

AN OVERVIEW OF THE GLOBAL PROGRESS TOWARDS TECHNOLOGY TRANSITIONS

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Introduction

In 2014, the Federal Communications Commission (FCC) released the *Technology Transitions Order*, a framework for experiment proposals and data collection initiatives designed to evaluate and plan for the modernization of communications networks.¹ In his accompanying statement, Chairman Wheeler directed the International Bureau to provide a benchmark of global progress towards the transition to all Internet Protocol (IP)-based communications networks.² Pursuant to

¹ *Technology Transitions, et al.*, GN Docket No. 13-5 et al., Order, Report and Order and Further Notice of Proposed Rulemaking, Report and Order, Order and Further Notice of Proposed Rulemaking, Proposal for Ongoing Data Initiative, 29 FCC Rcd. 1433 (2014) (*Technology Transitions Order*).

² *Id.* at 1538. As reflected in the *Technology Transitions Order*, this move towards IP-based communications networks encompasses a broad range of technology transitions, including the transition from time-division multiplexed (TDM) circuit-switched voice services to an all-IP network (the “IP transition”); the diversification of physical facilities from twisted copper loops for voice and co-axial cable for video to a combination of fiber optic

the Chairman's directive, the International Bureau has prepared this overview for the purpose of contributing an international perspective to the ongoing national dialogue on policies related to the transition to next-generation networks in the United States. Accordingly, this overview will be included in the relevant dockets associated with the *Technology Transitions Order*.

Historic technology transitions are taking place on a global scale. Driven by the uptake of Next Generation Networks (NGNs), both fixed and mobile broadband deployments around the globe are growing exponentially.³ Fixed broadband deployment has increased 7% annually for the past three years,⁴ with some countries experiencing more than 100% growth in fiber connections.⁵ Global mobile broadband penetration reached 47% in 2015, a twelve-fold increase since 2007.⁶ Data traffic grew 55% from the first quarter of 2014 to the first quarter of 2015, with a nine-fold increase in traffic expected by the end of 2020.⁷ At the same time, the transition from traditional public switched telephone networks (PSTN)⁸ to all IP-based networks is rapidly transforming global voice communications services. In 2014, Voice over IP (VoIP) connections made up 20% of fixed lines worldwide, up from just 8% in 2008, and forecasts predict that by 2018 VoIP will account for nearly one-third of all voice lines.⁹ As of April 2015, sixteen operators in seven countries had launched Voice over LTE (VoLTE), compared to only three launches the previous

cable, co-axial cable, and wireless technologies for voice and data transmissions; and the network evolution from traditional voice telephony to ever-expanding IP services, such as Voice over IP (VoIP) and Voice over LTE (VoLTE). *See id.* at 1436-1441 (discussing the various types of technology transitions).

³ *See, e.g.*, U.N. Broadband Comm'n, THE STATE OF BROADBAND 2014: BROADBAND FOR ALL (Sept. 2014), available at <http://www.broadbandcommission.org/documents/reports/bb-annualreport2014.pdf> (accessed July 10, 2015). "Next Generation Networks" (NGNs) refers to the deployment of access independent services over converged fixed and mobile networks using IP to transport various types of traffic, such as voice, video, and data. *See* Euro. Telecomm. Standards Inst. (ETSI), *Next Generation Networks* (2015), <http://www.etsi.org/technologies-clusters/technologies/next-generation-networks> (accessed July 10, 2015).

⁴ ITU, ICT FACTS & FIGURES: THE WORLD IN 2015 2 (May 2015), available at <http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2015.pdf>.

⁵ From June 2013 to June 2014, four countries experienced more than 100% annual growth in fiber-to-the-premises (FTTP) connections: New Zealand (272%), Luxembourg (139%), Chile (122%), and Spain (109%). OECD Broadband Portal, Chart 1.11 (June 2014), <http://www.oecd.org/sti/broadband/oecdbroadbandportal.htm> (accessed July 10, 2015).

⁶ ITU, ICT FACTS & FIGURES: THE WORLD IN 2015, *supra* note 4, at 2.

⁷ Ericsson, ERICSSON MOBILITY REPORT 11-12 (June 2015), available at <http://www.ericsson.com/res/docs/2015/ericsson-mobility-report-june-2015.pdf> (accessed July 10, 2015).

⁸ In this report, in the international context, the term "traditional public switched telephone network (PSTN)" is being used to describe legacy telephone networks using circuit-switched telephony, employing copper wires to carry analogue voice or data over a dedicated channel (or circuit) between two points.

⁹ Telegeography, *Fixed Line Telephony: A Far Cry From Dead* (Oct. 15, 2014), <https://www.telegeography.com/products/commsupdate/articles/2014/10/15/fixed-line-telephony-a-far-cry-from-dead/> (accessed Dec. 19, 2014). By 2017, the global VoIP service sector is expected to be worth \$82.7 billion. *See* Mike Bragg, *Global VoIP Trends in 2014*, WHICH VOIP (Sept. 25, 2013), <http://www.whichvoip.com/global-voip-trends.htm> (accessed Dec. 19, 2014).

year.¹⁰ Given the global trend towards IP technology, countries around the world are increasingly recognizing the importance of understanding and managing the impending IP transition.¹¹

In this overview, we provide a snapshot of global technology transitions in certain countries. To gather information, we contacted our counterparts in regulatory agencies around the world, then supplemented the information we received with secondary research. The case studies included in this overview reflect those countries that have progressed far enough in their technology transitions to offer a meaningful point of comparison. These case studies are presented for illustrative purposes only, and this overview should not be understood as an exhaustive review of the status of technology transitions everywhere in the world.

As the relatively small number of case studies demonstrates, we found our inquiry necessarily limited in scope. Most countries have not yet begun to comprehensively examine technology transition issues.¹² Many countries, particularly in the developing world, are still focused on building out their initial networks; as a result, they have not yet reached the “tipping point” that would cause them to consider decommissioning legacy services.¹³ Due to the lack of infrastructure, many developing nations have largely bypassed landlines altogether and moved straight to mobile technology.¹⁴ Because they did not have a large base of legacy copper circuit-switched networks to begin with, these countries have not undergone the transition to IP-based technologies in the way it is understood in the United States.¹⁵

¹⁰ Anne Morris, *GSA: VoLTE Launches Reach 16 as Operators Embrace HD Voice Benefits*, FIERCEWIRELESS (Apr. 10, 2015), <http://www.fiercewireless.com/europe/story/gsa-volte-launches-reach-16-operators-embrace-hd-voice-benefits/2015-04-10> (accessed July 9, 2015).

¹¹ See, e.g., Eur. Comm’n, *Commission Staff Working Document: Explanatory Note*, Doc. No. SWD(2014) 298, at 16 (Oct. 9, 2014), available at <http://ec.europa.eu/digital-agenda/en/news/explanatory-note-accompanying-commission-recommendation-relevant-product-and-service-markets> (describing the “increasing migration to IP-based networks” as a key technological development); Can. Radio-television and Telecomm. Comm’n [CRTC], *Telecom Regulatory Policy CRTC 2012-24*, File No. 8643-C12-201105297 ¶ 23 (Jan. 19, 2012), available at <http://www.crtc.gc.ca/eng/archive/2012/2012-24.htm> (describing the IP transition as “imperative”); Telecom Regulatory Auth. of India [TRAI], *CONSULTATION PAPER ON MIGRATION TO IP BASED NETWORKS* ¶ 7 (June 30, 2014), available at <http://www.trai.gov.in/consultation%20paper%20on%20migration%20to%20IP%20based%20networks-30.06.2014.pdf> [*hereinafter* TRAI Consultation Paper] (noting that the proliferation of IP-based networks requires the establishment of an appropriate policy and regulatory framework).

¹² In South Korea, for example, the Ministry of ICT, Science, and Future Planning (MSIP) has not made any decisions regarding the IP transition, primarily because the incumbent fixed line operator KT Corp, which owns the entire PSTN network, has not presented it with any migration plans.

¹³ See *Technology Transitions Order*, *supra* note 1, at ¶ 3 (describing the IP transition as a tipping point at which most providers wish to cease offering legacy services in favor of IP-based technology).

¹⁴ Pew Research Center, *Survey Report: Emerging Nations Embrace Internet, Mobile Technology* (Feb. 13, 2014), <http://www.pewglobal.org/2014/02/13/emerging-nations-embrace-internet-mobile-technology/> (accessed Dec. 19, 2014).

¹⁵ See *Technology Transitions Order*, *supra* note 1, at ¶ 3 (describing the situation in which IP-based technology begins to supplant, rather than supplement, existing legacy copper circuit-switched voice services already in the marketplace).

In Ghana, for example, less than 1% of the population has a landline connection, but nearly 80% of Ghanaians have a mobile phone.¹⁶ Due to the ubiquity of mobile technology for both voice and data, Ghana's two main service providers, Vodafone and Airtel, have seen little incentive to expand or upgrade fixed line services.¹⁷ Not surprisingly, therefore, the National Communication Authority (NCA), Ghana's regulator, has not concerned itself with technology transitions, instead allowing the service providers to roll out new IP-based networks according to their own commercial strategies and interests.

Overview

This overview begins by examining the role that international organizations have played in technology transitions. Then, we review technology transitions in eight countries – Austria, Australia, Canada, India, Japan, the Netherlands, Singapore, and the United Kingdom. We conclude by offering some general observations on the current state of global progress with respect to technology transitions.

The Role of International Organizations

Because of their multilateral membership, international and regional organizations like the International Telecommunication Union (ITU) and the Body of European Regulators for Electronic Communications (BEREC) are limited in their ability to set out specific policy prescriptions. In the context of their broader work on the development of NGNs, however, both organizations have identified issues for regulators to consider as they prepare for technology transitions. Both the ITU and BEREC plan to examine technology transition issues closely.

ITU

Composed of nearly 200 Member States, the ITU represents a wide range of perspectives. The countries in the ITU, each with their own legal frameworks and regulatory regimes, all find themselves at different stages in network modernization. As a result, the ITU has recognized that there is “no single way” or “best way” for countries to transition to new IP-based technologies; rather, migration plans should be tailored to a country's individual situation.¹⁸

Nevertheless, over the past several years, the ITU has begun to address technology transition issues in the context of its broader work on the development of NGNs, offering some general recommendations in its recent reports and regulatory toolkits. Overall, the ITU suggests that regulators carefully manage the transition from legacy networks to next-generation technologies,

¹⁶ Pew Research Center, *supra* note 14.

¹⁷ Telegeography GlobalComms Database: GHANA (2014), <https://www.telegeography.com/products/globalcomms/data/country-profiles/af/ghana/wireline.html> (accessed Dec. 19, 2014).

¹⁸ ITU, *ITU-D Study Group 2 – Question 26/2: Migration from Existing Networks to Next-Generation Networks for Developing Countries: Technical, Regulatory, and Policy Aspects* 14 (Oct. 4, 2013), available at http://www.itu.int/dms_pub/itu-d/opb/stg/D-STG-SG02.26-2014-PDF-E.pdf [*hereinafter* ITU-D SG2 Report].

promoting consumer protection and encouraging competition while remaining cognizant of changing market conditions.

To best protect consumers, the ITU recommends “an incremental conversion” to IP-based networks.¹⁹ Particularly in developing countries, the ITU recommends that the migration to NGNs should be gradual, and older and newer technologies should co-exist for a reasonable period of time.²⁰ Moreover, during the migration from PSTN/Integrated Services Digital Network (ISDN) to NGNs, the ITU counsels that regulators should ensure that service providers continue to offer: (1) basic telephone service with the same or better quality and availability as the existing PSTN/ISDN; (2) capability for accurate charging and accounting; (3) support for number portability and emergency services; (4) accessibility for all users, including the disabled; (5) mechanisms to support lawful monitoring and interception of services, in accordance with the national legal framework; and (6) interoperability between legacy networks and NGNs.²¹

The ITU also advises that regulators pay particular attention to prices from the perspective of both consumers and operators. According to the ITU, as service providers invest in more advanced networks, they should not subject customers to immediate or substantial hikes in service rates in an effort to quickly recoup the initial costs.²² Moreover, the ITU cautions that a large price differential between older and newer networks may discourage consumers from switching to next-generation networks.²³ At the same time, however, the ITU recommends that regulators encourage investment in NGNs by ensuring that pricing policies do not undermine operators’ business plans.²⁴

Finally, the ITU emphasizes that regulators should focus on promoting competition throughout technology transitions.²⁵ The ITU points out that regulators should recognize that a significant gap might emerge between the market conditions that traditional regulatory frameworks were designed to address and the market conditions that emerge in a converged environment.²⁶ Therefore, the ITU suggests that the appropriate authorities align regulation to promote

¹⁹ ITU, BROADBAND TOOLKIT § 5.1.1, <http://broadbandtoolkit.org/5.1> (accessed Dec. 10, 2014).

²⁰ ITU-D SG2 Report, *supra* note 18, at 14.

²¹ *Id.* at 13-14.

²² ITU, BROADBAND TOOLKIT, *supra* note 19.

²³ ITU, *Strategies for the Deployment of NGN and NGA in a Broadband Environment – Regulatory and Economic Aspects* 35 (Dec. 2012), available at <http://www.itu.int/ITU-D/finance/Studies/NGN%20deployment%20strategies-en.pdf> [hereinafter ITU Strategies for NGN Deployment Report].

²⁴ *Id.* at 34; see also ITU, ICT REGULATION TOOLKIT § 3.8.1.1, <http://www.ictregulationtoolkit.org/3> (accessed Dec. 10, 2014) (encouraging regulators to consider the high cost of rolling out of IP-based networks).

²⁵ See ITU Strategies for NGN Deployment Report, *supra* note 23, at 21 (noting that “[r]egulatory aims with NGN remain the same as legacy networks: the encouragement of competition wherever possible”); cf. ITU-D, *Best Practices for Implementing Next Generation Network in the Asia and Pacific Region – Case Study: India, Philippines, and Sri Lanka* 94 (June 2012), available at http://www.itu.int/ITU-D/tech/NGN/CaseStudies/NGN_CaseStudy_IND_PHIL_SLKA_V2.pdf (identifying the promotion of competition as a key recommendation for national policies and strategies).

²⁶ ITU, ICT REGULATION TOOLKIT, *supra* note 24, at § 3.8.1.1.

investment in and migration to NGNs.²⁷ The ITU also urges regulators to strive to provide regulatory certainty in order to avoid discouraging service providers from participating in the market.²⁸

With these recommendations, the ITU encourages countries to carefully examine the various perspectives at play in technology transitions.²⁹ The ITU plans to delve more deeply into these issues in the future. Per Resolution 101 adopted by the ITU Plenipotentiary 2014, the incoming Secretary-General will prepare an annual report to the ITU Council, an elected group of countries that serves as the ITU's governing body.³⁰ The report will provide "a comprehensive summary of the activities the ITU is undertaking in regard to IP based networks, and the roles and activities of other relevant international organizations describing their involvement in the topic."³¹ In drafting the report, the Secretary-General will seek input from Member States; the General Secretariat, the ITU's administrative leadership; and Sector Members, which include representatives from industry, academia, and other international and regional organizations.³²

BEREC

As the European Commission reiterated in October 2014, the migration to IP-based networks represents a key technological development affecting the future of the European telecommunications market.³³ BEREC is the primary entity currently examining technology transition issues at the European level. As an advisory body to the European Commission, BEREC prepares recommendations and guidelines, develops best practices, and assists national governments in implementing the European Union's telecommunications regulatory framework.³⁴

As part of its strategic priority to promote competition and investment, BEREC plans to undertake a comprehensive analysis of the regulatory implications of technology transitions in the near future.³⁵ At its third plenary meeting of 2015, BEREC will hold a workshop on

²⁷ ITU Strategies for NGN Deployment Report, *supra* note 23, at 34.

²⁸ *Id.* at 33; *see also* ITU, ICT REGULATION TOOLKIT, *supra* note 24, at § 3.8.1.1.

²⁹ *Cf.* ITU-D SG2 Report, *supra* note 18, at 14 (encouraging regulators to consider "various aspects" and "various perspectives" when developing plans for the migration of network infrastructure).

³⁰ ITU, Res. 101 (Rev. Busan, 2014).

³¹ *Id.*

³² *Id.*

³³ *See* Eur. Comm'n, *Commission Staff Working Document: Explanatory Note*, *supra* note 11, at 16.

³⁴ *See generally* Body of Eur. Regulators for Elec. Commc'n [BEREC], *What is BEREC?*, http://berec.europa.eu/eng/about_berec/what_is_berec/ (accessed Jan. 5, 2015) (describing BEREC's mission and scope of work).

³⁵ BEREC Board of Regulators, *Work Programme 2015*, Doc. No. BoR(14) 185, at ¶ 3.1.4 (Dec. 4, 2014), available at http://berec.europa.eu/eng/document_register/subject_matter/berec/annual_work_programmes/4779-work-programme-2015-berec-board-of-regulators.

migration to all-IP networks.³⁶ Additionally, during its first plenary meeting of 2016, BEREC intends to issue a report on migration towards IP-based interconnection for voice services.³⁷

In their work on NGNs, BEREC and its predecessor, the European Regulators Group (ERG), have previously explored various challenges to a convergent IP environment, particularly IP interconnection.³⁸ Specifically, from 2007 to 2010, BEREC examined voice interconnection in view of the migration towards IP networks.³⁹ Overall, BEREC has taken the position that interconnection issues have been handled well on a case-by-case basis so far, and it has not yet identified any need for significant regulatory intervention.⁴⁰ At the same time, as its current program of work demonstrates, BEREC has begun to favor increased information-gathering and closer monitoring of national regulators.⁴¹

Case Studies

In the following overview, we provide brief case studies on technology transitions in eight countries – Austria, Australia, Canada, India, Japan, the Netherlands, Singapore, and the United Kingdom. We focus on the four enduring values that the FCC seeks to preserve during the technology transitions.⁴² Specifically, we examine the ways in which other countries are preserving the core values of public safety, universal service, competition, and consumer protection during their transitions.

³⁶ *Id.* BEREC holds four plenary meetings a year. The third plenary meeting of 2015 (the 24th BEREC Plenary) will be held in October 2015 in Riga. See BEREC, *BEREC Events 2015*, http://berec.europa.eu/eng/events/berec_event_2015/ (accessed July 22, 2015).

³⁷ BEREC Board of Regulators, *Work Programme 2015*, *supra* note 35, at ¶ 3.1.4.

³⁸ See, e.g., BEREC, *An Assessment of IP Interconnection in the Context of Net Neutrality*, Doc. No. BoR (12) 130 (Dec. 6, 2012), available at http://berec.europa.eu/eng/document_register/subject_matter/berec/reports/1130-an-assessment-of-ip-interconnection-in-the-context-of-net-neutrality; ERG, *Common Statement on Regulatory Principles of IP-IC/NGN Core*, Doc. No. ERG (08) 26 (Oct. 2008), available at http://berec.europa.eu/doc/publications/erg_08_26_final_ngn_ip_ic_cs_081016.pdf; ERG, *Final Report on IP Interconnection*, Doc. No. ERG (07) 09 (Mar. 2007), available at http://erg.eu.int/doc/publications/erg_07_09_rept_on_ip_interconn.pdf.

³⁹ Cara Schwarz-Schilling, Chair of the BEREC Working Group on NGN/IP-IC, Presentation at the European Peering Forum: European Regulators View of IP-Interconnection, Doc. No. BoR (14) 122, at 3 (Sept. 22-24, 2014), available at http://www.peering-forum.eu/system/documents/22/original/2014_09_Split_BEREC_on_IP-IC.pdf.

⁴⁰ *Id.* at 8.

⁴¹ *Id.* (discussing the outlook for BEREC's involvement with IP interconnection issues).

⁴² See *Technology Transitions Order*, *supra* note 1, at ¶ 23 (identifying the core statutory values of public safety, universal service, competition, and consumer protection).

AUSTRIA

A1 Telekom Austria, Austria's largest carrier, is among the first fixed operators in Europe to carry out a complete migration to an all-IP based network.⁴³ The project, known as "Next Generation Network Voice," began in 2009 and involved the migration of 1,481 exchanges and 2.3 million access lines to IP-based technology at the access node, as well as the creation of a new central VoIP platform.⁴⁴ As of the end of 2013, only 13% of Austria's total wireline subscribers relied on the PSTN.⁴⁵

Technology transitions have not been contentious in Austria, and existing regulations have proved sufficient to accommodate the transitions so far.⁴⁶ Austria's regulator, the Regulatory Authority for Broadcasting and Telecommunications (RTR), has not issued any recent reports, public consultations, or findings directly pertaining to the transitions. However, an industry group has begun working on a national interface specification for IP-based voice interconnection, and RTR hopes to see some concrete output on this issue by the end of 2015.

Although it has an IP-based network, A1 Telekom Austria still offers interconnection for voice services based on legacy copper technology.⁴⁷ A1 Telekom Austria's next-generation network spans between the access nodes and the gateway nodes at the interconnection to other networks, a feature that allowed Austria to conduct the IP transition without impacting customer premises or interconnection partners. The regulatory framework for call termination on fixed networks is generally technology-neutral; however, RTR only plans to step in and settle the details of IP-based interconnection should the operators find themselves unable to reach a consensus on their own.

⁴³ Eur. Comm'n, *Commission Staff Working Document: Implementation of the EU Regulatory Framework for Electronic Communications 2014*, Doc. No. SWD(2014) 249, at 27 (July 14, 2014), available at <http://ec.europa.eu/digital-agenda/en/news/2014-report-implementation-eu-regulatory-framework-electronic-communications>. Deutsche Telekom (DT) is another leader in the European IP transition. In 2014, DT subsidiaries Makedonski Telekom and Slovak Telekom completed the migration to all-IP based networks in Macedonia and Slovakia, respectively. See DT, *Slovakia Second Market to Go All-IP* (Dec. 18, 2014), <http://www.telekom.com/innovation/261242> (accessed Jan. 12, 2015). DT plans to complete its IP transition in Croatia and Montenegro by the end of 2015, and in Romania, Greece, and Germany by the end of 2018. See DT, *Macedonia is First European Country with All-IP Network* (Feb. 13, 2014), <http://www.telekom.com/media/company/214696> (accessed Jan. 12, 2015).

⁴⁴ Telekom Austria Group, *Fixed Networks*, ANNUAL REPORT 2013, available at <http://ar2013.telekomaustria.com/management-track-record/network-investments/fixed-networks.html>.

⁴⁵ As of end-2013, Austria had 439,000 PSTN subscribers and 2,910,000 VoIP subscribers. Telegeography GlobalComms Database: AUSTRIA (2014), <https://www.telegeography.com/products/globalcomms/data/country-profiles/we/austria/wireline.html> (accessed Dec. 11, 2014).

⁴⁶ Communications with the Regulatory Authority for Broadcasting and Telecommunications (RTR) indicated that the regulator was not aware of any problems or concerns in terms of universal service, emergency calling, or competition.

⁴⁷ A1 Telekom Austria's 2.3 million access lines are still based on legacy technology to the customer premises (*i.e.*, POTS, ISDN, or DSL). The conversion to/from IP is made at the access nodes (*e.g.*, multi-service access node).

AUSTRALIA

Australia has adopted a highly centralized top-down approach to instituting a nationwide transition from the existing copper network to fiber technology. In April 2009, the government introduced a national broadband initiative to roll out a high-speed fiber-based national broadband network (NBN). Less than a year later, after rejecting a competitive bidding process for the project, the government announced the formation of a new public-private company, NBN Co, to design, build, and operate the NBN. NBN Co, a wholly-owned Government Business Enterprise, works closely with Telstra, Australia's former fixed line monopoly operator, and Optus, Telstra's main competitor, to facilitate the rollout of the NBN.⁴⁸

Originally, NBN Co aimed to replace the existing copper network with fiber-to-the-home (FTTH) across 93% of Australia, with a target completion date of ten years (from 2012 to 2022).⁴⁹ The election of a new government in September 2013 (from the Labour Party to the current Coalition government) had a substantial impact on this project.⁵⁰ In April 2014, citing NBN Co's "financial and operational under-performance,"⁵¹ the government abandoned the exclusively fiber rollout in favor of a new mixed technology approach, which combines FTTH with newly-built fiber-to-the-node (FTTN) technology and existing hybrid fiber co-axial (HFC)

⁴⁸ See Telegeography GlobalComms Database: NBN Co (2014), <https://www.telegeography.com/products/globalcomms/data/company-profiles/ap/nbn-co/company-overview.html> (accessed Dec. 11, 2014) (describing the development of NBN Co). Under a new deal finalized in December 2014, NBN Co plans to assume ownership of Telstra's legacy copper and hybrid fiber co-axial (HFC) networks. See Josh Taylor, *NBN Co to Take Over Telstra, Optus Networks in New Deals*, ZDNET (Dec. 14, 2014), <http://www.zdnet.com/article/nbn-co-and-telstra-sign-amended-11-billion-deal/> (accessed Jan. 12, 2015).

⁴⁹ Telegeography GlobalComms Database: NBN Co (2014), *supra* note 48.

⁵⁰ See Telegeography GlobalComms Database: AUSTRALIA (2014), <https://www.telegeography.com/products/globalcomms/data/country-profiles/ap/australia/country-overview.html> (accessed Dec. 11, 2014) (detailing the political controversies surrounding the NBN). Most recently, in October 2014, a government-appointed Panel of Experts recommended disaggregating and potentially divesting NBN Co and requiring developers and consumers to meet infrastructure costs. See Dep't of Commc'n, *NBN Market and Regulation Report*, http://www.communications.gov.au/broadband/national_broadband_network/cost-benefit_analysis_and_review_of_regulation/nbn_market_and_regulation_report (accessed Dec. 11, 2014). The government initially rejected the report's recommendations, claiming that the financial burden on the budget and taxpayers would be too severe. In December 2014, however, the government adopted a controversial new policy, allowing NBN Co to charge a connection fee for services, as well as levy a deployment charge on developers for new fiber infrastructure. See Telegeography Comms Update, *Australian Government Updates Policy; Allows NBN Co to Charge Connection Fee for Services* (Dec. 11, 2014), <https://www.telegeography.com/products/commsupdate/articles/2014/12/11/australian-government-updates-policy-allows-nbn-co-to-charge-connection-fee-for-services/> (accessed Dec. 12, 2014).

⁵¹ NBN Co, *National Broadband Network: Strategic Review* (Dec. 2013), available at <http://www.nbnco.com.au/content/dam/nbnco2/documents/NBN-Co-Strategic-Review-Report.pdf>.

infrastructure.⁵² Using the mixed technology approach, NBN Co aims to cover eight million premises by 2020.⁵³

Telstra began decommissioning its copper infrastructure in May 2014, switching off copper-based services to its first 19,000 premises.⁵⁴ Telstra has continued to progressively disconnect copper telephone lines.⁵⁵ As of the end of June 2015, Telstra had exceeded its goal of 140,000 premises to be cut off by that date, having disconnected copper lines at approximately 192,000 premises.⁵⁶

Key Features

During and after the NBN rollout, Telstra, Australia's designated universal service provider, is responsible for continuing to provide equitable access to standard telephone service. Due to Australia's technology-neutral universal service framework, Telstra can employ any type of technology, including a fixed copper or fiber connection, or a wireless or satellite connection, to fulfill its universal service obligation.⁵⁷

⁵² Telegeography CommsUpdate, *NBN Project Officially Switched to Multi-Technology Mix Approach* (Apr. 10, 2014), <http://www.telegeography.com/products/commsupdate/articles/2014/04/10/nbn-project-officially-switched-to-multi-technology-mix-approach/> (accessed Dec. 11, 2014). In November 2014, NBN Co subsequently confirmed the principles for the multi-technology rollout: it will connect up to 50% of premises with newly-built FTTN, cover up to 26% with FTTP, and service the remainder with existing HFC infrastructure. See Telegeography CommsUpdate, *NBN Co Confirms Principles for Multi-Technology Rollout* (Nov. 13, 2014), <http://www.telegeography.com/products/commsupdate/articles/2014/11/13/nbn-co-confirms-principles-for-multi-technology-rollout/> (accessed Dec. 11, 2014).

⁵³ NBN Co, *Corporate Plan 2014-2017* (Nov. 11, 2014), <http://www.nbnco.com.au/content/dam/nbnco2/documents/nbn-co-corporate-plan-2014-17-Nov11.pdf> (accessed June 18, 2015). In April 2015, NBN Co announced the addition of 550,000 premises to the rollout schedule, increasing its interim coverage goal to nearly 4 million premises by September 2017. See Telegeography CommsUpdate, *NBN Co Updates National Construction Plan* (Apr. 1, 2015), <https://www.telegeography.com/products/commsupdate/articles/2015/04/01/nbn-co-updates-national-construction-plan/>. As of May 28, 2015, the network covered 1,030,845 premises. See NBN Co, *Rollout Information – Weekly Summary* (May 28, 2015), <http://www.nbnco.com.au/content/dam/nbnco2/documents/nbnco-rollout-metrics-28052015.pdf> (accessed June 18, 2015).

⁵⁴ See, e.g., Allie Coyne, *NBN Co Prepares to Switch Off Copper for 19,000 Premises*, IT NEWS AUSTRALIA (May 22, 2014), <http://www.itnews.com.au/News/386169,nbn-prepares-to-switch-off-copper-for-19000-premises.aspx> (accessed Dec. 11, 2014). Switch-off occurs 18 months after customers receive notice of the NBN's availability. See NBN Co, *What Services Will Be Switched Off?*, <http://www.nbnco.com.au/connect-home-or-business/information-for-home/fixed-line/what-services-will-be-switched-off.html#.VIItChivF98E> (accessed Dec. 11, 2014).

⁵⁵ See, e.g., iiNet, *Record Sydney Premises Hit NBN Copper Cut-Off D-Day This Week*, IMPRESS MEDIA AUSTRALIA (Apr. 13, 2015), <http://www.impress.com.au/newsroom/iinet/1859-record-sydney-premises-hit-nbn-copper-cut-off-d-day-this-week.html> (accessed May 4, 2015).

⁵⁶ NBN Co, *Switch-Off Dates* (July 2015), <http://v1.mynbn.info/switchoff/list/p/1> (accessed July 17, 2015).

⁵⁷ Austl. Comm'n & Media Auth. [ACMA], *The USO & the NBN*, <http://www.acma.gov.au/Citizen/Consumer-info/My-connected-home/The-NBN-and-you/the-universal-service-obligation-and-the-nbn> (accessed Jan. 5, 2015).

In March 2012, the Australian Parliament passed a universal service reform package. The legislation created a new government agency, the Telecommunications Universal Service Management Agency (TUSMA), to administer the USO.⁵⁸ TUSMA also managed the migration of voice services to the NBN.⁵⁹ In May 2014, however, in an effort to promote government efficiency, the Coalition government abolished TUSMA and transferred its functions to the Department of Communications.⁶⁰

In addition to the universal service obligation, other key consumer safeguards continue to apply during the migration to the NBN, including relevant telecommunications industry codes, emergency call service access, and accessibility requirements.⁶¹ Australia's regulator, the Australian Communications and Media Authority (ACMA), oversees compliance with these consumer protections. Furthermore, the Department of Communications and NBN Co work together to deliver the Public Information on Migration (PIM) campaign, a public education initiative that informs consumers about the switchover from the existing copper network to the NBN.⁶² The Australian Communications Consumer Action Network (ACCAN) also works to ensure consumer protection during the transition to the NBN, publishing tip sheets and consumer guides.⁶³

CANADA

Canadian carriers have all begun deploying IP-based technologies to varying degrees. Cable companies and new wireless entrants are primarily IP-based. Incumbent fixed line operators have deployed IP technology in certain parts of their core networks, but they still rely on

⁵⁸ See TUSMA, *Our Role*, http://www.tusma.gov.au/our_role (accessed Jan. 5, 2015) (discussing TUSMA's role in administering access to telephones and pay phones, untimed local calls in rural and remote areas, the National Relay Service, and the Emergency Call Service).

⁵⁹ TUSMA, *Migration of Voice Services to the National Broadband Network*, http://www.tusma.gov.au/our_role/migration_of_voice_services_to_the_national_broadband_network (accessed Jan. 5, 2015). TUSMA was responsible for ensuring that arrangements were in place to inform eligible customers of the impending disconnection of their standard telephone service and provide in-premises wiring to ensure that voice-only customers do not face significant barriers to migrate their voice-only service to the NBN. *Id.*

⁶⁰ Chris Duckett, *Budget 2014: Universal Service Agency Functions Transferred to Communications Department*, ZDNET (May 13, 2014), <http://www.zdnet.com/article/budget-2014-universal-service-agency-functions-transferred-to-communications-department/> (accessed Jan. 5, 2015).

⁶¹ ACMA, *NBN Consumer Info*, <http://165.191.2.87/Citizen/Consumer-info/My-connected-home/The-NBN-and-you/nbn-consumer-1> (accessed Dec. 8, 2014). See also Paul White, *National Broadband Network – Consumer Protections*, [http://www.acma.gov.au/webwr/_assets/main/lib100656/3.2nbn_consumer_protections\(paul_white\).pdf](http://www.acma.gov.au/webwr/_assets/main/lib100656/3.2nbn_consumer_protections(paul_white).pdf) (accessed Dec. 8, 2014).

⁶² See Dep't of Commc'n, *Program 1.1: Broadband and Communications Infrastructure*, http://www.communications.gov.au/about_us/annual_reports/annual_report_2012-13/section_2_performance_review/program_1.1_broadband_and_communications_infrastructure (accessed Dec. 8, 2014).

⁶³ See generally ACCAN, <https://accan.org.au/consumer-info> (accessed Dec. 8, 2014).

extensive circuit-switched infrastructure, particularly in terms of access and distribution. Moreover, most end-user terminal devices are not IP-enabled.⁶⁴

The Canadian Radio-television and Telecommunications Commission (CRTC), Canada's regulator, views the transition to IP-based technology as "imperative."⁶⁵ CRTC has adopted a largely hands-off regulatory approach, allowing competitive market forces to determine the details of technology transitions, such as interconnection arrangements. At the same time, CRTC has developed technical initiatives to encourage the market to proceed in the direction of the retirement of copper networks.⁶⁶

In March 2011, CRTC initiated a public proceeding to conduct a broad policy review of network interconnection for voice services. Despite the evolution towards IP-based technology, CRTC recognized that arrangements originally established to interconnect legacy circuit-switched networks continue to remain prevalent. As a result, the proceeding sought to determine whether existing interconnection frameworks could be simplified and consolidated and whether changes might be necessary to ensure technological neutrality, enhance competition, and, ultimately, benefit consumers.⁶⁷

In its January 2012 decision, CRTC reiterated its commitment to allowing IP voice network interconnection arrangements, like technology transitions generally, to develop on a commercial basis.⁶⁸ Nevertheless, CRTC established a set of guiding principles to facilitate the industry's progress towards full IP-based voice interconnection.⁶⁹ Overall, CRTC determined that most aspects of IP voice network interconnection, such as compensation for the exchange of voice traffic and the number of points of interconnection, should be negotiated by the carriers themselves.⁷⁰ CRTC did specifically mandate, however, that in areas where a carrier provides IP voice interconnection to an affiliate, a division of its operations, or an unrelated service provider,

⁶⁴ CRTC, *Telecom Regulatory Policy CRTC 2012-24*, *supra* note 11, at ¶ 19.

⁶⁵ *Id.* at ¶ 23.

⁶⁶ Alcatel-Lucent, *PSTN Industry Analysis and Service Provider Strategies: Synopsis (Bell Labs Analysis for BT) 6* (April 2013), available at <http://www.btplc.com/Thegroup/RegulatoryandPublicaffairs/Consultativeresponses/Ofcom/2013/NarrowbandMarketReview/BellLabsAnalysisforBT-PSTNIndustryAnalysisandServiceProvider.pdf>.

⁶⁷ *See generally* CRTC, *Telecom Regulatory Policy CRTC 2012-24*, *supra* note 11.

⁶⁸ *Id.* at ¶ 23.

⁶⁹ The principles relate to the following: scope; off-tariff negotiations for IP voice network interconnection arrangements; conditions to trigger IP voice network interconnection; compensation for the exchange of voice traffic; costs of converting voice traffic; points of interconnections (POIs); implementation time frames; disclosure, sharing, and filing requirements for information related to IP voice network interconnection; future review; and CISC [CRTC Interconnection Steering Committee] activities. *See* CRTC, *Telecom Regulatory Policy CRTC 2012-24*, *supra* note 11, at ¶¶ 25-79.

⁷⁰ *See id.* at ¶ 39 ("The Commission does not consider that it is appropriate or necessary, at this time, to prescribe any particular compensation model for IP voice network interconnection, and **decides** that compensation for the exchange of IP traffic should be subject to bilateral negotiations"); *id.* at ¶ 52 ("The Commission therefore **decides** that the number of POIs is to be established by the carriers themselves through negotiations") (emphasis in original).

the carrier must negotiate a similar arrangement with any other carrier that requests such an arrangement.⁷¹

CRTC also encouraged its Interconnection Steering Committee (CISC), an industry working group, to develop a new IP voice network interconnection architecture for 911 emergency services.⁷² CRTC currently requires VoIP providers that offer local telephony to extend 911 services to their customers.⁷³ Additionally, providers must offer general subscriber education, informing customers of any limitations associated with their services.⁷⁴ CRTC plans to continue to educate new VoIP providers to ensure that they understand and comply with these obligations.⁷⁵

At the time of the January 2012 CRTC decision, a sense of overall agreement among service providers suggested that the shift to IP would be rapid, and that turndown of PSTN would follow soon after.⁷⁶ Although CRTC did not set an official deadline, it expected carriers to complete (or make significant progress towards completing) the implementation of IP voice network interconnection arrangements by January 2013.⁷⁷ Technical complications, however, have impeded progress to date.⁷⁸

In 2013, CRTC initiated a fact-finding exercise to review the current state of the IP interconnection landscape, but it determined that not much had changed since the previous proceeding.⁷⁹ According to its current Three-Year Plan (2015-2018), CRTC will undertake another review of the status of IP voice interconnection in 2016.⁸⁰

⁷¹ *Id.* at ¶ 36. Arrangements must be concluded within six months of the formal request. *See id.* at ¶ 57. *See also* Competitive Commc'n Ass'n (Comptel), *PSTN Transition to IP (a.k.a. Definitional Issues of SIP Interconnection)* 22 (Mar. 13, 2013), <http://files.comptelplus.org/013SpringAudio/Slides/Final-Definitional%20Issues%20Slides%20for%20Workshop%203-13-13-final%20all%20slides.pdf> (accessed Dec. 16, 2014) (discussing the decision and concluding that Canada has moved faster than the U.S. when it comes to interconnection).

⁷² CRTC, *Telecom Regulatory Policy CRTC 2012-24*, *supra* note 11, at ¶ 70.

⁷³ CRTC, 2012-2013: REPORT ON PLANS AND PRIORITIES 21, *available at* <http://www.tbs-sct.gc.ca/rpp/2012-2013/inst/rtc/rtc-eng.pdf>.

⁷⁴ Alcatel-Lucent, *supra* note 66, at 6.

⁷⁵ *Id.* at 7.

⁷⁶ *Id.* at 6.

⁷⁷ CRTC, *Telecom Regulatory Policy CRTC 2012-24*, *supra* note 11, at ¶ 60.

⁷⁸ Alcatel-Lucent, *supra* note 66, at 6.

⁷⁹ *See generally* CRTC, *Proceeding to Review Network Interconnection Matters: 8643-C12-201105297*, http://www.crtc.gc.ca/PartVII/eng/2011/8643/c12_201105297.htm (consolidating all documents related to the proceeding).

⁸⁰ CRTC, *THREE-YEAR PLAN: 2015-2018* (Apr. 29, 2015), *available at* <http://www.crtc.gc.ca/eng/backgrnd/plan2015/plan2015.pdf>.

INDIA

India has begun to experience a shift towards packet-switched, IP-based networks. Major service providers have installed IP-based core transport networks for carrying voice and data traffic, and the volume of IP-based traffic continues to increase every year. Nevertheless, the current regulatory environment remains primarily based on TDM networks.⁸¹ In June 2014, in order to engage the industry in establishing an appropriate policy and regulatory framework, India's regulator, the Telecom Regulatory Authority of India (TRAI), released a comprehensive consultation paper on the migration to IP-based networks.⁸² In December 2014, TRAI held an open house discussion on the migration to IP-based networks, and it continues to engage with the topic.⁸³

Key Features

The consultation paper addresses three main topics: interconnection issues, Quality of Service (QoS) issues, and operational issues. Of these topics, TRAI considers interconnection most extensively, raising a number of questions regarding various interconnection options. TRAI weighs mandatory interconnection versus demand-based interconnection,⁸⁴ for example, and contemplates the different types of charging principles available for IP interconnection.⁸⁵

The paper also discusses other key features of telecommunications networks, particularly consumer protection and public safety.

TRAI emphasizes the importance of meeting customer expectations and ensuring reliability.⁸⁶ It stresses that the regulatory framework should take into account “customer centric parameters,” such as network service and availability, service activation and de-activation time, the ease of switching plans, round-the-clock availability of customer service, and the redress of grievances.⁸⁷

The consultation paper specifies that IP-based networks must continue to provide the following requirements for emergency calls: identification of the dialed digits as an emergency number, the retrieval of caller location for routing, the identification of routing destination, and the provision

⁸¹ See TRAI Consultation Paper, *supra* note 11, at 2-3 (providing an introduction to the status of networks in India).

⁸² *Id.* Comments closed in August 2014, with TRAI receiving 22 comments, mostly from service providers. See TRAI, *Consultation Papers: Consultation Paper on Migration to IP Based Networks*, http://www.traigov.in/Content/ConDis/724_0.aspx (accessed Jan. 5, 2015).

⁸³ *TRAI to Hold OHD on “Migration to IP-Based Networks” on 2 Dec*, TELEVISION POST (Nov. 13, 2014), <http://www.televisionpost.com/traigov/traigov-to-hold-ohd-on-migration-to-ip-based-networks-on-2-dec/> (accessed May 4, 2015).

⁸⁴ See TRAI Consultation Paper, *supra* note 11, at ¶¶ 2.9-2.12.

⁸⁵ See *id.* at ¶¶ 2.21-2.23.3.

⁸⁶ *Id.* at ¶ 3.15.

⁸⁷ *Id.* at ¶ 3.13(II).

of caller location.⁸⁸ TRAI is exploring several ideas to help address the challenge of identifying caller location for calls made with IP technology.⁸⁹

JAPAN

Japan is an early adopter of IP-based technology, especially VoIP.⁹⁰ Under the supervision of the Ministry of Internal Affairs and Communications (MIC), Japan is committed to ensuring a smooth transition of the current PSTN network owned by the incumbent fixed line carriers, Nippon Telegraph and Telephone (NTT) and its regional subsidiaries NTT East and NTT West. The transition in Japan has focused on the core network transition from a circuit-switched to an IP-based network, not on the subscriber line transition from copper to fiber.

In November 2010, NTT released its general framework for the PSTN migration, announcing its intention to begin the migration around 2020 and complete the migration (*i.e.*, switch off the PSTN network entirely) by 2025.⁹¹ Japan does not have any legally mandated timeline for completing the core network transition, but 2025 has become widely accepted as a tentative goal.

Following NTT's announcement, MIC directed its advisory body, the Information and Communications Council, to outline the issues raised by the transition. In its December 2010 report, the Council came to several basic conclusions. First, the report recognized that NTT's PSTN network has served the essential functions of providing "basic services," an "infrastructure of competition," and "hub functions of other carriers/ISPs," and determined that NTT's next-generation networks should continue to fulfill these same roles. In addition, the report recommended that MIC and NTT ensure "continuity," "predictability," and "flexibility" during the transition. Finally, the report suggested that MIC keep in mind all of the relevant factors, including public safety, universal access, competition, and consumer protection.⁹²

Key Features

In order to safeguard key features of telecommunications networks during the transition, Japan has largely applied or adapted existing rules and legislation. A 2007 law, for example, promotes public safety by obligating carriers that provide IP-based telephone services to ensure the location notification function of emergency calls. Similarly, general consumer protection rules apply to both the PSTN and IP-based networks and services, and NTT East and NTT West can

⁸⁸ *Id.* at ¶ 4.25.

⁸⁹ *Id.* at ¶ 4.24.

⁹⁰ With nearly 29 million subscribers in 2012, Japan is second only to the U.S. in the number of total VoIP subscribers. As of 2012, Japan also had the second-highest VoIP proliferation in the world (behind France), at 77.5% of broadband subscribers. Bragg, *supra* note 9.

⁹¹ NTT East & NTT West, PSTN MIGRATION: GENERAL OUTLOOK (Nov. 2, 2010).

⁹² Communications with the Embassy of Japan.

fulfill their universal service obligations by providing either PSTN-based or IP-based telephone service.⁹³

In June 2011, NTT established a framework for consulting with interconnecting carriers and Internet service providers (ISPs); with MIC as an observer, NTT hosts meetings to coordinate on technical and operational issues.⁹⁴

NETHERLANDS

Dutch fixed line incumbent KPN (Royal Dutch Telecom) is a global frontrunner in the deployment of IP-based networks and services.⁹⁵ The dynamics between KPN and Dutch regulatory authorities highlight the challenges in developing a regulatory approach for a new all-IP environment that encourages investment while also protecting enduring values, particularly competition.

As early as 2005, KPN announced an ambitious project, known as “All-IP,” to migrate to a nationwide single-technology multi-service network by 2010.⁹⁶ In implementing All-IP, KPN sought to provide competitive broadband services, realize cost savings, and replace its existing network as it neared the end of its lifecycle.⁹⁷

The Dutch regulator, the Independent Post and Telecommunications Authority (*Onafhankelijke Post en Telecommunicatie Autoriteit*, or OPTA),⁹⁸ welcomed KPN’s All-IP project as a positive

⁹³ *Id.*

⁹⁴ *Id.*

⁹⁵ See, e.g., Janeann Bann, *KPN Goes All IP with Help from Alcatel-Lucent*, 1 ENRICHING COMMUN’C no. 1 (2007), http://www3.alcatel-lucent.com/enrich/v1i12007/article_c2a3.html (describing KPN as “the frontrunner in the world” with respect to the IP transition).

⁹⁶ The All-IP plan involved a transmission network based on IP/Ethernet, providing FTTH with maximum speeds of up to 100 megabits per second. In addition to the upgrade of the core network, KPN planned to dismantle more than 1,300 main distribution frame (MDF) locations, which had previously allowed alternative DSL providers to purchase unbundled access to KPN’s local loop. Instead, 28,000 street cabinets would connect to approximately 150 “Metro Core Locations” (MCLs) via fiber to the curb (FTTC), resulting in VDSL-2 broadband access with speeds of up to 50 megabits per second. Indep. Post & Telecomm. Auth. [OPTA], *KPN’s Next-Generation Network: All-IP*, Issue Paper OPTA/BO/2006/201599 4 (May 22, 2006), available at <https://www.acm.nl/en/download/publication/?id=9055> [hereinafter OPTA Issue Paper]; Remko Bos, OPTA, *NGN in the Netherlands: A Regulatory Perspective* 11-12 (June 26, 2007), http://www.globaltelecomsbusiness.com/pdf/OPTA_PPT.pdf (accessed July 20, 2015).

⁹⁷ See Wolter Lemstra, *The Netherlands*, in *THE DYNAMICS OF BROADBAND MARKETS IN EUROPE: REALIZING THE 2020 DIGITAL AGENDA* 55, 72 (Wolter Lemstra & William H. Melody, eds., 2015) (discussing the goals of the All-IP project).

⁹⁸ In April 2013, OPTA merged with the Netherlands Competition Authority (NMa) to create a new regulatory agency, the Netherlands Authority for Consumers and Markets (ACM). Telegeography GlobalComms Database: NETHERLANDS (2015), <https://www.telegeography.com/products/globalcomms/data/country-profiles/we/netherlands/regulations.html> (accessed July 20, 2015).

investment in efficient new infrastructure.⁹⁹ Because KPN planned to dismantle more than 1,300 main distribution frame (MDF) locations, however, OPTA recognized that the All-IP project could have a significant impact on effective infrastructure competition.¹⁰⁰ In May 2006, OPTA issued a consultation paper on KPN's proposed plans, inviting stakeholders to comment on the anticipated effects of All-IP on the regulatory and competitive landscape.¹⁰¹ OPTA adopted an initial position of regulatory restraint, noting that it would only intervene should KPN fail to fulfill its responsibilities to the market.¹⁰²

In October 2006, in response to the consultation, OPTA released a position paper, announcing the start of a new market analysis to determine if and how All-IP would alter KPN's obligations as to local loop unbundling, wholesale broadband access, and service data flow (SDF) backhaul.¹⁰³ OPTA also detailed a set of "policy guidelines" it intended to impose on KPN as conditions for phasing out MDF-based access.¹⁰⁴

In January 2007, however, OPTA changed its approach.¹⁰⁵ OPTA urged KPN to take the lead in determining appropriate alternatives for MDF access or developing MDF phase-out conditions acceptable to its competitors.¹⁰⁶ Negotiations proved difficult, but by February 2008, KPN had signed memoranda of understanding with alternative operators BBned, Tele2, and Orange, allowing it to begin rolling out its new networks.¹⁰⁷ Nevertheless, OPTA subsequently decided to incorporate the impact of All-IP in a general review of the markets, and in its July 2008

⁹⁹ OPTA Issue Paper, *supra* note 96, at 6. Cf. Bos, *supra* note 96, at 18 (calling All-IP "an important and welcome development"); Jilles van den Beukel, KPN, ALL IP (Apr. 17, 2007), http://berec.europa.eu/doc/whatsnew/kpn_van_den_beukel_erg_17_apr_07.pdf (accessed July 20, 2015) (describing OPTA's "positive attitude towards the All IP plan").

¹⁰⁰ Bos, *supra* note 96, at 19.

¹⁰¹ See generally OPTA Issue Paper, *supra* note 96.

¹⁰² *Id.* at 6.

¹⁰³ OPTA, *KPN's Next-Generation Network: All-IP*, Position Paper OPTA/BO/2006/202771 7 (Oct. 3, 2006), available at <https://www.acm.nl/en/download/publication/?id=9117> [*hereinafter* OPTA Position Paper]. See also Telecoms Regulatory Expertise Eur. [T-REGS], *Netherlands: OPTA Position Paper on KPN's 'All-IP' Next Generation Network* (Oct. 3, 2006), <http://www.t-regs.com/index.php/2006/10/03/netherlands-opta-position-paper-on-kpns-all-ip-next-generation-network-2/> (accessed July 20, 2015) (summarizing and commenting on the position paper).

¹⁰⁴ OPTA Position Paper, *supra* note 103, at 40.

¹⁰⁵ T-REGS, *Netherlands: OPTA Fundamentally Revises Its Position on KPN's 'All-IP' Project* (Jan. 25, 2007), <http://www.t-regs.com/index.php/2007/01/25/netherlands-opta-fundamentally-revises-its-proposed-position-on-kpns-all-ip-project-2/> (accessed July 21, 2015).

¹⁰⁶ T-REGS, *Netherlands: OPTA Update on Regulation of KPN's 'All-IP' Project and Functional Separation* (Mar. 5, 2007), <http://www.t-regs.com/index.php/2007/03/05/netherlands-opta-update-on-regulation-of-kpns-all-ip-project-and-functional-separation-2/> (accessed July 20, 2015).

¹⁰⁷ Lemstra, *supra* note 97, at 72.

decision, OPTA required KPN to grant unbundled access (full or shared local loop unbundling) to its competitors.¹⁰⁸

KPN has continued to transition to all-IP networks over the past several years, implementing VDSL as an intermediate step while focusing on FTTH as its long-term technology of choice.¹⁰⁹ KPN's efforts have contributed to the rapid uptake of next-generation technologies in the Netherlands. From June 2013 to June 2014, fiber connections grew 27%, and analysts predict that the growth of fiber will continue to accelerate, with an estimated 3.5 million FTTH lines in service by 2017.¹¹⁰ At the end of 2014, the Netherlands had more than twice as many VoIP subscribers than PSTN subscribers.¹¹¹

Dutch regulatory authorities have continued to pay close attention to the effect of the transition on the competitive environment.¹¹² OPTA positioned its regulatory interventions as a trade-off between the short-term promotion of competition (through access obligations on dominant operators) and the encouragement of efficient investment.¹¹³ Similarly, OPTA's successor, the Netherlands Authority for Consumers and Markets (ACM), has extended KPN's wholesale obligations through 2017 with the stated goal of preserving competition and benefiting consumers.¹¹⁴

¹⁰⁸ *Id.*; Telegeography GlobalComms Database: NETHERLANDS (2015), *supra* note 98. According to KPN, the regulation drove down wholesale copper prices, thereby failing to stimulate large-scale fiber roll-out. See KPN, *Update on KPN's Fiber Roll-Out: Next Phase in Consumer Strategy* 34 (Dec. 15, 2009), http://www.kpn.com/v2/upload/4140a0cd-d7b7-4104-b7b1-76ba7c3419fc_Presentation_Fiber_update.pdf (accessed July 21, 2015).

¹⁰⁹ KPN, *supra* note 108, at 36.

¹¹⁰ OECD Broadband Portal, *supra* note 5; Telegeography GlobalComms Database: NETHERLANDS (2015), *supra* note 98.

¹¹¹ See Telegeography GlobalComms Database: NETHERLANDS (2015), *supra* note 98 (detailing that the Netherlands had 5.2 million VoIP subscribers compared to 2.5 million PSTN subscribers).

¹¹² In November 2008, for example, OPTA issued regulations on wholesale FTTH unbundling fees. T-REGS, *Netherlands: OPTA Consultation on Fees for Unbundled Fibre Access* (Nov. 25, 2008), <http://www.t-regs.com/index.php/2008/11/25/netherlands-opta-consultation-on-fees-for-unbundled-fibre-access-2/> (accessed July 21, 2015). In December 2011, OPTA clarified that KPN is required to provide wholesale access to both its copper and fiber networks. Telegeography GlobalComms Database: NETHERLANDS (2015), *supra* note 98.

¹¹³ T-REGS, *supra* note 112.

¹¹⁴ ACM, *For the Next Three Years, Dutch Telecom Company KPN Must Continue to Grant Its Competitors Access to Its Networks* (Oct. 31, 2014), <https://www.acm.nl/en/publications/publication/13464/For-the-next-three-years-Dutch-telecom-company-KPN-must-continue-to-grant-its-competitors-access-to-its-network/> (accessed July 21, 2015). See also *ACM Publishes Revised Decision on Wholesale Broadband Market*, TELECOMPAPER (July 17, 2015), <http://www.telecompaper.com/news/acm-publishes-revised-decision-on-wholesale-broadband-market--1093033> (accessed July 21, 2015) (noting that, following a review by the European Commission, ACM upheld and further justified its decision).

SINGAPORE

Singapore's telecommunications networks represent a combination of traditional circuit-switched networks coupled with new IP-based technology. At the end of 2013, 95% of Singapore's nearly 2 million total fixed line subscribers relied on the PSTN.¹¹⁵ Recently, however, operators – particularly SingTel, the dominant fixed line provider – have increasingly turned to IP-based platforms.¹¹⁶

Since the adoption of a revised Telecom Competition Code in 2012, Singapore has had a robust, technology-neutral mandatory interconnection regime. In order to ensure “seamless any-to-any communications,” the Code requires all licensed operators to interconnect with each other.¹¹⁷ The Info-communications Development Authority of Singapore (IDA), Singapore's regulator, strongly encourages licensees to enter into Interconnection Agreements through commercial negotiations; however, IDA takes a more active role in monitoring just, reasonable, and non-discriminatory Interconnection Agreements involving dominant licensees.¹¹⁸

Moving beyond interconnection issues, Singapore has recently begun considering technology transitions more holistically. In January 2014, IDA released a reference specification on the PSTN/ISDN evolution to NGNs.¹¹⁹ Developed by the Telecommunications Standards Advisory Committee (TSAC), a consultative group composed of industry and academia, the report provides a high-level overview of general IP migration.¹²⁰ The reference specification presupposes a market-driven, operator-led transition, stating that operators can choose different evolution paths based on their own resources, strategies, and business plans.¹²¹ It also notes the importance of ensuring universal service and public safety in the migration from PSTN/ISDN to IP-based networks.¹²²

¹¹⁵ As of end-2013, Singapore had 1,870,800 PSTN subscribers and 100,000 VoIP subscribers. Telegeography GlobalComms Database: SINGAPORE (2014), <https://www.telegeography.com/products/globalcomms/data/country-profiles/ap/singapore/wireline.html> (accessed Jan. 6, 2015).

¹¹⁶ *Id.*

¹¹⁷ Info-communications Dev. Auth. of Sing. [IDA], CODE OF PRACTICE FOR COMPETITION IN THE PROVISION OF TELECOMMUNICATIONS SERVICE 2012 (TELECOM COMPETITION CODE 2012) ¶¶ 5.1.2-5.2 (Apr. 23, 2012), available at http://www.ida.gov.sg/~media/Files/PCDG/Practice%20Guidelines/TCC/2012TCC_wef_2July2014.pdf.

¹¹⁸ *Id.* at ¶ 6.1.2. See also Telegeography GlobalComms Database: SINGAPORE (2014), *supra* note 115 (discussing the interconnection regulations).

¹¹⁹ IDA, REFERENCE SPECIFICATION: PSTN/ISDN EVOLUTION TO NGN (Jan. 2014), available at http://www.ida.gov.sg/~media/Files/PCDG/Licensees/StandardsQoS/TechRefSpec/Draft_IDARSPSTNEVO_i1r1.pdf.

¹²⁰ See *id.* at ¶ 1.1 (describing the scope of the reference specification as “defin[ing] the possible ways of evolving PSTN/ISDN to NGN”).

¹²¹ *Id.* (“Evolution of networks to NGN is dependent on operators’ choices and needs. Network operators will choose an evolution path depending on their actual resources, business plans and strategies. They may choose different technologies and timeframes”).

¹²² See *id.* at ¶¶ 2.3(d)-(e) (noting that the NGN should continue to provide support for public interest aspects and disaster recovery efforts); *id.* at ¶ 2.4 (discussing the provision of emergency telecommunications services).

UNITED KINGDOM

The Office of Communications (Ofcom), the UK's regulator, has identified technology transitions as a high priority on its current agenda.¹²³ Currently, the vast majority of the UK's fixed telephony customers remain on legacy systems.¹²⁴ A number of major communications providers, however, have indicated their need to retire existing PSTN systems at end of life and replace them with VoIP-based "derived voice" delivered over DSL, DOCSIS, or FTTP.

Key Features

Ofcom considers access to emergency services a prime concern.¹²⁵ Early on in the deployment of FTTP, Ofcom recognized that the switch from copper to fiber significantly impacts uninterrupted access to emergency calls in the event of a power failure.¹²⁶ In December 2011, Ofcom published a report on the use of battery back-up to protect emergency services delivered via fiber technology.¹²⁷ It developed the following guidelines: service providers deploying new-build or overlay fiber technology must provide a battery back-up with a duration of at least one hour, and they should take appropriate steps to secure the needs of vulnerable customers who require additional protection.¹²⁸

Ofcom has taken additional steps to protect consumers. In its July 2013 consultation on wholesale broadband access, Ofcom developed the concept of anchor pricing.¹²⁹ According to this pricing scheme, the price of the legacy technology "anchors" the price of the new technology.¹³⁰ Under the anchor pricing approach, in other words, any voice-only customer served by broadband-delivered derived voice should not be expected to pay more than the

¹²³ Communications with Ofcom.

¹²⁴ According to Ofcom estimates, at end-2013, the UK had 27,750,000 PSTN subscribers and 5,600,000 VoIP subscribers; in other words, PSTN subscribers represented approximately 83% of total subscribers. *See* Telegeography GlobalComms Database: UNITED KINGDOM (2014), <https://www.telegeography.com/products/globalcomms/data/country-profiles/we/united-kingdom/wireline.html> (accessed Dec. 19, 2014).

¹²⁵ Communications with Ofcom.

¹²⁶ *See generally* Ofcom, NEXT GENERATION NEW BUILD: DELIVERING SUPER-FAST BROADBAND IN NEW BUILD HOUSING DEVELOPMENTS 23-29 (Sept. 23, 2008), *available at* <http://stakeholders.ofcom.org.uk/consultations/newbuild/> (discussing uninterrupted access to emergency services).

¹²⁷ *See generally* Ofcom, GUIDELINES ON THE USE OF BATTERY BACK-UP TO PROTECT LIFELINE SERVICES DELIVERED USING FIBRE OPTIC TECHNOLOGY (Dec. 19, 2011), *available at* http://stakeholders.ofcom.org.uk/binaries/consultations/superfast-broadband/statement/Battery_Backup_Statement.pdf.

¹²⁸ *Id.* at 22-23.

¹²⁹ Ofcom, REVIEW OF THE WHOLESALE BROADBAND ACCESS MARKETS: CONSULTATION ON MARKET DEFINITION, MARKET POWER DETERMINATIONS AND REMEDIES § 7.111 (July 11, 2013), *available at* http://stakeholders.ofcom.org.uk/binaries/consultations/review-wba-markets/summary/WBA_July_2013.pdf.

¹³⁰ *Id.*

previous market norm for PSTN service. This concept ensures that consumers are not made worse off as a result of an operator choosing to change its technology.¹³¹

With respect to universal service, the United Kingdom has a technology-neutral universal service framework, allowing the two designated universal service providers, BT and Kingston, the flexibility to determine how to discharge their obligations.¹³²

Finally, Ofcom views technology transitions as potentially pro-competitive, in principle allowing a wide range of over-the-top (OTT) service providers to compete with the vertically integrated offerings of the access providers. Concurrently, competition might be constrained by Ofcom's ability to require specific bearer service functionality (such as appropriate voice traffic prioritization) to be made available on an open access basis, which might be restricted to those access providers with market power.¹³³

Conclusion

In this overview, we have briefly explored the ways in which international organizations, namely the ITU and BEREC, have contributed to technology transitions. Then, we examined the state of technology transitions in eight different countries. Through these case studies, we can arrive at several general observations:

- **Many regulators are only just beginning to focus on technology transitions.** By and large, traditional circuit-switched copper networks currently co-exist with new packet-switched networks, as operators take the lead in beginning to deploy IP-based technology to varying degrees. At the regulatory level, our study suggests that many countries have only just begun to comprehensively consider the migration to IP-based networks. In many cases, pre-existing technology-neutral legal frameworks have minimized the need for regulators to actively engage with technology transitions issues thus far.
- **Due largely to the predominance of technology-neutral regulations, many regulators have successfully applied or adapted their existing legal framework during technology transitions.** The increasing prevalence of technology-neutral regulatory frameworks has helped make it easier for many countries to accommodate technology transitions. In Japan, for example, general consumer protection rules apply to both legacy and IP-based networks, and the incumbent fixed line carrier can fulfill its universal service obligations by providing either legacy or IP-based telephone service. Where existing regulations have proved insufficient to protect enduring values, regulators have supplemented the existing framework with new rules. In the United Kingdom, for

¹³¹ *Id.*

¹³² Ofcom, *Designation of BT and Kingston as Universal Service Providers, and the Specific Universal Service Conditions*, <http://stakeholders.ofcom.org.uk/telecoms/ga-scheme/specific-conditions-entitlement/universal-service-obligation/designation-of-bt-and-kingston/> (accessed Dec. 19, 2014).

¹³³ Communications with Ofcom.

example, Ofcom has ensured emergency calling capabilities by mandating the use of battery back-up to protect emergency services delivered via fiber technology.

- **Interconnection remains a foremost concern, and regulators are primarily considering the impact of technology transitions on competition.** To preserve and promote a competitive marketplace, interconnection has become the primary issue for many regulators. Nonetheless, many regulators also aim to preserve access to public safety services, universal service, and consumer protection, and they have begun to take these values into account when planning for the migration to IP-based networks.
- **A number of countries seem to support a market-driven, operator-led approach to IP interconnection and other technology transition issues, while simultaneously maintaining a regulatory backstop.** Some countries have allowed market forces to determine the details of technology transitions; in Canada, for example, CRTC has encouraged carriers to negotiate their own IP voice network interconnection agreements. Even where regulators afford operators significant leeway in managing the transitions, however, they often maintain a regulatory backstop intended to preserve enduring values, including competition, should commercial arrangements fall short. For example, in Singapore, IDA allows operators to enter into Interconnection Agreements through commercial negotiations, but intervenes if necessary to ensure competition. Likewise, in Austria, RTR only plans to regulate IP-based interconnection should operators find themselves unable to reach consensus on their own.

As the United States and other countries continue to transition towards next-generation networks, we hope that these insights into international approaches to technology transitions can inform and contribute to ongoing dialogue.