sysmocom

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OsmoS1GW User Manual

by sysmocom - s.f.m.c. GmbH

The Asciidoc source code of this manual can be found at https://gitea.osmocom.org/osmocom/osmo-s1gw

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Contents

1 Foreword

Digital cellular networks based on the GSM specification were designed in the late 1980s and first deployed in the early 1990s in Europe. Over the last 25 years, hundreds of networks were established globally and billions of subscribers have joined the associated networks.

The technological foundation of GSM was based on multi-vendor interoperable standards, first created by government bodies within CEPT, then handed over to ETSI, and now in the hands of 3GPP. Nevertheless, for the first 17 years of GSM technology, the associated protocol stacks and network elements have only existed in proprietary *black-box* implementations and not as Free Software.

In 2008 Dieter Spaar and I started to experiment with inexpensive end-of-life surplus Siemens GSM BTSs. We learned about the A-bis protocol specifications, reviewed protocol traces and started to implement the BSC-side of the A-bis protocol as something originally called `bs11-abis`. All of this was *just for fun*, in order to learn more and to boldly go where no Free Software developer has gone before. The goal was to learn and to bring Free Software into a domain that despite its ubiquity, had not yet seen any Free / Open Source software implementations.

`bs11-abis` quickly turned into `bsc-hack`, then *OpenBSC* and its *OsmoNITB* variant: A minimal implementation of all the required functionality of an entire GSM network, exposing A-bis towards the BTS. The project attracted more interested developers, and surprisingly quickly also commercial interest, contribution and adoption. This allowed adding support for more BTS models.

After having implemented the network-side GSM protocol stack in 2008 and 2009, in 2010 the same group of people set out to create a telephone-side implementation of the GSM protocol stack. This established the creation of the Osmocom umbrella project, under which OpenBSC and the OsmocomBB projects were hosted.

Meanwhile, more interesting telecom standards were discovered and implemented, including TETRA professional mobile radio, DECT cordless telephony, GMR satellite telephony, some SDR hardware, a SIM card protocol tracer and many others.

Increasing commercial interest particularly in the BSS and core network components has lead the way to 3G support in Osmocom, as well as the split of the minimal *OsmoNITB* implementation into separate and fully featured network components: OsmoBSC, OsmoMSC, OsmoHLR, OsmoMGW and OsmoSTP (among others), which allow seamless scaling from a simple "Network In The Box" to a distributed installation for serious load.

It has been a most exciting ride during the last eight-odd years. I would not have wanted to miss it under any circumstances.

— Harald Welte, Osmocom.org and OpenBSC founder, December 2017.

1.1 Acknowledgements

My deep thanks to everyone who has contributed to Osmocom. The list of contributors is too long to mention here, but I'd like to call out the following key individuals and organizations, in no particular order:

- Dieter Spaar for being the most amazing reverse engineer I've met in my career
- Holger Freyther for his many code contributions and for shouldering a lot of the maintenance work, setting up Jenkins - and being crazy enough to co-start sysmocom as a company with me ;)
- Andreas Eversberg for taking care of Layer2 and Layer3 of OsmocomBB, and for his work on OsmoBTS and OsmoPCU
- Sylvain Munaut for always tackling the hardest problems, particularly when it comes closer to the physical layer
- Chaos Computer Club for providing us a chance to run real-world deployments with tens of thousands of subscribers every year
- Bernd Schneider of Netzing AG for funding early ip.access nanoBTS support
- On-Waves ehf for being one of the early adopters of OpenBSC and funding a never ending list of features, fixes and general improvement of pretty much all of our GSM network element implementations
- sysmocom, for hosting and funding a lot of Osmocom development, the annual Osmocom Developer Conference and releasing this manual.

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- NLnet Foundation, for providing funding for a number of individual work items within the Osmocom universe, such as LTE support in OsmoCBC or GPRS/EGPRS support for Ericsson RBS6000.
- WaveMobile Ltd, for many years of sponsoring.

May the source be with you!

— Harald Welte, Osmocom.org and OpenBSC founder, January 2016.

2 Preface

First of all, we appreciate your interest in Osmocom software.

Osmocom is a Free and Open Source Software (FOSS) community that develops and maintains a variety of software (and partially also hardware) projects related to mobile communications.

Founded by people with decades of experience in community-driven FOSS projects like the Linux kernel, this community is built on a strong belief in FOSS methodology, open standards and vendor neutrality.

2.1 FOSS lives by contribution!

If you are new to FOSS, please try to understand that this development model is not primarily about “free of cost to the GSM network operator”, but it is about a collaborative, open development model. It is about sharing ideas and code, but also about sharing the effort of software development and maintenance.

If your organization is benefiting from using Osmocom software, please consider ways how you can contribute back to that community. Such contributions can be many-fold, for example

- sharing your experience about using the software on the public mailing lists, helping to establish best practises in using/operating it,
- providing qualified bug reports, workarounds
- sharing any modifications to the software you may have made, whether bug fixes or new features, even experimental ones
- providing review of patches
- testing new versions of the related software, either in its current “master” branch or even more experimental feature branches
- sharing your part of the maintenance and/or development work, either by donating developer resources or by (partially) funding those people in the community who do.

We’re looking forward to receiving your contributions.

2.2 Osmocom and sysmocom

Some of the founders of the Osmocom project have established *sysmocom - systems for mobile communications GmbH* as a company to provide products and services related to Osmocom.

sysmocom and its staff have contributed by far the largest part of development and maintenance to the Osmocom mobile network infrastructure projects.

As part of this work, sysmocom has also created the manual you are reading.

At sysmocom, we draw a clear line between what is the Osmocom FOSS project, and what is sysmocom as a commercial entity. Under no circumstances does participation in the FOSS projects require any commercial relationship with sysmocom as a company.

2.3 Corrections

We have prepared this manual in the hope that it will guide you through the process of installing, configuring and debugging your deployment of cellular network infrastructure elements using Osmocom software. If you do find errors, typos and/or omissions, or have any suggestions on missing topics, please do take the extra time and let us know.

2.4 Legal disclaimers

2.4.1 Spectrum License

As GSM and UMTS operate in licensed spectrum, please always double-check that you have all required licenses and that you do not transmit on any ARFCN or UARFCN that is not explicitly allocated to you by the applicable regulatory authority in your country.

Warning
Depending on your jurisdiction, operating a radio transmitter without a proper license may be considered a felony under criminal law!

2.4.2 Software License

The software developed by the Osmocom project and described in this manual is Free / Open Source Software (FOSS) and subject to so-called *copyleft* licensing.

Copyleft licensing is a legal instrument to ensure that this software and any modifications, extensions or derivative versions will always be publicly available to anyone, for any purpose, under the same terms as the original program as developed by Osmocom.

This means that you are free to use the software for whatever purpose, make copies and distribute them - just as long as you ensure to always provide/release the *complete and corresponding* source code.

Every Osmocom software includes a file called `COPYING` in its source code repository which explains the details of the license. The majority of programs is released under GNU Affero General Public License, Version 3 (AGPLv3).

If you have any questions about licensing, don't hesitate to contact the Osmocom community. We're more than happy to clarify if your intended use case is compliant with the software licenses.

2.4.3 Trademarks

All trademarks, service marks, trade names, trade dress, product names and logos appearing in this manual are the property of their respective owners. All rights not expressly granted herein are reserved.

For your convenience we have listed below some of the registered trademarks referenced herein. This is not a definitive or complete list of the trademarks used.

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2.4.4 Liability

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3 Introduction

3.1 Required Skills

Please note that even while the capital expenses of running mobile networks has decreased significantly due to Osmocom software and associated hardware like sysmoBTS, GSM networks are still primarily operated by large GSM operators.

Neither the GSM specification nor the GSM equipment was ever designed for networks to be installed and configured by anyone but professional GSM engineers, specialized in their respective area like radio planning, radio access network, back-haul or core network.

If you do not share an existing background in GSM network architecture and GSM protocols, correctly installing, configuring and optimizing your GSM network will be tough, irrespective whether you use products with Osmocom software or those of traditional telecom suppliers.

GSM knowledge has many different fields, from radio planning through site installation to core network configuration/administration.

The detailed skills required will depend on the type of installation and/or deployment that you are planning, as well as its associated network architecture. A small laboratory deployment for research at a university is something else than a rural network for a given village with a handful of cells, which is again entirely different from an urban network in a dense city.

Some of the useful skills we recommend are:

- general understanding about RF propagation and path loss in order to estimate coverage of your cells and do RF network planning.
- general understanding about GSM network architecture, its network elements and key transactions on the Layer 3 protocol
- general understanding about voice telephony, particularly those of ISDN heritage (Q.931 call control)
- understanding of GNU/Linux system administration and working on the shell
- understanding of TCP/IP networks and network administration, including tcpdump, tshark, wireshark protocol analyzers.
- ability to work with text based configuration files and command-line based interfaces such as the VTY of the Osmocom network elements

3.2 Getting assistance

If you do have a support package / contract with sysmocom (or want to get one), please contact support@sysmocom.de with any issues you may have.

If you don’t have a support package / contract, you have the option of using the resources put together by the Osmocom community at https://projects.osmocom.org/, checking out the wiki and the mailing-list for community-based assistance. Please always remember, though: The community has no obligation to help you, and you should address your requests politely to them. The information (and software) provided at osmocom.org is put together by volunteers for free. Treat them like a friend whom you’re asking for help, not like a supplier from whom you have bought a service.

If you would like to obtain professional/commercial support on Osmocom CNI, you can always reach out to sales@sysmocom.de to discuss your support needs. Purchasing support from sysmocom helps to cover the ongoing maintenance of the Osmocom CNI software stack.

4 Overview

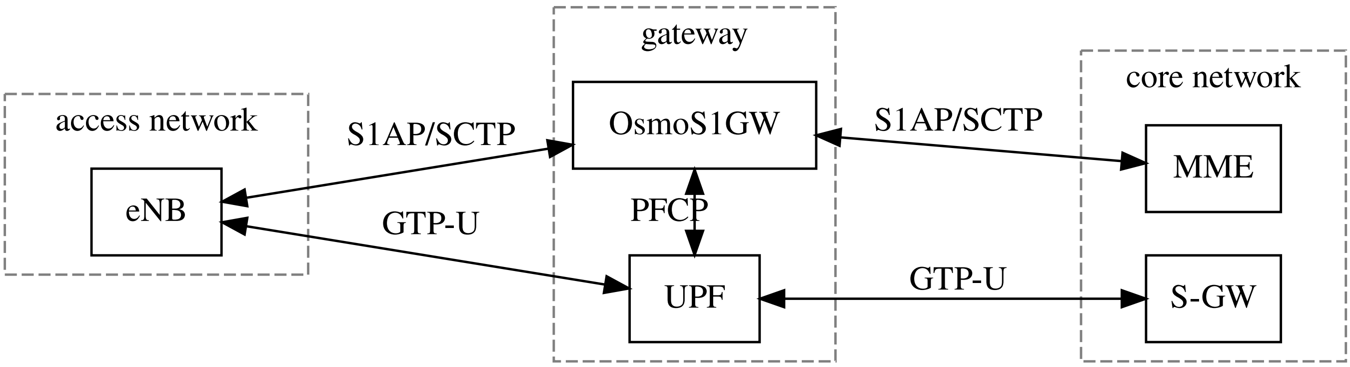
4.1 About OsmoS1GW

OsmoS1GW is an S1 Gateway for LTE (4G) networks, developed by sysmocom. It acts as a transparent proxy between eNBs (radio access network) and one or more MMEs (core network), relaying S1AP signalling over SCTP/IP in both directions.

In addition to S1AP proxying, OsmoS1GW manages GTP-U data plane tunnels (E-RABs / EPS bearers) by communicating with a co-located UPF (User Plane Function) via PFCP. OsmoS1GW does not carry GTP-U traffic itself: GTP-U flows directly between the eNB and the UPF (access side), and between the UPF and the S-GW of the core network (core side). OsmoS1GW only instructs the UPF — via PFCP Session Establishment, Modification, and Deletion procedures — to create, update, or tear down the corresponding forwarding rules. It also rewrites the GTP-U TEID and Transport Layer Address (TLA) IEs inside S1AP messages so that eNBs send their GTP-U traffic to the co-located UPF rather than directly to the core network.

4.2 Architecture

The following diagram shows the high-level data flow through OsmoS1GW:



All S1AP messages are inspected by the gateway. Most are forwarded unchanged; those that carry GTP-U endpoint information (E-RAB Setup, Modify, Release, Initial Context Setup, etc.) are rewritten so that the UPF's TLA/TEID is substituted before forwarding to the eNB/MME. GTP-U traffic itself never passes through OsmoS1GW — it flows directly between the eNB and the UPF, and between the UPF and the S-GW.

Internally, OsmoS1GW is structured as a set of Erlang/OTP processes:

- **`sctp_server`** — Listens for incoming eNB SCTP connections and spawns one `enb_proxy` instance per connection.
- **`enb_proxy`** — One instance per connected eNB. Manages the outbound SCTP connection to the selected MME and drives the S1 Setup handshake. Implements MME pooling and retry logic.
- **`s1ap_proxy`** — Paired with each `enb_proxy`. Inspects S1AP PDUs in both directions and manages per-UE `erab_fsm` instances.
- **`erab_fsm`** — One instance per active E-RAB. Exchanges PFCP Session Establishment/Modification/Deletion messages with the UPF and rewrites GTP-U F-TEID IEs in S1AP messages.
- **`pfcp_peer`** — Manages the PFCP association with the UPF (UDP-based), including periodic heartbeat and SEID allocation.
- **`mme_registry`** — Manages the pool of known MMEs. MMEs can be provisioned statically via the configuration file or dynamically via the REST API.
- **`enb_registry`** — Tracks all active eNB connections and their state. Queryable via the REST API (see Section 10.6).
- **`rest_server`** — OpenAPI-based HTTP REST interface for monitoring and management (see Section 10).

4.3 Use Cases

4.3.1 Separated Core and Access Networks

A possible deployment scenario in private or industrial LTE networks is one where the core network (EPC) and the radio access network (RAN) reside in strictly separated IP domains with no direct routing between them — for example, a dedicated operations network for eNBs and a separate production network for the EPC.

In this configuration, OsmoS1GW is deployed at the boundary between the two networks. Each eNB connects to the gateway's access-facing SCTP listener, and the gateway in turn connects outward to the MME. The eNBs never need a route to the core, and the EPC never needs a route to the radio access domain.

The gateway acts as the sole point of contact between the two networks, providing a natural place to apply access control, logging, and monitoring.

4.3.2 MME Pooling

OsmoS1GW supports connecting multiple MMEs in a pool. When an eNB connects and performs the S1 Setup procedure, the gateway selects an MME from the pool, establishes an SCTP connection to it, and forwards the S1 Setup Request. If the selected MME rejects the setup or is unreachable, the gateway automatically retries with the next candidate in the pool before returning a failure to the eNB.

Pool members can be filtered by Tracking Area Code (TAC): each MME entry in the pool can carry an optional list of TACs it is willing to serve. The gateway uses the TAC list advertised by the eNB in the S1 Setup Request to restrict selection to compatible MMEs.

MMEs can be configured statically in the configuration file or managed dynamically at run time via the REST API (see Section 10.5).

5 Running OsmoS1GW

5.1 Requirements

OsmoS1GW requires:

- Erlang/OTP 25 or later.
- A Linux kernel with SCTP support (`sctp` kernel module).
- A reachable UPF that speaks PFCP (e.g. OsmoUPF).
- One or more reachable MMEs (e.g. Open5GS).

5.2 Installation Options

5.2.1 Official Osmocom Binary Packages

Osmocom provides binary packages of OsmoS1GW for a variety of GNU/Linux distributions, primarily Debian based ones. This is the recommended installation method for production deployments. For up-to-date instructions on how to add the Osmocom package repository for your distribution, see: https://osmocom.org/projects/cellular-infrastructure/wiki/Binary_Packages.

Two packages are provided: `osmo-s1gw` (the gateway itself) and `osmo-s1gw-cli` (the management CLI, see Section 9). To install both, run:

```
apt install osmo-s1gw osmo-s1gw-cli
```

5.2.2 Building from Source

OsmoS1GW uses rebar3 as its build tool, wrapped by a convenience `Makefile` in the project root. To fetch dependencies and compile:

```
git clone https://gitea.osmocom.org/osmocom/osmo-s1gw.git
cd osmo-s1gw
make
```

5.2.2.1 Available Make Targets

The following targets are available:

make / make build
: Compile the application and all dependencies (default target).

make shell / make run
: Compile and start OsmoS1GW in an interactive Erlang shell. Intended for development and local testing. The config file used is controlled by the `CONFIG` variable (default: `config/sys.config`).

make check
: Run the EUnit test suite. Additional arguments can be passed to the test runner via the `EUNIT_ARGS` variable.

make analyze
: Run Dialyzer static type analysis.

make release
: Build a self-contained Erlang/OTP release package (includes the ERTS runtime) under `_build/default/rel/osmo-s1gw/`

make run-release
: Build the release and immediately start it using the `osmo-s1gw.sh` bootstrap script (see Section 5.3.1). The `CONFIG` variable selects the config file.

make install
: Build the release and install OsmoS1GW system-wide. See Section 5.2.2.3 for details.

make clean
: Remove all build artefacts.

5.2.2.2 Make Variables

The following variables customise the build and installation:

Variable	Description	Default
`CONFIG`	Config file used by `make shell` and `make run-release`	`config/sys.config`
`EUNIT_ARGS`	Extra arguments forwarded to `rebar3 eunit`	(none)
`BINDIR`	Installation directory for executables	`/usr/bin`
`LIBDIR`	Installation directory for the release package	`/usr/lib`
`CONFDIR`	Installation directory for the config file	`/etc/osmocom`
`SYSTEMDUNITDIR`	Installation directory for the systemd unit	`/lib/systemd/system`
`DESTDIR`	Staging root prefix (for package builds)	(empty)

5.2.2.3 Installation

Running `make install` (typically as root, or with `DESTDIR` set for packaging) installs the release package, bootstrap script, management CLI, example config file, and systemd unit to their respective directories as configured by the variables in Section 5.2.2.2.

5.3 Running Options

5.3.1 The `osmo-s1gw` Bootstrap Script

The installed `osmo-s1gw` executable is a POSIX shell script (`contrib/osmo-s1gw.sh`) that locates the bundled ERTS runtime inside the release package and launches `erlexec` with the correct boot, config, and node parameters. It is the standard entry point both for systemd and for manual invocation.

Usage:

```
osmo-s1gw [-s] [-r ROOTDIR] [-c CONFIG] [-C COOKIE] [-n NAME@HOST]
```

Options:

-r ROOTDIR
: Path to the Erlang/OTP release root directory. Default: /usr/lib/osmo-s1gw.

-c CONFIG
: Path to the configuration file. Default: /etc/osmocom/osmo-s1gw.config.

-C COOKIE
: Erlang distribution cookie used for inter-node communication. Default: osmo-s1gw.

-n NAME@HOST
: Erlang node name. Default: osmo-s1gw@<hostname>.

-s
: Start with an interactive Erlang shell instead of running headless. Useful for debugging on a deployed system.

5.3.2 Running Under systemd

After installation, enable and start OsmoS1GW as a systemd service:

```
systemctl enable osmo-s1gw
systemctl start osmo-s1gw
```

The unit file runs OsmoS1GW as the osmocom user and group and requests the CAP_NET_ADMIN capability (required for GTP-U KPI monitoring). The service is restarted automatically on failure with a 2-second delay. OsmoS1GW reads its configuration from /etc/osmocom/osmo-s1gw.config.

To inspect the log output:

```
journalctl -u osmo-s1gw -f
```

5.4 Logging

OsmoS1GW uses the standard Erlang/OTP logger framework. Two log handlers are configured by default:

default
: Writes formatted log lines to standard output. When running under systemd this output is captured by the journal. The log level is set to info by default.

gsmtap
: Sends log messages as GSMTAP frames over UDP to a configurable destination (default: 127.0.0.1).

The global minimum log level is controlled by the logger_level kernel parameter; individual handler levels can be overridden independently. See Section 6.7 for the relevant configuration section.

6 Configuration

OsmoS1GW is configured through an Erlang/OTP system configuration file. By default this file is config/sys.config in the source tree, or /etc/osmocom/osmo-s1gw.config after installation. A different path can be supplied at start time via the -c option of the osmo-s1gw bootstrap script (see Section 5.3.1) or via the CONFIG variable when using the project Makefile (see Section 5.2.2.1).

The file uses Erlang term syntax. The top level is a list of {ApplicationName, [{Key, Value}, ...]} tuples. OsmoS1GW-specific parameters live under the osmo_s1gw application key. Kernel parameters (logging) live under the standard kernel key, and metrics reporting parameters under the exometer_core key.

6.1 `sctp_server` — eNB-Facing SCTP Listener

This section controls the SCTP socket on which OsmoS1GW listens for incoming connections from eNodeBs.

```
{sctp_server, #{
    laddr => "127.0.1.1",  %% local bind address
    lport => 36412,        %% local bind port (S1AP standard port)
    sockopts => #{ }       %% optional socket options (see below)
}}
```

laddr
IP address to bind to. Accepts a string in dotted-decimal (IPv4) or colon-separated (IPv6) notation, or the atom `any` to bind to all interfaces. Default: `"127.0.1.1"`.

lport
TCP/SCTP port to listen on. Default: `36412` (the IANA-assigned S1AP port).

sockopts
An optional map of additional SCTP socket options:

Option	Description	Default
`recbuf`	Receive buffer size in bytes	`65536`
`sndbuf`	Send buffer size in bytes	`65536`
`nodelay`	Disable Nagle algorithm (`true` to disable)	`true`

6.2 `mme_pool` — MME Pool Configuration

The `mme_pool` key defines the list of MMEs that OsmoS1GW may connect to on behalf of connecting eNBs. This is the recommended way to configure MME connectivity; it supports multiple MMEs and TAC-based selection.

```
{mme_pool, [
    #{
        name => "mme0",           %% unique name (required)
        raddr => "192.168.2.10", %% MME IP address (required)
        rport => 36412,           %% MME SCTP port (default: 36412)
        laddr => any,             %% local bind address (default: any)
        tac_list => []            %% allowed TACs (default: [] = all)
    },
    #{
        name => "mme1",
        raddr => "192.168.2.20",
        tac_list => [100, 101, 102]
    }
]}
```

Each entry in the list is a map with the following fields:

name
A unique, human-readable string identifying this MME in log messages, the REST API, and per-MME metrics. Required.

raddr
The remote IP address of the MME. Required.

rport
The remote SCTP port of the MME. Default: `36412`.

laddr
The local IP address to bind to when connecting to this MME. Accepts a string or the atom `any`. Default: `any`.

tac_list
A list of Tracking Area Codes (TACs) that this MME is willing to serve. When an eNB connects and sends its S1 Setup Request, OsmoS1GW filters the pool to MMEs whose `tac_list` is a superset of the eNB's advertised TACs. An empty list means the MME accepts all TACs. Default: `[]`.

MMEs can also be added and removed at run time via the REST API without restarting OsmoS1GW (see Section 10.5).

> **Note**
> The `mme_pool` key is mutually exclusive with the deprecated `sctp_client` key described in the next section. If `mme_pool` is present, keys `laddr`, `raddr`, and `rport` from the `sctp_client` block are ignored.

6.3 `sctp_client` — Single MME (Deprecated)

Prior to the introduction of MME pooling, the outbound MME connection was configured via the `sctp_client` section:

```
{sctp_client, #{
    laddr => "127.0.2.1",  %% local bind address
    raddr => "127.0.2.10", %% MME IP address
    rport => 36412,        %% MME SCTP port
    sockopts => #{ }       %% optional socket options (same as sctp_server)
}}
```

When OsmoS1GW starts and finds no `mme_pool` key in the configuration, it automatically creates a single `"default"` MME pool entry from the `sctp_client` parameters and logs a deprecation warning. This allows existing single-MME deployments to continue working without changes, but migration to `mme_pool` is strongly recommended.

> **Note**
> The socket options (`sockopts`) from the `sctp_client` section are still used for the outbound SCTP socket regardless of whether `mme_pool` or `sctp_client` is used for MME addressing.

6.4 PFCP — User Plane Function

These parameters control the PFCP session between OsmoS1GW and the UPF.

```
{pfcp_peer, #{
    laddr => "127.0.1.1",  %% local address for PFCP (UDP)
    raddr => "127.0.1.2"   %% remote address of the UPF
    %% assoc_setup_timeout  => 2000,  %% optional, milliseconds
    %% heartbeat_req_timeout => 2000, %% optional, milliseconds
    %% heartbeat_interval => 0        %% optional, milliseconds (0 = disabled)
}},

%% Optional Network Instance IEs:
%% {pfcp_net_inst_core,   "core-side"},
%% {pfcp_net_inst_access, "radio-side"}
```

laddr
Local IP address on which OsmoS1GW listens for PFCP messages from the UPF. Default: `"127.0.1.1"`.

raddr
Remote IP address of the UPF. Default: `"127.0.1.2"`.

assoc_setup_timeout
How long (in milliseconds) to wait for a PFCP Association Setup Response before retrying. Default: `2000`.

heartbeat_req_timeout
How long (in milliseconds) to wait for a PFCP Heartbeat Response before declaring the heartbeat timed out. Default: `2000`.

heartbeat_interval
Interval (in milliseconds) between periodic PFCP Heartbeat Requests sent by OsmoS1GW while associated with the UPF. Set to `0` to disable periodic heartbeats entirely. Default: `10000`.

> **Note**
> The legacy flat keys `pfcp_loc_addr` and `pfcp_rem_addr` are still accepted for backwards compatibility. The `pfcp_peer` map takes priority if both are present.

pfcp_net_inst_core
Value for the PFCP Network Instance IE on the core-network side of each GTP-U session. Omit if the UPF does not require Network Instance IEs.

pfcp_net_inst_access
Value for the PFCP Network Instance IE on the radio-access side of each GTP-U session. Omit if the UPF does not require Network Instance IEs.

6.5 GTP-U KPI Reporting (Optional)

OsmoS1GW can optionally poll nftables counters to derive per-eNB GTP-U traffic statistics and report them as exometer metrics (see Section 8). This feature requires a matching nftables ruleset.

```
%% {gtpu_kpi_enable,     true},
%% {gtpu_kpi_table_name, "osmo-s1gw"},
%% {gtpu_kpi_ul_addr,    s1ap},
%% {gtpu_kpi_dl_addr,    s1ap},
%% {gtpu_kpi_interval,   3000}
```

gtpu_kpi_enable
Set to `true` to enable the GTP-U KPI module. Default: `false`.

gtpu_kpi_table_name
The nftables table name to read counters from. Default: `"osmo-s1gw"`.

gtpu_kpi_ul_addr
Source of the uplink GTP-U address used to match nftables counters. `s1ap` means learn the address from S1AP signalling; `sctp` means use the eNB's SCTP source address. Default: `s1ap`.

gtpu_kpi_dl_addr
Source of the downlink GTP-U address. Same options as `gtpu_kpi_ul_addr`. Default: `s1ap`.

gtpu_kpi_interval
How often (in milliseconds) to poll the nftables counters. Default: `3000`.

6.6 REST Interface

```
%% {rest_srv_port,       8080},
%% {rest_srv_swagger_ui, true}
```

rest_srv_port
TCP port on which the HTTP REST server listens. Default: `8080`.

rest_srv_swagger_ui
Whether to serve the Swagger UI at `http://host:rest_srv_port/swagger`. Default: `true`.

For the full REST API reference see Section 10. For the interactive CLI tool that wraps the REST API see Section 9.

6.7 kernel — Logging

OsmoS1GW uses the standard Erlang/OTP `logger` framework. The `kernel` application section controls log levels and handlers. See Section 5.4 for a description of the log handlers configured by default.

```
{kernel, [
    {logger_level, debug},
    {logger, [
        {handler, gsmtap, logger_gsmtap_h,
         #{level => debug,
           config => #{rem_addr => "127.0.0.1",
                       app_name => "OsmoS1GW"}}},
        {handler, default, logger_std_h,
         #{level => info,
           formatter => {logger_color_formatter, #{...}}}}
    ]}
]}
```

logger_level
The global minimum log level. Log records below this level are discarded before reaching any handler. Common values: `debug`, `info`, `notice`, `warning`, `error`.

For each handler in the `logger` list:

level
Handler-specific minimum log level. Can be set independently per handler to, for example, send only `warning` and above to the console while sending all `debug` output over GSMTAP.

gsmtap handler (logger_gsmtap_h)
Sends log messages as GSMTAP frames over UDP.

rem_addr
Destination IP address. Default: `"127.0.0.1"`.

app_name
Application name tag embedded in each GSMTAP frame.

default handler (logger_std_h)
Writes log lines to standard output. When OsmoS1GW runs under systemd this output is captured by the journal.

6.8 exometer_core — Metrics and StatsD Reporting

See Section 7 for an introduction to OsmoS1GW metrics and the full list of available counters and gauges. The `exometer_core` section configures reporters — processes that periodically push metric values to an external destination.

The default configuration reports all counters and gauges to a StatsD server:

```
{exometer_core, [
    {report, [
        {reporters, [
            {exometer_report_statsd, [
                {hostname, "127.0.4.10"},
                {port, 8125},
                {prefix, "s1gw"},
                {type_map, []}
            ]}
        ]},
        {subscribers, [
            {select, {[{ {['_'|'_'], counter, '_'}, [], ['$_']}],
                      exometer_report_statsd, value, 10_000, true,
                      [{report_type, counter}]}},
            {select, {[{ {['_'|'_'], gauge, '_'}, [], ['$_']}],
                      exometer_report_statsd, value, 10_000, true,
                      [{report_type, gauge}]}}
        ]}
    ]}
]}
```

hostname
IP address or hostname of the StatsD server.

port
UDP port of the StatsD server. Default: `8125`.

prefix
String prepended to all metric names as reported to StatsD. Default: `"s1gw"`.

The `subscribers` list uses exometer's `select` mechanism to automatically subscribe all counters and gauges to the StatsD reporter with a reporting interval of 10 000 ms. To disable StatsD reporting, comment out or remove the `exometer_report_statsd` reporter entry.

7 Metrics

OsmoS1GW exposes internal metrics using the exometer_core library, and ships with the exometer_report_statsd plugin for StatsD reporting. See Section 6.8 for configuration details.

Two metric types are used:

Counter
A monotonically increasing integer, incremented each time a specific event occurs. Counters never decrease.

Gauge
An integer that reflects a current quantity (e.g. the number of active connections). Gauges can go up and down.

7.1 Metric Names

Metric names follow a hierarchical dot-separated structure that reflects the subsystem they belong to. For example, metrics related to S1AP processing contain `s1ap` in their name, while metrics specific to PFCP contain `pfcp`. When StatsD reporting is enabled, all metric names are further prefixed with the configured `prefix` string (default: `s1gw`), giving e.g. `s1gw.s1ap.proxy.in_pkt.all`.

7.2 Global Counters

The following counters are registered at startup and count events across all connections.

7.2.1 PFCP Counters

Metric name	Description
pfcp.heartbeat_req.tx	PFCP Heartbeat Requests sent to the UPF
pfcp.heartbeat_req.rx	PFCP Heartbeat Requests received from the UPF
pfcp.heartbeat_req.timeout	PFCP Heartbeat Requests that timed out
pfcp.heartbeat_resp.tx	PFCP Heartbeat Responses sent to the UPF
pfcp.heartbeat_resp.rx	PFCP Heartbeat Responses received from the UPF
pfcp.assoc_setup_req.tx	PFCP Association Setup Requests sent
pfcp.assoc_setup_req.timeout	PFCP Association Setup Requests that timed out
pfcp.assoc_setup_resp.rx	PFCP Association Setup Responses received
pfcp.assoc_setup_resp.rx_ack	PFCP Association Setup Responses with success cause
pfcp.assoc_setup_resp.rx_nack	PFCP Association Setup Responses with failure cause
pfcp.unexpected_pdu	Unexpected or unrecognised PFCP PDUs received

7.2.2 S1AP Counters

Metric name	Description
s1ap.enb.all.rx	S1AP PDUs received from any eNB
s1ap.enb.all.rx_unknown_enb	S1AP PDUs received from an unregistered eNB
s1ap.proxy.exception	Exceptions raised during S1AP PDU processing
s1ap.proxy.in_pkt.all	S1AP PDUs received by the proxy (all directions)
s1ap.proxy.in_pkt.drop.all	Received S1AP PDUs dropped by the proxy
s1ap.proxy.in_pkt.decode_error	Received S1AP PDUs that failed to decode
s1ap.proxy.in_pkt.proc_error	Received S1AP PDUs that failed to process
s1ap.proxy.in_pkt.erab_setup_req	E-RAB SETUP REQUEST PDUs received
s1ap.proxy.in_pkt.erab_setup_rsp	E-RAB SETUP RESPONSE PDUs received
s1ap.proxy.in_pkt.erab_modify_req	E-RAB MODIFY REQUEST PDUs received
s1ap.proxy.in_pkt.erab_modify_rsp	E-RAB MODIFY RESPONSE PDUs received
s1ap.proxy.in_pkt.erab_release_cmd	E-RAB RELEASE COMMAND PDUs received
s1ap.proxy.in_pkt.erab_release_rsp	E-RAB RELEASE RESPONSE PDUs received
s1ap.proxy.in_pkt.erab_release_ind	E-RAB RELEASE INDICATION PDUs received
s1ap.proxy.in_pkt.erab_mod_ind	E-RAB MODIFICATION INDICATION PDUs received
s1ap.proxy.in_pkt.erab_mod_cnf	E-RAB MODIFICATION CONFIRM PDUs received
s1ap.proxy.in_pkt.init_ctx_req	INITIAL CONTEXT SETUP REQUEST PDUs received
s1ap.proxy.in_pkt.init_ctx_rsp	INITIAL CONTEXT SETUP RESPONSE PDUs received
s1ap.proxy.in_pkt.release_ctx_req	UE CONTEXT RELEASE REQUEST PDUs received
s1ap.proxy.in_pkt.release_ctx_cmd	UE CONTEXT RELEASE COMMAND PDUs received
s1ap.proxy.in_pkt.release_ctx_compl	UE CONTEXT RELEASE COMPLETE PDUs received
s1ap.proxy.in_pkt.handover_cmd	HANDOVER COMMAND PDUs received
s1ap.proxy.in_pkt.handover_req	HANDOVER REQUEST PDUs received
s1ap.proxy.in_pkt.handover_req_ack	HANDOVER REQUEST ACKNOWLEDGE PDUs received

Metric name	Description
s1ap.proxy.out_pkt.forward.all	S1AP PDUs forwarded (total)
s1ap.proxy.out_pkt.forward.proc	S1AP PDUs forwarded after processing (with IE rewriting)
s1ap.proxy.out_pkt.forward.unmodified	S1AP PDUs forwarded without modification
s1ap.proxy.out_pkt.reply.all	S1AP PDUs generated locally by the proxy (total)
s1ap.proxy.out_pkt.reply.erab_setup_rsp	E-RAB SETUP RESPONSE PDUs generated locally

7.2.3 eNB Proxy Counters

Metric name	Description
enb_proxy.s1setup.req	S1 SETUP REQUEST PDUs received from eNBs
enb_proxy.s1setup.rsp	S1 SETUP RESPONSE PDUs received from the MME and forwarded
enb_proxy.s1setup.failure	S1 SETUP FAILURE PDUs received from an MME (triggers retry)
enb_proxy.s1setup.req.timeout	Timeouts waiting for S1 SETUP REQUEST from an eNB
enb_proxy.s1setup.rsp.timeout	Timeouts waiting for S1 SETUP RESPONSE from an MME
enb_proxy.conn_est.timeout	MME SCTP connection establishment timeouts
enb_proxy.conn_est.failure	MME SCTP connection establishment failures
enb_proxy.unexpected_pdu	Unexpected PDUs received from an eNB or MME
enb_proxy.malformed_pdu	Malformed PDUs received from an eNB or MME
enb_proxy.mme_select.ok	Successful MME selections from the pool
enb_proxy.mme_select.error	Failed MME selections (pool exhausted)

7.2.4 SCTP Error Counters

Metric name	Description
sctp.error.all	Total number of SCTP errors
sctp.error.send_failed	SCTP send operation failures
sctp.error.pdapi_event	SCTP partial delivery API failures
sctp.error.remote_error	SCTP remote error notifications

7.3 Per-eNB Counters

When an eNB connects and its Global-eNB-ID becomes known (after the S1 Setup procedure), OsmoS1GW dynamically creates a set of per-eNB counters scoped to that eNB. These counters mirror the global eNB proxy counters but are broken down per connected base station.

The naming scheme for per-eNB counters is `enb.{Global-eNB-ID}.{suffix}`, where `{Global-eNB-ID}` is the MCC-MNC-eNBId string (e.g. `001-01-1337`).

In addition to the mirrored proxy counters, the following per-eNB counters are also registered:

Metric name	Description
enb.{id}.uptime	Time (in seconds) since the eNB connected
enb.{id}.gtpu.packets.ul	GTP-U uplink packets (requires GTP-U KPI)
enb.{id}.gtpu.packets.dl	GTP-U downlink packets (requires GTP-U KPI)
enb.{id}.gtpu.bytes.ue.ul	GTP-U uplink bytes (UE side, requires GTP-U KPI)
enb.{id}.gtpu.bytes.ue.dl	GTP-U downlink bytes (UE side, requires GTP-U KPI)
enb.{id}.gtpu.bytes.total.ul	GTP-U uplink bytes (total, requires GTP-U KPI)
enb.{id}.gtpu.bytes.total.dl	GTP-U downlink bytes (total, requires GTP-U KPI)

GTP-U counters are only populated when the GTP-U KPI module is enabled (see Section 6.5).

7.4 Per-MME Counters

When an MME is registered in the pool — either at startup from the configuration file (see Section 6.2) or dynamically via the REST API (see Section 10.5) — OsmoS1GW creates a set of per-MME counters scoped to that MME entry.

The naming scheme is `mme.{name}.{suffix}`, where `{name}` is the MME's configured name (e.g. `mme0`).

Metric name	Description
`mme.{name}.selected`	Number of times this MME was selected for a connection attempt
`mme.{name}.conn_est.timeout`	Connection establishment timeouts to this MME
`mme.{name}.conn_est.failure`	Connection establishment failures to this MME
`mme.{name}.s1setup.rsp`	Successful S1 Setup procedures completed via this MME
`mme.{name}.s1setup.failure`	S1 SETUP FAILURE responses received from this MME
`mme.{name}.s1setup.rsp.timeout`	Timeouts waiting for S1 SETUP RESPONSE from this MME

7.5 Gauges

Metric name	Description
`pfcp.associated`	`1` if the PFCP association with the UPF is currently established, `0` otherwise
`s1ap.enb.num_sctp_connections`	Current number of active eNB SCTP connections

8 GTP-U KPI Monitoring

OsmoS1GW includes an optional GTP-U KPI monitoring module that tracks per-eNB GTP-U traffic volume. Because OsmoS1GW does not carry GTP-U traffic itself (see Section 4.2), it cannot count packets and bytes from the data path directly. Instead, it leverages the Linux nftables framework: when an eNB connects and its GTP-U transport address becomes known, OsmoS1GW dynamically installs nftables rules with named counters to measure the traffic for that eNB. The counters are polled at a configurable interval and the results are exposed as exometer metrics.

This feature is disabled by default. See Section 6.5 for the configuration parameters.

8.1 Requirements

- Linux kernel 5.2 or later with nftables support.
- The `CAP_NET_ADMIN` capability is required to manipulate nftables rules. This is already granted by the installed systemd unit (see Section 5.3.2).

8.2 How It Works

8.2.1 nftables Table and Chains

At startup, the GTP-U KPI module creates a dedicated nftables table (an `inet` family table named `osmo-s1gw` by default, configurable via `gtpu_kpi_table_name`). The table is marked as process-owned, so the kernel automatically removes it if OsmoS1GW terminates unexpectedly. If a table with the same name already exists from a previous run, it is flushed first.

Inside this table the module creates two base chains:

`gtpu-ul` (hook: `prerouting`)
: Counts uplink GTP-U traffic — packets whose source address matches a registered eNB's GTP-U address.

`gtpu-dl` (hook: `postrouting`)
: Counts downlink GTP-U traffic — packets whose destination address matches a registered eNB's GTP-U address.

Both chains prepend two rules that fast-skip non-GTP-U packets (i.e. anything that is not UDP or whose destination port is not 2152).

8.2.2 GTP-U Address Learning

GTP-U transport addresses are not explicitly configured; they are learned at run time from the S1AP signalling exchanged during E-RAB establishment. The source of the address used for nftables rule matching is controlled by the `gtpu_kpi_ul_addr` and `gtpu_kpi_dl_addr` configuration parameters:

`s1ap` (default)
: The GTP-U address is taken from the F-TEID IEs carried in S1AP PDUs (E-RAB Setup, Initial Context Setup, etc.).

`sctp`
: The GTP-U address is assumed to be the same as the eNB's SCTP source address. Useful when the GTP-U and S1AP addresses are always the same.

8.2.3 Per-eNB Counter Rules

Once an eNB's GTP-U address is known, the module adds:

- A named nftables counter (`ul-{GlobalENBId}` for uplink, `dl-{GlobalENBId}` for downlink).
- A rule in the appropriate chain that matches packets by source (UL) or destination (DL) IP address and updates the corresponding counter.

When an eNB disconnects, the matching nftables rule is removed, but the counter object is intentionally left in place. This means counters accumulate across reconnections of the same eNB and do not reset to zero if the eNB briefly drops and re-establishes its connection.

8.2.4 Counter Polling and Metric Reporting

A periodic timer (interval configurable via `gtpu_kpi_interval`, default 3000 ms) fires and reads all named counters from the nftables table. For each registered eNB the difference since the last poll is computed and added to the corresponding exometer counters.

Three metrics are maintained per eNB per direction (see also Section 7.3):

`enb.{id}.gtpu.packets.{ul|dl}`
: Total number of GTP-U packets seen for this eNB.

`enb.{id}.gtpu.bytes.total.{ul|dl}`
: Total bytes seen for this eNB, including the outer IP, UDP, and GTP-U headers (i.e. what nftables reports).

`enb.{id}.gtpu.bytes.ue.{ul|dl}`
: Estimated UE payload bytes — total bytes minus the fixed overhead of the outer IP header (20 bytes), UDP header (8 bytes), and GTP-U header (8 bytes), i.e. 36 bytes per packet.

Note
The UE payload byte estimate assumes a fixed 20-byte IP header. IPv6 or IP options would result in a slight overcount in the overhead subtraction.

---

9 Interactive CLI (`osmo-s1gw-cli`)

Unlike the other Osmocom projects, OsmoS1GW does not have a traditional telnet/VTY interface. Instead, it comes with `osmo-s1gw-cli` — an interactive command-line shell built on Python's cmd2 library. It communicates with OsmoS1GW via the REST interface (see Section 10), and provides a convenient alternative to issuing raw HTTP requests.

9.1 Installation

`osmo-s1gw-cli` is available as the `osmo-s1gw-cli` binary package from the Osmocom package repository (see Section 5.2.1).

When building from source, the following Python packages are required:

- cmd2
- tabulate

Install via pip:

```
pip install cmd2 tabulate
```

Or via the system package manager (Debian/Ubuntu):

```
sudo apt install python3-cmd2 python3-tabulate
```

After `make install` (see Section 5.2.2.3), the CLI is available system-wide as `osmo-s1gw-cli`.

9.2 Usage

```
osmo-s1gw-cli [-h] [-v] [-p PORT] [HOST]

  HOST   OsmoS1GW REST host/address (default: localhost)
  -p     REST port (default: 8080)
  -v     Enable verbose/debug logging
```

Once inside the shell, available commands can be listed with `help -v` and per-command help is accessible with `help <command>`. In addition to tab-completion, output can be filtered (`CMD | grep ...`) or redirected to a file (`CMD > FILE`).

9.3 Commands

9.3.1 config_show

Display the effective runtime configuration (see Section 10.2).

Example:

```
OsmoS1GW# config_show

[gtpu_kpi]
| Parameter    | Value     |
|-------------|-----------|
| enable       | False     |
| interval     | 3000      |
| table_name   | osmo-s1gw |

[pfcp]
| Parameter    | Value      |
|-------------|------------|
| laddr        | 127.0.3.1  |
| raddr        | 127.0.3.10 |

[rest]
| Parameter    |   Value |
|-------------|---------|
| port         |    8080 |
```

```
| swagger_ui  |    True |

[sctp_client]
| Parameter   | Value                                                     |
|-------------|-----------------------------------------------------------|
| laddr       | 127.0.2.1                                                 |
| raddr       | 127.0.2.10                                                |
| rport       | 36412                                                     |
| sockopts    | {'recbuf': 65536, 'sctp_nodelay': True, 'sndbuf': 65536} |

[sctp_server]
| Parameter   | Value                                                     |
|-------------|-----------------------------------------------------------|
| laddr       | 127.0.1.1                                                 |
| lport       | 36412                                                     |
| sockopts    | {'recbuf': 65536, 'sctp_nodelay': True, 'sndbuf': 65536} |
```

9.3.2 `fetch_openapi_spec`

Fetch the OpenAPI specification (JSON) from the server and display it.

9.3.3 `metrics_list`

Get a list of metrics, optionally filtered by type and/or name path.

```
Usage: metrics_list [-h] [-t {all,counter,gauge}] [PATH]

positional arguments:
  PATH                  Metric path prefix (dot-separated)

optional arguments:
  -t, --type {all,counter,gauge}
                        Metric type (default: all)
```

Example: obtaining PFCP association metrics.

```
OsmoS1GW# metrics_list pfcp.assoc
| Name                           | Type    |   Value |
|--------------------------------|---------|---------|
| pfcp.assoc_setup_req.timeout   | counter |      21 |
| pfcp.assoc_setup_req.tx        | counter |      22 |
| pfcp.assoc_setup_resp.rx       | counter |       0 |
| pfcp.assoc_setup_resp.rx_ack   | counter |       0 |
| pfcp.assoc_setup_resp.rx_nack  | counter |       0 |
| pfcp.associated                | gauge   |       0 |
```

Example: listing all gauge metrics.

```
OsmoS1GW# metrics_list --type gauge
| Name                           | Type   |   Value |
|--------------------------------|--------|---------|
| pfcp.associated                | gauge  |       0 |
| s1ap.enb.num_sctp_connections  | gauge  |       0 |
```

9.3.4 `pfcp_assoc_state`

Display the current PFCP association state.

```
OsmoS1GW# pfcp_assoc_state
| Parameter                  | Value      |
|----------------------------|------------|
| State                      | connected  |
| Local address              | 127.0.3.1  |
| Remote address             | 127.0.3.10 |
| Local Recovery TimeStamp   | 3967211233 |
| Remote Recovery TimeStamp  | 3965211123 |
```

9.3.5 pfcp_assoc_setup

Initiate the PFCP Association Setup procedure.

9.3.6 pfcp_assoc_release

Initiate the PFCP Association Release procedure.

9.3.7 pfcp_heartbeat

Send a PFCP Heartbeat Request to the UPF and display the result.

```
OsmoS1GW# pfcp_heartbeat
Heartbeat succeeded

OsmoS1GW# pfcp_heartbeat
Heartbeat failed: timeout
```

9.3.8 mme_list

List the MMEs currently registered in the pool.

```
Usage: mme_list [-h] [-S {none,name,laddr,raddr}] [--reverse]

optional arguments:
  -S, --sort-by {none,name,laddr,raddr}
                         Sort by (default: none)
  --reverse              Reverse sort order
```

Example:

```
OsmoS1GW# mme_list
| Name   | Local address    | Remote address/port    | Allowed TACs    |
|--------|------------------|------------------------|-----------------|
| mme0   | 127.0.2.1        | 127.0.2.10:36412       | all             |
| mme1   | 127.0.2.1        | 127.0.2.11:36412       | all             |
| mme2   | 127.0.2.1        | 127.0.2.12:36412       | all             |
```

9.3.9 mme_add

Add an MME to the pool.


```
Usage: mme_add -N NAME -ra RADDR [-h] [-la LADDR] [-rp RPORT] [--tac TAC_LIST]

Add an MME to the pool

required arguments:
  -N, --name NAME     MME name (example: mme0)
  -ra, --raddr RADDR  Remote address (example: 192.168.1.101)

optional arguments:
  -la, --laddr LADDR  Local address (default: any)
  -rp, --rport RPORT  Remote port (default: 36412)
  --tac TAC_LIST      Allowed TAC (Tracking Area Code)
```

Example:

```
OsmoS1GW# mme_add --name mme42 --raddr 192.168.1.101
```

9.3.10 `mme_info`

Show configuration details for a specific MME.

```
Usage: mme_info [-h] (-N NAME | -a ADDR[:PORT])

MME ID:
  -N, --name NAME          MME name (example: mme0)
  -a, --addr ADDR[:PORT]   MME address with optional port (default: 36412),
                           e.g. 192.168.1.1 or 192.168.1.1:36412
```

Example:

```
OsmoS1GW# mme_info --name mme0
| Parameter           | Value             |
|---------------------|-------------------|
| Name                | mme0              |
| Local address       | any               |
| Remote address/port | 127.0.2.10:36412 |
| Allowed TACs        | all               |
```

9.3.11 `mme_delete`

Remove an MME from the pool.

```
Usage: mme_delete [-h] (-N NAME | -a ADDR[:PORT])

MME ID:
  -N, --name NAME          MME name (example: mme0)
  -a, --addr ADDR[:PORT]   MME address with optional port (default: 36412),
                           e.g. 192.168.1.1 or 192.168.1.1:36412
```

Example:

```
OsmoS1GW# mme_delete --name mme0
```

9.3.12 enb_list

List all currently connected eNBs.

```
Usage: enb_list [-h] [-S {handle,pid,state,genb_id,uptime}] [--reverse]

optional arguments:
  -S, --sort-by {handle,pid,state,genb_id,uptime}
                        Sort by (default: handle)
  --reverse             Reverse sort order
```

Example (address columns omitted for readability):

```
OsmoS1GW# enb_list
|   handle | PID       | Global-eNB-ID  | State      | ... | MME name |   Uptime |   E-RABs |
|----------|-----------|----------------|------------|~~~~~|----------|----------|----------|
|        0 | <0.699.0> | 001-01-0       | connected  | ... | mme0     |      418 |        0 |
|        1 | <0.701.0> | 001-01-1       | connected  | ... | mme0     |       33 |        3 |
|        2 | <0.703.0> | 001-01-2       | connected  | ... | mme0     |     3600 |       20 |
```

9.3.13 enb_info

Show details for a specific eNB. The eNB can be identified by any of the following selectors:

```
Usage: enb_info [-h] (-H HANDLE | -P PID | -G GENBID |
                      --enb-sctp-aid AID | --mme-sctp-aid AID |
                      --enb-conn ADDR:PORT)

eNB ID:
  -H, --handle HANDLE      eNB handle (example: 0)
  -P, --pid PID            eNB process ID (example: 0.33.1)
  -G, --genbid GENBID      Global-eNB-ID (example: 262-42-1337)
  --enb-sctp-aid AID       eNB SCTP association identifier
  --mme-sctp-aid AID       MME SCTP association identifier
  --enb-conn ADDR:PORT     eNB connection address/port (example: 192.168.1.1:34650)
```

Example: selecting by handle.

```
OsmoS1GW# enb_info -H 8
| Parameter              | Value                    |
|------------------------|--------------------------|
| eNB handle             | 8                        |
| PID                    | <0.715.0>                |
| Global-eNB-ID          | 001-01-8                 |
| State                  | connected                |
| eNB saddr:sport (aid)  | 127.0.1.10:57362 (5734)  |
| MME saddr:sport (aid)  | 127.0.2.1:73421 (5745)   |
| MME daddr:dport (aid)  | 127.0.2.10:36412 (5745)  |
| MME name               | mme0                     |
| Uptime (s)             | 521                      |
| # E-RABs               | 99                       |
```

9.3.14 enb_delete

Force-disconnect an eNB, terminating its SCTP connection. Accepts the same selectors as `enb_info`.

9.3.15 enb_erab_list

List the E-RABs associated with a specific eNB.

```
Usage: enb_erab_list [-h] [-f] [-S {pid,state,mme_ue_id,erab_id}]
                     [--reverse]
                     (-H HANDLE | -P PID | -G GENBID |
                      --enb-sctp-aid AID | --mme-sctp-aid AID |
                      --enb-conn ADDR:PORT)

optional arguments:
  -f, --full   Print full table including PFCP and GTP-U F-TEID columns
  -S, --sort-by {pid,state,mme_ue_id,erab_id}
               Sort by (default: pid)
  --reverse    Reverse sort order
```

Example:

```
OsmoS1GW# enb_erab_list -G 001-01-0
| PID       |   MME-UE-S1AP-ID |    E-RAB-ID | State      |
|-----------|------------------|------------|------------|
| <0.707.0> |             4242 |          0 | erab_setup |
| <0.708.0> |             4242 |          1 | erab_setup |
| <0.709.0> |             4242 |          2 | erab_setup |
```

9.3.16 erab_list

List all E-RABs across all connected eNBs. Accepts the same `-f`, `--sort-by`, and `--reverse` options as `enb_erab_list`.

9.3.17 erab_info

Show details for a specific E-RAB, identified by its process ID.

```
Usage: erab_info -P PID

required arguments:
  -P, --pid PID  E-RAB process ID (example: 0.33.1)
```

Example:

```
OsmoS1GW# erab_info -P 0.714.0
| Parameter      | Value                  |
|----------------|------------------------|
| PID            | <0.714.0>              |
| MME-UE-S1AP-ID | 4242                   |
| E-RAB-ID       | 1                      |
| State          | erab_setup             |
| SEID (local)   | 0x0000000000000002     |
| SEID (remote)  | 0x5454434e2d330001     |
| U2C F-TEID     | 0x00010001@127.0.0.1 |
| C2U F-TEID     | 0x01010001@127.0.1.1 |
| A2U F-TEID     | 0x02020001@127.0.2.2 |
| U2A F-TEID     | 0x00020001@127.0.0.2 |
```

9.3.18 erab_delete

Terminate an E-RAB FSM process, triggering PFCP Session Deletion.

```
Usage: erab_delete -P PID

required arguments:
  -P, --pid PID  E-RAB process ID (example: 0.33.1)
```

10 REST Interface

OsmoS1GW exposes an HTTP REST API for monitoring and management. The API follows the OpenAPI 3.0 specification; the full machine-readable spec is served at `GET /openapi.json`. A Swagger UI is available at `/swagger` when enabled (see Section 6.6). An interactive CLI tool (`osmo-s1gw-cli`) is also available as a convenient alternative to issuing raw HTTP requests — see Section 9.

By default the REST server listens on port `8080`. No authentication is implemented; access control should be enforced at the network level if required.

10.1 Resource Identifiers

Several endpoints accept a resource identifier in the URL path that can be expressed in multiple forms:

10.1.1 MME Identifier (`{MmeId}`)

Form	Pattern	Example
Name	`name:<name>`	`name:mme0`
Address/port	`addr:<ip>-<port>`	`addr:192.168.1.1-36412`

10.1.2 eNB Identifier (`{EnbId}`)

Form	Pattern	Example
Registry handle	`handle:<n>`	`handle:42`
Process ID	`pid:<x>.<y>.<z>`	`pid:0.33.1`
Global-eNB-ID	`genbid:<mcc>-<mnc>-<id>`	`genbid:999-70-1337`
eNB SCTP assoc ID	`enb-sctp-aid:<n>`	`enb-sctp-aid:42`
MME SCTP assoc ID	`mme-sctp-aid:<n>`	`mme-sctp-aid:42`
eNB connection addr	`enb-conn:<ip>-<port>`	`enb-conn:192.168.1.1-34650`

10.1.3 E-RAB Identifier (`{ErabId}`)

Form	Pattern	Example
Process ID	`pid:<x>.<y>.<z>`	`pid:0.33.1`

10.2 Configuration

10.2.1 `GET /config` — Runtime Configuration

Returns the effective runtime configuration that OsmoS1GW is currently using, with all defaults applied. This reflects the values read via `osmo_s1gw:get_env/2` at startup, which may differ from the raw `sys.config` if legacy environment variables were merged in.

Response (HTTP 200):


```
{
  "sctp_server": {
    "laddr": "127.0.1.1",
    "lport": 36412,
    "sockopts": {"recbuf": 65536, "sndbuf": 65536, "sctp_nodelay": true}
  },
  "sctp_client": {
    "laddr": "127.0.2.1",
    "raddr": "127.0.2.10",
    "rport": 36412,
    "sockopts": {"recbuf": 65536, "sndbuf": 65536, "sctp_nodelay": true}
  },
  "pfcp": {
    "laddr": "127.0.1.1",
    "raddr": "127.0.1.2",
    "assoc_setup_timeout": 2000,
    "heartbeat_req_timeout": 2000,
    "heartbeat_interval": 10000
  },
  "gtpu_kpi": {
    "enable": false,
    "table_name": "osmo-s1gw",
    "interval": 3000
  },
  "rest": {
    "port": 8080,
    "swagger_ui": true
  }
}
```

sctp_server
: Configuration of the eNB-facing SCTP server.

  laddr
  : Local bind address.

  lport
  : Local bind port.

  sockopts
  : Effective SCTP socket options, including defaults.

sctp_client
: Legacy/deprecated section reflecting the MME-facing SCTP client defaults. MME pool entries are managed via Section 10.5.

  laddr
  : Local bind address.

  raddr
  : Default remote (MME) address.

  rport
  : Default remote (MME) port.

  sockopts
  : Effective SCTP socket options, including defaults.

pfcp

  laddr
  : Local PFCP bind address.

raddr
: Remote UPF (PFCP peer) address.

assoc_setup_timeout
: PFCP Association Setup response timeout in milliseconds.

heartbeat_req_timeout
: PFCP Heartbeat Request response timeout in milliseconds.

heartbeat_interval
: Periodic PFCP heartbeat interval in milliseconds (0 = disabled).

gtpu_kpi

enable
: Whether GTP-U KPI reporting via nftables counters is active.

table_name
: nftables table name used for GTP-U KPI counters.

interval
: KPI polling interval in milliseconds.

rest

port
: REST server listen port.

swagger_ui
: Whether the Swagger UI endpoint is enabled.

10.3 Metrics

10.3.1 `GET /metrics-list` — List Metrics

Returns a list of all matching metrics with their current values.

Query parameters:

type
: Filter by metric type. One of `all` (default), `counter`, or `gauge`.

path
: Filter by metric name prefix (dot-separated). For example, `s1ap.proxy` returns all metrics whose name starts with `s1ap.proxy`.

Response (HTTP 200):

```
[
  {"type": "counter", "name": "pfcp.heartbeat_req.tx",      "value": 42},
  {"type": "counter", "name": "pfcp.heartbeat_req.timeout", "value": 0},
  {"type": "gauge",   "name": "pfcp.associated",            "value": 1}
]
```

Returns HTTP 404 if no metrics match the given filter.

See Section 7 for the full list of metric names.

10.4 PFCP

10.4.1 GET /pfcp/assoc — PFCP Association State

Returns the current PFCP association state between OsmoS1GW and the UPF.

Response (HTTP 200):

```
{
  "state": "connected",
  "laddr": "127.0.1.1",
  "raddr": "127.0.1.2",
  "lrts": 3967211233,
  "rrts": 3965211123
}
```

state
: Current association state: `connecting` or `connected`.

laddr
: Local PFCP bind address.

raddr
: Remote UPF address.

lrts
: Local Recovery Timestamp.

rrts
: Remote Recovery Timestamp (present only when associated).

10.4.2 POST /pfcp/assoc — Initiate PFCP Association Setup

Triggers an immediate PFCP Association Setup Request to the UPF. Returns an `OperationResult` object indicating success or failure.

10.4.3 DELETE /pfcp/assoc — Release PFCP Association

Initiates a PFCP Association Release procedure. Returns an `OperationResult` object.

10.4.4 POST /pfcp/heartbeat — Send PFCP Heartbeat

Sends a PFCP Heartbeat Request to the UPF and waits for the response. Returns an `OperationResult` object.

10.5 MME Pool

10.5.1 GET /mme-list — List MMEs

Returns the current contents of the MME pool.

Response (HTTP 200):

```
[
  {"name": "mme0", "laddr": "any", "raddr": "192.168.2.10", "rport": 36412, "tac_list":  ↩
      []},
  {"name": "mme1", "laddr": "any", "raddr": "192.168.2.20", "rport": 36412, "tac_list":  ↩
      [100, 101]}
]
```

10.5.2 POST /mme-list — Add MME

Adds a new MME to the pool. The request body is a JSON object with the same fields as the entries returned by `GET /mme-list`:

name (required)
: Unique human-readable name.

raddr (required)
: Remote IP address of the MME.

laddr (optional)
: Local bind address. Default: `"any"`.

rport (optional)
: Remote SCTP port. Default: `36412`.

tac_list (optional)
: List of TACs this MME serves. Default: `[]` (all).

Returns HTTP 201 on success, HTTP 409 if the name or address is already registered.

10.5.3 GET /mme/{MmeId} — MME Info

Returns configuration details for a single MME. The response format is the same as a single element from `GET /mme-list`.

Returns HTTP 404 if no matching MME is found.

10.5.4 DELETE /mme/{MmeId} — Delete MME

Removes an MME from the pool. Active connections to this MME are not affected; the change only prevents the MME from being selected for future connection attempts.

Returns HTTP 200 on success, HTTP 404 if no matching MME is found.

10.6 eNB Connections

10.6.1 GET /enb-list — List eNB Connections

Returns a list of all currently connected eNBs.

Response (HTTP 200):

```
[
  {
    "handle": 0,
    "pid": "<0.699.0>",
    "genb_id": "001-01-0",
    "plmn_id": {"mcc": "001", "mnc": "01"},
    "enb_id": 0,
    "state": "connected",
    "enb_saddr": "192.168.1.10",
    "enb_sport": 56767,
    "enb_sctp_aid": 5706,
    "mme_name": "mme0",
    "mme_saddr": "192.168.2.1",
    "mme_sport": 34500,
    "mme_daddr": "192.168.2.10",
    "mme_dport": 36412,
```

```
    "mme_sctp_aid": 5707,
    "uptime": 418,
    "erab_count": 3
  }
]
```

handle
: Unique integer identifier within the eNB registry.

pid
: Erlang process ID of the `enb_proxy` process.

genb_id
: Global-eNB-ID (MCC-MNC-eNBId) parsed from the S1 Setup Request.

plmn_id
: PLMN identifier as received in the S1 Setup Request, encoded as an object with `mcc` and `mnc` string fields.

enb_id
: eNB identifier (integer) parsed from the S1 Setup Request.

state
: Current proxy state: `wait_s1setup_req`, `connecting`, `wait_s1setup_rsp`, or `connected`.

enb_saddr / enb_sport
: Source address and port of the eNB's SCTP connection.

enb_sctp_aid
: SCTP association ID of the eNB-S1GW connection.

mme_name
: Name of the selected MME (from the MME pool).

mme_saddr / mme_sport
: Local address and port of the S1GW-MME SCTP connection.

mme_daddr / mme_dport
: Destination address and port of the MME.

mme_sctp_aid
: SCTP association ID of the S1GW-MME connection.

uptime
: Seconds since the eNB connected.

erab_count
: Number of currently active E-RABs for this eNB.

10.6.2 `GET /enb/{EnbId}` — eNB Info

Returns details for a single eNB. The response format is the same as a single element from `GET /enb-list`.

Returns HTTP 404 if no matching eNB is found.

10.6.3 `DELETE /enb/{EnbId}` — Force Disconnect eNB

Forcibly terminates the SCTP connection to the specified eNB. This causes the eNB to reconnect and restart the S1 Setup procedure.

Returns HTTP 200 on success, HTTP 404 if no matching eNB is found.

10.7 E-RAB Bearers

10.7.1 GET /erab-list — List All E-RABs

Returns a list of all active E-RABs across all connected eNBs.

10.7.2 GET /enb/{EnbId}/erab-list — List E-RABs for an eNB

Returns all active E-RABs for a specific eNB.

Returns HTTP 404 if no matching eNB is found.

The response for both list endpoints is an array of E-RAB objects (same format as `GET /erab/{ErabId}`).

10.7.3 GET /erab/{ErabId} — E-RAB Info

Returns details for a single E-RAB.

Response (HTTP 200):

```
{
  "pid": "<0.714.0>",
  "mme_ue_id": 4242,
  "erab_id": 1,
  "state": "erab_setup",
  "pfcp_lseid": 2,
  "pfcp_rseid": 6076548759901618177,
  "f_teid_u2c": {"teid": 65537, "tla": "127.0.0.1"},
  "f_teid_c2u": {"teid": 16842753, "tla": "127.0.1.1"},
  "f_teid_a2u": {"teid": 33686529, "tla": "127.0.2.2"},
  "f_teid_u2a": {"teid": 131073, "tla": "127.0.0.2"}
}
```

pid
Erlang process ID of the `erab_fsm` process.

mme_ue_id
MME-UE-S1AP-ID.

erab_id
E-RAB-ID.

state
Current FSM state.

pfcp_lseid / pfcp_rseid
Local and remote PFCP SEIDs.

f_teid_u2c
GTP-U F-TEID for UPF → Core direction.

f_teid_c2u
GTP-U F-TEID for Core → UPF direction.

f_teid_a2u
GTP-U F-TEID for Access (eNB) → UPF direction.

f_teid_u2a
GTP-U F-TEID for UPF → Access (eNB) direction.

Each F-TEID object has a `teid` (integer) and a `tla` (Transport Layer Address, dotted IP string).

10.7.4 `DELETE /erab/{ErabId}` — Terminate E-RAB

Forcibly terminates the `erab_fsm` process for the given E-RAB. This triggers PFCP Session Deletion towards the UPF. Use with caution on live connections.

Returns HTTP 200 on success, HTTP 404 if no matching E-RAB is found.

11 Glossary

2FF
: 2nd Generation Form Factor; the so-called plug-in SIM form factor

3FF
: 3rd Generation Form Factor; the so-called microSIM form factor

3GPP
: 3rd Generation Partnership Project

4FF
: 4th Generation Form Factor; the so-called nanoSIM form factor

A Interface
: Interface between BTS and BSC, traditionally over E1 (*3GPP TS 48.008* [3gpp-ts-48-008])

A3/A8
: Algorithm 3 and 8; Authentication and key generation algorithm in GSM and GPRS, typically COMP128v1/v2/v3 or MILENAGE are typically used

A5
: Algorithm 5; Air-interface encryption of GSM; currently only A5/0 (no encryption), A5/1 and A5/3 are in use

Abis Interface
: Interface between BTS and BSC, traditionally over E1 (*3GPP TS 48.058* [3gpp-ts-48-058] and *3GPP TS 52.021* [3gpp-ts-52-021])

ACC
: Access Control Class; every BTS broadcasts a bit-mask of permitted ACC, and only subscribers with a SIM of matching ACC are permitted to use that BTS

AGCH
: Access Grant Channel on Um interface; used to assign a dedicated channel in response to RACH request

AGPL
: GNU Affero General Public License, a copyleft-style Free Software License

AQPSK
: Adaptive QPSK, a modulation scheme used by VAMOS channels on Downlink

ARFCN
: Absolute Radio Frequency Channel Number; specifies a tuple of uplink and downlink frequencies

AUC
: Authentication Center; central database of authentication key material for each subscriber

BCCH
: Broadcast Control Channel on Um interface; used to broadcast information about Cell and its neighbors

BCC
: Base Station Color Code; short identifier of BTS, lower part of BSIC

BTS
Base Transceiver Station

BSC
Base Station Controller

BSIC
Base Station Identity Code; 16bit identifier of BTS within location area

BSSGP
Base Station Subsystem Gateway Protocol (*3GPP TS 48.018* [3gpp-ts-48-018])

BVCI
BSSGP Virtual Circuit Identifier

CBC
Cell Broadcast Centre; central entity of Cell Broadcast service

CBCH
Cell Broadcast Channel; used to transmit Cell Broadcast SMS (SMS-CB)

CBS
Cell Broadcast Service

CBSP
Cell Broadcast Service Protocol (*3GPP TS 48.049* [3gpp-ts-48-049])

CC
Call Control; Part of the GSM Layer 3 Protocol

CCCH
Common Control Channel on Um interface; consists of RACH (uplink), BCCH, PCH, AGCH (all downlink)

Cell
A cell in a cellular network, served by a BTS

CEPT
Conférence européenne des administrations des postes et des télécommunications; European Conference of Postal and Telecommunications Administrations.

CGI
Cell Global Identifier comprised of MCC, MNC, LAC and BSIC

CSFB
Circiut-Switched Fall Back; Mechanism for switching from LTE/EUTRAN to UTRAN/GERAN when circuit-switched services such as voice telephony are required.

dB
deci-Bel; relative logarithmic unit

dBm
deci-Bel (milliwatt); unit of measurement for signal strength of radio signals

DHCP
Dynamic Host Configuration Protocol (*IETF RFC 2131* [ietf-rfc2131])

downlink
Direction of messages / signals from the network core towards the mobile phone

DSCP
Differentiated Services Code Point (*IETF RFC 2474* [ietf-rfc2474])

DSP
Digital Signal Processor

dvnixload
: Tool to program UBL and the Bootloader on a sysmoBTS

EDGE
: Enhanced Data rates for GPRS Evolution; Higher-speed improvement of GPRS; introduces 8PSK

EGPRS
: Enhanced GPRS; the part of EDGE relating to GPRS services

EIR
: Equipment Identity Register; core network element that stores and manages IMEI numbers

ESME
: External SMS Entity; an external application interfacing with a SMSC over SMPP

ETSI
: European Telecommunications Standardization Institute

FPGA
: Field Programmable Gate Array; programmable digital logic hardware

Gb
: Interface between PCU and SGSN in GPRS/EDGE network; uses NS, BSSGP, LLC

GERAN
: GPRS/EDGE Radio Access Network

GGSN
: GPRS Gateway Support Node; gateway between GPRS and external (IP) network

GMSK
: Gaussian Minimum Shift Keying; modulation used for GSM and GPRS

GPL
: GNU General Public License, a copyleft-style Free Software License

Gp
: Gp interface between SGSN and GGSN; uses GTP protocol

GPRS
: General Packet Radio Service; the packet switched 2G technology

GPS
: Global Positioning System; provides a highly accurate clock reference besides the global position

GSM
: Global System for Mobile Communications. ETSI/3GPP Standard of a 2G digital cellular network

GSMTAP
: GSM tap; pseudo standard for encapsulating GSM protocol layers over UDP/IP for analysis

GSUP
: Generic Subscriber Update Protocol. Osmocom-specific alternative to TCAP/MAP

GT
: Global Title; an address in SCCP

GTP
: GPRS Tunnel Protocol; used between SGSN and GGSN

HLR
: Home Location Register; central subscriber database of a GSM network

HNB-GW
: Home NodeB Gateway. Entity between femtocells (Home NodeB) and CN in 3G/UMTS.

HPLMN
: Home PLMN; the network that has issued the subscriber SIM and has his record in HLR

IE
: Information Element

IMEI
: International Mobile Equipment Identity; unique 14-digit decimal number to globally identify a mobile device, optionally with a 15th checksum digit

IMEISV
: IMEI software version; unique 14-digit decimal number to globally identify a mobile device (same as IMEI) plus two software version digits (total digits: 16)

IMSI
: International Mobile Subscriber Identity; 15-digit unique identifier for the subscriber/SIM; starts with MCC/MNC of issuing operator

IP
: Internet Protocol (*IETF RFC 791* [ietf-rfc791])

IPA
: *ip.access GSM over IP* protocol; used to multiplex a single TCP connection

Iu
: Interface in 3G/UMTS between RAN and CN

IuCS
: Iu interface for circuit-switched domain. Used in 3G/UMTS between RAN and MSC

IuPS
: Iu interface for packet-switched domain. Used in 3G/UMTS between RAN and SGSN

LAC
: Location Area Code; 16bit identifier of Location Area within network

LAPD
: Link Access Protocol, D-Channel (*ITU-T Q.921* [itu-t-q921])

LAPDm
: Link Access Protocol Mobile (*3GPP TS 44.006* [3gpp-ts-44-006])

LLC
: Logical Link Control; GPRS protocol between MS and SGSN (*3GPP TS 44.064* [3gpp-ts-44-064])

Location Area
: Location Area; a geographic area containing multiple BTS

LU
: Location Updating; can be of type IMSI-Attach or Periodic. Procedure that indicates a subscriber's physical presence in a given radio cell.

M2PA
: MTP2 Peer-to-Peer Adaptation; a SIGTRAN Variant (*RFC 4165* [ietf-rfc4165])

M2UA
: MTP2 User Adaptation; a SIGTRAN Variant (*RFC 3331* [ietf-rfc3331])

M3UA
: MTP3 User Adaptation; a SIGTRAN Variant (*RFC 4666* [ietf-rfc4666])

MCC
: Mobile Country Code; unique identifier of a country, e.g. 262 for Germany

MFF
Machine-to-Machine Form Factor; a SIM chip package that is soldered permanently onto M2M device circuit boards.

MGW
Media Gateway

MM
Mobility Management; part of the GSM Layer 3 Protocol

MNC
Mobile Network Code; identifies network within a country; assigned by national regulator

MNCC
Mobile Network Call Control; Unix domain socket based Interface between MSC and external call control entity like osmo-sip-connector

MNO
Mobile Network Operator; operator with physical radio network under his MCC/MNC

MO
Mobile Originated. Direction from Mobile (MS/UE) to Network

MS
Mobile Station; a mobile phone / GSM Modem

MSC
Mobile Switching Center; network element in the circuit-switched core network

MSC pool
A number of redundant MSCs serving the same core network, which a BSC / RNC distributes load across; see also the "MSC Pooling" chapter in OsmoBSC's user manual [userman-osmobsc] and *3GPP TS 23.236* [3gpp-ts-23-236]

MSISDN
Mobile Subscriber ISDN Number; telephone number of the subscriber

MT
Mobile Terminated. Direction from Network to Mobile (MS/UE)

MTP
Message Transfer Part; SS7 signaling protocol (*ITU-T Q.701* [itu-t-q701])

MVNO
Mobile Virtual Network Operator; Operator without physical radio network

NCC
Network Color Code; assigned by national regulator

NITB
Network In The Box; combines functionality traditionally provided by BSC, MSC, VLR, HLR, SMSC functions; see OsmoNITB

NRI
Network Resource Indicator, typically 10 bits of a TMSI indicating which MSC of an MSC pool attached the subscriber; see also the "MSC Pooling" chapter in OsmoBSC's user manual [userman-osmobsc] and *3GPP TS 23.236* [3gpp-ts-23-236]

NSEI
NS Entity Identifier

NVCI
NS Virtual Circuit Identifier

NWL
Network Listen; ability of some BTS to receive downlink from other BTSs

NS
Network Service; protocol on Gb interface (*3GPP TS 48.016* [3gpp-ts-48-016])

OCXO
Oven Controlled Crystal Oscillator; very high precision oscillator, superior to a VCTCXO

OML
Operation & Maintenance Link (ETSI/*3GPP TS 52.021* [3gpp-ts-52-021])

OpenBSC
Open Source implementation of GSM network elements, specifically OsmoBSC, OsmoNITB, OsmoSGSN

OpenGGSN
Open Source implementation of a GPRS Packet Control Unit

OpenVPN
Open-Source Virtual Private Network; software employed to establish encrypted private networks over untrusted public networks

Osmocom
Open Source MObile COMmunications; collaborative community for implementing communications protocols and systems, including GSM, GPRS, TETRA, DECT, GMR and others

OsmoBSC
Open Source implementation of a GSM Base Station Controller

OsmoNITB
Open Source implementation of a GSM Network In The Box, combines functionality traditionally provided by BSC, MSC, VLR, HLR, AUC, SMSC

OsmoSGSN
Open Source implementation of a Serving GPRS Support Node

OsmoPCU
Open Source implementation of a GPRS Packet Control Unit

OTA
Over-The-Air; Capability of operators to remotely reconfigure/reprogram ISM/USIM cards

PC
Point Code; an address in MTP

PCH
Paging Channel on downlink Um interface; used by network to page an MS

PCP
Priority Code Point (*IEEE 802.1Q* [?])

PCU
Packet Control Unit; used to manage Layer 2 of the GPRS radio interface

PDCH
Packet Data Channel on Um interface; used for GPRS/EDGE signalling + user data

PIN
Personal Identification Number; a number by which the user authenticates to a SIM/USIM or other smart card

PLMN
Public Land Mobile Network; specification language for a single GSM network

PUK
PIN Unblocking Code; used to unblock a blocked PIN (after too many wrong PIN attempts)

RAC
Routing Area Code; 16bit identifier for a Routing Area within a Location Area

RACH
Random Access Channel on uplink Um interface; used by MS to request establishment of a dedicated channel

RAM
Remote Application Management; Ability to remotely manage (install, remove) Java Applications on SIM/USIM Card

RF
Radio Frequency

RFM
Remote File Management; Ability to remotely manage (write, read) files on a SIM/USIM card

Roaming
Procedure in which a subscriber of one network is using the radio network of another network, often in different countries; in some countries national roaming exists

Routing Area
Routing Area; GPRS specific sub-division of Location Area

RR
Radio Resources; Part of the GSM Layer 3 Protocol

RSL
Radio Signalling Link (*3GPP TS 48.058* [3gpp-ts-48-058])

RTP
Real-Time Transport Protocol (*IETF RFC 3550* [ietf-rfc3550]); Used to transport audio/video streams over UDP/IP

SACCH
Slow Associate Control Channel on Um interface; bundled to a TCH or SDCCH, used for signalling in parallel to active dedicated channel

SCCP
Signaling Connection Control Part; SS7 signaling protocol (*ITU-T Q.711* [itu-t-q711])

SDCCH
Slow Dedicated Control Channel on Um interface; used for signalling and SMS transport in GSM

SDK
Software Development Kit

SGs
Interface between MSC (GSM/UMTS) and MME (LTE/EPC) to facilitate CSFB and SMS.

SGSN
Serving GPRS Support Node; Core network element for packet-switched services in GSM and UMTS.

SIGTRAN
Signaling Transport over IP (*IETF RFC 2719* [ietf-rfc2719])

SIM
Subscriber Identity Module; small chip card storing subscriber identity

Site
A site is a location where one or more BTSs are installed, typically three BTSs for three sectors

SMPP
Short Message Peer-to-Peer; TCP based protocol to interface external entities with an SMSC

SMSC
Short Message Service Center; store-and-forward relay for short messages

SS7
: Signaling System No. 7; Classic digital telephony signaling system

SS
: Supplementary Services; query and set various service parameters between subscriber and core network (e.g. USSD, 3rd-party calls, hold/retrieve, advice-of-charge, call deflection)

SSH
: Secure Shell; *IETF RFC 4250* [ietf-rfc4251] to 4254

SSN
: Sub-System Number; identifies a given SCCP Service such as MSC, HLR

STP
: Signaling Transfer Point; A Router in SS7 Networks

SUA
: SCCP User Adaptation; a SIGTRAN Variant (*RFC 3868* [ietf-rfc3868])

syslog
: System logging service of UNIX-like operating systems

System Information
: A set of downlink messages on the BCCH and SACCH of the Um interface describing properties of the cell and network

TCH
: Traffic Channel; used for circuit-switched user traffic (mostly voice) in GSM

TCP
: Transmission Control Protocol; (*IETF RFC 793* [ietf-rfc793])

TFTP
: Trivial File Transfer Protocol; (*IETF RFC 1350* [ietf-rfc1350])

TOS
: Type Of Service; bit-field in IPv4 header, now re-used as DSCP (*IETF RFC 791* [ietf-rfc791])

TRX
: Transceiver; element of a BTS serving a single carrier

TS
: Technical Specification

u-Boot
: Boot loader used in various embedded systems

UBI
: An MTD wear leveling system to deal with NAND flash in Linux

UBL
: Initial bootloader loaded by the TI Davinci SoC

UDP
: User Datagram Protocol (*IETF RFC 768* [ietf-rfc768])

UICC
: Universal Integrated Chip Card; A smart card according to *ETSI TR 102 216* [etsi-tr102216]

Um interface
: U mobile; Radio interface between MS and BTS

uplink
: Direction of messages: Signals from the mobile phone towards the network

USIM
Universal Subscriber Identity Module; application running on a UICC to provide subscriber identity for UMTS and GSM networks

USSD
Unstructured Supplementary Service Data; textual dialog between subscriber and core network, e.g. **100 → Your extension is 1234*

VAMOS
Voice services over Adaptive Multi-user channels on One Slot; an optional extension for GSM specified in Release 9 of 3GPP GERAN specifications (*3GPP TS 48.018* [3gpp-ts-48-018]) allowing two independent UEs to transmit and receive simultaneously on traffic channels

VCTCXO
Voltage Controlled, Temperature Compensated Crystal Oscillator; a precision oscillator, superior to a classic crystal oscillator, but inferior to an OCXO

VLAN
Virtual LAN in the context of Ethernet (*IEEE 802.1Q* [ieee-802.1q])

VLR
Visitor Location Register; volatile storage of attached subscribers in the MSC

VPLMN
Visited PLMN; the network in which the subscriber is currently registered; may differ from HPLMN when on roaming

VTY
Virtual TeletYpe; a textual command-line interface for configuration and introspection, e.g. the OsmoBSC configuration file as well as its telnet link on port 4242

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