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The Problems

It has been 126 years since Alexander Graham Bell invented the telephone and around 50 years since Indonesia had its own telephone company.

Unfortunately, the penetration of telephones in Indonesia today (2004), counting fixed as well as mobile telephone lines in use, is only 10.45% according to the figures published by the Directorate of Post and Telecommunications.

This paper will point out the inherent problems Indonesia has with regards to telephone penetration and take you through some of the solutions to overcome them.

There are two main problems regarding the low penetration of telephone lines. Firstly, the typology of Indonesia. As the world's largest archipelago country, Indonesia faces the severe challenges of infrastructure and "mainland" connectivity. Indonesia has more than 17 thousand islands with 5 big islands. With such spreads, cabling and connectivity infrastructure requires huge investments and efforts.

Secondly, the uneven spread of its approximately 220 million population. Most of the population is residing in Java and Bali (60% or 124 million). 43.2 million people (21%) live in Sumatra, 5.5% in Kalimantan, 7.2% in Sulawesi, while about 2.1% of Indonesia's population dwell in the Molluca islands and Papua (West Irian). With this equation, it has not been possible for the incumbent phone company to answer the telecommunications needs of small and remote communities, even for many locations in Java and Sumatra.

Based on the penetration figures of fixed and mobile telephone, the number of PCs and Internet users, Indonesia lags far behind many other countries in the world. According to ITU Reports, the 2002 penetration of fixed lines in Indonesia was 3.60 telephone lines per 100 population, and cellular subscribers reached 5.52 per 100 population. This number is far behind Indonesia's neighbors such as Malaysia, Singapore, Thailand and also China. Indonesia's penetration of phone lines is only one fourth of Asia's average penetration. See Table 1.

	Phone Lines Per 100 pop.	Cell Subs Per 100 pop.	Internet Hosts Per 10,000 pop.	PC's Per 100 pop.	Internet Users Per 100 pop.
Indonesia	3.6	5.52	2.18	1.1	191.23
China (PRC)	16.69	16.09	0.68	1.9	460.0
Malaysia	19.79	34.88	31.10	12.61	2,731.09
Philippines	4.17	17.77	3.94	2.17	255.69
Singapore	46.36	79.14	479.18	50.83	5,396.64
Thailand	9.87	26.02	11.75	2.78	775.61
Vietnam	6.85	2.34	0.06	0.98	184.62
ASIA (coverage)	12.13	12.19	29.88	3.95	557.56

Table 1. ITU Indicators 2002
Source: World Telecommunication Development Report 2003, ITU 2003

Within Indonesia itself, the penetration also differs greatly from province to province. The penetration in Java is more than twice as high as in Kalimantan and other eastern islands of Indonesia. According to statistics from PT Telkom, its fixed telephone lines in use in the greater Jakarta area reached a penetration of 32.5 % in the Second Quarter of 2003.

Solutions

Satellite technology conveniently strikes observers as the only feasible solution to rise up to the challenge of catering to Indonesia's telecommunications needs. Satellites have a wide reach and can cover all of Indonesia.

Currently there are 4 satellite operators in Indonesia: PT. Pasifik Satelit Nusantara, PT. Telkom, PT. Indosat (the original satellite operator, PT. Satelindo recently merged with PT Indosat), and PT. Mediacitra Indostar (Direct Broadcasting by Satellite). Most of the C-Band transponders of Palapa Satellites B2R, B4, C1, C2 are operated by PT. Telkom and PT. Indosat.PT. Pasifik Satelit Nusantara (PSN) owns the Ext-C band transponders in both Palapa C1 and C2. PSN has also part ownership in the Garuda-1 satellite which covers a significant part of South East Asia and the Asian mainland for Mobile Satellite Service.

Before PSN commenced operations, earth terminals were still too expensive as allow for major extension of services into the unserved areas of our nation.

Pasifik Satelit Nusantara

PSN is Indonesia's first private satellite telecommunications company in Indonesia. This Indonesia-based company focuses on becoming a fully integrated provider of satellite-based telecommunications products and services in the region. Being a satellite operator and with its products BYRU (Satellite GSM), PASTI (Portable Fixed Satellite), and BINA (Integrated Data Communication Network), PSN aims to pursue its vision "to serve the unserved." Providing isolated areas with telecommunications, the digital divide now existing may be eliminated or narrowed at some point in future.

The current achievements of PSN cannot be separated from its CEO, Adi Rahman Adiwoso, who founded the company together with Iskandar Alisjahbana in 1992. They foresaw that Indonesia's telecommunication problems can only be solved using satellite technologies and they also believed that private companies have to be given the chance to become satellite operators. At that time, Telkom was the only satellite telecommunications operator in Indonesia.

In the later part of this paper, we will show the satellite network PSN has developed, utilizing the Garuda 1 satellite. Using this network, local small holders have established numerous Public Calling Centers, so that the surrounding community is able to communicate for economic and social purposes. These Public Call Centers are commercial ventures and help to bring communications to the 72,000 villages in Indonesia. However, there is still a serious gap, because not all locations can be served in a commercially viable manner. In 2003, there remained 43,000 villages without any telephone access.

Government efforts to eliminate the digital divide in Indonesia are realized, among other ways, through the Universal Service Obligation Program (USO-program) in which PSN has been assigned a major role. There are also programs sponsored by the Ministry of Education in bringing about communications to isolated Secondary Schools, again using PSN's network and services. For Indonesia's 2004 General Elections, PSN had to build data connection facilities in many 'unserved areas" so that those areas could send their vote counts to the General Election Committee Data Center in Jakarta.

The USO Program

The technology of Garuda-1 is currently used by PSN to carry out the government sponsored universal service obligation (USO) project. The International Telecommunication Union's definition of USO refers to household access to at least one telephone. For the moment, USO in Indonesia is defined as the access to a telephone for public use (through Public Call Centers) in rural and remote areas. Previously, based on the Telecommunication Act No. 3/1989, USO was carried by PT. Telkom, as the monopoly holder of public telecommunications. Based on the current Law, No 36/1999, USO shall be funded by government budget, telecommunications operators, and others. Starting in 2004, telecommunication operators in Indonesia have to contribute 0.75% of their gross revenues to support the USO program.

It has been identified that there are around 43 thousand out of 72 thousand villages in Indonesia that do not have telephone access. Therefore, to resolve this the Indonesian government estimated that they could budget the funds to reach all villages within 3 or 4 years of completion. In practice, last year (2003), 3.010 USO phone lines were built, of which 2.975 locations were in the format of PSN's Fixed Portable Satellite (FPS) technology called PASTI and 35 locations used another, more conventional, VSAT Technology. This number is way below the original target of 8.370 lines to be completed in 2003. One of the problems is the deficiency of the state budget to cover the program in 2003.

Implementing the USO program is a big challenge because most of the places are hard to reach given the poor means of transportation and transport infrastructure. However, PSN imprints its success by completing the task of placing 2975 PASTIs all over Indonesia. In Sumatera, PSN put 1.049 PASTIs, in Kalimantan 542, in the East part of Indonesia 1384 PASTIs with a speed of about 1,000 added locations a month. The USO program is to continue beyond 2004.

PASTI is commonly operated as a pre-paid public pay phone where the villagers can use the phone and pay to the operator the charges displayed on the equipment. The money is collected to buy re-fill vouchers for future use. Vouchers can easily be found in outlets spread all over Indonesia.

Problems facing PSN in implementing the USO program required PSN's installation coordinator to made quick decisions. In 30 locations PSN had to provide batteries, as there was no commercial power available. Some locations had to be cancelled or relocated because inhabitants had left the village empty for security reasons. In reaching another location, the PSN installing crew had trouble with transport, and even had to cope with a sunken boat.

General Election Project

For the first time in Indonesia's history, and as a result of the political reform in the country, direct election of the President and Vice President have been instituted. The 2004 General Elections are conducted in 3 consecutive stages. In April 2004, the Parliamentary Election allowed citizens to vote for members of Provincial and Regency House(s) of Representatives. In July, the elimination round for Presidential candidates took place, leaving two final candidates for

President. In September, the final round took place. Each Presidential candidate was teamed up with his/her Vice Presidential candidate.

In 2004, also for the first time, Indonesia used information technology to deliver the results of vote counting at the sub-district or "kecamatan" level directly to the General Election Data Center in Jakarta. Within each sub-district, voting results were conveyed manually from the numerous voting stations to the sub-district capital. There are 5110 sub-districts all over Indonesia, and the General Election Committee had chosen a total 4615 sub districts and regencies to be equipped with computers, Internet access and phone lines. Sub districts that could not be connected through PT. Telkom lines (the incumbent telephone operator), used the satellite based telecommunication service from PSN's PASTI. Of course, there were mostly in the more remote sub-districts. With a total of 1850 PASTI facilities placed in those sub-districts, PSN again took up the challenge of serving the un-served areas. Using PASTIs, the operators in remote sub-districts sent the results of vote counting through Intranet.

Through the system created for the 2004 General Elections, the result of approximately 500 thousands voting location could be shown transparently within a week after election day, which is remarkable, considering the need for manually transporting data within sub-districts, and verifying the data before transmitting. The experiences of PSN in providing facilities for data transmission points in those sub-districts show the following facts. (a) There were more problems that stemmed from non-technical matters both in the April and in the July election days (86% in July 2004) compared to problems of a technical nature (14%). Examples of human errors were: incorrect insertion of SIM card, incorrect Access Code used, SIM-Card lost. (b) Learning goes fast. Comparing the performance of the April 2004 and the July 2004 election days shows that certain locations that at the time of the April election failed to send data electronically (therefore causing delays by having to manually forward the data to another data-transmitting location), had overcome this problem in the July vote counting process.

The Satellite Technology

Communications satellites have been utilized quite extensively for some time in Indonesia. The common disadvantage of satellite communication is the relatively high cost of earth stations. This has hindered the use of conventional satellite communications as an affordable, widespread access network. The availability of low cost VSAT terminals over the past 10 years helped to a certain extent; it allowed corporate and government users to have high speed data and voice satellite networks at an economical cost. But the average household in the country still has to rely on terrestrial local loop access networks for basic telecommunications services that are still deemed not very economical to build outside urban areas. This and a lot of other factors impede teledensity growth in Indonesia.

The Asia Cellular Satellite System - Extending Reach to Rural Indonesia

The Asia Cellular Satellite System adopted the concept of a regional mobile satellite access network. It was designed to provide access to basic circuit-switched telecommunication services in Asia through the use of low cost, small handheld satellite terminals. It was not the first system of its kind when it was launched in 2000, but many of its characteristics are unique as we will elaborate further.

The ACeS System Architecture

The ACeS System network is comprised of 4 major components namely: the Garuda-1 Satellite, the small User Terminals (UT), earth station Gateways (GW) and a Network Control Center (NCC). Each of these are specifically tailored for the main purpose of the network. Like any other satellite system, ACeS also has a Spacecraft Control Facility (SCF) which is in this case co-located with the NCC. But to focus on the network, we will not go into the details of the SCF.

Describing in a glance the main functions of the components, to make an outgoing call the UT requests service directly via the Garuda-1 satellite to the GW, which in turn provides the necessary resources and forwards the call to the ultimate destination outside (or back inside) the network. The NCC plays a more supervisory role in the system such as static resource allocation among gateways, although it is also involved in some aspects of call setup. All communications between the 4 major components of the system is channeled via the Garuda-1 satellite through L-band and C-band links.

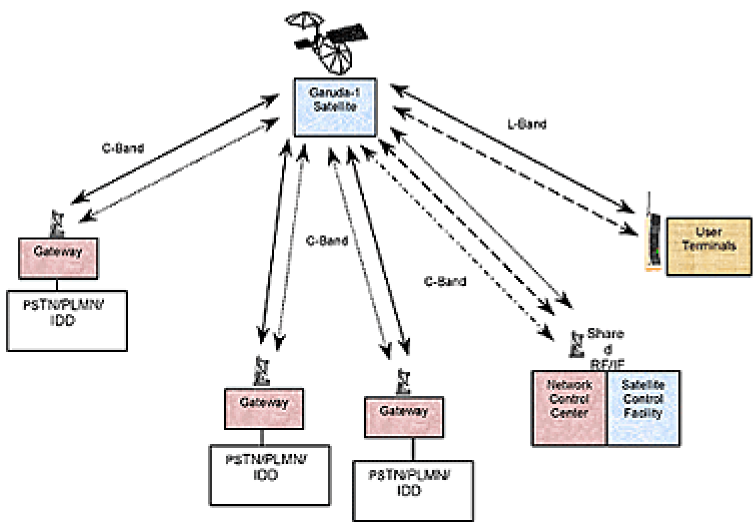

Fig. 1: ACeS System Architecture

The concept of a regional (as opposed to global) system allowed the Indonesian providers to use a single geostationary satellite for the whole network. A drawback of such a configuration is the relatively higher transmission delay that can occur in some cases but ACeS has proven since the start of commercial operations of the system that the modest lag time is acceptable to the users.

Garuda-1 Satellite

The Garuda-1 satellite is a vital element of the system. The specific purpose of the network made the spacecraft design unconventional. The most distinguishing characteristics are the relatively high aggregate L-band Effective Isotropic Radiated Power (EIRP) and sensitivity (G/T) which is mostly attributed to the 12-meter L-band reflectors. This on-board satellite feature allows reliable two-way L-band communications to small, low-powered user terminals. This high gain characteristic of the L-band reflectors also narrows the beam-width, thus 140 separate spotbeams were needed to cover the whole footprint.

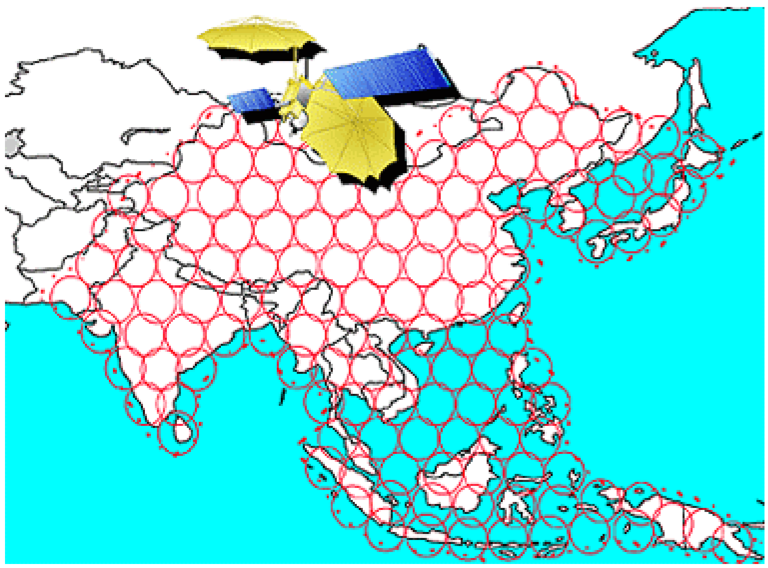

Fig. 2: Garuda-1 Satellite and its Footprint Coverage

On-board the spacecraft is another unconventional element, a real-time TDMA processor. This feature allows the TDMA/FDMA ACeS network to route single hop calls directly between user terminals through the Garuda-1 Satellite, therefore minimizing the voice transmission delay. The spacecraft is designed to handle 10,000 simultaneous calls and cover almost all of Asia.

Gateways

The Gateway functions mainly as the interconnection point to the external networks. Its architecture to some extent resembles a terrestrial GSM cellular network architecture. Going from inner side outwards there is the Traffic Channel Equipment (BTS equivalent), a Gateway Station Controller (BSC equivalent) and a standard GSM Mobile Switching Center (MSC). Most protocols and functions used in the system are adopted from the GSM standard.

The Gateway is also responsible for generating billing data, providing secure subscriber authentication and subscriber provisioning. It also interacts with the NCC to allocate dynamic system resources on a per call-setup basis.

This similarity with the GSM networks allows one very important feature, that is inter-operator roaming capability with terrestrial GSM networks. This enables ACeS system users to roam among terrestrial GSM networks when going outside the satellite coverage areas or into buildings. Similarly, GSM subscribers can also take advantage of the ACeS system using the ACeS user terminals. Seamless switching between networks is made possible with the dual mode (ACeS-GSM) feature of the ACeS user terminals.

User Terminals

The high-power characteristics of the Garuda-1 Satellite allows the implementation of low-cost, handheld user terminals with the shape, transmit power and receive sensitivity comparable to terrestrial cellular user terminals. At the beginning of commercial operations, the R-190 terminal was available as a mobile satellite terminal for the ACeS network which is similar to a GSM phone. The major difference is the directional right-hand circular-polarized antenna which makes the R-190 user terminal a bit bulky. The R-190 features dual-mode ACeS and GSM network capability and 2.4 kbps data.

The nature of satellite communications also requires the Garuda-1 satellite to have a direct line-of-sight path with the user terminal, thus making the R-190 only suitable as outdoor mobile terminals.

Fig. 3: R-190 (left) and FR-190 (right) user terminals

Another type of terminal was developed for fixed indoor use, the ACeS FR-190. With the main unit placed indoors connected to an outdoor antenna, the FR-190 also provides basic telephony and 2.4 kbps data.

Conclusion

With the availability of the R-190 and FR-190 terminals and the ACeS network, PSN is capable of deploying thousands of terminals throughout Indonesia in a relatively short time and at low cost as described in this article, including for Public Call Centers, for the USO and General Election projects and others, providing instant connectivity to rural Indonesia.