

Embedding SE within Network Rail

Brian Halliday
Enhancement Engineering

Embedding SE within Network Rail



Need
Process
People
Tools

Railway Business Needs



Lower
Ownership
Costs

Reduced
Journey Times

Increased
Capacity

Enhanced
Safety

Increased
Availability

Improved
Punctuality

West Coast Route Modernisation A Catalyst for Change

- Built in 1800's
- UK's busiest mixed traffic railway
- 2,500 train moves per day
- 75 million passenger journeys per year
- 43% of UK freight traffic

– £9 billion



West Coast SE Team Composition



**Recruited
Experienced
SE Practitioners**



**SE
Consultants**



**Rail Discipline
Engineers**



**External Specialist
Services**



**Programme
Management Team
Staff**



**System
Integrator
contract**

Systems Engineering on WCRM

– Lessons Learnt

- **Top-down commitment to SE was vital**
- **Control of system requirements & project workscope fundamental**
- **Systems modelling key to selecting railway layouts & system designs**
- **SE approach had to embrace new technology, major enhancements & condition-based renewals**
- **Use of external expertise was key in establishing SE practice but,**
 - Effectiveness constrained by limited domain knowledge
 - Capability retention an issue



CP4 Output Requirements (2009-14)

- Increase punctuality to 92.6%
- Reduce delay minutes by 23%
- Increase railway availability by 37%
- Reduce costs by 21%
- Deliver capacity projects





Thameslink



Crossrail



IEP

Signalling Centres




Kings Cross



Birmingham New Street

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Process

A wide-angle, high-angle photograph of a busy railway construction site. Numerous workers in bright orange safety vests and hard hats are scattered across several parallel tracks. Several large yellow excavators are positioned along the tracks, some with their arms raised. The ground is a mix of gravel, dirt, and concrete. The scene is set in an open area with some trees visible in the background. The overall atmosphere is one of active, large-scale infrastructure work.

Guide to Railway Investment Projects (GRIP)

1 Output Definition	2 Pre- Feasibility	3 Option Selection	4 Single Option Develop	5 Detailed Design	6 Construct. Testing & Comm.	7 Scheme Handback	8 Project Close Out
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- **Applied to all Network Rail projects**
- **Eight stage development lifecycle reflecting the significant business and technical milestones**
- **Emphasis on front-end options identification & selection**
- **Each stage delivers an agreed set of products to defined quality criteria**
- **Stage gate reviews test a project's progress**

Modular S&C – Adopting a Systems Approach

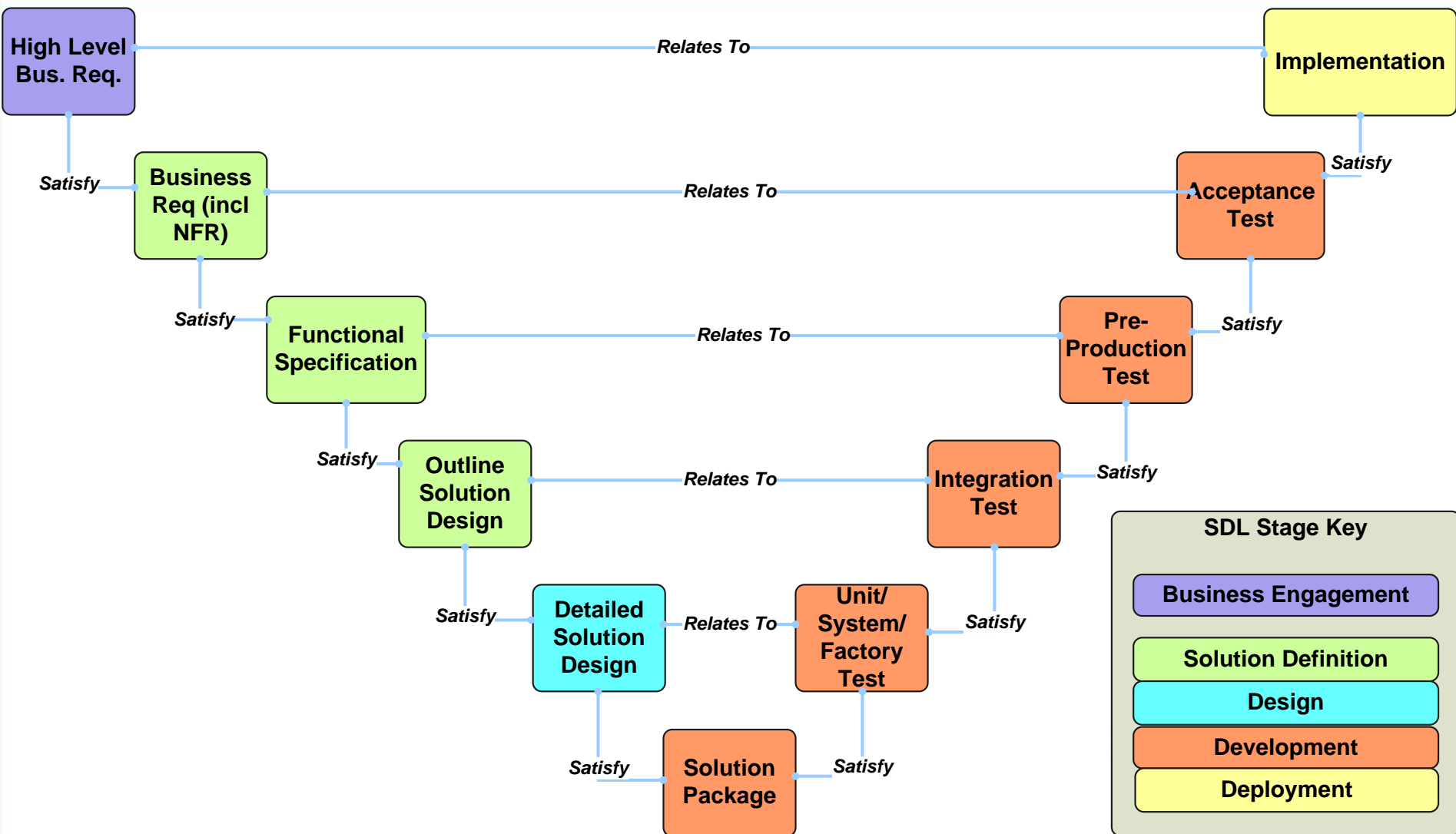


High Output Ballast Cleaning System



**Integrated System Validation Trail
- Austria**

Information Management Service Development Lifecycle: V-Model



Capacity Projects - Enhancement Engineering

Client & Stakeholder Functional Requirements

Enhancement Engineering

Maint. & Ops. Requirements

Rail Systems Modelling

Programme Specification

- Issued by Eng. Spec. Panel
- Functional Requirements
- Scheme Layouts
- Engineering Reqmts
- Process Reqmts

Asset Condition & Renewals

Engineering Asset Policies

Project Teams:

- Produce designs
- Produce engineering deliverables
- Stage gate review by ESP

PROGRAMME SPECIFICATION ENGINEERING DELIVERABLE DOCUMENTS REQUIREMENTS LIST	DESIGN STAGES							
	1	2	3	4	5	6	7	8
	Development Specification	Concept Design	Preliminary Design	Reference Design	Detailed Design	Construction & Test &	As Fitted	Project Close Out

SYSTEMS ENGINEERING

	1	2	3	4	5	6	7	8
Systems Engineering Management Plan	D	D	D	D				
Requirements Management Database	D	D	D	D	D	D	D	D
System Design Justification			D	D	D			
System Design Criteria		D	D	D	D			
System Functional Block Diagram			D	D	D			
Performance Requirements Specification	D	D	D	D				
Journey Time Specification		D	D					
Journey Time Assessment		D	D					
Line Speed Profiles Delivery Specification			D	D	D	D		
Rolling Stock Performance Evaluation		D	D	D				
Signalling Performance Assessment			D	D	D			
Layout Capacity Utilisation (CUI) Assessment		D	D	D				
Control System Capability Assessment			D	D				
Passenger Capacity Assessment		D	D	D				
Timetable Performance Modelling Assessment		D	D	D				
RAM Plan		D	D	D	D			
Maintenance Strategy			D	D	D			
RAM Apportionment		D	D	D				
Product RAM Assessment			D	D	D			
System RAM Assessment			D	D	D			
System / Route FMECA			D	D	D			
System RAM Model			D	D	D			
Programme DRACAS				D	D	D	D	D
Electrification Demand Assessment			D	D	D			
EMGTPA Assessment			D	D	D			
Life Cycle Cost Assessment		D	D	D	D			

➤ **Standard set of Engineering Deliverables**

➤ **Tailored to needs of each project**



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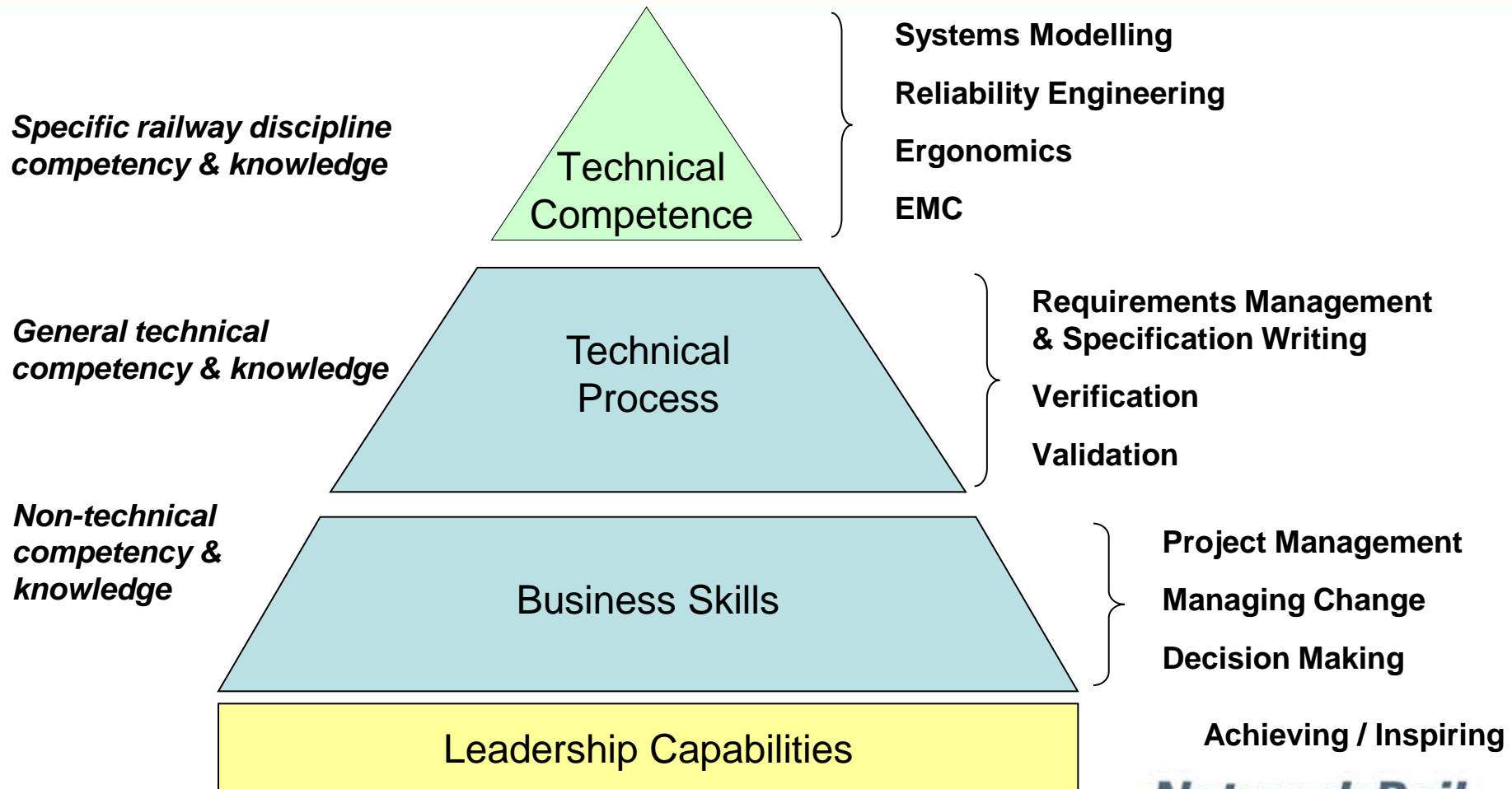


People

Engineering Core Competence Framework (ECCF)

- Started in August 2007
- Facilitate getting right people in the right posts, understand individual competence vs. competence required by a post and inform development needs
- Includes all professional engineering posts in Infrastructure Group.

Engineering Core Competence Framework

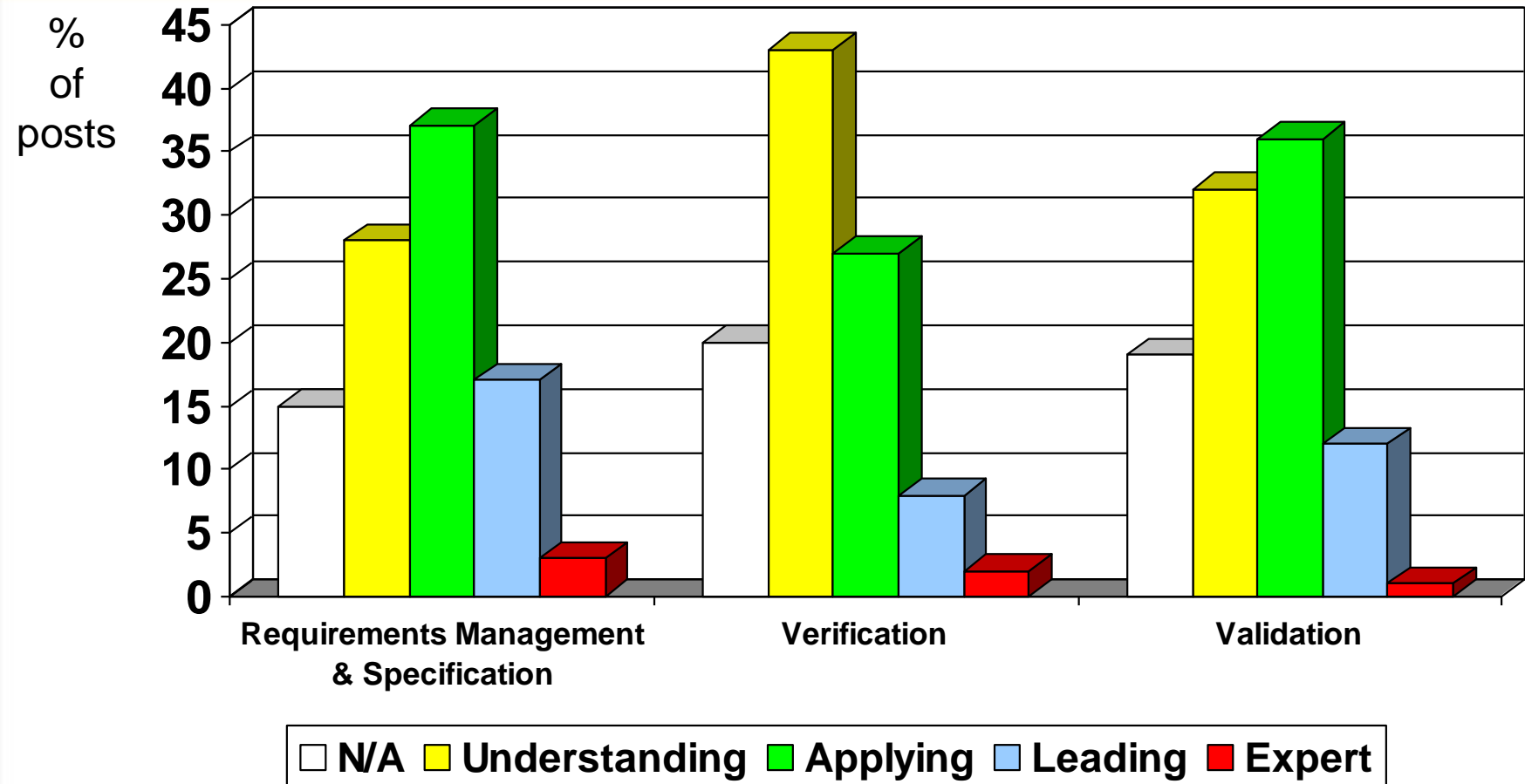


ECCF Generic Competence Maturity Levels

Understanding	Applying	Leading	Expert
'Appreciates'	'Competent Doer'	'Critical Reviewer'	'Trusted Advisor'
<p>Basic comprehension of technical knowledge</p> <p>Awareness of technical policy and processes</p>	<p>Routinely applies technical knowledge and experience</p> <p>Routinely applies technical policy, standards and processes</p>	<p>Routinely makes complex technical decisions based on substantial technical knowledge</p> <p>Provides strategic framework and leads the development of technical policy, standards and process</p>	<p>Recognised internally and externally as having extensive technical theoretical and applied knowledge and experience</p> <p>Routinely develops and applies innovative technical solutions and policies</p>

Role Profiles

Engineering Directorate (>500 posts)



Role & Personal Profile Mapping

Post Title	XXX ENGINEER	Role Profile	Personal Profile	
Band				
Technical Competencies	Railway Engineering (Railway Integration)	Expert	Exp	No
	Reliability Design Assessment (incl. RRDH & AVSIM) (The combination of reliability theory and design analysis used to critically assess designs to ensure reliability robustness)	Understanding	App	No
	Railway System Modelling (TRAIL) (The ability to represent a system through physical, mathematical or logical methods in order to predict its reliability)	Expert	Expert	No
	Reliability Testing (Predicting and understanding the reliability of a component or system in order to discover potential problems with the design as early as possible and ultimately, provide confidence that the system meets its reliability requirements)	Understanding	Apply	No
	System Modelling & Simulation (VISION + CUI) (The ability to represent a system through physical, mathematical or logical methods in order to predict its function and performance and allow exploration of scenarios outside normal operating parameters)	Leading	Leading	No
	System Architecture Design & Functional Analysis (The method of understanding what the system has to do to meet the needs of the end user or customer and the knowledge of how to partition systems into realisable system elements to meet those requirements)	Expert	Applying	Yes
	Operational Rules & Regulations	Applying	Applying	No
	Signalling / Train Control Operations	Applying	Understanding	Yes
	On Track Plant Operation	Understanding	Understanding	No
	Possession Management/Staff Protection	Understanding	Understanding	No
	Human Reliability and Incident Investigation	Understanding	Understanding	No
	CAD and Mapping Services	Understanding	Understanding	No
	System and Job Design	n/a	n/a	No
	Technical Process Competencies	Asset Data Management (Use of instrumentation; data/information collection and maintenance; and development of asset systems to support asset management efficiency)	Understanding	Applying
Application of Technology Solutions (Technology innovation/improvements that deliver business efficiency)		Applying	Applying	No
Requirement Management & Specification (inc Decommissioning) (Engineering requirements specification including technical standards, that will deliver sustained optimum asset performance for the organisation)		Understanding	Applying	No
Design (Renewal/Enhancements) (Detailed design in accordance with the engineering requirements)		Understanding	Understanding	No
Installation & Construction (Design implementation and supplier Management)		Understanding	Understanding	No
Validation (inc. Testing & Commissioning and Acceptance/Approval) (Checking that the product is implemented into the operational environment in accordance with the detailed design specification)		Understanding	Understanding	No
Inspections and Examinations (Process of gathering data about an asset either through direct visual inspection or using equipment. This includes taking measurements, recording deviations to requirements and instating the necessary actions when the data has)		Understanding	Understanding	No
Operating & Maintenance (Ongoing maintenance programme that will optimise the theoretical life of the asset)		Understanding	Understanding	No
Verification (Checking the operational capability of the asset is in accordance with the relevant technical standards including Engineering Assurance TSI = Technical Standard for Interoperability)		Understanding	Understanding	No
Safety Management (Systematic reduction and control of the adverse effects of the safety risks to which an organisation is exposed)		Understanding	Applying	No

Competency Gaps identified and personal development plan agreed



SE Competence Development

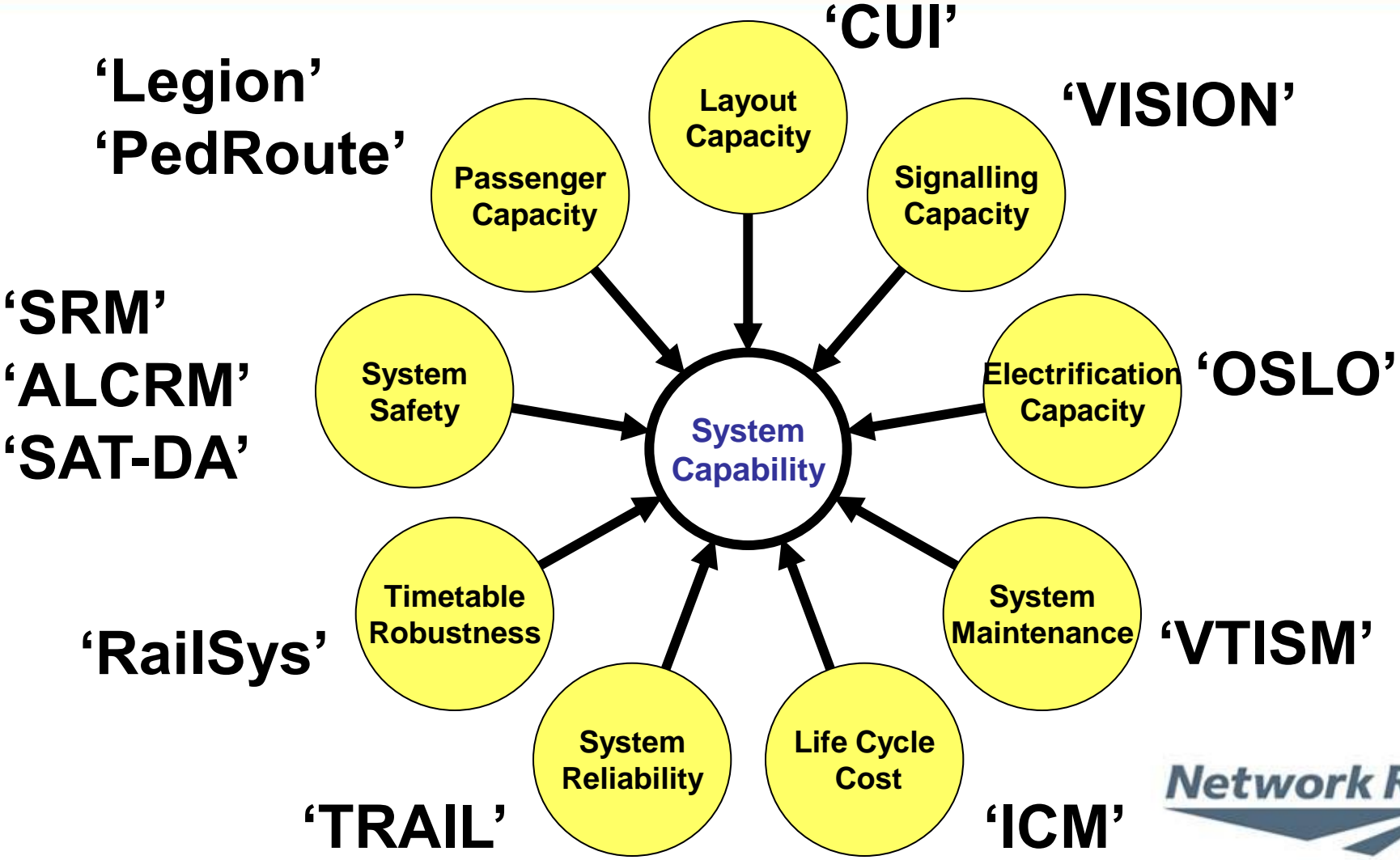
- On the job training
- Process workshops
- Internal training courses
- Internal briefings
- External courses
- Rail Systems MSc course

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Tools

Railway System Model



Systems Engineering Tools

WCML.ORSS.TrainPerf.Generic

- Enterprise Agreement covering DOORS / System Architect / CM Synergy
 - Leading to significant increase in Doors application across business:
 - Engineering (Projects & Company Stds)
 - Infrastructure Investment (Delivery Projects)
 - Information Management
 - Planning & Regulation
- 300 regular users of DOORS

3 | 421

The train meets or exceeds the modelling assumptions made for the

Trains delivering their specified performance depend on all the following

The train meets or exceeds the modelling assumptions made for the

Driver performance does not exceed that assumed in the

For electric trains, the characteristics of the train

For electric trains, the performance shall be

Environmental

The train is

Trains capable of running on any journey that requires a

Tilting trains have a system to inhibit tilting at certain locations

Tilting trains have a system to inhibit tilting at certain locations

Existing 25kV AC trains only deploy re-generative braking when and where specially authorised by the RSAB certificate

the rolling stock is compliant with [ref GM/RC1502] and the

input power at the pantograph at unity power factor. This

Regenerative braking may only be provided on the rolling stock if it is compliant with [ref GM/RC1503] and the

The power drawn by existing 25kV AC locomotives and multiple units does not exceed 6.7 MW input power at the pantograph at unity power

Embedding SE within Network Rail

So where are we?

- **Systems Engineering accepted by company leaders as the way forward to achieve CP4 outputs and beyond**
- **GRIP based development cycle has been a great SE enabler**
- **System Models used as matter of course**
- **SE skills development across all functions**
- **We have come a long way since West Coast!**

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So where are we?



Performing

Norming

Storming

Forming

