



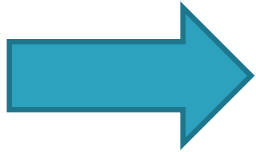
# ProRail

INTELLISWITCH Workshop 3  
Copenhagen, 28-30<sup>st</sup> August 2017

## **Risk-based switch maintenance** *Lower costs, higher performance*

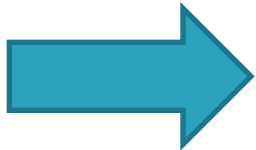
Jan Swier, ProRail. Tel. +31 88 231 2218. Email: [jan.swier@prorail.nl](mailto:jan.swier@prorail.nl) or [jan.swier@xmsnet.nl](mailto:jan.swier@xmsnet.nl)

## INTELLISWITCH in brief



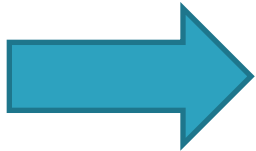
### **Project:**

Dealing with the Conditions and Maintenance of Swiches and Crossings (S&C's) in the Danish Rail system.



### **Primary goal:**

formulate a Maintenance Performance Indicator (MPI) which informs about the Condition of the individual S&Cs



### **Work packages:**

WP1 – Instrumentation and data logging

WP2 – Signal-based condition monitoring

WP3 – Dynamic modelling

WP4 – Metallurgical characterization

WP5 – Modelling of Maintenance Performance Indicator

## **Content of the presentation**

- Asset management and risks
- Results at ProRail
- Strategy to improve the switch results
- A MPI for switches

# Asset management = Professionalized Maintenance & Renewal + ....

AM definition PAS55

Systematic and coordinated activities and practices through which an organization **optimally and sustainably manages** its assets and asset systems, their associated **performance, risks and expenditures over their life cycles** for the purpose of achieving its organizational plan with long term visions and goals **to meet stakeholders requirements and objectives**



# Asset performance has three dimensions and is managed in two coherent life cycle phases



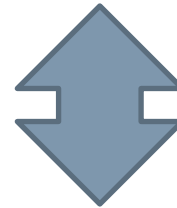
*Investment phase*

*Exploitation phase*

Reliability	R
Availability	A
Maintainability	M
Safety	S
Health	H
Environment	E
Durability	D



**1. Network capacity**



**2. Asset functionality**

with an initial quality



**3. Network & asset quality**

*Projects*

*Processes*

# Risks form a universal language that connects all parties in the life cycle

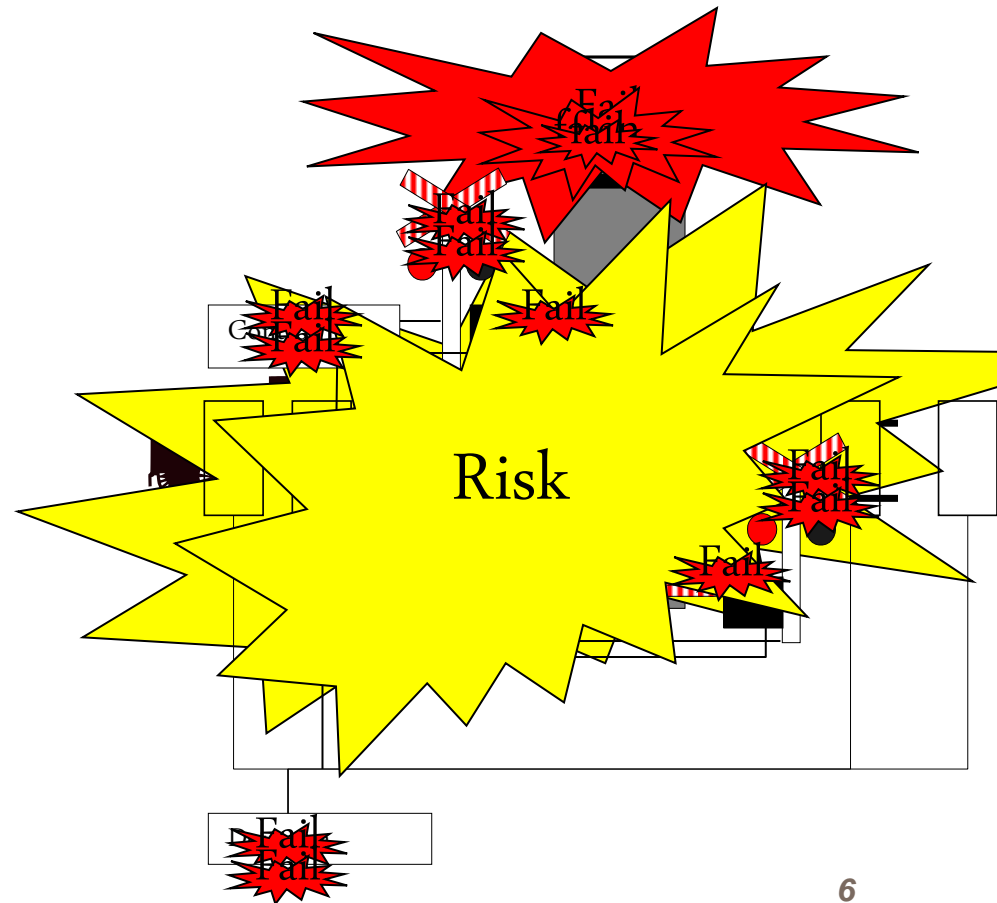
Design & Build

**Create network capacity with asset functionality and an initial RAMS-quality**  
(= build new assets)

Operation

**Maintain the functionality of existing assets at a certain RAMS-quality level**

Performance RISK = Probability \* Impact of an irregularity



# Risk management: multi types but one method

- Strategic risks

- Institutional or political
- Social or environmental
- Technological
- Merge or take over
- Juridical
- .....

- Operational risks

- Technology or Production
- Organization
- Market
- Personal
- Performance
- .....

- Financial risks

- Interest, Credit, currency rate
- Liquidity, cash flow
- Budget and costs
- .....

- Calamity risks

- Nature
- Contracts
- Environment
- Suppliers
- .....

## One Method:

- Failure cause, -mode and -effect
- Criticality analysis
- Strategy
- Risk control activities; inspections, M&R activities, specs,.....

**Risk scope of an Asset Manager:**  
*Performance and Costs*



## ProRail uses risk management through the whole organization to manage the uncertainties between goals and realization

### Strategic goals

- Risk policy board: risk matrix and ALARP)\* evaluation

Business TARGETS ProRail								RISK CHANCE						
	Image/ Surrounding	Safety	En- viron- ment	Costs (financial damage)	Avail- ability infra	Clean stations	Social Security stations	Access stations	Very unlikely 1'1000 yrs = 0.001	Unlikely 1'100 yrs = 0.01	Probably 0.1'1 yrs = 0.1	Incident: 1'1 yr = 1	Regular: Monthly 1'1 yr = 10	Very regular: Daily 100'1 yr = 100
RISK IMPACT	None to very small/ 0	geen negatieve uitwerking op de afb.	geen last of overlast van de afb.	geen negatieve uitwerking op de afb.	geen effect op de afb.	geen effect op de afb.	geen negatieve uitwerking op de afb.	geen effect op de afb.						
	Small/ 1	negatieve uitwerking op de afb.	last of overlast van de afb.	negatieve uitwerking op de afb.	last of overlast van de afb.	negatieve uitwerking op de afb.	negatieve uitwerking op de afb.	negatieve uitwerking op de afb.						
	Limited/ 10	negatieve uitwerking op de afb.	last of overlast van de afb.	negatieve uitwerking op de afb.	last of overlast van de afb.	negatieve uitwerking op de afb.	negatieve uitwerking op de afb.	negatieve uitwerking op de afb.						
	Considerable/ 100	negatieve uitwerking op de afb.	last of overlast van de afb.	negatieve uitwerking op de afb.	last of overlast van de afb.	negatieve uitwerking op de afb.	negatieve uitwerking op de afb.	negatieve uitwerking op de afb.						
	Large/ 1.000	negatieve uitwerking op de afb.	last of overlast van de afb.	negatieve uitwerking op de afb.	last of overlast van de afb.	negatieve uitwerking op de afb.	negatieve uitwerking op de afb.	negatieve uitwerking op de afb.						
RISK value									0,1	1	10	100	1000	10000
									1	10	100	1000	10000	10000
									10	100	1000	10000	10000	10000

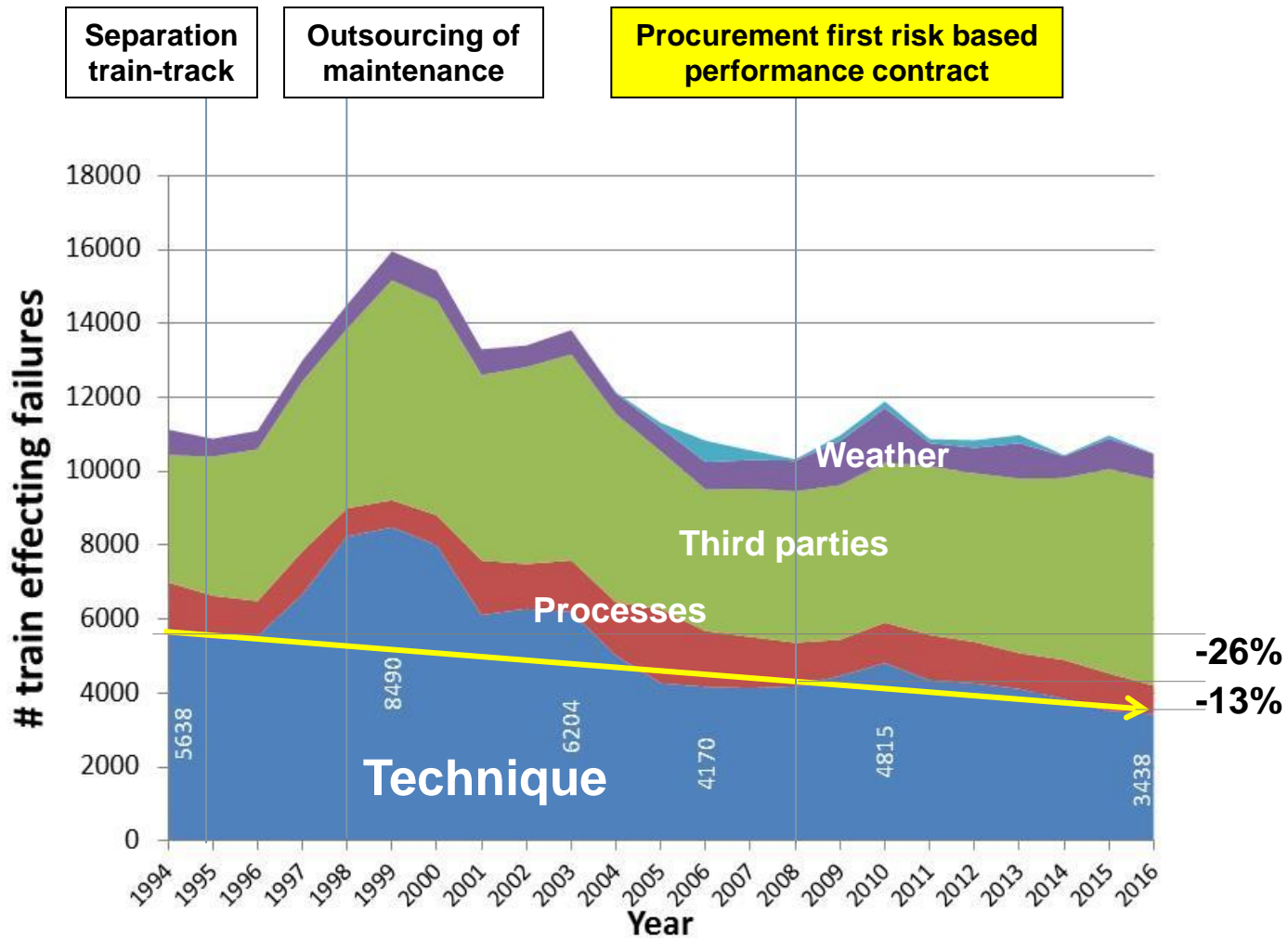
)\* ALARP = As Low As Reasonably Possible

- **Enterprise Risk Management system** (COSO framework, ISO 31.000 principles)
  - Responsibilities and corporate procedures
- **Safety Management System** (Railway Safety Directive 2004/49/EC)
  - Business units, responsibilities, procedures, controls, .....
- **Risk Analysis (FMECA) & Risk Control Activities**
  - Control RAMS-quality of asset capacity and functionality

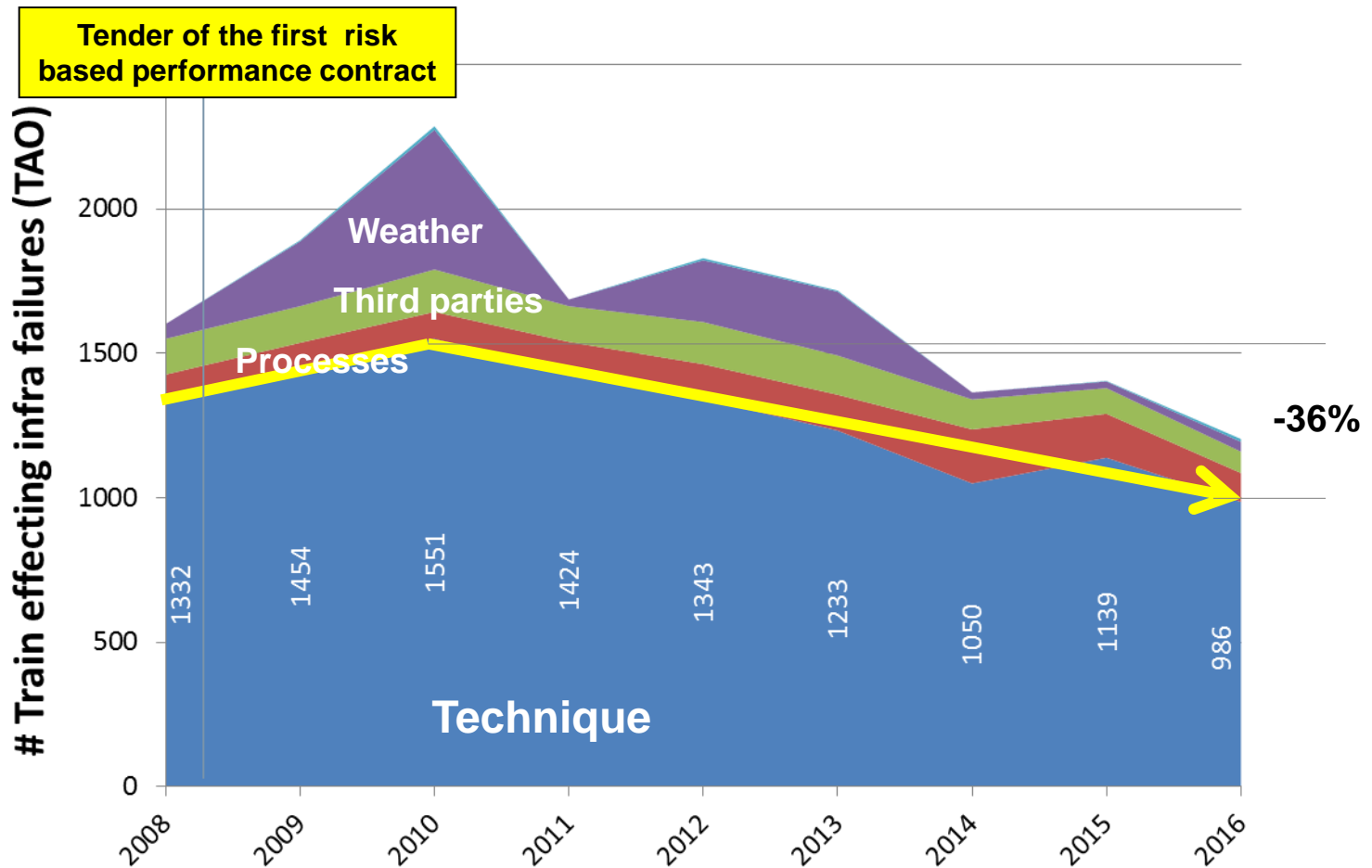
Realization



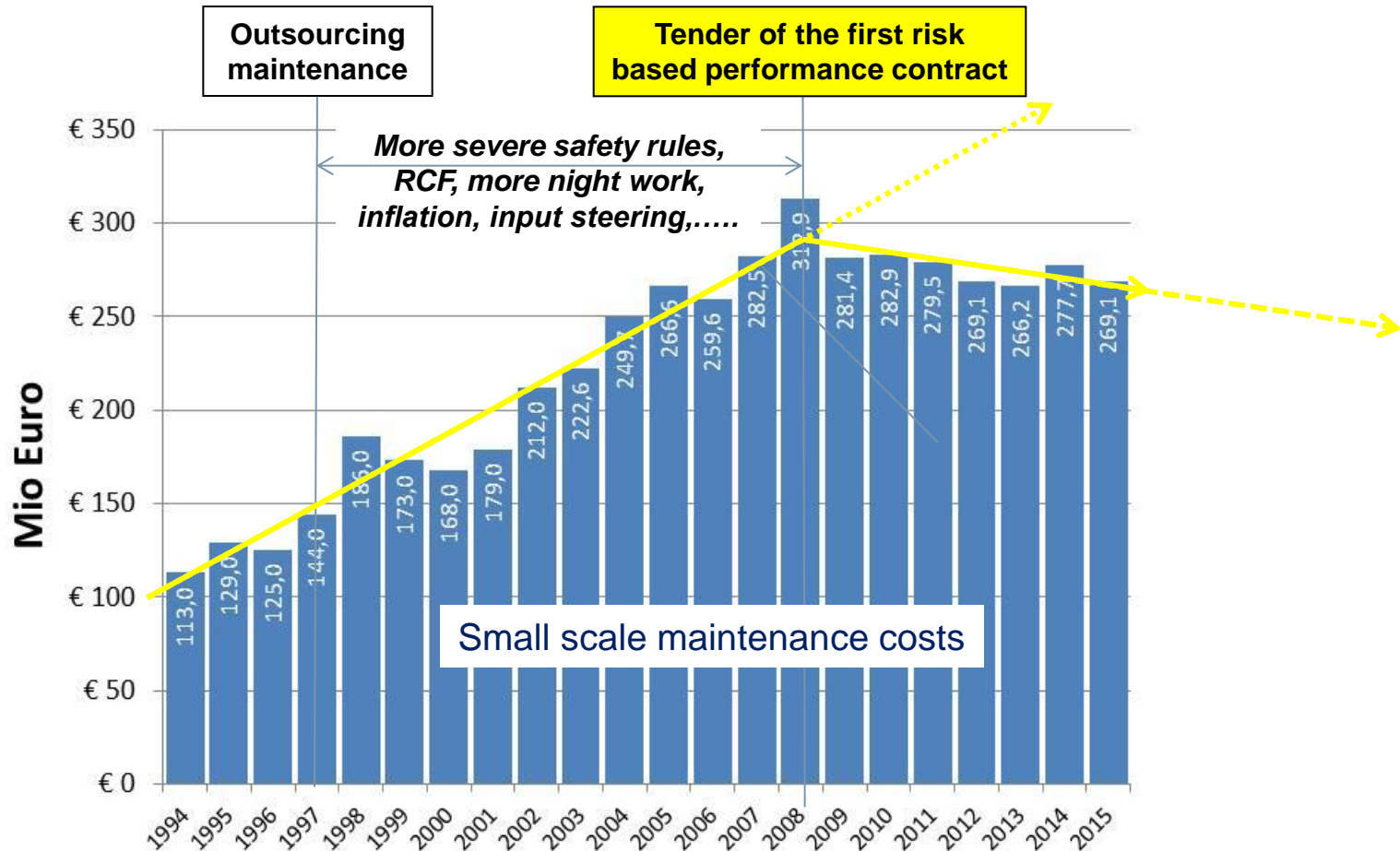
# Asset performance has improved after outsourcing and the procurement of risk based performance contracts



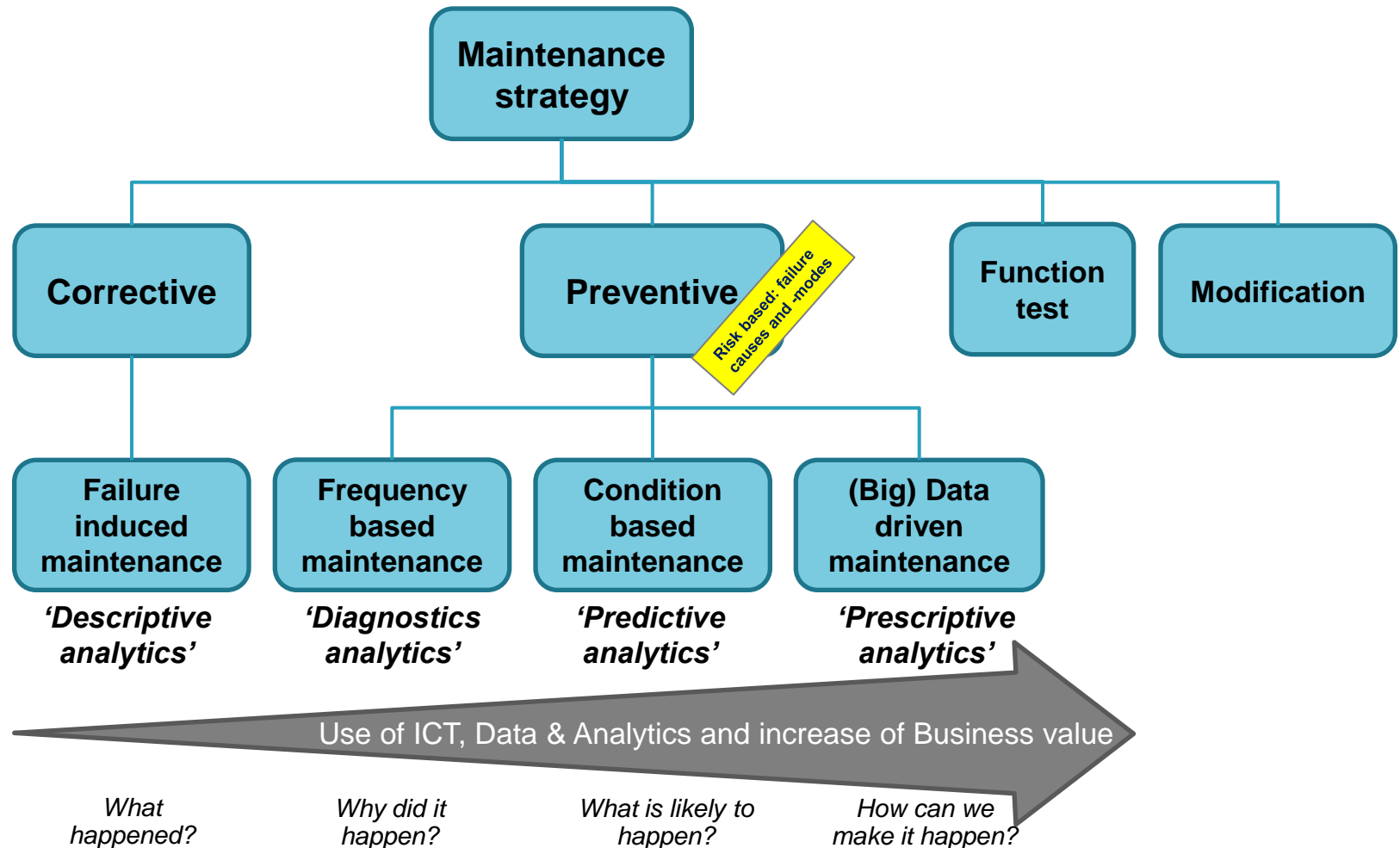
# The switches have contributed significantly to the improvement of asset performance



# The procurement of risk based performance contracts resulted in (the start of) a cost decrease

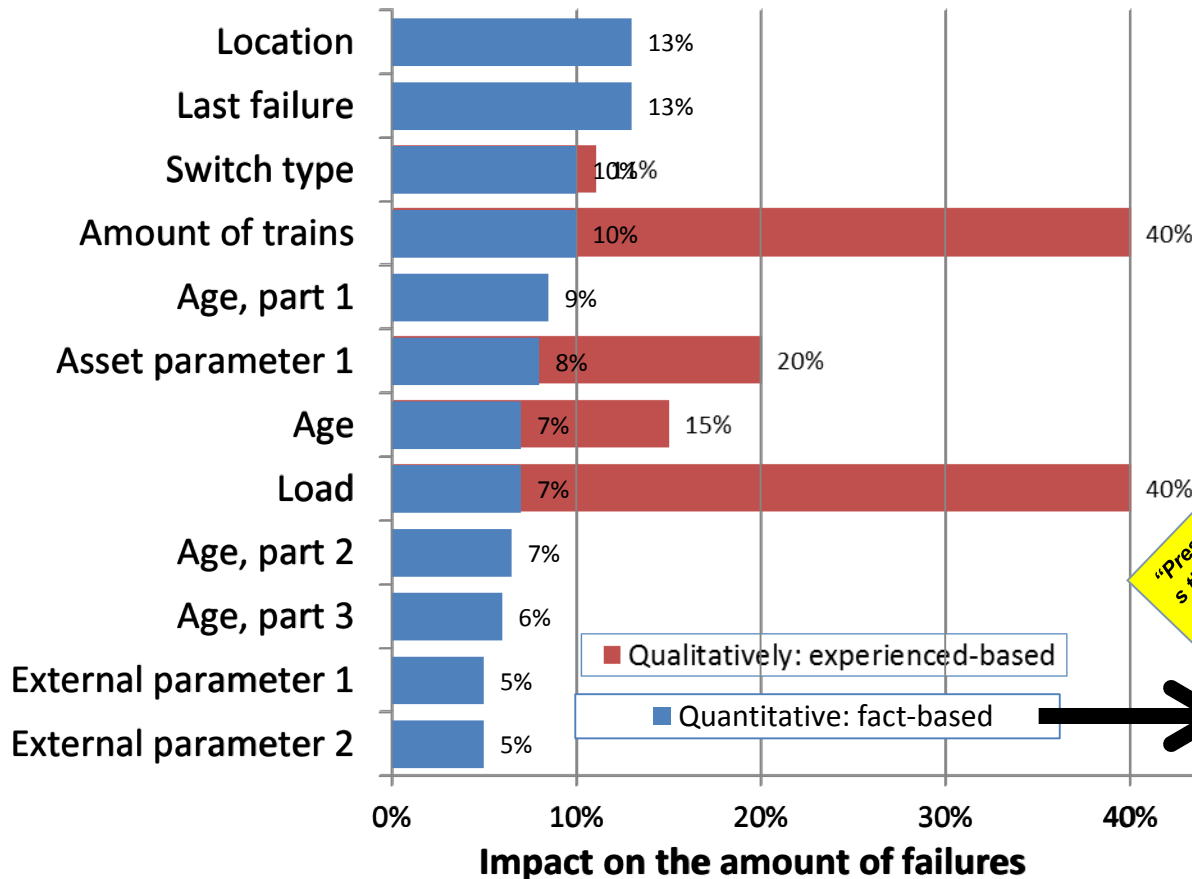


# ICT, Data and Analytics are key to optimize the performance/cost ratio



# Example of a prescriptive analytic with 'big data'

Source: Maarten Zanen, ARCADIS, Predictive maintenance ASSET Rail



**Aim:** identification of switches with the highest performance risk

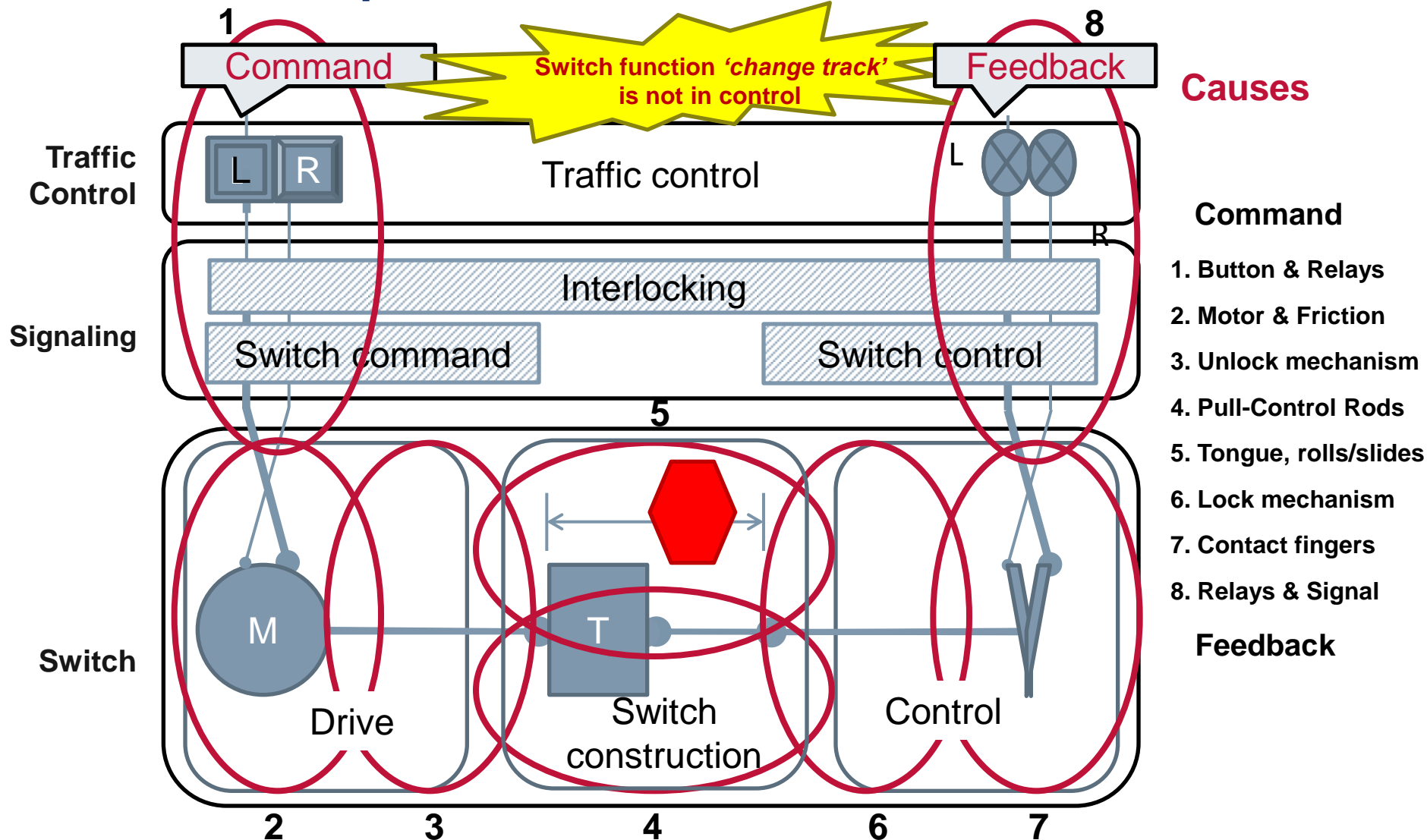
**Result:** high prediction rate

“Prescriptive analytics is the final frontier of analytic capabilities”

## Prescriptive analytic steps:

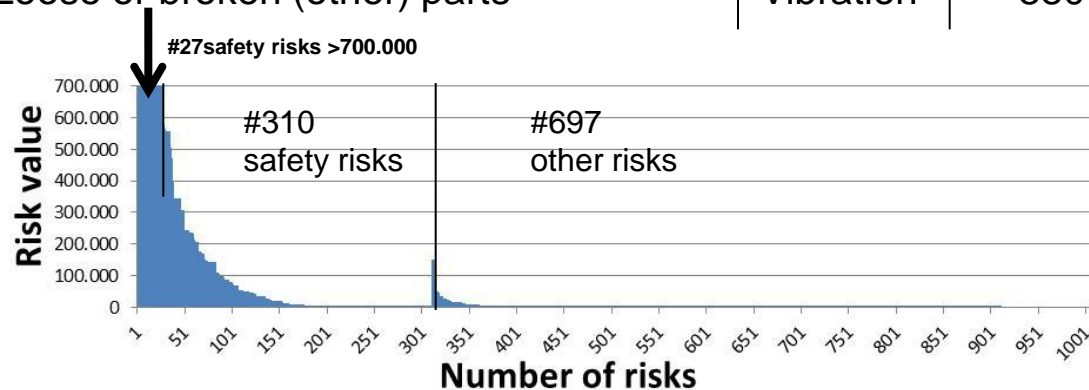
- Data collection
  - Data visualization
  - Data enrichment
  - Data patterns
  - Machine learning
- Failures
  - Train effecting failures
  - Age
  - Maintenance
  - Location
  - Traffic intensity
  - Traffic weight
  - Switch type
  - Switch angle

## Predictive analytics; a functional model helps to identify all possible risk control measures

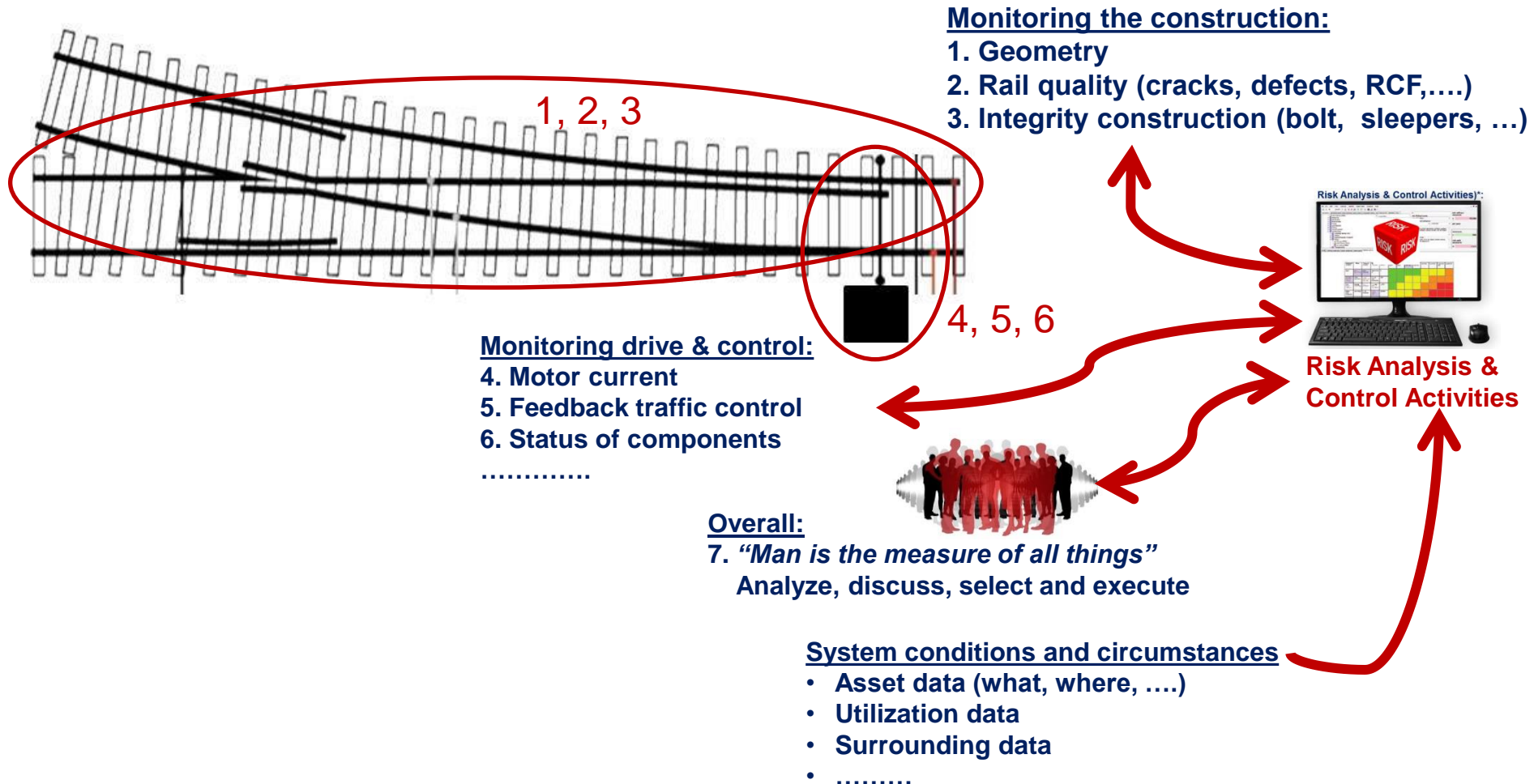


## Overview of the top switch risks in NL with causes and modes

Part/function	Failure causes	Failure mode	Risk value (chance*impact)	
			1 switch	Nationwide
Tongue	Curved, fractured	Wear	3,500	46,900,000
Drive (Ebi)	Emergency break-mechanism broken	Load	21,100	40,500,000
Sleeper, wood	Rotten, broken, ....	Aging	92	18,600,000
Tongue	Torn, fractured	Use	1,055	14,080,000
Drive	Loose drive	Vibration	1,760	8,620,000
Wheel guidance	Loose or broken bolts in guidance	Vibration	700	7,400,000
Drive	Loose/defective bolt, brace, lock	Diverse	880	4,835,000
Drive	Broken motion bar	Fatigue	350	4,690,000
Drive	Non-functional control bar	Diverse	520	2,580,000
Tongue	Loose bolts, parts, fixed role, .....	Diverse	175	2,340,000
Drive	Loose bolts, wrong securing	Montage	520	2,020,000
Wheel guidance	Broken or loose attachment(s)	Diverse	20	1,480,000
Wheel guidance	Incorrect adjustment and fixing	Diverse	105	1,110,000
Drive	Broken compression spring	Wear	530	1,010,000
Drive	Loose or broken (other) parts	Vibration	880	725,000



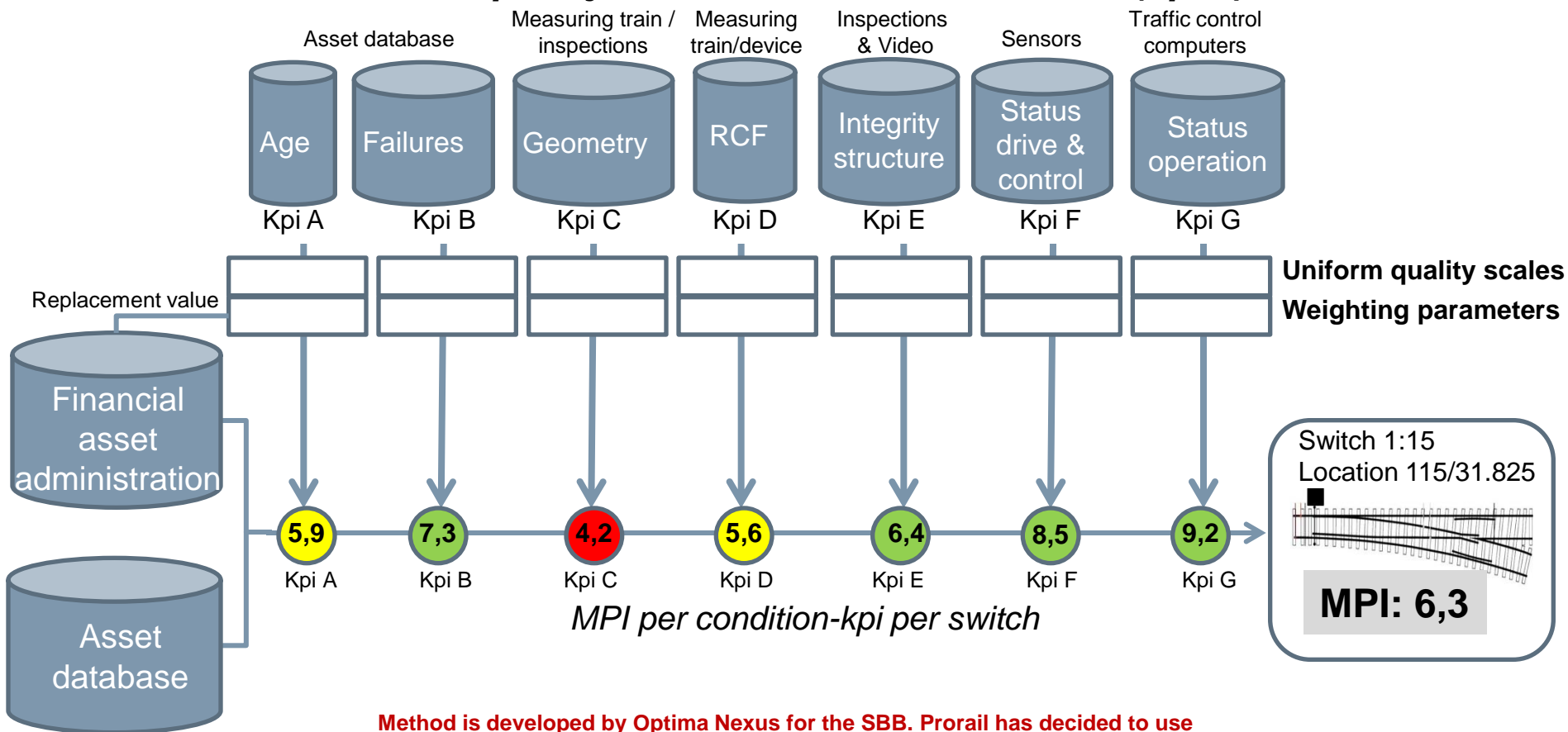
## Risk control in operation through monitoring the technical asset quality and the system conditions and circumstances





# The asset quality data can also be used for a Maintenance Performance Indicator (MPI)

## Available quality data of individual switches (kpi's)



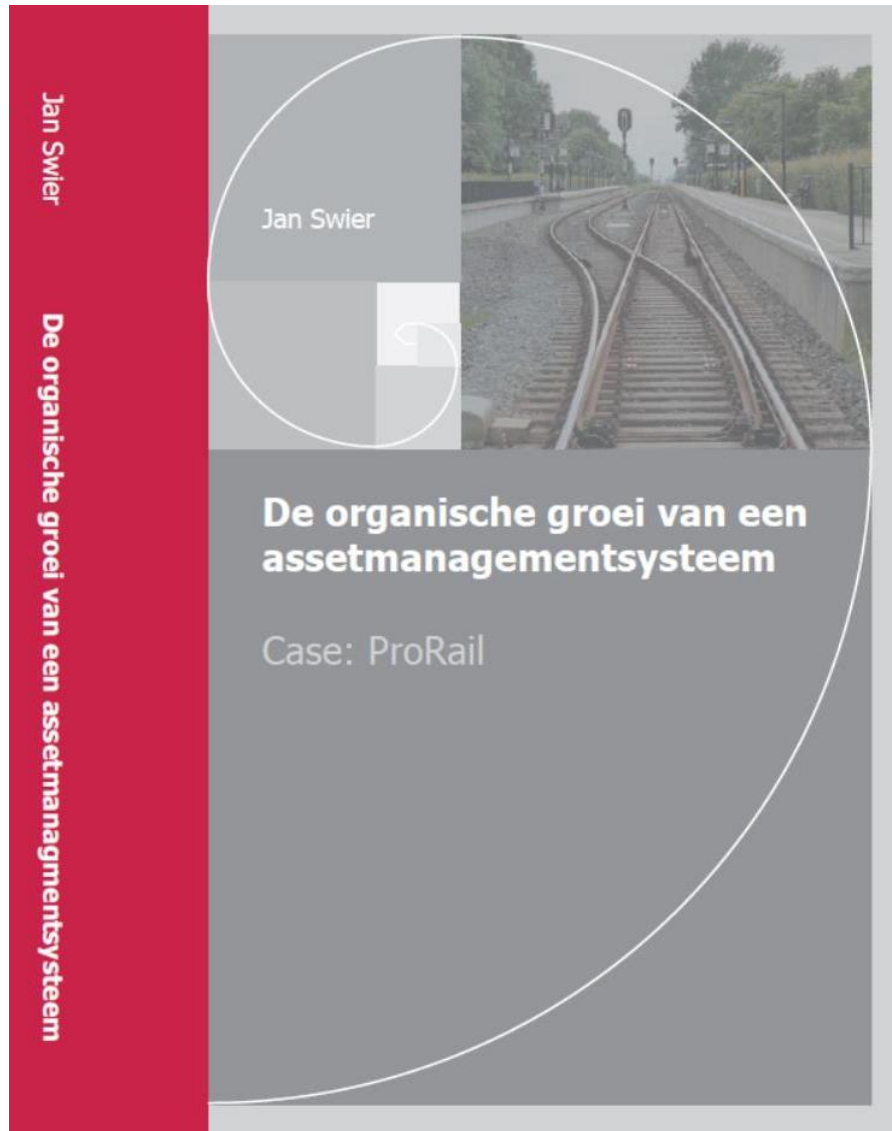
Method is developed by Optima Nexus for the SBB. ProRail has decided to use the same methodology and implement it: system per system and kpi per kpi

# Summarizing

- *“Only if you can specify & monitor it, you can manage it”*
- *“Only if you can manage performance, you can manage costs”*
- **Focus on the performance risks and the most effective and efficient methods to control the risk causes, -modes and –impact.**
- **Improve Design**                      **Improve asset capacity, functionality and their initial quality; invest in research and new assets.**
- **Improve M&R**                        **Improve RAMS-quality of existing assets; invest in ICT and mngt. techniques)\*\*, and apply.**

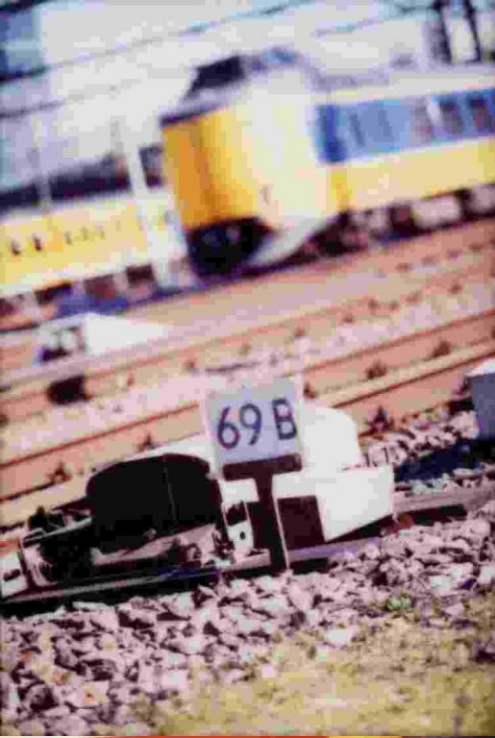
)\* Performance = capacity, functionality and (RAMS-) quality

)\*\* Life Cycle-, Risk-, RAMS- and Information management



After 12<sup>th</sup> October my book is available about:  
***“The organic growth of an asset management system”.***

Sorry, but it is in Dutch.



***Are you still awake?***

***If so, do you have a  
question or comment?***



# ICT, Data and Analytics are key to improve switch performance and lower the costs

**Predictive analytics:** *technical condition and historical data is combined with rules and algorithms to determine the probable future outcome of an event or the likelihood of a situation occurring.*

**Prescriptive analytics:** *it suggests actions to benefit from the predictions and showing the implications of each decision option. The use of 'big data' and machine learning are key.*