Microdesic network as the basis for WLL

Takeshi Shinohara Chief Consultant, Center for Knowledge Exchange & Creation, Nomura Research Institute, Ltd. Visiting Professor of Kyoto University,
Hidehiko Sanada Professor, Graduate School of Economics, Osaka University,
Shiro Uesugi Full-time Lecturer, School of Commerce, Matsuyama University

Abstract

In this paper, we consider how Microdesic network can become a basis for WLL where no such facility exists. A case study of wireless LAN in Japan is analyzed, illustrating how the mechanism of popular participation works. Following this, through the analysis of Moore's law and Gilder's Law the availability of Micordesic technology is predicted. Consequently, a "Vender Model" is considered in order to analyze the feasibility of Microdesic in rural areas. Our conclusion includes a policy proposal of *Laissez-Faire* regulation and the use of Microdesic network for closing digital divide.

Key Words

Microdesic network, Community Area Network (CAN), Vender Model, Participatory Development

1. Introduction

We envisage the use of the conceptual framework of Microdesic Network to develop an Internet and IP based network. Microdesic network is a synthesis of "Micro" + "geodesic" network, and a digital communication network, composed of routers working as each node geographically close to each other.

The problem of under developed infrastructure for Internet and IP-based network in African countries may be advantageous when a digital communication network tailored to convey digital data, is introduced. The low level of historical investment in the "old" telecommunication system may be an advantage as the sunk-cost in the industry is much less than that in countries such as Japan where the co-existence of old and new is becoming problematic.

However, this would only be realized under the condition that there is a balance between national and local results, successful in building infrastructure information. On the one hand, Macroeconomic factors should be taken into consideration on a national level and on the other hand, Microeconomic factors should be taken into consideration on a local level. The issue must be considered at two separate levels. Our consideration concentrates on the latter.

Our first task is to identify that Microdesic network provides a solution to building a digital communication network, which is compatible with Internet and IP-based at a local community level in Africa. Within a limited area, the "nodes" are placed in such a manner that they relay signals to neighboring nodes.

In order to examine and enhance the above argument, we will present a case study and we will provide a prediction of microeconomic feasibility of this sample case. Furthermore, we will present the policy consideration necessary for reflecting the advancement of technology.

The sample case we will deal with is the one of wireless local loops installed within a relatively small Japanese local community. By examining the case, we present the effectiveness of the provision of WLL with wireless LAN equipments. A cost benefit analysis will be presented.

As an application of this study, and furthering the idea of why Microdesic network is effective, we provide a time series analysis of decreasing prices of equipment and increasing capacity of nodes. This will result in a basis for future predictions on how Microdesic WLL would be constructed from a microeconomic perspective.

At the same time, we point out the challenge of managerial issues. As the Microdesic network requires participatory development of network, management of the network by the community is a core characteristic. Unlike building huge telecommunication infrastructure, Microdesic network does not need huge carriers. The users of the network are the owners of the network.

Finally, we propose a policy consideration, namely, *Laissez-Faire*, assignment for the frequency of very weak radio communication. This is essential for the argument and we will demonstrate why this is feasible.

2. What is Micordiesic network?

Microdesic network is a conceptual framework where all communication points are interconnected to all others and act as nodes. Each node communicates with other nodes in such a manner that the network realizes intra and extra communication without a central exchange switching mechanism. A main characteristic of Microdesic netowork is its dependency on geographical proximity. Microdesic being a synthesis of "Micro" and "geodesic," heavily depends on Shannon's first law and stresses the theory of "the distance between two nodes is closer, the bandwidth can be wider with lower level of power." [1]

2.1 Technologies

There are numbers of technologies that can establish the Microdesic network. For example, Wireless Routers and Terminodes [2] are typical technology which can realize the idea of a Microdesic network. Furthermore, Microdesic network technology is available to both wireless but wired systems. For example, power-line communication systems would create new kinds of electric home appliances that have the ability of both servers and nodes. They would communicate to each other to decide how much electricity the air-conditioner should consume when the compressor of the refrigerator is running. Ubiquitous network[1] that will be enabled by IP v.6 technology would realize this kind of micro-area digital communication network.

2.2 Sample case

We have been able to observe the "on-the-field" application of Microdesic network in the shape of wireless routers consisting of WLL. It was presented as a solution for the IP-phone system reported by KDDI at ITU-FG7.[4] The wireless routers used in the report were produced by the Root Inc. of Tokyo, Japan. Presently, Root Inc. is testing their RTB (Roof-Top-Box) technology in conjunction with optical fibers. In a suburban area of Tokyo, they provide PCMCIA card type radios and RTB nodes; each installed on PCs at home and on terminals of optical fiber on telephone poles. As only a few months has passed the test results are yet to come.

2.3 What comes next?

Technology will also create a leap in the arena of Microdesic network. The IEEE 802.11b standard seemingly provides a feasible Microdesic solution. With the number of venders increasing, there has been a sharp decline in equipment prices. The compatibility between different models has been on the increase. The data transfers are fast enough so to realize quality broadband digital communications.

The next question is how they will be installed so as to make them communicate to each other. Are there any ways to start smooth installation where engineering capacity is scarce? Are there any ways to raise money in order to procure equipment? In order to learn from past experience, we would like to present a story of people who employ wireless LAN system to build an Intranet in the countryside on one of Japan's islands.

3. A case study of Wireless LAN system in Nankoku City [5]

Nankoku City is situated in one of Japan's islands and is next to the capital of the Kochi-prefecture. It has a population of

[1] "Ubiquitous" means omnipresent or present everywhere. Thus, a "Ubiquitous network" is one in which every person or thing is connected to every other in a broadband network. [3]

roughly 50,000, with 17,000 households in an area of approximately 125 square kilometers.

In Nankoku City, major municipal buildings are connected by wireless LAN. These buildings include 13 primary schools, 4 junior-high schools and 18 municipal facilities. Using Wireless Local Loop (WLL) may not seem to be a new idea. If this is the case when planning was carried out by the municipal government with standard procedure, there would be nothing new to learn. But this case is different. The story behind how the Local Loop has developed is worth investigating. It is a story of how participatory development of WLL has been carried out.

3.1 Beginning

In September 24th and 25th in 1998 a severe storm directly hit the region. The record showed the rainfall to be well over 120 millimeters per hour. In one night, over 200 centimeters rainfall was recorded. Cars were washed out. There were 1,600 flooded houses. The economic loss amounted to more than 5 billion yen (approximately 45 million dollars).

The severe damage not only ruined lands and buildings, but also destructed lifelines including telephone lines. Luckily, those who could hook up to the Internet found themselves to be in a better position. Exchange of information over the net was, in many ways, better than talking over the phone. They could ask for help all over Japan as they appealed the situation to the public over the net. However, they had to face another profound problem -- access to the Internet. Those with access to the inter-university backbone (SINET) were able to retain their access to the Internet, but others could not.

3.2 Self-help

NTT was the only carrier existing in Nankoku City. People who used the public access line had no choice but to use a NTT telephone line to hook up to the Internet. Then, these Internet users bitterly realized that they could not communicate to each other even they were living in the same community. The bandwidth restriction imposed by NTT because of the emergency had worsened the situation.

This group of people, consisting mainly of heavy users of Internet, were very frustrated. “Why were long distance calls prioritized when it was important to gather information locally?” “Why was it taking so long to weaken local access restrictions?” These questions and vain efforts to solicit the company made them come to a decision: "Build own network for self-help."

3.3 Trial and error

At first, members who worked at universities and the college of technology came together to set up a working group in order to consider various, feasible technical solutions. Some of them knew the existence of packet radio technology. Thus, they invited experts of packet radio users group (PRUG), a non-profit organization in Japan, to give a talk on what the packet radios were. They also learned of a fainting technology of Spread-Spectrum radios.

After starting the construction, it was a series of trial and error. As they used equipment, which operated with 2.4 GHz ISM band, noise from electric appliances sometimes became a severe problem although overall performance of the connection was reported to be usable. In most of the points, average speed close to 2Mbps was observed. Setting antennae to the right direction was another challenge. Calculation usually does not work. Only many trials brought them too the right solution.

Later, there was a time when the network suddenly stopped working. When the members of the network looked for the cause, they found other groups in Nankoku City started using the ISM band in the same area and caused interference. In this case, they needed to check every possible cause.

What is important here is there are always predictable errors and unpredictable errors. Many predictable errors can be solved by merely rebooting the system but this requires the commitment and manpower of the users. In the case of unpredictable errors, professional knowledge is required, which usually they did not know a priori. It may be interesting to note that they believe the period of trial and error to be of great benefit. They say that solving the problem raised their skills of not only maintaining the network but also constructing a new network. Because they gained skills and knowledge from dealing with errors, they increased the capacity as a whole. This is similar to job training.

3.4 How to finance?

Firstly, they purchased Spread Spectrum radio with a subsidy for the sum of 500,000 yen (approx. 4,000 dollars) by the prefecture government. They purchased the 2.4 GHz ISM band Spread Spectrum radios (BR-200) made by ICOM Inc. with unit price of about 200,000 yen. Apparently, 500,000-yen was not enough. They provided whatever they had in hands, including bolt and nuts and poles for antenna, all the labor force, etc. As the result, they could complete a wireless connection between school and a house.

In the following year, they earned the national telecommunication research grant for the sum of 25,000,000 yen. They put more effort into expanding the network. They installed access points and repeaters. A grant of the same amount in the following year was also used to increase the number of communication points and upgrade their quality. By March 2000, they had installed 20 access points mutually connected via 3 repeaters, not only covering Nankoku City but also covering neighboring cities, and they have become the Experimental Council for Kochi City-size Area Network (KCAN).

Up to today, approximately 50,000,000 yen (about 400,000 dollars) has been spent to cover the construction costs. The amount has been mainly spent to purchase equipment and to develop software, which was designed to monitor the performance of the Intranet.

3.5 Current situation

KCAN is running well and the wireless network created by them is providing quality services for members. This is not all that they have achieved but they also had a significant impact on the local information infrastructure. City government was influenced. They even provided a seed for a new business.

Nankoku City government decided to introduce Intranet built on wireless LAN as it admitted that the system would be beneficial for disaster preparation and in wireless surveillance system of river flood. Nankoku City asked members of KCAN to construct a wireless LAN disaster preparation system. Citynet Inc. establised with KCAN since 1999 constructed the disaster preparation system for Nankoku City.

In addition, Nankoku City government decided to establish "Nankoku City Freenet" because they valued the utility of wireless LAN. They have utilized FY1999's Japanese government's subsidy, and succeeded in connecting all primary schools and junior high schools with wireless LAN. "Freenet" has become a municipally owned wireless network and is maintained by Citynet.

According to the president of Citynet, "Freenet" is a case of "killing two birds with one stone."

Firstly, the students at schools use the Intranet for daily Internet connection. There is no access charge or air charge that would have been required if they used another kind Internet access type. The students are enjoying the benefits of the WLL.

Secondly, the daily use of the equipment exposes them to daily testing. Remember that, the original purpose of the installation of WLL was to prepare for disaster. Testing the condition of the equipment daily is thus a very effective way in preparing for an unpredictable moment. Furthermore, schools are places where people gather if a disaster hit the city. The telecommunication system independent to carrier lines will serve as an alternative way to gather information within the city as they are inter-connected with each other.

3.6 Findings

There are a lot of things to learn from this case; including Merits and Demerits. Furthermore, there are cost-benefit issues and microeconomic issues. To begin with, let us summarize the *Merits* and *Demerits*.

Merits:

- High quality

  Wireless LAN system using Spread Spectrum radio and IEEE 802.11b system enables the user to enjoy a high-speed network. They can enjoy access as fast as 5Mbps communication within 2 kilometers.

- Low Cost

  Installations of a Spread Spectrum radio system, connecting stations far apart, costs within a maximum of 5,000 dollars. The cost of building LAN around the station is a few hundred dollars excluding the cost for personal computer terminals.

- Developing skills

  Experiences in maintenance help develop skills in digital networking. The expertise is so useful that it could enable people to set up a new business.

- Creating New Job

  As LAN is owned by the city and a number of people have started using the system, maintenance has become an independent business that creates new jobs.

Demerits:

- Maintenance needs

  Today's IEEE 802.11b systems and Spread Spectrum radio systems are not maintenance free. Hence, to maintain operation of the system, a lot of maintenance is required. Software has been developed to assist maintenance but still a lot of manpower is required.

- Bottleneck

  The present system operates using Spread Spectrum radios as a means to connect access points. This may cause the problem in making the radio station a bottleneck. However, once Microdesic network is present, the bottleneck will be resolved.

Cost-Benefit Issues

The total money put into the project amounts to less than 1,000,000 dollars for three years. KCAN utilized about 400,000 dollars. In contrast, the number of the users, including students, residents, and administration officials, comes to more than a thousand. They enjoy the benefits of broadband which is faster than T-1 services as well as the security from any disaster. The cost they had to bear for these benefits was (taking that only 1,000 people had benefited) about 90 cents per day.

Microeconomic view

Why is the cost performance so good? It is clear that without relying on the carriers, who are destined to pursue profits, total operating costs required for the network becomes smaller. The cost is shared among the users of the network. In other words, this type of methodology can be applicable to the place where traditional carriers are hesitant to invest because the expected payments from the potential users does not cover the primary investment. However, this case suggests that, as long as the potential users are willing to donate their manpower, the sunk-cost in traditional means is not a particular cause for concern. On the contrary people's willingness to commit is. Further analysis relating to this point is made in the following section.

4. Why Microdesic is useful?

In the prior section, we illustrated a Japanese case where popular participation was the key to the development of the WLL. We have seen that it was a cost-effective way and maintained a high level of quality.

In the following section, we would like to present a general principle, which indicates that Micorodesic type of network is a feasible solution where there is no digital communication infrastructure and the number of users expected is relatively small.

The discussion is presented in two folds. Firstly, we would like to discuss how far technology advancement would benefit to the ease of installation both economically and technically. The drop in equipment prices and the increase in capacity are still on the truck even after so-called "IT bubble" has been said to have burst.

Secondly, as a consequence of the trend that is illustrated above, a "Vender model" is presented as a feasible solution. Rural areas where ordinary carriers are hesitant to construct digital communication networks are suitable areas to this model and beneficial in creating a new kind of network without traditional carriers.

To begin with, let us review our preconditions. Our insight is dependent on two principles. One is the Moore's Law, and the other is Guilder's Law. It seems evident to us that the combination of both laws will provide the technologies and socioeconomic foundation that realize Microdesic network.

4.1 Moore's Law

In 1965 Gordon Moore, the co-founder of Intel, predicted that the number of transistors that could be packed onto a silicon chip would double every 18 months, making it cooler, faster, better and cheaper. In fact, the cost effectiveness rose by the square of the number of transistors that can be packed onto a chip. The effect has come to be known as Moore's Law.

Often Moore's Law is quoted as the indication and explanation for the intense increase of the integration of microchip circuit. In the original article, however, he stressed more clearly on the issue of cost effectiveness shown in the following quotation.

> " *Reduced cost is one of the big attractions of integrated electronics, and cost advantage continues to increase as the technology evolves toward the production of larger and larger circuit functions on a single semiconductor substrate. For simple circuits, the cost per component is nearly inversely proportional to the number of components, the result of the equivalent price of semiconductor in the equivalent package containing more components. But as components are added, decreased yields more than compensate for the increased complexity, tending to raise the cost per component. Thus there is a minimum cost at any given time in the evolution of the technology."*

> " *… The complexity for minimum component costs has increased at a rate of roughly a factor of two per year."* [6]

What is important, in relation to the Microdesic idea, is not only the power of the CPU per minimum cost grades up periodically, but also the cost of CPU in real term drops sharply at the same time. Hence, the abundance of CPU power could have been easily widespread economically while innovators of circuits having maintained the profit. Furthermore, it created the world, which has been filled by microchips to the extent that it is called "Ubiquitous network" will soon be actualized. In the world of Ubiquitous network, communication nodes would be everywhere and they will communicate to each other, realizing the world of Microdesic network.

4.2 Guilder's Law

In 1993 George Gilder, renowned commentator on the cyber-culture, predicted that total bandwidth will triple every year for at least the next 25 years. This has come to be known as Gilder's Law of "Telecosm." This law is inevitable for Microdesic because Moore's Law does not secure enough bandwidth to realize the world of Ubiquitous network. Gilder's Law of "Telecosm" is as follows.

> " *During the next decade or so, industry will go through a new technology wringer and submit to a new law: the law of the telecosm."*

> " *… Another word for communications power is bandwidth. Just as the entire world had to learn to waste transistors, the entire world will now have to learn how to waste bandwidth. In the 1990s and beyond, every industry and economy will go through the wringer again*." [7]

Even though Gilder discusses the case of fiber optics and does not pay attention to whether it can be applicable in the case of the nodes being near each other, he clearly forecasts the tremendous burst in communication bandwidth. Furthermore, he forecasts the increasing capacity of the computer, which is competent to this burst of the bandwidth. Gilder states:

> " *What this means is that while complexity rises exponentially with bandwidth, computer efficiencies are rising even faster. The result is to open new vistas of spectrum in the atmosphere as dramatic as the gains of spectrum so far achieved in the fibersphere*." [8]

What derives from his debate in conjunction with Moore's Law, is that we can obtain enough CPU power for communication network at the same time plenty of bandwidth are waiting for the consumption. In short, technically and economically, Microdesic network can be realized.

4.3 Generalization

The generalization of the conjuncture of Moore's Law and Gilder's Law can be stated as follows:

$$C \propto p / (t * n) \qquad (1)$$

where, C denotes *Capacity* of switch and/or router, p denotes unit *price* of processor, t denotes *time* need for generation alternation, n denotes *numbers* of ICs on one processor.

In other words, this is the expression of "the smaller the size of processor, the denser the integration is and the faster the generation alternation happens and the cheaper the price will be."

4.4 Vender Model

Let us move to present "Vender Model." As is discussed above, CPU powers will be plenty so as Bandwidth. Then, how are they going to be supplied, and who will in charge of providing them?

The short answer for "who?" is the "Consumers and Venders," and the short answer for "how?" is the participatory way. The term "Vender" here means the producers of the CPU and/or terminal. The "Vender Model", we are proposing, can be briefly stated as follows.

The "Vender Model" is the method of building a digital communication network, where no such network exists, in the manner that (1) Users of the communication network purchase the nodes, and (2) Users connect the lines by themselves. Consequently, the Vender Model will require onetime expenditure but it will not require future recovery of the investment by means of collecting access charge or air charge.

Hayashi [9] presented three models, which should be adopted in constructing information highway (Table 1). In the article he has presented, he predicted the future pattern of information highway's development, as the one that follows "User-Initiative," where he meant that carriers followed the demand and initiative of the users. Our idea of Vender Model is on the same line that Hayashi presented. The difference exists where our idea does not suppose the inclusion of common carriers.

(Table 1)

	Planning	Carrier-Initiative	User-Initiative	Vender Model
Plan	G & C	C	U	U
Build	C (partly G)	C (partly U)	C & U	U
Own	C	C (partly U)	C & U	U
Operate	C, SP	C, SP, U	C, SP & U	U
Environment	Mainframe	PC	Multi-Media	Multi-Media
	Hierarchical	Geodesic Network	Interconnection	Interconnection

Legend: G = Government, C = Common Carrier, U = User, SP = Service Provider

Adopted from Hayashi [9] "3 models for constructing information highway"

4.5 Explanation of Model

In the following, we will present a more detailed explanation. We adopt simplified structure of the telecommunication network where components are divided into two: nodes and paths. To simplify, we suppose that those are the only cost factors where *Cn* denotes cost per a node and *Cp* denotes total cost of path, other than the cost of switch *Cs*. Also we suppose there is no prior investment in the infrastructure.

Let us consider, firstly, the Carrier Model, where carriers invested once only and the system goes on forever, the cost of investment depends on the numbers of the line the switch can accommodate.

$$I\text{-}carrier = Cs + Cp\text{-}carrier \qquad (2)$$

where, I : total investment of Carrier Model, k : number of lines, and $Cs \propto Cs(k)$, $Cp\text{-}carrier \propto Cp\text{-}carrier(k)$.

Because the carrier needs to recover the investment from the yearly revenue (= R) from the users, they need to set R at the level of:

$$R\text{-}carrier >= r * \{ Cs(k) + Cp\text{-}carrier(k) \} \qquad (3)$$

where, r :discount rate.

As a matter of course, this is the simplest case disregarding all the cost factors other than the initial investment. In other words, a Carrier Model basically consists of three steps. They are:

1. Initial investment (I) by carrier,
2. Recover investment with yearly revenue (R) as well as earn profit (π) for the re-investment,

3. Re-investment for the enhancement of the capacity.

On the contrast, the Vender Model goes:

1. Initial investment (I) by users,
2. Free air charge, or no access charge,
3. Re-investment would be made when new users enter.

Therefore, it can be expressed:

$$I\text{-vender} = Cn * k + Cp\text{-vender} \quad (4)$$

where $Cp\text{-vender} \propto Cp\text{-vender}(k)$

If we compare (1) and (2),

$$Cs\ (k) + Cp\text{-carrier}\ (k) <> Cn * k + Cp\text{-vender}\ (k) \quad (5)$$

and we have

$$Cs\ (k) <> Cn * k \quad (6)$$

$$Cp\text{-carrier}\ (k) <> Cp\text{-vender}\ (k) \quad (7)$$

then

$$Cs\ (k) > Cn * k$$

since we suppose *(1)*, one large central switch costs more than integral costs of small and distributed nodes.

and

$$Cp\text{-carrier}\ (k) > Cp\text{-vender}\ (k)$$

since the length of paths required to connect to switch for *k* is longer than the case of nodes are connecting each other.

Hence

$$Cs\ (k) + Cp\text{-carrier}\ (k) > Cn * k + Cp\text{-vender}\ (k)$$

To sum up, it can be concluded that, unlike the traditional telecommunication network, where carriers need to invest a lot of money to switches and paths, the Vender Model requires less expensive investment in constructing digital communication network.

5. Policy implications

Once the Microdesic communication system is fully developed and available on the market, Vender Model will soon be a standard means to defuse broadband digital communication infrastructure. What is observed today in Japan -- a business model where service providers lend Spread Spectrum radio/ Wireless routers to subscribers and collect rents -- will not stand long because of the scarcity of bandwidth in metropolitan area. Their "First come, first serve" way is not a sustainable way as long as they rely on today's technology. Meeting customer's demand in heavily populated area will become more difficult.

However, in rural areas, where the population is scarce, bandwidth will not be a huge problem even in using today's technology. It is advantageous for those areas where there are not many electric appliances that create radio wave noise. However, if we foresee the future construction of rural area networks as a Microdesic network, we need to consider such policy environment issues as radio wave allocation policy. Furthermore, other policy issues will be presented such as; policy justification, and the policy to employ foreign aids.

5.1 Radio wave allocation

In order to prepare for the future use of radio wave, what Microdesic suggests is a *Laissez-Faire* policy. Microdesic does not have to be very cautious about interference due to the low energy level of radios. The radio wave resources shall become re-usable, or repetitively used.

5.2 Needs for Test-beds

Test-beds are necessary and are very effective to build human capital in networking engineering. In Nankoku City's case, as they had accumulated experience, they have decided to defuse their system to more rural area nearby. It is easier to defuse the techniques, which are experimented in environments where circumstances and climates are the same.

One of the difficult challenges in Africa pointed out is that a lot of severe scarcities exist along with economic capital. Furthermore, the climates are generally severe such that it is difficult for delicate machines like personal computers to survive.

To find out whch equipments are resistant to the environment, "Test-beds" are needed.

5.3 Participatory Development and ODA

Foreign Aid, Japanese Official Development Assistance (ODA) in particular, has played an important role in building telephony infrastructure in many countries, and will have a considerable role in assisting with building the Microdesic network. Japan's ODA is keen to look at the degree of people's participation when municipal governments are involved. In addition, training local engineers, who in turn train rural engineers maintaining the network and consult with users, could be covered by the ODA. In some cases, people may be sent to other developing countries where there are better conditions to learn from their experiences.

In proposing how Japanese ODA in the field of IT (e-ODA) policies should be tailored, Shinohara raised three approaches, namely (1) Aid for IT, (2) Aid by IT, (3) Aid with IT.[10] Among them, "(1) Aid for IT" is important because, in that, he stressed the significance of timing and intellectual support. Japan's ODA usually disbursed to recipient country's government or governmental bodies, and the disbursement takes a lot of time. Shinohara proposed to shorten the leading time and e-ODA should be disbursed to private sector as well. His argument is shown in the followings.

> "*IT implies as a wide range of concepts, from communication infrastructure, which is mainly a hard aspect, and intellectual aspects, such as applications and social systems. In order to allocate an ODA budget to the IT field, it is important to recognize that the innovation speed is significantly rapid in the field. This point is also important in aspects of related infrastructure. In the case of submarine cables, development by a consortium of communication carriers were normal, but currently, private cables are being introduced. When deciding the aid budget allocation to the terrestrial facilities linked to private cables, it takes half a year for the decision to be made. However, currently most decision-making is not proceeding smoothly. Furthermore, the speed of innovation in personal computers and other IT equipment is extremely rapid, and the value of this equipment changes every six month. In the case of ODA application to the IT field, the appraisal process and accounting system need to be modified. For example, it is necessary to declare that all appraisals conclude in three to six months.*
>
> *In addition, it is necessary to support national education, systems and policy making. Thus, knowledge is more important than hardware, and more cooperation is needed with private sector IT personnel and NPOs.*" [10]

This argument is important since it shows why Japanese ODA had been assisting carriers in developing countries to install large-scale systems. Here, "large-scale" implies to systems such as PHS based WLL within relatively densely populated area. The points are, in short, the recipients were restricted to the government or quasi-governmental body (i.e. not private), and the long lead-time for installation makes only well developed large-scaled technologies be available for receiving Japan's ODA.

Good news is that Japanese foreign ministry is requesting the financial authorization of a budget with a total sum of 7.5 billion-yen (approximately 60 million dollars) for the promotion of e-ODA. Considering the utilization of these budgets may be one of solutions for gaining initial investment.

6. Conclusions

Microdesic network will be one of the solutions to solve the problem of digital divide in Africa by enabling participatory development of digital telecommunication network. It may take some time before maintenance free equipment is available on the market. Hopefully, it shall not be long before we have it according to what George Gilder tells us, and what we learn from the generalization of Moore's Law and Gilder's Law: *"The smaller the size of processor, the denser the integration is and the faster the generation alternation happens and the cheaper the price will be."*

We envisage the world of Ubiquitous network, where Microdesic type of network connection is dominant. Ubiquitous network will bring about a paradigm shift from PC centered world to non-PC world. Telecommunication appliances will also be benefited by the shift. The future Microdesic terminal will not be in the shape of what we recognize as computers. Furthermore, Ubiquitous network will create new mechanism in such field as the production system, the distribution channeling, and the consumption. It will not be limited to only the field of ICT but also be inclusive all the imaginable circumstances of the daily life, regardless of rural or metropolitan, rich or poor, well advanced or developing.

The experience in Nankoku City in Japan tells us that it is feasible to realize a participatory development of wireless LAN even today. From what we call "Vender Model," we predict it will be the economically feasible way to construct digital communication network where presently no such facility exists.

For the first instance, it will be worth considering use of Foreign Aid for the purpose of creating "Test-beds." The Test-beds will, in turn, become a source of human resources and origin for defusing new technologies.

7. Acknowledgement

Part funding of this research was provided by Matsuyama University's Special Research Grant for FY2001. Special thanks to Professor Kazumasa Imai at Kochi National College of Technology for providing information about KCAN and Wireless LAN system in Nankoku City.

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9. WEB sites

http://www.terminodes.org/

http://www.icom.co.jp/

(The followings is in Japanese)

http://www.kcan.ne.jp/

http://www.musen.net/

10. Appendix

Major nodes and paths surrounding Nankoku City

(http://www.kcan.ne.jp/map.html)