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Integration of Wired and Wireless Networks through a Personal Communication network (PCN)

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Abstract: *The Personal Communication Network (PCN) is known as the personal communication services (PCS) and is the result of the evolution of a mobile phone system. The PCN aims to support the services provided by the second generation mobile systems and also provides services which were not previously implemented. Thus the PCN is visioned as a system that will integrate all the wired and wireless networks. As we know that all the wired and wireless networks are widespread while others are emerging. Thus we need to study how these networks are being interconnected to each other to form a communication infrastructure.*

I. Theory

The Personal Communication Network(PCN) is known as the Personal Communication Services (PCS) in North America [57] and is the result of the evolution of a mobile phone system whose first deployments can be traced back to tile early 1980s. In order to understand why tile PCN is now emerging it is worth going through the different stages of its evolution.

First-generation mobile phone systems

The first-generation of mobile wireless phone systems were analogue and invented by Bell Laboratories about 1982. They were deployed in several countries: in the USA AMPS (Advanced Mobile Phone Systems) standardized was widely used; in England TACS (Total Access Communication System) was deployed; while in Japan the NTT (Nippon Telephone and Telegraph). The only service provided by these system was voice communication transmitted using frequency modulation techniques using two bands of frequencies; one for base station to mobile phone and another for mobile phone to base station transmission.

Second generation mobile phone systems

The second-generation of mobile phone systems is characterized by the use of digital technology. They have been in use in several countries since the early 1980s. Currently there are three inter- national standards
GSM: The Global System for Mobile Communication used in European countries.
IS-54: The North American Electronic Industry Association system used in the USA, Canada and Mexico. In contrast with the GSM and Japanese Personal Digital Cellular (PDC) systems which are fully digital, this system is digital-analogue, i.e. it enhances rather than replaces the old AMPS analogue system.
PDC: The Personal Digital Cellular System used in Japan.
Second-generation systems offer advanced transmission techniques like speech coding, error correcting channel codes, and bandwidth modulation techniques

Third generation mobile phone systems

As second-generation mobile phone networks are still being deployed a third generation is emerging. This system is a digital one and expected to integrate existing and future wire and wireless phone systems and called the PCN (Personal Communication Network) in Europe and PCS (Personal Communication Systems) in North America. Briefly, the PCN can be described as a system with enhanced capabilities for worldwide ubiquitous multimedia communication.

II. The PCN

Tile PCN is aimed not only at supporting the existing services provided by existing second generation mobile systems but also to provide

• **ubiquitous communication**: based on personal and terminal mobility the PCS will provide facilities for communication between two parties anywhere at any time i.e. regardless of the terminal they use two parties will be able to communicate at any time independently of their geographical location even when one of the or both are on tile move.

• **single universal phone number**: Users will 11ave a mobile handset which will respond to the same number regardless of where in the world the user is located; naturally, users will get a single bill.

• **Customized set of services**: independent of location a user will have the services she is used to.

• **high-functionality handset**: Tile mobile user handset is expected to evolve towards a mobile device with multimedia data communication and computation capabilities; among those capabilities are: voice telephony, voice e-mail, fax, video

telephony, teleconferences, database access, navigation, location, etc.

III. Mobile Data Networks

Mobile cellular phone networks like the European GPS, the North American IS-54, -and the Japanese PDC were designed mainly for voice communication. Although they can also transmit data messages at 9.6 Kbps, they have to compete against mobile data networks in this field. Mobile data networks have been designed specifically to provide data services in urban regions and offer data rates of 8 to 19.2 kbps. They offer wireless data transmission upon which several applications can be built; among the most important are: Internet access, e-mail, remote database and file access, wireless bank card verification, and real time vehicle (taxis, trucks) location. Currently MOBITEX (developed by Ericsson), ARDIS (developed and run by Motorola), and CDPD (the Cellular Digital Packet Network introduced by IBM) dominate the market.

IV. Satellite Networks

Thanks to their high location (thousands of kilometres up in the sky) and their wireless communication medium satellites can offer unique features that can certainly complement both wire and wireless terrestrial communications.

Wide coverage A single geostationary satellite can cover 1/3 of the earth's surface. In other words, a constellation (a group of satellites working for the same purpose) of three of them can cover the whole surface of the earth (the polar regions excluded Needless to ay, communication takes place regardless of-the distance and obstacles between the communicating points.

Wide mobility support Worldwide communication is guaranteed for everyone located under the satellite communication umbrella, even for users on the move walking, driving, sailing and flying.

Independence of geographical impediments A satellite communication infrastructure is a suit- able solution for hostile terrains (archipelagos for example).

Flexibility Having the satellite in orbit it is relatively easy and quick to deploy a communication network over a wide geographical area and to reconfigure it according to changes in user location and traffic requirements; this facility could be the answer to the problem of casual concentrations of mobile users for short periods of time (at football stadiums for example); moreover, in cases of terrestrial catastrophes when terrestrial networks are normally damaged a satellite link might be of great use.

Broadcast capability a satellite beam is inherently a broadcast medium; for applications of broadcast nature like remote conferences satellite communications might offer advantages over terrestrial ones.

V. Related Work

Projects aimed at the integration of these networks are currently under way. The International Telecommunication Union (lTU) is supporting the so-called Future Public Mobile Land Telecommunication System (FPLMTS) project that will provide a world-wide Personal Communication Network (PCN). In Europe The RACE programme was launched in 1987 and include projects to identify the enabling techniques for what would be the Universal Mobile Telecommunication System (UMTS); it concluded its activities in 1995; more exactly its activities were continued by the R&D into Advanced Communications Technologies and Services (ACTS) programme. In the USA the Defence Advanced Research Agency (DARPA) initiated the Global Mobile Information System (GloMo) programme in 1994. The GloMo aims to conduct research on new opportunities for advancing the state of the art in mobile, wireless, multimedia system technologies.

Integration of wired and wireless networks

In most industrialized countries people are familiar with services provided by the communication networks we have studied. In the future the number of these communication networks and their services is expected to be even larger. If this is true, we are on the way to ending up with a mess of incompatible networks offering similar services unless some work is conducted toward their integration. The purpose of this integration is to ensure that a user, be he indoors or on the move, is provided with the communication services he demands, no matter what terminal he is using or what computers or networks his information travels through on its way to its final destination.

For this to be possible it is necessary to integrate all the individual networks together into what we foresee as a global ubiquitous communication network (we will call it a global communication network for short) i.e. a network made up of multiple interconnected local and wide area networks with the already well established wired telephone and Internet networks serving as backbones. The essential goals of FPLMTS, UMTS, and GloMo] are the same. The system everybody has in mind is in fact the global worldwide universal ubiquitous communication network expected to be at least partially operational in 2000. In order that this goal be met the following must be achieved:

- Integration of existing wired and wireless networks. The PSTN, ISDN, B-ISDN, Internet and cellular telephone network to mention some of them,
- Deployment of services for delivering voice, video, and data communication between ubiquitous communicating counterparts, be they people or computers. Among these services are:

- dialogue (eg., speech, video telephony)

- messaging (email, fax, paging voice)
- Information retrieval (eg. multimedia WWW documents, voice, music, video on demand, newspapers)
- Access to electronic libraries
- When applicable the quality of wireless services should match that of wired networks.
- Support of unlimited mobility for both computers and users.
- Development of new computing techniques supporting mobile computing.

A picture of how the global ubiquitous communication network will probably look in the near future in presented in figure 1.1. In this figure a computer equipped with a wireless antenna and called a mobile support station plays the role of a bridge between the wireless PDA and the wired world. This will be explained below.

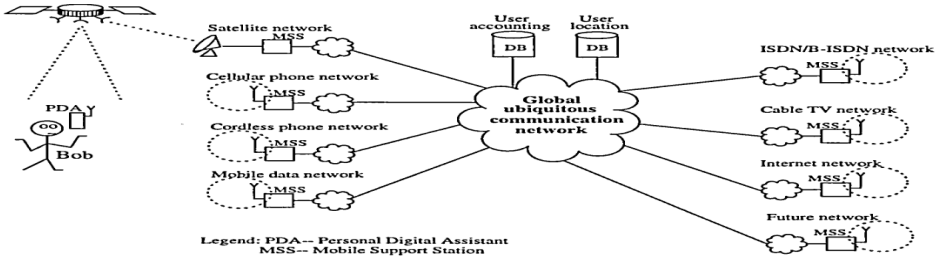

FIGURE 1.1 Global Communication Network

As illustrated in figure 1.2 there are many existing and potential services that make our predictions appealing to both ordinary individuals and business oriented people, an individual will use this global ubiquitous communication network to access several facilities:

- To exchange information (e-mailing) with his wife who is home and with his son who is on his way to the cinema.
- To retrieve information from his office, from a central database for example.
- To access publicly available databases; for example, databases of job vacancies, tourist attractions, etc.
- To access remote available services like bank transactions, Internet shopping, train booking, weather forecasts, financial news, and so on.

VI. WAP Protocol

An essential component of the global ubiquitous communication network is the mobile computer represented in figures1.1 and 1.2 by Bob's PDA. Although in the figure is called a PDA, it can be any electronic dev ice equipped with a wireless antenna to send and receive messages and, in most

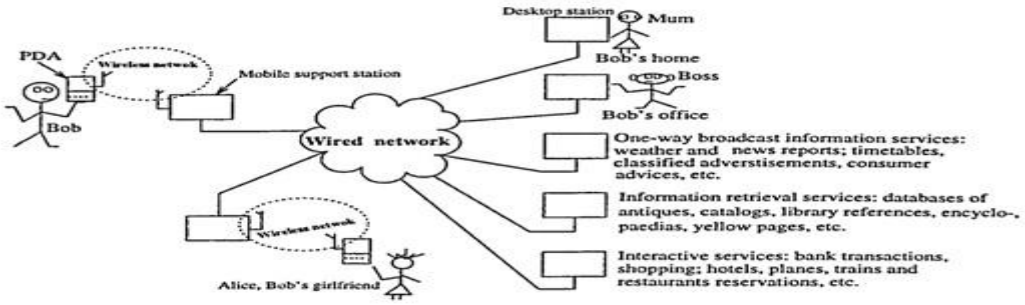

FIGURE 1.2: Services of a Communication Network

Cases, with computational power to process information Good examples of SUCll electronic device are: PDAs, mobile telephones, pagers, and other handheld communicators.

As its name and the name of its promoters imply, the WAP protocol is an industrial standard for integrating mobile communicators and the Internet. It primarily aims at providing access to Web information and services to mobile telephone users. Consequently, it is designed to run on top of already deployed wireless transports (called bearers) like GSM, IS-54, PDC, CDPD, MOBITEX, DECT, etc.}. The WAP designers decided to include IP as a separate bearer to leave room for integrating wireless devices with any IP-based network, for example a wireless LAN.\

Rather than inventing new technology, the designer of the WAP protocol made intensive Use of already proven technology, in particular, they based their design on the Web technologies and philosophies. To gain access to the large amount of information stored on Web pages from a devices with power, energy, communication bandwidth, and screen-size limitations they proposed a proxy architecture shown in figure 1.3.

The WAE User Agent that runs on the wireless client on top of its WAP protocol stack is a micro browser specially designed to run on a small screen and manipulated by a mobile telephone notepad. The Gateway is a proxy server that translates requests from the WAP protocol stack to the WWW protocol stack. To reduce the size of data over the network and the size of the data received from a Web server (Origin Server in WAP terminology) Encoders and Decoders are

used in the gateway. The latest news about the WAP protocol and complete specification of each layer of its protocol stack can be found in the Web page Forum [88].

Based on the latest tendencies in wireless communications we are positive that tile WAP protocol will be well established in the market in about three to five years time.

If our prognosis about the WAP success and the massive proliferation of PDAs in the future is correct, PDAs and similar devices will serve as the most popular outdoor interface to gain access to the global ubiquitous communication network. For this to be possible, MSS have to be widely geographically available and handy.

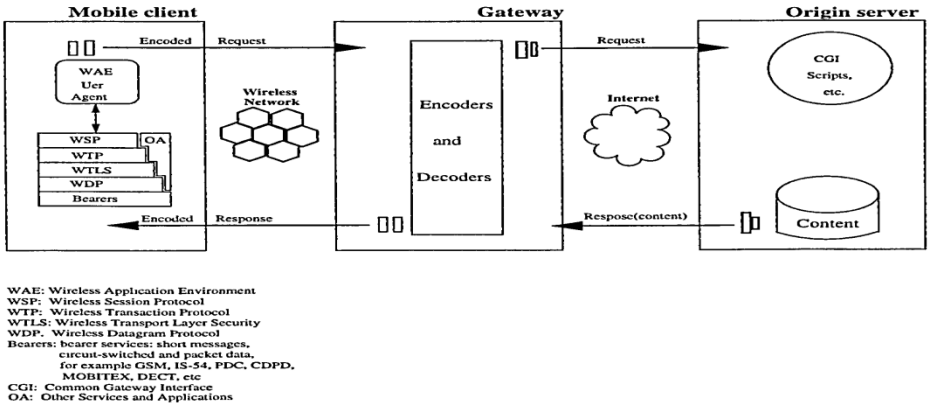

FIGURE 1.3: WAP Architecture

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- We assume that in the near future the earth will be crowded by thousands of MSS; some of them will belong to private LANs and be located indoors; others will belong to communication providers (WAP bearers for example) and be located outdoors.
- A private MSS will be run by a private company and provide access solely to PDAs belonging to its company.
- A public MSS will be run by a public communication provider and serve any PDA user willing to pay for the communication service.
- Optionally, a private MSS may serve visitors.

VII. Conclusion

Based on the latest tendencies in wireless communications we are positive that the WAP Protocol will be well established in the market in about 3 to 5 years time. If our prognosis about the WAP success and the massive proliferation of PDAs in the future is correct, PDAs and similar devices will serve as the most popular outdoor interface to gain access to the global ubiquitous communication network. If the above assumptions provides to be true in the future, a PDA user located inside a building will gain access to network services through his WLAN mobile support stations, if he decides to leave the building than his connection will switch to a public mobile support station, then if he drives his car to an area of sparse population where no public MSSs are available, his mobile terminal should be able to switch to a satellite network and remain connected to the world.

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