Motivating Community Based ICT Infrastructure Development

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Abstract

The community-based ICT infrastructure started as unsupported activities at the Institute of Technology in Bandung, Indonesia in 1992. In the early stages, we managed to link several schools in Bandung city using a slow 1200bps packet radio technology running on Very High Frequency (VHF) band. With no financial support from the government, the World Bank or the IMF, this became Indonesia's initial largest pre-InterNet network installation.

This article will document the path and experiences in facilitating a community movement to build its own infrastructure. Currently, there are more than 5000 outdoor WiFi installations, at the rate of 200-300 new outdoor WiFi nodes installations a month. A shift is occurring from old fashion community tele-centers and cybercafes towards wide area neighbourhood networks. Efforts to "liberate" WiFi band from government licensing requirements are underway. Among the expected outcomes is a significant increase in Indonesian Internet users to reach ~20 million users by 2006 and facilitate narrowing the digital divide.

Fully supported by the International Development Research Center (IDRC) and Bellanet, Canada, I am able to share the practical knowledge of wide area WiFi infrastructure deployment in English. This practical knowledge gain to support development of community-based ICT infrastructure is currently host at http://sandbox.bellanet.org/~onno/ and can be download free of charge. Practical discussions of WiFi & VoIP technology in English can be found at wifi4d@dgroups.org, an online virtual discussion platform. It is our hope that others can continue to benefit from our practical experiences and expertise.

Acknowledgement

I would like to thank IDRC for their guidance and support. This work is dedicated to all my comrades who help the Indonesian Internet communities.

A Glimpse of The Past

RMS Ibrahim, Suryono Adisoemarta, Muhammad Ihsan, Robby Soebiakto, Putu, Firman Siregar, Adi Indrayanto, Basuki Suhardiman, and Arman Hazairin are some of the legendary names in early Internet development in Indonesia from 1992-1995. Most of the current Indonesian Internet users may not know them, however, each of them invested their considerable knowledge to build PaguyubanNet, the earliest form of Internet in Indonesia. "Paguyuban" is an Indonesian language word, which means helping each other.

In 1986, early Internet development in Indonesia was inspired by the activities taking place among the Indonesian amateur radio especially the Amateur Radio Club Institute of Technology in Bandung (ITB). Equipped with Single Side Band transmitter belonging to Harya Sudirapratama, callsign YC1HCE, and an Apple II+ computer with 64Kbyte RAM belonging to Onno W. Purbo, callsignYC1DAV, 10-20 young ITB students were learning from our senior amateur radio pioneers such as Robby Soebiakto, callsign YB1BG, Achmad Zaini, callsign YB1HR, to run packet radio networks & TCP/IP protocol in the amateur radio band.

Today, the learning process is shared through various Indonesian mailing lists, such as, orari-news@yahoogroups.com, indowli@yahoogroups.com, genetika@groups.or.id.

As a result of this learning process, the core of the early Indonesian Internet network was created, based on a slow 1200bps amateur packet radio technology. It was used to link friends at the Ministry of Research and Technology (Jakarta), University of Indonesia (Jakarta), Indonesian Aerospace Institute (Bogor) and the Institute of Technology Bandung (Bandung), later known as Paguyuban Network in 1992-1994.

In early 1993, started with a slow packet radio network, ITB gradually built the Internet communities in Bandung and its surroundings. In 1995, ITB received a free 14.4Kbps leased line to the Indonesian Telkom as part of the Science Technology Network. This acquisition opened up the mindset of many students and young Internet enthusiasts in Bandung area.

September 1996, was a major turning point for ITB, they invested on Ku-Band satellite ground station and integrating ITB into Asia Internet Interconnection Initiatives research network to Japan at 1.5Mbps bandwidth (now 4Mbps). ITB added 2Mbps interconnection to TelkomNet for local traffic, which set ITB as one of the leading institution to integrate Indonesian educational institutions to the Internet around 1997-1999 known as AI3 Indonesia network.

I have to admit that ITB is not the only one who led integrating education institutions to the Internet.

Since 2001, Dr. Gatot H.P. at the Ministry of Education is also currently leading the integration of more than 1500 vocational schools to the Internet. We still have a long way to go with the total of 1300 colleges / universities, 10,000 high schools, 10,000 Islamic

schools, 4,000 vocational schools. It is indeed a challenging task to integrate all of these educational institutions.

This is a glimpse of some of the historical aspects of the Indonesian Internet development. It was a fun process and involved many good and dedicated Indonesians who enjoyed sharing their knowledge, expertise and resources for the betterment of Indonesian society.

Modifying Indoor WiFi To Bypass Telco

Any analysis of the cost to operate an Internet infrastructure, would clearly show that most of the money actually goes into the Indonesian Telco's pocket to pay for the telecommunication lines, and the current increase in Indonesian Telco's tariff. This phenomenon drives the community to seek alternates solutions to build their own network to bypass the Telco.

One of the easiest ways to accomplish this is to use the off-the-shelf low cost Wireless LAN (WLAN) technology running at 2.4GHz & 5.8GHz band (also known as WiFi) to bypass the Telco's last mile. The WiFi wireless Internet solutions can easily be found on web sites, such as, http://www.wavelan.com, http://www.ydi.com, http://www.wipop.com, and http://sandbox.bellanet.org/~onno/. One should explore alternatives on 5 or 5.8GHz for newer equipment with higher speeds at 11-54Mbps.

WiFi equipment is originally designed for indoor usage. However, in our community based network, it is used for the outdoors and along with a 20-30 meter tower, it can reach 5-8 km distances.

The major difference, in contrast to normal indoor WiFi installation, is we use an outdoor external antenna to extend the range of the radio coverage. Some WLAN cards and WiFi Access Points have an external antenna connector pop up at the end of the card, which can be used to connect the antenna cable and external antenna to the card. With an external high gain antenna, we may easily reach 5-8 km distances.

With approximately US$50-70 per WLAN card, someone with a strong Linux background may easily build a low cost gateway / router to integrate a LAN or a community to the Internet at 11Mbps. For those who like to build their own infrastructure, the Linux's driver of the card is available in public domains, such as, http://www.sourceforge.org.

Building low cost homemade 2.4GHz antenna is not very difficult; a tincan with 90 mm diametre, and 215 mm length can be easily used as a 2.4GHz antenna for 1-2 km distances. It costs approximately US$5-10 per antenna.

At the moment, 5000+ corporate users including the good Internet cafes and some residential users are using this deployment. Most of the wireless Indonesian Internet operators can be found at indowli@yahoogroups.com and struggling for low cost, if possible free license for the frequency.

We have created a mailing list wifi4d@dgroups.org to support practical WiFi & VoIP discussion in English for international practitioners.

Community Movement For WiFi-based Infrastructure

At the moment, I have my home LAN as well as my surrounding neighborhood connected to the Internet for 24-hour access at 11Mbps. I personally share Rp. 330.000 / month (approximately US$30 / month), it is part of a neighborhood network of around 60 houses and apartment. Without a neighborhood network and WiFi, it is not possible to bypass Telco for ISP connection.

Unlike normal Telco infrastructure, the Indonesian WiFi-based infrastructure is based around an extension of the old concept of Community Tele-Center (CTC). WiFi is used as the medium for reaching 5-8 km, beyond the Telco's infrastructure last mile.

As normal Community Tele-Center (CTC) connects several computers in a room or a house, we extend the LAN cables to our neighbors to create the so-called neighborhood network with 24-hour Internet access.

As more houses or computers in the neighborhood become connected to the neighborhood network, the operating cost as well as the investment cost will decline. Since the investment per house is relatively low (around US$50-80/house with an operating cost US$15-45/month/house0, it really sparks the interest of many neighborhoods to create their own NeighborhoodNet.

This movement applies for school networks, office networks and other types of networks. It is not surprising to see more than 5000 outdoor WiFi nodes installed in Indonesia.

Large-scale community investment in its own infrastructure leads to community-based ICT infrastructure.

Expanding to regional networks, we need to think of how to building the regional network. We use two (2) main technologies to build our regional network, namely,

- Satellite backbone. The cheapest solution we can currently get in Indonesia is DVB-RCS satellite backbone selling for US$200-700 at 64Kbps depending on the agreement on the satellite ground station.
- Fiber / microwave backbone rented from cellular operators. The excess capacity of cellular backbone is used to pass our data traffic from city to city. The local ISP normally rents the backbone from the cellular operators, and then sells it as part of Internet access to the community.

Another emerging controversial technology is Internet telephony (Voice over Internet Protocol or VoIP). Started in early January 2003, the Indonesian VoIP Network known as VoIP Merdeka (in Indonesian) or RebelNet, is a reaction to the Government plan to increase phone tariff, on January 1, 2003.

VoIP MaverickNet is a community based VoIP Network run on top the existing Indonesian Internet Infrastructure. It is a free VoIP network & one of the most complex countrywide Internet Telephony infrastructures ever implemented with currently more than 200 VoIP softswitches and thousand of subscribers.

An open source gatekeeper (www.gnugk.org) and other open source VoIP software at http://www.openh323.org are used to drive the movement.
The detail technical references can be downloaded from http://sandbox.bellanet.org/~onno/the-guide/voip with discussion group at wifi4d@dgroups.org.

I have to admit that these solutions may not be appropriate for some countries, especially those with strict regulation on frequency usage and connection to Telco infrastructure. Fortunately, the Indonesian media helps keep us from being thrown into jail.

Self-Financed Scheme for ICT Infrastructure

I would argue that cost-wise a community based infrastructure rely on WiFi, VoIP and Private Branch Exchange (PBX) would have a much lower initial investment and operating costs compared to the conventional cellular or public switch telephony network infrastructure. Thus, it would be of interest to look at such an alternative infrastructure for other developing countries.

A typical Internet Telephony Gateway (ITG) with four (4) ports would cost about US$400 each. The ITG will translate conventional voice traffic into VoIP traffic over Internet infrastructure.

To reduce the investment and operating cost, we normally connect the ITG to a Private Automated Branch Exchange (PBX) and share the VoIP lines with more people in the office or neighbors. Thus, it is normal to connect all four (4) ITG's port to PBX. A typical PBX, such as, Panasonic KX-TA616 has 6 CO lines and 16 extensions. Panasonic KX-TA616 may cost around US$400-500.

Ready to use client side WiFi equipment would cost about US$150-200. A LAN connector is available for use on the back panel so that this equipment can be connected to other network equipment on our local network. To extend the distance, a US$50-100 external antenna may be added. Such a configuration can reach 5-8 km distances, a good enough distance to cover most medium size cities in developing countries. Those who like to build their own PC based client WiFi equipment may get a much reduced WiFi investment.

The total investment cost does not exceed US$1200 for WiFi equipment, an Internet Telephony Gateway and a PBX. The 16 subscribers connected through the extension of the PBX must pay these investment costs. Thus, investment cost per subscriber is about US$75.
A typical cellular investment / subscriber is about US$300-400/subscriber. While, a typical fixed wire telephony network / public switch telephone network requires about

US$1000/subscriber. Therefore, WiFi & VoIP based infrastructure per line costs much less when compared to the typical investment per subscriber in a cellular network and in typical public switch telephone network.

Based on the IP bandwidth calculation http://www.erlang.com, a typical full duplex G.723.1 (ACELP) 5.3Kbps compressed voice including the TCP/IP protocol header will require about 64Kbps for a four (4) lines VoIP.

A dedicated 64Kbps Internet link would normally sell at US$350-400 /month directly from the Internet Service Provider (ISP). A free, 24-hour local connection to the ISP can be done using WiFi equipment replacing the local Telco's leased line.

The actual monthly operating cost per subscriber of such community based infrastructure is only US$350-400/16 or about US$20-25/month/subscriber including "unlimited" long distance calls over the Internet to other community-based networks.

If US$20-25/month/subscriber seems too high, one can always resell their access to others in their communities as demonstrated by the women in Bangladesh who subscribe to Grameen Phone microcredit initative.

Both low investment cost and low operating cost has been demonstrated in a simple community-based infrastructure based on WiFi, VoIP and PBX. I hope to see such infrastructure flourish in many countries in the years to come.

Encourage Local Knowledge Producers to Share Knowledge.

Educated, dedicated & sometimes militant people are the key to success, behind all the movement and activities in deploying such revolutionary infrastructure. This attempts to transform Indonesia into knowledge-based society clearly shows the strength of community education.

A clear result of a capacity building and community empowerment is the community based ICT development, including the development of Indonesian open source development community or the VoIP MaverickNet. It is an art in itself to be able to create a countrywide community based self-finance self-motivated ICT movement with minimal support from the government and no loan from World Bank & IMF.

In this section, practical strategies in initiating such community based ICT movement will be explored. There are several important ingredients that enable such a movement, including,

1. Clear cause must exist. Some may see this as the vision; others may see it as the stumbling block, or challenge.
2. There must be a good informal leader that has the vision, knows the way, shows the way and goes the way. Finding such a leader is a very difficult task.
3. Ability to shift the paradigm of the common people, from being a information / knowledge consumer into an information / knowledge producer.

In closely examine the technology trends; one may easily notice that technology is becoming more affordable and more user-friendly. Thus, the future challenge in the existing regulatory framework is apparent as shown in the table below.

	Conventional	**Future?**
Technology	Expensive & Complex	Affordable & User-friendly
Specialized Skill	Yes	No
From	Licensed by Government	Common People
Invest by	Investor (Multinational)	Common People
Build by	Vendor & Contractor	Common People
Run by	Operator	Common People
For	User & Customer	Common People

It is not surprising to see a significant shift in the industry towards ICT-based infrastructure invested by people, built by people, and run by people for the people.

This philosophy enables communities, offices, and resellers to act as unlicensed service providers and / or unlicensed physical network operators. Such shift creates a significant problem in the policy & regulatory framework that accept only licensed operators to run a network.

This leads to no available room for a community-based infrastructure; with homebrew equipments, from people, by people, for people. There is no room for WiFi-based last mile nor for VoIP based community networks.

In this example, the reasons & challenges are very clear.

However, having access to low cost technology on hand is not enough. ICT knowledge in local language is fairly limited; translating the knowledge on the Internet or various technical books is very labor and funding intensive.

Therefore, the ability to generate and distribute ICT knowledge in the local language at a low cost will be critical.

Sustaining the deployment for the digital divide bridge in a long period of time and the ability to self-finance local knowledge generation cycle are two crucial factors. Key success in deploying the information infrastructure would rely heavily on the masses of quality & skill of the human resources. The ability to distribute the required knowledge & skills at a low cost would be crucial in creating demand & needed technicians, skilled at deploying the infrastructure. The ability to access ICT knowledge in English would be an added benefit. Interestingly, since equipment can be shared and is getting cheaper, funding is not the primary concern in deploying ICT infrastructure.

In creating a self-financed knowledge cycle, there are basically two (2) critical strategies, namely,

- Transforming some locals into local knowledge producer.
- Supply created-by-demand strategy.

Unfortunately, the whole process takes at least ten (10) years. Never ever expect to financial benefit in a short time, it will never happen that way.

Most failures are likely due to demand created by the supply path or heavy top-down approaches. Failure to increase society's level of education will likely impede the development of information infrastructure.

A conservative route would be initially to connect the school and university network. School network will affordably cost US$ 0.50/student/month with a Return of Investment in 1-2 years. Furthermore, the young generation will be an effective agent of change for their parents and surrounding communities.

In developing countries, like Indonesia, practical know how on various ICT technologies in local language is in high demand. Publishers are begging for manuscripts on various ICT practical guides in local language. Most of the best Authors are in their 30's and acquiring their ICT knowledge through their school and university's Internet access. Thus, it is very crucial to integrate schools and universities to the Internet, as they are the one who produce the desperately needed local knowledge 3-5 years after their initial introduction to the Internet.

Simplified Steps in Knowledge Generation & Demand Creation

- We always start on a discussion / mailing list to share knowledge among us. Create a discussion platform for 2-way interaction to exchange tacit (implicit) knowledge. It may be radio or TV talk shows, or Internet mailing lists at no cost. Thus, no requirement for any initial knowledge is required, and communities will generate their own knowledge from their past experiences / knowledge.

- After 1-2 years, some individuals, mostly young students, will start to synthesize the collective community knowledge into books / articles and, thus, convinces others who are not yet using ICT. It costs US$ 1-2 to buy a book or magazine. The young authors, in return, normally receive an incentive of US$ 15-25 /article or US$ 400-700 /book. The best selling and the most productive authors will easily get equipment donation from various vendors.

- Some may need physical contact through seminar and workshop to be convinced. We are normally looking at 500-1000 participants/seminar. The favourite seminar agenda would be to provide tutorial and demonstration on various ICT technologies. It costs US$ 3 /person to participate in such seminars as many vendors may likely give a sponsorship.

- As more people are convinced, demand is created within the communities for their very own "digital divide bridge". Sound business plan, with US$ 2000-4000

investment and return in 1-2 years, will persuade people to invest their money to deploy their very own "digital divide bridge". A conservative path would connect the school network first before connecting the neighborhood.

- Deploy & maintain the "digital divide bridge" may cost 50 cents/student/month at school or about US$ 15-30/month/house. We finally have financially sustainable digital divide bridges with minimal support from the Bank, the government & hopefully free of license.

To give some extreme ideas, we can actually mingle with the current education system. For example,

- When I thought at Institute of Technology Bandung, I removed the necessary attendance. No mid term exam. No final exam. Mark is based on students' ability to become a knowledge producer. I use a simple tactic: forcing the students to publish article in the magazine, e.g. 5 articles A, 4 articles B, 3 articles C etc. or publish a book for an A.

- Another way to encourage the students, I gave free access to the Internet for those who like to help maintain and run the network system in my laboratory. In the end, I asked them to write a book based on the knowledge gain during the process.

Through these simple processes, we forced young students to become a knowledge producer to benefit the whole society through local knowledge accumulation and then publishing the knowledge.

These steps would not be completed over night. It will take years to complete these steps. Committed leaders & personnel are needed for such a long-term deployment ICT movement.

Struggle To Liberate 2.4GHz and 5/8GHz WiFi Band

In early 2004, at the time this manuscript is written, a fierce fighting is currently underway over several Indonesian mailing lists, such as, indowli@yahoogroups.com and genetika@groups.or.id, between many individuals from the Indonesian grass root communities and individuals from the telecommunication regulators.

The subject debated is on liberating WiFi band from any requirement of government licenses. In October 2003, a draft on ministry of telecommunication decree on WiFi is being written. Many people from the communities fight for freedom, while some people on the telecommunication regulator insisted to license the band.

Would it be fair to charge US$250 per year per Access Point for frequency usage, while the price of an Access Point is only US$100-150 each? Furthermore, the license will be limited only for ISPs. Those who run the system without any license will have their equipment revoked.

As knowledge on WiFi deployment can be freely downloaded from the Internet at http://sandbox.bellanet.org/~onno/, more people can build, install and run the system.

It is getting more difficult for the government to fight, as more of its own people can build, install and run the system. The government will have to face a large mass of people to fight with every day.

It is a shame that some of the telecommunication regulator does not realize the impact of liberating 2.4GHz & 5.8 GHz WiFi band, not to mention the likely spin off effect which lead to more economical benefit for the country. An underestimate calculation reveals that there will be an increase from the current status:

- One (1) million to 17.8 million WiFi based Internet users.
- Rp. 1 Billion/year to Rp. 21 Billion/year ISP tax.
- Rp. 7 Billion/year to Rp. 128 Billion/year VAT.
- Rp. 18 Billion to Rp. 600 Billion investment tax.
- 50.000 units to 2 million unit computers.
- 5.5000 units to 130.000 units ISM band equipment.
- Such increase in ISM band equipment needs will justify an industrial migration from antenna and tower manufacturing to ISM band equipment manufacturing at US$4.5 million value.

A rough exchange rate for US$1 is about Rp. 8500.

There are many version of WiFi band liberation scheme; the one that proposed by Onno W. Purbo (and supported by many individual in the community) to the ministry of telecommunication is as follows,

1. Liberate ISM & UNII (2.4 GHz, 5.2GHz & 5.8GHz) band
2. No license and registration requirement for ISM & UNII band users.
3. No type approval requirement for equipment approved by FCC and ETSI.
4. Limit the maximum Effective Isotropic Radiated Power (EIRP) to 30-36 dBm. Those who violate the limit may be prosecuted under Telecommunication Act No. 36/1999.
5. The community coordinates frequency sharing and reuse coordination for Metropolitan Area Network (MAN).

Onno W. Purbo (onno@indo.net.id), resigned from Indonesian civil servant & retired lecturer, a maverick driven by a plain & simple vision to see an Indonesian knowledge based society, has been committing his time writing thousands articles, papers and 30+ books on Internet technology mostly in Indonesian language in attempting to educate the Indonesian on IT. All of his articles are copylefted & can be freely downloaded from the Internet, such as, http://sandbox.bellanet.org/~onno/ (English version), http://www.apjii.or.id/onno/ or http://www.bogor.net/idkf (Indonesian version) or http://onno.vlsm.org.