

# A Novel Optimization Method to Mitigate Congestion in Edge Computing using Tabu Search Algorithm -Configuration Manual

MSc Research Project  
Cloud Computing

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# A Novel Optimization Method to Mitigate Congestion in Edge Computing using Tabu Search Algorithm -Configuration Manual

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## 1 Introduction

A configuration handbook is a booklet that contains all the information necessary for downloading, installing, and configuring software. The comprehensive instructions for obtaining and configuring the NAM (Network Animator) program are included in this setup manual. The handbook is divided into three sections: Section 1 covers details on obtaining the tools and software needed for the research; Section 2 covers tool installation; and Section 3 covers details on software setup. The research has a strong emphasis on simulation studies utilizing the NS2 simulator in conjunction with NAM, which is utilized as a tool for creating simulation-related scenarios. To verify the configuration, a VMware virtual machine running the Ubuntu operating system is made to simulate the wireless network architecture.

## 2 System configuration requirements

The user rebuilding the configuration using this configuration manual must have a fundamental knowledge of TCL scripting. The user should also utilize a Windows or Linux machine.

### 2.1 Hardware requirements

The experiments was carried out on the following environment.

#### 1. For Windows :

- Processor: 11th Gen Intel(R) Core(TM) i5-1135G7 @ 2.40GHz 2.42 GHz
- RAM : 16.0 GB
- System type : 64-bit operating system, x64-based processor

#### 2. For Ubuntu:

- RAM : 4 GB
- Storage : 32 GB
- System type : Ubuntu 64-bit operating system
- version : 18.04.6 LTS

## 2.2 Minimum System Requirements

This subsection outlines the very system requirements needed to replicate the experiment situation.

- Operating System : Windows/Linux based OS.
- (RAM) : Minimum of 8 GB.
- Disk Space : At least 32 GB of empty space.

## 3 Downloading and Installation of Tools and Packages

To run Ubuntu, we downloaded VMware Workstation Player 16.2.5 on a Windows 10 machine.

The tools and packages are installed in the following steps:

### 3.1 Installation of NS2 package

The Network Simulator 2 is installed using the following procedures on Ubuntu 64-bit:

**Step 1:** The Ubuntu libraries must be updated using the command Fig.1 below in order to install the NS2 package.

```
prajakta@prajakta-virtual-machine:~$ sudo apt-get update
Hit:1 http://security.ubuntu.com/ubuntu bionic-security InRelease
Hit:2 http://us.archive.ubuntu.com/ubuntu bionic InRelease
Hit:3 http://us.archive.ubuntu.com/ubuntu bionic-updates InRelease
Hit:4 http://us.archive.ubuntu.com/ubuntu bionic-backports InRelease
Reading package lists... Done
prajakta@prajakta-virtual-machine:~$ sudo apt-get install
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following packages were automatically installed and are no longer required:
 fonts-liberation2 fonts-opensymbol gir1.2-gst-plugins-base-1.0 gir1.2-gstreamer
 libboost-filesystem1.65.1 libboost-iostreams1.65.1 libboost-locale1.65.1 libcdr
 libdataserverui-1.2-2 libeot0 libepubgen-0.1-1 libetonyek-0.1-1 libevent-2.1-6
 libgpod4 liblangtag-common liblangtag1 liblirc-client0 libmediaart-2.0-0 libmsp
 libvncclient1 libwinpr2-2 libxapian30 libxmlsec1-nss linux-hwe-5.4-headers-5.4.
 python3-markupsafe syslinux syslinux-common syslinux-legacy usb-creator-common
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 36 not upgraded.
```

Figure 1: Ubuntu update installation

**Step 2:** The command shown below was used to install the Network Simulator 2 package Fig2.

```

prajakta@prajakta-virtual-machine:~$ sudo apt-get install ns2
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following packages were automatically installed and are no longer required:
 fonts-liberation2 fonts-opensymbol gir1.2-gst-plugins-base-1.0 gir1.2-gstreamer-1.0
 libboost-filesystem1.65.1 libboost-iostreams1.65.1 libboost-locale1.65.1 libboost-regex1.65.1
 libboost-system1.65.1 libboost-thread1.65.1 libboost-timer1.65.1 libboost-wave1.65.1 libboost1.65.1
 libedataserverui-1.2-2 libeot0 libepubgen-0.1-1 libetonyek-0.1-1 libevent-2.1-6 libexiv2-14
 libgpgod4 liblangtag-common liblangtag1 liblirc-client0 liblua5.3-0 libmediaart-2.0-0 libmspack-1.0-1
 libnvcclient1 libwinpr2-2 libxapian30 libxmlsec1-nss lp-solve media-player-info python3-mako
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
 libotcl1 libtcl8.6 libtclcl1 libtk8.6
Suggested packages:
 tcl8.6 tk8.6 gnuplot
The following NEW packages will be installed:
 libotcl1 libtcl8.6 libtclcl1 libtk8.6 ns2
0 upgraded, 5 newly installed, 0 to remove and 133 not upgraded.
Need to get 3,907 kB of archives.
After this operation, 21.9 MB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://us.archive.ubuntu.com/ubuntu bionic/main amd64 libtcl8.6 amd64 8.6.8+dfsg-3 [14.4 kB]
Get:2 http://us.archive.ubuntu.com/ubuntu bionic/universe amd64 libotcl1 amd64 0.9.0-2 [14.4 kB]
Get:3 http://us.archive.ubuntu.com/ubuntu bionic/universe amd64 libtclcl1 amd64 0.9.0-2 [14.4 kB]
Get:4 http://us.archive.ubuntu.com/ubuntu bionic/main amd64 libtk8.6 amd64 8.6.8+dfsg-3 [14.4 kB]
Get:5 http://us.archive.ubuntu.com/ubuntu bionic/universe amd64 ns2 amd64 2.3.2-1 [14.4 kB]
Fetched 3,907 kB in 15s (257 kB/s)

```

Figure 2: NS2 package installation

**Step 3:**The command shown below was used to install the tclsh package Fig3.

```

prajakta@prajakta-virtual-machine:~$ sudo apt install tclsh
Reading package lists... Done
Building dependency tree
Reading state information... Done
Note, selecting 'tcl' instead of 'tclsh'
The following packages were automatically installed and are no longer required:
 fonts-liberation2 fonts-opensymbol gir1.2-gst-plugins-base-1.0 gir1.2-gstreamer-1.0 gir1.2-gstreamer-1.0
 libboost-filesystem1.65.1 libboost-iostreams1.65.1 libboost-locale1.65.1 libcdr-0.1-1 libclucene-light
 libedataserverui-1.2-2 libeot0 libepubgen-0.1-1 libetonyek-0.1-1 libevent-2.1-6 libexiv2-14
 libgpgod4 liblangtag-common liblangtag1 liblirc-client0 liblua5.3-0 libmediaart-2.0-0 libmspack-1.0-1
 libnvcclient1 libwinpr2-2 libxapian30 libxmlsec1-nss lp-solve media-player-info python3-mako
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
 tcl8.6
Suggested packages:
 tcl-tclreadline
The following NEW packages will be installed:
 tcl tcl8.6
0 upgraded, 2 newly installed, 0 to remove and 133 not upgraded.
Need to get 19.5 kB of archives.
After this operation, 62.5 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://us.archive.ubuntu.com/ubuntu bionic/main amd64 tcl8.6 amd64 8.6.8+dfsg-3 [14.4 kB]
Get:2 http://us.archive.ubuntu.com/ubuntu bionic/universe amd64 tcl amd64 8.6.0+9 [5,146 B]
Fetched 19.5 kB in 1s (22.6 kB/s)

```

Figure 3: tclsh package installation

**Step 4:**To check NS2 is successfully installed, use the bellow command Fig4.

```

prajakta@prajakta-virtual-machine:~$ ns
%
% ^C

```

Figure 4: Successfully installation of NS2

## 3.2 Installation of NAM package

The NAM package is installed following the installation of NS2 to depict the network simulation results visually fig5.

```
prajakta@prajakta-virtual-machine:~$ sudo apt install nam
[sudo] password for prajakta:
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following packages were automatically installed and are no longer
 fonts-liberation2 fonts-opensymbol gir1.2-gst-plugins-base-1.0 gir1.2
 libboost-filesystem1.65.1 libboost-iostreams1.65.1 libboost-locale1.6
 libedataserverui-1.2-2 libeot0 libepubgen-0.1-1 libetonyek-0.1-1 lib
 libgpod-common libgpod4 liblangtag-common liblangtag1 liblirc-client
 libsuitesparseconfig5 libvncclient1 libwinpr2-2 libxapian30 libxmlsec
Use 'sudo apt autoremove' to remove them.
The following NEW packages will be installed:
 nam
0 upgraded, 1 newly installed, 0 to remove and 133 not upgraded.
Need to get 191 kB of archives.
After this operation, 683 kB of additional disk space will be used.
Get:1 http://us.archive.ubuntu.com/ubuntu bionic/universe amd64 nam amd64 1.15-4 [191 kB]
Fetched 191 kB in 1s (143 kB/s)
Selecting previously unselected package nam.
(Reading database ... 151575 files and directories currently installed.)
Preparing to unpack .../archives/nam_1.15-4_amd64.deb ...
Unpacking nam (1.15-4) ...
Setting up nam (1.15-4) ...
Processing triggers for man-db (2.8.3-2ubuntu0.1) ...
prajakta@prajakta-virtual-machine:~$
```

Figure 5: NAM package installation

## 4 Execution of NS file:

Instructions for extracting and running code files on NS2 can be found in the section below.

### 4.1 Extraction of the file

Utilize the command: "unzip filename.zip" by providing the path as shown in Fig. 6 to extract the zip file to one of the directories in Ubuntu.

```

prajakta@prajakta-virtual-machine:~/Desktop$ ls
Final PrajaktaResearch.zip Temp
prajakta@prajakta-virtual-machine:~/Desktop$ unzip PrajaktaResearch.zip
Archive: PrajaktaResearch.zip
  creating: PrajaktaResearch/
  inflating: PrajaktaResearch/1_hop_bcast.awk
  inflating: PrajaktaResearch/1_hop_nei.awk
  inflating: PrajaktaResearch/2_hop_bcast.awk
  inflating: PrajaktaResearch/2_hop_nei.awk
  inflating: PrajaktaResearch/3_hop_bcast.awk
  inflating: PrajaktaResearch/3_hop_nei.awk
  inflating: PrajaktaResearch/4_hop_bcast.awk
  inflating: PrajaktaResearch/4_hop_nei.awk
  inflating: PrajaktaResearch/5_hop_bcast.awk
  inflating: PrajaktaResearch/5_hop_nei.awk
  inflating: PrajaktaResearch/check_congestion.awk
  inflating: PrajaktaResearch/fitness_nodes.awk
  inflating: PrajaktaResearch/main.tcl
  inflating: PrajaktaResearch/node_disjoint_paths.awk
  inflating: PrajaktaResearch/node_disjoint_paths2.awk
  inflating: PrajaktaResearch/result_efficiency.awk
  inflating: PrajaktaResearch/result_energy.awk
  inflating: PrajaktaResearch/route.awk
  inflating: PrajaktaResearch/route_reply.awk
  inflating: PrajaktaResearch/send_data.awk
  inflating: PrajaktaResearch/send_data2.awk
  inflating: PrajaktaResearch/src_bcast.awk
  inflating: PrajaktaResearch/tabu_search.awk
  inflating: PrajaktaResearch/throughput.awk
prajakta@prajakta-virtual-machine:~/Desktop$ ls
Final PrajaktaResearch PrajaktaResearch.zip Temp
prajakta@prajakta-virtual-machine:~/Desktop$

```

Figure 6: Extraction of zip file

## 4.2 Execution of main file in NS2

Run the command”ns main.tcl” to run the simulation ref Fig.7.

```

prajakta@prajakta-virtual-machine:~/Desktop$ ls
Final PrajaktaResearch PrajaktaResearch.zip Temp
prajakta@prajakta-virtual-machine:~/Desktop$ cd PrajaktaResearch/
prajakta@prajakta-virtual-machine:~/Desktop/PrajaktaResearch$ ls
1_hop_bcast.awk 2_hop_nei.awk 4_hop_bcast.awk 5_hop_nei.awk main.tcl
1_hop_nei.awk 3_hop_bcast.awk 4_hop_nei.awk check_congestion.awk node_disjoint_paths2.
2_hop_bcast.awk 3_hop_nei.awk 5_hop_bcast.awk fitness_nodes.awk node_disjoint_paths.a
prajakta@prajakta-virtual-machine:~/Desktop/PrajaktaResearch$ ns main.tcl
num_nodes is set 100
warning: Please use -channel as shown in tcl/ex/wireless-mitf.tcl
INITIALIZE THE LIST xListHead
Start of simulation...
SORTING LISTS ...DONE!
channel.cc:sendUp - Calc highestAntennaZ_ and distCST_
highestAntennaZ_ = 1.5, distCST_ = 250.0

```

Figure 7: Run main.tcl file

## 4.3 Topology in NAM

Once we completed above steps successfully, we will get below network animator with created network topology Fig.8.

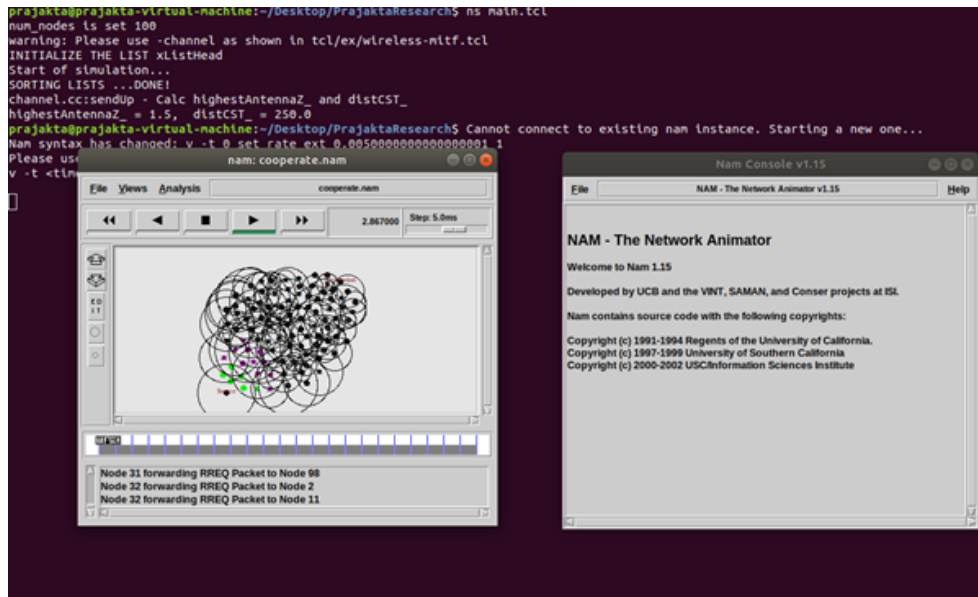


Figure 8: Network animator window and graphical presentation

## References

Canonical (n.d.), ‘Ubuntu official website’.

URL: <https://releases.ubuntu.com/18.04/>

*The Network Simulator: Building NS* (n.d.).

URL: <https://www.isi.edu/nsnam/ns/ns-build.html>