European railway harmonization: How technology induces organizational and institutional mutations

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New technological standards are used to support the harmonization of European railways. The shift towards interoperability requires a deep mutation of institutions and organizations in the sector.

At the beginning of the 1990s the European Commission (EC) launched a harmonization policy to increase the performance of the European Rail System. Together with the Member States the EC worked out national deployment plans to implement common and interoperable standards. Two decades after the EC decision, and a decade after the first national deployment plans, harmonization is still not completed. Much resistance had to be overcome and the cost required for technical harmonization still requires to be spread over a significant period of time due to financing issues. Harmonizing railway networks in Europe implied not only solving technical issues. Setting common political goals required significant institutional and organizational transformation.

European transportation policy and technology

The plan to harmonize the European Rail network contained the three following objectives:

• Split the role of former national operators between infrastructure managers and operators;
• Create a new entity at the European level for the management of path allocation;
• Provide new technical standards allowing technical interoperability.

In order to achieve interoperability among European rail networks the EC promoted the development and deployment of new European standards through the so-called Technical Specifications for Interoperability (TSI). Addressing the technical issues in order to remove technical barriers for interoperability was a priority. This strategy of deploying new technical standards in order to promote interoperability with the opening of market was defined at the end of the 1990s. After a decade of technical specifications and prototyping the norms were ready for the first commercial implementations in 2002. Since then they are improved year after year to ensure that new infrastructures are interoperable on international corridors and to allow cross-border operations within a single European market.

This pan-European harmonization required a deep change in the rail communication and signaling systems. In the past seven different national standards were deployed across Europe. As they were basically non-interoperable, defining an innovative solution as a new European standard for railway signaling became a key issue. The new European Rail Traffic Management System (ERTMS) was therefore a prerequisite to improve transportation services as part of the European harmonization and liberalization policy.

The case study of the ERTMS development underlines the deep changes affecting the European rail market. This systemic innovation brings increased performances for safety, capacity and allows interoperability, all great achievements on the technological side. In other words the technology has acted as a mean to support the significant mutation of the rail market defined by the European transport policy. While the technical harmonization and the related technological innovations seem to be more the focus of engineers, technology is often very dependent of the organizations and institutions that produced them.

Cohesion between technology and institutions

Only a suitable institutional framework has enabled the ERTMS innovation to become a standard in Europe and beyond. The creation of the European Rail Agency (ERA) was a cornerstone in the European policy and the transformation of its institutions. But even more than defining a new innovative standard, the key role of ERA

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is to manage the long-term sustainability of the standard. For this a strong and neutral arbitration of interests in a multi-stakeholder environment is necessary, each actor having its own interest in terms of functions or timing.

If the institutional framework is sometimes a prerequisite for the emergence of such systemic innovations, additional leverage and means must be defined for the deployment or diffusion of the standard. While things are clear when building new rail lines the key issue for ERTMS remains the case of renewals of existing infrastructures to ensure interoperability. Here railways don’t find always a business case matching the planning of the EC which is a problem for the deployment of European corridors. New ways need to be developed to find better means to proceed if one wants to keep increasing the overall performance of the European rail network. One of the issues is that so far only national bodies are making decisions, often without full considerations for cross-border impacts.

Three aspects highlight the role and the efforts of institutions and how they had to adapt at each step of the process from the mid 1990s up to today.

- Building the reference and norms for the European standard: The role of the EC has been key to support the development of specifications by funding maximum of 50% of the specification efforts. Two main working groups were set up for the definition of the new European interoperability standard. The operators’ user group (EEIG) and the manufacturers’ group (now UNISIG) were created early in the 1990s and were working with the EC. A decade has been necessary to tailor all organizational and institutional processes leading in 2004 to the creation of ERA. This also allowed working out the processes of ERTMS cross-acceptance among the European countries (for certification and homologation).
- Incentives to favor the initial deployment of ERTMS and validate the specifications: The Commission funded partially nine pilot lines and prototypes in six countries between 1998 and 2002. It aimed to provide industries and operators the experience necessary to demonstrate the interoperability and improve the technical specifications for interoperability. The goal was to speed-up the development process among manufacturers and to test the largest part of the technical specifications for interoperability. This step brought to operators and to manufacturers a first important experience which facilitated to some extend the first deployment projects.
- Incentives and funding for deployment projects: In line with the EC’s decision mechanisms were created to support the deployment of standards in Europe. Via the coordination of national deployment plans one of the incentives was to provide more support to the first projects. This measure aimed at boosting the harmonization of the European network and at reducing any support for later implementation. This is a major focus of the EC nowadays, for both the implementation on the network (infrastructure managers) and on the train fleet (operators).

How organizations are shaping technological trajectories

Innovation processes at the European level have been strongly reshaped since a decade with the redefinition of the roles of rail actors. In this process the role of institutions has been key. For instance the definition of the TSIs allowed the current technical harmonization. But this process is still ongoing and institutions are still evolving. For instance the link between European and national institutions is in constant flux as can be witnessed by the recent birth in France of the ARAF, the new French regulatory rail agency.

In comparison to previous innovations in signaling technologies the development of ERTMS required a significant change in the innovation process. Before the 1990s there was a strong cohesion between national institutions and organizations (national railways and suppliers), co-developing national technologies. The national operator worked with a selected manufacturer (usually a ‘national champion’) within a well-defined and tailored institutional framework. Risks were shared through study contracts and implementation projects with a high degree of collaboration. In this model the operator was also the technical specifier instead of being only focused on functional needs. The former “National Innovation Models” was in fact strongly driven by national industrial policies: protected market niches were encouraging in vitro development of innovative solutions up to a critical market size. However such captive markets led to strong monopolistic situations and in fine issue of non-interoperability strongly affected the rail competitiveness.

Since then the main challenge at the European level for ERTMS development has been to set up an appropriate framework: redefining the role of operators, infrastructure-owners, manufacturers and institutions and allowing interoperability and the opening of the rail market. Building up this new process and redefining roles was a critical step as all the system (i.e., institutions, organizations and the new technical standards) had to evolve in the same timeframe. The technical innovations were done in a context of intense organizational mutations.

After a decade of mergers the restructuring of the rail
manufacturing industry is going one step further by adapting its processes to the constraints of the new market. A new approach of R&D programs’ definition has been carried out. Like before it is driven by the strategies of national operators through study contracts. Manufacturers have now to identify the needs of operators more independently and to bring efficient innovative solutions to the market. However one of the major difficulties lies in the fact that, for commercial contracts, operators want proven technologies. In the new market, R&D expenses have globally shifted towards the supplier side. But operators and infrastructure owners don’t like to bear risks of innovative solutions and prefer on-the-shelves products.

ERTMS has been a key experience for operators as their role has shifted from technical to functional specifications. They are not any longer as much responsible in the technology development as before, letting manufacturers doing their role in the definition of technological specifications. In addition the role is split between operators for on-board equipment and infrastructure owners for track-side equipment. While this separation of roles was a condition for the opening of rail markets it has led to a new challenge for system integration: the number of partners and decision-makers has significantly increased. As a result the implementation of systemic innovations such as ERTMS is more complex, in particular as to the decision-making process and the management of interfaces.

Technical and operational harmonization
When the first main deployment projects entered the testing phase (between 2005 and 2008), interoperability issues appeared in several corridors, creating a lot of discussions between the main actors of rail systems in Europe and the EC. It appears that operational rules of the various railways were not yet harmonized at that time. Some interoperability issues were detected in some cases related to these national procedures: If usually it is more related to processes and infrastructure owners, it still affected the interoperability, as usually also embedded in the software of the signaling control. At that time it appeared that ERTMS has been promoted as a European Standard, pushing the industry to deliver standard products whereas railways had not worked on their way to harmonize operational rules for ERTMS lines.

Pushing first a technical standard for interoperability that de facto required in project implementation to solve the remaining operational interoperability was probably the only way to go forward. But major operators had strong difficulties to find convergence in such areas, with the weight of their organizations and habits. Therefore a lot of specific transfer modules (STM) have appeared since 2005 to answer specific national needs and accommodate various operators’ strategy. When ERA conducted an audit on STMs in 2008 it found more than 30 types of them in Europe (of which more than 50% were not aligned to the official TSI). Behind this was a clear issue of interoperability and lock-in market strategy, often the result of organizational matters and knowledge related to the former national systems. Since then ERA put more emphasis to ensure that TSI were well followed in Member states.

The recent discussions on the choice of a new signaling system for RER or suburban rail applications is very informative to better understand the link between the cohesion of technology and organizations. In large cities such as London, Paris, Milan or Copenhagen, there were discussions about implementing either the new ERTMS system or the metro signaling standard. If in a first round discussions were focusing on the technological and operational particularities of each system (e.g., stop accuracy, automatic doors on platforms, mix traffic etc.) it appeared that organizational factors could be very important in the decision process. For instance the knowledge of the technical departments of the operator or infrastructure owner is something that plays a significant role in the decision: First through the ability of engineers to supervise the solution’s design and R&D but also to manage the solution implementation, testing as well as its migration phase. Secondly, the proper knowledge management for the operation of the system is also important (drivers, PC operators etc.) as well as its maintenance.

Specific organizational experiences can influence technological choices. It was for instance interesting to see some technical directors of European operators still ignoring the fact that in 2011 ERTMS was working efficiently in several countries. Sometimes false rumors are strongly persistent in some big organizations and they affect either technological trajectories or at least their deployment timeframe. In the case of big networks where a critical mass is reached in term of deployment, the influence is more important on the technological trajectories: as the industry may keep its standards focused on it to rationalize its efforts.

Conclusion
The mutation of the European railway market has implied a redefinition of the roles of each actor: operators, infrastructure owners, manufacturers and institutions. The definition and on-going deployment of the ERTMS standard has been a driving case in the European harmonization process. It also implied an increasing efficiency in the coordination between the main actors at national and European level in order to make ERTMS deployment successful. After a decade of practice, accompanied by deep organization and
institutional evolutions, all actors adapted to the new context, improving their own efficiency while still tailoring their processes.

The aspect of financing could be seen as a strong factor slowing down the harmonization of railway networks in Europe. But organizational issues as well as the reluctance of increased competition were also a critical factor, underlining the fact that organizations remain a cornerstone for any success. The coordination for the deployment of such technologies and standards was key in the new European framework, especially as the changes in the last decade induced a strong increase in the number of actors.

The role of organizational and institutional factors has been key in the mutation of the rail sector. First, through the level and the quality of coordination required between all actors (including EC and Member States). Second, through the level of competence and knowledge required to support an optimal transition to the new technological trajectory. The role of institutions and organizations (e.g., associations such as EIM for infrastructure managers, CER for operators or UNISIG for the industry) has been instrumental in providing a new standardized and interoperable European rail network.

Challenges remain. They include the cross-acceptance of international projects and the decision-making for international corridors based on a high-level approach rather than a segmented and national basis. There are questions related to institutional models and organizations and research shall be conducted in this direction to support the improvement of transportation systems and railways. This will be a cornerstone to build efficient and sustainable networks for the 21st century.

References