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Case studies on automation and digitalization in intermodal freight transport and logistics

Submitted by the Chair the secretariat

I. Introduction

1. The case studies in this document are provided by member States to supplement the Handbook on Automation and Digitalization in Intermodal Freight Transport and Logistics as contained ECE/TRANS/WP.24/2024/5. The case studies provided are categorized by the objectives of the provided solutions under various applications. These case studies would start with a brief introduction of its objective, followed by how it has improved operations and a cost-benefit analysis (where provided), and the lessons learned. To facilitate navigation, a set of keywords are also provided.

2. The case studies are provided in annex.

Annex

Case studies

I. Solutions for business analytics

A. NITOB – submitted by Austria

Keywords: digital twin, business analytics, optimization, Data and information exchange and management platform

1. *Objective*

The NITOB project of Austria collects weaknesses along the entire rail-related transport chain and evaluates optimization options, both from a technological point of view (e.g., automation and digitization) and from a process point of view (e.g., improved scheduling).

2. *Application, benefits and costs*

It has already been worked out in detail in various projects such as the EntKuRo project. In addition, effects on the forerun and on-carriage processes in the transport chain are taken into account. This enables for the first time an evaluation of the optimization potential of various measures in several dimensions (cost-benefit; risks in implementation, strengths and weaknesses, effects on the forerun and on-carriage processes, emission reduction).

3. *Lessons learned*

The findings and results offer railroad companies well-founded decision-making support about which measures they want/should tackle in the future. Hence, they are an appropriate means in actively approaching potential partners in the future to set up such an R&D project in order to prepare the practical implementation of selected optimization measures

B. Automated system for maintaining and analysing the schedule of the performed movement (GID System) – submitted by Russian Federation

Keywords: business analytics, terminals operations, maintenance, scheduling, Data and information exchange and management platform

1. *Objective*

The GID system of the Russian Railways is designed to automate the functions of the transportation process management and includes forecasting, planning, control, accounting and analysis of the transportation process. The system allows, in particular, to track the movement of trains on long routes, large stations and multi-track sections, to control the progress of distribution and transfer of local cargo.

2. *Application, benefits and costs*

An important function of the system is the analysis of the implementation of the train schedule, the weight and speed of their movement, the formation of incomplete and incomplete trains. Main functions:

- Automated maintenance of the schedule of the executed movement;
- Quick access to information about trains, trains and locomotives;
- Issuance of train position in graphic and tabular forms;
- Display of the current situation at stations and hauls on the screen (dispatch control board);

- Control of locomotive location and condition;
- Accounting and analysis of the schedule, section speed, weight and length of freight trains and their downtime at technical stations;
- Train movement forecasting;
- Monitoring of locomotive and locomotive crew operations;
- Recording the exchange of trains and wagons at junction points;
- Analysis of completed train operations and train delays;
- Search for trains, locomotives, and wagons.

A distinctive feature of the GID system is a unified technology and a unified interface at all management levels. The set of functions and their customization for a specific user allow the system to be operated both in the traffic management directorate and in other services. The GID system is constantly being improved to include more functionalities.

Currently, the GID system is implemented across the Russian Railways network in all dispatcher sections, and manual scheduling has been eliminated in 92 per cent of these sections. More than 70,000 GID workstations have been installed on the Russian Railways network.

GID is used in the many well-known projects, including the Adler–Sochi–Krasnaya Polyana sections, where the Winter Olympic Games were held, the Moscow Central Circle, the Moscow Central Diameters, and others.

3. *Lessons learned*

Implementation of the GID system has yield the following benefits:

- Reduction of routine work for the dispatching staff;
- Increased length and reduced number of dispatcher sections;
- Elimination of an unnecessary management layer by transferring train dispatchers to the Transportation Management Centres;
- Radical improvement in the timeliness and accuracy of information;
- Elimination of manual executed movement scheduling.

C. Unified Corporate Automated System for Locomotive Complex Management (EK ASUT) – submitted by Russian Federation

Keywords: business analytics, railway operations, maintenance, data and information exchange and management platform

1. *Objective*

The automated control system of the Russian Railways is designed to automate the management of the locomotive fleet and crews in accordance with the safety of the transportation process. Functionality of the system includes:

- Accounting of the fleet of traction units;
- Optimization of the work of drivers and the use of rolling stock;
- Planning and control of various types of locomotive repairs.

2. *Application, benefits and costs*

The objective is to create a unified information model of technological data for the locomotive complex. This model will be based on data from key participants in the processes – locomotives, locomotive crews, operations and traffic services, and track work customers. The aim is to address comprehensive tasks that require system integration within a unified

information space of EK ASUT, using hardware and software platforms for storing and processing large volumes of data, and generating reports on the locomotive complex as a whole. The implementation of the automated process control system contributes to the improvement of the following indicators:

- Reduction of operating costs when entering and exiting through the control post;
- Reduction of locomotive downtime in scheduled repairs and, as a result, saving on the cost of their purchase;
- Reduction of costs when the locomotive is idle waiting for repairs;
- Cost reduction due to the release of crews;
- Improve the responsiveness and quality of managing the operational modes of the locomotive complex's barrier functions;
- Increase accuracy in determining the current location of locomotives through the use of modern geolocation tools;
- Reduce labour intensity and improve the efficiency of managing locomotive crews;
- Reduce labour intensity and eliminate human error in deploying traction rolling stock;
- Improve the analysis of professional skills and certifications of locomotive crews;
- Enhance the management of locomotive fleet maintenance;
- Improve the quality and convenience of monitoring depot performance;
- Enhance the monitoring of locomotives that inefficiently consume fuel resources.

3. *Lessons learned*

Ongoing project – not applicable.

D. Customer relationship management (AS UVK) system for freight transport – submitted by Russian Federation

Keywords: business analytics, customer relations, online sales, data and information exchange and management platform

1. *Objective*

Implementation of a customer-oriented strategy in the field of freight transport and transport logistics services through the use of advanced management and information technologies.

2. *Application, benefits and costs*

The project involves the phased development and implementation of subsystems of the Automated Customer Relationship Management System for Freight Transport (AS UVK) within the Russian Railways (RZD) holding. This will ensure the expansion of the system's functionality following the reengineering of business processes and the preparation of necessary regulatory documents.

The following subsystems are being developed and implemented within the framework of AS UVK:

- Unified Customer Database (existing and potential customers of the RZD holding's services);
- Customer Inquiry Management;
- Sales Management of Freight Transport Services;
- Marketing Campaign Management;
- Customer Loyalty Management;

- Sales Analysis and Performance Evaluation;
- Module for Potential Customer Search;
- Module for Service Selection for Existing Customers.

The implementation of AS UVK can significantly reduce the risks of losing freight volumes and increase customer satisfaction with railway transport services.

3. Lessons learned

Over 2,000 employees across the Russian Railways network are currently connected to the subsystems of the AS UVK. Upon the completion of the development and deployment of all AS UVK subsystems, it is anticipated that over 5,000 users will be engaged with the system.

With the implementation of AS UVK subsystems, over 13 million digital customer profiles have been created. Annually, the system processes more than 40,000 transactions, attracts over 1,000 new customers to rail transport, and handles over 300,000 customer inquiries as part of its customer support efforts.

E. Electronic Freight Trading Platform (ETP GP) – submitted by Russian Federation

Keywords: business analytics, customer relations, online sales, data and information exchange and management platform

1. Objective

Online sales of the Russian Railways Group's services in the field of freight transportation and integrated transport and logistics products, a single digital space for freight transportation and logistics (interaction between customers and service providers when organising transport and logistics services using modern digital technologies).

In March 2017, as part of the digitalisation of railways, Russian Railways put into commercial operation the Freight Transportation Electronic Trading Platform (ETP GP).

The main function of the ETP GP is to provide any client in electronic form with an optimal offer for the provision of basic transportation services with the provision of rolling stock for this transportation.

Its operational mobility and available algorithms have created a steady trend to expand the audience of users due to effective parity in the processing of applications, their on-line approval, transparency of payments for services, timely execution and issuance of accompanying documentation, including the railway consignment note in an electronic legally significant form. And the technological level of ordering transportation has acquired all the necessary features of modern electronic services.

Thus, for the first time, the Russian transport market was offered an end-to-end electronic service: from the moment the customer contacted Russian Railways to the completion of transportation.

2. Application, benefits and costs

The ETP GP enables digital interaction with freight forwarders, allowing the formation of transport contracts for shipments to CIS countries and the exchange of data throughout the order execution process. Russian clients and exporters can carry out international rail transportation through border crossings involving railways that have joined the ETP GP terms, without the need to establish contractual agreements between the client and the railway administration of the neighbouring country.

The electronic trading platform offers a wide range of services:

- Station-to-station transportation service in both universal and specialized rolling stock;

- Terminal services. It is part of the logistics chain of transportation at the final or intermediate delivery point. This service may include loading, unloading, transshipment and storage of cargo;
- Auctions in lots of rolling stock. Substation lots are a system of bidding for rolling stock within the site, bidding takes place on an increase for the possibility of providing wagons for individual transportation. Any confirmed user of the ETP GP has the opportunity to take part in the auction;
- Payment for transit, import. Import, export, transit freight forwarding services;
- Search for schemes and drawings. A database of schemes and drawings of cargo placement and securing on/in rolling stock.

The algorithm of the site is arranged in such a way that after the client-shipper fills in the single application template, the ETP GP automatically sends its parameters to all service providers connected to it. Suppliers, in turn, send their proposals to the organization of transportation and the provision of rolling stock.

If the operator has previously formed an offer for a wagon and the client has accepted it, an application for transportation is automatically generated and the wagon is "sent" for the declared transportation. Upon arrival of the wagon and completion of loading, the consignor draws up a transportation document. Moreover, he can independently track all transactions with the car and its current location in his personal account.

Registration on the ETP GP is carried out remotely, without a visit to the office. Payment for services for customers is made on the basis of an automatically generated invoice and an act of services rendered after the completion of transportation. The consignor chooses the forms of payment available to him: according to the presented invoice or by forming advance payments on a single personal account opened with the operator of the ETP GP.

3. Lessons learned

The relevance of the ETP GP is confirmed by the positive dynamics of its performance indicators. Since the platform's inception, the number of active users has been steadily increasing. Currently, more than 9,800 clients are registered on the platform. The highest level of activity outside Russia is shown by shippers from Belarus, China, and Kazakhstan. The platform has 147 registered service providers, of which 134 are rolling stock operators.

F. TARO – Towards Automated Railway Operation – submitted by Austria

Keywords: digital twin, automated coupling, business analytics, terminals

1. Objective

Rail is now widely regarded as the most-environmentally-friendly form of surface transport, and yet there is an urgent need to increase capacity, productivity as well as quality of the railway. These key challenges will be tackled by the project TARO ("Towards Automated Railway Operation").

Not only in terms of railway usage, Austria is a leading railway country in the European Union (no. 1 passenger-kilometres per capita, no. 2 freight transport, no. 1 night trains) but also regarding its railway industry (no. 5 global export, no. 1 in railway patents per capita). Given such an excellent starting position, taking railway to the next level with the help of automation and digitalisation technology should be self-evident. Hence, the submitted project proposal "TARO" focuses on 3 different areas:

- Digital Twin development of digital twin vehicle with special regard to condition-based maintenance and predictive maintenance; development and simulation of digital twin infrastructure, as it is one of the fundamentals of automated train operation;
- Process automation in freight transport, in particular in terms of automated coupling, as well as shunting and planning;

- Automated railway solutions such as low-cost autonomous on-track side elements, low-cost train control systems for regional lines, as well as location of vehicles.

2. *Application, benefits and costs*

The estimated project results are expected to contribute to an increase in capacity, productivity and quality of the entire railway system. To guarantee that these results are achieved, a steering board consisting of national and international railway experts will be established.

The results could either be successively transferred to real operation or further processed in subsequent R&D projects. It was for example possible to create the basis for a digital twin vehicle. The results are now to be further developed. Furthermore, a mathematical model for the optimized scheduling of freight wagons was designed. This is now to be successively incorporated into regular operations, make the work of dispatchers easier and make rail freight transport more attractive overall. In addition, tests of the digital automatic coupling in Austria were accompanied and evaluated and migration strategies were developed.

3. *Lessons learned*

Ongoing project – no applicable.

II. Solutions for terminals and railways operations

A. DACIO – Digital Automated Coupling in Infrastructure Operations – submitted by Austria

Keywords: automatic coupling, terminal operations, railway operations, DAC4EU

1. *Objective*

Today's rail freight services suffer from out-dated coupling and shunting processes, mainly due to screw couplings, which prohibit state-of-the-art automation. Due to this situation, especially wagon load traffic is very often no longer competitive. Current research within the project DAC4EU and the subsequent project "European DAC Delivery Program" (EDDP) are paving the way for the introduction of a Digital Automatic Coupling (DAC) system for use within Europe. The new technology of DAC shall lead to an increase in productivity and will enable the rail freight system to connect to state-of-the-art technologies analogous to developments in industry 4.0.

For the successful implementation of the DAC, additional research into automatic coupling and decoupling, as well as all related processes is the main focus of the DACIO project (DACIO – Digital Automatic Coupling in Infrastructure Operations). Examples of these are the bleeding of the brakes and the brake test itself. This research project is based on the planned introduction of the DAC type 4. Type 4 will enable all steps to be performed automatically, with the exception of the decoupling.

The DACIO project has the following goals:

- Investigation of the impact of the DAC on the of the area-wide coverage processes;
- Scientific support of the test program, which is planned within the EDDP. This support is focused on the shunting processes in the marshalling yard and in the wide-area;
- Research into additional processes in the marshalling yard which could be automated. Appropriate functional models and lab prototypes will be delivered. Of keen interest are the decoupling and the handling of the brakes before and after the gravity hump. Additionally the question of a safe roll-away protection of the trains will also be taken into consideration;

- Research into additional automation steps on the wagon, with a focus on developing novel brake systems and a possible array of sensors used to detect the approach to other wagons;
- Research into the impact of the DAC on the structure and scope of the shunting infrastructure. The main goal is to increase the efficiency of the rail freight system.

The DACIO project should help to further the goals of EDDP, in addition to providing initial findings, which could lead to future pilot projects within the new program Shift2Rail2.

2. *Application, benefits and costs*

Ongoing project – not applicable.

3. *Lessons learned*

Ongoing project – not applicable.

B. PRODIGY – Process innovation through digitalisation - new technologies at the interface between road and inland terminal – submitted by Austria

Keywords: terminal operations, railway operations, transport documents, PRODIGY

1. *Objective*

PRODIGY aims to optimise today processes at the interface between road and terminal using digitisation and new (distributed ledger) technologies. Four specific use cases will be newly developed using distributed ledger technologies such as blockchain networks and smart contracts. The use cases are:

- Assessment of damages at intermodal transport units (ITE) at the terminal gate-In;
- Recording and processing of freight documents on arrival and departure;
- Train service connection to other cities offered by the terminal operator;
- Trucking service offered by the terminal operator.

2. *Application, benefits and costs*

An impact analysis of the process innovations is then carried out on two levels: i) an evaluation of the effects on downstream processes (micro level) and ii) an evaluation of the effects on medium- and long-term terminal performance (macro level). The multi-criteria analysis allows a quantitative comparison of the status quo with the optimised processes, i.e. on the basis of several measurable indicators (e.g. time expenditure, staff deployment, environmental impacts (global, regional and local emissions)). The focus is therefore not only on the economic benefit of an intermodal transport or logistics employer, but also on increasing the efficiency of the entire system. The process innovations should make the transport network more resistant and flexible, make the flow of information between different actors more efficient and effective and promote the use of real-time information (e.g. traffic information linked with an electronic pre-registration of trucks at the terminal, information regarding the disposability of terminal infrastructure).

In particular, the automated assessment of damages represents a disruptive innovation, as so far damage to trailers has been documented and evaluated manually. Within the research project, Use Case 1 is processed with a high degree of detail. For the first time, an algorithm for an automated recognition of damage cases at ITE is being developed. Using image recordings of arriving ITE at the terminal gate-In and an innovative software solution, the process of damage assessment and further damage processing (recording, communication, administration, settlement account) is to be revolutionized in the medium term. As a result, an increasing handling speed (road/rail) can be expected.

3. Lessons learned

Ongoing project – not applicable.

C. Automated Terminal and Warehouse Complex Control System (ACS TSC) – submitted by Russian Federation

Keywords: terminal operations, ACS TSC

1. Objective

The purpose of creating the Automated Terminal and Warehouse Management System is to develop an automated model for the terminal and warehouse activities of the Central Directorate for Terminal and Warehouse Complex Management – a branch of OJSC "Russian Railways" – using modern software and hardware complexes and Russian software. This aims to increase data transparency, reduce the impact of human factors, enhance employee productivity by simplifying the execution of production processes, and provide a comprehensive view of the operational situation at each cargo terminal for making necessary and timely management decisions.

2. Application, benefits and costs

The Central Directorate for Terminal and Warehouse Complex Management, a branch of Russian Railways, implemented the Automated Terminal and Warehouse Complex Control System (ACS TSC) project, which was implemented in 16 regional directorates and also integrated with automated control systems of Russian Railways.

Currently, Russian Railways customers have access to the following services through the Russian Railways Client Account in the field of freight transportation: the ability to conclude an agreement with the Directorate in electronic form, submit an application for passes to public places in electronic form, submit orders for loading and unloading operations, the current status of order execution, generate reporting documents for the execution of orders and the automated generation of primary documents for loading and unloading operations. as well as the delivery and export of containers with their signing with an electronic signature.

In addition, the Warehouse Management module has been implemented as part of the automated control system of TSK, which allows you to provide cellular storage. At any time, the employees of the Directorate have access to information about the occupancy of all warehouses (more than 650 cargo terminals) and the cargo up to the cell that is stored there, which also allows you to optimize work.

As part of the automation of the process of recognizing the license plates of wagons, cars and containers imported and exported from the cargo terminal, software and hardware complexes "technical vision" and "entry groupF are used at the cargo terminals of St. Petersburg, Finlyandsky, Kuntsevo-2, Belgorod and Sochi. Also, an automated system of number-by-number accounting of operations with containers, installed on container loaders, determining the location of the start, end and container number, minimizing the human factor.

3. Lessons learned

The implementation of the automated management system has allowed for the automation of production processes and management functions, including loading, unloading, storage, management of movable and immovable assets, warehouse management, production planning, performance monitoring, and financial management.

Currently, the ACS TSC has digitized information, including data on movable and immovable assets across all cargo terminals operated by the Central Directorate for Terminal and Warehouse Complex Management. More than 5,000 service orders have already been processed through the "Client Personal Account of OJSC Russian Railways" in the field of cargo transportation. Over 700 companies have utilized these services.

D. Virtual Coupling Technology – submitted by Russian Federation

Keywords: virtual coupling, terminal operations, railway operations

1. Objective

This is one of the innovative technologies that makes it possible to reduce the interval between the following trains from 12 to 6-8 minutes due to the exchange of information about the mode of movement between the locomotives of the leading and slave trains via a digital radio channel.

2. Application, benefits and costs

Virtual coupling is being actively implemented by Russian Railways for use on particularly freight-intensive sections of the railway network, such as the Trans-Siberian Railway. To date, about 360 locomotives equipped with this intelligent system are already operating at the Eastern Operating Domain.

When driving trains using the "Virtual coupling" technology, a connection is established between the locomotives via a radio channel, and a continuous data exchange between the locomotives is carried out (location, length, weight, current mode of operation, future mode of operation). The next locomotive (slave) running in the same direction, processing information from the locomotive in front (lead), chooses the most optimal mode of operation.

Based on the information received from the leading train, the moment of changing the signal of the locomotive traffic light from "yellow" to "green" or from "red-yellow" to "yellow" is calculated, thereby observing the shortest safe distance between the leading and driven trains without applying braking, and violation of the speeds established by safety devices. The efficiency of the braking system, both in its own composition and virtually coupled, is continuously calculated to calculate the optimal trajectory of the train.

The following are a few benefits of the system:

- Effectiveness of application;
- Increasing the capacity of railway sections (up to 15 additional pairs of trains per day);
- Improving traffic safety;
- Facilitating the work of locomotive crews;
- Increase in section speed.

Thanks to the embedded solutions, with the further development of the technology, it is planned to:

- Organization of a package of up to five locomotives operating on the "virtual coupling" technology;
- Driving packages during the "windows" working hours;
- Identification of pre-failure conditions of locomotive components and assemblies on board the locomotive;
- Increasing the coefficient of technical availability of the locomotive without additional pre-trip diagnostics due to the formation of statistically significant arrays of data on the operation of the locomotive;
- Improving the power supply of trips by accumulating data on the voltage in the contact network and the current consumption of the locomotive tied to the track.

3. Lessons learned

To increase the throughput and capacity of the Trans-Siberian Railway within the Eastern Polygon on the section from Mariinsk to Taishet to Karymskaya to Smolyaninovo, an experimental implementation of interval train control technology using virtual coupling is being implemented.

Freight trains using virtual coupling technology are operated on schedule threads that do not include stops between technical stations, even for overtaking by trains of other categories. This allows for the most efficient application of this technology.

On 13 September 2023, for the first time in the railway network, the feasibility of passing five empty freight trains as a single unit using interval regulation technology with virtual coupling was practically demonstrated. Controlled trials were conducted on the Smolyaninovo to Obluchye section of the Far Eastern Railway, with a total length of 342 empty wagons forming a virtual train. The journey time was 26 hours, with an inter-train interval of 9 minutes.

E. System “Avtomashinist” – Submitted by the Russian Federation

Keywords: railway operations, autonomous train

1. *Objective*

The goal of the “Avtomashinist” project is to transit to full autonomous technologies in shunting operations, thereby increasing labour productivity at Russian Railways.

2. *Application, benefits and costs*

The objectives of the project “Implementation of the Avtomashinist system on hump yard locomotives” are:

- Implementing technology for unmanned shunting operations at stations and sorting yards;
- Developing a unified system that enables shunting locomotives to operate without a driver, for replication across shunting locomotives;
- Developing and implementing a stationary control complex for forward wagon movement on a test site;
- Creating an on-board expandable system with the following functions:
- Traffic safety;
- Automated driving;
- Remote control;
- Avtomashinist;
- Single-person train operation;
- Locomotive control;
- Radio communication;
- Data transmission via radio channel for both diagnostic and operational information;
- Navigation;
- Locomotive equipment diagnostics;
- Infrastructure diagnostics;
- Interval regulation of train movement;
- Monitoring the driver’s condition.

The qualitative effect of the Avtomashinist project lies in improving train traffic safety by identifying safety threats and forming management decisions regarding incidents and events occurring on the locomotive and infrastructure.

3. Lessons learned

The project is in the stage of developing and approving technical documentation, with implementation and replication planned for 2025-2026.

F. Rail Connected Port of Rotterdam – submitted by The Netherlands

Keywords: railway operations, digitization of rail processes, Rotterdam

1. Objective

The "Rail Connected" growth programme arose from the Rail-freight Transport Package of Measures drawn up by the Dutch Ministry of Infrastructure and Water Management to promote freight transport by rail. The 'Rail Connected' programme is funded by the Ministry of Infrastructure and Water Management of the Netherlands and the Port of Rotterdam Authority. The Port of Rotterdam Authority coordinates the programme, which is developed together with market parties. The programme started in 2022 and is intended to finish at the end of 2025. The Ministry provided €1M for the period from 2022-2024 and intends to provide in addition €200,000 in 2025.

The aim is to use digitalization to streamline information-sharing between carriers, rail operators and terminals, thus reducing manual operations. The first step has been taken: pre-reporting of trains. Once a week, everyone submits a digital report stating which trains are planned for the coming week. Step 2 – "train composition" – enters final testing in January 2025. That means greater clarity in a digital environment on the composition of freight trains arriving and departing Rotterdam in terms of locomotive, wagons and containers.

Recently the twenty-fifth market party joined Rail Connected, this means that the Rotterdam rail-freight sector is almost completely covered.

2. Application, benefits and costs

Key to every digitalization process is to use existing interface standards. The European Union Association for Railways (ERA) already has standards for consignment note and train data, yet there are still differences in between, for instance, how terminals and carriers code locations in their systems. In "Rail Connected" these disparities are being solved. The perspective of greater efficiency, transparency and reliability beckons.

Pre-reporting of the train arrival is up and running. Train composition message is almost ready for launch. In 2024, the estimated time of arrival (ETA) function will go live. Traction suppliers need to add the train number in MCA (Notification Container Hinterland) Rail application of Portbase, so that it can be linked to the "path" via the RailNetEurope Train Information System. Sensors in the track enable ProRail, the Dutch rail infrastructure manager, to monitor and update the ETA along these paths and to optimize the use of railway capacity by a more efficient capacity allocation process. ProRail is currently working on additional use of cameras and sensors, so that all applicable routes provide information.

The next step is to draw up an integrated plan of how we could use the digitized processes, and the data derived as a result, to optimize loading, train paths and terminal utilization.

3. Lessons learned

The main lesson learned is to involve market parties from the start. Without their commitment from the very first moment these processes are doomed to fail. Taking the digitization process step by step further in the pace that fits with the market party that leads to successful implementation of projects.

More information at: www.portofrotterdam.com/en/logistics/connections/intermodal-transportation/rail-transport/the-railway-growth-programme-rail.

III. Solutions for Interoperability

A. Development of Electronic e-CIM/SMGS railway consignment note to enhance interoperability across the Trans-Caspian and TRACECA routes, using the UN/CEFACT semantic standards and Multimodal Transport Reference Data Model – submitted by TRACECA and UNECE

Keywords: interoperability, digitalized data exchange, UN/CEFACT standards

1. Objective

Adopting a single, standardized electronic format for a document accompanying goods transported by rail along the Trans-Caspian/TRACECA corridors (CIM/SMGS consignment note) using the UN/CEFACT semantic standards and Multimodal Transport Reference Data Model (MMT RDM) to streamline processes, enhance efficiency of movements of cargo across borders, and pave the way for multimodal data and document exchange along corridors by using the UN/CEFACT standards.

As with other pilot projects for the implementation of the UN/CEFACT package of standards, this project builds on the understanding that fragmented digitalization efforts in increasingly multimodal trade and transport corridors and cross-border supply chains are suboptimal. The project focused on the use of UN/CEFACT semantic standards and MMT RDM as a link between different solutions for data exchange in the railway industry, the different modes of transport and segments in the supply chain.

The project was elaborated and is implemented in cooperation between ECE, its subsidiary body UN/CEFACT, the Permanent Secretariat of the Intergovernmental Commission of TRACECA, the International Rail Transport Committee (CIT), the International Union of Railways (UIC), and the Organization for Co-operation between Railways (OSJD).

Countries along the Trans-Caspian route currently exchange railway consignment note data in various formats: SMGS (Azerbaijan, Georgia, and Kazakhstan) and some use the UN/EDIFACT IFTMIN message for electronic data interchange of the SMGS consignment note data; CIM (Türkiye), or the combined CIM/SMGS (Ukraine). The objective of this pilot implementation was to test the feasibility of digitalizing a common consignment note (CIM/SMGS). The objective included:

- Adoption of UN/CEFACT standards: by implementing UN/CEFACT standards ensure universal compatibility of the digitalized railway consignment note with other railway exchanges and easy integration in seamless data sharing in multimodal data and document exchange and the whole supply chain.
- Development of a prototype of an electronic CIM/SMGS consignment note that is testable and scalable, serving as a practical model for future system-wide adoption.
- Facilitate multimodal transport and simplify data exchange by promoting easier exchange of data in a standardized format across countries to support multimodal transport.

2. Application, benefits and costs

Five railway agencies along the Trans-Caspian trade and transport corridor signed a memorandum of understanding to carry out a pilot implementation project for the digitalization of the CIM/SMGS railway consignment note using the UN/CEFACT multimodal interoperability standards and reference data model. This implied creating a working group and several ad hoc task forces, developing a prototype based on the standards and testing it.

The core consultant under the project, who had to develop and guide the test of the eCIM/SMGS consignment note, started with engagement with the UN/CEFACT standard-setting experts for deep insights in the development and use of the international standards. The project then moved from theory to practice in applying the UN/CEFACT standards.

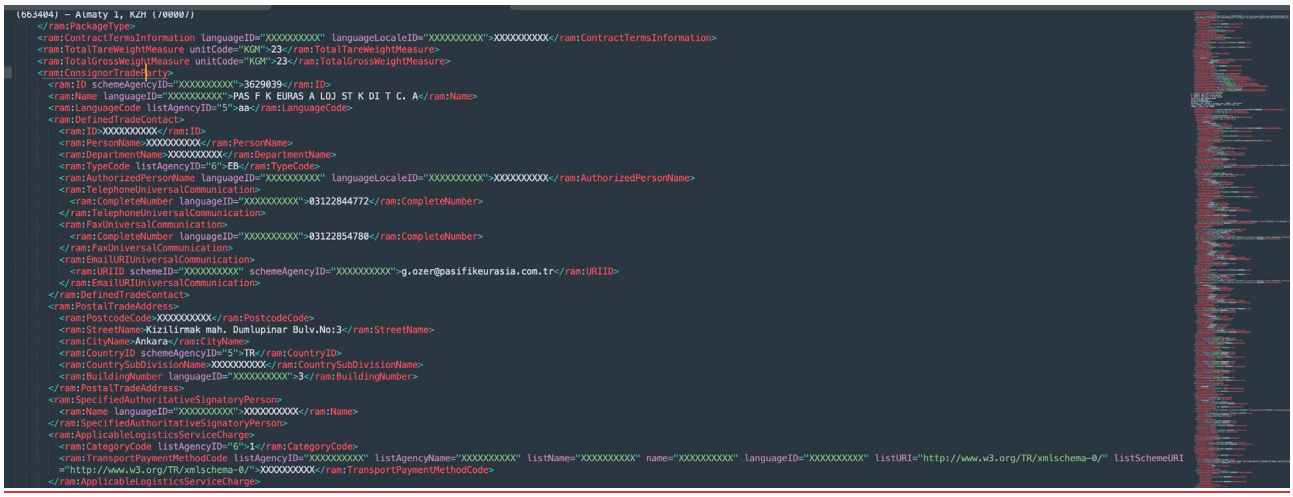
Through strong support from the Permanent Secretariat of the Intergovernmental Commission of TRACECA and UNECE, the next stage covered collaboration and information exchange with the practical users of the digitalization of the CIM/SMGS consignment note. Azerbaijan and Türkiye provided PDF files with the core SMGS and CIM/SMGS data. Kazakhstan shared IFTMIN examples for mapping to the UN/CEFACT MMT RDM and the CIM/SMGS. Georgia contributed with SMGS PDFs for integration. The PDF versions of consignment notes were converted into electronic CIM/SMGS for data mapping, and the results of the data mapping were shared with the working group on the project. The outcome was a unified, standard-focused electronic document equivalent developed from the diverse data formats. The lessons learned, including challenges for railways to change the course from divergent digitalization formats and projects, were very useful. The international cooperation and data sharing enhanced the project.

The Prototype Testing included the following stages:

- The tests started with XML file exchange by e-mail for the test in April 2024.
- The XML file exchanges tested global compatibility and adherence to best practices in data exchange and the use of the global (UN) standards.
- The initial testing among partners produced feedback and lessons, which should lead to further improvements, testing and refinement.
- In their information technology systems, country railways tested and adopted the possibility to export and import e-CIM/SMGS XML files.
- By June 2024, Azerbaijan, Türkiye, and Kazakhstan finalized the tests, while Georgia and Ukraine continued their tests.

Figure I

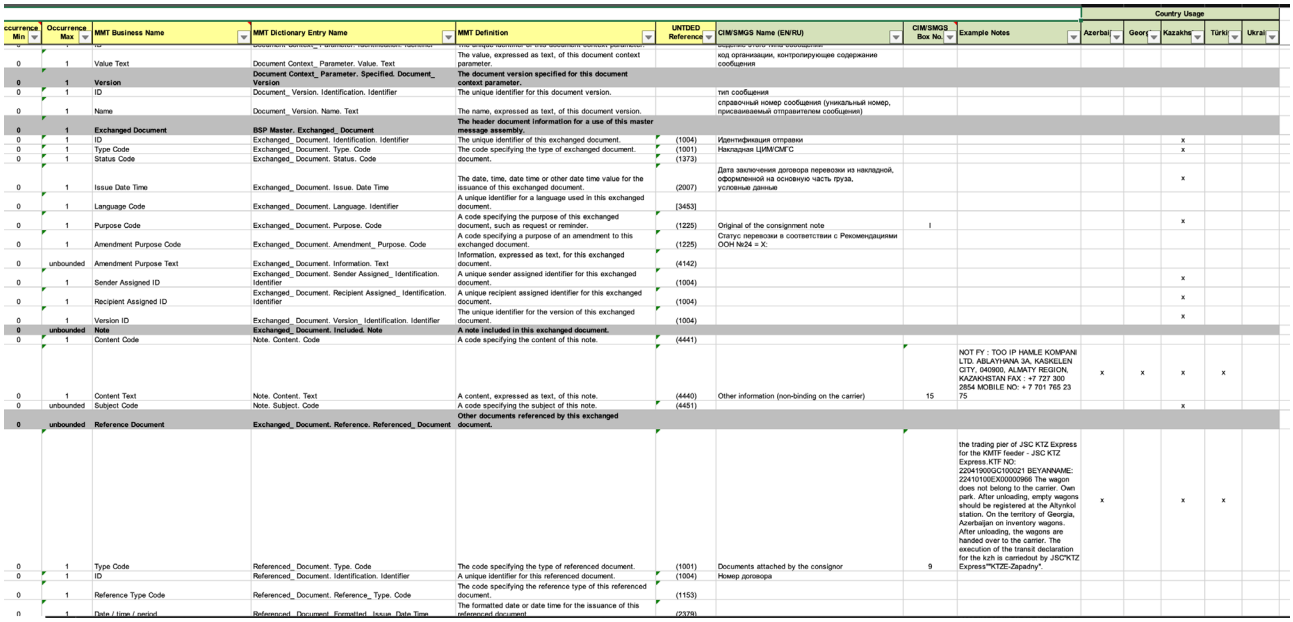
Snapshot example of an XML message for the CIM/XML consignment note



Source: Mr. Orkhan Namazov, ECE consultant.

Figure II

Guidelines for filling in the XML fields, in compliance with the UN/CEFACT standards, presented in a table



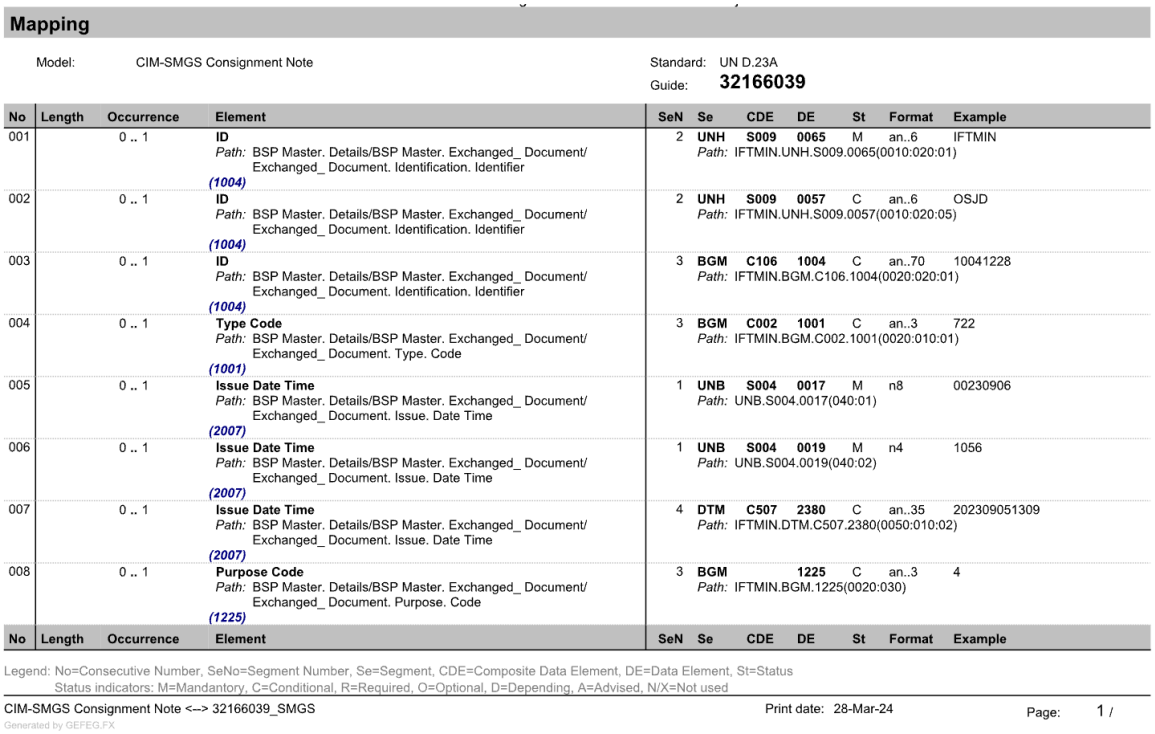
								Country Usage				
Occurrence Min	Occurrence Max	MMT Business Name	MMT Dictionary Entry Name	MMT Definition	UNTDED Reference	CIM/SMGS Name (EN/RU)	CIM/SMGS Box No.	Example Notes	Azerbai	Geor	Kazakhs	Türki	Ukrai
0	1	Value Text	Document Context_ Parameter. Value. Text	The value, expressed as text, of this document context parameter.		код организации, контролирующие содержание сообщения							
0	**1**	**Version**	**Document Context_ Parameter. Specified. Document_ Version**	**The document version specified for this document context parameter.**									
0	1	ID	Document_ Version. Identification. Identifier	The unique identifier for this document version.		тип сообщения							
0	1	Name	Document_ Version. Name. Text	The name, expressed as text, of this document version.		справочный номер сообщения (уникальный номер, присваиваемый отправителем сообщения)							
0	**1**	**Exchanged Document**	**BSP Master. Exchanged_ Document**	**The header document information for a use of this master message assembly.**									
0	1	ID	Exchanged_ Document. Identification. Identifier	The unique identifier of this exchanged document.	(1004)	Идентификация отправки					x		
0	1	Type Code	Exchanged_ Document. Type. Code	The code specifying the type of exchanged document.	(1001)	Накладная ЦИМ/СМГС					x		
0	1	Status Code	Exchanged_ Document. Status. Code	document.	(1373)								
0	1	Issue Date Time	Exchanged_ Document. Issue. Date Time	The date, time, date time or other date time value for the issuance of this exchanged document.	(2007)	Дата заключения договора перевозки из накладной, оформленной на основную часть груза, условные данные					x		
0	1	Language Code	Exchanged_ Document. Language. Identifier	A unique identifier for a language used in this exchanged document.	[3453]								
0	1	Purpose Code	Exchanged_ Document. Purpose. Code	A code specifying the purpose of this exchanged document, such as request or reminder.	(1225)	Original of the consignment note	I				x		
0	1	Amendment Purpose Code	Exchanged_ Document. Amendment_ Purpose. Code	A code specifying a purpose of an amendment to this exchanged document.	(1225)	Статус перевозки в соответствии с Рекомендациями ООН №24 = X;							
0	unbounded	Amendment Purpose Text	Exchanged_ Document. Information. Text	Information, expressed as text, for this exchanged document.	(4142)								
0	1	Sender Assigned ID	Exchanged_ Document. Sender Assigned_ Identification. Identifier	A unique sender assigned identifier for this exchanged document.	(1004)						x		
0	1	Recipient Assigned ID	Exchanged_ Document. Recipient Assigned_ Identification. Identifier	A unique recipient assigned identifier for this exchanged document.	(1004)						x		
0	1	Version ID	Exchanged_ Document. Version_ Identification. Identifier	The unique identifier for the version of this exchanged document.	(1004)						x		
0	**unbounded**	**Note**	**Exchanged_ Document. Included. Note**	**A note included in this exchanged document.**									
0	1	Content Code	Note. Content. Code	A code specifying the content of this note.	(4441)								
0	1	Content Text	Note. Content. Text	A content, expressed as text, of this note.	(4440)	Other information (non-binding on the carrier)	15	NOT FY : TOO IP HAMLE KOMPANI LTD. ABLAYHANA 3A, KASKELEN CITY, 040900, ALMATY REGION, KAZAKHSTAN FAX : +7 727 300 2854 MOBILE NO: + 7 701 765 23 75	x	x	x	x	
0	unbounded	Subject Code	Note. Subject. Code	A code specifying the subject of this note.	(4451)						x		
0	**unbounded**	**Reference Document**	**Exchanged_ Document. Reference. Referenced_ Document**	**Other documents referenced by this exchanged document.**									
0	1	Type Code	Referenced_ Document. Type. Code	The code specifying the type of referenced document.	(1001)	Documents attached by the consignor	9	the trading pier of JSC KTZ Express for the KMTF feeder - JSC KTZ Express.KTF NO: 22041900GC100021 BEYANNAME: 22410100EX00000966 The wagon does not belong to the carrier. Own park. After unloading, empty wagons should be registered at the Altynkol station. On the territory of Georgia, Azerbaijan on inventory wagons. After unloading, the wagons are handed over to the carrier. The execution of the transit declaration for the kzh is carriedout by JSC"KTZ Express""KTZE-Zapadny".	x		x	x	
0	1	ID	Referenced_ Document. Identification. Identifier	A unique identifier for this referenced document.	(1004)	Номер договора							
0	1	Reference Type Code	Referenced_ Document. Reference_ Type. Code	The code specifying the reference type of this referenced document.	(1153)								
0	1	Date / time / period	Referenced_ Document. Formatted_ Issue. Date Time	The formatted date or date time for the issuance of this referenced document.	(2379)								

Source: Mr. Orkhan Namazov, ECE consultant.

Under the UNECE-UN/CEFACT-TRACECA pilot project, the consultant prepared a mapping between the CIM/SMGS consignment note and the UN/EDIFACT IFTMIN message used for the SMGS in a number of countries in the region, based on the UN/CEFACT Multimodal Transport Reference Data Model (MMT RDM) as the common reference and foundation for interoperability. This mapping is meant to serve as a foundation for a converter between the widely used in the Eurasian space UN/EDIFACT messages (IFTMIN and other messages) and new Internet-based technologies, such as XML, JSON, APIs and blockchain. Further, mapping to the MMT RDM can serve as the basis for digital interoperability between many documents in the supply chain, including in multimodal transport.

Figure III

MMT RDM mapping between the CIM/SMGS consignment note and UN/EDIFACT message IFTMIN under the UNECE – UN/CEFACT – TRACECA pilot project



Mapping

Model: CIM-SMGS Consignment Note

Standard: UN D.23A
Guide: **32166039**

No	Length	Occurrence	Element	SeN	Se	CDE	DE	St	Format	Example
001		0 .. 1	**ID** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Identification. Identifier *(1004)*	2	**UNH**	**S009**	**0065**	M	an..6	IFTMIN *Path:* IFTMIN.UNH.S009.0065(0010:020:01)
002		0 .. 1	**ID** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Identification. Identifier *(1004)*	2	**UNH**	**S009**	**0057**	C	an..6	OSJD *Path:* IFTMIN.UNH.S009.0057(0010:020:05)
003		0 .. 1	**ID** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Identification. Identifier *(1004)*	3	**BGM**	**C106**	**1004**	C	an..70	10041228 *Path:* IFTMIN.BGM.C106.1004(0020:020:01)
004		0 .. 1	**Type Code** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Type. Code *(1001)*	3	**BGM**	**C002**	**1001**	C	an..3	722 *Path:* IFTMIN.BGM.C002.1001(0020:010:01)
005		0 .. 1	**Issue Date Time** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Issue. Date Time *(2007)*	1	**UNB**	**S004**	**0017**	M	n8	00230906 *Path:* UNB.S004.0017(040:01)
006		0 .. 1	**Issue Date Time** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Issue. Date Time *(2007)*	1	**UNB**	**S004**	**0019**	M	n4	1056 *Path:* UNB.S004.0019(040:02)
007		0 .. 1	**Issue Date Time** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Issue. Date Time *(2007)*	4	**DTM**	**C507**	**2380**	C	an..35	202309051309 *Path:* IFTMIN.DTM.C507.2380(0050:010:02)
008		0 .. 1	**Purpose Code** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Purpose. Code *(1225)*	3	**BGM**		**1225**	C	an..3	4 *Path:* IFTMIN.BGM.1225(0020:030)

Legend: No=Consecutive Number, SeNo=Segment Number, Se=Segment, CDE=Composite Data Element, DE=Data Element, St=Status
Status indicators: M=Mandantory, C=Conditional, R=Required, O=Optional, D=Depending, A=Advised, N/X=Not used

CIM-SMGS Consignment Note <--> 32166039_SMGS Print date: 28-Mar-24 Page: 1 /

Generated by GEFEG.FX

Source: Mr. Orkhan Namazov, ECE consultant.

3. *Lessons learned*

Among the achievements of the project were the development of a prototype of an electronic equivalent of the CIM/SMGS railway consignment note, in compliance with the global, UN/CEFACT standards and MMT RDM. The project resolved data mapping challenges for seamless integration between SMGS and CIM/SMGS, building on international and cross-institutional collaboration, refining the CIM/SMGS prototype with feedback from partners. The impact on multimodal transport is that the prototype supports future integration and interoperability of information exchange on cargo in multimodal transport, enabling efficient data sharing using global standards.

The next steps include extensive testing of the CIM/SMGS prototype and continued improvements, based on feedback. This would imply further customization of the standards and integration of the data in the prototype with national railway information technology systems, building converters between different solutions, using the UN/CEFACT standards as a common foundation.

Further steps would involve essentially multimodal pilot tests – involving seamless data exchange between the railway consignment notes and documents accompanying goods in other modes of transport. Implementers may explore integration of the data exchange into global supply chains.

One of the lessons learned from the project is the need for a legal basis for action on each stage of the pilot implementation project. The CIM/SMGS pilot project included a memorandum of agreement among the five railway operators in the five countries, expressly stating their willingness to participate in the pilot. Another necessary agreement would be on the functional implementation of the exchange of electronic datasets (electronic records) in place of the data exchanged in the consignment notes.

B. IRS Cargo - Integrating the Railway System – submitted by Austria

Keywords: interoperability, digitalized data exchange

1. Objective

The objective of the exploratory project is to develop a modular process chain to achieve interoperability of information communication technology systems in the rail sector, especially for the needs of combined and intermodal transport. The innovative approach of the project is to use reasonable methodological knowledge from other sectors and achieve faster results in the rail sector by exploiting synergies.

The further objective of the exploration is to prepare an research and development project, which allows for the first concrete implementation of the participatory approach with suitable project partners. Many stakeholders are involved in freight logistics, which leads to many insular solutions, system breaks and technology leaps, especially in IT systems. Accordingly, there is a demand for a consistent, transparent supply chain. This is also seen as a prerequisite for future competitiveness vis-à-vis the road.

The basis of the exploratory project is an established methodology from the health sector, where interoperability of different systems has been successfully implemented internationally for a long time. Manufacturers and users work together in a participatory process to ensure the interoperability of relevant ICT systems. The methodology can be used for any type of data exchange of ICT systems and therefore for other sectors. The exploratory project is now to analyse, adapt and transfer this methodology for the rail and logistics sector to the implementation of real use cases.

2. Application, benefits and costs

On-going project. Not applicable.

3. Lessons learned

On-going project. Not applicable.

C. ETRAN (Electronic Consignment Note) – submitted by Russian Federation

Keywords: interoperability, ETRAN, digitalized data exchange

1. Objective

ETRAN is an automated system for the preparation and execution of transportation documents for rail freight transportation by Russian Railways across the territory of the Russian Federation. The purpose of the ETRAN system is to use electronic document management to interact with users of railway transport services in the organization of cargo transportation. The functions of ETRAN are implemented in terms of preparation, execution and review of transportation documents, master planning, provision of contractual work and calculation of freight charges and transportation distances, technological and technical support using electronic signature tools at the workplaces of ETRAN users.

2. Application, benefits and costs

Advantages:

- The life cycle of documents takes place in the system in paperless form;
- Costs for the preparation and delivery of documents are reduced;
- Planning costs by pre-calculating the cost in the submitted application;
- Possible errors in the calculation of the freight charge are excluded;
- Independent execution and control of all shipping documents;

- Safe and comfortable user experience, regardless of the Client's location.

The main package of services of ETRAN is as follows:

- Submission of an application for the transportation of goods and control of fulfilment;
- Execution of all waybills for the transportation of goods;
- Control over the availability of funds on the Service User's Unified Account;
- Tracking of the entire shipment, including to the address of the user of transport services from the entire network of the Russian Federation;
- Payment for transportation for other shippers (forwarding);
- Electronic signature of the shipper's representative responsible for the placement and securing of the cargo;
- Tracking Projected Shipment Arrival Times;
- Registration of applications for the placement of rolling stock not involved in the transportation process on public tracks;
- Receipt of acts of services rendered, list of primary documents for acts of services rendered and invoices;
- Submission of applications for the diversion of wagons;
- Information service services;
- Calculation of freight charges.

The ETRAN system is the first centralised real-time document processing system at Russian Railways. When designing the architecture of the software and hardware complex of the system, the requirements of reliability and uninterrupted operation in the 7x24 mode were taken into account.

3. Lessons learned

To date, more than 40,000 users from 11,000 organisations have been connected to ETRAN, including 17,500 users from 8,000 client enterprises that are not divisions of Russian Railways.

During periods of maximum activity, there are up to 10 thousand concurrent users in the system. More than five million electronic documents are issued per month, including over 136 thousand applications and more than 1.6 million invoices.

To date, the full technological cycle of the formation of documents in accordance with the Rules of Cargo Transportation has been automated (application for the transportation of goods, transportation documents (consignment notes) of all types, including international ones, for departure on the basis of an application, credited documents upon arrival, etc.).

ETRAN is the only system that automates the entire process of sales of basic and related services and settlements with customers in the course of cargo transportation.

D. Electronic interaction with foreign carriers – submitted by Russian Federation

Keywords: interoperability, UN/EDIFACT, SMGS, CIM, consignment note, customs clearance

1. Objective

Russian Railways, in cooperation with foreign railways, implements projects for electronic interaction and information support of international rail freight transportation, aimed at exchanging data in the international standard UN/EDIFACT of traffic documents (SMGS, CIM/SMGS, train information) in real time for the transportation of export-import goods by rail.

Electronic interaction in international freight transportation is carried out on the basis of the concluded Agreements on Electronic Data Interchange (hereinafter referred to as the EDI Agreement).

Electronic data interchange facilitates border crossings by providing electronic information in advance about the cargo to be crossed.

2. *Application, benefits and costs*

At present, there are bilateral EDI Agreements between Russian Railways and the railway administrations of Azerbaijan, Belarus, China, Estonia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Mongolia, and Poland as well as a trilateral EDI Agreement between Russian Railways, DB (Germany) and DB CARGO Polska (Poland).

Russian Railways interacts electronically with the Federal Customs Service of the Russian Federation (hereinafter referred to as the FCS of Russia), including the following functionality:

- Preliminary informing of the customs authorities in electronic form about the cargo (goods) planned to cross the border, and electronic registration of the arrival of the cargo at the border station;
- Receipt of export declarations for exported goods and information from the transit declaration from the unified automated system of the Federal Customs Service of Russia;
- Completion of the customs procedure of customs transit on the territory of the Russian Federation in electronic form without delivery of paper documents to the customs authorities.

For export rail transportation, electronic marks are obtained from the customs authorities, confirming the export of goods from the territory of the Russian Federation for all international transportation. Russian Railways receives from the Federal Customs Service of Russia electronic analogues of the customs authorities' marks, indicating that goods have been placed under procedures that provide for their export outside the Eurasian Economic Union, for all export shipments, both on electronic consignment notes and on paper.

Russian Railways and the Federal Tax Service of the Russian Federation have organised data exchange to enable the tax authorities to submit to the tax authorities the information on the railway consignment notes required to confirm the 0 per cent VAT rate in electronic form.

3. *Lessons learned*

In terms of implementing informational interaction for import transportation, the system has been designed to provide preliminary information about planned shipments, handle notifications to customs authorities for registering the arrival of goods at the border station and the destination station. The customs transit procedure is completed electronically, eliminating the need to deliver paper documents to customs authorities after the goods arrive at the destination station.

The introduction of electronic interaction has reduced costs for railway carriers involved in international cargo transport, decreased the workload on railway and customs personnel for customs control and clearance, and created favourable conditions for participants in foreign economic activity.

Electronic Document Exchange enables the creation of a unified informational space within the railway network and provides tools for electronic document flow with foreign railways, partners, clients using railway transport services, and, importantly, with government and regulatory bodies.

E. Port-rail interaction – submitted by Russian Federation

Keywords: interoperability

1. *Objective*

On an ongoing basis, work is underway to involve marine terminal operators in information interaction within the framework of the "road-port" and "port-to-road" technology in terms of the formation of an automated plan for the supply of trains.

2. *Application, benefits and costs*

At the first stage of the implementation of the technology, the interaction of the automated system of Russian Railways with the automated systems of marine terminal operators was organized. As part of this stage, work was carried out with the largest terminals that have their own automated control systems.

The second stage is to provide user access to the interface of ETRAN for terminals that do not have their own automated control system for 22 terminals on the Far Eastern Railway, and two terminals with the North Caucasus Railway.

3. *Lessons learned*

Automated systems for interaction between seaports and federal executive authorities facilitate electronic communication among all participants in the process of customs clearance for goods and vehicles at maritime entry points. The goal is to create favourable conditions for accelerating trade through the customs border of the Eurasian Economic Union, reducing the time required for customs operations, and enhancing the effectiveness of customs control.

F. INTERTRAN – submitted by the Russian Federation

Keywords: interoperability, INTERTRAN, custom clearance, digitalized data exchange

1. *Objective*

The INTERTRAN project was initiated by Russian Railways in 2018. FESCO Transportation Group became a partner in the project. It has received the support of key international organizations - the EEC ITC and UNESCAP, OSJD, UIC, CCTT, FIATA.

INTERTRAN is a comprehensive project for the implementation of intermodal transportation with the issuance of electronic documents, in which the operator of the sea line, the carrier represented by Russian Railways, customs authorities, shippers and consignees take part.

The created INTERTRAN information technology contains specifications for processing the operations of transportation participants in its information systems, which form a single information environment for each transportation.

2. *Application, benefits and costs*

INTERTRAN is the first information technology in history that enables intermodal transport in a fully digital format.

The technology developed within the framework of INTERTRAN to close the customs procedure of customs transit in electronic form at the destination station is currently used at all Russian Railways stations working with containers. Application, benefits and costs

The introduction of INTERTRAN has contributed to the development of all import transport under the VTT regime. According to the technology, 95 per cent of import cargoes are cleared in the VTT mode through the port of VMTP. 50 per cent of the total volume of shipments processed via VTT through the port of VMTP using the INTERTRAN technology.

3. Lessons learned

The results of the analysis of transportation showed that the implementation of digital technologies and automation of operations for the execution of documents within the framework of the INTERTRAN project at all stages of intermodal transportation made it possible to reduce the total time of cargo clearance by 4 days due to the transfer of applications to electronic form, the introduction of mobile workplaces for acceptance agents and tallymen in the port, electronic interaction with customs authorities, as well as by reducing unproductive losses related to the movement of employees for the execution of customs, transportation documents and primary documentation, both at the port and at the destination station.

As a result, a modern information and logistics service has been formed, which makes it possible to accompany the transportation of a container of any freight forwarder or operator with electronic data along the entire route, to provide the necessary electronic information not only to interested parties, but also to state regulatory authorities.

IV. Other Solutions and Case Studies

A. Human-centric approach – submitted by the Russian Federation

Keywords: human resources, human-centric, retraining, upskilling

1. Objective

In order to improve the qualifications and retraining of personnel, Russian Railways established the Centre for the Organisation of Training and Development of Workers. The Centre develops retraining programmes for workers in professions related to the operation of automated systems, based on professional standards, and programmes for the acquisition of new professional competencies, based on professional competence models and standard staff positions for employees of Russian Railways' branches and business units.

2. Application, benefits and costs

The following training programmes have been developed and are being implemented:

- "The main program of professional training is a retraining program in the profession of "machinist-operator";
- Training program for the acquisition of new professional competencies for employees of the Traction Directorate "Driving trains using the Virtual Coupling technology";
- Training program for the acquisition of new professional competencies for employees of the Traction Directorate "Locomotive Management, Train Driving and Diesel Locomotive Maintenance" (for work without an assistant driver);
- Each training and retraining program contains a section on the study of new equipment and technologies, which provides for the study of new means of labour, and for repair personnel, the introduction of new objects of labour;
- When implementing simulator training for locomotive and multiple-unit rolling stock drivers, the procedure for operating automatic guidance and resource saving systems is studied;
- Vocational qualification training centres have organised training for personnel in connection with technological violations and the identification of competencies that require development in accordance with the procedure established by Russian Railways, as well as under programmes for the acquisition of new professional competencies, including in connection with the introduction of new equipment and technologies.

3. Lessons learned

Ongoing. Not applicable.

B. Study: Job profiles and opportunities for employment in an automated and digitalised Austrian mobility sector 2040 – Submitted by Austria

Keywords: human resources, human-centric, retraining, upskilling

1. Objective

Against the background of increasing automation and digitalization, this study looked at the emerging and coming changes in the job profiles relevant to the Austrian mobility sector up to the year 2040, as well as the resulting opportunities and risks for employment and quality of work. The study aims at increasing automation and digitalization in the mobility sector, in particular at emerging and upcoming changes in the job profiles relevant to the mobility sector by 2040, as well as the resulting opportunities and risks for employment. It fills a (still) existing gap in knowledge, as there have been hardly any studies on the subject of employment effects in an increasingly digitalized and automated mobility sector. For the analysis, three scenarios ("Forward 2040", "Local Life", "Digital Divide") were developed with a time horizon of 2040, which were discussed and evaluated with a wide range of stakeholders from all modes of transport as well as freight and passenger transport. The discussion and evaluation of the three partly contradictory scenarios illustrated many parallels between the scenarios, so that a cross-scenario overall picture could be drawn for the future of employment, job profiles, skills, quality of work and gender in the mobility sector. From these findings, concrete areas of action for politics and interest groups (mobility and transport policy, RTI policy, labor market and social policy, education policy) as well as for companies were derived.

2. Application, benefits and costs

The studies "Job profiles" and "SozA" are finished and have been used as input for other R&I-projects as well as national roadmaps and strategies but also for discussion with the public and specific groups, which have been addressed in the studies. There are no further activities planned.

3. Lessons learned

Both studies "Job profiles" and "SozA" gave an excellent overview about challenges, hurdles and necessary actions. However, based on the results and the high dynamic behind the evolvement of the technology, it would have been necessary to update the results on a regular base (e.g. every year). This seems not efficient as it is still not clear how automated transport will look like. Much more it makes sense to start with the evaluation on an European level to enable a comparison of results an data instead on focussing on national levels. In this respect Austria is actively participating within the CCAM-Partnership, the SRG (States Representative Group), the HLD (High Level Dialogue on Connected and Automated Driving) to discuss the impact on employment on a European level.

C. SozA – Social and organisational effects of increasing automation in the Austrian freight transport system – submitted by Austria

Keywords: human-centric

1. Objective

This R&D service systematically considers the social and organisational effects of increasing automation on freight transport and transport logistics. In particular, the effects of automation on road and rail freight transport were estimated on the basis of various scenarios up to 2045 in order to identify barriers and enablers and derive RTI and transport policy measures.

Automated driving and semi-automated systems are successively brought to market by manufacturers and used by users. Studies on the social and organisational effects of increasing automation on freight transport and transport logistics from a systemic perspective are still largely absent. In particular, the effects of automation on road and rail freight transport and the distribution of transport performance between these two modes of transport are to be determined in the course of R&D services. For this reason, different automation scenarios were formulated up to 2045, the social and traffic-organisational effects of which were presented and, based on these, RTI and transport policy measures derived, which on the one hand ensure and strengthen the positive effects and on the other hand reduce the negative effects identified.

The analyses were based on the survey of the technological, legal, organisational and social framework conditions in the form of expert interviews and an in-depth literature analysis. The evaluation of the degree and future development of automation was based on the transport chain components: - internal logistics, - the preliminary run (by truck), - the main leg (by rail, inland waterway or truck), - the on-carriage (by truck or rail), - distribution and - any special cases.

2. *Application, benefits and costs*

The studies “Job profiles” and “SozA” are finished and have been used as input for other R&I-projects as well as national roadmaps and strategies but also for discussion with the public and specific groups, which have been addressed in the studies. There are no further activities planned.

3. *Lessons learned*

The impact analysis regarding the expected change in transport costs, transport time and transport quality due to different automation tendencies in the individual components of the transport chain shows that, on the one hand, automation will develop at different speeds per component and, on the other hand, the effects to be achieved per component may vary. Because of the impact analysis it was noted that:

Transports for which high quality (transport safety, punctuality) is of great importance will have better rail options to choose from in the future. This can lead to a modal shift to the rail if there are corresponding rail offers for the required routes,

for time-sensitive transports, for which the shortest possible transport time is relevant, hardly any changes can be expected due to automation and therefore hardly any modal shift is to be expected and

in the short term, cost-intensive transports are likely to shift to road transport or possible combined transport, but cost reductions are to be expected in the relatively expensive rail single wagonload and combined transport sectors in the long term and thus there will be increased demand for rail services in this area (insofar as they still exist in single wagonload traffic).

Both studies “Job profiles” and “SozA” gave an excellent overview about challenges, hurdles and necessary actions. However, based on the results and the high dynamic behind the evolvement of the technology, it would have been necessary to update the results on a regular base (e.g. every year). This seems not efficient as it is still not clear how automated transport will look like. Much more it makes sense to start with the evaluation on an European level to enable a comparison of results an data instead on focussing on national levels. In this respect Austria is actively participating within the CCAM-Partnership, the SRG (States Representative Group), the HLD (High Level Dialogue on Connected and Automated Driving) to discuss the impact on employment on a European level.

D. Test track Digitrans (Test track for autonomous driving in St. Valentin) – submitted by Austria

Keywords: autonomous driving, Digitrans

1. Objective

The Austrian Test environment Digitrans enables testing of automated driving functions under various infrastructural conditions. The focus is on automated and autonomous vehicles and mobility systems in the field of municipal services, logistics and heavy goods traffic.

2. Application, benefits and costs

The classic test elements of the already existing proving ground, such as asphalt tracks with different road markings, bad road tracks, twisting tracks, off-road terrain, different gradients and circular tracks will be expanded by 2023 to include further important ODD elements and the necessary digital infrastructure (C-ITS / 5G). In total, around seven zones for testing autonomous vehicles and transport vehicles in the heart of Europe will be available on the autonomous driving proving ground in St. Valentin by 2023.

In total over 6 million Euro have been invested for the development of a city zone, an outdoor raining facility, digital infrastructure as well as components for simulation and validation. The test track is used by OEMs, R&I-institutes, startups from all over the world to test their applications. Especially the outdoor raining facility is in its specification unique and hence attractive for companies to test their advanced driver assistance systems as well as highly automated vehicles. Additionally, the test track can be used for human-machine-interaction trainings and teleoperation.

3. Lessons learned

Test environments are crucial for the further development of automated freight mobility solutions. Technology is still not ready yet and has to be further improved. It's not possible to cover any situation with one test track as technology is evolving fast. Hence test tracks have to be evaluated every year if changes are necessary and if the facilities meet the requirements. The most critical part is data management as the results have to be interoperable being used by different test tracks not only in one country but over the world and by including all different stakeholders. This might be the most challenging task. Beside that the involvement of the infrastructure operator (e.g. road operator) is crucial for the development and deployment of automated trucks.

E. Endowed University Profesorship on Sustainable Transportation Logistics 4.0 – Submitted by Austria

Keywords: Intelligent transport systems

1. Objective

The Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology supports since 2018 a university professorship on Sustainable Transportation Logistics 4.0 (with focus on Intelligent Transport Systems) at the Institute of Production and Logistics Management (PLM) of the Johannes Kepler University Linz. The institute is researching the implementation of systems based on the exchange of data between vehicles, infrastructure and people, using digital technologies that are based on the use of sensors from information and communication technologies. Research is also done on the interaction between the elements of the networked system within the framework of the "Physical Internet" and the "Internet of Things" by also taking human behaviour into account.

2. Application, benefits and costs

Not applicable.

3. Lessons learned

Not applicable.

F. Technology WaggonTracker and Smart freight train – submitted by Austria

Keywords: Waggon tracker, smart freight train

1. Objective

WaggonTracker is an overall digital system that fulfills a variety of monitoring functions and automated processes. Using sophisticated measurement technology, WaggonTracker determines important information about freight transport in real time. The large number of functionalities is guaranteed by the wheel hub generator, which has a much higher energy potential than a battery solution whose functional life is only around six to seven years. In addition, complex manual processes such as brake testing or load weight monitoring are completely automated. These process optimizations create cost and time savings for railway companies. WaggonTracker is patented and developed in Austria. Series production started around two years ago. Over 2,500 WaggonTracker systems are already in use by international customers, such as SBB Cargo, Mercitalia, Lenzing and RCG.

Mercitalia Intermodal and the Austrian company PJM initiated a smart rail freight train and won the Austrian Mobility Award of VCÖ. The pilot train shows that digital technologies can be integrated into everyday life on the rails. Getting more freight transport onto the rails is central to achieving the climate targets. To achieve this, it is also important that rail freight transport becomes more efficient. One solution is to speed up processes through increased digitalisation, as demonstrated by the “Digital Rail Transport” project of the Graz-based company PJ Monitoring. A pilot train was fully digitally equipped, from automated brake testing to ongoing monitoring. This results in shorter turnaround times and faster delivery times, reduces wear and tear and thus maintenance work, and the monitoring gives the workshop information on the problem in advance, which in turn speeds up repairs. The integrated in-train communication is capable of transmitting data to the train driver in case of derailment, incorrect braking conditions, brake overloads, hot box warnings, trestle monitoring and any other safety-related and technical relevant problems.

2. Application, benefits and costs

Not applicable.

3. Lessons learned

Not applicable.