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A simple model for the IP packet service time in UMTS networks

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Abstract This paper presents a simple model for the service time of IP packets in UMTS networks. The model reflects both the delay characteristics for an individual IP packet, as well as the correlation of the delay of successive IP packets. Our goal is not to obtain a quantitatively exact model. Instead, we provide a simple and easy to implement model, which qualitatively reflects the statistical properties of a UMTS radio link. Such a model is of great interest for network level simulations, where cross-layer interactions are the main focus. It provides a simple means to investigate the behavior of higher-layer protocols in a UMTS network without the need to implement a detailed model of the UMTS link layer. We verify our model by comparing the statistical properties of the IP packet service time to those obtained using a detailed UMTS model. Additionally, the results of our TCP simulations show a very good match between the simple model and the detailed UMTS link layer model.
Keywords: UMTS, WCDMA, ARQ, reordering delay

1 Introduction

It is well known that cellular communication systems of the 2nd and 3rd generation feature a relatively high packet delay and a large delay jitter if they are used for packet switched communication. Both factors may impose problems to higher layer protocols, which are usually designed to operate in wireline networks offering a small round trip time (RTT) and a small delay jitter. These cross-layer interactions between the data link layer of a mobile communication system and higher layers have extensively been studied especially for TCP (e.g. [1], [2], [3], [4]).

The loss probability of a MAC frame in cellular mobile networks may be very high. In order to compensate these losses, Automatic Repeat Request (ARQ) mechanisms are applied on the link layer. In UMTS, a selective repeat ARQ (SR-ARQ) mechanism [5] is applied on the Radio Link Control (RLC) layer. Usually, a cellular mobile network provides sequence integrity and delivers IP packets in-order to higher layers. As a consequence, the loss of a MAC frame will delay the delivery of all subsequent correctly received frames until the lost MAC frame has been retransmitted successfully. This additional delay is usually referred to as *reordering delay* or *resequencing delay*. As the detection of a loss and the retransmission of the corresponding packet take a significant amount of time, the