Smart Railway Solutions to Support Railways Challenges

transport connectivity in the COVID-19 context
Background:

Study on Smart Solutions for Railway Transport (2020)
A1 - Automation of Terminals
A2 - Advanced Traffic Management Systems
B1 - Condition-Based and Predictive Maintenance
C1 - Automation of Train Driving
D1 - Electronic Information Exchange
D2 - New Technologies for Efficient and Secure Border Crossing
D3 - Railway Consignment Note as a Customs Document
D4 - Efficient Break of Gauge Operations
D5 - Joint Border Controls and Streamlined Border Crossing
E1 - Client Orientation
F1 - Green and Sustainability Focused Financing
Structure of the training modules

- Introduction
- Main objectives of the module
- Topics covered by the module
- Examples of research/implementation
- Questions and discussion topics
- Brief reflection
- Session plan

Module B1 Condition-based and predictive maintenance

Introduction (3 min)
Railways have to continually ensure that the rolling stock and infrastructure are in good condition, with high resilience against failures. There are number of challenges in planning of high-quality maintenance that has to be organized on efficient and cost-effective manner.

Module objectives (2 min)
- To understand general principles of condition-based and predictive maintenance
- To comprehend functions of condition-based maintenance and predictive maintenance model and key architecture elements necessary to develop such maintenance systems
- To expand the knowledge on latest developments and practical examples in implementation of condition-based and predictive maintenance
- Recognize the benefits and challenges for introduction of condition-based and predictive maintenance.

Content (80 min)
1. Concept of condition-based and predictive maintenance solutions (5 min)
2. Railway maintenance strategies (15 min)
3. Condition-based and predictive maintenance model (25 min)
4. Case studies on condition-based and predictive maintenance solutions (35 min)

Summary (5 min)
Condition-based and predictive maintenance solutions are governed by real-time monitoring of the conditions of railway components. Such solutions offer capacity for prediction of failures before they happen and organization of maintenance activities on optimized manner. Even though implementation of condition-based and predictive maintenance solutions is a complex and demanding endeavor, it also brings significant reduction of maintenance costs and increase reliability and availability.

Feedback and Discussion (5 min)
Feedback on this module and discussion on status of condition-based and predictive maintenance in the countries of participants, benefits and challenges in implementation of such maintenance systems.

Instructor’s notes:
See other Module B1 resources
Capacity building programme

- expanded knowledge on smart railway solutions
- support for development and implementation of smart railway solutions

- Initial workshop (train the trainer)
- Training workshop (national, multi-country)
- Self learning tool (Training manual, web-based tools)
- Specialized training workshops (expanded specific topics)
- Follow-up activities (when necessary after evaluation)

- Modular concept
- Living Document
- Cooperation with partners
A1 Automation of Terminals

- Automation of loading/unloading
  - bulk, container, palletized cargo
  - automated cranes / guided vehicles
  - transshipment and intermodal
- Use of intelligent gate systems
- Automation of train formation / marshalling
- Automatic coupling
- State-of-the-art terminal/yard management IT systems
A2 Advanced Traffic Management Systems

- Existing advanced traffic management systems
  - ERTMS level 1 & 2 / CTCS level 2 & 3

- Future advanced traffic management systems (ERTMS level 3 / CTCS level 4)
  - Train Integrity Monitoring
  - Moving block technology
  - Concept of virtual coupling

- Future Railway Mobile Communication System (FRMCS) / High-speed and high-volume data exchange (5G & LTE, Wi-Fi, SatComm)

- Advanced train positioning systems (satellite-based localization)

Source: Shift2Rail MOVINGRAIL Project, 2019
B1 Condition-Based and Predictive Maintenance

- Railway Maintenance Strategies
  - Optimization of maintenance timing
  - Organizational Changes

- Condition-based & Predictive Maintenance
  - Sensor and scanning technologies
  - Signal processing and data acquisition
  - Condition monitoring, health assessment and diagnosis
  - Analysis and prognosis
  - Decision support and optimization

- Case Studies
  - French Railway SNCF & German Railway DB

Source: C. Verdun, F. Turgis, P. Audier, 2019, Remote Diagnosis and Condition Based Maintenance for Rolling Stock at SNCF
C1 Automation of Train Driving

- Grades of automation in train operations
  - ATO, Driverless, Unattended
- ATO system architecture
- ATO system functional requirements
- Technologies for automation of train driving
  - localization and perception
- Obstacle detection systems
  - active sensors (e.g. RADAR, LiDAR) or
  - passive visual cameras
- Examples of automation of train driving
  - Rio Tinto AutoHaul system (GoA4)
  - ATO over ETCS on GoA2 in Europe
  - ATO in high-speed trains in China
D1 Electronic Information Exchange

- Between railways
  - EU TAF - TSI & OTIF TAF-UTP
  - OSJD/SMGS & Bilateral EDI agreements
  - CIS CRT (e.g. MASPLAN)

- Among railways and control agencies
  - Pre-arrival information
  - Customs transit

- Case Study
  - Electronic interaction Railways – Customs in Russian Federation and Project INTERTRAN

- Impact of E-Interoperability
D2 New Technologies for Efficient and Secure Border Crossing

- Automated and dynamic inspections
  - Electronic dynamic weighing scales
  - Multifunctional intelligent gate systems
    (OCR, RFID, laser scanning, imaging and detecting, video surveillance, sensor technologies)
- Non-intrusive inspections
  - X-ray; thermal imaging, radiation monitoring
- Electronic tracking (e-seals) for secure border crossing
  - Options and adapted ESCAP SCBTM for railways
  - Examples of implementation in India and Russian Federation

Source: Lithuanian Railways
Customs formalities/procedures and railway documents (CIM, SMGS, CIM-SMGS, other)

Customs requirements on railway transport
- entry/exit advance information
  (WCO SAFE FoS, WCO Data Model)
- Transit and simplifications (WCO RKC)

Customs transit based on railway consignment note
- Example of simplifications in EU, Turkey, RF
- Concept of new international railway customs transit arrangement(s)
D4 Efficient Break of Gauge Operations

- Transshipment of containers
  - directly and simultaneously
  - through container yards
  - automation of loading/unloading

- Change of bogies
  - optimization and organization
  - automation of shunting / coupling

- Variable-gauge bogies
  - Specific instances (e.g. passenger trains)
  - Examples of technologies
  - Examples of implementation:
    Moscow – Berlin / Baku – Tbilisi – Kars

Alashankou station (China), Source: ADB
Sarakhs border crossing, Source Iranian Railways
D5 Joint Border Controls & Streamlined Border Crossing

- Joint border controls within a country
  - Transfer of border control responsibilities
  - Joint border inspection teams
  - Single window inspection principles
- Single window facility for railway transport
- Single stop inspections at joint border crossing
- Crossing the border without stopping at the border stations
- Case Study of Rezekne (Latvia) railway border crossing
E1 Client Orientation

- Digital platforms and integrated solutions for railway transport related services
  - Electronic trade platform “Freight Transportation” in Russian Federation (e-sales)
  - Corridor One-Stop Shops (C-OSSs) on European Rail Freight Corridors (RFC)
  - ETA electronic information exchange (ELETA Project)
  - National Transport and Logistics Public Information Platform (LOGINK) in China (B2B, B2G & G2B)

- Visibility and electronic tracking
  - GNSS electronic tracking options
  - Indian Railways Real-time Train Information System

- Case study: Indian Railway’s mobile application - Rail SUGAM (Smart User Group with Advance Mobility)
F1 Green and Sustainability Focused Financing

- Green bonds, sustainability bonds and green loans
- Voluntary principles, standards and certification
  - International Capital Market Association (ICMA)
  - Climate Bonds Initiative (CBI)
  - Climate Bonds taxonomy for freight rail
- Examples of Certified Green bonds in Railway Transport
  - French Railway (SNCF)
  - Russian Railway (RZD)
- Government/intergovernmental funds and PPP
  - European Green Deal and European Green Deal Investment Plan (EGDIP)

Green Bond Value Chain, Source: EU Study 2016, (COWI)