

Chapter 4

Architecture for IP– Based Next Generation Radio Access Network

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ABSTRACT

High call volumes due to novel mobile data applications necessitate development of next generation wireless networks centered on high performing and highly available radio access networks (RANs). In this chapter, the authors present an innovative IP-based wireless routing architecture (for a RAN) with mechanisms for seamless handoff operations and high Quality of Service (QoS). Algorithms for dynamic configuration of the RAN, and efficacious network bandwidth management through traffic control are also presented. The authors establish the superiority of their system with real-life data indicating significant cost and availability improvements with our system over the traditional networks.

INTRODUCTION

Explosive growth in mobile data applications in recent times has motivated the mobile operators to explore efficacious and cost effective solutions for handling the backhaul traffic (from base-stations to their core networks). These solutions for the B3G (Beyond 3rd Generation) wireless networks include bandwidth optimizations in the current radio access networks (RANs) as well as IP (Internet Protocol)-based RANs over the T1/E1 and Ethernet backhaul for 1X-EVDO CDMA (1 time radio transmission

technology Code Division Multiple Access) (TIA/EIA/IS-2000.1.A -2, 2002) and HSPA W-CDMA (High Speed Packet Access Wideband CDMA) networks (3GPP2 C-S0033 Rev 0 Ver 2.0, 2003). We propose here IP-based RANs which replace legacy mobile wireless systems with innovative wireless routers (WRs) equipped with traffic management and self-configuration capabilities. These attributes together with high system availability and high QoS makes our IP RAN an ideal choice for next generation mobile wireless networks.

The proposed IP-based RAN architecture can be adapted to new long term evolution (LTE) standard for mobile communications (Ekström *et al.*, 2006,

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Ergen, 2009, Fazel & Kaiser, 2009) based on orthogonal frequency division multiple access (OFDMA) technology developed by 3rd generation partnership project (3GPP). The evolved packet system (EPS) for the evolved universal mobile telephone system (UMTS) terrestrial radio network (E-UTRAN), which forms the access side of the LTE architecture, will not impact the IP-architecture proposed here. However, our proposal could be compatible with the IP-based flat core network architecture of LTE, variously known as extended packet core (EPC) and System Architecture Evolution (SAE). As a matter of fact, since LTE release 8's air interface is intended for use over any IP-network, compatibility of our IP architecture is no issue at all.

Now that LTE has been ratified in March 2009, adaptation of the current work to LTE can be carried out.

Worldwide Interoperability for Microwave Access (WiMAX) is another competitive next generation technology for mobile communications (Ergen, 2009, Fazel & Kaiser, 2009). It is based on the IEEE 802.16 standard for broadband wireless access. The WiMAX forum proposed an architecture for integration of a WiMAX network with an IP core network. This makes it possible to adapt our IP architecture to WiMAX networks also.

BACKGROUND

Since IP-based RANs is an emerging technology, the literature on flexible and reconfigurable next generation RAN architectures based on versatile wireless routers is rather sparse. An interesting paper in this direction, Ghosh, Basu & Das (2005) provides an insight into a flexible, reliable, and cost effective IP-based RAN architecture with BSs connected to form a mesh. Bu, Chan & Ramjee (2006) discuss connectivity, performance and resiliency of IP-based CDMA RANs focusing on a star topology between the BSs and RNC (Radio

Network Controller). Vassiliou *et al* (2002) propose a RAN for next generation wireless networks based on multi-protocol label switching (MPLS) and hierarchical mobile IP. Kempf & Yegani (2002) propose a new architecture called open-RAN for mobile wireless IP RANs. Yasukawa, Nishikido, & Hisashi (2001) propose an IPv6-based wireless routing architecture with scalable mobility and quality of service (QoS) support. Chen & Hamalainen (2003) present a method for handovers in IP RANs.

The proposed wireless router (WR) architecture, its mechanisms for efficacious traffic and bandwidth management, and dynamic self-configuration are based on our earlier patented research work (Dantu, 2005; Dantu et al., 2006; Patel et al., 2006).

WIRELESS ROUTER ARCHITECTURE

1. Issues, Controversies, Problems

The legacy mobile wireless architecture shown on the right half of Figure 1 with a hierarchy of BS (Base Station)s, BSC (Base Station Controller)s, and MSC (Mobile Switching Center)s has a number of shortcomings with respect to handling of large volumes of data in B3G networks: i) wireless frame selection for handoff management is done at BSCs resulting in the duplicate traffic flow on the backhaul, ii) even during the ideal periods of a call, transmission resources are reserved resulting resources wastage in contrast to the IP-networks equipped with the statistical multiplexing scheme, iii) only 15% of the BS-BSC traffic is payload, and the rest is overhead, iv) BSs forward erroneous frames also BSC and this results in dead payload on the backhaul, v) uneven utilization of links makes the system inefficient, cost-ineffective, and unsuitable for deployment of new data intensive services, vi) transmission delays in long BS-BSC links could cause soft-handoff failures and call

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