Railway Infrastructure Asset Management System (RI-AMS) in the West Balkans Region (WBR)

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Ex-ConnecTA Project 2017-2018

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Topics discussed:

- ***Why is Railway Infrastructure Maintenance (and its management) important***
- ***Current situation concerning the condition of Railway Infrastructure Assets (RIA) in the West Balkans Region (WBR)***
- ***Importance and means for improving the condition of Railway Infrastructure Assets in the West Balkans Region (WBR) – need for RI-AMS (Railway Infrastructure Asset Management System)***
- ***RI-AMS:***
  - ***Key constitutive parts & Functionalities***
  - ***Key benefits for the WBR Railways***
  - ***Key steps and recommendations for its implementation at the WBR Railways***

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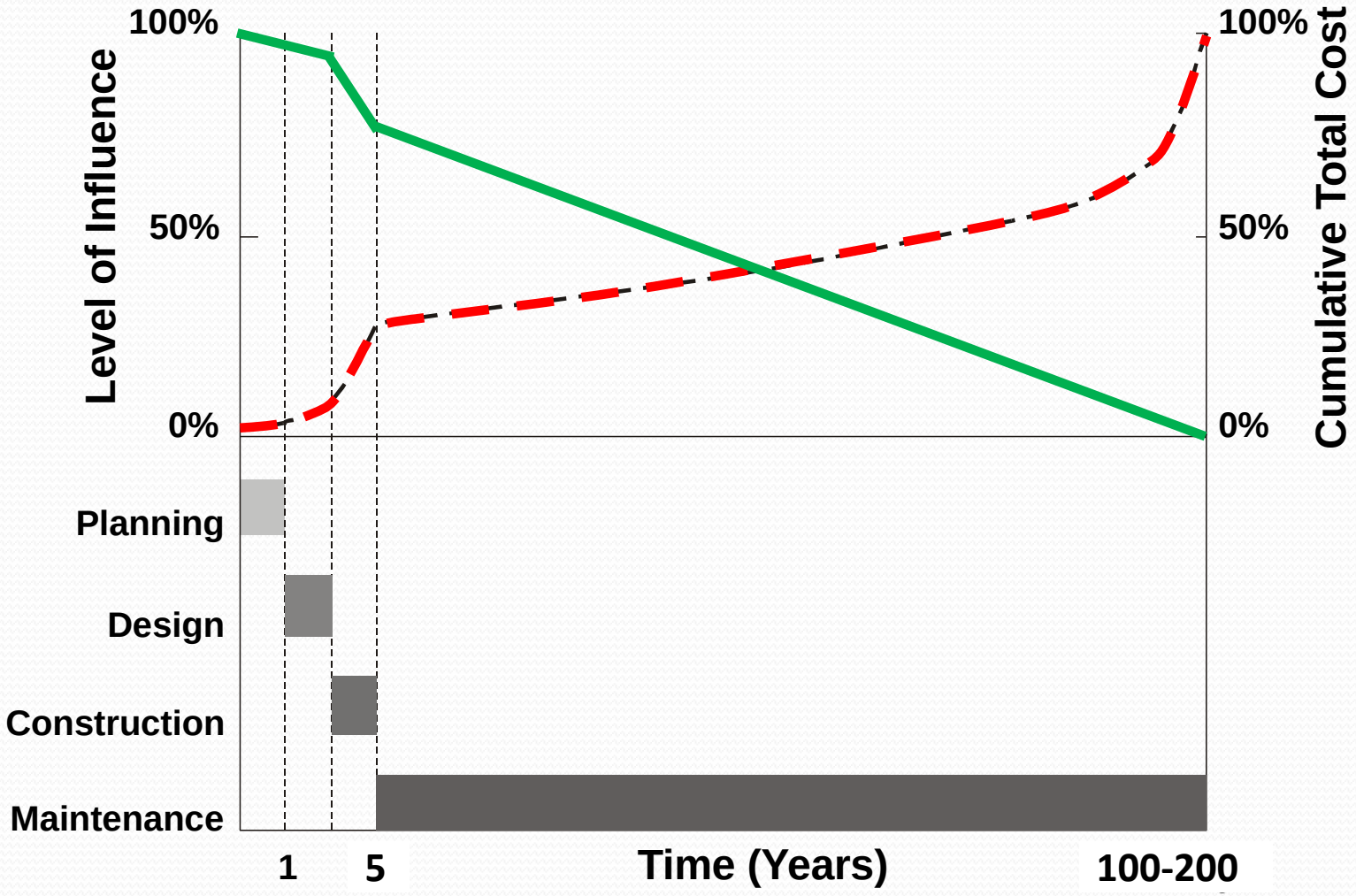
Importance of maintenance



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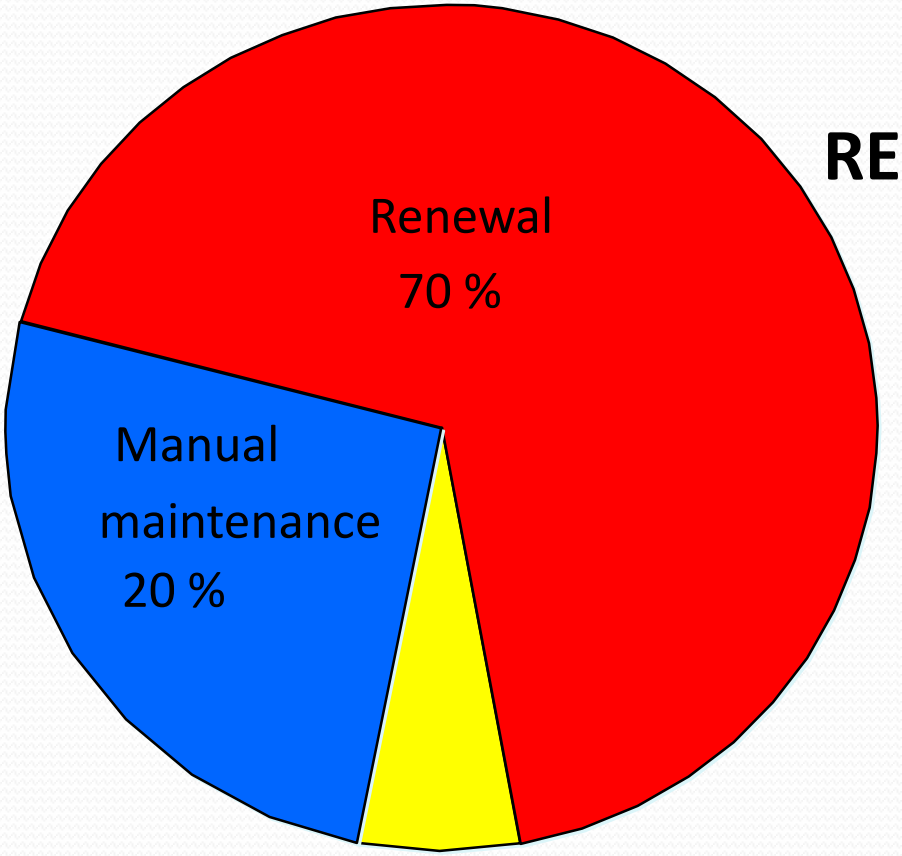
Costs of Track maintenance



TOTAL MAINTENANCE AND RENEWAL COST on Dutch Railway network (ProRail)

€ 250 million per year
for 4.500 km track
Price level 2006

Average in Western Europe:
≈ 50,000 EUR/km/year
on conventional lines

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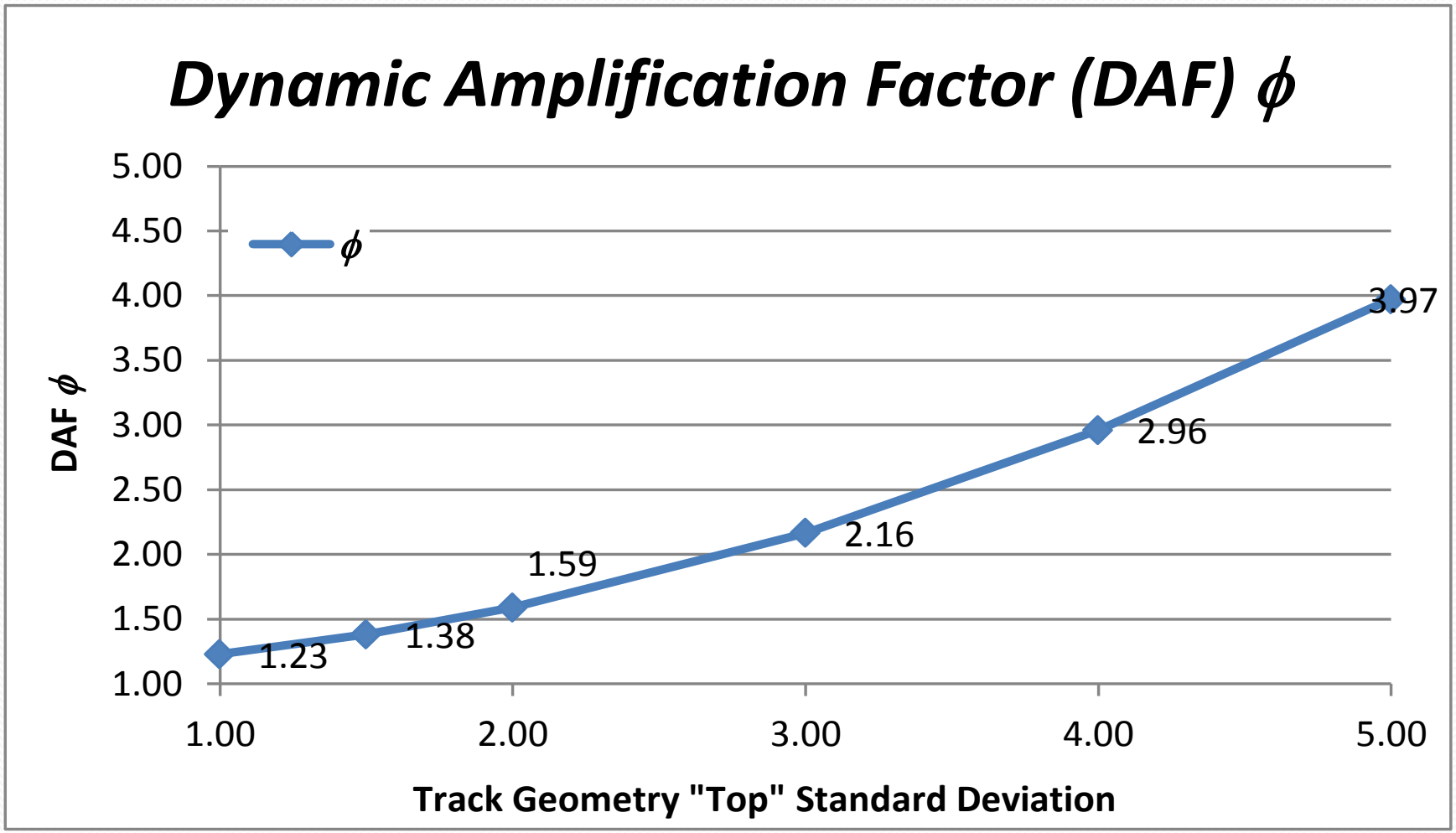
How does Railway Infrastructure Deterioration works



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Strictness of Track Geometry Thresholds:

Speed [km/h]	Vertical Track Geometry (D1) Standard Deviation Thresholds [mm]				
	Track Quality Classes				
	A	B	C	D	E
V < 80	< 1.25	1.75	2.75	3.75	> 3.75
80 < V ≤ 120	< 0.75	1.10	1.80	2.50	> 2.50
120 < V ≤ 160	< 0.65	0.85	1.40	1.85	> 1.85
160 < V ≤ 230	< 0.60	0.75	1.15	1.60	> 1.60
230 < V ≤ 300	< 0.40	0.55	0.85	1.15	> 1.15
V > 300	N/A	N/A	N/A	N/A	N/A

The scatter in deterioration rate values is between 1 and 10 mm SD / 100 MGT, and largely depends on exerted dynamic forces.

Typical improvement rate achieved by Tamping machines is about 30%.

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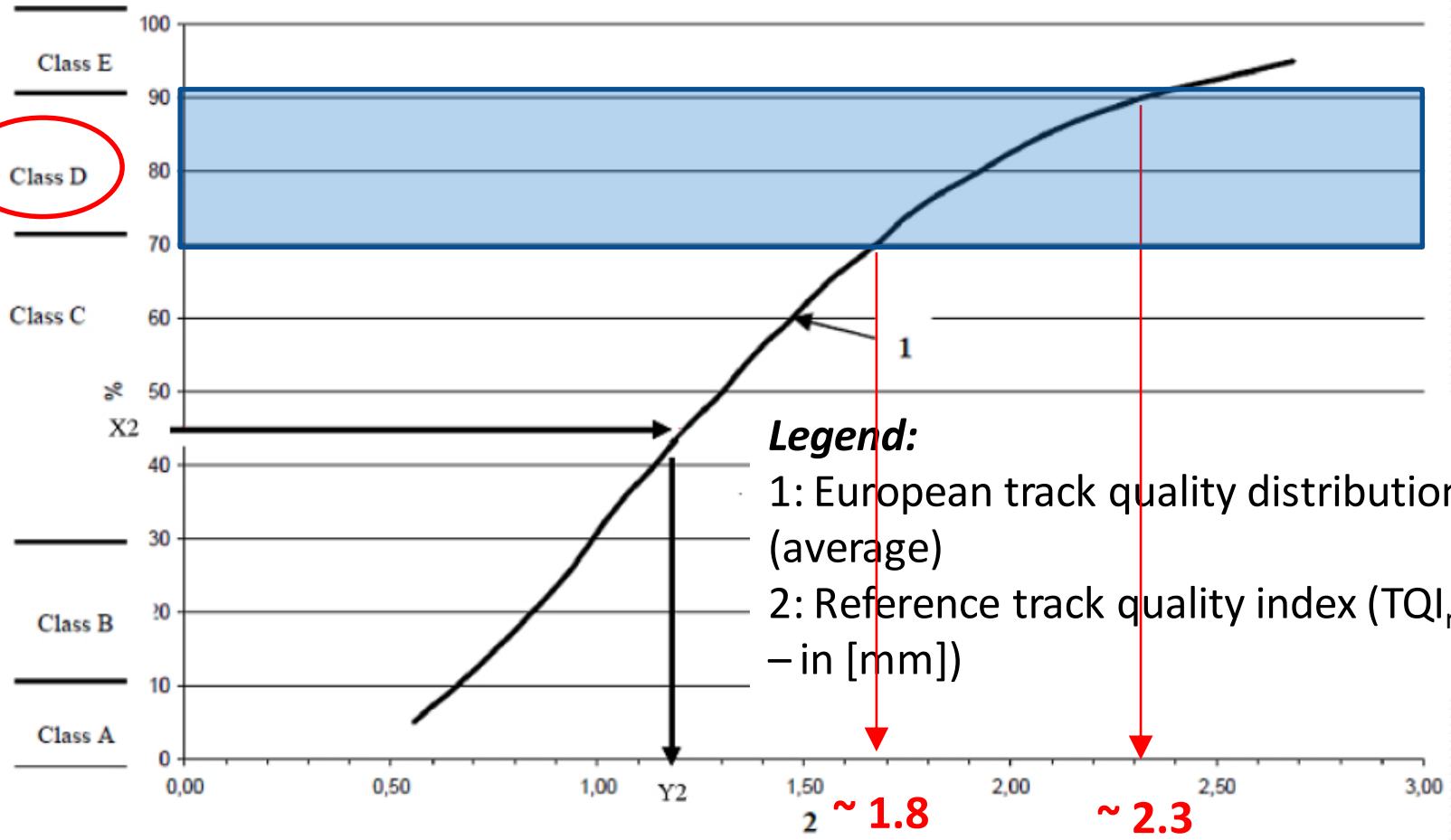
Prosečna brzina vozova u Srbiji 42 km/h

FoNet | 29. januar 2013. 13:51 | Komentara: 8

Zbog lošeg stanja pruga u Srbiji 12 novih železničkih garnitura, koje mogu da postignu velike brzine, voze u proseku između 30 i 40 kilometara na sat

Determination of the classes of track quality according to European Norms



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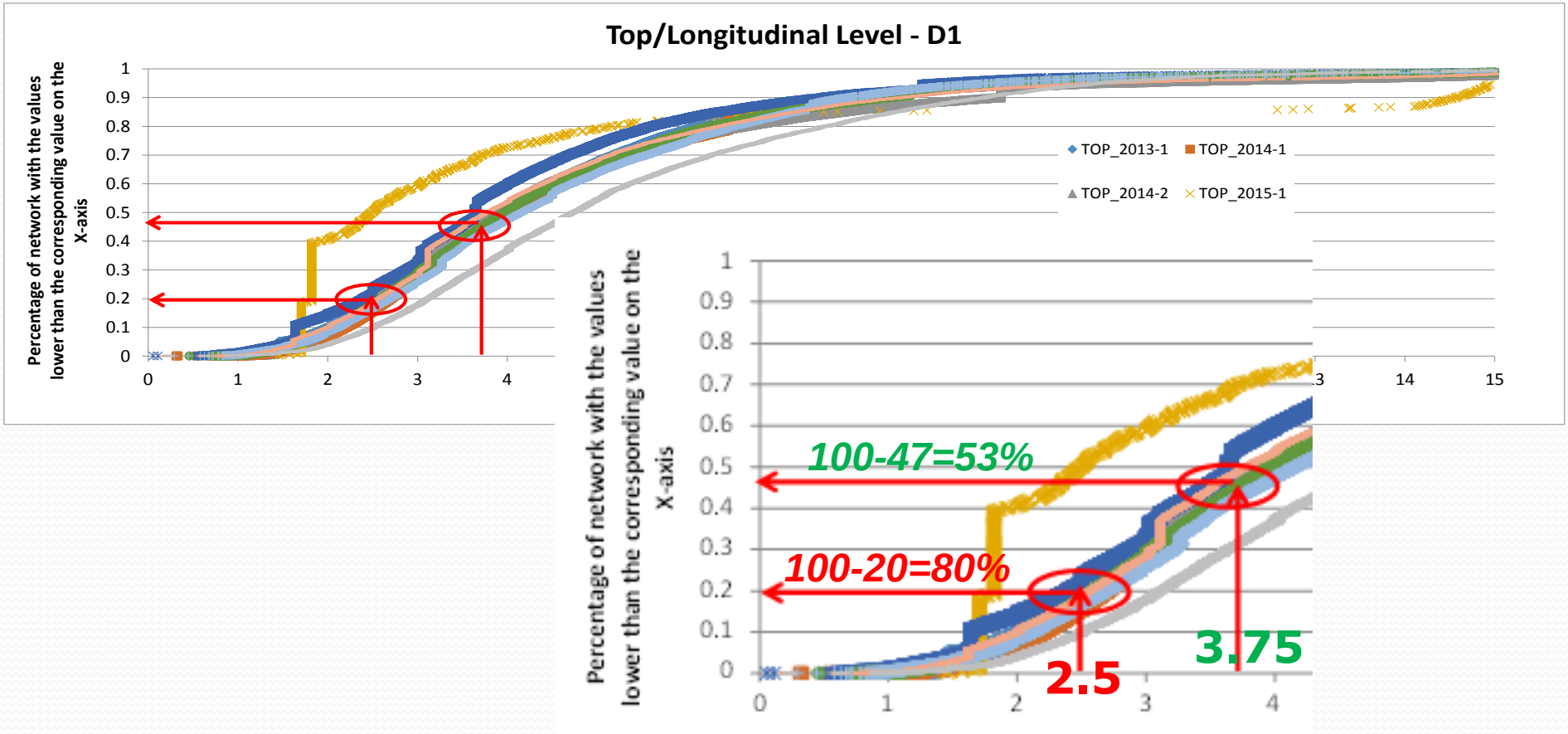
Track Geometry Standard Deviation distribution on the Serbian railway network (zoomed into the most important area)



ConnecTA Project (2017-2018)

Project Goals (aimed at satisfying Project Purposes & Objectives):

Perform thorough ***analysis of the current condition of the key Railway Infrastructure Assets (RIA)*** in the WB6 region

Asset Management part

Determine Maintenance & Renewal (M&R) needs, in terms of volumes of M&R works and related budgets, to improve the RIA to the acceptable level by European standards

Determine ***short and long-term actions, measures and initiatives*** (including regulatory) necessary to maintain the RIA condition at the required level for a longer period of time:

Propose the ***optimal framework for performing RIA condition-measuring, assessment and consequential M&R needs determination and management*** in the future	Propose an ***optimal organisational framework*** for performing and managing M&R works in the future, in order to secure required RIA quality at all times, for a longer period of time

ConnecTA Project (2017-2018)

Basic TEN-T Rail Core & Comprehensive Network characteristics

Regional Participant		Network length [defined by SEETO]	Network length(Covered by data) [km]	Layout & Operating				Superstructure				Civil works [%]	Electrical [%]	Signalling [%]	Catalogues [%]	Overall condition data [%]	Other [%]	Total
				Speeds [%]	Loads [%]	Curves [%]	Slopes [%]	Rails [%]	Sleepers [%]	Ballast [%]	Switches & Crossings							
ALB *		472	*383.0675*	100	60	100	100	99	99	99	0	100	100	100	65	0	100	64.13
BiH	ŽRS **	357	*361.966*	100	100	100	10	99	99	85	10	10	60	10	55	100	0	60.8
BiH	ŽFBiH	441	*0*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KOS		201	*194.308*	100	100	100	100	100	100	100	100	100	100	100	100	100	100	97.9
MKD		531	*487.3735*	99	0	95	100	100	100	85	100	100	80	80	80	0	75	76.06
MNE **		184	*192.862*	100	100	100	100	99	99	99	98	100	65	65	80.5	0	60	86.4
SRB		1723	*1955*	99	100	100	100	100	80	100	80	99	95	95	90	100	90	93.56
	Total:	3909	3574.577	3550.2	2934	3550.2	3248.8	3565	3174.198	3441								
ALB			91	91	75	91	83	91%	81%	88%								

**Line Pogradec-Korca (l=80km) is missing from the data since the railway line is not costructed yet.*

**Within the obtained data there were not any information about section VIII.09 (Lin-Qafe Thane)*

MNE, ŽRS

***The discrepancy beetween the SEETO defined network length and length*

Total Network Length investigated: 3,909 km

Average percentage of all infrastructure data received: 93.56 %

ConnecTA Project (2017-2018)

Some of the key findings:

- ***Infrastructure in WBR was in general in quite poor condition, thus the M&R Plan is very much reflecting the backlog of works piled up over the past years, if not decades***
- A ***significant portion of the M&R Regulation & Rulebooks was not updated*** since the old times of the Yugoslav Railways (not applicable to ALB), and those that were updated, were still most often ***not in line with the modern M&R practice***.
- More importantly, even in cases where they were in line with the modern practice, ***they would stipulate the usage of condition-data***, i.e. condition-monitoring (such as *track geometry (TG), rail profile, rail corrugation, ultrasonically detected internal rail defects, rail surface defects, Ground Penetrating Radar (GPR) detected ballast and formation problems, Overhead Line (OHL) geometry and wear, etc.*) ***all of which unfortunately were never performed on any of the RPs*** (except for TG which was performed only in SRB and MKD).

ConnecTA Project (2017-2018)

Key Methodology approach – Residual Service Lives (RSL)

- Based on the current age (current SLs) and maximum/limit SLs (per each of RIA, established from the best European practice), the remaining, i.e. ***"Residual" Service Lives (RSLs)*** were established

$$RSL = MAX\ SL - CurrentAge$$

$$RSL\ [\%] = (MAX\ SL - CurrentAge) / MAX\ SL$$

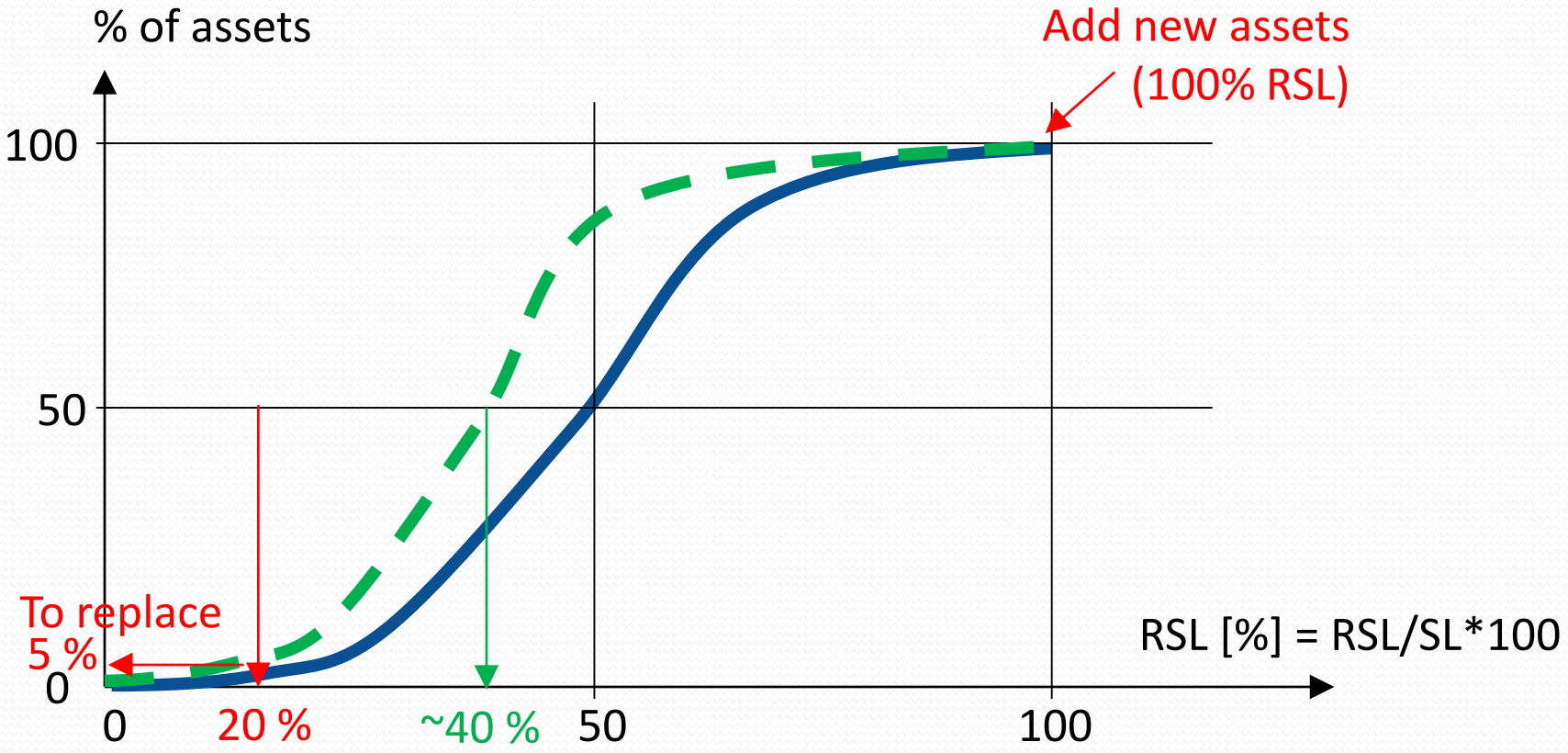
RSL	< 0 %	0 – 20 %	20 – 40 %	40 – 60 %	> 60 %
Condition	*Very poor*	*Poor*	Medium	Good	Very good

- ***RIA with RSLs < 20% need renewal !***

ConnecTA Project (2017-2018)

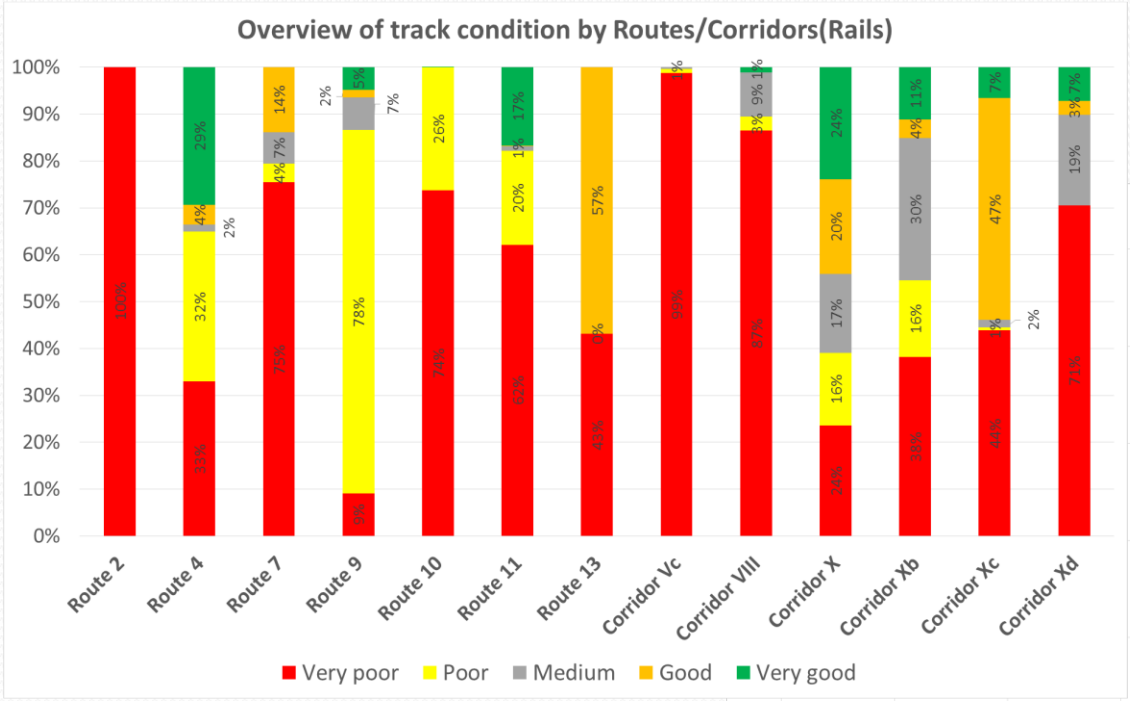
Key Methodology approach – Residual Service Lives (RSL)

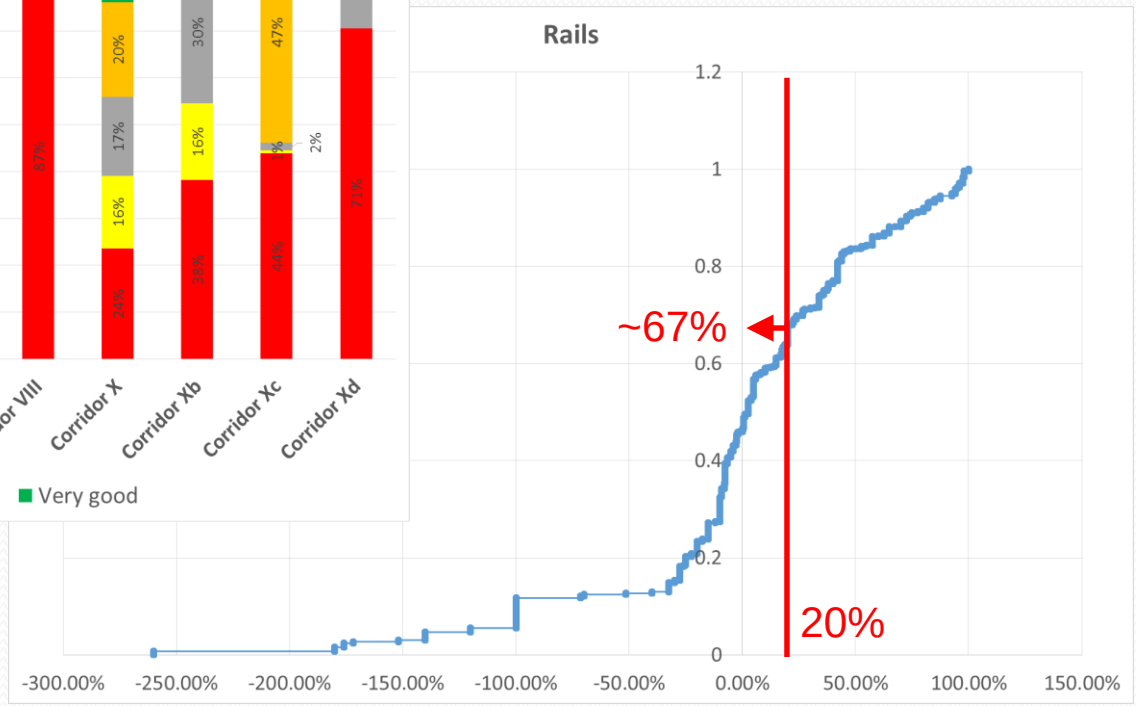
A typical RSL cumulative curve (good/normal European situation)



ConnecTA Project (2017-2018)

RSL cumulative curve for the WBR - **RAILS**

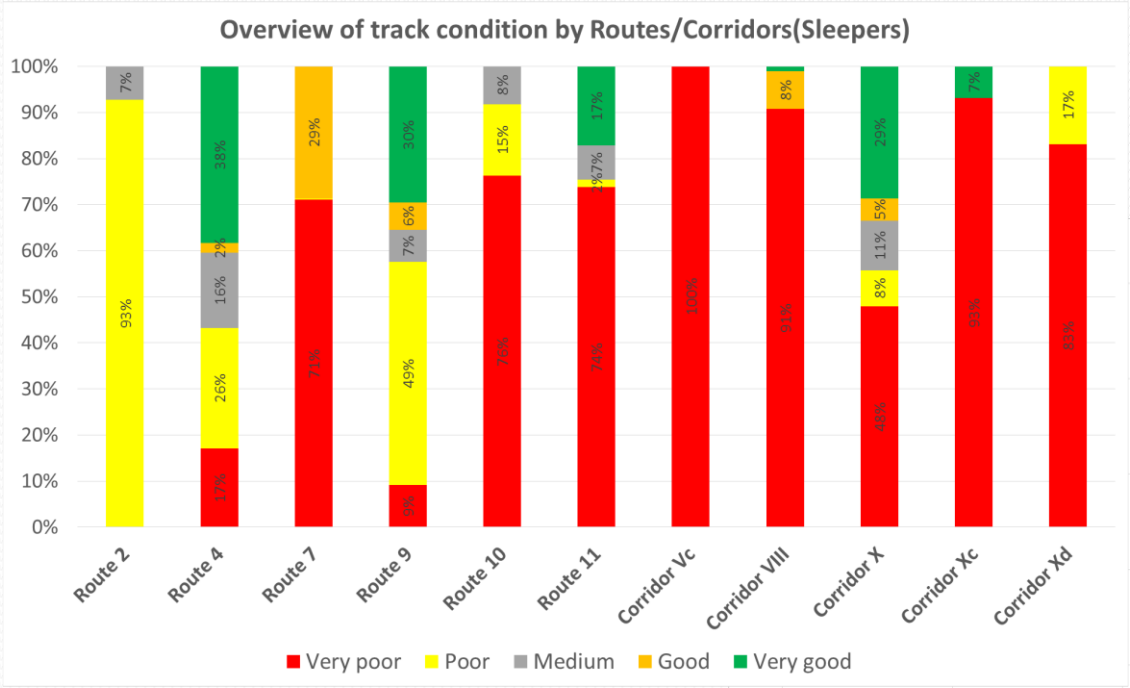


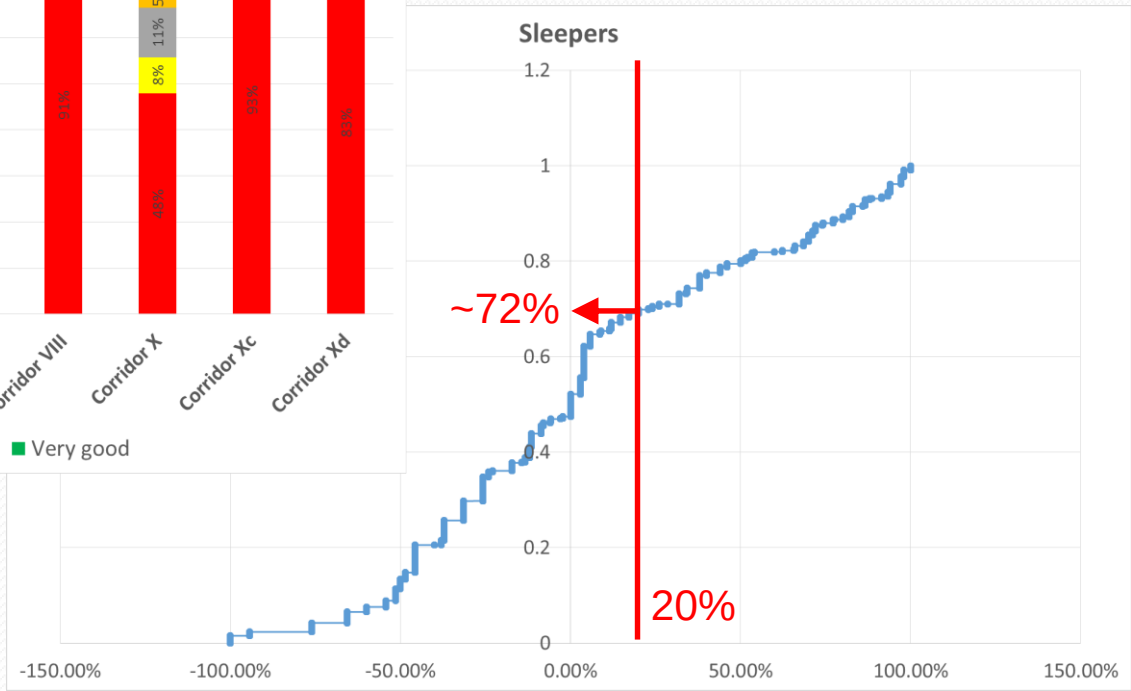


Cumulative distribution curves of the ***Rail RSLs*** on the entire TEN-T C&CNWB (without ZFBiH)

ConnecTA Project (2017-2018)

RSL cumulative curve for the WBR - **SLEEPERS**

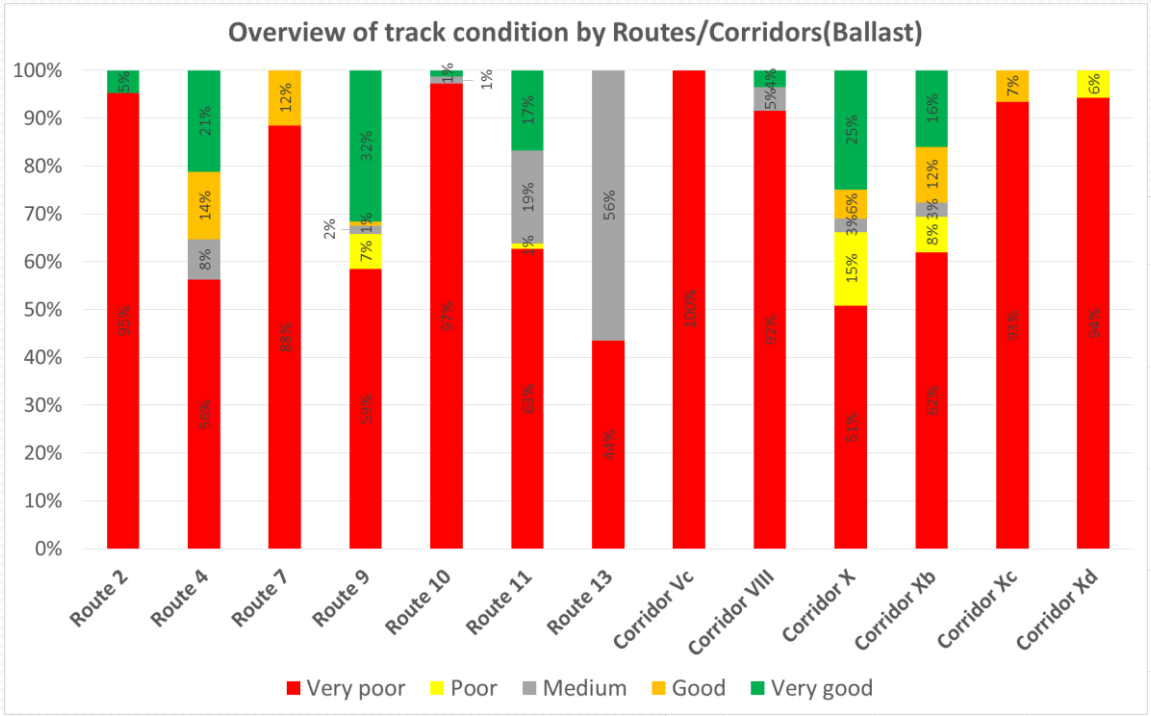


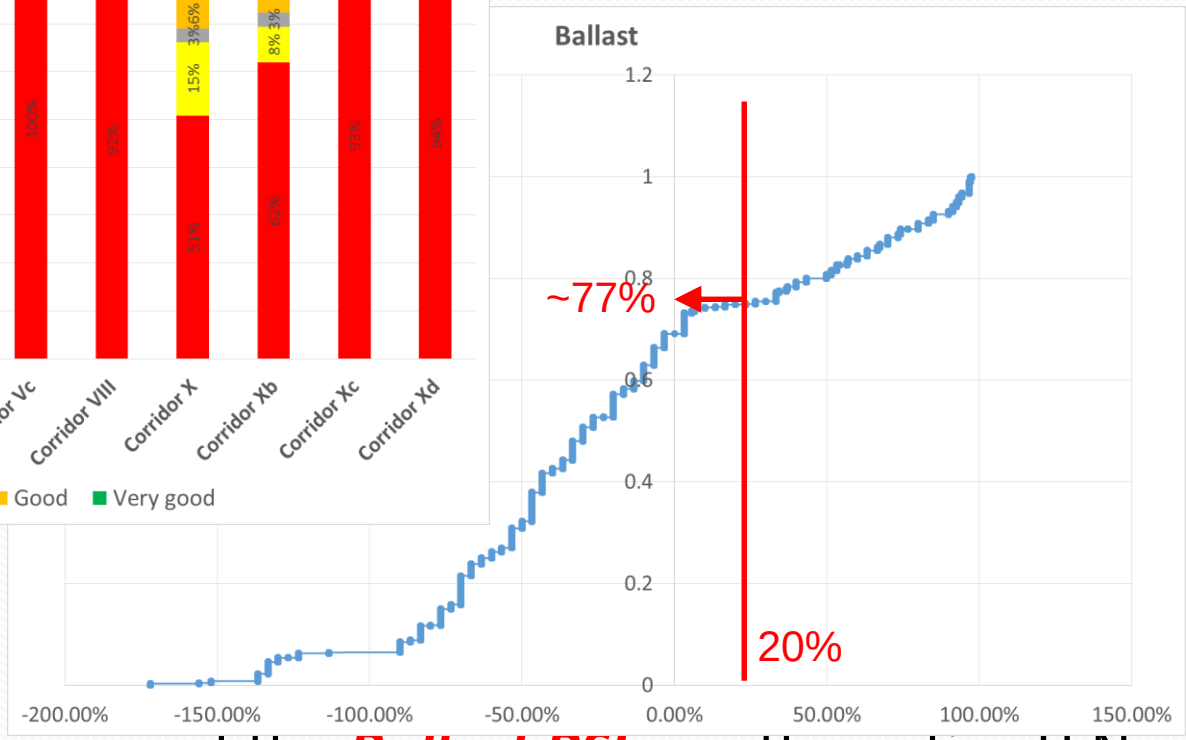


Cumulative distribution curves of the ***Sleeper RSLs*** on the entire TEN-T C&CNWB (without ZFBiH)

ConnecTA Project (2017-2018)

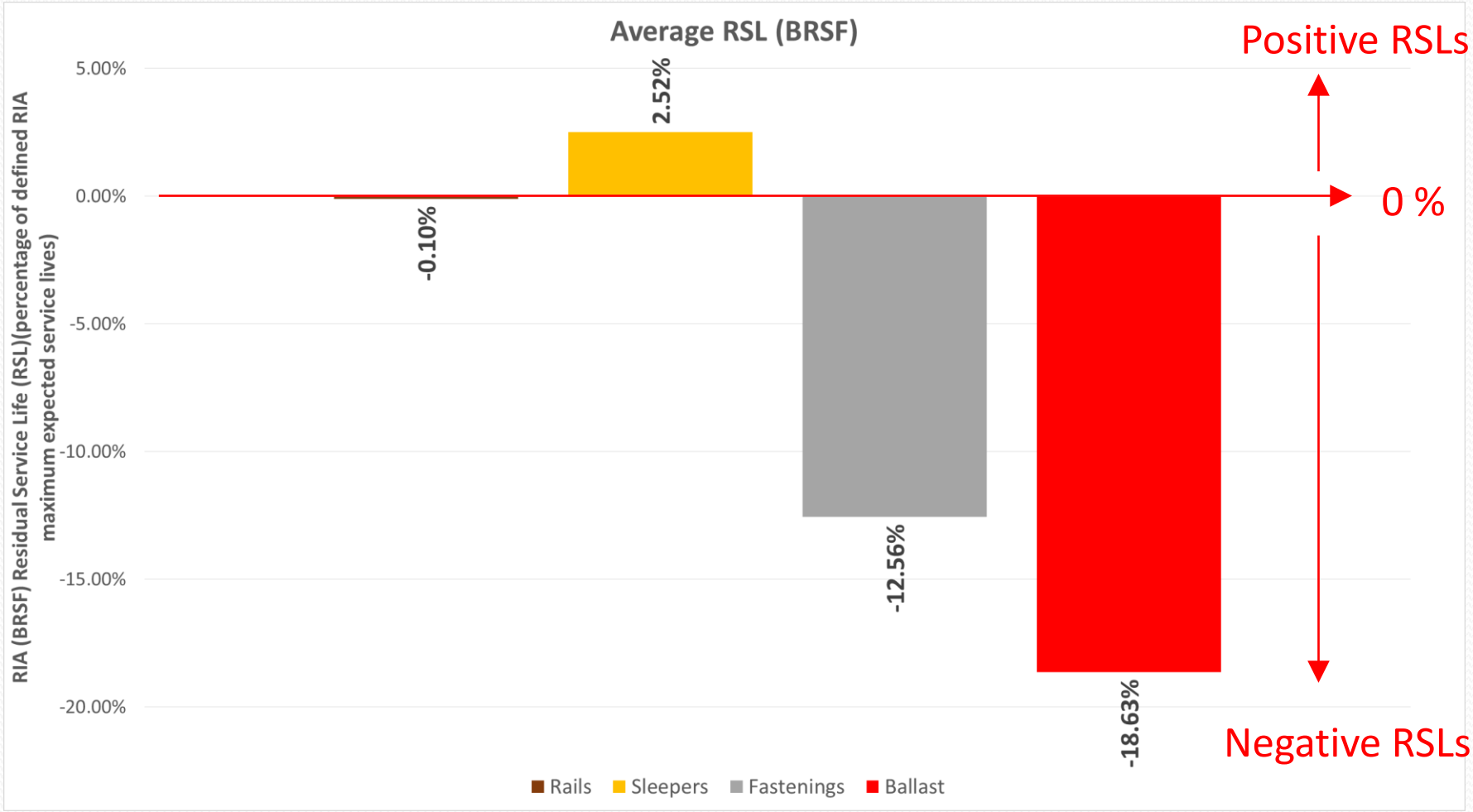
RSL cumulative curve for the WBR - **BALLAST**





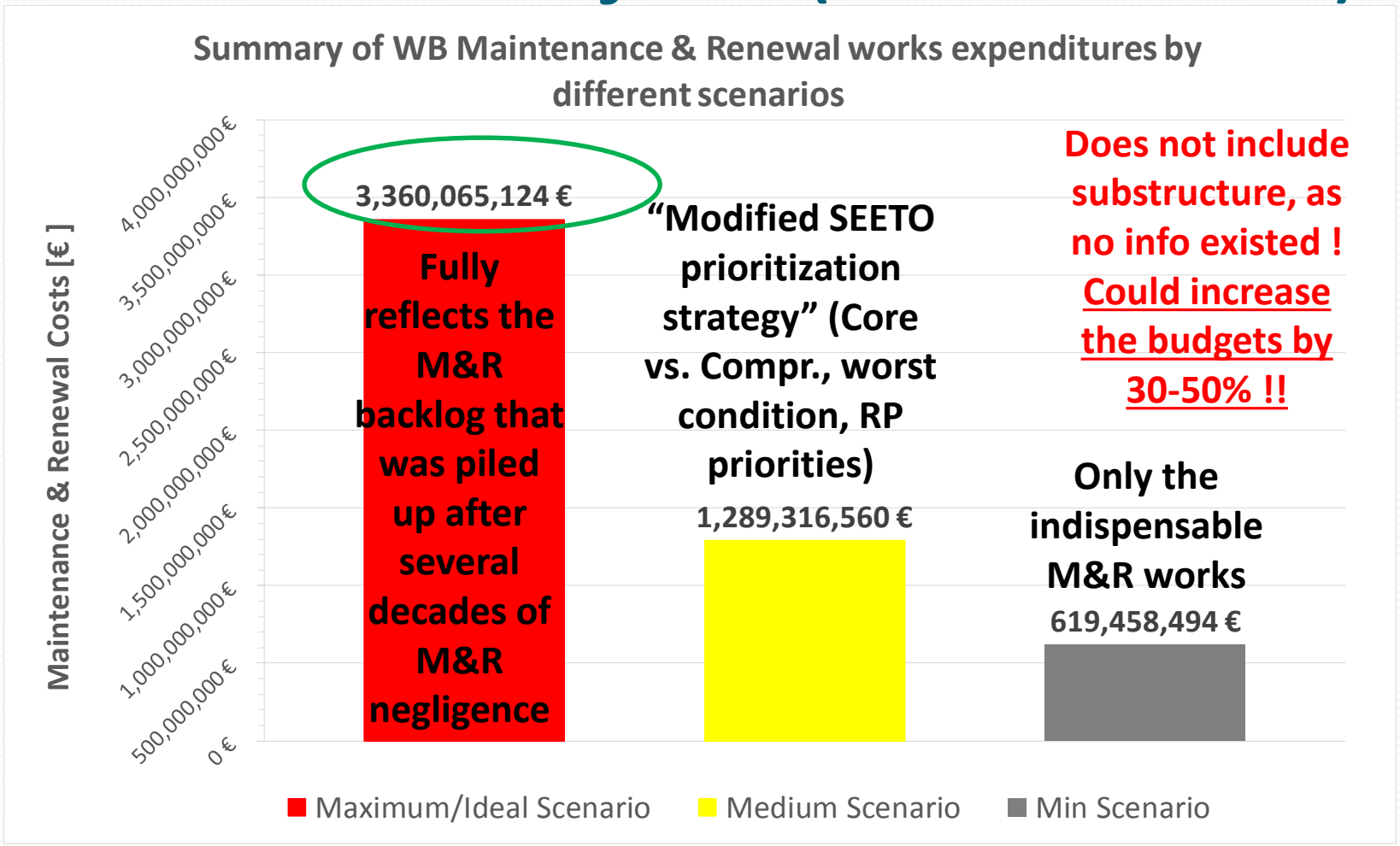
Cumulative distribution curves of the ***Ballast RSLs*** on the entire TEN-T C&CNWB (without ZFBiH)

ConnecTA Project (2017-2018)



Average RSLs of Ballast, Rails, Sleepers and Fastenings (BRSF) on the entire WB6 network

ConnecTA Project (2017-2018)



Rail Infrastructure 5-year (2019-2023) M&R Budgets for ***all 3 scenarios***

ConnecTA Project (2017-2018)

How to improve this situation:

- *If we had RSL at the level of 40%, in order to remain at that level, we would only need to:*
  - *find about 3% of "worst assets" and replace them every year (as RIA on average have a SL of about 30 years) and*
  - *ensure that geometric characteristics of RIA always remain within required limits (to slow down their deterioration)(**need for condition-monitoring**)*
- *Since our situation is much worse (negative RSLs), we need to:*
  - *Replace assets at much higher rate (about 5-10 % per year), until we reach the desired RSL level of 40%*

ConnecTA Project (2017-2018)

How to improve this situation:

- *However, when replacing those 5-10 % of RIA, we need to prioritize among them to find:*
  - ***Assets in worst condition present on lines with highest traffic, which as such present the highest risk for the safety of railway traffic*** *(RIA with low RSL are prone to failures, i.e. have much higher probability of failure occurrence than younger assets, which may happen (and most often happen) under traffic, so thus they also have higher probability of causing traffic accidents*
  - ***Prioritization indispensably requires RIA condition-data****, in order to understand the actual condition of RIA, assess their speed of deterioration and thus the likelihood of failure occurrence*
  - *To process RIA condition-data, considering the immense number of assets and thousands of kilometers of rail network,* ***the only possible way is to deploy Railway Infrastructure Asset Management System – RI-AMS***

RI-AMS

Why is RI-AMS needed:

The process of determining whether, when, where and how to intervene and deciding on an optimum allocation of resources, while minimizing the costs, is very complex because:

- *different assets and track sections tend to behave differently under the effects of loading and environment;*
- *decision processes for M&R works are closely interrelated, both technically and economically;*
- *decision-making for M&R is based on a tremendous amount of technical and economic information, extensive knowledge and above all experience.*

RI-AMS

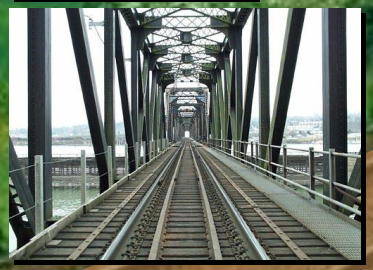
RI-AMS

How it works:

1. Know your assets (what they are & where they are) (***Asset Register***)
2. Know (measure) asset condition regularly
3. Know allowable assets' condition limits (traffic safety, risk levels)
4. Know how assets' condition is changing over time and under traffic (***deterioration modeling***)
5. Use deterioration modeling to forecast when assets will reach their respective condition limits (***M&R Planning***)
6. Group M&R works to optimize performance and minimize costs (***Resource Allocation Optimization***)

RI-AMS

- Track
- Rails
- Overhead Line
- Contact Wire
- Sleepers
- Fastening
- Ballast
- Signalling
- Telecommunications
- Bridges
- Switches



RI-AMS

RI-AMS Basic Data Groups

Inventory Data

- Map data
- Track Layout
  - Curves
  - Transitions
  - Slopes
  - Superelev.
- Assets Inventory
- Assets Location
- Assets Characteristics
  - Types
  - Installation Dates

Operating Data

- Speeds
- Annual Loads
- Axle Loads
- Costs
- Line Categories

Condition Measurements

- Track Geometry
- Rail geometry
- Corrugation
- Wheel/Rail forces
- Ride comfort
- Ultrasonic measurements
- Rail Surface Defects
- Ballast % of “fines”
- Geotech/Petrogr. anal. of ballast
- Sleeper cracking and/or clustering
- Various (visual) inspection data

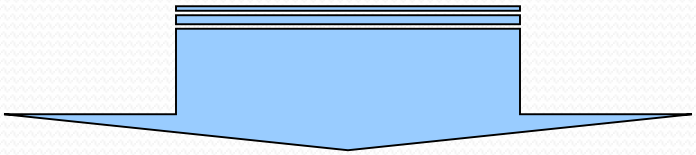
Work History

- M&R Works
  - Type
  - Date
  - Location
  - Costs
- Inspections
- Other interventions

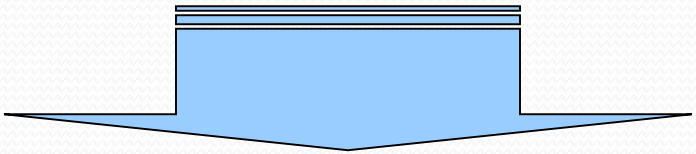
RI-AMS

Typical measuring vehicle Operational Management

Total length of lines to survey	About 10,000 - 20,000 km
Survey Frequency	1 week / 3 months
Total amount of km covered in 1 year	80.000 Km
Average length surveyed in 1 working day	500 km



Acquired data in 1 month	1 Tb



Need for RI-AMS

RI-AMS

Visualization

Reporting/Printing

Data Export

Track

Rolling Stock

Switches & Crossings

Overhead Line

Signaling

Statistical tools & Simulations (Global Network-level Management)

Traffic optimization

Resource Allocation & Optimization

Degradation models (Condition Analysis)

Long-term planning (Maintenance vs. Renewal)

Short-term planning (Interventions)

COSTS vs. QUALITY

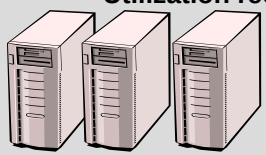
Simulations

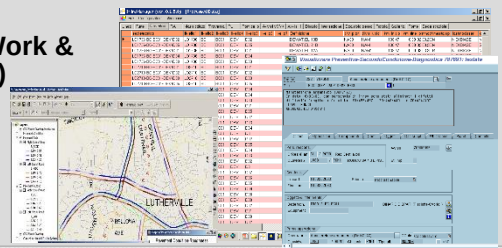
Horizontal Functionalities (Connection Manager – Universal Data Interface, Data Import & Configuration, Asset Registry, Multi Level Segmentation, etc.)

Database

External Systems

(Measuring Systems, Asset Inventory, Work & Utilization records, EAM, ERP, etc.)

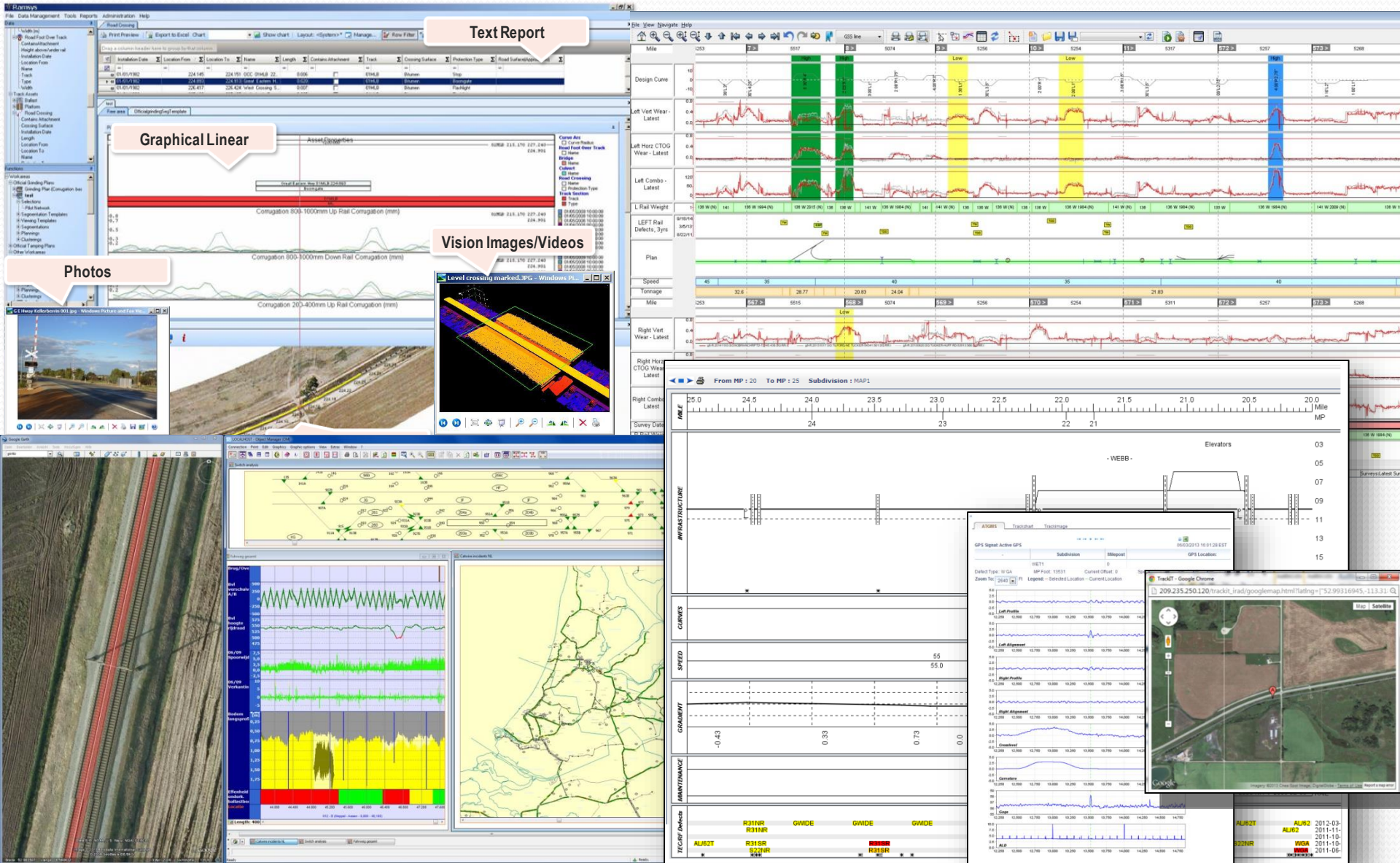




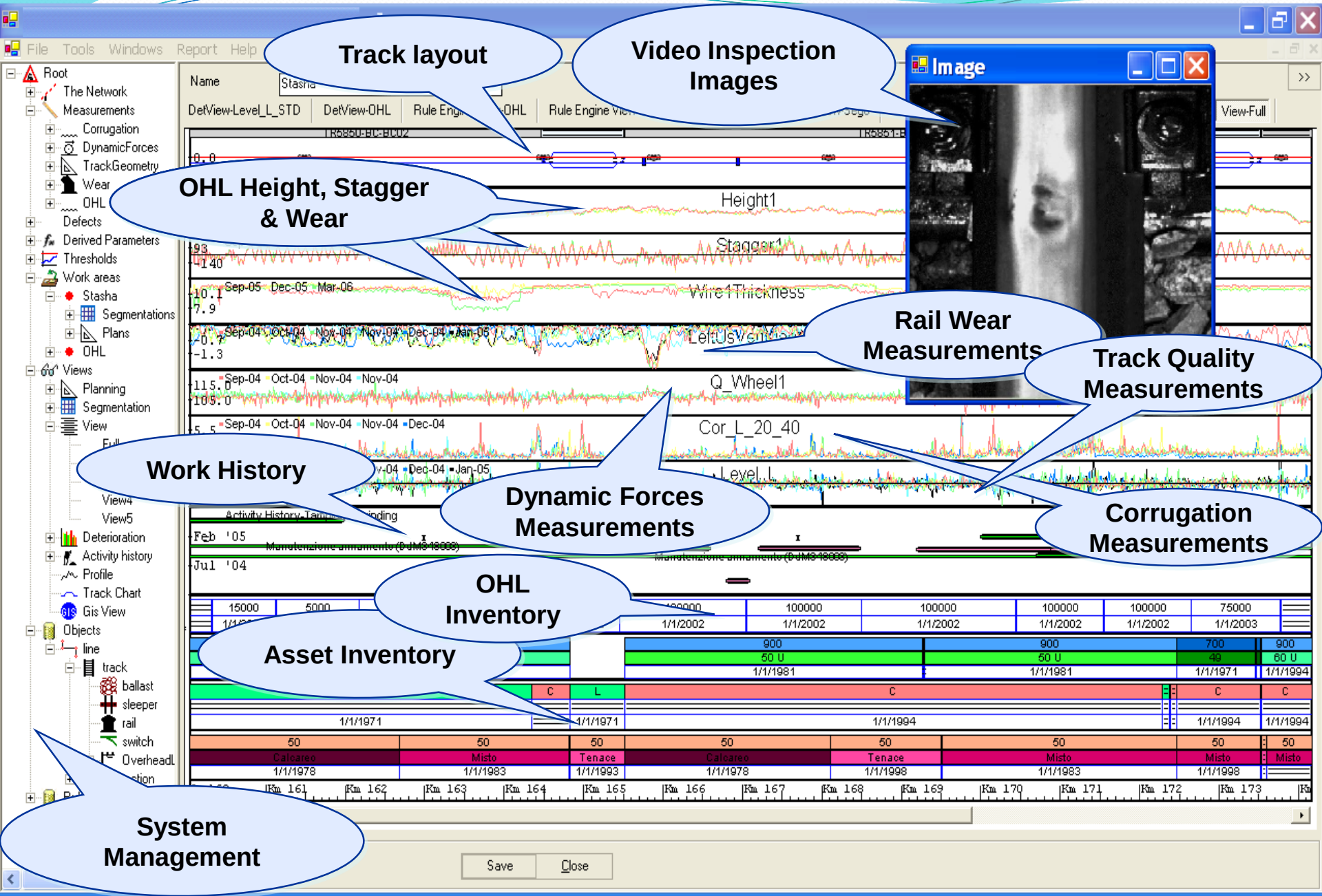
RI-AMS – Essential Functionalities

- ***Ability to model railway infrastructure as linear/spatial assets using "Link" and "node" objects, and "location-along-the-link" reference of all other singular (point) objects***
- ***Liner/Spatial (L/S) referencing of all "distributed" properties***
- ***Integrated handling capability of any kind of data different in nature (inventory, layout, condition, operation, work history, etc.)***
- ***Full compatibility with third-party GIS, EAM/ERP systems and other DBMS & tools***
- ***Superb visualization capabilities (assets & condition-parameters)***
- ***Flexible track segmentation (as the platform for all analyses)***
- ***Flexible, "generic" Deterioration Models & Condition forecasting***
- ***Automatic M&R planning***
- ***M&R clustering/optimization***
- ***Resource Allocation Optimization***

RI-AMS (Visualization)



RI-AMS (Visualization)



RI-AMS

RI-AMS deliverables/benefits:

- Optimal M&R Work Plan (*long, short and middle term*)
- ***What-if*** analysis - ability to test different Maintenance and Resource Management Policies & Strategies
- Estimation of Resource Requirements & Optimal Resource Allocation
- Estimation of Traffic Disturbances
- Full Cost-breakdown & Cost/Budget Optimization

While ensuring optimal assets' condition at all times !

RI-AMS – How to implement

ConnecTA - tentative Action Plan

Full and true ***separation of railway infrastructure management from train operations*** and ***adoption of Railway Laws fully in accordance with EU directives*** (*for those RPs who have not done it yet, or completely*)

Formulation of ***multi-annual Business Plans*** followed by corresponding multi-annual ***contractual relationships*** with the respective Government institutions

Formulation of a modern long-term concept concerning RIA M&R, preferably on ***PBMC-basis***, utilising specialised IMCs and KPI-based controlling and pricing mechanisms

Updating of ***Technical Regulations and Rulebooks*** and their alignment with the European and international best practice

Implementation of a modern ***RI-AMS system***

Enabling and ensuring regular comprehensive ***RIA condition-monitoring*** (*special focus on Civil Works, i.e. structures*)	**Phased RI-AMS implementation**: ***Pilot/Trial Implementation*** (*RI-AMS Feasibility Studies*), ***Full-scale Implementation***,	**RI-AMS** Increased attention to improving the **safety of road level-crossings**

RI-AMS – How to implement

ConnecTA – proposed future steps

1. ***Regular Condition-monitoring***
2. *Condition-analysis of Civil Works (structures)(i.e. bridges, tunnels, culverts, etc., where bridges are arguably the most critical) (**Structural Health Monitoring** - SHM).*
3. *Implementing **RI-AMS system** (possibly starting with RI-AMS Feasibility Studies – i.e. Trial Implementations);*
4. *Updating of existing **regulations and rule-books**;*
5. *Improving the safety of **level-crossings (LCR)***

RI-AMS – How to implement

Benefits of RI-AMS with regular RIA condition-monitoring

a) *Enabling **the only manner for precise and objective determination of M&R works** needs and prioritisation between them*

b) ***Promoting contractual relationships** **between the responsible Ministries and Infrastructure Managers (IMs), as well as between IMs and Infrastructure maintenance Contractors (IMCs) (e.g. through PBMC concept)**, as RIA condition-monitoring data are indispensable for the creation of infrastructure KPIs, and which are crucial for proper monitoring of the entire contracting process.*

c) *Precise and objective RIA condition-monitoring data forms an **indisputable ground and arguments for the requests to International Financing Institutions (IFIs, e.g. banks) for funding of RIA M&R works** as it promotes complete transparency and objectivity, rather than subjectivity and "rule of thumb", which is how IFIs mostly perceive the IMs estimates and requests nowadays*

Railway Infrastructure Asset Management System (RI-AMS) in the West Balkans Region

Thank you for your kind attention !

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