

Trends in Mobile Multimedia and Networks

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Abstract. NTT DoCoMo is the company to "DO COmmunications over the MObile Network". It reached 43 million subscribers in Japan, early 2003. This presentation covers the multimedia services over mobile networks and give a glimpse of future directions of mobile multimedia networks and applications. DoCoMo's 2G and 3G mobile networks currently offer mobile visual phones, multimedia mails, and video clip download as well as enhanced "i-mode" services. After introducing the mobile multimedia applications and related technologies, future challenges and directions beyond the current networks are discussed, taking three keywords: hyper operator network, mobile content, and seamless service.

1 Introduction

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 million¹. The expansion of mobile communications so far has been led by the growth of voice usage. However, voice usage will certainly saturate in the near future, simply because the population will not increase any more, and people's active hours in a day are limited. As for Internet, the number of "wired" Internet users in Japan is about 20 million, while the mobile users were 60 million, of which 36 million are i-mode² subscribers in early 2003. According to the forecast by Japanese government, the number of Internet users in Japan is expected to reach 77 million by 2005, pushed by the increase in the number of mobile users accessing the Internet from a mobile device. Owing to the internet access initiated by i-mode, the three major telecommunication operators in Japan (i.e., DoCoMo, KDDI, and J-phone) have maintained the revenue from the data traffic. Fig.1 shows such a revenue analysis. This means we need to generate new demands for mobile communications to further expand the market. Fortunately, the use of Internet is increasing rapidly. Therefore, we should take the challenge to combine mobile communications with the Internet, and develop 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" as depicted in Fig.2. The figure shows an optimistic but vital view.

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

² i-mode is NTT DoCoMo's mobile internet access system, and is also a trademark and/or service mark owned by NTT DoCoMo.

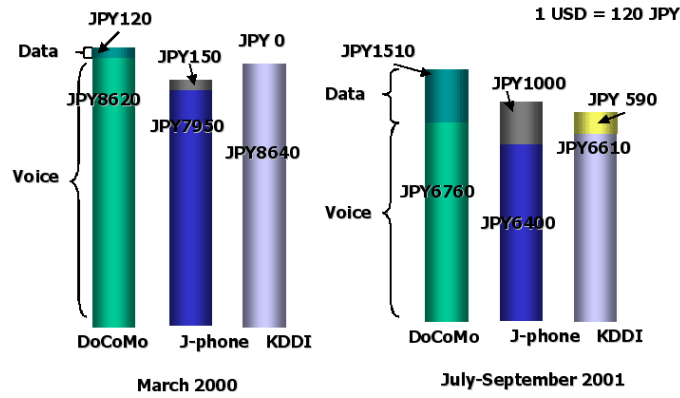


Fig. 1. Average Revenue Per User in Japan's Mobile Communication.

2 Mobile Multimedia Today

In view of Mobile Multimedia Frontier, we 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. Thus DoCoMo now operates dual generation mobile networks in which 2G network provides 28.8 Kbps packet switch connection.

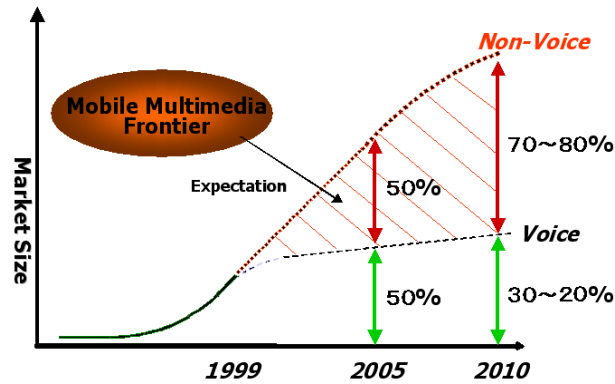


Fig. 2. Mobile Multimedia Frontier.

Fig. 3 summarizes the current and anticipated mobile multimedia services over 2G and 3G networks

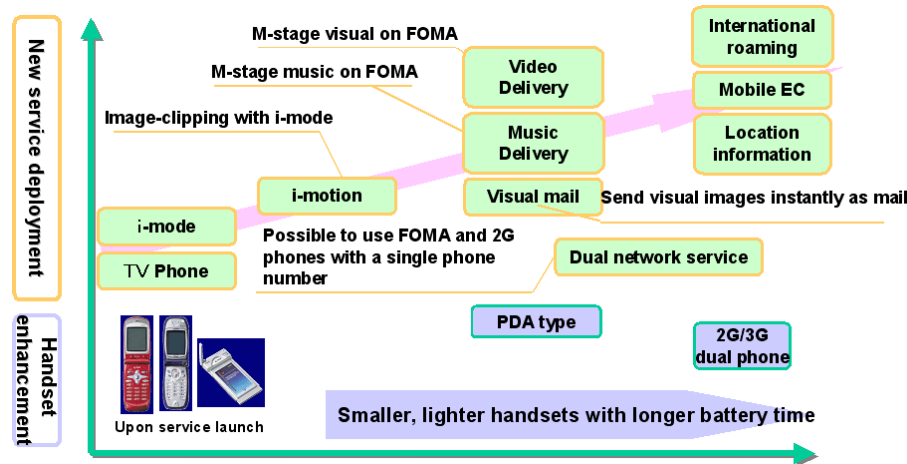


Fig. 3. Evolution Path of Mobile Multimedia Services.

e-mail : This is one of killer applications regardless of mobile network generations. You can send e-mail to other mobile phones and to anyone who has an Internet e-mail address, and receive e-mail vice versa. The two major points should be noticed here. It costs less than 1 cent and interoperability to Internet mail is guaranteed.

Web Browsing : The legacy 2G network has allowed mainly text-based HTML browsing with some small graphics. In enhanced 2G and 3G networks, JPEG was adopted and commonly used in mobile web browsing. Now we are using a 2-inch or similar size display with a limited resolution though, the resolution will be eventually extended to VGA within a year.

Java Application : In early 2001, DoCoMo launched Java application download service. Users now can download and store a variety of dynamic applications via the 2G and 3G networks. All new i-mode phones are now equipped with the Java capability and Secure Sockets Layer (SSL) Protocol, which provides cryptography for the safe transmission of personal information (e.g., credit card numbers). It is expected that the Java new phones will be used for financial service and other e-commerce businesses in addition to video games.

Videoclip Download : The 3G service, dubbed "i-motion" will enable users to obtain video content at speeds of up to 384 kbps (64 kbps uplinks) from sites accessed via DoCoMo's official portal with new DoCoMo's 3G handsets. Movie trailers, news highlights and music files will be among the many types of increasingly rich content to be offered. Data will be provided in three formats: video with sound for promotional videos, news, etc. still frames with sound for famous movie scenes etc., and sound-only music files.

Multimedia Mail : Mobile picture mail services have proved a major hit with the Japanese market. 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. The picture mail service allows subscribers to transmit still images taken with compatible mobile phones having built-in digital cameras to virtually any device capable of receiving e-mail, including the DoCoMo's 36 million handsets now in use. J-phone has now 12 million subscribers, of which 6 million subscribers' phones are with built-in cameras. As one of DoCoMo's 3G services, the mail service is extended to enables user to e-mail approximately 15-second/100 KB video clips taken either with the handset's built-in dual cameras or downloaded from sites. The phone shoots video content at a rate of up to 15 frames/second.

Video Phone : Visual phone Service is a typical application on the top of DoCoMo's 3G network. That utilizes 64Kbps circuit connection.

Consequently, multimedia mail is now becoming one of killer mobile applications next to e-mail and web browsing.

Concerning the web browsing, due to the limited bandwidth and screen display size on the phone, Internet standards for web service could not be directly applied to mobile internet service. Thus, a new standard needed to be introduced. In Japan, two standards were introduced. First is the i-mode HTML, which is the standard, created by NTT DoCoMo, based on Internet protocol. The other standard is WAP, (Wireless Access Protocol), specified by the WAP Forum, an industry forum comprised of wireless operators and manufacturers worldwide. The standard established is a public/open standard integrated with cellular protocol. Fig. 4 summarizes two streams of mobile markup language formats. At

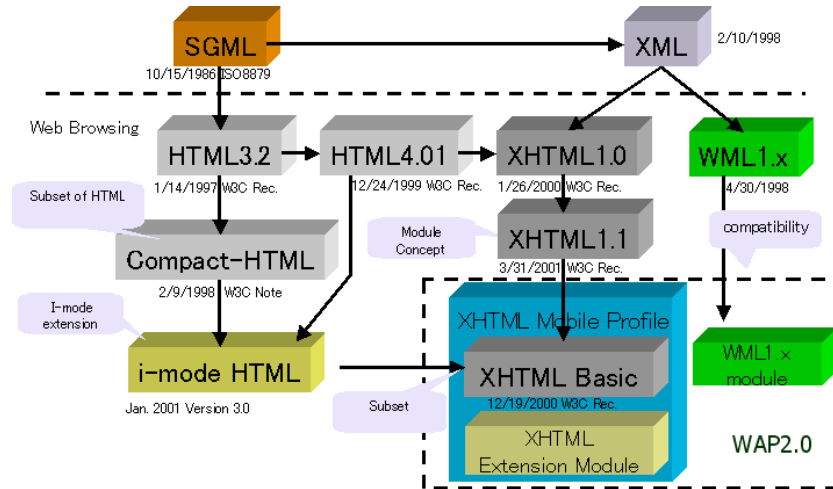


Fig. 4. Compact HTML and WAP.

this point, we have a very optimistic view to such an "estranged" situation. One

reason is that the current mobile web browsing is mainly for database access such as inquiring train time table, weather forecast, and mobile news, in which web contents are automatically generated by a front-end system which knows "user agent" information from each cell phone. The majority of mobile web content with valued information is dynamically and automatically created. The other reason is that we will eventually have convergence into an Internet dominant content format, which is supposed to be (X)HTML or its derivatives. Since the cell phone's capability and bandwidth environment are now growing to follow the wired environments, i.e., legacy Internet, then we will have to consider the interoperability between mobile content and legacy content more than ever.

3 Technology Research Trends

Breathtaking advances in LSI technologies, expanding network bandwidth, advanced coding technology and heterogeneous access networks will change the way we use mobile networks forever. Future users will interact with the network using any device, in any location and demand consistent, familiar service. They will expect completely reliable delivery of virtually any type of content or service including real time high quality video audio, games, text and video conferencing. The ultimate goal of mobile multimedia technology development is to make any type of multimedia content and services be available anywhere and anytime. Here let me focus on three research topics: Hyper Operator Network, Mobile Content, Seamless and Ubiquitous Service technologies.

3.1 Hyper Operator Network as Overlay Network

Fig. 5 illustrates an ideal mobile future network including a fourth generation (4G) radio access network. As we can see in the figure, heterogeneous, rather than homogeneous, user terminals, wireless access networks, backbone networks, and even service operators/contents providers gradually become a reality. The heterogeneity will bring much more choices to customers to meet their preferred requirements individually. On the other hand, however, a conventional operator may face a difficulty to provide all satisfied services required by users with its own resources. The concept of hyper operator comes to absorb this heterogeneity by using the resources from both itself and other parties. The word "Hyper" 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. Different from the conventional concept, not only mobile subscribers including human beings, pets and machines but also service providers probably providing radio access, Internet access/backbone, and contents or application

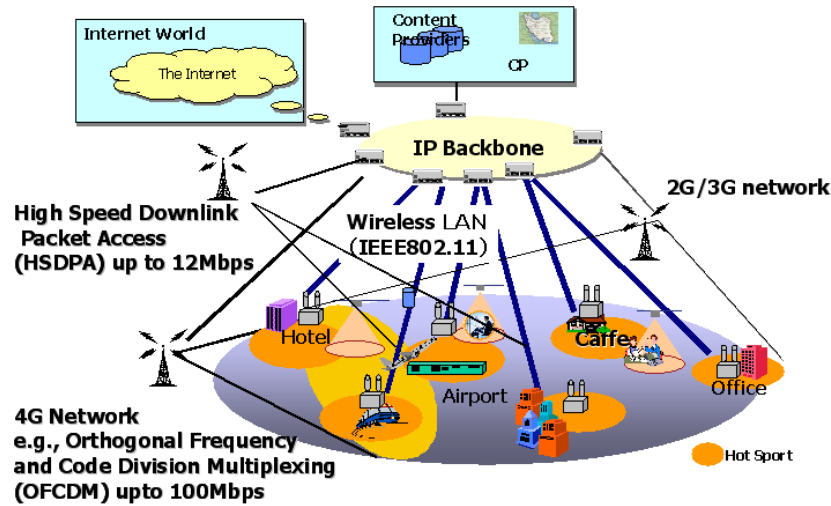


Fig. 5. Heterogeneous Network as Future Mobile Network.

services will become customers of a hyper operator. Then, a hyper operator will 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.

A hyper operator will have different configurations. In a horizontal business model of wireless Internet services, possible service providers would be applied to radio access network (RSP), Internet access/core network (ISP), application (ASP). A hyper operator may be established based on any combination of these service providers. That is, it might be an RSP, an RSP+ISP, an RSP+ISP+ASP, etc. Nevertheless, a hyper operator must have a hyper operator overlay architecture/platform/network to provide seamless services.

Besides the services provided by existing operators, such as connectivity services by network service providers, applications and contents services by ASPs, the hyper operator overlay network is constructed to provide value added services including AAA (authentication, authorization, and account) services, service portal services for seamless applications, hyper handover support, and so on. As for AAA services, we know that different access networks have different level of security, in terms of authentication/ authorization/identification management. It is necessary to provide a uniform security level in heterogeneous access networks. Integrated AAA and composed AAA services will be considered. To provide third parties' applications seamlessly to mobile subscribers in terms of user's preference/profiles and device's diversities, a hyper operator service portal is needed for service selection, device adaptation, service decomposition,

and service integration. Handover in the heterogeneous network environment is different from that in the same wireless access system (e.g., from one base station to another). While the handover within the same system is defined as horizontal handover, the handover between different administrative domains, different access technologies, user terminals, or applications is defined as hyper handover. Hyper operator overlay network will support the hyper handover. A plausible objective is thus to develop an overlay network on which a hyper operator can construct an application platform to provide new value added service and provide cross-provider/-layer coordination to absorb the heterogeneity. Mobility management and AAA are identified as key technologies here.

3.2 Mobile Multimedia Content and Seamless/Ubiquitous Service

Here let us take a question. What factors differentiate mobile multimedia content from conventional one? There are many futures including:

- Relatively Limited Bandwidth
- Error Prone Environment
- Terminal Capabilities such as Speakers, Displays and Limited Power Consumption Batteries, and
- Mobile Specific Emerging Applications (e.g., multimedia mail)

Although our next generation radio access technology is expected to provide higher bandwidth to users, compression still remains essential one due to the limited radio resources. This is especially true in image coding and hyper media that has more dimensions and requires the certain amount of data. Providing the best coding efficiency still remains essential technologies.

Speech is and will continue to be the traditional medium for communication, whether wired or wireless. Improved speech coding therefore remains a significant objective. Fundamental research work is delivering real advances both in coding efficiency and subjective performance. On the other hand, to preate from the viewpoint of practical preparation toward next decade, a speech CODEC suitable for Voice over mobile IP Network should be also considered. Imaging and video are emerging media in wireless communications as we discussed. Further advances in coding efficiency and subjective performance will in the future enhance the user experience by providing sharper images with higher resolution and higher frame rate.

The research in this area is not limited to the compression. In the upcoming generation networks, devices, communication, available resources, and services are expected to become ever more diversified. Against this background, end users and service providers want both a "seamless" experience and ease of use without being confused by the multitude of available alternatives. Out of the many issues involved, the following topics are essential for mobile applications:

- Management, adaptation, and use of the diversity in user devices
- Management, adaptation, and use of the diversity in available networks and changes in operating conditions

Quick Overview

*Essence of content should
be taken while moving around*



**Delivery of Essential
Information**

User Adaptivity

*Content should be customized
depending on user 's condition*



Fig. 6. Mobile Content Delivery Environment.

- Discovery, adaptation, and use of various resources and services

Here let us point out characteristics of a content delivery for mobile users as follows:

- Mobile content consists of spatially and temporally localized information in addition to that of non-mobile content (e.g., TV programs). "Spatially localized" means for example that the information within a mile radius from the user is useful for shopping or finding a fancy restaurant. "Temporally localized" means also for example that the present information, say 30 minutes before or later is useful for the abovementioned localized purpose
- Viewing time of mobile content is very limited by its nature. Mobile users are usually moving around, thus they do not have enough time to enjoy 2-hour movies

Mobile terminal are now highly personalized. Many personal data including user's preference on content viewing, terminal capability, or geometrical location will be stored or signaled by a mobile terminal. Mobile content should be customized so that its essential information can be presented properly depending on user's environment. Fig. 6 summarizes the mobile specific environments for the content delivery.

Here let us point out again the importance of metadata for seamless service customization since it provides hint information on how to customize the target content. In the context of content delivery, description of "user", "system (terminal and network)", and "mobile content" should be considered so that a content delivery system can respond the dynamic change of the content delivery environment (Fig. 7). Content description data represents semantic structure of the content to be delivered, which is required to identify what part of video data has to be delivered. For example, RDF framework has been specified to annotate semantics of the web content. Second one is the delivery environment

description consisting of terminal description and network resource description. CC/PP defines the framework for specifying metadata dictionary for this type of information. Thirdly, user description addresses user's personal data or content viewing conditions, which can be dynamically changed. Thus representation of the environments (i.e., delivery context), and the adaptation mechanism based on the representation are essential.

New media processing, handling, and coding technologies together with networking technologies will inevitably revolutionize the way users interact with the mobile and fixed networks.

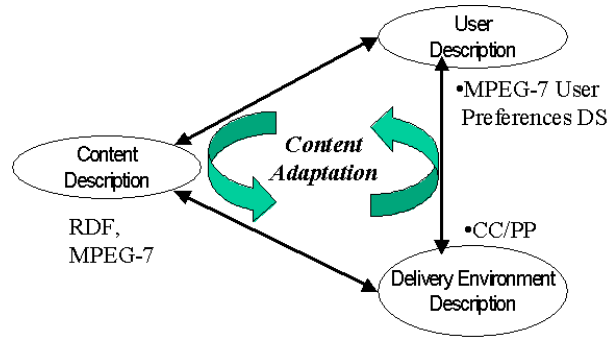


Fig. 7. Environment Description for Content Adaptation.

4 Conclusion

We have introduced the current mobile multimedia applications first. 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. The other one is to recognize what value 'mobile' adds. Multimedia mail s becoming a killer application and is particular to mobile environments, in which cell phones eventually will be equipped with 1M pixel CCD built-in cameras and VGA full color displays. 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. In that context, we have discussed the future direction with three key words: hyper operator network, mobile content, and seamless service, in which mobility support, AAA, environment/delivery context representation and adaptation mechanism are identified as key technologies. We anticipate that the new technologies will be realized soon.