

Convergence Technology for Enabling Technologies

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INTRODUCTION

Today, we find a large number of wireless networks based on different radio access technologies (RATs). Every existing RAT has its own merits. Now the focus is turned towards the next-generation communication networks (Akyildiz, Mohanty, & Xie, 2005), which will seamlessly integrate various existing wireless communication networks, such as wireless local area networks (WLANs, e.g., IEEE 802.11 a/b/g and HIPERLAN/2), wireless wide area networks (WWANs, e.g., 1G, 2G, 3G, IEEE 802.20), wireless personal area networks (WPANs, e.g., Bluetooth, IEEE 802.15.1/3/4), and wireless metropolitan area networks (WMANs, e.g., IEEE 802.16) to form a converged heterogeneous architecture (Cavalcanti, Agrawal, Cordeiro, Xie, & Kumar, 2005). Seamless integration does not mean that the RATs are converged into a single network. Instead the services offered by the existing RATs are integrated as shown in Figure 1.

Convergence technology is a technology that combines different existing access technologies such as cellular,

cordless, WLAN-type systems, short-range wireless connectivity, and wired systems on a common platform to complement each other in an optimum way and to provide a multiplicity of possibilities for current and future services and applications to users in a single terminal. After creating a converged heterogeneous architecture, the next step is to perform a common radio resource management (RRM) (Magnusson, Lundsjo, Sachs, & Wallentin, 2004). RRM helps to maximize the use of available spectrum resources, support mixed traffic types with different QoS requirements, increase trunking capacity and grade of service (GoS), improve spectrum usage by selecting the best RAT based on radio conditions (e.g., path loss), minimize inter-system handover latency, preserve QoS across multiple RATs, and reduce signaling delay. A typical converged heterogeneous architecture (Song, Jiang, Zhuang, & Shen, 2005) is shown in Figure 2.

CHALLENGES

The integration of different networks to provide services as a single interworking network requires many difficult challenges to be addressed. Because existing networks do not have fair RRM, the major challenge that needs to be addressed has to be mobility management. The heterogeneous network architecture will be based on IP protocol that will enhance the interoperability and flexibility. IETF Mobile IP protocol is used to support macro mobility management. But both IP protocol and mobile IP protocol (Pack & Choi, 2004; Montavont & Noel, 2002) was not basically designed to support the real-time applications. So, during the handoff between systems, users will experience the service discontinuity, such as long service time gap or network disconnection. Besides this service discontinuity, the different service characteristics of these interworked networks may degrade the quality of service (QoS).

Some of the other challenges include topology and routing, vertical handoff management, load balancing, unified

Figure 1. Convergence of services

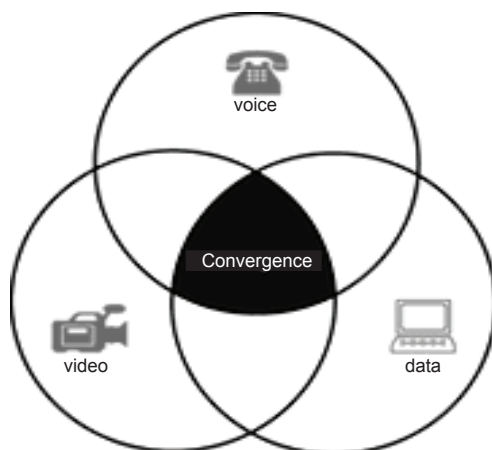
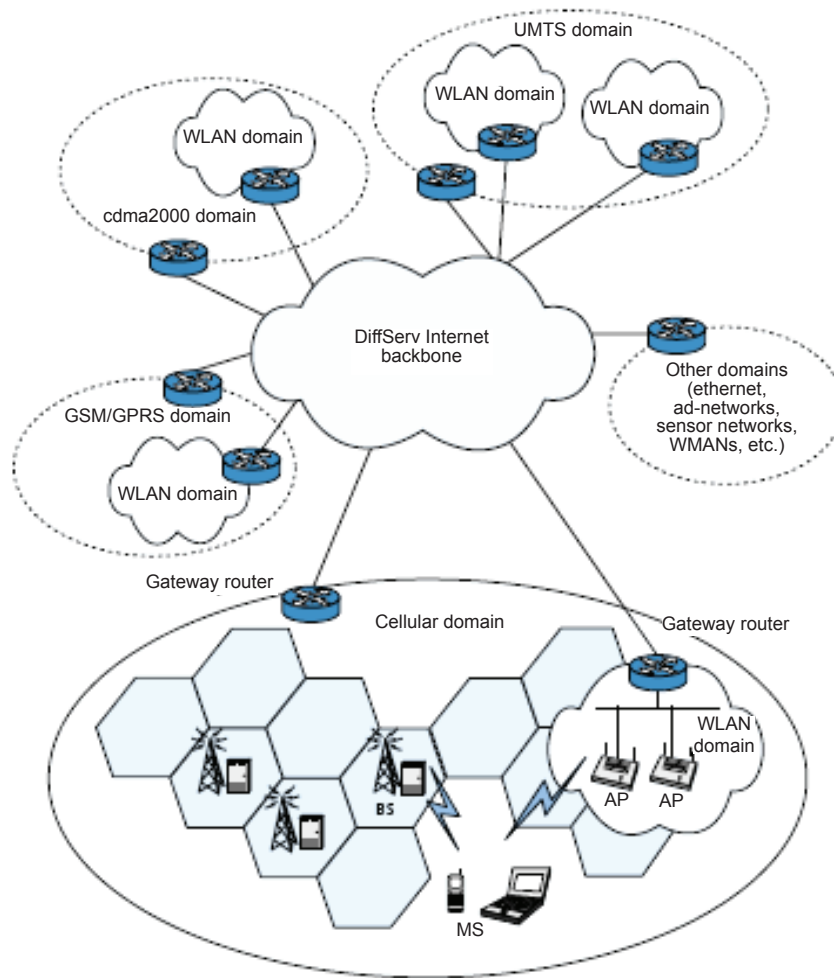


Figure 2. Converged heterogeneous network architecture



accounting and billing, and last but not least the protocol stack of mobile station (MS), which should contain various wireless air-interfaces integrated into one wireless open terminal so that same end equipment can flexibly work in the wireless access domain as well as in the mobile cellular networks.

PROTOCOL STACK

In a homogeneous network, all network entities run the same protocol stack, where each layer has a particular goal and provides services to the upper layers. 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. So in a heterogeneous environment, different mobile devices can execute different protocols for a given layer. For example, the protocol stack of a dual-mode MS is given in Figure 3.

This protocol stack consists of multiple physical, data link, and medium access control (MAC) layers, and network, transport, and application layers. Therefore, it is critical to select the most appropriate combination of lower layers (link, MAC, and physical) that could provide the best service to the upper layers. Furthermore, some control planes such as mobility management and connection management can be added. These control planes can eventually use information from several layers to implement their functionalities. The network layer has a fundamental role in this process, since it is the interface between available communications interfaces (or access technologies) that operate in a point-to-point fashion, and the end-to-end (transport and application) layers. In other words, the task of the network layer is to provide a uniform substrate over which transport (e.g., TCP and UDP), and application protocols can efficiently run, independent of the access technologies used in each of the point-to-point links in an end-to-end connection. Although there are issues in all layers, the network layer has received more attention than

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