ECE 636
COMPUTER NETWORKING LABORATORY

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Lab 8
Introduction to network modeling and simulation using ns-3

8.2.1

Running the script

To run the program the change directory command was used on the terminal :

cd /afs/cad/courses/ece/f22/ece/636/101/[UCID]/ns-allinone-3.25/ns-3.25

To navigate to the ns-3.25 directory.

Hello Simulator program was run using

./waf--run hello-simulator

Waf first checks to make sure that the program is built correctly and executes
a build if required.

```
[2258/2285] Linking build/bindings/python/ns/wifi.so
[2259/2285] Linking build/bindings/python/ns/dsdv.so
[2260/2285] Linking build/src/netanim/examples/ns3.25-uan-animation-debug
[2261/2285] Linking build/bindings/python/ns/mesh.so
[2262/2285] Linking build/bindings/python/ns/lte.so
[2263/2285] Linking build/examples/tcp/ns3.25-star-debug
[2264/2285] Linking build/bindings/python/ns/olsr.so
[2265/2285] Linking build/bindings/python/ns/aodv.so
[2266/2285] Linking build/bindings/python/ns/wave.so
[2267/2285] Linking build/bindings/python/ns/point_to_point_layout.so
[2268/2285] Linking build/bindings/python/ns/bridge.so
[2269/2285] Linking build/bindings/python/ns/stats.so
[2270/2285] Linking build/bindings/python/ns/spectrum.so
[2271/2285] Linking build/bindings/python/ns/buildings.so
[2272/2285] Linking build/bindings/python/ns/sixlowpan.so
[2273/2285] Linking build/bindings/python/ns/topology_read.so
[2274/2285] Linking build/bindings/python/ns/uan.so
[2275/2285] Compiling src/fd-net-device/helper/tap-device-creator.cc
[2276/2285] Compiling src/fd-net-device/helper/encode-decode.cc
[2277/2285] Compiling src/fd-net-device/helper/creator-utils.cc
[2278/2285] Linking build/src/fd-net-device/ns3.25-tap-device-creator-debug
[2281/2285] Compiling src/fd-net-device/helper/raw-sock-creator.cc
[2281/2285] Compiling src/fd-net-device/helper/encode-decode.cc
[2281/2285] Compiling src/fd-net-device/helper/creator-utils.cc
[2282/2285] Linking build/src/fd-net-device/ns3.25-raw-sock-creator-debug
[2284/2285] Compiling src/tap-bridge/model/tap-encode-decode.cc
[2284/2285] Compiling src/tap-bridge/model/tap-creator.cc
[2285/2285] Linking build/src/tap-bridge/ns3.25-tap-creator-debug
Waf: Leaving directory `/afs/cad.njit.edu/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/ns-3.25/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (2m17.123s)
Hello Simulator
t3net04-68 ns-3.25 >:
```

Output showing the waf build and the Hello simulator output.

./waf configure–enable-tests

```
waf: error: no such option: -e
t3net04-63 ns-3.25 >: ./waf configure-enable-tests
No function configure-enable-tests defined in /afs/cad.njit.edu/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/ns-3.25/wscript
t3net04-64 ns-3.25 >: ./waf configure --enable-tests
Setting top to                             : /afs/cad.njit.edu/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/ns-3.25
Setting out to                             : /afs/cad.njit.edu/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/ns-3.25/build
Checking for 'gcc' (C compiler)            : /usr/bin/gcc
Checking for cc version                    : 4.8.5
Checking for 'g++' (C++ compiler)          : /usr/bin/g++
Checking for compilation flag -Wl,--soname=foo support : ok
Checking for program 'python'                        : /afs/cad/linux/anaconda-2.1.0/anaconda/bin/python
Checking for python version                          : (2, 7, 15, 'final', 0)
python-config                                        : /afs/cad/linux/anaconda-2.1.0/anaconda/bin/python-config
Asking python-config for pyembed '--cflags --libs --ldflags' flags : yes
Testing pyembed configuration                        : Could not build a python embedded interpreter
Testing pyembed configuration                        : yes
Asking python-config for pyext '--cflags --libs --ldflags' flags : yes
Testing pyext configuration                          : Could not build python extensions
Testing pyext configuration                          : yes
Checking for compilation flag -fvisibility=hidden support   : ok
Checking for compilation flag -Wno-array-bounds support     : ok
Checking for pybindgen location                      : ../pybindgen-0.17.0.post49+ng0e4e3bc (guessed)
Checking for python module 'pybindgen'               : 0.17.0.post49+ng0e4e3bc
Checking for pybindgen version                       : 0.17.0.post49+ng0e4e3bc
Checking for code snippet                            : yes
Checking for types uint64_t and unsigned long equivalence   : no
Checking for code snippet                            : no
Checking for types uint64_t and unsigned long long equivalence : yes
Checking for the apidefs that can be used for Python bindings : gcc-LP64
Checking for internal GCC cxxabi                     : complete
Checking for python module 'pygccxml'                : v1.6.2
Checking for pygccxml version                        : 1.6.2
Checking for program 'gccxml'                        : not found
gccxml missing; automatic scanning of API definitions will not be possible
Checking boost includes                              : headers not found, please provide a --boost-includes argument (see help)
Checking boost includes                              : headers not found, please provide a --boost-includes argument (see help)
Checking for click location                          : ../click (guessed)
Checking for library dl                              : yes
Checking for library nsclick                         : yes
Checking for program 'pkg-config'                    : /usr/local/bin/pkg-config
Checking for 'gtk+-2.0' >= 2.12                       : not found
Checking for 'libxml-2.0' >= 2.7                      : yes
```

./waf configure–enable-examples

```
t3net04-65 ns-3.25 >: ./waf configure --enable-examples
Setting top to                             : /afs/cad.njit.edu/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/ns-3.25
Setting out to                             : /afs/cad.njit.edu/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/ns-3.25/build
Checking for 'gcc' (C compiler)            : /usr/bin/gcc
Checking for cc version                    : 4.8.5
Checking for 'g++' (C++ compiler)          : /usr/bin/g++
Checking for compilation flag -Wl,--soname=foo support : ok
Checking for program 'python'                        : /afs/cad/linux/anaconda-2.1.0/anaconda/bin/python
Checking for python version                          : (2, 7, 15, 'final', 0)
python-config                                        : /afs/cad/linux/anaconda-2.1.0/anaconda/bin/python-config
Asking python-config for pyembed '--cflags --libs --ldflags' flags : yes
Testing pyembed configuration                        : Could not build a python embedded interpreter
Testing pyembed configuration                        : yes
Asking python-config for pyext '--cflags --libs --ldflags' flags : yes
Testing pyext configuration                          : Could not build python extensions
Testing pyext configuration                          : yes
Checking for compilation flag -fvisibility=hidden support   : ok
Checking for compilation flag -Wno-array-bounds support     : ok
Checking for pybindgen location                      : ../pybindgen-0.17.0.post49+ng0e4e3bc (guessed)
Checking for python module 'pybindgen'               : 0.17.0.post49+ng0e4e3bc
Checking for pybindgen version                       : 0.17.0.post49+ng0e4e3bc
Checking for code snippet                            : yes
Checking for types uint64_t and unsigned long equivalence   : no
Checking for code snippet                            : no
Checking for types uint64_t and unsigned long long equivalence : yes
Checking for the apidefs that can be used for Python bindings : gcc-LP64
Checking for internal GCC cxxabi                     : complete
Checking for python module 'pygccxml'                : v1.6.2
Checking for pygccxml version                        : 1.6.2
Checking for program 'gccxml'                        : not found
gccxml missing; automatic scanning of API definitions will not be possible
Checking boost includes                              : headers not found, please provide a --boost-includes argument (see help)
Checking boost includes                              : headers not found, please provide a --boost-includes argument (see help)
Checking for click location                          : ../click (guessed)
Checking for library dl                              : yes
```

For running the first script in ns3 scratch/ak2739first.cc is copied from the first.cc file path using the command, cp. The ak2739first.cc is edited using the gedit command.

```
t3net04-54 ns-3.25 >: cp ns-3.25/examples/tutorial/first.cc scratch/ak2739first.cc
cp: cannot stat 'ns-3.25/examples/tutorial/first.cc': No such file or directory
t3net04-55 ns-3.25 >: cp ns-3.25/examples/tutorial/first.cc/scratch/ak2739first.cc
cp: missing destination file operand after 'ns-3.25/examples/tutorial/first.cc/scratch/ak2739first.cc'
Try 'cp --help' for more information.
t3net04-56 ns-3.25 >: cp ns-3.25/examples/tutorial/first.cc scratch/ak2739first.cc
cp: cannot stat 'ns-3.25/examples/tutorial/first.cc': No such file or directory
t3net04-57 ns-3.25 >: cp examples/tutorial/first.cc scratch/ak2739first.cc
cp: overwrite 'scratch/ak2739first.cc'? ^C
t3net04-58 ns-3.25 >: cp examples/tutorial/first.cc scratch/ak2739first.cc
cp: overwrite 'scratch/ak2739first.cc'? ^C
t3net04-58 ns-3.25 >: gedit scratch/ak2739first.cc
t3net04-59 ns-3.25 >: cp examples/tutorial/first.cc scratch/ak2739first.cc
cp: overwrite 'scratch/ak2739first.cc'? yes
t3net04-60 ns-3.25 >: cp examples/tutorial/first.cc scratch/ak2739first.cc
cp: overwrite 'scratch/ak2739first.cc'? y
t3net04-60 ns-3.25 >: gedit scratch/ak2739first.cc
t3net04-61 ns-3.25 >: nano scratch/first.cc
t3net04-62 ns-3.25 >: gedit scratch/ak2739first.cc
t3net04-63 ns-3.25 >: ./waf --run scratch/ak2739first
Waf: Entering directory `/afs/cad.njit.edu/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/ns-3.25/bu
ild'
[ 888/2291] Compiling scratch/ak2739first.cc
[2254/2291] Linking build/scratch/ak2739first
Waf: Leaving directory `/afs/cad.njit.edu/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/ns-3.25/bui
ld'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (1.952s)
At time 2s client sent 1024 bytes to 10.1.7.2 port 9
At time 2.00381s server received 1024 bytes from 10.1.7.1 port 49153
At time 2.00381s server sent 1024 bytes to 10.1.7.1 port 49153
At time 2.00762s client received 1024 bytes from 10.1.7.2 port 9
t3net04-64 ns-3.25 >: cp ns-3.25/examples/tutorial/first.cc scratch/UCIDfirst.cc []
```

- Changing the values in ak2739first.cc
- Changing the value of DataRate as 3 Mbps.
- Setting the transmission delay of the point to point channel as 1ms.
- Changing addressbase to 10.1.7.0 to include the addresses 10.1.7.1 and 10.1.7.2
- Changing the start events for the server and the client at 1.0 seconds, 2.0 seconds
- The Stop events for the server and the client both at 15.0 seconds

```cpp
#include "ns3/applications-module.h"
#include "ns3/netanim-module.h"

using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("FirstScriptExample");

int
main (int argc, char *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 ("3Mbps"));
  pointToPoint.SetChannelAttribute ("Delay", StringValue ("1ms"));

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

  InternetStackHelper stack;
  stack.Install (nodes);

  Ipv4AddressHelper address;
  address.SetBase ("10.1.7.0", "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 (15.0));

  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 (15.0));

  AnimationInterface anim ("animation.xml");
  anim.SetConstantPosition(nodes.Get(0),1.0, 3.0);
  anim.SetConstantPosition(nodes.Get(1),1.0, 5.0);

  Simulator::Run ();
```

```
t3net04-60 ns-3.25 >: gedit scratch/ak2739first.cc
t3net04-61 ns-3.25 >: nano scratch/first.cc
t3net04-62 ns-3.25 >: gedit scratch/ak2739first.cc
t3net04-63 ns-3.25 >: ./waf --run scratch/ak2739first
Waf: Entering directory `/afs/cad.njit.edu/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/ns-3.25/bu
ild'
[ 888/2291] Compiling scratch/ak2739first.cc
[2254/2291] Linking build/scratch/ak2739first
Waf: Leaving directory `/afs/cad.njit.edu/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/ns-3.25/bui
ld'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (1.952s)
At time 2s client sent 1024 bytes to 10.1.7.2 port 9
At time 2.00381s server received 1024 bytes from 10.1.7.1 port 49153
At time 2.00381s server sent 1024 bytes to 10.1.7.1 port 49153
At time 2.00762s client received 1024 bytes from 10.1.7.2 port 9
t3net04-64 ns-3.25 >: ls
1111111111111111111111.xml   examples/     scratch/          testpy.supp      utils.py     wscript
AUTHORS                      LICENSE       second-0-0.pcap   third-0-0.pcap   utils.pyc    wutils.py
bindings/                    Makefile      second-170-0.pcap third-0-1.pcap   VERSION      wutils.pyc
build/                       __pycache__/  second-171-0.pcap third-1-0.pcap   waf*
CHANGES.html                 README        src/              third-1-1.pcap   waf.bat*
doc/                         RELEASE_NOTES test.py*          utils/           waf-tools/
t3net04-65 ns-3.25 >: cd /afs/cad/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/
```

Output

```
t3net04-63 ns-3.25 >: ./waf --run scratch/ak2739first
Waf: Entering directory `/afs/cad.njit.edu/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/ns-3.25/bu
ild'
[ 888/2291] Compiling scratch/ak2739first.cc
[2254/2291] Linking build/scratch/ak2739first
Waf: Leaving directory `/afs/cad.njit.edu/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/ns-3.25/bui
ld'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (1.952s)
At time 2s client sent 1024 bytes to 10.1.7.2 port 9
At time 2.00381s server received 1024 bytes from 10.1.7.1 port 49153
At time 2.00381s server sent 1024 bytes to 10.1.7.1 port 49153
At time 2.00762s client received 1024 bytes from 10.1.7.2 port 9

t3net04-63 ns-3.25 >: ./waf --run scratch/ak2739first
Waf: Entering directory `/afs/cad.njit.edu/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/ns-3.25/bu
ild'
[ 888/2291] Compiling scratch/ak2739first.cc
[2254/2291] Linking build/scratch/ak2739first
Waf: Leaving directory `/afs/cad.njit.edu/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/ns-3.25/bui
ld'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (1.952s)
At time 2s client sent 1024 bytes to 10.1.7.2 port 9
At time 2.00381s server received 1024 bytes from 10.1.7.1 port 49153
At time 2.00381s server sent 1024 bytes to 10.1.7.1 port 49153
At time 2.00762s client received 1024 bytes from 10.1.7.2 port 9
t3net04-64 ns-3.25 >: cp ns-3.25/examples/tutorial/first.cc scratch/UCIDfirst.cc
```
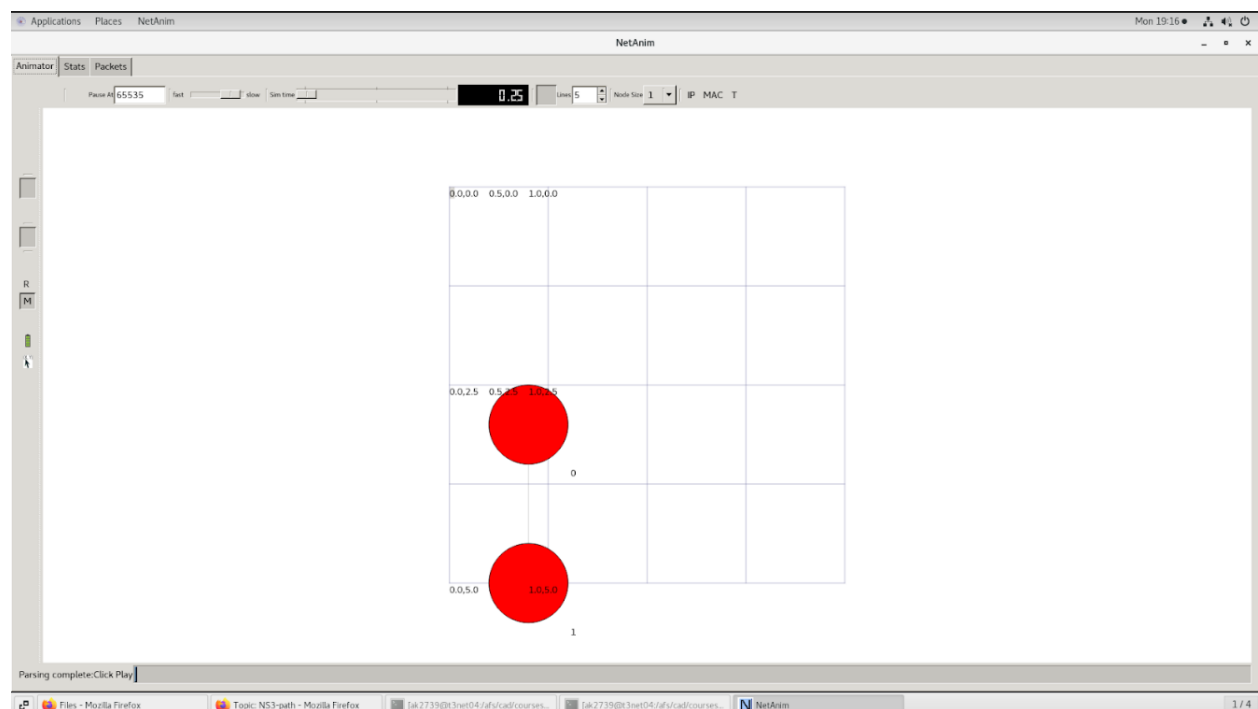
8.2.4 Adding netanim to your program

Make clean command execution

```
t3net04-69 netanim-3.107 >: make clean
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_qtpropertybrowserutils
_p.cpp moc_qtpropertybrowser.cpp moc_qtgroupboxpropertybrowser.cpp moc_qteditorfactory.cpp moc_qtbuttonpr
opertybrowser.cpp moc_animpropertybrowser.cpp moc_filepathmanager.cpp moc_fileeditfactory.cpp moc_fileedi
t.cpp moc_packetsmode.cpp moc_table.cpp moc_qcustomplot.cpp
rm -f qrc_resources.cpp qrc_qtpropertybrowser.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 animpac
ket.o netanim.o animatormode.o mode.o animxmlparser.o animatorview.o animlink.o animresource.o statsview.
o statsmode.o routingxmlparser.o routingstatsscene.o interfacestatsscene.o flowmonxmlparser.o flowmonstat
sscene.o textbubble.o qtvariantproperty.o qttreepropertybrowser.o qtpropertymanager.o qtpropertybrowserut
ils.o qtpropertybrowser.o qtgroupboxpropertybrowser.o qteditorfactory.o qtbuttonpropertybrowser.o animpro
pertybrowser.o filepathmanager.o fileeditfactory.o fileedit.o packetsmode.o packetsview.o packetsscene.o
graphpacket.o table.o countertablesscene.o qcustomplot.o moc_animatorscene.o moc_animpacket.o moc_netanim
.o moc_animatormode.o moc_statsmode.o moc_qtpropertybrowserutils_p.o moc_animpropertybrowser.o moc_filepa
thmanager.o moc_fileeditfactory.o moc_fileedit.o moc_packetsmode.o moc_table.o moc_qcustomplot.o qrc_reso
urces.o qrc_qtpropertybrowser.o
rm -f *~ core *.core
```

qmake NetAnim.pro command

```
t3net04-70 netanim-3.107 >: qmake NetAnim.pro
```



```
AnimationInterface anim ("animation.xml");
anim.SetConstantPosition(nodes.Get(0),1.0, 3.0);
anim.SetConstantPosition(nodes.Get(1),1.0, 5.0);
```

Running the NetAnim using ./NetAnim and navigating to the right folder using ls and cd commands.

```
t3net04-41 ~ >: cd /afs/cad/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/ns-3.25
t3net04-42 ns-3.25 >: gedit scratch/ak2739first.cc
t3net04-43 ns-3.25 >: gedit scratch/ak2739first.cc
t3net04-43 ns-3.25 >: ls
1111111111111111111111.xml    __pycache__/         testpy.supp         waf*
AUTHORS                       README               third-0-0.pcap      waf.bat*
bindings/                     RELEASE_NOTES        third-0-1.pcap      waf-tools/
build/                        scratch/             third-1-0.pcap      wscript
CHANGES.html                  second-0-0.pcap      third-1-1.pcap      wutils.py
doc/                          second-170-0.pcap    utils/              wutils.pyc
examples/                     second-171-0.pcap    utils.py
LICENSE                       src/                 utils.pyc
Makefile                      test.py*             VERSION
t3net04-44 ns-3.25 >: ls ..
bake/          constants.py        pybindgen-0.17.0.post49+ng0e4e3bc/
build.py*      netanim-3.107/      README
click/         ns-3.25/            util.py
t3net04-45 ns-3.25 >: cd netanim-3.107/
bash: cd: netanim-3.107/: No such file or directory
t3net04-46 ns-3.25 >: cd netanim-3.107
bash: cd: netanim-3.107: No such file or directory
t3net04-47 ns-3.25 >: cd /netanim-3.107
bash: cd: /netanim-3.107: No such file or directory
t3net04-48 ns-3.25 >: cd /netanim-3.107/
bash: cd: /netanim-3.107/: No such file or directory
t3net04-49 ns-3.25 >: ^C
t3net04-49 ns-3.25 >: cd /afs/cad/courses/ece/f22/ece/636/101/ak2739/ns-allinone-3.25/
t3net04-50 ns-allinone-3.25 >: ls
bake/          constants.py        pybindgen-0.17.0.post49+ng0e4e3bc/
build.py*      netanim-3.107/      README
click/         ns-3.25/            util.py
t3net04-51 ns-allinone-3.25 >: cd netanim-3.107
t3net04-52 netanim-3.107 >: ./NetAnim
Gtk-Message: Failed to load module "pk-gtk-module"
Gtk-Message: Failed to load module "canberra-gtk-module"
```