FROM ANALOG TO DIGITAL

Philippine Policy and Emerging Internet Technologies

Mary Grace Mirandilla-Santos

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The Asia Foundation

Better Broadband Alliance

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The Asia Foundation

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Sam Chittick

Country Representative
The Asia Foundation

FOREWORD

As an archipelago, connectivity in the Philippines varies greatly across the 7,107 islands. In the wealthier, more densely populated urban areas connectivity is relatively better, but a large portion of the Philippine poor live on islands that have low population density and often limited electricity. In these areas the country cannot depend on traditional telecom technologies for connectivity. There are numerous emerging technologies being tested or already used in other countries to connect people, especially in remote, rural areas. But the current Philippine policy environment is biased towards the existing dominant models which are based on the deployment of traditional telecommunications infrastructure.

To address these challenges facing the Philippines and to support connectivity through emerging technologies, The Asia Foundation and the Better Broadband Alliance (BBA) have produced this study, which examines how the Philippine policy environment facilitates the deployment of these technologies to improve Internet access, quality, and affordability in the Philippines. Comprehensive research was conducted on a wide range of emerging Internet technologies—such as fiber to the premises, loons, drones, TV White Space, and high-throughput low- and medium-earth orbit satellites—to assess if the policy and regulatory environment allows their use in the country.

With Internet access now widely recognized as a key driver to economic growth, we believe this report offers valuable insights into the policy space and identifies the most promising and suitable Internet technologies for the country. In this age of rapid expansion and information sharing, it is easy to get left behind. The overarching goal of this publication is to encourage a more digital-friendly policy environment that fosters increased innovation and investment in the Philippines.

The Asia Foundation and Better Broadband Alliance would like to thank Google for their generous support.

ABOUT THE AUTHORS

Mary Grace Mirandilla-Santos

Grace is a leading researcher specializing in telecommunications and ICT policy, with a particular focus on technology's impact on development and society in the Philippines. She has over fifteen years of experience in the field, with focus on universal ICT access and broadband connectivity. She is lead convener of the Better Broadband Alliance, a research fellow of LIRNEasia, a regional ICT policy think tank, and is currently vice president for policy of the Internet Society Philippines Chapter. Grace regularly blogs about telecommunications and ICT at *https://www.telecomasia.net/blog/list/Grace%20Mirandilla-Santos.*

Jonathan Brewer

Jonathan is the principal of Telco2, a New Zealand based telecommunications consultancy. Its work is focused on the design, build, and operation of fixed and wireless networks for broadband, public safety, and the Internet of Things. In addition to work for network operators and government bodies, Jonathan has led workshops in more than twenty countries on topics including the IoT, network management, network security, and wireless engineering. His personal website is *https://jon.brewer.nz/.*

Jaime Faustino

Jaime is a development manager at The Asia Foundation in the Philippines. Jaime worked with leaders and donors to introduce reforms in telecommunications, civil aviation, property rights, and tax reform. Based on those experiences, he fostered the use of entrepreneurial principles and practices in the development field.

ABOUT THE PARTNERS

The Asia Foundation

The Asia Foundation

is a nonprofit international development organization committed to improving lives across a dynamic and developing Asia. Informed by six decades of experience and deep local expertise, our work across the region addresses five overarching goals—strengthen governance, empower women, expand economic opportunity, increase environmental resilience, and promote regional cooperation.

Better Broadband Alliance

Better Broadband Alliance

is a coalition of citizens and stakeholders committed to supporting initiatives that bring better broadband services to the Philippines. They envision a Philippines where anyone has access to reliable and affordable broadband services anytime, anywhere, and using any technology. The BBA partners are the Internet Society – Philippines Chapter, Democracy.net.ph, Foundation for Media Alternatives, Beyond Access, Molave Foundation Inc, National Library of the Philippines, ICT Davao Inc, WiFi Interactive Network, The American Chamber of Commerce, The European Chamber of Commerce, The Philippine Association of Multinational Companies, The Australian-NewZealand Chamber of Commerce, Canadian Chamber of Commerce, Korean Chamber of Commerce Inc, Japanese Chamber of Commerce Inc, Game Developers Association of the Philippines, Philippine Cable TV Association, Philippine Network Operators' Group.

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Jonathan Brewer thanks Mozilla Fellow Steve Song and Marco Zennaro of the T/ICT4D Laboratory at The Abdus Salam International Centre for Theoretical Physics for their inputs.

Jaime Faustino thanks his wife, Therese.

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Philippine Policy and Emerging Internet Technologies

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EXECUTIVE SUMMARY

The challenges of poor access, poor quality, and high cost of Internet connectivity in the Philippines are well-documented:

- About 45% of the total population of 103 million remain unconnected to the Internet.
- The Philippines' 4G speed ranked 4th slowest of 88 countries in OpenSignal's 2018 *State of LTE* and recorded the poorest overall mobile video experience of 69 countries in OpenSignal's 2018 *State of Mobile Video*.
- Fixed broadband service costs consumers 7.1% of gross national income per capita per month—well above the 5% affordability threshold recommended by the International Telecommunications Union.

There are promising emerging technologies that can significantly improve Philippine Internet access, quality, and cost. This report presents various Internet technologies and recommends ways to make the country's policy and regulatory framework more open to potentially innovative solutions. The feasibility and potential commercial success of the technologies discussed is beyond the scope of this report.

The report starts with an elaboration of emerging Internet technologies that are being tested or are already being used in other countries. Based on an assessment, three technologies which seem appropriate and possible for the Philippines are explored in detail. These include 1) Fiber to the Premises with Gigabit Passive Optical Network; 2) Fixed mobile substitution with 5G; and 3) Low earth orbit satellite networks.

Drawing on an understanding of these technologies, the report turns to how the Philippine policy and regulatory environment affects the entry and use of these emerging technologies. After a review of policies and regulations, the paper posits that the overall policy framework was developed and continues to be based primarily on analog-era cellular and landline technology as opposed to digital technology. As a result, government agencies, regulators, and service providers interested in deploying new digital technologies have to operate in an analog-era policy environment.

Given the mismatch of analog-era policies and digital technologies, the report identifies reforms to allow new services and/or providers to deploy emerging technologies which can dramatically improve access, quality, and cost of Philippine Internet service. These include the reclassification of data services to distinguish and unshackle them from basic telecommunications; the removal of the requirements to install landlines for entry into the telecommunications and broadband markets; the relaxation of restrictions on foreign ownership to encourage more investment and foster greater competition; the introduction of standards and harmonized rules for communications and broadband infrastructure; the adoption of spectrum management reforms, such as the issuance of a spectrum policy roadmap and a spectrum use audit in the immediate term to help determine the need to recall or redistribute underutilized spectrum to various types of service providers who can offer emerging Internet technologies; and the enhancement of the regulatory environment that, for example, will give service providers room to experiment with emerging Internet technologies. It is hoped that the rise of emerging Internet technologies — with the promise to bridge the digital divide—can provide the much-needed impetus for reforming the Philippines' policy and regulatory environment to bring it to the digital age.

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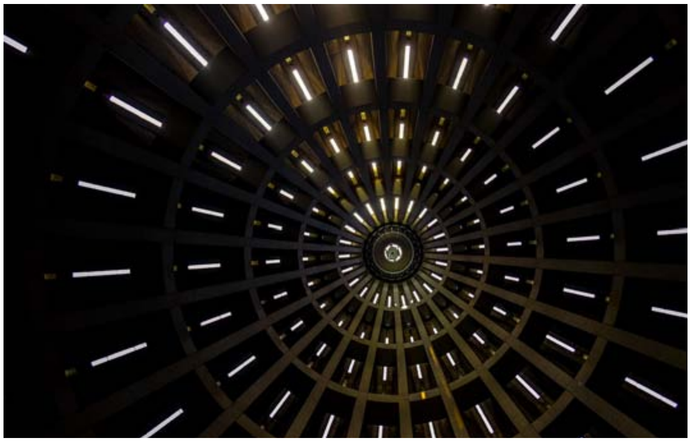

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Introduction

Photo by Angelo Gutierrez

"Despite the real and promised benefits of the Internet, half the world's population—about 3.9 billion people—is still offline."

I. Introduction

The Internet is seen as a critical enabler for sustainable development.[1] The United Nations' Sustainable Development Goal 9.c targets to "significantly increase access to information and communications technology (ICT) and strive to provide universal and affordable access to the Internet in least developed countries by 2020."[2] It has been called the "great transformer" that exerts a strong influence on economic growth rates across countries.[3] According to McKinsey (2011), the Internet accounts for an average of 3.4% of GDP across the large economies that make up 70% of global GDP.[4] Meanwhile, a World Bank (2009) study says low-income and middle-income countries have experienced "about a 1.35 percentage point increase in GDP for each 10-percent increase in [broadband] penetration" between 2000 and 2006.[5]

Internet access — broadband[6] in particular — was also found to have positive socioeconomic effects on household income. An Ericsson study (2014) revealed that introducing a 0.5 Mbps broadband connection in less developed countries, such as Brazil, India, and China, increases household income by US$800 per year.[7]

Despite the real and promised benefits of the Internet, half the world's population—about 3.9 billion people—is still offline.[8] In many countries, emerging Internet technologies aim to connect remote, rural areas that have remained unserved and underserved amid tremendous growth in the telecommunications industry and the rise of giant tech companies.[9] Emerging technologies have dislodged outdated and inefficient traditional technologies, and have brought in a more diverse set of service providers.[10] As the world enters what has been dubbed as the Fourth Industrial Revolution,[11] Internet connectivity will be a more important development enabler, especially for developing countries.

> **"In the case of the Philippines, the challenges of poor access, poor quality, and high cost of Internet connectivity are well-documented.**

In the case of the Philippines, the challenges of poor access, poor quality, and high cost of Internet connectivity are well-documented:

Access. As an archipelago, connectivity in the Philippines varies greatly across the 7,000+ islands. In the wealthier, more densely populated urban areas, connectivity is relatively better, but a large portion of the Philippine poor live on islands that have low population density and often limited electricity.[12] According to the 2017 World Risk Report, the Philippines is also the third most vulnerable country to natural disasters in the world,[13] which also makes communication infrastructure vulnerable to disruption. About 45% of the total population of 103 million and 61% of 23 million households remain unconnected to the Internet.[14] Around 74% of 46,700 public schools nationwide are unable to connect to Internet facilities in their communities, despite having the budget allocation from the Department of Education.[15]

Viet Nam with a lower GDP per capita ($2,343 vs the Philippines at $2,989) has 170% more fiber connections than the two dominant Philippine operators have of all types of fixed broadband subscribers combined (see Section II). The Philippines also has one of the lowest cell site densities in Asia. It has 20,000 towers, far below Vietnam's 70,000 and Indonesia's 90,000 towers.[16]

Quality. Internet speed in the Philippines is reported as among the slowest in the world. Akamai Technologies' State of the Internet report has been ranking the Philippines' fixed broadband speed as the slowest in Asia Pacific since the 4th quarter of 2016.[17] OpenSignal's Global State of Mobile Networks placed the country's 3G/4G speeds at 2nd slowest in the world in February 2017.[18] A year later, its State of LTE ranked the country's 4G/LTE (Long Term Evolution) speed as fourth slowest out of 88 countries measured.[19] OpenSignal's State of Mobile Video report also recorded the country's mobile video experience as the poorest globally.[20] According to the Bandwidth and Signal Strength (BASS) measurement, a local and independently developed mobile broadband

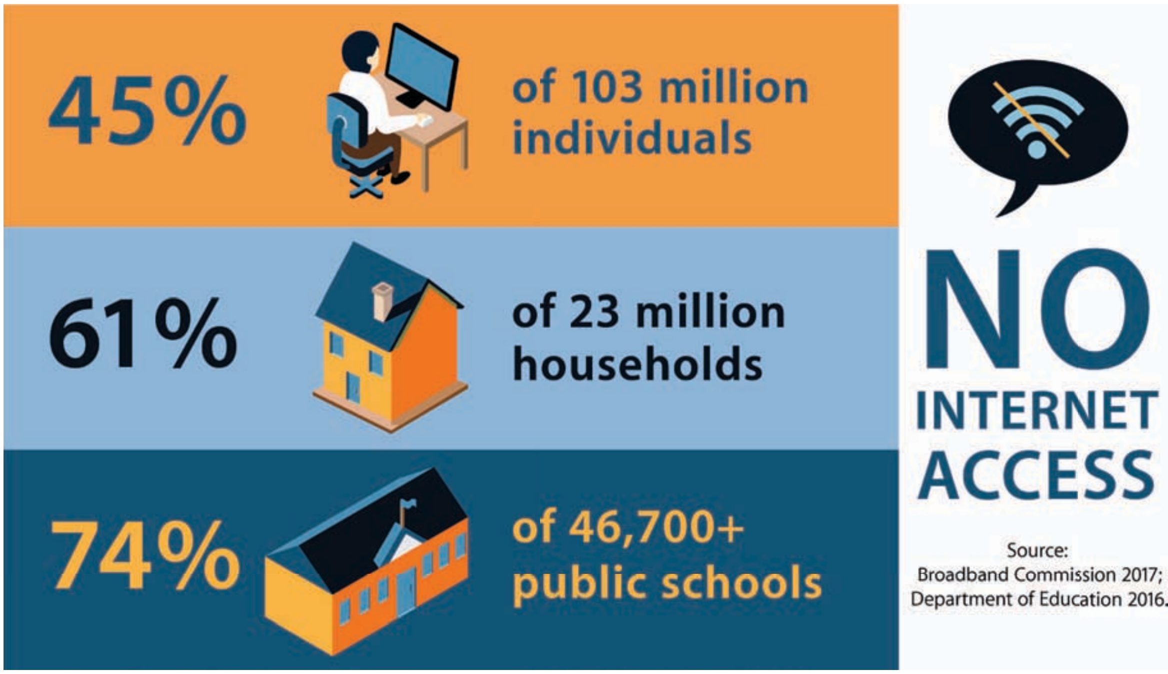


Figure 1. Percentage of individuals and institutions in the Philippines with no Internet access (as of 2016)

monitoring tool, about 60% of all its measures in January-December 2017 were at a median of 1 to 5 Mbps.[21]

Affordability. Internet access in the Philippines is also seen as expensive. Although prices are dropping, fixed broadband (postpaid) service is considered unaffordable, as it costs 7.1% of the country's gross national income (GNI) per capita per month or the average monthly earnings of Filipinos. It is above the 5% affordability threshold recommended by the ITU[22] and well over the 2% recommended by the Alliance for Affordable Internet.[23] Mobile (postpaid, 1GB) broadband service was unaffordable for quite some time, but there was a huge, sudden price drop seen between 2015, from 6.74% to 2.1% of GNI per capita in 2016.[24]

Report Purpose and Structure

Through the generous support of Google, The Asia Foundation and Better Broadband Alliance hope to contribute to increased understanding of emerging technologies and their potential applicability to dramatically improve Philippine Internet access, quality, and cost.

The report explores three key questions:

1. What are the emerging Internet technologies being tested or already being used in other countries that may be suitable to the Philippine setting?
2. How does the current Philippine policy and regulatory environment affect the entry and use of these emerging technologies?
3. What policy and regulatory reforms may be considered to create the environment for new services and/or providers to deploy these emerging technologies to dramatically improve access, quality, and cost of Philippine Internet service?

To provide initial answers to those questions, the report is organized into six sections.

Section I provides the introduction and context against which this report is situated. Section II starts with a broad definition of emerging technology and its relationship to competition and sustainable development. It also provides a framework for analyzing how regulation affects emerging technologies and potentially disruptive innovation. Section III provides an overview of the various emerging technologies such as cabled, wireless, and satellite. In an effort to provide clarity, this section also elaborates on three emerging Internet technologies that are in an advanced stage of testing or deployment in other countries and the Philippines. Section IV of the report describes local policies and regulations that affect telecommunications and Internet services. Section V then examines how the Philippines' policy and regulatory environment may influence the deployment of new technologies for Internet connectivity. In Section VI, the report presents its key findings and recommendations aimed at creating a Philippine policy and regulatory environment that embraces openness and fosters innovation and investment in technologies that may significantly improve access, quality, and cost of the Internet in the Philippines.

Scope and limitations

This report seeks to initiate the discussion on possible technologies beyond those traditionally used for Internet connectivity in the Philippines, especially those that may benefit the unserved and underserved areas. It does not, in any way, intend to endorse any particular technology for adoption in the country. The analysis aims to help the government explore various solutions to achieving broadband Internet access that is pervasive—"Internet that is available anytime, anywhere," as "complemented by emergent wired and wireless broadband technology solutions."[25] As such, the report endeavors to discuss the different types of technologies that make up broadband networks, whether wired or wireless, fixed or mobile, terrestrial or satellite.

Based on an operating definition of what constitutes an "emerging technology" (see Section II), the report zeroes in on specific technologies, with a more extensive discussion of wireless technologies. The decision to focus on certain technologies is also based on their pervasiveness in similarly situated archipelagic countries.

The report cites how different emerging technologies are either being tested or utilized in different countries. It needs to be emphasized, however, that several factors affect the decision to use certain types of technologies. Physical infrastructure and geography vastly differ from country to country, and even from region to region within a country. Hence, a technology that works well in one geographic area may not work in another.[26] The ultimate goal of the report is to present various Internet technologies and recommend ways to make the country's policy and regulatory framework more open to potentially innovative solutions. The feasibility and potential commercial success of the technologies discussed here is beyond the scope and objective of this report.

II Emerging Technologies: Definition and Regulation

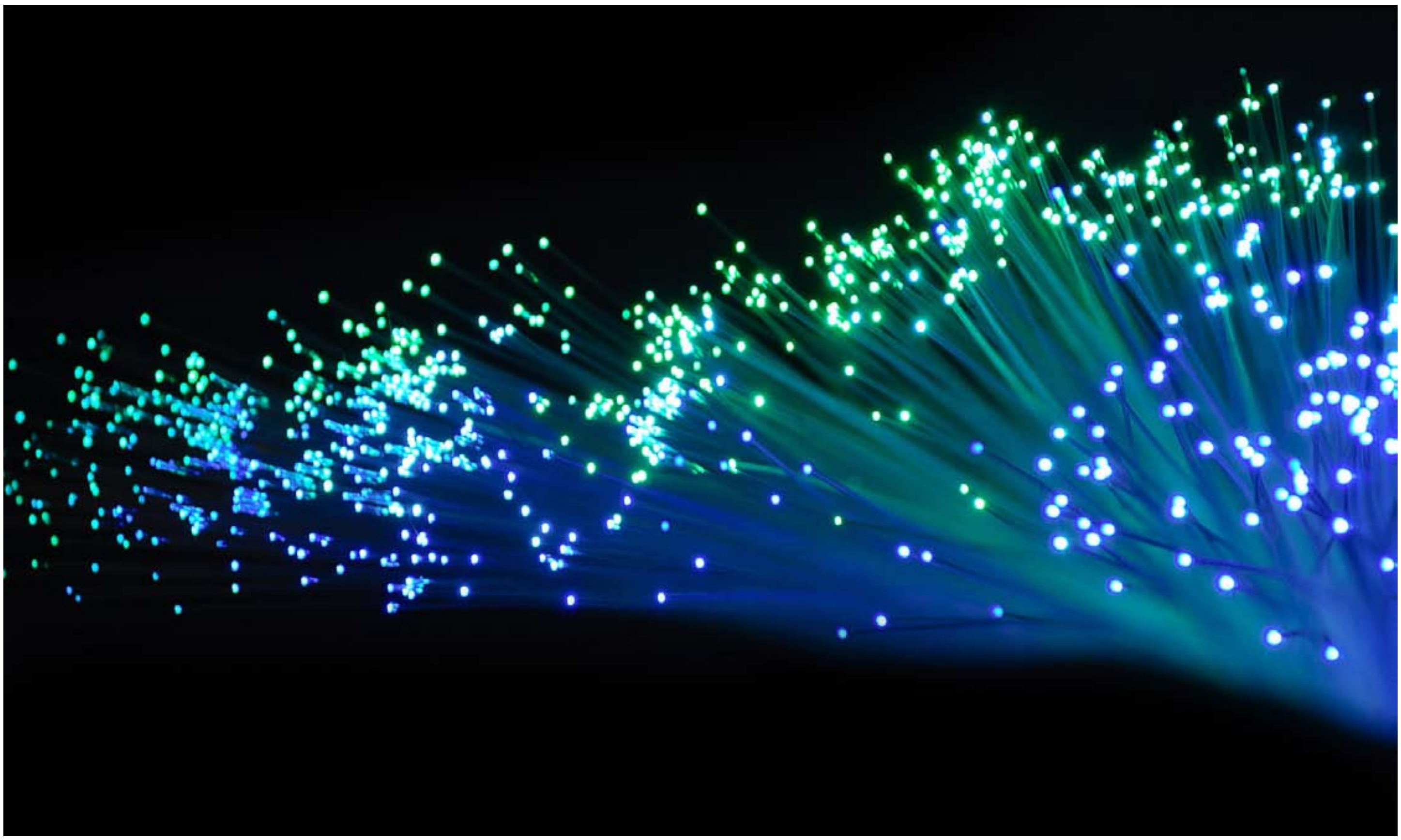


Photo by Андрей Баклан from PixaBay

"New and emerging technologies have the potential to solve many of humanity's problems and deliver results, although their effects remain immeasurable at the early stages of their adoption."

II. Emerging Technologies: Definition and Regulation

This section introduces the various concepts surrounding emerging technologies. It is divided into two parts. The first part establishes a common understanding of emerging technologies while the second half elaborates on the different types of regulation and how they influence the use and prevalence of new and emerging technologies.

The very nature of emerging technologies guarantees uncertainty, and, therefore, still unknown outcomes. New and emerging technologies have the potential to solve many of humanity's problems and deliver results, although their effects remain immeasurable at the early stages of their adoption. In the same way, these technologies can also disrupt ways of delivering products and services, as well as the market where incumbent actors and their technologies prevail.

Defining Emerging Technology

Rotolo et al (2015) offer a working definition of emerging technology:

> *A radically novel and relatively fast growing technology characterised by a certain degree of coherence persisting over time and with the potential to exert a considerable impact on the socio-economic domain(s) which is observed in terms of the composition of actors, institutions and patterns of interactions among those, along with the associated knowledge production processes. Its most prominent impact, however, lies in the future and so in the emergence phase is still somewhat uncertain and ambiguous.*

Based on this definition, Rotolo et al (2015) identified five important attributes of emerging technologies:

1. ***Radical novelty*** points to a technology's ability to be "revolutionary" in terms of achieving a new or changed purpose or function (e.g., cars with an internal combustion engine versus an electric engine) and to be "evolutionary" in terms of putting existing technologies to new use (e.g., technology for measuring electromagnetic waves used now for wireless communication technology and data transmission).
2. ***Relatively fast growth*** is observed in a number of dimensions pertaining to an emerging technology, such as: (a) diversity of interested stakeholders (e.g., scientists, universities, firms, users); (b) public and/or private funding; (c) knowledge outputs or the number of documents on a particular technology produced over time (e.g., publications, patents); or (d) other indicators of growth, such as number of prototypes, products released or services rendered.
3. There is ***coherence*** in the presence of an expert community of practice that adopts and iterates the concepts or constructs underlying a particular emerging technology.
4. A technology gains popularity for its ***prominent impact*** or promised profound effect on specific domains (e.g., diagnostic technologies for a particular disease) or wide-ranging impact across different domains and potentially the entire socio-economic system (e.g., molecular biology, ICT).
5. Finally, an emerging technology is usually shrouded with ***uncertainty and ambiguity***. The prominent impact of emerging technologies lies somewhere in the future suggesting that it is ***not yet finished***. Emerging technologies have the potential to change existing ways of doing things. However, the application of the technology is still malleable and fluid. The knowledge of possible outcomes is incomplete, which include unintended consequences.

Some emerging technologies hold the promise of being "disruptive innovations,"[27] an idea introduced by Bower and Christensen (1995) to describe "new technologies that undermine and eventually displace established products, firms, or even entire industries."[28] Thus, by its nature, disruptive innovation challenges regulators (Cortez, 2014, p. 199).

Emerging Technologies and Competition. One aspect that emerging technologies can address is the lack of competition in certain industries. Disruptive technologies (e.g., radio broadcasting in the 1920s), unexpected market entry (e.g., the entry of Japanese manufacturers in electronics in the 1970s), or the rise of a new business model (e.g., pizza delivery) serve as an "external shock" that creates a dynamic industry (Wu, 2011, 1848). But when these innovations first emerged, their future or function was difficult to predict (Wu, 2011, p. 1848).

Wu and Yoo (2007) posit that innovation happens best in a competitive environment, where new players and new technologies can freely enter the market and challenge the incumbents.[29] A market with non-competitive or monopoly conditions stunts innovation, as incumbents tend to "block market entry and innovative technologies that threaten their existing business model."[30] Furthermore, rules that favor or are targeted at specific technologies, to the detriment of emerging technologies, "can also serve as market barriers to entry that further entrench incumbents." So, while effective competition is conducive to the growth of emerging technologies, allowing the development and adoption of emerging technologies is also an important tool for improving competition (Wu & Yoo, 2007).

> **"Innovation happens best in a competitive environment, where new players and new technologies can freely enter the market and challenge the incumbents.**

Regulating Emerging Technologies

New and emerging technologies raise a whole new set of regulatory issues that did not exist before or were simply not contemplated when regulating older technologies. These issues will become more urgent as society becomes more interconnected with the advent of the Internet of Things (Mandel, 2015). This can result in regulations that are restrictive when applied to new technologies or in a new context. For example, the regulatory requirement enacted over 20 years ago for network operators to secure a nationwide telecom license and rollout landlines—for the purpose of universal access—may not be practical and relevant anymore in the Internet Age where niche service providers can build and operate a data service network much faster and more efficiently, on a smaller scale.

There are several different approaches to regulating emerging technologies and innovation.

One recommends that the state allows permissionless or unabated exploration of technological innovations while another approach promotes early and decisive regulation to ensure that harm is prevented and to help spur adoption of the technology by the market. Meanwhile, there are those that support adopting the basic principles of existing rules to address the challenges of new technologies, without the need to make new ones.

Permissionless innovation. Adam Thierer (2016) defines permissionless innovation as the idea that "experimentation with new technologies and business models should generally be permitted by default. Unless a compelling case can be made that a new invention will bring serious harm to society, innovation should be allowed to continue unabated and problems, if they develop at all, can be addressed later."[31] The premise behind this is that innovation leads to development. Thierer (2016) points to two major economic surveys which found that technological progress accounts for a third of growth in Western countries. Thus, "creating a legal and regulatory environment conducive to ongoing technological change and the general freedom to innovate" is considered most important for raising long-term living standards.[32]

There are arguments against applying old rules for new technology, especially if the result is more protection of the status quo than benefit to the public. Thierer (2016) emphasized that "merely because restrictions were once justified on consumer protection grounds does not mean they actually accomplished those goals, or that they are still needed today."[33] Legacy policies that create barriers to entry for new technologies should be removed especially if they are "raising prices, limiting competition, or undermining new forms of life-enriching innovation that could better serve the public."[34]

Table 1. Four types of decisions that agencies must make when confronted with disruptive technology

Decisions	Questions
Timing	• When should the agency intervene, if at all? • Does waiting necessarily generate a better informational basis on which to regulate? • What are the drawbacks of waiting?
Form	• Should the agency regulate via rule, adjudication, guidance, or some alternate form? • Given the costs and benefits of each, which best accommodates the uncertainties of the innovation? • Does form even matter?
Durability	• Should the agency's intervention be permanent, or temporary, or conditional? • How long should it endure? • And are there ways to better calibrate regulatory interventions to the innovation?
Enforcement	• How rigorously should the agency monitor and sanction noncompliance? • How much should agencies temper enforcement against novel products, firms, or industries?

Source: Cortez. (2014). pp. 199-200.

Faced with new regulatory issues, Koopman, Mitchell, & Thierer (2015) argue that the solution is not to discourage new technologies by applying the old regulatory regime to them. To prevent stifling technological innovation—often brought in by a new entrant—and creating regulatory asymmetries that favor a new player and put the incumbent actors at a disadvantage, the better alternative is to level the playing field by 'deregulating down' to put everyone on equal footing, instead of 'regulating up' to achieve parity.[35] As new technologies challenge the status quo, policymakers should consider relaxing old rules on both the incumbents and new entrants, "especially when new innovations seem to correct market imperfections better than the outmoded regulations" (Thierer, 2016).

Early and decisive regulation. Nathan Cortez (2014), on the other hand, argues against non-action from the regulator, as this can lead to "suboptimal regulation" for the entire industry. He cautions "agencies" against being so timid when confronting new technologies—even disruptive ones. If concerned about imposing regulation that is "mis-calibrated or premature," Cortez recommends "reducing the cost of errors by using timing rules, alternative enforcement mechanisms, and other variations that might 'soften' traditional regulation without undermining it long-term."

As opposed to not responding to a disruptive technology or applying old regulation to new technologies, Cortez posits that new technologies can benefit from decisive, well-timed regulation. Early regulatory interventions could sometimes even be "market-constituting" (Carpenter, 2010) as they enable "a robust market that otherwise might not exist" (Cortez, 2014, pp. 179-180).

Innovation often disrupts industry incumbents who are used to doing things a certain way or who benefit from the status quo. Other times, however, new technology disrupts the regulatory framework—that is, when innovation "does not fall within an agency's regulatory schemes that contemplate more established technologies or business practices." This is called "regulatory disruption" (Cortez, 2014, p. 175).

In this case, the regulatory agency can decide to use threats. The agency threat framework put forward by Wu (2011) argues that agencies should use "informal" threats against regulated industries under conditions of "high uncertainty" or scenarios in which alternative future states of the world do not occur with quantifiable probability."[36] These threats can be in the form of a "guidance document, warning letter, or press release that it will take action against a company that employ novel technologies or business practices in a certain way."[37] While regulatory threats can be abused, Wu argues that they can be an important tool for agencies dealing with certain types of problems and ought to be used responsibly (Wu, 2011, p. 1854-57).

In addressing regulatory disruption, Cortez (2014) points to four related decisions that agencies must make on whether to use threats:[38] (i) when to intervene, (ii) the form that intervention should take, (iii) how durable or transitory that intervention should be, and (iv) how rigorously to monitor and sanction noncompliance.[39]

How the agency chooses to make its decision will determine the entry and adoption of an emerging technology and, in large part, how a potentially disruptive innovation will affect a particular industry.

Zetzsche et al (2017), looking at the regulatory challenges being faced by financial technology (fintech), offer a rich insight into various regulatory approaches that seek to address emerging innovation. One approach is framed as *doing nothing*, which can span from being permissive to being highly restrictive, depending on the context. There is regulation that allows *cautious permissiveness* (on a case-by-case basis) through special charters. Some approach innovation through *structured experimentalism* (such as sandboxes or piloting), while others develop *specific new regulatory frameworks*. Finally, there are those that argue for a new regulatory approach, which incorporates rebalanced objectives, called *smart regulation*.[40]

The first approach, ***doing nothing***, involves not regulating the new technology, which can result in either permissiveness or laissez-faire, depending on the current regulations. Doing nothing can involve requiring the new technology to comply with traditional regulation, which is a cautious approach to protect against risks. However, doing nothing can also can stifle innovation, as a result.[41]

Some regulators take a ***cautiously permissive approach*** based on forbearance, where the regulators choose to allow certain amounts of flexibility on a case-by-case basis. This can involve no-action letters, restricted licenses, special charters or partial exemptions for innovative firms, or established intermediaries testing new technologies. This approach also allows regulators to acquire sufficient data and experience with innovation.[42]

A third approach is regulators providing a ***structured context for experimentation*** through a regulatory sandbox or structured piloting. A regulatory sandbox refers to a regulatory "safe space" for experimentation with new approaches or technologies. It creates "an environment for businesses to test products with less risk of being 'punished' by the regulator." In a regulatory sandbox, the regulator puts in place appropriate safeguards[43] and predefined restrictions, such as limited number of clients, risk exposure or time of testing.[44]

Finally, a formal approach can be taken wherein ***existing regulation can be reformed or new regulations developed*** for a more appropriate and balanced approach for new entrants and new activities.[45]

III Evolution of Emerging Internet Technologies: Global Experience and Promising Technologies for the Philippines

Photo by PixaBay

"...the report provides a technical explanation of a broad range of emerging technologies that are being tested or deployed locally and in other countries to provide Internet connectivity."

III. Evolution of Emerging Internet Technologies: Global Experience and Promising Technologies for the Philippines

In this section, the report provides a technical explanation of a broad range of emerging technologies that are being tested or deployed locally and in other countries to provide Internet connectivity. This section also explores in detail specific emerging Internet technologies and how they are or can be deployed in the Philippines.

Wired or Cabled Technologies

Wired or cabled Internet technologies—which deliver Internet services through a physical wire or cable—have improved significantly over the last two decades. From submarine cables that interconnect the world to the access technology that we connect to our computers, wired Internet service is continuing to evolve as the demand for bandwidth increases.

The first submarine cables carried telegram messages and it was not until the 1890s that submarine cables for telephone was built. Today, submarine cables are used for communication and connecting to the Internet, and transmits an increasing amount of data every year. Similarly, wired access technology keeps evolving and has become more and more capable of carrying higher bandwidth.[46]

Dial-up Internet services in the 1990s rode on the copper wire network of traditional telephone lines and offered a maximum bandwidth of about 56 kilobits per second (Kbps). This was good enough until a better technology, Digital Subscriber Line (DSL), came along. DSL also used existing copper telephone lines but, unlike the dial-up modems, it does not interfere with voice communications, as both voice and data can work simultaneously.

DSL technology has evolved as equipment manufacturers have found ways of reliably using higher and higher frequencies for communications.

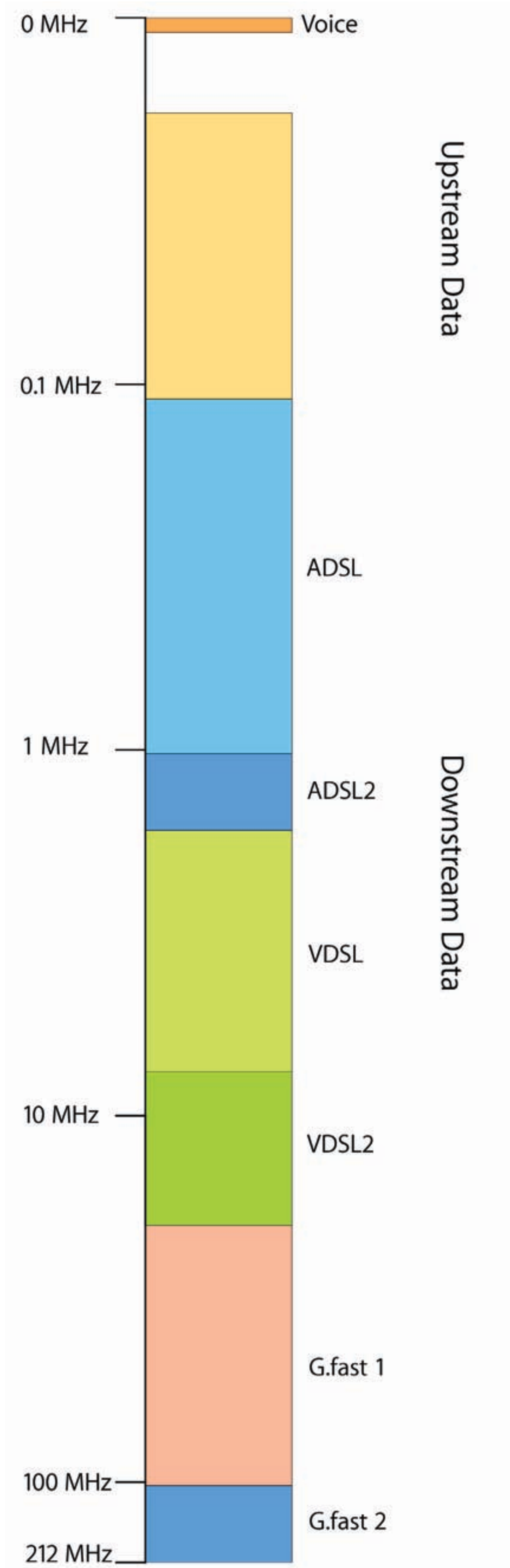


Figure 2. Copper Technology Frequencies Downstream and Upstream

Variants, from slowest to fastest, include ADSL, ADSL2+, VDSL, VDSL2, and an emerging technology called G.fast. This latest technology can use frequencies up to 212 MHz to provide near-gigabit speeds. For more details on DSL technologies, please refer to Appendix A.

While they carry more data, the high frequencies used by modern DSL systems attenuate rapidly as they travel over copper lines. The resulting lower signal levels equate with lower speeds, so Internet service providers must keep copper cable lengths short to keep speeds high.

To enable higher bandwidth for end users, innovation in DSL has been focused on moving equipment as close to consumers as possible, thus preventing degrading the signal through attenuation, and getting equipment out of centralized locations to protect users from interference as a result of signal leakage (called crosstalk) inside tight bundles of thousands of pairs of copper cables out to the street.

Even with copper wire in the last mile[47], high-speed Internet service can be achieved through different iterations of the DSL technology, using a combination of copper wire and fiber optic.

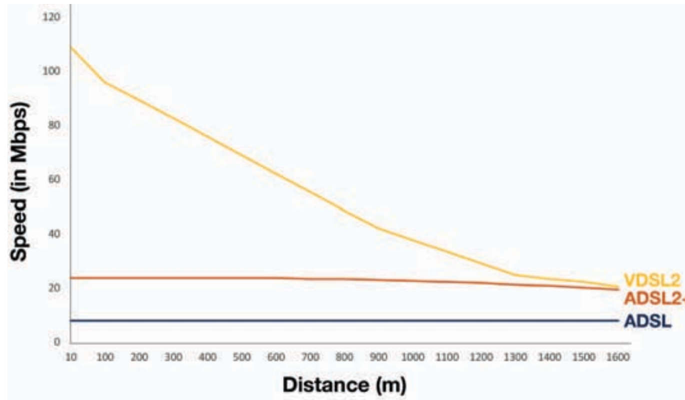


Figure 3. DSL Technologies (Speed Over Distance)

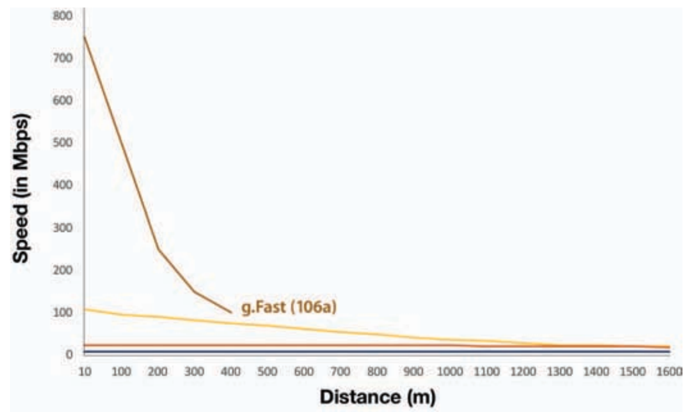


Figure 4. G.fast vs Others (Speed Over Distance)

1. Fiber to the x

The variations of fiber connection are determined by up to where the fiber is run to (fiber to the "x" or FTTx). There are cases where the fiber is run to a place near the customer, like an interim node in the neighborhood (fiber to the "node" or FTTN) or the roadside (fiber to the "curb" or FTTC). In some cases, the fiber is run all the way to the customer (fiber to the "home" or FTTH or fiber to the "premises" or FTTP).

FTTN and FTTC have managed to shorten copper loop lengths. FTTC, in particular, uses fiber optic cables that are run from the telephone exchange to a pit or pole box outside of each address and copper wires, which are connected from "the curb" or roadside into the house of the customer. This can deploy high-speed Internet service in mid- to low-density environments, without the cabinet or power requirements of FTTN (see illustration). For more details on FTTx, please refer to Appendix A.

The beauty of fiber is that its capacity can be increased significantly—even while using a single physical fiber—through ***Wave Division Multiplexing (WDM).*** This technique uses multiple frequencies of light (colors) on a fiber, transmitting different information on each color. Compared to early fiber optic systems, which supported only a single color of light, common WDM systems can support anywhere from 18 to 96 different colors. The use of more colors means more bandwidth for transferring more data over a single fiber optic network, as a single fiber can be shared for several services (voice, Internet, TV). For more technical details on Wave Division Multiplexing, please refer to Appendix A.

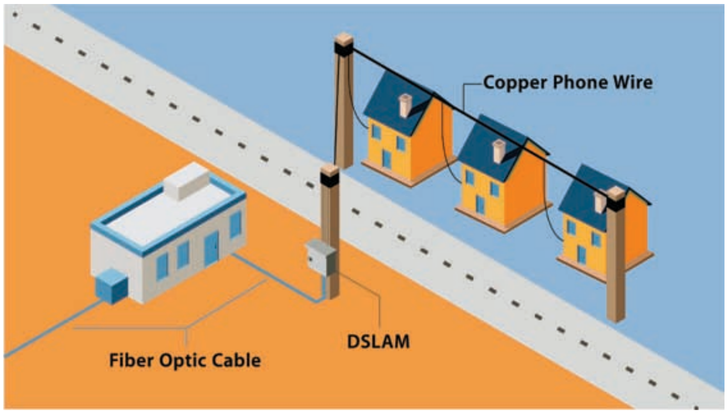


Figure 5. Fiber to the Node (FTTN)

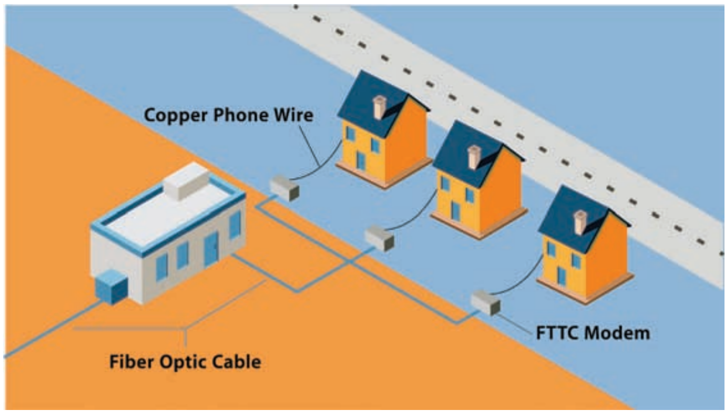


Figure 6. Fiber to the Curb (FTTC)

2. Passive Optical Network (PON)

For wired Internet service that goes all the way to the customer, ***Passive Optical Network (PON)*** technologies allow for inexpensive, centralized fiber to the premises (FTTP) or the home (FTTH) in the last-mile networks. Much in the way DSL was originally designed, active equipment is installed in a telephone exchange. For each group of up to 256 end users, a single optical port and a single physical fiber is connected to a device called an optical line termination (OLT). The OLT broadcasts encrypted traffic to each group of end users, such that all users in a group receive all traffic transmitted. Subscriber devices are provided with keys to decrypt only the traffic they are intended to see.

Passive Optical Networks use one frequency of light for downstream traffic, and another frequency for upstream. As data travels towards end users, it encounters passive splitter devices, which can be located on poles or underground. (see illustration).
Downstream traffic is replicated to all end terminals, making PON an ideal medium for broadcast traffic. Providers wishing to offer television over their systems can do so in an efficient way not possible with DSL. Up to 25 high-definition channels can be shown to all users simultaneously while consuming a small amount of the system's available bandwidth.
Upstream traffic is coordinated by Time Division Duplex, with subscribers being assigned time slots, so that each can use the same frequency to transmit at different times without interfering with each other.

There are two competing PON technologies, Gigabit PON (GPON) and Ethernet PON (EPON).

GPON end users, in its most basic form, share 2.4 Gbps of download capacity and 1.2 Gbps of upload capacity.[48]

EPON users share 1.25 Gbps of symmetric upload/download capacity. In the Philippines, EPON is known to be used by some cable TV operators and smaller players in the countryside. Globally, it has a diminishing market share compared to GPON.

Since PON is an optical network, there are no interference concerns as there are with ADSL. Passive splitters—small enough to fit in one's hand—means there are no large cabinets outside the exchange that require power or battery backups.

PON is being used in the Philippines by companies targeting both corporate and home customers. In developing markets like Vietnam and Bangladesh, PON is being used to deliver to both high and low density / rural markets. It can also be a viable technology for cellular backhaul or fronthaul.

GPON in Asia and the Philippines

Fiber to the Premises networks emerged in wealthy dense urban areas like Hong Kong[49] and Japan[50] more than 10 years ago. More recently it has begun to be used in low density countries, like New Zealand[51], and developing markets, like India.[52] Today, there are more than 300 million FTTP connections[53] in the Asia Pacific region. FTTP is likely the least costly and complex technology available for providing broadband service in densely populated areas.

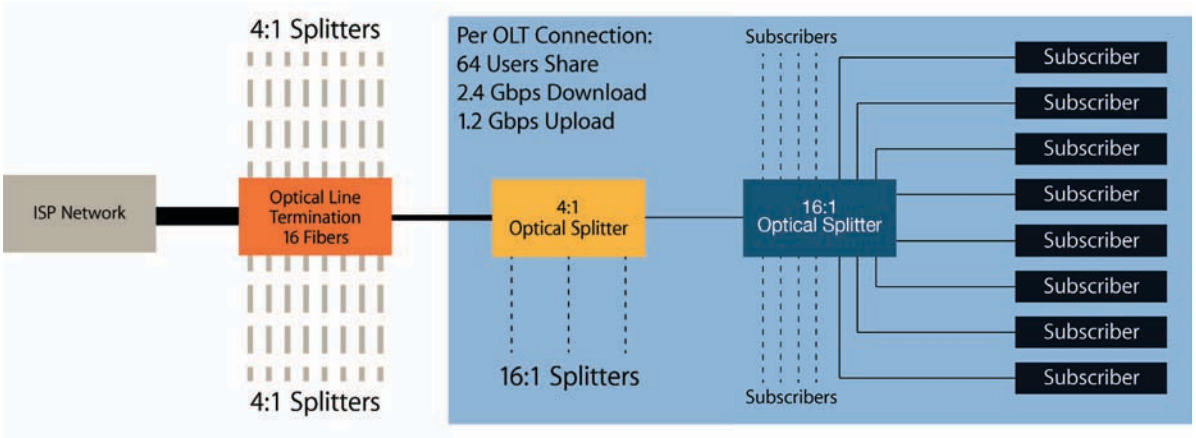


Figure 7. 1,024 Subscriber Gigabit Passive Optical Network (GPON)

There are different ways that GPON can be installed, each with its own benefits. Aerial fiber attaches fiber on utility poles. Microtrenching uses a small groove, where a fiber or set of microtubes is laid, and then the road is restored all at the same time. An emerging technology in trials is surface application, which glues fiber to the road surface. Microducting allows providers and local authorities to share the physical cost and space of fiber installation without forcing them to cooperate on sharing pairs of a single fiber cable. For more details on fiber installation techniques, please refer to Appendix A.

Power transmission grids also carry optical fiber for network management. These fibers are installed inside earth wires, running along the tops of poles, which help provide an air terminal and path for energy from lightning strikes so that it can safely be handled without damage to the power network. Most transmission grids sell access to their optical earth wire fiber to telcos and government institutions on an open-access basis. In June 2018 the Philippines Department of Information and Communications Technology (DICT) signed an agreement[54] to use National Transmission Corp. (TransCo) Optical Earth Wire assets as part of a new fibre backbone. DICT could best use this asset by pairing it with an Active DWDM system.

Recently, Vietnam saw an impressive increase in its fiber connections. Box 1 discusses how Vietnam was able to wire the country in a short period of time.

Box 1. GPON in Vietnam

GPON in Vietnam

In 2015, Vietnam had 4.4 million DSL connections and 280,000 fiber connections. After recognizing that FTTP performs better[55] over long distances and is less affected by environmental conditions than DSL, the government initiated a plan to adopt fiber. Under the country's "National Telecommunications in 2020" plan, the government set a target[56] for telecommunications operators to have 19 million fiber connections by 2020.

Through rapid construction of aerial fiber GPON networks, Vietnam recorded 4.5 million FTTP subscribers by April 2016[57] and 5.5 million subscribers by October 2016.[58] German research firm Infocom expected that number to balloon to 9.3 million connections by the end of 2017.[59]

Vietnam has multiple providers and even some overlapping FTTP builds.[60] Operator costs are very low but their average revenue per subscriber (ARPU) is correspondingly low. One provider, VNPT, reports an FTTP ARPU of 200,000 Vietnamese Dong, or around US $8.70 per month. About 47% of premises passed are taking fiber,[61] partly because fiber plans are being offered at lower cost[62] than existing copper broadband plans. Even with low ARPU and a rapid expansion, incumbent carrier Viettel remains financially healthy.[63]

Expanding into Myanmar this year, Viettel was able to add a million FTTP subscribers to their new network in that country in the first 10 days of its operation.[64] Compared to the Philippines, Vietnam—which has a lower GDP per capita[65] —has 170% more fiber connections than what Philippine operators Globe and PLDT have for all types of fixed broadband subscribers combined.[66]

FTTP for Residential Access in the Philippines - A Cost Model

Table 2. Cost model for GPON installation in Lapu-Lapu City, Cebu

Component	Cost	Quantity	Total	Cost Per Household
14 card GPON Chassis with Power Supplies	$4,000	3	$12,000	$0.15
16-port GPON card supporting 2,048 users	$700	40	$28,000	$0.34
4-way GPON splitters (outdoor)	$16	640	$10,240	$0.13
32-way GPON splitters (outdoor)	$32	2,560	$76,800	$0.94
Fiber optic lead-in cable (200m per household)	$40	81,920	$3,276,800	$40.00
Lead-in installation (4 hours, 2 pax)	$13	81,920	$1,064,960	$13.00
Fiber optic backbone installed (per kilometer)	$2,500	450	$1,125,000	$13.73
Subscriber Terminal with Ethernet and Wi-Fi	$23	81,920	$1,884,160	$23.00
Total Cost			**$7,477,960**	**$91.28**
Over 60 months, 25% interest on finance				**$2.68**

Source: Cost estimates from an anonymous Philippine ISP.

FTTP is ideal for high-population-density cities, including major cities in the Philippines. In a competitive market, a new entrant with access to utility poles could install aerial fiber and provide a fiber service as quickly and inexpensively as has been done in Vietnam and Myanmar.

The following table provides approximate costs for a dense urban GPON system to cover all households in Lapu-Lapu City in Cebu, Philippines based on census figures[67] published by the Philippine Statistics Authority, and market prices for equipment and fiber. For simplicity, this cost model assumes a contiguous area of 60 square kilometers with a uniform distribution of 81,920 households. They assume an existing pole access agreement and no-fee permits to install.

Costs in this model are loaded onto end user installations, with only 17% apportioned to core network. This means that building into a new region is inexpensive for carriers. The majority of costs are not incurred until users are actually connected to the network and paying subscription fees. With an amortized connection cost of around $2.70/month, a provider could offer an affordable service to end users—and likely one far less expensive than the $21.77/month ARPU[68] PLDT extracts from its fixed broadband customers.

> **“ Compared to the Philippines, Vietnam—which has a lower GDP per capita—has 170% more fiber connections than what Philippine operators Globe and PLDT have for all types of fixed broadband subscribers combined.**

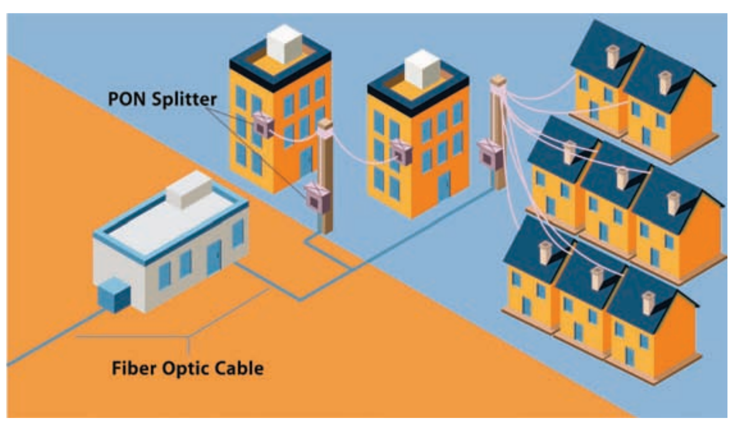


Figure 8. Fiber to the Premises (FTTP)

Wireless Technologies

Wireless technologies use the radio spectrum to transmit information. They can be used for international connectivity, national backbone, middle mile[69] and access networks.[70]

The rapid uptake of wireless technologies, particularly mobile cellular, has helped increase access to basic telecommunications tremendously. This is influenced by competitive markets, lower cost of deployment compared to wired networks, falling mobile device prices, and no-contract (prepaid) subscriptions. As a result, mobile subscribers overtook fixed telephone line subscribers worldwide, across geographic, socio-demographic, and economic criteria by 2002.[71] The evolution of mobile phone technologies also offered more options in Internet connectivity. While the first generation of mobile technologies facilitated voice telephony, the second generation already enabled access to basic Internet services, such as email. Today, all kinds of services and applications can be accessed on smartphones, which demand higher and higher bandwidth from mobile networks.

Radio frequencies are also used for fixed access, traditionally the domain of wired technologies. For example, microwave transmitters, which have seen commercial use for voice and broadcast since the late 1930s, are now a popular middle-mile solution for delivering data due to their ease of deployment, even in remote areas.[72]

For local area networks, the continued development of the IEEE 802.11 Wi-Fi standard, a technology that allows nomadic or itinerant mobility, since the late 1990s has allowed for a new generation of smart and common devices to be connected to the Internet.[73] As the world becomes increasingly reliant on data connectivity, the evolution of wireless technologies will only gain more importance.

1. Mobile Broadband Technology

5G Technologies and Spectrum

5G is the common name for a new set of International Mobile Telecommunications (IMT) standards.[74] It is the most significant emerging technology today, mainly due to the broad enthusiasm and promises of support from equipment vendors, network operators, and device manufacturers. The 5G standards being developed define how data is handled inside mobile network cores, how it is encoded and transmitted from towers, and the frequency bands used for data transmission.

On the encoding and transmission front, 5G will likely be the first wide-scale implementation of Massive Multi-In Multi-Out (Massive MIMO). Massive MIMO is the practice of using the same frequency over multiple antennas to send different streams of data. It increases the spectral efficiency of services—allowing more data to be sent than older systems without occupying more radio spectrum. Massive MIMO (also referred to as 3D-MIMO[75]) scales the number of elements up to 16, 64, or even 256 antennas[76] in a single array. It allows high data rates, beam steering to target individual client devices, and interference protection for the base station, which can choose not to listen to certain noisy areas. Massive MIMO works exceptionally well with Millimeter Wave (MMW) frequencies, bands between 24 and 300 GHz, which typically offer bandwidth of at least 1 Gbps. For more details about Massive MIMO and MMW frequencies, please refer to Appendix A.

When carriers move from 4G to 5G, mobile data will become faster and more reliable. As with the transition from 3G to 4G networks, improvements for mobile users will be gradual and may take years to manifest. The two immediate issues 5G presents for the Philippines are the opening of new radio spectrum bands and the use of mobile technologies to deliver fixed broadband connections—a practice called Fixed Mobile Substitution (FMS).

The 600 MHz band is very likely to be added to IMT[77] frequencies as a companion to the 700 MHz band. This gives companies who missed out on 700 MHz frequencies, or countries where 700 MHz has become concentrated in the hands of a few providers, an opportunity to introduce a new cellular network with equivalent or better performance to the incumbents. In some regions of the Philippines, the 600-MHz band is free (not assigned for use by a broadcaster), as only a small amount of television channels is transmitted from terrestrial towers. In places like Metro Manila and Metro Cebu, however, the 600-MHz band is well used by broadcasters and may never be available for cellular broadband use.

The 1.4-GHz band is mid-way point between the coveted sub 1-GHz frequencies and the higher density urban and suburban 1.8 GHz and higher bands. It is traditionally a satellite band but could also be a potential solution for terrestrial broadband.

The 3.5-GHz band is used in the Philippines now for Broadband Fixed Wireless Access (BFWA) and point-to-point communications systems. In the United States, it is used for radar applications, but is being opened up for 5G use via a spectrum-sharing arrangement called "Citizens Broadband Radio Service" (CBRS). In this arrangement, base stations consult a centralized spectrum-management database to find free channels on which they can transmit, in much the same way as how TVWS works. The 3.5-3.7 GHz band is very likely to be added to IMT frequencies for mobile broadband, and carriers will use it for urban mobile broadband much the same as they use their existing 2-GHz spectrum allocations.

The 24-30 GHz bands, often called Millimeter Wave (MMW) bands (see discussion above and in Annex A), are likely to add the most capacity to networks, as there is a large amount of spectrum available. Beyond raw capacity, an advantage of these bands is that they are small waves that need only very small antennas. Their primary disadvantage is susceptibility to rain fade when used on distances longer than a few hundred meters. The 24 - 30 GHz bands are likely to be used for fixed mobile substitution. Developed market carriers are likely to offer direct-to-handset communications using MMW, with the first handset-ready antenna array released[78] by Qualcomm in July 2018.

It should be noted that some telecommunication companies (telcos) want to start using Long Term Evolution (LTE) in the 5 GHz Industrial, Scientific, and Medical (ISM) radio band, to add capacity to their networks without having to buy more radio spectrum. The 5 GHz ISM band is now used for Wi-Fi. Adding LTE to this band would degrade Wi-Fi and would be an unpopular move with current users of 5 GHz for Wi-Fi.

FEATURE: 5G —Trends and Prospects for the Philippines

LTE was the first cellular mobile technology designed primarily to deliver high-speed data. Cellular operators deployed LTE to relieve data congestion on their voice-centric 2G and 3G networks, and to enable lower cost, higher data-cap plans. Its data-centric design enables performance equivalent to or better than fixed line ADSL2+ connections.

LTE networks now operate in a number of bands, including 700, 1800, 2300, and 2600 MHz.

Fixed Mobile Substitution (FMS) is the idea of serving fixed telecommunications needs with mobile technologies. It has been a trend in developed markets for nearly 20 years,[79] starting with mobile phone replacing wired telephones.

FMS for broadband using LTE was a new technology in 2012, when its suitability for use in New Zealand was evaluated.[80] Since then, FMS for broadband using LTE has become a standard practice around the world, and nearly 10% of all New Zealand broadband connections are served via LTE.[81]

5G is a further evolution of 4G, which adds higher data rates and expands the available spectrum. 5G adds the potential for operation in several new frequency bands, including 600 MHz, 1.5 GHz, 3.5 GHz, and 26-30 GHz. All of these bands are in the growth plans of global mobile network operators (MNOs). Adding 5G to a mobile tower will require new equipment and antennas, which vary in size depending on the frequency chosen. Higher frequency 5G equipment can use very small, easily installed antennas. Lower frequency bands like 600 MHz can require large panels up to two meters tall. Adding such large antennas to towers can significantly slow a rollout, as permits and structural engineering considerations can be significant.

Given the configuration of 5G trials to date, it appears that many carriers intend to provide fixed broadband with 5G. In markets with underdeveloped fixed-line assets and barriers to aerial fiber, it is likely to be the most prevalent emerging technology of the next 10 years.

In most markets, nearly all mobile towers in urban and suburban areas are fiber fed, with backhaul that is highly scalable without additional cost. In the Philippines, the number of fiber-fed towers is unknown. Towers with microwave backhaul will need to be connected to fiber before they are used for 5G, as nearly all 5G technologies exceed the speeds of the types of microwave links used to backhaul 3G and 4G.

Fiber optic cables are essentially unlimited in the amount of bandwidth they can carry. Radio spectrum, on the other hand, can be very limited. Lower frequencies such as 600 MHz can travel tens of kilometers, resulting in a very low level of reuse. Higher frequencies, on the other hand, do not travel as far, and have a very high degree of reuse.

The following table estimates how a 60-square kilometer city like Lapu-Lapu might be covered by 5G at several frequencies, and compares effective bandwidth to a FTTP network.

Table 3. 5G coverage of Lapu-Lapu City vs FTTP network

Frequency	Spectrum	Efficiency	No. of Towers	Bandwidth (Total)	Bandwidth per Household*
600 MHz	15 MHz	6 bps / Hz	5	450 Mbps	0.005 Mbps
3.5 GHz	100 MHz	6 bps / Hz	20	12,000 Mbps	0.15 Mbps
28 GHz	800 MHz	6 bps / Hz	20	96,000 Mbps	1.17 Mbps
Standard GPON with 128 users sharing each fiber uplink				**1,536,000 Mbps**	**18.75 Mbps**

Source: Estimates of author.
Note: *Lapu-Lapu, a highly urbanized city in the province of Cebu, had a total population of 350,467 persons as of May 1, 2010, according to the Philippine Statistics Authority (PSA).

Standard GPON in its least expensive configuration provides at least 16x the bandwidth of 5G over a similar sized area and can be upgraded to a higher capacity at minimal cost. Even if 5G were available at a significant cost advantage, it would seem an inappropriate technology choice for a new network build.

It is useful, however, when assessing how 5G can handle broadband, to consider that networks have "heavy users" and "light users." Cisco,[82] Sandvine,[83] and several academic papers,[84,85] report that a small percentage of heavy users on the Internet are responsible for the majority of Internet traffic use. According to Sandvine's 2013 report, the top 20% of subscribers who make the most use of a network's resources typically consume 70-80% of all traffic, as measured across multiple markets including North America, Europe, and Asia Pacific. Conversely, "the network's lightest 50% of users account for only 6.4 % of total monthly traffic" in North America, and 6.7% of total monthly traffic in Asia Pacific.

Cisco's VNI[86] estimates that general Asia Pacific traffic will grow from 5.5 GB to 18.9 GB per month per capita, between 2016 and 2021. For this analysis, it will be assumed that the average Philippine household of 4.4 persons in 2021 will consume 83 gigabytes of traffic a month. If we consider the 50% of all households that are considered light users, that figure drops to only 5.5 GB per month.

How and when traffic is used has a major impact on the ability of a network to provide a good service. It can be assumed that around 20% of all user traffic is consumed during a two-hour peak time every day. A light user household in the Philippines would consume around .05 Mbps of traffic during their peak utilization time. An average user household would consume around 0.750 Mbps.

It is evident from the calculations above that a 5G system at 3.5 GHz could easily handle the traffic requirements of light user Philippine households in 2021, and a 5G system at 28 GHz could handle the traffic of an average household. Even though GPON FTTP provides 16x the bandwidth, 5G FMS would be appropriate for up to 80% of Internet users.

2. High Altitude Platform Stations

High Altitude Platform Stations (HAPS) are defined by the ITU as "a station on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth." Today's emerging high-altitude technologies are anything but fixed, and the technology space has been one of rapid experimentation and development, but little commercial success.

Tethered blimps are being used by Massachusetts-based start-up Altaeros[87] to provide LTE for rural broadband. At just 250 meters above ground level, they are able to cover an area of 10,000 square kilometers—nearly the size of the island of Mindoro in the Philippines. Japanese mobile telco Softbank is one of their latest investors,[88] giving credibility to their plans.

Free-floating balloons have been used in pilot projects by Google since the Loon project launched[89] in 2013 in New Zealand. In Peru in 2017, the Loon team collaborated with Peru's Telefonica to provide service to areas of the country isolated by flooding.[90] The temporary network reportedly provided 160 gigabytes of data[91] to "tens of thousands of people." Later in 2017 the Loon team worked with AT&T and T-Mobile to provide service to Puerto Rico in the aftermath of Hurricane Maria.[92] Service was limited[93] to "some people with LTE-enabled phones." Loon's partnerships with mobile operators are a result of their choice to change wireless technologies from FWA to mobile broadband. With that decision came a requirement for mobile spectrum, which, in the cases of Peru and Puerto Rico, was donated by the local carriers for limited, project-based use. Loon's next planned commercial network is for Kenya,[94] where they will partner with Telkom Kenya.

Drones have captured the minds of many start-ups and investors. The Titan Aerospace Solara 50[95] was a high-altitude, solar-powered, fixed-wing drone designed to provide telecommunications services to rural and remote locations. Titan was purchased by Google in April 2014. After several years without major success, the project was shut down in January 2017. Facebook's Aquila drone was a high-altitude, solar-powered, fixed wing drone similar in design and mission to the Titan Solara. The drone was developed by Facebook in 2014 and had its first test flight in 2016. After beginning a collaboration on drones with Airbus[96] in 2017, Facebook cancelled the Aquila program in June 2018.[97]

3. Television Whitespace

The switch from Analog to Digital TV broadcasting released a large amount of radio spectrum known as the Digital Dividend.[98] Television Whitespace (TVWS) is a technology that can take advantage of that spectrum to provide broadband Internet. The core protocol of TVWS products is IEEE 802.22,[99] which was ratified in 2011. While many technologies are capable of using digital-dividend spectrum, 802.22-compliant products can do so without causing harmful interference to neighboring television channels. TVWS base stations communicate with a spectrum database to find free channels in specific geographic locations. Subscriber units and base stations spend some of their time listening to the radio spectrum to ensure that they are not interfering with other users of the spectrum.

To date, no operator anywhere in the world has deployed TVWS at scale. Equipment manufacturers like Carlson, Redline, and 6harmonics have moved their TVWS equipment away from the 802.22 standard. Regulatory enablement has also been slow, however several countries including the United States and the United Kingdom have favorable conditions for TVWS use.[100] Adoption of the technology has been very slow, and no manufacturers are building enough equipment to allow for a large-scale operational deployment.

In the Philippines, there have been pilot TVWS networks but no evidence that they reached any scale or provided anything that was not possible with another technology, in a less costly and less complex way.

Absent any positive confirmation of operational networks, there needs to be more assessment of TVWS as a technologically feasible solution. Hopefully, the lessons learned from are TVWS are well-considered in future dynamic spectrum implementations, like citizens broadband radio service.

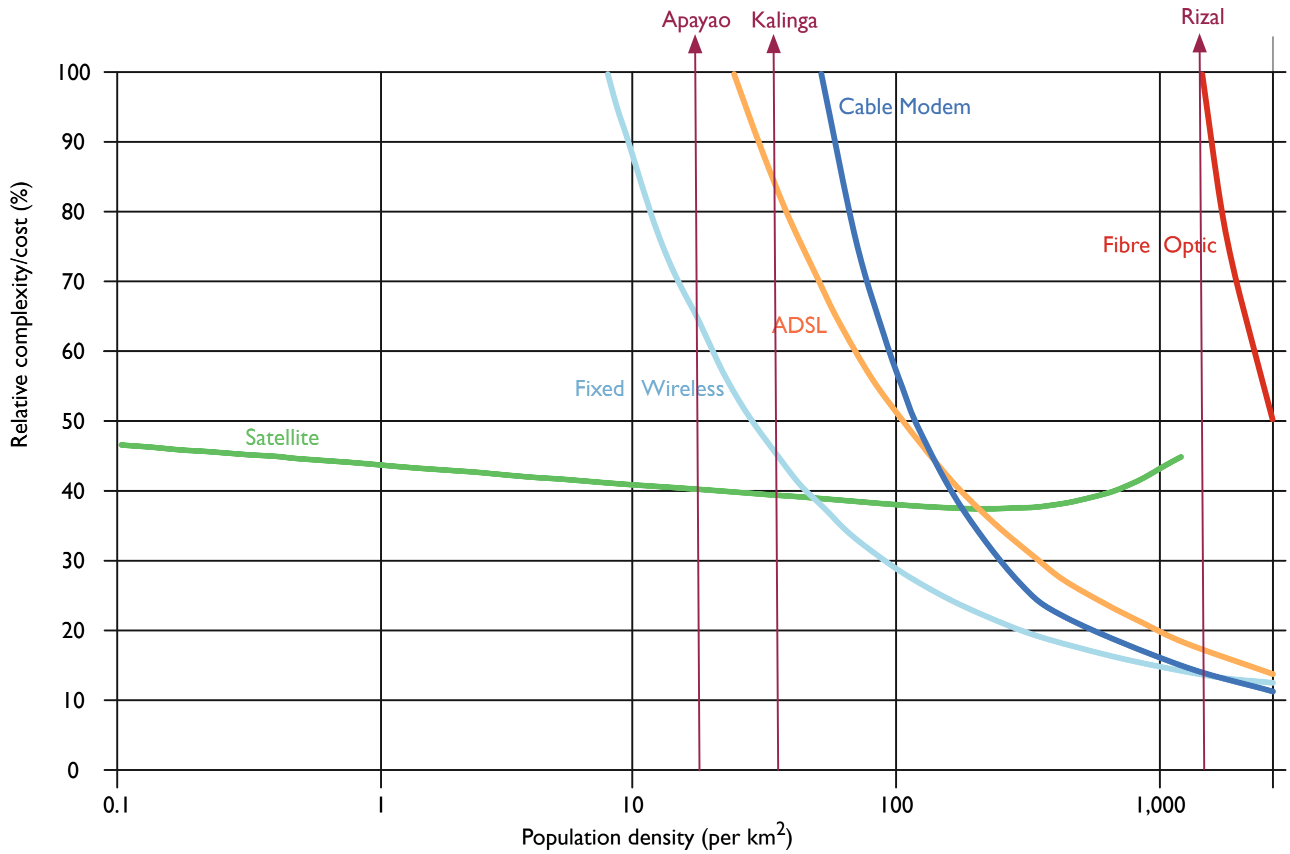


Figure 9. Suitable broadband access technologies as a function of population density

Source: Author, based on Communications Research Centre Canada (CRC). Cited in Chouinard, G. (2006).

4. Fixed Wireless Access

Wireless broadband has reduced in cost and increased in capacity steadily over the years, with most equipment designed for the 5-GHz band. While it does not compare to LTE from a spectral efficiency standpoint, the cost of entry for providers of wireless broadband is very low. The sub-10 GHz frequency bands are most appropriate in rural and remote contexts. Across markets with favorable regulation, Wireless ISPs (WISPs[101]) have proliferated to take advantage of Fixed Wireless Access (FWA) equipment to service markets overlooked by traditional carriers.

Non-5G Millimeter Wave (MMW) FWA is an emerging space with some vendors selling[102] 10-Gbps access points in the 60-GHz band. Additionally, pre-market technologies like Facebook's Terragraph[103] combine MMW and Massive MIMO to provide 10 Gbps per end user, with access points delivering 240 Gbps of capacity per small (street-light sized) installation.

Satellite Networks

Some populations are too difficult or expensive to connect with terrestrial broadband technologies. In 2006, Communications Research Canada produced a study[104] comparing the relative cost and complexity of delivering broadband to Canadians using several technologies, with the key factor being population density. This research showed that in populations below around 70 people per square kilometer, satellite is the best choice for delivering broadband. A chart of the results is reproduced below, with the densities of several Philippine provinces superimposed. Today, these cost-complexity curves may have adjusted due to technological developments, but the principle remains: below a certain population density, satellite will be the best option from a cost/complexity standpoint.

As carriers and governments push towards achieving Universal Access,[105] satellite is a key area of innovation.

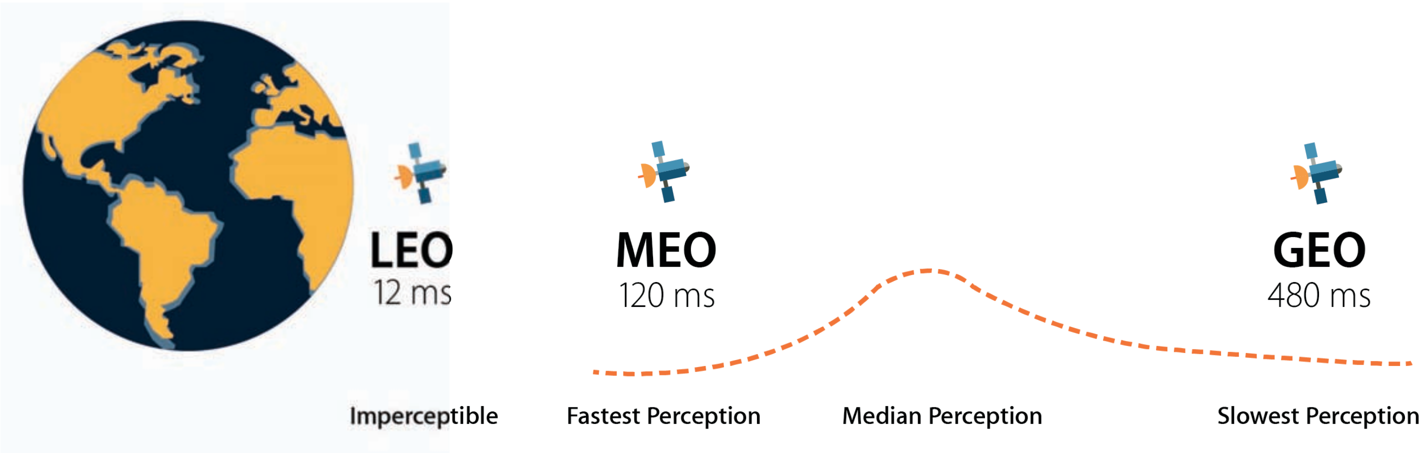


Figure 10. Satellite Latency vs. Human Perception

Note: Satellite icon by Freepik from www.flaticon.com.

Emerging technologies in launch capabilities, satellite manufacturing, MMW, Massive MIMO, and Free Space Optics (FSO)[106] are all being incorporated into new satellite networks, which could end the possibility of being disconnected anywhere on Earth, and even replace some terrestrial networks.

In developed populations of sufficient size to support a competitive satellite market, the only drawback to using satellite broadband is latency. After taking more than 67 million measurements,[107] the Human Benchmark Project has determined the median reaction time of people is around 270 milliseconds (ms). After that point, humans can perceive a delay in communications.

The latency introduced by the distance that signals have to travel to reach satellites can be significant. In the case of most existing satellite networks (geostationary orbit or GEO) latency starts at 480 milliseconds and goes up from there. This means most people will perceive satellite communications from GEO satellites to be slow. But with the emerging use of different orbital configurations that are nearer Earth, there is great potential to change that perception.

Satellite technology has evolved and improved tremendously from when it was first used for communication. Its benefits and features dramatically change, depending on how near or far the satellite is to the earth's orbit.

Geostationary Orbit (GEO)

Geostationary is a Geosynchronous[108] equatorial orbit around 36,000 kilometers above the earth, directly over the equator. It has been used for commercial communications for decades, and for commodity broadband for more than 10 years. Satellites placed in the GEO orbits circles the earth in the same direction and same speed as the rotation of the earth, making them appear to be motionless to the users on the ground. Satellite dishes pointed at a GEO satellite can be aimed once, and kept in the same position for the life of their service. Due to the curvature of the earth, GEO satellites can only cover to +/- 82 degrees from the equator. To achieve near-global coverage, a network would require three equally-distant satellites. GEO services have a latency of around 480 ms, so most people perceive them to be slow.

Medium Earth Orbit (MEO)

Any orbit between 2,000 and 36,000 kilometers above the earth can be described as MEO. However, new and emerging MEO satellite networks are mainly destined for orbits at between 8,000 and 12,000 km above the earth. MEO satellites orbit the earth between once and twelve times a day.[109] Satellite dishes on the ground need to "track" or follow satellites across the sky to keep in contact. This makes MEO terminals expensive to install and maintain, and not appropriate for direct-to-consumer services. The highest-capacity MEO broadband network, O3b, covers +/- 45 degrees from the equator, and has a latency around 120 ms. Since the network's beginning in 2014, it has added tens of gigabits of second of capacity into remote markets, including many Pacific island nations. The network is the first entrant into this emerging market, and is growing with additional capacity launched into orbit[110] this year.

Low Earth Orbit (LEO)

LEO is an orbit between 400 and 900 kilometers above the earth, with satellites that circle the globe around once every 90 minutes.[111] Communications satellites in LEO typically use polar orbits, meaning they cross over the north and south pole in their circuit of the earth. LEO networks are designed so subscribers on the ground can use a single, stationary or mobile antenna, and maintain connection with one or more satellites at all time. LEO networks are the only satellite systems that provide complete coverage of the earth, including the poles. To date, only voice and low-speed data communications have been supported by LEO networks. That's set to change with at least five new networks[112] planning to launch broadband services. These networks plan to have latencies between 12-30 ms—which will be imperceptible to end users and a major change in the capabilities of satellite broadband.

SmallSats and CubeSats

SmallSats are satellites weighing under 180 kg.[113] Cubesats are nano-satellites weighing around a kilo, and measured in units of 10cm^3. While most are a single cube, they can grow as large as 20x20x30cm. Since the major cost of satellites is in launch costs, lowering the size of a satellite reduces its cost significantly. Launches into LEO for a CubeSat like the one that the Philippines' Department of Science and Technology (DoST) sent in June 2018[114] can be had for as low as $40,000.[115] SmallSats can be launched for as little as $5 million[116] through new launch platforms like RocketLab.[117] This low cost means that small ISPs, educational institutions, and government departments can fund their own satellites. At certain frequencies—if governments support applicants—SmallSats could be ideal for providing remote connectivity needs.

Box 2. Satellite Radio Spectrum

Satellite Radio Spectrum

L-band is a small allocation of frequencies around 1.5 GHz, typically used for mobile voice and low-speed data communications. From a GEO orbit, its reusability would be very poor, so it's mainly used by LEO networks. L-band is impervious to weather and in some cases can penetrate through foliage. As a mobile band, device antennas are usually small and omnidirectional.

C-band is a large allocation of frequencies between 4 and 8 GHz. It is impervious to weather but requires a large dish antenna. C-band frequencies are often used from GEO satellites to broadcast television or radio over entire regions at once.

Ku-band is an allocation of frequencies around 12 GHz that is often used for digital or pay television. Its reusability is good—a single GEO satellite can re-use the same block of Ku band spectrum many times over different areas, and a network of MEO satellites can gain very high re-use. Its antenna size is also good; typical subscriber antennas range from 300 to 900 mm. Ku frequencies fade in heavy rain and snow, but generally have very high reliability in most climate zones. Their capacity is sufficient to provide gigabits per second of data from a single spot beam.

Ka-band is the highest capacity set of frequencies used for satellite to ground communications. There is a large amount of spectrum available from 26 to 40 GHz, with extremely high reusability. Relatively small antennas can be used. The only drawback of the Ka-band is rain fade. In tropical applications, Ka-band services may only be available 97% of the time.

V-band is an emerging satellite band above 50 GHz. It has very high reusability and there is a large amount of spectrum, but due to how it interacts with the atmosphere and rain, it can only be used in space. V-band is likely to be a common method for satellite-to-satellite communications in the future, replacing more expensive and less reliable optical connections.

A number of radio frequency bands are used for satellite communication. Each block of spectrum has very different properties and is used in different cases. These properties include availability, reusability, antenna size, and rain fade. The box below discusses the different satellite radio frequencies and how they are being, or can be, used by satellite networks.

There are a number of emerging technologies that are helping increase the capacity and reliability of satellites while making them less expensive to launch and operate. There are technologies, such as software defined radio (SDR) that allows satellites to be built and launched at low cost. There is the optical satellite network that allows for ultra-high capacity without the requirement for radio spectrum and also allow for nearly infinite re-use of spectrum. Finally, there's a smart blended network that combines FSO and MMW as seen in terrestrial systems, MEO and LEO orbits, or even fiber optic plus satellite, such that frequencies and technologies are used at the best and most appropriate time. For more details on SDR, optical satellite networks, and blended networks, please refer to Appendix A.

LEO and the future of satellites

Low Earth Orbit is the next space race, and all of the networks announced in recent years plan to offer global coverage. By 2025, the earth could be covered with new broadband networks operated by Boeing, LeoSat, OneWeb, SpaceX, Telesat, Theia Holdings, Viasat, and more. These networks have a chance to make a significant impact on rural and remote connectivity in the Philippines. Three of the more developed ventures are discussed below.

1. OneWeb

OneWeb started life in 2014 as WorldVu Satellites Limited,[118] founded by entrepreneur Greg Wyler with funding from Google.[119] Wyler previously founded O3b networks, the first successful MEO broadband network now owned by SES.[120] Wyler's idea with WorldVu was to provide ultra-high speed, low-latency connectivity to end users anywhere on Earth.

Early on, OneWeb, as WorldVu came to be known, settled on the idea of having a constellation of more than 700 satellites, using Ku-band spectrum from a failed company called Skybridge.[121] Their innovation was a unique method of transmitting to not interfere with existing users, leading to very high re-usability of the spectrum. OneWeb's business model evolved to selling wholesale to a master distributor, who will then sell to mobile carriers, to help them provide ubiquitous coverage for their existing networks.

Initial partners for OneWeb included Airbus, Coca-cola, Qualcomm, and Virgin. Each partner brought its own area of expertise or demand. Airbus is skilled in designing and building satellites.[122] Qualcomm brings its telecommunications expertise, and has designed a system[123] that will allow data services to be supplied to millions of subscribers from satellites that may only be connected to subscribers for a few minutes as they pass overhead. Virgin brings both a mobile network that can be used to wholesale the OneWeb service, and an aerial launch platform[124] to help OneWeb get its satellites into orbit. Coca-cola brings a network of millions of vending locations, some of which are outdoors and could act as local broadband distribution points.[125]

Sensing the excitement and potential of OneWeb, Intelsat made a major investment in 2015.[126] By the end of that year, OneWeb was already starting to promote blended offerings,[127] where its customers could receive service by both GEO satellites and LEO satellites at the same time. The two companies later planned a merger, that eventually collapsed in 2017 due to issues restructuring Intelsat's corporate debt.[128]

OneWeb's latest major partner is Japanese telecommunications company SoftBank. They invested[129] a billion dollars in OneWeb in 2017, and will be OneWeb's master distributor[130] for bandwidth worldwide.

OneWeb's satellites are going to be some of the smallest communications satellites ever launched—weighing only 150 kg each. Their initial network of 700+ satellites is expected to have 6 Gbps of capacity per satellite, resulting in a total network capacity of 4.2 Terabits per second (Tbps).

The OneWeb service could be used by a MNO to offer service direct to end-user houses or cars. Due to its frequencies, it will never be sent directly to mobile phones—only to receiver antennas, which will share access to mobile devices via 4G or Wi-Fi hotspots.

As the MNO would be purchasing a wholesale service through an intermediary, they may offer service at a premium over their standard rates.

2. LeoSAT

LeoSat is a European venture partnered with Thales Alenia Space. Its mission is to provide high-speed, low-latency connectivity to corporate customers and network operators. One of LeoSat's goals is to provide fast intercontinental backhaul that will survive natural disasters and the severing of undersea fiber optic cables.

LeoSat will use satellites nearly eight times bigger than OneWeb—an existing satellite platform that is already used by Iridium Next in low earth orbit, and O3b in medium earth orbit.

Each LeoSat will have 16 Gbps of capacity and will use optical lasers to communicate in space between satellites. They will have a much smaller constellation than OneWeb, with only 78 satellites in total—for a 1.2 Tbps network.

It is very likely LeoSat will be used by mobile operators to provide backhaul for remote cellular towers. This could allow towers to be built on islands where it is impossible to get fiber optic or microwave connectivity.

When carriers use a third party for backhaul, they typically absorb the cost of the link, and end users do not receive a more expensive service as a result.

3. SpaceX StarLink

In November 2014, Elon Musk announced a potential satellite collaboration with OneWeb[131] but, by January 2015, decided to go it alone with an independent network.[132] Around the same time, former OneWeb partner, Google, purchased a billion-dollar stake[133] in SpaceX. By November of 2015, SpaceX had announced firm plans by way of an application[134] to the United States Federal Communications Commission (FCC) to launch a network of 4,425 satellites. In March 2018, the FCC approved[135] these plans, allowing SpaceX to increase the number of active communications satellites in orbit by four times.

By 2018, the SpaceX service had a name, StarLink, and plans to expand[136] the network to a total of 12,000 satellites. As a vertically integrated enterprise, SpaceX will eschew the many partners OneWeb has taken on. SpaceX will build nearly every component[137] of their satellites. It has already launched two prototype satellites,[138] and when it begins service, it will exclusively use its own rockets.

As a global service, StarLink could have an impact on the Philippines, but only if granted a license to operate. SpaceX intends to sell direct-to-customer and so does not have a model compatible with local providers, as OneWeb and LeoSat do. It would not be unprecedented for SpaceX to prohibit use of their service in the Philippines—global satellite phone network Iridium does not offer service in India[139] due to that government's licensing requirements.

The Starlink service will provide gigabit speeds and will end distance as a cause of the digital divide. It is not, however, expected to help with affordability. SpaceX plans to earn $30 billion a year from a network that will support 40 million subscribers,[140] figures that indicate end users will pay more than $60 per month. This is in line with ViaSat's existing 675,000 subscribers at an average revenue per user of $63.11.[141]

IV | Philippine Telecommunication, Internet Policy and Regulation

Photo by PixaBay

"Internet in the Philippines is almost synonymous to telecommunications (telecoms). This is the result of the policy and regulatory environment governing communications in the country."

IV. Philippine Telecommunication and Internet Policy and Regulation

Internet in the Philippines is almost synonymous to telecommunications (telecoms). This is the result of the policy and regulatory environment governing communications in the country. The basic laws, and the succeeding regulations based on them, that are used to determine the ownership, establishment, and operation of the infrastructure necessary to the provide the Internet were approved 1995 or earlier, i.e., prior to the commercial success of the Internet. As a result, the policy and regulation meant for basic telecommunications services are also often used for Internet service, which is classified as a value-added service.

Telecommunications and Internet in the Philippines

1. Telecommunications Service, Ownership, and Operations

Telecommunications is considered a public utility and is, therefore, required to secure a franchise from Congress and a certificate of public convenience and necessity (CPCN) from the National Telecommunications Commission (NTC), the industry regulator. As a ***public utility***, foreign ownership of a telco is limited by a cap of 40 percent.

The Philippine Constitution of 1987 requires a public utility to secure a franchise, certificate or authorization, which shall be granted to entities with at least 60% Filipino ownership.

> "SECTION 11. No franchise, certificate, or any other form of authorization for the operation of a public utility shall be granted except to citizens of the Philippines or to corporations or associations organized under the laws of the Philippines ***at least sixty per centum of whose capital is owned by such citizens***, nor shall such franchise, certificate, or authorization be exclusive in character or for a longer period than fifty years… The participation of foreign investors in the governing body of any public utility enterprise shall be limited to their proportionate share in its capital, and all the executive and managing officers of such corporation or association must be citizens of the Philippines." [142] (emphasis provided by author)

The Commonwealth Act 146 of 1936 or the Public Service Act defines a "public service" as including every person that "may own, operate, manage, or control in the Philippines, for hire or compensation, with general or limited clientele, whether permanent, occasional or accidental, and done for general business purposes." Under the law, a public service includes "any common carrier… wire or wireless communications system, wire or wireless broadcasting stations and other similar public services."[143] CA 146 requires entities offering a public service, such as telecommunications, to secure a certificate of public convenience (CPC) or certificate of public convenience and necessity (CPCN) to be issued by the Public Service Commission, which "shall have jurisdiction, supervision, and control over all public services and their franchises, equipment, and other properties"—a function now designated to the sector regulators.[144]

All public utilities are regulated to assure (i) controlled roll-out of utilities to ensure viability and prevent duplication of facilities; (ii) affordable rates to the public; and a 12-percent return on investment (ROI) cap, which should be plowed back into capital investment, continued maintenance and upgrading of systems.

Republic Act 3846 of 1931 or the Radio Control Law provides that only persons or entities with a legislative franchise can "construct, install, establish, or operate a radio station."[145] This is interpreted to mean that only 60-percent Filipino owned companies can be granted a franchise.

Republic Act 7925 of 1995 or the Public Telecommunications Policy Act opened up the market previously monopolized by PLDT and institutionalized the sector's liberalization, which began in the late-1980s through department and executive issuances.[146] It established the national policy to ensure the growth and development of telecommunications services based on fundamental objectives "to develop and maintain viable, efficient, reliable and universal telecommunication infrastructure using the best available and affordable technologies"[147] and "to prioritize improving and extending basic services" to unserved areas.[148]

RA 7925 also reiterates the mandate of the NTC to allocate radio spectrum "to service providers who will use it efficiently and effectively to meet public demand for telecommunications service."[149] It also provides that spectrum allocation and assignment shall be subject to "periodic review," that use of spectrum shall be subject to a reasonable "spectrum user fees," and that the NTC shall hold open tenders "where demand for specific frequencies exceed availability." [150]

As a result of liberalization, a number of new entities entered the Philippines' telecoms market, especially in cellular mobile services.[151] When mobile phones shifted from analog to digital technology that was capable of sending short messaging service (SMS), and operators started offering prepaid payment schemes, fixed-line subscription began to decline rapidly. By 2000, there were more mobile phone subscriptions compared to fixed lines.[152]

While laws and policies promoted competition when they were first introduced, some of them also serve as barriers to the entry and operation of a more diverse set of service providers and technology today. For a summary of the laws and policies that affect ownership and operations in each segment of the telecommunications network, please refer to Appendix B.

2. Basic Telecommunications and Value-Added Services

Telecoms services in the Philippines are classified as either "basic" or "enhanced." Under RA 7925, telecommunications is defined as "any process which enables a telecommunications entity to relay and receive voice, data, electronic messages, written or printed matter, fixed or moving pictures, words, music or visible or audible signals or any control signals of any design and for any purpose by wire, radio or other electromagnetic, spectral, optical or technological means."[153]

A ***basic telecoms service*** is provided by a ***public telecommunications entity (PTE)***, defined as "any person, firm, partnership or corporation, government or private, engaged in the provision of telecommunications services to the public for compensation."[154] A PTE needs to secure a ***franchise***, a privilege conferred by Congress, "authorizing that entity to engage in a certain type of telecommunications service."[155] It also needs to secure a provisional authority (PA)[156] or a ***certificate of public convenience and necessity (CPCN)***[157] from the NTC in order to operate a particular service.

Only a telco with a legislative franchise and PA/CPCN is allowed to build transmission and switching facilities, offer a local exchange service (landline), and operate inter-exchange service (backbone) and an international gateway facility (IGF).

> **"Only a telco with a legislative franchise and PA/CPCN is allowed to build transmission and switching facilities, offer a local exchange service (landline), and operate inter-exchange service (backbone) and an international gateway facility (IGF).**

Under RA 7925, an ***international carrier*** that wishes to build and operate an IGF is required to comply with obligations to provide local exchange service (landline) in unserved and underserved areas within three (3) years from the grant of its authority. In the IRRs, the obligation is detailed as at least 300,000 local exchange services.[158] Similarly, a mobile radio or cellular mobile telephone system (CMTS) operator is required to comply with its obligations to roll-out 400,000 landlines within three (3) years from the grant of its authority.[159]

Photo by Manolo Franco from PixaBay

When the Internet became commercially available, cable landing stations (CLS) began to emerge. Similar to the IGF of basic voice services, a cable landing station can only be built and operated by a PTE with a franchise and a CLS license. However, the NTC does not impose the landline-rollout obligation to a CLS operator.[160]

An enhanced or value-added service refers to "a service which adds a feature or value not ordinarily provided by a [PTE] such as format, media, conversion, encryption, enhanced security features, computer processing, and the like; provided that in the provision of the enhanced service, no law, rule, regulation or international convention on telecommunications is circumvented or violated."[161] Under the implementing rules and regulations (IRRs) of RA 7925, the term "enhanced service" is used interchangeably with value-added service.[162] The Supreme Court found this definition "unnecessarily confusing" and asserted that the NTC should have consistently used the term "VAS" as it is used in RA 7925.[163]

A VAS provider is not required to secure a franchise from Congress, but only needs a certificate of registration from the NTC "provided that it does not put up its own network."[164] This provision in RA 7925 is widely understood to mean that VAS is deregulated. However, it is NTC that officially defined by enumeration which services constitute VAS and set the requirements for offering VAS.[165] The Supreme Court, in its decision in G.R. No. 143964, asserted that, as the sector regulator, it is within the NTC's mandate to define which services constitutes a VAS.[166]

The NTC classifies the Internet or broadband service as a VAS,[167] although there is no regulatory issuance on the matter.[168]

An ***Internet service provider (ISP)*** in the Philippines is considered a VAS provider, who is not required to secure a franchise from Congress and a PA/CPCN from the NTC. However, an ISP is not allowed to put up its own ***network***.[169] Instead, a non-telco entity that wishes to offer Internet services shall rely on "the transmission, switching and local distribution facilities of the local exchange and inter-exchange operators, and overseas carriers."[170]

As a VAS provider, an ISP shall be allowed to offer services "and lease or rent telecommunications equipment and facilities necessary to provide such specialized services, in the domestic and/or international market in accordance with network compatibility."[171] In short, an ISP is ***required to connect to a telco facility*** to render its services.

3. Radio Frequency Management

Republic Act 3846 of 1931 or the Radio Control Law grants the NTC the power to: (i) classify radio stations (equipment) and prescribe the nature of service to be rendered by each class and by each station; (ii) assign frequencies and license radio stations (equipment), and (iii) make rules and regulations to prevent and eliminate interference between stations.[172]

RA 3846 provides that only persons or entities with a legislative franchise can "construct, install, establish, or operate a radio station."[173] Entities need to secure a permit from the NTC before construction or installation of a radio facility, and operation of a radio station should be in accordance with the provisions stipulated in a license awarded by the regulator.[174]

Photo by Angelo Gutierrez

Radio frequency spectrum is assigned by the NTC through an administrative process. However, RA 7925 provides that "where demand for specific frequencies exceed availability, the Commission shall hold open tenders" in order "to ensure wider access to this limited resource." To date, the NTC has never conducted an open tender or auction.

The NTC's present policies and procedures for the allocation, assignment, recall and re-assignment of spectrum are stated in ***NTC Memorandum Circular (MC) 03-03-96***, a circular enacted as an addendum to Rule 600 of NTC MC 08-09-95, the Implementing Rules and Regulations of RA 7925.

4. Infrastructure and Network Deployment

The NTC does not regulate the construction of passive telecommunications infrastructure such as towers, poles, ducts, utility corridors and in-building risers and cabling. Section 16 of RA 7925 also provides that the upgrading and expansion of networks and services within a previously authorized service area does not require any approval from the NTC. As such, the construction of these kinds of passive infrastructure are subject only to the requirements of the National Building Code, which is administered at the local level by Local Government Units (LGUs), i.e., the barangays, municipalities, and cities where the facilities are to be located. The NTC will only step in when there are complaints that a particular site causes interference with the radio signal of another.

LGUs in themselves impose their own requirements for the construction of passive infrastructure, and they vary from one LGU to another. Approval of permits and payment of fees required by the local authorities are done individually by the proponents. Apart from the LGU, the homeowners' associations (HoA) in subdivisions and condominium projects, and building administrators also impose certain guidelines and requirements based on Housing and Land Use Regulatory Board (HLURB) Resolution No. R-626 issued in 1998 on the locational guidelines[175] for cellular mobile base stations and other wireless communications services.

Telcos and ISPs have complained about the sheer number of permits required, the amount of bureaucracy they encounter, and the expenses required to facilitate the issuance of permits for passive infrastructure. Local governments reportedly impose arbitrary fees for permits and clearances that have no clear basis[176] and are sometimes unaccounted for. National government agencies also require telcos to secure clearances for various purposes. Apart from government, telcos complain that exclusive villages and homeowners' associations—who refuse to have unsightly antennas or "equipment that emit radiation" put up in their vicinity—also give them a difficult time.[177] The telcos are also subject to real property taxes not only for land they own and use for sites, but also for radio equipment located on sites, which are considered under the law as real property because they are bolted to the ground or attached to structures built on leased or owned land.

Globe Telecom estimates that at least 25 permits are needed to put up one cell site and at least eight (8) months are needed to complete the whole permitting process.[178] According to Globe, the following permits need to be acquired per cell site.

Table 4. Why it takes 8 months before one cell site can be constructed

Right of Way
Negotiations and documentation of prospective cell site location
No. of permits: 8 | **Time:** 1-2 months

Social Acceptability
Barangay resolution, Home Owners Association consent, and residents' conformity
No. of permits: 5 | **Time:** 1-2 months

Various LGU permits
Zoning clearance from HLURB city or municipal resolution, occupancy permit, mayor's permit
No. of permits: 5 | **Time:** 2 months

National permits
DENR, LLDA, CAB, DOH, PCSD, BFAR, NCP
No. of permits: 8 | **Time:** 1-2 months

Structural permits
Zoning permits, locational clearance, building permit inclusive of electrical permit, sanitation permit and mechanical permit, occupancy permit
No. of permits: 3| **Time:** 3-5 months

Construction starts

Source: Globe Live. (2016, May 16). Why it takes 8 months before one cell site can be constructed. https://community.globe.com.ph/community/welcome/guide/blog/2016/05/16/why-it-takes-8-months-before-one-cell-site-can-be-constructed

To address this issue, Globe has called for the amendment of the Local Government Code to expedite the issuance of all local permits for telecommunications facilities.[179]
The telcos, with the help of NTC and the National Housing Authority (NHA), have been working to get these requirements incorporated in the National Building Code so that they are, at least, standardized and individual LGUs do not create unique requirements, which varies from place to place.

There is also duplication in some permitting requirements. For example, proponents must secure an Environmental Clearance Certificate from the Department of Environment and Natural Resources (DENR), but at least one province is known to also require its own "Provincial ECC" aside from the DENR's own ECC. There are separate height and zoning clearances from the city or the municipality, something that is also required by other permits.

However, some critics, including legislators, have pointed out that service providers should not use the permitting process as an excuse for not building out cell sites and expanding their network. The big telcos, for examples, should have provided for all the permits, and the time it takes to secure them, in their planning process. To cope with the 8-month timeframe, the telcos start the site acquisition the year before they need the location. The telcos start planning for the next phase even as they are starting the current phase. As this process is continuous, there should be a number of new cell sites every year. Thus, while bureaucracy is an issue, it is not an insurmountable hurdle and, critics say, should not be used as an excuse for having very low cell site density in the country.[180]

There is no policy or regulation requiring the telcos and ISPs to share their network rollout plans with the regulator or any government agency, so there is minimal[181] to no concerted effort on the part of government to coordinate the digging of roads with the telcos and broadband service providers for underground cabling. However, service providers do coordinate with the Metro Manila Development Authority (MMDA) and the Department of Public Works and Highways (DPWH) when digging national roads for cable and pole installation.

Government Institutions

1. National Telecommunications Commission

The powers and functions of the NTC are contained in Section 15 of Executive Order (EO) No. 546 "Creating a Ministry of Public Works and a Ministry of Transportation and Communications" issued in 1979, which serves as the Commission's charter. The NTC is mandated to, among others:

a. Issue Certificates of Public Convenience for the operation of communications utilities and services;

b. Establish, prescribe and regulate areas of operation of particular operators of public service communications (including the prescription of charges or rates pertinent to the operation of such public utility facilities and services;

c. Grant permits for the use of radio frequencies for wireless telephone and telegraph systems and radio communication systems including amateur radio stations and radio and television broadcasting systems;

d. Sub-allocate series of frequencies of bands allocated by the International Telecommunications Union to the specific services;

e. Establish and prescribe rules, regulations, standards, specifications in all cases related to the issued Certificate of Public Convenience and administer and enforce the same. [182]

The NTC's mandate to regulate the telecommunications sector emanates mainly from CA 146 or the Public Service Act. Specifically, the quasi-judicial functions and the power of the NTC to impose penalties on telecommunications entities that are in violation of their franchise are provided in CA 146—functions that used to belong to the Public Service Commission.

The NTC has licensing functions or the ability to authorize specific entities to provide specific ICT services, and to regulate the quality and performance of such entities in rendering services. This function is established in law and by Supreme Court decisions.[183] Under Section 5 of RA 7925, these responsibilities include the following:

a. ***Adopt an administrative process which would facilitate the entry of qualified service providers*** and adopt a pricing policy which would generate sufficient returns to encourage them to provide basic telecommunications services in unserved and underserved areas;

b. ***Ensure quality, safety, reliability, security, compatibility and inter-operability of telecommunications facilities and services*** in conformity with standards and specifications set by international radio and telecommunications organizations to which the Philippines is a signatory;

c. ***Mandate a fair and reasonable interconnection of facilities of authorized public network operators and other providers of telecommunications services through appropriate modalities of interconnection and at a reasonable and fair level of charges,*** which make provision for the cross subsidy to unprofitable local exchange service areas so as to promote telephone density and provide the most extensive access to basic telecommunications services available at affordable rates to the public;

d. ***Foster fair and efficient market conduct through, but not limited to, the protection of telecommunications entities from unfair trade practices of other carriers;*** compliance with service standards from such entity"

The NTC is also mandated to promote consumer welfare. As stated in Sec. 5 of RA 7925, it is tasked to:

e. ***Promote consumer welfare by facilitating access to telecommunications services whose infrastructure and network must be geared towards the needs of individual and business users;***

f. ***Protect consumers against misuse of a telecommunications entity's monopoly or quasi-monopolistic powers*** by, but not limited to, the investigation of complaints and exacting compliance with service standards from such entity

The regulator also has a clear-cut mandate on the management of spectrum. Under Sec. 4 of RA 7925, it states:

- The government shall allocate the spectrum to service providers who will use it efficiently and effectively to meet public demand for telecommunications service and may avail of new and cost effective technologies in the use of methods for its utilization.

2. Department of Information and Communications Technology

In 2016, the Department of Information and Communications Technology (DICT) was created by Republic Act 10844 to serve as "the primary policy, planning, coordinating, implementing, and administrative entity… that will plan, develop, and promote the national ICT agenda."

The NTC became an attached agency of DICT, for policy and budgetary reasons. While the NTC continues to operate under RA 7925, the DICT, under RA 10844, is now responsible for:

a. The development and maintenance of a long-term strategic national development plan for telecommunications to serve as a guide to the industry and potential investors as well as to the Commission;
b. The coordination of research and development activities in government with the work of other institutions in the field of telecommunications;
c. The representation and promotion of Philippine interests in international bodies, and the negotiation of the nation's rights and obligations in international telecommunications matters; and
d. The operation of a national consultative forum to facilitate interaction amongst the telecommunications industries, user groups, academic and research institutions in the airing and resolution of important issues in the field of communications

Apart from policy formulation and recommendation on the development of ICT, the DICT shall (i) prescribe rules and regulations for the establishment, operation, and maintenance of ICT infrastructures in unserved and underserved areas, and (ii) establish a free Internet service that can be accessed in government offices and public areas using the most cost-effective telecommunications technology, through partnership with private sector providers.

ICT has a broader scope than telecommunications. According to RA 10844, the "ICT sector" includes "telecommunications and broadcast information operators, ICT equipment manufacturers, multimedia content developers and providers, ICT solution providers, Internet service providers, ICT training institutions, software developers and ICT-[enabled service] providers."

This means that the DICT has broad powers to promulgate policy and rules even for telecommunications and on spectrum management, if they concern the implementation of the "national ICT agenda." This also means that the NTC, as an attached agency of the DICT, now regulates and enforces rules based on the policy guidelines and rules issued by the DICT that affect the broader ICT industry.[184]

To date, the DICT has prioritized: (i) the development of a National Broadband Plan to accelerate the deployment of fiber optic cables and wireless technologies to improve Internet speed; (ii) provision of free Wi-Fi access in public places, including parks, plazas, public libraries, schools, government hospitals, train stations, airports, and seaports; (iii) development of a National ICT Portal; and (iv) selection of a third major telecom player.

Universal Broadband Access Initiatives

In 2015, the government, through the Information and Communications Technology Office (ICTO), the precursor to the DICT, launched the Free Public Wi-Fi program called Juan, Konek! (later on changed to Pipol Konek! [trans. People Connect!]). It aims to bridge the digital divide by providing free Internet access to "a total of 1,634 localities, spanning 1,489 Class 1-6 municipalities and 145 cities with 13,024 sites covered by 18 Points of Presence (PoP) across the Philippines." The public places include "plazas and parks, public libraries, schools, colleges, and universities, rural health units and government hospitals, train stations, airports, and seaports, and national and local government offices."[185]

The first bidding was a failure; it was found that the big telcos did not have enough facilities even in some of the 1st to 2nd income class municipalities.[186,187] Two years after its launch, only 181 of the 13,024 planned sites were operational in 17 provinces or a little over 1% of the target set for 2017 by the Juan, Konek! project.[188] Between February 2015 and September 2017, there were 807 access points installed.

In August 2017, President Rodrigo Duterte signed Republic Act 10929 or the "Free Internet Access in Public Places Act," which institutionalized the government's role in ensuring Internet access for all Filipinos, especially those in the areas that remain unserved and underserved by current service providers. One of the key features of this law was a section promoting partnership with the private sector and allowing Internet service providers "to acquire and utilize Internet connectivity directly from satellites and other emerging Internet technologies to ensure universal coverage."[189]

Soon after, the DICT changed the network design and opened up the bidding to the small players, mostly the Internet service providers, who are serving the remote areas and whose business model is anchored on serving their community. The result was almost instantaneous. The total Free Wi-Fi access points increased by 98% in less than a year.

Recognizing that the existing local telcos cannot cope with the demands of the free Wi-Fi project, the DICT is seeking the help of the United Nations Development Program to bring foreign companies and expertise, and provide training based on the successful Wi-Fi rollout in other countries.

In June 2017, the DICT launched the Philippines' first National Broadband Plan, which will serve as the blueprint for broadband development in the country. The Plan aims to accelerate the deployment of fiber and wireless technologies nationwide to improve access, quality, and affordability of broadband services. The strategies include: (i) policy and regulatory reforms, (ii) government investment in broadband infrastructure, and (iii) support for the stimulation of broadband demand.[190]

A key feature of the Plan, under Outcome no. 3 on "More Places Connected," is leveraging the use of satellite and emerging technologies to provide connectivity in geographically isolated places. Satellite and TV White Space technologies are emphasized as "a feasible alternative in providing Internet and broadband access in the countryside." According to the Plan, the deployment of satellite receivers can cater to areas "where other terrestrial and submarine broadband technologies are not feasible." TV White Space can be used particularly in low or sparsely populated areas.

The Philippine government is also investing in building and operating its own cable landing stations where the upcoming Facebook submarine system will land and pass through. The project, called the "Luzon Bypass infrastructure," will be used by Facebook as a redundancy and alternate route to the Luzon Strait, which is prone to typhoon and earthquake. In exchange for the landing rights, Facebook will provide the Philippine government with spectrum or cable capacity equivalent to 2 terabits per second (Tbps) or 2 million Mbps.[191] For the backbone, the DICT will use 6,200 kilometers of dark fiber from the national power transmission grid.[192] For the last mile, the DICT plans to tap the electric cooperatives to help establish government points of presence in underserved and unserved areas and to bring fiber to the home.[193]

V | Regulation of Emerging Technologies in the Philippines

Photo by Angelo Gutierrez

"Given the difficulty of connecting an archipelagic country like the Philippines, it would be an ideal location for testing and adopting emerging Internet technologies for possible use in underserved and unserved areas."

V. Regulation of Emerging Technologies in the Philippines

Given the difficulty of connecting an archipelagic country like the Philippines, it would be an ideal location for testing and adopting emerging Internet technologies for possible use in underserved and unserved areas. To introduce emerging technologies into the market, the first step would be to seek approval from the regulator, the NTC.

Thus far, ***DICT and NTC have not issued specific policies and rules regarding the testing and use of emerging Internet technologies***.

Policymaking for emerging technologies. As a new government agency created in 2016, DICT Undersecretary Denis Villorente says the DICT is prioritizing the operationalization of its mandate first, as provided by RA 10844. Compared to the DICT, Villorente says the Department of Science and Technology (DOST) has a more established role in research and development of emerging technologies, complete with papers and publications. However, the DOST's mandate is to "provide central direction, leadership, and coordination of scientific and technological efforts;"[194] policymaking related to ICT, including Internet technologies, belongs to the DICT. The DICT is slowly building its organizational structure that will support the study of emerging technologies. According to Villorente, the DICT has created the Government Digital Transformation Bureau, which will focus on infrastructure development and prioritize opportunities for tech developers and ICT infrastructure, among others.[195]

For DICT Asec. Allan Cabanlong, laws and policies must be at par with technology, but should not restrict or hinder innovation. He sees DICT's role in promoting universal access using emerging technologies as pivotal. However, the government should also ensure that safeguards are in place. For example, with increasing access to the Internet and with the advent of the Internet of Things, Cabanlong is focusing on developing a cybersecurity platform that will protect the government from vulnerabilities.[196]

Test permit for emerging technologies. For the NTC, the testing of emerging technologies will undergo the usual process for getting a permit. Engr. Imelda Walcien, director of NTC's Regulation Branch, advises that any entity that seeks to test a technology will be required to produce an authority (i.e., a provisional authority or CPCN) for the particular service that it wishes to use the technology for.[197] It will be recalled from the previous section that a PA or a CPCN is issued to a PTE with a Congressional telco franchise. Based on this premise, only a duly enfranchised local PTE can be granted a permit to test emerging Internet technologies.

The NTC applies the basic principles of existing laws to deal with emerging Internet technologies (for details about these laws, see previous section on "Philippine Telecommunications and Internet Policy and Regulation").

" Thus far, DICT and NTC have not issued specific policies and rules regarding the testing and use of emerging Internet technologies.

Engr. Roberto Tolentino, chief of the NTC's Radio Spectrum Planning Division, said that 30 days is the usual time limit for a testing/demo of a technology, but that this is often extendable. Tolentino also added that if the interested parties who wish to introduce a particular technology are non-telcos, they go to the NTC's National Capital Region (NCR) regional office or to the Special Licensing Branch. If they are a telco, they go to the NTC Central Office's Regulation Branch. The requirements for the test permit include:

1. Letter specifying intent to test/demonstrate the technology; the frequency to be used
2. Pro-forma invoice for the equipment involved
3. Location to be used for the testing/demonstration
4. Conformé of telco, if the test will be done within the telco's premises

Table 5. Philippine Laws Affecting Emerging Internet Technologies

<table>
<tr><th>Emerging Internet technologies</th><th>Applicable Laws</th></tr>
<tr><td>a. If the entity offering the technology will be operating as a telecommunications company within the Philippines</td><td>1987 Philippine Constitution, particularly the foreign ownership restrictions (1987)</td></tr>
<tr><td>b. If the entity proposing the technology will offer a service for compensation</td><td>C.A. 146 or the Public Service Act (1936)</td></tr>
<tr><td>c. If the technology is for a service that will operate on a telecommunications network, whether wired or wireless</td><td>R.A. 7925 or the Public Telecommunications Policy Act (1995)</td></tr>
<tr><td>d. If the technology is for wireless communications, even for testing purposes</td><td>R.A. 3846 or the Radio Control Law (1931)

• A base station, regardless of the location (or altitude) will require a license. As an example, NTC points to the licensing of the radio operator, pilot, and radio equipment used in airplanes to transmit messages. Since emerging technologies like loons and drones follow a similar aeronautical service, these technologies will be subject to the same NTC rules.

• The only exception under the Radio Control Law is military communication, as there are specific bands reserved for its use.

• The NTC issues a "type approved/accepted" permit for the equipment to be used in order to ensure that it does not cause interference, that the equipment fits the frequency assigned, and that it complies with the National Radio Frequency Allocation Table (NRFAT)[198]</td></tr>
</table>

Source: Interview with NTC Deputy Commissioner Edgardo Cabarios, August 1, 2018; with NTC Regulation Branch Director Imelda Walcien, July 18, 2018.

When testing emerging technologies, the NTC does not issue a permit for a technology that has not passed through the ITU, the telecom arm of the United Nations. Once the ITU issues its recommendations on the method of regulation for a particular technology, according to Walcien, that is the only time the NTC will adopt or propose local rules and regulations. In that sense, the NTC takes a cautious, even guarded approach towards technologies that have not been approved or recognized by the ITU.

The NTC also suggests that it looks to ASEAN nations and how they craft policy and regulation for emerging Internet technologies, especially countries like Indonesia, which is close to the geographic profile and population of the Philippines.

Atty. Caridad Gonzales, an independent telecommunications legal expert, agrees that anybody who wants to test wireless technology (for broadcast or telecom) would need an authorization of some kind, in accordance with RA 3846 or the Radio Control Law. This can either be a PA or a CPCN or, in the case of a VAS, a certificate of registration, to be able to get approval from the NTC for a permit to test a technology. However, Gonzales asserts that it is within the discretion and latitude of the Commission if it would like to grant a test permit to an entity or to grant exemptions for specific purposes—such as, for scientific, educational, or test purposes—that are non-commercial in nature.

It is correct for the regulator to look to the ITU for recommendations, according to Gonzales. However, the local regulator, within its own sphere, is sovereign. Gonzales asserts that even if a country is a signatory to international treaty on communications, the national regulatory authority has certain flexibility especially if the decision is only for the testing stage of an emerging technology. For example, Japan has its own technology and standards, but that does not mean it is any less compliant to the ITU.

Walcien admits that the current regulatory landscape is reactive. The NTC does not pro-actively seek out ways to regulate emerging technologies; it only acts on new technologies once brought to the Commission.[199]

However, NTC Deputy Commissioner Edgardo Cabarios, who has been with the regulatory agency for about 30 years, thinks this is not always the case. The Philippines is not a telecom manufacturing country and, thus, depends on technologies developed by other countries. But there have been cases in the past when NTC had pro-actively issued rules on emerging technologies. Cabarios points to when NTC issued rules for International Mobile Telecommunications (IMT) 2000 or the Third Generation (3G) mobile telecommunications in 2005[200] before the technology became available in the country.[201] The most recent regulatory issuance for an emerging Internet technology is for TV White Space in 2017 (discussed in the proceeding section).[202]

According to Cabarios, the NTC does not issue rules for new technology immediately because the Philippines' regulatory approach is technology-neutral. If the NTC finds it necessary to issue rules for the introduction of new technology, then it prepares the rules. "Otherwise, [we] let technology be used [in the country] without any impediment at all," Cabarios explains.[203]

When faced with new technology, the NTC takes into consideration the position of stakeholders who may potentially be affected. The regulator asserts that it needs to determine whether the benefits of adopting a new technology would outweigh the cost of the disruption to the current users of the old technology. Once this has been established, then the regulator could decide to pro-actively promote the use of the new technology. An example would be re-farming frequencies for use by new technologies.[204]

As part of due process, parties that could be potentially affected by the new technology is given a venue for them to raise their concerns, which sometimes delays or even prevents newer and more efficient technologies from coming in. Cabarios notes that affected parties can be very protective of their business and can put up a strong lobby against a regulatory decision, such as spectrum recall.

Gonzales thinks that there is a lot of opportunity for emerging Internet technologies in the Philippines. The country has always been at the cutting edge of telecommunications technology. Filipinos are very good tech adopters. They became easily enamored with GSM technology and SMS before,[205] and with social media[206] and mobile apps[207] today. Thus, telecom suppliers have always looked at the Philippines as a very good market in which to introduce technology.

The government plays a huge role in the adoption and uptake of emerging technologies. While the exploration and development of new technology is usually led by the private sector, the decision to adopt and the speed of adoption of a technology requires government approval. Europe, for example is known for taking a pro-active role in promoting emerging Internet technology. In anticipation of 5G, the EU regulator announced in advance the recall of certain frequencies to free them up for future technology.[208]

When the private telcos do not go to the unserved and underserved areas, technology adoption stops at the profitable urban areas. As a result, the greater benefit of extending technology to the outskirts is lost—hence, the digital divide.

There is no scarcity of available bandwidth that can be tapped by providers. The challenge is in getting the abundant supply of capacity to the end users in the access network. As pointed out by the Submarine

Telecoms Forum, "there is a need to stimulate deployment across the whole territory," not just the "lucrative, easy-to-serve urban areas." The digital gap is due mainly to "lack of infrastructure, affordability, lack of skills, or lack of relevant local content." This is often the result of inefficiencies on the supply side, caused by "ineffective policies, outdated regulatory frameworks and reduced incentives to invest."[209]

A country like the Philippines, with 53% of population living in rural areas,[210] will never cross the digital divide unless the telcos are made to cross the geographical and income barriers. This is where the government must intervene. The government's mandate, under the general welfare clause, is to take care of its people regardless of where they are, Gonzalez explains. The regulator needs to push the telcos to build their network until it reaches customers in the countryside. And when the incumbent telcos refuse to go to the rural, low-income areas, the government must innovate by ensuring that policy and regulation will introduce new players—with new ideas and more creative solutions—who will.

The next section discusses the policy issues and challenges for specific emerging Internet technologies.

Regulating Wired Internet Technologies

The NTC seems focused more on the wireless technologies than wired, based on their regulatory issuances and budgetary requirements (e.g., monitoring broadband quality). However, as Brewer discussed in the previous section, there is promise for wired technology, such as GPON, or a combination or wired and wireless, in connecting the Philippines.

According to NTC's Cabarios, building a fiber optic network and testing it in the Philippines is allowed, even if one is a non-telco (e.g., a VAS provider or a foreign entity). However, once the fiber network will be used for commercial purposes, such as to sell Internet to the public, then that becomes the turf of the PTEs. Once the fiber optic network operator starts putting bandwidth onto those cables, it will be treated as a "network," which only PTEs can put up and operate.

Another area of concern for wired networks is the need to secure permits and licenses, right of way going to the homes. This includes getting approvals from national government agencies, local government units, homeowners' associations, building administrators—each of whom would have a different set of rules, permitting process, and fees for service providers.

There are proposals to make the laying of fiber more efficient and coordinated, with the aim of lowering the cost for everyone. To do this, one of the proposals is to amend the National Building Code to include co-deployment. The DICT and the Department of Public Works and Highways (DPWH) have a memorandum of agreement (MOA) on coordinating civil works for road construction and repair under a "dig-once" policy, which is also a target reform under the National Broadband Plan. At the 2017 Telecoms Summit, the DICT also signed an agreement with DPWH and NTC regarding the creation of a "Right-f-Way Technical Working Group" and with the Department of Interior and Local Government and the various groups of LGUs on the creation of a TWG for the standardization of LGU fees.

For aerial fiber, there is no existing regulation on pole attachment. Each service provider is left to negotiate with a pole owner, often an electric power company or an electric cooperative in the countryside, to attach fiber onto a pole. The absence of any policy guidelines or regulation seems to have given rise to problems in pole use for broadband providers. There are anecdotes about arbitrary or exorbitant pole attachment rates, refusal to allow other operators to attach to a pole, and fiber cuts in aerial installations. Fees for permits and right of way are also said to be constantly changing from one local government or one government agency to another.

There is no law that sets restrictions to putting up a pole, except for the permit(s) from the local government for local roads and the Department of Public Works and Highway (DPWH) for national roads. In July 2018, the DICT signed a memorandum of agreement with the National Electrification Administration (NEA) to tap electric cooperatives to bring fiber connectivity to their members in the countryside or become Internet service providers themselves. The electric cooperatives have access to 95% of households. And some of these cooperatives have fiber optic cables in their distribution lines.[211]

Photo by Miguel Padrinan from Pexels

In June 2018, the DICT signed a tripartite agreement with the transmission grid operator National Grid Corporation of the Philippines (NGCP) and grid owner National Transmission Corporation (TransCo) for the free use of the spare fiber optic cables of the power grid in order to accelerate the implementation of the National Broadband Plan.

Regulating Wireless Internet Technologies

Although fiber is still the technology of choice when it comes to high-capacity applications, wireless technologies are an important complement that provide levels of mobility impractical or impossible with fiber. As the mode of Internet access has evolved and diversified - from stationary terminals indoors to mobile devices that can go anywhere - so too has the demand driving technology innovation. While wireless is unlikely to replace fiber anytime soon, improvements to its underlying technologies continue to be important to improving access, and to spurring the growth of new applications and services, such as the Internet of Things. Consequently, the trajectory of development for Internet networking technologies in recent years has been oriented towards wireless.

The development of wireless technologies, however, does not exist in a vacuum. With the exception of the nascent Li-Fi technology, which uses varying wavelengths of visible light to transmit information, the predominant wireless paradigm continues to rely on use of the radio frequency spectrum. Spectrum resources are scarce, and are regulated by the state; their use relies on the assent of the government. This means that the space for innovation and growth of wireless technologies can be heavily affected by what spectrum resources are made available by the state. In fact, even the characteristics of the technologies that can be developed are shaped in part by what frequencies can be used legally. Generally speaking, high-frequency wireless technologies allow for faster speeds, while low-frequency technologies can cover greater distances. If, for example, the use of low-frequency bands of spectrum is barred by the state, it would be much more difficult to develop a practical technology meant to provide access over a wide area.

Table 6. ITU-R Recommended Frequencies for HAPS

WRC	Frequency	Geographical	Avail BW
WRC 97	47.2-47.5 GHz and 47.9-48.2 GHz		600 MHz
WRC 2000	27.9-28.2 GHz(D); 31.0-31.3 GHz outside region 2	23 countries	600 MHz
WRC12	6.440-6.520 MHz(D); 6.560-6.640 MHz(U)	5 countries	160 MHz
WRC15	21.4-22 GHz and 24.25-27.5	Region 2	3.85 GHz
	38-39.5 on a global		1.5 GHz

Source: Nava, P. 2017. HAPS/WRC-19 agenda item. 1st ITU Inter-Regional Workshop on WRC-19 Preparation. Geneva, 21-22 November 2017. https://www.itu.int/dms_pub/itu-r/md/15/wrc19prepwork/c/R15-WRC19PREPWORK-C-0028!!PDF-E.pdf.

Once a wireless technology has been developed, spectrum availability continues to be a determining factor as to whether a technology will succeed in the market or not. For this reason, uncertainty over how much of a frequency will be made available by the regulator for licensing, to whom, and for how long, can be very detrimental to service providers' willingness to invest capital and other resources in deploying a new technology. In one example, regulatory uncertainty in the United States over use of the TV White Space (TVWS) and Educational Broadband Service (EBS) frequencies contributed to low adoption rates among providers, and also made deployment more difficult for market players that did decide to use the technologies.

On the other hand, defining and limiting the use of all bands of frequency must also be avoided, even in the name of reducing regulatory uncertainty. As Harrison (2015) argued, unlicensed frequencies provide important room for innovation and the development of new wireless technologies and applications. The nature of what can be done with spectrum resources, even with identical bands of frequency, can depend on the specific context of the application. For example, the use of TVWS to provide backhaul might be less desirable in an urban area where the band is more congested, lending itself better to other applications, such as IoT. Regulations must be flexible enough to allow multiple applications for the same frequencies to co-exist under the same regulatory environment; they have to "have sufficient flexibility to encourage a wide variety of applications and innovation".

1. Loons and Drones

Global standards for HAPS. Loons and drones are classified as High-Altitude Platform Stations (HAPS), which are described in the ITU's Radio Regulations as "stations located on an object at an altitude of 20-50 km and at a specified, nominal, fixed point relative to the Earth."[212] Since 1998, the Radio Regulations include provisions to permit the use of certain specific frequency bands by HAPS. Since they are located at nominal fixed points, they have been considered as belonging to ***fixed service.***

ITU's Radio Regulations allow HAPs to transmit using the 2.4 GHz unlicensed frequency band (see Table 6), along with the licensed mm-wave frequency bands that range from 30 GHz to 300 GHz (the bands also currently being studied for use with 5G). Facebook's drone project used E-band mm-wave frequencies between 60-90 GHz. Google's Loons also originally used frequencies in the unlicensed 2.4GHz and 5GHz bands.

However, since 2014, Project Loon tests reportedly shifted to LTE bands, among others, to transmit data.[213] The ITU has expressed concern about the potential of LTE for loons to cause interference with telecom and scientific equipment on the ground, even those outside the balloon's official footprint. Despite this, some national regulators, such as Sri Lanka's, have provided Project Loon with LTE licenses. In the Sri Lanka case, the government has pointed to ITU as the cause of delay in the deployment of Loon. The ITU has clarified that existing Radio Regulations include provisions to permit the use of certain specific frequency bands by HAPS and that countries who have signed the Final Acts of the most recent World Radiocommunication Conferences are expected to have decided to be bound by this international treaty. ITU also declared that potential additional frequencies for HAPs will be included as Agenda 1.14 for the next WRC, scheduled for November 2019.[214]

In October 2017, the U.S. FCC gave an "experimental license" to X for Loon to help provide cellular service to Puerto Rico after the island was hit by Hurricane Maria. Nearing three weeks after the storm, 82% of Puerto Rico was still without cell service.[215] In January 2017, Loon was also used to provide Internet services to Peru when it was ravaged by floods.[216]

Local regulation for HAPS. Given the technology and functions used by HAPS, loons and drones would more or less be governed by a combination of regulations enforced by the NTC for its radio transceiver and the Civil Aviation Authority of the Philippines (CAAP) for the balloon's overflight.

Loon has been described as "a floating cellular tower."[217] It is designed to relay signal from the nearest base station of a telecommunications company on the ground. As such, loons need to use radio frequency spectrum. According to Engr. Robert Tolentino, chief of the NTC's radio frequency management division, like drones, loons are likely to use 2.4GHz.[218] Tolentiono suggests that loon is classified as a ***short-range device***, suggesting that it uses unlicensed spectrum and its radio equipment does not exceed 250 milliwatts.[219] However, according to Jonathan Brewer (one of this report's authors), given the altitude of loons of 18 kilometers, it seems unlikely that the regulation for short-range devices would apply, as radio equipment with a maximum transmit power of 250 mW typically has a range of a few hundred meters up to a few kilometers only.

The radio equipment of loons also requires a specific type approval process, to be determined once the specifications of the loon to be used is identified. Engr. Tolentino also notes that these types of technology are often accompanied with tools to mitigate interference. Spread spectrum technology, for example, assists in ***frequency hopping***,[220] which are used for unlicensed spectrum. Frequency hopping was used in earlier broadband technologies, particularly the 802.11 variants, during the latter part of 1990s. Brewer notes that Orthogonal Frequency Division Multiplex (OFDM) is the basis of modern broadband technologies, including LTE and 5G.

Looking at CAAP regulations, these loons can be considered a remotely piloted aircraft system (RPAS)," which includes "its associated remote pilot stations, the required command and control links and any other components as specified in the type design."[221] There are no CAAP regulations specifically for a loon carrying a radio transceiver.

HAPS like Project X's Loon came to the Philippines before, but the NTC's Cabarios said it did not meet the nationality requirement of at least 60% Filipino ownership for entities that will be given a spectrum license, as provided in RA 3846 and which, according to the NTC, must be strictly enforced even for testing purposes. According to Cabarios, Google was about to partner with Globe at the time, but the American multinational technology company wanted the spectrum to be licensed under its name. The Loon project would have used LTE frequencies, had it been pursued.

Similarly, a drone is considered an "unmanned aircraft vehicle" (UAV) or an aircraft operated with no pilot on board. Drones were introduced in the country around 2013 and became popular among hobbyists and photographers. Drones are now being tested for use in aerial land surveys and road monitoring programs. In late 2014, the CAAP issued Memorandum Circular 21-14 to regulate the operation of UAVs for commercial purposes.[222] While the use of UAVs solely for model, sports, hobby and recreational activities are exempted from the regulation, certain restrictions have been put in place to ensure the security and safety of the public.[223]

There is no information on the certification of high-altitude free balloons. However, the CAAP has rules for drones.

For non-commercial drones, large remotely piloted aircraft (RPA) operators must have a Controller Certificate and a Certificate of Registration for the RPA. Non-commercial operations are also limited to the Visual Line of Sight and are prohibited at night, unless authorized by the CAAP. The pilots or controllers are also certified by CAAP.

2. LEO Satellites

Global standards for satellite. As with all satellites, the launching of LEO satellites requires the assignment of an orbital slot by the ITU, as facilitated by the relevant national regulator. An orbital slot is valid for the lifetime of the satellite.[224] This may be even more important for LEOs, as they function best as part of a constellation of many other LEOs, requiring many orbital slots.

Other than the orbital slot, LEO satellites also depend on the ITU's regulation on the spectrum they will use to transmit and receive information to and from Earth. The ITU allocates four main bands of frequency for satellite broadband services:

- C band (4/6 GHz) FSS (fixed satellite services)
- Ku band (11/14 GHz) FSS (fixed satellite service)
- Ka band (20/30 GHz) bent pipe (with no on-board processing in the satellite)
- Ka band (20/30 GHz) with satellite on board processing
- L band (1.5/1.6 GHz) MSS (mobile satellite service)

Table 7. Active Satellites[(a)] per Country

Country	Count of Active Satellites
China (People's Republic of)	188
Japan	158
Indonesia (Republic of)	27
Korea (Republic of)	27
Malaysia	22
Thailand	15
Singapore (Republic of)	9
Vietnam (Socialist Republic of)	7
Lao (People's Democratic Republic)	1
Philippines (Republic of the)	1
Cambodia	Soon to launch (2021)
Myanmar	Soon to launch (2019)

Source: ITU-R's list as of 30 July 2018; https://www.itu.int/net/ITU-R/space/snl/listinuse/index.asp?sel_satname=&sel_orbit_from=&sel_orbit_to=&sel_adm=&sel_org=&sel_date_from=&sel_date_to=&sel_sns_id=&sel_prov=&sel_rec=&mod=asc&order=&npage=1 various press releases.

Note: (a) "Active" means satellites that are actually transmitting, i.e., using spectrum resources.

An LEO satellite providing broadband services may use any of the above mentioned bands, depending on its specifications and application requirements.

As an archipelago, it is surprising that the Philippines is not taking advantage of satellite technology as much as its Asian neighbors. Today, the Philippines does not have its own geostationary satellite and, reportedly, has failed to secure its orbital slot.[225] However, in 2016, the former ICTO (now DICT) issued a Notice of Offer for Orbital Slot. The notice of intent offered "the Philippine orbital slot at 98 degrees East for planned broadcast satellite services to be carried, on a non-exclusive basis, allowing for a multiple redundant satellite deployment."[226] This seems to suggest that the country still has jurisdiction over its orbital slot.

The Philippines used to have Agila-1 (launched in 1987) and Agila-2 (launched in 1999), which were both owned by PLDT subsidiary Mabuhay Philippines Satellite Corporation.[227] The operation of Agila-1 ended in 1998 and the satellite was deorbited. In 2009, PLDT sold Agila-2 to Asia Broadcast Satellite, after which the satellite was renamed ABS-3.

In 2016, the Philippines launched Diwata, the first Filipino-made satellite to ever go to orbit. The microsatellite is expected to help in weather forecasting, disaster risk management, forest protection, and other public services.[228] Two years later, the government, under the Development of Philippine Scientific Earth Observation Microsatellite program (PHL-MICROSAT), launched Maya-1, a cube satellite. Maya-1 can be used to receive and send messages from far-flung areas in the country that have no telecommunications networks and during or after typhoons when communication signals are down.[229] Its expected lifetime is around a year.[230]

To date, the Philippines has one (1) satellite in orbit under PHL-MICROSAT, as recorded by the ITU. Meanwhile, neighboring countries like Indonesia, Malaysia, and Thailand, have launched multiple satellites over the past few years (see Table 5). Even Singapore, a city-state just slightly bigger than Metro Manila, the Philippines' National Capital Region, has nine (9) satellites under its name.

There are a few service providers in the Philippines that use satellite for backhaul, but on a limited capacity. Globe Telecom has reportedly started using satellite technology for its cellular mobile backhaul to reach isolated provinces.[231] Some private sector partners of the DICT are also using VSAT to provide connectivity for the government's Free Wi-Fi program or Pipol Konek. The "Free Internet Access in Public Places Act" encourages the private sector partners of the government in its free Wi-Fi program to use satellites and other emerging Internet technologies.

Local regulation on VSAT. Up until the mid-1990s, international satellite communication in the Philippines was a monopoly of Philcomsat, the lone signatory to Intelsat, which was originally formed in 1993 as an international telecommunications satellite organization composed on an intergovernmental consortium owning and managing a constellation of communication satellites.[232]

As part of its liberalization and reform efforts, the Philippine government soon allowed any carrier with an international gateway facility (IGF) license to access international satellites directly.[233] In 1998, President Fidel Ramos issued Executive Order (EO) 467 to break the Philcomsat monopoly.[234] A year later, the NTC issued Memorandum Circular 04-03-99 as the implementing guidelines to EO 467.

While these issuances were meant to open up the market in satellite communications at the time, the policy limited direct access to international satellite services to duly enfranchised PTEs only. This was because VSAT was traditionally used for the transmission of voice channels to remote offices and customers, as well as for private leased line service. Hence, satellite access was lumped together with basic telecom service. As a result of the high barrier to entry, the growth and use of satellite technology was stunted as PTEs kept to their traditional copper wire and cellular mobile technologies used mostly in the densely populated and highly urbanized areas. Up until now, the telcos have used satellite sparingly, and often during disaster response only.

Today, if a satellite operator wishes to establish operations in the Philippines, the NTC says it would need a satellite earth station license (regardless if they are merely testing or doing business commercially). If the operator wishes to operate commercially and get subscribers in the country, it would need a telco franchise, as specified in R.A. 7925, which also implies the payment of spectrum user fees (SUF).

3. 5G and IoT

Photo by Tracy Le Blanc from Pexels

Global standards on 5G. The technical standards for 5G technology, which is still under development, has yet to be finalized but the ITU has outlined the necessary characteristics for a technology to qualify as 5G through its IMT-2020 recommendation documents.[235]

The ITU states that 5G must have a downlink peak data rate of 20Gbps and a user-experienced data rate of 100Mbps. It also recommends that 5G must have 100x the network energy efficiency of LTE, and 3x the spectrum efficiency of LTE.

These characteristics are necessary to achieve the promise of 5G when used in three application areas, as recommended by ITU.

- ***Enhanced Mobile Broadband (eMMB)*** - More connected devices with faster connection speeds, allowing for virtual and augmented reality applications and other high-bandwidth, low-latency uses.
- ***Massive Machine type Communications (mMTC)*** - Internet of Things (IoT) applications such as health trackers, smart grid meters, and environmental monitoring devices.
- ***Ultra-Reliable and Low Latency Communications (uRLLC)*** - Communication with drones, vehicle-to-everything communications such as with self-driving cars, control of manufacturing equipment (Industrial IoT).

Effective spectrum management is key to the adoption of 5G technologies. Compared to existing technologies where one device communicates with one cell tower and hands over from tower to tower as the user moves, devices using 5G technologies "will be able to communicate simultaneously with several towers, over different frequencies and using different radio protocols," which is envisioned to result in "far faster and more responsive wireless communications," which is the foundation for the Internet of Things.[236]

With 5G, multi-connectivity and carrier aggregation—which will allow wireless service providers to combine different frequencies in new ways to offer faster speeds and improved performance—will be critical. Multi-connectivity "enables traffic from multiple sites and across different technologies to be combined at the handset," allowing providers "to combine licensed and unlicensed spectrum and, thus, use different frequencies for different user needs." Carrier aggregation, on the other hand, lets providers "combine relatively fragmented, disparate bands of spectrum into a larger and more efficient block of spectrum and, thus, gain the advantages that large blocks have over disparate smaller blocks."[237]

Local regulation on 5G. The NTC is awaiting the recommended 5G standards from the World Radio Conference in 2019 before it makes a regulatory issuance, which may include reallocation of spectrum for IMT 2020 and auctioning frequencies, such as 24-28GHz and 37-42GHz. Meanwhile, Globe and Smart had both announced 5G testing and commercial deployment as early as 2019.[238,239]

NTC's Engr. Tolentino, however, explained that the NTC cannot recall or reclassify frequencies, as there is no frequency shortage, hence, no "urgency" to reclassify spectrum amid the rise of 5G. Operators can shift to 5G by following a migration plan that does not necessarily entail changing their core network. Tolentino added that the operators would often only need to add "racks" to implement 5G-ready technologies. This implies that the 3400MHz to 3600MHz currently being used by the two dominant telcos for LTE can be easily migrated to 5G. The 3G frequencies are also a candidate for 5G, including the 1800MHz band for 2G. If 5G will be used in the higher frequencies (3300MHz to 4200MHz), it will provide coverage. Meanwhile, 20GHz+ will provide capacity. The NTC, if this technology is introduced, may also identify coverage frequencies in the lower bands as well.

Gonzales, however, thinks that the regulatory approach for 5G is yet to be determined, as various research looks at different 5G deployment cases.[240,241] The necessity to recall or reclassify frequencies, according to Gonzales, rests on the regulator and can be done in the interest of public service and to conform to ITU-T recommendations.

Meanwhile, Brewer observes that "while a number of potential 5G radio bands are already used for communications in the Philippines, a few are used for other purposes. These bands may require legislative changes to open them for mobile broadband use. In other cases, spectrum is used for older technologies that would not be compatible the 5G networks. Older networks would need to be turned off and the spectrum reclaimed by the NTC for 5G use."

Globally, governments and corporations are opening up more wireless frequencies, around 11GHz for 5G. This amount of spectrum allows much wider channel with more data, i.e., 800MHz wide compared to 60MHz for 4G.[242]

To achieve the promise of 5G, the NTC needs to ensure the availability of spectrum bands that can offer both coverage and capacity. This means a combination of low and high frequency bands, chunks of which may have existing holders.

For 5G consumer use, the NTC envisions a wide range of short-range devices, which will use unlicensed frequencies. These are devices with radio equipment with 250mW of effective radiated power, which, since used indoors, will not affect or interfere with licensed, commercial frequencies. Internet of Things technologies are also short-range devices. This implies that they do not need large bandwidth (like 5G). If they have a base station that goes beyond the specification of short-range devices, the NTC says that's the only time they would need a radio station license (RSL).

4. TV Whitespace

Global standards for TVWS. The ITU has no existing standards on TVWS, nor any official recommendation documents on the technology. Through various platforms however, ITU has, over the years, come to a working description of the concept and some tentative recommendations for its use.[243]

In various publications, ITU has described the use of TVWS technology as an "opportunistic use of spectrum" or, alternatively, as part of a dynamic spectrum management approach. This is because TVWS applications rely on the use of spectrum in between frequencies already used for another application or that is technically earmarked for an existing application but is now unused. This description applies to "white space" technologies in general; among these, TVWS is the most prominent and promising.[244]
TVWS technology specifically uses frequencies that

lie somewhere in the 470-806 MHz band, which corresponds to the UHF analog TV broadcast band and the space between the VHF and UHF broadcast bands. It commonly uses the 698-706 MHz UHF frequency bands, as the lower frequencies are typically allocated for Digital TV. The technology uses either unused frequencies previously allocated for analog TV, or the guard bands designed to prevent interference between frequencies assigned to broadcast entities. TVWS has been used for transmitting data, although other potential applications exist.[245]

For now, ITU has left the decision to allocate TVWS frequencies to national regulators, despite "increasing interest in harmonizing allocations so that mobile use is co-primary with the broadcasting service around the world." Because white space has not been officially defined by the ITU, it is arguable that "primary and secondary allocations to the mobile service in the UHF broadcasting bands around the world" have already allowed TVWS applications to operate. Further adoption of TVWS is complicated by disagreement on whether TVWS should be a licensed or unlicensed frequency, a topic on which the ITU has not issued a recommendation.

In January 2018, the Dynamic Spectrum Alliance, a global organization advocating for laws and regulations for more efficient and effective spectrum utilization, issued new rules designed to assist regulators to enable the quick and efficient deployment of TWVS networks. The rules are based on the regulatory environments already promulgated by Ofcom in the U.K. and the Federal Communications Commission (FCC) in the U.S. The rules, updated from an earlier version published in 2014, are meant to "offer higher availability for dynamic spectrum devices and stronger protection for incumbent users to avoid interference, as well as "to close the digital gap in rural communities."[246]

In 2010, the U.S. FCC adopted final rules to allow unlicensed radio transmitters to operate in the white spaces. This action, according to the FCC, "made a significant amount of spectrum available for new and innovative products and services, such as Wi-Fi." The rules provide for: (i) the operation of both fixed and personal/portable devices in the white spaces in the TV bands on an unlicensed basis; and (ii) the use of geo-location capability of the white spaces devices, combined with database access to identify vacant TV channels at specific locations, as the primary method of preventing interference to TV and other services. The databases are established and administered by parties selected by the FCC.

In the U.K., Ofcom issued the Wireless Telegraphy (White Space Devices) (Exemption) (Amendment) Regulations 2015, which exempts the establishment, installation and use of wireless telegraphy stations or wireless telegraphy apparatus from certain provisions of the Wireless Telegraphy Act 2006. Section 8(1) of the Wireless Telegraphy Act 2006 requires devices that operate on the TV spectrum to be licensed. Section 3 of the 2015 Regulations allows the license-exempt use of the white space devices, which are required to contact a database listed in the rules.[247] Similar to the FCC rules, these databases need to complete qualification as approved by Ofcom.[248] The white spaces covered in the regulations are in frequencies currently used for digital terrestrial TV and wireless microphones, among other services, in the 470-790 MHz spectrum band.

TV White Space Pilot-test in the Philippines. The Philippines was one of the first developing countries where the technical feasibility of TV White Space for Internet connectivity was tested.

The pilot test began in 2005 with support from companies like Microsoft and Nokia. Trials on Internet over TVWS began in the United States in 2011-2012, and the TV White Space Alliance was created in Cambridge to show its commercial applications. By 2012, the U.S., U.K., and Canada had made model regulations for TVWS. In 2013, TVWS rollout in countries like the Philippines and Kenya began.

In the Philippines, Microsoft worked with the then-ICTO to find a compelling use case for TVWS. The USAID-funded Bohol Ecosystems Improved for Sustainable Fisheries (ECOFISH) project of the Department of Agriculture's Bureau of Fisheries and Aquatic Resources (BFAR) was chosen, where TVWS helped register the project beneficiaries, the fishermen, onsite instead of having them travel long hours to go to the local government office. Five (5) municipalities in Bohol, including Talibon, Trinidad, Bien Unido, Ubay, and Carlos P. Garcia, which consisted of 19,000 families at the time, were within the scope of the pilot test. This meant that around 19,000 families, residing within the coverage area of the 100 sites scattered throughout the five municipalities, could access TVWS-enabled Internet through Wi-Fi access points installed in public places if they had Wi-Fi-ready devices.[249] According to Mr. Damian Domingo "Dondi" Mapa, former Microsoft national technology officer in the Philippines, since TVWS equipment allows connectivity of 5-10 kilometers that can go over water, it made the fishermen registration in the remote islands easier and the uploading of data over the Internet possible.[250] The TVWS deployment was also able to bring Internet service to an island that other connectivity solutions could not reach, according to Louis Casambre, former undersecretary and executive director of the ICTO.[251] For a more detailed description of the TVWS pilot test in Bohol, please refer to Appendix C.

Local regulation for TVWS. For the Bohol TVWS pilot-test, the NTC issued a 1-year provisional authority to the ICTO. However, according to Mapa, the initiative encountered a number of regulatory issues. First, the pilot test was not able to use a geo-location database[252] for the TVWS cognitive radios, which would have allowed them to transmit at specific frequencies. This was due to the Philippine government's failure to resolve the issue of who would be operating the database system. Second, the NTC did not want to use dynamic spectrum access and opted to assign a working TV channel for the pilot test, making it difficult for the TVWS project proponents to look for viable channels in order to continue the project. To this, NTC's Cabarios said that it is safer to license spectrum, as database technologies may fail and interference may occur. In some areas, Mapa also noted that there were frequencies already assigned and blocked off even if there were no towers or network infrastructure in sight. Initially, there was a draft NTC memorandum circular (MC) that allowed anyone to use TVWS. There was strong opposition from the Kapisanan ng mga Brodkaster ng Pilipinas (KBP) (Association of Philippine Broadcasters) to the proposed regulation, as they did not want to give up their analog frequencies. KBP opposed the proposal. In the end, the MC that was issued limited TVWS use to government-defined functions. For a more detailed discussion of the regulatory issues encountered by the TVWS Bohol pilot test, please refer to Appendix C.

A primary concern for the adoption of TVWS is managing interference, which has been used to argue for the necessity of licensing frequencies for TVWS applications, if they are to exist at all. Another concern is that most TVWS applications (particularly providing data connectivity) require a minimum of 30MHz available in all areas of operation to be viable, which might not be possible in large urban centers. Despite these apprehensions, the DICT believes that TVWS holds promise as a way to improve spectrum efficiency and provide broadband access especially in the underserved and unserved areas where there are no TV stations using the frequencies. The DICT's Pipol Konek aims to benefit from the use of TVWS, especially to connect access points in 3rd to 6th income class municipalities where infrastructure is poor to absent. The "Free Internet Access in Public Places Act of 2017" provides that ISPs and other private sector partners who participate in the government's free public Internet program are "allowed to acquire and utilize Internet connectivity directly from satellites and other emerging technologies."[253] The terms of reference of the Pipol Konek contractors also specify that operators can use any technology to provide Internet connectivity. According to one of DICT private sector partners, TVWS is one of the technologies they use to address the availability of broadband Internet in remote locations with no line of sight from the nearest telecommunications wireless or cable/wired network. However, this is still on a small-scale basis, with a handful of subscribers (e.g., 20 subscribers per base station).

The NTC, however, cautions that any use of TVWS must be cleared with its Radio Spectrum Planning Division and the Broadcast Services Division of the NTC. For the Free Wi-Fi Program, the DICT needs to clearly specify who its private sector partners are and for what services the TVWS will be used for. The TWVS license will be issued to the DICT, who, in turn, must designate its partners. NTC's Engr. Tolentino said this will also help the NTC coordinate the frequencies to be used, which needs to be done perhaps in the absence of a database.

The NTC clarifies that the so-called ***digital dividend***[254] does not exist in the Philippines for TVWS. According to Engr. Tolentino, there is not much guard band or white space to speak of because, to begin with, the Philippines had assigned analog TV broadcast frequencies in 512-698 MHz, most of which are in Mega Manila (National Capital Region plus proximate regions such as Rizal, Cavite, and Laguna). This is unlike in other countries, such as the United States,[255] where the analog TV broadcast spectrum is spread out between 470 and 806 MH. As a result, the regulators in these countries needed to reallocate the "700 MHz band" (~694-790 MHz) from broadcasting service to mobile service.[256]

Photo by Mary Grace Mirandilla-Santos

The 700 MHz (698MHz-806MHz) in the Philippines did not have to be reallocated from broadcast or as a result of digital TV transition. A huge chunk (80MHz) of the 700MHz was assigned to Liberty Broadcasting Network, Inc. (LBNI) in the 1990s. In 2009, LBNI, through Liberty Telecom Holdings, Inc., became a subsidiary of San Miguel Corporation (SMC).[257] In 2016, PLDT and Globe jointly acquired SMC's telco assets and applied (and got NTC approval) for spectrum co-use with SMC, which included 2100MHz, 700MHz. TV broadcasting in the country is in the process of transitioning from analog to digital. The migration plan, crafted by the DICT, sets the completion of the analog switch-off by 2023.[258]

5. Innovative Spectrum Access Schemes

Ever since radio spectrum was used for communication, it has gained more and more value as a finite natural resource. In the advent of the Internet and mobile data traffic growth, its value continues to increase exponentially.[259]

Traditional vs. innovative spectrum approaches. The traditional way of dealing with radio spectrum is for the government to award exclusive licenses for specific frequency bands and for specific purposes.[260] While the objective of every government is to ensure that valuable spectrum is utilized efficiently, traditional regulation has often led to the opposite.[261] Exclusive licensing of spectrum provides a licensee unfettered use of a particular swath of spectrum, which can result in large portions of spectrum to be unused or underutilized. Broad licenses which gives a few spectrum licensees cover large geographic areas may result in the same, as the incumbent service providers may not have the economic incentives to build out their networks and fully utilize all the spectrum licensed to them,[262] especially in areas which they consider commercially unattractive. Many regulators auction spectrum rights to the highest bidder, which gives the licensee the expectation of exclusive use of a particular spectrum.

Adopting innovative spectrum access schemes will ensure that spectrum is used to the fullest not just in high-income urban and densely populated areas, but in bringing connectivity to the unserved communities as well. In the Internet Society's report on spectrum approaches for community networks,[263] it identifies a number of ways that spectrum access can be democratized through unlicensed spectrum, sharing licensed spectrum/dynamic spectrum access, and innovative licensing.

Unlicensed spectrum allows users to utilize spectrum with minimal regulatory requirements and without the need to pay high cost to obtain spectrum.[264] License-exempt or unlicensed spectrum refers to frequency bands, such as those for Wi-Fi technologies, for which regulators do not grant exclusive licenses, but instead protect against interference and achieve important operational safeguards through equipment certification and clear and enforceable technical rules.[265] In many jurisdictions, this has proven to be a means to bringing new innovative wireless technologies to the citizens.

Sharing licensed spectrum or dynamic spectrum access (DSA) allows the use of already-licensed spectrum on a secondary basis, made possible through recent technological advancements in radio equipment.[266] Examples of DSA are using TV white spaces to provide Internet access and Citizens Band Radio Service (CBRS) in the U.S., which spectrum currently occupied by the U.S. Department of Defense and fixed satellite services is shared on a secondary and tertiary basis.[267]

Innovative licensing is licensing not solely based on economic benefits. One example is a "social purpose license," an exclusive service license granted in rural unserved and underserved areas specifically for non-traditional network operators. In this type of licensing, regulators remove the competitive nature of licensing and prioritizes spectrum use for non-commercial purposes. An example of innovative licensing is in India where a recent Supreme Court decision held that TVWS could be allocated on an unlicensed basis as long as such a policy is backed by a social or welfare purpose.[268]

Emerging technologies and new business models are tapping into the benefits of unlicensed frequencies to help connect more and more unserved areas. The use of ISM bands, such as for Wi-Fi, is classified as unlicensed in a number of countries. However, amid the ITU recommendation for unlicensed use of ISM bands, the decision ultimately lies in the national regulatory authorities.

In the Philippines, the use of spectrum for Wi-Fi is license-free only when used indoors. NTC MC 09-09-2003 defines "indoor use" as using radio equipment and devices with effective radiated power (ERP) not exceeding 250mW and no external antenna. Inversely, "outdoor use" involves radio equipment with ERP exceeding 250mW. The same MC defines a "public data network" as referring to "wireless data network offered to the public for compensation and shall only be provided by duly authorized public telecommunications entities (PTEs)."[269] Essentially, Wi-Fi offered to the public outside a building structure uses licensed spectrum awarded to a telco. NTC MC 03-08-2013 identify these ISM bands as including (i) 2400 MHz to 2483.5 MHz; (ii) 5150 MHz to 5350 MHz; (iii) 5470 MHz to 5850 MHz; and (iv) 915MHz to 918MHz. According to the rules, they "shall be open and unprotected but shall not, however, cause interference to other authorized radio systems."[270]

This is in contrast to a more progressive approach towards unlicensed use of ISM bands. In the U.S., for example, the FCC ruled to intentionally allocate the ISM frequencies for almost exclusive unlicensed use. The objective is to encourage wireless broadband networks to proliferate beyond those controlled by the big operators.[271] In Peru, the 2.4-GHz band that is traditionally confined indoors and subject to strict power restrictions was allowed unlicensed use by the regulator through a special permission obtained by the proponent of a community network called the Chancay-Huaral Project to enable connectivity in unserved areas. As one scholar notes: "the future availability of unlicensed spectrum for experimentation, innovation and risk-taking in technologies and services will be what will sustain the Internet and our overall broadband development."[272]

There are initial policy reform efforts in the Philippines to allow the use of unlicensed spectrum and sharing of spectrum. In the implementing rules and regulations of RA 10929 or the Free Internet Access in Public Places Act of 2017, for example, the NTC is mandated to assign certain ISM bands (2400 MHz to 2483.5 MHz; 5150 MHz to 5350 MHz; 5470 MHz to 5850 MHz), together with TV white spaces and other white spaces, to the DICT for use in the government's free Internet program. This will allow the private sector partners of the DICT the unlicensed use of these frequencies within the areas covered by their contract with the DICT. However, in an earlier regulatory issuance of the NTC, only unassigned and unused VHF TV broadcast channels were covered.[273]

VI | Findings and Recommendations

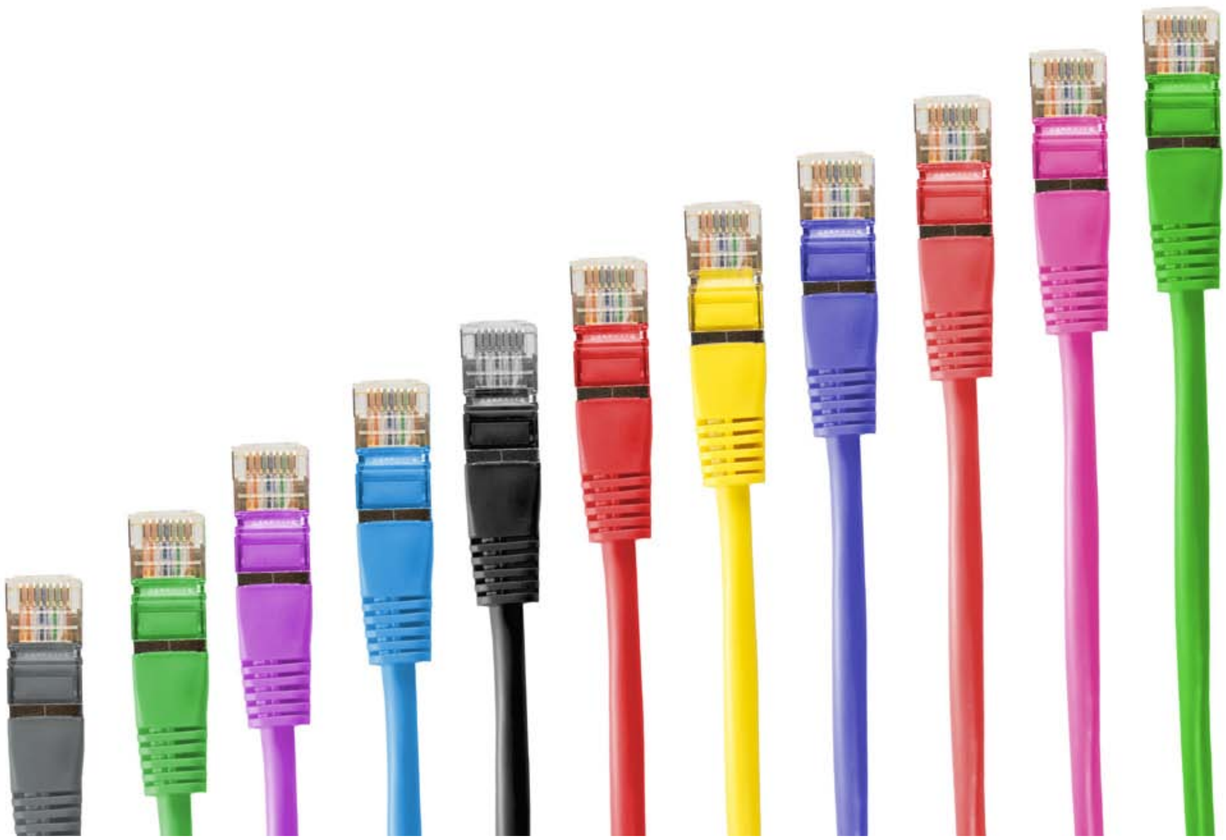


Photo by Michael Schwarzenberger from PixaBay

"It is hoped that the rise of emerging Internet technologies — with the promise to bridge the digital divide—can provide the much-needed impetus for reforming the Philippines' policy and regulatory environment to bring it to the digital age."

VI. Findings and Recommendations

This section returns to the original set of questions of the report.

1. **What are the emerging Internet technologies being tested or are already being used in other countries that may be suitable to the Philippine setting?**

The report identified a number of emerging Internet technologies that are being tested or already being used in other countries which may be suitable to the Philippine setting. These include:

a. ***Wired Internet technologies.*** These technologies have improved over the years in terms of reliability, efficiency, and capability to carry more data. From the traditional public switched telephone network that use copper wire, different variants of DSL technology have emerged. Today, communications and data services are shifting towards fiber optic cables that can carry a huge amount of information over longer distances. Fiber installation closer to the customer is making fast broadband service available to individual users. Passive Optical Networking (PON) technologies allow for inexpensive, centralized fiber to the premises (FTTP) of the customer, without the interference concerns of DSL and without need for large cabinets outside the exchange that require power backups. Two competing standards of PON are already being used in the Philippines: Gigabit PON share 2.4 Gbps of download and 2.2 Gbps of upload capacity while Ethernet PON share 1.25 Gbps of symmetric upload/download capacity. Globally, FTTP is now being delivered to both high- and low-density rural markets. Vietnam, a country with a lower GDP per capita than the Philippines, is a good example of a developing market that increased its fiber connections tremendously by rapidly rolling out aerial GPON networks. Based on a cost model for GPON installation in Lapu-Lapu City in Cebu, Philippines, the report shows that GPON can be offered at a lower cost compared to the current offerings of large telcos—varying local permits and fees for installation, notwithstanding.

b. ***Wireless Internet technologies.*** Given the country's archipelagic nature, wireless Internet technologies are seen as the most efficient way to connect even the remote, rural islands. The rapid uptake of mobile cellular technology in countries like the Philippines has helped increase access to basic telephony from the 1990s. Today, wireless technologies are doing the same for increasing access to Internet services.

High altitude platform stations (HAPS)—such as blimps, balloons, and drones—used for Internet connectivity have undergone rapid experimentation and development in various parts of the world, albeit with little commercial success to date. The use of HAPS technologies is targeted at complementing the mobile networks on the ground by transmitting data to remote locations that are often not reached by the traditional telecommunications service provider.

TV White Space (TVWS) is also meant to complement existing networks by connecting areas with non-line of sight (NLOS), which other wireless technologies like microwave links cannot do.

Emerging mobile technologies like ***5G*** are envisioned to offer a substitute for fixed connections, as they are poised to deliver ultra-fast data speeds. However, 5G technologies will require opening up new radio spectrum bands for coverage and capacity, and fiberizing towers in order to meet faster speed requirements. Based on a comparison of 5G and FTTP, the report suggests that 5G would be inappropriate for a new network build. But considering the presence of light and heavy Internet users, it is safe to say that 5G using 3.5 GHz and 28 GHz can handle the traffic of an average Philippine household.

Fixed wireless access (FWA) offers an alternative low-cost solution to service markets that are overlooked by traditional providers. Non-5G Millimeter Wave (MMW) FWA have vendors selling 10-Gpbs access points in the 60-GHz band.

c. ***Satellites.*** The report points to satellite as a key area of innovation for achieving universal access. Emerging technologies in launch capabilities, manufacturing, MMW, Massive MIMO, and Free Space Optics (FSO) are all being incorporated into new satellite networks, making satellites more capable of higher throughput and launch and maintenance less costly. The drawback of latency in using satellite broadband will soon be diminished with the emerging use of different orbital configurations that are nearer the earth, such as MEO and LEO satellites.

2. How does the current Philippine policy and regulatory environment affect the entry and use of these emerging technologies?

The Philippine policy environment can be described as restrictive with regard to emerging Internet technologies. This is largely due to the fact that the Philippine policy environment is made up of laws enacted in a span of 80 years, which are primarily based on the analog and voice-based services from the 1930s to the 1990s. There are a number of specific examples that reflect this:

a. ***Telco-centric classification of service providers.*** Only a PTE, with a Congressional franchise and NTC provisional authority/CPCN, is allowed to build and operate a network. By law, a "network" is defined based on connections that will accommodate telecommunications. The regulatory constraints prevent non-telcos, such as ISPs and VAS providers, and particularly affects small players, from utilizing emerging and alternative Internet technologies, to operate a data-only network and provide connectivity where the large telcos would not go. Where does a telecom network end and the last mile network, where ISPs connect the end users, begin? The regulatory definitions remain vague due to outdated policy.

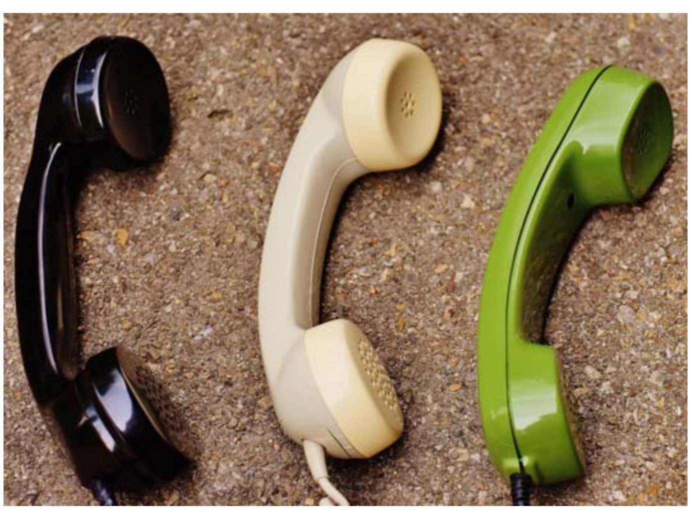


Photo by Alexas Fotos from PixaBay

b. ***Landline requirements.*** International gateway and cellular mobile operators are required to rollout hundreds of thousands of landlines. Potential providers of digital and other emerging technologies are subject to requirements for a bygone era. For example, a niche mobile data-only service provider would still be required to provide landlines if the network is anchored on cellular mobile. In an era where landline growth is flat or declining, it does not make economic sense to apply those requirements on new entrants, particularly those who wish to focus on broadband services.

c. ***Restrictions on foreign ownership.*** Current laws and policies are particularly constraining for emerging wireless technologies, which require an entity building and operating a radio station (equipment) and using licensed spectrum or acquiring Internet directly from a satellite provider to secure a franchise and be a 60-percent owned PTE. While foreign entities are not barred from entering into a partnership with a local telco to operate in the Philippines, the restrictions make it difficult even to conduct the testing of emerging technologies. For wired networks, the current regulatory interpretation[274] is that they can be set up by a foreign entity, but once used to sell a commercial service, only a Filipino-owned telco is allowed to operate it.

d. ***The lack of standard and harmonized rules for infrastructure buildout.*** There are a whole host of fees and approvals such as for local permits and fees related to fiber installation, tower build, and pole attachment that are part of the cost of doing business. These can lead to slow, inefficient, and unnecessarily more expensive network rollout for new and starting wired and wireless service providers. This would negatively affect the uptake and deployment of GPON and 5G technologies, which promise to deliver fast broadband services and connect various devices for IoT.

e. ***Inefficient use of spectrum.*** The major advancements in wireless technologies are making spectrum one of the most valuable national assets. Unfortunately, the Philippines lacks a spectrum policy roadmap and has limited capacity to monitor spectrum use and hoarding. These challenges hamper the ability of the country from enjoying the benefits of new wireless technologies such as 5G, which require freeing up new spectrum or reallocating spectrum for mobile use. The key law governing radio frequencies, enacted in 1931, was designed for two things only: communications and broadcast. It can be argued that RA 7925 implicitly amended RA 3846 when it classified several telecommunications services, with each having different requirements. However, it is clear that the policy framework is analog-based and the spectrum management provisions in RA 7925 are also very limited.

It is important to note that within those constraints, the regulator has, in the past, shown its ability to proactively address challenges.


Photo by Peter Heeling from Skitter Photo

One example was the decision of the NTC in 1991 suspending[275] the enforcement of regulation that required acquiring a license (permit to purchase and permit to install a radio station) for cellular mobile phone subscribers. The result was a democratized access to mobile devices, which helped facilitate the uptake of mobile service subscription.

Another example is the initiative of the regulator to issue rules in 2005 on 3G in anticipation of the forthcoming technology.

And, finally, amid the growing demand for Internet-based services, the NTC in 2005 classified Voice over Internet Protocol (VoIP) as a value-added service,[276] which meant that entities who wish to offer VoIP as a commercial service are not required to secure a Congressional telco franchise and needed only to register with the NTC.

Today, there is a good opportunity for the Philippines to be at the forefront of some emerging technologies again, such as satellites and TV White Space. However, the policy environment needs to be more flexible and innovation-led in order for regulation to be responsive.

3. **What policy and regulatory reforms may be considered to create the environment for new services and/or providers to deploy these emerging technologies to dramatically improve access, quality, and cost of Philippine Internet service?**

Based on the analysis in this report, it seems clear that existing policy and regulation meant for basic telecommunications services may hinder, rather than facilitate, the entry and adoption of emerging Internet technologies. Philippine policymakers should, thus, consider establishing a policy and regulatory environment geared for the digital era. This concluding section outlines the contours of the new policy environment that would ease the entry and deployment of emerging technologies.

a. ***Re-classify services.*** There needs to be policy that specifically addresses Internet connectivity and distinguish it from telecommunications services for the simple reason that they are two different services. While Internet connection may be established through a telecommunications network, the former is not entirely dependent on the latter. Their ecosystems are also different from each other, although they might deliver the same functions at times. Traditional telecommunications is anchored on a centralized system. The Internet, on the other hand, thrives on redundancy and decentralization, where the network becomes more resilient as more networks are connected. The policy framework should allow non-telcos, including VAS providers, to build and operate their own networks in order to offer Internet connectivity.

On satellite technology, for example, the government should revisit the country's policy and consider reclassifying VSAT as a VAS. This would allow VAS providers and ISPs to use VSAT for direct access to satellite services, without the need to secure or use a Congressional franchise or a provisional authority from the NTC, if they are offering broadband over satellite. This has the potential of unleashing wireless ISPs and other entrepreneurs to roll-out small-scale satellite-based service to provide data services, especially in the unserved and underserved areas.

A broader approach is proposed in the Open Access in Data Transmission bill, which aims to lower the barriers to entry for data-only service providers by removing the requirement for a Congressional franchise and an NTC authorization for a provider to build and operate a network. It also proposes to lower the cost to operate a network by mandating interconnection, access to infrastructure for fair and reasonable market fees, as well as transparency in rates and spectrum assignments. The bill was approved by the House of Representatives in November 2017 and is pending approval at the Senate,[277] as of this writing.

b. ***Remove landline requirements.*** There is a need to amend RA 7925 or the Public Telecommunications Policy Act in order to remove the requirement for entities who wish to operate an international gateway facility or a cellular mobile network to roll out local exchange services or landlines. This technology-centric policy has hampered competition in the traditional telecom services and has also raised barriers to entry even for Internet service providers that use mobile technologies. While the NTC has, in the past, allowed the putting up of base stations as a substitute to landline rollout, it will be best to have a clear legal basis for all current and future NTC officials, particularly in dealing with emerging cellular mobile-based technologies. The removal of the landline requirement is a key amendment to RA 7925 introduced in a bill approved by the House of Representatives in November 2017 and being tackled in the Senate,[278] as of this writing.

c. ***Relax restrictions on foreign ownership.*** There are critical policy and regulatory changes that will encourage and influence investment in, and rollout of, certain types of emerging technologies that can help bring fast and reliable broadband services directly to end users. For wired technologies, such as PON, there needs to be a more open policy in terms of who can establish and operate a fiber optic network. Relaxing the foreign ownership restriction can encourage investment that can help expand wired and fixed broadband services, which now stand at a low 3.2 per 100 inhabitants (as of end-2017) due primarily to low wired networks. This can be made possible through the amendment of Commonwealth Act 146, which will define telecommunications as a public service, instead of a public utility. As a public service, foreign-owned entities will be allowed to build and operate a telecommunications network and offer services, as long as they comply with the regulatory requirements of a PTE, as provided in RA 7925.

Allowing both foreign and local entities to offer telecommunications and data services can result in significant improvement in access. In Myanmar, for example, the government opened up the telecommunications market and allowed anyone to operate in any segment of the network. The response was immediate; foreign and local companies came pouring in, armed with their own technologies and business models. As a result, the country's mobile service subscribers grew from nil to almost 20 million in just four years![279] The Philippines has had a similar experience when the telecommunications sector was liberalized in the mid-1990s, starting when the government opened up the market for international gateway facilities and cellular mobile services. As several new players entered the market, the introduction of new technologies and creative payment schemes reinvigorated the telecommunications industry, including the incumbent.[280]

Photo by Angelo Gutierrez

d. ***Standardize and harmonize rules for infrastructure.*** To prepare for the entry of emerging Internet technologies, it is important to address how providers can more efficiently and cost-effectively carry out fiber installation and put up cell sites. This will be especially important as the government implements the National Broadband Plan and encourages the entry of new players in the telecommunications and data sectors.

Whether fiber installation is underground or aerial, innovative solutions to prevent unnecessary waste of resources, such as co-deployment and shared utility corridors. Tower co-location should also be mandated. This way, digging the roads is done only once and one tower is built for multiple service providers in a particular area. In the process, local permits and fees, and use of resources, are not duplicated.

Sharing infrastructure, especially for mobile, can help providers lower costs and help boost competition,[281] as new market players gain a foothold and get some leeway to compete with existing providers. This will also promote efficiencies even in aspects outside of the actual installation. For example, having regulation on civil works for underground cabling will prevent the delay of road construction or repair and allow the business in the affected areas to go back to normal much sooner. More importantly, the presence of clear, consistent rules that apply to infrastructure rollout will help all players and promote a level playing field. Immediately, the DICT can issue policy to help harmonize tower build and introduce rules for pole attachment, with the NTC tasked with regulation and enforcement. The streamlining of the permits process will also help address delays brought about by bureaucratic red tape. These regulations should be adopted based on the national policy of promoting and expanding essential infrastructure, such as for communication and data transmission.

e. ***Adopt spectrum management reforms.*** In order to take advantage of emerging technologies, such as TVWS and 5G technology, it is imperative for the Philippines to carry out a comprehensive radio spectrum management reform. Specifically:

1. **Government should be able to rapidly develop a spectrum policy roadmap** and regularly carry out a spectrum use audit through means within its reach, such as comparing approved radio licenses with spectrum assigned and actual rollout. In the long-term, the government should free up spectrum that are underutilized and effectively distribute this scarce resource to various types of service providers who can offer emerging Internet technologies.

   One example of this is TVWS, where the Philippines is in a strategic position to introduce the technology as an alternative means to connect the underserved and unserved areas. It has had the benefit of being one of the first few countries where pilot-testing of TVWS was carried out, with support from the private sector and international partners. Despite the absence of any successful commercial deployment of TVWS to date, the Philippines can be at the forefront of exploring the different possibilities that this technology brings. Based on the pilot-test in Bohol, Tacloban, and Cavite, and those in other countries, the NTC should consider adopting lessons from good practices in the use of TVWS for Internet connectivity.

The NTC can look to the examples of the U.S. FCC, the first to allow license-exempt access to TV White Spaces in 2008.[282] The U.K.'s Ofcom[283] and Singapore's IDA[284] offer other examples of regulation that allows flexibility in maximizing the use of white spaces.

Amid the growing demand for spectrum use, national regulatory authorities globally are beginning to recognize and study the importance not only of white spaces, but of spectrum sharing and license-exemption in general, in order to use spectrum more efficiently. Thanki (2012) urges governments to resist requests from operators for more exclusive use of spectrum, as this will lead to a substantial concentration in the ownership of valuable spectrum, and also risk decreased competition and innovation. To achieve a balanced approach, policymakers and regulators should enable more dynamic spectrum sharing and licensed-exempt access across spectrum, as these methods of broadband delivery promote more efficiency in their use of spectrum than their licensed counterparts.[285] The policy discussion on spectrum sharing and license-exempt use of spectrum in the Philippines should also begin.

However, beyond the technical aspects, some issues involving emerging technologies seem to be more rooted in the political feasibility of the proposed policy and regulatory changes. In the case of TVWS, for example, Cabarios explains that the NTC had to consider the opinion of the KBP, which resulted in a compromise regulation that allowed unlicensed use of TVWS for VHF channels and for government use only.

2. **Certain laws need to be amended to allow wider access and better use of emerging wireless technologies.** It should be pointed out that the NTC, as regulator, must struggle with the interpretation, harmonization, and implementation of laws enacted almost three generations ago–RA 3846 (1931), CA 146 (1936), as well as the 28-year old RA 7925—that could not have possibly foreseen the kind of digital technologies in use today, nor foreshadowed the day when data transmission services, particularly wireless, would be close to taking over traditional voice and be just as essential to daily life. Three particular aspects of law and regulation may be singled out in this regard:

   a. ***RA 3846***, the Radio Control Act, which was enacted way back in 1931, needs to be amended to expressly allow VAS providers (including ISPs) to have access to emerging wireless technologies without need of a Congressional franchise. VAS as a service category did not exist when RA 3846 was enacted, but was created by RA 7925, enacted in 1995. RA 7925 does not require VAS to have a Congressional franchise. These two laws, thus, need to be harmonized to expressly address wireless technologies for the digital, data-hungry age.

   b. ***RA 7925*** should itself be amended to allow VAS providers to put up their own network to render their value-added services, including mobile data, without needing to depend on the enfranchised PTEs. This will not only promote investment and growth in the data transmission services sector, but also delink service quality for data transmission services from dependencies on the traditional voice-centric networks.

   c. ***NTC MC 03-03-96***, which sets out the process for spectrum recall, needs to be strengthened to allow the State to take back frequencies without legal challenge. Radio spectrum is a property of the state. However, once the state has licensed it out, it becomes a challenge for the state to take back its own property, even from parties who only hold it but do not use it, and from parties who may have more than what they really need. The NTC has the power to recall spectrum for reasons it deems necessary for the promotion of public interest, subject to due process. Due process requires the NTC to serve notice and hearing on the frequency holders whose spectrum is to be recalled in order to give these parties a chance to contest the recall. Parties who are unhappy with the NTC's decisions on spectrum can take the NTC to court, which the regulatory body sees as a disincentive to making any action that will attract strong opposition. Cases that have been brought to court can last a few years to over a decade. In the case of TVWS, for example, Cabarios says that even if the NTC believes that some frequencies are not being used (including the guard bands), the regulator agreed to a compromise to allow secondary use of VHF channels for the DICT's Free Wi-Fi program and other government projects.

Cabarios thinks that the solution to this problem is to create a law that explicitly and categorically states what the NTC can do. Otherwise, the NTC would be burdened with court cases and the regulatory decision-making process will be protracted. And when the courts issue an injunction, the NTC will not be able to do anything.[286] The regulators are also concerned about criminal cases that can be filed against them as individuals. This issue can be addressed in the proposed amendments to RA 7925, which grants the NTC immunity from suit and indemnity when carrying out its functions.[287]

Restrictive interpretations of antiquated laws have limited possession of vital frequencies for broadband, and consequently the utilization of technology, to the very few enfranchised entities. At the same time, the lack of a single statute that better defines the powers of a modern-day NTC leaves the regulator itself doubting the strength of its powers to institute spectrum reform. Comprehensive spectrum reform must, thus, include basic changes in the laws and regulatory environment to unlock the potential of these frequencies for use with new and emerging technologies, and ensure that the regulator has the necessary power to launch and sustain a dynamic spectrum management framework.

Enhancing the regulatory environment. In the Philippines' case, the policymakers and regulator often decide to use existing policy to address the entry and testing of emerging Internet technologies. While this approach has its own benefits, such as preventing unnecessarily burdening new entrants or stifling innovation before they take off the ground, it is often the case that current policies are designed for traditional technologies and old business models without the foresight of the nuances and issues that will arise from emerging technologies.

Given this dilemma, perhaps the government can consider sandbox regulation where a certain amount of leeway will be allowed for entities, foreign or local, to experiment on the possible application of emerging Internet technologies to the Philippines. This way, policy and regulatory decisions will be informed by the actual experience of using the technology in a particular setting, geographic area, and/or for a specific amount of time.

The conservative and restrictive regulation towards emerging technologies can be symptomatic of the disconnect between the Philippines' policy and regulatory environment and the reality on the ground. Hence, beyond promoting regulation that will allow more access to promising emerging technologies, the country needs to improve its overall ICT regulatory environment.

According to the ITU's ICT Regulatory Tracker since 2007, the Philippines has not shown any indication of improvement based on its ranking and score over the past decade. Compared to its Asian neighbors, the Philippines garnered extremely low scores (receiving less than half of the maximum score per indicator) in 2017 in terms of regulatory authority, regulatory mandate, regulatory regime, and competition framework. These scores did not change much over the course of 10 years. Meanwhile, the Philippines'

Asian neighbors have improved significantly, particularly Cambodia, China, and Vietnam—countries which started with a very low base score in 2007. For a summary of the ICT Regulatory Tracker results, please refer to Appendix D.

While the Philippines started with a relatively high overall score 33.67 in 2007, it scored only 41.67 in 2017, recording a measly improvement of 24%. Cambodia, which started with a score of 14 in 2007 ended up with a high score of 70.33 in 2017, which translates to over 400 percent of improvement over a decade. Vietnam, which recorded a score of 18.83 in 2007 scored 74 in 2017, a change of almost 300 percent. Myanmar, which was a closed country for decades, scored higher than the Philippines at 53.83, perhaps owing to its aggressive open-entry policy in telecommunications.

The Philippines, for all its status as the texting and now social media capital of the world, faces significant challenges when it comes to Internet connectivity. The government may not have enough funds to invest in, or a battalion of engineers and scientists to experiment on emerging Internet technologies. However, it can help shape the market by facilitating the entry and use of technologies that have the potential to improve many aspects of Internet services. The country's laws and regulations that affect Internet provision have not changed much since 1995. As a result, the Philippines continues to use analog policies for an increasingly digitizing world. It is hoped that the rise of emerging Internet technologies — with the promise to bridge the digital divide—can provide the much-needed impetus for reforming the Philippines' policy and regulatory environment to bring it to the digital age.

Appendix A: Emerging Internet Technologies

Digital Subscriber Line (DSL) Technologies

DSL is a technique for providing last-mile broadband communications over copper telephone lines. It is a commercially available technology available in high- and medium-density areas in nearly every country in the world. While DSL is considered a mature access technology, its latest iteration G.fast has the potential for being used in a novel and impactful way.

DSL differs from dedicated network technologies like Ethernet in that It is designed specifically for use on existing copper telephone lines. Unlike dial-up modems used for Internet connectivity in the 1990s, DSL doesn't interfere with voice communications in that both voice and data can work simultaneously.

On a telephone line with DSL, voice communications occupy only a tiny amount of the usable bandwidth across the copper line, right at the bottom of the spectrum available for communications. Subscriber modems use a small block of spectrum above the voice communications band to send data to the Internet, while provider multiplexers (Digital Subscriber Line Access Multiplexers, or DSLAMs) use a large block of spectrum above the subscriber modem to send traffic to subscribers.

DSL technology has evolved as equipment manufacturers have found ways of reliably using higher and higher frequencies for communications. Variants, from slowest to fastest, include ADSL, ADSL2+, VDSL, VDSL2, and an emerging technology called G.fast. This latest technology can use frequencies up to 212 MHz to provide near-gigabit speeds.

While they carry more data, the high frequencies used by modern DSL systems attenuate rapidly as they travel over copper lines. Lower signal levels equate with lower speeds, so providers must keep copper cable lengths short to keep speeds high. The chart below shows the speed of the four technologies as cables get longer.

Early versions of DSL were designed to operate directly from telephone exchanges. This leads to very long copper distances between DSLAMs and end users. In addition to degrading the signal through attenuation, it also exposed users to interference as a result of signal leakage (called crosstalk) inside tight bundles of thousands of pairs of copper cables out to the street.

With high speeds available only over short distances and interference problems in large exchanges, much of the innovation in building DSL networks has been to do with getting equipment out of centralized locations and as close to consumers as possible.

Fiber to the X (FTTx)

Fiber to the Node

Carriers have responded to consumer demands for higher speeds by installing roadside, pole mount, or in-building DSLAMs (nodes), then using fiber-backhaul to connect the "nodes" to the exchange. Moving DSLAMs closer to users serves to increase speeds by shortening copper cable lengths and reducing crosstalk. One downside of Fiber to the Node (FTTN) configurations is a requirement for a power connection to each node, and a battery backup system at the node in locations with unreliable power.

Fiber to the Curb

A revolutionary use of DSL can be found in Fiber to the Curb (FTTC). This new, emerging technology seeks to shorten copper loop lengths even further than FTTN. It can do so without the cabinet or power requirements of FTTN. With FTTC, a fiber connection is run from the telephone exchange to a pit or pole box outside of each address. Existing copper wires are used from "the curb" or roadside into the house. A G.fast modem is installed at the curb and in the house. The existing copper cables are used to provide both a data link to the street, plus power to the outdoor G.fast modem. FTTC is being used by Australia's NBNCo[288] to lower the cost of bringing high-speed services to end users in mid- to low-density environments, while offering near-gigabit speeds.

Amongst Philippine providers, Globe offers commercial VDSL services, but PLDT offers only ADSL2+, a standard approved by the ITU in 2009. PLDT announced a G.fast VDSL product in 2016[289] but it does not appear in their product offerings yet.

Wave Division Multiplexing (WDM)

WDM is the idea of using multiple frequencies of light (colors) on a fiber, transmitting different information on each color. While early fiber optic systems supported only a single color of light, common WDM systems can support anywhere from 18-96 different colors. Emerging WDM technologies are being integrated into last-mile communications, carrier networks, and submarine fiber cables, dramatically increasing capacity for all.

Active Wave Division Multiplexing. Active systems are powered devices often capable of converting light from one color to another, dynamically changing channel sizes, and amplifying signals so they can travel long distances. They've traditionally been very expensive, and generally only used by large carriers with deep pockets.

Passive Wave Division Multiplexing. Passive systems are unpowered devices that rely on end device optics that have a fixed color to transmit and receive. They can't change the color or amplify the light travelling through them - they can only use finely tuned optics to combine separate colors onto a single fiber. While WDM has been a standard since 2002, advances in the design and manufacturing of passive WDM equipment have made it an emerging technology affordable for small organizations and even community networks.

Optical Circulators. In most Wave Division Multiplexing systems one fiber is used for transmitting traffic, and one for receiving. Optical Circulators are devices that allow a single frequency (or set of frequencies) to be used for both transmitting and receiving on a single fiber cable. They are often combined with WDM systems to enable high capacity in systems with limited amounts of physical fiber.

Coarse Wave Division Multiplexing. Coarse Wave Division (CWDM) is a passive technique where low-cost prisms are used to multiplex and demultiplex up to 18 different color lasers onto a single fiber. When organizations have access to dark fiber they can use CWDM to increase the capacity of a single pair of fiber, or even a single fiber, from 10 Gbps up to 180 Gbps.

Dense Wave Division Multiplexing. Dense Wave Division Multiplexing (DWDM) uses fine optics to combine up to 96 different color lasers onto a single fiber. It has both passive and active variants, and has been in use since the mid-1990s.

Passive DWDM is an emerging technology for metropolitan and suburban fiber networks. The newest systems allow 960 Gbps of traffic - nearly a terabit - on a single fiber, while still using inexpensive optical modules compatible with standard switches.

Active DWDM systems are frequently used for long-distance transmission between metropolitan markets, and for submarine cable networks. Active DWDM signals can be regenerated without routing or switching equipment, making them ideal for use along long stretches of power lines or under water. Once the domain of the world's largest carriers, innovations in DWDM including Facebook's release of an open-source hardware design[290] have made DWDM an emerging technology to watch.

Fiber installation

There are different types of fiber installation, each with their benefits and key features.

Aerial Fiber. In developing economies where ramping up connectivity is more important than the aesthetics of utility poles and wires, aerial fiber can allow multiple competing providers to offer FTTN and FTTP services, cellular network fronthaul/backhaul, and network transmission services over the same poles. In developed markets, there are cases wherein a single operator is allowed to run aerial fiber but restricted to selling wholesale (not retail) services on the fiber.

Microtrenching. Microtrenching is an installation technology where a small groove is cut in a paved road, a fiber or set of microtubes is laid in the groove, and the road is restored all at the same time. Microtrenching can allow fast installation of fiber along roads both urban and rural, without needing the road to be closed for a long time while works are being done. The downside of shallow trenching is that road works or other utilities maintenance can result in fiber cuts.

Surface Application. Surface application is an emerging technology where fiber is glued to road surfaces[291] with a compound that adheres well and protects fiber from vehicle damage. It is unproven and relatively expensive, but with time could be an important tool.

Microducting. Microducting is the idea of running multiple thin tubes through a single larger duct or conduit. Then individual providers can run their own cables or blown fiber inside the microducts. It allows providers and local authorities to share the physical cost and space of fiber installation without forcing them to cooperate on sharing pairs of a single fiber cable, or capacity on a lit system.

Millimeter Wave (MMW)

Bands between 30 and 300 GHz are defined by the ITU as "Extremely High Frequency" but, in common use, they are called Millimeter Wave (MMW), as their waves range in size from one (1) to 10 millimeters. Today, even bands down to 24 GHz are given the same name. MMW bands have a huge amount of available radio spectrum and typically offer bandwidth of at least 1 Gbps. However, they suffer from environmental factors, including oxygen and rain attenuation, and do not have good performance through foliage or buildings. MMW bands can have good reflective performance, making them ideal for use in urban and indoor settings. In the 60 GHz band, oxygen absorption that limits range is also a positive aspect; the reusability of 60 GHz is excellent as waves do not go far.

MMW is at the center of a number of emerging technologies in terrestrial and space-based communications. Development of the band has accelerated in recent years as technologies to print components have come into use. In home/office applications, 802.11ad (WiGig) base stations and adapters are being developed for AR/VR[292] applications. For ISPs, several manufacturers have released low-cost MMW products in 2017 and 2018. For carriers, microwave links of up to 40 Gbps capacity are coming to market, intended to be used as backhaul for 5G base stations. Facebook claims[293] distances of up to 13 km using these new platforms. And for aerial[294] and space[295,296] based applications, MMW is the technology of choice for high-speed backhauls.

Massive Multi-In Multi-Out (MIMO)

Massive MIMO is the practice of using the same frequency over multiple antennas to send different streams of data. It increases the spectral efficiency of services - allowing more data to be sent than older systems without occupying more radio spectrum. MIMO is a commercial technology used in cellular networks and Wi-Fi base stations for nearly ten years. In both networks, up to four antennas are used at the base station to communicate with client devices that have at least two receive antennas.

Massive MIMO (also referred to as 3D-MIMO[297]) scales the number of elements up to 16, 64, or even 256 antennas[298] in a single array. It is being installed today[299] in "pre-5g" cellular base stations. The spatial multiplexing achieved by Massive MIMO allows high data rates, beam steering to target individual client devices, and interference protection for the base station, which can choose not to listen to certain noisy areas using a technique called "nulling.[300]" Massive MIMO works exceptionally well with MMW frequencies, as the size of antennas and components are small enough that an antenna array can be printed on a single chip.[301]

Software Defined Radio (SDR)

An SDR is one that is not fixed to a particular frequency. A combination of software and hardware is used to generate waveforms to communicate data at modulations, frequencies, and bandwidths determined and reconfigurable on-the-fly. SDR on Satellite is an emerging technology that can allow satellites to be built and launched at low cost even before they are needed. It can also allow satellites to be used for short periods of time then re-configured to another use. San Francisco-based startup Astranis[302] is the pioneer in this field, having launched its first satellite into GEO in January 2018.[303] It plans to offer services, including mobile tower backhaul, which could be instrumental in allowing carriers in island nations to build towers in areas without fiber or microwave line-of-sight.

Optical Satellite Networks

Acquiring radio spectrum for satellite can be a lengthy and expensive proposition, and can involve international negotiations. ***Optical networks*** allow for ultra-high capacity without the requirement for radio spectrum. They also allow for nearly infinite re-use of spectrum. On the downside, optical satellite networks suffer all of the issues seen with Free Space Optics (FSO) (refer to main text). And given the inability of light to penetrate clouds, this could make optical satellites a poor choice for some parts of the world. Start-up LaserLight Communications[304] plans to offer a network complementary to (used along with) submarine fiber cables, that will provide opportunistic fast light paths. They also plan cabled networks that will link earth stations in a metropolitan area, allowing laser data to hop around any clouds.

Blended Network Offerings

Blended network offerings allow the stacking of frequencies and technologies to use the best and most appropriate for the highest priority data, and slow down or drop low-priority data when conditions do not support its transmission. Such bundling could well combine FSO and MMW as seen in terrestrial systems, MEO and LEO orbits (refer to main text), or even fiber optic plus satellite. They are an emerging technology not yet supported by common Internet protocols, but in active development[305] by standards bodies.

Other Factors Influencing Change

New and emerging technologies with the potential for impact in the Philippines go beyond the development of access networks. They include changes in the architecture of the Internet, new business methods, and changes in regulations.

Internet Architecture

Content Delivery Networks (CDNs). Over the past five years, the Internet has moved from an "end to end" model where most traffic was direct between users, or between users and centrally located servers, to a model where caches provide an intermediation layer between almost all transactions—including Chat and Skype/Facebook Voice, which may be considered direct between two parties.

This new method of operation has happened in parallel to the concentration of traffic and market power in the hands of Akamai, Amazon, Apple, Baidu, Facebook, Google, Microsoft, Netflix, QQ, and Yahoo.

Cache servers owned by major content companies are now located in metro exchanges and telco pops all over the world. In many cases, the content providers themselves build and operate the global distribution networks to feed them. In the Philippines, this is exemplified by the Pacific Light Cable Network[306] (PLCN), which both Google and Facebook funded for their own use, not for resale to telcos. PLCN is one of 11 cables[307] Google has invested in, while Microsoft, Facebook, and Amazon have similar strategies.[308]

Software Defined Networking (SDN). SDN is an emerging technology premised on network equipment that can be centrally programmed. It allows companies to deploy complex smart networks without the overhead of having to individually manage a large number of devices. Central orchestrators determine how a network topology should be designed—as an overlay to a physical topology—and can automatically make changes to optimize performance or deliver new services. Some novel uses of SDN are providing firewalls or corporate wide area networking services, with most of the important equipment run "in the cloud" or by a service provider.

Business Models and Commercial Arrangements

Tower Sharing. Regulation of towers can force cooperation and innovation. In the state of Connecticut in the U.S., a single body governs the citing of cellular towers,[309] and balances public need, environmental standards, and tower sharing. This means fewer towers are built, and firms must compete by upgrading equipment and offering better services, rather than on having unique coverage of a particular area. Tower sharing managed by third parties happens worldwide; leaders in the field include Crown Castle[310] and American Tower,[311] but new companies are growing especially in South America.[312]

Radio Access Network (RAN) Sharing. RAN sharing is the idea where multiple providers offer their service sets over a common radio infrastructure in a commercial, pre-agreed way. This happens without a primary carrier and roaming networks—all connectivity is native. RAN sharing is unusual as a commercial concept and is emerging in a few markets including Latin America[313,314] and New Zealand. In Mexico, a new 700-MHz wholesale-only network was launched[315] as a public-private partnership (PPP) between the government, Nokia, and Huawei. In New Zealand a joint venture[316] between the three cellular operators, where each operator holds a 33.3% stake in the venture, will provide rural and remote connectivity for all three retail networks. This separate company has been formed with staff seconded or hired away from the three companies to ensure one partner is not dominant in the design or operation of the network.

Internet Exchanges. Exchanges are not a new or emerging technology in themselves; basic Internet exchanges have existed for more than 25 years. The emerging technology in exchanges has to do with CDN hosting and access.

In the traditional model of cache server hosting, an ISP will host a CDN server within its network and will provide all of the upstream bandwidth required to the Internet in order to fill this cache. This provides the CDN host with some savings in upstream bandwidth but confers a financial benefit to the CDN owner. In an emerging model of Internet Exchange, two things have happened: (1) global internet giants have started purchasing their own submarine fiber capacity and cables from their hubs to Internet exchanges around the world, where they provide CDNs and peer their content with any participating networks—ensuring that their content is faster than any content from competitors not present at the same Internet Exchange point (IXP); and (2) Internet Exchanges have started purchasing their own global transit links in order to fill CDNs who do not purchase their own caches of smaller players, and spread the cost of those transit links amongst their participant. It is a major change for exchanges, which, historically, have been only neutral peering points, and has the potential to enable smaller operators to break the monopolies of large companies who may control submarine cable access.

Radio Modelling. Predictive technologies and modelling are an important component of 5G access planning and operation. With previous cellular and wireless technologies, waves were of a size where low-resolution models could suffice to predict and/or explain their behavior. Models for these networks could be made from satellite scans and imagery. 5G MMW requires far higher resolution data–typically sourced from terrestrial and/or airborne (but not satellite) sensors. Two emerging technologies are contributing:

- **Light Detection and Ranging (LiDAR)** is a laser range finding typically done by a municipality or state on a large scale. It is typically done using fixed-wing aircraft but can also be done at small scale with motor vehicles and drones. LiDAR data sets are interesting and useful to telecommunications, utilities, real estate, city planning, disaster planning, and disaster recovery.
- **Drone Photogrammetry** is a model constructed from video imagery taken by operators on a small scale. Data sets are equivalent to LiDAR and are easier to do over small areas but are more difficult to accomplish at large scale.

Infrastructure Mapping. Five years ago, governments and carriers might have had a few licenses for an expensive commercial mapping tool like ArcGIS. They likely had a few trained operators who handled all GIS data and occasionally produced static maps. Mapping is, however, emerging technology due to the lowering in cost and complexity of using GIS systems. Today, there are a large number of cloud GIS providers with free or low-cost plans allowing both public and private hosting of geodata. They are easy to use for anyone familiar with cloud tools and allow anyone to interact with geodata. This emerging technology democratizes geodata and allows users at all levels of government and civil society to have access to information for planning.

Economic and Regulatory Regime

Universal Service / Universal Access. The ITU has been promoting Universal Service and Universal Access[317] for around 15 years, but programs have become more creative in recent years. Universal Service Funds (USFs) are common in both developed and developing markets, and are often used to subsidize the build of infrastructure in remote locations or the connections for those who cannot afford them.

Emerging models of Universal Service funding have seen governments bid out regions, enforce of open access principles on funded infrastructure, and prevent operators from overbuilding existing networks. Some programs have been designed to cause incumbents to compromise and work together, as seen with New Zealand's new RAN sharing rural cellular network.

Emerging models of Universal Access have seen the private sector give away access, often with users losing privacy, having limited web access, being exposed to advertisements, or all of the above. One example of an emerging universal access model is zero-rated content, where the subscribers of a network operator are given access to a basic or lite version of a particular content free of charge.

Spectrum Licensing and Spectrum Sharing. The licensing of spectrum can have a major impact on the ability of telcos to implement services. New and emerging technologies in this area include whitespace derived databases allowing primary and secondary use of frequencies, and real-time information on where spectrum is in use or idle. While TVWS networks have been commercially unsuccessful, spectrum sharing is seeing a resurgence in the U.S. in the use of the CBRS band at 3.5 GHz.

Open Data. While not an emerging technology in developed markets, Open Data is very much emerging in developing markets like the Philippines. In developed markets there is a vast amount of public, open data with no application or approval required to access it. Data useful to the development of telecommunications includes: address sets, census data, terrain models, digital surface models, locations of radio licenses (cell towers, microwave links), locations of government and school buildings, locations of power transmission lines. This data is typically available from open data portals as both tabular and GIS format and allows companies to plan coverage, competition, marketing, and universal access programs.

Structural Separation. First conceived in the power utility market, structural separation splits retail and wholesale parts of a utility business.[318] Structural separation helps ensure that all end users have adequate basic infrastructure, and leaves companies to compete for customers based on retail services. Structural separation has been the engine that has pulled New Zealand from the bottom of the broadband rankings to near the top when compared to its peer countries. By funding a number of wholesale-only fiber companies, the government has created a market where dozens of retail providers (both mass market and specialist) have equal terms access to fiber connections entering more than 87% of New Zealand's properties. A massive amount of innovation has come both from this wholesale access and from mobile network operators deploying new products to try and compete with these wholesale fiber products.

Appendix B: Philippine Policy and Regulation that Affect Ownership and Operations of a Telecommunications Network

Source: Compiled by author.

SEGMENT	OWNERSHIP	FRANCHISE, LICENSE OR PERMIT	OPERATION
International connectivity			
Submarine cable system	Open to all	Commercial agreement among submarine cable consortium members. No local franchise or permit required.	Philippine laws do not have jurisdiction over the operation of international submarine cables, until they land on Philippine shores.
International Gateway Facility (IGF)	At least 60% Filipino owned	An IGF operator is a local telco with a Congressional franchise and a certificate of public convenience and necessity (CPCN) from NTC. **RA 7925:** Public Telecoms Policy Act[319] International carrier: Only entities which will provide local exchange services and can demonstrably show technical and financial capability to install and operate an international gateway facility shall be allowed to operate as an international carrier. **NTC MC 09-07-93:** Interconnection of Authorized Public Telecoms Carriers (as updated by MC 14-07-2000) provides the following definitions: **International Gateway Facility (IGF):** A facility consisting of international transmission, switching and network management facilities which serve as point of entry and exit in the Philippines of international traffic between the national network and point/s outside the Philippines. **International Gateway Facility (IGF) Operator:** a public telecommunications carrier providing IGF services.	
Cable landing stations	At least 60% Filipino owned	**NTC MC 06-10-2008:** Rules on the Mandatory Interconnection of Cable Landing Stations to Backhaul Networks[320] Guideline no. 1 – Backhaul network operator – refers to duly enfranchised and authorized inter-exchange carriers or international gateway facilities or international carriers.	**NTC MC 06-10-2008:** Rules on the Mandatory Interconnection of Cable Landing Stations to Backhaul Networks[321] *Guideline no. 2* – The interconnection of backhaul networks to all cable landing stations shall be mandatory. *Guideline no. 7* – The cable landing station operator and the backhaul network operator shall negotiate and enter into an interconnection agreement… [which] shall be submitted to the Commission not later than thirty (30) days from the date of the agreement for approval.
Bandwidth/Capacity seller Bandwidth Aggregator	100% foreign owned company allowed to sell, but bandwidth distribution within the Philippines can only be done by a local telco	There is no policy or regulation specific to entities selling bandwidth. According to the NTC, a bandwidth aggregator / seller is considered a "carrier's carrier." But as long as the entity only sells bandwidth and does not put up its own network or offer a telecom service for a fee, it does not need to secure a Congressional telco franchise.	Foreign bandwidth sellers need to secure a VAS license from the NTC but can only sell or distribute capacity to their clients using the network of local telcos.

Backhaul network			
National backbone	If a telco, at least 60% Filipino owned	**RA 7925** and its implementing rules and regulations (IRRs), as contained in MC 08-09-95, refers to an inter-exchange carrier (IXC) as a "carrier's carrier or national backbone network operator." **NTC MC 09-07-93:** Implementing Guidelines on the Interconnection of Authorized Public Telecoms Carriers (as updated by **MC 14-07-2000**) defines the following: **Inter-exchange Carrier (IXC)** – a public telecommunications carrier providing transmission and switching facilities which connect local exchanges as well as IGFs within the Philippines enabling them to offer telecommunications services of any type, whether of voice, data or images for which there is a charge separate from the rate schedule applied to subscribers within a local exchange area.	**NTC MC 06-10-2008:** Rules on the Mandatory Interconnection of Cable Landing Stations to Backhaul Networks[322] *Guideline no. 2* – The interconnection of backhaul networks to all cable landing stations shall be mandatory. *Guideline no. 7* – The cable landing station operator and the backhaul network operator shall negotiate and enter into an interconnection agreement… [which] shall be submitted to the Commission not later than thirty (30) days from the date of the agreement for approval.
Fiber optic cable provider	If a telco, at least 60% Filipino owned If a cable TV operator, must be 100% Filipino owned If a contractor, service using the fiber must be operated by a local telco	Telcos can lay fiber by underground or aerial infrastructure or by attaching to poles. Cable TV providers who have an NTC certificate of authority can also lay fiber for broadcast, but it needs to secure a VAS license before it can offer cable Internet service. Like other VAS providers, cable Internet service providers are not allowed to put up a network but may use the facilities of a local telco.	
Last mile			
Local exchange carrier (LEC)	At least 60% Filipino owned	**Legal requirements:** Congressional franchise NTC Provisional Authority or CPCN **RA 7925: Public Telecommunications Policy Act** **Sec. 3(b)** Public telecommunications entity - any person, firm, partnership or corporation, government or private, engaged in the provision of telecommunications services to the public for compensation. **Sec. 3(d)** Franchise - a privilege conferred upon a telecommunications entity by congress, authorizing that entity to engage in a certain type of telecommunications service. **Sec. 3(e)** Local exchange operator - an entity providing transmission and switching of telecommunications services, primarily but not limited to voice-to-voice service, in a geographic area anywhere in the Philippines. **Sec. 16.** Franchise – No person shall commence of conduct the business of being a public telecommunications entity without first obtaining a franchise. The Commission, in granting a Certificate of Public Convenience and Necessity (CPCN), may impose such conditions as to duration and termination of the privilege, concession, or standard or technical aspects of the equipment, rates, or service, not contrary to the terms of the franchise. In no case, however, shall the CPCN be shorter than five (5) years, nor longer than the life of the franchise. A CPCN expiring at the same time as the franchise shall be deemed to have been renewed for the same term if the franchise itself is also renewed or extended. A Provisional Authority (PA) contains a (i) description of the service, (ii) the specific rate or a general rate structure that may be charged for the service, and (iii) the regulations under which that service can be provided (Serafica, 2001).	**NTC MC 09-07-93** or "Implementing Guidelines on the Interconnection of Authorized Public Telecoms Carriers"[323] (as updated by **MC 14-07-2000**[324]) **Art. II, Sec. 3** All authorized public telecommunications carriers shall be interconnected into a universally accessible and fully integrated nationwide telecommunications network for the benefit of the public. **Art. II, Sec. 4** All IXCs and IGFs shall interconnect with all LECs to provide freedom of choice to toll facilities. **Art. II, Sec. 6** Interconnection among authorized public telecommunications carriers in accordance with Section 3 shall be compulsory and may be effected through: Negotiation Submission by parties to the Commission **Art. II, Sec. 7** Interconnection shall at all times satisfy the requirements of fair competition and shall be effected in a non-discriminatory manner.

Internet service provider (ISP)	Local and foreign companies allowed Enterprises with a paid-up capital in excess of $2.5 million can be wholly owned by foreigners (based on Retail Trade Act).	**Legal Requirements:** NTC VAS license **RA 7925:** Public Telecoms Policy Act **Art. IV, Sec 11** Value-added Service Provider – Provided that it **does not put up its own network,[325] a VAS provider need not secure a franchise.** A VAS provider shall be allowed to competitively offer its services and/or expertise, and lease or rent telecommunications equipment and facilities necessary to provide such specialized services, in the domestic and/or international market in accordance with network compatibility. **NTC MC 05-08-2005:** Voice Over Internet Protocol[326] a. **Enhanced services** – shall mean those services that improve upon the quality and/or functionality of services ordinarily offered by local exchange and inter-exchange operators and overseas carriers. b. **Value-added services (VAS)** – refers to enhanced services beyond those ordinarily provided for by local exchange and inter-exchange operators, and overseas [international] carriers through circuit switched networks **NTC MC 02-05-2008:** Value-Added Service (VAS)[327] **Sec. A(1)** The following are classified as value added services: (i) messaging services (including SMS); (ii) audio conferencing; (iii) audio and video conferencing; (iv) voice mail service; (v) email service; (vi) information service; (vii) electronic gaming service except gambling; (viii) applications service; (ix) content and program service; (x) audiotext service; (xi) facsimile service; (x) virtual private network service; (xi) hosting service. **Sec. B(5)** No entity shall provide value added service without valid certificate of registration from the Commission… **Sec. C(9)** The rates for value added services shall be deregulated. The VAS provider shall inform the Commission of the rates for each of the VAS offered at least seven (7) days prior to the offering of such VAS.	**NTC MC 02-05-2008:** Value-Added Service (VAS) **Sec. A(4)** PTEs shall offer leased line service to VAS providers at the same quality and at a price not higher than the prevailing leased line prices offered by the PTEs to the public. PTEs' shall not deny requests by VAS providers for leased line service.
Cable Internet service providers	At least 60% Filipino owned	Legal requirements: NTC Provisional Authority or Certificate of Authority Executive Order 436 (s. 1997)[328]: Prescribing Policy Guidelines to Govern the Operations of Cable Television in the Philippines Section 1: The operation of cable television systems, as a subscriber service undertaking with a unique technology, shall be maintained separate and distinct from telecommunications or broadcast television. Section 3: NTC grants a Provisional Authority or a Certificate of Authority for CATV operators to persons, associations, partnerships, corporations or cooperatives to… "install, operate and maintain a cable television system or render cable television service within a service area."	Cable TV operators who wish to offer Internet service needs to secure a VAS license from NTC and use the network of duly enfranchised local telcos.

Spectrum user	At least 60% Filipino owned	**Legal requirements:** Congressional franchise NTC Provisional Authority or CPCN Radio station license Permit to purchase equipment **RA 3846:** Radio Control Law[329] Sec. 1. No person, firm, company, association or corporation shall construct, install, establish, or operate a radio station within the Philippine Islands without having first obtained a franchise therefor from the Philippine Legislature. Sec. 2. The construction or installation of any station shall not be begun, unless a permit therefor has been granted by the Secretary of Commerce and Communications. No station shall be operated except under and in accordance with the provisions of a license issued therefor by the Secretary of Commerce and Communications (mandate transferred to the NTC). Sec. 3. The Secretary of Commerce and Communication (now NTC) is hereby empowered to regulate the establishment, use, and operation of all radio stations and of all forms of radio communications and transmissions within the Philippine Islands and to issue such rules and regulations as may be necessary. **RA 7925:** Public Telecoms Policy Act **Art. II, Sec. 4(c)** The radio frequency spectrum is a scarce public resource that shall be administered in the public interest and in accordance with international agreements and conventions to which the Philippines is a party and granted to the best qualified. The government shall allocate the spectrum to service providers who will use it efficiently and effectively to meet public demand for telecommunications service and may avail of new and cost-effective technologies in the use of methods for its utilization; **Art. V, Sec. 15** Radio Frequency Spectrum. - The radio frequency spectrum allocation and assignment shall be subject to periodic review. The use thereof shall be subject to reasonable spectrum user fees. Where demand for specific frequencies exceed availability, the Commission shall hold open tenders for the same and ensure wider access to this limited resource.	**NTC MC 03-03-96:** Review, Allocation and Assignment of the Radio Spectrum[330] 602. Frequency Assignment Authorization c. A review of assigned radio frequencies to determined compliance with authorizations issued to authorized users shall be conducted periodically. d. Additional radio frequencies may be assigned to PTEs to satisfy demand for services authorized to be offered upon submission of information, number of subscribers per radio channel and number of operating radio stations to justify the additional grant. e. Assigned radio frequencies to private networks covered by valid permits and licenses issued by the Commission unused for a period of at least one (1) year from date of issuance of permits and licenses shall be called after service of notice in writing. Radio frequencies assigned to PTEs unused for at least one (1) year from the date of issuance of permits and licenses may be recalled after service of notice and hearing. f. No reservation of radio frequency channels or bands shall be allowed. 604. Open Tenders g. Open tenders shall follow the standard government bidding process. 605. Spectrum User Fees a. The appropriate schedule of spectrum users fees shall be applied uniformly and without discrimination to all users under the same classification / category. b. For mobile radio services, the SUF shall be charged based on the RF band occupied and the area covered. c. For Fixed radio services and satellite earth stations, the SUF shall be based on the RF band occupied and the number of stations. **NTC MC 11-10-97:** General Bidding Procedure for the Assignment Radio Frequencies[331]

Appendix C: TV White Space Pilot Test in Bohol, Philippines

Before the official launch of TV White Space in the Philippines, Microsoft worked with the Information and Communications Technology Office (ICTO), the precursor to the Department of ICT, to find a compelling "use" case for the rollout. They looked for locations in the country without Internet and found the USAID-funded Ecosystems Improved for Sustainable Fisheries (ECOFISH) project of the Department of Agriculture's Bureau of Fisheries and Aquatic Resources (BFAR) in Bohol. The main objective of the ECOFISH project was to improve the management of important coastal and marine resources and associated ecosystems that support local economies.[332] It aims to foster fishing sector reforms through the application of the Ecosystem Approach to Fisheries Management in larger marine conservation areas. One of the activities of the ECOFISH Project was to register fishermen in the region and to provide them with different training programs, such as alternative livelihood in cases where fishing was not sustainable at ecosystem scales.

Phase 2 of the ECOFISH project focused on remote areas, especially those where biodiversity needed to be preserved. The project recognized that in more remote areas, it took more time to register the fishermen who had to travel long hours (sometimes even days) to reach the local authorities.

Microsoft and ICTO partnered with the ECOFISH project to provide Internet connectivity over TV white space for use in conducting interviews and registering the fishermen in the remote fishing villages. Five (5) municipalities in Bohol, including Talibon, Trinidad, Bien Unido, Ubay, and Carlos P. Garcia, which consisted of 19,000 families at the time, were included in the pilot test. This meant that around 19,000 families, residing within the coverage area of the 100 sites scattered throughout the five municipalities, could access TVWS-enabled Internet through Wi-Fi access points installed in public places if they had Wi-Fi-ready devices. Since TV white space equipment allows for connectivity to reach 5-10 kilometers and to go over water, it made fishermen registration in remote islands and communities easier and uploading the registration information using the Internet possible. The TVWS deployment was also able to bring Internet service to an island that other connectivity solutions could not reach, according to Louis Casambre, former undersecretary and executive director of the ICTO.[333]

USAID launched the ECOFISH project with BFAR, which was in charge of coordinating with the people on the ground, including the fishermen and local governments. Microsoft later became a partner to provide technological support (i.e., phones and tablets used by the ECOFISH team and the registration app that would run on the tablet). The ICTO was designated to take care of all the necessary regulatory clearances.

The TVWS radios used for the program were sourced by ICTO from a Singaporean manufacturer called Power Automation (PA), the digital arm of Singapore Power which used TVWS to read electricity meters. ICTO was able to get the radios free of charge, and over a period of one year starting April 2014 (see timeline below).

The backhaul of the TVWS project was VSAT, which was provided by the ITU. There was also backhaul provided by the TelecommunicaTELOF using microwave.

In 2015, the project was cited as a model Public-Private Partnership (P3) and won the P3 Impact Award from the US Department of State.[334]

Timeline of the Pilot-test in Bohol

Date	Activity
JUN 2013	ICTO signs an MOU with Microsoft to explore the use of TV white space for Internet connectivity
JUL 2013	ICTO and Microsoft selects ECOFISH project; signs MOU with USAID. The ordering of the radios and selection of deployment areas are also decided. Target deployment by October/November

OCT 2013	7.2 magnitude earthquake hits Bohol. The TVWS radios meant for the ECOFISH project is deployed in calamity-stricken areas (especially those hit hardest by the earthquake). The radios are mainly used in reporting, warehousing, delivery of goods, and disaster-response functions.
NOV 2013	The next batch of TVWS radios arrives. However, ICTO decides to re-deploy the next batch of radios to Tacloban, which is hardest hit by Typhoon Yolanda (Haiyan). TVWS connects the first-responders to their home bases (in Manila and other capital cities). The radios are deployed to Palo, Tacloban inside the Philippine Science High School Easter Visayas Campus, which serves as an evacuation center
DEC 2014 - JAN 2014	The TVWS radios are used until network capacity is re-established in calamity-stricken areas. Around January, the radios are pulled out and brought back to the ECOFISH sites.
APR 2014	The ECOFISH project is formally inaugurated.
JUL 2014	The project finishes registering the participants. About 40% of the total registration process used TV white space.
DEC 2014	ECOFISH Project's TVWS partnership officially closes.

Source: Interview with Dondi Mapa, former national technology officer of Microsoft Philippines and lead proponent of the TV White Space pilot-testing; ECOFISH Project Quarterly Update (01 October – 31 December 2014). ECOFISH Document No. 01/2015. http://faspselib.denr.gov.ph/sites/default/files//Publication%20Files/ECOFISH%20Project%20Update.PDF.pdf

Regulatory Issues:

1. The TVWS cognitive radios could have made use of a geo-location database[335] that would allow them to transmit at specific frequencies. The Japanese government offered to donate its database to the Philippines, which the ICTO initially accepted. However, the Philippines was unable to resolve who should operate the system, so the database was never donated. In the end, all the radios required "hardcoding" based on the channels given by NTC.

2. The NTC did not want to use dynamic spectrum access and opted to assign a working TV channel for the TVWS project. However, some of the assigned channels had "colorum" (illegal) users, which caused interference. As a result, the TVWS project proponents had to look for other viable channels in order to continue the project.

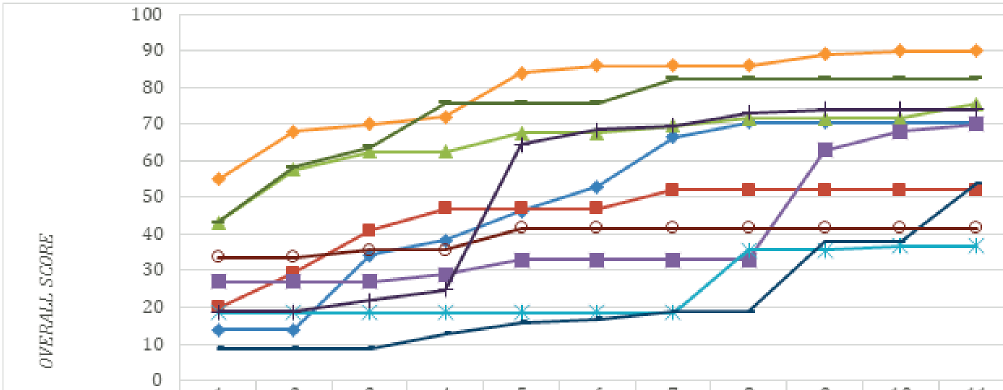
3. In some areas, there were frequencies already assigned and blocked off even if there were no towers or network infrastructure in sight.

4. There was incompatibility and inefficiency issues during the initial TVWS deployment because the Singaporean-made radios used were on channel 6 while the Philippines uses channel 8 (for the same frequency).

5. The Kapisanan ng mga Brodkaster ng Pilipinas (KBP) (Association of Philippine Broadcasters) does not want to give up their analog frequencies for TVWS use, an opinion expressed strongly to the NTC. The organization initially claimed that TVWS was causing interference.

6. Initially, there was a draft NTC memorandum circular (MC) that allowed anyone to use TVWS. KBP opposed the proposal. The final MC limited TVWS use to government-defined functions. In 2017, the NTC issued MC No. 02-04-2017, which allows the DICT to use unassigned and unused VHF TV broadcast channels on secondary and non-interference basis in the implementation and operation of ICT projects of the government, including the Free Public Wi-Fi project. This means the DICT must accept interference from VHF TV broadcasting service to which the band is allocated on primary basis. While DICT's use of the spectrum is exempted from payment, DICT-operated radio stations and equipment will be covered by appropriate registration, permits, and licenses, for which DICT shall pay the necessary fees.[336]

Appendix D: ICT Regulatory Tracker



	1	2	3	4	5	6	7	8	9	10	11
Cambodia	14	14	34.33	38.33	46.33	52.83	66.33	70.33	70.33	70.33	70.33
China	19.83	29.33	41	47	47	47	52	52	52	52	52
India	43.17	57.5	62.5	62.5	67.5	67.5	69.5	71.5	71.5	71.5	75.5
Indonesia	27	27	27	29	33	33	33	33	63	68	70
Lao PDR	18.67	18.67	18.67	18.67	18.67	18.67	18.67	35.67	35.67	36.67	36.67
Malaysia	55	68	70	72	84	86	86	86	89	90	90
Myanmar	8.83	8.83	8.83	12.83	15.83	16.83	18.83	18.83	37.83	37.83	53.83
Philippines	33.67	33.67	35.67	35.67	41.67	41.67	41.67	41.67	41.67	41.67	41.67
Thailand	43.17	58.17	63.67	75.67	75.67	75.67	82.33	82.33	82.33	82.33	82.33
Viet Nam	18.83	18.83	21.83	24.83	64.5	68.5	69.5	73	74	74	74

Figure 11. ICT Regulatory Environment Scores per Country, 2007-2017

Source: ITU ICT Regulatory Environment Tracker 2017, http://www.itu.int/net4/itu-d/irt/#/tracker-by-country/regulatory-tracker/2017

According to the ITU, the ICT Regulatory Tracker is an evidence-based tool that aims to help decision-makers and regulators make sense of the rapid evolution of ICT regulation. The Tracker makes possible benchmarking and the identification of trends in ICT legal and regulatory frameworks, and helps identify the gaps in existing regulatory frameworks, making the case for further regulatory reform towards achieving a vibrant and inclusive ICT sector.

The ICT Regulatory Tracker is composed of a total of 50 indicators (11 composite, see full list below) grouped into four clusters:

1. the regulatory authority (focusing on the functioning of the separate regulator),
2. regulatory mandates (who regulates what),
3. the regulatory regime (what regulation exists in major areas) and
4. the competition framework in the ICT sector (level of competition in the main market segments).

The Tracker covers between 187 and 190 ITU Member States over the period 2007 – 2017.

The table above is a summary of the results for select countries in Asia Pacific for 2017.

Glossary

ADSL: Asymmetric Digital Subscriber Line https://www.itu.int/rec/T-REC-G.992.1/en
ADSL2+: https://www.itu.int/rec/T-REC-G.992.5/en
ASAM: ATM Subscriber Access Multiplexer
High-Throughput Satellite (HTS): is a marketing term for a new generation of satellites designed for high-speed broadband services. They have at least 2 times, but up to 20 times the throughput[337] of the previous generation of satellites.
iSAM: Integrated Services Access Manager
ISM: a set of radio frequencies allowed by the US FCC for relatively unrestricted use for Industrial, Scientific, and Medical purposes. Many countries in the world have harmonised their own radio spectrum plans so that their markets can take advantage of devices developed for ISM band use. The best example of ISM technology is Wi-Fi.
Dark Fibre: A physical fibre optic path, not interrupted by a media converter or multiplexed onto an active system by a provider. Light transmitted into one end of a dark fibre will come out the other end without being altered in any way.
DSLAM: Digital Subscriber Line Access Multiplexer
xDSL: A generic term for Digital Subscriber Line technologies
FTTN: Fibre to the Node https://www.nbnco.com.au/residential/learn/network-technology/fibre-to-the-node-explained-fttn.html
FTTC: Fibre to the Curb https://www.nbnco.com.au/residential/learn/network-technology/fibre-to-the-curb-explained-fttc.html
FTTP: Fibre to the Premises - https://www.nbnco.com.au/residential/learn/network-technology/fibre-to-the-premises-explained-fttp.html
GEO: Geostationary Earth Orbit – a satellite orbit around 36,000 km above the earth. http://www.radio-electronics.com/info/satellite/satellite-orbits/geostationary-earth-orbit.php
gPON: Gigabit Passive Optical Network - https://www.itu.int/rec/T-REC-G.984.1
10gPON: 10-Gigabit-capable Passive Optical Network - http://www.itu.int/rec/T-REC-G.987/en
HFC: Hybrid Fibre Coaxial - https://www.nbnco.com.au/residential/learn/network-technology/hybrid-fibre-coaxial-explained-hfc-3.html
LEO: Low Earth Orbit – a satellite orbit below 2,000 km above the earth. Most communications satellites in LEO orbits are located between 800-1200 km above the earth. http://www.radio-electronics.com/info/satellite/satellite-orbits/low-earth-orbit-leo.php
MIMO: Multiple-In Multiple-Out – a radio technology that takes advantage of spatial multiplexing to transmit high wireless data rates. https://www.intel.sg/content/www/xa/en/support/articles/000005714/network-and-i-o/wireless-networking.html
Mu-MIMO: Multi-user Multiple-In Multiple-Out – a radio technology that uses both spatial multiplexing and beamforming to simultaneously transmit different streams of data to different subscribers from the same antenna array. https://www.networkcomputing.com/wireless-infrastructure/how-does-mu-mimo-work/748964231
OGW: Optical Ground Wire - https://www.aflglobal.com/Products/Fiber-Optic-Cable/Aerial/OPGW.aspx - https://www.generalcable.com/na/us-can/products-solutions/communications/fiber-optic-cable/optical-ground-wire - http://www.tesmec.com/en/stringing/applications/optical-ground-wire.html
Passive CWDM: https://edgeoptic.com/passive-cwdm-vs-dwdm-choose/
RAN: Radio Access Network – a term typically used to describe the radio component of a cellular network.
VDSL: Very High Speed Digital Subscriber Line - https://www.itu.int/rec/T-REC-G.993.1
VDSL2: Very High Speed Digital Subscriber Line - https://www.itu.int/rec/T-REC-G.993.2
Wi-Fi Alliance: A trade organisation that exists to standardise and promote Wi-Fi technologies. https://www.wi-fi.org/who-we-are
Wi-Gig: the Wireless Gigabit Alliance – an industry trade group formed to promote the acceptance of 802.11ad – Wi-Fi in the 60 GHz band. Now a part of the Wi-Fi Alliance. https://web.archive.org/web/20090510071452/http://www.wigig.org:80/about
WDM: Wave Division Multiplexing - http://www.lightreading.com/wavelength-division-multiplexing-(wdm)/d/d-id/575175
CWDM: Coarse Wave Division Multiplexing - https://www.lightreading.com/ethernet-ip/cwdm-low-cost-capacity/d/d-id/588243
DWDM: Dense Wave Division Multiplexing - https://www.lightreading.com/ethernet-ip/metro-dwdm/d/d-id/584155

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147 Section 4 (a) of Republic Act 7925 or the Public Telecommunications Policy Act
148 Section 4 (b) of RA 7925.
149 Section 4 (c) of RA 7925.
150 Section 15 of RA 7925.

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152 NTC database reports from 1998 to 2001.

153 Section 1 (a) of RA 7925.

154 Section 1 (b) of RA 7925.

155 Section 1 (d) of RA 7925.

156 A provisional authority (PA) refers to "an authority, for a limited period, granted to a qualified applicant to operate and maintain a public telecommunications facility/service by the Commission, pending the grant of the CPCN." NTC MC 08-09-95 or the IRRs of RA 7925.

157 A certificate of public convenience and necessity (CPCN) refers to "a grant consistent with the telecommunications policies and objectives to a qualified applicant, after due notice and hearing, of a final authority to own, operate and maintain a public telecommunications facility/service by the [NTC]." NTC MC 08-09-95 or the IRRs of RA 7925. It is an authority required for providers of public service under CA 146.

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"The country's laws and regulations that affect Internet provision have not changed much since 1995. As a result, the Philippines continues to use analog policies for an increasingly digitizing world. It is hoped that the rise of emerging Internet technologies—with the promise to bridge the digital divide—can provide the much-needed impetus for reforming the Philippines' policy and regulatory environment to bring it to the digital age.

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