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Asian Information Superhighway: seamless connectivity for sustainable development in Asia and the Pacific

Asian Information Superhighway: seamless connectivity for sustainable development in Asia and the Pacific

Note by the secretariat**

Summary

Despite the substantial gains reaped from broadband Internet across all sectors, progress has been spread unevenly across Asia and the Pacific. The reasons for these persistent inequities across the region, and within countries, are complex. The Internet is the product of different types of hard and soft infrastructure, continuous technical innovation and agreements between various parties, all of which are interlinked through business models that continue to evolve. One of the key underlying components is the availability of international bandwidth, which provides a general measure of the capacity to deliver affordable and reliable broadband Internet. The physical infrastructure of the Internet, mainly submarine and terrestrial fibre optic networks and Internet exchange points (IXPs), plays an important role in determining the supply and price of international bandwidth in Asia and the Pacific.

Targeted investments and policy reforms that enhance the seamlessness of current configurations of Internet infrastructure, as well as competitive markets that allow for the efficient use of this infrastructure, would help reduce regional inequities and increase the overall development impact. Given the shortcomings of the existing fibre infrastructure in Asia and the Pacific, interest among members and associate members has grown regarding the development of pan-Asian terrestrial fibre. A transcontinental fibre network that provides seamless connectivity between land- and sea-based fibre infrastructure would lower consumer prices for broadband Internet and meet the growing need for international bandwidth in the region. Developing such a pan-Asian network will require close collaboration between members and associate members, as well as with private sector partners, international organizations, public funding agencies and development banks. Members and associate members may wish to consider the issues and policy recommendations raised and provide the secretariat with guidance on the future direction of this work.

* E/ESCAP/CICT(4)/L.1.

** The late submission of the present document to conference services is due to the need to incorporate material that had been deliberated by the Commission at its seventieth session from 4 to 8 August 2014.

Contents

I. Introduction

1. As the international community intensifies discussions on the United Nations development agenda beyond 2015, broadband Internet is emerging as one of the key means of implementation. Broadband-enabled technologies such as smart grids, intelligent transport systems, integrated water management systems and big data will increase efficiencies across all sectors of the economy. The Internet also plays an important role in modernizing government services and enhances the interaction and accountability between public administrations, citizens and businesses. Furthermore, in a region that faces heightened risk of natural disasters and exogenous shocks, broadband Internet is increasingly recognized as critical infrastructure for strengthening e-resilience. This issue is explored in detail in the document E/ESCAP/CICT(4)/5. There is also increasing focus across the region on unleashing infrastructure synergies across sectors for sustainable development. Governments have begun synchronizing the planning, construction and deployment of infrastructure in the information and communications technology (ICT), transport and energy sectors, as a means of saving costs and increasing efficiency.

2. Progress and benefits have been spread unevenly across Asia and the Pacific. In the Republic of Korea, for example, 99.6 per cent of young people have been active on the Internet for at least five years, while in Timor-Leste this figure is less than 1 per cent.[1] The reasons for these persistent inequities across the region, and within countries, are complex. The Internet is the product of different types of hard and soft infrastructure, continuous technical innovation and agreements between various parties, all of which are interlinked through business models that continue to evolve. The central premise of this note, which has been prepared for agenda item 2, is that enhancing connectivity in Asia and the Pacific will require a set of policy actions aimed at strengthening the foundation of the Internet – the hard infrastructure. Targeted investments and policy reforms that enhance the seamlessness of current configurations of Internet infrastructure in the region, as well as competitive markets that allow for the efficient use of this infrastructure would help reduce regional inequities and increase the overall development impact of the Internet. This note will also provide an update on progress achieved on the Asia-Pacific information superhighway initiative since the third session of the Committee.

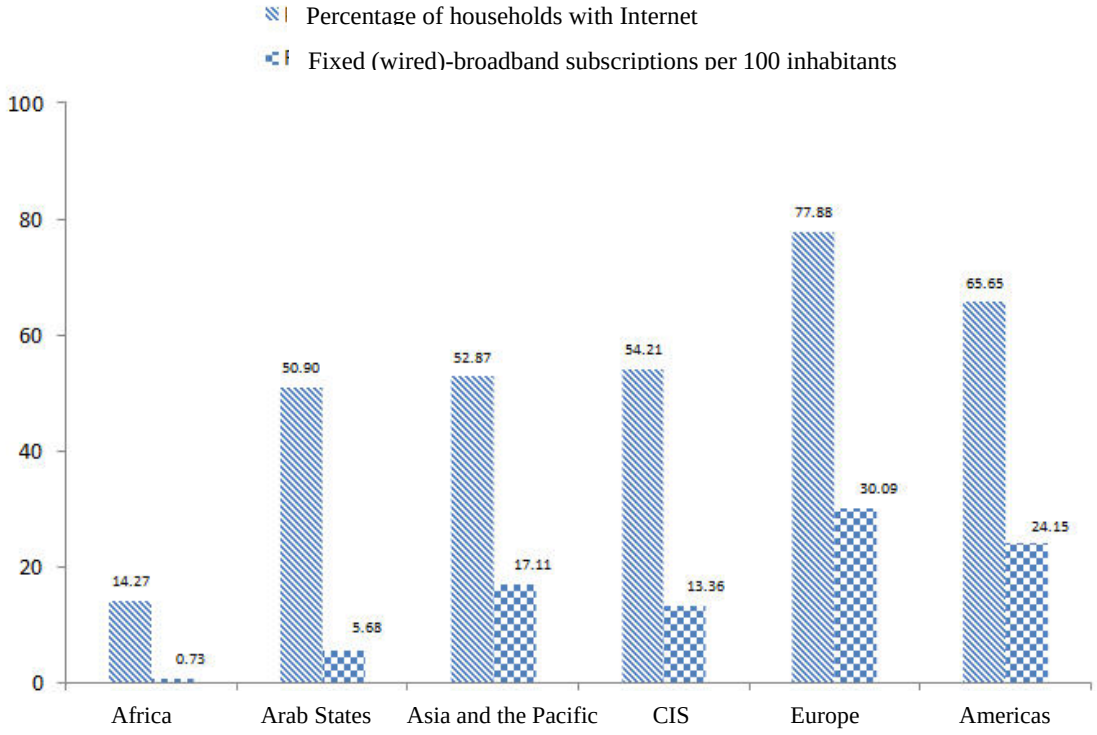
II. Broadband Internet

3. Recent data from the International Telecommunication Union (ITU) show that nearly 53 per cent of households in Asia and the Pacific have access to the Internet. This is higher than in Africa (14.27 per cent), but lower than in the Americas (65.65 per cent) and Europe (77.88 per cent). In the Commonwealth of Independent States (CIS), 54.21 per cent of households have access to the Internet (figure 1). Although these figures show significant progress in basic Internet access, the vast potential of the Internet can only be tapped with a high-speed broadband connection. Data-intensive collaboration between universities and scientific institutions, for example, requires high-speed connections. Governments and businesses require broadband Internet for essential tasks such as executing financial

[1] International Telecommunication Union, *Measuring the Information Society 2013* (Geneva, 2013).

transactions, meeting via videoconference and conducting online training, and even day-to-day use of widespread Internet applications, such as Skype and YouTube, require broadband Internet. Downloading a 20 megabit video clip at a connection speed of 256 kilobits per second (kbit/s) would takes more than 10 minutes, compared to two seconds at a connection speed of 100 megabits per second (Mbit/s).

Figure 1
Internet access in world regions and the Commonwealth of Independent States as a percentage of households and per 100 inhabitants



Source: ESCAP calculations based on ITU, World Telecommunications/ICT Indicators database 2014.

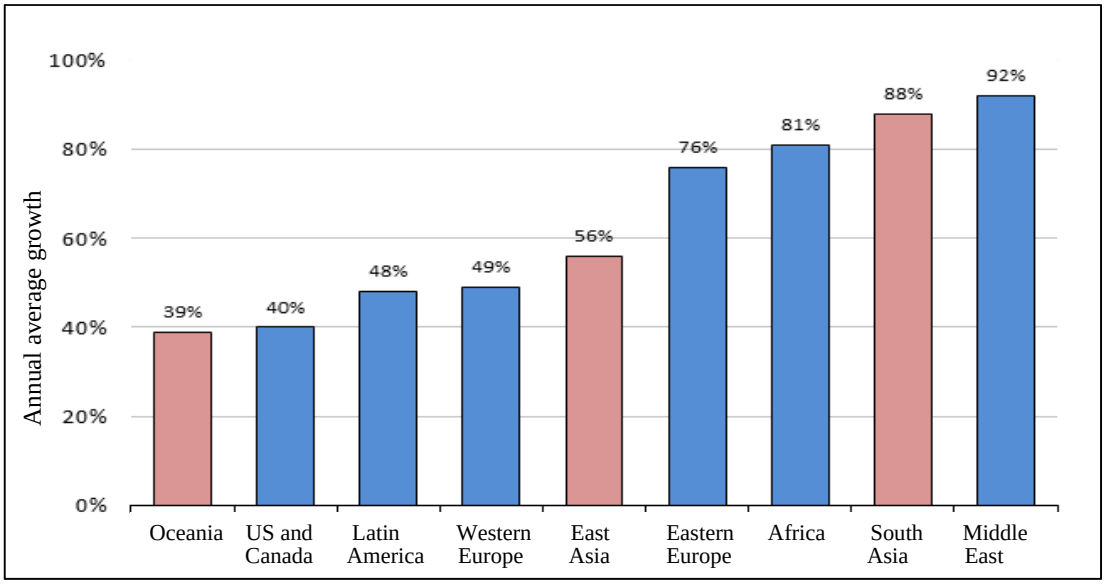
Note: Data are weighted by country GDP in current United States dollars.

4. Figures for broadband access, therefore, provide a more useful measure of the impact of the Internet than figures for basic access. A widely used indicator of broadband Internet access, fixed (wired) broadband subscriptions per 100 inhabitants, shows that it remains relatively low. There are 17.11 fixed broadband subscriptions per 100 inhabitants in the region, compared to 24.15 in the Americas and 30.09 in Europe. In some ESCAP subregions, the disparities are even greater. In South and South-West Asia and South-East Asia, for example, there are only 1.65 and 3.22 subscriptions per 100 inhabitants, respectively. And in least developed countries (LDCs) and Pacific island developing countries, there is on average less than 1 subscription per 100 inhabitants.

5. A range of factors influence the prevalence of broadband Internet, including policy and regulatory frameworks, income levels and the availability of local language content. One of the key underlying components is the

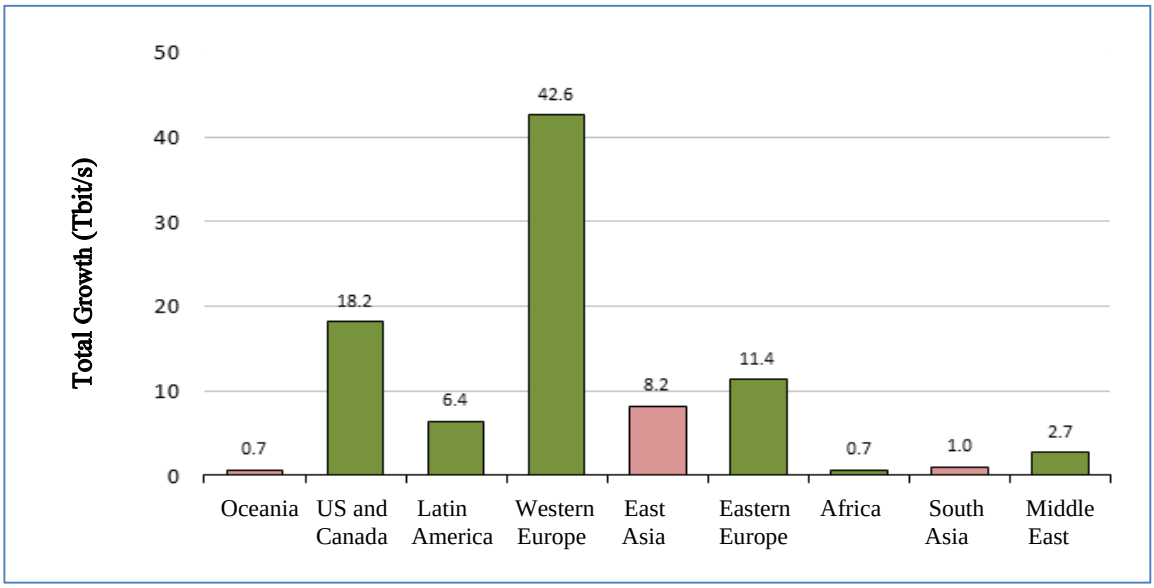
total amount of available international Internet bandwidth (measured in Mbit/s). This indicator measures the volume of Internet traffic that can travel from one country to another, akin to the width of highways in road transport, and provides a general view of the capacity to deliver affordable and reliable broadband Internet. Although the region has achieved impressive growth rates for international bandwidth over the past five years (figure 2), the total amount of bandwidth added during the period remains much less than in North America and Europe (figure 3).

Figure 2
Annual average growth in bandwidth by region (2008-2012)



Source: "2013 TeleGeography Landscape", presentation at the Pacific Telecommunications Council Annual Conference, Honolulu, Hawaii, 20-23 January 2013.

Figure 3
Distribution of growth in bandwidth by region (2008-2012)



Source: "2013 TeleGeography Landscape", presentation at the Pacific Telecommunications Council Annual Conference, Honolulu, Hawaii, 20-23 January 2013.

6. In the context of the large population of Asia and the Pacific, relatively low levels of total international bandwidth translates into much lower international bandwidth per Internet user, compared to other regions. According to data from ITU, Europe has 144,315 bit/s of international bandwidth per Internet user, more than six times that of Asia and the Pacific, and more than twenty times that of Asia-Pacific LDCs and Pacific island developing countries (table 1).

Table 1
Measurements of international Internet bandwidth, selected regions and country groupings

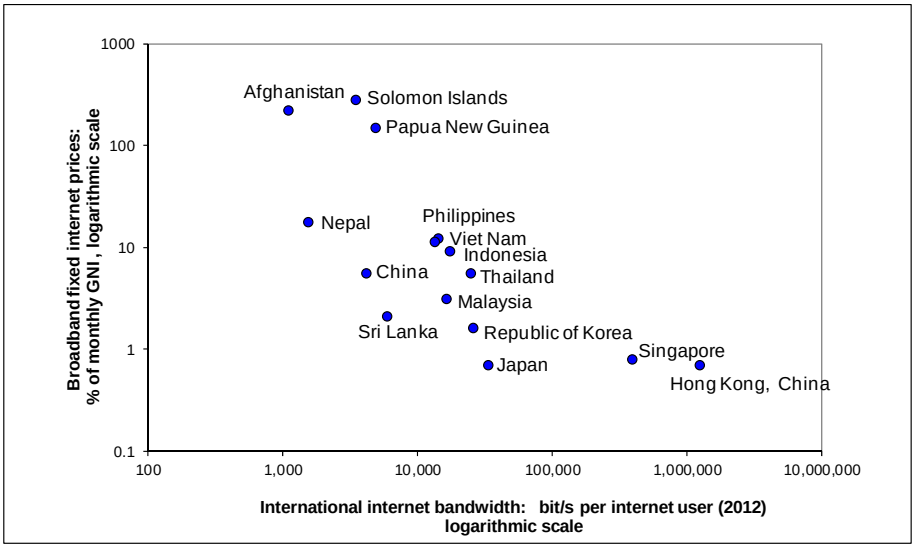
Region or country grouping	Bit/s per Internet user	Total Mbit/s
Africa	3 396	558 618
Arab States	23 453	1 640 792
Asia and the Pacific	22 612	13 147 825
CIS	30 362	4 442 981
Europe	144 315	54 787 540
The Americas	58 900	26 976 467
LDC Asia and the Pacific	4 113	67 926
LLDC Asia and the Pacific	24 932	597 373
Pacific island developing countries	6 118	7 430

Source: ESCAP calculations based on ITU, World Telecommunications/ ICT Indicators database 2014.

Notes: Asia and the Pacific excludes CIS. Data for bit/s per Internet user are weighted averages of country GDP in current United States dollars.

7. In most developing economies of Asia and the Pacific, low levels of international bandwidth correlate to the high prices of monthly broadband Internet packages. This means consumers in developed and advanced economies enjoy high-quality broadband at low prices, while consumers in LDCs and landlocked developing countries (LLDCs) pay high prices for much lower quality connections. In Japan; Macao, China; Singapore; and Hong Kong, China, it costs less than 1 per cent of monthly gross national income (GNI) per capita to purchase a monthly subscription for entry-level broadband Internet. In developing economies of the region, the costs rise to 8.8 per cent, while for LDCs and LLDCs the equivalent figures rises to 41.7 per cent and 63.5 per cent, respectively. In Pacific island developing States, a monthly subscription for an entry-level broadband plan would cost on average 126.0 per cent of monthly GNI per capita.

Figure 4
Broadband indicators, selected economies



Source: ESCAP based on ITU, *Measuring the Information Society 2013* (Geneva, 2013) and World Bank GNI data available from http://data.worldbank.org/indicator/NY.GNP.PCAP.CD.

8. In the coming years, the demand for international bandwidth is expected to grow significantly in Asia and the Pacific. In addition to growing demand from higher economic growth and deeper regional integration, more people in Asia and the Pacific are transitioning to higher capability mobile devices. These devices, capable of hosting bandwidth-intensive applications for video streaming, social media and cloud computing services, are becoming the norm at home and in the workplace. GSMA Intelligence forecasts global 4G and 3G connections in 2020 will number over two billion and three billion, respectively,[2] with much of this growth coming from developing countries. This will lead to much higher levels of data transfer and will require an enormous increase in overall international bandwidth capacity. It is important to note that smart mobile devices, although receiving the last leg of data through a wireless network, still require backhaul networks to carry data from towers and servers to the global Internet. The rapidly increasing demand for data over wireless networks, therefore, will put increased pressure on backbone networks[3] in the region.

III. Regional Internet infrastructure challenges

9. The physical infrastructure of the Internet, mainly submarine and terrestrial fibre optic networks and Internet exchange points (IXPs), plays an important role in determining the supply and price of international

[2] Available from www.gsmamobileeconomy.com/GSMA_ME_Report_2014_R2_WEB.pdf.

[3] The technical specifications of "backbone networks" and "backbone infrastructure" vary from country to country, but "backbone" is generally understood to refer to the primary data routes connecting computer networks on the Internet.

bandwidth. In Asia and the Pacific, the low levels of international bandwidth can be attributed to a number of factors related to the configuration and efficiency of this infrastructure.

10. *Reliance on submarine cables*: A large portion of interregional and intraregional Internet traffic in Asia and the Pacific is routed through submarine cables, with heavy reliance on IXPs located in the United States of America and Europe, as well as Singapore and Hong Kong, China. This reliance on sea-based cables puts the region at risk in the event of a disruption caused by natural disasters, marine vessel accidents or sabotage. In 2009, Typhoon Morakot and the subsequent undersea earthquake damaged 10 submarine cables and adversely affected voice and data traffic across South-East Asia and in China, India and Japan. Similar submarine cable disruptions were observed following earthquakes in Japan and Taiwan Province of China, and sabotage has become a concern following the deliberate attempt to damage the SEA-ME-WE 4 undersea cable in 2013.

11. *Infrastructure choke points*: In addition to the risk of network outages, the reliance on submarine cables has also resulted in infrastructure choke points for international bandwidth. Four regional bottlenecks for submarine traffic have emerged, namely the Strait of Luzon between the Philippines and Taiwan Province of China, the Strait of Malacca between Indonesia and Malaysia, the Strait of Hormuz between the Islamic Republic of Iran and the United Arab Emirates, and the Suez Canal in the Red Sea region. Much of the traffic from Asia to Europe, for example, passes through submarine cables that traverse the Suez Canal, a route that is vulnerable to disruptions that could negatively affect network traffic. Increasingly, carriers in Asia and the Pacific are seeking alternative land routes, as a complement to the existing sea-based infrastructure, that would bypass these choke points and add critical redundancy to outgoing and incoming network traffic.

12. *Limited cross-border terrestrial connectivity*: The role of point-to-point connectivity utilizing land-based infrastructure remains limited, making it difficult for inland markets, particularly LLDCs, to effectively tap into the global Internet. Much of the fibre infrastructure in the region has developed in a hub-and-spoke configuration around submarine cable hubs rather than more direct terrestrial fibre in a mesh configuration. Developing and least developed economies are heavily reliant on the international connectivity offered by these hubs, which are mainly located in developed economies. The region is heavily dependent on the reliability and capacity of the connecting undersea cables.

13. *No uniformity across terrestrial networks*: The terrestrial networks that do exist in the region provide variable quality, cost and service conditions. For example, operators in neighbouring countries may offer different access terms and service guarantees for transmission over its segment of the same international terrestrial network. This leads to market inefficiencies and operational complications, and domestic backbone networks are unable to effectively compete with submarine cables for international connectivity. As terrestrial connectivity in the region currently functions as a patchwork of domestic networks that rely on submarine cables for international connectivity, the quality and utility of land-based fibre infrastructure is restrained by the weakest terrestrial segment.

14. *High wholesale Internet bandwidth prices*: Wholesale Internet bandwidth prices at major IXPs in Asia and the Pacific remain relatively high, particularly when compared to countries in Europe and North America. For example, the median wholesale bandwidth price of 1 gigabit per second (Gbit/s) in Hong Kong, China, a major international gateway for international bandwidth in the region, has remained 3 to 5 times the price in London over the past three years. This means local Internet service providers, operating under transit agreements with international bandwidth providers, pay more than their European counterparts to access the global Internet. Furthermore, wholesale prices in the developing economies of the region are even higher than those of advanced economies of the region, which are already high when compared to global prices.

Table 2
Median wholesale Internet bandwidth prices per month, 2010-2013

	Q2 2010	Q2 2011	Q2 2012	Q2 2013	2012-2013	2010-2013
	United States dollars				Compound annual growth rate(%)	
Advanced Asia						
Hong Kong, China	28.00	22.00	16.00	16.49	3	-16
Seoul	49.16	37.00	25.00	20.00	-20	-26
Singapore	39.00	31.00	14.40	13.51	-6	-30
Taiwan Province of China	43.50	39.33	25.00	21.34	-15	-21
Tokyo	31.76	30.01	20.00	18.00	-10	-17
Developing Asia						
Jakarta	50.00	26.00	25.50	20.00	-22	-26
Kuala Lumpur	57.00	45.03	31.08	26.85	-14	-22
Manila	156.23	132.97	60.00	49.98	-17	-32
Mumbai	38.09	40.00	38.00	38.00	0	0

Source: TeleGeography.

Note: Prices for gigabit ethernet (1,000 Mbit/s), full-port commitment, excluding local access and installation fees.

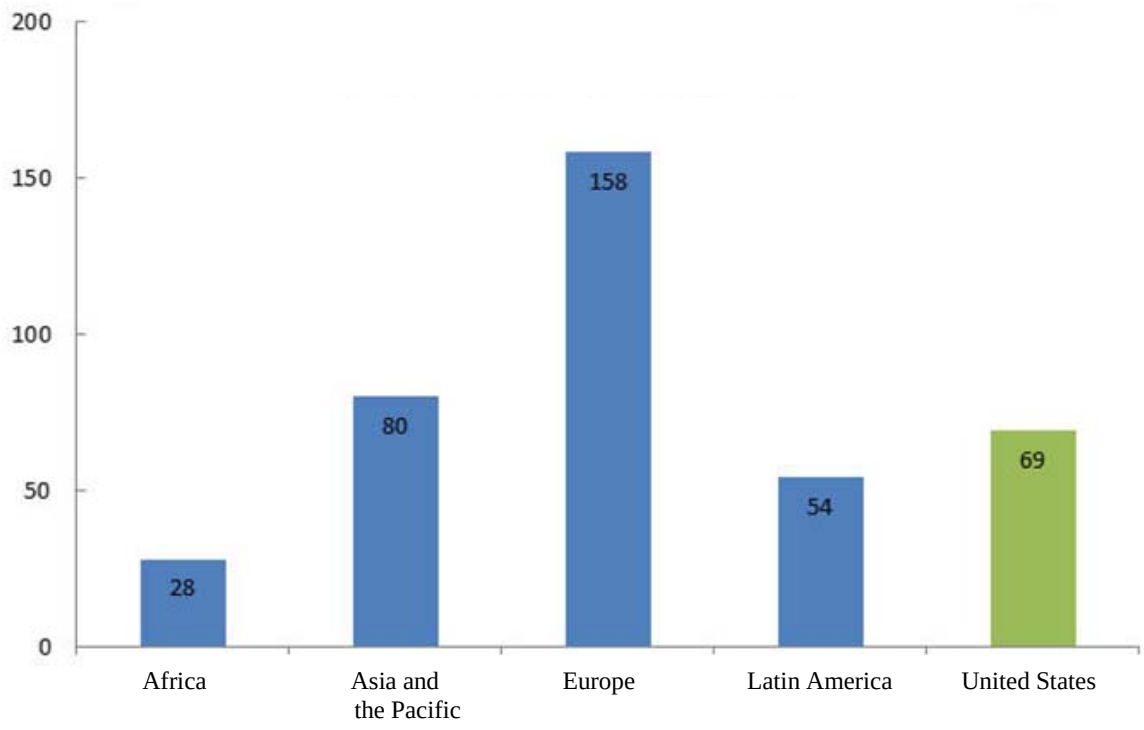
15. *Incumbent operators*: Many of the terrestrial cross-border links in the region are owned and operated by incumbents associated with submarine carriers. Cross-border terrestrial links are therefore configured to route traffic onto incumbent submarine cables, which in turn connect to IXPs in other countries and regions. For this reason, regional network traffic in Asia and the Pacific often passes through multiple IXPs located outside the region, with each additional router, switch or kilometre of network impacting the performance, reliability and price of the connection.

16. *Lack of sufficient regional IXPs*: It is commonplace to have short-haul Internet traffic traverse several countries, within or outside the region, before returning to a user in a neighbouring country (known as "traffic tromboning"). For example, Internet traffic from Kuala Lumpur could connect to IXPs in Los Angeles and San Francisco before arriving in Singapore. Similarly, traffic from Hanoi to Singapore commonly routes through Hong Kong, China; Tokyo; and Seattle. Although these circuitous

paths take a matter of milliseconds, it reduces network quality, raises prices and takes up valuable transmission capacity that could be used for interregional traffic.

17. The availability of additional IXPs in the region would allow for more direct routing of Internet traffic and reduce the need to use long-distance transmission capacity for intraregional traffic. Although Asia and the Pacific has the largest landmass of all regions, it has a total of only 80 IXPs (figure 5). Of these, only nine are in LDCs, LLDCs, and small island developing States. Europe, with a much smaller geographic landmass, has 158 IXPs, and the United States alone has 69 IXPs.

Figure 5
Number of Internet exchange points in selected regions and the United States



Source: Available from www.pch.net/ixpdir/summary.

Note: Figures as of 11 August 2014.

IV. Subregional perspectives

18. In addition to the overall challenges facing the region, each ESCAP subregion faces unique challenges related to its geographic location. For example, LLDCs do not have direct access to submarine cables and are wholly reliant on cross-border terrestrial networks for international bandwidth. For small island developing States, the primary challenge is achieving connectivity to the global Internet through high-capacity submarine cables. For countries with relatively well-developed bandwidth infrastructure, the primary challenge is increasing connectivity in rural areas. Other countries lack appropriate redundancy for reliable and

affordable network growth, or remain constrained by high transit fees at international gateways.

A. South-East Asia

19. An ESCAP analysis of bandwidth infrastructure in South-East Asia found that low-cost, high-speed and high-quality broadband services are concentrated in commercially viable urban and coastal markets, while rural and inland markets are often neglected or left underserved.[4] The existing terrestrial networks in the subregion contain weaknesses that contribute to low international bandwidth capacity, including limited geographic coverage due to point-to-point bilateral links, little or no network redundancy and low transmission capacity. Currently, intercontinental traffic is aggregated in hubs such as Singapore and Hong Kong, China, over subsea links, with terrestrial links generally operated by incumbents. In these scenarios, other operators lack cost-effective access the networks, or are unable to gain entry into the market to provide competitive services, leading to reduced international bandwidth capacity and higher overall broadband prices. Despite some progress made with the construction of the Greater Mekong Subregion Information Superhighway Network, results have not lived up to their potential. Therefore, additional fibre infrastructure is still needed to meet the growing demand for international bandwidth in the subregion.

20. Many of the main cross-border links in the subregion operate at 10 gigabits or less, making it difficult to effectively connect inland markets to high-capacity submarine cables. Higher capacity terrestrial links would supplement interregional fibre networks, provide redundancy to submarine cable choke points, and increase subregional bandwidth capacity. The ESCAP study of bandwidth infrastructure in South-East Asia shows that upgrading the capacity of the 13 existing cross-border links in the subregion and constructing additional cross-border links would help bring higher levels of international bandwidth to underserved markets. Building a cross-border link between Indonesia and Malaysia on the island of Borneo, and duplicating the existing connectivity between the Lao People's Democratic Republic and Yunnan Province, China, were identified in the study as high priority projects for the subregion. The importance of enhancing terrestrial backbone networks in the subregion was reiterated during an expert consultation co-organized by ESCAP and the ICT Office of the Department of Science and Technology, Philippines, held in Manila in September 2013. The experts recommended a scalable meshed network that would complement submarine cables, increase overall international bandwidth capacity in the subregion and bring affordable connectivity to underserved markets.

B. North and Central Asia

21. Situated between Europe and the rest of Asia, the North and Central Asia subregion is strategically located. It provides a key transit corridor for Eurasian connectivity, relying greatly on cross-border terrestrial fibre infrastructure for its international bandwidth. With no direct access to submarine cables, each landlocked country in the subregion must rely on

[4] ESCAP, *An In-depth Study of Broadband Infrastructure in the ASEAN Region*, (August 2013). Available from www.unescap.org/resources/depth-study-broadband-infrastructure-asean-region-0.

its neighbours for international connectivity. Fibre links exist across most international borders in the subregion, however these links are generally low-capacity and do not provide adequate international bandwidth. The low capacity of the Trans Asia Europe line, for example has limited its effectiveness in delivering affordable international bandwidth to the subregion, and the other cross-border links in the subregion typically operate at no more than a few gigabits per second. In-depth analysis undertaken by ESCAP found that upgrading the capacity of the following cross-border links would significantly enhance the international connectivity of the subregion: Turkmenistan to Kazakhstan; Kyrgyzstan to Uzbekistan; Tajikistan to Uzbekistan; and Turkmenistan to Uzbekistan.[5]

22. Strengthening terrestrial networks in North and Central Asia would also help address one of the most pressing concerns of the global telecommunications industry, namely the lack of reliable and cost-effective international bandwidth between Asia and Europe. The subregion provides key overland connectivity between the two continents and this "bandwidth bridge" will become increasingly important as Europe emerges as a global Internet hub. Bandwidth demand between Asia and Europe is growing rapidly, with current demand in excess of 5 terabits per second and growth rates as high as 50 per cent per year. Experts at a subregional consultation held in Baku in December 2013, organized by ESCAP and the Azerbaijan Ministry of Communications and High Technologies, noted that routing a portion of the future and current submarine traffic through terrestrial routes would enhance competition and provide significant revenue opportunities for Governments and operators in North and Central Asia.[6] Governments could earn revenue by leasing or selling access to physical infrastructure, such as highways and railways, installed ducts and manholes, or unlit fibre, and operators would benefit from a larger retail market for broadband services. This issue is explored in more detail in the document E/ESCAP/CICT(4)/2-E/ESCAP/CTR(4)/2. Furthermore, at the High-level Regional Roundtable on Telecommunications Connectivity in Central Asia, held in Almaty, Kazakhstan, in June 2013 and organized by ESCAP and the World Bank, representatives of Central Asian Governments endorsed an outcome statement that recommends including provisions in the Asian Highway and Trans-Asian Railway agreements that would encourage the cohabitation of ICT and transport networks.[7]

C. South and South-West Asia

23. Much like the rest of the Asia-Pacific region, rural and inland markets in South and South-West Asia experience low international bandwidth capacity. An ESCAP analysis of the Asian Highway and Trans-Asian Railway agreements, and existing land-based fibre infrastructure shows several areas where low bandwidth capacity in South and South-West Asia could be addressed by terrestrial networks. In some cases, this could be achieved by deploying fibre networks alongside the routes of the Asian Highway and Trans-Asian Railway. One such example is the area of India comprising seven north-eastern states bordered by Bangladesh to the west and Myanmar to the south. Constructing links from Bangladesh and Myanmar into this area of India, alongside existing and planned segments

[5] Ibid.

[6] Ibid.

[7] See E/ESCAP/CICT(4)/6.

of the Trans-Asian Railway, would significantly enhance subregional connectivity. According to information that ESCAP and ITU have been provided by member countries for the development of maps of terrestrial backbone networks, Bangladesh would benefit from access to the SEA-ME-WE 3 cable through Myanmar and route-diversity through India, and the Indian north-eastern region would benefit from enhanced fibre access through Bangladesh and Myanmar. Likewise, cross-border connectivity between India and Pakistan would greatly enhance subregional connectivity by providing critical redundancy to existing routes, India would benefit from a potential westward land route to Europe, and Pakistan would benefit from terrestrial access to large international gateways in Mumbai and Chennai.

24. Afghanistan has significantly increased its bandwidth capacity over the past five years through dedicated investments in national and international terrestrial fibre infrastructure. In 2009, only three neighbouring countries were connected to Afghanistan via fibre networks and overall the country had approximately 1,300 kilometres of operational fibre. Today, Afghanistan has over 5,000 kilometres of operational or planned fibre and is connected to five neighbouring countries, with plans to install fibre-to-the-home in six metropolitan areas. Looking ahead, it will be important to ensure that access to fibre networks in Afghanistan are made available to smaller operators and Internet service providers, including new market entrants, in order to foster healthy market dynamics that result in lower consumer prices.

D. East and North-East Asia

25. East and North-East Asia is the most developed Internet market in terms of international bandwidth capacity, access to IXPs, and overall uptake of broadband Internet. One of the reasons for the high fibre penetration in Japan and the Republic of Korea (exceeding 65 per cent of the population) is the fact that the majority of the population lives in densely populated cities, often in large apartment buildings that can be cost effectively connected to national backbone networks through a single fibre cable. Even single-family homes in densely populated neighbourhoods can be efficiently connected through one fibre loop. In the Republic of Korea, the cost of per-home deployment for fibre is estimated at US$110-US$170, much lower than in countries with more geographically dispersed populations.

26. In rural areas of the subregion, where the marginal cost of connecting each additional residence is significantly higher than in urban areas, broadband uptake tends to be lower. Notwithstanding significant investments and progress made, including the cohabitation of fibre infrastructure along railway networks, large swathes of China and Mongolia, for example, remain underserved by the regional and global Internet market. In the next decade, however, the growth of the Internet and telecommunications market in China will provide a significant contribution to terrestrial fibre infrastructure in the subregion. For example, China Telecom has deployed seven terrestrial cable systems in the direction of Europe and its regional neighbours, and China Unicom has multiple Eurasian terrestrial cable systems.

E. The Pacific

27. The Pacific island developing States combine many of the greatest challenges in fibre deployment and Internet uptake: small populations, geographic isolation, relatively low incomes and vast intervening distances across deep seabeds. Broadband penetration is still particularly low in the subregion, with Fiji, Kiribati, Micronesia (Federated States of), Nauru, Papua New Guinea, Samoa, Solomon Islands, Tonga and Vanuatu all having less than two fixed broadband subscription per 100 inhabitants. These low rates of uptake can be attributed to the high cost of broadband Internet in the subregion. In Papua New Guinea and Solomon Islands, for example, broadband with low-level usage of 2 gigabits per month costs approximately 141.6 per cent and 218.3 per cent of GNI per capita, respectively. Basic dial-up Internet service is considerably cheaper, however the bandwidth limitations are significant.

28. Despite the significant challenges, recent developments in the subregion are promising. Tonga is now connected to high-speed Internet through a submarine cable financed by the Asian Development Bank, World Bank, participating member countries and other private and public sector partners. The submarine cable, which connects to an international submarine cable system in Fiji, is expected to reduce international connectivity costs in Tonga by up to 50 per cent. In January 2014, Vanuatu launched its first international submarine fibre optic cable system, also linked to the Southern Cross Cable in Fiji, and work is now underway for a 3,000 kilometre cable system to link Vanuatu to Solomon Islands and Papua New Guinea.[8]

V. Towards an Asia-Pacific information superhighway

29. The regional and subregional challenges outlined above have led to interest by Governments in the region to develop greater cross-border terrestrial connectivity, along with sufficient regional IXPs. This would increase overall international bandwidth capacity in the region and help reduce the cost of broadband Internet. Additional terrestrial networks would also boost the competitiveness of telecommunication carriers in Asia and the Pacific. Operators would be relieved from investing in short-haul and medium-haul undersea cable projects, allowing them to invest in long-haul submarine cable projects focused on intercontinental connectivity with Europe and North America. Furthermore, additional IXPs in the subregion would support more efficient interconnection between domestic operators and reduce the prevalence of local traffic leaving the region via uneconomical international transit paths. Landlocked countries, in particular, would benefit from more efficient traffic interconnections and reduced reliance on neighbouring countries for international bandwidth.

30. Based on the analysis carried out since the third session of the Committee, and the recommendations of experts, ESCAP has thus proposed the development of pan-Asian fibre networks providing cost-effective access to international Internet bandwidth. This could involve a meshed network of submarine and terrestrial fibre optic cables that would provide access to all operators on fair and reasonable terms. A

[8] Country statement of Vanuatu at the seventieth session of the Commission, 7 August 2014.

transcontinental network that provides seamless connectivity between land- and sea-based fibre infrastructure would lower consumer prices for broadband Internet and help meet the growing demand for international bandwidth in the region. In particular, the Asia-Pacific information superhighway would enhance the connectivity of LLDCs in the region, many of which currently lack direct links to submarine cables and major IXPs.

31. Cross-border terrestrial connectivity is sometimes perceived to be less effective than submarine cables, however the experience of landlocked countries of the Organisation for Economic Co-operation and Development (OECD) demonstrate the critical role of both land- and sea-based fibre infrastructure. Of the 34 OECD member countries, six are landlocked and rely solely on terrestrial fibre networks for international bandwidth, yet fixed broadband rates in those six countries are higher than many countries with direct access to submarine cables. Landlocked Austria, Luxembourg and Switzerland all have fixed broadband rates above 25 per cent, and rely on high-capacity terrestrial links to connect to the global Internet. In Asia and the Pacific, however, LLDCs suffer from low-capacity terrestrial links and limited international connectivity, factors that have contributed to an average fixed broadband rate of 5 per cent in those countries.

32. The overall success of landlocked OECD countries, some of which have emerged as key bandwidth transit wholesalers, provide a compelling model for landlocked countries in North and Central Asia. In 2013, nearly 40 per cent of the 19.9 terabits of international bandwidth in Asia was connected to the United States and Canada, down from 48 per cent in 2009. The decline in the share of trans-Pacific international bandwidth has been largely picked up by Europe. As transit prices on the Europe-Asia route have declined due to the introduction of multiple new submarine cables, the share of bandwidth from Asia to Europe has increased from 21 per cent in 2009 to 28 per cent in 2013,[9] and the percentage of bandwidth capacity from South Asia to Europe has grown from 6 per cent in 2003 to 46 per cent in 2013.[10] Telecommunications experts anticipate a continuation of this trend as Europe counters the traditional dominance of North America in international bandwidth.

33. The development of an Asia-Pacific information superhighway will require strong international submarine connectivity, enhanced terrestrial fibre infrastructure, sufficient regional and subregional IXPs and satellite services where appropriate, all seamlessly configured in a meshed network. Developing this type of integrated information and communications infrastructure will also require close collaboration between members and associate members, as well as with private sector partners, international organizations, public funding agencies and development banks. Towards this end, a common set of guiding principles could be agreed on. These principles, outlined below, are based on outcomes of expert consultations held in Manila (September 2013), Baku (December 2013), and Almaty, Kazakhstan (June 2014).

[9] TeleGeography Insider, “Asia’s connectivity patterns shift as carriers become less dependent on US”, 17 October 2013.

[10] TeleGeography, “Europe Emerges as Global Internet Hub”, 18 September 2013.

A. Common principles for pan-Asian network development

34. *Fully integrated and coherent*: Robust cross-border connectivity, developed in a mesh configuration, would increase international bandwidth capacity and allow for in-network healing in the event of cable disruptions.

35. *Transparency, open-access and non-discriminatory pricing*: Operators accessing the network on equal, transparent and non-discriminatory terms would help lower the costs for international bandwidth. Open-access principles implemented across the region would allow developing countries, LLDCs and Pacific island developing States to receive bandwidth at fair and reasonable prices.

36. *Uniform quality*: A single uniform network with standard terms and quality of service guarantees would address the inefficiencies and operational complications arising from the existing patchwork of domestic backbone networks.

37. *Leverage existing infrastructure*: Utilizing existing passive infrastructure in energy, water, transport and telecommunications, including the accompanying rights-of-way, would lower deployment costs and increase network reliability. This could be achieved through partnerships with existing long-distance infrastructure networks such as the Asian Highway, the Trans-Asian Railway, or power transmission networks. Partnerships with ongoing and planned terrestrial links, such as the Trans-Eurasian Information Superhighway, could also feed into a pan-Asian terrestrial network.

38. *Regional and subregional IXPs:* Shorter paths between IXPs, Internet service providers and the consumer would yield higher performance at lower prices. The establishment of additional regional and subregional IXPs, therefore, should form a key part of efforts to develop pan-Asian terrestrial networks.

B. A cohesive regional network through cooperation and collaboration

39. A regional approach — or at least coordinated subregional approaches — can add significant value. If coordination is lacking, countries may choose to improve international connectivity by negotiating on their own for transit capacity with neighbouring countries, without contemplating the impact of such decisions on the wider region. Such bilateral approaches have contributed to the existing fragmentation of backbone networks in the region. Developing bilateral relationships with networks in other countries, without an overarching regional framework, would also limit competition at cross-border links and international gateways. A cohesive regional network, however, would bring less connected countries directly into the global Internet, stimulating overall demand and ultimately, leading to lower broadband prices, higher productivity contributions and improved economic growth overall.

C. Public funding and regulatory support for broadband infrastructure projects

40. Significant investments will be required to construct, deploy, maintain and operate sufficient terrestrial networks across the region. For the period 2010-2020, it has been estimated that Asia and the Pacific will

need to invest about US$8 trillion in infrastructure, of which around 10 per cent will need to be invested in the ICT sector,[11] including fibre networks and Internet exchanges. In addition to investments in new fibre infrastructure, additional investments will be needed to augment the capacity of existing infrastructure.

41. As investments in fibre infrastructure are capital intensive and investment gaps are mostly in sparsely populated areas where the future flow of returns on investments are uncertain, support from public entities will be required. Public entities can support fibre deployment in several ways, including through regulatory policies that promote competition and cohabitation of infrastructure, however more direct involvement in the deployment of fibre networks will also be needed. Utilizing public funds will become increasingly necessary to expand broadband networks into rural and underserved areas that are not commercially viable for private operators, who have thus far focused on urban areas with lower per-home connection costs. Experiences from the region have shown that companies prefer to build networks in densely populated areas.

42. Given these challenges, Governments and the private sector could combine their resources and expertise through public-private partnerships. This would involve sharing the investment cost of deploying fibre infrastructure among multiple operators and national Governments, on the condition that the network is operated on terms that meet public policy goals as well as commercial objectives. Governments would benefit from higher growth and innovation, and operators, including incumbents, would benefit from a larger retail market for broadband services. Most importantly, consumers would benefit from lower bandwidth costs and higher network quality. In some cases, specific policy or regulatory measures may be needed to foster competitive markets and attract global carriers to invest in the region. Transparent and open access to existing and new networks, unbundled wholesale access to international bandwidth and non-discriminatory transit tariffs are among the regulatory measures to consider to spur network development.

43. Although it will take dedicated efforts by public entities to fill the current gaps in the telecommunications market, recent global and regional developments are promising. Governments in Asia and the Pacific have increased their efforts to deploy national fibre networks and cost-effective models are being explored. For public or public-private infrastructure projects, Governments generally tap funds from general revenue, or from funds allocated for national infrastructure development. In Australia, the National Broadband Network is a government infrastructure initiative that aims to increase the reach of broadband across the country, through a mix of fibre-to-the-premises and fibre-to-the-node technologies.

44. Some Governments have decentralized efforts and found success funding fibre networks at the municipal level, using local funds to connect cities and towns; however, this approach does not always adequately address the lack of connectivity in rural areas. Experiences from outside the region provide useful examples for addressing this issue. In Colombia, for example, the Government created a list of unconnected municipalities

[11] Asian Development Bank and Asian Development Bank Institute, *Infrastructure for a Seamless Asia* (Tokyo, Asian Development Bank Institute, 2009). Available from www.adbi.org/files/2009.08.31.book.infrastructure.seamless.asia.pdf.

and offered public funding to co-finance backhaul networks if service providers were willing to connect these municipalities. The successful bidder was the firm that offered to connect the greatest number of municipalities. In this case, the winner of the tender connected 245 previously unconnected municipalities, far beyond the minimum expectations of the Government (70 municipalities).[12] Public institutions can also provide low-cost loans to operators to support fibre deployment to rural areas, a strategy that has been used in developed markets in North America and Europe.

45. It is important to note that even in cases where public funding is provided for fibre infrastructure projects, partnership with existing private operators will be required in order to ensure seamless connectivity across old and new infrastructure, as well as fair and transparent competition. In some cases, Governments may find that management of the network is best handled by the private sector. For example, the successful broadband strategy implemented by the Republic of Korea can be credited to a combination of deregulation, competition and government investment in the construction of a backbone network. Upon completing various broadband networks, the Government transferred ownership of the infrastructure to the private sector, cognizant that private companies would be better suited to manage the network.

D. Open-access principles for cohesive regional network development

46. As public funds are increasingly utilized to develop fibre infrastructure across the region, the adoption of open-access principles has become an important policy objective. Practices from around the world illustrate an emerging consensus on the general principles for open access on fair, reasonable, and non-discriminatory terms.[13] In the European Union and the United States, for example, "open access" is used in all public funding frameworks for broadband networks. Increasingly, open-access obligations are imposed by public authorities in the context of private sector mergers or acquisitions, as well as for those operators who are awarded public funding for broadband infrastructure projects. These obligations, widely used when deploying fibre to underserved or rural areas, are aimed at stimulating competition and assisting third-party access to broadband infrastructure.

47. Enhanced peering agreements between operators could contribute to lower costs and reduced latency.[14] Because no entity is able to connect to the global Internet on its own, Internet providers access international bandwidth through peering or transit agreements. Transit agreements allow Internet providers to access the network of a bandwidth provider for a fee, in return for quality of service guarantees. Under peering agreements, however, Internet traffic is exchanged between two networks with similar amounts of traffic volume, without monetary compensation. There are benefits and drawback to both models of traffic exchange, however, Internet providers have gradually migrated from purchasing transit capacity

[12] OECD, "International cables, gateways, backhaul and international exchange points", OECD Digital Economy Papers, No. 232 (18 February 2014).

[13] OECD, "Broadband networks and open access", OECD Digital Economy Papers, No. 218 (2013).

[14] Ibid.

to establishing peering arrangements. The share of global Internet traffic connected via transit agreement declined from 47 per cent in 2010 to 41 per cent in 2014.[15] In a recent paper published by OECD, it has been suggested that multilateral peering agreements, where all connected parties at an IXP voluntarily agree to exchange traffic under the same conditions, could help ensure that smaller Internet providers have equal access to the global Internet.

48. Another form of open access, namely the required sharing of civil engineering assets such as ducts and conduits, could also provide widespread benefits by making it more cost-effective for competitors to deploy fibre, especially to less commercially attractive locations. Municipal authorities with access to local utility networks such as water, sewage and electricity infrastructure could also leverage these networks for streamlined broadband deployment. Granting access to publically-operated networks would lower deployment costs, and offer opportunities for co-management of the infrastructure, which could result in additional cost savings. In the Republic of Korea, open access to the wiring infrastructure of apartment buildings was a key element of expanding broadband connectivity throughout the country, as 58.6 per cent of Koreans live in apartment buildings. The Building Certification Programme (BCP) certified that an apartment building was equipped with suitable infrastructure for fibre connectivity. The programme significantly increased competitive access to in-house facilities and prevented apartment buildings from being locked into a single provider.[16]

49. Open-access policies are subject to varying interpretations of the basic principles for open access, conflicting regulatory provisions from different authorities and practical challenges in implementation. In this respect, formal and informal cooperation between government authorities, telecommunications regulators, public funding agencies and the private sector should be strengthened. Given the economic, legal and cultural diversity of the region and disparities in the level of Internet infrastructure and connectivity between countries, ensuring open access will require a broad regional platform to exchange ideas and formulate guiding principles. ESCAP could provide a regional platform for members and associate members to exchange ideas and develop a set of principles for the implementation of open-access arrangements under appropriate circumstances.

VI. Secretariat activities

50. The need for pan-Asian terrestrial connectivity, achieved in a cohesive manner, has been voiced by members and associate members through various forums, particularly through Commission resolution 69/10 on promoting regional information and communications technology connectivity and building knowledge-networked societies in Asia and the Pacific. The region is in need of an overarching framework that would provide long-term predictability and reduce risks associated with the high capital costs and long implementation timelines of fibre infrastructure projects. ESCAP, as the sole region-wide intergovernmental platform and

[15] TeleGeography, “IP transit revenues, volumes dependent on peering trends”, 8 July 2014.

[16] OECD, “Broadband networks and open access” OECD Digital Economy Papers, No. 218 (2013). Available from http://dx.doi.org/10.1787/5k49qgz7crmr-en.

as the main United Nations economic and social development centre in the region, is ideally placed to lay the foundation for such a regional cooperation framework.

51. The information superhighway initiative aims to increase the availability of international bandwidth and affordability of broadband Internet across Asia and the Pacific, by strengthening the underlying terrestrial fibre infrastructure in the region. The initiative, administered by ESCAP, encompasses regional and subregional backbone network maps, research and policy analysis, and norm-setting to support countries in their efforts to develop a seamless information and communication space.

52. In partnership with ITU, ESCAP developed digital maps featuring terrestrial backbone networks in Asia and the Pacific, including optical fibre and wireless networks. ESCAP also added layers featuring the routes of the Asian Highway and Trans-Asian Railway. The interactive maps allow policymakers to identify weak points in regional and subregional fibre infrastructure, as well as opportunities for cross-sectoral infrastructure development in the ICT and transport sectors. Printed versions of the maps have been sent to members and associate members. Recently, the international submarine cables in Asia and the Pacific have been added to the maps, while the addition of IXPs is under development.

53. Subregional studies of the fibre infrastructure, including detailed analyses of cross-border links, deployment costs and market structures, were carried out for South-East Asia, North and Central Asia, and South and South-West Asia. These studies were further enriched by contributions from global and regional experts and have been widely disseminated to policymakers throughout the region. The study for North and Central Asia has also been translated into Russian.

54. Technical analysis has been carried out on the speed, reliability and resilience of network traffic in the region. Data has been compiled and analysed from various proprietary and public sources, and the results have been integrated into the regional and subregional backbone network maps and subregional studies.

55. Consultations have been carried out in each of the ESCAP subregions in order to obtain a complete view of the connectivity challenges facing the region. These consultations have guided the work of the secretariat and are reflected in this Committee note.

VII. Issues for consideration by the Committee

56. The Committee may wish to direct the secretariat to review experiences in other regions. For example, South American countries have long been aware of the problem of insufficient backbone network connectivity and high costs. In March 2012, the Union of South American Nations met in Asuncion, Paraguay, and agreed on a road map for developing a regional fibre backbone network that would complement existing undersea cable connectivity. Consequently, countries are in the process of designing an interconnection map. In 2008, at the OECD Ministerial Meeting on the Future of the Internet Economy, held in Seoul, countries adopted the Seoul Declaration for the Future of the Internet Economy that paved the way for enhanced cooperation in the development of Internet networks. The declaration pledges support for increased

investments in high-capacity information and communication infrastructure, and promotes regulatory and funding principles for the future development of the Internet, particularly in OECD countries.

57. Members and associate members may wish to address another important aspect of terrestrial infrastructure, namely the technical specifications of "backbone infrastructure". To forge regional consensus on this issue, ESCAP could collect examples from Governments and private sector operators in the region. Thereafter, multilateral discussions could lead to consensus on the basic criteria and characteristics of backbone infrastructure. This would enhance the capacity of the region to develop cross-border networks under the Asia-Pacific information superhighway initiative.

58. Towards this end, members and associate members may wish to provide further guidance to the secretariat on the following:

(a) Establish a working group on the Asia-Pacific information superhighway, composed of senior government representatives, telecommunications regulators and the private sector. In implementation of Commission resolution 69/10 the objective would be to draft an intergovernmental framework on principles and norms for the development of a pan-Asian network of terrestrial fibre infrastructure. The working group would also collaborate with United Nations system partners and other international organizations, notably ITU and the World Bank, and tap into expert analysis provided by researchers, policy think tanks and regional and national institutions such as LIRNEasia in Sri Lanka and the National Information Society Agency in Seoul;

(b) Enhance, through partnerships with ITU and regional policy research institutions, the regional and subregional maps of the Asia-Pacific information superhighway, with additional value-added features, including the locations of existing and planned IXPs and dry ports, and continue to promote the maps as a multisectoral policymaking tool for enhanced regional connectivity;

(c) With funding support from development partners, and in partnership with members and associate members, undertake further analysis of the regulatory and other policy barriers that impede the formation of a single information and communication infrastructure across the region, including identification of modalities and circumstances for implementing open-access principles;

(d) Conduct further analyses of international connectivity and backbone networks, on a subregional basis, starting with South-East Asia. Such analysis would include current measurements of the speed and quality of Internet traffic in the subregion as well as projections under different scenarios, with a view towards developing potential network topologies, funding arrangements and implementation models for the Asia-Pacific information superhighway.

VIII. Conclusion

59. In Asia and the Pacific, as in other regions of the world, broadband Internet is accelerating the process of regional integration and has been recognized as a key means of implementation in the United Nations development agenda beyond 2015. Despite this, the digital divide both within and between countries persists. Drawing on cross-regional

experiences, a regional network that contributes to more cost-effective access to international Internet bandwidth, as well as reduced latency and improved network quality has assumed urgency. Towards this end, with guidance from members and associate members, and with the generous funding support of development partners, the secretariat stands ready to put in place the building blocks for an Asia-Pacific information superhighway.