Megaco/H.248

version 1.0

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Contents

1 Megaco Users Guide 1
1.1 Introduction . . . 1
1.1.1 Scope and Purpose . . . 1
1.1.2 Prerequisites . . . 1
1.1.3 About This Manual . . . 2
1.1.4 Where to Find More Information . . . 2
1.2 Architecture . . . 2
1.2.1 Network view . . . 2
1.2.2 General . . . 4
1.2.3 Single node config . . . 5
1.2.4 Distributed config . . . 5
1.2.5 Message round-trip call flow . . . 6
1.3 Running the stack . . . 8
1.3.1 Starting . . . 8
1.3.2 MGC startup call flow . . . 9
1.3.3 MG startup call flow . . . 10
1.3.4 Configuring the Megaco stack . . . 12
1.3.5 Initial configuration . . . 13
1.3.6 Changing the configuration . . . 13
1.4 Internal form and its encodings . . . 13
1.4.1 Internal form of messages . . . 13
1.4.2 The different encodings . . . 14
1.4.3 Configuration of Erlang distribution encoding module . . . 16
1.4.4 Configuration of text encoding module(s) . . . 16
1.4.5 Configuration of binary encoding module(s) . . . 17
1.5 Transport mechanisms . . . 17
1.5.1 Callback interface . . . 17
1.5.2 Examples . . . 17
1.6 Implementation examples . . . 17
1.6.1 A simple Media Gateway Controller . . . 17

1.6.2 A simple Media Gateway 18
1.7 Debugging 19
1.7.1 Tracing 19
1.8 Megaco Release Notes 19
1.8.1 Megaco 1.0 19
1.8.2 Megaco 0.9.5 20
1.8.3 Megaco 0.9.4 20
1.8.4 Megaco 0.9.3 21
1.8.5 Megaco 0.9.2 21
1.8.6 Megaco 0.9.1 22
1.8.7 Megaco 0.9 22

2 Megaco Reference Manual 27
2.1 megaco 31
2.2 megaco_flex_scanner 41
2.3 megaco_tcp 42
2.4 megaco_udp 44
2.5 megaco_user 46

List of Figures 51

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).

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 appliacation, 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 R7B 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:

- RFC 3015 (http://www.ietf.org/rfc/rfc3015.txt)
- the ASN.1 User's Guide
- the Reference Manual
- Concurrent Programming in Erlang, 2nd Edition (1996), Prentice-Hall, ISBN 0-13-508301-X.

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 therefor not aware of wether or not Megaco is being used underneath.

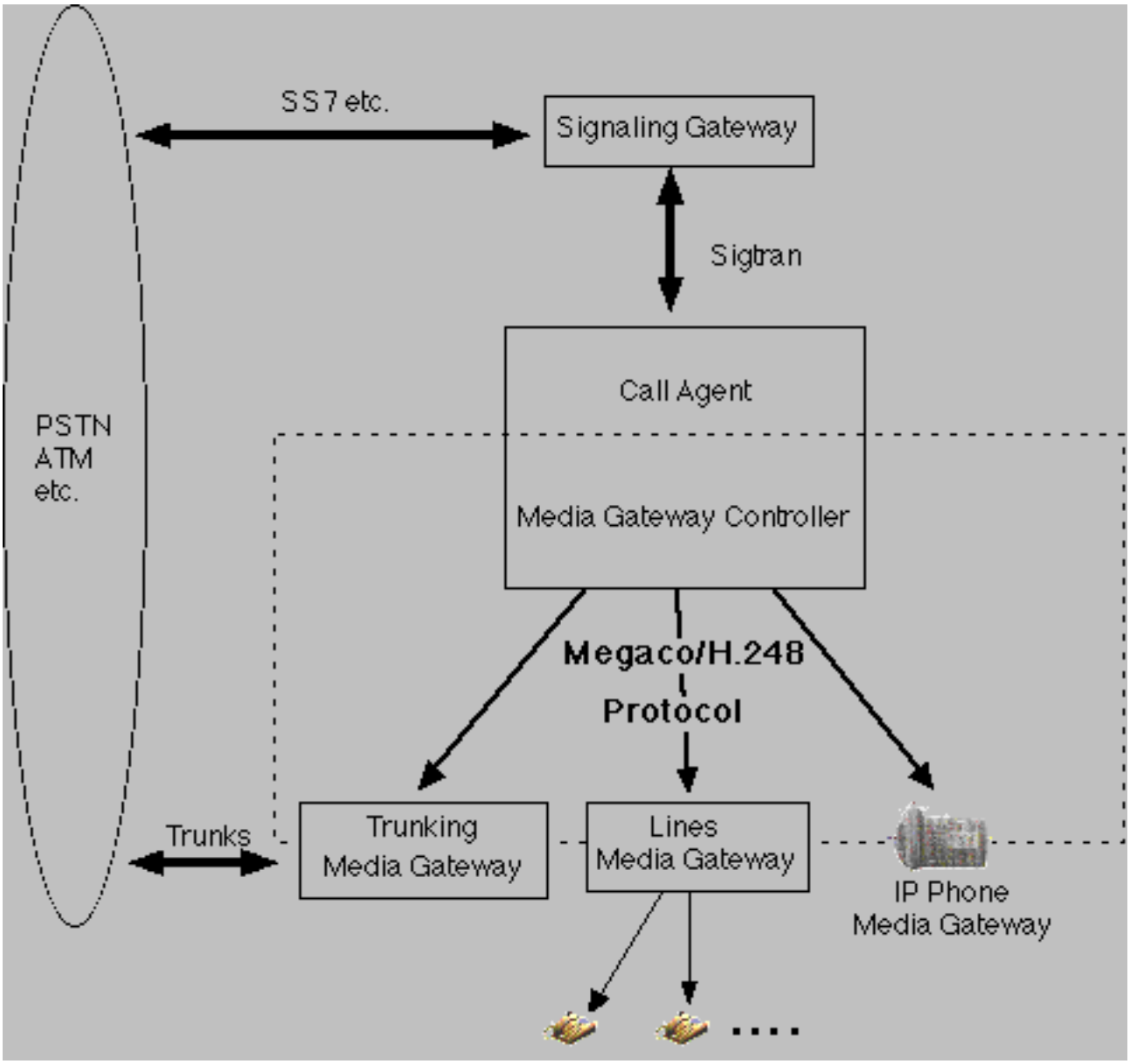

Figure 1.1: Network architecture

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

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 explicitely 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:

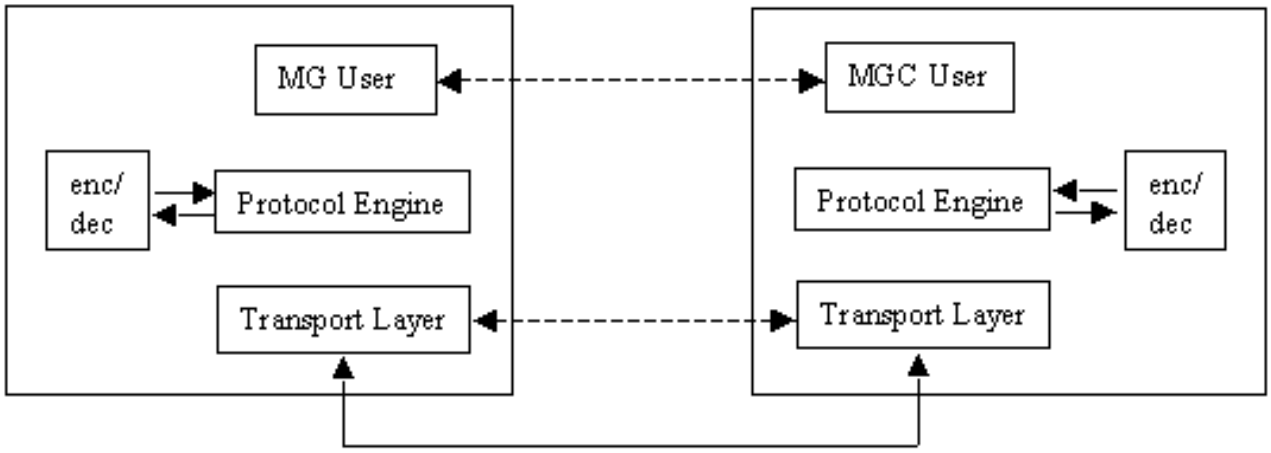

Figure 1.2: Single node config

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 on locally on one node, that is node(1), in order to avoid unneccessary transfer of data between the Erlang nodes.

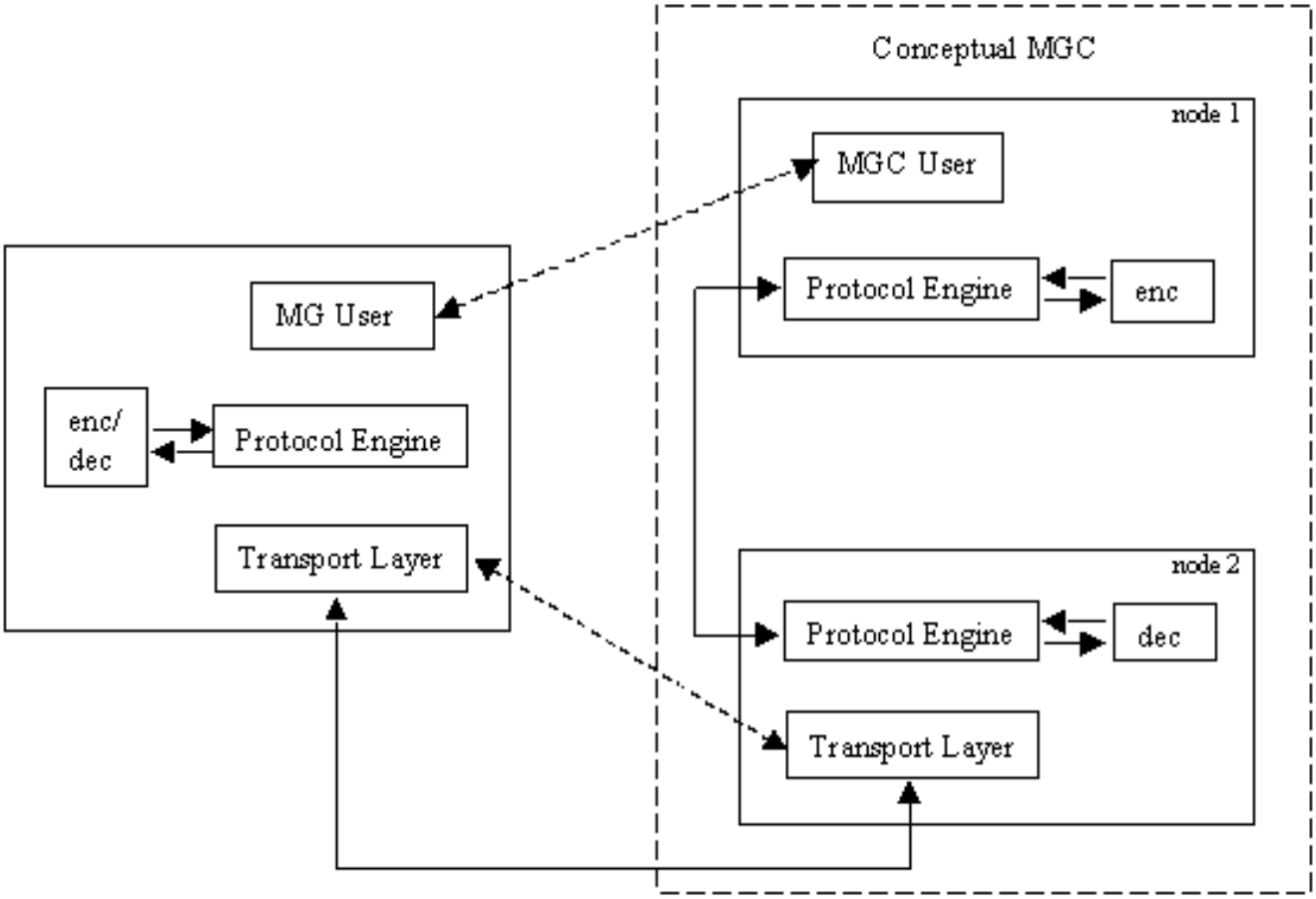

Figure 1.3: Distributes node config

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:

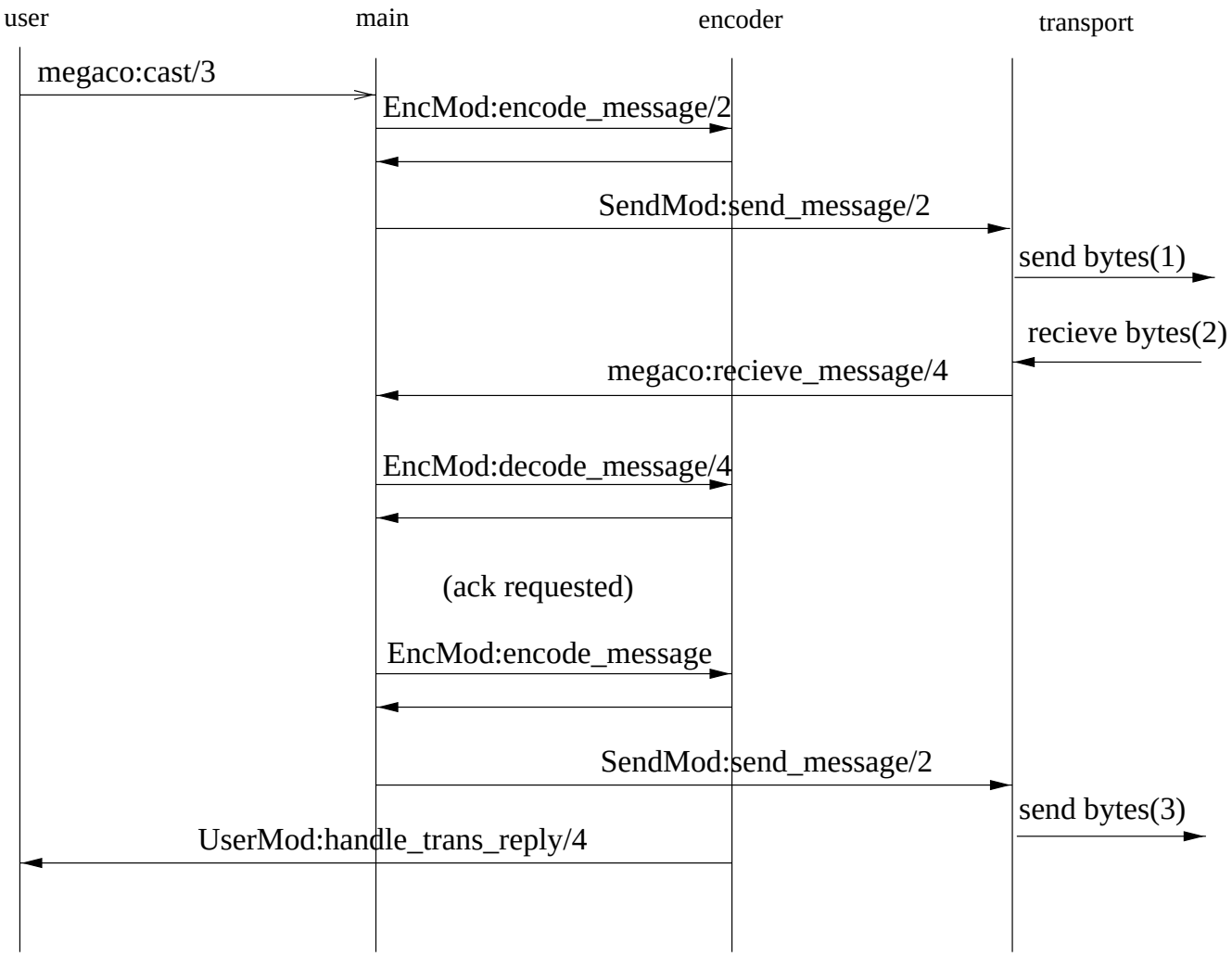

Figure 1.4: Message Call Flow (originating side)

Then we continue with the call flow on the destination side:

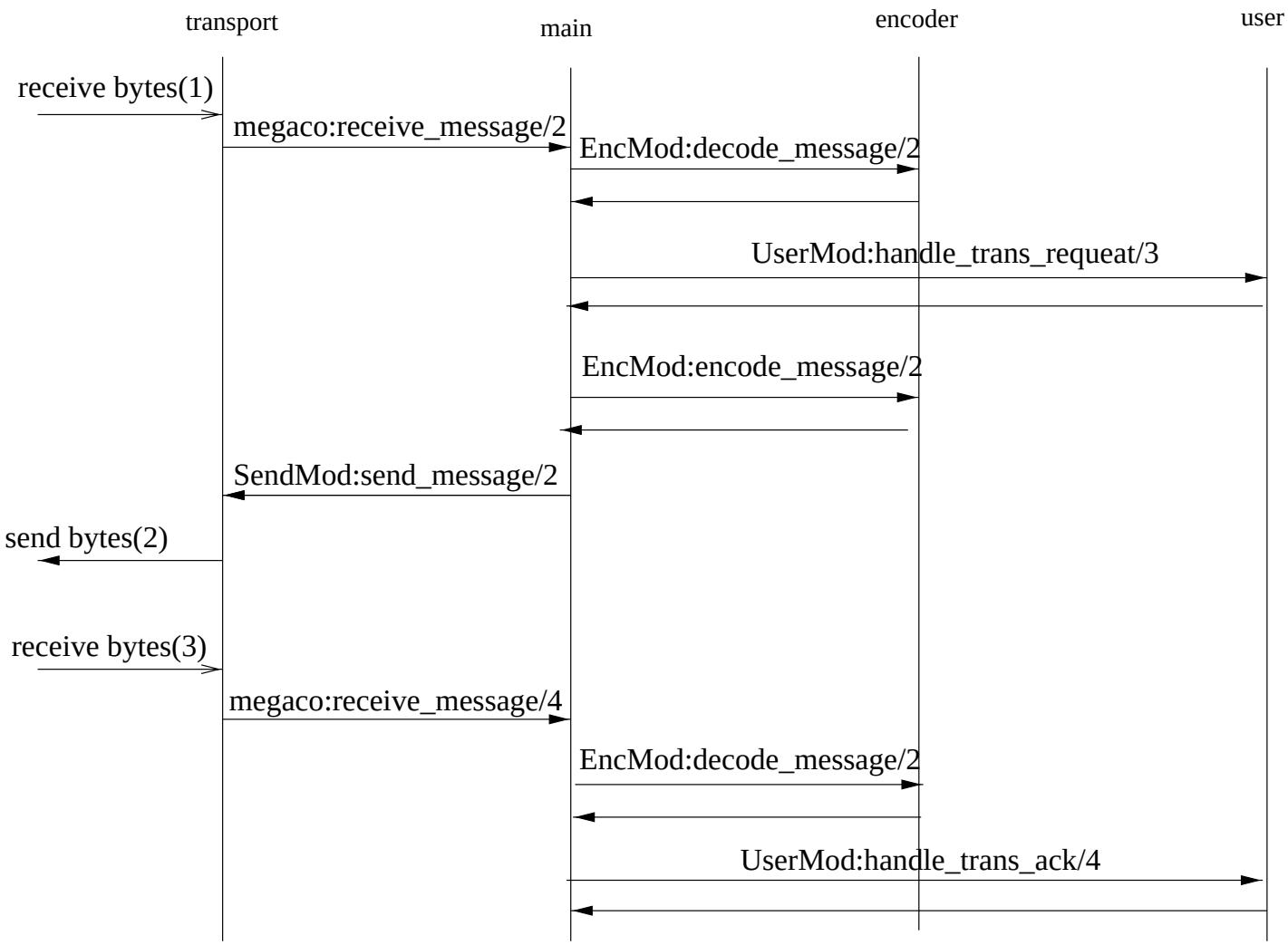

Figure 1.5: Message Call Flow (destination side)

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.

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. An MGC 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.

- 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:

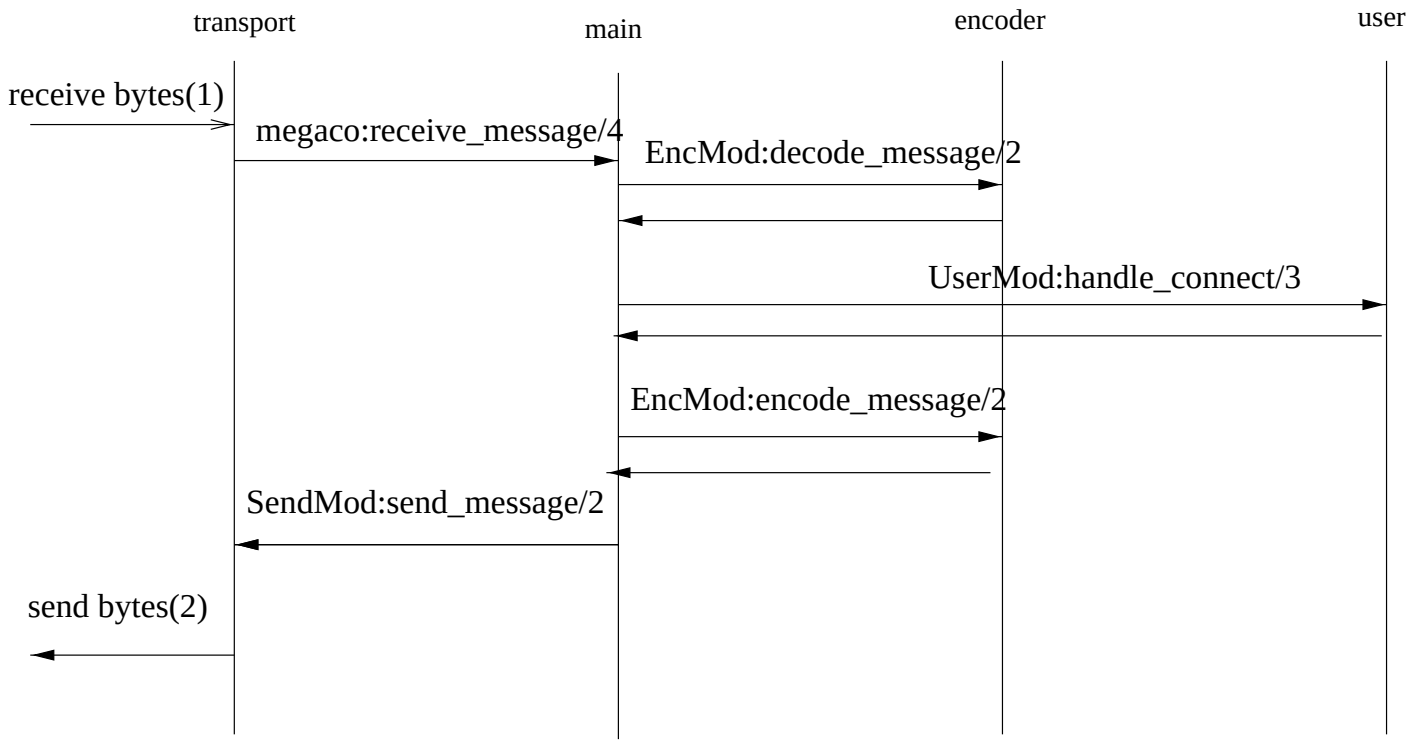

Figure 1.6: MGC Startup Call Flow

1.3.3 MG startup call flow

In order to prepare the MG 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:

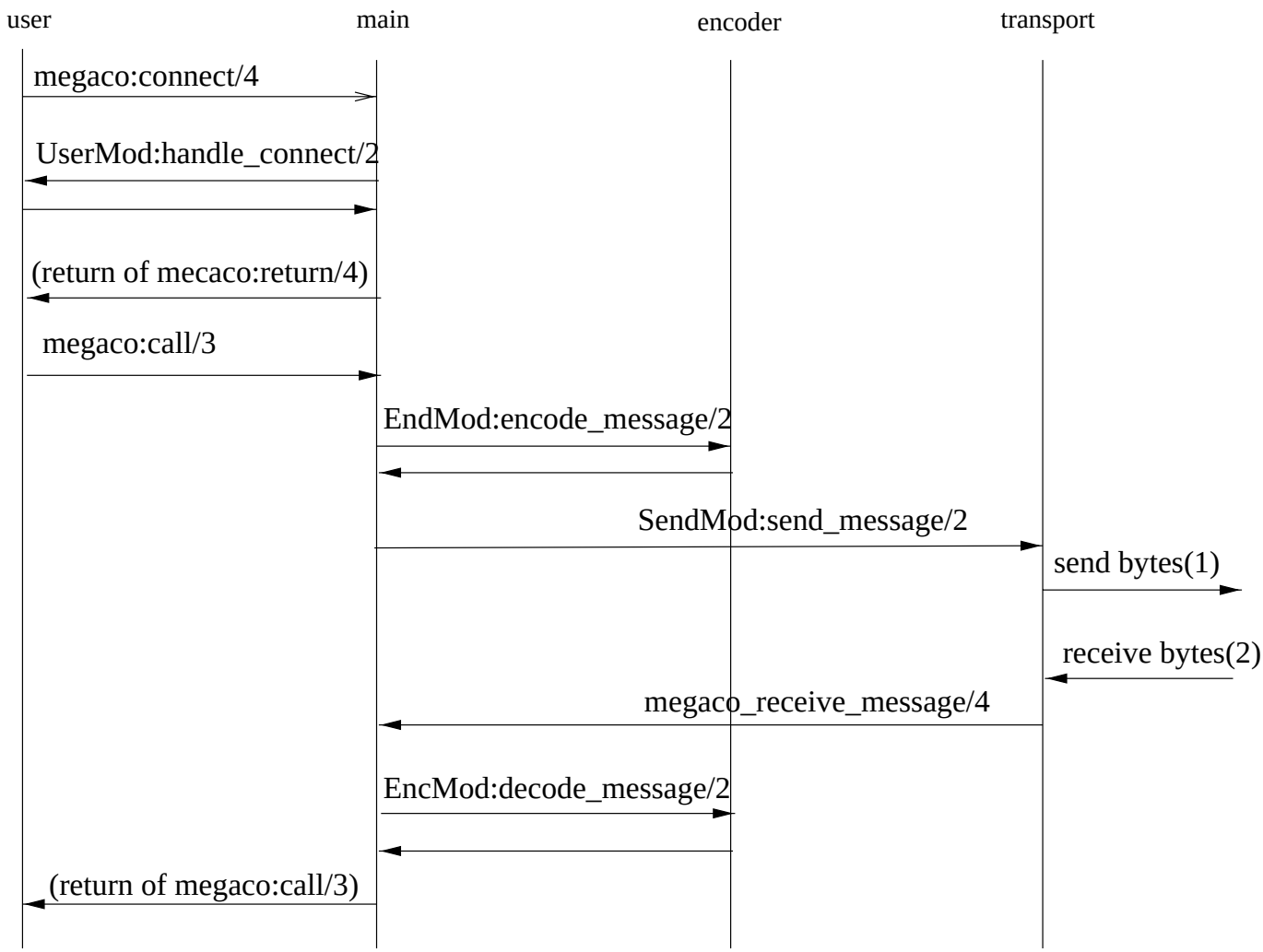

Figure 1.7: MG Startup Call Flow

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:

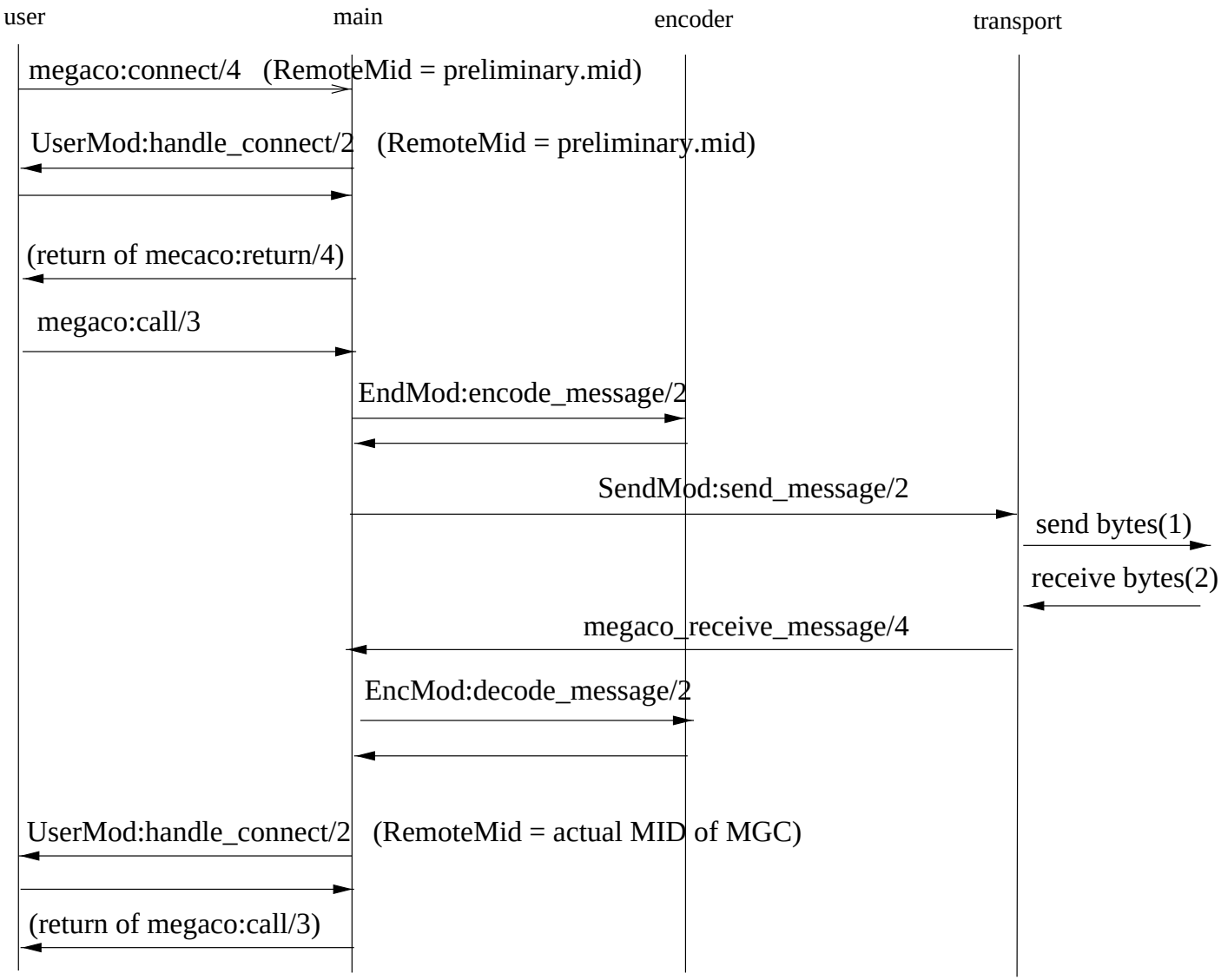

Figure 1.8: MG Startup Call Flow (no MID)

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 32].
- Connection info - Information regarding connections. Read/Write.
  This information can be retrieved using megaco:conn_info [page 33].
- System info - System wide information. Read only.
  This information can be retrieved using megaco:system_info [page 34].

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 33] and megaco:update_conn_info [page 34]

1.4 Internal form and its encodings

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, defined in (megaco/doc/rfc3015.txt) 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. In megaco/test/megaco_call_flow_test.erl youwill find the internal form of all examples in Appendix A (in the Megaco/H.248 spec).

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:

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

The following encoding modules are supported:

- 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 - encode/decode ASN.1 BER messages.

- megaco_ber_encoder - encode/decode ASN.1 BER messages.
- megaco_per_encoder - encode/decode ASN.1 PER messages. N.B. that this format is not included in the Megaco standard.
- 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:

- `[]` - Encodes the messages to the standard distribution format. It is rather verbose but encoding and decoding is blinding fast.
- `[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 codec 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 to 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. Therefor:
  - 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.

- `[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]`).

1.5 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 usefull for flow control.
- `unblock` - Unblock the transport. *Optional*

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 44], and TCP/TPKT, see megaco_tcp [page 42].

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 MG with the same transport mechanism UDP/IP or TCP/IP.

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

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

```
cd megaco/examples/simple
erl -pa ../../../megaco/ebin -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_mg.erl 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:

```
cd megaco/examples/simple
erl -pa ../../../megaco/ebin -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):

```
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 Debugging

1.7.1 Tracing

We have instrumented our code in order to enable tracing. Running the application with tracing deactivated, causes a neglectible 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.

We have a framework for automated testing which is rather useful. It is a subset of Mnesia's test server. The test server may be used in conjunction with the event tracing, e.g. by:

```
   cd megaco/test
   gmake test

or

   cd megaco/test
   gmake utest

or

   cd megaco/test
   gmake ftest

or
   cd megaco/test
   gmake gnuplot_gif
```

1.8 Megaco Release Notes

This document describes the changes made to the Megaco system from version to version. The intention of this document is to list all incompatibilities as well as all enhancements and bugfixes for every release of Megaco. Each release of Megaco thus constitutes one section in this document. The title of each section is the version number of Megaco.

1.8.1 Megaco 1.0

Improvements and new features

- Flex scanner: Added *scanner* to system info.

Fixed bugs and malfunctions

-

Incompatibilities

-

Known bugs and problems

-

1.8.2 Megaco 0.9.5

Improvements and new features

-

Fixed bugs and malfunctions

- Flex scanner: Decoding of digit map timer values fixed.
- Missed some files in the megaco app file.

Incompatibilities

-

Known bugs and problems

-

1.8.3 Megaco 0.9.4

Improvements and new features

- Added the flex scanner: This is a Megaco scanner (used when decoding incoming text messages) written as a linked in driver (in C).

Fixed bugs and malfunctions

-

Incompatibilities

-

Known bugs and problems

- Decoding of digit map timer values erroneous.
- The megaco_flex_scanner and megaco_flex_scanner_handler modules was missing from the megaco app file.

1.8.4 Megaco 0.9.3

Improvements and new features

-

Fixed bugs and malfunctions

- Transport modules: The included transport modules (megaco_tcp & megaco_udp) had a bug causing incoming messages larger then 200 bytes not to be processed.

> **Note:**
> In order to be able to use the flex scanner, the library must be compiled. This is not done by default in this version. To get it, cd to the Megaco top directory and type:
>
> gmake ENABLE_MEGACO_FLEX_SCANNER=true

Incompatibilities

-

Known bugs and problems

-

1.8.5 Megaco 0.9.2

Improvements and new features

- Binary encoding now up to date (including the Implementors Guide version 6).
- Message processing has been changed in order to improve perfomance. This change consists of
  - The (message handling) process created by calling the function `megaco:receive_message`, has a larger minimum heap size.
  - Adding a new function, `megaco:process_received_message`, that performs the message processing in the context of the calling process.

  Own Id: OTP-4110
- Text encoding: Handle the Topology Descriptor according to the IGv6.
  Own Id: OTP-4088

Fixed bugs and malfunctions

- Text encoding: Missing last curly bracket, "}", results in error message "Error Code 400, Syntax Error on Line 999999". The line number information has been corrected.
  Own Id: OTP-4085
  Aux Id: Seq 7080

Incompatibilities

-

Known bugs and problems

- Transport modules: The included transport modules (megaco_tcp & megaco_udp) had a bug causing incoming messages larger then 200 bytes not to be processed.

1.8.6 Megaco 0.9.1

Improvements and new features

-

Fixed bugs and malfunctions

- The ABNF keyword changes introduced in release 0.9 of the embed and emergency tokens, was inconsistently implemented. It has now been corrected.

Incompatibilities

-

Known bugs and problems

-

1.8.7 Megaco 0.9

Improvements and new features

The application has been adpted to the Implementors Guide version 6 (IGv6).

- Added `[]` as default value for the #'ActionReply'.commandReply field, as a matter of convenience.
- Enabled customized handling of transport errors. Instead of performing a brute disconnect, the error reason returned by `TransportMod:send_message/2` is now propagated as `{error,{send_message_failed,Reason}}` to `UserMod:handle_trans_reply/4` or returned from `megaco:call/3` as other error cases. The old behaviour can still be achieved by a explicit call to `megaco:disconnect/2`.
- The `keepActive` field in RequestedActions and SecondRequestedActions, has been made optional in order to comply with IGv6 6.15. It does also mean that the new default value is `asn1_NOVALUE`.
- The `statValue` field in StatisticsParameter, has been made optional in order to comply with IGv6 6.22. It does also mean that the new default value is `asn1_NOVALUE`.
- The short keyword for the embed token in the ABNF spec. has been changed from “EB” to “EM” in order to comply with IGv6 6.6.
- The short keyword for the emergency token in the ABNF spec. has been changed from “EM” to “EG” in order to comply with IGv6 6.6.

- A new timer has been introduced. It is called `pending_timer` and implements the "provisonal response timer" in the RFC. By using the new timer, pending transaction replies are sent automatically, if the timer expires before a the final transaction reply has been sent by the user.
- A special "all" value for request identities has been introduced in order to comply with IGv6 6.30. It is represented as `?megaco_all_request_id` (which is a constant defined in megaco.hrl) in the internal form.
- The semantics of audit replies has been at last been made equal. The definition of `'AuditReply'` and `'AuditResult'` has been redefined in order to comply with IGv6 6.38. This does not affect the ABNF spec. at all, but has some impact of the ASN.1 spec. and the internal form. The old 'AuditReply' record hasd been replaced with a tagged tuple: {contextAuditResult, [#'TerminationID'{}]} or {error, #'ErrorDescriptor'{}} or {auditResult, #'AuditResult'{}}. The old tagged tuple representation of AuditResult has now been replaced with a #'AuditResult{terminationID = #'TerminationID'{}, terninationAuditResult = #'TerminationAudit'{}} record.
- The ASN.1 definition of the `Value` type has been changed in order to comply with IGv6 6.40. This does not affect the ABNF spec. at all, but has some impact of the ASN.1 spec. and the internal form. The old Value type (OCTET STRING) was represented as list of integers. The new value type (SEQUENCE OF OCTET STRING) is represented as a list of elements where each element is a list of integers.
- The ABNF definition modemDescriptor has been changed in order to comply with IGv6 6.42. This affects the ABNF spec., but not the internal form.
- The ABNF definition auditOther has been changed in order to comply with IGv6 6.48. This affects the ABNF spec., but not the internal form.
- The `streams` field in MediaDescriptor, has been made optional in order to comply with IGv6 6.50. It does also mean that the new default value is `asn1_NOVALUE`.
- A new `extraInfo` field has been introduced in both EventParameter and SigParameter in the ASN.1 spec. in order to comply with IGv6 6.56. The new field is optional and defaults to `asn1_NOVALUE`.
- A new `timeStamp` field has been introduced in ServiceChangeResParm in both the ASN.1 spec. and the ABNF spec., in order to comply with IGv6 6.58. The new field is optional and defaults to `asn1_NOVALUE`.
- The `terminationID` field in NotifyReply that earlier was optional in the ASN.1 spec. has now been made mandatory, in order to comply with IGv6 6.62. The field does now default to `[]`.
- The `mtpAddress` in both the mid and the serviceChangeAddress has been changed in the ASN.1 spec., in order to comply with IGv6 6.25 and IGv6 6.68 respectively. The old fixed size octet string, has been replaced with a dynamic octet string whose size may range from 2 to 4.
- The `serviceChangeAddress` in ABNF has now been changed, in order to comply with IGv6 6.68. From now on the serviceChangeAddress may either contain a plain port number or a complete MID.
- The `reservedValue` and `reservedGroup` fields in the LocalControlDescriptor, has been made optional in order to comply IGv6 6.69. It does also mean that the new default value is `asn1_NOVALUE`.
- The `TransactionResponseAck` has been redefined in ASN.1, in order to comply IGv6 6.70.

Fixed bugs and malfunctions

- Text encoding: Did not handle alternative list in property parm.
  Own Id: OTP-4013

Aux Id: Seq 5301

- Text encoding: Allowed multiple mode parameters in Local Control Descriptor (the last was choosen)..
  Own Id: OTP-4011
  Aux Id: Seq 5300
- Misspelled message “header” (MEGCAO instead of MEGACO) results in an reply with error code 500 instead of 400 or 401.
  Own Id: OTP-4007
  Aux Id: Seq 5289
- Text encoding: Fixed a problem with termination id lists in audit replies: could only be of length 1.
- Fixed a race condition that could occur when a gateway was too eager too re-send its initial service change message. Now the controller will reply on transaction requests with a pending transaction in order to make the gateway back off until the automatic connect procedure has completed. The other transaction types are silently ignored.
- Fixed the cause to the following error message:

```
=ERROR REPORT==== 17-Apr-2001::16:28:36 ===
Error in process <0.26230.0> on node 'cp1-19@b04d09' with exit value:
{{badmatch,unknown_remote_mid},[{megaco_messenger,fake_conn_data,4},{megaco_messenger,process_receive
,...
```

Incompatibilities

- The new `pending_timer` may cause pending transaction replies to be sent. In order to obtain the old behaviour the timer must explicitly be set to ’infinity’.
- The short keyword for the embed token in the ABNF spec. has been changed. See above for more details.
- The short keyword for the emergency token in the ABNF spec. has been changed. See above for more details.
- The `keepActive` field in RequestedActions and SecondRequestedActions has been made optional. See above for more details.
- The `statValue` field in StatisticsParameter, has been made optional. See above for more details.
- A special “all” value for request identities has been introduced. See above for more details.
- The definitions of AuditReply and AuditResult has been redefined. See above for more details.
- The definition of the `Value` type has been changed. See above for more details.
- The `streams` field in MediaDescriptor, has been made optional. See above for more details.
- The `terminationID` field in NotifyReply, is now mandatory and asn1_NOVALUE is not a legal value anymore. See above for more details.
- The `mtpAddress` in both the mid and the serviceChangeAddress has been changed in the ASN.1 spec. See above for more details.
- The `serviceChangeAddress` in ABNF has now been changed. See above for more details.
- The `reservedValue` and `reservedGroup` fields in the LocalControlDescriptor has been made optional. See above for more details.

Known bugs and problems

- Binary messages may currently be mapped to the native internal form of ASN.1, but the framework for mapping of binary messages to an internal form, common for both text and binary encodings is not ready yet.

Megaco Reference Manual

Short Summaries

- Erlang Module megaco [page 31] – Main API of the Megaco application
- Erlang Module megaco_flex_scanner [page 41] – Interface module to the flex scanner linked in driver.
- Erlang Module megaco_tcp [page 42] – Interface module to TPKT transport protocol for Megaco/H.248.
- Erlang Module megaco_udp [page 44] – Interface module to UDP transport protocol for Megaco/H.248.
- Erlang Module megaco_user [page 46] – Callback module for users of the Megaco application

megaco

The following functions are exported:

- `start() -> ok | {error, Reason}`
  [page 31] Starts the Megaco application
- `stop() -> ok | {error, Reason}`
  [page 31] Stops the Megaco application
- `stop`
  [page 31] Stops the Megaco application
- `start_user(UserMid, Config) -> ok | {error, Reason}`
  [page 31] Initial configuration of a user
- `stop_user(UserMid) -> ok | {error, Reason}`
  [page 31] Delete the configuration of a user
- `user_info(UserMid, Item) -> Value | exit(Reason)`
  [page 32] Lookup user information
- `update_user_info(UserMid, Item, Value) -> ok | {error, Reason}`
  [page 33] Update information about a user
- `conn_info(ConnHandle, Item) -> Value | exit(Reason)`
  [page 33] Lookup information about an active connection
- `update_conn_info(ConnHandle, Item, Value) -> ok | {error, Reason}`
  [page 34] Update information about an active connection
- `system_info(Item) -> Value | exit(Reason)`
  [page 34] Lookup system information

- `connect(ReceiveHandle, RemoteMid, SendHandle, ControlPid) -> {ok, ConnHandle} | {error, Reason}`
  [page 35] Establish a ”virtual” connection
- `disconnect(ConnHandle, DiscoReason) -> ok | {error, ErrReason}`
  [page 36] Tear down a ”virtual” connection
- `call(ConnHandle, ActionRequests, Options) -> {ProtocolVersion, UserReply}`
  [page 36] Sends a transaction request and waits for a reply
- `cast(ConnHandle, ActionRequests, Options) -> ok | {error, Reason}`
  [page 37] Sends a transaction request but does NOT wait for a reply
- `cancel(ConnHandle, CancelReason) -> ok | {error, ErrReason}`
  [page 37] Cancel all outstanding messages for this connection
- `process_received_message(ReceiveHandle, ControlPid, SendHandle, BinMsg) -> ok`
  [page 37] Process a received message
- `receive_message(ReceiveHandle, ControlPid, SendHandle, BinMsg) -> ok`
  [page 38] Process a received message
- `parse_digit_map(DigitMapBody) -> {ok, ParsedDigitMap} | {error, Reason}`
  [page 39] Parses a digit map body
- `eval_digit_map(DigitMap) -> {ok, Letters} | {error, Reason}`
  [page 39] Collect digit map letters according to the digit map
- `eval_digit_map(DigitMap, Timers) -> {ok, Letters} | {error, Reason}`
  [page 39] Collect digit map letters according to the digit map
- `report_digit_event(DigitMapEvalPid, Events) -> ok | {error, Reason}`
  [page 39] Send one or more events to the event collector process
- `test_digit_event(DigitMap, Events) -> {ok, Letters} | {error, Reason}`
  [page 40] Feed digit map collector with events and return the result

megaco_flex_scanner

The following functions are exported:

- `start() -> {ok, Port} | {error, Reason}`
  [page 41]

megaco_tcp

The following functions are exported:

- `start_transport() -> {ok, TransportRef}`
  [page 42]
- `listen(TransportRef, ListenPortSpecList) -> ok`
  [page 42]
- `connect(TransportRef, OptionList) -> {ok, Handle, ControlPid} | {error, Reason}`
  [page 42]

- close(Handle) -> ok
  [page 42]
- socket(Handle) -> Socket
  [page 43]
- send_message(Handle, Message) -> ok
  [page 43]
- block(Handle) -> ok
  [page 43]
- unblock(Handle) -> ok
  [page 43]

megaco_udp

The following functions are exported:

- start_transport() -> {ok, TransportRef}
  [page 44]
- open(TransportRef, OptionList) -> {ok, Handle, ControlPid} | {error, Reason}
  [page 44]
- close(Handle, Msg) -> ok
  [page 44]
- socket(Handle) -> Socket
  [page 44]
- create_send_handle(Handle, Host, Port) -> send_handle()
  [page 45]
- send_message(SendHandle, Msg) -> ok
  [page 45]
- block(Handle) -> ok
  [page 45]
- unblock(Handle) -> ok
  [page 45]

megaco_user

The following functions are exported:

- handle_connect(ConnHandle, ProtocolVersion) -> ok | error | {error,ErrorDescr}
  [page 47] Invoked when a new connection is established
- handle_disconnect(ConnHandle, ProtocolVersion, Reason) -> ok
  [page 47] Invoked when a connection is teared down
- handle_syntax_error(ReceiveHandle, ProtocolVersion, DefaultED) -> reply | {reply,ED} | no_reply | {no_reply,ED}
  [page 47] Invoked when a received message had syntax errors
- handle_message_error(ConnHandle, ProtocolVersion, ErrorDescr) -> | no_reply
  [page 48] Invoked when a received message just contains an error

- `handle_trans_request(ConnHandle, ProtocolVersion, ActionRequests) -> pending() | reply()`
  [page 48] Invoked for each transaction request
- `handle_trans_long_request(ConnHandle, ProtocolVersion, ReqData) -> reply()`
  [page 49] Optionally invoked for a time consuming transaction request
- `handle_trans_reply(ConnHandle, ProtocolVersion, UserReply, ReplyData) -> ok`
  [page 49] Optionally invoked for a transaction reply
- `handle_trans_ack(ConnHandle, ProtocolVersion, AckStatus, AckData) -> ok`
  [page 50] Optionally invoked for a transaction acknowledgement

megaco

Erlang Module

Interface module for the Megaco application

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

`start_user(UserMid, Config) -> ok | {error, Reason}`

Types:

- UserMid = megaco_mid()
- Config = [{user_info_item(), user_info_value()}]
- 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.

`stop_user(UserMid) -> ok | {error, Reason}`

Types:

- UserMid = megaco_mid()
- Reason = term()

Delete the configuration of a user

Requires that the user does not have any active connection.

`user_info(UserMid, Item) -> Value | exit(Reason)`

Types:

- Handle = user_info_handle()
- UserMid = megaco_mid()
- Item = user_info_item()
- Value = user_info_value()
- Reason = term()

Lookup user information

The following Item's are valid:

`connections` Lists all active connections for this user. Returns a list of megaco_conn_handle records.

`receive_handle` Construct a megaco_receive_handle record from user config

`min_trans_id` First trans id. A positive integer, defaults to 1.

`max_trans_id` Last trans id. A positive integer or infinity, defaults to infinity.

`request_timer` Wait for reply. A Timer (see explanation below, defaults to #megaco_incr_timer{}.

`long_request_timer` Wait for reply after pending. A Timer (see explanation below, defaults to infinity.

`auto_ack` Automatic send transaction ack when a the transaction reply has been received. A boolean, defaults to false.

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

`reply_timer` Wait for an ack. A Timer (see explanation below, defaults to 30000.

`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. Current default is 1.

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

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

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

A Timer may be:

`infinity` Means that the timer never will time out

`Integer` Waits the given number of milli seconds before it times out.

`IncrTimer` A megaco_incr_timer record. Waits a given number of milli seconds, recalculates a new timer by multiplying a static factor and adding a static increment and starts all over again after retransmitting the message again. A maximum number of repetition can be stated.

`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 conenction.

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

`receive_handle` Construct a megaco_receive_handle record.

`min_trans_id` First trans id. A positive integer, defaults to 1.

`max_trans_id` Last trans id. A positive integer or infinity, defaults to infinity.

`request_timer` Wait for reply. A Timer (see explanation below, defaults to #megaco_incr_timer{}.

`long_request_timer` Wait for reply after pending. A Timer (see explanation below, defaults to infinity.

`auto_ack` Automatic send transaction ack when a the transaction reply has been received. A boolean, defaults to false.

`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 Timer (see explanation below, defaults to 30000.

`reply_timer` Wait for an ack. A Timer (see explanation below, defaults to 30000.

`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. Current default is 1.

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

A Timer may be:

`infinity` Means that the timer never will time out

`Integer` Waits the given number of milli seconds before it times out.

`IncrTimer` A megaco_incr_timer record. Waits a given number of milli seconds, recalculates a new timer by multiplying a static factor and adding a static increment and starts all over again after retransmitting the message again. A maximum number of repetition can be stated.

`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:

-

Lookup system information

The following items are valid:

`scanner` The scanner config. A 2-tupple of the encoding_config and the scanner start MFA.

`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 SendMod: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 explicitely be deactivated by a local call to megaco:disconnect/2 or implicitely 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 explicitely invoke megaco:connect/4 and use a provisioned MID of the MGC as the RemoteMid.

`upgrade preliminary MID` The MG may explicitely invoke megaco:connect/4 with the atom ’preliminary_mid’ as a temporary MID of the MGC, send an intial 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 to 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.

`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, ActionRequests, Options) -> {ProtocolVersion, UserReply}`

Types:

- ConnHandle = conn_handle()
- ActionRequests = [#'ActionRequest'{}]
- Options = [send_option()]
- send_option() = {request_timer, timer()} | {long_request_timer, timer()} | {send_handle, term()}
- UserReply = success() | failure()
- success() = {ok, [#'ActionReply'{}]}
- failure() = message_error() | other_error()
- message_error() = {error, error_descr()}
- other_error() = {error, term()}

Sends a transaction request and waits for a reply

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.

An other_error(), indicates some other error such as timeout or {user_cancel, ReasonForCancel}.

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

Types:

- ConnHandle = conn_handle()
- ActionRequests = [#'ActionRequest'{}]
- Options = [send_option()]
- send_option() = {request_timer, timer()} | {long_request_timer, timer()} | {send_handle, term()} | {reply_data, reply_data()}
- UserReply = success() | failure()
- success() = {ok, [#'ActionReply'{}]}
- failure() = message_error() | other_error()
- message_error() = {error, error_descr()}
- other_error() = {error, term()}
- Reason = term()

Sends a transaction request but does NOT wait for a reply

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.

`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_ack/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_trans_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_trans_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_trans_request/3 indicates that the acknowledgement is important the following callback function will be invoked:

- UserMod:handle_trans_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, Letters} | {error, Reason}
eval_digit_map(DigitMap, Timers) -> {ok, 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()
- Letters = [letter()]
- letter() = $0..$9 | $a .. $k
- 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

`test_digit_event(DigitMap, Events) -> {ok, 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()
- 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.

megaco_flex_scanner

Erlang Module

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 permament. 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() | regname()
- 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() | regname()
- OptionList = [Option]
- Option = {port, integer()} | {host, Ipaddr} |{options, list()} |{receive_handle, term()}
- Handle = socket_handle()
- ControlPid = pid()
- Reason = term()

This function is used to open a TPKT connection.

`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 incomming messages on the socket.

`unblock(Handle) -> ok`

Types:

- Handle = socket_handle()

Starting to receive incomming messages from the socket again.

megaco_udp

Erlang Module

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

Exports

`start_transport() -> {ok, TransportRef}`

Types:

- TransportRef = pid()

This function is used for starting the UDP/IP transport service. Use exit(TransportRef, Reason) to stop the transport service.

`open(TransportRef, OptionList) -> {ok, Handle, ControlPid} | {error, Reason}`

Types:

- TransportRef = pid() | regname()
- OptionList = [Option]
- Option = {port, integer()} | {options, list()} | {receive_handle, term()}
- Handle = socket_handle()
- ControlPid = pid()
- Reason = term()

This function is used for open an UDP/IP socket.

`close(Handle, Msg) -> ok`

Types:

- Handle = socket_handle()
- Msg

This function is used for closing an active UDP socket.

`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.

`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

`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.

megaco_user

Erlang Module

This module defines the callback behaviour of Megaco users. A megaco_user compliant callback module must export the following functions:

- handle_connect/2
- handle_disconnect/3
- handle_syntax_error/3
- handle_message_error/3
- handle_trans_request/3
- handle_trans_long_request/3
- handle_trans_reply/4
- handle_trans_ack/4

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 retreived 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()` 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 implicitely at the first invokaction 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 explicitely by a call to megaco:disconnect/2 or implicitely 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) -> | no_reply`

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 not will get any response (request -> reply; reply -> ack).

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

Types:

- ConnHandle = conn_handle()
- ProtocolVersion = protocol_version()
- ActionRequests = [#'ActionRequest'{}]
- pending() = {pending, req_data()}
- req_data() = term()
- reply() = {ack_action(), actual_reply()}
- ack_action() = discard_ack | {handle_ack, ack_data()}
- actual_reply() = [#'ActionReply'{}] | error_descr()
- ack_data() = term()

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 two main options:

`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).

The ack_action() is either:

`discard_ack` Meaning that you don't care if the reply is acknowledged or not.

`{handle_ack, ack_data()}` 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.

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_long_request(ConnHandle, ProtocolVersion, ReqData) -> reply()`

Types:

- ConnHandle = conn_handle()
- ProtocolVersion = protocol_version()
- ActionRequests = [#'ActionRequest'{}]
- ReqData = req_data()
- req_data() = term()
- reply() = {ack_action(), actual_reply()}
- ack_action() = discard_ack | {handle_ack, ack_data()}
- actual_reply() = [#'ActionReply'{}] | error_descr()
- ack_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() = message_error() | other_error()

- message_error() = {error, error_descr()}
- other_error() = {error, 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 explicitely 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.

An other_error(), indicates some other error such as timeout or {user_cancel, ReasonForCancel}.

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

Types:

- ConnHandle = conn_handle()
- ProtocolVersion = protocol_version()
- AckStatus = ok | {error, Reason}
- 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 preceeding call to handle_trans_request/3. The handle_trans_request/3 function may decide to return {handle_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 indicating that the acknowledgement not was delivered, but there is no point in waiting any longer for it to arrive. This happens either when the reply_timer eventually times out or when the user has explicitly cancelled the wait (megaco:cancel/2).

List of Figures

1.1 Network architecture 3
1.2 Single node config 5
1.3 Distributes node config 6
1.4 Message Call Flow (originating side) 7
1.5 Message Call Flow (destination side) 8
1.6 MGC Startup Call Flow 10
1.7 MG Startup Call Flow 11
1.8 MG Startup Call Flow (no MID) 12

Index of Modules and Functions

Modules are typed in *this way*.
Functions are typed in `this way`.

`block/1`
megaco_tcp , 43
megaco_udp , 45

`call/3`
megaco , 36

`cancel/2`
megaco , 37

`cast/3`
megaco , 37

`close/1`
megaco_tcp , 42

`close/2`
megaco_udp , 44

`conn_info/2`
megaco , 33

`connect/2`
megaco_tcp , 42

`connect/4`
megaco , 35

`create_send_handle/3`
megaco_udp , 45

`disconnect/2`
megaco , 36

`eval_digit_map/1`
megaco , 39

`eval_digit_map/2`
megaco , 39

`handle_connect/2`
megaco_user , 47

`handle_disconnect/3`
megaco_user , 47

`handle_message_error/3`
megaco_user , 48

`handle_syntax_error/3`
megaco_user , 47

`handle_trans_ack/4`
megaco_user , 50

`handle_trans_long_request/3`
megaco_user , 49

`handle_trans_reply/4`
megaco_user , 49

`handle_trans_request/3`
megaco_user , 48

`listen/2`
megaco_tcp , 42

megaco
`call/3`, 36
`cancel/2`, 37
`cast/3`, 37
`conn_info/2`, 33
`connect/4`, 35
`disconnect/2`, 36
`eval_digit_map/1`, 39
`eval_digit_map/2`, 39
`parse_digit_map/1`, 39
`process_received_message/4`, 37
`receive_message/4`, 38
`report_digit_event/2`, 39
`start/0`, 31
`start_user/2`, 31
`stop`, 31
`stop/0`, 31
`stop_user/1`, 31
`system_info/1`, 34
`test_digit_event/2`, 40
`update_conn_info/3`, 34
`update_user_info/3`, 33

user_info/2, 32

megaco_flex_scanner
start/0, 41

megaco_tcp
block/1, 43
close/1, 42
connect/2, 42
listen/2, 42
send_message/2, 43
socket/1, 43
start_transport/0, 42
unblock/1, 43

megaco_udp
block/1, 45
close/2, 44
create_send_handle/3, 45
open/2, 44
send_message/2, 45
socket/1, 44
start_transport/0, 44
unblock/1, 45

megaco_user
handle_connect/2, 47
handle_disconnect/3, 47
handle_message_error/3, 48
handle_syntax_error/3, 47
handle_trans_ack/4, 50
handle_trans_long_request/3, 49
handle_trans_reply/4, 49
handle_trans_request/3, 48

open/2
megaco_udp , 44

parse_digit_map/1
megaco , 39

process_received_message/4
megaco , 37

receive_message/4
megaco , 38

report_digit_event/2
megaco , 39

send_message/2
megaco_tcp , 43
megaco_udp , 45

socket/1
megaco_tcp , 43
megaco_udp , 44

start/0
megaco , 31
megaco_flex_scanner , 41

start_transport/0
megaco_tcp , 42
megaco_udp , 44

start_user/2
megaco , 31

stop
megaco , 31

stop/0
megaco , 31

stop_user/1
megaco , 31

system_info/1
megaco , 34

test_digit_event/2
megaco , 40

unblock/1
megaco_tcp , 43
megaco_udp , 45

update_conn_info/3
megaco , 34

update_user_info/3
megaco , 33

user_info/2
megaco , 32