

## **Networking with Linux Lab**

### **Module 1: Introduction to Network Simulation and sniffing software**

#### **Assignment 1**

##### **1. Installation of NS3, NetAnim and Wireshark on Linux**

**Aim:** To install NS3 (Network Simulator 3), NetAnim, and Wireshark on a Linux system for network simulation and analysis

##### **Theory:**

###### **Network Simulator 3 (NS3)**

The ns-3 simulator is a discrete-event network simulator primarily designed for research and educational purposes. ns-3 is open-source and free. Simulation is applied in various contexts, including technology performance tuning, optimization, safety engineering, testing, training, education, and video games. ns-3 is structured as a set of libraries that can be combined with each other and external software libraries. Users may utilize several external animators, data analysis, and visualization tools with ns-3. However, users should be comfortable working at the command line and using C++ and/or Python software development tools.

###### **Wireshark**

Wireshark is a network packet analyzer that presents captured packet data in as much detail as possible. Network administrators use it to troubleshoot network problems, developers use it to debug protocol implementations, and network security engineers use it to examine security issues.

###### **NetAnim**

NetAnim is an offline animator based on the Qt toolkit. It animates simulations using an XML trace file collected during the simulation. The first version was developed by George F. Riley. NetAnim processes XML files for graphical output generated through ns3.

##### **Command & Screenshot:**

###### **Prerequisites for Installing NS3.32**

**Note:** Ensure that your operating system has GCC version  $\geq 5.4.0$ .

1. To check the GCC version on your system.

2. Open the terminal (use the Ctrl+Alt+T keyboard shortcut). Type the following command and press Enter:

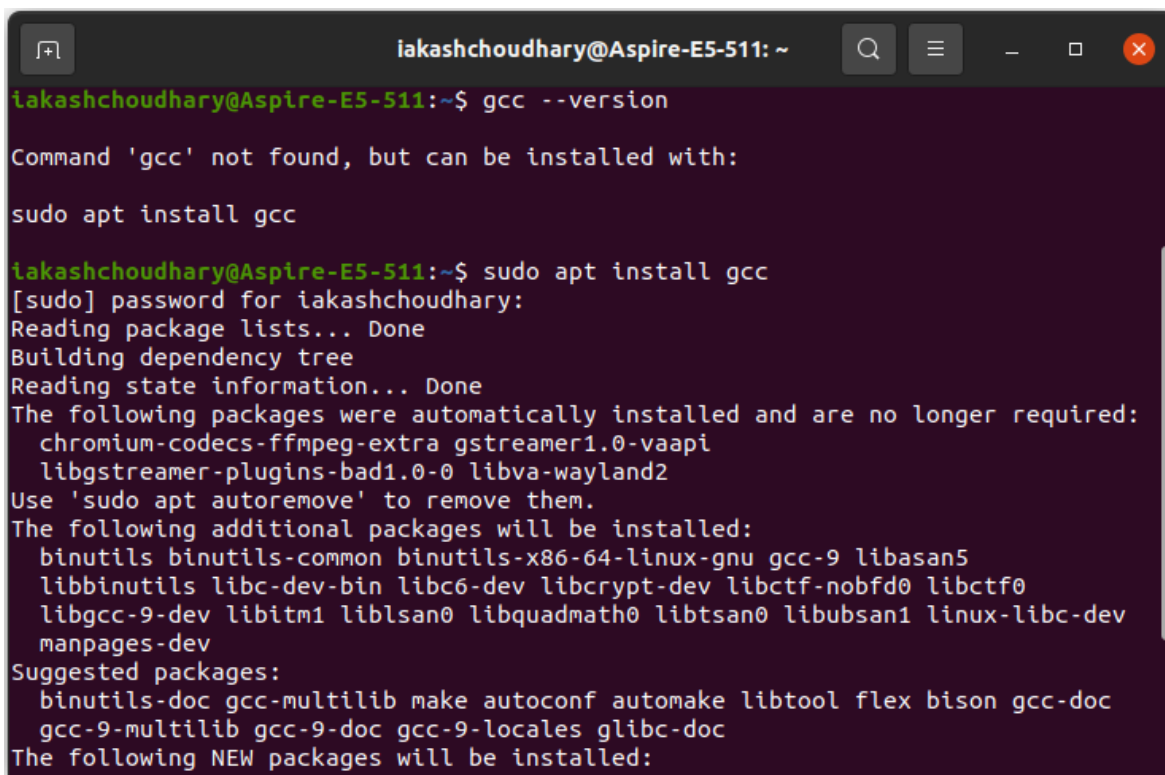
Option 1: Issue the command "gcc --version" (Example: ...)

Option 2: Issue the command "gcc -v"

NS-3 is supported and currently tested on the following primary platforms: Linux (x86 and x86\_64) with gcc/g++ versions 8 and above.

1. **\$ gcc --version** should be  $\geq 5.4.0$  | **\$ gcc -v**.

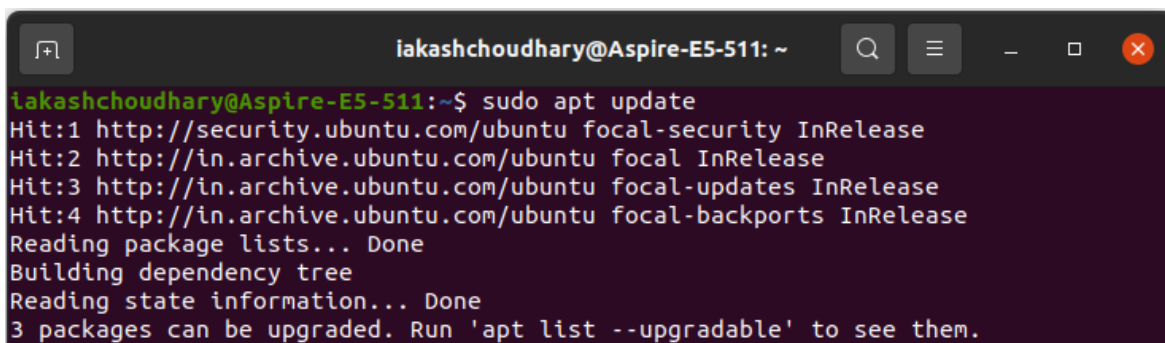
If gcc not found, then install gcc using command: **\$ sudo apt install gcc**

A terminal window titled 'iakashchoudhary@Aspire-E5-511: ~' with search, menu, and window control icons. The user enters 'gcc --version' and receives the message 'Command 'gcc' not found, but can be installed with: sudo apt install gcc'. Then, the user enters 'sudo apt install gcc'. The terminal shows the password prompt, package list reading, dependency tree building, and state information reading. It lists packages to be removed (chromium-codecs-ffmpeg-extra, gstreamer1.0-vaapi, libgstreamer-plugins-bad1.0-0, libva-wayland2) and additional packages to be installed (binutils, binutils-common, binutils-x86-64-linux-gnu, gcc-9, libasan5, libbinutils, libc-dev-bin, libc6-dev, libcrypt-dev, libctf-nobfd0, libctf0, libgcc-9-dev, libitm1, liblsan0, libquadmath0, libtsan0, libubsan1, linux-libc-dev, manpages-dev). It also lists suggested packages (binutils-doc, gcc-multilib, make, autoconf, automake, libtool, flex, bison, gcc-doc, gcc-9-multilib, gcc-9-doc, gcc-9-locales, glibc-doc). Finally, it states that 3 new packages will be installed.

```
iakashchoudhary@Aspire-E5-511:~$ gcc --version
Command 'gcc' not found, but can be installed with:
sudo apt install gcc

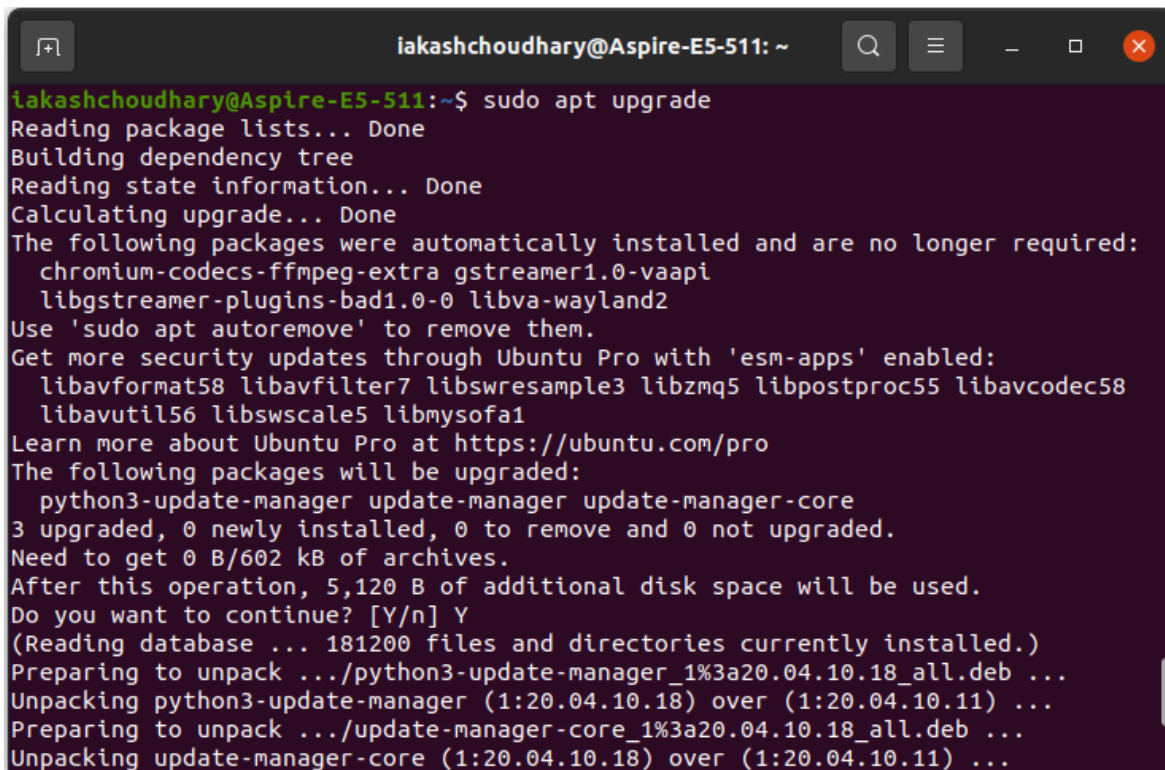
iakashchoudhary@Aspire-E5-511:~$ sudo apt install gcc
[sudo] password for iakashchoudhary:
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following packages were automatically installed and are no longer required:
  chromium-codecs-ffmpeg-extra gstreamer1.0-vaapi
  libgstreamer-plugins-bad1.0-0 libva-wayland2
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
  binutils binutils-common binutils-x86-64-linux-gnu gcc-9 libasan5
  libbinutils libc-dev-bin libc6-dev libcrypt-dev libctf-nobfd0 libctf0
  libgcc-9-dev libitm1 liblsan0 libquadmath0 libtsan0 libubsan1 linux-libc-dev
  manpages-dev
Suggested packages:
  binutils-doc gcc-multilib make autoconf automake libtool flex bison gcc-doc
  gcc-9-multilib gcc-9-doc gcc-9-locales glibc-doc
The following NEW packages will be installed:
```

2. **\$ sudo apt update**

A terminal window titled 'iakashchoudhary@Aspire-E5-511: ~' with search, menu, and window control icons. The user enters 'sudo apt update'. The terminal shows the process of checking for updates from security.ubuntu.com and in.archive.ubuntu.com for focal, focal-updates, and focal-backports. It then reads the package lists, builds the dependency tree, and reads the state information. Finally, it reports that 3 packages can be upgraded and suggests running 'apt list --upgradable' to see them.

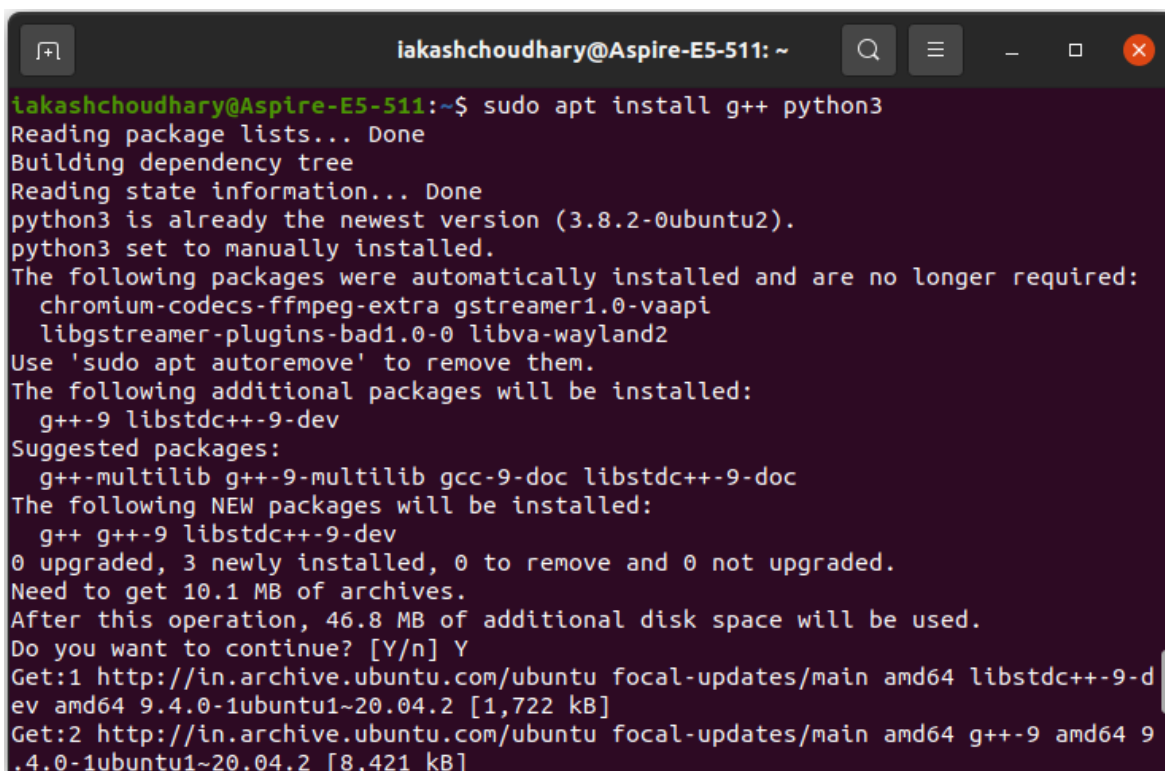
```
iakashchoudhary@Aspire-E5-511:~$ sudo apt update
Hit:1 http://security.ubuntu.com/ubuntu focal-security InRelease
Hit:2 http://in.archive.ubuntu.com/ubuntu focal InRelease
Hit:3 http://in.archive.ubuntu.com/ubuntu focal-updates InRelease
Hit:4 http://in.archive.ubuntu.com/ubuntu focal-backports InRelease
Reading package lists... Done
Building dependency tree
Reading state information... Done
3 packages can be upgraded. Run 'apt list --upgradable' to see them.
```

### 3. \$ sudo apt upgrade

A terminal window titled 'iakashchoudhary@Aspire-E5-511: ~' showing the output of the command 'sudo apt upgrade'. The output indicates that several packages are no longer required and will be removed, including chromium-codecs-ffmpeg-extra, gstreamer1.0-vaapi, libgstreamer-plugins-bad1.0-0, and libva-wayland2. It also lists security updates available through Ubuntu Pro. Three packages (python3-update-manager, update-manager, and update-manager-core) will be upgraded. The operation requires 0 B of disk space. The user confirms the upgrade with 'Y'.

```
iakashchoudhary@Aspire-E5-511:~$ sudo apt upgrade
Reading package lists... Done
Building dependency tree
Reading state information... Done
Calculating upgrade... Done
The following packages were automatically installed and are no longer required:
  chromium-codecs-ffmpeg-extra gstreamer1.0-vaapi
  libgstreamer-plugins-bad1.0-0 libva-wayland2
Use 'sudo apt autoremove' to remove them.
Get more security updates through Ubuntu Pro with 'esm-apps' enabled:
  libavformat58 libavfilter7 libswresample3 libzmq5 libpostproc55 libavcodec58
  libavutil56 libswscale5 libmysofa1
Learn more about Ubuntu Pro at https://ubuntu.com/pro
The following packages will be upgraded:
  python3-update-manager update-manager update-manager-core
3 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
Need to get 0 B/602 kB of archives.
After this operation, 5,120 B of additional disk space will be used.
Do you want to continue? [Y/n] Y
(Reading database ... 181200 files and directories currently installed.)
Preparing to unpack .../python3-update-manager_1%3a20.04.10.18_all.deb ...
Unpacking python3-update-manager (1:20.04.10.18) over (1:20.04.10.11) ...
Preparing to unpack .../update-manager-core_1%3a20.04.10.18_all.deb ...
Unpacking update-manager-core (1:20.04.10.18) over (1:20.04.10.11) ...
```

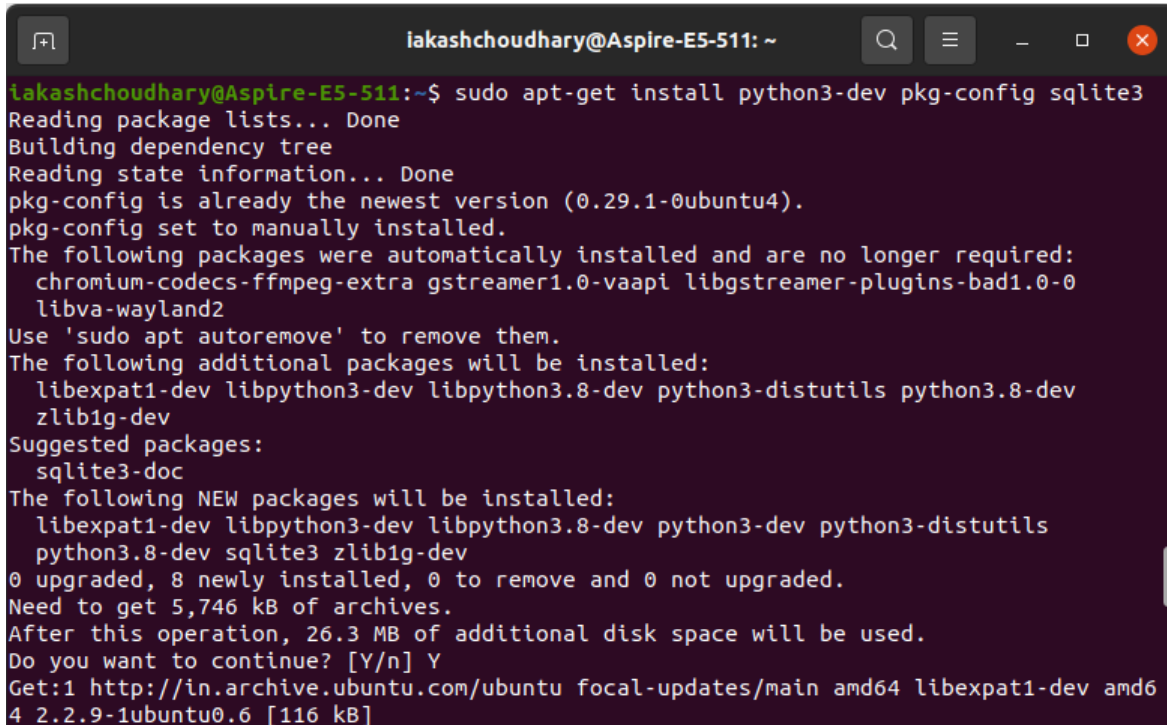
### 4. Minimal requirements for C++ users: \$ sudo apt install g++ python3

A terminal window titled 'iakashchoudhary@Aspire-E5-511: ~' showing the output of the command 'sudo apt install g++ python3'. It confirms that python3 is already installed. It lists packages that are no longer required. It identifies additional packages to be installed: g++-9 and libstdc++-9-dev. Suggested packages include g++-multilib, gcc-9-doc, and libstdc++-9-doc. The operation will install 3 new packages and require 10.1 MB of disk space. The user confirms the installation with 'Y'. The terminal shows the download progress for libstdc++-9-dev and g++-9.

```
iakashchoudhary@Aspire-E5-511:~$ sudo apt install g++ python3
Reading package lists... Done
Building dependency tree
Reading state information... Done
python3 is already the newest version (3.8.2-0ubuntu2).
python3 set to manually installed.
The following packages were automatically installed and are no longer required:
  chromium-codecs-ffmpeg-extra gstreamer1.0-vaapi
  libgstreamer-plugins-bad1.0-0 libva-wayland2
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
  g++-9 libstdc++-9-dev
Suggested packages:
  g++-multilib g++-9-multilib gcc-9-doc libstdc++-9-doc
The following NEW packages will be installed:
  g++ g++-9 libstdc++-9-dev
0 upgraded, 3 newly installed, 0 to remove and 0 not upgraded.
Need to get 10.1 MB of archives.
After this operation, 46.8 MB of additional disk space will be used.
Do you want to continue? [Y/n] Y
Get:1 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 libstdc++-9-d
ev amd64 9.4.0-1ubuntu1~20.04.2 [1,722 kB]
Get:2 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 g++-9 amd64 9
.4.0-1ubuntu1~20.04.2 [8,421 kB]
```

5. Minimal requirements for Python API users:

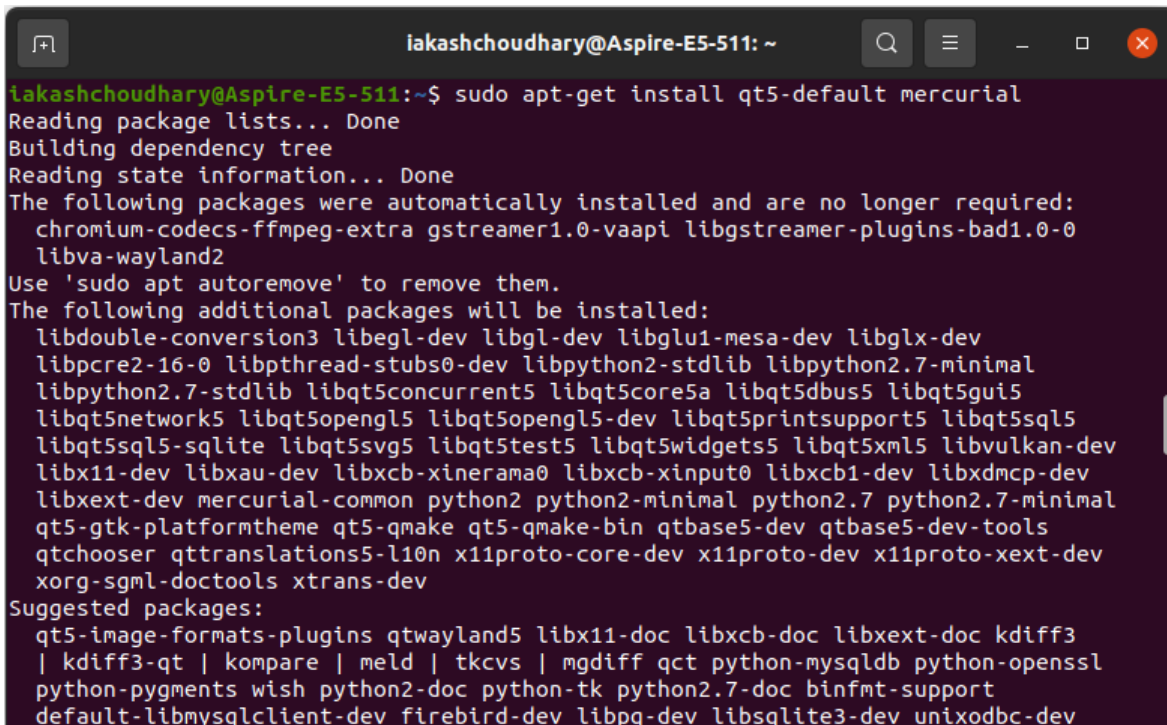
**\$ sudo apt-get install python3-dev pkg-config sqlite3**



```
iakashchoudhary@Aspire-E5-511: ~
iakashchoudhary@Aspire-E5-511:~$ sudo apt-get install python3-dev pkg-config sqlite3
Reading package lists... Done
Building dependency tree
Reading state information... Done
pkg-config is already the newest version (0.29.1-0ubuntu4).
pkg-config set to manually installed.
The following packages were automatically installed and are no longer required:
  chromium-codecs-ffmpeg-extra gstreamer1.0-vaapi libgstreamer-plugins-bad1.0-0
  libva-wayland2
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
  libexpat1-dev libpython3-dev libpython3.8-dev python3-distutils python3.8-dev
  zlib1g-dev
Suggested packages:
  sqlite3-doc
The following NEW packages will be installed:
  libexpat1-dev libpython3-dev libpython3.8-dev python3-dev python3-distutils
  python3.8-dev sqlite3 zlib1g-dev
0 upgraded, 8 newly installed, 0 to remove and 0 not upgraded.
Need to get 5,746 kB of archives.
After this operation, 26.3 MB of additional disk space will be used.
Do you want to continue? [Y/n] Y
Get:1 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 libexpat1-dev amd64 2.2.9-1ubuntu0.6 [116 kB]
```

6. qt5 development tools are needed for NetAnim Animator:

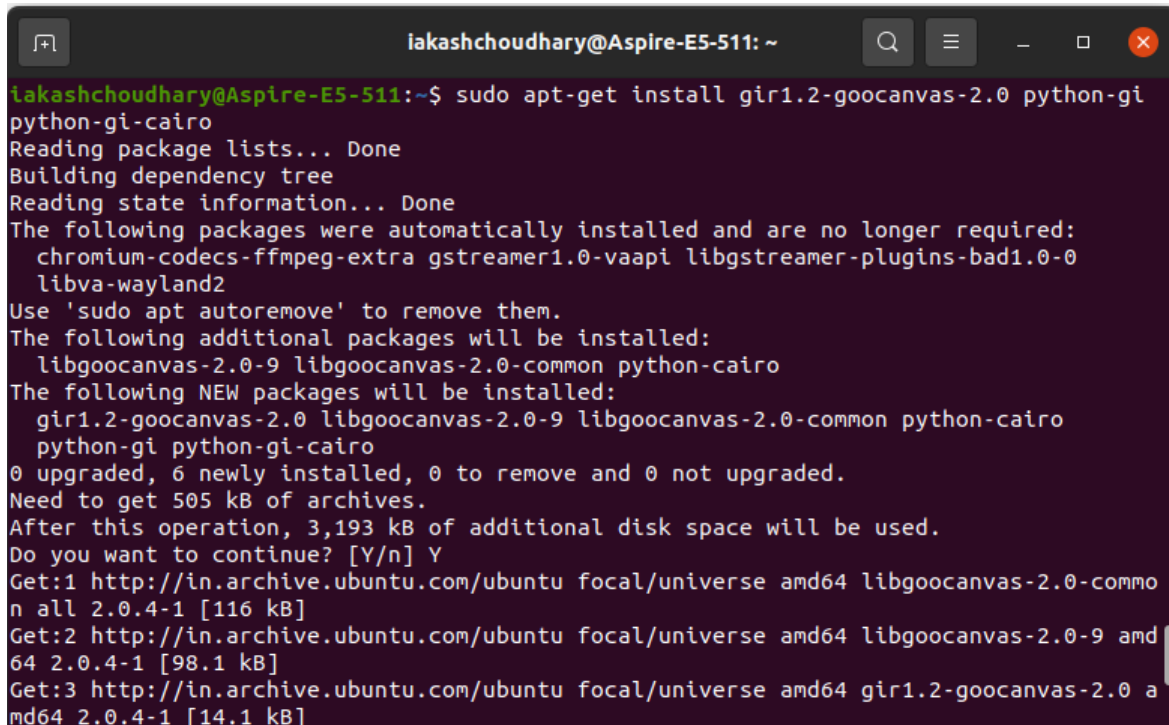
**\$ sudo apt-get install qt5-default mercurial**



```
iakashchoudhary@Aspire-E5-511: ~
iakashchoudhary@Aspire-E5-511:~$ sudo apt-get install qt5-default mercurial
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following packages were automatically installed and are no longer required:
  chromium-codecs-ffmpeg-extra gstreamer1.0-vaapi libgstreamer-plugins-bad1.0-0
  libva-wayland2
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
  libdouble-conversion3 libegl-dev libgl-dev libglu1-mesa-dev libglx-dev
  libpcre2-16-0 libpthread-stubs0-dev libpython2-stdlib libpython2.7-minimal
  libpython2.7-stdlib libqt5concurrent5 libqt5core5a libqt5dbus5 libqt5gui5
  libqt5network5 libqt5opengl5 libqt5opengl5-dev libqt5primitives5 libqt5sql5
  libqt5sql5-sqlite libqt5svg5 libqt5test5 libqt5widgets5 libqt5xml5 libvulkan-dev
  libx11-dev libxau-dev libxcb-xinerama0 libxcb-xinput0 libxcb1-dev libxdmcp-dev
  libxext-dev mercurial-common python2 python2-minimal python2.7 python2.7-minimal
  qt5-gtk-platformtheme qt5-qmake qt5-qmake-bin qtbase5-dev qtbase5-dev-tools
  qtchooser qttranslations5-l10n x11proto-core-dev x11proto-dev x11proto-xext-dev
  xorg-sgml-doctools xtrans-dev
Suggested packages:
  qt5-image-formats-plugins qtwayland5 libx11-doc libxcb-doc libxext-doc kdiff3
  | kdiff3-qt | kompare | meld | tkcvs | mgdiff qct python-mysqldb python-openssl
  python-pygments wish python2-doc python-tk python2.7-doc binfmt-support
  default-libmysqlclient-dev firebird-dev libpq-dev libsqlite3-dev unixodbc-dev
```

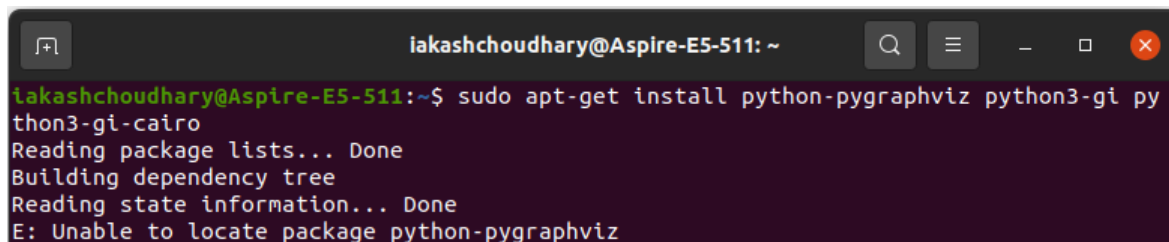
## 7. Ns-3-pyviz visualizer:

**\$ sudo apt-get install gir1.2-goocanvas-2.0 python-gi python-gi-cairo**



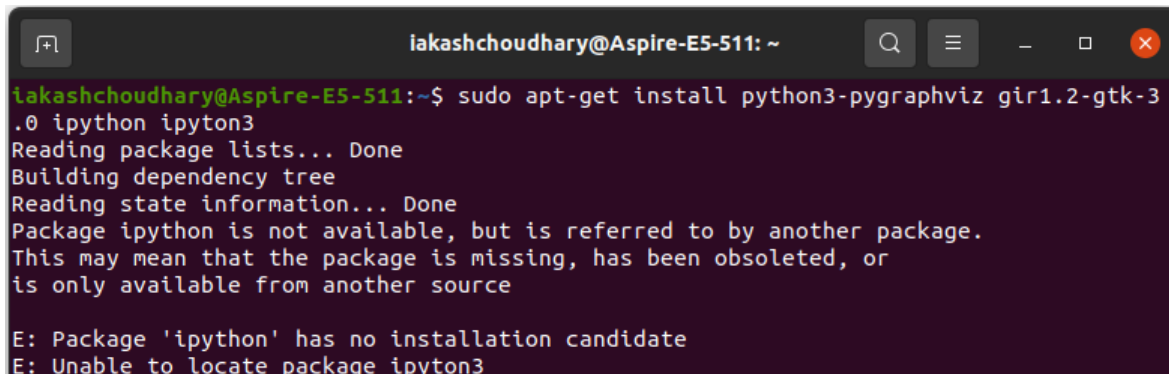
```
iakashchoudhary@Aspire-E5-511: ~  
iakashchoudhary@Aspire-E5-511:~$ sudo apt-get install gir1.2-goocanvas-2.0 python-gi  
python-gi-cairo  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
The following packages were automatically installed and are no longer required:  
  chromium-codecs-ffmpeg-extra gstreamer1.0-vaapi libgstreamer-plugins-bad1.0-0  
  libva-wayland2  
Use 'sudo apt autoremove' to remove them.  
The following additional packages will be installed:  
  libgoocanvas-2.0-9 libgoocanvas-2.0-common python-cairo  
The following NEW packages will be installed:  
  gir1.2-goocanvas-2.0 libgoocanvas-2.0-9 libgoocanvas-2.0-common python-cairo  
  python-gi python-gi-cairo  
0 upgraded, 6 newly installed, 0 to remove and 0 not upgraded.  
Need to get 505 kB of archives.  
After this operation, 3,193 kB of additional disk space will be used.  
Do you want to continue? [Y/n] Y  
Get:1 http://in.archive.ubuntu.com/ubuntu focal/universe amd64 libgoocanvas-2.0-commo  
n all 2.0.4-1 [116 kB]  
Get:2 http://in.archive.ubuntu.com/ubuntu focal/universe amd64 libgoocanvas-2.0-9 amd  
64 2.0.4-1 [98.1 kB]  
Get:3 http://in.archive.ubuntu.com/ubuntu focal/universe amd64 gir1.2-goocanvas-2.0 a  
md64 2.0.4-1 [14.1 kB]
```

**\$ sudo apt-get install python-pygraphviz python3-gi python3-gi-cairo**



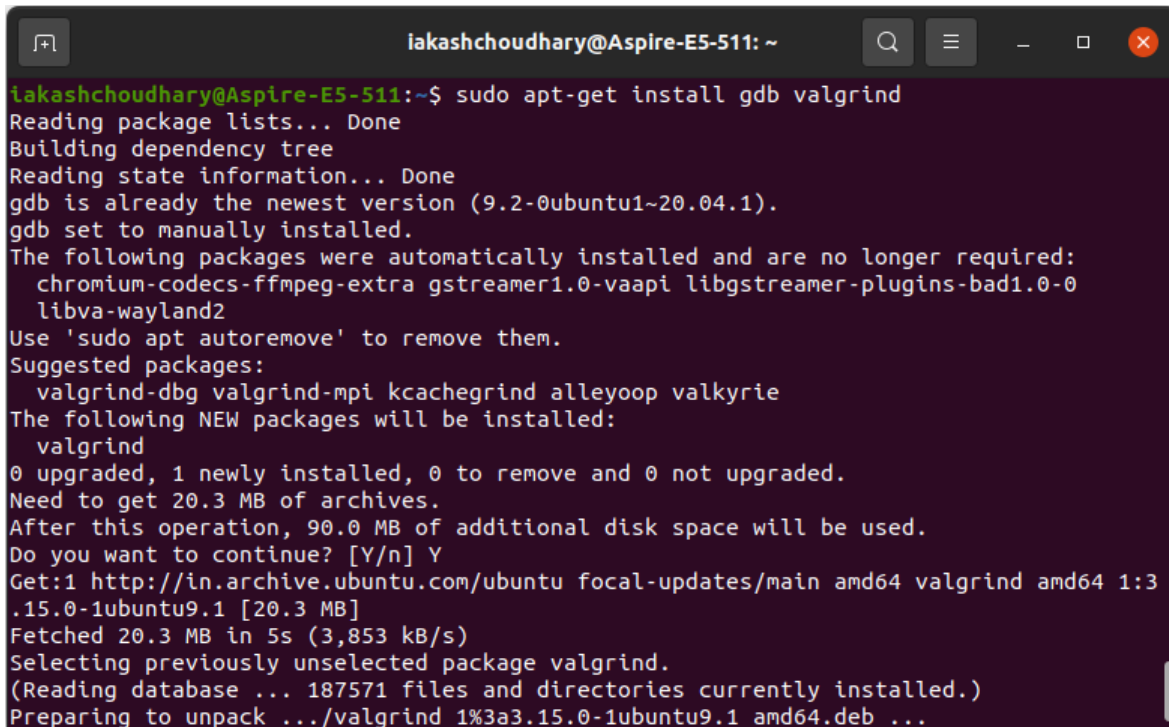
```
iakashchoudhary@Aspire-E5-511: ~  
iakashchoudhary@Aspire-E5-511:~$ sudo apt-get install python-pygraphviz python3-gi py  
thon3-gi-cairo  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
E: Unable to locate package python-pygraphviz
```

**\$ sudo apt-get install python3-pygraphviz gir1.2-gtk-3.0 ipython ipython3**



```
iakashchoudhary@Aspire-E5-511: ~  
iakashchoudhary@Aspire-E5-511:~$ sudo apt-get install python3-pygraphviz gir1.2-gtk-3  
.0 ipython ipython3  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
Package ipython is not available, but is referred to by another package.  
This may mean that the package is missing, has been obsoleted, or  
is only available from another source  
  
E: Package 'ipython' has no installation candidate  
E: Unable to locate package ipython3
```

## 8. Debugging:

**\$ sudo apt-get install gdb valgrind**A terminal window titled 'iakashchoudhary@Aspire-E5-511: ~' with standard window controls. The terminal output shows the command 'sudo apt-get install gdb valgrind' being executed. It reports that gdb is already installed and valgrind is new. It lists several packages to be removed and suggests others. It shows the disk space requirements and that the operation will continue. It then fetches the valgrind package from the Ubuntu repository and prepares to unpack it.

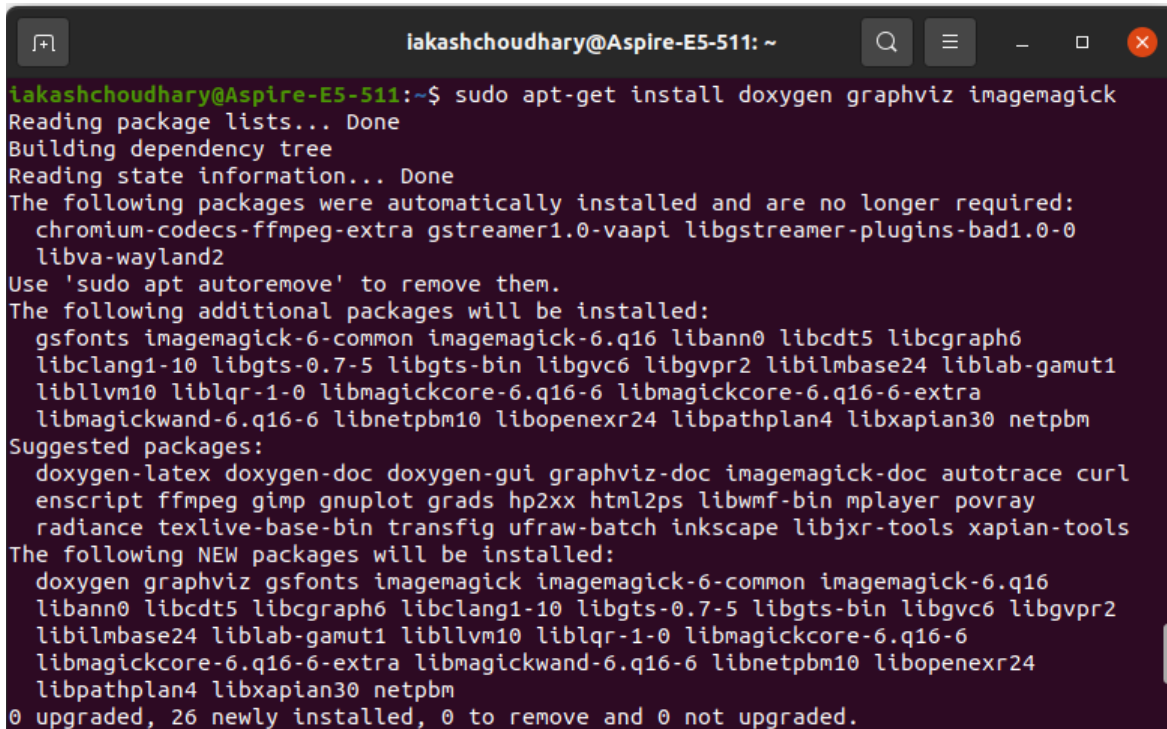
```
iakashchoudhary@Aspire-E5-511:~$ sudo apt-get install gdb valgrind
Reading package lists... Done
Building dependency tree
Reading state information... Done
gdb is already the newest version (9.2-0ubuntu1~20.04.1).
gdb set to manually installed.
The following packages were automatically installed and are no longer required:
  chromium-codecs-ffmpeg-extra gstreamer1.0-vaapi libgstreamer-plugins-bad1.0-0
  libva-wayland2
Use 'sudo apt autoremove' to remove them.
Suggested packages:
  valgrind-dbg valgrind-mpi kcachegrind alleyoop valkyrie
The following NEW packages will be installed:
  valgrind
0 upgraded, 1 newly installed, 0 to remove and 0 not upgraded.
Need to get 20.3 MB of archives.
After this operation, 90.0 MB of additional disk space will be used.
Do you want to continue? [Y/n] Y
Get:1 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 valgrind amd64 1:3
.15.0-1ubuntu9.1 [20.3 MB]
Fetched 20.3 MB in 5s (3,853 kB/s)
Selecting previously unselected package valgrind.
(Reading database ... 187571 files and directories currently installed.)
Preparing to unpack .../valgrind_1%3a3.15.0-1ubuntu9.1_amd64.deb ...
```



### 9. Doxygen and related inline documentation:

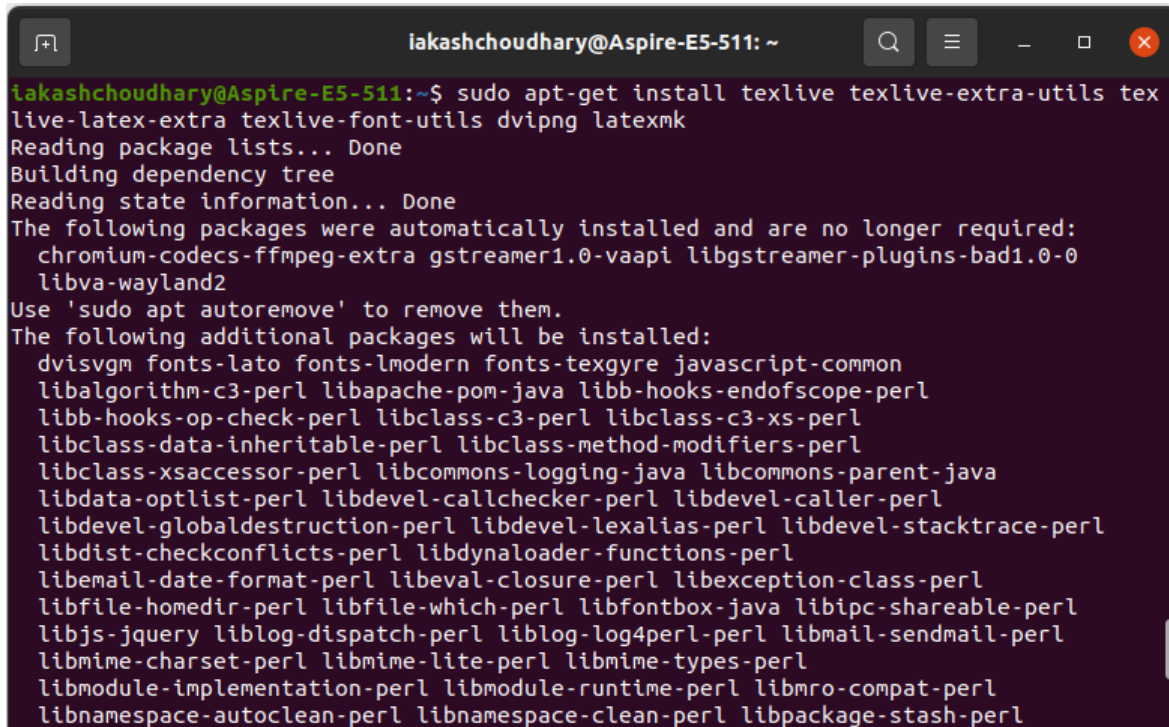
Doxygen is a widely-used documentation generator tool in software development. It automates the generation of documentation from source code comments, parsing information about classes, functions, and variables to produce output in formats such as HTML and PDF.

**\$ sudo apt-get install doxygen graphviz imagemagick**

A terminal window titled 'iakashchoudhary@Aspire-E5-511: ~' showing the execution of the command 'sudo apt-get install doxygen graphviz imagemagick'. The output displays the package lists, dependency tree, and state information. It lists packages to be removed, additional packages to be installed, suggested packages, and new packages to be installed. The final summary shows 0 upgraded, 26 newly installed, 0 to remove, and 0 not upgraded.

```
iakashchoudhary@Aspire-E5-511:~$ sudo apt-get install doxygen graphviz imagemagick
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following packages were automatically installed and are no longer required:
 chromium-codecs-ffmpeg-extra gstreamer1.0-vaapi libgstreamer-plugins-bad1.0-0
 libva-wayland2
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
 gsfonts imagemagick-6-common imagemagick-6.q16 libann0 libcdt5 libcgraph6
 libclang1-10 libgts-0.7-5 libgts-bin libgvc6 libgvpr2 libilmbase24 liblab-gamut1
 libllvm10 liblqr-1-0 libmagickcore-6.q16-6 libmagickcore-6.q16-6-extra
 libmagickwand-6.q16-6 libnetpbm10 libopenexr24 libpathplan4 libxapian30 netpbm
Suggested packages:
 doxygen-latex doxygen-doc doxygen-gui graphviz-doc imagemagick-doc autotrace curl
 enscript ffmpeg gimp gnuplot grads hp2xx html2ps libwmf-bin mplayer povray
 radiance texlive-base-bin transfig ufrax-batch inkscape libjxr-tools xapian-tools
The following NEW packages will be installed:
 doxygen graphviz gsfonts imagemagick imagemagick-6-common imagemagick-6.q16
 libann0 libcdt5 libcgraph6 libclang1-10 libgts-0.7-5 libgts-bin libgvc6 libgvpr2
 libilmbase24 liblab-gamut1 libllvm10 liblqr-1-0 libmagickcore-6.q16-6
 libmagickcore-6.q16-6-extra libmagickwand-6.q16-6 libnetpbm10 libopenexr24
 libpathplan4 libxapian30 netpbm
0 upgraded, 26 newly installed, 0 to remove and 0 not upgraded.
```

**\$ sudo apt-get install texlive texlive-extra-utils texlive-latex-extra texlive-font-utils dvipng latexmk**

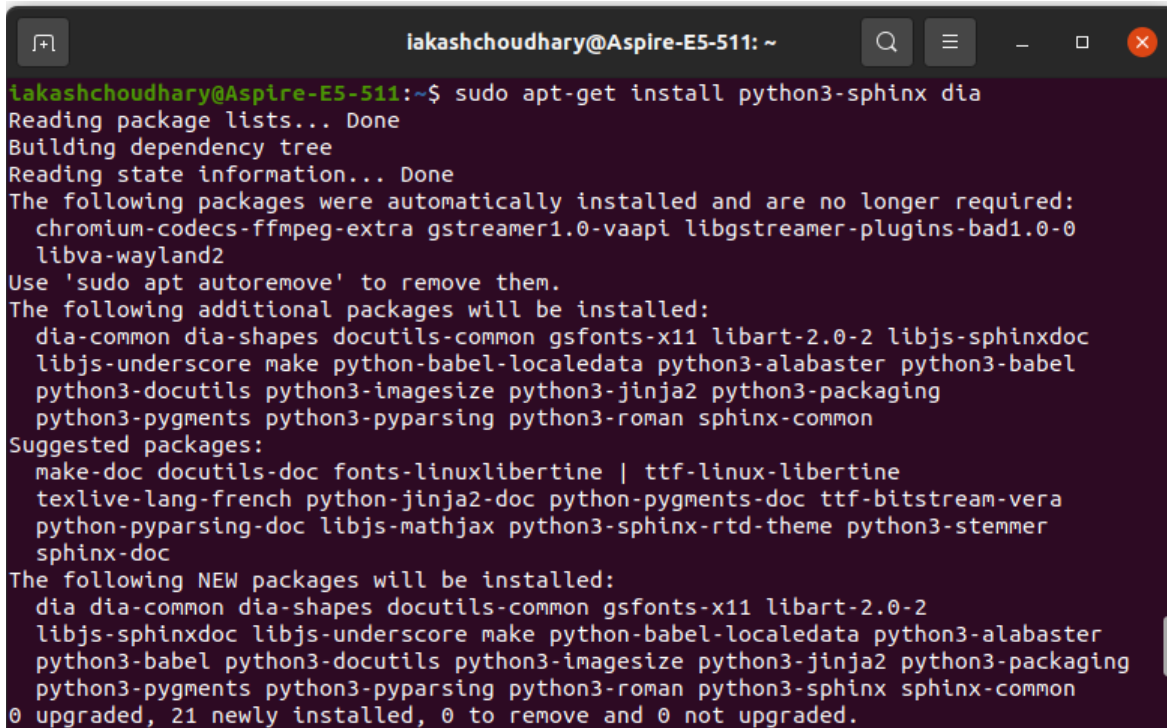


```
iakashchoudhary@Aspire-E5-511: ~  
iakashchoudhary@Aspire-E5-511:~$ sudo apt-get install texlive texlive-extra-utils texlive-latex-extra texlive-font-utils dvipng latexmk  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
The following packages were automatically installed and are no longer required:  
  chromium-codecs-ffmpeg-extra gstreamer1.0-vaapi libgstreamer-plugins-bad1.0-0  
  libva-wayland2  
Use 'sudo apt autoremove' to remove them.  
The following additional packages will be installed:  
  dvisvgm fonts-lato fonts-lmodern fonts-texgyre javascript-common  
  libalgorithm-c3-perl libapache-pom-java libb-hooks-endofscope-perl  
  libb-hooks-op-check-perl libclass-c3-perl libclass-c3-xs-perl  
  libclass-data-inheritable-perl libclass-method-modifiers-perl  
  libclass-xsaccessor-perl libcommons-logging-java libcommons-parent-java  
  libdata-optlist-perl libdevel-callchecker-perl libdevel-caller-perl  
  libdevel-globaldestruction-perl libdevel-lexalias-perl libdevel-stacktrace-perl  
  libdist-checkconflicts-perl libdynaloader-functions-perl  
  libemail-date-format-perl libeval-closure-perl libexception-class-perl  
  libfile-homedir-perl libfile-which-perl libfontbox-java libipc-shareable-perl  
  libjs-jquery liblog-dispatch-perl liblog-log4perl-perl libmail-sendmail-perl  
  libmime-charset-perl libmime-lite-perl libmime-types-perl  
  libmodule-implementation-perl libmodule-runtime-perl libmro-compat-perl  
  libnamespace-autoclean-perl libnamespace-clean-perl libpackage-stash-perl
```



10. The ns-3 manual and tutorial are written in reStructuredText for Sphinx (doc/tutorial, doc/manual, doc/models), and figures are typically created in Dia (which also requires the texlive packages mentioned above):

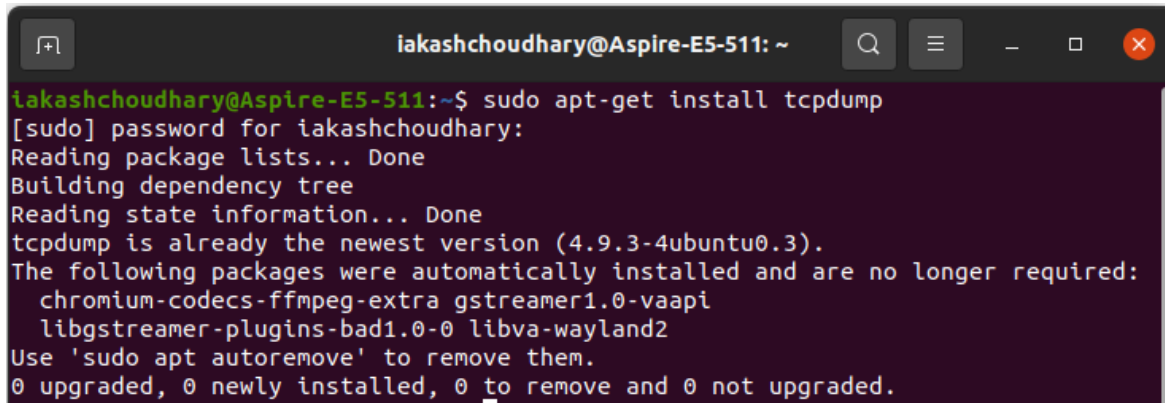
**\$ sudo apt-get install python3-sphinx dia**

A terminal window titled 'iakashchoudhary@Aspire-E5-511: ~' showing the output of the command 'sudo apt-get install python3-sphinx dia'. The output includes package lists, dependency tree building, state information, a list of packages to be removed, a list of additional packages to be installed, suggested packages, and a final summary of the installation.

```
iakashchoudhary@Aspire-E5-511:~$ sudo apt-get install python3-sphinx dia
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following packages were automatically installed and are no longer required:
  chromium-codecs-ffmpeg-extra gstreamer1.0-vaapi libgstreamer-plugins-bad1.0-0
  libva-wayland2
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
  dia-common dia-shapes docutils-common gsfonts-x11 libart-2.0-2 libjs-sphinxdoc
  libjs-underscore make python-babel-localedata python3-alabaster python3-babel
  python3-docutils python3-imagesize python3-jinja2 python3-packaging
  python3-pygments python3-pyparsing python3-roman sphinx-common
Suggested packages:
  make-doc docutils-doc fonts-linuxlibertine | ttf-linux-libertine
  texlive-lang-french python-jinja2-doc python-pygments-doc ttf-bitstream-vera
  python-pyparsing-doc libjs-mathjax python3-sphinx-rtd-theme python3-stemmer
  sphinx-doc
The following NEW packages will be installed:
  dia dia-common dia-shapes docutils-common gsfonts-x11 libart-2.0-2
  libjs-sphinxdoc libjs-underscore make python-babel-localedata python3-alabaster
  python3-babel python3-docutils python3-imagesize python3-jinja2 python3-packaging
  python3-pygments python3-pyparsing python3-roman python3-sphinx sphinx-common
0 upgraded, 21 newly installed, 0 to remove and 0 not upgraded.
```

11. To read pcap packet traces:

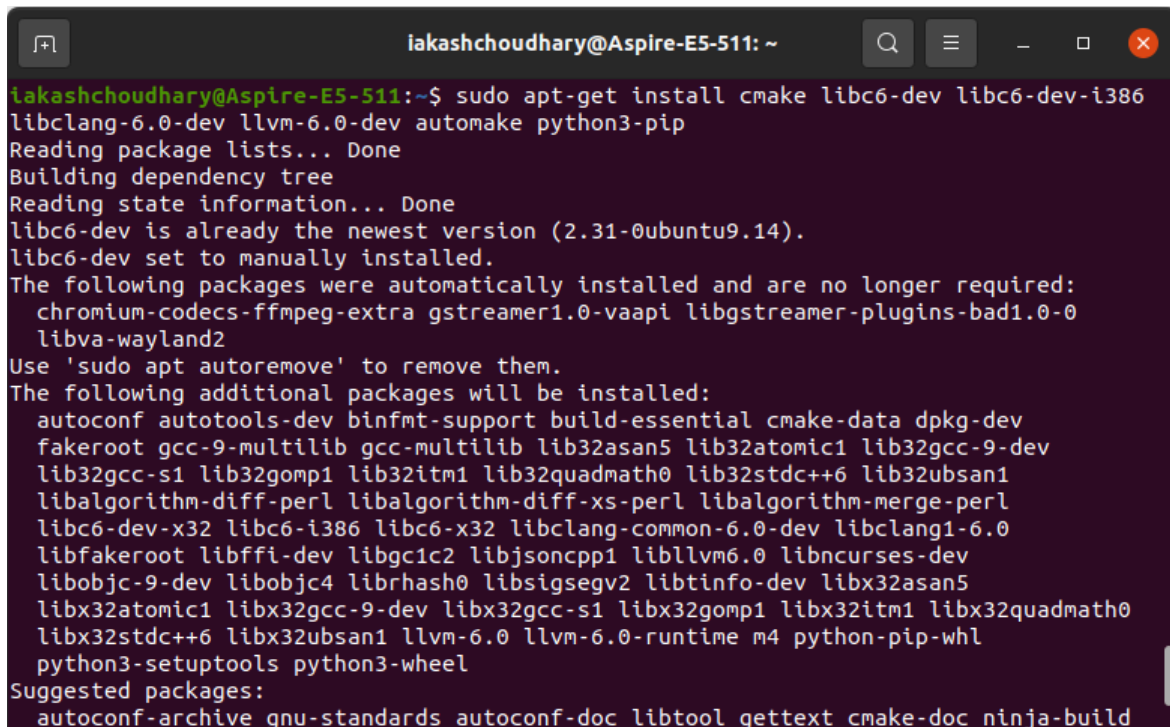
**\$ sudo apt-get install tcpdump**



```
iakashchoudhary@Aspire-E5-511: ~  
iakashchoudhary@Aspire-E5-511:~$ sudo apt-get install tcpdump  
[sudo] password for iakashchoudhary:  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
tcpdump is already the newest version (4.9.3-4ubuntu0.3).  
The following packages were automatically installed and are no longer required:  
  chromium-codecs-ffmpeg-extra gstreamer1.0-vaapi  
  libgstreamer-plugins-bad1.0-0 libva-wayland2  
Use 'sudo apt autoremove' to remove them.  
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
```

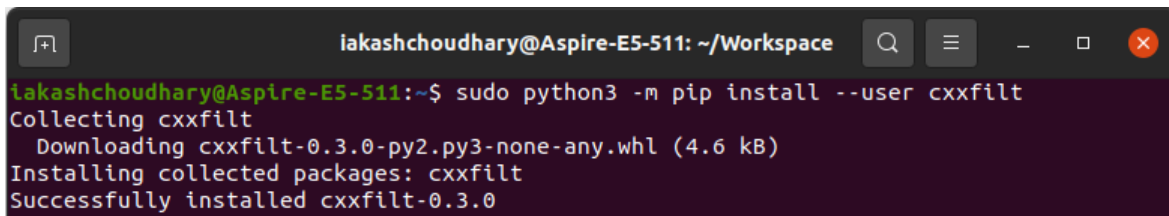
12. Support for generating modified python bindings:

**\$ sudo apt-get install cmake libc6-dev libc6-dev-i386 libclang-6.0-dev automake  
llvm-6.0-dev python3-pip**



```
iakashchoudhary@Aspire-E5-511: ~  
iakashchoudhary@Aspire-E5-511:~$ sudo apt-get install cmake libc6-dev libc6-dev-i386  
libclang-6.0-dev llvm-6.0-dev automake python3-pip  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
libc6-dev is already the newest version (2.31-0ubuntu9.14).  
libc6-dev set to manually installed.  
The following packages were automatically installed and are no longer required:  
  chromium-codecs-ffmpeg-extra gstreamer1.0-vaapi libgstreamer-plugins-bad1.0-0  
  libva-wayland2  
Use 'sudo apt autoremove' to remove them.  
The following additional packages will be installed:  
  autoconf autotools-dev binfmt-support build-essential cmake-data dpkg-dev  
  fakeroot gcc-9-multilib gcc-multilib lib32asan5 lib32atomic1 lib32gcc-9-dev  
  lib32gcc-s1 lib32gomp1 lib32itm1 lib32quadmath0 lib32stdc++6 lib32ubsan1  
  libalgorithm-diff-perl libalgorithm-diff-xs-perl libalgorithm-merge-perl  
  libc6-dev-x32 libc6-i386 libc6-x32 libclang-common-6.0-dev libclang1-6.0  
  libfakeroot libffi-dev libgcc1c2 libjsoncpp1 libllvm6.0 libncurses-dev  
  libobjc-9-dev libobjc4 librtmp0 libsigsegv2 libtinfo-dev libx32asan5  
  libx32atomic1 libx32gcc-9-dev libx32gcc-s1 libx32gomp1 libx32itm1 libx32quadmath0  
  libx32stdc++6 libx32ubsan1 llvm-6.0 llvm-6.0-runtime m4 python-pip-whl  
  python3-setuptools python3-wheel  
Suggested packages:  
  autoconf-archive gnu-standards autoconf-doc libtool gettext cmake-doc ninja-build
```

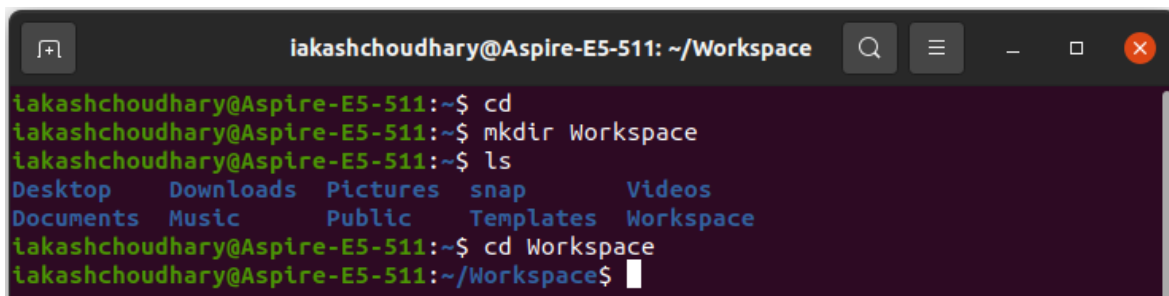
**\$ sudo python3 -m pip install --user cxxfilt**



```
iakashchoudhary@Aspire-E5-511: ~/Workspace
iakashchoudhary@Aspire-E5-511:~$ sudo python3 -m pip install --user cxxfilt
Collecting cxxfilt
  Downloading cxxfilt-0.3.0-py2.py3-none-any.whl (4.6 kB)
Installing collected packages: cxxfilt
Successfully installed cxxfilt-0.3.0
```

13. Create Workspace folder in home directory using command:

**\$ cd; \$ mkdir Workspace; \$ cd Workspace**



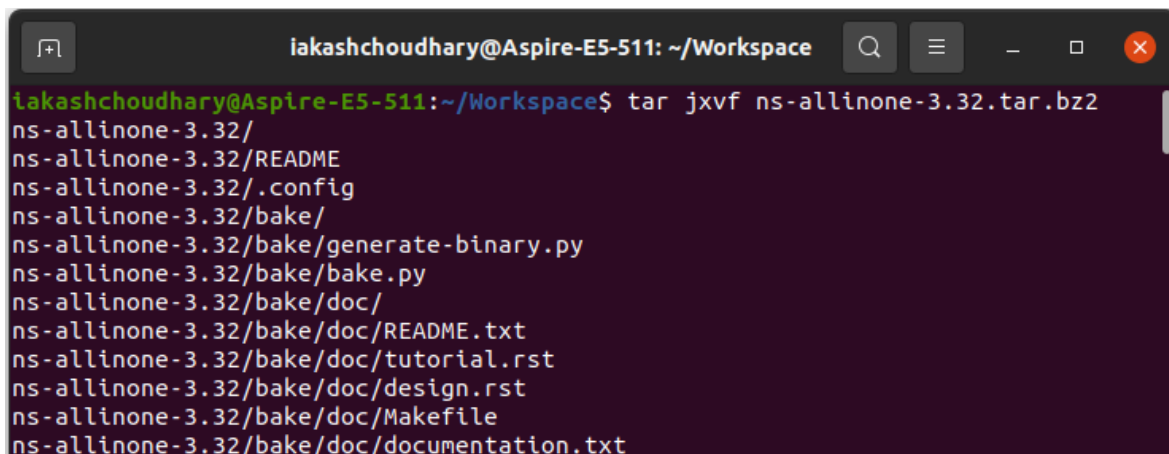
```
iakashchoudhary@Aspire-E5-511: ~/Workspace
iakashchoudhary@Aspire-E5-511:~$ cd
iakashchoudhary@Aspire-E5-511:~$ mkdir Workspace
iakashchoudhary@Aspire-E5-511:~$ ls
Desktop  Downloads  Pictures  snap      Videos
Documents Music      Public    Templates Workspace
iakashchoudhary@Aspire-E5-511:~$ cd Workspace
iakashchoudhary@Aspire-E5-511:~/Workspace$
```

Now, download the ns-allinone-3.32.tar.bz2 file from the browser. Then, copy and paste the tar file in the Workspace folder.



Unzip the ns-allinone-3.32.tar.bz2 file:

**\$ tar jxvf ns-allinone-3.32.tar.bz2**

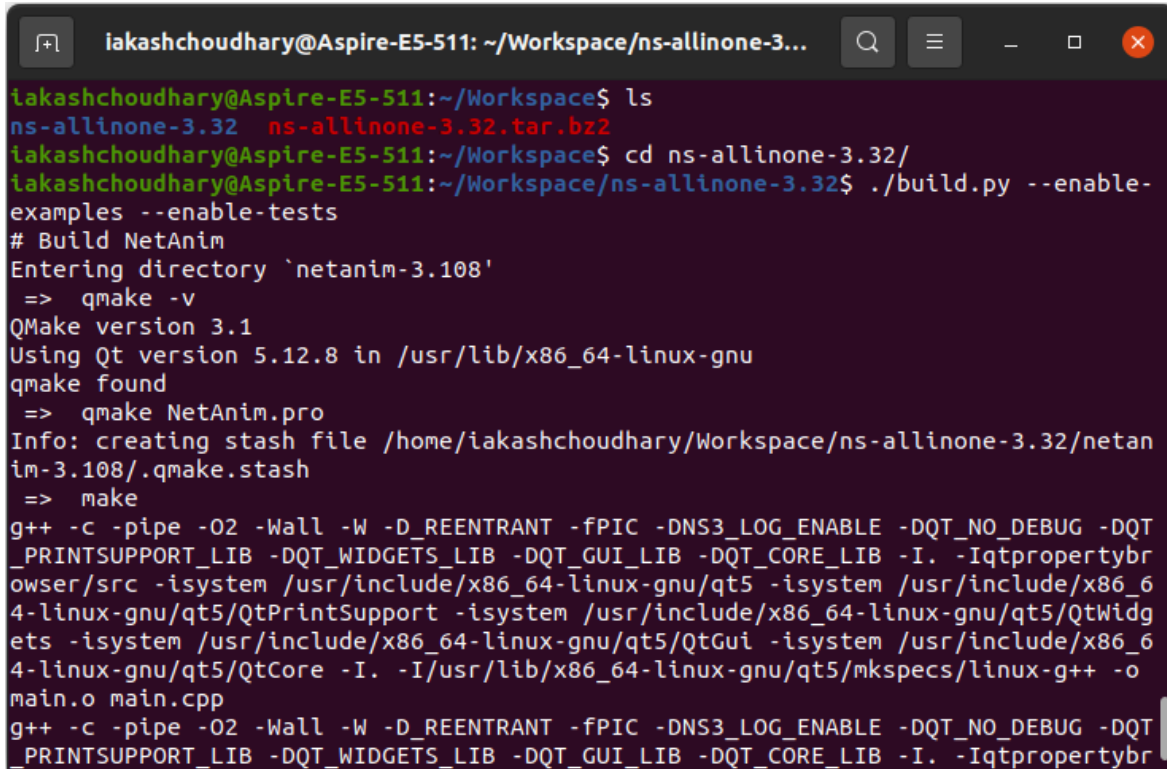


```
iakashchoudhary@Aspire-E5-511: ~/Workspace
iakashchoudhary@Aspire-E5-511:~/Workspace$ tar jxvf ns-allinone-3.32.tar.bz2
ns-allinone-3.32/
ns-allinone-3.32/README
ns-allinone-3.32/.config
ns-allinone-3.32/bake/
ns-allinone-3.32/bake/generate-binary.py
ns-allinone-3.32/bake/bake.py
ns-allinone-3.32/bake/doc/
ns-allinone-3.32/bake/doc/README.txt
ns-allinone-3.32/bake/doc/tutorial.rst
ns-allinone-3.32/bake/doc/design.rst
ns-allinone-3.32/bake/doc/Makefile
ns-allinone-3.32/bake/doc/documentation.txt
```

14. Change directory from Workspace to ns-allinone-3.32 using command:

**\$ cd ns-allinone-3.32/**

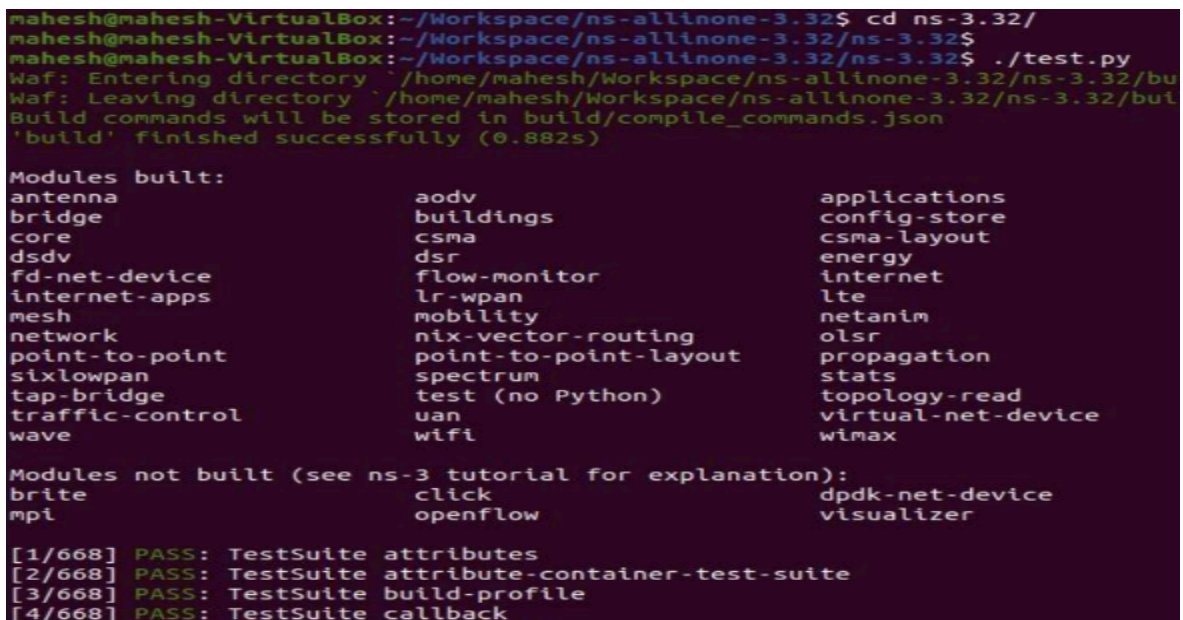
Then, build the ns-3.32: **\$ ./build.py --enable-examples --enable-tests**



```
iakashchoudhary@Aspire-E5-511: ~/Workspace/ns-allinone-3...
iakashchoudhary@Aspire-E5-511:~/Workspace$ ls
ns-allinone-3.32  ns-allinone-3.32.tar.bz2
iakashchoudhary@Aspire-E5-511:~/Workspace$ cd ns-allinone-3.32/
iakashchoudhary@Aspire-E5-511:~/Workspace/ns-allinone-3.32$ ./build.py --enable-examples --enable-tests
# Build NetAnim
Entering directory `netanim-3.108'
=> qmake -v
QMake version 3.1
Using Qt version 5.12.8 in /usr/lib/x86_64-linux-gnu
qmake found
=> qmake NetAnim.pro
Info: creating stash file /home/iakashchoudhary/Workspace/ns-allinone-3.32/netanim-3.108/.qmake.stash
=> make
g++ -c -pipe -O2 -Wall -W -D_REENTRANT -fPIC -DNS3_LOG_ENABLE -DQT_NO_DEBUG -DQT_PRINTSUPPORT_LIB -DQT_WIDGETS_LIB -DQT_GUI_LIB -DQT_CORE_LIB -I. -Iqtpropertybrowser/src -isystem /usr/include/x86_64-linux-gnu/qt5 -isystem /usr/include/x86_64-linux-gnu/qt5/QtPrintSupport -isystem /usr/include/x86_64-linux-gnu/qt5/QtWidgets -isystem /usr/include/x86_64-linux-gnu/qt5/QtGui -isystem /usr/include/x86_64-linux-gnu/qt5/QtCore -I. -I/usr/lib/x86_64-linux-gnu/qt5/mkspecs/linux-g++ -o main.o main.cpp
g++ -c -pipe -O2 -Wall -W -D_REENTRANT -fPIC -DNS3_LOG_ENABLE -DQT_NO_DEBUG -DQT_PRINTSUPPORT_LIB -DQT_WIDGETS_LIB -DQT_GUI_LIB -DQT_CORE_LIB -I. -Iqtpropertybr
```

15. Test the ns-3.32 build and installation success by running the test.py in the ns-3.32 folder:

**\$ cd ns-3.32/; \$ ./test.py**



```
maresh@maresh-VirtualBox:~/Workspace/ns-allinone-3.32$ cd ns-3.32/
maresh@maresh-VirtualBox:~/Workspace/ns-allinone-3.32/ns-3.32$ ./test.py
Waf: Entering directory `/home/maresh/Workspace/ns-allinone-3.32/ns-3.32/build'
Waf: Leaving directory `/home/maresh/Workspace/ns-allinone-3.32/ns-3.32/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (0.882s)

Modules built:
antenna          aodv              applications
bridge           buildings         config-store
core             csma              csma-layout
dsvd             dsr               energy
fd-net-device    flow-monitor     internet
internet-apps    lr-wpan           lte
mesh             mobility          netanim
network          nix-vector-routing olsr
point-to-point   point-to-point-layout propagation
sixlowpan        spectrum          stats
tap-bridge       test (no Python) topology-read
traffic-control  uan              virtual-net-device
wave             wifi             wimax

Modules not built (see ns-3 tutorial for explanation):
brite            click             dpdk-net-device
mpi              openflow          visualizer

[1/668] PASS: TestSuite attributes
[2/668] PASS: TestSuite attribute-container-test-suite
[3/668] PASS: TestSuite build-profile
[4/668] PASS: TestSuite callback
```

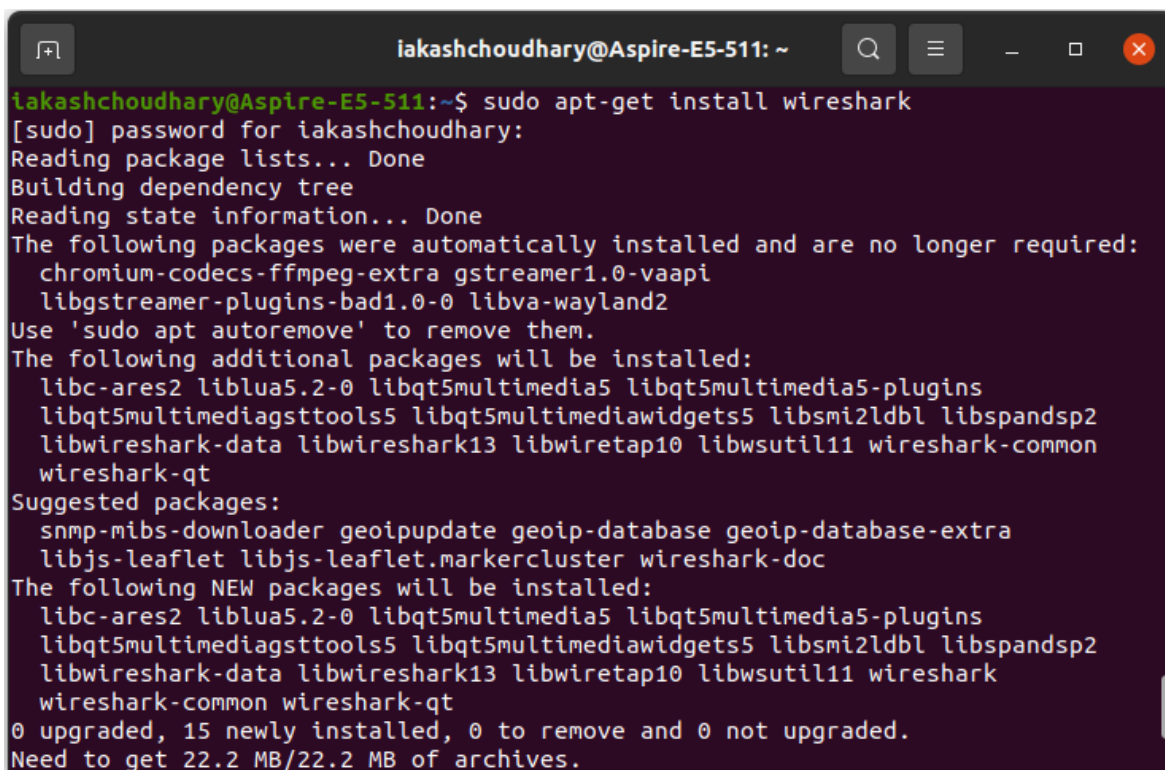
**16. \$ ./waf --run hello-simulator**

This will print 'Hello Simulator,' which indicates that ns3 is installed successfully.

```
maresh@maresh-VirtualBox:~/Workspace/ns-allinone-3.32/ns-3.32$ ./waf --run hello-simulator
Waf: Entering directory '/home/maresh/Workspace/ns-allinone-3.32/ns-3.32/build'
Waf: Leaving directory '/home/maresh/Workspace/ns-allinone-3.32/ns-3.32/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (0.722s)
Hello Simulator
```

**17. Installing Wireshark:**

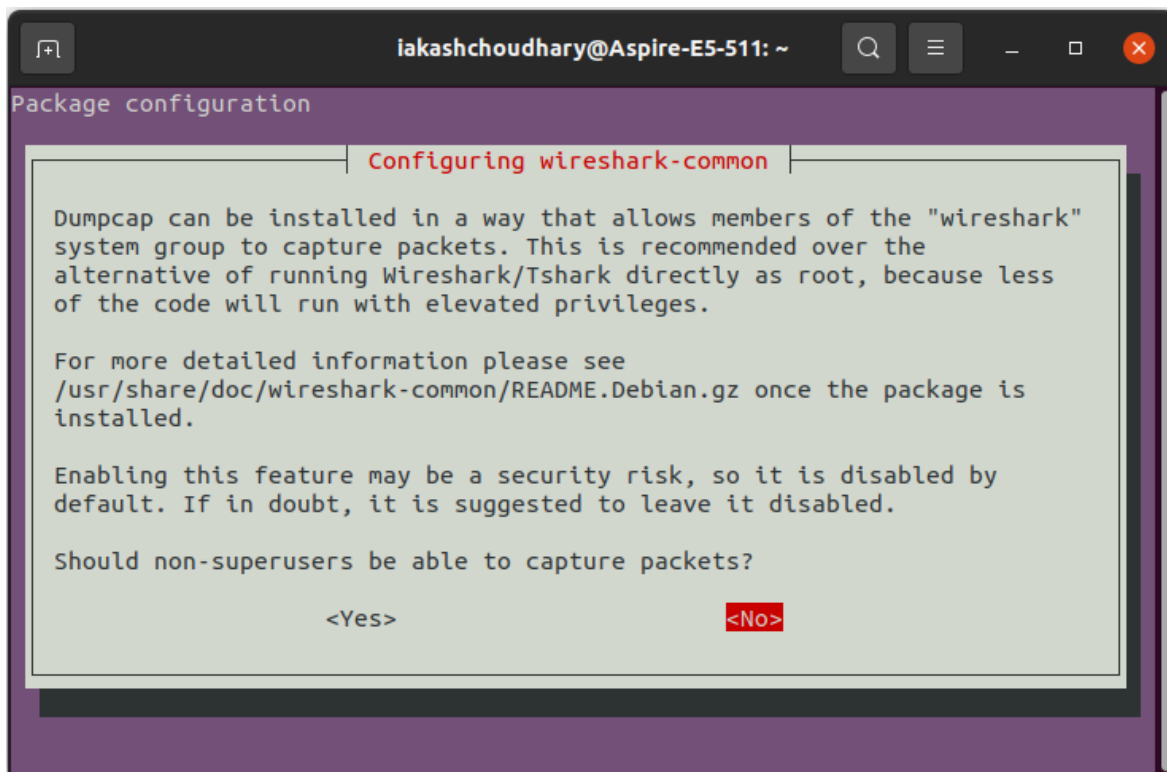
**\$ sudo apt-get install wireshark**



```
iakashchoudhary@Aspire-E5-511: ~$ sudo apt-get install wireshark
[sudo] password for iakashchoudhary:
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following packages were automatically installed and are no longer required:
  chromium-codecs-ffmpeg-extra gstreamer1.0-vaapi
  libgstreamer-plugins-bad1.0-0 libva-wayland2
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
  libc-ares2 liblua5.2-0 libqt5multimedia5 libqt5multimedia5-plugins
  libqt5multimediagsttools5 libqt5multimediawidgets5 libsmi2ldbl libspandsp2
  libwireshark-data libwireshark13 libwiretap10 libwsutil11 wireshark-common
  wireshark-qt
Suggested packages:
  snmp-mibs-downloader geoipupdate geoip-database geoip-database-extra
  libjs-leaflet libjs-leaflet.markercluster wireshark-doc
The following NEW packages will be installed:
  libc-ares2 liblua5.2-0 libqt5multimedia5 libqt5multimedia5-plugins
  libqt5multimediagsttools5 libqt5multimediawidgets5 libsmi2ldbl libspandsp2
  libwireshark-data libwireshark13 libwiretap10 libwsutil11 wireshark
  wireshark-common wireshark-qt
0 upgraded, 15 newly installed, 0 to remove and 0 not upgraded.
Need to get 22.2 MB/22.2 MB of archives.
```



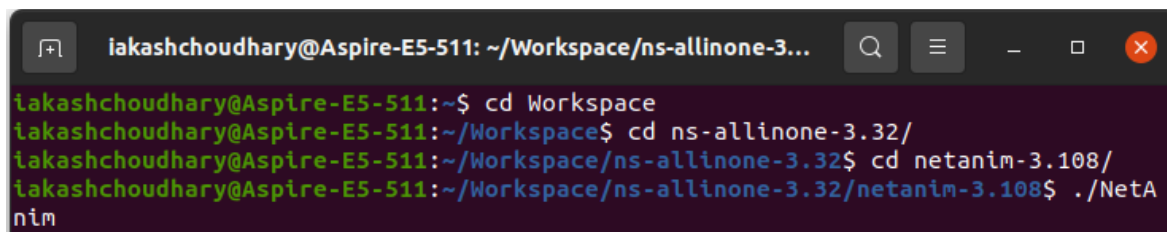
Then Select **Yes** using the key and press Enter.



18. Installing NetAnim:

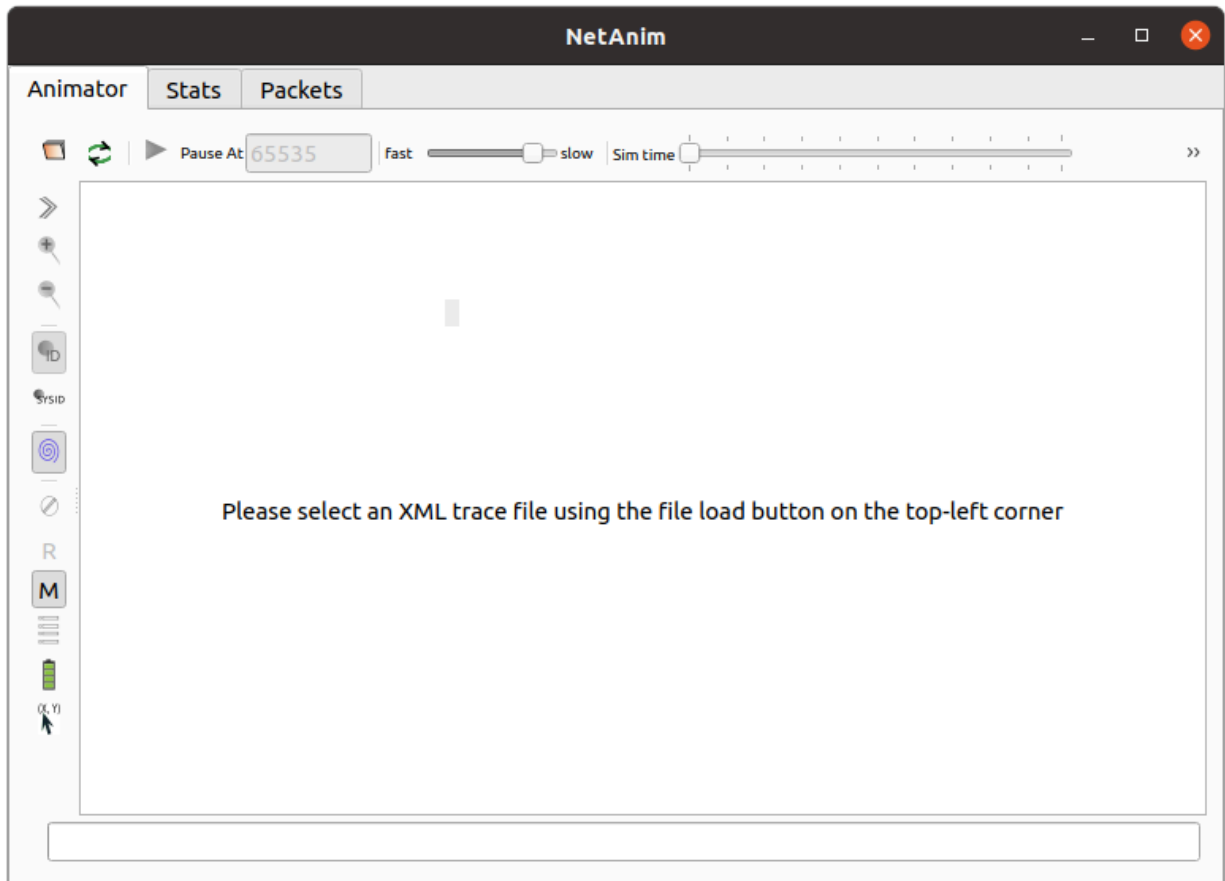
Move to NetAnim folder: **\$ cd Workspace/ns-allinone-3.32/netanim-3.108/**

Then Type: **\$ ./NetAnim**





Above command, will start the NetAnim application.



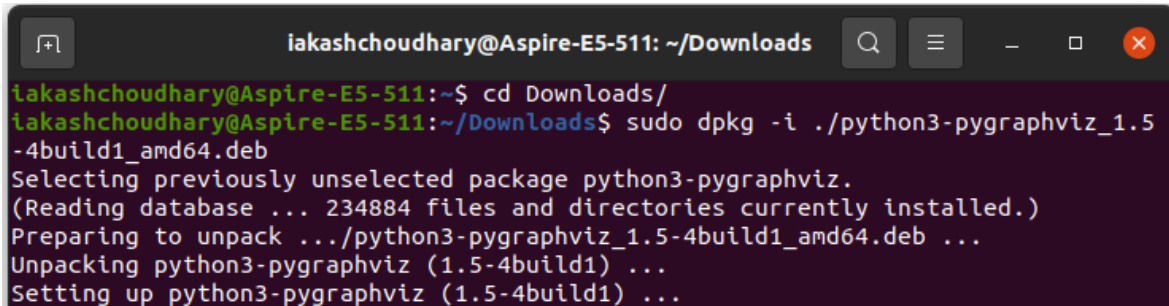
### Manually installing pygraphviz:

1. Download python3-pygraphviz\_1.5-4build1\_amd64.deb file from the browser.



2. Change directory from home to Downloads folder and Type the command:

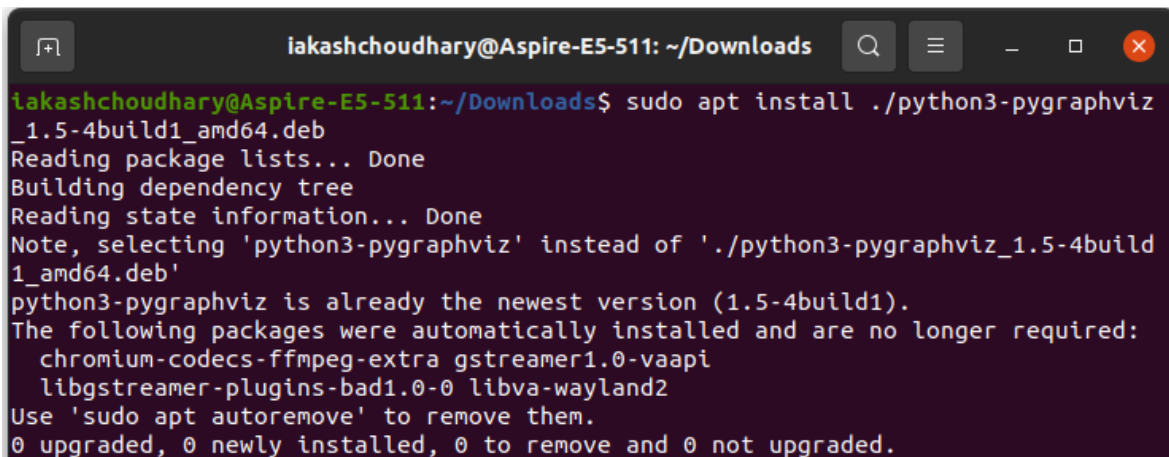
**\$ cd Downloads; \$ sudo dpkg -i ./python3-pygraphviz\_1.5-4build1\_amd64.deb**



```
iakashchoudhary@Aspire-E5-511: ~/Downloads
iakashchoudhary@Aspire-E5-511:~$ cd Downloads/
iakashchoudhary@Aspire-E5-511:~/Downloads$ sudo dpkg -i ./python3-pygraphviz_1.5-4build1_amd64.deb
Selecting previously unselected package python3-pygraphviz.
(Reading database ... 234884 files and directories currently installed.)
Preparing to unpack .../python3-pygraphviz_1.5-4build1_amd64.deb ...
Unpacking python3-pygraphviz (1.5-4build1) ...
Setting up python3-pygraphviz (1.5-4build1) ...
```

3. Now install that package using command:

**\$ sudo apt install ./python3-pygraphviz\_1.5-4build1\_amd64.deb**



```
iakashchoudhary@Aspire-E5-511: ~/Downloads
iakashchoudhary@Aspire-E5-511:~/Downloads$ sudo apt install ./python3-pygraphviz_1.5-4build1_amd64.deb
Reading package lists... Done
Building dependency tree
Reading state information... Done
Note, selecting 'python3-pygraphviz' instead of './python3-pygraphviz_1.5-4build1_amd64.deb'
python3-pygraphviz is already the newest version (1.5-4build1).
The following packages were automatically installed and are no longer required:
  chromium-codecs-ffmpeg-extra gstreamer1.0-vaapi
  libgstreamer-plugins-bad1.0-0 libva-wayland2
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
```

**OR**

### Direct Download

1. Download the given file into the home directory:

[https://drive.google.com/file/d/1tQHYd6HYxeZlu\\_nrQwMu\\_xeqiaSLyCXu/view](https://drive.google.com/file/d/1tQHYd6HYxeZlu_nrQwMu_xeqiaSLyCXu/view)

2. Then, open terminal and type command:

**\$ sudo chmod +x installation.sh**

3. After that run installation.sh file using command:

**\$ sudo ./installation.sh**

It will automatically install all the necessary packages and applications.

**Conclusion:** Hence, NS3, Wireshark, and NetAnim have been successfully installed on the Linux system.