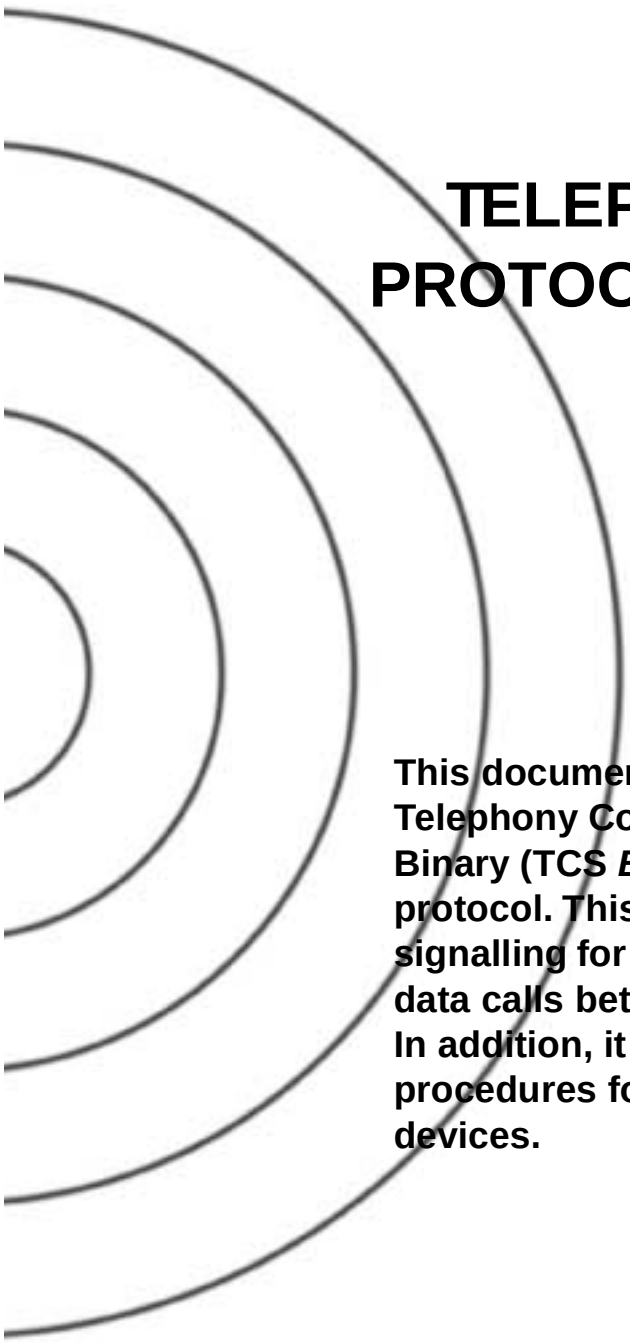
Part F:3

TELEPHONY CONTROL PROTOCOL SPECIFICATION

TCS Binary



This document describes the Bluetooth Telephony Control protocol Specification – Binary (TCS *Binary*), using a bit-oriented protocol. This protocol defines the call control signalling for the establishment of speech and data calls between Bluetooth devices.
In addition, it defines mobility management procedures for handling Bluetooth TCS devices.

CONTENTS

1 GENERAL DESCRIPTION

1.1 OVERVIEW

The Bluetooth Telephony Control protocol Specification Binary (TCS *Binary*) is based on the ITU-T Recommendation Q.931[1], applying the symmetrical provisions as stated in Annex D of Q.931. The resulting text does not discriminate between user and network side, but merely between Outgoing Side (the party originating the call) and Incoming Side (the party terminating the call). Effort was made to only apply those changes necessary for Bluetooth and foreseen applications, enabling re-use of Q.931 to the largest extent possible.

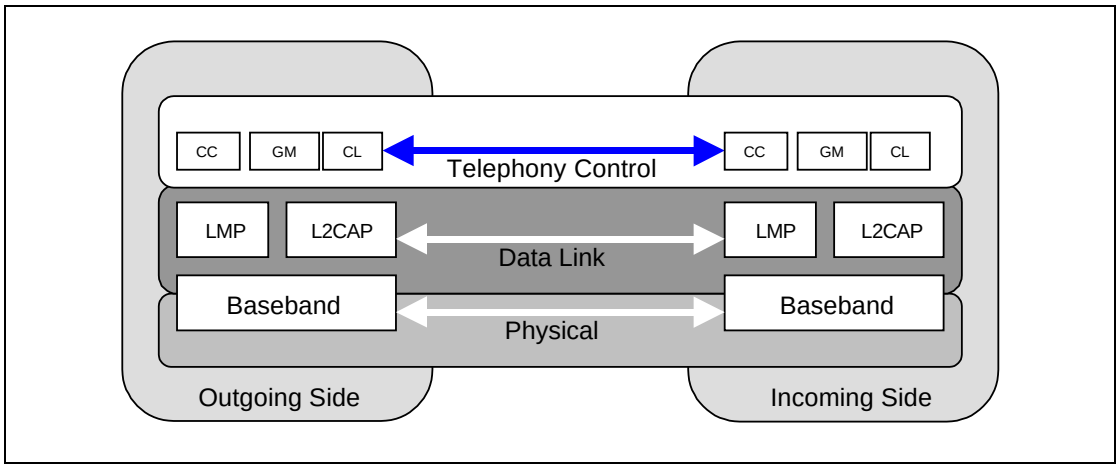


Figure 1.1: TCS within the Bluetooth stack

The TCS contains the following functionality:

- Call Control (CC) – signalling for the establishment and release of speech and data calls between Bluetooth devices
- Group Management – signalling to ease the handling of groups of Bluetooth devices
- ConnectionLess TCS (CL) – provisions to exchange signalling information not related to an ongoing call

1.2 OPERATION BETWEEN DEVICES

TCS uses point-to-point signalling and may use point-to-multipoint signalling. Point-to-point signalling is used when it is known to which side (Bluetooth device) a call needs to be established (*single-point configuration*).

Point-to-multipoint signalling may be used when there are more sides available for call establishment (*multi-point configuration*); e.g. when, for an incoming call, a home base station needs to alert all phones in range.

Point-to-point signalling is mapped towards a connection-oriented L2CAP channel, whereas point-to-multipoint signalling is mapped towards the connectionless L2CAP channel, which in turn is sent as broadcast information on the beacon channel (piconet broadcast).

Figure 1.2 illustrates point-to-point signalling to establish a voice or data call in a single-point configuration. First the other device is notified of the call request using the point-to-point signalling channel (A). Next, this signalling channel is used to further establish the speech or data channel (B).

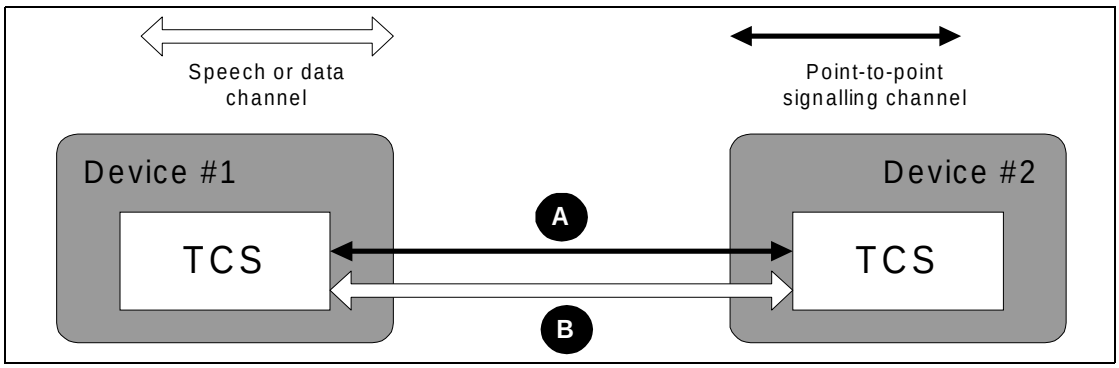


Figure 1.2: Point-to-point signalling in a single-point configuration

Figure 1.3 below illustrates how point-to-multipoint signalling and point-to-point signalling is used to establish a voice or data call in a multi-point configuration. First all devices are notified of the call request using point-to-multipoint signalling channel (A). Next, one of the devices answers the call on the point-to-point signalling channel (B); this signalling channel is used to further establish the speech or data channel (C).

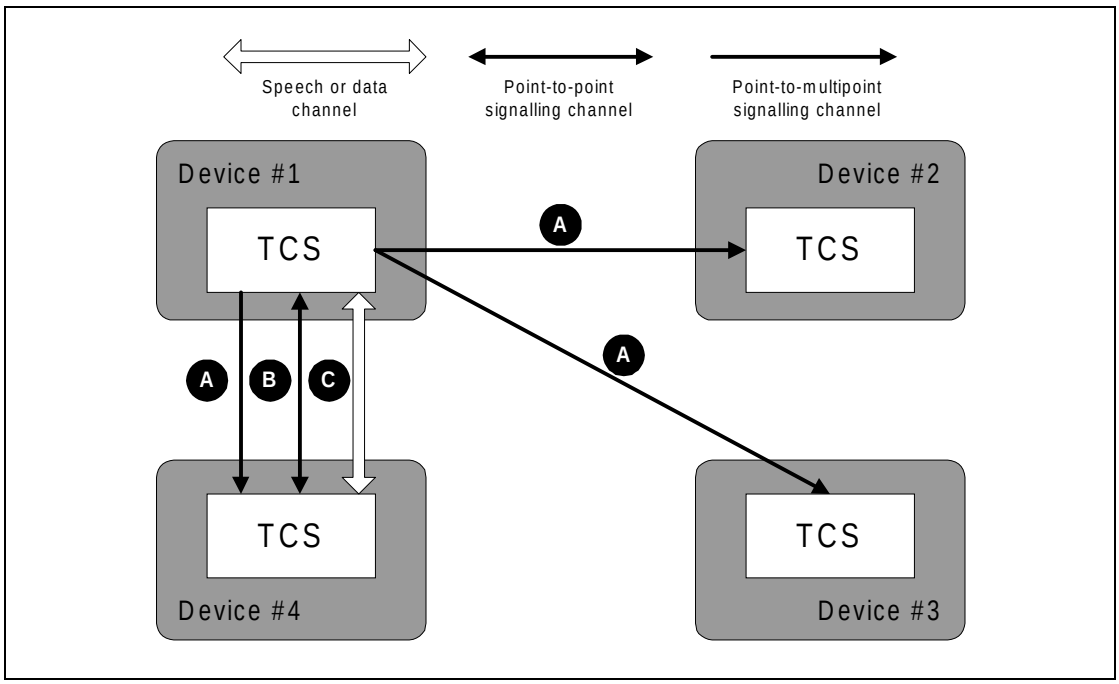


Figure 1.3: Signalling in a multi-point configuration

1.3 OPERATION BETWEEN LAYERS

TCS implementations should follow the general architecture described below (note that, for simplicity, handling of data calls is not drawn).

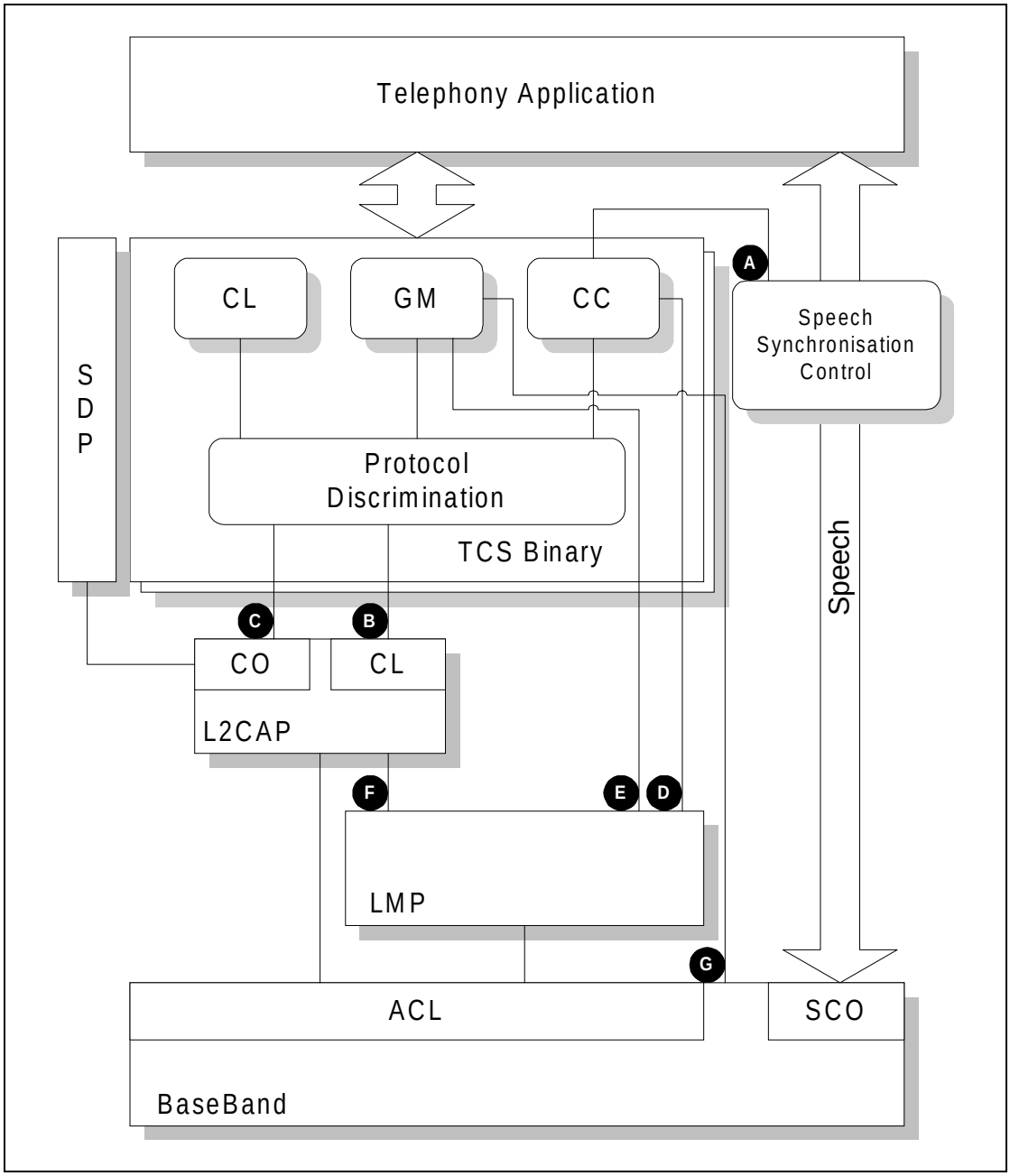


Figure 1.4: TCS Architecture

The internal structure of TCS Binary contains the functional entities Call Control, Group Management and ConnectionLess as described in Section 1.1 on page 449, complemented with the Protocol Discrimination which, based upon the TCS internal protocol discriminator, routes traffic to the appropriate functional entity.

To handle more calls simultaneously, multiple instances of TCS Binary may exist at the same time. Discrimination between the multiple instances can be based on the L2CAP channel identifier.

TCS Binary interfaces with a number of other (Bluetooth) entities to provide its (telephone) services to the application. The interfaces are identified in Figure 1.4 above, and information is exchanged across these interfaces for the following purposes:

A The Call Control entity provides information to the speech synchronization control about when to connect (disconnect) the speech paths. This information is based upon the call control messages (e.g. reception of CONNECT ACKNOWLEDGE or DISCONNECT, see Section 2 on page 453)

B To send a SETUP message (see Section 2.2.1 on page 453) using point-to-multipoint signalling, it is delivered on this interface to L2CAP for transmission on the connectionless channel. The other way round – L2CAP uses this interface to inform TCS of a SETUP message received on the connectionless channel. The connectionless L2CAP channel maps onto the piconet broadcast

C Whenever a TCS message needs to be sent using point-to-point signalling, it is delivered on this interface to L2CAP for transmission on a connection-oriented channel. During L2CAP channel establishment specific quality of service to be used for the connection will be indicated, in particular the usage of low power modes (L2CAP will inform LMP about this – interface F)

D The Call Control entity controls the LMP directly, for the purpose of establishing and releasing SCO links

E & G. The Group Management entity controls the LMP and LC/Baseband directly during initialization procedures to control (for example) the inquiry, paging and pairing.

2 CALL CONTROL (CC)

2.1 CALL STATES

The call states used by the TCS are those identified in Q.931[1], for the user side only. To allow for implementation within computing power- and memory-restricted devices, only a subset of the states is mandatory for TCS based implementations. This mandatory subset is termed **Lean TCS**.

The states are named as follows. States in bold are mandatory states, part of Lean TCS:

General States
- ***Null (0)***
- ***Active (10)***
- ***Disconnect request (11)***
- ***Disconnect indication (12)***
- ***Release request (19)***

Outgoing Side States
- ***Call initiated (1)***
- *Overlap sending (2)*
- *Outgoing call proceeding (3)*
- *Call delivered (4)*

Incoming Side States
- ***Call present (6)***
- *Call received (7)*
- ***Connect request (8)***
- *Incoming call proceeding (9)*
- *Overlap receiving (25)*

These states, together with the state transitions, have been indicated in the state diagram contained in Appendix 1 – TCS Call States. For clarity, a separate state diagram has been included for Lean TCS.

2.2 CALL ESTABLISHMENT

A connection-oriented L2CAP channel between the Outgoing and Incoming Side shall be available before any of the CC procedures can operate.

Additionally, in a multi-point configuration (see Section 1.2 on page 449), a connectionless L2CAP channel shall be available between the Outgoing and Incoming Side.

2.2.1 Call Request

The Outgoing Side initiates call establishment by sending a SETUP message, and starting timer T303.

In case of a single-point configuration (see Section 1.2 on page 449), the SETUP message is delivered on the connection-oriented channel.

In case of a multi-point configuration (see Section 1.2 on page 449), the SETUP message may be delivered on the connection-less channel. This causes the SETUP message to be transmitted as a broadcast message at every beacon instant (as described in Baseband Specification Section 10.8.4 on page 112).

If no response (as prescribed in Section 2.2.4 on page 455) is received from the Incoming Side before timer T303 expires, the Outgoing Side shall:

1. If the SETUP message was delivered on a connection-less channel, return to the Null state. This stops the transmission of the SETUP message.
2. If the SETUP message was delivered on a connection-oriented channel, send a RELEASE COMPLETE message to the Incoming Side. This message should contain cause # 102, *recovery on timer expiry*.

The SETUP message shall always contain the call class. It shall also contain all the information required by the Incoming Side to process the call. The number digits within the Called party number information element may optionally be incomplete, thus requiring the use of overlap sending (Section 2.2.3 on page 455). The SETUP message may optionally contain the Sending complete information element in order to indicate that the number is complete.

Following the transmission of the SETUP message, the Outgoing Side shall enter the Call initiated state. On receipt of the SETUP message the Incoming Side shall enter the Call present state.

2.2.2 Bearer selection

The SETUP message sent during the Call Request may contain the Bearer capability information element, to indicate the requested bearer. The Incoming Side may negotiate on the requested bearer by including a Bearer capability information element in the first message in response to the SETUP message.

The Bearer capability information element indicates which lower layer resources (the *bearer channel*) are used during a call. If bearer capability 'Synchronous Connection-Oriented (SCO) ' is indicated, an SCO link will be used, with the indicated packet type and voice coding to enable speech calls. If bearer capability 'Asynchronous Connection-Less (ACL)' is indicated, an ACL link will be used. On top of this, there will be an L2CAP channel with indicated QoS requirements, to enable data calls. If bearer capability 'None' is indicated, no separate bearer channel will be established.

Note: it is the responsibility of the implementation to assure that the bearer capability as indicated is available to the call.

2.2.3 Overlap Sending

If the received SETUP message does not contain a Sending complete indication information element, and contains either –

a) incomplete called-number information, or

b) called-number information which the Incoming Side cannot determine to be complete,

then the Incoming Side shall start timer T302, send a SETUP ACKNOWLEDGE message to the Outgoing Side, and enter the Overlap receiving state.

When the SETUP ACKNOWLEDGE message is received, the Outgoing Side shall enter the Overlap sending state, stop timer T303, and start timer T304.

After receiving the SETUP ACKNOWLEDGE message, the Outgoing Side shall send the remainder of the call information (if any) in the called party number information element of one or more INFORMATION messages.

The Outgoing Side shall restart timer T304 when each INFORMATION message is sent.

The INFORMATION message, which completes the information sending, may contain a sending complete information element. The Incoming Side shall restart timer T302 on receipt of every INFORMATION message not containing a sending complete indication, if it cannot determine that the called party number is complete.

At the expiry of timer T304, the Outgoing Side shall initiate call clearing in accordance with Section 2.3.1 with cause #102, *recovery on timer expiry*.

At the expiry of timer T302, the Incoming Side shall:

- if it determines that the call information is incomplete, initiate call clearing in accordance with Section 2.3.1 with cause #28, *invalid number format*.
- otherwise the Incoming Side shall reply with a CALL PROCEEDING, ALERTING or CONNECT message.

2.2.4 Call Proceeding

2.2.4.1 Call proceeding, enbloc sending

If enbloc sending is used (i.e. the Incoming Side can determine it has received sufficient information in the SETUP message from the Outgoing Side to establish the call) the Incoming Side shall send a CALL PROCEEDING message to the Outgoing Side to acknowledge the SETUP message and to indicate that the call is being processed. Upon receipt of the CALL PROCEEDING message, the Outgoing Side shall enter the Outgoing Call proceeding state stop

timer T303 and start timer T310. After sending the CALL PROCEEDING message, the Incoming Side shall enter the Incoming Call proceeding state.

2.2.4.2 Call proceeding, overlap sending

Following the occurrence of one of these conditions –

- the receipt by the Incoming Side of a Sending complete indication, or
- analysis by the Incoming Side that all call information necessary to effect call establishment has been received,

the Incoming Side shall send a CALL PROCEEDING message to the Outgoing Side, stop timer T302, and enter the Incoming Call proceeding state.

When the Outgoing Side receives of the CALL PROCEEDING message it shall enter the Outgoing Call proceeding state, stop timer T304 and, if applicable, start timer T310.

2.2.4.3 Expiry of timer T310

On expiry of T310 (i.e. if the Outgoing Side does not receive an ALERTING, CONNECT, DISCONNECT or PROGRESS message), the Outgoing Side shall initiate call clearing in accordance with Section 2.3.1 on page 460 with cause #102, *recovery on timer expiry*.

2.2.5 Call Confirmation

Upon receiving an indication that user alerting has been initiated at the called address, the Incoming Side shall send an ALERTING message, and shall enter the Call received state.

When the Outgoing Side receives the ALERTING message, the Outgoing Side may begin an internally generated alerting indication and shall enter the Call delivered state. The Outgoing Side shall stop timer T304 (in case of overlap receiving), stop timer T303 or T310 (if running), and start timer T301 (unless another internal altering supervision timer function exists).

On expiry of T301, the Outgoing Side shall initiate call clearing in accordance with Section 2.3.1 on page 460 with cause #102, *recovery on timer expiry*.

2.2.6 Call Connection

An Incoming Side indicates acceptance of an incoming call by sending a CONNECT message to the Outgoing Side, and stopping the user alerting. Upon sending the CONNECT message the Incoming Side shall start timer T313.

On receipt of the CONNECT message, the Outgoing Side shall stop any internally generated alerting indications, shall stop (if running) timers T301, T303, T304, and T310, shall complete the requested bearer channel to the Incoming Side, shall send a CONNECT ACKNOWLEDGE message, and shall enter the Active state.

The CONNECT ACKNOWLEDGE message indicates completion of the requested bearer channel. Upon receipt of the CONNECT ACKNOWLEDGE message, the Incoming Side shall connect to the bearer channel, stop timer T313 and enter the Active state.

When timer T313 expires prior to the receipt of a CONNECT ACKNOWLEDGE message, the Incoming Side shall initiate call clearing in accordance with Section 2.3.1 on page 460 with cause #102, *recovery on timer expiry*.

2.2.7 Call Information

While in the Active state, both sides may exchange any information related to the ongoing call using INFORMATION messages.

2.2.8 Non-selected user clearing

When the call has been delivered on a connection-less channel (in case of a multi-point configuration), in addition to sending a CONNECT ACKNOWLEDGE message to the Incoming Side selected for the call, the Outgoing Side shall send a RELEASE message (indicating cause #26, *non-selected user clearing*) to all other Incoming Sides that have sent SETUP ACKNOWLEDGE, CALL PROCEEDING, ALERTING, or CONNECT messages in response to the SETUP message. These RELEASE messages are used to notify the Incoming Sides that the call is no longer offered to them.

2.2.9 In-band tones and announcements

When the Incoming Side provides in-band tones/announcements, and if the requested bearer implies speech call, the Incoming Side will first complete the bearer channel (if not already available). Then a progress indicator #8, *in-band information or appropriate pattern is now available* is sent simultaneously with the application of the in-band tone/announcement. This progress indicator may be included in any call control message that is allowed to contain the progress indicator information element or, if there is no call state change, in a dedicated PROGRESS message.

Upon receipt of this message, the Outgoing Side may connect (if not already connected) to the bearer channel to receive the in-band tone/announcement.

2.2.10 Failure of call establishment

In the Call present, Overlap receiving, Incoming call proceeding, or Call received states, the Incoming Side may initiate clearing as described in Section 2.3 on page 460 with a cause value indicated. Examples of some the cause values that may be used to clear the call, when the Incoming Side is in the Call present, Overlap receiving, or Incoming call proceeding state are the following:

#1 unassigned (unallocated) number
#3 no route to destination
#17 user busy
#18 no user responding
#22 number changed
#28 invalid number format (incomplete number)
#34 no circuit/channel available
#44 requested circuit/channel not available
#58 bearer capability not presently available
#65 bearer capability not implemented

Examples of two of the cause values that may be used to clear the call when the Incoming Side is in the Call received state are as follows:

#19 no answer from user (user alerted)
#21 call rejected by user

2.2.11 Call Establishment Message Flow

The figure below provides a complete view of the messages exchanged during successful Call Establishment, as described in the sections above. The mandatory messages, part of the Lean TCS, are indicated by a solid arrow. A dotted arrow indicates the optional messages. A triangle indicates a running timer.

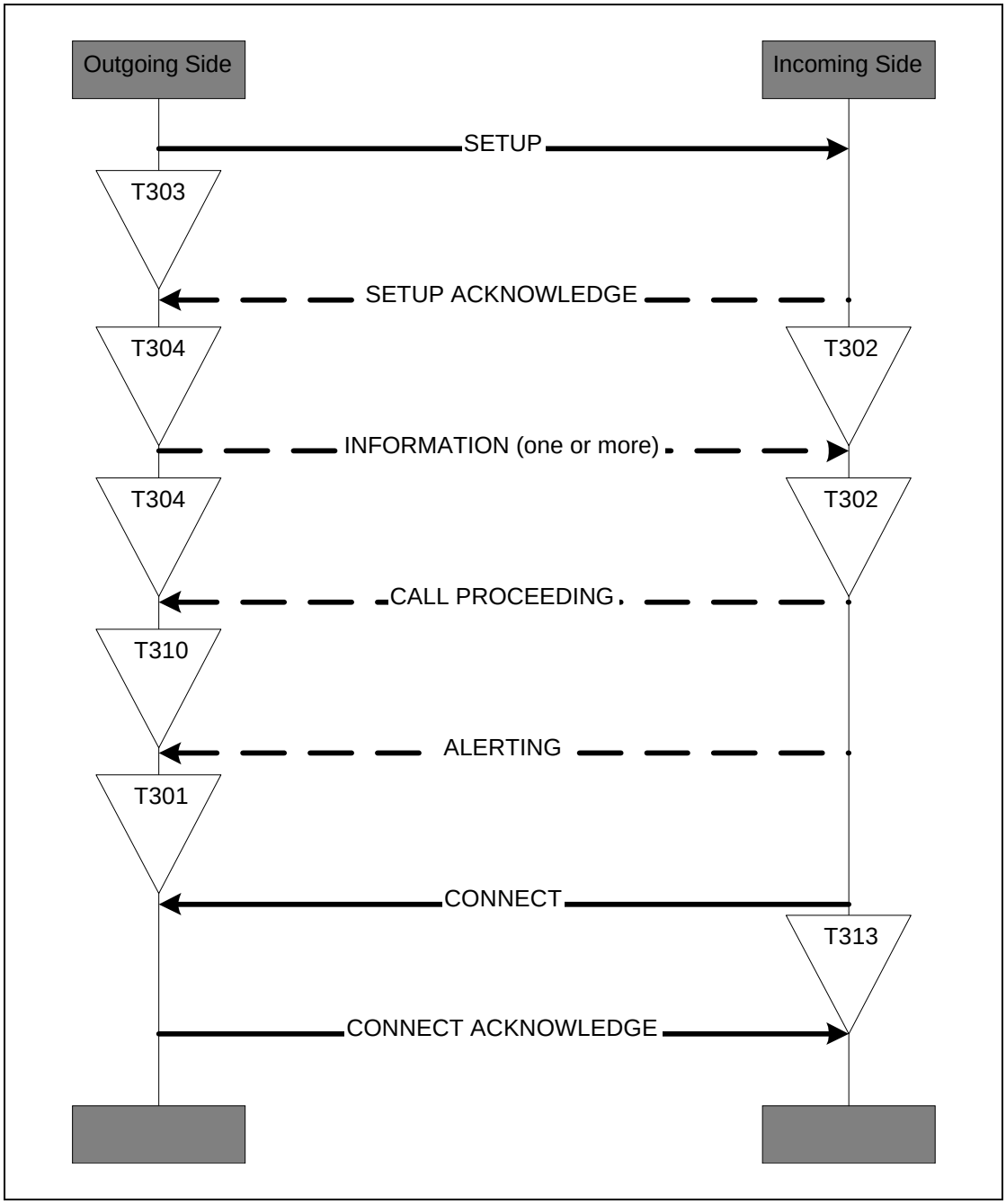


Figure 2.1: Call establishment message flow

2.3 CALL CLEARING

2.3.1 Normal Call Clearing

Apart from the exceptions identified in Section 2.3.2 on page 461, the clearing procedures are symmetrical and may be initiated by either the Outgoing or the Incoming Side. In the interest of clarity, the following procedures describe only the case where the Outgoing Side initiates clearing.

On sending or receiving any call clearing message, any protocol timer other than T305 and T308 shall be stopped.

The Outgoing Side shall initiate clearing by sending a DISCONNECT message, starting timer T305, disconnecting from the bearer channel, and entering the Disconnect request state.

The Incoming Side shall enter the Disconnect indication state upon receipt of a DISCONNECT message. This message prompts the Incoming Side to disconnect from the bearer channel. Once the channel used for the call has been disconnected, the Incoming Side shall send a RELEASE message to the Outgoing Side, start timer T308, and enter the Release request state.

On receipt of the RELEASE message the Outgoing Side shall cancel timer T305, release the bearer channel, send a RELEASE COMPLETE message, and return to the Null state.

Following the receipt of a RELEASE COMPLETE message from the Outgoing Side, the Incoming Side shall stop timer T308, release the bearer channel, and return to the Null state.

If the Outgoing Side does not receive a RELEASE message in response to the DISCONNECT message before timer T305 expires, it shall send a RELEASE message to the Incoming Side with the cause number originally contained in the DISCONNECT message, start timer T308 and enter the Release request state.

If in the Release request state, a RELEASE COMPLETE message is not received before timer T308 expires, the side that expected the message shall return to the Null state.

Clearing by the called user employing user-provided tones/announcements

In addition to the procedures described above, if the requested bearer signals a speech call, the Outgoing Side may apply in-band tones/announcements in the clearing phase. When in-band tones/announcements are provided, the Outgoing Side will first complete the bearer channel (if not already available), and next send the DISCONNECT message containing progress indicator *#8, in-band information or appropriate pattern is now available* .

Upon receipt of this message, the Incoming Side may connect (if not already connected) to the bearer channel to receive the in-band tone/announcement, and enter the Disconnect indication state.

The Incoming Side may subsequently continue clearing (before the receipt of a RELEASE from the Outgoing Side) by disconnecting from the bearer channel, sending a RELEASE message, starting timer T308, and entering the Release request state.

2.3.2 Abnormal Call Clearing

Under normal conditions, call clearing is initiated when either side sends a DISCONNECT message and follows the procedures defined in Section 2.3.1 on page 460. The only exceptions to the above rule are as follows:

a In response to a SETUP message, the Incoming Side can reject a call (e.g. because of unavailability of suitable resources) by responding with a RELEASE COMPLETE message provided no other response has previously been sent, and enter the Null state

b In case of a multi-point configuration, non-selected user call clearing will be initiated with RELEASE message(s) from the Outgoing Side (Section 2.2.8 on page 457)

c In case of a multi-point configuration, where the SETUP message is delivered on an connection-less channel, if a remote (calling) user disconnect indication is received during call establishment, any Incoming Side which has responded, or subsequently responds, shall be cleared by a RELEASE message, and the procedures of Section 2.3.1 on page 460 are then followed for that user. The Outgoing Side enters the Null state upon completion of clearing procedures for all responding Incoming Sides.

2.3.3 Clear Collision

Clear collision occurs when the Incoming and the Outgoing Sides simultaneously transfer DISCONNECT messages. When either side receives a DISCONNECT message while in the Disconnect request state, the side shall stop timer T305, disconnect the bearer channel (if not disconnected), send a RELEASE message, start timer T308, and enter the Release request state.

Clear collision can also occur when both sides simultaneously transfer RELEASE messages. The entity receiving such a RELEASE message while within the Release request state shall stop timer T308, release the bearer channel, and enter the Null state (without sending or receiving a RELEASE COMPLETE message).

2.3.4 Call Clearing Message Flow

The figure below provides the complete view on the messages exchanged during normal Call Clearing, as described in the sections above. All messages are mandatory.

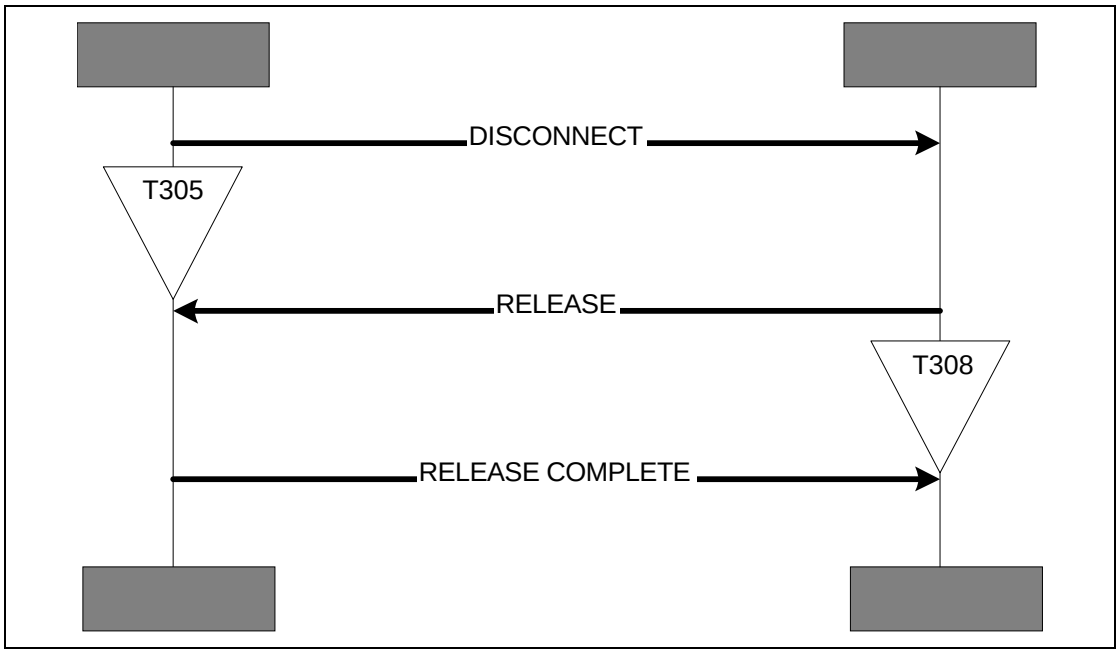


Figure 2.2: Call clearing message flow

3 GROUP MANAGEMENT (GM)

3.1 OVERVIEW

The Group Management entity provides procedures for managing a group of devices.

The following procedures are supported:

- Obtain access rights (Section 3.3 on page 465)
  enables the requesting device to use the telephony services of another device, part of a group of devices
- Configuration distribution (Section 3.4 on page 466)
  facilitates the handling and operation of a group of devices
- Fast inter-member access (Section 3.5 on page 467)
  enables faster contact establishment between devices of the same group

A connection-oriented L2CAP channel between devices shall be available before any of the GM procedures can operate.

For group management, the concept of Wireless User Group (WUG) is used.

3.2 THE WIRELESS USER GROUP

3.2.1 Description

A WUG consists of a number of Bluetooth units supporting TCS. One of the devices is called the WUG master. The WUG master is typically a gateway, providing the other Bluetooth devices – called WUG members – with access to an external network. All members of the WUG in range are members of a piconet (active or parked). Master of this piconet is always the WUG master.

The main relational characteristics of a WUG are:

- All units that are part of a WUG know which unit is the WUG master and which other units are member of this WUG. WUG members receive this information from the WUG master.
- When a new unit has paired with the WUG master, it is able to communicate and perform authentication and encryption with any other unit part of the WUG without any further pairing/initialization. The WUG master provides the required authentication and encryption parameters to the WUG members.

Both relational characteristics are maintained through the Configuration distribution procedure.

3.2.2 Encryption within the WUG

In order to allow for encrypted transmission on the connectionless L2CAP channel, the WUG master issues a temporary key (K_{master}). As a Bluetooth unit is not capable of switching between two or more encryption keys in real time, this key is normally also used for encrypted transmission on the connection-oriented channel (individually addressed traffic). Since the WUG master piconet may be in operation for extended periods without interruption, the K_{master} shall be changed periodically.

In order to allow for authentication and encryption to be performed between WUG members, the WUG master may use the Configuration distribution procedure to issue link keys that the WUG members use for communication with each other. Just as if pairing had created these keys, the keys are unique to a pair of WUG members and hence a WUG member uses a different key for every other WUG member it connects to.

The Configuration distribution shall always be performed using encrypted links. The K_{master} shall not be used for encryption; rather the WUG master shall ensure that the semi-permanent key for the specific WUG member addressed shall be used.

3.2.3 Unconscious pairing

For TCS, pairing a device with the WUG master implies pairing a device with all members of the WUG.This is achieved using the Configuration distribution procedure. This avoids the user of the device having to pair with each and every device of the WUG individually.

In Bluetooth, pairing is not related to a specific service but rather to a specific device. After pairing, all services provided by a device are accessible, if no further application- or device-specific protection is provided.

Without further provisions, pairing a device with the WUG master implies that all services provided by the new device are accessible to all other WUG members. And vice versa, without further provisions, the new device can access all services provided by other WUG members.

For this reason, implementers of TCS – and in particular the Configuration distribution procedure – are recommended to add provisions where:

1. a new device entering the WUG is not mandated to initiate the Obtain access rights procedure to become a WUG member, and is consequently only able to use the services provided by the WUG master (gateway)
2. a WUG master can reject a request to obtain access rights
3. a WUG member is not forced to accept the pairing information received during the Configuration distribution

This applies in particular to devices offering more than just TCS- related services.

3.3 OBTAIN ACCESS RIGHTS

Using the Obtain access rights procedure, a device can obtain the rights to use the telephony services provided by another device, part of a WUG.

3.3.1 Procedure description

A device requests access rights by sending an ACCESS RIGHTS REQUEST message and starting timer T401. Upon receipt of the ACCESS RIGHTS REQUEST message, the receiving device accepts the request for access rights by sending an ACCESS RIGHTS ACCEPT.

When the requesting device receives the ACCESS RIGHTS ACCEPT, it shall stop timer T401. Then, the access rights procedure has completed successfully.

If no response has been received before the expiration of timer T401, the requesting device shall consider the request for access rights to be denied.

If, upon receipt of the ACCESS RIGHTS REQUEST message, the receiving device is for some reason unable to accept the access rights, it shall reply with an ACCESS RIGHTS REJECT message. Upon receipt of an ACCESS RIGHTS REJECT message, the requesting device shall stop timer T401 and consider the request for access rights to be denied.

3.3.2 Message flow

The figure below provides the complete view on the messages exchanged during the Obtain access rights procedure.

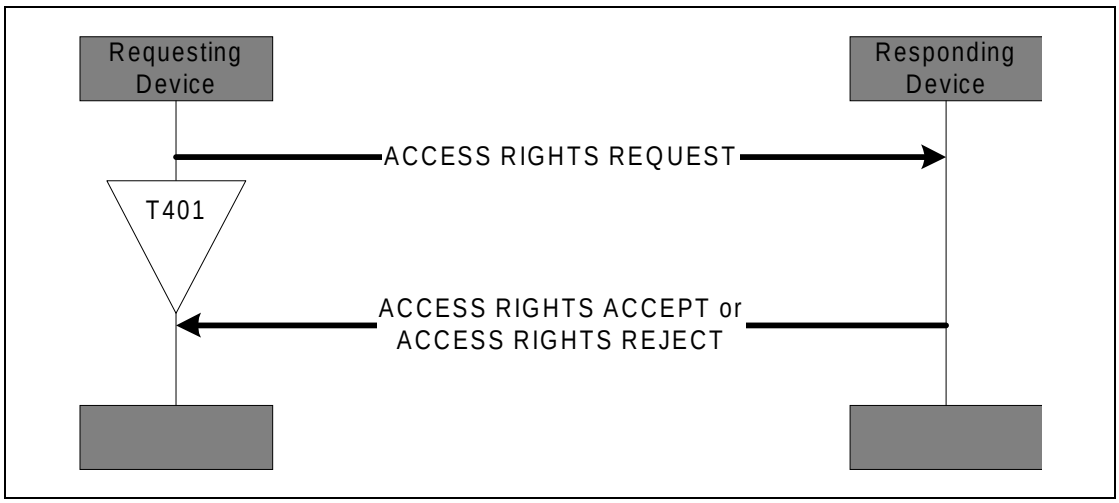


Figure 3.1: Obtain access rights message flow

3.4 CONFIGURATION DISTRIBUTION

The units in the WUG need to be informed about changes in the WUG; e.g. when a unit is added or removed. The Configuration distribution procedure is used to exchange this data.

When a WUG configuration change occurs, the WUG master initiates the Configuration distribution procedure on all WUG members. The WUG master keeps track of which WUG members have been informed of WUG configuration changes.

Some WUG members may be out of range and may therefore not be reached. The update of these WUG members will be performed when these members renew contact with the WUG master.

3.4.1 Procedure Description

The WUG master initiates the Configuration distribution procedure by starting timer T403, and transferring the INFO SUGGEST message. The INFO SUGGEST message contains the complete WUG configuration information. Upon receipt of the INFO SUGGEST message, the WUG member shall send an INFO ACCEPT message, to acknowledge the proper receipt of the WUG configuration information.

When the WUG master receives the INFO ACCEPT, the timer T401 is stopped, and the Configuration distribution procedure has completed successfully. On expiry of timer T403, the Configuration distribution procedure is terminated.

3.4.2 Message flow

The figure below provides the complete view on the messages exchanged during the Configuration distribution procedure, as described in the sections above.

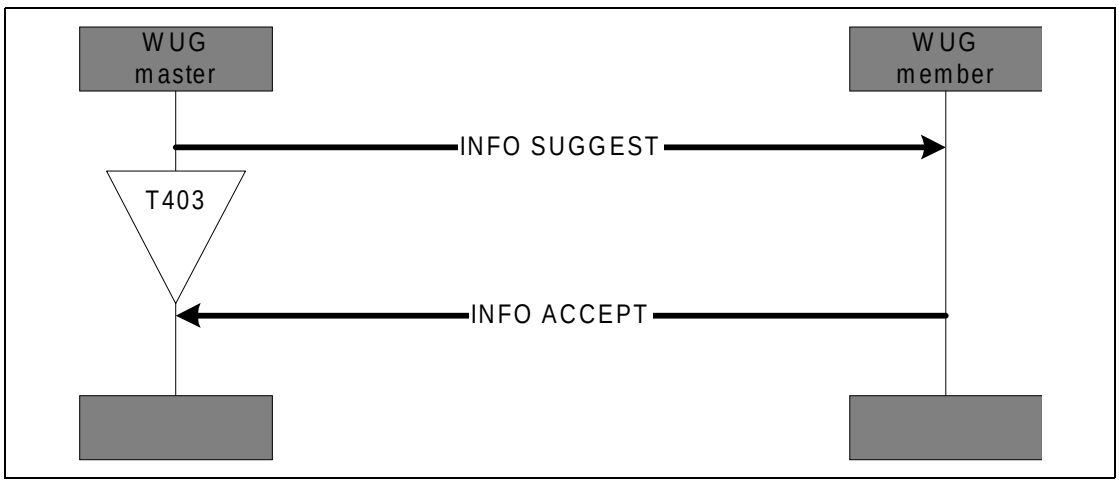


Figure 3.2: Configuration distribution message flow

3.5 FAST INTER-MEMBER ACCESS

When two WUG members are both active in the WUG master piconet, a WUG member can use the Fast inter-member access procedure to obtain fast access to another WUG member. With the Fast inter-member access procedure, the originating WUG member obtains clock information from the terminating WUG member and forces the terminating WUG member to go into PAGE_SCAN for a defined period (T406).

3.5.1 Listen Request

The originating WUG member initiates the Fast inter-member access procedure by starting timer T404 and transferring the LISTEN REQUEST message to the WUG master, indicating the WUG member with which it wishes to establish contact.

If, before expiry of timer T404, the originating WUG member receives no response to the LISTEN REQUEST message, the originating WUG member shall terminate the procedure.

3.5.2 Listen Accept

Upon receipt of the LISTEN REQUEST message, the WUG master checks that the indicated WUG member is part of the WUG. If this is the case, the WUG master initiates the Fast inter-member access towards the terminating WUG member side by starting timer T405 and sending the LISTEN SUGGEST message to the terminating WUG member.

Upon receipt of the LISTEN SUGGEST message, the terminating WUG member confirms the suggested action (internal call) by sending a LISTEN ACCEPT message to the WUG master. This message contains the terminating WUG member's clock offset. After sending the LISTEN ACCEPT, the terminating WUG member shall go to PAGE-SCAN state, for T406 seconds, to enable connection establishment by the originating WUG member.

Upon receipt of the LISTEN ACCEPT message, the WUG master stops timer T405, and informs the originating WUG member of the result of the WUG fast inter-member access by sending a LISTEN ACCEPT message. This message contains the terminating WUG member's clock offset. Upon receipt of the LISTEN ACCEPT message, the originating WUG member stops timer T404, and starts paging the terminating WUG member.

If no response to the LISTEN SUGGEST message is received by the WUG master before the first expiry of timer T405, then the WUG master shall terminate the Fast inter-member access procedure by sending a LISTEN REJECT message to both originating and terminating WUG member using cause #102, *recovery on timer expiry*.

3.5.3 Listen Reject by the WUG Master

If the WUG master rejects the Fast inter-member access procedure, it sends a LISTEN REJECT message to the originating WUG member.

Valid cause values are:
#1, *Unallocated (unassigned) number* (when the indicated WUG member is not part of the WUG)
#17, *User busy* (in case terminating WUG member is engaged in an external call)
#20, *Subscriber absent* (upon failure to establish contact with the terminating WUG member), or
any cause value indicated in a LISTEN REJECT message received from/sent to the terminating WUG member.

Upon receipt of the LISTEN REJECT message, the originating WUG member stops timer T404, and terminates the procedure.

3.5.4 Listen Reject by the WUG Member

If the terminating WUG member rejects the suggested action received in the LISTEN SUGGEST message, it sends a LISTEN REJECT message to the WUG master. Valid cause value is #17, *User busy* (in case terminating WUG member is engaged in another internal call).

Upon receipt of the LISTEN REJECT, the WUG master stops timer T405, and continues as described in Section 3.5.3 on page 468.

3.5.5 Message flow

The figure below provides a view of the messages exchanged during Fast inter-member access, as described in the sections above. A successful Fast inter-member access procedure ends with the terminating WUG member going into page scan, thus allowing the originating WUG member to contact him directly.

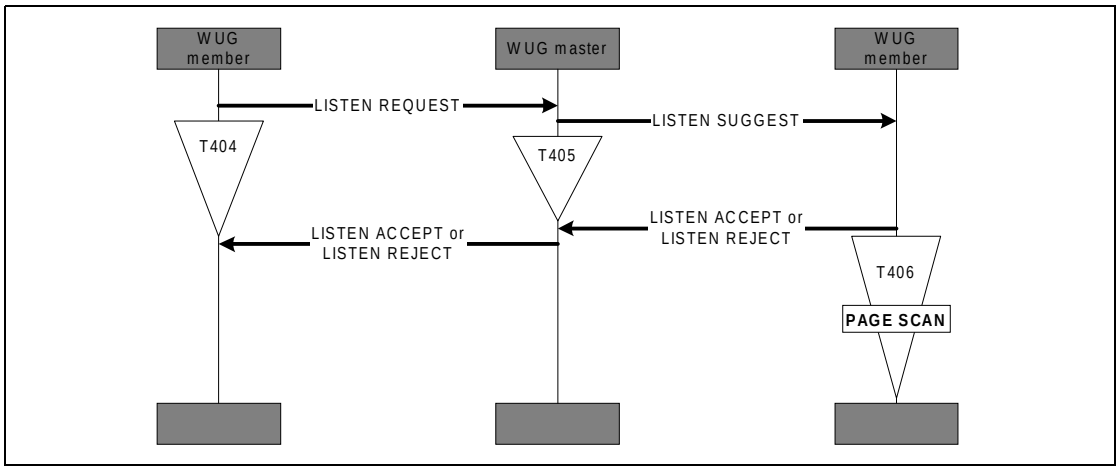


Figure 3.3: Fast inter-member access message flow

4 CONNECTIONLESS TCS (CL)

A connectionless TCS message can be used to exchange signalling information without establishing a TCS call. It is thus a connectionless service offered by TCS.

A connectionless TCS message is a CL INFO message (as defined in Section 6.3.1 on page 484).

A connection-oriented L2CAP channel between the Outgoing and Incoming Side shall be available before a CL INFO message can be sent.

Note: In the case of a connection-oriented channel, it may choose to delay the termination of the channel for a defined period to exchange more CL INFO messages.

Alternatively, in a multi-point configuration (see Section 1.2 on page 449), a connectionless L2CAP channel may be used and, if so, shall be available before a CL INFO can be sent.

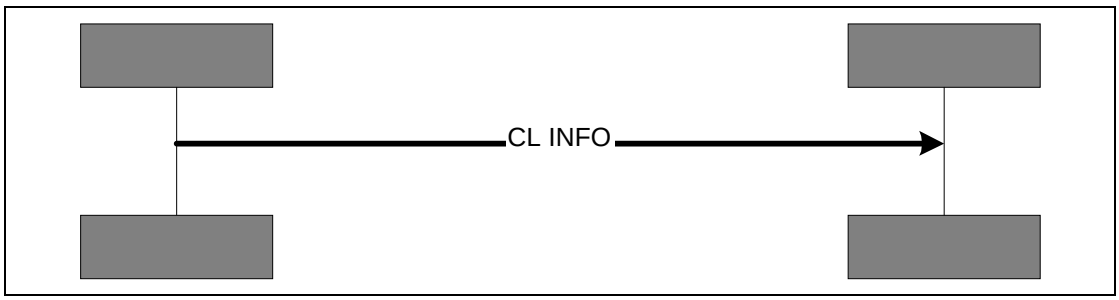


Figure 4.1: Connectionless TCS message flow

5 SUPPLEMENTARY SERVICES (SS)

The TCS provides explicit support for only one supplementary service, the Calling Line Identity (seeSection 5.1 on page 470).

For supplementary services provided by an external network, using DTMF sequences for the activation/de-activation and interrogation of supplementary services, the DTMF start & stop procedure is supported (see Section 5.2 on page 470). This procedure allows both finite and infinite tone lengths.

Section 5.3 on page 472 specifies how a specific supplementary service, provided by an external network, called register recall is supported.

For other means of supplementary service control, no explicit support is specified. Support may be realized by either using the service call, or use the company specific information element, or a combination.

5.1 CALLING LINE IDENTITY

To inform the Incoming Side of the identity of the originator of the call, the Outgoing Side may include the calling party number information element (see Section 7.4.6 on page 495) in the SETUP message transferred as part of the call request. If the CLIP information is first available after having sent the SETUP message, it is also allowed to send the CLIP information included in a INFORMATION message.

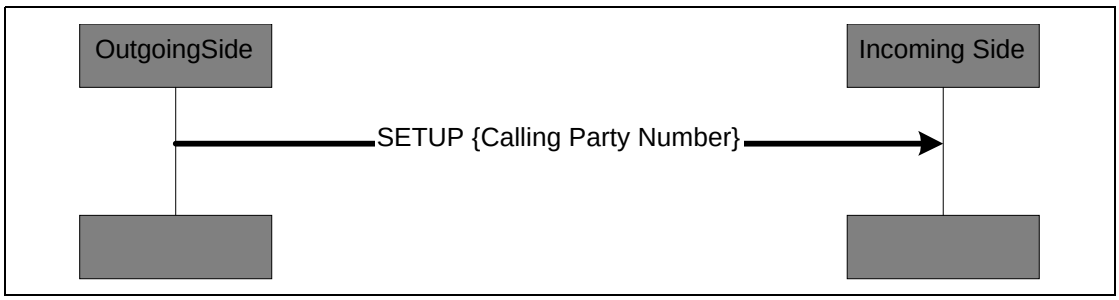


Figure 5.1: Calling line identity message flow

5.2 DTMF START & STOP

The DTMF start & stop procedure is supported to provide supplementary service control on PSTN type of networks.

In principle DTMF messages can be initiated by either (Outgoing or Incoming) Side; in practice, however, the Side (gateway) connected to the external PSTN network will be the recipient.

DTMF messages can be transmitted only in the active state of a call. Tone generation shall end when the call is disconnected.

5.2.1 Start DTMF request

A user may cause a DTMF tone to be generated; e.g. by depression of a key. The relevant action is interpreted as a requirement for a DTMF digit to be sent in a START DTMF message on an established signalling channel. This message contains the value of the digit to be transmitted (0, 1...9, A, B, C, D, *, #).

Only a single digit will be transferred in each START DTMF message.

5.2.2 Start DTMF response

The side receiving the START DTMF message will reconvert the received digit back into a DTMF tone which is applied toward the remote user, and return a START DTMF ACKNOWLEDGE message to the initiating side. This acknowledgment may be used to generate an indication as a feedback for a successful transmission.

If the receiving side cannot accept the START DTMF message, a START DTMF REJECT message will be sent to the initiating side, using cause #29, *Facility rejected*, indicating that sending DTMF is not supported by the external network.

5.2.3 Stop DTMF request

When the user indicates the DTMF sending should cease (e.g. by releasing the key) the initiating side will send a STOP DTMF message to the other side.

5.2.4 Stop DTMF response

Upon receiving the STOP DTMF message, the receiving side will stop sending the DTMF tone (if still being sent) and return a STOP DTMF ACKNOWLEDGE message to the initiating side.

5.2.5 Message flow

The figure below provides a view of the messages exchanged when a single DTMF tone needs to be generated.

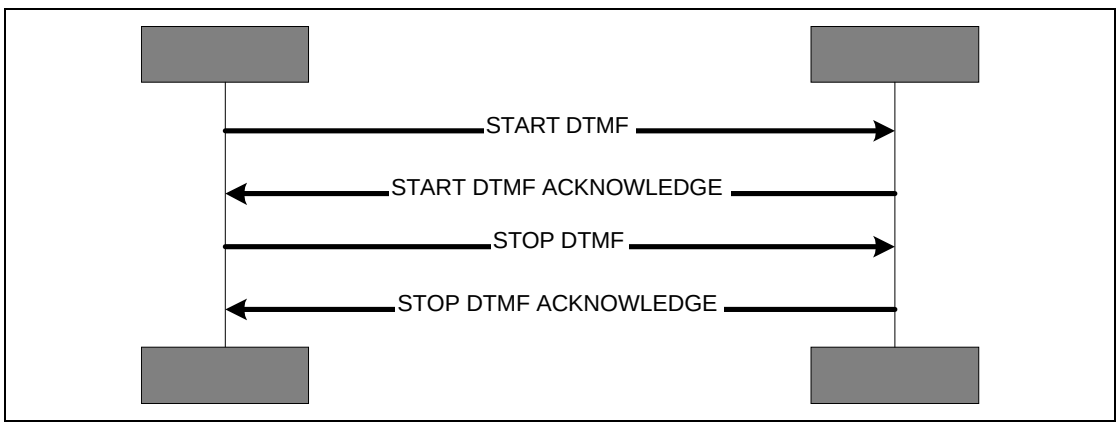


Figure 5.2: DTMF start & stop message flow

5.3 REGISTER RECALL

Register recall means to seize a register (with dial tone) to permit input of further digits or other action. In some markets, this is referred to as 'hook flash'. Register recall is supported by sending an INFORMATION message with a keypad facility information element, indicating 'register recall' (value 16H). Further digits are sent using the procedures as indicated in Section 5.2 above.

6 MESSAGE FORMATS

This section provides an overview of the structure of messages used in this specification, and defines the function and information contents (i.e. semantics) of each message.

Whenever a message is sent according to the procedures of Sections 2, 3 and 4, it shall contain the mandatory information elements, and optionally any combination of the optional information elements specified in this section for that message.

A message shall always be delivered in a single L2CAP packet. The start of a message (the LSB of the first octet) shall be aligned with the start of the L2CAP payload.

Each definition includes:

a) A brief description of the message direction and use

b) A table listing the information elements in order of their appearance in the message (same relative order for all message types)

c) Indications for each information element in the table, specifying –

- the section of this specification describing the information element
- whether inclusion in mandatory (’M’) or optional (’O’)
- the length (or length range) of the information element, where ’*’ denotes an undefined maximum length which may be application dependent.

d) Further explanatory notes, as necessary

All message formats are denoted in octets.

6.1 CALL CONTROL MESSAGE FORMATS

6.1.1 ALERTING

This message is sent by the incoming side to indicate that the called user alerting has been initiated.

Message Type: ALERTING

Direction: incoming to outgoing

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Bearer capability	7.4.3	O Note 1)	4(26)
Progress indicator	7.4.13	O	2
SCO Handle	7.4.14	O	2
Destination CID	7.4.11	O	4
Company specific	7.4.9	O	3-*

Table 6.1: ALERTING message content

Note 1: Allowed only in the first message sent by the incoming side.

6.1.2 CALL PROCEEDING

This message is sent by the incoming side to indicate that the requested call establishment has been initiated and no more call establishment information will be accepted.

Message Type: CALL PROCEEDING

Direction: incoming to outgoing

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Bearer capability	7.4.3	O Note 1)	4(26)
Progress indicator	7.4.13	O	2
SCO Handle	7.4.14	O	2
Destination CID	7.4.11	O	4
Company specific	7.4.9	O	3-*

Table 6.2: CALL PROCEEDING message content

Note 1: Allowed only in the first message sent by the incoming side.

6.1.3 CONNECT

This message is sent by the incoming side to indicate call acceptance by the called user.

Message Type: CONNECT

Direction: incoming to outgoing

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Bearer capability	7.4.3	O[Note 1)]	4(26)
SCO Handle	7.4.14	O	2
Company specific	7.4.9	O	3-*

Table 6.3: CONNECT message content

Note 1: Allowed only in the first message sent by the incoming side.

6.1.4 CONNECT ACKNOWLEDGE

This message is sent by the outgoing side to acknowledge the receipt of a CONNECT message.

Message Type: CONNECT ACKNOWLEDGE

Direction: outgoing to incoming

Information Element	Ref.	Type	Length
Message type	7.3	M	1
SCO Handle	7.4.14	O	2
Destination CID	7.4.11	O	4
Company specific	7.4.9	O	3-*

Table 6.4: CONNECT ACKNOWLEDGE message content

6.1.5 DISCONNECT

This message is sent by either side as an invitation to terminate the call.

Message Type: DISCONNECT

Direction: both

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Cause	7.4.7	O	2
Progress indicator	7.4.13	O	2
SCO Handle	7.4.14	O	2
Destination CID	7.4.11	O	4
Company specific	7.4.9	O	3-*

Table 6.5: DISCONNECT message content

6.1.6 INFORMATION

This message is sent by either side to provide additional information during call establishment (in case of overlap sending).

Message Type: INFORMATION

Direction: both

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Sending complete	7.4.15	O	1
Keypad facility	7.4.12	O	2
Calling party number	7.4.6	O	3-*
Called party number	7.4.5	O	3-*
Audio control	7.4.2	O	3-*
Company specific	7.4.9	O	3-*

Table 6.6: INFORMATION message content

6.1.7 PROGRESS

This message is sent by the incoming side to indicate the progress of a call in the event of interworking or by either side in the call with the provision of optional in-band information/patterns.

Message Type: PROGRESS

Direction: incoming to outgoing

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Progress indicator	7.4.13	M	2
SCO Handle	7.4.14	O	2
Destination CID	7.4.11	O	4
Company specific	7.4.9	O	3-*

Table 6.7: PROGRESS message content

6.1.8 RELEASE

This message is used to indicate that the device sending the message had disconnected the channel (if any) and intends to release the channel, and that receiving device should release the channel after sending RELEASE COMPLETE.

Message Type: RELEASE

Direction: both

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Cause	7.4.7	O[Note 1)]	2
SCO Handle	7.4.14	O	2
Company specific	7.4.9	O	3-*

Table 6.8: RELEASE message content

Note 1: Mandatory in the first call clearing message.

6.1.9 RELEASE COMPLETE

This message is used to indicate that the device sending the message has released the channel (if any), and that the channel is available for re-use.

Message Type: RELEASE COMPLETE

Direction: both

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Cause	7.4.7	O[Note 1)]	2
SCO Handle	7.4.14	O	2
Company specific	7.4.9	O	3-*

Table 6.9: RELEASE COMPLETE message content

Note 1: Mandatory in the first call clearing message.

6.1.10 SETUP

This message is sent by the outgoing side to initiate call establishment.

Message Type:

Direction:

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Call class	7.4.4	M	2
Sending complete	7.4.15	O	1
Bearer capability	7.4.3	O	4(26)
Signal	7.4.16	O	2
Calling party number	7.4.6	O	3-*
Called party number	7.4.5	O	3-*
Company specific	7.4.9	O	3-*

Table 6.10: SETUP message content

6.1.11 SETUP ACKNOWLEDGE

This message is sent by the incoming side to indicate that call establishment has been initiated, but additional information may be required.

Message Type: SETUP ACKNOWLEDGE

Direction: incoming to outgoing

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Bearer capability	7.4.3	O[Note 1)]	4(26)
Progress indicator	7.4.13	O	2
SCO Handle	7.4.14	O	2
Destination CID	7.4.11	O	4
Company specific	7.4.9	O	3-*

Table 6.11: SETUP ACKNOWLEDGE message content

Note 1: Allowed only in the first message sent by the incoming side.

6.1.12 Start DTMF

This message contains the digit the other side should reconvert back into a DTMF tone, which is then applied towards the remote user.

Message Type: Start DTMF

Direction: both

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Keypad facility	7.4.12	M	2

Table 6.12: Start DTMF message content

6.1.13 Start DTMF Acknowledge

This message is sent to indicate the successful initiation of the action required by the Start DTMF message.

Message Type: Start DTMF Acknowledge

Direction: both

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Keypad facility	7.4.12	M	2

Table 6.13: Start DTMF Acknowledge message content

6.1.14 Start DTMF Reject

This message is sent to indicate that the other side cannot accept the Start DTMF message.

Message Type: Start DTMF Reject

Direction: both

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Cause	7.4.7	O	2

Table 6.14: Start DTMF Reject message content

6.1.15 Stop DTMF

This message is used to stop the DTMF tone sent towards the remote user.

Message Type: Stop DTMF

Direction: both

Information Element	Ref.	Type	Length
Message type	7.3	M	1

Table 6.15: Stop DTMF message content

6.1.16 Stop DTMF Acknowledge

This message is sent to indicate that the sending of the DTMF tone has been stopped.

Message Type: Stop DTMF Acknowledge

Direction: both

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Keypad facility	7.4.12	M	2

Table 6.16: Stop DTMF Acknowledge message content

6.2 GROUP MANAGEMENT MESSAGE FORMATS

6.2.1 ACCESS RIGHTS REQUEST

This message is sent by the initiating side to obtain access rights.

Message Type: ACCESS RIGHTS REQUEST

Direction:

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Company specific	7.4.9	O	3-*

Table 6.17: ACCESS RIGHTS REQUEST message content

6.2.2 ACCESS RIGHTS ACCEPT

This message is sent by the responding side to indicate granting of access rights.

Message Type: ACCESS RIGHTS ACCEPT

Direction:

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Company specific	7.4.9	O	3-*

Table 6.18: ACCESS RIGHTS ACCEPT message content

6.2.3 ACCESS RIGHTS REJECT

This message is sent by the responding side to indicate denial of access rights.

Message Type: ACCESS RIGHTS REJECT

Direction:

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Company specific	7.4.9	O	3-*

Table 6.19: ACCESS RIGHTS REJECT message content

6.2.4 INFO SUGGEST

This message is sent by the WUG master to indicate that a change has occurred in the WUG configuration.

Message Type: INFO SUGGEST

Direction: WUG master to WUG member

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Configuration Data	7.4.10	M	*
Company specific	7.4.9	O	3-*

Table 6.20: INFO SUGGEST message content

6.2.5 INFO ACCEPT

This message is sent by the WUG member to indicate the acceptance of the updated WUG configuration.

Message Type: INFO ACCEPT

Direction: WUG member to WUG master

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Company specific	7.4.9	O	3-*

Table 6.21: INFO ACCEPT message content

6.2.6 LISTEN REQUEST

This message is sent by a WUG member to indicate to the WUG master the request for a Fast inter-member access to the indicated WUG member.

Message Type: LISTEN REQUEST

Direction: WUG member to WUG master

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Called party number	7.4.6	M	3-*
Company specific	7.4.9	O	3-*

Table 6.22: LISTEN REQUEST message content

6.2.7 LISTEN SUGGEST

This message is sent by a WUG master to indicate to the WUG member the request for a Fast inter-member access.

Message Type: LISTEN SUGGEST

Direction: WUG master to WUG member

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Company specific	7.4.9	O	3-*

Table 6.23: LISTEN SUGGEST message content

6.2.8 LISTEN ACCEPT

This message is sent to indicate the acceptance of the previous request for a Fast inter-member access.

Message Type: LISTEN ACCEPT

Direction: both

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Clock offset	7.4.8	O	4
Company specific	7.4.9	O	3-*

Table 6.24: LISTEN ACCEPT message content

6.2.9 LISTEN REJECT

This message is sent to indicate the rejection of the previous request for a Fast inter-member access.

Message Type: LISTEN REJECT

Direction: both

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Cause	7.4.7	O	2
Company specific	7.4.9	O	3-*

Table 6.25: LISTEN REJECT message content

6.3 TCS CONNECTIONLESS MESSAGE FORMATS

6.3.1 CL INFO

This message is sent by either side to provide additional information in a connectionless manner.

Message Type: CL INFO

Direction: both

Information Element	Ref.	Type	Length
Message type	7.3	M	1
Audio control	7.4.2	O	3-*
Company specific	7.4.9	O	3-*

Table 6.26: CL INFO message content

7 MESSAGE CODING

The figures and text in this section describe message contents. Within each octet, the bit designated ’bit 1’ is transmitted first, followed by bit 2, 3, 4, etc. Similarly, the octet shown at the top of the figure is sent first.

Whenever a message is sent, according to the procedures of Sections 2, 3 and 4, it shall be coded as specified in this section.

7.1 OVERVIEW

The coding rules follow ITU-T Recommendation Q.931, but is tailored to the specific needs of TCS.

Every message consists of:

a) Protocol discriminator

b) Message type, and

c) Other information elements, as required

The Protocol discriminator and Message type is part of every TCS message, while the other information elements are specific to each message type.

8	7	6	5	4	3	2	1	
Protocol discriminator			Message type					octet 1
Other information elements as required								octet 2

Table 7.1: General message format

A particular information element shall be present only once in a given message.

The term ’default’ implies that the value defined shall be used in the absence of any assignment or negotiation of alternative values.

For notation purposes – when a field extends over more than one octet, the order of bit values progressively decreases as the octet number increases. The least significant bit of the field is represented by the lowest numbered bit of the highest-numbered octet of the field. In general, bit 1 of each octet contains the least significant bit of a field.

7.2 PROTOCOL DISCRIMINATOR

The purpose of the protocol discriminator is to distinguish the TCS messages into different functional groups. The protocol discriminator is the first part of every message.

The protocol discriminator is coded according to Figure 7.1 and Table 7.2.

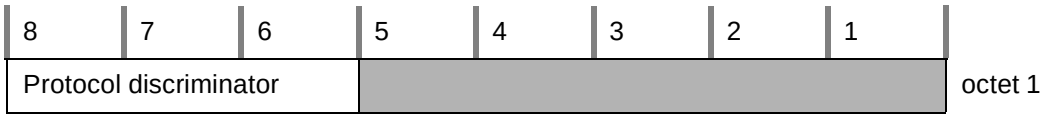


Figure 7.1: Protocol discriminator

Bits			
8	**7**	**6**	
0	0	0	Bluetooth TCS Call Control
0	0	1	Bluetooth TCS Group management
0	1	0	Bluetooth TCS Connectionless
All other values reserved			

Table 7.2: Protocol discriminator

7.3 MESSAGE TYPE

The purpose of the message type is to identify the function of the message being sent.

The Message type is the first part of every message and it is coded as shown in Figure 7.2 and Table 7.3.

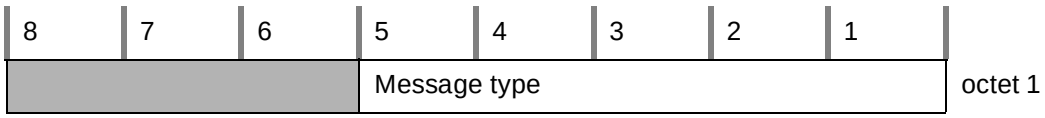


Figure 7.2: Message type

Bits					
5	**4**	**3**	**2**	**1**	
					Call Control messages
					Call Establishment
0	0	0	0	0	ALERTING

Table 7.3: Message type

Bits					
5	**4**	**3**	**2**	**1**	
0	0	0	0	1	CALL PROCEEDING
0	0	0	1	0	CONNECT
0	0	0	1	1	CONNECT ACKNOWLEDGE
0	0	1	0	0	PROGRESS
0	0	1	0	1	SETUP
0	0	1	1	0	SETUP ACKNOWLEDGE
					Call clearing
0	0	1	1	1	DISCONNECT
0	1	0	0	0	RELEASE
0	1	0	0	1	RELEASE COMPLETE
					Miscellaneous
0	1	0	1	0	INFORMATION
1	0	0	0	0	START DTMF
1	0	0	0	1	START DTMF ACKNOWLEDGE
1	0	0	1	0	START DTMF REJECT
1	0	0	1	1	STOP DTMF
1	0	1	0	0	STOP DTMF ACKNOWLEDGE
					Group management messages
0	0	0	0	0	INFO SUGGEST
0	0	0	0	1	INFO ACCEPT
0	0	0	1	0	LISTEN REQUEST
0	0	0	1	1	LISTEN ACCEPT
0	0	1	0	0	LISTEN SUGGEST
0	0	1	0	1	LISTEN REJECT
0	0	1	1	0	ACCESS RIGHTS REQUEST
0	0	1	1	1	ACCESS RIGHTS ACCEPT
0	1	0	0	0	ACCESS RIGHTS REJECT
					Connectionless messages
0	0	0	0	0	CL INFO

Table 7.3: Message type

7.4 OTHER INFORMATION ELEMENTS

7.4.1 Coding rules

The coding of other information elements follows the coding rules described below.

Three categories of information elements are defined:

a) single octet information elements (see Figure 7.3 on pag e488)

b) double octet information element (see Figure 7.4 on pa g e488)

c) variable length information elements (see Figure 7.5 on page488).

Table 7.4 on page 488 summarizes the coding of the information element identified bits for those information elements used in this specification.

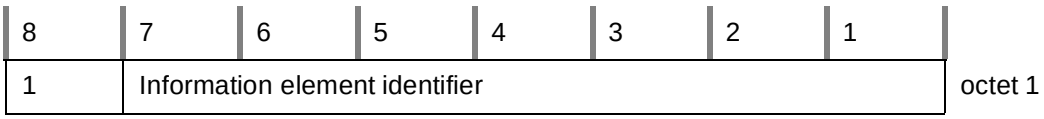


Figure 7.3: Single octet information element format

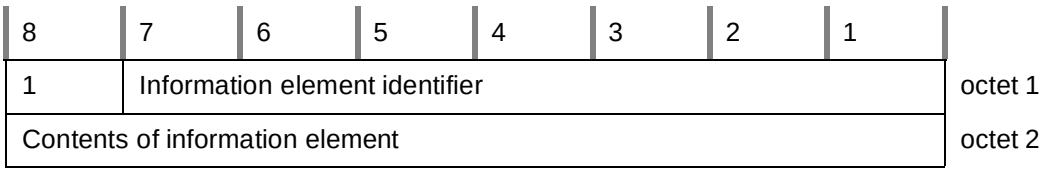


Figure 7.4: Double octet information element format

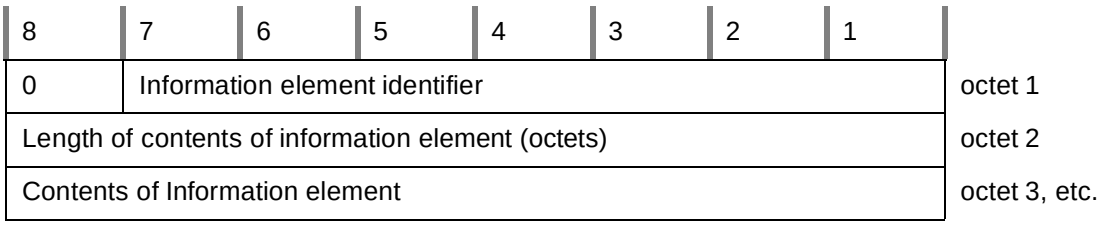


Figure 7.5: Variable length information element format

Coding									Ref.	Max Length (octets)
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**			
1								*Single octet information elements*		
	0	1	0	0	0	0	1	Sending complete	7.4.15	1
1								*Double octet information elements*		

Table 7.4: Information element identifier coding

Coding									Ref.	Max Length (octets)
8	7	6	5	4	3	2	1			
	1	0	0	0	0	0	0	Call class	7.4.4	2
	1	0	0	0	0	0	1	Cause	7.4.7	2
	1	0	0	0	0	1	0	Progress indicator	7.4.13	2
	1	0	0	0	0	1	1	Signal	7.4.16	2
	1	0	0	0	1	0	0	Keypad facility	7.4.12	2
	1	0	0	0	1	0	1	SCO handle	7.4.14	2
0								*Variable length information elements*		
	0	0	0	0	0	0	0	Clock offset	7.4.8	4
	0	0	0	0	0	0	1	Configuration data	7.4.2	*
	0	0	0	0	0	1	0	Bearer capability	7.4.3	4(26)
	0	0	0	0	0	1	1	Destination CID	7.4.11	4
	0	0	0	0	1	0	0	Calling party number	7.4.6	*
	0	0	0	0	1	0	1	Called party number	7.4.5	*
	0	0	0	0	1	1	0	Audio control	7.4.2	*
	0	0	0	0	1	1	1	Company specific	7.4.9	*

Table 7.4: Information element identifier coding

The descriptions of the information elements below are organized in alphabetical order. However, there is a particular order of appearance for each information element in a message. The code values of the information element identifier for the variable length formats are assigned in ascending numerical order, according to the actual order of appearance of each information element in a message. This allows the receiving devices to detect the presence or absence of a particular information element without scanning through an entire message.

Where the description of information elements in this specification contains spare bits, these bits are indicated as being set to ’0’. In order to allow compatibility with future implementation, messages should not be rejected simply because a spare bit is set to ’1’.

The second octet of a variable length information element indicates the total length of the contents of that information element regardless of the coding of the first octet (i.e. the length is calculated starting from octet 3). It is the binary coding of the number of octets of the contents, with bit 1 as the least significant bit (2°).

An optional variable-length information element may be present, but empty (zero length). The receiver should interpret this as if that information element

was absent. Similarly, an absent information element should be interpreted by the receiver as if that information element was empty.

7.4.2 Audio control

The purpose of the Audio control information elements is to indicate information relating to the control of audio.

8	7	6	5	4	3	2	1	Octets
0	0	0	0	0	1	1	0	1
Length of contents of information element (octets)								2
Control information								3

Figure 7.6:

Control information (octet 3)								
	Bits							
	7	**6**	**5**	**4**	**3**	**2**	**1**	
	0	0	0	0	0	0	0	Volume increase
	0	0	0	0	0	0	1	Volume decrease
	0	0	0	0	0	1	0	Microphone gain increase
	0	0	0	0	0	1	1	Microphone gain decrease
	0	X	X	X	X	X	X	Reserved for Bluetooth standardization
	1	X	X	X	X	X	X	Company specific

Table 7.5: Audio Control information element coding

7.4.3 Bearer capability

The purpose of the Bearer capability information elements is to indicate a requested or available bearer service.

If this information element is absent, the default Bearer capability is Link type Synchronous Connection-Oriented with packet type HV3, using CVSD coding for the User information layer 1.

8	7	6	5	4	3	2	1	Octets
0	0	0	0	0	0	1	0	1
Length of contents of information element (octets)								2
Link type								3

Figure 7.7:

Link type element coding = 00000000 (SCO)

User information layer 1	Packet type	4

Figure 7.8:

Link type element coding = 00000001 (ACL)

Flags		4
Service type		5
Token Rate		6
		7
		8
		9
Token Bucket Size (bytes)		10
		11
		12
		13
Peak Bandwidth (bytes/second)		14
		15
		16
		17
Latency (microseconds)		18
		19
		20
		21
Delay Variation (microseconds)		22
		23
		24
		25
User information layer 3	User information layer 2	26

Figure 7.9:

Note: the Quality of Service is repeated at TCS level, as only TCS has the knowledge of end-to-end Quality of Service requirements.

Link type (octet 3)

Bits

8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	Synchronous Connection-Oriented
0	0	0	0	0	0	0	1	Asynchronous Connection-Less
0	0	0	0	0	0	1	0	None

All other values are reserved

Octet 4 coding (Link type element coding = 000000000)

Packet type (octet 4)

Bits

5	4	3	2	1	
0	0	1	0	1	HV1
0	0	1	1	0	HV2
0	0	1	1	1	HV3
0	1	0	0	0	DV

All other values are reserved

User information layer 1 (octet 4)

Bits

8	7	6	
0	0	1	CVSD
0	1	0	PCM A-law
0	1	1	PCM µ-law

All other values reserved

Octets 4-26 coding (Link type element coding = 000000001)

The details of the coding Octets 4-25 can be found in L2CAP, see L2CAP, Section 6 on page 297

User information layer 2 (octet 26)

Bits

4	3	2	1	
0	0	0	0	RFCOMM over L2CAP

All other values are reserved

User information layer 3 (octet 26)

Bits

8	7	6	5	
0	0	0	0	Not specified
0	0	0	1	PPP
0	0	1	0	IP

All other values reserved

Octet 4 coding (Link type element coding = 000000010)

Octet 4 is absent

Table 7.6: Bearer capability information element coding

7.4.4 Call class

The purpose of the Call class is to indicate the basic aspects of the service requested. This element allows the user to indicate the use of default attributes, thereby reducing the length of the set-up message.

8	7	6	5	4	3	2	1	Octets
1	1	0	0	0	0	0	0	1
Call Class								2

Figure 7.10:

Call class (octet 2)								
	Bits							
8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	External call
0	0	0	0	0	0	0	1	Intercom call
0	0	0	0	0	0	1	0	Service call
0	0	0	0	0	0	1	1	Emergency call
	All other values reserved							

Table 7.7: Call class information element coding

Note

- An external call is a call to/from an external network; e.g. the PSTN.
- An intercom call is a call between Bluetooth devices.
- A service call is a call for configuration purposes.
- An emergency call is an external call using a dedicated emergency call number, using specific properties.

7.4.5 Called party number

The purpose of the Called party number information element is to identify the called party of a call.

8	7	6	5	4	3	2	1	Octets
0	0	0	0	0	1	0	1	1
Length of contents of information element (octets)								2
0	Type of number			Numbering plan identification				3
0	Number digits (Bluetooth character set) (Note)							4 etc.

Note – The number digits appear in multiple octet 4's in the same order in which they would be entered, that is, the number digit which would be entered first is located in the first octet 4.

Figure 7.11:

Type of number (octet 3)

Bits			
7	6	5	
0	0	0	Unknown
0	0	1	International number
0	1	0	National number
0	1	1	Network specific number
1	0	0	Subscriber number
1	1	0	Abbreviated number
1	1	1	Reserved for extension

All other values are reserved

Numbering plan identification (octet 3)

Bits				
4	3	2	1	
0	0	0	0	Unknown
0	0	0	1	ISDN/telephony numbering plan E.164
0	0	1	1	Data numbering plan Rec. X.121
0	1	0	0	Reserved
1	0	0	0	National standard numbering plan
1	0	0	1	Private numbering plan

All other values are reserved

Table 7.8: Called party information element coding

7.4.6 Calling party number

The purpose of the Calling party number information element is to identify the origin of a call.

8	7	6	5	4	3	2	1	Octets
0	0	0	0	0	1	0	0	1
Length of contents of information element (octets)								2
0	Type of number			Numbering plan identification				3
0	Presentation indicator		0	0	0	Screening indicator		4
0	Number digits (IA5 characters)							5 etc.

Figure 7.12:

Type of number (octet 3)

Bits			
7	6	5	
0	0	0	Unknown
0	0	1	International number
0	1	0	National number
0	1	1	Network specific number
1	0	0	Subscriber number
1	1	0	Abbreviated number
1	1	1	Reserved for extension

All other values are reserved

Numbering plan identification (octet 3)

Bits				
4	3	2	1	
0	0	0	0	Unknown
0	0	0	1	ISDN/telephony numbering plan E.164
0	0	1	1	Data numbering plan Rec. X.121
0	1	0	0	Reserved
1	0	0	0	National standard numbering plan
1	0	0	1	Private numbering plan

All other values are reserved

Presentation indicator (octet 4)

Bits		
7	6	
0	0	Presentation allowed
0	1	Presentation restricted
1	0	Number not available due to interworking
1	1	Reserved

All other values are reserved

Table 7.9: Calling party information element coding

Screening indicator (octet 4)		
Bits		
2	1	
0	0	User-provided, not screened
0	1	User-provided, verified and passed
1	0	User-provided, verified and failed
1	1	Network provided
All other values are reserved		

Table 7.9: Calling party information element coding

7.4.7 Cause

The purpose of the Cause is to indicate the remote side of the cause of the failure of the requested service.

8	7	6	5	4	3	2	1	Octets
1	1	0	0	0	0	0	1	1
Cause value								2

Figure 7.13:

Cause (octet 2)	
Bits	
8 7 6 5 4 3 2 1	
0	These 7 bits are coded alike the Cause value subfield defined in Section 2.2.5 of ITU-T Recommendation Q.850[2].

Table 7.10: Cause information element coding

7.4.8 Clock offset

The purpose of the Clock offset information element is to indicate the Bluetooth clock offset used.

8	7	6	5	4	3	2	1	Octets
0	0	0	0	0	0	0	0	1
Length of contents of information element (octets)								2
Clock offset								3
								4

Figure 7.14:

Clock offset coding (octet 3 and 4)															
	Bits (octet 3)								Bits (octet 4)						
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
0	Contains bits 16-2 of Bluetooth clock														

Table 7.11: Clock offset information element coding

7.4.9 Company specific

The purpose of the Company specific information element is to send non-standardized information.

8	7	6	5	4	3	2	1	Octets
0	0	0	0	0	1	1	1	1
Length of contents of information element (octets)								2
Company Identification								3
Company Identification								4
Company specific contents								
								L+2

Figure 7.15:

Company identification coding (octet 3 and octet 4)																
	Bits (octet 3)								Bits (octet 4)							
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Ericsson
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	Nokia Mobile Phones
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	Intel Corporation
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	IBM Corporation
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	Toshiba Corporation
	All other values are reserved															

Table 7.12: Company specific information element coding

7.4.10 Configuration data

The purpose of the Configuration data information element is to indicate the Configuration data.

8	7	6	5	4	3	2	1	Octets
0	0	0	0	0	0	0	1	1
Length of contents of information element (octets)								2
0	Internal number of WUG member 1 (IA5 characters)							3
0	Internal number of WUG member 1 (IA5 characters)							4
Bluetooth address of WUG member 1								5
								…
								10
Link key to be used towards WUG member 1								11
								..
								26
……								
0	Internal number of WUG member n (IA5 character)							**3+((n-1)*24)**
0	Internal number of WUG member n (IA5 character)							**4+((n-1)*24)**
Bluetooth address of WUG member n								**5+((n-1)*24)**
								…
								10+((n-1)*24)
Link key to be used towards WUG member n								**11+((n-1)*24)**
								..
								2+(n*24)

Note – The internal number (2 digits) appears in octets 3 and 4 in the same order in which they would be entered; that is, the number digit which would be entered first is located in octet 3.

Note – The octets 3-26 are repeated for all *n* WUG members.

Figure 7.16:

7.4.11 Destination CID

The purpose of the Destination CID information element is to enable the remote side to associate the established L2CAP channel with the ongoing call. The Destination CID is identical to the Destination CID (DCID) exchanged in the Configuration Request packet (see L2CAP, Section 5.4 on page 288).

8	7	6	5	4	3	2	1	Octets
0	0	0	0	0	0	1	1	1
Length of contents of information element (octets)								2
DCID byte 1								3
DCID byte 0								4

Figure 7.17:

7.4.12 Keypad facility

The purpose of the Keypad facility information element is to convey Bluetooth character sets; e.g. entered by means of a terminal keypad.

8	7	6	5	4	3	2	1	Octets
1	1	0	0	0	1	0	0	1
0	Keypad facility information (Bluetooth character set)							2

Figure 7.18:

7.4.13 Progress indicator

The purpose of the Progress indicator information element is to describe an event that has occurred during the life of a call.

8	7	6	5	4	3	2	1	Octets
1	1	0	0	0	0	1	0	1
0	Progress description							2

Figure 7.19:

Progress information (octet 2)	
Bits 7 6 5 4 3 2 1	
0 0 0 1 0 0 0	In-band information or appropriate pattern is now available
All other values reserved	

Table 7.13: Progress indicator information element coding

7.4.14 SCO Handle

The purpose of the SCO handle information element is to enable the remote side to associate the established SCO link with the ongoing call. The SCO handle is identical to the SCO handle exchanged in the LMP_SCO_link_req sent by the piconet master (see LMP, Section 3.21 on page 226).

8	7	6	5	4	3	2	1	Octets
1	1	0	0	0	1	0	1	1
SCO handle value								2

Figure 7.20:

7.4.15 Sending complete

The purpose of the Sending complete information element is to optionally indicate completion of called party number.

8	7	6	5	4	3	2	1	Octet
1	0	1	0	0	0	0	1	1

Figure 7.21:

7.4.16 Signal

The purpose of the Signal information element is to convey information to a user regarding tones and alerting signals.

8	7	6	5	4	3	2	1	Octets
1	1	0	0	0	0	1	1	1
Signal value								2

Figure 7.22:

Signal value (octet 2)								
	Bits							
8	7	6	5	4	3	2	1	
0	1	0	0	0	0	0	0	External call
0	1	0	0	0	0	0	1	Internal call
0	1	0	0	0	0	1	0	Call back
0	X	X	X	X	X	X	X	Reserved for Bluetooth standardization
1	X	X	X	X	X	X	X	Company specific

Table 7.14: Signal information element coding

8 MESSAGE ERROR HANDLING[1]

8.1 PROTOCOL DISCRIMINATION ERROR

When a message is received with a protocol discriminator coded other than the ones defined in Section 7.2 on page 486, that message shall be ignored.

8.2 MESSAGE TOO SHORT OR UNRECOGNIZED

When a message is received that is too short to contain a complete message type information element, that message shall be ignored.

When a message is received that contains a complete message type information element, but with a value which is not recognized as a defined message type, that message shall be ignored.

8.3 MESSAGE TYPE OR MESSAGE SEQUENCE ERRORS

Whenever an unexpected message, except RELEASE or RELEASE COMPLETE message is received in any state other than the Null state, that message shall be ignored.

When an unexpected RELEASE message is received, the receiving side shall disconnect and release the bearer channel if established, return a RELEASE COMPLETE message, stop all timers, and enter the Null state.

When an unexpected RELEASE COMPLETE message is received, the receiving side shall disconnect and release the bearer channel if established, stop all timers, and enter the Null state.

8.4 INFORMATION ELEMENT ERRORS

The information elements in a message shall appear (if present for information elements indicated as optional) in the exact order as indicated in Section 6.

When a message is received which misses a mandatory information element, or which contains a mandatory information element with invalid content, the message shall be ignored.

In case the error occurred with a mandatory information element in a SETUP message, a RELEASE COMPLETE message shall be returned, either with cause #96, *mandatory information element is missing*, or with cause #100, *invalid information element contents*.

1. In this section, when it is stated to ignore a certain message or part of a message (information element), this shall be interpreted as to do nothing – as if the (part of the) message had never been received.

When a message is received which has an unrecognized information element, or has an optional information element with an invalid content, or has a recognized information element not defined to be contained in that message, the receiving side shall ignore the information element.

Information elements with a length exceeding the maximum length (as given in Section 7 on page 485) shall be treated as an information element with invalid content.

9 PROTOCOL PARAMETERS

9.1 PROTOCOL TIMERS

Timer name	Value
T301	Minimum 3 minutes
T302	15 seconds
T303	20 seconds
T304	30 seconds
T305	30 seconds
T308	4 seconds
T310	30 –120 seconds
T313	4 seconds
T401	8 second
T402	8 seconds
T403	4 second
T404	2.5 seconds
T405	2 seconds
T406	20 seconds

Table 9.1: Timer values

10 BLUETOOTH STANDARD CHARACTER SET

The Bluetooth character set is based on the first 128 characters of ITU-T Recommendation T.50, except for the first 32 (control) characters, which are redefined as Bluetooth "control codes".

Character codes 00 Hex to 1F Hex are specific to the Bluetooth character set. They are not used in the standard IA5 sense. The following values are defined:

Code (Hex)	*Control character*
05	Dialling pause[Note 1)]
16	Register recall
All other values are reserved	

Table 10.1: Bluetooth standard character set

Note 1: The duration of the dialling pause is determined by the side receiving the pause character.

11 REFERENCES

[1] Q.931, “Digital Subscriber Signalling System No. 1(DSS 1) – ISDN User-Network interface Layer 3 Specification for Basic Call Control”, 03/93

[2] Q.850, “Digital Subscriber Signalling System No. 1 General – Usage of cause of location in the Digital Subscriber Signalling system No. 1 and the signalling system No. 7 ISDN User Part”, 03/93

12 LIST OF FIGURES

13 LIST OF TABLES

APPENDIX 1 - TCS CALL STATES

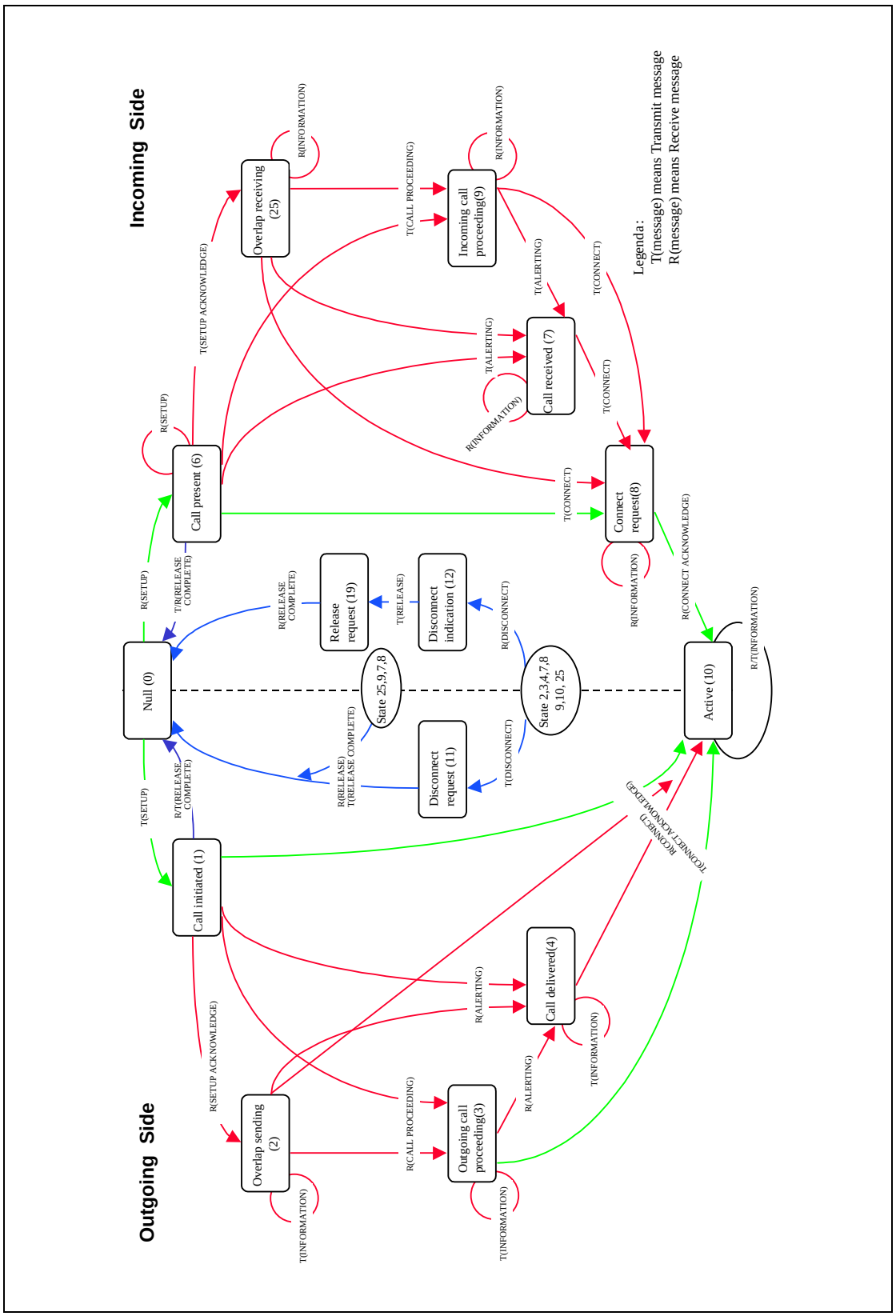


Figure A: Full TCS State Diagram

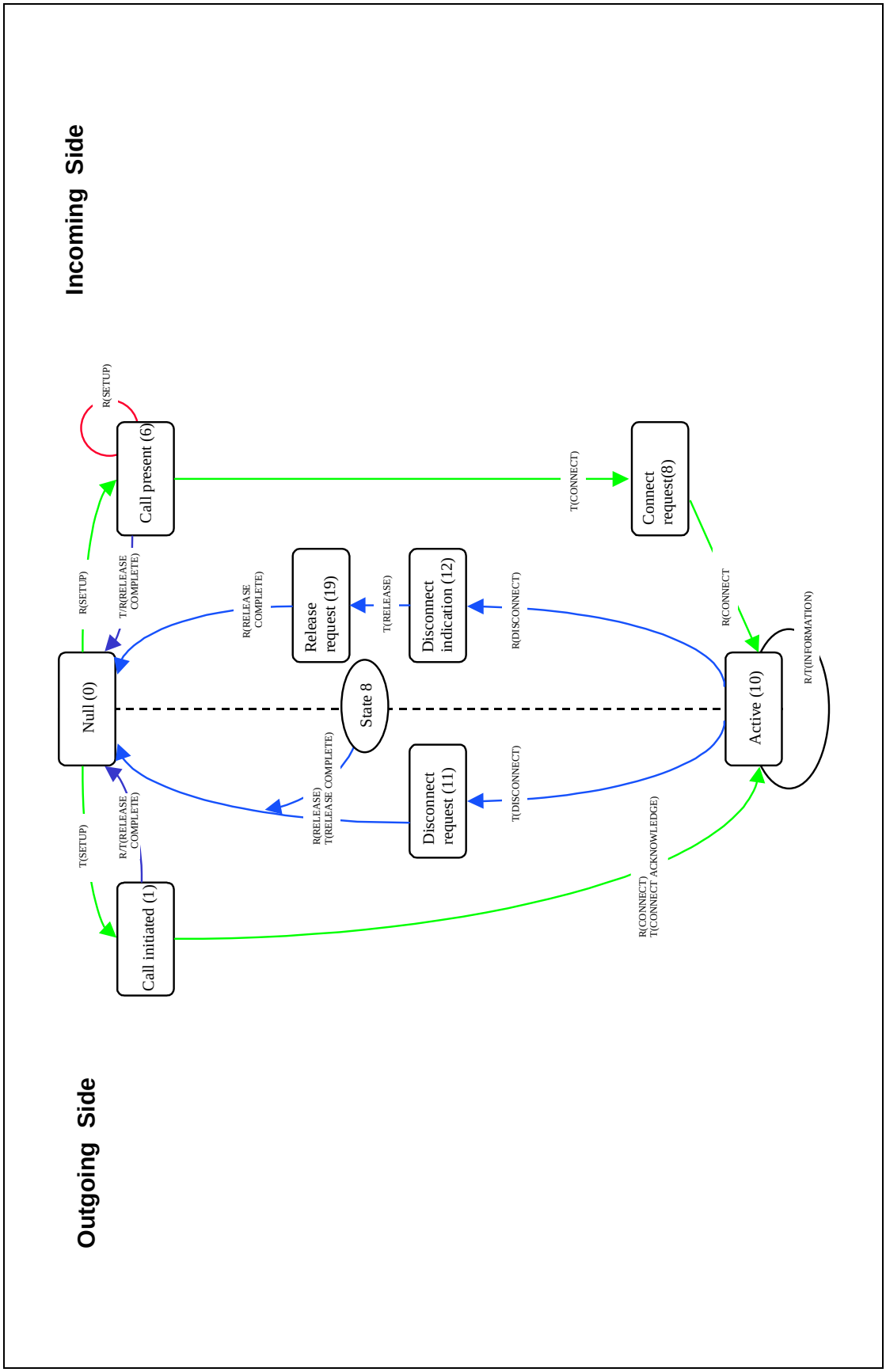


Figure B: Lean TCS State Diagram