Capella

by Artal

kinéis

# Optimization of Kinéis (nano-satellites constellation) system tests using MBSE approach

Jonathan Lasalle - ARTAL Technologies

# The actors: CNES / Kinéis / Artal

cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

- Designs / manages complex space systems
- First satisfying Capella experience some months ago
- MBSE spreading in progress

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artal technologies

- Capella expertise: training / coaching
- Capella customization

# History: introducing Capella inside CNES SVOM project

- CNES/Artal: first MBSE collaboration (2018->2021)
  - SVOM: Space system dedicated to gamma ray detection
    - Reverse engineering: historical processes vs MBSE principles comparison
    - Operational capture of system test
      Development of Capella extensions dedicated to V&V

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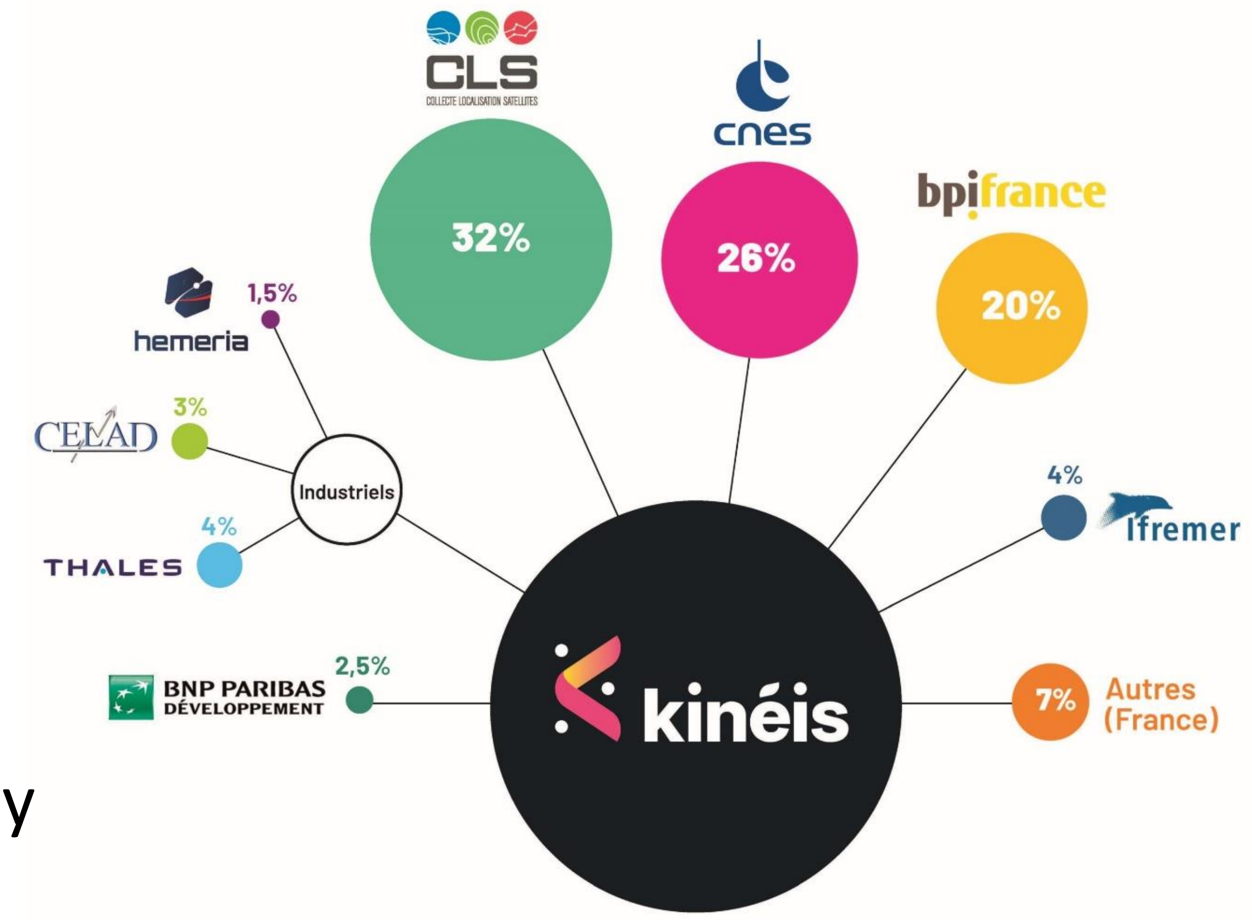
- Set-up of the Kinéis/Artal collaboration

⇒ **1st CNES POC on an operational project under development**

  - Capture Kineis system using Capella in order to identify the dedicated functional chains
  - Definition of validation objectives and associated test scenarios
  - Capella model being considered as single source of truth

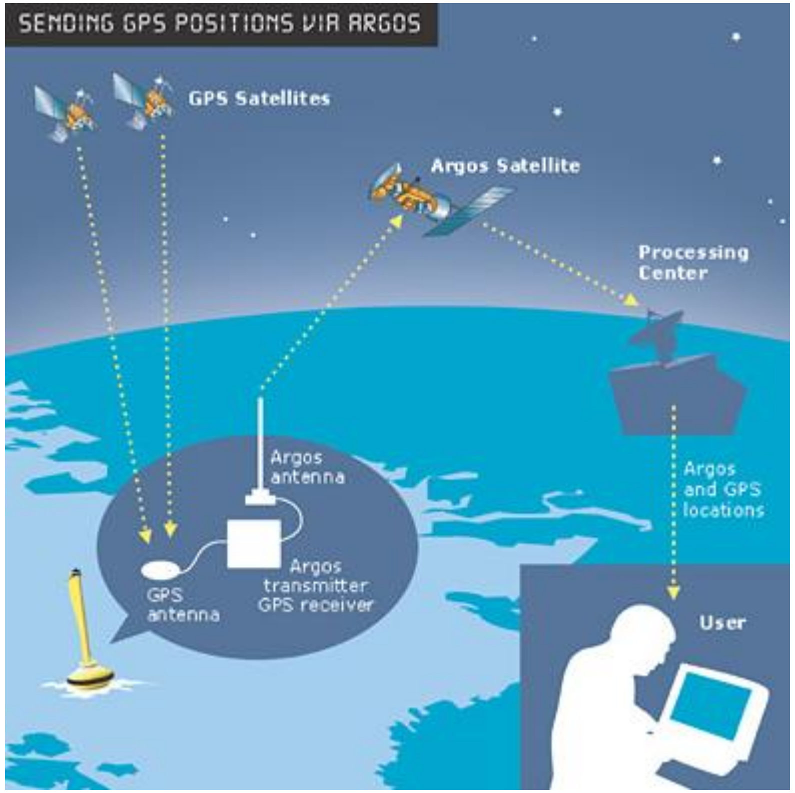
# Kinéis company

- **Kinéis**
  - Created in 2018
  - Where NewSpace meets the IoT (Internet of Things)
  - ~ 50 employees (+150% in 18 months)
  - Initiated by:
    - the CNES (French Space Agency)
    - CLS (*Collecte, Localisation, Satellites*)
- **Goal**
  - Democratization of Argos technology
  - Extend it to the entire IoT market

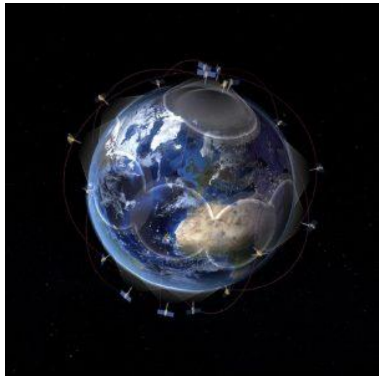


# ARGOS system

- Initiated in 1978
- Dedicated to studying, monitoring and protecting our planet's environment
- Structure
  - Space segment: GPS and Argos satellites
  - Ground segment: transmitters and process centers
- Data collection from various devices around the world
  - 7 Argos Satellites
  - 22 000 active transmitters (8 000 dedicated to animal tracking)
  - Over 100 countries
  - 3 Argos generation coexist: ARGOS 2, ARGOS 3 and ARGOS 4
  - Revisit time: 1H30 / 2H (satellite connection period)



# Kinéis main goal



- Kinéis main purpose:
  - Extension of the ARGOS system to handle IoT principles
  - Development, production and launch into orbit: 25 new nanosatellites
  - Installation of 20 ground stations around the globe
  - Revisit time => 5 min / 15 min (instead of 1H30 / 2H)
  - Upgrade of the IT infrastructures
- Challenges:
  - Design the new system
  - Validate and launch the constellation
  - Become a key actor for the IoT market

- MBSE process
  - Use the Capella model as the (single) source of truth for system tests

⇒Support the system tests need using Capella models

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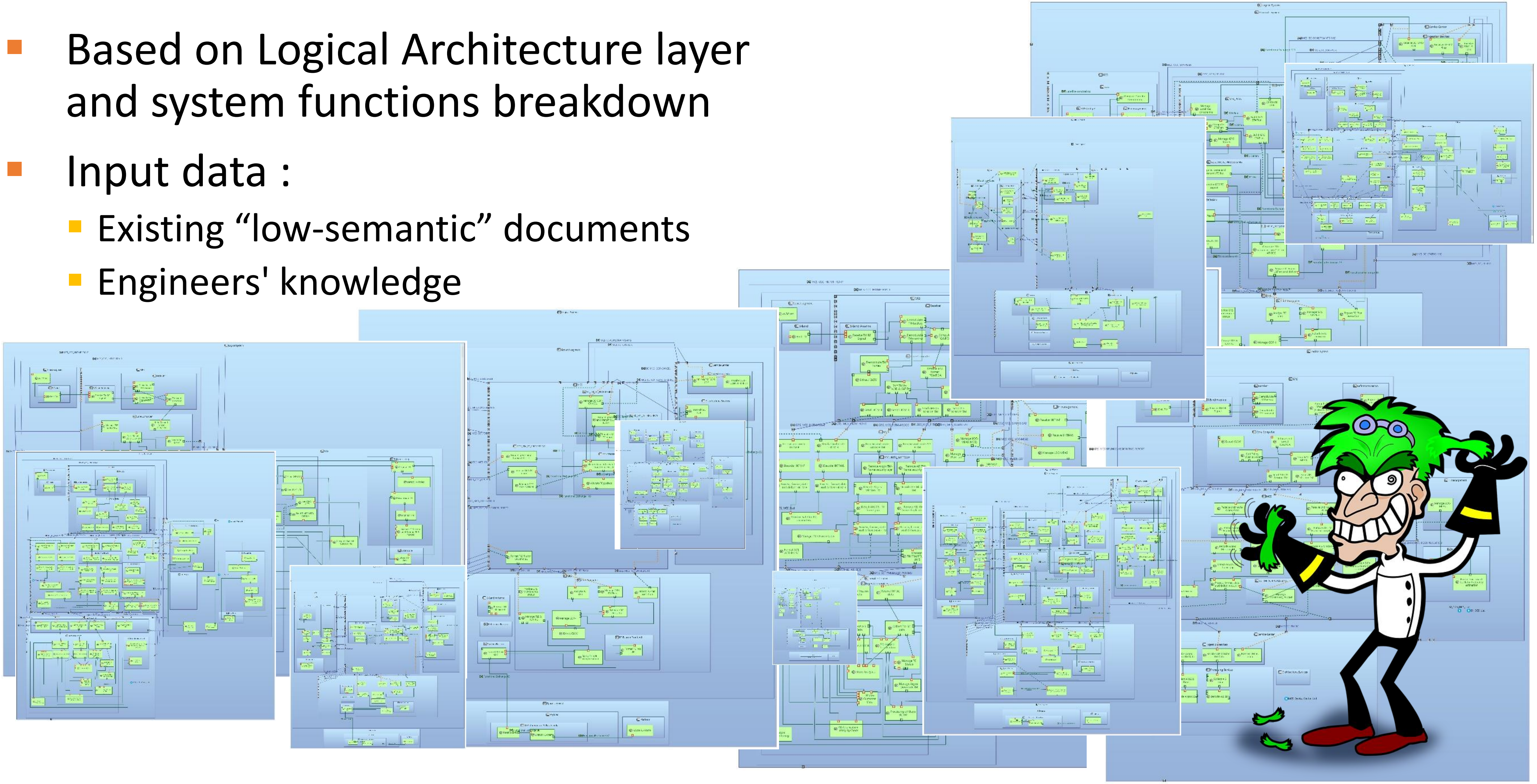
Generate: take advantage of the formal description to generate assets required for system test manual execution and archiving

# Step 1: model initialization (overall view)

- Based on Logical Architecture layer and system functions breakdown
- Input data :
  - Existing “low-semantic” documents
  - Engineers' knowledge



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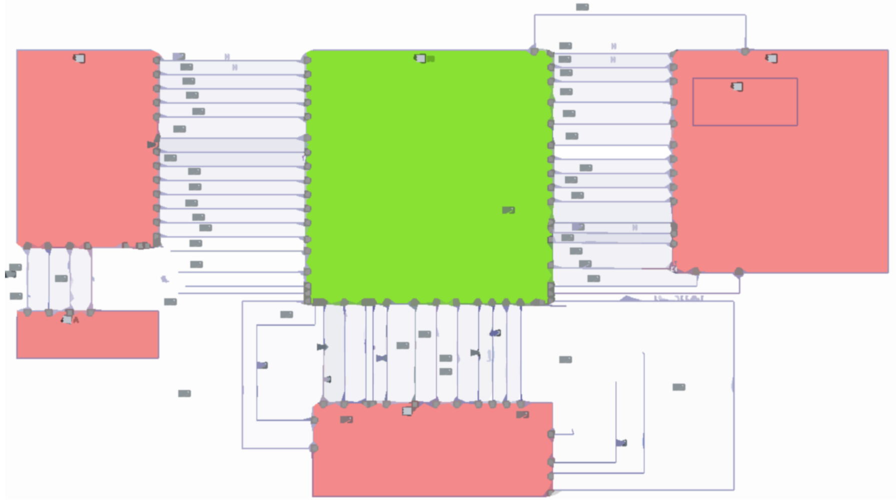

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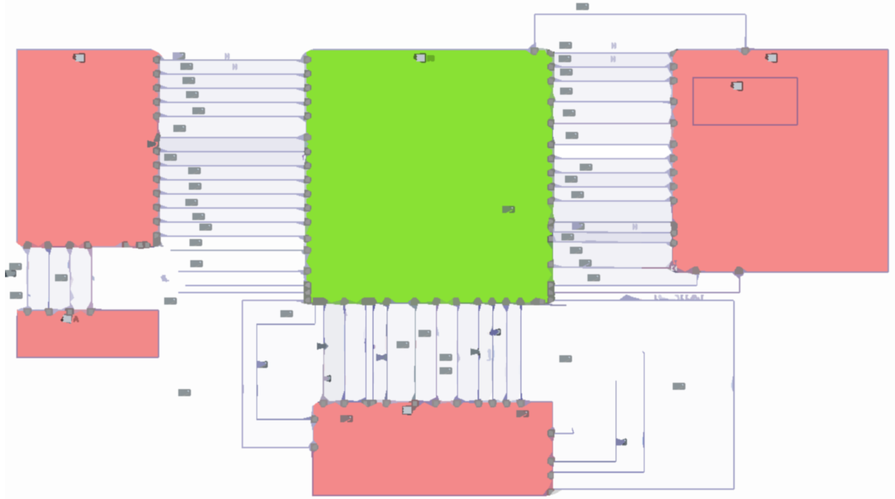

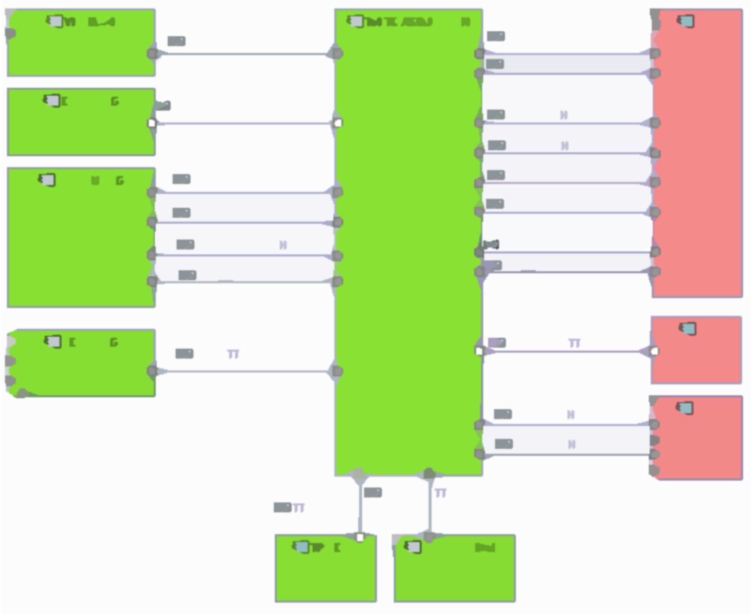

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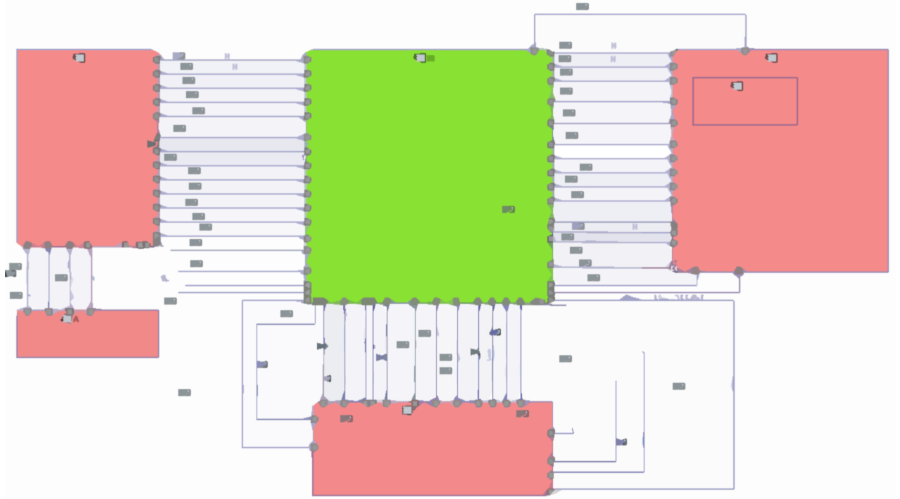

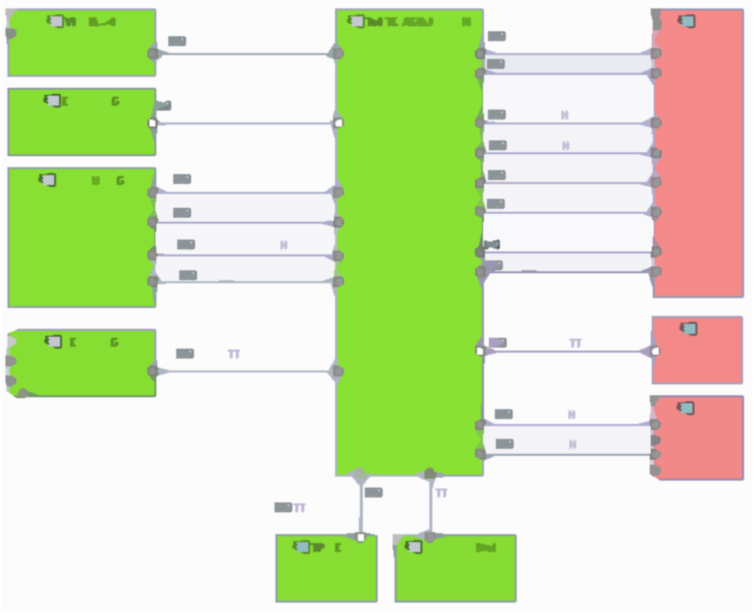

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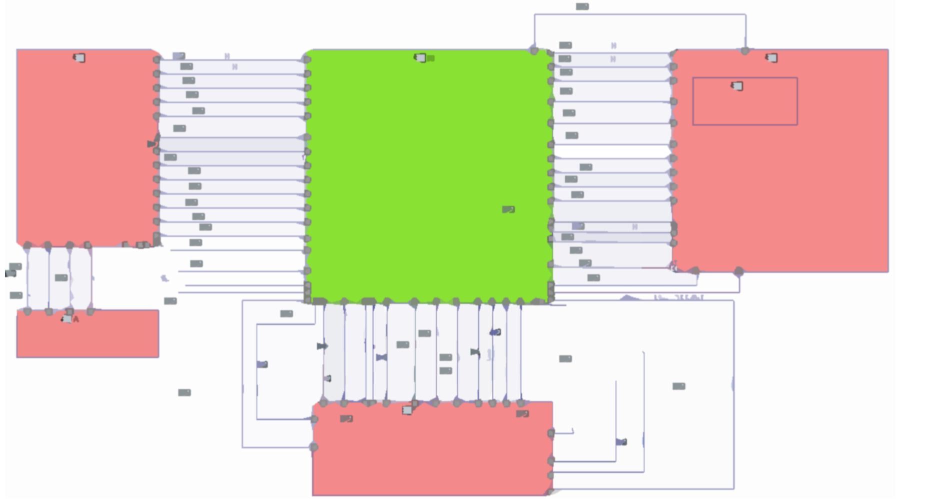
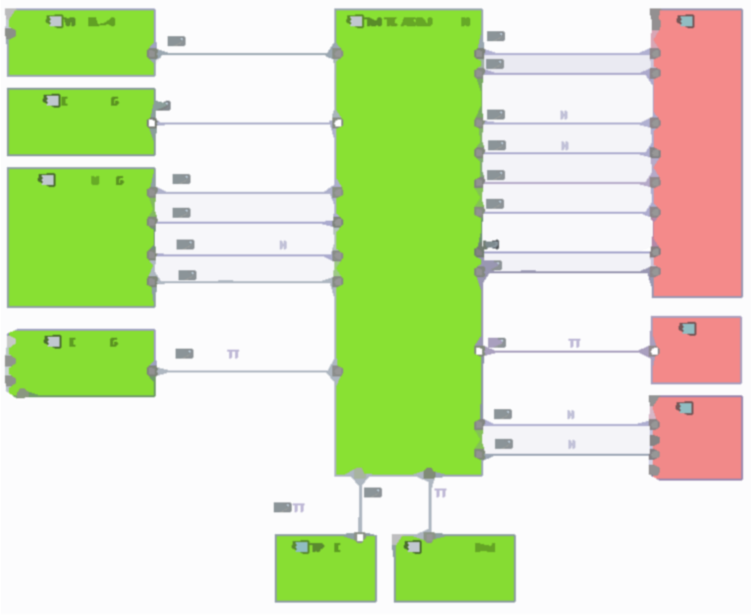
  - How to link the two models ?
  - How to “automatically” inject modifications of the sub-model into the main one ? (Iteratively ?)





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- Solutions:
  - Updates the models to reconnect them using a Capella dedicated feature (REC/RPL)
  - Set traceability link “manually” between the two models
  - Implement a specific “home-made” synchronization algorithm
  - Implement Word document generation to easily compare them “manually”

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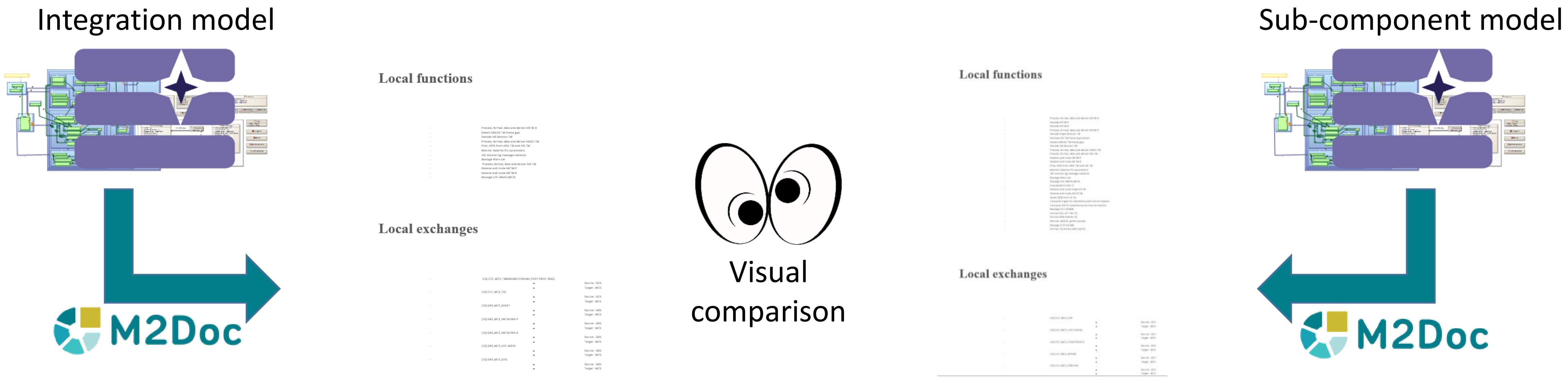

Integration model

Sub-component model

Local functions

Local exchanges

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Visual comparison

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KINEIS feedback

Define the system MBSE model at the beginning of the program in order to work on the same MBSE project with the sub-contractor

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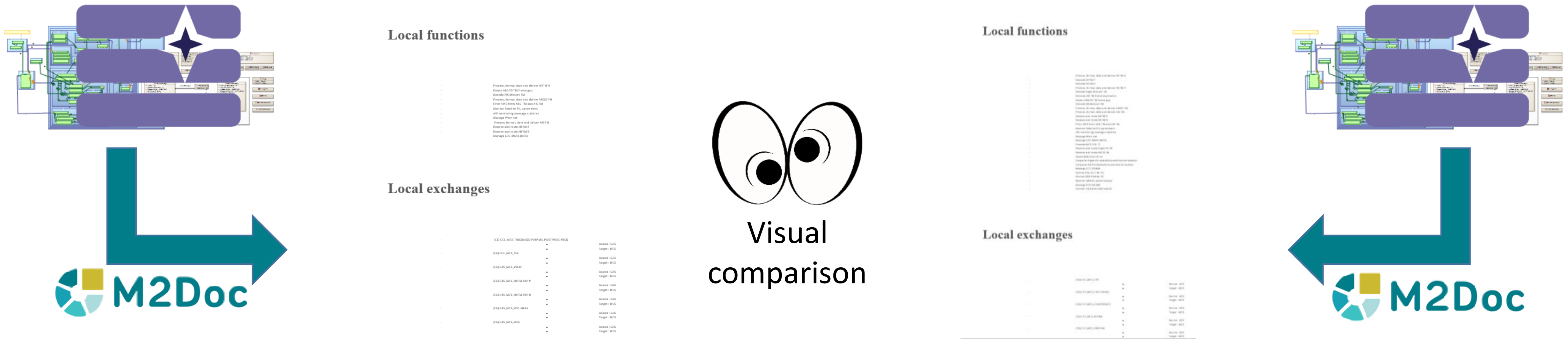
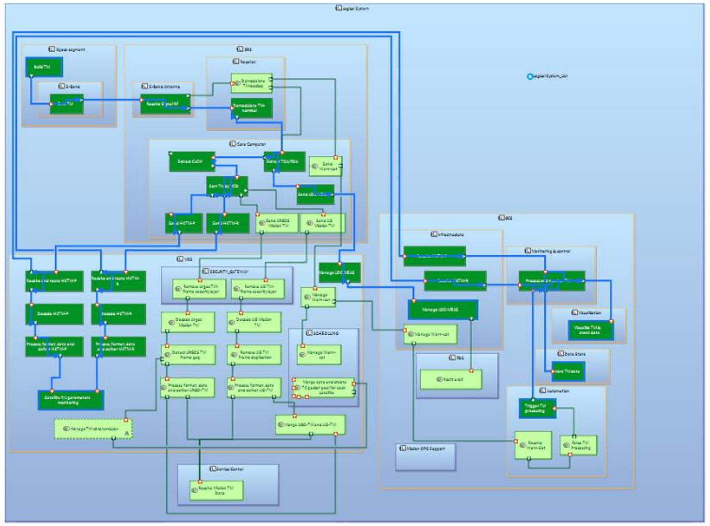
Sub-component model



Visual comparison

# Step 3: description of V&V objectives

- Capture functional chains:
  - In order to highlight composite behaviors
  - In order to identify validation objectives
    - Entry point of the proposed process defined during the CNES/Artal collaboration



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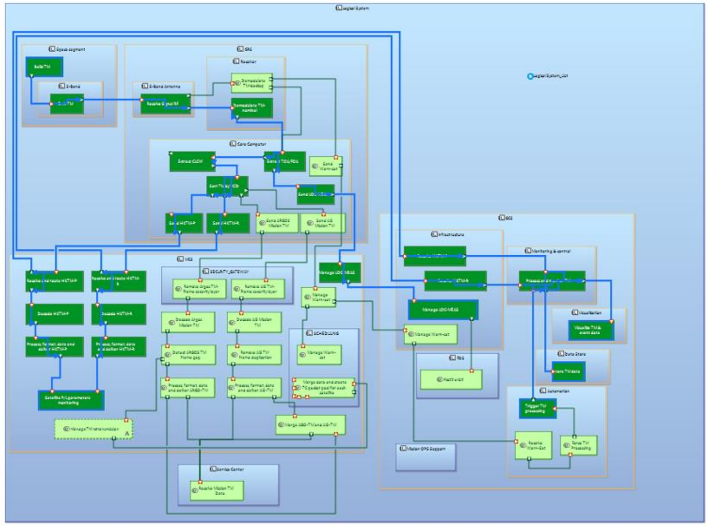

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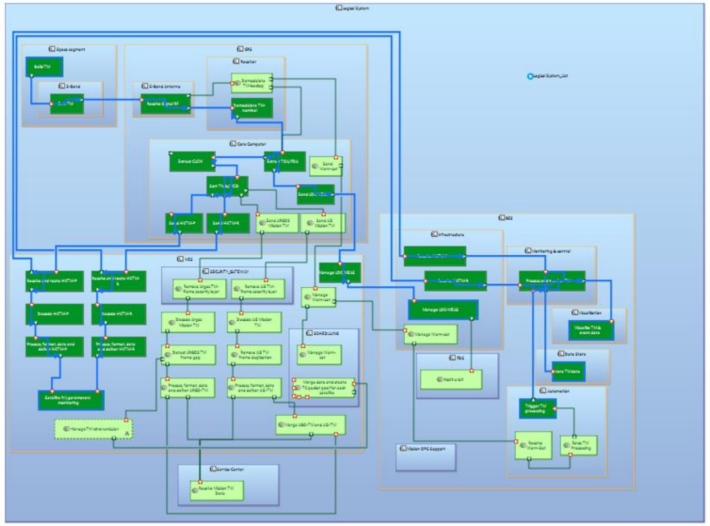
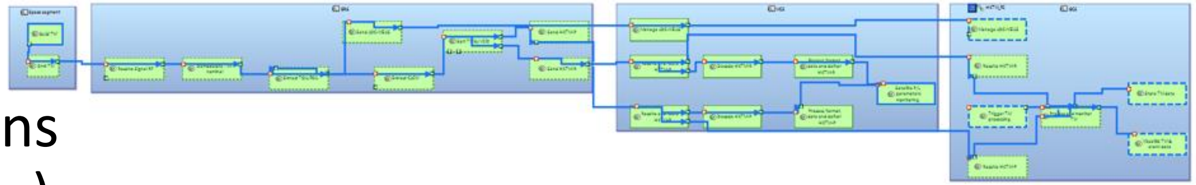


- Limitation: hard to read/understand for non-initiated people
  - Creation of dedicated representations (Focusing on a given functional chain)

    ⇒ To clarify inputs and functions to be validated for each sub-system

    ⇒ Assisted by a new dedicated tool that simplify their generation



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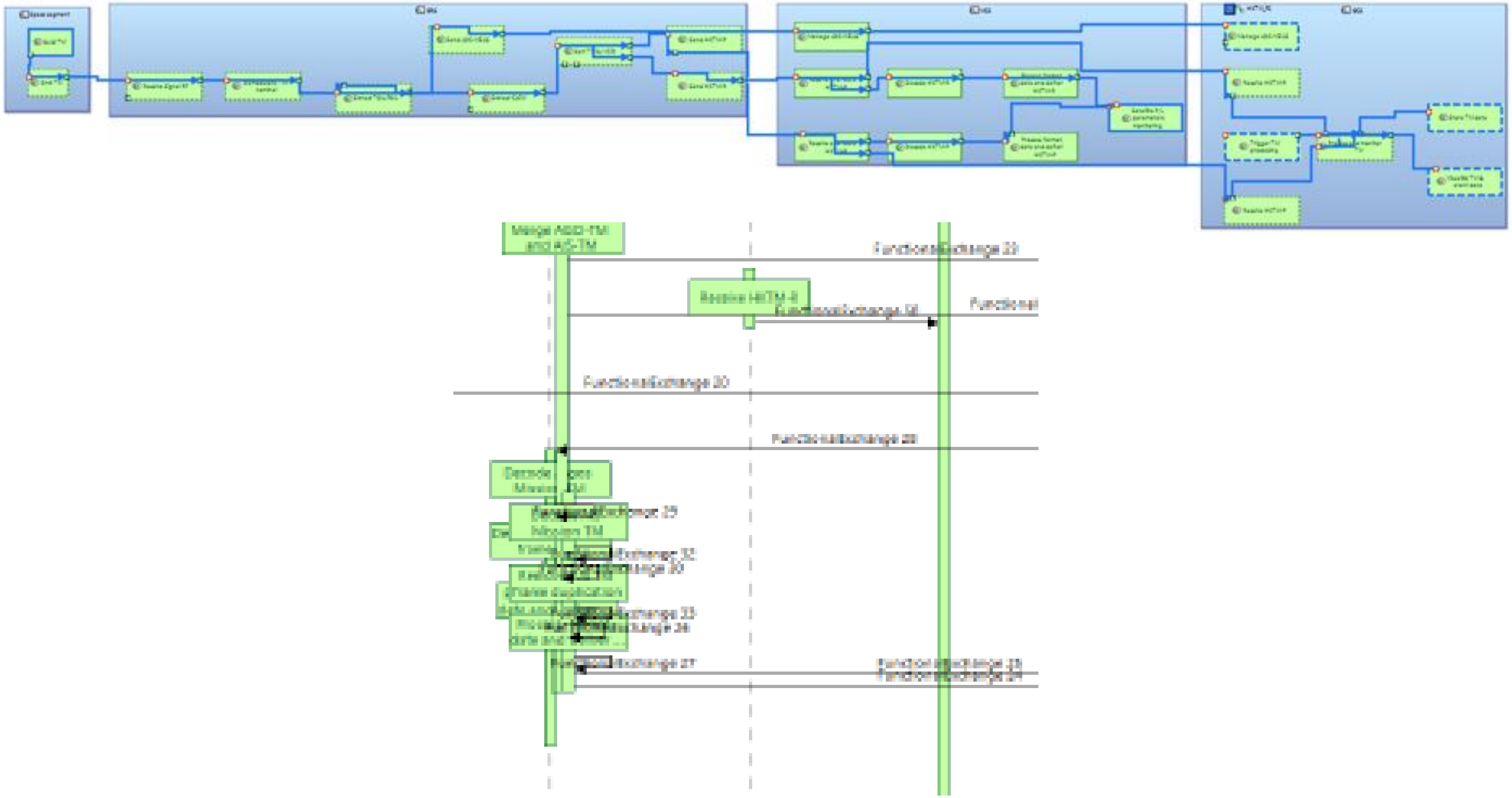

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    - Allows functions “superposition”
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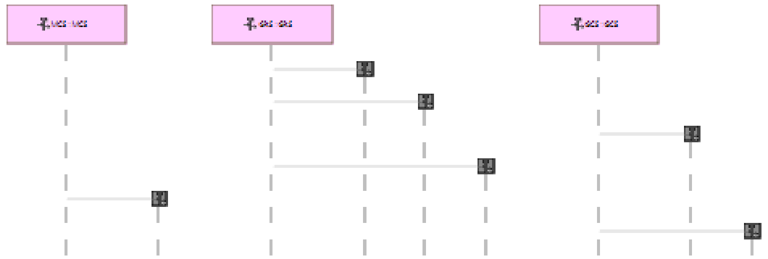

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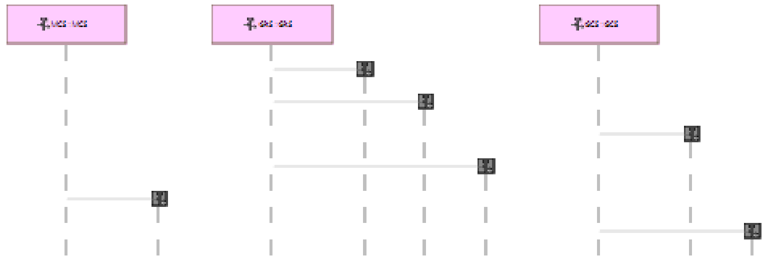
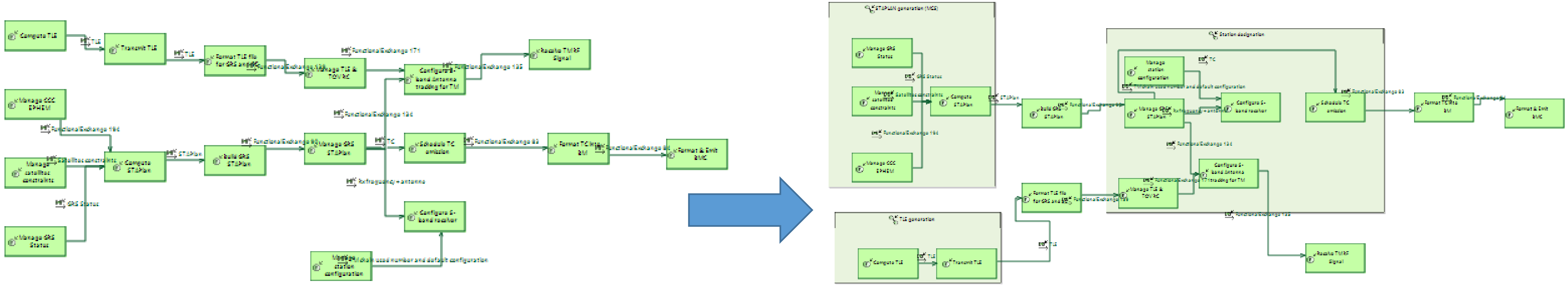


  - Injection of “sub-functional chain” support to compact scenarios



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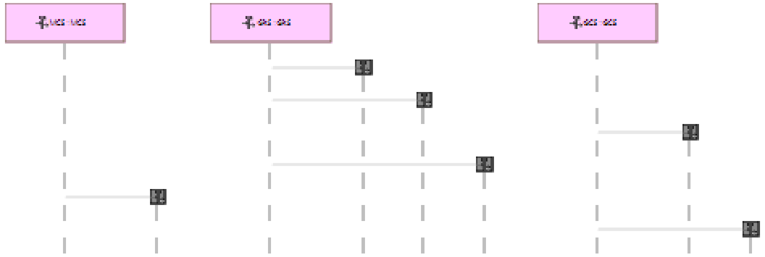

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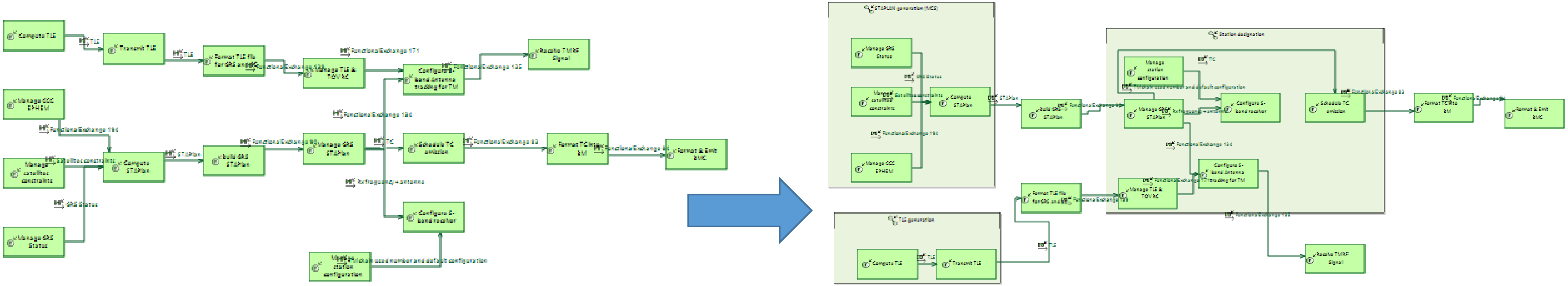

  - Injection of “super-compression” feature for extreme cases

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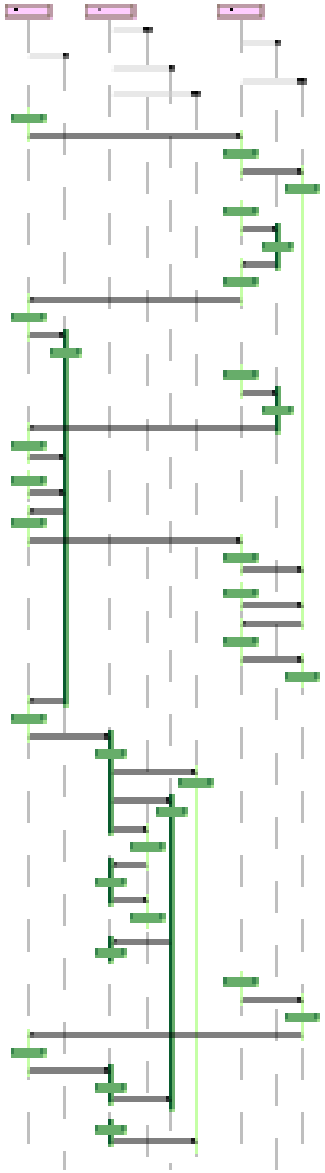

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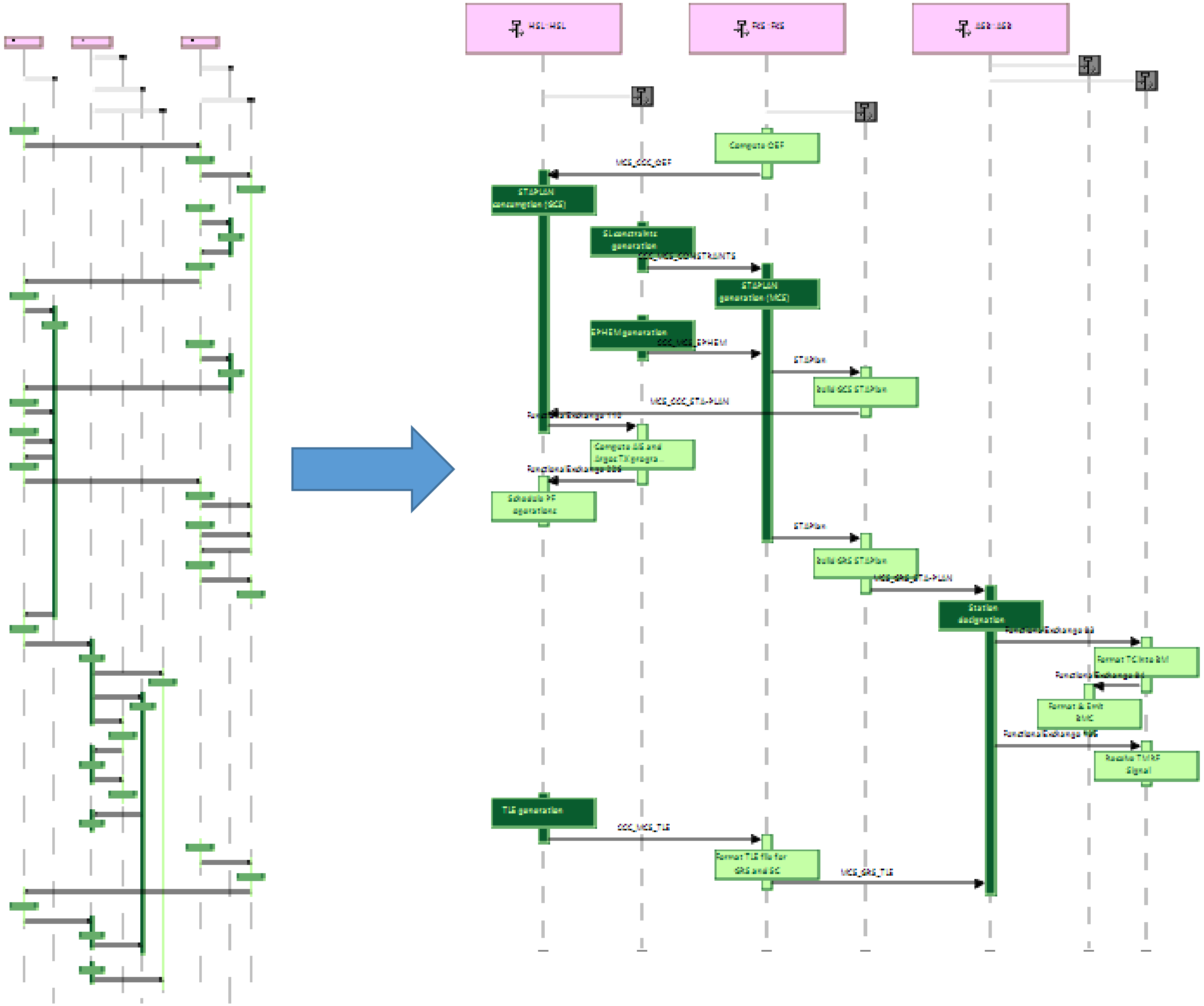

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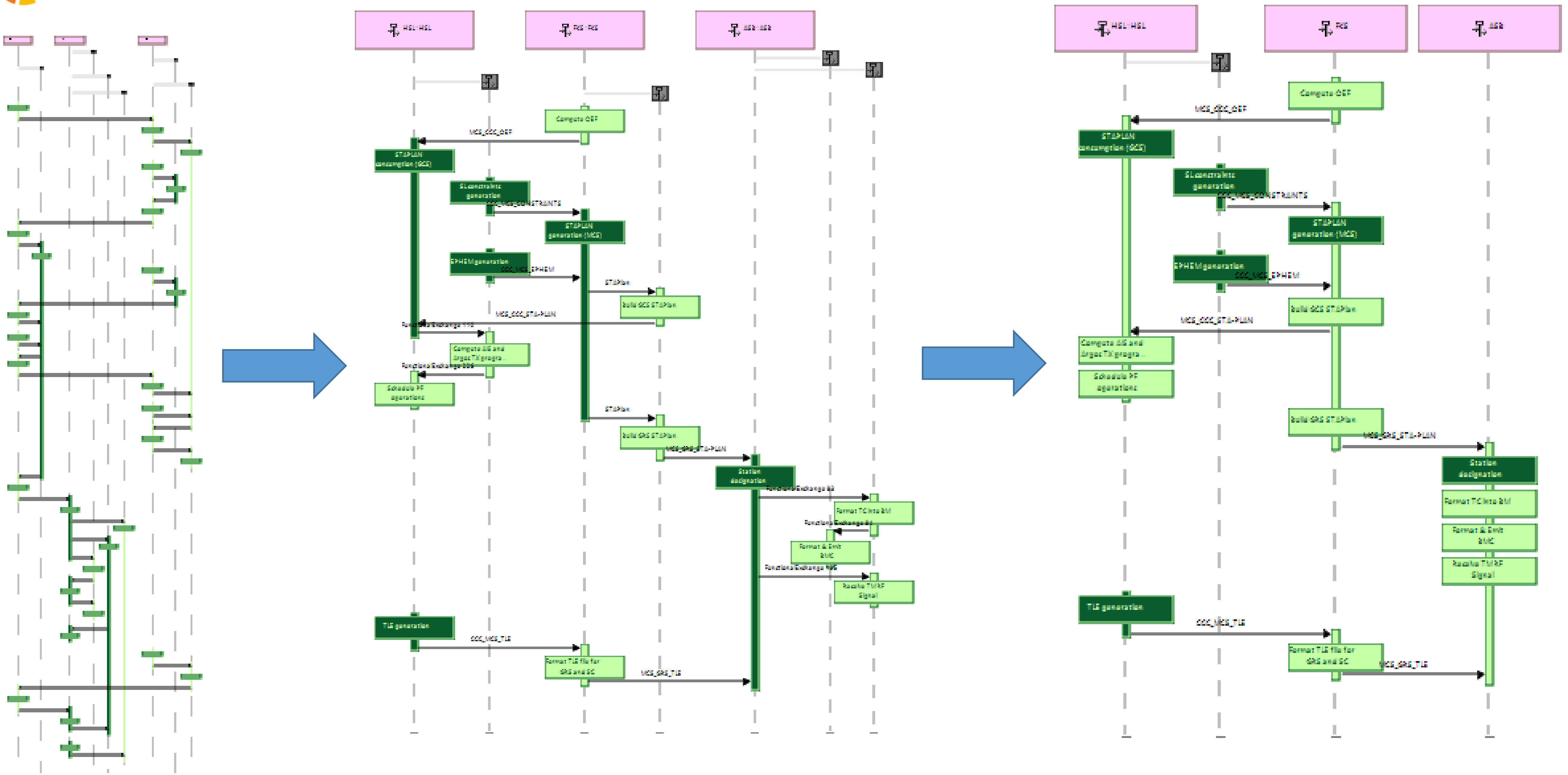

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  - Identification of user interactions and success criteria

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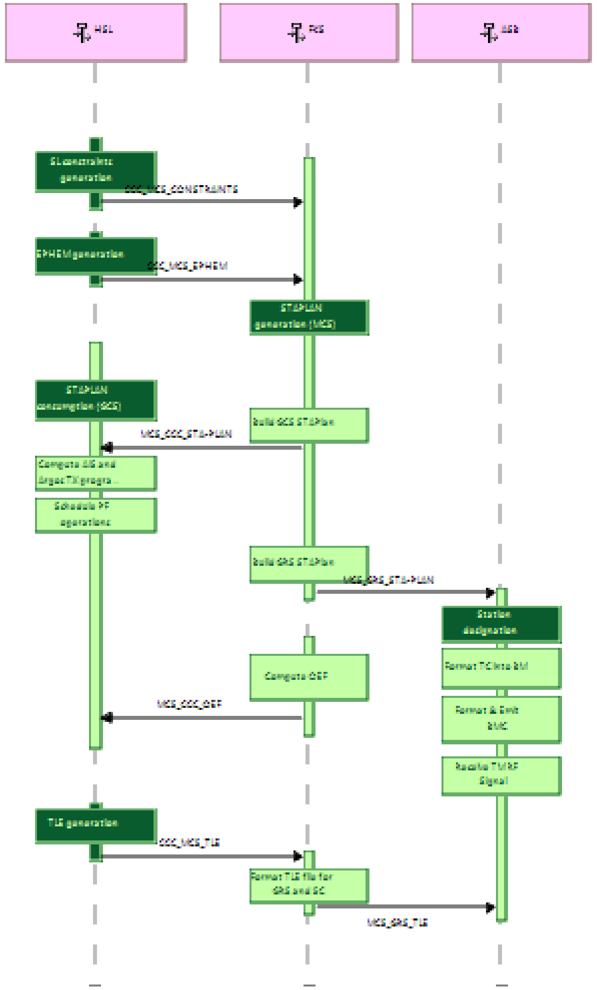
# Step 5: user interaction and success criteria

- Inject test scenarios execution instructions



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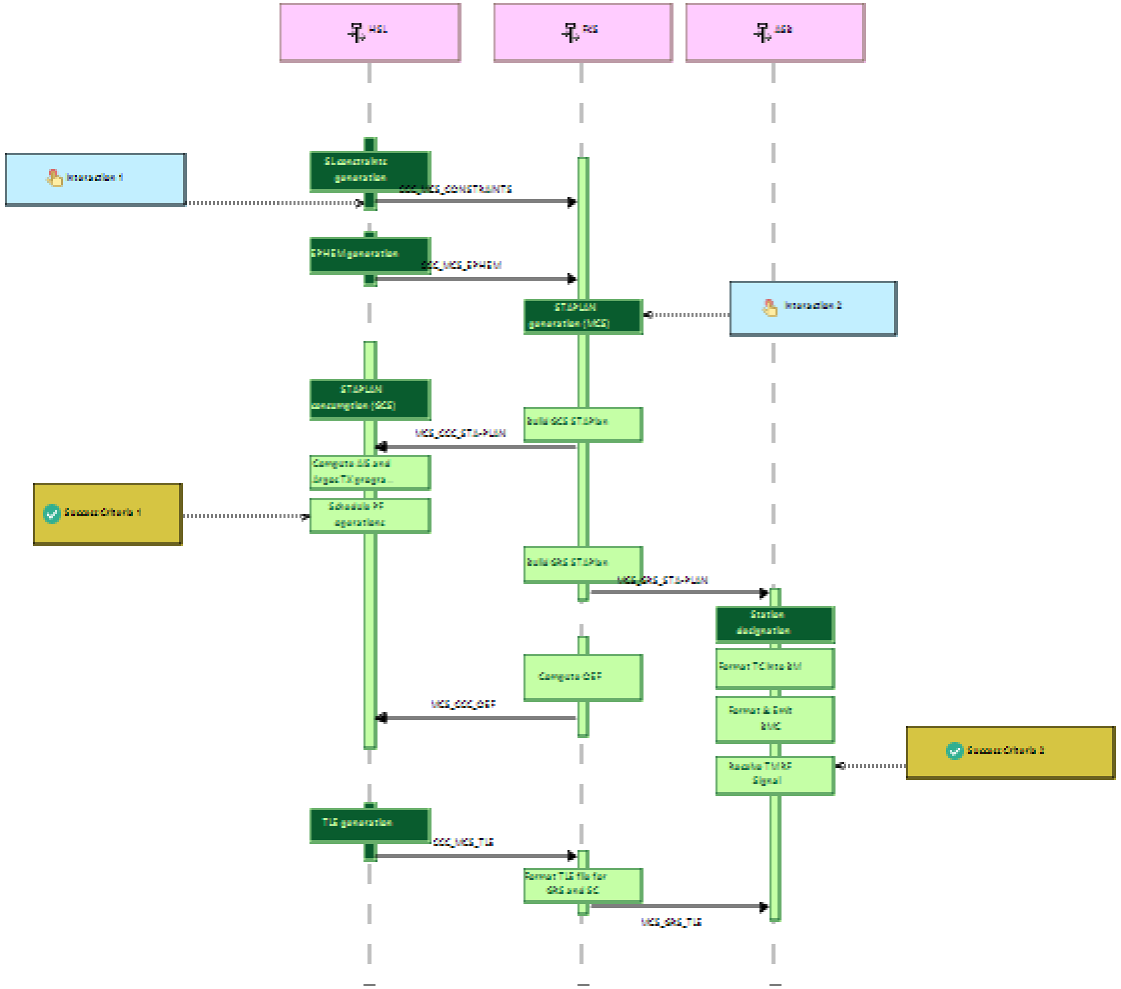

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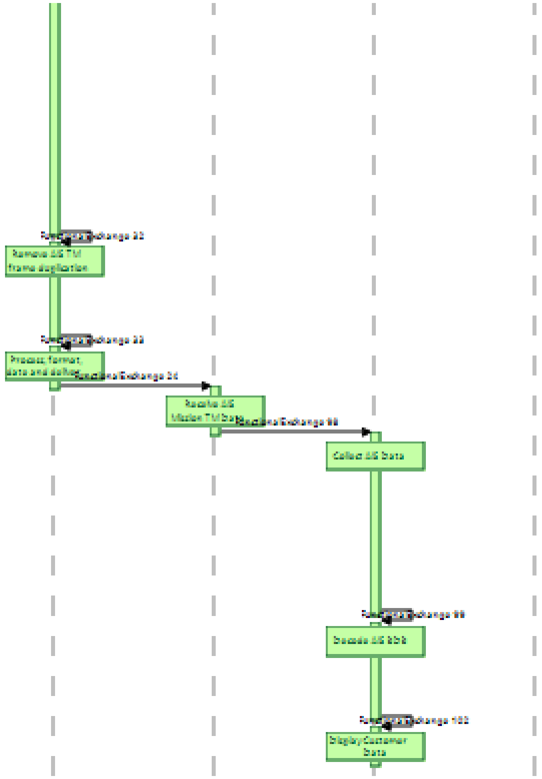
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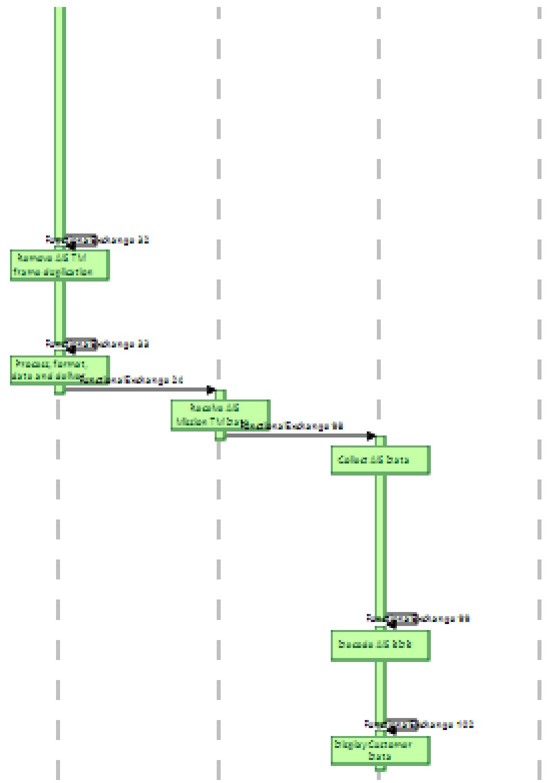

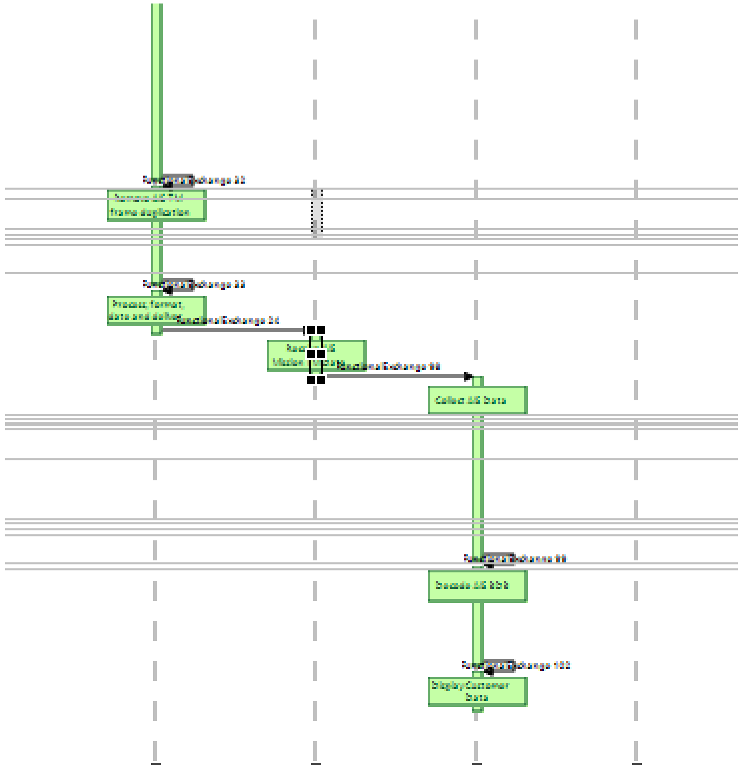

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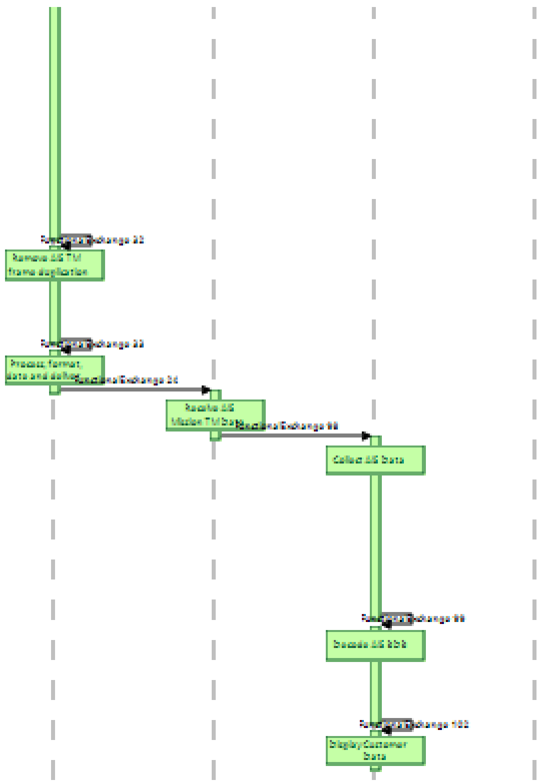
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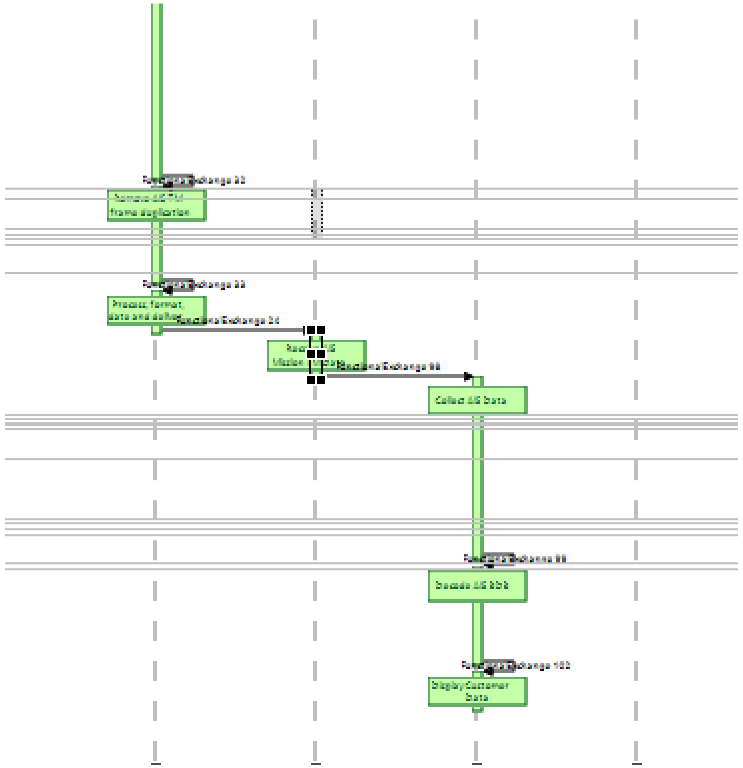
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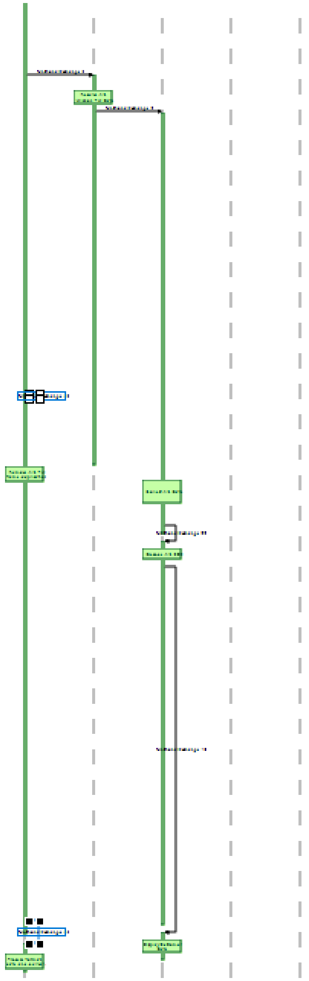

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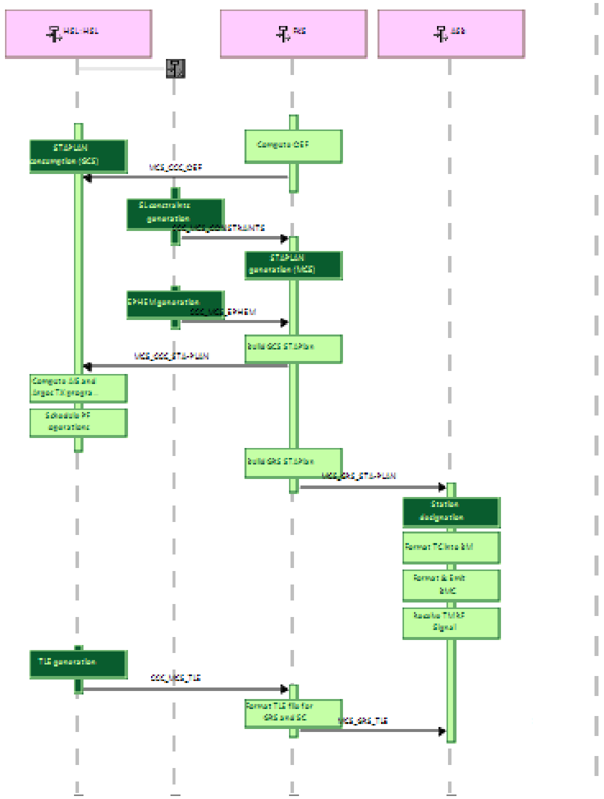

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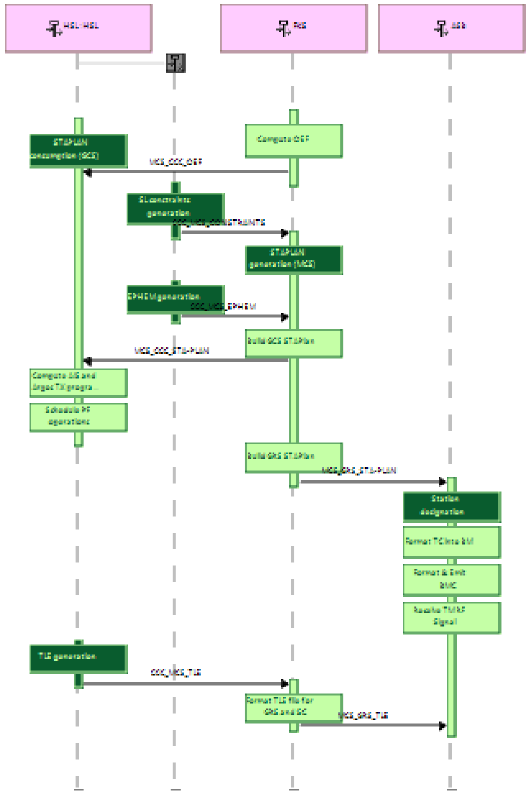

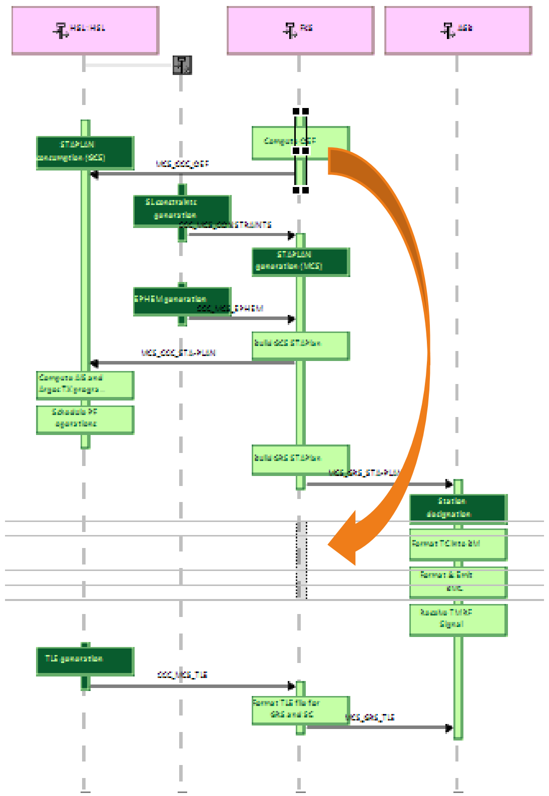

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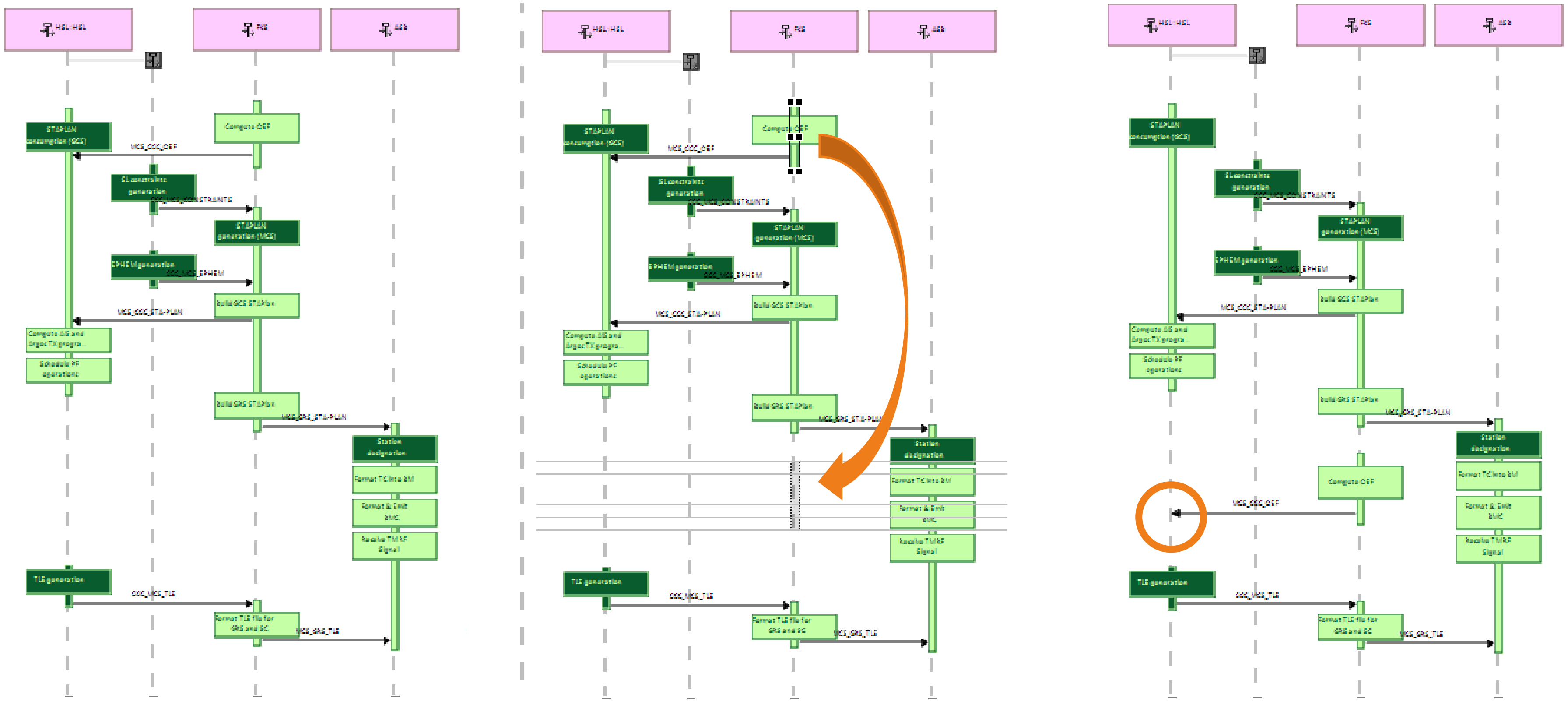

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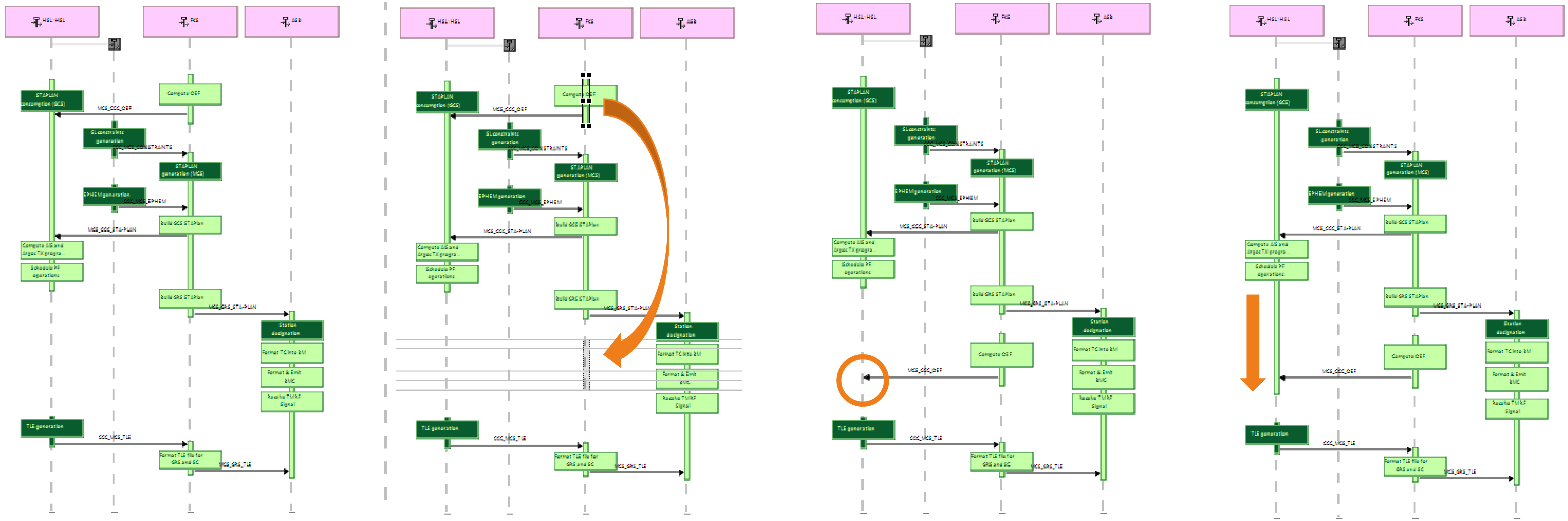
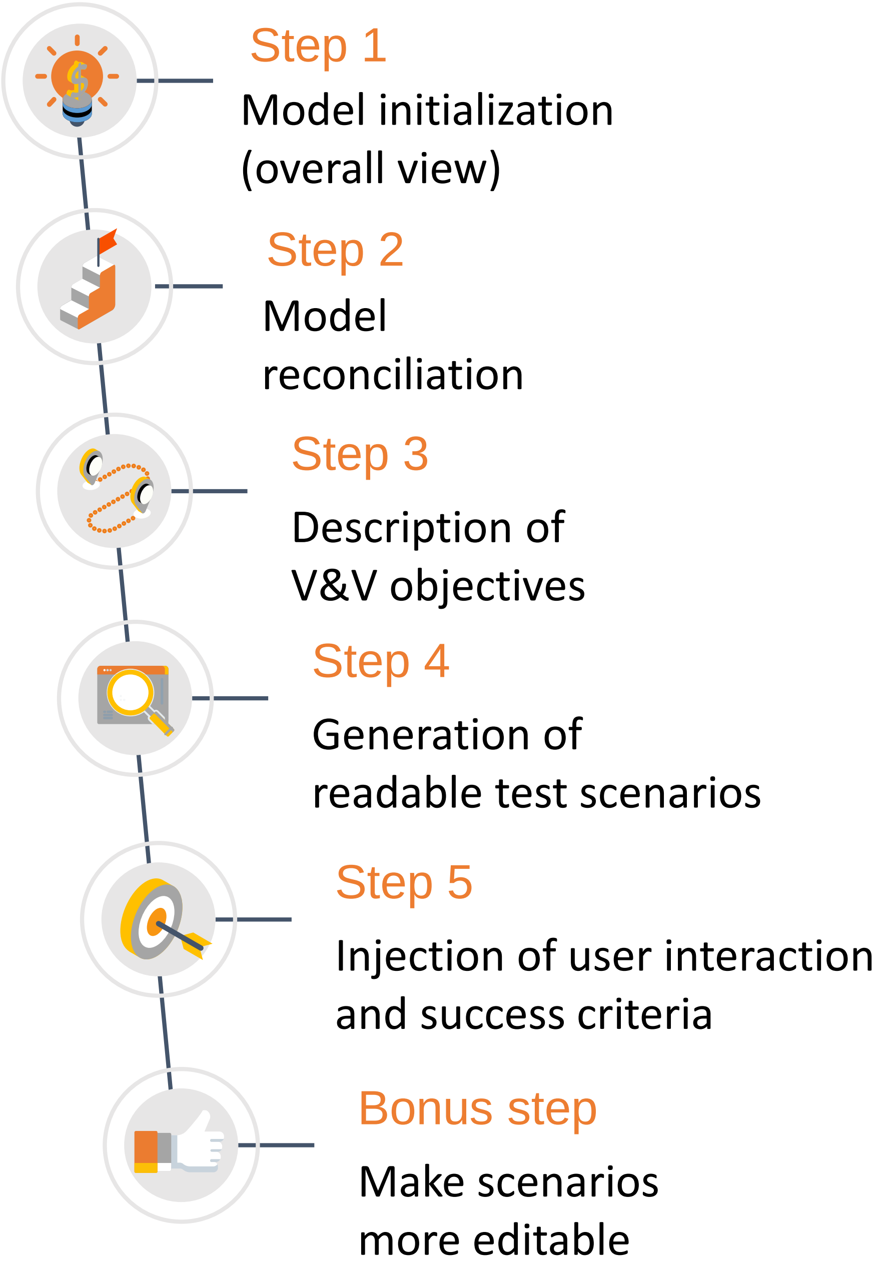


# Conclusion

- Review:
  - 1 year Kinéis / Artal collaboration
  - Remaining 9 months before launch
  - Kinéis have gained a new skill: MBSE/Capella
  - System tests capture in progress
    - Based on Capella models (growing)
      - 33 components / 112 component ports
      - 200 functions / 500 function ports
      - 33 functional chains
    - Using a dedicated Capella extension



Step 1
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Step 2
Model reconciliation

Step 3
Description of V&V objectives

Step 4
Generation of readable test scenarios

Step 5
Injection of user interaction and success criteria

Bonus step
Make scenarios more editable

# Conclusion: Kinéis feedback

- ⊕ Improvement of communication between teams
- ⊕ Optimization of component development plans according to the functional needs of the system
- ⊕ Automatic update of V&V objectives and scenarios (in case of system architecture modification)
- ⊕ Better visibility for system test definition
- ⊕ Automatic initialization of test cases scenario

- ⊖ Capella not easy to pick-up, assistance (and time) required
- ⊖ Difficult responsiveness in real time (during meetings)
- ⊖ Model reconciliations are laborious

  => Essential to respect scheduling: main view prior to sub-components in this case

More information on

http://capella.artal-group.com