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An MPLS-based architecture for scalable QoS and traffic engineering in converged multiservice mobile IP networks

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Abstract

Mobile Internet connectivity is the fastest growing business in the telecommunications market because of the evolution of digital cellular, portable computing and personal communication technologies, and is playing a vital role in shaping the 21st century communications paradigms. In this scenario, the deployment of innovative wireless data networks, the integration with the Internet and the interworking between different wireless technologies, typically 2.5/3G cellular and Wireless LAN (WLAN), will be challenging objectives for competitive service providers. These factors, combined with the impact that mobile-related traffic may have on the fixed infrastructure, and the convergence of mobile and fixed services, drive towards a rationalization of the resource allocation and management procedures and make it urgent to address quality of service and traffic engineering for mobile data communications at the core transport level. The Multi-Protocol Label Switching (MPLS) technology is a versatile solution to address the above problems which delivers a unified control mechanism with connectionless multiprotocol capabilities, running over mixed media infrastructures, and defining evolutionary signalling mechanisms to support both quality of service (QoS) and traffic engineering to allow fine control of traffic flows in the network. The purpose of this paper is to show how MPLS technology can be employed to address all the required functions of tomorrow's converged wireless/wired networks, from initial IP-level authentication and session control to sophisticated resource reservation, traffic distribution, quality of service and policy management.

Keywords: Mobile IP; WLAN; 3G mobile communication; QoS; MPLS; Traffic engineering

1. Introduction

In the last decade the Internet has evolved into a ubiquitous network and inspired the development of a variety of new voice and multimedia-based applications in business and consumer

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markets. These new applications have driven the demand for increased and guaranteed bandwidth requirements in the whole network. Furthermore, in addition to the traditional wire-line connectivity currently provided over the Internet, mobile data communication services have been experiencing an accelerated penetration which has culminated in an explosive growth to mass market dimensions over the last months, with the outlook for continued growth. Experience with laptop computers and personal digital assistants (PDAs) has shown that many end users desire their portable equipment to provide essentially the same environment and applications they enjoy at their desks with few compromises, thus demonstrating the singular importance of widespread coverage and anywhere/anytime access. Furthermore, with increasing demands for various mobile wireless data services such as wireless Internet, video on demand, video telephony, multimedia mobile mail, etc., through the emerging WLAN technologies (such us Bluetooth, 802.11b or 802.11g) and 2.5G and 3G mobile communication systems (e.g., GPRS, UMTS, CDMA2000 and W-CDMA), the number of subscribers to the wireless data services will keep growing at an astonishing pace. Accordingly, mobile-related traffic is forecast to be comparable in volume with that related to fixed networks in a not too distant future. These factors, combined with the impact that mobile-related traffic may have on the fixed infrastructure, and the convergence of the mobile and fixed services on a common IP-based stratum which can ensure full interworking between all the different wireless technologies and the traditional IP networks, drive towards a rationalization of the network architecture, resource allocation and both inter- and intra-operators' management procedures.

Unlike the classical pure wire-line network, the network also supporting mobile data services should have different unique characteristics: enormous adaptivity in handing high-speed large traffic volumes, rapid changes of throughput variability, network congestions and re-routing, and the like. Indeed, the associated dimensions of space/time dependence of mobile traffic demand, "hostile" operation environment, unpredictable quality, and changing user's network attachment point represent major deviations with respect to the traditional communications paradigm. Consequentially, from the perspective of service providers, the diffusion of new multimedia and real-time mobile data services could become another burden to be seriously handled because it could require enormous new investments and efforts to expand and manage networks, which are how optimized only for static wired data or voice services. The more critical issues for the 3G and extended WLAN network operators would be to provide a consistent and scalable end-to-end QoS solution to deliver seamless content to the mobile users without excessive delay or corrupted images and consequently build optimal traffic engineering policies for the converged IP transport network to prepare for the heavy traffic growth and handle the great variability in the flow distribution generated from the increasing number of mobile users foreseen in the coming future. However, delivering such a solution is complex, and the solution will only be as strong as the weakest link in the network. Furthermore, since the number of mobile users and terminals connected to the future wireless systems would be very large, the scalability of the QoS and traffic engineering solution and clearly of the whole backbone is of great concern and interest. To address this challenge, the MPLS protocol can give us very flexible and intelligent opportunities to dynamically and efficiently route the data flows on a traffic engineering and resource requirements basis, and to configure the protection paths for any resource failures. MPLS is actually playing a key role in delivering QoS and traffic engineering features in IP networks and can be considered a promising technology to enhance the ability of the network operators in controlling the network behaviour to deliver mobile IP services, according to customized service contracts or Service Level Agreements (SLAs).

This paper explains how the MPLS hierarchical architecture for label-switched networks can be used to address all required functions of tomorrow's converged/unified networks, from initial IP-level authentication and configuration, security, session control, resource reservation, admission control, to quality of service and policy management, enhanced only where necessary to address