Radio Resource Management in Convergence Technologies

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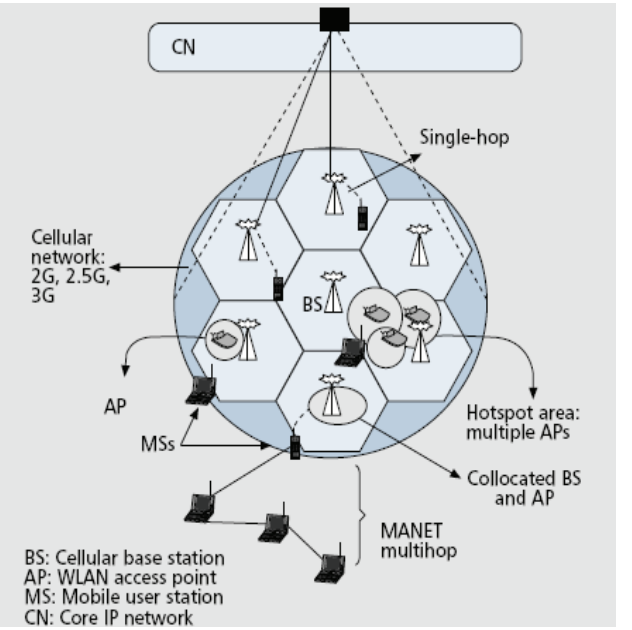
INTRODUCTION

Today we find a large number of wireless networks based on different radio access technologies (RATs) and standards. Furthermore, new RATs will be developed to complement those that exist already today. Each RAT will have its strengths and weaknesses with respect to capacity, cost, achievable data rates, and support for end user mobility. As no single RAT will be able to fully support all service and user requirements, B3G networks will integrate multiple RATs in a common network. It can be anticipated that within a few years' time, a user terminal (UT) will have a choice of access technologies via which it can connect to the fixed communication infrastructure. This paves the way towards new possibilities of managing user service quality as well as radio resource utilization. The idea of multi-access radio resource management (MRRM) handling is to explore these possibilities by co-coordinating radio resource usage of different RATs such that total system capacity as well as perceived performance for individual users is increased. The integration of different technologies with different capabilities and functionalities is an extremely complex task and involves issues at all the layers of the protocol stack. The integrated heterogeneous architecture (Dave, 2005) is shown in Figure 1.

The rest of the article is organized as follows. The internetworking proposals, the challenges while approaching radio resource management, and the RRM functions are discussed. The proposals for vertical handover management are briefed, and finally multi-access RRM distribution in B3G multi-radio access networks is discussed.

Figure 1. Heterogeneous network architecture



INTERNETWOKING PROPOSALS

There are three proposals for internetworking existing networks: tight coupling, loose coupling, and hybrid coupling. *Tight coupling* connects the WLAN network to the rest of the core network in the same manner as other UMTS radio access technologies. From the view of the UMTS core network, the 802.11 WLAN service area works like another GPRS serving node (SGSN) coverage area. As a result, all traffic—including data and signaling generated in the WLAN networks—is injected directly into the UMTS core network.

Loose coupling separates the data paths for the 802.11 WLAN and UMTS core networks. The WLAN gateway connects to the Internet, and all data traffic is transmitted into the core network, instead of into the UMTS core network, while signaling may optionally go through either the UMTS network or through the core Internet. *Hybrid coupling* creates a new wireless link between the base station (BS) in a cellular network and the access point (AP) in a WLAN within a same cell area using IEEE 802.16. It has advantages

Figure 2. Internetworking proposals

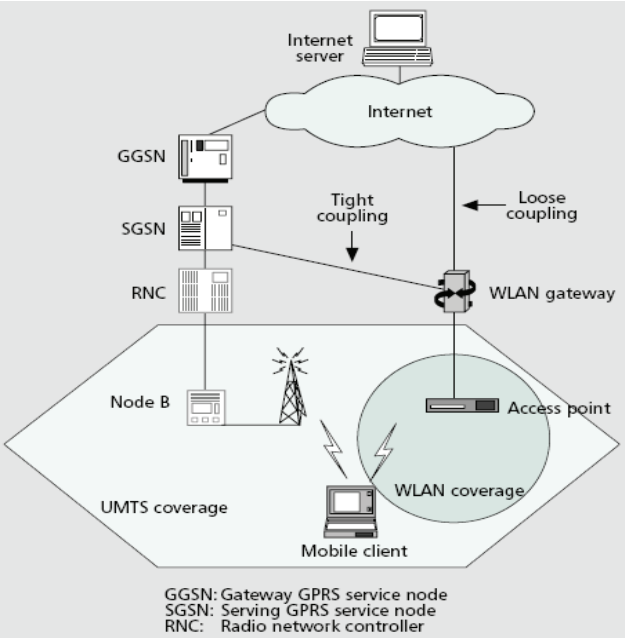
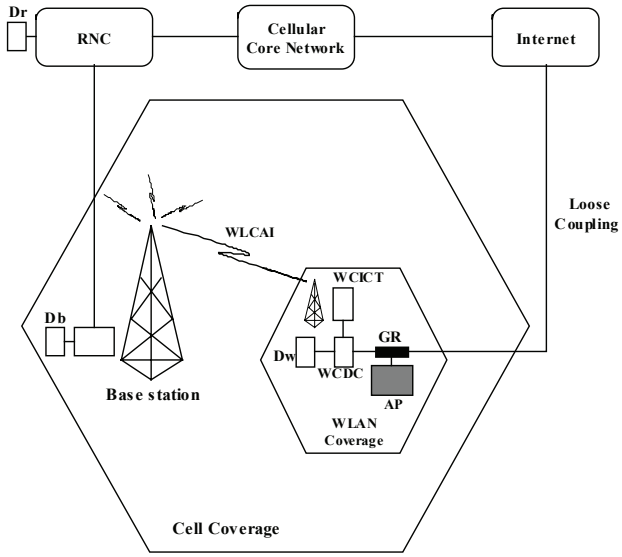


Figure 3. Priority-based service hybrid coupling interworking architecture



RNC	Radio Network Controller
GR	Gateway Router
AP	Access Point
WLCAI	WLAN-to-Cellular Air Interface
WCICT	WLAN-to-Cellular in Cell Transceiver
WCDC	WLAN-to-Cellular Direct Controller
Dr	Local Database in RNC
Db	Local Database in Base Station
Dw	Local Database in WLAN

including dynamically reducing signaling cost and handoff latency due to adoption of the fast handoff techniques, and relieving the burden of core networks through dynamically distributing the traffic.

Both tight coupling and loose coupling increase the burden of core networks (Liu & Zhou, 2004), since all signaling and data transmission pass through the UMTS core network or the core Internet, and even results in bottleneck congestion or reconfiguration of network load when the interchanging traffic is too much. These two proposals are illustrated in Figure 2.

In order to overcome these shortcomings, a priority-based service interworking architecture with hybrid coupling is developed. In hybrid coupling, a new wireless link using the IEEE 802.16 standard is created between the base station (BS) in a cellular network and the 802.11 WLAN within a same cell area. Hybrid coupling has advantages including dynamically reducing signaling cost and handoff latency, relieving the burden of core networks through dynamically distributing traffic in a low-level network, and enhancing the robustness of the integrated networks through adding a new wireless link.

The priority-based service interworking architecture with hybrid coupling is presented in Figure 3. In hybrid coupling, both the cellular network and WLAN are considered as IPv6-based networks, and each element in the interworking networks has a distinct ID number corresponding to the network routing address.

RRM CHALLENGES IN FUTURE

The distribution of RRM (Magnussen, 2004) in existing RATs varies greatly, at least partly because the RATs have been optimized for different purposes. 2.5G and 3G RATs like GSM/EDGE, WCDMA, and cdma2000 have sophisticated network-centric RRM focusing on maximizing the use of available spectrum resources and also supporting mixed traffic types with different QoS requirements(voice, videoconference, Internet surfing, file download, etc.). The basic principle is that RRM decisions are made in a network node1, in most cases based on measurements collected from terminals and other network nodes. In contrast to this, IEEE 802.11 WLAN includes limited RRM support in a terminal-centric fashion, focusing on a simple (low-cost) solution providing high-peak bit rate best-effort data without any QoS. In this case the terminal is making the most of the RRM decisions, for example which access point (AP) to connect to, with some influence from parameters broadcasted by the APs. It has been identified that the simplistic RRM support in 802.11 is an obstruction to large-scale network