

## Mobile Telecommunications Networks Mini Project 2

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- What I do

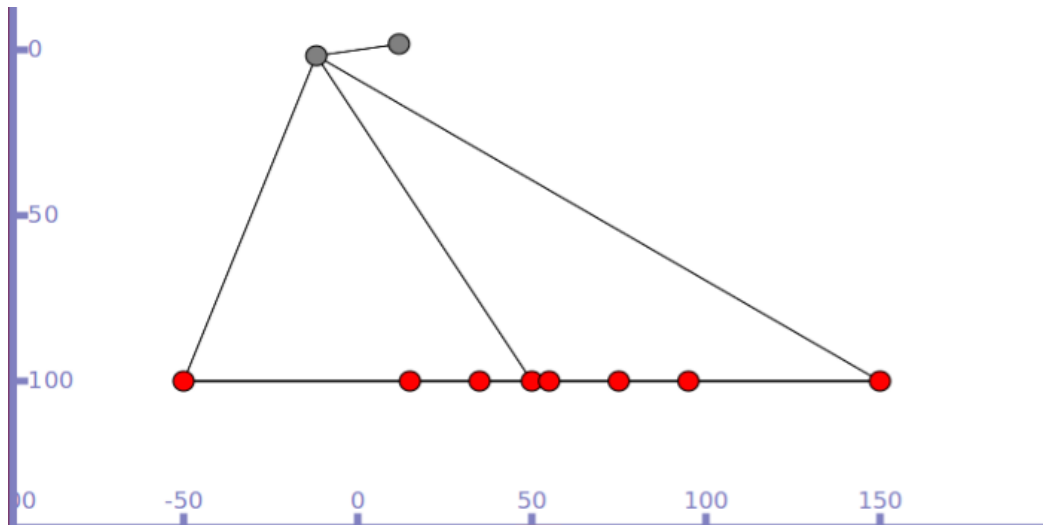
- 1) Network topology:

Create 5 UEs, and eNodeB in LTE network.

每個 eNodeB 距離 100 m，共用同一個PDN-GW，eNodeB 之間藉由X2 interface進行溝通，eNodeB 由左至右從編號 1 開始依序做編號直到編號 3;

```
lteHelper->AddX2Interface (enbNodes);
```

每個 UE 距離 25 m，並且會隨機以 30 (m/s) 向任意方向走動，UE由左至右從編號 1 開始依序做編號直到編號 5。



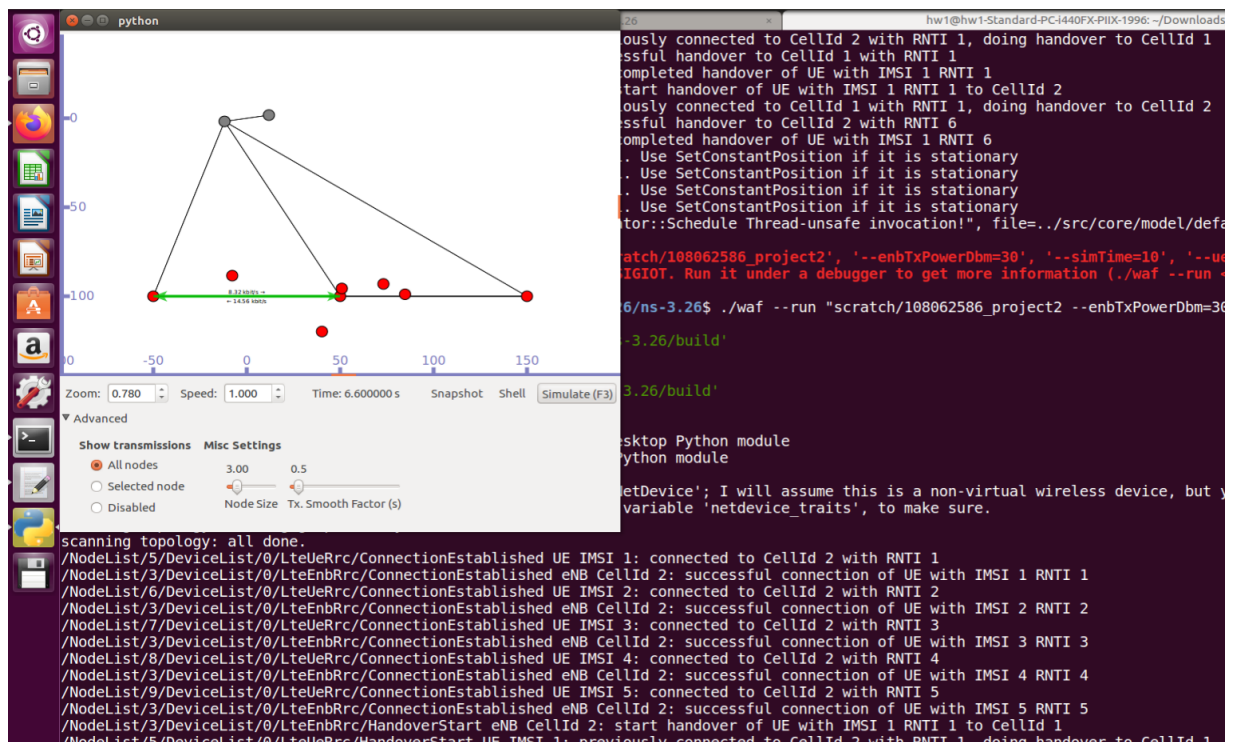
- 2) Schedule each UE to attach to eNodeB in every second

使用 Simulator::Schedule() function，透過另外自訂義的function (ueAttachLteNet，主要負責將UE配對至指定的eNB，加入網路之中)

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//                                     Do schedule here                               //
//      input arg** (ltehelper, ue for attach network, enb)                        //
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
for (uint16_t i = 0; i < numberOfUes; i++)
{
    Simulator::Schedule(Seconds(1), &ueAttachLteNet, lteHelper, ueLteDevs.Get(i), enbLteDevs.Get(1));
}

void
ueAttachLteNet (Ptr<LteHelper> lteHelper, Ptr<NetDevice> ueLteDevs, Ptr<NetDevice> enbLteDevs)
{
    lteHelper->Attach (ueLteDevs, enbLteDevs);
}
```

### 3) visualizer



### 4) Command line arguments

ue, enb, simTime, speed, enbTxPowerDbm, tracing

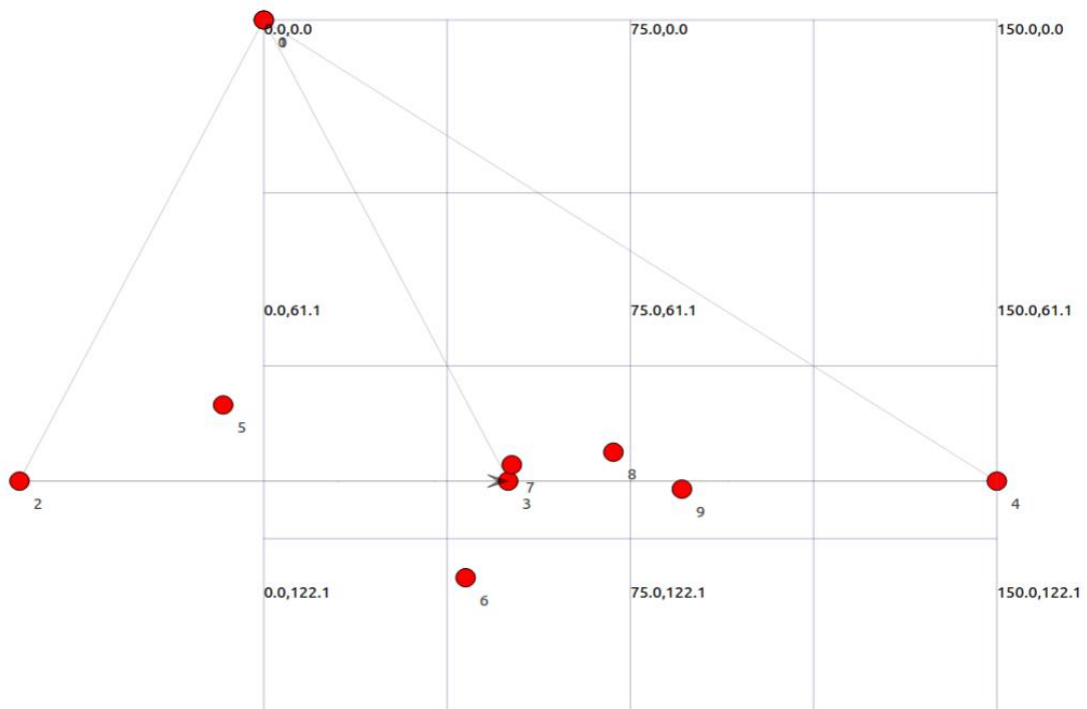
- My observation (.pcap file, animation and etc)

#### 1) log file:

```
hw1@hw1-Standard-PC-i440FX-PIIX-1996:~/Downloads/ns-allinone-3.26/ns-3.26$ ./waf --run "scratch/108062586_project2 --enbTxPowerDbm=30"
Waf: Entering directory '/home/hw1/Downloads/ns-allinone-3.26/ns-3.26/build'
[ 927/2639] Compiling scratch/108062586_project2.cc
[2592/2639] Linking build/scratch/108062586_project2
Waf: Leaving directory '/home/hw1/Downloads/ns-allinone-3.26/ns-3.26/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (28.774s)
AnimationInterface WARNING:Node:0 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:1 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:0 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:1 Does not have a mobility model. Use SetConstantPosition if it is stationary
/NodeList/5/DeviceList/0/LteUeRrc/ConnectionEstablished UE IMSI 1: connected to CellId 2 with RNTI 1
/NodeList/3/DeviceList/0/LteEnbRrc/ConnectionEstablished eNB CellId 2: successful connection of UE with IMSI 1 RNTI 1
/NodeList/6/DeviceList/0/LteUeRrc/ConnectionEstablished UE IMSI 2: connected to CellId 2 with RNTI 2
/NodeList/3/DeviceList/0/LteEnbRrc/ConnectionEstablished eNB CellId 2: successful connection of UE with IMSI 2 RNTI 2
/NodeList/7/DeviceList/0/LteUeRrc/ConnectionEstablished UE IMSI 3: connected to CellId 2 with RNTI 3
/NodeList/3/DeviceList/0/LteEnbRrc/ConnectionEstablished eNB CellId 2: successful connection of UE with IMSI 3 RNTI 3
/NodeList/8/DeviceList/0/LteUeRrc/ConnectionEstablished UE IMSI 4: connected to CellId 2 with RNTI 4
/NodeList/3/DeviceList/0/LteEnbRrc/ConnectionEstablished eNB CellId 2: successful connection of UE with IMSI 4 RNTI 4
/NodeList/9/DeviceList/0/LteUeRrc/ConnectionEstablished UE IMSI 5: connected to CellId 2 with RNTI 5
/NodeList/3/DeviceList/0/LteEnbRrc/ConnectionEstablished eNB CellId 2: successful connection of UE with IMSI 5 RNTI 5
/NodeList/5/DeviceList/0/LteUeRrc/HandoverStart UE IMSI 1: previously connected to CellId 2 with RNTI 1, doing handover to CellId 1
/NodeList/2/DeviceList/0/LteEnbRrc/HandoverEndOk eNB CellId 1: completed handover of UE with IMSI 1 RNTI 1
/NodeList/3/DeviceList/0/LteUeRrc/HandoverStart UE IMSI 5: previously connected to CellId 2 with RNTI 5, doing handover to CellId 3
/NodeList/9/DeviceList/0/LteUeRrc/HandoverEndOk UE IMSI 5: successful handover to CellId 3 with RNTI 1
/NodeList/4/DeviceList/0/LteEnbRrc/HandoverEndOk eNB CellId 3: completed handover of UE with IMSI 5 RNTI 1
/NodeList/2/DeviceList/0/LteEnbRrc/HandoverStart eNB CellId 1: start handover of UE with IMSI 1 RNTI 1 to CellId 2
/NodeList/5/DeviceList/0/LteUeRrc/HandoverStart UE IMSI 1: successfully connected to CellId 1 with RNTI 1, doing handover to CellId 2
/NodeList/5/DeviceList/0/LteUeRrc/HandoverEndOk UE IMSI 1: successful handover to CellId 2 with RNTI 6
/NodeList/3/DeviceList/0/LteEnbRrc/HandoverEndOk eNB CellId 2: completed handover of UE with IMSI 1 RNTI 6
```

首先可以觀察出五個 UE 是批次加入網路中(透過 eNodeB 2)，其中發生了三次的換手，分別由 UE 1 和 UE 5 走動而發生。由於 UE 1 和 UE 5 位於 eNodeB 2 的覆蓋範圍邊緣地帶，所以較容易發生換手。

#### 2) animation:



從圖中為顯示出 UE 在兩基地台換手的過程，其中 node5 (UE) 正逐步遠離 node3 (eNB 2)，並漸漸移動至node2 (eNB 1)。在本次的 project 中，是使用 LteHelper 的SetHandoverAlgorithmType 方法實現A2A4RsrqHandoverAlgorithm，藉由基地台觀察 UE 的移動而自動觸發。

- **What you learn**

這次的 project 主要為了解如何建立 LTE 網路；LTE 網路換手的過程；練習ns-3的schedule function，將UE一個個分批加入LTE網路之中。