MB4SE AG Meeting

DIGIPROC

Digital Engineering and Procurement across the Lifecycle

October 8th, 2024

AGENDA

1. Scope and Context
2. Characterisation of Procurement Processes
3. Definition of Use Cases
4. Procurement UoD
5. Conclusion

1. Scope and Context

Context

Motivation

Procurement Processes are not digitalised.

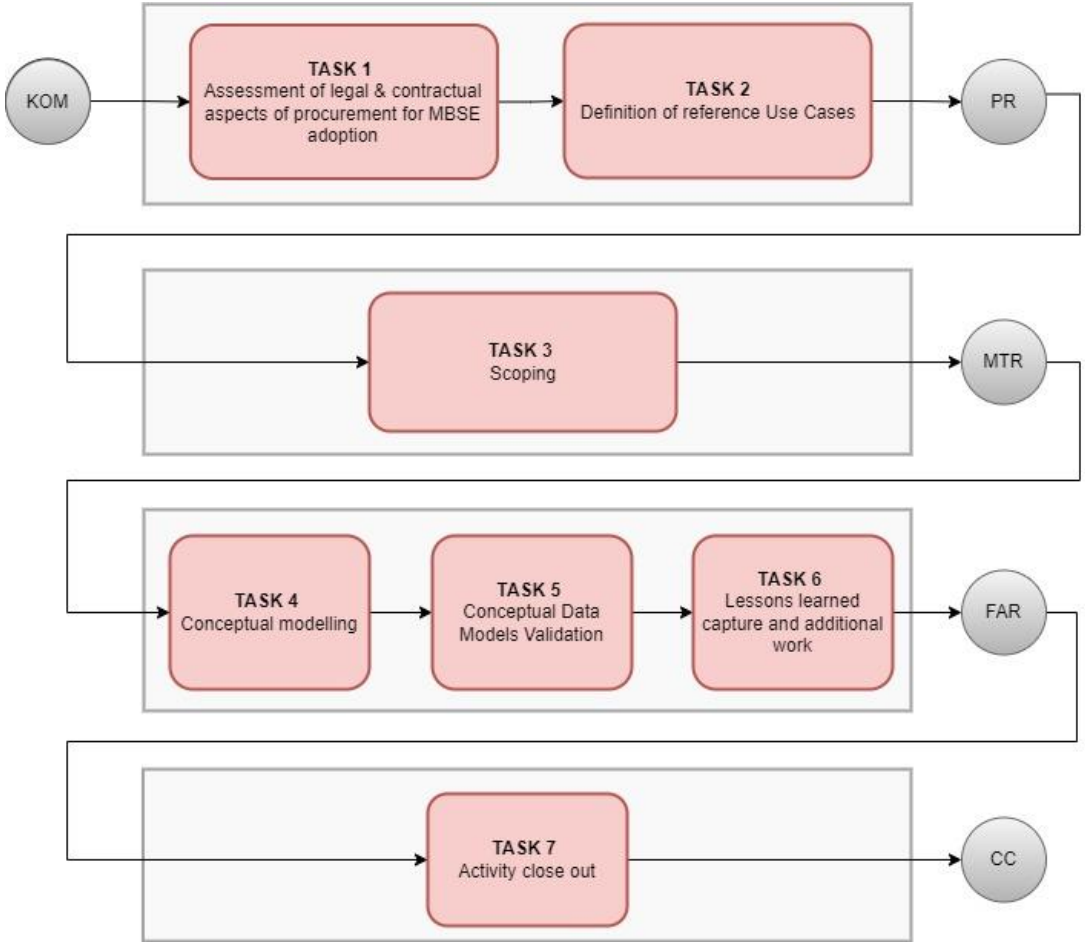
Most of the artefacts are document-based (e.g. low level of automation, and reusability) and exchanged via e-mail.

Objective

The conceptualisation of the Space Systems Procurement UoD, covering those processes related to legal and contractual aspects across customer-supplier boundaries throughout the space mission project lifecycle, using digital modelling technologies, to enable digital continuity

DIGIPROC Consortium

Work Logic



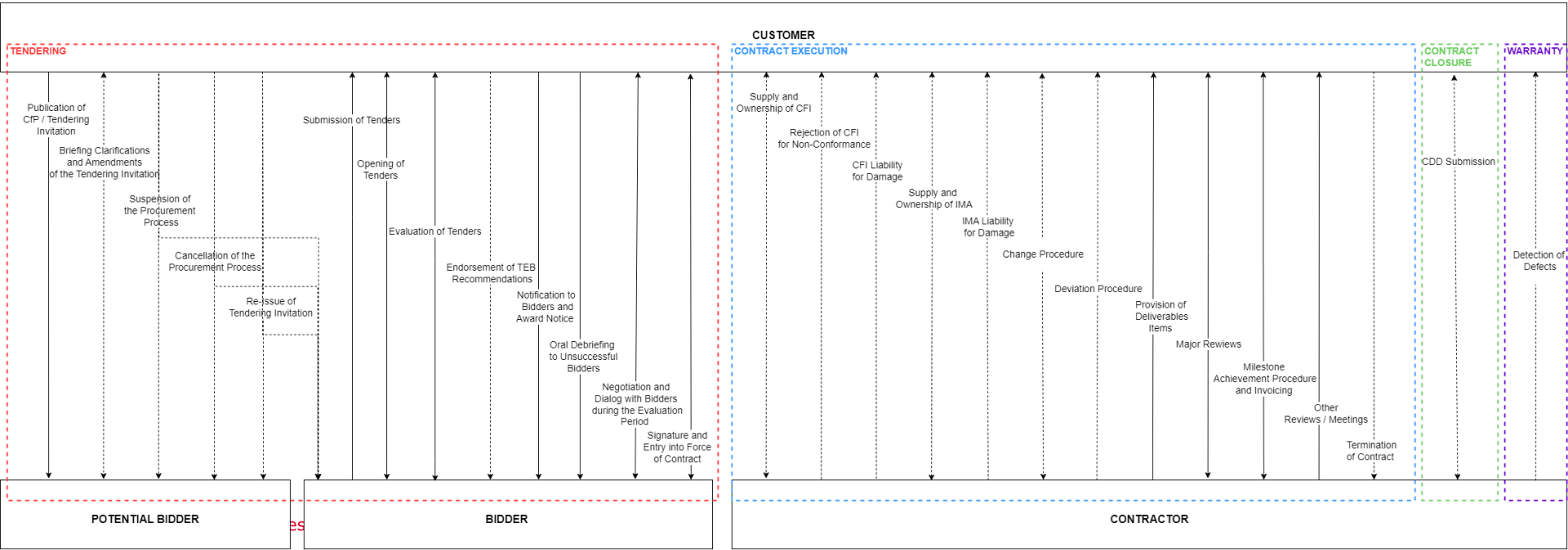
2. Characterisation of Procurement Processes

2. CHARACTERISATION OF PROCUREMENT PROCESSES

Scope

The characterisation is limited to the goals and objectives of DIGIPROC activity.

1. Focus on those which are at the **interface** of organisations, e.g. Customer-Bidder
2. Applicable to **any system** within a Space project, i.e. generic/abstract definition
3. Applicable at **any Customer-Supplier level**, i.e. it shall not be ESA-centric
4. Based on **current implementation** rather than future digitalisation

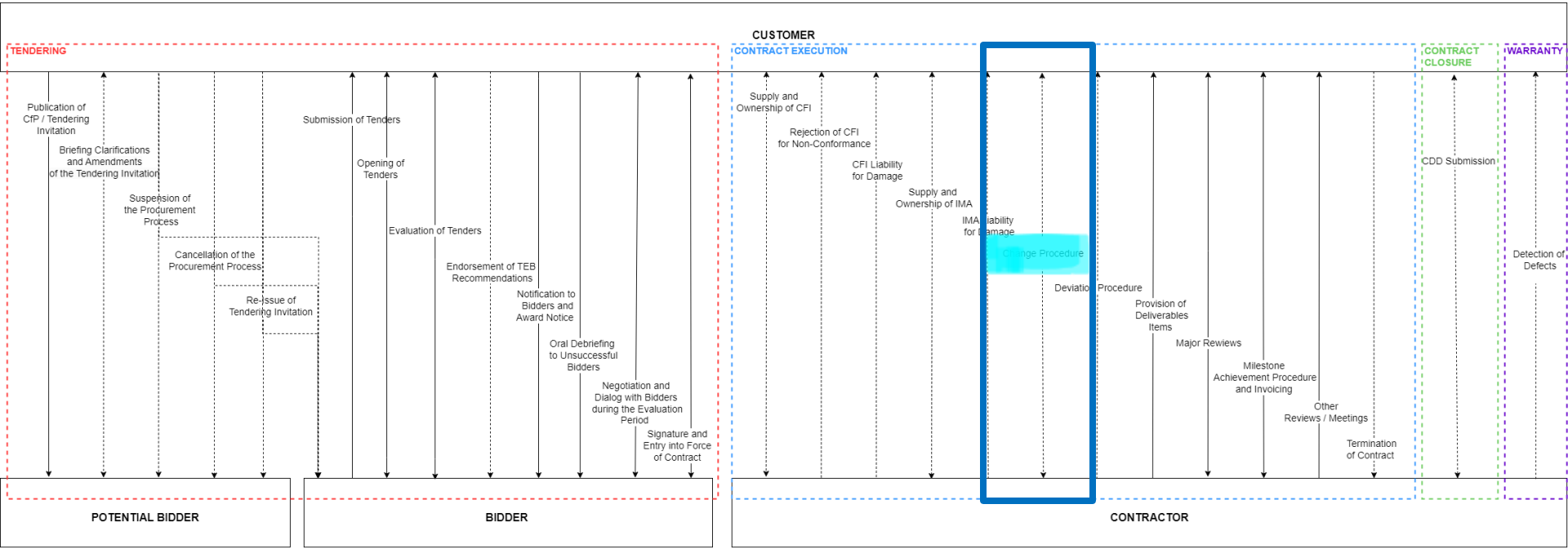


2. CHARACTERISATION OF PROCUREMENT PROCESSES

Processes analysed

Tendering	Contract Execution	Contract Closure	Warranty
• Publication of CfP/Tendering Invitation • Briefing, Clarifications and Amendments of the Tendering Datapack • Suspension of the Procurement Process • Cancellation of the Procurement Process • Submission of Tenders • Opening of Tenders • Re-Issue of Tendering Invitation • Evaluation of Tenders • Endorsement of TEB Recommendation • Notification to Bidders and Award Notices • Oral Debriefing to Unsuccessful Bidders • Negotiation and Dialogue with Bidders during the Evaluation Period • Signature and Entry into Force of Contract	• Supply and Ownership of CFI • Rejection of CFI for Non-Conformance • CFI Liability for Damage • Supply and Ownership of IMA • IMA Liability for Damage • Change Procedure • Deviation Procedure • Provision of Deliverables • Major Reviews • Other Reviews / Meetings • Milestone Achievement Procedure and Invoicing • Termination of Contract with fault/ without fault/ for special cases	• CCD Submission	• Detection of Defects

Example: Change Procedure



2. CHARACTERISATION OF PROCUREMENT PROCESSES

STEP 1: Characterisation

Example: Change Procedure – Step 1

Characteristic		Description	
Procurement General Process		Contract Execution	
Procurement Sub-Process		Change Procedure	
Type of Sub-process		Optional	
Description		Change procedure initiated by Customer: • Customer requests a change to the requirements covered by the Contract through a Change Request (CR). [OPTIONAL] • Contractor provides a Contract Change Notice (CCN) to Customer within the time-limit specified in the CR and in accordance with its requirements. [OPTIONAL] • Contractor informs Customer of any objection it has to the content of the CR. [OPTIONAL] Change procedure initiated by Contractor: • Contractor proposes a change submitted in the format of a CCN. [OPTIONAL] • Customer acknowledges the receipt of the CCN. [OPTIONAL] In both cases: • Upon evaluation and acceptance of the CCN by Customer, Customer and Contractor sign the CCN. [OPTIONAL]	
Roles		Contractor Customer	
Exchange Artefacts		CCN (Contract Change Notice) CR (Change Request) [OPTIONAL] Notification of CCN Reception [OPTIONAL] Notification of CR Objection [OPTIONAL]	
Tools	Generation Tools	MS Office	-
	Exchange Tools	e-mail	-
Additional Information		• CR is signed by the requester (i.e. Customer), whereas the CCN is signed by all parties involved (i.e. Customer and Contractor). In case changes affect some Subcontractors, the Contractor must elaborate dedicated Change Requests for the impacted Subcontractors to produce their own CCN(s). • The Customer should clarify which phase is applied by the PSS (Procedures, Specification and Standards), included in the CR. • The CCN template is defined in the Contract. • The CCN may include other artefacts such as price, deliverables, MPP, WBS, etc.	
Potential Digitalisation Areas		Digitalisation of CR and CCN. This could be performed in a commonly accessible tool for all the parties (Customer, Contractor, and Subcontractor if any) to allow efficient end to end configuration control, track changes and automatic analysis of the impact on other requirements. The digitalization will also benefit of: • Automation of documents flow-down/flow-up towards Customer, Contractor and Subcontractor chains. • Keep a link with affected elements, e.g. MPP, WBS, CISL, etc. These artefacts are part of the Contract and should be updated accordingly to approved CCN. They (e.g. MPP, WBS, CISL) also need to be digitalized for easy update from the Signed Contract after any CCN signature. This will avoid mistakes, and facilitate engineers' vision regarding deliverable precise event, initiate invoice automatically…). • Keep trace with the Contract articles/clauses modified.	
Engineering Tasks / Milestones		Engineering Task related to this Procurement sub-process is: • System Engineering Integration and Control: Changes and Nonconformance Control. No specific Milestones are related to this Procurement sub-process, as this depends on the stage of the space project lifecycle in which the contract is framed.	

2. CHARACTERISATION OF PROCUREMENT PROCESSES

Example: Change Procedure – Step 2

STEP 2: Data Representation, tools and gap analysis

Characteristic	Description
Procurement General Process	Contract Execution
Procurement Sub-Process	Change Procedure
Type of Sub-process	Optional
Description	Change procedure initiated by Customer: • Customer requests a change to the requirements covered by the Contract through a Change Request (CR). [OPTIONAL] • Contractor provides a Contract Change Notice (CCN) to Customer within the time-limit specified in the CR and in accordance with its requirements. [OPTIONAL] • Contractor informs Customer of any objection it has to the content of the CR. [OPTIONAL] Change procedure initiated by Contractor: • Contractor proposes a change submitted in the format of a CCN. [OPTIONAL] • Customer acknowledges the receipt of the CCN. [OPTIONAL] In both cases: • Upon evaluation and acceptance of the CCN by Customer, Customer and Contractor sign the CCN. [OPTIONAL]
Roles	Contractor Customer
Exchange Artefacts	CCN (Contract Change Notice) CR (Change Request) [OPTIONAL] Notification of CCN Reception [OPTIONAL] Notification of CR Objection [OPTIONAL]

Exchange Artefact	Data Representation	Domain-Specific Tool		Gap Analysis
		Generation Tool	Exchange Tool	
CCN	Document-based artefact that follows a Customer-defined template with pre-established fields.	MS Office	e-mail	A major gap in the use of domain-specific tools for the generation and exchange of the artefacts identified in this sub-process (namely CCN and CR) exists. Thus, their management is not integrated in a digital environment. From a data representation perspective, both CCN and CR rely on quite solid data structure templates, typically defined by the Customer. As anticipated in the previous point, these templates have not been digitalized and it constitutes a gap.
CR	Document-based artefact that follows a Customer-defined template with pre-established fields.			
Notification of CCN Reception	No specific data representation.			
Notification of CR Objection	No specific data representation.			

2. CHARACTERISATION OF PROCUREMENT PROCESSES

Example: Change Procedure – Step 3

STEP 3: Impact on ECSS standards

ECSS-M-ST-40C

Table G-1: Change request scope and content

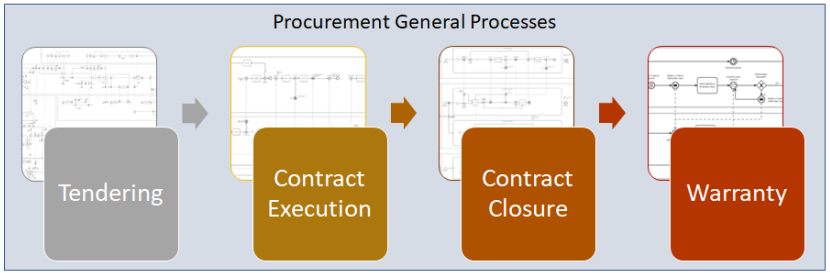
No.	Data	Description
1	Organization	Identification of the change request originating organization
2	Number	Unique identification and register number
3	Issue	Issue status of the change request
4	Date	Issue date of the change request
5	Project	Project under which the change request is supplied
6	Title	Title of change request
7	Affected item(s)	Identification of the CI(s) or PI(s) (number and name) which are affected by the change request
8	Affected document(s)	Identification of the document(s) to which the change request applies (document number and issue, paragraph or requirement id)
9	Reason for change	Reason why the proposed change has to made (Rationale)
10	Description of change	Change description, and when requirements are affected, proposed new wording
11	Approval	Names, date and signatures of the relevant authorities
12	Authorization to proceed	Information on the authorization to proceed or the limit of liability, if the change has to be incorporated immediately

Exchange Artefact	Data Representation	Domain-Specific Tool		Gap Analysis
		Generation Tool	Exchange Tool	
CCN	Document-based artefact that follows a Customer-defined template with pre-established fields.	MS Office	e-mail	A major gap in the use of domain-specific tools for the generation and exchange of the artefacts identified in this sub-process (namely CCN and CR) exists. Thus, their management is not integrated in a digital environment. From a data representation perspective, both CCN and CR rely on quite solid data structure templates, typically defined by the Customer. As anticipated in the previous point, these templates have not been digitalized and it constitutes a gap.
CR	Document-based artefact that follows a Customer-defined **template** with pre-established fields.			
Notification of CCN Reception	No specific data representation.			
Notification of CR Objection	No specific data representation.			

3. Definition of Use Cases

3. DEFINITION OF USE CASES

Scope



Tasks

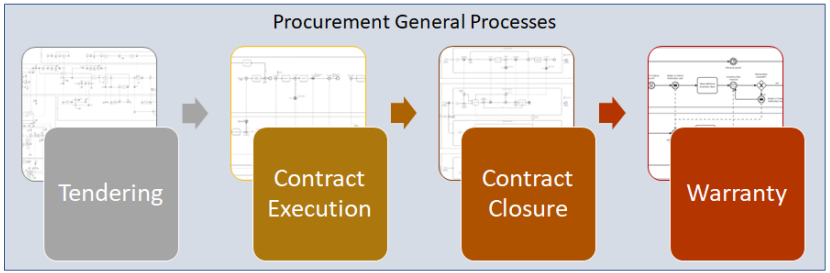
- Define of relevant Use Cases within the Procurement processes that represent common scenarios pertinent to Procurement digitalisation.
- Model the Use Cases in BPMN (Business Process Model and Notation).

Objectives

1. To ease the conceptualisation of the Procurement UoD for those non-knowledgeable about Procurement.
2. To convey the information in an unambiguous way.
3. To identify the role of the Exchange Artefacts in the Procurement lifecycle, including how they are progressively updated (e.g. initial version, information on details, new versions, etc.).
4. To explore potential benefits of using BPM methodologies in the context of the Procurement lifecycle.

3. DEFINITION OF USE CASES

Use Cases



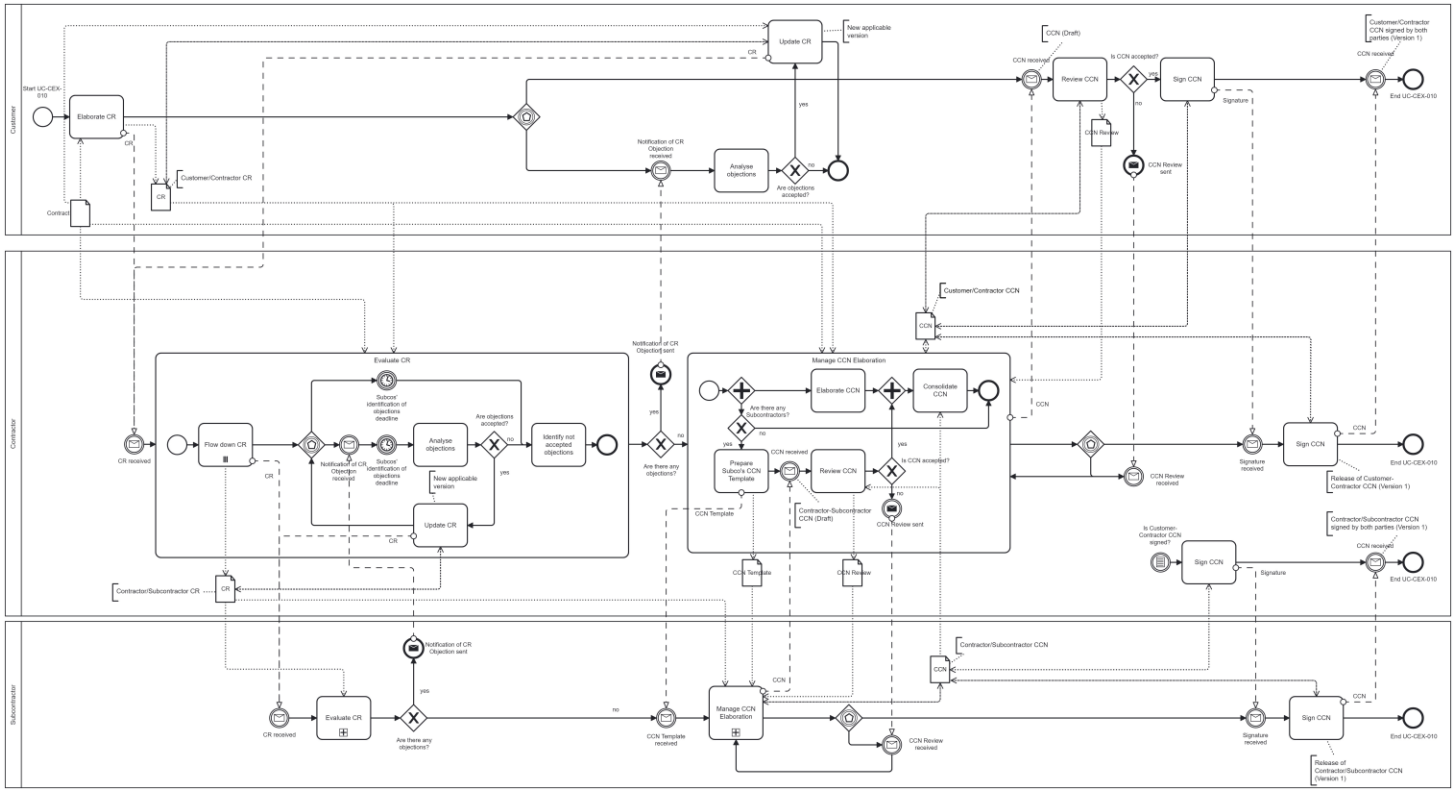
Process	Use Case ID	Use Case Name
Tendering	**UC-TEN-010**	Flow down of Tendering Datapack to Potential Subcontractors.
	UC-TEN-020	Management of Evaluation Grid when multiple organisations are involved in the TEB.
	UC-TEN-030	Management of NIR elaboration and evolution through Contract Negotiation.
Contract Execution	**UC-CEX-010**	Generation of CCN from CR initiation and flow down to Subcontractors.
	UC-CEX-020	Management of Contract baseline evolution.
	UC-CEX-030	Management of contractual/technical milestone.
Contract Closure	**UC-CCL-010**	Elaboration of CCD and traceability to the Contract baseline and engineering artefacts.
Warranty	**UC-WAR-010**	Management of Warranty Deliverable Items during the maintenance period.

3. DEFINITION OF USE CASES

Example: Generation of CCN and flow down to Subcontractors

Characteristic	Description
Use Case ID	UC-CEX-010
Use Case Name	Generation of CCN from change request initiation and flow down to Subcontractors.
Description	• Customer initiates Change Request and sends it to Contractor. • Contractor evaluates Change Request. • Contractor flows down applicable Change Request subset to Subcontractor. • In case of Subcontractor's objections, Subcontractor informs Contractor of any objections it has to the content of the Change Request. • In case Subcontractor's objections are accepted, Contractor updates the CR and sends it to Subcontractor. • In case of Contractor's objections, Contractor informs Customer of any objections it has to the content of the CR. • In case Contractor's objections are accepted, Customer updates the CR and sends it to the Contractor. • Once the CR is agreed, Contractor defines CCN Template. • Contractor elaborates CCN, identifying any affected elements (e.g. MPP, Applicable Document list, BIPR list…). • Contractor flows down CCN. • Subcontractor fills in CCN required fields, identifying any affected elements (e.g. MPP, Applicable Document list, BIPR list…). • Subcontractors sends filled CCN back to Contractor. • Contractor consolidates CCN with information from the Subcontractors' CCNs. • Contractor sends consolidated CCN to Customer. • Contractor and Customer sign CCN. • Customer and Subcontractor sign CCN.
Roles	Contractor Customer Subcontractor
Exchange Artefacts	CCN (Contract Change Notice) CR (Change Request) Notification of CR Objection
Analysis	This Use Case focuses on the elaboration and flow down of the CCN to the applicable set of Subcontractors due to a Change Request. As for UC-TEN-020, this Use Case consists of repetitive and manual tasks which do not benefit its effectiveness, including: • manual elaboration of CR and CCN, • distribution via e-mail, • CCN consolidation by integrating relevant information from each individual CCN received from the Subcontractors. Thus, the digitalisation of a CCN form would increase the efficiency of its production, distribution and consolidation.

Example: Generation of CCN and flow down to Subcontractors



4. Procurement UoD

Main Constituting Elements

How are the Main Constituting Elements identified?

- The Use Cases are used to identify the main element of the Procurement UoD, focusing on those elements that are exchanged between different stakeholders.

What are the Main Constituting Elements?

- The artefacts exchanged in the Use Cases → **Exchanged Artefacts** (e.g. Contract, CCN).
  - This includes some artefacts exchanged only internally within an organization but that their production is complex and/or inefficient → Evaluation Grid.
  - It shall be noted that during the conceptualization additional elements may be needed to contextualize the Exchanged Artefacts → Roles involved, other elements that are linked to them, etc.

Prioritisation

The artefacts exchanged in the Use Cases are evaluated and prioritised according to the following **prioritisation criteria**:

1. **Impact** (i.e. save time)
2. **Relevance** (i.e. relevant for the Procurement and enabling MBSE adoption)
3. **Monitoring need** (i.e. artefact updates or monitoring)
4. **Complexity** (i.e. conceptualization effort)

Exchange Artefact	Score
Contract	12
Applicability Matrix Statement of Compliance Matrix	11
CCD CCN CR NIR	10
PMAC Proposal SoW TEB Report	8
Invoice Minutes of Meeting SCOT Tendering Cover Letter	7

The priorities were barely refined during conceptualization to take into account the following issues:

- The **importance of Contract** conceptualization became evident.
- **Some artefacts were not considered as they represent information exchanged verbally**, and then out of the scope of the project, e.g. notifications such as the Authorisation to submit the CCD.
- **Evaluation Grid was not considered** as it is internal to each organization.

Glossary of terms

A definition is provided for every Main Constituting Element.

- In case ECSS or ESA Regulations defines the term, and the definition is considered adequate, that definition is used and the source document is specified.
- Otherwise, Oxford Dictionary definition are used.
- In case it is not valid, new definitions are provided.

Term	Definition
advance payment	payment foreseen in the contract intended to provide the supplier with liquidity to allow the initiation of the contractual works
amendment	modification of a tender after its publication
applicability matrix	traceability to the applicable / reference documents of an organisation for a particular project
applicability statement	statement of the applicability of a requirement to a supplier
applicable document	document containing additional provisions ACRONYM: AD
background intellectual property rights	intellectual property relevant for the contract owned by the supplier ACRONYM: BIPR

4. PROCUREMENT UoD

Conceptualisation Approach

Modelling Decisions

- General conventions
  - Procurement UoD will be developed following the **design conventions** defined (e.g. development lifecycle, language, approach, etc.) defined in OSMoSE Development Plan.
  - ORM diagrams will be developed following the **Quality and Product Assurance rules** defined in OSMoSE Project Plan.

a) Keep ORM diagrams clean without crossing lines, aligning model elements if possible.
b) Separate the model in different model pages organized by subject, according to the documentation that will be produced, e.g. based on the information that has to be included in each chapter.
c) Provide an overview page as the first page of the model.
d) Build first the global model and later create hierarchies. One of those hierarchies will be selected to express the UoD in the documentation.
e) Name model pages according to the page subject.
f) Use comments to highlight questions, work in progress, and also for descriptions.
g) Add custom properties 'Definition', 'Synonym' and 'Acronym' to the model.
h) Agree on the tool configuration for verbalisation (e.g. using 'telemetry parameter' instead of 'TelemetryParameter').
i) Create predicates for both reading directions of fact types.
j) Name Entity Types and Value Types using camel convention.

1. Identify, from the Use Cases, the terms that refer to concepts considered of potential relevance for the Space System.
   a. Examples:
      i. "*customer*",
      ii. "*supplier*",
      iii. "*technical specification*",
      iv. "*history*"...
2. Identify, for each term or concept of relevance the UoD that should contain the definition of that concept. Each concept should be defined in a single UoD, and can be referred from any other UoD.
   a. Examples:
      i. "*customer*" and "*supplier*" should be defined in the "*Management and planning*" UoD;
      ii. "*technical specification*" should be defined in the "*Requirements management*" UoD;
      iii. "*history*" should be defined in the "*Support to configuration control, change management and non-conformance control*" UoD...
3. Ensure that each concept is properly termed and defined, to ensure that all stakeholders have the same understanding of that concept.
   a. Concepts may be termed differently by different stakeholders. The different terms used can be kept in the model as synonyms using the custom property 'Synonym'.
   b. The same term can be used by the different stakeholders to refer to different concepts (i.e. homonyms). The definitions shall ensure that such ambiguity is not possible.
   c. Acronyms shall be added as custom property 'Acronym'.
   d. The generated documentation shall be checked to ensure that the same term is not used anywhere with a different purpose.

The definition of terms is therefore very important and shall follow this approach:

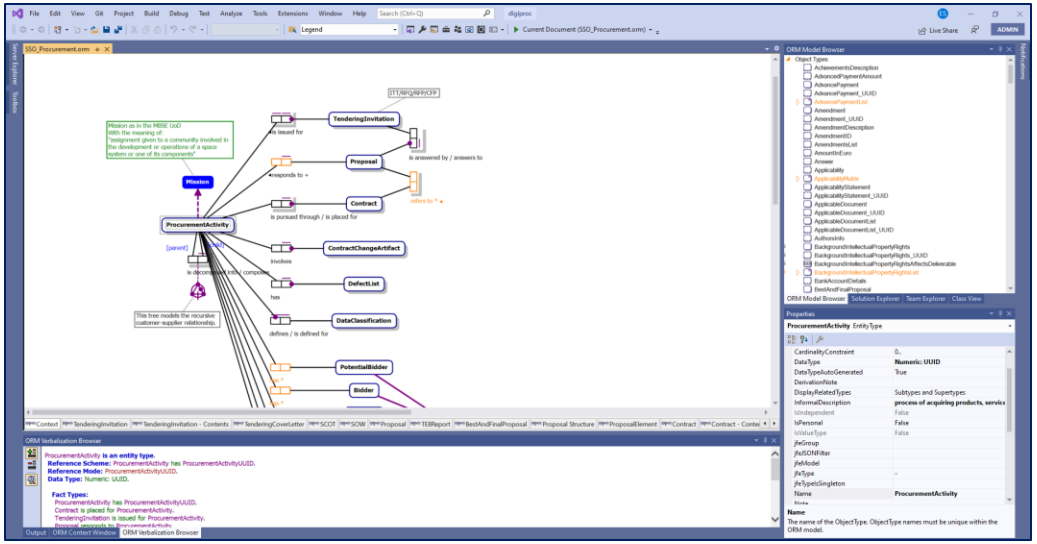
1. When a term is introduced, ECSS standards shall be checked.
2. If it is defined in ECSS and the definition is adequate, that definition is considered for the Object Type and it is not necessary (though recommendable) to include the definition in the ORM model.
3. If it is defined but the definition is not correct, a change request to ECSS shall be proposed.
4. If the definition is not included in the ECSS standards, the definition of the Oxford dictionary shall be used.
5. Otherwise, or in case the Oxford definition is not valid, a new definition shall be provided and included in the ORM model as the value of a 'Definition' custom property.

4. PROCUREMENT UoD

ORM Model (1/8)

Some statistics

- ~70 entities identified
- ~40 ORM diagrams



ORM Model (2/8)

Context

- This diagram shows the main conceptual entities of the Procurement UoD.
  - Concepts in blue represent 'connection points' with other UoDs.
  - Facts in orange represent calculated data (derivations).
- The UoD covers the Procurement Activity, from the Tendering to the Contract, including the Proposal and the changes to the Contract during the execution.
- It also identifies the Legal Entities participating in the Procurement Activity.
- The focus of the modelling has been the Contract, leaving the rest of the entities detailed enough to fulfil that objective.

ORM Model (3/8)

Contract

- This diagram shows the Contract, and the entities directly related with it.
- The emphasis in the model is in:
  - Tracking of changes to the Contract, with proper granularity.
  - Flow-down of the Contract to Subcontracts.

ORM Model (4/8)

Contract Changes Tracking

- A Contract is made of Contract Elements (e.g. the CFI list). Each Contract Element can have its own lifecycle, its contents can change along the time.
- The Contract can be organised in Parts.
- It is possible to track a change (e.g. in a CCN) to a specific Content of a Contract Element. This way the impact of a CCN in a Contract is evident.
- Such versioning of the Contents of a Contract allow the definition of Baselines of a Contract, and a view of the current, latest status of a Contract.

ORM Model (5/8)

Contract Flow-down

- The Customer/Supplier relationships are reflected in a hierarchy of Procurement Activities.
- The flow-down of the Contents of a Contract to the Subcontract mirrors that hierarchy.
- It is possible to track what has been flowed-down, what has not been flowed-down, and the link between the Contents.

ORM Model (6/8)

Contract Contents

- Many Contract Contents have been modelled to expose their details.
- There is the option to not further detail the Contents, and store just the text.
- Detailing the Contents allows for better consistency.

ORM Model (7/8)

Contract Contents Example

- The Milestone Payment Plan collects Payment Milestones.
- Milestones have been already defined (e.g. in the SoW).

ORM Model (8/8)

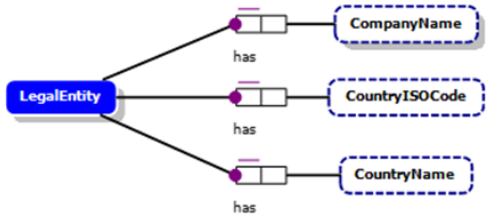
Contract Closure Documentation

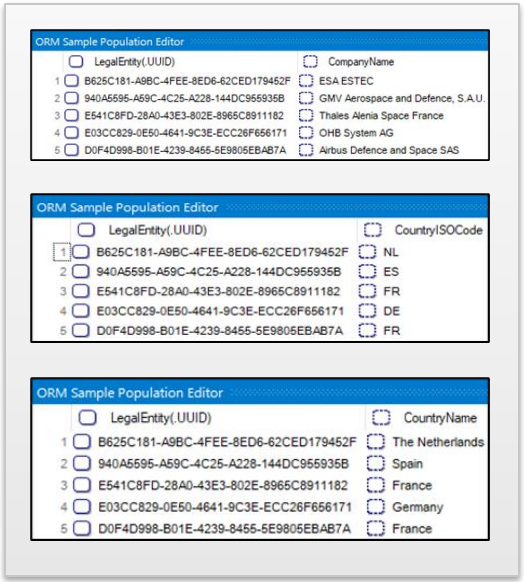
- The dream of an automatic generation of the CCD is closer.
- The calculations to generate at least parts of the CCD have been modelled.

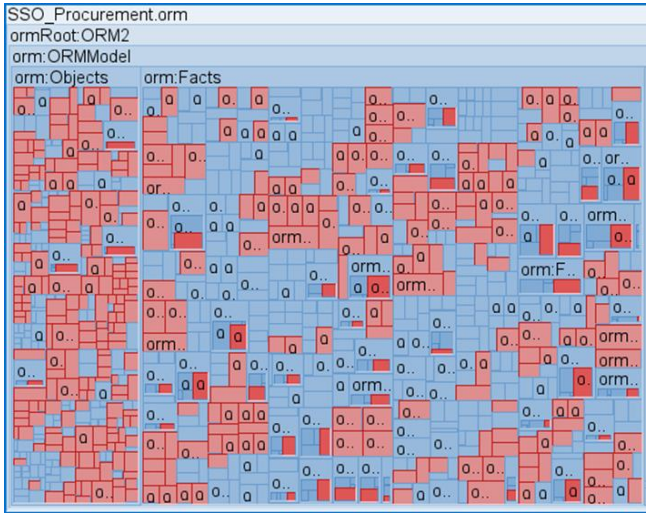
Validation (1/2)

Model populated with real examples

- To check the model adequacy.
- Populated directly in NORMA.







Validation (2/2)

Working Sessions

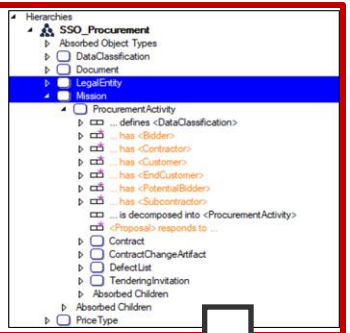
Participants: Thales, Airbus, OHB and GMV

Goals:

- To validate the model correctness.
- To identify missing concepts.
- To identify superfluous parts of the model to be removed.

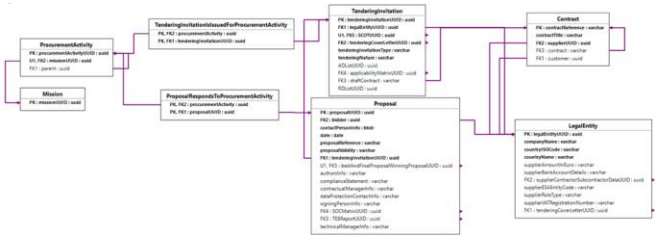
Hierarchy

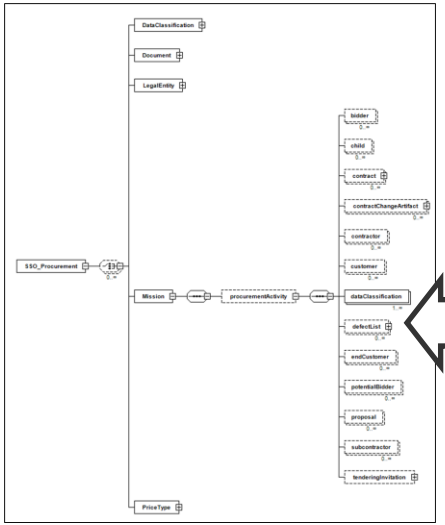
- To deduce existential dependencies between entities from the relationships and constraints in the model.
- E.g. to identify missing fact types or wrong cardinalities that can be adjusted to obtain a conceptually sound hierarchy.



SQL Representation

- Produced using NORMA and created in a PostgreSQL.
- To verify e.g. that the length of identifiers is adequate.





XSD Representation

5. Conclusion

5. CONCLUSION

Wrap-up

Achievements

- Characterisation of Procurement processes.
- Identification of Legal and Contractual aspects to be considered when exchange digital items.
- Identification of main Procurement Use Cases subject to be digitalised.
- Procurement UoD, focusing on those constituting elements that contribute to DIGIPROC goals.

Challenges

- Ensure the independence of project results with respect to any organisation approach, guaranteeing that are generic enough to be applicable to any Customer-Supplier level.
- To limit the scope of Procurement UoD to DIGIPROC goals.
- ORM model validation.

Way Forward

- Consolidation of Procurement UoD and integration into the Space System Ontology (SSO).
- Tool prototype development to allow the creation and exchange of Procurement artefacts.
- Representative demonstrator.

Questions?

Thank you!

DIGIPROC Team