

How MBSE is used in Rail

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Atkins

Overview

- Introduction
 - Company overview
- Using MBSE
 - Process definition
 - Requirements
 - Architecture
 - V&V/assurance
- Delivering MBSE

Introduction

Model-based Systems Engineer - Rail

- London Underground,
- Network Rail,
- HSL Zuid,
- MARTA.

Atkins Consultant

- Requirements, Architecture, Information, Architecture Frameworks, Process definition.

Company overview



At a glance

Atkins is one of the world's leading design, engineering and project management consultancies.

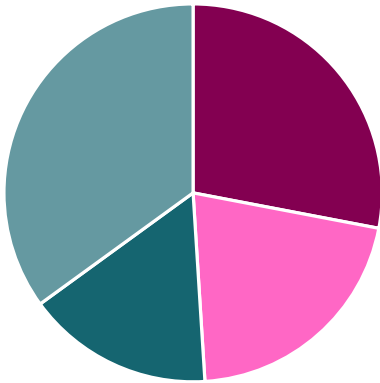
We have the depth and breadth of expertise to respond to the most technically challenging and time-critical infrastructure projects and the urgent transition to a low carbon economy.

In 2013 Atkins is celebrated 75 years in business.



Our clients

Revenue by client type

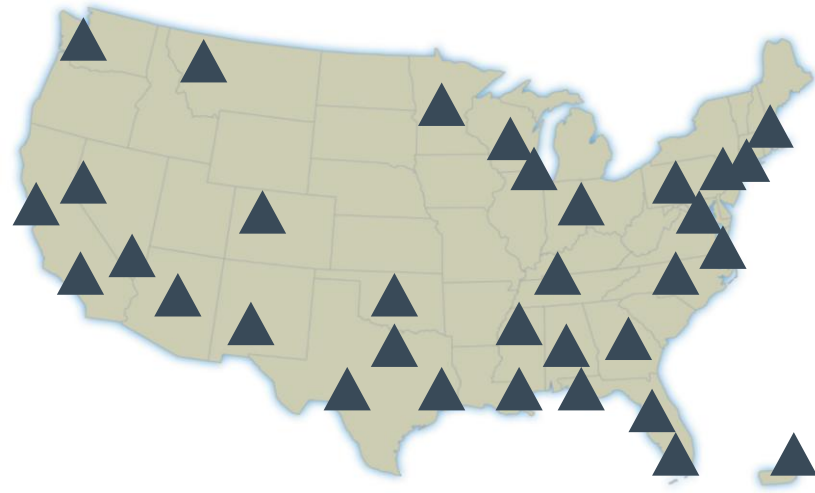


Key Transport clients include:

Network Rail
Texas Dept of Transportation
UK Highways Agency
Florida Department of Transportation
Transport for London
Trafikverket
BAM Group (UK)
Banedanmark (RailDenmark)

New York City Transit
MTR Corporation Ltd
Etihad Rail Company PJSC
Jernbaneverket (Rail Norway)
Ministry of Municipality & Urban Planning (MMUP) Qatar
Crossrail
MARTA

- Public sector: local government 28%
- Public sector: national government 21%
- Regulated 16%
- Private sector 35%



Crossrail

United Kingdom

ATKINS

Detailed design of twin bored tunnels,
and design and specification Tottenham Court Road and
Custom House stations and Plumstead depot

Image courtesy of Crossrail

Birmingham New Street Station

United Kingdom

ATKINS

Birmingham
New Street Station



Lead consultant,
design management and
urban planning

Image courtesy of Network Rail

European Rail Traffic Management System

Denmark

ATKINS



Client advisor for the design, implementation and testing of ERTMS on the entire Danish rail network (3200km)

Using MBSE

Process Modelling

Process definition

Aim

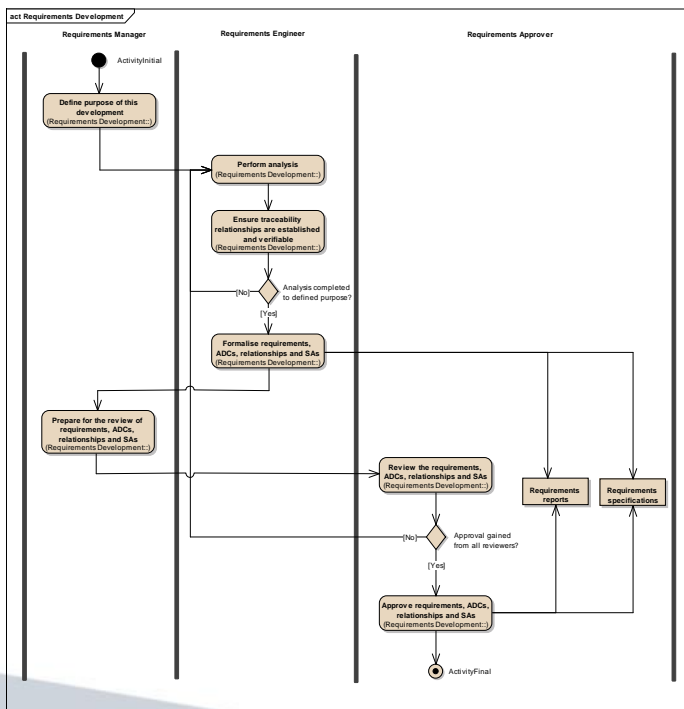
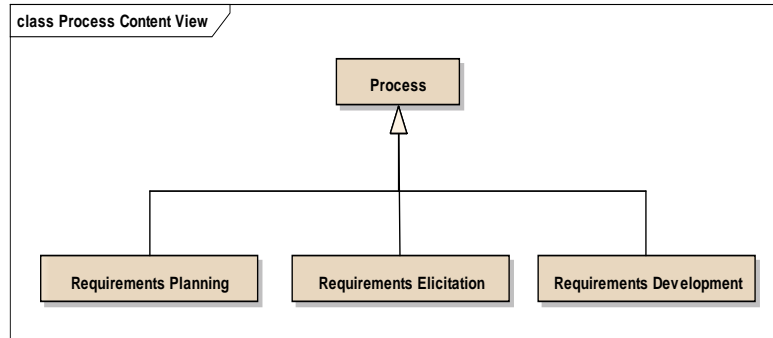
- Identify the right process
- Understand the information and activities to be delivered
- Ensure consistency between activities and information
- Focus on Activities not documents

Approach

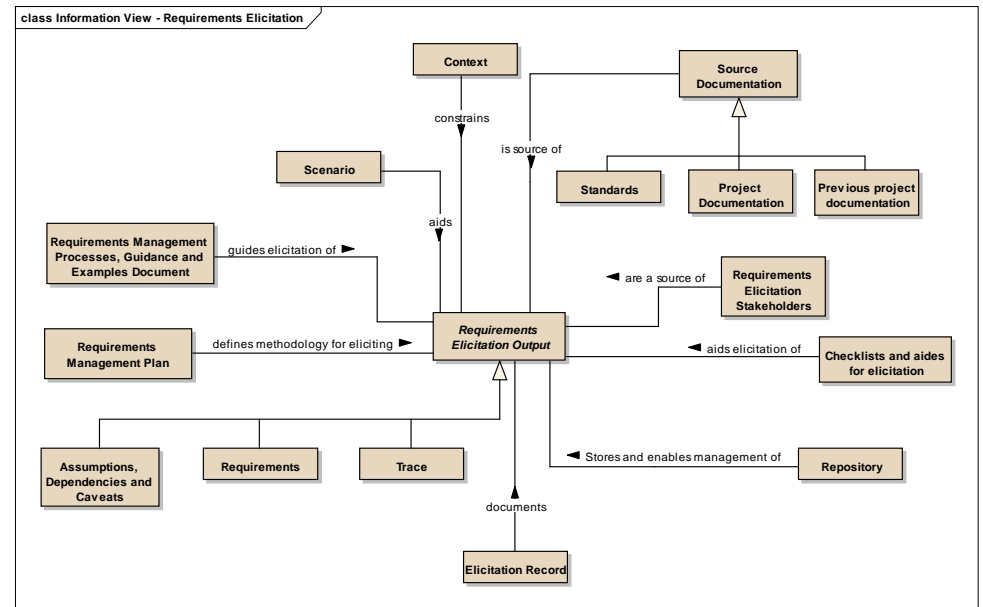
- Take multiple views of a process
- Combine/contrast views to provide consistency.
- Be pragmatic regarding rigour and maturity of information.
- Expect repetition of processes, not one shot.

Process definition

Process List



Process Flow



Process Information

Process definition

Benefits

- Cross domain application
- Enables balance between generic process and specific technique.
- Relevant to people with differing levels of expertise.
- Consistent activities and information

Using MBSE

Requirements Modelling

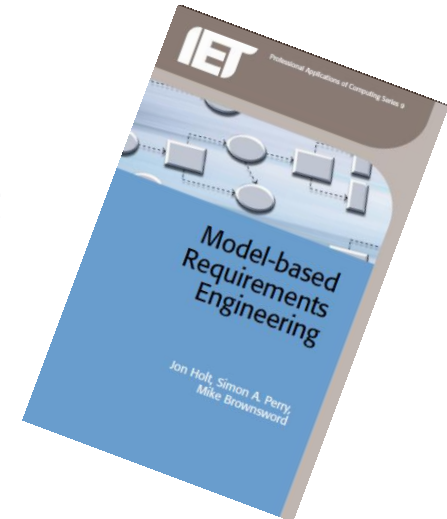
Requirements Analysis

Aim

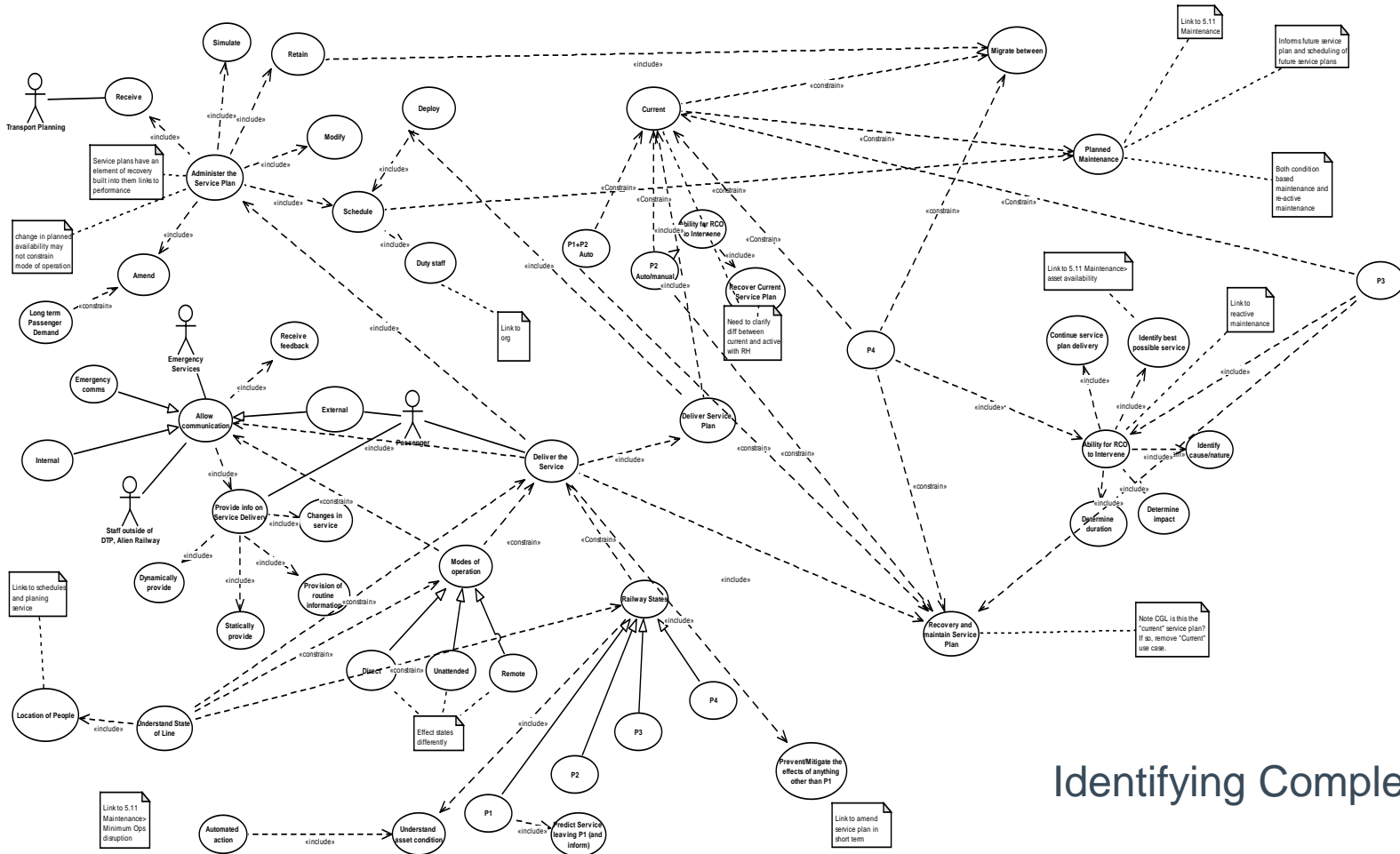
- Ensure requirements have a home
- Understand the essence of the requirements
- To support the development of the whole set of requirements – not just individual statements.
- Understand the problem and whether it is being solved.
- Differentiate between different types of requirement (Stakeholder vs System)

Approach

- Provide relationships between requirements within a set
- Clearly separate requirements into contexts

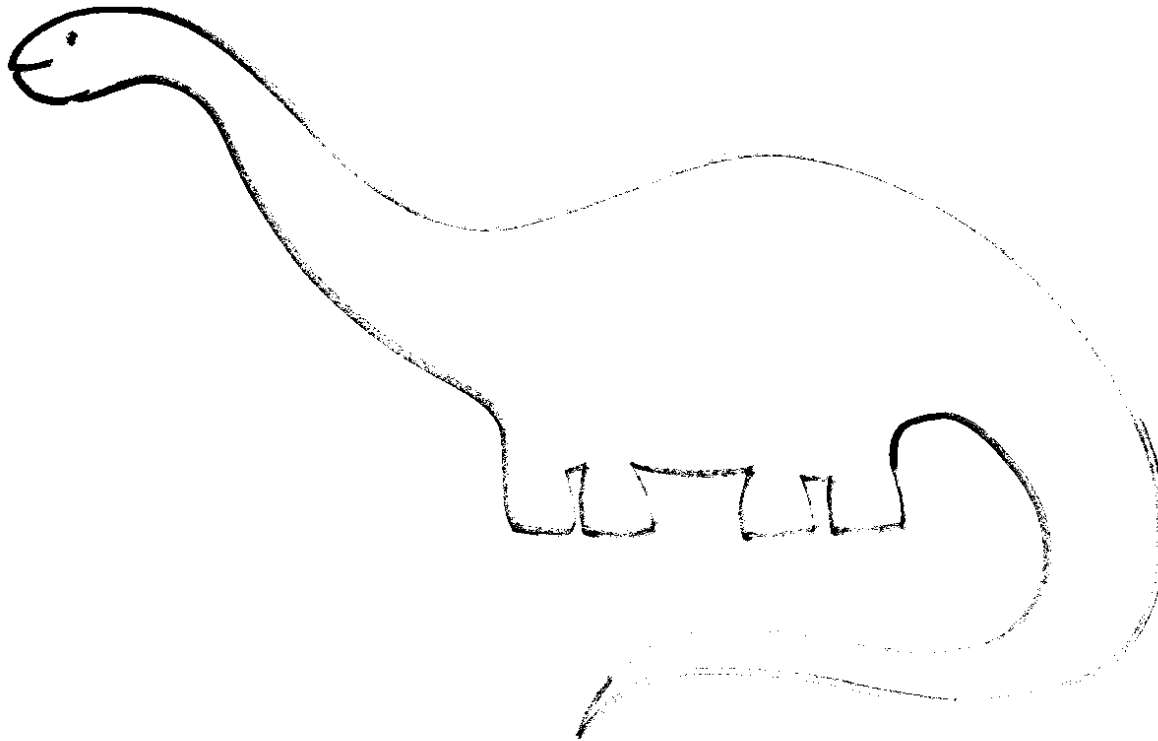


Where to start?

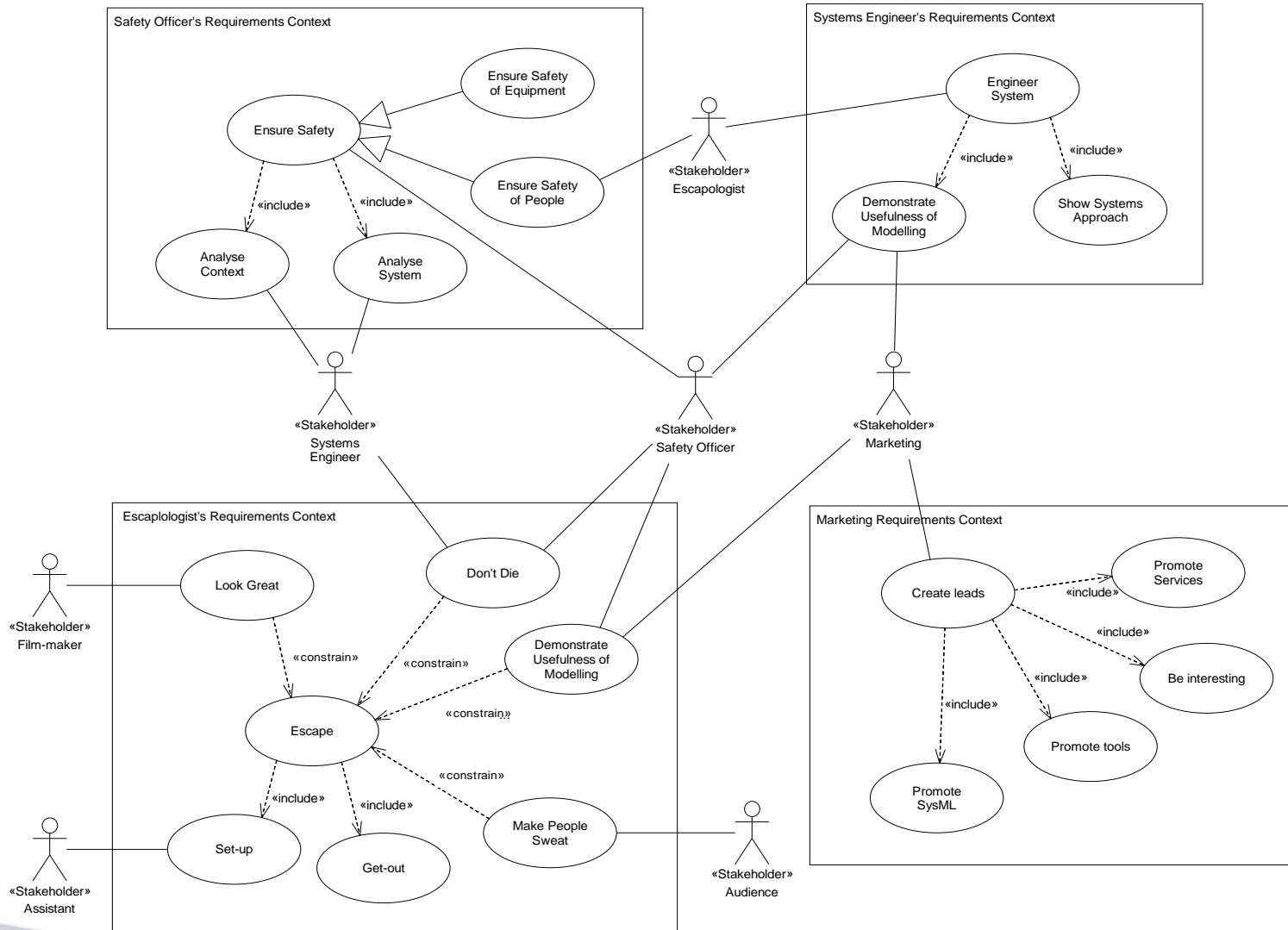


Identifying Complexity

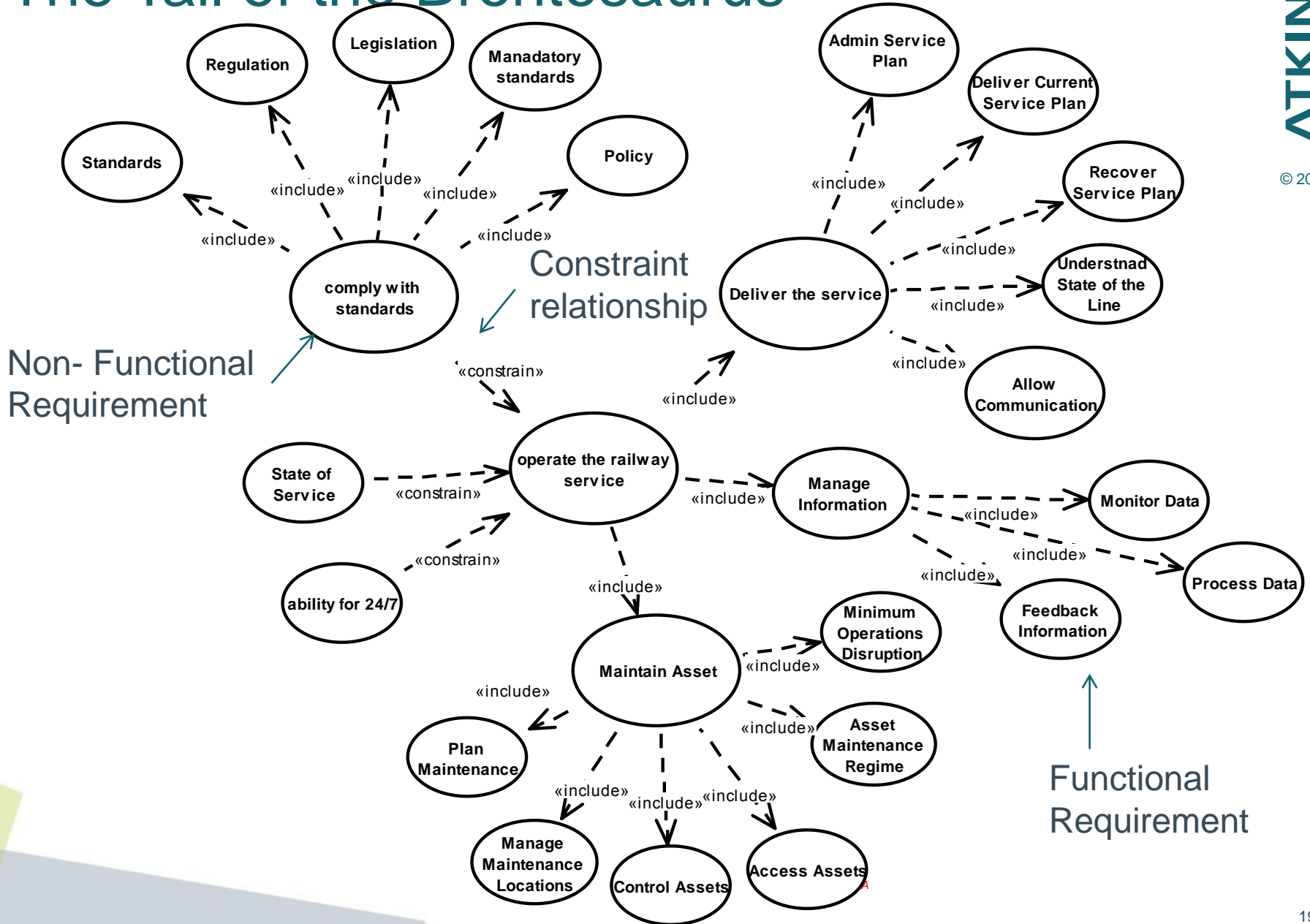
The Tail of the Brontosaurus



Comparing contexts



The Tail of the Brontosaurus



Requirements Analysis

Benefits

- Enables well structured requirement sets to be developed
- Enables visualisation of requirements including relationships between functional and non-functional.
- Model-based view validates text
- Improves communication and engagement with stakeholders
- Enables conflict resolution
- Enables levelling of requirements

Using MBSE

Architecture Modelling

Architecture

Aim

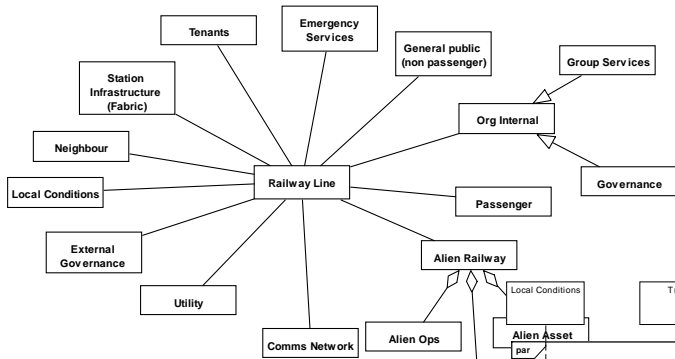
- Facilitate development of and capture design information
- To answer specific stakeholder questions/issues/concerns, i.e. How do we migrate?
- Deliver facts aligned with fuzzy pictures
- Ensure it isn't 'just' another railway
- Understand boundaries and interfaces
- Ensure structure and function are consistent

Approach

- Deliver information in the best way for the stakeholder to understand.
- Provide multiple representations of information where appropriate.
- Ensure consistency between information.

Many Views make life work

System Context

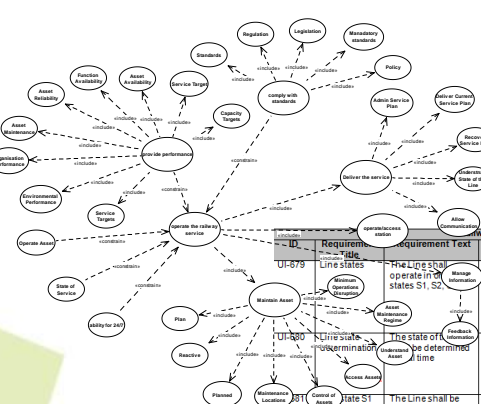
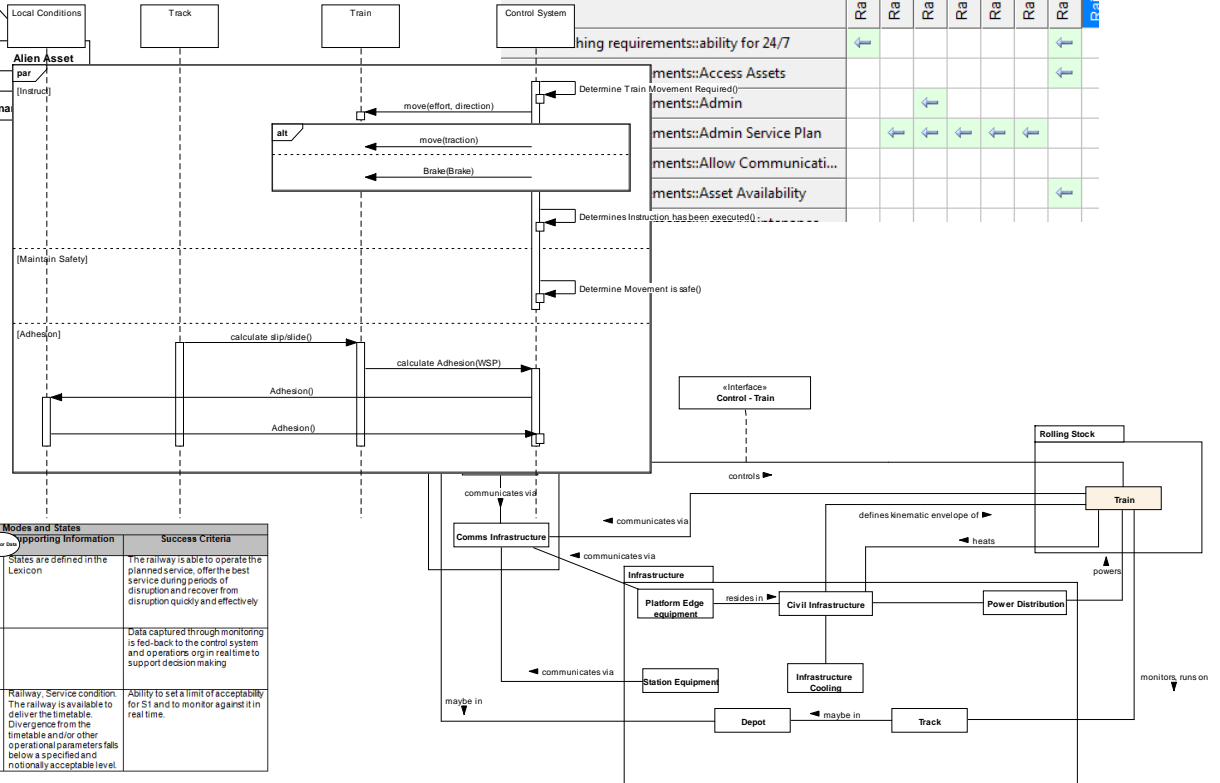


Traceability

Source: 5.0 Overarching ... Type: UseCase ... Link Type: Trace
 Target: Railway process ... Type: Activity ... Direction: Target -> Source

| Requirement | Railway process:0: Operate the D | Railway process:1: Maintain the L | Railway process:1:1 Develop the | Railway process:1:2 Maintain the | Railway process:1:3 Select a Sen | Railway process:1:4 Enquire on S | Railway process:2: Deliver the Pla |
|-----------------------------------|----------------------------------|-----------------------------------|---------------------------------|----------------------------------|----------------------------------|----------------------------------|------------------------------------|
| Requirements:ability for 24/7 | ↑ | | | | | | ↑ |
| Requirements:Access Assets | | | | | | | ↑ |
| Requirements:Admin | | | | | | | ↑ |
| Requirements:Admin Service Plan | | ↑ | ↑ | ↑ | ↑ | ↑ | |
| Requirements:Allow Communicati... | | | | | | | ↑ |
| Requirements:Asset Availability | | | | | | | ↑ |

Interaction



Requirements

Interfaces

Architecture

Benefits

- Enables confidence in design
- Facilitates focused technical discussion.
- Enables re-use of information
- Provides consistency
- Supports demonstration of performance

Using MBSE

V&V/Assurance

V&V/Assurance

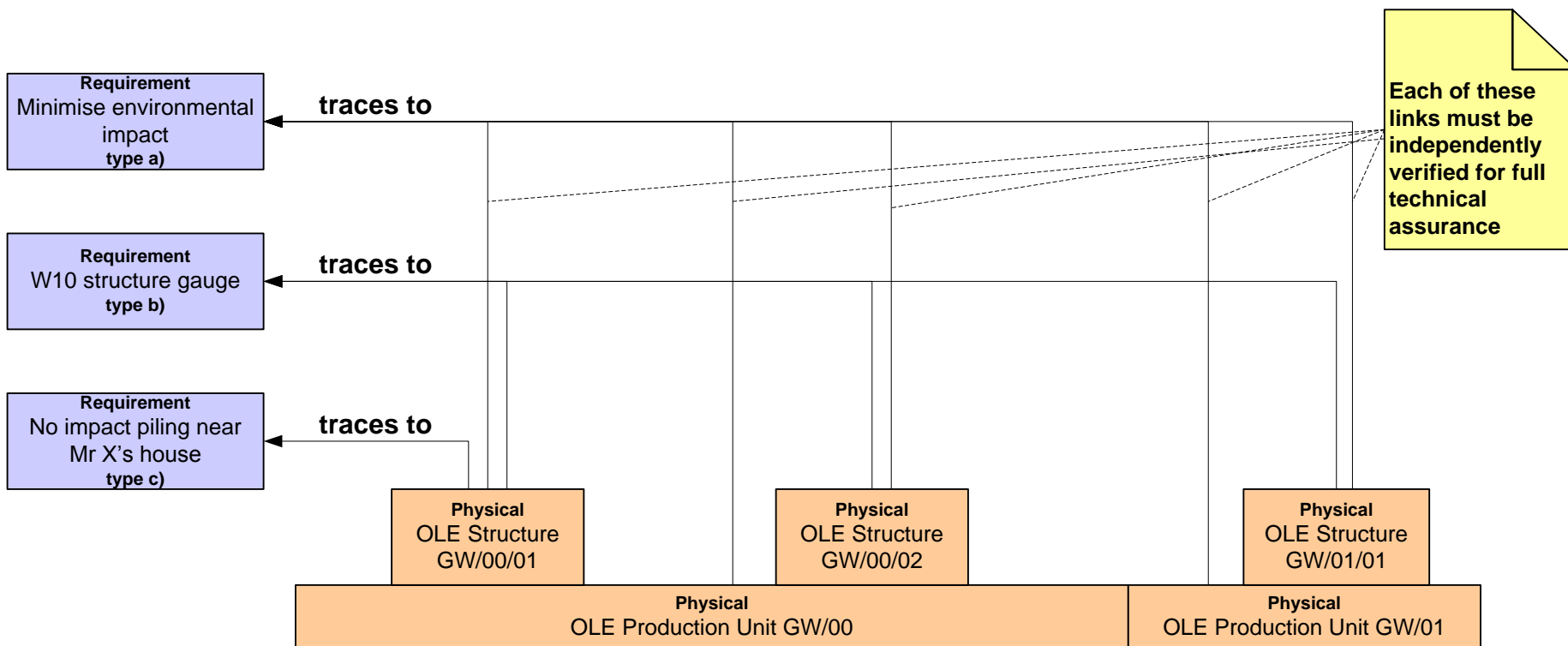
Aims

- Ensure all requirements are met
- Reduce manual application of traceability
- Increase consistency

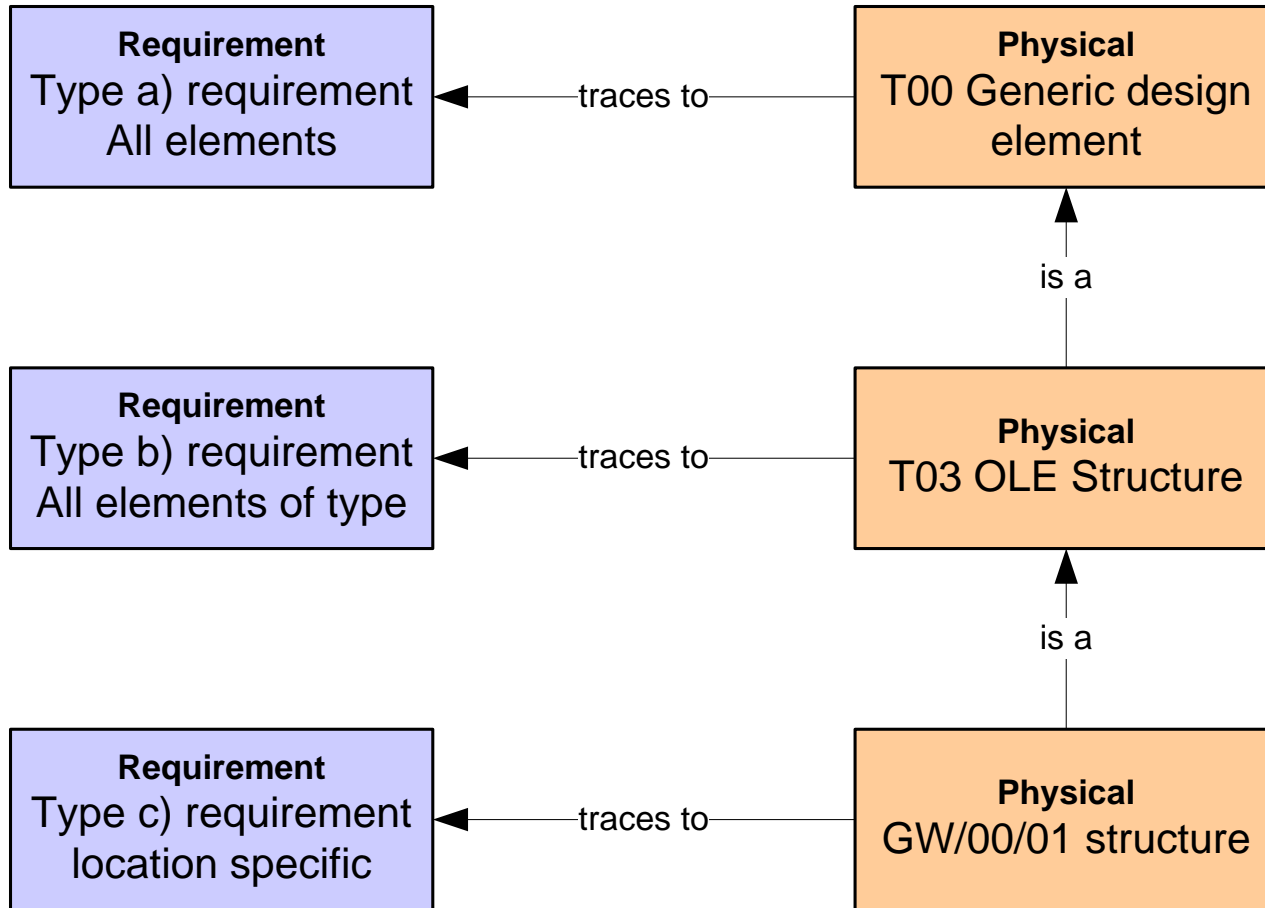
Approach

- Provide rich traceability
- Integrate Requirements and Architecture

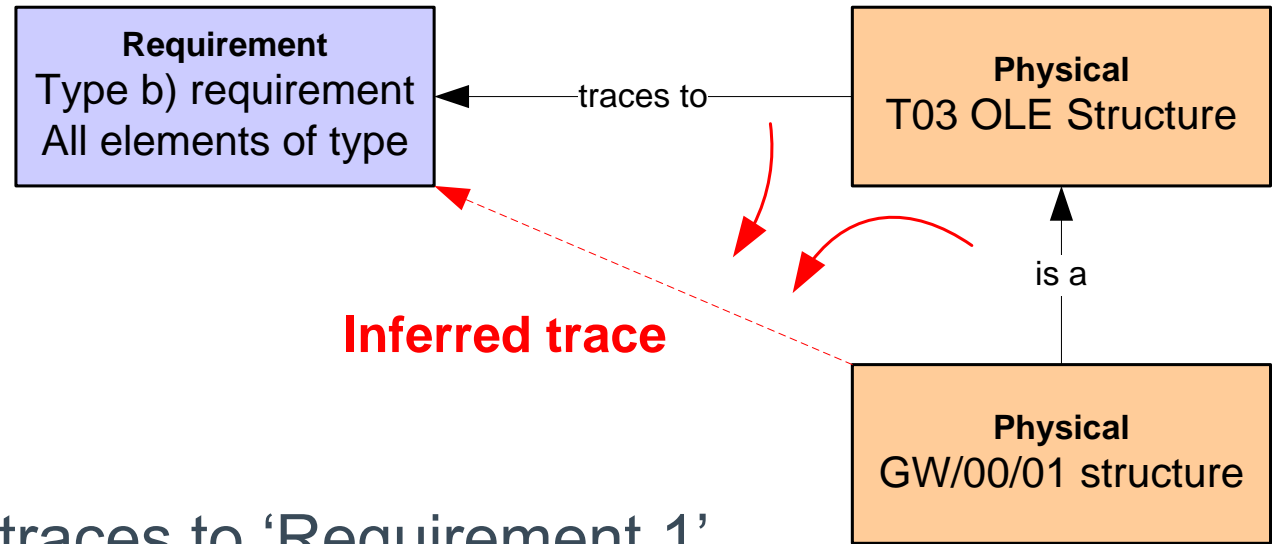
Tracing distributed systems



Multi-level applicability of requirements



Inferred applicability



Inference:

If 'Signal Head' traces to 'Requirement 1'
and 'colour light signal' is a type of 'Signal Head'
then a 'colour light signal traces' to 'Requirement 1'

V&V/Assurance

Benefit

- Integrates Architecture and Requirements
- Enables re-use and normalisation information
- Provides consistency of traceability and approach
- Delivery of information to conform with stakeholder need

Delivering MBSE

Information Modelling

Information Modelling

Aim

- Understand the information required
- Understand the relationship between the information
- Understand how it all fits together
- Enable successful delivery to stakeholders.

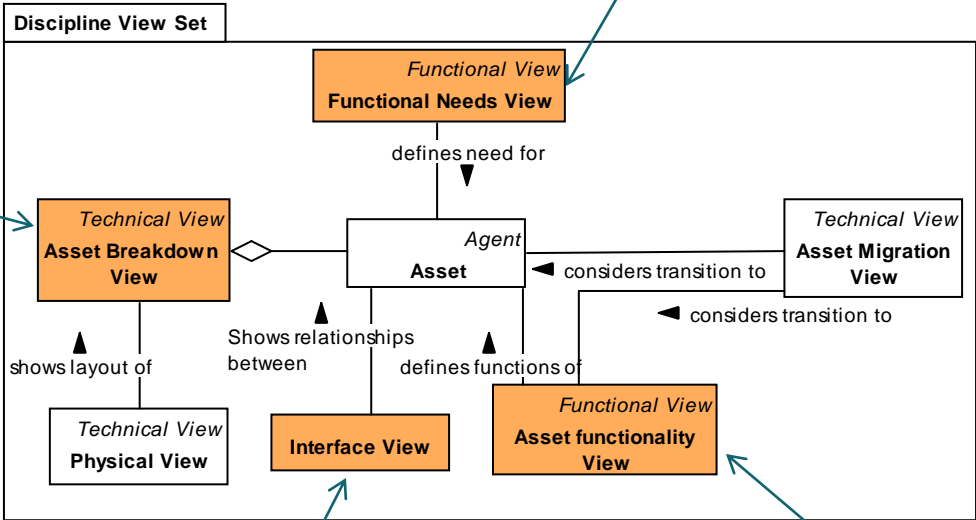
Approach

- Organise information for the business
- Use the businesses terminology

What are the Views

Defines the hierarchy of the elements.

Defines the requirements of the element.

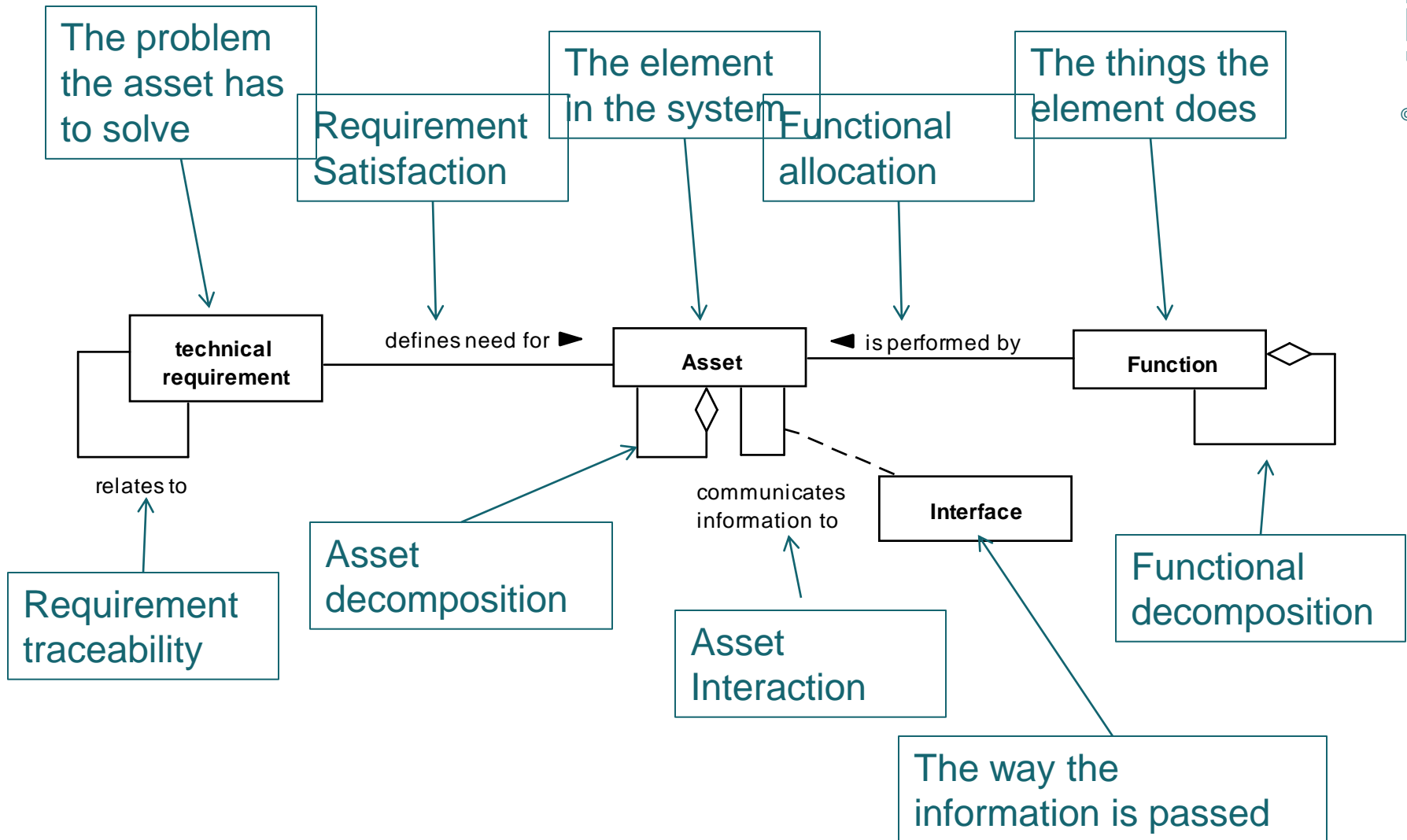


Defines the relationships between the elements as pictures, tables and matrices

Shows what the element does and the information flow between elements.

The Context of a set of information

What is the Information



Information Modelling

Benefit

- Enables consistent information definition
- Enables Impact analysis
- Assessment of information maturity
- Enables consistency of approach
- Brings together process, Architecture, Requirements and Assurance

Questions



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