Heterogeneous Wireless Networks Using a Wireless ATM Platform

Spiros Louvros
COSMOTE S.A., Greece

Dimitrios Karaboulas
University of Patras, Greece

Athanassios C. Iossifides
COSMOTE S.A., Greece

Stavros A. Kotsopoulos
University of Patras, Greece

INTRODUCTION

Within the last two decades, the world of telecommunications has started to change at a rapid pace. Data traffic, where the information is transmitted in the form of packets and the flow of information is bursty rather than constant, now accounts for almost 40 to 60% of the traffic that is transmitted over the backbone telecommunication networks (Esmailzadeh, Nakagawa, & Jones, 2003). In addition to data traffic, video traffic (variable rate with real-time constraints) was made possible by low-cost video-digitizing equipment (Houssos et al., 2003).

Asynchronous transfer mode (ATM) technology is proposed by the telecommunications industry to accommodate multiple traffic types in a very high-speed wireline-backbone network. Briefly, ATM is based on very fast (on the order of 2.5 Gbits/sec or higher; Q.2931 ATM network signaling specification, ITU, n.d.) packet-switching technology with 53-byte-long packets called cells being transmitted through wireline networks running usually on fiber-optical equipment.

Wireless telecommunications networks have broken the tether in wireline networks and allow users to be mobile and still maintain connectivity to their offices, homes, and so forth (Cox, 1995). The wireless networks are growing at a very rapid pace; GSM-based (global system mobile) cellular phones have been successfully deployed in Europe, Asia, Australia, and North America (Siegmund, Redl, Weber, & Oliphant, 1995). For higher bit-rate wireless access, the *Universal Mobile Telecommunications System* (UMTS) has been already developed. Finally, for heterogeneous networks, including ex-military networks, ad hoc cellular and *high altitude stratospheric platform* (HASP) technologies are under development, and standardization for commercial data transmissions in heterogeneous environments has launched.

A *wireless ATM transmission network* provides a natural wireless counterpart to the development of ATM-based wireline transmission networks by providing full support for multiple traffic types including voice and data traffic in a wireless environment. In this article, an architecture for a wireless ATM transmission platform is presented as a candidate for the interconnection of heterogeneous, wireless cellular networks.

TECHNICAL BACKGROUND

Wireless Mobile Network Overview

In 1991 the European Telecommunication and Standardization Institute (ETSI) accepted the standards for an upcoming mobile, fully digital and cellular communication network: GSM. It was the first Pan-European mobile telephone-network standard that replaced all the existing analogue ones.

Broadband integrated-services data networks (B-ISDNs) are the state-of-the-art technology in today's wired telecommunication links. The main feature of the B-ISDN concept is the support of a wide range of voice and nonvoice applications in the same network. Mobile networks have to follow the evolution of fixed networks in order to provide moving subscribers with all the services and applications of fixed subscribers. The result of this effort (although somewhat restrictive in terms of realizable bit rates) was another evolution in mobile networks: general packet radio services (GPRSs) and the enhanced data for GSM evolution (EDGE) network (usually referred to as 2.5G), with rates of up to 115 Kb/s and 384 Kb/s, respectively, when fully exploited.

UMTS is the realization of a new generation of telecommunications technology for a world in which personal services will be based on a combination of fixed and mobile services to form a seamless end-to-end service for the subscriber. Generally speaking, UMTS follows the demand posed by moving subscribers of upgrading the existing mobile cellular networks (GSM, GPRS) in nonhomogeneous environments.

3.5G and 4G systems (Esmailzadeh et al., 2003) are already under investigation. Aiming to offer "context-aware personalized ubiquitous multimedia services"(Houssos et al., 2003), 3.5G systems promise rates of up to 10 Mb/s (3GPP [3rd Generation Partnership Project] Release 5), while the use of greater bandwidth may raise these rates even more in 4G (Esmailzadeh et al.). On the other hand, in the last five years a standardization effort has started for the evolution of WLANs (wireless local-area networks) in order to support higher bit rates in hot spots or business and factory environments with a cell radius in the order of 100 m. For example, IEEE 802.11 variants face rates of up to 11 Mb/s (802.11b) and 54 Mb/s (802.11a/g), while rates in excess of 100 Mb/s have already been referred (Simoens, Pellati, Gosteau, Gosse, & Ware, 2003). European HIPERLAN/2 supports somewhat lower rates but with greater cell coverage and enhanced MAC (medium access control) protocols. In any case, 4G and WLAN technology are going to be based on an IP (Internet protocol) backbone between APs and access controllers, or routers and the Internet. Mobile IPv4 and IPv6 are already under investigation (Lach, Janneteau, & Petrescu, 2003) to provide user mobility support for context-type services.

Heterogeneous Wireless Networks Overview

In the near future, the offered communication services to mobile users will be supported by combined heterogeneous wireless networks. This situation demands actions in the following engineering issues.

- Integration with existing technologies in the radio network and in the switching levels of the involved combined wireless communication networks.
- Reengineering of the appropriate interface units at the link layers of the involved networks in order to support optimum access procedures to the corresponding media.
- Implementation of systemic handover procedures in order to combine the independent handover and roaming procedures of the involved wireless networks.
- Introduction of new methods and techniques to provide a number of effective security measures.
- Introduction of advanced ATM procedures in order to support optimum information routing between the main nodes of the combined wireless network.
- New protocol versions of the existing technologies in order to support interoperability demands.

It is worthwhile to mention that the possible involved wireless networks that are going to set the futuristic heterogeneous environment belong to the following categories.

- WLANs covering small geographical areas. In this case the WLANs with the adopted protocols IEEE 802.11a and IEEE 802.11g, and supporting user services on the orthogonal frequency-division multiple-access (OFDM) technique seem to appear as the great scientific interest (Simoens et al., 2003).
- Ad hoc networks, operating in specific geographical areas using the IEEE 802.11b protocol, will be involved on nested schemes under the technology of the existing cellular communication systems.