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# **pyosmocom-usermanual**

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Within the Osmocom (Open Source Mobile Communications) project family, there have been a number of implementations of key protocols or interfaces in the C language, and occasionally also Erlang.

This repository contains python implementation of key Osmocom related library code, like

- utilities for common problems found in mobile communications
- TLV parsers/encoders
- helpers for 'construct' based encoders/decoders



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### 1.1 osmocom.utils

various pyosmocom utilities osmocom: various utilities

```
class osmocom.utils.JsonEncoder(*, skipkeys=False, ensure_ascii=True, check_circular=True,  
                                allow_nan=True, sort_keys=False, indent=None, separators=None,  
                                default=None)
```

Extend the standard library JSONEncoder with support for more types.

Constructor for JSONEncoder, with sensible defaults.

If skipkeys is false, then it is a TypeError to attempt encoding of keys that are not str, int, float or None. If skipkeys is True, such items are simply skipped.

If ensure\_ascii is true, the output is guaranteed to be str objects with all incoming non-ASCII characters escaped. If ensure\_ascii is false, the output can contain non-ASCII characters.

If check\_circular is true, then lists, dicts, and custom encoded objects will be checked for circular references during encoding to prevent an infinite recursion (which would cause a RecursionError). Otherwise, no such check takes place.

If allow\_nan is true, then NaN, Infinity, and -Infinity will be encoded as such. This behavior is not JSON specification compliant, but is consistent with most JavaScript based encoders and decoders. Otherwise, it will be a ValueError to encode such floats.

If sort\_keys is true, then the output of dictionaries will be sorted by key; this is useful for regression tests to ensure that JSON serializations can be compared on a day-to-day basis.

If indent is a non-negative integer, then JSON array elements and object members will be pretty-printed with that indent level. An indent level of 0 will only insert newlines. None is the most compact representation.

If specified, separators should be an (item\_separator, key\_separator) tuple. The default is (', ', ': ') if indent is None and (',', ':') otherwise. To get the most compact JSON representation, you should specify (',', ':') to eliminate whitespace.

If specified, default is a function that gets called for objects that can't otherwise be serialized. It should return a JSON encodable version of the object or raise a TypeError.

**default**(o)

Implement this method in a subclass such that it returns a serializable object for o, or calls the base implementation (to raise a TypeError).

For example, to support arbitrary iterators, you could implement default like this:

```
def default(self, o):
    try:
        iterable = iter(o)
    except TypeError:
        pass
    else:
        return list(iterable)
    # Let the base class default method raise the TypeError
    return JSONEncoder.default(self, o)
```

`osmocom.utils.all_subclasses(cls)` → set

Recursively get all subclasses of a specified class

`osmocom.utils.auto_int(x)`

Helper function for argparse to accept hexadecimal integers.

`osmocom.utils.b2h(b: bytearray)` → *hexstr*

convert from a sequence of bytes to a string of hex nibbles

`osmocom.utils.h2b(s: Hexstr)` → bytearray

convert from a string of hex nibbles to a sequence of bytes

`osmocom.utils.h2i(s: Hexstr)` → List[int]

convert from a string of hex nibbles to a list of integers

`osmocom.utils.h2s(s: Hexstr)` → str

convert from a string of hex nibbles to an ASCII string

**class** `osmocom.utils.hexstr(s: str)`

Class derived from 'str', representing a string of hexadecimal digits. It differs in that comparisons are case-insensitive, and it offers encoding-free conversion from hexstr to bytes and vice-versa.

**classmethod** `from_bytes(bt: bytes)` → *hexstr*

instantiate hex-string from bytes

**to\_bytes()** → bytes

return hex-string converted to bytes

`osmocom.utils.i2h(s: List[int])` → *hexstr*

convert from a list of integers to a string of hex nibbles

`osmocom.utils.i2s(s: List[int])` → str

convert from a list of integers to an ASCII string

`osmocom.utils.is_decimal(instr: str)` → bool

Method that can be used as 'type' in `argparse.add_argument()` to validate the value consists of an even sequence of decimal digits only.

`osmocom.utils.is_hex(string: str, minlen: int = 2, maxlen: int | None = None)` → bool

Check if a string is a valid hexstring

`osmocom.utils.is_hexstr(instr: str)` → *hexstr*

Method that can be used as 'type' in `argparse.add_argument()` to validate the value consists of an even sequence of hexadecimal digits only.



`osmocom.utils.is_hexstr_or_decimal(instr: str) → str`

Method that can be used as ‘type’ in `argparse.add_argument()` to validate the value consists of [hexa]decimal digits only.

`osmocom.utils.lpad(s: str, l: int, c='f') → str`

pad string on the left side. :param s: string to pad :param l: total length to pad to :param c: padding character

**Returns**

String ‘s’ padded with as many ‘c’ as needed to reach total length of ‘l’

`osmocom.utils.rpad(s: str, l: int, c='f') → str`

pad string on the right side. :param s: string to pad :param l: total length to pad to :param c: padding character

**Returns**

String ‘s’ padded with as many ‘c’ as needed to reach total length of ‘l’

`osmocom.utils.s2h(s: str) → hexstr`

convert from an ASCII string to a string of hex nibbles

`osmocom.utils.str_sanitiz(e: str) → str`

replace all non printable chars, line breaks and whitespaces, with ‘ ’, make sure that there are no whitespaces at the end and at the beginning of the string.

**Parameters**

**s** – string to sanitize

**Returns**

filtered result of string ‘s’

`osmocom.utils.swap_nibbles(s: Hexstr) → hexstr`

swap the nibbles in a hex string

## 1.2 osmocom.construct

Helpers for the *consturct* declarative parser/encoder Utility code related to the integration of the ‘construct’ declarative parser.

**class** `osmocom.construct.BcdAdapter(subcon)`

convert a bytes() type to a string of BCD nibbles.

`osmocom.construct.BitsRFU(n=1)`

Field that packs Reserved for Future Use (RFU) bit(s) as defined in TS 31.101 Sec. “3.4 Coding Conventions”

Use this for (currently) unused/reserved bits whose contents should be initialized automatically but should not be cleared in the future or when restoring read data (unlike padding).

**Parameters**

**n** (*Integer*) – Number of bits (default: 1)

`osmocom.construct.BytesRFU(n=1)`

Field that packs Reserved for Future Use (RFU) byte(s) as defined in TS 31.101 Sec. “3.4 Coding Conventions”

Use this for (currently) unused/reserved bytes whose contents should be initialized automatically but should not be cleared in the future or when restoring read data (unlike padding).

**Parameters**

**n** (*Integer*) – Number of bytes (default: 1)

**class** osmocom.construct.**DnsAdapter**(*subcon*)

Convert between DNS label format (length-prefixed labels) and string format.

**class** osmocom.construct.**GreedyInteger**(*signed=False, swapped=False, minlen=0*)

A variable-length integer implementation, think of combining GreedyBytes with BytesInteger.

**class** osmocom.construct.**GsmOrUcs2Adapter**(*subcon*)

Try to encode into a GSM 03.38 string; if that fails, fall back to UCS-2 as described in TS 102 221 Annex A.

osmocom.construct.**GsmOrUcs2String**(*n*)

GSM 03.38 or UCS-2 (TS 102 221 Annex A) encoded byte string of fixed length *n*. Encoder appends padding bytes (b'xff') to maintain length. Decoder removes those trailing bytes.

Exceptions are raised for invalid characters and length excess.

**Parameters**

**n** (*Integer*) – Fixed length of the encoded byte string

osmocom.construct.**GsmString**(*n*)

GSM 03.38 encoded byte string of fixed length *n*. Encoder appends padding bytes (b'xff') to maintain length. Decoder removes those trailing bytes.

Exceptions are raised for invalid characters and length excess.

**Parameters**

**n** (*Integer*) – Fixed length of the encoded byte string

**class** osmocom.construct.**GsmStringAdapter**(*subcon, codec='gsm03.38', err='strict'*)

Convert GSM 03.38 encoded bytes to a string.

**class** osmocom.construct.**HexAdapter**(*subcon*)

convert a bytes() type to a string of hex nibbles.

**class** osmocom.construct.**InvertAdapter**(*subcon*)

inverse logic (false->>true, true->>false).

**class** osmocom.construct.**Ipv4Adapter**(*subcon*)

Encoder converts from 4 bytes to string representation (A.B.C.D). Decoder converts from string representation (A.B.C.D) to four bytes.

**class** osmocom.construct.**Ipv6Adapter**(*subcon*)

Encoder converts from 16 bytes to string representation. Decoder converts from string representation to 16 bytes.

**class** osmocom.construct.**MultiplyAdapter**(*subcon, multiplier*)

Decoder multiplies by multiplier Encoder divides by multiplier

**Parameters**

- **subcon** – Subconstruct as defined by construct library
- **multiplier** – Multiplier to apply to raw encoded value

**class** osmocom.construct.**PaddedBcdAdapter**(*subcon*)

Representatin of a BCD string of potentially odd number of BCD digits, which then need to be padded at the end with an 'f' nibble.

**class** osmocom.construct.**PlmnAdapter**(*subcon*)

convert a bytes(3) type to BCD string like 262-02 or 262-002.

**class** osmocom.construct.**Rpad**(*subcon*, *pattern=b\xff*, *num\_per\_byte=1*)

Encoder appends padding bytes (b\xff) or characters up to target size. Decoder removes trailing padding bytes/characters.

#### Parameters

- **subcon** – Subconstruct as defined by construct library
- **pattern** – set padding pattern (default: b\xff)
- **num\_per\_byte** – number of ‘elements’ per byte. E.g. for hex nibbles: 2

**class** osmocom.construct.**StripTrailerAdapter**(*subcon*, *total\_length: int*, *default\_value=b\x00*, *min\_len=1*)

Encoder removes all trailing bytes matching the default\_value Decoder pads input data up to total\_length with default\_value

This is used in constellations like “FlagsEnum(StripTrailerAdapter(GreedyBytes, 3), ...” where you have a bit-mask that may have 1, 2 or 3 bytes, depending on whether or not any of the LSBs are actually set.

**class** osmocom.construct.**Ucs2Adapter**(*subcon*)

convert a bytes() type that contains UCS2 encoded characters encoded as defined in TS 102 221 Annex A to normal python string representation (and back).

**class** osmocom.construct.**Utf8Adapter**(*subcon*)

convert a bytes() type that contains utf8 encoded text to human readable text.

osmocom.construct.**build\_construct**(*c*, *decoded\_data*, *context: dict = {}*)

Helper function to handle total\_len.

osmocom.construct.**filter\_dict**(*d*, *exclude\_prefix='\_'*)

filter the input dict to ensure no keys starting with ‘exclude\_prefix’ remain.

osmocom.construct.**normalize\_construct**(*c*, *exclude\_prefix: str = '\_'*)

Convert a construct specific type to a related base type, mostly useful so we can serialize it.

osmocom.construct.**parse\_construct**(*c*, *raw\_bin\_data: bytes*, *length: int | None = None*, *exclude\_prefix: str = '\_'*, *context: dict = {}*)

Helper function to wrap around normalize\_construct() and filter\_dict().

## 1.3 osmocom.tlv

TLV parser/encoder for BER-TLV, DGI and COMPREHENSION-TLV TLV parser/encoder library supporting various formats.

**class** osmocom.tlv.**BER\_TLV\_IE**(*\*\*kwargs*)

TLV\_IE formatted as ASN.1 BER described in ITU-T X.690 8.1.2.

**class** osmocom.tlv.**COMPACT\_TLV\_IE**(*\*\*kwargs*)

TLV\_IE formatted as COMPACT-TLV described in ISO 7816

**to\_tlv**(*context: dict = {}*)

Convert the internal representation to binary TLV bytes.

**class** osmocom.tlv.**COMPR\_TLV\_IE**(*\*\*kwargs*)

TLV\_IE formatted as COMPREHENSION-TLV as described in ETSI TS 101 220.

**is\_tag\_compatible**(*rawtag: int*) → bool

Override `is_tag_compatible` as we need to mask out the comprehension bit when doing compares.

**class** `osmocom.tlv.ComprTlvMeta`(*name, bases, namespace, \*\*kwargs*)

**class** `osmocom.tlv.DGI_TLV_IE`(*\*\*kwargs*)

TLV\_IE formatted as GlobalPlatform Systems Scripting Language Specification v1.1.0 Annex B.

**class** `osmocom.tlv.IE`(*\*\*kwargs*)

Base class for various Information Elements. We understand the notion of a hierarchy of IEs on top of the Transcodable class.

**child\_by\_name**(*name: str*) → *IE* | None

Return a child IE instance of given snake-case/json type name. This only works in case there is no more than one child IE of the given type.

**child\_by\_type**(*cls*) → *IE* | None

Return a child IE instance of given type (class). This only works in case there is no more than one child IE of the given type.

**from\_bytes**(*do: bytes, context: dict = {}*)

Parse *the value part* from binary bytes to internal representation.

**from\_dict**(*decoded: dict*)

Set the IE internal decoded representation to data from the argument. If this is a nested IE, the child IE instance list is re-created.

This method is symmetrical to `to_dict()` above, i.e. the outer dict must contain just a single key-value pair, where the key is the snake-reformatted type name of 'self'

**from\_val\_dict**(*decoded*)

Set the IE internal decoded representation to data from the argument. If this is a nested IE, the child IE instance list is re-created.

This method is symmetrical to `to_val_dict()` above, i.e. there is no outer dict containing the snake-reformatted type name of 'self'.

**is\_constructed**()

Is this IE constructed by further nested IEs?

**to\_bytes**(*context: dict = {}*) → bytes

Convert the internal representation *of the value part* to binary bytes.

**to\_dict**()

Return a JSON-serializable dict representing the [nested] IE data. The returned data contains an outer dict with the snake-reformatted type of 'self' and is hence sufficient to re-create an object from it.

**abstract to\_ie**(*context: dict = {}*) → bytes

Convert the internal representation to entire IE including IE header.

**to\_val\_dict**()

Return a JSON-serializable dict representing just the [nested] value portion of the IE data. This does not include any indication of the type of 'self', so the resulting dict alone will be insufficient to recreate an object from it without additional type information.

**class** `osmocom.tlv.TLV_IE`(*\*\*kwargs*)

Abstract base class for various TLV type Information Elements.

**is\_tag\_compatible**(rawtag) → bool

Is the given rawtag compatible with this class?

**to\_ie**(context: dict = {})

Convert the internal representation to entire IE including IE header.

**to\_tlv**(context: dict = {})

Convert the internal representation to binary TLV bytes.

**class** osmocom.tlv.TLV\_IE\_Collection(desc=None, \*\*kwargs)

A TLV\_IE\_Collection consists of multiple TLV\_IE classes identified by their tags. A given encoded DO may contain any of them in any order, and may contain multiple instances of each DO.

**from\_bytes**(binary: bytes, context: dict = {}) → List[TLV\_IE]

Create a list of TLV\_IEs from the collection based on binary input data. :param binary: binary bytes of encoded data

**Returns**

list of instances of TLV\_IE sub-classes containing parsed data

**from\_dict**(decoded: List[dict]) → List[TLV\_IE]

Create a list of TLV\_IE instances from the collection based on an array of dicts, where they key indicates the name of the TLV\_IE subclass to use.

**class** osmocom.tlv.TlvCollectionMeta(name, bases, namespace, \*\*kwargs)

Metaclass which we use to set some class variables at the time of defining a subclass. This allows us to create subclasses for each Collection type, where the class represents fixed parameters like the nested IE classes and instances of it represent the actual TLV data.

**class** osmocom.tlv.TlvMeta(name, bases, namespace, \*\*kwargs)

Metaclass which we use to set some class variables at the time of defining a subclass. This allows us to create subclasses for each TLV/IE type, where the class represents fixed parameters like the tag/type and instances of it represent the actual TLV data.

**class** osmocom.tlv.Transcodable

**from\_bytes**(do: bytes, context: dict = {})

Convert from binary bytes to internal representation. Store the decoded result in the internal state and return it.

**to\_bytes**(context: dict = {}) → bytes

Convert from internal representation to binary bytes. Store the binary result in the internal state and return it.

osmocom.tlv.ber\_tlv\_encode\_len(length: int) → bytes

Encode a single Length value according to ITU-T X.690 8.1.3; only the definite form is supported here. :param length: length value to be encoded

**Returns**

binary output data of BER-TLV length field

osmocom.tlv.ber\_tlv\_encode\_tag(t) → bytes

Encode a single Tag value according to ITU-T X.690 8.1.2

osmocom.tlv.ber\_tlv\_parse\_len(binary: bytes) → Tuple[int, bytes]

Parse a single Length value according to ITU-T X.690 8.1.3; only the definite form is supported here. :param binary: binary input data of BER-TLV length field

**Returns**

Tuple of (length, remainder)

`osmocom.tlv.bertlv_parse_one(binary: bytes) → Tuple[dict, int, bytes, bytes]`

Parse a single TLV IE at the start of the given binary data. :param binary: binary input data of BER-TLV length field

**Returns**

dict, len:int, remainder:bytes)

**Return type**

Tuple of (tag

`osmocom.tlv.bertlv_parse_one_rawtag(binary: bytes) → Tuple[int, int, bytes, bytes]`

Parse a single TLV IE at the start of the given binary data; return tag as raw integer. :param binary: binary input data of BER-TLV length field

**Returns**

int, len:int, remainder:bytes)

**Return type**

Tuple of (tag

`osmocom.tlv.bertlv_parse_tag(binary: bytes) → Tuple[dict, bytes]`

Parse a single Tag value according to ITU-T X.690 8.1.2 :param binary: binary input data of BER-TLV length field

**Returns**

int, constructed:bool, tag:int}, remainder:bytes)

**Return type**

Tuple of ({class

`osmocom.tlv.bertlv_parse_tag_raw(binary: bytes) → Tuple[int, bytes]`

Get a single raw Tag from start of input according to ITU-T X.690 8.1.2 :param binary: binary input data of BER-TLV length field

Returns: Tuple of (tag:int, remainder:bytes)

`osmocom.tlv.bertlv_return_one_rawtlv(binary: bytes) → Tuple[int, int, bytes, bytes]`

Return one single [encoded] TLV IE at the start of the given binary data. :param binary: binary input data of BER-TLV length field

**Returns**

int, len:int, tlv:bytes, remainder:bytes)

**Return type**

Tuple of (tag

`osmocom.tlv.comprehensientlv_encode_tag(tag) → bytes`

Encode a single Tag according to ETSI TS 101 220 Section 7.1.1

`osmocom.tlv.comprehensientlv_parse_one(binary: bytes) → Tuple[dict, int, bytes, bytes]`

Parse a single TLV IE at the start of the given binary data. :param binary: binary input data of BER-TLV length field

**Returns**

dict, len:int, remainder:bytes)

**Return type**

Tuple of (tag

`osmocom.tlv.comprehensiveltv_parse_tag(binary: bytes) → Tuple[dict, bytes]`

Parse a single Tag according to ETSI TS 101 220 Section 7.1.1

`osmocom.tlv.comprehensiveltv_parse_tag_raw(binary: bytes) → Tuple[int, bytes]`

Parse a single Tag according to ETSI TS 101 220 Section 7.1.1

`osmocom.tlv.dgi_encode_len(length: int) → bytes`

Encode a single Length value according to GlobalPlatform Systems Scripting Language Specification v1.1.0 Annex B. :param length: length value to be encoded

**Returns**

binary output data of encoded length field

`osmocom.tlv.dgi_parse_len(binary: bytes) → Tuple[int, bytes]`

Parse a single Length value according to GlobalPlatform Systems Scripting Language Specification v1.1.0 Annex B. :param binary: binary input data of BER-TLV length field

**Returns**

Tuple of (length, remainder)

`osmocom.tlv.flatten_dict_lists(inp)`

hierarchically flatten each list-of-dicts into a single dict. This is useful to make the output of hierarchical TLV decoder structures flatter and more easy to read.

## 1.4 osmocom.gsmtap

GSMTAP pseudo-header for protocol traces Osmocom GSMTAP python implementation. GSMTAP is a packet format used for conveying a number of different telecom-related protocol traces over UDP.

**class** `osmocom.gsmtap.GsmtapMessage(encoded=None)`

Class whose objects represent a single GSMTAP message. Can encode and decode messages.

**class** `osmocom.gsmtap.GsmtapReceiver(bind_ip: str = '127.0.0.1', bind_port: int = 4729)`

Simple receive-side socket implementation for GSMTAP messages.

**read\_packet()** → *GsmtapMessage*

Perform a blocking read on the GSMTAP socket and decode it as GSMTAP message.

## 1.5 osmocom.gsup

GSUP protocol (Osmocom TCAP/MAP alternative) This is an encoder/decoder implementation for the Osmocom GSUP protocol, built upon the `osmocom.tlv` and `osmocom.construct` infrastructure.

**class** `osmocom.gsup.message.GSUP_TLV_IE(**kwargs)`

Class representing the TLV format as used in Osmocom GSUP. It's a simple '8-bit tag / 8-bit length / value' variant.

**class** `osmocom.gsup.message.GsupMessage(msg_type: MsgType | int)`

Represents a single message within the GSUP protocol.

**classmethod** **from\_bytes**(*encoded: bytes*) → *GsupMessage*

Create a GsupMessage instance from the decode of the given bytes.

**classmethod** `from_dict(decoded: dict) → GsupMessage`

Create a GsupMessage instance from the decoded dict.

**to\_bytes()**

Encode a GsupMessage instance into bytes.

**to\_dict()**

Encode a GsupMessage instance into a json-serializable dict.

**class** `osmocom.gsup.message.MsgType(value, names=None, *, module=None, qualname=None, type=None, start=1, boundary=None)`

GSUP protocol message type. Keep this in sync with <https://gitea.osmocom.org/osmocom/libosmocore/src/branch/master/include/osmocom/gsm/gsup.h>

**class** `osmocom.gsup.message.tlv`

TLV definitions for the GSUP IEs, utilizing the osmocom.tlv code. Keep this in sync with <https://gitea.osmocom.org/osmocom/libosmocore/src/branch/master/include/osmocom/gsm/gsup.h>

**class** `AnApdu(**kwargs)`

**class** `AuthTuple(**kwargs)`

**nested\_collection\_cls**

alias of `auto_collection_AuthTuple`

**class** `CancelType(**kwargs)`

**class** `Cause(**kwargs)`

**class** `CauseBssap(**kwargs)`

**class** `CauseRr(**kwargs)`

**class** `CauseSm(**kwargs)`

**class** `CnDomain(**kwargs)`

**class** `CurrentRatType(**kwargs)`

**class** `DestinationName(**kwargs)`

**class** `FreezePTMSI(**kwargs)`

**class** `HlrNumber(**kwargs)`

**class** `IMEI(**kwargs)`

**class** `IMSI(**kwargs)`

**class** `IeCollection(desc=None, **kwargs)`

**class** `ImeiCheckResult(**kwargs)`

**class** `MSISDN(**kwargs)`

**class** `MessageClass(**kwargs)`

**class** `NumVectorsReq(**kwargs)`

**class** `PCO(**kwargs)`



```

class PdpInfo(**kwargs)
    nested_collection_cls
        alias of auto_collection_PdpInfo
class PdpInfoCompl(**kwargs)
class SessionId(**kwargs)
class SessionState(**kwargs)
class SmAlert(**kwargs)
class SmRpCause(**kwargs)
class SmRpDa(**kwargs)
class SmRpMms(**kwargs)
class SmRpMr(**kwargs)
class SmRpOa(**kwargs)
class SmRpUi(**kwargs)
class SourceName(**kwargs)
class SupplementaryServiceInfo(**kwargs)
class SupportedRatTypes(**kwargs)
class auth
    Nested TLV IEs within the AuthTuple.
    class AUTN(**kwargs)
    class AUTS(**kwargs)
    class CK(**kwargs)
    class IK(**kwargs)
    class Kc(**kwargs)
    class RAND(**kwargs)
    class RES(**kwargs)
    class SRES(**kwargs)
class pdp
    Nested TLV IEs within the PdpInfo.
    class AccessPointName(**kwargs)
    class PdpAddress(**kwargs)
    class PdpChargingCharacteristics(**kwargs)
    class PdpContextId(**kwargs)
    class Qos(**kwargs)

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