European Rail Traffic Management System (ERTMS): supporting competition on the European rail network?

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Abstract:
European Railway Reform, which is based on a split between the network and operation, is deeply linked with the improvements in the quality of service of the railway network. It is indeed clear that competition on the network will only work if network activities are reliable, fair und optimally priced. On this point, rail operation in Europe remains connected through a fragmented network in which it is still difficult for the engines to cross national borders. Interoperability must be improved. Designed to strengthen the European integration, interoperability is necessary for thinking open and competitive systems of transport. The European Commission (EC) decided to implement a single signalling system, the European Rail Traffic Management System or ERTMS (EC, 2006). Thus, the EC opted for radical innovation for all Member States rather than the promotion of the extension of an existing national system. Why was such a direct action taken in the complex framework of rail signalling system? Will this action strengthen competition?

Keywords: European Railway Network, European Commission, Competition

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European Railway reform, which is based on a split between the network and operation, is deeply linked with the improvements in the quality of service of the railway network. It is indeed clear that network competition will only work if network activities remain reliable, with fair pricing (Nash, C., 2005). On this point, work remains to be done, both at European level but also among the member states. Railway reform has led to numerous innovations, both within an institutional framework (for example, separating network and transport activities) and in operational transport and network activities. Technology drives railway changes and innovations, for instance, in the network. In 2010, European rail operations remained connected through a fragmented network in which it was still difficult for the engines to cross national borders, even though these borders had been "open" since the Rome Treaty (1957). At the beginning of the 1990s, the European Commission (EC, 1996 and 2010) had already decided to initiate a large-scale rail standardization program based on the key concept of "interoperability" (Nash, C. and Rivera-Trujillo, C., 2004; Crozet, Y., 2005). Aimed at strengthening European integration, interoperability defines the aptitude of Trans-European Railway Network to allow a "reliable and continuing traffic of the trains" (Maastricht Treaty, 1992) facilitating competition on the network and cross-boundary international train operations from different train operators (Mulley, C. and Nelson, J.D., (1999); EC, 2001 and 2011; Giannopoulos, G., 2009). In railway networks, interoperability is necessary for open and competitive systems of transport. Among all interoperability factors, the most important is the command-control and signaling subsystem. Up to the 1990s, this system followed national rules defined by the historical operator and the signaling industry was strongly linked to the national system (EC, 1996).

In this context, the EC decided to directly implement a single signaling system standard, the ERTMS (European Rail Traffic Management System). Thus, the EC opted for radical innovation for all member states rather than the promotion of the extension of an existing national system. Why such a direct action in the complex framework of rail signaling systems? Will this action strengthen competition?

In railway technology, the signaling field is composed of two parts (Winter, P., 2009): the train control system (block system) and the track protection (post trigger). The EU innovation concerns the block system, which is the easiest and least expensive part of the signaling system to change. The EU proposes replacing the national systems with a unique European system, ERTMS. ERTMS is composed of two large parts (Winter, P., 2009). First, the ETCS (European Rail Signaling System), composed of two "modules" (track-train), allows the data transmission to the cab from the rail signaling system and data processing by the board computer. Secondly, the GSM-R radio system, from GSM technology, allows the information exchange between the track and the train. There are three ETCS levels. The first level concerns the data transmission made from the "eurobalises" positioned on the tracks. The board computer receives simple information about speed and priorities. The second level concerns the transmission made by the GSM-R radio. The "eurobalises" and the signalling become useless (investment and maintenance savings). Finally, the third level concerns the trains and the information they transmit, which enables the desk operator to follow them in real time on the tracks and increases the line's capacity. On a European scale, these functionalities are defined by Technical Specifications for Interoperability (TSI) to ensure a common base of development for the European industrials (Otteborn, D., 2004). Currently, the EC promotes ERTMS level 2 as an alternative for new tracks to improve the capacity of European networks and as a motor for international services competition (White Book, 2011): track capacity could be increased by up to 50% (Delaborde, F., 2012; Lacôte, F., 2012).

Our objective is to study not the technical characteristics of the ERTMS system but instead the European Transport Policy in innovation and Intelligent Transportation Systems (ITS) through the ERTMS innovation process case linked with railroad network competition in Europe. We will focus on European Transport Policy and the role played by the EC in the first section. In the second section, we will analyze the ERTMS innovation process according to the Innosutra[3] methodology. Finally, we will analyze the difficulties for the implementation of an ITS innovation, the necessity of good innovation management, and the possible impact on the competition.

I – European Transport Policy: toward network interoperability

In the beginning, European transport policy was not a priority for member states (Decoster, F., Versini, F., 2009). Based on a complaint from the European Parliament supported by the Commission, the Court of Justice recognized on 22 May 1985 the lack of action from the Council regarding transportation and requested that it be remedied. Thus, European transport policy started relatively late compared to the development of the great European market (Decoster, F., Versini, F., 2009). Many exemptions concerning transport were listed in the Treaty of Rome (1957), such as the ability of maritime companies to set up cartels and agreements.

[3] Innovation Process In Surface Transport (www.innosutra.eu), European Project 2010-2011

The rapid development of deregulation within the United Nations and then in the US at the end of the 1970s (1978: Airline Deregulation Act) and in the 1980s, first in air transportation, led the European Union to move in the same direction. In Europe, the CEMT (European Conference of the European Transport Ministries), created on 17 October 1953 and linked with OECD, was the starting point for European debates on deregulation.

We can then highlight three time periods in European transport policy (Decoster, F., Versini, F., 2009): 1958 – 1972, virtually nothing; 1972 – 1985, a timid start due to growth in the UK, Ireland, and Denmark; 1985 – 2010 and beyond, a jump-start and a boom.

In 1985, the European Court of Justice stated that the European market could be opened for passenger and freight transport. In 1986 (European Unique Act) and 1992 (Great Market), transport, both for passenger and freight, appears as a key motor for a deeper European integration. The Maastricht treaty of 1993 confirms this trend: free access of the transport market in the EU, fair pricing (integrating the famous negative external effects of transport and environmental impact following the white book of 1993). The need for harmonization and interoperability of networks is highlighted, which implies an extremely large program to harmonize weight and social regulation (driving times, etc.). At the same time, a large infrastructure financing program was launched based on the second white book in 1993, "Growth, Competiveness and Employment", which aims to relaunch activities with a European policy of building infrastructures: the Trans-European Network (TEN) (EC, 2005). Action in Research/Development is also integrated (Chapter XV and "Christophersen" report, 1994).

In 2001, a white book was published to assess European transport policy for the next 10 years (EC, 2001). In 2010, transport was expected to play a leading role in European Union decision making.

The strategic direction of the EU, still active today, is based on four main objectives:

1) Remove barriers to the mobility of people and goods in the European Union while maintaining a high level of security.
2) Reinforce the competitiveness of the European Union economy and strengthen the European interior great market.
3) Balance globalization and become a partner
4) Take into account climate change and greenhouse effects

ERTMS must be understood within the two first objectives: interoperability, competitiveness, and competition in the interior great railway market.

Intermodality and complementarity of modes are key elements of transport policy with the aim of renewing the attractiveness of railway transport due to reduced damage to the environment. Action towards fair pricing is also a way to improve the efficiency of transport activities in Europe. Later, the strategy was changed by the expansion towards Eastern Europe and further integration remains a priority, especially in rail transport (ERTMS), facing the opportunism and dynamism of international road freight transport (EC, 2005 and 2008).

Railway transport and ERTMS: supporting the recovery of rail transport

As previously stated, the debate on the European Transport Policy began at the end of the 1950s in the CEMT institution, now integrated with the OECD (general annual meeting, often held at the end of May, at the International Transport Forum (ITF) in Leipzig, Germany). On the level of the European Union, the leading institutions in charge of European Transport Policy are the European Commission, the European Parliament, the European Council, the European Court of Justice, and new emerging European agencies (European Rail Agency (ERA) since 2004).

On the institutional and political side, the railway transport sector in Europe is currently undergoing profound change. This mode now represents approximately 10% of freight transport (down from 20% in 1970 for freight transport in the EU). Faced with the threat of global warming, noise issues, pollution from cars and heavy goods vehicles (HGVs), urban congestion, and road safety problems, rail travel offers new opportunities for a transition from road to rail for passengers as well as goods. Formerly presented as a typical example of a natural monopoly in the theoretical literature on public economy (Crozet, Y., 1997), it was decided, under the impetus of the European Community and pioneering countries (particularly Sweden), to separate the business of transport from the management of the infrastructure and reduce the level of public subsidies, to open the exploitation of rail transport to competition (CE, 1996).

This change was effected through three “rail packages” (upcoming: fourth “railway package”) by the EC and is typical of the work of the European Union in the field of transport:

- Guideline 91/440 (19 may 1991): split infrastructure network;
- First package: 2001/12, 2001/13 and 2001/14 (26 February 2001, freight transport opened to competition);
- Second package: 2004/49, 2004/50 and 2004/51, regulation 881/2204 (29 April 2004, interoperability and rail security; freight railway transport totally opened to competition);

- Third package: 2007/58 regulations 1370 and 1371 (23 October 2007, opening railway passenger transport to competition).

Nevertheless, the network remains in the regulated framework of a natural monopoly, which can be managed by public authority – directly (France via the RFF) or more indirectly (Germany via the subsidiary company DB Netz, part of DB AG holding; the United Kingdom via Network Rail, a private company under the control of the *Office of Rail Regulation* (*O.R.R.*)).

New European rules have therefore been created concerning market access for new entrants. These rules take into account the safety regulations and interconnections between different Member States as well as the ERTMS standards developed by the European Commission itself through the European Rail Agency, on the reciprocity of rules governing competition between European countries, rules on pricing for use of the infrastructure, and taking into account public service missions (European Directives on Public Service Obligation and on the decentralization of regional passenger rail services).

II – Analysis of the innovation process: a long path

The objective of this second part is to analyze the innovation process managed by the EC through the ERTMS case (cf. tables 2 and 3 in the appendix for historical synthesis) according to the methodology developed by the Innosutra consortium. Three key periods are identified, taking into account actor game and barriers: initiation, development, and adoption of the innovation by the market. Concerning ERTMS, one of the key success factors is the acceptability by all of the rail transport chain of a given innovation. The issue of confidence and trust among actors is then essential. Carlota P. (2002) identifies a turning point in the innovation process between frenzy/gilded and synergy/golden ages, which is often linked with “institutional adjustment”. We can then consider “institutional adjustment” as a key element for the success of ERTMS innovation in the railway network sector.

Institutional adjustment is the point at which the innovation is becoming accepted by all the actors involved. State intervention is not necessarily the motor of such a change; sometimes, state intervention into technological change turns out to be a very poor decision. However, trust/confidence in the technological change is crucial for its future development.

Initiation period: toward a European signaling system

The ERTMS project initiation period occurred between the 1980s and the 1990s (Pellegrin, J., 1999; Lancien, D., 2004; Winter, P., 2009). Two factors initiated the move towards this project: the necessity in the 1980s for several networks to reconsider their control-command systems (in particular because of the high-speed development in Europe) and the emergence of new technologies on the market (information technologies).

Several projects have been developed independently in Europe by each network: the Société Nationale des Chemins de Fer (SNCF) with Astrée in 1986, the Deutsche Bahn (DB) with the Dibmof project, and the UIC, which initiates a more normative approach by drafting the first specifications of the future European system of command-control (ETCS). Benefiting from this emulation, the EC gave a European and political dimension to this project in 1989. The Council of the Transport Ministers asked for a working group on the railway technical harmonization question to be set up to best utilize high-speed rail. The idea was to pool resources, relaunch rail in Europe, and ensure efficiency in international traffics (EC, 1996).

At the beginning of the 1990s, the project was quickly structured and transformed by the EC's work to develop a command-control system unique to the European networks in the name of "interoperability". In 1990, the Council of Transport Ministries asked for the creation of a European Guideline project to initiate the harmonization of the train command-control systems. This guideline was formalized in 1996 (Guideline 96/48). It defines interoperability as "the ability of the trans-European high speed rail system to allow the safe and uninterrupted movement of high-speed trains […]. This ability rests on all the regulatory, technical and operational conditions which must be met in order to satisfy essential requirements".

Thus, the beginning of the 1990s was the initiation of a great "cultural revolution" for European railways. This European project marked the beginning of the railway competition policy in Europe (1991). The EC reacted promptly as a catalyst, whereas France and Germany begun to share their knowledge and the UIC developed a European command-control project.

Development period: the multiplication of versions

We consider the beginning of the development period to have started with the formalization of Guideline 96/48, which provides a clear objective (interoperability for European high-speed networks) and defines how tasks should be shared between actors to develop a reliable TSI for subsequent adoption of the system by the market (Pellegrin, J., 1999; Lancien, D., 2004; Winter, P., 2009). We can distinguish the "user's group", which represent railway operators and network managers, (European Association for Railway Interoperability, AEIF) from the European rail industries (Union Industry of Signaling, part of UNIFE). This point was the beginning of a long succession of versions and updates.

A first version was officially adopted in 2001 and represented the beginning of the adoption phase by the market. The year 2001 was also marked by a new step towards interoperability. Guideline 2001/16 extended the interoperability from the high-speed to the conventional European network, announcing a development plan for six freight rail corridors equipped in ERTMS (Mulley, C. and Nelson, J-D., 1999; EC, 2005). However, 2001 also marked the multiplication of the "change requests" delivered by the users to the coordination services of the ERTMS project. The development period continued, and the multiplication of updates marked a new phrase, with the risk of making incompatible versions (Jackson, C., 2005)

In the context of version instability, Member States and networks were reluctant to adopt the system (Walenberg, F., Te Pas, R. and Zigterman, L., 2012). A new version was adopted in 2005, 2.3.0, while a sub-version, 2.3.0.*b*, was adopted in 2008 to take into account the demand of industrial actors. Currently, the networks are expected to be upgraded to version 3.0.0, which is planned to remain in force for at least five years (ending in 2012).

This development period shows the complexity of network innovation at a European level and the need for political support, especially if competition is a driving motor in the field of transport operations, because of its cost-killing function (Pellegrin, J., 2008). While the system has already been proposed in different product ranges (range ATLAS by Alstom), the "change requests" required by users must be taken into account, which requires that the system remain reasonably open to adaptation. Thus, this innovation comprises important risks for the investor, which may explain its poor reception by the European networks.

Adoption period: the "ETCS island"

The adoption of ERTMS by rail actors began in 2002 after a two-year test period. The European networks' investment was progressive and fragmented. In 2010, the ERTMS network in Europe did not exist as such, with only 4000 km of lines equipped in Europe (UIC, 2012), while the EC assessed an implementation period of 10 to 12 years in 2005 (Brühwiler, A., 2002; Cordner, K., 2004; Vinois, J-A., 2004; Barrot, J., 2008). We speak currently of "ETCS islands", with several local applications without global consistency (Walenberg, F., *et alii.,*2012).

Thus, we remain far from interoperability. The instability of the versions and their lack of intercompatibility reduce the system's attractiveness. In this context, many great networks are still reluctant to implement ERTMS, as is the case for France and Germany, although some small networks have already begun their migration (Luxemburg, Denmark, Switzerland, and Belgium)[4]. In 2012 (www.ertms-online.com), 440 km are equipped in France (1.4% of the total network) and 408 km in Germany (1.05%) compared to 275 km in Luxemburg (42%), 285 km in Nederland (9.8%) and 407 km in Belgium (11.6%).

In addition to these delays, the operators conceive the migration toward ERTMS as an additional cost (Vinois, J-A., 2004; Crozet, Y., 2005; Winter, P. *and al,* 2007; Walenberg, F. *and alii.*, 2012). The Thalys example illustrates very well the difficulties arising with ERTMS. Provided that the entire itinerary travelled by Thalys trains will not be equipped exclusively with ERTMS, the ERTMS system will be a simple command-control system to be added to the other national command-control systems (seven plus ERTMS) already boarded on the trains. The other international railway services are also concerned both for passenger (Eurostar) and freight transport.

Therefore, ERTMS implementation raises the question of the migration ability of a network: Could we go faster? Is the system that will be put into action not already obsolete on a functional basis and especially on a technical one? These issues are taken on as risk by small networks, such as Switzerland, Luxembourg, or Denmark, while integrally equipping their network in ERTMS and hoping that large networks, such as the French or the German networks, will follow them ("strategy of small networks"). In the field of transport operation, it is interesting that large countries, with strong monopolistic behavior, like France, are reluctant to implement this new system and sometimes try to slow down the process. Do they consider the implementation of new systems as increasing competition and therefore a danger to the state monopolies? Could ERTMS be a competitive factor ?

To conclude this section, we state that the extension of the development period over the adoption period can be a major risk for project success (risk of incompatibility between the versions, trust crisis, etc.). Once again, the EC role in this innovation seems to be crucial. However, its actions have been highly criticized by the European specialized press since the beginning of the 2000s.

III – Economic cost and policy intervention

This final section proposes a focus on the implementation problems and the role of the main actors.

European Commission management

The development of an ITS project at a European rail network scale requires more than a strong policy with a long-term perspective. It also requires an undertaking from the economic actors to invest in the new project.

This last point has been the main drawback from the EC innovation management (Cordner, K., 2004; Laperrouza, M. and De Tiliere, G., 2010). The actors criticized its excessive interventionism in the drafting of the technical specifications (Pellegrin, J., 2008). Its "obsessional" aim to respect the interoperability principle in the drafting of the specifications has tended to delay the drafting and the initial tests. However, as a consequence of its refusal to favor an industrialist as master-builder, it has been criticized as not applying the rules of true management and allowing too many freedoms to the networks and industrialists, which have each developed their own conception of the system (multiplication of the costs and delays).

The main barrier for the EC has been in the management of the migration of the European networks towards the new system (Brühwiller, A., 2002; Cordner, K., 2004, Vinois, J-A., 2004; Laperrouza, M. and Finger, M., 2009). This challenge is important because the success of ERTMS requires a minimal number of line kilometers equipped to form a true network. As long as this critical point (or "critical mass") is not reached, the ERTMS project may not be interoperable and may constitute a net extra cost for the operators and network managers. This cost problem is strengthened by the legal impossibility for the EC to subsidize rail operators for their migration (rule competition). Therefore, the timely implementation of ERTMS requires that the rail operators make a significant investment in the system.

The EC therefore needed to adapt its strategy to the innovation process evolution and improve its understanding of the good governance of a project to the European scale (Laperrouza, M. and De Tiliere, G., 2010).

Economic assessment: performance for capacity

We have developed the political and historical aspects of the innovation. We propose to return now to the economic interest in developing a new system for the European rail.

A first debate concerns the question of the implementation cost of ERTMS (Vinois, J-A., 2004; Veider, A., 2005; Vinck, K., 2005; Winter, P. *et al.*, 2007; Barrot, J., 2008). The EC, represented by K. Vinck (ERTMS coordinator since 2005), defends the ERTMS profitability, whereas most actors in the rail sector express doubt about its economic benefits. Concerning the cost of the system, the responsibility can be shared between the EC and the industrialists who, due to a lack of authority from the EC, have each developed their products and have proposed many changes to request more subsidies, therefore increasing the costs of the test bases and consequently the price of the ERTMS equipment. However, concerning the cost of the "track" system, A. Veider from Alcatel TAS (Austria), who has led the equipment of the Vienna-Budapest line, considers this trial to be somewhat biased (Jackson, C., 2005; Veider, A., 2005; Dancre, J-F., 2006). The implementation cost of the level 1 superposed to the existing system has been 25 000€/km, which is competitive with a classical system. The level 2 cost, without classical signaling, has been 200 000€/km. However, in reality, 75% of this sum has been spent for signal box modernization, etc. With or without ERTMS, these investments are a necessity. The costs of ERTMS implementation on the networks are therefore limited for A. Veider. According to DB, the infrastructure migration toward level 1 and 2 on its European corridors (TEN-T) could cost approximately 4.5€ billion, or 1.3€M/km. This assessment is strongly discussed by the EC, which quotes the Swiss case, where the migration of 3500 km of track toward level 1 is estimated as 250€M, or 70 000€/km (Charlier, L., 2012). Nevertheless, in 2009, the Danish government, despite being Eurosceptic, approved the investment of 2.4€ billion over a period of 12 years to renew 3240 km of track with level 2 by 2021 (750 000€/km) (Sondergaard, M., 2010). The shared cost for ERTMS implementation is estimated as 300 000€/km, including adaptations to the track and cabling. In summary, it is difficult to obtain a good estimation of the ERTMS cost, and there is very little information about it. The DB estimation seems to be over-evaluated in comparison to the other networks, but the cost depends on the ERTMS level and the characteristic track. The implementation on a new line is often less costly than that on existing routes, which is rather complex and costly (adaption of interlockings, etc.).

However, beyond the cost of the system (primary issues), the question of the interest to migrate toward ERTMS is raised (secondary issues). ERTMS is a radical innovation: the issue of adapting the new system to the old one is important (Godoe, H., 2000; Cordner, K., 2004; Barrot, J., 2008; Bruzelius, N., 2010; De Tilière, G., 2011). Consequently, in the context of non-stabilized versions and austerity measures for the Member-States and firms, it is understandable that rail transport operators have done little to equip their rolling material. The recent German example illustrates this problem. In 2011, Germany renounced the implementation of ERTMS on its European corridors (TEN-T), preferring to invest in an intermediate system (200€ M) despite EC pressure. This example shows the difficulties faced by a network when adopting a radical innovation. This difficulty seems to be more important for large networks than small ones. Indeed, whereas cost issues have been raised in Germany, the question of system security is mainly discussed in France, and its engines continue to use national signaling on the new lines equipped with ERTMS.

Small networks are more involved in ERTMS implementation, as exemplified by the cases of Denmark and Switzerland. In Denmark, the Danish national rail network is under a double constraint: its signaling equipment is obsolete and its network is an important point of contact between the Scandinavian and the continental network (Sondergaard, M., 2010). Therefore, the potential benefits are two-fold for the network. First, the renewal of the signaling system is necessary and subsidies from the EC are available for ERTMS (50% of track equipment cost). Second, with the ERTMS system, Denmark can improve its rail capacity at lower cost and greatly improve the income of its network manager while also increasing its ability to cross boundaries and compete with other foreign train operators.

Finally, concerning the capacity gain by ERTMS, Lacôte F., Vice President of Alstom Transport, shows that the migration to ERTMS system provides an increase in traffic capacity of nearly 50% (cf. table 1).

Table 1: Capacity gain with ERTMS level 2

Type of signaling	"Technical" interval between two trains	Capacity (TGV/hour /way)
TVM 300	186 s	13
ERTMS level 2	122 s	16
ERTMS level 2 with virtual slot	111 s	17
ERTMS level 2 with virtual slot and relative journey of braking	91 s	20

Source: Lacôte F. (2012)

We also expect this system to improve train traffic. It reduces the risk of delay and congestion. In this case, the infrastructure manager is the winner, and we can distinguish three levels of benefits among the operators. First, all operators win in service quality (best traffic management reliability). Second, the capacity gain allows new operators to work on the main lines. Finally, this improvement costs less than a new infrastructure would. Therefore, this situation seems to be a good opportunity to improve competition on the main European axis.

The ERTMS future: economic equation between rail operators and network managers

The equation is simple. Except in Switzerland, where policy intervention has been strong for ERTMS migration, in the most of other UE networks, the subsidies for this implementation were given to network managers but not operators (Vinois, J-A., 2004; Winter, *et al.*, 2007; EC, 2010). We see then immediately where the difficulty in the expansion of the ERTMS system remains. Without political support, the largest investments to be done on the great European networks are in the rolling stock materials. Therefore, in the French case, RFF (French Network Railway) would benefit from migrating progressively toward ERTMS on the main axes to benefit from the EU subsidies and increase capacity and traffic (and therefore its revenues). For RFF, there is a direct return on investment. The economic interest is less obvious for the SNCF. First, the cost of the rolling stock material adaptation is important (immobility of material, cabin conversion, etc.). Second, no subsidy is provided and the capacity gain for the network manager could be an advantage for new operators and therefore for competition on international lines. Consequently, the ERTMS implementation for the SNCF is perceived as an extra cost without any direct benefit.

Has the cost of the development and implementation of this new technology prevented the entrance of new operators on some ERTMS networks? We suspect not. For example the Betuwe Route – equipped with ERTMS – is experiencing real competition among the main rail operators in Europe.

Thus, the main problem of ERTMS implementation comes from this lack of balance between train operators and network managers, the operators being the main investors in the ERTMS system but also less supported by public authorities. The EC and the European Parliament seem to be aware of this unbalance. The recast project (2010) is considering changing Article 32 by proposing a lower price of rail slot allocation for train operators using ERTMS. According to the amendment, "Trains equipped with the European Train Control System (ETCS) running on lines equipped with national command control and signalling systems shall enjoy a temporary reduction of the infrastructure charge in accordance with Annex VIII, point 5" (CE, 2010).

To conclude, the EC is aware that, beyond regulation, principles, and specifications, it is necessary to find good means of applying pressure to encourage the rail networks to begin the migration. We believe that this new system will favor more competition – mainly cross-boundaries – on the railway network.

Findings and discussion: toward proactive management by EC

ERTMS is a complex innovation that can have a substantial impact on competition. Its complexity is due to its European scale and nature. As a network innovation, its success depends on one condition linked with the theory of network externalities (Curien, 2005): that all European networks adopt the system as soon as possible in a truly cooperative way. Thus, ERTMS interest lies in the network and continuity concept, which will strengthen competition. An actor that refuses the migration will create a network discontinuity ("island ERTMS"). The EC challenge for innovation success is therefore to support the migration conditions from the old national networks to the new system. This concept is also linked with the idea that the small Member States (Switzerland, Luxembourg, etc.) have defined their strategy in adopting national plans to equip their network, hoping to take the large neighbor networks in their wake ("small network strategy").

Concerning the managerial implication from EC, the necessity of rigorous management and a strict calendar is obvious to trust the actors and guarantee them a quick investment return. Without this dynamic, none of the actors will want to start investing. The ERTMS project must adopt a strategy of “reinforcement”, moving from the concept of “negative feedback” towards that of “positive feedback” (success) (Shapiro and Varian, 1998). This shift can only be achieved if transparency, confidence, and fairness are key behaviors shared by all partners, from the member states to the EC.

Finally, the progressive character of innovation remains a factor contributing to the rail actors’ distrust. Consequently, the problem concerns not only the investment return question but also the development of the system, which can make the previous versions incompatible with previous version and call for new investments.

The strengthening of EC action for ERTMS is therefore necessary to progress toward interoperability and equitable competition conditions. Thus, Article 32 from the recast first railway package (2010) adopted by European Parliament in 2012 proposes the reduction of infrastructure access charges on ETCS equipped infrastructures for ETCS equipped trains to reduce the transition period and directly encourage the operators to adopt it.

This paper highlights, from a scholarly perspective towards European policy, the importance of EC management in the interoperability and competition within the European railway network. The scarcity of available statistics, the isolated projects, and the need for new specifications contribute to the climate of “wait and see” regarding ERTMS. However, from a long-term perspective, the ERTMS will strengthen the EU’s competitiveness in the rail sector, and we assume that these experiences will be shared with the rest of the world.

1.1 Appendix

Table 2: Project history

Project history

1989

- Connection of the Astree project (French) with the Dibmof project (German) in the DEUFRAKO cooperation
- The UIC develops a European command-control system project
- The EC asks for the formation of a working group to address railway technical harmonization.

1991 : Guideline 91/440 (separating infrastructure from train operation)

1992 : Maastricht Treaty and interoperability concept definition

1995 : Formation of an EEIG (of the ERTMS users)

1996 : Guideline 96/48 (project formalization for high-speed rail)

1998 : The “Winners Group” becomes UNISIG

2000 : “Delivery of ERTMS specifications” in Madrid by UNISIG

2001 : Guideline 2001/16 (project extension to the classical network)

2002

- Decision 2002/731 (the EC forces the Member States to define a national TSI implementation plan)
- New version 2.2.2

2004

- New version 2.2.3
- The EC elaborates a coherent plan for ERTMS implementation
- ERA creation

2005 : New version 2.3.0

2012 – 2013 : New version 3.0.0

Source: authors

Table 3: Phases of ERTMS project

	Studies and specifications 1989-1997	**Final specifications 1998-2004**	**Roll-out 2004-2008 (till 2020)**
Technical level		Class P to Class 1 SRS	SRS 2.2.2 and 2.3.0 Work on 3.0.0
Financial level	National	National	National and subventions from EU
Organizational level	Integrated railways	Integrated railways	Unbundled railways
Legal level	Directive 96/48/EC	Directive 2001/16/EC	Directive 2004/50/EC Transposition delays
Administrative level	No regulation (Ministry)	No regulation (Ministry)	Independent railway authority
Stakeholders	EEIG, ERRI, EUROSIG	UNISIG, CENELEC, AEIF	ERA and associations
Emphasis	**Engineering**	**Politics**	**Financial**

Source: Adapted from UIC and Winter (2007) and personal interviews.

In M. Laperrouza and G. de Tilière, *Governance of innovation in the European railway sector*, for the World Conference on Transport Research, Lisbon, July 11-15, 2010

1.2 Acronyms

AEIF: European Association for Railway Interoperability

Astrée: Automation of the train followed in real time

DEUFRAKO: Deutsche Französische Kooperation

EC: European Commission

EEIG: European Economic Interest Grouping

ERA: European Railway Agency

ERRI: European Railway Research Institute

ERTMS: European Rail Traffic Manager System

ETCS: European Rail Signaling System

EU: European Union

FP: Framework Programme

TSI: Technical Specifications for Interoperability

UIC: International Union of Railways

UNIFE: Association of the European Rail Industry

UNISIG: Union Industry of Signaling

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