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1. Executive Summary

The objective of the Translate4Rail project is to eradicate language barriers enabling any driver to continue to drive safely in foreign countries while not speaking the official language of the infrastructure manager. The project develops a simple and effective solution that will be proven in field tests.

A developed prototype of the language tool can then be further enhanced to be implemented that enables the train driver and the traffic controller to communicate with each other, allowing each to speak in his/her native language. The tool will aid in achieving the goals of maintaining a high level of safety, increasing traffic flow in international operations, and reducing educational cost of the train drivers, thereby elevating the competitiveness of the rail sector. Offering train drivers and traffic controllers such a tool opens the possibility to effective communication during international traffic movements without fulfilling the required driver language competence.

This deliverable addresses the general requirements for functional and technical specifications of future language tools, based on the Translate4Rail concept solutions.







2. Abbreviations and acronyms

Abbreviation / Acronyms	Description
Consortium	RNE and UIC
ERA	European Union Agency for Railways
ERFA	European Rail Freight Association
FRMCS	Future Railway Mobile Communication System
GDPR	General Data Policy Regulation
GSM-R	Global System for Mobile Communication - Railway
IM	Infrastructure Manager
ITC	IT Company
LP	Language Programme; the dedicated RNE work structure
LT	Language Tool
MVP	Minimal Viable Product
NSA	National Safety Authority
PDM(s)	Predefined message(s)
Pilot	The phase of the preparation, testing and upgrading of the LT
RNE	RailNetEurope
RU	Railway Undertaking
S2T	Speech-to-text
TD	Train Driver
T2S	Text-to-speech
T4R	Translate4Rail
UIC	Union Internationale des Chemins de Fer







3. Background

The present document constitutes the Deliverable D1.3 "Tool Requirements" in the framework of the T4R project.

This subtask of the T4R project defines the main functional and technical specifications/requirements for the language tool(s), which will be made available to the RU and IM community.







4. Objective/Aim

This document provides the basis for a Minimal Viable Product (MVP) for subsequent language tool development. It also presents the fundamental requirements' covering necessary aspects, such as:

- LT General requirements and development phase;
- LT basic functionality;
- LT connectivity;
- LT speech recognition, translation engine and output voice;
- LT messages, the usage of PDMs;
- LT for potential Pilot testing;
- Safety, security and GDPR.







5. Definition

The following definitions relate to a Language Tool prototype preparation:

- **Controller** An individual responsible for the conduct of some aspect of train operations (also known as a dispatcher). For the purposes of this specification the following functional roles of controllers are defined:
 - primary controller;
 - secondary controller;
 - traffic controller;
 - power supply controller.

Dependent upon local conditions, a number of functional roles can be carried out by a single controller, or a single functional role can be carried out by a number of controllers.

Group call A call made to all members of a pre-defined group within a local geographical area. Only one member of the group may talk at any instant with all other group members only in listening mode.

Infrastructure manager¹

Means any body or firm responsible for the operation, maintenance and renewal of railway infrastructure on a network, as well as responsible for participating in its development as determined by the Member State within the framework of its general policy on development and financing of infrastructure.

ITC Information Technologies Company.

Operational communications

These are railway communications directly concerned with train movements or train operation. For example, controller-driver communications.

Primary controller

The location and direction of movement of any particular train permit the unique identification of a Primary Controller. The Primary Controller is the current coordinator of train emergency calls. The Primary Controller is usually responsible for the operation of a designated area of the track. The exact responsibilities of the Primary Controller are determined on a national basis.

Railway emergency call

¹ DIRECTIVE 2016/2370/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 14 December 2016 amending Directive 2012/34/EU as regards the opening of the market for domestic passenger transport services by rail and the governance of the railway infrastructure







This is a call of the highest priority warning drivers, controllers and other concerned personnel of a dangerous situation in a pre-defined area. Two types of Railway emergency calls are defined:

- Train emergency calls (for Railway emergencies while not involved in Shunting operations);
- Shunting emergency calls (for Railway emergencies whilst involved in Shunting operations).

Railway undertaking²

Means any public or private undertaking licensed according to this Directive, the principal business of which is to provide services for the transport of goods and/or passengers by rail with a requirement that the undertaking ensure traction; this also includes undertakings which provide traction only.

Traffic controller³

As staff of an infrastructure manager, a traffic controller undertakes the task of authorising the movement of trains by documentation and communication.

- **Train driver**⁴ Means a person capable and authorised to drive trains, including locomotives, shunting locomotives, work trains, maintenance railway vehicles or trains for the carriage of passengers or goods by rail in an autonomous, responsible and safe manner.
- **User** For the purpose of this document, the "User" is a common designation for train driver and controller.

² DIRECTIVE 2012/34/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 November 2012 establishing a single European railway area

³ COMMISSION IMPLEMENTING REGULATION (EU) 2019/773 of 16 May 2019 on the technical specification for interoperability relating to the operation and traffic management subsystem of the rail system within the European Union and repealing Decision 2012/757/EU

⁴ DIRECTIVE 2007/59/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2007 on the certification of train drivers operating locomotives and trains on the railway system in the Community







6. Requirements for a Language Tool

The basis to define requirements for the Language Tool is the concept solutions covered by the T4R project (Starting concept and Basic concept), which in its prototype version, was developed as a tablet solution according to the requirements of having the MVP. Nevertheless, the tool usability was verified through pilot testing in specific phases. For the T4R field tests, train drivers with the language skills at the level of B1 for the language of the IM, are being considered. (Details are stated in the deliverable D2.1 Guidelines for implementation and description of the pilots.) For language pilots train drivers with language skills lower than level B1 (for the language of the targeted IM), the procedure of Directive 2007/59/EC should be followed.

To define the requirements of the language tool, the communication principles are recommended to be described in the following by using:

- PDMs;
- PDMs and so-called variables (figures and names of railway infrastructure parts);
- free speech not matching to any PDMs.

The defined essential groups of the requirements should be the basis for any call for tender for the tool's potential developer. The general proposal for the call for tender and evaluation criteria is set forth in chapter 7.

6.1. The T4R Concept approach

This chapter describes the conditions defined for the Translate4Rail Concept Solution. It includes the required approach and success criteria, which provide the definition of minimum standards to be followed for any future development.

The T4R concept architecture concentrates on the requirements of an MVP (minimum viable product) for such a Pilot, with the following priorities:

- Integration of essential functions for a Language Tool (functional experience);
- Easy integration into existing IM infrastructure and operational rules (easy of use);
- Cost effective development and maintenance, providing added value for the Pilot (probability of cost management).

The overall concept of the translation is based on a module approach where the communication runs through three modules. The first one is the speech to text module transforming the user speech to text format for further process of translation.

The text as an output from this module continues into the second module, which ensures the text translation. There are several possibilities of the translation starting with sentence paring in the







case of PDMs. Another way is to combine the PDMs with free speech and the last one is the free speech translation including the railway jargon.

Such a translated text is proceeding to the module for transformation of the translated text into speech. This part is closing the translation loop and providing audio output to USB-C tablet interface.

The overall process is presented on the following figure with highlighted modules:



Figure 1: Language Tool Modules

The example of the translation in Module 2 is presented in Figure 1 where the combination of pairing and free speech translation is combined to tackle the kilometre value and railway station name. These two elements represent the case when PDMs contain parts which can change. For such a case, the "pairing module" selects the matched predefined message and the "free speech translation tool" handles translating "the variable" part of the message. (explained in the *Example PDMs* below and Figure 2).

Example

PDM about identification and exact location (PDMs are not every time translated word-by-word, but also cover the way how they are communicated based on the rules of the concerned IM)

English / Italian / AT-German

This is train <train_number> between stations <station_name> and <station_name> at kilometer <km>

Qui agente di condotta del treno <train_number> tra le stazioni di <station_name> e







<station_name> al chilometro <km>

Zug <train_number> zwischen den Bahnhöfen <station_name> und <station_name> in Kilometer <km>



Figure 2: PDM scheme

The Translate4Rail Concept Solution uses a tablet as a key device to support the translation issue:



Figure 3: Voice-Local Tablet Translation

The T4R Concept covers communication between two users via the GSM-R network. This system was chosen as the most appropriate one following the ERTMS implementation in Europe. The use of GSM-R ensures the smooth language tool implementation over Europe without special adaptation to national legacy communication systems. Connection of the tablet to audio outputs of the GSM-R equipment doesn't need a special adaptation of the currently used GSM-R equipment. Such a connection enables the tablet to receive and send an audio signal via its USB-C interface. The translation application is communicating with this interface. Such an equipment is providing the full required translation functionality working with PDMs and free speech. Basically, both parties, a train driver and a traffic controller, can pre-select the destination language on their tablets and orally dictate PDMs into the tablet, for example via a goose-neck microphone. The user may then check the displayed transcript in his own language, and then press the button to let the tablet work with the message translating it and presenting via speech in a neutral voice.

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Figure 4: T4R LT User interface

As the tablet is not integrated into the on-board communications system, the train driver/traffic controller must handle tablet functions together with the call setup and find a suitable way to allow the voice from the tablet to be picked up by the microphone of the cab-radio/signaller console. The noise level in the cabin may be low enough for the tablet to be placed in a holder so that the voice output is still received by the cab-radio, or some special audio output equipment from the tablet. Everything should be arranged/integrated with the cab-radios microphone to couple the voice transmission well enough.

A similar procedure is also required on the part of the controller, as communication is possible in both directions.







To simplify the expected solutions, the following schemes show the principles of the "Tablet solution" prototype:



Figure 5: T4R concepts scheme

Concept approach

• To keep the safety level and reach the required functionality;







- Speech recognition;
- Gradual development with requested reliability;
- Starting concept at the beginning reaching the requested quality level;
- Basic concept continues as a target solution;
- Further development of the Language Tool (based on the Translate4Rail concepts) can be oriented to the solution of having a Language Tool application installed locally on devices of a traffic controller (IM side) and a train driver (RU side).

Concept approach criteria

- Safety;
- GDPR;
- Agility;
- Cost;
- Translation Latency;
- Acceptability;
- Speed of implementation.

Expected benefits are listed below arising from a Language Tool usage in a communication

- Both, source and targeted languages can be selected before the Language Tool;
 - Alternative, which describes the recommended status: Language of the driver is preselected with the tablet and the language of the IM can be set once entering a new country (on the IM controllers tablet the train drivers language still has to be evaluated with each conversation).
- GDPR requires that sensitive user data (voice template) is only stored locally on the driver's device (under the direct control of driver);
- Possibility of additional interaction with printed PDMs on the tablet, or digitally transmitted messages over other channels than the GSM-R voice call subsequently added;
- Visual Feedback of voice recognition and message transcription on the tablet before sending a message over to the other side.

6.2. Requirements for a Language Tool in specific groups

The requirements defined for the preliminary version (and used for the tender) were continuously evaluated throughout the T4R LT development phase and partly enhanced based on the testing results. The following list of requirements represent the final output of WP1 regarding the Language Tool.

The requirements can be split into two following groups:

- to be generally used;
- to be used in case of tablet solution (defined as additional ones to general requirements).







In a case that the company wants to develop its own tool the following requirements should be kept:

LT General requirements and development phase

- The LT should translate between two distinct languages (bi-directional);
- The user can choose the relevant language pairs combination based on the intended communication;
- ITC must provide all necessary information relating to the tool, necessary its approval, certification, operation and maintenance;
- ITC must provide a written manual in electronic form for installation, operation and maintenance of the LT;
- ITC guarantees at least 5 years lifetime service provision for the LT (can be covered with a separate contract);
- ITC disclaims any proprietary rights to the Language Tool;
- The development phase should allow for gradual fine-tuning of the Language Tool by ITC, according to the findings from the development and testing phases, to achieve the required level of reliable speech recognition and translation;
- The LT could run on a standard tablet computer not bigger than A4 with usual environmental requirements. The UI interaction with surface touch is preferred. The tablet may use any operational system as of Android, Apple, Microsoft or other where ITC can guarantee the tool functionality.

LT basic functionality

- LT needs to be able to recognise common communication using the railway jargon (represented in PDMs and free speech as well);
- The LT must log all user actions: Buttons pushed, transcribed messages, edit of a message, translation of message etc., and the possibility of downloading the log file(s) for the administrator;
- LT needs to be able to work reliably at the noise level present in the train driver cab at a standstill or train running as well as signaller office noise or outside at a railway station environment;
- LT needs to be able to recognise the PDMs in any range of words and sentences including railway jargon with the railway parts codes (switch, platform, track, signals names and codes);
- LT needs to be able to combine PDMs with variables (figures, letters and their variations) and constants (any fix names related to the railway line section);
- Match notification: In case a match with a PDM has been reached, a notification sound and display notification could help the speaker to stop speaking;
- The customer will have full access to the dictionary for maintenance purposes to edit (add/delete/substitute) - word, word pairs, words sections, sentences, as well as upload the updated dictionary/database into the tool;







 Language recognition will be initiated manually by pressing a "record a PDM" or "record free speech" button on the tablet. It will be stopped manually by pressing a "stop" button on the tablet or automatically. A notification will be shown on the tablet in the case a match with a PDM has been reached.

LT connectivity

- The LT must use a language engine that supports concerned languages / language pairs;
- The LT must be able to extend the tool with different language packs;
- ITC company should provide the hardware with standard audio connectivity and touchscreen display;
- The tablet must be able to work in daily operations without an internet connection. It is expected that the tablet will have an Internet connection at least once a day for updates and download of all communication in the form of recognised and translated texts.

LT speech recognition, translation engine and output voice

- For the LT, the own engine for the S2T, translation and T2S should be developed, decrease the level of the dependency on the existing market solutions;
- Speaker independent: The tool should be speaker independent and able to effectively recognise speech, regardless of accent, pronunciation, articulation, roughness, nasality, pitch, volume and speed;
- The tool should be based on machine learning algorithms and should have the possibility to be based on predefined messages and words (such as station names);
- The software should take into account any environmental noise (i.e. engine, rain etc.) and an acoustical distortion (such as microphone and GSM-R sound distortion);
- It must support user profiling and machine learning processes that may significantly enhance the speech recognition;
- The neutral voice should be customisable during project development. It should be a clear voice that is easy to understand in the surrounding noise of the train cabin and could be easy to be recorded and translated by the tablet on the receiving side;
- The output neutral voice must be clear and fluent in the addressed language.

LT messages, the usage of PDMs

- After recording a message to be translated, the message will be transcribed by the LT;
- Messages acknowledged by the user should be translated to the destination language by the LT;
- The LT should translate the message with the help of predefined messages or its dictionary. The translated message is being read out in standard audio output with a universal voice;
- PDMs are a set of static sentences with 0..x variables that could be station names, conditions, or numbers. For each variable in a PDM, there is a set of values (Strings) or range (Numbers);
- The LT can work on the basis of offering one or several recognised spoken message(s);







- The LT should be able to recognise "Emergency PDMs" directly from the sourced database and offers to the user an option of their direct usage via the separate button;
- The user should be able to mark incorrectly translated PDMs/variables/words as one of the options to increase the accuracy of the tool;
- The LT should be able to suggest new PDMs to the user based on the often used free speech sentences;
- LT must allow for editing recognised sentences, rearrange the sentence order and delete sentences;
- For free speech, there should be an easy way to support the user to edit parts of the transcribed message in case of errors. There should be options for each word by tapping on it to get supported help. A dropdown menu could offer the choice from dictionary help or a list of predefined station names or numbers;
- When recording voice messages from the user, the user should be able to select directly PDMs in some intuitive way. There should be an area where the user could visually select PDMs with icons or symbols. By clicking the symbol, he will be guided visually as much as possible through a process where the PDM is completed with all necessary information (variables);
- The user should be able to change the order of recognised/paired/translated messages before they will be sent out to the other party.

LT for potential Pilot testing

- The ITC should take part in the pilot testing to be able to adapt the LT according to the Pilot findings and customers' requests;
- The Pilot will be developed in an agile process together with the client;
- Each pilot test consists of laboratory and field testing within which the ITC will provide support to the customer(s);
- ITC should cooperate with all test participants in the pilot (pilot testing teams). Pilot testing teams, in case of need, will provide to ITC with relevant requirements also from competent authorities;
- ITC should assist the whole pilot testing;
- ITC should be contracted for the development phase, laboratory and filed testing phase providing the full support and application adaptation based on the user requirements.

Safety, security and GDPR

- The user must acknowledge a message to be ready for translation and going "on-air";
- Safety autocorrect tool: In the case of PDMs translation/matching where accuracy is not at a sufficient level, the repetition can be offered directly by the LT;
- Confirmation loop: For every communication, the software should ask for the confirmation of the message (free speech or PDM);
- The LT must conform to all GDPR requirements;
- The installation of the LT, in case of an application, should be secured (e.g. with a security *file*).







7. General proposal for tendering and evaluating of the offers

Organising a Call for Tender of the Language Tool development can be adversely impacted by several external reasons (especially due to sanitary constraints posed by the COVID-19 pandemic). The process of the tool tender was in line with the provisions of the grant agreement. It is also reminded that any call for tenders has to follow national and European law on public procurement, which has been done by RNE in the framework of the Translate4Rail. The fulfilment of the General terms and conditions (Annex 1 LT-General terms and conditions) and the signing of the Confidentiality declaration (Annex 2 LT-Confidentiality declaration) from the candidate's side are the first preconditions to be met before the start of the tender process.

However, there is an expectation of live demonstrations during the tender process from the candidates, where the tenderer(s) can use their existing tool (as an example) to demonstrate their ability to ensure the fulfilment of the offer. The ITC must demonstrate their ability to fulfil the defined requirements by signing the Tenderers' declaration (Annex 3 LT-Tenderers' declaration).

As the standard part of the announced call for tender, the request for the price offer should be submitted to the customer(s) (Annex 4 LT-Price sheet). The submitted price offer should be one of the criteria of evaluation of received bids. Other criteria, instead of price, to be used for evaluation should cover the area as functionality, quality of the offered product as well as the quality of the company (Annex 5 LT-Evaluation criteria).

of each criterion could be defined based on the priority of the tenderers.

 Criteria
 Description

The following criteria could be considered in the tendering procedure as a benchmark. The weight

Criteria	Description
Functionality	Recognition of the test patterns
Price	The total price of all services
Quality	Quality of written approach/methodology of solution development.
	Understanding of the subject and capability to develop the solution
	Project organisation including a timetable of activities and number of
	expert days proposed.
	Quality control/risk measures and maintenance concept
	Written approach to language tool fine-tuning during the pilot testing
	Company evaluation

If a physical meeting will not be possible with the candidates, the following steps can be used to evaluate the offer via a TELCO meeting:

- The presentation of tenderers and offers can be done via videoconference;
- The "Voice test patterns" can be used and the tenderer will have an opportunity to use these pre-prepared sentences to set up a tool (not a final version nor prototype) and







present a potential tool/approach to the Evaluation Committee via videoconference, according to the defined rules;

- The scheme to present the offer from the tenderer's side should be defined before the tenderer's presentation. The tenderer must be notified of the presentation's scheme;
- The number of evaluation rounds should be announced in advance.

After tendering, the ITC that fulfils the requirement will be selected. The first Language Tool should be delivered based on the agreed plan in the contract. The general framework of the contract should be defined and published in the specific Call for Tender (Annex 6 LT-Framework agreement).

During the Call for Tender period, candidates are allowed to ask questions about the customer's expectations of the tool. To maintain transparency, each question received must be answered and published on the website, together with the declared requirements (Annex 7 LT-Questions&Answers).

The performance of the tool should be tested by the project team. It is recommended that the pilot managers test the correct functionality of the tool during the Sand Phase of the Laboratory test (according to the T4R Deliverable 2.1 Part 2).

Regular contact and a feedback loop should be established between the project team and ITC for improving the first prototype (if needed) until final validation. This regular contact will help the ITC to be involved in the whole pilot testing process.







8. Conclusion

This deliverable provides the overview of basic functional and technical specifications and requirements for the future language tools.

The first group of requirements were defined in March 2020 as an essential one to start the tool development. Using this list of conditions, a tendering procedure was launched to develop a T4R Language Tool prototype. Gradually, the results from all phases have been applied to update and clarify the defined language tool requirements reflecting the users and sector needs. All phases starting with development via laboratory to field tests helped to finalise this deliverable based on the T4R project goals.

The specifications and requirements of the T4R Language Tool were developed according to the current communication possibilities reflecting the GSM-R overall functionality. It is recommended that the defined requirements should be the basis of a future language tool tendering, also when GSM-R is replaced by a Future Railway Mobile Communication System (FRMCS). The technical details of a transfer to the new railway communication framework should be updated with the sector experts and reflected by the future language tool developer. However, the general specifications should remain except that operational procedures could significantly change.







9. Annexes

- Annex 1 LT-General terms and conditions
- Annex 2 LT-Confidentiality declaration
- Annex 3 LT-Tenderers' declaration
- Annex 4 LT-Price sheet
- Annex 5 LT-Evaluation criteria
- Annex 6 LT-Framework agreement
- Annex 7 LT-Questions&Answers