

Practical No: 1

Aim: Installation of NS-3 in Linux

Steps:

1. sudo apt upgrade

```
lab2-@lab2-B250M-D2V:~$ sudo apt upgrade
[sudo] password for lab2-:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
Get more security updates through Ubuntu Pro with 'esm-apps' enabled:
  libjs-jquery-ui
Learn more about Ubuntu Pro at https://ubuntu.com/pro
The following packages will be upgraded:
  apt apt-utils cups-browsed cups-filters cups-filters-core-drivers
  distro-info-data gdm3 gir1.2-gdm-1.0 im-config libapt-pkg6.0 libcupsfilters1
  libfontembed1 libgdm1 libglib2.0-0 libglib2.0-bin libglib2.0-data
  libgssapi-krb5-2 libk5crypto3 libkrb5-3 libkrb5support0 libldap-2.5-0
  libldap-common libllvm15 libnss-systemd libpam-systemd libsystemd0 libudev1
  libwebp7 libwebpdecoder3 libwebpmux3 linux-firmware linux-libc-dev python3-tz
  systemd systemd-oomd systemd-sysv systemd-timesyncd tzdata
  ubuntu-advantage-tools udev xserver-common xserver-xephyr xserver-xorg-core
  xserver-xorg-legacy
44 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
```

2. sudo apt update

```
lab2-@lab2-B250M-D2V:~$ sudo apt update
Hit:1 http://in.archive.ubuntu.com/ubuntu jammy InRelease
Get:2 http://security.ubuntu.com/ubuntu jammy-security InRelease [110 kB]
Get:3 http://in.archive.ubuntu.com/ubuntu jammy-updates InRelease [119 kB]
Get:4 http://in.archive.ubuntu.com/ubuntu jammy-backports InRelease [108 kB]
Get:5 http://in.archive.ubuntu.com/ubuntu jammy-updates/universe i386 Packages [610 kB]
Get:6 http://in.archive.ubuntu.com/ubuntu jammy-updates/universe amd64 Packages [901 kB]
Fetched 1,848 kB in 3s (616 kB/s)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
All packages are up to date.
lab2-@lab2-B250M-D2V:~$
```

3. sudo apt-get install g++ python3

```
lab2-@lab2-B250M-D2V:~$ sudo apt-get install g++ python3
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
g++ is already the newest version (4:11.2.0-1ubuntu1).
python3 is already the newest version (3.10.6-1~22.04).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
lab2-@lab2-B250M-D2V:~$
```

4. sudo apt-get install g++ python3python3-dev pkg-config sqlite3

```
lab2-@lab2-B250M-D2V:~$ sudo apt-get install g++ python3 python3-dev pkg-config
sqlite3
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
g++ is already the newest version (4:11.2.0-1ubuntu1).
pkg-config is already the newest version (0.29.2-1ubuntu3).
python3 is already the newest version (3.10.6-1~22.04).
python3-dev is already the newest version (3.10.6-1~22.04).
sqlite3 is already the newest version (3.37.2-2ubuntu0.1).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
lab2-@lab2-B250M-D2V:~$
```

5. sudo apt install -y qtcreator qtbase5-dev qt5-qmake cmake

```
lab2-25@lab225-B250M-D2V: ~
lab2-25@lab225-B250M-D2V:~$ sudo apt install -y qtcreator qtbase5-dev qt5-qmake cmake
[sudo] password for lab2-25:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
qtcreator is already the newest version (6.0.2-2build1).
cmake is already the newest version (3.22.1-1ubuntu1.22.04.1).
qt5-qmake is already the newest version (5.15.3+dfsg-2ubuntu0.2).
qtbase5-dev is already the newest version (5.15.3+dfsg-2ubuntu0.2).
0 upgraded, 0 newly installed, 0 to remove and 14 not upgraded.
lab2-25@lab225-B250M-D2V:~$
```

6. sudo apt-get install gir1.2-goocanvas-2.0 python3-pygraphviz python3-gi-cairo python3-pygraphviz gir1.2-gtk-3.0

```
E: Unable to locate package pyhton-gi
lab2-25@lab225-B250M-D2V:~$ sudo apt-get install gir1.2-goocanvas-2.0 python3-pygraphviz python3-gi-cairo python3-pygraphviz gir1.2-gtk-3.0
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
gir1.2-goocanvas-2.0 is already the newest version (2.0.4-1build1).
python3-pygraphviz is already the newest version (1.7-3build1).
gir1.2-gtk-3.0 is already the newest version (3.24.33-1ubuntu2).
python3-gi-cairo is already the newest version (3.42.1-0ubuntu1).
0 upgraded, 0 newly installed, 0 to remove and 14 not upgraded.
lab2-25@lab225-B250M-D2V:~$
```

7. sudo apt-get install gdb valgrind

```
lab2-25@lab225-B250M-D2V:~$ sudo apt-get install gdb valgrind
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
valgrind is already the newest version (1:3.18.1-1ubuntu2).
gdb is already the newest version (12.1-0ubuntu1-22.04).
0 upgraded, 0 newly installed, 0 to remove and 14 not upgraded.
lab2-25@lab225-B250M-D2V:~$
```

8. sudo apt-get install doxygen graphviz imagemagick

```
0 upgraded, 0 newly installed, 0 to remove and 14 not upgraded.
lab2-25@lab225-B250M-D2V:~$ sudo apt-get install doxygen graphviz imagemagick
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
doxygen is already the newest version (1.9.1-2ubuntu2).
graphviz is already the newest version (2.42.2-6).
imagemagick is already the newest version (8:6.9.11.60+dfsg-1.3ubuntu0.22.04.3).
0 upgraded, 0 newly installed, 0 to remove and 14 not upgraded.
lab2-25@lab225-B250M-D2V:~$
```

9. sudo apt install python3-pip

```
0 upgraded, 0 newly installed, 0 to remove and 14 not upgraded.
lab2-25@lab225-B250M-D2V:~$ sudo apt install python3-pip
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
python3-pip is already the newest version (22.0.2+dfsg-1ubuntu0.2).
0 upgraded, 0 newly installed, 0 to remove and 14 not upgraded.
lab2-25@lab225-B250M-D2V:~$
```

10. pip install ipython

```
0 upgraded, 0 newly installed, 0 to remove and 14 not upgraded.
lab2-25@lab225-B250M-D2V:~$ pip install ipython
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: ipython in ./local/lib/python3.10/site-packages (8.12.0)
Requirement already satisfied: pexpect>4.3 in /usr/lib/python3/dist-packages (from ipython) (4.8.0)
Requirement already satisfied: pickleshare in ./local/lib/python3.10/site-packages (from ipython) (0.7.5)
Requirement already satisfied: pygments>=2.4.0 in ./local/lib/python3.10/site-packages (from ipython) (2.14.0)
Requirement already satisfied: matplotlib-inline in ./local/lib/python3.10/site-packages (from ipython) (0.1.6)
Requirement already satisfied: jedi>=0.16 in ./local/lib/python3.10/site-packages (from ipython) (0.18.2)
Requirement already satisfied: stack-data in ./local/lib/python3.10/site-packages (from ipython) (0.6.2)
Requirement already satisfied: backcall in ./local/lib/python3.10/site-packages (from ipython) (0.2.0)
Requirement already satisfied: decorator in ./local/lib/python3.10/site-packages (from ipython) (5.1.1)
Requirement already satisfied: traitlets>=5 in ./local/lib/python3.10/site-packages (from ipython) (5.9.0)
Requirement already satisfied: prompt-toolkit!=3.0.37,<3.1.0,>=3.0.30 in ./local/lib/python3.10/site-packages (from ipython) (3.0.38)
Requirement already satisfied: parso<0.9.0,>=0.8.0 in ./local/lib/python3.10/site-packages (from jedi=>0.16->ipython) (0.8.3)
Requirement already satisfied: wcwidth in ./local/lib/python3.10/site-packages (from prompt-toolkit!=3.0.37,<3.1.0,>=3.0.30->ipython) (0.2.6)
Requirement already satisfied: pure-eval in ./local/lib/python3.10/site-packages (from stack-data->ipython) (0.2.2)
Requirement already satisfied: asttokens>=2.1.0 in ./local/lib/python3.10/site-packages (from stack-data->ipython) (2.2.1)
Requirement already satisfied: executing>=1.2.0 in ./local/lib/python3.10/site-packages (from stack-data->ipython) (1.2.0)
Requirement already satisfied: six in /usr/lib/python3/dist-packages (from asttokens>=2.1.0->stack-data->ipython) (1.16.0)
lab2-25@lab225-B250M-D2V:~$
```

11. sudo apt-get install python3-sphinx dia


```

N: Unable to acquire the aptg frontend lock (/var/lib/aptg/lock/frontend); is another process using it.
lab2-25@lab225-B250M-D2V:~$ sudo apt-get install python3-sphinx dia
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
python3-sphinx is already the newest version (4.3.2-1).
dia is already the newest version (0.97.3+git20160930-9build1).
0 upgraded, 0 newly installed, 0 to remove and 9 not upgraded.
lab2-25@lab225-B250M-D2V:~$

```

12. sudo apt-get install tcpdump

```

0 upgraded, 0 newly installed, 0 to remove and 9 not upgraded.
lab2-25@lab225-B250M-D2V:~$ sudo apt-get install tcpdump
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
tcpdump is already the newest version (4.99.1-3ubuntu0.1).
0 upgraded, 0 newly installed, 0 to remove and 9 not upgraded.
lab2-25@lab225-B250M-D2V:~$

```

13. sudo apt-get install -y llvm-11 llvm-11-dev clang-11 llvm-11-tools

```

N: See apt-secure(8) Manpage for repository creation and user configuration details.
lab2-25@lab225-B250M-D2V:~$ sudo apt-get install -y llvm-11 llvm-11-dev clang-11 llvm-11-tools
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  libclang-common-11-dev libclang-cpp11 libclang1-11 libllvm11 llvm-11-linker-tools llvm-11-runtime
Suggested packages:
  clang-11-doc llvm-11-doc
The following NEW packages will be installed:
  clang-11 libclang-common-11-dev libclang-cpp11 libclang1-11 libllvm11 llvm-11 llvm-11-dev llvm-11-linker-tools llvm-11-runtime
  llvm-11-tools
0 upgraded, 10 newly installed, 0 to remove and 9 not upgraded.
Need to get 82.3 MB of archives.
After this operation, 469 MB of additional disk space will be used.
Get:1 http://in.archive.ubuntu.com/ubuntu jammy/universe amd64 libllvm11 amd64 1:11.1.0-6 [19.6 MB]
Get:2 http://in.archive.ubuntu.com/ubuntu jammy/universe amd64 libclang-cpp11 amd64 1:11.1.0-6 [10.5 MB]
Get:3 http://in.archive.ubuntu.com/ubuntu jammy/universe amd64 libclang-common-11-dev amd64 1:11.1.0-6 [5,247 kB]
Get:4 http://in.archive.ubuntu.com/ubuntu jammy/universe amd64 llvm-11-linker-tools amd64 1:11.1.0-6 [1,275 kB]
Get:5 http://in.archive.ubuntu.com/ubuntu jammy/universe amd64 libclang1-11 amd64 1:11.1.0-6 [6,053 kB]
Get:6 http://in.archive.ubuntu.com/ubuntu jammy/universe amd64 clang-11 amd64 1:11.1.0-6 [75.8 kB]
Get:7 http://in.archive.ubuntu.com/ubuntu jammy/universe amd64 llvm-11-runtime amd64 1:11.1.0-6 [186 kB]
Get:8 http://in.archive.ubuntu.com/ubuntu jammy/universe amd64 llvm-11 amd64 1:11.1.0-6 [9,118 kB]
Get:9 http://in.archive.ubuntu.com/ubuntu jammy/universe amd64 llvm-11-tools amd64 1:11.1.0-6 [359 kB]
Get:10 http://in.archive.ubuntu.com/ubuntu jammy/universe amd64 llvm-11-dev amd64 1:11.1.0-6 [29.9 MB]
Fetched 82.3 MB in 52s (1,596 kB/s)
Selected previously unselected packages: libllvm11 clang-11

```

14. pip install cxxfilt

```

N: See apt-secure(8) Manpage for repository creation and user configuration details.
lab2-25@lab225-B250M-D2V:~$ pip install cxxfilt
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: cxxfilt in ./local/lib/python3.10/site-packages (0.3.0)
lab2-25@lab225-B250M-D2V:~$

```

15. ./build.py--enable-examples--enable-tests

```

lab2-25@lab225-B250M-D2V:~/Aniket$ cd ns-allinone-3.36.1/
lab2-25@lab225-B250M-D2V:~/Aniket/ns-allinone-3.36.1$ ./build.py --enable-examples --enable-tests
# Build NetAnim
Entering directory 'netanim-3.108'
=> qmake -v
QMake version 3.1
Using Qt version 5.15.3 in /usr/lib/x86_64-linux-gnu
qmake found
=> qmake NetAnim.pro
=> make
make: Nothing to be done for 'first'.
Leaving directory 'netanim-3.108'
# Building examples (by user request)
# Building tests (by user request)
# Build NS-3
Entering directory: '/home/lab2-25/Aniket/ns-allinone-3.36.1/./ns-3.36.1'

```

16. cdns-3.36.1

17. ./test.py

```

lab2-25@lab225-B250M-D2V:~/Aniket/ns-allinone-3.36.1/ns-3.36.1$ ./test.py
Finished executing the following commands:
cd cmake-cache; cmake --build . -j 7 ; cd ..
[1/733] PASS: TestSuite cosine-antenna-model
[2/733] PASS: TestSuite isotropic-antenna-model
[3/733] PASS: TestSuite aodv-routing-id-cache
[4/733] PASS: TestSuite degrees-radians
[5/733] PASS: TestSuite angles
[6/733] PASS: TestSuite uniform-planar-array-test

```

Practical No: 2

Aim: Installation of NetAnim

Steps:

1. Sudo apt upgrade

```
lab2-@lab2-B250M-D2V:~$ sudo apt upgrade
[sudo] password for lab2-:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
Get more security updates through Ubuntu Pro with 'esm-apps' enabled:
  libjs-jquery-ui
Learn more about Ubuntu Pro at https://ubuntu.com/pro
The following packages will be upgraded:
  apt apt-utils cups-browsed cups-filters cups-filters-core-drivers
  distro-info-data gdm3 gir1.2-gdm-1.0 im-config libapt-pkg6.0 libcupsfilters1
  libfontembed1 libgdm1 libglib2.0-0 libglib2.0-bin libglib2.0-data
  libgssapi-krb5-2 libk5crypto3 libkrb5-3 libkrb5support0 libldap-2.5-0
  libldap-common libllvm15 libnss-systemd libpam-systemd libsystemd0 libudev1
  libwebp7 libwebpdemux2 libwebpmux3 linux-firmware linux-libc-dev python3-tz
  systemd systemd-oem systemd-sysv systemd-timesyncd tzdata
  ubuntu-advantage-tools udev xserver-common xserver-xephyr xserver-xorg-core
  xserver-xorg-legacy
44 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
```

2. sudo apt update

```
lab2-@lab2-B250M-D2V:~$ sudo apt update
Hit:1 http://in.archive.ubuntu.com/ubuntu jammy InRelease
Get:2 http://security.ubuntu.com/ubuntu jammy-security InRelease [110 kB]
Get:3 http://in.archive.ubuntu.com/ubuntu jammy-updates InRelease [119 kB]
Get:4 http://in.archive.ubuntu.com/ubuntu jammy-backports InRelease [108 kB]
Get:5 http://in.archive.ubuntu.com/ubuntu jammy-updates/universe i386 Packages [610 kB]
Get:6 http://in.archive.ubuntu.com/ubuntu jammy-updates/universe amd64 Packages [901 kB]
Fetched 1,848 kB in 3s (616 kB/s)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
All packages are up to date.
lab2-@lab2-B250M-D2V:~$
```

3. ./ns3 configure

```
lab2-@lab2-B250M-D2V:~/Desktop/vaibhavi/ns-allinone-3.36.1/ns-3.36.1$ ./ns3 configure
-- Using default output directory /home/lab2-/Desktop/vaibhavi/ns-allinone-3.36.1/ns-3.36.1/build
-- Proceeding without cmake-format
-- find_external_library: SQLite3 was found.
-- HarfBuzz is required by GTK3 and was not found.
-- LibXML2 was found.
-- LibRT was found.
-- Visualizer requires Python bindings
-- GSL was found.
-- docs: doxygen documentation not enabled due to missing dependencies: doxygen;dia
-- Failed to locate sphinx-build executable (missing: SPHINX_EXECUTABLE)
-- docs: sphinx documentation not enabled due to missing dependencies: Sphinx;epstopdf;pdflatex;latexmk;convert;dvipng
```

4. ./ns3 build

```
lab2-@lab2-B250M-D2V:~/Desktop/vaibhavi/ns-allinone-3.36.1/ns-3.36.1$ ./ns3 build
Consolidate compiler generated dependencies of target stdlib_pch
Consolidate compiler generated dependencies of target stdlib_pch_exec
Consolidate compiler generated dependencies of target libantenna-obj
Consolidate compiler generated dependencies of target libaodv-obj
[ 0%] Building CXX object CMakeFiles/stdlib_pch_exec.dir/cmake_pch.hxx.gch
[ 0%] Building CXX object CMakeFiles/stdlib_pch.dir/cmake_pch.hxx.gch
Consolidate compiler generated dependencies of target libenergy-obj
Consolidate compiler generated dependencies of target libstats-obj
```


5. cd and ls

```
lab2-@lab2-B250M-D2V:~/Desktop/vaibhavi/ns-allinone-3.36.1/ns-3.36.1$ cd ..
lab2-@lab2-B250M-D2V:~/Desktop/vaibhavi/ns-allinone-3.36.1$ ls
bake          constants.py  ns-3.36.1    __pycache__  util.py
build.py      netanim-3.108 pybindgen-0.22.1 README.md
lab2-@lab2-B250M-D2V:~/Desktop/vaibhavi/ns-allinone-3.36.1$ cd netanim-3.108
lab2-@lab2-B250M-D2V:~/Desktop/vaibhavi/ns-allinone-3.36.1/netanim-3.108$ ls
abort.h                    moc_fileedit.cpp
animatorconstants.h        moc_fileeditfactory.cpp
animator_fileopen.svg      moc_fileeditfactory.o
animator_grid.svg          moc_fileedit.o
animatormode.cpp           moc_filepathmanager.cpp
animatormode.h             moc_filepathmanager.o
animatormode.o             moc_netanim.cpp
animator_mouseposition.png moc_netanim.o
```

6. makeclean

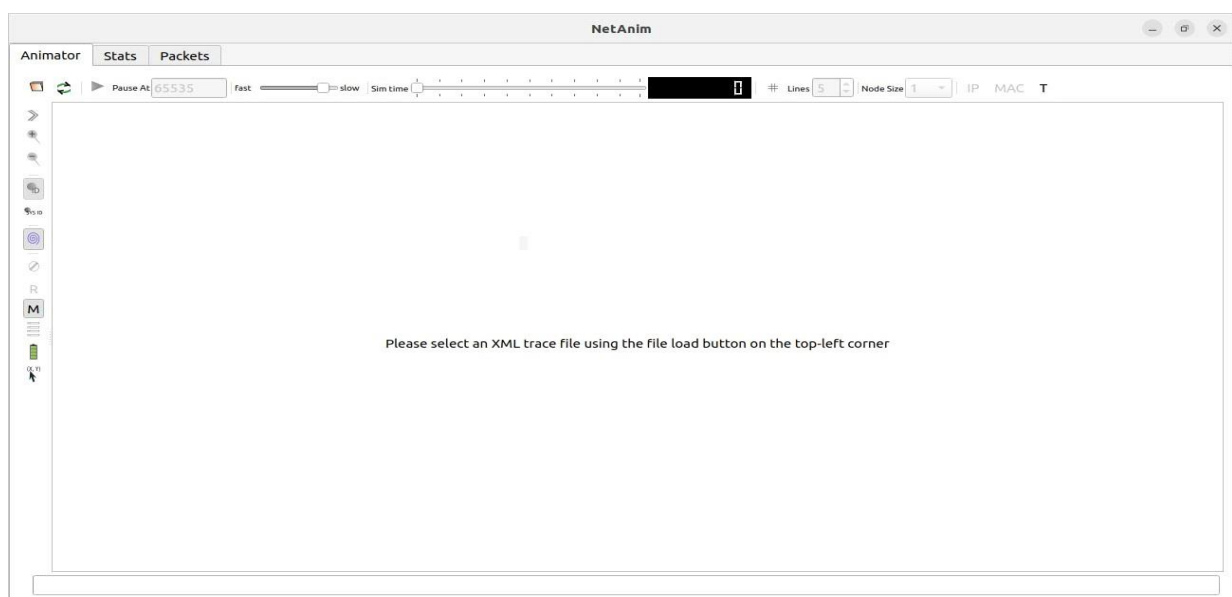
```
lab2-@lab2-B250M-D2V:~/Desktop/vaibhavi/ns-allinone-3.36.1/netanim-3.108$ make clean
rm -f qrc_resources.cpp qrc_qtpropertybrowser.cpp
rm -f moc_predefs.h
rm -f moc_animatorscene.cpp moc_animpacket.cpp moc_netanim.cpp moc_animatormode.cpp moc_statsmode.cpp
moc_qtvariantproperty.cpp moc_qttreepropertybrowser.cpp moc_qtpropertymanager.cpp moc_qtpropertybrowse
rutils_p.cpp moc_qtpropertybrowser.cpp moc_qtgroupboxpropertybrowser.cpp moc_qteditorfactory.cpp moc_q
tbuttonpropertybrowser.cpp moc_animpropertybrowser.cpp moc_filepathmanager.cpp moc_fileeditfactory.cpp
moc_fileedit.cpp moc_packetsmode.cpp moc_table.cpp moc_qcustomplot.cpp
rm -f qttreepropertybrowser.moc qtpropertymanager.moc qteditorfactory.moc
rm -f main.o log.o fatal-error.o fatal-impl.o logqt.o resizeableitem.o animnode.o animatorscene.o anim
packet.o netanim.o animatormode.o mode.o animxmlparser.o animatorview.o animlink.o animresource.o stat
sview.o statsmode.o routingxmlparser.o routingstatsscene.o interfacestatsscene.o flowmonxmlparser.o fl
owmonstatsscene.o textbubble.o qtvariantproperty.o qttreepropertybrowser.o qtpropertymanager.o qtprope
rtybrowserutils.o qtpropertybrowser.o qtgroupboxpropertybrowser.o qteditorfactory.o qtbuttonpropertybr
owser.o animpropertybrowser.o filepathmanager.o fileeditfactory.o fileedit.o packetsmode.o packetsview
.o packetscene.o graphpacket.o table.o countertablescene.o qcustomplot.o qrc_resources.o qrc_qtprope
rtybrowser.o moc_animatorscene.o moc_animpacket.o moc_netanim.o moc_animatormode.o moc_statsmode.o moc
_qtpropertybrowserutils_p.o moc_animpropertybrowser.o moc_filepathmanager.o moc_fileeditfactory.o moc_
fileedit.o moc_packetsmode.o moc_table.o moc_qcustomplot.o
rm -f *-core *.core
```

7. qmakeNetAnim.pro

```
lab2-@lab2-B250M-D2V:~/Desktop/vaibhavi/ns-allinone-3.36.1/netanim-3.108$ qmake NetAnim.pro
lab2-@lab2-B250M-D2V:~/Desktop/vaibhavi/ns-allinone-3.36.1/netanim-3.108$
```

8. ./NetAnim

```
lab2-@lab2-B250M-D2V:~/Desktop/vaibhavi/ns-allinone-3.36.1/netanim-3.108$ ./NetAnim
Warning: Ignoring XDG_SESSION_TYPE=wayland on Gnome. Use QT_QPA_PLATFORM=wayland to run on Wayland any
way.
```



Practical No: 3

Aim: Installation of Wireshark

Steps:

1. sudo apt upgrade

```
lab2-@lab2-B250M-D2V:~$ sudo apt upgrade
[sudo] password for lab2-:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
Get more security updates through Ubuntu Pro with 'esm-apps' enabled:
  libjs-jquery-ui
Learn more about Ubuntu Pro at https://ubuntu.com/pro
The following packages will be upgraded:
  apt apt-utils cups-browsed cups-filters cups-filters-core-drivers
  distro-info-data gdm3 gir1.2-gdm-1.0 im-config libapt-pkg6.0 libcupsfilters1
  libfontembed1 libgdm1 libglib2.0-0 libglib2.0-bin libglib2.0-data
  libgssapi-krb5-2 libk5crypto3 libkrb5-3 libkrb5support0 libldap-2.5-0
  libldap-common libllvm15 libnss-systemd libpam-systemd libsystemd0 libudev1
  libwebp7 libwebpdemux2 libwebpmux3 linux-firmware linux-libc-dev python3-tz
  systemd systemd-oem systemd-sysv systemd-timesyncd tzdata
  ubuntu-advantage-tools udev xserver-common xserver-xephyr xserver-xorg-core
  xserver-xorg-legacy
44 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
```

2. sudo apt update

```
lab2-@lab2-B250M-D2V:~$ sudo apt update
Hit:1 http://in.archive.ubuntu.com/ubuntu jammy InRelease
Get:2 http://security.ubuntu.com/ubuntu jammy-security InRelease [110 kB]
Get:3 http://in.archive.ubuntu.com/ubuntu jammy-updates InRelease [119 kB]
Get:4 http://in.archive.ubuntu.com/ubuntu jammy-backports InRelease [108 kB]
Get:5 http://in.archive.ubuntu.com/ubuntu jammy-updates/universe i386 Packages [
610 kB]
Get:6 http://in.archive.ubuntu.com/ubuntu jammy-updates/universe amd64 Packages
[901 kB]
Fetched 1,848 kB in 3s (616 kB/s)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
All packages are up to date.
lab2-@lab2-B250M-D2V:~$
```

3. sudo add-apt-repository ppa:wireshark-dev/stable

```
lab2-25@lab225-B250M-D2V:~/Wireshark$ cd ..
lab2-25@lab225-B250M-D2V:~$ sudo add-apt-repository ppa:wireshark-dev/stable
PPA publishes dbgSYM, you may need to include 'main/debug' component
Repository: 'deb https://ppa.launchpadcontent.net/wireshark-dev/stable/ubuntu/ jammy main'
Description:
Latest stable Wireshark releases back-ported from Debian package versions.

Back-porting script is available at https://github.com/rbalint/pkg-wireshark-ubuntu-ppa

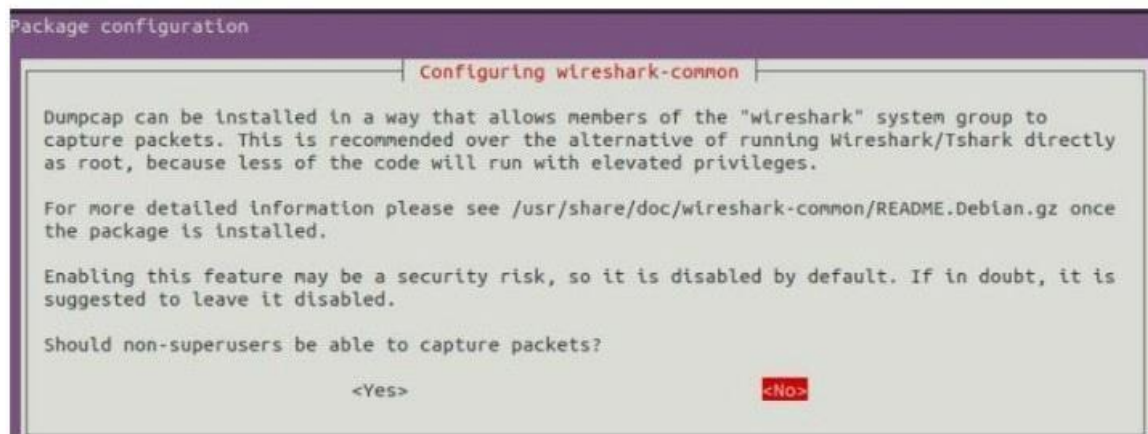
From Ubuntu 16.04 you also need to enable "universe" repository, see:
http://askubuntu.com/questions/148638/how-do-i-enable-the-universe-repository

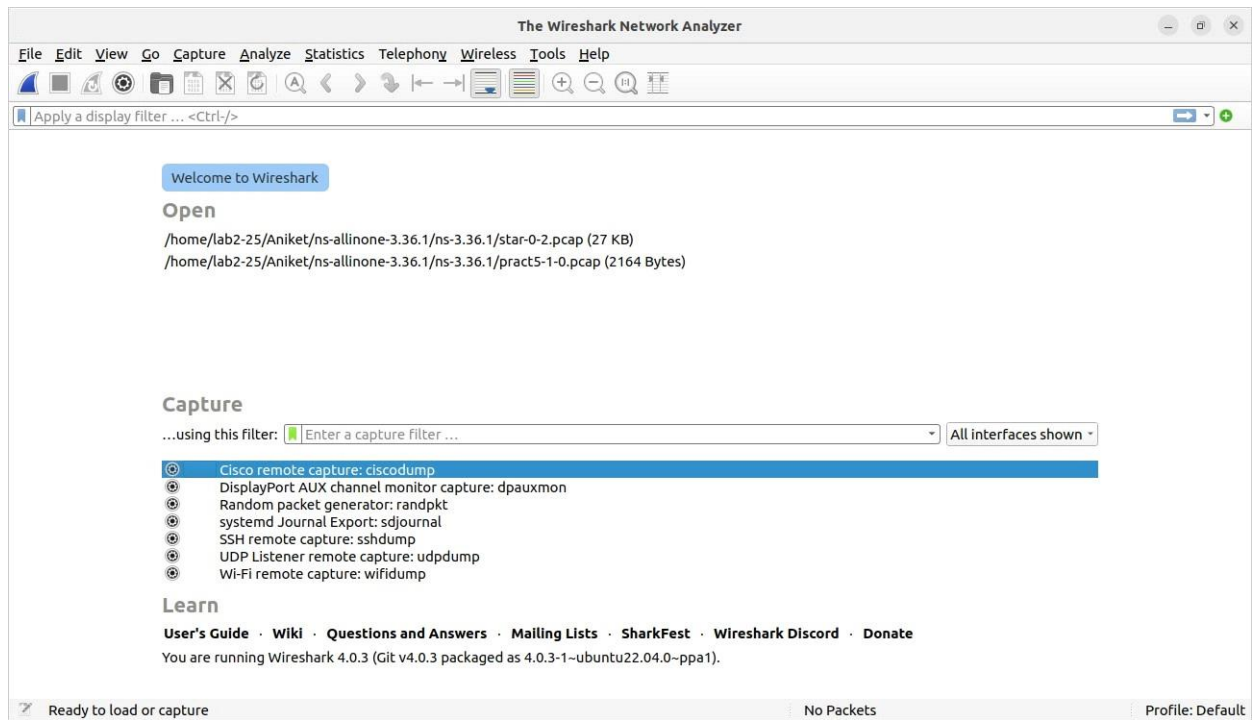
The packaging repository for Debian and Ubuntu is at: https://salsa.debian.org/debian/wireshark
More info: https://launchpad.net/~wireshark-dev/+archive/ubuntu/stable
Adding repository.
Press [ENTER] to continue or Ctrl-c to cancel.
Adding deb entry to /etc/apt/sources.list.d/wireshark-dev-ubuntu-stable-jammy.list
Adding disabled deb-src entry to /etc/apt/sources.list.d/wireshark-dev-ubuntu-stable-jammy.list
Adding key to /etc/apt/trusted.gpg.d/wireshark-dev-ubuntu-stable.gpg with fingerprint A2E402B85A4B70CD78D8A3D9D87551314ECA0F0
Hit:1 http://in.archive.ubuntu.com/ubuntu jammy InRelease
0% [Waiting for headers] [Waiting for headers] [Connected to ppa.launchpadcontent.net (185.125.190.52)]
```

4. sudo apt install wireshark

```
lab2-25@lab225-B250M-D2V: $ sudo apt install wireshark
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following packages were automatically installed and are no longer required:
  libwireshark15 libwiretap12 libwsutil13
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
  libwireshark-data libwireshark16 libwiretap13 libwsutil14 wireshark-common wireshark-qt
Suggested packages:
  geopupdate geopip-database geopip-database-extra libjs-leaflet libjs-leaflet.markercluster snmp-mibs-downloader wireshark-doc
The following NEW packages will be installed:
  libwireshark16 libwiretap13 libwsutil14
The following packages will be upgraded:
  libwireshark-data wireshark wireshark-common wireshark-qt
4 upgraded, 3 newly installed, 0 to remove and 3 not upgraded.
Need to get 28.2 MB of archives.
After this operation, 115 MB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 https://ppa.launchpadcontent.net/wireshark-dev/stable/ubuntu jammy/main amd64 libwireshark-data all 4.0.3-1-ubuntu22.04.0-ppa1 [1,744 kB]
Get:2 https://ppa.launchpadcontent.net/wireshark-dev/stable/ubuntu jammy/main amd64 libwsutil14 amd64 4.0.3-1-ubuntu22.04.0-ppa1 [142 kB]
Get:3 https://ppa.launchpadcontent.net/wireshark-dev/stable/ubuntu jammy/main amd64 libwiretap13 amd64 4.0.3-1-ubuntu22.04.0-ppa1 [507 kB]
```

5. configuring wireshark click yes





Practical No: 4

Aim: Program to simulate traffic between two nodes

Code:

Point.cc

```
#include "ns3/core-module.h"
#include "ns3/network-module.h"
#include "ns3/internet-module.h"
#include "ns3/point-to-point-module.h"
#include "ns3/applications-module.h"
#include "ns3/netanim-module.h"
#include "ns3/mobility-module.h"
// Default Network Topology
//10.1.1.0
// n0 ----- n1
//
//point-to-point
//
using namespace ns3;
NS_LOG_COMPONENT_DEFINE ("FirstScriptExample");
int
main (int argc, char *argv[])
{
CommandLine cmd (__FILE__);
cmd.Parse (argc, argv);
Time::SetResolution (Time::NS);
LogComponentEnable ("UdpEchoClientApplication",
LOG_LEVEL_INFO);
LogComponentEnable ("UdpEchoServerApplication",
LOG_LEVEL_INFO);
NodeContainer nodes;
nodes.Create (2);
PointToPointHelper pointToPoint;
pointToPoint.SetDeviceAttribute ("DataRate", StringValue ("5Mbps"));
pointToPoint.SetChannelAttribute ("Delay", StringValue ("2ms"));
NetDeviceContainer devices;
devices = pointToPoint.Install (nodes);
InternetStackHelper stack;
stack.Install (nodes);
Ipv4AddressHelper address;
address.SetBase ("10.1.1.0", "255.255.255.0");
Ipv4InterfaceContainer interfaces = address.Assign (devices);
UdpEchoServerHelper echoServer (9);
ApplicationContainer serverApps = echoServer.Install (nodes.Get (1));
serverApps.Start (Seconds (1.0));
serverApps.Stop (Seconds (10.0));
UdpEchoClientHelper echoClient (interfaces.GetAddress (1), 9);
```

```

echoClient.SetAttribute ("MaxPackets", UIntegerValue (1));
echoClient.SetAttribute ("Interval", TimeValue (Seconds (1.0)));
echoClient.SetAttribute ("PacketSize", UIntegerValue (1024));
ApplicationContainer clientApps = echoClient.Install (nodes.Get (0));
clientApps.Start (Seconds (2.0));
clientApps.Stop (Seconds (10.0));
MobilityHelper mobility;
mobility.SetMobilityModel("ns3::ConstantPositionMobilityModel");
mobility.Install(nodes);
AnimationInterface anim("first.xml");
AnimationInterface::SetConstantPosition(nodes.Get(0),10,25);
AnimationInterface::SetConstantPosition(nodes.Get(1),40,25);
anim.EnablePacketMetadata(true);
pointToPoint.EnablePcapAll("point");
Simulator::Run ();
Simulator::Destroy ();
return 0; }

```

Output:

```

Consolidate compiler generated dependencies of target libolsr-obj
Consolidate compiler generated dependencies of target libsixlowpan-obj
Consolidate compiler generated dependencies of target libtap-bridge-obj
Consolidate compiler generated dependencies of target libtopology-read-obj
[ 0%] Building CXX object scratch/CMakeFiles/scratch_firenet.dir/firenet.cc.o
[ 0%] Linking CXX executable ../../build/scratch/ns3.36.1-firenet-default
At time +2s client sent 1024 bytes to 10.1.1.2 port 9
At time +2.00369s server received 1024 bytes from 10.1.1.1 port 49153
At time +2.00369s server sent 1024 bytes to 10.1.1.1 port 49153
At time +2.00737s client received 1024 bytes from 10.1.1.2 port 9

```

```

Consolidate compiler generated dependencies of target libtopology-read-obj
[ 0%] Building CXX object scratch/CMakeFiles/scratch_prac.dir/prac.cc.o
[ 0%] Linking CXX executable ../../build/scratch/ns3.36.1-prac-default
At time +2s client sent 1024 bytes to 10.1.1.2 port 9
At time +2.00369s server received 1024 bytes from 10.1.1.1 port 49153
At time +2.00369s server sent 1024 bytes to 10.1.1.1 port 49153
At time +2.00737s client received 1024 bytes from 10.1.1.2 port 9
lab2-42@lab242-B250M-D2V:~/Desktop/saurabh_92/ns-allinone-3.36.1/ns-3.36.1$ cd ..
lab2-42@lab242-B250M-D2V:~/Desktop/saurabh_92/ns-allinone-3.36.1$ cd netanim-3.108
lab2-42@lab242-B250M-D2V:~/Desktop/saurabh_92/ns-allinone-3.36.1/netanim-3.108$ ./NetAnim

```

Practical No: 4.1

Aim: Point to point topology with ns3 & Net-

Anim. Code:

```
#include "ns3/core-module.h"
#include "ns3/network-module.h"
#include "ns3/internet-module.h"
#include "ns3/point-to-point-module.h"
#include "ns3/applications-module.h"
#include "ns3/netanim-module.h"
#include "ns3/mobility-module.h"
// Default Network Topology

//10.1.1.0

// n0 _____ n1

//

//point-to-point

//

using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("FirstScriptExample"); int
main (int argc, char *argv[])

{
CommandLine cmd (
_____F
ILE_____);
cmd.Parse (argc, argv);
Time::SetResolution
(Time::NS);
LogComponentEnable ("UdpEchoClientApplication",
LOG_LEVEL_INFO);
LogComponentEnable ("UdpEchoServerApplication",
LOG_LEVEL_INFO);
NodeContainer nodes;
nodes.Create (2);
PointToPointHelper pointToPoint;
pointToPoint.SetDeviceAttribute ("DataRate", StringValue ("5Mbps"));
pointToPoint.SetChannelAttribute ("Delay", StringValue ("2ms"));
NetDeviceContainer devices;
devices = pointToPoint.Install (nodes);
InternetStackHelper stack; stack.Install
(nodes);
Ipv4AddressHelper address;
address.SetBase ("10.1.1.0", "255.255.255.0");
Ipv4InterfaceContainer interfaces = address.Assign (devices);
```



```

UdpEchoServerHelper echoServer (9);
ApplicationContainer serverApps = echoServer.Install (nodes.Get (1));
serverApps.Start (Seconds (1.0));
serverApps.Stop (Seconds (10.0));

UdpEchoClientHelper echoClient (interfaces.GetAddress (1), 9);
echoClient.SetAttribute ("MaxPackets", UIntegerValue (1));
echoClient.SetAttribute ("Interval", TimeValue (Seconds (1.0)));
echoClient.SetAttribute ("PacketSize", UIntegerValue (1024));
ApplicationContainer clientApps = echoClient.Install (nodes.Get (0));
clientApps.Start (Seconds (2.0));
clientApps.Stop (Seconds (10.0));
MobilityHelper mobility;
mobility.SetMobilityModel("ns3::ConstantPositionMobilityModel");
mobility.Install(nodes);
AnimationInterface anim("first.xml");
AnimationInterface::SetConstantPosition(nodes.Get(0),10,25);
AnimationInterface::SetConstantPosition(nodes.Get(1),40,25);
anim.EnablePacketMetadata(true);
pointToPoint.EnablePcapAll("pract2Mana");
Simulator::Run
();
Simulator::Destro
y (); return 0; }

```

Output:



slow

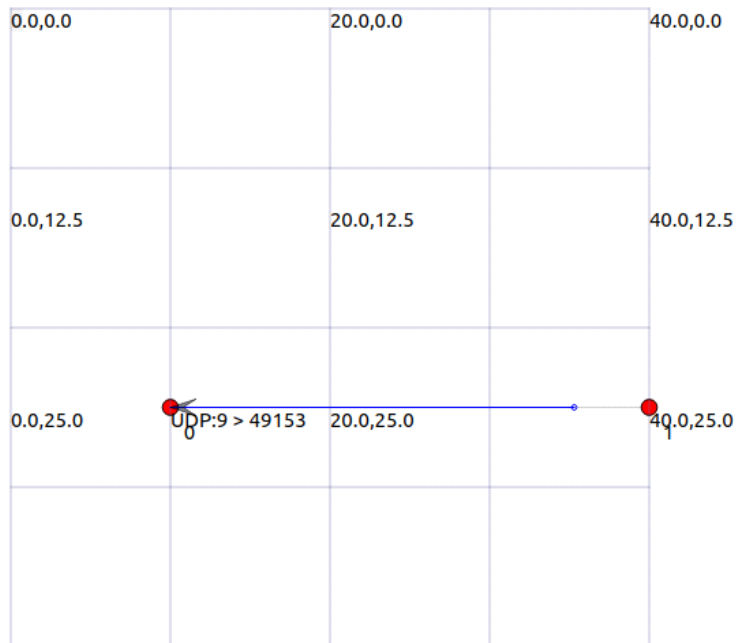
Sim time

2.0056864

Lines 5

Node Size 1

IP



Practical No: 5

Aim: Program to simulate star topology

Code:

```
#include "ns3/network-module.h"
#include "ns3/internet-module.h"
#include "ns3/point-to-point-star.h"
#include "ns3/applications-module.h"
#include "ns3/netanim-module.h"
#include "ns3/mobility-module.h"
#include "ns3/onoff-application.h"
using namespace ns3;
//NS_LOG_COMPONENT_DEFINE ("Star");
NS_LOG_COMPONENT_DEFINE ("StarExample");
int
main (int argc, char *argv[])
{
// Set up some default values for the simulation.
Config::SetDefault ("ns3::OnOffApplication::PacketSize",
UIntegerValue (137));
// ??? try and stick 15kb/s into the data rate
Config::SetDefault ("ns3::OnOffApplication::DataRate", StringValue
("14kb/s"));
// Default number of nodes in the star. Overridable by command line argument.
uint32_t nSpokes = 8;
CommandLine cmd (__FILE__);
cmd.AddValue ("nSpokes", "Number of nodes to place in the star", nSpokes);
cmd.Parse (argc, argv);
LogComponentEnable ("UdpEchoClientApplication", LOG_LEVEL_INFO);
LogComponentEnable ("UdpEchoServerApplication",
LOG_LEVEL_INFO);
NS_LOG_INFO ("Build star topology.");
PointToPointHelper pointToPoint;
pointToPoint.SetDeviceAttribute ("DataRate", StringValue ("5Mbps"));
pointToPoint.SetChannelAttribute ("Delay", StringValue ("2ms"));
PointToPointStarHelper star (nSpokes, pointToPoint);
NS_LOG_INFO ("Install internet stack on all nodes.");
InternetStackHelper internet;
star.InstallStack (internet);
NS_LOG_INFO ("Assign IP Addresses.");
star.AssignIpv4Addresses (Ipv4AddressHelper ("10.1.1.0",
"255.255.255.0"));
NS_LOG_INFO ("Create applications.");
// Create a packet sink on the star "hub" to receive packets.
uint16_t port = 50000;
Address hubLocalAddress (InetSocketAddress (Ipv4Address::GetAny
(), port));
PacketSinkHelper packetSinkHelper ("ns3::TcpSocketFactory",
hubLocalAddress);
```



```

ApplicationContainer hubApp = packetSinkHelper.Install (star.GetHub
());
hubApp.Start (Seconds (1.0));
hubApp.Stop (Seconds (10.0));
// Create OnOff applications to send TCP to the hub, one on each spokenode.
OnOffHelper onOffHelper ("ns3::TcpSocketFactory", Address ());
onOffHelper.SetAttribute ("OnTime",
StringValue("ns3::ConstantRandomVariable[Constant=1]"));
onOffHelper.SetAttribute ("OffTime",
StringValue("ns3::ConstantRandomVariable[Constant=0]"));
ApplicationContainer spokeApps;
for (uint32_t i = 0; i < star.SpokeCount (); ++i)
{
AddressValue remoteAddress (InetSocketAddress
(star.GetHubIpv4Address (i), port));
onOffHelper.SetAttribute ("Remote", remoteAddress);
spokeApps.Add (onOffHelper.Install (star.GetSpokeNode (i)));
}
spokeApps.Start (Seconds (1.0));
spokeApps.Stop (Seconds (10.0));
NS_LOG_INFO ("Enable static global routing.");
// Turn on global static routing so we can actually be routed across thestar.
Ipv4GlobalRoutingHelper::PopulateRoutingTables ();
NS_LOG_INFO ("Enable pcap tracing.");
//
// Do pcap tracing on all point-to-point devices on all nodes.
//
pointToPoint.EnablePcapAll ("star");
star.BoundingBox(1,1,100,100);
AnimationInterface anim("star.xml");
NS_LOG_INFO ("Run Simulation.");
Simulator::Run ();
Simulator::Destroy ();
NS_LOG_INFO ("Done.");
return 0;
}

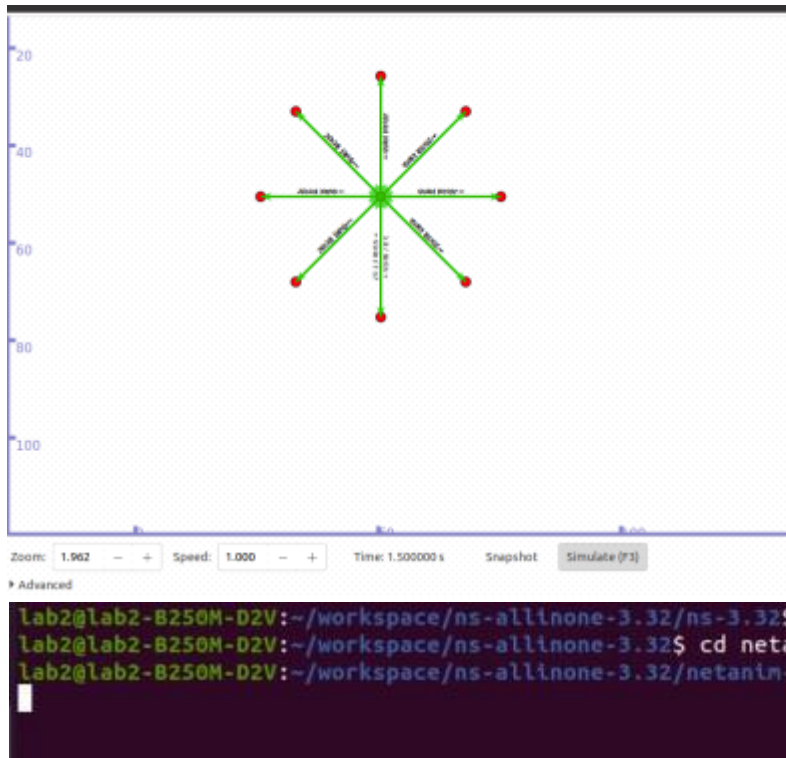
```

Output:

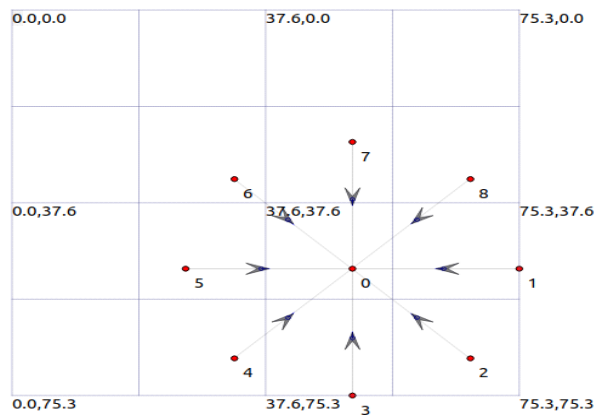
```

lab2@lab2-B250M-D2V:~/workspace/ns-allinone-3.32/ns-3.32/scratch$ cd ..
lab2@lab2-B250M-D2V:~/workspace/ns-allinone-3.32/ns-3.32$ ./waf --run scratch/pract3Mana
Waf: Entering directory '/home/lab2/workspace/ns-allinone-3.32/ns-3.32/build'
Waf: Leaving directory '/home/lab2/workspace/ns-allinone-3.32/ns-3.32/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (0.083s)
lab2@lab2-B250M-D2V:~/workspace/ns-allinone-3.32/ns-3.32$ ./waf --run scratch/pract3Mana --vis
Waf: Entering directory '/home/lab2/workspace/ns-allinone-3.32/ns-3.32/build'
Waf: Leaving directory '/home/lab2/workspace/ns-allinone-3.32/ns-3.32/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (0.089s)
Could not load plugin 'show_last_packets.py': No module named 'kiwi'
Could not load icon applets-screenshooter due to missing gnomedesktop Python module
scanning topology: 9 nodes...
scanning topology: calling graphviz layout
scanning topology: all done.
lab2@lab2-B250M-D2V:~/workspace/ns-allinone-3.32/ns-3.32$

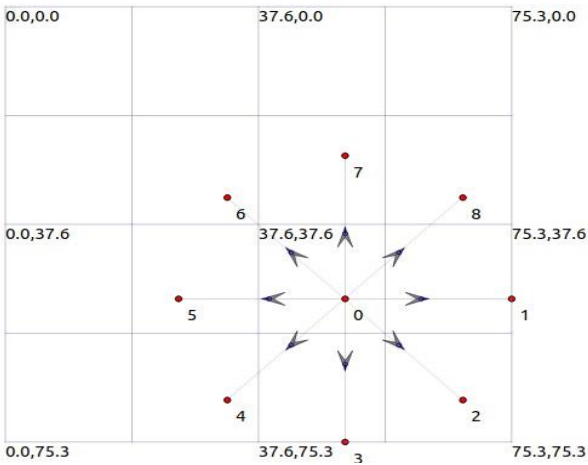
```



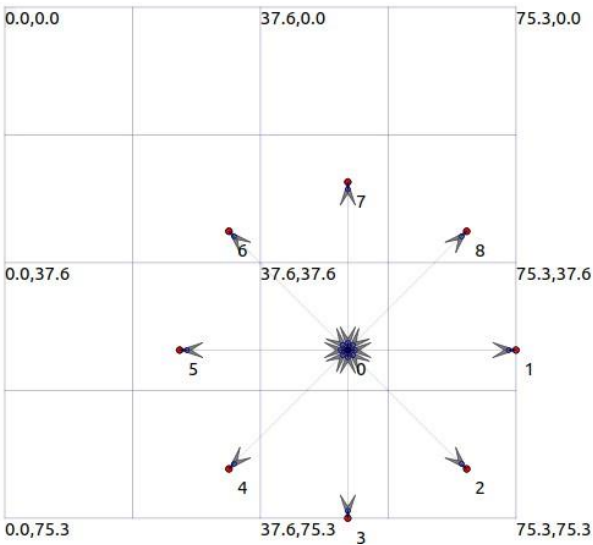
Use At: 65535 | fast | slow | Sim time: 1.001 | # Lines: 5 | Node Size: 1 | IP M



Use At: 65535 fast ☐ slow Sim time: 2.02 10 1989 # Lines: 5 Node Size: 1 IP M



Pause At: 65535 fast ☐ slow Sim time: 10.0040864 # Lines: 5 Node Size: 1 IP MAC T



Practical No: 6

Aim: Program to simulate bus topology

Code:

pract7.cc

```
#include "ns3/core-module.h"
#include "ns3/network-module.h"
#include "ns3/csma-module.h"
#include "ns3/internet-module.h"
#include "ns3/point-to-point-module.h"
#include "ns3/applications-module.h"
#include "ns3/ipv4-global-routing-helper.h"
// Default Network Topology
//
//
//10.1.1.0
// n0-----n1 n2 n3 n4
//
//
//
//point-to-point |||
//|
//=====
//LAN 10.1.2.0
using namespace ns3;
NS_LOG_COMPONENT_DEFINE ("SecondScriptExample");
int
main (int argc, char *argv[])
{
    bool verbose = true;
    uint32_t nCsma = 5;
    CommandLine cmd (__FILE__);
    cmd.AddValue ("nCsma", "Number of \"extra\" CSMA nodes/devices", nCsma);
    cmd.AddValue ("verbose", "Tell echo applications to log if true", verbose);
    cmd.Parse (argc,argv);
    if (verbose)
    {
        LogComponentEnable ("UdpEchoClientApplication", LOG_LEVEL_INFO);
        LogComponentEnable ("UdpEchoServerApplication", LOG_LEVEL_INFO);
        nCsma = nCsma == 0 ? 1 : nCsma;
        NodeContainer p2pNodes;
        p2pNodes.Create (2);
        NodeContainer csmaNodes;
        csmaNodes.Add (p2pNodes.Get (1));
        csmaNodes.Create (nCsma);
        PointToPointHelper pointToPoint;
        pointToPoint.SetDeviceAttribute ("DataRate", StringValue ("10Mbps"));
        pointToPoint.SetChannelAttribute ("Delay", StringValue ("5ms"));
```

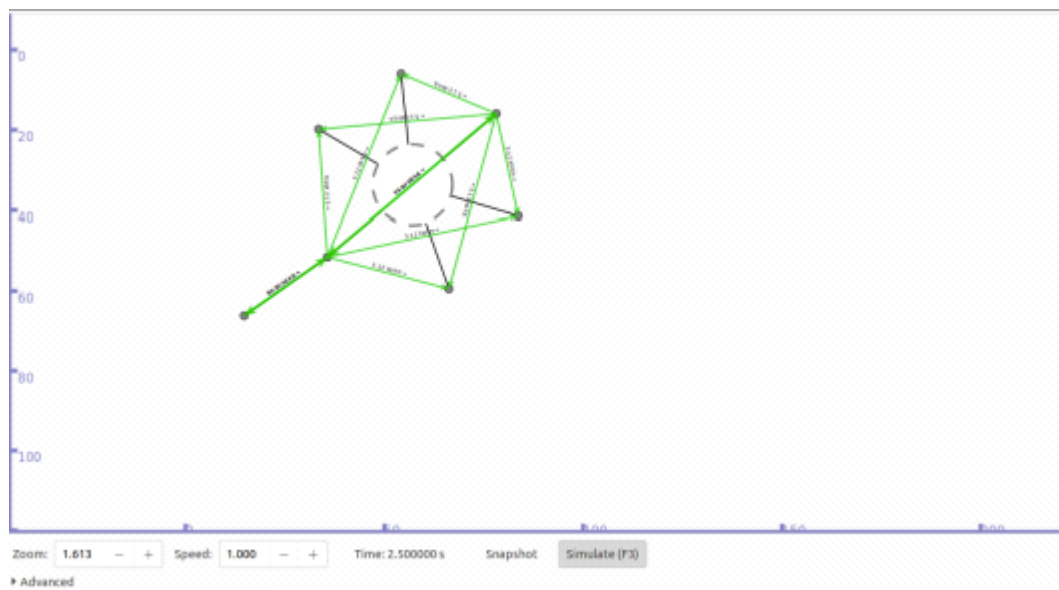
```

NetDeviceContainer p2pDevices;
p2pDevices = pointToPoint.Install (p2pNodes);
CsmaHelper csma;
csma.SetChannelAttribute ("DataRate", StringValue ("100Mbps"));
csma.SetChannelAttribute ("Delay", TimeValue (NanoSeconds (6560)));
NetDeviceContainer csmaDevices;
csmaDevices = csma.Install (csmaNodes);
InternetStackHelper stack;
stack.Install (p2pNodes.Get (0));
stack.Install (csmaNodes);
Ipv4AddressHelper address;
address.SetBase ("10.1.1.0", "255.255.255.0");
Ipv4InterfaceContainer p2pInterfaces;
p2pInterfaces = address.Assign (p2pDevices);
address.SetBase ("10.1.2.0", "255.255.255.0");
Ipv4InterfaceContainer csmaInterfaces;
csmaInterfaces = address.Assign (csmaDevices);
UdpEchoServerHelper echoServer (9);
ApplicationContainer serverApps = echoServer.Install (csmaNodes.Get (nCsma));
serverApps.Start (Seconds (1.0));
serverApps.Stop (Seconds (10.0));
UdpEchoClientHelper echoClient (csmaInterfaces.GetAddress (nCsma), 9);
echoClient.SetAttribute ("MaxPackets", UIntegerValue (1));
echoClient.SetAttribute ("Interval", TimeValue (Seconds (1.0)));
echoClient.SetAttribute ("PacketSize", UIntegerValue (1024));
ApplicationContainer clientApps = echoClient.Install (p2pNodes.Get (0));
clientApps.Start (Seconds (2.0));
clientApps.Stop (Seconds (10.0));
Ipv4GlobalRoutingHelper::PopulateRoutingTables ();
pointToPoint.EnablePcapAll ("pract2Mana");
csma.EnablePcap ("pract2Mana", csmaDevices.Get (1), true);
Simulator::Run ();
Simulator::Destroy ();
return 0;
}
}

```

Output:

```
[ 0%] Building CXX object scratch/CMakeFiles/scratch_practical7.dir/practical7.cc.o
[ 0%] Linking CXX executable ../../build/scratch/ns3.36.1-practical7-default
At time +2s client sent 1024 bytes to 10.1.2.6 port 9
At time +2.00596s server received 1024 bytes from 10.1.1.1 port 49153
At time +2.00596s server sent 1024 bytes to 10.1.1.1 port 49153
At time +2.01192s client received 1024 bytes from 10.1.2.6 port 9
lab2-42@lab242-B250M-D2V:~/Desktop/saurabh_92/ns-allinone-3.36.1/ns-3.36.1$ ./ns3 run scratch/practical7 -- vis
Consolidate compiler generated dependencies of target scratch_practical7
At time +2s client sent 1024 bytes to 10.1.2.6 port 9
At time +2.00596s server received 1024 bytes from 10.1.1.1 port 49153
At time +2.00596s server sent 1024 bytes to 10.1.1.1 port 49153
At time +2.01192s client received 1024 bytes from 10.1.2.6 port 9
lab2-42@lab242-B250M-D2V:~/Desktop/saurabh_92/ns-allinone-3.36.1/ns-3.36.1$
```



Practical No: 7

Aim: Program to simulate mesh topology

Code:

practmesh.cc

```
#include "ns3/applications-module.h"
#include "ns3/core-module.h"
#include "ns3/internet-module.h"
#include "ns3/mesh-helper.h"
#include "ns3/mesh-module.h"
#include "ns3/mobility-module.h"
#include "ns3/network-module.h"
#include "ns3/yans-wifi-helper.h"
#include <fstream>
#include <iostream>
#include <sstream>
using namespace ns3;
NS_LOG_COMPONENT_DEFINE("MeshExample");
// Declaring these variables outside of main() for use in trace sinks
uint32_t g_udpTxCount = 0; //!< Rx packet counter.
uint32_t g_udpRxCount = 0; //!< Tx packet counter.
/**
 * Transmission trace sink.
 *
 * \param p The sent packet.
 */
void
TxTrace(Ptr<const Packet> p)
{
    NS_LOG_DEBUG("Sent " << p->GetSize() << " bytes");
    g_udpTxCount++;
}
/**
 * Reception trace sink,
 *
 * \param p The received packet.
 */
void
RxTrace(Ptr<const Packet> p)
{
    NS_LOG_DEBUG("Received " << p->GetSize() << " bytes");
    g_udpRxCount++;
}
/**
 * \ingroup mesh
 * \brief MeshTest class
 */
```



```

class MeshTest
{
public:
/// Init test

MeshTest();
/**
 * Configure test from command line arguments
 *
 * \param argc command line argument count
 * \param argv command line arguments
 */
void Configure(int argc, char** argv);
/**
 * Run test
 * \returns the test status
 */
int Run();
private:
int m_xSize; ///< X size
int m_ySize; ///< Y size
double m_step; ///< step
double m_randomStart; ///< random start
double m_totalTime; ///< total time
double m_packetInterval; ///< packet interval
uint16_t m_packetSize; ///< packet size
uint32_t m_nIfaces; ///< number interfaces
bool m_chan; ///< channel
bool m_pcap; ///< PCAP
bool m_ascii; ///< ASCII
std::string m_stack; ///< stack
std::string m_root; ///< root
/// List of network nodes
NodeContainer nodes;
/// List of all mesh point devices
NetDeviceContainer meshDevices;
/// Addresses of interfaces:
Ipv4InterfaceContainer interfaces;
/// MeshHelper. Report is not static methods
MeshHelper mesh;
private:
/// Create nodes and setup their mobility
void CreateNodes();
/// Install internet m_stack on nodes
void InstallInternetStack();
/// Install applications
void InstallApplication();
/// Print mesh devices diagnostics
void Report();
};

```

```

MeshTest::MeshTest()
: m_xSize(3),
m_ySize(3),
m_step(50.0),
m_randomStart(0.1),
m_totalTime(100.0),
m_packetInterval(1),
m_packetSize(1024),
m_nIfaces(1),

m_chan(true),
m_pcap(false),
m_ascii(false),
m_stack("ns3::Dot11sStack"),
m_root("ff:ff:ff:ff:ff:ff")
{
}
void
MeshTest::Configure(int argc, char* argv[])
{
CommandLine cmd(__FILE__);
cmd.AddValue("x-size", "Number of nodes in a row grid", m_xSize);
cmd.AddValue("y-size", "Number of rows in a grid", m_ySize);
cmd.AddValue("step", "Size of edge in our grid (meters)", m_step);
// Avoid starting all mesh nodes at the same time (beacons may collide)
cmd.AddValue("start", "Maximum random start delay for beacon jitter (sec)",
m_randomStart);
cmd.AddValue("time", "Simulation time (sec)", m_totalTime);
cmd.AddValue("packet-interval", "Interval between packets in UDP ping (sec)",
m_packetInterval);
cmd.AddValue("packet-size", "Size of packets in UDP ping (bytes)", m_packetSize);
cmd.AddValue("interfaces", "Number of radio interfaces used by each mesh point",
m_nIfaces);
cmd.AddValue("channels", "Use different frequency channels for different interfaces",
m_chan);
cmd.AddValue("pcap", "Enable PCAP traces on interfaces", m_pcap);
cmd.AddValue("ascii", "Enable Ascii traces on interfaces", m_ascii);
cmd.AddValue("stack", "Type of protocol stack. ns3::Dot11sStack by default", m_stack);
cmd.AddValue("root", "Mac address of root mesh point in HWMP", m_root);
cmd.Parse(argc, argv);
NS_LOG_DEBUG("Grid:" << m_xSize << "*" << m_ySize);
NS_LOG_DEBUG("Simulation time: " << m_totalTime << " s");
if (m_ascii)
{
PacketMetadata::Enable();
}
}
void
MeshTest::CreateNodes()
{

```

```

/*
 * Create m_ySize*m_xSize stations to form a grid topology
 */
nodes.Create(m_ySize * m_xSize);
// Configure YansWifiChannel
YansWifiPhyHelper wifiPhy;
YansWifiChannelHelper wifiChannel = YansWifiChannelHelper::Default();
wifiPhy.SetChannel(wifiChannel.Create());
/*
 * Create mesh helper and set stack installer to it
 * Stack installer creates all needed protocols and install them to
 * mesh point device
 */
mesh = MeshHelper::Default();
if (!Mac48Address(m_root.c_str()).IsBroadcast())
{
    mesh.SetStackInstaller(m_stack, "Root",
        Mac48AddressValue(Mac48Address(m_root.c_str())));
}

else
{
    // If root is not set, we do not use "Root" attribute, because it
    // is specified only for 11s
    mesh.SetStackInstaller(m_stack);
}
if (m_chan)
{
    mesh.SetSpreadInterfaceChannels(MeshHelper::SPREAD_CHANNELS);
}
else
{
    mesh.SetSpreadInterfaceChannels(MeshHelper::ZERO_CHANNEL);
}
mesh.SetMacType("RandomStart", TimeValue(Seconds(m_randomStart)));
// Set number of interfaces - default is single-interface mesh point
mesh.SetNumberOfInterfaces(m_nIfaces);
// Install protocols and return container if MeshPointDevices
meshDevices = mesh.Install(wifiPhy, nodes);
// AssignStreams can optionally be used to control random variable streams
mesh.AssignStreams(meshDevices, 0);
// Setup mobility - static grid topology
MobilityHelper mobility;
mobility.SetPositionAllocator("ns3::GridPositionAllocator",

"MinX",
DoubleValue(0.0),
"MinY",
DoubleValue(0.0),
"DeltaX",

```

```

DoubleValue(m_step),
"DeltaY",
DoubleValue(m_step),
"GridWidth",
UIntegerValue(m_xSize),
"LayoutType",
StringValue("RowFirst"));

mobility.SetMobilityModel("ns3::ConstantPositionMobilityModel");
mobility.Install(nodes);
if (m_pcap)
{
wifiPhy.EnablePcapAll(std::string("mp"));
}
if (m_ascii)
{
AsciiTraceHelper ascii;
wifiPhy.EnableAsciiAll(ascii.CreateFileStream("mesh.tr"));
}
}
void
MeshTest::InstallInternetStack()
{
InternetStackHelper internetStack;
internetStack.Install(nodes);
Ipv4AddressHelper address;
address.SetBase("10.1.1.0", "255.255.255.0");
interfaces = address.Assign(meshDevices);

}
void
MeshTest::InstallApplication()
{
uint16_t portNumber = 9;
UdpEchoServerHelper echoServer(portNumber);
uint16_t sinkNodeId = m_xSize * m_ySize - 1;
ApplicationContainer serverApps = echoServer.Install(nodes.Get(sinkNodeId));
serverApps.Start(Seconds(1.0));
serverApps.Stop(Seconds(m_totalTime + 1));
UdpEchoClientHelper echoClient(interfaces.GetAddress(sinkNodeId), portNumber);
echoClient.SetAttribute("MaxPackets",

UIntegerValue((uint32_t)(m_totalTime * (1 / m_packetInterval))));
echoClient.SetAttribute("Interval", TimeValue(Seconds(m_packetInterval)));
echoClient.SetAttribute("PacketSize", UintegerValue(m_packetSize));
ApplicationContainer clientApps = echoClient.Install(nodes.Get(0));
Ptr<UdpEchoClient> app = clientApps.Get(0)->GetObject<UdpEchoClient>();
app->TraceConnectWithoutContext("Tx", MakeCallback(&TxTrace));
app->TraceConnectWithoutContext("Rx", MakeCallback(&RxTrace));
clientApps.Start(Seconds(1.0));

```

```

clientApps.Stop(Seconds(m_totalTime + 1.5));
}
int
MeshTest::Run()
{
CreateNodes();
InstallInternetStack();
InstallApplication();
Simulator::Schedule(Seconds(m_totalTime), &MeshTest::Report, this);
Simulator::Stop(Seconds(m_totalTime + 2));
Simulator::Run();
Simulator::Destroy();
std::cout << "UDP echo packets sent: " << g_udpTxCount << " received: " <<
g_udpRxCount
<< std::endl;
return 0;
}
void
MeshTest::Report()
{
unsigned n(0);
for (NetDeviceContainer::Iterator i = meshDevices.Begin(); i != meshDevices.End(); ++i,
++n)
{
std::ostringstream os;
os<< "mp-report-" << n << ".xml";
std::cerr << "Printing mesh point device #" << n << " diagnostics to " << os.str() << "\n";
std::ofstream of;
of.open(os.str().c_str());
if (!of.is_open())
{
std::cerr << "Error: Can't open file " << os.str() << "\n";
return;
}
mesh.Report(*i, of);
of.close();
}
}
int
main(int argc, char* argv[])
{
MeshTest t;
t.Configure(argc, argv);
return t.Run();
}

```


Output:

```
[ 0%] Building CXX object scratch/CMakeFiles/scratch_practical7.dir/practical7.cc.o
[ 0%] Linking CXX executable ../../build/scratch/ns3.36.1-practical7-default
At time +2s client sent 1024 bytes to 10.1.2.6 port 9
At time +2.00596s server received 1024 bytes from 10.1.1.1 port 49153
At time +2.00596s server sent 1024 bytes to 10.1.1.1 port 49153
At time +2.01192s client received 1024 bytes from 10.1.2.6 port 9
lab2-42@lab242-B250M-D2V:~/Desktop/saurabh_92/ns-allinone-3.36.1/ns-3.36.1$ ./ns3 run scratch/practical7 -- vis
Consolidate compiler generated dependencies of target scratch_practical7
At time +2s client sent 1024 bytes to 10.1.2.6 port 9
At time +2.00596s server received 1024 bytes from 10.1.1.1 port 49153
At time +2.00596s server sent 1024 bytes to 10.1.1.1 port 49153
At time +2.01192s client received 1024 bytes from 10.1.2.6 port 9
lab2-42@lab242-B250M-D2V:~/Desktop/saurabh_92/ns-allinone-3.36.1/ns-3.36.1$
```

```
lab2-@lab2-B250M-D2V:~/Desktop/ns-allinone-3.36.1/ns-3.36.1$ cd ..
lab2-@lab2-B250M-D2V:~/Desktop/ns-allinone-3.36.1$ cd netanim-3.108/
lab2-@lab2-B250M-D2V:~/Desktop/ns-allinone-3.36.1/netanim-3.108$ ./NetAnim
Warning: Ignoring XDG_SESSION_TYPE=wayland on Gnome. Use QT_QPA_PLATFORM=wayland to run on Wayland anyway.
Segmentation fault (core dumped)
```

Practical No: 8

Aim: Program to simulate hybrid topology

Code:

hybrid.cc

```
#include "ns3/core-module.h"
#include "ns3/point-to-point-module.h"
#include "ns3/network-module.h"
#include "ns3/applications-module.h"
#include "ns3/mobility-module.h"
#include "ns3/csma-module.h"
#include "ns3/internet-module.h"
#include "ns3/yans-wifi-helper.h"
#include "ns3/ssid.h"
// Default Network Topology
//
// Wifi 10.1.3.0
// AP
// * * * *
// |||| 10.1.1.0
// n5 n6 n7 n0----- n1 n2 n3 n4
// point-to-point ||||
// =====
// LAN 10.1.2.0
using namespace ns3;
NS_LOG_COMPONENT_DEFINE ("ThirdScriptExample");
int
main (int argc, char *argv[])
{
    bool verbose = true;
    uint32_t nCsma = 3;
    uint32_t nWifi = 3;
    bool tracing = false;
    CommandLine cmd (__FILE__);
    cmd.AddValue ("nCsma", "Number of \"extra\" CSMA nodes/devices", nCsma);
    cmd.AddValue ("nWifi", "Number of wifi STA devices", nWifi);
    cmd.AddValue ("verbose", "Tell echo applications to log if true", verbose);
    cmd.AddValue ("tracing", "Enable pcap tracing", tracing);

    cmd.Parse (argc,argv);
    // The underlying restriction of 18 is due to the grid position
    // allocator's configuration; the grid layout will exceed the
    // bounding box if more than 18 nodes are provided.
    if (nWifi > 18)
    {
        std::cout << "nWifi should be 18 or less; otherwise grid layout exceeds the bounding box" <<
        std::endl;
        return 1;
    }
}
```

```

}
if (verbose)
{
LogComponentEnable ("UdpEchoClientApplication", LOG_LEVEL_INFO);
LogComponentEnable ("UdpEchoServerApplication", LOG_LEVEL_INFO);
}
NodeContainer p2pNodes;
p2pNodes.Create (2);
PointToPointHelper pointToPoint;
pointToPoint.SetDeviceAttribute ("DataRate", StringValue ("5Mbps"));
pointToPoint.SetChannelAttribute ("Delay", StringValue ("2ms"));
NetDeviceContainer p2pDevices;
p2pDevices = pointToPoint.Install (p2pNodes);
NodeContainer csmaNodes;
csmaNodes.Add (p2pNodes.Get (1));
csmaNodes.Create (nCsma);
CsmaHelper csma;
csma.SetChannelAttribute ("DataRate", StringValue ("100Mbps"));
csma.SetChannelAttribute ("Delay", TimeValue (NanoSeconds (6560)));
NetDeviceContainer csmaDevices;
csmaDevices = csma.Install (csmaNodes);
NodeContainer wifiStaNodes;
wifiStaNodes.Create (nWifi);
NodeContainer wifiApNode = p2pNodes.Get (0);
YansWifiChannelHelper channel = YansWifiChannelHelper::Default ();
YansWifiPhyHelper phy;
phy.SetChannel (channel.Create ());
WifiMacHelper mac;
Ssid ssid = Ssid ("ns-3-ssid");
WifiHelper wifi;
NetDeviceContainer staDevices;
mac.SetType ("ns3::StaWifiMac",
"Ssid", SsidValue (ssid),
"ActiveProbing", BooleanValue (false));
staDevices = wifi.Install (phy, mac, wifiStaNodes);

NetDeviceContainer apDevices;
mac.SetType ("ns3::ApWifiMac",
"Ssid", SsidValue (ssid));
apDevices = wifi.Install (phy, mac, wifiApNode);
MobilityHelper mobility;
mobility.SetPositionAllocator ("ns3::GridPositionAllocator",
"MinX", DoubleValue (0.0),
"MinY", DoubleValue (0.0),
"DeltaX", DoubleValue (5.0),
"DeltaY", DoubleValue (10.0),
"GridWidth", UIntegerValue (3),
"LayoutType", StringValue ("RowFirst"));
mobility.SetMobilityModel ("ns3::RandomWalk2dMobilityModel",
"Bounds", RectangleValue (Rectangle (-50, 50, -50, 50)));

```

```

mobility.Install (wifiStaNodes);
mobility.SetMobilityModel ("ns3::ConstantPositionMobilityModel");
mobility.Install (wifiApNode);
InternetStackHelper stack;
stack.Install (csmaNodes);
stack.Install (wifiApNode);
stack.Install (wifiStaNodes);
Ipv4AddressHelper address;
address.SetBase ("10.1.1.0", "255.255.255.0");
Ipv4InterfaceContainer p2pInterfaces;
p2pInterfaces = address.Assign (p2pDevices);
address.SetBase ("10.1.2.0", "255.255.255.0");
Ipv4InterfaceContainer csmaInterfaces;
csmaInterfaces = address.Assign (csmaDevices);
address.SetBase ("10.1.3.0", "255.255.255.0");
address.Assign (staDevices);
address.Assign (apDevices);
UdpEchoServerHelper echoServer (9);
ApplicationContainer serverApps = echoServer.Install (csmaNodes.Get (nCsma));
serverApps.Start (Seconds (1.0));
serverApps.Stop (Seconds (10.0));
UdpEchoClientHelper echoClient (csmaInterfaces.GetAddress (nCsma), 9);
echoClient.SetAttribute ("MaxPackets", UIntegerValue (1));
echoClient.SetAttribute ("Interval", TimeValue (Seconds (1.0)));
echoClient.SetAttribute ("PacketSize", UIntegerValue (1024));
ApplicationContainer clientApps =
echoClient.Install (wifiStaNodes.Get (nWifi - 1));
clientApps.Start (Seconds (2.0));
clientApps.Stop (Seconds (10.0));
Ipv4GlobalRoutingHelper::PopulateRoutingTables ();
Simulator::Stop (Seconds (10.0));
if (tracing)
{
phy.SetPcapDataLinkType (WifiPhyHelper::DLT_IEEE802_11_RADIO);
pointToPoint.EnablePcapAll ("third");
phy.EnablePcap ("third", apDevices.Get (0));
csma.EnablePcap ("third", csmaDevices.Get (0), true);
}
Simulator::Run ();
Simulator::Destroy ();
return 0;
}

```

Output:

```

lab2-@lab2-B250M-D2V: ~/Desktop/ns-allinone-3.36.1/ns-3.36.1$ ./ns3 run scratch/hybrid
Consolidate compiler generated dependencies of target scratch_hybrid
At time +2s client sent 1024 bytes to 10.1.2.4 port 9
At time +2.01624s server received 1024 bytes from 10.1.3.3 port 49153
At time +2.01624s server sent 1024 bytes to 10.1.3.3 port 49153
At time +2.02849s client received 1024 bytes from 10.1.2.4 port 9

```

Practical No : 9

Aim: Program to simulate UDP Server client.

Code:

udp.cc

```
#include <fstream>
#include "ns3/core-module.h"
#include "ns3/core-module.h"
#include "ns3/csma-module.h"
#include "ns3/applications-module.h"
#include "ns3/internet-module.h"

using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("UdpClientServerExample");

int
main (int argc, char *argv[])
{
//
// Enable logging for UdpClient and
//
LogComponentEnable ("UdpClient", LOG_LEVEL_INFO);
LogComponentEnable ("UdpServer", LOG_LEVEL_INFO);

bool useV6 = false;
Address serverAddress;

CommandLine cmd;
cmd.AddValue ("useIpv6", "Use Ipv6", useV6);
cmd.Parse (argc, argv);

//
// Explicitly create the nodes required by the topology (shown above).
//
NS_LOG_INFO ("Create nodes.");
NodeContainer n;
n.Create (2);

InternetStackHelper internet;
internet.Install (n);

NS_LOG_INFO ("Create channels.");
//
// Explicitly create the channels required by the topology (shown above).
//
CsmaHelper csma;
csma.SetChannelAttribute ("DataRate", DataRateValue (DataRate (5000000)));
```



```

csma.SetChannelAttribute ("Delay", TimeValue (Milliseconds (2)));
csma.SetDeviceAttribute ("Mtu", UIntegerValue (1400));
NetDeviceContainer d = csma.Install (n);

//
// We've got the "hardware" in place. Now we need to add IP addresses.
//
NS_LOG_INFO ("Assign IP Addresses.");
if (useV6 == false)
{
    Ipv4AddressHelper ipv4;
    ipv4.SetBase ("10.1.1.0", "255.255.255.0");
    Ipv4InterfaceContainer i = ipv4.Assign (d);
    serverAddress = Address (i.GetAddress (1));
}
else
{
    Ipv6AddressHelper ipv6;
    ipv6.SetBase ("2001:0000:f00d:cafe::", Ipv6Prefix (64));
    Ipv6InterfaceContainer i6 = ipv6.Assign (d);
    serverAddress = Address(i6.GetAddress (1,1));
}

NS_LOG_INFO ("Create Applications.");
//
// Create one udpServer applications on node one.
//
uint16_t port = 4000;
UdpServerHelper server (port);
ApplicationContainer apps = server.Install (n.Get (1));
apps.Start (Seconds (1.0));
apps.Stop (Seconds (10.0));

//
// Create one UdpClient application to send UDP datagrams from node zero to
// node one.
//
uint32_t MaxPacketSize = 1024;
Time interPacketInterval = Seconds (0.05);
uint32_t maxPacketCount = 320;
UdpClientHelper client (serverAddress, port);
client.SetAttribute ("MaxPackets", UIntegerValue (maxPacketCount));
client.SetAttribute ("Interval", TimeValue (interPacketInterval));
client.SetAttribute ("PacketSize", UIntegerValue (MaxPacketSize));
apps = client.Install (n.Get (0));
apps.Start (Seconds (2.0));
apps.Stop (Seconds (10.0));

//
// Now, do the actual simulation.

```

```
//
NS_LOG_INFO ("Run Simulation.");
Simulator::Run ();
Simulator::Destroy ();
NS_LOG_INFO ("Done.");
}
```

Output:

```
scratch/udp1.cc
-- Using default output directory /home/lab2-/Desktop/vaibhavi/ns-allinone-3.36.1/ns-3.36.1/build
-- Proceeding without cmake-format
-- find_external_library: SQLite3 was found.
-- Harfbuzz is required by GTK3 and was not found.
-- LibXML2 was found.
-- LibRT was found.
```

```
Consolidate compiler generated dependencies of target libwifi-obj
Consolidate compiler generated dependencies of target liblte-obj
[ 0%] Building CXX object scratch/CMakeFiles/scratch_udp1.dir/udp1.cc.o
[ 0%] Linking CXX executable ../../build/scratch/ns3.36.1-udp1-default
TraceDelay TX 1024 bytes to 10.1.1.2 Uid: 0 Time: +2s
TraceDelay: RX 1024 bytes from 10.1.1.1 Sequence Number: 0 Uid: 0 TXtime: +2e+09ns RXtime: +2.01592e+09ns Delay: +1.59188e+07ns
TraceDelay TX 1024 bytes to 10.1.1.2 Uid: 5 Time: +2.05s
TraceDelay: RX 1024 bytes from 10.1.1.1 Sequence Number: 1 Uid: 5 TXtime: +2.05e+09ns RXtime: +2.05371e+09ns Delay: +3.712e+06ns
TraceDelay TX 1024 bytes to 10.1.1.2 Uid: 6 Time: +2.1s
TraceDelay: RX 1024 bytes from 10.1.1.1 Sequence Number: 2 Uid: 6 TXtime: +2.1e+09ns RXtime: +2.10371e+09ns Delay: +3.712e+06ns
TraceDelay TX 1024 bytes to 10.1.1.2 Uid: 7 Time: +2.15s
TraceDelay: RX 1024 bytes from 10.1.1.1 Sequence Number: 3 Uid: 7 TXtime: +2.15e+09ns RXtime: +2.15371e+09ns Delay: +3.712e+06ns
TraceDelay TX 1024 bytes to 10.1.1.2 Uid: 8 Time: +2.2s
TraceDelay: RX 1024 bytes from 10.1.1.1 Sequence Number: 4 Uid: 8 TXtime: +2.2e+09ns RXtime: +2.20371e+09ns Delay: +3.712e+06ns
TraceDelay TX 1024 bytes to 10.1.1.2 Uid: 9 Time: +2.25s
TraceDelay: RX 1024 bytes from 10.1.1.1 Sequence Number: 5 Uid: 9 TXtime: +2.25e+09ns RXtime: +2.25371e+09ns Delay: +3.712e+06ns
TraceDelay TX 1024 bytes to 10.1.1.2 Uid: 10 Time: +2.3s
```

Practical No: 10

Aim: Program to simulate DHCP server and n clients.

Code:

```
#include "ns3/core-module.h"

#include "ns3/internet-apps-module.h"

#include "ns3/csma-module.h"

#include "ns3/internet-module.h"

#include "ns3/point-to-point-module.h"

#include "ns3/applications-module.h"

using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("DhcpExample");

int main (int argc, char *argv[])

{

CommandLine cmd (_FILE_);

bool verbose = true;

bool tracing = false;

cmd.AddValue ("verbose", "turn on the logs", verbose);

cmd.AddValue ("tracing", "turn on the tracing", tracing);

cmd.Parse (argc, argv);

// GlobalValue::Bind ("ChecksumEnabled", BooleanValue (true));

if (verbose)

{

LogComponentEnable ("DhcpServer", LOG_LEVEL_ALL);

LogComponentEnable ("DhcpClient", LOG_LEVEL_ALL);

LogComponentEnable ("UdpEchoServerApplication", LOG_LEVEL_INFO);

LogComponentEnable ("UdpEchoClientApplication", LOG_LEVEL_INFO);

}

Time stopTime = Seconds (20);

NS_LOG_INFO ("Create nodes.");
```

```
NodeContainer nodes;

NodeContainer router;

nodes.Create (3);

router.Create (2);

NodeContainer net (nodes, router);

NS_LOG_INFO ("Create channels.");

CsmaHelper csma;

csma.SetChannelAttribute ("DataRate", StringValue ("5Mbps"));

csma.SetChannelAttribute ("Delay", StringValue ("2ms"));

csma.SetDeviceAttribute ("Mtu", UIntegerValue (1500));

NetDeviceContainer devNet = csma.Install (net);

NodeContainer p2pNodes;

p2pNodes.Add (net.Get (4));

p2pNodes.Create (1);

PointToPointHelper pointToPoint;

pointToPoint.SetDeviceAttribute ("DataRate", StringValue ("5Mbps"));

pointToPoint.SetChannelAttribute ("Delay", StringValue ("2ms"));

NetDeviceContainer p2pDevices;

p2pDevices = pointToPoint.Install (p2pNodes);

InternetStackHelper tcpip;

tcpip.Install (nodes);

tcpip.Install (router);

tcpip.Install (p2pNodes.Get (1));

Ipv4AddressHelper address;

address.SetBase ("172.30.1.0", "255.255.255.0");

Ipv4InterfaceContainer p2pInterfaces;

p2pInterfaces = address.Assign (p2pDevices);

// manually add a routing entry because we don't want to add a dynamic routing

Ipv4StaticRoutingHelper ipv4RoutingHelper;
```

```

Ptr<Ipv4> ipv4Ptr = p2pNodes.Get (1)->GetObject<Ipv4> ();

Ptr<Ipv4StaticRouting> staticRoutingA = ipv4RoutingHelper.GetStaticRouting (ipv4Ptr);
staticRoutingA->AddNetworkRouteTo (Ipv4Address ("172.30.0.0"), Ipv4Mask ("/24"),
Ipv4Address ("172.30.1.1"), 1);

NS_LOG_INFO ("Setup the IP addresses and create DHCP applications.");

DhcpHelper dhcpHelper;

// The router must have a fixed IP.

Ipv4InterfaceContainer fixedNodes = dhcpHelper.InstallFixedAddress (devNet.Get (4),
Ipv4Address ("172.30.0.17"), Ipv4Mask ("/24"));

// Not really necessary, IP forwarding is enabled by default in IPv4.

fixedNodes.Get (0).first->SetAttribute ("IpForward", BooleanValue (true));

// DHCP server

ApplicationContainer dhcpServerApp = dhcpHelper.InstallDhcpServer (devNet.Get (3),
Ipv4Address ("172.30.0.12"),
Ipv4Address ("172.30.0.0"), Ipv4Mask ("/24"),
Ipv4Address ("172.30.0.10"), Ipv4Address ("172.30.0.15"),
Ipv4Address ("172.30.0.17"));

// This is just to show how it can be done.

DynamicCast<DhcpServer> (dhcpServerApp.Get (0))->AddStaticDhcpEntry (devNet.Get
(2)->GetAddress (), Ipv4Address ("172.30.0.14"));

dhcpServerApp.Start (Seconds (0.0));

dhcpServerApp.Stop (stopTime);

// DHCP clients

NetDeviceContainer dhcpClientNetDevs;

dhcpClientNetDevs.Add (devNet.Get (0));

dhcpClientNetDevs.Add (devNet.Get (1));

dhcpClientNetDevs.Add (devNet.Get (2));

ApplicationContainer dhcpClients = dhcpHelper.InstallDhcpClient (dhcpClientNetDevs);

dhcpClients.Start (Seconds (1.0));

dhcpClients.Stop (stopTime);

UdpEchoServerHelper echoServer (9);

```



```

ApplicationContainer serverApps = echoServer.Install (p2pNodes.Get (1));

serverApps.Start (Seconds (0.0));

serverApps.Stop (stopTime);

UdpEchoClientHelper echoClient (p2pInterfaces.GetAddress (1), 9);

echoClient.SetAttribute ("MaxPackets", UIntegerValue (100));

echoClient.SetAttribute ("Interval", TimeValue (Seconds (1.0)));

echoClient.SetAttribute ("PacketSize", UIntegerValue (1024));

ApplicationContainer clientApps = echoClient.Install (nodes.Get (1));

clientApps.Start (Seconds (10.0));

clientApps.Stop (stopTime);

Simulator::Stop (stopTime + Seconds (10.0));

if (tracing)
{
    csma.EnablePcapAll ("dhcp-csma");

    pointToPoint.EnablePcapAll ("dhcp-p2p");
}

NS_LOG_INFO ("Run Simulation.");

Simulator::Run ();

Simulator::Destroy ();

NS_LOG_INFO ("Done.");
}

```

Output:

```

lab2-439lab243-B250M-B2V1:/Downloads/ns-allinone-3.36.1/ns-3.36.1$ ./ns3 run scratch/dhcp.cc
Consolidate compiler generated dependencies of target scratch_dhcp
[ 0%] Building CXX object scratch/CHakeFiles/scratch_dhcp.dir/dhcp.cc.o
[ 0%] Linking CXX executable ../build/scratch/ns3.36.1-dhcp-default
DhcpServer: DhcpServer(0x563a3fd59400)
DhcpServer: AddStaticDhcpEntry(0x563a3fd59400, 02-06-00:00:00:00:03, 172.30.0.14)
DhcpClient: DhcpClient(0x563a3fd8dff0)
DhcpClient: DhcpClient(0x563a3fd84d30)
DhcpClient: DhcpClient(0x563a3fd85d20)
DhcpServer: StartApplication(0x563a3fd59400)
Adding 172.30.0.10 to the pool
Adding 172.30.0.11 to the pool
Adding 172.30.0.13 to the pool
Adding 172.30.0.14 to the pool
Adding 172.30.0.15 to the pool
DhcpClient: StartApplication(0x563a3fd8dff0)
My address is 02-06-00:00:00:00:00:01
My m_chaddr is 00-10-00:00:00:00:00:01:00:00:00:00:00:00:00:00:00:00:00:00
DhcpClient: Boot(0x563a3fd8dff0)
DHCP DISCOVER sent
DhcpClient: StartApplication(0x563a3fd84d30)
My address is 02-06-00:00:00:00:00:02
My m_chaddr is 00-10-00:00:00:00:00:00:02:00:00:00:00:00:00:00:00:00:00:00
DhcpClient: Boot(0x563a3fd84d30)
DHCP DISCOVER sent
DhcpClient: StartApplication(0x563a3fd85d20)
My address is 02-06-00:00:00:00:00:03
My m_chaddr is 00-10-00:00:00:00:00:00:03:00:00:00:00:00:00:00:00:00:00:00
DhcpClient: Boot(0x563a3fd85d20)
DHCP DISCOVER sent
DhcpServer: TimerHandler(0x563a3fd59400)
DhcpServer: NetHandler(0x563a3fd59400, 0x563a3fd87fd0)
DhcpServer: SendOffer(0x563a3fd59400, 0x563a3fd617f0, (type=), 04-07-00:00:00:00:44:00:00)
DHCP DISCOVER from: 0-0-0-0 source port: 68
DHCP OFFER offered Address: 172.30.0.10
DhcpClient: NetHandler(0x563a3fd8dff0, 0x563a3fd88cf0)
DhcpClient: OfferHandler(0x563a3fd8dff0, (type=))
DhcpClient: NetHandler(0x563a3fd84d30, 0x563a3fd89dc0)
DhcpClient: NetHandler(0x563a3fd85d20, 0x563a3fd89dc0)

```

```
DhcpClient:NetHandler(0x563a3fd8dff0, 0x563a3fd88cf0)
DhcpClient:AcceptAck(0x563a3fd8dff0, (type=), 04-07-ac:1e:00:0c:43:00:00)
DHCP ACK received
Got a new address (172.30.0.10), removing old one: 0.0.0.0
Current DHCP Server is 172.30.0.12
DhcpClient:NetHandler(0x563a3fd84d30, 0x563a3fd89dc0)
DhcpClient:NetHandler(0x563a3fd85d20, 0x563a3fd8af30)
DhcpClient:Select(0x563a3fd84d30)
DhcpClient:Request(0x563a3fd84d30)
DhcpServer:NetHandler(0x563a3fd59400, 0x563a3fd87fd0)
DhcpServer:SendAck(0x563a3fd59400, 0x563a3fd617f0, (type=), 04-07-00:00:00:00:44:00:00)
DHCP REQUEST from: 0.0.0.0 source port: 68 - refreshed addr: 172.30.0.11
DhcpClient:NetHandler(0x563a3fd8dff0, 0x563a3fd88cf0)
DhcpClient:NetHandler(0x563a3fd84d30, 0x563a3fd89dc0)
DhcpClient:AcceptAck(0x563a3fd84d30, (type=), 04-07-ac:1e:00:0c:43:00:00)
DHCP ACK received
Got a new address (172.30.0.11), removing old one: 0.0.0.0
Current DHCP Server is 172.30.0.12
DhcpClient:NetHandler(0x563a3fd85d20, 0x563a3fd8af30)
DhcpClient:Select(0x563a3fd85d20)
DhcpClient:Request(0x563a3fd85d20)
DhcpServer:NetHandler(0x563a3fd59400, 0x563a3fd87fd0)
DhcpServer:SendAck(0x563a3fd59400, 0x563a3fd617f0, (type=), 04-07-00:00:00:00:44:00:00)
DHCP REQUEST from: 0.0.0.0 source port: 68 - refreshed addr: 172.30.0.14
DhcpClient:NetHandler(0x563a3fd8dff0, 0x563a3fd88cf0)
DhcpClient:NetHandler(0x563a3fd84d30, 0x563a3fd89dc0)
DhcpClient:NetHandler(0x563a3fd85d20, 0x563a3fd8af30)
DhcpClient:AcceptAck(0x563a3fd85d20, (type=), 04-07-ac:1e:00:0c:43:00:00)
DHCP ACK received
Got a new address (172.30.0.14), removing old one: 0.0.0.0
Current DHCP Server is 172.30.0.12
DhcpServer:TimerHandler(0x563a3fd59400)
DhcpServer:TimerHandler(0x563a3fd59400)
DhcpServer:TimerHandler(0x563a3fd59400)
DhcpServer:TimerHandler(0x563a3fd59400)
At time +10s client sent 1024 bytes to 172.30.1.2 port 9
At time +10.0196s server received 1024 bytes from 172.30.0.11 port 49153
At time +10.0196s server sent 1024 bytes to 172.30.0.11 port 49153
```

```
DhcpServer:TimerHandler(0x563a3fd59400)
At time +15s client sent 1024 bytes to 172.30.1.2 port 9
At time +15.0074s server received 1024 bytes from 172.30.0.11 port 49153
At time +15.0074s server sent 1024 bytes to 172.30.0.11 port 49153
At time +15.0148s client received 1024 bytes from 172.30.1.2 port 9
DhcpServer:TimerHandler(0x563a3fd59400)
At time +16s client sent 1024 bytes to 172.30.1.2 port 9
At time +16.0074s server received 1024 bytes from 172.30.0.11 port 49153
At time +16.0074s server sent 1024 bytes to 172.30.0.11 port 49153
At time +16.0148s client received 1024 bytes from 172.30.1.2 port 9
DhcpServer:TimerHandler(0x563a3fd59400)
At time +17s client sent 1024 bytes to 172.30.1.2 port 9
At time +17.0074s server received 1024 bytes from 172.30.0.11 port 49153
At time +17.0074s server sent 1024 bytes to 172.30.0.11 port 49153
At time +17.0148s client received 1024 bytes from 172.30.1.2 port 9
DhcpServer:TimerHandler(0x563a3fd59400)
At time +18s client sent 1024 bytes to 172.30.1.2 port 9
At time +18.0074s server received 1024 bytes from 172.30.0.11 port 49153
At time +18.0074s server sent 1024 bytes to 172.30.0.11 port 49153
At time +18.0148s client received 1024 bytes from 172.30.1.2 port 9
DhcpServer:TimerHandler(0x563a3fd59400)
At time +19s client sent 1024 bytes to 172.30.1.2 port 9
At time +19.0074s server received 1024 bytes from 172.30.0.11 port 49153
At time +19.0074s server sent 1024 bytes to 172.30.0.11 port 49153
At time +19.0148s client received 1024 bytes from 172.30.1.2 port 9
DhcpClient:StopApplication(0x563a3fd8dff0)
DhcpClient:StopApplication(0x563a3fd84d30)
DhcpClient:StopApplication(0x563a3fd85d20)
DhcpServer:StopApplication(0x563a3fd59400)
DhcpClient:DoDispose(0x563a3fd8dff0)
DhcpClient:DoDispose(0x563a3fd84d30)
DhcpClient:DoDispose(0x563a3fd85d20)
DhcpServer:DoDispose(0x563a3fd59400)
DhcpClient::~DhcpClient(0x563a3fd8dff0)
DhcpClient::~DhcpClient(0x563a3fd84d30)
DhcpClient::~DhcpClient(0x563a3fd85d20)
DhcpServer::~DhcpServer(0x563a3fd59400)
```

lab2-43@lab243-B250M-D2V:~/Downloads/ns-allinone-3.36.1/ns-3.36.1\$

Practical No : 11

Aim: Program to simulate FTP using TCP protocol

Code:

ftp.cc

```
#include <string>
#include <fstream>
#include "ns3/core-module.h"
#include "ns3/point-to-point-module.h"
#include "ns3/internet-module.h"
#include "ns3/applications-module.h"
#include "ns3/network-module.h"
#include "ns3/packet-sink.h"

using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("TcpBulkSendExample");

int
main (int argc, char *argv[])
{
    bool tracing = false;
    uint32_t maxBytes = 0;

    //
    // Allow the user to override any of the defaults at
    // run-time, via command-line arguments
    //
    CommandLine cmd;
    cmd.AddValue ("tracing", "Flag to enable/disable tracing", tracing);
    cmd.AddValue ("maxBytes",
        "Total number of bytes for application to send", maxBytes);
    cmd.Parse (argc, argv);

    //
    // Explicitly create the nodes required by the topology (shown above).
    //
    NS_LOG_INFO ("Create nodes.");
    NodeContainer nodes;
    nodes.Create (2);

    NS_LOG_INFO ("Create channels.");

    //
    // Explicitly create the point-to-point link required by the topology (shown above).
    //
    PointToPointHelper pointToPoint;
```

```

    pointToPoint.SetDeviceAttribute ("DataRate", StringValue ("500Kbps"));
    pointToPoint.SetChannelAttribute ("Delay", StringValue ("5ms"));

    NetDeviceContainer devices;
    devices = pointToPoint.Install (nodes);

    //
    // Install the internet stack on the nodes
    //
    InternetStackHelper internet;
    internet.Install (nodes);

    //
    // We've got the "hardware" in place. Now we need to add IP addresses.
    //
    NS_LOG_INFO ("Assign IP Addresses.");
    Ipv4AddressHelper ipv4;
    ipv4.SetBase ("10.1.1.0", "255.255.255.0");
    Ipv4InterfaceContainer i = ipv4.Assign (devices);

    NS_LOG_INFO ("Create Applications.");

    //
    // Create a BulkSendApplication and install it on node 0
    //
    uint16_t port = 9; // well-known echo port number

    BulkSendHelper source ("ns3::TcpSocketFactory",
                           InetSocketAddress (i.GetAddress (1), port));
    // Set the amount of data to send in bytes. Zero is unlimited.
    source.SetAttribute ("MaxBytes", UIntegerValue (maxBytes));
    ApplicationContainer sourceApps = source.Install (nodes.Get (0));
    sourceApps.Start (Seconds (0.0));
    sourceApps.Stop (Seconds (10.0));

    //
    // Create a PacketSinkApplication and install it on node 1
    //
    PacketSinkHelper sink ("ns3::TcpSocketFactory",
                           InetSocketAddress (Ipv4Address::GetAny (), port));
    ApplicationContainer sinkApps = sink.Install (nodes.Get (1));
    sinkApps.Start (Seconds (0.0));
    sinkApps.Stop (Seconds (10.0));

    //
    // Set up tracing if enabled
    //
    if (tracing)
    {

```

```

    AsciiTraceHelper ascii;
    pointToPoint.EnableAsciiAll (ascii.CreateFileStream ("tcp-bulk-send.tr"));
    pointToPoint.EnablePcapAll ("tcp-bulk-send", false);
}

//
// Now, do the actual simulation.
//
NS_LOG_INFO ("Run Simulation.");
Simulator::Stop (Seconds (10.0));
Simulator::Run ();
Simulator::Destroy ();
NS_LOG_INFO ("Done.");

Ptr<PacketSink> sink1 = DynamicCast<PacketSink> (sinkApps.Get (0));
std::cout << "Total Bytes Received: " << sink1->GetTotalRx () << std::endl;
}

```

Output:

```

lab2-52@lab252-B250M-D2V:~/Desktop/ns-allinone-3.36.1/ns-3.36.1$ ./ns3 run scratch/ftp
-- Using default output directory /home/lab2-52/Desktop/ns-allinone-3.36.1/ns-3.36.1/build
-- Proceeding without cmake-format
-- find_external_library: SQLite3 was found.
-- Harfbuzz is required by GTK3 and was not found.
-- LibXML2 was found.
-- LibRT was found.
-- Visualizer requires Python bindings
Total Bytes Received: 553152
lab2-52@lab252-B250M-D2V:~/Desktop/ns-allinone-3.36.1/ns-3.36.1$ ./ns3 run scratch/ftp
Consolidate compiler generated dependencies of target scratch_ftp
Total Bytes Received: 553152
lab2-52@lab252-B250M-D2V:~/Desktop/ns-allinone-3.36.1/ns-3.36.1$

```

Practical No: 12

Aim: Animate a simple network using Net Anim in Network Simulator.

Code:

```
#include "ns3/coremodule.h"

#include "ns3/network-module.h"

#include "ns3/csmamodule.h"

#include "ns3/internet-module.h"

#include "ns3/point-to-pointmodule.h"

#include "ns3/applications-module.h"

#include "ns3/ipv4-globalrouting-helper.h"

//Inculding Header File

#include "ns3/netanim-module.h"

// Default Network Topology

//

// 10.1.1.0 // n0----- n1 n2 n3 n4

// point-to-point | | |

// =====

// LAN 10.1.2.0

using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("SecondScriptExample");

int main (int argc, char *argv[])

{ bool verbose = true;

uint32_t nCsma = 3;

CommandLine cmd ( FILE );

cmd.AddValue ("nCsma", "Number of \"extra\" CSMA nodes/devices",

nCsma);cmd.AddValue ("verbose", "Tell echo applications to log if true", verbose);
```

```
cmd.Parse (argc,argv);
if (verbose)

{

    LogComponentEnable ("UdpEchoClientApplication",
LOG_LEVEL_INFO);LogComponentEnable
("UdpEchoServerApplication", LOG_LEVEL_INFO);
}

nCsma = nCsma == 0 ? 1 : nCsma;

NodeContainer p2pNodes;

p2pNodes.Create (2);

NodeContainer csmaNodes;

csmaNodes.Add (p2pNodes.Get (1));

csmaNodes.Create (nCsma);

PointToPointHelper pointToPoint;

    pointToPoint.SetDeviceAttribute ("DataRate", StringValue ("5Mbps"));
pointToPoint.SetChannelAttribute ("Delay", StringValue ("2ms"));

    NetDeviceContainer p2pDevices;

p2pDevices = pointToPoint.Install (p2pNodes);

CsmaHelper csma;

csma.SetChannelAttribute ("DataRate", StringValue ("100Mbps"));
csma.SetChannelAttribute ("Delay", TimeValue (NanoSeconds (6560)));

    NetDeviceContainer csmaDevices;

csmaDevices = csma.Install (csmaNodes);

InternetStackHelper stack;

stack.Install (p2pNodes.Get (0));

stack.Install (csmaNodes);

Ipv4AddressHelper address;

address.SetBase ("10.1.1.0", "255.255.255.0");

Ipv4InterfaceContainer p2pInterfaces;

p2pInterfaces = address.Assign (p2pDevices);
```



```

address.SetBase ("10.1.2.0", "255.255.255.0");

Ipv4InterfaceContainer csmaInterfaces;

csmaInterfaces = address.Assign (csmaDevices);

UdpEchoServerHelper echoServer (9);

ApplicationContainer serverApps = echoServer.Install (csmaNodes.Get (nCsma));serverApps.Start
(Seconds (1.0));

serverApps.Stop (Seconds (10.0));

UdpEchoClientHelper echoClient (csmaInterfaces.GetAddress (nCsma), 9);

echoClient.SetAttribute ("MaxPackets", UIntegerValue (1));

echoClient.SetAttribute ("Interval", TimeValue (Seconds (1.0)));

echoClient.SetAttribute ("PacketSize", UIntegerValue (1024));

ApplicationContainer clientApps = echoClient.Install (p2pNodes.Get (0));

clientApps.Start (Seconds (2.0));

clientApps.Stop (Seconds (10.0));

Ipv4GlobalRouting Helper::PopulateRoutingTables ();

pointToPoint.EnablePcapAll ("pract9");

csma.EnablePcap ("pract9", csmaDevices.Get (1), true);

//Including Animation AnimationInterface

anim("pract9.xml");

Simulator::Run ();

Simulator::Destroy ();

return 0;

}

```

Output:

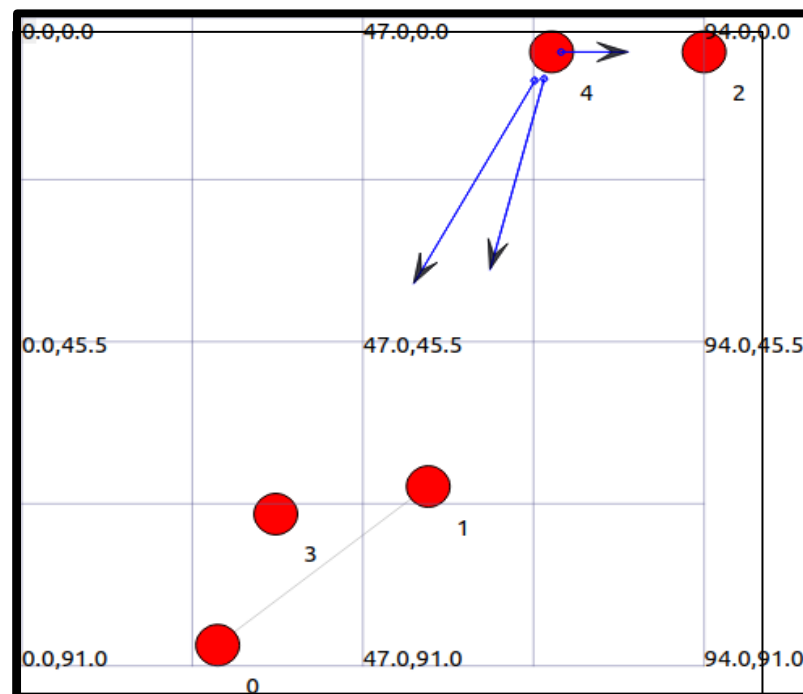
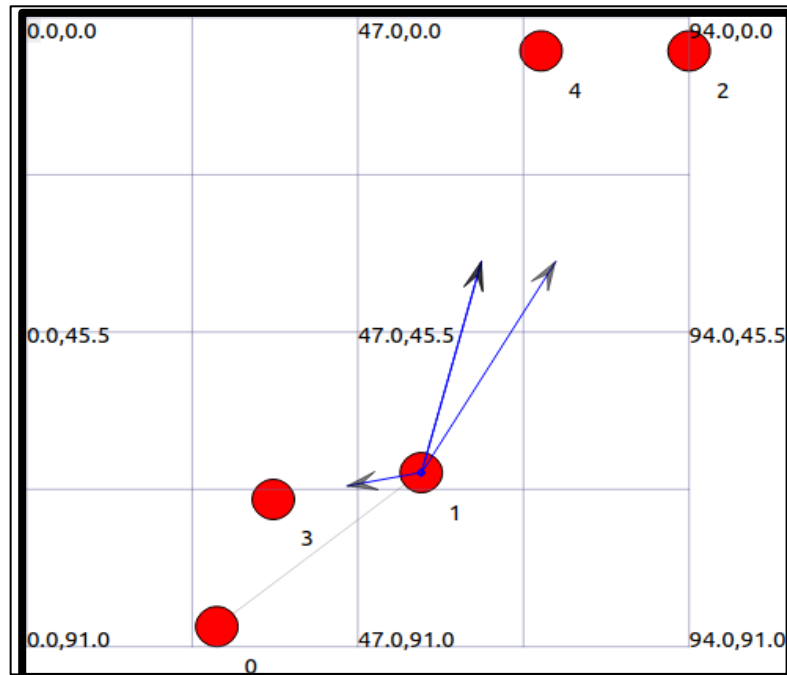
Running the file and visualizing

```

lab2@lab2-B250M-D2V: ~/workspace/ns-allinone-3.32/netanim-3.108
lab2@lab2-B250M-D2V:~/workspace/ns-allinone-3.32/ns-3.32$ ./waf --run scratch/pract9
Waf: Entering directory '/home/lab2/workspace/ns-allinone-3.32/ns-3.32/build'
[2834/2932] Linking build/scratch/pract5Mana
[2837/2932] Linking build/scratch/subdir/subdir
[2838/2932] Linking build/scratch/pract5
[2843/2932] Compiling scratch/pract9.cc
[2892/2932] Linking build/scratch/pract9
Waf: Leaving directory '/home/lab2/workspace/ns-allinone-3.32/ns-3.32/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (3.522s)
AnimationInterface WARNING:Node:0 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:1 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:2 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:3 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:4 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:0 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:1 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:2 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:3 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:4 Does not have a mobility model. Use SetConstantPosition if it is stationary
At time +2s client sent 1024 bytes to 10.1.2.4 port 9
AnimationInterface WARNING:Node:1 Does not have a mobility model. Use SetConstantPosition if it is stationary

```

```
lab2@lab2-B250M-D2V:~/workspace/ns-allinone-3.32/ns-3.32$ ./NetAnim
bash: ./NetAnim: No such file or directory
lab2@lab2-B250M-D2V:~/workspace/ns-allinone-3.32/ns-3.32$ cd ..
lab2@lab2-B250M-D2V:~/workspace/ns-allinone-3.32$ cd netanim-3.108
lab2@lab2-B250M-D2V:~/workspace/ns-allinone-3.32/netanim-3.108$ ./NetAnim
```



Practical No: 13

Aim: Animate three-way handshake for TCP Connection using NetAnim.

Code:

pract9.cc

```
#include "ns3/core-module.h"
#include "ns3/network-module.h"
#include "ns3/csma-module.h"
#include "ns3/internet-module.h"
#include "ns3/point-to-point-module.h"
#include "ns3/applications-module.h"
#include "ns3/ipv4-global-routing-helper.h"
//Including Header File
#include "ns3/netanim-module.h"
// Default Network Topology
//
// 10.1.1.0
// n0-----n1 n2 n3 n4
NETWORKING WITH LINUX
// point-to-point |||
// =====
// LAN 10.1.2.0
using namespace ns3;
NS_LOG_COMPONENT_DEFINE ("SecondScriptExample");
int
main (int argc, char *argv[])
{
    bool verbose = true;
    uint32_t nCsma = 3;
    CommandLine cmd (__FILE__);
    cmd.AddValue ("nCsma", "Number of \"extra\" CSMA nodes/devices", nCsma);
    cmd.AddValue ("verbose", "Tell echo applications to log if true", verbose);
    cmd.Parse (argc,argv);
    if (verbose)
    {
        LogComponentEnable ("UdpEchoClientApplication", LOG_LEVEL_INFO);
        LogComponentEnable ("UdpEchoServerApplication", LOG_LEVEL_INFO);
    }
    nCsma = nCsma == 0 ? 1 : nCsma;
    NodeContainer p2pNodes;
    p2pNodes.Create (2);
    NodeContainer csmaNodes;
    csmaNodes.Add (p2pNodes.Get (1));
    csmaNodes.Create (nCsma);
```

```

PointToPointHelper pointToPoint;
pointToPoint.SetDeviceAttribute ("DataRate", StringValue ("5Mbps"));
pointToPoint.SetChannelAttribute ("Delay", StringValue ("2ms"));
NetDeviceContainer p2pDevices;
p2pDevices = pointToPoint.Install (p2pNodes);
CsmaHelper csma;
csma.SetChannelAttribute ("DataRate", StringValue ("100Mbps"));
csma.SetChannelAttribute ("Delay", TimeValue (NanoSeconds (6560)));
NetDeviceContainer csmaDevices;
csmaDevices = csma.Install (csmaNodes);
InternetStackHelper stack;
stack.Install (p2pNodes.Get (0));
NETWORKING WITH LINUX
stack.Install (csmaNodes);
Ipv4AddressHelper address;
address.SetBase ("10.1.1.0", "255.255.255.0");
Ipv4InterfaceContainer p2pInterfaces;
p2pInterfaces = address.Assign (p2pDevices);
address.SetBase ("10.1.2.0", "255.255.255.0");
Ipv4InterfaceContainer csmaInterfaces;
csmaInterfaces = address.Assign (csmaDevices);
UdpEchoServerHelper echoServer (9);
ApplicationContainer serverApps = echoServer.Install (csmaNodes.Get (nCsmas));
serverApps.Start (Seconds (1.0));
serverApps.Stop (Seconds (10.0));
UdpEchoClientHelper echoClient (csmaInterfaces.GetAddress (nCsmas), 9);
echoClient.SetAttribute ("MaxPackets", UIntegerValue (1));
echoClient.SetAttribute ("Interval", TimeValue (Seconds (1.0)));
echoClient.SetAttribute ("PacketSize", UIntegerValue (1024));
ApplicationContainer clientApps = echoClient.Install (p2pNodes.Get (0));
clientApps.Start (Seconds (2.0));
clientApps.Stop (Seconds (10.0));
Ipv4GlobalRoutingHelper::PopulateRoutingTables ();
pointToPoint.EnablePcapAll ("pract9");
csma.EnablePcap ("pract9", csmaDevices.Get (1), true);
//Including Animation
AnimationInterface anim("pract9.xml");
Simulator::Run ();
Simulator::Destroy ();
return 0;
}

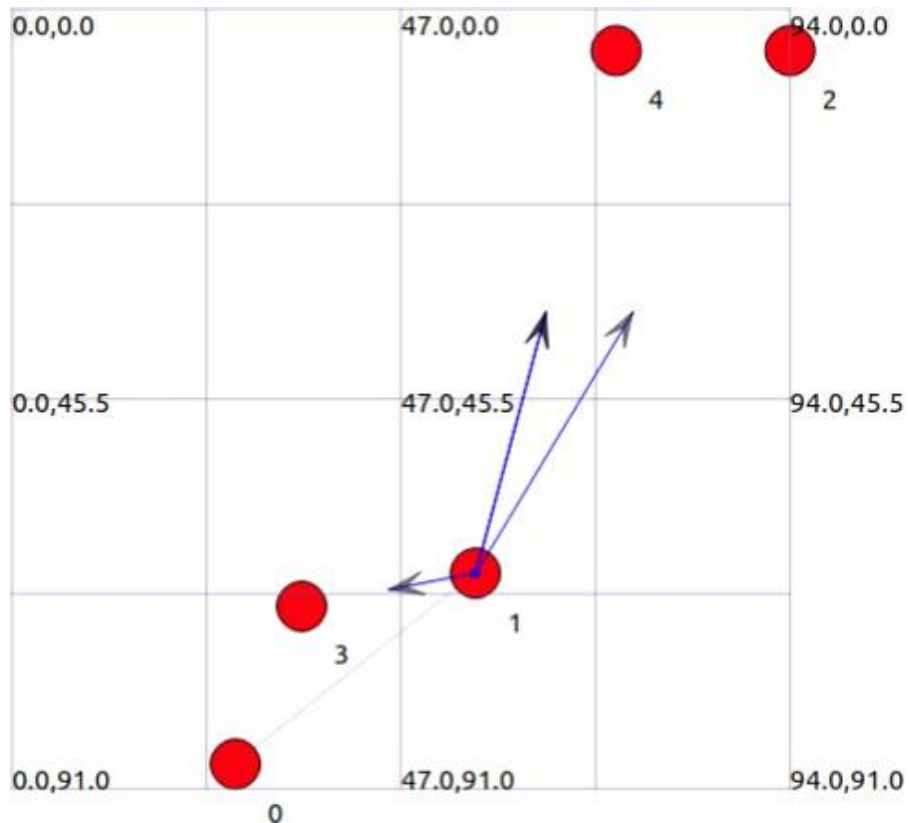
```

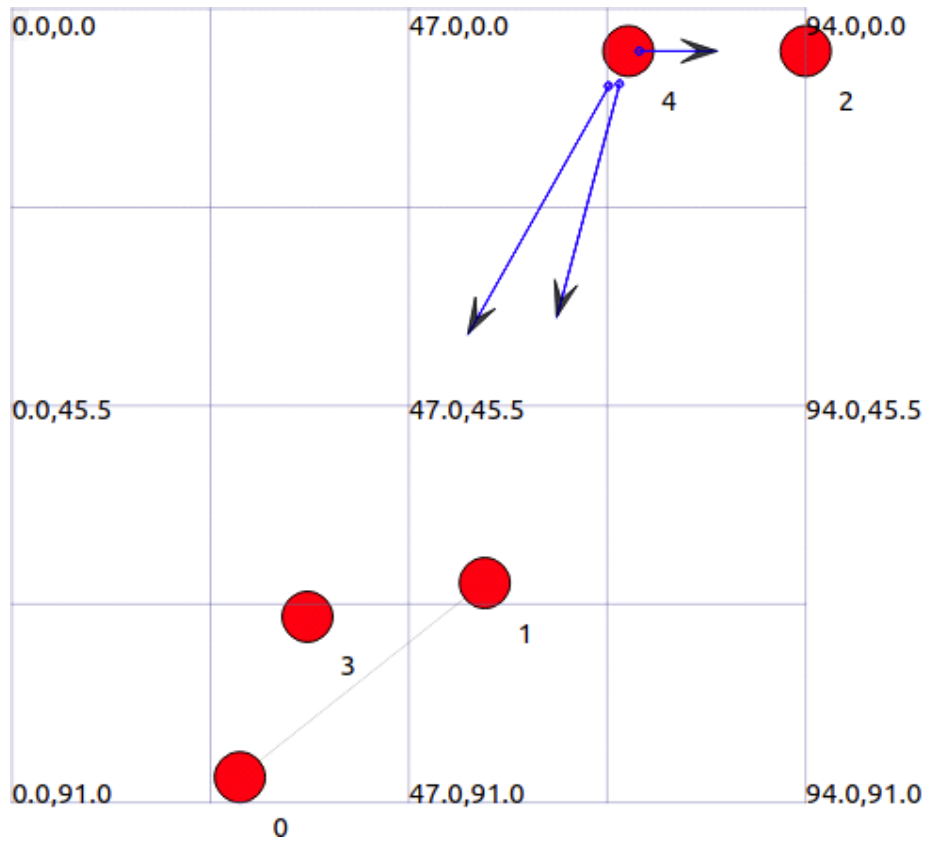
Output:

Running the file and visualizing it.

```
lab2@lab2-B250M-D2V: ~/workspace/ns-allinone-3.32/netanim-3.108
lab2@lab2-B250M-D2V:~/workspace/ns-allinone-3.32/ns-3.32$ ./waf --run scratch/pract9
waf: Entering directory '/home/lab2/workspace/ns-allinone-3.32/ns-3.32/build'
[2834/2932] Linking build/scratch/pract9Main
[2837/2932] Linking build/scratch/subdir/subdir
[2838/2932] Linking build/scratch/pract5
[2843/2932] Compiling scratch/pract9.cc
[2892/2932] Linking build/scratch/pract9
waf: Leaving directory '/home/lab2/workspace/ns-allinone-3.32/ns-3.32/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (3.522s)
AnimationInterface WARNING:Node:0 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:1 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:2 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:3 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:4 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:0 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:1 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:2 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:3 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:4 Does not have a mobility model. Use SetConstantPosition if it is stationary
At time +2s client sent 1024 bytes to 10.1.2.4 port 9
AnimationInterface WARNING:Node:0 Does not have a mobility model. Use SetConstantPosition if it is stationary
```

```
lab2@lab2-B250M-D2V:~/workspace/ns-allinone-3.32/ns-3.32$ ./NetAnim
bash: ./NetAnim: No such file or directory
lab2@lab2-B250M-D2V:~/workspace/ns-allinone-3.32/ns-3.32$ cd ..
lab2@lab2-B250M-D2V:~/workspace/ns-allinone-3.32$ cd netanim-3.108
lab2@lab2-B250M-D2V:~/workspace/ns-allinone-3.32/netanim-3.108$ ./NetAnim
```





Practical No: 14**Aim: Program to assign IPv4 Addresses in NS3.****Code:**

```

#include "ns3/core-module.h"
#include "ns3/network-module.h"
#include "ns3/internet-module.h"
#include "ns3/point-to-point-module.h"

using namespace ns3;

int main(int argc, char* argv[]) {
    // Create a node container
    NodeContainer nodes;
    nodes.Create(3);

    // Create two point-to-point helpers
    PointToPointHelper pointToPoint1, pointToPoint2;
    pointToPoint1.SetDeviceAttribute("DataRate", StringValue("5Mbps"));
    pointToPoint1.SetChannelAttribute("Delay", StringValue("2ms"));
    pointToPoint2.SetDeviceAttribute("DataRate", StringValue("5Mbps"));
    pointToPoint2.SetChannelAttribute("Delay", StringValue("2ms"));

    // Create two net device containers and install devices
    NetDeviceContainer devices1, devices2;
    devices1 = pointToPoint1.Install(nodes.Get(0), nodes.Get(1));
    devices2 = pointToPoint2.Install(nodes.Get(1), nodes.Get(2));

    // Install Internet stack on nodes
    InternetStackHelper internet;
    internet.Install(nodes);

    // Assign IP addresses
    Ipv4AddressHelper ipv4;
    ipv4.SetBase("10.1.1.0", "255.255.255.0");
    Ipv4InterfaceContainer interfaces1 = ipv4.Assign(devices1);
    Ipv4InterfaceContainer interfaces2 = ipv4.Assign(devices2);

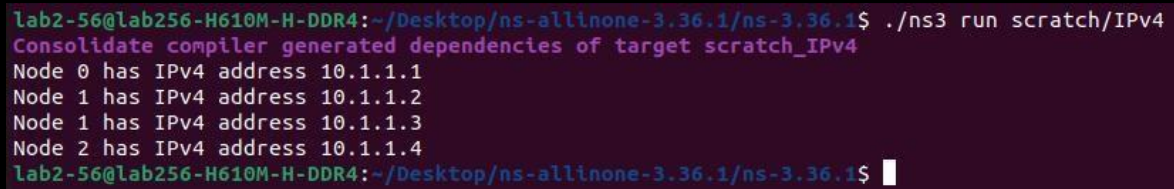
    // Print assigned IP addresses
    for (uint32_t i = 0; i < interfaces1.GetN(); ++i) {
        std::cout << "Node " << i << " has IPv4 address " << interfaces1.GetAddress(i) <<
        std::endl;
    }
    for (uint32_t i = 0; i < interfaces2.GetN(); ++i) {
        std::cout << "Node " << i+1 << " has IPv4 address " << interfaces2.GetAddress(i) <<

```



```
std::endl;  
}  
  
Simulator::Run();  
Simulator::Destroy();  
  
return 0;  
}
```

Output:

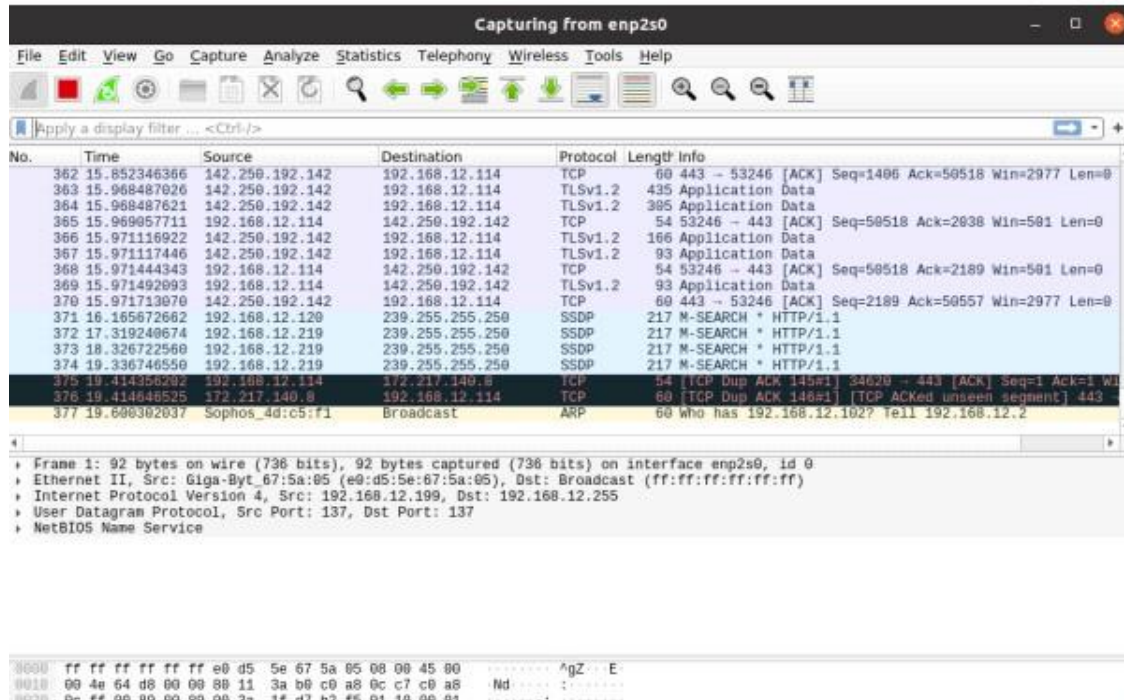


```
lab2-56@lab256-H610M-H-DDR4:~/Desktop/ns-allinone-3.36.1/ns-3.36.1$ ./ns3 run scratch/IPv4  
Consolidate compiler generated dependencies of target scratch_IPv4  
Node 0 has IPv4 address 10.1.1.1  
Node 1 has IPv4 address 10.1.1.2  
Node 1 has IPv4 address 10.1.1.3  
Node 2 has IPv4 address 10.1.1.4  
lab2-56@lab256-H610M-H-DDR4:~/Desktop/ns-allinone-3.36.1/ns-3.36.1$
```

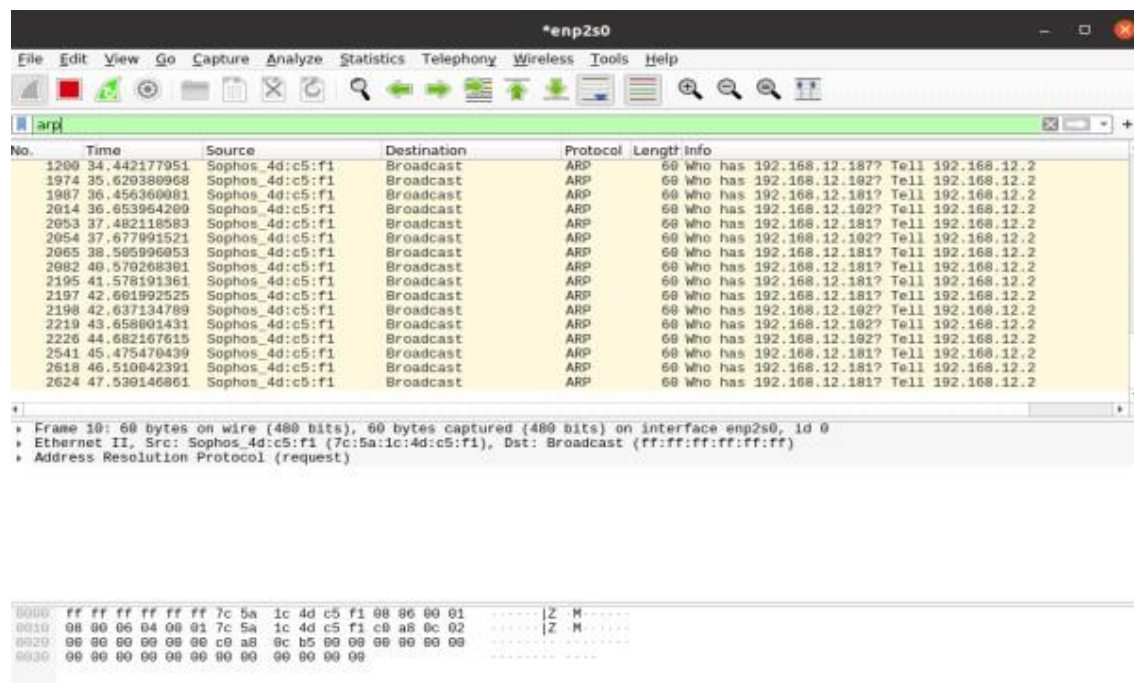
Practical No :15

Aim: Analyze the Network traffic using Wireshark

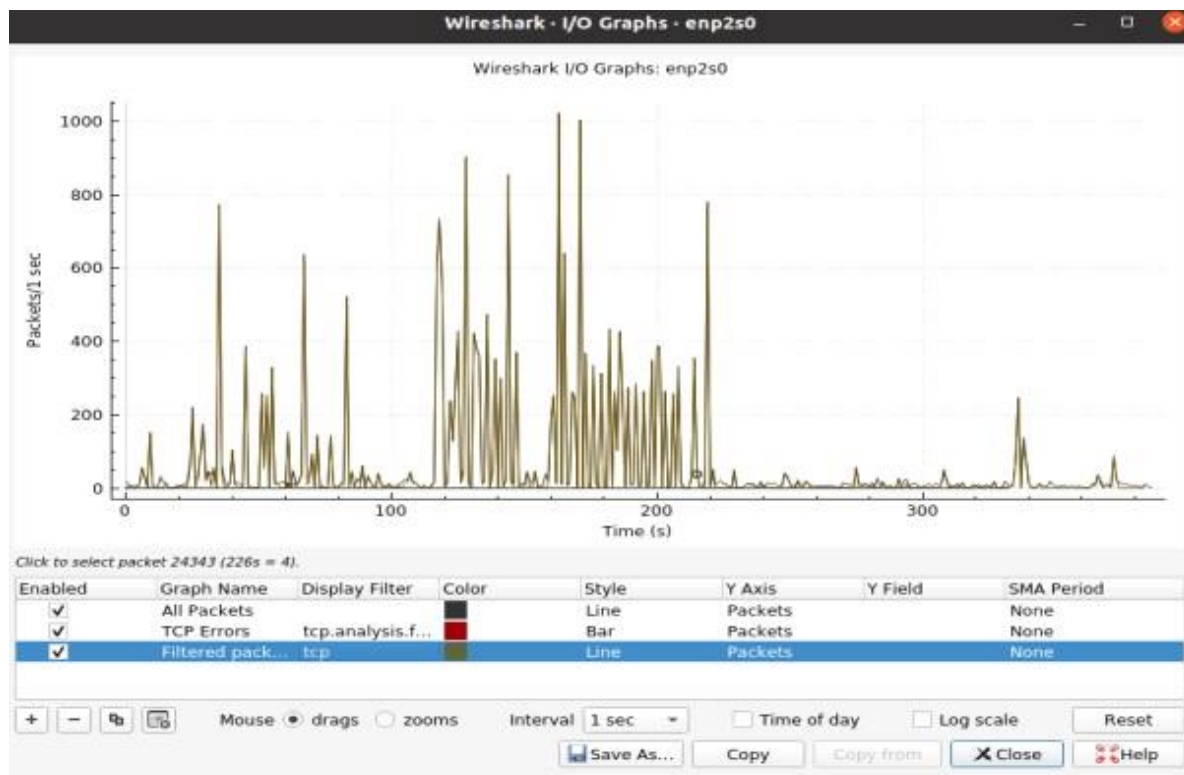
Steps: Considering en2s0 network



2. ARP



3. Graph

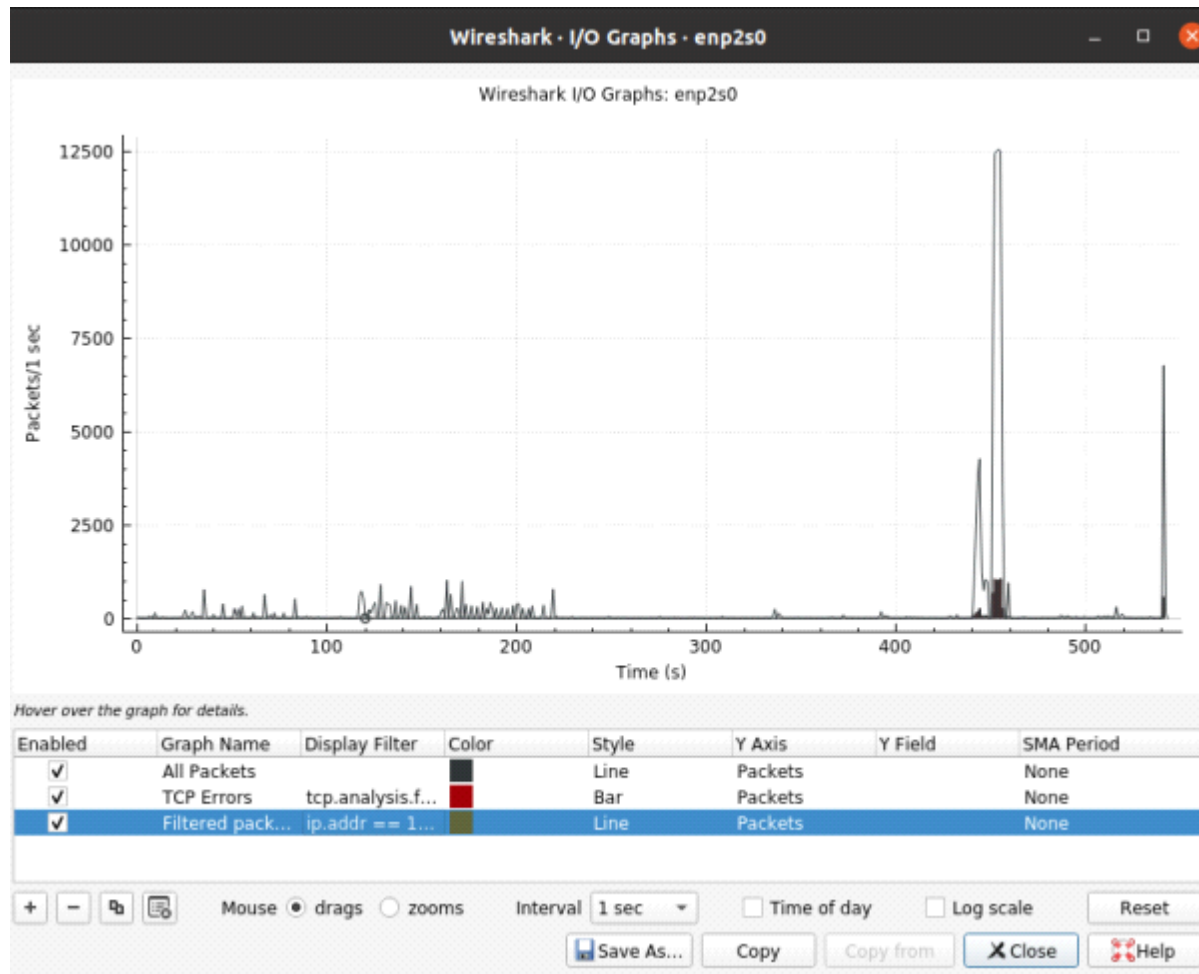


4. TCP

*enp2s0						
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help						
tcp						
No.	Time	Source	Destination	Protocol	Length	Info
1065..	493.825173840	142.250.192.142	192.168.12.114	TCP	60	443 → 53246 [ACK] Seq=39134 Ack=338242 Win=4380 Len=0
1065..	493.825174415	142.250.192.142	192.168.12.114	TCP	60	443 → 53246 [ACK] Seq=39134 Ack=338556 Win=4380 Len=0
1065..	493.825251065	142.250.192.142	192.168.12.114	TCP	60	443 → 53246 [ACK] Seq=39134 Ack=339746 Win=4380 Len=0
1065..	493.934628535	142.250.192.142	192.168.12.114	TLSv1.2	448	Application Data
1065..	493.934628938	142.250.192.142	192.168.12.114	TLSv1.2	445	Application Data
1065..	493.934861308	192.168.12.114	142.250.192.142	TCP	54	53246 → 443 [ACK] Seq=339746 Ack=39919 Win=698 Len=0
1065..	493.936706596	142.250.192.142	192.168.12.114	TLSv1.2	114	Application Data
1066..	493.936706234	142.250.192.142	192.168.12.114	TLSv1.2	93	Application Data
1066..	493.936836046	192.168.12.114	142.250.192.142	TCP	54	53246 → 443 [ACK] Seq=339746 Ack=40018 Win=698 Len=0
1066..	493.936853620	192.168.12.114	142.250.192.142	TLSv1.2	93	Application Data
1066..	493.937074272	142.250.192.142	192.168.12.114	TCP	60	443 → 53246 [ACK] Seq=40018 Ack=339785 Win=4380 Len=0
1066..	494.897126307	185.125.190.36	192.168.12.114	TCP	60	80 → 39922 [RST, ACK] Seq=672340 Ack=2077 Win=39040
1067..	499.652815540	172.217.166.42	192.168.12.114	TLSv1.2	138	Application Data
1067..	499.652845754	192.168.12.114	172.217.166.42	TCP	54	50638 → 443 [ACK] Seq=7201 Ack=7489 Win=501 Len=0
1067..	505.901276010	43.255.166.254	192.168.12.114	TCP	60	80 → 55718 [FIN, ACK] Seq=9191051 Ack=4477 Win=80000
1067..	505.942373049	192.168.12.114	43.255.166.254	TCP	54	55718 → 80 [ACK] Seq=4477 Ack=9191052 Win=1325440 Le

Frame 19: 774 bytes on wire (6192 bits), 774 bytes captured (6192 bits) on interface enp2s0, 1d 0
 Ethernet II, Src: Giga-Byt 66:35:be (e0:d5:5e:66:35:be), Dst: Sophos 4d:c5:f1 (7c:5a:1c:4d:c5:f1)
 Internet Protocol Version 4, Src: 192.168.12.114, Dst: 172.217.166.42
 Transmission Control Protocol, Src Port: 39150, Dst Port: 443, Seq: 1, Ack: 1, Len: 720
 Transport Layer Security

0000	7c 5a 1c 4d c5 f1 e0 d5 5e 66 35 be 08 00 45 00	[Z M ... Af5 ... E
0010	02 f0 36 7b 40 00 40 06 e1 62 c0 a8 0c 72 ac 09	6(0 @ b r
0020	a6 2e 08 ee 01 bb ee 02 9a 3b ed 04 61 f3 50 18	; a P
0030	25 89 23 0d 00 00 17 03 03 02 cb 00 c7 0c 09 00	% # ... 1
0040	25 08 40 cd 58 0b 49 09 f7 22 ca 45 3c 01 ef 9c	4 F X 1 Y ... E
0050	f0 d1 42 eb 37 8d c3 ea fc 10 e3 31 a6 2c 2d 2f	... 7a ... 1
0060	10 e0 00 0c 04 44 9f 77 b9 ad bf 7e 71 ee b6 9f	... D w ... q
0070	a4 b2 a1 08 3b 33 cc 67 f4 54 e8 82 fb 15 27 3c	... 3 g ... T
0080	ad 57 29 94 5d 25 b4 18 c3 b3 ec 73 72 9a 7e 45	(W) ... % ... 9T ...



Practical No: 16

Aim: Analyze the performance parameter of the network using Wireshark.
Steps:

1. SSL

Wireshark capture of SSL traffic on interface enp2s0. The packet list shows multiple TLSv1.2 Application Data packets. The packet details pane shows the structure of a TLSv1.2 packet, including the TLSv1.2 header and the Application Data field.

No.	Time	Source	Destination	Protocol	Length	Info
188	26.400329179	192.168.12.114	192.168.12.114	TLSv1.2	83	Application Data
209	26.762510000	192.168.12.114	192.168.12.114	TLSv1.2	437	Client Hello
212	26.769921682	192.168.12.114	192.168.12.114	TLSv1.2	437	Client Hello
226	26.845718388	192.168.12.114	192.168.12.114	TLSv1.2	139	Application Data
228	26.845829204	192.168.12.114	192.168.12.114	TLSv1.2	83	Application Data
238	26.846159836	192.168.12.114	192.168.12.114	TLSv1.2	83	Application Data
232	26.846248248	192.168.12.114	192.168.12.114	TLSv1.2	83	Application Data
234	26.861387164	192.168.12.114	192.168.12.114	TLSv1.2	289	Application Data
248	26.142382594	192.168.12.114	192.168.12.114	TLSv1.2	123	Application Data
242	26.143569209	192.168.12.114	192.168.12.114	TLSv1.2	83	Application Data
243	26.143569961	192.168.12.114	192.168.12.114	TLSv1.2	83	Application Data
248	26.144123695	192.168.12.114	192.168.12.114	TLSv1.2	83	Application Data
248	26.144915420	192.168.12.114	192.168.12.114	TLSv1.2	1291	Application Data
254	26.431789930	192.168.12.114	192.168.12.114	TLSv1.2	123	Application Data
255	26.431787625	192.168.12.114	192.168.12.114	TLSv1.2	183	Application Data
267	26.387869870	192.168.12.114	192.168.12.114	TLSv1.2	83	Application Data
269	26.402663583	192.168.12.114	192.168.12.114	TLSv1.2	83	Application Data

Frame 2: 78 bytes on wire (624 bits), 78 bytes captured (624 bits) on interface enp2s0, id 0
 Ethernet II, Src: Sophos_40:c5:f1 (7c:5a:1c:40:c5:f1), Dst: Giga-Byt_08:35:be (08:05:be:08:35:be)
 Internet Protocol Version 4, Src: 96.17.158.120, Dst: 192.168.12.114
 Transmission Control Protocol, Src Port: 443, Dst Port: 38806, Seq: 1, Ack: 1, Len: 24
 Transport Layer Security

Hex dump of the captured data:

```

0000  e0 05 5e 46 35 be 7c 5a 1c 40 c5 f1 08 00 45 00  *PS |Z N E
0010  00 40 1a d7 40 00 40 06 5c 30 00 11 96 78 c9 a8  @ @ @ \x
0020  0c 72 81 8b 8f c0 e0 5d b1 78 ca 32 db c1 90 18  r... ] x 2 P
0030  00 fa ea 3d 00 00 17 03 03 00 13 1b 00 e0 57 a1  .]... W
0040  f3 65 53 99 6a 4d 7a cc 06 a3 03 b1 07 5d      e5 mZ... ]
  
```

2. TCP

Wireshark capture of TCP traffic on interface enp2s0. The packet list shows multiple TCP packets, including a SYN packet and several data packets. The packet details pane shows the structure of a TCP packet, including the TCP header and the data field.

No.	Time	Source	Destination	Protocol	Length	Info
1880	85.613778462	192.168.12.114	198.252.206.25	TCP	54	58508 -> 443 [ACK] Seq=518 Ack=4381 Win=62562 Len=0
1891	85.613827835	198.252.206.25	192.168.12.114	TLSv1.2	757	Certificate Status, Server Key Exchange, Server Hello Done
1892	85.613832288	192.168.12.114	198.252.206.25	TCP	54	58508 -> 443 [ACK] Seq=518 Ack=5004 Win=61952 Len=0
1893	85.626079173	192.168.12.114	198.252.206.25	TLSv1.2	180	Client Key Exchange, Change Cipher Spec, Encrypted Handshake
1894	85.626321094	198.252.206.25	192.168.12.114	TCP	60	443 -> 58508 [ACK] Seq=5884 Ack=644 Win=20376 Len=0
1895	85.822759490	198.252.206.25	192.168.12.114	TLSv1.2	165	Change Cipher Spec, Encrypted Handshake Message
1896	85.822775113	192.168.12.114	198.252.206.25	TCP	54	58508 -> 443 [ACK] Seq=644 Ack=5135 Win=64128 Len=0
1897	85.822988940	192.168.12.114	198.252.206.25	TLSv1.2	636	Application Data
1898	85.823160501	198.252.206.25	192.168.12.114	TCP	60	443 -> 58508 [ACK] Seq=5135 Ack=1226 Win=31488 Len=0
1899	85.842810005	192.168.12.114	198.252.206.25	TCP	54	160 -> 443 [ACK] Seq=1 Ack=1226 Win=31488 Len=0
1900	85.841642881	192.168.12.114	198.252.206.25	TCP	60	TCP Reset Seq=38806 [TCP Reset Seq=38806] 643 -> 34856 [RST]
1901	85.819370387	198.252.206.25	192.168.12.114	TLSv1.2	240	Application Data
1902	85.819999967	192.168.12.114	198.252.206.25	TCP	54	58508 -> 443 [ACK] Seq=1226 Ack=5336 Win=64128 Len=0
1903	85.823679469	192.168.12.114	198.252.206.25	TLSv1.2	133	Application Data
1904	85.823719570	192.168.12.114	198.252.206.25	TLSv1.2	165	Application Data
1905	85.823808910	198.252.206.25	192.168.12.114	TCP	60	443 -> 58508 [ACK] Seq=5336 Ack=1305 Win=31488 Len=0
1906	85.82406770	198.252.206.25	192.168.12.114	TCP	60	443 -> 58508 [ACK] Seq=5336 Ack=1356 Win=31488 Len=0

Frame 2: 78 bytes on wire (624 bits), 78 bytes captured (624 bits) on interface enp2s0, id 0
 Ethernet II, Src: Sophos_40:c5:f1 (7c:5a:1c:40:c5:f1), Dst: Giga-Byt_08:35:be (08:05:be:08:35:be)
 Internet Protocol Version 4, Src: 96.17.158.120, Dst: 192.168.12.114
 Transmission Control Protocol, Src Port: 443, Dst Port: 38806, Seq: 1, Ack: 1, Len: 24
 Transport Layer Security

Hex dump of the captured data:

```

0000  e0 05 5e 46 35 be 7c 5a 1c 40 c5 f1 08 00 45 00  *PS |Z N E
0010  00 40 1a d7 40 00 40 06 5c 30 00 11 96 78 c9 a8  @ @ @ \x
0020  0c 72 81 8b 8f c0 e0 5d b1 78 ca 32 db c1 90 18  r... ] x 2 P
0030  00 fa ea 3d 00 00 17 03 03 00 13 1b 00 e0 57 a1  .]... W
0040  f3 65 53 99 6a 4d 7a cc 06 a3 03 b1 07 5d      e5 mZ... ]
  
```


3. ARP

Wireshark capture of ARP traffic on interface enp2s0. The packet list shows multiple ARP requests and responses. The packet details pane shows the structure of an ARP request packet.

No.	Time	Source	Destination	Protocol	Length	Info
2855	115.873834288	Sophos_48:c5:f1	Broadcast	ARP	60	Who has 192.168.12.102? Tell 192.168.12.2
2869	116.897835897	Sophos_48:c5:f1	Broadcast	ARP	60	Who has 192.168.12.102? Tell 192.168.12.2
2838	121.803821838	Sophos_48:c5:f1	Broadcast	ARP	60	Who has 192.168.12.102? Tell 192.168.12.2
2939	121.974880444	Giga-Byt_66:45:20	Broadcast	ARP	60	Who has 169.254.169.254? Tell 192.168.12.225
2942	122.059848338	Giga-Byt_66:45:20	Broadcast	ARP	60	Who has 169.254.169.254? Tell 192.168.12.225
2943	122.912982989	Sophos_48:c5:f1	Broadcast	ARP	60	Who has 192.168.12.102? Tell 192.168.12.2
2948	123.083233541	Giga-Byt_67:5c:7b	Giga-Byt_66:35:be	ARP	60	Who has 192.168.12.114? Tell 192.168.12.140
2947	123.083375628	Giga-Byt_66:35:be	Giga-Byt_67:5c:7b	ARP	42	192.168.12.114 is at 66:35:be:66:35:be
2948	123.059673542	Giga-Byt_66:45:20	Broadcast	ARP	60	Who has 169.254.169.254? Tell 192.168.12.225
2949	123.937161456	Sophos_48:c5:f1	Broadcast	ARP	60	Who has 192.168.12.102? Tell 192.168.12.2
2956	126.838523688	Giga-Byt_67:5a:05	Broadcast	ARP	60	Who has 169.254.169.254? Tell 192.168.12.199
2957	126.922931717	Giga-Byt_67:5a:05	Broadcast	ARP	60	Who has 169.254.169.254? Tell 192.168.12.199
2958	127.932625786	Giga-Byt_67:5a:05	Broadcast	ARP	60	Who has 169.254.169.254? Tell 192.168.12.199
2959	128.372251139	Giga-Byt_66:19:f9	Broadcast	ARP	60	Who has 169.254.169.254? Tell 192.168.12.247
2960	128.981256919	Giga-Byt_66:19:f9	Broadcast	ARP	60	Who has 169.254.169.254? Tell 192.168.12.247
2967	129.888350513	Sophos_48:c5:f1	Broadcast	ARP	60	Who has 192.168.12.102? Tell 192.168.12.2
2968	129.981163158	Giga-Byt_66:19:f9	Broadcast	ARP	60	Who has 169.254.169.254? Tell 192.168.12.247

Frame 1: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface enp2s0, id 0
 Ethernet II, Src: Giga-Byt_67:5c:7b (68:0d:3e:67:5c:7b), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
 Address Resolution Protocol (request)

Packet details for Frame 1:

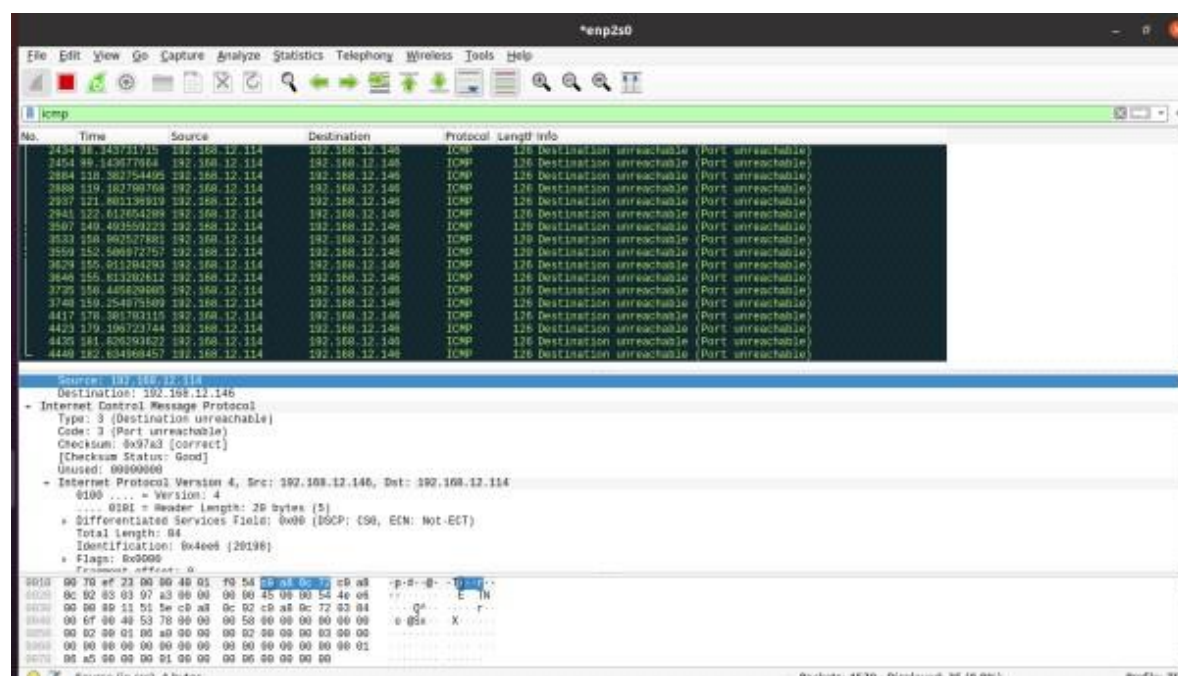
```

  0000  ff ff ff ff ff ff 08 05  5e 67 5c 7b 08 00 00 81  .....Ag\{
  0010  08 00 06 04 00 01 60 c5  5e 67 5c 7b c0 a8 0c 32  .....Ag\{
  0020  08 00 06 00 00 00 c0 a8  0c 0a 00 00 00 00 00 00  .....
  0030  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  .....
  
```

4. ICMP

Wireshark capture of ICMP traffic on interface enp2s0. The packet list shows multiple ICMP destination unreachable messages.

No.	Time	Source	Destination	Protocol	Length	Info
1884	94.933855599	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
2892	94.433858554	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
2898	94.935863825	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
2395	95.748433189	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
2434	96.343731715	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
2454	96.243677664	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
2894	118.382784498	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
2888	119.182786768	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
2837	121.681136018	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
2941	122.812654289	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
3597	140.483593224	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
3531	150.992527681	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
3559	152.588677257	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
3629	155.012784293	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
3646	155.813282611	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
3735	158.443828885	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)
3748	159.754975589	192.168.12.134	192.168.12.140	ICMP	128	Destination unreachable (Port unreachable)



5. Tcp.port == 80

