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Harnessing cross-sectoral infrastructure synergies

Committee on Transport

Fourth session
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Note by the secretariat***

Summary

The present document has been prepared for the consideration of the Committee on Transport and the Committee on Information and Communications Technology at their joint session on harnessing cross-sectoral infrastructure synergies. In the document, potential synergies between information and communications technologies (ICTs) and transport are considered, as well as synergies with other infrastructures, by providing information on the cost of deploying fibre optics, exploring potential win-win strategies in the co-deployment and cohabitation of fibre and transport infrastructure and drawing lessons from good practices in the Asia-Pacific region and beyond. It contains a set of key policy measures to maximize win-win outcomes, which include synergies with the Asian Highway and Trans-Asian Railway. It also contains an examination of the potential of ICTs in making sustainable transport a transformative building block of sustainable development, as foreseen in the Five-Year Action Agenda of the Secretary-General. Safer, more secure and efficient transport through the emergence of so-called intelligent transport systems is expected to play a key role in the evolution of sustainable development goals. The note proposes policy measures at the regional level for the consideration of both Committees.

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*** The late submission of the present document is due to the need to incorporate details of the deliberations on these issues by the Commission at its seventieth session from 4 to 8 August 2014.

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I. The context: the central role of fibre in data transmission

A. Fibre optic emergence in data transmission

1. Thinner than human hair and made of very pure glass, optical fibre strands are used to carry information via light signals that are modulated in wavelength and colour. Compared with traditional copper wires, the physical characteristics of optical fibre offer superior robustness, corrosion resistance, higher speeds of transmission and stronger isolation from external electrical interference. From the perspective of transmission, optical fibre also offers vastly superior bandwidth with far less loss over a longer distance.

2. The use of fibre optics was developed in the 1970s initially for telephone and television signal transmission. The technology was improved rapidly and transmission capacity over fibre increased by several orders of magnitude in the past few decades. During the mid-1990s until the so-called dot-com crisis, many operators invested massively in optical fibre transmission networks in the United States of America and other developed countries. The emergence in these countries of meshed and dense fibre networks combined with market liberalization and regulatory reforms, resulted in lower prices for transmission capacity and facilitated further progress towards fixed-line broadband transmission, a process which continues to this day.

B. Fibre’s role in next generation networks

3. Today, the growing use of wireless technology for third generation (3G) and fourth generation (4G) mobile broadband and telephony is further increasing the demand for fibre. While this may appear contradictory, the situation arises from the need to better coordinate the activities of microwave-emitting antennas, as well as the need for higher traffic aggregation and backhaul.[1] It is also caused by the finite nature of the spectrum used for mobile communications. Furthermore, the growing ubiquity of data-intensive devices, such as tablets and so-called smartphones, greatly contributes to the increased demand for data transmission capacity and international transit, for example through increased demand for video streaming services. This situation is likely to increase the need for national and international fibre optic transmission capacity. Finally, it is sometimes argued that fibre is a “future-proof” transmission technology as innovations are usually associated with improvements in the transmission and routing equipment rather than in the fibre itself.

4. To reap full benefits from broadband, several countries in the region are implementing fibre deployment strategies, in particular fibre in local loops, or so-called FTTx strategies.[2] The configuration varies across and within countries in terms of distance between the fibre and the individual user.

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1 Organisation for Economic Co-operation and Development, “The development of fixed broadband networks”, OECD Digital Economy Papers No. 239, (Paris, OECD Publishing, 2014). Available from http://dx.doi.org/10.1787/5jz2m5mlb1q2-en.

2 “Fibre to the x”, or FTTx, is a generic term for the “architecture” for any broadband network to furnish all or part of the local loop for “last-mile” telecommunications. For more information on these aspects, see www.thinkbroadband.com/guide/fibre-broadband.html.

C. Fibre network extensions in Asia and the Pacific

5. Fibre extension services are now common in Asia-Pacific countries, with Internet service providers often investing in last-mile connectivity. The Republic of Korea shows the best practice in the region as a precursor in systematically deploying fibre to the premises, as described in box 1.

Box 1
Fibre networks in the Republic of Korea

Since the mid-1990s, the Government of the Republic of Korea has led the development of the national broadband infrastructure, promoting a series of national ICT master plans, such as the KII Plan (Korea Information Infrastructure, 1995-2015), BCN Plan (Broadband Convergence Network) and UBcN Plan (Ultra Broadband Convergence Network, 2010-2015). Immediately after most of the nationwide fibre backbone network was deployed in 2000, the fibre optic network for end-users, such as schools, residential areas, apartments and rural areas, was set up. As of 2013, about 98 per cent of the population (about 50 million people) in the Republic of Korea were able to use broadband Internet at a speed of more than 50 megabits per second. The Government also has a plan to extend deployment of fibre networks to rural areas by 2017. About 5,700 agricultural and fishing villages, which cover less than 1 per cent of total population, are targeted.

The early deployment of the nationwide fibre network in the Republic of Korea was possible due to the Government's leadership and cooperation between the public and private sectors.

Key enablers of the Republic of Korea's early fibre network deployment include the following:

(a) Privatization of the State-owned telecommunications operator (KT Corporation) in 2002 and deregulation to lower the entry barriers for new players;

(b) Government investment in fibre networks connecting central/local government offices and public institutions, as well as public-private partnership programmes involving fibre optic access network for last-mile connectivity;

(c) Introduction of various stimulus programmes to encourage private sector investment and service competition, such as the "cyber-building certification (emblem) programme" for premises' fibre networks, and public dissemination of the results of "broadband service quality evaluation", which boosted the private sector's competition for last-mile fibre network investment.

Source: National Information Society Agency, Republic of Korea.

6. China, in its recently launched broadband strategy, has also made as a key objective the connection of all new housing projects to fibre. Chinese operators will also make available FTTC (fibre to the cabinet) for at least 10 per cent of the population.[3]

7. Fibre optic transmission remains underdeveloped in many countries in the region. In fact, Asia and the Pacific is the region of the world with the largest gaps in terms of fixed broadband access and bandwidth per capita. However, there are clear opportunities in deploying fibre optic backbones alongside other major infrastructure.

[3] The Internet research firm Ovum has predicted that in 2015 China will have 76.5 million FTTx subscribers, more than half the global total.

II. Elements of cost of fibre installation

8. Limitations in national backbones and access networks are among the obstacles to cheaper and higher-quality Internet access. Furthermore, as fibre will be increasingly important for the operations of future generations of mobile networks, the absence of an adequate fibre network could limit the extension of mobile broadband services. The cost of network deployment is therefore an important criterion influencing progress towards an inclusive information society. Elements of the costs connected with making available fibre networks are examined below.

A. Submarine fibre networks

9. At the international level, the costs for submarine cables are typically high but transmission capacity on these segments is huge and the data are transmitted over very long distances. Submarine cables typically connect a large number of countries across several continents, and their costs are in the range of several hundreds of millions of dollars, which requires working through complex consortia for their financing.[4]

B. Terrestrial fibres

10. Whether they are used for international transit, intercity traffic or the local loop, terrestrial fibre optic cables are typically laid either in underground ducts (or conduits) or in the air, connected by pylons, such as those that transmit electricity. Fibre can also be deployed in ducts or in the air along other existing utility infrastructure, along city streets, highways, railways, pipelines, underground water or sewage conduits and even along canals.

11. Evaluating the cost of "rolling out" terrestrial fibre can be complex and location specific, but information is available, including from local loop extension projects. Such extensions are more often than not heavily focused on bringing fibre into urban areas, a process which tends to be expensive. Nevertheless, elements of costs for deploying fibre based on these strategies do help to shed some light on the potential cost of extending fibre backbones in developing countries in the Asia-Pacific region. As indicated in table 1, the evidence suggests that the greatest share of the cost of fibre deployment usually involves civil engineering work, including digging trenches, which typically accounts for up to 80 per cent of the total cost. This 80/20 per cent partitioning of costs applies in situations where new cables have to be deployed underground, involving trenching and laying of ducts. While these figures are available for developed countries where labour costs are higher, it is unlikely that the 80/20 ratio would differ significantly in developing countries. In fact, the World Bank assumes that this rule of thumb is relevant in the Middle East and the Northern Africa subregion.

[4] See, for example, www.unescap.org/sites/default/files/Broadband%20Infrastructure%20in%20the%20ASEAN%20Region_0.pdf.

Table 1
Share of civil engineering work in fibre deployment costs in selected countries/regions

Country/region	Approximate average share of civil engineering work in fibre deployment cost (percentage)	Source
France	Approximately 80	Government of France (www.ant.developpement-durable.gouv.fr/)
United Kingdom of Great Britain and Northern Ireland	Between 70 and 80	www.redburn.com www.beyondbroadband.coop www.cityfibre.com/
Republic of Korea	Between 80 and 90	KT Corporation
European Union	Approximately 80	FTTH Council of Europe
European Union	Approximately 80	European Commission, Analysys Mason Ltd.
Member countries of the Organisation for Economic Co-operation and Development (OECD) (2008)	Between 50 and 80	OECD
Middle East and Northern Africa	Approximately 80	World Bank

C. Aerial fibre networks and emerging burying techniques

12. Aerial placement of fibre optic cables is often a cheaper[5] but not always realistic option for larger backbone networks owing to such factors as climate, particularly in places exposed to intense snowfall and typhoons or cyclones. Maintenance may also require interacting with power lines, which can be dangerous and may require shutting off or redirecting the current, which may increase the cost to telecommunication operators. Despite these constraints, the lower costs of deployment and the possibilities for infrastructure cohabitation discussed below make aerial fibre deployment a proposition worth consideration by ESCAP members and associate members under certain conditions.[6]

13. The high share of the digging of trenches in the total cost of fibre installation has recently led to the emergence of alternative technologies for burying cables. These techniques typically involve specialized equipment to dig smaller trenches, or underground galleries. Their benefits include lower costs, less disruption to road traffic and sometimes faster implementation.[7] The costs and benefits of these techniques could be worth exploring for ESCAP member States in the light of their national circumstances.

[5] By up to 90 per cent in France, if it is carried out on existing poles. See www.ant.developpement-durable.gouv.fr/le-point-sur-les-infrastructures-d-a17.html.

[6] The first fibre backbone to be put into place in Timor-Leste was deployed in the air on its own networks of poles, by one of the three mobile telephone operators based in Timor-Leste.

[7] "Installing fibre-optic cables underground", blog post by Neil Bradley in www.beyondbroadband.coop. Accessed 2 July 2014.

III. Building synergies through co-deployment

14. Given the significant share of civil engineering costs in total fibre deployment costs, there is an obvious incentive to look for opportunities to better utilize existing so-called dark fibre and conduits where they exist and for co-deployment where other infrastructure that uses fibre is being built or upgraded.

15. For various reasons, telecommunications operators and many utilities usually deploy excess fibre when building their networks. Such excess fibre remains unused and is called unlit or dark fibre. Likewise, telecom operators and utilities sometimes choose to lay out redundant ducts, which remain empty. This excess fibre or empty conduits can be sold or leased under indefeasible rights of use to carriers' telecom operators and become an important part in national backbones.

16. The benefits to be tapped may include shared investment costs and additional revenues for utilities and telecom incumbents that are earned by renting shared infrastructure. The reduction in the number of civil engineering works will also limit environmental degradation, as well as interference with road transport when ducts and cables are joined with major road works. Ultimately, however, co-deployment should drive down prices for telecommunication services that will result from improved access to fibre and increased competition.

A. Fibre along railways

17. Railways are typically heavy users of communication and sensor equipment, not least of all fibre optics, to address their traffic-monitoring, signalling and telecommunication needs. Railways have therefore often deployed large-scale fibre optic networks along their existing rights of ways. The ESCAP region offers multiple instances of railways that have deployed extensive fibre optic networks for their operation and have leased out excess capacity to third parties.

18. China TieTong Telecommunication Corporation was founded in late 2000 to integrate and improve the telecommunication systems of Chinese railways. After carrying out much upgrading work on the network, China TieTong was transferred from the Ministry of Railways to the administration of the State-owned Assets Supervision and Administration Commission of the State Council in 2004, when it started offering a large variety of communications services to the public and the business sector, as well as to Chinese railway systems. Its fibre network, running along railway tracks, is more than 100,000 km long and extends over all the country's provinces, including most major cities.

19. TransTelekom is a subsidiary of Russian Railways, the national railway operator. It uses fibre deployed along Russian railways to provide a wide gamut of communication services, including retail and wholesale services. It reaches out deeply into the provincial market, with people living in settlements of fewer than 100,000 inhabitants, accounting of almost 40 per cent of all connections. In addition, the company also offers international transit services between Asia and Europe.[8]

[8] For example, in 2007, it completed together with the Nippon Telegraph and Telephone Corporation of Japan an undersea fibre optic cable system linking the islands of Hokkaido (Japan) and Sakhalin (Russian Federation).

20. RailTel Corporation of India constitutes yet another good example of how railway operators can commercially exploit fibre. By leasing its excess unused capacity on its fibre optic networks, RailTel has emerged as one of the largest telecom infrastructure providers in the country. In the process, RailTel has diversified its revenue incomes and achieved robust profit margins, part of which are being reinvested in infrastructure upgrades and maintenance. RailTel has attracted telecom providers, chiefly because this would enable them to avoid the major expenses inherent in civil works in remote locations. In addition, RailTel furnishes the telecom providers with its existing right of way that must be secured in order to access excavation sites and activate the optical fibre.

21. Finally, in Manila, the rights of way provided by the Manila Metro Rail Transit System and Manila Light Rail Transit System were utilized by the Integrated Government Project to lay out fibre. This project is aimed at interconnecting public offices with fibre in Manila, for information-sharing and the delivery of common applications among users.[9]

B. Fibre along roads and highways

22. Fibre optic systems can be used along roads and railways for traffic monitoring and management purposes. Deploying fibre along roads presents the considerable advantage of enabling easy access to the network for maintenance purposes. Furthermore, as is discussed below, fibre constitutes a key element of intelligent transport systems (ITS) that will form a key building block of the sustainable development goals of the development agenda beyond 2015. When laying fibre for ITS, road and transport authorities can ensure that they contribute to the national backbone extension if they also install additional fibre, or at least additional ducts that can be leased to lay out fibre subsequently.

C. Optical ground wire and aerial fibre networks

23. High-voltage electricity transmission systems also use fibre optics in optical ground wire (OPGW) on transmission lines for both grounding and communication purposes.[10] OPGW runs on the top of electricity transmission wires, on pylons, and their fibres are used by the electricity utility for communication purposes, to monitor the power transmission lines, and they can be leased or sold to third parties for data transmission. The high-voltage lines below the fibre cables provide a degree of protection against vandalism, damage from rodents and other wildlife interference; however, unlike buried cable, they are not exposed to damage from excavation. For safety reasons, installation and maintenance can require shutting or diverting the transmission of high-voltage current to prevent accidents, and that process can be costly or impractical.

24. Examples of the use of OPGW for data transmission services abound in the ESCAP region, where power networks are gradually expanding along with economic growth. In India, POWERTEL has emerged as a major national carrier having one of the largest national terrestrial fibre backbones. The Power Grid Corporation of India (POWERGRID) is a State-owned

[9] Statement delivered by the representative of the Philippines during the Ministerial Round Table on Regional Connectivity for Shared Prosperity, which was held during the seventieth session of the Commission.

[10] An OPGW cable consists of a tubular structure containing one or several optical fibres surrounded by layers of steel and aluminium wire.

electric utility company transmitting approximately 50 per cent of the total power generated in India. In 2001, it established POWERTEL as a telecom venture to operate its OPGW fibre network for wholesale data transmission capacity. POWERTEL's fibre network grew from 19,500 km to 25,000 km in 2012,[11] connecting more than 206 cities. Over the same period, POWERTEL's revenues tripled to about US$ 33.2 million. POWERTEL greatly benefits from the existing rights of way already established by POWERGRID. It also reaches out in less connected and remote areas of the country, hence potentially contributing to alleviating the urban/rural digital divide in India. POWERTEL plans to offer international connectivity services to Bangladesh, Bhutan, Nepal and Sri Lanka. It is also planning to extend its fibre network by another 33,000 km.

25. Although they do not share a common border, Bangladesh and Bhutan have recently renewed their discussions on trading electricity from Bhutan for bandwidth capacity from Bangladesh.[12] These South Asian countries would need to negotiate rights of way from India for the high-voltage electricity transmission lines and pylons. This would contribute to network redundancy in both countries, and the resulting increasingly meshed network would benefit all countries in the subregion, including India.

26. The deployment of new electricity transmission lines represents a clear opportunity to develop national backbones and access networks linking densely populated areas, using OPGW technology. Obvious synergies arise from established rights of ways, relatively low deployment costs and the creation of additional revenues for power companies. However, they need to be examined with caution in regions that are prone to frequent wind-borne disasters. For example, during Typhoon Haiyan in the Philippines in 2013, aerial electricity and telecom transmission systems were destroyed simultaneously in the worst affected areas, compounding logistical coordination in disaster responses and relief supplies.

27. Burying transmission lines underground may thus be a better option for countries with high exposure to disasters. In this regard, concerns have been raised that terrestrial burial may make theft easier. Fibre cables are sometimes confused for high-value copper cables; as such they may be stolen, imposing on the industry millions of dollars in direct and indirect costs. Additional preventive measures, such as raising awareness at the community level, setting alarms along the lines and creating patrols at hotspots, may produce further positive results, while evidence in some countries, such as Malaysia, suggests that burying aerial cable may actually reduce cable theft.

28. Recent developments in electricity transmission technology, in particular high-voltage direct current transmission, have opened renewed prospects for the transmission of electricity over long distances. This could be of key importance in the ESCAP region, which includes countries with structural surpluses and deficits in terms of power generation. ESCAP member States have requested the secretariat to identify options on regional energy connectivity, such as an intergovernmental framework for developing an Asian energy highway, conceptualized as a regional integrated power

[11] See www.tele.net.in/company-stories/item/10955-powertel-riding-on-the-demand-for-high-bandwidth-services. Accessed 11 July 2014.

[12] See http://lirneasia.net/2014/05/power-grid-to-energize-bangladesh-and-digitize-bhutan-india/.

grid.[13] For this initiative, it will be necessary to maximize the potential synergies in terms of cohabitation with fibre.

D. Optical fibre networks in other utilities

29. Fibre is becoming essential along pipelines, whether fibre is used to carry water, natural gas or other fossil fuels. Fibres are used by utilities for internal communication purposes, as well as to monitor these vital infrastructures against threats that include natural hazards and human intrusion. Fibre optic distributed sensing technology can be used to help keep track of changing pressures, temperatures and ground movements, among other such uses which help in detecting and pinpointing the occurrence of events on pipeline networks before they develop into an actual threat. For example, this approach is critical in identifying leakage. The fibre helps identify the precise location of such an incident in real time, which facilitates tailoring the response to threats.[14] In the light of this, many pipeline owners and operators are deploying distributed fibre sensing technology on their infrastructure, both above and below ground. Supplementary fibre capacity could be leased or sold for commercial telecommunications purposes.

30. GAIL (India) is the country’s largest natural gas processing and distributing State-owned company. It set up GAILTEL in 2001 as an affiliate to market communication services using the firm’s redundant fibre capacity. GAILTEL has deployed approximately 10,000 km of fibre along its pipelines and the country’s road network. GAILTEL leases dark fibre and duct space in indefeasible rights of use agreements. It also offers colocation facilities, for an annual revenue of approximately US$ 4 million.[15] Fibre has also been laid over pipelines; fibre is being used successfully for data transmission in other regions, for example in Africa along the Chad-Cameroon pipeline.[16]

E. Additional synergies applicable to fibre networks

31. Fibre optic capacity for sensing and detecting changes in the surrounding environment opens interesting potentials in terms of large-scale environmental monitoring. This can be applied in disaster warning systems, as submarine cables can detect and report sudden tectonic activity or abrupt water movement preceding a tsunami. In cases when a threat is detected, the early warning can enable the adoption of protection measures on the coasts or other exposed areas and such measures can greatly mitigate the impact of a disaster. Submarine cables equipped with sensors could also comprise great tools for tracking water temperatures and thereby help to monitor global climate change.

32. The International Telecommunication Union (ITU) together with the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization have launched an initiative to promote the use of submarine fibre optic cables laid out by telecom operators and carriers to develop a network of sensors and detectors at the bottom of the sea. Under the initiative known as Submarine Cables for Ocean/Climate Monitoring and Disaster Warning, a strategy and road map have been

[13] See www.unescap.org/events/expert-group-meeting-asia-pacific-energy-highway.

[14] See www.princeton.edu/~bglisic/Glisic_Pipeline.pdf.

[15] See www.slideshare.net/jinvaibhav1/gailtel.

[16] See www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR08/PDF/Cameroon_E.pdf.

launched to equip submarine cable repeaters with scientific sensors for climate monitoring and disaster risk reduction.[17]

33. Countries in the ESCAP region, which is an area highly exposed to disasters and the potential impact of climate change, should lend their support to this global initiative and encourage telecom operators based in the region to actively participate in it. Once clear technical standards have been laid out under the initiative for repeaters to host sensing equipment, participation in the data collection programme could be made mandatory for cables deployed from the shores of ESCAP members and associate members.

IV. Policy measures to maximize the synergies across infrastructure sectors

34. Increasingly, countries are taking measures to tap these important potential synergies to stimulate co-deployment and cohabitation. At this stage, such efforts are still being spearheaded by developed countries, but they often constitute valuable examples which could be tailored to the situations of ESCAP developing countries. Potential also emerges in using the possibilities offered under regional cooperation intergovernmental agreements, such as the Asian Highway and Trans-Asian Railway network agreements, to boost the development of fibre transmission networks at the regional level. Measures to boost co-deployment and other synergies are detailed below.

A. Advocacy and transparency

35. Except for the railway organizations mentioned above which lease their fibre networks on commercial terms, traditional utilities (roads, electricity, water networks and pipeline operators) are not always aware of the potential benefits of co-deployment in terms of reduced investment costs or the potential revenues that could be gained from leasing duct space and capacity on fibre. Such commercial advantages are perhaps least obvious to traditional utilities that are State-owned or that retain a strong public sector culture. Hence, one of the short-term priorities in developing countries in the Asia-Pacific region should be to raise their awareness as to the potential commercial benefits of co-deployment and passive infrastructure rental. As discussed in the previous section, there are a number of good practices in the region that can be used as reference guides for the way forward.

36. Increased knowledge of the benefits of infrastructure-sharing is not sufficient however. For the synergies to materialize, another condition is access to reliable information on both existing infrastructure and planned civil engineering works. Such information can be made public in various forms. The European Commission, for example, has issued a proposal for a European Union initiative[18] to reduce the cost of high-speed broadband infrastructure deployment, which includes a series of measure that would facilitate cross-infrastructure synergies in deployment. The first one of these measures is a call to establish national atlases of all available passive

[17] ITU, WMO and IOC, *Using Submarine Cables for Climate Monitoring and Disaster Warning: Opportunities and Legal Challenges* (ITU, 2012). Available from www.itu.int/dms_pub/itu-t/oth/4B/04/T4B040000160001PDFE.pdf.

[18] The proposal by the European Commission was issued as a directive and was endorsed by the Council of the European Union and the European Parliament in early 2014. European Union member States will need to implement it by July 2016. See www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/trans/141234.pdf.

infrastructures (ducts, dark fibre, poles and other transmission lines) that could be used by telecom operators. Another approach could consist of mapping all civil engineering work with potential passive infrastructure supply, as such work is performed. Transparency can also be improved through the development of a database, or single information point, to include all planned civil works of potential interest to deploy fibre. In France, for example, civil engineering works above a pre-defined threshold[19] need to be reported to telecom operators and local authorities through a specialized entity. Interested parties then have a six-week window to express their interest in joining the works, which the utility commissioning the work is mandated to accept. The telecom operator (or local authority) wishing to lay the ducts is required to compensate the utility for the additional expenses incurred. The compensation is established against a set of pre-defined criteria and depends on the diameter of the ducts or the weight of the cables if they are to be deployed on electricity poles.

37. While the provision of this information is important at the national level to foster co-deployment, the adoption of such transparency measures may be even more important at the regional level when cross-country infrastructure projects are envisaged. A regional or subregional database of planned infrastructure projects with co-deployment potential could be created at the regional level, possibly managed by the ESCAP secretariat, which already has experience in collecting network information in the transport, energy and ICT sectors. This would include all major cross-border road, railway, electric transmission and pipeline projects. Maps[20] of the Asia-Pacific information superhighway already constitute a first repository of information on existing fibre networks, and they include information on ESCAP transport networks (the Asian Highway and Trans-Asian Railway). These maps could be further enriched by including additional information on other cross-country infrastructure projects with co-deployment potential.

B. Regulatory and institutional aspects in ensuring rights of way and open access

38. Regulatory frameworks also need to be adjusted to ensure that the synergies materialize. This can take many forms and each ESCAP member State will need to reflect what adjustments need to be made to its own specific regulation system. Reviews of the regulatory framework should be aimed at achieving a double objective: on one hand, they should generally promote the usage of the utilities' existing rights of way by actors deploying the fibre; on the other, they should also promote open access to the fibre operators, that is, non-discriminatory access to cohabiting infrastructure at a reasonable cost.

39. Current jurisdictions sometimes are limited to one clearly stated objective concerning the rights of way that are granted to utilities to deploy their networks through public land or private property. This single purpose right of way is often related to the provision of one unique type of public service (electricity or water, for example). The legislation of ESCAP members and associate members should ensure that every time a right of way has been granted to a utility to deploy its network, it is automatically extended to fibre deployment, either simultaneously or subsequently. In order

[19] The minimum threshold for reporting civil engineering works is a length of at least 150 metres in urban areas or 1 km in rural areas. See www.ant.developpement-durable.gouv.fr/le-point-sur-l-article-l49-du-cpce-a509.html.

[20] See www.unescap.org/idd/maps/asia-pacific-superhighway/.

to further facilitate rights of way, one recommendation of interest is the creation of a one-stop shop on rights of way and administrative procedures.[21] Obtaining all the necessary information from a centralized institution can help operators save time and money.

40. While reviewing good practices in the European Union, researchers reported[22] that mandated access to passive infrastructure was an important measure to decrease the cost of network deployment. Providing mandatory access also applies to telecom operators themselves, in particular the historical incumbent, in addition to other utilities. The authors noted that, while in the short term, synergies seem to happen mostly between telecom operators sharing their ducts, in the longer term, electricity utilities could be increasingly interested in sharing their infrastructures with telecom operators as they could in return obtain the Internet backhaul necessary for implementation of so-called smart grids. Likewise, for transport infrastructures it is increasingly likely that advantages will be perceived regarding laying out fibre to enable intelligent transport systems. The “dig once” sets of policies of the United States of America require that individual states in that country install broadband conduits during the construction of federally funded highway projects. Access to such conduits should be available for a cost-based charge.[23]

41. Ensuring open-access to fibre or ducts in other infrastructure is one of the ways to increase competition and bring down ICT prices. The case for open access is further strengthened when public funding is provided to deploy infrastructure. Open access requires that all operators are afforded market entry to the infrastructure on similar conditions. It typically requires establishing clear guidelines of non-discrimination between telecom operators and access to the utility infrastructure at fair prices, which include the recovery of costs in addition to a small profit margin. Rental and maintenance charges of passive infrastructure may need to be regulated to ensure that the physical infrastructure owner receives adequate incentives to continue building and maintaining it.

C. Asian Highway and Trans-Asian Railway and pan-regional fibre deployment

42. The ESCAP secretariat promotes a vision of international integrated intermodal transport and logistics system covering the whole region. This has led to the development and use of three networks, namely on the Asian Highway, Trans-Asian Railway and dry ports, as building blocks in planning and upgrading regional transport networks.

43. The notion of developing region-wide road and rail networks can be traced back to the late 1950s for the Asian Highway and the early 1960s for the Trans-Asian Railway. In the late 1980s and early 1990s, sweeping

[21] Matt Yardley, Rod Parker and Mike Vroobel, “Support for the preparation of an impact assessment to accompany an EU initiative on reducing the costs of high-speed broadband infrastructure deployment”, a study prepared for the European Commission, DG Communications Networks, Content and Technology, by Analysys Mason Limited, 2012. Available from http://ec.europa.eu/digital-agenda/en/news/support-preparation-impact-assessment-accompany-eu-initiative-reducing-costs-high-speed.

[22] Ibid.

[23] United States Government Accountability Office, “Planning and flexibility are key to effectively deploying broadband conduit through Federal highway projects”, Washington, D.C., 2012. Accessible from www.gao.gov/assets/600/591928.pdf.

changes in the political and economic environment in the ESCAP region led to a revival of the two projects. The ESCAP secretariat, in close collaboration with member countries, carried out a number of corridor studies aimed at identifying the routes of the two networks based on the criteria that the selected routes had to be:

(a) Capital-to-capital links;

(b) Connections to main industrial and agricultural centres;

(c) Connections to major sea and river ports;

(d) Connections to major container terminals and depots.[24]

44. To reinforce project ownership by the member States, the secretariat also involved existing subregional groupings as partners in the implementation process, as well as governmental and non-governmental technical organizations.

45. To date, the Asian Highway network includes 143,000 km of roads passing through 32 member States, while the Trans-Asian Railway network includes 117,500 km of railway lines serving 27 member States.

46. Recognizing that the two networks were gradually becoming flexible tools to promote international and transit traffic as well as a mechanism that assisted member countries in defining their national transport policies, the Commission mandated the secretariat to formalize them through two intergovernmental agreements. The International Agreement on the Asian Highway Network[25] came into force in July 2005, while the Intergovernmental Agreement on the Trans-Asian Railway Network[26] entered into force in June 2009. To date, there are 29 parties to the Intergovernmental Agreement on the Asian Highway Network and 18 parties to the Intergovernmental Agreement on the Trans-Asian Railway Network. The following table sums up the status of signatories and parties.

[24] Connection to major tourist attractions was later added to the Asian Highway route selection criteria.

[25] United Nations, *Treaty Series*, vol. 2323, No. 41607.

[26] United Nations, *Treaty Series*, vol. 2596, No. 46171.

Table 2
Status of signatories and parties to international transport agreements

	Intergovernmental Agreement on the Asian Highway Network		**Intergovernmental Agreement on the Trans-Asian Railway Network**	
	Signatory	**Party**	**Signatory**	**Party**
Afghanistan	Yes	Yes	Not yet a member of the Trans-Asian Railway	
Armenia	Yes	Yes	Yes	No
Azerbaijan	Yes	Yes	Yes	No
Bangladesh	Yes	Yes	Yes	Yes
Bhutan	Yes	Yes	No rail network	
Cambodia	Yes	Yes	Yes	Yes
China	Yes	Yes	Yes	Yes
Democratic People's Republic of Korea	No	Yes	No	Yes
Georgia	Yes	Yes	Yes	Yes
India	Yes	Yes	Yes	Yes
Indonesia	Yes	Yes	Yes	No
Iran (Islamic Republic of)	Yes	Yes	Yes	Yes
Japan	Yes	Yes	Not yet a member of the Trans-Asian Railway	
Kazakhstan	Yes	Yes	Yes	No
Kyrgyzstan	Yes	Yes	No	No
Lao People's Democratic Republic	Yes	Yes	Yes	Yes
Malaysia	Yes	Yes	No	No
Mongolia	Yes	Yes	Yes	Yes
Myanmar	Yes	Yes	No	No
Nepal	Yes	Yes	Yes	Yes
Pakistan	Yes	Yes	Yes	Yes
Philippines	Yes	Yes	Not a member of the Trans-Asian Railway	
Republic of Korea	No	Yes	Yes	Yes
Russian Federation	Yes	Yes	Yes	Yes
Singapore	No	No	No	No
Sri Lanka	Yes	Yes	Yes	Yes
Tajikistan	Yes	Yes	Yes	Yes
Thailand	Yes	Yes	Yes	Yes
Turkey	Yes	Yes	Yes	No
Turkmenistan	No	No	No	No
Uzbekistan	Yes	Yes	Yes	Yes
Viet Nam	Yes	Yes	Yes	Yes

Source: ESCAP.

47. Under the terms of the agreements, working groups were established, one each for the Asian Highway and Trans-Asian Railway networks. The working groups meet biennially to review the implementation of the agreements and monitor progress in developing the two networks. They provide a forum for member States to discuss common issues, coordinate projects and identify potential investment sources.

48. The Asian Highway and Trans-Asian Railway play a catalytic role in the coordinated planning and construction of international roads and railway lines in Asia and help countries optimize the use of their infrastructure by creating intermodal transport opportunities. Although the quality of the Asian Highway network across and within member countries remains uneven, significant progress has been made in raising the quality of infrastructure along Asian Highway routes. In 2010, the proportion of routes of Primary and Class I standards reached 30.2 per cent of the network, that is, 43,000 km, up from 20 per cent in 2004, while those that did not meet the minimum required standards fell to 8.3 per cent of the network, that is, 11,915 km, down from 16 per cent in 2004.[27]

49. Meanwhile, much progress has also been made in the development and upgrading of the Trans-Asian Railway network. In early 2008, the Kerman-Zahedan line section in the Islamic Republic of Iran was completed, offering continuous rail infrastructure through the Islamic Republic of Iran to Pakistan, India and Bangladesh. In early 2009, a line section was inaugurated between the towns of Nongkhai in Thailand and Ban Dong Phosy (Thanaleng Railway Station) in the Lao People’s Democratic Republic, marking the beginning of rail operations in the Lao People’s Democratic Republic. Work is also ongoing to put into place a number of missing links in the network. The Islamic Republic of Iran Railways is pursuing the construction of a cross-border rail link to Afghanistan and links with Azerbaijan and the Russian Federation. Once completed, there will be continuous rail infrastructure from Western Europe to Bangladesh via Poland, Belarus, the Russian Federation, Azerbaijan, the Islamic Republic of Iran, Pakistan and India. In Turkey and Georgia, work is about to be completed on the 98-km line section between Kars (Turkey) and Akhalkalaki (Georgia) as part of a wider project to develop the Kars-Tbilisi-Baku rail corridor under a memorandum of understanding signed by the Governments of Azerbaijan, Georgia and Turkey. In India, the construction of the rail connection with Myanmar is considered as a priority project, while in China projects are at various stages of planning or implementation to put into place connections with the Lao People’s Democratic Republic and Myanmar and improve the existing lines to Viet Nam.

50. The Trans-Asian Railway network is increasingly proving an important conduit for international trade. In China, intermodal services continue to gain ground in the overall traffic task of the China Railway Corporation, both domestically and internationally, with increased long-distance cross-border movements to Central Asia and Mongolia. China Railway Corporation is also building on its success in order to develop international container block-train services to and from European destinations, such as Antwerp in Belgium and Leipzig and Wackersdorf in Germany. Developments have also taken place in other parts of the region

[27] Under annex II to the Intergovernmental Agreement on the Asian Highway Network, Asian Highway routes are classified into four types: Primary; Class I; Class II; and Class III. “Primary” standards are access-controlled highways with asphalt or concrete pavement. Routes of “Class I” standards are of four lanes (or more) in configuration with asphalt or concrete pavement. Routes of “Class II” standards are of two-lane configuration with asphalt or concrete. Routes of “Class III” standards are of two-lane configuration with double bitumous treatment. Different design standards related to gradient, speed, cross-section, alignment and curves also apply. Asian Highway routes that do not meet “Class III” standards are reputed as not meeting the minimum requirements. The detailed classification and design standards are available from https://treaties.un.org/doc/Treaties/2003/12/20031218%2003-14%20PM/ch_XI_B_34p.pdf.

with the trial run in August 2009 of a container block-train on the 6,500-km rail route from Islamabad to Istanbul via Tehran.

51. ESCAP member States could use these two agreements to promote fibre deployment. Each transport segment being built could include a duct or fibre deployment component. One possible way of doing this would be to invite data carriers and network operators to pay for the additional expenses related to deploying fibres or ducts in exchange for the right to use them. Resources available under universal access funds could also be tapped to cover the projects' additional expenses if the backbone network extension is viewed by the Government as important but the commercial dictates are insufficient to attract private operators. Given the increasing visibility of this issue, it should not be too difficult to convince international financial institutions[28] and international donors to endorse the principles of mandatory co-deployment on an open access basis, especially since this is bound to lead to substantial savings and additional revenue.

52. The Almaty Declaration on Strengthening Central Asia Connectivity through Enhanced Telecommunications Infrastructure resolved to "leverage existing regional connectivity opportunities offered by the Asian Highway and Trans-Asian Railway, in order to utilize the right-of-way of existing transport networks, and achieve rapid, cost-effective deployment of optical fibre across and within countries". For public funding in particular, access would need to be made open to all potential operators on a non-discriminatory basis and at reasonable cost. Towards this end and as contained in the Almaty Declaration, it is proposed that such provisions be included in the texts of the Asian Highway and Trans-Asian Railway agreements.

V. Information and communications technology and transport convergence towards intelligent transport systems

53. In addition to offering prospects of mutual synergies in its deployment and cohabitation with other infrastructure, ICT as a meta-infrastructure can play a transformative role when incorporated into these other infrastructures. Rapid progress in information processing and transmission capacity have enabled the emergence of the "Internet of Things" and so-called smart infrastructures.[29] In the area of transport, such progress has permitted the gradual emergence of the previously mentioned intelligent transport systems. In this section, there will be a brief presentation of such systems, their development benefits and a few policy recommendations to facilitate their emergence at the regional level in Asia and the Pacific.[30]

A. Definition of intelligent transport systems and development benefits

54. While there is currently no single internationally agreed definition for intelligent transport systems, ITS is generally understood to be the combination of technologies, most of which involve ICT as a platform, that are embedded within conventional transportation infrastructure for which

[28] The World Bank appears particularly supportive (see for example "Broadband networks in the Middle East and North Africa, accelerating high-speed Internet access" (World Bank, 2014). Available from www.worldbank.org/en/region/mena/publication/broadband-networks-in-mna).

[29] See E/ESCAP/CICT(3)/2.

[30] This section is drawn largely from a forthcoming ESCAP paper on ITS for development in Asia and the Pacific.

increased traffic efficiency, safety and security are sought. They include telematics and all types of communications in vehicles, between vehicles and between vehicles and infrastructure.

55. Typically, ITS can address traffic congestion, reduce traffic accidents, mitigate environmental externalities generated by road transport and more generally improve efficiencies along geographically dispersed supply chains by improving logistics and facilitating multimodal transport, including public transport. ITS can therefore greatly contribute to the three pillars of sustainable development by reducing travel times, saving fuel and reducing carbon dioxide and pollutant emissions, and improving transport safety and security, as well as increasing the comfort of users and creating new lines of economic activity.[31]

B. Applications of intelligent transport systems

56. Central to ITS is the collection, analysis and distribution of traffic information using sensors, transmitters and broadcasting. This approach provides drivers with spatially and temporally accurate information on traffic. Traffic management systems can then utilize the traffic information to modify traffic flows using signal control systems, with a view to smoothen the traffic by slowing it or reducing the inflows of vehicles. Electronic toll collection and electronic road pricing systems can further contribute to traffic management systems.

57. Information systems can also improve the provision of public transport services in several ways, for example by helping to identify demand for new routes, by automating payment systems or by using traffic signal control to prioritize public transport.

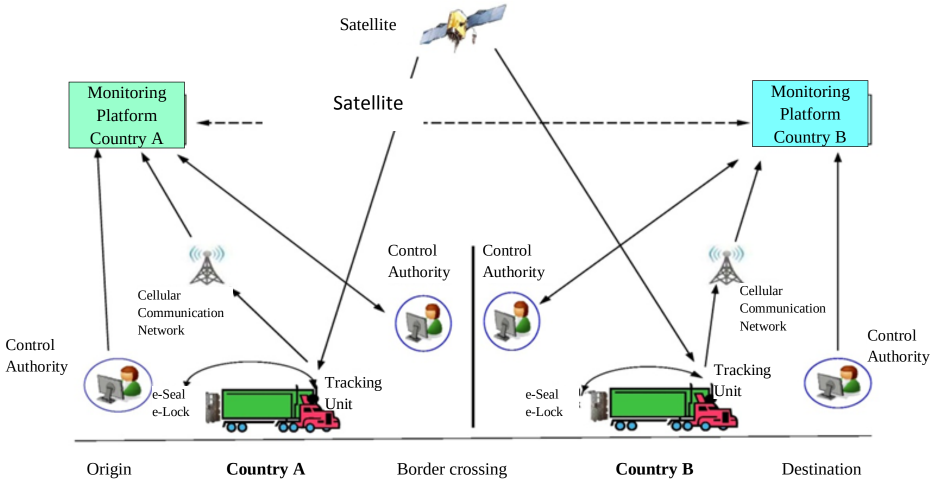
58. ITS improves transport fleet management, security of transport process, customs control of cross-border and transit traffic and formalities at border crossings, which can significantly increase efficiencies, reduce costs and lessen adverse environmental impacts. As part of its efforts to promote efficient cross-border transport, the ESCAP secretariat has developed several models showing how ICT applications can be adapted and applied to cross-border and transit transport. Two examples of such models are briefly depicted in boxes 2 and 3.

[31] ITS Asia-Pacific Secretariat, "ITS guideline for sustainable transport in Asia-Pacific", 6 December 2013. Available from www.its-jp.org/english/its_asia/1153/.

Box 2

Secure cross-border transport model

The secure cross-border transport model provides a conceptual and standardized basis for the design of a cross-border vehicle monitoring system using new technologies, including ICT, satellite positioning and electronic seals. The model prescribes standardized components and their interaction and institutional requirements.



This model demonstrates that the integrated use of ICT can secure and facilitate trade and transport, while taking care of the concerns of control authorities. A vehicle-tracking system based on the model can give control authorities the confidence they need to open up more land routes for international trade and transport while also enabling transport operators to manage their operations efficiently.

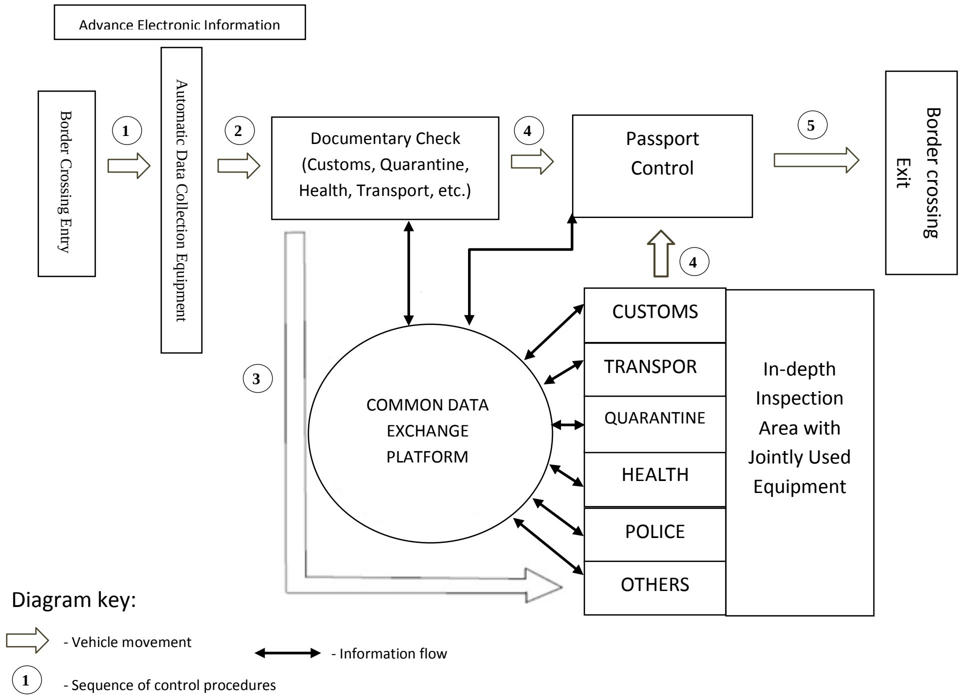
Source: ESCAP secretariat. Further details are available on the ESCAP website at www.unescap.org/resources/secure-cross-border-transport-model.

Box 3

Border-crossing management information system

The model on integrated controls at border crossings shows how information from automated equipment, advanced information from freight carriers and data provided by government agencies can be connected to the central border-crossing database of a country, and how this information could then be fed to the various border agencies. The model depicts an innovative concept of a border-crossing management information system (BCMIS). Such a system could be used in conjunction with various automated equipment and can be integrated into “single window” initiatives. With ICT, BCMIS can be applied to overcome the existing difficulties in processing cross-border traffic with enhanced security, cooperation and efficiency. Importantly, as volumes of trade and traffic grow, the system can also be scaled up without large additional investments.

BCMIS-based simplified workflow for the exit of goods:



Source: www.unescap.org/resources/model-integrated-controls-border-crossings.

C. Promoting intelligent transport systems at the regional level: areas for action

59. Intelligent transport systems rely extensively on high-speed and high-capacity communication facilities. It is important therefore to continue deploying communication infrastructure, in particular along, or in close proximity to, major roads where such systems are envisaged. ITS require both fibre and wireless communications, with fibre facilitating real-time communications between a wide variety of field devices and traffic control centres.[32] Fibre for ITS will need to be more systematically deployed along major roads, which could provide opportunities for co-deployment as discussed above. Wireless systems are also extensively utilized in ITS.

[32] www.fiber-optics.info/articles/fiber_optic_intelligent_traffic_systems.

60. Developing countries usually utilize international standards to organize and articulate ITS modules. These standards and international models are developed under the aegis of the International Organization for Standardization. The active participation of ESCAP developing countries is important to ensure that standards evolve with relevance to various developmental exigencies.

61. ITS will increasingly rely on open data and so-called big data systems. Advanced Asia-Pacific countries, such as the Republic of Korea, are already making use of open and big data to improve their transport systems, for example by developing applications to assess the demand for public transport routes. A close corollary to this trend is the need to ensure personal data security and privacy, which require strong authentication and authorization procedures. ESCAP countries will therefore need to ensure that their statistical systems and regulatory frameworks foster the usage of big data and open data systems, while ensuring data privacy and security.

VI. Issues for the consideration of the Committee on Information and Communications Technology and the Committee on Transport

62. In building a terrestrial meshed network of fibre, there is a strong incentive to leverage synergies across infrastructure sectors, notably with transport. A number of good practices exist in the ESCAP region and beyond. They typically result in win-win outcomes, including additional revenues for hosting utilities, and cheaper and more extensive fibre deployment which should ultimately contribute to improved access to ICT at the national and regional levels.

63. In this regard, both Committees may wish to consider the following recommendations and provide the secretariat with further guidance that would take the work forward:

(a) Members and associate members could consider legislation at the national level to encourage, if not mandate explicitly, open access to passive communication infrastructure;

(b) Members and associate members could also adopt measures that raise awareness, transparency and eventually systematically open new civil engineering works to co-investment and co-deployment opportunities. This would include establishing atlases of existing passive infrastructures and databases of planned civil engineering works that could offer co-deployment opportunities;

(c) Existing rights of way of traditional utilities could be automatically extended for fibre deployment, and a one-stop centralized system to acquire rights of way could be created to facilitate the process. Members and associate members could call upon international financing institutions and donors to introduce co-deployment of infrastructure on an open-access basis as a systematic requirement for cross-country infrastructure projects;

(d) Members and associate members could support amending the Intergovernmental Agreement on the Trans-Asian Railway Network and the Intergovernmental Agreement on the Asian Highway Network to include recommendations that encourage cohabitation, as outlined in the outcome of the Almaty Expert Consultation;

(e) Member States could consider lending their active support to the initiative of the International Telecommunication Union (ITU) on submarine cables for ocean/climate monitoring and disaster warning;

(f) To reap the potential sustainable development benefits of intelligent transport systems, members and associate members could accelerate the deployment of transmission capacity along the region's main roads and improve wireless frequency allocation;

(g) Members and associate members should also ensure that their regulatory frameworks are conducive to the use of big data and open data, including in the transport sector which will increasingly be a central component of intelligent transport systems.

64. The Committee may wish to support the working group on seamless connectivity in transport, ICT and energy, which was established pursuant to Commission resolution 70/1, and direct the secretariat to prioritize its future work towards this end. As a start, the secretariat could create a database of pan-regional infrastructure projects with existing or future fibre co-deployment potential. This information could be integrated into the ESCAP/ITU online maps of the Asia-Pacific information superhighway.