Megaco/ H.248

version 3.5
Typeset in \LaTeX\ from SGML source using the \verb|DOCBUILDER| 3.3.3 Document System.
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Chapter 1

Megaco Users Guide

The Megaco application is a framework for building applications on top of the Megaco/H.248 protocol.

1.1 Introduction

Megaco/H.248 is a protocol for control of elements in a physically decomposed multimedia gateway, enabling separation of call control from media conversion. A Media Gateway Controller (MGC) controls one or more Media Gateways (MG).

This version of the stack supports version 1, 2 and 3 as defined by:

- version 1 - RFC 3525 & H.248-IG (v10-v13)
- version 2 - draft-ietf-megaco-h248v2-04 & H.248.1 v2 Corrigendum 1 (03/2004)
- version 3:
  - prev3a - as defined by TD-33 (except segments)
  - prev3b - TD-33 updated to be backward compatible with v2 (except segments)
  - prev3c - As defined by ITU H.248.1 (09/2005) (except segments)

The semantics of the protocol has jointly been defined by two standardization bodies:

- IETF - which calls the protocol Megaco
- ITU - which calls the protocol H.248

1.1.1 Scope and Purpose

This manual describes the Megaco application, as a component of the Erlang/Open Telecom Platform development environment. It is assumed that the reader is familiar with the Erlang Development Environment, which is described in a separate User's Guide.
1.1.2 Prerequisites

The following prerequisites is required for understanding the material in the Megaco User’s Guide:

- the basics of the Megaco/H.248 protocol
- the basics of the Abstract Syntax Notation One (ASN.1)
- familiarity with the Erlang system and Erlang programming

The application requires Erlang/OTP release R10B or later.

1.1.3 About This Manual

In addition to this introductory chapter, the Megaco User’s Guide contains the following chapters:

- Chapter 2: “Architecture” describes the architecture and typical usage of the application.
- Chapter 3: “Internal form and its encodings” describes the internal form of Megaco/H.248 messages and its various encodings.
- Chapter 4: “Transport mechanisms” describes how different mechanisms can be used to transport the Megaco/H.248 messages.
- Chapter 5: “Debugging” describes tracing and debugging.

1.1.4 Where to Find More Information

Refer to the following documentation for more information about Megaco/H.248 and about the Erlang/OTP development system:

- version 1, RFC 3525¹
- old version 1, RFC 3015²
- Version 2 Corrigendum 1³
- version 2, draft-ietf-megaco-h248v2-04⁴
- TD-33 (Draft H.248.1 version 3)⁵
- H.248.1 version 3⁶
- the ASN.1 User’s Guide
- the Reference Manual

¹URL: http://www.erlang.org/project/megaco/standard/rfc3525.txt
²URL: http://www.ietf.org/rfc/rfc3015.txt
³URL: http://www.erlang.org/project/megaco/standard/H.248.1-Corr1-200403.doc
⁴URL: http://www.erlang.org/project/megaco/standard/draft-ietf-megaco-h248v2-04.txt
⁵URL: http://www.itu.org/
⁶URL: http://www.itu.org/
1.2 Architecture

1.2.1 Network view

Megaco is a (master/slave) protocol for control of gateway functions at the edge of the packet network. Examples of this is IP-PSTN trunking gateways and analog line gateways. The main function of Megaco is to allow gateway decomposition into a call agent (call control) part (known as Media Gateway Controller, MGC) - master, and an gateway interface part (known as Media Gateway, MG) - slave. The MG has no call control knowledge and only handle making the connections and simple configurations. SIP and H.323 are peer-to-peer protocols for call control (valid only for some of the protocols within H.323), or more generally multi-media session protocols. They both operate at a different level (call control) from Megaco in a decomposed network, and are therefore not aware of whether or not Megaco is being used underneath.
Megaco and peer protocols are complementary in nature and entirely compatible within the same system. At a system level, Megaco allows for

- overall network cost and performance optimization
- protection of investment by isolation of changes at the call control layer
- freedom to geographically distribute both call function and gateway function
- adaption of legacy equipment

Figure 1.1: Network architecture
1.2.2 General

This Erlang/OTP application supplies a framework for building applications that needs to utilize the Megaco/H.248 protocol.

We have introduced the term “user” as a generic term for either an MG or an MGC, since most of the functionality we support, is common for both MG’s and MGC’s. A (local) user may be configured in various ways and it may establish any number of connections to its counterpart, the remote user. Once a connection has been established, the connection is supervised and it may be used for the purpose of sending messages. N.B. according to the standard an MG is connected to at most one MGC, while an MGC may be connected to any number of MG’s.

For the purpose of managing “virtual MG’s”, one Erlang node may host any number of MG’s. In fact it may host a mix of MG’s and MGC’s. You may say that an Erlang node may host any number of “users”. The protocol engine uses callback modules to handle various things:

- encoding callback modules - handles the encoding and decoding of messages. Several modules for handling different encodings are included, such as ASN.1 BER, pretty well indented text, compact text and some others. Others may be written by you.
- transport callback modules - handles sending and receiving of messages. Transport modules for TCP/IP and UDP/IP are included and others may be written by you.
- user callback modules - the actual implementation of an MG or MGC. Most of the functions are intended for handling of a decoded transaction (request, reply, acknowledgement), but there are others that handles connect, disconnect and errors cases.

Each connection may have its own configuration of callback modules, re-send timers, transaction id ranges etc. and they may be re-configured on-the-fly.

In the API of Megaco, a user may explicitly send action requests, but generation of transaction identifiers, the encoding and actual transport of the message to the remote user is handled automatically by the protocol engine according to the actual connection configuration. Megaco messages are not exposed in the API.

On the receiving side the transport module receives the message and forwards it to the protocol engine, which decodes it and invokes user callback functions for each transaction. When a user has handled its action requests, it simply returns a list of action replies (or a message error) and the protocol engine uses the encoding module and transport module to compose and forward the message to the originating user.

The protocol stack does also handle things like automatic sending of acknowledgements, pending transactions, re-send of messages, supervision of connections etc.

In order to provide a solution for scalable implementations of MG’s and MGC’s, a user may be distributed over several Erlang nodes. One of the Erlang nodes is connected to the physical network interface, but messages may be sent from other nodes and the replies are automatically forwarded back to the originating node.
1.2.3 Single node config

Here a system configuration with an MG and MGC residing in one Erlang node each is outlined:

![Diagram of single node config]

Figure 1.2: Single node config

1.2.4 Distributed config

In a larger system with a user (in this case an MGC) distributed over several Erlang nodes, it looks a little bit different. Here the encoding is performed on the originating Erlang node (1) and the binary is forwarded to the node (2) with the physical network interface. When the potential message reply is received on the interface on node (2), it is decoded there and then different actions will be taken for each transaction in the message. The transaction reply will be forwarded in its decoded form to the originating node (1) while the other types of transactions will be handled locally on node (2).

Timers and re-send of messages will be handled locally on one node, that is node(1), in order to avoid unnecessary transfer of data between the Erlang nodes.
1.2.5 Message round-trip call flow

The typical round-trip of a message can be viewed as follows. Firstly we view the call flow on the originating side:
Then we continue with the call flow on the destination side:
1.3 Running the stack

1.3.1 Starting

A user may have a number of “virtual” connections to other users. An MG is connected to at most one MGC, while an MGC may be connected to any number of MG’s. For each connection the user selects a transport service, an encoding scheme and a user callback module.

An MGC must initiate its transport service in order to listen to MG’s trying to connect. How the actual transport is initiated is outside the scope of this application. However a send handle (typically a socket id or host and port) must be provided from the transport service in order to enable us to send the message to the correct destination. We do however not assume anything about this, from our point of view, opaque handle. Hopefully it is rather small since it will passed around the system between processes rather frequently.
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A user may either be statically configured in a .config file according to the application concept of Erlang/OTP or dynamically started with the configuration settings as arguments to megaco:start_user/2. These configuration settings may be updated later on with megaco:update_conn_info/2.

The function megaco:connect/4 is used to tell the Megaco application about which control process it should supervise, which MID the remote user has, which callback module it should use to send messages etc. When this “virtual” connection is established the user may use megaco:call/3 and megaco:cast/3 in order to send messages to the other side. Then it is up to the MG to send its first Service Change Request message after applying some clever algorithm in order to fight the problem with startup avalanche (as discussed in the RFC).

The originating user will wait for a reply or a timeout (defined by the request_timer). When it receives the reply this will optionally be acknowledged (regulated by auto_ack), and forwarded to the user. If an interim pending reply is received, the long_request_timer will be used instead of the usual request_timer, in order to enable avoidance of spurious re-sends of the request.

On the destination side the transport service waits for messages. Each message is forwarded to the Megaco application via the megaco:receive_message/4 callback function. The transport service may or may not provide means for blocking and unblocking the reception of the incoming messages.

If a message is received before the “virtual” connection has been established, the connection will be setup automatically. A MG may be real open minded and dynamically decide which encoding and transport service to use depending on how the transport layer contact is performed. For IP transports two ports are standardized, one for textual encoding and one for binary encoding. If for example an UDP packet was received on the text port it would be possible to decide encoding and transport on the fly.

After decoding a message various user callback functions are invoked in order to allow the user to act properly. See the megaco_user module for more info about the callback arguments.

When the user has processed a transaction request in its callback function, the Megaco application assembles a transaction reply, encodes it using the selected encoding module and sends the message back by invoking the callback function:

- SendMod:send_message(SendHandle, ErlangBinary)

Re-send of messages, handling pending transactions, acknowledgements etc. is handled automatically by the Megaco application but the user is free to override the default behaviour by the various configuration possibilities. See megaco:update_user_info/2 and megaco:update_conn_info/2 about the possibilities.

When connections gets broken (that is explicitly by megaco:disconnect/2 or when its controlling process dies) a user callback function is invoked in order to allow the user to re-establish the connection. The internal state of kept messages, re-send timers etc. is not affected by this. A few re-sends will of course fail while the connection is down, but the automatic re-send algorithm does not bother about this and eventually when the connection is up and running the messages will be delivered if the timeouts are set to be long enough. The user has the option of explicitly invoking megaco:cancel/2 to cancel all messages for a connection.

1.3.2 MGC startup call flow

In order to prepare the MGC for the reception of the initial message, hopefully a Service Change Request, the following needs to be done:

- Start the Megaco application.
- Start the MGC user. This may either be done explicitly with megaco:start_user/2 or implicitly by providing the -megaco users configuration parameter.
1.3: Running the stack

- Initiate the transport service and provide it with a receive handle obtained from megaco:user_info/2.

When the initial message arrives the transport service forwards it to the protocol engine which automatically sets up the connection and invokes UserMod:handle_connect/2 before it invokes UserMod:handle_trans_request/3 with the Service Change Request like this:

```
transport receive bytes(1) megaco:receive_message/4 EncMod:decode_message/2
```

```
SendMod:send_message/2
```

```
send bytes(2)
```

\[ \text{Figure 1.6: MGC Startup Call Flow} \]

1.3.3 MGC startup call flow

In order to prepare the MGC for the sending of the initial message, hopefully a Service Change Request, the following needs to be done:

- Start the Megaco application.
- Start the MG user. This may either be done explicitly with megaco:start_user/2 or implicitly by providing the -megaco users configuration parameter.
- Initiate the transport service and provide it with a receive handle obtained from megaco:user_info/2.
- Setup a connection to the MGC with megaco:connect/4 and provide it with a receive handle obtained from megaco:user_info/2.

If the MG has been provisioned with the MID of the MGC it can be given as the RemoteMid parameter to megaco:connect/4 and the call flow will look like this:
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Figure 1.7: MG Startup Call Flow

If the MG cannot be provisioned with the MID of the MGC, the MG can use the atom 'preliminary_mid' as the RemoteMid parameter to megaco:connect/4 and the call flow will look like this:
1.3.4 Configuring the Megaco stack

There are three kinds of configuration:

- **User info** - Information related to megaco users. Read/Write.
  A User is an entity identified by a MID, e.g., a MGC or a MG.
  This information can be retrieved using megaco:user_info [page 40].
- **Connection info** - Information regarding connections. Read/Write.
  This information can be retrieved using megaco:conn_info [page 43].
- **System info** - System wide information. Read only.
  This information can be retrieved using megaco:system_info [page 47].
1.3.5 Initial configuration

The initial configuration of the Megaco should be defined in the Erlang system configuration file. The following configured parameters are defined for the Megaco application:

- **users = [[Mid, [user, config()]]].**
  Each user is represented by a tuple with the Mid of the user and a list of config parameters (each parameter is in turn a tuple: {Item, Value}).
- **scanner = flex | {Module, Function, Arguments, Modules}**
  flex will result in the start of the flex scanner.
  The other alternative makes it possible for Megaco to start and supervise a scanner written by the user (see supervisor:start_child for an explanation of the parameters).

1.3.6 Changing the configuration

The configuration can be changed during runtime. This is done with the functions megaco:update_user_info [page 43] and megaco:update_conn_info [page 47]

1.3.7 The transaction sender

The transaction sender is a process (one per connection), which handle all transaction sending, if so configured (see megaco:user_info [page 40] and megaco:conn_info [page 43]).

The purpose of the transaction sender is to accumulate transactions for a more efficient message sending. The transactions that are accumulated are transaction request and transaction ack. For transaction ack's the benefit is quite large, since the transactions are small and it is possible to have ranges (which means that transaction acks for transactions 1, 2, 3 and 4 can be sent as a range 1-4 in one transaction ack, instead of four separate transactions).

There are a number of configuration parameter's that control the operation of the transaction sender. In principle, a message with everything stored (ack's and request's) is sent from the process when:

- When trans_timer expires.
- When trans_ack_maxcount number of ack's has been received.
- When trans_req_maxcount number of requests's has been received.
- When the size of all received requests exceeds trans_req_maxsize.
- When a reply transaction is sent.
- When a pending transaction is sent.

When something is to be sent, everything is packed into one message. Unless the trigger was a reply transaction and the added size of the reply and all the requests is greater then trans_req_maxsize, in which case the stored transactions is sent firts in a separate mesage, and the the reply in another message.

When the transaction sender receives a request which is already “in storage” (indicated by the transaction id) it is assumed to be a resend and everything stored is sent. This could happen if the values of the trans_timer and the request_timer is not properly choosen.
1.4 Internal form and its encodings

This version of the stack is compliant with:


1.4.1 Internal form of messages

We use the same internal form for both the binary and text encoding. Our internal form of Megaco/H.248 messages is heavily influenced by the internal format used by ASN.1 encoders/decoders:

- "SEQUENCE OF" is represented as a list.
- "CHOICE" is represented as a tagged tuple with size 2.
- "SEQUENCE" is represented as a record, defined in "megaco/include/megaco_message_v1.hrl".
- "OPTIONAL" is represented as an ordinary field in a record which defaults to ‘asn1_NOVALUE’, meaning that the field has no value.
- "OCTET STRING" is represented as a list of unsigned integers
- "ENUMERATED" is represented as a single atom.
- "BIT STRING" is represented as a list of atoms.
- "BOOLEAN" is represented as the atom ‘true’ or ‘false’.
- "INTEGER" is represented as an integer.
- "IA5String" is represented as a list of integers, where each integer is the ASCII value of the corresponding character.
- "NULL" is represented as the atom ‘NULL’.

In order to fully understand the internal form you must get hold on a ASN.1 specification for the Megaco/H.248 protocol, and apply the rules above. Please, see the documentation of the ASN.1 compiler in Erlang/OTP for more details of the semantics in mapping between ASN.1 and the corresponding internal form.

Observe that the ‘TerminationId’ record is not used in the internal form. It has been replaced with a megaco_term_id record (defined in “megaco/include/megaco.hrl”).

1.4.2 The different encodings

The Megaco/H.248 standard defines both a plain text encoding and a binary encoding (ASN.1 BER) and we have implemented encoders and decoders for both. We do in fact supply five different encoding/decoding modules.

In the text encoding, implementors have the choice of using a mix of short and long keywords. It is also possible to add white spaces to improve readability. We use the term compact for text messages with the shortest possible keywords and no optional white spaces, and the term pretty for a well indented text format using long keywords and an indentation style like the text examples in the Megaco/H.248 specification.

Here follows an example of a text message to give a feeling of the difference between the pretty and compact versions of text messages. First the pretty, well indented version with long keywords:
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MEGACO/1 [124.124.124.222]
Transaction = 9998 {
  Context = - {
    ServiceChange = ROOT {
      Services {
        Method = Restart,
        ServiceChangeAddress = 55555,
        Profile = ResGW/1,
        Reason = "901 Cold Boot"
      }
    }
  }
}

Then the compact version without indentation and with short keywords:

!/1 [124.124.124.222]
T=9998{C=-{SC=ROOT{SV[MT=RS,AD=55555,PF=ResGW/1,RE="901 Cold Boot"}]}}

And the programmers view of the same message. First a list of ActionRequest records are constructed
and then it is sent with one of the send functions in the API:

Prof = #'ServiceChangeProfile'{profileName = "resgw", version = 1},
Parm = #'ServiceChangeParm'{serviceChangeMethod = restart,
  serviceChangeAddress = {portNumber, 55555},
  serviceChangeReason = "901 Cold Boot",
  serviceChangeProfile = Prof},
Req = #'ServiceChangeRequest'{terminationID = [#megaco_root_termination_id],
  serviceChangeParms = Parm},
Actions = [#'ActionRequest'{contextId = #megaco_null_context_id,
  commandRequests = {serviceChangeReq, Req}}],
megaco:call(ConnHandle, Actions, Config).

And finally a print-out of the entire internal form:

{"MegacoMessage",
 asn1_NOVALUE,
 {"Message",
  1,
  {ip4Address,{"IP4Address", [124,124,124,222], asn1_NOVALUE}},
  {transactions,
   [transactionRequest,
    {"TransactionRequest",
     9998,
     [{"ActionRequest",
       0,
       asn1_NOVALUE,
       asn1_NOVALUE,
       ["CommandRequest",
        serviceChangeReq,"\n"]}],"\n"}]]}}
1.4: Internal form and its encodings

```plaintext
{"ServiceChangeRequest",
 [   {megaco_term_id, false, ["root"]},
    {"ServiceChangeParm",
     restart,
     {portNumber, 55555},
     asn1_NOVALUE,
    {"ServiceChangeProfile", "resgw", version = 1},
    "901 MG Cold Boot",
     asn1_NOVALUE,
     asn1_NOVALUE,
     asn1_NOVALUE
    }
    }
    ,
    asn1_NOVALUE,
    asn1_NOVALUE
}
}
```

The following encoding modules are provided:

- megaco.pretty_text.encoder - encodes messages into pretty text format, decodes both pretty as well as compact text.
- megaco.compact_text.encoder - encodes messages into compact text format, decodes both pretty as well as compact text.
- megaco.binary.encoder - encode/decode ASN.1 BER messages. This encoder implements the fastest of the BER encoders/decoders. Recommended binary codec.
- megaco.ber.encoder - encode/decode ASN.1 BER messages.
- megaco.ber.bin.encoder - encode/decode ASN.1 BER messages. This encoder uses ASN.1 ber_bin which has been optimized using the bit syntax.
- megaco.per.encoder - encode/decode ASN.1 PER messages. N.B. that this format is not included in the Megaco standard.
- megaco.per.bin.encoder - encode/decode ASN.1 PER messages. N.B. that this format is not included in the Megaco standard. This encoder uses ASN.1 per_bin which has been optimized using the bit syntax.
- megaco.erl.dist.encoder - encodes messages into Erlangs distribution format. It is rather verbose but encoding and decoding is blinding fast. N.B. that this format is not included in the Megaco standard.

1.4.3 Configuration of Erlang distribution encoding module

The encoding config of the megaco.erl.dist.encoder module may be one of these:
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- [ ] - Encodes the messages to the standard distribution format. It is rather verbose but encoding and decoding is blinding fast.
- [megaco_compressed] - Encodes the messages to the standard distribution format after an internal transformation. It is less verbose, but the total time of the encoding and decoding will on the other hand be somewhat slower. (see the performance [page 22] chapter for more info).
- [[megaco_compressed, Module]] - Works in the same way as the megaco_compressed config parameter, only here the user provide their own compress module. The module must export two functions: encode/1 and decode/1.
- [compressed] - Encodes the messages to a compressed form of the standard distribution format. It is less verbose, but the encoding and decoding will on the other hand be slower.

1.4.4 Configuration of text encoding module(s)

When using text encoding(s), there is actually two different configs controlling what software to use:

- [] - An empty list indicates that the erlang scanner should be used.
- [[flex, port()]] - Use the flex scanner when decoding.

The Flex scanner is a Megaco scanner written as a linked in driver (in C). There are two ways to get this working:

- Let the Megaco stack start the flex scanner (load the driver).
  To make this happen the megaco stack has to be configured:
    - Add the {scanner, flex} directive to an Erlang system config file for the megaco app. This will make the Megaco stack initiate the default megaco_receive_handle with the encoding_config set to the [[flex, port()]].
    - When retrieving the megaco_receive_handle, retain the encoding_config.
  The benefit of this is that Megaco handles the starting, holding and the supervision of the driver and port.

- The Megaco client (user) starts the flex scanner (load the driver).
  When starting the flex scanner a port to the linked in driver is created. This port has to be owned by a process. This process must not die. If it does the port will also terminate. Therefore:
    - Create a permanent process. Make sure this process is supervised (so that if it does die, this will be noticed).
    - Let this process start the flex scanner by calling the megaco_flex_scanner:start() function.
    - Retrieve the port() and when initiating the megaco_receive_handle, set the encoding_config to [[flex, port()]].
    - Pass the receive_handle to the transport module.

1.4.5 Configuration of binary encoding module(s)

When using binary encoding, the structure of the termination id’s needs to be specified.

- [driver|] - make use of the asn1 driver for decode (ber_bin) and encode (per_bin). This option is only available for encoding modules: megaco_binary_encoder, megaco_ber_bin_encoder and megaco_per_bin_encoder.
  If this option is present in the encoding config, it must to be the first, unless the version3 [page 19] encoding config is present, in which case it must come second, after the version3 encoding config, e.g. [[version3, prev3b], driver].
1.4: Internal form and its encodings

- [native] - skips the transformation phase, i.e. the decoded message(s) will not be transformed into our internal form.
- [integer()] - A list containing the size (the number of bits) of each level. Example: [3,8,5,8].
- integer() - Number of one byte (8 bits) levels. N.B. This is currently converted into the previous config. Example: 3 ([8,8,8]).

1.4.6 Handling megaco versions

Since the version 3 implemented, in this version of the Megaco application, is preliminary, it is necessary to have a way to handle different version 3 implementations. For this reason the encoding config option {version3, version3()} has been introduced. This option, if present, has to be first in the encoding config list. Version 1 and 2 codec's ignore this option, if found.

version3() -> prev3a | prev3b | prev3c
- prev3a
  Preliminary version 3, based on TD-33
- prev3b
  Preliminary version 3, based on TD-33, but text encoding updated with the final solution for priority in contextProperty (which is backward compatible with v2).
- prev3c
  Preliminary version 3, based on the final version of the v3-standard, but excluding segments!

There are two ways to handle the different megaco encoding versions. Either using dynamic version detection (only valid for for incoming messages) or by explicit version setting in the connection info.

For incoming messages:

- Dynamic version detection
  Set the protocol version in the megaco_receive_handle to dynamic (this is the default).
  This works for those codecs that support partial decode of the version, currently text, and ber_bin (megaco_binary_encoder and megaco_ber_bin_encoder).
  This way the decoder will detect which version is used and then use the proper decoder.

- Explicit version
  Explicitly set the actual protocol version in the megaco_receive_handle.
  Start with version 1. When the initial service change has been performed and version 2 has been negotiated, upgrade the megaco_receive_handle of the transport process (control_pid) to version 2.
  See megaco_tcp [page 67] and megaco_udp [page 71].
  Note that if udp is used, the same transport process could be used for several connections. This could make upgrading impossible.
  For codecs that does not support partial decode of the version, currently megaco_ber_encoder, megaco_per_encoder and megaco_per_bin_encoder, dynamic will revert to version 1.

For outgoing messages:

- Update the connection info protocol_version.
- Override protocol version when sending a message by adding the item {protocol_version, integer()} to the Options. See call [page 49] or cast [page 50].
  Note that this does not effect the messages that are sent autonomously by the stack. They use the protocol_version of the connection info.
1.4.7 Encoder callback functions

The encoder callback interface is defined by the `megaco_encoder` behaviour, see `megaco_encoder` [page 63].

1.5 Transport mechanisms

1.5.1 Callback interface

The callback interface of the transport module contains several functions. Some of which are mandatory while others are only optional:

- `send_message` - Send a message. Mandatory
- `block` - Block the transport. Optional
  This function is useful for flow control.
- `unblock` - Unblock the transport. Optional

For more detail, see the `megaco_transport` [page 69] behaviour definition.

1.5.2 Examples

The Megaco/H.248 application contains implementations for the two protocols specified by the Megaco/H.248 standard; UDP, see `megaco_udp` [page 70], and TCP/TPKT, see `megaco_tcp` [page 66].

1.6 Implementation examples

1.6.1 A simple Media Gateway Controller

In `megaco/examples/simple/megaco_simple_mgc.erl` there is an example of a simple MGC that listens on both text and binary standard ports and is prepared to handle a Service Change Request message to arrive either via TCP/IP or UDP/IP. Messages received on the text port are decoded using a text decoder and messages received on the binary port are decoded using a binary decoder.

The Service Change Reply is encoded in the same way as the request and sent back to the MGC with the same transport mechanism UDP/IP or TCP/IP.

After this initial service change message the connection between the MGC and MGC is fully established and supervised.

The MGC, with its four listeners, may be started with:

```erl
cd megaco/examples/simple
erl -pa ../../../megaco/ebin -s megaco -s megaco_filter -s megaco
megaco_simple_mgc:start().
```

or simply `gmake mgc`.

The `-s megaco_filter` option to `erl` implies, the event tracing mechanism to be enabled and an interactive sequence chart tool to be started. This may be quite useful in order to visualize how your MGC interacts with the Megaco/H.248 protocol stack.

The event traces may alternatively be directed to a file for later analyze. By default the event tracing is disabled, but it may dynamically be enabled without any need for re-compilation of the code.
1.6.2 A simple Media Gateway

In megaco/examples/simple/megaco_simple.mgerl there is an example of a simple MG that connects to an MGC, sends a Service Change Request and waits synchronously for a reply. After this initial service change message the connection between the MG and MGC is fully established and supervised.

Assuming that the MGC is started on the local host, four different MG’s, using text over TCP/IP, binary over TCP/IP, text over UDP/IP and binary over UDP/IP may be started on the same Erlang node with:

```erlang
cd megaco/examples/simple
erl -pa ../../../megacoebin -s megaco filter -s megaco
megaco_simple.mg:start().
```
or simply ‘gmake mg’.

If you “only” want to start a single MG which tries to connect an MG on a host named “baidarka”, you may use one of these functions (instead of the megaco_simple.mg:start/0 above):

```erlang
megaco_simple.mg:start_tcp_text("baidarka", []).
megaco_simple.mg:start Tcp_binary("baidarka", []).
megaco_simple.mg:start_udp_text("baidarka", []).
megaco_simple.mg:start udp_binary("baidarka", []).
```

The -s megaco_filter option to erl implies, the event tracing mechanism to be enabled and an interactive sequence chart tool to be started. This may be quite useful in order to visualize how your MG interacts with the Megaco/H.248 protocol stack.

The event traces may alternatively be directed to a file for later analyze. By default the event tracing is disabled, but it may dynamically be enabled without any need for re-compilation of the code.

1.7 Megaco mib

1.7.1 Intro

The Megaco mib is as of yet not standardized and our implementation is based on draft-ietf-megaco-mib-04.txt. Almost all of the mib cannot easily be implemented by the megaco application. Instead these things should be implemented by a user (of the megaco application).

So what part of the mib is implemented? Basically the relevant statistic counters of the MedG wyG gatewayStatsEntry.

1.7.2 Statistics counters

The implementation of the statistic counters is lightweight. I.e. the statistic counters are handled separately by different entities of the application. For instance our two transport module(s) (see megaco_tcp [page 67] and megaco_udp [page 71]) maintain their own counters and the application engine (see megaco [page 57]) maintain it’s own counters.

This also means that if a user implement their own transport service then it has to maintain it’s own statistics.
1.7.3 Distribution

Each megaco application maintains its own set of counters. So in a large (distributed) MG/MGC it could be necessary to collect the statistics from several nodes (each) running the megaco application (only one of them with the transport).

1.8 Performance comparison

1.8.1 Comparison of encoder/decoders

The Megaco/H.248 standard defines both a plain text encoding and a binary encoding (ASN.1 BER) and we have implemented encoders and decoders for both. We do supply a bunch of different encoding/decoding modules and the user may in fact implement their own (like our erl_dist module). Using a non-standard encoding format has its obvious drawbacks, but may be useful in some configurations.

We have made four different measurements of our Erlang/OTP implementation of the Megaco/H.248 protocol stack, in order to compare our different encoders/decoders. The result of each one is summarized in a line chart:
1.8: Performance comparison

Encoded message size in bytes

Figure 1.9: Encoded message size in bytes
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Encode time in micro seconds

Figure 1.10: Encode time in micro seconds
Figure 1.11: Decode time in micro seconds
1.8.2 Description of encoders/decoders

In Appendix A of the Megaco/H.248 specification (RFC 3525), there are about 30 messages that shows a representative call flow. We have also added a few extra version 1, version 2 and version 3 messages. We have used these messages as basis for our measurements. The numbers within parentheses are the plain average values. Our figures have not been weighted in regard to how frequent the different kinds of messages that are sent between the media gateway and its controller.
The test compares the following encoder/decoders:

- **pretty** - pretty printed text. In the text encoding, the protocol stack implementors have the choice of using a mix of short and long keywords. It is also possible to add white spaces to improve readability. The pretty text encoding utilizes long keywords and an indentation style like the text examples in the Megaco/H.248 specification.
- **compact** - the compact text encoding uses the shortest possible keywords and no optional white spaces.
- **ber** - ASN.1 BER.
- **per** - ASN.1 PER. Not standardized as a valid Megaco/H.248 encoding, but included for the matter of completeness as its encoding is extremely compact.
- **erl** - Erlang's native distribution format. Not standardized as a valid Megaco/H.248 encoding, but included as a reference due to its well known performance characteristics. Erlang is a dynamically typed language and any Erlang data structure may be serialized to the erl dist format by using predefined built-in functions.

The actual encoded messages have been collected in one directory per encoding type, containing one file per encoded message.

Here follows an example of a text message to give a feeling of the difference between the pretty and compact versions of text messages. First the pretty printed, well indented version with long keywords:

```
MEGACO/1 [124.124.124.222]
  Transaction = 9998 
  Context = - { 
    ServiceChange = ROOT { 
      Services { 
        Method = Restart, 
        ServiceChangeAddress = 55555, 
        Profile = ResGW/1, 
        Reason = "901 MG Cold Boot" 
      } 
    } 
  } 
```

Then the compact text version without indentation and with short keywords:

```
!/1 [124.124.124.222] T=9998{
  C=-(SC=ROOT{SV{MT=RS,AD=55555,PF=ResGW/1,RE="901 MG Cold Boot"}})}
```

### 1.8.3 Setup

The measurements has been performed on a HP workstation xw6000 with an Intel Xeon 2.8 GHz, 1 GB memory running Fedora Core 4 (FC4), kernel 2.6.14. Software versions was the open source OTP R10B-10 updated with megaco-3.4.
1.8.4 Complete measurement result

This chapter details the effects of the possible encoding configurations for every codec. The result above are the fastest of these configurations for each codec. The figures presented are the average of all used messages.
### Codec and config

<table>
<thead>
<tr>
<th>Codec and config</th>
<th>Size</th>
<th>Encode</th>
<th>Decode</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>pretty</td>
<td>355</td>
<td>47</td>
<td>197</td>
<td>244</td>
</tr>
<tr>
<td>pretty [flex]</td>
<td>355</td>
<td>47</td>
<td>101</td>
<td>148</td>
</tr>
<tr>
<td>compact</td>
<td>192</td>
<td>42</td>
<td>163</td>
<td>205</td>
</tr>
<tr>
<td>compact [flex]</td>
<td>192</td>
<td>42</td>
<td>95</td>
<td>137</td>
</tr>
<tr>
<td>per bin</td>
<td>96</td>
<td>146</td>
<td>151</td>
<td>297</td>
</tr>
<tr>
<td>per bin [driver]</td>
<td>96</td>
<td>91</td>
<td>143</td>
<td>233</td>
</tr>
<tr>
<td>per bin [native]</td>
<td>96</td>
<td>110</td>
<td>116</td>
<td>226</td>
</tr>
<tr>
<td>per bin [driver,native]</td>
<td>96</td>
<td>55</td>
<td>108</td>
<td>163</td>
</tr>
<tr>
<td>ber bin</td>
<td>174</td>
<td>85</td>
<td>121</td>
<td>206</td>
</tr>
<tr>
<td>ber bin [driver]</td>
<td>174</td>
<td>85</td>
<td>78</td>
<td>163</td>
</tr>
<tr>
<td>ber bin [native]</td>
<td>174</td>
<td>49</td>
<td>87</td>
<td>136</td>
</tr>
<tr>
<td>ber bin [driver,native]</td>
<td>174</td>
<td>49</td>
<td>44</td>
<td>93</td>
</tr>
<tr>
<td>erl_dist</td>
<td>919</td>
<td>11</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>erl_dist [megaco,compressed]</td>
<td>364</td>
<td>13</td>
<td>12</td>
<td>26</td>
</tr>
<tr>
<td>erl_dist [compressed]</td>
<td>357</td>
<td>193</td>
<td>46</td>
<td>238</td>
</tr>
<tr>
<td>erl_dist [megaco,compressed,compressed]</td>
<td>194</td>
<td>162</td>
<td>29</td>
<td>191</td>
</tr>
</tbody>
</table>

Table 1.1: Codec performance

### 1.8.5 Summary

In our measurements we have seen that there are no significant differences in message sizes between ASN.1 BER and the compact text format. Some care should be taken when using the pretty text style (which is used in all the examples included in the protocol specification and preferred during debugging sessions) since the messages can then be quite large. If the message size really is a serious issue, our per encoder should be used, as the ASN.1 PER format is much more compact than all the other alternatives. Its major drawback is that it is has not been approved as a valid Megaco/H.248 message encoding.

When it comes to pure encode/decode performance, it turns out that our fastest text encoder (compact) is about 14% faster than our fastest binary encoder (ber). For decode the fastest binary decoder (ber) is 52% better then our fastest text (compact). Please, observe that these performance figures are related to our implementation in Erlang/OTP. Measurements of other implementations using other tools and techniques may of course result in other figures. If the pure encode/decode performance really is a serious issue, our erl_dist encoder should be used, as the encoding/decoding of the erlang distribution format is much faster than all the other alternatives. Its major drawback is that it is has not been approved as a valid Megaco/H.248 message encoding.

### 1.9 Testing and tools

#### 1.9.1 Tracing

We have instrumented our code in order to enable tracing. Running the application with tracing deactivated, causes a negligible performance overhead (an external call to a function which returns an atom). Activation of tracing does not require any recompilation of the code, since we rely on Erlang/OTP’s built in support for dynamic trace activation. In our case tracing of calls to a given external function.
Event traces can be viewed in a generic message sequence chart tool, that we have written. It can either be used in batch by loading event traces from file or interactively, as we are doing at demos and when we debug our own code. The event trace stuff can for the moment be found under megaco/utils but, will later be documented and released as an own application.

1.9.2 Measurement and transformation

We have included a simple tool for codec measurement and message transformation. The tool is located in the example directory.

Requirement

- Erlang/OTP, version R11B or later.
- Version 3.4 or later of this application.
- Version 1.4.4.10 or later of the asn1 application.
- The flex libraries. Without it, the flex powered codecs cannot be used.

Results

The results from the measurement run is four excel-compatible textfiles:

- decode_time.xls -> Decoding result
- encode_time.xls -> Encoding result
- total_time.xls -> Total (Decoding+encoding) result
- message_size.xls -> Message size

Instruction

The tool contain three things:

- The transformation module
- The measurement module
- The basic message file archive

Transformation module  The transformation module is used to transform a set of messages encoded with one codec into another other codec’s.

Example: Start an erlang node, and make sure it has the path to both the latest megaco ebin-dir as well as the dir containing the transformation module:

```
% erl -pa <path-megaco-ebin-dir> -pa <path-to-tranformation-module-dir>
Erlang (BEAM) emulator version 5.3 [source]

Eshell V5.3 (abort with ^G)
1> megaco_codec_transform:t(pretty, [compact, per, ber, erlang]).
...  
2> halt().
```

or to make it even easier if you as above use pretty text as base:
1.9: Testing and tools

```
% erl -noshell -pa <path-megaco-ebin-dir> -pa <path-to-transformation-module-dir> 
or using ber binary as base:
% erl -noshell -pa <path-megaco-ebin-dir> -pa <path-to-transformation-module-dir> 
```

Now the messages in the ‘pretty’ directory has been trasnformed and stored into the other codec dir’s.
It is possible to transform from any codec to any other.

Measurement module: The measurement module is used to measure the decode and encode the 
messages in the codec dirs.
Example: Start an erlang node, and make sure it has the path to both the latest megaco ebin-dir as well 
as the dir containing the measurement module:

```
% erl -pa <path-megaco-ebin-dir> -pa <path-to-meas-module-dir> 
Erlang (BEAM) emulator version 5.3 [source]

Eshell V5.3 (abort with ^C)
1> megaco_codec_meas:t([pretty, compact, per, ber, erlang]). 
... 
2> halt(). 
```

or to make it even easier, assuming a measure shall be done on all the codecs (as above):

```
% erl -noshell -pa <path-megaco-ebin-dir> -pa <path-to-meas-module-dir> 
```

When run as above (this will take some time), the measurement process is done as followes:

```
For each codec: 
  For each message: 
    Read the message from the file 
    Detect message version 
    Measure decode 
    Measure encode 
    Write results, encode, decode and total, to file 
```

The measure is done by iterating over the decode/encode function for approx 5 seconds per message 
and counting the number of decodes/encodes.
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Message file archive  This is basically a gzipped tar file of a directory tree with the following structure:

    time_test/pretty/<message-files>
    compact/
    per/
    ber/<message-files>
    erlang/

The only directories containing any files are the pretty-dir and the ber-dir. It's the same messages encoded with different codec's. This means it is possible to choose the message basis for the (transformation and) measurement.

These files include both version 1 and version 2 messages.

It is of course possible to add and remove messages at will. The messages included are the ones used in our own measurements.

Notes

Binary codecs  There are two basic ways to use the binary encodings: With package related name and termination id transformation (the ‘native’ encoding config) or without. This transformation converts package related names and termination id’s to a more convenient internal form (equivalent with the decoded text message).

The transformation is done _after_ the actual decode has been done.

Furthermore, it is possible to make use of a linked in driver that performs some of the decode/encode, decode for ber and encode for per (the ‘driver’ encoding config).

Therefore in the tests, binary codecs are tested with four different encoding configs to determine exactly how the different options effect the performance: with transformation and without driver ([]), without transformation and without driver ([native]), with transformation and with driver ([driver]) and finally without transformation and with driver ([driver,native]).

Included test messages  These messages are ripped from the call flow examples in an old version of the RFC.

Measurement tool directory name  Be sure not to name the directory containing the measurement binaries starting with ‘megaco-’, e.g. megaco-meas. This will confuse the erlang application loader (erlang applications are named, e.g. megaco-1.0.2).
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Short Summaries

- Erlang Module `megaco` [page 39] - Main API of the Megaco application
- Erlang Module `megaco_codec_meas` [page 60] - This module implements a simple megaco codec measurement tool.
- Erlang Module `megaco_flex_scanner` [page 65] - Interface module to the flex scanner linked in driver.
- Erlang Module `megaco_user` [page 73] - Callback module for users of the Megaco application

megaco

The following functions are exported:

- `start() -> ok | {error, Reason}` [page 39] Starts the Megaco application
- `stop() -> ok | {error, Reason}` [page 39] Stops the Megaco application
- `stop(UserMid) -> ok | {error, Reason}` [page 40] Stops the Megaco application
- `start_user(UserMid, Config) -> ok | {error, Reason}` [page 40] Initial configuration of a user
- `stop_user(UserMid) -> ok | {error, Reason}` [page 40] Delete the configuration of a user
- `user_info(UserMid, Item) -> Value | exit(Reason)` [page 40] Lookup user information
- `update_user_info(UserMid, Item, Value) -> ok | {error, Reason}` [page 43] Update information about a user
• conn_info(ConnHandle, Item) -> Value | exit(Reason)  
  [page 43] Lookup information about an active connection
• update_conn_info(ConnHandle, Item, Value) -> ok | {error, Reason}  
  [page 47] Update information about an active connection
• system_info(Item) -> Value | exit(Reason)  
  [page 47] Lookup system information
• connect(ReceiveHandle, RemoteMid, SendHandle, ControlPid) -> ok, ConnHandle | {error, Reason}  
  [page 47] Establish a “virtual” connection
• disconnect(ConnHandle, DiscoReason) -> ok | {error, ErrReason}  
  [page 48] Tear down a “virtual” connection
• call(ConnHandle, Actions, Options) -> {ProtocolVersion, UserReply}  
  [page 49] Sends one or more transaction request(s) and waits for the reply
• cast(ConnHandle, Actions, Options) -> ok | {error, Reason}  
  [page 50] Sends one or more transaction request(s) but does NOT wait for a reply
• encode_actions(ConnHandle, Actions, Options) -> ok, BinOrBins | {error, Reason}  
  [page 50] Encode action requests for one or more transaction request(s)
• token_tag2string(Tag) -> Result  
  [page 51] Convert a token tag to a string
• token_tag2string(Tag, EncoderMod) -> Result  
  [page 51] Convert a token tag to a string
• token_tag2string(Tag, EncoderMod, Version) -> Result  
  [page 51] Convert a token tag to a string
• cancel(ConnHandle, CancelReason) -> ok | {error, ErrReason}  
  [page 51] Cancel all outstanding messages for this connection
• process_received_message(ReceiveHandle, ControlPid, SendHandle, BinMsg) -> ok  
  [page 51] Process a received message
• receive_message(ReceiveHandle, ControlPid, SendHandle, BinMsg) -> ok  
  [page 52] Process a received message
• parse_digit_map(DigitMapBody) -> {ok, ParsedDigitMap} | {error, Reason}  
  [page 53] Parses a digit map body
• eval_digit_map(DigitMap) -> {ok, MatchResult} | {error, Reason}  
  [page 53] Collect digit map letters according to the digit map
• eval_digit_map(DigitMap, Timers) -> {ok, MatchResult} | {error, Reason}  
  [page 53] Collect digit map letters according to the digit map
• report_digit_event(DigitMapEvalPid, Events) -> ok | {error, Reason}  
  [page 53] Send one or more events to the event collector process
• test_digit_event(DigitMap, Events) -> {ok, Kind, Letters} | {error, Reason}  
  [page 54] Feed digit map collector with events and return the result
• encode_sdp(SDP) -> {ok, PP} | {error, Reason}  
  [page 54] Encode an SDP construct
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#### Decode an property parameter construct

- `decode_sdp(PP) -> {ok, SDP} | {error, Reason}`
  - [Page 55] Decode an property parameter construct

#### Retrieve various system and application info

- `versions1() -> {ok, VersionInfo} | {error, Reason}`
  - [Page 56] Retrieve various system and application info

- `versions2() -> {ok, Info} | {error, Reason}`
  - [Page 56] Retrieve various system and application info

#### Formatted print of result of the versions functions

- `print_version_info() -> void()`
  - [Page 57] Formatted print of result of the versions functions

- `print_version_info(VersionInfo) -> void()`
  - [Page 57] Formatted print of result of the versions functions

#### Start megaco tracing

- `enable_trace(Level, Destination) -> void()`
  - [Page 57] Start megaco tracing

- `disable_trace() -> void()`
  - [Page 57] Stop megaco tracing

- `set_trace(Level) -> void()`
  - [Page 57] Change megaco trace level

#### Retrieve various system and application info

- `get_stats() -> {ok, TotalStats} | {error, Reason}`
  - [Page 58]

- `get_stats(GlobalCounter) -> {ok, CounterStats} | {error, Reason}`
  - [Page 58]

- `get_stats(CallHandle) -> {ok, CallHandleStats} | {error, Reason}`
  - [Page 58]

- `get_stats(CallHandle, Counter) -> {ok, integer()} | {error, Reason}`
  - [Page 58]

- `reset_stats() -> void()`
  - [Page 58]

- `reset_stats(SendHandle) -> void()`
  - [Page 58]

- `test_request(ConnHandle, Version, EncodingMod, EncodingConfig, Actions) -> {MegaMsg, EncodeRes}`
  - [Page 58] Tests if the Actions argument is correct

- `test_reply(ConnHandle, Version, EncodingMod, EncodingConfig, Reply) -> {MegaMsg, EncodeRes}`
  - [Page 59] Tests if the Reply argument is correct

#### megaco_codec_meas

The following functions are exported:

- `t() -> void()`
  - [Page 60]

- `t(Dirs) -> void()`
  - [Page 60]
megaco_codec_transform

The following functions are exported:

- `tt() -> void()`
  [page 61]
- `tb() -> void()`
  [page 61]
- `t([FromCodec, ToCodecs]) -> ok | {error, Reason}`
  [page 61]
- `t(FromCodec, ToCodecs) -> ok | {error, Reason}`
  [page 61]
- `tmf(FromFile, FromCodec, ToCodec) -> ok | {error, Reason}`
  [page 61]
- `tm(FromMsg, FromCodec, ToCodec) -> binary()`
  [page 62]

megaco_encoder

The following functions are exported:

- `Module:encode_message(EncodingConfig, Version, Message) -> {ok, Bin} | Error`
  [page 63] Encode a megaco message.
- `Module:decode_message(EncodingConfig, Version, Bin) -> {ok, Message} | Error`
  [page 63] Decode a megaco message.
- `Module:decode_mini_message(EncodingConfig, Version, Bin) -> {ok, Message} | Error`
  [page 63] Perform a minimal decode of a megaco message.

megaco_flex_scanner

The following functions are exported:

- `start() -> {ok, Port} | {error, Reason}`
  [page 65]

megaco_tcp

The following functions are exported:

- `start_transport() -> {ok, TransportRef}`
  [page 66]
- `listen(TransportRef, ListenPortSpecList) -> ok`
  [page 66]
- `connect(TransportRef, OptionList) -> {ok, Handle, ControlPid} | {error, Reason}`
  [page 66]
The following functions are exported:

- `close(Handle) -> ok`  
  [page 66]
- `socket(Handle) -> Socket`  
  [page 67]
- `send_message(Handle, Message) -> ok`  
  [page 67]
- `block(Handle) -> ok`  
  [page 67]
- `unblock(Handle) -> ok`  
  [page 67]
- `upgrade_receive_handle(ControlPid) -> ok`  
  [page 67]
- `get_stats() -> {ok, TotalStats} | {error, Reason}`  
  [page 67]
- `get_stats(SendHandle) -> {ok, SendHandleStats} | {error, Reason}`  
  [page 67]
- `get_stats(SendHandle, Counter) -> {ok, CounterStats} | {error, Reason}`  
  [page 67]
- `reset_stats() -> void()`  
  [page 68]
- `reset_stats(SendHandle) -> void()`  
  [page 68]

**megaco_transport**

The following functions are exported:

- `Module:send_message(Handle, Msg) -> ok | {cancel, Reason} | Error`  
  [page 69] Send a megaco message.

**megaco_udp**

The following functions are exported:

- `start_transport() -> {ok, TransportRef}`  
  [page 70]
- `open(TransportRef, OptionList) -> {ok, Handle, ControlPid} | {error, Reason}`  
  [page 70]
- `close(Handle, Msg) -> ok`  
  [page 70]
- `socket(Handle) -> Socket`  
  [page 70]
- `create_send_handle(Handle, Host, Port) -> send_handle()`  
  [page 71]
- `send_message(SendHandle, Msg) -> ok`  
  [page 71]
megaco

The following functions are exported:

- **block(Handle)** -> ok  
  [page 71]
- **unblock(Handle)** -> ok  
  [page 71]
- **upgrade_receive_handle(ControlPid, NewHandle)** -> ok  
  [page 71]
- **get_stats()** -> {ok, TotalStats} | {error, Reason}  
  [page 71]
- **get_stats(SendHandle)** -> {ok, SendHandleStats} | {error, Reason}  
  [page 71]
- **get_stats(SendHandle, Counter)** -> {ok, CounterStats} | {error, Reason}  
  [page 71]
- **reset_stats()** -> void()  
  [page 72]
- **reset_stats(SendHandle)** -> void()  
  [page 72]

megaco_user

The following functions are exported:

- **handle_connect(ConnHandle, ProtocolVersion)** -> ok | error | {error, ErrorDescr}  
  [page 74] Invoked when a new connection is established
- **handle_disconnect(ConnHandle, ProtocolVersion, Reason)** -> ok  
  [page 74] Invoked when a connection is tear down
- **handle_syntax_error(ReceiveHandle, ProtocolVersion, DefaultED)** ->  
  reply | {reply, ED} | no_reply | {no_reply, ED}  
  [page 74] Invoked when a received message had syntax errors
- **handle_message_error(ConnHandle, ProtocolVersion, ErrorDescr)** -> ok  
  [page 75] Invoked when a received message just contains an error
- **handle_trans_request(ConnHandle, ProtocolVersion, ActionRequests)** ->  
  pending() | reply() | ignore_trans_request  
  [page 75] Invoked for each transaction request
- **handle_trans_long_request(ConnHandle, ProtocolVersion, ReqData)** ->  
  reply()  
  [page 76] Optionally invoked for a time consuming transaction request
- **handle_trans_reply(ConnHandle, ProtocolVersion, UserReply, ReplyData)** -> ok  
  [page 77] Optionally invoked for a transaction reply
- **handle_trans_ack(ConnHandle, ProtocolVersion, AckStatus, AckData)** -> ok  
  [page 78] Optionally invoked for a transaction acknowledgement
- **handle_unexpected_trans(ReceiveHandle, ProtocolVersion, Trans)** -> ok  
  [page 79] Invoked when an unexpected message is received
- **handle_trans_request_abort(ReceiveHandle, ProtocolVersion, TransNo, Pid)** -> ok  
  [page 79] Invoked when an transaction request has been aborted
megaco

Erlang Module

Interface module for the Megaco application

DATA TYPES

megaco_timer() = infinity | integer() | megaco_incr_timer()
megaco_incr_timer() = #megaco_incr_timer()

The record megaco_incr_timer contains the following fields:

wait_for = integer() The actual timer time.
factor = integer() The factor when calculating the new timer time (wait_for).
incr = integer() The increment value when calculating the new timer time (wait_for).
max_retries = infinity | infinity_restartable | integer() The maximum number of repetitions of the timer.

There is a special case for this field. When the max_retries has the value infinity_restartable, it means that the timer is restartable as long as some external event occurs (e.g. receipt of a pending message for instance). But the timer will never be restarted “by itself”, i.e. when the timer expires (whatever the timeout time), so does the timer. Whenever the timer is restarted, the timeout time will be calculated in the usual way!

Exports

start() -> ok | {error, Reason}

Types:

• Reason = term()

Starts the Megaco application

Users may either explicitly be registered with megaco:start_user/2 and/or be statically configured by setting the application environment variable 'users' to a list of (UserMid, Config) tuples. See the function megaco:start_user/2 for details.

stop() -> ok | {error, Reason}

stop

Types:

• Reason = term()
Stops the Megaco application

\[
\text{start\_user(UserMid, Config)} \rightarrow \text{ok | \{error, Reason\}}
\]

Types:
- \text{UserMid = megaco\_mid()}
- \text{Config = [{user\_info\_item(), user\_info\_value()}]}
- \text{Reason = term()}

Initial configuration of a user

Requires the megaco application to be started. A user is either a Media Gateway (MG) or a Media Gateway Controller (MGC). One Erlang node may host many users.

A user is identified by its UserMid, which must be a legal Megaco MID.

Config is a list of \{Item, Value\} tuples. See megaco:user\_info/2 about which items and values that are valid.

\[
\text{stop\_user(UserMid)} \rightarrow \text{ok | \{error, Reason\}}
\]

Types:
- \text{UserMid = megaco\_mid()}
- \text{Reason = term()}

Delete the configuration of a user

Requires that the user does not have any active connection.

\[
\text{user\_info(UserMid, Item)} \rightarrow \text{Value | exit(Reason)}
\]

Types:
- \text{Handle = user\_info\_handle()}
- \text{UserMid = megaco\_mid()}
- \text{Item = user\_info\_item()}
- \text{Value = user\_info\_value()}
- \text{Reason = term()}

Lookup user information

The following Item's are valid:

- \text{connections Lists all active connections for this user. Returns a list of megaco\_conn\_handle records.}
- \text{receive\_handle Construct a megaco\_receive\_handle record from user config}
- \text{trans\_id Current transaction id.}
  - A positive integer or the atom undefined\_serial (in case no messages has been sent).
- \text{min\_trans\_id First trans id.}
  - A positive integer, defaults to 1.
- \text{max\_trans\_id Last trans id.}
  - A positive integer or infinity, defaults to infinity.
request_timer Wait for reply.
   The timer is cancelled when a reply is received.
   When a pending message is received, the timer is cancelled and the
   long_request_timer is started instead (see below). No resends will be performed
   from this point (since we now know that the other side has received the request).
   When the timer reaches an intermediate expire, the request is resent and the
   timer is restarted.
   When the timer reaches the final expire, either the function megaco:call will
   return with {error, timeout} or the callback function handle_trans_reply will
   be called with UserReply = {error, timeout} (if megaco:cast was used).
   A Megaco Timer (see explanation above), defaults to #megaco_incr_timer{}.

long_request_timer Wait for reply after having received a pending message.
   When a pending message is received, the timer is restarted.
   When a pending message is received, and the long_request_timer is not "on it's
   final leg", the timer will be restarted, and, if long_request_resend = true, the
   request will be re-sent.
   A Megaco Timer (see explanation above), defaults to infinity.

long_request_resend This option indicates weather the request should be resent until
   the reply is received, even though a pending message has been received.
   Normally, after a pending message has been received, the request is not resent
   (since a pending message is an indication that the request has been received). But
   since the reply (to the request) can be lost, this behaviour has it's values.
   It is ofcourse pointless to set this value to true unless the long_request_timer (see
   above) is also set to an incremental timer (#megaco_incr_timer{}).
   A boolean, defaults to false.

reply_timer Wait for an ack.
   When a request is received, some info related to the reply is store internally (e.g.
   the binary of the reply). This info will live until either an ack is received or this
   timer expires. For instance, if the same request is received again (e.g. a request
   with the same transaction id), the (stored) reply will be (re-) sent automatically by
   megaco.
   If the timer is of type #megaco_incr_timer{}, then for each intermediate timeout,
   the reply will be resent (this is valid until the ack is received or the timer expires).
   A Megaco Timer (see explanation above), defaults to 30000.

auto_ack Automatic send transaction ack when the transaction reply has been received
   (see trans_ack below).
   This is used for three-way-handshake.
   A boolean, defaults to false.

trans_ack Shall ack's be accumulated or not.
   This property is only valid if auto_ack is true.
   If auto_ack is true, then if trans_ack is false, ack's will be sent immediatelly. If
   trans_ack is true, then ack's will instead be sent to the transaction sender process
   for accumulation and later sending (see trans_ack_maxcount,
   trans_req_maxcount, trans_req_maxsize, trans_ack_maxcount and
   trans_timer).
   See also transaction sender [page 14] for more info.
   A boolean, defaults to false.
trans_ack_maxcount Maximum number of accumulated ack’s. At most this many ack’s will be accumulated by the transaction sender (if started and configured to accumulate ack’s).

See also transaction sender [page 14] for more info.
An integer, defaults to 10.

trans_req Shall requests be accumulated or not.

If trans_req is false, then request(s) will be sent immediately (in it’s own message).

If trans_req is true, then request(s) will instead be sent to the transaction sender process for accumulation and later sending (see trans_ack_maxcount, trans_req_maxcount, trans_req_maxsize, trans_ack_maxcount and trans_timer).

See also transaction sender [page 14] for more info.
An boolean, defaults to false.

trans_req_maxcount Maximum number of accumulated requests. At most this many requests will be accumulated by the transaction sender (if started and configured to accumulate requests).

See also transaction sender [page 14] for more info.
An integer, defaults to 10.

trans_req_maxsize Maximum size of the accumulated requests. At most this much requests will be accumulated by the transaction sender (if started and configured to accumulate requests).

See also transaction sender [page 14] for more info.
An integer, defaults to 2048.

trans_timer Transaction sender timeout time. Has two functions. First, if the value is 0, then transactions will not be accumulated (e.g. the transaction sender process will not be started). Second, if the value is greater then 0 and auto_ack and trans_ack is true or if trans_req is true, then transaction sender will be started and transactions (which is depending on the values of auto_ack, trans_ack and trans_req) will be accumulated, for later sending.

See also transaction sender [page 14] for more info.
An integer, defaults to 0.

pending_timer Automatically send pending if the timer expires before a transaction reply has been sent. This timer is also called provisional response timer.
A Megaco Timer (see explanation above), defaults to 30000.

sent_pending_limit Sent pending limit (see the MGOriginatedPendingLimit and the MGCOOriginatedPendingLimit of the megaco root package). This parameter specifies how many pending messages that can be sent (for a given received transaction request). When the limit is exceeded, the transaction is aborted (see handle_trans_request_abort [page 79]) and an error message is sent to the other side.

Note that this has no effect on the actual sending of pending transactions. This is either implicit (e.g. when receiving a re-sent transaction request for a request which is being processed) or controlled by the pending_timer, see above.
A positive integer or infinity, defaults to infinity.

recv_pending_limit Receive pending limit (see the MGOriginatedPendingLimit and the MGCOOriginatedPendingLimit of the megaco root package). This parameter specifies how many pending messages that can be received (for a sent transaction
request). When the limit is exceeded, the transaction is considered lost, and an
error returned to the user (through the call-back function handle_reply).
A positive integer or infinity, defaults to infinity.

send_mod Send callback module which exports send_message/2. The function
SendMod:send_message(SendHandle, Binary) is invoked when the bytes needs to
be transmitted to the remote user.
An atom, defaults to megaco_tcp.

ingencoding_mod Encoding callback module which exports encode_message/2 and
decode_message/2. The function EncodingMod:encode_message(EncodingConfig,
MegacoMessage) is invoked whenever a 'MegacoMessage' record needs to be
translated into an Erlang binary. The function
EncodingMod:decode_message(EncodingConfig, Binary) is invoked whenever an
Erlang binary needs to be translated into a 'MegacoMessage' record.
An atom, defaults to megaco_pretty_text_encoder.

encoding_config Encoding module config.
A list, defaults to [].

protocol_version Actual protocol version.
An integer, default is 1.

strict_version Strict version control, i.e. when a message is received, verify that the
version is that which was negotiated.
An boolean, default is true.

reply_data Default reply data.
Any term, defaults to the atom undefined.

user_mod Name of the user callback module. See the reference manual for
megaco_user for more info.

user_args List of extra arguments to the user callback functions. See the reference
manual for megaco_user for more info.

threaded If a received message contains several transaction requests, this option
indicates whether the requests should be handled sequentially in the same process
(false), or if each request should be handled by it's own process (true i.e. a
separate process is spawned for each request).
An boolean, defaults to false.

update_user_info(UserMid, Item, Value) -> ok | {error, Reason}

Types:
• UserMid = megaco_mid()
• Item = user_info_item()
• Value = user_info_value()
• Reason = term()
Update information about a user
Requires that the user is started. See megaco:user_info/2 about which items and values
that are valid.

conn_info(ConnHandle, Item) -> Value | exit(Reason)

Types:
- ConnHandle = #megaco_conn_handle()
- Item = conn_info_item()
- Value = conn_info_value()
- Reason = term()

Lookup information about an active connection
Requires that the connection is active.

control_pid The process identifier of the controlling process for a connection.

send_handle Opaque send handle whose contents is internal for the send module. May be any term.

local_mid The local mid (of the connection, i.e. the own mid). megaco_mid().

remote_mid The remote mid (of the connection). megaco_mid().

receive_handle Construct a megaco_receive_handle record.

trans_id Next transaction id. A positive integer or the atom undefined_serial (only in case of error).

Note that transaction id’s are (currently) maintained on a per user basis so there is no way to be sure that the value returned will actually be used for a transaction sent on this connection (in case a user has several connections, which is not at all unlikely).

max_trans_id Last trans id.

A positive integer or infinity, defaults to infinity.

request_timer Wait for reply.

The timer is cancelled when a reply is received.

When a pending message is received, the timer is cancelled and the long_request_timer is started instead (see below). No resends will be performed from this point (since we now know that the other side has received the request).

When the timer reaches an intermediate expire, the request is resent and the timer is restarted.

When the timer reaches the final expire, either the function megaco:call will return with \{error, timeout\} or the callback function handle_trans_reply will be called with UserReply = \{error, timeout\} (if megaco:cast was used).

A Megaco Timer (see explanation above), defaults to #megaco_incr_timer().

long_request_timer Wait for reply after having received a pending message.

When the timer reaches an intermediate expire, the timer restarted.

When a pending message is received, and the long_request_timer is not “on it’s final leg”, the timer will be restarted, and, if long_request_resend = true, the request will be re-sent.

A Megaco Timer (see explanation above), defaults to infinity.

long_request_resend This option indicates weather the request should be resent until the reply is received, even though a pending message has been received.

Normally, after a pending message has been received, the request is not resent (since a pending message is an indication that the request has been received). But since the reply (to the request) can be lost, this behaviour has it’s values.

It is of course pointless to set this value to true unless the long_request_timer (see above) is also set to an incremental timer (#megaco_incr_timer()).

A boolean, defaults to false.
reply_timer  Wait for an ack.
    When a request is received, some info related to the reply is stored internally (e.g. the binary of the reply). This info will live until either an ack is received or this timer expires. For instance, if the same request is received again (e.g. a request with the same transaction id), the (stored) reply will be (re-)sent automatically by megaco.
    If the timer is of type \#megaco_incr_timer{}, then for each intermediate timeout, the reply will be resent (this is valid until the ack is received or the timer expires).
    A Megaco Timer (see explanation above), defaults to 30000.

auto_ack  Automatic send transaction ack when the transaction reply has been received (see trans_ack below).
    This is used for three-way-handshake.
    A boolean, defaults to false.

trans_ack  Shall ack's be accumulated or not.
    This property is only valid if auto_ack is true.
    If auto_ack is true, then if trans_ack is false, ack's will be sent immediately. If trans_ack is true, then ack's will instead be sent to the transaction sender process for accumulation and later sending (see trans_ack_maxcount, trans_req_maxcount, trans_req_maxsize, trans_ack_maxcount and trans_timer).
    See also transaction sender [page 14] for more info.
    A boolean, defaults to false.

trans_ack_maxcount  Maximum number of accumulated ack's. At most this many ack's will be accumulated by the transaction sender (if started and configured to accumulate ack's).
    See also transaction sender [page 14] for more info.
    A integer, defaults to 10.

trans_req  Shall requests be accumulated or not.
    If trans_req is false, then request(s) will be sent immediately (in it's own message).
    If trans_req is true, then request(s) will instead be sent to the transaction sender process for accumulation and later sending (see trans_ack_maxcount, trans_req_maxcount, trans_req_maxsize, trans_ack_maxcount and trans_timer).
    See also transaction sender [page 14] for more info.
    A boolean, defaults to false.

trans_req_maxcount  Maximum number of accumulated requests. At most this many requests will be accumulated by the transaction sender (if started and configured to accumulate requests).
    See also transaction sender [page 14] for more info.
    A integer, defaults to 10.

trans_req_maxsize  Maximum size of the accumulated requests. At most this much requests will be accumulated by the transaction sender (if started and configured to accumulate requests).
    See also transaction sender [page 14] for more info.
    A integer, defaults to 2048.

trans_timer  Transaction sender timeout time. Has two functions. First, if the value is 0, then transactions will not be accumulated (e.g. the transaction sender process
will not be started). Second, if the value is greater than 0 and `auto_ack` and `trans_ack` is true or if `trans_req` is true, then transaction sender will be started and transactions (which is depending on the values of `auto_ack`, `trans_ack` and `trans_req`) will be accumulated, for later sending.

See also transaction sender [page 14] for more info.

An integer, defaults to 0.

**pending_timer** Automatic send transaction pending if the timer expires before a transaction reply has been sent. This timer is also called provisional response timer.

A Megaco Timer (see explanation above), defaults to 30000.

**sent_pending_limit** Sent pending limit (see the MG-OriginatedPendingLimit and the MG-OriginatedPendingLimit of the megaco root package). This parameter specifies how many pending messages that can be sent (for a given received transaction request). When the limit is exceeded, the transaction is aborted (see handle_trans_request_abort [page 79]) and an error message is sent to the other side.

Note that this has no effect on the actual sending of pending transactions. This is either implicit (e.g. when receiving a re-sent transaction request for a request which is being processed) or controlled by the pending_timer, see above.

A positive integer or infinity, defaults to infinity.

**recv_pending_limit** Receive pending limit (see the MG-OriginatedPendingLimit and the MG-OriginatedPendingLimit of the megaco root package). This parameter specifies how many pending messages that can be received (for a sent transaction request). When the limit is exceeded, the transaction is considered lost, and an error returned to the user (through the callback function handle_trans_reply).

A positive integer or infinity, defaults to infinity.

**send_mod** Send callback module which exports `send_message/2`. The function `SendMod:send_message(SendHandle, Binary)` is invoked when the bytes needs to be transmitted to the remote user.

An atom, defaults to `megaco.tcp`.

**encoding_mod** Encoding callback module which exports `encode_message/2` and `decode_message/2`. The function `EncodingMod:encode_message(EncodingConfig, MegacoMessage)` is invoked whenever a `MegacoMessage` record needs to be translated into an Erlang binary. The function `EncodingMod:decode_message(EncodingConfig, Binary)` is invoked whenever an Erlang binary needs to be translated into a `MegacoMessage` record.

An atom, defaults to `megaco.pretty_text_encoder`.

**encoding_config** Encoding module config.

A list, defaults to `[]`.

**protocol_version** Actual protocol version.

A positive integer, Current default is 1.

**strict_version** Strict version control, i.e. when a message is received, verify that the version is that which was negotiated.

A boolean, default is true.

**reply_data** Default reply data.

Any term, defaults to the atom `undefined`.

**threaded** If a received message contains several transaction requests, this option indicates whether the requests should be handled sequentially in the same process (false), or if each request should be handled by its own process (true i.e. a separate process is spawned for each request).

A boolean, defaults to false.
update_conn_info(ConnHandle, Item, Value) -> ok | {error, Reason}

Types:
  • ConnHandle = #megaco_conn_handle()
  • Item = conn_info_item()
  • Value = conn_info_value()
  • Reason = term()

Update information about an active connection
Requires that the connection is activated. See megaco:conn_info/2 about which items
and values that are valid.

system_info(Item) -> Value | exit(Reason)

Types:
  • Item = system_info_item()

Lookup system information
The following items are valid:

  text_config The text encoding config.
  connections Lists all active connections. Returns a list of megaco_conn_handle records.
  users Lists all active users. Returns a list of megaco_mid()’s.
  n_active_requests Returns an integer representing the number of requests that has
    originated from this Erlang node and still are active (and therefore consumes
    system resources).
  n_active_replies Returns an integer representing the number of replies that has
    originated from this Erlang node and still are active (and therefore consumes
    system resources).
  n_active_connections Returns an integer representing the number of active
    connections.

connect(ReceiveHandle, RemoteMid, SendHandle, ControlPid) -> {ok, ConnHandle} |
  {error, Reason}

Types:
  • ReceiveHandle = #megaco_receive_handle()
  • RemoteMid = preliminary_mid | megaco_mid()
  • SendHandle = term()
  • ControlPid = pid()
  • ConnHandle = #megaco_conn_handle()
  • Reason = term()
Establish a “virtual” connection

Activates a connection to a remote user. When this is done the connection can be used to send messages (with UserMod:send_message/2). The ControlPid is the identifier of a process that controls the connection. That process will be supervised and if it dies, this will be detected and the UserMod:handle_disconnect/2 callback function will be invoked. See the megaco_user module for more info about the callback arguments. The connection may also explicitly be deactivated by invoking megaco:disconnect/2.

The ControlPid may be the identity of a process residing on another Erlang node. This is useful when you want to distribute a user over several Erlang nodes. In such a case one of the nodes has the physical connection. When a user residing on one of the other nodes needs to send a request (with megaco:call/3 or megaco:cast/3), the message will encoded on the originating Erlang node, and then be forwarded to the node with the physical connection. When the reply arrives, it will be forwarded back to the originator. The distributed connection may explicitly be deactivated by a local call to megaco:disconnect/2 or implicitly when the physical connection is deactivated (with megaco:disconnect/2, killing the controlling process, halting the other node, ...).

The call of this function will trigger the callback function UserMod:handle_connect/2 to be invoked. See the megaco_user module for more info about the callback arguments.

A connection may be established in several ways:

- **provisioned MID**: The MG may explicitly invoke megaco:connect/4 and use a provisioned MID of the MGC as the RemoteMid.

- **upgrade preliminary MID**: The MG may explicitly invoke megaco:connect/4 with the atom ‘preliminary_mid’ as a temporary MID of the MGC, send an initial message, the Service Change Request, to the MGC and then wait for an initial message, the Service Change Reply. When the reply arrives, the Megaco application will pick the MID of the MGC from the message header and automatically upgrade the connection to be a “normal” connection. By using this method of establishing the connection, the callback function UserMod:handle_connect/2 will be invoked twice. First with a ConnHandle with the remote_mid-field set to preliminary_mid, and then when the connection upgrade is done with the remote_mid-field set to the actual MID of the MGC.

- **automatic**: When the MGC receives its first message, the Service Change Request, the Megaco application will automatically establish the connection by using the MG MID found in the message header as remote mid.

- **distributed**: When a user (MG/MGC) is distributed over several nodes, it is required that the node hosting the connection already has activated the connection and that it is in the “normal” state. The RemoteMid must be a real Megaco MID and not a preliminary_mid.

An initial megaco_receive_handle record may be obtained with megaco:user_info(UserMid, receive_handle)

The send handle is provided by the preferred transport module, e.g. megaco_tcp, megaco_udp. Read the documentation about each transport module about the details.

```erlang
disconnect(ConnHandle, DiscoReason) -> ok | {error, ErrReason}
```

Types:
- ConnHandle = conn_handle()
- DiscoReason = term()
• ErrReason = term()
  Tear down a “virtual” connection
  Causes the UserMod:handle_disconnect/2 callback function to be invoked. See the
  megaco_user module for more info about the callback arguments.

call(ConnHandle, Actions, Options) -> {ProtocolVersion, UserReply}

Types:
• ConnHandle = conn_handle()
• Actions = action_reqs() | [action_reqs()]
• action_reqs() = binary() | [#'ActionRequest'()]
• Options = [send_option()]
• send_option() = {request_timer, megaco_timer()} | {long_request_timer, megaco_timer()} | {send_handle, term()} | {protocol_version, integer()}
• ProtocolVersion = integer()
• UserReply = user_reply() | [user_reply()]
• user_reply() = success() | failure()
• success() = {ok, [#'ActionReply'()]}  
• failure() = message_error() | user_cancel_error() | send_error() | other_error()
• message_error() = {error, error descr()}
• user_cancel_error() = {error, user_cancel_reason()}
• user_cancel_reason() = {user_cancel, reason_for_user_cancel()}
• reason_for_user_cancel() = term()
• send_error() = {error, send_reason()}
• send_reason() = send_cancelled_reason() | send_failed_reason()
• send_cancelled_reason() = {send_message_cancelled, reason_for_send_cancel()}
• reason_for_send_cancel() = term()
• send_failed_reason() = {send_message_failed, reason_for_send_failure()}
• reason_for_send_failure() = term()
• other_error() = {error, term()}

Sends one or more transaction request(s) and waits for the reply.
When sending one transaction in a message, Actions should be action_reqs()
(UserReply will then be user_reply()). When sending several transactions in a
message, Actions should be [action_reqs()] (UserReply will then be
[user_reply()]). Each element of the list is part of one transaction.
For some of our codecs (not binary), it is also possible to pre-encode the actions, in
which case Actions will be either a binary() or [binary()].
The function returns when the reply arrives, when the request timer eventually times
out or when the outstanding requests are explicitly cancelled.
The default values of the send options are obtained by megaco:conn_info(ConnHandle, Item). But the send options above, may explicitly be overridden.
The ProtocolVersion version is the version actually encoded in the reply message.
At success(), the UserReply contains a list of 'ActionReply' records possibly
containing error indications.
A message_error(), indicates that the remote user has replied with an explicit
transactionError.
A `user_cancel_error()`, indicates that the request has been canceled by the user. `reason_for_user_cancel()` is the reason given in the call to the cancel [page 51] function.

A `send_error()`, indicates that the send function of the megaco transport callback module failed to send the request. There are two separate cases: `send_cancelled_reason()` and `send_failed_reason()`. The first is the result of the send function returning `[cancel, Reason]` and the second is some other kind of erroneous return value. See the `send_message` [page ??] function for more info.

An `other_error()`, indicates some other error such as timeout.

cast(ConnHandle, Actions, Options) -> ok | {error, Reason}

Types:
- ConnHandle = conn_handle()
- Actions = action_reqs() | [action_reqs()]
- action_reqs() = binary() | [#'ActionRequest']
- Options = [send_option()]
- send_option() = {request_timer, megaco_timer()} | {long_request_timer, megaco_timer()} | {send_handle, term()} | {reply_data, reply_data()} | {protocol_version, integer()}
- Reason = term()

Sends one or more transaction request(s) but does NOT wait for a reply.
When sending one transaction in a message, Action should be `action_reqs()`. When sending several transactions in a message, Actions should be `[action_reqs()]`. Each element of the list is part of one transaction.

For some of our codecs (not binary), it is also possible to pre-encode the actions, in which case Actions will be either a `binary()` or `[binary()]`

The default values of the send options are obtained by `megaco:conn_info(ConnHandle, Item)`. But the send options above, may explicitly be overridden.

The `ProtocolVersion` version is the version actually encoded in the reply message.

The callback function `UserMod:handle_trans_reply/4` is invoked when the reply arrives, when the request timer eventually times out or when the outstanding requests are explicitly cancelled. See the `megaco_user` module for more info about the callback arguments.

Given as UserData argument to `UserMod:handle_trans_reply/4`.

cast(ConnHandle, Actions, Options) -> ok | {error, Reason}

Types:
- ConnHandle = conn_handle()
- Actions = action_reqs() | [action_reqs()]
- action_reqs() = [#'ActionRequest']
- Options = [send_option()]
- send_option() = {request_timer, megaco_timer()} | {long_request_timer, megaco_timer()} | {send_handle, term()} | {reply_data, reply_data()} | {protocol_version, integer()}
- BinOrBins = binary() | [binary()]
- Reason = term()
Encodes lists of action requests for one or more transaction request(s).

When encoding action requests for one transaction, Actions should be `action_reqs()`. When encoding action requests for several transactions, Actions should be `[action_reqs()]`. Each element of the list is part of one transaction.

token_tag2string(Tag) -> Result

token_tag2string(Tag, EncoderMod) -> Result

token_tag2string(Tag, EncoderMod, Version) -> Result

Types:
- Tag = atom()
- EncoderMod = pretty | compact | encoder_module()
- encoder_module() = megaco_pretty_text_encoder | megaco_compact_text_encoder | atom()
- Version = int_version() | atom_version()
  - int_version() = 1 | 2 | 3
  - atom_version() = v1 | v2 | v3 | prev3b
- Result = string() | {error, Reason}
- Reason = term()

Convert a token tag to a string
If no encoder module is given, the default is used (which is pretty).
If no or an unknown version is given, the best version is used (which is prev3b).
If no match is found for Tag, Result will be the empty string ([])..

cancel(ConnHandle, CancelReason) -> ok | {error, ErrReason}

Types:
- ConnHandle = conn_handle()
- CancelReason = term()
- ErrReason = term()

Cancel all outstanding messages for this connection
This causes outstanding megaco:call/3 requests to return. The callback functions UserMod:handle_reply/4 and UserMod:handle_trans_acks/4 are also invoked where it applies. See the megaco_user module for more info about the callback arguments.

process_received_message(ReceiveHandle, ControlPid, SendHandle, BinMsg) -> ok

Types:
- ReceiveHandle = #megaco_receive_handle{}
- ControlPid = pid()
- SendHandle = term()
- BinMsg = binary()
Process a received message
This function is intended to be invoked by some transport modules when get an incoming message. Which transport that actually is used is up to the user to choose.

The message is delivered as an Erlang binary and is decoded by the encoding module stated in the receive handle together with its encoding config (also in the receive handle). Depending of the outcome of the decoding various callback functions will be invoked. See megaco_user for more info about the callback arguments.

Note that all processing is done in the context of the calling process. A transport module could call this function via one of the spawn functions (e.g. spawn_opt). See also receive_message/4.

If the message cannot be decoded the following callback function will be invoked:

- UserMod:handle_syntax_error/3

If the decoded message instead of transactions contains a message error, the following callback function will be invoked:

- UserMod:handle_message_error/3

If the decoded message happens to be received before the connection is established, a new "virtual" connection is established. This is typically the case for the Media Gateway Controller (MGC) upon the first Service Change. When this occurs the following callback function will be invoked:

- UserMod:handle_connect/2

For each transaction request in the decoded message the following callback function will be invoked:

- UserMod:handle_transaction_request/3

For each transaction reply in the decoded message the reply is returned to the user. Either the originating function megaco:call/3 will return. Or in case the originating function was megaco:case/3 the following callback function will be invoked:

- UserMod:handle_transaction_reply/4

When a transaction acknowledgement is received it is possible that user has decided not to bother about the acknowledgement. But in case the return value from UserMod:handle_transaction_request/3 indicates that the acknowledgement is important the following callback function will be invoked:

- UserMod:handle_transaction_ack/4

See the megaco_user module for more info about the callback arguments.

receive_message(ReceiveHandle, ControlPid, SendHandle, BinMsg) -> ok

Types:
- ReceiveHandle = #megaco_receive_handle{}
- ControlPid = pid()
- SendHandle = term()
- BinMsg = binary()
Process a received message

This is a callback function intended to be invoked by some transport modules when get an incoming message. Which transport that actually is used is up to the user to choose.

In principle, this function calls the process_received_message/4 function via a spawn to perform the actual processing.

For further information see the process_received_message/4 function.

```
parse_digit_map(DigitMapBody) -> {ok, ParsedDigitMap} | {error, Reason}
```

Types:
- DigitMapBody = string()
- ParsedDigitMap = parsed_digit_map()
- parsed_digit_map() = term()
- Reason = term()

 Parses a digit map body
Parses a digit map body, represented as a list of characters, into a list of state transitions suited to be evaluated by megaco:eval_digit_map/1,2.

```
eval_digit_map(DigitMap) -> {ok, MatchResult} | {error, Reason}
eval_digit_map(DigitMap, Timers) -> {ok, MatchResult} | {error, Reason}
```

Types:
- DigitMap = #{DigitMapValue} | parsed_digit_map()
- parsed_digit_map() = term()
- ParsedDigitMap = term()
- Timers = ignore() | reject()
- ignore() = ignore | {ignore, digit_map_value()}
- reject() = reject | {reject, digit_map_value()} | digit_map_value()
- MatchResult = {Kind, Letters} | {Kind, Letters, Extra}
- Kind = kind()
- kind() = full | unambiguous
- Letters = [letter()]
- letter() = $0..$9 | $a .. $k
- Extra = letter()
- Reason = term()

Collect digit map letters according to the digit map.

When evaluating a digit map, a state machine waits for timeouts and letters reported by megaco:report_digit_event/2. The length of the various timeouts are defined in the digit_map_value() record.

When a complete sequence of valid events has been received, the result is returned as a list of letters.

There are two options for handling syntax errors (that is when an unexpected event is received when the digit map evaluator is expecting some other event). The unexpected events may either be ignored or rejected. The latter means that the evaluation is aborted and an error is returned. 

```
report_digit_event(DigitMapEvalPid, Events) -> ok | {error, Reason}
```
Types:
- DigitMapEvalPid = pid()
- Events = Event \[ Event
- Event = letter() | pause() | cancel()
- letter() = $0..9 | $a..$k | $A .. $K
- pause() = one_second() | ten_seconds()
- one_second() = $s | $S
- ten_seconds() = $l | $L
- cancel() = $z | $Z | cancel
- Reason = term()

Send one or more events to the event collector process.

Send one or more events to a process that is evaluating a digit map, that is a process that is executing megaco:eval_digit_map/1,2.

Note that the events $s | $S, $l | $L and $z | $Z has nothing to do with the timers using the same characters.

test_digit_event(DigitMap, Events) -> \{ ok, Kind, Letters \} | \{ error, Reason \}

Types:
- DigitMap = #DigitMapValue\{ \} | parsed_digit_map()
- parsed_digit_map() = term()
- ParsedDigitMap = term()
- Timers = ignore() | reject()
- ignore() = ignore | \{ ignore_digit_map_value() \}
- reject() = reject | \{ reject, digit_map_value() \} | digit_map_value()
- DigitMapEvalPid = pid()
- Events = Event \[ Event
- Event = letter() | pause() | cancel()
- Kind = kind()
- kind() = full | unambiguous
- Letters = [letter()]
- letter() = $0..9 | $a..$k | $A .. $K
- pause() = one_second() | ten_seconds()
- one_second() = $s | $S
- ten_seconds() = $l | $L
- cancel() = $z | $Z | cancel
- Reason = term()

Feed digit map collector with events and return the result

This function starts the evaluation of a digit map with megaco:eval_digit_map/1 and sends a sequence of events to it megaco:report_digit_event/2 in order to simplify testing of digit maps.

encode_sdp(SDP) -> \{ ok, PP \} | \{ error, Reason \}

Types:
- SDP = sdprop\{ prop\} | sdprop\{ prop\} | sdprop\{ prop\} | asn1\{ NOVALUE \}
- `sdp.property_parm() = sdp() | property_parm()
- `sdp() = sdp_c() | sdp_o() | sdp_s() | sdo_i() | sdo_u() | sdo_e() | sdo_p() | sdo_c() | sdo_r() | sdo_b() | sdo_z() | sdo_k() | sdo_a() | sdo_a_rtpmap() | sdo_a_ptime() | sdo_a() | sdo_e() | sdo_m()
- `sdp_v() = #megaco_sdp_v{ } (Protocol version)
- `sdp_o() = #megaco_sdp_o{} (Owner/creator and session identifier)
- `sdp_s() = #megaco_sdp_s{} (Session name)
- `sdp_i() = #megaco_sdp_i{} (Session information)
- `sdp_u() = #megaco_sdp_u{} (URI of description)
- `sdp_e() = #megaco_sdp_e{} (Email address)
- `sdp_p() = #megaco_sdp_p{} (Phone number)
- `sdp_c() = #megaco_sdp_c{} (Connection information)
- `sdp_b() = #megaco_sdp_b{} (Bandwidth information)
- `sdp_k() = #megaco_sdp_k{} (Encryption key)
- `sdp_a() = #megaco_sdp_a{} (Session attribute)
- `sdp_a_rtpmap() = #megaco_sdp_a_rtpmap{}
- `sdp_a_ptime() = #megaco_sdp_a_ptime{}
- `sdp_a_quality() = #megaco_sdp_a_quality{}
- `sdp_a_fmtp() = #megaco_sdp_a_fmtp{}
- `sdp_z() = #megaco_sdp_z{} (Time zone adjustment)
- `sdp_t() = #megaco_sdp_t{} (Time the session is active)
- `sdp_r() = #megaco_sdp_r{} (Repeat times)
- `sdp_m() = #megaco_sdp_m{} (Media name and transport address)
- `sdp.property_group() = [sdp]{}
- `sdp.property_groups() = [sdp.property_group()]
- `PP = property_parm() | property_group() | property_groups() | asn1_NOVALUE
- `property_group() = [property_parm()]
- `property_groups() = [property_group()]
- `Reason = term()

Encode (generate) an SDP construct.
If a `property_parm()` is found as part of the input (SDP) then it is left unchanged.

This function performs the following transformation:

- `sdp() -> property_parm()
- `sdp.property_group() -> property_group()
- `sdp.property_groups() -> property_groups()

```
decode_sdp(PP) -> {ok, SDP} | {error, Reason}
```

Types:
- `PP = property_parm() | property_group() | property_groups() | asn1_NOVALUE
- `property_group() = [property_parm()]
- `property_groups() = [property_group()]
- `SDP = sdp() | {property_parm(), DecodeError} | sdp.property_group() | {sdp.property_groups(), BadPPs} | asn1_NOVALUE
Decode (parse) a property parameter construct.

When decoding `property_group()` or `property_groups()`, those property parameter constructs that cannot be decoded (either because of decode error or because they are unknown), will be returned as a two-tuple. The first element of which will be the (decoded) property parameter and the other the actual reason. This means that the caller of this function has to expect not only sdp-records, but also this two-tuple construct.

This function performs the following transformation:

- `property_parm()` -> `sdp()`
- `property_group()` -> `sdp_property_group()`
- `property_groups()` -> `sdp_property_groups()`

`versions1()` -> `{ok, VersionInfo} | {error, Reason}`

`versions2()` -> `{ok, Info} | {error, Reason}`

Types:

- `VersionInfo = [version_info()]`
- `version_info()` = `term()`
- `Reason = term()`
Utility functions used to retrieve some system and application info.

The difference between the two functions is in how they get the modules to check. versions1 uses the app-file and versions2 uses the function application:get_key.

print_version_info() -> void()
print_version_info(VersionInfo) -> void()

Types:
- VersionInfo = [version_info()]
- version_info() = term()

Utility function to produce a formatted printout of the versions info generated by the versions1 and versions2 functions.

The function print_version_info/0 uses the result of function version1/0 as VersionInfo.

Example:
{ok, V} = megaco:versions1(), megaco:format_versions(V).

enable_trace(Level, Destination) -> void()

Types:
- Level = max | min | 0 <= integer() <= 100
- Destination = File | Port | HandlerSpec | io
  - File = string()
  - Port = integer()
  - HandlerSpec = {HandlerFun, Data}
  - HandlerFun = fun() (two arguments)
  - Data = term()

This function is used to start megaco tracing at a given Level and direct result to the given Destination.

It starts a tracer server and then sets the proper match spec (according to Level).

In the case when Destination is File, the printable megaco trace events will be printed to the file File using plain io:format/2.

In the case when Destination is io, the printable megaco trace events will be printed on stdout using plain io:format/2.

See dbg for further information.

disable_trace() -> void()

This function is used to stop megaco tracing.

set_trace(Level) -> void()

Types:
- Level = max | min | 0 <= integer() <= 100

This function is used to change the megaco trace level.

It is assumed that tracing has already been enabled (see enable_trace above).
get_stats() -> {ok, TotalStats} | {error, Reason}
get_stats(GlobalCounter) -> {ok, CounterStats} | {error, Reason}
get_stats(CallHandle) -> {ok, CallHandleStats} | {error, Reason}
get_stats(CallHandle, Counter) -> {ok, integer()} | {error, Reason}

Types:
- TotalStats = [total_stats()]
- total_stats() = [call_handle(), [stats()]] | [global_counter(), integer()]
- GlobalCounter = global_counter()
- GlobalCounterStats = integer()
- CallHandle = call_handle()
- CallHandleStats = [stats()]
- stats() = [counter(), integer()]
- Counter = counter()
- counter() = medGwyGatewayNumTimerRecovery | medGwyGatewayNumErrors
- global_counter() = medGwyGatewayNumErrors
- Reason = term()

Retrieves the (SNMP) statistic counters. The global counters handle events that cannot be attributed to a single connection (e.g. protocol errors that occur before the connection has been properly setup).

reset_stats() -> void()
reset_stats(SendHandle) -> void()

Types:
- SendHandle = send_handle()

Reset all related (SNMP) statistics counters.

test_request(ConnHandle, Version, EncodingMod, EncodingConfig, Actions) -> {MegaMsg, EncodeRes}

Types:
- ConnHandle = conn_handle()
- Version = integer()
- EncodingMod = atom()
- EncodingConfig = Encoding configuration
- Actions = A list
- MegaMsg = #MegacoMessage{}
- EncodeRes = {ok, Bin} | {error, Reason}
- Bin = binary()
- Reason = term()

Tests if the Actions argument is correctly composed.

This function is only intended for testing purposes. It's supposed to have a same kind of interface as the call [page 49] or cast [page 50] functions (with the additions of the EncodingMod and EncodingConfig arguments). It composes a complete megaco message and attempts to encode it. The return value, will be a tuple of the composed megaco message and the encode result.
test_reply(ConnHandle, Version, EncodingMod, EncodingConfig, Reply) -> {MegaMsg, EncodeRes}

Types:
- ConnHandle = conn_handle()
- Version = integer()
- EncodingMod = atom()
- EncodingConfig = A list
- Reply = actual_reply()
- MegaMsg = #MegacoMessage{}
- EncodeRes = {ok, Bin} | {error, Reason}
- Bin = binary()
- Reason = term()

Tests if the Reply argument is correctly composed.

This function is only intended for testing purposes. It’s supposed to test the actual_reply() return value of the callback functions handle_trans_request [page 75] and handle_trans_long_request [page 76] functions (with the additions of the EncodingMod and EncodingConfig arguments). It composes a complete megaco message and attempts to encode it. The return value, will be a tuple of the composed megaco message and the encode result.
megaco_codec_meas

Erlang Module

This module implements a simple megaco codec measurement tool. Results are written to file (excel compatible text files) and on stdout. Note that this module is not included in the runtime part of the application.

Exports

\[t() \to \text{void}()\]

This function runs the measurement on all the official codecs; pretty, compact, ber, per and erlang.

\[t(Dirs) \to \text{void}()\]

Types:

- Dirs = [codec()]
- codec() :- pretty | compact | ber | per | erlang

Runs the codecs as specified in Dirs. Note that the codec name used here is also assumed to be the same as the directory containing the encoded messages used in the measurement.
megaco_codec_transform

Erlang Module

This module implements a simple megaco message transformation utility. Note that this module is not included in the runtime part of the application.

Exports

\[ tt() \rightarrow \text{void() \ } \]
Transform messages using pretty text as base. Transform messages from pretty text encoding to compact, ber, per and erlang encoding.
This call is equivalent to the call: \[ t(\text{pretty, [compact, ber, per, erlang]}) \]

\[ tb() \rightarrow \text{void()} \]
Transform messages using ber binary as base. Transform messages from ber binary encoding to pretty, compact, ber, per and erlang encoding.
This call is equivalent to the call: \[ t(\text{ber, [pretty, compact, per, erlang]}) \]

\[ t([\text{FromCodec}, \text{ToCodecs}]) \rightarrow \text{ok \ } | \text{error, Reason} \]
Types:
- FromCodec = codec_string()
- ToCodecs = [codec_string()]
- codec_string() = "pretty" | "compact" | "ber" | "per" | "erlang"
Called from the command line (shell) to transform all messages in a given codec dir to a given list of codec dirs. The dirs will not be created.
Example: Converts from codec ber to codecs pretty, compact and per
\[
erl -noshell -sname megaco ../ebin \n -run megaco_codec_transform t ber pretty compact per erlang
\]

\[ t(\text{FromCodec}, \text{ToCodecs}) \rightarrow \text{ok \ } | \text{error, Reason} \]
Types:
- FromCodec = codec()
- ToCodecs = [codec()]
- codec() = pretty | compact | ber | per | erlang
Transforms all messages in a given codec dir to a given list of codec dirs. The dirs will not be created.

\[ tmf(\text{FromFile}, \text{FromCodec}, \text{ToCodec}) \rightarrow \text{ok \ } | \text{error, Reason} \]
Types:
- FromFile = string()
- FromCodec = codec()
- ToCodec = codec()

Transform a message in a file encoded with the given codec to another codec. The resulting message is written to file, in the ToCodec dir.

\[
\text{tm(FromMsg, FromCodec, ToCodec) \rightarrow \text{binary()}}
\]

Types:
- FromMsg = binary()
- FromCodec = codec()
- ToCodec = codec()

Transforms a message binary encoded with the given codec to another codec. The resulting message is returned (as a binary).
**megaco_encoder**

Erlang Module

The following functions should be exported from a `megaco_encoder` callback module:

**Exports**

```erlang
Module:encode_message(-EncodingConfig, Version, Message) -> {ok, Bin} | Error
```

*Types:*
- `EncodingConfig` = list()
- `Version` = integer()
- `Message` = megaco_message()
- `Bin` = binary()
- `Error` = term()

Encode a megaco message.

```erlang
Module:decode_message(EncodingConfig, Version, Bin) -> {ok, Message} | Error
```

*Types:*
- `EncodingConfig` = list()
- `Version` = integer() | dynamic
- `Message` = megaco_message()
- `Bin` = binary()
- `Error` = term()

Decode a megaco message.

Note that if the `Version` argument is `dynamic`, the decoder should try to figure out the actual version from the message itself and then use the proper decoder, e.g. version 1. If on the other hand the `Version` argument is an integer, it means that this is the expected version of the message and the decoder for that version should be used.

```erlang
Module:decode_mini_message(EncodingConfig, Version, Bin) -> {ok, Message} | Error
```

*Types:*
- `EncodingConfig` = list()
- `Version` = integer() | dynamic
- `Message` = megaco_message()
- `Bin` = binary()
- `Error` = term()
Perform a minimal decode of a megaco message.

The purpose of this function is to do a minimal decode of Megaco message. A successful result is a `MegacoMessage` in which only version and mid has been initiated. This function is used by the megaco messeger module when the decode_message/3 function fails to figure out the mid (the actual sender) of the message.

Note again that a successful decode only returns a partially initiated message.
This module contains the public interface to the flex scanner linked in driver. The flex scanner performs the scanning phase of text message decoding.

The flex scanner is written using a tool called flex. In order to be able to compile the flex scanner driver, this tool has to be available.

By default the flex scanner reports line-number of an error. But it can be built without line-number reporting. Instead token number is used. This will speed up the scanning some 5-10%. Use `--disable-megaco-flex-scanner-lineno` when configuring the application.

Exports

```
start() -> {ok, Port} | {error, Reason}
```

Types:

- `Port` = `port()`
- `Reason` = `term()`

This function is used to start the flex scanner. It locates the library and loads the linked in driver.

Note that the process that calls this function must be permanent. If it dies, the port will exit and the driver unload.
megaco_tcp
Erlang Module

This module contains the public interface to the TPKT (TCP/IP) version transport protocol for Megaco/H.248.

Exports

start_transport() -> {ok, TransportRef}
Types:
- TransportRef = pid()
This function is used for starting the TCP/IP transport service. Use exit(TransportRef, Reason) to stop the transport service.

listen(TransportRef, ListenPortSpecList) -> ok
Types:
- TransportRef = pid() | reename()
- OptionListPerPort = [Option]
- Option = {port, integer()} | {options, list()} | {receive_handle, term()}
This function is used for starting new TPKT listening socket for TCP/IP. The option list contains the socket definitions.

connect(TransportRef, OptionList) -> {ok, Handle, ControlPid} | {error, Reason}
Types:
- TransportRef = pid() | reename()
- OptionList = [Option]
- Option = {host, Ipaddr} | {port, integer()} | {options, list()} | {receive_handle, term()} | {module, atom()}
- Handle = socket_handle()
- ControlPid = pid()
- Reason = term()
This function is used to open a TPKT connection.
The module option makes it possible for the user to provide their own callback module. The receive_message/4 or process_received_message/4 functions of this module is called when a new message is received (which one depends on the size of the message; small - receive_message, large - process_received_message). Default value is megaco.

close(Handle) -> ok
Types:
- Handle = socket_handle()
This function is used for closing an active TPKT connection.

socket(Handle) -> Socket
Types:
- Handle = socket_handle()
- Socket = inet_socket()
This function is used to convert a socket_handle() to a inet_socket(). inet_socket() is a plain socket, see the inet module for more info.

send_message(Handle, Message) -> ok
Types:
- Handle = socket_handle()
- Message = binary() | iolist()
Sends a message on a connection.

block(Handle) -> ok
Types:
- Handle = socket_handle()
Stop receiving incoming messages on the socket.

unblock(Handle) -> ok
Types:
- Handle = socket_handle()
Starting to receive incoming messages from the socket again.

upgrade_receive_handle(ControlPid) -> ok
Types:
- ControlPid = pid()
Update the receive handle of the control process (e.g. after having changed protocol version).

get_stats() -> {ok, TotalStats} | {error, Reason}
get_stats(SendHandle) -> {ok, SendHandleStats} | {error, Reason}
get_stats(SendHandle, Counter) -> {ok, CounterStats} | {error, Reason}

Types:
- TotalStats = [send_handle_stats()]
- total_stats() = [send_handle(), [stats()]]
- SendHandle = send_handle()
- SendHandleStats = [stats()]
- Counter = tcp_stats_counter()
- CounterStats = integer()
Retrieve the TCP related (SNMP) statistics counters.

```c
reset_stats() -> void()
reset_stats(SendHandle) -> void()
```

**Types:**
- `SendHandle` = `send handle()`

Reset all TCP related (SNMP) statistics counters.
megaco_transport

Erlang Module

The following functions should be exported from a megaco_transport callback module:

Exports

Module:send_message(Handle, Msg) -> ok | {cancel, Reason} | Error

Types:
- Handle = term()
- Msg = binary() | iolist()
- Reason = term()
- Error = term()

Send a megaco message.
If the function returns {cancel, Reason}, this means the transport module decided not
to send the message. This is not an error. No error messages will be issued and no error
counters incremented. What actions this will result in depends on what kind of message
was sent. In the case of requests, megaco will cancel the message in much the same way
as if megaco:cancel had been called (after a successful send). The information will be
propagated back to the user differently depending on how the request(s) where issued:
For requests issued using megaco:call [page 49], the info will be delivered in the return
value. For requests issued using megaco:cast the info will be delivered via a call to the
callback function handle_trans_reply [page 77]. In the case of reply, megaco will cancel
the reply and information of this will be returned to the user via a call to the callback
function handle_trans_ack [page 78].
megaco_udp

Erlang Module

This module contains the public interface to the UDP/IP version transport protocol for Megaco/H.248.

Exports

\[\text{start\_transport}() \rightarrow \{\text{ok}, \text{TransportRef}\}\]

Types:
- \(\text{TransportRef} = \text{pid()}\)
This function is used for starting the UDP/IP transport service. Use \text{exit}(\text{TransportRef}, Reason) to stop the transport service.

\[\text{open}(\text{TransportRef}, \text{OptionList}) \rightarrow \{\text{ok}, \text{Handle}, \text{ControlPid}\} \mid \{\text{error}, \text{Reason}\}\]

Types:
- \(\text{TransportRef} = \text{pid()} \mid \text{regname()})\)
- \(\text{OptionList} = \{\text{option()})\}
- \(\text{option()} = \{\text{port, integer()}\} \mid \{\text{options, list()}\} \mid \{\text{receive\_handle, receive\_handle()}\}
- \{\text{module, atom()}\}
- \(\text{Handle} = \text{socket\_handle()}\)
- \(\text{receive\_handle()} = \text{term()}\)
- \(\text{ControlPid} = \text{pid()}\)
- \(\text{Reason} = \text{term()}\)
This function is used to open an UDP/IP socket. The \text{module} option makes it possible for the user to provide their own callback module. The functions \text{receive\_message/4} or \text{process\_received\_message/4} of this module is called when a new message is received (which one depends on the size of the message; small - \text{receive\_message}, large - \text{process\_received\_message}). Default value is \text{megaco}.

\[\text{close}(\text{Handle}, \text{Msg}) \rightarrow \text{ok}\]

Types:
- \(\text{Handle} = \text{socket\_handle()}\)
- \(\text{Msg}\)
This function is used for closing an active UDP socket.

\[\text{socket}(\text{Handle}) \rightarrow \text{Socket}\]

Types:
create_send_handle(Handle, Host, Port) -> send_handle()

Types:
- Handle = socket_handle()
- Host = {A,B,C,D} | string()
- Port = integer()

Creates a send handle from a transport handle. The send handle is intended to be used by megaco_udp:send_message/2.

send_message(SendHandle, Msg) -> ok

Types:
- SendHandle = send_handle()
- Message = binary() | iolist()

Sends a message on a socket. The send handle is obtained by megaco_udp:create_send_handle/3. Increments the NumOutMessages and NumOutOctets counters if message successfully sent. In case of a failure to send, the NumErrors counter is not incremented. This is done elsewhere in the megaco app.

block(Handle) -> ok

Types:
- Handle = socket_handle()

Stop receiving incoming messages on the socket.

unblock(Handle) -> ok

Types:
- Handle = socket_handle()

Starting to receive incoming messages from the socket again.

upgrade_receive_handle(ControlPid, NewHandle) -> ok

Types:
- ControlPid = pid()
- NewHandle = receive_handle()
- receive_handle() = term()

Update the receive handle of the control process (e.g. after having changed protocol version).

get_stats() -> {ok, TotalStats} | {error, Reason}

get_stats(SendHandle) -> {ok, SendHandleStats} | {error, Reason}

get_stats(SendHandle, Counter) -> {ok, CounterStats} | {error, Reason}

Types:
Retreive the UDP related (SNMP) statistics counters.

```
reset_stats() -> void()
reset_stats(SendHandle) -> void()

Types:
  * SendHandle = send_handle()

Reset all TCP related (SNMP) statistics counters.
This module defines the callback behaviour of Megaco users. A megaco_user compliant callback module must export the following functions:

- handle_connect/2 [page 73]
- handle_disconnect/3 [page 74]
- handle_syntax_error/3 [page 74]
- handle_message_error/3 [page 75]
- handle_trans_request/3 [page 75]
- handle_trans_long_request/3 [page 76]
- handle_trans_reply/4 [page 77]
- handle_trans_ack/4 [page 78]
- handle_unexpected_trans/3 [page 79]
- handle_trans_request_abort/4 [page 79]

The semantics of them and their exact signatures are explained below. There are a couple data types that are common for many of the functions. These are explained here:

conn_handle() is the 'megaco_conn_handle' record initially returned by megaco:connect/4. It identifies a "virtual" connection and may be reused after a reconnect (disconnect + connect).

protocol_version() is the actual protocol version. In most cases the protocol version is retrieved from the processed message, but there are exceptions:
- When handle_connect/2 is triggered by an explicit call to megaco:connect/4.
- handle_disconnect/3
- handle_syntax_error/3

In these cases, the ProtocolVersion default version is obtained from the static connection configuration:
- megaco:conn_info(ConnHandle, protocol_version).

error_descr() is an 'ErrorDescriptor' record.

The user_args configuration parameter which may be used to extend the argument list of the callback functions. For example, the handle_connect function takes by default two arguments:
- handle_connect(Handle, Version)

but if the user_args parameter is set to a longer list, such as [SomePid, SomeTableRef], the callback function is expected to have these (in this case two) extra arguments last in the argument list:
- handle_connect(Handle, Version, SomePid, SomeTableRef)
Exports

handle_connect(ConnHandle, ProtocolVersion) -> ok | error | {error, ErrorDescr}

Types:
  - ConnHandle = conn_handle()
  - ProtocolVersion = protocol_version()
  - ErrorDescr = error_descr()

Invoked when a new connection is established.
Connections may either be established by an explicit call to megaco:connect/4 or implicitly at the first invocation of megaco:receive_message/3.
Normally a Media Gateway (MG) connects explicitly while a Media Gateway Controller (MGC) connects implicitly.
At the Media Gateway Controller (MGC) side it is possible to reject a connection request (and send a message error reply to the gateway) by returning {error, ErrorDescr} or simply error which generates an error descriptor with code 402 (unauthorized) and reason "Connection refused by user" (this is also the case for all unknown results, such as exit signals or throw).

handle_disconnect(ConnHandle, ProtocolVersion, Reason) -> ok

Types:
  - ConnHandle = conn_handle()
  - ProtocolVersion = protocol_version()
  - Reason = term()

Invoked when a connection is teared down.
The disconnect may either be made explicitly by a call to megaco:disconnect/2 or implicitly when the control process of the connection dies.

handle_syntax_error(ReceiveHandle, ProtocolVersion, DefaultED) -> reply | {reply, ED} | no_reply | {no_reply, ED}

Types:
  - ReceiveHandle = receive_handle()
  - receive_handle() = #megaco_receive_handle{}
  - ProtocolVersion = protocol_version()
  - DefaultED = error_descr()
  - ED = error_descr()
Invoked when a received message had syntax errors
Incoming messages is delivered by megaco:receive_message/4 and normally decoded
successfully. But if the decoding failed this function is called in order to decide if the
originator should get a reply message (reply) or if the reply silently should be discarded
(no_reply).
Syntax errors are detected locally on this side of the protocol and may have many
causes, e.g. a malfunctioning transport layer, wrong encoder/decoder selected, bad
configuration of the selected encoder/decoder etc.
The error descriptor defaults to DefaultED, but can be overridden with an alternate one
by returning [reply,ED] or [no_reply,ED] instead of reply and no_reply respectively.
Any other return values (including exit signals or throw) and the DefaultED will be
used.

handle_message_error(ConnHandle, ProtocolVersion, ErrorDescr) -> ok

Types:
- ConnHandle = conn_handle()
- ProtocolVersion = protocol_version()
- ErrorDescr = error_descr()

Invoked when a received message just contains an error instead of a list of transactions.
Incoming messages is delivered by megaco:receive_message/4 and successfully decoded.
Normally a message contains a list of transactions, but it may instead contain an
ErrorDescriptor on top level of the message.
Message errors are detected remotely on the other side of the protocol. And you
probably don't want to reply to it, but it may indicate that you have outstanding
transactions that will get any response (request -> reply; reply -> ack).

handle_trans_request(ConnHandle, ProtocolVersion, ActionRequests) -> pending() |
reply() | ignore_trans_request

Types:
- ConnHandle = conn_handle()
- ProtocolVersion = protocol_version()
- ActionRequests = [#ActionRequest’{}]
- pending() = {pending, req_data()}
- req_data() = term()
- reply() = {ack_action(), actual_reply()} | {ack_action(), actual_reply(),
send_options()}
- ack_action() = discard_ack | {handle_ack, ack_data()} | {handle_pending_ack,
ack_data()} | {handle_sloppy_ack, ack_data()}
- actual_reply() = [#ActionReply’{}] | error_descr()
- ack_data() = term()
- send_options() = [send_option()]
- send_option() = {reply_timer, megaco_timer()} | {send_handle, term()} |
{protocol_version, integer()}

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Invoked for each transaction request.

Incoming messages is delivered by `megaco:receive_message/4` and successfully decoded. Normally a message contains a list of transactions and this function is invoked for each `TransactionRequest` in the message.

This function takes a list of 'ActionRequest' records and has three main options:

Return `ignore_trans_request` Decide that these action requests shall be ignored completely.

Return `pending()` Decide that the processing of these action requests will take a long time and that the originator should get an immediate 'TransactionPending' reply as interim response. The actual processing of these action requests instead should be delegated to the the `handle_trans_long_request/3` callback function with the `req_data()` as one of its arguments.

Return `reply()` Process the action requests and either return an `error_descr()` indicating some fatal error or a list of action replies (wildcarded or not).

If for some reason `megaco` is unable to deliver the reply, the reason for this will be passed to the user via a call to the callback function `handle_trans_ack` [page 78], unless `ack_action() = discard_ack`.

The `ack_action()` is either:

- `discard_ack` Meaning that you don't care if the reply is acknowledged or not.
  
  ```erlang
  {handle_ack, ack_data()} | {handle_ack, ack_data(), send_options()}
  ```

  Meaning that you want an immediate acknowledgement when the other part receives this transaction reply. When the acknowledgement eventually is received, the `handle_trans_ack/4` callback function will be invoked with the `ack_data()` as one of its arguments. `ack_data()` may be any Erlang term.

- `pending_ack()` with `send_options()`

  ```erlang
  {handle_pending_ack, ack_data()} | {handle_pending_ack, ack_data(), send_options()}
  ```

  This has the same effect as the above, if and only if `megaco` has sent at least one pending message for this request (during the processing of the request). If no pending message has been sent, then immediate acknowledgement will not be requested.

  Note that this only works as specified if the `sent_pending_limit` config option has been set to an integer value.

- `sloppy_ack()` with `send_options()`

  ```erlang
  {handle_sloppy_ack, ack_data()} | {handle_sloppy_ack, ack_data(), send_options()}
  ```

  Meaning that you want an acknowledgement sometime. When the acknowledgement eventually is received, the `handle_trans_ack/4` callback function will be invoked with the `ack_data()` as one of its arguments. `ack_data()` may be any Erlang term.

Any other return values (including exit signals or throw) will result in an error descriptor with code 500 (internal gateway error) and the module name (of the callback module) as reason.

```erlang
handle_trans_long_request(ConnHandle, ProtocolVersion, ReqData) -> reply()
```

**Types:**

- `ConnHandle = conn_handle()`
- `ProtocolVersion = protocol_version()`
- `ReqData = req_data()`
- `req_data() = term()`
Optionally invoked for a time consuming transaction request

If this function gets invoked or not is controlled by the reply from the preceeding call to handle_trans_request/3. The handle_trans_request/3 function may decide to process the action requests itself or to delegate the processing to this function.

The req_data() argument to this function is the Erlang term returned by handle_trans_request/3.

Any other return values (including exit signals or throw) will result in an error descriptor with code 500 (internal gateway error) and the module name (of the callback module) as reason.

handle_trans_reply(ConnHandle, ProtocolVersion, UserReply, ReplyData) -> ok

Types:
- ConnHandle = conn_handle()
- ProtocolVersion = protocol_version()
- UserReply = success() | failure()
- success() = {ok, [#{ActionReply()}]}
- failure() = {error, error_descr()}
- user_cancel_error() = {error, user_cancel_reason()}
- send_error() = {error, send_reason()}
- send_reason() = send_cancelled_reason() | send_failed_reason()
- send_cancelled_reason() = {send_message_cancelled, reason_for_send_cancel()}
- send_failed_reason() = {send_message_failed, reason_for_send_failure()}
- other_error() = {error, other_reason()}
- other_reason() = term()
- ReplyData = reply_data()
- reply_data() = term()

Optionally invoked for a transaction reply

The sender of a transaction request has the option of deciding, whether the originating Erlang process should synchronously wait (megaco:call/3) for a reply or if the message should be sent asynchronously (megaco:cast/3) and the processing of the reply should be delegated this callback function.
The ReplyData defaults to megaco:lookup(ConnHandle, reply_data), but may be explicitly overridden by a megaco:cast/3 option in order to forward info about the calling context of the originating process.

At success(), the UserReply contains a list of ‘ActionReply’ records possibly containing error indications.

A message_error(), indicates that the remote user has replied with an explicit transactionError.

A user_cancel_error(), indicates that the request has been canceled by the user. reason_for_user_cancel() is the reason given in the call to the cancel [page ??] function.

A send_error(), indicates that the send function of the megaco transport callback module failed to send the request. There are two separate cases: send_cancelled_reason() and send_failed_reason(). The first is the result of the send function returning {cancel, Reason} and the second is some other kind of erroneous return value. See the send_message [page ??] function for more info.

An other_error(), indicates some other error such as timeout.

handle_trans_ack(ConnHandle, ProtocolVersion, AckStatus, AckData) -> ok

Types:
- ConnHandle = conn_handle()
- ProtocolVersion = protocol_version()
- AckStatus = ok | user_cancel() | send_error() | other_error()
- user_cancel() = {error, user_cancel_reason()}
- user_cancel_reason() = {user_cancel, reason_for_user_cancel()}
- send_error() = {error, send_reason()}
- send_reason() = send_cancelled_reason() | send_failed_reason()
- send_cancelled_reason() = {send_message_cancelled, reason_for_send_cancel()}
- reason_for_send_cancel() = term()
- send_failed_reason() = {send_message_failed, reason_for_send_failure()}
- reason_for_send_failure() = term()
- other_error() = {error, other_reason()}
- other_reason() = term()
- AckData = ack_data()
- ack_data() = term()

Optionally invoked for a transaction acknowledgement

If this function gets invoked or not, is controlled by the reply from the preceding call to handle_trans_request/3. The handle_trans_request/3 function may decide to return {handle_ack, ack_data()} or {handle_sloppy_ack, ack_data()} meaning that you need an immediate acknowledgement of the reply and that this function should be invoked to handle the acknowledgement.

The ack_data() argument to this function is the Erlang term returned by handle_trans_request/3.

If the AckStatus is ok, it is indicating that this is a true acknowledgement of the transaction reply.

If the AckStatus is {error, Reason}, it is an indication that the acknowledgement or even the reply (for which this is an acknowledgement) was not delivered, but there is no point in waiting any longer for it to arrive. This happens when:
reply_timer  The reply_timer eventually times out.

reply send failure  When megaco failes to send the reply (see handle_trans_reply [page 77]), for whatever reason.

cancel  The user has explicitly cancelled the wait (megaco:cancel/2).

handle_unexpected_trans(ReceiveHandle, ProtocolVersion, Trans) -> ok

Types:
- ReceiveHandle = receive_handle()
- receive_handle() = #megaco_receive_handle{}
- ProtocolVersion = protocol_version()
- Trans = ‘TransactionPending’ | ‘TransactionReply’ | ‘TransactionResponseAck’

Invoked when a unexpected message is received

If a reply to a request is not received in time, the megaco stack removes all info about
the request from it’s tables. If a reply should arrive after this has been done the app has
no way of knowing where to send this message. The message is delivered to the “user”
by calling this function on the local node (the node which has the link).

handle_trans_request_abort(ReceiveHandle, ProtocolVersion, TransNo, Pid) -> ok

Types:
- ReceiveHandle = receive_handle()
- receive_handle() = #megaco_receive_handle{}
- ProtocolVersion = protocol_version()
- TransNo = integer()
- Pid = undefined | pid()

Invoked when a transaction request has been aborted

This function is invoked if the originating pending limit has been exceeded. This usually
means that a request has taken abnormally long time to complete.
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