Final Report

ITU-D
Study Group 1

Question 1/1

Policy, regulatory and technical aspects of the migration from existing networks to broadband networks in developing countries

including next-generation networks, m-services, OTT services and the implementation of IPv6

6th Study Period
2014-2017

CONTACT US
Website: www.itu.int/ITU-D/study-groups
ITU Electronic Bookshop: www.itu.int/pub/D-STG/
e-mail: devsg@itu.int
Telephone: +41 22 730 5999

Question 1/1: Policy, regulatory and technical aspects of the migration from existing networks to broadband networks in developing countries

including next-generation networks, m-services, OTT services and the implementation of IPv6

Final Report

Preface

ITU Telecommunication Development Sector (ITU-D) study groups provide a neutral contribution-driven platform where experts from governments, industry and academia gather to produce practical tools, useful guidelines and resources to address development issues. Through the work of the ITU-D study groups, ITU-D members study and analyse specific task-oriented telecommunication/ICT questions with an aim to accelerate progress on national development priorities.

Study groups provide an opportunity for all ITU-D members to share experiences, present ideas, exchange views and achieve consensus on appropriate strategies to address telecommunication/ICT priorities. ITU-D study groups are responsible for developing reports, guidelines and recommendations based on inputs or contributions received from the membership. Information, which is gathered through surveys, contributions and case studies, is made available for easy access by the membership using content-management and web-publication tools. Their work is linked to the various ITU-D programmes and initiatives to create synergies that benefit the membership in terms of resources and expertise. Collaboration with other groups and organizations conducting work on related topics is essential.

The topics for study by the ITU-D study groups are decided every four years at the World Telecommunication Development Conferences (WTDCs), which establish work programmes and guidelines for defining telecommunication/ICT development questions and priorities for the next four years.

The scope of work for **ITU-D Study Group 1** is to study "**Enabling environment for the development of telecommunications/ICTs**", and of **ITU-D Study Group 2** to study **"ICT applications, cybersecurity, emergency telecommunications and climate-change adaptation"**.

During the 2014-2017 study period **ITU-D Study Group 1** was led by the Chairman, Roxanne McElvane Webber (United States of America), and Vice-Chairmen representing the six regions: Regina Fleur Assoumou-Bessou (Côte d'Ivoire), Peter Ngwan Mbengie (Cameroon), Claymir Carozza Rodriguez (Venezuela), Victor Martinez (Paraguay), Wesam Al-Ramadeen (Jordan), Ahmed Abdel Aziz Gad (Egypt), Yasuhiko Kawasumi (Japan), Nguyen Quy Quyen (Viet Nam), Vadym Kaptur (Ukraine), Almaz Tilenbaev (Kyrgyz Republic), and Blanca Gonzalez (Spain).

Final report

This final report in response to **Question 1/1: "Policy, regulatory and technical aspects of the migration from existing networks to broadband networks in developing countries, including next-generation networks, m-services, OTT services and the implementation of IPv6"** has been developed under the leadership of its two Co-Rapporteurs: Yahya Nasser Mohammed Al Hajri (Oman Telecommunications Regulatory Authority (TRA)) and Vadym Kaptur (ONAT, Ukraine); and fourteen appointed Vice-Rapporteurs: Gilbert Balekette (Central African Republic), Mamadou Pathé Barry (Guinea), Jane Coffin (United States of America), Satya N. Gupta (ITU-APT Foundation of India, India), William Kyoungyong Jee (Republic of Korea), Albert Kamga (Cameroon), Serge Edgard Koudjo (Benin), Luc Missidimbazi (Republic of the Congo), Turhan Muluk (Intel Corporation, United States of America), Abdoulaye Ouedraogo (Burkina Faso), Rachid Outemzabet (Algeria), Joseph Bruno Yuma Utchudi (D.R. of the Congo), Patrick Hervé Bagodou Zeboua (Côte d'Ivoire) and Chunfei Zhang (People's Republic of China). They have also been assisted by ITU-D focal points and the ITU-D Study Groups Secretariat.

ISBN

978-92-61-22551-3 (Paper version)

978-92-61-22561-2 (Electronic version)

978-92-61-22571-1 (EPUB version)

978-92-61-22581-0 (Mobi version)

This report has been prepared by many experts from different administrations and companies. The mention of specific companies or products does not imply any endorsement or recommendation by ITU.

Please consider the environment before printing this report.

Table of Contents

Executive Summary

i. Introduction

Access to affordable broadband networks, services, and applications can facilitate economic and social development, including national priorities to promote education, employment, public safety, health, and good governance, and therefore, to achieve the sustainable development goals as defined within the framework of the United Nations. The World Telecommunication Development Conference (WTDC-2014) in Dubai (United Arab Emirates) resolves to promote the availability, accessibility, reliability, and affordability of broadband infrastructure and services in developing countries by enabling ITU Members to develop national policy and implementation strategies based on careful evaluation of the supply and demand for broadband.[1]

This report is the culmination of the work completed under study Question 1/1 which, informed by WTDC-2014 Resolution 77, examines policy, regulatory, operational, and technical issues associated with the transition from narrowband to broadband networks. The report includes country experiences and best practice guidelines to promote affordable broadband networks, services, and applications including those that stimulate demand for broadband such as e-education, e-health, m-banking, m-commerce, mobile money transfer, and over-the-top services (OTT). The report also includes polices to promote broadband deployment through effective competition, public and private investment, inter-platform competition, broadband stimulus, and universal service funds. Examples of experiences and policies facilitating the transition from narrowband to broadband networks including from IPv4 to and through deployment of IPv6 are also featured.

ii. Background

A number of policies are believed to effectively promote deployment, availability, affordability, and adoption of broadband services, and reduce prices and the digital divide between and within countries, genders, and generations.[2] [3] According to a working paper commissioned by the ITU for the 2016 special session of the Broadband Commission for Sustainable Development, a progressive regulatory environment has a positive impact on broadband penetration and use.[4] Further, the final report from ITU-D Study Group 1 on broadband issues from the 2010-2014 study period[5] identified several factors that affect the supply and deployment of broadband networks, including market reform to promote competition, universal service and other stimulus funds, and tax reductions. Similarly, the report noted factors that increase the demand for broadband services and thereby stimulates adoption and use: e.g., applications such as e-agriculture, e-education, e-health, m-banking m-commerce, and local content and services. Together these factors continue to play a pivotal role in the transition to broadband networks capable of supporting a wide array of services and applications. These networks provide the foundation for a digital technology-based economy that will provide greater opportunities, improved service delivery, and increased efficiency.

---

1 WTDC Resolution 77 (Dubai, 2014) on "Broadband technology and applications for greater growth and development of telecommunication/information and communication services and broadband connectivity".

2 The study Question 1/1 and expected outputs reflect elements from study Questions from the previous study period (2010-2014), notably Question 19-2/1 on "Implementation of Internet Protocol (IP) telecommunication services in developing countries", and Question 26/2 on "Migration from existing networks to next-generation networks for developing countries: technical, regulatory, and policy aspects".

3 Document 1/343, United States of America.

4 ITU, Report on the Special Session of the UN Broadband Commission for Sustainable Development at the Annual Meeting of the World Economic Forum: Working Together to Connect the Next 1.5 Billion by 2020, Davos, Switzerland, 2016.

5 ITU-D Study Group 1 Question 7-3/1: Implementation of universal access to broadband services, Final Report (2014) available at http://www.itu.int/dms_pub/itu-d/opb/stg/D-STG-SG01.07.3-2014-PDF-E.pdf).

iii. Objective

The World Telecommunication Development Conference (Dubai, 2014) decided that the ITU-D, with the active participation of Member States and Sector Members, should strive to help increase the availability of affordable broadband services by carefully analyzing the policy and technical issues associated with its deployment and use. The decision to study broadband access policies, implementation, and applications together is intended to eliminate fragmentation of these related issues and produce a clear roadmap of options from which developing countries can evaluate and choose the most appropriate means to achieve sustainable broadband service.

iv. Methodology

The Rapporteur Group (RG) studied the Question through contributions, and case studies from the membership and through different Reports (Broadband Commission, Global Symposium for Regulators, etc.). To study the Question, the RG carried out the following tasks:

Task 1: Collected country case studies, success stories and lessons, and information from events organized by the ITU;

Task 2: Receiving information from Regional Offices about situation with Policy and Regulation and also on the status of Transition and Implementation of Next Generation Networks (NGN) in the regions and receiving outputs from ongoing and future projects;

Task 3: Collected outputs and information from deliverables already available;

Task 4: Examined NGN Technologies development (new specifications finalized by ITU Telecommunication Standardization Sector (ITU-T) on services aspect, terminal devices and NGN capabilities).

1 CHAPTER 1 – The roadmap for affordable broadband/NGN services

1.1 Challenges: Connecting the unconnected

According to a recent Broadband Commission Report, while countries have made significant strides in connecting their population to broadband networks, in many developing countries in Africa and in Asia Pacific a significant portion of the population remain unconnected. Approximately sixty per cent of the world population are said to lack access to broadband Internet.[1] ITU data shows that while 84 per cent of world population live within coverage of 3G and 53 per cent live within coverage of 4G networks, and while 66 per cent of world population live within a 100 kilometer reach of fiber transmission networks, only 39 per cent of total population have 3G or 4G connections and only 11 per cent have fixed broadband subscriptions. Consequently, there is not only an infrastructure or access gap, but also an Internet usage gap. While reasons for the lack of broadband coverage vary from country to country, high costs of broadband deployment associated with difficult terrain (e.g., **People's Democratic Republic of Lao**),[2] disperse population centers (e.g., **Central African Republic**)[3] and rural areas (2015 Broadband Commission Report)[4] and lack of market and regulatory reforms are cited most often. As regards affordability, 57 per cent of the world's population currently cannot afford the Internet, because the costs of end-user devices, services, access and ancillary costs (including usage and device taxes) are still too high for many. In relation to relevance, there is a significant number of individuals that do not connect because they do not perceive a benefit from, trust or have an interest in being online. Others are prevented from going online for lack of relevant content, services or apps, or for cultural reasons or lack of skills. Regarding capability, currently, only 44 per cent of the global population have attended secondary education, a key determinant of Internet use.[5]

Without an enabling environment that promotes investment in broadband networks, benefits such as lower costs, increased efficiency, and the ability to support new devices and services cannot be fully attained. Over the years, both developed and developing countries have tried a number of policy tools to promote deployment and access to broadband networks. While every country has unique national interests, past experience has shown that successful deployment of broadband networks depends on an enabling environment that promotes competition, investment, facilitates migration from existing networks to the broadband networks, and promotes increased efficiency and the ability to support new devices and services. More specifically, countries with a high level of broadband penetration and use have implemented market and regulatory reforms and incentives for investment including public-private partnerships and the use of new broadband access technologies. In addition, successful broadband investment and deployment typically incorporate scalability, sustainability, and open and flexible access to enable innovation.

Some public initiatives to develop broadband/NGN networks in different countries are provided in **Annex 1**.

1.2 Economic and regulatory policies foster deployment of broadband networks

Deployment of broadband networks will depend on the local and national circumstances. However, countries have taken steps to address the deficiency in broadband infrastructure by adopting a National

1 Document 1/384, "The Global Connect Initiative", United States of America.
2 Document SG1RGQ/180, "Lao P.D.R Telecommunications Sector overview", Lao People's Democratic Republic.
3 Document 1/298, "Policy, regulatory and technical aspects of the deployment of broadband networks in the Central African Republic", Central African Republic.
4 Based on "The State of Broadband 2015", Broadband Commission.
5 The Broadband Commission, "Connecting the Unconnected," The Broadband Commission and the World Economic Forum Report, Davos, 2017.

Broadband Plan that include initiatives to implement broadband deployment[6]. Generally, a national broadband plan, among other issues, includes goals to be addressed, the means for implementing the goals, the entities involved and their roles, industry structure and regulatory measures to stimulate involvement, models of financing the implementation and technological neutrality. Broadband plans or initiatives of a number of countries include universal access to broadband networks. To achieve universal access, for example, **Lao (P.D.R)** has required every licensed ICT operator or service provider providing services to the public to contribute to the achievement of national Universal Access objectives as a condition of its license or authorization. In addition to introducing regulatory reforms, other countries including **Gambia** have introduced competition in the voice and data markets.[7]

Achieving widespread availability of broadband networks also involved investment strategies to finance universal access goals. Below is a brief description of broadband investment strategies from a number of countries.

Public-private partnerships

In a number of communities with unmet demand for broadband access, public officials and local leaders have taken actions to make certain that their citizens have access to broadband infrastructure. Several countries develop or support public private partnerships in order to gain ubiquitous broadband networks that are affordable and readily accessible[8]. Certain countries, especially those with many rural areas, may face significantly higher deployment costs due to low population density, lengthier middle-mile networks, or challenging terrain. A partnership can address such economic challenges through sharing capital costs and/or enhancing revenue potential. In other cases, countries create partnerships to foster high-speed, affordable broadband solutions for government and community facilities (e.g., schools and libraries). An effective broadband partnership spreads the risks and costs related to necessary capital investment, execution challenges, and adoption hurdles between the private and public sector.

The **United States** government has found public private partnerships to be a vital tool that encourages the build-out of broadband infrastructure. To that end, in January 2015, the U.S. Department of Commerce's National Telecommunications and Information Administration (NTIA) published *BroadbandUSA: An introduction to effective public-private partnerships for broadband investments*.[9] While partnership should reflect a communities' local needs, most generally follow one of three models:

– **Private Sector-Led:** In this instance, a commercial operator (private or non-profit) builds, owns and operates the network while Community Anchor Institutions (CAIs) and economic development authorities support the business case by contributing planning, monetary and regulatory support.

– **Government-Led and Private Supported:** A public entity (e.g. State, county or city government, municipal electric utility, or rural coop) owns the network, however private partners will build, operate and/or maintain the network in exchange for financial and in-kind support. The public entity may choose to use an existing organization, or create an entirely new one.

---

6 Documents SG1RGQ/180, "Lao P.D.R Telecommunications Sector overview", Lao People's Democratic Republic; SG1RGQ/300, "Open Access Policy and Competitive Provisioning for Afghanistan's fibre optic and broadband sectors", Afghanistan; SG1RGQ/257, "Broadband strategy of Viet Nam", Socialist Republic of Vietnam; SG1RGQ/148, "Moving from 2G to Broadband, the Gambian experience", Republic of Gambia; SG1RQ/299, "Overview of the Digital Senegal 2025 (Sénégal Numérique 2025) Strategy validated and adopted in 2016", Republic of Senegal; 1/383, "Broadband Development in Iran", Iran University of Science and Technology (Islamic Republic of Iran); SG1RGQ/56, "Broadband toolkit", United States of America; 1/402, "Deployment of broadband in Spain to guarantee the bridging of the digital divide", Spain.

7 Document SG1RGQ/148, "Moving from 2G to Broadband, the Gambian experience", Republic of the Gambia.

8 Document SG1RGQ/57, "Effective public-private partnerships for broadband investments", United States of America.

9 See: http://www2.ntia.doc.gov/Broadband-Resources#introduction.

– **Joint-Ownership Model:** A commercial operator (private or non-profit) and the public enterprise jointly invest in the network and share capacity. Both partners share in-kind and other support to fund the project.[10]

Municipal broadband

– Another method that public officials have taken to facilitate access to broadband infrastructure is deploying their own municipal broadband networks. In the **United States,** the private sector has invested billions of dollars to upgrade their broadband networks, yet in certain circumstances, insufficient financial incentives for private deployment of competitive networks still persist.[11] To overcome this challenge, many towns and cities across the United States have adopted their own broadband networks which have contributed to substantial economic growth and other benefits, such as greater competition, consumer choice, job creation and retention, and increased educational opportunities. Careful planning that considers the costs and benefits of various options for broadband deployment is critical to success, especially with municipal or community-based networks where the local community will bear the operational cost of the network.

The above discussions of the broadband investment strategies, however, do not address when and where to invest. Generally, governments have focused on investing in unserved and underserved areas. However, a case study by **Brazil** suggests how to maximize the benefits of investment in broadband infrastructure. Specifically, Brazil's 5565 municipalities were divided into clusters and ranked according to investment priorities. The results suggest that municipalities located at the outskirts of metropolitan regions, evenly distributed throughout the country, with a relative lower Human Development Index and higher demographic density were the top ranked destinations for investment.[12]

In addition to the investment strategies, a number of countries have also developed economic and regulatory policies to help assist in broadband deployment including promoting access to network, infrastructure sharing, access-to-rights of way, accounting and functional separation, and interconnection.

Open access

Several countries are adopting policies that create an enabling environment for open access. In **Afghanistan**, despite continuous growth for over a decade, the Afghan ICT sector has diminished in regards to revenue, connectivity, and technological advancement[13]. Current infrastructure is not able to handle the increased data traffic requirements of wireless 3G, 4G, and fixed broadband technology users, which has grown to nearly 10 penetration and make up approximately 15 of industry revenue. As a result, the transition from voice to data has been slow in Afghanistan and broadband access is still not widespread. To overcome this challenge, and to facilitate Afghanistan's commitment to connect 15 million Afghans to the internet by 2020 and its long-term goal to serve as a major data transit route from South to Central Asia and beyond, the Policy on Open Access and Competitive Provisioning ("Policy") was approved by the High Economic Council and the President of Afghanistan on August 28, 2016.

The Policy encourages the owners of communications infrastructure to share their resources in order to ensure large and small communications operators and ISPs have equal access to these networks, operate in a free and fair competitive market, and provide better and affordable services to the users with minimum capital. Currently, there are six major operators in Afghanistan. Of these, five are

[10] See: http://www.strategyand.pwc.com/reports/joint-ownership-approach-public-private.

[11] Document 1/177, "Case Studies: Community-Based (Municipal) Broadband Networks in the United States", United States of America.

[12] Document 1/333, "Massification of broadband internet access in Brazil: study case of an alternative dispute resolution settlement of administrative proceedings", Federative Republic of Brazil.

[13] Document SG1RGQ/300, "Open Access Policy and Competitive Provisioning for Afghanistan's fibre optic and broadband sectors", Afghanistan.

mobile GSM operators, who each hold at least 20 per cent market share. There are also a total of 51 ISPs offering Internet services throughout the country and two WiMax service providers. The Policy also enables private companies, public companies, and public private partnerships to be certified or licensed by the telecommunications regulator to build, own, and operate fiber-optic and broadband internet infrastructure, as well as international gateways and IXPs. Furthermore, the Policy encourages due consideration for liberalization of next generation technologies as they become available to the market. Finally, it requires that the fiber-optic and broadband sectors be free of any monopolies, either private or public. This transparent, non-discriminatory access to network infrastructure allows for effective competition.

The **Republic of Korea** also faced challenges with network investment and has adopted a policy on network neutrality to ensure better access to networks including open access. Shortly after the introduction of smart-devices in Korea in 2009, internet traffic previously centered on text-traffic rapidly evolved to video streaming-centered traffic, causing significant traffic congestion[14]. Some concerns raised included the immediate necessity for network upgrades through cost sharing between ISPs and CSPs as well as ISP unreasonable traffic management. In December 2011, the Korea Communications Commission (KCC) announced the "Guidelines for Network Neutrality and Traffic Management," which provided a harmonized approach between fair environment for networking users allowing open access to the internet and the sustainable development of network investment for ISPs. The guideline includes basic principles, which highlight user's rights, transparency, reasonable traffic management; managed service; cooperation between interest groups; and public consultation.

Other policies promoting competition and fostering enabling environment

Other examples of market and regulatory reforms that promote competition include **Gambia** where the government proposed functional separation of the incumbent operator between its wholesale and retail entities and a cost based model for wholesale connectivity.

To speed up broadband deployment by promoting competition, **Egypt** intends to implement a unified license regime allowing the four incumbent operators to provide all telecommunications services to users (fixed/mobile/data), issue a second infrastructure operator license allowing the licensee to build and operate infrastructure in Egypt, and award 4G spectrum and licenses[15]. Also, Egypt had limited success with local loop unbundling, a regulatory tool generally used to improve access, promote competition, and reduce costs of broadband deployment at the local level. More recently, the Egyptian policy makers are also examining the possibility of promoting competition between different access technologies to reduce broadband deployment costs and improve availability of broadband networks.[16]

Infrastructure sharing as a tool is also used by some countries to promote competition and encourage deployment of broadband networks, especially in places where competing physical infrastructure is economically not viable. **Côte d'Ivoire** suggested several principles for infrastructure sharing including establishing criteria for identifying both passive and active infrastructure sharing; focusing on areas where operators have significant market power and areas where they do not; defining a tariff framework methodology; and defining quality service requirements.[17]

The successful deployment of broadband networks not only requires access to broadband infrastructure but also requires access to rights-of-way to public infrastructure including roads, electrical transmission lines, railways, and pipelines. Lack of clear rights-of-way and property access was said to be one of the major impediments to deployment of Fiber to the Home (FTTH) construction in

14 Document 1/53, "Network neutrality in the Republic of Korea", Republic of Korea.
15 Document SG1RGQ/63, "The national broadband plan 'eMisr': Transition from planning to execution", Arab Republic of Egypt.
16 Document SG1RGQ/75, "Next generation access for broadband", Arab Republic of Egypt.
17 Document 1/163, "Elaboration of guidelines on passive infrastructure sharing", Republic of Côte d'Ivoire.

Indonesia.[18] An industry alliance working with the Indonesian Ministries of Communications and Home Affairs was able to implement policies that reduced cost of broadband deployment by shortening rights-of-way approval process and by allowing deployment of communications networks along newly built highways.

Internet Exchange Points (IXPs)

Access to broadband infrastructure including access to Internet backbone, access to landing stations, and access to international Internet gateways and Internet Exchange Points (IXPs) are also essential to the deployment of broadband network. More specifically, IXPs have played an important role in improving connectivity and reducing costs, thereby making broadband Internet more affordable.[19]

Interconnections between networks, content providers and users are essential to create the 'network of networks' that is the Internet. Internet Exchange Points are important to building national, regional, and international Internet ecosystems. They help keep local traffic local, improve Quality of Service (QoS), reduce transmission costs, strengthen local Internet infrastructure, and help build technical capacity in a country. IXPs are physical locations where different networks connect to exchange Internet traffic via common switching infrastructures. Efficient interconnection points are created by IXPs as network operators and are encouraged to connect in the same location in search of beneficial peering arrangements, cheaper, and better traffic exchange, and other value-added services. More importantly, by lowering the interconnection, transmissions and operating costs, IXPs help lower Internet access costs for the end users thereby making Internet access more affordable for a greater number of local Internet users.

The benefits of an IXP are not limited to end users and Internet Service Providers (ISPs) exchanging their customers' traffic with each other. IXPs benefits also extend to content providers who can use the IXP to efficiently distribute their traffic to all ISPs in the country. This demonstrably lowers the latency of accessing content, which increases usage, and also lowers the cost for ISPs to access the content.

The Internet Society commissioned several studies that showed significant benefits of IXPs in **Kenya**, **Nigeria**, and in Latin America and the Caribbean. These studies indicate that IXPs have, including reduced telecommunications and international capacity costs, improved data exchange, developed local technical capacity, improved quality of service, and generated additional revenues for the operators.

While the benefits of IXPs are clear, there are also practical challenges with respect to organizing and establishing IXPs. Collaboration and building trust establishing an IXP requires the cooperation between many actors, many of whom are competitors exchanging traffic at the IXP. Past experiences have shown that all IXP participants should agree upon a neutral location and management of the IXPs. For example, in **Côte d'Ivoire**, the Internet eXchange Point (CI-IXP) was housed within the premises of the incumbent operator that also served as the main node for the exchange of local and international traffic.[20] The CI-IXP failed to achieve the stated goal when it came to execution, resulting in the cessation of operations of the IXP. A renewed effort by the Telecommunication/ICT Regulatory Authority (ARTCI) and the Ministry of Digital Economy and Posts (MENUP), to establish a national IXP with participation by all stakeholder led the establishment of CIVIX which has two points of presence, one with incumbent Orange Côte d'Ivoire Télécom (OCIT) and the other with MTN-CI. As of 2016 seven entities were connected to the CIVX.

1.3 Transition to broadband networks

Technology and underlying architectural structure of broadband networks vary from country to country. Selecting a specific architectural model for constructing a broadband access network is a

[18] Document 1/277, "Local industrial alliance promotes broadband development through combined efforts", People's Republic of China.
[19] Document SG1RGQ/119, "Internet Exchange Points (IXPs): Background and some best practices", Internet Society.
[20] Document 1/321, "Experience of Côte d'Ivoire with its Internet exchange point", Republic of Côte d'Ivoire.

considerable task requiring analysis of the relevant technical and economic indicators. The key factors in determining the suitability of and approach to constructing a modern access network in a given locality are the locality's socio-economic and geographic parameters (characteristics)[21]. It is therefore not unusual to find countries that rely mostly on wired networks while others rely on satellite technology for access to the networks.[22] While countries differ with respect to the technology of their access networks, all most all of them are transitioning to the Next Generation Networks that rely on Internet Protocol (IP) to provide a variety of services and applications.

– This section will discuss how some countries have migrated or deployed broadband networks.

The evolution of networks to NGN has been a result of convergence of different types of communication networks and their transport on IP, providing a unified service platform for communication services.[23] Technological and market forces are driving network operators and service providers to migrate their traditional networks to an all-IP based networks sometimes referred to NGN . Some IP-based networks have been implemented and have become operational either as an overlay over the existing networks or as a separate network. With seemingly simple evolutionary steps, there is a general tendency to consider that this evolution towards IP would have little impact on regulation. However, as packet based IP networks provide a unified service platform for communication services, this evolution has the potential to cause substantial changes throughout the entire value chain of electronic communications service, and thereby raise challenges to communications regulators. For example, one of the main issues is to determine the most appropriate interconnection model, which could possibly be based on an IP interconnection model such as peering and transit; or possibly could be some form of modified Public Switched Telephone Network (PSTN) interconnection and tariff regime.

Regulators are also evaluating how technology transition affects customers. In the **United States** the Federal Communications Commission (FCC) is focused on three key technology transitions that significantly affect customers. First, the migration to new general purpose transport networks, second, the ongoing transition at the application layer where providers and third parties are transitioning customer's services from purpose-built networks to new applications that can ride over more general broadband transport networks, and third, the physical layer of last mile technology where communications are now increasingly sent over fiber optic cable, co-axial cable, and wireless technologies for fixed end-user voice and data transmissions. The FCC has stated that the success of the technology transitions will depend on preserving certain principles that have long defined the relationship between network providers and consumers. These principles – often referred to as the "Network Compact" – include competition, consumer protection, universal service, public safety and national security.[24]

The telecommunication service providers, on one hand, consider NGN as a means of significantly reducing their network operating costs and complexity, while on the other hand, the market players from the IT world believe that NGN has the potential to change and revolutionize the organizational model of the entire communication network. There is a worldwide trend in accepting NGN as the ultimate technology for telecommunications, and in the national context, the competing operators are already moving towards NGN-based services.

Cameroon initiated its transition from the existing telephone network to NGN in 2010 and expects to complete the transition by 2017. Cameroon's transition included meeting two primary objectives: (a) meeting the high-speed communication requirements of its subscribers and; (b) having a more

---

21 Document 1/21, "Methodology for the selection of technological solutions of telecommunication access networks", Odessa National Academy of Telecommunications n.a. A.S. Popov (Ukraine). See also **Annex 2** for further details on the methodology provided in this contribution.

22 Document SG1RGQ/313, "Evolution in satellite broadband", Inmarsat Plc. (United Kingdom of Great Britain and Northern Ireland).

23 Document SG1RGQ/90, "Developing regulatory framework in the context of Next Generation Networks (NGN) in Nepal", Nepal Telecommunications Authority (NTA) (Republic of Nepal).

24 Document SG1RGQ/58, "Technology transitions in the United States: FCC actions and the 'Network Compact'", United States of America.

flexible network in terms of new services and operational capabilities. To capitalize on the investment already made to deploy copper pairs and mobile (CDMA and LTE), Cameroon indicates that the access network will be built around FTTX and xDSL. The access nodes are multiservice with optical line termination. Transport will be entirely Internet Protocol Multiprotocol Label Switching (IP-MPLS) for more rapid routing. The core of the network will be IP multimedia subsystem (IMS), with one at Douala and another at Yaoundé. Upon completion, the incumbent operator of Cameroon is expected to have an IP/MPLS network with multiservice access nodes capable of interconnecting with other national and international operators as well as access networks including both fixed and mobile.[25]

In the case of **the People's Republic of China**, vigorous exploration focusing on rational, orderly, and cost-effective promotion of time division multiplex (TDM) equipment transition, in conjunction with network evolution, started with China Telecom's Sichuan branch as early as 2005.[26]. China found TDM equipment to be generally large in footprint and high in energy consumption and therefore made rational TDM equipment exit arrangements suited to local conditions in order to facilitate network evolution and also satisfy energy saving requirements. The introduction of NGN technology has generated huge economic benefits in the process of network exit and made a significant contribution to energy savings. NGN and IMS mark the two stages of TDM network migration to the all-IP network of the future, with NGN being the first stage and IMS being a more advanced development based on NGN. China identified the following features associated with different stages of network evolution:

- ***First stage*:** The service, control and load-bearing of traditional TDM switches constitute a tightly coupled relationship.
- ***Second stage*:** NGN separates control from load-bearing to facilitate distributed networking and independent evolution, which is a key, revolutionary step toward network streamlining and cost reduction.
- ***Third stage*:** IMS makes further advances on the basis of NGN and completely separates load-bearing, control, and service. The adoption of standard Session Initiation Protocol (SIP) interface enables the combination and transfer among services, making fixed–mobile convergence (FMC) possible.

The major technical difficulties for access-layer TDM switches to exit a network include inheritance of the original voice services and the continuing need to provide diversified modes of user access. It is necessary to analyze the customer base carefully and provide different NGN access solutions for different customers. By 2016, the Sichuan branch of China Telecom planned to achieve the exit of all TDM access layer equipment from the network, which is expected to save more than 50 million kWh of electricity per year and produce significant socio-economic benefits.

Broadband Transition

There have also been transitions from 2G to 3G networks**.** For example**, Ericsson** in its contribution highlighted the transformation of mobile networks from a voice only infrastructure into digital services where voice is now one more type of data. In developing countries, mobile networks are successfully providing broadband services to remote and rural areas that often face geographic and economic challenges. Deployment of new mobile broadband networks will also help administrations to support high traffic demand in the near future. According to Ericsson, mobile networks with 2G, 3G and 4G technologies are expected to serve 9.2 billion mobile subscribers by 2019 compared to 6.7 subscribers in 2013.[27]

[25] Document 1/311, "Migration from the switched telephone network (STN) of Camtel to next-generation networks (NGNs) in Cameroon", Republic of Cameroon.

[26] Document 1/160, **"**Facilitating transition from TDM networks to NGN and bringing about network evolution and reduction in energy consumption", People's Republic of China.

[27] Document 1/189, "Evolution in mobile broadband networks, for its consideration in the reports", Telefon AB – LM Ericsson (Sweden).

For example, in the case of **Gambia,** an ACE landing station coupled with new national backbone infrastructure has strategically positioned the country to maximally deploy broadband to the citizenry.[28] Gambia's launch of the ACE cable included many policy and regulatory changes. In 2013 the Gambian government issued a data license to the mobile and ISP operators to operate their own data gateways. Key regulatory changes included the development of a regulatory action plan through studies such as an Open Access study and a Fees and Taxation study. Prior to these actions, the incumbent operator GAMTEL had a monopoly over the voice and data gateways. Through government policies and a clear regulatory environment that responds to the need of the industry in a timely manner, Gambia hopes to boast of the highest penetration in the sub region within the next five years.

Burkina Faso is another example of how broadband transition can be supported or encouraged through government initiatives.[29] In addition to telecommunication regulations, Burkina Faso adopted an investment code extending a favourable treatment regime to service companies, including telecommunication/ICT operators. Telecom operators have repeatedly benefited from this scheme in the context of their various development projects, and in particular for the creation of infrastructure. In 2012, to enable the provision of mobile telephony services for 3G networks, the government fixed the financial conditions for obtaining the license by decree for the three operators in the market. The financial contribution, which was initially fixed at approximately USD 10 million, was reduced to approximately USD 3 million. This substantial reduction granted by the government, in consultation with operators, allowed two established operators to obtain licenses that granted them the right to operate mobile networks over 3G. By September 30, 2014, there were 1.4 million registered Internet subscribers.

According to the last report on broadband coverage in **Spain** published by the Secretariat of State for the Information Society and Digital Agenda[30], 94 per cent of the Spanish population have 4G mobile broadband coverage, 90 per cent have 10 Mbps Internet access coverage, and 75 per cent have a speed of 30 Mbps.

This increase in coverage compared with previous years[31] comes as a result of implementing various initiatives led by the Spanish Government regarding the deployment of broadband networks driven by the Digital Agenda for Spain (DAS)[32], approved on 15 February 2013 at the meeting of the Council of Ministers. The Agenda's six main objectives are: Promote the deployment of networks and services to ensure digital connectivity; Develop the digital economy; Improve e-administration and digital public services; Build confidence in digital; Promote R&D&I in information and communication technologies; Support digital inclusion and the training of new ICT professionals.

The most relevant initiatives include: development of a new General Law on Telecommunications, elaboration of a Plan for Telecommunications and Ultra-Fast Networks, approval of a Royal Decree on the coordination of public aid for broadband deployment and release of the digital dividend.

The various broadband deployment initiatives developed and implemented by the national government and put into operation in recent years meet the economic and social requirements identified in Spain relating to the lack of new technological infrastructure to strengthen development of the country's digital economy and make it possible to bridge the digital divide.

---

28 Document SG1RGQ/148, "Moving from 2G to Broadband, the Gambian experience", Republic of the Gambia.

29 Documents SG1RGQ/70, "Aperçu des initiatives publiques pour le développement des réseaux large bande, y compris les réseaux de prochaine génération" and 1/172, "Overview of public initiatives to develop broadband networks including next generation networks", Burkina Faso.

30 Broadband coverage in Spain mid-2016. November 2016. http://www.minetad.gob.es/telecomunicaciones/banda-ancha/cobertura/Documents/Cobertura-BA-Mediados2016.pdf.

31 In 2015, 76 per cent of Spaniards had 4G mobile broadband coverage, as against 48 per cent in 2014. Moreover, in 2015, 85 per cent had 10 mega Internet access coverage, as against 82% in 2014. Sixty-five per cent of Spaniards had coverage at a speed of 30 megas in 2015, as against 60 per cent in 2014. http://www.minetad.gob.es/telecomunicaciones/banda-ancha/cobertura/Documents/Cobertura-BA-Mediados2016.pdf.

32 http://www.agendadigital.gob.es/agenda-digital/recursos/Recursos/1.%20Versi%C3%B3n%20definitiva/Agenda_Digital_para_Espana.pdf.

Finally, satellite communication systems have also played a significant role in migrating next generation networks in both developing and developed countries. Satellite communications provide connectivity for rural and remote areas, and continue to serve as backup infrastructure for supporting critical communications during times of disaster or other disruption of terrestrial wired and wireless networks. While these roles for satellite communications systems remain important for developed and developing countries alike, recent innovations in satellite communications technology will also have a key role in the transition to next generation networks[33].

For example, a new generation of geostationary satellites, called High Throughput Satellites (HTS), use spot-beam architectures to provide greater broadband speed and reuse spectrum more efficiently, dramatically increasing overall system capacity. With peak single-point speeds well exceeding 1 Gbit/s, current and upcoming satellite systems offer a viable solution in many circumstances, including in urban, rural and remote areas. Advances in mobile satellite services (MSS), including higher-speed mobile services using durable, small-form factor, low-power devices, and satellite data broadcast technologies are driving innovation in machine-to-machine, Internet of Things (IoT), and connected car applications. As satellite technologies continue to evolve, satellite connectivity – whether as a backhaul or an access solution – will be key to achieving the performance, coverage, and reliability goals that demanded by next generation networks.

5G[34] considerations for broadband networks

Billions of increasingly smart and connected devices, data-rich personalized services, and cloud applications are driving the need for smarter and more powerful networks. 5G will provide new applications and services both for developed and developing countries. However, some of the 5G applications will be much more important for developing countries including smart transportation systems, e-health, education, smart grid, water management, and agriculture.[35]

The transition to 5G brings communications and computing together and is a fundamental shift for the industry. The industry is looking to 5G to provide the higher data rates (1-20 Gbit/s), lower latency and capacity needed to enable the IoT, new service models and immersive user experiences. This will require immense processing and communications power provided by sophisticated silicon solutions. Advanced technology is necessary to power the seamless end-to-end interconnectivity of 5G required to enable a smart and connected world. This includes a unique combination of computing, networking and wireless communications expertise to develop 5G solutions that integrate intelligence across the entire network, from device to data center.

There is one very significant difference between 5G and previous generations of wireless standards. 4G, 3G and 2G were wireless innovations focused largely on improving the speed and efficiency of a connection between point A (a cellular network antenna) and point B (your cellphone or other device). 5G is also about faster and more efficient wireless connectivity, but it is also about computing capability. 5G networks must be smarter, faster and more efficient to support the forthcoming billions of connected devices, data-rich personalized services, and cloud applications that will enable new experiences in our daily lives (e.g., telemedicine, self-driving cars).

First and second generation wireless networks were focused on voice services, while the focus of 3G and 4G shifted toward data and mobile broadband. While the focus on mobile broadband will continue with 5G, support for a much wider set of diverse usage scenarios expected.

The three major usage scenarios include: (1) enhanced mobile broadband; (2) ultra-reliable and low-latency communications; and (3) massive machine-type communications.

---

[33] Based on Document SG1RGQ/313, "Evolution in satellite broadband", Inmarsat Plc. (United Kingdom of Great Britain and Northern Ireland).

[34] Hereinafter the term "5G" is equal to "IMT-2020" (ITU-T Resolution 93 and ITU-R Resolution 65).

[35] Document 1/359, "Importance of 5G for Developing Countries", Intel Corporation (United States of America).

1.4 Best practices and conclusions

There is no one size fits all solution to achieve broadband investment and deployment. Each country has unique national interests and decision makers should consider all available investment and deployment options- including open access and infrastructure sharing, public-private partnerships, and municipal broadband networks – in deciding how to meet their citizen's broadband needs in a cost-effective and affordable manner.

Economic and regulatory policies foster deployment of broadband networks

Network access including open access

Transparent, non-discriminatory access to network infrastructure is critical to competitive and affordable service for end users. The following guidelines can help maintain open access, competition and cost sharing, ultimately fostering deployment of broadband networks:[36]

- **Non-discrimination** – Owners of communications infrastructure should not give preference to one operator over another when distributing or providing access to these networks in the market.
- **Transparency** – Owners of communications infrastructure should provide full, consistent and open disclosure to market subscribers/applicants. Owners should also provide usable and easily understood information.
- **Pricing** – Networks must be open and flexible to enable innovation by service providers at price levels that are competitive and fair, and that will encourage potential competing providers to become wholesale customers of the next generation access (NGA) network rather than setting up a separate network. Prices should be fixed by infrastructure owners, which may be under the direction of the telecommunications regulator. Prices should also be consistent with internationally accepted principles, with special consideration given to information obtained during public consultations. Passive infrastructure pricing should be cost-oriented and active infrastructure pricing should be market-based.
- **Exchange traffic and international gateways** – ICT providers should be eligible to enter into contracts with international private or government entities to interconnect facilities, exchange traffic, or any other commercial agreement relating to terrestrial fiber, microwave, or satellite facilities.
- **Reasonable access and right to refusal** – Access must be fair and reasonable; requests for access should be granted without discrimination and in a timely manner. Available infrastructure should also be shared with market subscribers/applicants on a first-come-first-serve basis. Rejection of an application for access should only occur if:
    1) The applicant requests services with technical specifications beyond the technical capability of the service provider and negotiations to rectify the problem do no achieve the desired outcome; or
    2) If the requested communication infrastructure has already been distributed and the service provider does not have additional capacity.

[36] Document SG1RGQ/300, "Open Access Policy and Competitive Provisioning for Afghanistan's fibre optic and broadband sectors", Afghanistan.

Leveraging Public-private partnerships

A Public-private partnership is a cost effective tool that can be used to accelerate broadband deployment. Some general guidelines for forming such a partnership include:[37]

- **Engaging a comprehensive set of partners** – Work with a broad set of partners, comprising of community leaders, public officials, and commercial entities. Benefits include the ability to carry out challenging projects and ensuring sustainability.
- Establishing early measures to facilitate coordination – Establish and document the role and contribution of each partner.
- **Building network with extra capacity** – In the case of fiber network, the marginal cost of installing extra fiber is small compared to deployment. Extra capacity becomes a critical asset that investment partners can use to interest new partners or to develop new business models in the event the original model fails to achieve its targeted objectives.

Municipal broadband network

A well-managed municipal broadband network that meets community needs can contribute significantly to economic growth and other benefits, such as greater competition, consumer choice, job creation and retention, and increased educational and health opportunities[38]. A successful municipal broadband network will include careful planning that considers the cost and benefits of various options for broadband.

Other policies promoting competition and fostering enabling environment

Competition plays an important role in reducing the costs of broadband deployment and improving the availability and use of broadband networks. Competition and hosts of other policy measures including, access to infrastructure, rights-of-way, functional separation only as a solution of last resort and infrastructure sharing reduce costs and lower bottlenecks encountered in the deployment of broadband networks.

Internet Exchange Points (IXPs)

IXPs improve connectivity, reduce costs and make Broadband Internet more affordable. Effective and well-functioning IXPs must have transparent policies and regulations that encourage regional and international entities to participate in the local interconnection and peering environment, lower the costs associated with connecting to IXPs, promote local investment in the shared IXPs opportunities via tax holidays, and reduced duties on the equipment needed to build IXPs.

Transition to broadband networks

- Transition to broadband networks should occur gradually so that such transition benefit both consumers and network operators. Although there are no set policies to guide transition to broadband networks, the three principles, competition, consumer protection, universal service, public safety and national security, may help guide policymakers to address issues related to the technology transition.

To choose the right investment model to build and transition to broadband or NGN, the following issues can be considered:

- **Scalability**

[37] See: http://www.ntia.doc.gov/report/2015/broadbandusa-introduction-effective-public-private-partnerships or http://www2.ntia.doc.gov/Broadband-Resources#introduction.

[38] Document 1/177, "Case Studies: Community-Based (Municipal) Broadband Networks in the United States", United States of America.

New technological alternatives offered by 4G may overcome some of the current financial obstacles. As the demand for access to data services continues to increase exponentially, any step taken to increase download speeds in rural and remote regions could be accommodated, even where it still compares poorly with what is available in urban areas.

– **Sustainability**

From a sustainability perspective, it is positive to see that some licensed national operators are participating in the implementation. This is particularly the case if they are involved in providing wholesale services that are an extension of the services they offer in other areas of the country.

– **A long-term view**

The NGA network can be particularly attractive to those investors looking for a cautious but relatively secure annual return over a long period from a business with a steady cash flow. In order to attract the level of investment required to meet objectives, it will be necessary to supplement public investment with significant private sector investment.

Public authorities can also contribute to the migration and development of broadband networks through the following measures:[39]

– Easing conditions of access to markets (licenses and authorizations) and to spectrum;

– Adopting incentives for operators, including financial incentives;

– Deploying, where appropriate, as a government initiative, broadband infrastructure projects: evolution towards the future generation of networks will be helped by the existence of high-quality basic infrastructure, the cost of which is not always affordable for private operators; and

Regulation adapted to the requirements of a high-connectivity environment.

5G considerations for broadband networks

5G encompasses many technologies and a much wider ecosystem than formerly seen in the wireless and telecommunications industries. But in order for billions of people and machines to be connected, we need smarter, faster and more efficient networks. The ability to connect to each other, to our machines and to the cloud, and to derive actionable insights from the massive amount of data, will bring new experiences to our daily lives and transform businesses. To facilitate 5G, the following three areas are important:

– Developing industry partnerships;

– End-to-end 5G-related hardware and software development; and

– Supporting 5G standards-setting that will create end-to-end solutions from the device to the network to the cloud.

As part of the industry effort to develop wireless radio access and device processing technologies for PCs, smartphones, tablets, wearables and many future connected devices and sensors, the following guidelines are suggested:

– Provide an open, general purpose platform for network operators; and

– Invest in the network in four key areas: advancing open source and standards, enabling open networking platforms, building out an open ecosystem and accelerating trials and deployments.

[39] Document, 1/172, "Overview of public initiatives to develop broadband networks including next generation networks", Burkina Faso.

2 CHAPTER 2 – Development and deployment of m-services

Mobile money continues to evolve as a service contributing to economic empowerment and poverty alleviation in developing nations. From saving a consumer travel time from rural areas to urban banks to helping a consumer avoid paying costly money transfers, mobile money serves as a fast and efficient way to transfer money. Perhaps most importantly for developing countries, it extends financial services to citizens who might not ordinarily have access to banking services or participate fully in the formal economy. Despite its numerous advantages, there are many barriers to the development and deployment of mobile money services including limitations imposed by the financial sector as well as privacy and security risks. This chapter provides case studies, an overview of the challenges and best practice guidelines for overcoming regulatory and technical barriers to the development and deployment of mobile money services.

2.1 Regulatory aspects

During the 15th Global Symposium for Regulators (GSR-15)[40], the ITU's Telecommunication Development Bureau (BDT) launched a consultation to identify best practice guidelines to facilitate the adoption and widespread use of mobile applications and services through targeted regulation. Based on the contributions received, a set of best practice guidelines was developed and adopted during the event.

a. Stimulating demand

Recognizing the potential of mobile money services and apps to improve the transparency, accountability, and efficiency of public services, governments can benefit from the knowledge and experience of stakeholders to formulate holistic strategies to allow users to use money mobile services and apps.

CIS countries

The A.S. Popov Odessa National Academy of Telecommunications (Ukraine) joined the Commonwealth of Independent States' (CIS) regional initiative on the "Development of recommendations and creation of a pilot segment of telecommunication/ICT system to support secure remote retail payments and the management of bank accounts using wireless communication networks" framework. The result of this work was a series of lectures and recommendations on the organization of a laboratory cycle on the subject of "Design, Technical Operation and Security of Mobile Payment Systems".[41]

The recommendations about structure of the curricula, text of the lectures, slides, and multimedia presentations, as well as recommendations about laboratory cycle, were based on an educational mobile payment system (EMPS). An EMPS provides students with the necessary basis of practical knowledge and the opportunity to reduce the time required to learn using other existing proprietary platforms. Recommendations are designed to help telecommunication universities in the CIS region contribute to human capacity building in the field of mobile payments and thereby contribute to strengthening confidence in this promising direction of development of a modern information society.

b. Facilitating availability, access, and use of mobile services and apps

It is important for policymakers and regulators to be mindful of the importance of designing flexible, incentive-based, and market-oriented policy and regulatory frameworks. The development of new markets and the industry for mobile devices can be sustained through appropriate regulatory measures.

Revisiting and reviewing, where necessary, current government policies to make sure that they are still valid and appropriate for the new environment and ensuring privacy and security of government,

[40] Document 1/174 (Rev.1), "Regulatory aspects of mobile applications and services", Democratic Republic of the Congo.
[41] Document SG1RGQ/18, "Structure of curricula on 'Design, technical operation and security of mobile payment systems'", Odessa National Academy of Telecommunications n.a. A.S. Popov ONAT (Ukraine).

business, and consumer data may be necessary. Moreover, open and collaborative regulatory frameworks can promote the development of cross-cutting services such as m-commerce, m-banking, and mobile money.

Egypt

The development of the mobile money market in **Egypt** to date is still relatively small-scale, but the mass market potential is considerable.[42]

Between 2013 and 2014, **Egypt's** financial institutions and mobile network operators launched four different mobile wallets. The number of people who are using the service is less than the market had anticipated.

Most of the barriers to the widespread adoption of mobile money services are connected to heavy regulations of the banking sector.

One of the concerns is the requirement for users to appear in person at a bank or mobile operator's premises to sign an agreement or application. This prevents consumers from immediately using the service since they have to first schedule a branch visit instead of signing up online or via phone applications. There are also restrictions about distribution channels because service can only be distributed via bank branches and mobile shops, where the use of agents is still very limited and subject to approval. These legislative limitations are imposed to prevent money laundering but it is also limiting the functionality of the service.

Despite these limitations, **Egypt** has an important regulatory advantage: the existence of an open system with a central switch that ensures transactions between any two parties, such as money transfers and point-of-sale purchases, are settled seamlessly. This ensures that all mobile money providers in the ecosystem have interoperable services. Until now, however, only one platform (Phone Cash) allows transactions to take place between mobile networks.

Way forward and potential opportunities

Since its issuance, the current regulations set by the Central Bank of Egypt (CBE) for mobile payment services created a highly restrictive environment. The CBE announced the current restrictions are for phase one only; if there are no problems, they will allow other services as long as customer rights are considered.

The main areas for improvement include:

- Increasing the daily and monthly transaction limits;
- Extending the agent selection criteria, allowing more distribution networks to work as agents;
- Expanding in-service functionality to allow customer-to-business (C2B) transactions and government-to-person (G2P) payments; and
- Changing the concept of mobile money as a unique deposit that is exempt from paying interest to customers to a deposit that accrues interest and is distributed to mobile money customers.

There is great opportunity for the Egyptian market that can be summarized as follows:

- *Leveraging mobile wallets for international remittance.* This will enable millions of Egyptians living and working abroad to use mobile money transfer services to send remittances to their families back home.
- *Enabling credit through the mobile finance ecosyste*m. This means providing reasonable credit amounts for mobile money clients as an incentive for attracting more subscribers. In In line with

[42] Document 1/218, "Mobile money in Egypt", Arab Republic of Egypt.

international best practices, these credit amounts can be used, among other things, to start small businesses.

c. Protecting consumers and suppliers

Regulators should consider the following:

- Encourage the adoption of measures aimed at enhancing the security of m-services and apps;
- Create reliable digital identities;
- Use subscriber identification and registration to protect consumers;
- Safeguard consumer personal data;
- Protect minors and vulnerable groups; and
- Promote transparency of online communications and transactions in particular.

Multi-stakeholder collaboration is therefore essential for ensuring that the rights and best interests of both consumers and suppliers are protected.

d. Promote enabling environment among ICT stakeholders

ICT regulators should adopt targeted regulatory measures to promote the development of broadband networks and services and provide for affordable and widespread access to mobile money by consumers, guarantee healthy competition between market players while promoting innovation, and ensure consumer protection.

Mobile money services and apps providers should strive to innovate and diversify the range and content of services and apps on offer, and make them affordable and accessible to large segments of the population.

Consumer associations also have a role to play in defining a framework for dialogue with other stakeholders, conducting independent research, and getting involved in awareness raising campaigns to contribute to the elaboration of informed policies and strategies for the digital economy.

Benin

Upon implementing Article 31 of Law No. 2014-14 on electronic communications and posts, the Beninese government established the procedures and conditions to operate value-added services.[43] Specifically, this law establish procedures for declarations and commercial operation.

In accordance with these provisions, the commercial operation of value-added services, the list of which is established by a decision of the regulatory authority, may be freely conducted by any legal entity that has submitted a declaration of their intention to market such services to the regulatory authority.

The service must use, through leasing, the connection capacities of one or more existing public telecommunication networks, unless the service provider holds a license to establish and operate public communications networks open to the public and wishes to use the network capabilities covered by that license, in accordance with specifications.

Mobile financial services have been identified as services that come under the remit of two regulators and have accordingly been paid special attention. The term mobile financial services (MFS) covers all financial services accessed via a phone or mobile terminal, with or without a bank account, including certain transactions. This type of valued-added service is subject to specific measures, as the commercial operation of a mobile financial service can be freely carried on by any legal entity after

[43] Document SG1RGQ/163, "Policy and regulatory framework for providing value-added services and specifically mobile financial services in Benin", Republic of Benin.

submitting a declaration to the regulation authority under the specified conditions. Those conditions relate in particular to interoperability of MFS platforms, which under the regulations, is obligatory for all providers of such services.

The technical and financial interoperability arrangements, as well as the conditions for their implementation, are determined by regulatory authority decision. Interoperability can only be refused if it is not technically feasible. The refusal must include reasons, the applicant must be notified, and the regulatory authority must be informed.

The consumer

To insure that customers are protected, mobile financial service operators and providers are required to provide transparent and fair information. Fees and charges must be clearly and legibly displayed on all audio-visual and marketing materials. Rates must be displayed in bold and in a font size that is at least equal to half that of the largest character featured on the marketing materials.

The regulator

The mobile financial service provider is required to submit a report on its activities during the preceding year.

Defense and security services

The mobile financial service provider must comply with injunctions and all requests for information on their customers or subscribers from judicial and regulatory authorities. They are required to cooperate with the authorities in the fight against cybercrime and money laundering in Benin.

CIS countries

For the most part, CIS countries and Georgia have legal frameworks that are adequate for the introduction and operation of mobile payment systems. Nevertheless, owing to differences in legal systems and economies, each country's framework has its own characteristics[44].

In **Azerbaijan** and **Turkmenistan**, for example, there are no laws dealing specifically with the payment system, the basic concepts and definitions in this regard being specified in a number of other laws. In Turkmenistan in particular, there is no legal definition of "prepaid card" although there is the concept of "trading card" which is used solely for paying for goods from a specific vendor – with cash withdrawals using such a card being prohibited.

Different countries also have differing regulatory mechanisms for requiring operators to inform their customers about payments. In **Azerbaijan**, such information is provided in the form of a paper document. In **Belarus**, information has to be provided in accordance with the rules of the payments system, as no provisions currently exist in that regard at the state level. In **Georgia** and **Kazakhstan**, the conditions regarding the provision of information have to be included in the agreement between the customer and electronic money issuer. In **Moldova** and **Ukraine**, banks are obliged to notify users of the settlement of transactions involving electronic means of payment, but no specific requirements are stipulated.

The legislative frameworks of **Azerbaijan**, **Tajikistan**, **Turkmenistan**, and **Uzbekistan** contain no clear definition of electronic money, although the concept of electronic money is used to varying degrees in a number of legal texts.

In **Georgia**, "non-personal" prepaid cards[45] may not be used to make payments over the Internet or for money transfers not involving the purchase of goods or services.

---

[44] Document 1/141, "Strategic, regulatory and technical aspects of developing the mobile payment business", Intervale (Russian Federation) and Odessa National Academy of Telecommunications n.a. A.S. Popov ONAT (Ukraine).

[45] A prepaid card where the cardholder name is not mentioned on the card nor on the card microchip/magnetic-stripe.

In the **Russian Federation**, Federal Law No. 161-FZ on the National Payment System (NPS) defines this concept, establishes the legal and organizational bases of the NPS and its subjects, and sets out the arrangements to provide payment services, including electronic money transfers and the exercise of supervision. The document introduces the concept of "significant payment systems" specifies all participants in the operation of the NPS, and stipulates their functions and responsibilities. It describes the procedures to provide payment services: general rules for money transfers; specific arrangements for transferring funds at the payee's request and for electronic money transfers; procedures for the use of electronic means of payment, including when transferring electronic money; and client identification. The document defines for the first time such concepts as "electronic money" and "electronic means of payment".

Ukraine legislations defines mobile payment as "an instrument is an electronic means of payment embedded within the hardware and software environment of a mobile telephone or other user mobile device". In Moldova, mobile payments are defined as "A payment instrument is a personalized means (e.g. payment card, mobile telephone) and/or set of procedures (technical: PIN codes, transaction authentication number (TAN) codes, other types of codes, username/password, etc.; or functional: credit transfer or direct debit), coordinated between the payment services user and payment services supplier, and used by the payment services user to initiate a payment order".

Paraguay

In 2016, with mobile operator's support, numerous sales points, and the increasing users trust, the two mobile operators accompanied by m-payment entities offered around 6,000 transaction points nationwide.[46] Around 2,650,000 people used in 2016 the e-payment services at least once (around 54 per cent of the adult population). In 2016, the e-payment market represented approximately 6 per cent of the country's GDP. The cornerstone of mobile money services is the conversion of physical money into e-money and vice versa.

The following services are offered by the two mobile operators accompanied by m-payment entities in Paraguay:

- Money transfers;
- E-Wallet;
- Invoices payment; and
- Microcredits.

The e-payment market developed initially without regulations, but in 2014 the Central Bank of Paraguay issued the Electronic Means of Payment Regulation, to regulate the provision of e-money, non-banking electronic transfers and requirements to be met by entities providing such services via telecommunication services.

This regulation provides that:

- The money transacted must at all times be backed up by a trust.
- The companies wishing to provide e-payments services must obtain authorization from the Central Bank. To receive this authorization, the companies are required to submit to the Central Bank an attestation issued by the telecom regulator.
- The service provision agreements must respect the principles of neutrality, non-discrimination and equal access.

[46] Document 1/400, "Development of mobile money market in Paraguay", Republic of Paraguay.

– The sole purpose of the e-Payment Entity must be the provision of e-payment services via telecommunication services, hence the telecommunication service providers cannot provide e-payment services.

In 2016, the National Telecommunications Commission issued the Regulations on the Provision of Telecommunication Services as Electronic Means of Payment. The purpose of the regulations is to establish the technical, economic and legal conditions applicable to the provision of telecommunication services used as the support for making e-payments over their networks.

2.2 Technical aspects

2.2.1 Promising technological avenues in the field of mobile payments

To protect mobile payments against data interception in a way that gives effect to the "sign what you see" principle,[47, 48] processors are now being developed with a so-called trusted execution environment (TEE), i.e., an isolated hardware-protected environment within the device's processor.

TEE protects the integrity and confidentiality of key resources, ensuring secure storage and processing of sensitive data and trusted applications. Applications running in a protected area have access to the resources of the main processor and memory, while hardware isolation protects these from user installed applications, or from applications introduced by an attacker, running in the main operating system. Software and cryptographic isolation inside the TEE protect the trusted applications contained within the TEE from each other. Additionally, TEE currently provides the highest level of physical and software protection for data.

At the same time, a widely-adopted principle is that of keeping the data stored on the user's device to a minimum through the use of temporary tokens. This principle forms the underpinning for another approach, known as host card emulation (HCE). The two main variants of HCE are the "cloud-based solution" and the "token-based solution".

The highest level of security is provided by the hybrid solution, in which the secure element contains a minimum of cryptographic key or peer entity authentication data, with all of the remaining critical data being stored in the cloud.

Another promising line of development now being actively pursued is biometric authentication, used in place of passwords. Biometric parameters include fingerprints, vein recognition, and electrical impulses from the heart, physiognomic features, retina scanning, and even behavioral biometrics.

Oman

Oman Public Key Infrastructure (PKI) is a national initiative that sets the infrastructure needed for private and government entities to provide m-Services in **Oman**.[49] It allows exchanging information securely with a high level of confidentiality using eID, mobile ID or USB Token. Oman PKI aims to provide secure technology for information documentation, electronic credibility and user identification and authentication and for signing all transactions online by using electronic ID.

PKI is responsible for:

– Delivering certification services on behalf of government;

---

47 Document 1/141, "Strategic, regulatory and technical aspects of developing the mobile payment business", Intervale (Russian Federation) and Odessa National Academy of Telecommunications n.a. A.S. Popov ONAT (Ukraine).

48 Sign-What-You-See also called Transaction Data Signing (TDS). This allows the user to authenticate the transaction with a challenge issued by the enterprise and a response based on the transaction details. The response that is generated becomes the unique digital signature that once processed allows the transaction to go through.

49 Based on Document 1/351, "Oman Public Key Infrastructure (PKI)", Oman Telecommunications Regulatory Authority TRA (Sultanate of Oman).

- Providing the possibility to join Oman National PKI at Registration Authority (RA) or Sub Certificate Authority (Sub CA); and
- Securing the communications (servers to servers) or (clients to servers).

PKI provides five main services:

- Authentication;
- Electronic Signature;
- Encryption;
- Email Encryption; and
- Email signature.

2.2.2 Technical challenge

CIS countries

CIS countries are clearly lagging in high-end technology penetration in their financial markets and this is having a particularly negative impact on the pace of mobile payment system development. The problem lies not only in the relatively low market share held by mobile devices supporting advanced technologies but also, and to a much greater degree, in the lack of a developed infrastructure for receiving payments made using such devices. Special attention needs to be paid to the digital divide that exists between the most developed countries and the countries of the CIS region with respect to the degree of high-quality mobile coverage.

Benin

Like many countries, **Benin** has not remained on the sidelines of technological evolution.[50] **Benin** has experienced the entry of financial services into the mobile telecommunications market. Mobile operators and Etisalat Benin Spacetel have provided this service to their subscribers, respectively as the "Mobile Money" and "Flooz" service. This service offers Benin the advantage of increasing financial inclusion, including the excluded layers of the traditional banking services, and to improve the quality of life of citizens. Additionally, networks for telecommunications operators are used to support traditional banking activities. Although there are no formally defined regulatory frameworks to provide mobile financial services in **Benin**, implementation is based on:

- Phone operators sign partnership agreements with local banks;
- The central bank issues a permit to the banking institution partner of the telecommunications operator; and
- The telecom operator produces a report by a computer security expert to allow the regulator to ensure the level of security of financial transactions over the network.

The telecommunications operator receives the first provisional authorization for a period of six months from the telecommunications regulator. The provisional authorization is then converted to final authorization after six months on the basis of a progress report by the telecommunications operator and no reports of major incidents during the experimental phase.

Exercising this activity under the auspices of the central bank and regulating the banking partner of the telecommunications operator helps to guarantee compliance with banking regulations. Indeed, banking regulations in principle control the safety and traceability of operations, transferable amounts, and fee schedules in order to guard against money laundering.

[50] Document SG1RGQ/72, "Etude de quelques défis liés à la fourniture des services mobiles financiers au Bénin", Republic of Benin.

Cameroon

The mobile money product introduced by mobile operators with the backing of approved banks comprises e-wallets that can be charged at sales points, from a bank account at a partner bank, or by transfer from another user.[51]

Subscription to the service requires an active phone number with the operator and a method of identification.

Mobile money offers the following services, including but not limited to:

- Transfer of money between a mobile money account with the same operator and a beneficiary without an account;
- Funding a mobile money account from an account with a partner bank;
- Transfer from a mobile money account to a bank account with a partner bank;
- Payment of: regular bills (electricity, water, TV packages, etc.), university fees for students; fuel at gas stations; bills in supermarkets and certain restaurants; goods and articles on some local e-commerce platforms; fees and taxes, insurance premiums; salaries; and transport tickets (airline, train, bus, etc.); and
- Transformation of money into credit for communications.

The main risk for users would appear to be security, since the security code is four digits, and it has been noted that when the account is opened, a code representing the year of birth of the subscriber is suggested.

Cameroonians are adopting mobile money *en masse*, making it clear that these new products are meeting a real need both for businesses and the general public, not least because they mean shorter queues of people waiting to pay bills at certain counters. It is nevertheless important for operators to foresee certain problems, which will soon present themselves. These include: Security of accounts and transactions; processing mobile money accounts in the context of number portability; and inter-connection of mobile money services.

Egypt

In mid-2013, mobile money services launched in **Egypt**[52]. The objective, backed by the CBE and NTRA, was to bring financial services to every Egyptian and enable them to use safe and convenient payment services through their cellphones. Since that date, four mobile wallets have launched: Vodafone Cash, Flous, MobiCash, and PhoneCash.

Customers can register for the service with their national ID card at mobile stores or bank branches, and then deposit cash in exchange for electronic money that they can send to their family or friends. Once they have registered, all transactions are completed securely by entering a PIN number. The recipient receives the electronic money in real-time and then redeems it for cash from any mobile store or bank branch.

In terms of interfacing with end-users, there are two ways to use the service: through smartphone apps and Unstructured Supplementary Service Data (USSD) protocol, which are both connected seamlessly to secure mobile payment gateways. Three mobile money wallets use the USSD application while the fourth wallet enable users to benefit from its services through the mobile application.

In the first stage, the mobile money services include: loading cash on cellphones or taking out cash through participating banks, mobile network operators, and service aggregator branches across Egypt;

[51] Document SG1RGQ/157, "Development of the e-Wallet in Cameroon", Republic of Cameroon.
[52] Document 1/218, "Mobile money in Egypt", Arab Republic of Egypt.

sending money to other clients participating at the service (P2P money transfers); paying bills through cellphones and top up mobile prepaid lines; donating to charity organizations; and serving inquiries about the latest transactions and wallet balance.

Then, in November 2014, the services were expanded to allow subscribers to pay for goods and services at different merchant locations nationwide, and use the service for e-commerce payments globally via a virtual card number (VCN) scheme.

People's Republic of China

In 2015, the total revenue of **China**'s telecom industry reached RMB 1.12 trillion yuan, among which RMB 31.02 million yuan came from the mobile data business, an increase of 30.9 per cent over the previous year, accounting for 27.6 per cent of the total revenue of telecom industry[53]. The access traffic of mobile Internet has risen rapidly, with the monthly mobile Internet access traffic per household reaching 389.3 MB, up 90 per cent.

With rapid development, mobile e-commerce has become the main mode of online shopping. In 2015, the scale of mobile e-commerce transactions in **China** hit RMB 2.1 trillion yuan, an increase of 123.2 per cent over the previous year, accounting for 55 per cent of the total volume of online retailing transactions, which surpassed that of PC-based e-commerce transactions for the first time.

In the third quarter of 2015, the total volume of mobile payment transactions in China exceeded RMB 80 trillion yuan, up more than 600 per cent, show a momentum of explosive growth.

The vigorous development of **China**'s mobile Internet has triggered a new entrepreneurial and innovation boom, opened up a broad development space and formed a more-than-trillion-dollar market. This could not be achieved without the enterprises' innovative development, and also benefited from the favorable development foundation and growth environment created by the Chinese government.

To develop the environment, the Chinese government attached great importance to innovation and development of mobile Internet industry, and issued a series policies and initiatives such as *the Guiding Opinions of the State Council on Actively Promoting the "Internet+" Actions* and *the Opinions of the State Council on Vigorously Developing E-commerce and Accelerating the Development of New Driving Forces,* which continuously increase efforts to streamline administration and delegate power to the low levels, constantly optimizing the government's service modes and accelerating a policy environment in favor of entrepreneurship and innovation for mobile Internet.

Japan

Au "Smart pass" is a subscription based service. Using this service application, the customer can access and enjoy the platform for provision of content and application.[54]

This application provides enormous advantages, such as unlimited access to information content, applications, cloud storage, coupons, security and support, and membership privileges, to the au subscribers with fixed monthly rate of about US$ 3.70 (Japanese Yen 372). Entertainment content services under "Smart pass" include Books, Songs, Video, Disney content and Anime (Animated Cartoon).

KDDI Corporation (Japan) provides other services, which are available via mobile terminal.

- Banking service (Transmit money to the account in mind (or to the mobile telephone number); recharge "prepaid card");
- Insurance (life insurance; property and casualty insurance);
- Loan (Housing Loan);

[53] Document SG1RGQ/235, "The overview of mobile internet development in China", People's Republic of China.
[54] Document 1/289, "Mobile Services (Content and Application) by KDDI", KDDI Corporation (Japan).

– au WALLET (prepaid card type and credit card type); and

– Shopping in town; e-Commerce.

In these kinds of "Mobile Operator oriented" services, subscribers can enjoy one-stop billing from the Mobile Operator. Information Providers can also utilize the mobile operator's platform, thus allowing Information Providers to reduce their operational cost, such as sending bills and collecting money.

3 CHAPTER 3 – Development and deployment of IP-based services and applications (Over-The-Top) services

The objectives of this chapter include:[55]

- Identify policy tools to facilitate the availability to consumers at the local and national levels of competitive IP-based services and applications;
- Identify alternative successful business arrangements that have been used to meet growing demand and other changes in the market;
- Identify the best practices and policies that create incentives for investment in IP-based services and applications; and
- Evaluate the challenges and provide an overview of best practices and guidelines regarding legal frameworks.

With the vigorous development of the broadband network and mobile Internet, apps are widely used in the communication and media industries. Online service providers (OSP) add value to the market and the economy by providing content aggregation, search engines, platform as a service (PaaS) and software as a service (SaaS), e-commerce and other transactions, social networks, video on demand, web content, messaging applications, and voice over IP (VoIP) applications and others.

The ITU defines multimedia services as those in which the interchanged information consists of more than one type (e.g., video, data, voice, and graphics).

Moreover, the ITU defines instant messaging as the transfer of messages between users in near real-time. There is no ITU or industry standard definition of online services. Such services can be divided into several categories, including VoIP, video on demand (VOD), messaging applications, search engines, e-commerce, SaaS and PaaS, among others.

Telecommunications operators (operators) and OSPs have an interdependent relationship, with each playing a critical part in the Internet ecosystem. The digital economy relies on these players as the vehicles to facilitate the social and economic benefits seen across the globe in numerous sectors, including technology, health, financial, education, among others. As we continue to embrace the digital economy, there is an opportunity to modernize and update regulatory frameworks to lessen regulation and encourage and support further innovation and competition in services, while providing maximum flexibility for future growth and development of all players in the Internet ecosystem.

3.1 Policy aspects: the impact of network neutrality on online services

Network Neutrality has been an evolving concept and has engendered vigorous debate. The network neutrality debate has expanded over time beyond initial debates over blocking content on the Internet.[56] Initially, network neutrality concerned the openness of the Internet and citizens' right to connect to networks. This core concern around network management has been greatly expanded to a much broader debate encompassing the complex commercial relationships and fundamental economic issues underlying the Internet business model. Now; the focus has switched to the legitimacy of the operators' network management strategy especially as that impacts online services.

The development of OTT services has become the most recent focus on the issue of network neutrality. At this stage, two principles "no blocking" and "no throttling" subject to reasonable network management has achieved relative consensus in most telecom industries, and the main debate is now focused on "No Paid Prioritization" which means the network providers should not provide

[55] Documents SG1RGQ/26, OTT Services definition and categories", Oman (Sultanate of), and 1/51, "The development, influence and research suggestion of OTT service", People's Republic of China.

[56] Document 1/186, "The Impact of Network Neutrality on the OTT Service of 5G Wireless Innovative System for Dynamically Operating Mega Communications. (WISDOM)", Center for Teleinfrastruktur (CTIF) of Aalborg University (Denmark).

differentiated services based on charges for QoS. That is, network providers should not charge Internet companies more money for the higher quality of broadband services, especially those providing communications and video services. The current discussion is actually, whether network providers should be able to charge Internet companies for bandwidth consumption demanded and used by the customers of the network operators beyond the subscription and other fees the network operators already charge their subscribers for Internet access services.

The emergence of the network neutrality debate is accompanied by new challenge and demands posed by the new broadband Internet economy. So far most regulators around the world, have been cautious in adopting sweeping new regulations because network neutrality will influence not only Internet investment, innovation, and vitality but also infrastructure construction, and upgrades. Considering all the above, we suggest that a sound policy optimally will:

- Incentivize network investments in broadband infrastructure and new economic arrangements that offer more choices to users
- Continue to encourage innovation at all levels of the Internet ecosystem from networks to applications and services, including new OSP services.
- Promote an open Internet principle.
- Bear in mind that it will be much better for the paradox to be solved where possible and appropriate by the market and competition so that all stakeholders can find a way to ensure the prosperous development of the industry in the market on their own.

Brazil

Since 2012, **Brazil** initiated the mandatory reduction of the mobile termination rates (MTR).[57]

This policy brought some changes to the mobile market in Brazil, initially affecting the net additions of subscribers, followed by a noticeable migration of subscribers from pre-paid to post-paid plans. The MTR reduction shows the impact of easing regulatory requirements on traditional telecom operators, in face of the higher adoption of OTT applications, especially those which provide voice and messaging services.

Telcos expected the transfer of subscribers from pre-paid to post-paid plans, including SMS packets to reduce the loss of revenue with this service. Since OTT applications usually require access to the Internet, operators expected subscribers to the transition to better data plans to compensate the revenue loss from traditional voice and SMS services. However, in Brazil this did not occur. Operators TIM, Claro and OI maintained a post-paid base growing less than 2 million a year in the period from 2011 to 2014, while Vivo managed to grow its post-paid customers by 4 million a year during the same period, increasing its market share in this segment by 10 per cent. Vivo intensively promoted migration to its post-paid plan, which included more attractive data plans than others.

Central African Republic

The incredible speed with which OTT services have evolved gives rise to significant financial, socioeconomic and legal challenges. The Central African Republic, with its high mobile telephone penetration rate faced such challenges with OTT services provided in the country. These challenges include the following:[58]

- Substantial fiscal revenue losses;
- Losses in revenue from licence fees and taxes;
- Poor quality of service due to reduced investments in maintenance and/or development;

[57] Document SG1RGQ/85, "New commercial strategies on mobile services market as an answer to the MTR reduction and the competition with OTTs", Federative Republic of Brazil.
[58] Document 1/429, "OTT services", Central African Republic.

- Disruption of international telecommunication market;
- Absence of protection of consumer rights;
- Non-compliance with national legislation and regulations;
- Attempts to form illegal and ad hoc partnerships between certain OTT operators and legally established operators despite the regulations in force;
- the traditional regulations are no longer appropriate;
- Unsuccessful attempts to block things technically;
- Data security as certain OTT services offer options for downloading mobile phone address books and other information deemed private.

Faced with this situation, the Central African Republic prefers not intervene, but to opt for National operators and OTT partnership. This was confirmed in 2016 national digital economy workshop. The workshop resulted that, without regulation, each operator is free to choose its type of cooperation with OTT service providers. Consequently, the following trends are emerging in Central African Republic telecom market:

- Some of mobile operators are seeking to join forces with the OTT service operators to create instant messaging and voice applications;
- Others, planning to launch with cooperation with OTT Service providers, SIM cards aiming to broaden their range of services;
- Operators that have not yet deployed 3G are relying on their mobile WiMAX network in order not to miss the opportunity offered by the emergence of OTT services.

3.2 Regulatory aspects

Regulators are experiencing the need to adapt the transition from a telecom market where service providers used to offer telecom services, to an ICT market where telecom operators and online service providers are offering services, and where traditional telecom services continue to be regulated, contrary to Internet-based services.[59] Online service providers offering services such as Internet voice, messaging and video, challenge traditional telecom operators and broadcasters. Furthermore, the problem regarding the relationship between income and traffic growth of telecom operators being out of step is challenging. Higher investment expansion pressure exists for telecom operators, and market pressures from convergence have incentivized some telecom operators to ask regulators to allow them to implement differential pricing or charge for additional costs to OTT service providers. Regulators should endeavor to apply the same regulatory regime to the same services.

Further, some believe that the risk of network and information security is increasing. Some online services have the ability to upload the entire address book on a cellphone or collect user information. Depending on how this is done including whether consent is obtained and what security measures are in place, this may violate personal privacy and lead to unwanted information disclosure. At the same time, where privacy is already covered under other more general regulations, and is already broadly applicable, it may be more prudent to rely instead on broader, more generally applicable laws.

Some operators are responding to online service providers by offering IP-based services and are adopting the following approaches:[60]

Blocking	**Fair usage**

[59] Document 1/51, "The development, influence and research suggestion of OTT service", People's Republic of China.
[60] Document 1/129, "Presentations on OTT services", Sultanate of Oman.

Studies undertaken in the EU indicate that some network operators discriminate against traffic by competing OTT services: one in four internet users have experienced blocking or throttling of internet content.	Some network operators have a fair usage policy that imposes data, voice and messaging usage limits.
Own OTT Apps	**Partnerships**
Other operators have developed their own services to enhance customers experience – e.g. Telefonica's "TU go" or Orange's "Libon" voice over IP service and messaging apps	By working with OTT providers-e.g. E-Plus's partnership with WhatsApp in Germany and Hutchison's partnership with Spotify in Austria.
Pricing	**Bundling**
Some network operators have introduced new pricing models, either to limit customers from using OTT services – e.g. by relating prices to use of certain services.	By bundling their own services with other offers telecom operators may put OTT providers in a disadvantaged position

3.3 Key regulatory issues

The following points summarizing the key elements and issues likely to be at the core of the policy and regulatory debates along with critical questions:[61]

1) **Net neutrality** – the open Internet net neutrality principle, which asks operators to treat all data equally, and not intentionally block or slow down traffic that competes with their own services. Is also relevant to traffic management policies. Zero rating (when end customers are not charged for data used for specific internet applications or services in capped data plans) is also currently a topic which is discussed among regulators.

2) **Zero rating** – the practice of some mobile network operators not charging end customers for data used by specific applications or Internet services in capped data plans. Should MNOs be allowed this practice? Should regulators continue to apply a hands-off approach to business practices and commercial agreements between MNOs and other partners? Are there certain circumstances under which zero rating should be encouraged- such as, for example, programs in which the ISP neither receives- payment from the content provider nor charges the consumer for accessing content, programs that are open to any content that meets the same technical criteria, or those designed to address a specific social need (such as connecting the public with government services)?

3) **Market reviews –** when competition is considered not effective, regulatory measures aiming to address market failure can be imposed on dominant firms by national regulatory authorities (NRAs) after conducting a thorough market review.

4) **Consumer rights –** certainly challenging for consumers to understand the impact of traffic management on their Internet use as it becomes more complex and widely used.

5) **Feasibility –** telecoms' business models' sustainability takes into account decreasing revenues and constant investment for increased bandwidth. For example, the European Union's political (digital) agenda has demanding objectives.

6) **Competition –** ensuring a level playing field between telecom operators and online service providers, and preventing anti-competitive behavior, taking into account the market power.

7) **Innovation –** Online service providers provide innovative services for consumers. Heightened regulation risks destroying these benefits.

[61] Document 1/129, "Presentations on OTT services", Sultanate of Oman.

8) **Lowering the egulatory burden on traditional telecommunications operators –** Regulators should consider lowering the regulatory burden on telecommunications operators where other general consumer protection or other laws already cover the behavior at issue.

3.4 Future OTT regulatory and competition issues

– Partnerships with OTTs:
  - Some believe that consumers benefit from zero-rating. Others believe that if zero rating is allowed, there is a risk that content will be limited. Regulators will need to take an evidence-based approach to assess the benefits of such programs versus any claims of harm.
  - Some believe that small, innovative start-ups will not be able to access the market, or will be bought by larger players.
  - These partnerships can bring opportunities in the market; will need further investigation and analysis.

– Licensing of online service providers? Many players believe that it does not make sense to license, to the extent they do not provide Internet access. Legacy telecommunications regulatory frameworks and approaches may no longer be adequate or appropriate for these new approaches and technologies.

– Consolidation:
  - Current wave of consolidation: battle for scale and multi-play offers.

– Could the provisioning of data alone, be the next major source of revenue for mobile operators and replace the traditional cash cows of voice and messaging?

– OTT as a portfolio of services:
  - Not a single functional block like voice or messaging;
  - Made up of dozens of new applications.

– Mobile operators as an enabler of or an OTT service provider? They can be both, innovation, market will decide.

3.5 Online service supervision

Fast development of online services generates new realities and provides new challenges for telecom regulators. Based on online service development features and influences, we believe that the goals of OSP supervision in the new period mainly constitute:[62]

1) Promoting innovation and investment throughout the entire digital communications ecosystem;

2) Taking into account the development of both the old and new market players; and

3) Protecting consumers' legitimate rights and interests.

The newly integrated online services have blurred the regulation boundaries. This development created new challenges to telecommunication industry regulation. First, traditional telecommunication regulation models need a reassessment to take into account the evolution of the market and foster investment and innovation.

[62] Document 1/208, "Goals, challenges and practices of OTT service supervision", People's Republic of China.

3.5.1 Measures taken by the Chinese government regarding OTT supervision

In July 2013, the Chinese Ministry of Industry and Information Technology published "Regulations on Protection of Telecom and Internet Users' Private Information," which develops operational rules in some specific business areas for issues related to user data collection, trading, and disclosure, and studies the boundary between user's private information exploration and OTT service applications and innovations.

In August 2014, the Cyberspace Administration of **China** released "Provisional Regulations on Managing the Development of Public Information Services of Instant Messaging Tools," which regulates the services offered by instant messaging tool providers and user behaviors to further promote the healthy and orderly development of public information services of such tools. The "regulations" require instant messaging service providers to acquire relevant qualifications to provide public information services; that instant messaging service users must get real identity authentication before the account registration process can be completed; and that both providers and users must promise to abide by the "seven baselines", including laws and regulations, the socialist system, national interests, citizens' legitimate rights and interests, public order, social morality, and information authenticity.

3.5.2 Suggestions for subsequent activity

Based on the OTT supervision goals and challenges faced, we suggest that regulators take these follow-up measures:

First, promote coordinated development between online service providers and telecom operators. On the one hand, encourage online service innovation to meet diversified demands of information service in all sectors of society, as well as nurture and enhance emerging businesses; on the other hand, facilitate the enabling environment for telecom operators to speed up innovation in integrated information services and transform data traffic operation models in order to give active responses to the influence generated from the decrease in traditional voice and SMS services.

Second, enhance collaborated supervision among appropriate sectoral agencies. Industry's self-regulation, including enterprises' participation, and consumers' consciousness, forming a multi-stakeholder participated supervision pattern, should be supported when and where appropriate.

3.6 New communications ecosystem

In the new communications ecosystem, connectivity, content, and services, while no longer tethered together, all remain critically interdependent.[63] The untethering of services from physical networks has only strengthened the interdependent relationships between services and networks. Applications depend on networks to provide the connectivity to access and use applications. Conversely, networks depend on the demand for applications and content to drive demand for more and better connectivity. Online content and service providers drive significant investment in much of the physical networks, equipment, and infrastructure that comprise the network of networks that is the Internet.[64] A recent study by WIK-Consult found that broadband networks in Europe benefit significantly from increased bandwidth demand driven by incremental use of applications, and specifically that "higher demand

[63] Document 1/377 (Rev.1), **"**A forward looking approach to communications services regulation", Facebook (United States of America); Microsoft Corporation (United States of America).

[64] *See Investment in Networks, Facilities, and Equipment by Content and Application Providers*, Analysis Mason Report (Sept. 2014), available at http://www.analysysmason.com/CAP-Internet-Sept2014. The potential for these entities to drive innovation and economic activity is significant; in 2009, for example, for every dollar of revenue earned by Microsoft, its partners generated local revenues for themselves of $8.70. Microsoft News Center, "Study Reveals Microsoft Partner Ecosystem Revenues of $580 Billion in 2010" (March 24, 2011). http://www.microsoft.com/en-us/news/press/2011/mar11/03-24idcpartnerecosystempr.aspx.

(and potentially willingness to pay) are key in enabling profitable investment and reducing risks for telecommunications providers".[65]

Regulation rarely evolves at the same velocity as technological progress. Foresight is necessary to determine whether current regulations remain useful, and whether new regulations are necessary. Any regulation—whether applicable to legacy telecommunications services or to new OSP services—must take into account the rationale behind the regulation (for example, protecting end users and competitors from the potentially anti-competitive effects of market power related to control of broadband access facilities), and not impose heightened regulation that risks destroying innovation.

3.7 Technical aspects

3.7.1 Guidelines and case studies

3.7.1.1 The development, influence and research suggestion of OTT service in China

The high-speed growth of OTT services has significant influence on the telecom industry, which is mainly reflected in the following two aspects. On the one hand, OTT services promote the innovative development of content providers. For example, in the past six years, content providers have developed 1.2 million applications for Apple's App store, which has facilitated the prosperity of the entire content development industry. According to forecasts[66], the sales volume of Apple's App store will be USD 45 billion by 2020. WeChat has gradually evolved into an integrated information service platform that can combine with various functions, such as a game center, ordering a taxi, managing money, finding a restaurant. These various functions maintain a high level of user activity.

– On the other hand, OTT services have a large impact on the revenue of telecom operators. **China**'s mobile voice duration and business income rose only 5 per cent and 1.9 per cent, respectively, in 2013, which decreased 6 per cent and 4 per cent, respectively, by OTT services. According to the report of British research institution Mobile Squared, global mobile operators lose USD 100 million every day because of inexpensive communications services provided by Skype and other VoIP and OTT services. Facing the serious situation, some telecom operators actively transform, such as China Telecommunications Corporation, which has cooperated with NETEASE to implement a mobile instant messaging service.

3.7.1.2 Relationship between telecom operators and OTT service providers in China

The high-speed growth of OTT services have more and more influence on the traditional voice services and SMSs of the telecom industry.[67] **China**'s mobile voice duration rose only 1 per cent in 2014, which was 4 percentage points lower than the previous year, and the overall SMS business fell 14.4 per cent in 2014, which declined to 13.8 percentage points over the 2013. What's more, mobile voice services began to enter a recession period where telecom industry contribution to mobile voice services turned negative for the first time in 2014. Facing the impact and influence of OTT services, telecom operators in China accelerated the pace of their transformation.

China Telecom cooperated with Netease to release a new mobile instant messaging application, which was named YiXin, and it achieved good results. By the end of 2014, YiXin had more than 150 million registered users, and it became one of the top 3 mobile instant messaging applications in **China**. The latest version of YiXin launched a free call function as well.

---

65 See WIK-Consult, "Applications and Networks: The Chicken or the Egg, the Role of Digital Applications in Supporting investment and the European Economy," March 2, 2015 at 3, available at: http://www.wik.org/fileadmin/Studien/2015/Microsoft_Cloud_framework.pdf.

66 App Annie, Feb 10th of 2016, http://go.appannie.com/report-forecast0516.

67 Document SG1RGQ/98, "The latest development of OTT service and co-opetition? Relationship between telecom operators and OTT service providers", People's Republic of China.

China Unicom of Guangdong province cooperated with Tencent by launching a new cellphone card that was named "WeChat Wo" and it provided 500MB of mobile data traffic for WeChat by spending only 10 yuan. This innovation mode promoted the new cellphone card to sell close to 1 million in one month. This cooperation mode demonstrates a win-win achievement between telecom operators and OTT service providers.

China Mobile combined with OTT service providers, such as Qihoo 360 and Sina, implemented the consequent charging mode (Reverse Charging)[68], in this setup, the OTT service providers (Qihoo 360 and Sina) endured users data traffic cost utilized by their applications. At the same time, China Mobile actively combined with some manufacturers, such as Samsung and Huawei, thereby testing a converged communication venture. The function would upgrade the traditional calls, messages, and contacts so that it can directly send messages, pictures, and videos as OTT services without installing any OTT applications.

3.7.1.3 CDN networks

Content distribution/delivery networks (CDNs) are composed of node server clusters distributed in different regions, and conduct real-time distribution of content resources efficiently and in a stable way to the network locations closest to terminal users – based on available information about network status and customer requests[69]. According to research and forecasts of professional consultants, CDNs have undertaken accelerated services of various domestic and international Internet-related enterprises (including Amazon, YouTube, Tencent, and Taobao), and will become a significant network infrastructure, probably growing threefold or more. The present study proposes establishing methods for CDN business models from the angle of telecom operators. Based on these methods, business models are formulated from elements including business value, business form, service differentiation, and service billing support in order to meet the requirements for CDN operations.

[68] Reverse Charging (REV) is a supplementary service allowing the served (called) user to be charged for the entire call or part of the call. Only usage-based charges can be charged to the called user.

[69] Document 1/161, "Brief analysis of the business model of telecommunication operators' CDN networks", People's Republic of China.

4 CHAPTER 4 – Transition from IPv4 to IPv6

The objectives of this chapter include:[70]

- Compiling the questions raised by, and requirements of, developing countries in their transition to IPv6;
- Consolidating and coordinating efforts to facilitate the transition to IPv6; and
- Surveying the available procedures, methods, and timeframes for the effective transition to IPv6, with particular regard to the experience of ITU Member States and Sector Members participating in ITU-D SG1.

The Internet today is a global network of networks serving billions of users worldwide, and this has happened because of the wide acceptability of IP. The current version of IP is IPv4, which is a 35-year-old protocol with many unexpected limitations. The biggest limitation is its 32-bit addressing space resulting in 4.3 billion IP addresses. While this may seem like a large number, the rapid growth of Internet, broadband, and mobile subscribers has led to accelerated consumption of IP addresses, which has resulted in the exhaustion of IPv4 addresses worldwide.

To overcome this problem of shortage, IPv6 was developed, which improves the addressing capacities of IPv4 by using 128-bit addresses instead of 32 bits, thereby making available an almost infinite pool of IP addresses. IPv6 also has various enhancements with respect to security, routing, auto-configuration, mobility, QoS, and more, offering better features and more security to end users. IPv6 will be one of the key enablers of the IoT, machine-to-machine (M2M) communications, and the Internet of everything (IoE).

4.1 Country transition examples

4.1.1 IPv6 transition in India

IPv6 adoption and implementation in India is major task, involving many stakeholders, and documented in two roadmaps released by the Indian government.[71]

The first version of the roadmap, the National IPv6 Deployment Roadmap, v-I (released in 2010), was based on the following recommendations:

- All major ISPs will target handling IPv6 traffic and offer IPv6 services;
- All central and state government ministries and departments, including its public sector undertakings (PSUs), will start using IPv6 services; and
- The India IPv6 Task Force will be formed.

On the basis of challenges faced during the first roadmap implementation process – and taking a cue from the National Telecom Policy (NTP)-2012, which recommends substantial transition to IPv6 in the country in a phased and time-bound manner – a second roadmap, the National IPv6 Deployment Roadmap, v-II, was prepared and released in March 2013, focusing on making the complete ecosystem ready in the country by 2017. Based on discussions in various meetings, workshops, seminars, and other forums and a desire for substantial transition to IPv6 by 2020, the government to mandate timelines for all stakeholders.

[70] Document SGRGQ/33, "IPv6 transition in India: The journey so far", Republic of India.
[71] Document 1/193, "IPv6 Transition in India: The journey so far", Republic of India.

Status after the launch of the National IPv6 deployment Roadmap, v-II in **India** across different stake-holders:

- The various government organizations prepared a detailed transition plan for complete transition to IPv6 (dual stack) by December 2017 based on the network complexity and equipment/ technological lifecycles. They have also been asked to have budgetary provisions in their demand for grants for IPv6 transition;
- All government organizations in the country were asked to provide all new IP-based services (like cloud computing, data centers, etc.) to be implemented for/by the government organizations on dual stack[72] supporting IPv6 traffic with immediate effect;
- All government organizations in the country were asked to transition all public interfaces of government projects for delivery of citizen-centric services to dual stack supporting IPv6;
- All government organizations were asked to procure ICT equipment that is IPv6 ready (dual stack) and go for deployment of IPv6 ready (dual stack) networks with end-to-end IPv6-supported applications;
- All public-dealing government organizations dealing with the public were asked to initiate pilot projects based on IPv6 innovative applications using IoT/M2M applications like smart metering, smart grids, smart buildings, smart cities, etc.;
- All government organizations were asked to develop skilled IPv6-trained human resources within the organization through periodic training over a period of one-to-three years to have a seamless transition with minimum disruption;
- Almost all the ISPs in the country are now ready to offer IPv6 services in this segment.

For existing enterprise customers that were not IPv6 ready, the ISPs have been asked to educate and encourage their customers to switch over to IPv6 (dual stack). Despite the two roadmaps released by the Indian government for IPv6 transition in the country, the uptake of IPv6 has not been encouraging.

4.1.2 Embedding IPv6 into economic strategy in Zimbabwe

The Government of **Zimbabwe** is working out a seamless migration from IPv4 to IPv6. In doing so, the country is taking into account the current social and economic environment in the country in order to ensure that there is both willingness and capacity among key stakeholders.[73] Zimbabwe has looked carefully at the issue of how the move to IPv6 can be done without adversely affecting businesses and commerce, and has come up with strategies including:

- Forming an IPv6 task force responsible for fact-finding and dissemination of relevant information and helping to develop a roadmap;
- Aligning ICT strategy with the economic strategy for the country;
- Implementing Public-Private Partnerships;
- Ensuring that current infrastructure projects take into account future technologies that can deliver social benefits through IPTV and smart city concepts;
- Ensuring that any future systems for use in Zimbabwe are IPv6-compliant, thereby hindering dumping of obsolete equipment in Zimbabwe;
- Ensuring that the Zimbabwean business and social communities can communicate with other IPv6 sites in the world;

[72] A dual stack network is a network in which all of the nodes are both IPv4 and IPv6 enabled.
[73] Document SG1RGQ/231, "Embedding IPv6 into economic strategy", Republic of Zimbabwe.

– Getting assistance from the ITU to establish the IPv6 test bed for Southern Africa and Zimbabwe; and

– Encouraging cooperation among equipment suppliers, application developers, and ISPs.

4.2 IPv4 and IPv6 resource assignment and allocation – Regional Internet registry communities

4.2.1 Regional Internet registries (RIRs)

The RIRs provide services for the administration, management, distribution, and registration of Internet number resources, specifically IPv4 and IPv6 addresses and autonomous system numbers, within their respective regions. Services are based, in part, on policies that the communities of each RIR develop in a multi-stakeholder, bottom-up approach that is open to all. The policy development process (PDP) applicable for each RIR region defines the way these policies are developed and adopted. The key services that the RIRs provide are administration of the Internet number resources to insure uniqueness, stewardship in their distribution to those who need these number resources, and the global publication of the registry of all assignments.

Each RIR operates in its respective region as a not-for-profit, member-based association in accordance with the laws in the countries where they are located. The five RIRs are:[74]

– African Network Information Center (AFRINIC) – established in 2005, and serving Africa, based in Mauritius;

– Asia-Pacific Network Information Centre (APNIC) – established in 1993, and serving the Asia-Pacific region, based in Australia;

– American Registry for Internet Numbers (ARIN) – established in 1997, and serving the United States, Canada, parts of the Caribbean, Northern Atlantic Islands, and Antartica, based in the United States;

– Latin America and Caribbean Network Information Centre (LACNIC) – established in 2002, and serves Latin America and parts of the Caribbean, based in Uruguay; and

– Réseaux IP Européens Network Coordination Centre (RIPE-NCC) – established 1992, serving Europe, Central Asia, and the Middle East, based in the Netherlands.

The RIR communities that develop policies and provide the governance for each of the RIRs, are comprised of a variety of organizations, including:

– Internet service providers of various types;

– Governments at all levels;

– Universities;

– Civil society; and

– For-profit and not-for-profit enterprises of all sizes and across all business sectors.

RIR communities are open to anyone that wants to participate in the policymaking process and related discussions. The communities make policy via open, transparent, and bottom-up, community-driven processes. Governments and their representatives are able to and do participate in this process, but do not have a privileged role as such. Given the important role that governments play in shaping public policy related to the Internet, however, their contribution to the RIR policy process is

[74] Document SG1RGQ/55, "Regional internet basics", American Registry for Internet Numbers (ARIN) (United States of America).

quite important, and the five RIRs individually engage in a range of outreach activities to encourage government participation in their respective regions.

To participate in the RIR discussions and the policy-making process, those interested in taking part subscribe to public mailing lists created for these purposes. Discussions also take place at RIR meetings, which are also open for everyone to participate in, physically or remotely. For a policy proposal to become an RIR policy (or amend an existing policy), consensus much be reached. This means that there should not be any arguments or objections that have not been addressed. It is the task of the community leadership (e.g., working group chairs, advisory council members) to assess that all arguments have been addressed and there is wide enough support to declare consensus on the proposed changes. In turn, each RIR is bound by its operational rules to execute the policies that have been developed by their communities through open, transparent, and bottom-up policy development processes. This obligation is detailed in the agreements that each RIR signs with their constituents.

4.3 Technical aspects – Case studies

4.3.1 Service test and analysis of IPv6 transition technology DS-Lite in China

While introducing the IPv6 technology necessary for NGNs, it is important to safeguard the normal operation of the services/applications (based on IPv4 technology) carried by existing networks[75]. To solve this problem, countries have adopted relevant implementation projects for research and trial deployment of the network technology to ensure smooth network evolution. DS-Lite is one of the major IPv6 transition technologies used for this purpose.

DS-Lite is a lightweight dual stack, integrating IPv4 in IPv6 tunneling and network address translation (NAT) translation technologies to provide user terminals with IPv4 and IPv6 access. The DS-Lite model is built on an IPv4-in-IPv6 tunnel, and it has the following characteristics:

- DS-Lite technology supports multiple-user sharing of a single IP in a way in which public network IPv4 addresses are shared and the utilization of IPv4 addresses is increased;
- It supports three types of terminals, namely pure IPv4, dual-stack, and pure IPv6;
- The architecture of DS-Lite technology can avoid subsequent or "second" network upgrades; and
- There is a performance bottleneck; DS-Lite is a kind of state-transition technology.

The test – conducted on the basis of a trial commercial network – shows that a DS-Lite device can already steadily perform such basic functions as address issuance, domain name system (DNS) proxy, account authentication, and speed limitation. DS-Lite technology can be used to upgrade existing networks and meet operators' network deployment requirements.

The desired results of the technical indicators obtained from the DS-Lite technology test are, apart from the relatively mature technology itself, inseparable from the adequate deployment of network equipment capabilities. During the later large-scale deployment stage, network builders should take into consideration the issue of key equipment redundancy to cope with the possible performance bottlenecks of the technology.

[75] Document 1/162, "Service test and analysis of IPv6 transition technology DS-Lite", People's Republic of China.

4.4 Guidelines and case studies

4.4.1 IPv6 transition in India: The journey so far

In India, efforts began as early as 2004 when "Migration from IPv4 to IPv6 in India" was listed as one of the items in the 10 Point Agenda given by the minister of communications and information technology.[76] After due deliberations, a committee under the chairmanship of advisor of the Department of Telecommunications (DoT) was formed and recommended that a suitable roadmap should be prepared to achieve transition the from IPv4 to IPv6 (as outlined above), clearly outlining the steps involved (**Annex 5**).

4.4.2 Implementation of IPv6 in Cameroon

In 2014, **Cameroon**[77] adopted a national strategy to implement the IPv6 protocol, with a monitoring committee reporting to the prime minister composed of the various national stakeholders. The vision of the strategy is, by 2018, to make **Cameroon**'s cyberspace one in which all websites and online services offered to individuals and companies are accessible in both IPv4 and IPv6. The strategic objectives are:

- Make all national infrastructure IPv6 ready by December 2015;
- Establish an IPv6 test environment by December 2015;
- Organize campaigns to raise the awareness of companies and individuals, and build staff capacity with respect to IPv6 throughout the duration of the project;
- Draw up plans to migrate all public and private entities by December 2016;
- Make all electronic services accessible by means of the two protocols by December 2017;
- Adopt provisions (technical and regulatory) prohibiting the use of NAT in all telecommunications networks by 2018; and
- Introduce a regulatory framework prohibiting "non-IPv6-ready" equipment to be imported into Cameroon.

The government's strategic priority action plan involves:

- Revising ICT strategies in order to place IPv6 at the center of all government ICT infrastructure;
- Making IPv6 support a compulsory requirement in all procurement contracts for services and IT equipment launched by the government;
- Prohibiting the importation into Cameroon of IPv6-incompatible ICT equipment;
- Requiring the enabling of IPv6 in all Internet connection initiatives undertaken by public institutions;
- Inviting administrations to ensure IPv6 and IPv4 accessibility for all websites and online services offered to individuals and companies;
- Mobilizing the universities in general, and those of the public sector in particular, to be among the first to activate IPv6 within their infrastructure, providing services via IPv6, and providing academic programs for IPv6 training;
- Organizing mass training campaigns for decision-makers, network and system administrators, and engineers; and
- Constructing and managing IPv6 networks, as is currently the case with IPv4.

[76] Document SG1RGQ/33, "IPv6 transition in India: The journey so far", Republic of India.
[77] Document SG1RGQ/146, "Implementation of the IPv6 protocol in Cameroon", Republic of Cameroon.

More specifically, the government's strategic priority action plan for telecommunication operators includes:

- Taking stock of the IPv6 address requirements;
- Planning the migration of their networks to IPv6;
- Requesting blocks of IPv4 and IPv6 addresses with a view to prepare for that migration and reduce the use of NAT;
- Conducting tests and launch the migration phase for all their infrastructure;
- Conducting IPv4-to-IPv6 migration awareness campaigns among their respective customers;
- Assigning a public IP address for each Internet connection, irrespective of the network or connection support; and
- Providing IPv6 training to their technical staff, network administrators, and systems engineers.

4.5 Factors impacting IPv6 uptake based on contributions from India and Ukraine

The rapid growth of traffic exchange on the one hand, and the depletion of IPv4 addresses on the other hand encourages communications networks to work on the process of continuous optimization of communication mechanisms used to transmit information.[78]

While trying to deploy IPv6, network owners usually want to give subscribers access to external IPv6 resources, or to give external users access to internal IPv6 resources. Thus, the majority of owners aim to solve both problems. Unfortunately, most companies are not in a hurry to move to IPv6 due to a number of different factors:

- **Demand** – depending on the class of the network, it can be external or internal factors, or both. Quantitative assessment of this factor can be done through a survey of subscribers (in terms of interest in the transition to IPv6) or estimating the share of resources available.
- **Market** – the availability of certified hardware and software on the market of a particular country (external factor). Not all countries have certified (approved for use on the network of country) equipment and/or software that can support IPv6.
- **Human capacity (availability of skilled professionals)** – can be both external and internal factors. It should be noted that this factor can significantly affect the economic feasibility of the uptake of IPv6.
- **Environment (external operators and providers in the country)** – an external factor that can be crucial for the network owner. If top-level operators cannot provide IPv6-traffic transfers, the feasibility of internal capabilities to migrate to IPv6 may be rather low.
- Owned infrastructure (availability of equipment, network structures, workstations, etc.) – an internal factor.
- **Equipment of customers (subscribers)** – an internal factor. It is necessary that work via IPv6 be supported not only by the equipment of operators, but also by the equipment of customers – workstations, home routers, etc.
- **Policy and regulation (government policy on the migration to IPv6)** – the external factor. Determines the availability of programs for the coordination of action to facilitate migration from IPv4 to IPv6.

[78] Documents SG1RGQ/149, "Analysis of influencing factors to the process of migration telecommunication networks from IPv4 to IPv6", Odessa National Academy of Telecommunications n.a. A.S. Popov (Ukraine), and SG1RGQ/33, "IPv6 transition in India: The journey so far", Republic of India.

Before creating concrete roadmaps for migration to IPv6, countries should take into account all the factors that can influence the choice of the most effective ways to migrate.

To determine the most perspective technology of telecommunications networks transition from IPv4 to IPv6 in the specific conditions these factors should be divided into two groups. The first group – the factors that will potentially influence the choice of the technical migration path to the IPv6 protocols stack.

This group includes: market (presence of certified hardware and software at the market of a particular country); owned infrastructure (status of internal infrastructure); equipment of customers (subscribers); and, human capacity (presence of skilled employees).

The second group includes factors that generally determine the practicability of migration, not regarding the technical ways: demand (necessity of connection to external networks); environment (provider environment and the state of external infrastructure); policy and regulation.

On the basis of the estimation procedure a simplified version of the method of analysis of hierarchies is laid, it uses a weighted index based on the scores of a number of factors and their weight coefficients, calculated by their pairwise comparison. A feature of the chosen method is that in the course of the expert session the expert opinions and judgements on the developed criteria (factors) are heard, and carried out factors evaluation in a quantitative form. As a result of this interaction of experts the union of their thoughts is provided and, as a result, the generalized evaluation of a factor with respect to the specific object of comparison is figured out.

The expert group included experts from leading companies in Ukraine, responsible for the migration of their own networks to IPv6. The calculation results showed that among the factors that will potentially influence the choice of the technical migration path to the IPv6 protocols stack (the first group), the most significant was human capacity.

Among the factors that determine the overall practicability of the technical migration, not regarding the technical method the demand has the highest weight coefficient.[79]

[79] Document 1/448, “Estimating the preparedness level of telecommunications operators for the introduction of IPv6 in their own networks”, Odessa National Academy of Telecommunications n.a. A.S. Popov (Ukraine).

5 CHAPTER 5 – ICT in education (policy and funding aspects)

Governments around the world are spending billions of US dollars each year for education would benefit from migrating to more ICT based education systems.[80] Usage of ICT in education is also key to increasing broadband usage in the larger community. Not only will students and teachers use ICT devices, but their family members will also use them at home. Usage of schools as community access centres another is important factor.

In order to bring 21st century skills to students, governments around the world are using e-learning programs to create the education environments that are best for their students. These programs bring together the solution elements – technology, connectivity, digital content, and improved teaching methods with professional development – and other considerations needed for success: policy, funding strategies, metrics/assessment, and the commercial ecosystem to make it happen.

5.1 Policy

There are four important factors for the success of “ICT in education" programs:

1) Political support at the top level from heads of state and other top decision-makers;
2) National plans with time-bound, measurable goals;
3) Coordination between ministries or departments (especially ICT and education ministries); and
4) Utilization of Universal Service Funds or other funding mechanisms.

Recommendations for national education transformation programs include:

- Connect all schools and classrooms with broadband;
- Provide interactive smartboards in classrooms;
- Provide subsidized computers for students and teachers;
- Educate all teachers and students regarding the use of ICTs, including developing and/or incorporating digital media literacy curricula;
- Provide digital content for education;
- Provide subsidized home broadband connectivity for low-income students and families; and
- Provide public Internet access at schools (community access centres).

To be effective, policies should be constantly evaluated and modified as needed. A systematic approach to policy formulation will establish realistic policies in reasonable timeframes.

5.2 Funding sources and strategies

It is important to determine how the aforementioned programs will be funded. Funding can come from myriad sources – governments, public-private partnerships, local businesses, or participants themselves. The potential funding sources discussed in this section should provide ideas for future programs.

1) Government and agency funding

Governments and government agencies are typically the primary sources of funding for large-scale national initiatives. This funding can take many forms – from direct subsidies and low-interest loans, to value-added tax (VAT) and duties whose proceeds are applied to an e-learning program, and reductions in VAT and duties on goods and services purchased by the e-Learning program. Depending

[80] Document 1/89, “Chapter 9: ICT in education”, Intel Corporation (United States of America).

on the hierarchy (in some cases, the national level makes policy whereas lower levels have the budgets), governments at all levels – national, state, provincial, and local – are candidates for providing funding support.

2) Universal Service Funds

Many countries are also using Universal Service Funds (funds that were initially created to ensure ubiquitous deployment of basic telephone equipment and services) for "ICT in education" programs which feature a combination of PCs and other digital devices, broadband connections, and localized content and services that can give citizens in even the most rural and remote regions access to better education and economic opportunities.

3) Non-governmental agencies

There are many NGOs, governmental agencies, and other private philanthropic organizations, such as the United States Agency for International Development (USAID), Mercy Corps, the World Bank, and the United States Telecommunications Training Institute (USTTI) that often fund programs and activities in various countries. These programs and activities often include a focus on education, healthcare, and economic development. In some cases, NGOs act as partners, offering direct funding; in other cases, they may provide human resources to perform training and capacity development, or provide some element of the e-learning program, such as digital content.

4) Public-private partnerships

Public-private partnerships (PPPs) are partnerships between a government (or a government organization or agency) and one or more private sector companies. The private sector company may provide some form of capital investment and/or in kind support, while the government provides matching funds, supporting government services, an in-kind contribution, or perhaps a contract to the private sector companies.

5) Telecommunication companies

A special type of public-private partnership involves leveraging business-funded incentives with telecommunication companies (telcos). Telcos present special opportunities because many of the future e-learning technology users are already their customers. For example, telcos might offer discounts to teacher PC programs as part of a connectivity contract. And telcos are often willing to apply the funds they would have spent on customer acquisition and marketing toward discounts to teachers. Telcos could also partner with a specific country's ministry of education to advertise and increase awareness through letters to teachers, teacher staff meetings, and so on. They could then make the bundle of products and services more attractive to teachers by providing discounts or free installation, such as in **Turkey**.

6) Banks

Like telcos, banks are often willing to apply the funds they would have spent on customer acquisition toward favorable PC financing terms for teachers or students. Furthermore, banks benefit by partnering with schools because schools are not only effective promotion vehicles but also employers and community anchors. Because of a school's unique role with teachers and parents (for example, their ability to withhold paychecks or diplomas), banks can enjoy a dramatically lower risk of default in their dealings with schools.

7) Funding by teachers, students, and parents

In many cases, financial appeals to end users – parents, students, and teachers – can finance school or district e-learning programs, through either fundraisers, crowdfunding, or other methods. Of course, the success of this funding strategy depends on the interest of these groups in an e-learning program as well as their funding capacity. But do not dismiss this option too quickly; there is a great deal of latent interest in e-learning programs among parents and teachers. Shared payment options,

combining government and end-user contributions, are often successful. The National Parent Teacher Association in the **United States** is a good example of this kind of funding.[81]

5.3 Regional Initiatives

5.3.1 WTDC-14 Arab States Regional Initiative on smart learning (ARB-4)

This initiative, aims to shift from traditional methods of teaching in schools and universities, using books and paper-based sources, to smart learning methods with the use of tablet computers, the latest software, and modern telecommunication/ICT-based techniques as well as provide access to a range of academic information, resources, and subject matters. Therefore, in order to achieve such goals, the following three projects were planned by the ITU and project partners for the period 2015-2017.

1) First project: Adoption of national strategies for smart learning and for eradicating digital illiteracy;
2) Second project: Promotion of the deployment of tablet PCs in schools in the Arab region; and
3) Third project: Promoting open educational resources

Implementation

1) Smart Learning Forum

The ITU-ALECSO Smart Learning Forum was organized by the ITU/Arab Regional Office in partnership with the Arab League Educational, Cultural, and Scientific Organization (ALECSO) in Dubai, **United Arab Emirates**, from 14 to 16 December 2015, kindly hosted by the Government of the U.A.E. in collaboration with Intel and Millennium@EDU.[82]

2) Guidelines for formulating national strategies on smart learning

These guidelines aim to serve as a practical tool to ease the process of the implementation of smart learning initiatives. It is aimed toward the national governments who are looking to establish strategies and policies for wider uptake of smart learning. This guide was developed during the implementation of the ITU Arab Regional Initiative on Smart Learning, which was adopted during World Telecommunication Development Conference (WTDC) 2014. Moreover, the partners who developed these guidelines are the ITU, ALECSO, Intel, and Millenium@EDU.[83]

[81] Details can be seen at: http://www.pta.org.
[82] Link: http://www.itu.int/en/ITU-D/Regional-Presence/ArabStates/Documents/events/2015/SL/Forumfinalenglishreport-clean.pdf.
[83] Link: http://www.itu.int/en/ITU-D/Regional-Presence/ArabStates/Documents/events/2015/SL/Advanced%20Draft%20of%20Guidelines%20to%20formulate%20national%20strategies%20on%20Smart%20Learning.pdf.

Abbreviations and acronyms

Various abbreviations and acronyms are used through the document, they are provided here.

Abbreviation/acronym	Description
AFRINIC	African Network Information Center
APNIC	Asia-Pacific Network Information Centre
ARIN	American Registry for Internet Numbers
ARTCI	Telecommunication/ICT Regulatory Authority (Côte d'Ivoire)
C2B	Customer-to-Business
CAIs	Community Anchor Institutions
CBE	Central Bank of Egypt
CDMA	Code Division Multiple Access
CDN	Content Delivery Network
CI-IXP	Internet eXchange Point
DSL	Digital Subscriber Line
EMPS	Educational Mobile Payment System
FCC	Federal Communications Commission (United States)
FMC	Fixed–Mobile Convergence
FTTH	Fiber to the Home
FTTX	Fiber to the x
G2P	Government-to-person
GAMTEL	Gambia Telecommunications Services Company
GSM	global system for mobile communication
GSR-15	15th Global Symposium for Regulators
HCE	Host Card Emulation
IAP	Internet Access Provider
ICT	Information and Communications Technology
IMS	Internet Protocol Multimedia Subsystem
IoT	Internet of Things
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ISP	Internet Service Provider

Abbreviation/acronym	Description
ITU	International Telecommunication Union
IXP	Internet Exchange Point
KCC	Korea Communications Commission
LACNIC	Latin America and Caribbean Network Information Centre
LTE	Long-Term Evolution
M2M	Machine-to-Machine
MENUP	Ministry of Digital Economy and Posts (Côte d'Ivoire)
MFS	Mobile Financial Services
MTR	Mobile Termination Rates
MVNO	Mobile Virtual Network Operator
NAT	Network Address Translation
NGA	Next Generation Access
NGN	Next Generation Network
NPV	Net Present Value
NTIA	United States Department of Commerce's National Telecommunications and Information Administration
OCIT	Orange Côte d'Ivoire Télécom
OSP	Online service providers
OTT	Over-the-Top
PaaS	Platform as a Service
PDH	Plesiochronous Digital Hierarchy
PKI	Oman's Public Key Infrastructure
QoS	Quality of Service
RIPE-NCC	Réseaux IP Européens Network Coordination Centre
RIR	Regional Internet Registry
RoI	Return on Investment
SaaS	Software as a Service
SDH	Synchronous Digital Hierarchy
SIP	Session Initiation Protocol
SMS	Short Message Service
SS7	Signalling System No. 7

Abbreviation/acronym	Description
STN	Switched Telephone Network
TAN	Transaction Authentication Number
TDM	Time-Division Multiplexing
TEE	Trusted Execution Environment
USSD	Unstructured Supplementary Service Data
VAT	Value-Added Tax
VCN	Virtual Card Number
VoD	Video on Demand
VoIP	Voice over Internet Protocol
VPN	Virtual Private Network
WTDC	World Telecommunication Development Conference

Annexes

Annex 1: Overview of public initiatives to develop broadband/NGN networks

The Global Connect Initiative

In today's world, access to, and use of, the Internet for the world's citizens and businesses is an essential part of development – similar to roads, ports, electricity, and other infrastructure. With this in mind, the United States' Department of State has launched the Global Connect Initiative to promote and support action from key stakeholders, including governments, industry, civil society, and the technical community, to help bring an additional 1.5 billion people online by 2020. Under this initiative, every partner country or stakeholder contributes what they can to bring us towards these goals, be it infrastructure technology, good regulatory practices, or financial or technical support.[84]

Specifically, the objectives include: (1) encouraging all countries to integrate Internet connectivity as a key part of their national development strategy; (2) encouraging international development institutions, such as multilateral development banks and development agencies, to prioritize digital access; (3) promoting dialogue and action on how to harness, deploy, and enable innovative technologies to support affordable and sustainable connectivity for the unconnected, particularly in power-deficient communities.

Overall, Global Connect also aims to create the policy environments around the world to encourage investment in infrastructure and innovative technical solutions that expand connectivity.

The United States has already built a broad coalition of countries, industry members, NGOs and technical experts who are supporting the Global Connect Initiative (GCI). Participating stakeholders announced actions in support of GCI's goals, amounting to 65 new and ongoing initiatives that accounted for over $20 billion in planned and recent investments.

Policy regulatory aspects toward migration to broadband in India

Many positive steps have been and are being taken in India by the Indian government and other stakeholders to analyze the reasons for slow penetration and create an ecosystem to accelerate connectivity, penetration, and the use of broadband to deliver the benefits of the same to all sections.[85]

Though consultative processes launched by the Indian Telecom Regulatory Authority (TRAI), departments of telecommunication and information technology along with others have taken a leading role in policy, planning, and implementation with other agencies. One of the major initiatives is the National Optical Fiber Network (NOFN) as the national infrastructure project to reach the last mile of every part of India, even in remote and rural areas. The same framework is being implemented for service delivery platforms with many stakeholders as well. The aim of this project is to bring 250,000 villages (gram panchayats) on the broadband network so that society at large can benefit from the fruits of broadband in fast-track mode.

Broadband connectivity and services, if designed appropriately and innovatively in addition to implemented effectively, can be a key driver for several socio-economic gains, such as economic growth and employment generation; education; health; governance; and citizen empowerment required to

[84] Document 1/384, "The Global Connect Initiative", United States of America.
[85] Document 1/90, "Policy regulatory and technical aspects towards migration to broadband – Accelerating broadband", Republic of India.

achieve these economic goals for all citizens, including the rural population that cannot be covered effectively using traditional brick and mortar solutions.

The major issues that are retarding the growth of broadband in India include: the right of way for faster fiber laying; target demography and prioritization; insufficient digital literacy and awareness; regional content and people awareness; stakeholder incentive and funds for such incentives; and business cases for the industry.

Technology and policy to accelerate broadband development in the People's Republic of China

China's national broadband network has experienced rapid growth over recent years[86]. In 2014, the Chinese government also announced an ambitious plan to expand full broadband coverage across the nation's rural and urban areas. In order to realize the deployment for broadband coverage, there are several key points to consider: technology to support Gigaband while still using the existing media and telecommunications resources; investment-friendly regulatory policy to encourage investments; and easy access to non-telecommunications infrastructure for effective rollout.

Fiber technology lays the foundation for Gigaband access. While gigabit-capable passive optical networks (GPONs) provide 2.5Gbit/s of downstream bandwidth that can be distributed among multiple users, 10G PON technology is popular for its 10Gbit/s increased bandwidth, and in the future, 40G TWDM PON (time- and wavelength-division multiplexed passive optical network) will provide the bandwidths of multiple 10G PONs on multiple wavelengths.

For copper lines, Giga Copper technologies will make Gigaband access a reality. With the newly released G.fast standard, copper networks now achieve 500 Mbit/s to 1 Gbit/s bandwidth, and a pair of copper lines is projected to eventually reach a 5 Gbit/s access rate.

Over coaxial cables, Giga Coax technologies help to achieve Gigaband access. Compared to traditional telephone lines, coaxial cables feature better frequency performance and higher working frequencies. The 32-channel DOCSIS 3.0 provides 1.6 Gbit/s shared bandwidth, but in the future, DOCSIS 3.1 will support multiple frequency bands and can provide 10 Gbit/s bandwidth.

The whole coverage area should be separated as two main parts. The first is a focus on the urban area and can be driven by the market as telecoms can easily earn revenue to balance the investment. The second is for rural areas and should be driven by policy, as in this area telecoms do not easily able to generate income to withdraw the cost. Thus, governments should give greater policy and funding support to telecoms to reduce their investment risks.

The government has implemented a universal service obligation and compensation scheme with its "Broadband Countryside Project" and direct investment from the Finance Ministry to boost broadband universal coverage.

The Gigaband City project in Chinese cities

In 2013, the Broadband China strategy was upgraded to a national strategy[87]. Meanwhile, the country has put forward a new bandwidth standard in the new era: to deliver a bandwidth of 20 Mbps to more than 80 per cent of the subscribers; to provide urban residential subscribers with the 1 Gbit/s service; and to unveil the first benchmark Gigaband City project in Shenzhen.

In the process of deployment, the Gigaband City project will focus on service, network and technology applications. The top priority of the project is to achieve urban coverage in line with the urban development strategy.

---

86 Document 1/192, "In Gigaband era, technology and policy to accelerate broadband development", People's Republic of China.

87 Document 1/279, "The Gigaband City project heralds the ultra-wideband deployment in Chinese cities", People's Republic of China.

The service scenarios cover residential subscribers, corporate private lines (e.g., hotels) and the private network applications for government interconnection. Among them, residential subscribers will be provided with premium quality video experience, with 4K video as a flagship service offering and the introduction of VR video technology as part of the development of video services, e.g., the first release of VR video episodes. Enterprises and governments will be provided with a "one-stop" gigabit business solution, including such new services as all-optical parks, Gigabit hotels, "optical + cloud" government-enterprise packages and so forth.

The government has a vital role and a great leverage in all the echelons of the business and the society. The deployment of the Gigaband City project will include multiple aspects, such as funding, pipeline sharing, deployment access, experience assurance, etc. The government should enact friendly industrial policies to encourage the sharing of non-telecom pipeline infrastructures, formulate legislations to ensure the accessibility of residential quarters, improve the FTTH standard by implementing Gigabit wiring standards in newly-completed buildings, create and authorize a third party to publish status reports on broadband speed and service experience, and provide tax incentives and the Universal Service Fund (USF) support to help operators reduce their costs and stimulate their willingness in rolling out networks and earmarking investments.

National broadband strategy of the Sultanate of Oman

The Government of Oman developed a national broadband strategy (NBS) for the Sultanate.[88] The NBS is designed to ensure that:

1) Every resident in Oman has access to high-speed broadband at affordable prices.
2) All businesses in Oman have access to world-class broadband services which make them globally competitive.
3) Rural and remote communities have access to broadband connectivity that closes the digital.

The strategy is based on the below stated principles which need to be considered during implementation of all initiatives and projects under this strategy:

- **Compatibility:** To be aligned with the objectives of the national vision 2020 and its updates.
- **Acceleration:** To speed-up broadband take-up beyond that which market players would provide commercially with minimum distortion of the competitive market.
- **Integration:** To supplement government investment with operators and other private investments in broadband.
- **Selectiveness:** To invest only when the generated social and economic benefits will exceed the cost of supply.
- **Cost-efficiency:** To reduce the capital cost of broadband rollout and to offer the service at affordable price for all customers.

Broadband development in Iran

According to Iran National Development Plan and related policies the broadband networks should be rapidly deployed to provide affordable e-services in Iran.[89] This vision has prepared lots of facilities for operators including tax reduction and incentive programs by support them financially and motivates them by giving different amenities. In provision of broadband services in Iran, during recent years, deploying modern ICT infrastructure in all part of country (both rural and urban) has been targeted. Moreover to the activity of private sector, this policy is applied by government to provide communication infrastructure in unattractive areas for private sector mainly caused due to low profitability.

[88] Document 1/296, "National Broadband Strategy of Sultanate of Oman", Oman Telecommunications Regulatory Authority (TRA), Sultanate of Oman.
[89] Document 1/383, "Broadband development in Iran", Iran University of Science and Technology, Islamic Republic of Iran.

By considering incentives for cooperating in broadband technologies, updating policies for regulation and implementing national developing plan by government, the broadband access has been improved during past years in all area of Iran.

In past years, by using new technologies in the cellular networks, the share of active operators in providing high speed internet and new technologies have been increases that results in implementation of 3G and 4G networks. Significant progress has been made in regulation and policy level in Iran. As result, the development of national broadband infrastructure can be addressed in Iran through increased roll out of fiber infrastructure, creation of the necessary enabling policy and regulatory environment and ensuring that the network is optimized by creating the internet exchange points. The main target is obtaining affordable e-services that result in sustainable development.

eMisr: The transition from planning to execution in Egypt

eMisr is the national broadband plan of Egypt that aims for the diffusion of broadband services in Egypt.[90] eMisr is a two-staged plan (the first stage ending by 2018, and the second stage – 2020). The key strategic objectives of the plan aim to develop telecom infrastructure, creating job opportunities, increasing productivity of governmental entities through up-to-date ICT platforms, and using innovative ICT applications.

By 2018 it is envisaged to increase households fixed broadband coverage by up to 80 per cent and increase fixed broadband penetration to 40 per cent of the households. Moreover, it is targeted to cover 85 per cent of the population with mobile coverage through 4G and a population penetration of 25 per cent for mobile broadband services. Lastly, it aims to connect 50 per cent of Egyptian communities (government entities like schools, hospitals etc.) to high speed (50 Mbps or more) connections.

To achieve these objectives, the national broadband initiative will focus on fostering both supply and demand sides. Supply-side will be encouraged through the focus on the rollout of up-to-date broadband networks; regulatory intervention will be the catalyst for speeding up the networks rollout. Regulatory intervention will be in the form of implementing a unified license regime allowing the four incumbent operators to provide all telecommunications services to users, the issuance of a second infrastructure operator license allowing the licensee to build and operate infrastructure in Egypt, and awarding 4G spectrum and licenses.

Another catalyst for both supply and demand is direct governmental contributions by implementing a series of government-funded projects to connect governmental sectors, such as education, health, justice, etc., with high-speed broadband access and taking the necessary measures to ensure service usage and sustainability. The final pillar is a demand stimulation through promoting e-content, e-commerce, and the use of ICTs to develop a digital economy and society, transparent government, and efficient public administration.

Policy, regulatory and technical aspects of the deployment of broadband networks in the Central African Republic

The Central African Republic (CAR), in its endeavors to strengthen its digital economy, has developed legislation and public policies that are geared to the situations described here[91]. This has also been behind its decision to conclude an agreement with the Chinese Government on funding the National Fibre-Optic Project, while will be implemented to create the National Broadband ICT Network Infrastructure, in three phases as follows:

– International backbone (Cameroon – Bangui) crossing six sites, metropolitan network (Bangui), NGN, FTTx, hotspots, deployment of 4G in Bangui;

[90] Document SG1RGQ/63, "The national broadband plan 'eMisr': Transition from planning to execution", Arab Republic of Egypt.

[91] Document 1/298, "Policy, regulatory and technical aspects of the deployment of broadband networks in the Central African Republic", Central African Republic.

– National backbone to serve 16 prefectures in the CAR;

– International outgoing backups with certain adjacent countries, making the CAR an African hub.

The feasibility study is being reviewed for approval. Once that is done the Government will negotiate with the Chinese Government for funding on the basis of a bilateral agreement. Once funding is obtained, it will call for bids with a view to hiring companies to implement the project and supervise the work.

Within the Central African Economic and Monetary Community (CEMAC) directive established the legal framework for protecting the rights of users of electronic networks and services. Regulation CEMAC strengthens this further and defines the key areas of harmonization of regulation and regulatory policy governing electronic communications in this region. The goals of these subregional regulations include the following:

– Establishing universal services;

– Bringing about full liberalization of the sector with good QoS and affordable prices;

– Ensuring non-discriminatory access to high-quality ICT services;

– Meeting the needs of vulnerable social groups and in particular the disabled;

– Strengthening the rights and obligations of consumers;

– Ensuring sustainable consumer protection.

In addition, the Extraordinary Plenary Assembly of Ministers of the Conference of Posts and Telecommunications of Central Africa (COPTAC) also adopted a series of Recommendations regarding the deployment of subregional fibre-optic interconnection infrastructure and on the policy of constructing and operating landing points for fibre-optic submarine cables on the coastline of COPTAC countries.

Review of the current state of regional initiatives related to broadband access and adoption of broadband in all regions

– Africa (AFR3): Development of broadband access and adoption of broadband

Objective: To assist Member States in the development of broadband infrastructure and access thereto in urban and rural areas, with particular emphasis on subregional and continental interconnection.

– Americas (AMS3): Development of broadband access and adoption of broadband

Objective: To provide assistance to Member States in the development of policies to increase broadband access and uptake.

– Americas (AMS4): Reduction of telecommunication service prices and Internet access costs

Objective: To provide assistance to Member States in defining and coordinating policies, ways and means to reduce the cost of access and interconnection, and the prices of telecommunication and Internet services as well as Internet for users through necessary investments.

– Arab States (ARB1): Development of broadband access and adoption of broadband

Objective: To assist Arab States (particularly least developed countries) in the implementation and development of broadband infrastructure in urban and rural areas, and to develop, facilitate, and spread access to broadband networks and services in the Arab States, including issues related to conformity and interoperability.

– Asia-Pacific (ASP3): Harnessing the benefits of new technologies

Objective: To assist Member States in utilizing new technologies and address human and technical capacity challenges related to issues such as those identified in the expected results, among others.

– Asia-Pacific (ASP4): Development of broadband access and adoption of broadband

Objective: To assist Member States in the development of broadband access in urban and rural areas as well as support system construction to resolve social issues leveraging the benefits of telecommunications and ICT applications.

– CIS (CIS4): Development of broadband access and adoption of broadband

Objective: To assist interested Member States in the Commonwealth of Independent States (CIS) in developing broadband access, including in rural and remote areas, using energy-efficient technologies.

– Europe (EUR2): Development of broadband access and adoption of broadband

Objective: Due to significant differences that exist among European countries, there is an urgent need to take steps and assist administrations in every aspect of the practical implementation and development of high-speed networks. This action may also comprise the establishment of local/regional broadband roll-out plans. The development of communication networks would be boosted by using the experience in infrastructure-sharing with the energy sector (smart grids) and should aim to benefit from cross-sectoral synergies. The degree of progress in this field varies considerably between Member States in the region; therefore, sharing best practices and regulatory policies in addition to providing assistance would help to maximize the effective use of resources.

Infrastructure sharing for optical broadband roll-out in the rural areas of the People's Republic of China

In order to implement the government's "Broadband China" strategy, Sichuan as the one of the pilot provinces in the national "Broadband Village" project, worked out an innovative solution that shares existing rural infrastructure to overcome the challenges of poor network infrastructure, weak foundation and large investment.[92] The innovations have effectively reduced the project cost and significantly speeded up the progress of projects.

Deploying broadband in the vast rural areas requires huge investment to build new roads with new poles. Therefore, how to minimize the need to set up new poles is key to rapid roll-out of broadband service in rural areas. Non-metallic self-supporting optical cable with insulated metallic fittings is used to share existing power transmission poles has reduced the demand for new poles, lowered the cost, and hence accelerated the pace of roll-out. This innovative solution is particularly suitable for areas inaccessible by the poles.

Compared to the traditional solution which requires more poles, the new solution is notable for cost saving. With the ease of implementation, the new solution has simplified the procedure and speeded up the progress. Under the traditional mode, building new poles requires a group of 5 people working for 7 days for each kilometer of optical cable in rural area, while the new scheme shortens the cycle to 2 days. The new solution can be widely deployed to address the complicated conditions in rural areas. With the new solution, the average cost of a single village has dropped, and the average project cycle has been shortened from 15 days to 10 days for each village.

[92] Document 1/284, "Innovative sharing of infrastructure to facilitate the optical broadband roll-out in the rural areas", People's Republic of China.

Lao P.D.R telecommunications sector overview

Telecommunications sector of **Lao People's Democratic Republic** (Lao PDR) is essential to the country's overall social and economic growth and development. The Government of Lao PDR had designed new telecommunications sector policy frameworks to guide the sustained growth and development of the Laotian telecommunications sector and to facilitate the delivery of modern and efficient services to meet demands of users, businesses, and government. The main purposes of this policy framework are to:

- Increase access to telecommunications services, especially in rural areas;
- Encourage foreign direct investment;
- Create an enabling environment for the migration to new technologies;
- Ensure efficient use of resources;
- Develop skills and competencies in government and in the sector;
- Remove obstacles to competition and anti-competitive practices;
- Increase the deployment of national telecommunications infrastructure, especially in regional and remote areas of the country;
- Ensure a financially viable telecommunications sector conducive to sustainable investment in telecommunications infrastructure and services by the private and public sector as well as aid agencies;
- Improve the efficiency and effectiveness of telecommunications service delivery to end users;
- Cost effectively satisfy end user demand for telecommunications services at affordable prices; and
- Strengthen regulatory capabilities and skill sets within the government so as to ensure a high standard of sector governance and oversight of market participants.

Every licensed ICT operator or service provider in Lao PDR that provides services to the public are obligated to contribute to the achievement of national Universal Access objectives as a condition of its license or authorization. The government also specifies these obligations in the course of exercising their licensing and regulatory responsibilities.[93]

ICTs in Guinea

[94]The first submarine cable to cross the Guinean coast was constructed in 1975. After Dakar, Senegal, the cable laying survey had planned for a landing at Conakry, the capital of Guinea. Given the contentious relations between Guinea and its neighbors, the cable landing at Conakry was seen more as a means of destabilizing Guinea's revolutionary regime than as a badly needed means of communication and way to break the isolation of the country.

The second submarine cable on the coast of Guinea was laid in 1987. During the same year, the new authorities launched a broad program of economic and social reforms, which affected every area of national life. With other priorities to consider, and because of a failure to perceive the importance of such a submarine cable project, Guinea missed this second opportunity.

Within the framework of improving and strengthening the offer of transport and access services, Guinea subscribed to a commitment to land the ACE submarine cable at Conakry in June 2010. It was brought into service during the first quarter of 2013. With the arrival of the ACE cable, most of

[93] Document SG1RGQ/180, "Lao P.D.R Telecommunications Sector overview", Lao People's Democratic Republic.

[94] Documents SG1RGQ/61, "Accessibility of broadband in Guinea"; 1/271, "Enabling environment for the development of telecommunications/ICTs"; SG1RGQ/282, "Current situation and evolution of the telephony sector in Guinea", Republic of Guinea.

the mobile operators and Internet access providers (IAPs) switched their international traffic to the submarine cable. This has resulted in a significant improvement in Internet speed for Guinean users. There has been a significant increase in the availability of international bandwidth, from 0.15 Gbit/s when the ACE cable was brought into service in 2012, to 8 Gbit/s at the end of the first half of 2014.

The retail price of Internet services fell from USD 1,200 per Mbit/s per month in 2010 to USD 800 by the end of the first half of 2014. The positive effects on the profitability of small and medium-sized companies and the performance of the private sector in general are already apparent, reflected in investment in new equipment and infrastructure as well as the launch of new services.

Despite the cessation, in 2012, of the activities of the incumbent operator SOTELGUI (*Société des télécommunications de Guinée*), with the establishment of Guinea's four telephony operators the offers are multiplying at all levels and consumers are increasingly able to access the various products and services available.

This in turn is providing the sector with significant earnings, and hence the State with increasing revenues through taxes, duties, charges and fees.

The mobile telephony sector in Guinea is experiencing very significant progress, in terms of service penetration and quality of service. From 2014 to 2015, the penetration rate for mobile telephony rose from 88.5 to 99.1 per cent, while Internet penetration rose from 17 to 21.2 per cent.

The number of mobile users is rising rapidly in 2016 by comparison with previous years. In the first quarter of 2016, it stood at 10 907 156 users as against 10 764 958 users in the fourth quarter of 2015, an increase of one per cent.

Prepaid mobile and postpaid mobile subscriptions numbered 10 857 692 (99.5 per cent of the total) and 49 464 (0.5 per cent of the total), respectively, in the first quarter of 2016, as against 10 712 460 and 52 498 subscriptions in the fourth quarter of 2015.

In Guinea, in the latter part of 2010, the three leaders in the telecommunication sector began providing fixed and mobile Internet access in order to satisfy the goods and services requirements of their main users. The various Internet offers have evolved from GPRS/EDGE to WIMAX, 3G and 3G+ connections.

In the first quarter of 2016, the total number of Internet users rose by 3.42 per cent to 2 521 000 from 2 438 000 in the fourth quarter of 2015. The mobile Internet penetration rate was 23 per cent in the first quarter of 2016 as against 22.4 per cent in the fourth quarter of 2015, an increase of 0.6 per cent.

Broadband strategy of Viet Nam

The Government of Vietnam has carried out the national broadband strategy with specific targets and action plans.[95] Principles of strategy implementation:

- Building up and developing modern, safe, high-capacity, high-speed and national wide service coverage broadband telecommunication infrastructure;
- Providing diversified broadband telecommunications services with good quality and reasonable rates according to the market mechanism;
- Applying the telecommunications technology which is modern, energy saving, environmentally friendly, appropriate with the general development trend in the world;
- Efficiency of using telecommunication resources: Using effectively the telecommunication resources, frequency resources, domain names, IP internet addresses, satellite orbit resources

[95] Document SG1RGQ/257, "Broadband strategy of Viet Nam", Socialist Republic of Viet Nam.

to serve modern broadband telecommunications infrastructure and providing diversified broadband-based services with high quality and reasonable cost;

– Carrying out the synchronization of technology and network to increase the data download speed.

Specific objectives of the strategy toward 2020 include:

– **Broadband for family.** At least 40% of households (or individual subscribers) across the country can access to and use the fixed broadband services, in which at least 60% of the subscribers are connected to the minimum downlink speed at 25Mb/s.

– **Broadband for the public telecommunications access points.** 100% of public telecommunications access points across the country can use the fixed broadband services in which at least 50% of the points applying fixed broadband access with minimum speed downlink at 50Mb/s.

– **Broadband for public library location.** Over 99% of public library points across the country can use the fixed broadband services in which at least 50% of the points apply the fixed broadband access with minimum speed downlink at 50Mb/s.

– **Mobile Broadband.** Ensuring at least 95% of residential areas are covered with 3G / 4G with average downlink speed at greater than 4Mb/s in urban and 2Mb/s in rural areas.

– **Broadband for educational institutions.** More than 99% of educational institutions have broadband connections in which at least 60% of higher education institutions such as colleges, universities and institutes use broadband services with minimum downlink speeds at 1Gb/s; at least 60% of general educational establishments, vocational schools, vocational training centers can access to broadband with minimum speed downlink at 50Mb/s.

– **Broadband for clinics and treatment.** More than 99 per cent of health care facilities across the country have broadband connections in which at least 20 per cent of facilities with broadband access applying minimum speed downlink at 100Mb/s; from 40 per cent to 60 per cent of connections to minimum downlink speed at 25MB/s.

– **Broadband for administrative authorities and enterprises.** 100 per cent of agencies and units of the Party, the Government, political organizations - social and enterprises have broadband connections in which at least 30 per cent minimum downlink speed connection at 100Mb/s; from 40 per cent to 60 per cent minimum downlink speed connection at 25MB/s. 100 per cent of websites of the agencies and units of the Party, the Government, political organizations - social; the public administrative services portal, public professional services supports IPv4 and IPv6 Internet protocols at the same time.

The experience of Senegal

Through the Plan for an Emerging Senegal (PES), Senegal has set a new course towards the structural transformation of its economy in pursuit of strong, sustainable and lasting growth.[96] The PES focuses on the development of new drivers in the areas of agriculture, agro-business, social housing, mining and tourism, as well as on consolidation of the traditional growth drivers such as the telecommunication sector, which constitutes the powerhouse of the digital economy. This is the context within which the Digital Senegal 2025 strategy was elaborated.

The Digital Senegal 2025 strategy is a long-term vision (from 2016 to 2025). It is made up of strategic prerequisites and priorities that hinge around the slogan: “Senegal in 2025: digital for all and for use in everything, with a dynamic and innovative private sector within an effective ecosystem”.

For Senegal, access to high- and very-high-speed connectivity constitutes an opportunity to boost growth and make the country a vital services hub. The priority here is to achieve national fibre-optic

[96] Document SG1RGQ/299, “Overview of the Digital Senegal 2025 (Sénégal Numérique 2025) Strategy validated and adopted in 2016”, Republic of Senegal.

coverage and implement appropriate infrastructures whereby all areas of the country have guaranteed access to high-quality, secure, affordable and competitive telecommunication service offers.

In the interests of enhancing efficiency and synergy in public services, the administration is connected in order to better serve user requirements, with the virtualization of administrative procedures resulting in higher productivity at lower cost and shorter transaction times. The overall objective is to bring the administration closer to users in their respective localities.

Significant reforms will be adopted to improve the environment within which support is provided to the local digital private sector in the interests of enabling it to secure optimum benefit from the potential and opportunities offered by digital development. Senegal's ambition is to build the first and biggest regional digital platform in order to foster investment and the exportation of services.

The aim here is to promote innovative uses of digital technology to boost the productivity and competitiveness of key sectors of the national economy, thereby improving agricultural efficiency and access to quality healthcare, education and training, trade and public services. Sustainable development goals will also be taken into account.

To handle strategic management, there is an inter-ministerial committee headed by the Prime Minister, together with a technical committee headed by the minister responsible for digital technologies and comprising representatives from the ministries involved in implementing the strategic action plan and other national stakeholders.

Annex 2: Methodology for selecting appropriate technologies for constructing telecommunication access networks

Selecting a specific architectural model for constructing an access network is a considerable task, and is based on an analysis of the relevant technical and economic indicators.[97] The key factors in determining the suitability of and approach to constructing a modern access network in a given locality are the locality's socio-economic and geographic parameters (characteristics). In order to systematize these parameters, parametric model of a locality was developed by A.S. Popov ONAT, Ukraine.

All parameters in the proposed model can be divided into classes. Examples of classes might include: "Geography", "Building", "Infrastructure", "Electricity Supply", "Population and Demand", "Competition". The approach for determining the optimal access technology for a given locality (or a number of localities) is based on imitation modeling of the network construction and operating processes. The purpose of such modeling is to determine the following elements: cost and duration of network construction; network operating costs; and expected revenues from the provision of services. Modeling is done in two stages.

The first involves verifying the technical feasibility of using different options to construct a network in a given locality.

In the second stage, the relevant quantitative and economic indicators are calculated. Calculating quantitative and economic indicators include modelling the process of developing and converting the location chosen for siting access equipment, installing and tuning access equipment, and the process of installing subscriber lines.

In essence, modeling involves calculating the quantitative indicators (e.g., quantity of equipment, number of sites, number and extent of communication channels, number of potential subscribers) and subsequent determination of the overall investment required (e.g., costs of design, equipment, installation work, licenses), expected operating costs (salaries, electrical energy costs, etc.), and expected revenues from the provision of services to potential subscribers. The results of the modeling, presented in the form of a single integrated assessment (based on the "net cash flow" indicator), are used to compare to identify the most promising technology. The most promising technology is considered to be the one with the highest net present value (NPV), while the suitability of constructing a network in the locality using a given technology is assessed on the basis of the established NPV boundary value.

[97] Document 1/21, "Methodology for the selection of technological solutions of telecommunication access networks", Odessa National Academy of Telecommunications n.a. A.S. Popov (Ukraine). See also: http://www.itu.int/en/ITU-D/Regional-Presence/CIS/Documents/Events/Regional%20Initiatives/RI4%20broadband/BANC_Recommendations_Rev8.pdf.

Annex 3: Case studies about IXPs development

Assessment of the impact of IXPs – An empirical study of Kenya and Nigeria

The importance and role of IXPs: This study highlights the importance and role of IXPs in developing local Internet infrastructure and the economic role they play in two African countries: Kenya and Nigeria.[98] As the Internet increasingly globalizes, the interconnection between networks, content providers, and users is more and more critical to creating the 'network of networks' that constitutes the Internet. At the center of this globalization IXPs, facilities where all Internet players can interconnect directly to each other. IXPs have already played a key role in the development of an advanced Internet ecosystem across North America, Europe, and Asia. This section details the impact that such IXPs have had in two emerging markets in sub-Saharan Africa: Kenya and Nigeria.

Lifting barriers to Internet development in Africa

Suggestions for improving connectivity: This study examines the factors that are obstructing the further development of the Internet ecosystem in Africa and the implications of those obstructions. It goes on to explore the possible remedies that can assist in resolving them. It follows up from a previous study on the impact of IXPs in Kenya and Nigeria, which found that IXPs can and do improve the quality of Internet services and save African operators millions of dollars per year in connectivity fees – but that a key factor in the success of IXPs is the availability of good domestic connectivity.

Connectivity in Latin America and the Caribbean

The role of IXPs: This study continues the work that the Internet Society (ISOC) has conducted to demonstrate the far-reaching economic and social benefits of establishing IXPs in emerging markets. The study, commissioned by ISOC and conducted by Professor Hernan Galperin of the Universidad de San Andrés in Argentina, examined the critical cost and performance benefits of IXPs in Argentina, Brazil, Colombia, and Ecuador – countries on the leading edge of Internet growth in Latin America. The study also identifies the positive impact that IXPs have made, including reduced telecommunications costs, faster and better local data exchange, and local technical capacity development.

IXP Toolkit and Best Practices Guide

The IXP Toolkit and Best Practices Guide[99] highlights the role of IXPs, institutional and operational models, IXP best practices, economics, and a methodology for assessing IXPs. The toolkit also provides numerous examples and robust data on IXPs in various countries. A complimentary "portal" provides additional data and information.

[98] Document 1/37, "Studies related to enabling local infrastructure and recommendations for lifting barriers to connectivity", Internet Society.

[99] IXP Toolkit and Best Practices Guide at http://ixptoolkit.org.

Annex 4: Mobile payments – problems and prospects

In October 2014, the ITU, in cooperation with CJSC Intervale (Russian Federation) and the A.S. Popov Odessa National Academy of Telecommunications (Ukraine), with support from the international not-for-profit organization Mobey Forum and at the kind invitation of the Ministry of Communications and High Technologies of the Azerbaijani Republic, held a regional seminar for the CIS countries titled "Mobile Payments: Problems and Prospects". The seminar was the final stage in the implementation of the CIS regional initiative "Development of recommendations and creation of a pilot segment of telecommunication / ICT system to support secure remote retail payments and the management of bank accounts using wireless communication networks," initiated by the Intervale company and adopted by the World Telecommunication Development Conference (Hyderabad, 2010). [100]

The seminar focused on such topical issues as the activities of the ITU and the Bank for International Settlements aimed at promoting services based on mobile payments; the evolution of mobile payments in the different regions of the world; experience of CIS countries in the development of mobile payments; defining the range of tasks that can be accomplished using the mobile payment system and the main requirements vis-à-vis that system; and issues involved in the training of specialists to develop and support the operation of mobile payment systems. The seminar also generated recommendations for the development of mobile payments in CIS countries.

The seminar was attended by 68 representatives of ministries and agencies, telecommunication and financial regulators, banking and financial institutions, telecommunication operators, higher education institutions, telecommunication equipment manufacturers, mobile payment software developers, international organizations and other interested organizations from 14 ITU Member States (Azerbaijan, Belarus, France, Greece, Kazakhstan, Kyrgyzstan, Moldova, the Russian Federation, Spain, Switzerland, Tajikistan, Ukraine, the United Kingdom, and the United States), of which eight are countries from the CIS region.

The seminar participants noted:

- The substantial contribution made by the Intervale company to the process of implementing the regional initiative "Development of recommendations and creation of a pilot segment of telecommunication / ICT system to support secure remote retail payments and the management of bank accounts using wireless communication networks;"
- The importance of the work being done by ONAT to develop human potential in the CIS region with respect to the design and operation of modern mobile payment systems;
- The timeliness and relevance of the themes covered by the seminar;
- The practical relevance of the presentations given and the opportunities for participants to put them to good use in the context of their work;
- The usefulness of the exchange of opinions and experience during the course of the seminar; and
- The need to maintain the practice of holding regular ITU seminars on mobile payment issues, with the active participation of experts and stakeholders.

[100] Document SG1RGQ/30, "Mobile payments: problems and prospects", Intervale (Russian Federation).

Annex 5: National IPv6 deployment roadmap in India

The DoT adopted a consultative approach, and based on the input received from different stakeholders, it released the "National IPv6 Deployment Roadmap, v-I" in July 2010. India was the first country where any government around the world has released such a roadmap. The policy decisions it detailed were aimed at sensitizing the ecosystem and enabling it to take the first step for a smooth IPv6 transition. The plan stipulated:

- All major service providers (having at least 10,000 Internet customers or synchronous transport module level-1 (STM-1) bandwidth) will target handling IPv6 traffic and offer IPv6 services by December 2011;
- All central and state government ministries and departments, including its PSUs, will being using IPv6 services by March 2012; and
- An IPv6 task force should be formed

In order to facilitate government organizations, a 16-point activity sheet was prepared by the DoT, and IPv6 nodal officers were appointed in all central government ministries/departments as well as states and union territories (UTs). On request of government organizations, a group of consultants was also recruited through an open request for proposal (RFP) to ensure smooth IPv6 implementation in the government sector. As a result of the policy guidelines of the abovementioned roadmap, the majority of the major service providers in India became ready to handle IPv6 traffic and offer IPv6 services. The central and state government ministries and departments, including their PSUs, were sensitized to and trained in the transition to IPv6. An India IPv6 task force headed by Secretary (T) with a three-tier structure consisting of an oversight committee, a steering committee, and working groups was constituted. Thus, the prime objectives envisaged in the first roadmap were achieved.

The National Telecom Policy (NTP)-2012, released in 2012, also recognizes futuristic roles of IPv6 and its applications in different sectors of the Indian economy. It aims to achieve a substantial transition to new IPv6 in the country in a phased and time-bound manner by 2020 and encourage an ecosystem for the provision of a significantly large bouquet of services via an IP platform. As far as service providers are concerned, the majority of them are ready in the enterprise segment, while some are ready in the retail segment whereas others are in the process. The IPv6 adoption milestone was received from all (84/84) central government ministries/departments and all (36/36) states/UTs.

All major mobile handset manufacturers (e.g., Samsung, Microsoft, Apple, HTC, Lava, Sony, Micromax, Intex, Karbonn, etc.) support IPv6 on all newly launched devices (w.e.f. 01-07-2014) in accordance with the Roadmap, v-II. The National Informatics Centre (NIC) is working to transition websites of government organizations to IPv6 (dual stack). The websites of around 12 scheduled commercial banks are already using IPv6, and the payment gateways are underway to be ready on IPv6.

Since, IPv6 is not backward compatible with IPv4, the transition to IPv6 is likely to be a complex, mammoth, and long-term exercise during which both IPv4 and IPv6 will coexist. The vast geographic area, legacy networks, and financial constraints, along with the multitude of stakeholders involved, makes the task even more challenging. Even though a lot has been achieved in terms of IPv6 transition in India, the journey has only just begun, with IPv6 traffic in India significantly below the world average of about of 5 per cent.

International Telecommunication Union (ITU)
Telecommunication Development Bureau (BDT)
Office of the Director
Place des Nations
CH-1211 Geneva 20 – Switzerland
Email: bdtdirector@itu.int
Tel.: +41 22 730 5035/5435
Fax: +41 22 730 5484

Deputy to the Director and Chief, Administration and Operations Coordination Department (DDR)
Email: bdtdeputydir@itu.int
Tel.: +41 22 730 5784
Fax: +41 22 730 5484

Infrastructure Enabling Environment and e-Applications Department (IEE)
Email: bdtiee@itu.int
Tel.: +41 22 730 5421
Fax: +41 22 730 5484

Innovation and Partnership Department (IP)
Email: bdtip@itu.int
Tel.: +41 22 730 5900
Fax: +41 22 730 5484

Projects and Knowledge Management Department (PKM)
Email: bdtpkm@itu.int
Tel.: +41 22 730 5447
Fax: +41 22 730 5484

Africa

Ethiopia

International Telecommunication Union (ITU)
Regional Office
P.O. Box 60 005
Gambia Rd., Leghar ETC Building
3rd floor
Addis Ababa – Ethiopia

Email: ituaddis@itu.int
Tel.: +251 11 551 4977
Tel.: +251 11 551 4855
Tel.: +251 11 551 8328
Fax: +251 11 551 7299

Cameroon

Union internationale des télécommunications (UIT)
Bureau de zone
Immeuble CAMPOST, 3e étage
Boulevard du 20 mai
Boîte postale 11017
Yaoundé – Cameroun

Email: itu-yaounde@itu.int
Tel.: + 237 22 22 9292
Tel.: + 237 22 22 9291
Fax: + 237 22 22 9297

Senegal

Union internationale des télécommunications (UIT)
Bureau de zone
8, Route du Méridien
Immeuble Rokhaya
B.P. 29471 Dakar-Yoff
Dakar – Sénégal

Email: itu-dakar@itu.int
Tel.: +221 33 859 7010
Tel.: +221 33 859 7021
Fax: +221 33 868 6386

Zimbabwe

International Telecommunication Union (ITU)
Area Office
TelOne Centre for Learning
Corner Samora Machel and Hampton Road
P.O. Box BE 792 Belvedere
Harare – Zimbabwe

Email: itu-harare@itu.int
Tel.: +263 4 77 5939
Tel.: +263 4 77 5941
Fax: +263 4 77 1257

Americas

Brazil

União Internacional de Telecomunicações (UIT)
Regional Office
SAUS Quadra 06, Bloco "E"
10º andar, Ala Sul
Ed. Luis Eduardo Magalhães (Anatel)
70070-940 Brasilia, DF – Brazil

Email: itubrasilia@itu.int
Tel.: +55 61 2312 2730-1
Tel.: +55 61 2312 2733-5
Fax: +55 61 2312 2738

Barbados

International Telecommunication Union (ITU)
Area Office
United Nations House
Marine Gardens
Hastings, Christ Church
P.O. Box 1047
Bridgetown – Barbados

Email: itubridgetown@itu.int
Tel.: +1 246 431 0343/4
Fax: +1 246 437 7403

Chile

Unión Internacional de Telecomunicaciones (UIT)
Oficina de Representación de Área
Merced 753, Piso 4
Casilla 50484, Plaza de Armas
Santiago de Chile – Chile

Email: itusantiago@itu.int
Tel.: +56 2 632 6134/6147
Fax: +56 2 632 6154

Honduras

Unión Internacional de Telecomunicaciones (UIT)
Oficina de Representación de Área
Colonia Palmira, Avenida Brasil
Ed. COMTELCA/UIT, 4.º piso
P.O. Box 976
Tegucigalpa – Honduras

Email: itutegucigalpa@itu.int
Tel.: +504 22 201 074
Fax: +504 22 201 075

Arab States

Egypt

International Telecommunication Union (ITU)
Regional Office
Smart Village, Building B 147, 3rd floor
Km 28 Cairo – Alexandria Desert Road
Giza Governorate
Cairo – Egypt

Email: itu-ro-arabstates@itu.int
Tel.: +202 3537 1777
Fax: +202 3537 1888

Asia and the Pacific

Thailand

International Telecommunication Union (ITU)
Regional Office
Thailand Post Training Center, 5th floor,
111 Chaengwattana Road, Laksi
Bangkok 10210 – Thailand

Mailing address
P.O. Box 178, Laksi Post Office
Laksi, Bangkok 10210 – Thailand

Email: itubangkok@itu.int
Tel.: +66 2 575 0055
Fax: +66 2 575 3507

Indonesia

International Telecommunication Union (ITU)
Area Office
Sapta Pesona Building, 13th floor
Jl. Merdan Merdeka Barat No. 17
Jakarta 10110 – Indonesia

Mailing address:
c/o UNDP – P.O. Box 2338
Jakarta 10110 – Indonesia

Email: itujakarta@itu.int
Tel.: +62 21 381 3572
Tel.: +62 21 380 2322/2324
Fax: +62 21 389 05521

CIS countries

Russian Federation

International Telecommunication Union (ITU)
Area Office
4, Building 1
Sergiy Radonezhsky Str.
Moscow 105120
Russian Federation

Mailing address:
P.O. Box 47 – Moscow 105120
Russian Federation

Email: itumoskow@itu.int
Tel.: +7 495 926 6070
Fax: +7 495 926 6073

Europe

Switzerland

International Telecommunication Union (ITU)
Telecommunication Development Bureau (BDT)
Area Office
Place des Nations
CH-1211 Geneva 20 – Switzerland
Switzerland
Email: eurregion@itu.int
Tel.: +41 22 730 6065

International Telecommunication Union
Telecommunication Development Bureau
Place des Nations
CH-1211 Geneva 20
Switzerland
www.itu.int

ISBN 978-92-61-22561-2

Printed in Switzerland
Geneva, 2017

07/2017