



WIRELESS NETWORKS

Converting TMAC or SMAC to M-SMAC

By:

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Installing Omnetpp 5.3 with Modified Version of Castalia

To cope up with the Windows 10 and the latest version of Omnetpp. A study was done in order to find about the latest compatible version. The following link was used for this purpose:

<https://github.com/boulis/Castalia/issues/12>

The same above-mentioned link was used to download the modified version of Castalia. According to the description given in the link Omnetpp 5.3 version was tested to be compatible with the modified Castalia version. Hence, Omnetpp 5.3 was being downloaded using the following link:

<https://omnetpp.org/download/old>

Firstly, the files from the both of the above-mentioned links were downloaded and extracted. After that, following steps were followed in order to install Omnetpp and integrate it with Castalia:

1. Open Omnet folder and run mingwenv.cmd
2. Enter ./configure
3. Copy the Castalia folder in the Omnet directory
4. Add Castalia\bin and Omnet\bin in the environment variable
5. In the already opened mingwenv.cmd panel change directory to Castalia
6. Enter ./make make
7. Enter ./make
8. Enter omnetpp
9. After omnet setup has opened up, go to File > Open Project From filesystem >Directory
10. Select and import Castalia folder.

After this firstly the radio test simulation was run. In this version of Castalia the GUI is available, but it does not:

- Show the movement of a node if it has mobility.
- Let the commands run on the mingwenv.cmd

When a command was tried to run on mingwenv.cmd it gives the following error:

```
/e/omnetpp-5.3-src-windows/omnetpp-5.3/samples/Castalia/Simulations/radioTest$ ../../bin/Castalia  
bash: ../../bin/Castalia: /usr/bin/python: bad interpreter: No such file or directory
```

Installing Omnetpp 4.6 with Castalia 3.2

Omnetpp 4.6 was being downloaded using the following link:

<https://omnetpp.org/download/old>

After that Castalia 3.2 was downloaded from the following link:

<https://github.com/boulis/Castalia/releases>

Another setup that was required for the correct working of Omnetpp with Castalia in order to run command line in mingwenv.cmd and that is Castalia-3.2_omnet-IDE_Windows_Linux. It was downloaded from the following link:

https://github.com/alexlacerda/Castalia-3.2_omnet-IDE_Windows_Linux

Firstly, the files from the both of the above-mentioned links were downloaded and extracted. After that, following steps were followed in order to install Omnetpp and integrate it with Castalia:

1. Open Omnet folder and run mingwenv.cmd
2. Enter ./configure
3. Copy the Castalia folder in the Omnet directory
4. Add Castalia\bin and Omnet\bin in the environment variable
5. In the already opened mingwenv.cmd panel change directory to Castalia
6. Enter ./make make
7. Enter ./make
8. Rename the extracted Castalia-3.2_omnet-IDE_Windows_Linux folder to castalia_update
9. Copy the castalia_update folder to omnet\bin.
10. Navigate to castalia_update folder in omnet\bin
11. Enter ./updatecastalia.sh
12. Navigate back to omnet directory
13. Enter omnetpp
14. After omnet setup has opened up, go to File > Open Project From filesystem >Directory
15. Select and import Castalia folder.

Now if I tried to run radiotest simulation in Castalia on command line following output was shown:

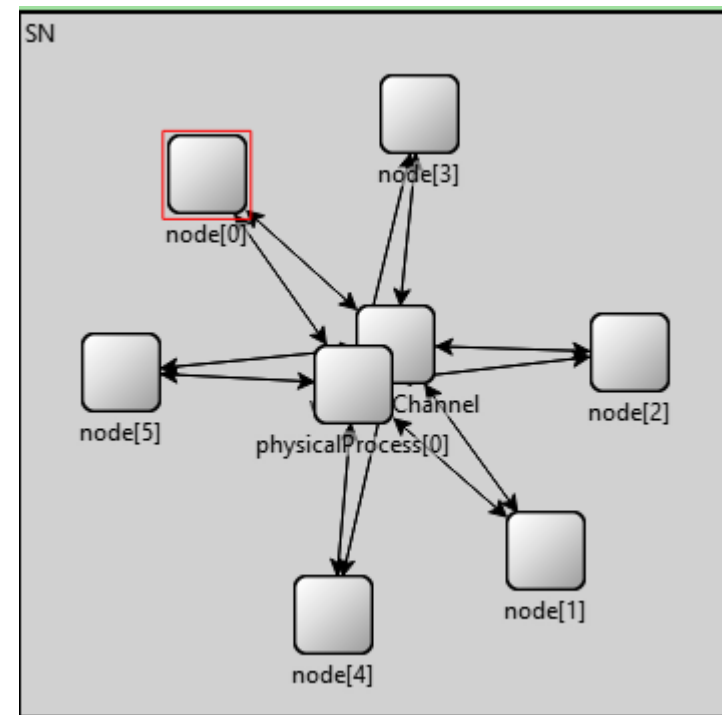
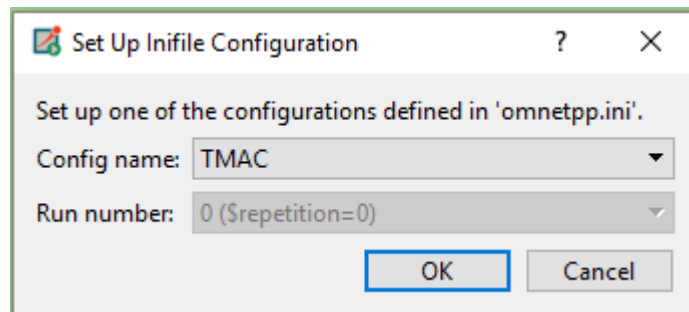
```
/e/omnetpp-4.6-src-windows/omnetpp-4.6/samples/Castalia/Simulations/radioTest$ ../../bin/Castalia
List of available input files and configurations:
* omnetpp.ini
  General
  InterferenceTest1
  InterferenceTest2
  CSInterruptTest
  varyInterferenceModel
```

But this version of Castalia does not has a GUI and the results are shown only on mingwenv.cmd.

For this project it was decided to use Omnetpp 5.3 with the modified version of Castalia as the main aim of this project was to convert TMAC present in Castalia to MSMAC. And as this version of Castalia shows the generated results and GUI of the selected configuration.

Running Simple TMAC Configuration

Results



```

** Event #49520 t=51 on endsimulation (omnetpp::cEndSimulationEvent)
<!-- Simulation time limit reached -- at t=51s, event #49520
** Calling finish() methods of modules
INFO (WirelessChannel) SN.wirelessChannel: SN.wirelessChannel: Castalia| module:SN.wirelessChannel
INFO (WirelessChannel) SN.wirelessChannel: SN.wirelessChannel: Castalia| histogram name:Fade depth distribution
INFO (WirelessChannel) SN.wirelessChannel: SN.wirelessChannel: Castalia| histogram_min:-50 histogram_max:15
INFO (WirelessChannel) SN.wirelessChannel: SN.wirelessChannel: Castalia| histogram_values 2 3 3 14 40 99 208 600 1209 1743 1395 336 16 0
INFO (ResourceManager) SN.node[0].ResourceManager: SN.node[0].ResourceManager: Castalia| module:SN.node[0].ResourceManager
INFO (ResourceManager) SN.node[0].ResourceManager: SN.node[0].ResourceManager: Castalia| simple output name:Consumed Energy
INFO (ResourceManager) SN.node[0].ResourceManager: SN.node[0].ResourceManager: Castalia| 0.0190605
INFO (ResourceManager) SN.node[0].ResourceManager: SN.node[0].ResourceManager: Castalia| simple output name:Estimated network lifetime (days)
INFO (ResourceManager) SN.node[0].ResourceManager: SN.node[0].ResourceManager: Castalia| 517.837
INFO (ResourceManager) SN.node[0].ResourceManager: SN.node[0].ResourceManager: Castalia| simple output name:Remaining Energy
INFO (ResourceManager) SN.node[0].ResourceManager: SN.node[0].ResourceManager: Castalia| 18720
INFO (Radio) SN.node[0].Communication.Radio: SN.node[0].Communication.Radio: Castalia| module:SN.node[0].Communication.Radio
INFO (Radio) SN.node[0].Communication.Radio: SN.node[0].Communication.Radio: Castalia| simple output name:RX pkt breakdown
INFO (Radio) SN.node[0].Communication.Radio: SN.node[0].Communication.Radio: Castalia| 30 Failed, below sensitivity
INFO (Radio) SN.node[0].Communication.Radio: SN.node[0].Communication.Radio: Castalia| 63 Failed, non RX state
INFO (Radio) SN.node[0].Communication.Radio: SN.node[0].Communication.Radio: Castalia| 438 Received with NO interference
INFO (Radio) SN.node[0].Communication.Radio: SN.node[0].Communication.Radio: Castalia| simple output name:TXed pkts
INFO (Radio) SN.node[0].Communication.Radio: SN.node[0].Communication.Radio: Castalia| 410 TX pkts
INFO (TMAC) SN.node[0].Communication.MAC: SN.node[0].Communication.MAC: Castalia| module:SN.node[0].Communication.MAC
INFO (TMAC) SN.node[0].Communication.MAC: SN.node[0].Communication.MAC: Castalia| simple output name:Sent packets breakdown
INFO (TMAC) SN.node[0].Communication.MAC: SN.node[0].Communication.MAC: Castalia| 185 ACK

INFO (TMAC) SN.node[0].Communication.MAC: SN.node[0].Communication.MAC: Castalia| 216 CTS
INFO (TMAC) SN.node[0].Communication.MAC: SN.node[0].Communication.MAC: Castalia| 9 SYNC
INFO (ThroughputTest) SN.node[0].Application: SN.node[0].Application: Castalia| module:SN.node[0].Application
INFO (ThroughputTest) SN.node[0].Application: SN.node[0].Application: Castalia| index:3 simple output name:Packets loss rate
INFO (ThroughputTest) SN.node[0].Application: SN.node[0].Application: Castalia| 0.257028 total
INFO (ThroughputTest) SN.node[0].Application: SN.node[0].Application: Castalia| index:3 simple output name:Packets received per node
INFO (ThroughputTest) SN.node[0].Application: SN.node[0].Application: Castalia| 185
INFO (ThroughputTest) SN.node[0].Application: SN.node[0].Application: Castalia| index:3 simple output name:Packets reception rate
INFO (ThroughputTest) SN.node[0].Application: SN.node[0].Application: Castalia| 0.742972 total
INFO (ThroughputTest) SN.node[0].Application: SN.node[0].Application: Castalia| histogram name:Application level latency, in ms
INFO (ThroughputTest) SN.node[0].Application: SN.node[0].Application: Castalia| histogram_min:0 histogram_max:600
INFO (ThroughputTest) SN.node[0].Application: SN.node[0].Application: Castalia| histogram_values 5 7 2 4 4 4 6 3 0 2 8 6 3 2 5 4 7 1 0 5 7 6 2 4 3 4 7 0 0 1 73
INFO (ResourceManager) SN.node[1].ResourceManager: SN.node[1].ResourceManager: Castalia| module:SN.node[1].ResourceManager
INFO (ResourceManager) SN.node[1].ResourceManager: SN.node[1].ResourceManager: Castalia| simple output name:Consumed Energy
INFO (ResourceManager) SN.node[1].ResourceManager: SN.node[1].ResourceManager: Castalia| 0.0212963
INFO (ResourceManager) SN.node[1].ResourceManager: SN.node[1].ResourceManager: Castalia| simple output name:Remaining Energy
INFO (ResourceManager) SN.node[1].ResourceManager: SN.node[1].ResourceManager: Castalia| 18720
INFO (Radio) SN.node[1].Communication.Radio: SN.node[1].Communication.Radio: Castalia| module:SN.node[1].Communication.Radio
INFO (Radio) SN.node[1].Communication.Radio: SN.node[1].Communication.Radio: Castalia| simple output name:RX pkt breakdown
INFO (Radio) SN.node[1].Communication.Radio: SN.node[1].Communication.Radio: Castalia| 29 Failed, below sensitivity
INFO (Radio) SN.node[1].Communication.Radio: SN.node[1].Communication.Radio: Castalia| 906 Received with NO interference
INFO (Radio) SN.node[1].Communication.Radio: SN.node[1].Communication.Radio: Castalia| simple output name:TXed pkts
INFO (Radio) SN.node[1].Communication.Radio: SN.node[1].Communication.Radio: Castalia| 8 TX pkts
INFO (TMAC) SN.node[1].Communication.MAC: SN.node[1].Communication.MAC: Castalia| module:SN.node[1].Communication.MAC

```

```

INFO (TMAC) SN.node[1].Communication.MAC: SN.node[1].Communication.MAC: Castalia| simple output name:Sent packets breakdown
INFO (TMAC) SN.node[1].Communication.MAC: SN.node[1].Communication.MAC: Castalia| 8 SYNC
INFO (ResourceManager) SN.node[2].ResourceManager: SN.node[2].ResourceManager: Castalia| module:SN.node[2].ResourceManager
INFO (ResourceManager) SN.node[2].ResourceManager: SN.node[2].ResourceManager: Castalia| simple output name:Consumed Energy
INFO (ResourceManager) SN.node[2].ResourceManager: SN.node[2].ResourceManager: Castalia| 0.0213348
INFO (ResourceManager) SN.node[2].ResourceManager: SN.node[2].ResourceManager: Castalia| simple output name:Remaining Energy
INFO (ResourceManager) SN.node[2].ResourceManager: SN.node[2].ResourceManager: Castalia| 18720
INFO (Radio) SN.node[2].Communication.Radio: SN.node[2].Communication.Radio: Castalia| module:SN.node[2].Communication.Radio
INFO (Radio) SN.node[2].Communication.Radio: SN.node[2].Communication.Radio: Castalia| simple output name:RX pkt breakdown
INFO (Radio) SN.node[2].Communication.Radio: SN.node[2].Communication.Radio: Castalia| 22 Failed, below sensitivity
INFO (Radio) SN.node[2].Communication.Radio: SN.node[2].Communication.Radio: Castalia| 4 Failed, non RX state
INFO (Radio) SN.node[2].Communication.Radio: SN.node[2].Communication.Radio: Castalia| 907 Received with NO interference
INFO (Radio) SN.node[2].Communication.Radio: SN.node[2].Communication.Radio: Castalia| simple output name:TXed pkts
INFO (Radio) SN.node[2].Communication.Radio: SN.node[2].Communication.Radio: Castalia| 8 TX pkts
INFO (TMAC) SN.node[2].Communication.MAC: SN.node[2].Communication.MAC: Castalia| module:SN.node[2].Communication.MAC
INFO (TMAC) SN.node[2].Communication.MAC: SN.node[2].Communication.MAC: Castalia| simple output name:Sent packets breakdown
INFO (TMAC) SN.node[2].Communication.MAC: SN.node[2].Communication.MAC: Castalia| 8 SYNC
INFO (ResourceManager) SN.node[3].ResourceManager: SN.node[3].ResourceManager: Castalia| module:SN.node[3].ResourceManager
INFO (ResourceManager) SN.node[3].ResourceManager: SN.node[3].ResourceManager: Castalia| simple output name:Consumed Energy
INFO (ResourceManager) SN.node[3].ResourceManager: SN.node[3].ResourceManager: Castalia| 0.0210892
INFO (ResourceManager) SN.node[3].ResourceManager: SN.node[3].ResourceManager: Castalia| simple output name:Remaining Energy
INFO (ResourceManager) SN.node[3].ResourceManager: SN.node[3].ResourceManager: Castalia| 18720
INFO (Radio) SN.node[3].Communication.Radio: SN.node[3].Communication.Radio: Castalia| module:SN.node[3].Communication.Radio
INFO (Radio) SN.node[3].Communication.Radio: SN.node[3].Communication.Radio: Castalia| simple output name:RX pkt breakdown
INFO (Radio) SN.node[3].Communication.Radio: SN.node[3].Communication.Radio: Castalia| 29 Failed, below sensitivity
INFO (Radio) SN.node[3].Communication.Radio: SN.node[3].Communication.Radio: Castalia| 409 Received with NO interference
INFO (Radio) SN.node[3].Communication.Radio: SN.node[3].Communication.Radio: Castalia| simple output name:TXed pkts
INFO (Radio) SN.node[3].Communication.Radio: SN.node[3].Communication.Radio: Castalia| 502 TX pkts
INFO (TMAC) SN.node[3].Communication.MAC: SN.node[3].Communication.MAC: Castalia| module:SN.node[3].Communication.MAC
INFO (TMAC) SN.node[3].Communication.MAC: SN.node[3].Communication.MAC: Castalia| simple output name:Sent packets breakdown
INFO (TMAC) SN.node[3].Communication.MAC: SN.node[3].Communication.MAC: Castalia| 185 DATA
INFO (TMAC) SN.node[3].Communication.MAC: SN.node[3].Communication.MAC: Castalia| 309 RTS
INFO (TMAC) SN.node[3].Communication.MAC: SN.node[3].Communication.MAC: Castalia| 8 SYNC
INFO (ThroughputTest) SN.node[3].Application: SN.node[3].Application: Castalia| module:SN.node[3].Application
INFO (ThroughputTest) SN.node[3].Application: SN.node[3].Application: Castalia| simple output name:Energy nJ/bit
INFO (ThroughputTest) SN.node[3].Application: SN.node[3].Application: Castalia| 135.709
INFO (ResourceManager) SN.node[4].ResourceManager: SN.node[4].ResourceManager: Castalia| module:SN.node[4].ResourceManager
INFO (ResourceManager) SN.node[4].ResourceManager: SN.node[4].ResourceManager: Castalia| simple output name:Consumed Energy
INFO (ResourceManager) SN.node[4].ResourceManager: SN.node[4].ResourceManager: Castalia| 0.0213537
INFO (ResourceManager) SN.node[4].ResourceManager: SN.node[4].ResourceManager: Castalia| simple output name:Remaining Energy
INFO (ResourceManager) SN.node[4].ResourceManager: SN.node[4].ResourceManager: Castalia| 18720
INFO (Radio) SN.node[4].Communication.Radio: SN.node[4].Communication.Radio: Castalia| module:SN.node[4].Communication.Radio
INFO (Radio) SN.node[4].Communication.Radio: SN.node[4].Communication.Radio: Castalia| simple output name:RX pkt breakdown
INFO (Radio) SN.node[4].Communication.Radio: SN.node[4].Communication.Radio: Castalia| 51 Failed, below sensitivity
INFO (Radio) SN.node[4].Communication.Radio: SN.node[4].Communication.Radio: Castalia| 886 Received with NO interference
INFO (Radio) SN.node[4].Communication.Radio: SN.node[4].Communication.Radio: Castalia| simple output name:TXed pkts
INFO (Radio) SN.node[4].Communication.Radio: SN.node[4].Communication.Radio: Castalia| 8 TX pkts
INFO (TMAC) SN.node[4].Communication.MAC: SN.node[4].Communication.MAC: Castalia| module:SN.node[4].Communication.MAC

```

```

INFO (TMAC) SN.node[4].Communication.MAC: SN.node[4].Communication.MAC: Castalia| simple output name:Sent packets breakdown
INFO (TMAC) SN.node[4].Communication.MAC: SN.node[4].Communication.MAC: Castalia| 8 SYNC
INFO (ResourceManager) SN.node[5].ResourceManager: SN.node[5].ResourceManager: Castalia| module:SN.node[5].ResourceManager
INFO (ResourceManager) SN.node[5].ResourceManager: SN.node[5].ResourceManager: Castalia| simple output name:Consumed Energy
INFO (ResourceManager) SN.node[5].ResourceManager: SN.node[5].ResourceManager: Castalia| 0.0210939
INFO (ResourceManager) SN.node[5].ResourceManager: SN.node[5].ResourceManager: Castalia| simple output name:Remaining Energy
INFO (ResourceManager) SN.node[5].ResourceManager: SN.node[5].ResourceManager: Castalia| 18720
INFO (Radio) SN.node[5].Communication.Radio: SN.node[5].Communication.Radio: Castalia| module:SN.node[5].Communication.Radio
INFO (Radio) SN.node[5].Communication.Radio: SN.node[5].Communication.Radio: Castalia| simple output name:RX pkt breakdown
INFO (Radio) SN.node[5].Communication.Radio: SN.node[5].Communication.Radio: Castalia| 118 Failed, below sensitivity
INFO (Radio) SN.node[5].Communication.Radio: SN.node[5].Communication.Radio: Castalia| 17 Failed, non RX state
INFO (Radio) SN.node[5].Communication.Radio: SN.node[5].Communication.Radio: Castalia| 783 Received with NO interference
INFO (Radio) SN.node[5].Communication.Radio: SN.node[5].Communication.Radio: Castalia| simple output name:TXed pkts
INFO (Radio) SN.node[5].Communication.Radio: SN.node[5].Communication.Radio: Castalia| 9 TX pkts
INFO (TMAC) SN.node[5].Communication.MAC: SN.node[5].Communication.MAC: Castalia| module:SN.node[5].Communication.MAC
INFO (TMAC) SN.node[5].Communication.MAC: SN.node[5].Communication.MAC: Castalia| simple output name:Sent packets breakdown
INFO (TMAC) SN.node[5].Communication.MAC: SN.node[5].Communication.MAC: Castalia| 9 SYNC

```

Try 1: Trying to Create a Separate File for New Protocol

An extended help manual was found over the internet about Castalia in which a method outline was given to add your own network protocol in the Castalia simulations. This can be found in the section 7 in the link below:

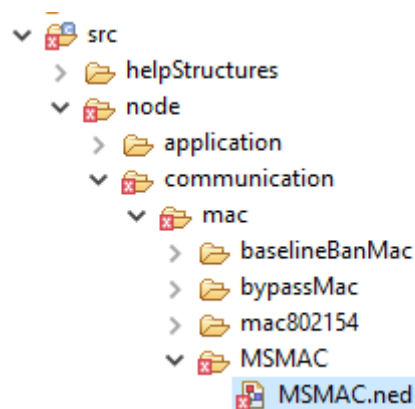
[Http://cpham.perso.univ-pau.fr/WSN-MODEL/Castalia.html](http://cpham.perso.univ-pau.fr/WSN-MODEL/Castalia.html)

According to the given description the following steps were followed:

1. Navigate to src/node/communication/mac
2. Create a new folder called MSMAC
3. Enter cd MSMAC
4. Enter cat TMAC.ned | sed -e 's/TMAC/MSMAC/g' > MSMAC.ned

After this step error occurs and copying of data fails.

```
/e/omnetpp-5.3-src-windows/omnetpp-5.3$ cd samples/Castalia
/e/omnetpp-5.3-src-windows/omnetpp-5.3/samples/Castalia$ cd src/node/communication/mac/MSMAC
/e/omnetpp-5.3-src-windows/omnetpp-5.3/samples/Castalia/src/node/communication/mac/MSMAC$ cat TMAC.ned | sed -e 's/TMAC/MSMAC/g' > MSMAC.ned
cat: TMAC.ned: No such file or directory
```



Try 2: Trying to convert TMAC into SMAC

The configuration method to convert TMAC into SMAC is already given in the omnetpp.ini file of bridgetest. As here we are trying to convert TMAC to SMAC in bantest so just copy that configuration in the omnetpp.ini file of bantest

```
[Config SMAC]
SN.node[*].Communication.MACProtocolName = "TMAC"
SN.node[*].Communication.MAC.listenTimeout = 61
SN.node[*].Communication.MAC.disableTAextension = true
SN.node[*].Communication.MAC.conservativeTA = false
SN.node[*].Communication.MAC.collisionResolution = 0
```

Try 3: Trying to Add Cluster Head

Now for MSMAC we need a cluster head in a cluster so that it can maintain the cluster schedule. According to the Castalia Manual section 3.6.1:

“All scenarios use the throughputtest application, where all nodes send packets to a sink/hub node at a constant (configurable) rate. The hub is node 0.”

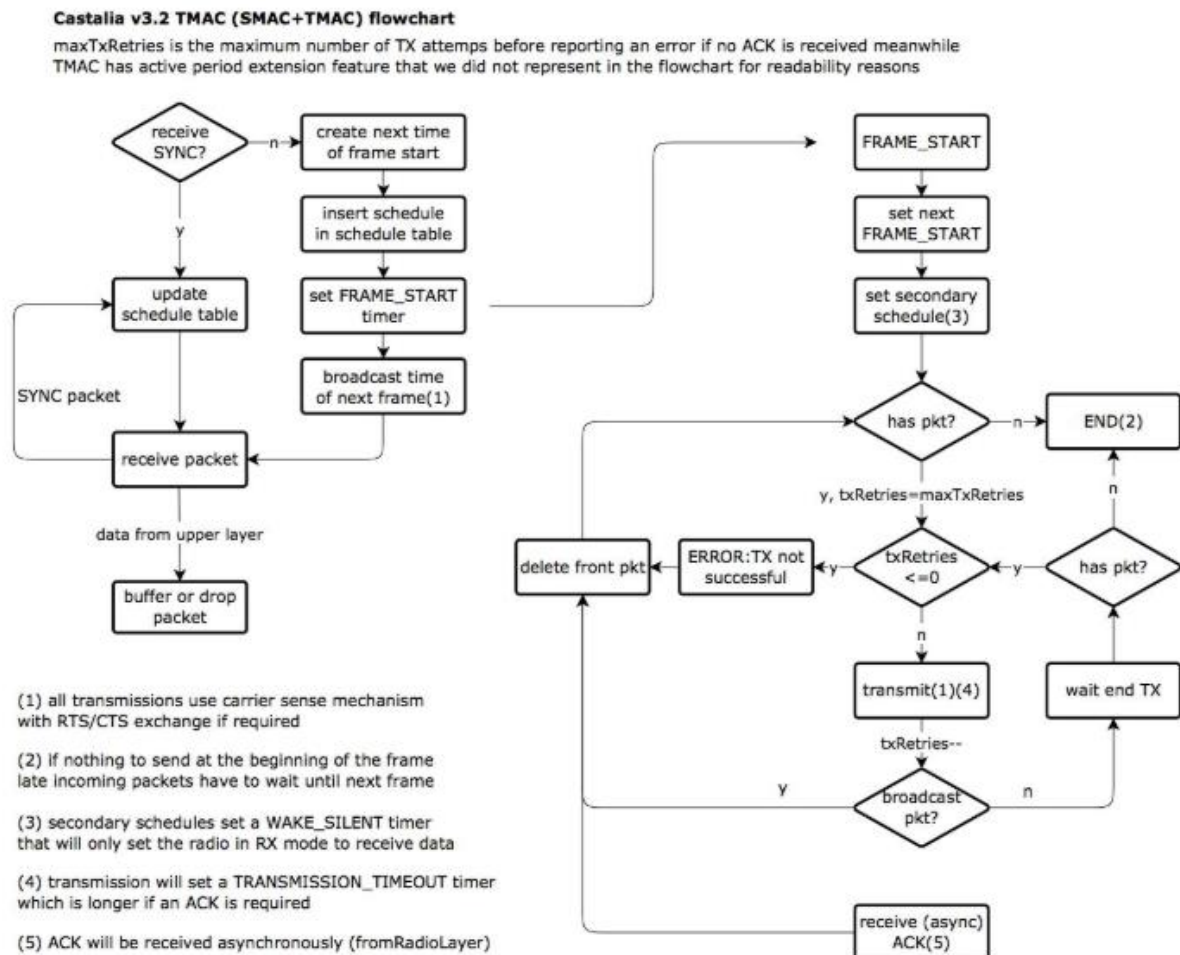
As a hub in a network also acts as a cluster head. It means that here node 0 is already acting as a cluster head. Hence, we don't need to make another cluster head for making one cluster. And as according to the description given in the extended manual of Castalia in section 8 of the link below:

[Http://cpham.perso.univ-pau.fr/WSN-MODEL/Castalia.html](http://cpham.perso.univ-pau.fr/WSN-MODEL/Castalia.html)

In Castalia, in TMAC the schedule of the node is already maintained by the nodes, so here we don't need to design a separate scheduling mechanism.

Understanding TMAC and SMAC Working in Castalia

The TMAC control flow diagram present in the above link can also be checked in the following image:

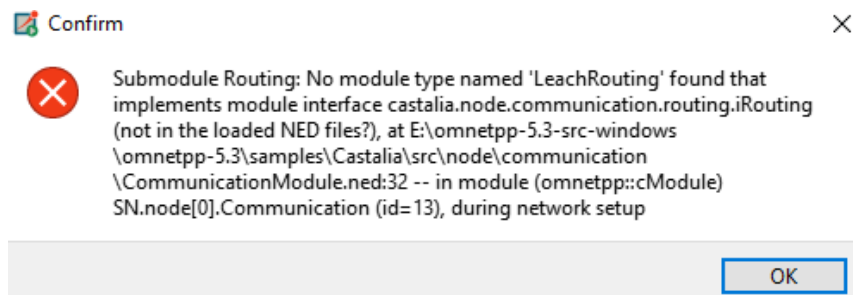


Try 1: Trying to Add LEECH Protocol

Someone tried to test the performance of TMAC with SMAC using LEECH. He had tried to make a LEECH configuration in bridgetest. Following was the code used by the tester in the bridgetest original omnetpp.ini file:

```
[Config LEECH]
SN.node[*].Communication.routingprotocolname = "leechrouting"
SN.node[*].Communication.Routing.netbuffersize = 4000
SN.node[0].Communication.Routing.issink = true
SN.node[*].Communication.Routing.slotlength = 0.2
SN.node[*].Communication.Routing.roundlength = 20s
SN.node[*].Communication.Routing.percentage = 0.05
#SN.node[*].Communication.Routing.advpacketsize = 11
SN.node[*].Communication.Routing.powersconfig = xmldoc("powersconfig.xml")
SN.node[*].Communication.Routing.collecttraceinfo = true
SN.node[*].Communication.Routing.datarate = 250000 #must be the same than Radio module
SN.node[*].Communication.Routing.phyframeoverhead = 6 #must be the same than Radio module
```

Result



Try 2: Trying to Add LEECH Protocol – Finding Community Working on LEECH Integration with Castalia

While searching over the internet – a group of some other people was found who were trying to integrate LEECH protocol in Castalia. That group discussion can be found over here:

<https://groups.google.com/forum/#!Msg/castalia-simulator/xkanhogjc24/i23aegnrzqi>

A group member in that group had mentioned a link to find the protocol codes that had been developed and tested by the collaboration of a university:

<http://www.gercom.ufpa.br/downloads/wsn/>

Result

While trying to access this link it was found that the following domain is not working. Following message is shown when we try to access that link.

A large, bold, dark gray '404' is centered on the page, indicating a page not found error.

Page not found

The page you are looking for does not exist or another error has occurred. Back , or GERCOM to choose a new direction.

Try 3: Trying to Find and Access GERCOM Website

By back tracking the above link the correct link was found to be as:

[Http://www.gercom.ufpa.br/index.php?Option=com_osdownloads&view=downloads&Itemid=515&lang=en](http://www.gercom.ufpa.br/index.php?Option=com_osdownloads&view=downloads&Itemid=515&lang=en)

Over this link four downloadable sensor network protocols have been given which can be integrated with Castalia. These four protocols are:

1. AODV
2. LABILE
3. LEECH
4. REL

Try 4: Understanding Working of LEECH Protocol

A good explanation of working of LEECH Protocol is given in research paper: *Implementation and Comparison of LEECH and NON-LEECH Protocols in Wireless Sensor Networks* by Nishanth *et al.* This research paper can be found over the following link:

https://www.academia.edu/4607939/Implementation_and_Comparison_of_LEECH_and_NON_LEECH_Protocols_in_Wireless_Sensor_Networks

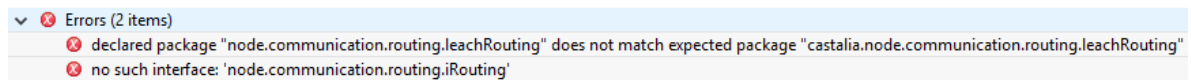
Try 5: Trying to Integrate LEECH Protocol with Castalia

Attempt 1

1. Download the file named leachclusteringprotocol from the GERCOM website.
2. Copy the file adjustmentfile.patch to the Castalia folder. E.g. Home/user/Castalia
3. Open the prompt, go to the Castalia folder and type the following command: `patch -p0 -i adjustmentfile.patch`
4. Copy the folder leachrouting to the following path Castalia/src/node/communication/routing/
5. Copy the folder leach to the following path Castalia/Simulations/
6. Type `./makemake`
7. Type `make`

Result

Some package name problem was encountered

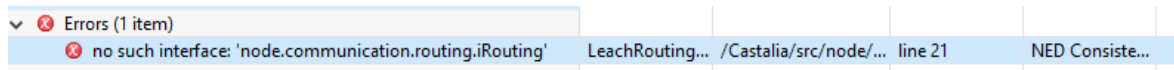


Attempt 2

1. Rename leachclusteringprotocol folder to leachrouting
2. Path change to castalia.node.communication.routing.leachrouting; in leachrouting.ned

Result

Still some path error was encountered.



Attempt 3

1. Navigate to leechrouting.ned

2. Change

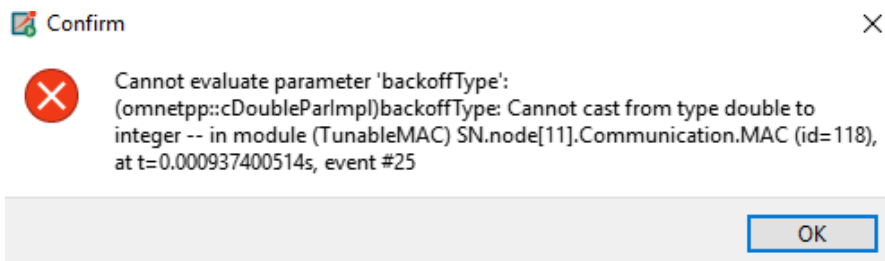
node.communication.routing.irouting

To

castalia.node.communication.routing.irouting

Result

undisposed object: (omnetpp::cMessage) SN.node[11].Communication.MAC.Network --> Mac startup message -- check module destructor



Attempt 4

1. Navigate to src/node/communication/mac/tunablemac
2. Change

```
backofftype = par("backofftype");
```

To

```
backofftype = (int)par("backofftype");
```

Attempt 5

1. Navigate to tunablemac.h
2. Change

```
int backofftype;
```

To

```
double backofftype;
```

Result

❌ Errors (4 items)		
❌ make: *** [Makefile:87: src_dir] Error 2	Castalia	
❌ make[1]: *** [Makefile:215: ../out/clang-release/src/node/communication/mac/tunableMac/TunableMAC.o] Error 1	Castalia	
❌ statement requires expression of integer type ('double' invalid)	TunableMAC.....	/Castalia/src/nod
❌ statement requires expression of integer type ('double' invalid)	TunableMAC.....	/Castalia/src/nod
> ⚠️ Warnings (15 items)		
> ⓘ Infos (17 items)		

Attempt 6

1. Navigate to leach.ini
2. Change

```
include ../Parameters/MAC/CSMA.ini
```

To

```
include ../Parameters/MAC/SMAC.ini
```

Result

No error but seems like clusterhead not being announced – LEECH mechanism not working properly

Attempt 7

1. Navigate to tunablemac.ned
2. Change

```
double backofftype = default (1);
```

To

```
int backofftype = default (1);
```

Result

```
<!-- Cannot evaluate parameter 'backoffbasevalue': (omnetpp::cintparimpl)backoffbasevalue:
Cannot cast from type integer to double -- in module (tunablemac)
SN.node[11].Communication.MAC (id=118), at t=0.000937400514s, event #25
```

Attempt 8

1. Navigate to tunablemac.ned
2. Change

```
int backoffbasevalue = default (16);
```

To

```
double backoffbasevalue = default (16);
```

Result

Cluster Head are being dynamically allocated – LEECH protocol working successfully for cluster head selection

Try 6: Trying to make LEECH mechanism work with SMAC

Attempt 1

1. Navigate to leach.ini
2. Change

```
include ../Parameters/MAC/CSMA.ini
```

To

```
include ../Parameters/MAC/SMAC.ini
```

Result

Either simulation gets stuck on a self-message loop over a single node or sim-time goes out of bound.

Attempt 2

Reduce total number of nodes

1. Navigate to leach.ini
2. Change

SN.numnodes = 100

SN.deployment = "[1..99]->uniform"

To

SN.numnodes = 50

SN.deployment = "[1..49]->uniform"

Result

Cluster Head are being dynamically allocated – LEECH protocol working successfully for cluster head selection

Try 7: Checking Cluster Formation in LEECH Protocol

Attempt 1

1. Navigate to leachrouting.cc.
2. Navigate to function startup()
3. Change


```
clustermembers.clear();
```

 To


```
EV << "Cluster Clear on Start";
clustermembers.clear();
```
4. Navigate to function timerfiredcallback()
5. Navigate to case START_ROUND
6. Change


```
clustermembers.clear();
```

 To


```
EV << "Cluster Clear on Start";
clustermembers.clear();
```
7. Navigate to case SEND_ADV
8. Change


```
break;
```

 To


```
EV << "Cluster Head announced";
break;
```
9. Navigate to case JOIN_CH
10. Change


```
string dst = buffer.str();
```

 To


```
string dst = buffer.str();
EV << "Cluster Member - " << dst;
```
11. Navigate to case MAKE_TDMA
12. Change


```
clusterlength = clustermembers.size();
```

 To


```
clusterlength = clustermembers.size();  
int* a = &clustermembers[0];  
char* cm = reinterpret_cast<char*>(clustermembers);  
EV << "Cluster Members" << cm;
```

Result

From the output it seems that simulation end even before cluster formation completes – may be due to large number of nodes.

Attempt 2

Increase simulation time

1. Navigate to leach.ini
2. Change
`sim-time-limit = 20s`
To
`sim-time-limit = 60s`

Result

Simulation working good but cluster members are not showing.

Try 8: Checking Cluster Members During LEECH Protocol

Attempt 1

1. Navigate to leachrouting.cc
2. Navigate to function timerfiredcallback()
3. Navigate to case MAKE_TDMA
4. Change

```
clusterlength = clustermembers.size();
int* a = &clustermembers[0];
char* cm = reinterpret_cast<char*>(clustermembers);
EV << "Cluster Members" << cm;
```

To

```
clusterlength = clustermembers.size();
int* a = &clustermembers[0];
EV << "Cluster Members";
for (int i=0; i< clustermembers.size(); i++){
    EV << a[i]<<" ";
}
```

Result

Cluster members are displayed, clusters are formed, and simulation is running good but cluster head name is not showing.

Try 9: Checking Cluster Heads in Each Cluster during LEECH Protocol

Attempt 1

1. Navigate to leachrouting.cc
2. Navigate to function timerfiredcallback()
3. Navigate to case MAKE_TDMA
4. Change

```
clusterlength = clustermembers.size();
int* a = &clustermembers[0];
EV << "Cluster Members";
for (int i=0; i< clustermembers.size(); i++){
    EV << a[i]<<" ";
}
```

To

```
clusterlength = clustermembers.size();
int* a = &clustermembers[0];
EV << "Cluster Members";
for (int i=0; i< clustermembers.size(); i++){
    EV << a[i]<<" ";
}
EV<< "Source - " << crtlpkt->getsource();
```

Result

Cluster head declaration message shown correctly with the name of the cluster members and their cluster head.

Try 10: Checking if Clusters are Overlapping or Not to Check if Border Node(s) Exist

Attempt 1

Analyzing the simulation log even if multiple cluster heads are selected at the same time and multiple clusters are formed the clusters are not overlapping.

Result

At a time in simulation five clusters were formed as:

Cluster Members 17 44 35 8 16 46 48 14 38 19 Source - 30

Cluster Members 31 5 25 40 Source - 29

Cluster Members 41 21 13 49 39 23 36 10 32 Source - 45

Cluster Members 7 20 43 37 26 12 11 47 24 34 Source - 33

Cluster Members 1 15 28 27 9 22 4 3 Source - 42

Here the source is the cluster head. All of the cluster members of each cluster show that the clusters are not overlapping as no node in any cluster is a member of any other cluster. It means that no border node(s) exist in this scenario.

Attempt 2

Changing the node distribution

Change node distribution to center in leach.ini.

Result

Run 1 – simulation time out of bound

Run 2 – simulation stuck on self-message loop on a node

Run 3 – even if two cluster heads are there, no two clusters are overlapping

Attempt 3

Change node distribution to 2x2 in leach.ini.

Result

Run 1 – simulation stuck on self-message loop on a node

Run 2 – simulation stuck on self-message loop on a node

Run 3 – Cannot schedule message (timerservicemessage)Timer message to the past

Run 4 – even if two cluster heads are there, no two clusters are overlapping

Attempt 4

Change node distribution to 2x2x2 in leach.ini.

Result

Run 1 – simulation stuck on self-message loop on a node

Run 2 – simulation stuck on self-message loop on a node

Run 3 – simulation stuck on self-message loop on a node

Run 4 – even if two cluster heads are there, no two clusters are overlapping

Try 11: Double the Simulation Time as The Overlapping Clusters may be Formed Later in The Simulation

1. Navigate to leach.ini
2. Change
SN.deployment = "[1..49]->2x2x2"
To
SN.deployment = "[1..49]->uniform"
3. Change
sim-time-limit = 60s
To
sim-time-limit = 120s

Result

Still no overlapping clusters formed

Try 12: Trying to introduce a mobile node in the simulation

Attempt 1

1. Navigate to leach.ini
2. Change
`sim-time-limit = 120s`
To
`sim-time-limit = 60s`
3. Change
`SN.numnodes = 50`
`SN.deployment = "[1..49]->uniform"`
To
`SN.numnodes = 51`
`SN.deployment = "[1..49]->uniform"`
4. Add
`SN.node[50].mobilitymanagername = "linemobilitymanager"`
`SN.node[50].mobilitymanager.updateinterval = 10`
`SN.node[50].mobilitymanager.speed = 5`
5. Change
`SN.wirelesschannel.onlystaticnodes = true`
To
`SN.wirelesschannel.onlystaticnodes = false`

Result

Run 1 – simulation stuck on self-message loop on a node

Run 2 – Cannot convert 3.29432e+007 to simtime_t: Out of range

Run 3 – simulation stuck on self-message loop on a node

Run 4 – simulation stuck on self-message loop on a node

Attempt 2

1. Set things back as were before Attempt 1 except the simulation time

2. Navigate to leach.ini

3. Change

SN.numnodes = 50

SN.deployment = "[1..49]->uniform"

To

SN.numnodes = 51

SN.deployment = "[1..50]->uniform"

4. Add

SN.node[..49].mobilitymanagername = "nomobilitymanager"

SN.node[50].mobilitymanagername = "linemobilitymanager"

SN.node[50].mobilitymanager.updateinterval = 10

SN.node[50].mobilitymanager.xcoorddestination = 200

SN.node[50].mobilitymanager.ycoorddestination = 200

SN.node[50].mobilitymanager.speed = 15

5. Change

SN.wirelesschannel.onlystaticnodes = true

To

SN.wirelesschannel.onlystaticnodes = false

Result

The mobile node is becoming a part of the cluster but stops sending message when it goes out of bound also due to interrupt it can't send messages to the cluster head

Try 13: Trying to Integrate AODV protocol with Castalia

Attempt 1

1. Downlaod aodv from the link :
http://www.gercom.ufpa.br/index.php?Option=com_osdownloads&view=downloads&Itemid=515&lang=en
2. Copy the folder AODV to the Castalia folder. E.g. home/user/Castalia-3.2
3. Open the prompt, go to the AODV folder
4. Type sh install.sh
5. Answer with "n" to any question that appear on the console

Result

Some error regarding path and statements appears.

Attempt 2

1. Navigate to src/node/communication/routing/aodvRouting/aodvrouting.ned
2. Change
node.communication.routing.aodvRouting;
To
castalia.node.communication.routing.aodvRouting;
3. Navigate to Simulations/AODVtest/omnetpp.ini
4. Comment out the lines before [General]
5. Remove ; from SN.Node[0].Application.issink = true

Result

```
node/communication/routing/aodvRouting/AodvRouting.cc
node/communication/routing/aodvRouting/AodvRouting.cc:16:10: fatal error: 'csimulation.h' file not found
#include <csimulation.h>
          ^
1 error generated.
make[1]: *** [Makefile:215: ../out/clang-release/src/node/communication/routing/aodvRouting/AodvRouting.o] Error 1
make[1]: Leaving directory '/e/omnetpp-5.3-src-windows/omnetpp-5.3/samples/Castalia/src'
make: *** [Makefile:87: src_dir] Error 2
```

Attempt 3

1. Navigate to `src/node/communication/routing/aodvRouting/aodvrouting.cc`
2. Comment out the line:

```
#include <csimulation.h>
```

Result

▼ ✖ Errors (2 items)					
✖ Missing section heading	Castalia.ini	/Castalia/Simulatio...	line 20	Inifile Parse P...	
✖ No such NED type: castalia.SN (when included from /Castalia/	Castalia.ini	/Castalia/Simulatio...	line 27	Inifile Validati...	
> ⚠ Warnings (25 items)					

Attempt 4

1. Navigate to in Simulations/Parameters/Castalia.ini
2. Add [General] in the start

Result

<!-- Cannot evaluate parameter 'activeroutetimeout':

(omnetpp::cintparimpl)activeroutetimeout: Cannot cast from type integer to double -- in
module (aodvrouting) SN.node[11].Communication.Routing (id=149), at
t=0.000937400514s, event #52

Attempt 5

1. Navigate to src/node/communication/routing/aodvRouting/aodvrouting.cc
2. Change

```
activeroutetimeout = (double)par("activeroutetimeout") / 1000.0;
```

To

```
activeroutetimeout = (double)par("activeroutetimeout").intValue() / 1000.0;
```

Result

<!-- Cannot evaluate parameter 'hellointerval': (omnetpp::cintparimpl)hellointerval: Cannot cast from type integer to double -- in module (aodvrouting)

SN.node[11].Communication.Routing (id=149), at t=0.000937400514s, event #52

Attempt 6

1. Navigate to src/node/communication/routing/aodvRouting/aodvrouting.cc
2. Change

```
hellointerval = (double)par("hellointerval") / 1000.0;
```

To

```
hellointerval = (double)par("hellointerval").intValue() / 1000.0;
```

Result

<!-- Cannot evaluate parameter 'nodetraversalttime':

(omnetpp::cintparimpl)nodetraversalttime: Cannot cast from type integer to double -- in
module (aodvrouting) SN.node[11].Communication.Routing (id=149), at
t=0.000937400514s, event #52

Attempt 7

1. Navigate to src/node/communication/routing/aodvRouting/aodvrouting.cc
2. Convert

```
nodetraversaltime = (double)par("nodetraversaltime") / 1000.0;
```

To

```
nodetraversaltime = (double)par("nodetraversaltime").intValue() / 1000.0;
```

Result

Nodes working correctly with AODV routing protocol