

Megaco/H.248

version 1.2

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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 is compliant with Megaco/H.248 version 1 (RFC3015) updated to Implementors Guide version 6 (IGv6).

Please observe that some incompatible features is introduced by IGv6.

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 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 3015¹
- Implementors Guide version 6²
- 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.

¹URL: <http://www.ietf.org/rfc/rfc3015.txt>

²URL: <http://www.erlang.org/project/megaco/standard/IGv6.pdf>

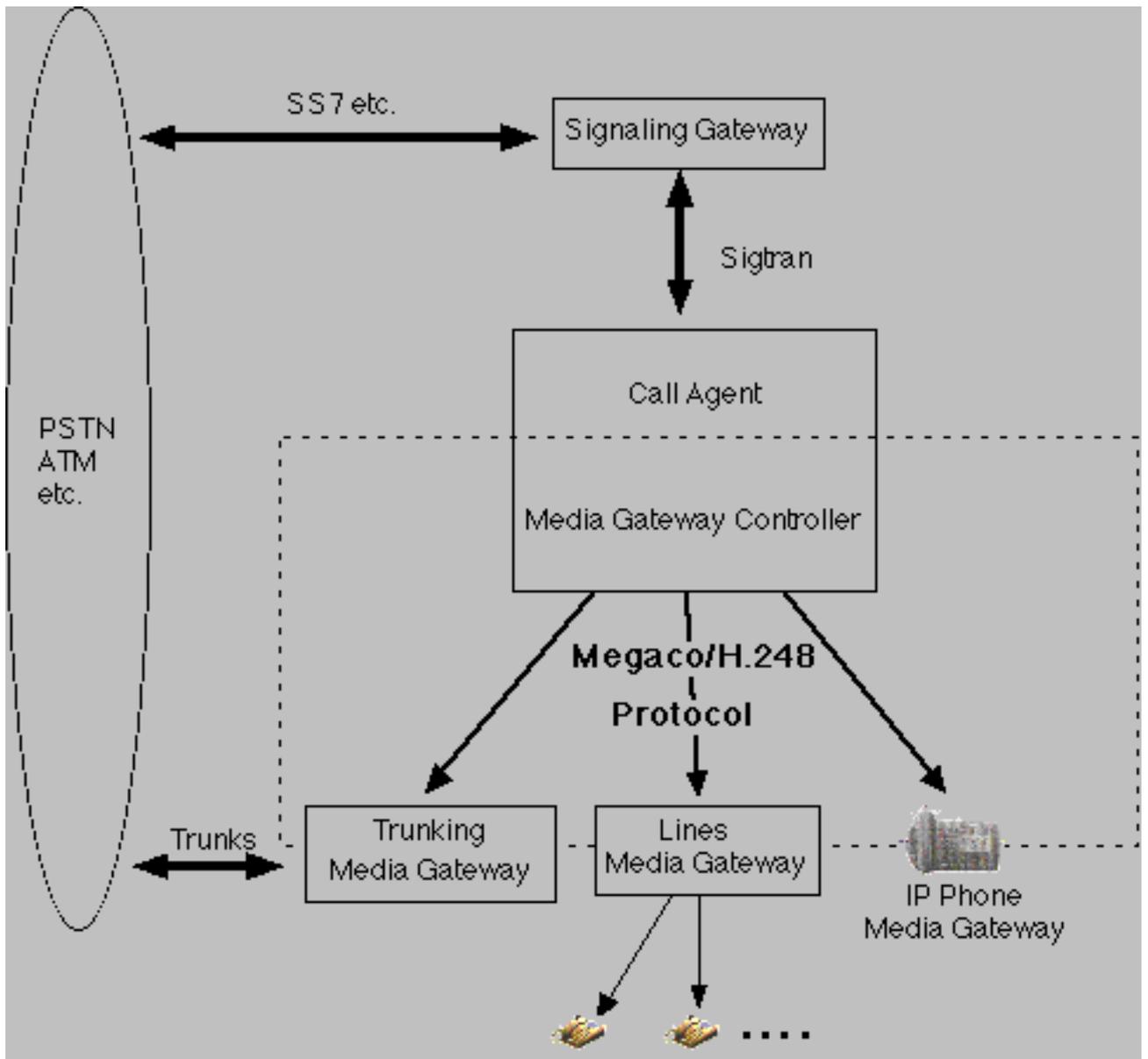


Figure 1.1: Network architecture

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 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:

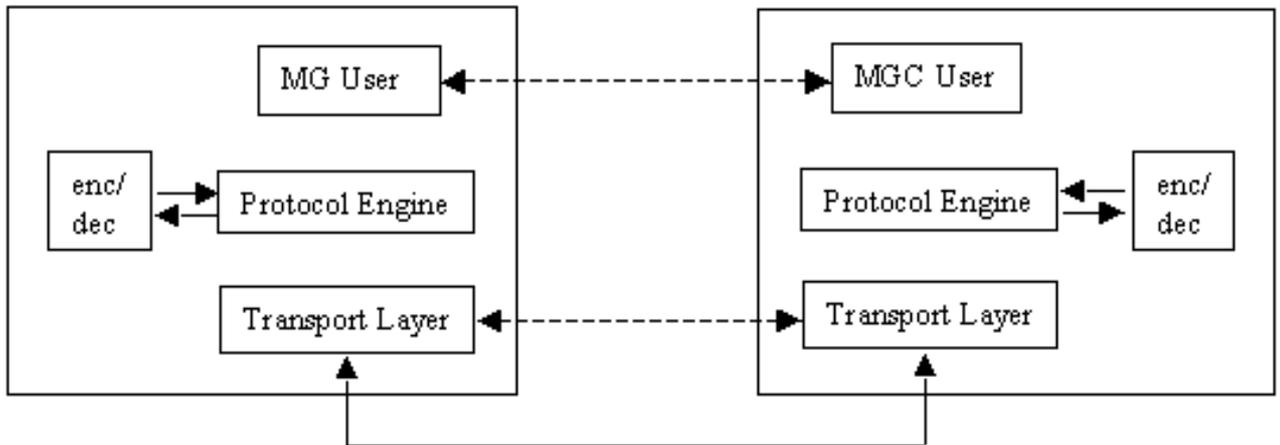


Figure 1.2: Single node config

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 unnecessary transfer of data between the Erlang nodes.

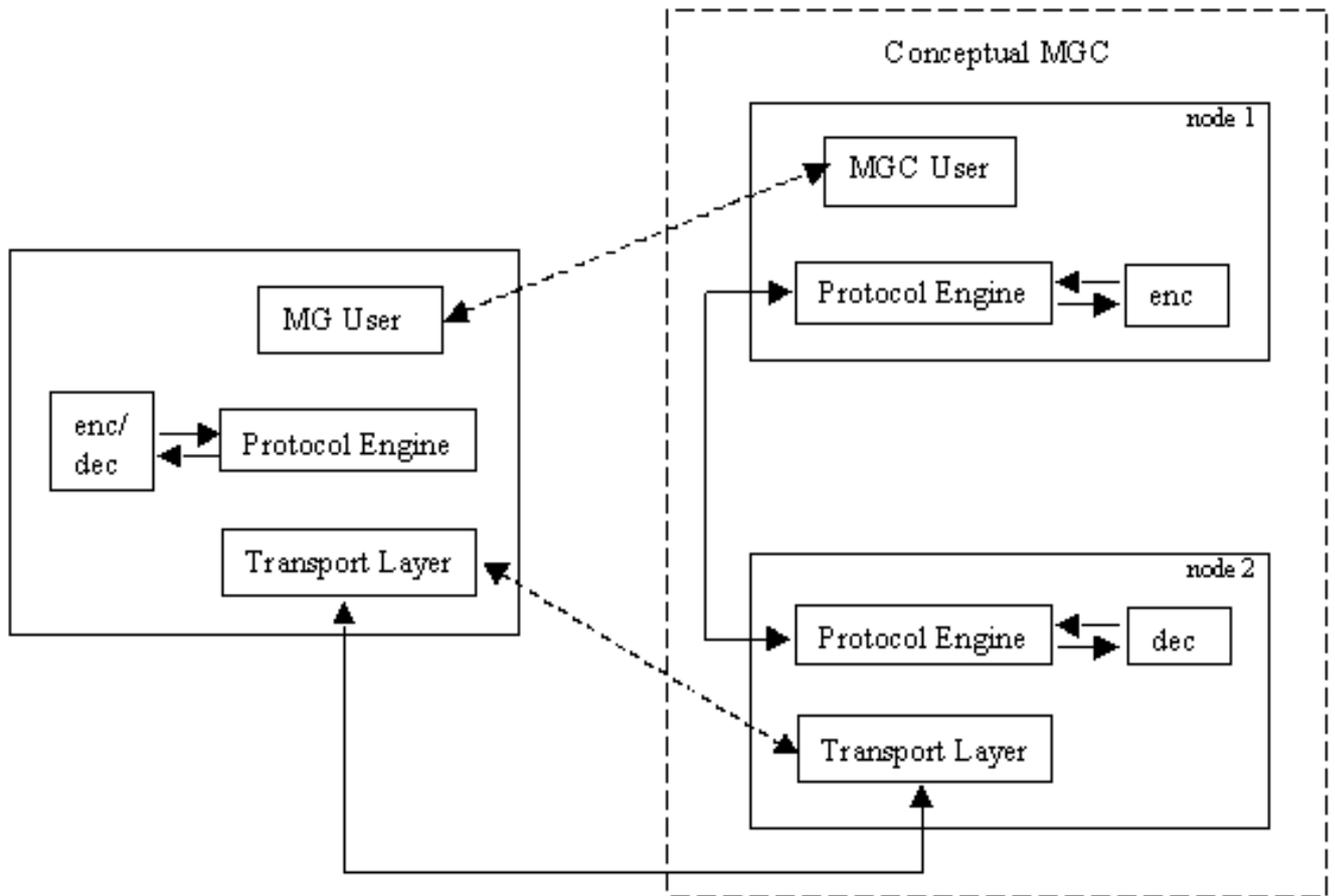


Figure 1.3: Distributed node config

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:

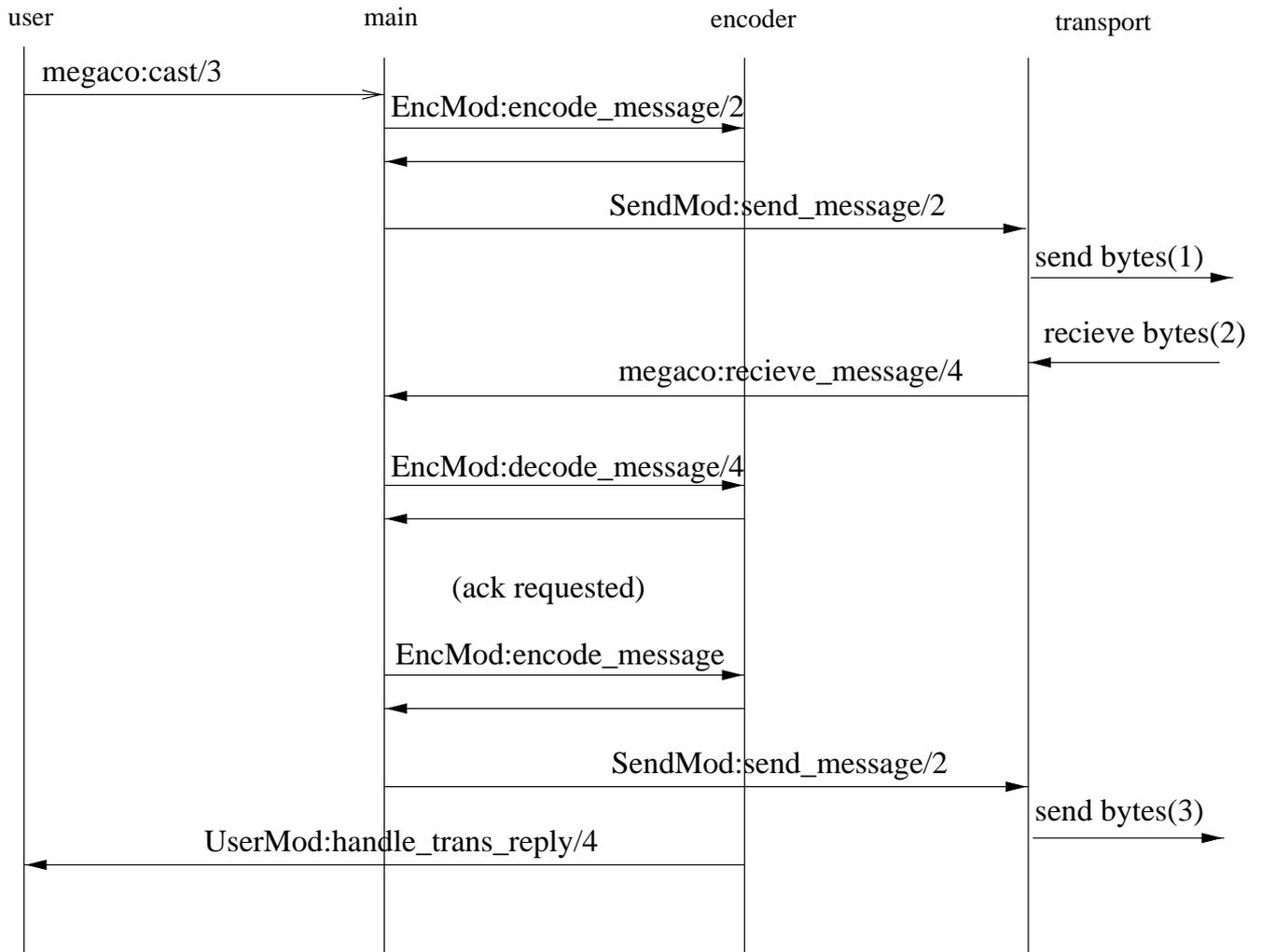


Figure 1.4: Message Call Flow (originating side)

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

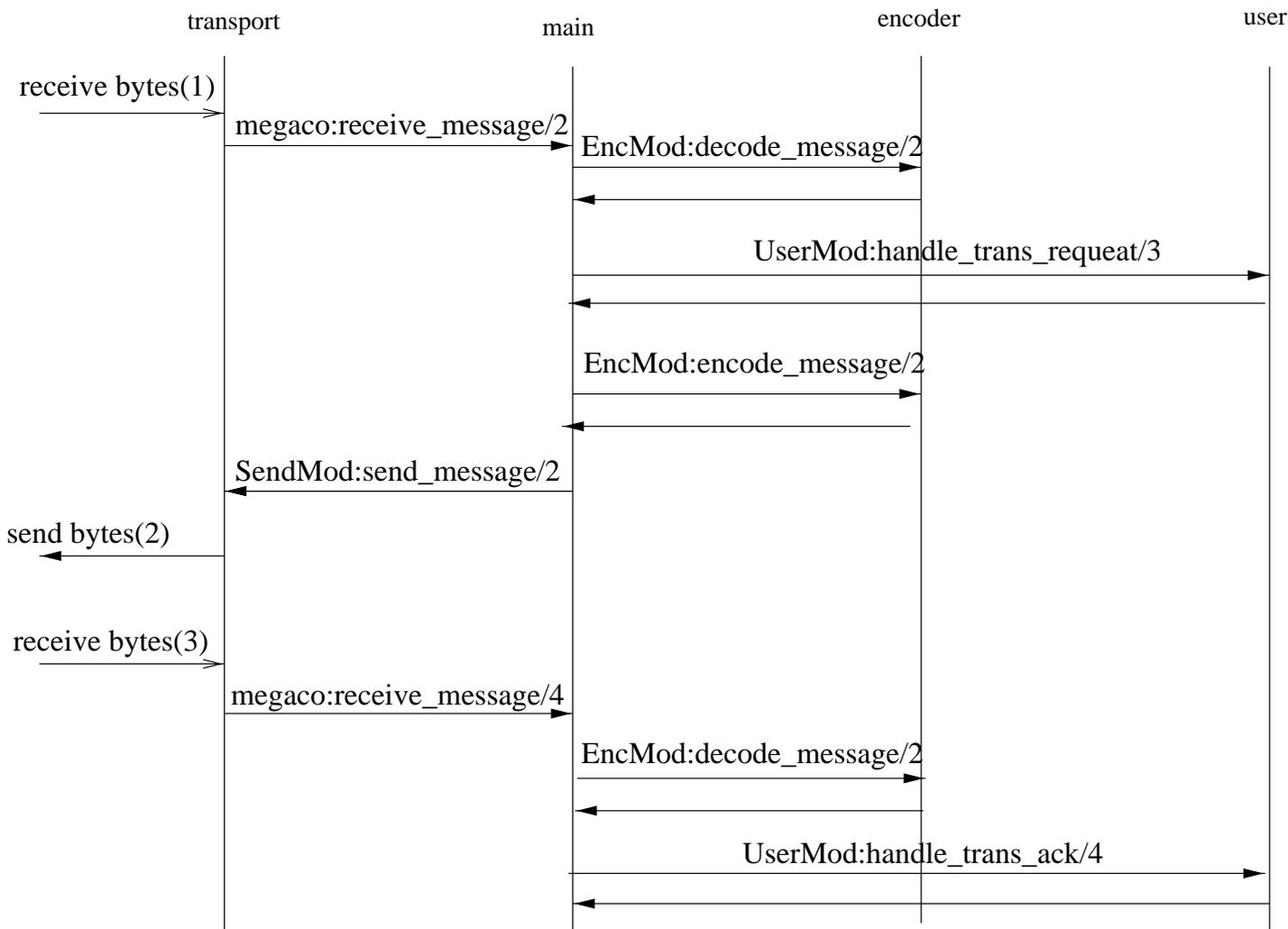


Figure 1.5: Message Call Flow (destination side)

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:

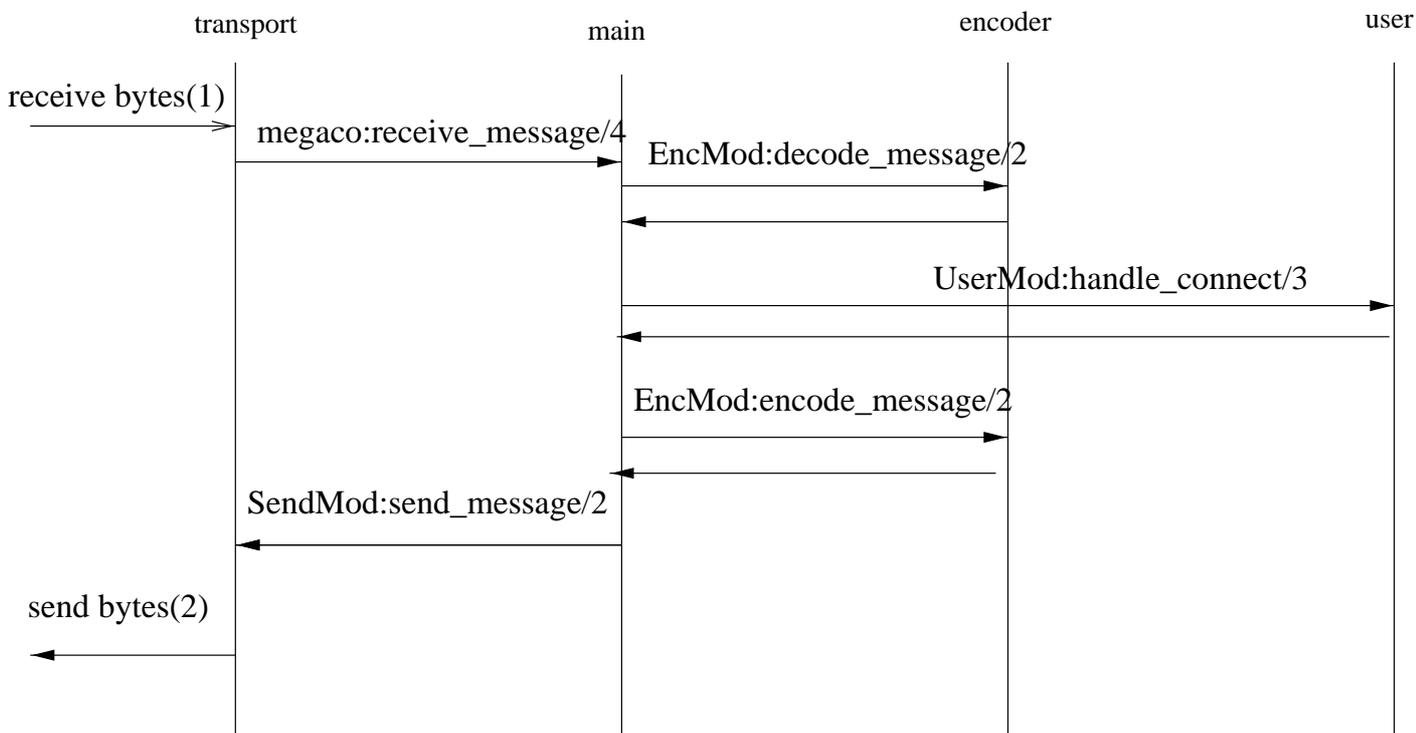


Figure 1.6: MGC Startup Call Flow

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:

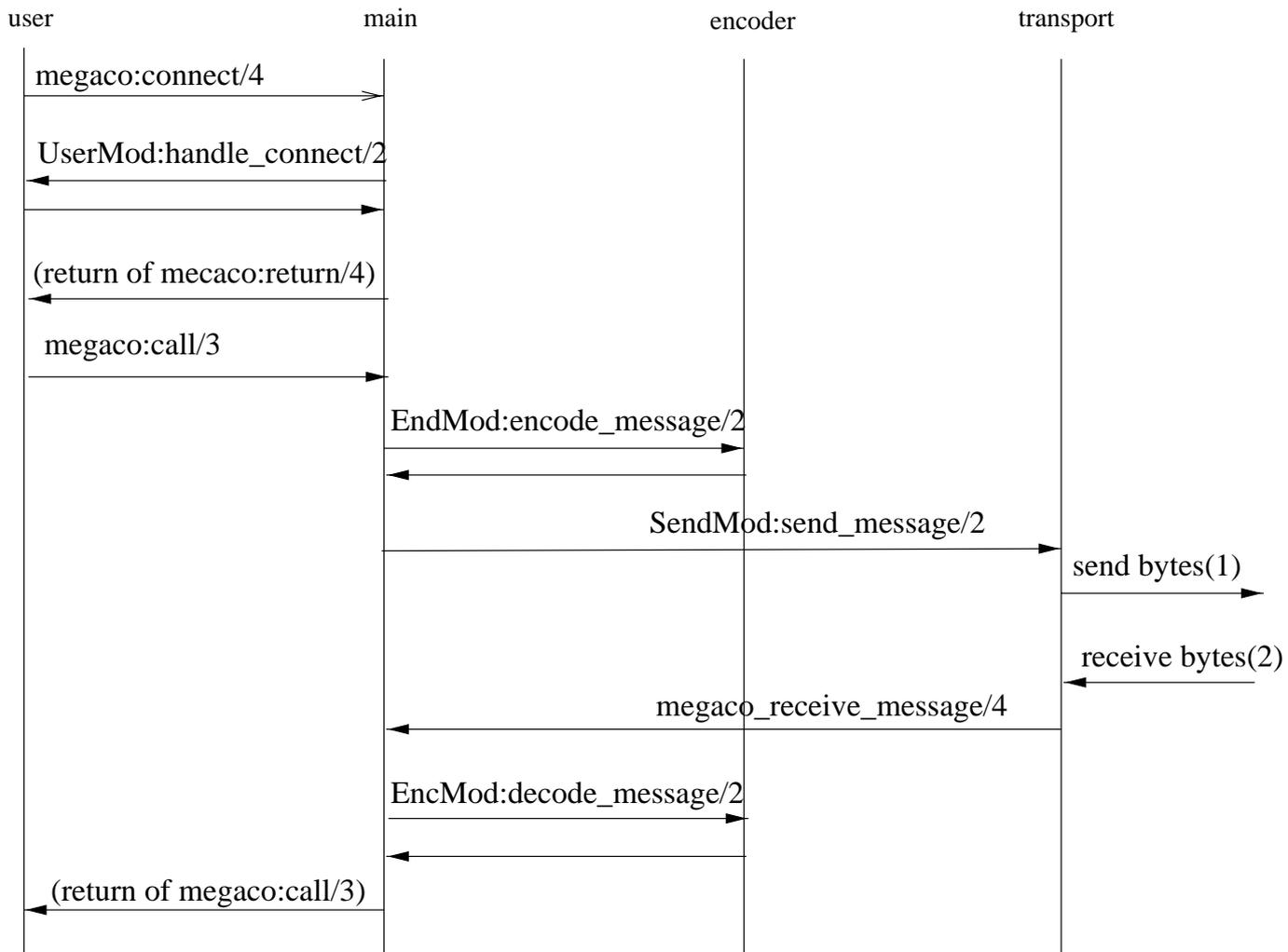


Figure 1.7: MG Startup Call Flow

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:

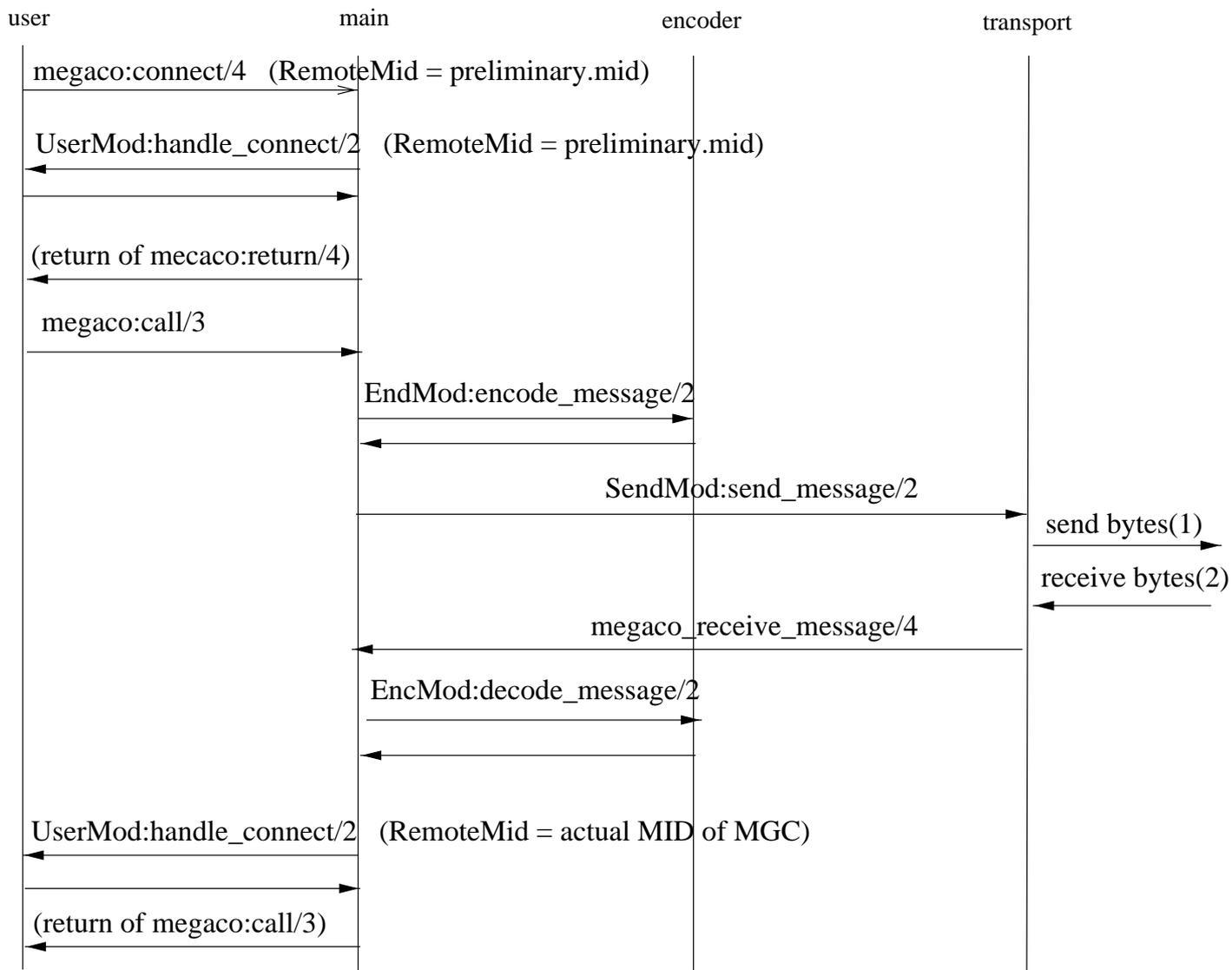


Figure 1.8: MG Startup Call Flow (no MID)

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 47].
- Connection info - Information regarding connections. Read/Write.
This information can be retrieved using megaco:conn_info [page 48].
- System info - System wide information. Read only.
This information can be retrieved using megaco:system_info [page 50].

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 48] and `megaco:update_conn_info` [page 49]

1.4 Internal form and its encodings

This version of the stack is compliant with Megaco/H.248 version 1 (RFC3015) updated to Implementors Guide version 6 (IGv6).

Please observe that some incompatible features is introduced by IGv6.

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:

```
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,
```


- `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:

- `[]` - 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.

- `[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])`.

1.5 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 65], and TCP/TPKT, see `megaco_tcp` [page 62].

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 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 *MedGwyGatewayStatsEntry*.

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 63] and *megaco_udp* [page 66]) maintain their own counters and the application engine (see *megaco* [page 56]) 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 it's 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 Performace 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:

Encoded message size in bytes

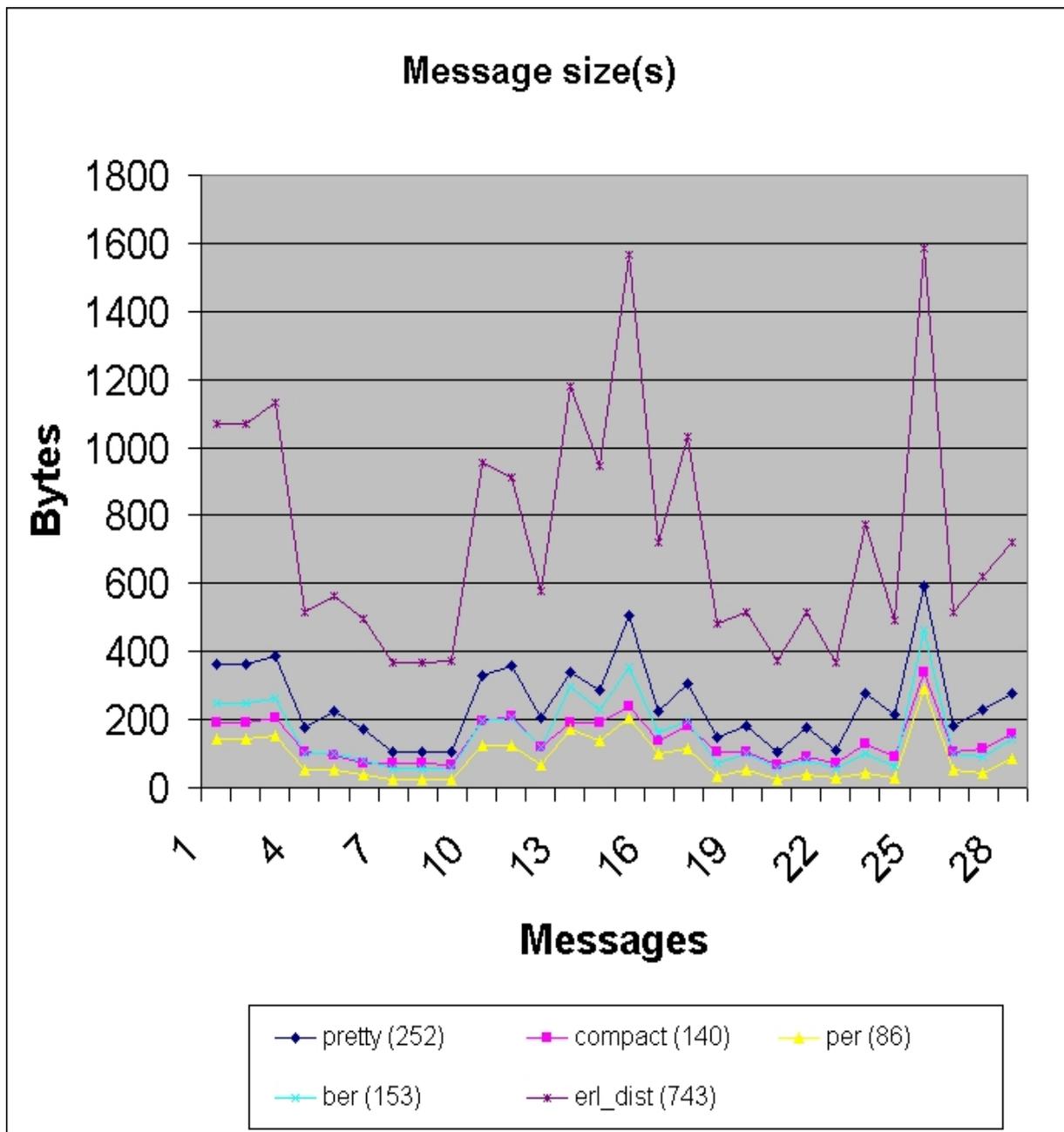


Figure 1.9: Encoded message size in bytes

Encode time in micro seconds

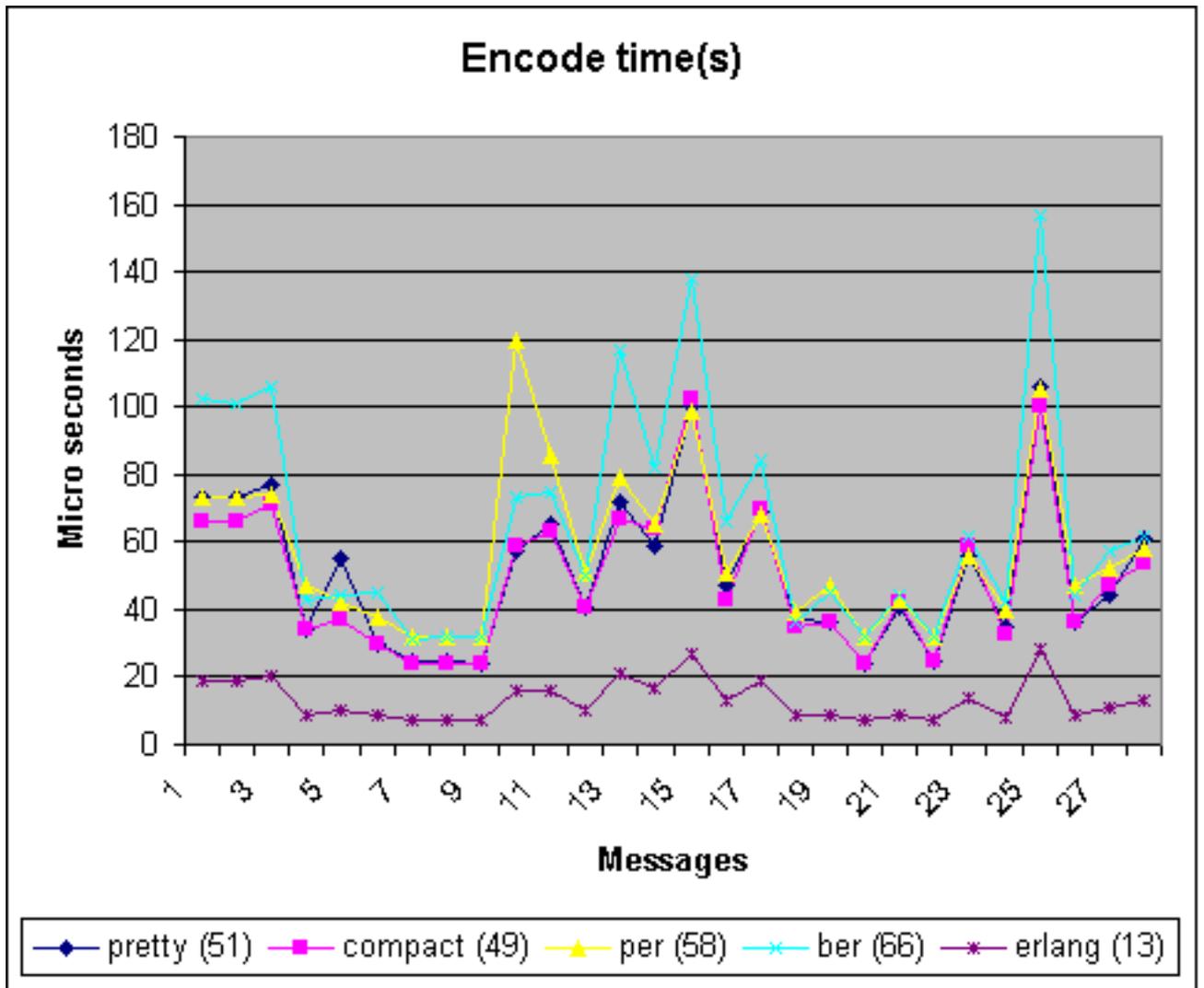


Figure 1.10: Encode time in micro seconds

Decode time in micro seconds

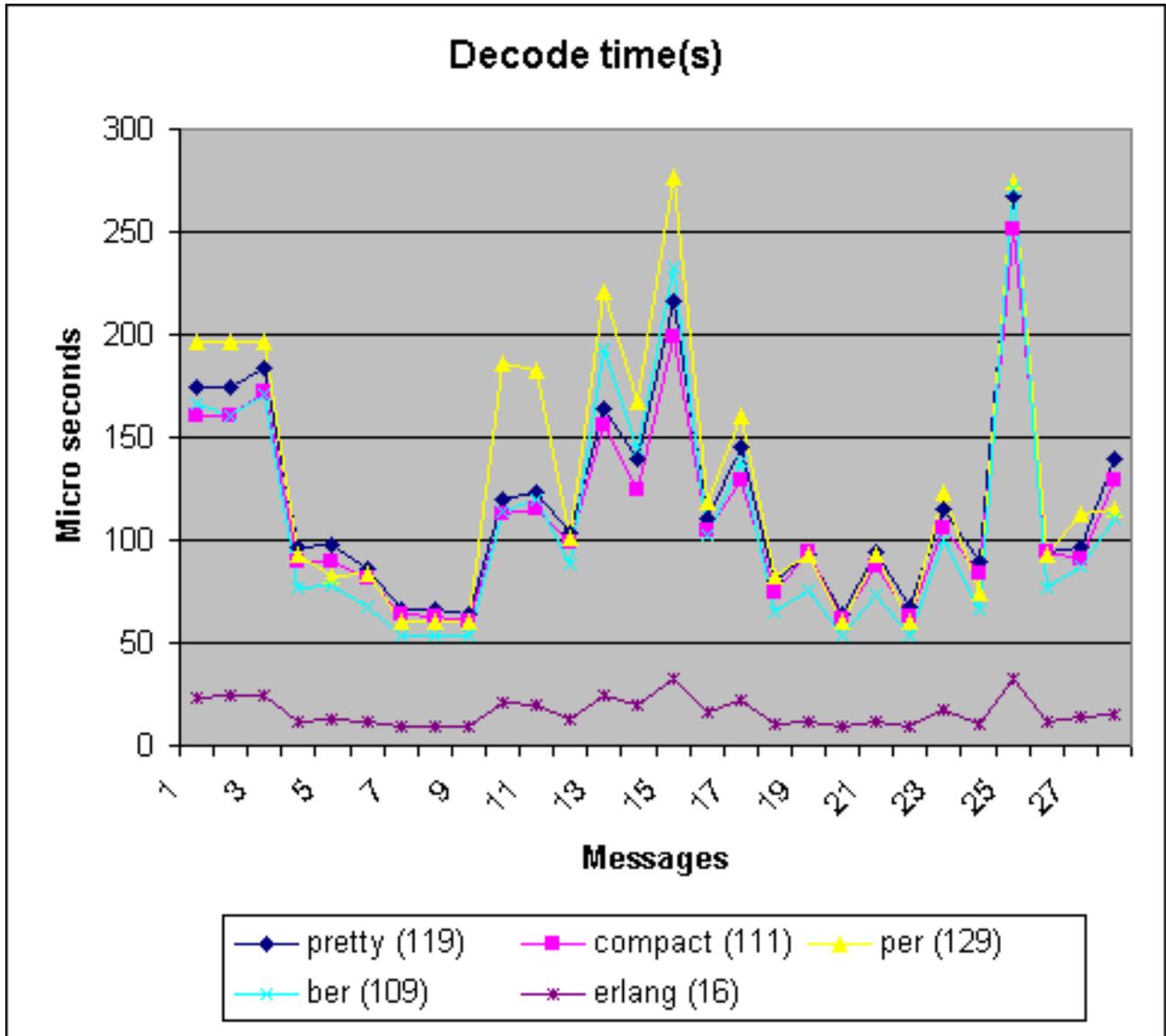


Figure 1.11: Decode time in micro seconds

Sum of encode and decode time in micro seconds

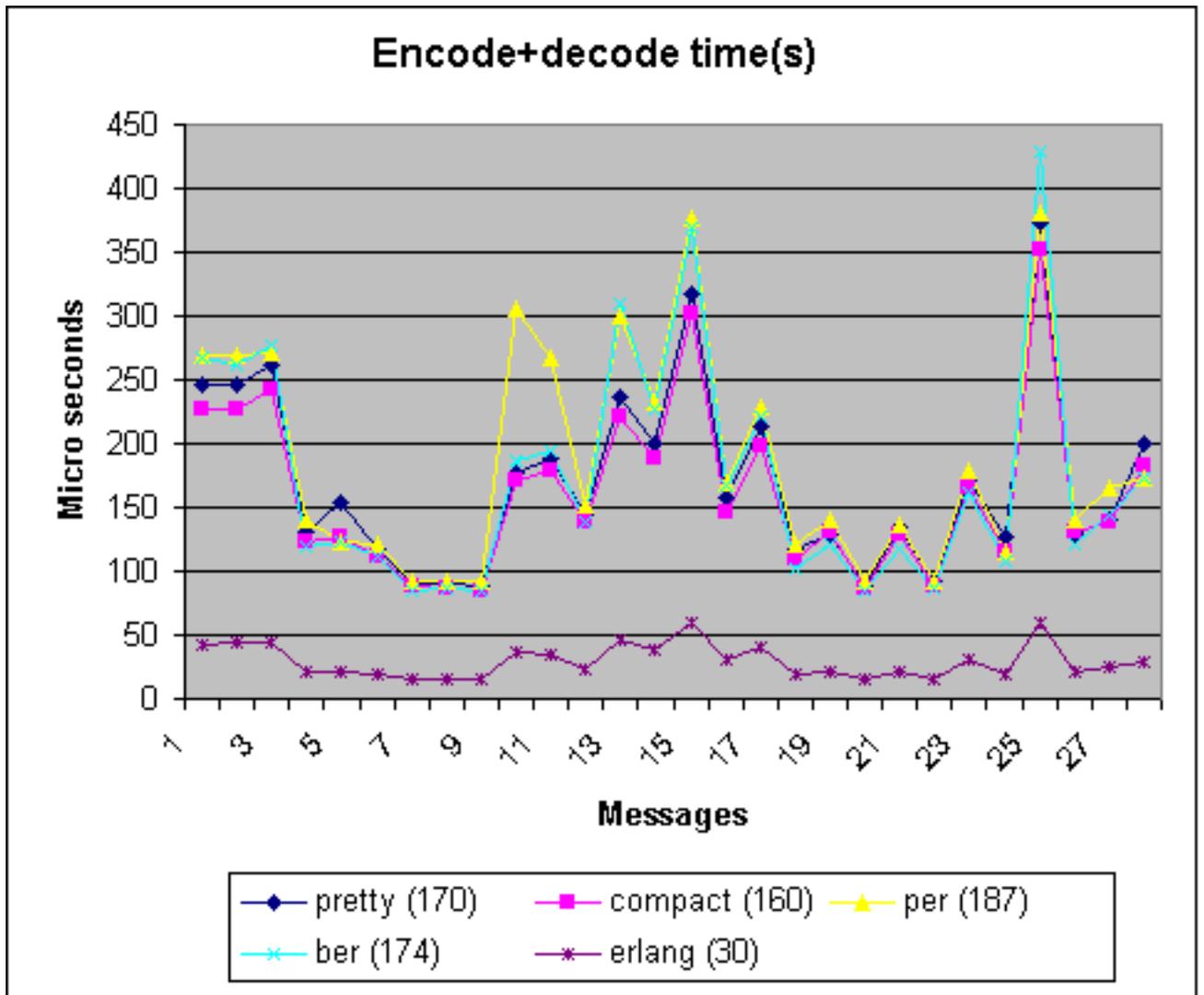


Figure 1.12: Sum of encode and decode time in micro seconds

1.8.2 Description of encoders/decoders

In Appendix A of the Megaco/H.248 specification (RFC 3015), there are about 30 messages that shows a representative call flow. We have used these example 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_dist* - 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 NoName PC, with an Intel P4 1800 MHz CPU, 512 MB DDR memory running RedHat Linux 7.3, kernel 2.4.18. A pre-release of the OTP R9 release has been used (2002-10-08).

1.8.4 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 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 15% faster than our fastest binary encoder (per). For decode the fastest binary decoder (ber) is marginally better than 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 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 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/utills 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 R8B or later.
- Version 1.0.2 or later of the *this* 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 5.1 [threads:0]

Eshell V5.1 (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:

```
% erl -noshell -pa <path-megaco-ebin-dir> -pa <path-to-tranformation-module-dir> \n
```

or using ber binary as base:

```
% erl -noshell -pa <path-megaco-ebin-dir> -pa <path-to-tranformation-module-dir> \n
```

Now the messages in the 'pretty' directory has been tranformed 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 5.1 [threads:0]

Eshell V5.1 (abort with ^G)
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> \n
```

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

```
For each codec:
  For each message:
    Read the message from the file
    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 and counting the number of decodes/encodes.

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.

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 ways to use the binary encodings: With ([]) or without ([native]) package related names and termination id transformation. 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.

Therefor in the tests, binary codecs are tested both with transformation ([]) and without transformation ([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* no 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).

1.10 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.

1.10.1 Megaco 1.2.3

Improvements and new features

-

Fixed bugs and malfunctions

- Megaco re-transmission loop, when setting the long request timer to an incremental timer. Megaco changes to the long request timer when receiving an pending message (after having sent a request). Each time the (long) timer expire, it will incorrectly result in an re-send of the request. This is meaningless since we know from the received pending that the "other side" has received the request and is working on it. Furthermore, when in this case the "other side" receives the request again, it will send another pending message. Receiving a pending message in this case will *restart* the timer (reset it to the initial values). This means that the timer will actually never fully expire and the two stacks will continue to exchange request/pending messages for as long as the "other side" is working on the request.

Own Id: OTP-4760

Aux Id: Seq 8003

Incompatibilities

-

Known bugs and problems

-

1.10.2 Megaco 1.2.2

Version 1.2.2 supports code replacement in runtime from/to version 1.2.1 and 1.2.

Improvements and new features

- Only spawn a process for the reply-timer if the user uses three-way-handshake.
Own Id: OTP-4729

Fixed bugs and malfunctions

- Encoding and decoding of the hexdig in AuthenticationHeader incorrect.
Own Id: OTP-4710

Incompatibilities

When downgrading from 1.2.2, reply-timers started when running 1.2.2 will not be properly handled since the format has changed. An error message will be printed when they expire.

Known bugs and problems

-

1.10.3 Megaco 1.2.1

Version 1.2.1 only supports code replacement in runtime from/to version 1.2.

Improvements and new features

- This is just a code up-/downgrade cleanup release. I.e. It's the same as version 1.2 minus the ugly stuff needed to handle up-/downgrade from/to version 1.1.2, 1.1.1 and 1.1.0.

Fixed bugs and malfunctions

-

Incompatibilities

-

Known bugs and problems

-

1.10.4 Megaco 1.2

Version 1.2 supports code replacement in runtime from/to version 1.1.2, 1.1.1 and 1.1.0.

Improvements and new features

- It is now possible to send more than one transaction (request) in a message. See call [page 52] and cast [page 52].
Req Id: M[4]-1
Own Id: OTP-4589
- Two new parameters for user and connection info has been added: `accu_ack_timer` and `accu_ack_maxcount`. These are used together with the `auto_ack` flag and control whether the acks should be sent immediately or accumulated (and sent later). Note that this has nothing to do with the `immAckRequired`-flag in reply transactions. See `user_info` [page 47] and `conn_info` [page 48].
Own Id: OTP-4669

Fixed bugs and malfunctions

- TCP transport supervision error (cut-and-paste error).
The `megaco_tcp` worker child was started as if it were a supervisor (and not a worker) and with a dependency to `megaco_tcp_connection_sup` (which it has none)
Own Id: OTP-4649
- Encoding of transaction ack fails with id ranges.
This was not really a problem in previous releases since such a message was never created (Ack was, possibly, sent for each received transaction reply).
Own Id: OTP-4652

Incompatibilities

-

Known bugs and problems

- Neither the TCP nor the UDP transport mechanisms are part of the megaco supervision tree. This makes code up-/downgrade difficult when either of them are used as transport.
This will be fixed in a future release of megaco.

1.10.5 Megaco 1.1.2

Version 1.1.2 supports code replacement in runtime from/to version 1.1.1 and 1.1.0.

Improvements and new features

-

Fixed bugs and malfunctions

- Service change reason text encoding now always quoted string.
Peter-Henry Mander
Own Id: OTP-4632

Incompatibilities

-

Known bugs and problems

-

1.10.6 Megaco 1.1.1

Version 1.1.1 supports code replacement in runtime from/to version 1.1.0.

Improvements and new features

- Added support for the Megaco mib.

Fixed bugs and malfunctions

- Result of catch `gen_udp:open` not properly handled.
Own Id: OTP-4566

Incompatibilities

-

Known bugs and problems

-

1.10.7 Megaco 1.1.0

Version 1.1.0 does not support code replacement in runtime from previous versions.

Improvements and new features

- Reply ack timeout now results in a call to callback function `handle_trans_ack/4` with `AckStatus = {error, timeout}`.
Own Id: OTP-4378
- The binary codecs `ber_bin` and `per_bin` is now both compiled with the `+optimize` compiler flag for better runtime performance.
Own Id: OTP-4383
- The previously included tool, `et`, has been moved out of the Megaco application. It is now provided as a separate application in OTP (as of R9).
Own Id: OTP-4487
- Added attribute `app_vsn` to all modules.
Own Id: OTP-4486

Fixed bugs and malfunctions

- Decode of oneStream incorrect.
Own Id: OTP-4490
- Transaction id counter wrapping incorrect when Max is infinity.
Incorrectly the documentation defined a connection info item `min_trans_id`. It should have been `trans_id`.
Own Id: OTP-4484
- Package name check in the text parser incorrect.
Own Id: OTP-4364
- Fixed a minor build problem causing the file 'megaco_text_parser.yrl' to not be included in the release.
Own Id: OTP-4363

Incompatibilities

-

Known bugs and problems

-

1.10.8 Megaco 1.0.4

Version 1.0.4 supports code replacement in runtime from/to version 1.0.2 and 1.0.3.

Improvements and new features

- Adding utility functions for megaco tracing.
Own Id: OTP-4339

Fixed bugs and malfunctions

- Optional line-number configure for the megaco flex scanner incorrect.
The intention was that line-numbering could be replaced with token number in order to improve performance. This did not work (line-numbers was always chosen). This has no runtime effect.
Own Id: OTP-4336
- Improved error reporting from the megaco messenger module.
Own Id: OTP-4337
- Text parsing of type octet string erroneous.
Own Id: OTP-4357
- A message containing a transaction request without the transaction id value is incorrectly reported back to the sender with a just an ErrorDescriptor. The correct behaviour is describen in chapter 8.1.1 of RFC 3015. Now the result will be a transactioReply with transaction id = 0 and an ErrorDescriptor.
Own Id: OTP-4359
Aux Id: Seq 7330

Incompatibilities

-

Known bugs and problems

-

1.10.9 Megaco 1.0.3

Improvements and new features

-

Fixed bugs and malfunctions

- Handling of comments in text messages incorrect.
For the ordinary text codec comments did not work. For the flex text codecs, double quoted strings in comments did not work.
Own Id: OTP-4299
Aux Id: Seq 7330
- 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`.
Own Id: OTP-4288
- The user arguments was not supplied to the callback function `handle_unexpected_trans` as described by `megaco_user` [page 68].
Own Id: OTP-4290

Incompatibilities

- The `scanner` item of system info has been removed and instead been replaced by `text.config`. Also no longer contains any MFA info. From now on, just the text config.

Known bugs and problems

-

1.10.10 Megaco 1.0.2

Improvements and new features

- Added another binary decoder; `per_bin`.
To be able to *use* the `per_bin` encoder the ASN.1 application of version 1.3.2 or later is needed for R8B systems. For R7B01, ASN.1 of version 1.3.1.3 or later must be used.

Fixed bugs and malfunctions

- Memory leak in the flex scanner. Message larger than approx. 1000 bytes cannot be decoded. Will cause a core dump! Note that this will only be a problem *if* the flex scanner has been configured as encoding/decoding module!
Own Id: OTP-4236
- Fixed Makefile.in for the flex scanner. Removed unnecessary '-lfl' link option.
Own Id: OTP-4224
- Installed source was not placed in their proper (sub-) directory.

Incompatibilities

-

Known bugs and problems

-

1.10.11 Megaco 1.0.1

Improvements and new features

-

Fixed bugs and malfunctions

- The megaco application now forwards unexpected replies. This is done with a call to `handle_unexpected_trans/3` [page 72].
Own Id: OTP-4212
Aux Id: Seq 7181
- Megaco leaves entries in the `megaco_replies` table.
Own Id: OTP-4213
Aux Id: Seq 7208

Incompatibilities

-

Known bugs and problems

-

1.10.12 Megaco 1.0

Improvements and new features

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

Fixed bugs and malfunctions

-

Incompatibilities

-

Known bugs and problems

-

1.10.13 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

-

1.10.14 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.

1.10.15 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 than 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

-

1.10.16 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 performance. 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 than 200 bytes not to be processed.

1.10.17 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

-

1.10.18 Megaco 0.9

Improvements and new features

The application has been adapted 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 an 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 “provisional 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 has 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'{} , terminationAuditResult = #'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 chosen)..
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_re
,...
```

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 46] – Main API of the Megaco application
- Erlang Module **megaco_codec_meas** [page 58] – This module implements a simple megaco codec measurement tool.
- Erlang Module **megaco_codec_transform** [page 59] – Megaco message transformation utility.
- Erlang Module **megaco_flex_scanner** [page 61] – Interface module to the flex scanner linked in driver.
- Erlang Module **megaco_tcp** [page 62] – Interface module to TPKT transport protocol for Megaco/H.248.
- Erlang Module **megaco_udp** [page 65] – Interface module to UDP transport protocol for Megaco/H.248.
- Erlang Module **megaco_user** [page 68] – Callback module for users of the Megaco application

megaco

The following functions are exported:

- `start() -> ok | {error, Reason}`
[page 46] Starts the Megaco application
- `stop() -> ok | {error, Reason}`
[page 46] Stops the Megaco application
- `stop`
[page 46] Stops the Megaco application
- `start_user(UserMid, Config) -> ok | {error, Reason}`
[page 46] Initial configuration of a user
- `stop_user(UserMid) -> ok | {error, Reason}`
[page 46] Delete the configuration of a user
- `user_info(UserMid, Item) -> Value | exit(Reason)`
[page 47] Lookup user information
- `update_user_info(UserMid, Item, Value) -> ok | {error, Reason}`
[page 48] Update information about a user
- `conn_info(ConnHandle, Item) -> Value | exit(Reason)`
[page 48] Lookup information about an active connection

- `update_conn_info(ConnHandle, Item, Value) -> ok | {error, Reason}`
[page 50] Update information about an active connection
- `system_info(Item) -> Value | exit(Reason)`
[page 50] Lookup system information
- `connect(ReceiveHandle, RemoteMid, SendHandle, ControlPid) -> {ok, ConnHandle} | {error, Reason}`
[page 50] Establish a "virtual" connection
- `disconnect(ConnHandle, DiscoReason) -> ok | {error, ErrReason}`
[page 51] Tear down a "virtual" connection
- `call(ConnHandle, Actions, Options) -> {ProtocolVersion, UserReply}`
[page 52] Sends one or more transaction request(s) and waits for the reply
- `cast(ConnHandle, Actions, Options) -> ok | {error, Reason}`
[page 52] Sends one or more transaction request(s) but does NOT wait for a reply
- `cancel(ConnHandle, CancelReason) -> ok | {error, ErrReason}`
[page 53] Cancel all outstanding messages for this connection
- `process_received_message(ReceiveHandle, ControlPid, SendHandle, BinMsg) -> ok`
[page 53] Process a received message
- `receive_message(ReceiveHandle, ControlPid, SendHandle, BinMsg) -> ok`
[page 54] Process a received message
- `parse_digit_map(DigitMapBody) -> {ok, ParsedDigitMap} | {error, Reason}`
[page 54] Parses a digit map body
- `eval_digit_map(DigitMap) -> {ok, Letters} | {error, Reason}`
[page 55] Collect digit map letters according to the digit map
- `eval_digit_map(DigitMap, Timers) -> {ok, Letters} | {error, Reason}`
[page 55] Collect digit map letters according to the digit map
- `report_digit_event(DigitMapEvalPid, Events) -> ok | {error, Reason}`
[page 55] Send one or more events to the event collector process
- `test_digit_event(DigitMap, Events) -> {ok, Letters} | {error, Reason}`
[page 55] Feed digit map collector with events and return the result
- `enable_trace(Level, Destination) -> void()`
[page 56] Start megaco tracing
- `disable_trace() -> void()`
[page 56] Stop megaco tracing
- `set_trace(Level) -> void()`
[page 56] Change megaco trace level
- `get_stats() -> {ok, TotalStats} | {error, Reason}`
[page 56]
- `get_stats(GlobalCounter) -> {ok, CounterStats} | {error, Reason}`
[page 56]
- `get_stats(CallHandle) -> {ok, CallHandleStats} | {error, Reason}`
[page 56]
- `get_stats(CallHandle, Counter) -> {ok, integer()} | {error, Reason}`
[page 56]

- `reset_stats() -> void()`
[page 57]
- `reset_stats(SendHandle) -> void()`
[page 57]

`megaco_codec_meas`

The following functions are exported:

- `t() -> void()`
[page 58]
- `t(Dirs) -> void()`
[page 58]

`megaco_codec_transform`

The following functions are exported:

- `tt() -> void()`
[page 59]
- `tb() -> void()`
[page 59]
- `t([FromCodec, ToCodecs]) -> ok | {error, Reason}`
[page 59]
- `t(FromCodec, ToCodecs) -> ok | {error, Reason}`
[page 59]
- `tmf(FromFile, FromCodec, ToCodec) -> ok | {error, Reason}`
[page 59]
- `tm(FromMsg, FromCodec, ToCodec) -> binary()`
[page 60]

`megaco_flex_scanner`

The following functions are exported:

- `start() -> {ok, Port} | {error, Reason}`
[page 61]

megaco_tcp

The following functions are exported:

- `start_transport()` -> {ok, TransportRef}
[page 62]
- `listen(TransportRef, ListenPortSpecList)` -> ok
[page 62]
- `connect(TransportRef, OptionList)` -> {ok, Handle, ControlPid} | {error, Reason}
[page 62]
- `close(Handle)` -> ok
[page 62]
- `socket(Handle)` -> Socket
[page 63]
- `send_message(Handle, Message)` -> ok
[page 63]
- `block(Handle)` -> ok
[page 63]
- `unblock(Handle)` -> ok
[page 63]
- `get_stats()` -> {ok, TotalStats} | {error, Reason}
[page 63]
- `get_stats(SendHandle)` -> {ok, SendHandleStats} | {error, Reason}
[page 63]
- `get_stats(SendHandle, Counter)` -> {ok, CounterStats} | {error, Reason}
[page 63]
- `reset_stats()` -> void()
[page 64]
- `reset_stats(SendHandle)` -> void()
[page 64]

megaco_udp

The following functions are exported:

- `start_transport()` -> {ok, TransportRef}
[page 65]
- `open(TransportRef, OptionList)` -> {ok, Handle, ControlPid} | {error, Reason}
[page 65]
- `close(Handle, Msg)` -> ok
[page 65]
- `socket(Handle)` -> Socket
[page 65]
- `create_send_handle(Handle, Host, Port)` -> send_handle()
[page 66]

- `send_message(SendHandle, Msg) -> ok`
[page 66]
- `block(Handle) -> ok`
[page 66]
- `unblock(Handle) -> ok`
[page 66]
- `get_stats() -> {ok, TotalStats} | {error, Reason}`
[page 66]
- `get_stats(SendHandle) -> {ok, SendHandleStats} | {error, Reason}`
[page 66]
- `get_stats(SendHandle, Counter) -> {ok, CounterStats} | {error, Reason}`
[page 66]
- `reset_stats() -> void()`
[page 67]
- `reset_stats(SendHandle) -> void()`
[page 67]

megaco_user

The following functions are exported:

- `handle_connect(ConnHandle, ProtocolVersion) -> ok | error | {error, ErrorDescr}`
[page 69] Invoked when a new connection is established
- `handle_disconnect(ConnHandle, ProtocolVersion, Reason) -> ok`
[page 69] Invoked when a connection is teared down
- `handle_syntax_error(ReceiveHandle, ProtocolVersion, DefaultED) -> reply | {reply, ED} | no_reply | {no_reply, ED}`
[page 69] Invoked when a received message had syntax errors
- `handle_message_error(ConnHandle, ProtocolVersion, ErrorDescr) -> | no_reply`
[page 70] Invoked when a received message just contains an error
- `handle_trans_request(ConnHandle, ProtocolVersion, ActionRequests) -> pending() | reply()`
[page 70] Invoked for each transaction request
- `handle_trans_long_request(ConnHandle, ProtocolVersion, ReqData) -> reply()`
[page 71] Optionally invoked for a time consuming transaction request
- `handle_trans_reply(ConnHandle, ProtocolVersion, UserReply, ReplyData) -> ok`
[page 71] Optionally invoked for a transaction reply
- `handle_trans_ack(ConnHandle, ProtocolVersion, AckStatus, AckData) -> ok`
[page 72] Optionally invoked for a transaction acknowledgement
- `handle_unexpected_trans(ReceiveHandle, ProtocolVersion, Trans) -> ok`
[page 73] Invoked when an unexpected message is received

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 the transaction reply has been received (see `accu_ack_timer` below). A boolean, defaults to false.

`accu_ack_timer` Accumulated ack's timeout time. Has two functions. First, if the value is 0, then ack's will not be accumulated. Second, if the value is greater than 0 and `auto_ack` is true, then ack's will be accumulated (instead of sent immediately) and the value indicates the maximum length (see `accu_ack_maxcount`) of time ack's will be accumulated before sending them (in one message) (see also `accu_ack_maxcount` below).
An integer, defaults to 0.

`accu_ack_maxcount` Maximum number of accumulated ack's. At most this many ack's will be accumulated.

The accumulated ack's will be sent either when the `accu_ack_timer` expires or when `accu_ack_maxcount` number of ack's has been accumulated, whichever happens first. (see `accu_ack_timer` above). An integer, defaults to 10.

`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.

`trans_id` Next trans id. A positive integer.

`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 the transaction reply has been received (see `accu_ack_timer` below). A boolean, defaults to false.

`accu_ack_timer` Accumulated ack's timeout time. Has two functions. First, if the value is 0, then ack's will not be accumulated. Second, if the value is greater than 0 and `auto_ack` is true, then ack's will be accumulated (instead of sent immediately) and the value indicates the maximum length (see `accu_ack_maxcount`) of time ack's will be accumulated before sending them (in one message) (see also `accu_ack_maxcount` below).
An integer, defaults to 0.

`accu_ack_maxcount` Maximum number of accumulated ack's. At most this many ack's will be accumulated.
The accumulated ack's will be sent either when the `accu_ack_timer` expires or when `accu_ack_maxcount` number of ack's has been accumulated, whichever happens first. (see `accu_ack_timer` above). An integer, defaults to 10.

`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 need 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:

- 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 `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 be 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` 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, Actions, Options) -> {ProtocolVersion, UserReply}
```

Types:

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

Sends one or more transaction request(s) and waits for the reply.

When sending one transaction in a message, Action 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.

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, Actions, Options) -> ok | {error, Reason}
```

Types:

- ConnHandle = conn_handle()
- Actions = action_reqs() | [action_reqs()]
- action_reqs() = [#'ActionRequest'{}]
- Options = [send_option()]
- send_option() = {request_timer, timer()} | {long_request_timer, timer()} | {send_handle, term()} | {reply_data, reply_data()}
- 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.

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` | `$$`
- `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.

`enable_trace(Level, Destination) -> void()`

Types:

- `Level` = `max` | `min` | `0 <= integer() <= 100`
- `Destination` = `File` | `Port` | `HandlerSpec`
- `File` = `string()`
- `Port` = `integer()`
- `HandleSpec` = `{HandlerFun, Data}`
- `HandleFun` = `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`).

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()`

Retrieve 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.

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() -> void()`

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

`t(Dirs) -> 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() -> 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(pretty, [compact, ber, per, erlang])`

`tb() -> 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(ber, [pretty, compact, per, erlang])`

`t([FromCodec, ToCodecs]) -> ok | {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 b
```

`t(FromCodec, ToCodecs) -> ok | {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(FromFile, FromCodec, ToCodec) -> ok | {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.

`tm(FromMsg, FromCodec, ToCodec) -> 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_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 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() | 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 = {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.

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()
- stats() = {tcp_stats_counter(), integer()}
- tcp_stats_counter() = medGwyGatewayNumInMessages | medGwyGatewayNumInOctets | medGwyGatewayNumOutMessages | medGwyGatewayNumOutOctets | medGwyGatewayNumErrors
- Reason = term()

Retrieve the TCP related (SNMP) statistics counters.

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

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

Types:

- SendHandle = send_handle()

Reset all TCP related (SNMP) statistics counters.

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()} | {module, atom()}`
- `Handle = socket_handle()`
- `ControlPid = pid()`
- `Reason = term()`

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

The `module` option makes it possible for the user to provide their own callback module. The functions `receive_message/4` or `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` - `receive_message`, `large` - `process_received_message`). Default value is *megaco*.

`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. 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.

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

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

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

Types:

- TotalStats = [total_stats()]
- total_stats() = {send_handle(), [stats()]}
- SendHandle = send_handle()
- SendHandleStats = [stats()]
- Counter = udp_stats_counter()
- CounterStats = integer()
- stats() = {udp_stats_counter(), integer()}

- `tcp_stats_counter()` = `medGwyGatewayNumInMessages` | `medGwyGatewayNumInOctets` | `medGwyGatewayNumOutMessages` | `medGwyGatewayNumOutOctets` | `medGwyGatewayNumErrors`
- `Reason = term()`

Retrieve the UDP related (SNMP) statistics counters.

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

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

Types:

- `SendHandle = send_handle()`

Reset all TCP related (SNMP) statistics counters.

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
- handle_unexpected_trans/3

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()` 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) -> | 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()} | {handle_sloppy_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 `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.

`{handle_sloppy_ack, ack_data()}` 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.

```
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()} | {handle_sloppy_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 preceding 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 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`.

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 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 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`).

`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 the this function on the local node (the node which has the the link).

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