LTE and NR Core Network

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1 Introduction

LTEMME is a LTE EPC (Evolved Packet Core) implementation. It has a built-in MME (Mobility Management Entity), SGW (Serving Gateway), PGW (Packet Data Network Gateway), PCRF (Policy and Charging Rule Function), HSS (Home Subscriber Server), EIR (Equipment Identity Register) and ePDG (evolved Packet Data Gateway). It can easily be used with the Amarisoft LTE eNodeB to build a highly configurable LTE test network.
Depending on your software license, it also includes a NR 5GC (5G Core Network). It has build-in AMF (Access and Mobility Management Function), AUSF (Authentication Server Function), SMF (Session Management Function), UPF (User Plane Function), UDM (Unified Data Management) and 5G-EIR (5G Equipment Identity Register).

2 Features

2.1 EPC

- LTE release 18 compliant.
- Implements one EPC with built-in MME, SGW, PGW, PCRF, HSS and EIR.
- Supports several eNodeBs with standard S1 interface (S1AP and GTP-U protocols).
- NAS integrity check and encryption using the AES, Snow3G and ZUC algorithms.
- Support of USIM cards using the XOR, Milenage or TUAK authentication algorithm.
- Handling of UE procedures: attach, authentication, security configuration, detach, tracking area update, service access, radio bearer establishment, paging.
- Multi-PDN support and built-in dynamic ERAB setup for easy VoLTE/IMS testing.
- Transparent access to the IP network (no external Serving Gateway or PDN Gateway is necessary).
- Configurable access point name, IP range, DNS and E-RAB QoS.
- Support sending of Public Warning System messages (ETWS/CMAS).
- IPv6 support.
- Configurable logging system for all channels with built-in text decoders.
- Remote API using WebSocket.
- Command line monitor.
- PSM and eDRX support.
- Group WUS support.
- Supports several IMS servers with Rx interface.
- Support of NB-IoT RAT.
- Support of control plane CIoT EPS optimization.
- Non-IP data delivery CIoT feature.
- Attach without PDN connectivity CIoT feature.
- User management via internal database without any external HSS.
- Support of optional S6a interface with external HSS.
- Support of optional S13 interface with external EIR.
- Support of optional SGsAP interface with external VLR/MSC.
- Support of optional SBcAP interface with external CBC.
- Support of broadcast and multicast PDN options.
- Support of DCNR UEs.
- Support of LCS-AP.
- Support of Ethernet PDN connectivity.

2.2 5GC

- NR release 18 compliant.
- Implements one 5GC with built-in AMF, AUSF, SMF, UPF, UDM and 5G-EIR.
- Supports several gNodeBs, ng-eNBs or N3IWFs with standard NG interface (NGAP and GTP-U protocols).
- NAS integrity check and encryption using the AES, Snow3G and ZUC algorithms.

- Support of USIM cards using the XOR, Milenage or TUAK 5G-AKA authentication algorithm.
- Handling of UE procedures: registration, authentication, security configuration, deregistration, service access, radio bearer establishment, paging.
- Multi PDU sessions support and built-in dynamic QoS flow setup for easy VoNR/IMS testing.
- Transparent access to the IP network (no external UPF is necessary).
- Configurable access point name, IP range, DNS and QoS flows.
- IPv4, IPv4v6, IPv6 and unstructured PDUs support.
- Configurable logging system for all channels with built-in text decoders.
- Remote API using WebSocket.
- Command line monitor.
- MICO, active time and eDRX support.
- Supports several IMS servers with Rx interface.
- Support of NB-IoT, LTE and non-3GPP RAT.
- User management via internal database without any external HSS.
- Support of broadcast and multicast PDU session options.
- Support sending of Public Warning System messages (ETWS/CMAS).
- Support of N12 interface with external AUSF.
- Support of N8 and N13 interface with external UDM.
- Support of N17 interface with external 5G-EIR.
- Support of N20 interface with external SMSF.
- Support of N50 interface with external CBC.
- Support of N62 interface with external AF.
- Support of network slicing.
- Support of control plane CIoT 5GS optimization.
- Non-IP data delivery CIoT feature.
- Support of NL1 interface.
- Support of N5 interface with the following restriction: IMS_SBI feature is declared by the PCF but credit management is not supported.
- Support of Ethernet PDU sessions.
- Support of MBS broadcast sessions.

3 Requirements

3.1 Hardware requirements

- LTEMME can run on the same PC as the Amarisoft eNodeB/gNodeB if a simple and compact solution is needed. Otherwise, any reasonnably recent PC with at least one Gigabit Ethernet port is acceptable.
- A test USIM card should be plugged into the UE. Test USIM cards from Anritsu are supported by the default configuration. Other test USIM cards should work as well provided they implement the dummy XOR authentication algorithm and that their IMSI and secret key are known. USIM cards using the Milenage or TUAK algorithm are also supported.

3.2 Software requirements

- A 64 bit Linux distribution. Fedora 42 is the officially supported distribution.
  The following distributions are known as compatible:
  - Fedora 22 to 42
  - Cent OS 7
  - Ubuntu 14 to 24

  Your system requires at least GLIBC 2.17.

4 Installation

[Quick installation instructions are also given in the Amarisoft eNodeB/gNodeB documentation in case LTEMME is installed on the same PC as the eNodeB/gNodeB].

The network access thru the Gigabit Ethernet port must be correctly configured.

LTEMME can be run directly from the directory when it was unpacked. No need for explicit installation.

4.1 Local network configuration

LTEMME will set up a new virtual network interface `tun0` where each UE has a specific IP address. If you want them to connect to your local network (and Internet), you need to set up IP forwarding and masquerading.

An example is found in the `lte_init.sh`:
Syntax:

```
sudo ./lte_init.sh [-6] <ifname>

sudo ./lte_init.sh default
sudo ./lte_init.sh -6 eth1
```

4.2 Linux setup

4.2.1 Packages

LTEMME uses the SCTP protocol for which the necessary packages are not usually installed. In order to install them, do as root user:

- Fedora

  ```
  dnf install lksctp-tools kernel-modules-extra
  ```

- Ubuntu

  ```
  sudo apt-get install lksctp-tools linux-image-extra-3.13.0-24-generic
  ```

  Note that linux-image-extra package name may differ depending on your kernel version.

To verify that SCTP kernel module is running, do as root user:

```
checksctp
```

If it reports that the protocol is not supported,

- check if you have a /etc/modprobe.d/sctp-blacklist.conf file
- edit it to comment the 'blacklist sctp' line

Then reboot the PC in case the Linux kernel was upgraded too.

4.2.2 OpenSSL

LTEMME has been compiled against openssl version 3.5.4.
If your system does not have compatible version installed you may have this error message at startup:

```
error while loading shared libraries: libssl.so.3: cannot open shared object file: No s
```

To overcome this problem, you may:

- Copy libssl.so.3 and libcrypto.so.3 from `libs` subdirectory of your release tarball.
  If you have installed software with automatic install script, this should have been done automatically.
- Compile and install proper openssl version yourself

In case of persisting issue, raise a ticket from our support site at `https://support.amarisoft.com/` with the information provided by below commands executed in LTEMME directory:

```
uname -a
ls -l
ldd ./ltemme
openssl version
```

4.2.3 NGHTTP2

LTEMME has been compiled against nghttp2 version 1.41.0.
If your system does not have compatible version installed you may have this error message at startup:

```
error while loading shared libraries: libnghttp2.so.14: cannot open shared object file
```

To overcome this problem, you may:

- Copy nghttp2.so.14 from `libs` subdirectory of your release tarball.
  If you have installed software with automatic install script, this should have been done automatically.
- Install libnghttp2 with your package manager
- Compile and install proper nghttp2 version yourself

In case of persisting issue, raise a ticket from our support site at `https://support.amarisoft.com/` with the information provided by below commands executed in LTEMME directory:

```
uname -a
ls -l
ldd ./ltemme
```

4.3 License key installation

LTEMME needs a license key file to run. *It is associated to your PC, so if you replace it or change its hardware configuration you must contact Amarisoft to get a new license key.*

The following steps are needed to get this license file:

- Run LTEMME:

  ```
  ./ltemme config/mme.cfg
  ```

  It says that the license key is not present and prints a 16 digit hexadecimal code.
- Send by mail to `delivery@amarisoft.com` this hexadecimal code to your contact at Amarisoft. You will get back the `ltemme.key` license key file.
- Copy the `ltemme.key` file to the `${HOME}/.amarisoft/` directory (`${HOME}` is the home directory of the `root` user). You can use the shell variable `AMARISOFT_PATH` to change this path.

Once the license key is installed, ltemme should start normally.

4.4 Initial testing

- Edit the file `config/mme.cfg` to set the bind address of the GTP-U interface. Normally it is the address of the default Ethernet of the PC (you can see it with `ifconfig`). You can also set the address of the DNS (`dns_addr` property). You don't need to change the other parameters for an initial test.

- LTEMME creates one virtual network interface where the UE traffic is redirected. A modification of the default routing rules and iptables is usually needed if you want to redirect the UE traffic to the local network and Internet. The script `lte_init.sh` in the Amarisoft LTEMME package gives an example of setup to configure a NAT to access the Internet.
- Start the program as root with:

  ```
  ./ltemme config/mme.cfg
  ```

  [The root access is only needed to set up the Linux virtual interface.]
- The command line interface is used to monitor the operation of LTEMME and to change the logging options. Use `help` to get the list of commands and `quit` to stop the program.
- Use `enb` to list the connected eNodeBs and `gnb` to list the connected gNodeBs.
- In addition to using the log file, you can monitor the traffic between LTEMME and the eNodeBs or gNodeBs with Wireshark. The LTE specific traffic is filtered by putting `s1ap || gtp` in the `filter` input area. The NR specific traffic is filtered by putting `ngap || gtp` in the `filter` input area.
- For optimal performance, it is better to avoid fragmenting the GTP-U packets. So the Ethernet interfaces used between the eNodeBs or gNodeBs and LTEMME should be configured to have a MTU of at least 1564 (assuming the UEs use the standard MTU of 1500). You can verify with Wireshark whether the GTP-U packets are fragmented.

5 Configuration reference

5.1 Configuration file syntax

The main configuration file uses a syntax very similar to the Javascript Object Notation (JSON) with few extensions.

1. Supported types:
   - Numbers (64 bit floating point). Notation: `13.4`
   - Complex numbers. Notation: `1.2+3*I`
   - Strings. Notation: `"string"`
   - Booleans. Notation: `true` or `false`.
   - Objects. Notation: `{ field1: value1, field2: value2, .... }`
   - Arrays. Notation: `[ value1, value2, .... ]`
2. The basic operations `+`, `-`, `*` and `/` are supported with numbers and complex numbers. `+` also concatenates strings. The operators `!`, `||`, `&&`, `==`, `!=`, `<`, `<=`, `>=`, `>` are supported too.
3. The numbers `0` and `1` are accepted as synonyms for the boolean values `false` and `true`.
4. {} at top level are optional.
5. " for property names are optional, unless the name starts with a number.
6. Properties can be duplicated.
   If properties are duplicated, they will be merged following [JSON merge rules], page 9, with overriding occuring in reading direction (last overrides previous).
   Ex:

```
{
    value: "foo",
    value: "bar",
    sub: {
        value: "foo"
    },
    sub: {
        value: "bar"
    }
}
```

   Will be equivalent to:

```
{
    value: "bar",
    sub: {
        value: "bar"
    }
}
```

7. Files can be included using *include* keyword (must not be quoted) followed by a string (without :) representing the file to include (path is relative to current file) and terminating by a comma.
   Arrays can't be included.
   Merge will be done as for duplicate properties.
   If *file1.cfg* is:

```
    value: "foo",
    include "file2.cfg",
    foo: "foo"
```

And *file2.cfg* is:

```
value: "bar",
foo: "bar"
```

Final config will be:

```
{
    value: "bar",
    foo: "foo"
}
```

8. A C like preprocessor is supported. The following preprocessor commands are available:

   `#define` *var expr*
   : Define a new variable with value *expr*. *expr* must be a valid JSON expression. Note that unlike the standard C preprocessor, *expr* is evaluated by the preprocessor.

   `#undef` *var*
   : Undefine the variable *var*.

   `#include` *expr*
   : Include the file whose filename is the evaluation of the string expression *expr*.

   `#if` *expr* Consider the following text if *expr* is true.

   `#else` Alternative of `#if` block.

   `#elif` Composition of `#else` and `#if`.

   `#endif` End of `#if` block.

   `#ifdef` *var*
   : Shortcut for `#if defined(var)`

   `#ifndef` *var*
   : Shortcut for `#if !defined(var)`

   In the JSON source, every occurrence of a defined preprocessor variable is replaced by its value.

9. Backquote strings: JSON expression can be inserted in backquote delimited strings with the `${expr}` syntax. Example: `` `abc${1+2}d` `` is evaluated as the string `"abc3d"`. Preprocessor variables can be used inside the expression. Backquote strings may span several lines.

5.1.1 JSON merge rules

Merge overriding direction depends on context, i.e source may override destination or the opposite.
JSON merge is recursive for Objects and Arrays.

Example, merging

```
{
    foo: { value: "bar" },
    same: "one",
    one: 1
}
```

with

```
{
    foo: { value: "none", second: true },
```

```
    same: "two",
    two: 1
}
```

Will become:

```
{
    foo: { value: "bar", second: true },
    same: "one",
    one: 1
    two: 1
}
```

assuming first object overrides second one.

In case of Array merging, the final array length will be the maximum length of all merged arrays.
For each element of the final array, merge will be done considering defined elements only.
Ex:

```
{
    array: [0, 1, 2, { foo: "bar" } ],
    array: [3, 4],
    array: [5, 6, 7, { bar: "foo" }, 8 ]
}
```

Will be merged to:

```
{
    array: [5, 6, 7, { foo: "bar", bar: "foo" }, 8 ],
}
```

5.2 Properties

`log_filename`
: String. Set the log filename. If no leading `/`, it is relative to the configuration file path. See [Log file format], page 130.

`log_options`
: String. Set the logging options as a comma separated list of assignments.

- *layer*.level=*verbosity*. For each layer, the log verbosity can be set to `none`, `error`, `info` or `debug`. In debug level, the content of the transmitted data is logged.
- *layer*.max_size=*n*. When dumping data content, at most `n` bytes are shown in hexa. For ASN.1, NAS or Diameter content, show the full content of the message if `n > 0`.
- *layer*.payload=[0|1]. Dump ASN.1, NAS, SGsAP or Diameter payload in hexadecimal.
- *layer*.key=[0|1]. Dump security keys (NAS and RRC layers).
- *layer*.crypto=[0|1]. Dump plain and ciphered data (NAS and PCDP layers).
- *layer*.verbose=[0|1]. If `layer` is `ipsec`, dump all packets filtering informations.
- time=[sec|short|full]. Display the time as seconds, time only or full date and time (default = time only).
- time.us=[0|1]. Dump time with microseconds precision.
- file=cut. Close current file log and open a new one.

- file.rotate=now. Move and rename to the same directory or to the directory pointed by `file.path` and open a new log file (Headers are kept).
- file.rotate=*size*. Every time log file size reaches *size* bytes, move and rename to the same directory or to the directory pointed by `file.path`, and open a new log file (Headers are kept).
  Size is an integer and can be followed by K, M or G.
- file.rotate=#*count*. Everytime number of logs in log file reaches *count*, move and rename to the same directory or to the directory pointed by `file.path`, and open a new log file (Headers are kept).
  Size is an integer and can be followed by K, M or G.
- file.path=*path*. When log rotation is enabled (`file.rotate` set), rename and move current log to this path instead of initial log path.
- append=[0|1]. (default=0). If 0, truncate the log file when opening it. Otherwise, append to it.

Available layers are: `nas`, `ip`, `s1ap`, `ngap`, `gtpu`, `rx`, `s6`, `cx`, `s13`, `sgsap`, `sbcap`, `lcsap`, `lppa`, `n12`, `n13`, `n8`, `n17`, `n50`, `n5`, `nl1`, `nrppa`, `epdg`, `ikev2`, `ipsec`, `n20`, `n62`

`log_sync` Optional boolean (default = false). If true, logs will be synchronously dumped to file.
Warning, this may lead to performances decrease.

`gtp_addr`

String or array of strings. Set the IP address (and an optional port) on which the GTP-U packets are received. The default port is 2152. It is normally the IP address of the network interface connected to the core network.

Syntax:

- `"1.2.3.4"` (use default port)
- `"1.2.3.4:5678"` (use explicit port)
- `"2001:db8:0:85a3::ac1f:8001"` (IPv6 address and default port)
- `"[2001:db8:0:85a3::ac1f:8001]:5678"` (IPv6 address and explicit port)

`gtp_ext_addr`

Optional string or array of strings. Set the IP address on which the eNodeB should transmit the GTP-U packets. It is the same as gtp_addr by default. It can be different if LTEMME is behind a NAT. It should have the same number of entries as the `gtp_addr` parameter.

`gtp_payload_mtu`

Optional integer (range 68 to 16384, default = 1500). MTU in bytes for the GTP-U payload. Do not forget to update the network interface MTU accordingly for optimal performance. See [Initial testing], page 6. If you want to use another value than the default one, you likely want to change the `mtu_ipv4` and/or `ipv6_mtu` parameters also.

`gtp_use_packet_bundling`

Optional boolean (default = false). Concatenate multiple GTP-U PDUs within a single UDP datagram. Be careful, this is a non-standard option that must not be activated if the peer is not an Amarisoft eNodeB/gNodeB/N3IWF with this option activated.

`s1ap_bind_addr`

Optional string or array of objects.
If the object is a string, it contains the IP address and optional port on which the

S1AP SCTP connection is bound.
If the object is an array, it contains the following parameters:

`bind_addr`
String. IP address and optional port on which the S1AP SCTP connection is bound.

`gtp_addr` String. IP address and optional port of the GTP-U interface associated with this S1AP interface. It must correspond to an entry of the `gtp_addr` object.

`ngap_bind_addr`
Optional string or array of objects.
If the object is a string, it contains the IP address and optional port on which the NGAP SCTP connection is bound.
If the object is an array, it contains the following parameters:

`bind_addr`
String. IP address and optional port on which the NGAP SCTP connection is bound.

`gtp_addr` String. IP address and optional port of the GTP-U interface associated with this NGAP interface. It must correspond to an entry of the `gtp_addr` object.

`plmn` String. PLMN identity of the MME (5 or 6 digits). It should match one of the PLMN identities broadcasted by the eNodeB or gNodeB.

`cag_support`
Optional boolean (default = false). Applicable to 5GC only. Indicates if the AMF supports the CAG feature. CAG feature cannot be declared as supported in a SNPN (ie when nid item is present).

`nid` Applicable to 5GC only in case of Stand-Alone Non-Public Network (SNPN). The NID (as defined in 3GPP TS 23.003 12.7 Stand-Alone Non-Public Network Identifier) associated with the AMF PLMN identifies the SNPN. It contains the following objects defining the NID:

`nid_value`
10 digits NID value.

`assignment_mode`
Optional enumeration: self, coordinated_1, coordinated_2, according to 3GPP TS 23.003 clause 12.7 (default = self).

`mme_group_id`
Optional integer, range: 0 to 65535. Set the MME group ID.

`mme_code` Optional integer, range: 0 to 255. Set the MME code.

`mme_name` Optional string. MME name used for S1AP signalling. If absent no MME name is used.

`amf_region_id`
Optional integer, range: 0 to 255. Set the AMF region ID. If not present, the value is derived from the `mme_group_id` value. If present, it must match the value derived from the `mme_group_id` value if it is present, using the rules defined in 3GPP TS 23.003 chapter 2.10.2.2.2.

`amf_set_id`
: Optional integer, range: 0 to 1023. Set the AMF Set ID. If not present, the value is derived from the `mme_group_id` and `mme_code` values. If present, it must match the value derived from the and `mme_code` values if they are present, using the rules defined in 3GPP TS 23.003 chapter 2.10.2.2.2.

`amf_pointer`
: Optional integer, range: 0 to 63. Set the AMF Pointer. If not present, the value is derived from the `mme_code` value. If present, it must match the value derived from the `mme_code` value if it is present, using the rules defined in 3GPP TS 23.003 chapter 2.10.2.2.2.

`truncated_amf_set_id`
: Optional integer, range: 0 to 7. Set the truncated AMF Set ID length for Control Plane CIoT 5GS optimization reestablishment procedure.

`truncated_amf_pointer`
: Optional integer, range: 0 to 5. Set the truncated AMF Pointer length for Control Plane CIoT 5GS optimization reestablishment procedure.

`amf_name` Optional string. AMF name used for NGAP signalling. Default is set to amarisoft.amf.5gc.mnc<MNC>.mcc<MCC>.3gppnetwork.org.

`amf_nf_instance_id`
: Optional 16 bytes hexadecimal string.
Defines the random number to use to create the AMF NF instance id.
Allows to keep the same value of AMF NF instance id even after a restart of the AMF.
If not present, the AMF instance id will be generated as described in IETF RFC 4122 paragraph 4.4.

`eps_5gs_interworking`
: Optional enumeration: none, without_n26, with_n26 (default = none). Defines whether inter RAT mobility between EPS and 5GS is supported or not, and whether N26 interface is supported or not. Note that interworking with N26 is required to perform handover between EPS and 5GS.

`eps_assign_5gs_resources_without_n1_mode_capability`
: Optional boolean (default = false). If set to true and if the UE does not indicate supporting N1 mode in its UE network capability IE, the EPC will still allocate 5GS QoS rules and Qos flow descriptions if the UE indicates a PDU session ID in its ESM PDN connectivity request message. Only applicable when `eps_5gs_interworking` is set to "with_n26".

`eplmn_list`
: Optional array of strings (1 to 15). List of equivalent PLMNs used for NAS, S1AP and NGAP messages.

`relative_capacity`
: Optional integer. Range: 0 to 255. Default : 50. Set the MME or AMF relative capacity value used for MME or AMF load balancing in S1AP S1 Setup Response, S1AP MME Configuration Update, NGAP NG Setup Response and NGAP AMF Configuration Update messages.

`nas_cipher_algo_pref`
: Array of integers. Set the preferred algorithms for NAS encryption in decreasing order of preference. If none match the UE capabilities, then EEA0/5G-EA0 (no encryption) is selected.

List of supported algorithms:

Value	Algorithm
1	EEA1/5G-EA1 (Snow 3G)
2	EEA2/5G-EA2 (128 bit AES)
3	EEA3/5G-EA3 (ZUC)

If encryption is necessary, for best performance use AES (EEA2/5G-EA2) as first choice if your CPU supports the AES NI Intel instruction set (available starting from Sandy bridge CPUs). Otherwise use Snow3G (EEA1/5G-EA1) or ZUC (EEA3/5G-EA3).

`nas_cipher_algo_null_allowed`

Optional boolean (default = true). If set to false, the use of NULL ciphering algorithm (EEA0/5G-EA0) is forbidden unless the UE performs an emergency registration.

`nas_integ_algo_pref`

Array of integers. Set the preferred algorithms for NAS integrity check in decreasing order of preference. If none match the UE capabilities, then EIA0/5G-IA0 (no integrity check) is selected.

List of supported algorithms:

Value	Algorithm
1	EIA1/5G-IA1 (Snow 3G)
2	EIA2/5G-IA2 (128 bit AES)
3	EIA3/5G-IA3 (ZUC)

For best performance, use AES (EIA2/5G-IA2) as first choice if your CPU supports the AES NI Intel instruction set (available starting from Sandy bridge CPUs). Otherwise use Snow3G (EIA1/5G-IA1) or ZUC (EIA3/5G-IA3).

`nas_integ_algo_null_allowed`

Optional boolean (default = true). If set to false, the use of NULL integrity algorithm (EIA0/5G-IA0) is forbidden unless the UE performs an emergency registration.

`tun_setup_script`

String. Set the path of the shell script to set up the virtual network interface. Script is called for each PDN connectivity or PDU session with following parameters:

1. Interface name
2. PDN or PDU session index
3. Access Point Name
4. Type: 'ipv4', 'ipv6' or 'ethernet'

If type is 'ipv4', the next parameters are:

1. IP address: interface address
2. First IP address
3. Last IP address
4. Subnet mask

If type is 'ipv6', the next parameters are:

1. Link local address
2. Interface IP address

3. First IPv6 prefix
4. Last IPv6 prefix
5. Subnet mask

If type if 'ethernet', there are no extra parameters

`t3402` Optional integer (default = -1). Value in seconds of the T3402 or T3502 timer. -1 means that the timer value is not transmitted in attach accept or TAU or registration accept so that the UE uses the default value (12 minutes).

`t3412` Optional integer (default = 1800). Value in seconds of the T3412 (TAU update) timer. -1 means that the timer is deactivated. This is the value sent to the UE in NAS signalling, unless the UE is requesting the use of a longer timeout with T3412 extended value information element.

`t3412_low_priority`
Optional integer (default = t3412 value). Value in seconds of the T3412 (TAU update) timer if the UE indicates NAS signalling low priority. -1 means that the timer is deactivated. This is the value sent to the UE in NAS signalling, unless the UE is requesting the use of a longer timeout with T3412 extended value information element.

`t3512` Optional integer (default = 1800). Value in seconds of the T3512 (periodic registration) timer. -1 means that the timer is deactivated. This is the value sent to the UE in NAS signalling, unless the UE is requesting the use of a longer timeout with requested T3512 value information element.

`t3501` Optional integer in range 1-30 (default = 5). Value in seconds of the MANAGE UE POLICY COMMAND timer in the PCF.

`n3gpp_dereg_timer`
Optional integer (default = 3240). Value in seconds of the non-3GPP de-registration timer. This is the value sent to the UE in NAS signalling.

`purge_timer`
Optional integer (default = -1). Value in seconds of the purge timer started when the UE gets deregistered. When it expires, the UE context is deleted. -1 means that the timer is deactivated.

`psm` Optional boolean (default = true). If set to false, MME will ignore the PSM request sent by the UE.

`mico_support`
Optional boolean (default = true). If set to false, AMF will ignore the MICO request sent by the UE.

`registration_area_alloc_ind`
Optional ingeger (default = 0). Sets the Registration Area Allocation Indication bit in the 5GMM MICO indication IE. 0 means 'all PLMN registration area not allocated' and 1 means 'all PLMN registration area allocated'.

`sprt_support`
Optional boolean (default = false). If set to true and if `mico_support` is set to true, the AMF will accept the use of the strictly periodic registration timer.

`t3412_extended_forced`
Optional integer (default = -1). Value in seconds of the T3412 extended timer if UE uses PSM. If different from -1, the MME will ignore the value requested by the UE and will send this one instead.

`force_t3412_extended_ie`
: Optional boolean (default = false). If set to false, the MME selects the greatest T3412 value between the one configured in the MME and the one requested by the UE for PSM (unless `t3412_extended_forced` is set), and it does not send the T3412 extended IE if the value can be encoded as a GPRS timer IE. If set to true, the MME accepts a T3412 value requested by the UE smaller than the configured one, and the T3412 extended IE is always sent.

`requested_t3512_forced`
: Optional integer (default = -1). Value in seconds of the T3512 timer if UE uses MICO. If greater than -1, the AMF will ignore the value requested by the UE and will send this one instead. If set to -2, the AMF will accept a T3512 value requested by the UE smaller than the configured one.

`t3324_forced`
: Optional integer (default = -1). Value in seconds of the T3324 timer if UE uses PSM or MICO. If different from -1, the MME or AMF will ignore the value requested by the UE and will send this one instead. -2 means that the timer is deactivated.

`t3346` Optional integer (default = -1). Value in seconds of the T3346 timer. The timer is transmitted in the reject messages if the EMM or 5GMM cause is #22 (congestion) and the value is not -1.

`t3442` Optional integer (default = 0). Value in seconds of the T3442 timer.

`t3448` Optional integer (default = -1). Value in seconds of the T3448 timer. The timer is transmitted if the value is different from -1 and the UE indicates its support in the UE network capability information element.

`t3460` Optional integer (default = 6). Value in seconds of the T3460 or T3560 timer.

`t3460_wb_ce`
: Optional integer (default = 24). Value in seconds of the T3460 or T3560 timer for UE operating in WB-S1/CE or WB-N1/CE mode.

`lower_bound_timer`
: Optional integer (default = -1). The timer is transmitted in the reject messages if the EMM or 5GMM cause is #78 (PLMN not allowed to operate at the present UE location) and the value is not -1.

`t3560_ng_ran_sat`
: Optional integer (default = 11). Value in seconds of the T3560 timer for UE operating in NR(MEO) or NR(GEO) satellite RAT.

`5gmm_backoff_timer`
: Optional integer (default = -1). Value in seconds of the 5GMM DL NAS transport back-off timer. The timer is transmitted if the value is not -1. -2 means that the timer is deactivated.

`edrx` Optional boolean (default = true). If set to false, the core network will ignore the eDRX request sent by the UE.

`edrx_ptw_wb_s1`
: Optional integer (0 to 15, default = 3). 4 bits Paging Time Window length for WB-S1 and WB-N1 UEs as defined in 3GPP TS 24.008 chapter 10.5.5.32.

`edrx_ptw_nb_s1`
: Optional integer (0 to 15, default = 3). 4 bits Paging Time Window length for NB-S1 and NB-N1 UEs as defined in 3GPP TS 24.008 chapter 10.5.5.32.

`edrx_ptw_nr`
: Optional integer (0 to 31, default = 3). 8 bits Paging Time Window length for NR connected to 5GCN UEs as defined in 3GPP TS 24.008 chapter 10.5.5.32.

`edrx_cycle_forced`
: Optional integer (-1 to 15, default = -1). 4 bits E-UTRAN or NR eDRX cycle length duration as defined in 3GPP TS 24.008 chapter 10.5.5.32. If different from -1, the core network will ignore the value requested by the UE and will send this one instead.

`gwus_support`
: Optional boolean (default = true). Group WUS support.

`gwus_prob_forced`
: Optional enumeration: -1, 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100 (default = -1: paging probability not forced). Force group WUS paging probability for all the UEs. The MME will ignore the value requested by the UE and will send this one instead.

`ims_list` Optional array. Each entry is an object defining connection to Amarisoft IMS server. This is useful for SMS over SG or 3GPP mode of IMS server when Rx interface is not used.
Each entry has following members:

`ims_addr` IP address of Amarisoft IMS server.

`bind_addr`
: IP address of network interface to use for IMS connection.

`ims_vops_eps`
: Optional boolean (default = false). Set the IMS voice over PS session in S1 mode supported bit of the EPS network feature support field in the NAS attach accept message (VoLTE).

`ims_vops_5gs_3gpp`
: Optional boolean (default = false). Set the IMS voice over PS session over 3GPP access indicator of the 5GS network feature support IE of the NAS registration access message. See 3GPP TS 24.501 table 9.11.3.5.1.

`ims_vops_5gs_n3gpp`
: Optional boolean (default = false). Set the IMS voice over PS session over non-3GPP access indicator of the 5GS network feature support IE of the NAS registration access message. See 3GPP TS 24.501 table 9.11.3.5.1.

`emc_bs` Optional boolean (default = false). Set the emergency bearer services in S1 mode supported bit of the EPS network feature support field in the NAS attach accept message (VoLTE, Release 9).

`emc` Optional integer (default = 0). Set the emergency service support indicator for 3GPP access bits of the 5GS network feature support IE in the NAS registration accept message. See 3GPP TS 24.501 table 9.11.3.5.1.

`emc_n3gpp`
: Optional boolean (default = false). Set the emergency service support indicator for non-3GPP access bits of the 5GS network feature support IE in the NAS registration accept message. See 3GPP TS 24.501 table 9.11.3.5.1.

`emf` Optional integer (default = 0). Set the emergency service fallback indicator for 3GPP access bits of the 5GS network feature support IE in the NAS registration accept message. See 3GPP TS 24.501 table 9.11.3.5.1.

`epc_lcs` Optional boolean (default = false). Set the Location services indicator via EPC supported bit of the EPS network feature support field in the NAS attach accept message.

`5gs_sms_over_nas`
Optional boolean (default = true). Defines if 5GC should indicate the support of SMS over NAS in the 5GMM registration accept message, if the UE indicated its support in the 5GMM registration request message.

`emergency_number_list`
Optional array of objects. Defines a list of emergency numbers to be sent to the UE in the NAS Attach Accept, Tracking Area Update Accept or Registration Accept messages.
Each object must contain the following parameters:

`category` Integer. Bitmask of the category bits as defined in 3GPP TS 24.008 table 10.5.135d (bit 1: police, bit 2: ambulance, bit 3: fire brigade, bit 4: marine guard, bit 5: mountain rescue).

`digits` String. Emergency number.

`extended_emergency_number_list`
Optional object. Defines a list of extended emergency numbers to be sent to the UE in the NAS Attach Accept, Tracking Area Update Accept or Registration Accept messages.
The object must contain the following parameters:

`validity` Enumeration (country or plmn).
Validity of the extended emergency number list.

`emergency_numbers`
Array of objects. Each object must contain the following parameters:

`digits` String. Emergency number.

`sub_services`
Optional string. Emergency number sub-services.

`cp_ciot_opt`
Optional boolean (default = false). If true, enable control plane CIoT optimization (if supported by the UE).

`attach_without_pdn`
Optional boolean (default = false). If true, enable attach without PDN functionality (if supported by the UE).

`fifteen_bearers`
Optional boolean (default = false). If true, enable the use of 15 EPS radio bearers (if supported by the UE).

`apn_oi` Optional string (default = mncABC.mccXYZ.gprs where ABC is the PLMN MNC and XYZ the PLMN MCC). Defines the APN/DNN Operator Identifier. An empty string removes the APN OI from the APN.

`network_name`
Optional string (default = empty). Set the network name in the EMM information or configuration update command message.

`network_short_name`
: Optional string (default = empty). Set the network short name in the EMM information or configuration update command message.

`emm_information_time_enable`
: Optional boolean (default = true). Include the time and time zone in the EMM information or 5GMM configuration update command message.

`emm_information_enable`
: Optional boolean. Default = true if `network_name` or `network_short_name` are not empty. If true, send the EMM information message after the NAS attach complete message or the 5GMM configuration update command message after the 5GS registration accept message.

`ext_emm_cause`
: Optional integer (range -1 to 15). If EMM cause is 15 in attach reject or tracking area update reject message and the value is different from -1, extended EMM cause IE is sent. The values 0 to 15 correspond to the bits specified in 3GPP TS 24.301 chapter 9.9.3.26A.

`attach_reject_error`
: Optional integer (range 0 to 255, default depending on scenario).
Force value of EMM reject cause in NAS attach reject message.

`tracking_area_update_reject_error`
: Optional integer (range 0 to 255, default depending on scenario).
Force value of EMM reject cause in NAS tracking area update reject message.

`service_reject_error`
: Optional integer (range 0 to 255, default depending on scenario).
Force value of EMM reject cause in NAS service reject message.

`pdn_connect_reject_error`
: Optional integer (range 0 to 255, default depending on scenario).
Force value of ESM reject cause in NAS PDN connectivity reject message.

`pdn_disconnect_reject_error`
: Optional integer (range 0 to 255, default depending on scenario).
Force value of ESM reject cause in NAS PDN disconnect reject message.

`bearer_resource_allocation_reject_error`
: Optional integer (range 0 to 255, default depending on scenario).
Force value of ESM reject cause in NAS bearer resource allocation reject message.

`bearer_resource_modification_reject_error`
: Optional integer (range 0 to 255, default depending on scenario).
Force value of ESM reject cause in NAS bearer resource modification reject message.

`registration_initial_reject_error`
: Optional integer (range 0 to 255, default depending on scenario).
Force value of 5GMM reject cause in NAS registration reject message (for 5GS

registration type 1 or 4).

`registration_mobility_periodic_reject_error`
: Optional integer (range 0 to 255, default depending on scenario).
Force value of 5GMM reject cause in NAS registration reject message (for 5GS registration type 2 or 3).

`5gs_service_reject_error`
: Optional integer (range 0 to 255, default depending on scenario).
Force value of 5GMM reject cause in NAS service reject message.

`pdu_session_establishment_reject_error`
: Optional integer (range 0 to 255, default depending on scenario).
Force value of 5GSM reject cause in NAS PDU session establishment reject message.

`pdu_session_release_reject_error`
: Optional integer (range 0 to 255, default depending on scenario).
Force value of 5GSM reject cause in NAS PDU session release reject message.

`pdu_session_modification_reject_error`
: Optional integer (range 0 to 255, default depending on scenario).
Force value of 5GSM reject cause in NAS PDU session modification reject message.

`5gmm_dl_nas_transport_error`
: Optional integer (range 0 to 255, default depending on scenario).
Force value of 5GMM reject cause in NAS DL NAS transport message.

`eps_user_unknown_reject_cause`
: Optional integer (range 0 to 255, default = 8).
EMM cause sent in the NAS attach reject message when the IMSI is unknown in the HSS.

`5gs_user_unknown_reject_cause`
: Optional integer (range 0 to 255, default = 3 or 75 if SNPN).
5GMM cause sent in the NAS registration reject message when the SUPI is unknown in the UDM.

`attach_result_mode`
: Optional string (default = auto). Set attach result of attach accept message.
Can be:

  `auto` This is standard LTE behavior.

  `eps_only` If set and UE is sending combined EPS/IMSI attach, the MME will answer with EPS only in attach accept message (EMM cause will be CS domain not available).

  `combined` If set and UE is sending EPS only attach, the MME will answer with combined in attach accept message.

`additional_update_result`
: Optional integer (default = 2). Set the value of additional update result in NAS attach accept and tracking area update accept messages.
If set to -1, the additional update result won't be set.

`network_policy`
: Optional integer (range -1 to 15, default = -1). Set the value of the network policy information element described in 3GPP TS 24.301 chapter 9.9.3.52. The value -1 means that the IE is not transmitted.

`imeisv_request_in_smc`
: Optional boolean (default = true). Ask for the UE IMEISV in the NAS security mode command message. Must be enabled if `multi_sim` is set to `true`. IMEISV will always be requested if a S13 or N17 connection is defined, or if `me_db` object is defined.

`coarse_location_information_support`
: Optional boolean (default = false). If set to true, and if a NB-IoT UE accessing the core network via a NTN cell supports the feature, the MME will request the coarse location information in the NAS security mode command message.

`authentication_mode`
: Optional string (default = auto). Set NAS authentication procedure behavior.
Can be:

  `auto` — The MME or AMF performs authentication procedure unless the UE is already successfully authentified.

  `force` — The MME or AMF forces a new NAS authentication procedure even if the Attach Request or Registration Request was already successfully authentified

  `skip` — The MME or AMF skips the NAS authentication procedure and uses EIA0/EEA0 or 5G-IA0/5G-EA0 algorithms. This needs to be supported on UE side also.

`dummy_authentication_autn_mac`
: Optional boolean (default = false). If set to true, the network will send an invalid AUTN MAC value in the NAS authentication request message.

`authenticate_known_emergency_supi`
: Optional boolean (default = false). If set to true, the network will authenticate known IMSI/SUPI during an emergency registration procedure and reject the UE if it fails.

`restrict_ec_wb`
: Optional boolean (default = false). Sets restriction on enhanced coverage for WB-S1 and WB-N1 UEs.

`restrict_ec_nb`
: Optional boolean (default = false). Sets restriction on enhanced coverage for NB-S1 and NB-N1 UEs.

`skip_smc_proc`
: Optional boolean (default = false). If set to true, the MME or AMF will not perform a NAS security mode control procedure and will send all messages as plain. This needs to be supported on UE side also.

`force_identity_request`
: Optional boolen (default = false). If set to true, the network will perform a NAS identity request procedure even if the GUTI in the attach request or the 5G-GUTI in the initial registration request is already known.

`allocate_new_guti_in_tau`
: Optional boolean (default = true). If set to true, a new GUTI is allocated during each Tracking Area Update procedure. If set to false, the UE keeps the GUTI allocated during the attach procedure.

`force_guti_in_tau`
: Optional boolean (default = false). If set to true, GUTI IE will be systematically present in Tracking Area Update Accept message even if it does not change.

`attach_reject_filter`
: Optional nullable object. Represent UE to reject when trying to attach to EPS.
Each property name represent IMSI. Use of wildcard `"*"` with an IMSI prefix is allowed to match IMSI range (Ex: 0010112456*). If multiple filters are matching, the one with the longest prefix will be used.
Each property value is an integer defining the redirection type as described in *rrc_redirect* eNB configuration.
The configuration may be removed using:
attach_reject_filter: null

  Example:

```
attach_reject_filter: {
    "*": 0,
    "0010112345678": 1
    "00101123456*": 2
}
```

  Will reject UE with IMSI *0010112345678* using redirection configuration 1 and all other UEs using redirection configuration 0.

`emm_procedure_filter`
: Optional object. Allows to define the MME behavior for a list of EMM procedures. Each property name represents an EMM procedure. The ones currently supported are `attach`, `attach_with_security_protection`, `tracking_area_updating`, `detach`, `service_request`, `identity`, `authentication`, `security_mode_control` and `nas_transport`.
Each property value is an object containing the following fields:

  `action` Enumeration (`treat` (UE message is processed), `ignore` (UE message is ignored) or `reject` (UE message is rejected)).

  `ttl` Optional integer. If set, the `reject` of `ignore` filter is applied `ttl` times. If not set, the filter is applied until it is modified.

  `send_status_on_reject`
  : Optional boolean. It set and if `action` is set to reject an EMM status message is sent.

  By default all procedures are treated.

  Example:

```
emm_procedure_filter: {
    attach: {
        action: "treat"
```

```
        },
        service_request: {
            action: "reject",
            ttl: 1
        }
    }
```

`5gmm_procedure_filter`
: Optional object. Allows to define the AMF behavior for a list of 5GMM procedures.
Each property name represents a 5GMM procedure. The ones currently supported are `registration_initial`, `registration_initial_with_security_protection`, `registration_mobility_periodic`, `service_request`, `identity`, `authentication`, `security_mode_control`, `generic_ue_update_command`, `nas_transport_n1_sm`, `nas_transport_sms`, `deregistration`, `control_plane_service_request`, `network_slice_specific_authentication` and `nas_transport_lpp`.
Each property value is an object containing the following fields:

`action`
: Enumeration (`treat` (UE message is processed), `ignore` (UE message is ignored) or `reject` (UE message is rejected)).

`ttl`
: Optional integer. If set, the `reject` of `ignore` filter is applied `ttl` times. If not set, the filter is applied until it is modified.

`send_status_on_reject`
: Optional boolean. It set and if `action` is set to reject a 5GMM status message is sent.

By default all procedures are treated.
Note that `nas_transport_n1_sm` filter must be used together with the `apply_nas_transport_n1_sm_filter` DNN parameter.
Example:

```
"5gmm_procedure_filter": {
    registration_initial: {
        action: "treat"
    },
    service_request: {
        action: "reject",
        ttl: 1
    }
}
```

`qci_dscp_mapping`
: Optional array of objects. Allows to define a specific IP differentiated services code point for a given QCI/5QI. QCI/5QI not explicitly configured use the default DSCP value 0.
Each object must contain the following properties:

`qci`
: Integer (range 1 to 254). QCI or 5QI value.

`dscp`
: Integer (range 0 to 63). DSCP value.

`rate_bucket_duration`
: Optional. Range 500 to 5000 (default = 2000). Duration in ms for the average bit rate estimation. It is used to enforce the APN and Session Aggregate Maximum Bit Rate.

`dcnr_support`
: Optional boolean (default = false). Set it to true to enable Dual Connectivity with NR support.

`dcnr_implicit_support`
: Optional boolean (default = false). If set to true, the MME will not send the 2nd byte of the EPS network feature support IE because of DCNR. Can be useful to test the UE behavior.

`cpu_core_list`
: Optional array of integers. Defines the list of CPU cores indexes on which LTEMME will run.
If not set, LTEMME may use all cores.
Note that the number of cores depends on Linux scheduler and LTEMME configuration.

`cn_assistance_info_support`
: Optional boolean (default = false), applicable to 5GC only. If set to true, the AMF will send a Core Network Assistance Information in the Initial Context Setup message.
This is mandatory to have a functional RRC Inactive support in the RAN.

`ecc_params`
: Optional object. Set the ECC network configuration for the SUPI protection and de-concealment of the SUCI. Applicable to 5GC only. It contains the following objects:

  `A`
  : Optional array of objects. Set the home network private key for profile A protection scheme.

    `home_nw_private_key`
    : String. Set the home network private key in hexadecimal format (32 bytes).

    `home_nw_key_id`
    : Optional integer in range 0 to 255 (default = 1). Set the home network key identifier.

  `B`
  : Optional array of objects. Set the home network private key for profile B protection scheme.

    `home_nw_private_key`
    : String. Set the home network private key in hexadecimal format (32 bytes).

    `home_nw_key_id`
    : Optional integer in range 0 to 255 (default = 2). Set the home network key identifier.

  Here is the procedure to generate a private/public key-pair:

```
Profile A:
openssl genpkey -algorithm x25519 -out key.pem
openssl pkey -in key.pem  -text

Profile B:
openssl ecparam -genkey -name secp256r1 -out key.pem
openssl ec -in key.pem  -noout -text -conv_form compressed
```

`nf_ssl_certificate`
: Optional string. Applicable to 5GC only. If set, forces SSL for NF interfaces. Defines CA certificate filename.

`nf_ssl_key`
: Optional string. Applicable to 5GC only. Mandatory if nf_ssl_certificate is set. Defines CA private key filename.

  Here is the procedure to generate the private key file key.pem and the certicate file cert.pem:

```
openssl req -new > cert.csr
openssl rsa -in privkey.pem -out key.pem
openssl x509 -in cert.csr -out cert.pem -req -signkey key.pem --days 365
```

`nssai`
: Applicable to 5GC only. Optional array. List of S-NSSAIs served by the AMF. Default content is sst: 1 (eMBB).
  Each entry will set a S-NSSAI value as defined below:

  `sst` Integer (range 0-255). Slice Service Type.

  `sd` Optional integer (range 0-0xFFFFFE). Slice Differentiator.

`default_nssai`
: Applicable to 5GC only. Optional array. List of default S-NSSAIs served by the AMF.
  Can only take S-NSSAIs contained in the non-default list above. If not present, takes the same content as the non-default list. See [nssai], page 25.

`nssai_inclusion_mode`
: Applicable to 5GC only. Optional enumeration (none, A, B, C, D, default = none). NSSAI inclusion mode value to send in message Registration accept.

`nssai_subject_to_nsac`
: Applicable to 5GC only.
  Optional array. List of the S-NSSAIs subject to NSAC. Can only take S-NSSAIs contained in the list of S-NSSAIs served by the AMF. Each entry of the array contains the following objects:

  `snssai` S-NSSAI value.

  `sst` Integer (range 0-255). Slice Service Type.

  `sd` Optional integer (range 0-0xFFFFFE). Slice Differentiator.

  `access_type`
  : Optional array of enumeration: 3gpp, non-3gpp (default value 3gpp).

  `eps_counting`
  : Optional boolean (default = false). If set to false, indicates that the network slice is subject to NSAC only in 5GS. If set to true, indicates that the network slice is subject to NSAC in EPS and 5GS.

  `ue_max_count`
  : Optional integer (range: 1 to MAX_INT). If present, the control of the number of UEs registered to the S-NSSAI is activated.

  `pdu_session_max_count`
  : Optional integer (range: 1 to MAX_INT). If present, the control of the number of PDU sessions registered to the S-SNNAI is activated.

`backoff_timer`
: Optional integer (default = -1). Value in seconds of the S-NSSAI backoff timer. If present and not set to -1, this value is transmitted in the IE Extended rejected NSSAI.

`eap_tls` Optional object applicable to 5GC only. Shall be present if EAP-TLS method is used in the UE database.
It contains the following objects:

`certificate`
: Define the server certificate filename.

`private_key`
: Define the server private key filename.

`ca_certificate`
: Define the CA certificate filename. It contains a list of root certificates to authenticate the user.

`tai_lists`
: Optional array of objects (up to 65535). Applicable to EPC only. Defines an array of TAI lists.
When the UE initiates registration in a tracking area, the TAI list containing this tracking area,
if available, is provided to the UE in the NAS Attach Accept and Tracking Area Update Accept messages.
Each object must contain the following parameters:

`plmn` String (5 or 6 digits). Must match the PLMN identity of the MME See [plmn], page 12, or an equivalent PLMN See [eplmn_list], page 13.

`tacs` Array of up to 16 integers in range 1 to 0xFFFF, except 0xFFFE. Each element defines a 2 bytes long tracking area code.

`tai_lists_5gs`
: Optional array of objects (up to 65535). Applicable to 5GC only. Defines an array of TAI lists.
When the UE initiates registration in a tracking area, the TAI list containing this tracking area, if available, is provided to the UE in the Registration Accept message.
Each object must contain the following parameters:

`plmn` String (5 or 6 digits). Must match the PLMN identity of the MME See [plmn], page 12, or an equivalent PLMN See [eplmn_list], page 13.

`tacs` Array of up to 16 integers in range 1 to 0xFFFFFF, except 0xFFFFFE. Each element defines a 3 bytes long tracking area code.

`forbidden_eps_tacs`
: Array of up to 16 integers in range 1 to 0xFFFF, except 0xFFFE. Applicable to EPC only. Forbidden tracking areas codes in the MME PLMN (See [plmn], page 12) or an equivalent PLMN (See [eplmn_list], page 13).

`areas_list_5gs`
: Optional array of objects. (up to 65535). Applicable to 5GC only.
Gives the list of tracking area codes associated to each area code.
This array is used in the interface AMF-UDM (See [allowed_5gs_tais], page 46, See [forbidden_5gs_tais], page 46). Each object must contain the following parameters:

`code` Integer in range 0 to 0xFFFF defining the area code (operator specific).

`tacs` Array of integers in range 1 to 0xFFFFFF, except 0xFFFFFE. List of the tracking areas codes in the area.

`operator_defined_access_categories`
Optional array of objects. Operator-defined access categories as defined in 3GPP TS 24.501 paragraph 9.11.3.38. Applicable to 5GC only. Each object contains the following parameters:

`precedence`
Integer in range 0 to 255. Precedence value.

`access_category`
Integer in range 32 to 63. Operator defined access category value.

`nssai` Optional array of S-NSSAIs. See [nssai], page 25.

`dnn_list` Optional array of strings.

`standard_access_category`
Optional integer (possible values 0, 1, 2, 3, 4, 5, 6, 7, 10). Access category number of the related standardized access category.

`akma_kaf_lifetime`
Optional integer in range: 1 to 3650 (default = 365). Applicable to 5GC only. AKMA Application Keys lifetime in days as defined in 3GPP 33.535 paragraph 5.2 AKMA key lifetimes.

`com_addr` Optional string. Address of the WebSocket server remote API. See [Remote API], page 66.
If set, the WebSocket server for remote API will be enabled and bound to this address.
Default port is 9000.
Setting IP address to [::] will make remote API reachable through all network interfaces.

`com_name` Optional string. Sets server name. MME by default

`com_ssl_certificate`
Optional string. If set, forces SSL for WebSockets. Defines CA certificate filename.

`com_ssl_key`
Optional string. Mandatory if *com_ssl_certificate* is set. Defines CA private key filename.

`com_ssl_peer_verify`
Optional boolean (default is false). If *true*, server will check client certificate.

`com_ssl_ca`
Optional string. Set CA certificate. In case of peer verification with self signed certificate, you should use the client certificate.

`com_log_lock`
Optional boolean (default is false). If *true*, logs configuration can't be changed via `config_set` remote API.

`com_log_us`
Optional boolean (default is false). If *true*, logs sent by `log_get` remote API response will have a `timestamp_us` parameters instead of `timestamp`

`com_auth` Optional object. If set, remote API access will require authentication.
Authentication mechanism is describe in [Remote API Startup], page 68, section.

- `passfile` Optional string. Defines filename where password is stored (plaintext). If not set, `password` must be set
- `password` Optional string. Defines password. If not set, `passfile` must be set.
- `unsecure` Optional boolean (default false). If set, allow password to be sent plaintext.
  NB: you should set it to true if you access it from a Web Browser (Ex: Amarisoft GUI) without SSL (https) as your Web Browser may prevent secure access to work.

`com_log_count`
Optional number (Default = 8192). Defines number of logs to keep in memory before dropping them.
Must be between 4096 and 2097152).

`sim_events`
Array of object. Each element defines a remote API request ([Remote API], page 66) except that `message` field is replaced by `event`.

`sim_events_loop_count`
If set, will define `loop_count` for each event of `sim_events`, See [loop_count], page 67.

`sim_events_loop_delay`
If set, will define `loop_delay` for each event of `sim_events`, See [loop_delay], page 67.

`license_server`
Configuration of the Amarisoft license server to use.
Object with following properties:

- `server_addr` String. IP address of the license server.
- `name` Optional string. Text to be displayed inside server monitor or remote API.
- `tag` Optional string. If set, server will only allow license with same tag.

Example:

```
license_server: {
    server_addr: "192.168.0.20",
    name: "My license"
}
```

5.2.1 PDN options

Note that the options are also applicable to 5GS DNN.

`ignore_initial_apn`
Optional boolean (default = false). If false, UE will be rejected if its desired APN is unknown. Any unknown APN requested outside of the initial PDN connectivity request sent during the EPS NAS attach request procedure will be rejected. This parameter does not apply to 5GS.

`explicit_apn_required`
: Optional boolean (default = false). If true, the UE must explicitly request an APN/DNN otherwise the PDN/PDU session establishment request will be rejected.

`allow_apn_in_attach_req`
: Optional boolean (default = false). If true, the EPC accepts an attach request containing an APN even if it is strictly forbidden in 3GPP requirement. This is required for some specific operator requirement.

`pdn_list`

: Array of objects. Configure the available EPS Packet Data Networks and 5GS Data Network Names. The first entry of each type (IP, unstructured, ethernet) is the default APN or DNN used in case the UE does not explicitly request it.

  Each object contains the following properties:

  `access_point_name`
  : String. Set the Access Point Name or Data Network Name network identifier. Use dots (.) to separate the APN or DNN elements.
    Array of string. You can use array to define aliases.

  `pdn_type` Optional enumeration: ipv4, ipv6, ipv4v6, unstructured, ethernet (default = ipv4). Select the PDN or PDU session type.

  `first_ip_addr`
  : Optional string. First available IPv4 address. Required if `pdn_type` is set to ipv4 or ipv4v6.

  `last_ip_addr`
  : Optional string. Last available IPv4 address. Required if `pdn_type` is set to ipv4 or ipv4v6.

  `ipv4_auto_increment`
  : Optional boolean (default = false). If set to false, the same IPv4 address is allocated for successive activation / deactivation of the PDN or PDU session. If set to true, the IPv4 address is incremented for successive activation / deactivation of the PDN or PDU session.

  `gateway` Optional string. If set, forces the address of the gateway used for this PDN or PDU session and sent to mme-ifup script. With default config, it will be used to provide a IP address to the tun interface.
  If not set, the first IP of the subnet will be used.

  `ip_addr_shift`
  : Optional integer (default = 0). The allocated IPv4 addresses are allocated starting from `first_ip_addr` with a difference of `2^ip_addr_shift`. Hence `last_ip_addr - first_ip_addr` must be a multiple of `2^ip_addr_shift`. This option can be useful in case of inter-UE communication to ensure that the IPv4 address of a given UE is the only one in its netmask.

  `ip_addr_config`
  : Optional string. If set, this parameter defines the Access Point Name of a PDN or PDU session that will be used for IPv4 allocation. In such case, both PDNs or PDU sessions will share the same IPv4 range and thus, `first_ip_addr`, `last_ip_addr`, `ipv4_auto_increment`, `gateway`, `mtu_ipv4` and `ip_addr_shift` will be skipped.

`first_ipv6_prefix`
: Optional string. First available global IPv6 prefix used in Router Advertisement message sent to the UE (only the high 8 bytes of the IPv6 address are meaningful). Note that the selected prefix will also be used as the interface identifier sent in NAS signalling. Required if `pdn_type` is set to ipv6 or ipv4v6.

`last_ipv6_prefix`
: Optional string. Last available global IPv6 prefix used in Router Advertisement message sent to the UE (only the high 8 bytes of the IPv6 address are meaningful). Note that the selected prefix will also be used as the interface identifier sent in NAS signalling. Required if `pdn_type` is set to ipv6 or ipv4v6.

`ipv6_auto_increment`
: Optional boolean (default = false). If set to false, the same IPv6 prefix is allocated for successive activation / deactivation of the PDN or PDU session. If set to true, the IPv6 prefix is incremented for successive activation / deactivation of the PDN or PDU session.

`ipv6_interface_identifier`
: Optional string. IPv6 link local address interface identifier for the MME network interface of this PDN or PDU session (only the low 8 bytes of the IPv6 address are meaningful).

`ipv6_interface_addr`
: Optional string. IPv6 global address for the MME network interface of this PDN or PDU session. If not present, the address is `first_ipv6_prefix` with a ::0 interface identifier.

`ipv6_prefix_config`
: Optional string. If set, this parameter defines the Access Point Name of a PDN or PDU session that will be used for IPv6 prefixes allocation. In such case, both PDNs or PDU sessions will share the same IPv6 prefix range and thus, `first_ipv6_prefix`, `last_ipv6_prefix`, `ipv6_auto_increment`, `ipv6_interface_identifier`, `ipv6_prefix_delegation_count` and `ipv6_mtu` will be skipped.

`ipv6_router_lifetime`
: Optional integer (range 0 to 65535, default is 65535). IPv6 Router Advertisement router lifetime in seconds.

`ipv6_valid_lifetime`
: Optional integer (default is infinity - 0xffffffff). IPv6 Router Advertisement valid lifetime in seconds.

`ipv6_pref_lifetime`
: Optional integer (default is `ipv6_valid_lifetime` value). IPv6 Router Advertisement preferred lifetime in seconds.
Must not be greater than `ipv6_valid_lifetime`.

`ipv6_onlink_flag`
: Optional boolean (default is true). Defines IPv6 Router Advertisement on-link flag state.

`ipv6_managed_addr_config_flag`
: Optional boolean (default is false). Defines IPv6 Router Advertisement managed address configuration flag state.

`ipv6_other_config_flag`
: Optional boolean (default is false). Defines IPv6 Router Advertisement other configuration flag state.

`ipv6_mtu` Optional integer (default is 0). Defines the MTU sent in the IPv6 Router Advertisement message. If set to 0, the MTU option is not sent.

`ipv6_ra_transmission_interval`
: Optional integer (range -1 to 1800, default is 0). Time in seconds between 2 periodical multicast Router Advertisement transmission, once the initial 3 transmissions have been performed after opening the PDN or PDU session. The value -1 means that no multicast transmission is done at all (including the 3 initial ones). The value 0 means that periodical transmission is deactivated.

`ipv6_drop_rs`
: Optional boolean (default is false). Defines whether the incoming Router Solicitation messages should be dropped by the MME and UPF or not.

`ipv6_send_dns_in_ra`
: Optional boolean (default is false). Defines whether Router Advertisement message should contain the configured IPv6 DNS servers address or not.

`ipv6_prefix_delegation_count`
: Optional integer (2, 4, 8, 16, 32). Defines the number of prefixes delegated by DHCPv6-PD (including the one allocated by the Router Advertisement message). Only the first IA_PD option in the DHCPv6 Solicit message is considered.

`dhcpv6_t1`
: Optional integer (default = 0xffffffff). DHCPv6 T1 option in seconds (Cf rfc3633) used for prefix delegation replies.

`dhcpv6_t2`
: Optional integer (default = 0xffffffff). DHCPv6 T2 option in seconds (Cf rfc3633) used for prefix delegation replies.

`dns_addr` Optional string or array of strings. IPv4 or IPv6 addresses of the DNS servers.

`p_cscf_addr`
: Optional string or array of strings. IPv4 or IPv6 addresses of the P-CSCF servers (VoLTE).

`mtu_ipv4` Optional integer. Set MTU size (0 means disabled).

`mtu_non_ip`
: Optional integer. Set MTU size for non-IP PDN (0 means disabled, the minimum valid value is 128).

`mtu_unstructured_link`
: Optional integer (default value set to `mtu_non_ip` value). Set MTU size for unstructured PDU session (0 means disabled).

`mtu_ethernet_frame_payload`
: Optional integer. Set MTU size for ethernet PDN or PDU session (0 means disabled).

`operator` Optional array of objects. Each element defines an operator reserved container in protocol configuration.

Properties of each element:

- `id` Integer. Container identifier, must be between 0xff00 and 0xffff as defined in 3GPP TS 24.008.
- `plmn` String. PLMN info of container.
- `value` String. Value to send in hexadecimal string format.
- `force` Optional boolean. If true, container will be sent event without request (false by default).

`5gs_authentication`
Optional enumeration: `none`, `pap`, `chap`, `eap-md5`, `eap-tls` or `eap-aka` (default set to `authentication`). Defines the authentication mechanism used for this DNN in 5GS.

`authentication`
Optional enumeration: `none`, `pap` or `chap` (default set to `none`). Defines the authentication mechanism used for this APN in EPS.

`username` Optional string (up to 100 characters) containing the user name used for `pap`, `chap` or `eap-md5` authentication.

`password` Optional string (up to 100 characters) containing the password used for `pap`, `chap` or `eap-md5` authentication.

`apn_aggregate_max_bitrate_dl`
Optional integer (default = -1). EPS APN or 5GS PDU session aggregate maximum bitrate for downlink (in bits/s). If set to -1, no APN-AMBR or PDU session AMBR is configured and UE-AMBR is used instead.

`apn_aggregate_max_bitrate_ul`
Optional integer (default = -1). EPS APN or 5GS PDU session aggregate maximum bitrate for uplink (in bits/s). If set to -1, no APN-AMBR or PDU session AMBR is configured and UE-AMBR is used instead.

`emergency`
Optional boolean (default = false). If set, PDN will be selected for emergency calls.

`serving_plmn_rate_control`
Optional integer (range 0 to 65535, default = 0). Defines the serving PLMN rate control IE content when PDN is used with control plane CIoT optimization only. If the value configured is less than 10, the IE is not transmitted.

`apn_rate_control_params`
Optional object. If defined, and if the UE indicates APN rate control parameters support in its protocol configuration options, the following parameters will be sent in Core Network protocol configuration options:

- `additional_exception_report`
  Boolean. Indicates if exception reports are allowed once the limit is reached.

`ul_time_unit`
: Enumeration: `unrestricted`, `minute`, `hour`, `day` or `week`.

`max_ul_rate`
: Integer (range from 0 to 16777215). Number of messages allowed to be sent per `ul_time_unit`.

`additional_apn_rate_control_exception_data_params`
: Optional object. If defined, and if the UE indicates additional APN rate control for exception data parameters support in its protocol configuration options, the following parameters will be sent in Core Network protocol configuration options:

`ul_time_unit`
: Enumeration: `unrestricted`, `minute`, `hour`, `day` or `week`.

`max_ul_rate`
: Integer (range from 0 to 65535). Number of messages allowed to be sent per `ul_time_unit`.

`backoff_timer`
: Optional integer (default = -1). Value in seconds of the T3396/T3584/T3585 timers. The timer is transmitted in the ESM and 5GSM reject messages if the value is not -1. -2 means that the timer is deactivated.

`re_attempt_ind`
: Optional integer (range -1 to 255, default = -1). Value of octet 3 of the Re-attempt indicator information element, as specified in 3GPP TS 24.301 chapter 9.9.4.13A and 3GPP TS 24.501 chapter 9.11.4.17. The value -1 means that the information element is not sent.

`automatic_release`
: Optional boolean (default = false). If set, when the last associated dedicated EPS bearer is released the MME releases the PDN connection. With 5GS, when the last non default QoS flow is released, the SMF releases the PDU session.

`automatic_release_timeout`
: Optional integer (default = 0). Delay in ms before releasing the PDN connection or PDU session when `automatic_release` is set to true.

`allow_multiple_pdn_connections`
: Optional boolean (default = false). If set, a UE can create multiple PDN connections to this APN, or multiple PDU sessions to this DNN for the same slice.

`single_address_bearers_only`
: Optional boolean (default = false). Only applicable when `pdn_type` is set to `"ipv4v6"`. If set to true, a UE trying to connect to the APN/DNN with IPv4v6 will only have a `single_address_bearers_first_address` address allocated and will receive the indication to create a new PDN connectivity/PDU session for the other IP address type.

`single_address_bearers_first_address`
: Optional enumeration (ipv4, ipv6, default = ipv4). Only applicable when `single_address_bearers_only` is set to true. Defines the address type allocated when the UE tries to connect to the APN/DNN with IPv4v6.

`ue_initiated_modification`
: Optional boolean (default = false). If set, the UE can request the modification of a bearer, otherwise the request is rejected.

`ip_src_violation_limit`
: Optional integer (default = -1). If greater than -1, the MME or UPF checks the IP source address of uplink packets. When `ip_src_violation_limit` packets are received, the PDN or PDU session is released. The value 0 means that the packets are dropped without triggering a release.

`integrity_protection`
: Optional enumeration (disabled, preferred, required, default = disabled). Defines whether integrity should be used for the PDN connection / PDU session or not.
For EPC, if the value is set to `preferred`, the EPC will activate integrity protection based on the UE capabilities. If set to `required`, and if the UE does not support integrity protection, the request will be rejected with ESM cause 30.
For 5GC, if the value is set to `preferred`, the 5GC will activate integrity protection based on the UE capabilities and the configured PDU session AMBR. If set to `required`, and if the UE does not support integrity protection for the bitrate configured in the PDU session AMBR, the request will be rejected with 5GSM error cause #82.

`tun_setup_script`
: Overrides [tun_setup_script], page 14, for this PDN or PDU session.

`tun_ifname`
: Optional string. If set, use this tun device instead of creating it.
Useful when LTEMME has no root privileges.

`erabs`
: Array of objects. Each element defines an E-RAB (E-UTRAN Radio Access Bearer) associated to the PDN or a QoS flow associated to the PDU session. The first E-RAB or QoS flow is the default radio bearer and must always be present. The additional E-RABs and QoS flows are dedicated radio bearers and must include a Traffic Flow Template (TFT) unless they are defined as UE initiated.

  Property of each element:

  `qci`
  : Range: 1 to 255. QoS Class Identifier of the E-RAB or 5G QoS Identifier of the QOS flow.

  `priority_level`
  : Optional integer (range: 1 to 15, default 15). ARP priority level.

  `pre_emption_capability`
  : Optional enumeration: `shall_not_trigger_pre_emption` or `may_trigger_pre_emption` (default `shall_not_trigger_pre_emption`).

  `pre_emption_vulnerability`
  : Optional enumeration: `not_pre_emptable` or `pre_emptable` (default `not_pre_emptable`).

`setup_type`
: Optional enumeration: automatic, on_demand, ue_initiated (default = automatic).

  - If set to automatic, the dedicated bearer is created with the default bearer.
  - If set to on_demand, the dedicated bearer is created when there is traffic matching the TFT filters. This option is useful to automatically create a dedicated bearer for IMS RTP voice traffic.
  - If set to ue_initiated, the dedicated bearer is created when receiving a ESM bearer resource allocation request or PDU session modification request message. In that case, the `gbr` object defines the maximum values allowed (MME will use the minimum between configured values and the ones sent by the UE) and `tft` object is not required (the core network will use the filters sent by the UE).

`5qi_qos`
: Optional object. 5QI QoS characteristics. List of properties:

  `priority_level`
  : Optional integer (range 0 to 127). 0 means that the field is absent. Its presence is mandatory if `packet_delay_budget` is present.

  `packet_delay_budget`
  : Optional integer (range -1 to 1023) in 0.5 ms unit. -1 means that the field is absent.

  `extended_packet_delay_budget`
  : Optional integer (range -1 to 109999) in 0.01 ms unit. -1 means that the field is absent.

  `packet_error_rate`
  : Optional string. It should be set to "xE-y" where x is the scalar value (0 to 9) and y is the exponent value (0 to 9). Its presence is mandatory if `packet_delay_budget` is present.

  `averaging_window`
  : Optional integer (range -1 to 4095) in ms unit. Only applicable to GBR bearers. -1 means that the field is absent.

  `maximum_data_burst_volume`
  : Optional integer (range -1 to 2000000) in byte unit. Only applicable to delay critical GBR bearers. -1 means that the field is absent.

  `cn_packet_delay_budget_dl`
  : Optional integer (range -1 to 1099990) in 0.01 ms unit. Only applicable to delay critical GBR bearers. -1 means that the field is absent.

`cn_packet_delay_budget_ul`
: Optional integer (range -1 to 1099990) in 0.01 ms unit. Only applicable to delay critical GBR bearers. -1 means that the field is absent.

`gbr`
: Optional object. Guaranted Bitrate information. List of properties:

  `maximum_bitrate_dl`
  : Integer. Bearer maximum bitrate for downlink (in bits/s).

  `maximum_bitrate_ul`
  : Integer. Bearer maximum bitrate for uplink (in bits/s).

  `guaranteed_bitrate_dl`
  : Integer. Bearer guaranteed bitrate for downlink (in bits/s).

  `guaranteed_bitrate_ul`
  : Integer. Bearer guaranteed bitrate for uplink (in bits/s).

`filters`
: Optional array of objects. List of TFT filters or QoS rules. Required for dedicated bearers with `setup_type` different from ue_initiated. Each filter has the following properties:

  `direction`
  : Enumeration: `dl`, `ul` or `both`. Set the filter direction.

  `id`
  : Range: 1 to 15. Set the filter identifier.

  `precedence`
  : Range: 0 to 254. Set the filter precedence. All the filters must have different precedence. 0 is the highest precedence. Note that precedence 80 is reserved for derived QOS rules in 5GS and thus will be rejected if configured.

  `reflective_qos`
  : Optional integer (default = false). If set to true, this QoS rule in 5GS can use reflective QoS if supported by the UE. Is it only applicable if `direction` is set to dl.

  `components`
  : Array of objects. Each component contains one of the following properties as described in 3GPP TS 23.060 chapter 15.3.2:

    `ipv4_remote_addr`
    : String. Match a remote (external network entity) IPv4 address with the additional `mask` property.

    `ipv4_local_addr`
    : String. Match a local IPv4 address with the additional `mask` property.

Note that not all UEs support it (they must indicate the support of the Local address in TFT in PCO/ePCO).

`ipv6_remote_addr`
: String. Match a remote (external network entity) IPv6 address with the additional `mask` property.

`ipv6_remote_addr_prefix`
: String. Match a remote (external network entity) IPv6 address with the additional `prefix_len` property. Note that not all UEs support it (they must indicate the support of the Local address in TFT in PCO/ePCO).

`ipv6_local_addr_prefix`
: String. Match a local IPv6 address with the additional `prefix_len` property. Note that not all UEs support it (they must indicate the support of the Local address in TFT in PCO/ePCO).

`proto_id` Range: 0 to 255. Match against the IP protocol identifier.

`local_port`
: Range: 0 to 65536. Match against the local (UE) port.

`local_port_range`
: Array of 2 integers. Match against a local (UE) port range.

`remote_port`
: Range: 0 to 65536. Match against the remote (external network entity) port.

`remote_port_range`
: Array of 2 integers. Match against a remote (external network entity) port range.

`security_parameter_index`
: 32 bit integer. Match the ESP or AH security parameter index.

`type_of_service`
: Range: 0 to 255. Match the type of service (IPv4) or the traffic class (IPv6) field. The additional `mask` property is the corresponding mask.

`mask`
: Depends on TFT component.
If ipv4_remote_addr is set, string representing IPv4 address used as a mask to apply on packet remote address.
If ipv6_remote_addr is set, string representing IPv6 address used as a mask to apply on packet remote address.
If type_of_service is set, integer between 0 and 255 used as a mask to apply on packet tos.

`flow_label`
: 20 bit integer. Match the IPv6 flow label.

`prefix_len`
: Range: 1 to 128. IPv6 address prefix length.

`destination_mac_addr`
: String. Match the destination MAC address.

`source_mac_addr`
: String. Match the source MAC address.

`802.1q_ctag_vid`
: Range: 0 to 4095. Match the 802.1Q C-TAG VID.

`802.1q_stag_vid`
: Range: 0 to 4095. Match the 802.1Q S-TAG VID.

`802.1q_ctag_pcp_dei`
: Range: 0 to 15. Match the 802.1Q C-TAG PCP and DEI.

`802.1q_stag_pcp_dei`
: Range: 0 to 15. Match the 802.1Q S-TAG PCP and DEI.

`ethertype`
: Range: 0 to 65535. Match the ethertype.

`destination_mac_addr_range`
: Array of 2 strings. Match the destination MAC address range. Only applicable to 5GC.

`source_mac_addr_range`
: Array of 2 strings. Match the source MAC address range. Only applicable to 5GC.

`on_demand_timeout`
: Optional integer. When `setup_type` is on_demand, set the duration (in ms) after which the dedicated bearer is released when there is no downlink or uplink traffic.

`on_demand_ul_trigger`
: Optional boolean (default = false). When `setup_type` is on_demand, if set to true an UL packet matching one of the TFT filters triggers the dedicated E-RAB or QoS flow establishment.

`transaction_identifier`
: Optional integer (range 0 to 127). If present, the transaction identifier IE is put in the EPS bearer activation message.

`llc_sapi`
: Optional integer (range 0 to 15). If present, the LLC service access point identifier IE is put in the EPS bearer activation message.

`radio_priority`
: Optional integer (range 0 to 7). If present, the radio priority IE is put in the EPS bearer activation message.

`packet_flow_identifier`
: Optional integer (range 0 to 127). If present, the packet flow identifier IE is put in the EPS bearer activation message.

`sm_qos`
: Optional string. If present, the quality of service IE is put in the EPS bearer activation message. The string must contain the hexadecimal representation of the IE without its IEI and length.

The following parameters are applicable to EPC only:

`esm_procedure_filter`
: Optional object. Allows to define the MME behavior for a list of ESM procedures.
Each property name represents an ESM procedure. The ones currently supported are `pdn_connectivity`, `pdn_disconnect`, `bearer_resource_allocation` and `bearer_resource_modification`.
Each property value is an object containing the following fields:

  `action`
  : Enumeration (`treat` (UE message is processed), `ignore` (UE message is ignored) or `reject` (UE message is rejected)).

  `ttl`
  : Optional integer. If set, the `reject` of `ignore` filter is applied `ttl` times. If not set, the filter is applied until it is modified.

  `send_status_on_reject`
  : Optional boolean. It set and if `action` is set to reject an ESM status message is sent.

  `ignore` does not apply to procedure `pdn_connectivity` performed during the attach procedure.
  By default all procedures are treated.

  Example:

```
esm_procedure_filter: {
```

```
        pdn_connectivity: {
            action: "treat"
        },
        bearer_resource_allocation: {
            action: "reject",
            ttl: 1
        }
    }
```

The following parameters are applicable to 5GC only:

`5gsm_procedure_filter`
: Optional object. Allows to define the SMF behavior for a list of 5GSM procedures.
Each property name represents a 5GSM procedure. The ones currently supported are `pdu_session_establishment`, `pdu_session_release` and `pdu_session_modification`.
Each property value is an object containing the following fields:

  `action` : Enumeration (`treat` (UE message is processed), `ignore` (UE message is ignored) or `reject` (UE message is rejected)).

  `ttl` : Optional integer. If set, the `reject` of `ignore` filter is applied `ttl` times. If not set, the filter is applied until it is modified.

  `send_status_on_reject`
  : Optional boolean. It set and if `action` is set to reject a 5GSM status message is sent.

  By default all procedures are treated.

  Example:

```
"5gsm_procedure_filter": {
    pdu_session_establishment: {
        action: "treat"
    },
    pdu_session_modification: {
        action: "reject",
        ttl: 1
    }
}
```

`always_on`
: Optional enumeration (auto, required, not_allowed, default = auto). Defines the always-on behavior for the PDU session. If the value is set to `auto`, the 5GC will follow whatever is requested by the UE. If the value is set to `required`, the 5GC will always set the PDU session as always-on required. If the value is set to `not_allowed`, the 5GC will always set the PDU session as always-on not allowed.

`confidentiality_protection`
: Optional enumeration (disabled, preferred, required, default = required). Defines if confidentiality must be used for the PDU session or not.

`apply_nas_transport_n1_sm_filter`
: Optional boolean (default = true). Indicates whether the 5GMM procedure filter `nas_transport_n1_sm` should apply to this DNN or not.

`eps_5gs_interworking`
: Optional boolean (default = true). If set to true, interworking between EPS and 5GS is allowed for this APN/DNN. Otherwise it is forbidden.

`5gsm_congestion_re_attempt_ind`
: Optional integer (range -1 to 255, default = -1). Value of octet 3 of the Re-attempt indicator information element, as specified in 3GPP TS 24.501 chapter 9.11.4.21. The value -1 means that the information element is not sent.

`rq_timer`
: Optional integer (default = -1). Value in seconds of the RQ timer for the PDU session, sent to the UE if it supports reflective QoS feature. -2 means that the timer is deactivated.

`slices`
: Optional array. Defines the QoS flows by S-NSSAI.
If a supported S-NSSAI is not present in the array, the QoS flows defined in [erabs], page 34, applies.
Each entry will set specific QoS flows for a slice as defined below:

  `snssai`
  : S-NSSAI value.

    `sst`
    : Integer (range 0-255). Slice Service Type.

    `sd`
    : Optional integer (range 0-0xFFFFFE). Slice Differentiator.

  `qos_flows`
  : Array of QoS flows. Each element of the array has the same structure as an element in [erabs], page 34, except that `"5qi"` shall be used instead of `"qci"`.

5.2.2 User database options

`ue_db`

Array of objects. Configure the user database. Each element is an entry for one user. The following properties are available:

`imsi`
: Optional string. Shall be present if `nai` is absent. Set the IMSI.

`nai`
: Optional string applicable to 5G only.
Shall be present if `imsi` is not set. Set the Network specific identifier-based SUPI.

`sim_algo`
: Optional enumeration. xor, milenage or tuak (default = xor). Set the USIM authentication algorithm. Note: test USIM cards use the XOR algorithm.

`sqn`
: Optional string (6 byte hexadecimal string). Default = `"000000000000"`. Set the initial sequence number. For the XOR algorithm, the actual value does not matter. For the Milenage or TUAK algorithm, a sequence number resynchronization is initiated if the sequence number does not match the one stored in the USIM.

`force_sqn_resync`
: Optional boolean (default = false). If set to true, the core network will reuse the last SQN value to force a SQN resynchronization procedure. Only applicable to Milenage or TUAK algorithm.

`K`
: String. Set the user secret key (as a 16 bytes hexadecimal string, or eventually 32 bytes hexadecimal string for TUAK).

`op`
: Optional string. Operator key (as a 16 byte hexadecimal string). When the Milenage authentication algorithm is used, either `op` or `opc` must be set.

`opc`
: Optional string. Operator key preprocessed with the user secret key (as a 16 byte hexadecimal string). When the Milenage authentication algorithm is used, either `op` or `opc` must be set.

`r`
: Optional array of 5 integers (range: 0 to 127). Allows to customize the r1 to r5 parameters when Milenage authentication algorithm is used. If the array is not present, the default values (as defined in 3GPP TS 35.206) are used.

`c`
: Optional array of 5 strings. Each value contains a 16 byte hexadecimal string. Allows to customize the c1 to c5 parameters when Milenage authentication algorithm is used. If the array is not present, the default values (as defined in 3GPP TS 35.206) are used.

`top`
: Optional string. Operator key (as a 32 byte hexadecimal string). When the TUAK authentication algorithm is used, either `top` or `topc` must be set.

`topc`
: Optional string. Operator key preprocessed with the user secret key (as a 32 byte hexadecimal string). When the TUAK authentication algorithm is used, either `top` or `topc` must be set.

`keccak_iter`
: Optional integer (range: 1 to MAX_INT). Allows to customize the number of Keccak permutations performed when using the TUAK authentication algorithm. If the item is not present, the default value 1 (as defined in 3GPP TS 35.231) is used.

`cag_info_list`
: Optional array. Subscribed CAG information list. Each element of the array contains:

  `plmn`
  : String (5 or 6 digits).

  `cag_id_list`
  : Array of 1 to 12 integers (range 0 to 4294967295) giving the list of the allowed CAG-Identifiers.

  `cag_only_ind`
  : Optional boolean (default = FALSE). Indication that the UE is only allowed to access 5GS via CAG cells.

`csg_info_list`
: Optional array of objects. Subscribed CSG information. Each element of the array contains:

  `plmn`
  : String (5 or 6 digits).

`csg_id_list`
: Array of integers in range 0 to 0x7FFFFFF. Allowed CSG id list in the PLMN.

`amf`
: Range: 0 to 65535. Set the Authentication Management Field.

`5gs_auth_type`
: Applicable to 5GC only.
Optional enumeration: 5g_aka, eap_aka_prime, eap_tls (default = 5g_aka).
5GMM authentication method.

`at_result_ind`
: Applicable to 5GC only.
Optional boolean (default = false).
Indicates if the AUSF shall include the AT_RESULT_IND attribute in message EAP-request/AKA'-Challenge.

`res_len`
: Optional integer (default = 8). Defines length of response in bytes during authentication. For TUAK authentication algorithm, the value must be 4, 8 or 16 bytes long.

`multi_sim`
: Optional boolean (default = false). If true, allow several UEs to have the same IMSI (useful when using several identifical test SIM cards in different UEs at the same time). They are distinguished with their IMEI. Note: it is only allowed with the XOR authentication algorithm.

`isim_auth`
: Optional object. If present, the object allows to configure some specific authentication parameters for the ISIM. Otherwise it uses the same parameters as those defined for the USIM. It contains the following configuration parameters: `sim_algo`, `K`, `op`, `opc`, `r`, `c`, `top`, `topc`, `keccak_iter` and `res_len`.

`msisdn`
: Optional string. Sets the UE MSISDN (that will be sent in the NAS PCO message if requested by the UE for example).

`ue_aggregate_max_bitrate_dl`
: Optional integer (default = 5e9). UE aggregate maximum bitrate for downlink (in bits/s).

`ue_aggregate_max_bitrate_ul`
: Optional integer (default = 2e9). UE aggregate maximum bitrate for uplink (in bits/s).

`t3412`
: Optional integer. Value in seconds of the T3412 (TAU update) ot T3512 timer for this IMSI. If not present, the MME or AMF will use the value coming from HSS or configured locally. It is sent to the UE in NAS signalling, unless the UE is requesting the use of a longer timeout with T3412 extended value or requested T3512 value information element.

`n3gpp_dereg_timer`
: Optional integer. Applicable to 5GC only. Value in seconds of the non-3GPP de-registration timer.

`count`
: Optional integer (default = 1). Create `n` user entries by incrementing the IMSI and K.

`restrict_nr_as_2nd_rat`
: Optional boolean (default = false). If set to true, the user is not allowed to use NR as secondary RAT (no DCNR).

`restrict_5gc_access`
: Optional boolean (default = false). If set to true, the user is not allowed to access 5GC when coming from EPC (no handover or cell redirection).

`restrict_epc_access`
: Optional boolean (default = false). If set to true, the user is not allowed to access EPC when coming from 5GC (no handover or cell redirection).

`subscriber_profile_id`
: Optional integer (range 1 to 256). User subscriber profile ID for RAT/frequency priority or index to RAT/frequency selection priority.

`restrict_pdn_list`
: Optional boolean (default = false). If set to true, only the PDNs or PDU sessions listed in the `pdn_list` object are allowed for the user.

`pdn_list` Optional array. Each entry will set specific parameters for a PDN or PDU session as defined below:

  `access_point_name`
  : String. Used to define what PDN or PDU session to configure.

  `default` Optional boolean (default = false). If true and UE does not specify the APN or DNN it wants to connect to, this PDN or PDU session will be used.

  `pdn_type` Optional enumeration: ipv4, ipv6, ipv4v6. Restrict the PDN type for this specific IMSI. The PDN or PDU session must be configured with a matching IP version.

  `ipv4_addr`
  : Optional string. If set, the UE will always use this IPv4 address.

  `ipv6_prefix`
  : Optional string. If set, the UE will always use this IPv6 prefix.

  `imei` Optional string (14 or 15 digits). If set, this configuration only applies to UE with matching IMEI. Only supported for EPS, not 5GS.

  `multicast`
  : Optional boolean (default = false). If set, IPv4 multicast traffic will be forwarded to this PDN or PDU session.

  `ipv6_multicast`
  : Optional boolean (default = false). If set, IPv6 multicast traffic will be forwarded to this PDN or PDU session.

  `broadcast`
  : Optional boolean (default = false). If set, IPv4 broadcast traffic will be forwarded to this PDN or PDU session.

`routes` Optional array. Each entry of array represent a list of filters. See [TFT components], page 36, for filters syntax except that remote refers to UE and local to network.
When a packet enters MME of UPF, if it matches one of the filter list, it will be sent to associated UE.

Ex:

```
routes: [
          [
            {
              ipv4_remote_addr: "10.0.0.0",
              mask: "255.255.255.0"
            }
          ]
        ]
```

Means that all packets addressed to 10.0.0.0/24 network will be sent to UE.

`nssai` Applicable to 5GC only.
Optional array. List of subscribed S-NSSAIs per DNN.
If not present, the list of the S-NSSAIs served by the AMF applies.
See [nssai], page 25.

`nssai_subject_to_nssaa`

Applicable to 5GC only.
Optional array. List of the subscribed S-NSSAIs subject to NSSAA. Each entry of the array contains the following objects:

`snssai` S-NSSAI subject to NSSAA.

`sst` Integer (range 0-255). Slice Service Type.

`sd` Optional integer (range 0-0xFFFFFE). Slice Differentiator.

`auth_type`

Optional enumeration: `eap_md5`, `eap_tls` or `eap_aka` (default set to `eap-md5`). Defines the authentication mechanism used for this S-NSSAI.

`username` String (up to 100 characters) containing the user name used for algo `eap_md5`.

`password` String (up to 100 characters) containing the password used for algo `eap_md5`.

`ue_slice_max_bitrate`

Applicable to 5GC only.
Optional array. Each entry of the array gives the UE maximum bitrate for uplink and downlink in a slice subject to NSAC and contains the following objects:

`snssai` S-NSSAI value. The S-NSSAI shall be contained in the list of the S-NSSAIs subject to NSAC given by nssai_subject_to_nsac.

`sst` Integer (range 0-255). Slice Service Type.

`sd` Optional integer (range 0-0xFFFFFE). Slice Differentiator.

`ue_slice_max_bitrate_ul`
Integer. UE maximum bitrate in the S-NSSAI for uplink (in bits/s).

`ue_slice_max_bitrate_dl`
Integer. UE maximum bitrate in the S-NSSAI for downlink (in bits/s).

`sms_over_nas_allowed`
Optional boolean (default = true). Indicates if the subscription of the UE allows SMS over NAS.

`allowed_5gs_tais`
Optional object. Allowed or not allowed TAIs in 5GS as defined in 3GPP TS 29.571 chapter 5.4.4.18. If not present, all TAs in the registration area are allowed. Each object must contain the following parameters:

`restriction_type`
Optional enumeration: allowed, not_allowed. Default value is allowed. Only applicable to 5GS. Gives the type of the service area restriction. If set to allowed, the areas defined in `tais` are allowed.

`tais` Array of objects (up to 65535). Only applicable to 5GS. Each object must contain the following parameters:

`plmn` String (5 or 6 digits).

`areas` Array of objects (up to 65535). Each object decribes an area defined by a specific operator code or a list of tracking areas codes as defined in 3GPP TS 29.571 chapter 5.4.4.17.
The same areas list must be configured for equivalent PLMNs. Each object contains the following parameters:

`code` Integer in range 0 to 0xFFFF. Area code as defined by the operator (See [areas_list_5gs], page 26). Must be present only if tacs is absent.

`tacs` Array of up to 16 integers in range 1 to 0xFFFFFF, except 0xFFFFFE. Each element defines a 3 bytes long tracking area code. Must be present only if code is absent.

`forbidden_5gs_tais`
Optional array of objects. Forbidden areas in 5GS. See [tais], page 46.

`mps_priority`
Optional boolean (default = false). Indicates whether the UE is subscribed to multimedia priority service.

`mcs_priority`
: Optional boolean (default = false). Indicates whether the UE is subscribed to mission critical service.

`routing_indicator`
: Optional string (default = "0"). Routing Indicator consisting of 1 to 4 decimal digits assigned by the home network operator as defined in 3GPP 23.003 2.2B Subscription Concealed Identifier (SUCI)).

`akma`
: Optional boolean (default = false). Indicates if AKMA keys need to be generated for the UE.

5.2.3 Public Warning System (ETWS/CMAS) options

`pws_msgs`

Optional array of objects. Define a list of ETWS/CMAS messages which can be sent to the connected eNodeBs with the `pws_write` monitor command. Check 3GPP TS 23.041 to have the exact definition of each field. Each message contains the following properties:

`local_identifier`
: Range: 0 to 65535. Local message identifier. Used as argument to the monitor commands `pws_write` or `pws_kill`.

`message_identifier`
: Range: 0 to 65535. Message Identifier.

`serial_number`
: Range: 0 to 65535. Serial Number.

`repetition_period`
: Optional integer, range: 0 to 4095 for EPC, 131071 for 5GC (default = 10). Periodicity of the warning message to be broadcast.

`number_of_broadcasts_requested`
: Optional integer, range: 0 to 65535 (default = 65535). Number of times a message is to be broadcast.

`warning_type`
: Optional integer. Range: 0 to 65535. Warning type (ETWS only).

`warning_security_info`
: Optional 50 byte hexadecimal string. Warning security information (ETWS optional).

`warning_message`
: Optional array of string. Message content (ETWS: optional, CMAS: mandatory). Each string is a message page and contains at most 93 GSM 7 bit or 41 UCS2 characters. At most 15 pages are allowed.

`warning_message_hex`
: Optional array of hexadecimal string. Message content (ETWS: optional, CMAS: mandatory). Each hexadecimal string is a message page and contains at most 164 characters. At most 15 pages are allowed. May be present only if `warning_message` is absent.

`data_coding_scheme`
: Optional integer. Range 0 to 255. Data coding scheme. Must be present if `warning_message_hex` is present. If `warning_message` is used, its

default value is set to 0x0f for GSM 7 bit encoding and 0x48 for UCS2 encoding.

`concurrent_warning_message_ind`
: Optional boolean (default = false). Indicates that the warning message is a new message to be scheduled for concurrent broadcast with any other ongoing broadcast of warning messages.

`send_warning_indication`
: Optional boolean (default = false). SBCAP interface: Gives the presence of Send Write Replace Warning Indication IE in the SBCAP message WRITE-REPLACE WARNING REQUEST. N50 interface: Gives the presence of sendRanResponse attribute the N50 message POST ../non-ue-n2-messages/transfer(N2InformationTransferReqData.

`warning_area_list`
: Optional object. If present, the Warning Area List IE will be sent in the message WRITE-REPLACE WARNING REQUEST. It should contain one of the following objects:

  `cell_id_list`
  : Optional array of objects (up to 65535). Each object must contain the following parameters:

    `plmn` String (5 or 6 digits).

    `cell_id` Integer. 28 bits long LTE cell identifier.

  `tai_list` Optional array of objects (up to 65535). Each object must contain the following parameters:

    `plmn` String (5 or 6 digits).

    `tac` Integer. 2 bytes long tracking area code.

  `emergency_area_id_list`
  : Optional array of integers (up to 65535). 3 bytes long emergency area identifier.

`warning_area_coordinates`
: Optional hexadecimal string. Maximum length 1024 bytes. Warning Area Coordinates octet string (CMAS only).

`omc_id` Optional string. Maximum length 20 bytes. Identity of an Operation and Maintenance Centre.

`enb` Optional object. Global eNB ID to send in the message WRITE-REPLACE WARNING REQUEST.

  `plmn` String (5 or 6 digits).

  `enb_type` Optional string (macro, home, short_macro or long_macro). Default value is "macro". Type of the global eNB ID.

  `enb_id` Integer. eNB ID.

`tai_list` Optional array of objects (up to 65535). TAI List to sent in the message WRITE-REPLACE WARNING REQUEST. See [tai_list], page 48.

`warning_area_list_5gs`
: Optional object. 5GS Warning Area List to send in the message WRITE-REPLACE WARNING REQUEST. It should contain one of the following objects:

`nr_cell_id_list`
: Optional array of objects (up to 65535). Each object must contain the following parameters:

  `plmn` String (5 or 6 digits).

  `cell_id` Integer. 36 bits long NR cell identifier.

`tai_list` Optional array of objects (up to 65535). See [tai_list_5gs], page 49.

`emergency_area_id_list`
: Optional array of integers (up to 65535). 3 bytes long emergency area identifier.

`tai_list_5gs`
: Optional array of objects (up to 65535). List of 5GS TAIs to send in the SBCAP message WRITE-REPLACE WARNING REQUEST or the N50 message POST ../non-ue-n2-messages/transfer(N2InformationTransferReqData). Each object must contain the following parameters:

  `plmn` String (5 or 6 digits).

  `tac` Integer. 3 bytes long tracking area code.

`ran_node_id`
: Optional integer. Applicable to SBCAP interface only. Value of the global RAN node ID to send in the SBCAP message WRITE-REPLACE WARNING REQUEST. It should contain one of the following objects:

  `gnb` gNB identifier.

  `plmn` String (5 or 6 digits).

  `gnb_id_bits`
  : Integer. Range 22 to 32. gNB ID length in bits.

  `gnb_id` Integer. The gNB global identifier.

  `ng_enb` ngENB identifier. See [enb], page 48.

`rat_selector_5gs`
: Optional boolean. Default value is false. Applicable to SBCAP interface only. Indicates the presence of RAT Selector 5GS IE in the message WRITE-REPLACE WARNING REQUEST.

`n50_rat_selector`
: Optional enumeration: nr, eutra, both. Default value is both. Applicable to N50 interface only. Gives the value of ratSelector attribute in N2InformationTransferReqDataTransfer.

`n50_ran_node_id_list`
: Optional array of objects. Applicable to N50 interface only. See [ran_node_id], page 49. List of the global RAN node ID to send in the N50 message POST ../non-ue-n2-messages/transfer(N2InformationTransferReqData).

5.2.4 NAS special conformance testing options

The MME or AMF can automatically activate UE test mode during attachment and configure test loop mode A, B or G (see 3GPP TS 36.509 and 38.509 for details). Once the loop is closed, the user can transmit downlink IP packets to the UE that will be loopbacked in UL.

`nas_test_procedure`
: Optional object allowing to configure the test procedure. It must contain the following objects:

  `test_loop_mode`
  : Enumeration: none, a, b, g. Defines which test loop will be activated.

  `lb_setup_list`
  : Optional array used for test loop mode A if UL PDCP SDU scaling is required. Each element of the array must contain the following 2 objects:

    `ul_pdcp_sdu_size`
    : Integer (range 0 to 1520). UL PDCP SDU size in bytes.

    `drb_id` Integer (range 1 to 32). Data Radio Bearer identity on which the UL PDCP SDU scaling is applied.

  `ip_pdu_delay`
  : Integer (range 0 to 255). Transmission delay in seconds of the EUTRA UL PDCP SDUs or NR UL SDAP SDUs when operating in test loop mode B.

  `operation_mode`
  : Enumeration (`upper` or `rlc`). `upper` means that data is returned in uplink at the EMM entity. `rlc` means that data is returned in uplink at the RLC AM-SAP of SRB1bis for NB-IoT UE or at the RLC AM-SAP of SRB2 for E-UTRA UE. Used in test loop mode G.

  `repetitions`
  : Integer (0 to 127). Number of repetitions of received content of received user data in downlink in uplink. Used in test loop mode G.

  `ul_data_delay`
  : Integer (0 to 255). Uplink data delay in seconds. Used in test loop mode G.

5.2.5 Rx options

`rx`
: Optional object allowing to configure the Rx options. It can contain the following objects:

  `bind_addr`
  : Optional string. IP address and optional port on which the Rx SCTP connection is bound. The default address is the same as the first S1AP SCTP connection and the default port is 3868.

  `qos` Optional object. It can contain 7 object properties: audio, video, application, data, control, text and message. Default QCI/5QI is 1 for audio, 2 for video and application, 6 for data and control, 8 for text and message. Each property contains the following fields:

    `qci` Integer (range 1 to 255). QoS Class Identifier of the E-RAB, or 5QI of the QoS flow.

`5qi_qos` Optional object. See [5QI QoS], page 35.

`origin_realm`
Optional string. Defines the string sent in the Origin-Realm AVP for Rx messages. Default is set to `mnc<MNC>.mcc<MCC>.3gppnetwork.org`.

`origin_host`
Optional string. Defines the string sent in the Origin-Host AVP for Rx messages. Default is set to `epc.mnc<MNC>.mcc<MCC>.3gppnetwork.org`.

`reservation_priority`
Optional array of 16 elements defining the S1AP ARP (Allocation and Retention Priority) parameters to be used for each Rx reservation priority level. If not present, `priority_level` is set to 15 (no priority), `pre_emption_capability` is set to `shall_not_trigger_pre_emption` and `pre_emption_vulnerability` is set to `not_pre_emptable`. If present the array must be ordered by increasing Rx priority level (from 0 to 15) and must contain the following fields:

`priority_level`
Range: 1 to 15. ARP priority level.

`pre_emption_capability`
Enumeration: `shall_not_trigger_pre_emption` or `may_trigger_pre_emption`.

`pre_emption_vulnerability`
Enumeration: `not_pre_emptable` or `pre_emptable`.

`emergency`
Optional object defining the QCI and ARP parameters to be used for the emergency dedicated EPS bearer context. If not present, `qci` is set to 1, `priority_level` is set to 1 (highest priority), `pre_emption_capability` is set to `may_trigger_pre_emption` and `pre_emption_vulnerability` is set to `not_pre_emptable`.

`qci` Range: 1 to 255.

`5qi_qos` Optional object. See [5QI QoS], page 35.

`priority_level`
Range: 1 to 15. ARP priority level.

`pre_emption_capability`
Enumeration: `shall_not_trigger_pre_emption` or `may_trigger_pre_emption`.

`pre_emption_vulnerability`
Enumeration: `not_pre_emptable` or `pre_emptable`.

5.2.6 S6a options

`s6`

Optional object allowing to configure the S6a options. It can contain the following objects:

`server_addr`
String. IP address and optional port of the HSS used for S6a interface. The default port is 3868.

`bind_addr`
: Optional string. IP address and optional port on which the S6a SCTP connection is bound. The default address is the same as the first S1AP SCTP connection.

`origin_realm`
: Optional string. Defines the string sent in the Origin-Realm AVP for S6 messages. Default is set to `mnc<MNC>.mcc<MCC>.3gppnetwork.org`.

`origin_host`
: Optional string. Defines the string sent in the Origin-Host AVP for S6 messages. Default is set to `epc.mnc<MNC>.mcc<MCC>.3gppnetwork.org`.

`transaction_timeout`
: Optional integer (range 1 to 15000, default = 2000). Defines the timeout in milliseconds for a transaction with the HSS.

`watchdog_duration`
: Optional integer (range 0 to 36000000, default = 30000). Tw watchdog timer in milliseconds to send the Diameter Device Watchdog Request message. The value 0 deactives the watchdog.

5.2.7 EIR/S13 options

`me_db`

Optional object allowing to define a list of IMEI (14 digits without the last Check Digit one) or IMEISV (16 digits), and their status (whitelisted, blacklisted, greylisted). If not present, all devices are considered as whitelisted.
It can contain the following objects:

`default_status`
: Enumeration (whitelisted, blacklisted, greylisted). Defines the default status for devices not explicitly defined in the next objects.

`whitelist`
: Optional array. It contains a list of IMEI or IMEISV whitelisted.

`blacklist`
: Optional array. It contains a list of IMEI or IMEISV blacklisted.

`greylist` Optional array. It contains a list of IMEI or IMEISV greylisted.

Example:

```
me_db: {
  default_status: "blacklisted",
  whitelist: [
    "01234567100000",
    "0123456700000001"
  ]
}
```

`s13`

Optional object allowing to configure the S13 options. It can contain the following objects:

`server_addr`
: String. IP address and optional port of the EIR used for S13 interface. The default port is 3868.

`bind_addr`
: Optional string. IP address and optional port on which the S13 SCTP connection is bound. The default address is the same as the first S1AP SCTP connection.

`origin_realm`
: Optional string. Defines the string sent in the Origin-Realm AVP for S13 messages. Default is set to `mnc<MNC>.mcc<MCC>.3gppnetwork.org`.

`origin_host`
: Optional string. Defines the string sent in the Origin-Host AVP for S13 messages. Default is set to `epc.mnc<MNC>.mcc<MCC>.3gppnetwork.org`.

`transaction_timeout`
: Optional integer (range 1 to 15000, default = 2000). Defines the timeout in milliseconds for a transaction with the EIR.

`watchdog_duration`
: Optional integer (range 0 to 36000000, default = 30000). Tw watchdog timer in milliseconds to send the Diameter Device Watchdog Request message. The value 0 deactives the watchdog.

5.2.8 SGs options

`sgs`
: Optional object allowing to configure the SGs options. It can contain the following objects:

`csfb_allowed`
: Optional boolean (default = false). If set to true, Circuit Switched Fall back procedures are accepted, otherwise they are rejected.

`lac`
: Optional integer (default = 0x001). Defines the Location Area Identifier of the MSC/VLR to connect to.

`server_addr`
: String. IP address and optional port of the MSC/VLR used for SGs interface. The default port is 29118.

`bind_addr`
: Optional string. IP address and optional port on which the SGs SCTP connection is bound. The default address is the same as the first S1AP SCTP connection.

5.2.9 SBc options

`sbcap_bind_addr`
: Optional string. IP address and optional port on which the SBc SCTP connection is bound. The default address is the same as the first S1AP SCTP connection.

5.2.10 LCS options

`lcs`
: Optional object allowing to configure the LCSAP interface options. It can contain the following objects:

`server_addr`
: Optional string. IP address and optional port of the e-SMLC location server. The default port is 9082. If not present, the test e-SMLC located in the MME will be used.

`bind_addr`
: Optional string. IP address and optional port on which the LCSAP SCTP connection is bound. The default address is the same as the first S1AP SCTP connection.

`local_e_smlc`
: Optional object used to configure an internal test e-SMLC located in the MME. The internal e-SMLC is not a real location server. It provides some apis useful for testing. It can contain the following objects:

  `lpp_test` Optional boolean (default = false). If set to true, the e-SMLC will use the LPP protocol. Otherwise, LPPa protocol will be used.

  `e_smlc_id`
  : Optional integer in range 0 to 255 (default = 0). e-SMLC identifier.

  `transaction_id`
  : Optional integer in range 0 to 32767 (default = 0). Transaction identifier to use in the message LPPA E-CIDMeasurementInitiationRequest.

  `cell_radius`
  : Optional integer (default = 5000). Cell radius in meters. This parameter is used to calculate the RSTD uncertainty in the LPP assistance data.

  `periodic_meas`
  : Optional boolean (default = false). Indicates if periodic measurements will be requested in the message LPPA E-CIDMeasurementInitiationRequest.

  `meas_period`
  : Optional integer in range 0 to 12 (default = 0), corresponding to [ms120, ms240, ms480, ms640, ms1024, ms2048, ms5120, ms10240, min1, min6, min12, min30, min60] according to the definition of MeasurementPeriodicity in 3GPP TS 36.455 MeasurementPeriodicity. Gives the measurement period to set in the message LPPA E-CIDMeasurementInitiationRequest in case of periodic measurements.

  `meas_id` Optional integer in range 1 to 15 (default = 1). Gives the value to use in the parameter E-SMLC-UE-Measurement-ID in the message LPPA E-CIDMeasurementInitiationRequest.

  `otdoa_assistance_data`
  : Optional nullable property. Gives the name of the file containing the ASN.1 description of the OTDOA-ProvideAssistanceData LPP IE. If present, it will be used in LPP ProvideAssistanceData. To remove an existing configuration, use: otdoa_assistance_data: null.
    See 3GPP TS 37.355 chapter 6.5.1.1 OTDOA Assistance Data.

  `nr_tdoa_assistance_data`
  : Optional nullable property. Gives the name of the file containing the ASN.1 description of the NR-DL-TDOA-ProvideAssistanceData-r16 LPP IE. If present, it will be used in the message LPP Provide Assistance Data. To remove an existing configuration, use:

nr_tdoa_assistance_data: null.
See 3GPP TS 37.355 chapter 6.5.10.1 NR DL-TDOA Assistance Data.

`gnss_assistance_data`
Optional nullable property. Gives the name of the file containing the ASN.1 description of the A-GNSS-ProvideAssistanceData LPP IE. If present, it will be used in LPP ProvideAssistanceData. To remove an existing configuration, use: gnss_assistance_data: null.
See 3GPP TS 37.355 chapter 6.5.2.1 GNSS Assistance Data.

`autonomous_mode`
Optional boolean (default = FALSE). On receipt of a location request (See [location_req], page 116):
- if autonomous_mode is set to TRUE, the e-SMLC will autonomously initiate the LPPa and LPP procedures necessary to obtain or estimate the position of the UE (See [location_req], page 116).
- if it is set to FALSE, the e-SMLC will send LPP requestCapabilities or LPPa E-CIDMeasurementInitiationRequest (See [location_req], page 116), and the APIs described in the sections LPPa and LPP must be invoked to continue the localization procedure.

`lpp_methods`
Optional array. Gives the list of the LPP methods that shall be used by the eSMLC during the LPP location procedure. If not present, the eSMLC shall use all the LPP methods supported by the UE. An element of the array is an enumeration: "ecid", "otdoa", "nr_ecid", "nr_tdoa", "gnss".

5.2.11 N12 options

`n12`

Optional object allowing to configure the N12 interface options. It can contain the following objects:

`api_root` Optional string. According to the definition in 3GPP TS 29.501, api_root is in the form: <scheme>://<host>:<port>, where <scheme> is "http" or "https". This field shall be present if an external AUSF is used.

`transaction_timeout`
Optional integer (range 1 to 15000, default = 3000). Defines the timeout in milliseconds for a transaction with the AUSF.

`bind_addr`
Optional string. IP address and optional port on which the N12 TCP connection is bound. The default address is the same as the first GTP-U connection.

5.2.12 N13 options

`n13`

Optional object allowing to configure the N13 interface options. It can contain the following objects:

`api_root` Optional string. According to the definition in 3GPP TS 29.501, api_root is in the form: <scheme>://<host>:<port>, where <scheme> is "http" or "https". This field shall be present if an internal AUSF is used with an external UDM.

`transaction_timeout`
Optional integer (range 1 to 15000, default = 3000). Defines the timeout in milliseconds for a transaction between the AUSF and UDM.

`bind_addr`
Optional string. IP address and optional port on which the N13 TCP connection is bound. The default address is the same as the first GTP-U connection.

5.2.13 N8 options

`n8`

Optional object allowing to configure the N8 interface options. It can contain the following objects:

`api_root` Optional string. According to the definition in 3GPP TS 29.501, api_root is in the form: <scheme>://<host>:<port>, where <scheme> is "http" or "https". This field shall be present if an external UDM is used.

`transaction_timeout`
Optional integer (range 1 to 15000, default = 3000). Defines the timeout in milliseconds for a transaction with the UDM.

`bind_addr`
Optional string. IP address and optional port on which the N8 TCP connection is bound. The default address is the same as the first GTP-U connection.

5.2.14 N17 options

`n17`

Optional object allowing to configure the N17 interface options. It can contain the following objects:

`api_root` Optional string. According to the definition in 3GPP TS 29.501, api_root is in the form: <scheme>://<host>:<port>, where <scheme> is "http" or "https". This field shall be present if an external 5G-EIR is used.

`transaction_timeout`
Optional integer (range 1 to 15000, default = 3000). Defines the timeout in milliseconds for a transaction with the 5G-EIR.

`bind_addr`
Optional string. IP address and optional port on which the N17 TCP connection is bound. The default address is the same as the first GTP-U connection.

5.2.15 N20 options

`n20`

Optional object allowing to configure the N20 interface options. It can contain the following objects:

`api_root` Optional string. According to the definition in 3GPP TS 29.501, api_root is in the form: <scheme>://<host>:<port>, where <scheme> is "http" or "https". This field shall be present if an external SMSF is used.

`transaction_timeout`
Optional integer (range 1 to 15000, default = 3000). Defines the timeout in milliseconds for a transaction with the SMSF.

`bind_addr`
Optional string. IP address and optional port on which the N20 TCP connection is bound. The default address is the same as the first GTP-U connection.

5.2.16 N50 options

`n50`

Optional object allowing to configure the N50 interface options. It can contain the following objects:

`transaction_timeout`
Optional integer (range 1 to 15000, default = 3000). Defines the timeout in milliseconds for a transaction with the CBC.

`server_bind_addr`
Optional string. IP address and optional port on which the N50 TCP connection is bound. The default address is the same as the first GTP-U connection and the default TCP port is 5558.

5.2.17 NL1 options

`nl1`

Optional object allowing to configure the NL1 interface options. It can contain the following objects:

`api_root` Optional string. According to the definition in 3GPP TS 29.501, api_root is in the form: <scheme>://<host>:<port>, where <scheme> is "http" or "https". This field shall be present if an external LMF is used.

`transaction_timeout`
Optional integer (range 1 to 1800000, default = 20000). Defines the timeout in milliseconds for a transaction with the LMF.

`server_bind_addr`
Optional string. IP address and optional port on which the NL1 TCP connection is bound. The default address is the same as the first GTP-U connection and the default TCP port is 5560.

`lmf_cfg` Optional object used to configure an internal test LMF located in the AMF. The internal LMF is not a real location server. It provides some apis useful for testing. It can contain the following objects:

`lpp_test` Optional boolean (default = false). If set to true, the LMF will use the LPP protocol. Otherwise, NRPPa protocol will be used.

`transaction_id`
: Optional integer in range 0 to 32767 (default = 0). Transation identifier to use in the message NRPPa E-CIDMeasurementInitiationRequest.

`cell_radius`
: Optional integer (default = 5000). Cell radius in meters. This parameter is used to calculate the RSTD uncertainty in the LPP assistance data.

`periodic_meas`
: Optional boolean (default = false). Indicates if periodic measurements will be requested in the message NRPPa E-CIDMeasurementInitiationRequest.

`meas_period`
: Optional integer in range 0 to 14 (default = 0), corresponding to [ms120, ms240, ms480, ms640, ms1024, ms2048, ms5120, ms10240, min1, min6, min12, min30, min60, ms20480, ms40960] according to the definition on MeasurementPeriodicity in 3GPP TS 38.455.

`meas_id`
: Optional integer in range 1 to 256 (default = 1). LMF-UE-Measurement-ID in the message NRPPa E-CIDMeasurementInitiationRequest.

`otdoa_assistance_data`
: Optional nullable property. Gives the name of the file containing the ASN.1 description of the OTDOA-ProvideAssistanceData LPP IE. If present, it will be used in LPP ProvideAssistanceData. To remove an existing configuration, use: otdoa_assistance_data: null.
See 3GPP TS 37.355 chapter 6.5.1.1 OTDOA Assistance Data.

`nr_tdoa_assistance_data`
: Optional nullable property. Gives the name of the file containing the ASN.1 description of the NR-DL-TDOA-ProvideAssistanceData-r16 LPP IE. If present, it will be used in the message LPP Provide Assistance Data. To remove an existing configuration, use: nr_tdoa_assistance_data: null.
See 3GPP TS 37.355 chapter 6.5.10.1 NR DL-TDOA Assistance Data.

`gnss_assistance_data`
: Optional nullable property. Gives the name of the file containing the ASN.1 description of the A-GNSS-ProvideAssistanceData LPP IE. If present, it will be used in LPP ProvideAssistanceData. To remove an existing configuration, use: gnss_assistance_data: null.
See 3GPP TS 37.355 chapter 6.5.2.1 GNSS Assistance Data.

`autonomous_mode`
: Optional boolean (default = FALSE). On receipt of a location request (See [nr_location_req], page 119):
- if autonomous_modes set to TRUE, the LMF will autonomously initiate the NRPPa and LPP procedures necessary to obtain or estimate the position of the UE (See [nr_location_req], page 119).
- if it is set to FALSE, the LMF will send LPP requestCapabilities or NRPPa E-CIDMeasurementInitiationRequest (See [nr_location_req], page 119), and the APIs described in the sections NRPPa and LPP must be invoked to continue the localization procedure.

`lpp_methods`
: Optional array. Gives the list of the LPP methods that shall be used by the LMF server during the LPP location procedure. If not present, the LMF shall use all the LPP methods supported by the UE. An element of the array is an enumeration: "ecid", "otdoa", "nr_ecid", "nr_tdoa", "gnss".

5.2.18 N5 options

The 5QI QoS settings are configured in the [Rx options], page 50.

`n5`
: Optional object allowing to configure the address and port of the PCF server. It can contain the following objects:

`server_bind_addr`
: Optional string. IP address and optional port on which the N5 TCP connection is bound. The default address is the same as the first GTP-U connection and the default TCP port is 5561.

5.2.19 N62 options

`n62`
: Optional object allowing to configure the address and port of the AAnF server. It can contain the following objects:

`server_bind_addr`
: Optional string. IP address and optional port on which the N62 TCP connection is bound. The default address is the same as the first GTP-U connection and the default TCP port is 5563.

5.2.20 CP-EDT options

`cp_edt` Optional object allowing to configure CP-EDT options. It can contain the following objects:

`mode` Optional enumeration: disabled, forced, automatic. Default value is automatic. If disabled is set: CP-EDT feature is disabled in the core network. If forced is set: CP-EDT is processed by the core network whatever the NAS RAI received with UL data. If automatic is set: if NAS RAI indicates that downlink data is expected, CP-EDT is processed by the core network. Otherwise connection establishment is requested by the core network.

`max_dl_len_nb`
: Optional integer. Default value is 85. Largest DL transport block (including user payload and MAC/RLC/RRC/NAS overhead) allowed without fallback to RRC connection establishment in NB-IoT.

5.2.21 ePDG options

`epdg` Optional object allowing to configure ePDG options. It shall contain the following objects:

`bind_addr`
: IP address on which the SWu connection is bound.

`private_key`
: String. Defines the ePDG private key filename.

`certificate`
: String. Defines the ePDG certificate filename. The default files epdg_private_key.pem and epdg_cert.pem are built for ePDG FQDN "epdg.epc.mnc001.mcc001.pub.3gppnetwork.org" following the procedure decribed below. For another ePDG FQDN, these files shall be re-built by setting the FQDN in subjectAltName field. Procedure to generate and check the private key file epdg_private_key.pem and the certificate file epdg_cert.pem:

```
openssl genrsa -out ca.key 2048
openssl req -new -x509 -days 3650 -key ca.key -out ca.crt
openssl req -newkey rsa:2048 -nodes -keyout epdg_private_key.pem
openssl x509 -req -extfile <(printf "subjectAltName=DNS:epdg.epc.
openssl x509 -in epdg_cert.pem -text
openssl rsa -in epdg_private_key.pem -text
```

`esp_duration`
: Optional integer in range 10 to 5*3600 (default = 300). Gives the duration in seconds of the ESP-Sa.

`ike_duration`
: Optional integer in range 20 to 48*3600 (default = 24*3600). Gives the duration in seconds of the IKE-Sa.

`omit_auth_in_first_auth_rsp`
: Optional boolean (default = false). If set, configures the EPDG to not send the AUTH payload in the first IKE_AUTH exchange.

`p_cscf_ipv4_address_attribute_type`
: Optional integer in range 16384-32767.
Allows to define a private type value for the attribute P-CSCF IPv4 address.

`p_cscf_ipv6_address_attribute_type`
: Optional integer in range 16384-32767.
Allows to define a private type value for the attribute P-CSCF IPv6 address.

`ike_encryption_algo_list`
: Optional list of IKE-Sa supported encryption algorithms "aes-cbc-128" (AES CBC 128 bits key length), "aes-cbc-192" (AES CBC 192 bits key length), "aes-cbc-256" (AES CBC 256 bits key length), "aes-gcm-128-16" (AES GCM 128 bits key length and 16 bytes ICV), "aes-gcm-256-16" (AES GCM 256 bits key length and 16 bytes ICV), "3des", "blowfish", "aes-ctr-128" (AES CTR 128 bits key length), "aes-ctr-192" (AES CTR 192 bits key length), and aes-ctr-256 (AES CTR 256 bits key length) ordered from most preferred to least preferred.
Default value is ["aes-cbc-128", "aes-cbc-192", "aes-cbc-256", "aes-gcm-128-16", "aes-gcm-256-16", "3des", "blowfish", "aes-ctr-128", "aes-ctr-192", "aes-ctr-256"].

`ike_integrity_algo_list`
: Optional list of IKE-Sa supported integrity algorithms "hmac-sha-1-96", "hmac-sha-1-160", "hmac-sha-256-128", "hmac-sha-384-192, "hmac-sha-512-256", "hmac-md5-96", "hmac-md5-128" and "aes-cmac-96" ordered from most preferred to least preferred.

Default value is ["hmac-sha-1-96", "hmac-sha-1-160", "hmac-sha-256-128", "hmac-sha-384-192", "hmac-sha-512-256", "hmac-md5-96", "hmac-md5-128", "aes-cmac-96"];

`ike_prf_list`
: Optional list of IKE-Sa supported pseudo-random functions "prf-hmac-sha1", "prf-hmac-sha2-256", "prf-hmac-sha2-384", "prf-hmac-sha2-512", "prf-hmac-md5" and "prf-aes128-xcbc" ordered from most preferred to least preferred.
Default value is ["prf-hmac-sha1", "prf-hmac-sha2-256", "prf-hmac-sha2-384, "prf-hmac-sha2-512", "prf-hmac-md5", "prf-aes128-xcbc"].

`ike_dh_group_list`
: Optional list of IKE-Sa supported Diffie-Hellman groups "group_1", "group_2", "group_5", "group_14", "group_15", "group_16", "group_17", "group_18", "group_19", "group_22", "group_23" and "group_24" ordered from most preferred to least preferred.
Default value is ["group_5", "group_14", "group_15", "group_16", "group_17", "group_18", "group_19", "group_22", "group_23", "group_24"].

`esp_encryption_algo_list`
: Optional list of ESP-Sa supported encryption algorithms "null", "aes-cbc-128" (AES CBC 128 bits key length), "aes-cbc-192" (AES CBC 192 bits key length), "aes-cbc-256" (AES CBC 256 bits key length), "aes-gcm-128-16" (AES GCM 128 bits key length and 16 bytes ICV), "aes-gcm-192-16" (AES GCM 192 bits key length and 16 bytes ICV), "aes-gcm-256-16" (AES GCM 256 bits key length and 16 bytes ICV), "3des", "blowfish", "aes-ctr-128" (AES CTR 128 bits key length), "aes-ctr-192" (AES CTR 192 bits key length), aes-ctr-256 (AES CTR 256 bits key length), "encr-null-auth-aes-gmac-128" (ENCR_NULL_AUTH_AES_GMAC 128 bits key length), "encr-null-auth-aes-gmac-192" (ENCR_NULL_AUTH_AES_GMAC 192 bits key length) and "encr-null-auth-aes-gmac-256" (ENCR_NULL_AUTH_AES_GMAC 256 bits key length) ordered from most preferred to least preferred.
Default value is ["null", "aes-cbc-128", "aes-cbc-192", "aes-cbc-256", "aes-gcm-128-16", "aes-gcm-192-16", "aes-gcm-256-16", "3des", "blowfish", "aes-ctr-128", "aes-ctr-192", "aes-ctr-256", "encr-null-auth-aes-gmac-128", "encr-null-auth-aes-gmac-192", "encr-null-auth-aes-gmac-256"].

`esp_integrity_algo_list`
: Optional list of ESP-Sa supported integrity algorithms "null", "hmac-sha-1-96", "hmac-sha-1-160", "hmac-sha-256-128", "hmac-sha-384-192, "hmac-sha-512-256", "hmac-md5-96", "hmac-md5-128" and "aes-cmac-96" ordered from most preferred to least preferred.
Default value is ["null", "hmac-sha-1-96", "hmac-sha-1-160", "hmac-sha-256-128", "hmac-sha-384-192", "hmac-sha-512-256", "hmac-md5-96", "hmac-md5-128", "aes-cmac-96"].

`esp_dh_group_list`
: Optional list of ESP-Sa supported Diffie-Hellman groups "none", "group_1", "group_2", "group_5", "group_14", "group_15", "group_16", "group_17", "group_18", "group_19", "group_22",

"group_23" and "group_24"ordered from most preferred to least preferred.
This list is used for rekeying ESP-Sa. Default value is ["none", "group_5", "group_14", "group_15", "group_16", "group_17", "group_18", "group_19", "group_22", "group_23" and "group_24"].

`dpd_timer_value`
Optional integer in range 5 to 300 (default = 300). Gives the "dead peer detection" timer value in seconds.

`mobike` Optional boolean (default = true). Indicates MOBIKE support.

`ike_generate_error`
Optional object. Allows to ignore a message or generate an error during an IKE exchange.
It contains the following objects:

`exchange` String. Gives the exchange to ignore or on which the error must be sent. Possible values are "none", "ike_sa_init", "ike_auth_step1", "ike_auth_step2", "ike_auth_step3", "dpd", "mobike".

`reject_notify_list`
Optional array. If absent, the message received during the exchange will be ignored.
If present, the message received during the exchange will be rejected, and each element of the array describes a Notify payload to insert in the response. Each element of the array contains:

`error` Optional integer. Gives the value of 'Notify Message Type' to send in the Notify payload rejecting the exchange.

`data` Optional hexadecimal string. May be present if error is present.
Gives the Notification Data to send in the Notify payload.

`ttl` Optional integer. If set, `ike_generate_error` is applied `ttl` times. If not set, `ike_generate_error` is applied until it is modified.

`apn_list` Optional array of 0 to 16 strings. Gives the list of the APNs for which `ike_generate_error` applies. If apn_list is empty or not present, `ike_generate_error` applies to any APN.

Example:

```
ike_generate_error: {
exchange: "ike_auth_step1"
reject_notify_list: [
 {
   error: 9002,
   data: "1234",
 },
```

```
  {
    error: 9003,
    data: "5678",
  }],
 ttl: 1
 }
```

`idr_for_emergency`
: Optional string (default = "EMERGENCY"). Name of the APN for emergency.

`dont_fragment`
: Optional boolean (default = true) used to enable/disable the fragmentation of the ESP packets.

`additional_ue_auth_type`
: Optional enumeration: `none`, `pap`, `chap` (default = `none`). Defines the authentication mechanism used for the additionnal UE authentication as described in 3GPP 33.402 chapters 6.5.2 and 6.5.3.
If present and not set to `none`:
MULTIPLE_AUTH_SUPPORTED notify payload will be sent by the ePDG in the message IKE_SA_INIT response (see 3GPP 33.402 chapter 6.5), and username (See [username], page 32) and password (See [password], page 32) must be configured in pdn_list to perform the authentication and authorization for a given APN.

5.2.22 MBS options

`mbs` Optional object allowing to configure MBS parameters. It contains the following parameters:

`nmbsmf` Object allowing to configure the MB-SMF server on the NMBSMF interface. It contains the following parameters:

`server_bind_addr`
: Optional string. IP address and optional port on which the nmbsmf TCP connection is bound. The default address is the same as the first GTP-U connection and the default TCP port is 5581.

`gtp_addr` String or array of 2 strings. IP address (and optional port) to which the GTP-U packets are sent. It is normally a multicast address. Several sessions can share the same IP address and have a different `gtp_teid`. Use an array to configure both an IPv4 (first entry in the array) and an IPv6 (second entry in the array) address if you use both IPv4 and IPv6 addresses in the ltemme `gtp_addr` top level parameter.

`ingress_tunnel_addr`
: Optional string or array of 2 strings. IP address used by the MB-UPF to receive the MBS data packets when unicast transfer is used over N6mb. The same address and different ports are used for different MBS sessions.

`tmgi_lifetime`
: Optional integer (range: 1 to MAX_INT, default value: 300). Lifetime of an allocated TMGI in seconds.

`service_area`
: Optional object. Describes the service area supported by the MBS server. it contains the following parameters:

  `cell_list`
  : Optional array of objects. Service area cell list. Each element contains the following parameters:

    `plmn` String. PLMN.

    `cell_id` Integer. 36 bits NR cell identity.

  `tai_list` Optional array of objects. Service area tracking area list. Each element contains the following parameters:

    `plmn` String. PLMN.

    `tac` Integer. Tracking area code.

`broadcast_sessions`
: Optional array of objects allowing to configure the MBS sessions at the client side on the NMBSMF interface. Each element describes a broadcast session and contains the following parameters:

  `tmgi` Object. Session TMGI. It contains the following parameters:

    `plmn` String. PLMN.

    `service_id`
    : Integer. 24 bits service identity.

  `nid` Optional object. See [nid], page 12.

  `snssai` Object. S-NSSAI value. it contains the following parameters:

    `sst` Integer (range 0-255). Slice Service Type.

    `sd` Optional integer (range 0-0xFFFFFE). Slice Differentiator.

  `service_area`
  : Optional object.
    It describes the service area in case of location dependent MBS session. See [service_area], page 63.

  `associated_session_id`
  : Optional hexdecimal string. Associated session identity.

  `autostart`
  : Optional boolean (default = true). Indicates if the session is started automatically or if it must be started manually.

  `user_plane_desc`
  : Optional object allowing to configure the parameters used for the transfer of the data to the MBS server.

    `use_n6mb_multicast`
    : Optional boolean (default = FALSE). Indicates if multicast transport is used over N6mb.

`multicast_dest_addr`
: Optional string. Shall be present if `sim` is TRUE (to build the RTP packets headers), or `use_n6mb_multicast` is FALSE (to fill the ssm field in the MBS session create request over the Nmbsmf interface). Source-specific multicast (SSM) destination address of the RTP flow sent by the MBS client (used for both unicast and multicast transport over N6mb).
See in RFC 4607 the addresses range reserved for use by source-specific applications and protocols: IANA assigned 232/8 for IPv4 and FF3x::/96 for IPv6.

`source_addr`
: Optional string. Shall be present if `sim` is TRUE (to build the RTP packets headers), or `use_n6mb_multicast` is FALSE (to fill the ssm field in the MBS session create request over the Nmbsmf interface). IP unicast address used as source address of the RTP flow sent by the MBS client (used for both unicast and multicast transport over N6mb).

`source_bind_addr`
: Optional string. IP source address and port used by the MBS client as bind address for the sending of MBS packets. If not present, the first address in the ltemme `gtp_addr` is used.

`sim`
: Optional boolean (default = false). If true, RTP packets are generated and sent to the MBS server using a RTP payload of `rtp_payload_len` bytes and a bitrate of `bitrate`.

`rtp_payload_len`
: Optional integer. RTP payload length in bytes (default = 1460 for IPv4 of 1440 for IPv6). RTP payload length of the RTP packets sent to the MBS server.

`bitrate`
: Integer. Bitrate in bit/s of the generated RTP stream. The bitrate includes the size of the IP, UDP and RTP headers.

`qos_flows`
: Array of objects. Each element contains the following parameters:

  `5qi`
  : Integer. 5G QoS Identifier of the QOS flow.

  `priority_level`
  : Optional integer (range: 1 to 15, default 15). ARP priority level.

`pre_emption_capability`
: Optional enumeration: `shall_not_trigger_pre_emption` or `may_trigger_pre_emption` (default `shall_not_trigger_pre_emption`).

`pre_emption_vulnerability`
: Optional enumeration: `not_pre_emptable` or `pre_emptable` (default `not_pre_emptable`).

`5qi_qos`
: Optional object. See [5QI QoS], page 35.

`gbr`
: Optional object. See [GBR], page 36.

`flow_descs`
: Optional array of strings. Contains the flow description for the MBS Downlink IP flow.
Each element contains an IpFilterRule according to clause 4.3 of IETF RFC 6733.
Refer to clause 5.3.8 of 3GPP TS 29.214 for encoding.

6 Remote API

You can access LTEMME via a remote API.
Protocol used is WebSocket as defined in RFC 6455 (`https://tools.ietf.org/html/rfc6455`).

Note that Origin header is mandatory for the server to accept connections.
This behavior is determined by the use of `nopoll` library.
Any value will be accepted.

To learn how to use it, you can refer to our the following tutorial (`https://tech-academy.amarisoft.com/RemoteAPI.html`).

6.1 Messages

Messages exchanged between client and LTEMME server are in strict JSON format.

Each message is represented by an object. Multiple message can be sent to server using an array of message objects.

Time and delay values are floating number in seconds.

There are 4 types of messages:

- Request

  Message sent by client.
  Common definition:

  `message` String. Represent type of message. This parameter is mandatory and depending on its value, other parameters will apply.

  `message_id`
  Optional any type. If set, response sent by the server to this message will have same message_id. This is used to identify response as WebSocket does not provide such a concept.

  `start_time`
  Optional float. Represent the delay before executing the message.
  If not set, the message is executed when received.

  `absolute_time`
  Optional boolean (default = false). If set, `start_time` is interpreted as absolute.
  You can get current clock of system using `time` member of any response.

  `standalone`
  Optional boolean (default = false). If set, message will survive WebSocket disconnection, else, if socket is disconnected before end of processing, the message will be cancelled.

  `loop_count`
  Optional integer (default = 0, max = 1000000). If set, message will be repeated `loop_count` time(s) after `loop_delay` (From message beginning of event).
  Response will have a `loop_index` to indicate iteration number.

`loop_delay`
: Optional number (min = 0.1, max = 86400). Delay in seconds to repeat message from its `start_time`. Mandatory when `loop_count` is set > 0.

- Notification

  For some API, intermediate message may be sent by server before reception of response.
  Common definition:

  `message` String. Same as request.

  `message_id`
  : Optional any type. Same as in request.

  `time` Number representing time in seconds of the message start, relative to the beginning of the process.
  Useful to send command with absolute time.

  `notification`
  : String. Notification purpose

  `utc` Number representing UTC seconds (local clock) when the response has been generated.

- Response

  Message sent by server after any request message has been processed.
  Common definition:

  `message` String. Same as request.

  `message_id`
  : Optional any type. Same as in request.

  `time` Number representing time in seconds of the message start, relative to the beginning of the process.
  Useful to send command with absolute time.

  `utc` Number representing UTC seconds (local clock) when the response has been generated.

  `absolute_time`
  : Optional string. If `absolute_time` has been set and message is reaching LTEMME too late, this field is present and set to `late`.

- Events

  Message sent by server on its own initiative.
  Common definition:

  `message` String. Event name.

  `time` Number representing time in seconds.
  Useful to send command with absolute time.

6.2 Startup

When WebSocket connections is setup, LTEMME will send a first message with name set to `com_name` and type set to MME.

If authentication is not set, message will be `ready`:

```
{
    "message": "ready",
```

```
    "type": "MME",
    "name": <com_name>,
    "version": <software version>,
    "product": <Amarisoft product name (optional)>
}
```

If authentication is set, message will be `authenticate` :

```
{
    "message": "authenticate",
    "type": "MME",
    "name": <com_name>,
    "challenge": <random challenge>
}
```

To authenticate, the client must answer with a `authenticate` message and a `res` parameter where:

```
res = HMAC-SHA256( "<type>:<password>:<name>", "<challenge>" )
```

`res` is a string and HMAC-SHA256 refers to the standard algorithm (`https://en.wikipedia.org/wiki/HMAC`)

If the authentication succeeds, the response will have a `ready` field set to `true`.

```
{
    "message": "authenticate",
    "message_id": <message id>,
    "ready": true
}
```

If authentication fails, the response will have an `error` field and will provide a new challenge.

```
{
    "message": "authenticate",
    "message_id": <message id>,
    "error": <error message>,
    "type": "MME",
    "name: <name>,
    "challenge": <new random challenge>
}
```

If any other message is sent before authentication succeeds, the error `"Authentication not done"` will be sent as a response.

6.3 Errors

If a message produces an error, response will have an error string field representing the error.

6.4 Sample nodejs program

You will find in this documentation a sample program: `ws.js`.
It is located in `doc` subdirectory.
This is a nodejs program that allow to send message to LTEMME.
It requires nodejs to be installed:

```
dnf install nodejs npm
npm install nodejs-websocket
```

Use relevant package manager instead of NPM depending on your Linux distribution.

Then simply start it with server name and message you want to send:

```
./ws.js 127.0.0.1:9000 '{"message": "config_get"}'
```

6.5 Common messages

`config_get`

Retrieve current config.

Response definition:

`type` Always "MME"

`name` String representing server name.

`logs` Object representing log configuration.
With following elements:

`layers` Object. Each member of the object represent a log layer configuration:

`layer name`
Object. The member name represent log layer name and parameters are:

`level` See [log_options], page 10,

`max_size` See [log_options], page 10,

`key` See [log_options], page 10,

`crypto` See [log_options], page 10,

`payload` See [log_options], page 10,

`verbose` Optional boolean. See [log_options], page 10,

`count` Number. Number of bufferizer logs.

`rotate` Optional number. Max log file size before rotation.

`rotate_count`
Optional number. Max log count before rotation.

`path` Optional string. Log rotation path.

`bcch` Boolean. True if BCCH dump is enabled (eNB only).

`mib` Boolean. True if MIB dump is enabled (eNB only).

`locked` Optional boolean. If `true`, logs configuration can't be changed with `config_set` API.

`config_set`

Change current config.
Each member is optional.
Message definition:

`logs` Optional object. Represent logs configuration. Same structure as config_get (See [config_get logs member], page 70).
All elements are optional.
Layer name can be set to `all` to set same configuration for all layers.
If set and logs are locked, response will have `logs` property set to `locked`.

`relative_capacity`
: Optional integer (range 0 to 255). Set the MME or AMF relative capacity value used for MME or AMF load balancing in S1AP S1 Setup Response, MME Configuration Update, NGAP NG Setup Response and NGAP AMF Configuration Update messages.

`attach_reject_error`
: Optional integer (range 0 to 255).
Force value of EMM reject cause in NAS attach reject message.

`tracking_area_update_reject_error`
: Optional integer (range 0 to 255).
Force value of EMM reject cause in NAS tracking area update reject message.

`service_reject_error`
: Optional integer (range 0 to 255).
Force value of EMM reject cause in NAS service reject message.

`pdn_connect_reject_error`
: Optional integer (range 0 to 255).
Force value of ESM reject cause in NAS PDN connectivity reject message.

`pdn_disconnect_reject_error`
: Optional integer (range 0 to 255).
Force value of ESM reject cause in NAS PDN disconnect reject message.

`bearer_resource_allocation_reject_error`
: Optional integer (range 0 to 255).
Force value of ESM reject cause in NAS bearer resource allocation reject message.

`bearer_resource_modification_reject_error`
: Optional integer (range 0 to 255).
Force value of ESM reject cause in NAS bearer resource modification reject message.

`registration_initial_reject_error`
: Optional integer (range 0 to 255).
Force value of 5GMM reject cause in NAS registration reject message (for 5GS registration type 1 or 4).

`registration_mobility_periodic_error`
: Optional integer (range 0 to 255).
Force value of 5GMM reject cause in NAS registration reject message (for 5GS registration type 2 or 3).

`5gs_service_reject_error`
: Optional integer (range 0 to 255).
Force value of 5GMM reject cause in NAS service reject message.

`pdu_session_establishment_reject_error`
: Optional integer (range 0 to 255).
Force value of 5GSM reject cause in NAS PDU session establishment reject message.

`pdu_session_release_reject_error`
: Optional integer (range 0 to 255).
Force value of 5GSM reject cause in NAS PDU session release reject message.

`pdu_session_modification_reject_error`
: Optional integer (range 0 to 255).
Force value of 5GSM reject cause in NAS PDU session modification reject message.

`5gmm_dl_nas_transport_error`
: Optional integer (range 0 to 255).
Force value of 5GMM reject cause in NAS DL NAS transport message.

`eps_user_unknown_reject_cause`
: Optional integer (range 0 to 255).
EMM cause sent in the NAS attach reject message when the IMSI is unknown in the HSS.

`5gs_user_unknown_reject_cause`
: Optional integer (range 0 to 255).
5GMM cause sent in the NAS registration reject message when the SUPI is unknown in the UDM.

`attach_reject_filter`
: Optional object. Represent UE to reject when trying to attach.
Each property name represent IMSI. Use of wildcard `"*"` with an IMSI prefix is allowed to match IMSI range (Ex: 0010112456*). If multiple filters are matching, the one with the longest prefix will be used.
Each property value may be:

  `null` Removes redirection matching IMSI

  `integer` Defines redirection type as described in *rrc_redirect* eNB configuration.

  `string` Defines PLMN to redirect to

`t3402` Optional integer. Value in seconds of the T3402 or T3502 timer. -1 means that the timer value is not transmitted in attach accept or TAU accept or registration accept so that the UE uses the default value (12 minutes).

`t3412` Optional integer. Value in seconds of the T3412 (TAU update) timer. -1 means that the timer is deactivated.

`t3412_low_priority`
Optional integer. Value in seconds of the T3412 (TAU update) timer if the UE indicates NAS signalling low priority. -1 means that the timer is deactivated.

`t3512` Optional integer. Value in seconds of the T3512 (periodic registration) timer. -1 means that the timer is deactivated. This is the value sent to the UE in NAS signalling, unless the UE is requesting the use of a longer timeout with requested T3512 value information element.

`t3501` Optional integer in range 1-30 (default = 5). Value in seconds of the MANAGE UE POLICY COMMAND timer in the PCF.

`n3gpp_dereg_timer`
Optional integer. Value in seconds of the non-3GPP de-registration timer. This is the value sent to the UE in NAS signalling.

`psm` Option boolean. If set to false, MME will ignore the PSM request sent by the UE.

`mico_support`
Optional boolean. If set to false, AMF will ignore the MICO request sent by the UE.

`registration_area_alloc_ind`
Optional ingeger. Sets the Registration Area Allocation Indication bit in the 5GMM MICO indication IE. 0 means 'all PLMN registration area not allocated' and 1 means 'all PLMN registration area allocated'.

`sprt_support`
Optional boolean. If set to true and if `mico_support` is set to true, the AMF will accept the use of the strictly periodic registration timer.

`t3412_extended_forced`
Optional integer. Value in seconds of the T3412 extended timer if UE uses PSM. If different from -1, the MME will ignore the value requested by the UE and will send this one instead.

`force_t3412_extended_ie`
Optional boolean. If set to false, the MME selects the greatest T3412 value between the one configured in the MME and the one requested by the UE for PSM (unless `t3412_extended_forced` is set), and it does not send the T3412 extended IE if the value can be encoded as a GPRS timer IE. If set to true, the MME accepts a T3412 value requested by the UE smaller than the configured one, and the T3412 extended IE is always sent.

`requested_t3512_forced`
Optional integer. Value in seconds of the T3512 timer if UE uses MICO. If greater than -1, the AMF will ignore the value requested by the UE and will send this one instead. If set to -2, the AMF will accept a T3512 value requested by the UE smaller than the configured one.

`t3324_forced`
Optional integer. Value in seconds of the T3324 timer if UE uses PSM. If different from -1, the MME will ignore the value requested by the UE and will send this one instead. -2 means that the timer is deactivated.

`t3346` Optional integer. Value in seconds of the T3346 timer. The timer is transmitted in the reject messages if the EMM of 5GSM cause is #22 (congestion) and the value is not -1.

`t3442` Optional integer. Value in seconds of the T3442 timer.

`t3448` Optional integer. Value in seconds of the T3448 timer. The timer is transmitted if the value is different from -1 and the UE indicates its support in the UE network capability information element.

`t3460` Optional integer. Value in seconds of the T3460 or T3560 timer.

`t3460_wb_ce`
Optional integer. Value in seconds of the T3460 or T3560 timer for UE operating in WB-S1/CE or WB-N1/CE mode.

`lower_bound_timer`
Optional integer. The timer is transmitted in the reject messages if the EMM or 5GMM cause is #78 (PLMN not allowed to operate at the present UE location) and the value is not -1.

`t3560_ng_ran_sat`
Optional integer. Value in seconds of the T3560 timer for UE operating in NR(MEO) or NR(GEO) satellite RAT.

`5gmm_backoff_timer`
Optional integer. Value in seconds of the 5GMM DL NAS transport back-off timer. The timer is transmitted if the value is not -1. -2 means that the timer is deactivated.

`edrx` Option boolean. If set to false, MME will ignore the eDRX request sent by the UE.

`edrx_ptw_wb_s1`
Optional integer. 4 bits Paging Time Window length for WB-S1 UEs as defined in 3GPP TS 24.008 chapter 10.5.5.32.

`edrx_ptw_nb_s1`
Optional integer. 4 bits Paging Time Window length for NB-S1 UEs as defined in 3GPP TS 24.008 chapter 10.5.5.32.

`edrx_ptw_nr`
Optional integer (0 to 31, default = 3). 8 bits Paging Time Window length for NR connected to 5GCN UEs as defined in 3GPP TS 24.008 chapter 10.5.5.32.

`edrx_cycle_forced`
Optional integer. 4 bits E-UTRAN eDRX cycle length duration as defined in 3GPP TS 24.008 chapter 10.5.5.32. If different from -1, the MME will ignore the value requested by the UE and will send this one instead.

`gwus_support`
Optional boolean. Group WUS support.

`gwus_prob_forced`
Optional enumeration: -1, 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100. Force group WUS paging probability for all the UEs. The MME will ignore the value requested by the UE and will send this one instead.

`ims_vops_eps`
: Optional boolean. Set the IMS voice over PS session in S1 mode supported bit of the EPS network feature support field in the NAS attach accept message (VoLTE).

`ims_vops_5gs_3gpp`
: Optional boolean. Set the IMS voice over PS session over 3GPP access indicator of the 5GS network feature support IE of the NAS registration access message. See 3GPP TS 24.501 table 9.11.3.5.1.

`ims_vops_5gs_n3gpp`
: Optional boolean. Set the IMS voice over PS session over non-3GPP access indicator of the 5GS network feature support IE of the NAS registration access message. See 3GPP TS 24.501 table 9.11.3.5.1.

`emc_bs` Optional boolean. Set the emergency bearer services in S1 mode supported bit of the EPS network feature support field in the NAS attach accept message (VoLTE, Release 9).

`emc` Optional integer. Set the emergency service support indicator for 3GPP access bits of the 5GS network feature support IE in the NAS registration accept message.

`emc_n3gpp`
: Optional boolean. Set the emergency service support indicator for non-3GPP access bits of the 5GS network feature support IE in the NAS registration accept message. See 3GPP TS 24.501 table 9.11.3.5.1.

`emf` Optional integer. Set the emergency service fallback indicator for 3GPP access bits of the 5GS network feature support IE in the NAS registration accept message.

`epc_lcs` Optional boolean. Set the Location services indicator via EPC supported bit of the EPS network feature support field in the NAS attach accept message.

`5gs_sms_over_nas`
: Optional boolean. Defines if 5GC should indicate the support of SMS over NAS in the 5GMM registration accept message, if the UE indicated its support in the 5GMM registration request message.

`emergency_number_list`
: Optional array of objects. Defines a list of emergency numbers to be sent to the UE in the NAS Attach Accept, Tracking Area Update Accept or Registration Accept messages.
To clear the current emergency number list, the array must be empty.
To configure an emergency number list, each object must contain the following parameters:

  `category` Integer. Bitmask of the category bits as defined in 3GPP TS 24.008 table 10.5.135d (bit 1: police, bit 2: ambulance, bit 3: fire brigade, bit 4: marine guard, bit 5: mountain rescue).

  `digits` String. Emergency number.

`extended_emergency_number_list`
: Optional object. Defines a list of extended emergency numbers to be sent to the UE in the NAS Attach Accept, Tracking Area Update Accept

or Registration Accept messages.
The object must contain the following parameters:

`validity` Optional enumeration (country or plmn).
Validity of the extended emergency number list.
Must be present if emergency_numbers is not empty.

`emergency_numbers`
Array of objects. To clear the current extended emergency number list, the array must be empty.
To configure an extended emergency number list, each object must contain the following parameters:

`digits` String. Emergency number.

`sub_services`
Optional string. Emergency number sub-services.

`cp_ciot_opt`
Optional boolean. If true, enable control plane CIoT optimization (if supported by the UE).

`attach_without_pdn`
Optional boolean. If true, enable attach without PDN functionality (if supported by the UE).

`fifteen_bearers`
Optional boolean. If true, enable the use of 15 EPS radio bearers (if supported by the UE).

`attach_result_mode`
Optional string. Set attach result of attach accept message.
Can be:

`auto` This is standard LTE behavior.

`eps_only` If set and UE is sending combined EPS/IMSI attach, the MME will answer with EPS only in attach accept message (EMM cause will be CS domain not available).

`combined` If set and UE is sending EPS only attach, the MME will answer with combined in attach accept message.

`additional_update_result`
Optional integer. Set the value of additional update result in NAS attach accept and tracking area update accept messages.
If set to -1, the additional update result won't be set.

`network_policy`
Optional integer (range -1 to 15). Set the value of the network policy information element described in 3GPP TS 24.301 chapter 9.9.3.52. The value -1 means that the IE is not transmitted.

`authentication_mode`
Optional string. Set NAS authentication procedure behavior.
Can be:

`auto` The MME or AMF performs authentication procedure unless the UE is already successfully authentified.

`force` The MME or AMF forces a new NAS authentication procedure even if the Attach Request or Registration Request was already successfully authentified

`skip` The MME or AMF skips the NAS authentication procedure and uses EIA0/EEA0 or 5G-IA0/5G-EA0 algorithms. This needs to be supported on UE side also.

`dummy_authentication_autn_mac`
Optional boolean. If set to true, the network will send an invalid AUTN MAC value in the NAS authentication request message.

`authenticate_known_emergency_supi`
Optional boolean. If set to true, the network will authenticate known IMSI/SUPI during an emergency registration procedure and reject the UE if it fails.

`restrict_ec_wb`
Optional boolean. Sets restriction on enhanced coverage for WB-S1 and WB-N1 UEs.

`restrict_ec_nb`
Optional boolean. Sets restriction on enhanced coverage for NB-S1 and NB-N1 UEs.

`skip_smc_proc`
Optional boolean. If set to true, the MME or AMF will not perform a NAS security mode control procedure and will send all messages as plain. This needs to be supported on UE side also.

`coarse_location_information_support`
Optional boolean. If set to true, and if a NB-IoT UE accessing the core network via a NTN cell supports the feature, the MME will request the coarse location information in the NAS security mode command message.

`force_identity_request`
Optional boolen. If set to true, the network will perform a NAS identity request procedure even if the GUTI in the attach request or the 5G-GUTI in the initial registration request is already known.

`allocate_new_guti_in_tau`
Optional boolean. If set to true, a new GUTI is allocated during each Tracking Area Update procedure. If set to false, the UE keeps the GUTI allocated during the attach procedure.

`force_guti_in_tau`
Optional boolean. If set to true, GUTI IE will be systematically present in Tracking Area Update Accept message even if it does not change.

`emm_procedure_filter`
Optional object. Allows to define the MME behavior for a list of EMM procedures.
Each property name represents an EMM procedure. The ones currently supported are `attach`, `tracking_area_updating`, `detach`, `service_request`, `identity`, `authentication`, `security_mode_control` and `nas_transport`.
Each property value is an object containing the following fields:

`action` Enumeration (`treat` (UE message is processed), `ignore` (UE message is ignored) or `reject` (UE message is rejected)).

`ttl` Optional integer. If set, the `reject` of `ignore` filter is applied `ttl` times. If not set, the filter is applied until it is modified.

`send_status_on_reject`
Optional boolean. It set and if `action` is set to reject an EMM status message is sent.

Example:

```
emm_procedure_filter: {
    attach: {
        action: "treat"
    },
    service_request: {
        action: "reject",
        ttl: 1
    }
}
```

`5gmm_procedure_filter`
Optional object. Allows to define the AMF behavior for a list of 5GMM procedures.
Each property name represents a 5GMM procedure. The ones currently supported are `registration_initial`, `registration_initial_with_security_protection`, `registration_mobility_periodic`, `service_request`, `identity`, `authentication`, `security_mode_control`, `generic_ue_update_command`, `nas_transport_n1_sm`, `nas_transport_sms` and `deregistration`.
Each property value is an object containing the following fields:

`action` Enumeration (`treat` (UE message is processed), `ignore` (UE message is ignored) or `reject` (UE message is rejected)).

`ttl` Optional integer. If set, the `reject` of `ignore` filter is applied `ttl` times. If not set, the filter is applied until it is modified.

`send_status_on_reject`
Optional boolean. It set and if `action` is set to reject a 5GMM status message is sent.

Note that `nas_transport_n1_sm` filter must be used together with the `apply_nas_transport_n1_sm_filter` DNN parameter.

Example:

```
"5gmm_procedure_filter": {
    registration_initial: {
        action: "treat"
    },
    service_request: {
        action: "reject",
        ttl: 1
```

```
        }
    }
```

`nr_support`
: Optional boolean. Set it to true to enable Dual Connectivity with NR support.

`dcnr_implicit_support`
: Optional boolean. If set to true, the MME will not send the 2nd byte of the EPS network feature support IE because of DCNR. Can be useful to test the UE behavior.

`ecc_params`
: Optional object. Set the ECC network configuration for the SUPI protection and de-concealment of the SUCI. Applicable to 5GC only. It contains the following objects:

  `A`
  : Optional array of objects. Set the home network private key for profile A protection scheme.

    `home_nw_private_key`
    : String. Set the home network private key;

    `home_nw_key_id`
    : Optional integer in range 0 to 255 (default = 1). Set the home network key identifier.

  `B`
  : Optional array of objects. Set the home network private key for profile B protection scheme.

    `home_nw_private_key`
    : String. Set the home network private key;

    `home_nw_key_id`
    : Optional integer in range 0 to 255 (default = 2). Set the home network key identifier.

`nssai_inclusion_mode`
: Applicable to 5GC only. Optional enumeration (none, A, B, C, D). NSSAI inclusion mode value to send in message Registration accept.

`cp_edt`
: Optional object allowing to configure CP-EDT options. It can contain the following objects:

  `mode`
  : Optional enumeration: disabled, forced, automatic. Default value is automatic. If disabled is set: CP-EDT feature is disabled in the core network. If forced is set: CP-EDT is processed by the core network whatever the NAS RAI received with UL data. If automatic is set: if NAS RAI indicates that downlink data is expected, CP-EDT is processed by the core network. Otherwise connection establishment is requested by the core network.

  `max_dl_len_nb`
  : Optional integer. Default value is 85. Largest DL transport block (including user payload and MAC/RLC/RRC/NAS overhead) allowed without fallback to RRC connection establishment in NB-IoT.

`epdg` Applicable to EPC only. Optional object allowing to configure ePDG options. It may contain the following object:

`esp_duration`
Optional integer in range 10 to 5*3600). Gives the duration in seconds of the ESP-Sa.

`ike_duration`
Optional integer in range 20 to 48*3600. Gives the duration in seconds of the IKE-Sa.

`ike_generate_error`
Optional object. Allows to ignore a message or generate an error during an IKE exchange. See [ike_generate_error], page 62.

`mobike` Optional boolean. Indicates MOBIKE support.

`dont_fragment`
Optional boolean (default = TRUE) used to enable/disable the fragmentation of the ESP packets.

`additional_ue_auth_type`
Optional enumeration: `none`, `pap`, `chap`. Defines the authentication mechanism used for the additional UE authentication as described in 3GPP 33.402 chapters 6.5.2 and 6.5.3.

`pdn_list` Optional array of object. Each object can contain the following properties:

`apn` String. APN allowing to identify the PDN or PDU session to be modified.

`operator` Optional array of objects. Each element defines an operator reserved container in protocol configuration.

Properties of each element:

`id` Integer. Container identifier, must be between 0xff00 and 0xffff as defined in 3GPP TS 24.008.

`plmn` String. PLMN info of container.

`value` String. Value to send in hexadecimal string format.

`force` Optional boolean. If true, container will be sent event without request (false by default).

`serving_plmn_rate_control`
Optional integer (range 0 to 65535). Defines the serving PLMN rate control IE content when PDN is used with control plane CIoT optimization only. If the value configured is less than 10, the IE is not transmitted.

`apn_rate_control_params`
Optional object. If defined, and if the UE indicates APN rate control parameters support in its protocol configuration options, the following parameters will be sent in Core Network protocol configuration options:

`additional_exception_report`
: Boolean. Indicates if exception reports are allowed once the limit is reached.

`ul_time_unit`
: Enumeration: `unrestricted`, `minute`, `hour`, `day` or `week`.

`max_ul_rate`
: Integer (range from 0 to 16777215). Number of messages allowed to be sent per `ul_time_unit`.

`additional_apn_rate_control_exception_data_params`
: Optional object. If defined, and if the UE indicates additional APN rate control for exception data parameters support in its protocol configuration options, the following parameters will be sent in Core Network protocol configuration options:

  `ul_time_unit`
  : Enumeration: `unrestricted`, `minute`, `hour`, `day` or `week`.

  `max_ul_rate`
  : Integer (range from 0 to 65535). Number of messages allowed to be sent per `ul_time_unit`.

`backoff_timer`
: Optional integer. Value in seconds of the T3396/T3584/T3585 timers. The timer is transmitted in the ESM and 5GSM reject messages if the value is not -1. -2 means that the timer is deactivated.

`re_attempt_ind`
: Optional integer (range -1 to 255). Value of octet 3 of the Re-attempt indicator information element, as specified in 3GPP TS 24.301 chapter 9.9.4.13A and 3GPP TS 24.501 chapter 9.11.4.17. The value -1 means that the information element is not sent.

`ipv6_router_lifetime`
: Optional integer (range 0 to 65535). IPv6 Router Advertisement router lifetime in seconds.

`ipv6_valid_lifetime`
: Optional integer. IPv6 Router Advertisement valid lifetime in seconds.

`ipv6_pref_lifetime`
: Optional integer (default is `ipv6_valid_lifetime` value). IPv6 Router Advertisement preferred lifetime in seconds. Must not be greater than `ipv6_valid_lifetime`.

`ipv6_onlink_flag`
: Optional boolean. Defines IPv6 Router Advertisement onlink flag state.

`ipv6_managed_addr_config_flag`
: Optional boolean. Defines IPv6 Router Advertisement managed address configuration flag state.

`ipv6_other_config_flag`
: Optional boolean. Defines IPv6 Router Advertisement other configuration flag state.

`ipv6_ra_transmission_interval`
: Optional integer (range -1 to 1800). Time in seconds between 2 periodical multicast Router Advertisement transmission, once the initial 3 transmissions have been performed after opening the PDN or PDU session. The value -1 means that no multicast transmission is done at all (including the 3 initial ones). The value 0 means that periodical transmission is deactivated.

`ipv6_send_dns_in_ra`
: Optional boolean. Defines whether Router Advertisement message should contain the configured IPv6 DNS servers address or not.

`ipv6_drop_rs`
: Optional boolean. Defines whether the incoming Router Solicitation messages should be dropped by the MME and UPF or not.

`automatic_release`
: Optional boolean. If set, when the last associated dedicated EPS bearer is released the MME releases the PDN connection. With 5GS, when the last non default QoS flow is released, the SMF releases the PDU session.

`automatic_release_timeout`
: Optional integer. Delay in ms before releasing the PDN connection or PDU session when `automatic_release` is set to true.

`allow_multiple_pdn_connections`
: Optional boolean. If set, a UE can create multile PDN connections to this APN.

`ue_initiated_modification`
: Optional boolean. If set, the UE can request the modification of a bearer, otherwise the request is rejected.

`ip_src_violation_limit`
: Optional integer. If greater than -1, the MME or UPF checks the IP source address of uplink packets. When `ip_src_violation_limit` packets are received, the PDN or PDU session is released. The value 0 means that the packets are dropped without triggering a release.

`integrity_protection`
: Optional enumeration (disabled, preferred, required, default = disabled). Defines whether integrity should be used for the PDN connection / PDU session or not.
For EPC, if the value is set to `preferred`, the EPC will activate integrity protection based on the UE capabilities. If set to `required`, and if the UE does not support integrity protection, the request will be rejected with ESM cause 30.

For 5GC, if the value is set to `preferred`, the 5GC will activate integrity protection based on the UE capabilities and the configured PDU session AMBR. If set to `required`, and if the UE does not support integrity protection for the bitrate configured in the PDU session AMBR, the request will be rejected with 5GSM error cause #82.

`dns_addr` Optional string or array of strings. IPv4 or IPv6 addresses of the DNS servers. Use an empty array to remove any previously configured DNS servers.

`p_cscf_addr`
Optional string or array of strings. IPv4 or IPv6 addresses of the P-CSCF servers (VoLTE). Use an empty array to remove any previously configured P-CSCF servers.

The following parameters are applicable to EPC only:

`esm_procedure_filter`
Optional object. Allows to define the MME behavior for a list of ESM procedures.
Each property name represents an ESM procedure. The ones currently supported are `pdn_connectivity`, `pdn_disconnect`, `bearer_resource_allocation` and `bearer_resource_modification`.
Each property value is an object containing the following fields:

`action` Enumeration (`treat` (UE message is processed), `ignore` (UE message is ignored) or `reject` (UE message is rejected)).

`ttl` Optional integer. If set, the `reject` of `ignore` filter is applied `ttl` times. If not set, the filter is applied until it is modified.

`send_status_on_reject`
Optional boolean. It set and if `action` is set to reject an ESM status message is sent.

`ignore` does not apply to procedure `pdn_connectivity` performed during the attach procedure.

Example:

```
esm_procedure_filter: {
    pdn_connectivity: {
        action: "treat"
    },
    bearer_resource_allocation: {
        action: "reject",
        ttl: 1
    }
}
```

The following parameters are applicable to 5GC only:

`5gsm_procedure_filter`
: Optional object. Allows to define the SMF behavior for a list of 5GSM procedures.
Each property name represents a 5GSM procedure. The ones currently supported are `pdu_session_establishment`, `pdu_session_release` and `pdu_session_modification`.
Each property value is an object containing the following fields:

  `action` Enumeration (`treat` (UE message is processed), `ignore` (UE message is ignored) or `reject` (UE message is rejected)).

  `ttl` Optional integer. If set, the `reject` of `ignore` filter is applied `ttl` times. If not set, the filter is applied until it is modified.

  `send_status_on_reject`
  : Optional boolean. It set and if `action` is set to reject a 5GSM status message is sent.

  Example:

```
"5gsm_procedure_filter": {
    pdu_session_establishment: {
        action: "treat"
    },
    pdu_session_modification: {
        action: "reject",
        ttl: 1
    }
}
```

`always_on`
: Optional enumeration (auto, required, not_allowed, default = auto). Defines the always-on behavior for the PDU session. If the value is set to `auto`, the 5GC will follow whatever is requested by the UE. If the value is set to `required`, the 5GC will always set the PDU session as always-on required. If the value is set to `not_allowed`, the 5GC will always set the PDU session as always-on not allowed.

`confidentiality_protection`
: Optional enumeration (disabled, required). Defines if confidentiality must be used for the PDU session or not.

`apply_nas_transport_n1_sm_filter`
: Optional boolean. Indicates whether the 5GMM procedure filter `nas_transport_n1_sm` should apply to this DNN or not.

`eps_5gs_interworking`
: Optional boolean. If set to true, interworking between EPS and 5GS is allowed for this APN/DNN. Otherwise it is forbidden.

`5gsm_congestion_re_attempt_ind`
: Optional integer (range -1 to 255). Value of octet 3 of the Re-attempt indicator information element, as specified in 3GPP TS 24.501 chapter 9.11.4.21. The value -1 means that the information element is not sent.

`rq_timer` Optional integer. Value in seconds of the RQ timer for the PDU session, sent to the UE if it supports reflective QoS feature. -2 means that the timer is deactivated.

`log_get` Get logs.
This API has a per connection behavior. This means that the response will depend on previous calls to this API within the same WebSocket connection.
In practice, logs that have been provided in a response won't be part of subsequent request unless connection is reestablished. To keep on receiving logs, client should send a new `log_get` request as soon as the previous response has been received.
If a request is sent before previous request has been replied, previous request will be replied right now without considering specific min/max/timeout conditions.

Message definition:

`min` Optional number (default = 1). Minimum amount of logs to retrieve. Response won't be sent until this limit is reached (Unless timeout occurs).

`max` Optional number (default = 4096). Maximum logs sent in a response.

`timeout` Optional number (default = 1). If at least 1 log is available and no more logs have been generated for this time, response will be sent.

`allow_empty`
: Optional boolean (default = false). If set, response will be sent after timeout, event if no logs are available.

`rnti` Optional number. If set, send only logs matching rnti.

`ue_id` Optional number. If set, send only logs with matching ue_id.

`layers` Optional Object. Each member name represents a log layer and values must be string representing maximum level. See [log_options], page 10. If *layers* is not set, all layers level will be set to *debug*, else it will be set to *none*.
Note also the logs is also limited by general log level. See [log_options], page 10.

`short` Optional boolean (default = false). If set, only first line of logs will be dumped.

`headers` Optional boolean. If set, send log file headers.

`start_timestamp`
: Optional number. Is set, filter logs older than this value in milliseconds.

`end_timestamp`
: Optional number. Is set, filter logs more recent than this value in milliseconds.

`max_size` Optional number (default = 1048576, i.e. 1MB). Maximum size in bytes of the generated JSON message. If the response exceeds this size, the sending of logs will be forced independently from other parameters.

Response definition:

`logs` Array. List of logs. Each item is a an object with following members:

- `data` Array. Each item is a string representing a line of log.
- `timestamp` Number. Milliseconds since January 1st 1970. Not present if `com_log_us` is set in configuration.
- `timestamp_us` Number. Microseconds since January 1st 1970. Only present if `com_log_us` is set in configuration.
- `layer` String. Log layer.
- `level` String. Log level: *error*, *warn*, *info* or *debug*.
- `dir` Optional string. Log direction: *UL*, *DL*, *FROM* or *TO*.
- `ue_id` Optional number. UE_ID.
- `cell` Optional number (only for PHY layer logs). Cell ID.
- `rnti` Optional number (only for PHY layer logs). RNTI.
- `frame` Optional number (only for PHY layer logs). Frame number (Subframe is decimal part).
- `channel` Optional string (only for PHY layer logs). Channel name.
- `src` String. Server name.
- `idx` Integer. Log index.
- `headers` Optional array. Array of strings.

`discontinuity` Optional number. If set, this means some logs have been discarded due to log buffer overflow.

`microseconds` Optional boolean. Present and set to true if `com_log_us` is set in configuration file.

`log_set` Add log.
Message definition:

- `log` Optional string. Log message to add. If set, *layer* and *level* are mandatory.
- `layer` String. Layer name. Only mandatory if *log* is set.
- `level` String. Log level: *error*, *warn*, *info* or *debug*. Only mandatory if *log* is set.
- `dir` Optional string. Log direction: *UL*, *DL*, *FROM* or *TO*.
- `ue_id` Optional number. UE_ID.
- `flush` Optional boolean (default = false). If set, flushes fog file.
- `rotate` Optional boolean (default = false). If set, forces log file rotation.

`cut` Optional boolean (default = false). If set, forces log file reset.

`log_reset`
Resets logs buffer.

`license` Retrieves license file information.
Response definition:

`products` String. List of products, separated by commas.

`user` String. License username.

`validity` String. License end of validity date.

`id` Optional string. License ID.

`id_type` Optional string. License ID type. Can be `host_id` or `dongle_id`

`uid` Optional string. License unique ID.

`filename` Optional string. License filename.

`server` Optional string. License server URL.

`server_id`
Optional string. License server ID.

`quit` Terminates ltemme.

`help` Provides list of available messages in *messages* array of strings and events to register in *events* array of strings.

`stats` Report statistics for LTEMME.
Every time this message is received by server, statistics are reset.
Warning, calling this message from multiple connections simultaneously will modify the statistics sampling time.
Response definition:

`cpu` Object. Each member name defines a type and its value cpu load in % of one core.

`instance_id`
Number. Constant over process lifetime. Changes on process restart.

`counters` Object. List of counters, with following sub members:

`messages` Object. Each member name is the message name and its value is its occurence.
To get list of message, type *cevent help msg* in LTEMME monitor.

`errors` Object. Each member name is the error name and its value is its occurence.
To get list of message, type *cevent help error* in LTEMME monitor.

`emm_registered_ue_count`
Integer. Number of UEs in EMM-REGISTERED or 5GMM-REGISTERED state.

`s1_connections`
Array of objects. List of S1AP connection betweens eNBs and MME. Each object contains the following fields:

`plmn` String. PLMN of the Global eNB ID.

`enb_id_type`
String (macro, home, short_macro or long_macro). Type of identifier of the Global eNB ID.

`enb_id` Integer. Identifier of the Global eNB ID.

`ip_addr` String. IP address and port of the eNB.

`ta_list` Array of objects. List of the Tracking Areas served by the eNB. Each object contains the following fields:

`plmn` String. PLMN of Tracking Area.

`tac` Integer. Tracking Area Code.

`emm_connected_ue_count`
Integer. Number of UEs in EMM-CONNECTED state for this S1AP connection.

`ng_connections`
Array of objects. List of NGAP connection betweens RANs and AMF. Each object contains the following fields:

`plmn` String. PLMN of the Global RAN ID.

`ran_id_type`
String (gNB, ng-eNB or N3IWF). Type of identifier of the Global RAN ID.

`ran_id` Integer. Identifier of the Global RAN ID.

`ip_addr` String. IP address and port of the RAN.

`ta_list` Array of objects. List of the Tracking Areas served by the RAN. Each object contains the following fields:

`plmn` String. PLMN of Tracking Area.

`tac` Integer. Tracking Area Code.

`cn_connected_ue_count`
Integer. Number of UEs in 5GMM-CONNECTED state for this NGAP connection.

`pdn_list` Array of objects. List of the APNs/DNNs configured. Each object contains the following fields:

`access_point_name`
String. APN / DNN.

`ul_bytes` Integer. Number of UL bytes received since the last call on the same socket.

`dl_bytes` Integer. Number of UL bytes received since the last call on the same socket.

`users` Object. It contains the following fields:

`total` Integer. Total number of entries in the user database.

`max_registered`
Integer. Number of different users having registered.

`gtp_tx_bitrate`
: Optional integer. This field will be filled when multiple calls on the same socket are done and represents the GTP payload bitrate (bits/seconds) sent to RAN and is equivalent to IP traffic.
The bitrate is computed using the delay between two calls.

`gtp_rx_bitrate`
: Optional integer. This field will be filled when multiple calls on the same socket are done and represents the GTP payload bitrate (bits/seconds) received from RAN and is equivalent to IP traffic.
The bitrate is computed using the delay between two calls.

`ip_tx_bitrate`
: Optional integer. This field will be filled when multiple calls on the same socket are done and represents the IP payload bitrate (bits/seconds) sent to tun interfaces.
The bitrate is computed using the delay between two calls.

`ip_rx_bitrate`
: Optional integer. This field will be filled when multiple calls on the same socket are done and represents the IP payload bitrate (bits/seconds) received from tun interfaces.
The bitrate is computed using the delay between two calls.

`register` Register client for messages generated by LTEMME. Message definition:

`register` Optional string or array of string. List of messages to register to.
Can be `registration`, `registration_reject`, `non_ip_data`, `generic_nas_transport`, `5gs_nas_transport`, `eps_bearer_notification`, `qos_flow_notification`

`unregister`
: Optional string or array of string. List of messages to unregister.
Can be `registration`, `registration_reject`, `non_ip_data`, `generic_nas_transport`, `5gs_nas_transport`, `eps_bearer_notification`, `qos_flow_notification`

`ipsec` Report ipsec SAs.
For ePDG

Response definition:

`SAs` Array. List of object representing a security association witth following definition:

`type`	String. IP version, can be `IPv4` or `IPv6`.
`dir`	String. Direction, can be `in` or `out`.
`spi`	Number. SPI.
`ue_id`	Number. Associated `ue_id`.
`mode`	String. ESP type, can be `tunnel` or `transport`
`src`	String. Source IP address.
`dst`	String. Destination IP address.
`tun_src`	Optional string. Tunnel source IP address.
`tun_dst`	Optional string. Tunnel destination IP address.

`src_prefix`
: Number. Source network prefix.

`dst_prefix`
: Number. Destination network prefix.

`authent_key`
: String. Authentication key in hexadecimal form (Empty string authentication is disabled).

`cipher_key`
: String. Ciphering key in hexadecimal form (Empty string ciphering is disabled).

6.6 LTE messages

`ue_get` Get UE informations.
Message definition:

`imsi` Optional string. If set, retrieve only information from UE with matching IMSI.

`nai` Optional string. Not applicable to 4G UEs.
May be present only if `imsi` is absent.
If set, retrieve only information from UE with matching NAI.

`imei` Optional string (14 or 15 digits). If set, retrieve only information from UE with matching IMEI.

`type` Optional enumeration (3gpp, n3gpp, both). Default value is both. Only display a UE connected to a RAN with matching type.

`mme_ue_id`
: Optional integer. If set, retrieve only information from UE connected to EPC with matching MME UE id. The `imsi`, `nai`, `imei` and `type` parameters are ignored.

`amf_ue_id`
: Optional integer. If set, retrieve only information from UE connected to 5CC with matching AMF UE id. The `imsi`, `nai`, `imei` and `type` parameters are ignored.

`radio_capabilities`
: Optional boolean. If set, provides `radio_capabilities` in response.

Response definition:

`ue_list` Array of current UEs.
Each element has the following definition:

`rat_type` Enumeration (LTE, NBIOT, NR or NON_3GPP). RAT currently used by the UE.

`imsi` Optional string. IMSI.

`nai` Optional string. Network specific identifier-based SUPI.

`imeisv` String. IMEISV.

`m_tmsi` Optional string. M-TMSI. Present for UEs connected to EPC.

`5g_tmsi` Optional string. 5G-TMSI. Present for UEs connected to 5GC.

`tac` Integer. Last known tracking area code.

`tac_plmn` String. Last known tracking area PLMN.

`ue_aggregate_max_bitrate_dl`
Number. UE aggregate maximum bitrate for downlink.

`ue_aggregate_max_bitrate_ul`
Number. UE aggregate maximum bitrate for uplink.

`registered`
Boolean. True if UE is currently registered to the network.

`t3412` Optional integer. T3412 timer in seconds. Only present if the UE connected to EPC is registered to the network.

`t3324` Optional integer. T3324 timer in seconds. Only present if the UE connected to EPC is registered to the network and PSM is activated, or if the UE connected to 5GC is registered to the network and MICO is activated.

`edrx` Optional object. eDRX configuration. Only present if the UE is registered to the network and eDRX is activated. The object has the following definition:

`paging_time_window`
Integer. 4 bits or 8 bits Paging Time Window length as defined in 3GPP TS 24.008 chapter 10.5.5.32

`cycle` Integer. 4 bits E-UTRAN or NR eDRX cycle length duration as defined in 3GPP TS 24.008 chapter 10.5.5.32.

`t3512` Optional integer. T3512 timer in seconds. Only present if the UE connected to 5GC is registered to the network.

`enb_plmn` Optional string. eNB PLMN. This field would only be present if the UE connected to EPC is still in connected mode.

`enb_id` Optional integer. eNB id. This field would only be present if the UE connected to EPC is still in connected mode.

`enb_ue_id`
Optional integer. eNB UE id. This field would only be present if the UE connected to EPC is still in connected mode.

`mme_ue_id`
Optional integer. MME UE id. This field would only be present if the UE connected to EPC is still in connected mode.

`ran_plmn` Optional string. RAN PLMN. This field would only be present if the UE connected to 5GC is still in connected mode.

`ran_id` Optional integer. RAN id. This field would only be present if the UE connected to 5GC is still in connected mode.

`ran_ue_id`
Optional integer. RAN UE id. This field would only be present if the UE connected to 5GC is still in connected mode.

`amf_ue_id`
Optional integer. AMF UE id. This field would only be present if the UE connected to 5GC is still in connected mode.

`ecgi` Optional object. E-UTRAN Cell Global Identy. This field would only be present if the UE is connected via an eNB or ng-eNB. It contains the following fields:

- `plmn` String. PLMN Identifier.
- `cell_id` Integer. E-UTRAN Cell Identity Cell Identity.

`ncgi` Optional object. NR Cell Global Identity. This field would only be present if the UE is connected via a gNB. It contains the following fields:

- `plmn` String. PLMN Identifier.
- `cell_id` Integer. NR Cell Identity Cell Identity.

`nid` Optional integer. NID. This field would only be present if the UE is connected via a gNB and NID is used.

`n3iwf` Optional object. NR Cell Global Identity. This field would only be present if the UE is connected via a N3IWF. It contains the following fields:

- `ue_addr` String. UE IP address and UDP source port.

`bearers` Array. List of connected default bearers or PDU sessions. Each object has the following definition:

- `erab_id` Optional integer. EPS Bearer ID. Present UEs connected to EPC.
- `pdu_session_id` Optional integer. 5GS PDU session ID. Present for UEs connected to 5GC.
- `sst` Optional integer. Slice Service Type. Present for UEs connected to 5GC.
- `sd` Optional integer. Slice Differentiator. Can be present for UEs connected to 5GC.
- `qos_flow_id` Optional integer. 5GS QoS flow ID. Present for UEs connected to 5GC.
- `ip` String. IPv4 address.
- `ipv6` String. Global IPv6 prefix.
- `ul_total_bytes` Number. Total uplink transferred bytes.

`dl_total_bytes`
Number. Total downlink transferred bytes.

`apn` String. Access point name.

`dedicated`
Array of object. Each object represents a dedicated bearer or non default QoS flow defined as follow:

`erab_id` Optional integer. EPS Bearer ID. Present for UEs connected to EPC.

`qos_flow_id`
Optional integer. 5GS QoS flow ID. Present for UEs conencted ot 5GC.

`ul_total_bytes`
Number. Total uplink transferred bytes.

`dl_total_bytes`
Number. Total downlink transferred bytes.

`radio_capabilities`
GSER string. UE radio access capabilities. Only present if `radio_capabilities` is set to true in request.

`ue_set` Modify the UE configuration in database.

`imsi` Optional string.

`nai` Optional string. Not applicable to 4G UEs.
May be present only if `imsi` is absent.

`pdn_list` Array. Each entry will set specific parameters for a PDN or PDU session as defined below:

`access_point_name`
String. Used to define what PDN or PDU session to configure.

`routes` Array of filters. See [routes], page 44.

`ue_add` Add UE to UE database.
Message definition:

`ue_db` Array. List of UE configuration. See [ue_db], page 41.

`ue_del` Remove UE from the UE database and performs a detach if necessary.
Message definition:

`imsi` Optional string. IMSI of the UE to delete.
Shall be present if `nai` is absent.

`nai` Optional string. Network specific identifier-based SUPI.
Not applicable to 4G UEs.
Shall be present if `imsi` is absent.

`local` Optional boolean (default = false). If set to true, the UE is locally detached without any NAS signalling.

`ue_detach`

Force a detach from network.
Message definition:

`imsi` Optional string. IMSI of the UE to detach.
Shall be present if `nai` is absent.

`nai` Optional string. Network specific identifier-based SUPI.
Not applicable to 4G UEs.
Shall be present if `imsi` is absent.

`imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`n3gpp` Optional boolean (default = false). Set it to true for a non 3GPP UE connected to 5GC.

`type` Optional number (EPS default = 2 / re-attach not required; 5GS default = 1 / re-registration not required, 3GPP access). Set NAS detach request type (according to 3GPP TS 24.301 9.9.3.7 Detach type) or de-registration type (according to 3GPP TS 24.501 9.11.3.20 De-registration type).

`cause` Optional number (default = 3 / illegal UE). Set EMM or 5GMM cause. The value -1 means that the EMM cause IE is not sent in the NAS Detach Request message or the 5GMM cause is not sent in the NAS Deregistration Request message.

`local` Optional boolean (default = false). If set to true, the UE is locally detached without any NAS signalling.

`ue_identity_request`

Force an identification procedure.
Message definition:

`imsi` Optional string. IMSI of the UE.
Shall be present if `nai` is absent.

`nai` Optional string. Network specific identifier-based SUPI.
Not applicable to 4G UEs.
Shall be present if `imsi` is absent.

`imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`n3gpp` Optional boolean (default = false). Set it to true for a non 3GPP UE connected to 5GC.

`type` Integer (range 1 to 5). Identity type.

`me_add` Add or update one or several devices in ME database.
Message definition:

`default_status`
Optional enumeration (whitelisted, blacklisted, greylisted). Defines the default status for devices not explicitly defined in the next objects.

`whitelist`
Optional array. It contains a list of IMEI (14 digits) or IMEISV (16 digits) whitelisted.

`blacklist`
: Optional array. It contains a list of IMEI (14 digits) or IMEISV (16 digits) blacklisted.

`greylist` Optional array. It contains a list of IMEI (14 digits) or IMEISV (16 digits) greylisted.

`me_del` Remove one or several devices in ME database.
Message definition:

`list` Array of strings. Each entry must be an IMEI (14 digits) or IMEISV (16 digits).

`pws_write`
Start broadcasting Public Warning System message.
Message definition:

`local_id` Number. ID of the message as defined by local_identifier in MME configuration file

`nf` Optional boolean (default = false). If not set, SBC interface is used. If set, N50 interface is used.

`increment_serial_number`
: Optional boolean (default = true). If set to false, the `serial_number` is not incremented.

`pws_kill` Stop broadcasting Public Warning System message.
Message definition:

`local_id` Number. ID of the message as defined by local_identifier in MME configuration file

`stop_all` Optional boolean. Gives the presence of Stop-All-Indicator IE in the message STOP-WARNING-REQUEST.

`send_warning_indication`
: Optional boolean. Default value is 0. Gives the presence of Send-Stop-Warning-Indication IE in the message STOP WARNING REQUEST.

`nf` Optional boolean (default = false). If not set, SBC interface is used. If set, N50 interface is used.

`cbc_notif_subscribe`
CBC subscription to notification.
Applicable to N50 interface only. Message definition:

`notify_cbk_uri`
: String. Callback URI on which the N2 information shall be notified.

`info_class`
: Optional enumeration: write-cancel, restart-failure (default = write-cancel). Class of N2 information to which the CBC wants to subscribe.

`cbc_notif_unsubscribe`
CBC unsubscription to notification.
Applicable to N50 interface only. Message definition:

`info_class`
: Optional enumeration: write-cancel, restart-failure (default = write-cancel). Class of N2 information to which the CBC wants to unsubscribe.

`enb` Get list of eNB connections.
Response definition:

`enb_list` Array of object. Each object represents an eNB connection:

`plmn` String. PLMN.

`eNB_ID_type` String (macro, home, short_macro or long_macro). eNB type.

`eNB_ID` Integer. eNB ID.

`name` Optional string. eNB name.

`address` String. eNB IP address and port.

`ue_ctx` Number. Number of UE contexts.

`ng_ran` Get list of NG-RAN node connections.
Response definition:

`ng_ran_list` Array of object. Each object represents a RAN connection:

`plmn` String. PLMN.

`RAN_ID_type` String (gNB, ng-eNB or N3IWF). RAN type.

`RAN_ID` Integer. RAN ID.

`name` Optional string. RAN node name.

`address` String. RAN IP address and port.

`ue_ctx` Number. Number of UE contexts.

`s6` Get information regarding the S6a connection.
Response definition:

`state` String. S6a connection state (disconnected, connecting, connected or inactive).

`address` String. HSS address and port.

`host` Optional string. HSS Diameter host identifier retrieved during Capabilities Exchange procedure.

`realm` Optional string. HSS Diameter realm identifier retrieved during Capabilities Exchange procedure.

`s6connect`
Force S6a connection establishment.
Message definition:

`addr` Optional string. If not set, the MME will try to connect to the previously configured address

`s6disconnect`
Force S6a connection release.

`s13` Get information regarding the S13 connection.
Response definition:

`state` String. S13 connection state (disconnected, connecting, connected or inactive).

`address` String. EIR address and port.

`host` Optional string. EIR Diameter host identifier retrieved during Capabilities Exchange procedure.

`realm` Optional string. EIR Diameter realm identifier retrieved during Capabilities Exchange procedure.

`s13connect`
Force S13 connection establishment.
Message definition:

`addr` Optional string. If not set, the MME will try to connect to the previously configured address

`s13disconnect`
Force S13 connection release.

`sgs` Get information regarding the SGs connection.
Response definition:

`state` String. SGs connection state (disconnected, connecting, connected or inactive).

`address` String. MSC/VLR address and port.

`sgsconnect`
Force SGs connection establishment.
Message definition:

`addr` Optional string. If not set, the MME will try to connect to the previously configured address

`sgsdisconnect`
Force SGs connection release.

`sbc` Get list of CBC connections.
Response definition:

`cbc_list` Array of object. Each object represents a CBC connection:

`address` String. CBC address and port.

`lcs` Get information regarding the LCS connection.
Response definition:

`state` String. LCS connection state (disconnected, connecting, connected or inactive).

`address` String. E-SMLC address and port.

`lcsconnect`
Force LCS connection establishment.
Message definition:

`addr` Optional string. If not set, the MME will try to connect to the previously configured address

`n8` Get information regarding the N8 interface.
Response definition:

`server_address`
String. UDM address and port.

`n8connect`
: Force N8 connections establishment.
Message definition:

  `api_root` Optional string. api_root of the UDM server in the form: <scheme>://<host>:<port>, where <scheme> is "http" or "https".
  If not set, the AMF will try to connect to the previously configured address

`n8disconnect`
: Disconnect the AMF client on the interface N8 from the UDM.

`n12` Get information regarding the N12 interface.
Response definition:

  `server_address`
  String. AUSF address and port.

  `client_address`
  String. Address of the AMF client connected to the AUSF.

`n12connect`
: Connect or reconnect the AMF client on the interface N12 to the AUSF.
Message definition:

  `api_root` Optional string. api_root of the AUSF server in the form: <scheme>://<host>:<port>, where <scheme> is "http" or "https".
  If not set, the AMF will try to connect to the previously configured address

`n12disconnect`
: Disconnect the AMF client on the interface N12 from the AUSF.

`n13` Available only in case of internal AUSF.
Get information regarding the N13 interface.
Response definition:

  `server_address`
  String. UDM address and port.

  `client_address`
  String. Address of the AUSF client connected to the UDM.

`n13connect`
: Available only in case of internal AUSF.
Connect or reconnect the AUSF client on the interface N13 to the UDM.
Message definition:

  `addr`

  `api_root` Optional string. api_root of the UDM server in the form: <scheme>://<host>:<port>, where <scheme> is "http" or "https".
  If not set, the AUSF will try to connect to the previously configured address.

`n13disconnect`
: Available only in case of internal AUSF.
Disconnect the AUSF client on the interface N13 from the UDM.

`n17` Get information regarding the N17 interface.
Response definition:

`server_address`
String. EIR address and port.

`client_address`
String. Address of the AMF client connected to the EIR.

`n17connect`
Connect or reconnect the AMF client on the interface N17 to the EIR.
Message definition:

`api_root` Optional string. api_root of the EIR server in the form: <scheme>://<host>:<port>, where <scheme> is "http" or "https".
If not set, the AMF will try to connect to the previously configured address.

`n17disconnect`
Disconnect the AMF client on the interface N17 from the EIR.

`nl1` Get information regarding the NL1 interface.
Response definition:

`server_address`
String. LMF address and port.

`client_address`
String. Address of the AMF client connected to the LMF.

`nl1connect`
Connect or reconnect the AMF client on the interface NL1 to the LMF.
Message definition:

`api_root` Optional string. api_root of the LMF server in the form: <scheme>://<host>:<port>, where <scheme> is "http" or "https".
If not set, the AMF will try to connect to the previously configured address.

`nl1disconnect`
Disconnect the AMF client on the interface NL1 from the LMF.

`ue_activate_dedicated_bearer`
Trigger a network initiated dedicated EPS bearer activation or a 5GS QoS flow activation.
Message definition:

`imsi` Optional string. UE IMSI.
Shall be present if `nai` is absent.

`nai` Optional string. Network specific identifier-based SUPI.
Not applicable to 4G UEs.
Shall be present if `imsi` is absent.

`imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`apn` Optional string. APN of the default EPS bearer associated to the dedicated one. Must be present if `pdu_session_id` or `linked_erab_id` are not present.

`sst` Optional integer. SST of the PDU session. Used for UEs connected to 5GC.

`sd` Optional integer. SD of the PDU session. Used for UEs connected to 5GC.

`linked_erab_id`
Optional integer. Identity of the default EPS bearer associated to the dedicated one. Used for UEs connected to EPC.

`pdu_session_id`
Optional integer. PDU session identity of the PDU session to select. Used for UEs connected to 5GC.

`qci` Integer (range 1 to 255). QoS Class Identifier of the E-RAB, or 5QI of the QoS flow.

`5qi_qos` Optional object. See [5QI QoS], page 35.

`priority_level`
Optional integer (1 to 15, default 15). ARP priority level.

`pre_emption_capability`
Optional enumeration (`shall_not_trigger_pre_emption` or `may_trigger_pre_emption`, default `shall_not_trigger_pre_emption`).

`pre_emption_vulnerability`
Optional enumeration (`not_pre_emptable` or `pre_emptable`, default `not_pre_emptable`).

`filters` Array. See [TFT], page 36.

`gbr` Optional object. See [GBR], page 36.

`transaction_identifier`
Optional integer (range 0 to 127). If present, the transaction identifier IE is put in the EPS bearer activation message.

`llc_sapi` Optional integer (range 0 to 15). If present, the LLC service access point identifier IE is put in the EPS bearer activation message.

`radio_priority`
Optional integer (range 0 to 7). If present, the radio priority IE is put in the EPS bearer activation message.

`packet_flow_identifier`
Optional integer (range 0 to 127). If present, the packet flow identifier IE is put in the EPS bearer activation message.

`sm_qos` Optional string. If present, the quality of service IE is put in the EPS bearer activation message. The string must contain the hexadecimal representation of the IE without its IEI and length.

Response definition:

`erab_id` Integer. Allocated ERAB identity for this dedicated EPS bearer. Sent if the procedure if for EPS.

`pdu_session_id`
Integer. PDU session identifier associated to the QoS flow identifier. Sent if the procedure if for 5GS.

`qos_flow_id`
: Integer. Allocated QoS flow identifier for this bearer. Sent if the procedure if for 5GS.

`ue_modify_bearer`
: Trigger a network initiated EPS bearer modification.
Message definition:

`imsi` String. UE IMSI.

`imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`erab_id` Integer. ERAB identity of the bearer to be modified.

`qos` Optional objet. If present a QoS modification is done. It should contain the following objects:

`qci` Integer (range 1 to 255). QoS Class Identifier of the E-RAB.

`priority_level`
: Optional integer (1 to 15, default 15). ARP priority level.

`pre_emption_capability`
: Optional enumeration (`shall_not_trigger_pre_emption` or `may_trigger_pre_emption`, default `shall_not_trigger_pre_emption`).

`pre_emption_vulnerability`
: Optional enumeration (`not_pre_emptable` or `pre_emptable`, default `not_pre_emptable`).

`gbr` Optional object. See [GBR], page 36.

`filters` Array. Contains the new TFT after modification. See [TFT], page 36.

`llc_sapi` Optional integer (range 0 to 15). If present, the LLC service access point identifier IE is put in the EPS bearer activation message.

`radio_priority`
: Optional integer (range 0 to 7). If present, the radio priority IE is put in the EPS bearer activation message.

`packet_flow_identifier`
: Optional integer (range 0 to 127). If present, the packet flow identifier IE is put in the EPS bearer activation message.

`sm_qos` Optional string. If present, the quality of service IE is put in the EPS bearer activation message. The string must contain the hexadecimal representation of the IE without its IEI and length.

`p_cscf` Optional boolean. Adds the P-CSCF addresses to the PCO information element of the modify EPS bearer context request message.

`dns` Optional boolean. Adds the DNS addresses to the PCO information element of the modify EPS bearer context request message.

Response definition:

`erab_id` Integer. ERAB identity of the EPS bearer.

`ue_modify_pdu_session`
Trigger a network initiated PDU session modification.
Message definition:

`imsi` Optional string. UE IMSI.
Shall be present if `nai` is absent.

`nai` Optional string. Network specific identifier-based SUPI.
Shall be present if `imsi` is absent.

`imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`n3gpp` Optional boolean (default = false). Set it to true for a non 3GPP UE connected to 5GC.

`pdu_session_id`
Integer. PDU session identity of the PDU session to be modified.

`qos_rules`
Optional array. List of the QoS rules after modification other than the default one. Each element of the array contains the followings properties:

`id` QoS rule identifier.

`qfi` Range: 0 to 63. QoS flow identifier.

`filters` Array of packet filters. See [TFT], page 36.

`qos_flow` Optional array. List of the QoS flows after modification other than the QoS flow associated to the default QoS rule. Each element of the array contains the following properties:

`qfi` Integer. Range: 0 to 63. QoS flow identifier.

`5qi` Integer. Range: 1 to 254. 5QI of the QoS flow.

`5qi_qos` Optional object. See [5QI QoS], page 35.

`priority_level`
Range: 1 to 15. ARP priority level.

`pre_emption_capability`
Enumeration: `shall_not_trigger_pre_emption` or `may_trigger_pre_emption`.

`pre_emption_vulnerability`
Enumeration: `not_pre_emptable` or `pre_emptable`.

`gbr` Optional object. See [GBR], page 36. Must be present for a GBR 5QI.

`p_cscf` Optional boolean. Adds the P-CSCF addresses to the ePCO information element of the PDU session modification command message.

`dns` Optional boolean. Adds the DNS addresses to the ePCO information element of the PDU session modification command message.

`mtu_ipv4` Optional boolean. Adds the IPv4 MTU to the ePCO information element of the PDU session modification command message.

`ue_modify_reflective_qos`

Modify the reflective QoS indicator bit for an existing UE packet filter.
Message definition:

`imsi` Optional string. UE IMSI.
Shall be present if `nai` is absent.

`nai` Optional string. Network specific identifier-based SUPI.
Shall be present if `imsi` is absent.

`imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`n3gpp` Optional boolean (default = false). Set it to true for a non 3GPP UE connected to 5GC.

`pdu_session_id`
Integer. PDU session identity of the QoS flow to be modified.

`qos_flow_id`
Integer. QoS flow identity of the QoS flow to be modified.

`filter_id`
Integer. Packet filter identity of the DL only filter to be modified.

`reflective_qos`
Boolean. Reflective QoS indicator for this packet filter.

`ue_deactivate_bearer`

Trigger a network initiated default or dedicated EPS bearer deactivation, or a 5GS QoS flow deactivation. It the UE is in RRC idle state, the bearer will be locally released without any NAS signalling.
Message definition:

`imsi` Optional string. UE IMSI.
Shall be present if `nai` is absent.

`nai` Optional string. Network specific identifier-based SUPI.
Not applicable to 4G UEs.
Shall be present if `imsi` is absent.

`imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`n3gpp` Optional boolean (default = false). Set it to true for a non 3GPP UE connected to 5GC.

`erab_id` Optional integer. ERAB identity of the bearer to be released. Must be present for an EPS procedure.

`esm_cause`
Optional integer (default = 36). ESM cause for the message. Can be present for an EPS procedure.

`pdu_session_id`
Optional integer. PDU session identifier of the QoS flow to release. Must be present for a 5GS procedure.

`qos_flow_id`
Optional integer. QoS flow identifier to release. Must be present for a 5GS procedure.

`5gsm_cause`
: Optional integer (default = 36). 5GSM cause for the message. Can be present for a 5GS procedure.

`non_ip_data`
: Send data over a non IP PDN or unstructured PDU session.
Message definition:

`imsi`
: Optional string. UE IMSI.
Shall be present if `nai` is absent.

`nai`
: Optional string. Network specific identifier-based SUPI.
Not applicable to 4G UEs.
Shall be present if `imsi` is absent.

`imei`
: Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`apn`
: Optional string. APN of the non IP bearer. Used for UEs connected to EPC. Shall be present if `erab_id` is absent.

`erab_id`
: Optional integer. ERAB identity of the non IP default bearer. Used for UEs connected to EPC. Shall be present if `apn` is absent.

`dnn`
: Optional string. DNN of the non IP bearer. Used for UEs connected to 5GC. Shall be present if `pdu_session_id` is absent.

`sst`
: Optional integer. SST of the non IP bearer. Used for UEs connected to 5GC. May be present if `dnn` is present.

`sd`
: Optional integer. Optional SD of the non IP bearer. Used for UEs connected to 5GC. May be present if `dnn` is present.

`pdu_session_id`
: Optional integer. PDU session ID of the non IP bearer. Used for UEs connected to 5GC. Shall be present if `dnn` is absent.

`data`
: String. ASCII representation of the data hexadecimal dump.

`generic_nas_transport`
: Send an EPS downlink generic NAS transport message.
Message definition:

`imsi`
: String. UE IMSI.

`imei`
: Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`type`
: Integer (range: 0 to 255). Generic message container type information element.

`payload`
: String. ASCII representation of the generic message container hexadecimal dump.

`add_info`
: Optional string. ASCII representation of the additional information hexadecimal dump.

`5gs_nas_transport`
: Send an 5GS downlink NAS transport message for LPP, SOR, UE policy, UE parameters update or location services.
Message definition:

`imsi`
: Optional string. UE IMSI.
Shall be present if `nai` is absent.

`nai` Optional string. Network specific identifier-based SUPI.
Not applicable to 4G UEs.
Shall be present if `imsi` is absent.

`imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`n3gpp` Optional boolean (default = false). Set it to true for a non 3GPP UE connected to 5GC.

`type` Integer (range: 3 to 6). Payload container type information element.

`payload` String. ASCII representation of the payload container hexadecimal dump.

`add_info` Optional string. ASCII representation of the additional information hexadecimal dump for LPP or location services.

`ursp_rules`
Send URSP rules to the UE. Message definition:

`imsi` Optional string. UE IMSI.
Shall be present if `nai` is absent.

`nai` Optional string. Network specific identifier-based SUPI.
Not applicable to 4G UEs.
Shall be present if `imsi` is absent.

`imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`n3gpp` Optional boolean (default = false). Set it to true for a non 3GPP UE connected to 5GC.

`ue_policy_section_management_list`
Array of objects. Contains the description of the UE policy section management list as defined in 3GPP TS 24.501 chapter D.6.2. Each element of the array has the following properties:

`plmn` String. PLMN identity of the MME (5 or 6 digits).

`instruction_list`
Array of objects. Each element describes an instruction as defined in 3GPP TS 24.501 chapter D.6.2. Each element has the following definition:

`upsc` Integer (range: 0 to 65 535). UE Policy Section Code.

`ue_policy_part_list`
Optional array. UE policy section contents as defined in 3GPP TS 24.501 chapter D.6.2 Figure D.6.2.6. Each element of the array contains a UE policy part and has the following properties:

`ursp_rules`
Optional array of objects. Each element describes a URSP rule as defined in 3GPP TS 24.526 chapter

5.2 Figure 5.2.2 and has the following properties:

`precedence`
: Integer (range: 0 to 255). Precedence value of URSP rule.

`traffic_descriptor_components`
: Array describing the Traffic descriptor as defined in 3GPP TS 24.526 chapter 5.2. Each element of the array contains one of the following properties:

  `match_all`
  : Optional boolean (default = false). Indicates the presence of match_all descriptor component type.

  `os_id_os_app_id`
  : Object. Match the OS Id and the OS application Id. Contains the following properties:

    `os_id` String Hexadecimal representation

sen-
ta-
tion
of
the
OS
Id.

`os_app_id`
: String.

`ipv4_remote_addr`
: String. Match a remote (external network entity) IPv4 address with the additional `mask` property.

`ipv6_remote_addr_prefix`
: String. Match a remote (external network entity) IPv6 address with the additional `prefix_len` property.

`proto_id`
: Range: 0 to 255. Match against the IP protocol identifier.

`remote_port`
: Range: 0 to 65536. Match against

the remote (external network entity) port.

`remote_port_range`
: Array of 2 integers. Match against a remote (external network entity) port range.

`ip_3_tuple`
: Array of objects. Each element of the array contains one of the `ipv4_remote_addr`, `ipv6_remote_addr_prefix`, `proto_id`, `remote_port` or `remote_port_range` properties.

`security_parameter_index`
: 32 bit integer. Match the ESP or AH security parameter index.

`type_of_service`
: Range: 0 to 255. Match the type of service (IPv4) or the traffic class (IPv6) field. The additional `mask` property is the corresponding mask.

`flow_label`
: 20 bit integer. Match the IPv6 flow label.

`destination_mac_addr`
: String. Match the destination MAC address.

`802.1q_ctag_vid`
: Range: 0 to 4095. Match the 802.1Q C-TAG VID.

`802.1q_stag_vid`
: Range: 0 to 4095. Match the 802.1Q S-TAG VID.

`802.1q_ctag_pcp_dei`
: Range: 0 to 15. Match the

802.1Q C-TAG PCP and DEI.

`802.1q_stag_pcp_dei`
: Range: 0 to 15. Match the 802.1Q S-TAG PCP and DEI.

`ethertype`
: Range: 0 to 65535. Match the ethertype.

`dnn`
: String. Match a DNN value.

`connection_capabilities`
: Array of enumeration: ims, mms, supl, internet. Match a connection capability identifier given in the array.

`destination_fqdn`
: String. Match the destination FQDN.

`os_app_id`
: String. Match the OS app id.

`destination_mac_addr_range`
: Array of 2 strings. Match the destination MAC address range.

`route_list`
: Array of objects describing the Route selection descriptor list as defined in 3GPP TS 24.526 Figure 5.2.3. Each element contains a Route selection descriptor as defined in 3GPP TS 24.526 Figure 5.2.4 and contains a variable number (at least one) of route selection descriptor components as described below:

  `precedence`
  : Integer (range 0-255). Precedence value of route selection descriptor.

  `components`
  : Array of objects. Contains a variable number (at least one) of route selection descriptor components as

defined below:

`ssc_mode` Integer. Indicates the SSC mode. Only value 1 is supported.

`snssai` Indicates the S-NSSAI value.

`sst` I (0 2 S S v T

`sd` C in t g (0 0 S D f e t t

`dnn` String. Indicates the DNN value.

`pdu_session_type`	Enumeration ipv4, ipv6, ipv4v6, unstructured, ethernet. Indicates the PDU session type.
`preferred_access_type`	Enumeration 3gpp, non-3gpp. Indicates the preferred access type.
`multi_access_preference`	Boolean (default = false). If set to true, indi-

cates the multi-access pref-er-ence.

`reset_ue_pos_stored_info`
: Send a test procedure reset UE positioning stored information message.
Message definition:

  `imsi` String. UE IMSI.

  `imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

  `techno` Integer (range: 0 to 255). UE positioning technology as specified in 3GPP TS 36.509 chapter 6.9.

`mt_cs_paging`
: Trigger a CS paging for a UE connected to EPC.
Message definition:

  `imsi` String. UE IMSI.

`guti_realloc`
: Initiate a LTE procedure GUTI reallocation. Message definition:

  `imsi` String. UE IMSI.

  `imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`load_balancing_tau`
: Initiate a LTE load balancing TAU procedure. Message definition:

  `imsi` String. UE IMSI.

  `imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`mbs_broadcast_session_setup`
: Starts a MBS broadcast session. Message definition:

  `index` Optional integer. Index (starting from 0) of the session to start in the `broadcast_sessions` array. If not present, the properties above are used to configure dynamically the session to start.

  `session_create`
  : Optional object. Must be present if `index` is absent. Gives the json description of the message Nmbsmf_MBSSession_Create Request (CreateReqData structure as defined in 3GPP 29.532).

  `user_plane_desc`
  : Optional object. See [user_plane_desc], page 64. multicast_dest_addr and source_addr are not needed because ssm is already encoded in `session_create`.

  Response definition:

  `cid` Integer. Unique connection ID of the client MBS session context.

`mbs_broadcast_session_release`
: Stops a MBS broadcast session. Message definition:

  `cid` Integer. Index (starting from 0) of the session to stop returned by `mbs_broadcast_session_setup`.

`mbs_tmgi_allocate`
: Requests TMGIs allocation. Message definition:

  `tmgi_allocate`
  : Mandatory parameter in json format encoded as described in 3GPP 29.532 6.1.6.2.2 Type: TmgiAllocate.

```
For example:  "tmgiNumber": 3,
              "tmgiList": [
                {
                  "mbsServiceId": "000000",
                  "plmnId": {
                    "mcc": "001",
                    "mnc": "01"
                  }
                 }
                ],
```

`mbs_tmgi_deallocate`
: Requests TMGIs deallocation. Has an optional parameter tmgi_list as described below. If no parameter is given, requests to deallocate all previously allocated TMGIs. Message definition:

  `tmgi_list`
  : Optional parameter given as a json array of TMGIs as defined in 29.571 5.9.4.2 Type: Tmgi.

```
      Example:
      "tmgiList": [
    {
      "mbsServiceId": "000002",
      "plmnId": {
        "mcc": "001",
        "mnc": "01"
      }
    },
    {
      "mbsServiceId": "000001",
      "plmnId": {
        "mcc": "001",
        "mnc": "01"
      }
    }
  ],
```

`mbs_session_info`
: Gets MBS session info at the server side. Response definition:

  `broadcast`
  : Array of objects. Each object contains the following properties:

`session_id`
: Object. MBS session identity. It contains the following properties:

  `tmgi` Object. Temporary Mobile Group Identity. It contains the following properties:

  `plmn` String. PLMN.

  `service_id` Integer. Service ID.

  `nid` Optional integer. Network Identifier.

`snssai` Object. It contains the following properties:

  `sst` Integer. Slice Service Type.

  `sd` Optional integer. Slice Differentiator.

`qos_flows`
: Array of objects. Each object contains the following properties:

  `qfi` Integer. QoS Flow identifier.

  `packets` Integer. Number of packets transmitted.

  `bytes` Integer. Number of bytes transmitted.

6.7 Positioning messages

The messages in this section are related to the positioning procedures. The messages that are initiated by the location server are used when the test e-SMLC or test LMF is used. See [lcs], page 53, to configure the test e-SMLC. See [nl1], page 57, to configure the test LMF.

6.7.1 LCSAP

The messages in this section are applicable to EPC only. They are sent on the LCSAP interface between the LCS client located in the MME and the e-SMLC.

`location_req`
: Start a location procedure by sending LCSAP Location-Request from the LCS client to the e-SMLC.
When the e-SMLC receives the message LCSAP Location-Request:
- if the e-SMLC is configured to run in autonomous mode (See [autonomous_mode], page 55), the e-SMLC will autonomously run the LPPa and LPP procedures necessary to obtain the location of the UE.
- else
: if the e-SMLC is configured to use the LPP protocol (See [lpp_test], page 54), the e-SMLC will send the message LPP RequestCapability message to the UE. The command lpp_request_location (See [lpp_request_location], page 118) can then be used to trigger a LPP RequestLocationInformation message in the e-SMLC.
Else if the e-SMLC is configured to use the LPPa protocol (See [lpp_test], page 54), the e-SMLC will send the message LPPa E-CIDMeasurementInitiationRequest to the eNB using the measurement configuration in the e-SMLC (See [local_e_smlc], page 54).
The following commands can then be used in the e-SMLC:
ecid_periodic_meas_termination to send LPPa e-CIDMeasurementTermination (See [ecid_periodic_meas_termination], page 117.

otdoa_information_req to send LPPa OTDOAInformationRequest ([otdoa_information_req], page 117).
Message definition:

`plmn` String (5 or 6 digits).

`cell_id` Integer. 28 bits long LTE cell identifier.

`session_id`
Optional integer in range 0 to 255. Location session identifier.

`type` Enumeration: geographic, assistance_info, last_known. Location type geographic information.

`imsi` String. IMSI of the UE.

`imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

Response definition: If the autonomous mode if configured, the command will return the result of the location procedure. If the autonomous mode if not configured, the command returns the correlation ID:

`correlation_id`
Integer in range 0 to 0xFFFFFF. Identifier of the created location context. This value shall be used in the command lpp_request_location.

`lcsap_reset_req`
Send LCSAP Reset-Request from the test e-SMLC to the LCS client both located in the MME.

6.7.2 LPPa

The messages in this section are applicable to EPC only, and are useful if the e-SMLC in not configured in autonomous mode (See [autonomous_mode], page 55). They are sent by the test e-SMLC to the eNB via the MME. LCSAP interface is used between the e-SMLC and the MME.

`ecid_periodic_meas_termination`
Send LPPa e-CIDMeasurementTermination from the test e-SMLC.
Message definition:

`session_id`
Integer in range 0 to 255. Location session identifier.

`transaction_id`
Optional integer in range 0 to 32767 (default = 0). Transaction identifier in LPPa e-CIDMeasurementTermination.

`e_smlc_meas_id`
Integer in range 1 to 15. E-SMLC-UE-Measurement_ID in LPPa e-CIDMeasurementTermination.

`enb_meas_id`
Integer in range 1 to 15. eNB_UE_Measurement_ID in LPPa e-CIDMeasurementTermination.

`otdoa_information_req`
Send LPPa OTDOAInformationRequest from the test e-SMLC.
Message definition:

`transaction_id`
Optional integer in range 0 to 32767. Transaction identifier in LPPa OTDOAInformationRequest.

`enb_plmn` String (5 or 6 digits). eNB PLMN.

`enb_type` Optional enumeration: macro, short_macro, long_macro or home (default = macro).

`enb_id` Integer. eNodeB global identifier. enb_plmn, enb_type and enb_id are used to identify the eNB to which the message LPPa OTDOAInformationRequest will be sent.

6.7.3 LPP

The messages in this section are applicable to EPC and 5GC. They are sent by the test e-SMLC in EPC or the test LMF in 5GC to the UE.

`lpp_request_location`

Send LPP RequestLocationInformation from the test e-SMLC or the test LMF.
If the UE answers with a LPP RequestAssistanceData message, the location server will use the assistance data in the e-SMLC or LMF configuration (See [otdoa_assistance_data], page 54, and/or See [nr_tdoa_assistance_data], page 54) to provide the OTDOA and NR-TDOA assistance data in LPP ProvideAssistanceData.
If `otdoa_assistance_data` and/or `nr_tdoa_assistance_data` are not configured, the location server must have previously retrieved the information necessary to build the requested assistance data (see [otdoa_information_req], page 117, [nr_otdoa_information_req], page 120, and [trp_information_req], page 121).
Message definition:

`is_5gs` Optional boolean (default = false). If set to true, send the LPP message from the test LMF using the NL1 interface. Otherwise send the LPP message from the test e-SMLC using the LCSAP interface.

`supi` String in the form "imsi-" or "nai-" followed by the value of the IMSI or the NAI.

`imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`correlation_id`
Integer in range 0 to 0xFFFFFF in EPC and to 0xFFFFFFFFFFFFFFFF in 5GC. Correlation ID as defined in 3GPP TS 29.171 and 3GPP TS 29.518.

`lpp_methods`
Optional array (default = ["ecid"]). An element of the array is an enumeration: "ecid", "otdoa", "nr_ecid", "nr_tdoa", "gnss". Gives the list of the LPP methods to request in the message LPP RequestLocationInformation. Note that "gnss" cannot be requested together with any other method, because only locationEstimate is supported for GNSS, and only locationMeasurements is supported for the other methods.

`report_type`
Enumeration: "once", "periodic", "triggered". Reporting configuration in the message LPP RequestLocationInformation.

6.7.4 NRPPa

The messages in this section are applicable to 5GC only and are useful if the LMF in not configured in autonomous mode (See [lmf_autonomous_mode], page 58). They are used to subcribe the LMF to N1/N2 notifications, trigger UE location, cancel UE location, and send

NRPPa PDUs from the test LMF to the gNB via the AMF. The NL1 interface is used between the LMF and the AMF.

`lmf_non_ue_n2_subscribe`
: LMF server subscription to the reception of non-UE NRPPa PDUs. See 3GPP TS 29.518 chapter 5.2.2.4.2 NonUeN2InfoSubscribe.
Message definition:

  `notify_cbk_uri`
  : String. n2NotifyCallbackUri as defined in 3GPP TS 29.518 chapter 6.1.6.2.10 Type: NonUeN2InfoSubscriptionCreateData.

`lmf_non_ue_n2_unsubscribe`
: LMF server unsubscription to the reception of non-UE NRPPa PDUs. See 3GPP TS 29.518 chapter 5.2.2.4.3 NonUeN2InfoUnSubscribe.
Message definition:

  `subscription_id`
  : n2NotifySubscriptionId as defined in 3GPP TS 29.518 chapter 6.1.3.9 Resource: Non UE N2 Messages Subscriptions Collection.

`nr_location_req`
: Start location procedure for a target UE in the AMF. The AMF will send to the LMF on the NL1 interface an HTTP POST request to the resource URI associated with the "determine-location" operation as specified in 3GPP TS 29.572 chapter 5.2.2.2.2 Retrieve UE Location.
If the embedded test LMF is used:
- if the LMF is configured to run in autonomous mode (See [lmf_autonomous_mode], page 58), the LMF will autonomously initiate the NRPPa and LPP procedures necessary to obtain or estimate the position of the UE.
- if the autonomous mode (See [lmf_autonomous_mode], page 58) is not configured and if the LMF is configured with LPP (See [lpp_test], page 54), the LMF will send a LPP requestCapabilities message to the UE.
- otherwise, the LMF will send a NRPPa E-CIDMeasurementInitiationRequest using the parameters `transaction_id`, `meas_id`, `periodic_meas` and `meas_period` configured in `lmf_cfg`.
Message definition:

  `supi`
  : String in the form "imsi-" or "nai-" followed by the value of the IMSI or the NAI.

  `pei`
  : Optional string in the form "imei-" or "imeisv-" followed by the value of the IMEI or the IMEISV. Required if `multi_sim` is set to true.

  `lcs_qos`
  : Optional object. QoS of the location request defined as specified in 3GPP 29.572 paragraph 6.1.6.2.13:

    `hAccuracy`
    : Optional float. Horizontal accuracy.

    `vAccuracy`
    : Optional float. Vertical accuracy.

    `vertRequested`
    : Optional boolean. Vertical accuracy requested.

    `responseTime`
    : Optional enumeration: LOW_DELAY, DELAY_TOLERANT, NO_DELAY.

`lcsQosClass`
Optional enumeration: BEST_EFFORT, ASSURED, MULTIPLE_QOS.

Response definition: if the LMF is configured to run in autonomous mode (See [lmf_autonomous_mode], page 58), the command returns the result of the location procedure. if the LMF is not configured to run in autonomous mode (See [lmf_autonomous_mode], page 58), the command returns the correlation ID:

`correlation_id`
Integer in range 0 to 0xFFFFFFFFFFFFFFFF. Identifier of the created location context. This value shall be used in the commands lpp_request_location and nr_cancel_location.

`nr_cancel_location`
Cancel periodic or triggered location procedure for a target UE.
Message definition:

`imsi` Optional string. UE IMSI.
Shall be present if `nai` is absent.

`nai` Optional string. Network specific identifier-based SUPI. Shall be present if `imsi` is absent.

`imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`correlation_id`
Integer in range 0 to 0xFFFFFF in EPC and to 0xFFFFFFFFFFFFFFFF in 5GC. Correlation ID as defined in 3GPP TS 29.171 and 29.518.

`nr_otdoa_information_req`
Send an HTTP POST request for "NonUeN2MessageTransfer" operation containing a NRPPa OTDOAInformationRequest PDU from the test LMF to the AMF.
See 3GPP TS 38.455 chapter 8.2.5 OTDOA Information Exchange.
See 3GPP TS 29.518 chapter 5.2.2.4.1 NonUeN2MessageTransfer.
Message definition:

`transaction_id`
Optional integer in range 0 to 32767 as defined in 3GPP TS 38.455 chapter 9.1.1.7. All other fields in the message NPRRa OTDOAInformationRequest are hardcoded.

`ran_node_id_list`
Array of objects. List of the global RAN node ID to send in the HTTP POST request as defined in 3GPP TS 29.518 chapter 6.1.6.2.9. See [ran_node_id], page 49.

`tai_list_5gs`
Optional array of objects (up to 65535). 5GS TAI List to set in the parameter taiList as defined in 3GPP TS 29.518 chapter 6.1.6.2.9. See [tai_list_5gs], page 49.

`tai_list` Optional array of objects (up to 65535). TAI List to set in the parameter taiList as defined in 3GPP TS 29.518 chapter 6.1.6.2.9. See [tai_list], page 48.

`rat_selector`
: Optional enumeration: nr, eutra, both (default = both). Value of the parameter ratSelector as defined in 3GPP TS 29.518 chapter 6.1.6.2.9.

`trp_information_req`
: Send an HTTP POST request for "NonUeN2MessageTransfer" operation containing a NRPPa TRPInformationRequest PDU from the test LMF to the AMF.
See 3GPP TS 38.455 chapter 8.2.8 TRP Information Exchange.
See 3GPP TS 29.518 chapter 5.2.2.4.1 NonUeN2MessageTransfer.
Message definition:

  `ran_node_id_list`
  : Array of objects. List of the global RAN node ID to send in the HTTP POST request as defined in 3GPP TS 29.518 chapter 6.1.6.2.9. See [ran_node_id], page 49.

  `tai_list_5gs`
  : Optional array of objects (up to 65535). 5GS TAI List to set in the parameter taiList as defined in 3GPP TS 29.518 chapter 6.1.6.2.9. See [tai_list_5gs], page 49.

  `tai_list` Optional array of objects (up to 65535). TAI List to set in the parameter taiList as defined in 3GPP TS 29.518 chapter 6.1.6.2.9. See [tai_list], page 48.

  `rat_selector`
  : Optional enumeration: nr, eutra, both (default = both). Value of the parameter ratSelector as defined in 3GPP TS 29.518 chapter 6.1.6.2.9.

  `transaction_id`
  : Optional integer in range 0 to 32767 as defined in 3GPP TS 38.455 chapter 9.1.1.7.

`meas_preconfig_req`
: Send an HTTP POST request for "N1N2MessageTransfer" operation containing a NRPPa MEASUREMENT PRECONFIGURATION REQUIRED from the test LMF to the AMF.
See 3GPP TS 38.455 chapter 8.2.12 Measurement Preconfiguration.
See 3GPP TS 29.518 chapter 5.2.2.3.1 N1N2MessageTransfer.
Message definition:

  `imsi` Optional string. UE IMSI.
  Shall be present if `nai` is absent.

  `nai` Optional string. Network specific identifier-based SUPI. Shall be present if `imsi` is absent.

  `imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

  `correlation_id`
  : Integer in range 0 to 0xFFFFFFFFFFFFFFFF. Correlation ID as defined in 3GPP TS 29.518.

  `transaction_id`
  : Optional integer in range 0 to 32767 as defined in 3GPP TS 38.455 chapter 9.1.1.7.

`nr_ecid_periodic_meas_termination_req`
Send an HTTP POST request for "N1N2MessageTransfer" operation containing a NRPPa E-CID Measurement Termination PDU from the test LMF to the AMF.
See 3GPP TS 38.455 chapter 8.2.4 E-CID Measurement Termination.
See 3GPP TS 29.518 chapter 5.2.2.3.1 N1N2MessageTransfer.
Message definition:

`imsi` Optional string. UE IMSI.
Shall be present if `nai` is absent.

`nai` Optional string. Network specific identifier-based SUPI. Shall be present if `imsi` is absent.

`imei` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`correlation_id`
Integer in range 0 to 0xFFFFFFFFFFFFFFFF. Correlation ID as defined in 3GPP TS 29.518.

`transaction_id`
Optional integer in range 0 to 32767 as defined in 3GPP TS 38.455 chapter 9.1.1.7.

`lmf_meas_id`
Integer in range 1 to 256. Value of LMF-UE-Measurement-ID in the message NRPPa E-CID Measurement Termination.

`ran_meas_id`
Integer in range 1 to 256. Value of RAN-UE-Measurement-ID in the message NRPPa E-CID Measurement Termination.

6.7.5 NRPPa/LPP common

The messages in this section are common to LPP and NRPPa and are applicable to 5GC only. They are used to connect and configure the LMF on the NL1 interface.

`lmf_ue_n1_n2_subscribe`
LMF server subscription to the reception of LPP messages and/or UE NRPPa PDUs. See 3GPP TS 29.518 chapter 5.2.2.3.3 N1N2MessageSubscribe.
Message definition:

`supi` String in the form "imsi-" or "nai-" followed by the value of the IMSI or the NAI.

`imei.` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`n1_notify_cbk_uri`
String. n1NotifyCallbackUri as defined in 3GPP TS 29.518 chapter 6.1.6.2.12 Type: UeN1N2InfoSubscriptionCreateData. This parameter shall be present if the LMF subscribes for LPP message notification. This IE represents the callback URI on which the N1 message shall be notified.

`n2_notify_cbk_uri`
String. n2NotifyCallbackUri as defined in 3GPP TS 29.518 chapter 6.1.6.2.12 Type: UeN1N2InfoSubscriptionCreateData. This parameter

shall be present if the LMF subscribes for a UE NRPPa information notification. This IE represents the callback URI on which the N2 information shall be notified.

`lmf_ue_n1_n2_unsubscribe`
LMF server unsubscription to the reception of LPP messages and/or UE NRPPa PDUs. See 3GPP TS 29.518 chapter 5.2.2.3.4 N1N2MessageUnSubscribe.
Message definition:

`supi` String in the form "imsi-" or "nai-" followed by the value of the IMSI or the NAI.

`imei.` Optional string (14 or 15 digits). UE IMEI (with or without check digit), required if `multi_sim` is set to true.

`subscription_id`
String. subscriptionId as defined in 3GPP TS 29.518 chapter 6.1.3.3 Resource: N1N2 Subscriptions Collection for Individual UE Contexts.

6.8 ePDG

The messages in this section are initiated in the ePDG and are related to an active non-3GPP PDN.

`epdg_send_p_cscf`
Request to ePDG to send IKE_INFORMATIONAL request to the UE containing the P-CSCF addresses in the CONFIGURATION payload.
The P-CSCF addresses are taken from the list of addresses configured in the PDN See [p_cscf_addr], page 31. Message definition:

`imsi` Optional string. UE IMSI.
Shall be present if `nai` is absent.

`nai` Optional string. UE network specific identifier-based SUPI.
Not applicable to UEs connected to EPC.

`imei` Optional string. UE IMEI, sent if available.

`apn` String. Access point name.

`epdg_pdn_reestab`
Request to ePDG to send IKE_INFORMATIONAL request to the UE containing DELETE Payload and NOTIFY payload of type REACTIVATION_REQUESTED_CAUSE.
Message definition:

`imsi` Optional string. UE IMSI.
Shall be present if `nai` is absent.

`nai` Optional string. UE network specific identifier-based SUPI.
Not applicable to UEs connected to EPC.

`imei` Optional string. UE IMEI, sent if available.

`apn` String. Access point name.

6.9 Remote events

Some messages (events) may be sent by LTEMME without client sollicitation.
To receive them, you need to register to those events via [remote event registration], page 89.
The received JSON will have a `message` property with the events name.

Ex:
Register to `<event name>` event:

```
{
  message: "register",
  register: "<event name>"
}
```

Message received:

```
{
  message: "<event name>",
  ...
}
```

Here is the list of events generated by LTEMME:

`registration`
: Generated when the UE registers or deregisters from the network, or when its M-TMSI or 5G-TMSI changes.
Message definition:

  `imsi` Optional string. UE IMSI.
  Shall be present if `nai` is absent.

  `nai` Optional string. UE network specific identifier-based SUPI.
  Not applicable to UEs connected to EPC.

  `imei` Optional string. UE IMEI, sent if available.

  `m_tmsi` Optional string. M-TMSI. Present for UEs connected to EPC.

  `5g_tmsi` Optional string. 5G-TMSI. Present for UEs connected to 5GC.

  `registered`
  : Boolean. True if UE is currently registered to the network.

`registration_reject`
: Generated when an initial registration attempt is rejected.
Message definition:

  `imsi` Optional string. UE IMSI, sent if available.

  `nai` Optional string. UE network specific identifier-based SUPI, sent if available.
  Not applicable to UEs connected to EPC.

  `imei` Optional string. UE IMEI, sent if available.

  `emm_cause`
  : Integer. EMM reject cause. Present for UEs connected to EPC.

  `5gmm_cause`
  : Integer. 5GMM reject cause. Present for UEs connected to 5GC.

`non_ip_data`
: Generated by data reception over a non IP PDN or unstructured PDU session.
Message definition:

  `imsi` Optional string. UE IMSI.
  Shall be present if `nai` is absent.

  `nai` Optional string. Network specific identifier-based SUPI.
  Not applicable to 4G UEs.
  Shall be present if `imsi` is absent.

  `imei` Optional string. UE IMEI, sent if `multi_sim` is set to true.

  `apn` Optional string. APN of the non IP bearer. Used for UEs connected to EPC.

  `erab_id` Optional integer. ERAB identity of the non IP default bearer. Used for UEs connected to EPC.

  `dnn` Optional string. DNN of the non IP bearer. Used for UEs connected to 5GC.

  `sst` Optional integer. SST of the non IP bearer. Used for UEs connected to 5GC.

  `sd` Optional integer. Optional SD of the non IP bearer. Used for UEs connected to 5GC.

  `pdu_session_id`
  Optional integer. PDU session ID of the non IP bearer. Used for UEs connected to 5GC.

  `data` String. ASCII representation of the data hexadecimal dump.

`generic_nas_transport`
: Generated when receiving an EPS uplink generic NAS transport message.
Message definition:

  `imsi` String. UE IMSI.

  `imei` Optional string. UE IMEI, sent if `multi_sim` is set to true.

  `type` Integer. Generic message container type information element.

  `payload` String. ASCII representation of the generic message container hexadecimal dump.

  `add_info` Optional string. ASCII representation of the additional information hexadecimal dump.

`5gs_nas_transport`
: Generated when receiving a 5GS uplink NAS transport message for LPP, SOR, UE policy or UE parameters update.
Message definition:

  `imsi` Optional string. UE IMSI.
  Shall be present if `nai` is absent.

  `nai` Optional string. Network specific identifier-based SUPI. Not applicable to 4G UEs.
  Shall be present if `imsi` is absent.

  `imei` Optional string. UE IMEI, sent if `multi_sim` is set to true.

`type` Integer (range: 3 to 6). Payload container type information element.

`payload` String. ASCII representation of the payload container hexadecimal dump.

`add_info` Optional string. ASCII representation of the additional information hexadecimal dump for LPP.

`eps_bearer_notification`
Generated when an EPS bearer is opened or released.
Message definition:

`imsi` Optional string. UE IMSI. Might not be present in case of emergency call.

`imei` Optional string. UE IMEI, sent if `multi_sim` is set to true.

`apn` String. Access point name.

`pdn_type` Enumeration (ipv4, ipv6, ipv4v6, non-ip). PDN type.

`activated`
Boolean. True on EPS bearer establishment, false on EPS bearer release.

`ipv4_address`
Optional string. IPv4 address allocated to the UE.

`ipv6_prefix`
Optional string. IPv6 prefix allocated to the UE.

`erab_id` Integer. ERAB identity.

`linked_erab_id`
Optional integer. ERAB identity of the default EPS bearer. Present when the EPS bearer opened is a dedicated bearer.

`dl_bytes` Optional integer. Number of dowlink bytes sent to the UE. Present when `activated` is set to false.

`ul_bytes` Optional integer. Number of uplink bytes received from the UE. Present when `activated` is set to false.

`start_date`
Integer. Start date in seconds since 1970-01-01 00:00:00

`duration` Optional number. Duration in seconds of bearer lifetime. Present when `activated` is set to false.

`qos_flow_notification`
Generated when a QoS flow is opened or released.
Message definition:

`imsi` Optional string. UE IMSI. Might not be present in case of emergency call.

`nai` Optional string. Network specific identifier-based SUPI.

`imei` Optional string. UE IMEI, sent if `multi_sim` is set to true.

`dnn` String. Data network name.

`pdn_type` Enumeration (ipv4, ipv6, ipv4v6, unstructured, ethernet). PDN type.

`activated`
: Boolean. True on EPS bearer establishment, false on EPS bearer release.

`ipv4_address`
: Optional string. IPv4 address allocated to the UE.

`ipv6_prefix`
: Optional string. IPv6 prefix allocated to the UE.

`pdu_session_id`
: Integer. PDU session identity.

`qos_flow_id`
: Integer. QoS flow identity;

`dl_bytes`
: Optional integer. Number of dowlink bytes sent to the UE. Present when `activated` is set to false.

`ul_bytes`
: Optional integer. Number of uplink bytes received from the UE. Present when `activated` is set to false.

`start_date`
: Integer. Start date in seconds since 1970-01-01 00:00:00

`duration`
: Optional number. Duration in seconds of bearer lifetime. Present when `activated` is set to false.

6.10 Examples

1. Config
   1. Client sends

```
{
    "message": "config_get",
    "message_id": "foo"
}
```

   2. Server replies

```
{
    "message_id": "foo",
    "message": "config_get",
    "name": "UE",
    "logs": {
        "phy": {
            "level": "error",
            "max_size": 0
        },
        ...
        "rrc": {
            "level": "debug",
            "max_size": 1
        }
    }
}
```

2. Error
   1. Client sends

```
{
```

```
    "message": "bar",
    "message_id": "foo"
}
```

2. Server replies

```
{
    "message_id": "foo",
    "message": "bar",
    "error": "Unknown message: bar"
}
```

7 Command line monitor reference

The following commands are available:

`help` Display the help. Use `help` *`command`* to have a more detailed help about a command.

`log [`*`log_options`*`]`
Display the current log state. If *log_options* are given, change the log options. The syntax is the same as the `log_options` configuration property.

`enb` List the connected eNodeBs.

`ng_ran` List the connected NG-RAN nodes.

`ue [`*`reg`*`]` List all the UE contexts (the UEs can be connected or not). If used with parameter *reg*, only registered UEs will be displayed.

`uectx` List all the active S1 or NG UE contexts.

`apn` List the configured APN/DNNs.

`pws_write` *`local_id`*
Start broadcasting the ETWS/CMAS message identified by *local_id* on all connected eNodeBs.

`pws_kill` *`local_id`*
Stop broadcasting the ETWS/CMAS message identified by *local_id* on all connected eNodeBs.

`n8` List the addresses of the AMF client and server and the UDM client and server on the N8 interface.

`n8disconnect`
Disconnect the AMF client from the UDM on the N8 interface.

`n8connect` *`api_root`*
Connect the AMF client to the UDM server on the N8 interface.
api_root is the api_root of the UDM server in the form: <scheme>://<host>:<port>, where <scheme> is "http" or "https".
If *api_root* is not provided, the AMF will try to connect to the previously configured address.

`n12` List the AMF client address and the AUSF server address on the N12 interface.

`n12disconnect`
Disconnect the AMF client from the AUSF on the N12 interface.

`n12connect` *`api_root`*
Connect the AMF client to the AUSF server on the N12 interface.
api_root is the api_root of the AUSF server in the form: <scheme>://<host>:<port>, where <scheme> is "http" or "https".
If *api_root* is not provided, the AMF will try to connect to the previously configured address.

`n17` List the AMF client address and the EIR server address on the N17 interface.

`n17disconnect`
Disconnect the AMF client from the EIR on the N17 interface.

`n17connect` *`api_root`*
Connect the AMF client to the EIR server on the N17 interface.
api_root is the api_root of the EIR server in the form: <scheme>://<host>:<port>,

where <scheme> is "http" or "https".
If *api_root* is not provided, the AMF will try to connect to the previously configured address.

`nl1` List the AMF client and server addresses and the LMF client and server addresses on the NL1 interface.

`nl1disconnect`
Disconnect the AMF client from the LMF on the NL1 interface.

`nl1connect` *`api_root`*
Connect the AMF client to the LMF server on the NL1 interface.
api_root is the api_root of the LMF server in the form: <scheme>://<host>:<port>, where <scheme> is "http" or "https".
If *api_root* is not provided, the AMF will try to connect to the previously configured address.

`lmf_client_connect`
Connect an LMF client to the AMF server on the NL1 interface.

`lmf_non_ue_n2_unsubscribe` *`n2_callback_uri`*
LMF server unsubscription to the reception of non-UE NRPPa PDUs.
See 3GPP TS 29.518 chapter 5.2.2.4.3 NonUeN2InfoUnSubscribe. *n2_callback_uri*: string. Non-UE N2 callback uri.

`lmf_ue_n1_n2_subscribe` *`supi imei n1_callback_uri n2_callback_uri`*
LMF server subscription to the reception of LPP messages and UE NRPPa PDUs.
See 3GPP TS 29.518 chapter 5.2.2.3.3 N1N2MessageSubscribe.
supi: string in the form "imsi-" or "nai-" followed followed by the value of the IMSI or the NAI.
imei: optional string. IMEI (14 digits).
n1_callback_uri: string. N1 callback uri.
n2_callback_uri: string. N2 callback uri.

`mbs_broadcast_session_setup` *`index`*
Starts a MBS broadcast session.
index: Integer. Index (starting from 0) of the session to start in the `broadcast_sessions` array.

`mbs_broadcast_session_release` *`index`*
Stops a MBS broadcast session.
index: Integer. Cid (starting from 0) of the session to stop, returned by `mbs_broadcast_session_setup`.

`mbs_session_info`
Displays MBS sessions info.

`quit` Stop the program and exit.

8 Log file format

8.1 NAS layer

When a NAS message is dumped, the format is:

```
time layer - message
```

When a NAS data PDU is dumped (debug level), the format is:

```
time layer dir MME_UE_ID message_type
        long_content
```

`time` Time using the selected format

`layer` Indicate the layer (`[NAS]` here).

`dir` UL (uplink) or DL (downlink).

`MME_UE_ID`
MME S1AP UE identifier (hexadecimal).

`message_type`
NAS message type.

`long_content`
Full content of the NAS message if `nas.max_size > 0`.

8.2 IP layer

When a IP data PDU is dumped (debug level), the format is:

```
time layer dir short_content
        long_content
```

`time` Time using the selected format

`layer` Indicate the layer (`[IP]` here).

`dir` UL (uplink) or DL (downlink).

`short_content`
Single line content (at least the IP protocol and the source and destination address).

`long_content`
Optional hexadecimal dump of the PDU if `ip.max_size > 0`.

8.3 S1AP, NGAP, SBcAP, LCSAP and GTP-U layers

When a message is dumped, the format is:

```
time layer - message
```

When a data PDU is dumped (debug level), the format is:

```
time layer dir ip_address short_content
        long_content
```

`time` Time using the selected format.

`layer` Indicate the layer (`[S1AP]`, `[NGAP]`, `[SBCAP]`, `[LCSAP]`, or `[GTPU]` here).

`dir` Direction: `TO` or `FROM`.

`ip_address`
source or destination IP address, depending on the `dir` field.

`short_content`
: Single line content.

`long_content`
: - S1AP, NGAP, SBCAP, LCSAP: full ASN.1 content of the message if `layer.max_size > 0`.
  - GTPU: hexadecimal dump of the message if `layer.max_size > 0`.

9 FAQ

9.1 Traffic control

I want to generate errors, limit bandwidth, introduce latency...

Easiest and most powerful way is to do this at IP level using the *tc* Linux command.
There are various tutorials on the internet but it is not a piece of cake so here are some common commands to handle simple case.

First, *tc* will operate at Linux interface level, which means that for LTE we will control the *tun0* interface created by MME.
Note that this configuration will be dropped each time you restart the MME so if you want to set it automatically and keep it we recommand to place the commands inside *config/mme-ifup* (See [tun_setup_script], page 14).

- To limit overall bandwidth to 2mbps:

```
tc qdisc add dev tun0 root handle 1:0 htb default 1
tc class add dev tun0 parent 1:0 classid 1:1 htb rate 2000kbit
```

- To simulate 10% packet loss:

```
tc qdisc add dev tun0 root handle 1: netem loss 10%
```

- To change previous packet loss to 20%:

```
tc qdisc change dev tun0 root handle 1: netem loss 10%
```

- To add 100ms latency with more or less 10ms:

```
tc qdisc add dev tun0 root handle 1: netem delay 100ms 10ms
```

- Same as previous but with a normal distribution:

```
tc qdisc add dev tun0 root handle 1: netem delay 100ms 10ms distribution normal
```

tc is very powerful and you may also chain filters (qdisc), apply them on specific traffic...

10 Known limitations

We present here the known limitations of LTEMME:

- A single equivalent PLMNs list is supported.
- No interface with external SGW/SMF/UPF is implemented.

11 Change history

11.1 Version 2025-12-12

- OpenSSL library is upgraded to 3.5.4
- removed deprecated DES-CBC IKE and IPsec encryption algorithm
- added IMEI based emergency call support in ePDG
- EPS tracking area update procedure now always allocates a new GUTI
  - added `allocate_new_guti_in_tau` parameter in configuration file and `config_set` remote API
  - the previous behavior can be restored by setting `allocate_new_guti_in_tau` to false
- `automatic_release_timeout` parameter is added to `pdn_list` configuration object and `config_set` remote API
- `eps_assign_5gs_resources_without_n1_mode_capability` parameter is added
- added the Nmbsmf interface to create and delete MBS sessions from an external AF
  - `nmbsmf`, `gtp_addr`, `ingress_tunnel_addr`, `tmgi_lifetime` and `service_area` parameters are added in `mbs` object
  - `broadcast_sessions` object parameters have changed
  - `mbs_tmgi_deallocate` remote API is added
  - no backward compatibility with previous configuration files is ensured
- `gnss_assistance_data` parameter is added to `lmf_cfg` and `local_e_smlc`
- remote APIs `epdg_send_p_cscf` and `epdg_pdn_reestab` are added
- `ecgi`, `ncgi`, `nid` and `n3iwf` parameters are added to `ue_get` remote API
- `lower_bound_timer` parameter is added

11.2 Version 2025-09-19

- `lpp_methods` parameter is added to `local_e_smlc` and `lmf_cfg` configuration objects
- `subscriber_profile_id` parameter is added to `ue_db` configuration object
- `id` parameter range in `filters` is changed from [0;14] to [1;15]
- `tac` parameter range is updated to forbid reserved values specified in 3GPP 23.003
- `p_cscf`, `dns` and `mtu_ipv4` parameters are added to `ue_modify_pdu_session` remote API
- `force_sqn_resync` parameter is added to user database options
- `coarse_location_information_support` parameter is added
- DCSP values for GTP-U tunnels are set to Expedited Forwarding for QCI/5QI 1 and 65 in the configuration files delivered

11.3 Version 2025-06-13

- NRPPa ASN.1 is updated to v18.5.0
- LPPa ASN.1 is updated to v18.1.0
- LPP ASN.1 is updated to v18.4.0
- MBS broadcast support is added
  - `mbs` parameter is added
  - `mbs_broadcast_session_setup`, `mbs_broadcast_session_release` and `mbs_session_info` remote API and monitor commands are added

    - added a mme-mbs.cfg sample configuration file
- `prf-aes128-xcbc` value is added to `ike_prf_list` in the `epdg` object
- `ip_3_tuple` parameter is added to the `traffic_descriptor_components` object of the `ursp_rules` remote API
- added an option to force EMM, ESM, 5GMM or 5GSM status message sending
    - `send_status_on_reject` parameter is added to `emm_procedure_filter`, `esm_procedure_filter`, `5gmm_procedure_filter` and `5gsm_procedure_filter` configuration objects
- `error` and `data` objects in `ike_generate_error` object are replaced by `reject_notify_list` object. The old syntax is still supported for backward compatibility
- `mme_ue_id` and `amf_ue_id` parameters are added to `ue_get` remote API
- `lcs_qos` object is added to the `nr_location_req` remote API
- `lmf_client_connect` remote API is removed. The embedded LMF connects automatically now
- `autonomous_mode` is added to `local_e_smlc` and `lmf_cfg` objects

11.4 Version 2025-03-14

- NGAP ASN.1 is updated to v18.4.0
- `restrict_ec_wb` and `restrict_ec_nb` parameters are added
- `gtp_addr`, `gtp_ext_addr`, `s1ap_bind_addr` and `ngap_bind_addr` parameters can be arrays
- `destination_mac_addr`, `802.1q_ctag_vid`, `802.1q_stag_vid`, `802.1q_ctag_pcp_dei`, `802.1q_stag_pcp_dei`, `ethertype` and `destination_mac_addr_range` parameters are added to the `traffic_descriptor_components` object of the `ursp_rules` remote API
- `ssc_mode` parameter is added to the `components` object of the `ursp_rules` remote API
- `p_cscf_ipv4_address_attribute_type` and `p_cscf_ipv6_address_attribute_type` parameters are added to the `epdg` object
- `apn_list` parameter is added to `ike_generate_error` configuration object

11.5 Version 2024-12-13

- S1AP ASN.1 is updated to v18.2.0
- NGAP ASN.1 is updated to v18.3.0
- `additional_ue_auth_type` parameter is added to `epdg` configuration object and `config_set` remote API
- `5gs_authentication` parameter is added
- `ttl` parameter is added to `emm_procedure_filter`, `5gmm_procedure_filter`, `esm_procedure_filter` and `5gsm_procedure_filter` configuration objects. The previous syntax is still supported for backward compatibility
- `amf_nf_instance_id` parameter is added
- `data` and `ttl` parameters are added to `ike_generate_error` configuration object
- `local` parameter is added to `ue_detach` and `ue_del` remote APIs
- `authenticate_known_emergency_supi` parameter is added

11.6 Version 2024-09-13

- N62 interface is added
- `eap` is now deprecated and `eap-md5`, `eap-tls` and `eap-aka` are added to `authentication` in `pdn_list`
- `auth_type` is added to `nssai_subject_to_nssaa`
- `5gmm_backoff_timer` parameter now accepts the value -2
- `akma` and `routing_indicator` are added to `ue_db`
- `akma_kaf_lifetime` parameter is added
- `ipv6_multicast` parameter is added in UE database
- `rq_timer` parameter is added to `pdn_list` array and `config_set` remote API
- `reflective_qos` parameter is added to `filters` array
- `ue_modify_reflective_qos` remote API is added
- `license` remote API is added
- `linked_erab_id` and `pdu_session_id` parameters are added to the `ue_activate_dedicated_bearer` remote API
- `mobike` parameter is added in `epdg` object and `config_set` remote API
- `ue_set` remote API is added
- use ARP priority 1 for emergency default bearer in mme-ims.cfg configuration file, like our default value for emergency dedicated bearers
- `dont_fragment` parameter is added to `epdg` configuration object and `config_set` remote API
- `nas_cipher_algo_null_allowed` and `nas_integ_algo_null_allowed` parameters are added
- `mobike` value is added to parameter `exchange` in `ike_generate_error`
- `com_logs_lock` parameter is renamed to `com_log_lock`. `com_logs_lock` is still supported for backward compatibility
- `com_log_us` parameter is added
- `encr-null-auth-aes-gmac-128`, `encr-null-auth-aes-gmac-192` and `encr-null-auth-aes-gmac-256` values are added to `esp_encryption_algo_list`

11.7 Version 2024-06-14

- OpenSSL library is upgraded to 1.1.1w
- nghttp2 library is upgraded to 1.61.0
- added indirect data forwarding support during intra RAT handover
- `correlation_id` parameter is added to remote APIs `location_req` and `nr_location_req` response message
- `mps_priority` and `mcs_priority` are added to `ue_db`
- `operator_defined_access_categories` is added
- `idr_for_emergency` parameter description is added
- `nr_ecid_periodic_meas_termination_req` remote API is added
- `t3324_forced` parameter now accepts the value -2
- added `apn` monitor command
- added `registration_reject` remote API event

11.8 Version 2024-03-15

- default APN or DNN is defined per type (IP, unstructured, ethernet)
- added MOBIKE support
- `emergency_number_list` and `extended_emergency_number_list` parameters can be changed with `config_set` remote API
- `5qi_qos` parameter is added to `erabs` array, `rx` object and `ue_activate_dedicated_bearer` and `ue_modify_pdu_session` remote APIs
- `qci` object in `rx` object is replaced by `qos` object. The old syntax is still supported for backward compatibility
- `type` input parameter and `rat_type` output parameter are added to `ue_get` remote API
- `local_e_smlc` and `lmf_cfg` parameters are added
- LPPa related `location_req`, `lcsap_reset_req`, `ecid_periodic_meas_termination` and `otdoa_information_req` remote apis are added
- NRPPa related `lmf_non_ue_n2_subscribe`, `lmf_non_ue_n2_unsubscribe`, `nr_location_req`, `nr_cancel_location`, `nr_otdoa_information_req` and `trp_information_req` remote apis are added
- LPP related `lpp_request_location` remote api is added
- common LPP/NRPPa `lmf_client_connect`, `lmf_ue_n1_n2_subscribe` and `lmf_ue_n1_n2_unsubscribe` remote apis are added
- `load_balancing_tau` remote API is added
- `sprt_support` parameter is added
- `mme_name` parameter is added
- `name` parameter is added to `s1` and `ng_ran` remote APIs

11.9 Version 2023-12-15

- EPS user plane integrity protection is added
- `registration_mobility_periodic_error` parameter is renamed to `registration_mobility_periodic_reject_error`. `registration_mobility_periodic_error` is still supported for backward compatibility
- value `preferred` is added to `confidentiality_protection` parameter
- `loop_count` and `loop_delay` are added to remote API messages
- `sim_events`, `sim_events_loop_count` and `sim_events_loop_delay` parameters are added
- `t3442` parameter is added
- `tai_lists` and `tai_lists_5gs` parameters are added
- `forbidden_eps_tacs` parameters is added
- `areas_list_5gs`, `allowed_5gs_tais` and `forbidden_5gs_tais` parameters are added
- `csg_info_list` is added to `ue_db`
- `com_ssl_ca` parameter is added for SSL verification
- `backoff_timer` parameter now accepts the value -2
- `always_on` parameter is added to `pdn_list`
- `registration_initial_with_security_protection` parameter is added to `5gmm_procedure_filter`

11.10 Version 2023-09-08

- NGAP ASN.1 is updated to v17.5.0
- N20 interface support is added
- `ursp_rules` remote API is added
- `t3501` parameter is added
- `attach_with_security_protection` parameter is added to `emm_procedure_filter` object
- `gtp_use_packet_bundling` parameter is added for GTP-U PDUs bundling support
- `ipsec` remote API added
- `ipv6_mtu` parameter can no longer be changed using the config_set remote API
- `ethernet` value is added to `pdn_type` parameter
- `mtu_ethernet_frame_payload` parameter is added
- `destination_mac_addr`, `source_mac_addr`, `802.1q_ctag_vid`, `802.1q_stag_vid`, `802.1q_ctag_pcp_dei`, `802.1q_stag_pcp_dei`, `ethertype`, `destination_mac_addr_range` and `source_mac_addr_range` parameters are added to `components` object
- `nssai_subject_to_nsac` parameter is added
- `ue_slice_max_bitrate` parameter is added

11.11 Version 2023-06-10

- N5 interface support is added
- NGAP ASN.1 is updated to v17.4.0
- `gtp_tx_bitrate`, `gtp_rx_bitrate`, `ip_tx_bitrate` and `ip_rx_bitrate` are added to the `stats` remote API
- `eplmn_list` parameter can no longer be changed with `config_set` remote API
- `nas_transport_lpp` parameter is added to `5gmm_procedure_filter`
- `pdn_type` parameter value `non-ip` in `pdn_list` array is renamed to `unstructured`. `non-ip` is still supported for backward compatibility
- `com_logs_lock` parameter added to disable logs configuration change via remote API

11.12 Version 2023-03-17

- `com_addr` parameter now uses [::] address instead of 0.0.0.0 in the delivered configuration files to allow IPv6 connection
- `cag_supported` parameter is renamed to `cag_support`. `cag_supported` is still supported for backward compatibility
- `requested_t3512_forced` parameter is added
- `gwus_support` and `gwus_prob_forced` parameters are added
- `purge_timer` parameter is added
- `nssai_subject_to_nssaa` parameter is added
- `network_slice_specific_authentication` parameter is added to `5gmm_procedure_filter`
- `ext_emm_cause` parameter is added
- `ipv6_send_dns_in_ra` parameter is added

11.13 Version 2022-12-16

- S1AP ASN.1 is updated to v17.2.0
- NGAP ASN.1 is updated to v17.2.0
- improved support for Equivalent PLMNs
- added `ca_certificate` parameter to `eap_tls`
- added `extended_emergency_number_list` parameter
- added `t3560_ng_ran_sat` parameter
- added S1AP/NGAP Masked IMEISV support
- added `sst` and `sd` parameters to the `ue_activate_dedicated_bearer` remote API
- added new ePDG IKE-Sa and ESP-Sa algorithms
- added `cag_supported`, `nid`, `cag_info_list`, `cag_id_list` and `cag_only_ind` parameters for NPN support
- added `edrx_ptw_nr` parameter
- added `single_address_bearers_only` and `single_address_bearers_first_address` parameters
- added `dpd` value to `exchange` parameter
- added `utc` parameter to remote API response messages

11.14 Version 2022-09-16

- "ipsec debug" monitor is now deprecated. Set ipsec.verbose to 1 in log configuration
- S1AP ASN.1 is updated to v17.1.0
- NGAP ASN.1 is updated to v17.1.1
- added missing `n3gpp` parameter to `ue_detach`, `ue_identity_request`, `ue_deactivate_bearer`, `ue_modify_pdu_session` and `5gs_nas_transport` remote APIs
- added `dhcpv6_t1` and `dhcpv6_t2` parameters
- added `dpd_timer_value` parameter
- added wildcard as a prefix support for `attach_reject_filter`
- added `priority_level`, `pre_emption_capability` and `pre_emption_vulnerability` parameters to `ue_modify_pdu_session` remote API
- added `guti_realloc` remote API
- added `registration` remote API event

11.15 Version 2022-06-17

- OpenSSL library is upgraded to 1.1.1n
- improved GTP-U performance
- removed `ue_db_filenename` configuration option and associated functionality
- added `ipv4_local_addr`, `ipv6_remote_addr_prefix` and `ipv6_local_addr_prefix` TFT components
- added new ePDG IKE-Sa and ESP-Sa algorithms and groups
- added ePDG IKE-Sa rekeying procedure
- added `apn`, `dnn`, `sst` and `sd` fields to `non_ip_data` remote API
- added `apn_oi` parameter
- added S1AP EN-DC SON Configuration Transfer support

- added `start_timestamp` and `end_timestamp` to `log_get` API
- added `allow_apn_in_attach_req` parameter
- added `ike_duration` parameter
- `esp_duration` and `ike_duration` parameters can be changed with `config_set` API
- configured TCP congestion control to bbr in lte_init.sh script
- S1AP ASN.1 is updated to v16.9.0
- added missing `n13` options
- added `n13`, `n13connect` and `n13disconnect` remote APIs

11.16 Version 2022-03-18

- added `--no-nat6` option to the `lte_init.sh` script
- added NAT traversal support to ePDG
- `increment_serial_number` optional parameter is added to `pws_write` remote API
- `ike_generate_error` configuration object is added
- `eps_user_unknown_reject_cause` and `5gs_user_unknown_reject_cause` optional parameters are added. The default EPS reject cause for an unknown user is changed from 2 (IMSI unknown in HSS) to 8 (EPS services and non-EPS services not allowed)

11.17 Version 2021-12-17

- LCSAP and NL1 support are added
- `registration_area_alloc_ind` parameter is added to control the MICO registration area allocation
- `ike_encryption_algo_list`, `ike_integrity_algo_list`, `ike_prf_list`, `ike_dh_group_list`, `esp_encryption_algo_list`, `esp_integrity_algo_list` and `esp_dh_group_list` parameters are added to make the list of ePDG supported algorithms configurable
- `license` monitor command is added
- `config_get`/`config_set` remote APIs are updated to handle more logging options
- `cpu_core_list` parameter is added to control the CPUs used by LTEMME
- `ue_aggregate_max_bitrate_dl` and `ue_aggregate_max_bitrate_ul` default values are increased
- `ue_modify_bearer` and `ue_modify_pdu_session` have a new `dns` parameter
- `nr_support` parameter is renamed to `dcnr_support`. `nr_support` is still supported for backward compatibility
- `dns_addr` parameter is added to the `config_set` remote API
- `dns` parameter is added to the `ue_modify_bearer` and `ue_modify_pdu_session` remote APIs
- S1AP ASN.1 is updated to v16.7.0

11.18 Version 2021-09-17

- the minimum GLIBC version is now 2.17
- addition of control plane CIoT 5GS optimization
- logs can be displayed with microseconds precision
- `truncated_amf_set_id` and `truncated_amf_pointer` parameters are added for NB-IoT control plane CIoT 5GS reestablishment

- the former `ims_vops` parameter is now split in 3 parameters `ims_vops_eps`, `ims_vops_5gs_3gpp` and `ims_vops_5gs_n3gpp`
- `emc_n3gpp` parameter is added to control emergency support indication in non-3GPP 5GS
- `control_plane_service_request` filter is added to `5gmm_procedure_filter`
- NAI can now be configured instead of IMSI, and the remote APIs are updated accordingly
- `omit_auth_in_first_auth_rsp` ePDG option is added to workaround some buggy UEs
- the mme-ims.cfg configuration file now logs more network interfaces by default
- S1AP ASN.1 is updated to v16.6.0
- NGAP ASN.1 is updated to v16.6.0

12 License

Abbreviations

5G-EIR	5G Equipment Identity Register
5GC	5G Core Network
5GS	5G System
5QI	5G QoS Identifier
AMF	Access and Mobility Management Function
APN	Access Point Name
AUSF	Authentication Server Function
DCNR	Dual Connectivity with NR
DL	Downlink
DNN	Data Network Name
E-RAB	E-UTRAN Radio Access Bearer
E-UTRA	Evolved UMTS Terrestrial Radio Access
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network
EIR	Equipment Identity Register
EPC	Evolved Packet Core
ePCO	Extended Protocol Configuration Options
ePDG	evolved Packet Data Gateway
EPS	Evolved Packet System
HSS	Home Subscriber Server
IMEI	International Mobile Equipment Identity
IMSI	International Mobile Subscriber Identity
LTE	Long Term Evolution
MBS	Multicast Broadcast Service
MME	Mobility Management Entity
NAS	Non Access Stratum
NR	New Radio
PCO	Protocol Configuration Options
PCRF	Policy and Charging Enforcement Function
PDN	Packet Data Network
PDU	Protocol Data Unit
PGW	Packet Data Network Gateway
QCI	Quality of Service (QoS) Class Identifier
QoS	Quality of Service
SDU	Service Data Unit

SGW	Serving Gateway
SMF	Session Management Function
TMSI	Temporary Mobile Subscriber Identity
UDM	Unified Data Management
UE	User Equipment
UL	Uplink
UPF	User Plane Function
USIM	Universal Subscriber Identity Module
VoLTE	Voice over LTE