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Understanding Latency

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1 Introduction

1.1 About This Document

This document provides the analysis of latency between the BS and the MS.

1.2 Abbreviations & Acronyms

Table 1-1

Abbreviations/Acronyms	Definition
BS	Base Station
MS	Mobile Subscriber Station
QOS	Quality Of Service
DL	Downlink
UL	Uplink
HARQ	Hybrid automatic repeat request
UGS	Unsolicited Grant Service
eRT	Extended Real-time
RT	Real time
NRT	Non Real time
BE	Best effort

1.3 Overview

Latency is a measure of time delay experienced in a system.

- DL Latency is defined as the time delay of packets that arrive to the BS and were received by the MS.
- UL Latency is defined as the time delay of packets that arrive to the MS and were received by the BS.

In this document, the following assumptions apply:

1. There are no scheduling delays, e.g. BS is not under heavy traffic.
2. There is no shortage or priority congestion.
3. The RF condition is assumed to be good with zero HARQ retransmissions.

2 DL Latency

This paragraph analyses the packet behavior that arrives to the BS from the Ethernet interface, forwarded to the air interface and received by the MS.

Such a packet goes through the following stages:

1. The packet is received on the BS Ethernet interface.
2. The packet is classified/stripped of the GRE header and associated with a connection.
3. The packet is scheduled to a transmission to the next frame.
4. The packet is sent and received by the MS.
5. The MS forwards the received packed to the Ethernet interface or delivers it to a higher layer interface (i.e. IP).

Normally, first and second stages or second and third stages may occur on the same frame. In some cases, all first to third stages may occur in the same frame.

Also fourth and fifth stages may occur in the same frame.

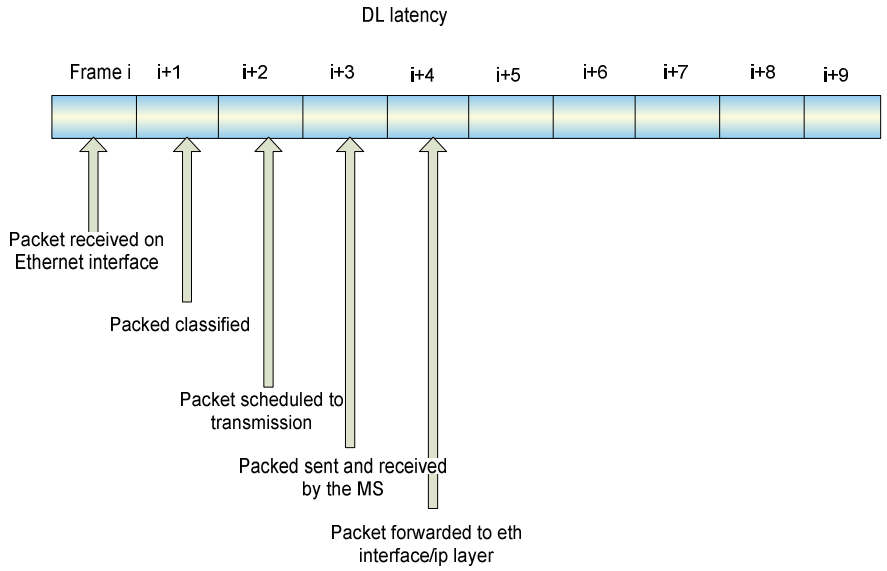
Therefore, in the average case, DL latency should be between 2-3 frames, since frame time is 5ms, the average DL latency should be around 10-15ms.

The best case scenario is between 1-2 frames, e.g. 5-10 ms.

The worst case scenario is about 4 frames, e.g. about 20ms.

The above latency calculation applies to all QOS types, e.g. UGS ,eRT, RT, NRT, BE.

Figure 2-1: DL Packet Latency



3 UL Latency

This paragraph analyses the packet behavior that arrives to the MS from the upper layer interface and sent to the air interface to the BS.

Such a packet goes through the following stages:

1. The packet arrives from the MS Ethernet interface/upper layer interface.
2. The MS sends the CDMA Bandwidth request (BWR) code. This code doesn't carry any information about the requested bandwidth.
3. The BS receives the CDMA code and allocates the bandwidth for the Bandwidth Request (BR), where the MS will identify itself and inform the BS about allocation demand.
4. The MS sends the BR asking to allocate bandwidth for the received packet.
5. The BS allocates bandwidth for the requested demand.
6. The MS sends the packet.
7. The Packet is received by the BS.
8. The BS forwards the packet to the Ethernet interface.

BE and NRT Service flow types

For BE and NRT Service flow types, normally this procedure should take about 9 frames, e.g. 45 ms as it is shown in a diagram below.

In some cases, the MS may piggyback BWR with previous data, therefore skipping stages 1-3, in that case the latency should be about 5 frames, e.g. 25 ms.

On the other hand, during stage #2, the CDMA code the MS sends may congest with the CDMA code sent from the other MS. In that case, both MSs will retry to send different codes after a random number of frames. The amount of congestions depends on the number of connected MSs and the possible number of BWR CDMA codes. The delay caused by this congestion may be around 100ms.

CDMA congestion can affect BE and NRT Quality of service (QOS) types of services only , since in other QOS types like UGS, eRT, RT data allocated in advance and CDMA codes are not used to request bandwidth.

RT Service flow type

For the RT Service flow type (also optionally NRT) , unicast polling used to pre-allocate data to send BR, latency for such connection will be Unicast Polling Interval (UPI) + 5-6 frames, i.e. for UPI = 20 ms, latency will be 25-45 ms.

UGS and eRT Service flow types

For UGS and eRT Service flow types, the BS pre-allocates data in UL per Unicast Grant Interval (UGI), so the MS shouldn't send BR. Therefore stages 2-4 are skipped. The resulting latency for such service flow is UGI plus 1-2 frames, i.e. for UGI = 10 ms, latency will be 15-20 ms.

Figure 3-1: UL Packet Latency