International Council on Systems Engineering
A better world through a systems approach

Enterprise Transformation Planning with UAF

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Hello.

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- PhD, MS, and BS in Software Systems Engineering
- 20 years in Software and Systems Engineering
- UAF co-chair in OMG, member of INCOSE and NATO ACaT
- Chair of Enterprise Systems Engineering WG in INCOSE
- Originator of the MagicGrid Framework
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CATIA Systems - Industry Process Senior Specialist

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Today's Agenda

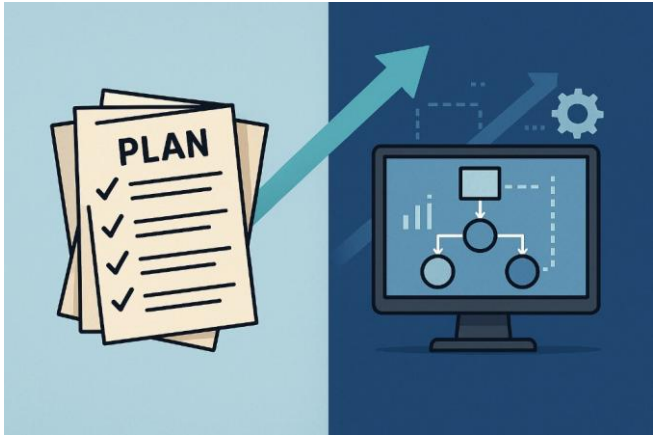
- Introduction
- Proposed Approach and Case Study
- Summary

Introduction

Enterprise Transformation

Proper planning is the key to achieving a successful Enterprise Transformation.

- **Documents** are widely used for this purpose today; however, they provide limited analytical support to the decision maker and lead to delays and failures of the Enterprise Transformation.
- **Model-Based Enterprise Architecture** can effectively support transformation planning by considering available resources, including systems, personnel, and technologies, as well as identifying any new resources to acquire or develop.



Are we speaking the same language?

- Engineered systems include products, services and **enterprises**
- "**Enterprise**" is intended to mean a large undertaking, especially one of large scope, complication and risk – "a complex web of interactions **distributed across geography and time**" (Rebovitch & White, 2011)
  - *a purposeful or industrious undertaking (especially one that requires effort or boldness)*
- Services and **enterprises** usually depend on technological products but are essentially forms of **socio-technical** systems

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Three types of Engineered Systems (INCOSE)

Product

Relatively simple
Verifiable Requirements
No human resources considered as part of system

Service

Software intensive
Involves products and other services
Human resources may be involved

Enterprise

Fuzzy Requirements
Involves a lot of risk
Rich of human resources
Made of services and products

Complicated — Complex

technical — socio-technical

Enterprises:

- Company/Multinational Corporation
- Program/Project (Space, Military, DT etc.)
- Mission
- Smart City
- Climate Mitigation and Energy Transition Efforts

- Apple, Toyota
- NASA Artemis Program
- NATO Air Policing Mission
- Singapore's Smart Nation
- European Green Deal

Why This Paper?

- This research:
  - Studies a city bus transportation transformation from hybrid to fully electric using Unified Architecture Framework (UAF).
  - Propose a UAF-based approach to enterprise transformation planning by streamlining the UAF EA guide to include only the relevant viewpoints, aspects, and views for this specific purpose
  - Assess the feasibility of using UAF as a tool for enterprise transformation planning
  - Tests the feasibility of UAF and proposes a new model-based approach to efficiently apply UAF to enterprise transformation planning.

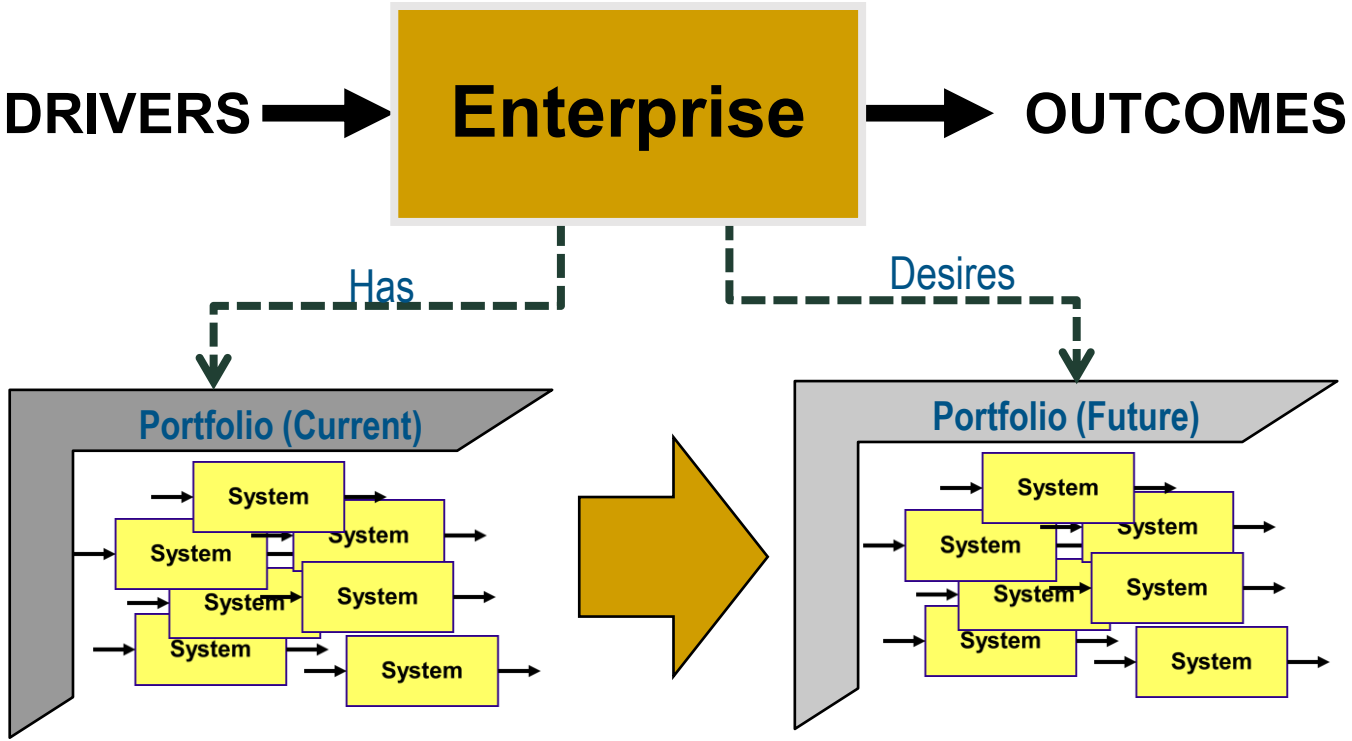
What is UAF?

- A standard to develop architectural descriptions
  - in commercial industries, federal governments, and military organizations
  - compatible with DoDAF, NAF, MODAF
- The UAF task force within OMG has identified 58 distinct use cases spanning systems, missions, enterprise, and System of Systems (SoS) engineering
- Developed by Object Management Group (OMG) with the leadership from Dassault Systemes and Lockheed Martin
- Is an international ISO standard ISO/IEC 19540:1 and ISO/IEC 19540:2
- Current version of UAF specification is 1.2
  https://www.omg.org/spec/UAF/1.2/About-UAF/

UAF Use Cases

15288 System Lifecycle Processes
Acquisition Decision Making
AOA (Analysis of Alternatives)
Application Portfolio Management
Budget Planning
Business and Mission Analysis - INCOSE
Business Process Reengineering
Business Transformation Planning
Capability Gaps Analysis
Capability Planning
Capability Portfolio Management
Capability-based Assessment
Certification Planning
Defense Acquisition System
Define and analyze problem space
Describe SoS
Design Surety
Digital Engineering Planning and Execution
Digital Transformation Planning
Digital Twin
Doctrine Development
Ecosystem Sustainability
Enterprise Planning
Enterprise Systems Engineering - INCOSE
Federated Mission Network (FMN)
JCIDS
Logistics Support Planning
Mission Assurance
Mission Criticality
Mission Engineering
Operational Analysis
Operational Sustainability
Operations
Operations Planning
Optimization
Organizational and Strategic Planning
Performance Management
Policy Formulation
Portfolio Management
PPBE
Predictive Analytics
Program Assessment and Evaluation
Program Formulation
Program Planning
Requirements Development and Flowdown
Risk and Opportunity Management
Security Analysis
Simulation Support
Strategic Planning and Execution
Sustainability
Sustainment Engineering
System Lifecycle Management
System Security Engineering
System Sustainability
Technology Planning and Assessment
Test Planning and Execution
Training

UAF – Transformational Approach



UAF	Motivation Mv	Taxonomy Tx	Structure Sr	Connectivity Cn	Processes Pr	States St	Sequences Sq	Information[c] If	Parameters[d] Pm	Constraints Ct	Roadmap Rm	Traceability Tr
Architecture Management[a] Am	Architecture Principles Am-Mv	Architecture Extensions Am-Tx[e]	Architecture Views Am-Sr	Architecture References Am-Cn	Architecture Development Method Am-Pr	Architecture Status Am-St		Dictionary Am-If	Architecture Parameters Am-Pm	Architecture Constraints Am-Ct	Architecture Roadmap Am-Rm	Architecture Traceability Am-Tr
Summary & Overview Sm-Ov												
Strategic St	Strategic Motivation St-Mv	Strategic Taxonomy St-Tx	Strategic Structure St-Sr	Strategic Connectivity St-Cn	Strategic Processes St-Pr	Strategic States St-St		Strategic Information St-If	Environment En-Pm-E and Measurements Me-Pm-M and Risks Rk-Pm-R	Strategic Constraints St-Ct	Strategic Deployment, St-Rm-D Strategic Phasing St-Rm-P	Strategic Traceability St-Tr
Operational Op	Requirements Rq-Mv	Operational Taxonomy Op-Tx	Operational Structure Op-Sr	Operational Connectivity Op-Cn	Operational Processes Op-Pr	Operational States Op-St	Operational Sequences Op-Sq	Operational Information Op-If		Operational Constraints Op-Ct		Operational Traceability Op-Tr
Services Sv		Services Taxonomy Sv-Tx	Services Structure Sv-Sr	Services Connectivity Sv-Cn	Services Processes Sv-Pr	Services States Sv-St	Services Sequences Sv-Sq			Services Constraints Sv-Ct	Services Roadmap Sv-Rm	Services Traceability Sv-Tr
Personnel Ps		Personnel Taxonomy Ps-Tx	Personnel Structure Ps-Sr	Personnel Connectivity Ps-Cn	Personnel Processes Ps-Pr	Personnel States Ps-St	Personnel Sequences Ps-Sq	Resources Information Rs-If		Competence, Drivers, Performance Ps-Ct	Personnel Availability Ps-Rm-A Personnel Evolution PS-Rm-E Personnel Forecast Ps-Rm-F	Personnel Traceability Ps-Tr
Resources Rs		Resources Taxonomy Rs-Tx	Resources Structure Rs-Sr	Resources Connectivity Rs-Cn	Resources Processes Rs-Pr	Resources States Rs-St	Resources Sequences Rs-Sq			Resources Constraints Rs-Ct	Resources evolution Rs-Rm-E Resources forecast Rs-Rm-F	Resources Traceability Rs-Tr
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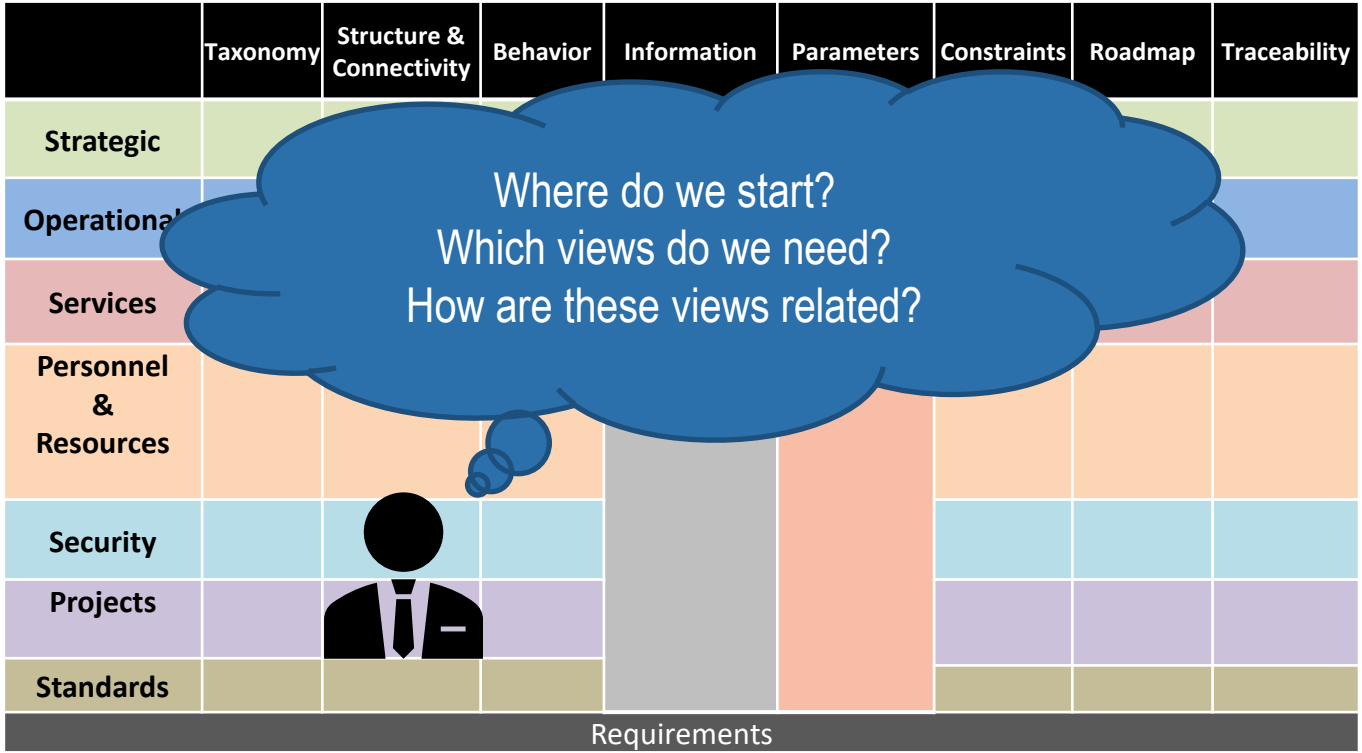
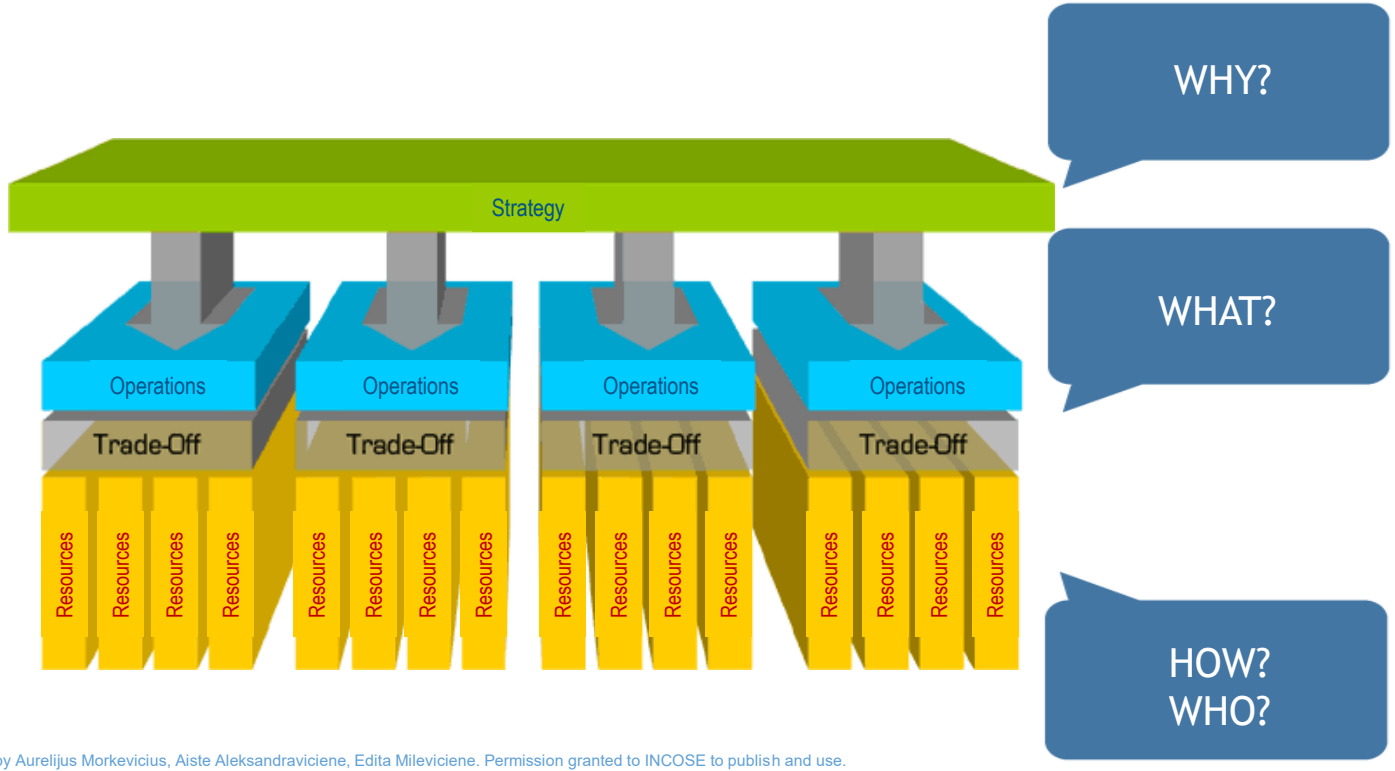
Standards Sd		Standards Taxonomy Sd-Tx	Standards Structure Sd-Sr								Standards Roadmap Sd-Rm	Standards Traceability Sd-Tr
Actual Resources Ar			Actual Resources Structure, Ar-Sr	Actual Resources Connectivity, Ar-Cn	Simulation[b]					Parametric Execution/ Evaluation[b]		

Modeling Workflow

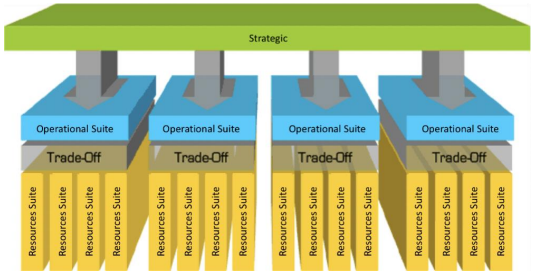


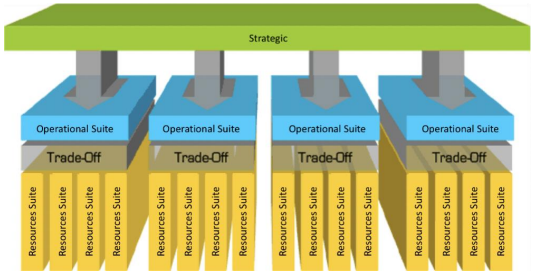
Solving UAF Puzzle – Principle Schematics

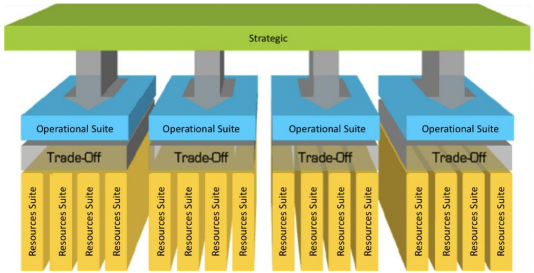


Architecture Evolution

Phase 1 → Phase 2 → Phase 3







Proposed Approach and Case Study

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	Taxonomy Tx	Structure Sr	Connectivity Cn	Processes Pr	States St	Interaction Scenarios Is	Information If	Parameters Pm
Operational Op	Operational Taxonomy Op-Tx	Operational Structure Op-Sr	Operational Connectivity Op-Cn	Operational Processes Op-Pr	Operational States Op-St	Operational Interaction Scenarios Op-Is	Conceptual Data Model,	Environment Pm-En
Services Sv	Service Taxonomy Sv-Tx	Service Structure Sv-Sr	Service Connectivity Sv-Cn	Service Processes Sv-Pr	Service States Sv-St	Service Interaction Scenarios Sv-Is	Logical Data Model,	
Personnel Pr	Personnel Taxonomy Pr-Tx	Personnel Structure Pr-Sr	Personnel Connectivity Pr-Cn	Personnel Processes Pr-Pr	Personnel States Pr-St	Personnel Interaction Scenarios Pr-Is	Physical schema, real world results	Measurements Pm-Me
Resources Rs	Resource Taxonomy Rs-Tx	Resource Structure Rs-Sr	Resource Connectivity Rs-Cn	Resource Processes Rs-Pr	Resource States Rs-St	Resource Interaction Scenarios Rs-Is		

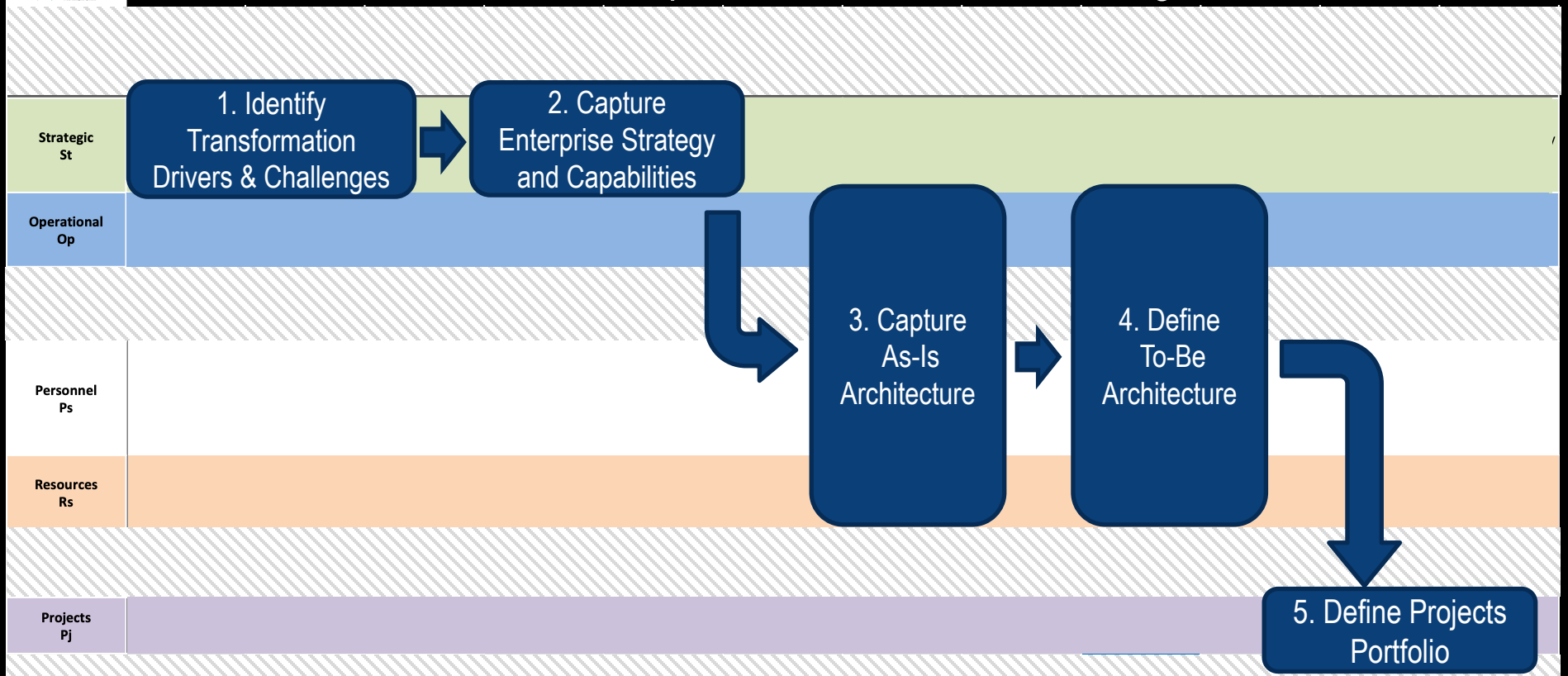
Dictionary * Dc

Summary & Overview SmOv

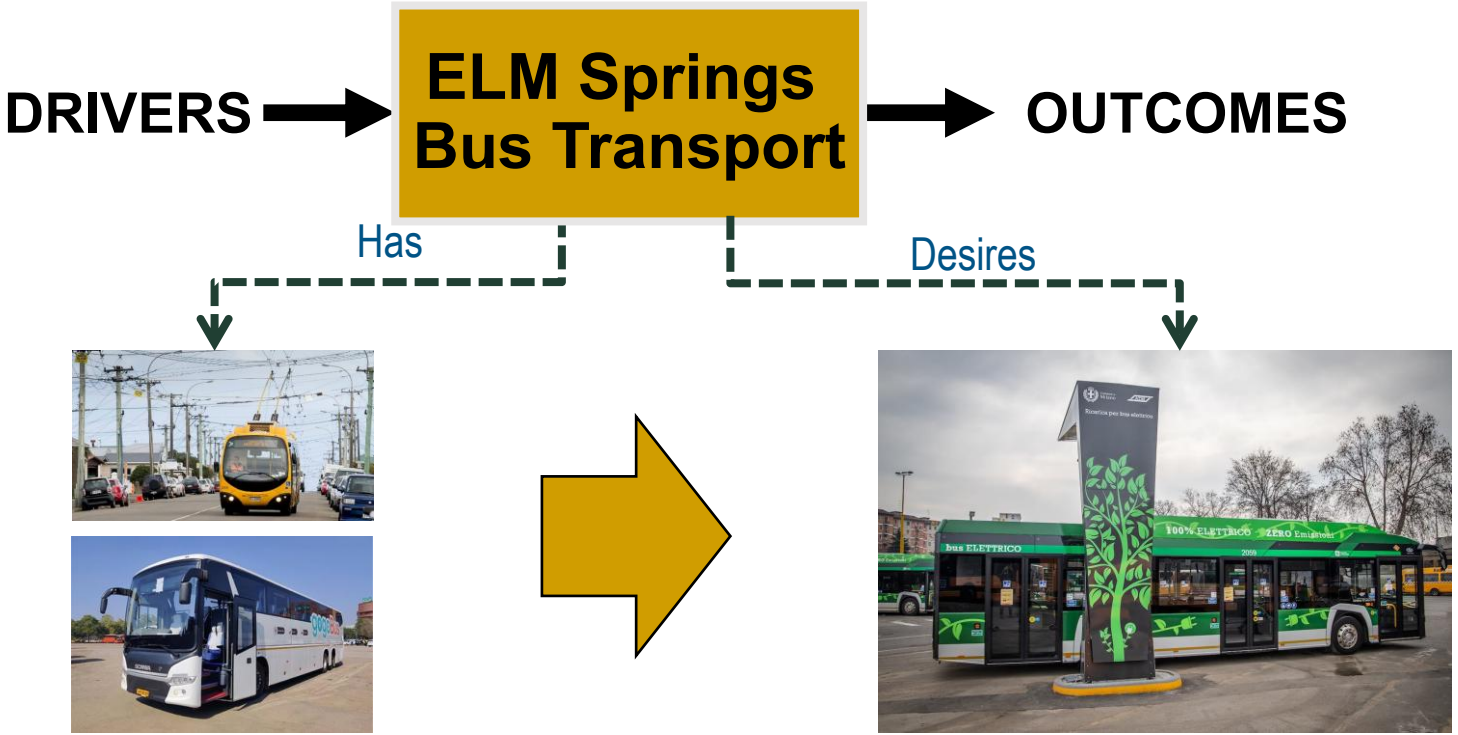
Requirements Rq

Can we use just these domains and models?

Model-Based Enterprise Transformation Planning Workflow



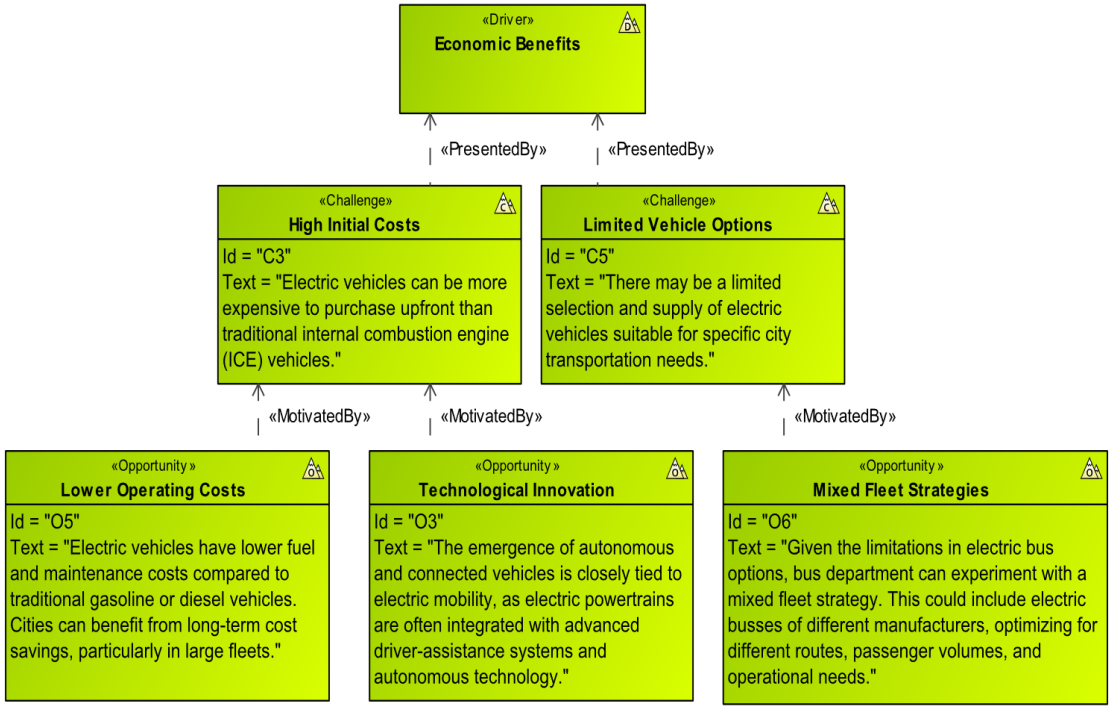
Transportation Enterprise Transformation



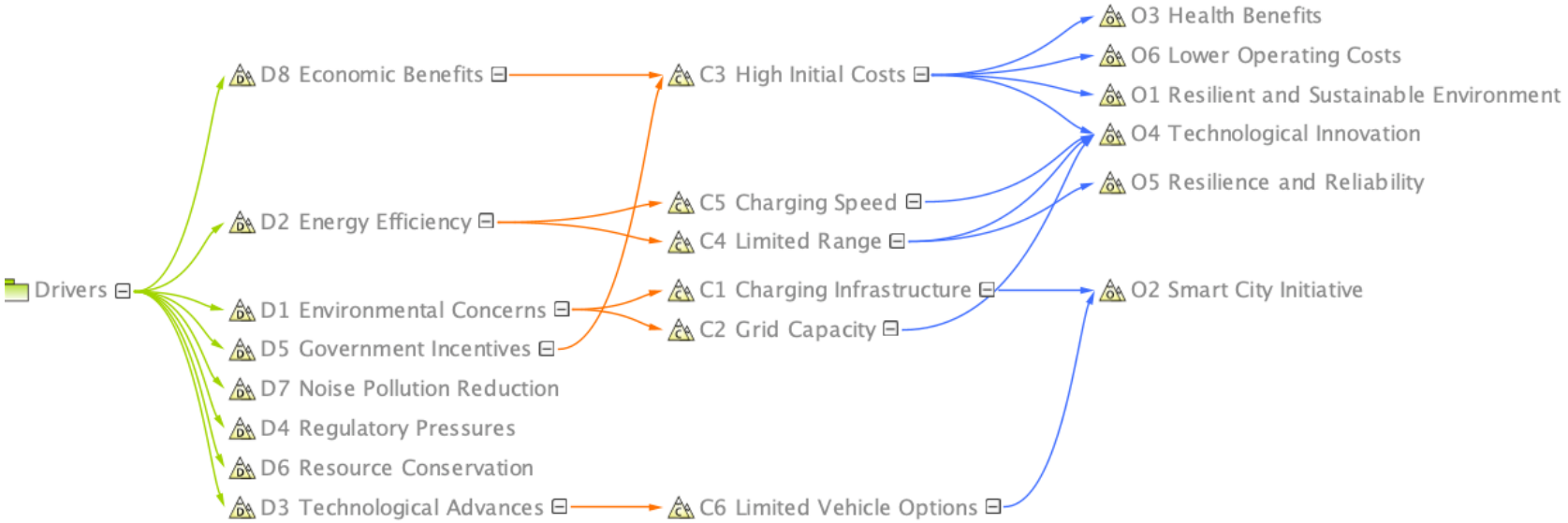
1. Identify Architecture Drivers and Challenges

Determine WHY an enterprise needs transformation:

- Drivers for a change
- Challenges that pursuing these drivers will present
- Opportunities based on drivers and challenges we can pursue

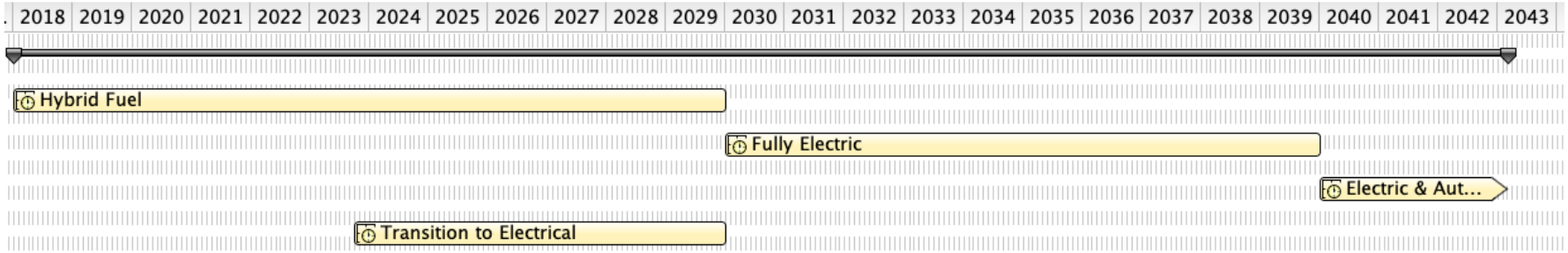


Drivers To Challenges To Opportunities

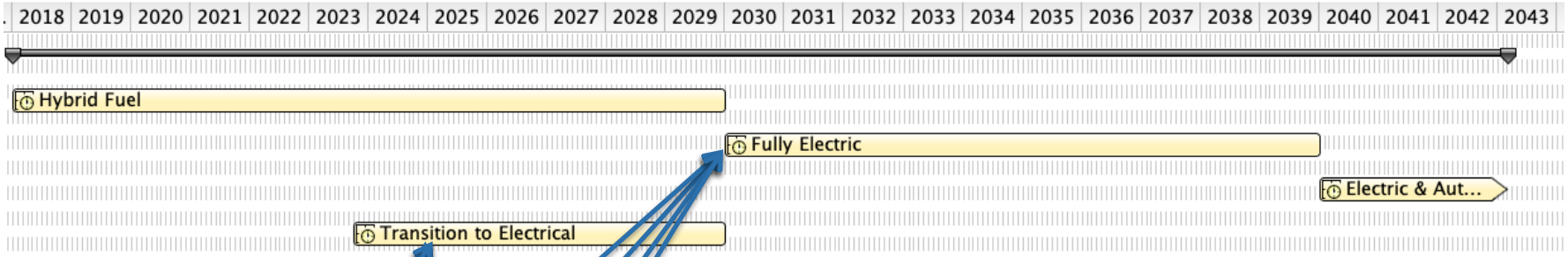


2. Capture Enterprise Strategy and Capabilities

- Plan an enterprise transformation from AS-IS phase to TO-BE phases
- Identify Goals and Capabilities of the current and target phases

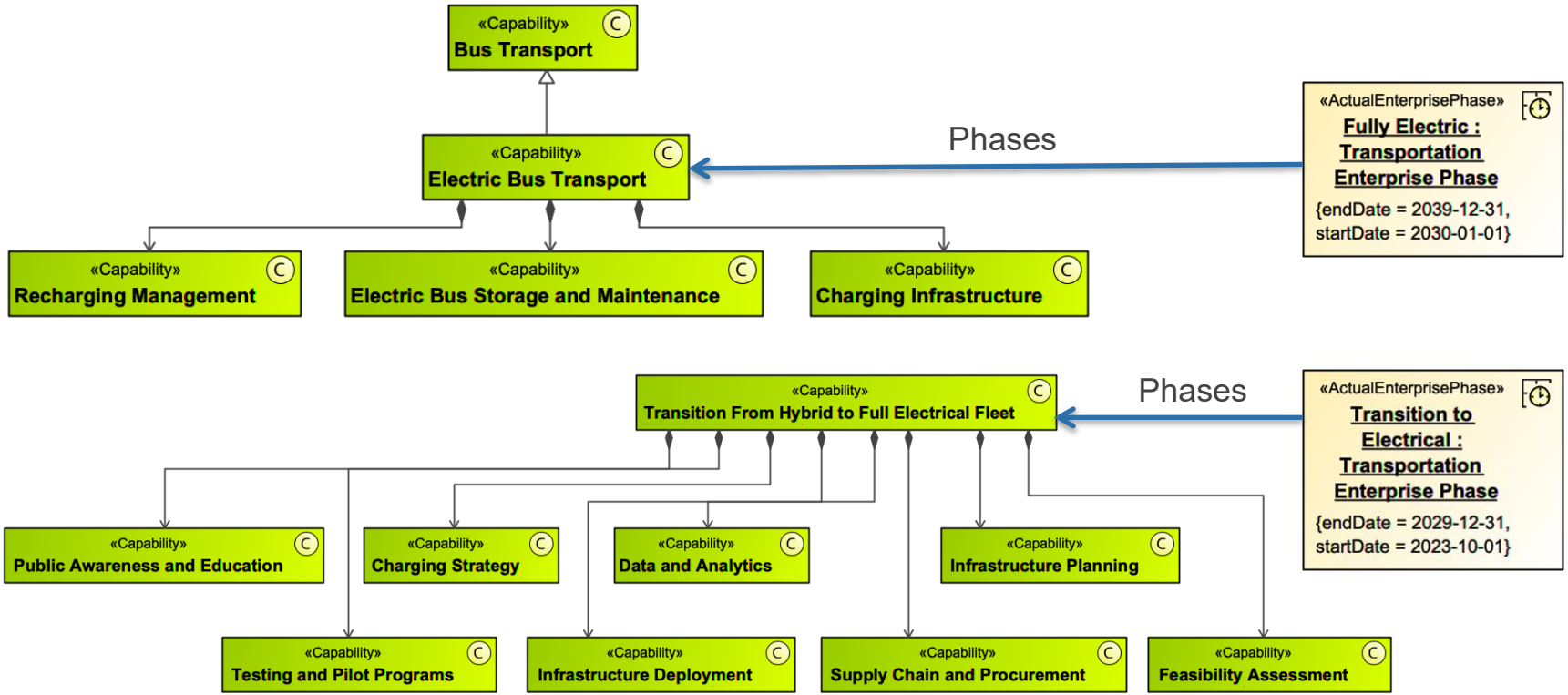


Enterprise Strategy

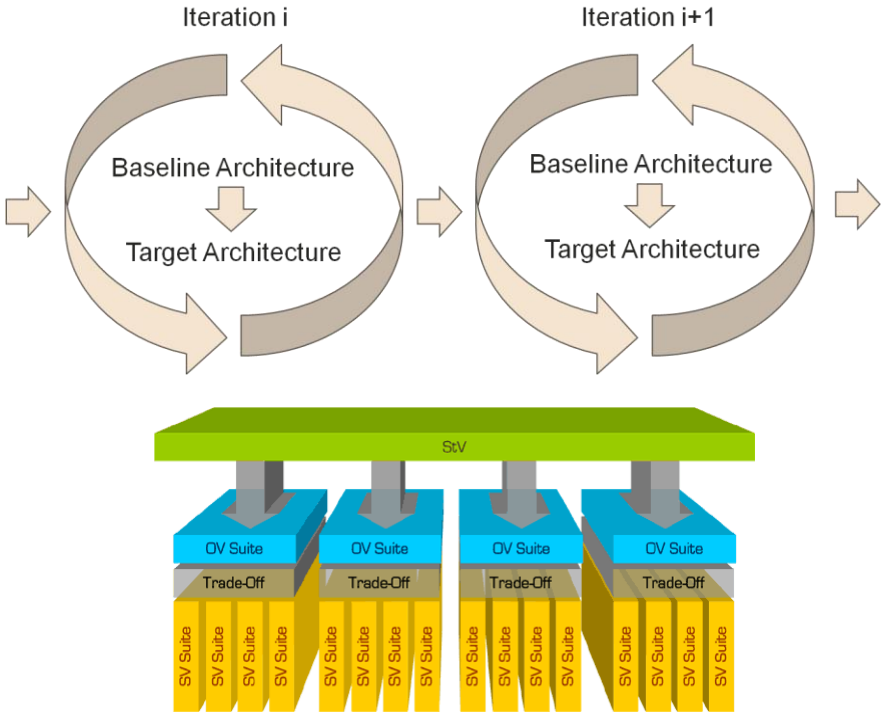


#	Name	Text
1	Goals	
2	EG1 Reduce Carbon Footprint	Reduce the carbon footprint of public transportation to 0
3	EG8 Transition to an Electric Bus Fleet	Transition the public transportation services to an all electric powered fleet.
4	EG9 Manage Charging	Ensure that buses are adequately charged and ready for service.
5	EG10 Deploy Charging Infrastructure	Develop the necessary charging infrastructure, including fast chargers and overnight charging facilities, to support electric bus operations.
6	EG2 Lower Operating Costs	Lower Operating Costs by 15%.
7	EG5 Ensure Efficient Operation	To operate electric buses in the most energy-efficient manner, optimizing charging schedules, maintaining batteries, and monitoring power consumption are key objectives.
8	EG6 Perform Cost-Benefit Analysis	Continuously assess and evaluate the cost-benefit analysis of operating electric buses versus diesel buses, ensuring that the objectives result in cost savings over the long term
9	EG7 Innovation and Technology Adoption	Strive to adopt innovative technologies, such as rapid-charging systems, battery management software, and advanced electric bus models to improve operational efficiency and reduce costs.
10	EG3 Lower Maintenance Costs	Lower Maintenance Costs by 40%
11	EG4 Training and Skill Development	Ensure that maintenance and operational staff receive the necessary training and skills to manage and maintain electric buses effectively

Enterprise Capabilities



3. Capture As-Is Architecture

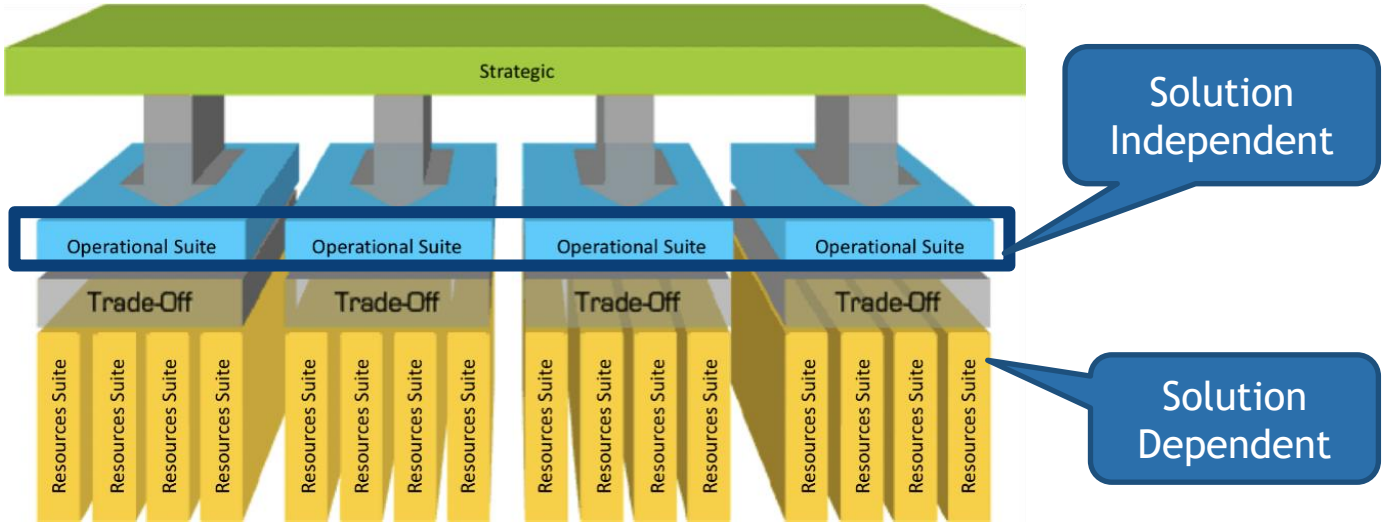


Document the architecture of the current enterprise phase (baseline architecture), including:

- "As-Is" Operational Architecture
- "As-Is" Personnel Architecture
- "As-Is" Resources Architecture

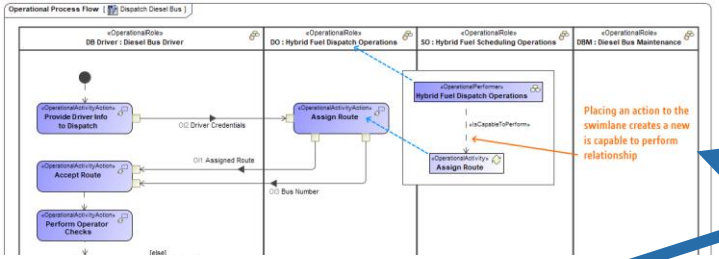
Operational Architecture

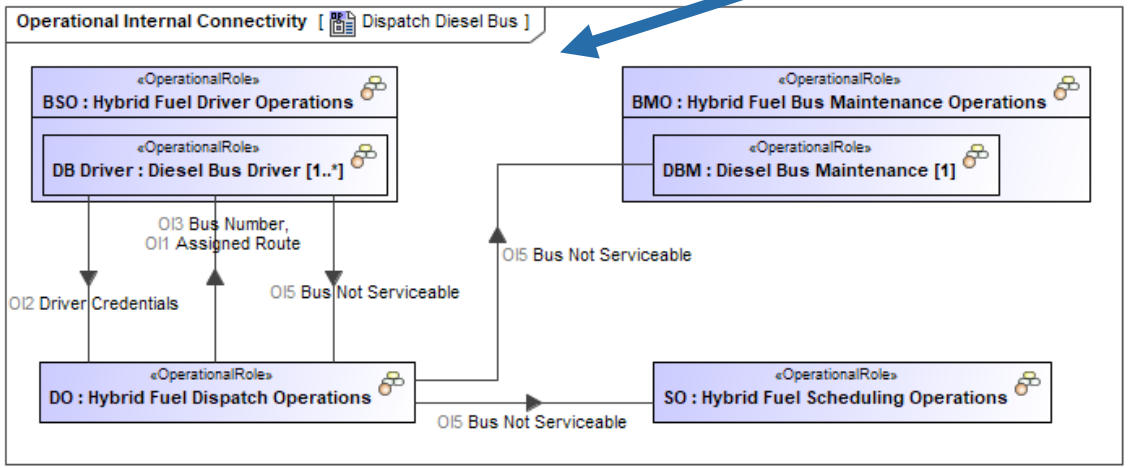
Purpose: describe the requirements, operational behavior, structure, and exchanges required to support (exhibit) capabilities. Define all operational elements in an implementation/solution independent manner

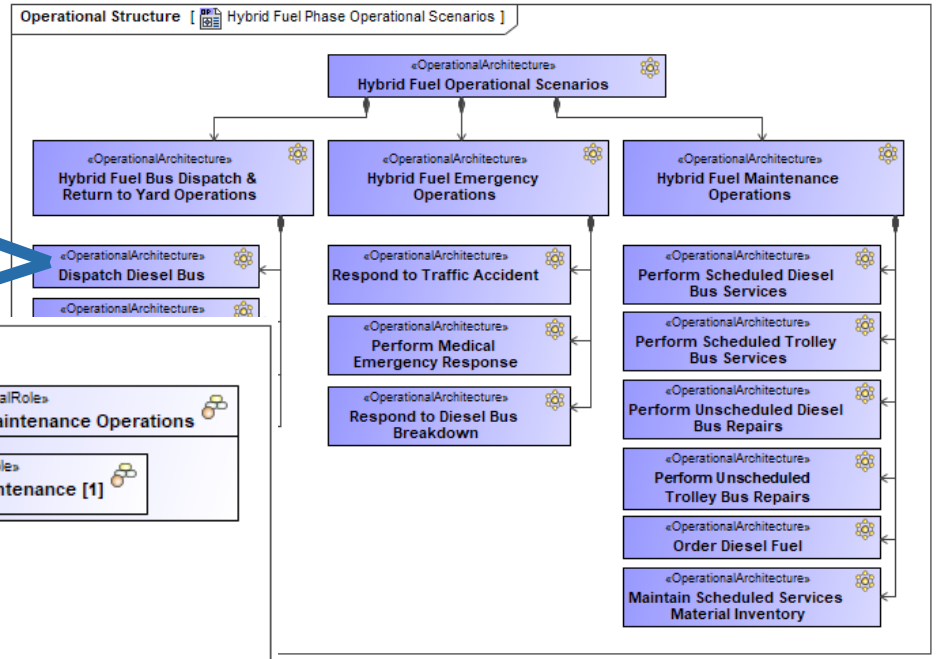


As-Is Operational Architecture

Hybrid Fuel Phase

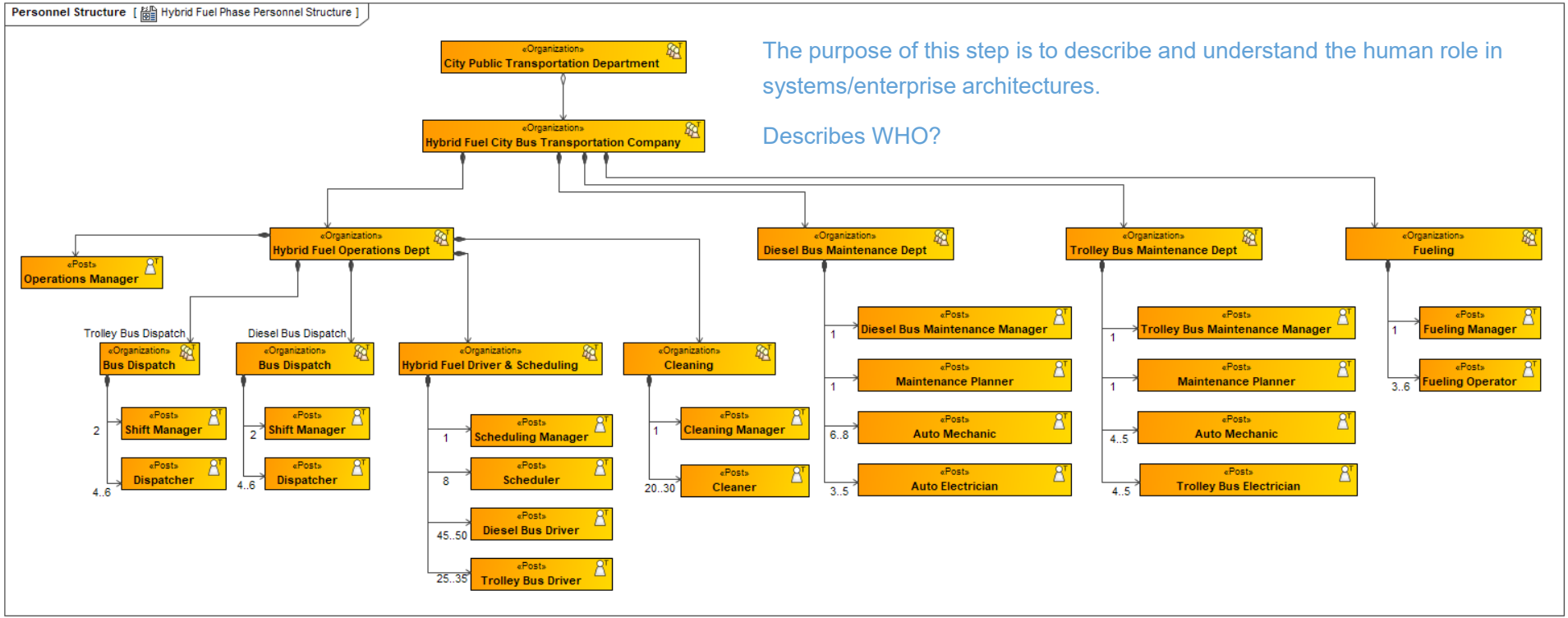






As-Is Personnel Architecture

Hybrid Fuel Phase

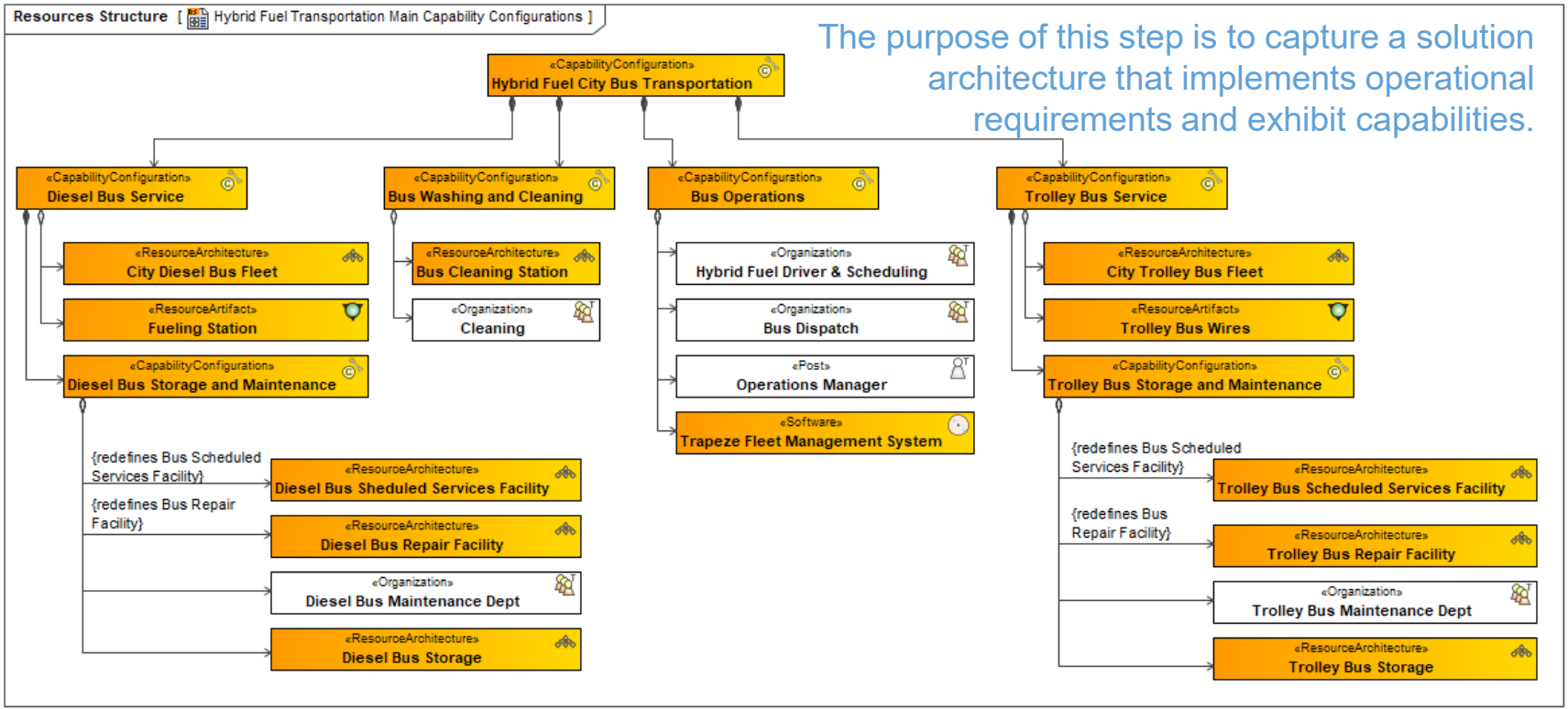


The purpose of this step is to describe and understand the human role in systems/enterprise architectures.

Describes WHO?

As-Is Resources Architecture

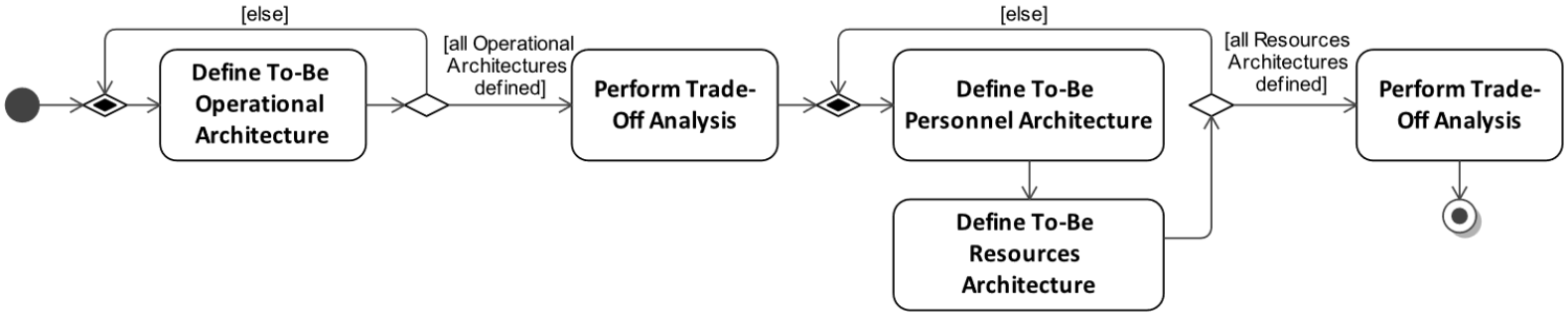
Hybrid Fuel Phase



The purpose of this step is to capture a solution architecture that implements operational requirements and exhibit capabilities.

Define To-be Architecture

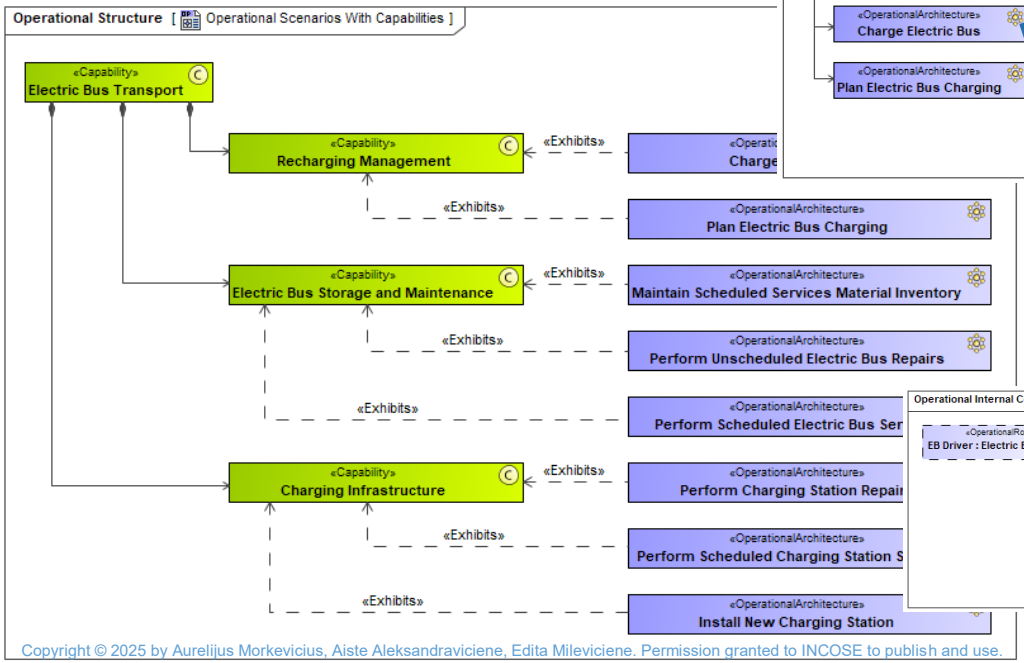
- Multiple “to-be” architectures can be produced
  - If multiple “to-be” architectures are specified, a trade-off analysis is performed to select the optimal one
- Additionally, the “to-be” architectures can be based on the relevant “as-is” architectures, using them as a baseline, rather than being created from scratch

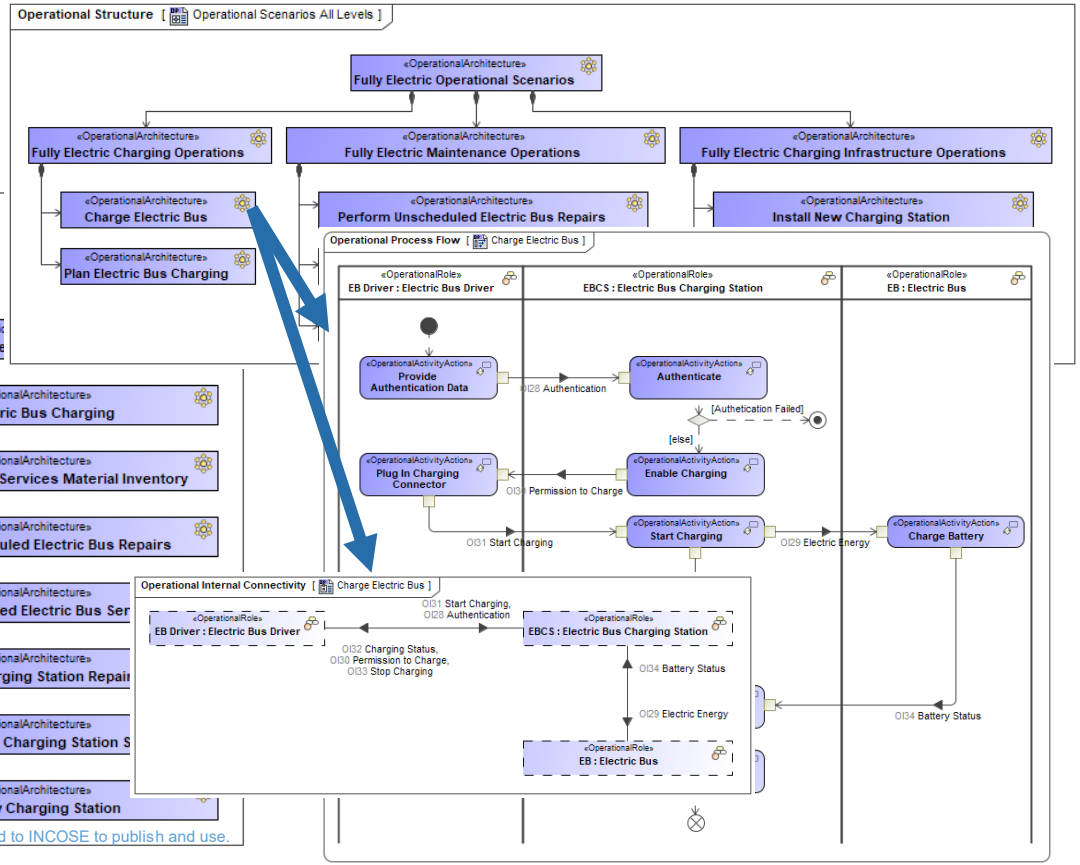


Define to-be operational Architecture

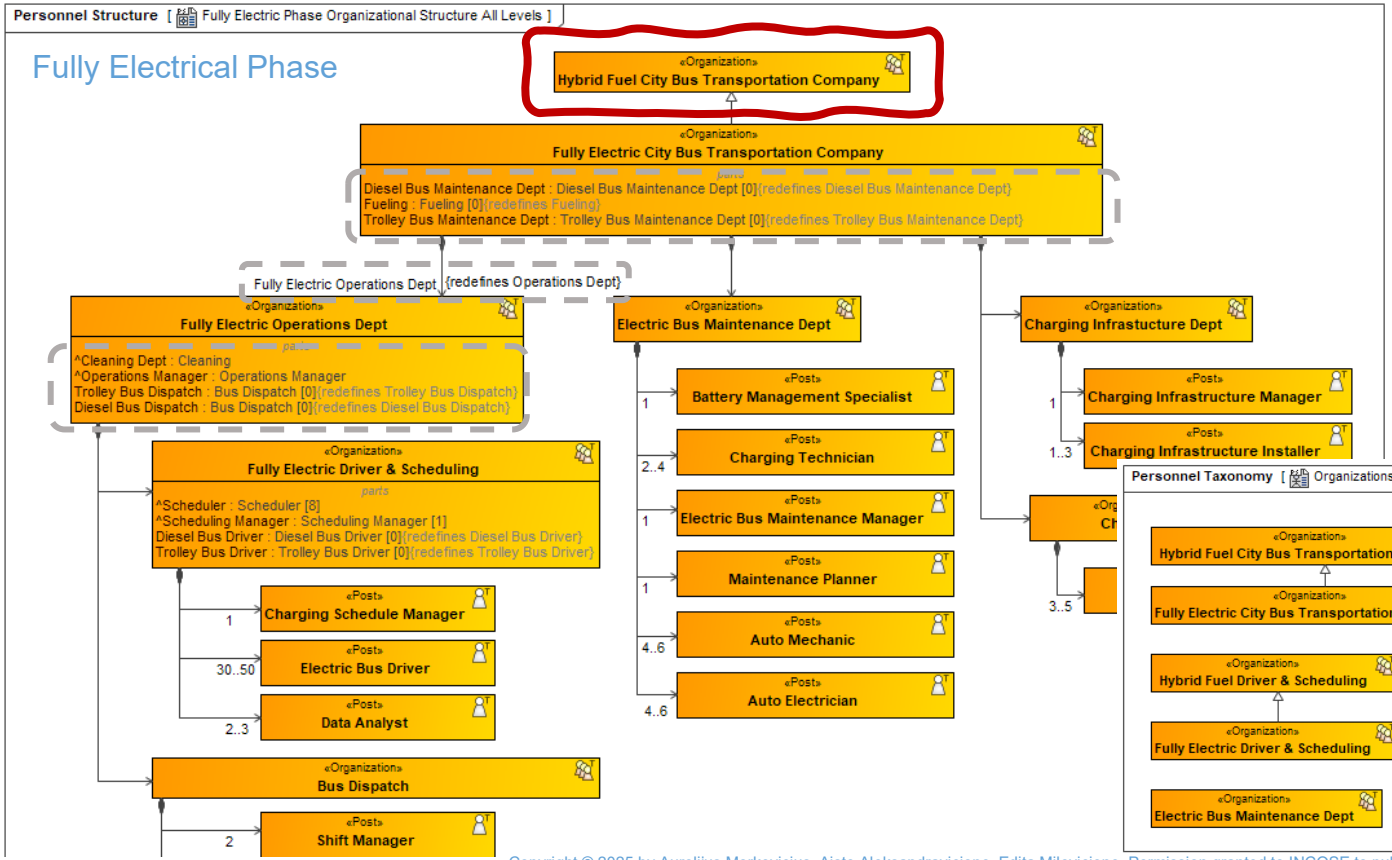
Fully Electrical Phase

Built from scratch to allow flexibility of the architecture and avoid constraints from existing solution





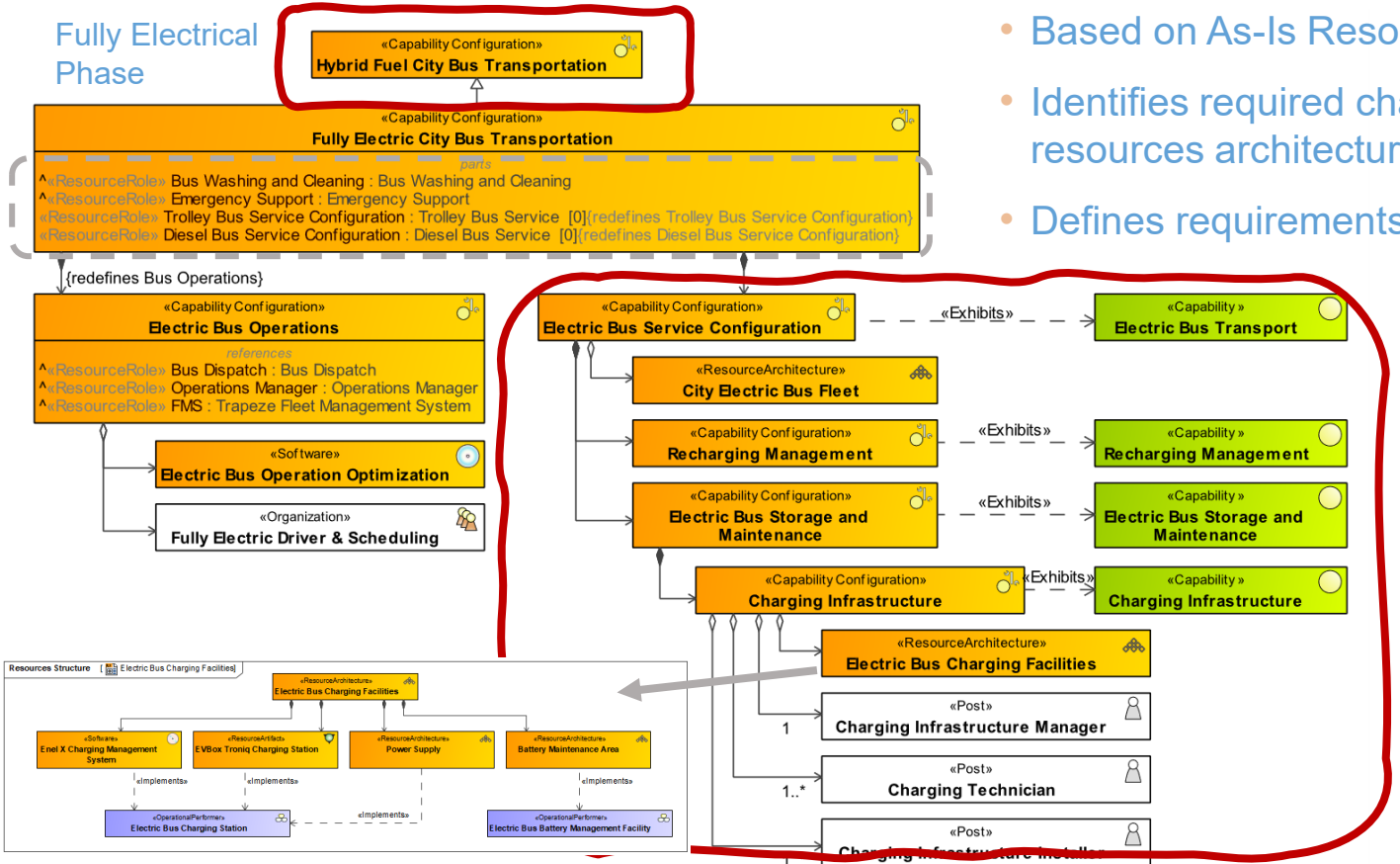
Define to-be Personnel Architecture



- Based on As-Is Personnel structure
- Identifies required changes for To-Be phase

Define to-be Resources Architecture

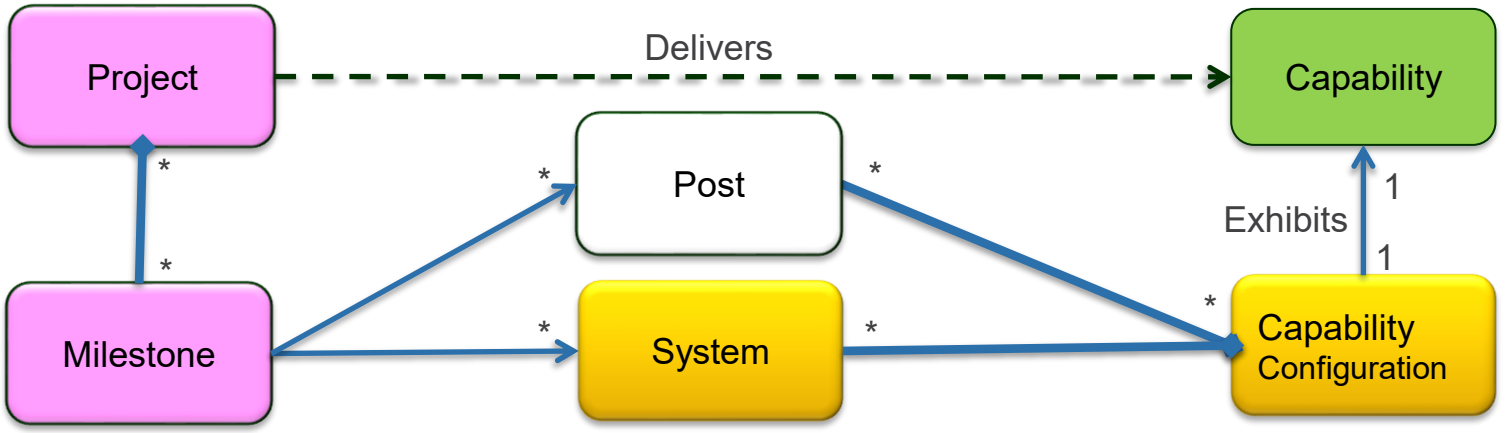
Fully Electrical Phase



- Based on As-Is Resources Architecture
- Identifies required changes to existing resources architecture
- Defines requirements for new resources

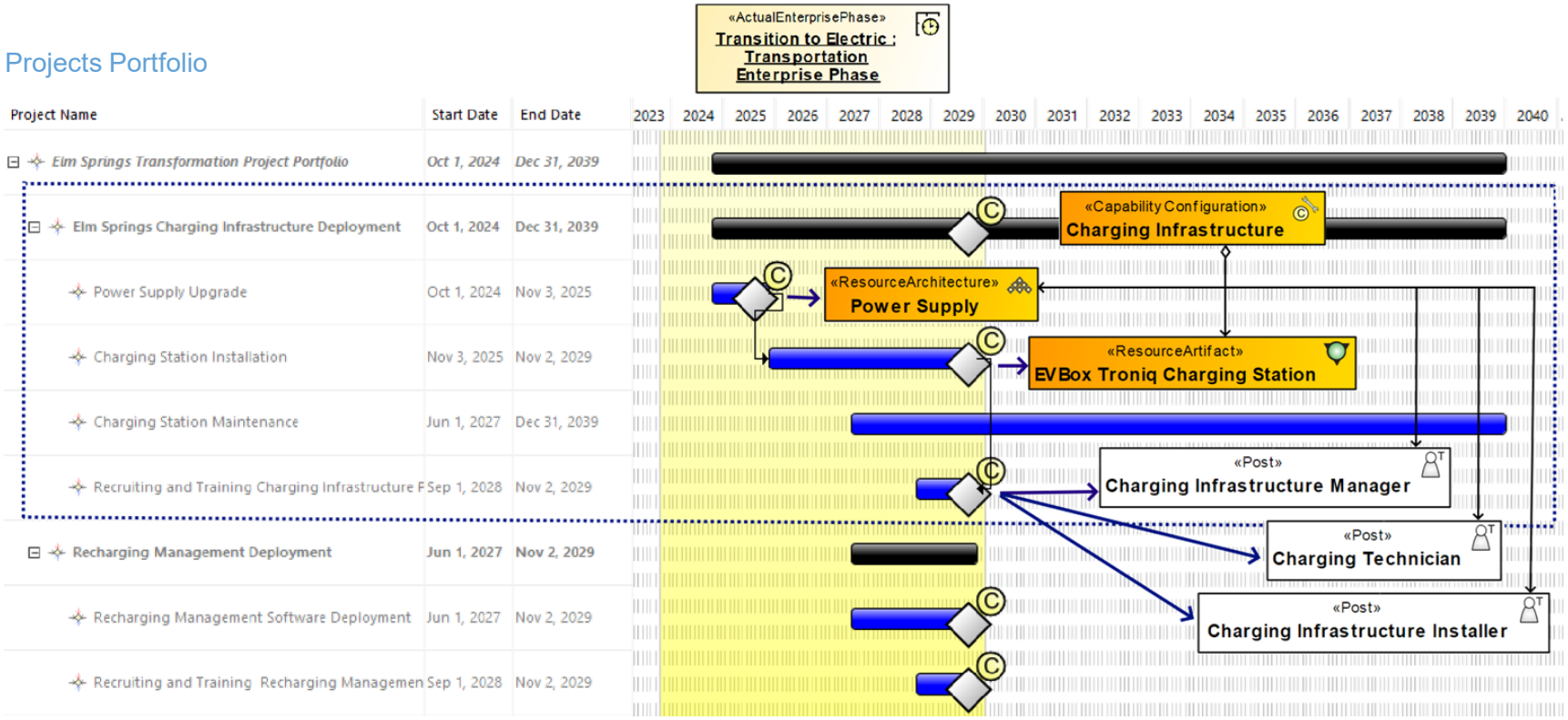
Define Projects Portfolio

- Identifies and describes projects required to transform the enterprise from the “As-is” to “To-be” phase
- **Projects** Deliver Resuorces -> Grouped into **Capability Configurations** -> achieving **Capabilities**



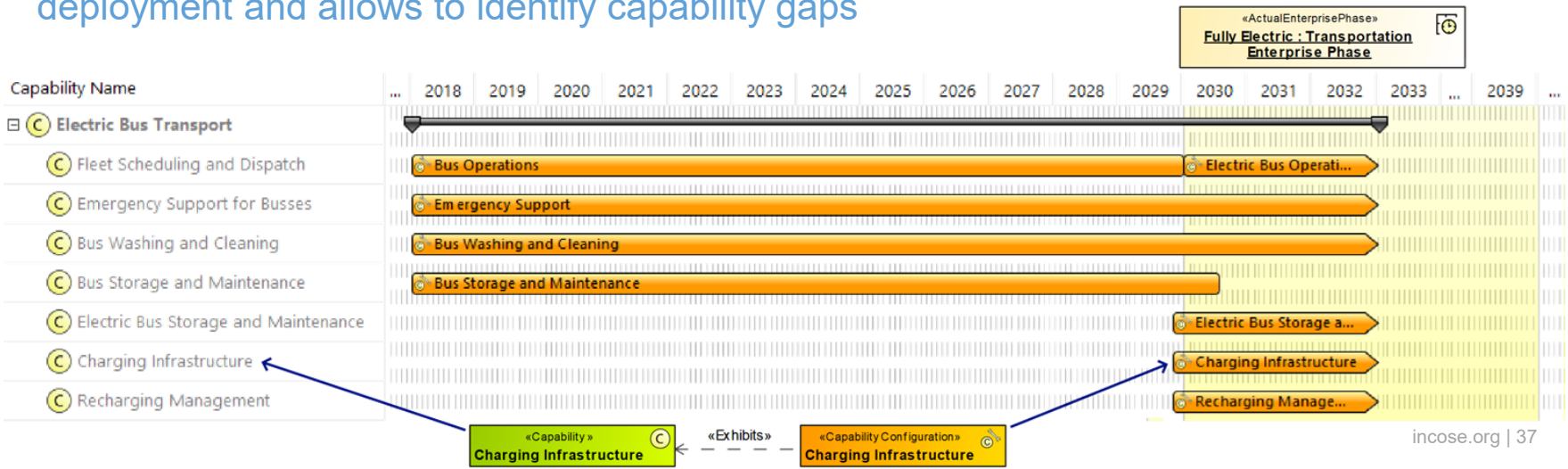
Projects Roadmap (Pj-Rm)

Projects Portfolio



Define Projects Portfolio (cont.)

- The projects portfolio definition enables analysis of capabilities delivery:
  - when each capability becomes available
  - which capability configuration realizes it, and for what period of time
- It also provides an overview of how changes in projects might affect capability deployment and allows to identify capability gaps

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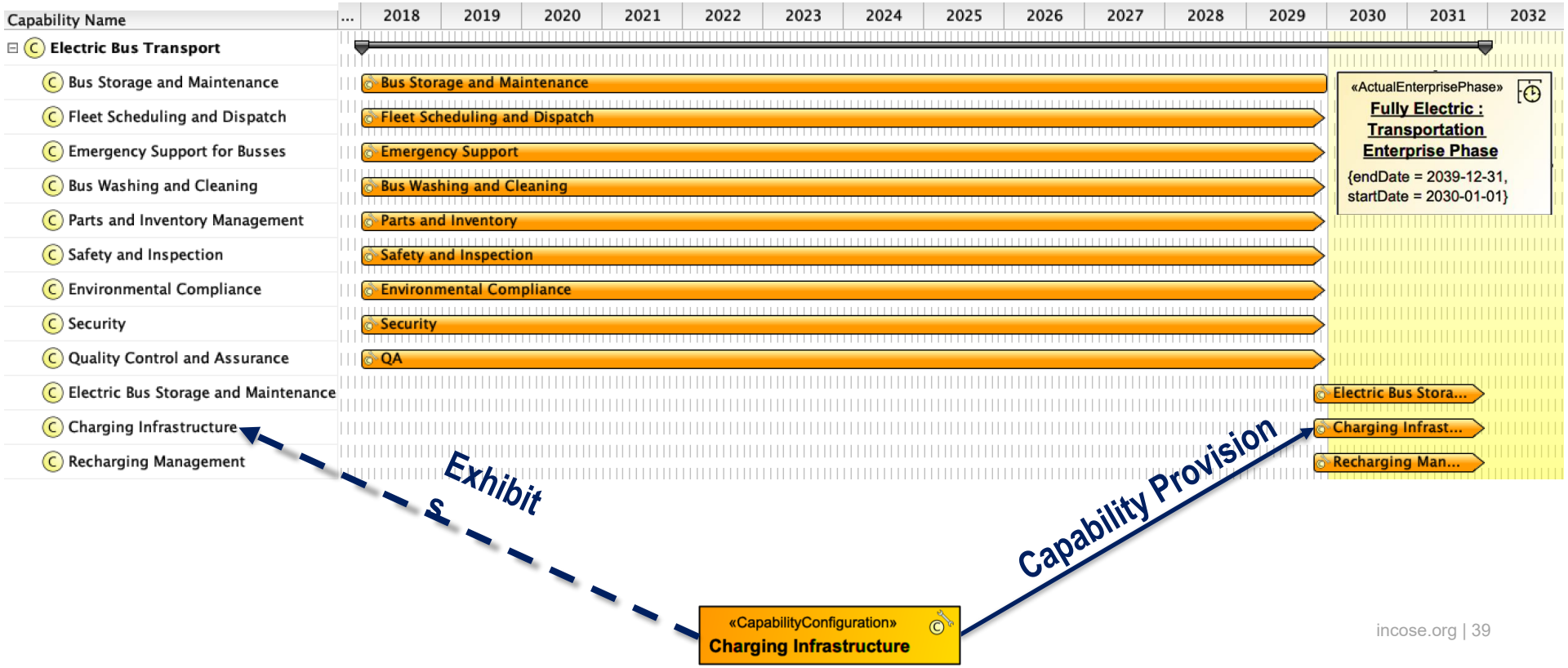
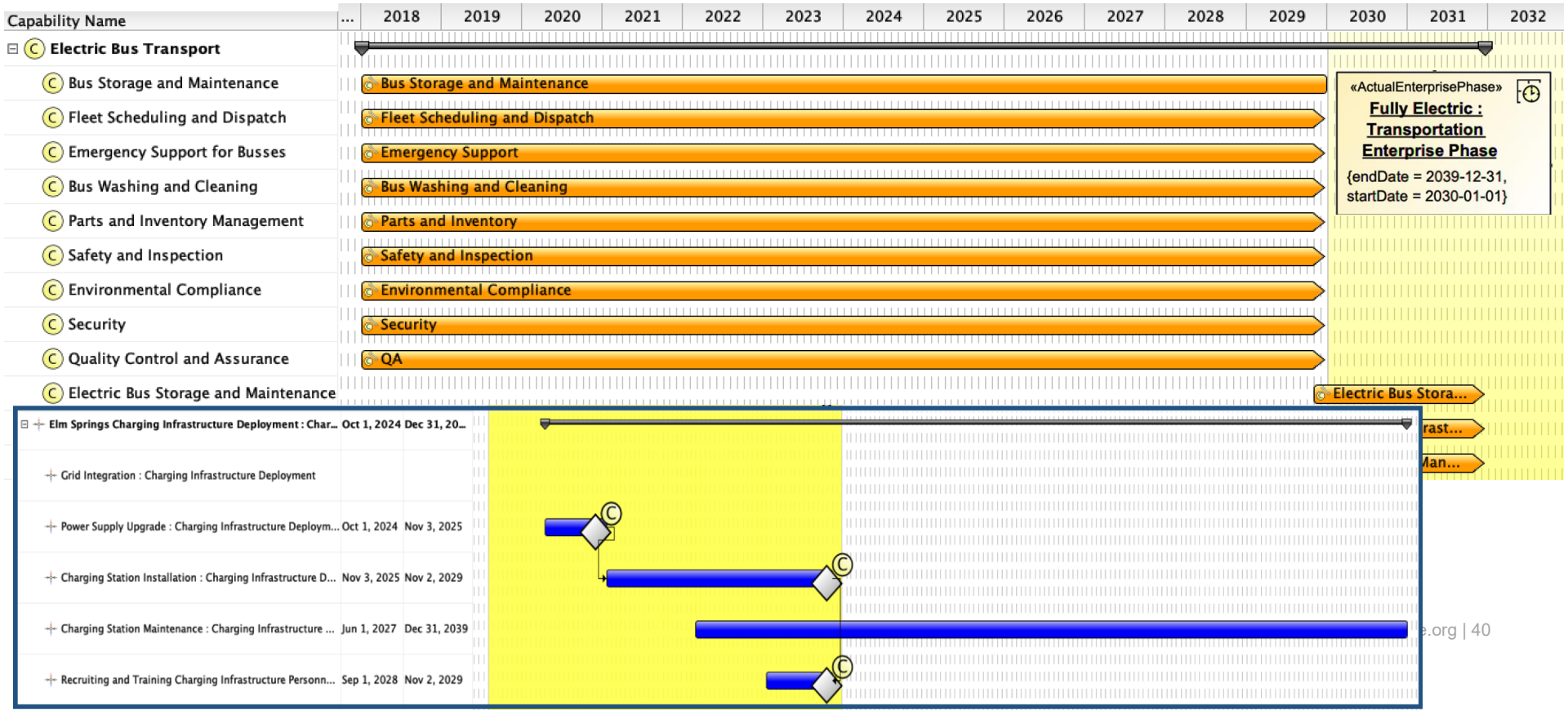
Operational Processes Op-Pr
Operational States Op-St
Operational Sequences Op-Sq
Operational Constraints Op-Ct
Operational Traceability Op-Tr
Services Sv
Services Taxonomy Sv-Tx
Services Structure Sv-Sr
Services Connectivity Sv-Cn
Services Processes Sv-Pr
Services States Sv-St
Services Sequences Sv-Sq
Operational Information Op-If
Services Constraints Sv-Ct
Services Traceability Sv-Tr
Requirements Rq-Mv
Environment En-Pm-E
and
Measurements Me-Pm-M
and
Risks Rk-Pm-R
Personnel Ps
Personnel Taxonomy Ps-Tx
Personnel Structure Ps-Sr
Personnel Connectivity Ps-Cn
Personnel Processes Ps-Pr
Personnel States Ps-St
Personnel Sequences Ps-Sq
Competence, Drivers, Performance Ps-Ct
Personnel Traceability Ps-Tr
Resources Information Rs-If
Resources Rs
Resources Taxonomy Rs-Tx
Resources Structure Rs-Sr
Resources Connectivity Rs-Cn
Resources Processes Rs-Pr
Resources States Rs-St
Resources Sequences Rs-Sq
Resources Constraints Rs-Ct
Resources Traceability Rs-Tr
Security Sc
Security Controls Sc-Mv
Security Taxonomy Sc-Tx
Security Structure Sc-Sr
Security Connectivity Sc-Cn
Security Processes Sc-Pr
Projects Roadmap Pj-Rm
Projects Pj
Projects Taxonomy Pj-Tx
Projects Structure Pj-Sr
Projects Connectivity Pj-Cn
Projects Processes Pj-Pr
Standards Sd
Standards Taxonomy Sd-Tx
Standards Structure Sd-Sr
Sd-Rm
Sd-Tr
Actual Resources Ar
Actual Resources Structure, Ar-Sr
Actual Resources Connectivity, Ar-Cn
Simulation[b]
Parametric Execution/ Evaluation[b]

Strategic Roadmap: Phasing (St-Rm-P)

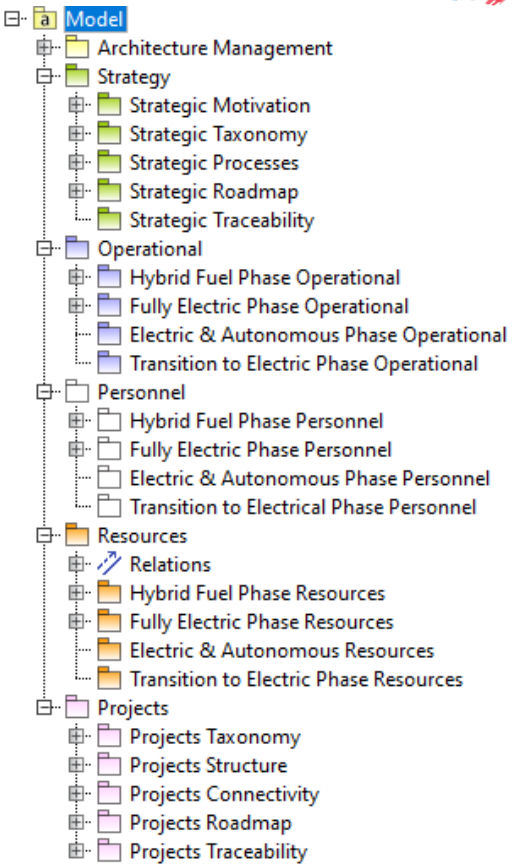


Strategic Roadmap: Phasing (St-Rm-P)



Model Structure

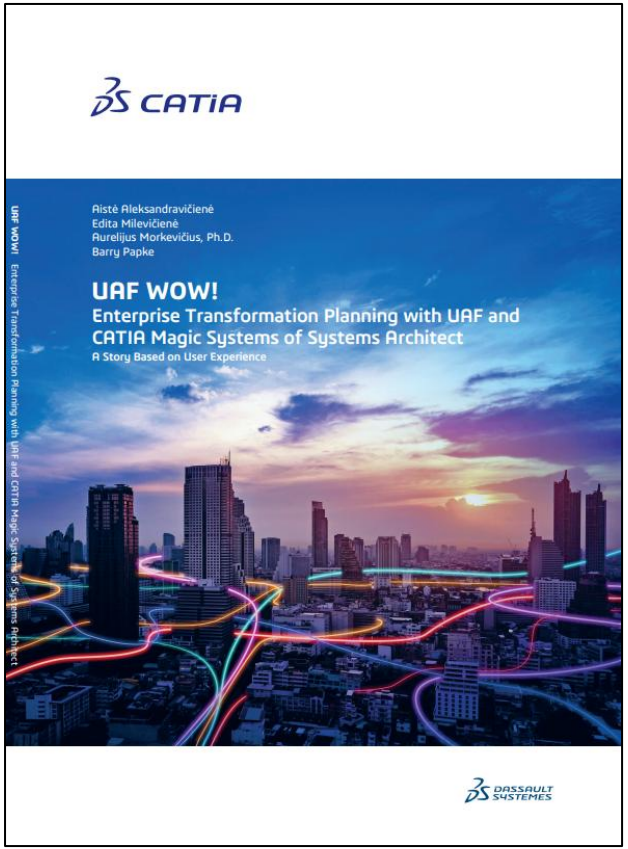
UAF	Motivation Mv	Taxonomy Tx	Structure Sr	Connectivity Cn	Processes Pr	States St	Sequences Sq	Information[c] If	Parameters[d] Pm	Constraints Ct	Roadmap Rm	Traceability Tr
Architecture Management[a] Am	Architecture Principles Am-Mv	Architecture Extensions Am-Tx[e]	Architecture Views Am-Sr	Architecture References Am-Cn	Architecture Development Method Am-Pr	Architecture Status Am-St		Dictionary Am-If	Architecture Parameters Am-Pm	Architecture Constraints Am-Ct	Architecture Roadmap Am-Rm	Architecture Traceability Am-Tr
Summary & Overview Sm-Ov												
Strategic St	Strategic Motivation St-Mv	Strategic Taxonomy St-Tx	Strategic Structure St-Sr	Strategic Connectivity St-Cn	Strategic Processes St-Pr	Strategic States St-St		Strategic Information St-If	Environment En-Pm and Measurements Me-Pm and Risks Rk-Pm	Strategic Constraints St-Ct	Strategic Deployment, St-Rm-D Strategic Phasing St-Rm-P	Strategic Traceability St-Tr
Operational Op	Requirements Rq-Mv	Operational Taxonomy Op-Tx	Operational Structure Op-Sr	Operational Connectivity Op-Cn	Operational Processes Op-Pr	Operational States Op-St	Operational Sequences Op-Sq	Operational Information Op-If		Operational Constraints Op-Ct		Operational Traceability Op-Tr
Services Sv		Services Taxonomy Sv-Tx	Services Structure Sv-Sr	Services Connectivity Sv-Cn	Services Processes Sv-Pr	Services States Sv-St	Services Sequences Sv-Sq			Services Constraints Sv-Ct	Services Roadmap Sv-Rm	Services Traceability Sv-Tr
Personnel Ps		Personnel Taxonomy Ps-Tx	Personnel Structure Ps-Sr	Personnel Connectivity Ps-Cn	Personnel Processes Ps-Pr	Personnel States Ps-St	Personnel Sequences Ps-Sq			Competence, Drivers, Performance Ps-Ct	Personnel Availability Ps-Rm-A Personnel Evolution PS-Rm-E Personnel Forecast Ps-Rm-F	Personnel Traceability Ps-Tr
Resources Rs		Resources Taxonomy Rs-Tx	Resources Structure Rs-Sr	Resources Connectivity Rs-Cn	Resources Processes Rs-Pr	Resources States Rs-St	Resources Sequences Rs-Sq	Resources Information Rs-If		Resources Constraints Rs-Ct	Resources evolution, Resources forecast Rs-Rm	Resources Traceability Rs-Tr
Security Sc	Security Controls Sc-Mv	Security Taxonomy Sc-Tx	Security Structure Sc-Sr	Security Connectivity Sc-Cn	Security Processes Sc-Pr					Security Constraints Sc-Ct		Security Traceability Sc-Tr
Projects Pj		Project Taxonomy Pj-Tx	Project Structure Pj-Sr	Project Connectivity Pj-Cn	Project Processes Pj-Pr						Project Roadmap Pj-Rm	Project Traceability Pj-Tr
Standards Sd		Standards Taxonomy Sd-Tx	Standards Structure Sd-Sr								Standards Roadmap Sd-Rm	Standards Traceability Sd-Tr
Actual Resources Ar			Actual Resources Structure, Ar-Sr	Actual Resources Connectivity, Ar-Cn	Simulation[b]					Parametric Execution/ Evaluation[b]		



Summary

Summary

- An end-to-end approach for planning enterprise transformation.
- Validated through a case study of transforming a city bus transportation enterprise from a hybrid to a fully electric system.
- Identified several critical decisions necessary to achieve a seamless, end-to-end transformation model.
- The approach is presented to the UAF Task Force within the Object Management Group (OMG) and gathered valuable feedback for further refinement.
- The approach and findings are documented in:
  - A new UAF WOW! book to disseminate knowledge and provide practical guidance on enterprise transformation using UAF.
  - https://discover.3ds.com/uaf-wow-enterprise-transformation-planning



Thank You!

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