

S-38.180 - Quality of Service in Internet

Exercise 3: Differentiated Services

13.10.2004

Introduction:

This exercise is divided into two parts. In the first part 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.

In the second part, based on these results and on the lectures and course book you will write a short essee on the deployment of differentiated services into a best-effort network from the network provider's point of view.

Exercise setting:

The objective is to study five different simulation scenarios which use different PHB-profiles for the communication peers. The network topology is presented in illustration 1. The PHBs used in this exercise are BE (Best-Effort), AF (Assured Forwarding) and EF (Expedited Forwarding). All PHB-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 division of PHBs in 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

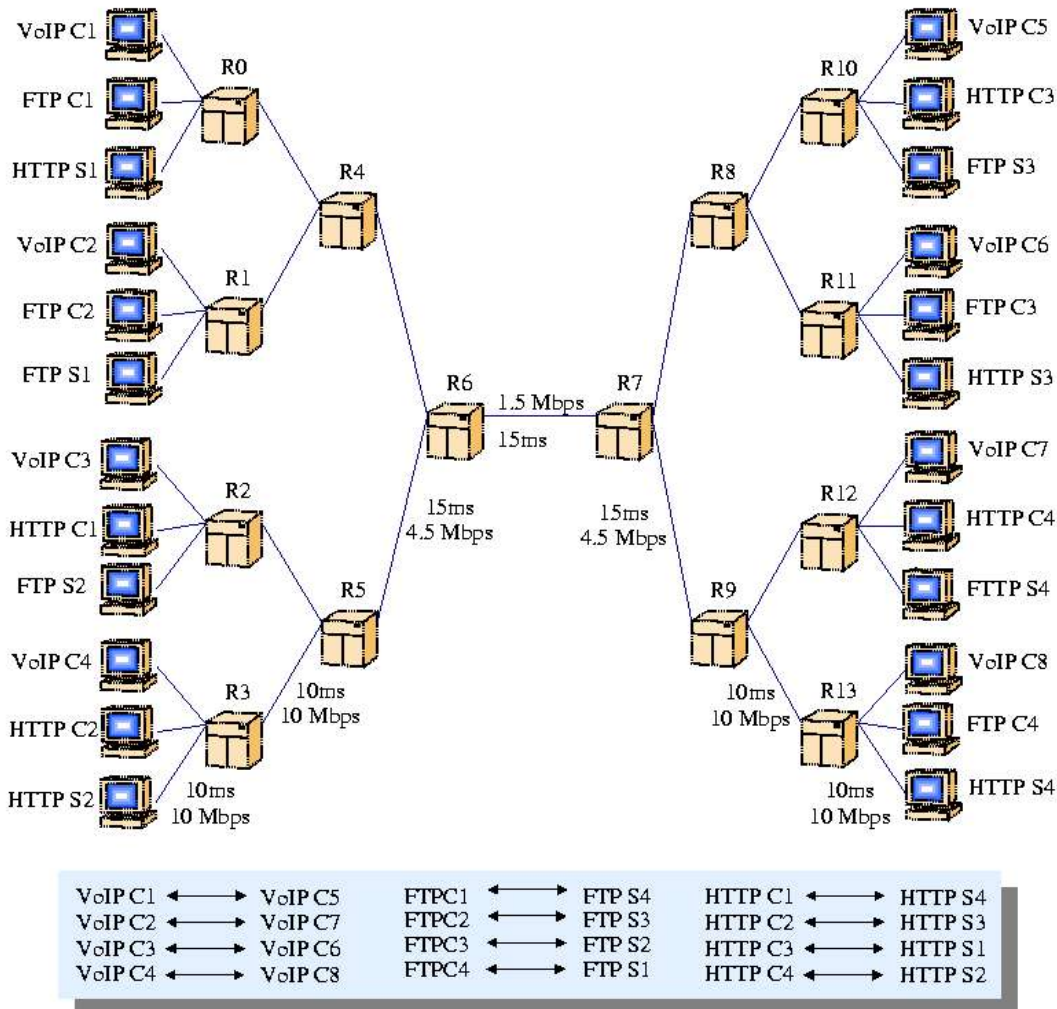


Illustration 1 Network topology to be simulated

Starting the simulation:

1) The simulation is started by typing:

```
ns diffnet.tcl
```

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.

2) 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.

The format of the statistics table is explained in NS-2 manual, section "9.3 Configuration". Code points are as follows:

- 10: EF in
- 11: EF out
- 20: AF in
- 21: AF out
- 30: BE

3) 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 but it is not necessary when you write your report.

4) A simulation produces a number of different monitoring files ending with ".mon". However, the information you get by following instruction 2) and 3) should give you a detailed enough view for this exercise.

Assignment:

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

- An explanation of how the traffic behaves and why it behaves like it. Also, compare the throughputs to the committed information rates (CIR) given for the applications (diffnet.tcl: variables cir_exp, cir_ftp and cir_http). Are the CIRs met and if not, why?
- Your conclusions from the scenario. For example, would the PHB-division simulated in the scenario be usable in a real network and if so, what purpose would it serve? What are its advantages and disadvantages? How well would the application (FTP, HTTP, VoIP) cope with the throughput, delay and packet loss ratio it experiences here, i.e. how would they affect the connection quality perceived by the end-user?
- Attach the statistics you get by typing "source stats.scr" as an appendix

Hint! Be aware of the scheduler and queue-management parameters

for the PHBs (assigned in the beginning of "2q2p.tcl"). They dictate how the treatment of the traffic is differentiated between the PHBs. Also, when using EF-class with VoIP-connections you will get a significant packet loss ratio depending on the CIR. This should not be interpreted as a negative behaviour. Explain in your answer, why!

2. On a more general level, discuss from an operator's point of view the benefits and difficulties of expanding a best-effort network into a differentiated services network. 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 you have determined this explain what are the technical and configurational issues as well as the risks they have to consider. The length of the answer should be about 1-2 pages.

Return your report as a PDF-version by e-mail to tvipuri@netlab.hut.fi OR as a paper-version to the course locker in the 2nd floor of G-wing in the Department of Electrical and Communications Engineering. The grading will be in the scale: 0—5. Deadline is **October 29th, 4pm.**

A few notes:

1) The following types of error messages may occur at the end of the simulation:

```
500.000000 FullTcpAgent(_o3379): app close in bad state FIN_WAIT_1  
and
```

```
502.310417: FullTcpAgent::recv(_o3247) got packet lacking ACK  
(state:6): [624959:30.17>37.17] (hlen:40, dlen:-1, seq:1, ack:-1,  
flags:0xa (<PSH,SYN>), salen:0, reason:0x1)
```

and

```
502.397611: FullTcpAgent::recv(_o3246): no SYN for our SYN:  
[624965:37.17>30.17] (hlen:40, dlen:0, seq:0, ack:1, flags:0x19  
(<PSH,ACK,FIN>), salen:0, reason:0x1)
```

They are caused by the way the simulation is ended and do not affect the results. So, don't bother about them.

2) On some scenarios you might get a negative packet loss ratio for some connections. If the PLR is negative but close to zero ($-0.002 < \text{PLR} < 0$) you can estimate that $\text{PLR} \approx 0$. This is because the calculation of PLR is not completely accurate here.

3) Read document [1] for a better insight into the simulation.

References:

- [1] Timo Viipuri, A Case Study of Simulating DiffServ in NS-2 (with a modified version of NS-2), <http://www.netlab.hut.fi/opetus/s38180/2004/exercises/H3/diffnet.pdf> , Helsinki University of Technology, 2002.