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1 Abstract

1.1 Preface

Today, considerable effort is expended in the automobile development value chain to constantly reduce throughput times in the development processes and to enhance the quality of digital product and process descriptions. Simultaneous engineering in product development and manufacturing planning and intensive cooperation between the various divisions within a company and with external partners are key factors for success in this context. One of the key challenges to be surmounted when shortening development times and ramp-up times in series manufacturing is to successfully and rapidly implement the changes which occur during these phases in a joint effort with partners from the fields of development, planning and manufacturing. Some factors which regularly motivate the wish to initiate changes include:

- Legislative changes
- Changes to market conditions or the competitive situation
- Internal inadequacies in development, planning or manufacturing
- Quality or safety problems
- Exploitation of additional optimization potential

The desire to make changes also necessitates corresponding changes to the cross-company engineering change management processes between the partners, suppliers and service providers to achieve greater dynamism and flexibility. Thus, mastery of engineering change management processes is increasingly becoming a crucial factor in the success of cooperative ventures in the automotive industry. Suppliers are today integrated into the development and planning process at an early stage. Differences which result from the nature of the partners and the projects in which they are involved mean that it is a challenging task to integrate partners into engineering change management. Small changes can, however, often have a significant impact on costs, processes, and development and manufacturing times. This means that standards and recommendations for structuring and implementing cross-company engineering change management processes and engineering change management data right down to the level of defining company-specific interfaces are indispensable if integration is to be efficient. According to estimates of the ECM project group, cost savings of up to around 40% can be expected as a result of reducing the times involved in retrieval, coordination and processing during the course of cross-partner engineering change management processes.

Harmonization of private (i.e. partner-specific) ECM processes is one key contribution towards exploiting the potential for improvement during development and when starting up series manufacturing. This current recommendation is based on the requirements and experiences of the partners in the joint SASIG ECM workgroup. This recommendation has been validated by means of pilot projects in the companies involved.

1.2 Objectives of the recommendation

The objective of the recommendation is to provide support for ECM processes with respect to the communication of change data between customers and suppliers. Use of the recommendation allows more efficient integration of all the partners involved in a proposed change as a result of:

- a reduction in the variety of communications methods used in the partner network
- a reduction in the throughput time for a proposed change
- improvements in the quality and reliability of the process
- improvement with respect to the transparency of changes for all those involved
- the reusability of process agreements, interfaces and tools

1.3 Structure of the recommendation

The recommendation is subdivided into individual parts reflecting the ECM Reference Sub-Process (3.3) involved during the course of a change; this subdivision is subject to change as a result of further developments.

Overview and general recommendations for ECM

This document gives an overview of and offers general recommendations for the overall ECM Reference Process, its modelling and a partner model. It describes fundamentals and basic recommendations valid for each ECM Reference Sub-Process. This document goes on to define

- ECM Reference Sub-Processes
- Interaction Scenarios
- Messages for the communication
- ECM Data Model objects and

which are shared by and relate to the specific parts of the recommendation as follows:

Part 1: ECR – Specification and Decision on Change

Part 1 offers recommendations with respect to communicating Engineering Change Request (ECR) data to support the specification of proposed changes and the associated decisions. It describes the ECR Reference Process which permits synchronization of the different internal procedures of the partners involved using ECR Messages. It offers recommendations for permitted sequences of ECR Messages to provide support for business-typical ECR Interaction Scenarios (IS) within the scope of bilateral communication between the cooperation partners and recommendations with respect to the minimum requirements applicable to communication and message content. The change data contained in the individual communication steps is described in the ECR Data Model.

Part 2: ECO – Engineering Implementation of Change

Part 2 offers recommendations for communicating Engineering Change Order (ECO) data compliant with Part 1 in order to allow implementation in engineering, such as the ECO Reference Process and the necessary ECO Messages and the ECO Data Model.

Further part is expected to cover the Sub-Process Alternative Solutions (AS). To provide solutions for the identified and described potential for improvement, one or more Alternative Solutions are generally developed which describe different approaches to implementing an idea for a change.

Part 2 is being planned and will be published when it is completed. Changes to structure and contents may however result from new insights and other information obtained during the course of the work.

1.4 Notational conventions

The following notational conventions are used in the context of this recommendation and are intended to highlight the specific names used in this document.

The abbreviations and terms defined in sections 1.5 and are valid within the scope of the recommendation.

Text in *italics as* used in the documents is intended to identify the following objects, as well as the objects which are defined within each of these domains:

- ECM Reference Process and ECM Reference Sub-Processes (e. g., phases, activities, process roles)
- ECM Interaction Scenarios (*request*, *respond* and *notify* messages)
- ECM Messages

The objects defined in the ECM Data Model (entities) are written in SMALL CAPITALS to distinguish them from the terms used for process-related objects.

1.5 Abbreviations

The following abbreviations apply within this document:

AS	**A**lternative **S**olution
API	**A**pplication **P**rogramming **I**nterface
ECM	**E**ngineering **C**hange **M**anagement
ECO	**E**ngineering **C**hange **O**rder
ECR	**E**ngineering **C**hange **R**equest
IS	**I**nteraction **S**cenario
ISO	**I**nternational **O**rganization for **S**tandardization
IT	**I**nformation **T**echnology

MCO	**M**anufacturing **C**hange **O**rder
OEM	**O**riginal **E**quipment **M**anufacturer
OMG	**O**bject **M**anagement **G**roup
PDM	**P**roduct **D**ata **M**anagement
PLM	**P**roduct **L**ifecycle **M**anagement
STEP	**ST**andard for the **E**xchange of **P**roduct Model Data
UML	**U**nified **M**odeling **L**anguage
XML	e**X**tensible **M**arkup **L**anguage

1.6 Definitions

The following definitions apply within this document:

activity:

Processing step during the course of a process which is used in activity diagrams for detailed description of a reference process (see phase), i.e. with conditional branches etc.

coordinator:

The organization, responsible for coordinating the ECM activities to solve an accepted issue against a product.

Note: *The coordinator will be in most cases the owner of the product.*

cross-phase:

Refers to relationships between two or more (process) phases or elements of these phases

dialog:

Synonym for an interaction instance

ECM objects:

Key data model objects which provide the basis for communication between partners within the ECM Reference Sub-Processes such as ECR, ECO or MCO

ECM Interaction Scenario (ECM IS):

Interaction scenarios defined within the scope of a specific ECM Reference Sub-Process. There are ECR Interaction Scenarios, ECO Interaction Scenarios, etc.

ECM Message:

Messages defined within the scope of the ECM Reference Process or within the scope of a specific ECM Reference Sub-Process. There are common ECM Messages, ECR Messages, ECO Messages, etc.

ECM Reference Process:

The overall reference process as it relates to ECM. The ECM Process comprises several ECM Reference Sub-Processes

ECM Reference Sub-Process

ECR Reference Process, ECO Reference Process, etc. are ECM Reference Sub-Processes. Note that, for example, the ECR Reference Process and ECO Reference Process may overlap

ECM Reference Sub-Process-independent:

Indicates elements which can be used in each ECM Reference Sub-Process in the same way

ECO Reference Process (synonym: Engineering Implementation of Change Process):

The specific ECM Reference Sub-Process which relates to an Engineering Change Order

ECR Reference Process (synonym: Specification and Decision on Change Process):

The specific ECM Reference Sub-Process which relates to an Engineering Change Request

Engineering change management (ECM):

The coordinated management and uniform tracking of changes, i.e. collecting ideas or need for product and product related changes, elaborating one or more possible solutions, evaluating them with respect to technical and cost aspects and implementing them with respect to engineering and manufacturing

Engineering Change Management (ECM):

Engineering change management according to this recommendation

Engineering Change Order (ECO):

A request to implement an engineering change, consisting of its planning, design, acceptance, testing, etc, documentation, review and release. An ECO is processed in a number of processing steps defined by the ECO Reference Process.

Engineering Change Request (ECR):

A request to evaluate a change to one or more products, involving changing parts, assemblies, documentation, or other items belonging to these products or by changing activities necessary to engineer or build these products.

An ECR is processed in a number of processing steps defined by the ECR Reference Process, thus enriching the ECR with the information required to enable a final decision to be made about its implementation by one or more ECO later on. (short: Change Request)

instantiation:

A Data Model groups objects from the real world into information classes (or simply "classes"). A class describes the general properties in the form of attributes and at the same time defines a data type. An instance of a class is a uniquely identified unit of data and represents the object from the real world. Instantiation refers to the generation of instances of a class. For example, an object in the real world is a person, and their name is a property. The class or data type 'person' represents all people. An instance of the data type 'person' assigns a value to each of the attributes defined in the class (name, age etc.) and can be identified using a unique ID.

interaction:

Results in an exchange of messages between partners[1]. An interaction can be a unidirectional interaction where a single message of the type *notify* is passed or a bidirectional interaction where one message each of the types *request* and *respond* are exchanged. Each unidirectional interaction comprises a send action on the part of the sender and a receive action on the part of the recipient. A bidirectional interaction comprises a second send- and receive-action with sender and receiver swapped.

interaction instance:

Instantiation of an interaction scenario between a specific coordinator organization and a specific participant organization (i.e. an "actual" interaction).

interaction scenario (IS):

Simplified description of the sequences used and the conditions under which data is exchanged between partners for a particular purpose using interactions2 in order to implement process integration for a specific type of cooperation. This recommendation defines interaction scenarios between the two interaction roles coordinator and participant by 1) defining the interactions which can occur, must occur or must not occur; 2) defining the permitted sequences in which interactions or messages may occur using syntax diagrams; 3) assigning send and receive actions of coordinator interactions to specific

[1] Based on N. Kavantzas, D. Burdett, G. Ritzinger, Y. Lafon (Eds.). “Web Services Choreography Description Language Version 1.0”. W3C, Working Draft 12 October 2004.

[2] Ibid.

points (synchronization points) in a reference process, thus defining additional permitted interactions and conditions and sequences for interactions (see protocol specification).

mandatory:

Indicates all activities or data objects which are obligatory, i.e., which must be carried out under all circumstances, or data objects which are absolutely necessary

Manufacturing Change Order (MCO):

A request to implement a change by manufacturing up to its release for production. An MCO is processed in a number of processing steps.

MCO Reference Process (synonym: Manufacturing Implementation of Change Process):

Denotes the specific ECM Reference Sub-Process relating to an MCO

message:

Sequence of symbols which contain information[3]. This recommendation distinguishes between three types of messages: 1) *request* 2) *respond* 3) *notify*.

milestone:

Describes a state in a process at which a particular process objective is achieved. Milestones are used in phase diagrams in particular.

optional:

Indicates all activities or data objects which may be used as the need arises or which may be required in certain cases

participant:

A partner who is involved in an ECM Process but who is not responsible for coordinating it

partner:

All people and organizations who participate in an ECM Reference Process, i.e. both the *coordinator* and the *participants*

phase:

Subdivision in a process used in phase diagrams for a rough description of an ECM Reference Sub-Process. Phase diagrams are used as an easily read representation of an ECM Reference Sub-Process and its component parts. For this reason, a number of activities are typically grouped together to form a phase in this form of representation

[3] H. Engesser, V. Claus. "Duden Informatik". 2nd Edition; Dudenverlag, 1993.

private process:

Describes a partner-specific process that is used internally, in contrast to a reference process, which is used as a common representation of a process.

protocol specification:

A protocol specification is used to precisely define the permitted message sequence per interaction scenario from a coordinator's and from a participant's point of view

reference process:

A workflow[4] for harmonized communication for data and process integration described using a schema. A reference process specifies the primary activities, possible interactions with partners and the sequence and conditions for activities and interactions. For the purposes of communication as per this recommendation, each partner maps his own internal process (i.e. terminology, process, data) onto a reference process.

role:

Describes a set of responsibilities in a process which can be embodied by a person or an organizational unit. Two types of roles are used in this recommendation: 1) process roles, in which the persons/organizations fulfilling the role carry out activities in an ECM Reference Sub-Process, such as the *Requestor* etc. 2) interaction roles where organizational units fulfil the role and interact as *coordinator* or *participant* in an ECM Interaction Scenario by carrying out a number of process roles. Further modelling elements of the organizational structure, such as group, (organizational) entity and organizational unit are described in detail in the respective parts.

synchronization point:

Defined point in an ECM Reference Sub-Process at which a specific interaction with a partner is possible to synchronize the private engineering change management processes of both the *coordinator* and *participant*

1.7 References to standards

CMMI:

Capability Maturity Model® Integration (CMMISM); Version 1.1
CMMISM for Systems Engineering, Software Engineering, Integrated, Product and Process Development, and Supplier Sourcing (CMMI-SE/SW/IPPD/SS, V1.1); March 2002

ISO 10303-11:

Industrial automation systems and integration – Product data representation and exchange – Part 11: Description methods: The EXPRESS language reference manual, November 1994

[4] Based on: S. Jablonski, M. Böhm, W. Schulze (Eds.). "Workflow Management". Heidelberg: dpunkt-Verlag, 1997.

ISO 10303-21:

Industrial automation systems and integration – Product data representation and exchange – Part 21: Implementation methods: Clear text encoding of the exchange structure

ODETTE PID:

ODETTE: Partner Identification and Database. Version 1.0. 2006

QDXReport8D-1.1

Quality Data eXchange; 31.03. 2006; www.vda-qmc.de

RFC 1034:

P. Mockapetris. Domain Names – Concepts and Facilities. RFC 1034. November 1987, http://www.ietf.org/.

VDA 5006:

Einheitliche Identifizierung von Partnerunternehmen – UPIK (Unique Partner Identification Key). VDA-Empfehlung 5006, 1st edition, August 2003.