

Future Broadband Mobile Services

Introduction

1. Over the past ten years, the rapid deployment of emerging information technologies, including mobile communications and Internet services, has had a great influence in changing our daily lives, and it continues to influence and affect our lives. It has brought about the innovation of conversion from analogue to digital in telecommunication media, the expansion of temporal and spatial casualness of information transfer by means of mobile technology, and the advancement of lifestyle for more Internet-based information. This aspect has been accelerated along with the emergence of new IT visions and paradigms such as ubiquitous networks, pervasive computing, and ambient intelligence. The trend is expected to stimulate the development of progressive information technologies beyond the current technical focus on fully mobile and widespread convergence of media. In the future vision of the “highly developed ubiquitous information society”, information technology is supposed not only to take part in information exchange but also to provide the key drivers or enablers for improving the quality of individual lives and social relationships.

Workspaces on broadband mobile multimedia

2. Broadband is a basis for enabling multimedia communications including video service. Technology development on mobility and bandwidth enhancement is nearing completion and integration of various services such as broadcasting and wireless packet access technologies is well under way. Recently, a strong trend of convergence known as “IP goes mobile and mobile gets IP” has surfaced. This widespread convergence technology enables virtual reality communication, distance learning, remote medical services, security and remote monitoring, distributed multimedia collaboration and teamwork/tele presence and many other applications surmounting spatial distance. IP provides inherently good interoperability, such that a barrier-free connectivity can easily be achieved. Technology development is greatly influencing people’s work and social lives, and it will ultimately lead to standardization of a highly technical culture and society in the future. New jobs will be created, and many applications designed to improve personal efficiency will be deployed.

Entering the ubiquitous information society

3. Advancement of user service technology based on the widespread convergence of broadband and mobile multimedia capability creates another breakthrough when it is combined with the new technological advancement of intelligent service application and micro/embedded device technology. These two technological trends produce synergistic innovation of basic communication models. Terminals and sensors are becoming the major source of data, and context-aware services are becoming common with a wide spread adoption of intelligent applications. These new challenges could bring about a new paradigm of ubiquitous information service. Ubiquitous service refers to the maximization of users’ convenience by means of user-centered, seamless services and the utilization of widely distributed resource and information. Many types of national-

scale intelligent application services are expected to be introduced, such as personal identification and public control, social resource monitoring, road and traffic sensing, and national territory monitoring, etc. Various technologies from different areas of IT will enable such changes to come about, but in mobile communications, which will act as the core infrastructure, multimedia services will be added to the existing voice services, migrating to IP-based network infrastructure, wireless Internet will be enabled, and a fourth-generation mobile communication environment that will provide large data transfer capacity.

Key technological issues and ongoing activities

4. Future broadband mobile communications aim to provide **seamless services** for all types of mobile communication services regardless of network or handset type. This is expected to be achieved through IP based networks that support portability for seamless interoperation between different networks. The evolution to all-IP networks in mobile communication to enable the services that can operate in different networks will become an important issue for the future broadband mobile communications and the development of the Internet.

5. A multimedia service that provides voice, data, and images services through wired, wireless and satellite environment and a global roaming service that can transmit all over the world are the concepts behind the 3G mobile communication system. The existing 3G systems were aimed at achieving global roaming through uniform worldwide technological systems and bandwidth frequency. The future broadband mobile communication system aims to achieve a seamless global roaming service through inter-system handover designed to enable handover between different technological systems and different bandwidth frequencies.

6. One of the biggest problems in providing wireless service to fast moving subscribers is service continuity. The future broadband mobile communications set the goal of ensuring high frequency efficiency and high transmission rate to a moving terminal at a low price, and providing various types of quality of services (QoS), etc. A key technology such as fast handover algorithms is required in order for future broadband mobile communications to provide fast-moving terminals with seamless service in a micro/pico cell environment. R&D of micro/pico cell structure to enhance the frequency efficiency and provide high data transmission rate are currently under way.

7. The communication service market recently moved rapidly from voice-centered service to data-centered service. Fast and high-quality IP based multimedia service is expected to become common in the future. In order to process the increase in data traffic, investments in super high-speed communication systems is needed, and the need for expansion of the fundamental technology for the development of the radio transmission system cannot be over-emphasized

Innovative wireless technologies

8. Recently in 3G communication technology, SDR (Software defined Radio), which started from the concept of programming of base band signal process, is gaining importance as a way to develop a multi-bandwidth/multi-mode system. The concept of

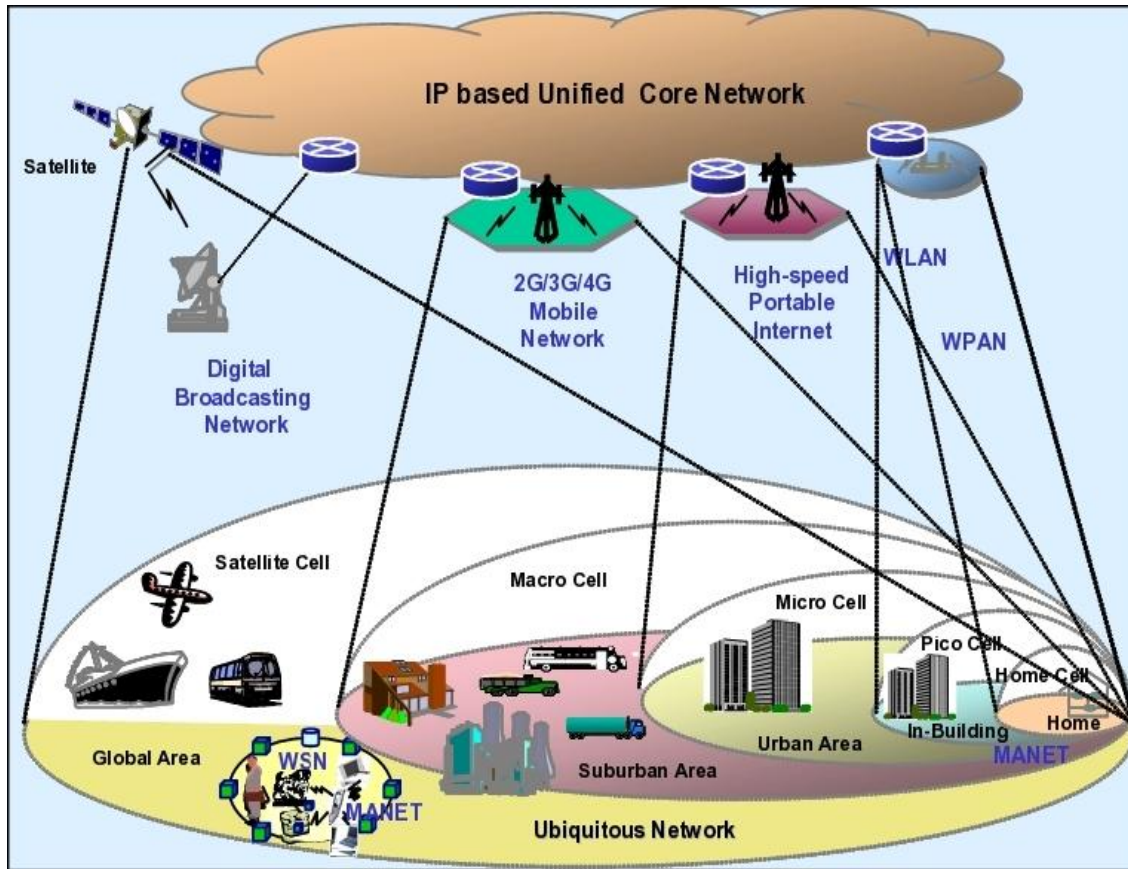
SDR is a technology that enables a system composition that can be applied to both the existing and the new system standards by using recomposable parts such as the high-speed digital signal processor, field programmable gate array (FPGA), to enable processing of signals from base band to RF/IF signals. The SDR technology that makes seamless global communication possible by allowing object-oriented structure application software to be downloaded on the open unified hardware platform for establishment of a system that is flexible and applicable to various wireless environments, is considered a system technology that can provide multi-standards, multi-processing frequency, and various services by enabling a single system to accommodate the various existing standards in the mobile communications market. The introduction of SDR technology into a commercial system has already begun and the interest in SDR is increasing as the worldwide SDR standardization organizations are formed in Europe and the United States.

Broadband mobile convergence network

9. Many mobile operators worldwide have started to deploy 3G wireless networks. Broadband connectivity of up to 2 Mbit/s, terminal mobility and multimedia services will provide a substantially wider and enhanced range compared to 2G systems. It is an appropriate time to look beyond 3G and search for breakthroughs that will bring true broadband mobile wireless technologies. The vision of future mobile networks in the converging environment will be the provision of broadband access, seamless global roaming, widely available multimedia, and utilization of the most appropriate connectivity technology. Over the next 10 years, the application of smart, embedded computing power in everyday objects and places will be the next major area of focus.

Concepts and characteristics

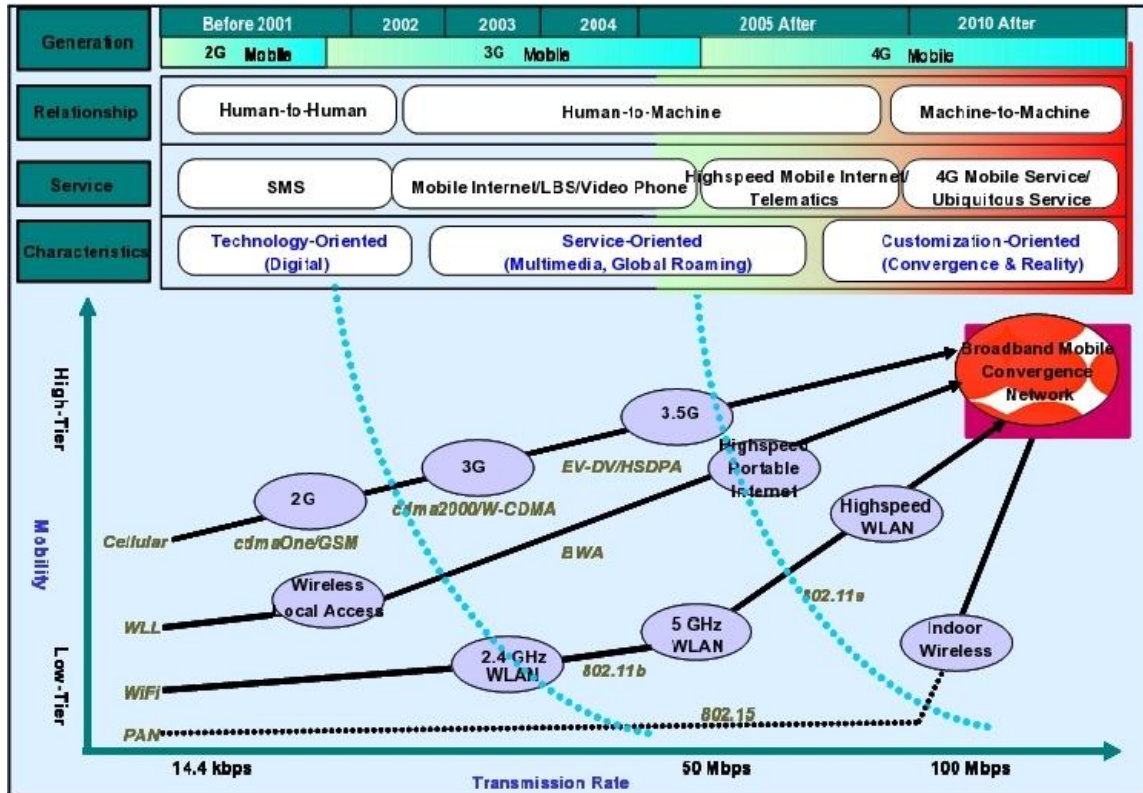
10. The concept of convergence refers to creation of the environments that can ultimately provide seamless and high-quality broadband mobile communication service and ubiquitous service through wired and wireless convergence networks without spatial and temporal constraints, by means of connectivity for anybody and anything, anytime and anywhere. Convergence among industries is also accelerated by formation of alliances through participation in various projects to provide convergence services. Various mobile wireless access systems will coexist to provide integrated services. Satellite, cellular, WLAN, digital broadcast, and other access systems will be connected to provide integrated and seamless services via a common IP-based core network. The heterogeneous access systems may be organized in a layered structure according to their application areas, cell ranges, and radio environments. This allows flexible and scalable environments for system deployment. Seamless Interoperation between the different access systems will be performed by vertical handover or session continuation. Starting from the home cell with coverage in private buildings such as a house or office to public hotspot locations such as airport, train station, conference center, and service may be provided through an access point. In a hierarchical multi-layered cell environments, extra intelligence is required so that the network can find a specific terminal or the terminal can determine the boundaries between wireless networks and switch to the most appropriate one.



Configuration of Mobile Convergence Network

Visions and directions

11. The idea of 3G became evident with the need for more capacity, new frequencies, and higher data transfer rates. In order to discover new growth sectors in the area of future mobile information communications, many active research projects on next-generation broadband mobile communications are being conducted by related international organizations or research centres such as the Wireless World Research Forum (WWRF), the Next-Generation Mobile Communication Forum (NGMCF) in Korea, and the Mobile IT Forum (mITF) in Japan. The objective of the WWRF is to formulate visions among industrial and academic circles on the direction of future strategic research in the wireless fields, and to generate, identify, and promote research topics and technical trends for mobile wireless system technologies. Also, cellular communications providers and carriers have been taking part in the Third-Generation Partnership Projects (3GPP and 3GPP2), which are revisiting the design of third-generation networks with the goal of enhancing IP mobility-related solutions to deliver seamless mobility without impairing cost effectiveness, application flexibility, and transparency of IP technologies. Currently, 3GPP and 3GPP2 are working at developing harmonization for converged IP-based mobile communication networks.



Visions for broadband mobile communications

Enabling mobile network technologies

12. Mobile communications have evolved from the first-generation analogue system to second-generation systems such as CDMA and GSM. Now, the third-generation IMT-2000 system has begun to provide a high quality multimedia service and global roaming. Despite the delay in the commercialization of IMT-2000 services due to the worldwide economic recession, next-generation mobile communication technology is being anticipated with enthusiastic interest. Next-generation broadband mobile communications, so-called fourth-generation, or beyond third-generation, is a system that will be able to provide diverse multimedia convergence and ubiquitous service.

13. The ITU Radio Communication Sector (ITU-R) has a working group (WG) to develop a vision and technology roadmap for IMT-2000 and system beyond IMT-2000. The vision for the future development of IMT-2000 as an evolutionary phase is that there will be a steady and continuous evolution. IMT-2000 systems are being enhanced and many will incorporate an ALL-IP network and mobile wireless access will offer increased capabilities such as transmission speeds up to 10 Mbit/s. In conjunction with IMT-2000, there may be an inter-relationship with WLAN and digital multimedia broadcasting. For beyond IMT-2000 systems, there may be a requirement for a new complementary wireless access technology. This will complement the future development of IMT-2000 and future development of other radio systems. Right now, research on core technology is desperately needed to build up the multimedia information and ubiquitous society based on high-speed mobile communication. In

addition to this, we have to take into account the ubiquitous era when people's daily lives are changing rapidly as a consequence of new technologies that resolve difficulties and improve quality of life, as well as providing simple information transmission and multimedia services. Research should be conducted into the various sensor network technologies and associated status detection, as well as user-centric service provision using location and context-aware based technologies.

Digital broadcasting networks

14. The media environments where communication and broadcasting are separated tend to converge rapidly, owing to digital multimedia contents. In particular, expansion of bandwidth in the mobile communication network and development of IT technology accelerate fusion of mobile communications and broadcasting. Convergence of communications and broadcasting occurs as demarcation between these services becomes obscure. As a result, the service providers in each area can easily provide value-added services that are beyond their unique business boundary. The main advantage of broadcasting services is their always-on nature, such that services can be accessed without any setup effort. A certain casting service may be offered in large areas or in limited areas only, according to coverage of the broadcast programme. The received information can be displayed immediately or can be stored for later retrieval. From the service provider's point of view, the convergence of mobile communications and broadcasting services involves on the one hand the mobile communications broadcasting service which is provided by mobile communications service providers over the mobile communication network, and the interactive data broadcasting service which is provided by broadcasting service providers using the up-link channel in mobile communications networks. Cooperation with the broadcasting network is included to open up new applications such as navigation, traffic information, and interactive multimedia services.

Mobile ad hoc networks

15. Mobile ad hoc networks are a technology to temporarily create a network to perform communications among the multiple terminals located in a certain area, namely, it is a network that is formed without any central administration or infrastructure. The possibility to build a network in a spontaneous and fast way gave rise to the name ad hoc networks. Because a mobile ad hoc network does not involve the use of existing networks, and it can be constructed even in extraordinary conditions like a disaster. In a mobile ad hoc network, nodes communicate with each other without the help of any pre-existing structure. The network is autonomously formed among many nodes such as PDA, laptops with varying functionalities and power levels. It will be the enabler for ubiquitous computing as well as perform significant functions during natural disasters where preexisting infrastructure may be destroyed. Another area of greater interest is military applications, which require dynamic autonomous architectures formed on the go. Recently, research on multi-hop communications using ad hoc networks has been undertaken aggressively, and is expected to provide an effective solution for building robust networks even in the event of an emergency.

16. The most representative ad hoc network is the multi-hop mobile ad hoc network based on IP, and this is being standardized by IETF's (Internet Engineering Task Force)

mobile ad hoc networking Mobile Adhoc Network (MANET) working group. The most conspicuous features of the mobile ad hoc network are dynamic network topology change associated with node mobility, which directly affects the routing protocol that manages the routes. Each node broadcasts its presence periodically, and maintains information on the neighbouring nodes that can be connected directly and update the route information based on it. Route information is generated and managed by the routing protocol, which can be classified into the proactive and reactive protocol. The proactive protocol enables all nodes to keep most recent route information. If route information is updated by network topology change or the periodical check, it is broadcast across the entire networks. The proactive routing protocol is always able to transmit the data through the optimal route without delay when traffic occurs, since the recent route information is continually updated. However, it has a problem of too many control messages for route information management.

17. Research on the mobile ad hoc network has been under way for a long time now, but is not applied to our daily lives. The reason is that most current networks were developed based on the infrastructure type instead of the mobile ad hoc one, and there are only few areas that the mobile ad hoc network can be applied, with many problems left unsolved for practical application. When configuring the home network with information devices in the house using wireless access technology however, the mobile ad hoc communication concept can be applied. The mobile ad hoc network can also be applied to the sensor network where the sensors are installed in the dangerous or inaccessible area, and it is configured to exchange information between these sensors.

Opportunities/threats to the mobile converging service

18. The world is becoming faster, riskier and more complex. Enterprises need to prepare themselves for this turmoil. Therefore, it is imperative to implement a strategic planning that consistently monitors trends and assesses business effects. Especially, service is a matter of great significant driver in the future mobile information society. Therefore, it is very important to create a beneficiary business model for promising applications, and to provide enabling key technologies in a timely way. Although predicting the future is a risky business in the mobile communication industry, an understanding of the core technologies for everywhere and anytime mobile communications can allow us to have some grasp on the shape and direction of the future broadband mobile communications. It is a crucial time to decide whether we drive an investment for the future promising broadband mobile convergence technology actively or not. Moreover, it is desirable to keep in mind the facts that flexible rolling-plan and time-to-market strategy for propelling a successful project are indispensable and what are the most disruptive trends and most significant opportunities arising from emerging broadband mobile communications.

19. Technology is bringing to society vast opportunities, including new ways to interact and organize. In many ways, technology empowers individuals by providing the potential for better information and services and greater flexibility. As a result, the availability of new mobile applications and services on broadband mobile convergence networks will help to lead an easy and amusing life for everyone fairly. By adopting advanced mobile technologies, operators could potentially generate new sources of revenue through useful/appealing new applications and services. But, there are many

problems in propelling the technological research and development related to future broadband mobile communications. Therefore, both industries and manufactures may have a conservative tendency that the best way is a vigilant approach to improve existing business processes a little or to maximize the return on investments already made.

First mover vs fast follower

20. To cope with the future broadband mobile communications toward a converged world, how can technology planners identify the technologies and applications that will generate maximum benefit for their enterprises? Once an enterprise has decided that an emerging technology will play a major role in its future business processes, it must determine the optimal time to invest seriously in the technology. If an enterprise launches its efforts too soon, it will suffer unnecessarily through the painful and expensive lessons associated with deploying an immature technology. If it delays action for too long, it runs the even greater risk of being left behind by competitors that have succeeded in making the technology work to their advantage. Technology planners should assess the relative impact of a technology and act early for high impact technologies, while waiting for others to move first on the technologies that are less relevant to the core of their business. Generally, there is a natural desire for enterprises to become the top innovation leader in a new market. The so-called first mover advantage is one of the most discussed aspects of the new economy, the theory that profits will inevitably follow market penetration without price competition initially.

21. The first movers acquire many patents and licenses, and have the prospect of high quality through more market savvy. The first movers will seek to initiate a number of important global trends in mobile service and applications, and attempt to glean a glimpse of the future mobile landscape. On the other hand, the major issue with this approach is that the likelihood of market adoption and the speed of market penetration are very large unknowns. Even if these risks were low, the first mover advantage is often more of a disadvantage, and more resource-intensive such as the need to create the demand. The new products are typically more immature, and may subject the brand to a risk such as danger of poor quality of new products. Fast followers can sometimes learn faster and avoid some of the costly mistakes of first movers. First movers make all expenditures without knowing market reactions well and risk the danger of employing wrong marketing approach. They take the risk that followers improve faster on the first movers' failures. Therefore, technology providers need to consider an appropriate time-to-market strategy carefully.

Conclusions

22. The advancement of IT that began with the Internet has converged with mobile communications, to create a new paradigm of mobile convergence. Up to now, these technological advancements have centered on intelligent, multifunction terminals, and these all-in-one terminals have led advancements in network convergence to a limited degree. However, the services of the near future that take the user's lifestyle and environment into consideration must be driven by network and service convergence, in addition to device convergence. Therefore, the information technology of the future must drive mobile convergence that eliminates the boundaries between wired and

wireless networks and home appliances and terminals, to provide easier interoperation and guarantee mobility. In addition, mobile communications, which are at the centre of these changes, will act as a content delivery network between various user-centered pico-networks or ad hoc networks, and value-added ubiquitous services, and convergence centered on mobile communications will become the core component of the ubiquitous infrastructure. The ubiquitous concept, which eliminates spatial and temporal limitations and uses various forms of multimedia to provide the optimal service for the user, absolutely requires the mobile communications centered convergence paradigm.