

Model Based Approach for Functional Chain Engineering

From System Model to SW Specification

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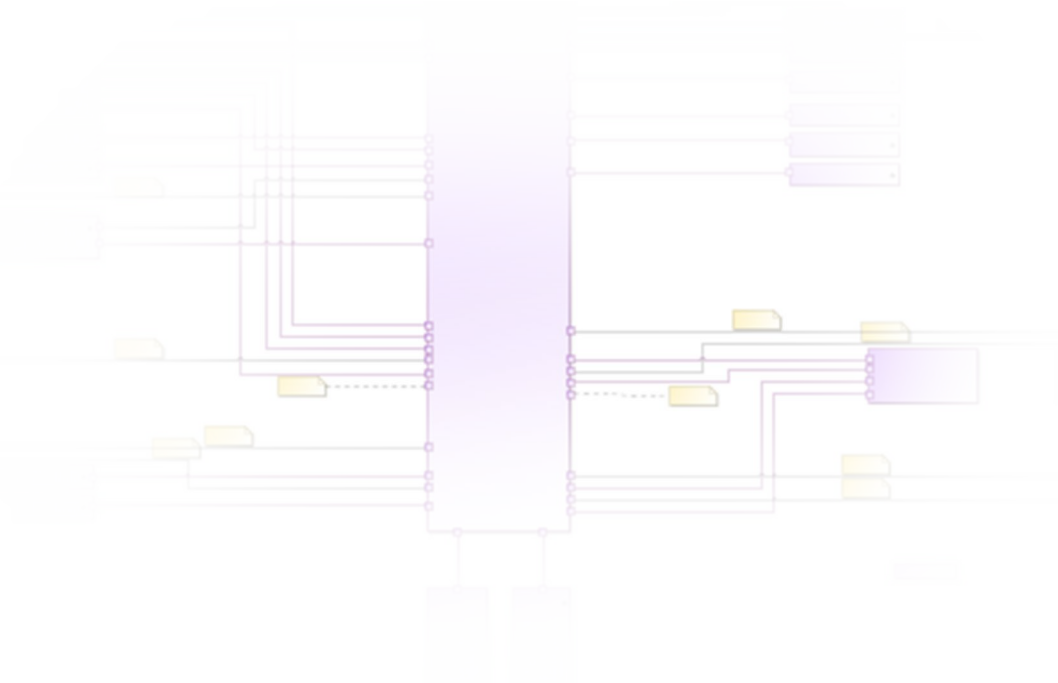
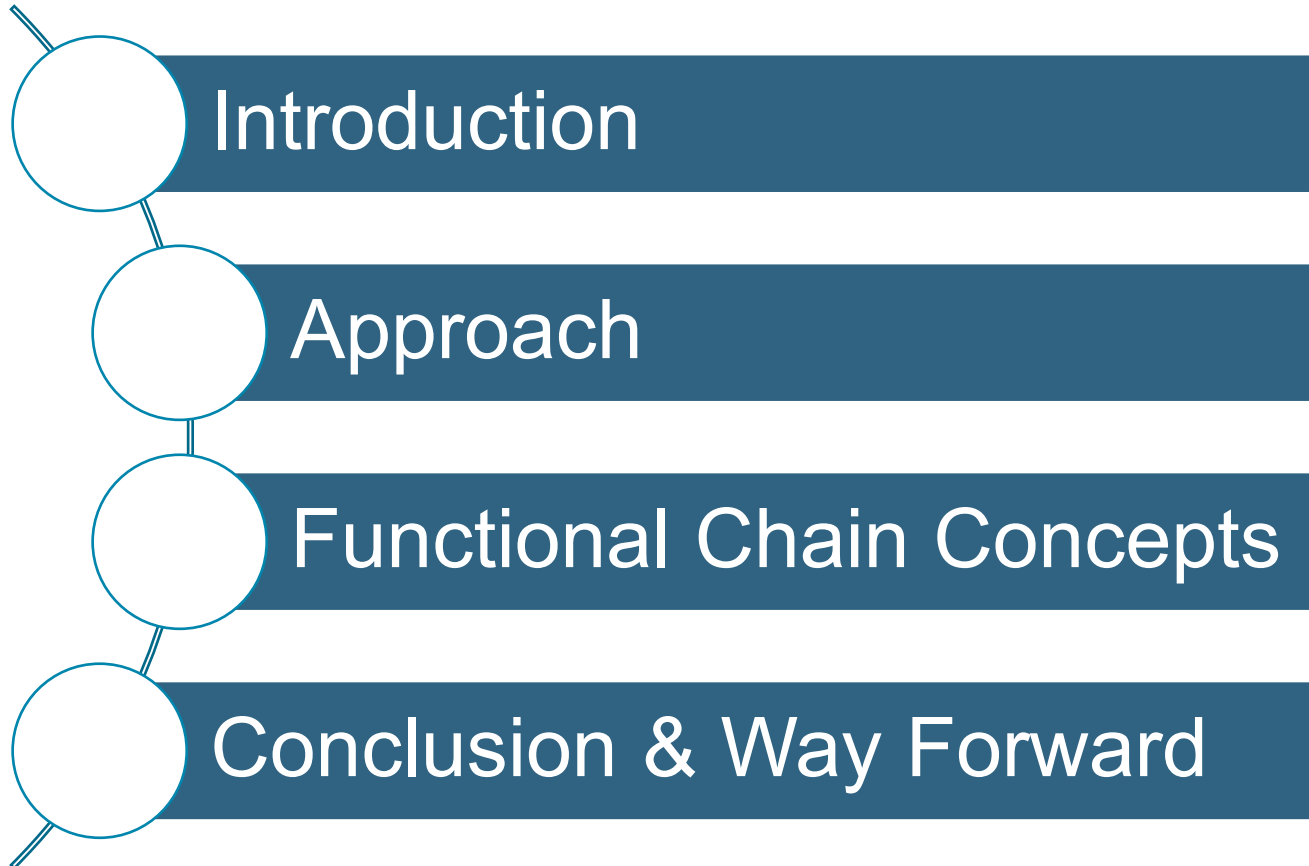
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Summary



Introduction

Heritage : ATV & ESM Orion's Functional Method (1/3)

- ATV & ESM Orion's approach : **Breakdown** of Functional Engineering in **Functional Chains**

Functional Chain (FC)

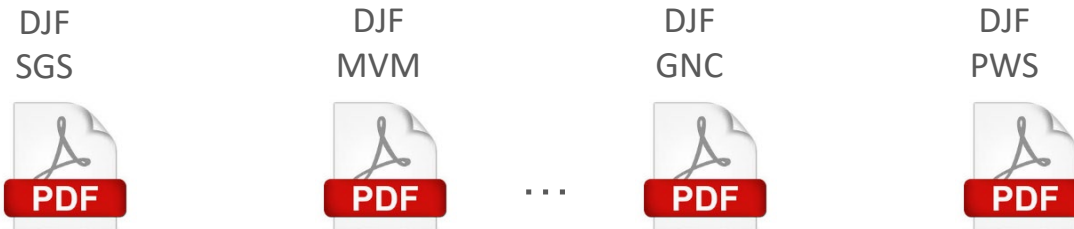
*FC is a set of functions and equipment physically linked to the same power and data bus, organized so as to **provide a common set of service** to the vehicle and its mission*

- Exemples of Functional Chains in ATV project :
 - ✓ **SGS** : Solar Generation System
 - ✓ **MVM** : Mode Vehicle Management
 - ✓ **GNC** : Guidance, Navigation and Control
- Equipment inside a same Functional Chain **may belong to a same subsystem or to different subsystems.**
- Some FC can be purely Functional (set of SW component).

Introduction

Heritage : ATV & ESM Orion's Functional Method (2/3)

- Each FC described in an independent DJF (*Design Justification File*) document.

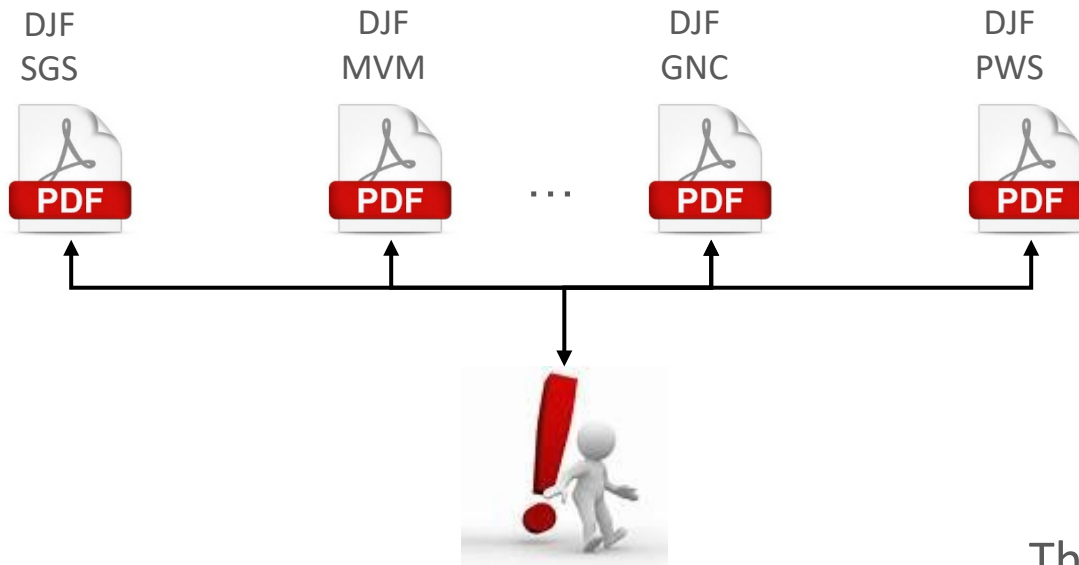


- Main content of DJF documents :
 - **Life Profile** of the FC
 - **(Virtual) Modes** of the FC
 - **Functional Blocks and Processes** (i.e. Functions & Functional Dynamic Scenarios)
 - **Observability & Commandability** aspects of the FC
 - **Hardware Implementation**
 - **Hardware Configurations** vs modes and life profile
 - **Commanding Sequences** for configuration switches

Introduction

Heritage : ATV & ESM Orion's Functional Method (3/3)

- Each FC described in an independent DJF (*Design Justification File*) document.



Functional Chains interacts !

This led to **big efforts** in maintaining the **consistency of the overall set of documents** including naming and typing of interfaces

Introduction

Model Based Approach for Functional Chain Engineering

Apply the ATV / ESM Orion's functional method using a Model-Based Approach :



- to **ensure consistency** between FC definition including interfaces
- to **improve the co-engineering** between systems, functional and SW architects
- to **improve internal and external review** processes of the functional design.

Approach

MOFLT© Framework Extension for FC

- **MOFLT© Airbus Framework :**

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- **MBSE Method** for capturing **Mission Operation Functional Logical Technical** architectures
- **MBSE Tool** based on SysML language and Cameo System Modeler®

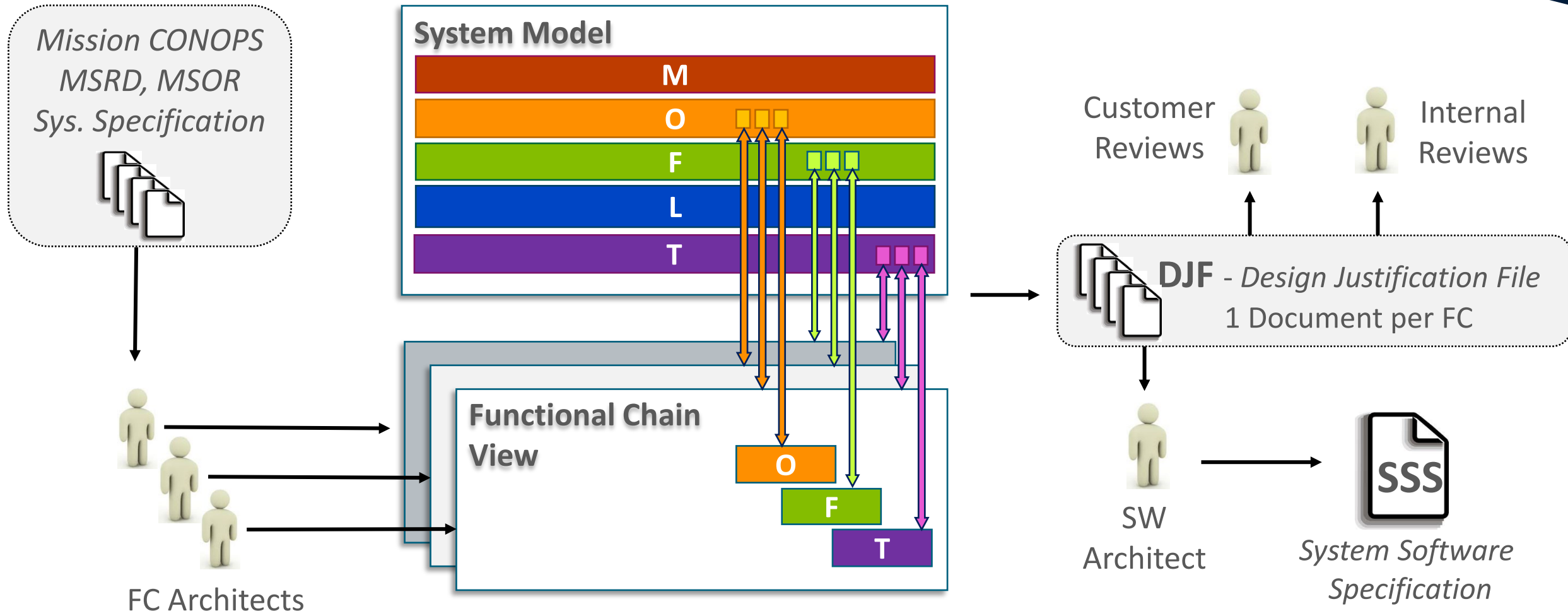
- **MOFLT© Framework has been extended to support Functional Chain Engineering approach**

- Extension fully compliant and relying on MOFLT©
- Introduction of new concepts to support FC engineering approach
 - UML Profiles & Customizations
- Extension of the tooling :
 - Dedicated Cameo Perspectives
 - Consistency validation rules
 - DJF Document generator



Approach

Model Based Approach for Functional Chain Engineering

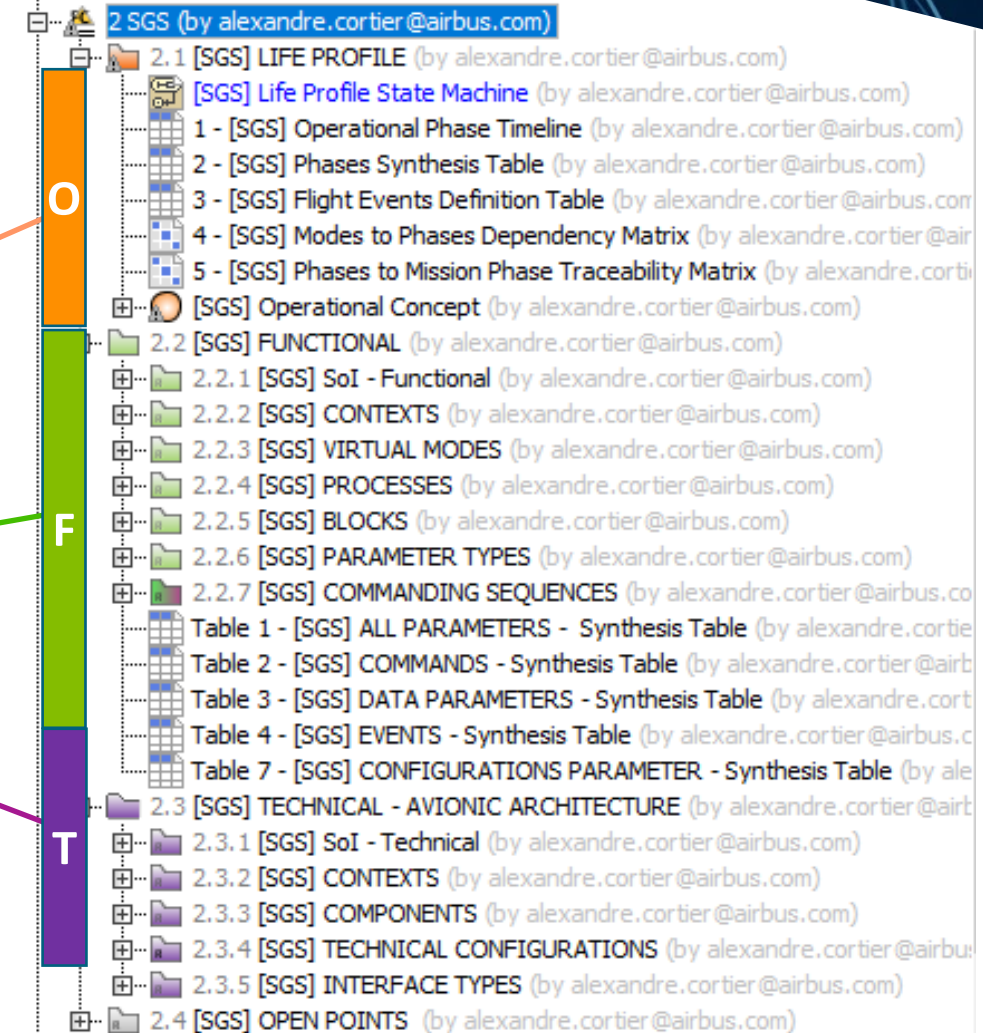
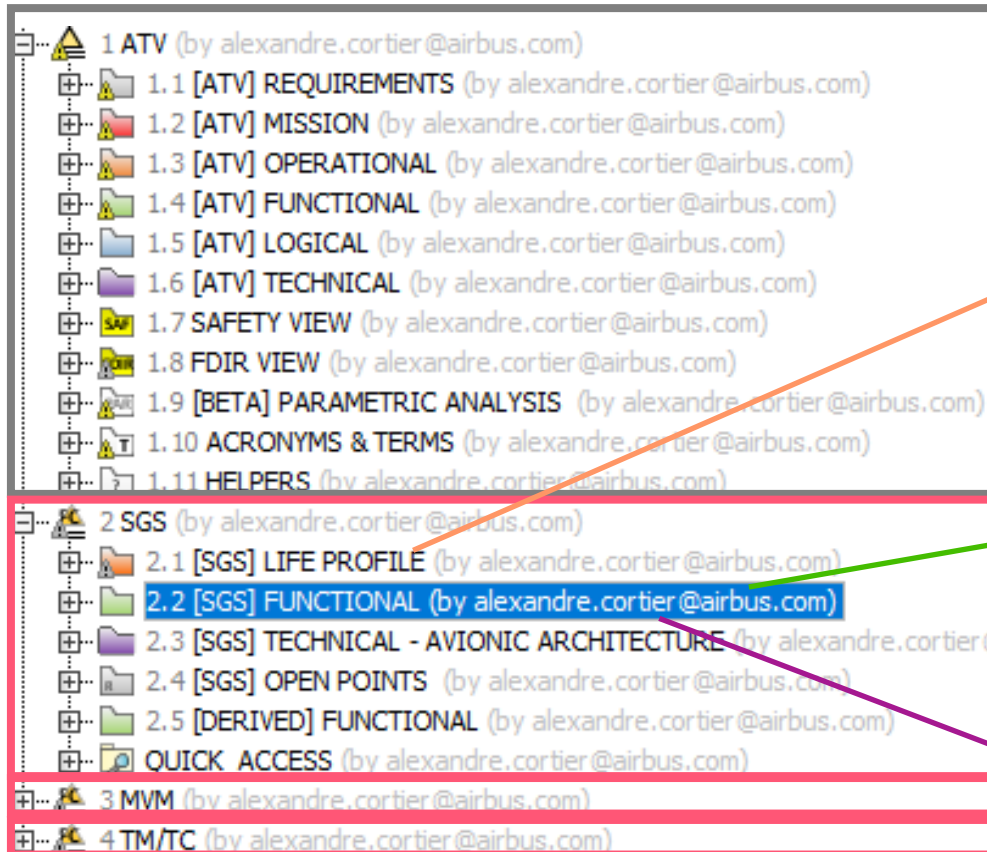


Approach

Model Based Approach for Functional Chain Engineering

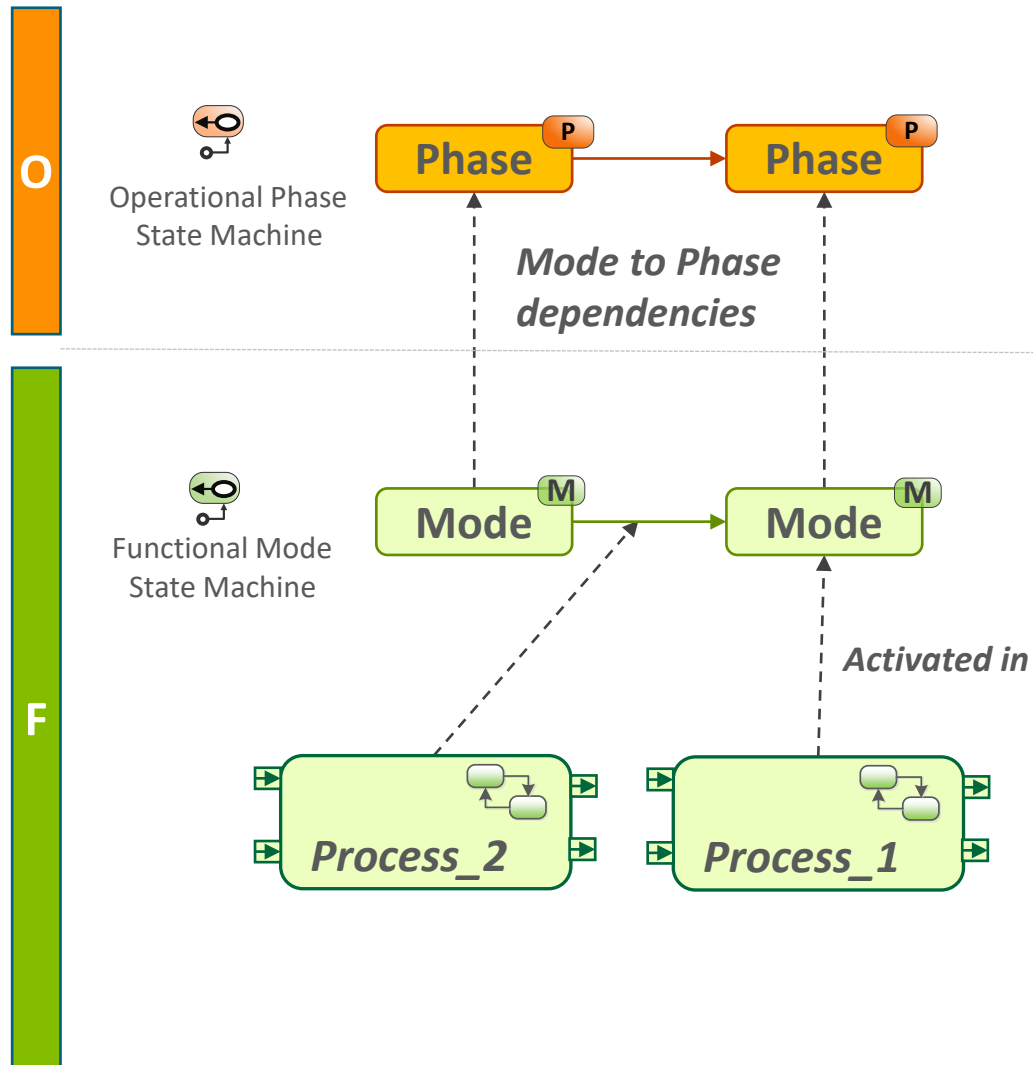
System Model
Template

Functional Chain
Views
Templates



One « sub-model » structure
per Functional Chain.

Functional Chain Concepts



FC Life Profile

- OperationalPhase & OperationalEvent
- Operational Timeline



Functional Modes

Functional Processes

- Dynamic Patterns & Activation frequency



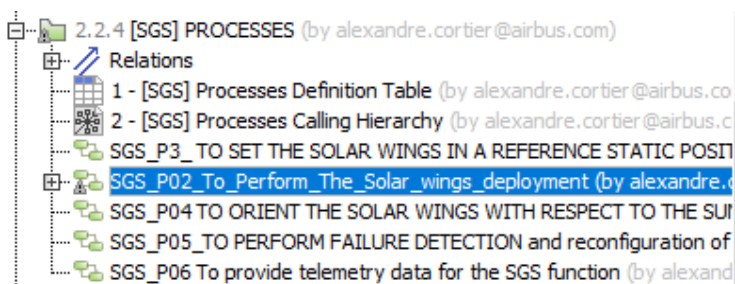
Functional Parameters

- Event, Command, Data parameters
- Configuration Parameters
- Observability & modifiability specification
- Encoding Format
- Engineering Unit
- Range



Functional Chain Concepts

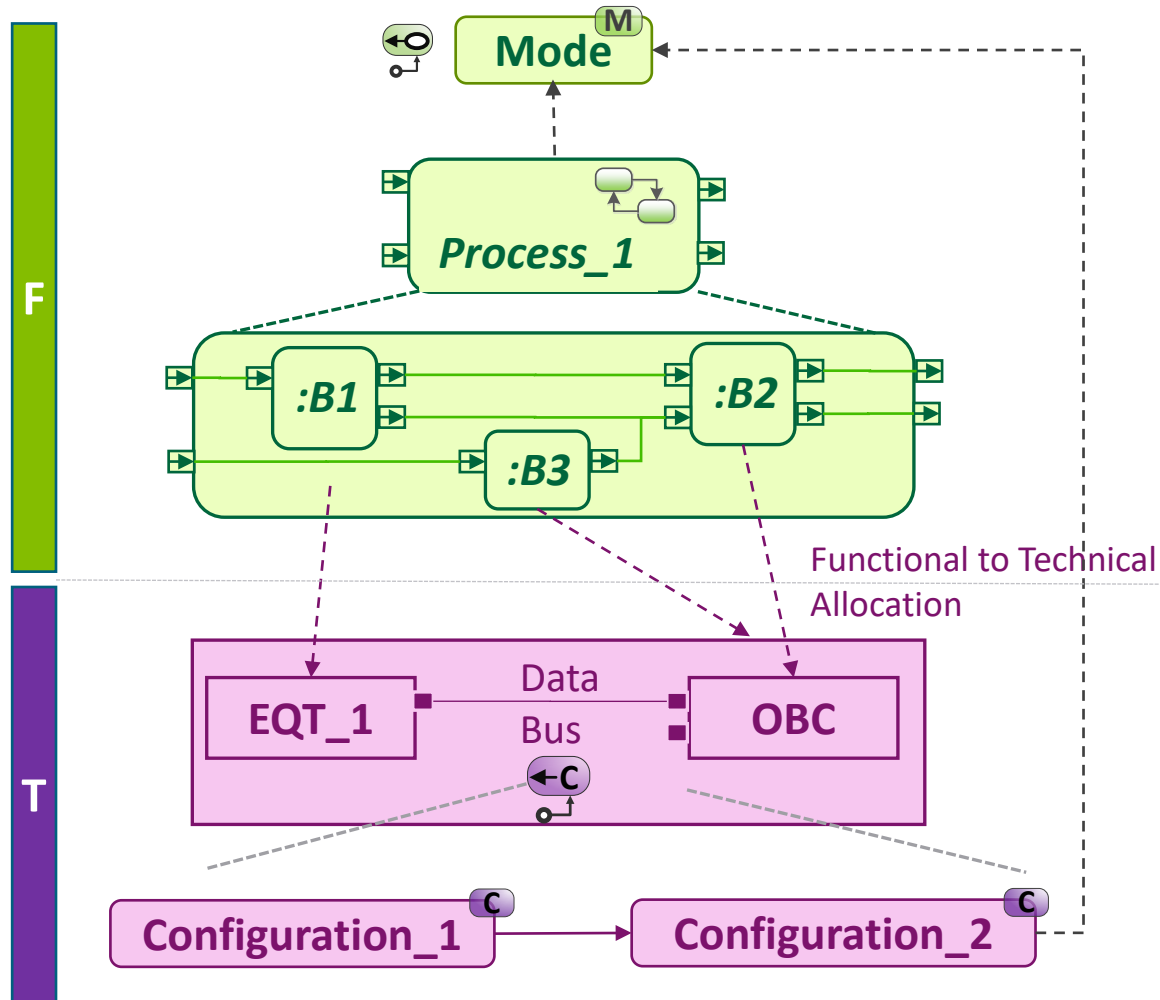
Containment Tree



Specification View of a Function / Process

Function Behavior	
Name	SGS_P02_To_Perform_The_Solar_wings_deployment
Short Description	
Behavior Owner	2.2.4 [SGS] PROCESSES [[SANDBOX]::[SGS]::[SGS] F...
Activable By Mode	
Dynamic Pattern	PERIODIC
To Do	
Periodic Specification	
Frequency	
Frequency Unit	hertz : DerivedUnit [ISO-80000::ISO80000-3 Space an...

Functional Chain Concepts



FC Modes

Functional Processes

- ⇔ MOFLT Composite Function Behavior

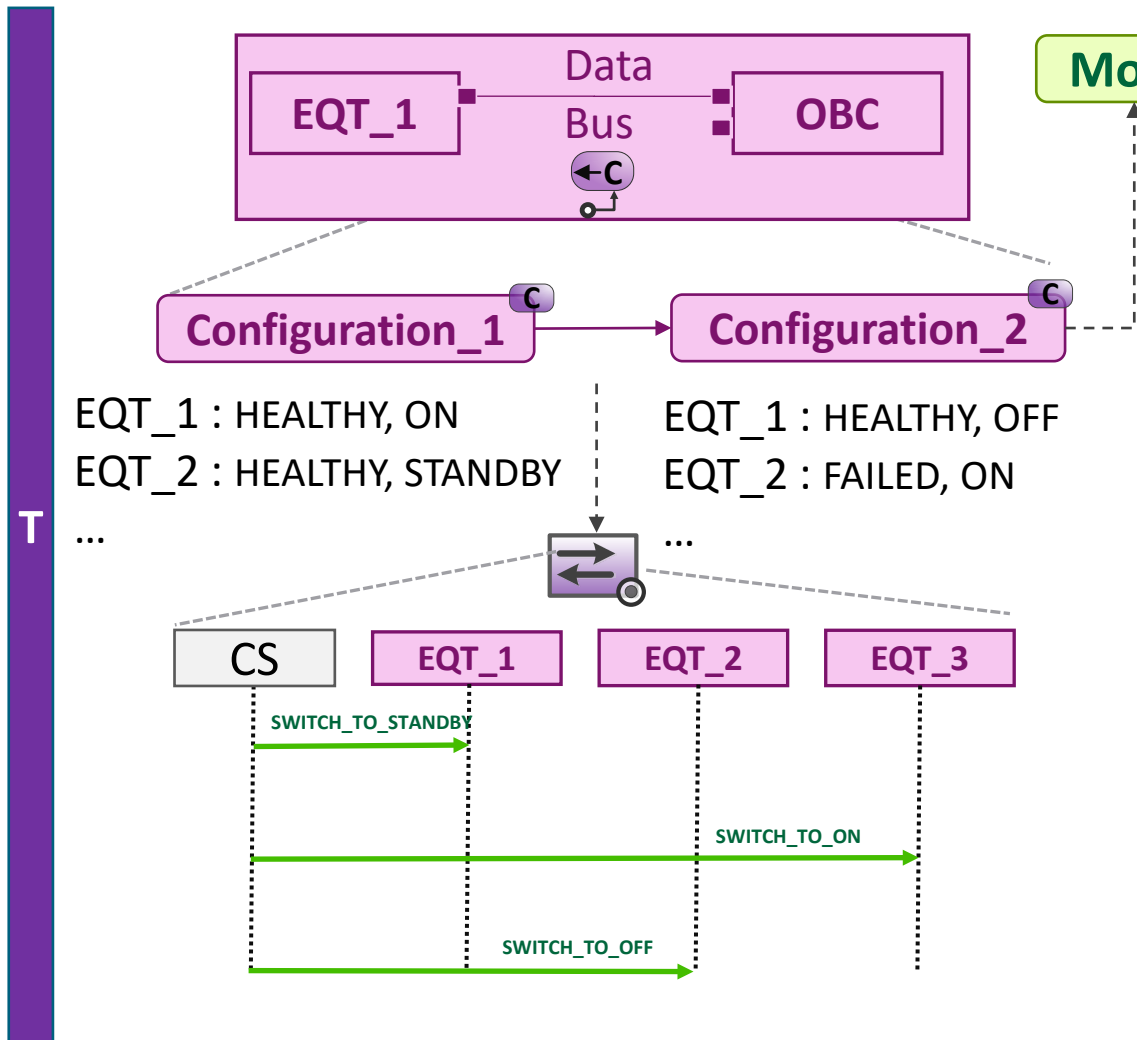
Functional Blocks

- ⇔ MOFLT Elementary Function Behavior

Avionic Architecture

- ⇔ MOFLT Technical Architecture

Functional Chain Concepts



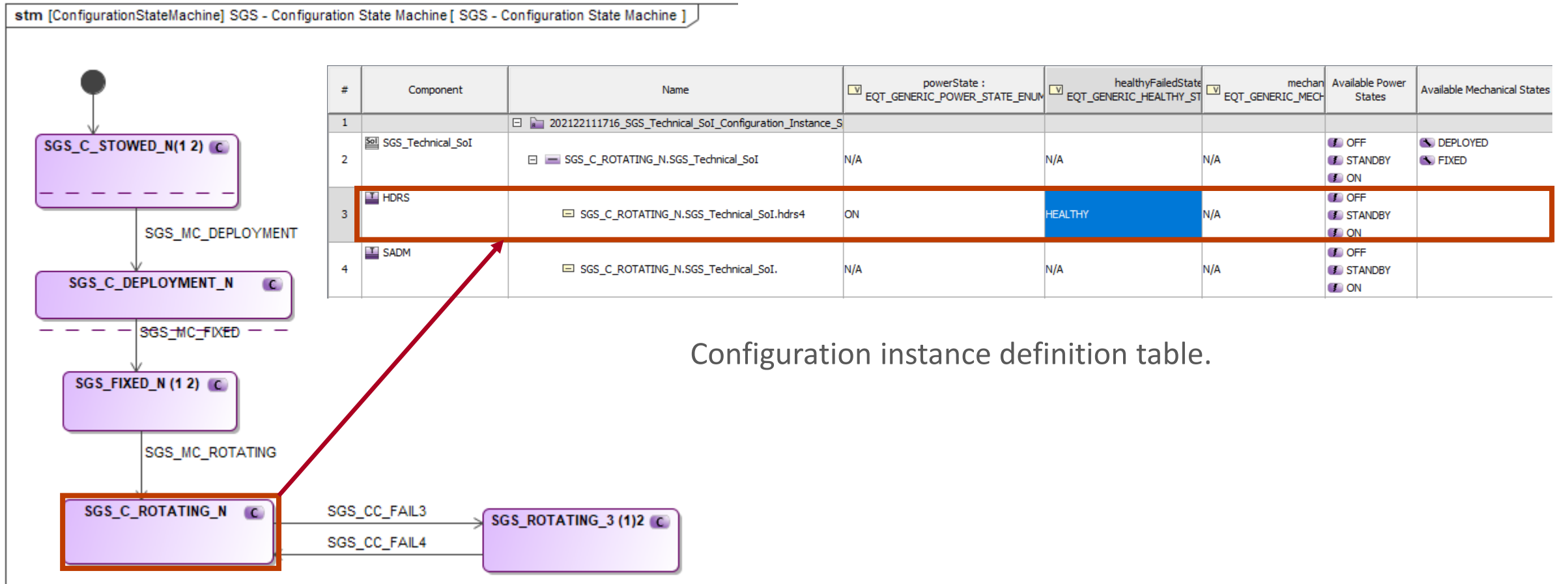
Technical Configurations ★ NEW

- **Equipment States**
 - Healthy States : HEALTHY/FAILED
 - Power States : ON/OFF/STANDBY
 - Mechanical States : DEPLOYED / UNDEPLOYED
- **Traceability :**
 - Configurations to Functional modes
 - Configurations to Operational phases

Commanding Sequence (Nominal & Recovery) ★ NEW

- Commands to be sent to the components to switch from one Configuration to another.
- Operability high level specification.

Functional Chain Concepts



Conclusion & Way Forward



Done

- Functional Chain Extension for MOFLT ready to be deployed :
 - ✓ Profile & Customization
 - ✓ DJF Document Generator
 - ✓ Model Templates
 - ✓ Wizards / Script for automations
- Approach Tested (Partly) on PILOT project



Way forward

- Improve FC extension by specific viewpoints :
 - RAMS / FDIR Viewpoints
- Bridge the gap between **System to SW** :
 - Identify method to map FC extension with **CBSE** (Component Based Software Engineering)

Thank you, any questions ?