

## EPC User's Guide

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### Abstract

The deliverable presents the EPC developed by EURECOM.

The document presents the deployment scenarios of the EPC, its configuration, installation testing and running.

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## List of authors

Company	Authors
EURECOM	Christian BONNET, Lionel GAUTHIER, Rohit GUPTA, Florian KALTENBERGER, Raymond KNOPP, Adlen Ksentini, Navid NIKAIEN, Cedric ROUX.
OPEN CELLS	Laurent THOMAS.

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## Abbreviations

3GPP	Third Generation Partnership Project.
APN	Access Point Name.
CIDR	Classless Inter-Domain Routing.
eNB	e Node B.
EPC	Evolved Packet Core.
EPS	Evolved Packet System.
FQDN	Fully qualified domain name.
HSS	Home Subscriber Server.
IMEI	International Mobile Station Equipment Identity.
IMEISV	International Mobile Station Equipment Identity Software Version.
LTE	Long Term Evolution.
MME	Mobility Management Entity.
MSISDN	Mobile Station International Subscriber Directory Number.
NW	Network.
P-GW	PDN Gateway, Packet Data Network Gateway.
PDN	Packet Data Network.
QoS	Quality of Service.
SCTP	Stream Control Transmission Protocol.
S-GW	Serving Gateway.
SIM	Subscriber Identity Module.
TCP	Transmission Control Protocol.
USIM	Universal Subscriber Identity Module.

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# 1 Introduction

## 1.1 Overview

The EURECOM EPC is a bundle of software components that provides the MME, S+P-GW, HSS functions of the LTE core EPC architecture (<http://www.3gpp.org/DynaReport/23002.htm>).

Actually the SGW and the PGW are merged together, there is no S5 or S8 interface between the two functional entities.

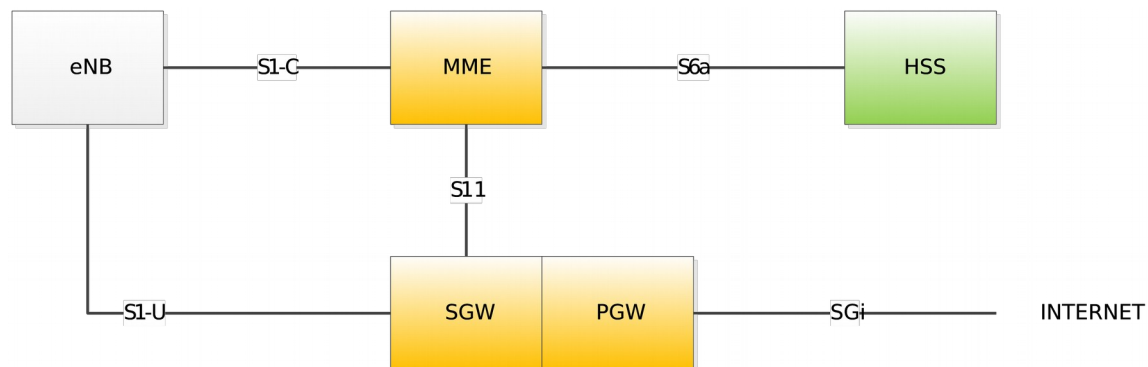


Figure 1 EURECOM core network entities overview

## 1.2 Deployment scenario

One deployment scenario is considered with the EURECOM EPC.

### 1.2.1 Separate EPC platform

Actually this deployment scenario is under development.

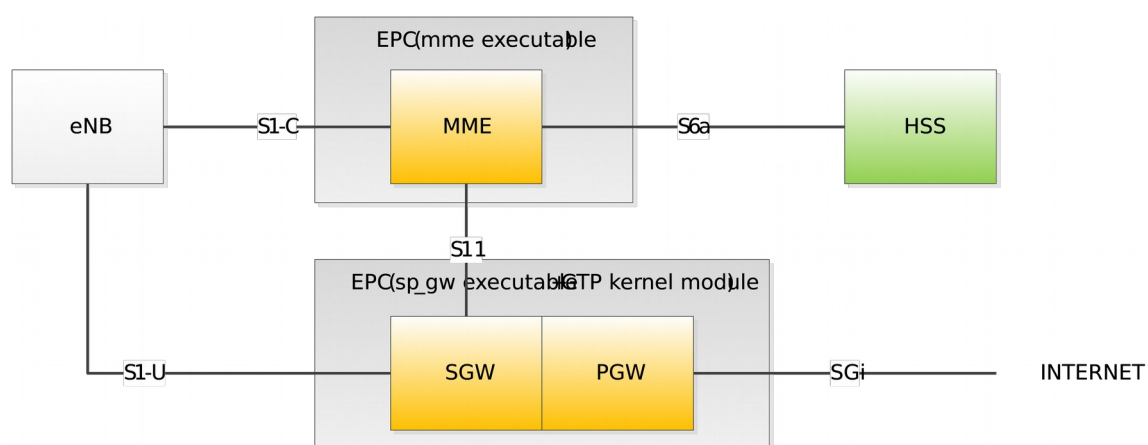


Figure 2 EPC Deployment in MME SP-GW

Any core network entity (MME, S/P-GW, HSS) may be deployed on the same EURECOM eNB host or on a common host or on its own host.



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If a third party eNB is used, then it is preferable not to run the EURECOM EPC on this eNB.

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## 2 EPC Installation

### 2.1 Operating system

The EPC software has only been tested on **UBUNTU 14.04x64** LINUX distribution on Intel x86 64 bits platforms. Actually on the host running the SP-GW, the GTPv1-U implementation **requires** that your host run a **kernel version equal to 3.19 (we use 3.19.0-28)**.

### 2.2 EPC source code

#### Important!

In this document **OPENAIRCN\_DIR** is the path to the EPC source code top directory (i.e. openair-cn working directory).

It is assumed that you are logged onto your machine(s) as a non root user and you configured your system to be a sudoer user.

The EPC software can be obtained from our git server. You will need a git client to get the sources.

If git is not installed on your computer, execute in a shell the following command (Ubuntu):

```
user@host:~ sudo apt-get install git
```

Configure git with your name/email address (only important if you are developer and want to checkin code to Git):

```
git config --global user.name "Your Name"
git config --global user.email "Your email address"
```

Add a certificate from gitlab.eurecom.fr to your Ubuntu 14.04 installation (you need to be root user):

```
root@host:~# echo -n | openssl s_client -showcerts -connect gitlab.eurecom.fr:443 2>/dev/null |
sed -ne '/-BEGIN CERTIFICATE-/,/-END CERTIFICATE-/p' >> /etc/ssl/certs/ca-certificates.crt
```

#### Important!

In this document **OPENAIRCN\_DIR** is the path to the EPC source code top directory (i.e. openair-cn working directory).

#### 2.2.1 Get the code without login

In order to checkout the Git repository (for OAI Users without login to gitlab server)

```
user@host:~ git clone https://gitlab.eurecom.fr/oai/openair-cn.git
```

#### 2.2.2 Get the code with login (contributors)

In order to check out the Git repository (for OAI Developers/admins with login to gitlab server)

Please send an email to [openair\\_tech@eurecom.fr](mailto:openair_tech@eurecom.fr) to be added to the repository as a developer (only important for users who want to commit code to the repository). If you do not have an account on gitlab.eurecom.fr, please register yourself to gitlab.eurecom.fr.

**Checkout with using ssh keys:**

You will need to put your ssh keys in <https://gitlab.eurecom.fr/profile/keys> to access to the git repo. Once that is done, checkout the git repository using:

```
git clone git@gitlab.eurecom.fr:oai/openair-cn.git
```

**Checkout with user name/password prompt:**

```
git clone https://YOUR\_USERNAME@gitlab.eurecom.fr/oai/openair-cn.git
```

## 2.3 Additional software

Some software installations have to be done prior to build the core network entities.

Please find for information, bellow a summary of third party software included in source tree or that must be installed prior to EPC components compilation.

Installed software	MME entity	S/P-GW entity	HSS entity	Licence
<b>UBUNTU packages</b>	<p><b><u>Removed packages:</u></b></p> <p>libgnutls-dev 'libgnutlsxx2?' nettle-dev nettle-bin.</p> <p><b><u>build/dev/debug tools:</u></b></p> <p>autoconf automake bison build-essential cmake cmake-curses-gui doxygen doxygen-gui flex gccxml, gdb git, pkg-config, subversion.</p> <p><b><u>Removed packages:</u></b></p> <p>libgnutls-dev 'libgnutlsxx2?' nettle-dev nettle-bin.</p> <p><b><u>Network tools:</u></b></p> <p>ethtool iperf iproute vlan tshark</p> <p><b><u>Libraries:</u></b></p> <p>guile-2.0-dev libconfig8- dev libgcrypt11-dev libgmp-dev libhogweed2 libgtk-3-dev libidn2-0- dev libidn11-dev libpthread-stubs0-dev libsctp1 libsctp-dev libssl-dev libtool libxml2 libxml2-dev mscgen openssl python.</p> <p><b><u>Others:</u></b></p> <p>check phpmyadmin python-dev python- pexpect unzip</p>	<p><b><u>build/dev/debug tools:</u></b></p> <p>autoconf, automake, bison, build-essential, cmake, cmake-curses-gui, doxygen, doxygen-gui, flex, gccxml, gdb, git, pkg-config, subversion.</p> <p><b><u>Removed packages:</u></b></p> <p>libgnutls-dev 'libgnutlsxx2?' nettle-dev nettle-bin.</p>	<p><b><u>Removed packages:</u></b></p> <p>libgnutls-dev 'libgnutlsxx2?' nettle- dev nettle-bin.</p> <p><b><u>build/dev/debug tools:</u></b></p> <p>autoconf automake bison build-essential cmake cmake-curses- gui doxygen doxygen- gui flex gdb pkg-config, git subversion.</p> <p><b><u>Libraries:</u></b></p> <p>libconfig8-dev libgcrypt11-dev libidn2- 0-dev libidn11-dev libmysqlclient-dev libpthread-stubs0-dev libsctp1 libsctp-dev libssl-dev libtool mysql- client mysql-server openssl.</p> <p><b><u>Others:</u></b></p> <p>phpmyadmin python- pexpect</p>	...
<b>Nettle</b> ( <a href="ftp://ftp.lysator.liu.se/pub/security/lsh/nettle-2.5.tar.gz">ftp://ftp.lysator.liu.se/pub/security/lsh/nettle-2.5.tar.gz</a> )	Yes <b><u>Dependancy:</u></b> autoconf automake build- essential libgmp-dev.	No	Yes	LGPL
<b>Gnutls</b> ( <a href="ftp://ftp.gnutls.org/gcrypt/gnutls/v3.1/gnutls-3.1.23.tar.xz">ftp://ftp.gnutls.org/gcrypt/gnutls/v3.1/gnutls-3.1.23.tar.xz</a> )	Yes <b><u>Dependancy:</u></b> autoconf automake build- essential libtasn1-6-dev libtasn1-6- dbg libp11-kit-dev libp11-kit0-dbg libtspi- dev libtspi1 libidn2-0-dev libidn11-dev	No	Yes	LGPLv2.1+

Installed software	MME entity	S/P-GW entity	HSS entity	Licence
<b>FreeDiameter</b> ( <a href="http://www.freediameter.net/hg/freeDiameter/archive/1.2.0.tar.gz">http://www.freediameter.net/hg/freeDiameter/archive/1.2.0.tar.gz</a> )	Yes <b>Dependancy:</b> autoconf automake bison build-essential cmake cmake-curses-gui debhelper flex g++ gcc gdb libgcrypt-dev libidn11-dev libmysqlclient-dev libpq-dev libsctp1 libscpt-dev libxml2-dev mercurial python-dev ssl-cert swig	No	Yes	BSD 3 clause license. Check for copyright informations: extensions/dict_sip/* extensions/app_sip/* extensions/app_radgw/rgwx_sip.c extensions/app_diameter/* extensions/dict_mip6a/* extensions/dict_mip6i/* extensions/dict_nas_mip6/* extensions/dict_rfc5777/*
<b>Asn1c</b> ( <a href="https://github.com/vlm/asn1c/trunk">https://github.com/vlm/asn1c/trunk</a> revision 1516)	Yes <b>Dependancy:</b> autoconf automake bison build-essential flex gcc libtool	No	No	BSD 2-Clause Licence
SRC/UTILS/tree.h	Yes	Yes	No	BSD 2-Clause Licence
SRC/UTILS/queue.h	Yes	Yes	No	BSD 3-Clause Licence
SRC/UTILS/LFDS/liblfs6.1.1. ( <a href="http://liblfs.org/">http://liblfs.org/</a> )	Yes	Yes	No	No license
SRC/GTPV2-C/nwgtpv2c-0.11	Yes	Yes	No	Free licence
xtables_addons patched for OAI ( <a href="https://gitlab.eurecom.fr/oai/xtables-addons-oai.git">https://gitlab.eurecom.fr/oai/xtables-addons-oai.git</a> )	No	Yes <b>Dependancy:</b> autoconf automake build-essential dkms iptables iptables-dev linux-headers. Run a kernel version equal to 3.19 (we use 3.19.0-28)	No	GPLv2
<b>The Better String Library</b> ( <a href="http://bstring.sourceforge.net/">http://bstring.sourceforge.net/</a> )	Yes	Yes	No	BSD 3-Clause Licence

**Table 1: 3<sup>rd</sup> party software**

These softwares will be installed by helper scripts, this will be described in following sections.

---

## 2.4 HSS

### 2.4.1 HSS pre-installation

In OPENAIRCN\_DIR/SCRIPTS directory, execute the following command:

```
user@hss-host:~/openair-cn/SCRIPTS$ ./build_hss -i
```

This command will install the required softwares on your host.

Find bellow some hints for some interactive software installations (mysql-server, phpmyadmin).

#### 2.4.1.1 Mysql server installation

Enter here a password for root user, lets call it MS\_PW\_ROOT.

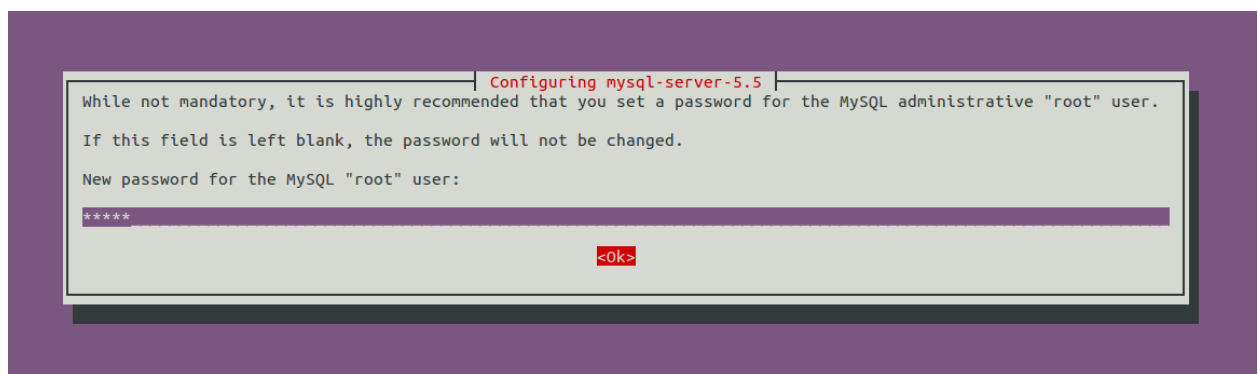
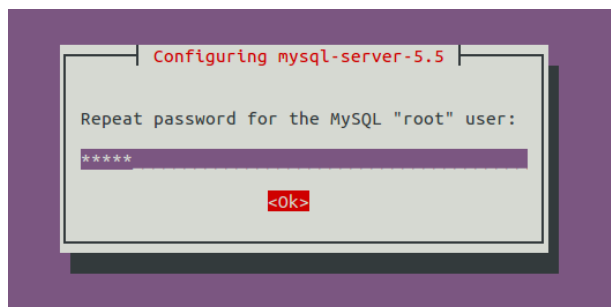


Figure 4 Mysql installation root password



The mysql-server installation process ends here.

#### 2.4.1.2 Phpmyadmin installation details

You should prefer the easiest way

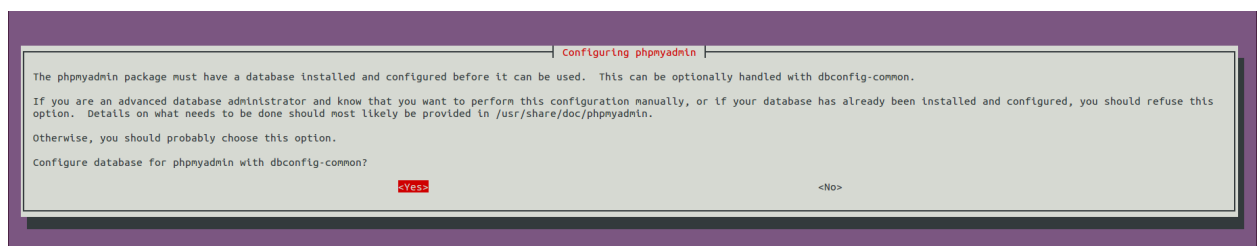


Figure 5 Phpmyadmin installation conf DB

---

Enter here the MS\_PW\_ROOT:

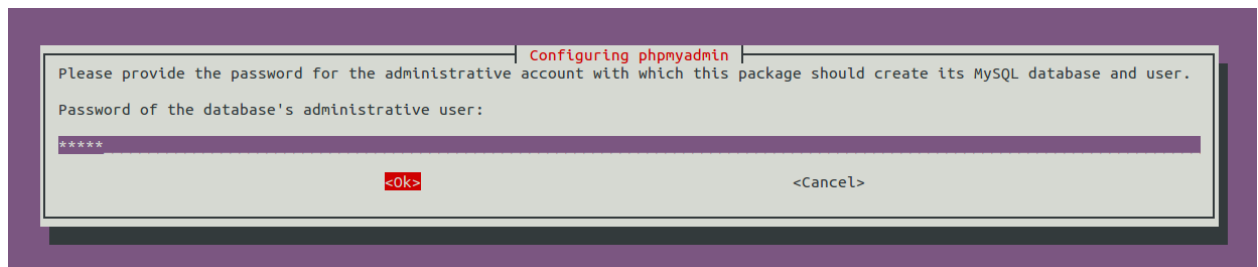


Figure 6 Phpmyadmin installation DB admin password

Please, enter here what will be the phpmyadmin application password, lets call it MS\_PW\_PHP:

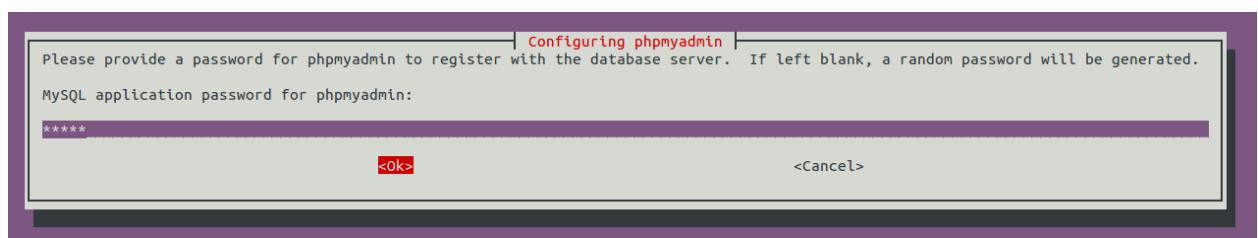
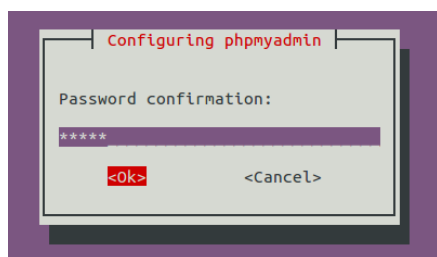


Figure 7 Phpmyadmin installation application password



Choose the web server that has to be configured: Apache.

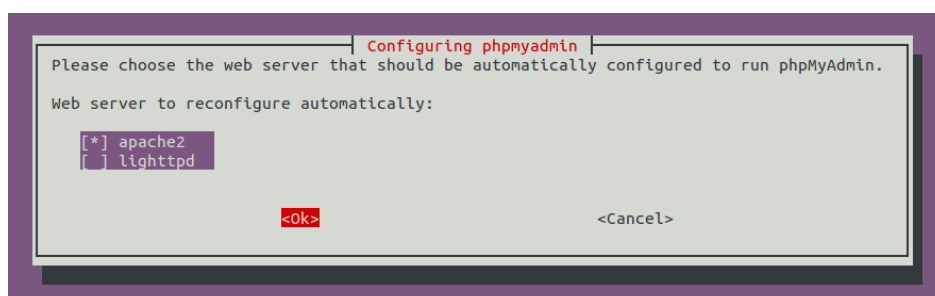


Figure 8 Phpmyadmin installation web server selection

#### 2.4.2 HSS configuration

A template of the HSS configuration file can be found at OPENAIRCN\_DIR/ETC/hss.conf. This configuration file follows the libconfig file syntax (<http://www.hyperrealm.com/libconfig>).

---

Content of OPENAIRCN\_DIR/ETC/hss.conf:

```
HSS :
{
## MySQL mandatory options
MYSQL_server = "127.0.0.1";
MYSQL_user   = "@MYSQL_user@";
MYSQL_pass   = "@MYSQL_pass@";
MYSQL_db     = "oai_db";

## HSS options
OPERATOR_key = "1006020f0a478bf6b699f15c062e42b3"; # OP key for oai_db.sql

RANDOM = "true";

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

#### 2.4.2.1 Step 1

Copy the file OPENAIRCN\_DIR/ETC/hss.conf in /usr/local/etc/oai directory:

```
user@hss-host:~/openair-cn/SCRIPTS$ sudo mkdir -p /usr/local/etc/oai
user@hss-host:~/openair-cn/SCRIPTS$ sudo cp $OPENAIRCN_DIR/ETC/hss.conf
/usr/local/etc/oai
```

Please take care of the permissions of your hss.conf file.

Then customize your copied HSS configuration file:

Parameter	Type	
<b>MYSQL_server</b>	String	IP address of the MySQL server instance where the HSS DB is stored.
<b>MYSQL_user</b>	String, user login	HSS administrator login, could be "hssadmin".
<b>MYSQL_pass</b>	String, password	HSS administrator password, should be MS_PW_PHP.
<b>MYSQL_db</b>	String, database name	Database name, default is oai_db for EURECOM subscribers.
<b>OPERATOR_key</b>	String	Operator key in plain text.
<b>RANDOM</b>	String, allowed values "yes", "no".	Default value is "true". Set false when you want to replay S1-C scenarios.
<b>FD_conf</b>	String	Path to HSS freeDiameter configuration file.

**Table 2: HSS configuration fields**

#### 2.4.2.2 Step 2

Copy the files OPENAIRCN\_DIR/ETC/hss\_fd.conf, OPENAIRCN\_DIR/ETC/acl.conf in /usr/local/etc/oai/freeDiameter directory:

```
user@hss-host:~/openair-cn/SCRIPTS$ sudo mkdir -p /usr/local/etc/oai/
freeDiameter
user@hss-host:~/openair-cn/SCRIPTS$ sudo cp $OPENAIRCN_DIR/ETC/acl.conf
$OPENAIRCN_DIR/ETC/hss_fd.conf /usr/local/etc/oai/freeDiameter
```

---

Please take care of the permissions of your configuration files.

Then customize your copied `hss_fd.conf`, `acl.conf` configuration files if necessary, if you follow this document, it should not be necessary, otherwise please refer to freeDiameter documentation.

### 2.4.2.3 Step 3

A FQDN has to be set for the HSS (see `hss_fd.conf`). An easy way to do that is to fill this FQDN in the `/etc/hosts` file:

For example on a host with hostname 'yang':

```
yang@yang:~$ cat /etc/hosts
127.0.0.1    localhost
127.0.1.1    yang
127.0.1.1    hss.openair4G.eur hss
```

### 2.4.3 HSS build

HSS can be built in two different ways: an executable that can run in a controlling terminal, or a daemon that run in the background.

In `OPENAIRCN_DIR/SCRIPTS` directory, depending on the chosen target execute the following command:

```
user@hss-host:~/openair-cn/SCRIPTS$ ./build_hss --clean --debug
```

or

```
user@hss-host:~/openair-cn/SCRIPTS$ ./build_hss --clean --debug --daemon
```

This command will compile the right target `oai_hss` or `oai_hssd`.

### 2.4.4 HSS run

In `OPENAIRCN_DIR/SCRIPTS` directory, a helper script called `run_hss` is provided for running the HSS.

Here are the `run_hss` options:

```
./run_hss -h
```

```
Usage: run_hss [OPTION]...
```

```
Run the HSS executable (experimental).
```

```
Options:
```

```
Mandatory arguments to long options are mandatory for short options too.
```

```
-c, --config-file filename    Config file to be used by HSS if you don't want to use the
                               default one: /usr/local/etc/oai/hss.conf
```

```
-e, --export-db filename      Export current database to a SQL file, file prefix is
                               $OPENAIRCN_DIR/SRC/OAI_HSS/db. (useful for replaying test scenarios)
```

```
-D, --daemon                  Run the daemon.
```

```
-i, --import-db filename      Import SQL file to current database, file prefix is
                               $OPENAIRCN_DIR/SRC/OAI_HSS/db. (useful for replaying test scenarios or restoring original
                               database content)
```

```
-I, --install-hss-files       Install HSS config files.
```

```
-g, --gdb                     Run with GDB.
```



---

-h, --help	Print this help.
-k, --kill	Kill the running local HSS.

#### 2.4.4.1 First run

##### 2.4.4.1.1 HSS deployment

Prior the first run of the HSS, you will have to generate certificates, install configuration files if not already done, create a HSS database. You can start with the database used by EURECOM or with your own database if you already have one:

```
user@hss-host:~/openair-cn/SCRIPTS$ ./run_hss --install-hss-files --import-db oai_db.sql
```

or

```
user@hss-host:~/openair-cn/SCRIPTS$ ./run_hss --install-hss-files --import-db oai_db.sql
--daemon
```

##### 2.4.4.1.2 Customize HSS database content

SQL operations (display, update, export, etc) can be done easily with the help of phpMyAdmin, you have to open the following URL with your browser: <http://yourhsshost/phpmyadmin>.

Otherwise you can use any other MySQL tool, script compatible with MySQL.

The steps for adding a subscriber are the following:

- Add your MME(s) in table mmeidentity

- Add subscriber(s) in table users

user.imsi=IMSI of your USIM.

user.msisdn= MSISDN of your USIM (unused).

users.imei=NULL

users.imei\_sv=NULL

users.ms\_ps\_status='PURGED'

users.rau\_tau\_timer=120

users.ue\_ambr\_ul=50000000

users.ue\_ambr\_dl=100000000

users.access\_restriction=47

users.mme\_cap=0

users.mmeidentity\_idmmeidentity='your MME key'

users.RFSP-Index=1

users.urpp\_mme=0

users.sqn='your USIM programmed SQN'

users.rand=0

users.OPc='the OPc key' (will be computed by the oai\_hss executable)

- Add subscriber(s) in table pdn.

#### **Table mmeidentity:**

Structure:

Field	Type	Null	Key	Default	Extra
idmmeidentity	int(11)	NO	PRI	NULL	auto_increment
mmehost	varchar(255)	YES		NULL	
mmerealm	varchar(200)	YES		NULL	
UE-Reachability	tinyint(1)	NO		NULL	

**Table 3: SQL Table structure mmeidentity**

Column idmmeidentity is the primary key of a MME.

Column mmehost contains the FQDN of a MME.

Column mmerealm contains the realm of a MME.

Example of content:

idmmeidentity	mmehost	mmerealm	UE-Reachability
2	yang.openair4G.eur	openair4G.eur	0
1	ng40-erc.openair4G.eur	openair4G.eur	0
3	ABEILLE.openair4G.eur	openair4G.eur	0

### **Table pdn:**

This table contains mainly the association between a subscriber (users\_imsi) and a APN (apn), and its QOS parameters.

Structure:

Field	Type	Null	Key	Default	Extra
id	int(11)	NO	PRI	NULL	auto_increment
apn	varchar(60)	NO		NULL	
pdn_type	enum('IPv4', 'IPv6', 'IPv4v6', 'IPv4_or_IPv6')	NO		NULL	
pdn_ipv4	varchar(15)	YES		NULL	0.0.0.0
pdn_ipv6	varchar(45)	YES		NULL	0:0:0:0:0:0:0:0
aggregate_ambr_ul	int(10) unsigned	YES		50000000	
aggregate_ambr_dl	int(10) unsigned	YES		100000000	
pgw_id	int(11)	NO	PRI	NULL	
users_imsi	varchar(15)	NO	PRI		
qci	tinyint(3) unsigned	NO		9	
priority_level	tinyint(3) unsigned	NO		15	
pre_emp_cap	enum('ENABLED', 'DISABLED')	YES		DISABLED	
pre_emp_vul	enum('ENABLED', 'DISABLED')	YES		DISABLED	
LIPA-Permissions	enum('LIPA-prohibited', 'LIPA-only', 'LIPA-conditional')	YES		LIPA-only	

**Table 4: SQL Table structure pdn**

Column id is the primary key of a pdn entry.

Column pdn\_type contains the type of PDN, actually only IPv4 is supported.

Column pdn\_ipv4 contains the IPv4 address of the PDN (unused).

---

Column pdn\_ipv6 contains the IPv6 address of the PDN (unused).

Column aggregate\_ambr\_ul TODO

Column aggregate\_ambr\_dl TODO

Column pgw\_id TODO

Column users\_imsi TODO

Column qci TODO

Column priority\_level TODO

Column pre\_emp\_capability TODO

Column pre\_emp\_vulnerability TODO

Column LIPA\_Permissions TODO

### **Table users**

This table contains mainly the informations about a subscriber: its IMSI, IMEI, key LTE K, SQN, operator key OP, QOS parameters, the last known MME identity where the subscriber registered.

Structure:

Field	Type	Null	Key	Default	Extra
imsi	varchar(15)	NO	PRI	NULL	
msisdn	varchar(46)	YES		NULL	
imei	varchar(15)	YES		NULL	
imei_sv	varchar(2)	YES		NULL	
ms_ps_status	enum('PURGED', 'NOT_PURGED')	YES		PURGED	
rau_tau_timer	int(10) unsigned	YES		120	
ue_ambr_ul	bigint(20) unsigned	YES		50000000	
ue_ambr_dl	bigint(20) unsigned	YES		100000000	
access_restriction	int(10) unsigned	YES		60	
mme_cap	int(10) unsigned zerofill	YES		NULL	
mmeidentity_idmmeidentity	int(11)	NO	PRI	0	
key	varbinary(16)	NO		0	
RFSP-Index	smallint(5) unsigned	NO		1	
urrrp_mme	tinyint(1)	NO		0	
sqn	bigint(20) unsigned zerofill	NO		NULL	
rand	varbinary(16)	NO		NULL	
OPc	varbinary(16)	YES		NULL	

**Table 5: SQL Table structure users**

TODO column description.

#### **2.4.4.2 Later runs**

By default (otherwise you know what you are doing) for all following runs of the HSS, use:

```
user@hss-host:~/openair-cn/SCRIPTS$ ./run_hss
```

---

or

```
user@hss-host:~/openair-cn/SCRIPTS$ ./run_hss --daemon
```

---

## 2.5 MME

### 2.5.1 MME pre-installation

In OPENAIRCN\_DIR/SCRIPTS directory, execute the following command:

```
user@mme-host:~/openair-cn/SCRIPTS$ ./build_mme -i
```

This command will install the required softwares on your host.

### 2.5.2 MME configuration

A template of the MME configuration file can be found at OPENAIRCN\_DIR/ETC/mme.conf. This configuration file follows the libconfig file syntax (<http://www.hyperrealm.com/libconfig>).

#### 2.5.2.1 Step 1

Copy the file OPENAIRCN\_DIR/ETC/mme.conf in /usr/local/etc/oai directory:

```
user@mme-host:~/openair-cn/SCRIPTS$ sudo mkdir -p /usr/local/etc/oai
```

```
user@mme-host:~/openair-cn/SCRIPTS$ sudo cp $OPENAIRCN_DIR/ETC/mme.conf /usr/local/etc/oai
```

Please take care of the permissions of your mme.conf file.

Then customize your copied MME configuration file:

#### 2.5.2.2 MME section

Parameter	Type	
<b>RUN_MODE</b>	String	Allowed values: "OTHER", "TEST". Set "OTHER" for normal operations, set "TEST" for S1C scenario player.
<b>REALM</b>	String	Diameter realm of the MME, default is openair4G.eur.
<b>MAXENB</b>	Num/Integer	Maximum number of eNB that can connect to MME.
<b>MAXUE</b>	Num/Integer	For debug purpose, used to restrict the number of served UEs the MME can handle.
<b>RELATIVE_CAPACITY</b>	Num/Integer	Even though this parameter is not used by the MME for controlling the MME load balancing within a pool (at least for now), the parameter has to be forwarded to the eNB during association procedure. Values going from 0 to 255, (Default value is 15)
<b>MME_STATISTIC_TIMER</b>	Num/Integer	Displayed statistic period in logs.
<b>EMERGENCY_ATTACH_SUPPORTED</b>	String	Actually only "no" is supported
<b>UNAUTHENTICATED_IMSI_SUPPORTED</b>	String	Actually only "no" is supported
<b>EPS_NETWORK_FEATURE_SUPPORT_IMS_VOICE_OVER_PS_SESSION_IN_S1</b>	String	Actually only "no" is supported
<b>EPS_NETWORK_FEATURE_SUPPORT_EMERGENCY_BEARER_SERVICES_IN_S1_MODE</b>	String	Actually only "no" is supported
<b>EPS_NETWORK_FEATURE_SUPPORT_LOCATION_SERVICES_VIA_EPC</b>	String	Actually only "no" is supported
<b>EPS_NETWORK_FEATURE_SUPPORT_EXTENDED_SERVICE_REQUEST</b>	String	Actually only "no" is supported

<b>IP_CAPABILITY</b>	String	Actually only IPV4 is supported, (Choice between IPV4, IPV4V6, IPV4ORV6)
----------------------	--------	--

**Table 6: MME configuration main section**

#### 2.5.2.2.1 INTERTASK\_INTERFACE subsection

Parameter	Type	
<b>ITTI_QUEUE_SIZE</b>	Num/Integer	Upper bound for the message queue size expressed in bytes (all messages exchanged by tasks have the same size). Restrict the number of messages in queues or detect a possible MME overload.

**Table 7: MME configuration subsection ITTI**

#### 2.5.2.2.2 S6A subsection

Parameter	Type	
<b>S6A_CONF</b>	String	FreeDiameter MME config file path, default value is “/usr/local/etc/oai/freeDiameter/mme_fd.conf”.
<b>HSS_HOSTNAME</b>	String	HSS hostname, default value is “hss”.

**Table 8: MME configuration subsection S6a**

#### 2.5.2.2.3 SCTP subsection

Parameter	Type	
<b>SCTP_INSTREAMS</b>	Num/Integer	Maximum number of SCTP input streams allowed for a S1-C connection.
<b>SCTP_OUTSTREAMS</b>	Num/Integer	Maximum number of SCTP output streams allowed for a S1-C connection.

**Table 9: MME configuration subsection SCTP**

#### 2.5.2.2.4 S1AP subsection

Parameter	Type	
<b>S1AP_OUTCOME_TIMER</b>	Num/Integer	Once an outcome is sent from MME to eNB, the MME locally starts a timer to abort the procedure and release UE context if the expected answer to this outcome is not received at the expiry of this timer. This timer is expressed in seconds. (Default value = 5 seconds)

**Table 10: MME configuration subsection S1AP**

#### 2.5.2.2.5 GUMMEI LIST subsection

This section contains the GUMMEIs of the MME, actually only one GUMMEI is supported.

Parameter	Type	
<b>{MCC, MNC, MME_GID, MME_CODE}</b>	String/String/String/String	Mobile country code of GUMMEI, Mobile network code of GUMMEI, MME group ID of GUMMEI, MME code of GUMMEI

**Table 11: MME configuration subsection GUMMEI**

### 2.5.2.2.6 TAI LIST subsection

The content of this section should be consistent with content of GUMMEI LIST section

Parameter	Type	
{MCC/MNC/TAC}	String/String/String	Each entry of the list is a triplet of a MCC, MNC and TAC. There can be up to 16 tracking areas identity set in this list. Actually we do not support shared networks, so the MCC/MNC field should all be equal among the list

Table 12: MME configuration subsection TAI LIST

### 2.5.2.2.7 NAS subsection

Parameter	Type	
ORDERED_SUPPORTED_INTEGRITY_ALGORITHM_LIST	Array of String	Preference list in decreasing order of supported integrity algorithms, actually supported integrity algorithms are EIA0, EIA1, EIA2
ORDERED_SUPPORTED_CIPHERING_ALGORITHM_LIST	Array of String	Preference list in decreasing order of supported integrity algorithms, actually supported integrity algorithms are EEA0, EEA1, EEA2
T3402	Integer	EMM timer, duration in minutes.
T3412	Integer	EMM timer, duration in minutes.
T3485	Integer	ESM timer, duration in seconds, unused (TODO).
T3486	Integer	ESM timer, duration in seconds, unused (TODO).
T3489	Integer	ESM timer, duration in seconds, unused (TODO).
T3495	Integer	ESM timer, duration in seconds, unused (TODO).

Table 13: MME configuration subsection NAS

### 2.5.2.2.8 Network interfaces subsection

Parameter	Type	
MME_INTERFACE_NAME_FOR_S1_MME	String	Interface name for S1-MME (S1-C), this interface name can be a real ethernet interface or a virtual ethernet interface. The script run_mme can configure it and bring it up if you provide the -i/--set- <u>nw</u> -interfaces option.
MME_IPV4_ADDRESS_FOR_S1_MME	String, CIDR	Binded address for S1-MME
MME_INTERFACE_NAME_FOR_S11_MME	String	Interface name for S11, this interface name can be a real ethernet interface or a virtual ethernet interface. The script run_mme can configure it and bring it up if you provide the -i/--set- <u>nw</u> -interfaces option.
MME_IPV4_ADDRESS_FOR_S11_MME	String, CIDR	Binded address for S11.

Table 14: MME configuration subsection Network Interfaces

### 2.5.2.2.9 Logging subsection

Parameter	Type	
OUTPUT	String	choice in { "CONSOLE", "UNBUFFERED_CONSOLE", "`path to file`", "IPv4@`:`TCP port <u>num</u> `"}. Choise "CONSOLE" means that logs go to STDOUT, STDERR in a manner that even if multiple concurrent threads dump a lot of logs, traces cannot

		<p>overlap (the cost here is that we need buffering).  Choice "UNBUFFERED_CONSOLE" means that logs go directly to STDOUT, STDERR, traces may overlap.  Choice "path to file", for example "/tmp/mme.log" is a file receiving the dump of logs without overlapping traces.  Choice "IPv4@:TCP port num" (for example "192.168.12.17:6789") dump the logs towards a TCP server. The logs can be easily displayed or dumped into a file with netcat (nc -kl 6789).</p>
COLOR	String	Choice in { "yes", "no" } means use of ANSI styling codes or no. TODO
SCTP_LOG_LEVEL	String	Log level choice in { "EMERGENCY", "ALERT", "CRITICAL", "ERROR", "WARNING", "NOTICE", "INFO", "DEBUG", "TRACE" }
S1AP_LOG_LEVEL	String	Idem as above
NAS_LOG_LEVEL	String	Idem as above
MME_APP_LOG_LEVEL	String	Idem as above
S6A_LOG_LEVEL	String	Idem as above
UTIL_LOG_LEVEL	String	Idem as above
MSC_LOG_LEVEL	String	Idem as above
ITTI_LOG_LEVEL	String	Idem as above
ASN1_VERBOSITY	String	Choice in { "none", "info", "annoying" }

Table 15: MME configuration subsection Network Interfaces

### 2.5.2.3 SGW section

The PGW, SGW selections are not implemented yet, so we need a mechanism that replace these selection: yet, we only support one PDN, one PGW, one SGW.

#### 2.5.2.3.1 Network interfaces subsection

Parameter	Type	
SGW_IPV4_ADDRESS_FOR_S11	String, CIDR	Binded SGW address for S11.

Table 16: MME configuration section SGW

### 2.5.2.4 Step 2

Copy the file OPENAIRCN\_DIR/ETC/mme\_fd.conf in /usr/local/etc/oai/freeDiameter directory:

```
user@hss-host:~/openair-cn/SCRIPTS$ sudo mkdir -p /usr/local/etc/oai/freeDiameter
```

```
user@hss-host:~/openair-cn/SCRIPTS$ sudo cp $OPENAIRCN_DIR/ETC/mme_fd.conf /usr/local/etc/oai/freeDiameter
```

Please take care of the permissions of your configuration files.

Then customize your copied mme\_fd.conf configuration files if necessary, if you follow this document, it should not be necessary, otherwise please refer to freeDiameter documentation.

### 2.5.2.5 Step 3

A FQDN has to be set for the MME (see mme\_fd.conf). An easy way to do that is to fill this FQDN in the /etc/hosts file:

For example on a host with hostname 'yang':



---

```
yang@yang:$ cat /etc/hosts
127.0.0.1    localhost
127.0.1.1    yang.openair4G.eur yang # MME host
127.0.1.1    hss.openair4G.eur hss # HSS located on MME host
```

### 2.5.3 MME build

MME can be built in two different ways: an executable that can run in a controlling terminal, or a daemon that run in the background.

In OPENAIRCN\_DIR/SCRIPTS directory, depending on the chosen target execute the following command:

```
user@mme-host:~/openair-cn/SCRIPTS$ ./build_mme --clean --debug
or
```

```
user@mme-host:~/openair-cn/SCRIPTS$ ./build_mme --clean --debug --daemon
```

This command will compile the right target oai\_mme or oai\_mmed.

### 2.5.4 MME run

In OPENAIRCN\_DIR/SCRIPTS directory, a helper script called run\_mme is provided for running the MME.

```
user@hss-host:~/openair-cn/SCRIPTS$ ./run_mme
```

or

```
user@hss-host:~/openair-cn/SCRIPTS$ ./run_mme --daemon
```

---

## 2.6 SP\_GW

### 2.6.1 SP-GW pre-installation

In OPENAIRCN\_DIR/SCRIPTS directory, execute the following command:

```
user@mme-host:~/openair-cn/SCRIPTS$ ./build_spgw -i
```

This command will install the required softwares on your host.

### 2.6.2 SP-GW configuration

A template of the SP-GW configuration file can be found at OPENAIRCN\_DIR/ETC/spgw.conf. This configuration file follows the libconfig file syntax (<http://www.hyperrealm.com/libconfig>).

#### 2.6.2.1 Step 1

Copy the file OPENAIRCN\_DIR/ETC/mme.conf in /usr/local/etc/oai directory:

```
user@mme-host:~/openair-cn/SCRIPTS$ sudo mkdir -p /usr/local/etc/oai
user@mme-host:~/openair-cn/SCRIPTS$ sudo cp $OPENAIRCN_DIR/ETC/spgw.conf
/usr/local/etc/oai
```

Please take care of the permissions of your spgw.conf file.

Then customize your copied SP-GW configuration file:

#### 2.6.2.2 SGW section

### 2.6.3 Network interfaces section

Parameter	Type	
SGW_INTERFACE_NAME_FOR_S11	String	Interface name for S11.
SGW_IPV4_ADDRESS_FOR_S11	String, CIDR notation	Binded address for S11.
SGW_INTERFACE_NAME_FOR_S1U_S12_S4_UP	String	Interface name for S1-U, this interface name can be a real ethernet interface or a virtual ethernet interface. The script run_spgw can configure it and bring it up if you provide the -i/--set-nw-interfaces option.
SGW_IPV4_ADDRESS_FOR_S1U_S12_S4_UP	String, CIDR notation	Binded address for S1-U
SGW_IPV4_PORT_FOR_S1U_S12_S4_UP	Num/Integer	Port number for S1-U (IANA), Should be 2152
SGW_INTERFACE_NAME_FOR_S5_S8_UP	String,	Interface name for S5 or S8, set to "none" because unused
SGW_IPV4_ADDRESS_FOR_S5_S8_UP	String, CIDR notation	Binded address for S5 or S8, set to 0.0.0.0/xx because unused

Table 17: S-GW configuration subsection Network Interfaces

#### 2.6.3.1.1 INTERTASK\_INTERFACE subsection

Parameter	Type
-----------	------

<b>ITTI_QUEUE_SIZE</b>	Num/Integer	Upper bound for the message queue size expressed in bytes (all messages exchanged by tasks have the same size). Restrict the number of messages in queues or detect a possible overload.
------------------------	-------------	--

**Table 18: MME configuration subsection ITTI**

### 2.6.3.1.2 Logging subsection

Parameter	Type	
<b>OUTPUT</b>	String	choice in { "CONSOLE", "UNBUFFERED_CONSOLE", "`path to file`", "IPv4@`:TCP port <u>num</u> `" }. Choice "CONSOLE" means that logs go to STDOUT, STDERR in a manner that even if multiple concurrent threads dump a lot of logs, traces cannot overlap (the cost here is that we need buffering). Choice "UNBUFFERED_CONSOLE" means that logs go directly to STDOUT, STDERR, traces may overlap. Choice "`path to file`", for example "/tmp/spgw.log" is a file receiving the dump of logs without overlapping traces. Choice "IPv4@`:TCP port <u>num</u> " (for example "192.168.12.18:6789") dump the logs towards a TCP server. The logs can be easily displayed or dumped into a file with netcat (nc -kl 6789).
<b>COLOR</b>	String	Choice in { "yes", "no" } means use of ANSI styling codes or no. TODO
<b>UDP_LOG_LEVEL</b>	String	Log level choice in { "EMERGENCY", "ALERT", "CRITICAL", "ERROR", "WARNING", "NOTICE", "INFO", "DEBUG", "TRACE" }
<b>GTPV1U_LOG_LEVEL</b>	String	Idem as above
<b>GTPV2C_LOG_LEVEL</b>	String	Idem as above
<b>SPGW_APP_LOG_LEVEL</b>	String	Idem as above
<b>S11_LOG_LEVEL</b>	String	Idem as above

**Table 19: MME configuration subsection Network Interfaces**

### 2.6.3.2 PGW section

#### 2.6.3.2.1 Main section

Parameter	Type	
<b>DEFAULT_DNS_1_IPV4_ADDRESS</b>	String, IPv4 dot decimal	IPv4 address of primary default DNS that can be queried by UEs
<b>DEFAULT_DNS_2_IPV4_ADDRESS</b>	String, IPv4 dot decimal	IPv4 address of secondary default DNS that can be queried by UEs
<b>FORCE_PUSH_PROTOCOL_CONFIGURATION_OPTIONS</b>	String	Non standard feature, normally should be set to "no", but you may need to set to yes for UE that do not explicitly request a PDN address through NAS signalling, MTU, DNS are also pushed even if not requested.

**Table 20: P-GW configuration main section**

#### 2.6.3.2.2 Network interfaces section

Parameter	Type	
<b>PGW_INTERFACE_NAME_FOR_S5_S8</b>	String	Interface name for S5 or S8, "none" because unused
<b>PGW_IPV4_ADDRESS_FOR_S5_S8</b>	String, CIDR notation	Binded address for S5 or S8, (0.0.0.0/xx) because unused
<b>PGW_INTERFACE_NAME_FOR_SGI</b>	String	Interface name for SGI
<b>PGW_IPV4_ADDRESS_FOR_SGI</b>	String, CIDR notation	Used IPv4 address for SGI, useful if UE traffic is masqueraded.
<b>PGW_MASQUERADE_SGI</b>	String	Should outgoing UE IPv4 traffic be masqueraded (source NAT), "yes" or "no".

---

**Table 21: P-GW configuration subsection Network Interfaces**

### 2.6.3.2.3 IP Address Pool section

Parameter	Type	
<b>IPV4_LIST</b>	String, CIDR notation	List of IPv4 netmasks that designate a list of available IPv4 addresses for UEs

**Table 22: P-GW configuration subsection IP Address Pool Selection**

---

## **3 Supported scenarios in EPC**

### **3.1 E-UTRAN Initial attach**

#### **3.1.1 Attach with IMSI**

TODO Add MSCGEN SEQ diagram

#### **3.1.2 Attach with GUTI**

TODO Add MSCGEN SEQ diagram

### **3.2 Tracking Area Update procedures**

TODO Add MSCGEN SEQ diagram

### **3.3 Routing Area Update procedures**

Not supported yet.

### **3.4 Service Request procedures**

#### **3.4.1 UE triggered Service Request**

TODO Add MSCGEN SEQ diagram

#### **3.4.2 Network triggered Service Request**

Not supported yet.

### **3.5 S1 Release procedure**

TODO Add MSCGEN SEQ diagram

### **3.6 GUTI Reallocation procedure**

Not supported yet.

### **3.7 Detach procedure**

#### **3.7.1 UE-Initiated Detach procedure for E-UTRAN**

TODO Add MSCGEN SEQ diagram

#### **3.7.2 MME-Initiated Detach procedure for E-UTRAN**

#### **3.7.3 HSS-Initiated Detach procedure for E-UTRAN**

Not supported.

### **3.8 HSS User Profile management function procedure**

Not supported.

---

## **3.9                    Bearer deactivation**

### **3.9.1                PDN GW initiated bearer deactivation**

Not supported

### **3.9.2                MME initiated Dedicated Bearer Deactivation**

Not supported yet

## **3.10                Intra E-UTRAN handover**

Not supported yet

---

## 4                      **Annex A: Tools for observing, debugging.**

### **4.1                      Wireshark/tshark**

You can launch wireshark instances on S1 (filter s1ap, gtpu), S6A (filter diameter, if TCP is the underlying protocol, you can select a TCP packet relative to the DIAMETER exchange and the select decode as DIAMETER).

### **4.2                      Mscgen**

Extract from <http://www.mcternan.me.uk/mscgen/>: “Mscgen is a small program that parses Message Sequence Chart descriptions and produces PNG, SVG, EPS or server side image maps (ismaps) as the output. Message Sequence Charts (MSCs) are a way of representing entities and interactions over some time period”...” Mscgen aims to provide a simple text language that is clear to create, edit and understand, which can also be transformed into common image formats for display or printing.”...

Openair use mscgen to offer another view of events (SDUs, timers, etc) that happens inside an executable and also (still under development) PDUs exchanged between protocol entities.

Openair HSS do not have the msgen feature.

#### **Important:**

Check that mscgen traces are configured for being generated (CFLAG MESSAGE\_CHART\_GENERATOR set to true in OPENAIRCN\_DIR/BUILD/MME/CMakeLists.template)

You have to instruct the openair mme\_gw executable to dump the ITTI messages to a file with the argument *-m path\_to\_directory*. The mscgen files will be located under the specified directory, in a directory containing the time of the generated traces (text and png files).

Example:

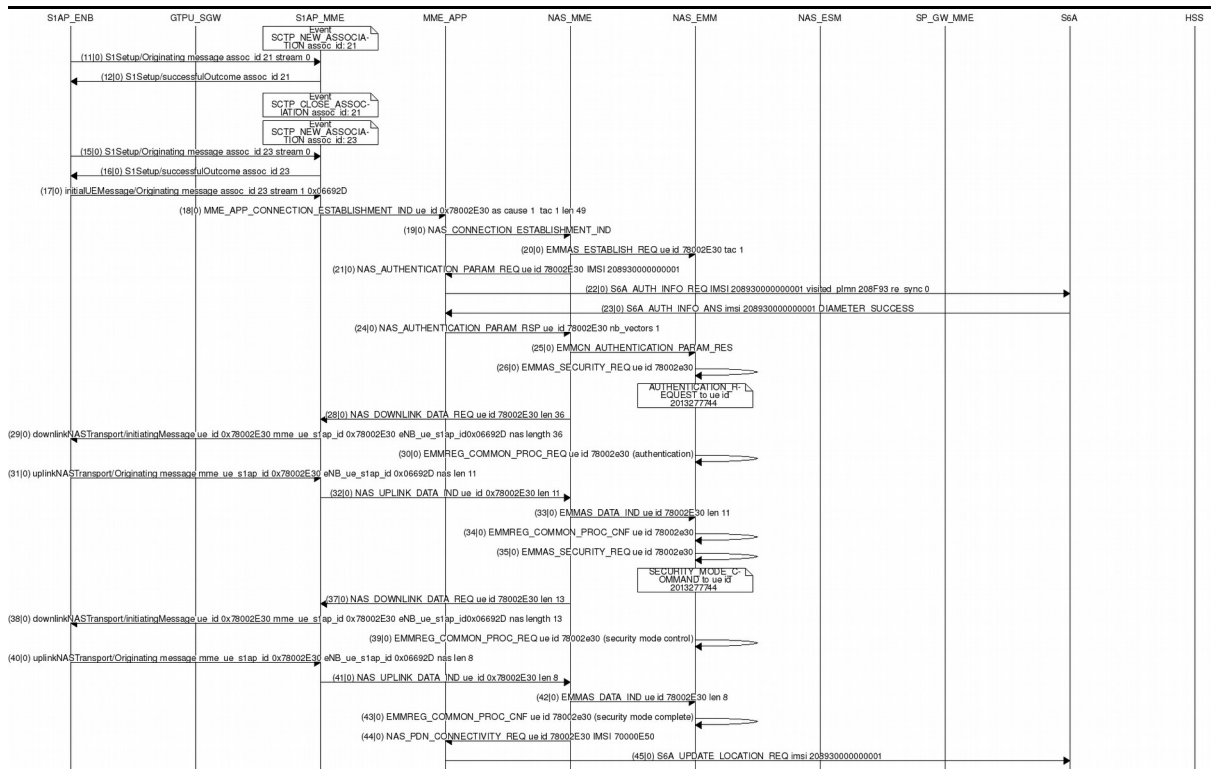


Figure 13 Mscgen output example



---

## 4.3 S1AP scenario replay

This tool is available in the **openairinterface5g** git repository, branch “Feature-6-fix\_test\_core\_network\_with\_scenarios”. This branch will be merged in the develop branch as soon as possible.

The aim of this tool is helping for bug reports, development, non-regression test, debug purpose, it allows to replay without the help of any eNB(s) or UE(s). a S1AP scenario previously captured as a pcap dumped file.

### 4.3.1 Overall process

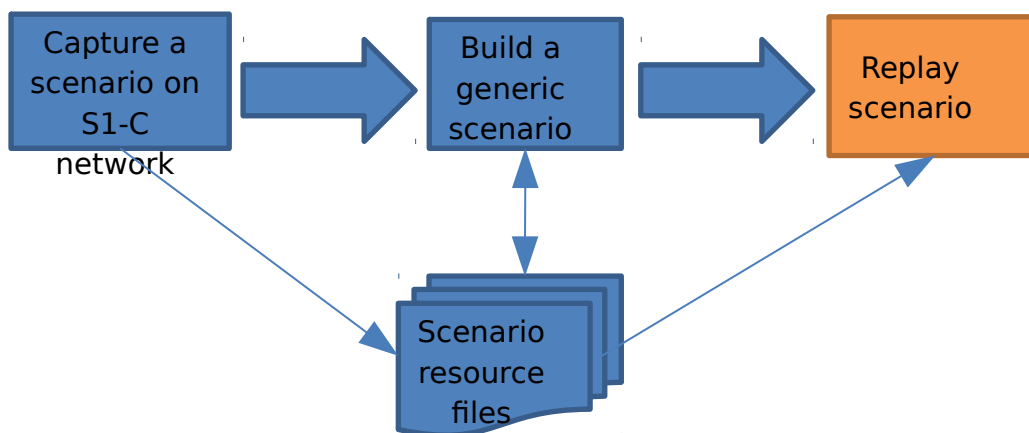


Figure 14 Workflow of scenario replay

In order to replay a scenario, a scenario has to be played/captured (step 1), then the captured artefacts have to be processed in order to generate a generic scenario (step 2) ready to be replayed on any other testbed (step 3).

The first step consists in capturing a network trace on S1-C network, the second step consists in building a scenario file that is generic, meaning there is no specific testbed references (IP addresses). The last step is the replaying of the scenario on an openair-cn testbed.

### 4.3.2 Flowchart of step1: Network trace capture on S1-C

The goal of this step is to capture a SCTP/S1AP trace that we want to be able to replay.

The red items in the following flowchart figure are part of the “scenario resource files”.

It is highly recommended to create a dedicated resource directory (`$RESOURCE_SCENARIO_DIR`) for each created scenario.

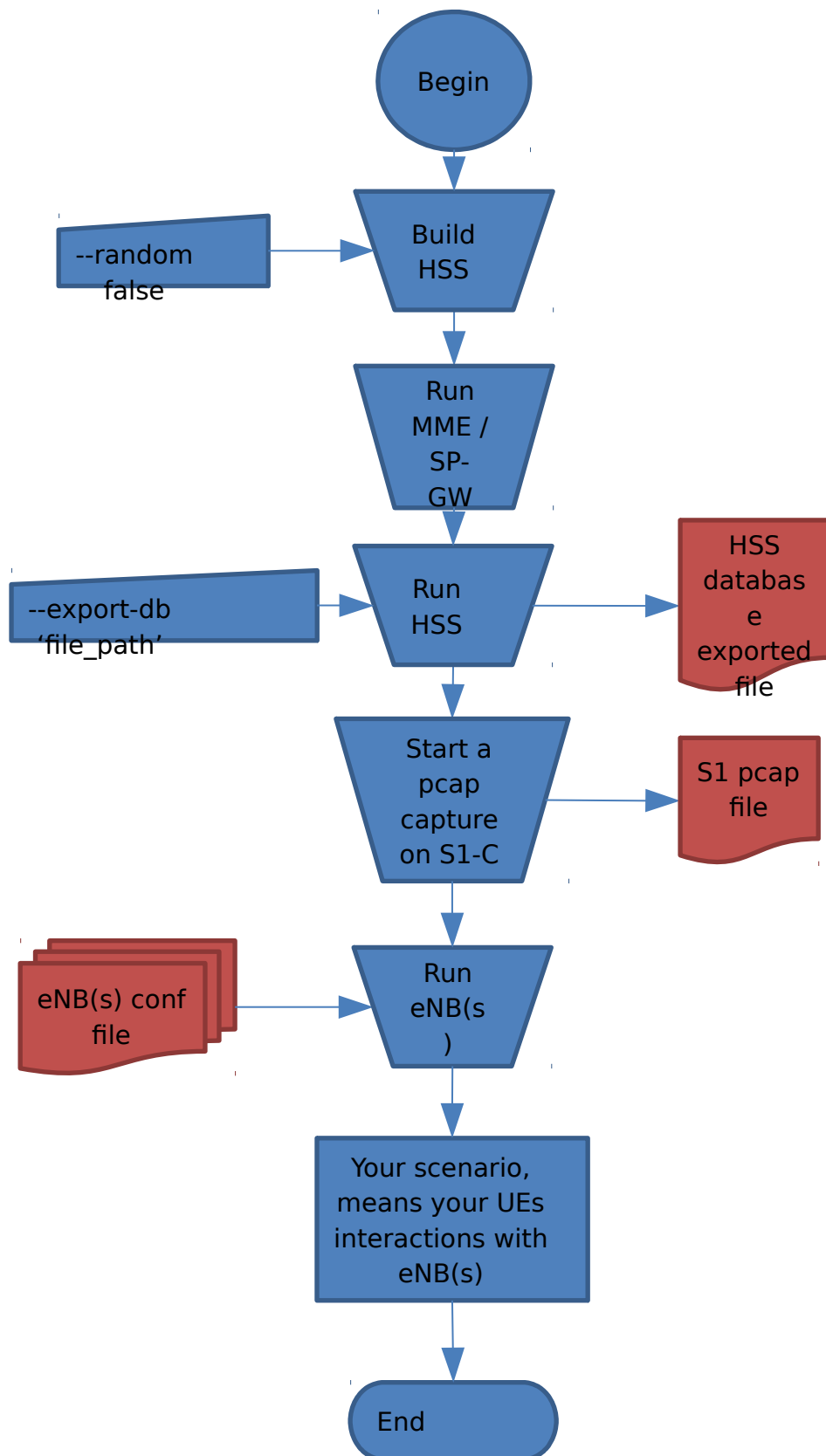


Figure 15 Flowchart of scenario capture

---

#### Step 1: build HSS

The HSS database has first to be configured for not generating randoms in security algorithms, otherwise we will not be able to replay trace coming from UE(s).

The extra argument that has to be passed in addition to other arguments to the build\_hss script is:  
*--random false*

#### Step 2: run MME

No change here compared to standard case.

#### Step 3: run SP-GW

No change here compared to standard case.

#### Step 3: run HSS

In order to be able to replay the scenario in the same conditions, the initial content of the database has to be saved.

The extra argument that has to be passed in addition to other arguments to the run\_hss script is:  
*--export-db \$RESOURCE\_SCENARIO\_DIR/scenario.sql*

#### Step 4: start a pcap-ng capture on S1-C

This step is not automated, you have to start on your own a tool to capture the network traffic on the S1-C network. (you can use Wireshark).

VERY IMPORTANT 1: PLEASE filter the packets with the following filter string:

*“s1ap or sctp.chunk\_type == INIT or sctp.chunk\_type == INIT\_ACK or sctp.chunk\_type == COOKIE\_ECHO or sctp.chunk\_type == COOKIE\_ACK”.*

VERY IMPORTANT 2: We need the scenario from the beginning, that means we need to have the SCTP INIT and SCTP INIT\_ACK messages captured, so you must start the capture before launching the eNB(s).

#### Step 5: start the eNB(s)

The eNB config files will be used later to make a scenario independent of IP addresses.

#### Step 6: run your scenario

At the end of this process please save in a directory whose name reflects the test case success or failure:

- The eNB(s) config file(s) with the name **“enb.conf”**
- The EPC config file with the name **“epc.conf.in”**
- The exported database SQL file with the name **“hss\_db.sql”**.
- The pcap-ng file containing all SCTP and S1AP traffic occurred on S1-C network with the name **“s1.pcapng”**.

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#### 4.3.3 Build a generic scenario

TODO: waiting for branch "[Feature-6-fix\\_test\\_core\\_network\\_with\\_scenarios](#)" merged on openairinterface5g.

#### 4.3.4 Replay a S1AP generic scenario

TODO: waiting for branch "[Feature-6-fix\\_test\\_core\\_network\\_with\\_scenarios](#)" merged on openairinterface5g.