Reaching into space TOGETHER

MB4SE 2020

Bridging the Gap from PUS-C FDB to SCOS MIB

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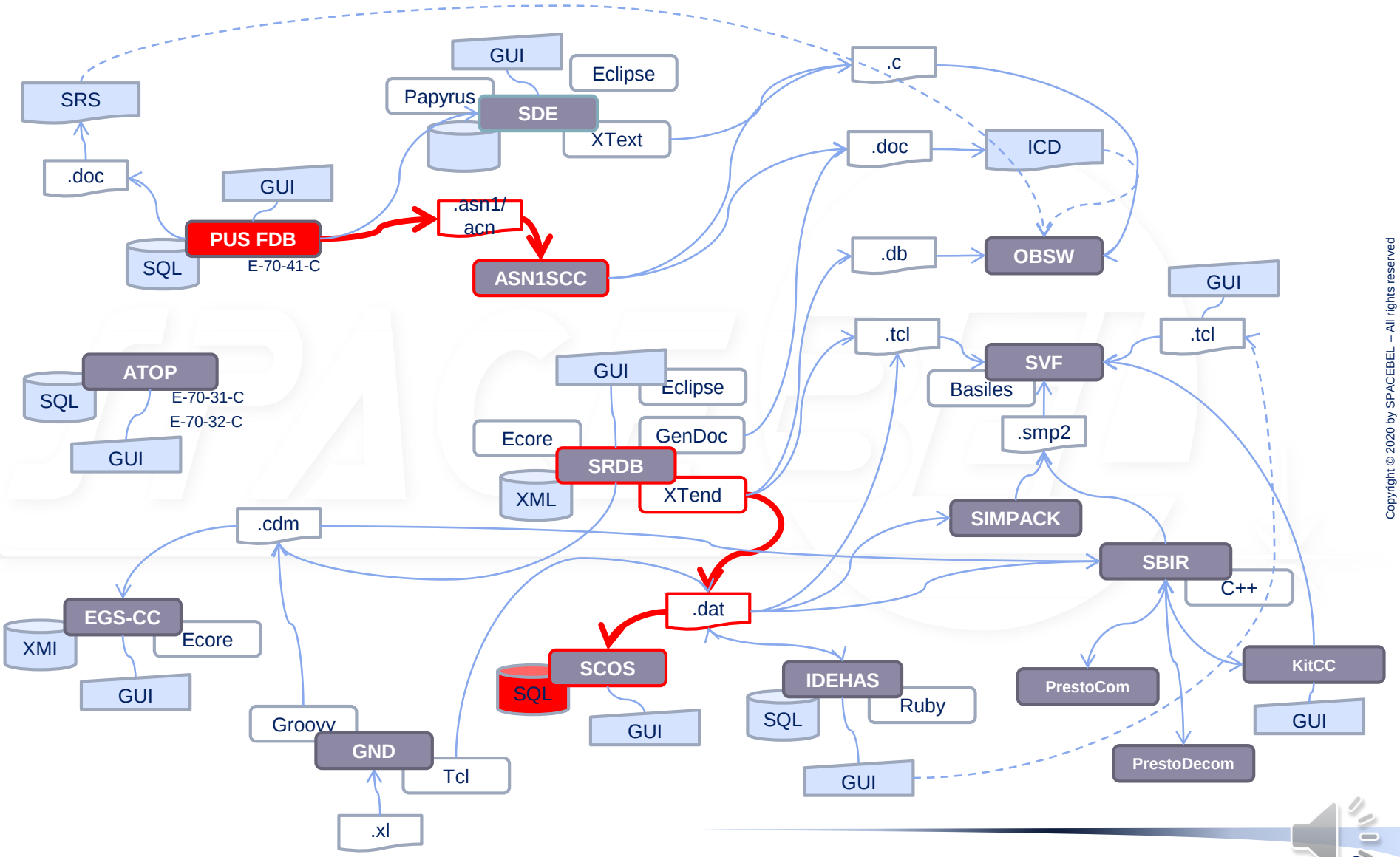
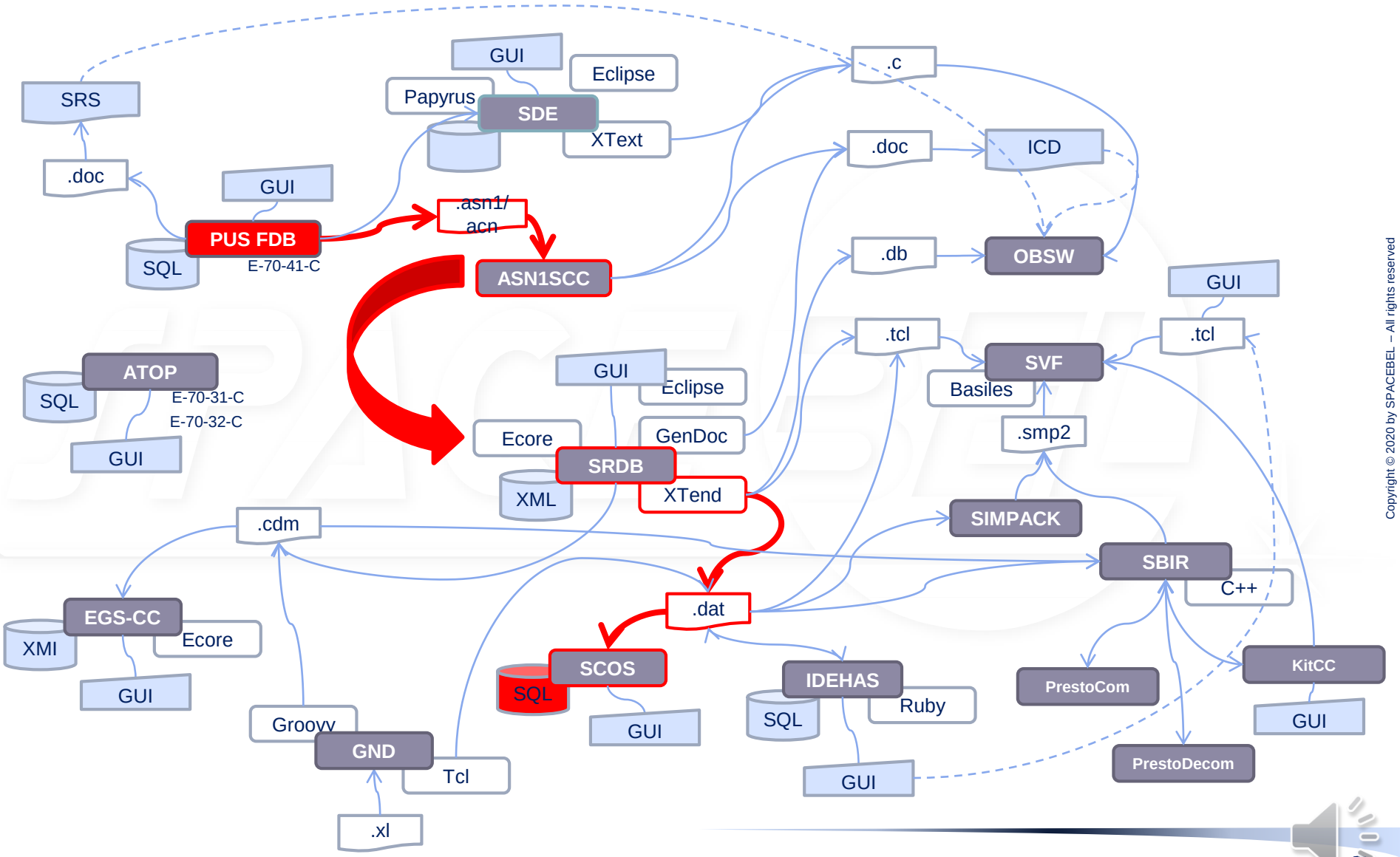
- Introduction
- Modelling Approach
- Practical Implementation
- Conclusion

The Executive View



The Executive View



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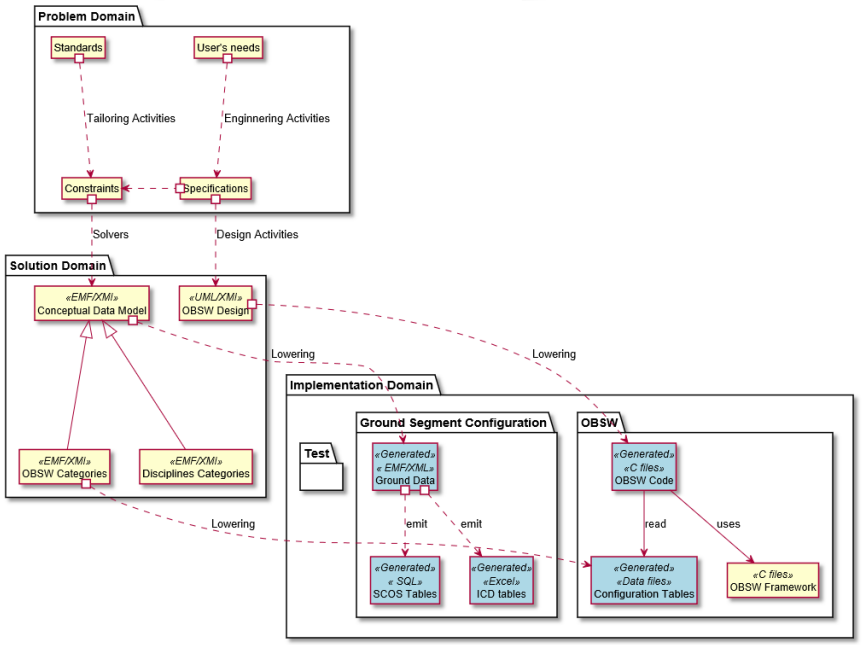
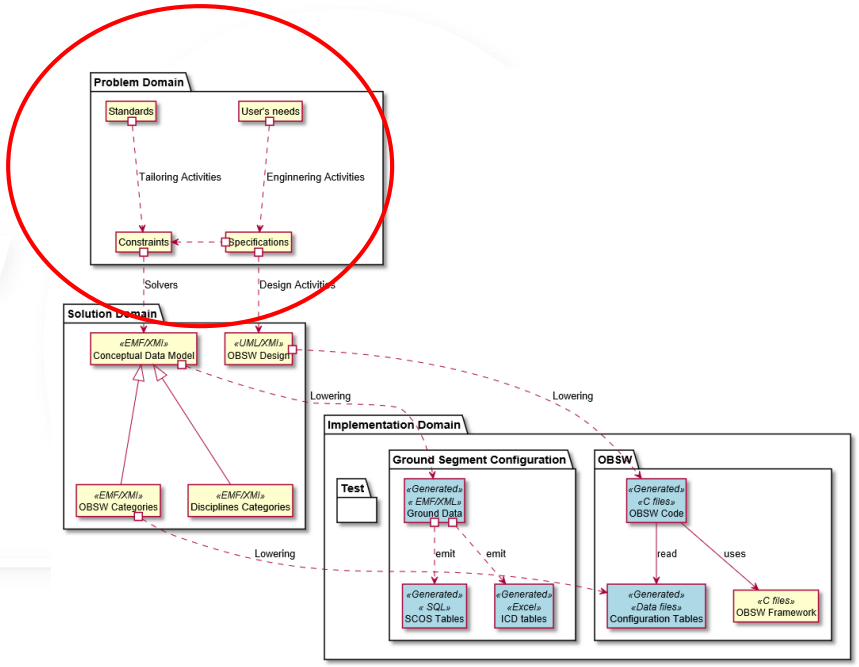
Modelling Domains

- Three Domains:
  - Problem,
  - Solution,
  - Implementation.
- Modelling
  - used on all domains.
- Transformations
  - Solver,
  - Lowering



Problem Domain

- Analysis of User's Needs and global Understanding of the Problem produces Uses Cases and Textual Specifications captured into a Specification Model.
- Specification model could include requirements defined by formal notations.
- ASN.1 and ACN are examples formal notations. Supported by ASN1SCC, part of TASTE.

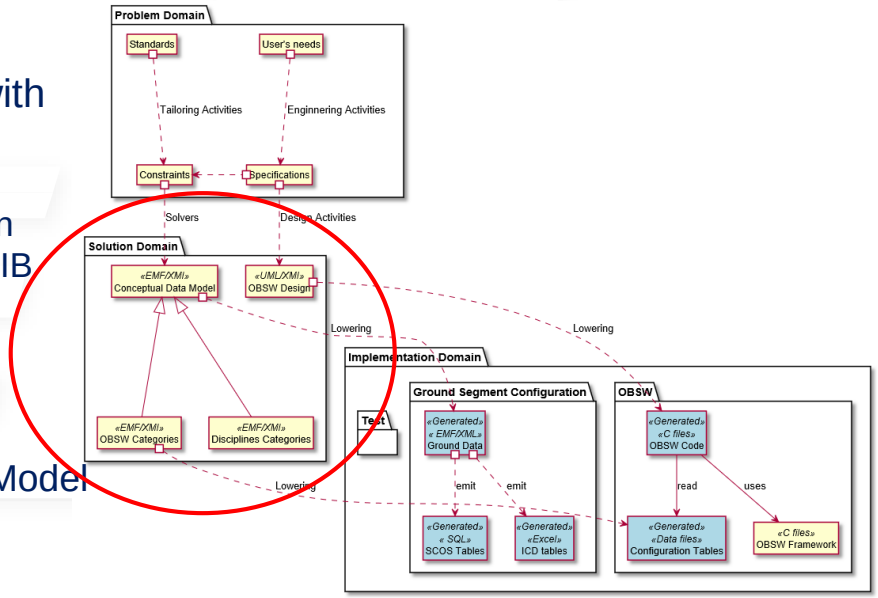


Generic definition: A Solver is an automated tool that consume formal specifications part of the problem domain to produce part of the solution domain.

Solution Domain

- The Solution domain provides an integrated view of the agreed Solution.
- This Solution domain will be latter implemented into the Implementation Domain.

- This Solution Model is composed of:
  - The OBSW design,
  - The CDM Conceptual Data Metamodel with
    - Core CDM,
      - common for all disciplines,
      - Cover onboard and ground configuration
      - Includes all the information for SCOS MIB
    - OBSW Data Model,
      - Specific to OBSW disciplines
      - OBSW framework configuration
      - Mission specific configuration
    - Others potentials extensions to the Data Model
      - As needed to support others disciplines



- It is defined using formal languages:
  - UML, for the OBSW design,
  - EMF, for Conceptual Data model,
  - DSL, for specific part of the Conceptual Data model,

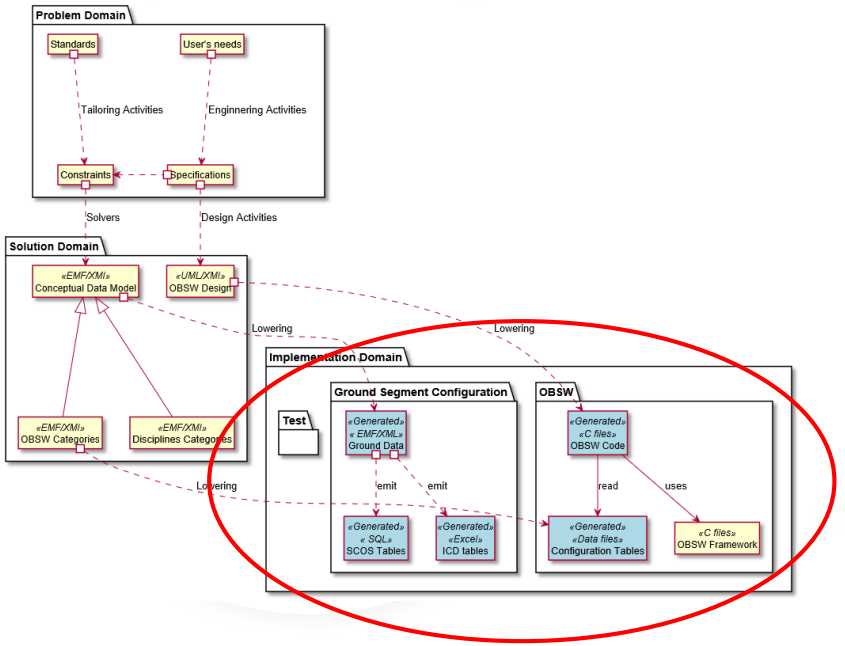
Solution Domain

- Hierarchical decomposition of the System into Subsystems and Localizations.
  - This hierarchy is the main organizational structure.
  - All items are attached to one and only one Subsystem or Localization.
  - “Qualified Name” identification of any items in the hierarchy, used to cross reference items.
- All Ground observable parameters, some are Onboard parameters.
- Parameters are related to Subsystems and Localizations.
- Calibration and Decalibration functions for all observable parameters.
- Structural definition of all Telecommand/Telemetry messages.
- Include all the information required to generate SCOS MIB

Implementation Domain

Generic definition: The lowering action is the automated production of software artefacts, starting from a formal description of a solution.*

- "Lowering" of the single solution to many target implementations:
  - On Board Software configuration,
  - Software Validation configuration,
  - Ground Segment configuration,
  - …
- Insure a coherent implementations for all the products, "by design".
- Top down only, no reverse, no round trip.



*this terminology is borrowed from the compiler's literature

Implementation Domain

- SCOS MIB is a “Relational Data Base”
  - “One to many” and “many to many” relationships are implemented as tables of keys/values
  - Editing the MIB require specific application
- EMF M2M transformations require “Object Oriented” meta model
  - OO meta model has been reverse engineered from SCOS RDB
  - Include OCL constraints to check SCOS ranges and relations
  - Only use “containment” relationships
  - For “many to many” relationships, for one of the directions, information is duplicated
  - Files are serialized as XML files (no “href”)

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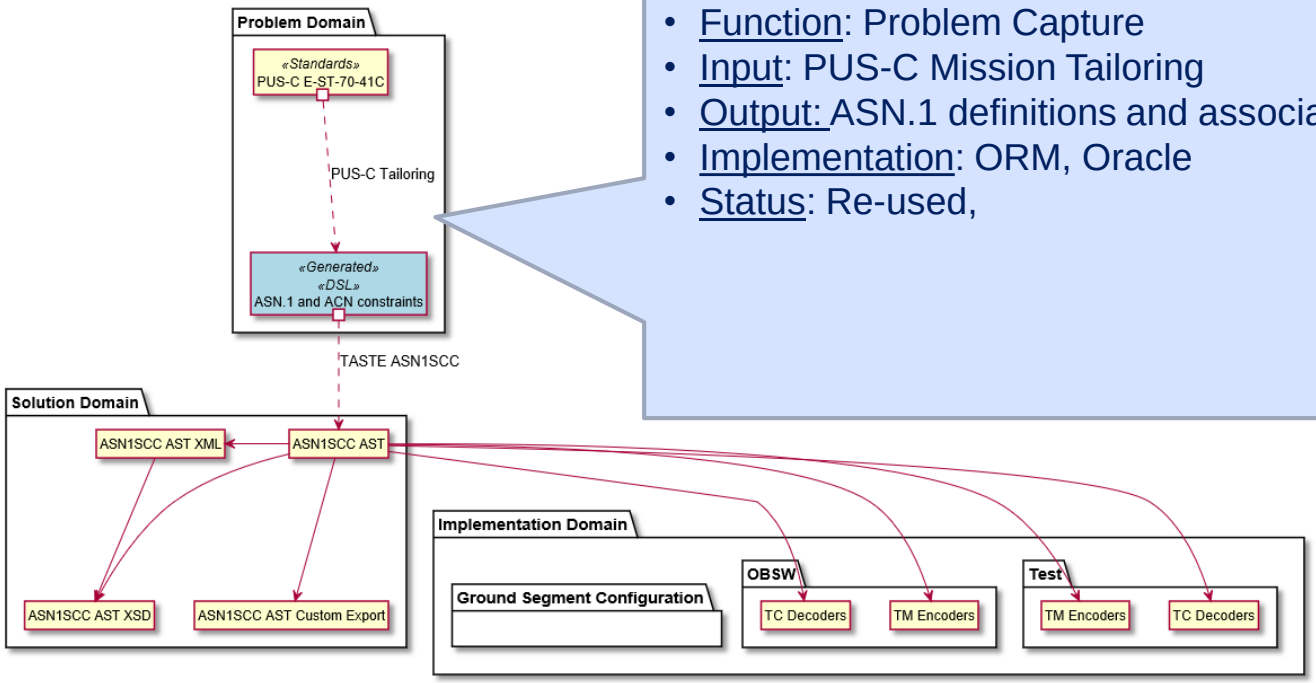
Bridging the Gap between PUS-C FDB and SCOS MIB

- A chain with
  - 3 Tools:
    1. PUS-C Foundation Tool
    2. ASN1SCC compiler
    3. EMF model to model and model to text transformations
  - 5 Steps:
    1. Tailoring of PUS Standard generates ASN1 files
    2. ASN1SCC front end generates abstract symbolic tree
    3. ASN1SCC back end generates Conceptual model
    4. Conceptual model generates SCOS model
    5. SCOS model generates SCOS table

PUS-C Foundation Tool

Step 1 :PUS-C Foundation Tool

- Domain Problem Domain.
- Function: Problem Capture
- Input: PUS-C Mission Tailoring
- Output: ASN.1 definitions and associated ACN constraints
- Implementation: ORM, Oracle
- Status: Re-used,



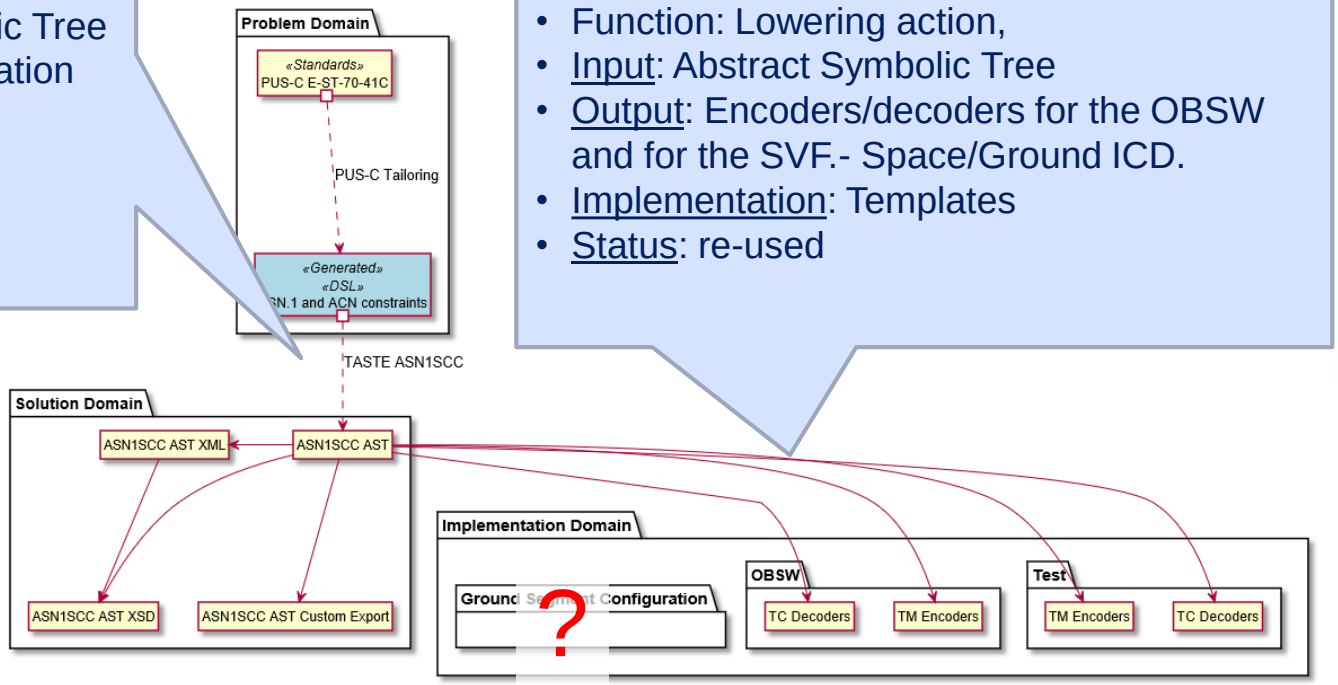
ASN1SCC

Step 2 : ASN1SCC Frontend

- Domain: Solution Domain
- Function: Solver,
- Input: ASN.1 and ACN
- Output : Abstract Symbolic Tree decorated with representation clauses
- Implementation: F#
- Status: re-used.

Step 3a : ASN1SCC Backend

- Domain: Implementation Domain,
- Function: Lowering action,
- Input: Abstract Symbolic Tree
- Output: Encoders/decoders for the OBSW and for the SVF.- Space/Ground ICD.
- Implementation: Templates
- Status: re-used



ASN1SCC custom backend

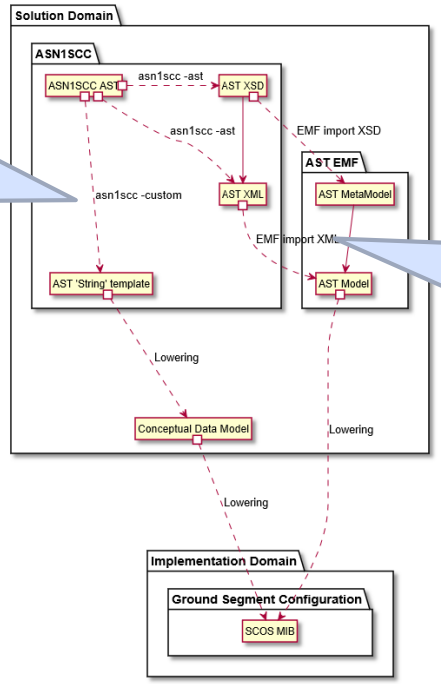
Step 3b :

- Domain: Solution Domain,
- Function: Lowering Actions,
- Input: ASN1SCC Abstract Symbolic Tree
- Outputs: Conceptual data model TM/TC definitions
- Implementation: see alternatives A and B.
- Status: Custom development.

Alternative B

Implementation:

ASN1SCC integrated Template language.



alternative A

Implementation:

XML export and EMF post processing

EMF M2M and M2T

- Final lowering in two steps:
  - Step 4) Model to Model transformation,
    - Solution Domain
    - New lowering action
    - Input Conceptual data model
    - Focus on the semantic of the lowering
    - Walk through the Conceptual Data Model, break references into relations tables, generate keys and qualified names according to mission specific SCOS naming convention (based on Conceptual Data Model tree structure)
    - Implemented in EMF Xtend
    - Output SCOS Model
  - Step 5) Model to Text transformation
    - Implementation Domain
    - New lowering action
    - Input SCOS model
    - Focus on the format of the output files
    - Emit SCOS MIB entries line by line, table by table
    - Implemented in EMF Acceleo
    - Output : SCOS table

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Conclusions

- The solution fills the gap
  - from the PUS FDP and the ASN.1 definition
  - to the SCOS MIB
  - through the OBSW SRDB
- The approach relies on
  - Three layers or domains (problem, solution, implementation)
  - Transformations between representations (solving, lowering)
    - Solver: Integration of the ASN.1SCC
    - Lowering: Development of Model transformations
- The tooling fits into the EMF based Flight Software SDE to
  - glue external solver
  - develop editors
  - implement model transformations
- The development is
  - Pragmatic: done by the OBSW team for the OBSW team
  - Operational: done in operational OBSW projects at SPB

Thank you for your attention !