BEYOND 3G: FROM 3G TO SEAMLESS INTERTECHNOLOGY WIRELESS NETWORKS

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1. LESSONS FROM 3G

During the recent four years, the total cellular customer based in Japan achieved a net growth of 10 million each year. As of January 2003, the mobile phone subscription in Japan was 74 million[1]. The expansion of mobile communications so far has been led by the growth of voice usage. However, we need to generate new demands for mobile communications to further expand the market. Fortunately, the use of the Internet is increasing rapidly and the Internet has become an essential infrastructure for communications. Thus, we have been taking the challenge to combine mobile communications with the Internet, and developing it into a mobile multimedia service, which can handle not only voice and data but also image communications. Let us call it "Mobile Multimedia Frontier." In view of Mobile Frontier, NTT DoCoMo launched W-CDMA network(i.e., IMT-2000 network) in 2001. That network allows 384Kbps packet switch connection for down link and 64Kbps circuit connection that is N-ISDN compatible, while DoCoMo's 2G network provides 28.8 Kbps packet switch connection. As a result, DoCoMo now operates dual generation mobile networks.

Slide 2 summarizes lessons from the 3G Networks including NTT DoCoMo's IMT-2000(see also [1] for furher technical and political discussions.) As for the 3G Network, it is said that no significant eye- or ear-catching services have not been emerged yet. It could be true, but take a look at our future plan, for which Slide 3 shows the current and anticipated mobile multimedia services over 2G and 3G networks. The multimedia mail is now becoming one of killer mobile applications next to e-mail and web browsing in 2G and 3G. It is noteworthy that in early 2003, penetration of camera phone handsets have topped the 5 million subscribers mark, less than eight months after DoCoMo's picture mail service was introduced. We need not to be pessimistic about killer applications. In Slide 3, there shall be a way out of those absence.

[1]For the current numbers, see http://www.tca.or.jp/index-e.html

2. SERVICE UBIQUITY AS ESSENTIAL

There would be two principles for creating killer applications. One is to follow what successfully happened in the legacy Internet. E-mail and web browsing are typical examples, although that way is not innovative. The other one is to recognize what value 'mobile' adds. Most of todays envisioned business opportunities for wireless Internet access involve big applications such as stock-trading and multiplayer gaming that have already found homes on wired, desktop computers. Billions are being sunk into new wireless venture committed to taking over these markets before innovators have a chance to learn what applications wireless is really best at delivering[2]. Please recall Sony's Walkman^{TM} debut. In a world where mobility has become a constant in our lives, LSI and exquisite miniaturization technologies had prepared an environment in which SONY's disruptive innovation could emerge. Generally speaking, no one knows a killer application before it emerges. From the viewpoint of R&D, there should be one essential direction. That is to provide an incubation environment for disruptive innovations. In my opinion, that is to prepare "service ubiquity" for portable devices and networks. Cell phones eventually will be equipped with 1M pixel CCD built-in cameras, VGA full color displays, and more than 100KB footprint size Java program download and 10MB working memory area for that. That will be more than PALM^{TM} and rather comparable to i-PAQ^{TM}. We have 2G and 3G networks now, and Wireless LAN is available. However some technological aspects are still missing in terms of 'ubiquity'. We would like discuss those in the following section.

3. 4G IMPERATIVES

There have been many interpretations about the fourth generation (4G) mobile network. According to the ITU-T vision, it can be summarized in Slides 6 and 8. Very recently, ITU-R WP8F has approved the Vision PDNR (Preliminary Draft New Recommendation) which defines the vision, framework and overall objectives of the future devel-

opment of IMT-2000 and systems beyond IMT-2000. The vision describes that the systems beyond IMT-2000 will be realized by functional fusion of existing, enhanced and newly developed elements of cellular systems, nomadic wireless access systems and other wireless systems with high commonality and seamless interworking. As targets for research and investigation, it is predicted that potential new radio interface(s) will need to support data rates of up to approximately 100 Mbit/s for high mobility such as mobile access and up to approximately 1 Gbit/s for low mobility such as nomadic/local wireless access, by around the year 2010. That is ITU-R's definition on the 4G Network. DoCoMo has shared such a view and is devoting comprehensive R&D efforts to the realization. Slide 5 summarizes DoCoMo's R&D activities related to the 4G network.

Here, let us define a more specific description of the 4G network that realizes the abovementioned service ubiquity, through the following discussion on *4G imperatives*. Those are *Radio Access Network(RAN), IP Network, and Ubiquitous Service Platform*. As for the RAN, we need a 4G radio access network as already shown in Slide 6. Please note that *Spectrum will remain the vital resource.* The existing Wireless LAN(WLAN) such as IEEE802.11 could be a complement to the current cellar networks though, WLAN itself is primarily a lap-top medium. To ensure the "connection ubiquity", the network architecture must be heterogeneous rather than homogeneous including wireless access networks. The heterogeneity of RAN will bring much more choices to customers to meet their preferred requirements individually. On the other hand, however, a conventional operator's architecture may face a difficulty to connect all radio access networks in an efficient way. To simplify the network that connects various radio access networks and not primarily to decrease costs but to enable services, true convergence with the Internet is critical. The point is to remove discontinuities at the wired/wireless interface and the data/voice interface. The Internet must also evolve to support wireless mobility and ubiquity efficiently as described in Slide 7.

Let us recall the lessons from 3G. We need killer applications over emerging mobile wireless networks, and thus bare the 4G imperatives. Please note that *4G network should be defined in terms of applications, services and markets not purely by air interface protocol, IP backbone or bandwidth.* The essential direction, which has been left insignificant in 4G imperatives, is 'ubiquity' as indicated in Slide 10. The word "service ubiquity" is to signify a coherent set of characterizing concepts: seamlessness in mobile subscriber and third party service provider experience; heterogeneity in wireless access networks, backbone networks, mobile terminals, as well as applications; openness in terms of allowing and supporting third party service providers to deploy and compose any kind of application services such as web services, and mobile users to engage in all kind of Internet transactions and services with appropriate trust and security relationship management support and open interfaces support.

As listed in Slide 9, we need additional technical elements of programmability[2] , Open APIs, AAA, mobility and ' plug and access' functionality. Let us call such a framework as "Ubiquitous Service Platform." Then a platform is expected to market comprehensive wireless Internet services to consumers, manage mobile subscribers, and offer them seamless services across heterogeneous wireless systems, networks, applications, terminals, and service providers at anytime in anywhere by anyway with minimum investment on infrastructure by using all possible resources.

Please note that the Internet has taken a sand glass/hour glass protocol model as depicted in Slide 11. Only IP is the single network layer in TCP/IP networks, where multiple link layers and transport/session protocols, and diverse applications are accommodated. That simplification has contributed to the wide range of connectivity. The technical challenge for us seems to create a simple ubiquitous service protocol layer. That may bring us a 4G funcional leap with the second waist that contributes to wide availability of services.

4. CONCLUSION

We have discussed lessons from the 3G network, where killer applications should emerge. Candidates are enhanced web access, and multimedia mail, Java-enabled applications. "Service ubiquity" is identified as the essential direction to prepare an incubation environment for future disruptive innovations. We have discussed 4G imperatives. Those are 4G Radio Access Network, IP Network, and Ubiquitous Service Platform. 4G should be defined in terms of the ubiquitous service platform, not purely by air interface protocol, (IP) backbone or bandwidth. 'Ubiquity' is the key word to go further beyond 3G.

We hope that future generations of wireless networks will provide virtually unlimited opportunities to the global, connected community. Innovations in network technology will provide an environment in which virtually anything is available, anywhere, at any time, via any connected device.

5. REFERENCES

[1] Lee Garber, "Will 3G Really Be the Next Big Wireless Technology?", Computer, Jan., pp. 26–32, 2002.

[2] Clayton M. Christensen, "The Rules of Innovation", Technology Review, June, pp.33–38, 2002.

[2]This does not equal "active networks" a la DARPA.