The development of mobile communication networks has led us to discuss wireless technology, which will continue to develop in the future.

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Abstract; Nowaday's common use of the term "wireless" in everyday speech virtually invariably refers to a mobile phone. Over the last decade, the mobile communications markets both in Japan and across the globe have seen unprecedented expansion. During these last ten years, voice communication has consistently been the most sought after service. Nonetheless, cutting-edge mobile communications systems are beginning to prioritize e-mail and Internet over phone calls. The future is a wireless multimedia civilization where mobile communications and the Internet work hand in hand. Mobile communication networks rely on wireless technologies. Focusing on wireless technology, this article examines the development of mobile communications systems during the last decade and predicts the emergence of cutting-edge wireless innovations essential to the realization of a wireless multimedia society over the next decade..

key words: *Word-of-mouth marketing, multimedia messaging, wireless Internet, and other mobile comms systems*

1. Introduction

Ultimately, we want to be able to share any kind of information, with anybody, at any time, from any location. Technology advancements in wireless communications are what make this a reality. We have relied on mobile communications for a decade because of the crucial capabilities they provide to our communication networks. When mobile communication devices first became available, people could only make and receive phone calls from their homes, workplaces, or public telephone booths. For the general public, the first mobile phone service began in Japan in December of 1979. The first decade had a slow pace of expansion. The recent decade has seen a dramatic increase in the use of mobile communications services, which had previously grown at a slower pace than other industries until the liberalization of mobile communications services in 1988 and terminal markets in 1994. Nearly 57 million people in Japan have signed up for cellular or PHS service by March 2000, which is roughly 45% of the population. Portable phones are simpler to use and have a higher usage efficiency (they weigh less and have longer conversation times [1], both of which are made possible by better LSI technology). A similar meteoric rise in mobile communications has seen Throughout the globe, nications services may be found in almost every city. Contrarily, the number of fixed analog telephone users has steadily decreased from its high of 61 million at the end of March 1997 to 55.4 million at the end of March 2000, and was surpassed by the number of mobile communications users. This demonstrates unequivocally that individuals prefer interacting with other people than seeing other locations. Our culture currently relies heavily on mobile communication technology. Mobile communication systems have just recently begun to advance beyond merely facilitating the transmission of voice and fax messages to facilitating the transmission of a rich variety of speech, text, and picture data through the Internet. Mobile communications systems are built on the foundation of wire- free technology. This article examines the development of mobile communications systems during the last decade and looks forward to the next decade, when cutting-edge wireless technology will be essential to the realization of a genuine wireless multimedia society.

2. Wireless Internet Society is Our Future

For a long time, voice chat was the most popular service on fixed networks. However, the advent of Internet The advent of modern communication methods has had a profound effect on our society. Rapid growth in mobile communications, personal computers, and the Internet may be seen in Figure 1 [2]. There is little doubt that Internet services have spread across our society at a far faster rate than more conventional services. With only a few clicks, users may access a wealth of information from a variety of sources on the World Wide Web.

Fig. 1 Time taken to arrive at 10% penetration (household) point

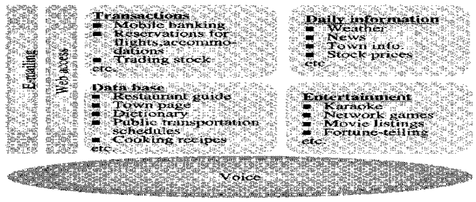
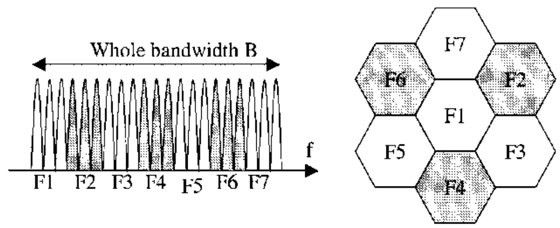


Fig. 2 "i-mode services" available with 2G systems.



information, including photographs, use online purchasing and trading services, and practically quickly ex- alter electronic mail messages instead of utilizing traditional postal systems. The focus of mobile communications services has switched from voice chat alone to electronic mailing and Internet access to match the rising popularity of Internet communications in fixed networks. One such service is "i-mode ser- vices," which enable mobile Internet access over 2nd generation (2G) cellular networks utilizing the Japan standard PDC-Packet technology [3]. In addition to regular phone calls, you may also take use of a host of other services, such as e-mail, the World Wide Web, and a host of other online offerings in every conceivable industry, from banking to video games (Fig. 2).

The mobile phone has evolved into a multipurpose device for both personal and professional usage, facilitating not just voice calls but also text messages, photos, and videos. Given the poor data transmission rates of the current 2G networks (e.g., 9.6 kbps) and the limited size of the screens on portable phones, users are limited to textual information. However, beginning in 2001-2002, far more robust representation will be available on the much-improved third-generation (3G) systems known as the International Mobile Telecom- munication Systems (IMT)-2000 in the International Telecommunication Union (ITU) [4]. Information transmission rates of up to 2 Mbps are possible..

3. Past 10 Years of Wireless

An Overview of Wireless Fundamentals

Two-generation (2G) networks nowadays are built on the back of the well-established cellular paradigm. To provide consistent user connectivity throughout a large geographical region, many base stations are deployed in a spread-out pattern. Each base station uses a separate channel group (an example of F = 7 is shown in Fig. 3), which is made up of all the wire- less channels in the available frequency bandwidth. Different clusters (F cells with unique assignments) share the same channel groups.

Fig. 3 Cellular concept.

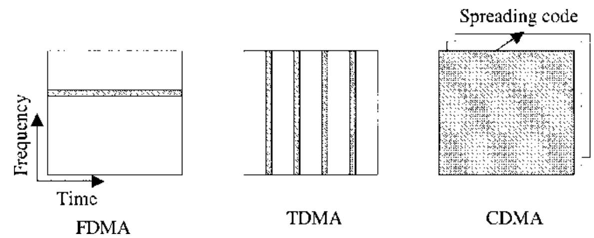


Fig. 4 Multiple access techniques.

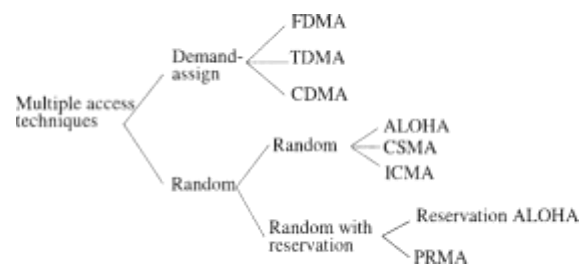


Fig. 5 FDMA, TDMA, and CDMA.

A clustering of channel groups. To cover a large geographical region with a little amount of frequency bandwidth, this method is used. Wire- free multiple access mechanisms must be used to allow for the maximum number of mobile users to communicate with a given base station. Different types of traffic need the employment of various multiple access strategies (see Fig. 4). With demand-assign based multiple access, the channels are divided in a static fashion and each user is allo- cated one or more channels by a base station during its communication regardless of whether or not trans- mitted data is generated, making it ideal for scenarios in which a very short trans- mission delay is required, such as voice conversation. Frequency division multiple access (FDMA), time division multiple access (TDMA), and code division multiple access (CDMA) all fall under the category of demand-assign based multiple access (CDMA). The available frequency, time, or coding space is used to set up the channels (see Fig. 5). In contrast to FDMA and TDMA, in CDMA all of the base stations utilize the same frequency bandwidth, such that F = 1, and all of the users share the same frequency bandwidth and time, but are kept apart by means of various spreading code sequences.

In contrast, random multiple access is employed when data creation is unpredictable and the peak-to-average rate ratio is large; in this scenario, several users share a single communication channel and send their packets in a haphazard or coordinated fashion. Most well known are ALOHA, CSMA, and ICMA [5]. It is possible to combine any kind of random multiple access with any form of demand-assign multiple access. When a mobile phone is turned on, it contacts the base station to seek a channel. The base station chooses one of many available channels to use depending on the kind of transmission being used (FDMA, TDMA, or CDMA). There is a cluster of busy mobile phones all using the same assigned channel. The mobile phone is included till it is put into a dormant condition. To prevent the channel from being overcrowded, the assignment of channels serves as a kind of admission control. During the dynamic state, mobile phones in the same cluster use a random multiple-access method to connect to the same base station. Fourth-generation (4G) systems, which provide superior Internet access services to mobile customers, will need this kind of wireless connectivity. Method of Evolution

The historical development of cellular mobile communications networks is seen in Figure 6. It's fascinating to see how each new decade brings new innovations that further improve the capacity for communication. We'll trace the development of wireless multiple access methods throughout the history of mobile communications. One Generation to the Next

It wasn't until the 1980s that the first generation (1G) of mobile communications systems like AMPS, TACS, and NTT were put into use. These networks used narrowband FDMA (25-30 kHz channel spacing) for analog FM wire-less access [6]. Then the 2G systems, such as the North American standards IS54/136, the European standards Global System for Mobile (GSM), and the Japanese standards Personal Digital Cellular (PDC), were introduced.

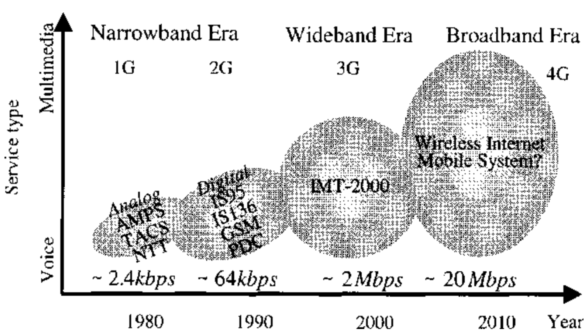


Fig. 6 Evolution path.

All of the systems that went live in the 1990s used TDMA, with channel spacings varying from 25 to 200 kHz. Later, IS-95 began rolling out a wireless access method based on narrow-band direct sequence CDMA (DS-CDMA) [7]. In comparison to other 2G systems, its channel spacing of 1250 kHz is quite generous.

As was previously noted, the "i-mode services" denote the evolution of the primary services supplied by current 2G networks from voice conversations to multimedia communications through the Internet. But all 1G and 2G systems were designed to be optimized for the most fundamental services, such as phone, fax, and low-speed voice-band data. Advanced services similar to "i-mode," but with far faster transmission rates and significantly better representation, are anticipated from the next 3G networks. From Second Generation to Third Generation

The development of 3G systems is warranted for three main reasons: improved support for multimedia, increased data transfer capacity, and the establishment of a universally accepted technical benchmark. The 9.6 kbps transmission rate of 2G networks is insufficient for accessing multimedia-rich content like articles and photos. We anticipate a significant spread in required data rates, from 8 kbps all the way up to several megabits per second. Next, the problem of connection capacity must be solved so that mobile communications can keep up with the still-continuing fast rise in demand. As more individuals in the 21st century travel for work and pleasure, establishing a worldwide standard is becoming more and more crucial (2G system standards are, more or less, regional stan- dards).

The goal is to achieve data transmission speeds as high as 2 Mbps with the same quality as fixed networks. Here we present the bare minimum requirements for various situations in terms of data transmission speeds and quality.

The bit error rate and data transfer rate in the house is 2.048 Mbps. Speeds of 384 kbps and a BER of 106 for pedestrians and 144 kbps and a BER of 106 for cars.

It takes 14 minutes at a 9.6 kbps user rate on 2G systems to send an image file measuring 1 MByte, but with a 2 Mbps transfer rate, the time required to send the file is drastically reduced (to 4 seconds).

The International Telecommunication Union (ITU) has entered the last stages of standardization for the 3G system. The wireless access method is now Wideband DS-CDMA [8]. The three modes of operation are shown in Fig. 7. Time division duplex (TDD) [9], Time division duplex (FDD) [10], and Frequency division duplex (FDD) [11]. The two-gigahertz band will be used. For the 2G systems now in use, two completely globalized core networks are available: GSM-MAP for GSM systems and ANSI-41 for AMPS and IS-95 systems.

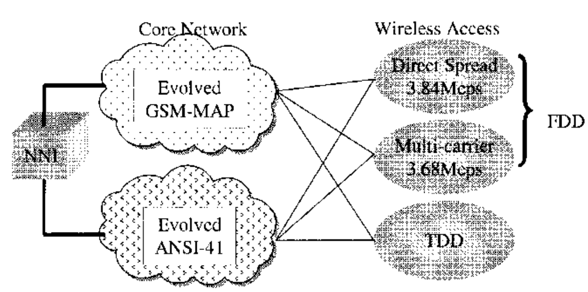


Fig. 7 3G system.

Fundamentalweb-

works will develop into 3G backbone networks, with the aforementioned air interfaces linking to both GSM- MAP and ANSI-41 backbone networks.

By the years 2001 and 2002, 3G networks will be available in most parts of the globe.

Towards a Wireless Future in the Next Decade

The arrival of 4G networks is predicted for approximately 2010 (see Figure 6). Broadband multimedia services for mobile users are a primary focus, since they will soon be widely available on fixed networks based on next-generation Internet technologies. The quality of data being sent over the Internet will improve with time. It's possible that high-quality still and moving photos make up the bulk of the data. Explanation of the 4G wireless standard, please.

As was indicated at the beginning of this article, 3G networks are superior than 2G networks in terms of data transfer capacity and their ability to manage Transmission Control Protocol and Internet Protocol (TCP/IP) traffic. However, 3G networks may not be completely optimized for TCP/IP packet traffic since they will progressively develop from 2G by capitalizing on their past. Therefore, the 4G system's core network must be completely optimized for TCP/IP traffic. It's possible that the data transmission speeds of 3G networks aren't robust enough to deal with the many types of information that rich graphics entail. This calls for a radical departure from the wireless and network designs of both 2G and 3G systems.
See Table 1 for a comparison of 1G to 4G systems, and Figure 8 for a proposed layout of 4G networks. The wireless component will converge on the wireless local area network (WLAN), but with the same wide area mobility management seen in 2G and 3G networks. Fast and reliable connections are essential for mobile communications systems' various call control services and distributed database. These will operate as a "virtual leased line" within the TCP/IP-based backbone networks. While speech traffic may be carried as TCP/IP packets (voice over IP), ensuring quality of service and minimizing latency remain significant challenges.

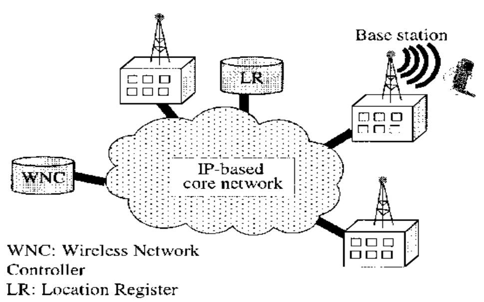


Fig. 8 Conceptual configuration of TCP/IP-based 4G systems.

Table 1 Comparison of 1G to 4G systems.

Generation	1G	2G	3G	4G
Wireless Access	Analog FDMA	*Digital* TDMA, *CDMA*	*Digital* *CDMA*	*Digital* *?*
Major Services	Voice	Voice *Internet (text only)*	Voice *Internet (text, images)*	*Voice over IP* *Rich Internet*
Core-network	Circuit-based	Circuit-based	Circuit- and *Packet-based*	*Fully IP-based*

technological issue (which may be simpler to implement if TCP/IP is utilized over ATM networks).
Concerning the wireless component, wireless Internet access will constitute the backbone:

- Wireless TCP/IP datagram

Extremely unequal volumes of traffic on the forward and backward connections; Broadband random multiple access.
An effective wireless random multiple access method is urgently required. Demand for peak throughput on the forward connections is expected to be more than 2 Mbps in a vehicle environment and greater than 10-20 Mbps in a stationary-to-pedestrian environment [10]. Because forward and reverse connections experience different volumes of traffic, wireless access networks need to be rethought from the ground up.
Wireless LAN and wireless ATM are two further methods that leverage wireless technologies to provide multimedia services to people on the go [11]. It is likely that in the 4G era, cellular core network designs will converge with wireless LAN and wireless ATM architectures and transition to a packet/cell-based model (or inter-technology mobility management will be introduced among cellular, wire- less LAN and wireless ATM networks). TCP/IP traffic is expected to greatly outnumber circuit switched traffic (such as voice) in the near future, making TCP/IP-based core networks very desirable.

pertaining to 4G service. Take note that various efforts are being made to provide TCP/IP data transmissions over ATM networks. The ATM network's ability to efficiently transmit several forms of traffic while ensuring their respective QoS criteria is a major benefit. These types of traffic include the delay-sensitive audio traffic and the best-effort type TCP/IP traffic. Could the Concept of Cells Eventually Fade Away?

The 4G systems are expected to operate at frequencies higher than 5 GHz. One thing to keep in mind is that the propagation loss increases as the carrier frequency does [13]. In addition to interference, the power available across the wireless channels is quite low. Because of this, a nano-cell or pico-cell structure is likely necessary, and an adjustable antenna array will undoubtedly play a crucial part in alleviating this power issue.
The nano/pico-cell structure means that propagation statistics are highly impacted by the microscopic structure of neighboring propagation settings and constantly evolve from cell to cell. Furthermore, countrywide coverage through 4G networks is next to impossible. Places with heavy use of multimedia devices may be covered. These results indicate that the cellular paradigm, which is based on the statistical features of propagation channels, may not be enough for designing 4G systems. Which theoretical framework should 4G networks be built on? For this problem, an ad hoc wireless network might be the answer. Each base station may be placed where it is most useful, and others can be removed or added as required; the stations link to each other in a self-configuring manner so that they can share TCP/IP traffic. This is quite close to the current Internet setup in hardwired systems. Ad hoc networks rely on dynamic TCP/IP routing algorithms that take into account user

mobility. Ad hoc network base stations' coverage zones do not overlap because of their limited range. Therefore, integration with 3G networks is crucial. These ad hoc networks will operate on top of the principal 3G cellular network in densely populated places like downtown cores, retail malls, airports, and the like. It is crucial to address the problem of inter-technology mobility management between 3G and 4G ad hoc networks. Software radio technology is needed for this, which would allow a single mobile terminal to connect to both 3G and 4G networks.

Distributing several receive stations is one strategy for lowering the transmit power of mobile phones; transmit base stations with high transmit powers may be positioned in close proximity to 3G networks' anchor nodes. Fig. 9 depicts this concept clearly. This idea works well for non-real-time TCP/IP packet transport since those functions need not be present in the same base station.

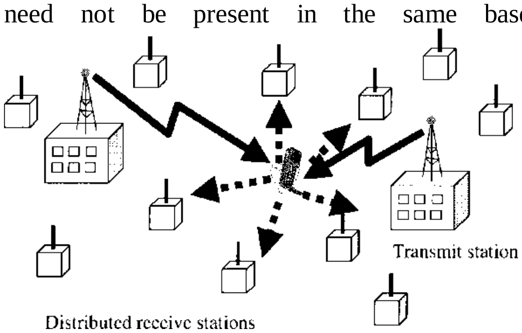


Fig. 9 Distributed receive stations.

Which Wi-Fi Method Should You Use?

There will inevitably be another dispute similar to the one over 3G wireless multiple access. The propagation channel becomes a severe frequency selective channel when multiple access methods are used, making it difficult to achieve a high data rate and good quality transmission. More sophisticated wireless methods need to be developed. Due to the large disparity in traffic between the forward and backward connections, it is possible that these two directions will each use a unique wireless access strategy.

The combination of orthogonal frequency division multiplex (OFDM) and code division multiple access (CDMA) is a viable choice for a random multiple access approach, since it provides both multi-rate and high-speed service flexibility and resilience against multipath fading. It's important to note that different types of multiple access may suffice for forward and reverse lines. For instance, DS-CDMA or OFDM-CDMA may enough for the reverse link, while OFDM-CDM may be more appropriate for the forward link. In addition, forward and reverse lines might have dissimilar frequency bandwidths. Consequently, TDD may be preferable than its counterpart, FDD, for the duplex design. Adaptive transmission, which adjusts its parameters to account for the channel's strengths and weaknesses, is another potential method. Random access with retransmission is a simple solution; nevertheless, performance guarantees at the very least are required. Here, the amount of modulation used may be changed depending on the state of the channel.

4. Conclusion

Wireless multimedia communication systems that can provide a wide range of Internet services to mobile users are the next logical step for mobile communication systems, which have rapidly become a crucial part of our society's underlying infrastructure. This article looked back at the development of mobile communication networks and discussed the last decade of wireless technology. A new generation emerges about every 10 years.

There was a sudden emergence of a system. To maximize the benefits of digital technology in terms of quality and frequency efficiency, wireless access approaches progressed from FDMA (1G) to TDMA (2G) and CDMA (3G). In 2010, 4G systems are expected to become widely available. The technological challenges of 4G networks were the topic of our conversation. The backbone of the network will be built on TCP/IP. Wireless communications are significantly power-limited since the projected frequency bands are above several GHz and the data rate over the air will be more than several Mbps. It's possible that a combination of OFDM and CDMA, two widely used random multiple access technologies, might be the most effective. The widely accepted and widely used cellular approach may not be the best solution. Wireless ad hoc networks, which provide adaptable base station placement, may offer a more workable alternative. More- over, it is feasible to lower the broadcast power of portable phones since the reception functions may be detached from the base station and can be geographically scattered.

A combination of mobile com- munications and the Internet will play a significant role in the development of the wireless multi-media society expected to emerge in the 21st century. There are a lot of challenging but exciting technological hurdles to overcome before we can create this society.

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