



5G行動寬頻人才培育計畫
-以5G和AI為架構之下世代物聯網聯盟中心

以5G和AI為架構之下世代 物聯網聯盟中心

5G-enabled and AI-based next generation IoT Alliance Center

物聯網軟體基地台設計與實作

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物聯網軟體基地台設計與實作 (1 / 3)

▶ 課程目標

- 以開放式軟體定義基地台來進行教學，教學內容包含：
 - 3GPP LTE和NB-IoT實體層處理流程
 - 5G開放軟體定義基地台建置流程
 - 軟體定義實體層執行緒控制流程
 - 軟體定義實體層演算法設計

▶ 核心能力

- 具備熟悉3GPP LTE實際運作流程，以及使用軟體定義基地台平台進行研究與開發的能力

物聯網軟體基地台設計與實作 (2/3)

▶ 課程大綱

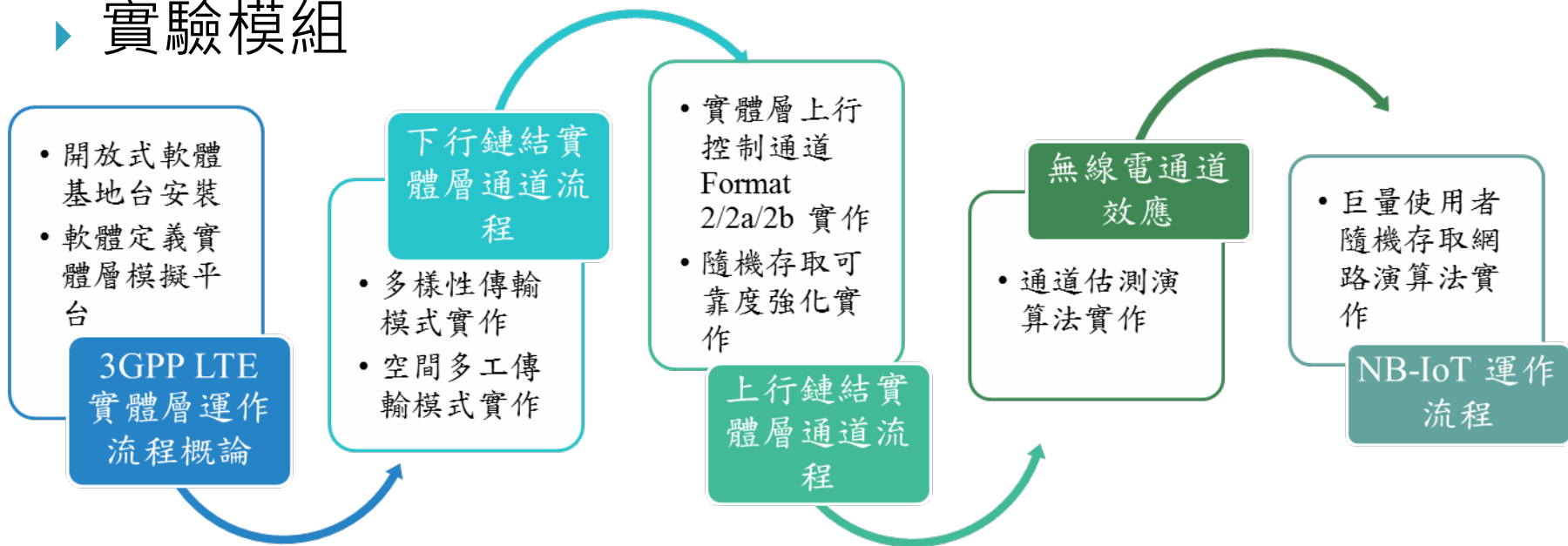
- 開放式軟體基地台安裝
- 軟體定義實體層之模擬平台
- 多樣性傳輸模式(TM2)實作
- 空間多工傳輸模式(TM3/TM4)實作
- 實體層上行控制通道(PUCCH) Format 2/2a/2b 實作
- 隨機存取可靠度強化實作
- 移動通訊之通道估測演算法實作
- 巨量使用者隨機從取網路演算法實作

▶ 評量方式

- 為加強學員在軟體基地台之實作與開發能力，本課程之主要評量方式以**課堂實作實驗(100%)**為主。

物聯網軟體基地台設計與實作 (3 / 3)

實驗模組



實作平台

- 透過COTS UE 與軟體基站對連進行實驗



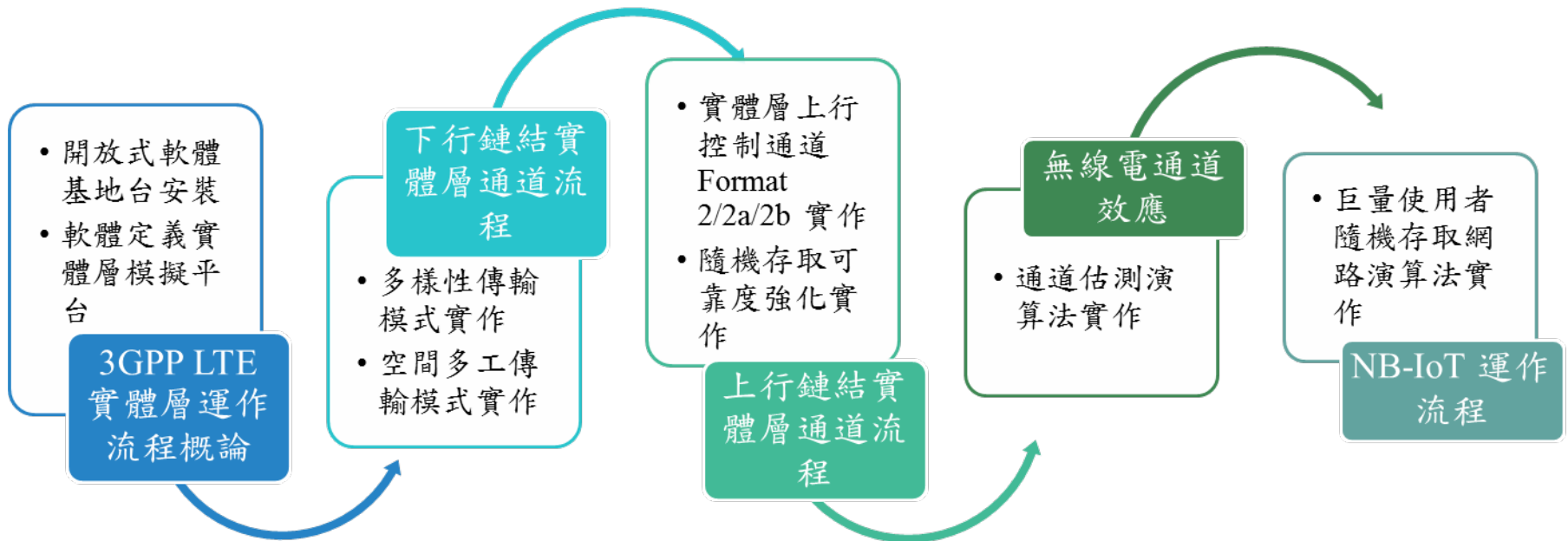
USRP



模組名稱

物聯網軟體基地台設計與實作

課程地圖介紹

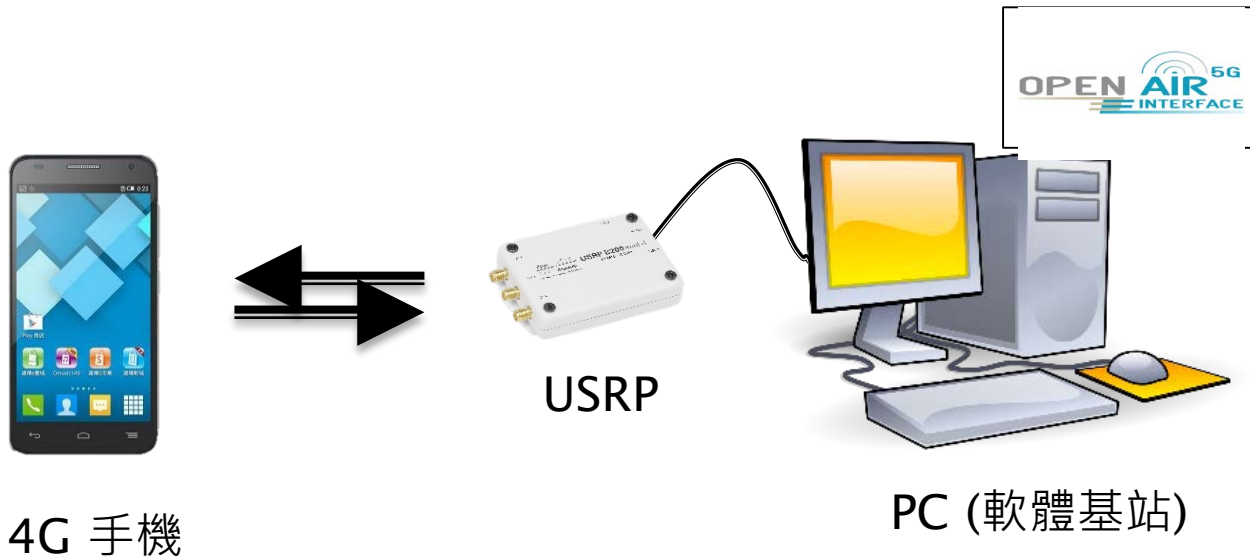


授課內容

1. 開放式軟體基地台安裝
 2. 軟體定義實體層之模擬平台
 3. 多樣性傳輸模式(TM2)實作
 4. 空間多工傳輸模式(TM3/TM4)實作
 5. 實體層上行控制通道(PUCCH) Format 2/2a/2b 實作
 6. 隨機存取可靠度強化實作
 7. 移動通訊之通道估測演算法實作
 8. 巨量使用者隨機從取網路演算法實作
- ▶ **課程講義: 240 頁 , 實驗手冊共7組**

實驗環境

- ▶ 透過COTS UE 與軟體基站對連進行實驗



Lab Example

- ▶ 單元1：3GPP LTE 實體層運作流程概論－軟體定義實體層模擬平台

What is OpenAirInterface?

Wireless

✓ OpenAirInterface (OAI)

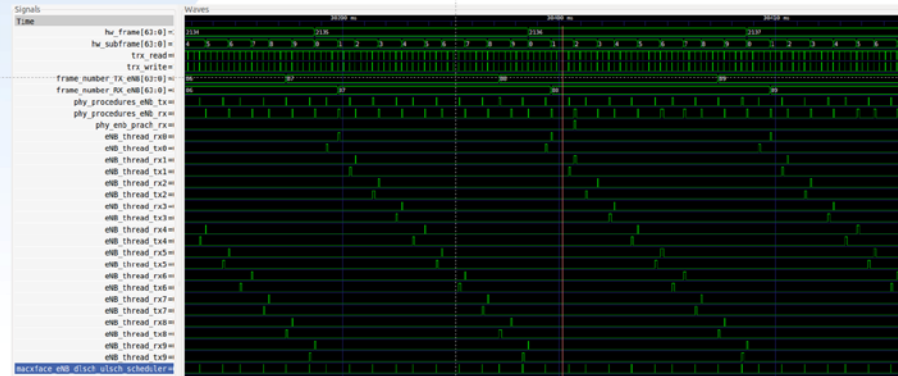
- Started and developed by **Eurecom**, France
- Open-source software-based implementation of 4G LTE Rel 8/9
- Fully-compliant 4G eNodeB and EPC in a commodity x86-based computer
- Features
 - LTE-Advanced (Rel 10/11/12)
 - LTE-Advanced-Pro (Rel 13/14)
 - 5G (Rel 15/16/...)
- Full protocol stack of 3GPP standard
 - E-UTRAN (eNB, partial UE) <https://gitlab.eurecom.fr/oai/openairinterface5g>
 - EPC (MME, S+P-GW, HSS) <https://gitlab.eurecom.fr/oai/openair-cn>
- Realtime RF and scalable emulation platforms
- Works with many SDR platforms



Value Change Dump (VCD) with OAI

Wireless

- ✓ tracks the execution time of each function working as a common profiler for performance improvement.
 - code optimization, bottleneck detection, and processing time measurements
- ✓ Output format is read by gtwave to view the signal transition and timing



Lab Example

▶ PRACH Simulator

- 實際修改程式碼後，透過模擬器與實際連線了解軟體基地台之運作

PRACH Simulator (1/2)

✓ RUN PRACH simulator

- Do the practice in lecture 1 (download OAI and build the simulator)
- Change folder


```
% cd oaisim/openairinterface5g/cmake_targets/lte-simulators/build
```
- See the help interface


```
% sudo ./prachsim -h
```

```

-h This message
-h Use AWGN channel and JNC multipath
-h Number of frames to simulate
-h Starting SNR, runs from SNR0 to SNR0 + 5 dB. If n_frames is 1 then just SNR is simulated
-h Ending SNR, runs from SNR0 to SNR1
-h [A,B,C,D,E,F,G,I,h] Use 3GPP SCN (A,B,C,D) or 3G-PP (E,F,G,H,I) or Rayleigh (I) or Rayleigh_000 (N) models (ignores delay spread and Ricean factor)
-h Number of RX antennas used in eNB
-h Nid_cell
-h oversampling factor (1,2,4,8,16)
-h Channel delay
-h Starting UE velocity in km/h, runs from 'u' to 'v'x500km/h. If n_frames is 1 just 'u' is simulated
-h Ending UE velocity in km/h, runs from 'u' to 'v'x1 rootsequenceindex (0-837)
-h NCS_config (ZeroCorrelationZone) (0-15)
-h Run with High-Speed Flag enabled
-h Number of ms (0-15x25,50,15,100)
-h Input filename (.txt format) for RX conformance testing
          
```

- For example, only AWGN on, SNR from 0 dB to 30 dB
 - Zero Correlation Zone is 5
 - High-speed-flag is false

```
% sudo ./prachsim -a -s 0 -S 30 -Z 5 -R 25
```

Wireless

PRACH Simulator (2/2)

✓ One UE transmits PRACH to one eNB

- The eNB detects all the energy and corresponding preamble indexes

✓ PRACH simulator flow

```

graph TD
    A[Variable declarations] --> B[System parameter generation  
lte_param_init()]
    A --> C[Initial setting parameter]
    A --> D[Input arguments]
    B --> E[PRACH sequence generation, x_u,v(0)  
compute_prach_seq()]
    E --> F[PRACH signal generation  
generation_prach()]
    C --> F
    D --> F
    F --> G[Channel effect multipath and AWGN  
multipath_tv_channel()]
    G --> H[RX PRACH detection  
rx_prach()]
    H --> I[Find the max. energy and corresponding preamble index]
          
```

Wireless

設備預算

品項	單位	價格	附註
高階個人電腦(含SSD)	台	30,000	可供2人使用
USRP射頻卡板	張	27,000	可供2人使用
低階4G手機	片	5,000	可供2人使用
實驗用SIM卡	台	2,000	可供2人使用

可提供之訓練與技術支援

- ▶ 課程助教培訓 (預計於交通大學舉辦)

聯絡窗口

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