European Ground Systems – Common Core (EGS-CC)

## *Conceptual data model utilisation*

- The work presented here is part of the EGS-CC SET CDM working group with the following participation:
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Utilization of a conceptual data model in the frame of the development and application of EGS-CC

Methodology

Tool Set

Utilization

# Background and objectives of the EGS-CC Initiative

- The objective of the EGS-CC Initiative is to developing a common European Monitoring & Control infrastructure that can:

  - be applied for all class of missions, including Launchers

  - used across all project phases

- EGS-CC is a collaboration of European large system integrators and space agencies to develop a common core:

  - Airbus Defence & Space (former Astrium Satellites and Astrium ST)

  - Thales Alenia (France & Italy)

  - OHB System

  - CNES (French National Agency)

  - DLR (German National Agency)

  - ESA (ESOC & ESTEC)

  - UKSA (UK National Agency)

CDM is required in order to specify the data which is exchange along the EGS-CC application process
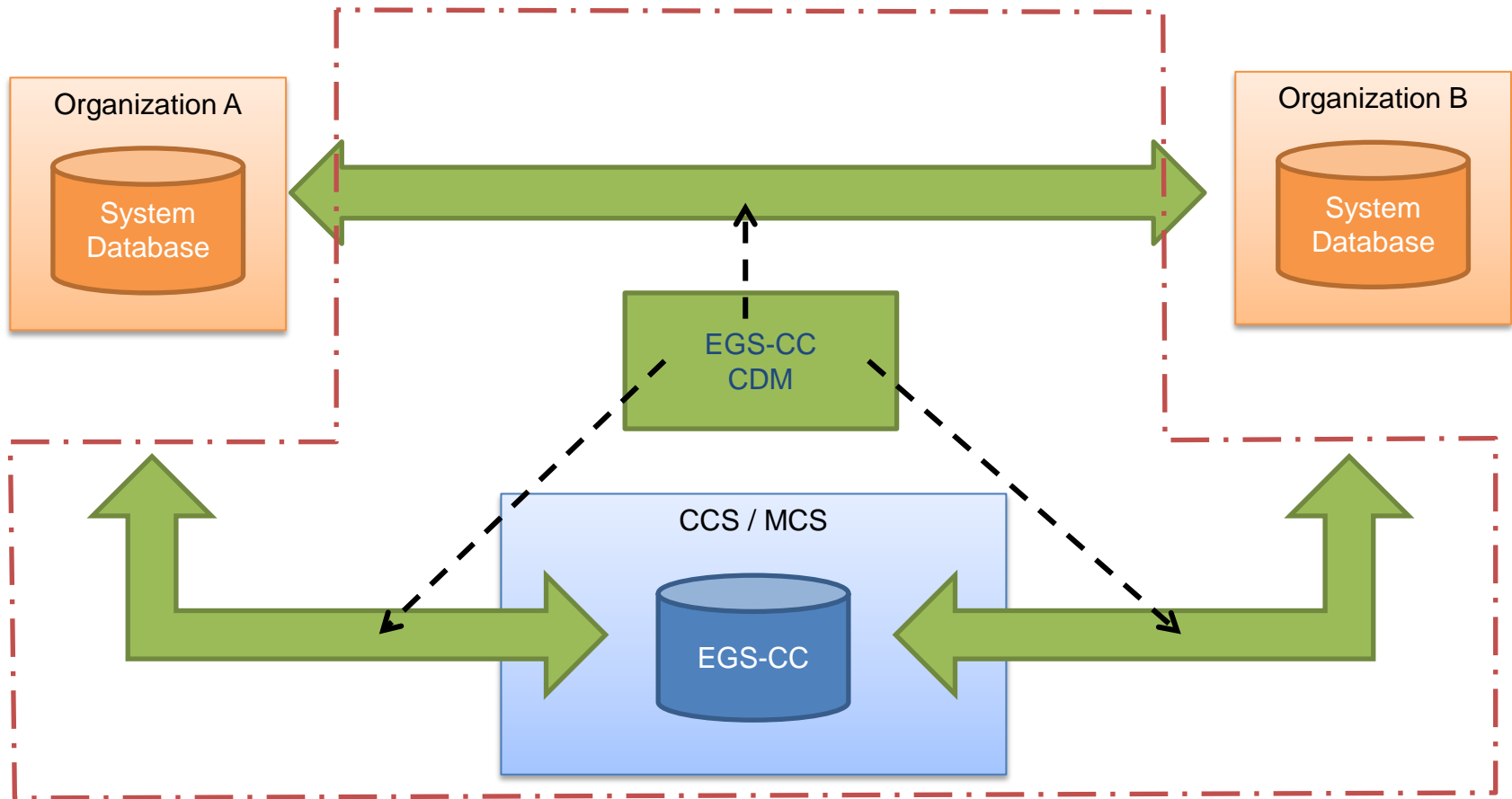
EGS-CC Development Scope

Overview Data Modeling approach for EGS-CC
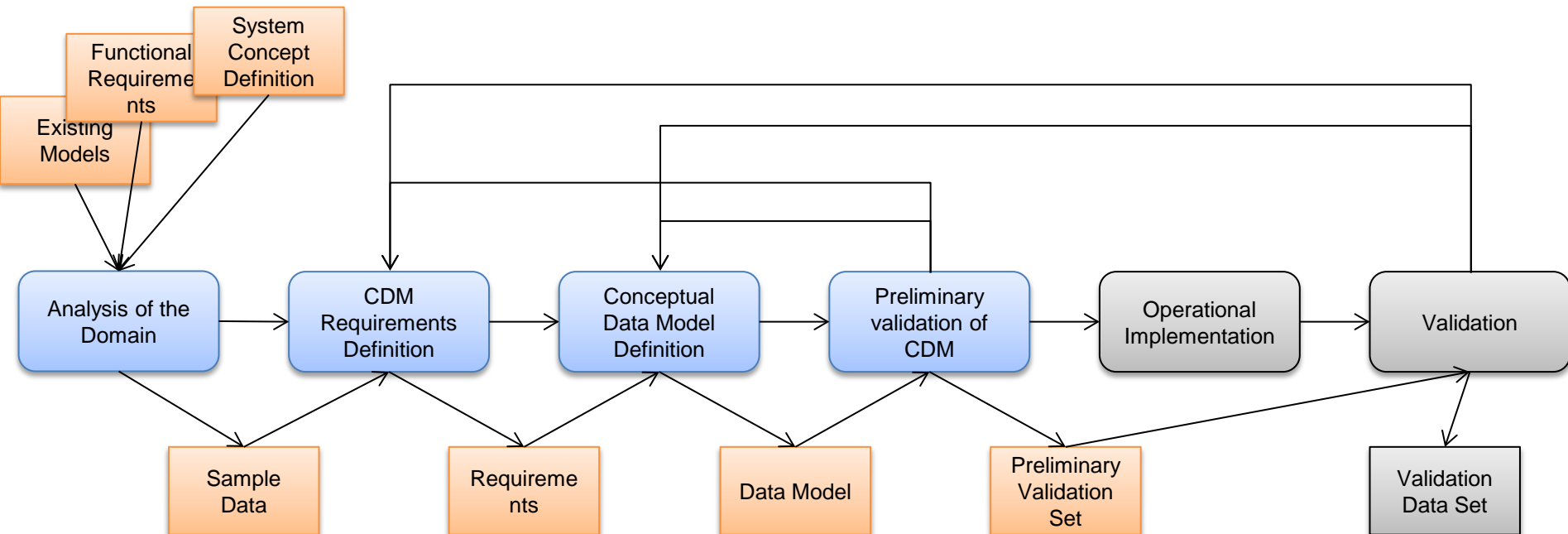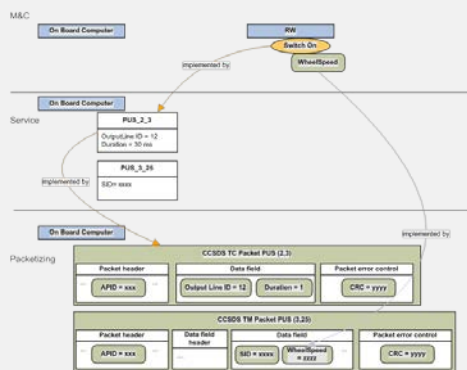
"Analysis of the domain" to elaborate on key concepts to be captured in the conceptual data model

M&C abstraction
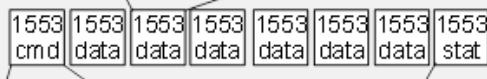
Sample Packet153 Packet
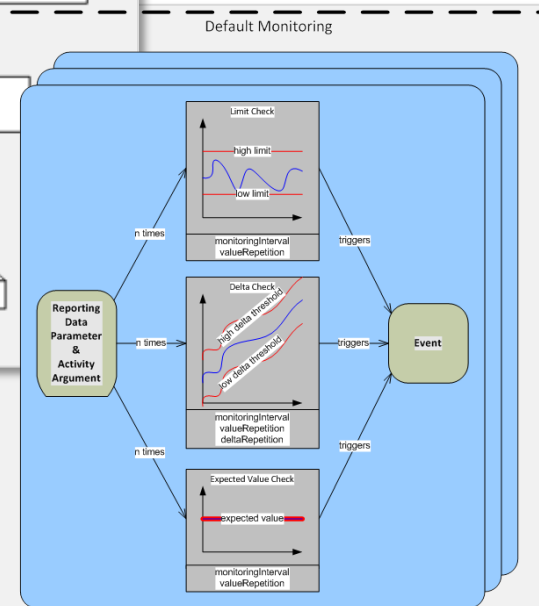
Check Concept
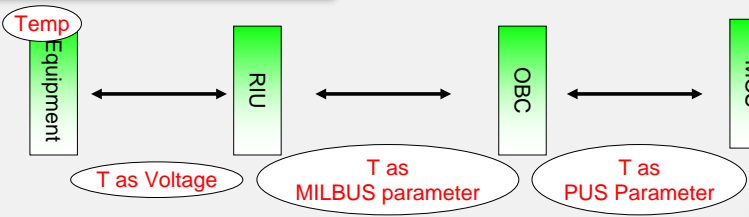
Parameter along the monitoring chain

Packetization

PUS

Table 1 (left):

ID	Name	Description	Remark
	Monitoring & Control Data		This section defines the common data which is used for M/C packages.
		General	
comment		The following requirements define the concepts and constraints that describe the nature of the M&C data to be handled. Still those requirements are considered as preliminary representing the level of detail as needed in phase A and will be updated in the upcoming project phases o	
comment		Even if independent from the other "Product Structure" Data m M&C data model also uses the different levels of data, that are configuration, occurrence and realization, to reflect the differen of data. These 3 concepts are mainly applicable to each concept of the model, unless no evidence of need.	
20-10	Generic fields	Generic requirement: unless specified negatively, each entity s generic fields such as : name and aliases short and long descriptions	
20-20	Uniqueness of names	If not otherwise noted, the used names shall be unique within t the global M&C data set namespace (of a project)	
20-25	Uniqueness of alias and alias context domain	If not otherwise noted, the used alias shall be unique within the of the alias context domain. Which may consider values like (e tailorable list): • System • Satellite • Simulation • Operations • Product names • …	
20-40	Automatic derivation of data for a particular configuration	Based on the M&C data, it shall be possible to automatically d particular M&C data set for a particular configuration, based or assembly tree respectively the built-status.	
20-43	Naming conventions	The CDM shall be capable to incorporate a given naming conv additional constraint on the monitoring and control data items.	
20-45	Standard items	For each monitoring and control data item, it shall be possible standard items which are not specific for a particular element s used and shared by all elements of a space system.	
20-47	Validation data	For each monitoring control item, at least the following validatic be considered (extensible list): • Data provider (person, organisation, source database) • Responsible for validation • Configuration status (like candidate, approved, verified qualified, impact by change, temporary) • Validation status • List of references to passed validation tests • …	
20-48	Confidentiality and commonality	For each monitoring and control item, it shall be possible to inc confidentiality and commonality level. The values are mission s	

Table 2 (right):

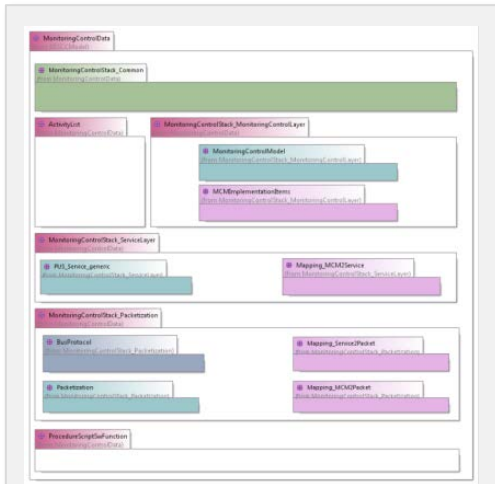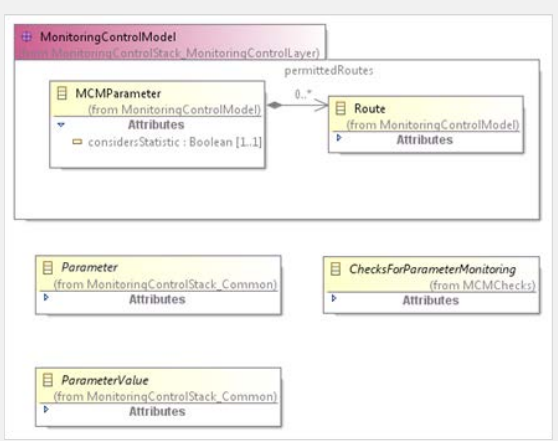| ID	Name	Description	Remark
		Monitoring & Control knowledge	
20-700	Monitoring and control knowledge	It shall be possible to model monitoring and control knowledge of a space project in differentiating activities, events and MCM parameter.	ECSS-E-ST-70-31C
20-705	Monitoring and control knowledge assignment	A data item defining monitoring control knowledge shall be assigned to a system element.	
20-730	Monitoring and control knowledge refinement	A monitoring and control data item shall be the abstraction of either: - A definition of a monitoring and control data item - A configuration/occurrence in the overall system - A representation of a monitoring and control data item of a system realization	
20-740	Extension of knowledge item by properties	Engineering properties and categories shall allow extending monitoring and control knowledge items by specific engineering characteristics. E.g. for defining a specific process ID used by an activity.	
20-745	Knowledge and predicted value	It shall be possible to indicate if a monitoring control knowledge item has a predicted value or not.	
20-747	Expression Language and predicted value	It shall be possible to reference predicted values in a grammar expression.	Predicted values may be considered for consistency checks which can be defined as part of a check based on a expression. Expression language so far is not fixed. This may be part of phase C/D of EGS-CC
		Monitoring & Control structure and knowledge	
20-715	Monitoring and control element	A monitoring and control element shall reflect a particular element of the space system from operational point of view. A monitoring and control element is a kind of S/E.	All elements that can be addressed by the product structure can be also accessed by the monitoring and control structure! M&C element is also a kind of S/E as defined in ECSS-E-ST-70-31C ([SD 2] contradictive explication of system element).
20-710	Flexible structure for addressing monitoring and control knowledge	It shall be possible to address monitoring and control knowledge in following a monitoring control structure based on nested monitoring and control elements.	As outlined in **Error! Reference source not found.**
20-717	Dynamics references to monitoring and control elements	It shall be possible to define that a M&C element can contain references to other M&C elements, MCM parameter items, events and activities (specifying multiplicity) but not specific to a definition (e.g. a reference to any activity occurrence). The minimum and maximum number of possible references of a specific kind shall be given.	There are situations to have an occurrence of an MCM object being shown at the same time in two different places within the MCM. For instance, in the Monitor&Control Element of the on-board queue model, if an activity is scheduled, the activity occurrence will be shown inside the M&C Element responsible for the execution of the activity, but also in the M&C Element modelling the on-board queue.
20-718	Multiple monitoring and control elements	It shall be possible to define sub monitoring control elements whose multiplicity at runtime is not always one, but can be M..N. This kind of M&C elements shares the same definition, but can have multiple occurrences. The number of occurrences might not be predictable at definition time, but both an upper bound and a lower bound can be specified in the definition.	The dynamic creation and deletion of M&C elements is needed because there are monitored & controlled objects that are dynamically created and removed at runtime. For instance, the SLE interface provides a way to monitor and control its SLE service instances as M&C Elements. Each service instance is created at some point, it has its own lifecycle, and it is finally removed, similarly to activity lifecycle.
20-719	Summary state	For a monitoring and control element, it shall be possible to identify a summary state which is calculated based on an expression. The result of the summary state shall be able to be monitored by according monitoring checks (applicable are the ones that are used for monitoring parameter).	The summary state is not restricted to a specific state machine as this depends on the M&C element characteristics.

For the "Conceptual Data Model Definition" the modeling language of EMF, Ecore is being used
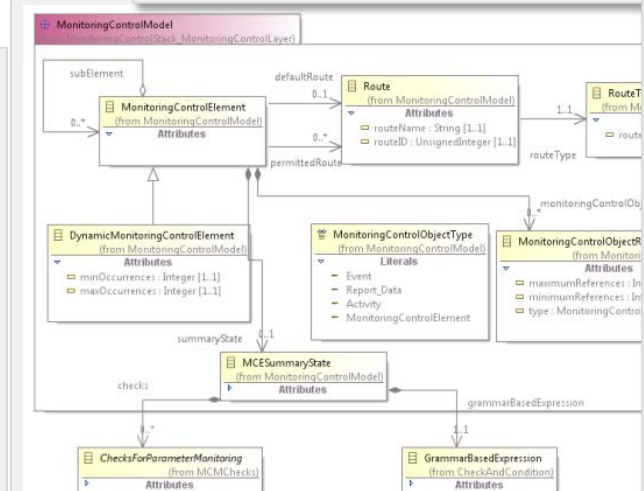

Monitoring and Control Overview
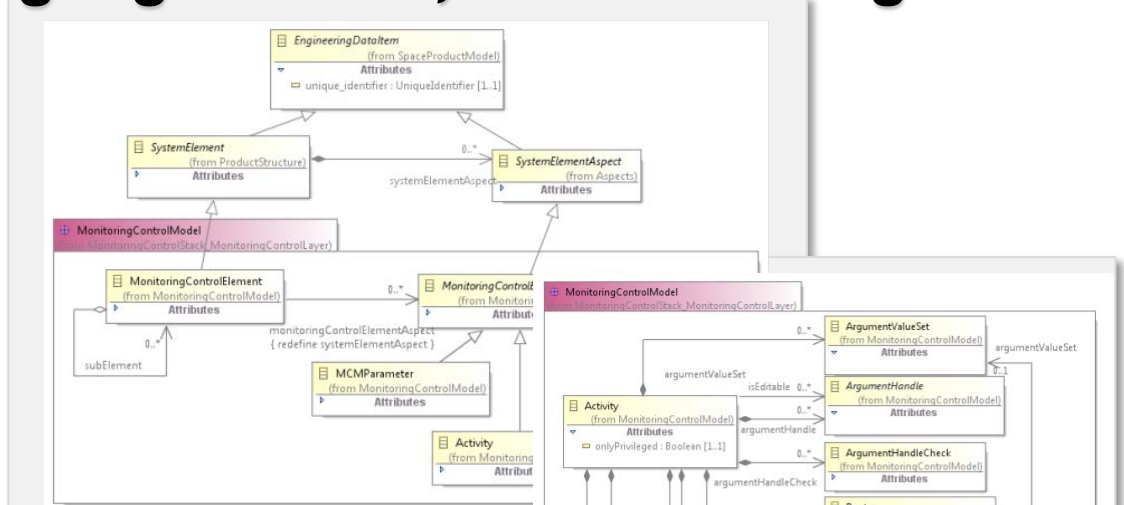
Monitoring and Control Aspect
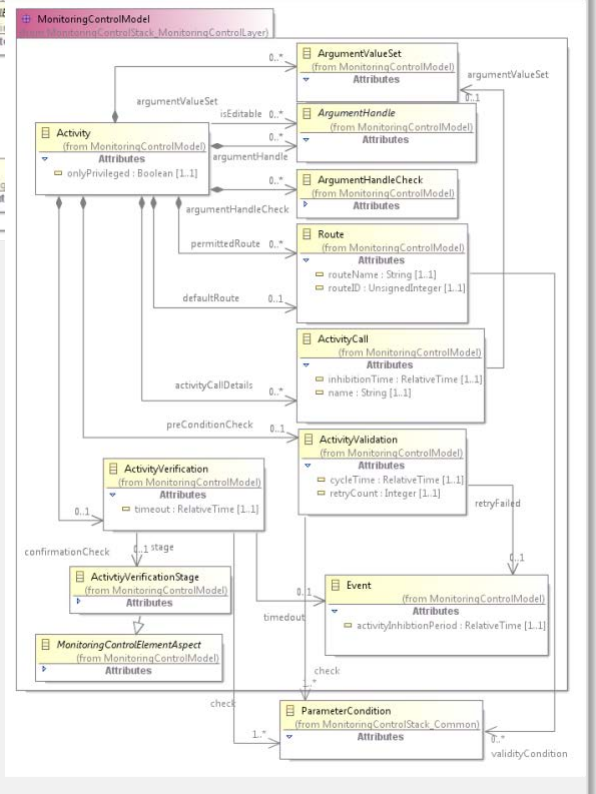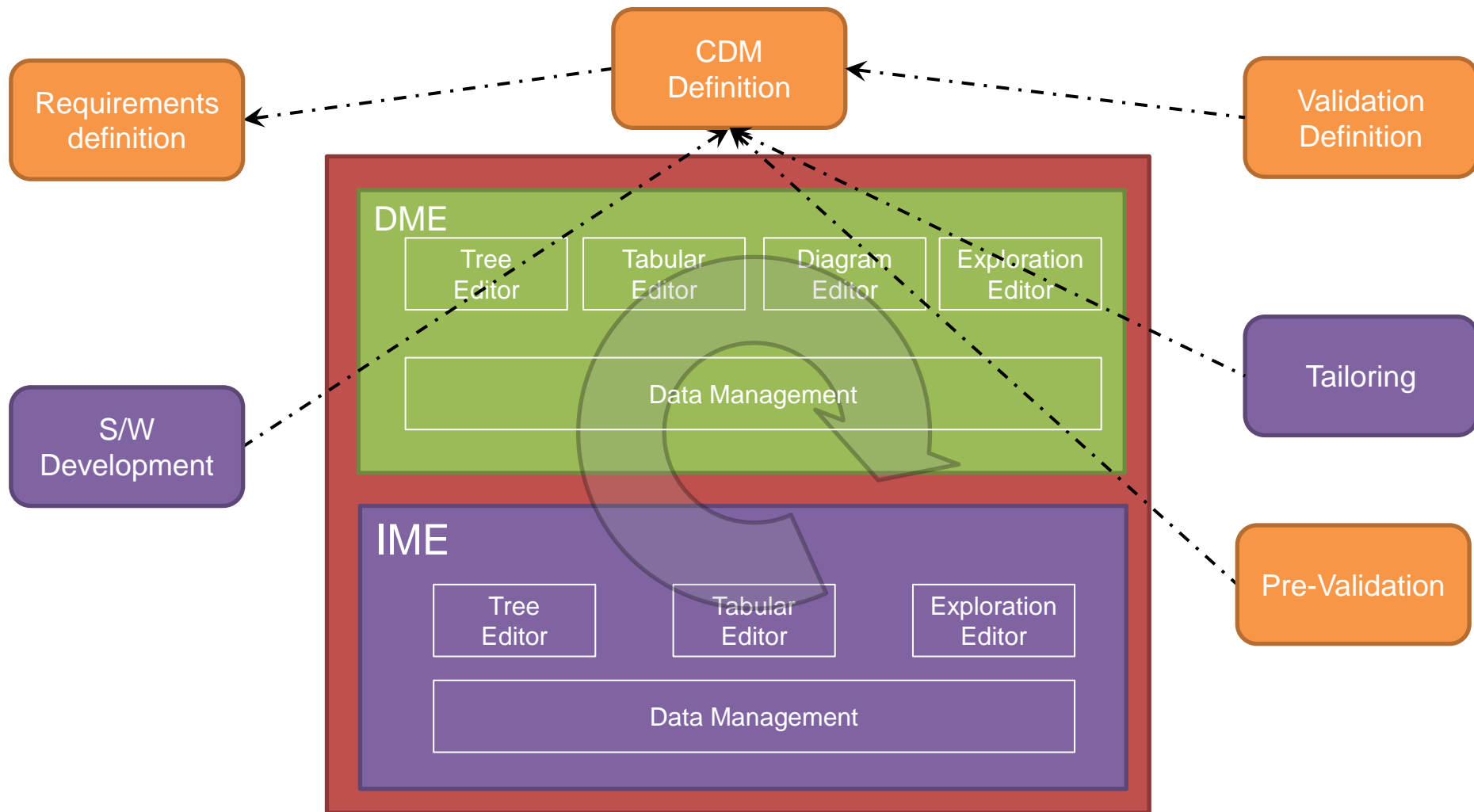
M&C Parameters

Monitoring and Control Element

Detailing of Activities

...ed TM Packet

ISIS Aggregate Parameters

MIB Parameter Checks

ISIS Aggregate Parameter...

MIB Parameter Definition

Variable TM Packet

The tooling applied for the CDM definition support all CDM related activities for engineering and utilization

The toolset of DME / IME offers a great set of functions, directly tailored for conceptual data modeling
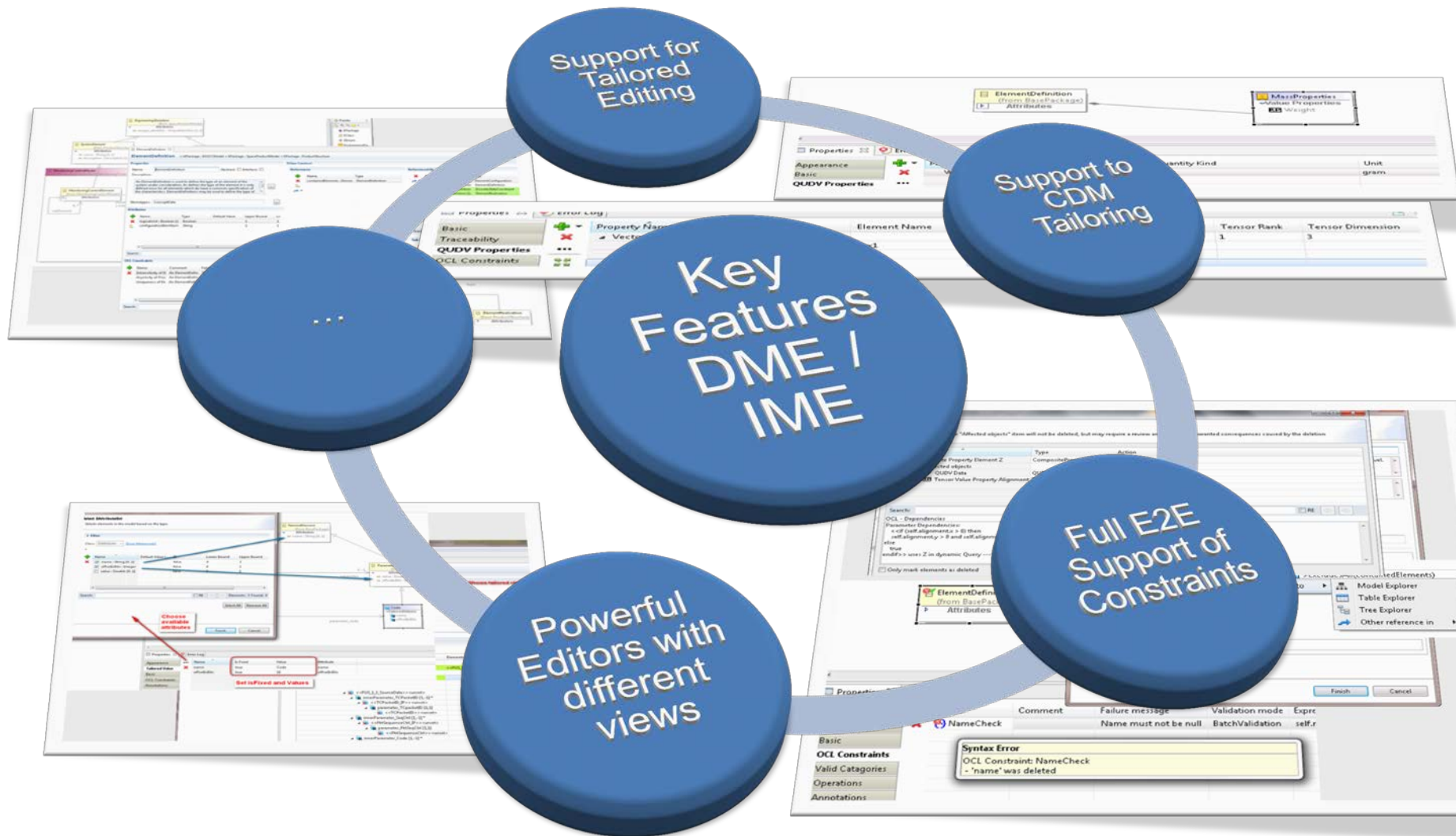
CDM tailoring as the balanced approach between very generic, week CDM and hard wired- inflexible CDM

- EGS-CC adopts the concept of "Category" as introduced in VSD

- Category, is a data structure which can be defined at runtime – attached to instances of "real" classes

- Categories can be used to tailor (for the actual set of properties managed) the data managed

- DME allows to manage the definition of CDM and categories in the same way

- Quantities of categories are relying on QUDV

- In order to allow a full support of the modeling of categories, the Ecore language was enhanced accordingly
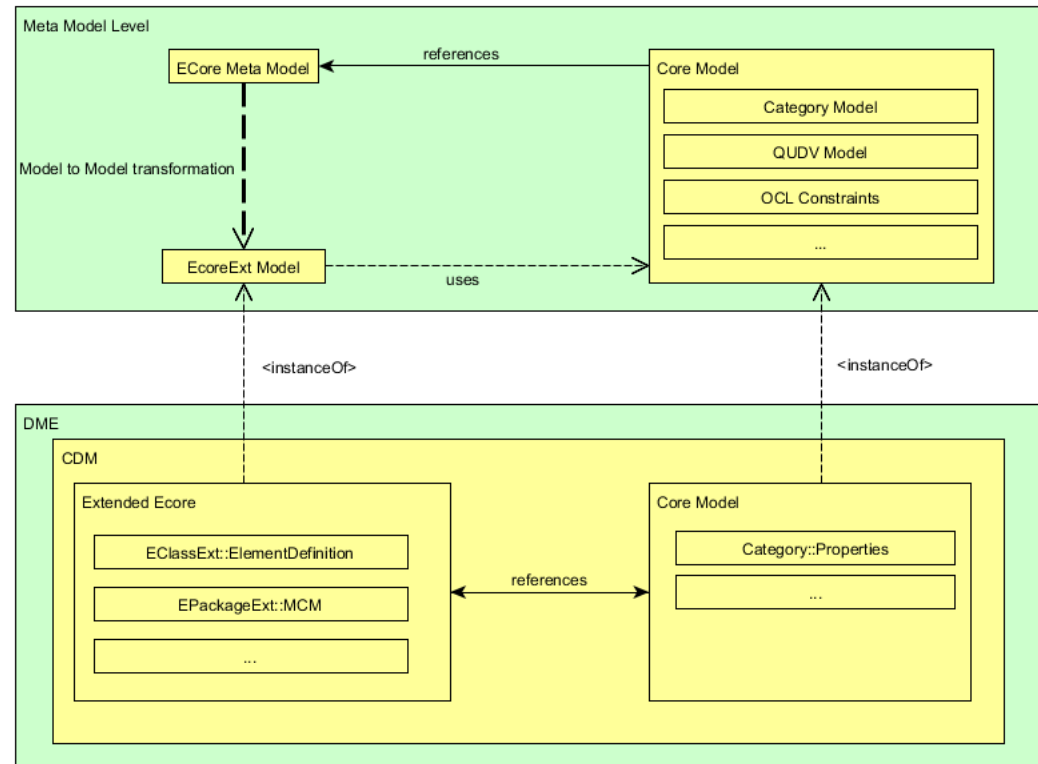
Required modular configuration control on the CDM enabling a tailored support of the different use cases
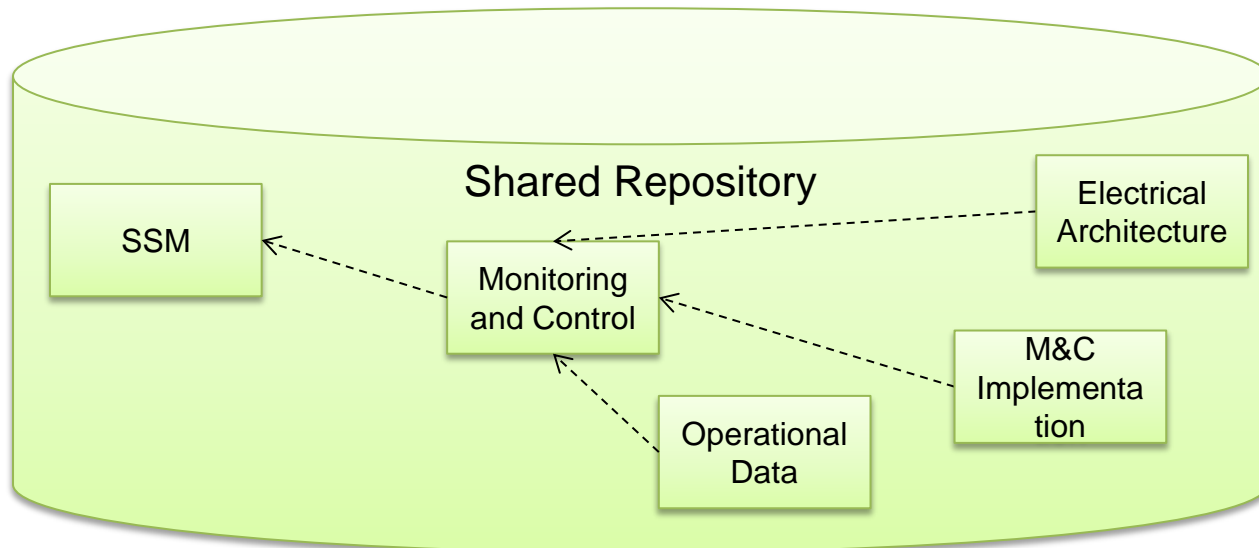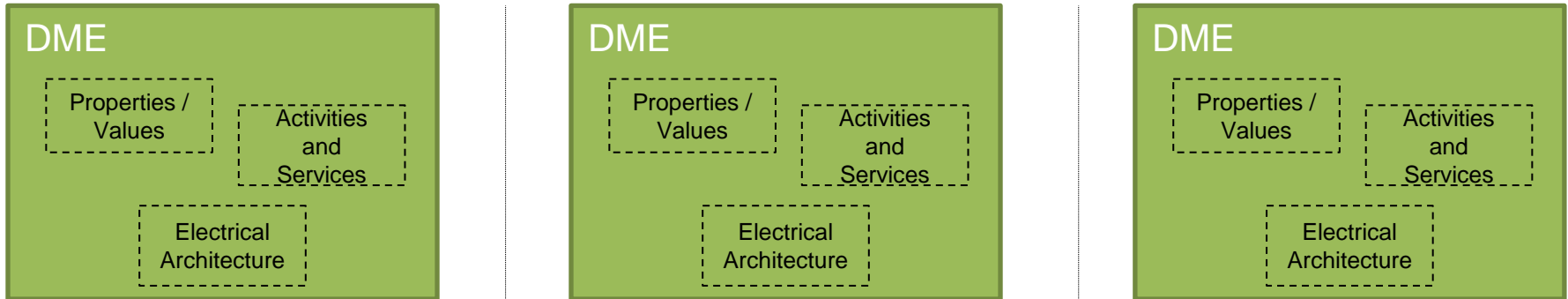
The utilization of the CDM will allow to automatically derive various artefacts in the overall system
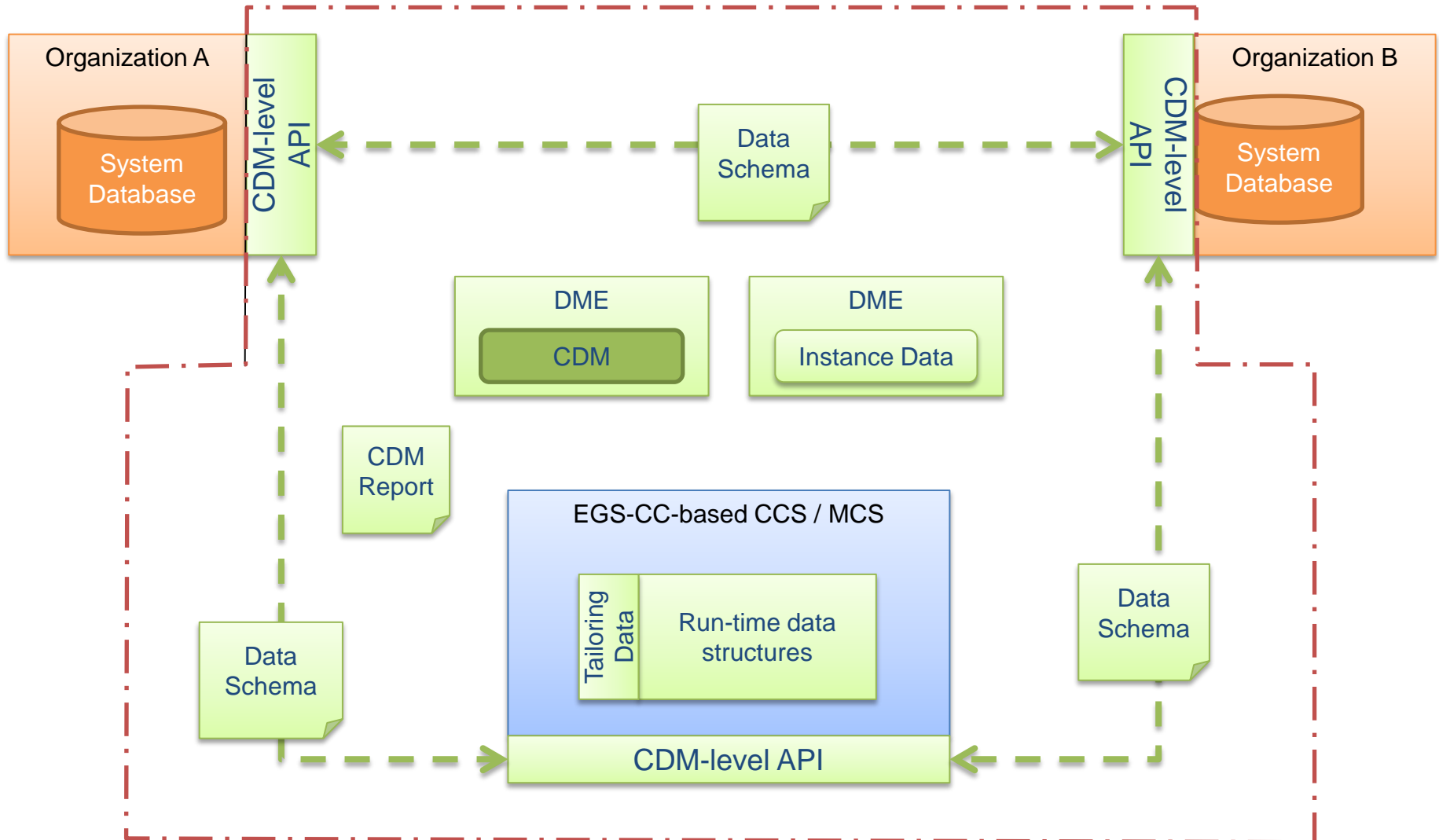
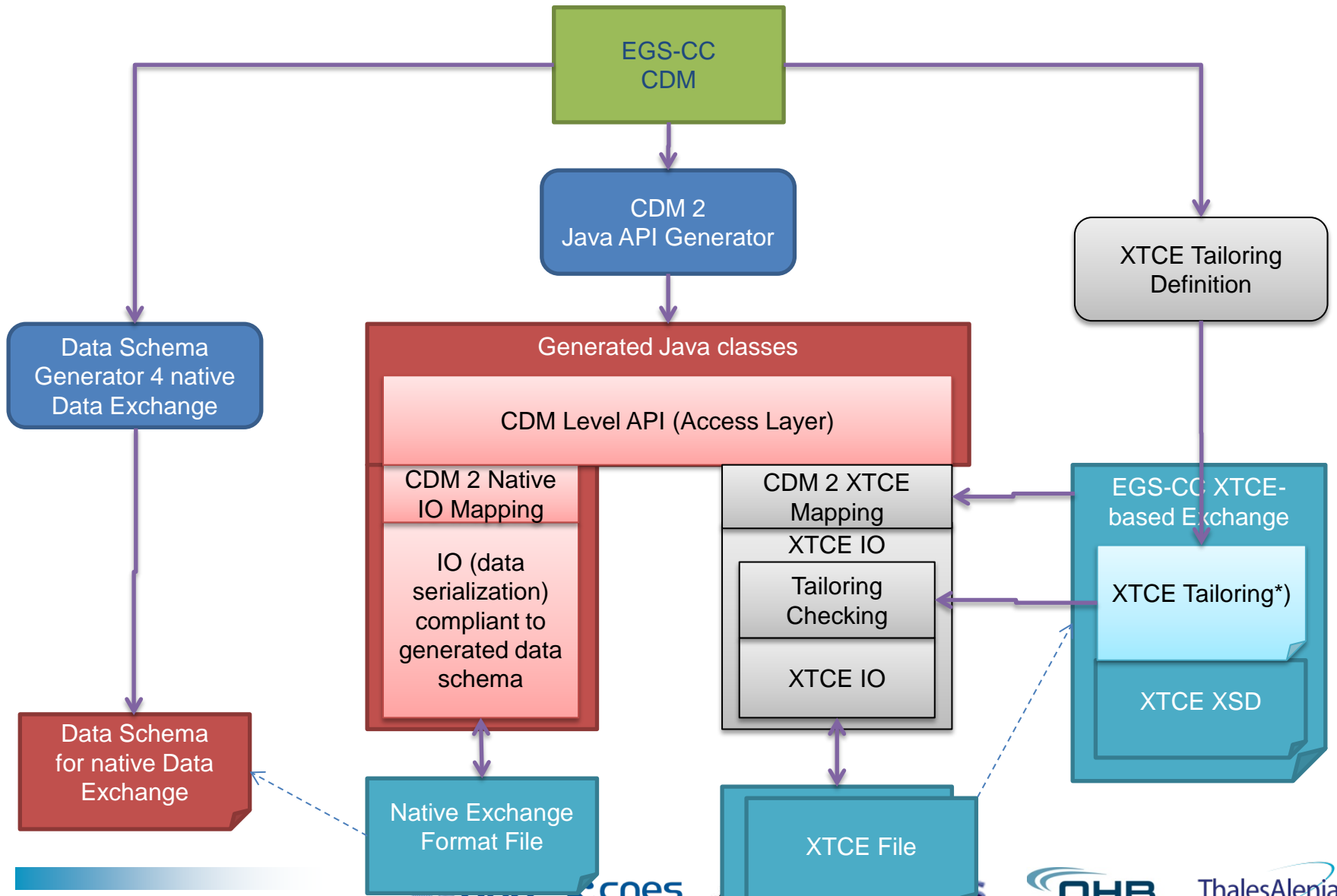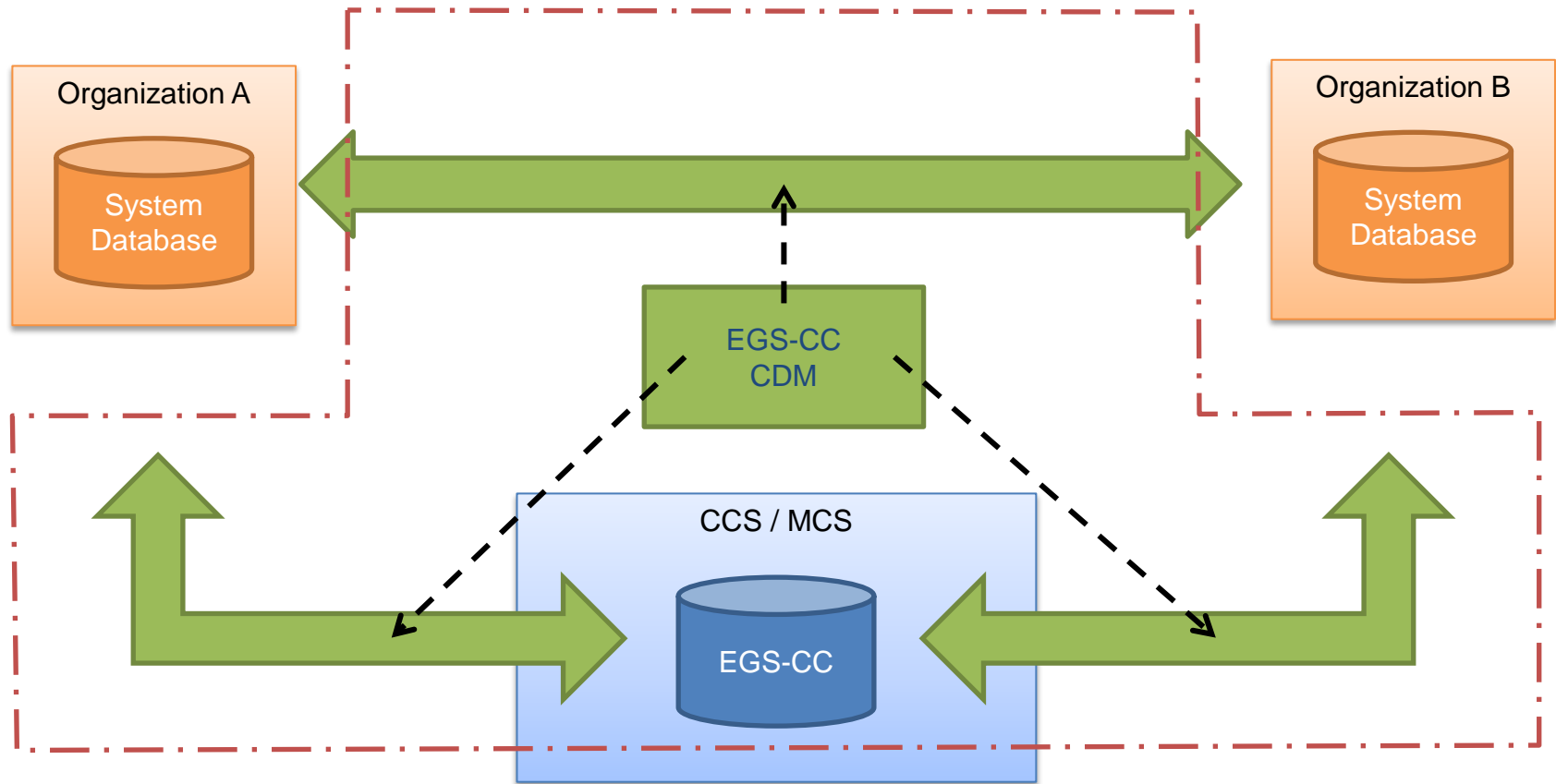# Management of artefacts directly derived from the CDM
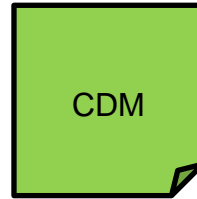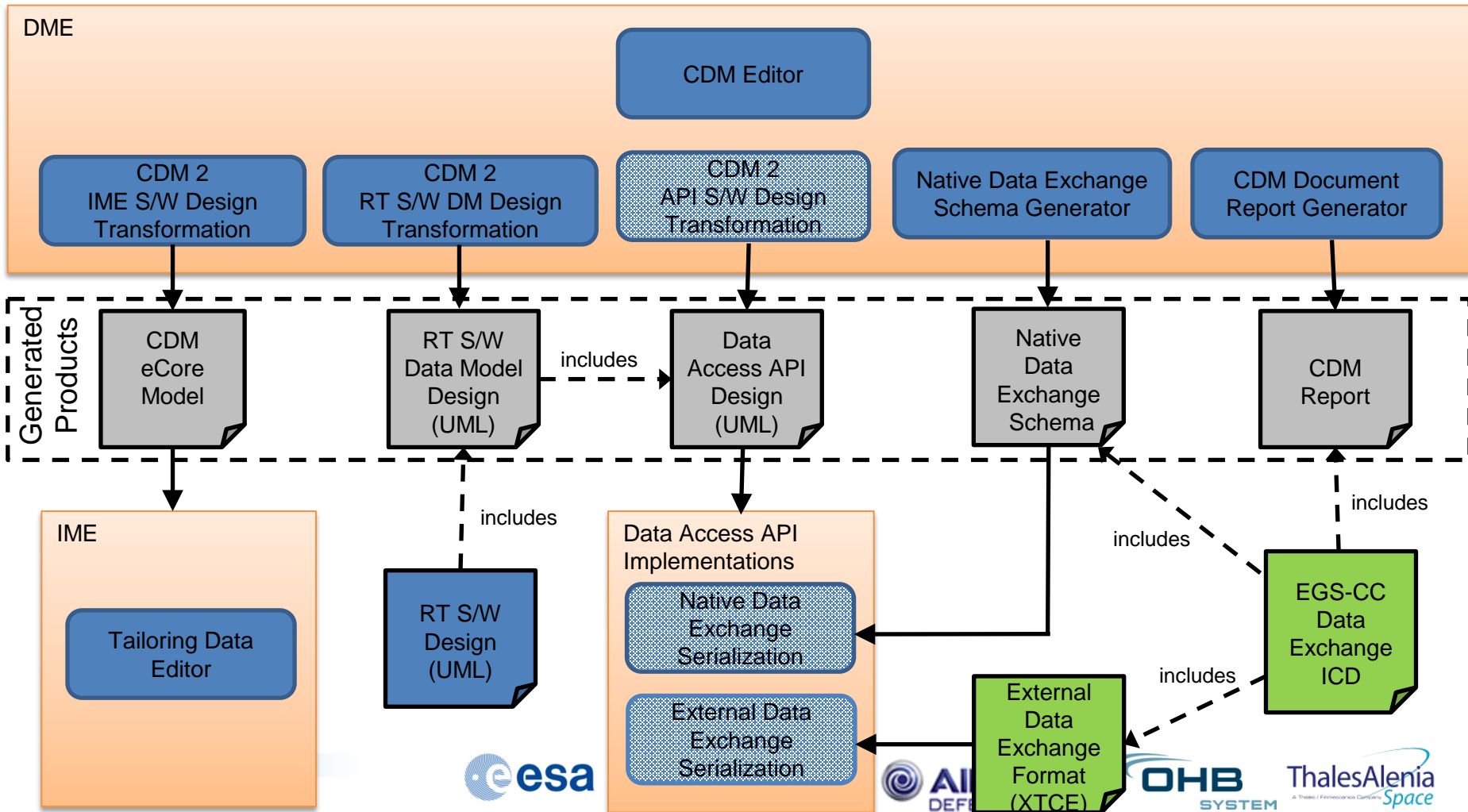
For the derivation of the artefacts from the CDM the following process pattern is applied
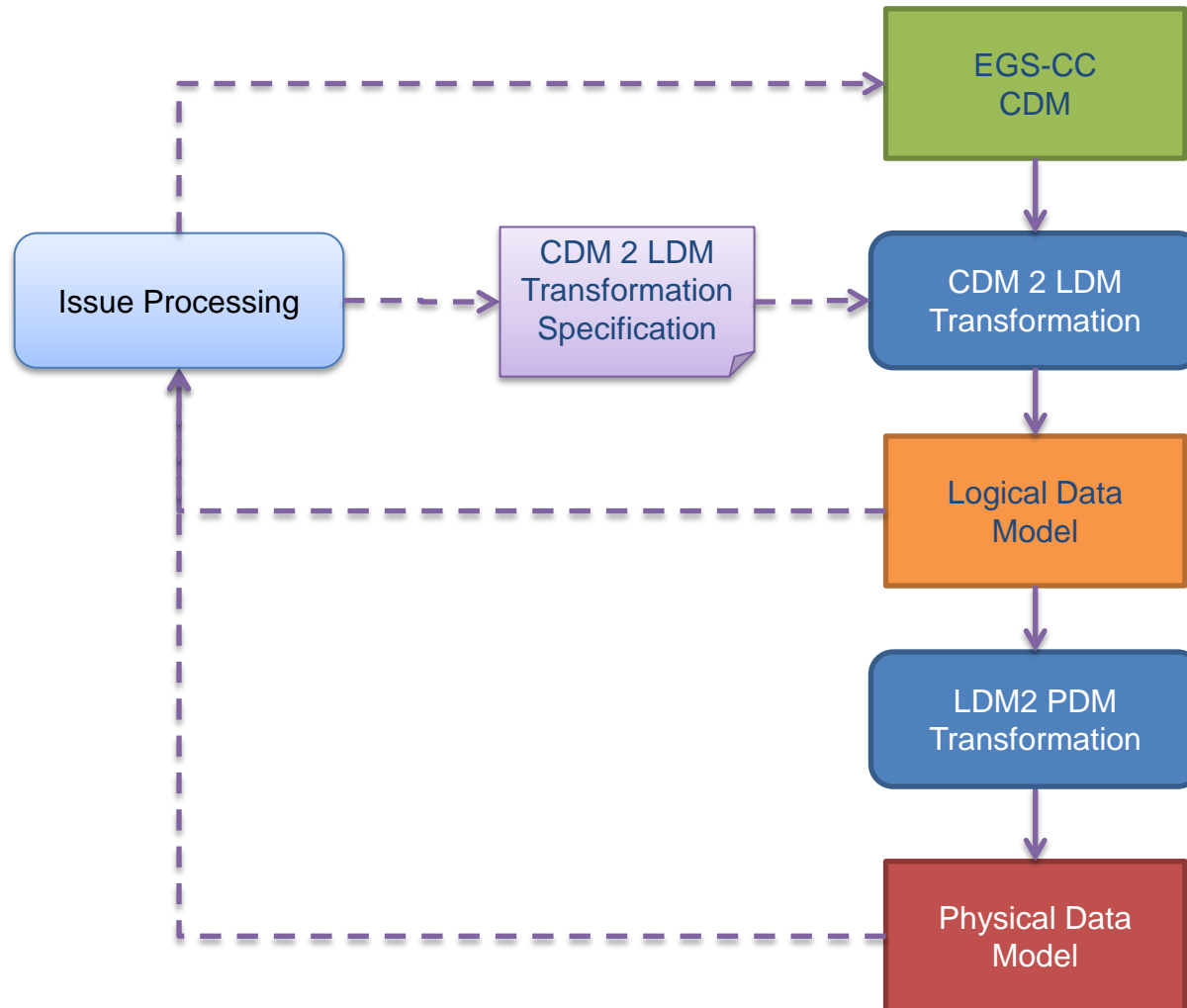
Leveraging the CDM for the development of the EGS-CC data exchange solution

The conceptual data model is a key element to enable efficient data exchange in EGS-CC

EGS-CC is leveraging a formally represented CDM – the approach might be adopted for other domains

- Data model engineering has been identified as a key element to obtain consistent infrastructures – and ties directly into model-driven S/W engineering

- EGS-CC defined a pragmatic approach relying on mainstream technologies for data modeling

- A dedicated tool set has been developed, using results of ESA TRP as underlying basis

- The applied tool set is "ESA open source" and in that can be used to adopt the "best practices "

- Eventually the approach taken can be considered on ECSS level to baseline "best practices"