

TGPS+ TRACKING OF FREIGHT FLOWS, TRAIN MOVEMENTS AND RECORDS IN RAIL FREIGHT TRANSPORT

Zoran STOŠIĆ¹
Jovan STOŠIĆ²
Života ĐORĐEVIĆ³

Abstract – Rail freight transport is an efficient and environmentally favourable mode for moving large and heavy consignments over long distances. It includes wagonload, block-train, combined and intermodal transport, as well as dangerous, exceptional and oversized consignments. Although GPS systems are commonly used for train positioning, location data are often not integrated with the operational records maintained by railway undertakings. TrainGPS+ (TGPS+) is a multilingual enterprise system that links train and freight data with real-time telemetry, enabling tracking, operational control and generation of statistical reports.

Keywords – freight, GPS, tracking, reports, records.

1. INTRODUCTION

Railway undertakings and transport organizers require real-time information on freight movement and status at border, departure and intermediate operating points. TGPS+ addresses this need by linking the train consist with satellite tracking through the locomotive, providing current status data and a basis for reporting and operational control. Each train consist is identified by a unique Transport Consignment Number (TBP), which remains unchanged along the route regardless of train number, station operations, locomotive changes or crew changes. Wagons and freight are linked to the TBP through the train list/S-3 document and to movement data through the locomotive. This enables continuous positioning of wagons and freight, freight-flow monitoring and movement history.

2. TGPS + SYSTEM



Fig. 1. Architecture and main functionalities of the TGPS Plus system

Train GPS+ (TGPS+) is a multilingual enterprise system for real-time telemetry and tracking of trains and freight. Its main components are:

- TGPS+ Server Frontend: central data hub for dispatchers, observers and controllers according to carrier procedures.
- TGPS+ Server Backend: CMS for managing users, permissions, routes, personnel, locomotives and wagons.
- TGPS+ Android application: used by drivers to report train activities, enter S-1 explanations and automatically transmit location.
- TGPS+ Station Android application: used by station staff to prepare and update train lists.

2.1. TGPS+ Server (Website/Web) Backend

Opening the TGPS+ Server link displays the administration screen and menu shown in Fig. 1.

¹ RAILIMPEX d.o.o, Balkanska Dimitrovgrad stosiczoran@yahoo.com

² QA Engineer, Software Quality Control j.stoske@gmail.com

³ Despotija d.o.o., Rolling Stock Advisor, Serbia zivota.tks@gmail.com

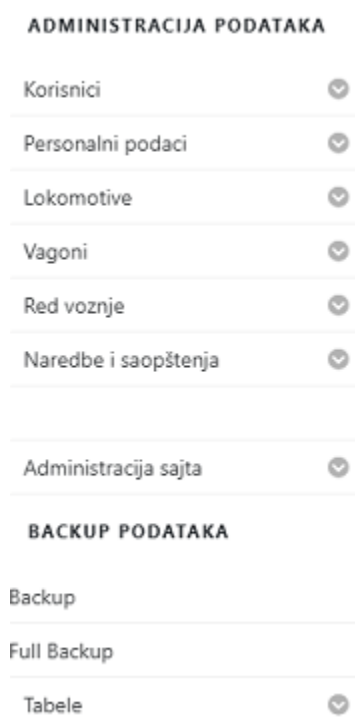


Fig. 2. TGPS+ Server administration menu

In addition, the server database contains data on stations, line numbers, station chainage, GPS coordinates and polygons defining station areas, based on working timetable documents and the infrastructure manager network statement, together with a rule table used for working-time calculation.

These data are prerequisites for operation of the system.

2.2. TGPS + Server (Website/Web) Frontend

The menu of this part of the system contains the options shown in Fig. 3.

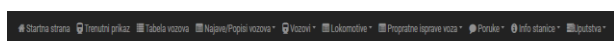


Fig. 3. Main navigation menu of the TGPS Plus web application

The most important option is the train announcements/train lists submenu, particularly the New announcement/list function.

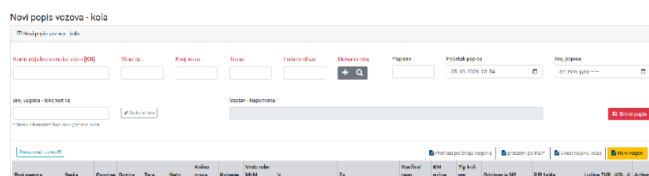


Fig. 4. Interface for creating a new train composition in the TGPS Plus web application

In the form shown in Fig. 3, the train announcement received from the transport organizer or CIT-23 is entered together with the TBP, receiving or train-forming station, train number and locomotive

data, if known when the train list is created.

Train-consist data can be imported from predefined XLS tables for a standard consist, a container train or an individual wagon, including data on freight, wagons and containers.

For larger transport operations, an electronic CIT-23 received from the transport organizer can also be imported directly into the train list.

Documents accompanying the train can also be uploaded to the server as image, PDF, DOC or other supported file formats.

After the train list is saved, the system automatically generates the S-3 train consignment document, the S-4 train composition and braking report, K-200 and KOL-65. If wagons are added or removed, or a brake is isolated, saving the change automatically updates all generated S-3, S-4, K-200 and KOL-65 documents.

The S-4 document is generated so that the braking-type field is selected according to the train mass.

ИЗВЕШТАЈ О СASTABУ И КОЧЕЊУ ВОЗА				
За воз бр. 40873		од 04.10.2026 18:38		
1.	Маса воза:	1066.9+120 = 1186.9 t		
2.	Број осовина:	15 kola / 60 осовине	Дужина воза 210.6 m	
3.	Врста кочења воза	P 40 [%]		
	P (RIC) R	G	P+G	РУЧНО
	ваздушно брзим дејством	ваздушно спорим дејством	ваздушно мешовитим дејством	
4.	Количина кола са	коч. пачуцама од композит. матер.	(K) (LL) (L)	15
5.	Стање кочних маса	ПКМ 475	СКМ 787.5+787	
6.	Положај менаџа кочног возила	(G) P R		
7.	Употреба пачуца	ДА НЕ		
8.	Где су укривљена кола товарена дугачким предметима спојена кљачилом			
9.	Где су укривљена кола товарена оквирним теретом			

ПРИМЕДБА:

Fig. 5. Example of a train composition and braking report generated by the TGPS Plus system

If the train list is generated by the dispatcher and the locomotive and train number are known, once the locomotive is assigned and the Android application is started, the driver immediately receives the train number and TBP and the system links them.

If the locomotive is already crewed but the train list has not yet been created, entering the train number causes the system to assign a temporary TBP in the format PNNNN and reserve an entry that can later be completed.

2.3. TGPS+ Android Application

The application is installed on the locomotive tablet and is used to transmit current movement parameters. It sends the following data to the server:

- Geographic location;
- Train position;
- Time;
- Speed;

- Train activities and explanations for intermediate delays.

In addition, when linked to the locomotive, the application enables:

- Recording of locomotive handover, takeover and crew changes;
- Transfer of locomotive mileage and fuel quantities at takeover, handover and refuelling;
- Activation of an alarm to the driver by the dispatcher or sending a message to the dispatcher;
- Supervision of locomotive and crew operation by authorized observers through the web interface.

The two basic application screens are shown below.

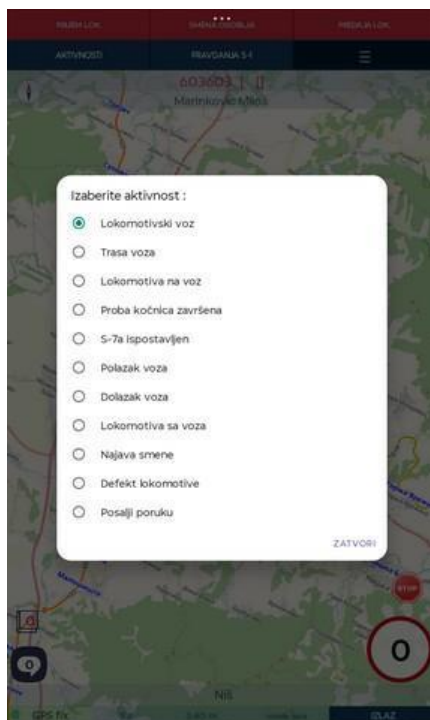


Fig. 6. Activity selection interface in the TGPS Plus mobile application

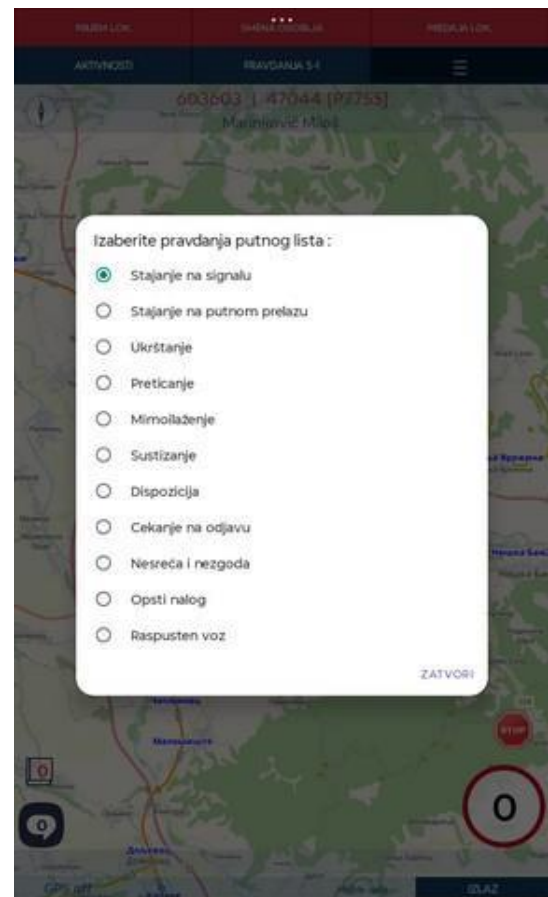


Fig. 7. Interface for selecting the reason for travel order justification in the TGPS Plus mobile application

By selecting and confirming an option, the information is sent to the TGPS+ server without any additional text entry. This reduces driver interaction with the device and allows attention to remain focused primarily on driving and traffic operations.

2.4. TGPS+ Station Android Application

The TGPS+ Station application is intended for station staff responsible for preparing train lists. In accordance with the railway undertaking procedures, the staff member can prepare a list while forming a train consist or modify a previously prepared list using the individual-wagon form.

Fig. 8. Wagon data entry interface

The entered data are immediately transferred to the server and the current status is updated.

3. SYSTEM NOTES

Communication between system components is interactive and bidirectional.

If the internet connection to the server is interrupted, data are stored locally on the tablet or phone and transmitted when the connection is restored.

Administration and reporting are handled through the CMS panel, including automatic e-mail notifications and urgent SMS alarms.

Required equipment includes one 8–10 inch Android 14–15 tablet with a SIM slot per locomotive, plus a leased domain and web server.

Mobile printers may additionally be used to print S-3 and S-4 documents at locations without carrier offices.

4. OUTPUT REPORTS AND SYSTEM RECORDS

- Attachments to the S-1 journey form: S-3 and S-4
- K-200 and KOL-65
- Crew working time with graphical presentation by day and period
- Locomotive mileage with graphical presentation by day and period
- Diesel-locomotive refuelling and fuel status at takeover and handover
- Tabular and graphical train-movement tracking
- Tabular and graphical train-stop tracking
- Train-speed XY diagram
- Routes-used report
- Gross tonne-kilometre report
- Freight-flow tracking by commodity and route
- Wagon-movement overview
- Monitoring of technological operations at stations
- Tracking of dangerous goods (RID), exceptional

consignments and wagon defects through additional fields in the train list and S-3 document, including approval numbers and AVV/GCU Appendix 9 defect codes.

5. CONCLUSION

By linking freight, wagons, trains and locomotives in real time, TGPS+ enables rapid information exchange, tracking and operational control with timely intervention.

Movement data and train documents are archived electronically on the web server and can be accessed remotely.

The system can exchange data electronically with other railway undertakings and transport organizers using agreed protocols.

It also supports direct communication between locomotive crews and dispatchers or other authorized staff.

Human error is reduced by checking personnel prerequisites and automatically setting expired qualifications or conditions to inactive status.

Automatic e-mail notifications and urgent SMS alarms enable fast transmission of important information.

Monitoring the duration of technological operations at departure and intermediate stations helps identify recurring delays and locations requiring corrective action.

Train-speed diagrams and explanations for stops or passage over malfunctioning level crossings help detect irregularities and support timely action to improve traffic safety.

The system is aligned with:

- Railway Directorate secondary legislation;
- the General Contract of Use for Wagons (GCU/AVV);
- CIT (International Rail Transport Committee);
- the COTIF Convention and CIM consignment note;
- RID regulations for dangerous goods by rail.

This ensures conformity with the relevant railway regulatory framework.

A planned wagon-inspector module will further complete the system from traffic and technical perspectives.

TGPS+ is expected to improve carrier efficiency, reduce operating costs and raise service quality with relatively low initial investment. With carrier-specific adaptation, it provides a practical solution focused on freight as the core revenue-generating element of rail freight transport.