THE WIRELESS ATM ARCHITECTURE

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Abstract

An overview of the proposed wireless ATM structure is provided. Wireless communication have been developed to a level where offered services can now be extended beyond voice and data. There are already wireless LANs, cordless systems offering data services and mobile data. Wireless LAN systems are basically planned for local, on-promises and in-house networking providing short distance radio or infrared links between computer system. The main challenge of wireless ATM is to harmonise the development of broadband wireless system with service B – ISDN/ATM and ATM LANs, and offer multimedia multiservice features for the support of time-sensitive voice communication, video, desktop multimedia applications, and LAN data traffic for the wireless user.

Keywords

ATM, wireless ATM, wireless LAN, mobile users, personal communications services

1. Introduction

The design of wireless ATM (WATM) has to be based on a vision of future wireless data communication user and therefore have a solid business case behind the technological development. The future public networks, the third generation systems such as the Universal Mobile Telecommunication System (UMTS) and Future Public Land Mobile Telecommunication System (FPLMTS) aim at providing end-users, apart from terminal and personal mobility. Compared to second generation systems, enhancements that will cover features all the way between the end-user and the core network elements are required, i.e., from mobile terminals to radio access and fixed network. UMTS is a system which assumes a B-ISDN core network. However, the exact radio access system to be used in a UMTS implementation has not yet been completely specified. European Union's project AC031-COBUCO aiming to implement a business-oriented UMTS environment, has selected Digital European Cordless Telecommunications (DECT) [6] and ATM technologies so as to build two trial islands, representing business environments and supporting both fixed ATM terminal and DECT cordless terminals. Additionally, fixed interconnection between those two remote islands will also be provided, via ATM links.

The future public networks, the third generation systems envisage scenarios for data users requiring bit rates up to 2 Mb/s. These future systems are predicted for high bit rate wireless access. UMTS is planned to meet the needs of a wide range of users; from people needing simple and cheap terminals for voice communication only to high-end users requiring sophisticated realtime multimedia services [5]. UMTS will offer higher bandwidth than its predecessors, but it will not be able to meet the evolving needs of users already using the new ATM based fixed broadband systems. These users require broadband data transmission with guaranteed Quality of Service (QoS). The next figure 1 shows what is the difference between future mobile system and wireless ATM system.

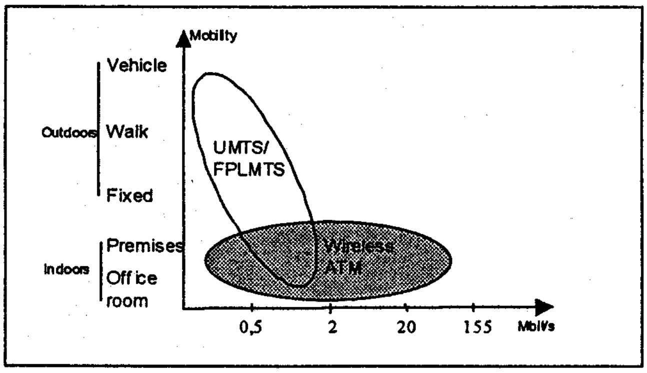

Fig.1 UMTS/FPLMTS and WATM relation.

These two systems are aiming at different user needs and do not compete with each other. The needs for the WATM development are as follows:

- multimedia applications need a wireless platform with multimedia support,
- user will require wireless access to ATM/B-ISDN network which is taken as backbone network and UMTS,
- wireless LANs cannot meet all future data user needs.

UMTS aims to integrate all mobile communication, but will fail to support broadband connections. The aim of the WATM model is orthogonal to that of UMTS; it aims to integrate the fixed and wireless broadband communications.

2. WATM System Requirements

The general aim with most wireless ATM proposals is to design an integrated services wireless networks that provide tetherless extensions of fibre-optic based ATM network capabilities in a relatively transparent, seamless, and efficient manner.

There are the four aspects that set requirements and constraints on WATM system design as follows [3] :

- supported environments,
- offered services,
- network access,
- system functions.

Environments

To design an air interface that is able to support a wide range of bit rates and quality-of-service (QoS) parameters in all kinds of environments is extremely hard. Besides, a system has to be designed to offer support in a specific environment. In European Union RACE (Research and Technology Development in Advanced Communications Technologies in Europe) research program mobile line projects, the access environments have been divided into following environments, some typical features are described:

The Business Customer Premises Network (BCPN) is private owned network that offers Private Branche Exchange (PBX) functions within the coverage area and covering large company buildings. The Domestic Customer Premises Network (DCPN) covers home-user environments. In these environments WATM service is provided in isolated areas (individual cells). In the Mobile Customer Premises Network (MCPN) an air interface is required to provide the access to the fixed network. This network covers mobile unit. The Public Network (PN) also provides function for roaming, handovers, location update and paging and is similar to the existing a public mobile network such as the Personal Access Communications System (PACS), Global System for Mobile Communications (GSM), US-Time-Division multiple Access (US-TDMA), and so on. It is expected that WATM concept would be introduced for DCPN and BCPN type of environments.

Services

The B-ISDN vision aims to integrate all communications into one universal system. ATM/B-ISDN networks offer flexible platform to the applications by supporting different services classes. The ATM forum has defined a set of traffic classes and their parameters. The traffic classes are called service categories. The ATM traffic classes defined by the ATM Forum are summarised below [1].

- Constant Bit Rate (CBR)
- Variable Bit Rate - real time (rt-VBR)
- Variable Bit Rate - non-real time (nrt-VBR)
- Available Bit Rate (ABR)
- Unspecified Bit Rate (UBR)

UMTS will offer bandwidth only up to 2 Mbit/s and in practice the actual transmission rate per terminal is expected to be lower. The RLANs (Radio LANs) are based on random access methods inherited from the fixed LANs and cannot support the transmission of delay critical broadband data. The ATM seems to be the first technology capable to offer switched broadband communication and still guarantee the QoS. Both the bandwidth and QoS are available on demand.

The WATM systems should achieve similar types of bit rates such as wireless LANs (WLAN) and HIPERLAN. The radio interface bandwidth is around 20Mbit/s and it can be dynamically allocated to uplink and downlink.

Network Access

The B-ISDN vision is to support all kinds of services in a single network. Therefore, B-ISDN needs an extremely flexible switching technology. The ATM technology has been developed to be able to fulfil the needs of the B-ISDN. So, ATM/B-ISDN is taken as backbone network. Wireless access to ATM/B-ISDN will be required by users and user find the new services offered by the fixed network useful and want to be able to use them also in a mobile environment.

The problem is how to extend the ATM and B-ISDN signalling to the wireless end-user over radio link and how include mobility into this WATM network. The introduction of terminal and user mobility into an ATM network causes a need to modify the existing network functions. There will be a user requirements to be able to move within the coverage area created by the radio transceivers and current signalling standards do not support mobility of terminals (by including signalling messages for location management or handovers).

System Functions

Mobile data offers low bit rate wireless data transmissions with wide are mobility and roaming possibility. WLANs offer mobility only in restricted, smaller areas of coverage without wide area roaming capabilities. The achieved bit rates are much greater than those achieved with typical mobile data systems.

The functions that are required to be implemented within the wireless customer premises ATM network are basically the same ones as in the wired equivalent such as call admission control, call control and policing.

Security functions of a WATM system could be similar to the security functions of the existing system.

Transmission over the wireless link imposes new constrains on security compared to transmission in fibre or cooper connections. In WATM the data bits will be transmitted over wireless air interface and eavesdropping is a real threat.

The connection management functions of a mobile system have to consider the characteristics of both the fixed and the wireless parts of the connection. The mobile terminals are moving and changing the base station they are using. Location management is needed to have information about the location of the terminal for the network to be able to communicate with the mobile terminal. In fixed networks connection control is needed to establish, modify and release connection.

Paging is the function for finding the mobile terminal and informing it about incoming traffic. Paging is done within the location areas (LA) where the mobile terminal is located according to the database entry. The page message is broadcast by the base stations of the LA.

Connection Admission Control (CAC) of an ATM network decides whether a new cell is to be accepted or blocked. Depending on the architecture of the WATM system, the consideration of one virtual path might not be enough as in wired network.

3. Mobility Support over fixed ATM Network

This parts discusses about mobile computing with wide-area internetworking in the concept of cellular and personal communications services (PCS) systems. Mobility is a key advantage of a wireless network. We focus on the internetworking between PCS and ATM. An architecture tend minimise modifications to the existing/emerging ATM and PCS specifications and implementations. There are three possible PCS-to-ATM internetworking architectures to support PCS mobility [2]. To allow normal ATM communication between fixed and mobile users, the systems are connected to a fixed ATM/B-ISDN networks. The first architecture is depicted in Fig. 2.

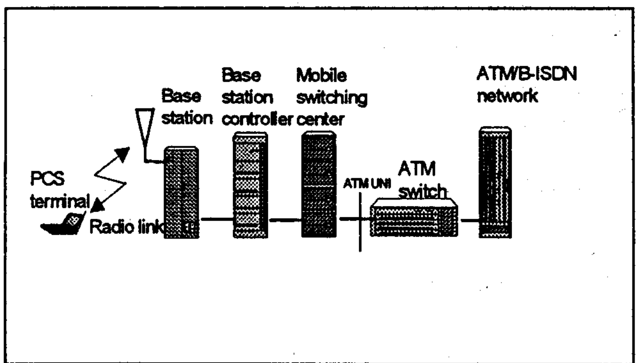

Fig.2 The mobility support by the conventional mobile switching center.

The mobility is not supported by ATM switches. The mobility specific functions are implemented to the conventional switch centers (MSCs). It is necessary to modify the MSCs to accommodate an ATM interface to connect ATM switch. The MSCs is connected to the ATM switches using the UNI. This structure require no particular standard extensions or modifications, existing ATM standard can be used.

The system shown in the Fig. 3. is assumed to consists of specific ATM switches, called ATM+ switches. These switches include mobility specific function to support terminal mobility in the system and MSCs are omitted. The base station controllers (BSCs) are modified to accommodate an ATM interface with the PCS protocols remaining basically unchanged, and in the ATM access switches. The BSCs is connected to the ATM+ switches using the UNI.

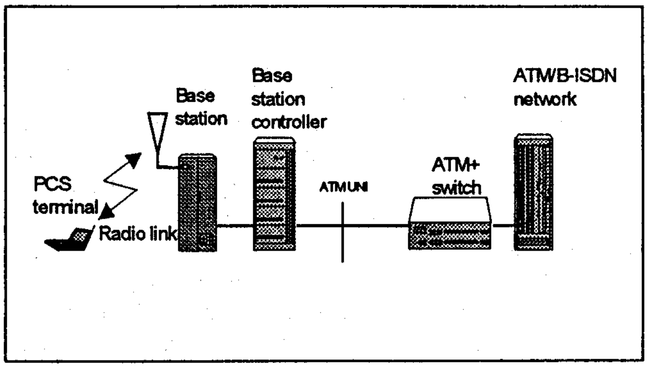

Fig.3 The architecture when the MSCs is omitted and mobility is supported ATM+ switch

The BSCs are omitted, and the base stations (BSs) are connected directly to the ATM+ switches as shown in Fig. 4. All mobility functions are moved to the BSs and/or ATM+ switches. The BSs is connected to the ATM+ switches using the UNI.

The second architecture should be more cost-effective than the first thanks to the low cost of ATM switches, in the third will be complicated the design of the BSs and ATM+ switches.

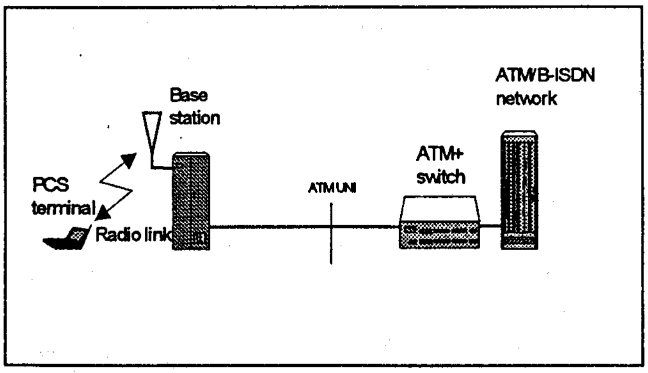

Fig.4 The architecture when the BSCs is omitted and BSs are connected directly to the ATM+ switch.

In the first architecture, signaling information is carried on separate transport platform. Data from user is transported over ATM networks, while signaling information is carried over existing Common Channel Signaling (CCS)/Signaling System No. 7 (SS7) [6] networks. In the second architecture, broadband SS7 network elements are introduced into the ATM network, and a hybrid mode of operation is considered where ATM coexist with SS7 network. In the last architecture, ATM replaces both the SS7 and trunk networks to provide unified transport for user and signaling information. These three different architectures provide several possible signaling evolution paths from the existing narrowband networks to the future broadband networks with mobility support. Three mobility signaling transport architecture for public broadband networks were detailed discussed in [7-9].

4. Conclusions

The progress towards ATM transport in fixed networks has already started and market push is strong. ATM offer data rates that are considerably higher than current fixed network services. It is expected that the new applications evolve that fully exploit all the capabilities of the ATM transport technology.

The benefits of a WATM access technology should be observed by user as improved service and improved accessibility. The WATM offers the promise of improved performance and quality of service, not obtainable by other wireless communications systems like cellular system, cordless networks or wireless LANs. On the second hand, WATM technology set extremely hard requirements on the wireless air interface. The successful introduction of WATM is strongly related to the success of ATM/B-ISDN in wired network.

The fate of ATM and B-ISDN strongly depends on commercial aspects; the availability of reasonably prized equipment, the consumers' interest in the new services and the cost of maintaining and upgrading existing systems. Today, however, it is commonly agreed that ATM will have a major role in the future of telecommunication.

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