UIC European Train Control System

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In an effort to make European rail networks more efficient and competitive with other forms of transport, the International Union of Railways (UIC) has begun developing a European Train Control System (ETCS) that must overcome the complexities produced by a host of different operating conditions, equipment, languages, and signaling cultures. Although the ETCS project is still in an early stage, it seems likely that it will use some of the higher levels of functionality of the Advanced Train Control Systems (ATCS) being developed in North America and rely on a wider range of transmission techniques than ATCS. A staged approach to implementing ETCS is being considered to avoid compatibility problems and the need for dual equipment on track.

The International Union of Railways (UIC), although it has members outside Europe, is primarily concerned with facilitating international rail traffic within Europe. It is the body that sets standards and makes recommendations for rolling stock and fixed equipment used in international traffic—passenger and freight. The UIC's standards and recommendations are also widely used for national traffic. The Office for Research and Experiments (ORE) is the research arm of the UIC, responsible for organizing research work for the joint benefit of the railways.

The UIC has undertaken the development of a European Train Control System (ETCS). Although the project is still in an early stage, some similarities to and differences from the North American Advanced Train Control Systems (ATCS) can be discerned.

EUROPEAN OPERATING PATTERNS

Operating patterns on the European railways differ very considerably from those in most of North America, and this dictates a different approach to the ETCS from that proposed for ATCS, where the emphasis seems to be very much on improving operation of lines with low levels of traffic and little or no signaling. In much of Western and Central Europe, the density and distribution of population (Figure 1), with major centers of population a few hundred miles apart, are favorable for intercity passenger transport by rail.

The size and density of development in and around major centers are also favorable conditions for rail to handle a significant proportion of local traffic, especially commuting. Government has often regarded subsidizing rail passenger transport as socially desirable. This means that in Europe there is a much greater emphasis on passenger traffic than in North America, and on some national railways this is much more important than the goods traffic.

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There is a wide range of speeds and densities of traffic on European railways. In most countries there is an intercity network carrying mixed traffic, including high-speed intercity trains. In the last 15 years or so, some countries have built new, very high-speed lines for speeds up to 185 mph; some of these are dedicated to high-speed passenger traffic only, while others carry mixed traffic. There are also suburban networks carrying very dense passenger traffic, rural branch lines with lower traffic levels but mostly carrying both passenger and goods traffic, and some lines carrying goods only.

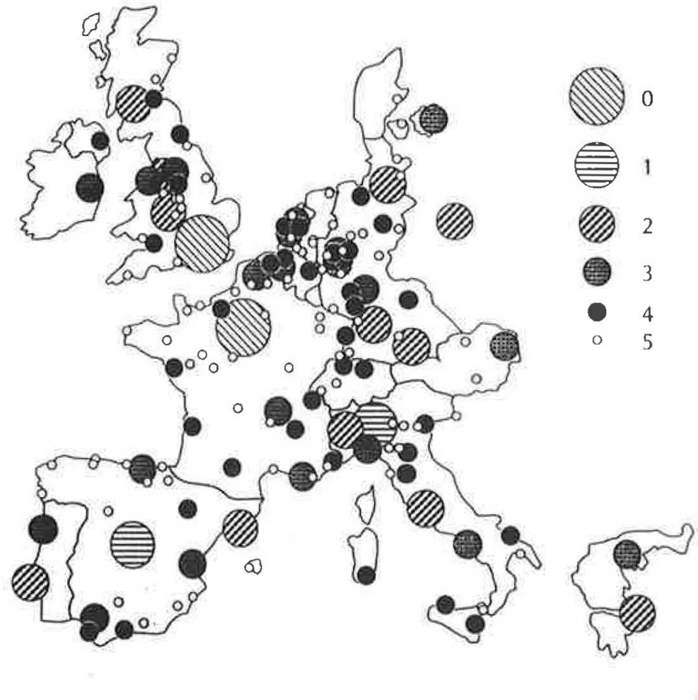
It follows that the European railways are "scheduled railways" and that most of the "management" applications of ATCS emphasized in North America are already looked after by Europe's national systems. The combination of these national systems into an overall European system for the management of international freight traffic is the aim of other UIC projects outside the scope of ETCS.

Most European railways were provided quite early on with comprehensive systems of lineside signaling, using semaphore signals, mechanical interlocking, and block telegraph. Over the last 30 or 40 years, the more heavily trafficked lines have generally been reequipped using relay technology, extensive track circuiting, and mainly with colored light signals. However, it was often uneconomic to apply this technology to lines with lower levels of traffic. Until recently there was no economic alternative to retaining the old equipment on these lines, so many have signaling that is obsolete—in some cases downright antiquated—and labor intensive to operate and maintain.

In most cases, warning, cab signaling, or speed supervision systems have been overlaid on the lineside signaling system. Only recently, on some very high-speed lines or very densely trafficked urban lines, have lineside signals been dispensed with. These warning or supervisory systems are of various ages and provide various levels of protection against driver error or inattentiveness. Some of the older ones are now considered to be obsolete or inadequate for present needs and require replacement.

INCOMPATIBLE NATIONAL SYSTEMS

Language problems, the political situation in Europe up to the middle of this century, and the different topographical and meteorological conditions in different parts of Europe led to very different solutions to signaling and train control problems in the past. Systems were, in general, developed to meet national needs, and compatibility with systems in adjacent countries is the exception rather than the rule. (In the context of compatibility it is interesting to note that no two adjacent countries in Western Europe have adopted the same



D'après RECLUS, 1989

Les villes européennes		
0	Population supérieure à 6,4 Mio d'habitants	
1	Population entre 3,2 et 6,4 Mio d'habitants	
2	Population entre 1,6 et 3,2 Mio d'habitants	
3	Population entre 0,8 et 1,6 Mio d'habitants	
4	Population entre 0,4 et 0,8 Mio d'habitants	
5	Population entre 0,2 et 0,4 Mio d'habitants	*Mai 1989*

FIGURE 1 Major population centers in the European Community.

electric traction system.) An attempt by ORE in the 1960s to produce an international track-train information transmission system was not really successful; the system produced was considered by most railways to be too heavily biased towards the requirements and practice of its country of origin.

This incompatibility has not been a serious problem until now, because the locomotives of most international trains are changed at or near the borders. However, these stops at borders have been a significant factor in limiting increases in the commercial speed of international passenger (and freight) services, a problem that has contributed to a decline in the competitive position of rail relative to road and air travel. Now not only do the railways wish to improve their competitive position, the European Community itself, faced with severe congestion on the roads and in the air, sees high-speed rail services as essential to its future development and has produced a plan for a network of high-speed railways (Figure 2).

This network will consist partly of new lines and partly of upgraded existing lines, some of which are already in service, (although only carrying national traffic). Others are under construction. On this network, stops at the borders will no longer be acceptable; border formalities are being greatly simplified. Those formalities that are not abolished will be carried out on the moving train.

The very high-speed passenger trains of the future will be made up of permanently coupled consists, including the motive power. Modern power electronics makes it feasible to construct multisystem tractive units. Limited multiple-equipping of locomotives for different train control systems is used on some routes and will be used on others in the future (e.g., Paris–Brussels–Köln–Amsterdam and London–Paris–Brussels), but this is limited by constraints of space, weight, and cost.

The above considerations have provided the stimulus to look at the possibility of a common range of train control equipment for the whole of Europe. A further incentive is that a common range of equipment would allow production on a larger scale and increased competition among suppliers, all of which should reduce the cost of equipment to the railways and should also simplify maintenance of international trains. Over the last few years a great deal of consideration has been given to the best way of tackling this question, and the evolution of ATCS has been of great interest. The result of this consideration has been a project to develop a system capable of meeting the full range of the European railways' requirements for internal as well as international traffic.

COMMUNICATION BARRIERS

Another aspect of incompatibility among countries' railways—and a difficulty that must be reckoned with in the

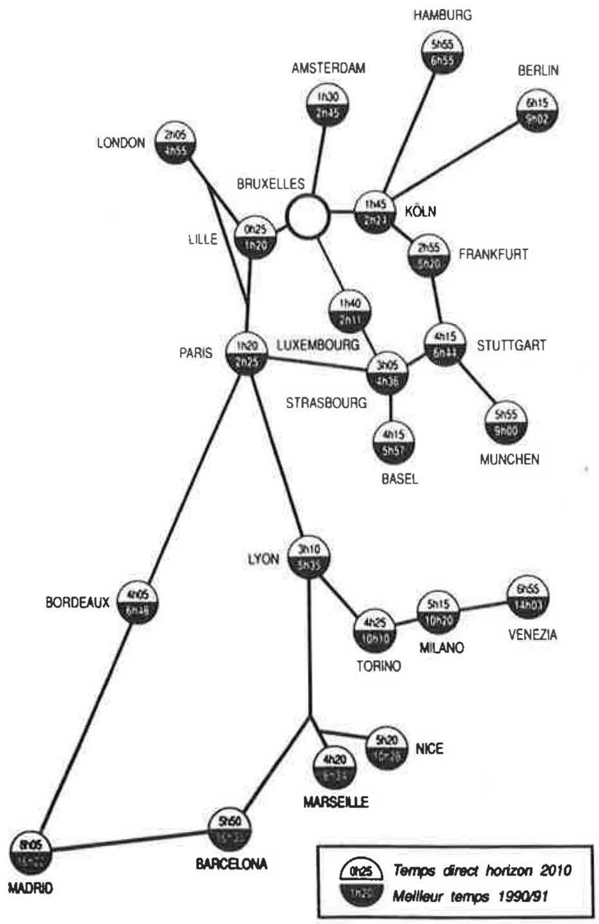


FIGURE 2 Future and present rail travel times from Brussels.

creation of a common ETCS—is the communication problem among the signal engineers or operators of the various countries. It is not just a language problem, although this problem is big enough, with more than 17 languages being spoken in the countries where the system may eventually be installed.

Just three of these languages (German, French, and English) are the official working languages of the UIC. Thus, for only a minority of the signal engineers is one of the three UIC working languages their native tongue. However, even in those cases, the communication problem is not solved, as the signaling cultures in the German-, French-, and English-speaking parts of Europe are so different that many concepts exist in just one of these languages and cannot be translated one-to-one into the signaling cultures of the other two.

To avoid some of these problems, the UIC has decided to use English as the only working language on the ETCS project, but this is not a complete solution. The now-active signal engineers were brought up in isolation in different subcultures, a fact that has led to great reluctance to adopt solutions or principles developed outside their own countries. In some cases, there is a reluctance, or even an inability, to understand the principles and solutions of other administrations. However, working closely together in a small group for a large proportion of the time should make it possible to overcome this problem, and this, in fact, is how the project will be organized.

THE ETCS PROJECT

It is self-evident that to cover the very wide range of the European railways' requirements adequately and do it at a cost commensurate with the different levels of traffic, a multilevel system, comparable to ATCS, is needed. Another point of similarity is that the UIC is also aiming at a modular system, specifying the modules in sufficient detail to allow interoperability between those from different manufacturers. The UIC is not aiming to develop equipment itself; this remains the manufacturers' task.

Because the project is in an early stage, the number and functionality of the levels have not yet been defined. This will be one of the first tasks after the full range of the railways' requirements has been established—work that is being done at present. It seems likely that the levels will be displaced upwards in comparison with ATCS; there is no interest in an equivalent of Level 10 and only limited interest in an equivalent of Level 20.

There is, however, interest in an equivalent of Level 30 that could be applied to secondary lines, especially where the signaling equipment is obsolete, but the greatest immediate interest is in the equivalent of Level 40—and possibly a level above this—for lines at the higher end of the range of speeds and traffic densities. The essential functions would be to enforce limits of movement authority and speed limits. The UIC will have to investigate to what extent such functions as train detection, train separation, and interlocking should continue to be carried out by conventional means or be incorporated into the new system; it is quite likely that both alternatives will have to be provided.

At the lower levels, corresponding to Levels 30 and 20 of ATCS, it seems likely to be economic for these functions to be incorporated into the new system. In particular, the low levels of traffic and light trains on many of the lines to which these levels would be applied make track circuits both uneconomic and unreliable. On many of these lines, train detection is still visual (i.e., done by signalmen). An economic technique for locating trains and proving them complete is needed that does not require significant additional equipment on-train, because a large proportion of rolling stock must be able to use such lines from time to time. This rules out the use of satellite navigation systems, which would not be applicable to the more heavily trafficked lines and so would require train equipment that would be underused.

The above considerations mean that the UIC will have to consider a wider range of transmission techniques than those proposed for ATCS. A number of techniques are used in the various systems installed on different railways, and it is likely to be a question of choosing which to use rather than of developing new technology. For discontinuous track-train communication, ETCS will probably use fixed-message transponders, as does ATCS, at the lower levels. But at the higher levels, ETCS will probably also use switchable transponders (i.e., the message can be varied according to information from other signaling equipment on the ground) or active beacons.

For radio transmission, the UIC has decided to concentrate its efforts on using the new train radio system it has decided to develop. This will be an all-digital voice/data system operating in the 900-MHz band, using as much as possible of the technology being developed for the public mobile radio networks. Provision will have to be made in the higher levels of the system for supplementing radio transmission by continuous track-train transmission, possibly two-way, to provide for cases in which the intensity of messages would become too great for the available radio channels or there are problems of breaks in continuity of radio coverage.

A major question is how to make the transition from the present multiplicity of systems to the new standard one. A suggested approach is to provide a data bus to which are connected a central processing unit (probably itself of modular construction), interface modules to the pickups for existing and new systems, train radio, brakes, and the driver's display/control unit. Trains would be equipped only with those modules needed for the lines they run on. The relevant modules would be added when the standard system is installed on those lines and removed as old systems are withdrawn. This would enable networks to be equipped with the new system in a staged manner, without compatibility problems or need for dual equipment on track. The new system would often be introduced in conjunction with resignaling on heavily used lines, while on more lightly used lines it would replace the old signaling completely.

It should be emphasized, however, that this project is only at an early stage. These preliminary thoughts could change as ETCS develops.