Enhancing Performance of IP Service in HIPERLAN/2 Networks

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Technical Subject Area:

Wireless IP and QoS

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Extended Abstract

1. Introduction

Wireless communications have enjoyed considerable attention in the last decade. To cope with the growing demand for improved Quality-of-Service (QoS) in Internet Protocol (IP) multimedia applications, the idea of enhancing mechanisms over wireless infrastructures features as a challenging solution.

In this work, a performance enhancing entity for IP traffic, applied in different wireless technologies and referred to as the Wireless Adaptation Layer (WAL) [1], is evaluated. The WAL can be seen as an extra layer placed between the IP and the underlying wireless technology. Our focus is on the performance evaluation of the WAL over HIPERLAN/2 [2] networks, concerning the QoS offered to different kinds of IP traffic.

2. WAL Architecture

The WAL architecture is shown in Figure 1. A novel and key feature of the WAL is that it can be seen as an abstraction used for service provisioning at the link layer. Each IP packet is classified by the WAL into *chains* and *associations*.

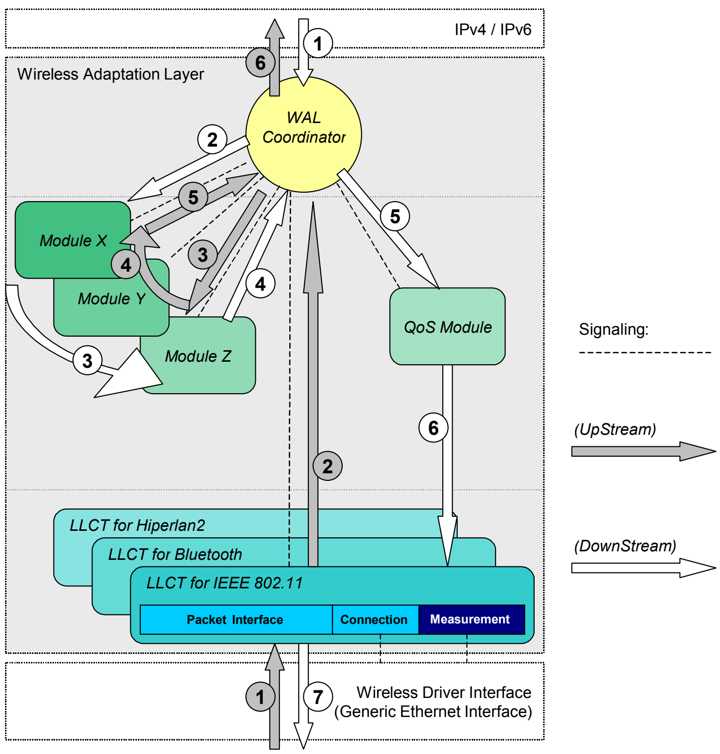

Figure 1 The WAL Architecture

A *WAL chain* defines the service offered to a particular set of IP packets and corresponds to a particular sequence of WAL modules that provide such a service. Classification of IP packets into a specific WAL chain is based on several parameters, such as the type of application traffic (e.g., audio/video streaming, bulk transfer, interactive transfer, Web) or the protocol type (e.g., TCP, UDP) etc. This classification is further explained in [3].

A *WAL association* identifies a stream of IP packets classified for the same WAL chain and destined to or originated from a specific mobile terminal (MT), i.e., *WAL_Association* = <*WAL_Chain, MT_Id*>. In other words, a WAL association corresponds to a particular type of service offered to a particular MT.

The central "intelligence" of the WAL is the WAL Coordinator. In the downstream flow, the WAL Coordinator intercepts IP packets, decides on the WAL chain that these packets should pass through, and appends the WAL header, containing the information required for the operation of the modules. In the upstream flow, the WAL Coordinator accepts WAL frames (encapsulated IP packets, as shown in Figure 2) and passes them through the sequence of modules, associated with the WAL chain, in the reverse order.

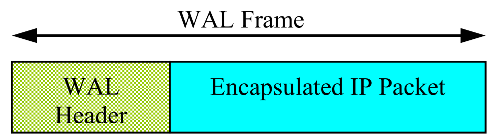

Figure 2 The structure of WAL Frame

The WAL manages to offer performance enhancements by the use of functional modules (X/Y/Z modules). The core module is the **QoS** module [4], which provides flow isolation and fairness guarantees through traffic shaping and scheduling. The other modules considered are the **Automatic Repeat Request (ARQ)** module (for error recovery), the **Forward Error Correction (FEC)** module (for error correction), the **Fragmentation (FRM)** module (for adjustment of WAL frame's length to network conditions), the **IP Header Compression (HC)** module (for increase of throughput), the **Snoop (SNP)** module [5] (for TCP performance improvement). The flexible and scalable architecture of the WAL allows the addition of new modules in the future, without changes in the overall scheme.

Finally, in order to interface with a number of different wireless technologies (such as IEEE 802.11b [6], Bluetooth [7] and HIPERLAN/2), one **Logical Link Control Translator (LLCT)** module has been introduced for each of them, performing stream adjustments and connection status updates.

3. Simulation model and results

The simulation work was performed with the use of the OPNET tool [8] and included two main parts of the system's functionality: i) the WAL and ii) the HIPERLAN/2 sub-models.

The WAL model incorporated the wide range of applications and the IP protocol stack modules available in OPNET. The functionality of the WAL was subdivided into 2 sublayers to allow flexibility. The upper sublayer included the WAL Coordinator and the dynamic creation of the WAL modules, while the lower modeled the LLCT operation. In order to simulate the HIPERLAN/2 system's behavior, a functional model based on the standards was built [9,10,11]. This model considered the basic user plane procedures at each layer (Medium Access Control, Data Link Control and Convergence Layer) and a channel model.

A variety of simulation runs with a large set of applications and network topologies were performed in order to reveal the WAL's capability to improve real-time traffic quality despite the presence of non-real-time flows. Due to space limitations, here we present only two indicative graphs from a scenario, where 2 MTs communicate through the AP with fixed hosts and exchange concurrently real-time (VoIP) and non real-time (FTP) traffic with them.

As shown in Figure 3, the WAL keeps TCP segment delay stable and low, while without the WAL, the TCP segment delay experiences great variances, resulting in greater timeouts and more retransmissions. The VoIP delay with the WAL (Figure 4) is below the threshold of 50 ms, while the absence of the WAL results in an undesirable delay up to 10 seconds.

A complete set of results is available and will be included in the full version.

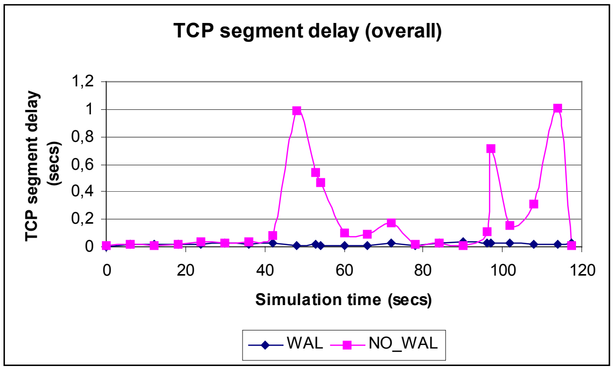

Figure 3 TCP segment delay

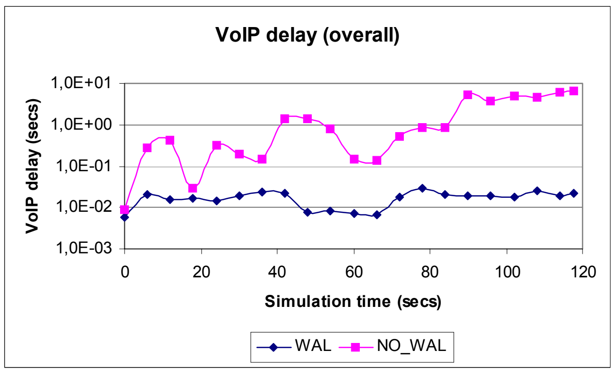

Figure 4 VoIP delay

4. References

[1] P. Mähönen, et al., "Platform-Independent IP Transmission over Wireless Networks: The WINE Approach", IEEE Personal Communications Mag. Vol.8 No.6, December 2001

[2] ETSI TR 101 683, "Broadband Radio Access Networks (BRAN); HIPERLAN Type 2, System Overview", February 2000.

[3] D. Skyrianoglou et. al., "A Generic Adaptation Layer for Differentiated Services and Improved Performance in Wireless Networks", submitted in PIMRC2002, Lisbon, Portugal, September 2002.

[4] Luca Becchetti, Franceso Delli Priscoli, and Tiziano Inzerilli, Petri Mähönen, "Enhancing IP Service Provision over Heterogeneous Wireless Networks: A Path toward 4G", IEEE Communications Magazine August 2001.

[5] H. Balakrishnan, S. Seshan, and R.H. Katz, "Improving Reliable Transport and Handoff Performance in Cellular Wireless Networks", Wireless Networks, vol. 1, no. 4, pp. 469-481, December 1995.

[6] "IEEE Standard for Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications", P802.11, Nov. 1997.

[7] Bluetooth consortium, "Specification of the Bluetooth system", v1.0B, Dec. 1999.

[8] OPNET Modeller Version 7.0.B – Simulation Tool. OPNET Web Site: http://www.opnet.com .

[9] ETSI TS 101 761-1 V1.2.1 (2000-11) "Broadband Radio Access Networks (BRAN); HIPERLAN Type2; Data Link Control (DLC) Layer; Part 1: Basic Data Transport Functions".

[10] ETSI TS 101 493-1 V1.1.1 (2000-04) "Broadband Radio Access Networks (BRAN); HIPERLAN Type2; Packet based Convergence Layer; Part 1: Common Part".

[11] ETSI TS 101 493-2 V1.1.1 (2000-04) "Broadband Radio Access Networks (BRAN); HIPERLAN Type2; Packet based Convergence Layer; Part 2: Ethernet Service Specific Convergence Sublayer (SSCS)".