TABLE OF CONTENTS

SUMMARY 3
RAILWAYS AND INFORMATION & COMMUNICATION TECHNOLOGY 3
THE INTEGRAIL CONTRIBUTION 3
THE BENEFITS OF THE INTEGRAIL APPROACH 3
WHAT IS STILL NEEDED AFTER INTEGRAIL? 3

1. INTRODUCTION: OUR VISION 4
   INFORMATION – KEY OF RAILWAY PERFORMANCE 4
   IMAGINE A RAILWAY WHERE… 5
   BETTER INFORMATION 5
   THE BENEFITS 6

2. APPROACH: WHAT HAS BEEN DEVELOPED 7
   INTEGRAIL IS… 7
   INTEGRAIL DEVELOPED… 7
   INTEGRAIL ALLOWS YOU TO… 8
   INTEGRAIL IS NOT… 8

3. IMPLEMENTATION: NEXT STEPS 9
   PREPARATION OF STANDARDS 9
   DEFINE A POLICY FOR INFORMATION SHARING 10
   FIND EARLY ADOPTERS TO SPREAD THE SYSTEM 10
   AVAILABILITY OF INTEGRAIL RESULTS TO INTERESTED PARTIES 10

4. CONCLUSION: USE INTEGRAIL! 11
RAILWAYS AND INFORMATION & COMMUNICATION TECHNOLOGY

The railway system is becoming more and more complex, Information & Communication Technologies have an increasingly vital role in ensuring that it can operate effectively, efficiently and safely. Therefore a good level of standardisation and interoperability between railway information systems is and will be required in order to control the complexity and allow further performance improvements.

The approach from the past applying specific solutions to solve individual problems proved to be too expensive and to bring limited results. The rail society has recognised that we need to found new solutions on a clear and sound general platform, which allows to easily integrate and manage different solutions and systems, while allowing their evolution according to the faster changing railway business models.

THE INTEGRAIL CONTRIBUTION

InteGRail defined such a platform, showing how it is able to support all main areas of the railway systems, integrating existing systems and paving the way for a new generation of systems.

By means of a modular architecture based on application and communication services, it was possible to achieve the envisaged targets in terms of integration, flexibility, decision support and possible evolution.

Applications implemented according to InteGRail rules can easily retrieve, elaborate and exchange information whenever needed. This became possible by the use of a common language, which avoids ambiguity and can automatically be processed, and of standard protocols (middleware), which enable communication between applications, wherever they are located.

During the project lifetime a limited number of example applications were developed, to demonstrate that the concepts developed in the project can really work. These example applications were demonstrated at the end of the project, to prove that the platform, the architecture and the common language strategy work and to prove that a real improvement of railway performance can be achieved by using this way to manage and share information.

THE BENEFITS OF THE INTEGRAIL APPROACH

Additional, richer information can support decision processes at all levels, helping to find and take the best decisions and optimise the overall system performance.

Open, standard interfaces can guarantee a controlled growth and evolution towards the future, in accord with advances in technology and adapting to the new needs of the railways.

The InteGRail approach will bring real benefits through better monitoring systems, optimised maintenance, improved decision support and more accurate evaluation of performance.

The system can be implemented gradually, bringing benefits even when implemented at a small scale, and expanded without limits, while ensuring that new parts are consistent with already existing ones.

WHAT IS STILL NEEDED AFTER INTEGRAIL?

After December 2008, when the project will be finished, InteGRail deployment needs to go through additional steps like standardisation agreements, rules and business procedures for information exchange and establishing of new organisational models. In such context, new products based on InteGRail and existing products adapted using InteGRail guidelines can start building the railway system of the future.

Failing to take this opportunity will delay the evolution of railways, reduce their competitiveness, leading to the risk of missing the market targets of European transportation policies and strategies.

InteGRail partners hope their effort can represent an important contribution to the success of railways in Europe and invite you to carefully check, reading this introductory document, if and how the achieved results can be usefully deployed in your organisation.
1. INTRODUCTION: OUR VISION

INFORMATION – KEY OF RAILWAY PERFORMANCE

All railways have the same basic targets. Beyond a safe railway, they are all working to minimise passenger and freight delays; maximise the capacity at which they can operate their networks; maximise the reliability of the infrastructure and rolling stock; and do all of these for minimum cost.

Many railways have improved their performance against these targets through a series of engineering and process improvements. But over time the level of improvement that can be achieved reaches a threshold beyond which further improvement by these means is minimal. Also, the separation of railways into Infrastructure Managers (IMs) and operating companies or Railway Undertakings (RUs) means that there is a limit to the improvement that can be achieved if IMs and RUs cannot work together effectively.

This is where InteGRail will make a difference. We all agree on the fact that the railway system should be regarded as one big system. In that vision an overall policy on information, i.e. of its content, use and exchange, would help to improve the performance of the system as a whole. Sharing information between IMs and RUs allows the whole railway to be managed as a single system. That single system doesn’t have to be restricted to only one country. InteGRail will let IMs and RUs across Europe act together as a single, optimised system.

Over many years, the railway has worked on the basis of finding problems and faults and fixing them. A more efficient railway needs a method for predicting the condition of its assets and then intervening to prevent them from failing. This is possible if data is collected continuously from the infrastructure and rolling stock; if that data is transformed and processed into coherent information; and if trends in that information are monitored and analysed so that assets can be maintained just in time.

InteGRail makes that possible by defining a common standard for railway information and enabling to more effectively manage and share it. That is its unique offering.

Therefore, we can now monitor the interaction between rolling stock and the infrastructure and translate the results from one area into predicted results for another.

InteGRail is not a system but defines a set of standards and methods for information sharing and interpretation so that IMs and RUs can integrate their existing systems and suppliers to the railway industry can develop and market systems that will integrate. Without making elaborate calculations it is clear that any of the participants in the railway system can improve its performance by using information gathered by some of the others. The InteGRail project has provided ideas, definitions and methods to reach these improvements.

Integrating railway information through InteGRail will create a single view and allow the management of European railways as a single system. As a result, greater efficiency can be achieved within individual railways and across European railways.

Better management of the rolling stock – infrastructure interaction will lead to greater reliability of those assets. In turn that leads to decreased maintenance costs and to improved punctuality. Reduced asset failure means that they are more available and so this leads to an increase in the usable capacity of the railway.

Also, InteGRail supports decision-making when a fault occurs, allowing traffic managers and operators to decide on the best course of action. Making the best decision leads to reduced delays. If recovery from a fault is made faster, trains can be timetabled closer together so, again, the usable capacity of the railway can be increased.

On its own, InteGRail will not lead to greater efficiencies in the railway but it will supply the information to support better decisions. Applying this new decision-making capability with new processes will minimise passenger and freight delays; maximise the capacity at which we can operate the networks; maximise the reliability of the infrastructure and rolling stock; and do all of these for minimum cost.
**MAGINE A RAILWAY WHERE...**

Imagine a railway system in which all collected data are available to all relevant parties, in a well-defined and secure way, that enables an easy access to and use of information.

- The condition, capability, capacity and availability of routes is visible to all operators
- Infrastructure maintenance, renewal and enhancement plans are available to all operators
- Operators can use tools to query and assess this information to optimise their bids for train paths
- And it doesn't matter which member country the operator is in
- An infrastructure manager can see the impact that a train has had on the infrastructure on another country
  - So decide whether to allow it onto their infrastructure
- A train operator can see the impact that a country’s infrastructure has had on its train
- These results can be extrapolated so that the train-infrastructure impact can be predicted for the first time a train goes over a new route
- The health of a train is being constantly monitored
  - It doesn't matter whether it is operating in its home country
  - Using the information that modern trains are already equipped to provide from their diagnosis and monitoring systems
- Incipient faults can be identified
- The options for action can be identified by a decision support system; and operators, infrastructure mangers and traffic managers can be guided on what to do.
  - It can be taken out of service
  - A “running repair” can be attempted at the next stop - operations control can know beforehand that a train will have a longer stop at a station due to urgent repairs
  - It can be scheduled for a full repair at its destination
- And it doesn’t matter whether it is in its home country or travelling abroad

*InteGRail will make all these things possible.*

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**Monitoring and prediction**

Modern trains and infrastructure are equipped with all kinds of diagnosis- and monitoring systems. The information collected by these systems can be useful for more stakeholders than just the one that installed the equipment.

- Imagine that the infrastructure manager will be notified if an axle-defect might have affected the quality of a certain piece of rail.
- Imagine that the TOC-operations control will know beforehand that a train will have a longer stop on a certain station due to urgent repairs.

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**DATA MODEL**

To precisely describe information we need to express it in terms of relation to other already defined concepts, creating a data model. Description logic is able to do this since a long time. Today semantic oriented technologies are able to code and elaborate such formal logic by means of computers.

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**ANALYSIS**

The InteGRail project has defined a way to deal with the aspects mentioned above. It created a common definition of railway-related objects in a way that will facilitate different information systems to exchange information. An information system equipped with an InteGRail interface will need nothing extra to use the information provided by other InteGRail systems.
THE BENEFITS

The general ideas of the benefits are already mentioned before: the sharing of information will contribute to a better performance of the system as a whole.

Concrete benefits that can be realised are:

• Cost reduction in railway operation: early information about train and infrastructure faults will help operators to adjust their schedules to the actual situation, choose a cost-effective solution and minimise delays.

• Cost reduction in maintenance: early warning through condition trend monitoring and predictive maintenance improves the effectiveness of maintenance activities. Providers of infrastructure and fleet owners can adapt their efforts and manpower according to actual situation and urgency.

• Minimise delays and disruption through more reliable infrastructure and rolling stock as a result of predictive maintenance procedures.

• Increase of transport volume. The easy exchange of information will reduce problems through prediction of future events; will lead to faster recovery from problems; and so allow greater use of the available trains and infrastructure.

• Better feedback to customers as a result of easier exchange of information.

• Manage the railway as a single system – integrating information about infrastructure, rolling stock, operations and traffic management; and integrating information from different countries to create a view of the railway as a single system.

• Protect existing investments through easy integration of legacy systems, by means of standard procedures and reusable software.

• Cost reduction in information technology: information systems using a common “language” can be connected easily. There is no need for special interfacing, extra programming or dedicated connections between systems. This will reduce both the investments and the costs of maintenance and modifications.

• The implementation of the TAF and the TAP TSIs require to exchange some mandatory information by means of a common information backbone. InteGRail provides a reference platform and candidate solutions for tools which can support the implementation of TAF and TAP TSIs.

• Standards for exchanging information can support multi-modal transport (door-to-door service, One Stop Shop).

Example of benefits
Set up of a new transportation service requires currently a long time, involving many offices and organisations. Moreover, human errors are possible. InteGRail developed the Network Statement Checker, which can automatically check that the envisaged train is compatible with the infrastructure on the planned path.
InteGRail is a research project which intends to develop solutions facilitating information management and communication between systems. It is a 4-year project that started on January 2005. The consortium doing the work consists of 39 companies, institutes and universities representing the major European railway companies, railway industry, universities and research and consultancy companies.

2. APPROACH: WHAT HAS BEEN DEVELOPED

INTEGRAIL IS …

InteGRail developed …

First of all InteGRail analysed the needs of the RUs and IMs. Out of these it defined in close interaction with the railways a list of railway key functions that are the ones with the highest potential to improve performance.

In parallel the project defined the InteGRail Information System (IGRIS), a common platform which will allow the combination of any railway information source to provide exactly the information a decision maker in one of the stakeholders’ organisations needs to optimise the performance of his process. IGRIS is the backbone of the whole system.

To prove that this platform works the project defined three demonstration scenarios (DS) which reflect the functions and prove that IGRIS can improve their performance:

- **DS1:** In the first demonstration scenario it will be proven how the setting up and the running of a new international freight train service could be improved if more information would be available in a standard format. One of the examples here is the easily accessible information on railway networks with all their properties, so operators can verify if certain international destinations are reachable with their locomotives.
- **DS2:** Another demonstration scenario deals with the optimisation of rolling stock and infrastructure maintenance, in a situation where all players have access to one another’s monitoring information. The assumption is that reliability and availability of both trains and track can be improved once condition information for these assets is openly available, both across company borders and country borders.
  - DS3: The third demonstrator aims at determining type and impact of an (incipient) failure on a passenger train that occurs while the train is in service and informing all stakeholders adequately about this failure. Failure prevention and failure management can be optimised once information sharing is dedicated and quick.

In order to have information ubiquitously transferred where it is needed, communication aspects were addressed as well, as part of the InteGRail common platform:

- **ICOM:** The Intelligent Communication framework can allow a smooth information flow between railway applications, wherever they are located, decoupling them from the technical solution which is used to establish the communication and providing a full set of communication services

Using the framework defined with the previous steps, a small number of realistic example applications within the demonstration scenarios were developed to prove the concept. These applications include:

- the Network Statement Checker, a web tool that uses infrastructure characteristics stored in national databases to check the match of the properties of a train meant for an international route (DS1)
- the Infrastructure Availability Checker, a web tool that uses infrastructure availability information from maintenance planning and disturbance logs to inform operator and traffic manager on an international level of availability of the route (DS1)
- the Wheel Trend Analyser and Track Trend Analyser, which provide means to better monitor the train-infrastructure interface, taking advantage and combining information from both systems (DS2)
- the Symptom Agent and Condition Analyser, which promptly detect problems on board trains and notify them to ground systems, in order to handle them as soon as possible, minimising their impact on the traffic (DS3)
- the Unplanned Event Manager, which evaluates any unexpected events and forwards them appropriately, in order to better handle them (DS3)
- the Intelligent Depot Tool, that offers to depot managers combined information from various sources in order to optimise trains and fleets maintenance (DS3)
- the Operational Decision Support System, that helps the traffic manager dealing with a failure on board of a train in the best possible way (DS3)
- the Lean Maintenance Optimiser, which helps maintainers in optimising their scheduling when unexpected activities have to be accommodated (DS3)
- the Predictive Maintenance Server, which tirelessly analyses huge amounts of data coming from different subsystems in order to identify incipient faults and start appropriate actions (DS3)

To support decisions at strategic level, a structure of Key Performance Indicators has been defined, covering the whole railway system. This so-called KPI-tree was built to set out the relations between the performances of the different stakeholders in the system, and a tool (KPI Assessment Tool) was developed to use this tree to model the performance in different railway situations.

All applications are available as working prototypes, which allowed to set up and run the envisaged Demonstration Scenarios. From them, real products will be derived, which will be used by railway operators, infrastructure managers, maintainers to complement or replace their information systems, in order to get the additional InteGRail benefits.

**INTEGRAIL ALLOWS YOU TO …**

- ... use existing information in a more effective way: without delay, without misinterpretations.
- ... use information from different databases, information systems, railway-related companies and different countries. In other words it allows you to query multiple databases through the same user interface.
- ... meet some of the TSI requirements in an easy way, without extra investments, applying the same general InteGRail solution that is needed in order to achieve all the benefits already described.

**INTEGRAIL IS NOT …**

- ... a new system, but it provides definitions and standards to connect (already available) information systems.
- ... new hardware: the definitions and standards are independent of the available hardware.

- ... something available on the market now. It provides the standards and outlines that will be used in new systems. Buying a system developed according to the InteGRail standards will allow the user to exchange information with other systems with no additional costs.
During the project lifetime a number of applications could be implemented in the demonstration scenarios. For the future it is important to define a working plan identifying how to roll out InteGRail in Europe. To achieve this, important questions must be answered.

PREPARATION OF STANDARDS

Some results of the InteGRail project relate to standardisation issues. Cooperation and exchange of data and information is possible only if all users agree on a specified format and protocol. A major goal for InteGRail is to establish a shared and ready-to-use technology platform to become a reference standard for railway applications.

Standardisation proved to be essential in order to get wide adoption of new technologies, opening the market and achieving interoperability and/or compatibility between products.

Actions in progress:

- communication of the results and possible benefits of the InteGRail project to the railway community
- getting support of the key players in railway business for the definitions developed in InteGRail
- cooperation with possible Standardisation Bodies that are entitled to set and maintain standards (e.g. IEC or CEN/CENELEC)
- preparation of InteGRail inputs for standardisation to be offered to IEC TC9 WG43 for standardisation at IEC level with parallel voting at CENELEC level. The overview of the subjects that are in the scope of standardisation of IEC TC9 WG43 and that are covered by InteGRail are shown in the following block diagram:
  - WG43 is working on two standardisation proposals. The first proposal (IEC61375 series) has the scope of standardizing the Ethernet and IP technology as Consist and Train communication networks. Furthermore the On-board to ground communication will be standardized. The second proposal (IEC62580 series) has the scope of standardising the multi media and onboard services like Video-surveillance, Passenger orientated services, Crew orientated services, Train Operator and Maintainer orientated services.
DEFINE A POLICY FOR INFORMATION SHARING

The main goal of the developed instruments and definitions is the managing and sharing of information. But, in modern business, information means money. Where information is a business-product for some parties, it is a necessary supply for others. Thus: a market is created. This fact forces to organise the way information is provided and to control the way data is made accessible for other parties. The introduction of an independent information broker is a possibility. Founding such an institute also creates the possibility to build a community that adopts the earlier mentioned standard. By joining an information institute one agrees on the use of a standard. But on the other hand one has access to a certain set of data of the other participants. In this way a self-enforcing development can be sustained. This institute will be responsible to administrate the databases and servers used during the demonstration scenarios.

Specific means to protect intellectual properties, involving security and authentication issues, are needed: data can be exchanged only if and when the request is motivated and fulfils previous agreements. The InteGRail structured platform favours such information management.

In the previous paragraph the necessity of an institute that maintains the standards was mentioned. The institute mentioned before might eventually and logically turn into the broker as meant in this paragraph.

Alternatively, existing organisations (UIC, UNIFE) can take such role, using their experience and facilities to reduce the start up time and the related costs.

Actions in progress:
- Elaborating the framework and possibilities of such an information brokerage institute. Defining the mechanism, describing the organisation.

FIND EARLY ADOPTERS TO SPREAD THE SYSTEM

In order to create progress in the implementation, the benefits have to be made very clear. In the InteGRail project the three demonstrators will measure the benefits. The results of these demonstrators have to be adopted by some key players to create a critical mass for implementation.

Actions in progress:
- Looking for key players in railways that are willing to elaborate the demonstrators in order to create a few life-examples of the application of InteGRail ideas, and as such be the early-adopters of IGR results.

AVAILABILITY OF INTEGRAIL RESULTS TO INTERESTED PARTIES

In InteGRail we have two types of results: the reference Technology Platform and the application prototypes. The former provides an open stable platform which is the basis for all applications developed in the project and will originate several standards. This is essential, in order to convince railway organisations to invest in developing and using products which are based on and strongly require a well defined platform. These will come starting from the prototype applications and tools developed in the project.

A deployment plan is being defined, clarifying how to join the InteGRail community and answering a number of questions like:
- if I am an IM or an operator and want to start using the ideas of InteGRail:
  - What do I need to do to implement it? Buying some SW or some HW or what? Training my personnel? How much training?
  - what could be a critical investment in order to see some benefit?
  - how the software packages made in IGR are available: commercial conditions (free of charge, favourable conditions, full price), code or executable, support available from IGR partners
  - which IPR applies to the knowledge? who is managing the licences after the project end?
4. CONCLUSION: USE INTEGRAIL!

The results of InteGRail help the railway system to improve performance and reduce costs. If you agree on the solutions and advantages as described in this paper, it is a logical step to start introducing them in your own organisation.

Some InteGRail partners are already using the InteGRail results, but adoption by outsiders will be welcome and useful. InteGRail partners will be happy to offer their assistance.

International strategy organisations are taking notice of the InteGRail results, and will consider making the proposed implementation steps part of their strategic plans.

Standardisation groups are taking notice of the IGR results and having a first analysis of specifications.

Do not miss this opportunity to be part of the leading group for InteGRail deployment and join the growing community of InteGRail users.
CONTACT:

Project Coordinator: Ms Helene Köpf, UNIFE – helene.koepf@unife.org
Project Director: Mr. Valerio Recagno, D’APPOLONIA – valerio.recagno@dappolonia.it
Quality Manager: Mr. Paolo Umiliacchi, UNIFE/CNC – paolo.umilicchi@integrail.info

www.integrail.info