System Architecture in (Rail) Infrastructure
SYSTEMS ENGINEERING IN THE DUTCH INFRASTRUCTURE DOMAIN
When did it start for this domain?

- In the 2nd half of the 1990’s the Rail Infrastructure manager started to experiment with applying Systems Engineering:
  - Functionally specifying the need instead of describing the solution
  - Give market parties room to innovate
  - First experiments gave positive results
- Up to 2005, focus on writing good specifications and requirements
- A 2002 parliamentary inquiry on fraud in the construction sector gave boost to need for transparency

Rail tunnel ‘Abcoude’ was the first rail infrastructure project where Systems Engineering was applied
Guidelines for applying Systems Engineering

- All parties realised the need for a sector wide guideline on SE
  - Supported by all parties involved
  - Created in collaboration
  - Used as generic guideline for doing projects

- Three versions of the guideline
  1. 1st version (2007) was about defining a common language and understanding
  2. 2nd version (2009) focussed on collaboration between parties
  3. 3rd version (2013) is reflecting experiences gained in recent years as well as the challenges for the near future. (Available in English via www.LeidraadSE.nl)
Development of SE in time

- Systems Engineering in the (rail) infrastructure industry has developed in time by:
  - Focus from writing specifications for construction-contractors to Engineering Requirements
  - …moving to apply it in the Engineering / Design process
  - …to emphasis on Verification & Validation
  - …to defining and understanding the System Architecture
SYSTEM ARCHITECTURE
Why System Architecture?

- Supports the decision process in an early stage of the project:
  - Project objectives
  - Requirements and Constrains
  - Development and implementation of strategies
  - Global system(Design) structure
  - Supports the business case

- Architecture describes:
  - Characteristics, structures, behaviour and relations.....
  - …….that are common for a family of systems

Architecture is the arch to success (James Martin)

Provides insight in the underlying design choices and consistency – or architecture- is required to achieve a unambiguous and consistent scope and set of requirements.

The architecture also the optimisation of the system regarding fulfilling the customer needs, reliability and costs.
System architecture

In a system architecture we optimise (sub)systems, aspect-systems and control levels in connection.

Golden architecture rules:

- Optimise the **performance** of aspect systems
- Minimise **interfaces** between (sub)systems
- Maximise **decoupling** of control levels
Views in architecture (DODAF)

- **Operational**
  - What needs to be achieved and ‘who’ makes it happen

- **System**
  - Connects the system and its characteristics to the operational need

- **Technical**
  - Describes standards and concepts for (sub)systems and system elements
ARCHITECTURE FRAMEWORKS
Why Architecture Frameworks?

- An Architecture Framework provides:
  - Standard approach for framing the architecture
  - Standard views and view descriptions
  - Standard information structure

- Enables effective development of architecture
  - Shorter development time by uniform application
  - Provides teams with uniform image
  - Uniform exchange of information

- Effective evaluation of architecture
  - Emphasizes on differences between alternatives
  - Supports (management) decision making

Source: James Martin
Architecture Frameworks

Federal Enterprise Architecture Framework (FEAF)

Zachman Enterprise Architecture Framework

Customer Application Function Concept Realization (CAFCR): Gerrit Muller (www.gaudisite.nl)

The Open Group Architecture Framework (TOGAF)

EMEASEC 2014, System Architecture in Rail infra
A3 Architecture Framework

- One compact overview with:
  - System demarcation (Context diagram)
  - Starting points
  - Concept of Operations
  - Physical description
  - Functional description
  - Listing of critical design parameters

A textual description of topics will be listed on the back of the A3 Architecture

Source: Maarten Bonnema (Twente University)
System Architectuur HRP

Consistency and standardisation of Systems

August 2014
ProRail Architecture framework (WS1 Kick-off)

The following ProRail architecture framework was developed and used as an outline for the next 4 workshop sessions.

**Operational architecture**
- Context diagram
- User views (CONOPS)
- Functional Description
  - Starting points
  - Principles for Value increase

**Physical architecture**
- System description
  - Critical Design Parameters
  - Design rules
  - Design decisions
- Objects

**Functional Design Context (FDC)**
- Stakeholder Needs
- Time table & Support
- Functionality & Performance

**Technical Design Context (TDC)**
- ProRail & TIS System modules
- Design guidelines

**WS 2 Scope & Objectives**
**WS 3 CONOPS**
**WS 4 Systemen**
**WS 5 Application**
HRP Scope and Context (WS2)

**Project Scope**

- Spoorlijn Ht - Utrecht
- Spoorlijn Nijmegen - Ht - Tilburg

**HRP Scope**

- Knooppunt Station HT
- Station Vg
- Station Bli
- Station Bet
- Knopppunt Station EHb
- Knopppunt Station EHv
- Emplacement Ehv

**Spoorlijn**

- Tilburg - Ehv - Venlo
- Nijmegen - Ht - Tilburg

**Spoorlijn Dienstregeling**

- Wilhelmina kanaal

**HRP scope within the A2 corridor**
HRP Conops (WS3)

Density of rolling stock 12 + 6 + 2 implies some consequences for the activities that the system supports, incl. its performance.
HRP physical building blocks (WS4)

- HRP Open track
- HRP Crossing
- HRP Connection
- HRP Station
- HRP Pass station
- HRP Node station
System Architecture

Operational architecture

Physical architecture

Functional Design Context (FDC)

Stakeholders

Time table & Support

Functionality & Performance

Technical Design Context (TDC)

ProRail & TIS System modules

Design guidelines
Thank you very much?

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