Spectrum Managements and Universal Service Considerations for Ubiquitous Society

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ABSTRACT

In this paper, universal service of mobile networks is analyzed by the questionnaire survey, and survey suggested the user demands for mobile universal services are very high. Second, number of users per each mobile base station is analyzed and the problem on universal service capability of ubiquitous networks is discussed from the view point of cost imbalance. Considerations on cost imbalance suggest that the spectrum utilization strategy should be reorganized. Finally, the future strategies of spectrum utilization are proposed.

1. INTRODUCTION

"Ubiquitous networks" and/or "Fixed Mobile Convergence (FMC)" are the important concepts for the future social activities after the "Fixed Broadband". Ubiquitous networks are the synergetic combination of the IP core networks and mobile broadband access, and supports all the social activities of future human beings for their happiness and cultural progress. So the media convergence to ubiquitous networks requires the considerations on the universal service support for the next coming society. Photonic technology, i.e. no band limitation, is the solutions for the fixed broadband. On the other hand, for broadband mobile system, spectrum resource managements is inevitable to overcome the limitation of spectrum resources. Especially, the universal service consideration and the spectrum managements are the keen issue from the viewpoint of the social and natural science.

In this paper, first, user demands for universal mobile service are analyzed from a questionnaire survey. Second, number of users per each mobile base station is analyzed and the problems on universal service capability of ubiquitous networks are discussed from the viewpoint of cost imbalance. From the results of them, some schemes of spectrum utilization strategies are proposed.

2. USER DEMANDS ON UNIVERSAL SERVICES

This questionnaire survey is executed in Jan. 2005 to the 26 persons aged 18 to 58 and average is 25 years old.[2] Figure1 shows the interest for the universal service. Term "Universal service" is known well to the 80% persons, but the details are not known for almost all of persons. In Japan, universal service funds are settled for the fixed telephone service and NTT has responsibility to serve them. However, almost all of the person didn't know the fund and scheme. This universal service fund framework is reconsidering now. [1]

Figure 2 shows the universal service criteria, such as what is universal and what is the universal service. From the answer, "Any where (Ubiquitous)" is the most universal criteria that is agreed by more than 90% persons. Next criteria is same price. Easy to use or digital divide by skill is not a universal criteria, and more the 70% think that easiness for aged person is not important for universal service. For question of "what services are universal? ", voice communications is first opinion, and second opinion is Internet communications such as mail and web browsing. Emergency call is not so important universal service from the answer, and half of the total person is not aware of the emergency call.

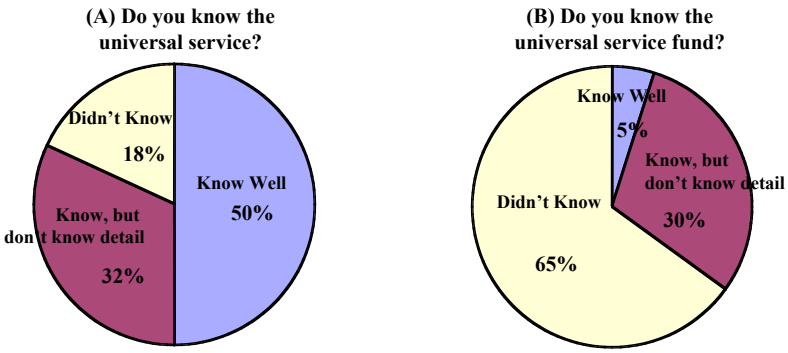

Fig.1 Universal Service Interest

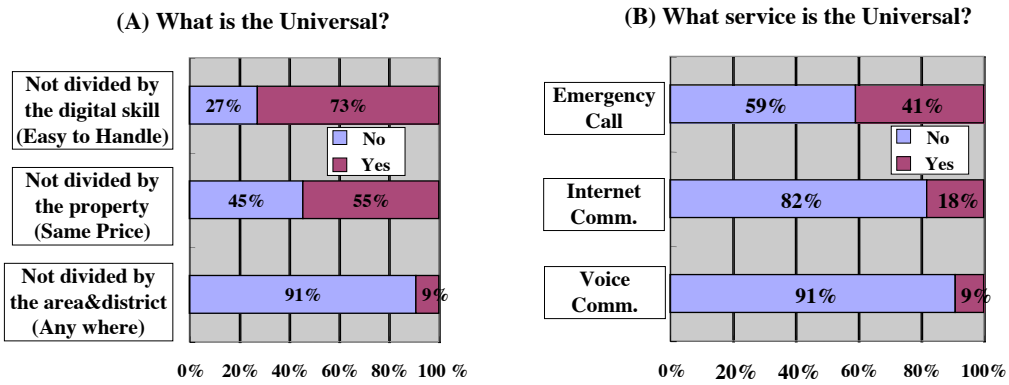

Fig.2 Universal Service Criteria

Figure 3 shows the universal service elements in detail. Answering options are "yes in future", "yes now" and "no needs". From the answer, universal service demands for personal voice communication is high rates, such as home phone and mobile phone. Business items are low rates, such as Public Switched Telephone Networks (PSTN) for business and leased circuit. Also the demands for low speed fixed digital service, such as Integrated Service Digital Networks (ISDN) are no interest, because of ADSL etc. On the other hand, low speed item with mobility is inevitable, such as email and web browsing on mobility, now. And in future, wireless broadband communication requirements show higher rates than fixed broad band. 3G mobile and hot spot service demands are high and havae same level rates. More than 70% persons require wireless broadband service should be universal in future.

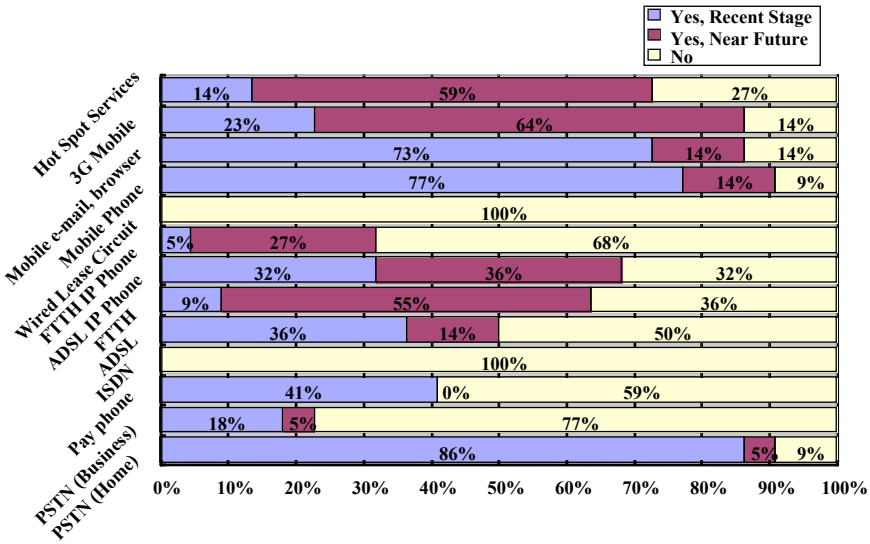

Fig.3 Universal Service Elements

3. PROBLEM TO BE SOLVED

3.1 Considerations on Cost Imbalance

Existing geographical data of Japanese domestic regions is summarized in Table.1. Gross area size, number of mobile base stations (MBS) and user terminals at the end of 2004 are shown. These data are web based.(3)(4)

From these basic data, service area size per MBS can be derived. Figure 4 shows the service area size of mobile phone system. In the rural area, area size is 3 to 6 times wider than the urban area. In the mobile phone system, area extension is easier by using the macro cell operation at this stage. Macro cell operation loose spectrum utilization efficiency, however it is allowable for rural area, because the mobile phone subscribers are few.

On the other hand, wireless broad band (wireless BB) requires wide band operation, as the result, it should be reduced the service area size. If the service area size is reduced to the ordinal rate of 2km^2, number of MBS should be increased in the rural area. Calculated results of required MBS for wireless BB is shown in Fig. 5. All over the domestic region in Japan, except for Kanto, Tokai and Kinki, number of MBS should be increased to 2 to 6 times comparing with the existing mobile phone system. In this analysis, it is assumed that the additional spectrum allocation for wireless BB is fully allowable for urban area. However the additional spectrum allocation is difficult and limited in real case, the cell size reduction should be more severe comparing with the calculated results. This problem is treated in the next section.

From the results of required MBS calculation, number of users per MBS is derived . Figure 6 shows the number of users per MBS, and existing mobile phone system and wireless BB are compared. This calculation is based on the optimistic assumption of number of users in wireless BB, and the same users will be gained in the rural area as that of existing mobile phone service. Figure shows that the cost imbalance spread more wide for the wireless BB.

Now mobile phone cost imbalance is compensated by the operator, however the cost imbalance of wireless BB is very difficult to compensate by the operators, because the imbalance becomes twice to 6 times larger than the mobile phone. This is why the universal service consideration is necessitated in future mobile system.

Table 1 Basic Data from Web

Dec-04	Gross Area (km^2)	Number of MBS	Number of Users
Hokkaido	83,408.96	5,646	3,573,870
Tohoku	62808.47	6,274	5,642,181
Kanto	35896.73	21,567	32,144,941
Shinetsu	23253.64	3,358	2,462,705
Hokuriku	7176.06	3,008	1,966,913
Tokai	28183.55	14,218	10,668,497
Kinki	27142.3	13,585	14,911,714
Chugoku	31712.64	6,409	4,875,812
Shikoku	18780.03	3,752	2,554,810
Kyushu	39737.03	9,909	8,337,692
Okinawa	2,262.81	1,047	809,622
Japan Total	373,723.76	88,773	87,948,757

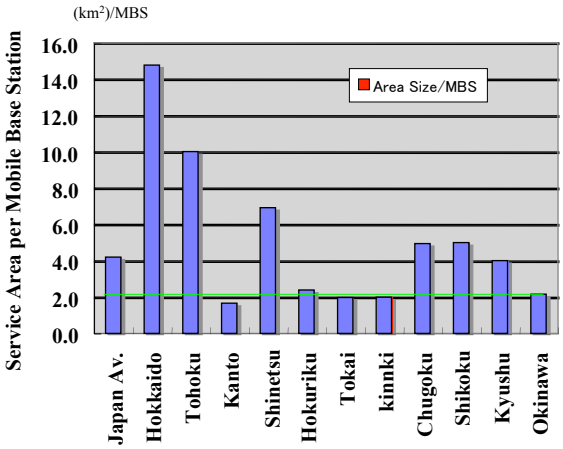

Fig.4 Service Area per Mobile Base Station

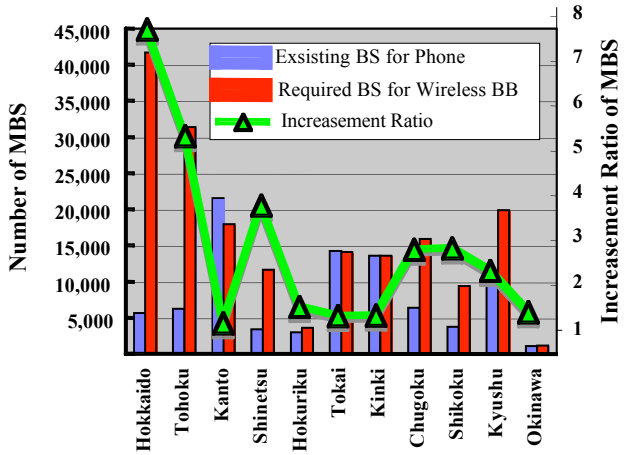

Fig.5 Required MBS for Wireless BB

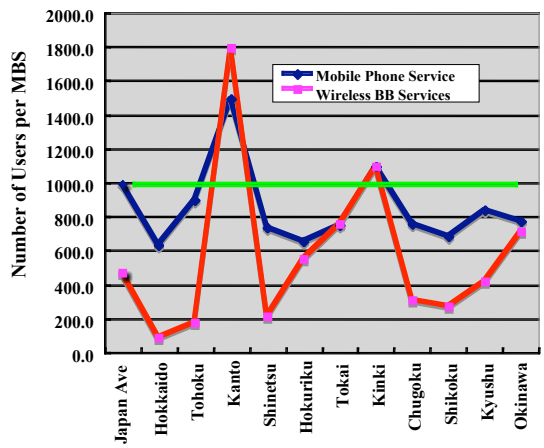

Fig.6 Number of Users per MBS

3.2 Spectrum Resources Limitation and Spectrum Management

Another problem is spectrum allocation and allotment. Existing spectrum allotment strategy is the (a) homogeneous and (b) exclusive. The word "homogeneous" means same operation frequency in the urban and rural area. The word "exclusive" means the spectrum is allotted to the operators, by partitioning all bandwidth into number of operators.

Wireless BB requires wide band operation capability. As mentioned in the previous section, wireless BB requires imbalance compensation in the rural area, if we consider the same bands are allotted. If the higher frequency band 2GHz or 5GHz are allotted, imbalance becomes larger. So, the spectrum management should be essential in the ubiquitous network society.

4. PROPOSAL

As mentioned before, spectrum utilization strategy should be changed to satisfy the universal service considerations. Figure7 illustrates the proposal. Option A includes heterogeneous frequency band operation, and common band operation in the rural area. Reorganization and common use of 900MHz bands are necessary, in this option. Another option, option B utilize same frequency band in rural area, i.e. Homogeneous operation, however

the MBS and network infrastructure is commonly used. In this option, framework of equipment common use should be set up. For this operation, SDRN (Software Definable Radio Networks) is effective for its flexibility of air interfaces. [5][6]

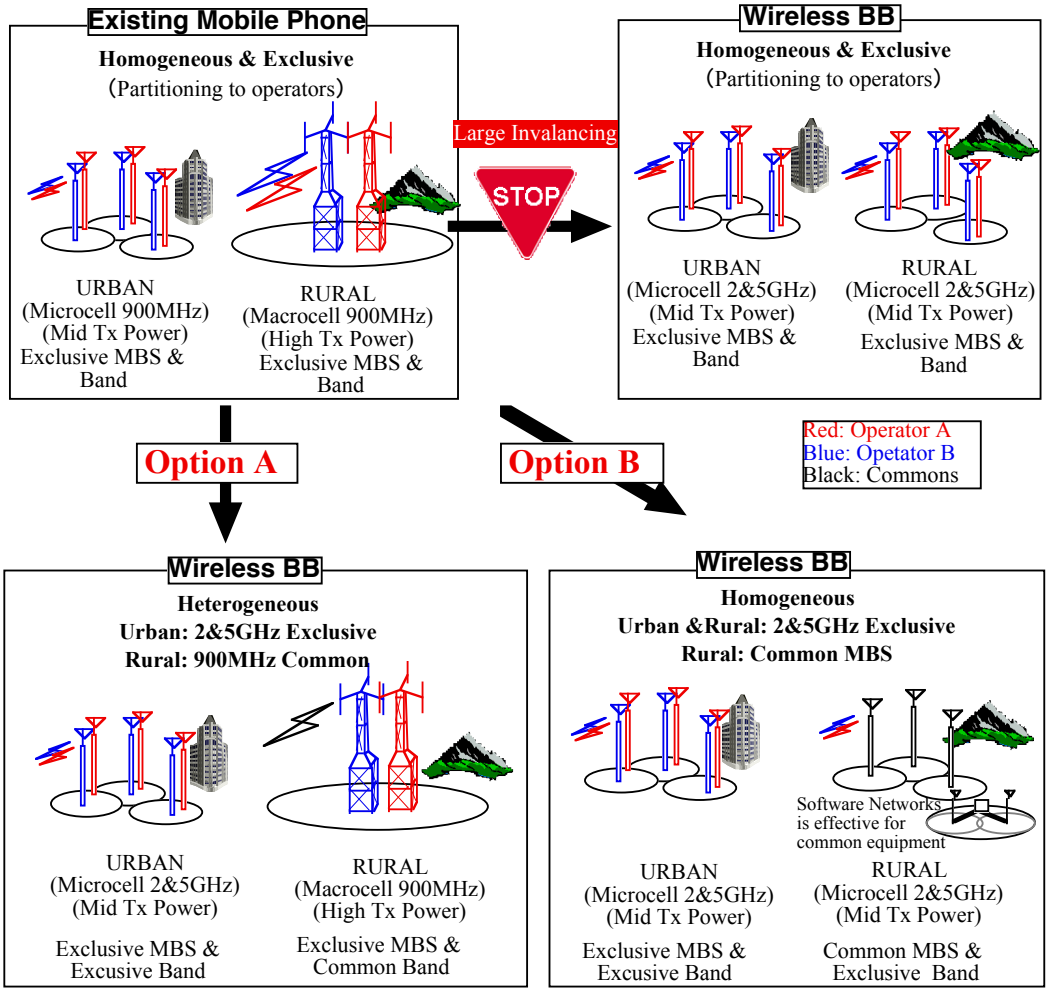

Fig.7 Proposal for Spectrum Utilization Strategy for Ubiquitous Network Society

5. CONCLUSION

This paper analyzed the universal service of the mobile systems, and suggested that the universal service consideration on wireless broadband networks is inevitable in FMC and/or Ubiquitous Network Society. Cost imbalance of urban and rural will be more severe in the next generation, and the spectrum utilization strategy should be changed to reduce imbalance. Some utilization strategies are proposed, such as heterogeneous frequency bands operation depending on urban or rural area, and common use of frequency bands and/or mobile base station equipment.

ACKNOWLEDGEMENTS

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