

COMP9334 LAB

Session 1, 2014

1 Introduction

This lab session will highlight the use of a traffic generating application and a network emulator to perform network analysis. The traffic generating application we are using is the Distributed Internet Traffic Generator (D-ITG). We are using the NetEm network emulator, found in the Linux 2.6 kernel, to emulate the network.

The remainder of this document is organized as follows:

- Section 2 present the e-learning platform IREEL which is going to be used in this lab.
- Section 3 provides some information regarding the tools used in this lab.
- Section 4 contains the detailed instructions for this lab.
- Details on how to write and submit the lab report can be found in Section 5.

2 IREEL

2.1 What is IREEL?

IREEL is an e-learning platform enabling the user to configure both network and application parameters for real experimentations. On the student's side, the IREEL platform offers a personal project for every user where the student will be able to edit private wiki pages in which experiments can be analysed

with the R language enhanced wiki and the user can explain their thoughts using mathematical writing with L^AT_EX.

Students using this platform does not need to install any particular software as all the intelligence resides in the web server. Nevertheless it is recommended to install the wireshark software¹ in order to analyse the network traces even if equivalent information is available inside an sqlite3² database.

2.2 How to Start?

In order to start using the IREEL platform students need to go to the dedicated IREEL website.³ The following of this section first details step by step how to create an account and start a first experiment, a kind of “hello world” on IREEL.

2.3 Account Creation

2.3.1 Account is created by web admin

We have created the account for each student. When a student first connect to the dedicated IREEL website, he/she should be able to use the CSE username to log in. The password is initialized to *IREELUNSW14* (you should change it after you log in). Please jump to Section 2.4.

2.3.2 Account is NOT created by web admin

In case your account is not created in advance, when a student first connect to the dedicated IREEL website, they need to create a new account. This is done by clicking on the register button on the top right of the website as displayed in Figure 1. Clicking on this button pass the user to a registration form where the user can create their account name and give several other details.

Once the form is filled, the platform would send an activation email to the user. Then the user is able to login as displayed in Figure 2. This first log-in creates a private space for the student who will be able to answer the questions in their own wiki and create sub-project according to the course. From there the student can start doing some experiments.

¹<http://tcpdump.org>

²<http://www.sqlite3.org>

³ IREEL platform is available on <http://ireel.mytestbed.net>.

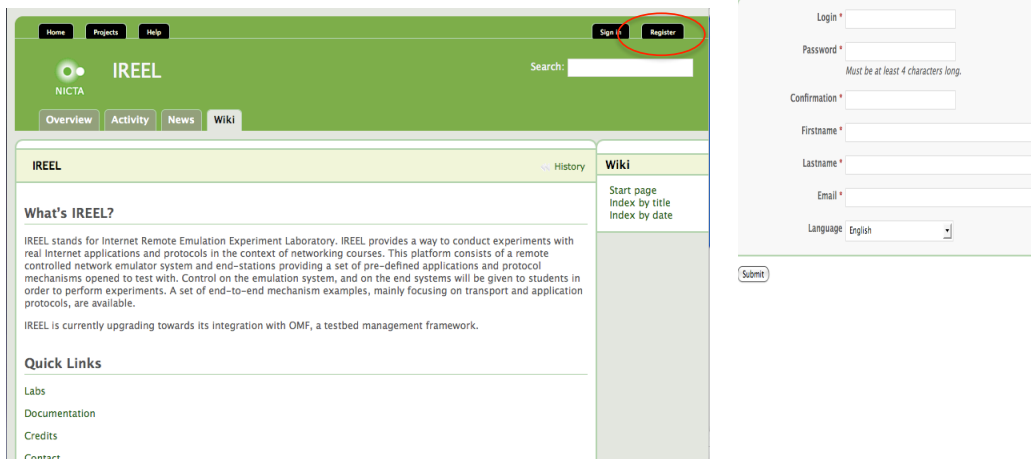


Figure 1: First Registration on IREEL

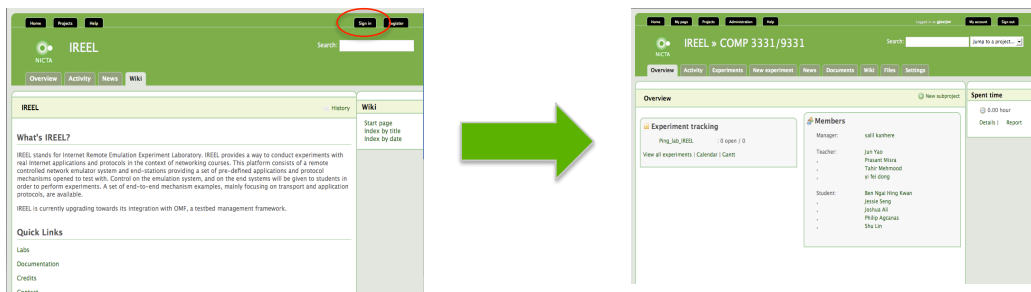


Figure 2: First Login on IREEL

Once a student's account is created, the associated student will be given access to the general IREEL project. In order to go to this project, the user needs to select the IREEL project in the "Jump to a project" tab at the top-right corner of any IREEL page. Then the user needs to go to the wiki interface of the IREEL project and then click on the labs link contained in the wiki welcome page.

2.4 Configuring own project

Now that the student is registered on the website, they have access to their own personal project. In this project, called “username-personnal” where username is the login of the student, they need to configure the wiki part of it. This is done by clicking on the setting tab, then select the “modules” sub-tab and finally select the “wiki” checkbox. Save you settings now.

Now the student is able to edit the wiki part of IREEL and use it as a lab book to answer the question.

2.5 Starting some experiments

The student is now ready to start some experiments related to this lab. First, they need to go to the lab project by selecting the adequate lab in the “*Jump to a project*” select at the top right part of the page. From this project, the student ail be able to select and configure the good experiment as described in Section 4.

CHECK LIST BEFORE GOING FURTHER

Table 1: Check List about IREEL

<u>Action</u>		
Account Creation	Yes	No
Login Done	Yes	No
Personal Project	Yes	No
Wiki Create	Yes	No
Access To Lab	Yes	No

3 Software

3.1 D-ITG

The D-ITG is an application that is able to generate traffic that reproduces packet inter-arrival times and packet sizes of many common distributions, e.g. exponential, normal, pareto. It is also able to generate packets at different layers of the networking protocols, e.g. application, network and transport.

3.2 NetEm Network Emulator

NetEm is a network emulator module that is enabled in the Linux 2.6 kernel. It uses the tc command that is part of the iprouter2 package of tools. By running the command on the network interface, it is possible to add delay, packet loss, packet duplication and rate limitations to emulate different network conditions.

3.3 R: Foundation for Statistical Computing

R is a free software programming language and a software environment for statistical computing and graphics. The R language is widely used among statisticians and data miners for developing statistical software and data analysis.

In the context of this lab, you will need to download and install R on your computer following the link <http://www.r-project.org/>. Once installed you will be able to access the measurements database from the experiments. These databases contains all the measurements you will need to analyse and discuss in your report.

4 Lab Instructions

We will now perform some experiments using the set up we have described. It consists of 3 machines connected by ethernet interfaces where the intermediate router is emulating a Wide Area Network (WAN) connection using the NetEm module.

4.1 Hypothetical WAN Setup

We are interested in the performance of traffic traversing between two end hosts through a WAN. A WAN typically consists of multiple intermediate networks/links with different bandwidth and delay characteristics. This is a result of the physical hardware (e.g. T-1 line, OC-1 line, router speed) as well as other traffic traversing the WAN. This topology can be seen as depicted in Figure 3.

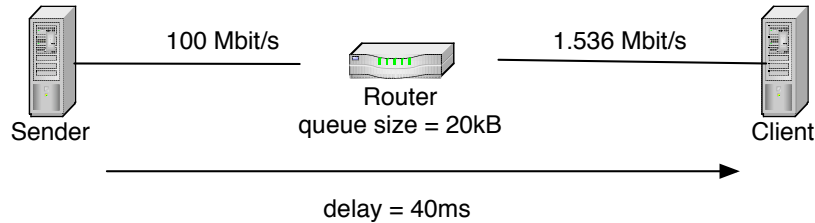


Figure 3: Experimental Topology

4.2 Experiments

4.2.1 First Set: Constant bit rate traffic

In this first set of experiments, we will emulate a WAN with a T1 line bottleneck link (approx. 1.536 Mbps) and a one-way delay of 40ms normally distributed with a standard deviation of 5ms.

Then on the end-host we will generate traffic with a packet size of 1500 bytes at a constant rate of 100 packets per second, running for 60 seconds.

Experiments. In order to start the experiment, click on the new experiment tab on the IREEL platform. Then select the different experiment parameters as shown in Table 2. Repeat the experiment five more time to obtain six independent runs.

Table 2: Configuration for First Set of Experiments

Lab	Duration	PacketPerSecond	Size
ITG-Constant	60000	100	1500

Results Analysis. Once you have configured an experiment on the *new Experiment* tab, the student needs to wait for the experiment to be run on the real testbed. Once this is done the student can access the result page. In this page, the student will have access to different result files and graphs.

In particular, in order to analyse the measurements, the student can access two different result files. These files are accessible in the results page of

the experiment at the bottom of it as shown in Figure 4. In the context of COMP 9334, the two files you are interested in are:

- `<exp_number>.sq3` contains two kind of measurements. A per packet measurement and a summary table.
- `<exp_number>.txt` contains only the summary table.

The main advantage of the database is to have a better interface with both R and the IREEL platform. Indeed, once downloaded you can interface the database with the statistical tool R with the RSQLite interface (<http://cran.r-project.org/web/packages/RSQLite/index.html>).



Figure 4: Bottom of the Experiment Results Page

4.2.2 Second Set: Stochastic Traffic

Real world traffic is never deterministic; i.e. they do not have constant packet rate and packet size. We will now introduce some randomness into the traffic characteristic by using two types of probability distributions to model the packet inter-arrival time. We will keep the mean packet departure

rate constant at 100 packets per second so as to make meaningful comparisons with the deterministic traffic.

Exponential Inter-Arrival Time. In the first set, configure the end-systems to generate an exponential traffic where packets are sent at exponential inter-departure time, with a mean packet rate of 100 packets per second. Refer to the table 3 for the different parameters of the IREEL platform.

Table 3: Configuration for Second Set of Experiments (exponential)

Lab	Duration	PacketPerSecond	Size
ITG-Exp	60000	100	1500

Finally again, repeat the experiment five times to get six independent runs.

Pareto Inter-Arrival Time. As you have learned in your lecture, the Pareto probability distribution is characterised by two parameters: shape γ and scale δ . The mean of the distribution is defined by:

$$\frac{\gamma\delta}{\gamma - 1}$$

In the D-ITG traffic generator, traffic with Pareto inter-arrival time (expressed in milliseconds) can be generated by specifying the appropriate γ and δ .

In the second set, configure the end-systems to generate an traffic with a shape (i.e. γ) value of 2. **Hint:** to get the appropriate scale (δ) value, note that the shape and scale need to define a Pareto distribution that has a mean inter-departure time of $1000 * 1/100 = 10ms$.

Table 4: Configuration for Second Set of Experiments (Pareto $\gamma = 2$)

Lab	Duration	PacketPerSecond	Size	Shape	Scale
ITG-Pareto	60000	100	1500	2	??

Refer to the table 4 for the different parameters of the IREEL platform. Again, repeat the experiment six times.

Finally change the shape value to $\gamma = 1.2$ and run the experiment defined in Table 5 six times and extract the results as before.

Table 5: Configuration for Second Set of Experiments (Pareto $\gamma = 1.2$)

Lab	Duration	PacketPerSecond	Size	Shape	Scale
ITG-Pareto	60000	100	1500	1.2	??

4.2.3 Third Set: Influence of buffer queue size

In the last set of experiment, we are going to redo the previous experiments but with a different value for the buffer size in the intermediate router. Refer to the table 6 for the different parameters of the IREEL platform. Again, repeat the experiment six times.

Table 6: Configuration for Third Set of Experiments

Lab	Duration	PacketPerSecond	Size	Shape	Scale	BuffSize
ITG-BuffCst	60000	100	1500	N/A	N/A	25kB
ITG-BuffExp	60000	100	1500	N/A	N/A	25kB
ITG-BuffPar	60000	100	1500	2	??	25kB
ITG-BuffPar	60000	100	1500	1.2	??	25kB
ITG-BuffCst	60000	100	1500	N/A	N/A	30kB
ITG-BuffExp	60000	100	1500	N/A	N/A	30kB
ITG-BuffPar	60000	100	1500	2	??	30kB
ITG-BuffPar	60000	100	1500	1.2	??	30kB

4.2.4 Wrapping all together

Plot the graphs of the average delay, effective bandwidth, packet dropped rate and utilization for the different queue buffer sizes. You should use what

you have learned in the lectures to include not just the mean of the six independent experimental runs, but also the 95% confidence intervals. If your graph plotting application supports errorbars, the confidence intervals can be included directly on the graphs. Otherwise, you should include the results in a table.

Discuss the significance of the results you have gotten in this lab.

5 Lab Report

For lab assessment, you are required to submit a report. The total marks for this report is 40 marks. This component is an individual work. You are expected to complete the report on your own.

5.1 Report Format

This section provides a basic format for the lab report that you are required to submit after you have performed these lab exercises. Note that this format only serves as a guide and you are free to submit your report in any appropriate format so long as you detail what you have done, include the results and discuss them.

1. Title Page

This should include the course name, course code, your name and student id.

2. Introduction

Provide a brief introduction of the experiment you are performing. It need not be longer than a paragraph.

3. Results

Along with the Discussion section, this is the main core and most important part of the report. You include the results – in tables, graphs or plain description to show the results you have acquired.

4. Discussion

The other main part of the report. You will need to discuss the results that you have gotten, to show that you are able to relate them to what you have learned in the lectures.

5. Conclusion

A short section to conclude your report.

5.2 Submission

Submit your report as a file called “lab.pdf”. The system will only accept this file name. Make sure you are in the same directory as your work, then do the following:

- When you are ready to submit, at the bash prompt type 9334;
- Next, type: `give cs9334 lab lab.pdf` (You should receive a message stating the result of your submission).

Your report must be submitted by **23:59:59 Monday 2 June 2014**. Two marks per day will be subtracted for late submission. Submissions which are overdue for more than five days will receive ZERO mark.

5.3 Lab Related Queries

Please consult Lab-coordinator Lukas regarding lab related queries (Wednesday 4.00pm - 5.00pm, K17-508). You can also send your query via class email account cs9334@cse.unsw.edu.au or request for appointment to kail@cse.unsw.edu.au if you can not come to consultation. For any problems on the website, please contact Guillaume Jourjon (Guillaume.Jourjon@nicta.com.au).