Interworking Architectures of 3G and WLAN

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INTRODUCTION

The complex and demanding communications needs of modern humans led recently to the deployment of the 3G/UMTS mobile data networks and the wireless LANs. The already established GSM/GPRS radio access technology can easily handle the voice and low-rate data traffic such as short messages (SMS); however, it is inadequate for the more challenging real-time multimedia exchanges that require higher data rates and ubiquitous connectivity. The UTRAN radio access technology provides wide area coverage and multimedia services up to 2Mbps, while the recently deployed WLANs offer radio access at hotspots such as offices, shopping areas, homes, and other Internet/intranet-connected networks, with very high data rates up to 54Mbps (IEEE 802.11g). Hence, there is a strong need to integrate WLANs and 3G access technologies, and to develop a heterogeneous network based on an all-IP infrastructure that will be capable to offer ubiquitous and seamless multimedia services at very broadband rates.

The major benefits that drive towards an all-IP based core network are the following (Wisely et al., 2002):

- **Cost Saving on Ownership and Management:** Network operators need to own and manage one single network, instead of multiple.
- **Cost Saving on Transport:** For example, the cost to provide IP transport is lower.
- **Future Proof:** It can be claimed that the future of backbone network, both for voice and data, is IP based. An IP-based network allows smooth interworking with an IP backbone and efficient usage of network resources.
- Smooth integration of heterogeneous wireless access technologies.
- The IP multimedia domain can support different access technologies and greatly assist towards fix/mobile convergence.
- **Capacity Increase:** The capacity enhancement of an IP-based transport network is quicker and cheaper. The same is also true to service capacity, thanks to the distributed nature of the service architecture.
- **Rich Services:** The benefits of VoIP are available for improved and new services, for example, voice/multimedia calls can be integrated with other services, providing a powerful and flexible platform for service creation.
- Enable peer-to-peer networking and service model.

This hybrid network architecture would allow the user to benefit from the high throughput IP-connectivity in 'hotspots' and to attain service roaming across heterogeneous radio access technologies such as IEEE 802.11, HiperLan/2, UTRAN, and GERAN. The IP-based infrastructure emerges as a key part of next-generation mobile systems since it allows the efficient and cost-effective interworking between the overlay networks for seamless provisioning of current and future applications and services (De Vriendt et al., 2002). Furthermore, IP performs as an adhesive, which provides global connectivity, mobility among networks, and a common platform for service provisioning across different types of access networks (Dagiuklas et al., 2002). The development of an all-IP interworking architecture, also referred to as fourth-generation (4G) mobile data network, requires specification and analysis of many technical challenges and functions, including seamless mobility and vertical handovers between WLAN and 3G radio technologies, security, authentication and subscriber administration, consolidated accounting and billing, QoS, and service provisioning (Tafazolli, 2005).

This article discusses the motivation, interworking requirements, and different architectures regarding 3G/WLAN interworking towards an all-IP hybrid networking environment. Five common interworking techniques and architectures that effectively can support most of the issues addressed previously are presented and discussed. These are

namely: open coupling, loose coupling, tight coupling, very tight coupling (3GPP, 2004), and the recently developed interworking technology named unlicensed mobile access (UMA), which arises as a very competitive solution for the interworking environment (3GPP-UMAC, 2005). The focus of the article is on a comparison and qualitative analysis of the above architectures.

3G AND WLAN INTERWORKING

Motivation

The main motivation for mobile operators to get involved in the WLAN business (Dagiuklas & Velentzas, 2003) is the following:

- Public WLANs provide the opportunity for mobile operators to increase their revenues significantly from mobile data traffic.
- WLANs can be considered as an environment for testing new applications at the initial stage.
- High-demand data traffic from hotspot areas can be diverted from 3G to WLAN, relieving potential network congestion.
- Location-based services in hotspot areas could be based on WLAN technology rather than using more-complex GPS-like systems.

On the other hand, a shift from WLAN to 3G could take place due to the following reasons:

- **Poor Coverage:** Users may be able to use WLAN services at the airport of departure, but not at the airport of arrival or at the hotel.
- **Lack of Brand Recognition:** The service operators are often new start-ups, which causes end-users to hesitate to use the service.
- **Lack of Roaming Agreements:** End users are forced to locate different service providers at the places they roam to.

The service provider value proposition for utilizing integrated WLANs with cellular networks includes the following benefits for carriers as well as their subscribers:

- Extension of current service offering by:
  - integrating cellular data and WLAN solutions,
  - positioning for voice phone service in hotspots, and
  - engaging enterprises with in-building solutions.
- Improve bottom line with new revenue and lower churn:
  - The carrier provides improved in-building coverage by using intranet bandwidth instead of in-building cell sites to provide coverage.
  - Cross system/service integration features become a competitive advantage for the carriers offering seamless mobility services.
  - The cellular provider derives service revenue for authentication services, mobility services, and calls that do not use cellular bearer channels.
  - The cellular handset becomes an indispensable element.
  - The handset can operate with more functionality, for example, even as gateway.
  - The subscriber increases his dependency on the handset.
- Payload traffic trade-off:
  - Some calls will hand over from cellular channels to WLAN connections when subscribers enter these coverage areas.
  - Other calls will hand over to cellular bearer channels when people leave WLAN coverage areas.
  - A more integrated approach to data traffic will probably increase the use of data transferred over cellular networks.

It becomes evident that as subscribers become more dependent on their much more useful handsets, they will call and be called more and everywhere.

3G and WLAN Architectures

The interworking between 3G and WLAN is a trivial issue that is under study by international standardization fora, namely, ETSI, 3GPP, and the UMTS Forum. The undergoing investigation has provided specific requirements that interworking solutions need to meet. The demands include the establishment of some kind of partnership between the 3G operator and the wireless Internet service provider (WISP), a common billing and accounting policy between roaming partners, and a shared subscriber database for authentication, authorization, and accounting (AAA) and security provisioning (Nakhjiri & Nakhjiri, 2005).

The work in this article refers to four already established interworking scenarios (Salkintzis, 2004) regarding 3G and WLAN, which are presented and compared to the recently developed UMA architecture.

In *open coupling* interworking architecture, there is no requirement for specific WLAN access, while each of the networks—3G and WLAN—follows separate authentication procedures. This architecture does not support seamless services, while the user performs a vertical handover from 3G towards WLAN and vice versa.