Chapter 17
An End-to-End QoS Framework for Vehicular Mobile Networks

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ABSTRACT

In recent years we have witnessed a great demand for high speed Internet access in vehicular environment, e.g., trains, buses and medical transport. This chapter introduces an integrated architecture for 4G vehicular mobile networks, which aims to guarantee high quality in provisioned triple-play traffic services (video, voice, and data) to road users. Within this architecture which is based on a cross layer design approach, our contributions can be described in three folds. Firstly, the authors introduce simple and efficient probing mechanisms which are integrated with network resource reservation policies for multihomed vehicular networks. Secondly, packet, flow and user splitting mechanisms have been integrated with end admission traffic control and scheduling mechanisms to guarantee even traffic load distribution among available air interfaces. Finally, the whole architecture has been evaluated under OMNeT++, where results illustrate the impact of network mobility on quality in provisioned services offered to a multihomed NEMO.

1. INTRODUCTION

Fourth-Generation (4G) wireless networks technology is based on all-IP networks architecture which is envisioned to transparently and ubiquitously support triple traffic, voice, video and data for end users. This future technology is driven by the needs for more bandwidth, network capacity and new radio spectrum, calling for performance enhancement and quality-of-service (QoS) guarantees in wireless access networks. IETF has defined QoS as a service agreement to provide a set of measurable networking attributes, including end-to-end delay, jitter and bandwidth. Alternatively, the QoS can be defined as a set of specific requirements, e.g. delay, jitter, throughput, packet loss and de-sequencing (packets reordering), for a particular service, e.g. Expedited Forwarding (EF) service class (Davie & Charny & Bennett & et, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

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2002) in Differentiated Services (DiffServ) (Blake & Black & Carlson & et, 1998), Guaranteed Service (GS) class in Integrated Services (IntServ) (Braden & Zhang & Berson, 1997), Assured Forwarding (AF) service class (Heinanen & Baker, 1999) in DiffServ, control load service in IntServ and Best Effort service (Clark & Fang, 1998), which can be provisioned as point-to-point service (p2p) or e2e service by service providers (SPs) (Yokota & Idoe & Hasegawa & Kato, 2002) to subscribed customers (Jamalipour & Lorenz, 2006).

One of the recognized goals in wide communication networking based on all-IP networks technology is to realize an efficient interoperability between various types of networks: wired, wireless, radio, cellular and mobile networks to support the convergence of all communication services (data, voice, and video) onto a common IP platform (Bai & Atiquzzaman, 2003). Such an IP-based unified communication platform will enable a mobile Internet network to get benefit of all the services that could be offered through Internet network (Agrawal & Zhang & Sreenan & Chen, 2004). Furthermore, this opens new arenas into the development of intelligent transport services for road users who can be drivers, passengers, manually driven vehicles or autonomous vehicles.

Network mobility has always been a determining factor in implementing a robust and efficient communication protocol for mobile networks. Most of the mobility protocols, which have been standardized so far, require QoS mechanisms to improve and add value to its performance. This chapter investigates some of those QoS mechanisms which are required to be incorporated into the network elements employed to run network mobility basic support protocol (NEMO-BSP) (Devarapalli & Wakikawa & Petrescu & Thubert, 2005; Ernst & Lach, 2007) for vehicular communications, namely IP-based vehicle-to-infrastructure communications. Figure 1 depicts mobile networks (NEMOs) that communicate via infrastructure with external entities (correspondent nodes (CNs) or a server hosted by intelligent transport service providers (ITSPs)). NEMO-BSP (Devarapalli & Wakikawa & Petrescu & Thubert, 2005) has given a basic solution for a challenging problem with regard to network mobility, where a set of IPv6 enabled and non enabled mobile nodes moving together in one entity called NEMO, e.g. bus or ambulance shown in Figure 1, can continue to communicate with any external entities despite high and dynamic network mobility.

NEMO-BSP runs between two main network elements: home agent (HA) and mobile router (MR) to track and localize a set of nodes moving in one mobile network. One or more mobile routers can be configured on a mobile network, based on its size and amount of traffic, to manage IP addresses resolution, configuration and allocation, which are required for managing the whole network mobility. In this chapter, however, we will focus on NEMO managed by a single multihomed (multi-interfaced) MR and served by a single HA. Mobile networks can have a wide range of mobile network nodes (MNNs) which interact with one or more home agents based on IPv6 technology (Soliman, 2004; SOLOMON, 1998). MNNs can be sensors mounted on NEMO, which transmit critical data to another NEMO or a server somewhere to analyze it for safety purposes and fleet management. MNNs can be simple users surfing on Internet or sending emails and communicating through their PDAs with other external CNs. MNNs can be a group of doctors performing a surgical operation and getting assistance from others in a hospital while they are in an ambulance driving them to the hospital. MNNs can be travelers listening to music and watching video in a bus or train. MNNs might be fishermen, in their ship or boat, watching a film on TV or listening to on-line radio news. While the MR acts as a gateway for MNNs or an anchor point, the HA forwards every packet destined to MNNs to one of the different MR egress interfaces that enable it to access Internet through access routers.

The variety in MNNs and mobile network topologies require various communication wireless