Quality of Service in Internet
Exercise 4: Differentiated Services

Introduction:

This exercise is divided into two parts. First you will simulate five network scenarios by assigning different combinations of PHBs (Per Hop Behaviour) to communication peers. The results are to be compared in terms of gained throughput, packet loss ratio and packet delay. Second, based on these results and on the lectures and course book you will write a short essee of the deployment of differentiated services into a best−effort network from the network provider's point of view.

Exercise setting:

In the simulations five different scenarios are used which have different PHB−profiles for the communication peers. The PHBs used in this exercise are BE (Best−Effort), AF (Assured Forwarding) and EF (Expedited Forwarding). All PHB−related parameters (RED−values, WRR−weights, etc.) are kept the same for all scenarios. Read chapter 2.5.1: "Defining PHBs (BE, AF, EF)" in [1]. The scenarios are as follows:

1. Pure BE−network
2. EF: all VoIP
   AF: all HTTP
   BE: all FTP
3. EF: all VoIP
   AF: half of the HTTP− and FTP−connections (ftpS1−ftpC4, ftpS3−ftpC2, httpS1−httpC3, httpS3−httpC2)
   BE: rest of the HTTP− and FTP−connections
4. EF: all VoIP
   BE: one connection (ftpS1−ftpC4)
   AF: all other connections
5. EF: half of the HTTP− and FTP−connections (ftpS2−ftpC3, ftpS4−ftpC1, httpS2−httpC4, httpS4−httpC1)
   AF: rest of the HTTP− and FTP−connections
   BE: all VoIP

Starting the simulation:

1) The NS2−environment is set up with "source usens.csh".

2) The simulation is started by typing:

```
ns diffnet.tcl
```

Each run takes about 10 minutes. The simulation scripts for the different scenarios are given to you and you don't need to modify them in any way. The scripts are located

in directories called:

```
1_BE_BE_BE
2_EF_BE_AF
3_EF_AF_BE_mixed
4_EF_AF_BE_uneven
5_BE_AF_EF
```

The numbering of the directories corresponds to the numbering for the scenarios listed in the exercise setting.

3) After the simulation has finished copy−paste the last "Packet Statistics"−table from the screen to a file. You can use this in your later analysis.

4) By typing

```
source stats.scr
```

you will see traffic statistics for each communication pair. This includes throughput, packet loss ratio and average packet delay. Also, extended statistics can be seen by typing

```
source stats_ext.scr
```

This gives you a more detailed view on what happened in the simulation.

5) A simulation produces a number of different monitoring files ending with ".mon". However, the information you get by following instruction 3) and 4) should give you a detailed enough view for this exercise.

Assignment:

Part 1. Launch the simulations and analyze the results for each scenario. At least the following have to be included for each scenario:

- An explanation of how the traffic behaves and why it behaves like this. Keep in mind the topology of the network (presented in illustration 1 of document [1]), the configurational issues related to Diffserv (CIR− and WRR−settings) and the traffic characteristics for different applications (FTP, HTTP, VoIP).
- Conclusions from the scenario. For example, would the PHB−profile suite for a real network and what sort of purpose would it serve? What are its advantages and disadvantages?
- A table of the statistics, i.e. the results that you get by following instructions 2 and 3. Attach them as an appendix!

Part 2. On a more general level, discuss the benefits and difficulties of expanding a best−effort network into a differentiated services network from an operator point of view. You are free to explore this question as you will. For example, one approach would be to first determine what the operator wants to achieve with DiffServ. After that explain what are the technical and configurational issues they have to consider. A rather short answer will do (about 1−2 pages). For starters, check out references [2]

and [3].

Your report should not exceed 6 pages. Note that the above−mentioned appendix is NOT included in the page count. Return your report in the course locker (2nd floor, G−wing). If you have any questions you can write in the course newsgroup (opinnot.sahko.s−38.tietoverkkotekniikka) or contact me by email (tviipuri@tct.hut.fi).

A few notes:

1) After the simulation has finished you will see some error messages produced by the underlaying TCP−agent. They don't effect the results and can be ignored. The error messages look something like this:

> 501.604013: FullTcpAgent::recv(_o3323): bad ACK for our SYN: [612389:33.5>35.5] (hlen:40, dlen:0, seq:257, ack:12989, flags:0x19 (<PSH,ACK,FIN>), salen:0, reason:0x1)

2) Fields in the "Packet statistics"−table, which is printed every 50 seconds during the simulation, are as follows:

- CP: Code Point of the traffic aggregate
  - 10: EF in
  - 11: EF out
  - 20: AF in
  - 21: AF out
  - 30: BE
- TotPackets: # of sent packets
- TxPackets: # of successfully transmitted packets
- ldrops: # of packets dropped due to buffer overflow
- edrops: # of early dropped packets

3) Read the document [1] to learn the basics of simulating DiffServ in NS2. For additional information on NS2 visit their home page (http://www.isi.edu/nsnam/ns/) and check the reference to "Ns Manual".

References:

[1] Timo Viipuri, Introduction to Differentiated Services in NS2 (diffnet.pdf). Helsinki University of Technology, 2002.

[2] Tao Ma, Bingxin Shi, Bringing Quality Control to IP QoS. Article in Network Magazine, May 5 2001. [http://www.networkmagazine.com/article/NMG20001103S0009/1]

[3] P. Fasano, QoS for IP Telephony. Presentatiom at ISIT'99, Vancouver, June 10 1999. [http://carmen.cselt.it/papers/isit/download/isit−diffserv.pdf]