

Personal communication services in wireless networks

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Abstract—The paper presents modern personal services and new trends observed in evolution of wireless services. The article covers voice and data transmission services offered in mobile networks as well as information services delivered to users over Internet/IP networks. With reference to voice services, selected GSM services based on IN services platform, e.g., the services of flexible scenarios are described. Moreover, the status of VoIP service provided over WLAN is explained. Concerning data transmission services, selected UMTS services are presented as well. Among information services, presentation of wide scope of services offered to mobile users, e.g., messaging, location-based information, transferring text information, unified communications as well as Internet services, e.g., e-commerce, e-shopping, telebanking and micropayments is done. For both, voice and data transmission services, personal services are presented exclusively. Generally, the most attractive services with personal features are selected and described in this paper.

Keywords—*personal services, information services, voice services, data transmission services, services of flexible scenarios, number portability, universal personal telecommunications, universal access number, messaging, location-based information, transferring text information services, unified communications, e-commerce, e-shopping, telebanking, micropayments.*

1. Introduction

Until the early 1980s telecommunication networks have handled fixed-line telephones and have delivered plain old telephony service (POTS) services only. Telephony services have included voice telephony above all, but with some small additional (non-voice) complements like telefax, telex and data communications, mainly over private networks. Later, this situation has significantly changed and it is still changing. Today, thanks to digitization of information as well as the convergence of information and technologies, telecommunication networks carry voice, data and images.

Another fundamental change was migration from wireline to wireless communications. Although wireline (fixed) communications is still the main sector of telecommunication market, the role of cellular networks as well as wireless local area networks (LANs) and wireless personal networks becomes more and more important.

In the beginning, in traditional networks, access to high bandwidth has been provided to the corporations only (mainly via leased line solution). Later the virtual private networks (VPNs) were introduced instead of leased lines. For some corporations these solutions remained the norm.

But for modern businesses as well as for mobile employees, wireless local area networks (WLANs) solution provided by either fixed or mobile operators or Internet service providers (ISP) is offered now. Its use has increased rapidly to meet the growing demand for private as well as personal communications, because high bandwidth and broadband services are seen as a major factor in pushing forward the information society now.

2. Wireless personal communications

Wireless personal communications is a hot topic in a whole world today. It is interesting concept both for the media and for the public. Therefore, it is important subject of several technical publications, conferences and seminars. Many people want wireless personal communications, but almost everyone prefers different version of them (someone wishes access to cellular mobile radio system, another one to wireless LANs, etc.).

Wireless personal communications include many different wireless networks, systems, technologies, services and applications as well as modes, functions and range of mobility or coverage in wireless personal communications (seven of them was described in *Journal of Telecommunications and Information Technology*, no. 3/2005). The main of them are: global system for mobile communications (GSM)/universal mobile telecommunication system (UMTS), wireless LANs (WLANs) and wireless personal area networks (WPANs). These networks support the standard-based platforms that provide and control the services offered to wireless subscribers. These are the application platforms that include built-in telecommunications features as well as such next generation applications as web-based control of subscriber features, unified messaging, etc.

Independently of all, it is clear that wireless personal communication is the fastest growing segment of telecommunications. It is clear also that among the different changes seen in communications, the main question is the change from wired communications between fixed locations to wireless mobile person to person communications, known as wireless personal communications.

3. Mobility and portability in wireless networks

Mobility and portability are the most significant attributes of wireless communications, thanks to which wireless networks have evolved from physical connections to commu-

nications networks. The possibility to be free and easily change location caused rapid growth of mobile technologies and wireless communications services. Development of technology enabled increase of speed of data transmission as well as security and privacy in wireless networks. Evolution of telecommunication services leads from voice services towards specialized wireless data applications offered in UMTS, WLAN, WPAN, etc. On the other hand, supporting voice and data transmission in one packet is the most important task today. The packet-oriented data transmission and circuit-oriented voice communications converge to similar solutions at large scale in many aspects, e.g., data transfer technology as well as hierarchical routing. With reference to data transfer technology, both transmission modes can be integrated in the asynchronous transfer mode (ATM)-based networks. Concerning hierarchical routing, some intelligent routers are able to handle delay-sensitive packets.

4. Personal communication services in GSM network

Because intelligent network (IN) services platform is separated from the physical level, it is very useful for creation and implementation of telecommunication services both in the fixed network as well as mobile and Internet protocol (IP)-based networks. Therefore, it was adapted in cellular network together with the concept of services implementation. In particular, the adaptation applies to significant group of services called flexible scenarios services being the most representative group of personal services. According to the concept of flexible scenarios services, users may participate in creation of their services. For this reason, these services are becoming more and more popular categories of telecommunication services today. Some of them have been provided widely for a long time (e.g., freephone, split charging, terminal portability), other will be provided over convergent network in the near future (universal personal telecommunications, user defined routing, etc.).

Call transfer services as well as voice mail services will probably be as attractive for users in the future as they are now. But it is expected that in the near future, mainly the convergent services will be developed. Currently, some operators offer application known as fix/mobile convergence, linking fixed and mobile network features within a single service. This application gives the mobile subscribers an integrated telephone service and enables to have one number and one bill for both fixed and mobile networks.

Great popularity of Internet and cellular networks causes that integration of IP and wireless technologies is required, too. It is required now that cellular networks provide access to Internet services and offer quality of service (QoS) for voice and data transmission services comparable to one guaranteed in fixed networks. Moreover, it is required that next generation mobile networks provide wider scope of telephone and information services, especially personal services, than existing 2G GSM.

As a result of services evolution, the new generation of IN networks plus new sets of IN services and service functions are developed. Evolution of telecommunication services is accompanied by separate trend concerning creation of IN in GSM environment. This trend, known as customized applications for mobile network enhanced logic (CAMEL) makes it possible to deliver full range of services registered in users profiles to subscribers being away from home network. Limitations in access to the services may be caused only by technological or functional barriers existing in foreign network. Thanks to this evolutionary path, the modern information services, especially location-based services, were deployed.

5. Personal communication services in UMTS network

Universal mobile telecommunication system provides wide bandwidth and appropriate broadband services provisioned in accordance with the user's needs and their location. As a convergence network, UMTS adapts different accesses, installed in particular hybrid networks, with mixed use for voice, data and video distribution. Moreover, it supports data transmission-oriented broadband services, which may be created as a personal services based on IN services platform. Mechanisms needed for creating of these services are delivered by functionality known as a service creation environment (SCE). With SCE, personal services may be created based on universal program modules called service independent building blocks (SIBs). Network operators and service providers may select and couple SIBs, according to subscriber needs or requirements, either themselves or in cooperation with their subscribers. Thanks to the SCE capabilities, specific telecommunication services, having personal features, may be created. Moreover, thanks to a rich of library SIBs, these services may have individual character and they don't recur. It should be underlined, that SCE functionality enables creation of services besides the offerings of manufactures.

Evolution of UMTS communications toward data transmission services. GSM built on traditional telecommunication network infrastructure operates in circuit-switched mode and it is designed in principle for voice services. Teleservices as well as data transmission services are treated as a complement to the main application, i.e., telephony. However at present, in 2G GSM+ (GSM integrated with general packed radio service – GPRS), more data transfer-oriented services, especially in Internet services area, will be offered.

The most significant application in UMTS is related to data transmission services delivered in packet mode. It is clear, that data transmission segment is highly dynamic in 3rd generation cellular networks. Development of data transmission applications is linked to the increasing transmission speed and implementation of new services. Thus,

generally one can say that evolution of UMTS services leads toward packet data transmission services above all.

Another evolutionary path runs toward information services, especially toward multimedia services. Development of new applications and data transmission services includes new categories of information services, e.g., messaging (i.e., services delivering information required by users), location-based information, unified communications, e-banking, a-commerce, etc. In many cases, users want information delivered by multimedia services. Thanks to packet data transmission it is possible to increase the bit rate as well as to allow virtual connections and asymmetrical division of bandwidth. High speed of data transmission is necessary for implementing information services because they require wider bandwidth than others. Moreover, high speed is a great problem concerning multimedia services, especially services offered over the Internet. Therefore, the possibility of negotiating load characteristics of given stream before the connection is established and during active connection are especially important for providing required QoS. The possibility of negotiation by users of significant attributes for given connection, e.g., circuit or packet mode, bit rate, delays, BER, etc., is almost as important. Packet data transmission with high bit rate eliminates the limitations existing in GSM and provides UMTS users with access to the services on a global scale. Moreover, it allows to change channel transmission speed both up and down, which is specially needed for Internet services using asymmetrical streams.

Evolutionary path related to development of data transmission services toward Internet services leads from traditional cellular networks toward IP-based networks. From functional point of view, this direction of evolution is quite natural and evident, because in packet oriented networks (cellular networks and LANs) subscribers can be reached everywhere and are always-on. It should be underlined that IP-based networks provide their subscribers with different transaction services as well as unique applications, e.g., teleworking, supporting communication between home office and corporation resources.

Evolution of UMTS applications is (much like GSM ones) directed toward fixed/mobile convergence, which allows to provide unified services over both fixed and mobile network. One of them is unified messaging using one mail account for different information (voice, data, fax information, etc.). Access to the universal mailbox will be provided from fixed and mobile phones as well as by fax or Internet.

6. Personal voice services delivered by wireless networks

Today, access to voice services is provided by all wireless networks ranging from GSM through UMTS to WPAN. Recently, the voice over IP (VoIP) application over the WLAN has been introduced. New service gives to ISP, WLAN operators and service providers the possibility to

provision selected voice services delivered over IP protocol in their networks. Generally one can say that voice services as well as data transmission services are dedicated to and are used by businessmen spending large proportion of their time travelling. Moreover, mobile local servants, trade employees and users of teleworking application are also significant group of users of the WLAN services.

6.1. Voice over IP in WLAN

Voice over IP in WLAN is an application known as voice over WLAN (VoWLAN). It provides basic telephone service in wireless LANs. This application works according to IEEE 802.11 standard and permits transmission of voice through the WLAN. New service corresponds to VoIP service in wired LANs and allows to establish voice connections based on IP telephony procedures coordinated by the SIP functions. Quality of service and security of communications is protected by some mechanisms included in 802.11e and 802.11i standards. Thanks to VoWLAN solution it is possible to transfer the voice connection between access points belonging to different WLANs as well as between WLANs and other networks. The new solution gives users the possibility to select type of network (GSM or WLAN) used in voice transmission. Due to this possibility, standardization processes concerning VoWLAN have a significant meaning for development of this technology. Introduction of this technology may be accelerated if IEEE 802.11f will be admitted as an obligatory standard and all basic problems concerning inter-network roaming will be solved.

6.2. Personal services in WPAN network

Wireless personal area networks (WPANs) like the WLANs provide access to the Internet and telecommunication services. WPANs offer speedy and easy access to wide selection of voice and data transmission services, especially information services.

Wireless PANs have a rich functionality, exceeding one of GPRS, and comparable only with UMTS capabilities. WPAN services are based on terminal intelligence, which plays the role of personal multifunction communicator including computers, notebook, mobile telephone, etc. Intelligent terminals allow to create ad hoc networks, built in, say, bluetooth standard. Depending on capabilities of terminals, WPANs can support some specific services like wireless home networking (WHN).

Wireless home networking enables grouping of different home electronic devices. The WHN is a collection of elements that process, manage, transport, and store information, enabling connection and integration of multiple computing, control, monitoring, and communication devices at home. Each element of WPAN may be made in different technologies and architectures and may include different features and technical solutions. One of practical solutions of WHN is the controller-based voice and data

service. In this scenario, the microprocessor-based digital switch acts as the communications server, addressing and routing voice and data traffic throughout the household area. The controller is a bridge between the transport network element serving the home from the networks of the customer-selected service provider and the wireless home network. There are four distinct functional areas served by a controller-based voice and data WHN solution:

- home local area network (this allows sharing of computer files, printers, and disk drives and support multiplayer personal computer (PC) games via a wireless Ethernet and a transmission control protocol/Internet protocol (TCP/IP) local area network);
- Internet gateway (controller provides an Internet gateway addressing and routing function for sharing a single ISP account and connection between all PCs);
- wireless voice networking (each wireless handset can view and manage up to four POTS lines while the PCs are simultaneously being used on the LAN; this solution allows users to access caller ID and voice-messaging status information and make decisions regarding call management in real time);
- traditional wireline POTS networking (all telephone lines serving the household terminate on the controller and they are distributed to wireless handsets or wireless phone jacks with built-in transceivers to which standard phones, fax machines, or modem-equipped PCs can be connected).

Wireless home networking is based on several different formats, standards and specifications, which are emerging in home networking and transport between IEEE 802.11 and other networks.

Single radio ad hoc for ultra wide band (UWB) based on wireless personal area networks application includes specific distinctive features like ad hoc self-configuration, power level aware routing, dynamic latency/throughput control and multiple pico-net controller support.

6.3. Personal voice services in GSM and UMTS networks

The GSM and UMTS provide wide range of voice services generally determined as supplementary services and IN-based services. Supplementary services include many services divided into few groups, such a number identification services, call offering services, call completion services, multiparty services, charging services, community of interest services, call booking services, call restriction services and short message service. Among IN-based services is the flexible scenarios group of services, comprising universal personal telecommunication, number portability, freephone and premium rate numbers. Some of them have been provided for a long time (number portability, freephone service, split charging, virtual private network), while

other will be provided in the near future (universal personal telecommunications, user defined routing).

Number portability (NP) in mobile networks has completely different means and functionality than in fixed networks. Address assigned to subscriber in mobile network does not include any valid information about his physical location within the network. This address known as a service number is always fixed, although the user moves across the network. However, in mobile networks exist also routing numbers, which are changed due to roaming. In these networks, routing number is assigned call by call, or session by session in IP-based networks. Service number provides access to the network anywhere; in the visited network of another operator it provides access to the same service profile as in a home network. Service profile moves through the network together with the user and number portability idea is related to virtual home environment (VHE) functionality based on unique service profiles.

Freephone service (FPH) allows making calls to certain numbers without payments by calling subscribers, because the cost is covered by called subscriber. Service may be provided with different additional possibilities, e.g., in one number version, with call forwarding on busy or non reply, with call barring, with call distribution, etc. In a case when FPH service customer has several regional divisions, scenario of the service may include routing of calls depending of geographical location of calling subscriber and time of the day (origin and time dependent routing version).

Split charging service (SPL) allows the cost to be divided between calling and called subscribers in any proportion. The customer using SPL service may have multiple regional divisions, which are reached by dialling the same number.

Virtual private network (VPN) permits the operators or selected users (administrators) to create private telecommunication networks using the resources of public network. The idea of virtual network is based on assumption that subscribers of private network may be registered in different home location registers (HLRs), but whole virtual network works like as a private network built on one PBX. It is possible to apply private numbering plan in such network, tailored to the structure of particular company. There are several versions of this service. One of them gives the possibility to assign the subscriber special facilities as well as possibility to create individual user profiles. Another one enables to add VPN subscribers belonging to others networks. The application allows associated subscribers to access VPN resources, after an authentication procedure is performed.

Universal personal telecommunication (UPT) enables to give the customer a personal telephone number to get access to any (fixed or mobile) network. Incoming calls are routed to destination indicated by UPT service customer. The destination is reached in accordance with customer requirements, thanks to the use of temporary forwarding number.

User defined routing (UDR) allows the users to define preferred routing paths for originating calls. Users are able to prepare appropriate preference lists containing selected public and private nodes. Selection of connections paths is based on preferences indicated by the users.

7. Personal information services delivered by Internet/IP networks

As it was said earlier, products of evolution of telecommunication networks toward IP-based networks include integrated services provisioned in circuit and packet modes, based on IN services platform. Part of them may be implemented as personal services. Personification of telecommunication services includes more and more groups of users of wireline and wireless networks.

Personal services, especially information services created using the mechanism and tools of IN services platform, i.e., open services platform (OSP) and personal services environment (PSE) as well as interactive voice response (IVR) and virtual home environment functionality, may be provided based on different applications.

Both standardized and propriety interfaces to mobile network are used to design and provision the services mentioned above.

Messaging services. Today's messaging services allow users to access, exchange and manage all their messages sent over all media more easily – saving time and increasing convenience. Messaging services include, e.g., services delivering information and instant messaging.

Location-based information services. Application works using current user location, obtained from network. It includes, e.g., information on demand (information about hotels, airports, stations, restaurants, cafes, shops, etc.) and home zone billing services.

Services for transferring text information. The group of services used for transferring text information consists of various types of voicemail and e-mail services (e.g., visual voicemail, voice e-mail service), SMS, paging and virtual phone services.

Unified communications. Unified communications encompasses all forms of call and multimedia/cross-media message management functions controlled by an individual user for both business and social purposes. This includes any enterprise informational or transactional application process that emulates human user and uses a single, content independent personal messaging channel (mailbox) for contact access. Unified communications comprises, e.g., voice/fax messaging and unified messaging services.

Speech enabled interactive voice response. Serving as a bridge between users and computer databases, interactive voice response platform implemented in IVR systems provide telephone users with the information they need, anywhere, any time. Today this application is used to support stock trade transactions, make travel arrangements and

manage bank accounts. Most of today's IVR and transaction processing applications employ a touch-tone or dual tone multifrequency (DTMF) user interface. However, applications that allow callers to use their own voice rather than DTMF inputs to complete transactions are rapidly emerging as the latest innovation in telephony-based remote self-service.

Telebanking. Telebanking is an application making possible to implement all or some types of bank transactions in remote manner.

E-commerce. Electronic commerce solution is used for purposes ranging from fund raising to selling products. This application supports also services like hotel and flight reservation.

Micropayments. Micropayments are a part of prepaid services based on smart card solutions. These enable service subscribers to purchase preloaded credit, enabling instant activation of new category of wireless capabilities – and a new way to view the operator-subscriber relationship. Cards can contain micropayments and shopping services.

Mobile Internet. Mobile Internet is an application developing in direction new services implementation. Mobile Internet should provide the same scope of services as the fixed Internet. It will be possible in the UMTS system.

Portals services. Portals services, accessible via suitable servers, are application development platforms which allow service providers or third-party software developers to deliver services to the telephony users and to add new services and unique applications. Portals services include, e.g., web services, web surfing services, synchronized web surfing etc.

Voice portal services. In general, voice portal solution comprises all services concerning voice-controlled dialogues, voice-controlled information browsing and different enhanced Internet applications. In particular it supports applications such as: call waiting Internet, speech banking, mobile Internet (web by phone), call center, computer telephony integration (CTI), unified messaging, voice-mail, lotteries and televoting. Mobile Internet comprises such services as voice XML application, Internet call directory assistant (ICDA), free and premium call button and others.

Internet broadcasting. Internet broadcasting service called also a webcasting service allows delivering text and audio information to the user. It may be some information send in defined cycle, advertisements and radio or TV content associated with sport or music performances.

E-learning. E-learning is a category of service which gives its users the capabilities for changing type and conditions of work as well as forms and methodology of education.

E-publishing. Electronic publishing application allows the users serve the same purposes and tasks as traditional publishing, but in a more attractive form.

Video on demand. Video on demand is an application which gives the possibility to multiply signals received from various sources and present video content on demand. It allows users to receive information selected by the user from his location.

8. Conclusions

The market for telecommunication services is changing fast. Therefore, design of strategies for introducing new services must be done by identifying general trends and subsequently permanently analyzing the environment (social, technological, political and economic factors, as well as the competitive environment) for implementation and correlation of given strategy with changes that have occurred.

At present, it is a general trend indicating that the fixed telephony losses ground to the mobile one. In many European countries, the density of mobile subscribers has exceeded the density of fixed ones. Though the number of households accounts for the market of the fixed telephony, the potential for mobile telephony is larger. Currently, another trend is also clear indicating that only information services are really developed both in fixed and mobile networks. Moreover, it is evident that among the information services, mainly personal services are really needed by wide range of subscribers and this category of services has the highest growth rate today.

In this situation, it is expected that all information services concerning messaging and delivering of location-based information as well as transferring and delivering information needed by the users, will be developed towards full personalization. According to this idea, modern services will be more specialized and subscriber-oriented applications. They will be applied for the purpose of delivering the users selected information accompanied by current locations, requirements, interests and time. Based on his individual menu, the subscriber will be able to configure himself the scenarios for delivering preferred types of information.

From costs point of view, the text communications is in many cases very useful and much more profitable than voice communication. Delivery of information in SMS or e-mail form has often replaced direct voice communication. Transfer of text information may be applied in situations when the manager gives the orders to his workers being out of office or when someone wants to reserve doctor's visits or to book any products or services. In the near future mobile telephones will have capabilities for e-mail communications.

With reference to the technical means applied for transferring information, one can say that currently the fax technology has been replaced by computer technology, in spite of the fax machine ensuring moderate costs and acceptable quality. Thanks to use of fax/modem cards, fax transmission may be realized between two computers without a dedicated fax machine serving as transmission device and role of fax is considerably reduced. It is estimated that in

the near future the role of fax and paging technologies will become marginal.

Education services will be used for specific service activities based on computer networks and general access to the Internet. It can comprise medical services as well as advisory and consultative services. This category of services enables change of methods and environments for working as well as the form and methods of education process. Higher schools in form of the open universities increase the chance of access to the knowledge for people living far from the town; remote access facilitates access to open medical centers, giving new access possibilities to specialized medical consulting offered by specialists being away from their potential patients. This category of services is provided in on-line mode, based on modern means and multimedia information tools.

Telebanking will deliver increased comfort of customer service in the area of the banking. Currently, only subscribers of fixed networks have access to banking services. In the near future, banking transactions will be offered for the subscriber from any location, because mobile telephones will be equipped with applications assuring security for mobile users, required for implementing financial transactions.

Electronic commerce will be a form of economic activity, relying on offering, reserving and purchasing different products and services over the Internet or other computer network. Currently, two forms of such activity are possible: indirect and direct commerce. In the first case, e-commerce service based on electronic capabilities supports any commercial activities. The second one is true electronic commerce, fully based on information technology. In case of indirect commerce all activities concerning business transactions (presentation of information, catalogs and lists of products as well as negotiation procedures and preparing a list of products ordered) coupled with financial matters are realized in Internet in electronic form based on specific applications. Products purchased are delivered in traditional manner. This form of product distribution is dedicated to sellers as well as ferrymans and owners of travel bureaux for reservation and sales of tickets and tour services. In the case of direct commerce all activities concerning sale, purchase and delivery of products are implemented within the framework of closed electronic procedure. Commercial products have an immaterial form, thanks to that they may be delivered to the clients by information tools and means. Subjects of such commerce are e-books, news, films and music as well as software, databases and on-line services.

Till now, Internet electronic shopping has developed mainly in fixed networks. It comprises wider and wider range of products and services. In some networks shopping is currently possible for mobile users, too.

The range of information services, especially personal services, accessible over the Internet to subscriber of wireless networks is expanding. These services will be developed toward increasing their functionality and acces-

sibility. Introduction of UMTS and popularity of IP networks should improve access and quality of services, mainly due to increase of the transmission speed in radio channels.

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