

Project 2

Outline



WHAT IS LTE



LTE-EPC Simulation Model



PROJECT
EXPLANATION

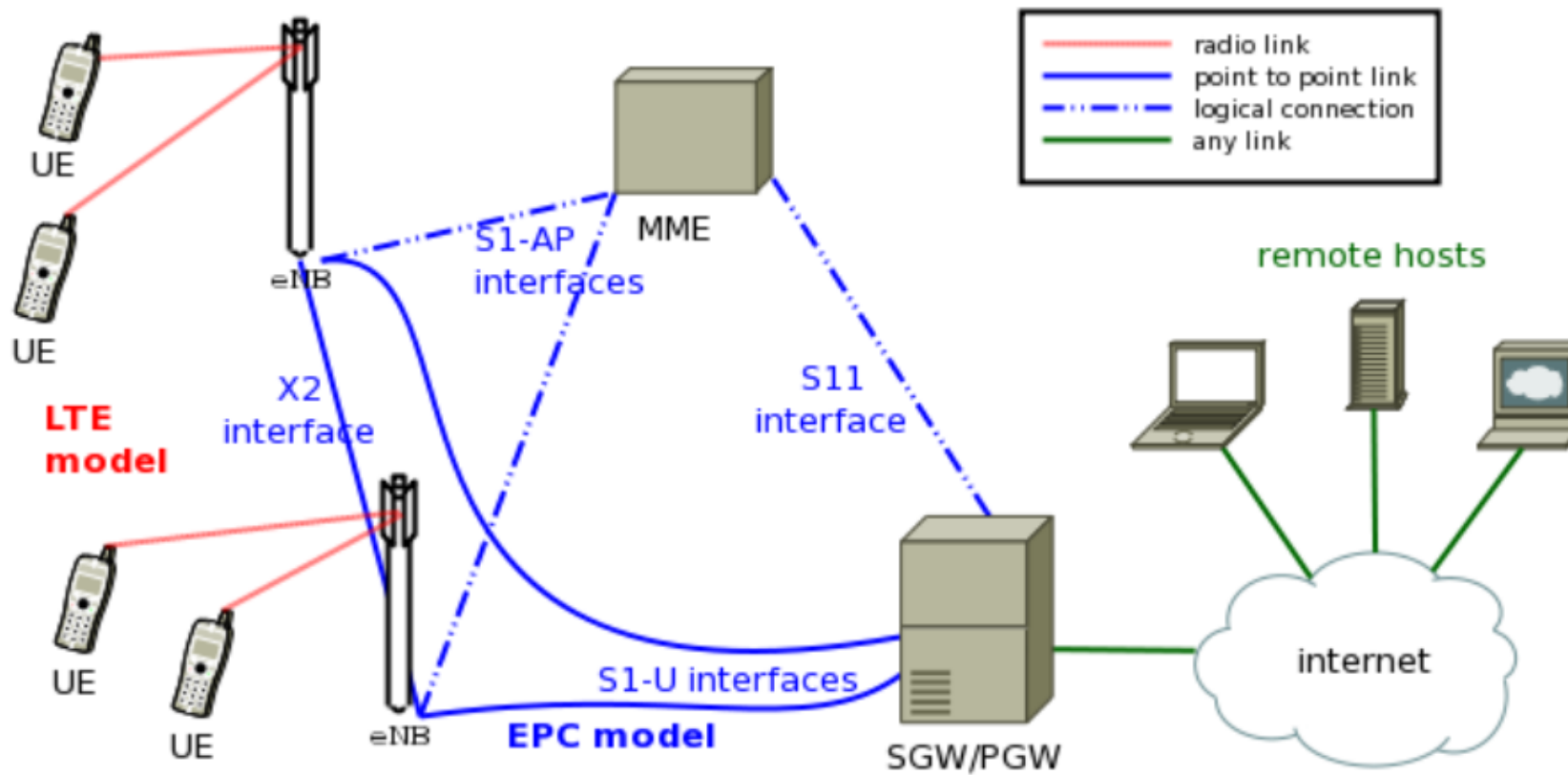
What is LTE

LTE

- A **standard** for wireless broadband communication for mobile devices and data terminals
- Designed for **lower latency** and **increased bandwidth**
- Maximum data rates is 100Mbps
- Feature :
 - The **higher bandwidth** enables faster access to content and applications, particularly video applications that can only be offered on fixed systems.
 - The **low latency** enables time-sensitive applications like voice services.
 - The **all-IP architecture** enables new converging services based on the IP Multimedia Subsystem (IMS).

LTE-EPC Simulation Model

LTE model



Overview of the LTE-EPC simulation model

LTE model

- Topology

- Build a 4G-Core network

- lteHelper

- Set epcHelper, scheduler type, handover algorithm type, handover algorithm attribute

- epcHelper

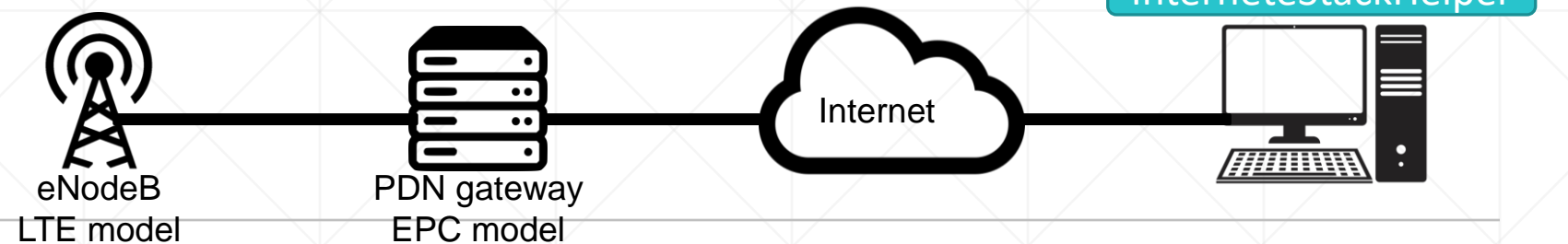
- Connect to LTE
 - Create PDN gateway

- Remote Host

- InternetStackHelper, PointToPointHelper (PDN gateway and Remote Host), Ipv4AddressHelper

- Create Routing Protocol between Internet Host and LTE network

- Ipv4StaticRoutingHelper

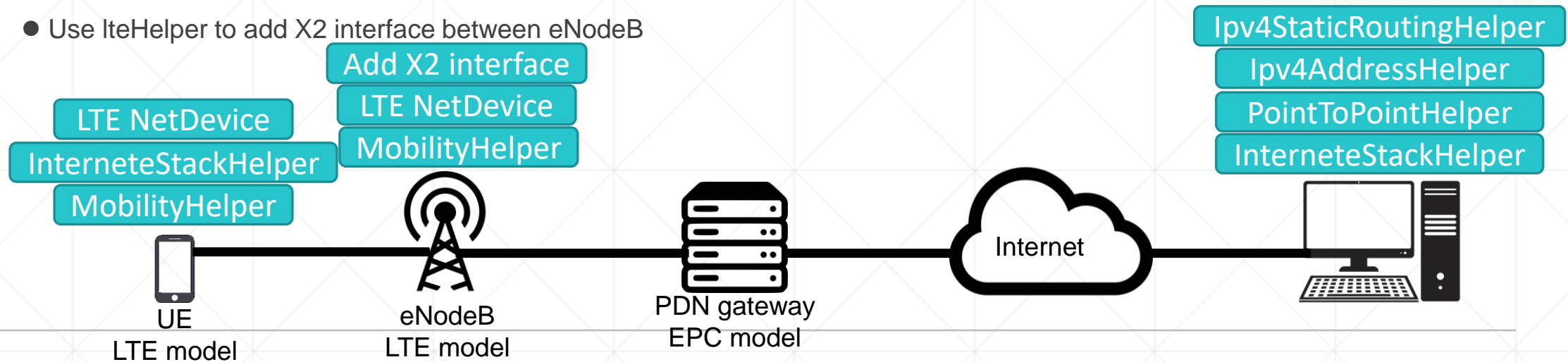


LTE model

- Topology

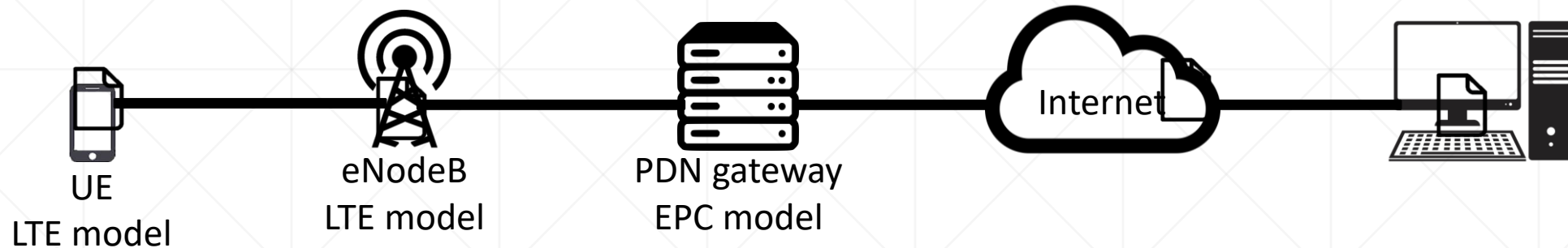
- Build a 4G-Core network

- Create eNodeB nodes
 - MobilityHelper
 - Create UE nodes
 - MobilityHelper, InternetStackHelper
 - Install LTE device on eNodeB and UE
 - Attach UE nodes to eNodeB node
 - Use IteHelper to add X2 interface between eNodeB



LTE model

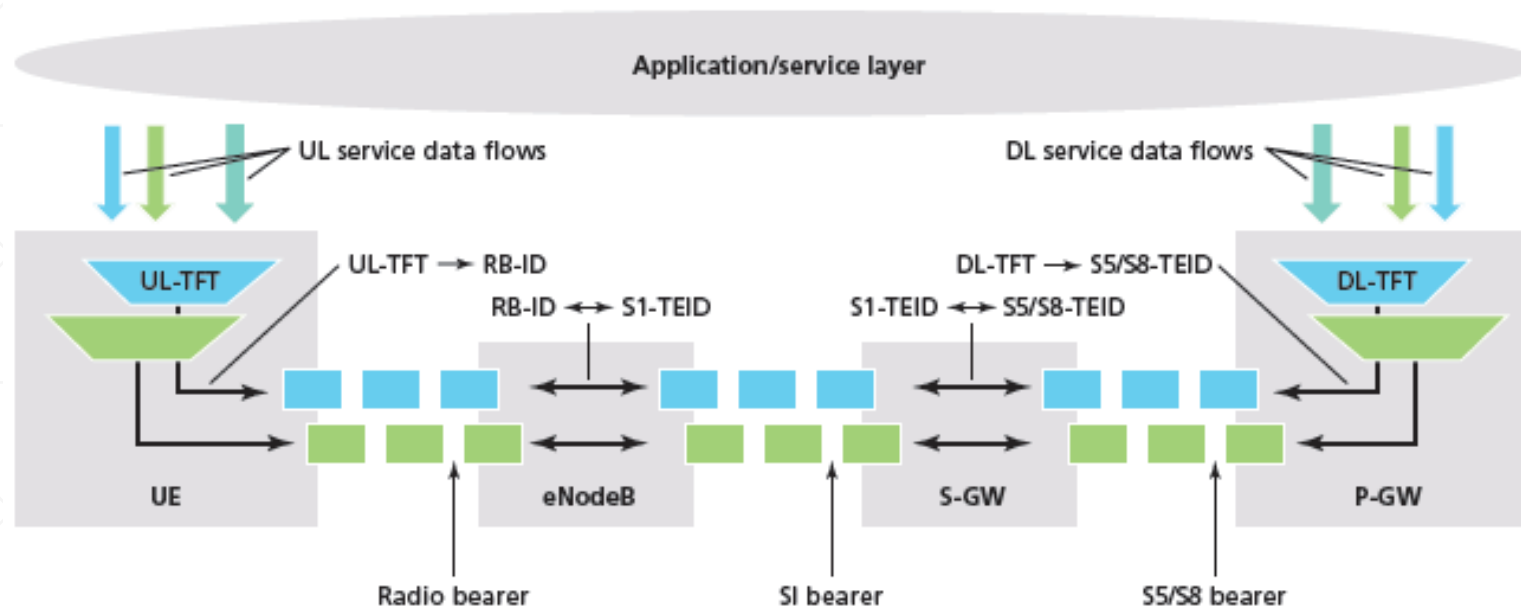
- Application
 - Set the default gateway for each UE (Routing protocol)
 - Install UDP Down Link application
 - UdpClientHelper (from Remote Host to UE) -> clientApps
 - PacketSinkHelper (UE sink the packet) -> ServerApps
 - Install UDP Up Link application
 - UdpClientHelper (from UE to Remote Host) -> clientApps
 - PacketSinkHelper (Remote Host sink the packet) -> ServerApps



LTE model

- Application

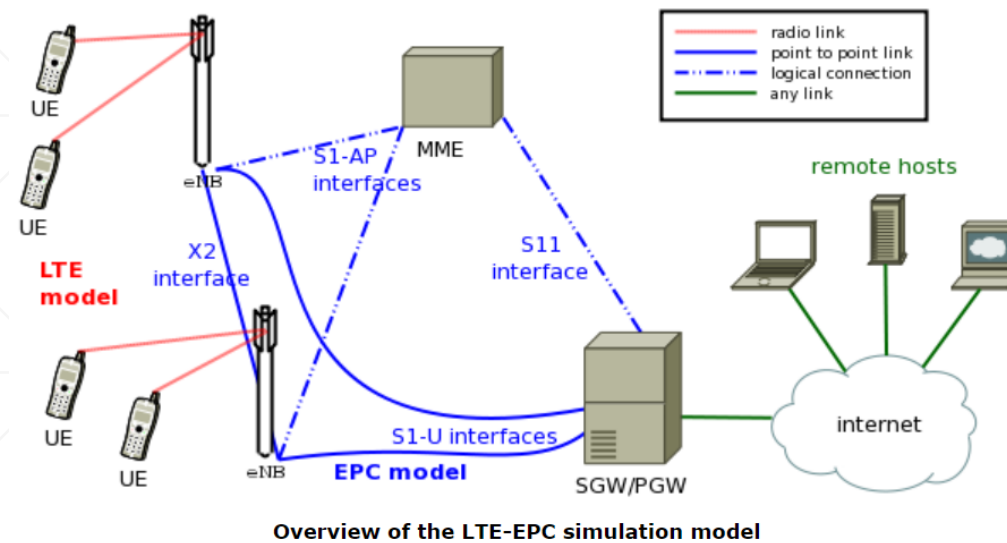
- Create a dedicated TFT(traffic flow template) of EPS bearer to PDN gateway
 - Set packet filter to corresponding DLport and Ulport, then add to TFT
 - Build a connection between TFT and EPS bearer



Project 2

Project 2

- Goal :
 - Simulate the LTE environment
 - Realize the handover procedure
 - Learn how to detect radio failure in LTE environment
 - Learn how to use scheduling function in ns-3



Project 2

- Requirement

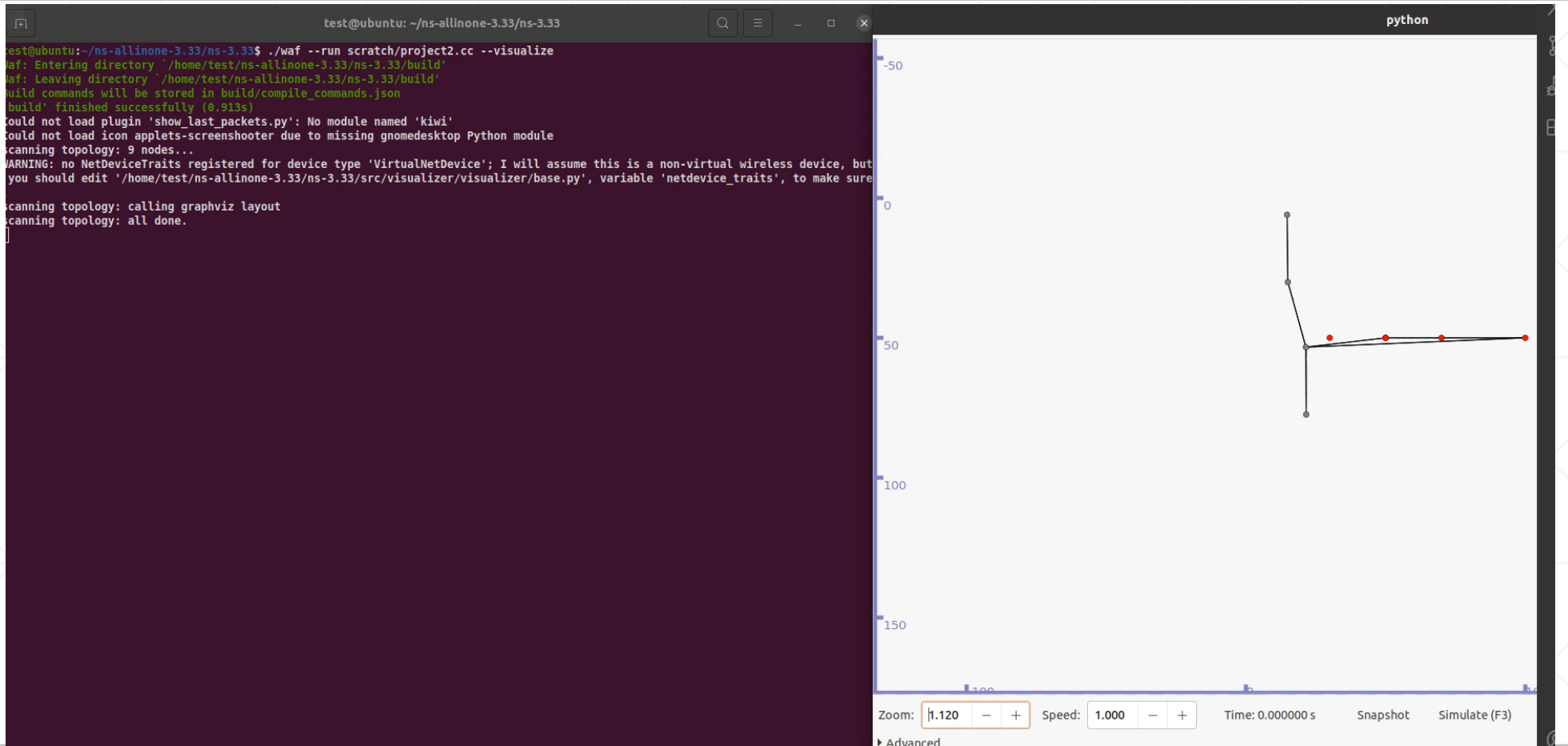
- Reference code “lena-x2-handover-measures.cc” and “lena-radio-link-failure.cc” (ns-3.26/src/lte/examples/)
- Create **three UE and two eNodeB** in LTE network
- Each **UE** should be scheduled to **attach to eNodeB in every second** ([Event and Schedule](#))
 - Ex: At the beginning, there is a UE nodes attach to the LTE network. A new UE will be added into LTE network in every second until there are 3 UE nodes in LTE network
- Every **UE node can walk randomly** and aim to **trigger handover**
- **Capture** which UE occurred **radio link failure** and print out its position
 - Note : For simplify the application, **NS_ABORT_MSG_IF()** is not needed.
- Present simulation by visualizer (./waf --run scratch/hw2 --visualize)

Project 2

- Example Code Instructions:

- Create **three UE and two eNodeB** in LTE network
 - Line 297 to line 298 => Declare the number of the Enbs and UEs
- Each **UE** should be scheduled to **attach to eNodeB in every second** ([Event and Schedule](#))
 - Line 277 to line 279 => Create a function to trigger attaching procedure
 - Line 599 => Schedule the attaching function you create
 - Scheduling Function Tutorial Reference: <https://rainsia.github.io/2018/11/01/ns3-012/>
- Every **UE node can walk randomly** and aim to **trigger handover**
 - Line 344 to line 348 => LteHelper -> SetHandoverAlgorithmType("ns3::A2A4RsrqHandoverAlgorithm")
 - Line 420 to line 441 => Use MobilityHelper to manage the mobility of Enbs and Ues
- **Capture** which UE occurred **radio link failure** and print out its position
 - Line 205 to line 213 => Radio link failure detection function

Project 2



Project 2

```
+1.06021s /NodeList/6/DeviceList/0/LteUeRrc/ConnectionEstablished UE IMSI 1: connected to cell id 1 with RNTI 1
+1.06021s /NodeList/4/DeviceList/0/LteEnbRrc/ConnectionEstablished eNB cell id 1: successful connection of UE with IMSI 1 RNTI 1
+2s UE with IMSI 2 RNTI 0 connected to cell 1 transitions from IDLE_START to IDLE_WAIT_MIB
+2.00021s UE with IMSI 2 RNTI 0 connected to cell 1 transitions from IDLE_WAIT_MIB to IDLE_CAMPED_NORMALLY
+2.00021s UE with IMSI 2 RNTI 0 connected to cell 1 transitions from IDLE_CAMPED_NORMALLY to IDLE_WAIT_SIB2
+2.016s UE with IMSI 2 RNTI 0 connected to cell 1 transitions from IDLE_WAIT_SIB2 to IDLE_RANDOM_ACCESS
+2.02021s UE with IMSI 2 RNTI 2 connected to cell 1 transitions from IDLE_RANDOM_ACCESS to IDLE_CONNECTING
+2.02021s UE with IMSI 2 RNTI 2 connected to cell 1 transitions from IDLE_CONNECTING to CONNECTED_NORMALLY
+2.02021s /NodeList/7/DeviceList/0/LteUeRrc/ConnectionEstablished UE IMSI 2: connected to cell id 1 with RNTI 2
+2.02021s /NodeList/4/DeviceList/0/LteEnbRrc/ConnectionEstablished eNB cell id 1: successful connection of UE with IMSI 2 RNTI 2
+3s UE with IMSI 3 RNTI 0 connected to cell 2 transitions from IDLE_START to IDLE_WAIT_MIB
+3.05021s UE with IMSI 3 RNTI 0 connected to cell 2 transitions from IDLE_WAIT_MIB to IDLE_CAMPED_NORMALLY
+3.05021s UE with IMSI 3 RNTI 0 connected to cell 2 transitions from IDLE_CAMPED_NORMALLY to IDLE_WAIT_SIB2
+3.056s UE with IMSI 3 RNTI 0 connected to cell 2 transitions from IDLE_WAIT_SIB2 to IDLE_RANDOM_ACCESS
+3.06021s UE with IMSI 3 RNTI 1 connected to cell 2 transitions from IDLE_RANDOM_ACCESS to IDLE_CONNECTING
+3.06021s UE with IMSI 3 RNTI 1 connected to cell 2 transitions from IDLE_CONNECTING to CONNECTED_NORMALLY
+3.06021s /NodeList/8/DeviceList/0/LteUeRrc/ConnectionEstablished UE IMSI 3: connected to cell id 2 with RNTI 1
+3.06021s /NodeList/5/DeviceList/0/LteEnbRrc/ConnectionEstablished eNB cell id 2: successful connection of UE with IMSI 3 RNTI 1
+3.26021s IMSI 3, RNTI 1, Cell id 2, Notify out of sync, no of sync indications: 1
/NodeList/5/DeviceList/0/LteEnbRrc/HandoverStart eNB CellId 2: start handover of UE with IMSI 3 RNTI 1 to CellId 1
+3.44s UE with IMSI 3 RNTI 1 connected to cell 2 transitions from CONNECTED_NORMALLY to CONNECTED_HANDOVER
/NodeList/8/DeviceList/0/LteUeRrc/HandoverStart UE IMSI 3: previously connected to CellId 2 with RNTI 1, doing handover to CellId 1
+3.44421s UE with IMSI 3 RNTI 3 connected to cell 1 transitions from CONNECTED_HANDOVER to CONNECTED_NORMALLY
/NodeList/8/DeviceList/0/LteUeRrc/HandoverEndOk UE IMSI 3: successful handover to CellId 1 with RNTI 3
/NodeList/4/DeviceList/0/LteEnbRrc/HandoverEndOk eNB CellId 1: completed handover of UE with IMSI 3 RNTI 3
+3.44421e+09ns IMSI 3, RNTI 1, Cell id 2, UE context destroyed at eNodeB
+5.26021e+09ns IMSI 3, RNTI 3, Cell id 1, radio link failure detected
```

IMSI : 3 at -16.7828,64.7462

```
+5.26021s UE with IMSI 3 RNTI 3 connected to cell 1 transitions from CONNECTED_NORMALLY to CONNECTED_PHY_PROBLEM
```


Project 2

- Grading Policy

- Finish Project 2 (60%)

- Topology (Describe the Network Topology, text or graphic)
 - Schedule function (Use ns3 Scheduling function to implement UE attaching procedure in every second)
 - Animation – Visualizer (Use comment line argument --visualize to start the visualization program)
 - Comment out the project code (Explain the part of code you revise and implement)

- Report (40%)

- (10%) What you do (Ex: Explain how you implement the project requirement in the code)
 - (25%) Observe the command lines => Provide comment lines screenshot and express your observation
 - (5%) Screenshot of your visualized simulation (Ex: The screenshot of the visualized simulation presented in page 15)

◆ Submit the Report within 3 pages, otherwise the grade will be deducted