Engineering Change Management (ECM)

RECOMMENDATION

Engineering Change Order (ECO)
PSI 3-2 (Draft)
Version 0.9

ProSTEP iViP

Abstract

This Recommendation documents the ECO (Engineering Change Order) related results of the ProSTEP iViP/VDA project group ECM (Engineering Change Management). It includes the ECO Reference Process phases, scenarios and data model. The current version 0.9 is mature for validation by concept pilots.

This Recommendation was originally planed as Part 2 of the VDA Recommendation 4965 (VDA 4965). Since the demand of the project group to ensure their results by concept pilots could not be fulfilled, the ECM project group decided to close its work at the end of 2007. But since the gathered ECO content is seen as mature and valuable for public, it is documented by this PSI 3-2 (Draft) Recommendation, especially for the members of the ProSTEP iViP Association.

It is recommended to make familiar with the concepts of VDA 4965 to understand this Recommendation.

"The VDA 4965 is subdivided into individual parts reflecting the ECM Reference Sub-Process involved during the course of a change; this subdivision is subject to change as a result of further developments.

The main document gives an overview of and offers general recommendations for the overall ECM Reference Process, its modeling 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,*
- *mappings onto standards*

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

Part 1 (ECR – Specification and Decision on Change) 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. The recommendation goes on to define how this information can be mapped to internationally accepted and established standards in order to permit implementation in the systems and interfaces involved.

This Recommendation was originally planed as Part 2 of the VDA Recommendation 4965 (VDA 4965). Until today these results could not be validated in industrial pilot applications. But as the gathered ECO content is seen as mature and valuable for public, the project group decided to publish it within this Draft PSI-3-2 Recommendation, ready to be used and validated in industrial pilot ECO applications.

Disclaimer

ProSTEP iViP Recommendations (PSI Recommendations) are recommendations that are available for anyone to use. Anyone using these recommendations is responsible for ensuring that they are used correctly.

This PSI Recommendation gives due consideration to the prevailing state-of-the-art at the time of publication. Anyone using PSI Recommendations must assume responsibility for his or her actions and acts at their own risk. The ProSTEP iViP Association and the parties involved in drawing up the PSI Recommendation assume no liability whatsoever.

We request that anyone encountering an error or the possibility of an incorrect interpretation when using the PSI Recommendation contact the ProSTEP iViP Association (psi-issues@prostep.com) immediately so that any errors can be rectified.

Copyright

This Recommendation has been drawn up and is supported by the VDA and the ProSTEP iViP Association.

Table of Contents

Figures

Tables

Abbreviations, Definitions, References

Abbreviations

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
IT **I**nformation **T**echnology
OEM **O**riginal **E**quipment Manufacturer
UML **U**nified **M**odeling **L**anguage

Definitions

Activity

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

Coordinator

The organization responsible for coordinating the ECO activities to solve an accepted implementation of an engineering change. Note: The coordinator will be in most cases the owner of the product(s) that have to be changed.

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 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).

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 scenario (IS):

Simplified description of the sequences used and the conditions under which data is exchanged between partners for a particular purpose using interactions[2] 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 points (synchronization points) in a reference process, thus defining additional permitted interactions and conditions and sequences for interactions (cf. 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.

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 Reference Process but who is not responsible for coordinating it.

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

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.

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 fulfill the role and interact as *coordinator* or *participant* in an ECM Interaction Scenario by carrying out a number of process roles. Further modeling 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*.

References to standards

VDA 4965, Engineering Change Management (ECM), V 2.0; Verband der Automobilindustrie (VDA), www.vda.de/cgi-bin/paperorder.cgi[5] , 2007

SASIG ECM Recommendation, V1.0; Strategic Automotive product data Standards Industry Group (SASIG), 2008

[4] Based on: S. Jablonski, M. Böhm, W. Schulze (Eds.). "Workflow Management". Heidelberg: dpunkt-Verlag, 1997.
[5] To find the recommendation it will be necessary to choose "VDA-Empfehlung" in the field "Ressort (Bereich)". Afterwards click the button "Suche starten".

1 ECO Reference Process fundamentals

This chapter provides an overview of the fundamental principles and key phases of the ECO Reference Process. It describes the solution approaches on which the ECO recommendation is based. This recommendation details the specific requirements as an ECM Reference Sub-Process to communicate Engineering Change Order (ECO) information to support the planning, performance and release of changes in engineering. The fundamental concepts and recommendations of VDA 4965 (ECM) are valid equivalent for this recommendation unless additional or different statements are given in this document.

1.1 ECO models and messages related to ECM

This Recommendation details the ECM Reference Sub-Process *Engineering Implementation of Change* and describes the ECO Reference Process which permits synchronization of the different internal procedures of the partners involved using ECO messages. It offers recommendations for possible sequences of ECO messages to provide support for permitted ECO Interaction Scenarios (IS) within the context of the overall ECM process between the cooperation partners.

Furthermore, it provides recommendations with respect to the minimum requirements applicable to the communication and ECO message content. Messages which are described within "Common Resources for ECM" of VDA 4965 are referenced or specified in more detail if necessary for the sub-process *Engineering Implementation of Change*.

The change order data contained in the individual communication steps is described in the ECO data model. Thereby objects of the "Common Resources for ECM" of VDA 4965 are used by reference. The recommendation goes on to define how ECO-specific data can be mapped to internationally accepted and established standards in order to permit implementation in the systems and interfaces involved. The mapping recommendations for the common resources of VDA 4965 (ECM) are also valid for this recommendation.

1.2 ECO specific rules

The global set of rules of VDA 4965 (ECM) is also valid for the phase *"Engineering Implementation of Change"*. Additional specific rules for the ECO Reference Process, ECO Interaction Scenarios and messages as well as the ECO data have not yet been defined.

2 Communication and the ECO Reference Process

This chapter introduces the ECO Reference Sub-Process for the *Engineering Implementation of Change* (also referred to as the ECO Reference Process) of the ECM Reference Process which covers the processing of an ECO from the planning of an approved change, execution of the change through to its release. The ECO Reference Process serves as a harmonized ECO process for standardized interaction between partners and forms the basis for a common understanding during communication. In chapter 3, ECO Interaction Scenarios are derived from the ECO Reference Process and define in detail specific roles and processing steps for the partners and the interactions for specific partnership constellations. Introductory notes on modelling are followed by a detailed description of *Engineering Implementation of Change,* which is the focus of this recommendation, together with its sub-processes.

2.1 Overview of the modeling concept and the notation used

The processes and sub-processes involved in the ECO Reference Process are described below on the basis of diagrams. Separate diagrams are used for a general overview of a process and for detailed views of a process. The ECO Reference Process and its sub-processes are described from the point of view of the primary process owner *(Coordinator)*. Partners *(Participants)* can fulfill certain roles in the process (see also section 2.3). In this case, interactions with the partner will take place. Phase diagrams are used to provide a general overview of the phases. These show a linear representation of the consecutive phases. Typically, phases are initiated when milestones are reached and, in the same way, milestones can be reached at the end of phases. Milestones represent the reaching of a positive state in the process meaning that the request to change is pursued further on. If one of the phases can be carried out by a partner, this phase is shown in a line entitled *"Participant"*, and the primary process is shown in the line entitled *"Coordinator"*. (If the partner does not have an active role in a phase, but only introduces or receives notifications, this is not indicated separately in the phase diagram.)

Activity diagrams are used to provide a more detailed description of the processes in the ECO Reference Process. These are described in UML 2 (Unified Modeling Language 2) (see VDA 4965 Appendix C). In the activity diagrams, the activities model processing steps which are carried out by roles. The sequence of the activities is described in more detail. Composite activities are described in further detail in separate diagrams or are derived from patterns which are described in VDA 4965 Appendix C. In the case of interaction between partners, individual interactions between roles, during which message objects are exchanged, are modeled. The relationships between the roles used in the ECO Reference Process and its sub-processes are represented in the diagram for the organization model. In particular, this shows which roles in the activity diagram are assigned to the *Coordinator* and which roles can be embodied by *Participants*. Specific statuses which describe the positive or negative result of an activity, for example, are modeled using specific objects.

To achieve greater clarity, a distinction is made between the normal flow of an activity and special variants of this flow and exceptions for the activity. The normal flow which is represented need not always be the normal case during actual execution; instead it describes the primary activities in a way which is easy to understand. VDA 4965 ECM, Appendix A contains notes on the notation used.

The following should be noted with respect to the terms "phase" and "activity": In the description of the phase diagrams, the term "phase" is used throughout to refer to the processing steps; in the descriptions of the activity diagrams, the term "activity" is used throughout. For each of the phases described in detail, there is either one activity which has the same name, or the phase comprises a number of activities. Similarly, the milestones used in the phase diagrams have corresponding states in the activity diagrams.

2.2 ECO Reference Process (overview)

The purpose of the phase will first be described, followed by an overview of each phase. This is then followed by more detailed descriptions of the activities in the course of the normal flow and of special flow variants and exceptions (cancellation, rollback).

2.2.1 Purpose

The objective of this phase is to implement an engineering change in engineering (product development) by planning an Engineering Change Order, executing it and finally releasing it to subsequent Sub-Processes of the ECM Reference Process, such as *Manufacturing Implementation of Change*.

At first, the ECO needs to be planned; i.e. specified precisely with respect to its scope, affected product data as well as the needed development tasks for design and validation together with schedule and planned performers. If an ECR is approved before and the planning is done during the ECR Reference Process, this goal may already be given at the beginning of the ECO Reference Process.

When the ECO is planned, the planned tasks need to be executed accordingly; i.e. activities for change and validation of product data are performed. If engineering considers the change to be executed completely, the release of the executed ECO as well as the product data can be triggered.

For release at product documentation the completeness of the ECO and the change of the affected objects is confirmed and ensured. Afterwards, affected partners as well as subsequent performers may be notified about the release.

2.2.2 Overview of phase

The *Engineering Implementation of Change* phase begins after milestone *M4.0, Initial ECO triggered,* has been reached[6]. In the first phase *Planning of Engineering Change* an ECO is created and defined precisely concerning scope, affected objects and plan. When this is finished, *M4.1 ECO detailed and planned* is reached.

If at the beginning of *Engineering Implementation of Change* an ECO is already defined completely, the ECO Reference Process may directly start from *M4.1* (see also below). Before or simultaneously to *Engineering Implementation of Change*, the *Coordinator* usually will have done *Specification and Decision of Change* using an ECR together or without the *Participant* with an approval for the change. In that case, the planning phase of the ECO might be significantly reduced or not even be present at all. In addition, in some cases, the *Coordinator* might run *Engineering Implementation of Change* using an ECO without a preceding *Specification and Decision of Change* using an ECR.

The next phase is *Execution of Engineering Change* where the planned ECO is executed at development by changing the affected product data objects, validating the results formally and technically and checking the ECO for completion. If development considers implementation of the change to be completed, *M4.2 Engineering Change Executed* is reached.

The next phase is *Release of Engineering Change* where the executed change is reviewed, documented and released. Affected partners and subsequent ECM processes are notified about the completed release, and the ECO Reference Process is finished reaching *M5 ECO released*.

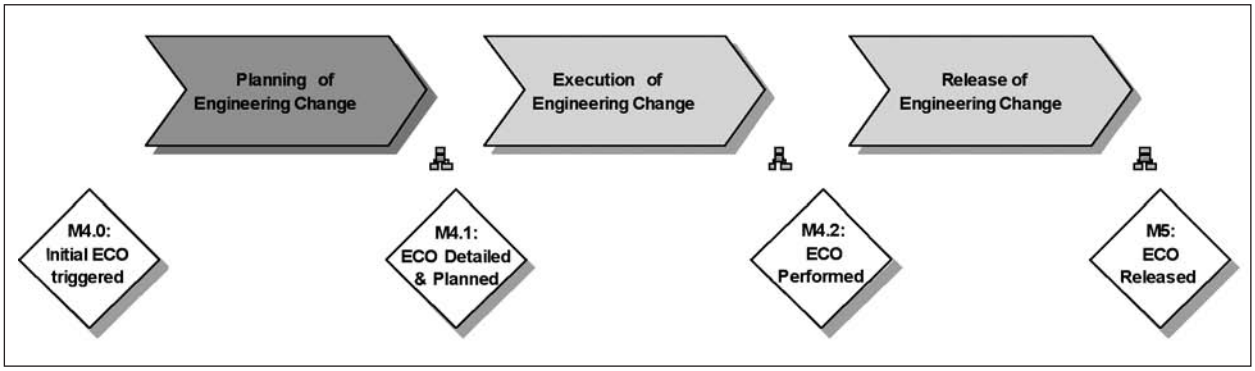


Figure 1: Phase overview for *Engineering Implementation of Change*

2.2.3 Normal flow and status

The *Engineering Implementation of Change* activity starts with *Planning of Engineering Change* and then goes on with *Execution of Engineering Change*, if this is required; otherwise it starts directly with *Execution of Engineering Change*. During *Execution of Engineering Change,* the ECO details like change scope, etc., as well as the plan containing scheduled tasks for the ECO may be adapted using Adapt ECO Details & Plan. After *Execution of Engineering Change* is complete, *Release of Engineering Change* follows, and *Engineering Implementation of Change* finishes.

[6] This needs to be adjusted with the ECM reference process milestones and the understanding of phases as sub processes that may be executed in an overlapping way.

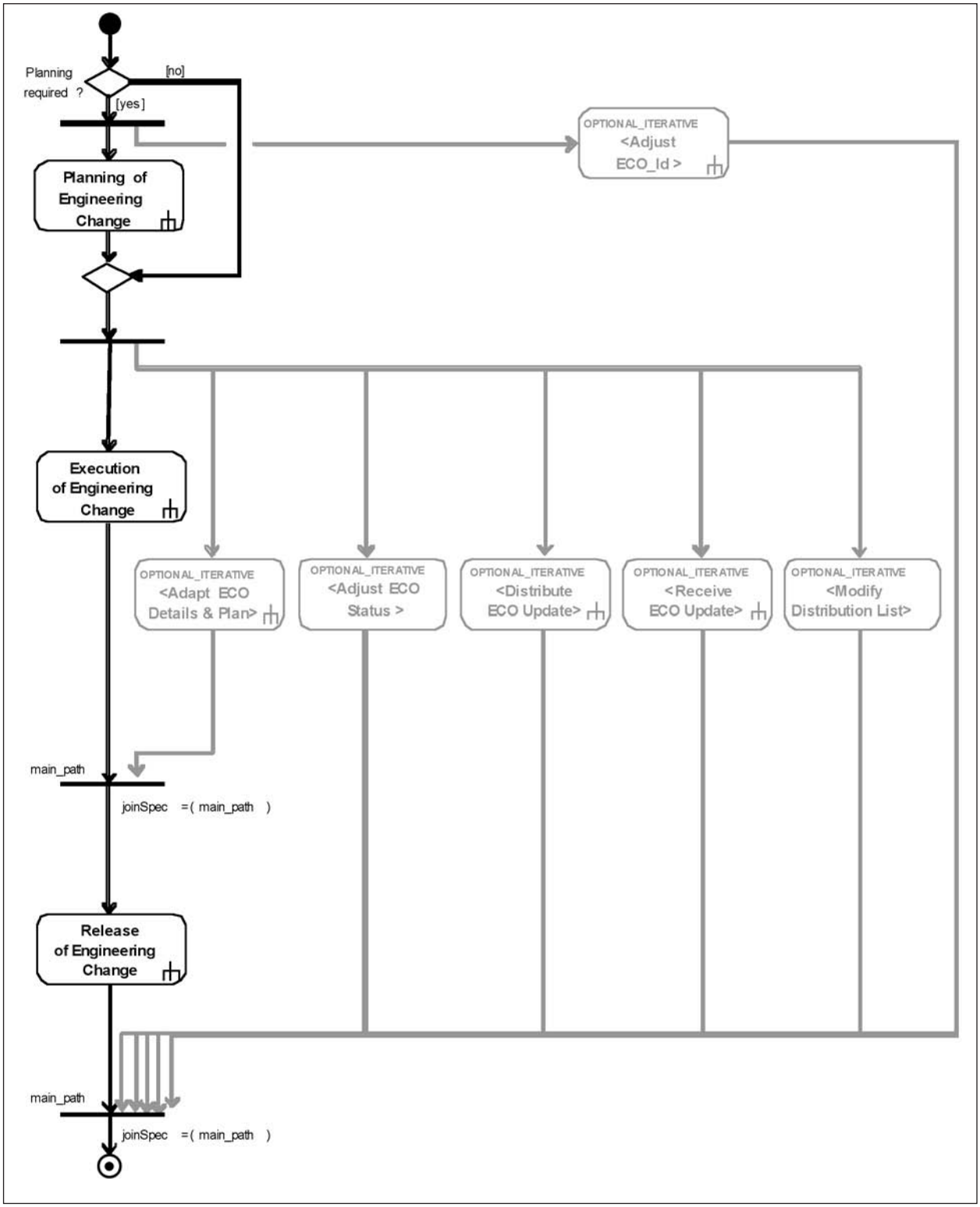


Figure 2: Normal flow for Engineering Implementation of Change

From the beginning of *Execution of Engineering of Change* until *Release of Engineering Change* is completed, the following activities may happen:

- The ECO Status, containing the state of the ECO Plan as well as links to gathered results, may be adjusted by the *Coordinator* to the progress of the *ECO Reference Process* using *Adjust ECO Status*.

- An update of the ECO, e.g. of changes in ECO Details, Plan or Status can be distributed by the *Coordinator* using *Distribute ECO Update*. As shown in Figure 3, the *Change Team* may trigger the message *Notify_ECO_update* after selecting a subset of desired recipients from the *Distribution List*.

- An update of the ECO, from the point of view of a *Participant*, may be received by the *Coordinator* (cf. Figure 4) e.g. in order to notify about progress according to or deviations from the ECO plan. (This, in turn, may be followed by *Adjust ECO Status* and *Distribute ECO Update* at the *Coordinator* further on). An *ECO Performer* may communicate this to the *Change Team* using a *Notify_ECO_update* message.

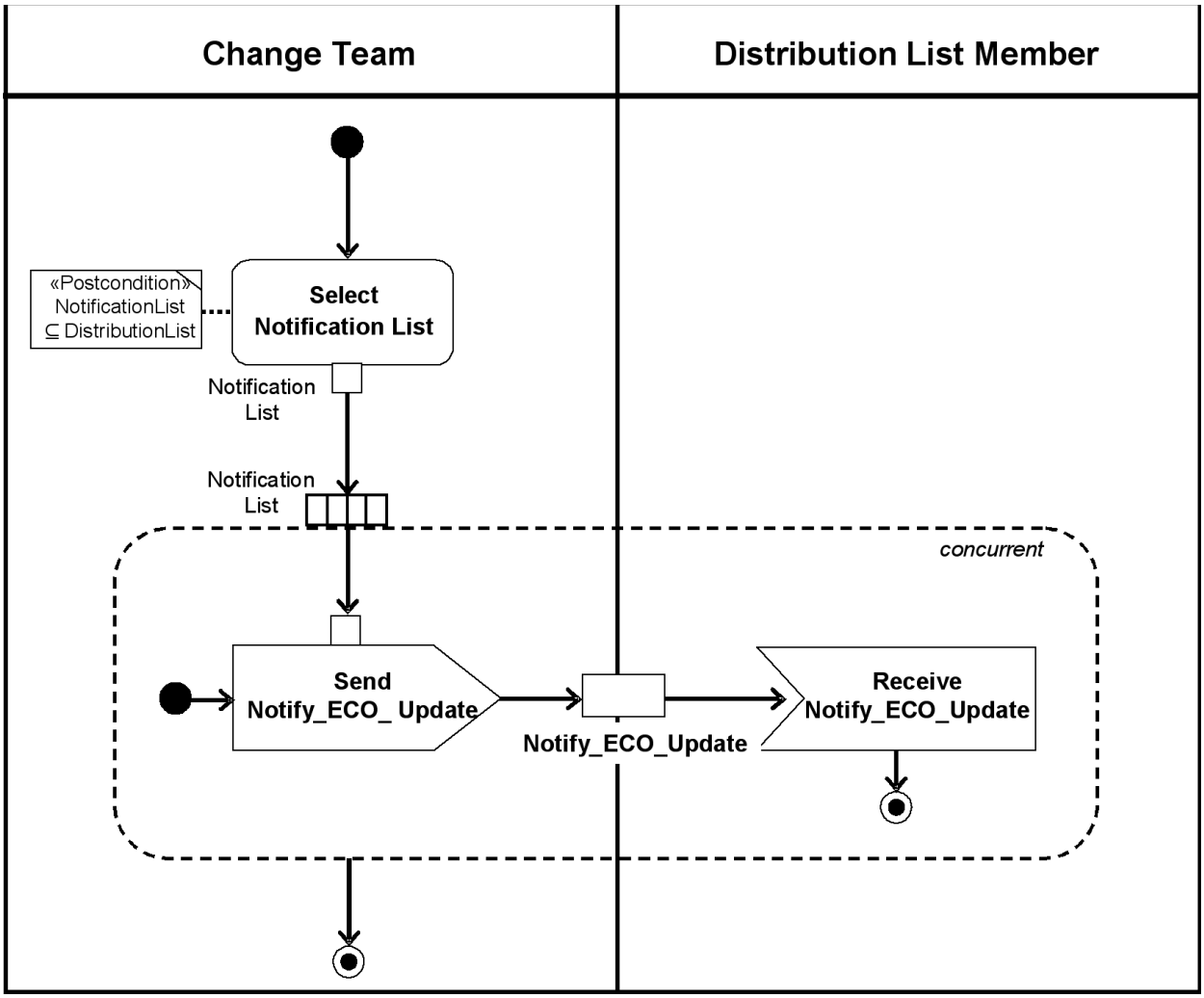


Figure 3: Activity *Distribute ECO Update*

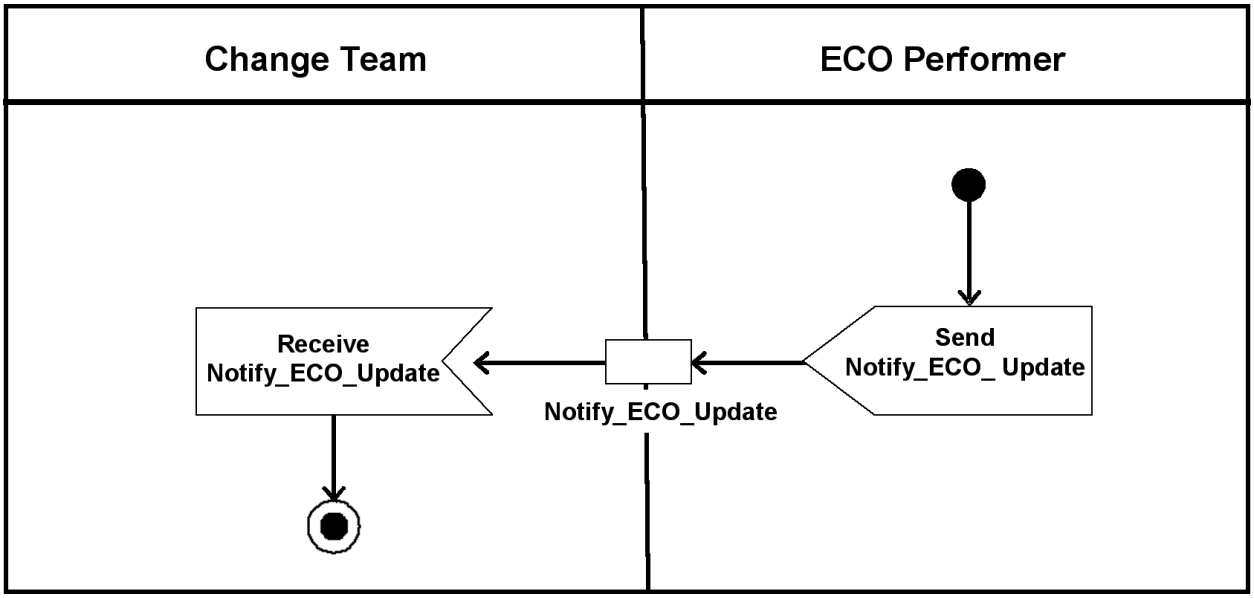


Figure 4: Activity *Notify ECO Update*

From the beginning up to the end of *Engineering Implementation of Change*, the ECO_id may be adjusted by the *Coordinator* using *Adjust ECO_id*. E.g., an ECO may start with a preliminary ID, such as the ECR_id of an associated ECR, and during *Release of Engineering Change* then may switch to the final ECO_id. In this case (cf. Figure 5), the *Change Team* may perform the switch of the ECO_id and then distribute the switch to the *Distribution List* using a *Notify_ECO_id_switched* message.

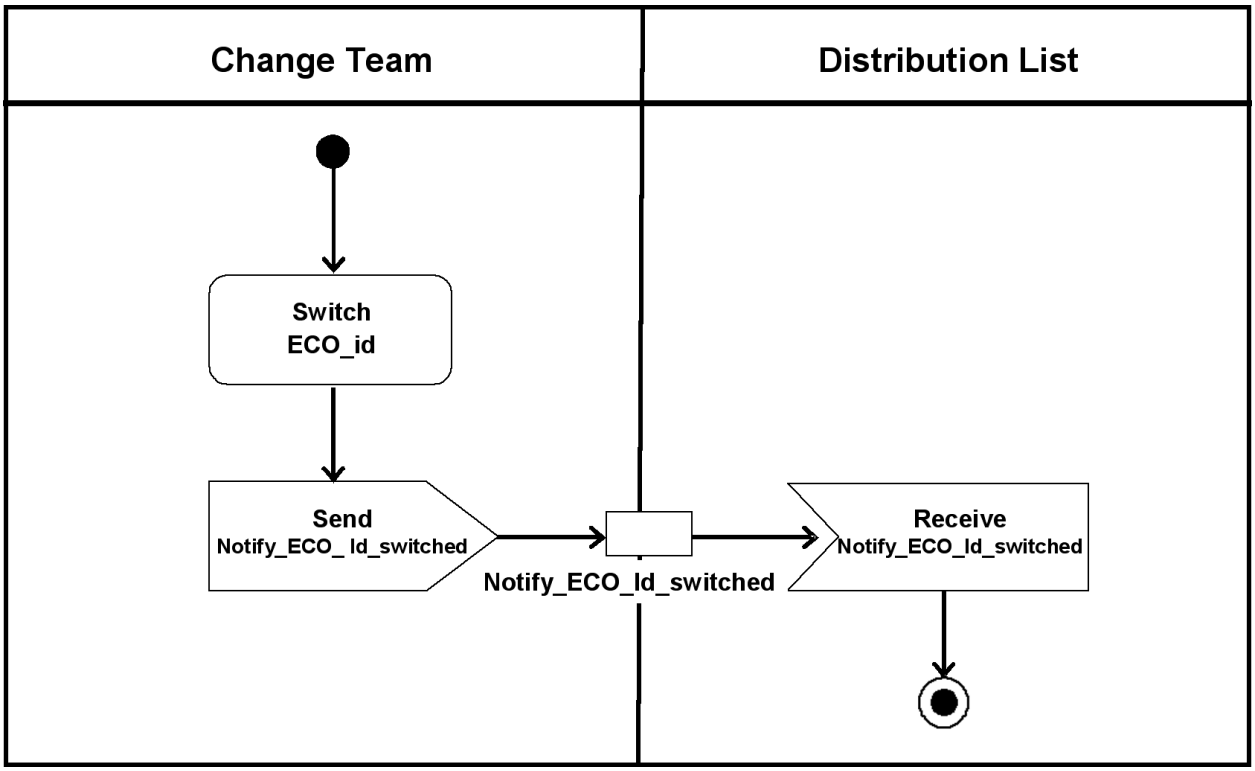


Figure 5: Activity *Adjust ECO_id*

2.2.4 Special flow variants and exceptions

In addition to the linear process flow described above, it is also possible to exit the process early, and to roll back the flow. These variants are described below and are illustrated in part in Figure 6.

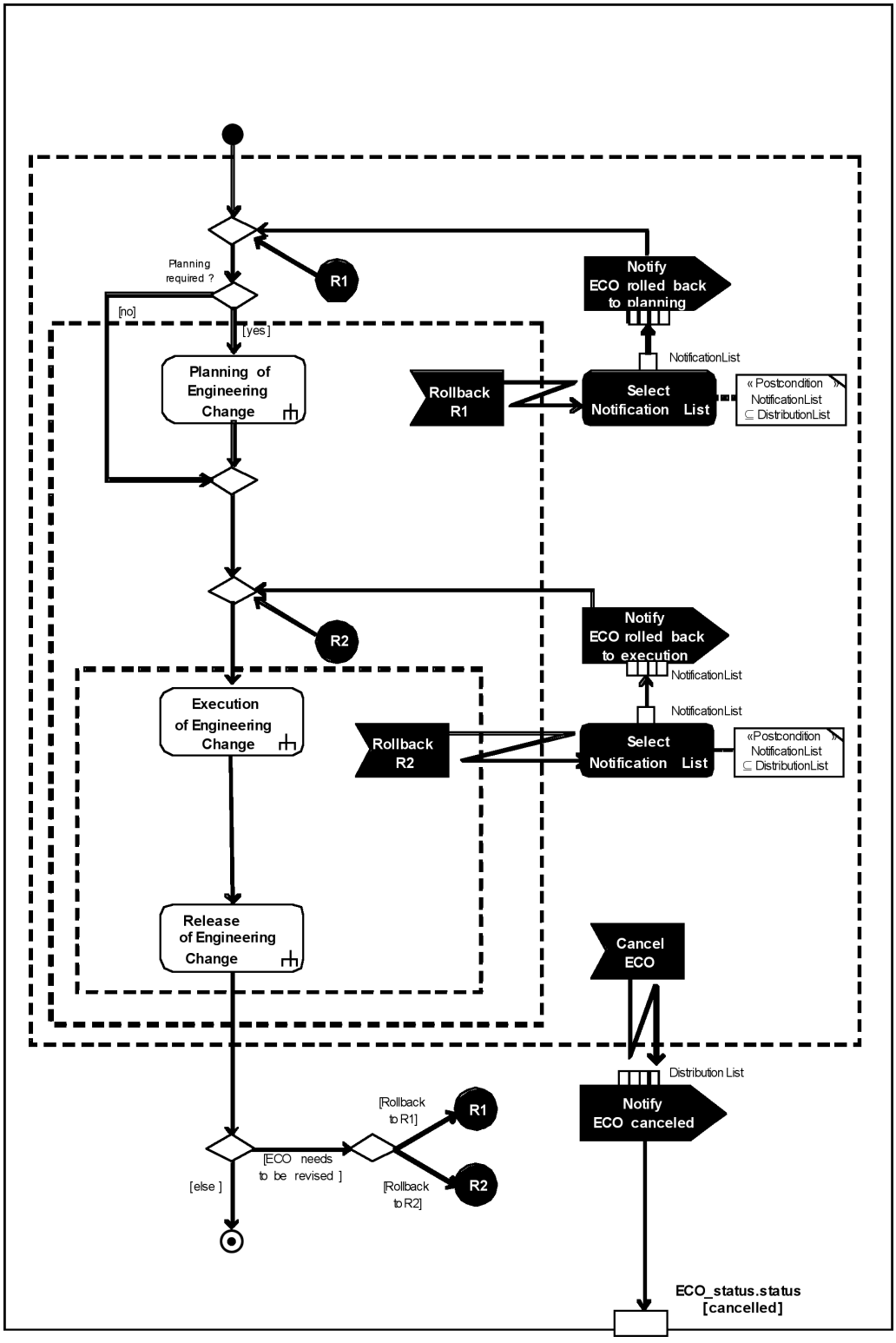


Figure 6: Flow variants for *Engineering Implementation of Change*

Cancellation of the ECO

The *ECO Reference Process* can be cancelled by means of *Cancel ECO* if the planned change no longer appears to have sufficient potential benefit during the course of the process, for example as a result of outlay or deadline considerations. In this case, persons from the *Distribution* List can be notified of this by the *Change Team* by means of the *Notify_ECO_canceled* message. In this case, ECO_STATUS.STATUS becomes *cancelled*.

Rollback and Revision

A rollback describes a situation in which a process is interrupted and is (partially) rolled back in order to repeat certain activities. A rollback is generally carried out at any point during an activity in progress, and the restart point is at the beginning of a previous activity. A revision of the ECO occurs when an ECO is reviewed during *Release of ECO* and the result is the need for a revision of the ECO Reference Process, i.e. part of it needs to be repeated.

Please note: The distinction between rollbacks and revision is made due to the following difference. When a rollback is executed, there may be currently running activities, e.g. of *Execution of ECO* at partners, which are aborted. In contrast, the revision happens at a dedicated and planned point in the *ECO Reference Process* where no activities need to be aborted.

Please note: Revision as used here does not imply that there is a need for versioning of the ECO.

The following types of rollback and revision may occur:

(1) Rollback R1: The ECO can be rolled back to the start of the activity *Planning of ECO*. This may, for example, be necessary if during subsequent processing of the ECO it becomes clear that the performance which is currently being carried out or which has already been carried out is/was insufficient or if new information with respect to the conditions that apply becomes known with the result that it is necessary to restart the planning. In this case, the activity *Select Notification List* can be used to specify a selection of the affected *Participants* in the process and inform them that the ECO Reference Process has been rolled back with the message *Notify_ECO_rolled_back_to_planning*.

(2) Rollback R2: The ECO can be rolled back to the start of the activity *Execution of ECO* during the activities *Execution of ECO* through *Release of ECO*. A rollback of this type may be necessary if during the subsequent course of *Execution of ECO* it becomes clear that the performance of the ECO which is currently being carried out or which has already been carried out is/was insufficient or if new information with respect to the conditions that apply becomes known with the result that it is necessary to restart *Execution of ECO*. In this case, the activity *Select Notification List* can be used to specify a selection of the affected Participants in the process and inform them that the process has been rolled back with the message *Notify_ECO_rolled_back_to_execution*.

(3) Revision: The activity *Approval of ECR* can result in the need to revise the ECR if the activity has resulted in one of the following values (documented in ECO_ACCEPTANCE.decision):

a) 'revision_needed_back_to_planning': In this case, the process goes back to the beginning of the activity *Planning of ECO*. This result can occur if, when reviewing the ECO, it is established that certain tasks requiring planning are needed or that the scope must be enlarged or that such issues must be re-examined during the *Planning of ECO*.

b) 'revision_needed_back_to_execution: In this case, the process goes back to the beginning of the activity *Execution of ECO*. This result can occur if, while reviewing the ECO, it is established that certain engineering implementation tasks must be performed additionally.

Variants of the ECO

The typical purpose of an ECO is considered to be a design change followed by validation activities by engineering. However, the following cases which change product documentation and thereby affect following processes in product creation may also be handled using *Engineering Implementation of Change*.

- Deletion order: An order to permanently remove the usage of specific parts in the currently released bill of material.
- Deviation order: An order to deviate provisionally and temporarily from part of the currently released bill of material, e.g. due to delivery issues.
- Stop order: An order to stop a currently part of the currently released bill of material typically used to end the validity of the effects of a deviation order.

Possible dependencies between ECR and ECO Reference Process
The following dependencies between ECR Reference Process and ECO Reference Process can occur.

1. ECR and ECO in sequence

As an ideal case, *Specification and Decision of Change* is executed completely finishing with a decision for the ECR, i.e. the ECR is approved, and then *Engineering Implementation of Change* begins. In such a scenario, *Planning of Engineering Change* might be significantly reduced or even be not present at all if generally all planning needed is done thoroughly during *Specification and Decision of Change.*

2. ECR and ECO concurrent to each other

In order to provide short process latencies for the ECR and ECO Reference Process, *Engineering Implementation of Change* may be started before approval is given. If this kind of scenario is used, the *Coordinator* and the *Participant* have to deal with the risk of investing effort in unapproved changes that may be rejected later, especially, for example, the design effort required to assess the feasibility of a change. In such a scenario, the ECR needs to be approved (completion of the phase "Approval of ECR") before *Release of Engineering Change* (see 2.4.3), at the latest, in order to release only approved changes. In addition, *Planning of Engineering Change* is typically based on results or may be executed in addition to, *Technical Analysis of ECR* and *Commenting on ECR;* therefore, the mentioned phases need to provide consistent results (same set of affected objects, etc.).

Such a scenario can also occur in the process variant "extraordinary authorization" of ECR (cf. 4965-1). In this case, *Engineering Implementation of Change* is started immediately on the basis of previously given approval. *Specification and Decision of Change* may then be used to document the ECR-relevant aspects of the change simultaneously or afterwards.

3. ECO without ECR

In some cases, *Engineering Implementation of Change* may be used without *Specification and Decision of Change*. This may be used for special cases of the ECO such as, for example, deletion orders. In addition, some partners may not have been involved in the ECR process and are therefore involved in the ECM process for the first time during *Engineering Implementation of Change.*

Note: In general, one ECR may result in zero or any number of ECOs, e.g. in order to subdivide the change scope of the ECR for implementation. On the other hand, one ECO may reference no ECR (as just explained) or any number of ECRs in order to reference the change scope approved therein. Therefore, in general, there may be an M:N relationship between ECR and ECO.

2.3 ECO organization model and roles

Certain organizational elements form the basis for the ECO Reference Process of *Engineering Implementation of Change*. These describe contiguous scopes of responsibility within the ECO Reference Process and are independent of concrete persons or organizational units. Within the ECO Reference Process, they appear as the performers of activities or as senders or recipients of notifications. In addition, some of them occur in the data model in order to communicate concrete persons or concrete organizational units (see 3.3). In this context, an organizational unit indicates an element of an organizational structure such as a company, department, etc. Organizational entity is the collective term for concrete persons and concrete organizational units. Figure 7 below shows a diagram of the various organizational elements and indicates the relationships between them.

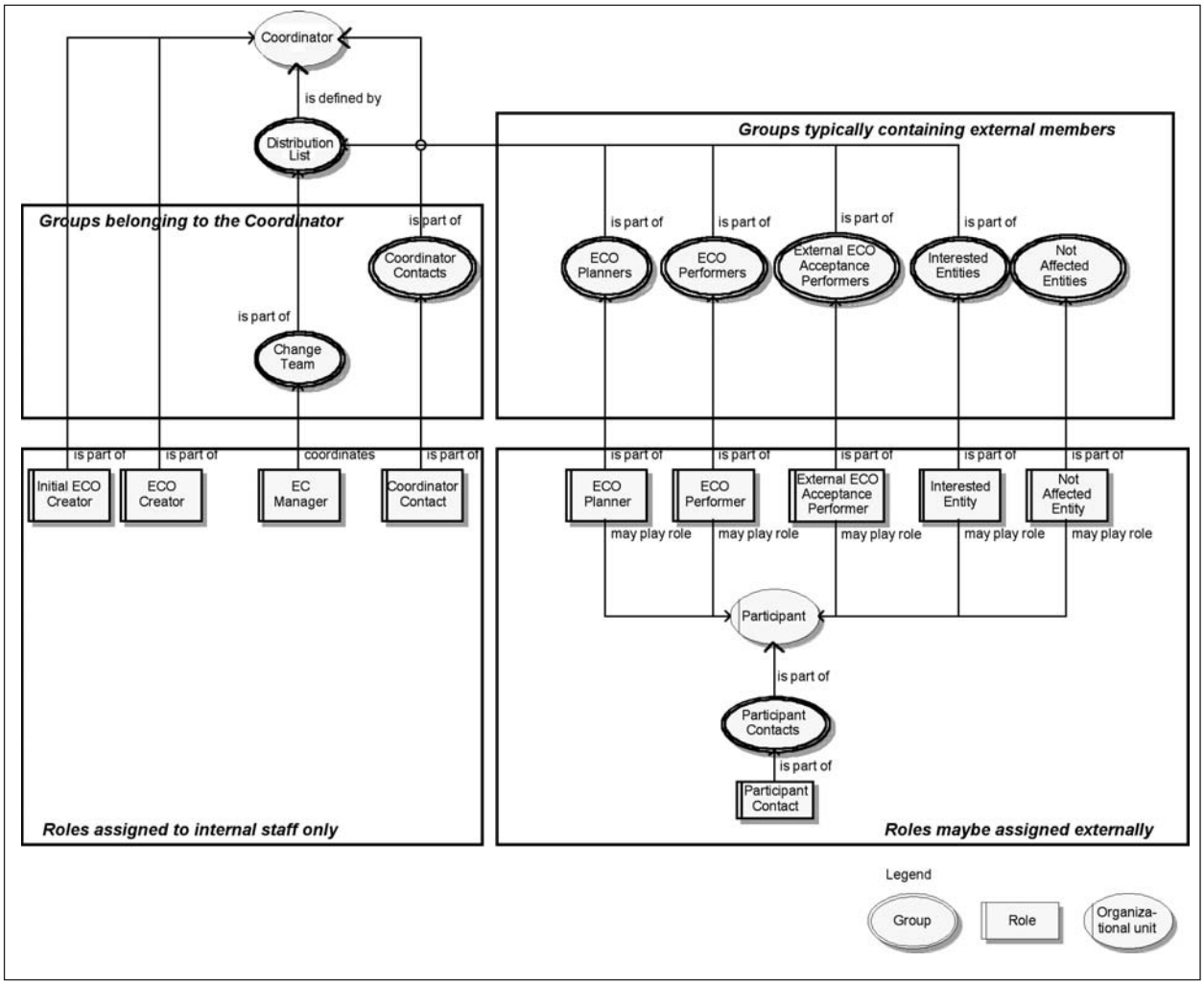


Figure 7: ECO organization model

A distinction is made between the following three types of organizational elements, each of which is indicated by a special symbol in the organization diagram:

– Organizational unit role: This is a placeholder for an organizational unit. This is the point at which the *Coordinator* and the *Participant* occur in the organization diagram. The *Coordinator* is a company which has responsibility for an ECO. The *Participant* is a company which is involved in an ECO process belonging to a *Coordinator*.

– Role: Placeholder for an organizational entity (person/organizational unit) which performs certain tasks and activities in one or more processes, which has a defined scope of responsibility and which possesses the appropriate competence. The roles are shown at the bottom of the diagram. Internal roles are only played by persons/institutions of the *Coordinator* and potentially external roles can also be played by the *Participant* or persons/institutions of the *Participant*.

– Group: Set of organizational entities (persons/organizational units) with a particular role. The groups are shown at the top of the diagram. A distinction is made between two types of groups. 'Groups belonging to the *Coordinator*' are groups in the ECO Reference Process which have roles played primarily by organizational entities within the *Coordinator* (Please note: These groups may also contain external members, but the group in general resides at - and therefore communicates from the side of - the *Coordinator*.) 'Groups typically containing external members': Groups in the ECO Reference Process which have roles that can also be played by a *Participant*. These groups can also be empty if there is no external partner involved, or

the groups can be made up of internal organizational entities. The *Distribution List* is a special group. This is a collective group and contains members of all groups involved in the ECO together with information on the role the organizational entities play. Members of this group are called *Distribution List Members*. The *Distribution List* is used in the ECO Reference Process when messages about the ECO Reference Process are to be issued which are of relevance to several or all groups. The *Distribution List* is also used as a collective term for all groups and the roles assigned to their members.

The following describes the roles and groups of the organization model in more detail.

Roles assigned to internal staff only:
- The *Initial ECO Creator* introduces a proposal for an ECO by creating an initial ECO with at least a rough description of the purpose and scope of a change.

- The *ECO Creator* creates the ECO based on an initial ECO and begins setting up the *Change Team* for the ECO.

- The *EC Manager* (Engineering Change Manager) is responsible for coordinating the ECO, i.e. for carrying out the planning, execution and release. He is a member of the *Change Team* that he coordinates.

- A *Coordinator Contact* is a person on the *Coordinator* side who can serve as a contact for one or more *Participants* with respect to the ECO or a special range of issues or subjects relating to the ECO (such as set of modules/parts, design, prototyping, homologation, etc.). This can be used during data exchange in order to inform the partner who is available as a contact person.

Roles that may be assigned externally:
- An *ECO Planner* is a person or organizational unit who provides technical details concerning the ECO, i.e. affected parts and part-specific change data, etc.; as well as scheduled tasks and responsibilities concerning the ECO.

- An *ECO Performer* is a person or organizational unit who carries out performance tasks of the ECO and returns the results to the *Change Team*.

- An *External ECO Acceptance Performer* is an external organizational unit requested to accept the change from their point of view during the *Release of ECO* phase.

- An *Interested Entity* is an external organizational unit interested in the progress or result of an ECO and is therefore informed of any important changes to the status of the ECO.

- A *Not Affected Entity* is a person or organizational unit initially involved because they were potentially affected, but during the course of the ECO are no longer regarded as being affected. This role allows such a situation to be documented in order to allow the person or organizational unit to still be mentioned during communication.

- A *Participant Contact* is a person or organizational unit who serves as a contact with respect to the ECO or a special range of issues or subjects relating to the ECO (such as set of modules/parts, design, prototyping, etc.). This can be used during data exchange in order to inform the *Coordinator* who is available as a contact person.

Groups belonging to the *Coordinator*:
- The *Change Team* group is a group of persons or organizational units which coordinates and pursues a specific ECO process. Among other things, the *Change Team* defines who is to be involved in the ECO process for planning, execution or release purposes. The *Change Team* can comprise only the EC Manager or, for example, one or more interdisciplinary teams responsible for the ECO.

- The *Coordinator Contacts* group contains all the persons who have the role *Coordinator Contact*.

Groups typically containing external members:

– The *ECO Planners* group contains all the persons/organizational units who have the role *Analysis Performer.*

– The *ECO Performers* group contains all the persons/organizational units who have the role *Comment Performer.*

– The *Interested Entities* group contains all the persons/organizational units who have the role *Interested Entity.*

– The *Not Interested Entities* group contains all the persons/organizational units who have the role *Not Interested Entity.*

– The group *External ECO Acceptance Performers* contains all the persons/organizational units who have the role E*xternal Acceptance Performer.* If this group contains any members, they are all external.

– The *Participant Contacts* group contains all the persons/institutions that have the role *Participant Contact.* If this group contains any members, they are all external.

Note: Which roles need to be communicated to the partner is cooperation-specific.

2.4 ECO Reference Process

In the following sections, the three phases of the ECO Reference Process *Engineering Implementation of Change* are described in detail: *Planning of ECO, Execution of ECO* and *Release of ECO*. The purpose of the phase will be described, followed by an overview of each phase. This is then followed by more detailed descriptions of the normal process and of special flow variants and exceptions.

2.4.1 Planning of ECO phase

This section provides a detailed description of the *Planning of ECO* phase.

Purpose

The Planning of ECO phase serves to define the ECO in detail in order to prepare for *Execution of ECO*. Therefore, ECO details and plan need to be defined and agreed, i.e. the affected objects and their change details need to be specified, and the tasks needed to achieve the desired results concerning design and validation of the affected objects are scheduled and assigned to responsible entities.

Overview of phase

The phase begins at *M4.0 Initial ECO triggered* with the creation of a preliminary, initial ECO and its management, i.e. its assignment and acceptance by a responsible person. Trigger for an initial ECO may be an approved ECR. The initial *Distribution List* is then defined and the *INITIAL_ECO* is distributed, gathering feedback on it. Next, an ECO is created and described. Finally, ECO details, i.e. affected objects and required results etc., as well as ECO plan, i.e. required scheduled tasks and responsibilities, are defined. *Planning of ECO* then finishes, reaching *M4.1 ECO Detailed & Planned*.

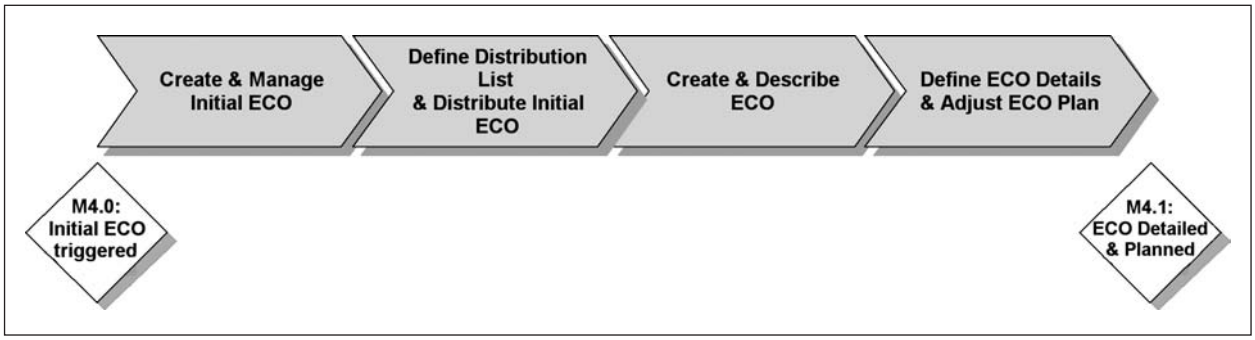


Figure 8: Phase overview of *Planning of Engineering Change*

Normal flow

Planning of ECO begins with an *Initial ECO Creator* who creates an *INITIAL_ECO* with a basic description and then manages it, i.e. he assigns it to a responsible *Change Team (cp. Figure 9)*. Basis and trigger for an *INITIAL_ECO* may be an approved change request. Next, the *Distribution List* is defined and the *INITIAL_ECO* is distributed to inform *ECO Planners* (see below) early. Then, an *ECO Creator* creates an ECO from the *INITIAL_ECO* and describes it in detail by specifying the change scope, ECO_CLASSIFICATION, etc. This is followed by the *Change Team,* typically together with *ECO Planners,* defining ECO details, i.e. specifying affected objects, object-specific changes, etc. and adjusting the ECO plan, i.e. specifying scheduled tasks as well as responsibilities for their performance (see below). During this activity, the *Change Team* may modify the *Distribution List* by adding affected entities or by removing entities not affected by the ECO in order to deal with added or removed affected objects and tasks. *Planning of ECO* finishes with ECO_STATUS.STATUS becoming *detailed and planned*.

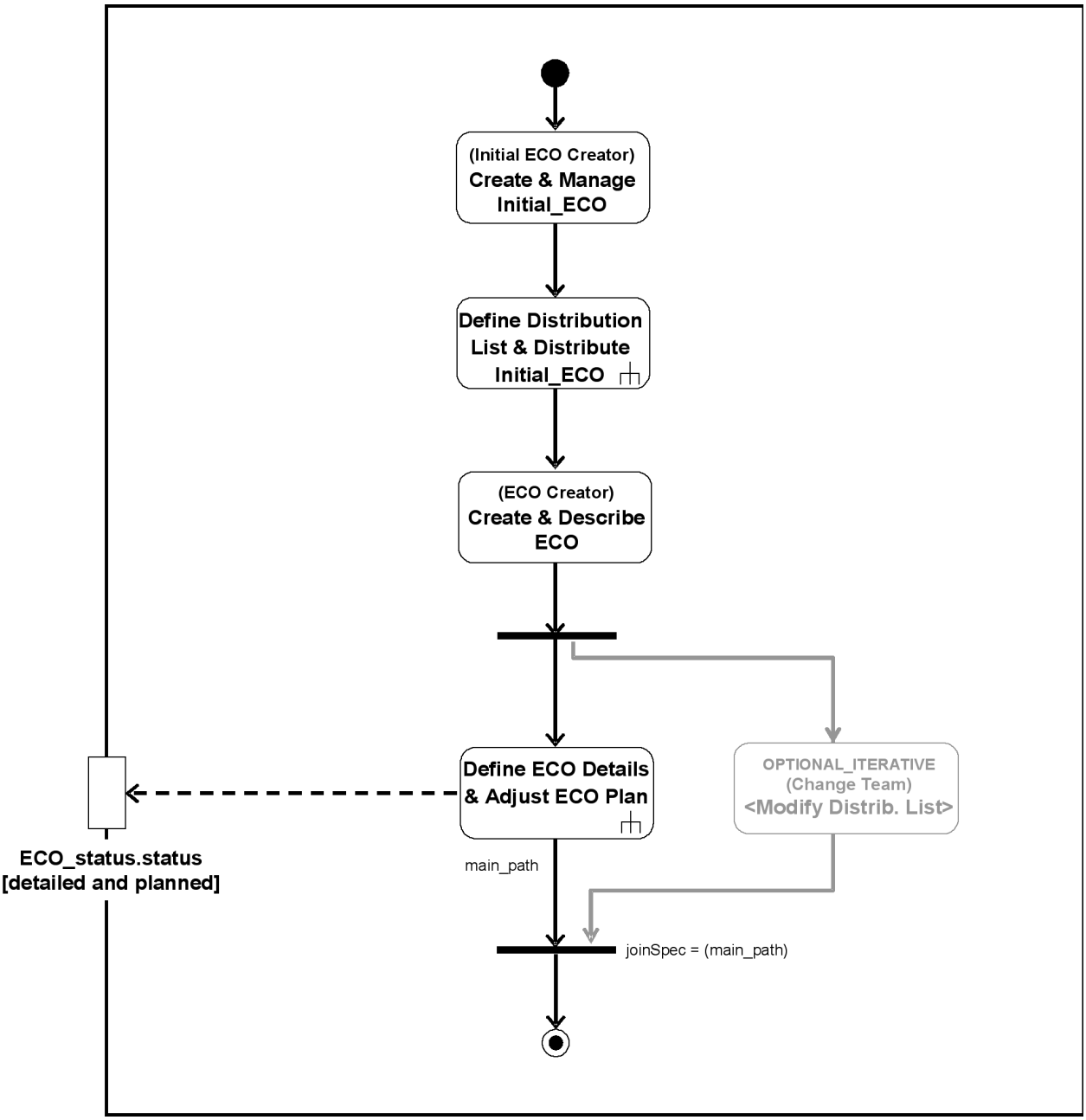


Figure 9: Normal flow of *Planning of ECO*

Activity *Define Distribution List & Distribute INITIAL_ECO*

The *Change Team* begins with the adaptation of the *INITIAL_ECO* by the Initial ECO Creator from the point of view of his knowledge and expertise, eventually preparing it for communication to *ECO Planners* (cf. Figure 10). Therefore, a *Distribution List* is defined first. Next, the *INITIAL_ECO* is distributed to *ECO Planners* using the message *Request_INITIAL_ECO*, thus informing them early about the *INITIAL_ECO* and asking for confirmation. An *ECO Planner* registers the *INITIAL_ECO* locally and confirms this, then sends back the message *Respond_Initial_ECO*. *Define Distribution List & Distribute INITIAL_ECO* is finished once all the response messages are received by the *Change Team*.

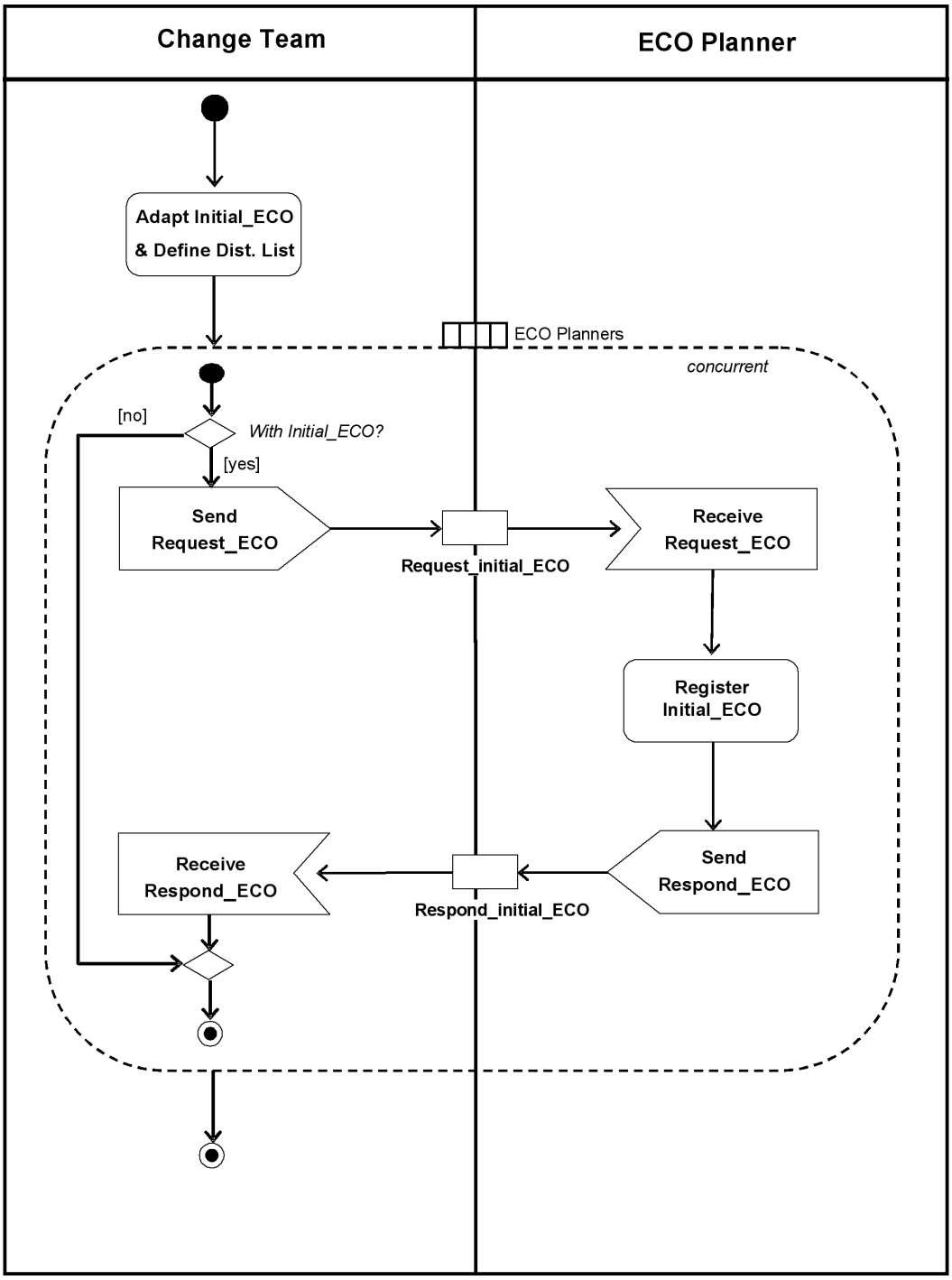


Figure 10: Activity *Define Distribution List & Distribute INITIAL_ECO*

Activity *Define ECO Details & Adjust ECO Plan*

The *Change Team* begins with the activity *Prepare ECO specification* (cf. Figure 11) by defining the ECO specification containing the ECO details, i.e. affected objects and object-specific change data, etc. as well as the ECO plan, i.e. required scheduled tasks with responsibilities for the ECO. Next, the *Change Team* can distribute this ECO specification to *ECO Planners* using the message *Request_ECO_Specification*. The *ECO Planner* then refines or adapts the ECO specification by detailing the ECO and adjusting the ECO plan and then sends this back to the *Change Team* using the message *Respond_ECO_Specification*. These steps may take place simultaneously with several *ECO Planners* responding and the *Change Team* adapting the requests based on those responses. At this point, the ECO specification is considered incomplete. Termination of this simultaneous interaction between *Change Team* and *ECO Planner* begins when the *Change Team signals that Request_ECO_Specification* is complete. An *ECO Planner* may then send some incomplete *Respond_ECO_Specification* messages but ultimately also signals completion. Once all these interactions between *Change Team* and *ECO Planners* have been completed, the *Change Team* finally consolidates the ECO specifications, thus finishing *Planning of ECO* and preparing *Execution of ECO*.

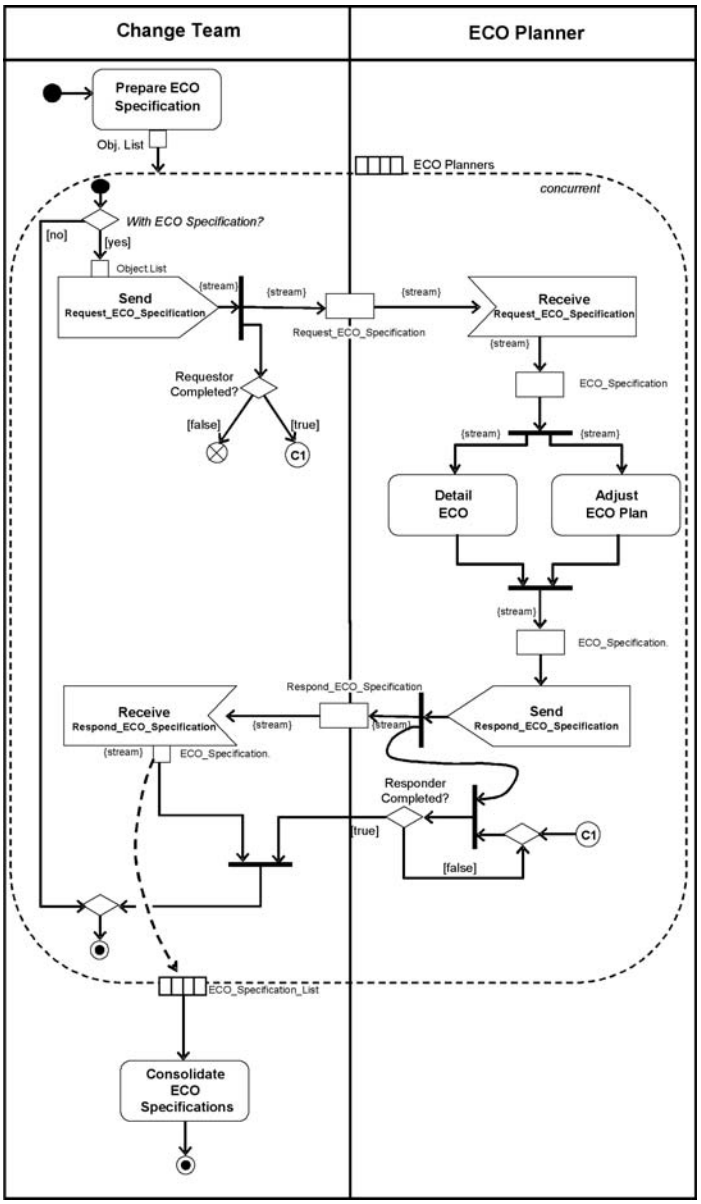


Figure 11: Activity *Define ECO Details & Adjust ECO Plan*

Special flow variants and exceptions
No special flow variants and exceptions are described.

Remark: The activity *Define ECO Details & Adjust ECO Plan* can be divided into a simpler normal flow with only "complete" request and response messages and the more complex flow described above (cf. activity Technical Analysis of ECR in 4964-1). This remains to be done.

2.4.2 Execution of ECO phase

This section provides a detailed description of the *Execution of ECO* phase.

Purpose
During this phase, the affected objects are changed according to the ECO details and the tasks are performed according to the schedule as planned during *Planning of ECO*. The ECO status is adapted and results (designed objects, validation protocols, …) are collected and are referenced by the ECO. The results are provided in a quality that allows *Release of ECO* to be started afterwards.

Overview of phase
This phase begins with preparing ECO performance requests from the ECO and distributing the ECO to *ECO Performers*. *ECO Performers* register the ECO locally and then begin with the performance of the scheduled tasks. After performance, the ECO and the affected objects are checked as to whether they have been performed completely. *Execution of ECO* finishes after consolidating the results, reaching *M4.2 ECO executed*.

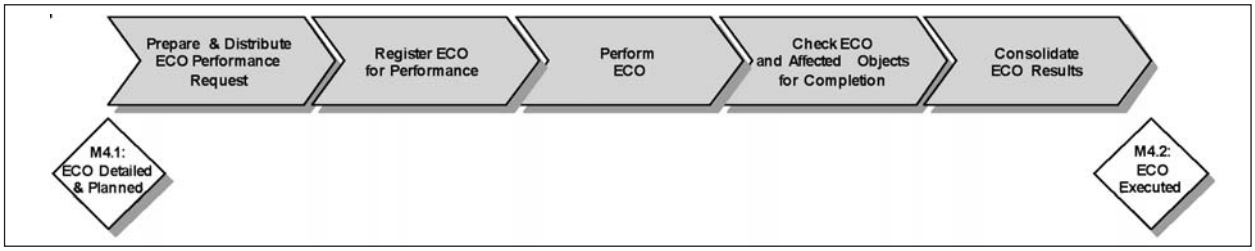


Figure 12: Phase overview of *Performance of ECO*

Normal flow
The *Change Team* prepares an ECO performance request for every *ECO Performer* in parallel (cf. Figure 13). For this purpose, it can refine the ECO specifically for one *ECO Performer* and provide specific data, e.g. current CAD models describing the neighboring geometry, etc. The *Change Team* requests performance of the ECO by the *ECO Performer* using the message *Request_ECO_performance*. The *ECO Performer* registers the ECO for performance locally and then replies with the message *Respond_ECO_performance,* thereby confirming that he has received the request. The *ECO Performer* then begins with the activity *Perform ECO* (see below), i.e. changing affected objects and validating the changes technically and formally. Upon completion of this activity, he notifies the *Change Team* using the message *Notify_ECO_performance_completed*. When the *Change Team* receives this message, it checks the ECO and the affected objects with regard to completion by performing formal checking as well as technical validations.

If the check is negative; i.e. the performance is not accepted as complete; the *Change Team* restarts with the activity P*repare ECO Performance Request,* specifying issues the *ECO Performer* needs to handle in order to complete the performance request, for example DMU collisions, violations of agreed requirements, simulation results, etc. If the check indicates the need for major corrections requiring re-planning and, for example, involving additional *ECO Performers,* a back-jump may be used (see 2.2.4).

If the check is positive, the *Change Team* can signal this fact to the *ECO Performer* using the message *Notify_ECO_performance_completed*. Once all results of all *ECO Performers* have been completed with regard to the check by the *Change Team,* the *Change Team* consolidates the ECO results and the phase *Execution of Engineering Change* is finished with the ECO_STATUS.STATUS becoming executed

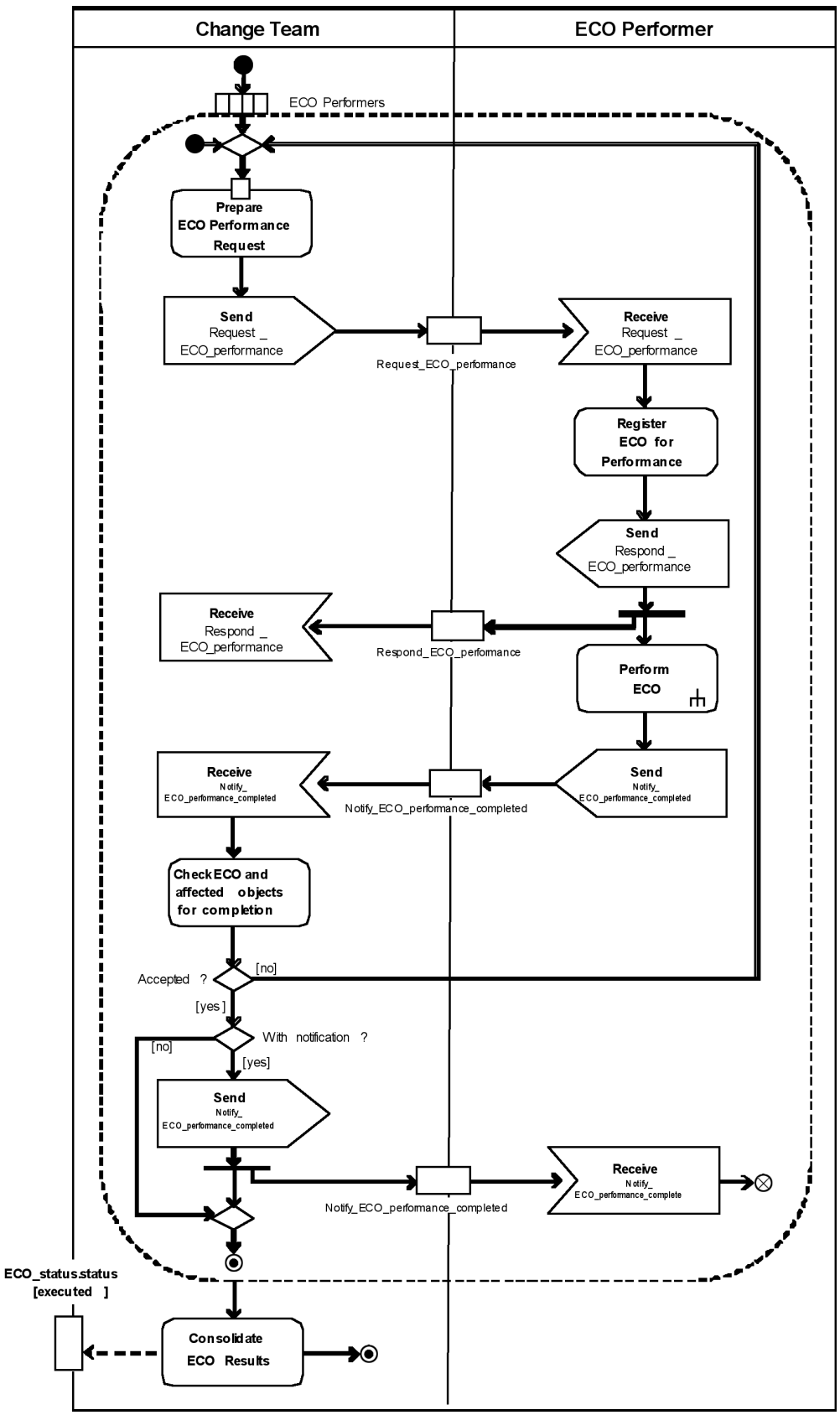


Figure 13: Normal flow of *Execution of ECO*

Activity *Perform ECO*

The activity *Perform ECO* begins with the *ECO Performer* managing its engineering change performance task, i.e. forwarding or assigning the task to a concrete person who then performs the task (cf. Figure 14). Next, the affected objects are created and validated according to the task. Depending on the task involved, this could mean, for example, that CAD models are designed and then tested using digital or physical simulation (mock-up, etc.). If these development steps are considered complete, the *ECO Performer* checks whether this is so in the activity *Confirm Engineering Change Performed*. If this activity shows that something is missing or still needs to be done, the *ECO Performer* restarts at *Create and Validate Affected Objects*. If the check ultimately confirms completion of performance, the *ECO Performer* is done with the activity *Perform ECO*.

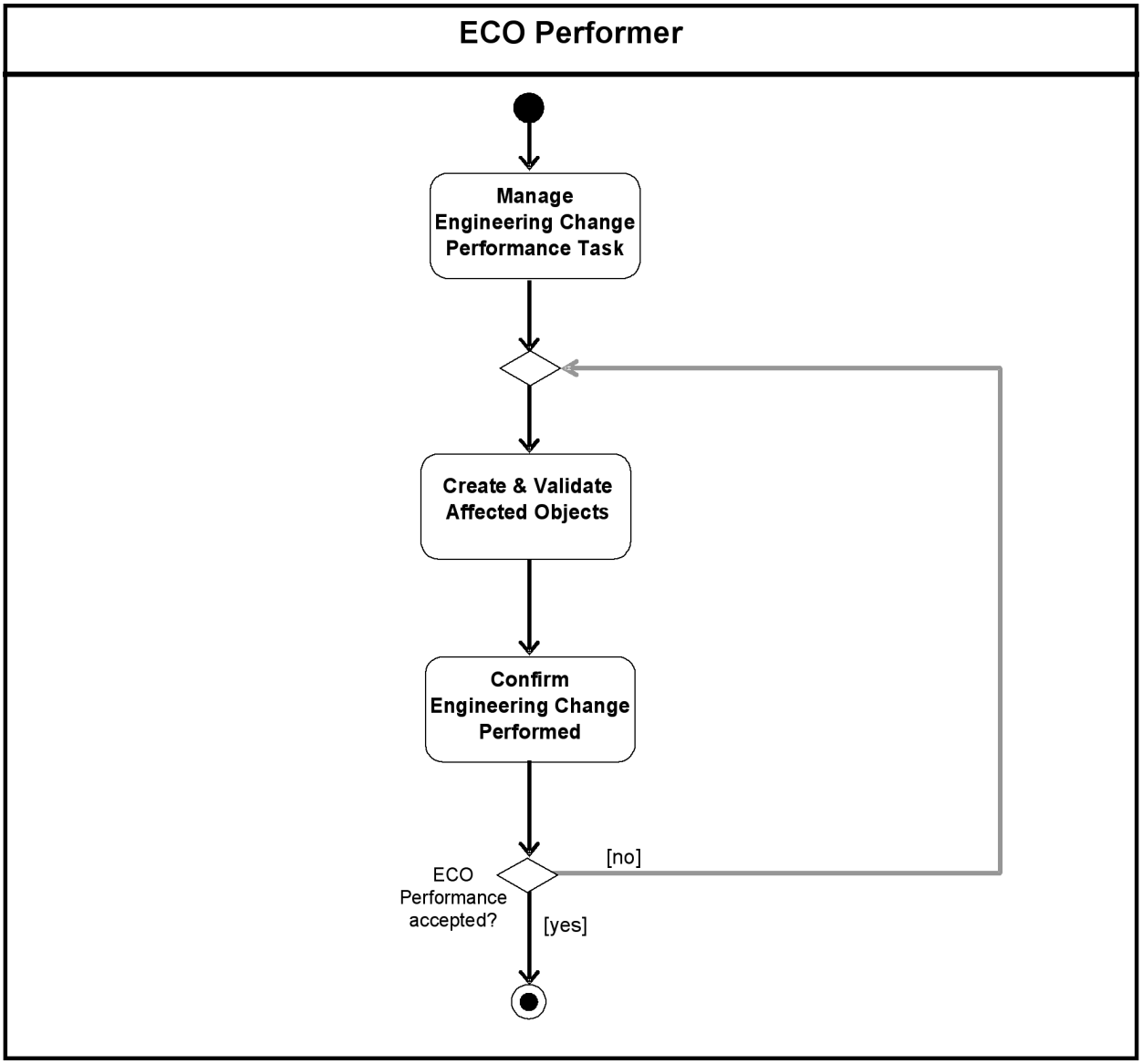


Figure 14: Activity *Perform ECO*

Activity *Confirm Engineering Change Performed*

With *Prepare ECO Performance Completion*, the *ECO Performer* begins the request for the *Change Team* and, as a result, sends the message *Request_ECO_performance_complete*. The *Change Team* receives the messages and performs *Check ECO and Affected Objects for Completion*, which involves inspecting the results of the *ECO Performer* with regard to whether the agreed tasks have been technically and formally completed for all affected objects, the results have the required quality (e.g. no relevant DMU collisions have been found), etc. The *Change Team* returns its findings and acceptance decision to the ECO Performer using the message *Respond_ECO_performance_complete*. The *ECO Performer* receives the message, the activity *Confirm Engineering Change Performed* is finished, and the higher-level activity *Perform ECO* continues depending on the acceptance decision as described above.

Special flow variants and exceptions

No special flow variants and exceptions are described.

2.4.3 Release of ECO phase

This section provides a detailed description of the *Release of ECO phase*.

Purpose

In *Release of ECO*, the engineering change which was executed in the preceding phase *Engineering Implementation of Change* is reviewed for technical and formal completeness so that it can be documented and released to subsequent processes (such as Manufacturing Implementation of Change); the affected entities are also reviewed. Specific scheduled tasks and responsibilities for this may have been agreed in the first phase *Planning of ECO*.

Overview of phase

This phase begins with a review of the current ECO and its affected objects during which the updated ECO relating to performed tasks and the affected objects is checked from the point of view of documentation in particular. Typically, the engineers or managers from development and documentation who are responsible for technical and formal criteria are required to confirm completion with regard to this. If the ECO and its affected objects successfully pass this review, the ECO is released, which allows subsequent process steps and affected entities to rely on its completion. Two variants are available for distribution to affected entities. The first variant involves distributing a simple notification. The second variant involves combining distribution with obtaining acceptance from the affected entities, e.g. partners.

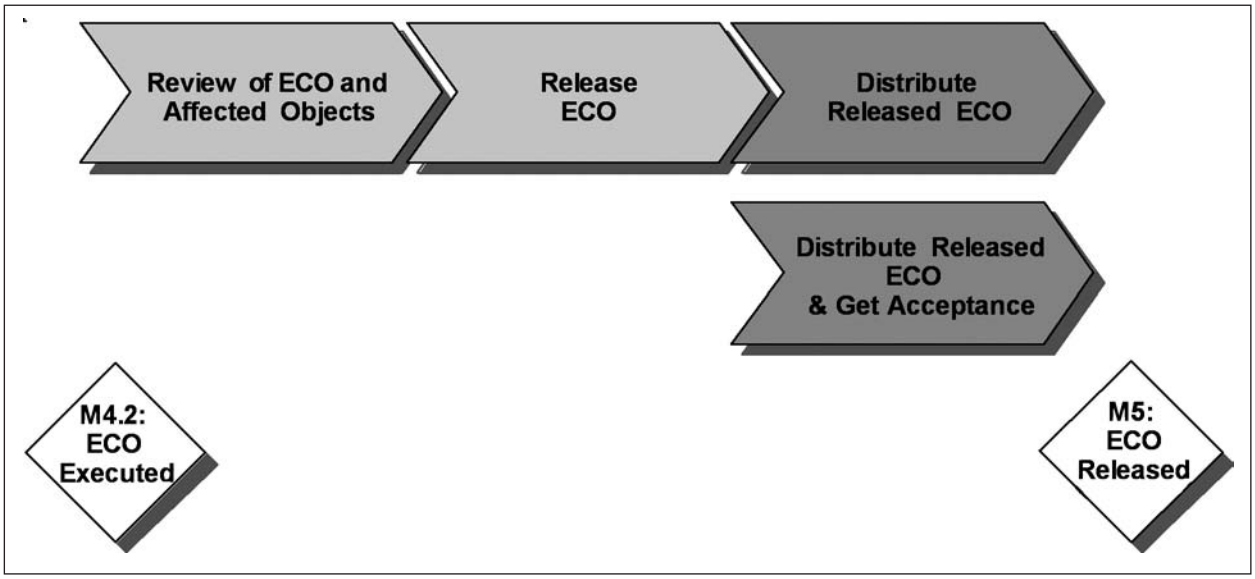


Figure 15: Phase *overview of Release of ECO*

Normal flow

Release of ECO begins with the activity *Review of ECO and Affected Objects* (see below). If the review is negative but only minor formal corrections are required, the *Change Team* may adapt the ECO and affected objects as necessary, and *Review of ECO* and *Affected Objects* is performed again. If the review determines the need for major corrections, a back-jump may occur (see 2.2.4).

If the review is negative and a revision is needed, *Release of ECO* is terminated and the process continues with a revision, starting again from *Planning of ECO* or from *Execution of ECO* (see 2.2.4).

If the result of the review is positive, the *Change Team* releases the ECO. Two variants can be used for subsequent distribution to affected entities and partners. Either simple distribution of the released ECO is selected (cf. Figure 17), which means that the *Change Team* sends the *message Notify_ECO_released* to the *Distribution List,* or the activity *Distribute Released ECO & Get Acceptance* is used to request acceptance by the affected entities (see below).

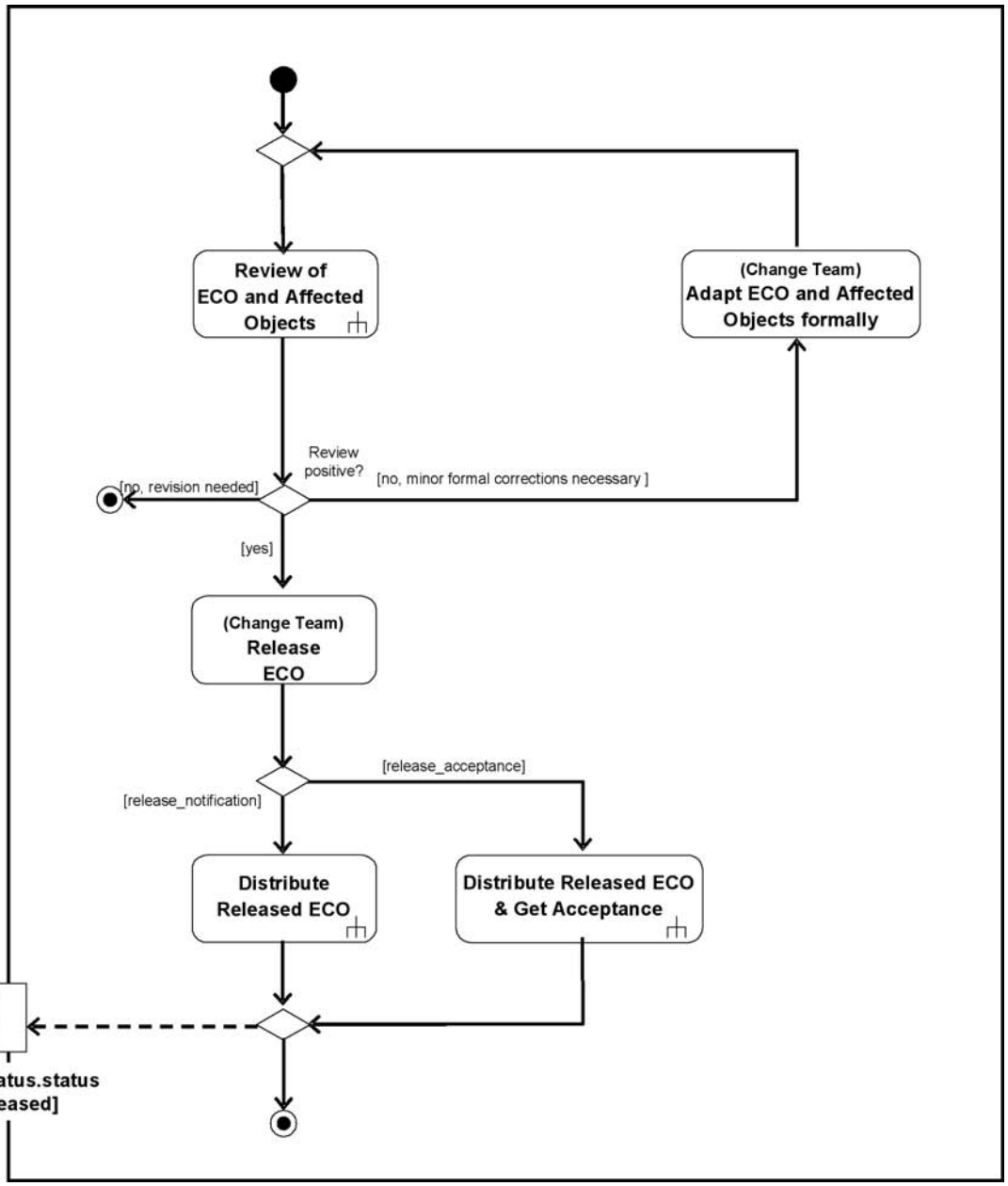


Figure 16: Normal flow of *Release of ECO*

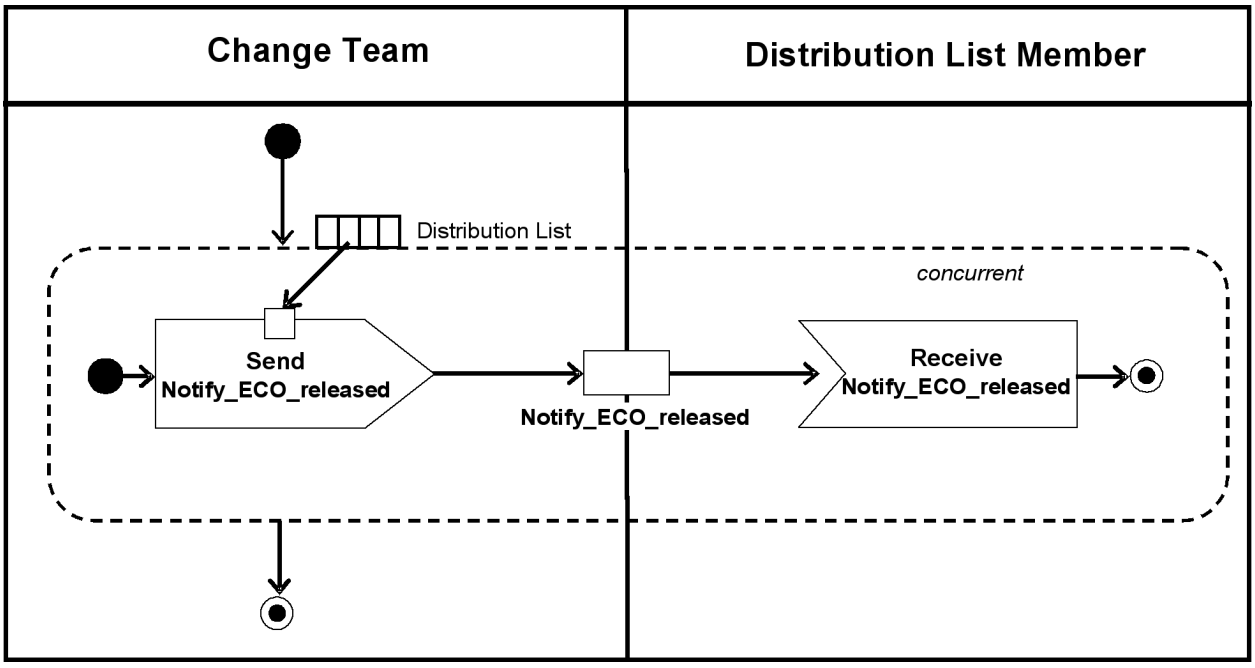


Figure 17: Activity *Distribute Released ECO*

Activity *Distribute Released ECO & Get Acceptance*

The *Change Team* prepares an *ECO Performance Request* and sends it to an *External ECO Acceptance Performer* using the message *Request_ECO_acceptance*. The *External ECO Acceptance Performer,* upon receiving the message, reviews the ECO and the affected objects and returns his acceptance decision to the *Change Team* using the message *Respond_ECO_acceptance*. The *Change Team,* upon receiving the message, reviews the acceptance of the *External ECO Acceptance Performer.* If the External ECO Acceptance Performer has not initially accepted the ECO, he may do so in a following response, again using the message *Respond_ECO_acceptance,* e.g. after clarifications of issues with the Change Team using another communication channel. The activity *Distribute Released ECO & Get Acceptance* only finishes after all *External ECO Acceptance Performers* have replied with positive acceptance.

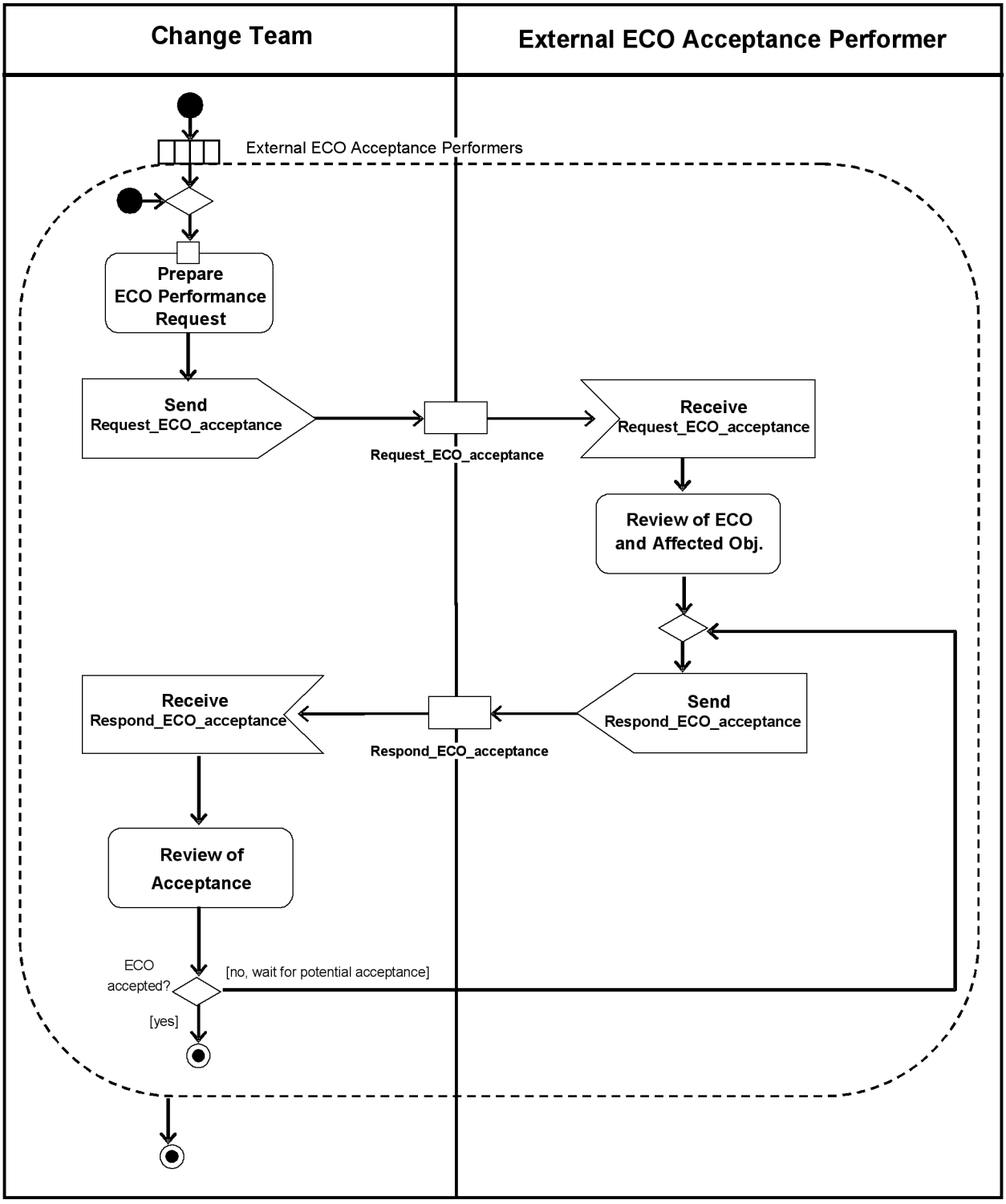


Figure 18: Activity *Distribute Released ECO & Get Acceptance*

Special flow variants and exceptions

No special flow variants and exceptions are described.

3 ECO Interaction Scenarios and ECO messages

Depending on the different business requirements and contractual conditions which apply, different data describing an ECO needs to be exchanged at different times in the different cooperative ventures. This section describes the three ECO Interaction Scenarios that might be applied in a cross-company ECO process. These three scenarios are:

- *ECO Interaction Scenario 1: Participant notification about release.*
  The Coordinator performs the phases Planning, Execution, and Release of Engineering Change and notifies the Participant after release. The Participant is not involved in the planning, execution or release of the change at engineering at the Coordinator. The Coordinator and the Participant may have previously agreed on the engineering change using an ECR. Because the Participant is only loosely involved in the engineering change, ECO updates from the Coordinator and rollbacks in the ECO Reference Process are not communicated to the Participant.

- *ECO Interaction Scenario 2: Participant acceptance of release.*
  The Coordinator only performs the phases Planning, Execution, and Release of Engineering Change and after release asks the Participant to accept the released ECO. The Participant may indicate his acceptance or non-acceptance in a response message. The Participant is not involved in the planning, execution or release of the change at engineering at the Coordinator (but is only asked for his acceptance at the end of the release). The Coordinator may repeat the request for acceptance, e.g. giving additional explanations, and the Participant may continue to answer negatively. IS2 finishes when the Participant has answered positively. Because the Participant is only loosely involved in the engineering change, ECO updates from the Coordinator, rollbacks in the ECO Reference Process are not communicated to the Participant.

- *ECO Interaction Scenario 3: Participant execution and release.*
  Within IS3, the Participant is typically a supplier of the Coordinator. The Coordinator may perform Planning / and Execution / together with the Participant and then performs Release of Engineering Change and notifies the Participant about it. The Coordinator and the Participant may have previously agreed on the engineering change using an ECR. The Participant needs more information about the ECO and is more closely linked to the Coordinator's ECO process. ECO updates from the Coordinator and rollbacks in the ECO Reference Process may occur in a manner visible to the Participant.

Figure 19 below illustrates the level of interaction between the Coordinator and the Participant in the phases of the ECO Reference Process for each ECO Interaction Scenario.

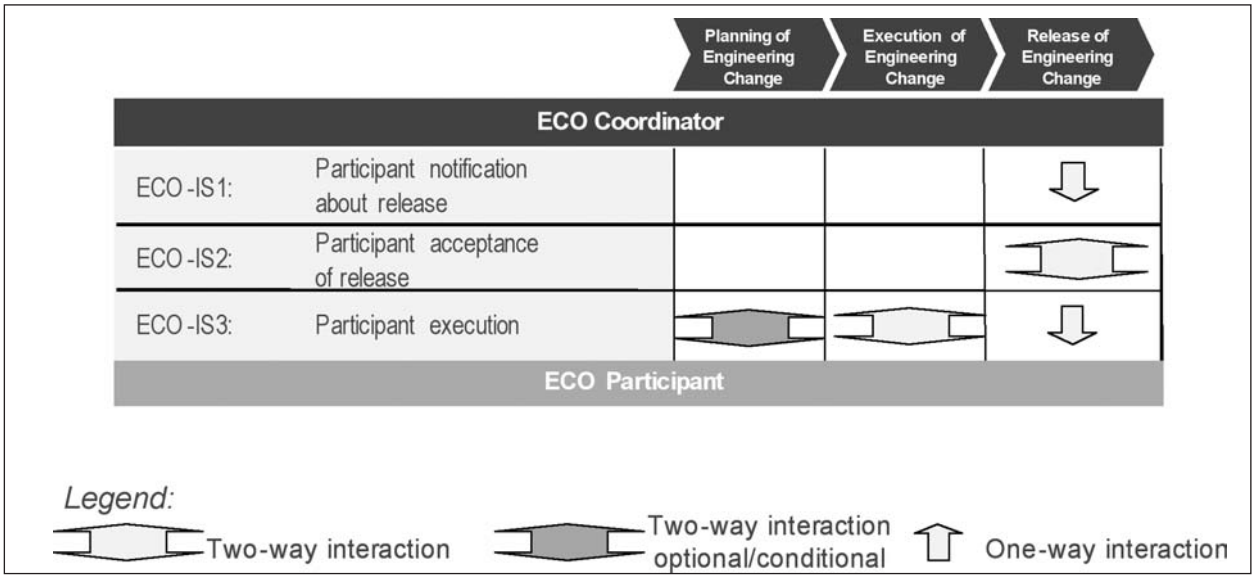


Figure 19: Level of interaction in the ECR Interaction Scenarios

The following table provides an overview of the roles of the *Participant* in each of the ECO Interaction Scenarios (Legend: "X": the *Participant* plays that role; "O": the *Participant* may play that role; "-": the Participant does not play that role).

Role of Participant	***ECO Planner***	***ECO Performer***	***External ECO Acceptance Performer***
Interaction Scenario 1	–	–	–
Interaction Scenario 2	–	–	X
Interaction Scenario 3	O	X	–

Table 1: Overview of the roles of the *Participant* in ECR Interaction Scenarios

3.1 Description method

An ECO Interaction Scenario describes how ECO data is exchanged between partners for a particular purpose using messages to implement process-oriented integration for a specific type of cooperation. ECO Interaction Scenarios make use of certain options for interaction provided by the ECO Reference Process in order to exchange the associated messages in a specific application context. A distinction is made between two different types of interaction: In unidirectional interactions, a single message of type *Notify* is sent; in bidirectional interactions, a message of type *Request* and one message of type *Respond* are exchanged.

In the following sections, the ECO Interaction Scenarios are briefly described by illustrating the application context and showing the assignment of the tasks between the *Coordinator* and the *Participant* in the ECO Reference Process.

This is supplemented by a description (if necessary for each variant of this ECO Interaction Scenario) of the message flow involved in exchange of ECO messages. A message flow diagram shows the possible flow of messages specific to the ECO Interaction Scenario from the *Coordinator* to the *Participant* and vice versa.

The ECO messages are assigned to the phases of the ECO Reference Process of the *Coordinator* in order to show the process context in which an ECO message is exchanged. This process context is precisely defined in section 2.4 of this document. The sending and receiving actions of the *Coordinator* are related with the sending and receiving actions the ECO Reference Process provides in general.

The meanings of the ECO messages which can occur in different ECO Interaction Scenarios are described in section 3.3.

Notes: Some ECO messages and other conditions which apply to the ECO message sequences, in particular for the flow variants and exceptions, are described by the ECO Reference Process only and are not explicitly illustrated in these ECO Interaction Scenario diagrams.

3.2 ECO Interaction Scenarios

3.2.1 ECO Interaction Scenario IS1 – Participant notification about release

Application context

Interaction Scenario 1 describes an engineering change process where the *Coordinator* executes the ECO without interactions with the Participant but notifies him at the end about its release.

Typical application: Development of an extent of parts is completely done by the *Coordinator*.

Typically, the *Coordinator* can be an OEM notifying a general contractor as the *Participant* about a change (that may be have been agreed in a preceding ECR) to be implemented by the *Participant's* manufacturing. Or, the general contractor as a *Coordinator* notifies the OEM analogously.

Message sequences
The following diagram illustrates the possible sequences of messages in this ECO Interaction Scenario:

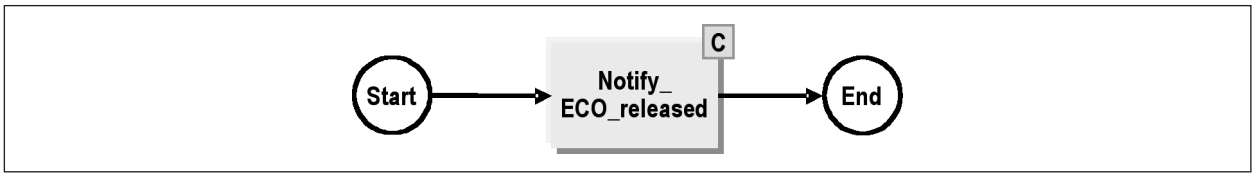


Figure 20: Possible sequences of messages for *Participant notification about release (IS1)*

Simple case:
The *Coordinator* sends the message *Notify_ECO_released* to the *Participant*.

Options:
No options described.

The following diagram illustrates the messages in *IS1* in the context of the ECO Reference Process. For a description of the individual *messages*, see section 3.3.

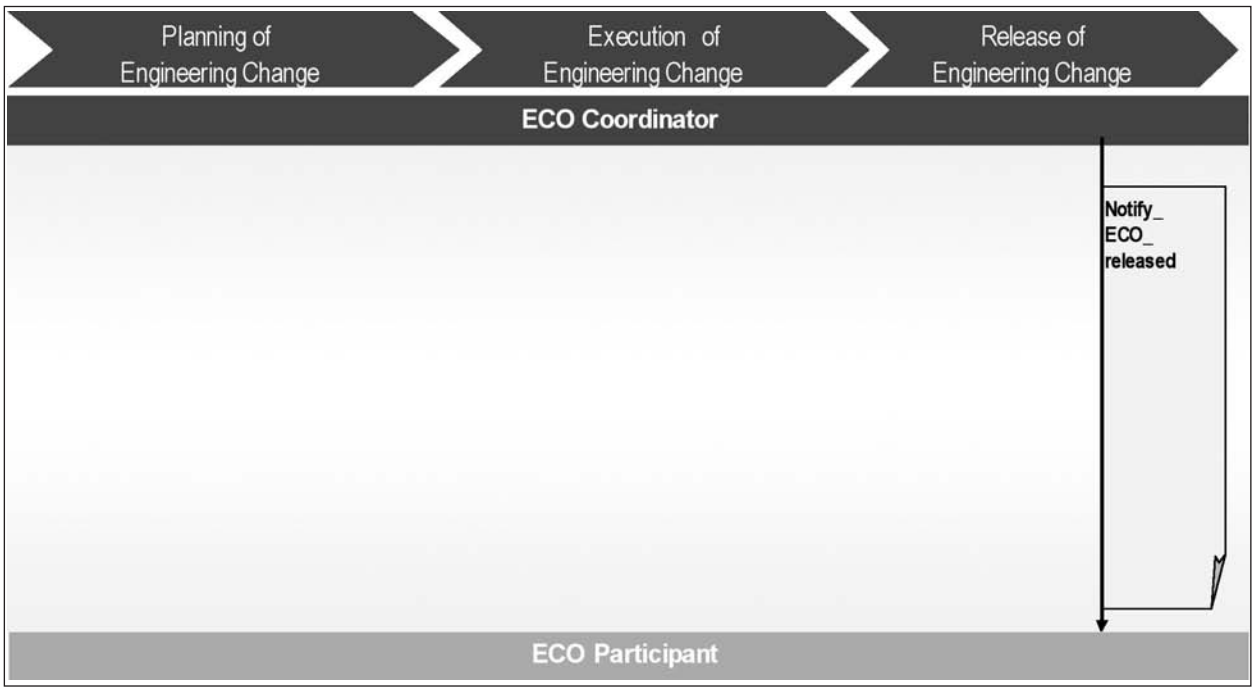


Figure 21: Messages in *IS1* in the context of the ECO Reference Process

3.2.2 *ECO Interaction Scenario IS2 – Participant acceptance of release*

Application context
In *IS2,* the *Coordinator* executes the engineering change and after completion notifies the *Participant* about the release.

Interaction Scenario 2 describes an engineering change process where the *Coordinator* executes the ECO without interactions with the *Participant* but notifies him at the end about the ECO release, in addition requesting his acceptance.

Typical application: Development of an extent of parts is completely done by the *Coordinator*.

Typically, the *Coordinator* can be a tier-n supplier notifying its tier n+1 suppliers or its customers about a change (that may have been agreed in a preceding ECR) of parts which will be implemented or used by the *Participant's manufacturing*.

Message sequences
The following diagram illustrates the possible sequences of messages in this ECO Interaction Scenario:

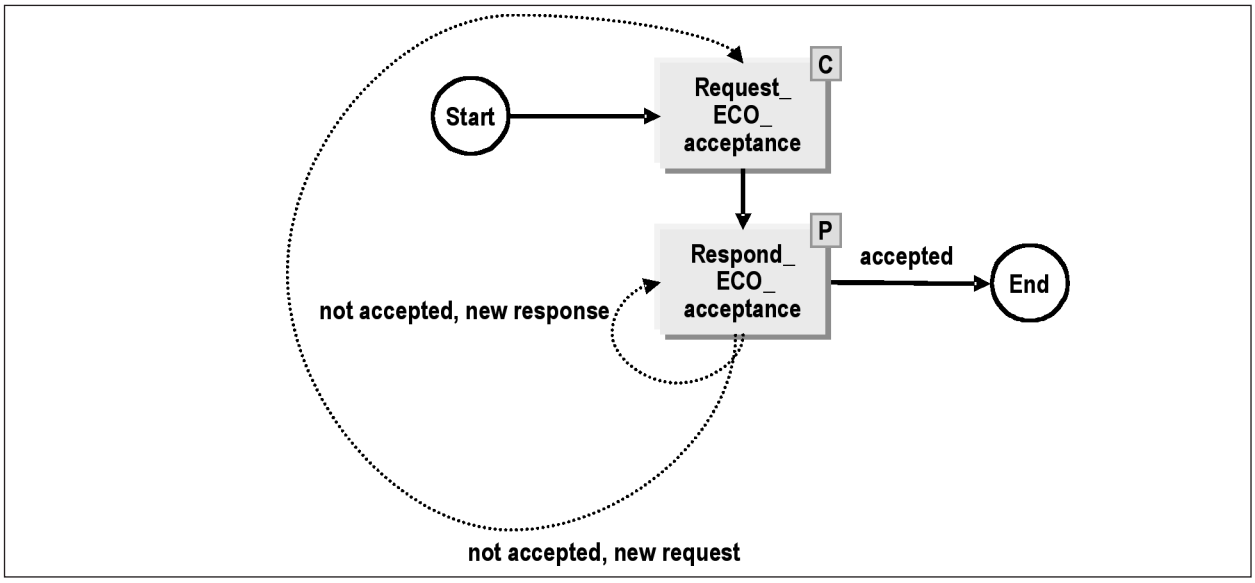


Figure 22: Possible sequences of messages for *Participant acceptance of release (IS2)*

Simple case:
The Coordinator sends the message Notify_ECO_released to the Participant. The Participant replies with Respond_ECO_acceptance, accepting the ECO.

Options:
The *Coordinator* sends the message *Notify_ECO_released* to the *Participant*. The *Participant* replies with *Respond_ECO_acceptance*, not accepting the ECO.

a) The *Participant* replies with *Respond_ECO_acceptance*, now accepting the ECO.

b) The *Coordinator* performs a back-jump (see 2.2.4; without notifying the *Participant),* and begins again with sending *Request_ECO_acceptance to the Participant.*

The following diagram illustrates the messages in IS2 in the context of the ECO Reference Process. For a description of the individual *messages*, see section 3.3.

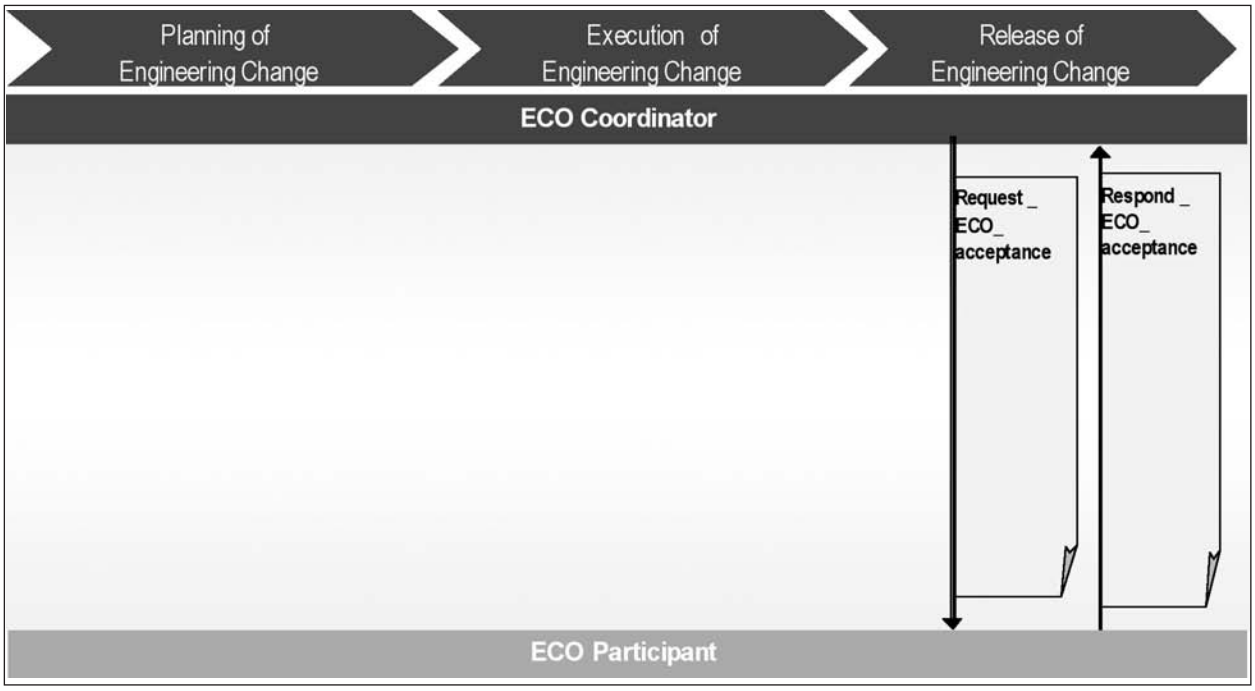


Figure 23: Messages in *IS2* in the context of the ECO Reference Process

3.2.3 *ECO Interaction Scenario IS3 – Participant performance*

Application context

In *IS3*, the *Coordinator* may notify a *Participant* about an Initial_ECO, may specify the ECO together with the *Participant*, may in addition request the *Participant* for execution of tasks for the engineering change and after release notifies the *Participant* about the release.

Interaction Scenario 3 describes an engineering change process where the *Participant* may specify and execute the ECO with interactions with the *Participant* and notifies him at the end about the ECO release.

Typical application: Development of an extent of parts is done by the *Participant*.

Typically, the *Coordinator* can be an OEM requesting a supplier as the *Participant* for execution of a change (that may have been agreed in a preceding ECR) of parts in context of an ECO.

Message sequences

The following diagram illustrates the possible sequences of messages in this ECO Interaction Scenario:

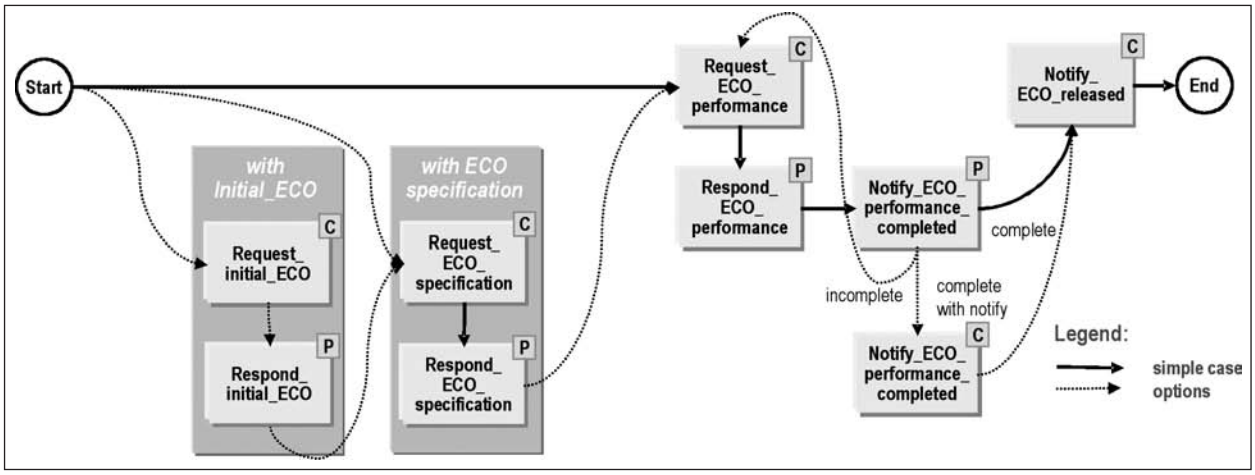


Figure 24: Possible sequences of messages for *Participant performance (IS3)*

Simple case:

The *Coordinator* sends the message *Request_ECO_performance* to the *Participant*. The *Participant* replies with *Respond_ECO_performance*. Upon completion of performance, the *Participant* sends *Notify_ECO_performance_completed* to the *Coordinator*. The *Coordinator*, if he considers performance to be incomplete, begins again by sending *Request_ECO_performance*. Or, if the *Coordinator* considers performance to be complete, he finally notifies the *Participant* using *Notify_ECO_released*.

Options:

The *Coordinator* may involve the *Participant* early during creation of an *INITIAL_ECO* by sending him *REQUEST_INITIAL_ECO* and receiving from him *Respond_Initial_ECO*.

The *Coordinator* may involve the *Participant* in the specification of ECO by sending him *Request_ECO_specification* and receiving from him *Respond_ECO_specification* (this can be done using preliminary requests and responses marked as incomplete, cf. 2.4.1).

After receiving *Notify_ECO_performance_completed* from the *Participant*, the *Coordinator* can send the message *Notify_ECO_performance_completed* back to the *Participant* if he considers the performance to have been completed.

The following two diagrams illustrate the messages in *IS3* in the context of the ECO Reference Process. For a description of the individual *messages*, see section 3.3.

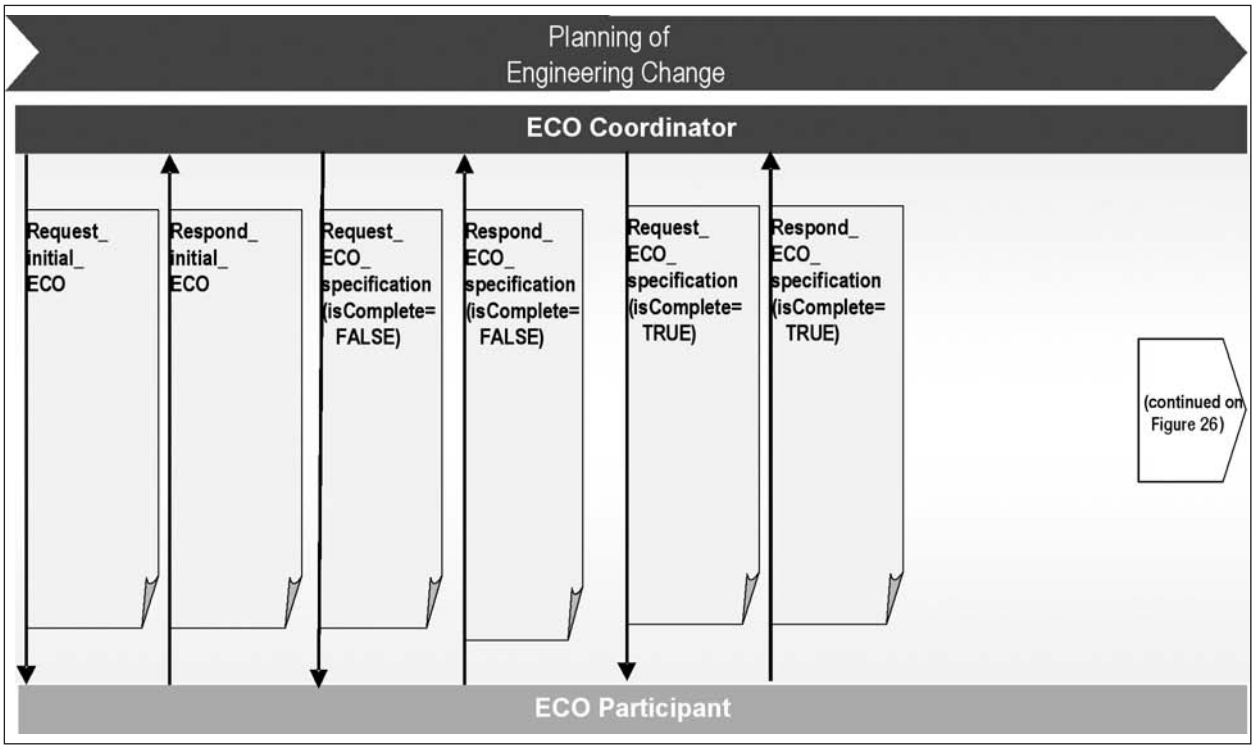


Figure 25: Messages in *IS3* in the context of the ECO Reference Process (1)

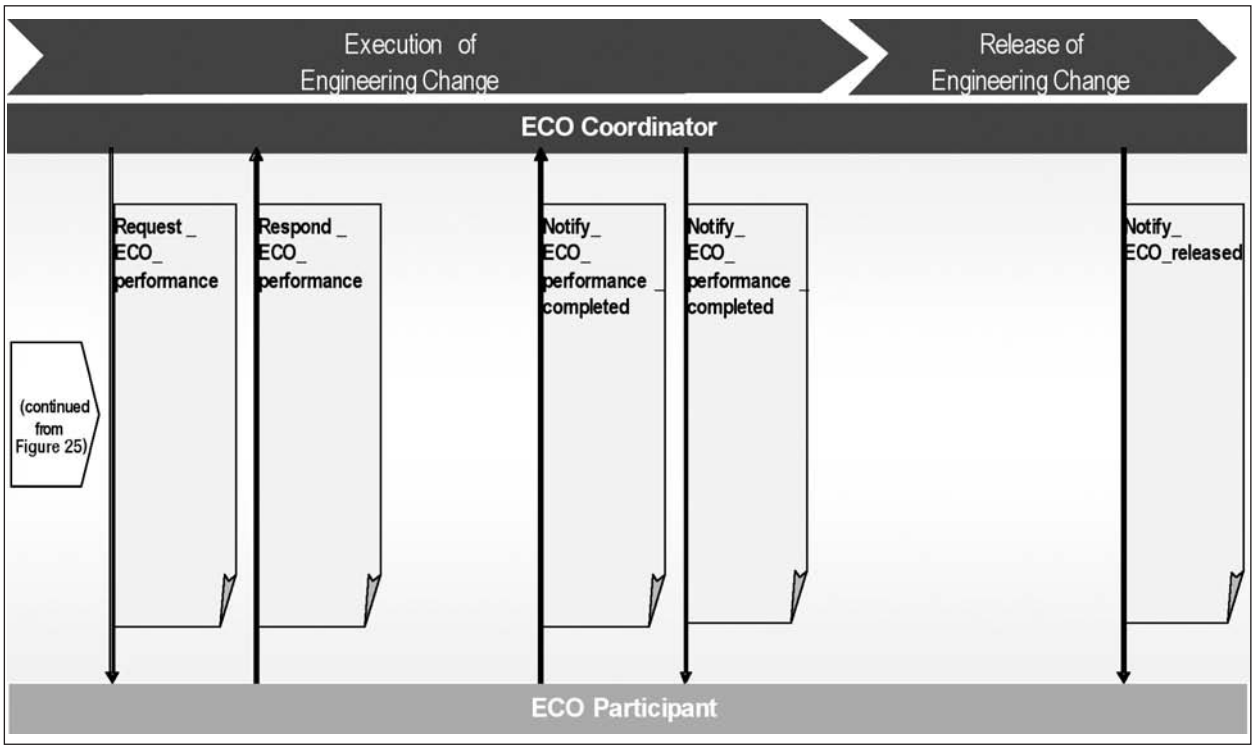


Figure 26: Messages in *IS3* in the context of the ECO Reference Process (2)

3.3 Messages

3.3.1 Data-oriented messages

Common messages, which can be used in each of the ECO Reference Process phases, have been defined to support data-oriented scenarios. If data-oriented communication is used in combination with process-oriented communication, these messages can occur within the ECO Interaction Scenarios, but they are not described in the ECO Interaction Scenarios (section 3.2) itself.

Request_all_ECO_ids

This message from the Participant requests all the existing identifying objects of an ECO in which the Participant is involved, as well as associated header information, from the *Coordinator*. This message itself does not contain any parameters.

Respond_all_ECO_ids

This message from the *Coordinator* is the response to the *Request_all_ECO_ids* message. It contains all the identifying objects (including at least a value for each of their mandatory attributes) and all existing relationship objects (including at least a value for each of their mandatory attributes) between theses identifying objects in which the *Participant* is involved. In addition, this message contains all the header information objects (including at least a value for each of their mandatory attributes) that are associated with the identifying objects.

Parameters:

- the identification of the ECO [mandatory]
- either the header information of the regular ECO associated to ECO_idn [optional] or the header information of the initial ECO associated to ECO_idn [optional]

Note: The criteria for determination the identifying objects (and hence also the associated header information) of the ECO data model that are send back to the *Participant* are implementation specific.

Note: The result returned by this message may consist of a zero, one or more pairs containing ECO identification and associated header information.

Request_ECO_data

This message from the *Participant* requests all the existing data objects of the data model for the given identifying information of an ECO (including a value for each of its mandatory attributes) from the *Coordinator*.

Parameters:

- the identification of the ECO [mandatory]

Respond_ECO_data

This message from the *Coordinator* is the response to the *Request_ECO_data* message. It contains all the data objects of the ECO data model (including at least a value for each of their mandatory attributes) that are associated with the identifying object (ECO) of the previously received *Request_ECO_data* message.

Parameters:

- the identification of the ECO [mandatory]
- general detail information associated to the ECO [optional] and/or
- specific detail information associated to the ECO [optional] and/or
- comment information associated to the ECO [optional] and/or
- acceptance information associated to the ECO [optional]

Note: The result returned by this message must contain one or more of the optional parameters.

Note: The criteria for determination of the data objects of the ECO data model that are send back to the *Participant* are implementation specific.

3.3.2 Process oriented messages

In the following, all the messages permitted in the ECO Reference Process are described. There are two categories of ECR message:

- Messages that are described in the ECO Interaction Scenarios
- Messages that can occur in the ECO Interaction Scenarios but which are not described in the ECO Interaction Scenarios (section 3.2) itself.

Request_initial_ECO
This message from the *Coordinator* contains a request to acknowledge an initial ECO and give back early ECO details (affected objects, etc.).

Respond_initial_ECO
This message from the *Participant* contains a response to *Request_initial_ECO* confirming receipt of the request and may also include some details from the point of view of the *Participant*.

Request_ECO_specification
This message from the *Coordinator* contains a request to specify details and plan for the ECO (affected parts, scheduled tasks with responsibilities, etc.) from the point of view of the *Participant*. ***Note:*** The message may be exchanged several times (isComplete-Method, cf. VDA 4965-1).

Respond_ECO_specification
This message from the *Participant* contains a response to the message *Request_ECO_specification* specifying details and plan (affected parts, scheduled tasks with responsibilities, etc.) from the point of view of the *Participant* and confirming and/or extending or changing the ECO details. ***Note:*** The message may be exchanged several times (isComplete-Method, cf. VDA 4965-1).

Notify_ECO_update
This message from the *Coordinator* or the *Participant* signals a change of the status of the performance or release of the ECO.

Notify_ECO_id_switched
This message from the *Coordinator* signals that the ECO_id is switched to a different value. For example, this message may be used in order to switch the ECO_id to an ID of the release sub-process.

Notify_ECO_rolled_back_to_planning
This message from the *Coordinator* or the *Participant* signals that the ECO has been rolled back to the planning phase. This may be needed if during the course of execution or release of the engineering change the need for additional performance tasks requiring the need to check the impact on the ECO plan is identified.

Notify_ECO_rolled_back_to_execution
This message from the *Coordinator* signals that the ECO has been rolled back to the execution phase. This may be needed if, during the course of execution or release of the engineering change, the need for additional performance tasks is identified.

Notify_ECO_canceled
This message from the *Coordinator* signals that the ECO is cancelled, i.e. the engineering change should not be pursued further.

Request_ECO_performance
This message from the *Coordinator* contains a request to specify details (affected parts, scheduled tasks with responsibilities, etc.) from the point of view of the *Participant*.

Respond_ECO_performance
This message from the *Participant* contains a response to the message *Request_ECO_performance* confirming receipt of the request by the *Participant*.

Notify_ECO_performance_completed
This message from the *Coordinator* or the *Participant* notifies the partner that the result of the execution by the *Participant* is considered to be completed.

Request_ECO_ acceptance
This message from the *Coordinator* contains a request to acknowledge and accept the release of an ECO and affected objects from the point of view of the *Participant*. ***Note:*** This message can be sent several times (if backjumps at the *Coordinator* are done internally).

Respond_ECO_acceptance
This message from the *Participant* contains a response to the message *Request_ECO_acceptance*, acknowledging receipt of the request and containing the acceptance from the point of view of the *Participant*. ***Note:*** This message can be sent several times (latest until the release is been accepted).

Notify_ECO_released
This message from the *Coordinator* notifies the *Participant* about the release of a change order and its affected objects.

3.3.3 Use of messages in each ECO Interaction Scenario

The table below provides information on which messages are used in each ECO Interaction Scenario. The following notation is used to indicate the recommended usage:

m	support of message in the IS is mandatory (Note: message occurrence can vary depending on concrete run of IS)
cs	message use needs to be agreed upon cooperation-specifically
na	message use is not applicable in the IS

Table 2: Classification for the recommended use of messages

Message Name	Meaning
Request_initial_ECO	Request of a preliminary ECO in order to early inform the participant about an ECO.
Respond_initial_ECO	Response to a preliminary ECO confirming the registration of the initial ECO at the participant.
Request_ECO_specification	Request a more precise ECO specification concerning ECO details and/or plan. May be exchanged several times (isComplete-Method, cf. VDA 4965-1).
Respond_ECO_specification	Response by the participant to Request_ECO_specification, confirming and/or extending or changing the ECO details and plan. May be exchanged several times (isComplete-Method, cf. VDA 4965-1).
Notify_ECO_update	Signals a change of the status of the performance or release of the ECO.
Notify_ECO_id_switched	Signals that the ECO id is switched to a different value. E. g., this message may be used in order to switch the ECO id to an id of the release sub-process.
Notify_ECO_rolled_back_to_planning	Signals that the ECO has been rolled back to the planning phase. This may be needed if during the course of performance or release of the engineering change the need for additional performance tasks requiring the need to check the impact on the ECO plan is identified.
Notify_ECO_rolled_back_to_execution	Signals that the ECO has been rolled back to the execution phase. This may be needed if during the course of performance or release of the engineering change the need for additional performance tasks is identified.
Notify_ECO_canceled	Signals that the ECO is canceled, i .e. the engineering change should not be followed further on.
Request_ECO_performance	Request by participant to the coordinator to check the ECO and the affected objects whether the performance is complete.
Respond_ECO_performance	Participant signals that he has registered the request to perform the ECO.
Notify_ECO_performance_complete	Participants signals that he has completed the ECO from his point of view.
Notify_ECO_performance_complete	Coordinator confirms that the participant has completed the ECO.
Request_ECO_acceptance	Request by coordinator to participant to accept the released ECO.
Respond_ECO_acceptance	Respond by the participant concerning his acceptance of the released ECO (positive or negative).
Notify_ECO_released	Notification about the release of a change order and affected objects.

Figure 27: Recommended use of messages in the ECR Interaction Scenarios

3.3.4 Message headers and control information

The following **additional** specifications and restrictions apply to the ECO message header for messages of the type request, notify and respond, extending the specification given in VDA 4965 section 7.1.

Data object	Description (type/format, sample value, meaning)
INTERACTIONID	Format: ORGANIZATIONID "/" ECO_ID.ID "/" SUBDIALOGNR; example: "717743322/AEA553421/1"
	Note: If the owner of the ECO_id is the sender, the ECO_ID.id_owner should identify the same organization as the ORGANIZATIONID (the same applies to the receiver).
INTERACTIONSCENARIONAME	Values: "ECO-IS1", "ECO-IS2", "ECO-IS3"
MESSAGENAME	Values: Name of the message, cf. section 3.3

4 ECO Data Model

This section provides a brief introduction to the ECO data model, an introduction to the fundamental data types and the relationships between them.

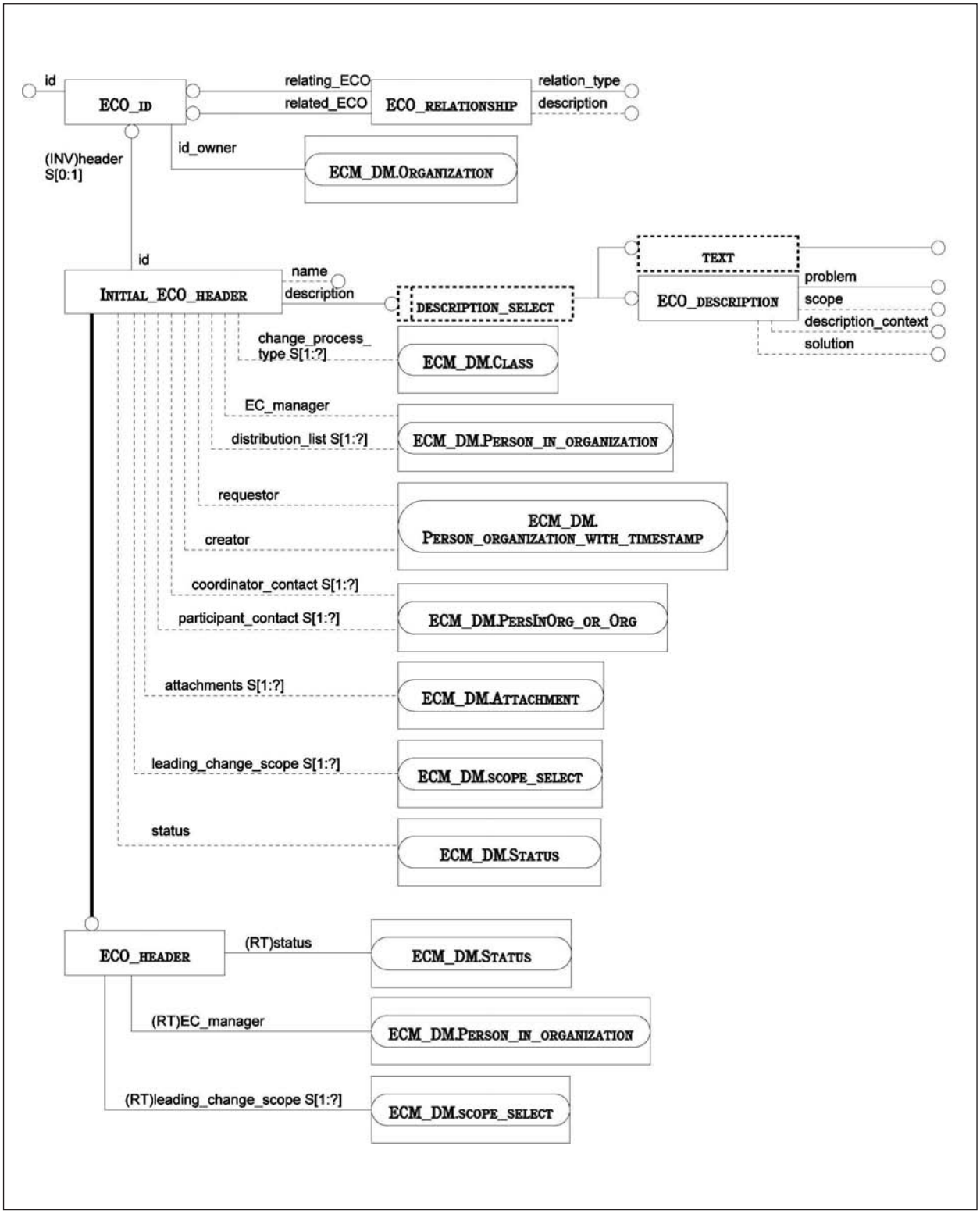


Figure 28: ECO identification and header data types

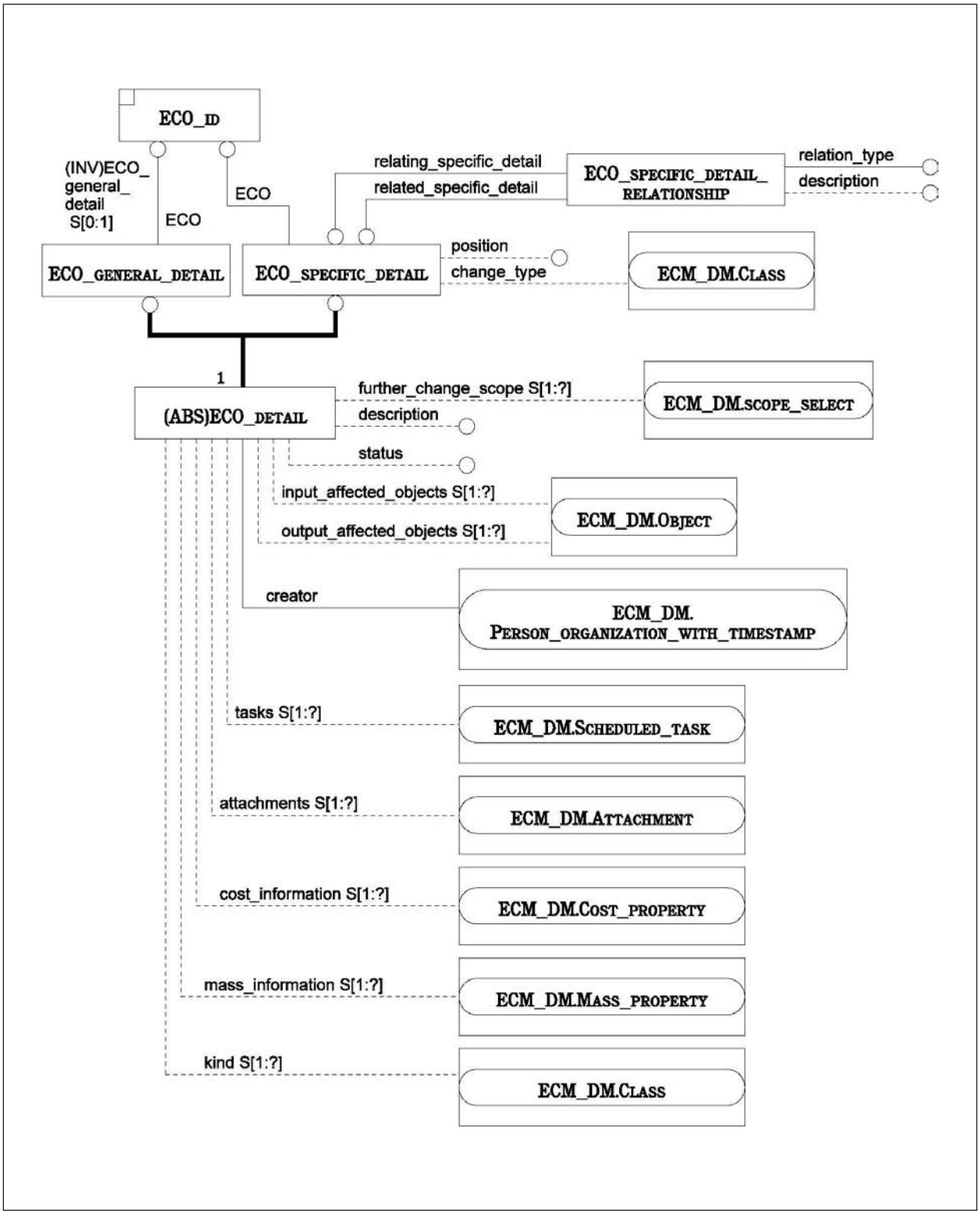


Figure 29: ECO detail data types

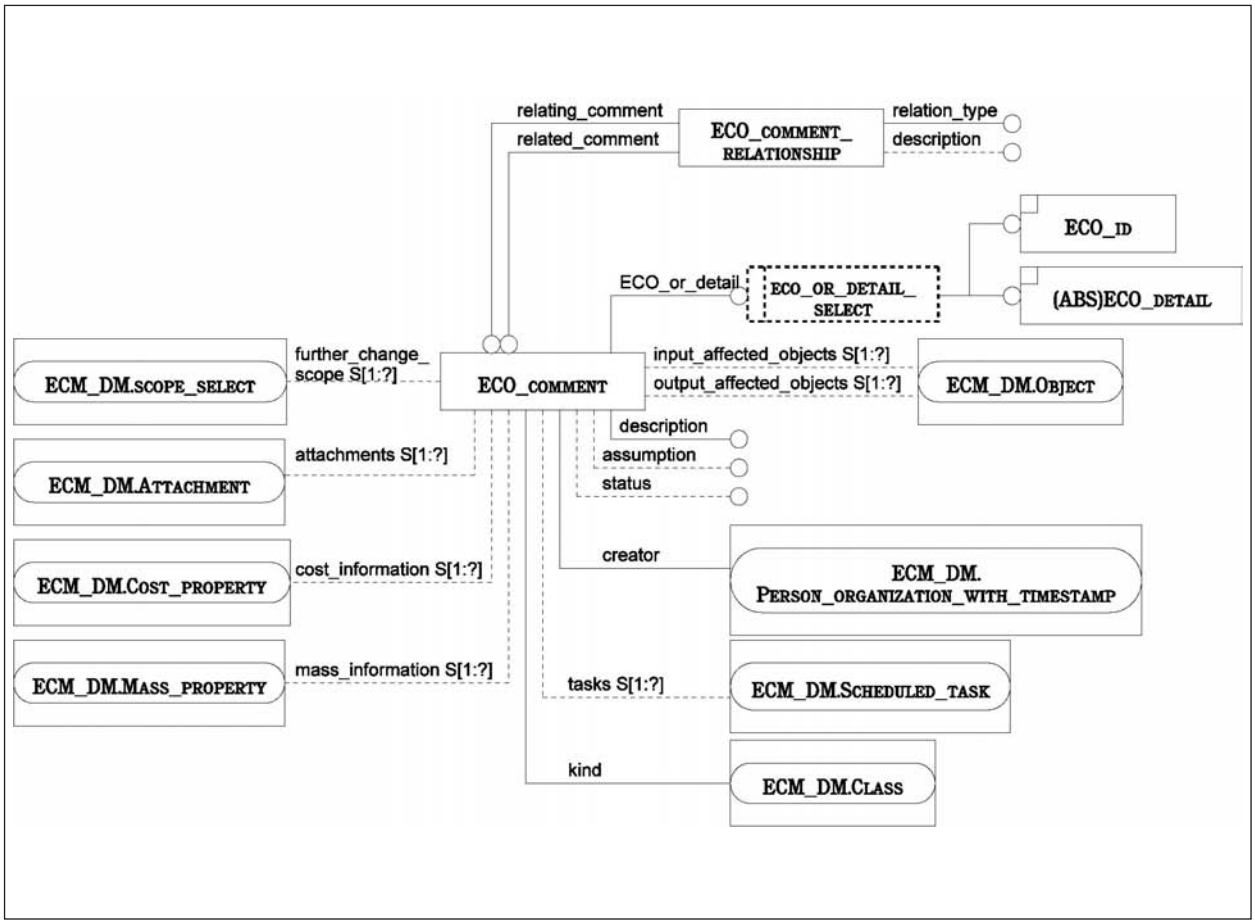


Figure 30: ECO comment data type

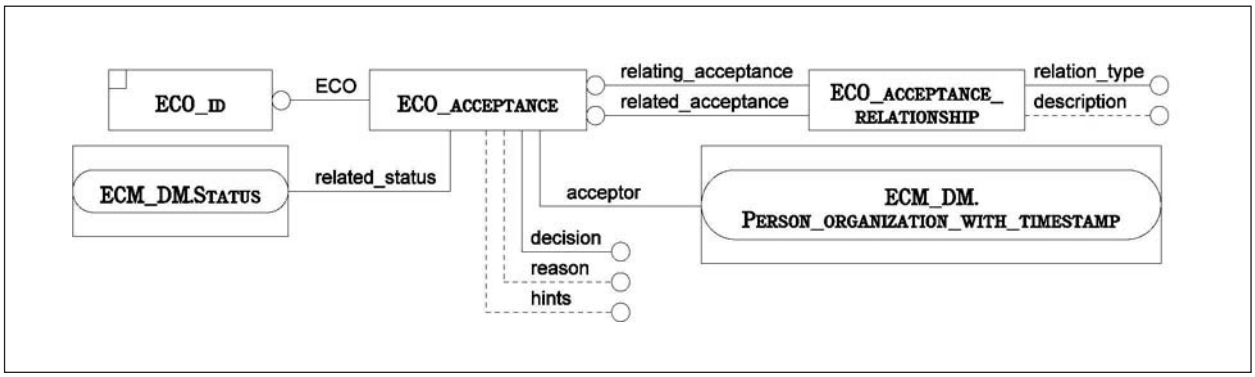


Figure 31: ECO acceptance data type

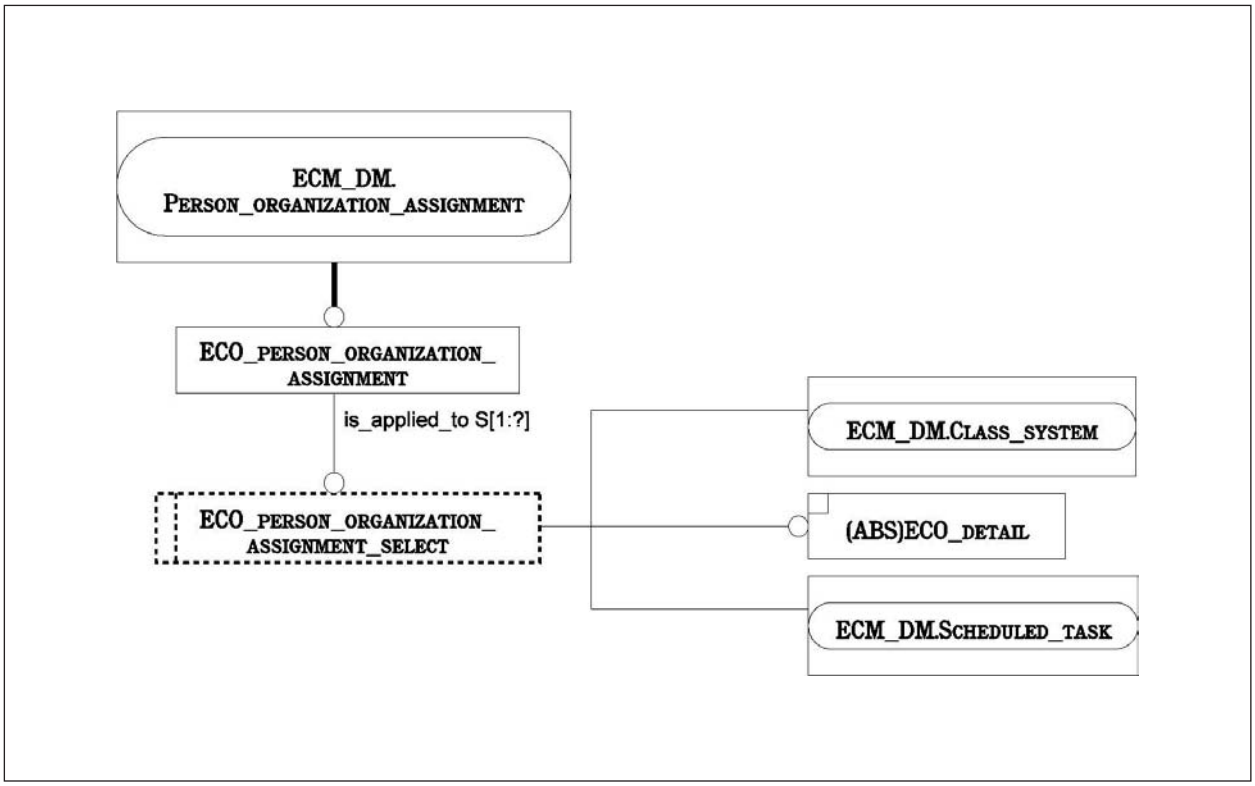


Figure 32: ECO person/organization assignment data type

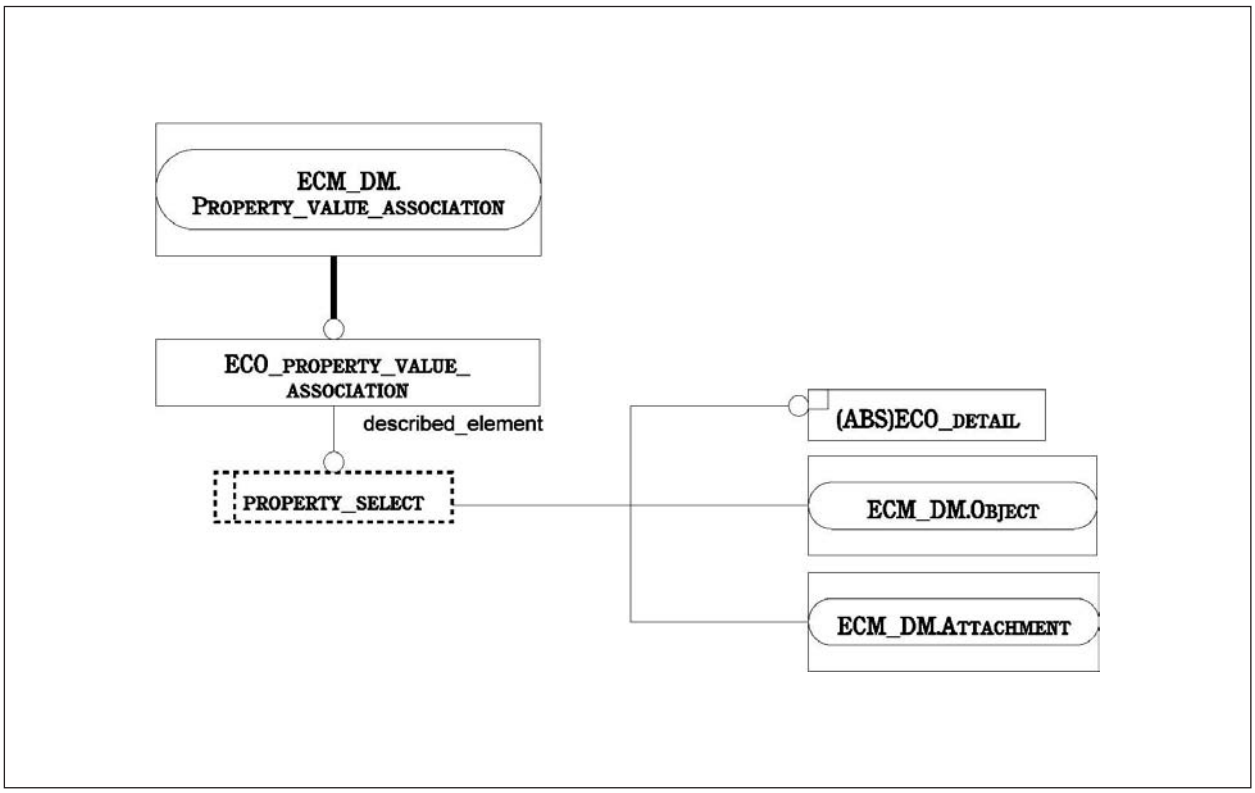


Figure 33: ECO property value association data type

Appendix A: ECO Data Model (Requirements Model) and Data Dictionary

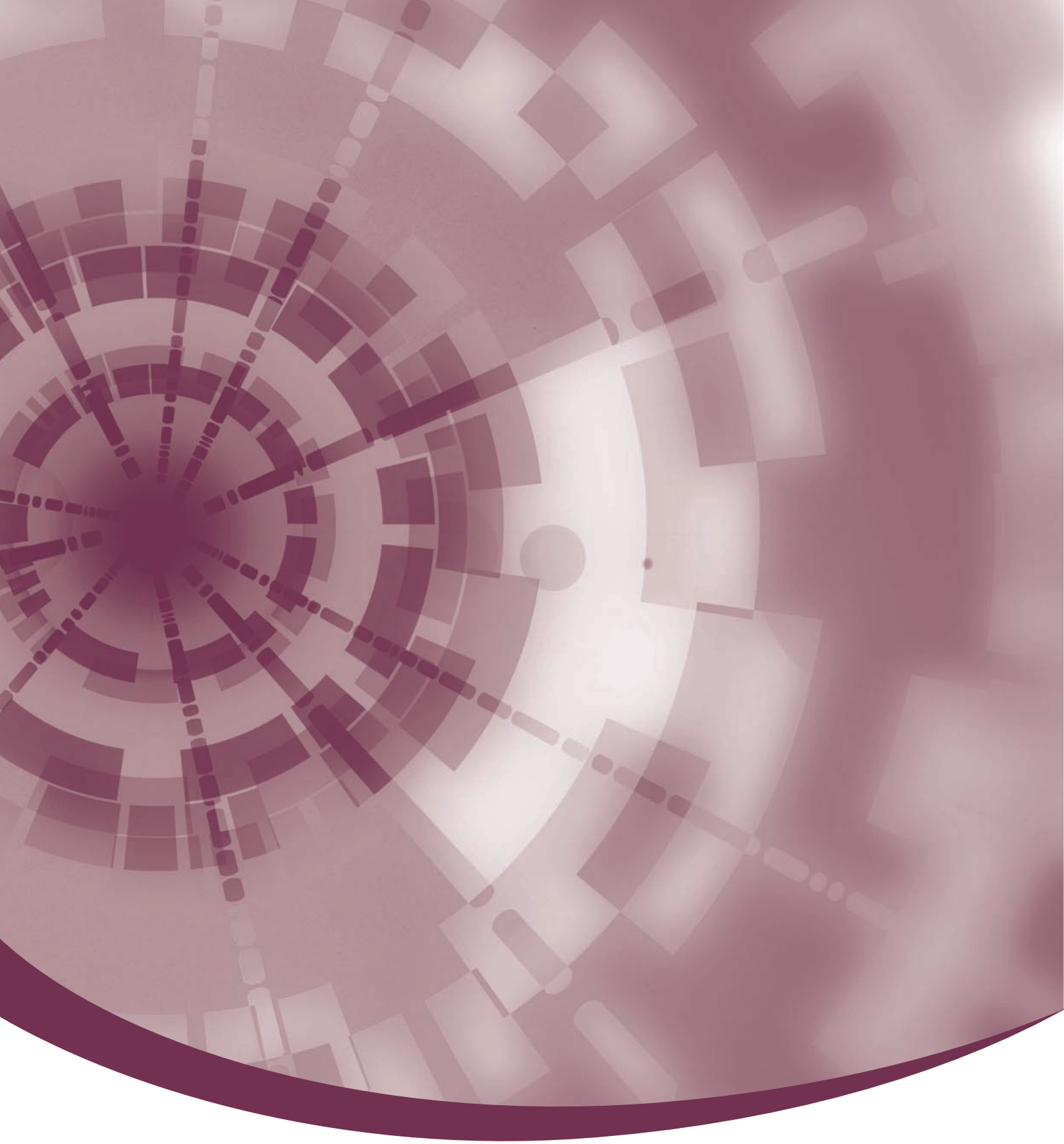
To be released in Version 1.0 of this document.

Appendix B: Mapping ECO-DM – AP214-ARM

To be released in Version 1.0 of this document.

Appendix C: ECO Interaction Scenario Protocol Specifications

To be released in Version 1.0 of this document.



ProSTEP iViP Association
Dolivostraße 11
64293 Darmstadt
Germany

Tel. +49-6151-9287336
Fax +49-6151-9287326

psev@prostep.com
www.prostep.org

ISBN 978-3-9811864-4-4

Version 0.9, December 2007