Part 02 – what is

Model Based System Engineering

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It's a new approach to system design

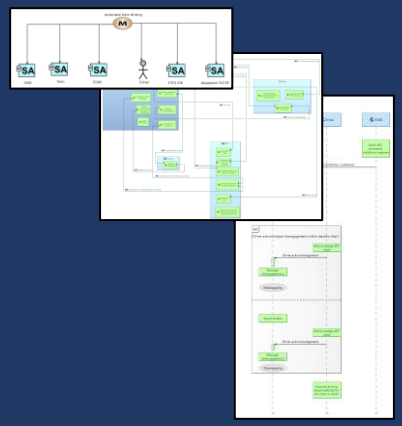
+ All information related to the system is centralized in one place, facilitating communication, synchronization, understanding, and collaboration.

+ Redefine the client-supplier relationship by fostering more transparent and efficient collaboration through shared models that ensure a common understanding of needs and solutions.

+ Provide organizations with a harmonized framework for engineering activities

+ facilitates knowledge capitalization and automatic restitution by centralizing system information within digital models, enabling easy retrieval, updates, and consistent dissemination across teams and projects.

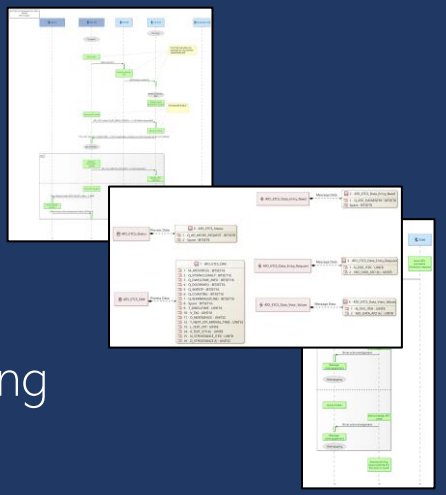
To achieve this, everything begins and ends with a model



Working view

Building

Producing



Engineering artefact view

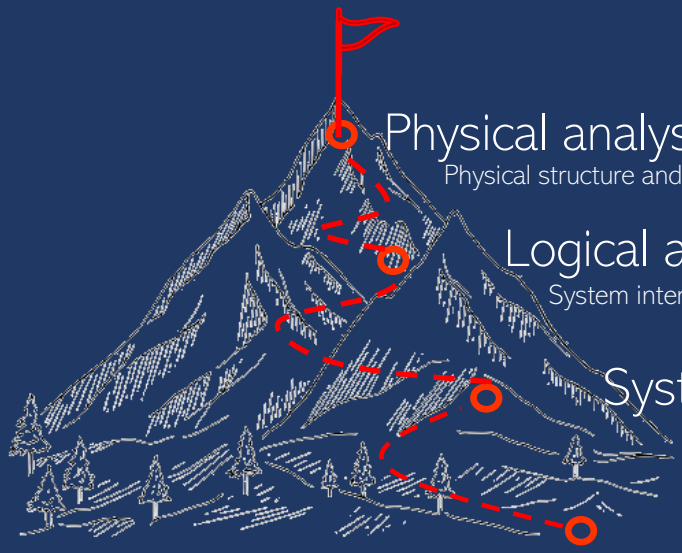
A model is a numerical representation of system characteristics, defined in a structured and standardized language. A dedicated development environment facilitates both the creation of the model and the extraction of views tailored to engineering activities.

But how the model help us to address engineering task

- ❑ Elicit present and future customer needs
- ❑ Define behaviour
- ❑ Define structure
- ❑ Evaluate alternatives
- ❑ Integrate transversal domains : human factor, cybersecurity, safety, environmental impact,...
- ❑ Connect to expert domain : mechanics, fluid dynamics, thermodynamics, software and electronics,...
- ❑ Support business objectives : cost evaluation, product line management, responsability allocation, risk management, lifecycle,...

First, it's a guide that supports your journey

It provides a step-by-step approach to managing abstraction and complexity



Physical analysis

Physical structure and function allocation

Logical analysis

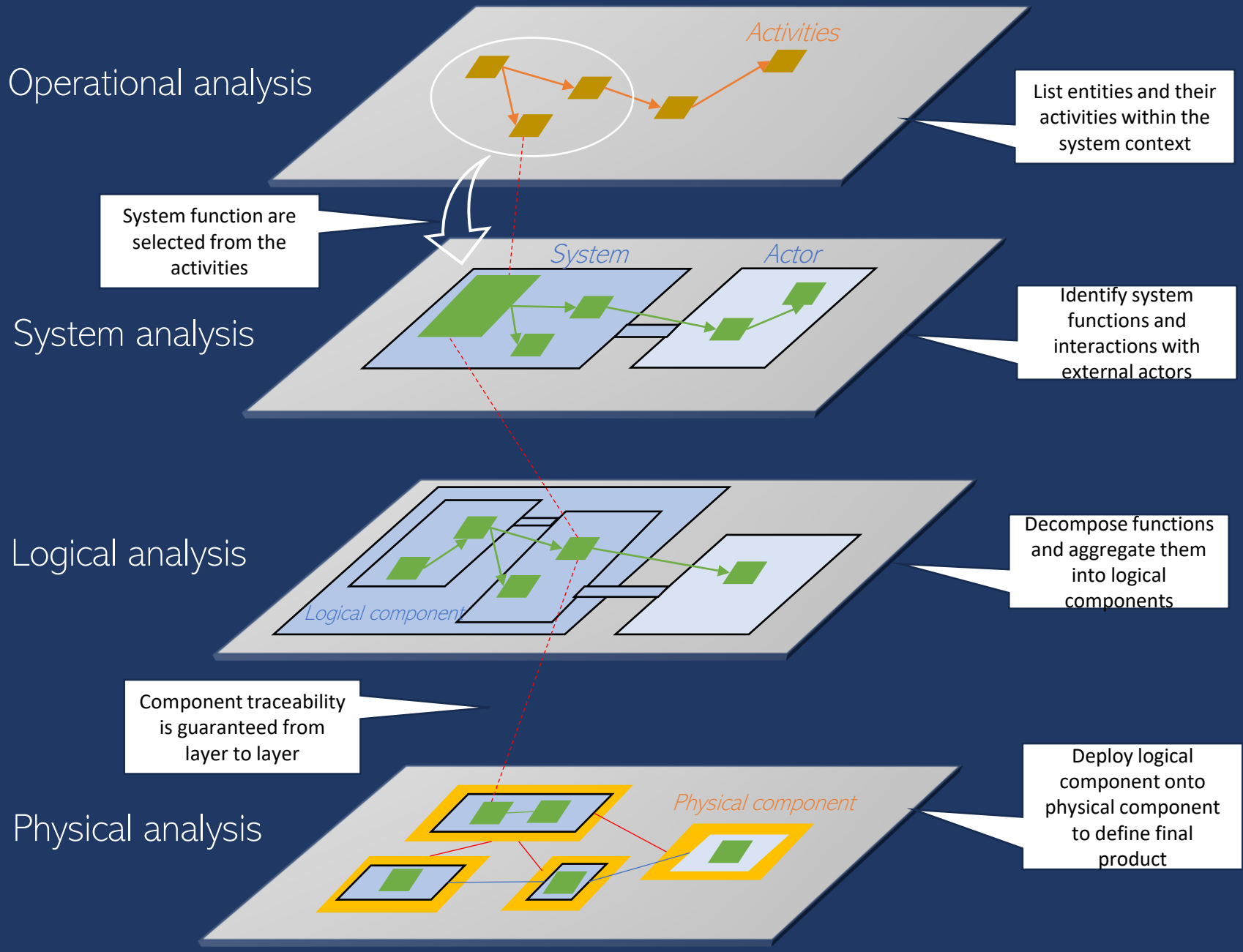
System internal function decomposition and gathering

System analysis

What the system do and its interaction with external actor

Operationnal analysis

The purpose of the system is defined through the identification of entities, activities, and interactions within the system context.


Operational analysis
Activities
List entities and their activities within the system context
System function are selected from the activities
System analysis
System
Actor
Identify system functions and interactions with external actors
Logical analysis
Logical component
Decompose functions and aggregate them into logical components
Component traceability is guaranteed from layer to layer
Physical analysis
Physical component
Deploy logical component onto physical component to define final product

Operationnal analysis helps identify opportunities for a new system

Example of designing a train driver advisory system for energy savings

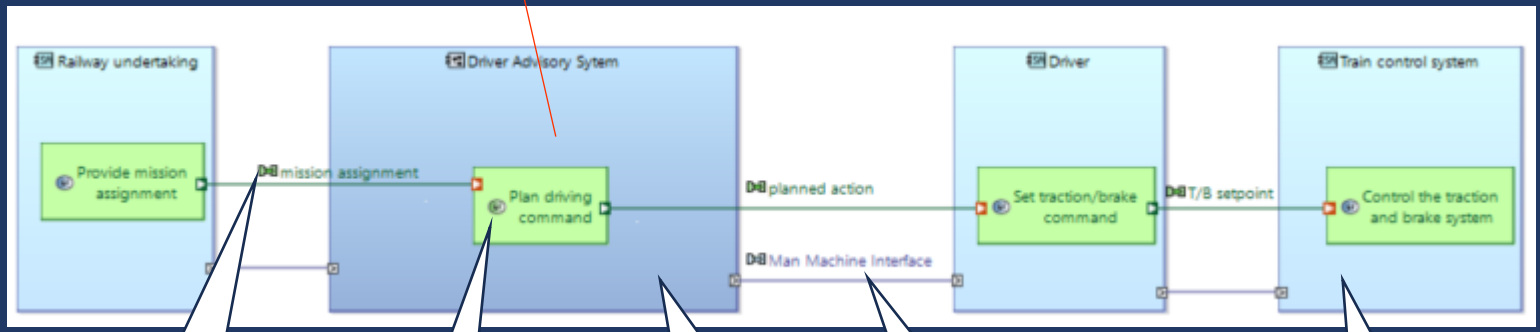
Entity

Activity

Interaction

Transition to system analysis

Activity allocation to the system



Functional exchange

Function

System

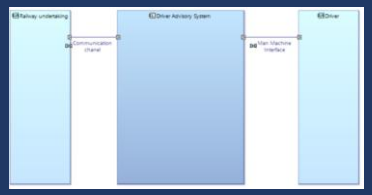
Component exchange

Actor

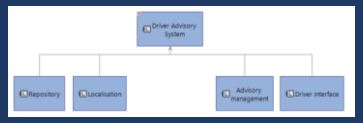
A diagram for each point of view

SYSTEM DESCRIPTION

STRUCTURE

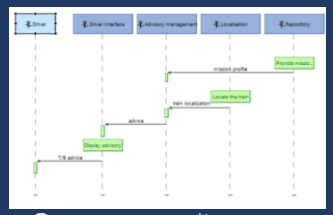


Internal/external architecture diagram

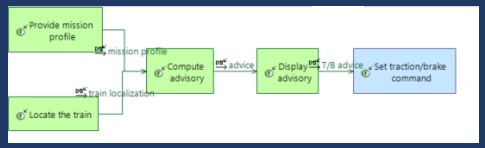


Breakdown diagram

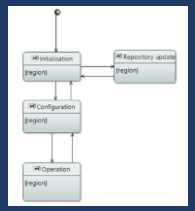
BEHAVIOR



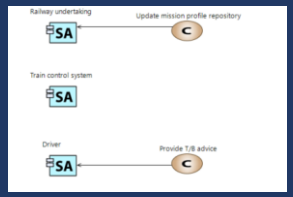
Sequence diagram



Functional chain diagram

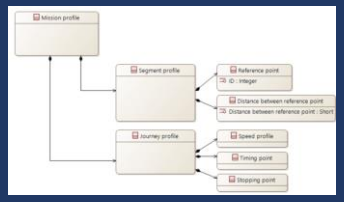


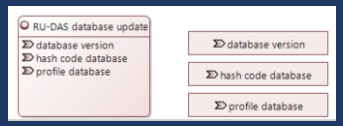
State machine



Capability

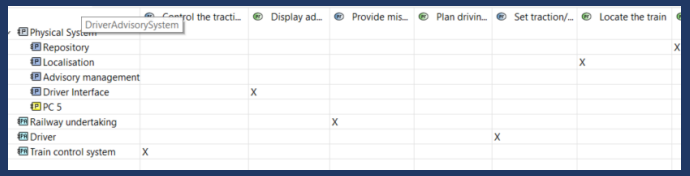
DATA





Class diagram for data managed by the system and interface exchange

CROSS ANALYSIS



Product x function matrix

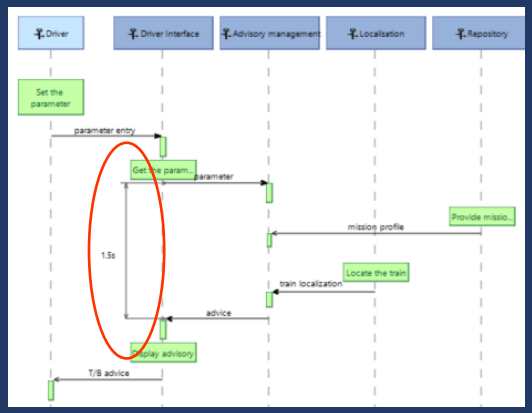
The model views feed into the system specification documents

Diagram / Engineering product	Architecture	Breakdown	Sequence	Functional chain	Class	State machine	Matrix
Requirement specification	X	X	X	X		X	
System specification	X	X	X	X		X	
Architecture specification	X	X	X	X		X	X
Interface control document	X				X		
Integration specification	X						
Test specification			X				

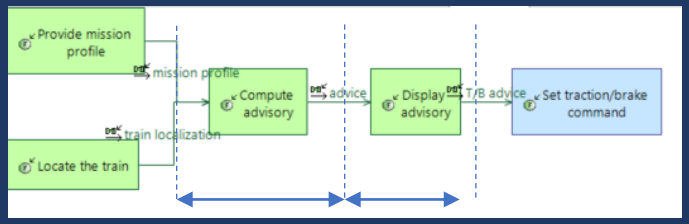
Model views feed cross-functional analyses

Diagram / Transversal analysis	Architecture	Breakdown	Sequence	Functional chain
Safety	List of function for FMECA	Fault tree analysis	Preliminary risk analysis	Fault management
Human factor	Ergonomic		Ergonomic, mental load	
Cybersecurity	Asset		Strategic attack vector	Detailed attack vector

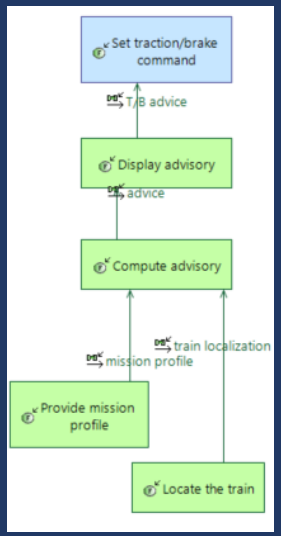
Performance criteria can be directly transcribed or facilitated



Time reaction allocation with « duration component »

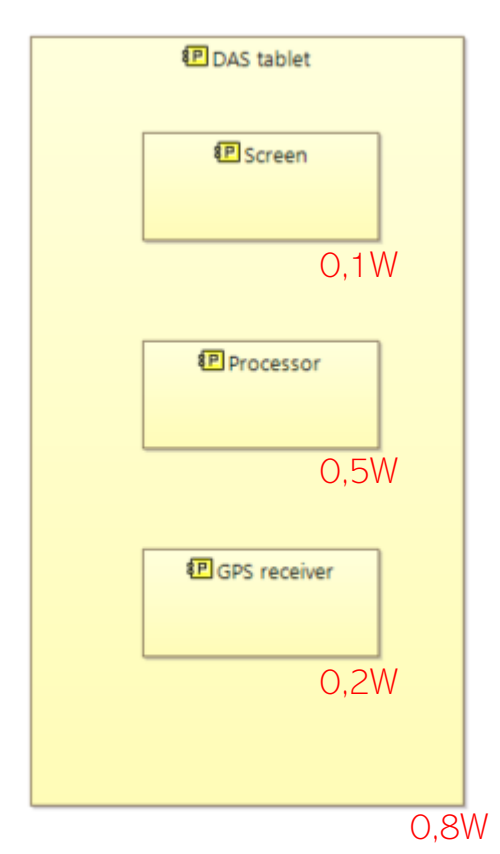


Functional chain are suitable for time reaction allocation



Functional chain are suitable for tolerable functional failure rate allocation (safety)

Conduct evaluation of design parameters



Parameters can be assigned to each component to support design parameter evaluation, such as:

- Weight
- Power
- Cost
- Security level
- …

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