River Information Services in a multimodal Intelligent Transport domain

by

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1 INTRODUCTION

Since the first initiatives of the European Commission on River Information Services, this concept on information exchange to support traffic and transport management in inland navigation, has found its way throughout the world. In recent years River Information Services (RIS) the development and especially the implementation of RIS has been considerable.

Multi- end Synchromodal transport and logistics will put new requirements on the RIS related services, systems, technology and standards. For RIS, this brings new opportunities for improving the quality and efficiency of Inland Waterway transport.

In the transport and logistics domain the focus is more and more on multimodal transport with information services in intermodal context. In this context important requirements are:

- A paper-free, electronic flow of information associating the physical flow of goods with a paperless trail built by ICT includes the ability to track and trace freight along its journey across transport modes
- The simplification of freight and transport information exchange to reduce the cost of transport.
- Freight should be identifiable and locatable regardless of the mode it is transported on.
- It is essential to create a single transport document for the carriage of goods in any mode.
- The increasing Reliability, Availability, Maintainability and Safety (RAMS) requirements of the systems supporting this services

It becomes more and more clear that digitization of transport and logistics is an essential prerequisite to guarantee in the coming decade an efficient and sustainable transport. Digitization has the objective to move from paper to electronic documents, through simplified procedures and integrated information exchanges across different sources.

A necessary condition is that standard (information) interfaces within the various transport modes are put in place and their interoperability across modes is assured.

RIS can contribute to above mentioned ambition and challenges if attention will be given to changing requirements on River Information Services in a multimodal environment and above all the focus will be on the seamless interfaces with information services in other transport modalities.

A key issue in this is to consider analyzing the interaction between RIS services with other concepts for the information services in other transport modes. In addition it can be of great benefit for the further development of RIS to consider using services, information, technologies, architecture, etc. that consists in the Intelligent Transport Systems (ITS) of these transport modes

A pro-active attitude towards this development of multi modal transport information services is essential. Development of multi modal information standards is demanded, Assessment of these future requirements should be put on the agenda of the RIS community. A transition strategy for RIS towards harmonized multi modal transport and logistics information services environment is to be developed.

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2 STATE-OF-THE-ART AND STANDARDS FOR RIS and ITS

As commented above, it has a wide spread of codes, standards and state-of-the-art definitions with regards to ITS, depending on its country or region of origin, its application (roads, railways, etc.), and others.

Although it is out of the scope of these paper to make an exhaustive compilation of all of existing reference standards, it is worth to note the ones with a greater range of applications or the corresponding to areas with a greater degree of development, and that has been the basis for the present compilation and compared analysis.

2.1 RIS standards

Without being exhaustive, an overview of key international rules and regulations that should be followed in case of the implementation and operation of River Information Services, is shown below:

i. Guidelines and recommendations for River Information Services (PIANC, WG 125, 2011)
ii. European Commission, Directive 2006/87/EC Technical requirements for inland waterway vessels, 2006
iii. Harmonised Commodity Description and Coding System of the WCO (world wide)
iv. UN Code for Trade and Transport Locations UN/LOCODE (world wide)
v. EDIFACT Standard of the UN (world wide)

2.2 Roads' ITS standards

Possibly the frame for Roads' ITSs is the most developed one, and where more innovations and efforts one could find involved. This fact, amongst others, is reflected in the existence not only of an extended bibliography, but also in the development of several national (and even regional like EU's one) standards that have finally led to the ISO 14813 (2015) – Intelligent Transport Systems, development.

Most relevant standards related to Roads ITSs considered for this Guidelines purposes are:

i. *Intelligent Transport Systems. Results from the transport research programme*. European Communities, 2001
ii. Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport
iii. U.S. National ITS Architecture. Intermodal Surface Transportation Efficiency Act of 1991
iv. European ITS Framework Architecture (informally called FRAME)
v. ITS Japan. Japanese ITS Architecture. (http://www.its-jp.org/)
vi. ISO 14813-1 Intelligent transport systems – Reference model architecture(s) for the ITS sector – Part 1: ITS service domains, service groups and services
vii. ISO 14813-3 Transport Information and Control Systems- System Architecture- Example Elaboration

As commented, yet from its first edition in 2007, the ISO 14813 has standardized the framework for Intelligent Transport Systems (ITS) in service domains and groups reflecting the evolution of technology-oriented transportation practices and applications. According ISO's defined framework, ITS are expected to address services in the following areas of the road transport domain:

In road traffic management	Traveler information	Electronic payment systems	Transport network operations and maintenance activities;	Freight mobility and inter-modal connectivity;
Multi-modal travel including both pre-trip and on-trip information and journey planning where the trip starts and/or finishes in the road transport domain;	Variable road pricing strategies for freight and personal travel;	Emergency and natural disaster-related response activities and coordination;	National security needs related to transportation infrastructure;	Cooperative-ITS.

Table 1. Service Domains for ITS according ISO 14813

ISO 14813 defines a framework based on ITS service domains, groups and services that serves as basis for developing ITS architectures and ITS-related concepts of operation, which in turn lead to the definition of the appropriate requirements, functionality and standards necessary to deploy specific ITS services.

Although ISO 14813 has been developed for road transport domain, as far as ITS are beginning to be applied in rail and maritime (RIS is an example) transport domains, it could be a proper reference standard at the time of developing the ones for other transport modes (as the RIS Guidelines are).

2.3 Railways

Unlike roads' domain, railways ITS developments haven't been accompanied by the conformation of a common standard that could provide some future applicable framework.

In the literature, one just could find some initial trials and common bodies of knowledge, or, like the EU case, a partial standardization effort on the frame of the European Rail Traffic Management System (ERMTS).

Considering the stated above, for these Guidelines purposes, the reference documents listed below have been considered:

i. *Intelligent Transport Systems for rail – A summary*. ITS United Kingdom, 2012 (www.its-uk.org.uk)
ii. ERTMS - European Rail Traffic Management System. © European Union, 1995-2017 (https://ec.europa.eu/transport/modes/rail/ertms_en)

Additionally to the previous documents, the experience obtained from the design and installation of several ITS systems and facilities throughout Europe and America has been considered for setting the definition and scope of the ITS services for railways.

Generally speaking, and again unlike road transport, a common body of definitions and standards hasn't been defined, resulting in a wide spread of terms and classifications for the services, systems and subsystems involved in ITS, depending on the concerned country or, even, the operating authority, who stablishes its own standards based on local experiences and operating requirements.

Additionally, and related to the previous, neither the concept of ITS services is clearly considered (unlike the ISO and/or RIS Guidelines do) for Railways, being most common the reference to systems or functionalities.

3 COMPARING RIS AND ITS

The PIANC working group on River Information Services did a restricted study on the ITS concept for roads and for railways (The ITS concept for railways is related, at some extent, to the Europe ERMTS - European Railway Traffic Management System). The aim of this study and consequently the presentation during the PIANC World Congress is to offer, firstly, an overview of the main features of the principal key objectives of ITS in comparison with RIS. Secondly a comparison focused on the services as provided by RIS and those of ITS for roads and ERTMS for railways. The presentation will give detailed information on the comparison between ITS road-services as defined in US, EU, Japan and ISO standards as well as a comparison of ERTMS Services for railways according several standards.

Based on the study, recommendations will be given regarding future interfaces with ITS development, or the extension of RIS services to other areas.

In order to obtain a reliable comparison according this standard purpose the features of ITS for roads and railways have been classified according the criteria considered for RIS and adapting, as much as possible, the concepts and definitions of roads and railways' ITS to them. Taking into account this classification criterion, a comparison considering the three levels of RIS definition: [1] Functional, [2] Services and [3] Technologies, will be made.

Finally, a classification will be given based on the Functions and Services established for RIS, and matching with them those concepts (both systems, functions, etc.) that best fit with their definitions.

3.1 Key Features comparison

WATERWAYS	ROADS	RAILWAYS
Oriented to Vehicle safety	Oriented to Safety	Highly oriented to the passenger => Active search for Service Improvement
Low interconnection with other modes	Medium level of intermodality	Interconnection / Interoperation / Intermodality
Fuel consumption optimization	Noise Reduction Fuel consumption reduction Alternative power systems (electrification)	Reduction of resources used to demonstrate environmental commitment
Public operated infrastructures Private operated fleets	Almost full Liberalization of infrastructures and fleets	Increasing competition between operators and gradual incorporation of new players (private or concessions)
N.D.	N.D.	Professionalization of the sector: Sale of associated services
Infrastructure Public management Private fleet management	Private management	Private management in public entities

Table 2. Key features comparison between RIS and ITS

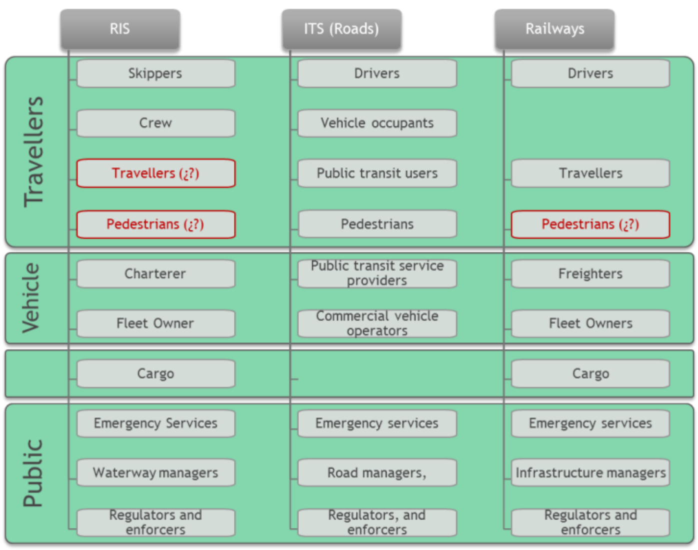

Table 3. Comparison of key stakeholders between RIS and ITS

3.2 Functional comparison

Although, from a general point of view, all Intelligent Transport Systems (considering RIS included in this category), should have, at the end, same or quite similar high-level functional requirements, it could be easily stated that actual features of the transport mode could made the owners to prioritize some of them above the rest.

This fact could be stated when comparing the Key functional requirements for RIS with the ones required to the Roads and Railways' ITS.

RIS	ITS ROADS	RAILWAYS
Improve inland navigation safety	Improve Operational safety	Improve Operational safety
Provide Traffic Information for safety and logistics	Provision of traffic data and statistics	**Sale of associated services**

RIS	ITS ROADS	RAILWAYS
Exchange information between vessels, locks, bridges, terminals and ports	Information exchange among infrastructure and assets: V2I (not only traffic but also transportation such as rolling stock interface towards PSD); V2V; V2G	Information exchange among infrastructure and assets:
Increase efficiency of use	Increasing Capacity through infrastructure **performance improvement** • operational efficiency (automatization processes) • economic efficiency (operation personnel optimization)	Increasing Capacity through infrastructure performance improvement **and management**
Environmental Protection	Energy Efficiency	Reduction of resources used to demonstrate environmental commitment
Integration of existing legacy systems	**Integration of existing legacy systems and operational procedures** **Integration of multisource and non-homogeneous technologies**	**Integration of existing legacy systems and operational procedures** **Integration of multisource and non-homogeneous technologies**
N.D.	**Dynamic adaptation to demand**	
N.D.	N.D.	**Active search for Service Improvement**
N.D.	N.D.	**Interconnection / Interoperation / Intermodality**

Table 4. Comparison of Key functional requirements for RIS and ITS

When comparing these systems, one could state that although most of indicated key functionalities are required to both of them, there are some differences in regards to the focus that is put in some areas.

It should be noted that this comparison is not exhaustive, and that has been made comparing non-homogeneous classifications. Hence, the fact that some functionality was not explicitly described for some environment (i.e. RIS or ITS), doesn't means that it hasn't been considered, but or it has been included, implicitly, in other concepts, or that doesn't have as much relevance than the others.

So, the shown comparison should be read in the sense that waterways RIS has a greater focus on environmental protection or data sharing between vehicles than ITS and, on the other hand, energy efficiency or demand adaptation has a greater impact in the case of roads and railways.

3.3 Services Comparison

As stated previously, in regards to ITS for roads there yet exists a wide body of knowledge and standards, developed from years ago, which has converged to a quite common framework that is, like the RIS case, based on the concept of Services.

The full services comparison analysis will be included in the incoming update of RIS guidelines. Although its extension exceeds the scope of the presente paper, in order to provide a general approach to performed comparison between these standards, a sample comparison is provided in the **¡Error! No se encuentra el origen de la referencia.** below, which compares ITS services as defined in US, EU, Japan and ISO standards for some of the services.

ISO 14813 (Roads) **ISO ITS Architecture Service Domains and Service Groupings** **Service domains**	**Rail ITS Services Envelope** **Rail ITS Services** **Services**	**RIS** **PIANC RIS Guidelines** **RIS Services and definitions**
N.D.	**Information to vehicle managers**	**Traffic Information (TI)**
N.D.	✓ Tactical Information ✓ Traffic Command & Control ✓ Rolling Stock Command & Control ✓ Strategic Information ✓ Dynamic traffic simulations (considering actual traffic and corridor conditions) ✓ Hourly program and calendar ✓ Machine - learning	Provision of information to network users 1. Tactical Traffic Information (TTI) 2. Strategic Traffic Information (STI)

ISO 14813 (Roads) ISO ITS Architecture Service Domains and Service Groupings Service domains	Rail ITS Services Envelope Rail ITS Services Services	RIS PIANC RIS Guidelines RIS Services and definitions
Traffic management and operations	**Traffic management system**	**Traffic Management (TM)**
Traffic control Transport-related incident management Demand management	European rail traffic management system (ERTMS) Automatic Train Location Train control Train communication Creation of trans-European traffic management facilities Stations management system Traffic Command & Control	Provision of management services Local Traffic Management (Vessel Traffic Services - VTS) Lock and Bridge Management (LBM) Traffic Planning (TP)
Traffic management and operations	**Maintenance & Construction (II)**	**N.D.**
Transport infrastructure maintenance management	Remote train maintenance management	

Table 5. Sample of services comparison between RIS and ITS for Roads and Railways

4 RAMS REQUIREMENTS

The increasing complexity of RIS infrastructure, the incoming increase of safety requirements (related with a quite more extensive use of waterborne transport and, the expected future use of unmanned vessels), the huge amount of input and output signals, the wide variety of failure functions of system's components, the complexity of functions relating SIL and failure probability, the restrictions on design based on the safe failure fraction, safety specification for different elements and the control of system failures as well as the own probabilistic nature of waterborne transport makes that RAMS requirements could be an incoming question to be afforded during planning and design stages of systems supporting RIS.

RAMS analysis (Reliability, Availability, Maintainability, and Safety), commonly used in other land transport ITS (Traffic Information Systems) infrastructures design (railways, highways, ports), could also be applied to inland waterway RIS (River Information Systems) environment, taking profit of its holistic scope for dimensioning operation and maintenance procedures taking into account not only functional and operational requirement, but also construction and design constraints.

The analyses are based on the use of the International Standard for Electrical, Electronic and Programmable Electronic Safety related systems (IEC 61508) as framework for the fully risk based approach for determining SIL (Safety Integrity Level) (SIL) requirements for those functions that are involved in the safety of the operations or in the achievement of the availability targets. This international standard uses a systems engineering approach the safety lifecycle as a framework in order to structure requirements relating to specification, design, integration, operation, maintenance, modification and decommissioning of the specific system.

5 DIFFERENCES AND SYNERGIES

Although RIS Guidelines are a well stablished and developed environment, and that from a general point of view, all Intelligent Transport Systems (considering RIS included in this category), should have, at the end, same or quite similar high-level functional requirements, it could be easily stated that actual features of the transport mode could made the stakeholders to prioritize some of them above the rest. This fact can be stated when comparing the Key functional requirements for RIS with the ones required to the Roads and Railways' ITS.

When comparing these systems, one could state that although most of indicated key functionalities are required to both of them, there are some differences in regards to the focus that is put in some areas pointed above. Therefore, and despite of the previous, being stated that still exists some room of improvement for RIS via cross feedback from ITS environment, main conclusion of developed work will be the proposal, included in WG 125 outcomes of a new working group oriented to develop a full comparison, focused in those developments in ITS domain that could best fit with inland navigation features, which would outline future RIS development trends.