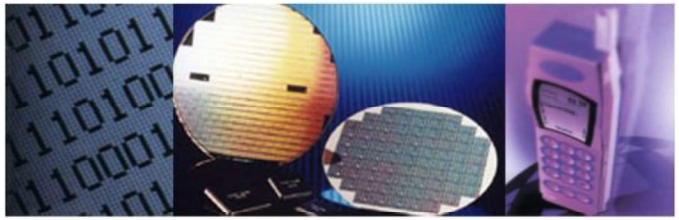
Wireless

Wireless LAN Technology

手機連線測試與除錯



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Dept. of Computer Science and Information Engineering
NCTU

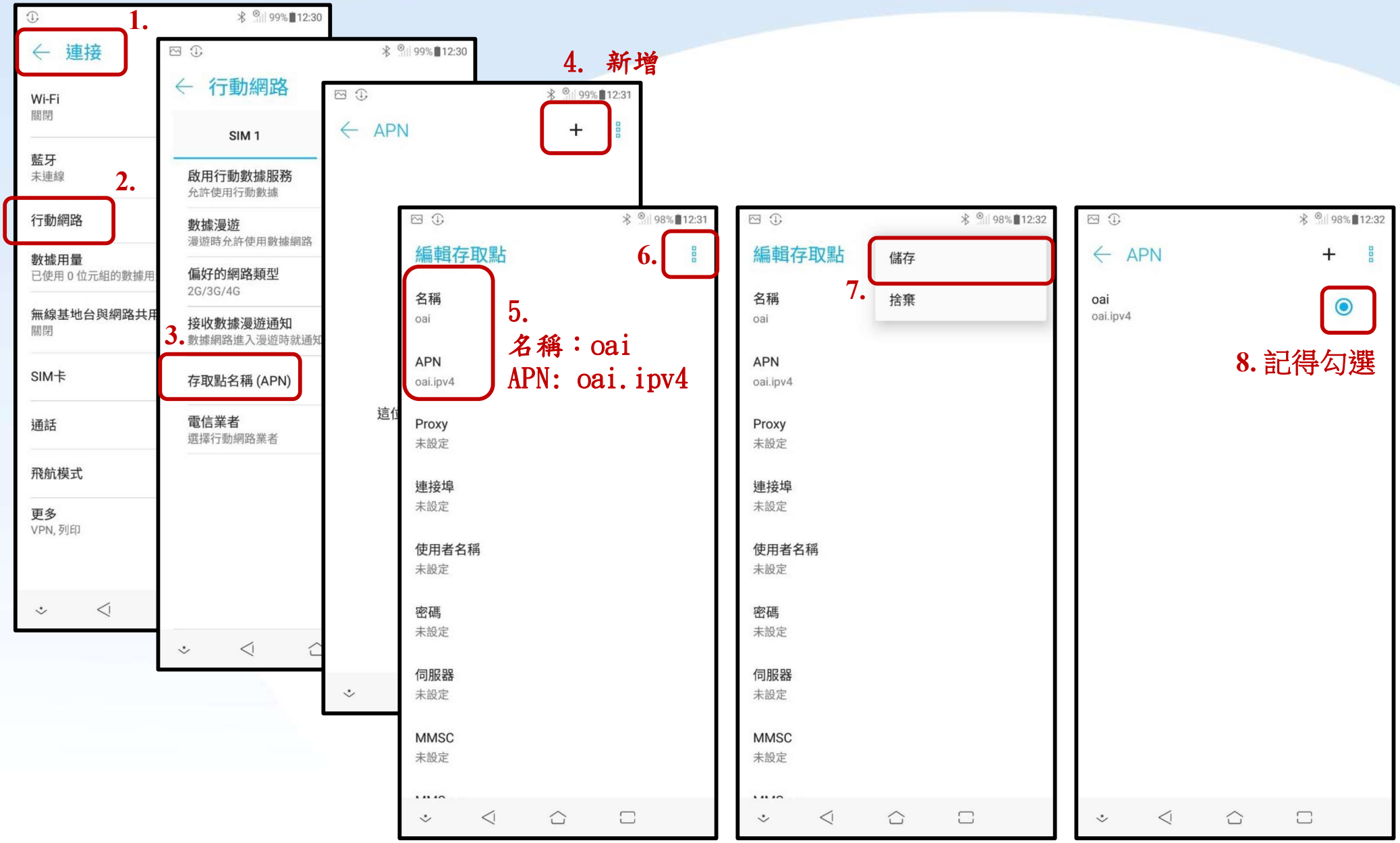
手機連線測試與除錯

✓ 手機連不上的疑難排解

1. 確認手機的APN設定 "oai.ipv4"
2. 修改網路卡的MTU為1800
   - 修改eNB連接EPC網路卡的MTU設定為1800
   - 修改EPC連接eNB網路卡的MTU設定為1800
   - 修改EPC連接外部internet網路卡的MTU設定為1800
3. 確認手機的軟體是否為最新版本
4. 確認EPC可以連外網, 若不能請檢察Gateway是否設定正確
5. 測試頻段改為 Band7, 5MHz, DL 2650MHz in eNB configuration
6. 使用iperf測試工具，測試eNB本機端與Cost UE的連線

確認手機的APN設定

Wireless

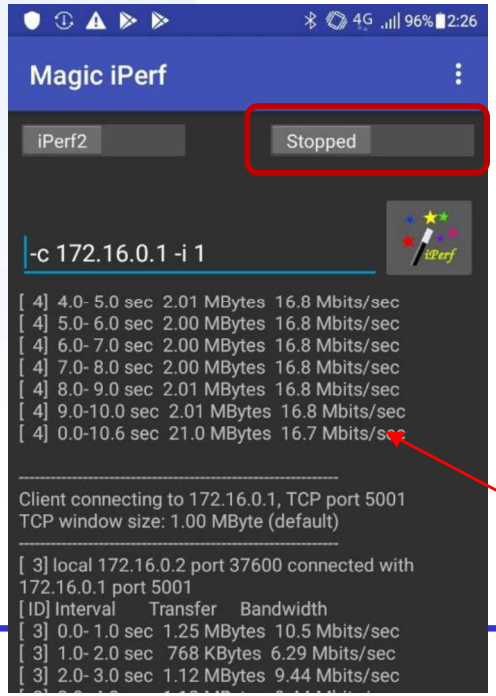


iperf工具測試eNB本機端與Cost UE的連線

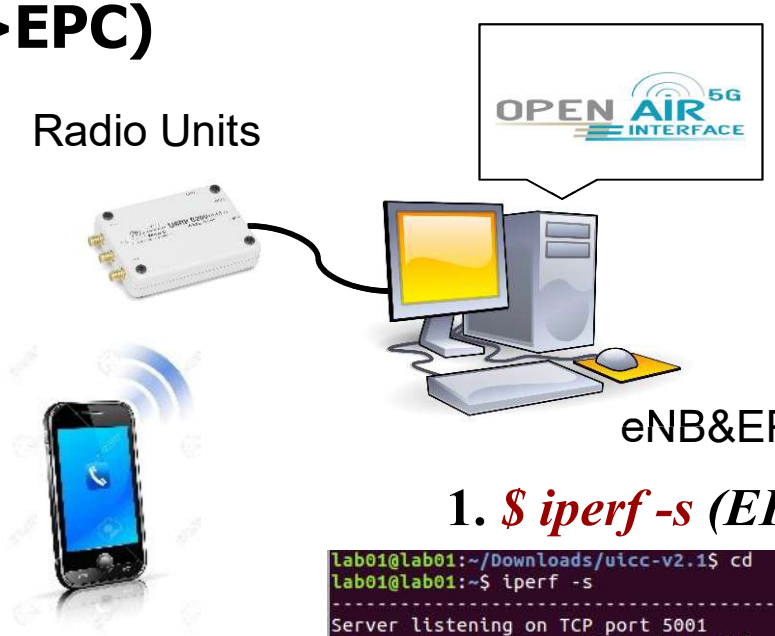
Wireless

- ✓ **Android download "magic iperf"**
  - Google search key word : "magic iperf apkpure"
- ✓ **Check IP address**
  - EPC IP: 172.16.0.1 (OAI default)
  - Cost UE: 設定=>關於本機
- ✓ **UL link test (UE=>EPC)**

2. *$ iperf -c 172.16.0.1 -i 1*
(UE as client)



Start



Sending throughput

Receiving throughput

1. *$ iperf -s (EPC as server)*

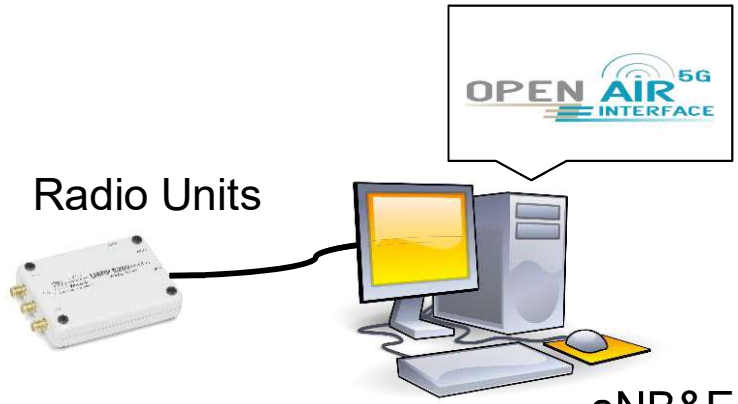
```
lab01@lab01:~/Downloads/uicc-v2.1$ cd
lab01@lab01:~$ iperf -s
------------------------------------------------------------
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
------------------------------------------------------------
[  4] local 172.16.0.1 port 5001 connected with 172.16.0.2 port 37530
[ ID] Interval       Transfer     Bandwidth
[  4]  0.0-10.6 sec  10.1 MBytes  8.02 Mbits/sec
[  5] local 172.16.0.1 port 5001 connected with 172.16.0.2 port 37531
[  5]  0.0- 2.4 sec  2.12 MBytes  7.36 Mbits/sec
[  4] local 172.16.0.1 port 5001 connected with 172.16.0.2 port 37538
[  4]  0.0-10.9 sec  9.00 MBytes  6.91 Mbits/sec
```

iperf工具 DL 測試

- ✓ **DL test (UE <= EPC)**
  - Ex: UE's ip address: 172.16.0.2

1. ***$ iperf -s (UE as server)***

Start



COTS UE

2. ***$ iperf -c 172.16.0.2 -i 1 (EPC as client)***

```
connect failed: Connection refused
lab01@lab01:~$ iperf -c 172.16.0.2
------------------------------------------------------------
Client connecting to 172.16.0.2, TCP port 5001
TCP window size: 85.0 KByte (default)
------------------------------------------------------------
[  3] local 172.16.0.1 port 46238 connected with 172.16.0.2 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-10.1 sec  21.0 MBytes  17.5 Mbits/sec
lab01@lab01:~$ ^C
```

iperf usage: https://cms.35g.tw/coding/%E5%88%A9%E7%94%A8-iperf-%E6%B8%AC%E8%A9%A6%E7%B6%B2%E8%B7%AF%E6%95%88%E8%83%BD/

Wireless

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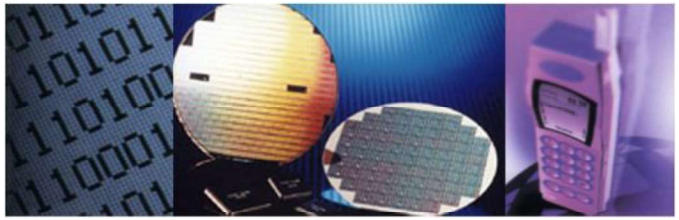
空白SIM燒錄



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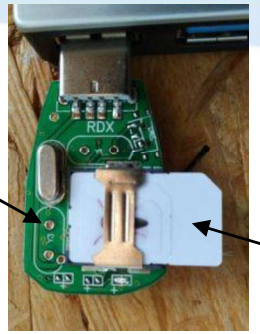
空白SIM燒錄 (1/2)

- ✓ **Prepare component [1]**
  - Blank USIM
  - Card reader/writer
- ✓ **Download UICC/SIM programing**
  - V2.1
    - https://open-cells.com/d5138782a8739209ec5760865b1e53b0/uicc-v2.1.tgz
- ✓ **Build/Run UICC/SIM (Linux) [2]**
  - *$ make*
    - (if the folder has the "program_uicc", delete the program_uicc first, after enter "make" command)
  - *$ sudo ./program_uicc --adm 29556183 --opc 8e27b6af0e692e750f32667a3b14605d --imsi 208930000000099 --key 8baf473f2f8fd09487cccbd7097c6862 --spn openairinterface --authenticate*
    - *(imsi:208930000000099)*
    - *(key:8baf473f2f8fd09487cccbd7097c6862)*
    - *(opc:8e27b6af0e692e750f32667a3b14605d)*
    - *Result shows MSISDN*
      - *Ex: 000001*



1. --port Linux port to access the card reader (/dev/ttyUSB0)
2. --adm The ADM code of the card (the master password is 85496936)
3. --iccid the UICC id to set
4. --imsi The imsi to set, we automatically set complementary files such as "home PLMN"
5. --opc OPc field: OPerator code: must be also set in HSS (exlusive with OP)
6. --isdn The mobile phone number (not used in simple 4G)
7. --acc One of the defined security codes
8. --key The authentication key (called Ki in 3G/4G, Kc in GSM), must be the same in HSS
9. --MNCsize Mobile network code size in digits (default to 2)
10. --xx OP field: OPerator code: must be also set in HSS (exclusive with OPc)
11. --authenticate Test the milenage authentication and discover the current sequence number
12. --spn service provider name: the name that the UE will show as 'network'
13. --rusimv Read USIM values: 1 -> yes, 0 -> no

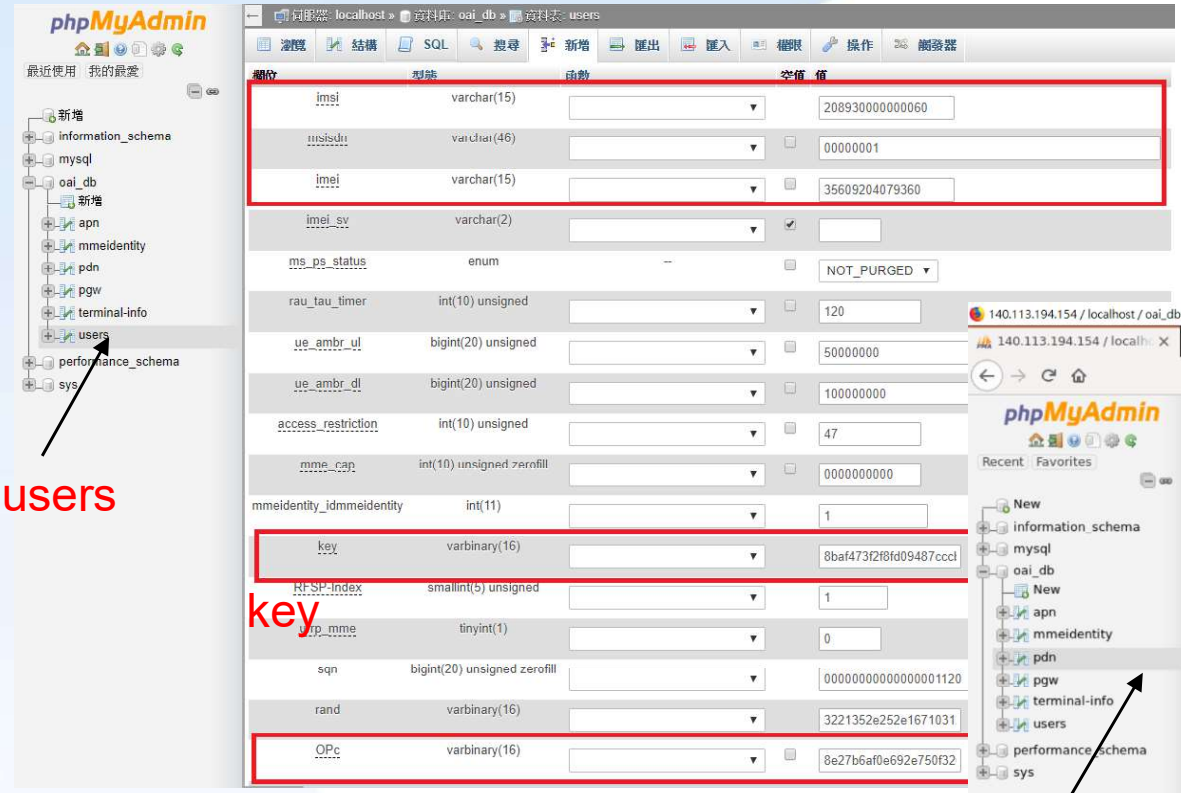
ADM from vendor

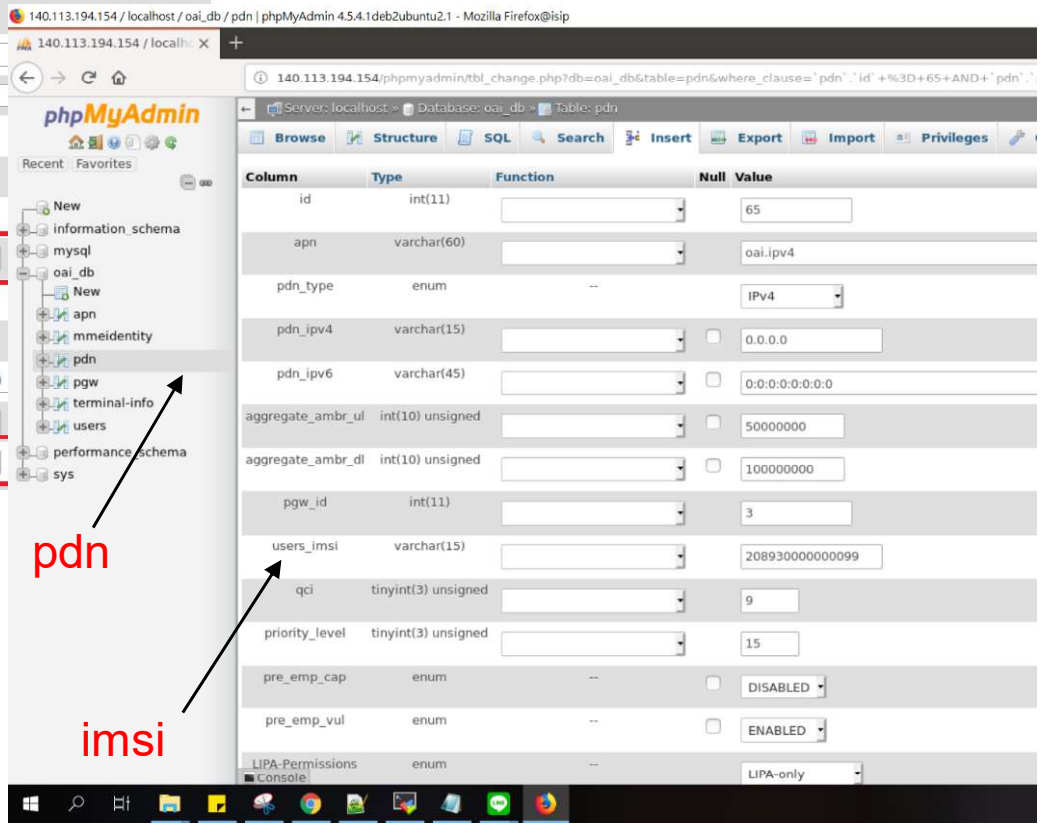
[1] https://open-cells.com/index.php/sim-cards/
[2] https://github.com/lfarizav/program_uicc

空白SIM燒錄 (2/2)

Wireless

✓ Config Phpmyadmin in EPC





(imsi:208930000000099)
(key:8baf473f2f8fd09487cccbd7097c6862)
(opc:8e27b6af0e692e750f32667a3b14605d)
MSISDN from UICC/SIM output
Ex: 000001

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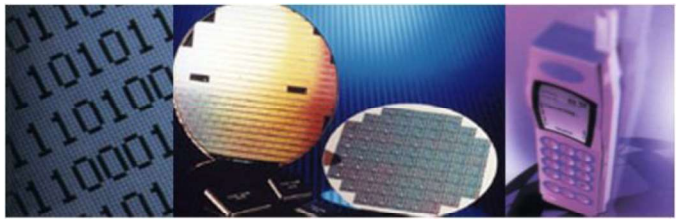
OAI PHY Simulator



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OAI PHY Simulator

- ✓ **OAI installation is finished**
- ✓ **Build simulators**
  - Change folder
    ```
    % cd openairinterface5g
    ```
  - Source OAI environment
    ```
    % source oaienv
    ```
  - Change folder
    ```
    % cd cmake_targets
    ```
  - Build PHY simulators
    ```
    % sudo ./build_oai --phy_simulators
    ```

- ✓ **Run the PHY simulator**
  - Change folder
    ```
    % cd lte-simulators/build
    ```
  - See the help interface (*ex: ulsim*)
    ```
    % sudo ./ulsim –h
    ```

```
kaitai@ubuntu:~/Desktop/oaisim/openairinterface5g/cmake_targets/lte-simulators/build$ ./ulsim -h
CPU Freq is 3.401585
Detected cpu_freq 3.401585 GHz
log init done
./ulsim -h(elp) -a(wgn on) -m mcs -n n_frames -s snr0 -t delay_spread -p (extended prefix on) -r nb_rb -f first_rb -o (srs on) -g channel_model [A:M] Use 3GPP 25.814 SCM-A/B/C/D('A','B','C','D') or
 3G-101 EPA('E'), EVA ('F'),ETU('G') models (ignores delay spread and Ricean factor), Rayghleigh8 ('H'), Rayleigh1('I'), Rayleigh1_corr('J'), Rayleigh1_anticorr ('K'), Rice8('L'), Rice1('M'), -d Ch
annel delay, -D maximum Doppler shift
```

-h (help)	-a (awgn on)	-m (mcs)	-n (n_frames)
-p (extended CP)	-r (nb_rb)	-f (first_rb)	-o (srs_on)
-s (snr0)	-t (delay_spread)	-g (channel_model)	

Simulator Results (1/2)

- ✓ **For example, AWGN on, Channel model is SCM-C, SNR start from 10dB**

```
% sudo ./ulsim -a -s 10 -g C
```

```
kaitai@ubuntu:~/Desktop/oaisim/openairinterface5g/cmake_targets/lte-simulators/build$ sudo ./ulsim -a -s 10 -g C
[sudo] password for kaitai:
CPU Freq is 3.394852
Detected cpu_freq 3.394852 GHz
log init done
Start ltc_param_init
lte_parms.c: Setting N_RB_DL to 25, ofdm_symbol_size 512
frame_parms->N_RB_DL=25
frame_parms->N_RB_UL=25
frame_parms->Nid_cell=0
frame_parms->Ncp=0
frame_parms->Ncp_UL=0
frame_parms->nushift=0
frame_parms->frame_type=0
frame_parms->tdd_config=3
frame_parms->tdd_config_S=0
frame_parms->mode1_flag=1
frame_parms->nb_antenna_ports_eNB=1
frame_parms->nb_antennas_tx=1
frame_parms->nb_antennas_rx=1
frame_parms->ofdm_symbol_size=512
frame_parms->nb_prefix_samples=36
frame_parms->nb_prefix_samples0=40
frame_parms->first_carrier_offset=362
frame_parms->samples_per_tti=7680
frame_parms->symbols_per_tti=14
Inittializing UE vars (abstraction 0) for eNB TXant 1, UE RXant 1
[openair][LTE_PHY][INIT] common_vars->txdataF[0][0] = 0x7f88588c9010 (286720 bytes)
[openair][LTE_PHY][INIT] common_vars->txdataF[0][5] = 0x7f8858882010 (286720 bytes)
[openair][LTE_PHY][INIT] common_vars->txdata[0][0] = 0x7f8858836010 (307200 bytes)
[openair][LTE_PHY][INIT] common_vars->rxdata[0][0] = 0x7f88587ea010 (307200 bytes)
[openair][LTE_PHY][INIT] common_vars->rxdata_7_5kHz[0][0] = 0x383a0b20 (61440 bytes)
[openair][LTE_PHY][INIT] prach_vars->rxsigF[0] = 0x387553c0
[openair][LTE_PHY][INIT] prach_vars->prach_ifft[0] = 0x3875b3d0
Done lte_param_init
1 . rxdataF_comp[0] 0x38770a30
Setting mcs = 0
n_frames = 5000
SNR0 10.000000, SNR1 40.000000
PUSCH Beta : ACK 2.000000, RI 1.250000, CQI 1.125000
Init UL hopping UE
Init UL hopping eNB
Rate = 0.880952 (mod 2)  coded bits 8400
```

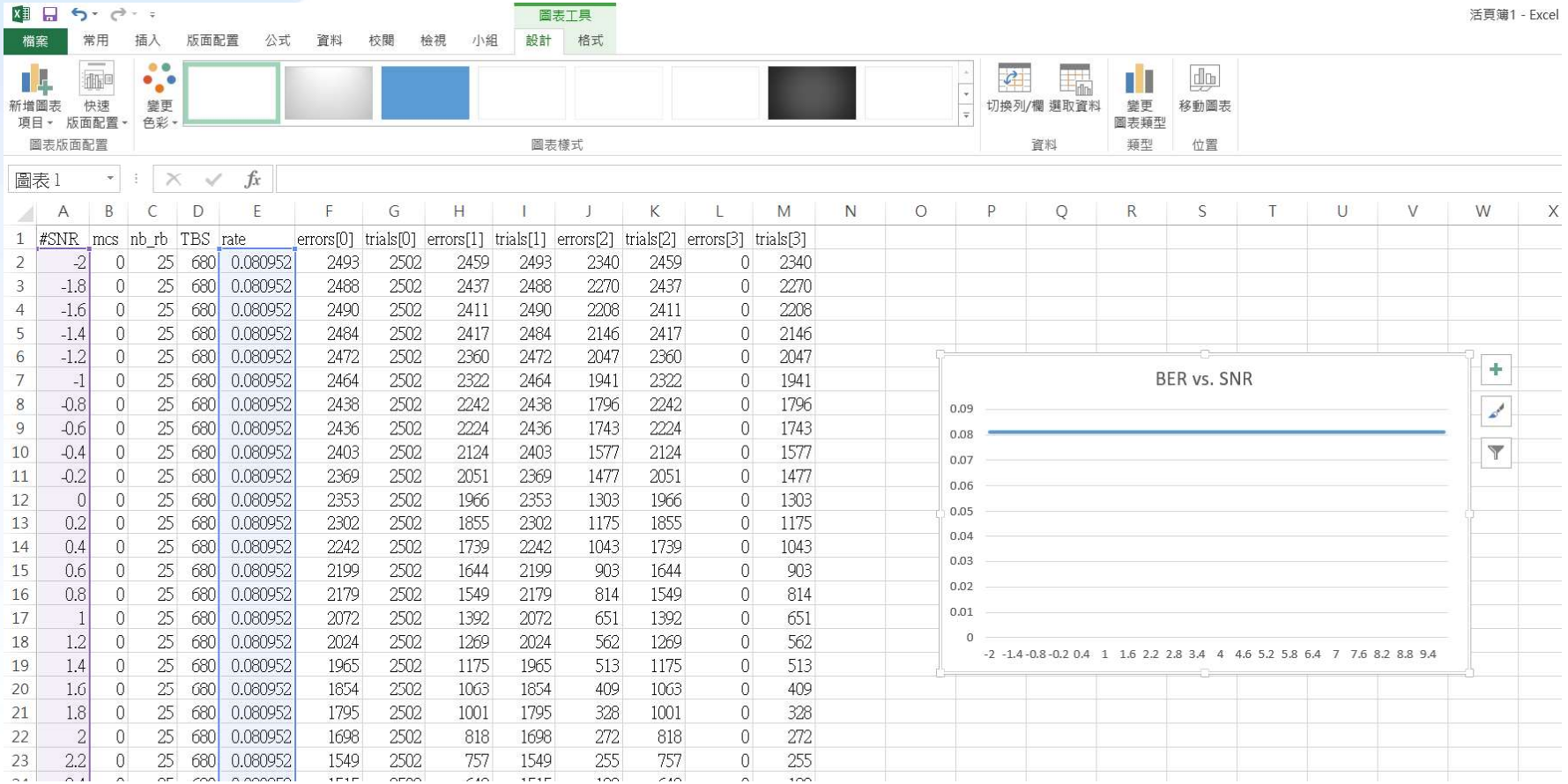
Simulation results

SNR step is 0.2dB

```
**********rb: 25 ***mcs : 0  *********SNR = 10.000000 dB (0.000000): TX 510 dB (gain -14.178070 dB), N0W 30.000000 dB, I0 29 dB, delta_IF -1268 [ (41,0) dB / (29,0) dB ]*************************
Errors (100/3381 2/100 0/2 0/0), Pe = (2.957705e-02,5.915410e-04,0.000000e+00,0.000000e+00) => effective rate 0.078582 (97.1%,0.080952,0.161905), normalized delay 0.001515 (1.030169)

**********rb: 25 ***mcs : 0  *********SNR = 10.200000 dB (0.000000): TX 510 dB (gain -13.975322 dB), N0W 30.000000 dB, I0 29 dB, delta_IF -1268 [ (40,0) dB / (29,0) dB ]*************************
Errors (100/3268 4/100 0/4 0/0), Pe = (3.059976e-02,1.223990e-03,0.000000e+00,0.000000e+00) => effective rate 0.078456 (96.9%,0.080952,0.161905), normalized delay 0.001517 (1.031824)

**********rb: 25 ***mcs : 0  *********SNR = 10.400000 dB (0.000000): TX 510 dB (gain -13.781580 dB), N0W 30.000000 dB, I0 29 dB, delta_IF -1268 [ (41,0) dB / (29,0) dB ]*************************
Errors (100/3714 6/100 0/6 0/0), Pe = (2.692515e-02,1.615509e-03,0.000000e+00,0.000000e+00) => effective rate 0.078706 (97.2%,0.080952,0.161905), normalized delay 0.001513 (1.028541)

**********rb: 25 ***mcs : 0  *********SNR = 10.600000 dB (0.000000): TX 510 dB (gain -13.574018 dB), N0W 30.000000 dB, I0 29 dB, delta_IF -1268 [ (37,0) dB / (29,0) dB ]*************************
Errors (91/5000 5/91 0/5 0/0), Pe = (1.820000e-02,1.000000e-03,0.000000e+00,0.000000e+00) => effective rate 0.079427 (98.1%,0.080952,0.161905), normalized delay 0.001499 (1.019200)

**********rb: 25 ***mcs : 0  *********SNR = 10.800000 dB (0.000000): TX 510 dB (gain -13.377673 dB), N0W 30.000000 dB, I0 29 dB, delta_IF -1268 [ (41,0) dB / (29,0) dB ]*************************
Errors (100/4682 3/100 0/3 0/0), Pe = (2.135839e-02,6.407518e-04,0.000000e+00,0.000000e+00) => effective rate 0.079210 (97.8%,0.080952,0.161905), normalized delay 0.001503 (1.021999)

**********rb: 25 ***mcs : 0  *********SNR = 11.000000 dB (0.000000): TX 510 dB (gain -13.179458 dB), N0W 30.000000 dB, I0 29 dB, delta_IF -1268 [ (43,0) dB / (29,0) dB ]*************************
Errors (73/5000 2/73 0/2 0/0), Pe = (1.460000e-02,4.000000e-04,0.000000e+00,0.000000e+00) => effective rate 0.079756 (98.5%,0.080952,0.161905), normalized delay 0.001493 (1.015000)

**********rb: 25 ***mcs : 0  *********SNR = 11.200000 dB (0.000000): TX 510 dB (gain -12.976682 dB), N0W 30.000000 dB, I0 29 dB, delta_IF -1268 [ (41,0) dB / (29,0) dB ]*************************
Errors (87/5000 2/87 0/2 0/0), Pe = (1.740000e-02,4.000000e-04,0.000000e+00,0.000000e+00) => effective rate 0.079537 (98.3%,0.080952,0.161905), normalized delay 0.001497 (1.017800)

**********rb: 25 ***mcs : 0  *********SNR = 11.400000 dB (0.000000): TX 510 dB (gain -12.779061 dB), N0W 30.000000 dB, I0 29 dB, delta_IF -1268 [ (39,0) dB / (29,0) dB ]*************************
Errors (62/5000 0/62 0/0 0/0), Pe = (1.240000e-02,0.000000e+00,0.000000e+00,0.000000e+00) => effective rate 0.079961 (98.8%,0.080952,0.161905), normalized delay 0.001489 (1.012400)

**********rb: 25 ***mcs : 0  *********SNR = 11.600000 dB (0.000000): TX 510 dB (gain -12.575662 dB), N0W 30.000000 dB, I0 29 dB, delta_IF -1268 [ (42,0) dB / (29,0) dB ]*************************
Errors (63/5000 3/63 0/3 0/0), Pe = (1.260000e-02,6.000000e-04,0.000000e+00,0.000000e+00) => effective rate 0.079898 (98.7%,0.080952,0.161905), normalized delay 0.001490 (1.013200)

**********rb: 25 ***mcs : 0  *********SNR = 11.800000 dB (0.000000): TX 510 dB (gain -12.376115 dB), N0W 30.000000 dB, I0 29 dB, delta_IF -1268 [ (44,0) dB / (29,0) dB ]*************************
```

Simulator Results (2/2)

- ✓ **The results will be dumped in *.csv**
- ✓ **Open the *.csv by Microsoft Excel**
  - Plot BER vs. SNR (Appendix A)



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	#SNR	mcs	nb_rb	TBS	rate	errors[0]	trials[0]	errors[1]	trials[1]	errors[2]	trials[2]	errors[3]	trials[3]
2	-2	0	25	680	0.080952	2493	2502	2459	2493	2340	2459	0	2340
3	-1.8	0	25	680	0.080952	2488	2502	2437	2488	2270	2437	0	2270
4	-1.6	0	25	680	0.080952	2490	2502	2411	2490	2208	2411	0	2208
5	-1.4	0	25	680	0.080952	2484	2502	2417	2484	2146	2417	0	2146
6	-1.2	0	25	680	0.080952	2472	2502	2360	2472	2047	2360	0	2047
7	-1	0	25	680	0.080952	2464	2502	2322	2464	1941	2322	0	1941
8	-0.8	0	25	680	0.080952	2438	2502	2242	2438	1796	2242	0	1796
9	-0.6	0	25	680	0.080952	2436	2502	2224	2436	1743	2224	0	1743
10	-0.4	0	25	680	0.080952	2403	2502	2124	2403	1577	2124	0	1577
11	-0.2	0	25	680	0.080952	2369	2502	2051	2369	1477	2051	0	1477
12	0	0	25	680	0.080952	2353	2502	1966	2353	1303	1966	0	1303
13	0.2	0	25	680	0.080952	2302	2502	1855	2302	1175	1855	0	1175
14	0.4	0	25	680	0.080952	2242	2502	1739	2242	1043	1739	0	1043
15	0.6	0	25	680	0.080952	2199	2502	1644	2199	903	1644	0	903
16	0.8	0	25	680	0.080952	2179	2502	1549	2179	814	1549	0	814
17	1	0	25	680	0.080952	2072	2502	1392	2072	651	1392	0	651
18	1.2	0	25	680	0.080952	2024	2502	1269	2024	562	1269	0	562
19	1.4	0	25	680	0.080952	1965	2502	1175	1965	513	1175	0	513
20	1.6	0	25	680	0.080952	1854	2502	1063	1654	409	1063	0	409
21	1.8	0	25	680	0.080952	1795	2502	1001	1795	328	1001	0	328
22	2	0	25	680	0.080952	1698	2502	818	1698	272	818	0	272
23	2.2	0	25	680	0.080952	1549	2502	757	1549	255	757	0	255

OAI PHY Simulator LAB

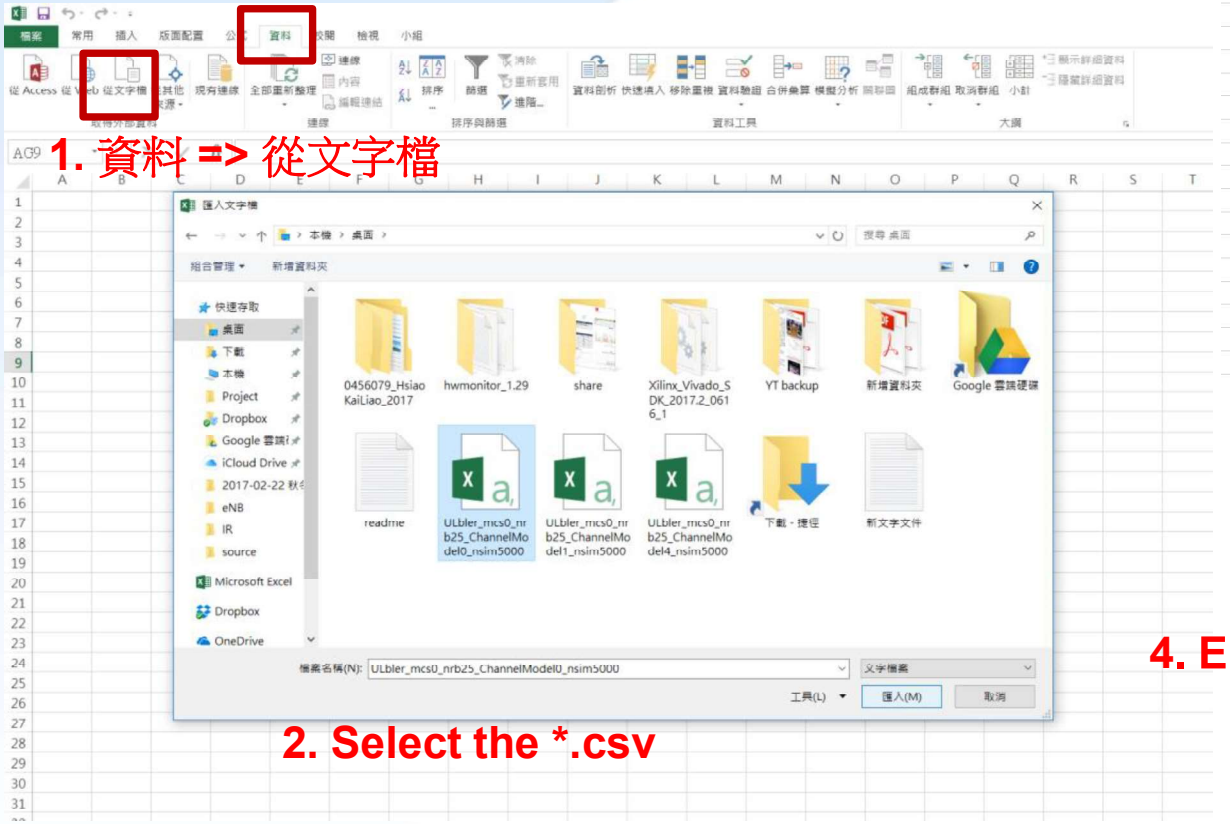
OAI PHY simulator

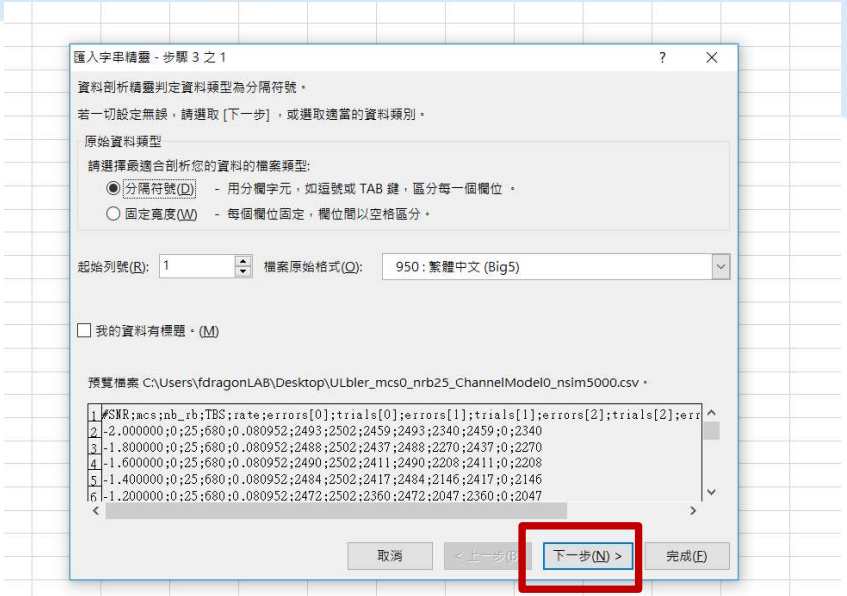
- ✓ Build the PHY simulator
- ✓ Trace the flow of the simulator, *ulsim*
- ✓ Re-fix the code and then the SNR step will be 1dB
  - "`/openairinterface5g/opanair1/SIMULATION/LTE_PHY/ulsim.c`".
- ✓ Show the simulation result in the terminal

Appendix A (1/2) Plot in Excel

Wireless

- ✓ **Open the *.csv by Microsoft Excel**
  - Plot BER vs. SNR

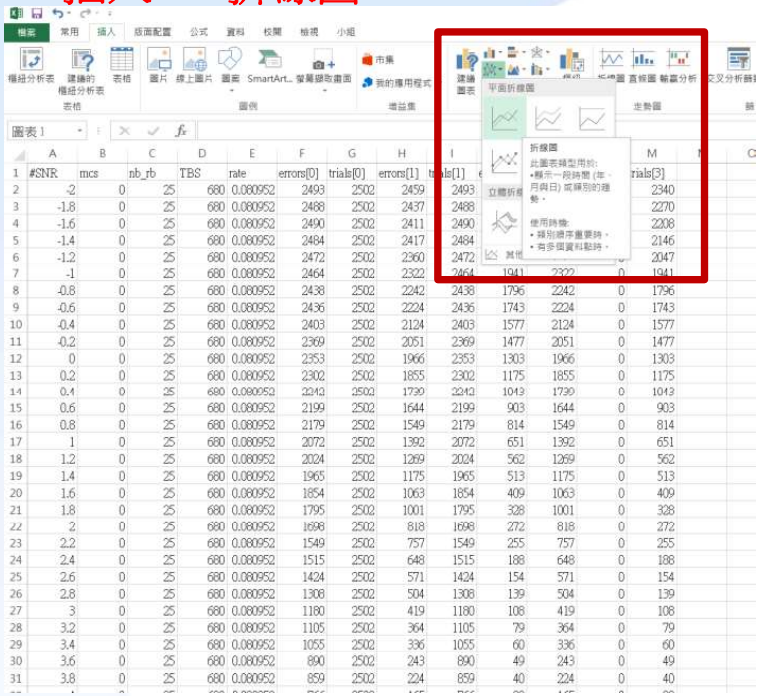




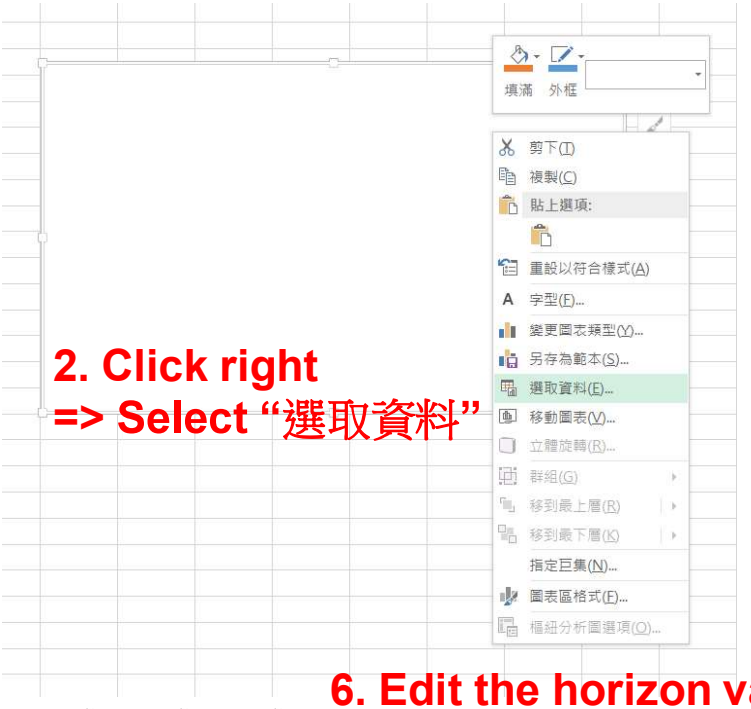
Appendix A (2/2) Plot in Excel

✓ Plots BER vs. SNR in Microsoft Excel

1. 插入 => 折線圖

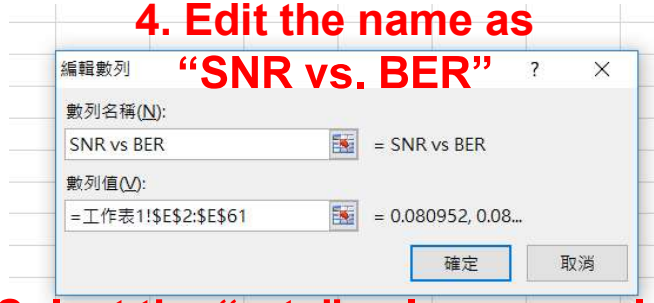


2. Click right
=> Select “選取資料”



3. 新增

4. Edit the name as “SNR vs. BER”



5. Select the “rate” column as values

6. Edit the horizon values as the “#SNR” column

Reference

[1] https://www.openairinterface.org/docs/workshop/8_Fall2019Workshop-Beijing/Training/2019-12-03-KALTENBERGER-1.pdf

[2] OAI wiki, https://gitlab.eurecom.fr/oai/openairinterface5g/-/wikis/home

[3] OAI system requirements, https://gitlab.eurecom.fr/oai/openairinterface5g/-/wikis/OpenAirSystemRequirements

[4] Open cells, https://open-cells.com/index.php/sim-cards/

[5] UICC/SIM program, https://github.com/lfarizav/program_uicc

[6] iperf usage, https://cms.35g.tw/coding/%E5%88%A9%E7%94%A8-iperf-%E6%B8%AC%E8%A9%A6%E7%B6%B2%E8%B7%AF%E6%95%88%E8%83%BD/