

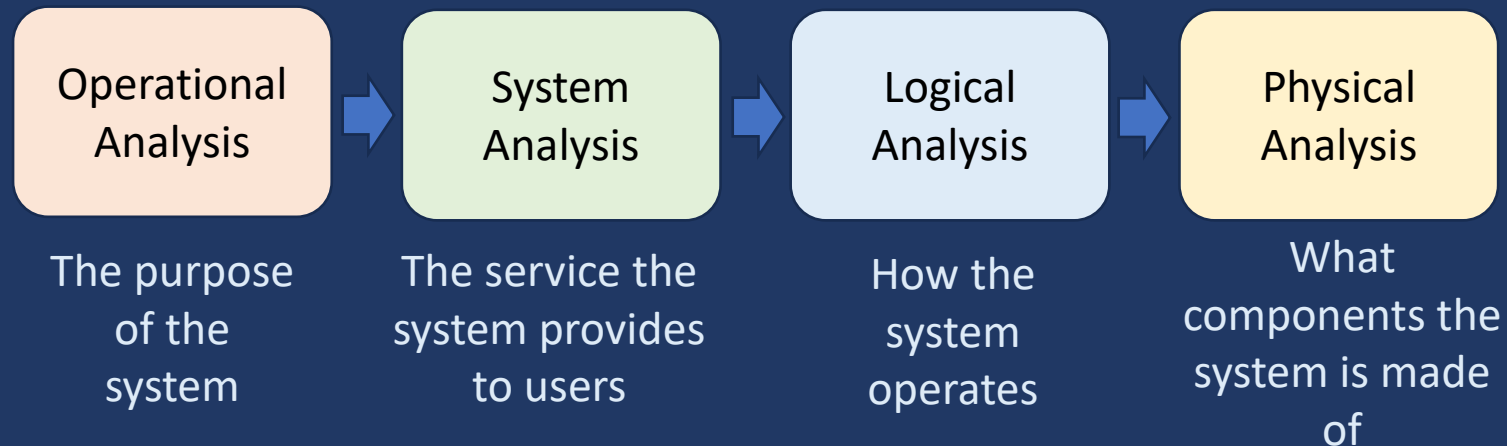
Part 03 – MBSE

Modeling Process



MBSE Steps

MBSE guides the design of complex systems through key stages...



... but what is the process within each step ?

Operational Analysis

Define the context in which the system evolves without representing the system itself

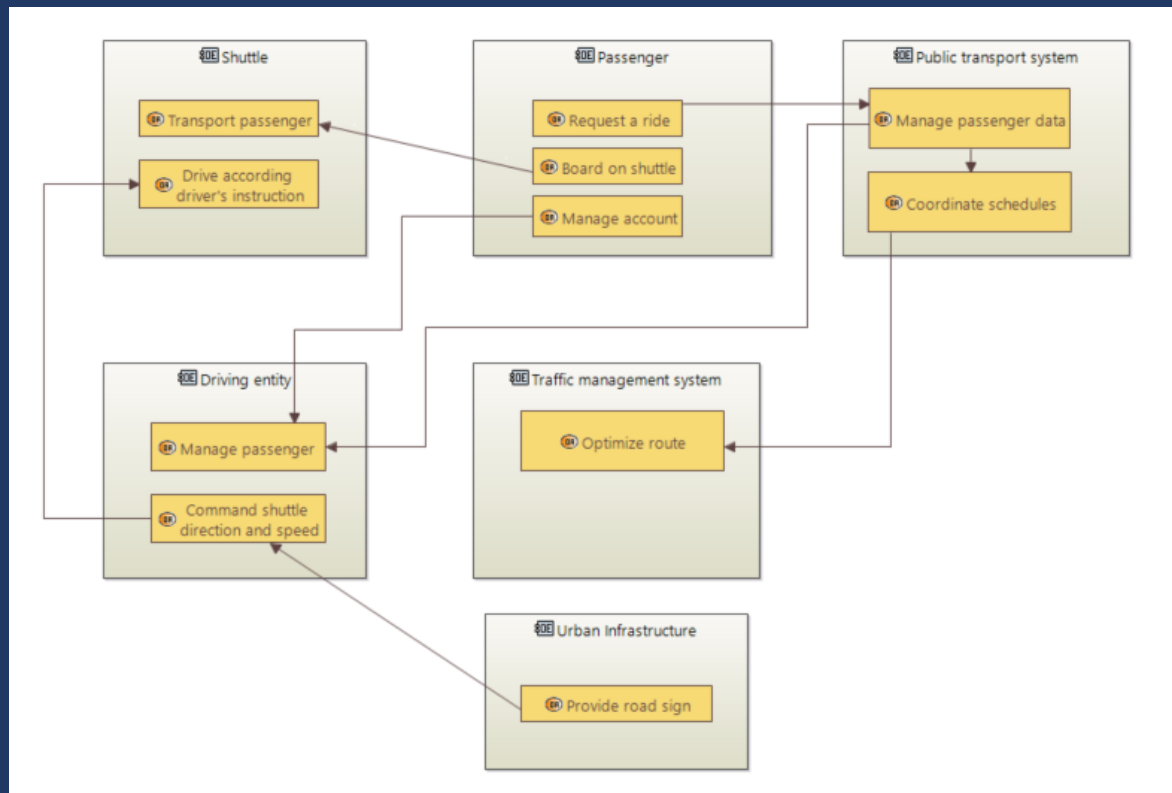
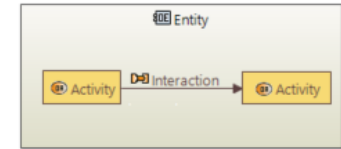
For example, an **Urban Transport Network** :



Operational Analysis

1

Define a preliminary architecture with entities, activities, and interactions



Operational Analysis

2

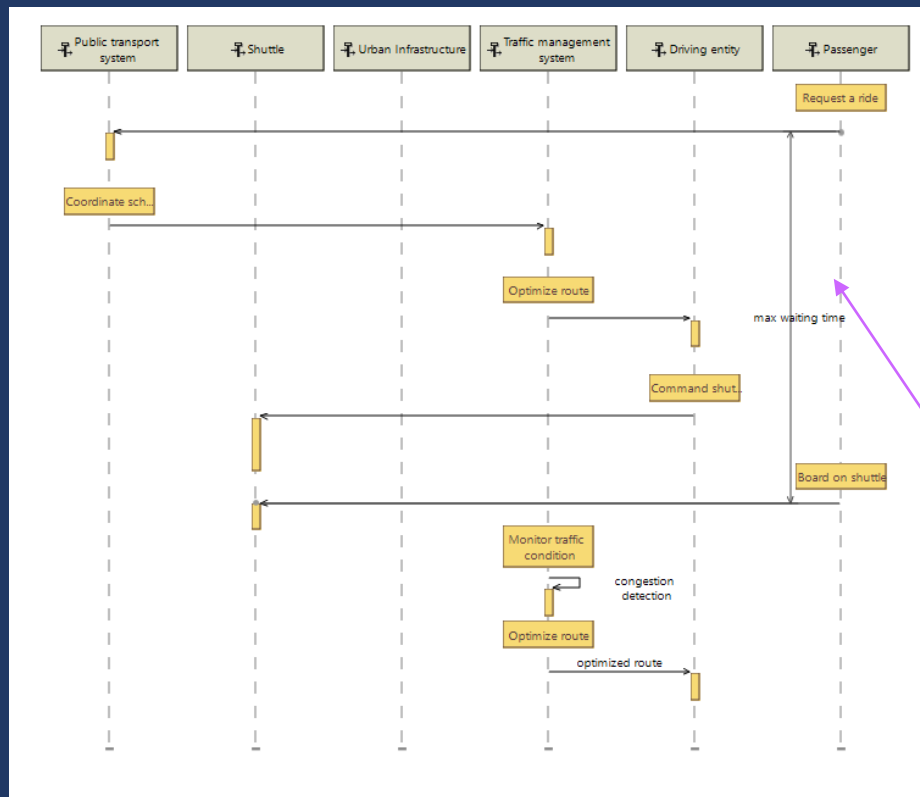
Define different scenarios to describe the context more precisely, emphasizing specific domains like safety, customer experience, etc

Imagine this kind of scenario :

- Passenger-Related
 - Passenger books a journey
 - Passenger boarding
 - Multimodal journey
 - Ride cancellation
- Navigation
 - Unexpected obstacles on the road
 - Traffic light coordination
- Safety
 - Onboard incident
 - Shuttle breakdown
 - Accident with other vehicles
- Interaction
 - Police stop request
 - ...

Operational Analysis

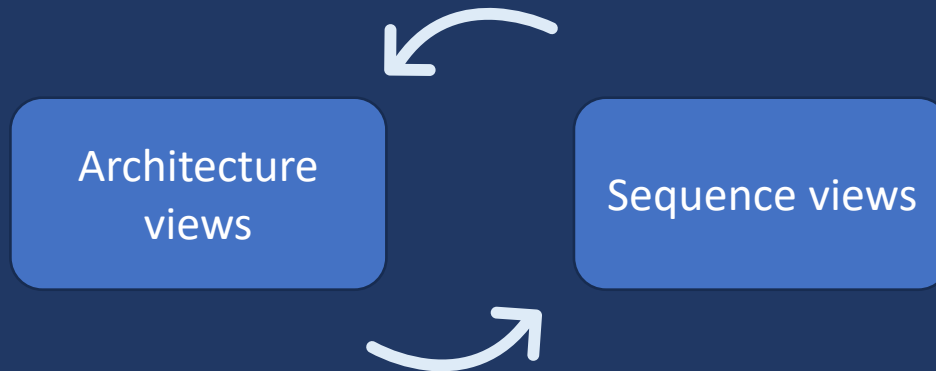
Diagram type	Sequence diagram
Description	Passenger journey with real-time traffic adaptation



Introduce Measure of effectiveness (Time reaction)

Operational Analysis

Iterate between the architectural view and the sequence view until achieving a sufficient level of detail



Until following criteria are met:

- All entities identified
- All scenario modelled
- Stakeholder review

How to identify ?

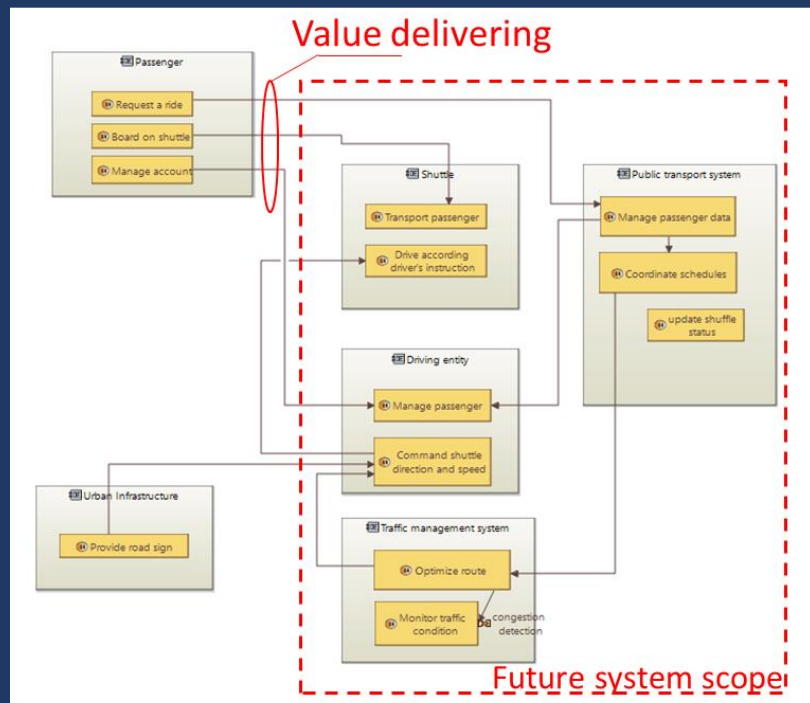
- *Experts interviews*
- *Brainstorming*
- *Benchmark....*

Technical and non-technical feedback

Operational Analysis

3

In preparation for system analysis, select the activities that will define the system's future functions. Interaction within this scope and with potential customers constitutes the value delivered.



Our choice leads to the design of an....

Urban Autonomous Transport Network

MBSE can address the multiple challenges

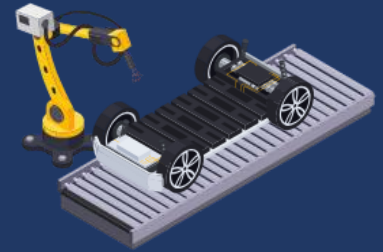
Supervision



Cloud
virtualization



EV
management



SD-WAN



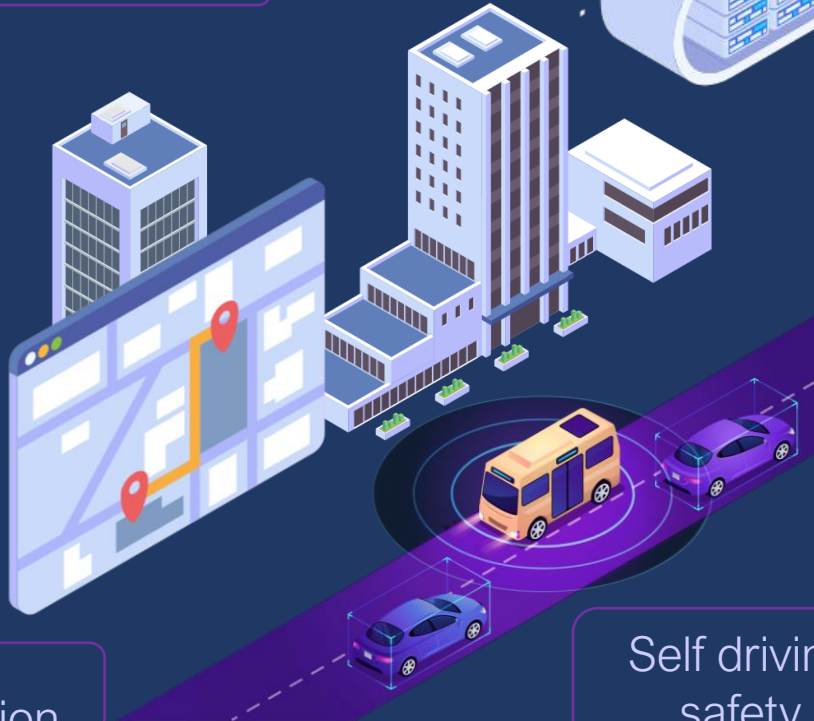
5G
communication



Customer
experience



Route
optimization



Self driving
safety

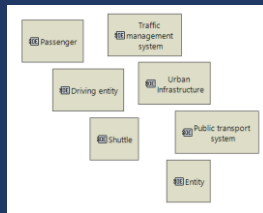
System Analysis

1

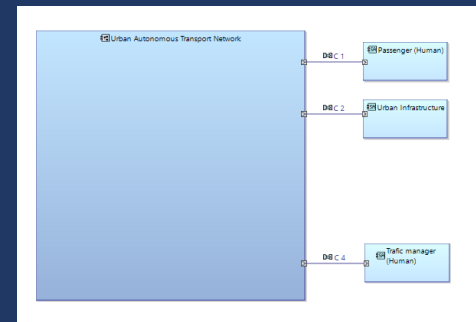
Perform a transition of operational layer to system layer.



Activities becomes
function to allocate
to actor or system



Entities becomes
actor which interacts
with the system

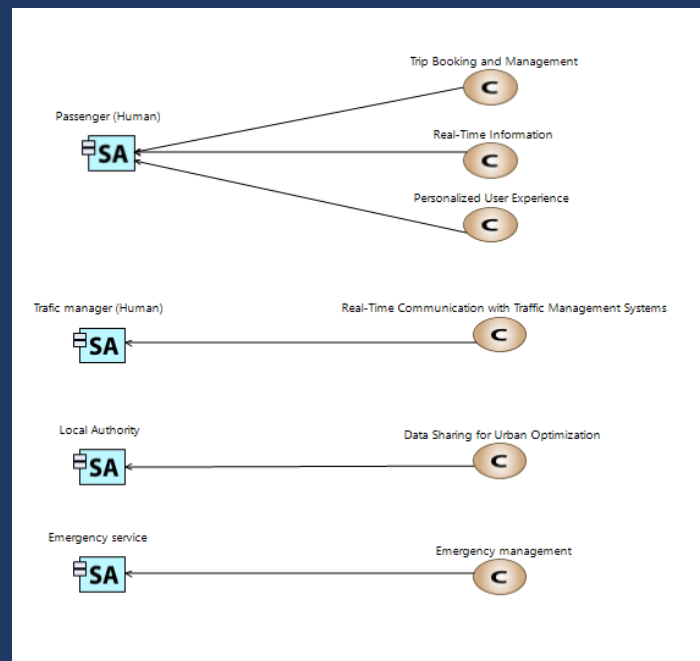


This step ensures tracability between the two layer
and initializes the first view of system architecture.

System Analysis

2

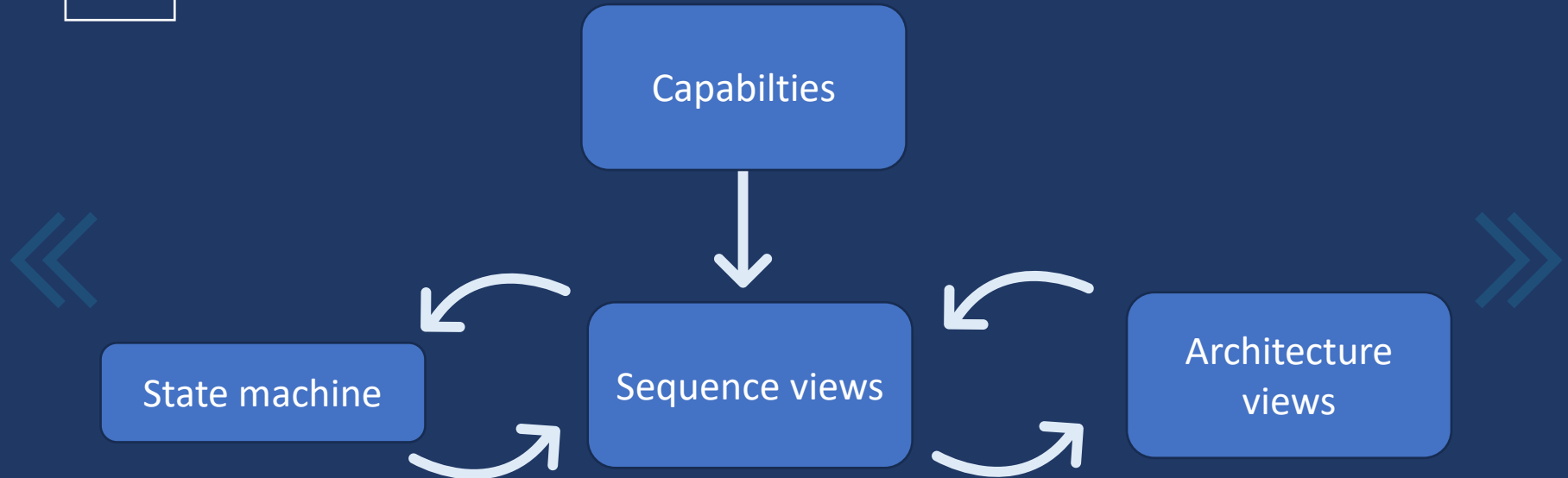
We identify system capabilities as the services the system provides to external actors.



System Analysis

3

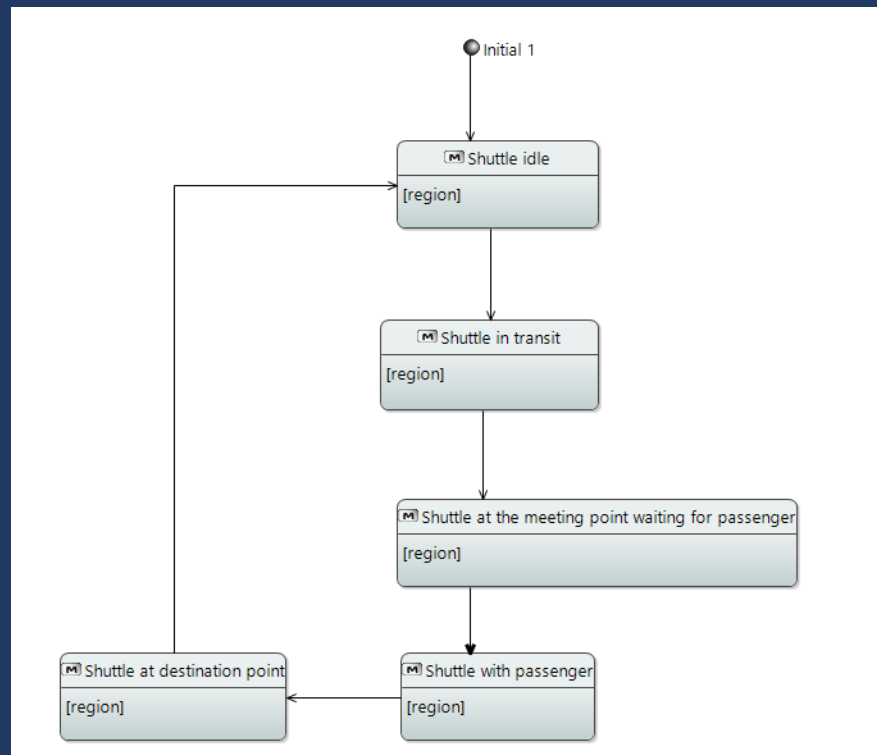
We describe each capability using a scenario through a sequence diagram.



We iterate between the architectural view and the sequence view until all the capabilities are modeled.

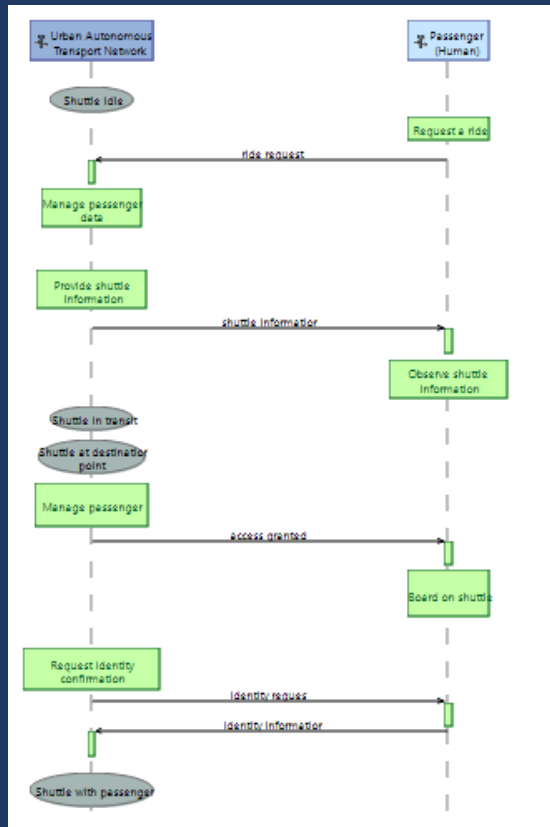
System Analysis

Diagram type	State machine diagram
Description	shuttle's mode



System Analysis

Diagram type	Sequence diagram
Description	Booking and boarding



System Analysis

Diagram type

Architecture diagrams

Description

Interface between system and passenger

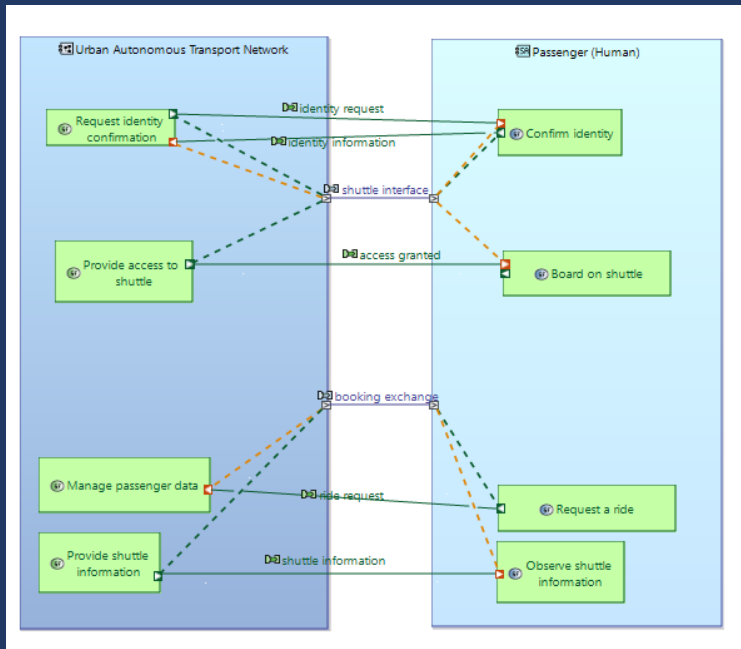
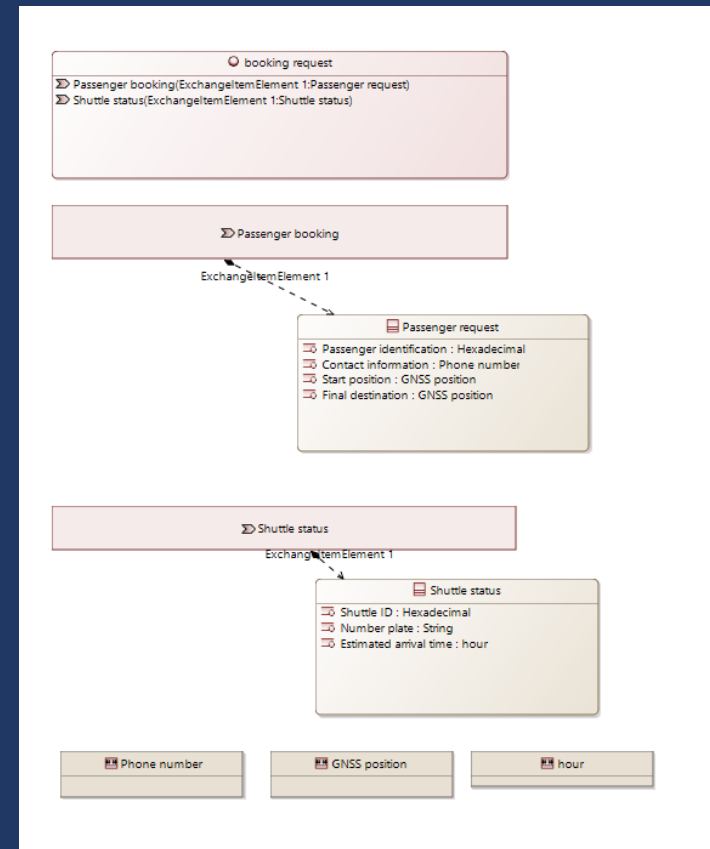


Diagram type

Class diagrams

Description

Passenger booking exchange



System Analysis

At this stage are defined :

- System high level functions and modes
- System interface with actor
 - Logical interface
 - Functional interface
 - Data exchanged
- Scenarii : useful for V&V process

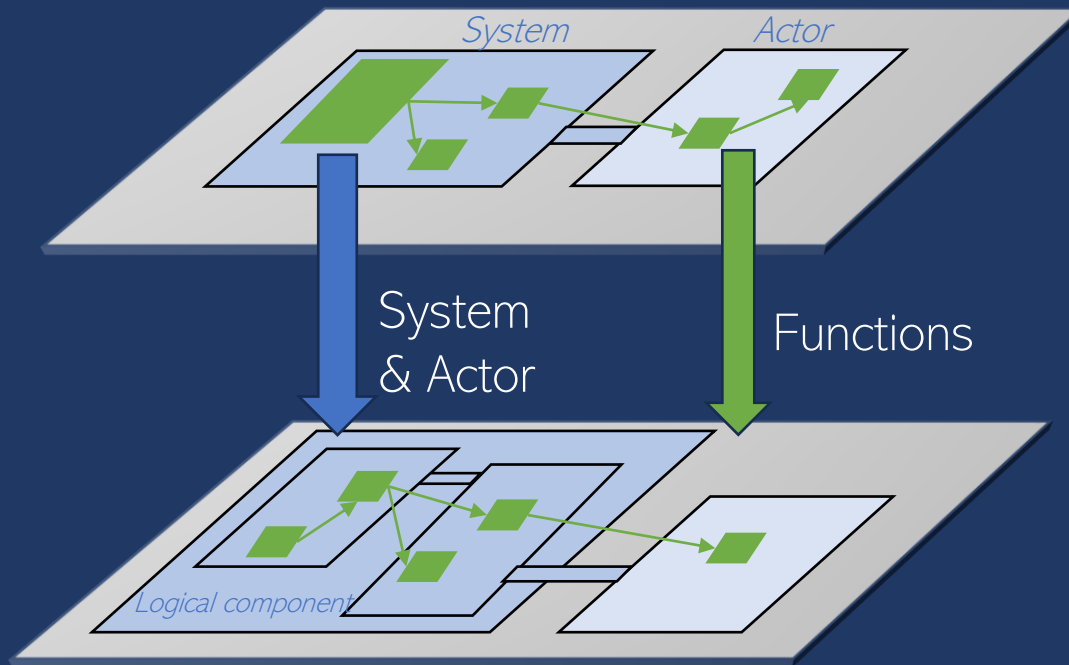
But we don't yet know how the system will perform its capabilities. We still have significant flexibility in the system design.

To begin making **technical choices** and to define how the system functions internally, we move to the logical layer...

Logical Analysis

1

Perform a transition of System layer to Logical layer (always to ensure traceability)



Logical Analysis

2

Perform a functional decomposition of system function



Logical Analysis

Diagram type	dataflow diagram
Description	Shuttle navigation

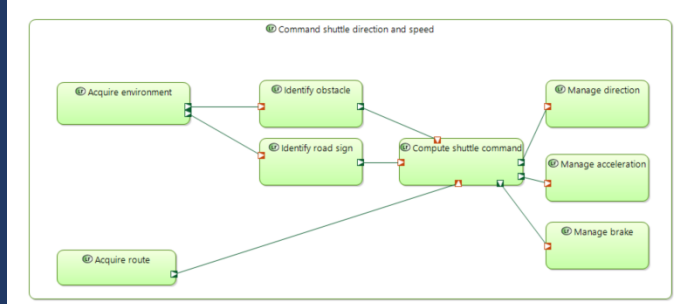
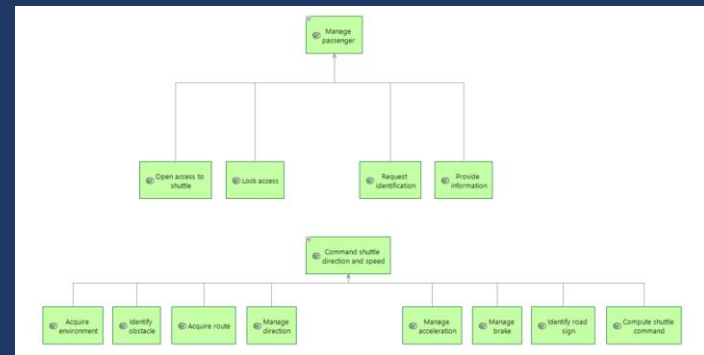


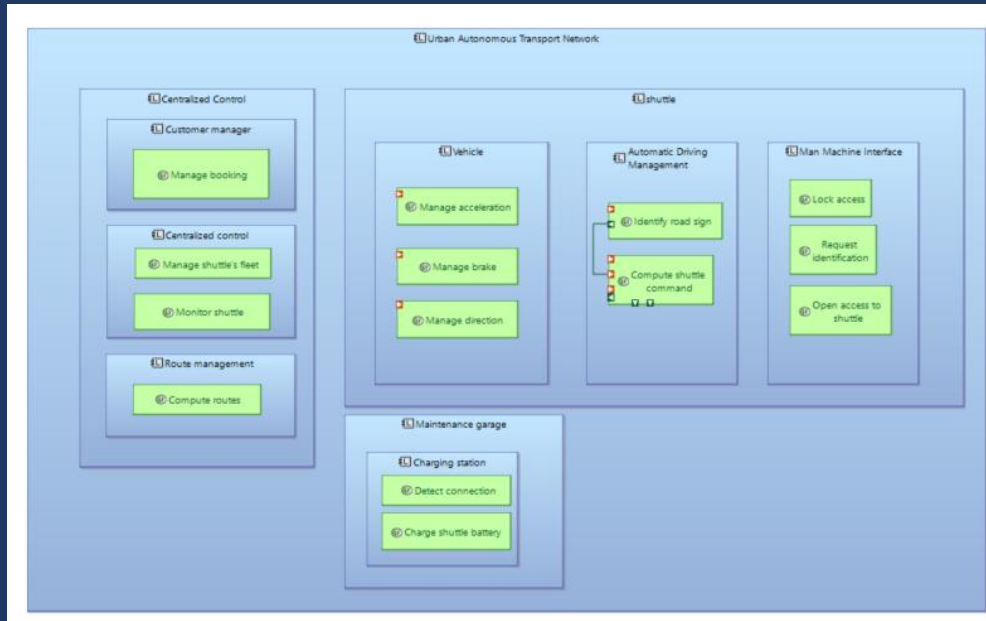
Diagram type	Functional breakdown diagram
Description	Shuttle functions



Logical Analysis

3

Perform a functional gathering in logical component



There are multiple criteria or gathering functions into logical component :

- Functions that share a common purpose
- Functions that interacts frequently
- Modularity

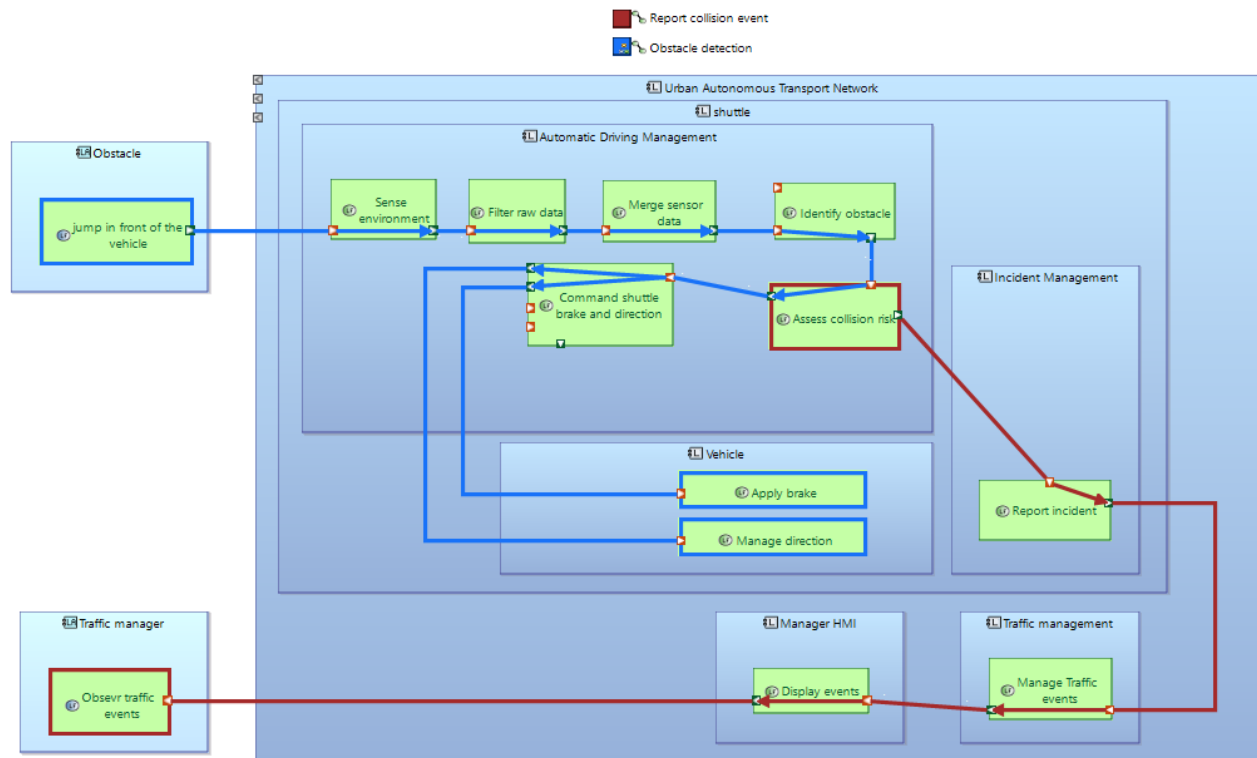
Separation of functions that handle distinct aspects (Information / Operational technology for e.g)

- Safety consistency
- By geographic proximity
- ...

Logical Analysis

4

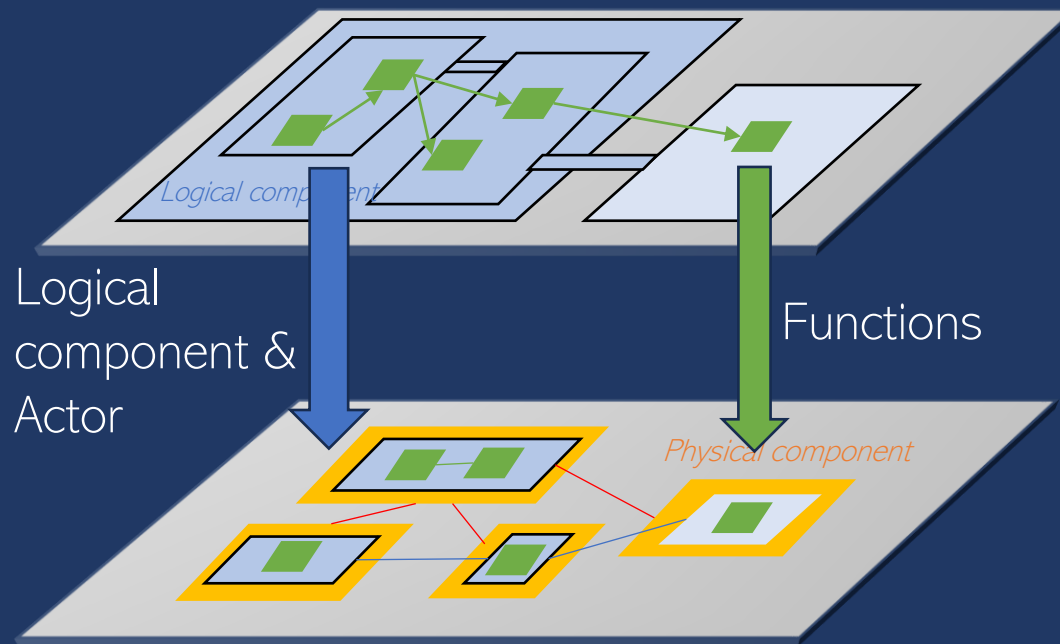
Identify functional chains, which are sequences of functions that support the critical capabilities of the system.



Physical Analysis

1

Perform a transition of logical layer to physical layer (for traceability)

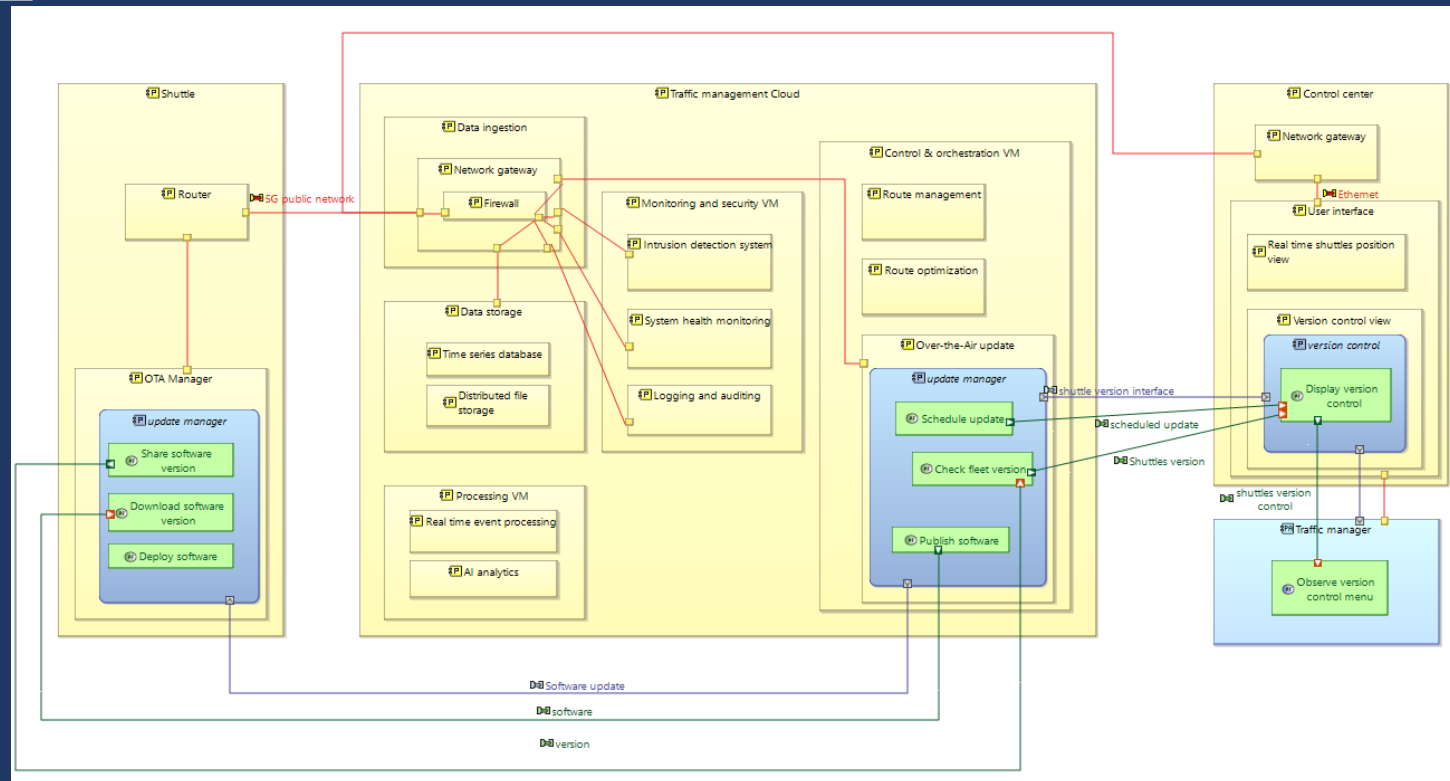


Physical Analysis



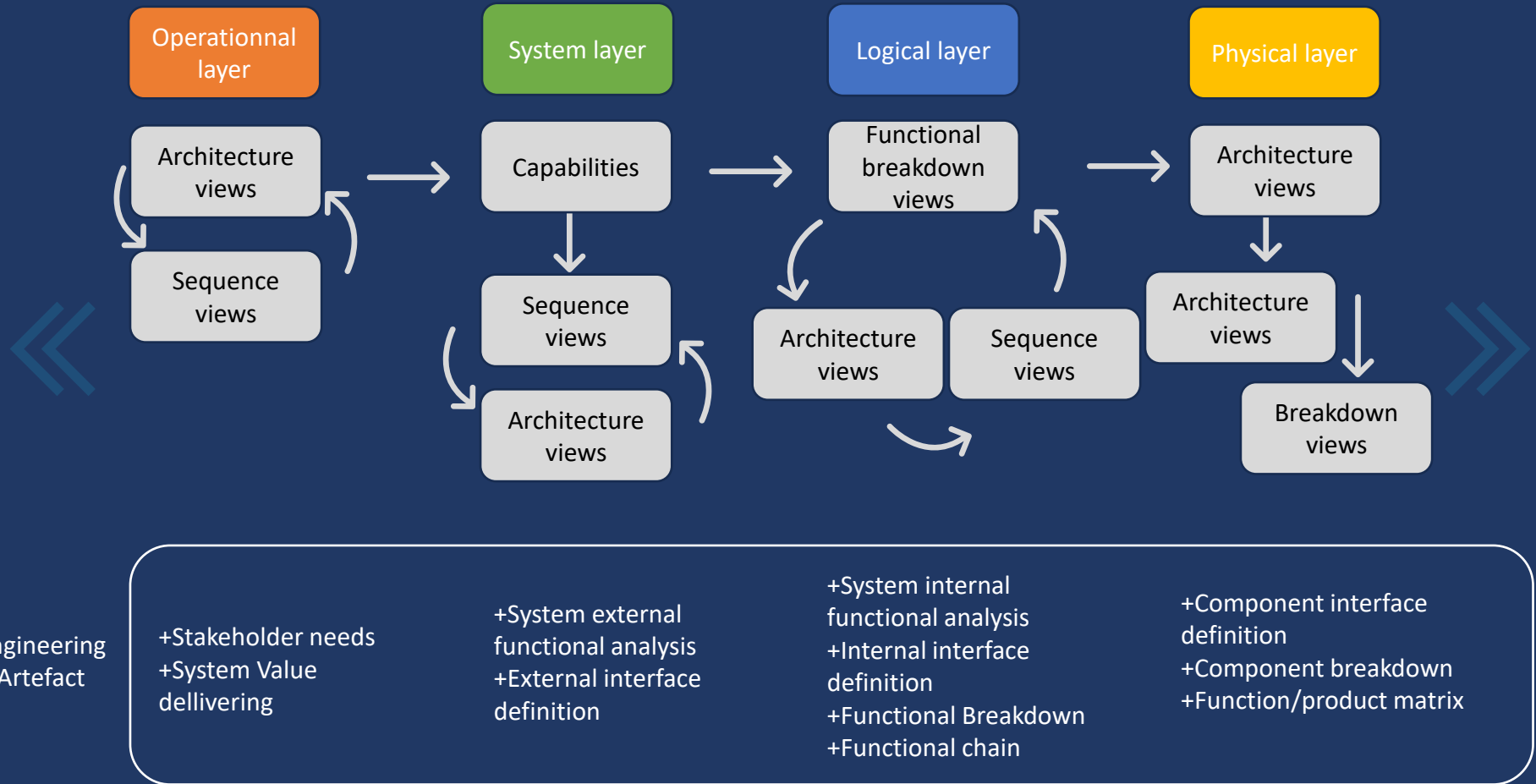
2

Deploy logical component into physical component and specify physical interface



Update Over-the-Air Architecture diagram

MBSE Map



Recommendations

1. Define Clear Objectives and Scope
 - Set clear, measurable goals for your modeling effort
 - Avoid overcomplicating the model at the beginning; focus on the most critical use cases.
2. Use the Right Tools Wisely
 - Remember: the tool is a means, not the end goal. Focus on the modeling itself rather than mastering every tool feature.
 - Adapt the tool's functionality to your specific project needs—avoid overloading the model with unused or unnecessary features.
3. Ensure Diagram Clarity
 - Keep diagrams simple and easy to understand, with clear labels, concise descriptions, and logical flows.
 - Use consistent notation and naming conventions across diagrams to avoid confusion.
 - Create diagrams for specific purposes, such as explaining interactions (sequence diagrams) or system organization (block diagrams).
4. Tailor Diagrams to the Audience
 - Always ask yourself: Who is the diagram for? Tailor the level of detail and content to match the knowledge and needs of the audience (e.g., engineers, managers, or clients).



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Book a 15mn free meeting to discuss
your needs and how MBSE can help you
improve your engineering process

<https://cal.com/thibaultmatthieu/15min>

