

Struggle in Narrowing the Indonesian Digital Divide

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With 88.1 million Internet user in 2014, the average Internet penetration in Indonesia is 34.9% (Puskakom UI, 2015, pp. 20). However, as shown in Table 1, international reports show a much lower penetration rate and far below other Southeast Asia countries. Furthermore, Indonesia is listed as one of twenty countries that home of three-quarters of 4.3 billion Internet non-users world wide (World Economic Forum, 2016, p. 7). This work will review the predicament Indonesia faces, which is poor Internet access to rural areas and villages.

Table 1. Internet penetration in selected countries from various sources.

	ITU (2014) ¹	ISOC (2015) ²	InternetStats (2016) ³	Country's Authority
Singapore	82.00%	73%	82.5%	79% ⁴
Malaysia	67.50%	67%	68.6%	100% ⁵
VietNam	48.31%	44%	52%	
Philippines	39.69%	37%	43.5%	
Thailand	34.89%	29%	42.7%	
Indonesia	17.14%	16%	20.4%	34.9% ⁶

This work reviews the government and the community effort in providing Internet access to rural and villages. The government rely heavily on Universal Service Obligation (USO) funds while the community self-financing the effort and rely heavily on their own human resource to deploy the infrastructure. Policy options need to be explored to get the maximum benefit from both top down as well as bottom up approaches. I will argue that the simplest option to increase Internet penetration in Indonesia is to conduct broader surveys and improve the empowerment processes of citizens before infrastructure deployment is implemented by the government. This is essential to ensure that future ‘top-down’ policies to improve rural Internet access do not follow the path of their predecessors.

1 International Telecommunication Union. (2016). *Percentage of Individuals using the Internet*. International Telecommunication Union. [online] Available at: http://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2015/Individuals_Internet_2000-2014.xls [Accessed 11 Jun. 2016]

2 (The Internet Society (ISOC) and TRPC, 2015, p. 12)

3 Web Resource: Internet Live Statistics <http://www.internetlivestats.com/internet-users-by-country/> [Accessed 11 Jun. 2016]

4 Data from InfoComm Development Authority of Singapore (IDA, 2015).

5 Data from Malaysian Communications and Multimedia Commission (MCMC)'s broadband penetration (MCMC, 2015b).

6 Data from PUSKAKOM-UI and APJII (Puskakom UI, 2015).

Increasing the Internet penetration, and, thus, narrowing the digital divide, is of country's interest as increasing Internet penetration will increase per-capita GDP growth. It has been studied that in the low and middle income countries, increase in 10% of high speed broadband penetration will contribute to per-capita GDP growth of 1.38% (World Bank, 2009, p. 45; Raul Katz, 2012, p. 5). While 10% increase in Internet penetration will contribute to per-capita GDP growth of 1.12% (World Bank, 2009, p. 45).

Indonesia is truly a mobile-first country, with almost 85% of the Internet users are using and getting their first taste of the Internet via mobile devices (Puskakom UI, 2015, p. 24). Furthermore, wireless network is of interest especially to provide access in rural areas. However, since wireless technology requires line-of-sight topology in the network, any obstacles such as mountain in the area will require more complex configuration in the system. Since 46.7% of Indonesians live in rural and villages (BPS-Statistics Indonesia, 2014a), to increase the Internet penetration above 50% will require the ability to penetrate villages where half of the country's population reside. This requires more in depth discussions, since many of these villages are (1) located on mountainous areas and, thus, technologically difficult, and / or (2) are not economically feasible from commercial operator's point of view. The discussed policy should be able to cover these difficulties while strengthening the public-private partnership in the process.

Overview of Indonesian Telecommunication and Internet

The major telecommunication networks are mainly operated by PT Telkom, Indonesia's largest telecommunications company and PT Indosat is Indonesia's second-largest cellular operator. Both PT Telkom and PT Indosat were partially privatized in the mid-1990s. The government retains shares in both companies, including over 50% ownership in the case of PT Telkom. Indonesia mobile market has exploded over the past couple of years. Cellular subscriptions stand at 326.3 million, way more than the population. 85% of the population own mobile phones, while 43% carry smart phones (Judith Balea, 2016).

The Indonesian Internet is currently operated by private sectors based on private investments. The Internet access is served by more than 300 distributed (not centralized) Internet Service Providers (ISP) thirty-five of which own network infrastructure. These ISPs interconnect locally through several Internet exchange points (IXP) (Matt Carrieri *et.al.*, 2014). Four (4) largest Indonesian Internet exchange points are Indonesia Internet Exchange (IIX-JK2) in Jakarta, NiCE/OpenIXP in Jakarta, Yogyakarta Internet Exchange (IIX-JO) in Yogyakarta dan Indosat Internet Exchange (INIX) in Jakarta. The first and the largest Indonesian data center are located at National Inter Connection Exchange (NiCE) or OpenIXP operated by Indonesia Data Center (IDC). The recorded traffic history of NiCE is on IDC web⁷. In its initial run in 1997, the peak traffic is only 1Mbps. In June 2016, the peak local Internet traffic within Indonesia is 240Gbps, while the total peak International Internet traffic for Indonesia is about 800 Gbps.⁸

In recent study, it is found that the majority of Internet users in Indonesia living in the western

⁷ The URL of history of NiCE is <http://www.idc.co.id/history.html>

⁸ Johar Alam, the CTO of Indonesia Data Center (IDC), personal communication on 4 June 2016.

region of Indonesia, especially Java. Penetration reached 36.9% of the total population in Java. In addition, approximately 83.4% of the Internet users living in urban areas. The ability to provide Internet access in rural areas is identified as the key development factor (Puskakom UI, 2015, p. 2).

It is interesting to note that 49% majority of Indonesian Internet users are in the 18-25 years range and most likely are digital natives. While the education level of the majority 64.7% of the Indonesian users is high school (Puskakom UI, 2015, pp. 10-25). Statistics like this would of interest, e.g., in politics, as it becomes decisive in elections (Juliana Fernandes *et.al.*, 2010). On the use of the Internet, there are three main reasons the Indonesians use the Internet, namely, to socialize and communicate (72%), getting daily information (65%), and following trends (51%). It is represented in four practical activities, namely, the use of social media (87%), browsing for information (69%), instant messaging (60%) and read news (60%). Furthermore, there are 79 million active Indonesian social media users. (Puskakom UI, 2015, pp. 30-31). The fast growing application of the Internet is e-commerce. Indonesian e-commerce is one of the most talked about in Southeast Asia's startup world. Big names like Lippo Group, Rocket Internet, as well as local StartUp, such as, Tokopedia and Bukalapak are competing for the market. However, online sales still only account for less than one percent of the nation's entire retail sector. It means we'll see more growth over the next decade (Judith Balea, 2016). As a side note, on June 2016, a draft on e-commerce regulation is being circulated.

The biggest challenge is in narrowing the existing digital divide especially in rural and villages which in turn will increase the Internet penetration while ensuring the ability of the communities to reap the potential benefits of the Internet. The telecommunications law number 36/1999 states clearly that only licensed operators may build and operate telecommunications infrastructure. To finance the infrastructure for the unconnected, government collects 1,25% of gross operator revenue as the Universal Service Obligation (USO) funds (Indonesian Government, 2009, p. 7) which can then be used to build rural infrastructure by the operator and no room for communities to participate, even if, they have financial and technical capacity to do it within their communities.

INDONESIA DIGITAL DIVIDE

Digital divide refers to the gap between individuals, households, businesses and geographic areas at different socio-economic levels or other demographic categories with regard to their opportunities to access to, use of, or impact of information and communication technologies (ICTs) on a wide variety of activities (OECD, 2001, p. 5). It has been studied that the inhibitors to Internet or broadband adoption are clustered around (1) level of education (completion not above secondary school); (2) age above 65; (3) location in rural areas; (4) disadvantaged socio-demographic groups, which is also correlated with level of education and employment status (unskilled workers, retirees and homemakers); and (5) low income (ITU, 2012, pp. 83-85; Pierre Montagnier and Albrecht Wirthmann, 2011, p. 4)

The Indonesian telecommunication policy has largely been viewed digital divide as an access divide. Providing access to the Internet has been the major focus in narrowing digital divide. As described explicitly in the Presidential Decree Number 45 Year 2016 on 2017 Government Work

Plan⁹, construction of broadband and broadcasting infrastructure are centered on three (3) priorities, namely, (1) broadband and broadcasting in non-commercial areas; (2) debottlenecking regulation and synchronization in deploying broadband and broadcasting, and (3) the development of human resources and the ICT industry (Indonesian Government, 2016, p. III-169). Furthermore, in 2017, 127 cellular Base Transceiver Station (BTS) in blank spot areas will be added to the existing 286 units. In 2019, the total target cellular BTS in blank spot areas is 575 units. In 2017, 800 cyber cafe for accessing the Internet in non-commercial areas will be build, while the 2019 projection is 4000 locations (Indonesian Government, 2016, p. IV-43). Mention of telecommunication policy is very minimal in the 2017 government work plan. The telecommunication seems to work in silo and not much synchronization with other policy, such as in education, tackling the socio-demographic problems, increasing income, and solutions for rural areas. The term non-commercial areas is used rather than rural or village in the telecommunication plan within the text of presidential decree.

On the access divide, would it be possible to increase the Indonesian Internet penetration beyond 34.6%? Since 85% majority of the users access through mobile, it would make sense to look at the condition of mobile network coverage. Fortunately, several Internet sites, such as, OpenSignal.com¹⁰ may provide cellular coverage picture all over the world including Indonesia. OpenSignal.com clearly shows that most of the cellular access, including 3G and 4G, are in the cities and rare cellular signal in rural and villages. Unfortunately, 46.7% of Indonesians live in rural and villages (BPS-Statistics Indonesia, 2014a). Thus, to increase Internet penetration higher than 50%, ability to deploy Internet infrastructure in rural and villages would be the important. Therefore, to understand the best way to narrowing the digital divide, one must understand the challenges in unserved areas, villages, rural areas, islands as well as border areas in Indonesia.

Learn the Past Indonesia Internet

The Indonesian government's first attempt to enter the cyber world is the NUSANTARA 21 in 1997-1998. NUSANTARA 21 conceptual framework clearly states the dream to transform Indonesian traditional society into knowledge based society and use Internet as the main vehicle (Onno W. Purbo *et.al.*, 1998, pp. 4). NUSANTARA 21 clearly position itself to push the government to enable and empower community based network. NUSANTARA 21 is not directed into a major government project but a community based self-funded movement that directed and given incentives through government policies and regulations. It is not the technology rather community empowerment is selected as the strategic key (Onno W. Purbo *et.al.*, 1998, pp. 9). NUSANTARA 21 was never implemented due to Indonesia severe economic and political crises in 1998.

The early attempts to build the Indonesian network is well documented in “An Asia Internet History : Third Decade (2001-2010)” (Kilnam Chon editor, 2016, Appendix D). The early Indonesian networks was build by geeks, hackers and techies. The networks was self-finance community based networks. Heavy community empowerment and knowledge sharing activities were common. The key to the process was not the equipment rather people the basic principle

9 In Indonesian, Peraturan President Republik Indonesia Nomor 45 Tahun 2016 tentang Rencana Kerja Pemerintah Tahun 2017.

10 OpenSignal.com may be accessed via web or android apps. It is basically collector signal report from the smartphone and aggregate it on top of the map. OpenSignal also provide several country's report but not for Indonesia.

adopted by NUSANTARA 21.

Prior to 1990's and prior to the Internet, the first Indonesian networks were born with two types of computer networks, i.e., Bulletin Board System and UUCP both using expensive dial-up telephone lines. Around 1992-1993, the early wireless based Internet was deployed. It run on very slow 0.0012 Mbps, low-cost, wireless based Internet network and led by LAPAN (the Indonesian Space Agency) and BPPT (the Indonesian Research Agency). The cyber communities slowly build on top the locally run Internet mailing lists. As servers and hosts grew, need for the .ID country code was slowly pushed. The .ID administrator was initially pioneered by Rahmat M. Samik-Ibrahim from University of Indonesia (Kilnam Chon editor, 2016, Appendix D).

In 1997-1998, the Indonesian Internet activists in Indonesia began to think hard to realize inexpensive Internet. The simplest way is to share an Internet access and share the cost. Warung Internet (WARNET) is the simplest technology is first introduced to the public to get low cost Internet. WARNET is also known as cyber cafe, telecenter. However, the term Community Access Point (CAP) is used in the Ministry of Information and Communication legal documents. (SpeedyWiki, 2012).

The first Indonesia cyber cafe was operational on July 1, 1995 by PT Bonet Utama which is the second private ISP after Indonet in Jakarta. The first Bonet office is at Botanicus Cafe located in the middle of the Bogor Botanical Garden, which instinctively transform into cyber cafe to serve Internet needs of tourists who visits Bogor Botanical Gardens. Cyber cafe operations in Indonesia is not without a struggle. In 2005-2006, Indonesian police was actively sweeping the cyber cafes, some computers confiscated for a variety of reasons ranging from pornography, pirated software, accused as illegal ISP (SpeedyWiki, 2012). Today, especially in big cities, cyber cafe is no longer of interest, as most people use smartphone to access the Internet. Cyber cafe is of interest in the area with limited or no cellular access. In the cities, the survived cyber cafes are normally transform into game centers.

Since year 2000, high-speed outdoor WiFi was adopted for building larger wireless local networks known as RT/RW-net which is a community neighborhood network. RT/RW-net coined by Nasar, Muji *et.al.* who was students at University Muhammadiyah Malang for their walkie talkie based computer network for their neighborhood in 1996. (SpeedyWiki, 2015). The Indonesian digital natives would likely seek for higher speed access especially for game and multimedia applications. Since minimum speed of WiFi is 1 Mbps with an average of 56 Mbps and the latest technology reaches 1.7 Gbps (Cisco. 2014, p. 7), WiFi based network would fit the need of the Indonesian digital natives. To extend WiFi coverage from 50 meters to 3-4 kilometers suitable for community neighborhood network, Gunadi in Purwakarta has to ingeniously modify USB WiFi adapter by adding Wok in front of it. The construction is fairly similar to Parabolic Antenna but build on Wok, the ingenious antenna was then called Wokbolic, or Wajanbolic in Indonesian. USB WiFi costs around US\$10. The whole Wokbolic construction may cost less than US\$30 (SpeedyWiki, 2012b). Unfortunately, WiFi frequency was on licensed band and one needs to pay US\$2000 tax per WiFi node per year. Need for high-speed networks pushed towards the fight to liberate WiFi frequencies. WiFi was liberated on January 5, 2005, when Hatta Rajasa finally signed Ministerial Decree No. 2/2005 on Wireless Internet in 2.4GHz (SpeedyWiki, 2016).

Since the liberation of WiFi, many innovations and community empowerment were done to

build community based networks. Some of the technology innovation are Voice over Internet Protocol for building community based telephony (Onno W. Purbo, 2011); OpenBTS for community based cellular as deployed in Wamena, Papua (David Talbot, 2013; Heimerl, K. *et.al.*, 2014); youtube like streaming servers at many vocational schools (Jordan Andrean *et.al.*, 2015); free e-learning servers at cyberlearning.web.id and belajaronline.web.id with more than 14.000 students etc. All of these movements are fueled by open source technology.

A Glimpse on Global Debate on Digital Divide

Internet speed and coverage gradually will rise, and, thus, digital divide narrowed. Many developed countries almost reached the Internet universal access for its citizens. However, at the same time, there is deficiency in the adoption awareness and the level of Internet usage. As a result, those left behind, including rural and village, would not be able to grasp the maximum benefit of the Internet, and falling behind even further in the digital society. It forces a necessary redefinition of the next digital divide beyond access divide, where the ability and motivation to maximize the benefits of the Internet is becoming the next frontier in the efforts to bridge the digital divide (Economist Intelligence Unit, 2013, p 25).

Recently, United Nations Educational, Scientific and Cultural Organization (UNESCO) estimate (2013) puts the global illiteracy rate at 15% of adults (UNESCO, 2013, p. 8). However, even when people are literate and relevant content is available, connecting the unconnected is more often not an infrastructure issue. The barriers to greater Internet use fall into four categories: infrastructure; affordability; skills, awareness and cultural acceptance; and local adoption and use, which is often due to a lack of local content (World Economic Forum, 2016, p. 9; ITU, 2015, pp. 93-94; MCMC, 2015, p. 10; IDA, 2015, p. 10).

The Global debate are usually at a more abstract and deeper level than that of Indonesia, such as, on access to knowledge (Steven W Witt, 2016), digital inclusion (Warschauer, Mark, 2004; Alexander *et.al.*, 2016), digital competence (Liisa Ilomäki *et.al.*, 2016), Internet skills (World Economic Forum, 2016, p. 9; ITU, 2015, pp. 93-94; MCMC, 2015, p. 10; IDA, 2015, p. 10; Madalyn Cohron, 2015), open Internet (Candeub, Adam; McCartney, Daniel, 2012; Greenstein, S, 2011), Internet neutrality (Tim Wu, 2003; Statovci-Halimi, Brikena; Franzl, Gerald. 2013), end-to-end principle (Tarleton Gillespie, 2006; Palfrey, John G., Jr; Rogoyski, Robert, 2006).

Digital inclusion, digital competence and Internet skill

Internet skills is important to be able to get maximum benefit from the Internet (Madalyn Cohron, 2015, p. 82). Access to ICT and the Internet comprises far more than merely providing computers and Internet connections. Rather, access to ICT is embedded in many factors beyond physical, digital, human, and social resources and relationships. Content and language, literacy and education, and community and institutional structures must all be taken into account if meaningful access to new technologies is to be provided (Warschauer, Mark, 2004, pp. 6-8). Internet skills should be considered as distinct from computer skills, as use of the Internet requires more skills than the use of a computer, for example, when people search for information, when they have to practice online communication, or when they create online content. Alexander *et.al.* proposed five (5) areas for measuring the Internet skills, namely, operational skill, Information navigation, social, creative, and mobile skill. (Alexander *et.al.*, 2016). This will eventually build the digital

competence which consists of (1) Operational, 'the skills to operate digital media'; (2) Formal, 'the skills to handle the special structures of digital media such as menus and hyperlinks'; (3) Information, 'the skills to search, select and evaluate information in digital media'; (4) Communication, 'the skills to employ the information contained in digital media as a means to reach a particular personal or professional goal' and (5) Content Creation, 'the skills to pool knowledge and exchange meaning' (Liisa Ilomäki *et.al*, 2016, pp. 805-807)

Unfortunately, the empowerment of Internet skills and, thus, digital inclusion and digital competence, is hardly done in Indonesia. As a result, Internet access in Indonesia is often synonymous with pornography, violence, terrorism, and bullying. Not surprisingly, one of the flagship programs of the government is precisely to block the Internet (KOMPAS, 2016) which violates the basic Internet neutrality (Tim Wu, 2003; Statovci-Halimi, Brikena; Franzl, Gerald. 2013) and end-to-end principle (Tarleton Gillespie, 2006; Palfrey, John G., Jr; Rogoyski, Robert, 2006). Furthermore, some sectors are not ready with the advent of the Internet, resulting in horizontal conflicts, for example, between conventional taxis and other online transportation, such, Gojek, Grab and Uber (Heru Margianto, 2016).

Internet Neutrality

Network neutrality is the principle that all Internet traffic should be treated equally. The best way to explain network neutrality is that a public information network will end up being most useful if all content, sites, and platforms are treated equally. Such debate occurs due to conflicts between the private interests of broadband providers and the public's interest in a competitive innovation environment centered on the Internet (Tim Wu, 2003). Earlier appearance has come in "open access" or Open Internet debate to guard against erosion of the "neutrality" of the network between competing content and applications (Candeub, Adam; McCartney, Daniel, 2012; Greenstein, S, 2011). During the net neutrality debate, President Obama proposed practical rules towards net neutrality, namely, no blocking, no throttling, increased transparency and no paid prioritization. The Americans stand up to keep the Internet neutral to make sure StartUp company should have the same chance to succeed as established corporations, and that access to a high school student's blog shouldn't be unfairly slowed down to make way for advertisers with more money. Finally on 26 February 2015, the U.S. Federal Communications Commission (FCC) ruled in favor of net neutrality to keep the Internet open and free, and, thus, to protect innovation and create a level playing field for the next generation of entrepreneurs by reclassifying broadband access as a telecommunications service and thus applying Title II (common carrier) of the Communications Act of 1934 to Internet service providers (The White House, 2015).

Liberating Technology

The foundation of Internet is very heavy on technology. Especially for rural and villages, the technology used is fairly different from those in cities. Low cost and long distance wireless becomes the choice of technology. The advancement in the Indonesian rural Internet infrastructure is partially due to generous sharing of technology and knowledge from International ICT for development experts which resulting in open development (Matthew L. Smith *et.al.*, 2011, p. iii). I would like to acknowledge some of these groups and their contributions, namely,

- Technology and Infrastructure for Emerging Regions research group (TIER), directed by

EECS University of Berkeley Professor DR. Eric Brewer resulting OpenBTS implementation in Wamena, Papua (Heimerl, K. *et.al*, 2014)

- Freifunk community in Berlin, Germany, Corinna "Elektra" Aichele is one of the leader, they focus on mesh technology and surrounding ecosystem. Their mesh network is used in some of the experimental high speed backbone networks in Indonesian rural.
- Radio Communications Unit at the Abdus Salam International Center for Theoretical Physics in Trieste, Italy. Carlo Fonda is the known activist, they are very active in wireless and sensor networking. The author learns a lot from Carlo Fond and share the wireless networking knowledge to other Indonesian.
- Networktheworld.org promotes and supports the growth of Internet connectivity around the world, lead by Jane Butler. They produce the bible for rural wireless, i.e., "Wireless Networking for Developing World" (Jane Butler editor, 2013). The book has been translated to Indonesian and can be freely downloaded¹¹.

CHALLANGES TO PENETRATE VILLAGES

The deployment of fiber optics cables is easier using undersea cable or following highway and railway roads in lowland areas. Thus, the Indonesian broadband network, Palapa Ring project, will likely benefit the big cities especially in lowland and coastal regions. Villages in rural and mountains may have to rely on more difficult wireless solutions.

In 2014, there are 17,640 privately own cyber cafes in Indonesia. Cyber cafes are mostly privately own / run and used for providing access in the area with limited access. Cyber cafe also acts as the knowledge information centers for those who wants to learn on how to use the Internet at the early stage. Unfortunately, low Internet penetration areas, such as, North Kalimantan, West Sulawesi, Maluku, Noth Maluku, West Papua and Papua has less than 80 Cyber Cafe in the respective province (BPS-Statistics Indonesia, 2014b, p. 104).

The overall picture of mobile access in rural Indonesia are not so bright either. Out of 82,190 villages in Indonesia, only 27,084 villages has cellular Base Transceiver Station (BTS) tower located in the village. Fortunately, 55,870 villages received strong cellular signal, thus, some receive from its neighboring BTS. Unfortunately, 18,603 villages receive only weak signals and 7,717 village has no cellular signal. Out of the 7,717 village with no signal, 4,876 villages are located in low Internet penetration areas, namely, Papua and Maluku islands (BPS-Statistics Indonesia, 2014b, p. 105). Furthermore, the reported cellular coverage at OpenSignal.com clearly shows the lack of signal in many Indonesian villages. Thus, the Government plan to install 575 BTS in non-commercial areas, by 2019 (Indonesian Government, 2016, p. IV-43), would not possibly be sufficient.

Level of difficulty in deploying wireless network increases in mountainous area. Out of 82,190 villages, 16,043 villages are located in the mountain peak or slope and 3,630 in valley surrounded by mountains. Many of these villages are located in low Internet penetration areas in Papua, Papua Barat, Maluku, Aceh and North Sumatra provinces (BPS-Statistics Indonesia, 2014b, p. 16).

11 The WNDW's Indonesian version may be freely downloaded from <http://wndw.net/pdf/wndw-id/wndw-id-ebook.pdf>

Tremendous challenges will be faced to penetrate the terrain in that particular regions. Due to line of sight nature of the radio signal, extra relay radios and equipments needs to be installed to cover and to reach mountain peak villages as compared to those in lowland areas.

Financial picture to penetrate the Internet to rural villages which mainly rely on agriculture is not too bright. Casual employees in agriculture in rural / villages have the lowest net monthly income Rp. 772,800 (BPS-Statistics Indonesia, 2014c, p. 22 and p. 118). Such low net monthly income creates pressure on the monthly average expenditure for good and services. In rural areas, the average expenditure for good and services is Rp. 72,524 or only about 10,06% of the average monthly income. It is much lower than urban area which lies on the range of 14,20% out of urban Rp. 1,1 million monthly income (BPS-Statistics Indonesia, 2015, p. 27). In rural and villages, spending on telecommunications and the Internet unfortunately have to compete in spending allocated for good and services, such as, health, toiletries, beauty equipment, textbooks, etc. Thus, it would not be surprising to see a monthly spending of a maximum Rp. 10,000 (less than US\$1) per capita for Internet in rural. At this level, it would be economically difficult for any commercial based operators provides service in Indonesian rural areas and villages.

To increase Internet penetration above 50% means to provide access for those in villages, as close to half of the Indonesian population lives in villages. The challenges to provide Internet access in Indonesian rural is very high. They have very limited income and spending for Internet access. They have very limited digital skills to be able to exploit the benefit of Internet. Not to mention technically challenging to deploy the equipments especially in mountainous areas.

SOLUTION FRAMEWORK

It is not an easy task in narrowing the digital divide, especially in remote villages and border areas. However, it doesn't mean an impossible task. Several technologies have been successfully implemented in the field, such as, long distance wireless network, neighborhood network, and community based cellular network. The Government has also tried fairly similar technology funded by Universal Service Obligation (USO) fund, such as, mobile cyber cafes and smart village. Creating a sustainable infrastructure would be the biggest challenge. Keeping the cost down, building local expertise and benefits local economy promotes sustainability (Laura Hosman, 2010, pp. 57-58).

Financially feasible would be very important to be able to deploy an infrastructure in rural areas. Let's calculate the level of investment which is acceptable by the rural communities and villages. Since 46.7% of 255.5 million Indonesians, i.e., 119.3 million Indonesians, live in 82,190 villages, we may safely assume that the average population of a village is about 1400 people. Assuming one-third of the village generates income for the population that would be on average about 500 people provide funds in the the village and is hopefully willing to spend Rp. 10,000 per month per person to invest to Internet access or around Rp. 5 million (close to US\$400) per month per village. It is very low for any commercial Internet provider to give access to the villagers.

It is interesting to note that Internet equipments are not that expensive. For example, a single of-the-shelf WiFi access point would cost around US\$50-US\$100. RaspberryPi based computer would cost around US\$50. A complete set of RaspberryPi computer including the monitor would cost around US\$100. These equipments are now fairly user friendly some even can be plug and play

and doesn't need any configuration. The equipment costs is actually within the village's budget. Thus, it is actually possible for each village to buy their main gears and self-financing the village Internet infrastructure. However, village people will likely to invest when they see a direct benefit.

Furthermore, with the passing of Village Law¹², in 2015, there are approximately Rp. 56,3 trillion village fund for use the villages. Each village receive varying amount of village fund. Some village, such as, village in Papua receive around Rp. 1.1 million, while some in Aceh receive only Rp. 240 million (KOMPAS, 2015). Village fund usage depends on the consensus of the community in the village. With such huge funds would be interesting if it could be used to build the Internet infrastructure in the village. However, as clearly calculated, the community in the village may also be able to build their own Internet infrastructure if no support available from the village fund as the required investment is not too expensive.

Human resource, particularly technical persons, is the key factor in successful deployment of an infrastructure especially in community based infrastructure. Detail discussion on the entire strategy was presented in detail in “Analysis of Indonesian IT Strategy” (Onno W. Purbo, 2007), the summary of the strategic keys are,

- Demand creation – community empowerment in various aspect, including technical and how to maximizing the benefit of Internet for the community.
- Community based network – questioning of legal aspect and empowerment of community networks, such as, cyber cafe, community neighborhood network, long distance wireless, Voice over Internet, Open Source BTS cellular network.
- Infrastructure resources – questioning ISP license requirement for community neighborhood networks, telephony area code allocation for the community, frequency / channel allocation for the community.
- Manufacturing ecosystem – questioning copy right, national standards, type approval requirements for community based equipments.

In deploying community based networks will normally require some stages on preparing the community to adopt the technology. The observed stages seems to be fairly demand driven, and not supply driven. The stages are as follows, (1) people empowered through education, articles, discussions, seminars, workshops, media, blog, (2) people interested and demand for Internet Infrastructure, (3) infrastructure responds to the demand, through either commercial operators or community based infrastructure, such as, cyber cafe or community neighborhood network, and (4) the manufacturing ecosystem supply the equipments (Onno W. Purbo, Matthew Walton, 2010).

In this scenario, the government role is mainly to assure all processes to be smooth, deployment at ease, and everyone get what they need. The whole process may be self-finance and rely on community's resources. An interesting calculation for self-finance process in connecting 46.000 schools assuming students willing to pay around Rp. 1000-5000 (much less than US\$1) per month, it shows that we will see 17.5 million and 2.6 million additional new Indonesian students per year, and 2.6 million teachers on the Internet with spending for about 22 Gbps bandwidth and Rp. 6 billion monthly revenue for local manufacturers (Onno W. Purbo, 2007).

12 Undang Undang Nomor 6 Tahun 2014 tentang Desa.

SNAPSHOT OF FIELD EXPERIENCES

Government Strategies

In general, government strategy will heavily rely on (1) private investment or (2) USO fund. USO funds normally used as enabler for unserved areas and narrowing the digital divide, while private investment in the economically feasible areas.

One of the current largest investment is the fiber optics backbone called Palapa Ring Project. With Presidential Decree No 96 Year 2014 on Indonesian Broad Band Plan 2014-2019¹³, Ministry of Information and Communication accelerates the deployment of the Palapa Ring Project which try to run fiber optics backbone to all 34 provinces and more than 440 districts, in 1+7 fiber rings, with a total of 35,280 kilometers of submarine cable and 21,807 kilometers of inland cable. Palapa Ring will likely provide better speed especially for cities. It is our hope to see 30% of the Indonesian city population, and, hopefully, 6% of villages will have access to high speed Broadband using fiber optics cable by 2019 (Basuki Yusuf Iskandar, 2008; Puskakom UI, 2015, p. 2). During the signing of the project on 4 March 2016 afternoon, finance minister Bambang Brodjonegoro explicitly mention that the government hope the project can be run and accelerated without having to rely on the national budget (KEMKOMINFO, 2015).

On the space segment, it is interesting to note that on 16 June 2016, 17:30-18:15 local time at Spaceport, French Guiana (Guiana Space Center), BRIsat is scheduled to be launched by Ariane 5 rocket (Jose Flores, 2016). BRIsat, designed and built for PT. Bank Rakyat Indonesia (Persero) Tbk by Space Systems/Loral (SSL) from US, is the world's first communications satellite dedicated to a financial institution. It will provide both C-band and Ku-band coverage of Indonesia, South East Asia and North East Asia. Positioned at 150.5 degrees East longitude, the satellite will enable BRI to provide enhanced secure banking communications for more than 10,600 operational branches, 236,939 electronic channel outlets, and almost 53 million customers across the Indonesian archipelago. There are 23 transponders allocated from banking purposes, and four (4) for the Indonesian government for data collection purposes (IndoTelko, 2016). The remaining 18 transponders usage is currently unknown. It would be interesting if these spare capacities may be used to increase the Internet penetration in Indonesia.

In 2012, early attempt to provide Internet to village, the project is called "Smart Village" or Desa PINTER, short for *Desa Punya Internet* or Village with Internet. The Smart Village package consists of a local WiFi hotspot, two (2) computers and one printer. It was funded from USO fund and deployed in about 4700 villages by Telkomsel. Many problems face by Smart Village, namely, Internet connection, village in blank spot and very limited electricity (TELKOMSEL, 2012). Maintenance and operation of the system is partly done by the villagers, some negative comments arise.

The largest USO project may be village cyber cafe, known as Pusat Layanan Internet Kecamatan (PLIK), and mobile cyber face, known as Mobil Pusat Layanan Internet Kecamatan (MPLIK). MPLIK is physically a modified truck to carry several laptop serving as mobile cyber cafe with a rooftop satellite disc. In 2010, the MPLIK project budget was around Rp. 2.4 trillion (MAJALAHICT, 2013).

13 Peraturan Presiden Republik Indonesia Nomor 96 Tahun 2014 tentang Rencana Pitalebar Indonesia 2014-2019.

In 2013, MPLIK has been predicted to fail, but Tifatul Sembiring declined (Sabrina Asril, 2013). Moreover, the commission one of the house of representatives (DPR) finds (1) involvement of political parties in the operation of PLIK / MPLIK services, (2) several MPLIK cars turned into registration booth for a political party, (3) PLIK placement at a number of cafes and not serving the purpose to educate rural community on the Internet, and (4) MPLIK cars often used for electricity payment point (Sabrina Asril, 2013b). Reports MPLIK program failure occurred in Aceh (Hasbi, 2014), Palembang area (M Eko Arif Wibowo, 2016), Kalimantan (Yohanes Kurnia Irawan, 2016; Ardhi Suryadhi, 2016), West Kalimantan, West Sumatera dan South Sumatera (Dwi Murdaningsih, 2016).

Santoso Serad the head of USO implementing body known as BP3TI¹⁴ who run the MPLIK program confess that the failure is largely due to the availability of bandwidth, electricity, and no open source human resources. Senator Tantowi Yahya questioned the accountability of the use of existing funds because it turns out that, since 2010, BP3TI spend only around Rp. 800 billion. This means Rp. 1.6 billion remaining funds were deposited in the account BP3TI (MAJALAH ICT, 2013). In 2014, budget for PLIK and MPLIK has been put on hold by the commission one of the house of representatives (DPR) due to variety negative records (KEMKOMINFO, 2014). Furthermore, in 2015, Ministry of Information and Communication announced to redesign the USO program and will adopt a more bottom-up approach to suite the need of local districts and rural areas or villages. The future USO program coverage will not only on infrastructure, but reaching ecosystem development (Yoga Hastyadi Widiartanto, 2015). Thus, 'top-down' project with very limited field surveys on the local capacity, and not much training for human resources that will handle the system will lead to the failure of the project.

Community Driven Infrastructure

The basic Internet structure is access sharing to create a low cost network of networks. There are several Internet technologies used in community based rural infrastructure in Indonesia, some of them are long distance WiFi based networks, cyber cafe, community neighborhood network, Voice over Internet Protocol (Onno W. Purbo, 2011), local streaming server (Jordan Andrean *et.al.*, 2015). and more advance technology, such as, Mesh Network (Li *et.al.*, 2008) and OpenBTS (Burgess, David, 2010; Onno W. Purbo, 2013). One of the best guide for practical technology for rural Internet may be “Wireless Networking in the Developing World” (Jane Butler editor, 2013). It describes on how to build affordable communication technology in local community by making best use of whatever resources are available. Using inexpensive off-the-shelf equipment, build high speed data networks that connect remote areas together, provide broadband network access in areas where even cellular doesn't exists, and ultimately connect the whole neighborhood to the global Internet.

Community driven infrastructure are usually operated by the informal sectors and, thus, difficult to obtain formal statistical data. Today, the infrastructure is mostly using two (2) brands of long distance wireless equipments, i.e., Mikrotik and Ubiquity. There are at least 5,500 outdoor Ubiquity units per month. Since the market sales of both Mikrotik and Ubiquity is comparable. It is safe to assume there are 100,000 new wireless outdoor units per year in Indonesia¹⁵. Many of these

14 Balai Penyedia dan Pengelola Telekomunikasi dan Informatika (BP3TI).

15 Personal communication with Teguh Wijaya, CEO of Spectrumindo the main distributor of Ubiquity on 9 June

outdoor wireless equipments are used for community neighborhood network.

A group of Indonesians in Manado led by Insan Balandatu and Nielson Assa from PT. Infotek Global Network has pushed the limit of long distance wireless connecting islands in North Manado and Maluku at speed between 20-56Mbps. Figure 1 shows the maps of high speed long range wireless links build using high performance Ubiquity AirFiber equipments in Manado, North Sulawesi area. To the north of Manado, they managed to connect Talaud Island at the border of Philippines via Tagulandang Island, Ondong Island and Sanghie Island. It covers a total distance of more than 350 kilometers via several relays. To the east of Manado, they managed to make connection to Halmahera Island via Maju Island relay which act as a hub to Ternate island and Tidore island. The longest path is more than 130 kilometers. The network runs at 56 Mbps equipped by Ubiquity AirFiber5 which can be obtained at fairly modest price of US\$550 per node or about US\$1100 per pair in a link¹⁶. For shorter distance up to 10-20 kilometer, we normally use an US\$50-80 equipment. At this price level, the infrastructure cost is actually affordable by villages while retain the high performance capacity in the network.

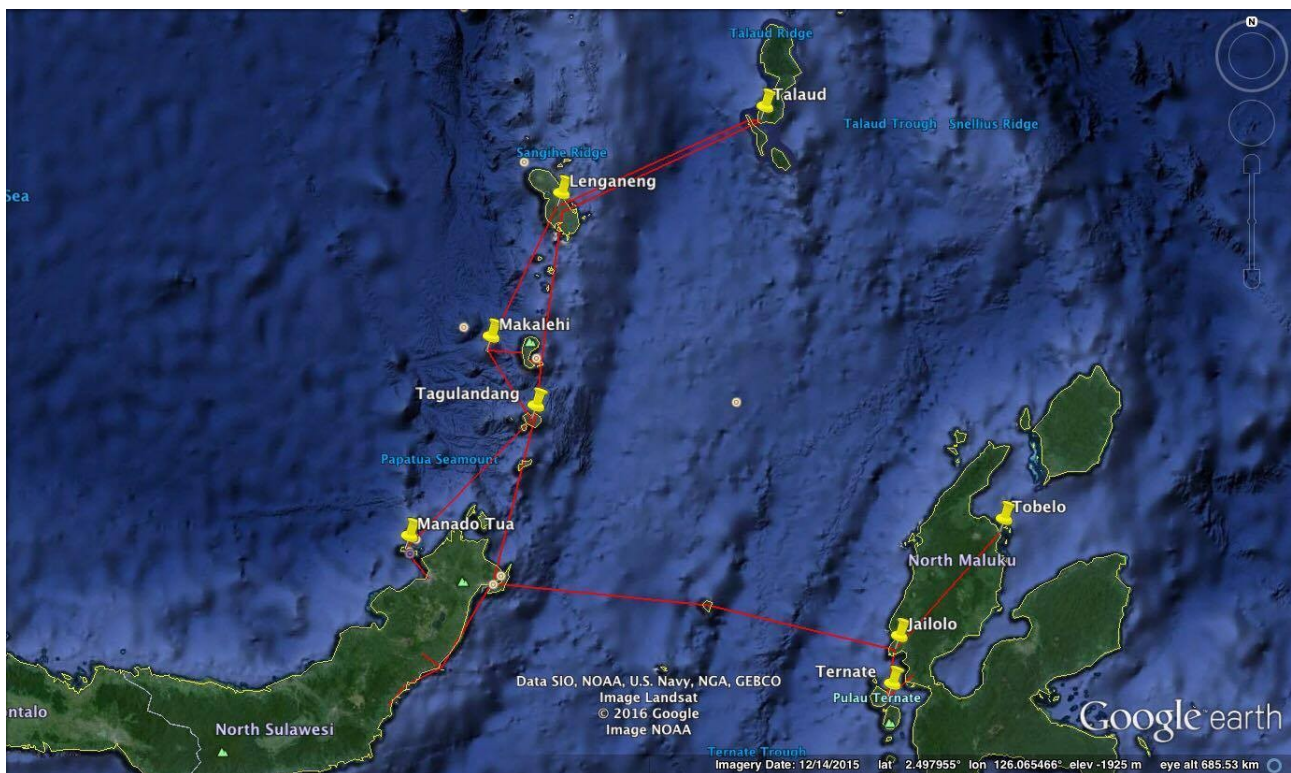


Figure 1. Map of AirFiber high speed long range wireless links connecting islands on northern Manado and Maluku in the range of 200 kilometers span (courtesy of PT. Infotek Global Network).

Cyber cafe business was booming around 1999-2006. Today, since many Internet users use smartphone, many cyber cafes transform into game centers in big cities. The next stage of cyber cafe is community neighborhood network. While cyber cafe simply connects multiple computers in one room, community neighborhood network connects computer in several houses in a neighborhood. Technologically, community neighborhood network is roughly similar to the campus networks in the developed world, but deployed in a neighborhood, villages and even rural

2016.

16 Personal communication with Teguh Wijaya, CEO of Spectrumindo on 13 June 2016.

Indonesia. Lots of low cost network technology innovation arise with the appearance community neighborhood network, among others, Wajanbolic to use low cost USB WiFi devices to reach a distance of 3-4 kilometers, local phone system over the IntraNet, local video streaming server to locally watch movies like youtube, and in village level an open source and free server for the information system of the village being developed.

Estimating the community neighborhood networks is quite a challenge. There is no formal records as most of these networks silently run to avoid problems with the authority. Fortunately, in the record of Mikrotik Indonesia users, out of more than 87,000 users, 3,374 users confess that they are running community neighborhood network¹⁷. A large number of these neighborhood networks is normally serve the villages. In addition, a group in Pemalang city, northern central Jawa, is now working to connect 211 villages in northern central Jawa¹⁸. Thus, it is safe to say around 3000 villages, or about 3,6% of the Indonesian villages, are currently connected to the Internet via wireless network. Searching through the Internet, we will find a very active and very large community neighborhood network public discussion group in Facebook with more than 22,100 members¹⁹. It cannot be used to estimate the number of village connected to the Internet as some of the members are equipments resellers, vocational school teachers, hobbyists etc. However, it can easily show the magnitude of activities in community networks. Knowing the yearly sales of long distance wireless equipments from Mikrotik and Ubiquity is about 100,000 units, we may estimate the network growth. Many of these wireless equipments are used by corporates, schools, government institutions as well as ISP. A conservative assumption of 5% of these equipments used by villages, with on average 20 nodes in a village, the growth of village connected to the Internet would be around 200 new villages per year. It is interesting to note that the community neighborhood network is normally self-finance by the community.

Similar to cyber cafe, community neighborhood network is also having problems with the Indonesian telecommunication regulation. Community neighborhood network equipments will face police confiscation due to various reasons, such as, no ISP license, no tower contribution payment, illegal resale of bandwidth. Even today, PT. Telkom explicitly prohibits any bandwidth resale by community neighborhood network²⁰. In 18-20 May 2015, during APJII national convention in Yogyakarta²¹, Ministry of Information and Communication official orally stated on stage that the ministry will not be able to defend the community neighborhood network as it has no ISP license and does not pay taxes.

In early 2003, the Indonesian government plans to raise the telephone cost. Triggered by the incident, some Internet activists Indonesia started developing the phone over the Internet named VoIP Merdeka. January 2003, VoIP Merdeka had become a feature in e-lifestyle MetroTV program and demonstrating life in video conferencing via the Internet from the MetroTV in Jakarta to Judhi Prasetyo located in Singapore. Internet connections used for the video conferencing life was dial-

17 Personal communication with Valens Riyadi, CEO of Mikrotik Indonesia on 9 June 2016.

18 Personal communication with Andri Johandri, activist of ICTWATCH on 9 June 2016.

19 The URL of community neighborhood network discussion group at Facebook is <https://www.facebook.com/groups/rtrwnetindonesia>

20 Copy of PT. Telkom's formal letter to prevent resale of bandwidth can be seen at <http://opensource.telkomspeedy.com/wiki/index.php/Image:Larangan-resale-akses-internet.jpg>

21 On 18 May 2016, I asked the question to Ismail Ahmad, the official from Ministry of Communication and Information, on stage.

up. In 2005, the community Internet telephony technology was switch using the Internet Engineering Task Force (IETF) standard by Anton Raharja *et.al*. This network is later known as VoIP Rakyat and operates until today. The VoIP Rakyat server is located in one of the Indonesian Internet Exchange and currently operates using their own area code²².

With the help from Kurtis Heimerl *et.al*. from TIER group in Berkeley, several hundred villagers in Papua are now starting to enjoy low cost mobile access. It was deployed using OpenBTS technology. Interestingly, rural doesn't mean outdated. Utilizing cellular network registration logs on OpenBTS, the adoption and usage of smartphones in an extremely remote community in Indonesia was explored. It was found that 16% of the phones in the area were smartphones (compared to between 14-24% in Indonesia). This shows that smartphone adoption in rural Indonesia is similar to the rest of the country (Kurtis Heimerl *et.al.*, 2016).

Cellular networks cross the globe, covering billions of people. However, other hundreds of millions still lack coverage. At least part of the reason is structural: Traditional cellular networks are built top-down, driven by the profit motive of large carriers or by political pressures from governments. Areas that are less profitable or lack powerful politicians are often left without communications services. Heimerl *et.al*. implement an alternative model for cellular systems in rural Papua based on OpenBTS technology: building them bottom-up, with local people installing and operating small-scale, sustainable telecommunications arms, leveraging local infrastructure when available. In the first 16 months in the network live with 349 subscribers providing US\$980 per month for the operator. The model is sustainable, and is running for three (3) years now, and benefit the community by bringing important telecommunications to areas that lack them. Heimerl *et.al*. belief that this bottom-up model can bring cellular connectivity to those without coverage in ways that are sustainable and profitable for local communities (Heimerl, K. *et.al.*, 2014, pp. 1-2).

Workshops on OpenBTS technology has been organize mostly by ICTWATCH and OnnoCenter. The first OpenBTS workshop in Indonesia is on 30 April 2011 in University Gajah Putih, Takengon, Aceh with about 40 students participante. Since then more then 80 OpenBTS workshops and demo sessions have been organized with a total of more than 14,300 participants²³. Futhermore, it has been featured in media, including Detik.com, KOMPAS, MetroTV and NET TV. Heavy Indonesian discussion can be identified via Twitter and use OpenBTS as search keyword. As a result, many universities invest some of the resources to do research on OpenBTS technology. An estimate OpenBTS units in campuses are as follows, Surya University 10 unit funded by Ford Foundation, Telkom University more than 5 units, Polytechnics Electronics in Surabaya more than 12 units, Institute Technology in Bandung more than 3 units, Politechnics Aceh 2 units, University of Indonesia 2 units, ICTWATCH 3 units, Airputih Foundation 1 unit. These units are mainly used for research purposes and building the human resource capacity capable in deploying OpenBTS in rural Indonesia.

On 6 January 2016, Rudiantara, Ministry of Communication and Information, join an informal community discussion at ICTWATCH headquarter on the possible community use of OpenBTS for rural. He agreed to support OpenBTS for rural deployment (Achmad Rouzni Noor II., 2016b). After

²² The area code is +62520 and +62521

²³ Detailed list of OpenBTS workshops is at

http://opensource.telkomspeedy.com/wiki/index.php/OpenBTS:_Daftar_Workshop_atau_Seminar_yang_pernah_dilakukan

much discussion, on 8 April 2016, Rudiantara signed Ministerial Decree Number 5 / 2016 on technology trial on telecommunications, informatics and broadcasting. It basically enforces the requirement for one who would like to try a technology for rural applications must submit a proposal to the minister to be evaluated and the non-commercial basis trial be performed at limited time.

Empower People

Empowering communities on the Internet skill is very important (Economist Intelligence Unit, 2013, p 25; World Economic Forum, 2016, p. 9; ITU, 2015, pp. 93-94; MCMC, 2015, p. 10; IDA, 2015, p. 10). There are two (2) main outcomes that may be obtained from the community empowerment process, namely, (1) the ability to create and maintain the local Internet infrastructure and (2) increase the Internet skills to maximize the Internet benefit (Madalyn Cohron, 2015).

The ability to use the Internet properly and safely be important for young Internet users. Ideally, it would be more effective if Internet skills can be integrated into the school curriculum. Unfortunately, since 2013, during Minister M. Nuh as Ministry of Education, ICT has been removed as compulsory course in Indonesian schools and, thus, many public schools stop using ICT and the Internet in their teaching activities (Elza Astari Retaduari, 2016). Furthermore, the current Minister of Education, Minister Anis Baswedan, doesn't plan to sign any decree on the use of ICT in school curriculum in the near future. Hence, the Indonesians have to rely on other type of empowerment methods to spread the Internet skills among the Indonesian.

In general, there are several types methods commonly performed with different targets. Since it is impossible to use school curriculum, Indonesian has to rely on community effort to acquire the knowledge. In this section, I will review the community effort in ICT empowerment. There are several major active communities in ICT empowerment, these are ICTWATCH, RelawanTIK and Raihan Technology Foundation. In addition, the two major wireless equipment distributors, i.e., Mikrotik and Ubiquity, also play an important role in community education.

ICTWATCH since 29 April 2002 sparked a movement started by launching *Internet Sehat* official website <http://internetsehat.org> and first edition of *Internet Sehat* hardcopy brochure. From various discussion archives, especially in sekolah2000.org, *Internet Sehat* (or Healthy Internet in English) advocacy program promoted by ICTWATCH is promoting freedom of expression on the Internet secure (safely) and sage (wisely), with the following approach (1) self-censorship only in families and schools, (2) increase positive, useful and interesting local content and (3) empower civil society on information and communication technology. In 2009-2012, ICTWATCH organized Healthy Internet Blog & Content Award (abbreviated ISBA) is an award given to blogger that have very good article, ideas, thought on their blog posts. This activity is trying to encourage blogger and writers to add positive contents on the Indonesian Internet.

Unfortunately, by 2009, the government, i.e., the Ministry of Information and Communication, in carrying the name of Healthy Internet using an opposite approach that is top-down approach by ordering the total filtering at ISP level. This type of program is clearly disobeying and injuring the spirit of the early Healthy Internet. Finally, to minimize misuse of Healthy Internet term by certain parties, in which sometimes simply getting project - in disguise of socializing, for personal interest or a handful of certain groups as if understand the spirit of the Healthy Internet, on October 21,

2010, *Internet Sehat* registered as a trademark to the Directorate General of Intellectual Property Rights (Internet Sehat team, 2010).

The struggle for more than 14 years ultimately wins an extraordinary price, ICTWATCH was selected for a 2016 WSIS Champion Projects Award, for the project entitled “‘Internet Sehat’ (Healthy Internet) Towards Indonesian Information Society.” Winners were announced at the 2016 WSIS Prize Ceremony in Geneva, Switzerland on May 3, 2016. WSIS Stocktaking documents the activities carried out by governments, international organizations, businesses, and civil society actors since the launch of the World Summit of Information Society conferences. ICTWATCH’s project was selected based on over 245, 000 votes, as well as a selection phase conducted by WSIS’s Expert Group. ICT Watch was one of five organizations selected under the “Ethical Dimensions of the Information Society” subcategory. This is the only program from Indonesian institutions were awarded as 'Champion' (Achmad Rouzni Noor II, 2016).

In addition to Healthy Internet movement, there seems to be a large movement to empower the young to be able to maximize their ability to get the maximum benefit from the Internet. One of the prominent movement is to create Start Up and e-commerce activities on the Internet. Some agencies, such as the coordinating body for natural disasters, e-procurement agency Indonesia, are very keen in holding the event hackathon events. Hackathon is an abbreviation of Hacking Marathon. Hackathon becomes a means to search for the best programmers and the best ideas to solve problems in various agencies. In the world of cyber security, the defense minister's office and several communities periodically conduct hacking games are usually known as Capture the Flag (CTF) several times a year.

To attract young programmers into programming world, a number of matches are organized. One of the biggest issues to obtain a good programmer is a good computer science and mathematics curriculum. Mathematics and math competitions should be done from the early age. This is especially felt in the global competition event, such as, Association of Computing Machinery (ACM) International Collegiate Programming Contest (ICPC) which is a multi-tier, team-based, programming competition. The average Indonesian winners are mostly those who very keen on programming as a hobbyist and not because of his academic training as described by Prof. Teddy Mantoro one of the ACM ICPC Indonesia judge.²⁴

The best programmers from ACM ICPC usually become the motor behind successful Start Ups, such as, Bukalapak.com and Tokopedia.com. Bukalapak was founded in 2011 by three co-founders. They are Achmad Zaky as CEO, Muhammad Fajrin Rasyin as CFO, and Heru Nugroho Cahyono as CTO. According to data from Tech in Asia, the current crew bukalapak has reached more than 200 people. Funding of bukalapak was last acquired series B of Emtek Group. Since 2014, bukalapak accommodate transactions worth more than Rp 1 trillion. Until early 2015, bukalapak already has 163,000 sellers. Towards the end of 2015, Zaky claims that bukalapak own 500,000 sellers with the average value of daily transactions of about Rp. 8 billion (Nurmayanti, 2015; Dewi Widya Ningrum, 2015).

Tokopedia was founded in 2009 by William Tanuwijaya and Leontinus Edison. In 2015, Tokopedia claimed they had 300,000 active sellers that serves 6 million products each month. Last Funding obtained by Tokopedia amounted to US\$ 100 million (approximately Rp. 1.2 billion at the

²⁴ Prof. Teddy Mantoro, personal communication 5 June 2016.

time). Funding was obtained from Sequoia Capital and Softbank Capital. Report from Tech Data in Asia, Tokopedia now has a crew of more than 200 people (Audi Eka Prasetyo, 2015)

The techies are mostly get knowledge through Internet discussion, either through social media, e.g., facebook and twitter, or through kaskus.co.id the largest Indonesian electronic forum with more than 6 million registered users. These platforms are used as media for intense question and answer sessions. Everyone on the network may read the written discussion and acquires the discussed knowledge.

The discussed topics varies widely, among others, techniques on how to build low cost Internet access, building neighborhood network, making of Wajanbolic antenna, create a video streaming server, run telco on on the Internet as well as fairly advanced topics as hacking, network security, Internet of Things, mesh network, OpenBTS, and various details about the linux operating system etc. To reduce the frequently ask questions, some activists write their knowledge in blogs, web, and wiki. To reach a more traditional audience and those who prefer read physical paper, many IT books are published especially from Elexmedia Computindo and Andi Publisher.

For those who seek a more structured knowledge, the activists create free access Moodle based e-learning sites. These sites, cyberlearning.web.id and belajaronline.web.id, have currently more than 14,500 students. The site is also used to teach teachers to create online courses and online exams. Online exam is very strategic to reduce the education costs, currently, most Indonesian schools have to allocate Rp. 6-20 million per semester for photocopying the exam materials. While a small server for a school cost only Rp. 10 million and can be used at least for the next five years. Currently, the ministry of education seems to encourage online final exam with no support for any tryout for the online exams. Since the end of 2015, a group of volunteer ICT teachers called KOGTIK²⁵ has organized self-finance workshop on the use of e-learning and online exams in 10 cities with an average of 100 teachers participate each cities. Each teacher who participate has to pay from their own pocket about Rp. 75.000-100.000 to participate in the event. It is about 2-5% of teacher's monthly salary.

Learn independently, albeit in the aid of the Internet, through discussion forums, web information, e-learning doesn't seem to be sufficient for many young Indonesians. Therefore, Raihan Technology Foundation organize self-finance IT workshops / seminars and roadshows in many districts. The target costs is not expensive, only Rp. 25-35,000 (or approximately US \$ 2-3) per person. With 200-300 participants, the collected funds is around Rp. 5-10 million per event. With the average cost of room leases is about Rp. 2.5 million, then the rest of the money would cover the transportation costs of good enough speakers to come to district and sometimes villages.²⁶ Since 2012, Raihan Technology Foundation has organized around 40 workshops mostly in districts with an average of 500-600 participants mostly vocational high school students. Total cost per workshops is around Rp. 10 million²⁷.

More professional wireless engineer workshops have been organized by Mikrotik and Ubiquity

25 KOGTIK's web site is <http://kogtik.or.id/>. Their Facebook group is <https://www.facebook.com/groups/kgtik/?fref=nf>.

26 Personal communication with Dadang, CEO of Raihan Technology Foundation (@raihanteknologi) dated 6 June 2016.

27 Personal communication with Dadang, CEO of Raihan Technology Foundation (@raihanteknologi) dated 9 June 2016.

distributors. Ubiquity through Spectrumindo organize several events documented on Facebook²⁸. There is at least four technical events per year with an average of 100 participants per event. In 2016, these events are organized in Surabaya, Bali, Medan and Manado. There are four training sessions²⁹ with about 20 participants, and one training for trainers workshop with about 25 participants. In total, about 500 wireless engineers per year are empowered³⁰. Events for Mikrotik in Indonesia is organized by Citraweb. There is a minimum of 40 training classes per year with about 24 participants per class³¹. On the average, Mikrotik educates about 1000 new wireless engineers per year. Photo documentation can be seen on the Web³². In addition, Mikrotik Indonesia partners with 170 vocational schools and universities to run their own Mikrotik certified trainings. Every year Mikrotik worldwide organize at least 30 Mikrotik User Meetings (MUMs)³³. On 9-10 October 2015, the seventh Indonesian Mikrotik User Meeting (MUM) organize in Yogyakarta attended by more than 2500 participants and the largest in the world³⁴. A total of 1500 wireless engineers per year are empowered through Mikrotik and Ubiquity workshops.

PRO RURAL POLICY

On June 10, 2016, Senator Achmad Muqowam, head of commission one of the house of representatives cried out loud, saying, "For us (the senators), the main and priority is to deploy telecommunication networks and the Internet to reach people in remote rural areas. Thus, the coverage of telecommunications and information should penetrate regional boundaries, so narrowing the distance between city-rural in terms of communication". The commission one urges the government, i.e, ministry communication and information, to prioritize network expansion to rural as their main program (Achmad Rouzni Noor II, 2016c). In addition, ability to provide Internet access in rural areas is identified as the key development factor (Puskakom UI, 2015, p. 2).

Constraints imposed by the government, finance minister Bambang Brodjonegoro explicitly mentioned that telecommunication sectors must be able to run and accelerated without having to rely on the national budget (KEMKOMINFO, 2015). Furthermore, the telecommunications law number 36/1999 states clearly that only licensed operators may build and operate telecommunications infrastructure and no room for communities to participate, even if, they have financial and technical capacity to do it within their communities.

To finance the telecommunication infrastructure for rural, there are three (3) major funding options, namely, using the USO funds (Indonesian Government, 2009, p. 7), village fund (KOMPAS, 2015), and self-finance by the community in the village. The key to a sustainable infrastructure is by keeping the cost down, building local expertise and benefits local economy (Laura Hosman, 2010, pp. 57-58). To catalyze positive change in ICT for development, open development approach may be adopted (Matthew L. Smith *et.al.*, 2011, p. iii)

28 The URL <https://www.facebook.com/spectrumindo/?fref=ts>

29 The URL <https://www.facebook.com/trainingubiquiti/?fref=ts>

30 Private communication with Teguh Wijaya, CEO of Spectrumindo on 10 June 2016.

31 The URL <http://www.mikrotik.co.id/training.php>

32 The URL http://www.mikrotik.co.id/training_list.php

33 The URL <http://mum.mikrotik.com/>

34 Personal communication with Valens Riyadi, CEO of Citraweb and Mikrotik Indonesia, dated 10 June 2016.

The government earlier attempt to provide village cyber cafe and mobile cyber cafe with very limited field surveys on local capacity, and not much training for human resources that will handle the system lead to the failure of the project. The newer government plan to install 575 BTS in rural areas by 2019 (Indonesian Government, 2016, p. IV-43), would not possibly be sufficient to cover 7,717 villages with no cellular signal (BPS-Statistics Indonesia, 2014b, p. 105).

I would suggest the pro rural policy to be divided into two major policies aiming (1) to equip people with Internet skills and (2) to narrow the access divide. The simplest policy that can be taken to equip young Indonesian with Internet competence by Minister of Education Anis Baswedan order the inclusion of ICT in school curriculum, re-employ the ICT teachers and the deploy Internet in the schools. Providing Internet in the schools can be funded by the USO fund or Village Fund in collaboration with the Ministry of Communication and Information else the community may self-funded the Internet at school. In the informal sector, people will still be able to acquire knowledge through various discussions on the Internet and workshops, as performed by Raihan Technology Foundation, Mikrotik and Ubiquity. This is in turn reducing the barrier to greater Internet adoption (World Economic Forum, 2016, p. 9; ITU, 2015, pp. 93-94; MCMC, 2015, p. 10; IDA, 2015, p. 10).

Teddy Mantoro *et.al.* have written an elaborate roadmap on human resources for ICT industry in Indonesia. The following is some of recommended strategic steps to bridge the competency gap in the ICT field, including, (1) strict control over the quality of education, with oversight rigorous curriculum of informatics and computer and its pedagogic, (2) establishing national and regional expertise certification centers, and (3) facilitate continuous interaction between ICT industries, government, and educational institutions to build knowledge and expertise in the field of informatics and computer (Teddy Mantoro *et.al.*, 2016, pp. 61-62).

To narrow the access divide, there is two (2) options by (1) fully government-operator driven, or (2) in combination with public-private (people) partnership. The telecommunications law number 36/1999 mandates ministry of communication and information to deploy the telecommunication network in rural. To reduce the failure rate in the fully government-operator driven projects, the government must conduct broader surveys on local capacity and more rigorous planning as well as improve the empowerment processes of citizens before infrastructure deployment is implemented. This is essential to ensure that future ‘top-down’ policies to improve rural Internet access do not follow the path of their predecessors.

With large number of operational community neighborhood network, thousands of wireless engineers, and many OpenBTS research groups, it would be beneficial to strengthen public-private (people) partnership in the pro rural policy. The simplest policy would to facilitate class license for community neighborhood network as has been done in WiFi frequency. If the license requirements will be enforced, then the government must be ready to process the ISP license for each community neighborhood network in more than 80,000 villages. In addition to ISP license, future research needs to be done to evaluate the optimum method, on how to use USO funds for communities, the optimal allocation of telecoms resources, such as, telephone area codes, network interconnection charges and cellular channel for the communities. To sustain the infrastructure, the policy must be able to keep the cost down, build local expertise and benefits local economy (Laura Hosman, 2010, pp. 57-58).

CONCLUSION

To narrow the digital divide and provide Internet skills to Indonesian will be one of the strategic key to the advancement of Indonesia. In order to increase Internet penetration for more than half of Indonesia's population is on the Internet, then inevitably we must be able to penetrate into the rural areas. Internet penetration into rural and village is not easy due to severe terrain conditions. With extremely limited financial and demand in rural and villages, it is not attractive for commercial providers to investment and to provide services.

Education is key to equip the citizens with Internet skills. Currently, the Indonesians have to rely on self-finance workshops, demos, seminars, online discussions to gain the required knowledge. Some of the professional workshops capable to empower 1500 wireless engineers per year. Inclusion of ICT in school curriculum, re-employ the ICT teachers and the deploy Internet in the schools will accelerate the empowerment process to gain Internet skills and Internet competence for the young Indonesians and, thus, reduce the barrier to greater Internet adoption.

To narrow the access divide, the government may employ USO funded fully operator driven projects by conducting broader surveys on local capacity and more rigorous planning as well as improving the empowerment processes of citizens before infrastructure deployment. This is essential to ensure that future 'top-down' policies to improve rural Internet access do not follow the path of their predecessors. However, with substantial capacity in the Indonesian Internet engineers community, it would be beneficial to strengthen public-private (people) partnership in the rural policy. The simplest policy would be to enforce class license for community neighborhood network else the government must be ready to provide ISP license for each of more than 80,000 villages.

Future studies need to be perform to evaluate optimum USO funding for communities, optimal allocation of telephone area codes, cellular channels for villages as well as on how to keep the cost down while building local expertise and provide benefits for local economy to be able to sustain the infrastructure for a long time.

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