



Update Automotive SPICE® PAM 3.1 to 4.0

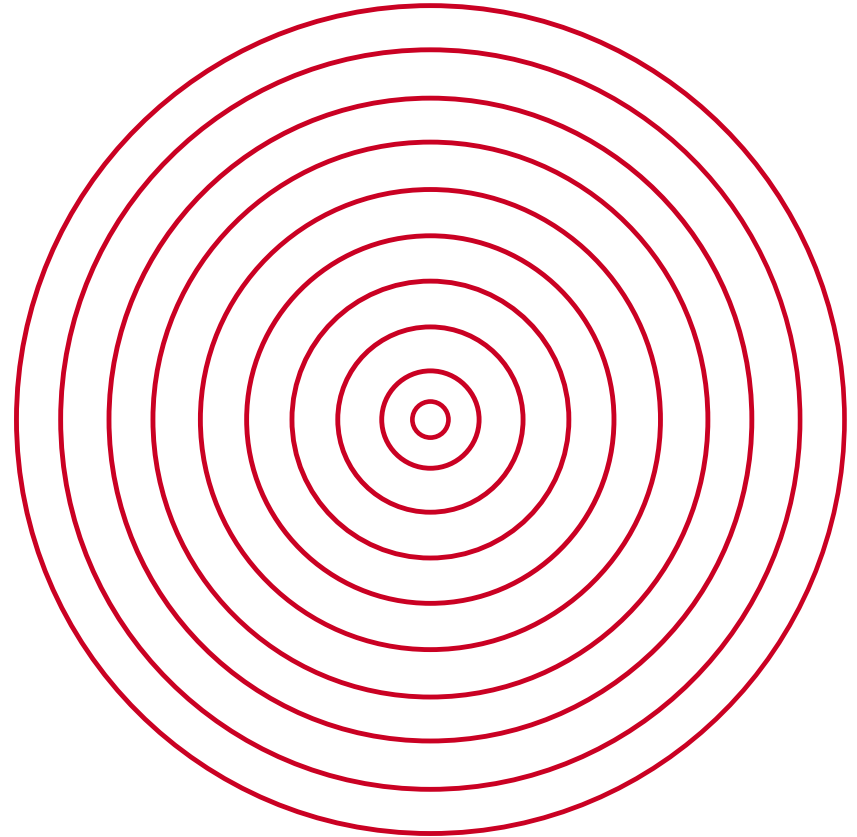


What will be covered?

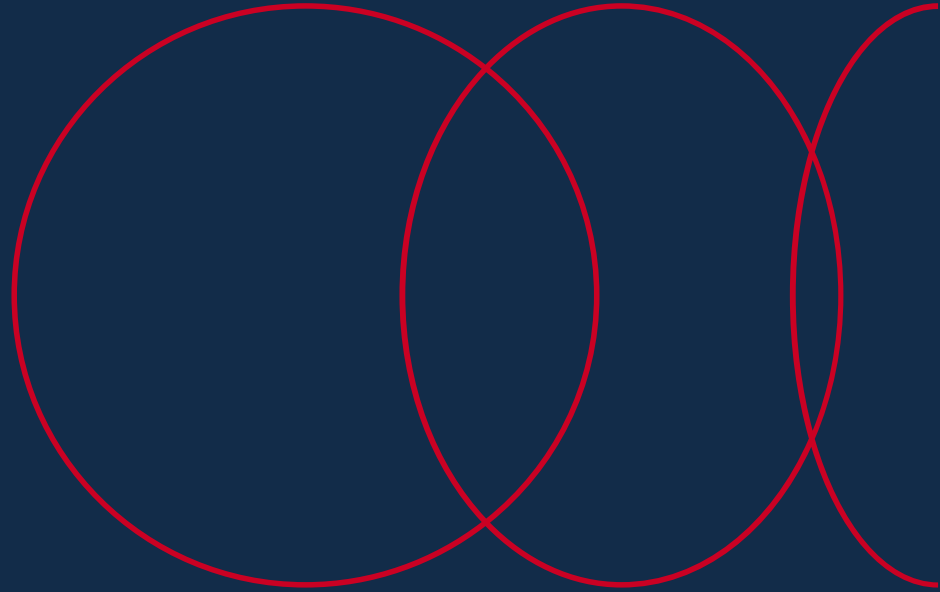
- Overview of changes to
 - Automotive SPICE® v3.1 and v4.0
 - Automotive SPICE Guidelines v1.0 and v2.0
 - Transition Plan
 - Message to Community

Disclaimer:

This is not intended to provide an exhaustive set of changes between 3.1 and 4.0 but focuses on the main topics.



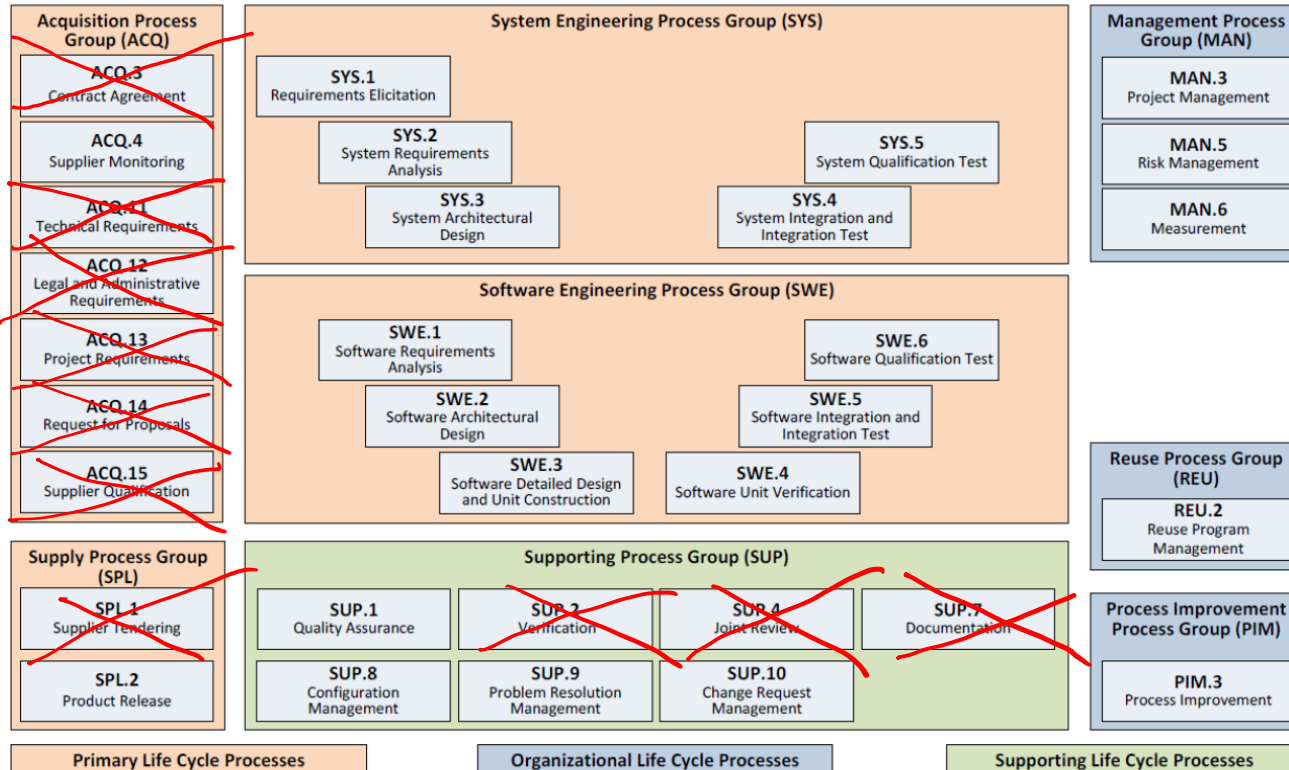
Automotive SPICE® PAM 4.0



Automotive SPICE® v4.0 – Overview of Changes

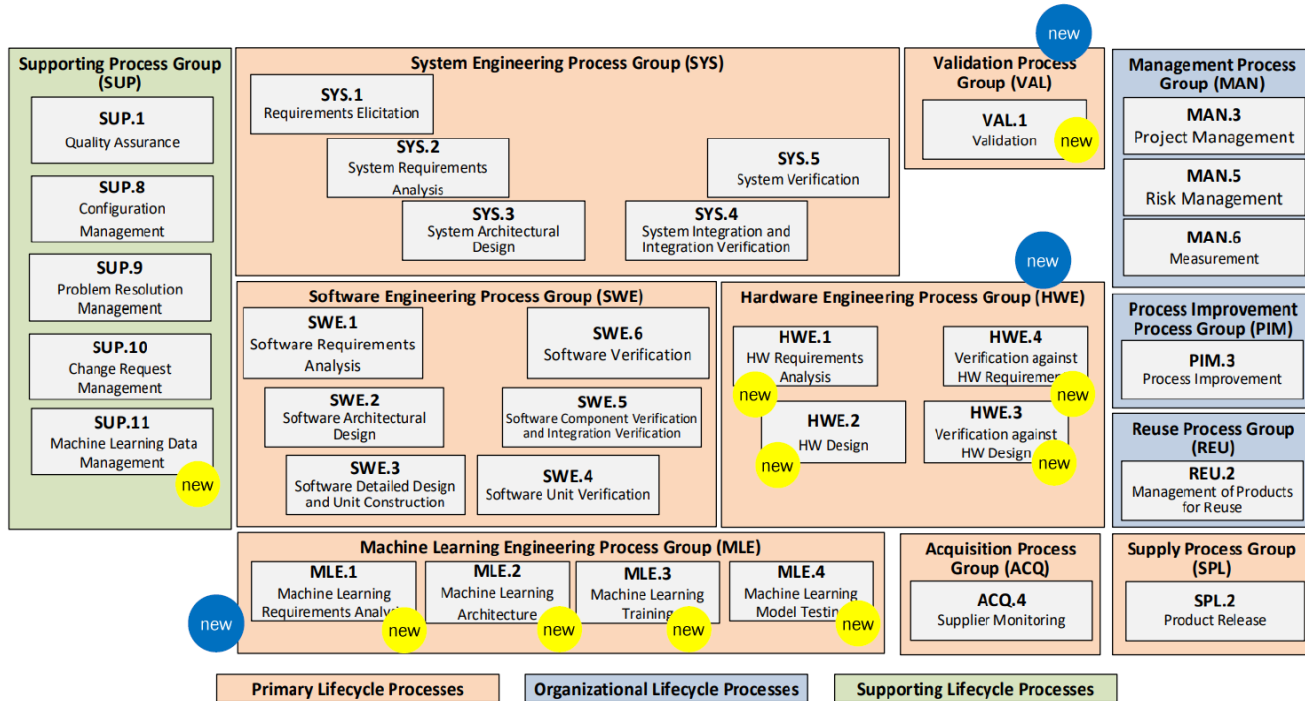
- Removal of 10 processes
- Addition of 10 relevant processes and 3 process groups
- Rework of all processes in the PAM
- Measurement framework updated (based on ISO/IEC 33020:2015)
- Planning-related aspects moved completely to level 2
- Restructuring of level 3 Generic Practices
- Set of indicators
 - Base Practices (BP)
 - Information Item (II) replace “Output Work Products”
 - Information Item Characteristics (IIC) replace “Work Product Characteristics”

Automotive SPICE® 3.1 Process Reference Model Overview



Source: VDA QMC

Automotive SPICE 4.0 Process Reference Model Overview



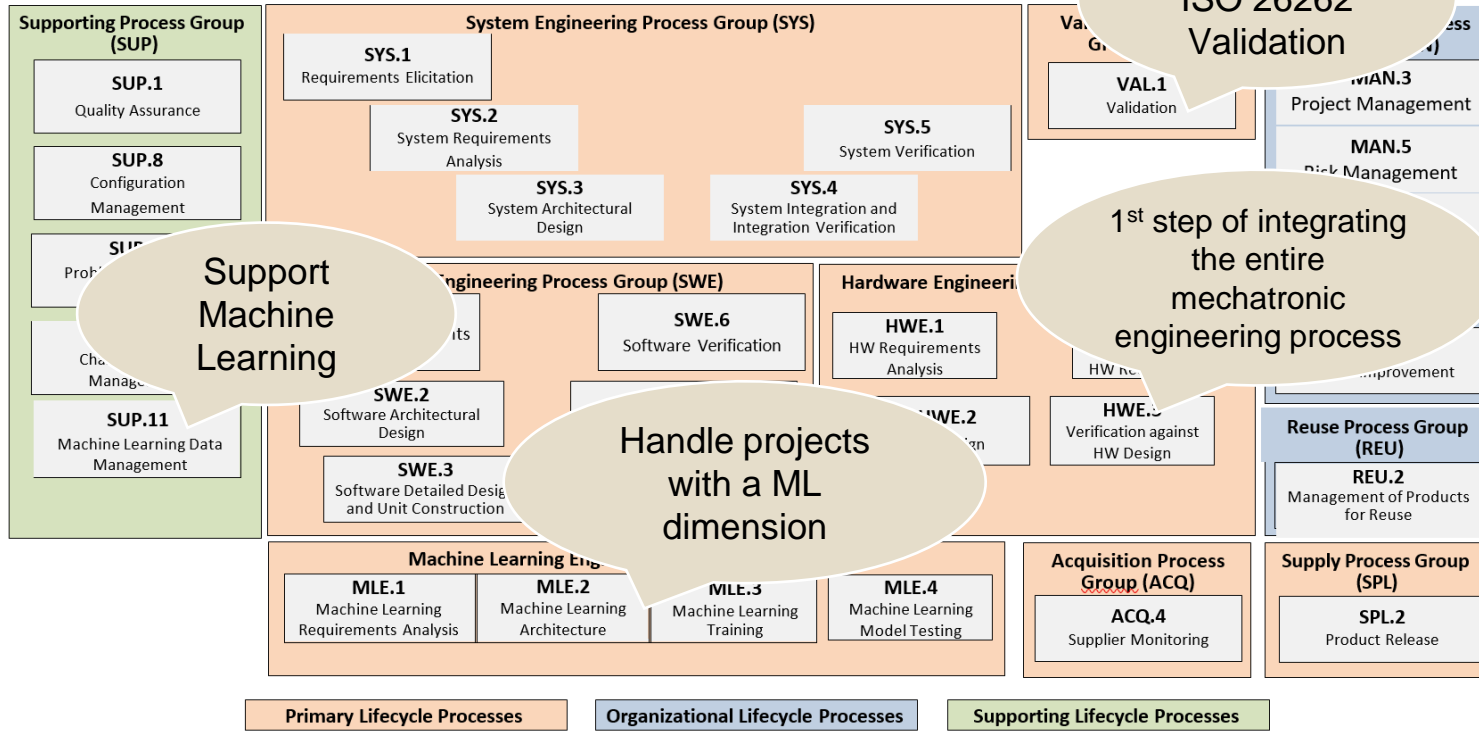
3 additional process groups ● new

10 additional processes ● new

10 processes removed
(SPL.1, SUP.2, SUP.4, SUP.7, ACQ.3, ACQ.11 -15)

2762 comments processed

Automotive SPICE 4.0 Process Reference Model Overview



Similar to ISO 26262 Validation

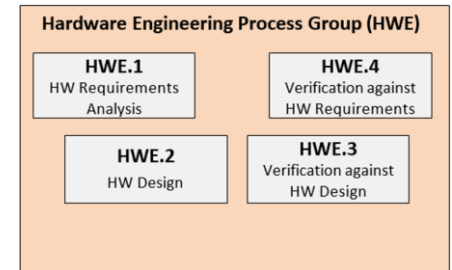
Support Machine Learning

Handle projects with a ML dimension

1st step of integrating the entire mechatronic engineering process

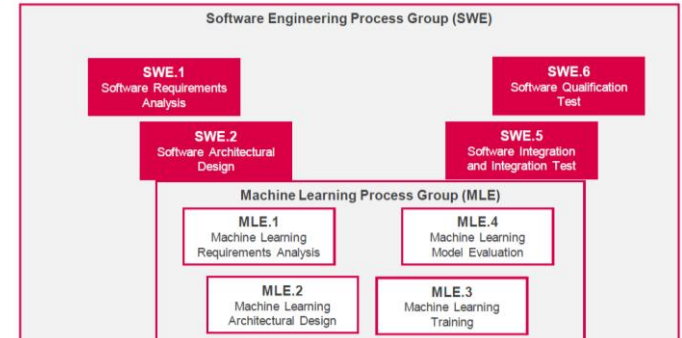
The Hardware Engineering Process Group Overview

- **Rationale:** HW Engineering SPICE existed as separate PAM, considering already some of the improvements that were introduced in 4.0
 - Its integration into ASPICE 4.0 allows to have a consistent way of handling process improvement across mechatronic disciplines, i.e., SYS, SW, HW
- **The technical scope of the HWE processes** is electrical or electronic hardware engineering
 - This **excludes** system level engineering, i.e., neither the mechatronic nor the ECU level, procurement, mechanical or hardware sample manufacturing, production processes (covered through **interfaces with affected processes**)
- The structure has **the typical V shape** like all other engineering process groups



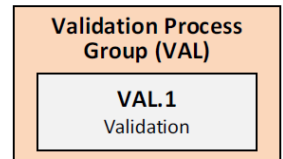
The Machine Learning Engineering Process Group Overview

- **Rationale:** an increasing number of products, especially in the ADAS domain, involve machine learning. The SWE.X processes are not suitable for assessing these.
- **General Considerations**
 - Machine Learning (ML) is different to the “typical” development of Automotive software-driven systems.
 - In ML, data analysis and management as well as algorithm training are the most important and critical activities
 - In ML, data quality is much more important than source code quality (SUP.11 ML Data Management)
 - The MLE group can be used as a plug-in below SWE.2 Software Architectural Design and finds its re-entry at SWE.5 Software Integration and Integration Test
- **Specific Output Information Items** are:
 - **Hyperparameters:** control the ML Model to be trained
 - **ML Data Set:** selection of ML Data to train the model
 - **ML Model** (trained, deployed): the final output-based on training the ML algorithm with a large amount of data



The Validation Process Group - Overview

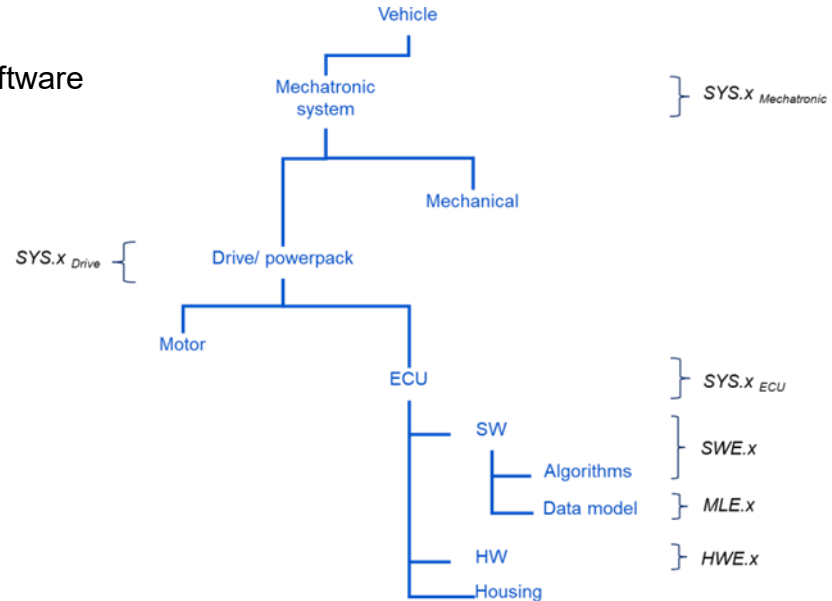
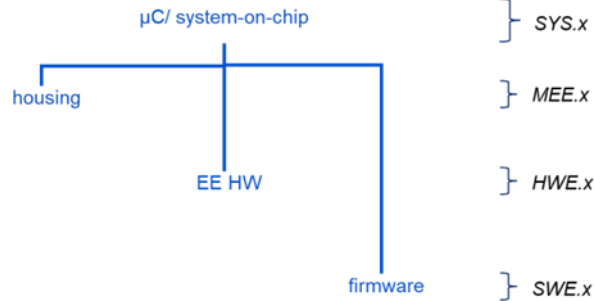
- The purpose is to **provide evidence** that the final product, **allowing direct end-user interaction**, satisfies the **intended use** expectations in its **operational target environment**
- Focus is on “**intended use**”, addressing the product’s end users
 - This excludes a large set of products in the vehicle that are not directly involved in this end-user interaction
- **Homologation and legal type approval requirements** are examples of stakeholder requirements subject to validation
- In absence of legal requirements (e.g., a maximum closing force of 100N for window regulators, or homologation requirements), the target expectations behind validation may be of an explorative, or even subjective nature (user experience, “feeling” or attitude during driving tests, attitude, ...)



The Interpretation of the "System"



- The SYS.x processes can be applied to **different levels of a product** and will be handled as different instances, e.g.:
 - a mechatronic system or drive (i.e. motor plus ECU)
 - a control unit (ECU)
 - a microcontroller or a system-on-chip
 - a “software system” comprising different pieces of software



What are the main Terminology Changes ?

Process Structure

- Output Information Item (II) replaces Output Work Products
- Information Item Characteristic (IIC) replaces Work product characteristics

Terminology used in processes:

- “Verification” instead of “testing”
 - Verification measures instead of test specification
- “Requirements” instead of “specification”
- The term “item” was removed because of conflicts with other standards, e.g., ISO 26262
- Definition of what is a unit: A unit can be both a single subroutine or a set of subroutines (respectively .c file) depending on the application domain* → **“inseparable coherent piece of behavior”**

What are the main Terminology Changes ?

- SWE.3.BP1 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**.*
- Information item 11-05 ("**Software Unit**") is defined as follows:
 - Software design model element **at the lowest level**, or commented source code including
 - parameter and return value information
 - variables and data structures defined
 - data types defined
 - algorithms defined
 - configuration files
 - or executable code
 - or commented scripts
 - or auto-coded code represented by model elements

What are the main Process Changes regarding Base Practices? (1/3)

Overall changes across all or several processes:

- The contents of the previous strategy BPs **have been moved to other BPs and to GP2.1.1** (affects SUP.1, SUP8/9/10, SYS.4/5, SWE.4/5/6)
- BPs for traceability and consistency have been **merged** (as in a previous ASPICE version, affects all engineering and verification processes)
- In the Output Information Items, “record” was replaced by “evidences” (e.g., communication evidences, consistency evidences, ...)
- The communication BPs do not mention “updated work products” in the description (SYS.2/SYS.3, SWE.1 to SWE.3)

What are the main Process Changes regarding Base Practices? (2/3)

Specific process changes:

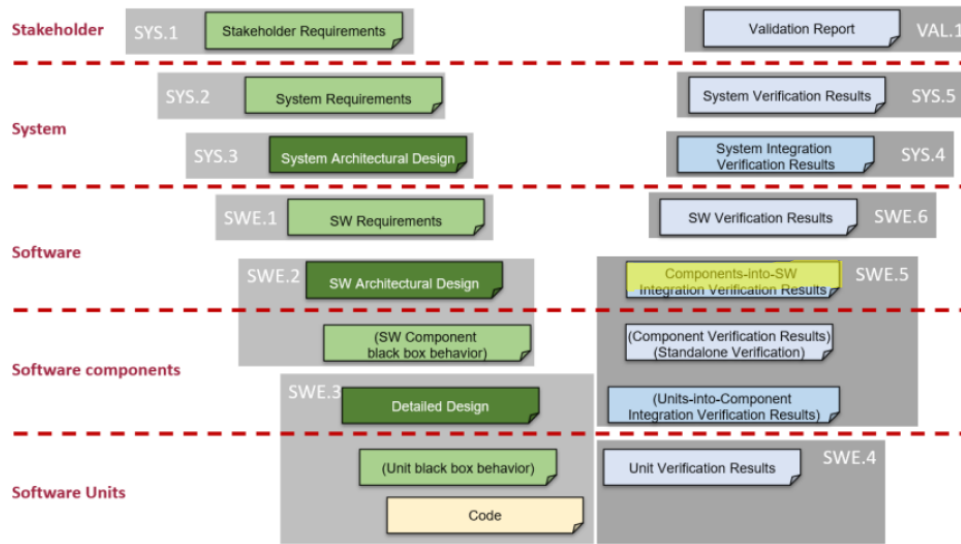
- **No separate BP for verification criteria**, now part of system/software requirements that must meet “defined characteristics for requirements” which include verification criteria (SYS.2, HWE.1, SWE.1)
- **No separate BP to evaluate alternative architectures**, instead the chosen architecture must be justified (BP3 “Analyze System / Software Architecture” (SYS.3, SWE.2), HWE.2.BP4 “Analyze hardware architecture and detailed design”)
- SWE.4.BP3 “Evaluate software detailed design” has been removed.

What are the main Process Changes regarding Base Practices? (3/3)

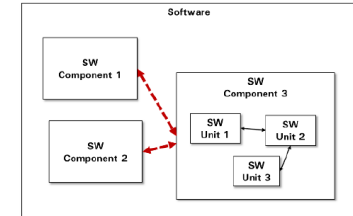
Specific process changes:

- Software testing reorganized:
 - There is now unit testing (SWE.4) and component testing (SWE.5).
 - “Element” is a generic term for “unit” and “component”
 - SWE.5.BP4 refers to the integration and integration verification of elements. This includes integrating and integration verification of **units into components** (which is new). **1** on next slide
It includes also integrating and integration verification of **components into larger elements** (which we know from 3.1 where they were called “items”) **2** on next slide
 - SWE.5.BP5 specifies that **components need to be verified** (which is new). **3** on next slide

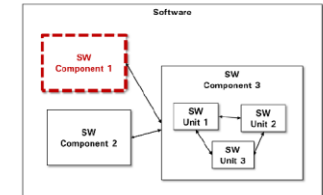
Clarification of Scope regarding SWE.5 Software Component Verification and Integration Verification



Integration and testing of software components



Testing of a single software component (prior to integration with other components)



Integration, and integration testing, of software units into their component

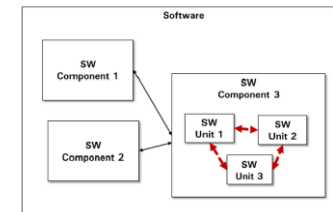


Figure 2-7: 2.2 Software Unit Behavior and Unit Integration, Component Behavior, and software Component-level testing

Strategies removed from CL1

Rationale:

- Evaluation results in the same or similar contexts sometimes differed significantly because of **overinterpretation of expectations** for “strategy” and “plan” indicators:
 - When an explicit written document was required even in very small settings, this led to overengineered processes
 - Documents were expected to have exactly the same structure as defined in the work product characteristics
 - Requirements of CL2 were already expected at CL1
- Strategies were expected just for a subset of processes

What was changed in 4.0 for Capability Level 2:

- GP2.1.1: “Identify the objectives ...” is replaced by “Identify the objectives and define a strategy for the performance of the process”
 - “Process Performance Strategy” for every process (can be jointly documented across several processes)

Changes regarding Capability Level 2

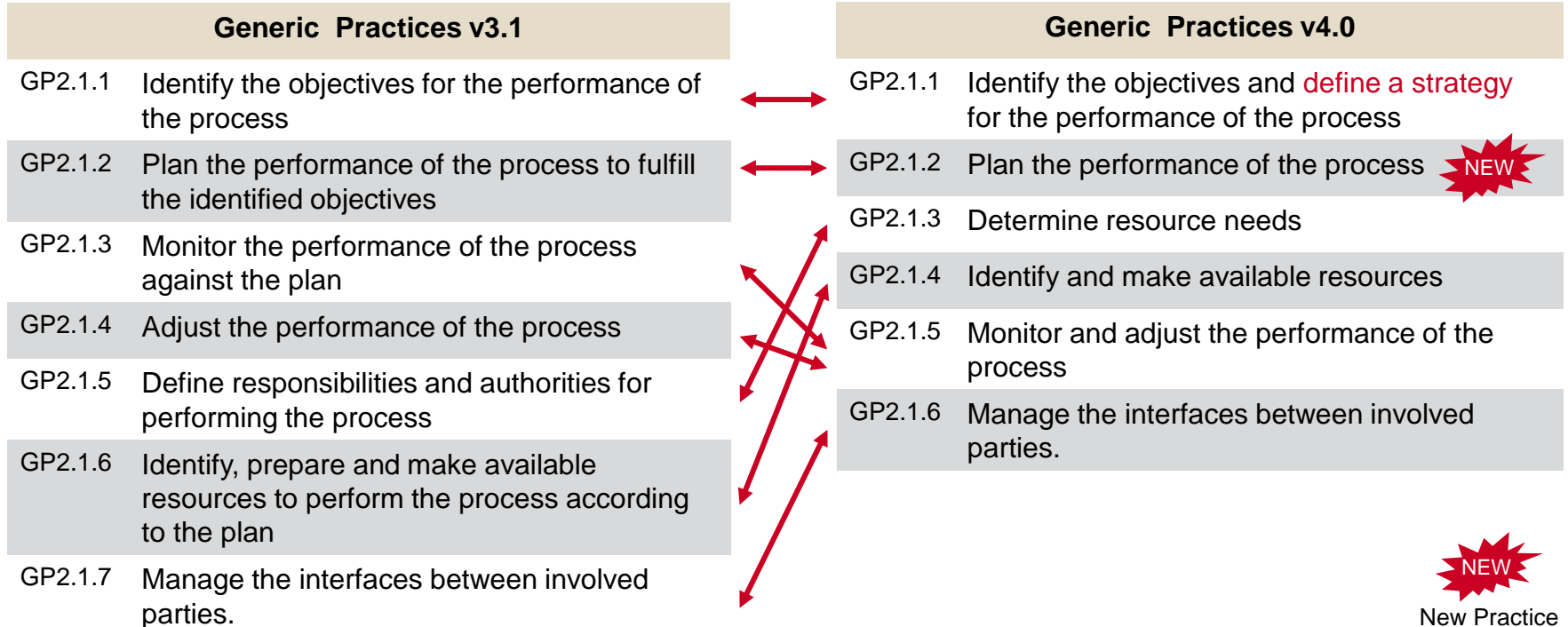
PA2.1

- The biggest change is in GP2.1.1 where the **strategy for the performance of the process** shall be defined (corresponding to the strategies in ASPICE v3.1, but now required for ALL processes)
 - Process performance objectives still exist with some examples provided e.g., budget targets, delivery dates, test coverage target, process Leadtime.
- The new GP2.1.3 “**Determine resources needs**” combines human resources (including process performance experience, knowledge, skills, responsibilities, authorities) and physical and material resources
- Other changes are aligned with changes in MAN.3 e.g., work packages instead of activities

PA2.2

- No changes in the structure
- GP2.2.2/GP2.2.3 have been clarified to be all about storage and control of work products (thereby removing some confusing details like distribution, traceability, dependencies that were in 3.1)

Generic Practices – CL2 – PA2.1



Generic Practices – CL2 – PA2.2

Generic Practices v3.1			Generic Practices v4.0	
GP2.2.1	Define the requirements for the work products.	↔	GP2.2.1	Define the requirements for the work products.
GP2.2.2	Define the requirements for documentation and control of the work products.	↔	GP2.2.2	Define the requirements for storage and control of the work products.
GP2.2.3	Identify, document and control the work products.	↔	GP2.2.3	Identify, store and control the work products.
GP2.2.4	Review and adjust work products to meet the defined requirements	↔	GP2.2.4	Review and adjust work products

Changes regarding Capability Level 3

- The semantics of level 3 remained unchanged, only a restructuring and simplification took place.

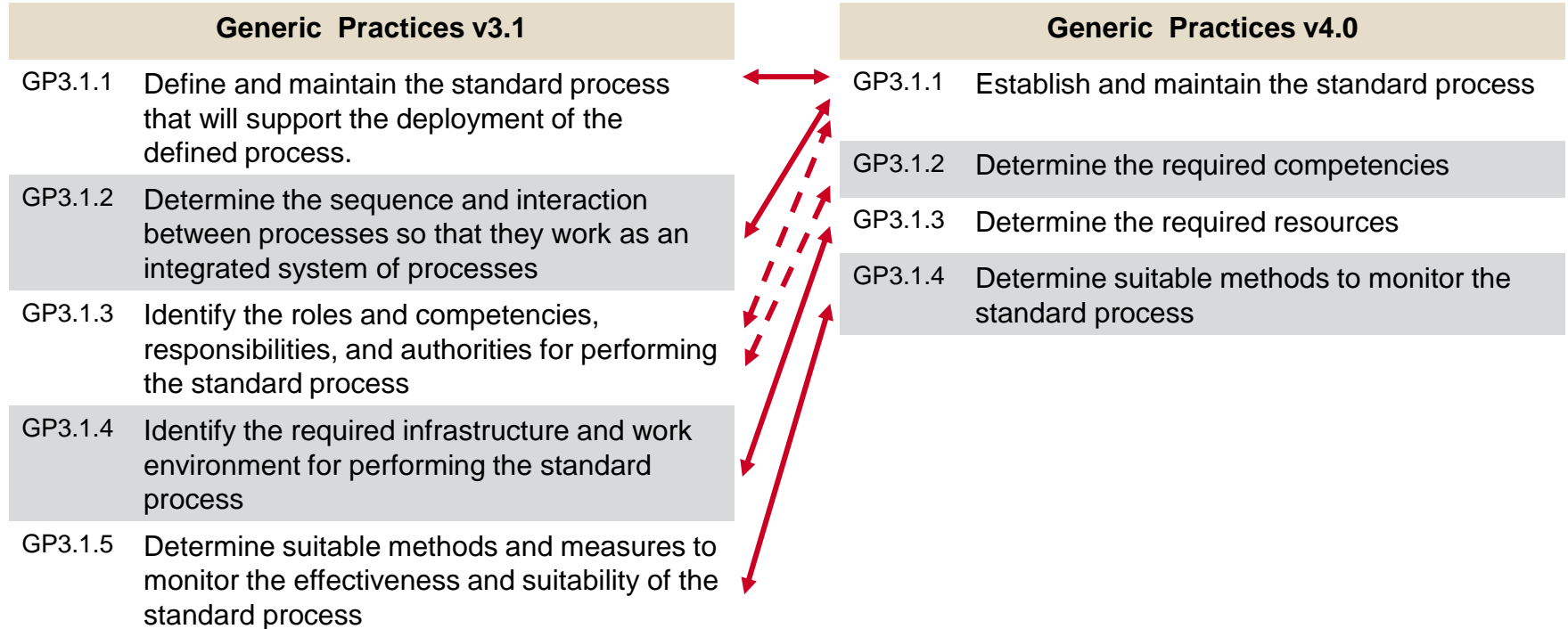
PA3.1

- **Generic Practices have been simplified**, combining some of them but also providing more details regarding expectations
 - GP3.1.1 contains the core CL3 concepts: Process interactions, roles, guidance, tailoring guidelines, process maintenance
 - GP3.1.2. exclusively addresses competencies and how to acquire them
 - GP3.1.3 has been slightly rephrased, focusing now on “resources” that includes infrastructure, physical and material resources

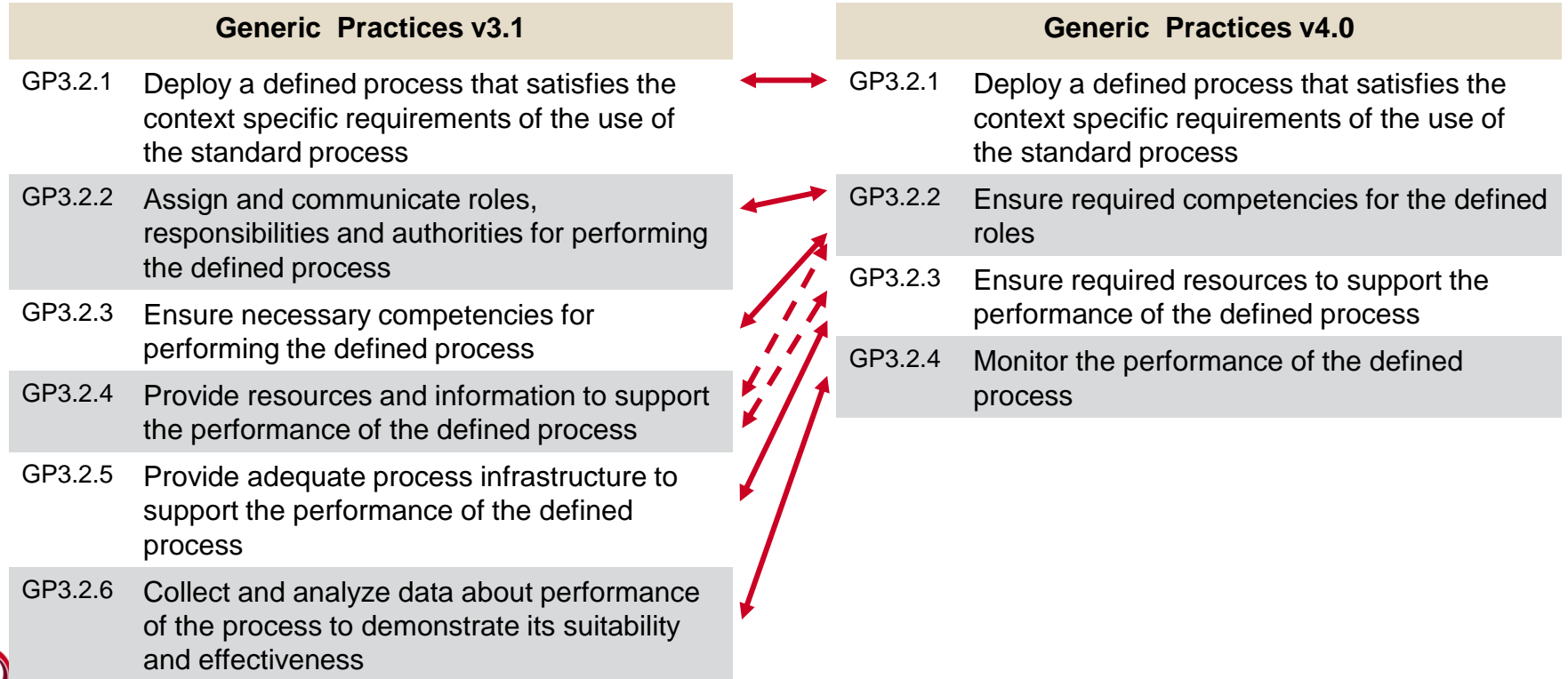
PA3.2

- **Simplifications in PA3.1 are mirrored in PA3.2**
 - GP3.2.2 includes both role allocation and ensuring competencies
 - GP3.2.3 resources relate to all kind of resources except human resources (that are covered in GP3.2.2)

Generic Practices – CL3 – PA3.1



Generic Practices – CL3 – PA3.2



Changes for increasing Efficiency / Consistency

- New process layout (See next slides)
- Tables for better overview of relationships of Base Practice to Outcomes and Output Information Items to Outcome
- Terminology at the beginning of the PAM instead of Annex C
- Unused abbreviations, terms and IIC (WPC) removed
- Consistent use of terms (metric, measurement, risk, tasks, ...)
- Process name excluded from purpose statement
- Phrase “As a result of successful implementation of the process” removed from “Process Outcomes” section

Conclusion – Main Changes in PAM 4.0

- Three new process groups
 - HW Engineering
 - Machine Learning Engineering
 - Validation
- Strategy no longer required for CL1, but for CL2 (which makes it mandatory for all processes)
- Reduction in the number of Base Practices
 - ASPICE v3.1 had 32 processes with 127 BPs, v4.0 has 32 processes with 97 BPs
 - Quite significant reduction of BPs in SYS.3, SYS.4, SWE.2, SWE.3

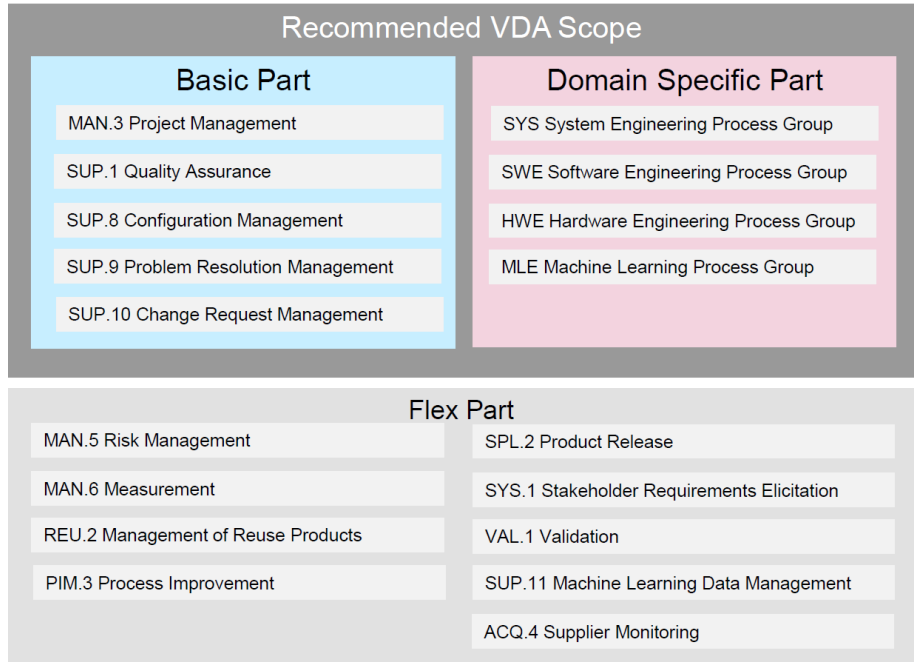
Recommended VDA Scope

Report from Working Group 13

Recommended VDA Scope

VDA QMC

Verband der Automobilindustrie
Qualitäts-Management-Center



Rules:

- Sponsor / Auftraggeber defines the Scope
- Recommended VDA Scope is a must
- Basic Part plus on process group from the domain specific part as a minimum
- Examples
 - former VDA Scope = Basic + SYS + SWE
 - Electronic dev. = Basic + SYS + HWE
 - Software Only = Basic + SWE
- Processes from Flex Part are selected based project specific context

Automotive SPICE® Guidelines 2.0

Process assessment using Automotive
SPICE in the development of software-based
systems

Draft version for 2nd edition, May 2023 Verband der
Automobilindustrie e.V. (VDA)
German Association of the Automotive Industry (VDA)

VDA Guidelines v2.0 – Overview of Changes

- Stronger emphasis on guidance for assessors to understand the context of the assessed organization
- Only rating rules for guidance – no ‚recommendations‘
- Concept of “Process context categories” removed
(Parts of a product/delivery vs. entire product/delivery)
- Disjunctive evaluation of processes: if a process gets downrated, others are not affected.
- ALL processes of the PAM 4.0 are addressed by the VDA Guidelines.

Purpose

- Automotive SPICE® Guidelines 2.0 is a means to support assessors.
- Automotive SPICE® Guidelines 2.0 is not an engineering standard to be compliant with.
- Strong emphasis on guidance for assessors to understand the context of the assessed organization.
- The guidelines are intended to improve the reproducibility of assessment results.

Main Changes

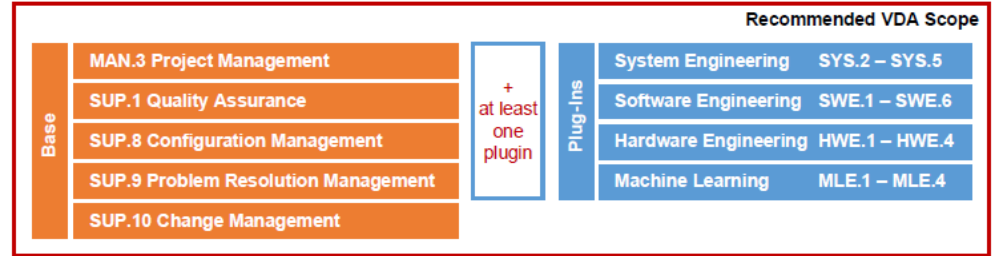
- Only rating rules for guidance
 - the recommendations as in V1.0 were removed, since the application of RC as a “may” or “can” was a source of inconsistent ratings.
- Focus on disjunctive evaluation of processes
- The concept of “process context categories” (parts of a product/entire product) was abandoned.
 - Every weakness detected in an assessment bears a risk for the product
 - Every assessment shall assign same rating to the same finding
 - Diverging ratings may come from scope definition
 - The PAM provides indicators for systematic approach and for completeness
- Simplified terminology defined for the formulation of the rules

Achievements

- 16 processes from v1.0 reworked
- 16 additional processes elaborated
- Rating guidelines for measurement framework reworked
- Rating rules for specific settings
- Rules eliminated that were redundant to existing rating indicators
- Definition of a recommended VDA scope
- No implicit requirements

The new VDA Scope

- The VDA Scope 4.0 (upper box) is essentially unchanged, only the number of plug-ins has increased.
- As before, processes can be added from what is now called the "Flex Scope", that has also some completely new processes like VAL.1 and SUP.11 and processes that were usually not considered (MAN.6, PIM.3, REU.2).



Flex / Optional	ACQ.4 Supplier Monitoring	SUP.11 Machine Learning Data Management
	MAN.5 Risk Management	SPL.2 Product Release
	MAN.6 Measurement	PIM.3 Process Improvement
	SYS.1 Requirements elicitation	REU.2 Management of Products for Reuse
	VAL.1 Validation	

Key concepts and overall guidelines

- No Production or Construction Processes and No Procurement Process
- Technical Scope of the HWE processes (new)
- The scope of “system” in SYS.x defined
- Requirements process oriented concepts
 - clear up misunderstandings the "Define Verification Criteria" BP
 - use of state-of-the-art requirements characteristics

Consistency and Traceability

- These two BPs have been reintegrated into one, which does not invalidate advantages of traceability
- Traceability can be distinctly established between clusters of information instead of individual atomic elements.
- Evidence for consistency
 - The Automotive SPICE® PAM requires ensuring consistency but not reviewing or documenting, which means that the exact way this is done cannot be predefined.

Verification process-oriented Concepts

- “Verification” instead of “testing” since respective SYS, SWE, and HWE processes have been advanced to address
- No more use of term “item” in verification processes in order to remove conflict with other standards
- No explicit notion of “specification” and “strategy” at level 1 but talk about “requirements” or “verification measures”
- The contents of the previous strategy BPs have been moved to other BPs and to GP2.1.1 (affects SUP.1, SUP8/9/10, SYS.4/5, SWE.4/5/6).
- Evaluating alternative architectures considered of higher practical value to provide arguments why a given design was chosen rather than explaining which other particular approaches were not chosen

Application in specific Environments

- MBD - Model based development - only minor changes, several rules removed
- AGE - Agile environments - many changes within the chapter
- DEX - Development external to the assessed project – 16 rules in total
 - Aspects from the following chapters of the Guidelines v1.0 were subsumed here
 - Management of Platform and Legacy Software
 - Management of 3rd party software
 - Distributed Development
 - Managing free and open-source software – only 1 rule kept, others removed
- APA - Application parameters - many changes within the chapter

Process Performance Management (PA 2.1)

- Focus on strategies as key element of having a managed process
- A strategy includes the need for process performance objectives and criteria
- Re-arranging and re-formulation of GPs
- More explanations and reasonings are given
- No rules for rating consistency, only relationships mentioned

Rating Guidelines on Process Performance

- For all processes of the PAM (except SYS.1) rating rules are defined
- Rating rules for the former 16 processes are re-written resp. adapted in the process context
- Rating rules for the 16 new processes defined
- There is no rule anymore to downrate a process, according to a rating of any other process

Work Product Management (PA 2.2)

- Instead of work products, “Information Items” are defined to describe the required content of output work products
- Each of the output information items is associated with one or more outcomes of the process and further detailed by information item characteristics
- Used as starting point for considering whether the observed work products are contributing to the intended purpose of the process
- Simplified rating consistency within PA 2.2
- Strong dependency between quality assurance (SUP.1) respectively configuration management (SUP.8) mentioned

Process Capability Level 3

- Number of rating rules increased significantly from 22 up to 55
- No explicit consistency dependencies were identified within the PAs
- No rating rules to other processes described
- Rating rules within the CL3 are more simplified and straightforward

Guidelines for performing the Assessment

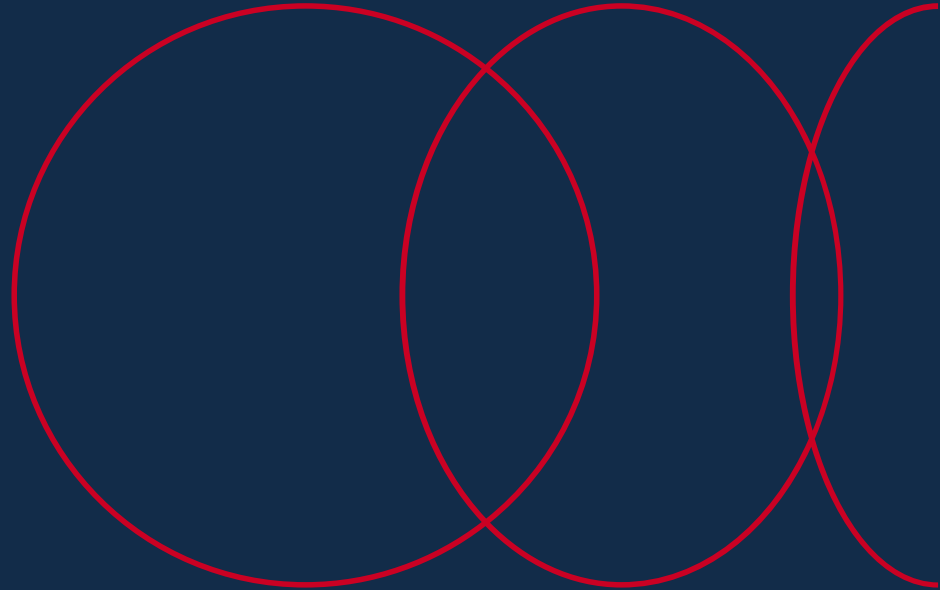
- Defined Automotive SPICE 4.0 process measurement framework to be used
- The assessment team leader has the authority, and the responsibility, to take any necessary precautions and actions to ensure that the assessment is conducted in compliance with the relevant ISO/IEC 330xx parts, the Automotive SPICE 4.0 measurement framework and this document.
- The assessment team leader has the right to dismiss individuals (assessment team or interviewees), or to cancel interviews
- Co-Assessor introduced instead of Assessor

Summary of Automotive SPICE® Guideline v2.0 Advantages

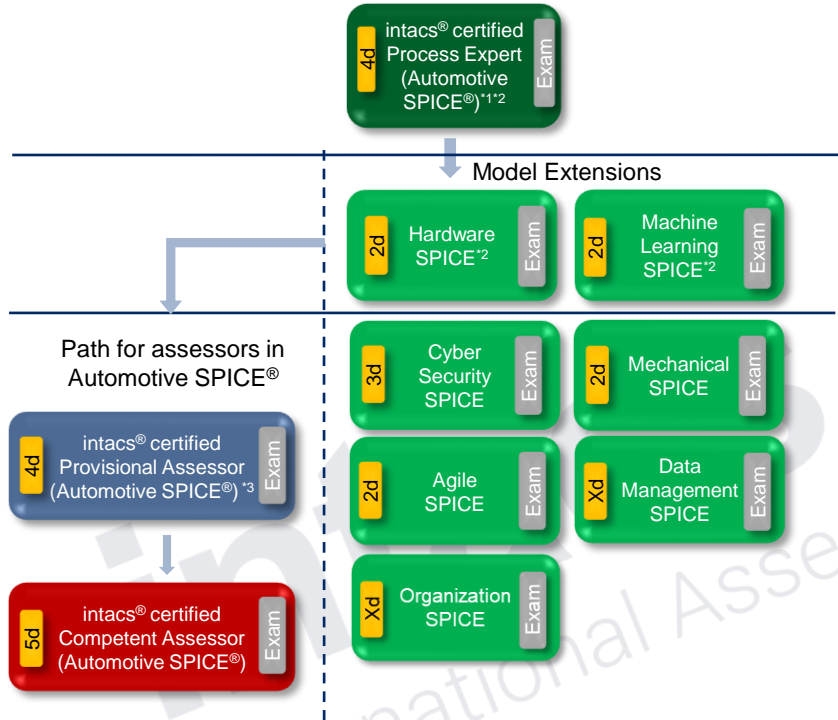
- Improved reproducibility by
 - Focus on understanding of the process context of the organization
 - Clear rules
 - No more “recommendations”
 - Reduction of interpretable content
- Rules are given for all processes in PAM 4.0
- No rules that repeat the PAM indicators
- Assessments with Automotive SPICE® v4.0 and Automotive SPICE® Guidelines 2.0 will be
- “More helpful, More efficient, More reproducible”

Transition

From Automotive SPICE® 3.1 to 4.0



Future intacs® Training Architecture for Automotive SPICE⁴



All Assessors need a training and certification for a **Core PAM⁵** to perform official assessments with this PAM.

Lead Assessors need a certification for a **model extension** to perform official assessments with this extension.

¹ includes all PAM 4.0 processes without HWE and MLE, emphasizes Process Improvement

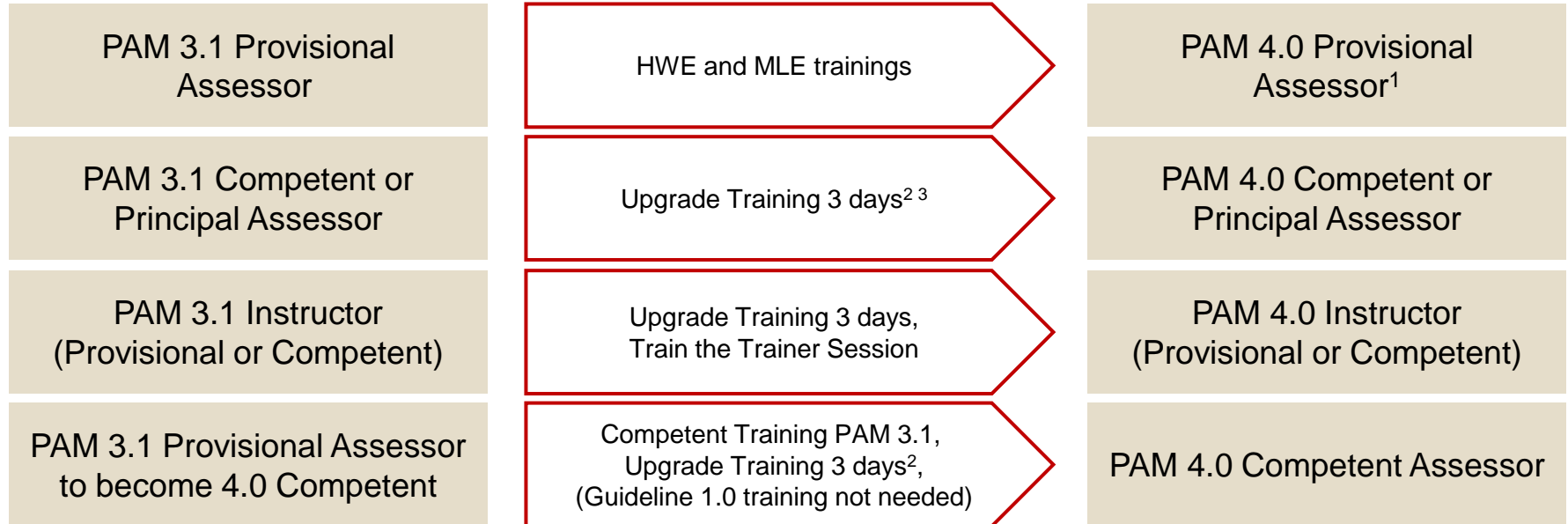
² includes all Guideline aspects regarding content

³ includes all Guideline aspects regarding rating

⁴ intacs supports also other models, e.g. Medical SPICE, SPICE for IT Services, Test SPICE, Organization SPICE,

⁵ Core PAM for Automotive SPICE® PAM 4.0 includes model extensions for Hardware and Machine Learning

Impact on Assessors and Instructors – Transition Phase



¹ V3.1 Provisional Assessors can re-certify as V3.1 Assessors without any trainings.

² Permitted only during the one-year transition phase following availability of upgrading training (after which they must complete the HWE and MLE trainings and pass their exams).

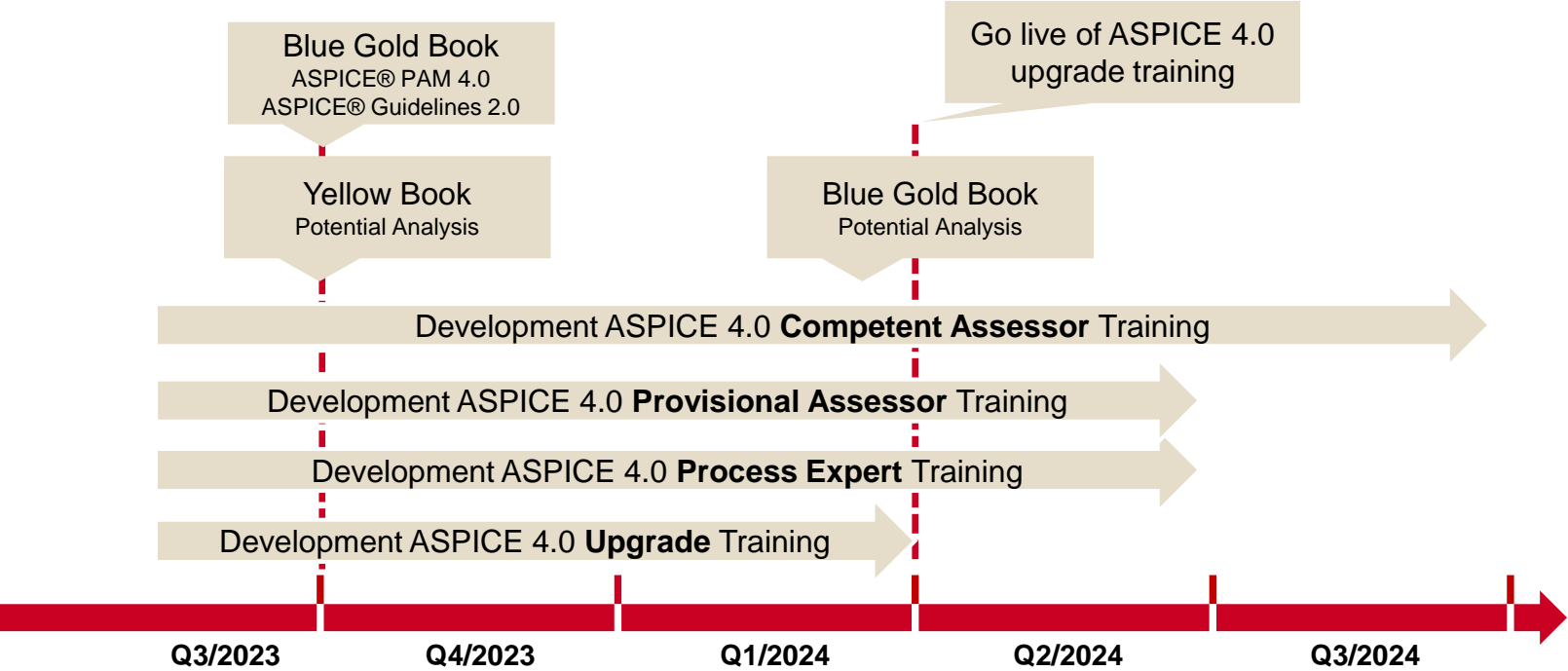
³ In the upgrade training there is no exam, but presentations of the participants, which are evaluated by a second instructor. If the presentations are accepted, a "Certificate of Competence" is issued.

Source: intacs® and VDA QMC

After the Transition Phase

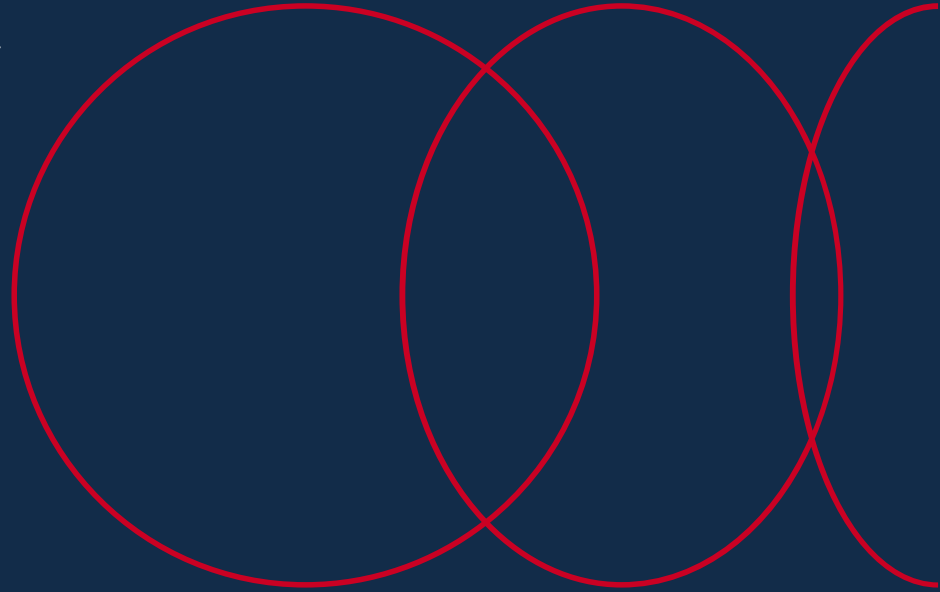
- The transition phase will end one year after the start of ASPICE 4.0 upgrade training.
- The VDA Guidelines 1.0 training will not be available anymore
- The ASPICE 4.0 Upgrade training will not be available anymore.
- Only ASPICE 4.0 trainings will be provided.
- When recertifying 4.0 assessors for the first time, the “Certificate of Competence” from the upgrade training must be presented to the VDA QMC.
- To become a Competent Assessor:
 - PAM 4.0 Competent Assessor Training + exam
 - HWE training + exam
 - MLE training + exam

The Transition Roadmap



Source: VDA QMC

Message to Community



No Changes Necessary for Organizations!

The updates to Automotive SPICE® 4.0 only impacts the assessor community

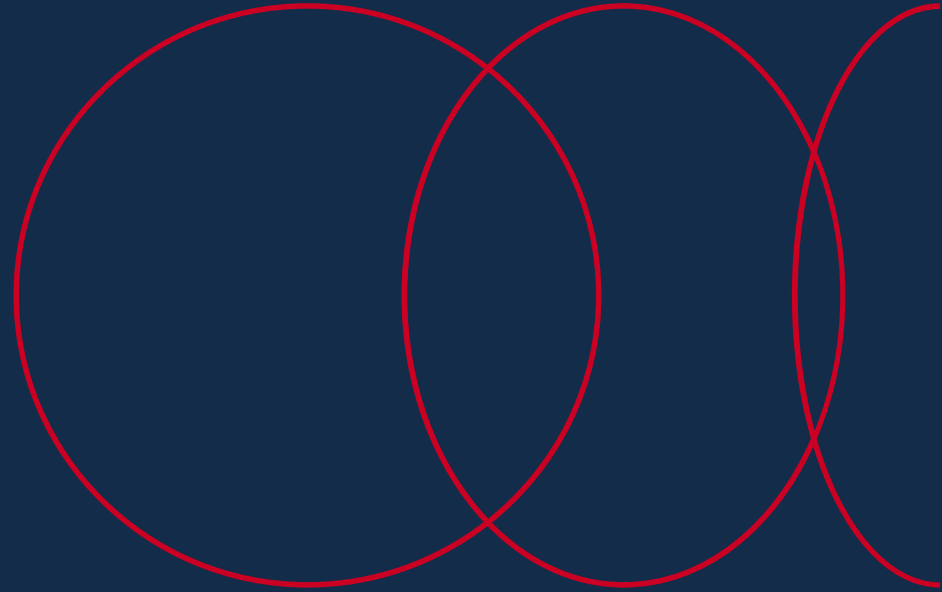
Organizations should not change their processes based on the new model...especially if they are adequate

Of course, if you are part of the community that named your processes based on the 3.1 model (or any previous model), changes may be required☺

Impact to Assessors Only

- Automotive SPICE® 4.0 VDA Guidelines 2.0
 - The Guidelines is a tool to support assessors.
 - It is NOT a technical standard that must be complied with.
 - Strong emphasis on guidance for assessors to understand the context of the assessed organization
- Competent and Principal Assessor must attend the official upgrade training of intacs®
 - Training will be available early 2024
 - Successful participation leads to a “Certificate of Competence” (new EE type).

Questions & Answers





Thank you



[UL.com/mobility](https://www.ul.com/mobility)