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DESIGNING M-COMMERCE APPLICATIONS BASED ON BOTH TECHNICAL VIEWPOINT AND THE END USERS' PERSPECTIVE

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Abstract

Recent advances in wireless technology have increased the number of mobile device users and given pace to the rapid development and deployment of e-commerce to the mobile user. This new type of e-commerce, conducting transactions via mobile terminals, is called mobile commerce (m-commerce). Due to its inherent characteristics such as ubiquity, personalization, flexibility, and dissemination, mobile commerce promises businesses unprecedented market potential, greater productivity and higher profitability. With this in mind, it is perhaps not surprising that mobile commerce is growing much faster than its fixed counterpart. Unlike e-commerce, m-commerce is more personalized and there is a need for a novel approach to evaluating m-commerce applications. This paper examines the issues in designing m-commerce applications not only from a technical viewpoint but also from the end users' perspective. Firstly, the enabling m-commerce technologies are presented, viz.: Wireless Application Protocol (WAP) and i-mode mobile Internet service. Two m-commerce application scenarios (case studies) are then illustrated by making use of Nokia toolkit version 4.0. Then results from the authors' on-line market research into user preferences are presented. Finally, conclusions are drawn on the future directions in wireless and mobile Internet service provision.

Keywords: Mobile Commerce, Fourth-generation Systems, and the End Users' Perspective.

Introduction

M-commerce is more than a mobile and wireless extension of the Web-based e-commerce. It is an entirely new sales and promotion channel and is the enabler for a whole range of new services such as buying air tickets, paying tax, reserving a table in a restaurant. Most importantly, it follows the user and is available anytime and anywhere. M-commerce enables a new mode of information exchange and purchases, and it presents an unexplored domain. To consumers, it represents convenience; merchants associate it with a huge earning potential; service providers view it as a large unexplored market; governments look at it as a viable and highly productive connection with their constituents [2,3,7,14]. In this paper, the current technologies that apply to m-commerce are discussed – Wireless Application Protocol (WAP), i-mode, even Fourth-generation (4G) Systems and their status reviewed. According to the characteristics of m-commerce, this paper describes ideal m-commerce architecture, and two scenarios (case studies)

are used to illustrate this architecture. The key findings from the authors' currently running web-based market survey strongly support the results. Finally, this paper concludes with suggestions for future work.

State of Art of M-commerce

In order to allow access to the Web from mobile devices, the WAP promoted by the WAP Forum is optimized for the wireless environment. It is the most popular Internet-enabling technology being adopted by handset manufacturers and service providers in Europe and America [11]. Moreover, in Japan there exists a proprietary wireless data and mobile Internet access service promoted by NTT-DoCoMo called i-mode, which attracted 43 million customers by February 2005 [6].

WAP for M-commerce

The WAP 1.0, published in 1998, is a broadly used and accepted protocol standard designed to enable different kinds of wireless devices to communicate and access the Internet. Due to the problems that come with the gateway, Version 2.0 of WAP suggests not to use the gateway but use instead the Internet's standards: eXtensible HTML (XHTML), Transmission Control Protocol (TCP) /IP, HTTP and Transport Layer Security (TLS). The most important goal for WAP 2.0 is to bring the mobile Internet services and standardization closer to Internet standards [4,5,9].

i-mode for M-commerce

With i-mode, mobile phone users gain easy access to more than 88,000 Internet sites form anywhere, anytime in Japan. As i-mode is not an open standard, the amount of available information and its breadth of use are limited at the moment to Japan and a few experiments around the world, particularly in Europe [6]. The idea behind i-mode is to use the HTML and HTTP as much as possible. As the i-mode service is not based on WAP, it does not require Wireless Markup Language (WML) to produce front-end applications for mobile phone screens. The i-mode services are based on compact HTML (cHTML) as its markup language and it supports high-resolution colour content, hence one of its successful attributes in attracting subscribers to the wireless Internet compared to WAP access. The main advantage of i-mode is the fact that the service is not garden-walled like many of the wireless service portals available in Europe and the USA [11]. Companies and individuals alike are able to create their own compatible Internet sites that can be accessed through the i-mode service.

Current Status – Convergence Verse Competition

Of course, i-mode is a serious competitor of WAP 2.0. It has been suggested that WAP may push ahead of i-mode in popularity because WAP has a large community of developers, whereas the tightly NTT-controlled i-mode may be stifled by lack of development mass [1,10]. As i-mode evolves towards support of XHTML and TCP, with the current WAP evolution, these two technologies will probably converge by evolving i-mode platforms to support WAP users by enabling WAP phones to access i-mode content. This is being done in Japan, and it is one way for i-mode manufacturers and service providers to sell more equipment and services. By enabling a WAP user to obtain i-mode content, an i-mode service provider could use the product as a way of convincing the WAP user to buy their primary service from the i-mode carrier. Most likely, a gateway function will be used to act as a mediation and conversion access point. In all probabilities, cHTML will become the common markup language for both i-mode and WAP. This convergence for the technologies will create more opportunities for content providers and the

Internet industries, resulting in more applications to m-commerce users, which can then expand the subscriber base in order to grow the revenue stream.

Overview of Existing Applications in M-commerce

The range of applications that characterize m-commerce activities can be largely divided into three categories [12]:

i. Content Delivery: The roaming user can be provided with information, alerts, entertainment or advertisements based on their location.
ii. Financial Transaction: Location-based transactions are perhaps the most complex set of services. The main thrust of the business model is billing based on the customer's location, while a mobile banking application can be customized to quickly deliver secure banking services and provide another value-added benefit.
iii. Location Based: Driving directions and the tracking of freight, packages and people are a core segment of the emerging Location-Based-Service (LBS) market. Intelligent transportation systems are being introduced around the world, and location-based technology plays a key part in almost every solution.

According to the characteristics of m-commerce business-to-consumer (B2C) commerce, an ideal mobile commerce architecture is shown in Figure 1. Such a system shall support the following: 1) Client authentication; 2) Server authentication, each party needs to be able to be authenticated by their counterpart to ensure that the counterpart is who they claim to be; 3) Secure channel, i.e., encrypted channel; 4) User-friendly payment scheme supporting micropayment, i.e., buy small things and to pay small amounts of money. The administrative charges for such payments must be small compared to the payments; 5) Receipt delivery, which contains reservation and transaction information; 6) Simple user interface, which is suitable for the mobile users to enter their personal data in any kind of situation [8,12].

In order to test and write applications to be readable by WAP-enabled devices, WAP emulator software can be used on computers. This software can then be used to simulate and test the actions of both WAP gateway and WAP-enabled mobile devices, which are currently the main technology devices utilizing WAP. A number of freely available WAP emulation software application packages exist to simulate WAP effects. Two m-commerce execution scenarios are developed using the Nokia WAP emulator version 4.0 and are showcased in detail; in order to further elaborate Figure 1 illustrates the ideal m-commerce architecture. Please refer to the case studies in the following two sections for detail.

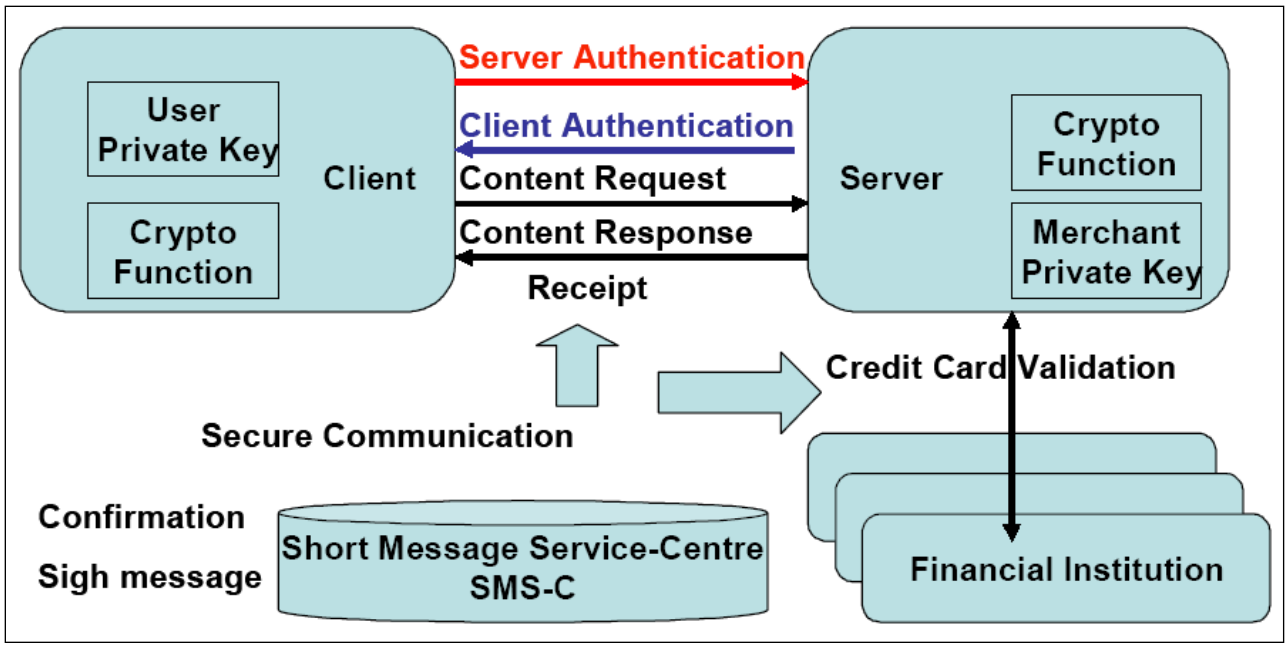

Figure 1: An Ideal Mobile Commerce Architecture

Restaurant Reservation Procedures and Signaling Flow

The first scenario, illustrated in Figure 2, is concerned with a LBS service that provides a list of restaurants, which are located near the current location and match a set of user preferences. This reservation service starts with the request from the browser to its Profile Agent (PA). The PA requests the list of context components such as network type and user location. In the presented example, the user is located in Birmingham; the PA forwards this information to both Network Agent (NA) and Local Restaurant Service Provider (LRSP) and requests the restaurant list from the LRSP. After obtaining the local restaurant report, the PA forwards it to the user together with the user's preference. The PA processes the user's requirement and sends confirmation to the SMS-C. This service is completed with a displayed confirmation on the user's mobile phone from SMS-C. For this reservation service, tourists are a key customer segment requiring the location-based information, since they are most often found in unfamiliar geographic surroundings.

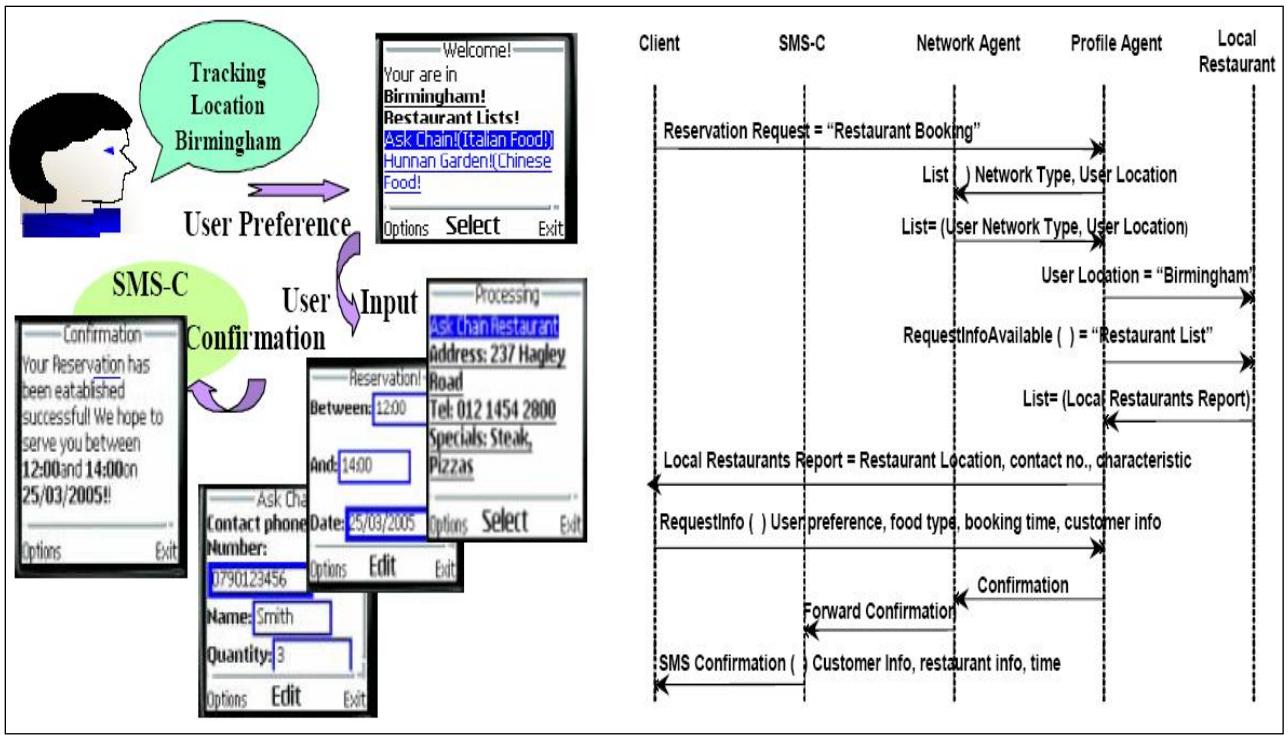

Figure 2: Restaurant Reservation Procedures and Signaling Flow

Mobile Ticket Ordering Procedures and Signaling Flow

The second scenario, illustrated in Figure 3, presents a whole financial transaction procedure by purchasing an air ticket while mobile. This is more complicated than the first scenario as it involves a money transaction and payment procedure. The initial steps are similar to the first scenario, which inputs a set of user preferences, such as departure time, destination and ticket type. Following this information, the user comes to a secure domain, which hosts financial institutions or banks. This step is a significant part in m-commerce applications. The money transaction will be performed in this secure channel by selecting the payment type. After the user performs the digital signature for the contract sent by the SMS-C which captures all the information about the transaction, the bank will generate a receipt and then sends it together with the Uniform Resource Locator (URL) continuation to the browser via the WAP gateway, and at the same time, the SMS-C sends a mobile ticket with bar-code. This kind of mobile ticket service creates an extra purchase possibility for public transportation tickets via the mobile phone. Even though the scenarios described above are complicated, from the mobile users' point of view, it is transparent and offers the benefit of being able to purchase goods and request services at anytime, anywhere, without the constraints of opening hours and physical distribution points, and most importantly, it is a cashless payment.

From the procedures that have been presented in the two scenarios, it is clear to see that there are two critical procedures that urgently need to be solved: user input usability between the client and server, and credit card payment security, which is performed by financial institutions. As the mobile phone user has to scroll through the information categories available for request and select the category by pressing a key on the phone pad, the wireless device must be easy to use. In this respect, usability could be the critical limitation. Security is still the main concern of businesses to adapt m-commerce for Intranet and extranet applications. These scenario procedures map onto the ideal m-commerce architecture and address the critical components in this system.

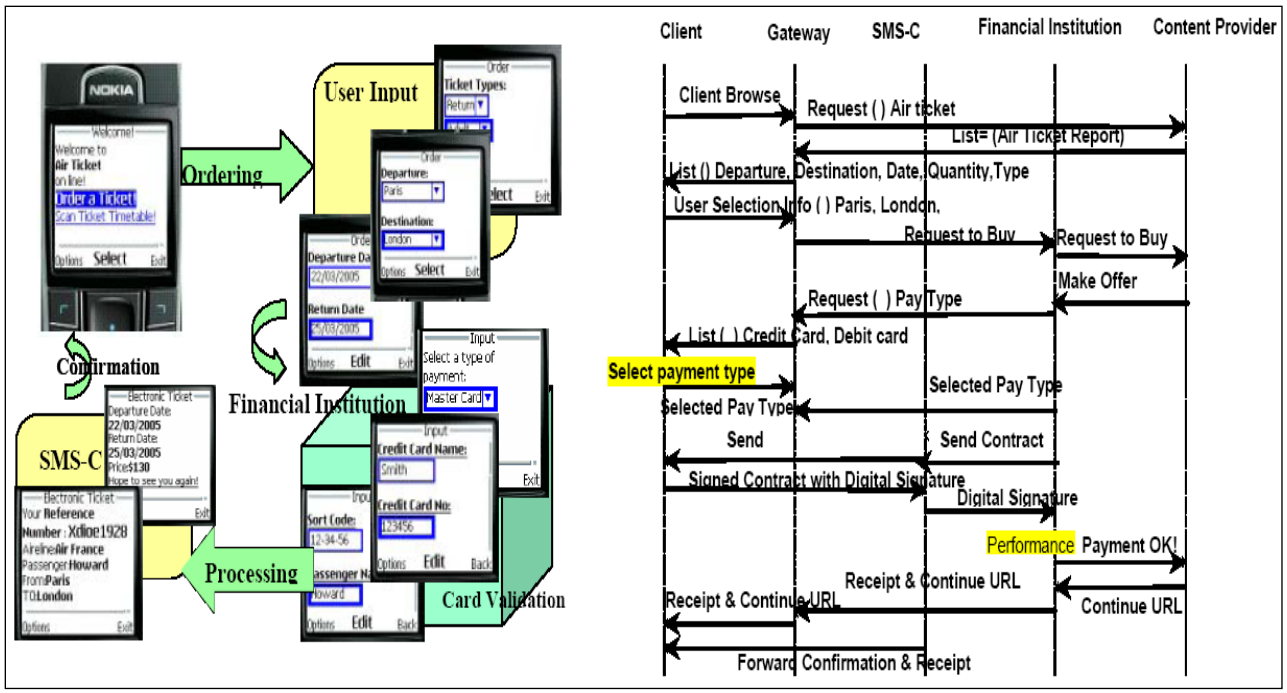

Figure 3: Mobile Ticket Ordering Procedures and Signaling Flow

Fourth-generation (4G) Systems

A 4G system will be able to provide a comprehensive IP solution where voice, data and streamed multimedia can be given to users on an "Anytime, Anywhere" basis, and at higher data rates than previous generations.

An Approach to 4G Systems

Figure 4 shows the positioning of the 4G system, which is one of the post-3G systems (systems beyond IMT-2000). In the figure, the vertical axis represents mobility, whereas the horizontal axis indicates the information speed in megabits per second. As the 4G system is an evolved version of the 3G one, the service scope and mobility of the 4G system must be compatible with those of the 3G system. Thus, 4G will be based on a cellular system, and in limited-mobility areas (e.g., indoors, hot spots), it will have to incorporate systems that accommodate wireless LAN technologies to achieve higher speed. On the other hand, another axis called ubiquity will be added anew in the age of 4G systems. In order to offer the capabilities represented along this axis, networks will be required to handle traffic patterns that are entirely different from those in existing communications. For example, a network may be required to efficiently handle intermittent signals transmitted at low speed, each being small in volume but generated by a huge number of terminals. In some cases, connections between terminals may primarily be based on local networks in an ad hoc fashion. Therefore, an extremely broad range of access and networking capabilities will be required in the age of 4G systems.

The implementation and penetration of 4G systems is expected to help close the gap in medical care, education, information, and other areas, and substantially contribute to environmental problems and an aging society. Specifically, in a society penetrated by 4G systems, home medical care and remote diagnosis will become common, checkup by specialists and prescription of drugs will be enabled at home and in underpopulated areas based on high-resolution image transmission technologies and remote surgery, and virtual hospitals with no resident doctors will be realized.

Preventive medical care will also be emphasized: for individual health management, data will constantly be transmitted to the hospital through a built-in sensor in the individual's watch, accessories, or other items worn daily, and diagnosis results will be fed back to the individual. In education, multimedia education using video between remote places and big cities, and field work using mobile terminals outdoors are expected to thrive. Also, the interface of various information terminals will be simplified, so no special operation will be required on the part of children or elderly people. Furthermore, regardless of differences in the languages used, use of these terminals may make everyday life more convenient. Sensors and control chips equipped with wireless communication functions will be attached to objects, fauna and flora rather than humans, which can make social contributions in areas such as improving logistics efficiency, protecting the global environment, and preventing disasters.

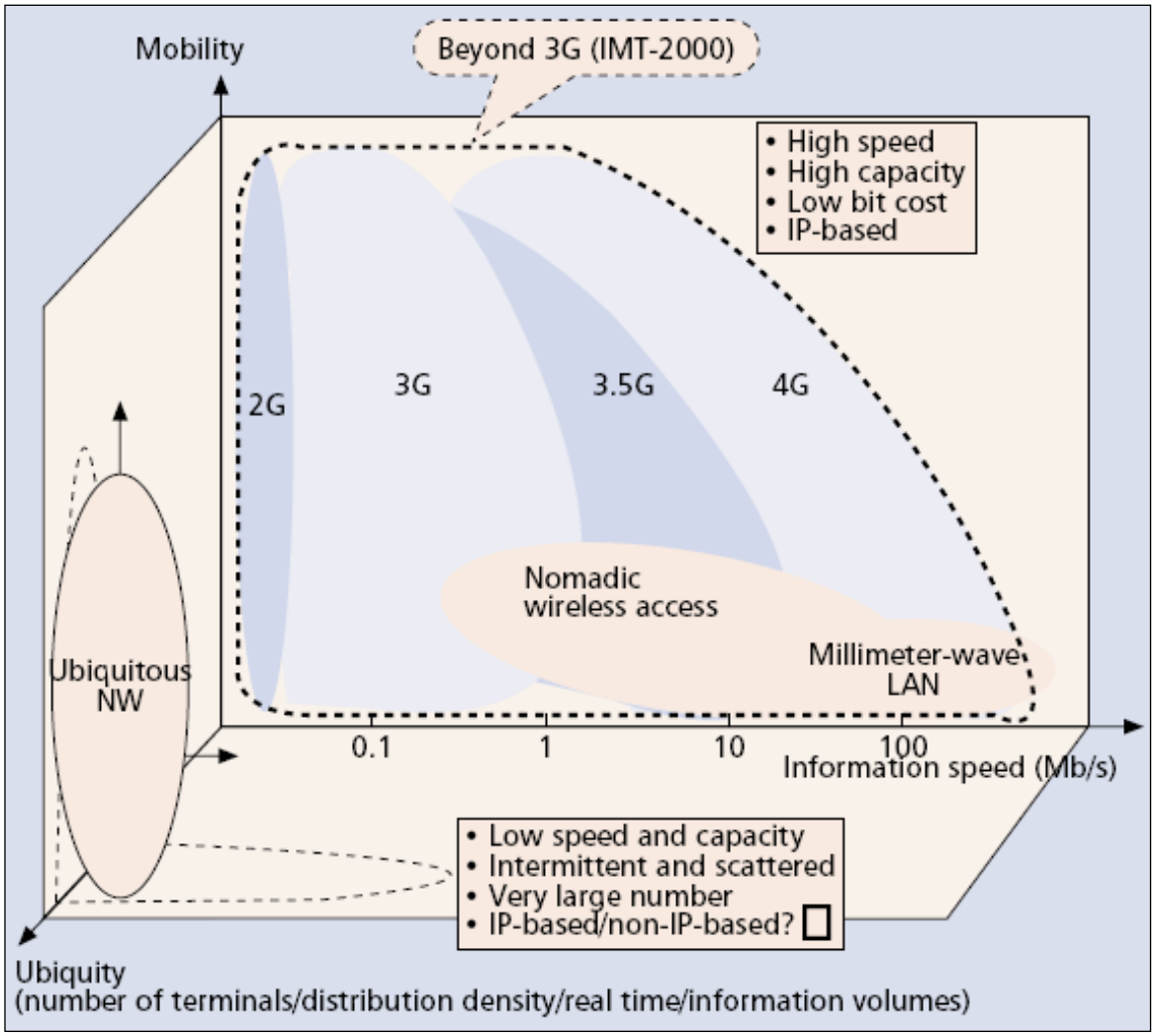

Figure 4: Mobile Systems Beyond 3G (IMT-2000)

The Technology Profile of 4G Systems

The system capacity must be at least 10 times greater than its 3G counterpart, and the cost per bit must be decreased to 1/10 to 1/100 of 3G, in order to avoid imposing a heavier burden on users associated with the expansion of information volume. Additionally, 4G must introduce various qualities of service (QoS) levels in order to provide many kinds of best effort multimedia services

corresponding to users' demand. Furthermore, Internet Protocol version 6 (IPv6) should be supported in IP networks so that a huge number of IP addresses of mobile terminals, especially in person-machine and machine-machine communications, can be accommodated. Figure 5 shows the configuration of a next-generation mobile network. IP over everything is believed to make progress, in which IP packets are processed based on various transport technologies (from asynchronous transfer mode, ATM, to optical routers). In the next-generation IP network, the control and packet forwarding functions will evolve independent of each other, and the functional configuration of the IP transport network and middleware will be separated logically. The middleware will consist of two platforms: the network control platform (NCPF) and the service support platform (SSPF). NCPF functions include mobility management, session management, QoS management, authentication/admission, and common radio resource management required for mobile communications management. NTT DoCoMo is considering an architecture for common mobility management that does not depend on a radio system, so services can be sustained seamlessly across different types of access systems. SSPF consists of service function groups exemplified by content conversion/distribution. SSPF functions include the provision of services unique to mobile communications, such as location services support.

Figure 6 shows an example of 4G service scenarios in contrast with its 3G counterparts. The illustration in the top row indicates that file transfers will be smoother than in the 3G system. For example, 4G mobile phones will enable faster downloading of application program files from servers and fulfill multimedia applications, harnessing the high-speed high-capacity data rate. The second row relates to the high-speed transmission of bulky image information. For example, 4G mobile terminals will be able to display, virtually and three-dimensionally, high-quality images equivalent to Hi-Vision, based on terminals like head-mounted displays that are constantly carried around. This will enable parents to check how their children are doing at nurseries, scientists to remotely monitor the life of wild animals, people to watch a movie when they are out, and so on. The third row is the service scenario of communications with realistic sensations, in which 3D sound, light, and pressure fields are sent to another party to reproduce a situation. Thus, virtual reality can be generated, letting you experience things as if you are "actually there." For example, if you can feel the atmosphere of the place the other person is visiting, you can perceive how he/she is doing "with realistic sensations," which are not easily identifiable just by 2D images and voice. This will not only enhance videoconference calls, but also make it possible to execute advanced surgery in remote places and developing countries, and install distributed/coordinated production lines by offering a workspace in harmony with remotely controlled robots and workers.

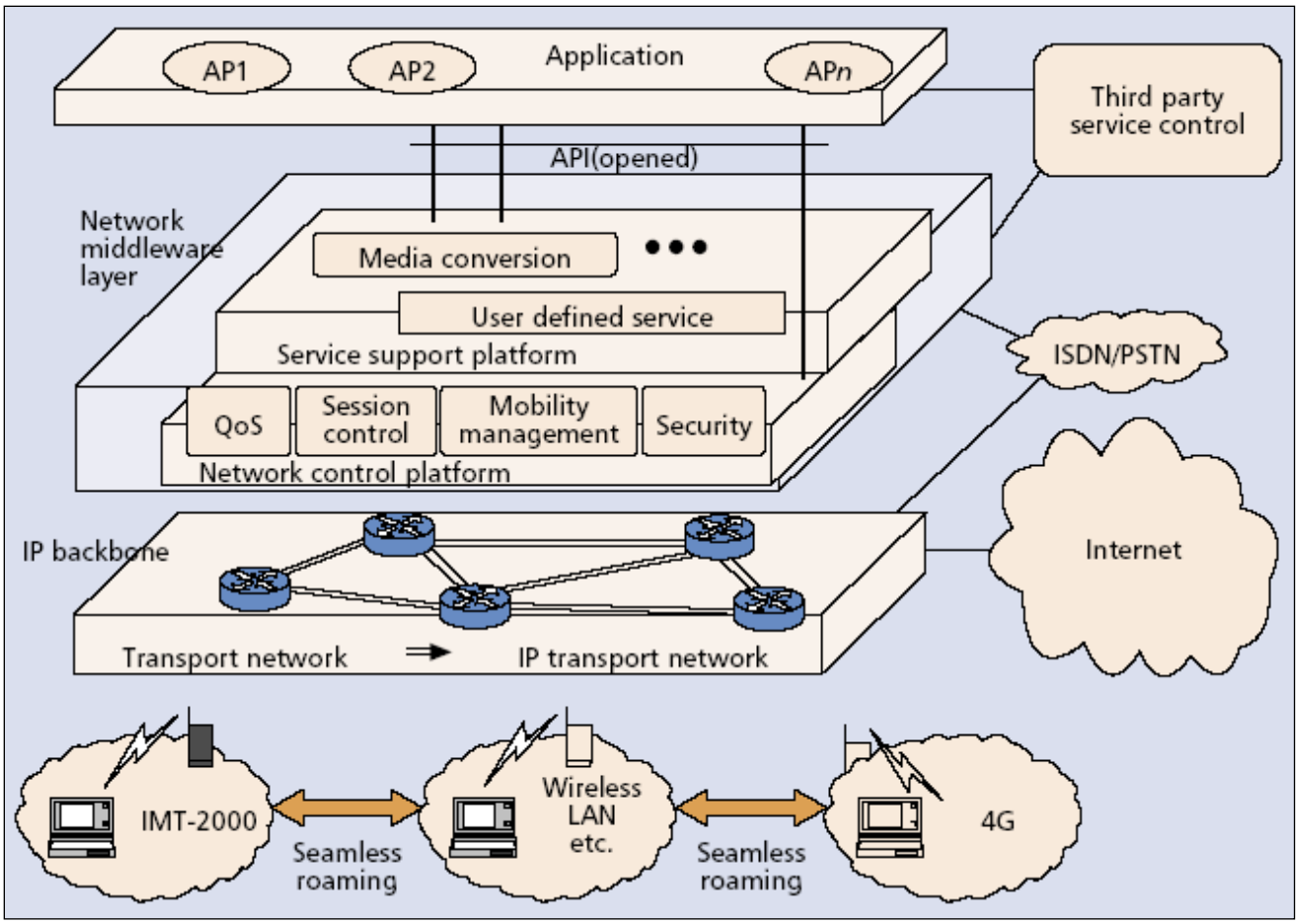

Figure 5: A 4G Mobile Network

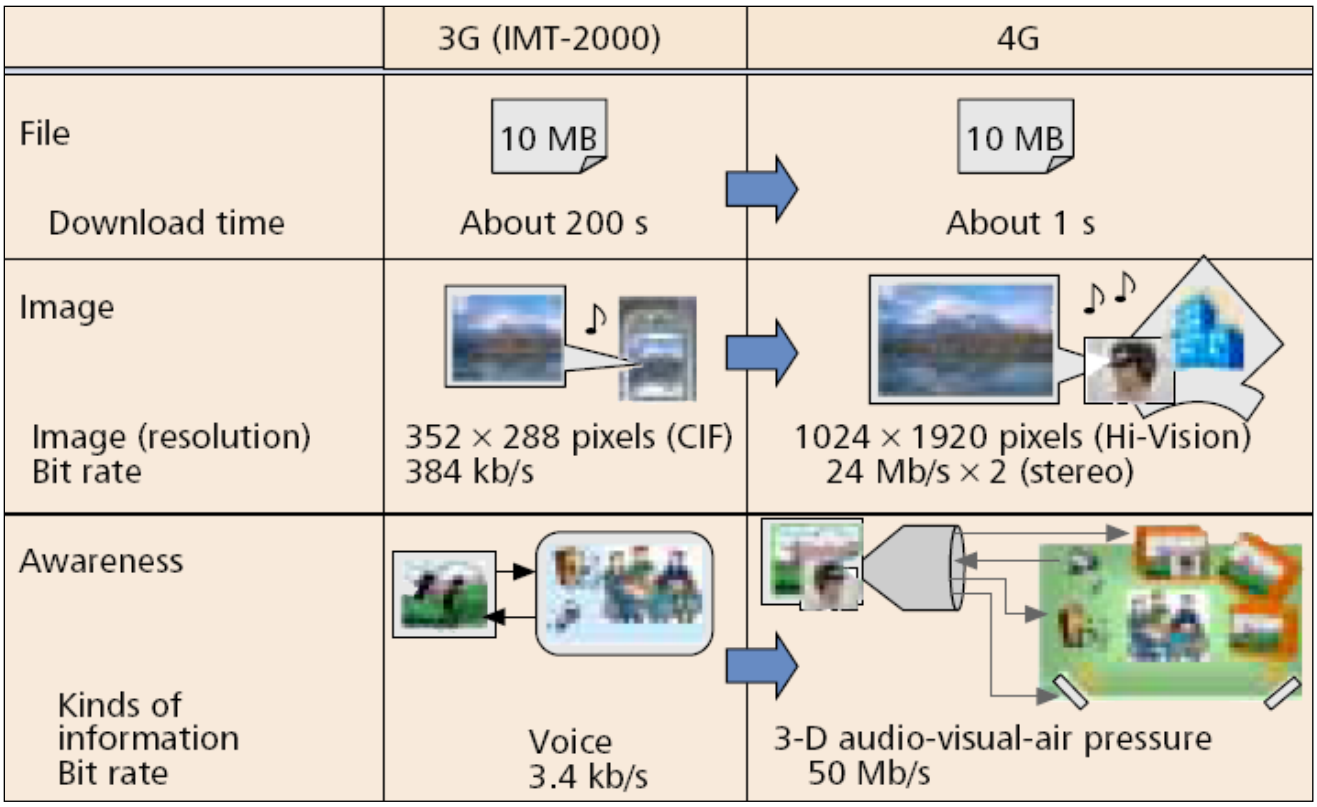

Figure 6: Service Evolution from 3G to 4G

Web-based Market Survey

Some authors conducted a research study of user preference on mobile services in early 2005, which is available at [13] in order to investigate the perception and acceptability rates of different mobile services among current and potential users. The study was based primarily in Europe, with more than 200 respondents from different communities, age groups, professions, etc. The teenagers/young adult age group (19-30 years) was chosen as being the major focus group, since this generation is known to have the most familiarity with and access to the latest wireless technologies. The research findings show that in spite of all the marketing hype about the range of services that m-commerce promises to provide, 70% of people still ranked traditional information services as their most important preference. Both entertainment services and financial transactions have been ranked as the least important by one-third of the respondents. Moreover, from the first 200 respondents, 78% selected "ease of use" and 79% selected "security" as "important" and "very important" factors, which influenced their adoption of the mobile services. When asked the reasons for interest in buying a 3G mobile phone, "services available" was the main reason, and followed by the "battery life", "ease of use/functionality" and "handset size/colour appearance".

Conclusions

Mobile communication is the enabler in broadband information and communication to make ubiquitous communications into a reality by harnessing mobile characteristics. Technological innovation and challenges must therefore continue in the future. For the creation of innovative technologies, it will be crucial to interact with researchers and engineers in universities and companies worldwide and desirable to exchange information and conduct joint experiments with

open minds. It is hoped that mobile communications technologies and mobile multimedia services will enjoy further progress through R&D and standardization activities on a global scale.

The 21st century, which may be signified by such keywords as humanity, environment, and information, is believed to migrate from a materialistic society to a human-oriented society that will bring about spiritual affluence. With this in the backdrop, it will be important for information and communications in the 21st century to conduct research on human-oriented, human-friendly communication systems. Potential research directions include pursuing humanness, utilizing the five senses (touch, taste, hearing, sight, and smell) and artificial intelligence; complementing human abilities, based on intelligence; pursuing new forms of communication, through robots and wearable models; and expanding the human space, by pushing the limits of communication quality.

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