TSG-RAN WG1 meeting #17

R1-001404

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Agenda item: AH24

Source: Golden Bridge Technology

Title: Simulations of the UMTS traffic model and number of simultaneous active calls

Document for: Discussion

Introduction

This contribution discusses the issue of number of simultaneous active packet calls and the uplink and downlink control requirements in the HSDPA proposal. Currently, the uplink SF of 256 and 128 is proposed in the uplink direction to support the downlink packet data transfer in the HSDPA proposal. The proposal requires SF=512 and 256 in the downlink direction. The main concern and objective of this contribution is to characterize the number of simultaneous active calls which leads us to having a stronger handle on the uplink and downlink control requirements.

Simple Example and motivation

As an example, simulations showed that with 128 kbps of information rate in downlink, 6 simultaneous packet calls can be supported given the UMTS data traffic model [1]. If 1.28 Mbps of downlink capacity was allocated to this service, then 60 simultaneous calls will be supported. This translates into the following requirements:

Uplink control and signaling requirement = 60 x [15 kbps + 2.7 kbps] = 1.062 Mbps
Downlink control requirement = 60 x 7.5 kbps = 450 kbps

If we assume the following:

uplink throughput = 700 kbps
downlink throughput = 1.3 Mbps

Then, uplink control requirement limits the downlink throughput. In this contribution, we focus on number of simultaneous packet active calls.

Simulation Assumptions

The objective of the simulation study was to determine the degree of overhead in the downlink and uplink directions associated with the UMTS traffic model. The followings are the basic assumption of the above-mentioned model:

1. Downlink source rate 144 kbps
2. Downlink(DL) 95% Web-browsing, 5% ftp
3. Uplink(UL): 0.5% of Downlink ftp (unidirectional)
4. Connection release timer = 1 second

FTP application:

- Average file size = 50,000 bytes;
- Packet size = deterministic; and
- 1500 bytes: Both UL and DL directions.

Web Browsing application:

- 8 objects per page
- Object size: Pareto distributed
- Shape factor =1.1

- Maximum file size = 2 Mbytes bytes
- Location factor = 4500 Bytes
- Average http page file size = 25 kbytes
- Maximum page size [cut-off = 200,000 bytes]
- Average reading time between packet calls = 120 seconds [100 Mobiles]
- Fixed Network Delay of = 100 ms [Internet Delay]
- Add a round trip delay of 100 ms to the Base Station for an additional wireless network delay

A note on protocol architecture in the simulation

In order to perform these set of simulations for the UMTS data traffic model and closed loop packet inter-arrival time, we need to have the TCP/IP in a slow start. We have also added the http application [the page size is Pareto distributed] in order to inject the bursty nature of the download into the process.

The RLC acks and the TCP acks are part of the process as well.

Simulation Results

Under these conditions, the simulation using the OPNET tool showed that the average packet call time is 8 seconds for 25 kbytes [1.4 s] of data at the 144 kbps source data rate. The simulations showed that 6 DPCCH channels are required in the uplink and downlink directions to support single downlink channel operating at 144 kbps.

This translates into a requirement of 90 kbps uplink control. The simulations also showed that the download required uplink signaling in the order of 1:8. In other words, in order to download at the 144 kbps, 18 kbps of uplink signaling is required. This simply means that before deciding on the uplink or DPCCH structures, the uplink signaling requirement should be sized by other groups. Another related point is the cost of this uplink signaling when DPCCH is used randomly by various users and there is no scheduling. Our simulations showed that 95% of the time the totals aggregate instantaneous signaling rate was less than 18 kbps x 2.5 = 45 kbps. This statistics is sensitive to the total number of users and the standard variation is less when the number of users increase. However, the higher layer signaling load should be sized before any serious contemplation of the uplink method.

When the number of pages was decreased to 10 (number of objects per page was changed from 8 to 48), the average packet call duration (per page) was 26 seconds for transfer of 125 Kbytes [6.9 s] of a single page. The simulations showed that 4 DPCCH channels are required in the uplink and downlink directions to support a single DSCH operating at 144 kbps. The uplink control requirement is 60 kbps in this case.

Figures 1-5 capture the results. Several conclusions are drawn from these figures:

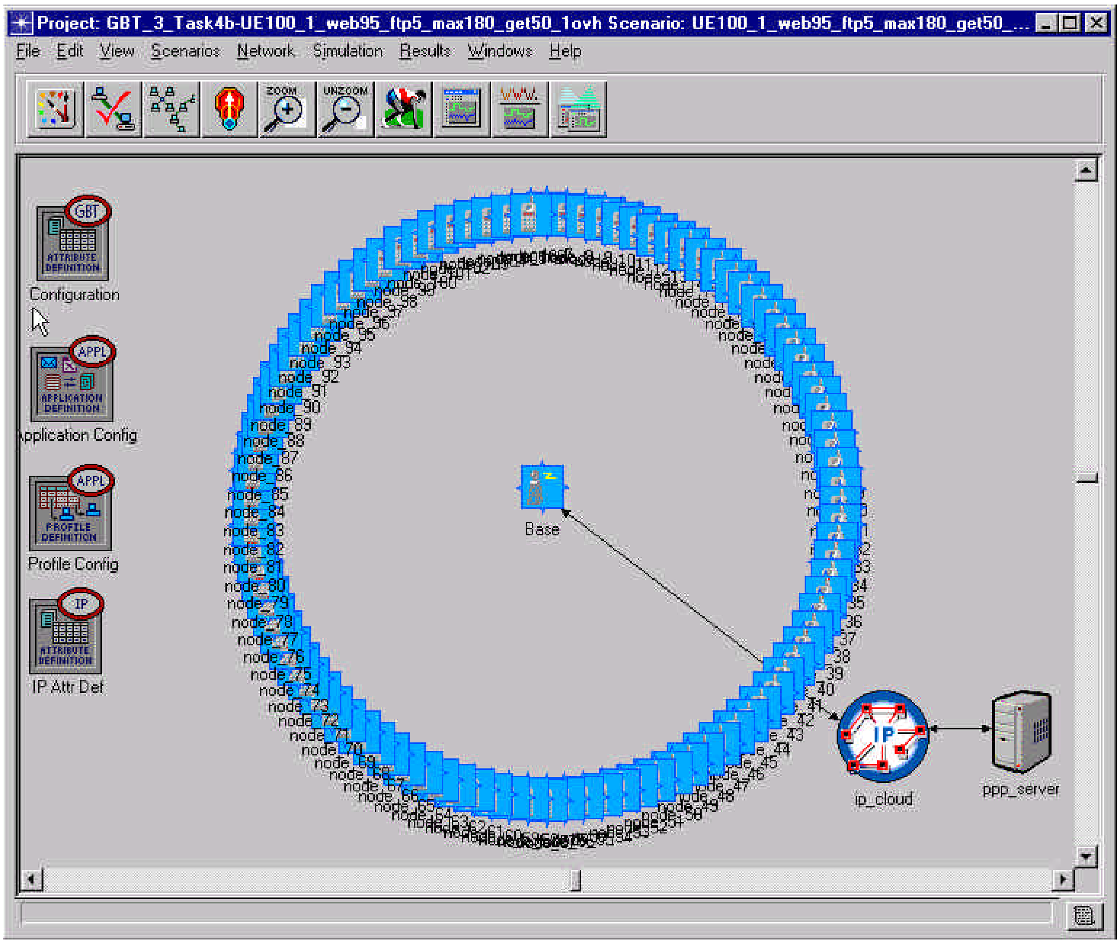
A. The packet call duration for transfer of an http page of length 25 kbytes over a 144 kbps is 8 seconds. The transfer of ftp file [50 kbytes] takes 9 seconds.

B. Uplink traffic requirement to support the http download is approximately 15% of the download. This shows an asymmetry factor of 1:8 for the web browsing application. This translates into signaling requirement of 18 kbps x TBD factor in the uplink.

C. The number of simultaneous active packet calls is 6 when the downlink rate is 144 kbps. If the total allocated downlink capacity was 10-fold, then more than 900 kbps of control+ higher layer signaling is required.

D. Note the statistics on the file size [Pareto Distributed].

Figure 1: Network topology



Simulation # 1 : Simulation of DCH for the 60 page case: Figures 1-4
Figure 2: Downlink and uplink requirements

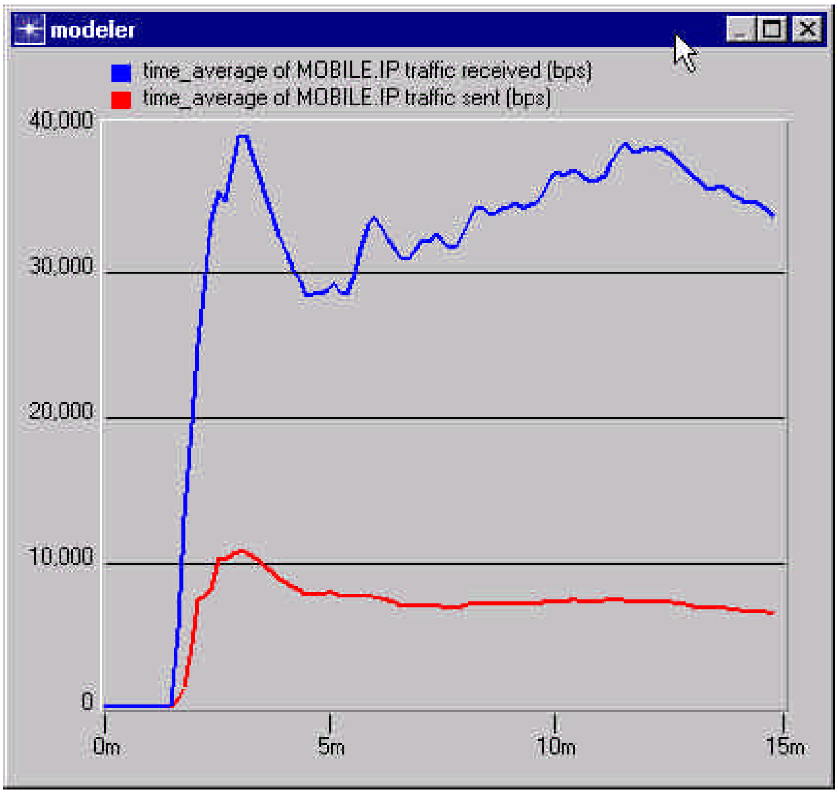


Figure 3: Response times

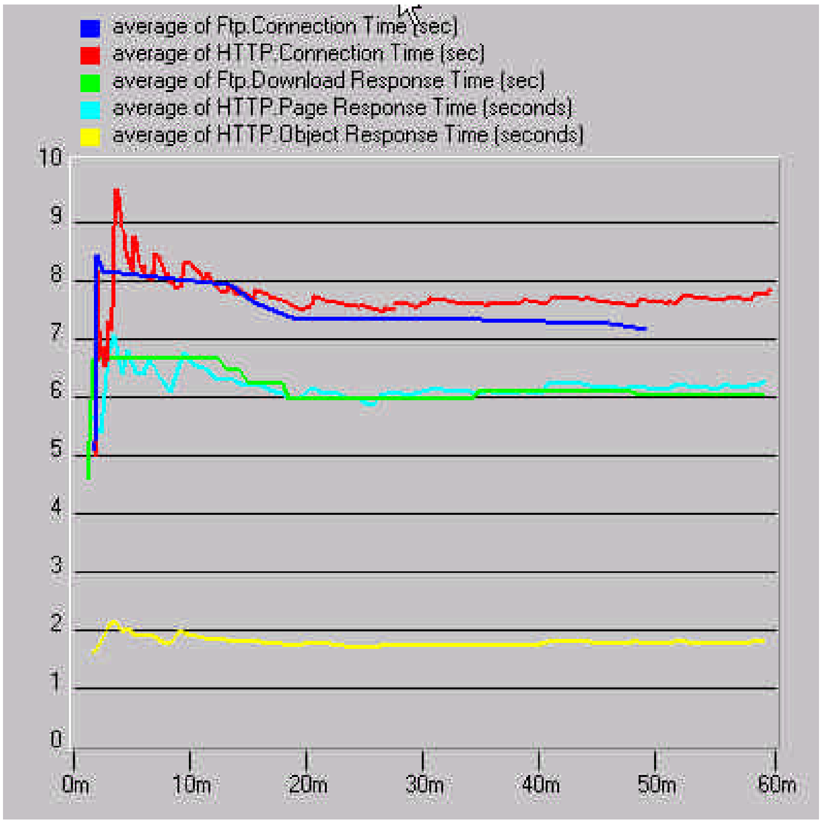


Figure 4: Page sizes

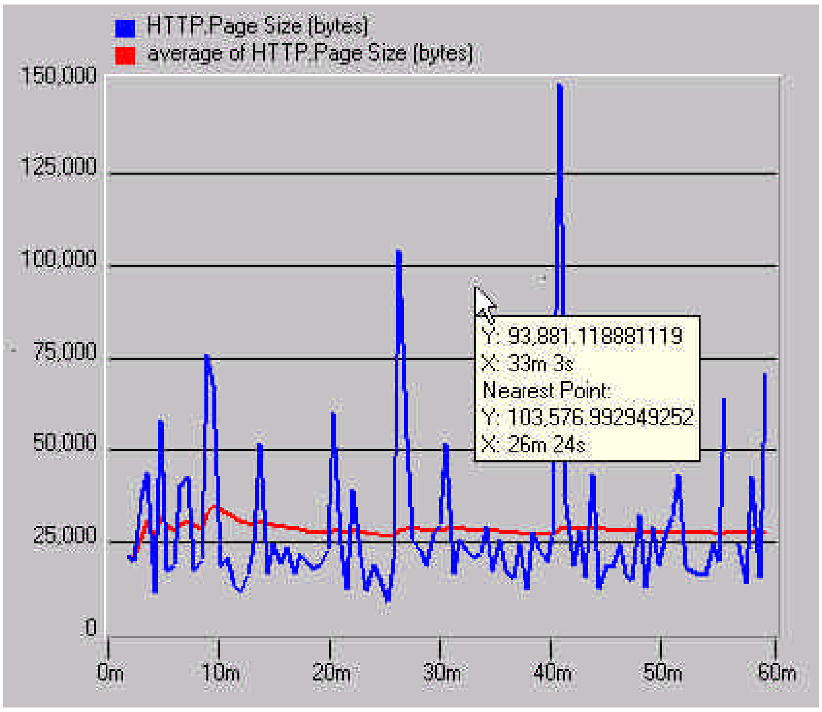
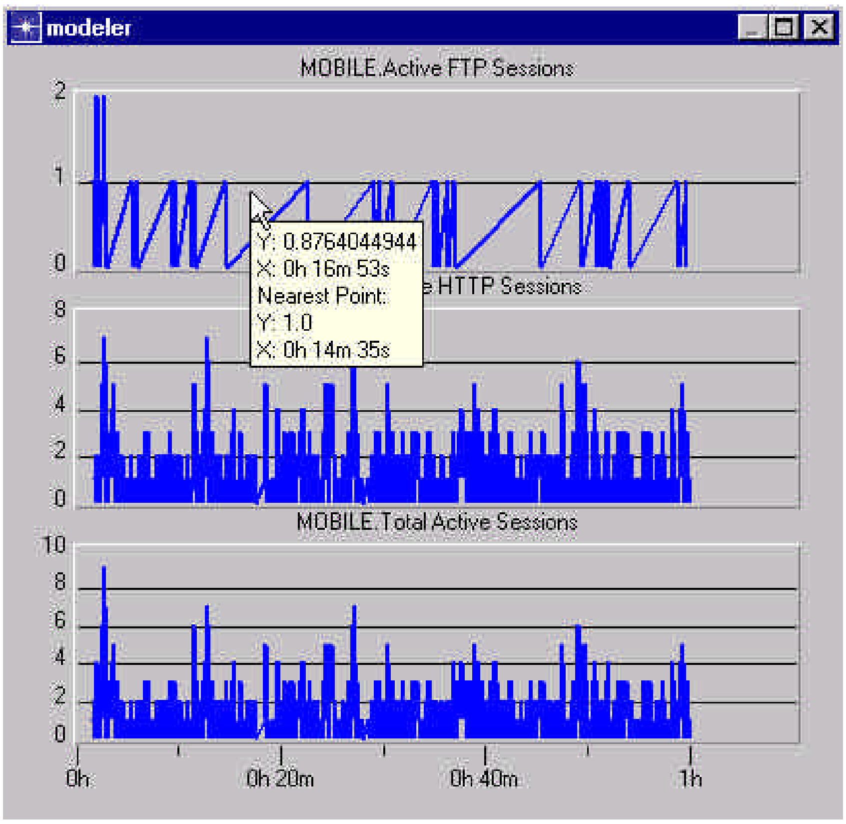


Figure 5: Number of active sessions



Simulation Results Using the Common Channels

Uplink and downlink signaling and control requirement is drastically reduced when common channels are employed. In this set of simulations, common channels are used in uplink and downlink directions. The simulation configuration is as follows:

1. Downlink (2 x 64 kbps) source rate = 128 kbps
2. Uplink source rate = 128 kbps
3. Same UMTS traffic model as the previous section

The uplink signaling and control requirement is reduced to the following:

Uplink requirement for 128 kbps in DL = 1 control channel (15 kbps) + 90 kbps/8 = 26.25 kbps
Uplink requirement for 10 x 128 kbps in DL = 262.5 kbps
Downlink requirement for 128 kbps = 7.5 x 2 = 15 kbps

Figure 6: Simulation of common channels (2 x 64 kbps in DL, 128 kbps in UL)
Downlink and Uplink throughput (IP traffic):

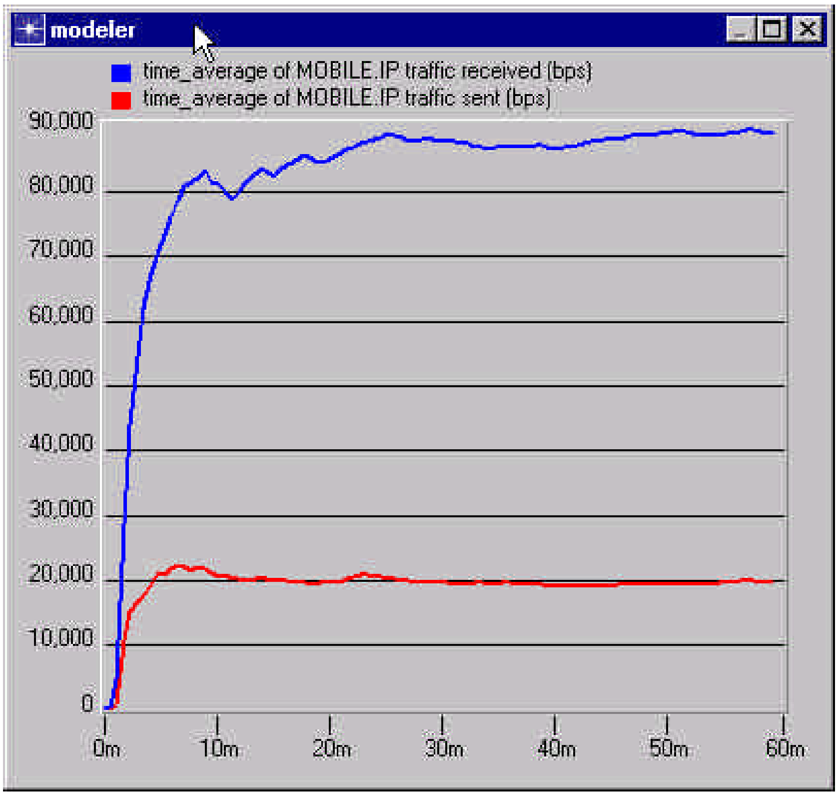


Figure 7: Active sessions for the uplink and downlink common channels simulations

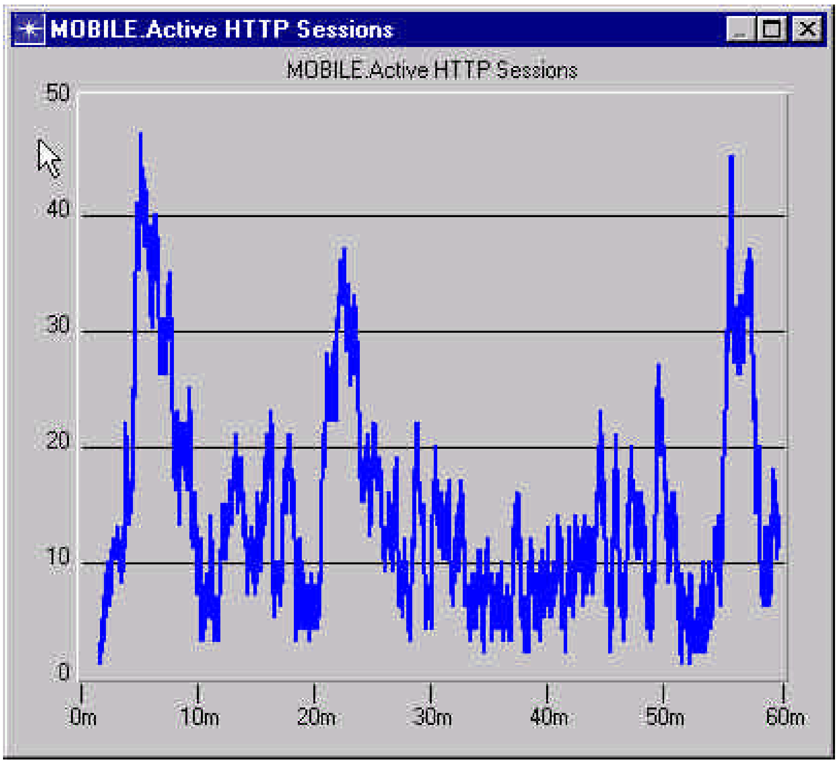


Figure 8: Response times for common channels

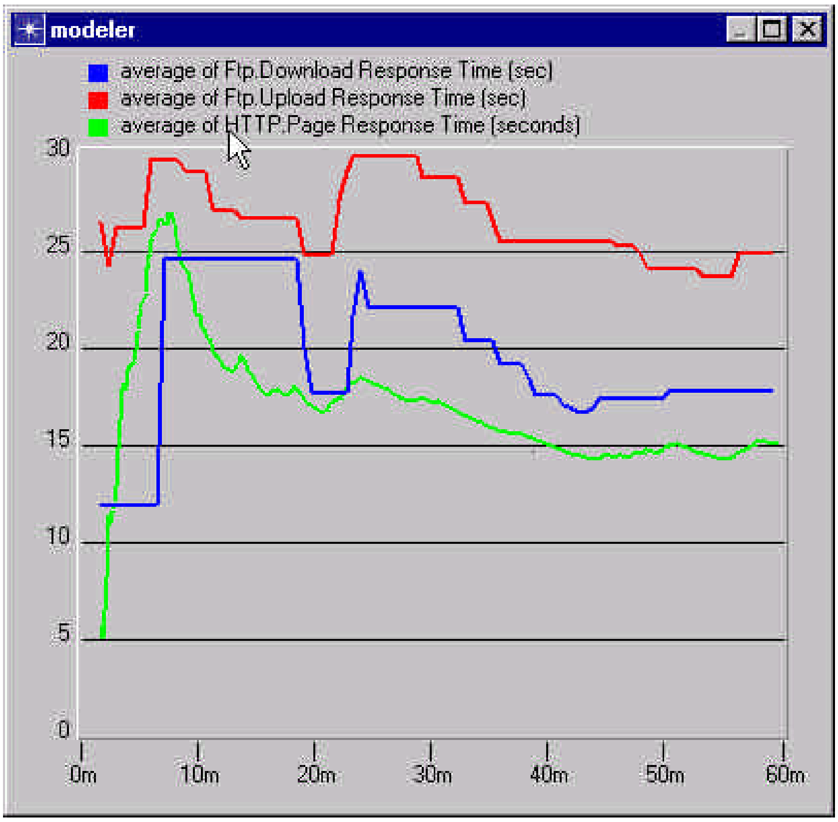
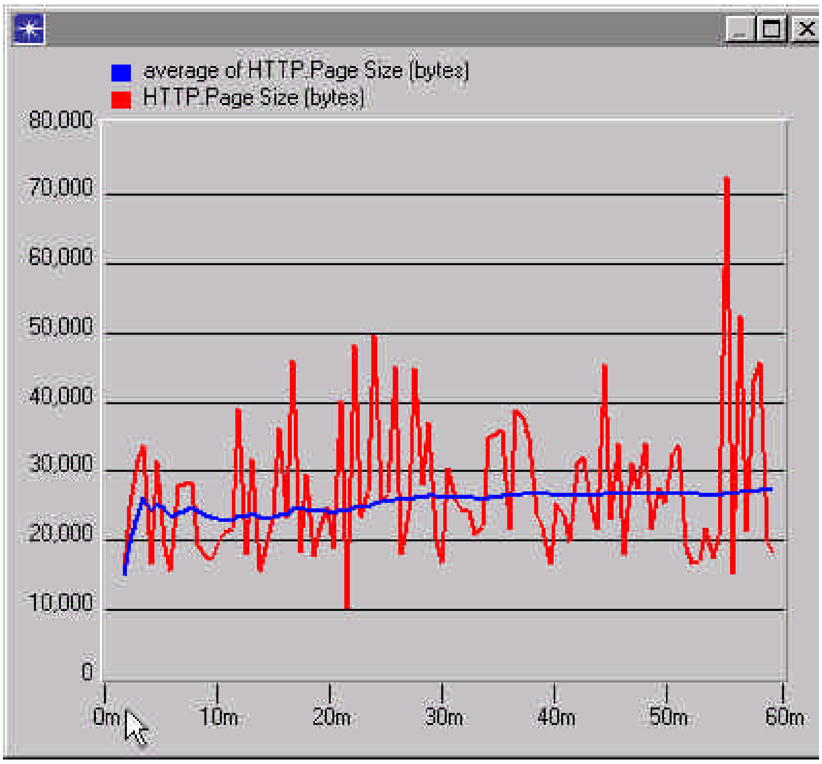


Figure 9: Page size distribution



Discussion

The uplink physical layer signaling in the HSDPA might necessitate the use of DPCCH in both uplink and downlink directions. In this case, the cost of uplink and downlink control and signaling are unavoidable. However, if there is room for using the common signaling due to more relaxed signaling delay requirements, then the avoidance of excessive uplink and downlink interference will lead to significantly higher system throughput. The problem is amplified in deployment scenarios where the weight of RT data increases. We propose a closer look at trade-offs between features in HSDPA that require fast physical layer signaling and the respective system throughput gain.

References

[1] Motorola contribution, R1-00-1094