ENHANCING INTEROPERABILITY FOR FACILITATION OF INTERNATIONAL RAILWAY TRANSPORT
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ENHANCING INTEROPERABILITY
FOR FACILITATION OF
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EXECUTIVE SUMMARY

Efficient international railway transport depends in part on high level of interoperability among the railways. Interoperability of railways, however, is a very broad concept and its implementation requires the cooperation of many entities, large budgets and a long time, it is very important for the involved countries to define as precisely as possible the level of interoperability they intend to achieve, most likely in a gradual approach.

The study details three main components of railway interoperability (a) unified contractual obligations vis-a-vis customers from origin to destination (or the legal interoperability) (b) common technical parameters of railways infrastructure and rolling stock (or the technical interoperability) (c) harmonized operational practices over an entire international route (or the operational interoperability).

The study defines three levels of technical and operational interoperability- level A - wagons of the train cannot cross the border, level B - wagons of the train can cross the border and level C - wagons and locomotive of the train can cross the border. It further identifies (a) technical parameters for railway infrastructure and rolling stock to be agreed for enhancing technical interoperability (b) operational parameters for defined level of operational interoperability.

The operational interoperability aspect goes beyond railways to harmonization of rules and regulations of other border agencies such as customs that are involved in international railway transport. Legal interoperability could be ensured if the railway of region become members of one of the railway organization.

The countries of region could learn from the experience of European Union that has been taking number of steps to enhance interoperability of railways in Europe. For achieving interoperability countries in the region must adopt a pragmatic approach, based on result oriented decisions, with achievable targets on short, medium and long term.
It is expected that the member countries would play a major role in achieving interoperability in railway through following: (a) support the investments in railway infrastructure to achieve technical interoperability; (b) harmonizing the regulatory framework for the railway industry (mainly common safety rules) to facilitate cross-recognition of rolling stock; (c) streamlining border crossing procedures to facilitate international traffic; and (d) implementing uniform commercial and legal framework for international rail transport.

The study concludes by suggesting that ESCAP could offer a common platform for all countries in the region for activities related to the railway interoperability subject, preserving common data base and knowledge for member countries. Enhancing interoperability in railways is a means to end which is to achieve more efficient international railway transport to support sustainable development among the countries this study attempts to provide ideas for higher interoperability among railway of the region.
ENHANCING INTEROPERABILITY FOR FACILITATION OF INTERNATIONAL RAILWAY TRANSPORT

I. BACKGROUND

In the current global economy, the economic opportunities are related to the mobility of people and goods, and robust economic development requires a strong transportation system. Transport provides access to markets by linking producers and customers, making trade possible, and boosting the countries’ development. Efficient transport systems reduce costs in many sectors providing enhanced economic and social opportunities and benefits, while inefficient transport systems increase these costs.

Today’s complex economic and social environment raises challenging questions related to the future of the transportation system as an indispensable component of our lives. Increased transport not only involve appropriate infrastructure, but also improved managerial expertise for organization and management of transportation services. At the same time, due to globalization challenges, countries would benefit from harmonized transport policies and planning.

These are not easy challenges to be faced, as their achievement requires issuing new legislation, common investments in technically compatible transport systems, and eliminating barriers to international transport. These issues must be addressed taking into consideration national security concerns, common targets on public safety and environment, the inherent monopolistic tendency in many transport modes, as well as the foreign ownership of the vital transport industry to protect national interests.

These questions cannot be answered by the transport services providers alone; they require direct involvement of many parties in the transport logistical chain, including the policy makers of all countries in a region.
In the context of defining a better environment for the international transportation system as support for economic development of the various regions of the world, the railways have a key role to play. Railways may offer appropriate solutions to many challenges countries face in their race for economic development, including a more sustainable transport.

UNESCAP Resolution 71/7 on Adoption of Regional Cooperation Framework for the Facilitation of International Railway Transport expresses the commitment of member states to cooperate toward the development of efficient international railway transport to support sustainable development.

To achieve this goal and consolidate their share of the transportation market, railways of ESCAP region must offer a cost-effective transportation choice to help member countries meet their development goals.
II. ASIAN\(^1\) RAILWAYS – GREAT POTENTIAL TO BECOME MAJOR INTERNATIONAL CARRIER

The railway network is one of the most important transport networks in the world, with more than 1 million km of track. The railway network in Asia has 232,675 km of track and represents about 23 per cent of the total railway network in the world, without considering the Russian Federation railway network, which is partially located in Europe. Figure 1 below illustrate that the Asian railway network is an important part of the worldwide railway system.

![Figure 1: Length of railway lines (km)](image)

About 9.7 trillion of ton-km and more than 3.07 trillion passenger-km were transported on the worldwide railway network in 2014. Asian railways have an important share of the annual volume of freight transported in the world with about 3,359 million ton-km representing about 35 per cent of the total freight volume transported in 2014 by rail (see Figure 2). Concerning the passenger transport, Asian railways are by far the dominant railway network in the world with 2,379 million passenger-km, representing about 78 per cent of worldwide passenger traffic operated by railways in 2014 (see Figure 3).

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1 The charts and tables in this chapter use data from the UIC Statistics – 2015, from OECD Reports or from other Governmental Reports indicated in the bibliography of this study.
In this context, it is important to note the dynamic development of the railway transport sector in Asia during the last decades. The comparative evaluation of the trends in the railway transport market between various regions of the world, illustrates that the railways in Asia have the most vigorous growth of transported volumes of freight and passengers since the year 2000. Thus, considering 2001 as the base year, Asian railways transported in 2014 a volume of freight higher by 171 per cent, superior to any other region of the world (see Figure 4). Regarding the passenger transportation, during the same interval, the Asian railways increased the volume of their services by 192 per cent, achieving similarly, the highest percentage increase compared with the rest of the world (see Figure 5).

2 NOTE: Data used for Figures 4 and 5 includes the Russian Federation data to the traffic of Europe. A fair distribution of the traffic data of the Russian Federation between Europe and Asia would make the development of the traffic on the Asian railways even more impressive.
Figure 4: Freight railway traffic evolution

Figure 5: Passenger rail traffic evolution

Figure 6: Traffic density by regions (Traffic units/km)
Figure 6 illustrates that the traffic density\(^3\) on the Asian railway network (light blue color line) is the highest in the world, almost double compared with the world average (yellow color), about three times higher than in America and about six times higher than in Europe. It illustrates the reliable performance of certain Asian railways able to operate with high safety standards on very crowded railway networks. It also underlines the need for further construction of new railway lines in Asia, to be able to address properly the continuously increasing needs of transport.

The above data reflect the potential of the Asian railway transport sector in the global context. Important railways are operating in Asia with remarkable results. Figures 7 and 8 present the major railway carriers of freight and passengers in Asia.

\[\text{Figure 7: Share of freight railways in Asia (Billions ton-km)}\]

\(^3\) Traffic Density is an indicator used to measure the level of utilization of a railway network and it is calculated by dividing the annual volume of traffic units (passenger-km + ton-km) realized by a railway to the total length of its lines [traffic-units / km of track]
The railways from China, India and Kazakhstan operated in 2014 about 96 per cent of the total freight volume of railway traffic in Asia. Concerning the passenger railway traffic, China, India, Japan and Kazakhstan operated 92 per cent of the total railway traffic in Asia. The traffic operated by the railway from the Russian Federation is not comprised in this statistic, as its volumes of traffic are considered in the UIC Statistics as part of the European railways community. However, for a comprehensive analysis of the Asian railway sector we have to consider also the performance of the Russian Railways which operated in 2014 about 2,299 billion ton-km (comparable with the total traffic of Chinese Railways) and 129 billion passenger-km (more than 50 per cent of the traffic of Japan). When assessing the potential of the railway sector in Asia, it is relevant to note that some of the most important railways in the world operate in Asia.

Another important aspect regarding the relevance of the railway sector is the share of each mode of transport in the total transport market. Usually, the railway market share (measured in traffic units\(^4\)) varies in most countries below 15 – 20 per cent for freight transport, and below 7 – 10 per cent for passengers. As the collection of data for road transport measuring the volume of operated traffic units (ton-km or passenger-km) is rather complex process, not all countries publish regularly such information; for this reason, a comprehensive comparison for all Asian countries is difficult to be identified. Based on the existent statistics some railways in the region achieved impressive share on the domestic transport market, as presented in Figures 9 and 10.

\(^4\) Traffic Unit = ton-km or passenger-km, depending on type of traffic
The data from the two tables illustrate that in those countries, railways play a major role in the transportation system of their countries. Such impressive market share is characteristic for countries with very long distances of transport, where railways have a clear advantage compared to road transport (e.g. USA, Canada, Australia have comparable performances concerning the achieved market share with the Russian or Chinese railways), or in countries where the road network is not sufficiently developed yet. In this context, it is important to highlight the significant market share in domestic transport of some Asian railways.

High market share of a transport mode is tightly related with the efficiency of services provides to the customers. One of the essential elements in the efficiency of railways, as service-oriented companies is productivity of staff. The railways of the region have a good labor productivity compared with railways in other regions of the world (see Figure 11). The average labor productivity of railways of the region (2 million traffic units per staff – see light blue bar) is close
to the world average (2.04 million traffic units per staff – see yellow bar), but superior to the average productivities achieved by the railways in Europe, Africa or Middle East. Only the American railways achieve a better productivity than the Asian railways.

**Figure 11: Railways labor productivity by regions (Traffic units/Staff)**

![Bar chart showing labor productivity by regions]

<table>
<thead>
<tr>
<th>Region</th>
<th>Productivity (Traffic units/Staff)</th>
</tr>
</thead>
<tbody>
<tr>
<td>America</td>
<td>12,406,898</td>
</tr>
<tr>
<td>World Average</td>
<td>2,328,060</td>
</tr>
<tr>
<td>Asia</td>
<td>2,040,725</td>
</tr>
<tr>
<td>Africa</td>
<td>2,000,630</td>
</tr>
<tr>
<td>Middle East</td>
<td>847,159</td>
</tr>
<tr>
<td>Europe</td>
<td>628,598</td>
</tr>
</tbody>
</table>

However, it is important to point out that the American railways are mostly freight oriented railways, while the Asian railways include important passenger-oriented railways (India, China, Japan) which require a larger number of staff. The efficiency of Asian railways is more visible if we compare their staff productivities with some of the most efficient railways in the world (see Figure 12). The selected Asian railways in the chart (Russia, Japan, China, Kazakhstan, India) are mixed services companies including freight and passenger transport operations, with a similar structure of traffic as that of the European railways (France, Germany). In this segment of activities, Asian railways obtained very good performance, illustrating their capacity to operate competitively on their domestic markets. Railways from the USA or South Africa are mostly freight oriented and this explain their impressive productivities. Figure 12 includes railways with different gauges (India, Russia, USA, China, Japan, South-Africa) as examples of some of the most efficient railways in the world. It illustrates that track gauge by itself is not a barrier to providing competitive transport services.
Figure 12: Railways labor productivity by country (Traffic units/Staff)

- USA: 14,203,199
- South-Africa: 6,220,375
- Kazakhstan: 3,232,831
- Russian Federation: 2,946,334
- Japan: 1,750,121
- China (Pop. Rep. Of): 1,540,384
- India: 1,367,730
- France: 771,374
- Germany: 520,639

All the above information shows railway transport as a reliable component of the domestic transportation system in many Asian countries. Globalization and the rapid economic development of the world during the last decades, as well as the population’s increased mobility, in the framework of market liberalization, have made the countries more and more dependent on their transport systems and created ideal conditions for more railway transportation services. The longer distances of transport specific for international markets and higher volumes to be transported with lower impact to the environment are the strong points in favor of railways in their competition with other modes of transport.

Despite these positive premises, the reality is that railways in the region are less successful on seizing the expected share of the international transport market. Presently, 98 - 99 per cent of goods traded between the Europe and the Asian Pacific region are transported by sea while the land transport crossing Asia barely accounts for 1 – 2 per cent. Becoming a competitive player in the international transport market is not easy for railways, and will certainly not be automatic. It requires providing quality transport services (price, speed, availability, punctuality, etc.) superior to those offered by the competition. In this way, railways could become an attractive option for shifting part of the existing volumes of traffic to rail or for taking on railways the new volumes of traffic generated by the economic development of the countries.
It is important to point out that the competitiveness of railways should be understood in the context of logistic chains, as the decision for a specific route or mode of transport is made not by the shippers, but by the logistic operators (freight forwarders). The role of the government and of the railway companies is limited only to create the adequate legal environment, to develop the transport infrastructure and to eliminate the operational barriers in developing flawless international transport services.

This study does not address all aspects of railway competitiveness; it tries to define the ways to make the railways of the region work better together for becoming one of the preferred carriers on international transport market.
III. RAILWAYS – FROM ISOLATED NATIONAL NETWORKS TO INTEROPERABLE CONNECTED NETWORK

Railways had a rapid development starting with the 19th century and quickly became essential for the fast movement of goods and of labor force necessary to the industrial revolution. Railway companies have been created in a relatively short period of time in many countries, as integrated and self-regulated entities in charge of the construction and maintenance of their infrastructure (track, tunnels, bridges, stations, shops) and with the provision of the transport services. As the business of the railway companies was limited for many years to their domestic markets, they developed their assets and their company culture independently, as their business ends at the national borders. It generated specific technical standards, operating rules, commercial contracts with the customers or institutional frameworks specific to each country. During that period railways did not face any serious competition and became the dominant mode of transportation; consequently, railways imposed their own rules and regulations on customers who, in most cases, did not have other alternatives. This approach worked successfully over a period of more than one hundred years, until the mid of 20th century, when the market environment changed dramatically.

The rapid development of road networks and the quick development of the automobile industry took place in most of the world after 1950. At the same time, a new economic development pattern required more and more trade between different countries or regions of the world and a new business environment was created by the gradual economic integration and lately by globalization. It was not easy for traditional railways, self-regulated companies with rigid rules, developed as isolated national transport networks to face the challenges of the new environment which requires flexibility and dynamic reaction to the needs of the continuously changing marketplace. Railways from different countries, having a strong culture of operating trains on isolated networks, had to face the challenges of a completely new transport market, open to competition, with more sophisticated customers, and with requirements of transport beyond the national borders. Suddenly, traditional railways discovered that their business culture was based
on obsolete concepts and they were trapped by technical constrains and operational and commercial behaviors inadequate to the new market environment.

A very complex process of adapting railways to the new market requirements started in all regions of the world, and it is not yet finished. All “good behaviors” from the past, proven as efficient for more than a century of activity, must be replaced by a new culture. Railways developed as isolated entities have to find ways to interconnect their networks and their business to become competitive by delivering flawless transport services from origin to destination, regardless of how many railway companies are involved in the process. They have to find ways to work together to better serve their customers. Common standards for working together had to be identified and agreed. This is how the notion of interoperability was embraced by railways.

The definition of interoperability depends on the domain of application. In rail transport, the concept of interoperability was adopted along with the implementation of European Directives for the establishment of the seamless railway market and the increase of transport by rail between countries in the European Union. The definition of interoperability, in railway terminology, is given by the Directive 2008/57/EC as follows: “Interoperability means the ability of a rail system to allow the safe and uninterrupted movement of trains which accomplish the required levels of performance for these lines. This ability depends on all the regulatory, technical and operational conditions which must be met to satisfy the essential requirements”.

About 25 years ago, when the integration process started in the European Union, railway companies from the member states were hardly able to offer a railway transport service from origin to destination across the EU territory due to numerous barriers, such as: three different track gauges, different clearance for track, tunnels or bridges, four types of electrical traction for locomotives, about 20 different signaling systems, different axle loads, different speeds, different operating rules, different maintenance regulations for rolling stock, different safety standards, etc. Billions of euros have been allocated by the member states to eliminate the technical incompatibilities and implement new common regulations and working rules. The process is not
yet finished and due to the large budgets required, a long time is still necessary for gradual achievement of full interoperability of railways.

Of course, the level of interoperability targeted by the European Union or the mechanisms to achieve the interoperability do not fit other regions as a “copy-paste” approach, but the goal of interoperability is a valid one for all railways which want to increase their competitiveness. Comparatively, in Asia, the railways from the former Soviet Union, which were part of a unique network for many years, inherited a more integrated railway system, with common technical, operational and commercial rules in all member states. Today, this is a useful asset for promoting smooth international railway traffic in Asia. It would be highly recommended to preserve the inherited interoperability by harmonizing the railway development plans in the region.
IV. COOPERATION IS THE KEY FOR THE INTERNATIONAL COMPETITIVENESS OF RAILWAYS

One major advantage of the railway transport system is that railway vehicles are moved on wheels rolling on a rigid rail which, due to lower frictional resistance, requires far less energy per ton-km moved than road transport. At the same time, the fact that railways are the only guided transport mode induces a more complex mode of organization of transport process, compared with road, air of sea transport.

For obvious safety reasons, only single train can be operated at a given time, on one railway track. In means that precise planning of circulation (timetable) of each train must be elaborated, including running times for each interval between two consecutive stations, times of arrival, duration of stopping and times of departure for each station, specific place and precise time of crossing other trains circulating from opposite directions on single lines, for passing a slower train or for waiting to be passed by another train, etc. Based on specific operating rules, the planning of circulation must include the intervals of times necessary for various technical or operational procedures for attachment / detachment of wagons, revision of breaking system of wagons, changing the train crew, changing the locomotive, etc.

As hundreds of trains can be operated each day on the same network, the pathways of all trains must be mapped for safe operation. During the circulation of trains, unexpected events (e.g. failure of a vehicle in train, external causes) may produce a deviation of a certain train from the planned timetable; consequently, the train will fail to arrive at the planned times in the locations where it is supposed to pass other trains, exchange wagons with other trains, connect with other trains (in case of passenger traffic), etc. A delayed train produces a domino effect in the operation of many other trains and corrections must be done by the traffic management centers to continue the operation of trains safely and to diminish the negative impact of unexpected events. Railways, as a guided transport mode, have more limited flexibility in cases of deviation from the traffic program, compared with other modes of transport.
The planning and management of circulation of international trains is even more complex. First, any international train must be technically compatible with the infrastructure of other railways and to map with the domestic trains operated on the same infrastructure. Apart from the technical interoperability issues, complex operational interoperability aspects need to be harmonized between neighboring railway companies to operate international transportation services.

Additionally, at border stations, the activities of many entities, which are not subordinated to railways (customs, phytosanitary, veterinary, immigration, etc.) must be harmonized between the neighboring railways. As many of these operations are executed by state authorities in charge of aspects sensitive to national security, reaching agreements and keeping under control the planned duration of such operations in a timetable is not easy.

Finally, the contractual obligations of railway companies involved in international transport must be harmonized from origin to destination to give customers the comfort that any contracted transport service is protected by commonly agreed upon provisions against any risk, and that liabilities are accepted by all involved railways.

In the current transport market, the competitiveness of any expedition depends on three major factors: duration of transport from origin to destination (*time*), the general quality of services during the transport, such as informing customers of the position of the expedition and the guarantee of the time of arrival at the destination (*service*) and the cost of transportation services from origin to destination (*tariff*).

Good timetable planning of international trains and a precise execution of scheduled expeditions, based on harmonized operating procedures and single contract with commonly accepted obligations in front of customers, are vital elements for delivering the expedition to the customer at the desired destination, at the guaranteed time, and with the lowest operating costs.
Providing poor quality services or delaying international trains is very likely to happen if a very tight coordination is missing among railways, governmental institutions, and countries on the route. The competitiveness of the international railway transport is a matter of active participation in a coordinated approach of all involved parties; as in all cases of logistic chains, the quality of operation of international traffic along a certain route is defined by the weakest link of the chain.
V. THE COMPREHENSIVE APPROACH TO RAILWAYS INTEROPERABILITY

In very general terms interoperability is defined as: a property of a product or system, whose interfaces are completely understood, to work with other products or systems, present or future, without any restricted access or implementation. To make railway interoperable with other railway means to harmonize the technical parameters, operational procedures and legal environment of the two entities. This is a complicated goal, as it depends of the interoperability of many other entities in the countries the two railways belong. International experience shows that achieving railway interoperability may become in some cases an exceptionally difficult task, as it requires strong political support and active involvements from all involved countries to harmonize national policies and practices.

Railway interoperability can be achieved through a coordinated approach of the member countries in three major directions (see Figure 13):

- unified contractual obligations vis-a-vis customers from origin to destination
- common technical parameters of railways infrastructure and rolling stock
- harmonized operational practices over an entire international route

**Figure 13: Components of railway interoperability**

![Diagram of railway interoperability components: Operational, Technical, Legal Interoperability]

The three components of the railway interoperability (technical, operational, legal) are tightly interconnected. First, the unified legal framework in the relationship with the customers is essential, regardless of the level of technical and operational interoperability. Second, achieving a certain technical interoperability through large investments is not justified if this is not capitalized in achieving appropriate operational interoperability for obtaining the targeted competitiveness of railways on the market.
Consequently, there are different levels of interoperability for providing international transport service by rail and the targeted level should always be defined taking into account the competition with other modes of transport.

As the interoperability of railways is a very broad concept and its implementation requires the cooperation of many entities, large budgets and a long time, it is very important for the involved countries to define as precisely as possible the level of interoperability they intend to achieve, most likely in a gradual approach. Countries in the ESCAP region must adopt a pragmatic approach, based on result oriented decisions, with achievable targets on short, medium and long term.

The major railways operating in ESCAP region (Russia, China, India, and others), with excellent records in operating domestic traffic can become the backbone of a much more competitive railway community, one able to capture more than the current modest one per cent share of the international transport market.

Governments must take the lead in the process and coordinate the activities of all involved state entities to develop and implement common rules and procedures to achieve railway technical, operational and legal interoperability. It is expected that the governments will play a major role in achieving the following:

- Support the investments in railway infrastructure to achieve technical interoperability
- Harmonizing the regulatory framework for the railway industry (mainly common safety rules) to facilitate cross-recognition of rolling stock
- Streamlining border crossing procedures to facilitate international traffic
- Implementing uniform commercial and legal framework for international rail transport
VI. TYPES OF BORDER CROSSING AND LEVELS OF INTEROPERABILITY

Border crossings are the points of fracture of continuity in transport services. There are many forms used by railways for the organization of activities for the border crossing, but relevant should be only the level of interoperability achieved. For evaluating the levels of interoperability, the following three main modes of organizing the border crossing activities can be defined:

- **MODE 1**: the various authorities of the two neighboring countries develop their procedures separately, sequentially, first in the exit border station and then in the entry border station
- **MODE 2**: the two neighboring countries agree to designate one single common border station, where the procedures of the authorities of both countries take place in parallel
- **MODE 3**: the two neighboring countries decide to implement common procedures for border crossing without the train stopping; the specific border crossing activities are organized in designated major stations on the route of the train, agreed upon by the two neighboring states, in parallel with the procedures of the railway companies for processing the train (locomotive change, technical inspection of wagons, etc.).

The border crossing is also the point of connection of the railway networks of the two neighboring countries. The level of technical interoperability of the two networks is decisive for providing the smooth trip of any international train from origin to destination. Different levels of technical interoperability between two consecutive neighboring railways, could be grouped in three major categories, depending on the existing local conditions, as follows:

- **LEVEL A - Wagons of the train cannot cross the border**: The train will be recomposed with new wagons after the transshipment of the freight. The new train will continue the trip on the entry railway in a new composition. This is a solution that could be used with good results for container transport, where the transshipment is rapid, but it is not recommended for general freight, due to the long duration of operation.
- **LEVEL B - Wagons of the train can cross the border** and continue the route. This requires compatibility between the two neighboring countries for a number of elements of the railway infrastructure and for the wagons.
- **LEVEL C - Wagons and locomotive of the train can cross the border** and continue the route. This is the highest level of technical interoperability, much more complex solution than the previous ones and requires additional compatibilities between the two railways in terms of infrastructure and locomotives.

In real life we may see in each border crossing, various combinations between one of the three modes of border crossing (one of the MODES 1 to 3) and one of the three major levels of technical interoperability (one of the LEVELS A to C). Each of these combinations provide certain operational interoperability, which defines the quality of transport services along a corridor and implicitly, the competitiveness of the railways on international traffic.

Table 1 below presents, in a schematic way, the major modes of border crossing and levels of interoperability between two neighboring railways. It illustrates the importance of all three aspects of the interoperability (legal, technical, operational) and the inter-relation between the three factors in achieving the highest interoperability.

### Table 1: Border crossing modes and interoperability levels

<table>
<thead>
<tr>
<th>Nr</th>
<th>Border Crossing Scheme</th>
<th>Agreed Legal framework</th>
<th>Technical Interoperability</th>
<th>Border crossing mode</th>
<th>Description of the achieved operational interoperability</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td><img src="Image1" alt="Diagram" /></td>
<td>NO</td>
<td></td>
<td></td>
<td>Harmonized legal environment between the two railways does not exist and international trains cannot be operated. Technical and operational harmonization are irrelevant in this case.</td>
</tr>
<tr>
<td>2</td>
<td><img src="Image2" alt="Diagram" /></td>
<td>YES</td>
<td>LEVEL A</td>
<td>MODE 1 or MODE 2</td>
<td>Harmonized legal environment between the two railways is in place. The train stops at the common border station agreed upon by the two neighboring countries. The wagons of the exit railway cannot operate on the network of entry railway. The freight is reloaded in the wagons of the entry railway and a new train with a locomotive from entry railway is composed. Border</td>
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<tr>
<td>No.</td>
<td>Level</td>
<td>Mode 1/MODE 2</td>
<td>Description</td>
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<td>3</td>
<td>YES</td>
<td>LEVEL B</td>
<td>Harmonized legal environment between the two railways is in place. The train stops at the common border station agreed upon by the two neighboring countries. The track gauge of the two railways is different and bogie change is necessary at the border station. The locomotive of the entry railway will replace the locomotive of the exit railway. Border crossing procedures are developed by the authorities of the two states in parallel or consecutively.</td>
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<tr>
<td>4</td>
<td>YES</td>
<td>LEVEL B</td>
<td>Harmonized legal environment between the two railways is in place. The train stops consecutively at the border stations of each country for border crossing procedures. The technical parameters of the two railways allow only wagons to continue the route. Locomotive of the entry railway will replace the locomotive of the exit railway.</td>
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<td>5</td>
<td>YES</td>
<td>LEVEL B</td>
<td>Harmonized legal environment between the two railways is in place. The train stops at the common border station agreed upon by the two neighboring countries. The technical parameters of the two railways allow only the wagons to continue the route. The locomotive of the entry railway will replace the locomotive of the exit railway. Border crossing procedures are developed in parallel by the authorities of the two states in one single point.</td>
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<tr>
<td>6</td>
<td>YES</td>
<td>LEVEL C</td>
<td>Harmonized legal environment between the two railways is in place. The technical parameters and operational rules are fully compatible. The train can continue smoothly the route without stopping at the border.</td>
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</table>
In most cases, international traffic involves more than two consecutive railways to manage the transport from origin to destination, and most international routes will include more border crossings. The border crossing types presented in Table 1 show that in order to maximize interoperability, it is highly recommended that the train continue the trip over the borders from origin to destination, with the same composition of wagons and with the same locomotive (border crossing LEVEL C and MODE 3). However, for various reasons, this is not always achievable, and, at a certain moment, different levels of operational interoperability could be met along the international route, depending on the local conditions of each border crossing.

Interoperability along the international corridors in Asia will be a combination of Levels A to C and of MODES 1 to 3 of border crossing presented before. While the interoperability, may not be in all cases, on the same level along the entire corridor, it is important to highlight that all countries must work together to implement the highest possible level of interoperability, balancing targeted competitiveness with realistic costs.

The general ideas presented above are illustrated by three examples of international railway corridors in Asia, as follows:

- Table 2 presents a corridor linking China and Europe. It can be extended to interconnect with the meter gauge railways from South-East Asia via China.
- Table 3 presents a corridor linking Central Asia Countries and Europe.
- Table 4 presents a corridor linking Southern Asia and Europe. Ideally, this corridor should start from India.

It is important to highlight that the three examples of corridors (Tables 4-6) are operational due to the fact that all railways along the route are members of the international organizations allowing for a unified legal framework (OSJD or COTIF).

Tables 2 – 4 illustrate levels of interoperability that could be obtained, not necessarily the present operational practices. Depending on the track characteristics along the corridors, Tables 2 - 4 include the modes of border crossing presented in Table 1 (MODES 1-3).
Knowing that the different gauge railway lines are characterized by different technical parameters, and that rolling stock is always designed and built to fit the characteristics of the infrastructure, it becomes more evident how complicated it is to achieve the adequate interoperability along the Asian railway corridors over very large distances (5,000 – 12,000 km).
VII. COMMON TECHNICAL PARAMETERS FOR INTEROPERABILITY

A. General considerations on common technical parameters

Technical interoperability is usually the most expensive component to be achieved compared with the operational and legal components of interoperability. It requires very large investments (hundreds of million or even billions of USD), harmonization of policies of neighboring countries and a long period of time for implementation.

There are no technical issues that cannot be addressed when trying to achieve technical interoperability, regardless of the technical differences between the railways. There is always a solution to solve any existent technical incompatibilities; the only issues are the cost of the solutions vis-a-vis the achieved competitiveness. It is very important to understand that the technical interoperability of railways is not a goal by itself; technical interoperability makes sense only if it facilitates a higher level of operational interoperability, implemented by all the railways along a given route. Starting from the necessary level of operational interoperability for achieving the targeted competitiveness on the market, the countries must agree and implement a set of common technical parameters.

These common technical parameters are fundamental for the gradual reduction of the fragmentation of railway traffic between railways of ESCAP region and for connecting with Europe. The agreed upon technical parameters will also guide railways in implementing their future plans for investments in the renewal or extension of the existing railway infrastructure and rolling stock fleet.

It would be relatively easy to propose common technical parameters for cases of developing green field international railway projects. There are already in place precise standards for all major railway constituents. The issue with technical parameters of railways is not the lack of standards, but the need of making right choice of appropriate set of standards for a targeted
performance of a railway. There are international bodies like OSJD, UIC\textsuperscript{5} or AREMA\textsuperscript{6} which developed comprehensive technical leaflets for technical parameters of railways, but there are also many national standards used by the railways and proved as reliable.

In this context, bringing the existent Asian railways (232, 675 km of track representing 23 per cent of the total railway length of the planet) on a common technical platform is much more complicated than choosing a set of standards for a new railway. When defining the common technical parameters to be followed by the Asian railways for facilitating the international transport, it is important to take into consideration the current situation of the existing railways on the continent.

For example, three of the most important railways in the world operate successfully in Asia and each of them owns extended railway networks of different gauges (66,989 km of 1435 gauge track in China, 85,266 km of 1520 gauge track in Russia, and 65,808 km of 1676 gauge track in India). Different gauges are a reality in Asia, where five different gauges exist in various countries (see Table 5); any technical interoperability solution must take this into consideration.

Most major railway corridors connecting Asian railways will include at least one exchange of gauge and it is not realistic to discuss technical interoperability through unification of track gauge in Asia. The common technical parameters agreed upon shall need to define the technical means necessary to allow trains to continue their routes through destination, running over different gauge railways.

\textsuperscript{5} UIC: International Union of Railways (UIC) is the worldwide professional association representing the railway sector and promoting rail transport; one of its objectives is to issue standards for infrastructure, rolling stock, and operation of railways

\textsuperscript{6} AREMA: The American Railway Engineering and Maintenance-of-Way Association (AREMA) was created in North-America for the development of both technical and practical knowledge and recommended practices pertaining to the design, construction and maintenance of railway infrastructure.
<table>
<thead>
<tr>
<th>Nr</th>
<th>Country</th>
<th>Track Gauge [mm]</th>
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<tr>
<td>1</td>
<td>Afghanistan</td>
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<td>9</td>
<td>Indonesia</td>
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<td>10</td>
<td>Iran, Islamic Rep. of</td>
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<td>11</td>
<td>Japan</td>
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<td>12</td>
<td>Kazakhstan</td>
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<td>13</td>
<td>Korea, Democratic People’s Rep of</td>
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<td>Kyrgyzstan</td>
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<td>Lao People’s Dem. Rep</td>
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<td>Republic of Korea</td>
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<td>29</td>
<td>Uzbekistan</td>
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Finally, taking into consideration the huge financial impact of eliminating the existing technical barriers in the Asian railway transportation system, it is highly advisable to develop a strategy for achieving the technical interoperability in stages, starting with the major railway corridors.
Depending on the existing traffic density and the traffic increase potential, priority international routes could be agreed upon or coordinating the investment efforts of the involved countries along each corridor. This way, member countries can better coordinate their efforts, focusing on corridors, and then, at a later stage they can gradually extend the implementation of the common parameters to other lines of their networks.

In conclusion, the following principles are recommended concerning the common technical parameters for Asian railways:

- agree upon a set of technical parameters, essential for the interoperability across the region
- take into account the existence of several track gauges in the region as an unchangeable element
- agree upon the values and methods for harmonization of the technical parameters for achieving technical interoperability
- decide on gradual implementation of technical interoperability, starting with the international corridors, in a coordinated way, depending on the priorities of international traffic

Based on the principles presented above, a list of technical parameters is identified in the present study and is recommended to be discussed for harmonization along the selected international corridors. It will be a long-term process that could be accomplished in a stage approach, by synchronizing in time the investments of the neighboring countries along the corridors.

The technical parameters are grouped in two categories: (i) related to infrastructure, and (ii) related to rolling stock. Parameters of each category are grouped according to the level of interoperability they will allow. (see the LEVELS A – C on Chapter 6)

B. Technical parameters related to railway infrastructure

1. For LEVEL B interoperability
i. **Track gauge**

The track gauge is the distance between the inner faces of the two load-bearing rails forming the railway track and is usually measured in millimetres.

As all vehicles on a rail network must be compatible with the track gauge (appropriate wheelsets), the track gauge is a dominant parameter determining the technical interoperability between various railways. It is difficult to say which is the prefect track gauge, as there are pros and cons for each of them. In general, the narrower gauges are less costly, while the larger gauges allow higher speeds and offer more stability and more capacity. A very important element for choosing the track gauge is the standardization. Most used track gauges in a descending order of the existing length of railway networks are: 1435 mm, 1520 mm, 1676 mm, 1067 mm and 1000 mm.

Currently, when large railway networks are already built on different track gauges, the efforts are directed to develop and to implement technical and operational procedures for increasing the interoperability between the existent different track railways by reducing the operating time in the track changing stations and diminishing the operating costs of railway transport from origin to destination.

ii. **Axle load**

Axle load indicates the maximum weight accepted on an axle of the railway vehicle circulating on infrastructure (track, bridges, tunnels, viaducts, etc.) It is calculated as a fraction of total railway vehicle weight resting on the wheels connected to a given axle. The maximum axle load is related to the strength of the track, which is determined by the characteristics of the components of the infrastructure, including the strength of bridges and viaducts.

Axle load is an important parameter for the design and construction of railway infrastructure which is built to tolerate a maximum weight-per-axle (axle load); exceeding the maximum rated axle load will cause damage to the rail tracks. In order to avoid such situations, in the case of long international corridors, trains are composed to be safely operated on the entire corridor, including the lowest axle load segment.
In some cases, when the axle load is very different from one country to another, it may represent a loss of capacity of transport and a lower efficiency of operations for railways. The agreement of the railways along a corridor to harmonize in time their axle load values is important for the benefit of all involved railways. The challenge for railways is to agree a common target for axle load for each corridor, and to work in good faith for the implementation of the agreement.

iii. **Structure gauge**

The structure gauge is the parameter defining the relevant dimensions of various components of railway infrastructure to ensure safe running of the trains. The term may apply to the minimum height and width of tunnels and bridges, to the minimum distance to railway platforms (passenger or freight), buildings, electrical equipment boxes, railway signal equipment, to supports for overhead catenaries from the track, or to the minimum height and width of the doors that allow a rail siding access into a warehouse.

Allowing a train to run from origin to destination on an international corridor with the same composition of wagons requires all railways along the corridor to have implemented compatible structure gauges. The values agreed upon for the structure gauge should be harmonized with the loading gauge, which is described in the following chapter presenting the technical parameters related to rolling stock. The difference between these two parameters, named *clearance*, will allow to railways to determine the appropriate speed of the train in areas with restricted clearance.

iv. **Passing siding length**

The passing siding (may be called passing loop or crossing loop) is a place on a single railway line where trains circulating in opposite directions can pass each other, or higher priority trains pass over slower or lower priority trains circulating in the same direction. In most cases, the passing loops are located in railway stations.

Sidings are very important for operating efficiency on single track lines. If the international corridors include some sections of single track, the railways along the corridor must agree as
much as possible on a uniform passing siding length, harmonized with the maximum train length (see the definition of “maximum train length” in the chapter of technical parameters related with rolling stock)

v.  **Platform length**
A railway platform is a structure built along rail tracks in a railway station where passengers can get on or can get off the train. The railway platform length must fit in all stations on the route, and should match the maximum length of the passenger trains circulating on an international corridor.

vi.  **Platform height**
The platform height is defined as the elevation of a railway platform above top of rail track. Railways use various platform heights: (i) high, at approximate car-floor height, (ii) low, at approximate top of the rail height, (iii) medium, at intermediate elevation above the top of the rail.

This parameter is very important for the safety of the passengers and is tightly related with the floor height of passenger coaches (see the definition “floor height” in the chapter of technical parameters related with rolling stock). The two parameters must fit together in order to allow safe boarding and disembarking of passengers on and off the trains. It is recommended that the railways along a corridor agree upon common standards for platforms and for the floor height of the passenger coaches along the entire route.

2.  **For LEVEL C interoperability**
   i.  **Signaling systems**
Signaling systems have a vital role in safe train circulation. They provide protection against the collisions, over-speeding or derailments. The high tonnage of trains combined with metal to metal wheel / rail interface means stopping distance can be greater than line of sight; as the speed of trains and the traffic intensity increase, the risk of accidents is higher and the signaling system are more and more sophisticated. Various types of signaling systems have been
introduced in time, depending on the traffic conditions of specific railway lines: timetable, manual block, semi-automatic block, automatic block, etc.

The safety of train movements on the main corridors of any railway network ("core network") is enforced through two systems:

- the signalling system stricto sensu comprised of block systems (open line) and interlocking systems (in stations). The signalling system gives information to train drivers through way-side signals (mechanical or electric signals). Train movements are safe (i.e. trains will not collide with each other), provided that train drivers abide by indications given by signals; and
- the Automatic Train Protection (ATP) system, the role of which is to supervise that train drivers do respect the indications given by way-side signals. In case they don’t, the ATP system will take corrective actions (e.g. apply emergency braking of the train in some circumstances).

ATP systems are comprised of “way-side equipment” and “on-board equipment” on locomotives. Functionally, the ATP systems have two major components:

- Cab signaling refers to a railway safety system that communicates track status information to the train cab (driving position), where the driver can see the information. The simplest systems display the trackside signal aspect (typically, green, yellow or red, indicating whether it is safe to proceed or not), while more sophisticated systems also display allowable speed, location of nearby trains, and dynamic information about the track ahead.
- Speed enforcement, used in modern systems, usually overlays on top of the cab signaling system to warn the driver of dangerous conditions, and to automatically apply the brakes and bring the train to a stop if the driver ignores the dangerous condition.

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7 The term « signalling system » is often used to designate both systems.
Signaling systems are very complex components of railway infrastructure, vital for traffic safety, but they may also be very different from country to country; a notable exception are the railways from the previous Soviet Union, which benefit from a uniform signaling system, with clear benefits for the international traffic (unfortunately, the risks of losing this uniformity exist, due to recent decisions of some railways for different new solutions of signaling).

Compatible signaling systems are important for the highest operational interoperability, allowing the locomotives of one railway to continue to pull the train over the border on the next railway network on the route, up to the station designated as the most appropriate for changing the locomotive for operational purposes. The countries along an international corridor may agree on the level of interoperability of signaling systems they are ready to implement to improve their operational efficiency.

\textit{ii. Traffic management}

Operational Control Centers (OCC) have the role to remotely control the railway traffic, as well as ensure overall supervision of the operation. Train movements will be controlled by dispatchers who have information on the position of the international trains along the corridors. Relevant information is collected by each OCC depending on the equipment existent on the track (block signal systems\footnote{Block Signal Systems to prevent trains from colliding on the same track.} and interlocking\footnote{Interlocking Systems to prevent trains from colliding when changing tracks.}) and on the locomotives. Adequate telecommunication means will transfer the information between OCC’s along the corridor.

The location of OCCs (including area of control for each of them and handover procedures) for traffic management along the corridors is to be agreed by the involved railways. Local control panels will be installed at all stations on the corridor to allow local control in case of disruption or breakdown of the system.

Interoperable traffic management practices are tightly related with the harmonization of operational practices along the international corridors. Interoperable OCC’s may also require
compatible signaling systems and the acceptance of locomotives of one railway to cross the border and pull trains on the next railway network on the route.

Last, but not least, interoperable OCC’s impose a common operating language for communications between the OCC’s and the locomotive drivers. It is a recommended feature to be implemented along the international corridors (competing modes of transport such as sea and air transport have already achieved this level of interoperability), but it will not be possible to be attained along entire length of a given corridor on short or medium term.

**iii. Telecommunications**

The interoperability of telecommunication is a highly complex task requiring sophisticated solutions. Fiber optics, wireless telecommunication and other high technology elements are to be chosen for providing functions specially adapted to railway needs, including data and voice communications. The railway telecommunication system is safety critical and must be designed in such a way that a single point of failure is “fail-safe”\(^{10}\). It should enable reliable communications between dispatchers and train drivers at any time.

It is recommended that telecommunication system would allow for dedicated systems of identification and location of locomotives and train sets to control the freight and passenger traffic. In addition, it should facilitate installation of information and service systems for passengers, for staff in charge of the wagon fleet management, and for exchange of information with customers and state authorities involved in border crossing procedures.

**iv. Traction system**

The traction system defines the type of engine that provides the motive power for a train. Currently, railways are using diesel or electric traction. While diesel traction equipment does not

\(^{10}\) Fail-safe: design feature of an equipment or procedure that in the event of a specific type of failure, prevents or mitigates unsafe consequences and continues to function with the same safety level as when it was operating correctly
require specific rail infrastructure equipment, electric traction depends on the characteristics of the power supply system installed along the railway (electrical substations and catenary system). There are different electric traction systems and the most used types are: 1.5 or 3 kilo-volts direct current, and 15 or 25 kilo-volts alternate current. Different electric traction systems will generate operational incompatibilities and will require changing the locomotive at the border or using multi-system locomotives.

C. Technical parameters related to rolling stock

1. For LEVEL B interoperability
   
i. Loading gauge
The loading gauge defines the dimensions of height and width which must not be exceeded by a rail vehicle or its load to not collide with bridges, tunnels and other lineside fixtures or structures. The loading gauge ensure safe passage of the railway vehicles and their loads through bridges, tunnels and other structures along the track. This parameter is tightly linked with the structure gauge parameter of infrastructure (see definition of “structure gauge” in the previous chapter of technical parameters related to infrastructure).

   ii. Maximum train length
The maximum train length is limited by the passing loop length (see the definition of “passing loop length” in the previous chapter for infrastructure technical parameters). Railways have the interest to operate the longest possible trains, but the composition of trains depends on the characteristics of marshalling yards and passing sidings from each country along the corridor, which may limit the length of trains. Railways along the corridor must agree to harmonize the maximum train length in order to enhance the operational performance by avoiding consecutive re-composition of trains at borders.

   iii. Coupling system of railway cars
A coupling system of wagons (or a coupler) is the mechanism designed for connecting vehicles in a train. It is an essential technical parameter for interoperability as flexibility and convenience
are maximized if rolling stock of various railways can be coupled together. The coupling system includes also the equipment at each end of the wagon that handles the compression and tension forces between the wagons of trains. Various systems of coupling exist in various countries (manual or automatic) and the compatibility of couplers of wagons used in international trains is essential for operation. The countries along the international corridors must agree on compatible equipment and systems to be used for coupling wagons belonging to different countries.

iv. Brake gear

Brake gear is the equipment used on the wagons coupled in a train to enable deceleration, control acceleration (downhill) or to keep wagons standing when parked. The braking system of wagons is more complex than for other vehicles as it needs to control multiple connected vehicles and to be effective even when the locomotive is no longer coupled with the train.

Two major braking systems are used by railways: air operated or vacuum operated brakes. These brakes use hoses connecting all the wagons of a train, so the driver could apply or release the brakes with a single valve in the locomotive. It is well accepted that air brakes are recommended as they can be much more effective than vacuum brakes for a given size of brake cylinder. Presently, most railways in the world use different forms of air brake systems (electro-pneumatic brakes or electronically controlled pneumatic) but there are still railways using vacuum operated brakes.

As the brake system is essential for safe operation of trains, the harmonization along the corridors is necessary, if the wagons circulate over several countries.

v. Floor height passenger coaches

The floor height of passenger coaches must be compatible with the platform height to allow the safe access of passengers for boarding and disembarking (see the definition of “platform height” in the previous chapter on technical parameters related to infrastructure. The entrances of the coaches must be designed for comfortable boarding and ideally, the vehicles floor should be on the same level as the platform, but this is not easy because of the lack of standardization heights
of floors as they differ among manufacturers and types of trains. Historically, there is a large variation in the platform heights adopted by different railways, sometimes even in the same country.

Even though the high platforms provide better accessibility to trains with high floors, this covers very limited types of trains (usually, the high-speed trains). Presently, most of the trains are built for direct accessibility to low platforms. Countries along the corridors must agree on the characteristics of coaches to be used in international trains to offer the best match with the platforms’ height along the corridor.

vi. Rail/wheel interface

The wheel profiles specified for the rolling stock must be compatible with the rail arrangements (rail profile, its inclination to the vertical, switches and crossings etc.). Mismatch between rail and wheels can increase train fuel consumption significantly. Furthermore, poor wheel and rail profile match can cause metal fatigue, wear, corrugations, and other defects that require maintenance and untimely replacement. A key part of reducing railway operating costs and improving safety is through better management of wheel and rail profiles to extend the life of rail track, of wheel of wagons, reduce vehicle and track maintenance, and improve vehicle stability. The railways along the international corridor need to standardize the rail / wheel parameters and use the agreed upon standards for the benefit of their common operation of the corridor.

vii. Electrical systems

The passenger coaches in the composition of international trains need compatibility on lightning system, air conditioning, shore supply connection, etc. The countries along the corridors using their passenger fleet on international trains must agree on compatible electrical equipment and systems to ensure safe functionality along the entire route.

viii. Water and waste
The countries along the corridors using their passenger fleet on international trains must agree on compatible equipment and systems for water and waste connections in different facilities throughout various countries along the corridor.

2. For LEVEL C interoperability
   i. **Locomotive type**
   Railways use diesel or electric traction, depending on the characteristics of infrastructure and intensity of traffic. Diesel locomotives are fully interoperable and can be used on any infrastructure with the same gauge as the locomotive. As there are different traction systems on different railways, the locomotive fleet of railways needs to be adapted to the infrastructure characteristics. As the uniform electric traction system along, international corridors is almost impossible to achieve (due to the huge costs for implementation), the realistic approach is to assess case by case the best way to achieve the operational interoperability in the context of different electric traction systems (e.g. multi-system locomotives or limited usage of Diesel traction across the border lines).

   ii. **Locomotive traction power**
   Locomotives are designed and built for various types of traction power; this is justified by obvious reasons of optimizing the operating costs of railways, depending on the tonnages per train. Each railway has a fleet of locomotives tuned for its own business. The locomotives used along the international corridors must be capable to haul heavy trains as well as fast freight trains with the tonnages agreed upon by the involved countries.

   iii. **Maximum speed**
   The wagons, carriages and locomotives used along the international corridors must be able to operate with the maximum speed decided for each segment of the corridor, according to the characteristics of the infrastructure. If the composition of international trains includes wagons or are pulled by locomotives designed for operating on a lower maximum speed than the speed allowed by the infrastructure, operational performance is diminished with a negative impact on
performance of railway transport. The involved railways must agree to operate trains at the maximum speed possible to increase their competitiveness on the market.
VIII. ENHANCING OPERATIONAL INTEROPERABILITY

A. General considerations on common operational parameters

Achieving operational interoperability is less costly than technical interoperability, but it is highly dependent on the existing level of technical interoperability. For example, harmonized values between neighboring countries on a corridor for technical parameters as axle load, passing siding length, structure gauge or train length, will allow same tonnages per trains eliminating the need to recompose the train at the border.

Although the operational interoperability is less expensive, it requires strong political willingness and synchronized efforts of the involved countries to work together in order to define and implement compatible procedures between various entities involved. Any missing link on an international route, due to the lack of cooperation of one entity from one country will make useless all investments for the technical interoperability and shall jeopardize the competitiveness of the entire route (missing link could be the lack of cooperation of a railway, a custom authority, an immigration entity, etc.).

It is important to highlight again that the operational interoperability is built on the common platform created by the achieved technical interoperability. By using common operational practice along international corridors, railways can capitalize on their advantages (high safety, large volumes, low costs on long distances) due to more rapid movement of trains with lower costs. For full operational interoperability, the harmonization of activities of other authorities which interfere in the operation of the international trains is necessary (customs, immigration, phytosanitary, etc.).

Consequently, the common operational parameters can be grouped in two categories:

- Operational interoperability of the railways for the organization of traffic according to compatible operating rules (train tonnage, train composition, speed of train, management of traffic, maintenance rules for assets, etc.),
- Operational interoperability of other state entities involved in the border crossing activities through commonly agreed upon procedures.

B. Harmonized operating rules for railways

Regarding the operational interoperability, the three levels of interoperability (A, B, C) previously defined (see Chapter 6), require specific agreements for harmonization between the railways on the corridor. The operational interoperability levels A, B, and C must be understood in a cumulative approach. It means that Level B includes the interoperability requirements of Level A and Level C includes the interoperability requirements for Levels A and B.

1. LEVEL A Operational Harmonization

This situation occurs in all cases when the wagons of the exit railway are not allowed to cross the border to the entry railway, or in cases of gauge changing between two railways, when the wagons of the exit railway are not equipped for wheel changing. In such cases, the train is practically completely recomposed at the border station using wagons and a locomotive from the entry railway. The locomotive has a driver of the entry railway and the train is operated in line with the operating rules of the entry railway. No interoperability between the exit and entry railways is necessary. However, the railways along the corridor still have to cooperate for achieving the following common operational parameters:

i. Harmonized international train timetables

ii. Exchange of information between the railways along the corridor for traffic management

iii. Development of a system of presenting the customers a single tariff for a specific international expedition from origin to destination, avoiding the risk of non-competitive tariffs or unexpected tariff adjustment

iv. Harmonization of facilities for passengers on stations opened for international traffic (pictograms, information booths, ticketing and booking desks, luggage rooms and lockers, washrooms, facilities for passengers with disabilities, waiting rooms, etc.)
2. LEVEL B Operational Harmonization

The continuation of the trip from the exit railway to the entry railway by the same wagons of the train requires that wagons are compatible with the operating rules of the entry railway. A compatible set of rules and procedures need to be developed and incorporated in the rulebook and procedures of all railways that will operate the wagons in that train along the corridor up to the final destination. Harmonized operating rules concern the following activities for creating conditions of seamless trip of wagons along the corridor:

i. Train composition
ii. Maintenance of wagons
iii. Breakdowns of wagons
iv. Handling and inspection of hazardous and perishable goods

If those operating rules are not harmonized, any entry railway on a route will not be able to accept the train composed by the exit railway, due to traffic safety risks.

3. LEVEL C Operational Harmonization

The continuation of the trip from the exit railway to the entry railway via an unchanged train (same wagons and same locomotive) requires the railways along the corridor to agree upon supplementary operational interoperability aspects, in addition to the measures from Levels A and B. Harmonized operating rules for this case are very complex and include harmonization of:

i. Management of traffic, Including rules for communication between drivers and OCC, language of communication
ii. Locomotive drivers operating locomotives on track of different railways
iii. Locomotive fueling and maintenance
iv. Criteria and procedures for certification for safety critical staff
v. Training of drivers and other safety critical staff

This level of interoperability is difficult to be achieved and requires advanced integration of operating rules among the railways along a corridor. However, it offers the highest operational performance along corridors.
C. Harmonized operating rules for other entities of the states involved in international rail transport

Probably, the most critical operational interoperability issues are related with the procedures for border crossings executed by various entities of the states along the international route. In general, international rail transport faces similar challenges in many countries:

- Delays at the border stations
- Excessive custom controls, often unreasonable and repetitive border checks
- Lack of harmonization of documents required by various countries
- Incorrect information written in the consignment notes or absence of consignment notes
- Inspections on both sides of the border

Due to the political sensitiveness of activities related to border crossing, each country may adopt specific procedures not always harmonized with those in neighboring countries. As each international route is a multi-country corridor, there are many border crossings, each of them adding additional waiting time.

Table 1 presents the three typical modes of border crossing (MODES 1 to 3). MODE 3 of border crossing represents the worst-case scenario. It is characteristic of the countries that do not have any agreement for working together on border crossing procedures. This mode of working generates delays of international trains and raises a serious question mark as to the usefulness of any financial efforts for technical or operational interoperability. This is the mode of border crossing that must be eliminated as soon as possible from all railway borders.

Countries must work together to create conditions to implement Mode 2 and Mode 1 border crossing procedures targeting gradual evolution toward Mode 1.

This goal can be achieved through international agreements on regional cooperation and cooperation between various authorities of the states under the coordination of their governments. Governments have major responsibilities in solving the significant challenges of border crossing by cooperation and political will to implement important facilitating measures:
• simplified customs procedures
• moving customs clearance to take place at the departure and arrival points to decrease congestion and delay at the border,
• extending and harmonizing opening hours for the customs offices,
• use of scanners to inspect moving wagons,
• use of mutually recognized electronic seals.

To achieve the harmonized operations at border crossing (Modes 1 and 2), the countries must act in a coordinated way, toward the following common operational parameters:

• Active membership in the international organizations regulating the rail transport and adherence to the decision of those organizations (OSJD or OTIF).
• Exclusive use of the common CIM/OSJD consignment note for international rail transport, facilitating the rapid processing of data at the border crossing
• Simplified and harmonized rules and procedures for custom procedures
• Development and implementation of an integrated information system or information exchange to provide accurate data on international traffic in a timely manner along the international corridors that would allow pre-approval messages in an electronic format to be generated automatically when a train is en route\(^\text{11}\) (e.g. requests for locomotives and handover trains, and electronic transmission of all necessary commercial and train documents).
• Development and implementation of the “Single Window”, a one-stop approach to exchange information between traders, government agencies involved in international transport, and railways as carriers, with the goal of simplifying the flow of information between trade and government. This would reduce time and costs involved in international trade and increase the competitiveness of international rail transport.

\(^\text{11}\) Preliminary IT already implemented at Zabaikalsk border station between Russia and China reduced the waiting time by 1.5 days.
(NOTE: This is a long-term objective and progress in this respect relies heavily on political will\textsuperscript{12}).

It is true that achieving interoperability at the border stations requires tight cooperation of governments and strong political will for implementation, but the benefits are very high and can be obtained without the major and expensive investments required by the technical interoperability parameters. In many cases, the benefits of lower travel times following hundreds of millions of USD invested in increasing train speed (better infrastructure and new rolling stock), are lost or overpassed by the time lost in the border stations due to poor organization of work or to lack of harmonization.

\textsuperscript{12} Legislative amendments are needed, such as the acceptance of electronic documents and e-signatures, need to engage the private sector in the development of a Single Window, and financing for Single Window design and implementation. Business process reengineering at single window agencies, new hardware, software, and networking tools will be needed to launch the Single Window project.
IX. LEGAL INTEROPERABILITY

A. General considerations on common legal environment

The major challenge railways face concerning the legal aspects is the lack of a global unified regime to cover rail transport, as opposed to air or maritime transport. Putting in place a compatible legal and institutional framework for railways is a mandatory condition for promoting international railway transport. These arrangements tend to be more politically sensitive and therefore might take long to be solved, but it is important to discuss actively all legal issues and to work on finding commonly agreed upon solutions. It is critical that such issues are dealt having in mind the common interest of promoting the international railway transport in Asia by acting on a pragmatic approach to bring benefits to all participants.

Currently, the countries of ESCAP region are in very different stages of reforming their railway systems and putting in place new legal and regulatory frameworks that are compatible with each other. The legal issues are to be addressed in parallel, on two levels: (i) at the national level in each country, and (ii) on a regional level.

B. Common legal national environment

The countries in ESCAP region must create legally compatible railway systems. This does not mean agreement on a unique form of organization or structure of railway company(ies). Countries preserve their rights to structure the railway transport market according to their national agenda. However, it is recommended to adopt common principles that will facilitate the development of the international railway transport, as follows:

- Allow flexibility in setting up tariffs for international expeditions for achieving the necessary competitiveness on the market
- Define the roles and functions of the railway companies, as separate entity(ies) from the state institutions
▪ Establish clear governmental responsibilities for addressing railway issues and allocate adequate resources in the national ministries of transport and in other relevant ministries for addressing the railway issues
▪ Create a non-biased regulatory framework between road and rail transport systems
▪ Promote gradually equivalent modes of financing the land transport infrastructures: road and rail
▪ Put in place a compatible regulatory framework for the railway sector, including safety management systems for railways (including licensing of railway operators, safety certification, accident investigation)
▪ Establish compatible rules for rolling stock maintenance, and safety standards for cross recognition of technical inspections at the border

C. Common legal international environment

A uniform legal framework to define the relationships between railways and vis-à-vis customers, to provide international transport services by rail is a very complex issue; the first railway that signs a transportation contract with a customer does not have the full control of the transport services up to the destination. Several other railways will oversee the execution of transport services and the same responsibilities must be transmitted from one railway to another.

Obviously, a common legal framework for unified contractual obligations and liabilities is a mandatory requirement for the development of any international railway traffic. Discussion about legal interoperability must fulfill this essential condition.

Any bi-lateral agreements without membership to one of the international rail conventions is meaningless. Agreements may help to solve local limited issues related to the cooperation of neighboring states or railways, but this is not a realistic approach for comprehensive legal interoperability; the harmonization of all aspects to satisfy all partners along an international route cannot be achieved by bi-lateral agreements only.
Joining the existing international railway conventions is *the only way* to comprehensively address the legal issues of international rail transport across the entire continent and in relationship with Europe.

After joining one of the existing international railways conventions, neighboring countries or all countries along a corridor may sign subsequent bilateral or multilateral agreements for joint implementation of their agreed upon obligations for managing international railway transport services, but only in the general framework established by the international convention they belong to.

**Figure 14: Layers of legal interoperability**

![Diagram](image)

Figure 14 presents in a schematic way the cascade of agreements in their logical order: governmental agreements, agreements of states institutions involved in border crossing procedures, agreements of neighboring railways for handing over the train at border, agreements between railways along the corridor for providing joint transport services. The combined provisions of all these agreements define the competitiveness of transport services along a railway corridor. Any missing component in the sequence of these agreements or the poor implementation of the agreed upon provisions by any of the countries / railways along the corridor will have a negative impact on the quality of transport services of the entire corridor. Lack of commitment on implementing common legal framework will make meaningless the financial efforts for achieving technical interoperability.
The fundamentals of legal interoperability already exist, as two international conventions, SMGS or COTIF have put in place two legal regimes:

- COTIF using the CIM consignment note
- OSJD using an SMGS consignment

Table 6: List of ESCAP countries – OSJD / OTIF membership

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<tr>
<th>Nr</th>
<th>Country</th>
<th>Member of International Rail Convention</th>
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<td></td>
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<td>OSJD</td>
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<td>1</td>
<td>Afghanistan</td>
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<td>2</td>
<td>Armenia</td>
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<td>3</td>
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<td>India</td>
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<td>9</td>
<td>Indonesia</td>
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<tr>
<td>10</td>
<td>Iran, Islamic Rep. of</td>
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<td>11</td>
<td>Japan</td>
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<tr>
<td>12</td>
<td>Kazakhstan</td>
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<td>13</td>
<td>Korea, Democratic People's Rep of</td>
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<td>14</td>
<td>Kyrgyzstan</td>
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<td>15</td>
<td>Lao People’s Dem. Rep</td>
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<td>Republic of Korea</td>
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<td>Russian Fed.</td>
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<td>Thailand</td>
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<td>27</td>
<td>Turkey</td>
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COTIF and OSJD cooperate tightly and common CIM/SMGS consignment note is currently agreed upon and in use on some international corridors\textsuperscript{13}; it has the scope to put in place a single legal regime from the Asia to Europe. It helps to avoid reissuing of transport documents and in so doing simplify customs clearance. Continuous work is necessary to achieve the moment when all customs administrations will accept the joint CIM/SMGS consignment note as an equivalent to a transit customs declaration. This will considerably increase the competitiveness of rail freight transportation.

The CIM/SMGS consignment note is also issued as an electronic document so that it can be exchanged electronically in advance with authorities and other transport parties.

In 2013 a joint declaration expressing willingness to create a common legal regime for rail traffic across Asia and Europe was signed by 37 countries at a ministerial meeting in Genève. The signatories are: Armenia, Azerbaijan, Belarus, Belgium, Bosnia-Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, France, Germany, Greece, Italy, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, The former Yugoslav Republic of Macedonia, Malta, Moldova, Mongolia, Netherlands, Pakistan, Poland, Portugal, Romania, Russia, Serbia, Spain, Sweden, Switzerland, Tajikistan, Turkey, Ukraine, Uzbekistan. The aim is to establish a unified set of transparent and predictable legal conditions for international rail freight transport “from the Atlantic to the Pacific”, equivalent to the regimes for competing road, air and water transport.

The planned general conditions of transport for Euro-Asian rail transport, known as GTC EurAsia, would include a common consignment note and - to the extent possible - a single liability regime.

\textsuperscript{13} Common CIM/SMGS consignment note may be used on the entire network of Russia, Belarus and Mongolia. In Kazakhstan, could be used for transit and on important import axes.
OTIF and OSJD agreed to set up a technical working group (joint OTIF-OSJD working group in which CIT will also take part) which could start preparing the application documents for the new Euro-Asian legal regime. More work is still needed to make OTIF and OSJD railway zones more coherent, convergent and interoperable, but the environment to develop the unique legal environment exists and the road ahead is clear.

Only few ESCAP countries are members of OSJD or COTIF and some of them are members of both organizations (see Table 6). There are still 12 ESCAP countries which are not part of OSJD or OTIF. All of these countries are advised to become members of the OSJD or COTIF depending on their own interest in developing international railway transport and taking into consideration the membership of their neighboring countries.

Any of these organizations defined uniform rules concerning the obligation to the carrier to carry the goods for reward to the place of destination and to deliver them there to the consignee, unique consignment note to destination, payment and costs, loading and unloading responsibilities, delivery of goods at destination, liabilities for loss or damage of goods, settlement of accounts between carriers (railways involved in the transport), liabilities in case of loss or damage of wagons.

Becoming a member of one of these organizations, allows for the harmonization of the legal framework, based on rules already used by many other railways in international transport. Membership to OSJD and/or COTIF is a necessary condition, but it is not sufficient for the enhancement of international rail transport. Recent history illustrates that sometimes, diverging interests are major factors generating non-cooperative behavior among states. After adhering to common organizations, governments must act to implement common policies and to cooperate actively for the international integration of the national transport networks, promoting corridors of transport, reciprocal liberalization of transit policies, and simplification and harmonization of the regulatory framework.
X. THE INTEROPERABILITY OF RAILWAYS - A STEP TO INTEGRATION IN LOGISTIC CHAINS

ESCAP member countries will significantly increase the competitiveness of their railways by addressing the technical, operational and legal interoperability issues. However, it will not be sufficient to make the railway transportation system of Asia a major player on the international transport market. Asian railways cannot win alone this competition. No matter how many efforts they will make to achieve higher technical and operational interoperability, it will not guarantee that the customers will select railways as the preferred transportation alternative.

As customers are interested in door to door transport solutions, railways must develop adequate interfaces with road, water and air transport to become part of logistic chains. It should be a vital objective for the railways, knowing that the decision of choosing the routes and modes of transport is usually made not by shippers, but by logistic operators.

Any transport corridor will attract traffic and trade only when it will be competitive in the context of supply chains. The needs of specific supply chains, the flexibility of the intermodal services and the provided value-added services will play paramount roles in the logistic decisions. These requirements do not apply to particular sections of the international routes, but to entire transport-logistic chains.

Presently, maritime transport is by far the dominating mode of transport in the Euro-Asian trade and it will preserve its position in the future. For objective reasons the Euro-Asian land corridors will not be able to compete in volume with maritime routes. However, by integrating railways with road and water transport as part of the logistic chains, land transport may become an important complement to shipping services and may increase the reliability of high-value and time-sensitive supply chains.

Railway in the region must be aware that the smooth interoperation of different modes of transport will facilitate more efficient use of the existing infrastructure and will increase the
efficiency of the overall transport system. Finally, high-performance transport corridors using intermodal transport chains and integrated routes will facilitate more rapid economic growth. All these challenges require further harmonized efforts of the member countries to identify appropriate solutions to complex issues, as:

a) intermodal trans-shipment terminals and logistics centers

b) trans-shipment technologies

c) efficient “first mile” and “last mile” concepts (optimizing road-based feed and delivery)

d) electronic fare management systems across different transport modes

e) transport management across different modes of transport

The present study does not address the challenges of integrating railways within the international logistic chains. This issue is only highlighted as the next essential step for enhancing the railway transport competitiveness, once the railway interoperability is achieved.
XI. FINDING THE WAY TO ACHIEVE HIGHER INTEROPERABILITY OF RAILWAYS IN THE REGION

A. Learning from others – The European Union Approach

Historically, Europe faced many similar problems with the Asian countries regarding the competitiveness of railways; most of the technical parameters were specific to countries (track gauges, traction systems, signaling, platforms dimensions, axle load, etc.) and the procedures at the border crossing were not harmonized between the neighbors. European countries started to work together from a longer period of time, to address the different aspects of the railway interoperability.

1. Harmonization of legal framework

In 1985 entered into force the Convention concerning International Carriage by Rail (COTIF) which marked the birth of the Intergovernmental Organization for International Carriage by Rail, known today as OTIF. That Convention was signed in Bern on 9 May 1980 and amended by the Vilnius Protocol in 1999 offering a unique legal framework for all members of the organization.

Presently, all EU countries are members of COTIF and a large number of barriers to the interoperability of railways, are eliminated. The railway traffic between the EU countries is based on the COTIF rules and regulations. In the framework of OTIF it have been created a harmonized legal framework for international rail transport law (passenger and freight traffic), the carriage of dangerous goods, contracts for the use of railway vehicles, contracts for the use of railway infrastructure, validation of technical standards and adoption of uniform technical specifications for railway equipment, removal of obstacles to the crossing of frontiers in international rail transport, provisions on interoperability and technical harmonization in the railway field, the technical approval of railway material intended for use in international traffic, and the facilitation of border crossing in international carriage by rail.
In the same time, some of the EU countries (mainly the countries which are neighbors with the OSJD member countries) are also members of the OSJD. In this way a bridge between the two legal systems (OSJD and COTIF) is created and the international railway traffic can take place without barriers with other regions of the world. It is important to mention that all EU member states are members of at least one of the two railway regulatory systems, which provides a sound legal background for the competitiveness of railways on international transport market.

Significant progress was obtained in the cooperation between COTIF and OSJD to put in place procedures and common documents for smooth crossing of international transport between the two legal systems. In this context, the utilization of the common CIM/SMGS consignment note is already proven as providing simplification of custom formalities, time and cost savings and greater legal certainty. It represents an important step to the realization of a Unified Rail Transport Law.

Figure 15: COTIF / OSJD membership

Source: image from the CIT site
2. **Reform of the railway transport sector**

The EU Directives for the railway sector (the Railway Packages) promoted a common approach in restructuring the management of the railway infrastructure and the operation of the railway transport services, based on a unique set of rules, to make the EU railways compatible with each other. Between 2001 and 2016, four legislative packages were adopted with the aim of gradually opening up rail transport service markets for competition, making national railway systems interoperable and defining appropriate framework conditions for the development of a single European railway area.

These include charging and capacity allocation rules, common provisions on licensing of railway undertakings and train driver certification, safety requirements, the creation of the European Agency for Railways and rail regulatory bodies in each Member State, as well as rail passenger rights. It is important to highlight that although the EU railways follow a common set of principles, to become compatible to each other, they have adopted diverse organizational structures (vertically integrated organizations, holding groups, separated entities for management of infrastructure and service provision, state owned or private companies).

It is already worldwide proven that in the railway reform process there is no “one size fits all” solution. The vertical separation along the lines of business recommended by the EU legislation for the organization of railways was developed to answer to the specific conditions and challenges of the European Union. The Asian railways must act in a pragmatic way to achieve seamless international traffic, by using adequate solutions for their local conditions, tailored for their individual needs.

3. **Technical specifications for interoperability**

Technical Specifications for Interoperability (TSIs) mean the specifications by which each subsystem or part of subsystem is covered in order to meet the essential requirements and to ensure the interoperability of the European Community's high speed and conventional rail systems. These activities have been institutionalized under the umbrella of the European Railway Agency which is presently succeeded by the European Union Railway Agency, in charge with the
activities for the enhancement of the level of interoperability of rail systems. The goal is to
develop a common approach to safety on the European railway system and to create a Single
European Railway Area without frontiers. The interoperability is addressed by specific activities
in four directions of action:

- Rolling stock sector, which is responsible for all the safety issues related to the vehicles,
- Fixed installations sector, which is responsible for all the safety issues related to the
  power supply and infrastructure subsystems,
- Operational sector, which is responsible for drafting and revising the TSIs on telematics
  applications and on operation and traffic management,
- Conformity assessment, registers and standards sector, which is responsible for the
  conformity assessment, setting up and maintaining interoperability
  registers, collaboration with European standardization organizations and OTIF, and for
  monitoring railway interoperability.

Technical specification for interoperability relating to the telematics applications for freight
subsystem of the rail system in the European Union (TAF TSI) has a vital role to achieve higher
competitiveness of the railway transport along the international corridors.

4. Core network corridors

These corridors have been defined to facilitate the coordinated implementation of the core
network of the EU. These corridors are meant to remove bottlenecks, build missing cross-border
connections and promote modal integration and interoperability. Nine major transport corridors
supported by a comprehensive network of routes, feeding into the core network at regional and
national level will be realized under this program. The aim is to ensure that progressively, by
2050, the great majority of Europe's citizens and businesses will be no more than 30 minutes
travel time from this comprehensive network. The development of the corridors is financed by
the EU funds and through the harmonized contribution of the countries along each corridor. The
activities for the development of corridors are carried out by Working Groups, created in
accordance with the provisions of the Memoranda of Understanding, commonly signed by the
involved countries.
5. Conclusions based on the European experience

The instruments used in the European Union for achieving competitive international railway transport are: (i) common technical, operational and legal rules issued on the EU level, (ii) intergovernmental Memoranda expressing the common willingness of countries along corridors to implement common set of objectives for development of international railway transport, and (iii) agreements between railway companies and other states authorities along the international corridors for the implementation of the provisions of the signed Memoranda between governments.

The memoranda are negotiated and signed under the umbrella of the European Commission, which comprises all governments. Once the Memoranda are signed, for achieving the technical, operational and commercial interoperability of railways, ad-hoc committees are created with representatives of the governments and railways, using the support of the international organizations like UIC, OSJD, COTIF which can help for addressing various aspects of the problem.

Compared with Asia, in Europe, this process is easier to be implemented, as the European Union offers the common political platform for all countries to work together for achieving the goals.

Strong and continuous political support is absolutely necessary to facilitate the international railway transport in the ESCAP region through: (i) the harmonization of transport policies between member countries, sometimes painful reforms in the transport sector, (ii) border crossing facilitation, and (iii) the management of large-scale transport investment programs. As shown by the present study, many other institutions could play actively their roles (customs authorities, immigration authorities, phytosanitary entities, regulatory bodies, safety authorities, etc.) to enhance the interoperability of railways.
B. Need for a coordinated approach for achieving interoperability

The ESCAP member countries expressed their political willingness to promote the international railway transport when they adopted the ESCAP Resolution 71/7, on Adoption of Regional Cooperation Framework for the Facilitation of International Railway Transport.

The main question is how to put in place a structured approach workable for all ESCAP countries to address the railway interoperability challenges, as the priority in the process of improving their competitiveness on the international transport market? How to make a step forward from the declarative intentions of cooperation, to sustainable forms of working together to accomplish commonly agreed objectives?

The ESCAP countries need to agree on a coordinated set of actions, according to the following ideas:

a) Assess the status: what is the current level of interoperability of railways and which are the existing barriers?

b) Set up the goals: what are the precise goals of the railways for improving their interoperability (agreed set of parameters and agreed values for each parameter)?

c) Develop action plans: how shall countries and railways develop and gradually implement the agreed programs for achieving the targeted interoperability?

d) Measure the results: how to measure the progress achieved by the railways at a certain stage of implementation of the agreed programs, in order to make the necessary corrections?

The reality illustrates that it is not easy to define and to put in place a harmonized concept for improving the interoperability of railways across the region. One of the main difficulty is the huge diversity of countries and railways in region. The historical, geographical and cultural diversity of the countries created diverse environments for the economic and social development resulting in significantly different railways on various parts of the region. It is difficult to compare railways
in East Asia (e.g. China, Republic of Korea, Japan) with railways in South-East Asia (e.g. Thailand, Malaysia, Cambodia) or with railways in South Asia (e.g. India, Pakistan, Bangladesh).

A brief overview can illustrate how different railways in region are and how distinctive are the challenges they face in their daily activities:

a) Afghanistan Railways is in the stage of building the national railway network
b) Kazakhstan Railways is an important operator in its own country, is well integrated in international railway transport, and is focused in improving its connectivity with the neighbors
c) India is one of the most important railways in the world, but operates very small international railway traffic mostly with its neighbors
d) South Asian railways develop minor international railway traffic based on their own bilateral agreements, different than any international legal framework
e) Russian Railways are fully integrated in the European railway system, active part of more international corridors and a major operator of the Euro-Asian railway international traffic

The agenda of actions for promoting international traffic varies from railway to railway depending on many factors, like their level of development, their geographical position, their connections with the neighboring countries. Obviously, some railways are much more advanced in the operation of the international railway traffic and their experience can be very useful to the rest of the continent. For example, the railways operating along the Trans-Siberian Corridor, which currently realize annually the highest volume of trans-Asian traffic, have different priorities than the railways from other regions of the continent.

Additionally, the political and the economic agreements between various countries have an important impact on the development of international railway transport. For example, the special economic environment created by the Custom Union (Russian Federation, Kazakhstan, Belarus), creates specific legal environment, which allowed the simplification of the operational
procedures of railways at the border crossings, with direct impact in the quality of the transport services between the involved railways.

The examples above prove that the railways in region face different stages of development of their business and consequently, their needs and objectives (especially on short term) are not identical. All these factors make difficult to define and to implement a fully harmonized strategy for the growth of the international railway transport, applicable for the entire Asian continent.

The enhancement of the railway performance in international transport cannot be achieved in the same pace all over the region. A set of common general long-term goals might be agreed by all countries, but the methods and the pace of implementation shall vary from country to country.

Any approach for achieving higher interoperability between the railways of the region must take into consideration their large diversity and must offer a clear road map of actions for each and every railway, no matter what their current situation is.

C. Starting from the assessment of the existing status in railways in ESCAP region

The directions of actions to enhance the interoperability, the railways of the region can be properly defined after the clarification of the status of the critical parameters for the interoperability (technical, operational, legal). In this context, it is recommended to agree on the structure and content of a data collection system, comprising the current values of the interoperability parameters along each international corridor.

The collected data should allow an accurate assessment of the current interoperability status of each and every railway along trans-Asian corridors and to propose commonly agreed working plans to achieve those targets.

In this context, the following tables are proposed to be used for data collection (see Annex 1):
Table 1 – Technical Parameters
Table 2 – Railway Operational Parameters
Table 3 – Railway and other State Entities Operational Parameters

The three Tables of Annex 1 are built based on the critical technical parameters defined by the present study and on the proposed classifications for the operational interoperability (MODE 1 – MODE 3), and for the technical interoperability (LEVEL A – LEVEL C). Each country which will be interested to enhance its interoperability of the railway transport system with its neighbors, will need to complete a set of Tables 1 – 3 for each international corridor crossing its national railway network.

Figure 16: Selected Asian Corridors

1. Collection and harmonization of data from the railways
During the elaboration of the present study, a set of the Tables 1, 2, 3 (described in the Annex 1) were distributed to many railways of ESCAP region for collection of relevant interoperability data along international corridors. The railways from Azerbaijan, Georgia, Islamic Republic of Iran, Mongolia, Russian Federation and Turkey, which allocated their time to fill the requested data
and to transmit the filled forms (Table 1, Table 2, Table 3). Unfortunately, the railways which communicated the data are not interconnected along the same railway corridor and the consolidation of data across one single route was not possible.

It is evident that more work need to be done by the countries connected along one corridor, to consolidate the information comprised by the Annex 2: all countries along one corridor must submit their data, meetings of clarification need to be organized, the mode of reporting the values of the technical parameters must be harmonized and the classification of the modes of operation in the common border stations must be agreed.

2. Consolidation of data along the Asian railway corridors

Once the data collected and agreed, the information can be consolidated along corridors, to get the image of the existing interoperability status (legal, technical and operational) along each international route (see the Tables 1A – 3A presented in the Annex 3 to this report). All activities of data collection and their aggregation along corridors will not be easy; it depends on the willingness of the railways to work together, to exchange information and to act proactively for enhancing their performance.

Once, the Tables 1A – 3A are filled with data, the railways in the ESCAP region would be able to define a consistent framework for the enhancement of their interoperability, as follows:

a) Based on data collected in Tables 1A – 3A, the railways may agree on targeted values for each interoperability factor, observing the international standards.

b) The data collected in the Tables 1A – 3A would allow to make a step forward from general recommendations for all railways, to specific objectives along corridors for each interoperability factor (e.g. values for technical parameters, procedures for operational interoperability, etc.). In this way, each railway may focus on specific actions, correlated with its neighbors and partners along one corridor to enhance the interoperability.

c) The permanent updating of data in the three Tables will also allow to measure the progress achieved in the process of railway interoperability, to identify the weak points and to set up the next stage targets for the involved railways.
This flexible approach will allow to elaborate specific programs for the enhancement of the railway interoperability along each railway corridor in Asia and a “variable speed” implementation rhythms, taking into consideration the barriers, the available resources and the priorities of the railways along each route.

a. Acting for the enhancement of Asian railways interoperability along corridors

The previous sub-chapter proposes a “variable speed” approach to increase the interoperability of the Asian railways, based on a commonly agreed system for data collection, specific target values for each interoperability parameter and specific working programs along different international corridors. The accomplishment of this approach requires the existence of an institutional framework, acceptable for all involved countries.

As it was already stated, the proposed institutional framework for the enhancement of the interoperability of railways can succeed only if it benefits of a strong and continuous political involvement of the governments.

The ESCAP member countries in 2015 expressed their political commitment to increase the competitiveness of the international railways transport by adoption of the ESCAP Resolution 71/7, on Adoption of Regional Cooperation Framework for the Facilitation of International Railway Transport. In this context, it is highly recommendable that the governments of region continue to use the ESCAP environment for developing adequate working programs with the scope of implementation of the objectives established by the Resolution 71/7.

ESCAP has a unique position to offer to all its member countries a solid institutional platform for achieving the higher competitiveness of the international railway transport. It is the single organization comprising all Asian countries, which can provide logistic support and facilities to all railways in the region for carrying out the activities for improving the international railway transport. ESCAP can use its worldwide influence to invite the experts from OSJD, UIC, COTIF and from other relevant international entities to support the efforts of the railways of the region in this direction.
As ESCAP is not a technical, a legal or a railway organization, it is clear that it will not overlap with other organizations like OSJD or COTIF, but will act as a neutral part, which could play its role offering support railways of member countries on the following: (i) to collect data necessary for interoperability along corridors, (ii) to define common goals for increasing the competitiveness of the international railway transport, (iii) to incentivize the governments for negotiation and signature of memoranda for developing railway international transport along specific corridors, and (iv) to act as the neutral secretariat for the implementation of the signed memoranda and for preserving the collected data.

ESCAP will limit its role as facilitator and the host of the meetings on railway interoperability. The governments would remain all the time in control of all activities and shall play their role in a proactively to make progress in the following directions:

- Agree the long-term goals for the development of international railway transport
- Agree and sign memoranda which shall stipulate the objectives to be accomplished along specific international corridors
- Put in place Working Groups on each corridor, to address specific issues (technical, operational, legal) based on the common will and of the needs of the countries along each route
- Agree specific Action Plans for addressing the specific issues for each corridor
- Set up indicators to measure the progress of the works for each corridor (volume transported, transit time, guaranteed time of arrival, etc.).

In this context, it will depend exclusively of the member countries how they can use ESCAP as a common platform for debating and addressing the railway interoperability aspects. In principle, there will be two types of meeting to be organized:

a) general meetings, debating subjects of common interest for all member countries directly related with the realization of the objectives of the Resolution 71/7 (e.g. the general targets of railway interoperability at the continental level, exchanging information on the best practices on border crossing procedures, getting agreements on technical
parameters for interoperability, for measuring the general progress on enhancing the competitiveness of railway transport in Asia, etc.),

b) selective participation meetings, debating subject of interest for limited number of countries / railways inter-connected by a specific corridor (e.g. sharing data about the interoperability status along corridor, developing working plan for achieving common goals for better technical and / or operational interoperability along one corridor, discussions on border crossing procedures between countries along one corridor, harmonization of implementation programs for interoperability, etc.).

ESCAP could be considered as the first option for hosting and providing logistic support for the general meetings. It would offer a common platform for all countries in the region and a consistent background for all activities on the railway interoperability subject, preserving a common data base and common knowledge, available for all member countries. This is the natural continuation for the implementation of the ESCAP Resolution 71/7.

The ESCAP support is equally recommended for being the host of the selective participation meetings on corridors issues. However, the level of involvement of the ESCAP for this type of meetings shall remain as an open option to be used by various countries depending on their specific needs. The countries along corridors may decide to plan their meetings in various other forms. For example, the railways which are part of the Custom Union (Russian Federation, Kazakhstan, Belarus) most likely may not need the support of the ESCAP, as long as they are well advanced in the process of enhancing their interoperability, and they have already institutionalized various forms of cooperation. The situation may be different for railways connected along other corridors, no so advanced in this process.

The support of the ESCAP for the implementation of the Resolution 71/7 along each corridor should be set to address with the maximum flexibility, the needs of the railways of the region, exclusively according with the willingness of the involved countries.
To become competitive on international railway transport is a very challenging task which requires cooperation of countries, adaptability of railways to the market demands and continuous improvement of the quality of railway transport services. The potential deeper involvement of the ESCAP in the implementation of the Resolution 71/7 is the first option for an institutionalized environment which may help the member countries to achieve this objective, in a coordinated approach and using working methods adapted to the needs and possibilities of each country.
ANNEX 1: PROPOSED TABLES TO BE FILLED BY RAILWAYS FOR MEASURING THE LEVEL OF INTEROPERABILITY ALONG INTERNATIONAL RAILWAYS CORRIDORS
### Table 1 - Technical Parameters

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Technical Parameter</th>
<th>Unit</th>
<th>Explanation</th>
<th>Current Value(s) or Short Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Track Gauge</td>
<td>millimeters</td>
<td>The smallest distance between rails perpendicular to the running surface intersecting each railhead profile.</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Axle Load</td>
<td>tons / axle</td>
<td>Axle load indicates the maximum weight accepted on an axle of the railway vehicle circulating on the national segment of the corridor (track, bridges, tunnels, viaducts, etc.).</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Structure Gauge</td>
<td>standard used</td>
<td>The structure gauge is the parameter defining the relevant dimensions of various components of railway infrastructure along the national segment of the international corridor, to ensure safe running of the trains. The term may apply to the minimum height and width of tunnels and bridges, to the minimum distance to railway platforms (passenger or freight), buildings, and other equipment along the track.</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Passing siding length</td>
<td>meters</td>
<td>The passing siding along the national segment of the international corridor is a place on a single railway line where trains circulating in opposite directions can pass each other, or higher priority trains pass over slower or lower priority trains circulating in the same direction.</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Platform length</td>
<td>meters</td>
<td>A railway platform is a structure built along rail tracks in a railway station on the national segment of the international corridor where passengers can get on or can get off the train.</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Platform height</td>
<td>millimeters</td>
<td>The platform height is defined as the elevation of a railway platform along the national segment of the international corridor, above top of rail track.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>System/Equipment</td>
<td>Short Description</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Signaling System</td>
<td>Type of signaling system with all its components (automatic block, interlocking, automatic train protection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Traffic management system</td>
<td>Type of traffic control system used</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Telecommunication</td>
<td>Type of telecomm equipment used and the main functions accomplished</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Traction system</td>
<td>Type of traction used on the national segment of the international corridor. For electric traction, please indicate the type of electric traction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Loading gauge</td>
<td>Defines the dimensions of height and width which must not be exceeded by a rail vehicle or its load to not collide with bridges, tunnels and other lineside fixtures or structures along the national segment of the corridor.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Maximum train length</td>
<td>Maximum train length operated on the national segment of the international corridor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Coupling system of railway cars</td>
<td>The mechanism designed for connecting vehicles in a train, including equipment at each end of the wagon that handles the compression and tension forces between the wagons of trains (for national cars)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Brake gear</td>
<td>Brake Gear is the equipment used on the wagons coupled in a train to enable deceleration, control acceleration (downhill) or to keep wagons standing when parked (for national cars)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Floor height passenger coaches</td>
<td>The floor height is defined as the elevation of floor of the passenger coach, above top of rail track (for national cars)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Types of locomotives</td>
<td>Please indicate the type of traction of locomotives, their traction power, and their maximum speed (for national fleet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Maximum speed</td>
<td>Please indicate the maximum technical speed along the national segment of the international corridor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Loading gauge standard used**

Defines the dimensions of height and width which must not be exceeded by a rail vehicle or its load to not collide with bridges, tunnels and other lineside fixtures or structures along the national segment of the corridor.

**Maximum train length meters**

Maximum train length operated on the national segment of the international corridor.

**Coupling system of railway cars short description**

The mechanism designed for connecting vehicles in a train, including equipment at each end of the wagon that handles the compression and tension forces between the wagons of trains (for national cars).

**Brake gear short description**

Brake Gear is the equipment used on the wagons coupled in a train to enable deceleration, control acceleration (downhill) or to keep wagons standing when parked (for national cars).

**Floor height passenger coaches millimeters**

The floor height is defined as the elevation of floor of the passenger coach, above top of rail track (for national cars).
Table 2 - Railway Operational Rules

<table>
<thead>
<tr>
<th>Nr</th>
<th>Operational Parameter</th>
<th>Border with Railway Neighbor 1</th>
<th>Border with Railway Neighbor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>1</td>
<td>Harmonized international timetable with neighboring railways</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Exchange of information with neighboring countries about the train and wagons status and position on the international route</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Do you use the LEVEL A of interoperability at the border stations with your neighboring railways? If the answer is YES please skip the rest of questions of this table.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Do you use the LEVEL B of interoperability at the border stations with your neighboring railways? If the answer is YES answer only to the questions 6 - 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Do you use the LEVEL C of interoperability at the border stations with your neighboring railways? If the answer is YES answer to the questions 6 - 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Commonly agreed operating rules with neighboring countries concerning the train composition (tonnage, order of wagons, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Commonly agreed operating rules with the rest of the countries along the international corridor concerning the maintenance of wagons on the route</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Commonly agreed operating rules with the rest of the countries along the international corridor concerning the repair of breakdown wagons on the route</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Commonly agreed operating rules with neighboring countries concerning the traffic management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Locomotive driver has the right to cross the border with the locomotive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Commonly agreed operating rules with neighboring countries concerning the fueling and maintenance of locomotives</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 3 - Railway and Other State Entities Operational Rules

<table>
<thead>
<tr>
<th>Name of the Corridor</th>
<th>Operational Parameter</th>
<th>Border with Railway Neighbor 1</th>
<th>Border with Railway Neighbor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>

1. Do you use the common CIM/SMGS consignment note for the international traffic on the national segment of the international corridor?

2. Do you use an information system allowing exchange of information with the authorities of your state for border crossing procedures (customs, veterinary, phytosanitary, immigration, etc.)?

3. Do you use an information system allowing exchange of information with the authorities of neighboring states for border crossing procedures (customs, veterinary, phytosanitary, immigration, etc.)?

4. Have you implemented the MODE 1 of border crossing procedures at the borders of the national segment of international corridor with the neighboring countries?

5. Have you implemented the MODE 2 of border crossing procedures at the borders of the national segment of international corridor with the neighboring countries?

6. Have you implemented the MODE 3 of border crossing procedures at the borders of the national segment of international corridor with the neighboring countries?

7. Do you participate in any Working Group for harmonization of technical, operational or legal parameters for facilitating international rail transport

8. If you use a different procedure at border crossings than MODES 1 or 2 or 3, please describe it shortly

If you answered NO to all three questions 4, 5, and 6, please add attachment with explanations.
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Technical Parameter</th>
<th>Unit</th>
<th>Country 1</th>
<th>Country 2</th>
<th>Country 3</th>
<th>Country n</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Length of the national route for this corridor</td>
<td>km</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0A</td>
<td>Average duration of transit time for freight train on national route for this corridor</td>
<td>hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Track Gauge</td>
<td>millimeters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1A</td>
<td>Axle Load</td>
<td>tons / axle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Structure Gauge</td>
<td>standard used</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Passing siding length</td>
<td>meters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Platform length</td>
<td>meters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Platform height</td>
<td>millimeters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Signaling System</td>
<td>short description</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Traffic management system</td>
<td>short description</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Telecommunication</td>
<td>short description</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Traction system</td>
<td>short description</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Units/Description</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------------</td>
<td>---------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Loading gauge</td>
<td>standard used</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Maximum train length</td>
<td>meters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Coupling system of railway cars</td>
<td>short description</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Brake gear</td>
<td>short description</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Floor height passenger coaches</td>
<td>millimeters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Types of locomotives</td>
<td>short description</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Maximum speed</td>
<td>km/h</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2A - Railway Operational Rules along Corridor

<table>
<thead>
<tr>
<th>Nr</th>
<th>Operational Parameter</th>
<th>Country 1</th>
<th>Country 2</th>
<th>Country 3</th>
<th>Country n</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Harmonized international timetable with neighboring railways</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Exchange of information with neighboring countries about the train and wagons status and position on the international route</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Do you use the LEVEL A of interoperability at the border stations with your neighboring railways? If the answer is YES please skip the rest of questions of this table.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Do you use the LEVEL B of interoperability at the border stations with your neighboring railways? If the answer is YES answer only to the questions 5 - 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Do you use the LEVEL C of interoperability at the border stations with your neighboring railways? If the answer is YES answer to the questions 5 - 11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Commonly agreed operating rules with neighboring countries concerning the train composition (tonnage, order of wagons, etc.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Commonly agreed operating rules with the neighboring countries along the international corridor concerning the maintenance of wagons on the route</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Commonly agreed operating rules with the neighboring countries along the international corridor concerning the repair of breakdown wagons on the route</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Commonly agreed operating rules with neighboring countries concerning the traffic management</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Locomotive driver has the right to cross the border with the locomotive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Commonly agreed operating rules with neighboring countries concerning the fueling and maintenance of locomotives</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Commonly agreed safety rules and procedures with neighboring countries along the international corridor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nr</td>
<td>Operational Parameter</td>
<td>Country 1</td>
<td>Country 2</td>
<td>Country 3</td>
<td>Country n</td>
</tr>
<tr>
<td>----</td>
<td>---------------------------------------------------------------------------------------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td>Average duration of all operations for an international freight train at this border</td>
<td>Border with Border with Border with Border with</td>
<td></td>
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<td>1</td>
<td>Do you use the common CIM/SMGS consignment note for the international traffic on the</td>
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<td>national segment of the international corridor?</td>
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<td>2</td>
<td>Do you use an information system allowing exchange of information with the authorities</td>
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<td>of your state for border crossing procedures (customs, veterinary, phytosanitary,</td>
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<td>immigration, etc.)?</td>
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<td>3</td>
<td>Do you use an information system allowing exchange of information with the authorities</td>
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<td>of neighboring states for border crossing procedures (customs, veterinary, phytosanitary, immigration, etc.)?</td>
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<td>4</td>
<td>Have you implemented the MODE 1 of border crossing procedures at the borders of the</td>
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<td>national segment of international corridor with the neighboring countries?</td>
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<td>5</td>
<td>Have you implemented the MODE 2 of border crossing procedures at the borders of the</td>
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<td>national segment of international corridor with the neighboring countries?</td>
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<td>6</td>
<td>Have you implemented the MODE 3 of border crossing procedures at the borders of the</td>
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<td>national segment of international corridor with the neighboring countries?</td>
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<td>7</td>
<td>Do you participate in any Working Group for harmonization of technical, operational or</td>
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<td>legal parameters for facilitating international rail transport</td>
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</table>
References

Monograph Series on Transport – Facilitation of International Railway Transport in Asia and the Pacific, Transport Division, ESCAP

International Transport in Central Asia: Understanding the Patterns of (Non-)Cooperation, Elena Kulipanova

CAREC - Transport Sector Progress Report and Work Plan 2016–2018

OTIF - Study on Corridors, Dariia Galushko, January 2016

CAREC Corridor Performance Measurement & Monitoring – Annual Report 2013

The geography of transport systems – Chapter 7 - Dr. Jean-Paul Rodrigue and Dr. Theo Notteboom (New York: Routledge, 440 pages - ISBN 978-1138669574)

UIC Statistics – 2015 (on-line statistics)

OSJD – Bulletin of Statistical data on Railway Transport for 2015


OECD - Recent Developments in Rail Transportation Services, 2013 (on-line document)

Eurostat - Freight Transport Modal Split, January 2016 (on-line document)


Switzerland - Mobility and Transport, Pocket Statistics - 2016

Australia - Road and Rail freight - Competitors or Complements? (Information Sheet 34, on-line)


A holistic approach for analyzing the interoperability of a railway system - M. Jacyna & J. Szkopiński Faculty of Transport, Warsaw University of Technology, Poland