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ERTMS's Future is... SAFETY

Through Design Diagnosis Maintenance
aied by **Web Expert System**
tecnology of SINCOS Group

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ERTMS's FUTURE is ...total SAFETY

ERTMS (European Rail Traffic Management System) is a global standard for both trackside and onboard trains, now international in status, specified by standards for new and upgrading rail infrastructure within the European Union and other European, Asian and other countries that adhere to the standard itself, such as China, India and some Arab Countries.

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The ERTMS architecture

ERTMS is a functional architecture physically realized in 3 parts.

ETCS (European Train Control System) is the operational trackside (SST, Sotto Sistema di Terra) and on-board (SSB, Sotto Sistema di Bordo) part, which includes the equipment to operationally manage the running of trains on the line and in station

GSM-R and TLCD-LD are its supports for radio and fiber optic cable communications.

ETML (European Train Management Layer) is the management of railway movement.

The goal is for every country in the EU and the rest of Europe to achieve this standard, which includes 10 important features, of SAFETY and train movement.

The top 10 features of ERTMS of the future

1. "Total Safety" and thus the elimination of accidents
2. Functional standards and technical requirements of a standard type for every network in the European Union
3. Interoperability, so that trains can run without any constraints in any country of Europe, from Portugal to Russia to India, China and the Arab countries
4. I"Holistic approach - Web Expert System" aided design, for high dependability (fiduciability, adequacy) of the system
5. "Diagnostics inside in the project" of the system online and continuous in order to have high levels of system availability
6. Evolution to L3 for train running management
7. Maximum efficiency of the infrastructure in order to increase its potentiality
8. Maximum simplification of operation and maintenance activities
9. Optimization of circulation for the most economical operation possible
10. International standard for ground infrastructure and trains, adoptable in other continents (Africa, America, Oceania) beyond Europe, with the advantages of being

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ERTMS/ETCS must respond to a "pyramid" of rules listed below in hierarchical order

- Pan-European Technical Specifications for Interoperability TSI-TSI, from the European Commission
- TSI-TSI Underlying Operational Standards Set (Subset), from the EU Railway Agency (ERA) and UIC
- National Specifications, depending on the existing NTC systems, drafted by the Infrastructure Managers and Railway Undertakings of the 27 EU countries, which will have to tend in a single set of Specifications, the same for all 27 Networks (International Train Control)
- The figure above graphically reveals the regulatory pyramid with 27 sets of National Standards for the various Train Control systems (NTC)

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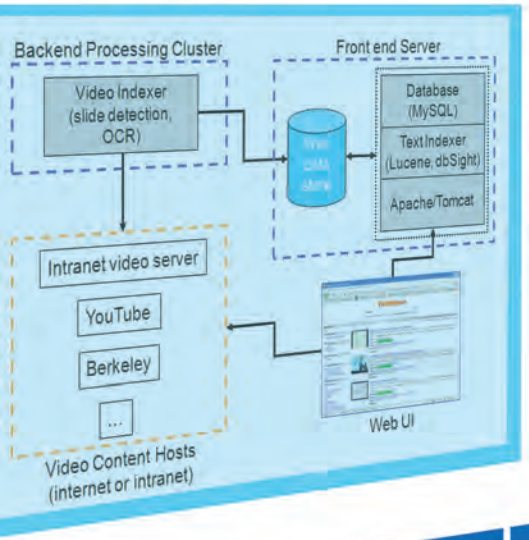
The EU and National
- Standards
- Dispositions
- Regulations

- The European Commission aims to have a single International Train Control (ITC) to make rail technologies uniform across all European Railway networks, desirable from 2027

- All this is necessary to have a single project document reference with uniquely definRequirements/Functions, with benefits also in the maintenance and development phases of the system

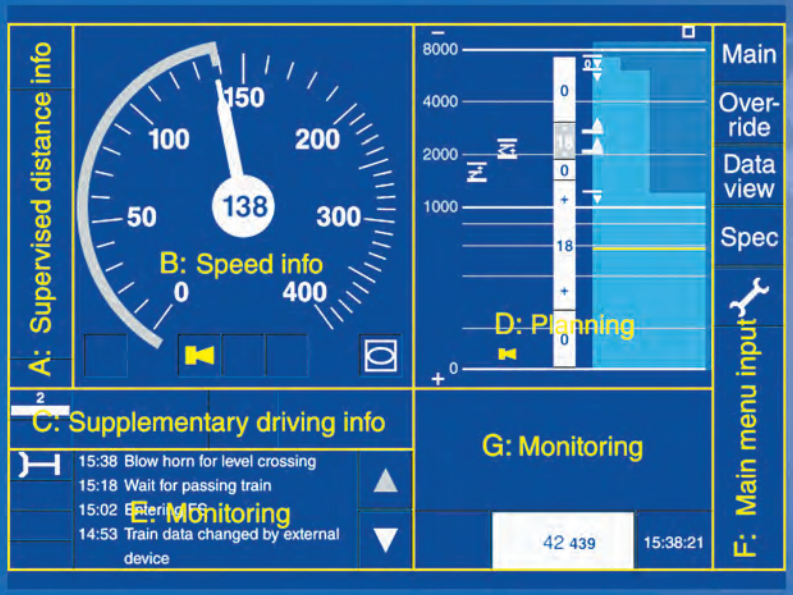
ERTMS's FUTURE is...10 advantages



1. The holistic design approach, for a system overview of "safety critical" systems
2. Train integrity "on the train" and L3
3. Safe tail without odometry and track circuits
4. Spacing with Mobile Blocking
5. BackEnd-FrontEnd Architecture

6. No RBC-Handover, Cloud Architecture and 5G
7. "Single-track" potentiality comparable to "Double-track"
8. L3: greater functionality and reliability than L2
9. L3: lower acquisition and maintenance costs than L2
10. Safety: Zero incidents

ETCS
European Trail Control System



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Spacing with Mobile Blocking

The implementation of the plans highlighted in Figures A and B constitutes an immense commitment-organizational, technological, production, and control-for both the developer and the constructors

Companies that provide specialized railway engineering services and training, and IT services and tools that help the builder meet the specifications and timelines of the NRRP (2026), and facilitate the control operations of the commissioning company, can be of great help in this regard, making a decisive contribution to safety in its various aspects.

Safety,in fact, arises from compliance with multiple regulations in both the apparatus design and production, operation, and maintenance phases.

Information technology, thanks also to the use of appropriate tools, e.g., Artificial Intelligence, can be of great help in ensuring compliance with regulations during the various stages of the process and in minimizing the time required for execution and control.

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2023/2036

Fig.A

Fig.B

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Artificial Intelligence (AI)

Artificial Intelligence is a set of technologies that enable a computer to develop an algorithm capable of solving a well-defined problem in a specific field of application. To generate this algorithm, the computer needs to possess the appropriate knowledge and the ability to use it.
AI can be divided into two strands according to the structuring of available knowledge.

Expert Systems do not automatically augment knowledge but produce certain results and justify how they are achieved.
Learning System: if knowledge is not available in a formalized way but is extracted

There are many learning algorithms that allow knowledge to be extracted and used. Eg. weather forecasting, visual recognition, natural language recognition etc..
Learning Systems can increase knowledge, but they produce probable results and cannot justify them.

Web Expert System (WES)

WES are web-deliverable Expert Systems generated with the WESTIGEN (on the Cloud) platform; they allow knowledge to be entered in the form of decision tables that are easy to interpret by the developer and easy to manage and transfer. T he WESTIGEN platform has an inferential engine, which allows run time to build algorithms for the entire case history provided in the knowledge base. The WES is able to ensure the correct application of the rules represented in the decision tables, and for each step of the process it performs "tracking" that highlights how the rules have been applied (COMPLIANCE).

The WES and maintenance

Expert Systems and particularly WESs are specifically effective in solving problems, based on certain standards and specifications,related to design, diagnostics and maintenance. It is no coincidence that the first Expert System (Mycin -70s-)was pioneered in the field of diagnostics.

Current maintenance process

Currently, when a component fails, operators must perform the diagnostic and equipment repair activities using graphs and flowcharts provided in a paper or electronic manual. In the process, the manual plays a passive role in the sense that it is the operator, through his skills, acquired through training and in the field, gradually identifies the manual paragraphs and diagrams where it is explained what to do for each step of the maintenance process. This process is not deterministic, with obvious criticality for the reliability and safety of the system to be maintained.

In the process through WES, the manual evolves from a passive object to an active mentoring system for those involved in fault diagnosis and/or repair. The WES is able to assist the operator by providing him with the right level of expertise and guiding him step by step through the various stages of the maintenance process,via a Chat Bot or other interface.

Wes Maker DARGEN, for the feasibility of large projects - Operations.

In processes requiring the use of innovative tools, one of the main problems is that of training personnel with specific know-how on the development platform, which is one of the main obstacles to the massive development of systems in an acceptable time frame. This is why Wes Maker DARGEN (Diagnostic and Repear Generator) was created, a particular WEB Expert System that can guide maintenance planners from various vendors to develop their own WESs needed for proprietary equipment according to the specifications required by the developer, without the need for special IT training.

The developer, under the control of DARGEN, is guided to enter data for automatic construction of the required elements in appropriate format. These can be: diagnostic diagrams, repair diagrams and other types of diagrams used in maintenance as well as any type of explanatory multimedia material provided to aid the operator that will be automatically associated with the context in the operational phase.will be automatically associated with the context in the operational phase.ESs are specifically effective in solving problems, based on certain standards and specifications,related to design, diagnostics and maintenance. It is no coincidence that the first Expert System (Mycin -70s-)was pioneered in the

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field of diagnostics. The result of the DARGEN process in addition to the production of the aforementioned elements required for the maintenance of the apparatus in question, produces a WES that in the operational phase acts as a tutor to the maintenance technician, which with the use of a tablet/phone/PC connected to the cloud, allows him to perform the entire maintenance process on the apparatus, in compliance with the specifications and automatically managing the updating of the various Data Bases

Feedback for continuous updating

A feedback system is provided at run time, through which the system, in the case of an unsuccessful operation, asks the operator to indicate in a note the reason, which will be taken care of later by the WES developer. Feedback management allows the maintenance process to be likened to a "counter-reacted control system," which, through reported difficulties allows knowledge to be changed and ensures the continuous improvement of the maintenance process very quickly. We are facing a huge and stringent organizational, resource and cost problem; in this context, the innovative technology of WES as a whole can provide valuable help in its solution.

Exercise Managementand from the Training of Maintainers - Background

During the implementation phase of ERTMS in L2 Architecture in the various lines, it is necessary to carry out warranty and post-warranty maintenance according to the standards imposed by the developer. It is also necessary to keep the currently existing trackside and on-board equipment in full working order. Therefore, the training of system maintenance personnel is essential, which is complex both because of the functions performed and because of the multiplicity of technologies of which the infrastructures are made up and because of the required solution timeframes, also in relation to the enormous increase in traffic. For these activities, for a variety of reasons it will be increasingly complex to have sufficient resources, including experienced personnel to be used as trainers.

The Management of the exercises from 2023-2026 and the training of maintainers – Operations

The use of WES technology and in particular WES Makers could effectively simplify the management of this phase, making it practically feasible, because:

- WES Makers make it possible to easily and quickly implementthe necessary WESs with personnel experienced in maintenance processes , even without specialized skills on the development platform
- WESs make it possible to provide, during the stages of anomaly diagnosis and equipment repair, the information necessary for problem solving, playing a real role as a tutor and providing operators with the right level of expertise with undeniable advantages.

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- a significant increase in the productivity of maintenance activities;
- significant savings in the cost of training such personnel;
- the assurance of compliance according to national regulations, with tracking of all interventions and evidence of all specifications (compliance);
- a uniformity in the management of the entire maintenance process;
- an automatic updating of the data detected in the maintenance process on customer databases;
- the automatic production of documentation and new manuals.

Knowledge is transformed: from knowledge distributed according to the expertise of individual operators into corporate knowledge available to all operators during the performance of their service.

This corporate knowledge goes to constitute an asset of great value and strategic importance for both the Contracting Company and the Company performing the apparatus maintenance services.

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Foreword to Applications "ERTMS's FUTURE is..."

For the future, realizations, compatible with the L3 Architecture, can be envisaged with great positive impact, some made possible by the evolution of technologies already available today.

"ERTMS's FUTURE is..." project, in addition to the functions envisaged in the current ERTMS, can envisage in summary:

- Rationalization of EU and National Standards/Dispositions/Regulations into a single ERTMS document;
- Processes for the "Computer-aided diagnosis/maintenance-Deterministic method "of the different devices that make up the entire system, in order to both minimize recovery time and optimize the quality/completeness of maintenance intervention; (tools already currently available for the L2 architecture)
- Training for maintainers;(tools already currently available for the L2 architecture)
- "Run Time" tool to test the system, simulating the Theoretical Exercise Schedule of each train (virtual train with preferred route and with optional routes), before it is actually affected by the train itself (real train), before its actual departure;
- "Run Time" tool to test the software affected by both the virtual train and the real train, for each type of route.

Some considerations on WESs with reference to ERTMS Architecture L3

The WES is capable of acquiring data: from the operator under the control of the WES; directly from the apparatus and/or system feeding a file with the values of variables representative of its state.

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Performing the diagnosis of an apparatus via file requires a processing time of a few tens of thousandths of a second.
The diagnostic process can be performed on any terminal, smartphone, tablet and PC at any location. E.g., on-site on ground apparatus, on board for on-board train apparatus and/or at any location from the ground service. The important thing is to have access to the data.
Adoption of WES technology within ERTMS would allow standardization of all maintenance processes for all apparatuses in a quick and easy way ensuring compliance with procedures for all. The WESTIGEN platform with which WESs are developed is a "general purpose" platform on the Cloud,
which can be used from anywhere in the world via the Internet by having a browser, with no need for additional local software installation. Ultimately, it is possible to develop Ultimately, it is possible to develop any type of rule-managed application in the ERTMS scenario. For example: it is feasible to implement a WES Maker for the apparatus design phase, for the massive production of the necessary WESs; data stored on files can be used for the realization of the Run Time Tools mentioned in the Foreword.

Conclusions

Having said all the above, it is inferred that realizing the ERTMS complex system with the "holistic" approach, with L3 architecture, and with the other features mentioned above, with WES development methodologies, in the design and maintenance sphere, is very advantageous, bringing numerous benefits...thus ensuring that a complex system consisting of several "safety critical" systems, has increased its safety significantly, so it can strive to achieve the goal "ZERO ACCIDENTS"