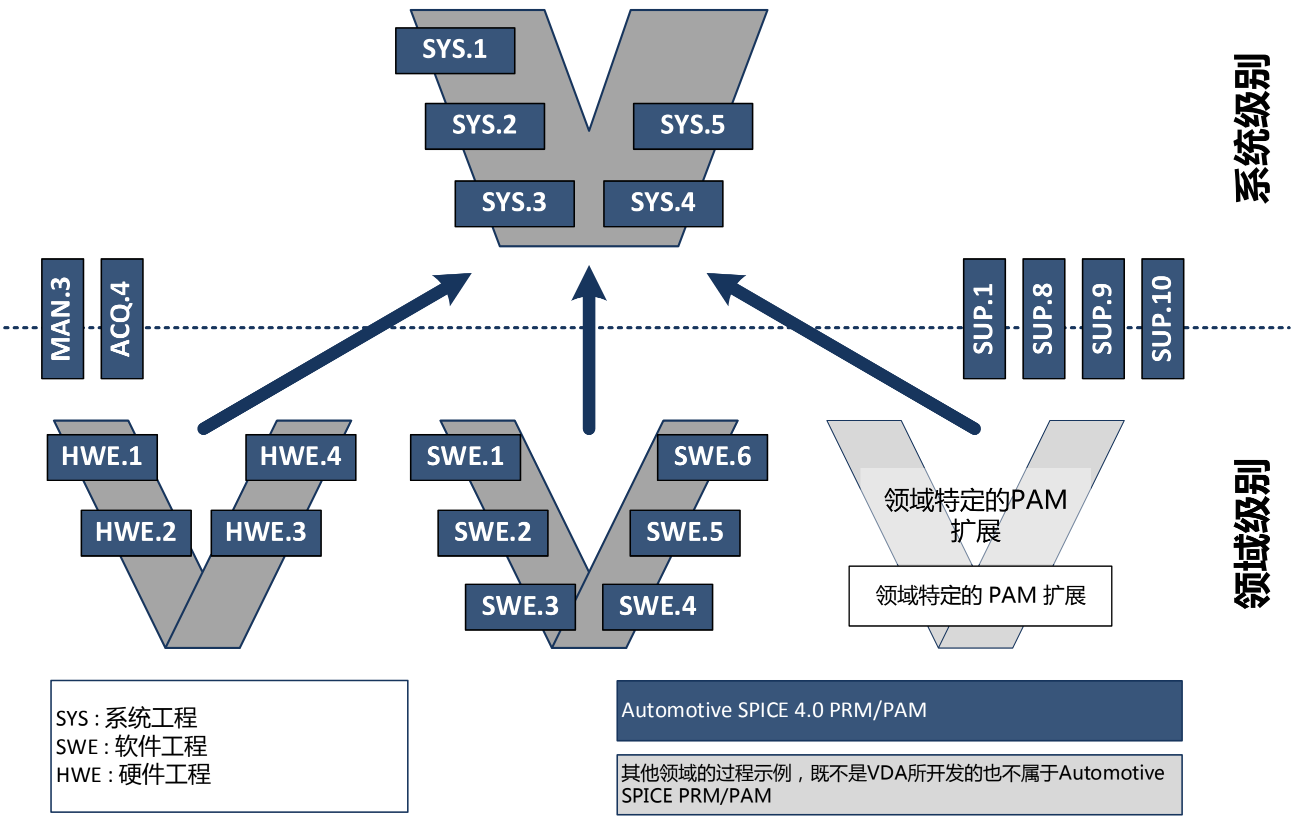

图 C.1 —插件” 的概念

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Annex C.2 "Element", "Component", and "Unit"

The following figure depicts the relationships between system elements, software components, and software units which are used consistently in the engineering processes. See the Terminology in Annex C to learn about the definitions of these terms.

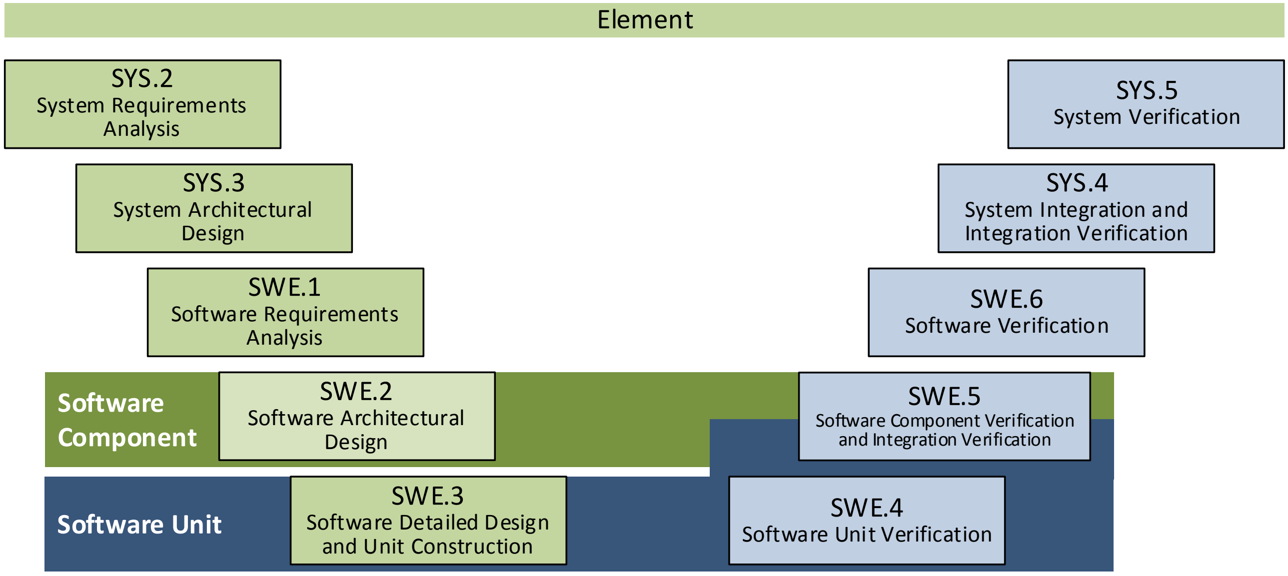

Figure C.2 — Element, component, and unit

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Annex C.2 "要素"、"组件"和"单元"

下图描述了贯穿于工程过程中应用到的系统要素、软件组件和软件单元之间的关系。具体这些词语释义请参考 Annex C 的术语定义。

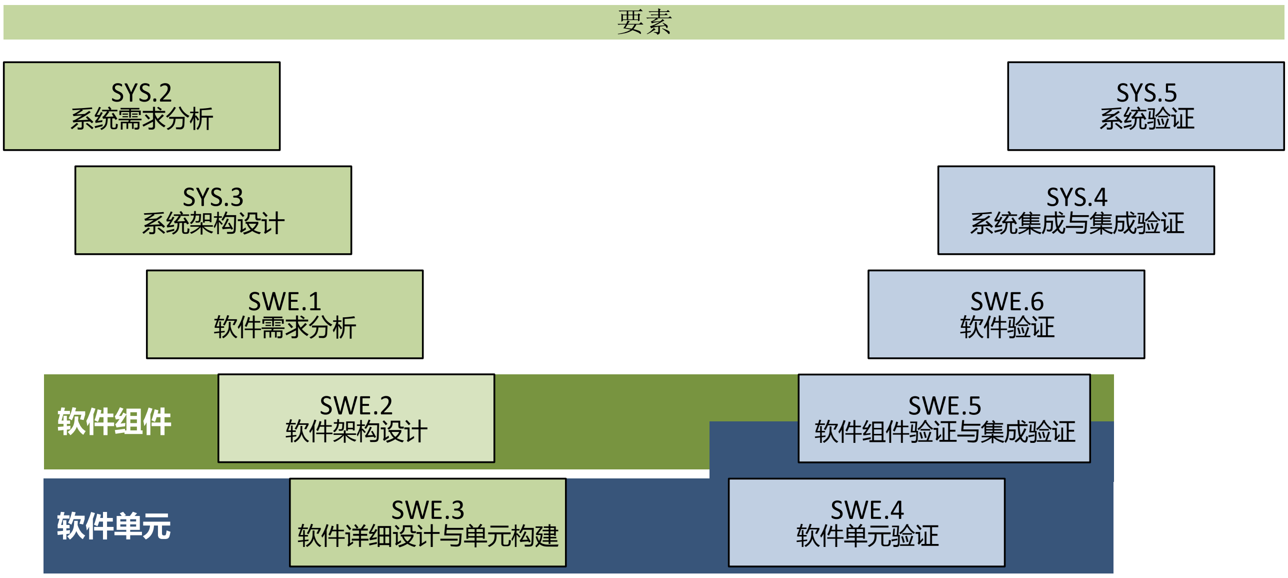

图 C.2 —要素、组件和单元

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Annex C.3 Integration of Machine Learning Engineering Processes

The following figure shows how the Machine Learning Engineering Processes are integrated within the engineering V-Cycle perspective. Usually, the MLE "Machine Learning Engineering" processes are used in a highly iterative way.

Within the Software Architecture software elements shall be identified which need to be developed with machine learning. For these ML-based software elements the MLE processes apply, for other software components SWE.3 "Software Detailed Design & Unit Construction" and SWE.4 "Software Unit Verification" applies. After the successful testing of the ML-based software elements they need to be integrated with the other software components by applying SWE.5 "Software Integration & Integration Test".

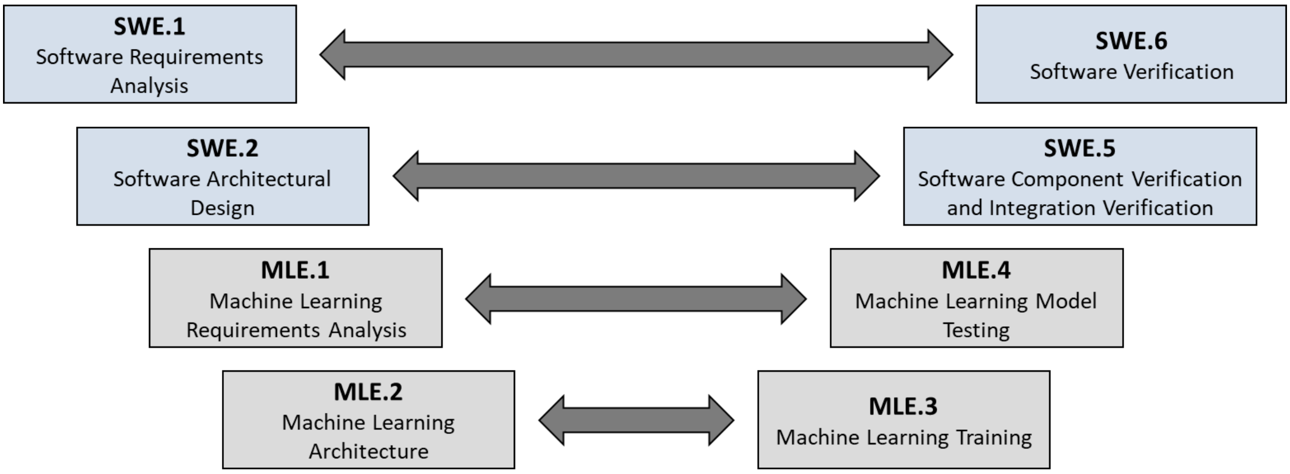

Figure C.3 — Integration of MLE Processes

The second figure shows the interdependencies within the MLE "Machine Learning Engineering" process group and to the SUP.11 "Machine Learning Data Management".

With MLE.1 "Machine Learning Requirements Analysis", machine learning related Software requirements allocated to the ML-based software elements need to be refined into a set of ML requirements. These requirements must contain ML data requirements which are input for the SUP.11 "Machine Learning Data Management" and other ML requirements which are input for the other MLE "Machine Learning Engineering" processes.

By applying the SUP.11 "Machine Learning Data Management" process ML data with assured quality and integrity, which fulfill the ML data requirements, are collected, processed, and made available to all affected parties.

The other ML requirements should be used within the MLE.2 "Machine Learning Architecture" process to develop an ML architecture supporting training and deployment. Therefore, the ML architecture must contain all necessary ML architectural elements like hyperparameter ranges and initial values, details of the ML model, and possible other software parts which are necessary for MLE.3 "Machine Learning Training".

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Annex C.3 机器学习工程过程的整合

下图中展示了机器学习工程过程是如何嵌入到常见的 V 模型开发中的。 需要注意的是 MLE "机器学习工程 "的过程往往是通过高度迭代的方式来进行实施的。

首先我们必须在软件架构中识别需要使用机器学习进行开发的软件要素。对于这些基于机器学习的软件要素，适用机器学习的过程；而对于其他类型的软件组件，则适用 SWE.3 "软件详细设计与单元构建 "和 SWE.4 "软件单元验证 "。在成功测试基于机器学习的软件要素后，需要通过 SWE.5 "软件集成与集成测试 "将其与其他软件组件集成。

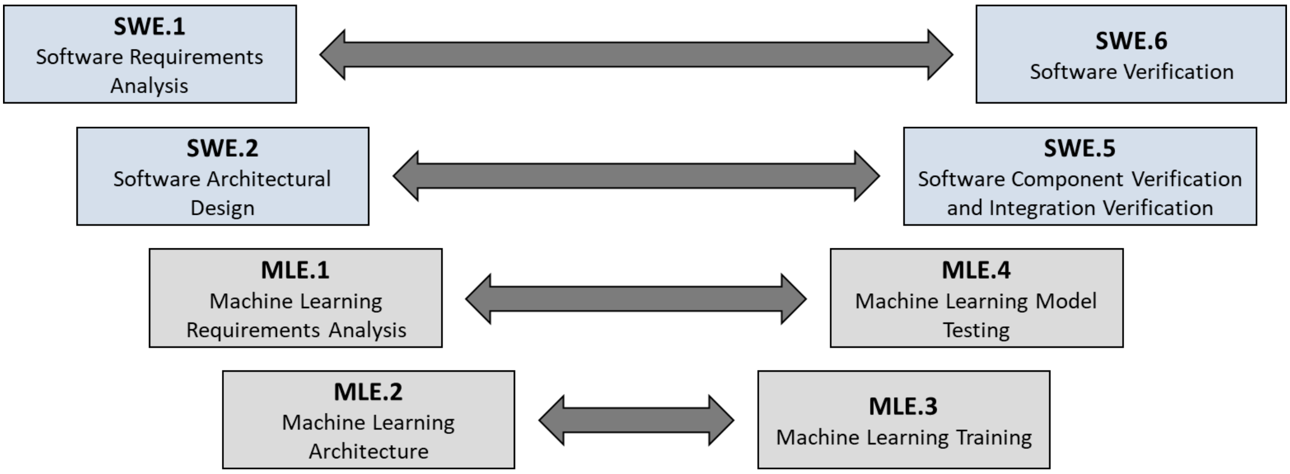

图 C.3 —机器学习工程过程的整合

第二张图显示了 MLE "机器学习工程 "过程组和 SUP.11 "机器学习数据管理 "过程组之间的相互依赖关系。

通过 MLE.1"机器学习需求分析"，需要将分配给基于机器学习的软件要素的机器学习相关的软件需求细化为一组机器学习需求。这些需求必须包含作为 SUP.11 "机器学习数据管理 "输入的机器学习的数据需求和作为其他 MLE "机器学习工程 "过程输入的其他机器学习需求。

通过应用 SUP.11 "机器学习数据管理 "过程，在满足机器学习数据需求的前提下， 去收集、处理并向所有受影响方提供具有质量和诚信性保证的机器学习数据。

其他机器学习需求应在 MLE.2 "机器学习架构 "过程中使用，以开发支持训练和部署的机器学习架构。因此，机器学习架构必须包含所有必要的机器学习架构要素，如超参数的范围和初始值、机器学习

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These other software parts should be developed according to SWE.3 “Software Detailed Design & Unit Construction” and SWE.4 “Software Unit Verification”.

Performing MLE.3 “Machine Learning Training” should start with specifying an ML training and validation approach. Based on this approach a training and validation dataset need to be created from the ML data pool provided by SUP.11 “Machine Learning Data Management” which is then used iteratively to optimize the ML model weights and hyperparameter values. When training exit criteria are reached the trained model should be agreed and communicated to all affected parties.

MLE.4 “Machine Learning Model Testing” focuses on testing the agreed trained model to ensure compliance with the ML requirements. Therefore, an ML test approach needs to be specified and an ML test dataset must be created from the provided ML data pool.

The ML test approach defines besides other details the distribution of data characteristics (e.g., sex, weather conditions, street conditions within the ODD) defined by ML requirements. The test dataset contains different test scenarios applying the required distribution of data characteristics e.g., driving during rain on a gravel road.

After successful testing the trained model, a deployed model is derived and tested as well. The deployed model will be integrated into the target system and may differ from the trained model which often requires powerful hardware and uses interpretative languages. Finally, the agreed test results and the deployed model must be communicated to all affected parties, so that the deployed model can be integrated with the other software units by applying SWE.5 “Software Integration and Integration Test”.

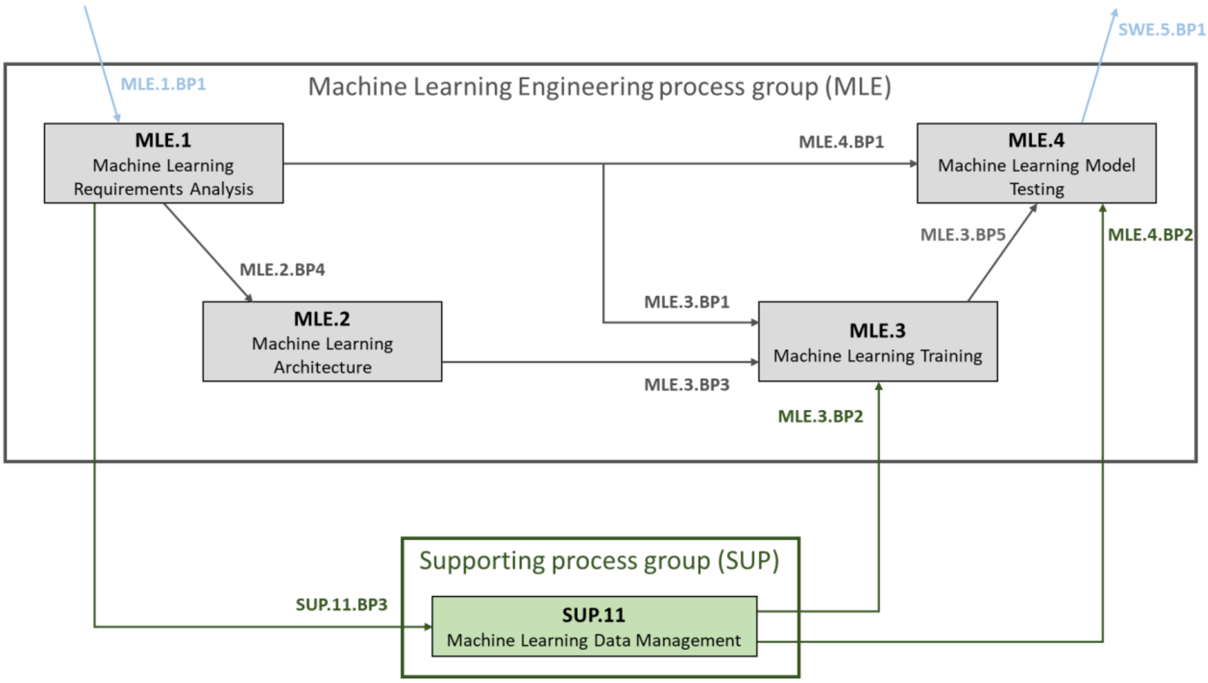

Figure C.4 — Interdependencies within MLE and SUP.11

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模型的细节以及 MLE.3 "机器学习训练"中可能需要的其他软件部分。这些其他软件部分应根据 SWE.3 "软件详细设计与单元构建 "和 SWE.4 "软件单元验证 "进行开发。

执行 MLE.3 "机器学习训练 "时，应首先定义一种机器学习训练和验证方法。基于这种方法，需要从 SUP.11 "机器学习数据管理 "提供的机器学习数据池中创建一个训练和验证数据集，然后使用该数据集反复优化机器学习模型的权重和超参数的数值。当达到训练准出准则时，应就训练好的模型达成一致意见，并与所有受影响方进行沟通。

MLE.4 "机器学习模型测试 "侧重于测试约定的训练模型，以确保符合机器学习需求。因此，需要指定机器学习测试方法，并从提供的机器学习数据池中创建机器学习测试数据集。

除其他细节外，机器学习测试方法还定义了机器学习需求所定义的数据特征分布（如 ODD 内的性别、天气条件、街道条件）。测试数据集包含不同的测试场景，应用了所需的数据特征分布，例如雨天在碎石路上行驶。

在成功测试已训练的模型后，还需导出已部署的模型并对其进行测试。部署模型将被集成到目标系统中，部署的模型和训练的模型可能有所不同，训练的模型往往需要强大的硬件支持或语言上的可解释性。最后，必须将约定的测试结果和部署的模型传达给所有受影响方，以便通过 SWE.5 "软件集成和集成测试 "将部署的模型与其他软件单元集成。

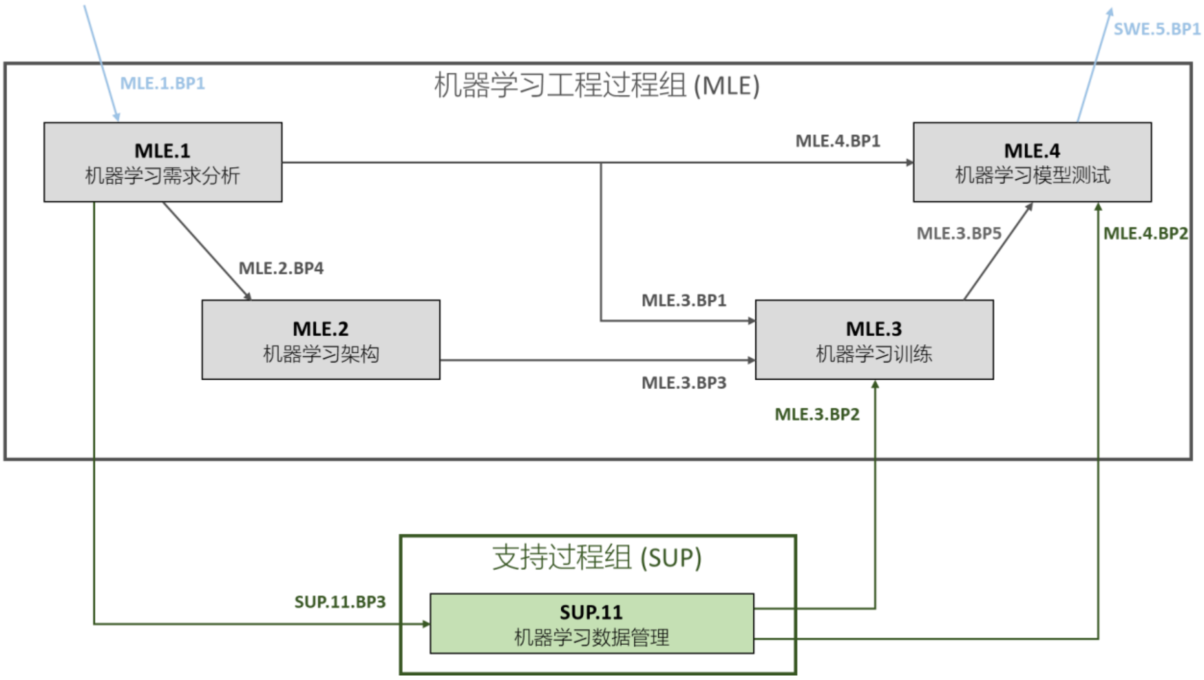

图 C.4 — MLE 和 SUP.11 内部的相互依赖关系

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Annex C.4 Example of an ML Architecture

The following figure shows an example of an ML architecture, describing the overall structure of the ML-based software element and the interfaces within the ML-based software element and to other software elements. The ML architecture typically consists of an ML model and other ML architectural elements, which are other (classical) software components developed according to SWE.3 “Software Detailed Design & Unit Construction” and SWE.4 “Software Unit Verification” and provided to train, deploy and test the ML model. Furthermore, the ML architecture describes details of the ML model like used layers, activation functions, loss function, and backpropagation.

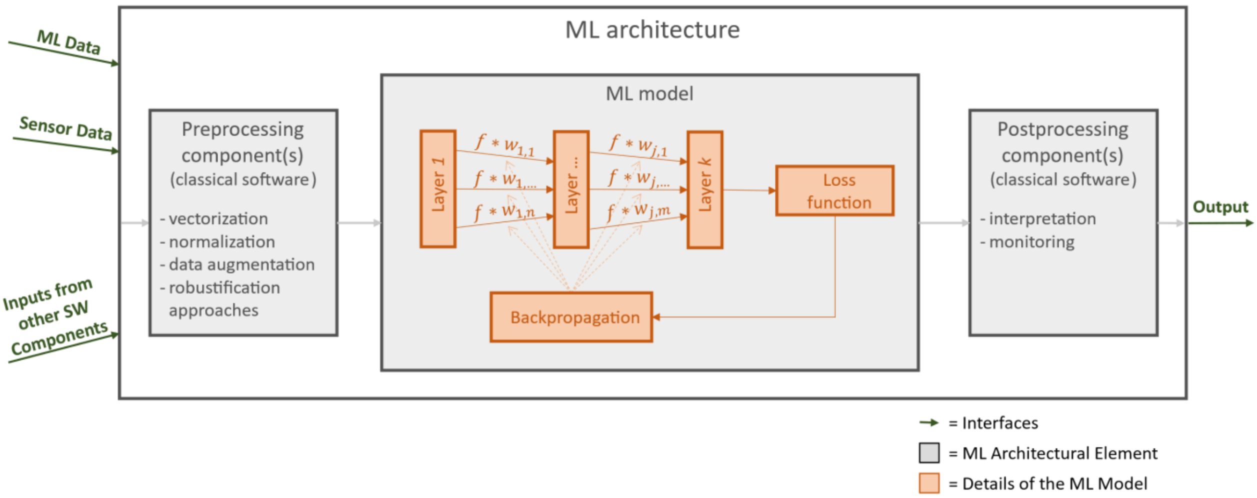

Figure C.5 — Example of an ML Architecture

During training, hyperparameters (see appendix c #hyperparameters) defining the ML model will change therefore it is recommended to define ranges of hyperparameter values and initial values for training start are defined. Because developing an ML-based software element is highly iterativ changes in the ML architecture might come up.

Furthermore, the ML architecture used for training can differ from the architecture of the deployed model, which will be integrated with the other software elements, these differences are part of the ML architecture as well.

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Annex C.4 机器学习架构的示例

下图中展示了一个机器学习架构的示例，描述了基于机器学习架构软件要素的整体结构，以及基于机器学习架构软件要素内部与其他软件要素的接口。机器学习架构通常由机器学习模型和其他机器学习架构要素组成，这些要素是根据 SWE.3 "软件详细设计与单元构建 "和 SWE.4 "软件单元验证 " 开发的其他（传统）软件组件，用于训练、部署和测试机器学习架构模型。此外，机器学习架构还描述了机器学习模型的细节，如所用各层、激活函数、损失函数和反向传播。

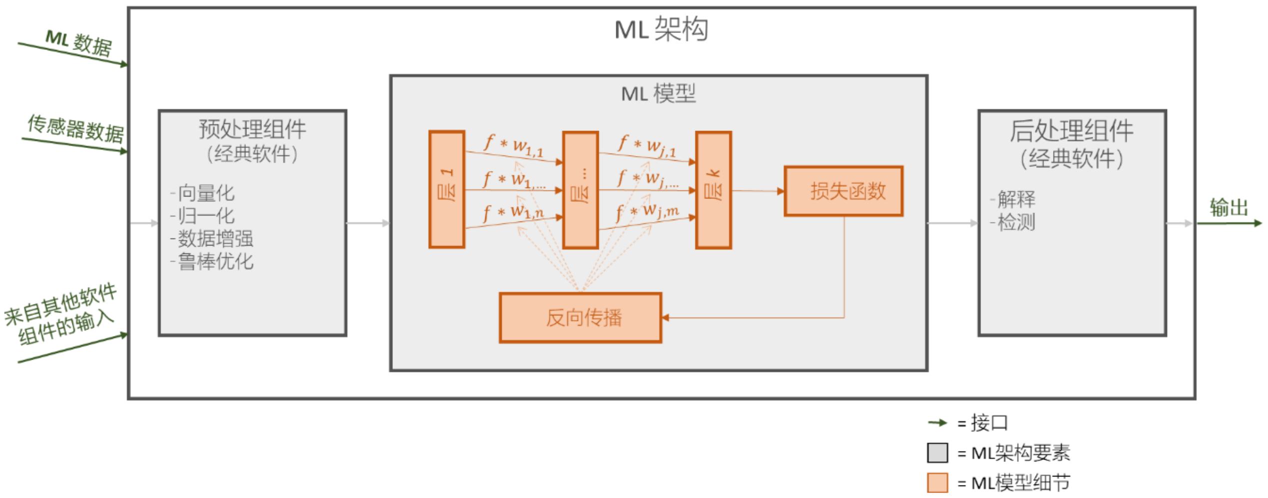

图 C.5 —机器学习架构的示例

由于机器学习模型的超参数（见附录 c #超参数）在训练过程中会发生变化，因此建议在训练开始时定义好超参数的初始值和范围。同时，由于开发基于机器学习的软件要素是一个高度迭代的过程，因此机器学习的架构可能会发生变化。

此外，用于训练的机器学习架构可能不同于已部署的模型的架构，后者将与其他软件要素集成，这些差异也是机器学习架构的一部分。

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Annex C.5 Traceability and consistency

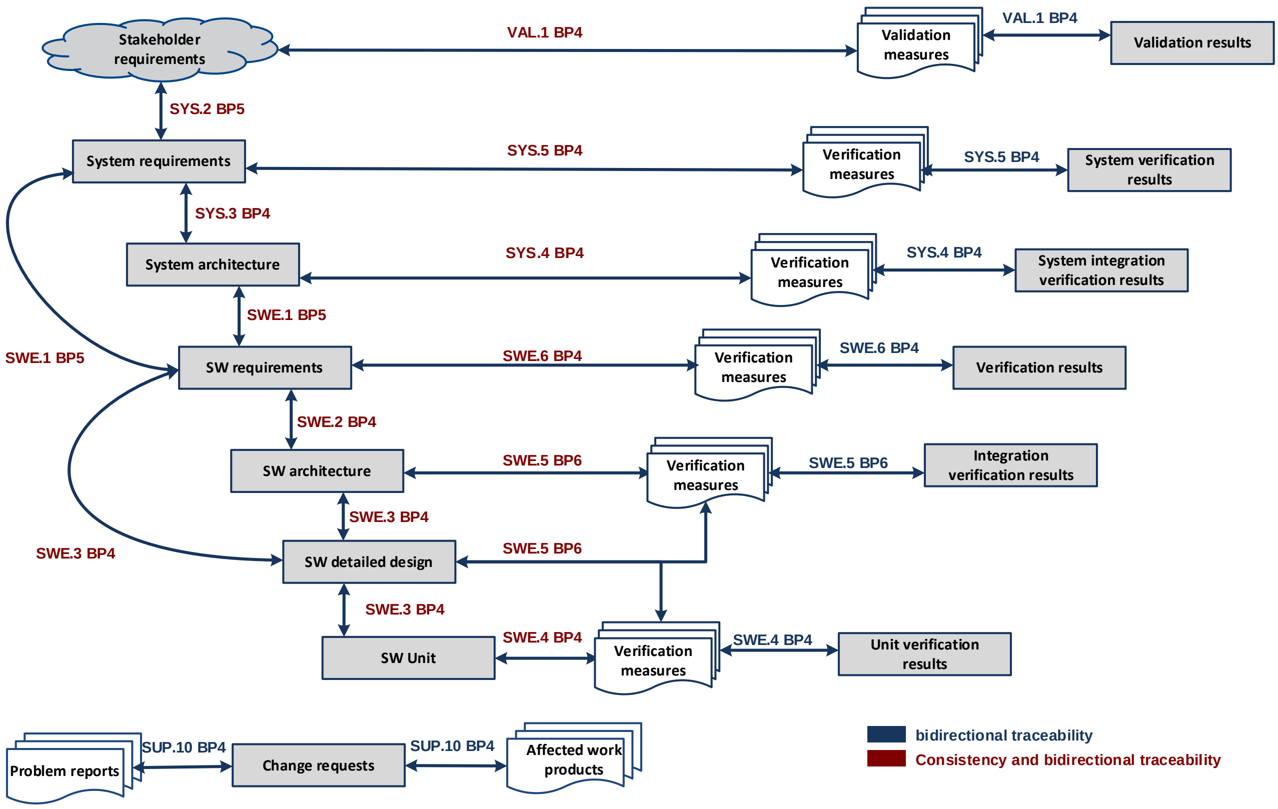

Figure C.2 — Consistency and traceability between system and software work products

Annex C.5 追溯性和一致性

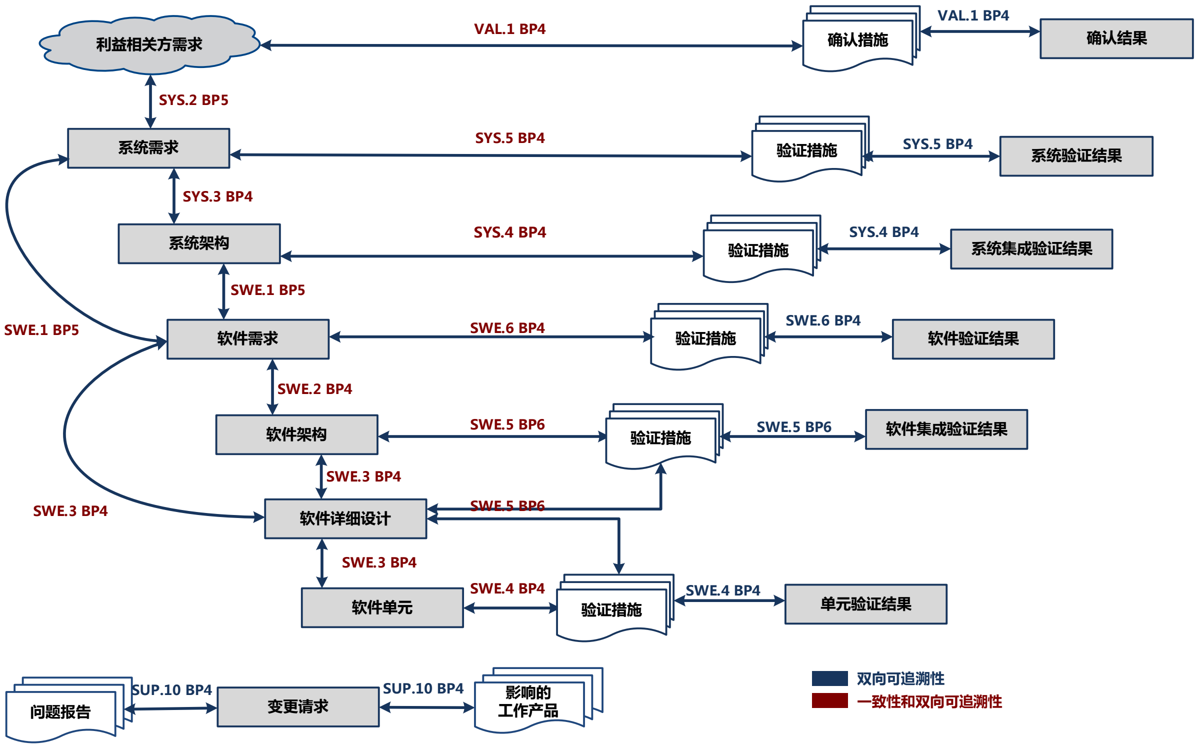

图 C.2 — 系统和软件工作产品之间的一致性和可追溯性

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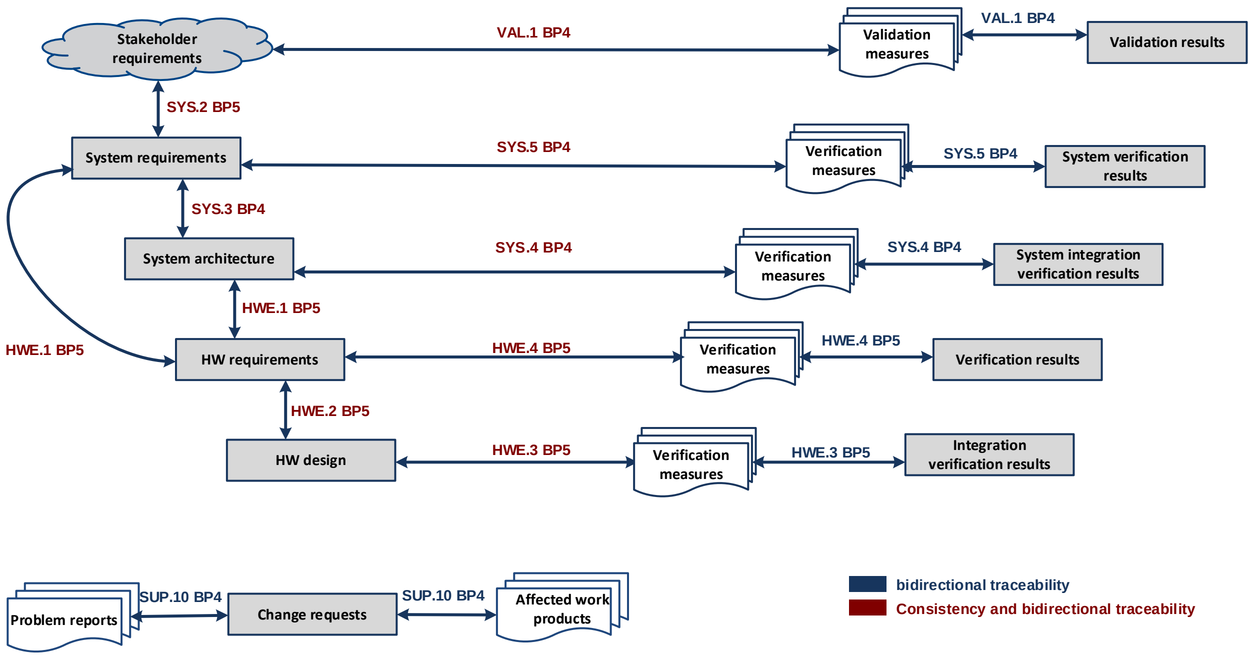

Figure C.3 — Consistency and traceability between system and hardware work products

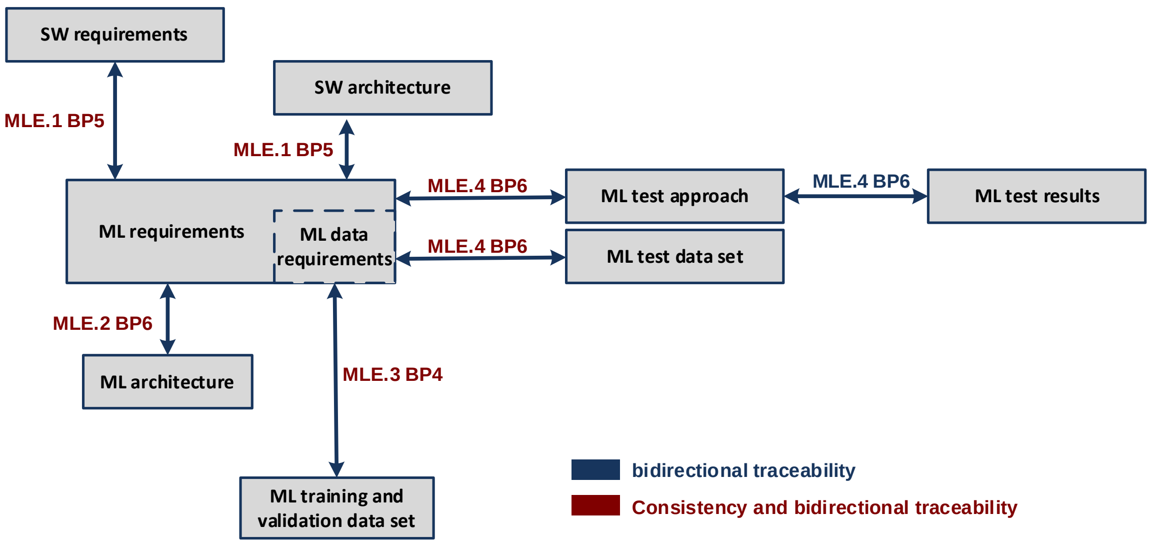

Figure C.4 — Consistency and traceability between ML work products

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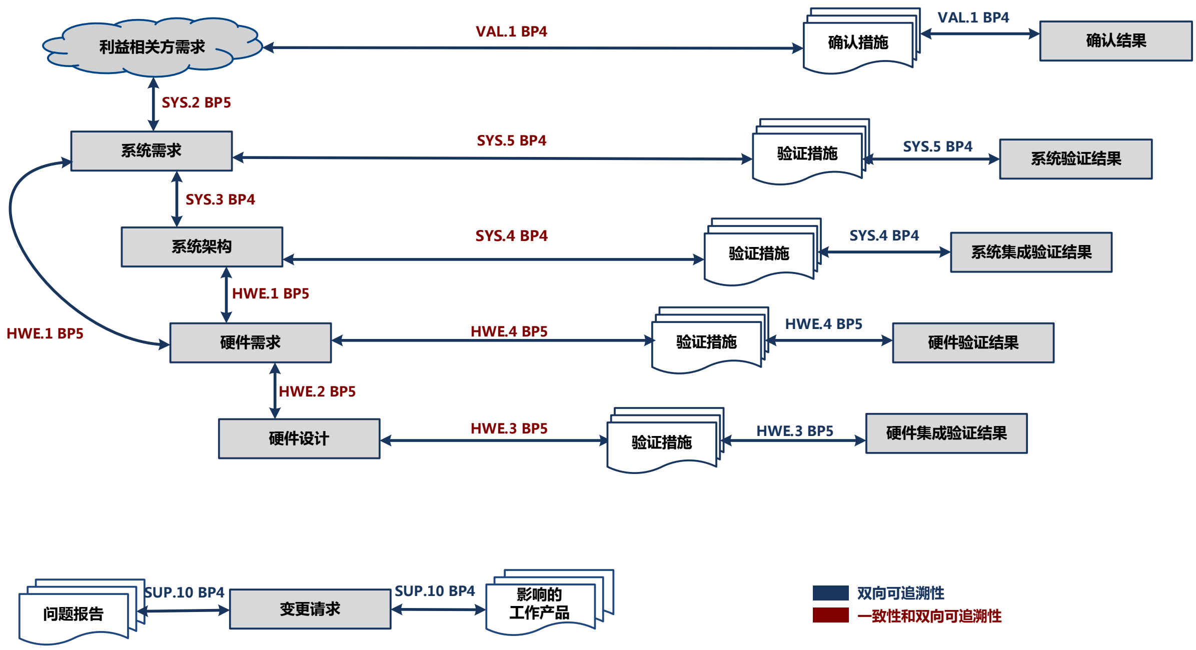

图 C.3 — 系统和硬件工作产品之间的一致性和可追溯性

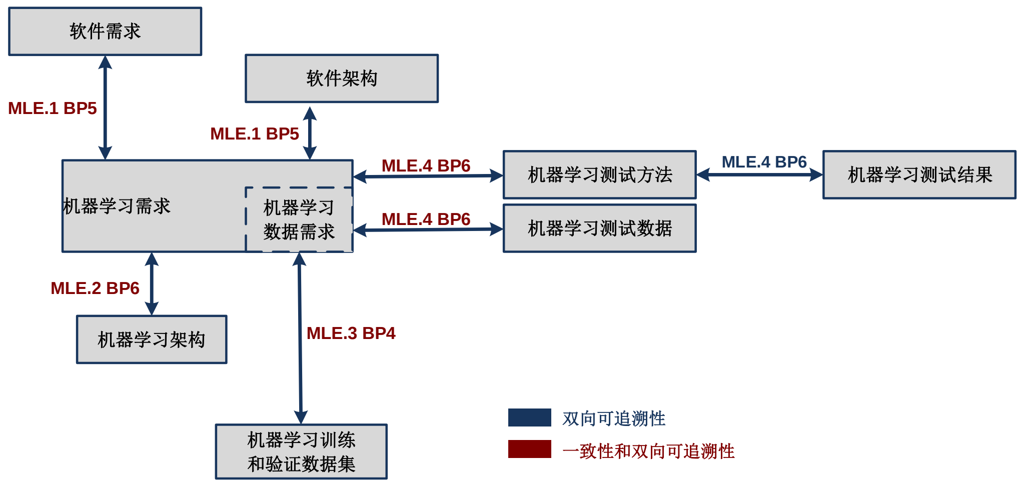

图 C.4 — 机器学习工作产品之间的一致性和可追溯性

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Annex C.6 "Agree" and "Summarize and Communicate"

The information flow on the left side of the "V" is ensured through a base practice "Communicate agreed 'work product x'". The term "agreed" here means that there is a joint understanding between affected parties of what is meant by the content of the work product.

The information flow on the right side of the "V" is ensured through a base practice "Summarize and communicate results". The term "Summarize" refers to abstracted information resulting from test executions made available to all affected parties.

These communication-oriented base practices do not require a planning-based approach, nor a formal approval, confirmation, or release, as this is targeted at by GP 2.1.6 on capability level 2. At capability level 1 the communication-oriented base practices mean that the work products (or their content) are to be disseminated to affected parties.

An overview of these aspects is shown in the following figure:

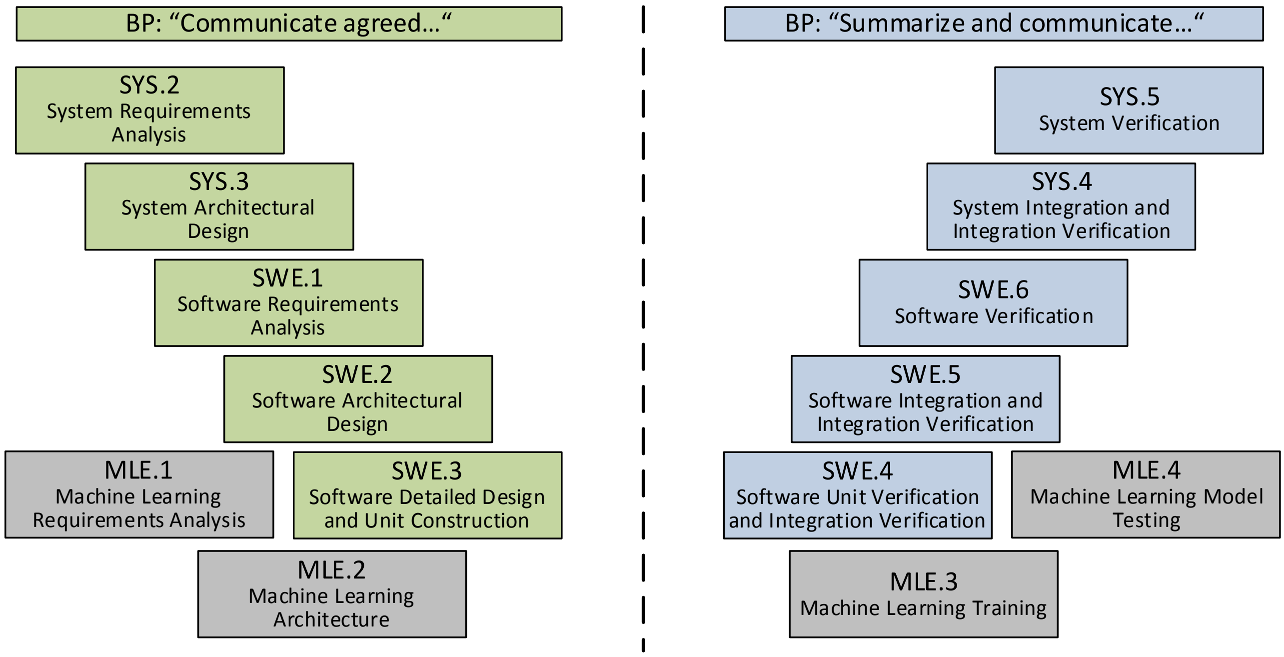

Figure C.5 — Agree, summarize and communicate

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Annex C.6 "约定"、"总结"和"沟通"

通过基本实践“沟通约定的‘工作产品 x’”确保在"V"左边的信息流。术语“约定”这里是指在受影响方之间对工作产品的内容有共同的理解。

通过基本实践“总结和沟通结果”确保在"V"右边的信息流。术语“总结”指的是测试执行所产生的抽象信息对所有受影响方是可用的。

注意这些面向沟通的基本实践不必需要正式的批准、确认或发布，像在 能力等级 2 级 GP 2.1.7 上要求的那样。在能力等级 1 级，以沟通为导向的基本实践指的是发送工作产品（或它们的内容）给受影响方。

上述方面的概览见下图所示：

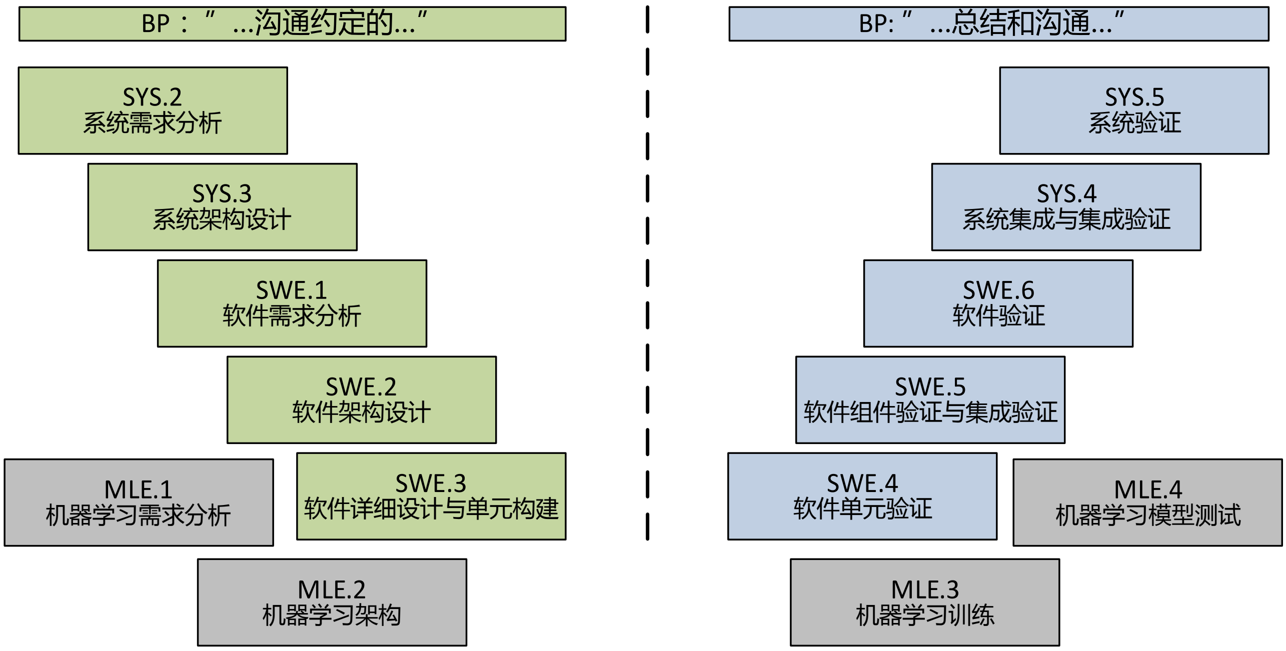

图 C.5 — 约定，总结和沟通

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Annex C.7 Key Changes in Automotive SPICE 4.0

Terminology – “Measure” vs. “Metric”

In the English literature the term “measure” can mean both

- “*to find the size, quantity, etc. of something in standard units, ‘size/quantity’*” and “*… to judge the importance, value or effect of something*”, respectively
- “*a plan of action or something done*”

In PAM v3.1, both meanings were inconsistently used in e.g.:

- MAN.5.BP6
- MAN.6
- PIM.3.BP7 Note 10
- work product characteristics 07-00 “Measure“ and 07-xx

In the assessment practice, this sometimes led to misconceptions with interpreting these assessment indicators and, thus, to varying assessment results. Since it was one of the objectives for Automotive SPICE 4.0 to use terminology more homogeneously, the decision was to consistently use the following terms and meaning:

- Quantitative measurement – “metric
- “A plan of action” – “measure”
- “To act in an operational manner” – “action”

Terminology – “Affected Party” (Level 1) vs. “Involved Party” (Level 2)

Processes at capability level 1 use the term “affected party” in the context of BP “Communicate”. This is to indicate that for every process instance A there is a downstream process instance B that requires the technical (i.e., capability level 1) output of A as a necessary input. Otherwise, process instance B would not be able to proceed, or update its output.

In contrast, “involved party” at capability level 2 includes, but goes beyond “affected parties”. For example, there may be a stakeholder who

- is passively kept in the information loop (e.g., a line manager, steering committee);
- is providing input (e.g., a deadline, a particular resource) and only requiring a commitment, but no further active involvement.

Affected parties thus are a subset of involved parties.

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Annex C.7 Automotive SPICE 4.0 中的关键变化

术语 – “Measure (措施)” vs. “Metric (度量项)”

在英语文学中，“measure” 术语的含义

- 分别指 "以标准单位计算某物的大小、数量等，'大小/数量'"和"……判断某物的重要性、价值或影响"
- “行动计划或已完成的事情”

在 PAM V3.1 中，两种含义的使用不一致，例如：

- MAN.5.BP6
- MAN.6
- PIM.3.BP7 注 10
- 工作产品特性 07-00 “Measure（度量项）” 和 07-xx

在评估实践中，这有时会导致对这些评估指标的理解出现偏差，从而导致评估结果的差异。由于 Automotive SPICE 4.0 的目标之一是更统一地使用术语，因此决定统一使用以下术语和含义：

- "定量度量" – "metric（度量项）"
- "行动计划" – "measure（措施）"
- "以可操作的方式行事" - "action（行动）"

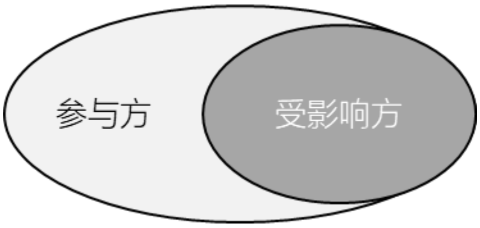
术语 – “受影响方（能力等级 1 级）” vs.“参与方（能力等级 2 级）”

能力等级 1 级 的过程在 BP "沟通 " 中使用 "受影响方 "一词。这表明，这表明对于每个过程实例 A，都有一个下游过程实例 B，需要将 A 的技术（即能力等级 1）输出作为必要输入。否则，过程实例 B 将无法继续进行或更新其输出。

相比之下，能力等级 2 级 中的 "参与方 "包括但不限于 "受影响方"。例如，可能有一个利益相关者

- 被动地处于信息环中（如直线经理、指导委员会）；
- 提供输入（如截止日期、特定资源），但只需要承诺，而不需要进一步的积极参与。

因此，受影响方是参与方的一个子集。



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Terminology – “Verification” instead of “Testing”

The former Automotive SPICE V3.1 process SUP.2 Verification has been removed in favor of advancing the respective SWE and SYS processes from pure testing to verification. The motivation for this was:

- SUP.2 was vague in regards to what ‘verification‘ should consider in contrast to testing processes
- Especially at the system level, testing is not the only verification approach. Rather, measurements (e.g., geometrical tolerances), calculations or analyses (e.g., strength/stress calculation using an FEM method), or simulations instead of using physical samples are other types of verification. The same is true for mechanical or hardware development. Therefore, the umbrella term verification now forms he center of those processes‘ purposes.
- The process SWE.4 ‘Unit Verification’ has already been an exception as a SW unit can be verified coherently by means of a combination of static analysis, testing, or code reviews (a view that is also inherent in ISO 26262-6 clause 9).

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术语 – “Verification (验证)” 代替“Testing (测试)”

之前的 Automotive SPICE V3.1 过程 SUP.2 验证已被取消，转而将 SWE 和 SYS 过程从纯粹的测试推进到验证。这样做的动机是：

- SUP.2 在 "验证 "与测试过程的对比方面含糊不清。
- 特别是在系统层面，测试并不是唯一的验证方法。相反，测量（如几何公差）、计算或分析（如使用有限元方法进行强度/应力计算）或仿真（而不是使用物理样本）是其他类型的验证。机械或硬件开发也是如此。因此，总括术语 "验证 "现已成为这些过程的核心目的。
- SWE.4 过程 "单元验证 "已经是一个例外，因为 软件单元可以通过静态分析、测试或代码审查的组合方式进行连贯的验证（这也是 ISO 26262-6 第 9 条固有的观点）。

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Annex D Reference standards

Annex D provides a list of reference standards and guidelines that support implementation of the Automotive SPICE PAM / PRM.

ISO/IEC 33001:2015	Information technology -- Process assessment – Concepts and terminology
ISO/IEC 33002:2015	Information technology -- Process assessment – Requirements for performing process assessment
ISO/IEC 33003:2015	Information technology -- Process assessment – Requirements for process measurement frameworks
ISO/IEC 33004:2019	Information technology -- Process assessment – Requirements for process reference, process assessment and maturity models
ISO/IEC 33020:2019	Information technology -- Process assessment – Process measurement framework for assessment of process capability
ISO/IEC/IEEE 24765:2017	Systems and software engineering -- Vocabulary
ISO/IEC/IEEE 29148:2018	Systems and software engineering – Life cycle processes – Requirements engineering
INCOSE Guide for Writing Requirements	https://www.incose.org/
PAS 1883:2020	Operational design domain (ODD) taxonomy for an automated driving system (ADS)
ISO 26262:2018	Road vehicles — Functional safety, Second edition 2018-12

Table D.1 — Reference standards

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Annex D 参考标准

附录 D 提供支持 Automotive SPICE 过程评估模型/过程参考模型实施的参考标准和指南的清单。

ISO/IEC 33001:2015	信息技术 - 过程评估 - 概念和术语
ISO/IEC 33002:2015	信息技术 - 过程评估 - 执行过程评估要求
ISO/IEC 33003:2015	信息技术 - 过程评定 - 过程度量框架要求
ISO/IEC 33004:2019	信息技术 - 过程评估 - 参考过程、过程评估和成熟度模型的要求
ISO/IEC 33020:2019	信息技术 - 过程评估 - 过程能力评估的过程评估框架
ISO/IEC/IEEE 24765:2017	系统和软件工程 - 词汇
ISO/IEC/IEEE 29148:2018	系统和软件工程 - 生命周期过程 - 需求工程
INCOSE 需求写作指南	https://www.incose.org/
PAS 1883:2020	自动驾驶系统（ADS）的操作设计域（ODD）分类法
ISO 26262:2018	道路车辆 – 功能安全，第二版 2018-12

表 D.1 —参考标准

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