1 Reading guide

This guide consists of some updated notes regarding OpenAirInterface, as well as some old notes which can be regarded as legacy made for an older version of OpenAirInterface. The reader should only use the legacy notes as a guideline as the suggested setup (eNodeB and CN on different PCs) has a different setup.

2 Notes

OpenAirInterface has recently overhauled their installation page (and wiki/git), they now provide a much more thorough installation guide, these can all be found by following this link: OAI home page
The installation guide can be found in Tutorials (Usage of OpenAirInterface) $--$ > How to connect OAI eNB (USRP B210) with COTS UE - or by following this link: OAI official installation guide.
Note that the site now also has community managed tutorials which popped up on the mailing list in the past year, some of these serve the same purpose as the legacy part of this document, expect that the external guides are probably more thorough since they made it to the official website.

2.1 Mailing lists

It is highly recommended that you subscribe to the mailing lists for both OAI (if you decide to use it) and SRS, (a mailing list is like a forum, but for smaller communities). This allows you to search the emails for answers if others had similar issues earlier (there is also an online archive of the list, but the search tool can be a bit tricky if one want to search many mails for a keyword).
Subscribing to the mailing list for OAI can be done here: OAI mailing list
I recommend subscribing to both openair5g-user and openaircn-user, sometimes quite a lot of mails are sent, so I recommend making a folder for each of them in your mail programs.
You can subscribe to srs here: SRS mailing list

3 Legacy

Note: This guide is based on EPC and CN running on the same machine.

OpenAirInterface base station installation guide

Date: 13 February 2017
    This manual describes the installation of OpenAirInterface base station on Ubuntu 14.04 LTS.
    This manual focus is on installing the Base Station module of OpenAirInterface, however many of the following steps should be relevant for other OAI modules

4 Linux preparations

1. Install Ubuntu 14.04 LTS

2. OpenAirInterface requires at least linux low latency kernel version 4.7, i recommend using 4.8.something as it had all the required packages

   Optional: Update '/etc/default/grub' file to automatically boot up with the new kernel.
   Comment out the line

#GRUB_DEFAULT=0

And add the line:

GRUB_DEFAULT="Advanced options for Ubuntu>Ubuntu, with Linux 4.8.something.0−031900−lowlate

Then run

```
$ sudo update−grub
```

The version can be verified using uname -r (it should show exact version)

5 Prerequisites

5.1 Install git

```
$ sudo apt−get update && sudo apt−get install git
```

5.2 Install USRP drivers

This part is in a "large part" copied from http://files.ettus.com/manual/page_build_guide.html First, the prerequisites should be installed

```
$ sudo apt−get install libboost−all−dev libusb−1.0−0−dev python−mako doxygen python−docuti
```

Obtain the source code:

```
$ mkdir ~/Desktop/massSDR
$ cd ~/Desktop/massSDR
$ git clone git://github.com/EttusResearch/uhd.git
```

Build and install:

```
$ cd uhd/host
$ mkdir build && cd build
$ cmake ../
$ make
$ make test
$ sudo make install
```

Setup library path:

```
$ sudo su −c "echo '/home/massm2m/Desktop/massSDR/uhd/host/build/lib ' \
> /etc/ld.so.conf.d/libuhd.conf"
$ sudo ldconfig
```

The installation can be verified by using the following command:

```
$ sudo uhd_find_devices
```

Which should list the USRP B210 Device

5.3 Updating USRP drivers

1. Pull newest version from git

```
$ cd ~/Desktop/massSDR/uhd
$ git pull
```

2. Uninstall existing installation

```
$ cd hosts/build
$ sudo make uninstall
```

Delete the file 'CMakeCache.txt' if it exists in the 'build' directory.

```
$ rm −f CMakeCache.txt
```

3. Compile and install new version

```
$ cmake ../
$ make
$ make test
$ sudo make install
```

4. Verify installation

```
$ sudo uhd_find_devices
```

6 Clone eNodeB and EPC

A large part of the remaining steps are from https://gitlab.eurecom.fr/oai/openairinterface5g/wikis/AutoBuild

1. Add certificate

```
echo −n | openssl s_client −showcerts −connect gitlab.eurecom.fr:443 2>/dev/null | sed −ne
```

2. Clone repositories

```
$ mkdir ~/Desktop/massSDR/openAirInterface
$ cd ~/Desktop/massSDR/openAirInterface
$ git clone https://gitlab.eurecom.fr/oai/openairinterface5g.git
$ git clone https://gitlab.eurecom.fr/oai/openair−cn.git
```

7 Overview

The set-up used in this user guide consists of running eNodeB and EPC on the same pc, this will mostly impact the configuration of the files. It does not matter if you start by installing EPC(located in openair-cn) or eNodeB (located in openairinterface5g) as shown on the picture below. Through this user guide, the hostname is "massm2m-OptiPlex-9020" and "111.111" is referred to as the realm.
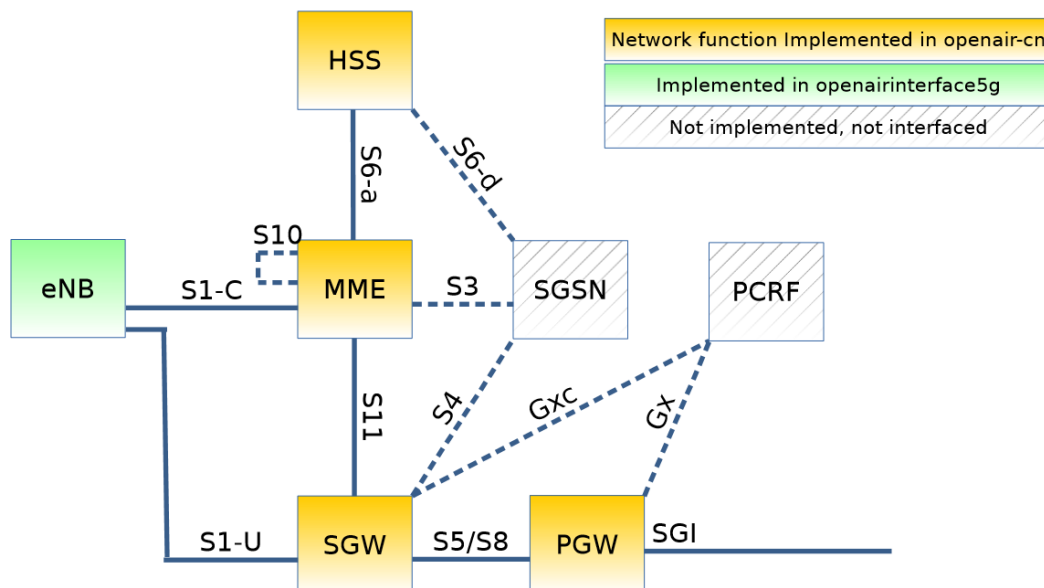

Figure 1 EURECOM core network entities overview

8   Install eNodeB

8.1   Edit PC host configuration

Note the output from

```
$ hostname
[hostname]
```

Add this to /etc/hosts as shown below

```
127.0.0.1                    [hostname].111.111  [hostname]
```

8.2   Install eNodeB

go to your Openairinterface5g directory and set the source environment

```
$ source oaienv
```

Go to cmake_targets directory

```
$ cd openairinterface5g/cmake_targets
```

Install OpenAirInterface eNB

```
$ ./build_oai −c −I −−eNB −x −w USRP
```

The Parameters are -c Clean install -I Installs external packages, this is only needed once, press Y to all packages not preciously installed –eNB Installs the Base Station of OpenAirInterface -x Adds a software oscilloscope -w USRP Adds hardware support for USRP boards More information can be found by running ./build_oai -h

```
./build_oai −h
```

If asked for MySQL root password enter "linux". The software is installed into the 'targets/' directory.

8.3   Configure eNodeB

In order to configure the eNodeB, you must first find the correct configuration file and store it somewhere nice, the config files are located in

```
cd ~/openairinterface5g/targets/PROJECS/GENERIC−LTE−EPC/CONF
```

In my case i had to use "enb.band7.tm1.usrpb210.conf" There are however some things that has to be changed, double check that the correct downlink frequency is set, as i had to change it from 2680000000 to 2660000000. This is also where the target powers are set for the different channels, the default values should suffice for most cases.

```
////////// MME parameters:
    mme_ip_address        = ( { ipv4        = "192.170.0.1";
                                ipv6        = "192:168:30::17";
                                active      = "yes";
                                preference  = "ipv4";
                              }
                            );

    NETWORK_INTERFACES  :
    {
            ENB_INTERFACE_NAME_FOR_S1_MME                = "eth0:3";
        ENB_IPV4_ADDRESS_FOR_S1_MME              = "192.170.0.2/24";

        ENB_INTERFACE_NAME_FOR_S1U               = "eth0:4";
```

4

```
        ENB_IPV4_ADDRESS_FOR_S1U                        = "192.170.1.2/24";
        ENB_PORT_FOR_S1U                                = 2153;
    };
```

Verify that the MCC/MNC configuration is contained in mcc_mnc_list in openairinterface5g/openair-cn/UTILS/mcc_mnc_itu.c. If not, then add an element to the list, e.g. 208, "93", and recompile epc and hss from openair-cn.

8.4   Run eNodeB

NB: You will have to install and configure EPC before you can connect to the eNodeB

In order to start the eNodeB, go to the following directory

```
~/openairinterface5g/targets/bin/lte-softmodem.Rel10 -O enb.band7.tm1.usrpb210.conf -26 -t1
```

Where: -O path to config file -m Maximum downlink MCS -t Maximum uplink MCS -W Enable L2 Wireshark messages on localhost (optional)

9   Install EPC

The overall config of the EPC is shown below, but will also be explained in steps as the files modules are installed
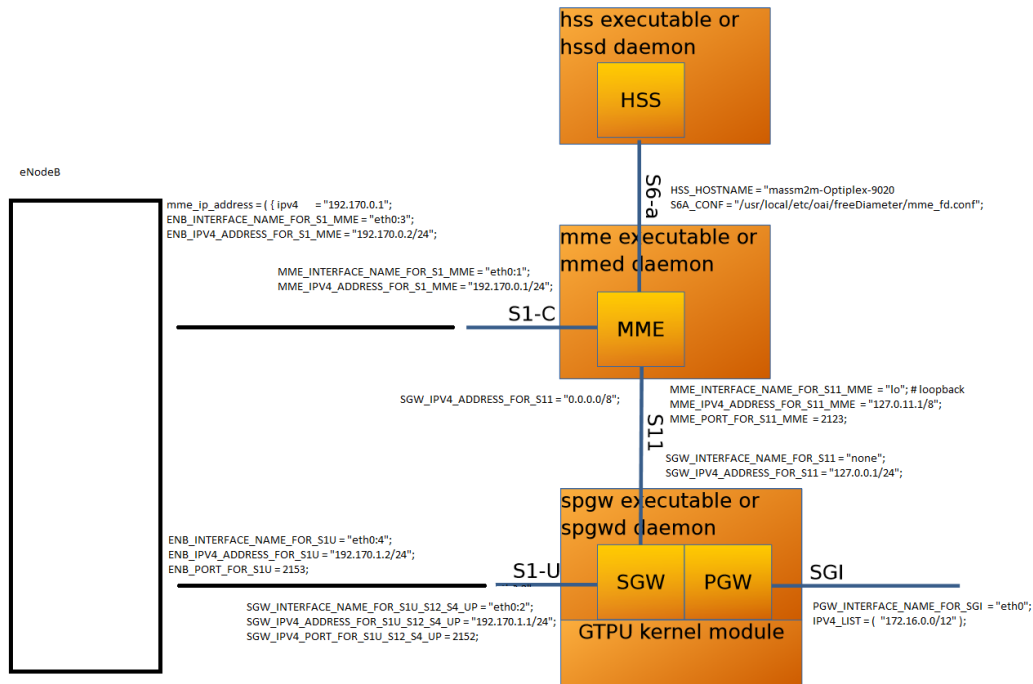

Figure 2 EPC Deployment view

9.1   Build HSS

Go to the openaircn/scripts directory

```
cd ~/openair-cn/SCRIPTS
```

Then run the build hss script

```
$ ./build_hss −i
```

Note that -i is only needed once, since it installs missing packages

You will be prompted to install MySQL and create a database If asked for MySQL root password, enter "linux".

You can choose to either install and use Phpmyadmin or use the database script shown in appendix B. Do note that if you choose to use phpmyadmin, press yes and follow the instructions, configure phpmyadmin as apache when prompted.

9.2 Configure HSS

A mySQL database has to be created:

```
cd ~/openair−cn/SCRIPTS
./create_hss_database root linux hssadmin admin oai_db
```

The arguments are login information and database name.

The contents of the HSS config file has to be changed, the file is located at openair-cn/ETC/hss.conf.

```
#################################
HSS  :
{
## MySQL mandatory options
MYSQL_server = "127.0.0.1";        # HSS S6a bind address
MYSQL_user   = "hssadmin";  # Database server login
MYSQL_pass   = "admin";  # Database server password
MYSQL_db     = "oai_db";        # Your database name

## HSS options
OPERATOR_key = "11111111111111111111111111111111"; # OP key matching your database

RANDOM = "true";                                    # True random or only pseudo random (fo

## Freediameter options
FD_conf = "/usr/local/etc/oai/freeDiameter/hss_fd.conf";
};
```

Copy the file OPENAIRCN_DIR/ETC/hss.conf into /usr/local/etc/oai

```
~/openair−cn/SCRIPTS$ sudo mkdir −p /usr/local/etc/oai/freeDiameter
~/openair−cn/SCRIPTS$ sudo cp $OPENAIRCN_DIR/ETC/hss.conf /usr/local/etc/oai
```

Note that you might need to change permission of the files, (can be done with chmod)

Copy the files OPENAIRCN_DIR/ETC/hss_fd.conf and OPENAIRCN_DIR/ETC/acl.conf into /usr/local/etc/oai/freeDiameter directory

```
~/openair−cn/SCRIPTS$ sudo  cp $OPENAIRCN_DIR/ETC/acl_fd.conf OPENAIRCN_DIR/ETC/hss_fd.con
```

Change Identity and Realm in hss_fd.conf as follows

```
Identity = "massm2m−OptiPlex−9020.111.111";
...
Realm = "111.111";
```

Nothing has to be changed in acl.conf.

Take care of file permissions.

If you haven't changed the /etc/hosts file yet (also done in eNodeB installation) change it now as follows:

```
127.0.0.1                    [hostname].111.111  [hostname]
```

"111.111" is usually referred to as "realm" You can find the name of the pc by using the "whoami" command

9.3 Run HSS

Before the first HSS run, you will have to check/generate the required certificates

˜/openair−cn/SCRIPTS$ ./check_hss_s6a_certificate /usr/local/etc/oai/freeDiameter massm2m−O

The HSS can be stared using the ./run_hss script, it should not be started with any flags for normal use, a list of options can be seen by running it with the -h flag.

9.4 Build MME

Go to the openaircn/scripts directory

cd ˜/openair−cn/SCRIPTS

Then run the build hss script

$ ./build_mme −i

Note that -i is only needed once, since it installs missing packages

9.5 Configure MME

The contents of the MME config file has to be changed, the file is located at openair-cn/ETC/mme.conf.

```
MME :
{
    REALM                                        = "111.111";
    ...

    S6A :
    {
    S6A_CONF                      = "/usr/local/etc/oai/freeDiameter/mme_fd.conf";
        HSS_HOSTNAME                   = "massm2m−OptiPlex−9020";
    };
    ...

GUMMEI_LIST = (
    {MCC="208" ; MNC="93"; MME_GID="4" ; MME_CODE="1"; } # YOUR GUMMEI CONFIG HERE
    );
        ...

TAI_LIST = (
        {MCC="208" ; MNC="93";  TAC = "1"; } # YOUR TAI CONFIG HERE
    );
        ...
NETWORK_INTERFACES :
    {
        # MME binded interface for S1−C or S1−MME  communication (S1AP), can be ethernet in
        MME_INTERFACE_NAME_FOR_S1_MME               = "eth0:1"; # YOUR NETWORK CONFIG HERE
        MME_IPV4_ADDRESS_FOR_S1_MME                 = "192.170.0.1/24"; # YOUR NETWORK CONFIG HEI

        # MME binded interface for S11 communication (GTPV2−C)
        MME_INTERFACE_NAME_FOR_S11_MME              = "lo"; # YOUR NETWORK CONFIG HERE
        MME_IPV4_ADDRESS_FOR_S11_MME                = "127.0.11.1/8"; # YOUR NETWORK CONFIG HERE
        MME_PORT_FOR_S11_MME                        = 2123; # YOUR NETWORK CONFIG HERE
    };
```

```
          . . .
Logging  output  can  be  set  as  the  user  wants ,  i  recommend  "CONSOLE"  while  debugging
          . . .
S–GW :
{
    # S–GW binded interface for S11 communication (GTPV2–C) ,  if  none  selected  the  ITTI  mes
    SGW_IPV4_ADDRESS_FOR_S11                    = "0.0.0.0/8"; # YOUR NETWORK CONFIG HERE
    #SGW_IPV4_ADDRESS_FOR_S11                   = "127.0.11.2/8"  # YOUR NETWORK CONFIG HERE

};
```

Copy the file OPENAIRCN_DIR/ETC/mme.conf into /usr/local/etc/oai

```
~/openair−cn/SCRIPTS$ sudo  cp $OPENAIRCN_DIR/ETC/mme. conf  / usr / lo c a l / e tc / oai
```

Take care of permissions if necessary

The contents of the MME_fd config file has to be changed, the file is located at openair-cn/ETC/mme_fd.conf

```
Identity = "massm2m−OptiPlex −9020.111.111";
Realm = "111.111";
. . .
ConnectPeer= "massm2m−OptiPlex −9020.111.111" { ConnectTo = "127.0.0.1"; No_SCTP ; No_IPv6;
realm = "111.111";};
```

Copy the file OPENAIRCN_DIR/ETC/mme_fd.conf into /usr/local/etc/oai/freeDiameter

```
~/openair−cn/SCRIPTS$ sudo   cp $OPENAIRCN_DIR/ETC/mme_fd. conf  / usr / lo c a l / e tc / oai / freeDiame
```

In order to build the MME, go to the openair-cn/SCRIPTS directory and use the following command

```
./ build_mme −−clean
```

9.6   Run MME

Before the first MME run, you will have to check/generate the required certificates

```
~/openair−cn/SCRIPTS$ ./ check_mme_s6a_certificate  / usr / lo c a l / e tc / oai / freeDiameter  massm2m−
```

The MME can be stared using the ./run_mme script, it should not be started with any flags for normal
use, a list of options can be seen by running it with the -h flag.

9.7   Build SPGW

Start by installing libgtpnl (http://git.osmocom.org/libgtpnl/) and any dependencies
    Go to the openaircn/scripts directory

```
cd  ~/openair−cn/SCRIPTS
```

Then run the build hss script

```
$ ./ build_mme −i
```

Note that -i is only needed once, since it installs missing packages

9.8   Configure SPGW

The contents of the SPGW config file has to be changed, the file is located at openair-cn/ETC/SPGW.conf

```
S–GW :
{
    NETWORK_INTERFACES :
    {
```

```
        # S–GW binded interface for S11 communication (GTPV2–C), if none selected the ITTI
        SGW_INTERFACE_NAME_FOR_S11                = "none"; # STRING, interface name, YOUR NE
        SGW_IPV4_ADDRESS_FOR_S11                  = "127.0.0.1/24"; # STRING, CIDR, YOUR NETV

        # S–GW binded interface for S1–U communication (GTPV1–U) can be ethernet interface
        SGW_INTERFACE_NAME_FOR_S1U_S12_S4_UP      = "eth0:2"; # STRING, interface name, YOUR
        SGW_IPV4_ADDRESS_FOR_S1U_S12_S4_UP        = "192.170.1.1/24"; # STRING, CIDR, YOUR NE
        SGW_IPV4_PORT_FOR_S1U_S12_S4_UP           = 2152; # INTEGER, port number, PREFER NOT
        ...
Logging output can be set as the user wants, i recommend "CONSOLE" while debugging
        ...
        # P–GW binded interface for SGI (egress/ingress internet traffic)
        PGW_INTERFACE_NAME_FOR_SGI                = "eth0"; # STRING, YOUR NETWORK CONFIG HERE
        ...
    IP_ADDRESS_POOL :
    {
        IPV4_LIST = (
                       "172.16.0.0/12"
# STRING, CIDR, YOUR NETWORK CONFIG HERE.
                     );
    };
```

Copy the file OPENAIRCN_DIR/ETC/spgw.conf into /usr/local/etc/oai

```
~/openair−cn/SCRIPTS$ sudo cp $OPENAIRCN_DIR/ETC/spgw.conf /usr/local/etc/oai
```

Take care of permissions if necessary

9.9   Run SPGW

The SPGW can be stared using the ./run_spgw script, it should not be started with any flags for normal use, a list of options can be seen by running it with the -h flag.

10   Startup

First, the interfaces has to be configured as follows:

```
$ ifconfig eth0:1 192.170.0.1 up
$ ifconfig eth0:2 192.170.1.1 up
$ ifconfig eth0:3 192.170.0.2 up
$ ifconfig eth0:4 192.170.1.2 up
```

The EPC and eNodeB should under normal circumstances always be started in this order:

1. HSS

2. MME

3. SPGW

4. eNodeB

This can be done manually as shown earlier, or by using a start-up script shown in appendix A.

11   Wireshark

If 'lte-softmodem' is started with the '-W' flag, then it is possible to capture and see packets in Wireshark.

11.1 Wireshark Configuration

1. Open Wireshark
    2. Go to Edit -¿ Preferences
    3. Protocols -¿ MAC-LTE Check "Try Heuristic LTE-MAC over UDP framing"
    4. Protocols -¿ PDCP-LTE Check "Try Heuristic PDCP-MAC over UDP framing"
    5. Protocols -¿ RLC-LTE Check "Try Heuristic RLC-MAC over UDP framing"
    6. Protocols -¿ UDP Check "Try Heuristic sub-dissectors first"

11.2 Start Capture

1. Start capture for all interfaces.
    2. Filter using 's1ap or lte_rrc or mac-lte or rlc-lte or pdcp-lte'.

11.3 Log LTE traffic only

If 'lte-softmodem' is started with '-P trace.pcap', then it saves the LTE traffic in 'trace.pcap'. Notice that if this is used, then LTE traffic will not be visible in Wireshark.

When the pcap file is opened in Wireshark, you may have to go to Edit -¿ Preferences -¿ Protocols -¿ DLT_USER -¿ Edit Encapsulation Table. Then add a new table with:
    - DLT: User 0 (DLT = 147) - Payload protocol: mac-lte-framed
    Then the packets should be parsed correctly by Wireshark.

Appendices

A Start-up script

Note that path might change for you, and that the sleep is optional.

```
#!/bin/bash

oai_path="/home/massm2m/Desktop/massSDR/openAirInterface"


echo "Configuring network"
sudo ifconfig eth0:1 192.170.0.1 up
sudo ifconfig eth0:2 192.170.1.1 up
sudo ifconfig eth0:3 192.170.0.2 up
sudo ifconfig eth0:4 192.170.1.2 up

#sleep 1

echo "Starting MME GW"
PROMPT_COMMAND='unset PROMPT_COMMAND; history -s "$CMD"; eval "$CMD"' \
    CMD='sudo ./openair-cn/SCRIPTS/run_epc \
    gnome-terminal --working-directory="${oai_path}"

#sleep 1

echo "Starting HSS"
PROMPT_COMMAND='unset PROMPT_COMMAND; history -s "$CMD"; eval "$CMD"' \
    CMD="sudo ./openair-cn/BUILD/HSS/BUILD/oai_hss \
    gnome-terminal --working-directory="${oai_path}"
```

```
#sleep 1

echo "Starting eNodeB"
PROMPT_COMMAND='unset PROMPT_COMMAND; history -s "$CMD"; eval "$CMD"' \
    CMD="sudo ./openairinterface5g/targets/bin/lte-softmodem.Rel10 -O enb.band7.tm1.usrpb21
    gnome-terminal --working-directory="${oai_path}"
#use "| tee testlog.txt" to see output in both terminal and logfile
```

B   HSS add user

In order to authenticate with OpenAirInterface it is required to add a user to the HSS database. This re-
quires several steps, so a script has been created for doing so: https://github.com/AndersKaloer/oai_adduser
Update MME_HOST and MME_REALM on the first lines to match the hostname and realm used in the
installation. It works as follows:

```
$ python oai_adduser.py --imsi=208930000000008 \
--msisdn=88211005938 --ki=2DC204753BEA70DC8F010A4DFEDCEE33 \
--opc=bfa1d8864980a90313f0560144f97a74
```