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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
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1 Scope

The present document specifies a Reliable Data Service (RDS) protocol between the UE and Service Capability Exposure Function (SCEF) or P-GW.

The present document defines the frame structure, format of fields and procedures for operation of the RDS protocol. RDS is mainly intended to be used for acknowledged data transfer, but it also supports unacknowledged data transfer.

The present document is applicable to the UE, the SCEF and to the P-GW in the Evolved Packet System (EPS).

2 References

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[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 23.682: "Architecture enhancements to facilitate communications with packet data networks and applications".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

For the purposes of the present document, the following terms and definitions given in 3GPP TS 23.682 [2] apply:

SCEF

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

RDS Reliable Data Service

4 Overview

4.1 General

The Reliable Data Service (RDS) protocol supports the following requirements:

- RDS supports peer-to-peer data transfers and shall provide reliable data delivery between the UE and the SCEF or P-GW. The data is transferred via a PDN connection between the UE and SCEF or P-GW.
- A UE can connect to multiple SCEFs or P-GWs. A UE can connect to multiple SCS/AS via the SCEF or P-GW.

- RDS shall support multiple applications on the UE to simultaneously conduct data transfers with their peer entities on the SCEF or P-GW using a single PDN connection between the UE and SCEF or P-GW.
- RDS shall support both acknowledged and unacknowledged data transfers.
- RDS shall support variable-length frames and shall allow detection and elimination of duplicate frames at the receiving endpoint.

4.2 Reference Model

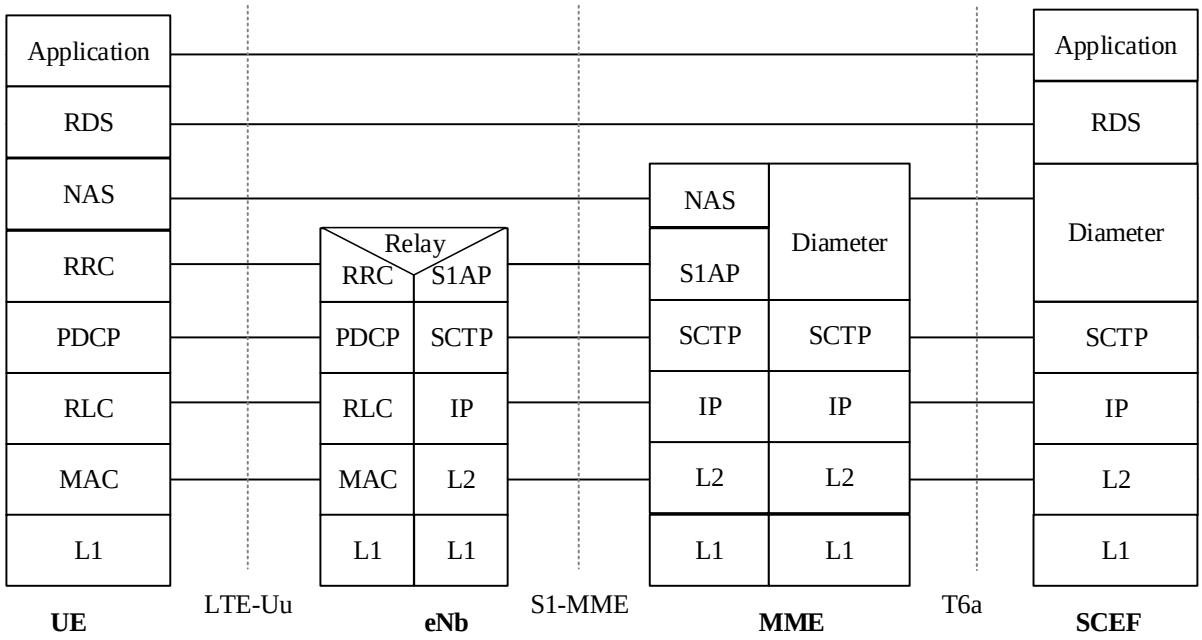

Figure 4.2-1: Protocol layering for reliable data transfer between UE and SCEF via E-UTRAN

The reference model showing the protocol layering for reliable data transfer between UE and SCEF is illustrated in figure 4.2-1. The RDS operates above the NAS and Diameter layers in the reference architecture.

4.3 Description of RDS protocol

4.3.1 Protocol functions

RDS establishes a peer-to-peer logical link between the UE and SCEF or P-GW. The logical link is identified by a pair of port numbers and EPS bearer ID. Each port number is used to identify an application on the UE side or at the network (SCEF or P-GW) side and is carried in the address field of each frame. The source port number identifies the application on the originator and the destination port number identifies the application on the receiver. When a single application on the originator conducts data transfer with a single application on the receiver, the source port number and destination port number need not be used. Each RDS frame shall consist of a header and an information field of variable length. The header shall contain information about port numbers and the frame number that is used to identify the frame and provide reliable transmission. The information field contains the payload to be transferred between the UE and SCEF or P-GW.

The UE establishes a PDN connection with the SCEF or P-GW either during Attach or through UE requested PDN connectivity. The UE shall use the EPS bearer ID to select the bearer to transfer RDS PDUs to the SCEF or P-GW. The EPS bearer ID identifies the destination (at the UE or at the SCEF or P-GW) and is not carried in the frame as it is already included in the NAS ESM message header. Once the UE and network successfully negotiate to use RDS for a particular PDN connection, the PDN connection shall transfer data only using RDS protocol.

RDS shall support both single and multiple applications within the UE. RDS shall provide fuctionality for flow control and sequence control to maintain the sequential order of frames across the logical link.

4.3.2 Acknowledged operation

In acknowledged operation the information is transmitted in order in numbered Information (I) frames. The I frames are acknowledged at the RDS layer. Error recovery and reordering mechanisms based on retransmission of acknowledged I frames are specified. Several I frames can be acknowledged at the same time. Flow control is implemented via a sliding window mechanism.

The procedure for establishment of acknowledged transfer is described in clause 6.

4.3.3 Unacknowledged operation

In unacknowledged operation the information is transmitted in numbered Unconfirmed Information (UI) frames. The UI frames are not acknowledged at the RDS layer. Error recovery and reordering mechanisms are not defined. Duplicate UI frames are discarded. Flow control procedures are not defined.

5 Frame structure and format of fields

5.1 General

The peer-to-peer transfers using RDS shall conform to the frame format as shown in figure 5.1-1. The frame header shall consist of the Address and Control field and is a minimum of 1 octet and a maximum of 3 octets long. The Information field is of variable length.

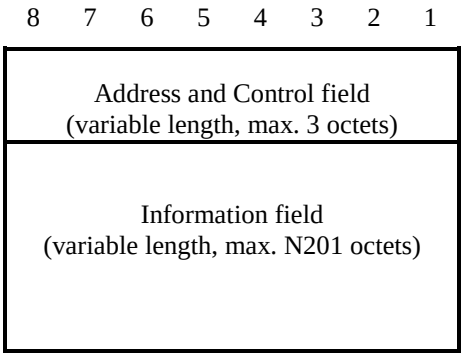

Figure 5.1-1: RDS frame format

5.2 Address and Control field

5.2.1 Address and Control field format

The Address and Control field identifies the type of frame and consists of minimum of 1 octet and maximum of 3 octets. The following types of control field frames are specified:

- confirmed information transfer (I frame);
- supervisory functions (S frame);
- unconfirmed information transfer (UI frame); and
- control functions (U frame).

The address and control field format for RDS is shown in figure 5.2.1-1.The description of address and control field bits is shown in Table 5.2.1-1.

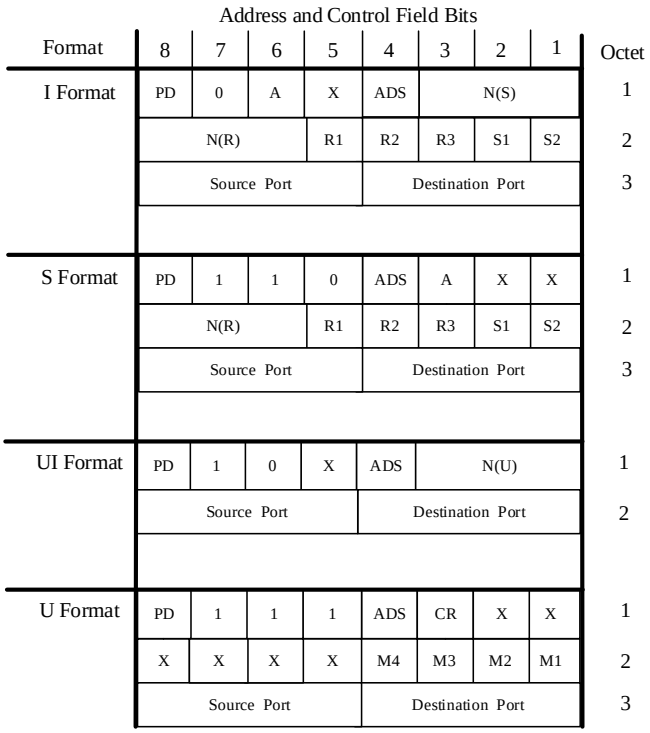

Figure 5.2.1-1: Address and Control field format

Table 5.2.1-1: Address and Control field bits description

Control field bits	Description
A	Acknowledgement request bit
M_n	Unnumbered function bit
N(R)	Receive sequence number
N(S)	Send sequence number
N(U)	Unconfirmed sequence number
S_n	Supervisory function bit
R_n	Selective acknowledgement bitmap bit
PD	Protocol Discriminator bit
C/R	Command / Response bit
ADS	Address bit
Source Port	Source port number
Destination Port	Destination port number
X	Spare bit

5.2.2 Protocol Discriminator bit (PD)

The PD bit indicates whether a frame is an RDS frame or belongs to a different protocol. RDS frames shall have the PD bit set to 0. If a frame with the PD bit set to 1 is received, then it shall be treated as an invalid frame.

5.2.3 Address bit (ADS)

The ADS bit controls if the Source Port and Destination Port are included in the frame format. When a single application on UE side conducts data transfer with a single application on SCEF or P-GW side, the source and destination port numbers need not be used. The source and destination port numbers enable multiple applications on the UE side to simultaneously communicate with their peer entities on the SCEF or P-GW side using the same PDN connection. Source Port and Destination Port are included in the frame format only if the ADS bit is set to 1.

5.2.4 Source port number (Source Port)

When a UE application starts to use the PDN connection to transmit RDS frames, the UE and the SCEF or P-GW establish which source port number will be used for the application on the UE side for MO traffic and which destination port number will be used for the application intended to receive the frames on the SCEF or P-GW side. Similarly for MT traffic when an application in the network starts to use the PDN connection to transmit RDS frames, the UE and the SCEF or P-GW establish which source port number will be used for the application on the SCEF or P-GW side and which destination port number will be used for the application intended to receive the frames on the UE side. How the applications on the originator side and their peer entities on receiver side synchronize port numbers is outside the scope of this specification.

Source Port is included only if the ADS bit is 1. Source Port shall have values from 0 to 15.

5.2.5 Destination port number (Destination Port)

The Destination Port is used to identify the destination application on the receiver that is receiving the frame.

Destination Port is included only if the ADS bit is 1. Destination Port shall have values from 0 to 15.

5.2.6 Information transfer frame - I

The I frame shall be used to perform an information transfer between peer entities with acknowledgement. Each I frame has a send sequence number N(S), a receive sequence number N(R) and an acknowledgement request bit A, that may be set to 0 or 1. The use of N(S), N(R), and A is defined in clause 6.

Each I frame also contains supervisory function bits S(n) and the Selective Acknowledgement bitmap R(n) which are defined in subclause 5.3.2.

5.2.7 Supervisory frame - S

The S frame shall be used to perform supervisory control functions such as acknowledge I frames. The supervisory frame has supervisory function bits S(n) that are used for encoding commands and responses which perform the supervisory control functions. Each supervisory frame has a receive sequence number N(R) and an acknowledgement request bit A, that may be set to 0 or 1. In acknowledged operation, all I and S frames contain R(n), the Selective Acknowledgement bitmap. The commands and responses are defined in subclause 5.4 and the use of S(n), N(R), A and R(n) is defined in clause 6.

5.2.8 Unconfirmed Information frame - UI

The UI frame shall be used to perform an information transfer between peer entities without acknowledgement. The UI frames contain N(U), the unconfirmed sequence number of transmitted UI frames. No verification of sequence numbers is performed for UI frames.

5.2.9 Unnumbered frame - U

The U frame shall be used to provide additional link control functions. Each U frame has Unnumbered function bits M(n) that are used to encode link control commands and response. The U frame has Command/Response bit (C/R) that identifies a U frame as either a command or a response. The U fame contains no sequence number. The commands and responses are defined in subclause 5.4 and the use of M(n) is defined in clause 6.

5.2.10 Command / Response bit (C/R)

The C/R bit identifies a frame as either a command or a response. The UE side shall send commands with the C/R bit set to 0, and responses with the C/R bit set to 1. The SCEF or P-GW side shall do the opposite; i.e., commands are sent with C/R set to 1, and responses are sent with C/R set to 0. The combinations for the SCEF or P-GW side and UE side are shown in table 5.2.10-1.

Table 5.2.10-1: C/R field bit usage

Type	Direction	C/R value
Command	SCEF or P-GW side to UE side	1
Command	UE side to SCEF or P-GW side	0
Response	SCEF or P-GW side to UE side	0
Response	UE side to SCEF or P-GW side	1

5.3 Control field parameters and associated state variables

The various parameters associated with the control field frames are described in this subclause.

5.3.1 Acknowledgement request bit (A)

All I and S frames contain the Acknowledgement Request (A) bit.

The A bit set to 1 is used to solicit an acknowledgement (i.e., an I frame or S frame) from the receiver. The A bit set to 0 is used to indicate that the receiver is not requested to send an acknowledgement.

5.3.2 Acknowledged operation variables and parameters

5.3.2.1 Send state variable V(S)

In acknowledged operation, each originator shall have an associated send state variable V(S) when using I frames. V(S) denotes the sequence number of the next in-sequence I frame to be transmitted. V(S) can take on the value 0 through (MAX SEQUENCE NUMBER -1). The value of V(S) shall be incremented by 1 with each successive I frame transmission, and shall not exceed acknowledge state variable V(A) by more than the maximum number of outstanding I frames k. The value of k may be in the range $1 \leq k \leq$ (MAX SEQUENCE NUMBER/2 -1). V(S) shall not be incremented when an I frame is retransmitted.

5.3.2.2 Acknowledge state variable V(A)

In acknowledged operation, each peer originator shall have an associated acknowledge state variable V(A) when using I frame and supervisory frame commands and responses. V(A) identifies the first I frame in the transmit window, so that V(A) - 1 equals N(S) of the last in-sequence acknowledged I frame. V(A) can take on the value 0 through (MAX SEQUENCE NUMBER -1). The value of V(A) shall be updated by the valid N(R) values received from its peer (see subclause 5.3.2.5). A valid N(R) value is in the range $V(A) \leq N(R) \leq V(S)$.

5.3.2.3 Send sequence number N(S)

In acknowledged operation, only I frames contain N(S), the send sequence number of transmitted I frames. At the time that an in-sequence I frame is designated for transmission, the value of N(S) is set equal to the value of the send state variable V(S).

5.3.2.4 Receive state variable V(R)

In acknowledged operation, each receiver shall have an associated receive state variable V(R) when using I frame and supervisory frame commands and responses. V(R) denotes the sequence number of the next in-sequence I frame expected to be received. V(R) can take on the value 0 through (MAX SEQUENCE NUMBER -1). The value of V(R) shall be incremented by one with the receipt of an error-free, in-sequence I frame whose send sequence number N(S) equals V(R).

5.3.2.5 Receive sequence number N(R)

In acknowledged operation, all I frames and S frames contain N(R), the expected send sequence number of the next in-sequence received I frame. At the time that a frame of the above types is designated for transmission, the value of N(R) is set equal to the value of the receive state variable V(R). N(R) indicates that the receiver transmitting the N(R) has correctly received all I frames numbered up to and including N(R) - 1.

5.3.2.6 Selective Acknowledgement (SACK) bitmap R(n)

In acknowledged operation, all I frames and S frames contain R(n), the SACK bitmap. At the time that a S frame is designated for transmission, the value of each bit R(n) in the bitmap shall be set to 0 or 1 depending on whether I frame number N(R) + n has been received or not. R(n) = 1 indicates that the receiver transmitting the S frame has correctly received I frame number N(R) + n. R(n) = 0 indicates that the receiver transmitting the S frame has not correctly received I frame number N(R) + n. The SACK bitmap contains (k) bits.

5.3.3 Unacknowledged operation variables and parameters

5.3.3.1 Unconfirmed send state variable V(U)

Each peer entity shall have an associated unconfirmed send state variable V(U) when using UI frame commands. V(U) denotes the sequence number of the next UI frame to be transmitted. V(U) can take on the value 0 through 7. The value of V(U) shall be incremented by 1 with each successive UI frame transmission.

5.3.3.2 Unconfirmed sequence number N(U)

Only UI frames contain N(U), the unconfirmed sequence number of transmitted UI frames. At the time that a UI frame is designated for transmission, the value of N(U) is set equal to the value of the unconfirmed send state variable V(U).

5.3.3.3 Unconfirmed receive state variable V(UR)

Each peer entity shall have an associated unconfirmed receive state variable V(UR) when using UI frame commands. V(UR) denotes the sequence number of the next in-sequence UI frame expected to be received. V(UR) can take on the value 0 through 7.

5.3.3.4 Other parameters and variables

The only other parameter defined for unacknowledged operation is the number of octets (N201) in the information field of the UI frame. See subclause 6.4.6.

5.4 Commands and responses

5.4.1 General

The following commands and responses are used by the UE side and SCEF or P-GW side as shown in table 5.4.1-1. Each link connection shall support the appropriate set of commands and responses for the type of operation desired.

Table 5.4.1-1: Commands and responses

Frame	Commands	Responses	Encoding					
			S1	S2	M4	M3	M2	M1
S Frame or I Frame	SACK	SACK	1	1	-	-	-	-
U Frame	ERROR	ERROR	-	-	0	0	0	1
U Frame	DISCONNECT	-	-	-	0	1	0	0
U Frame	-	ACCEPT	-	-	0	1	1	0
U Frame	SET_ACK_MODE	-	-	-	0	1	1	1
U Frame	SET_PARAMETERS	SET_PARAMETERS	-	-	1	0	1	1

5.4.2 Unnumbered (U) frames

5.4.2.1 SET_ACK_MODE command

The originator shall use the SET_ACK_MODE command to initiate acknowledged operation between the UE and SCEF or P-GW.

The receiver shall confirm acceptance of a SET_ACK_MODE command by the transmission of an ACCEPT response. Upon acceptance of SET_ACK_MODE command, the send state variable V(S), acknowledge state variable V(A), and receive state variable V(R), shall be set to 0. The transmission of a SET_ACK_MODE command indicates the clearance of any exception conditions.

Previously transmitted I frames that are unacknowledged when this command is sent shall be discarded. It is the responsibility of higher layers to recover from the possible loss of the contents of such I frames.

5.4.2.2 DISCONNECT command

The DISCONNECT command shall be transmitted in order to terminate the acknowledged operation.

No information field is permitted with the DISCONNECT command. Prior to executing the command, the receiver side receiving the DISCONNECT command shall confirm the acceptance of a DISCONNECT command by the transmission of an ACCEPT response. The originator that sends the DISCONNECT command shall terminate the acknowledge mode operation when it receives the ACCEPT or ERROR response.

Previously transmitted I frames that are unacknowledged when this command is executed shall remain unacknowledged and shall be discarded. It is the responsibility of higher layers to recover from the possible loss of the contents of such I frames.

5.4.2.3 ACCEPT response

The ACCEPT response shall be used by the originator to acknowledge the receipt and acceptance of the SET_ACK_MODE or DISCONNECT commands. The SET_ACK_MODE or DISCONNECT commands are acted upon only after the ACCEPT response is transmitted.

5.4.2.4 ERROR command / response

The ERROR unnumbered command shall be used by the originator to report to the receiver that the originator is in a state such that acknowledged operation cannot be performed. The receiver shall transmit an ERROR response to any valid command received that it cannot execute. No information field is permitted with the ERROR command or ERROR response.

5.4.2.5 SET_PARAMETERS command / response

The SET_PARAMETERS command and response is used to negotiate values of parameters between originator and receiver in both acknowledged and unacknowledged mode of transfer. These parameters shall include the version of the RDS.

If the originator wants to negotiate the value of parameters, the originator shall send a SET_PARAMETERS command including the set of parameters along with their values to the receiver. The receiver shall send a SET_PARAMETERS response, either confirming these parameter values by returning the requested values, or proposing different ones in their place. Both, the originator and the receiver shall use the negotiated values after the completion of the negotiation process.

Table 5.4.2.5-1 lists the negotiable RDS layer parameters. Figure 5.4.2.5-1 shows the SET_PARAMETERS field format. A parameter item consists of Type and Length octets followed by the value of that parameter. The Length octet indicates the number of octets that the value actually occupies.

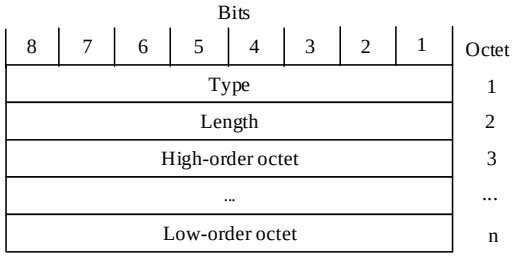

Figure 5.4.2.5-1: SET_PARAMETERS field format

Table 5.4.2.5-1: RDS layer parameters

Parameter Name	Type	Length	Format (87654321)	Range
RDS_Version	0	1	bbbbbbbb	0 through 255

5.4.3 Information (I) and Supervisory (S) frames

5.4.3.1 General

The function of the information (I) frame is to transfer, sequentially-numbered frames containing information fields provided by upper layers. This frame shall only be used in acknowledge operation.

Numbered I frames shall also carry supervisory information. A separate S frame is sent when there is no information field to be transferred. Whether an I or S frame is transmitted as a command or as a response is insignificant in the acknowledge operation.

5.4.3.2 Selective Acknowledgement (SACK) command / response

The supervisory frame containing the SACK bitmap shall be used by a receiver to acknowledge a single or multiple I frames. Frames up to and including N(R) - 1, and frames indicated by the SACK bitmap, are deemed to have been received correctly. The format of the SACK control field is shown in figure 5.2.1-1.

In addition to indicating the status of received I frames, the I or S frame containing the SACK bitmap with the A bit set to 1 may be used by the originator to request an acknowledgement from receiver.

6 Protocol procedures

6.1 Overview

This clause describes the RDS protocol procedures between the UE and SCEF or P-GW for acknowledged data service.

6.2 Procedures

6.2.1 Types of RDS procedures

The following RDS protocol procedures are defined:

- Establishment of acknowledged transfer;
- Acknowledged information transfer;
- Termination of acknowledged transfer; and
- Unacknowledged information transfer.

6.2.2 Establishment of acknowledged transfer procedure

6.2.2.1 General

The purpose of the establishment of acknowledged transfer procedure is for the originator to establish acknowledged transmission of information with the receiver. All frames other than U and UI frames received during the establishment of acknowledged transfer procedure shall be ignored.

6.2.2.2 Establishment of acknowledged transfer procedure initiation

The originator shall initiate the establishment of acknowledged transfer procedure when upper layers indicate information is to be transmitted using acknowledged operation. The originator and the receiver identify the source and destination port numbers before initiating establishment of acknowledged transfer procedure.

The originator initiates the establishment of acknowledged transfer procedure by transmitting a SET_ACK_MODE command to receiver. When a single application on the originator conducts data transfer with a single application on the receiver, the Source Port and Destination Port numbers need not be used; otherwise the originator shall set the Source Port to the port number of the source application on the originator and the Destination Port to the port number of the destination application on the receiver. The originator shall clear all exception conditions, discard all queued I frames, reset the retransmission counter and timer T200 shall be set.

If a logical link between the UE and SCEF identified without port numbers exists and the originator needs to initiate establishment of an additional acknowledged transfer procedure, the additional logical link between the UE and SCEF shall be identified with port numbers while the first logical link can remain without port numbers.

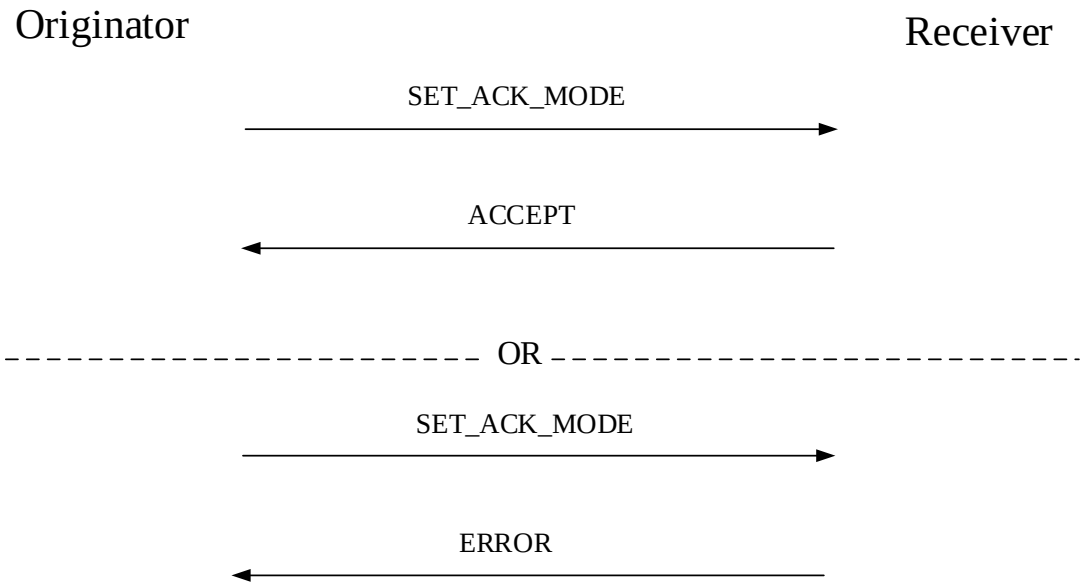

Figure 6.2.2.2-1: Establishment of acknowledged transfer procedure

6.2.2.3 Establishment of acknowledged transfer procedure accepted by receiver

Upon receiving a SET_ACK_MODE command, the receiver checks if the Destination Port number contained in the SET_ACK_MODE command corresponds to an application on the receiver.

If the check is successful and if the application accepts to enter acknowledged transfer mode, the receiver shall send an ACCEPT response to the originator. When a single application on the originator conducts data transfer with a single application on the receiver, the Source Port and Destination Port numbers need not be used; otherwise the receiver shall set the Source Port to the port number of the application on the receiver and the Destination Port to the port number of the application on the originator. The receiver shall reset timer T200 if active, clear all exception conditions and set V(S), V(R) and V(A) to 0.

6.2.2.4 Establishment of acknowledged transfer procedure completed by originator

Upon receipt of the ACCEPT response and if the Destination Port number corresponds to the application which initiated the establishment of acknowledged transfer procedure, the originator enters acknowledged mode transfer. The originator shall reset timer T200 if active, clear all exception conditions and set V(S), V(R) and V(A) to 0 and the establishment of acknowledged transfer procedure is successfully completed.

6.2.2.5 Establishment of acknowledged transfer procedure not accepted by receiver

Upon receiving a SET_ACK_MODE command if the Destination Port number contained in the SET_ACK_MODE command,

- is not supported by the receiver; or
- corresponds to an application that is not able to perform acknowledged transfer mode,

then the receiver shall send an ERROR response to the originator.

6.2.3 Acknowledged information transfer procedure

6.2.3.1 General

The purpose of the acknowledged information transfer procedure is for the originator to transfer I frames to receiver and receive acknowledgements for these frames from receiver.

The originator shall store the history of the transmitted I frames, and shall remember the I-frame transmission sequence. The history is used to decide which I frames to retransmit. Due to retransmission, the history is not necessarily an in-order sequence.

A frame within the receive window is either:

- received: the frame has been correctly received; or
- not received: the frame has not been correctly received.

A frame within the transmit window is either:

- not yet transmitted: the frame has not yet been transmitted;
- transmitted: the frame has been (re-) transmitted, but the originator does not know if the frame has been received by the receiver;
- acknowledged: the frame has been acknowledged by the receiver; or
- marked for retransmission: the originator has decided to retransmit this I frame.

I frames shall be transmitted in ascending N(S) order. When I frames are retransmitted, the frame with the lowest N(S) shall be retransmitted first. This is used by the receiver to detect lost frames.

6.2.3.2 Transmitting I frames and requesting acknowledgements

If the originator has received information to be transmitted from upper layers, the information is inserted in an I frame. The control field parameters N(S) and N(R) shall be assigned the values V(S) and V(R), respectively. V(S) shall be incremented by 1 at the end of the transmission of the I frame.

The originator shall request an acknowledgement from the receiver by transmitting an I or S frame with the A bit set to 1. The originator may request an acknowledgement at any time. An acknowledgement shall be requested when:

- the last I frame in a sequence of one or more I frames is transmitted; or
- V(S) = V(A) + k as a result of the transmission of the I frame.

The originator shall transmit a frame in the following order of priority:

- If there are any I frames marked for retransmission then the originator shall increment by 1 the retransmission count variable for the I frame with the lowest send sequence number N(S). If the retransmission count variable

exceeds the value of N200, then the originator shall initiate the Establishment of acknowledged operation procedure as described in subclause 6.2.2. If the retransmission count variable does not exceed the value of N200, then the originator shall retransmit the I frame.

- If the originator has a new I frame to transmit, if V(S) < V(A) + k (where k is the maximum number of outstanding I frames) then the new I frame shall be transmitted.

- If the originator has an acknowledgement to transmit then the originator shall transmit an S frame.

When requesting an acknowledgement, the originator shall set timer T201 and associate the timer with the I frame currently being transmitted, or, if the A bit is transmitted in an S frame, with the I frame last transmitted.

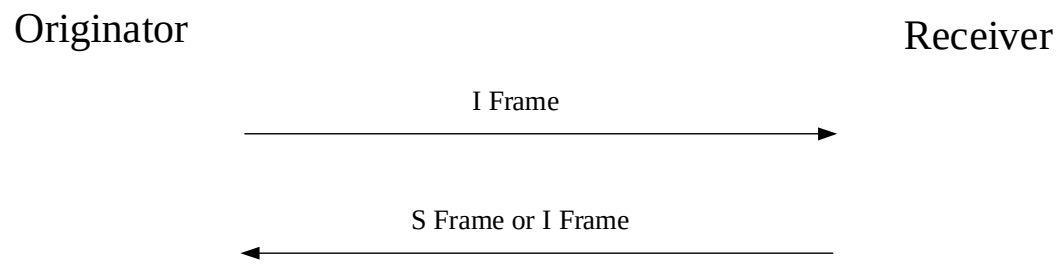

Figure 6.2.3.2-1: Acknowledged information transfer procedure

6.2.3.3 Receiving I frames and sending acknowledgements

When the receiver receives a valid I frame whose N(S) is equal to the current V(R), the receiver shall:

- pass the contents of the Information field to the appropriate upper layer entity;

- increment its V(R) by 1; and

- respond with a I or S frame containing the SACK bitmap, if the A bit of the received I frame was set to 1.

When the receiver receives a valid I frame whose N(S) is not in the range V(R) ≤ N(S) < V(R) + k, the receiver shall discard the frame as a duplicate.

When the receiver receives a valid I frame where V(R) < N(S) < V(R) + k, then the receiver shall store the I frame until all frames from V(R) to N(S) - 1 inclusive are correctly received. Once all the frames are correctly received the receiver shall then:

- pass the contents of the Information field to the appropriate upper layer entity; and

- set its V(R) = N(S) + 1.

Whenever the receiver detects an error in the sequence of received I frames, it shall transmit an I or S frame.

If the receiver receives an I frame with a higher N(S) than the N(S) of the previously received I frame, and if there are I frames missing between these two N(S) values, then the receiver shall assume that the missing I frames have been lost. If the receiver receives an I frame with a lower N(S) than the N(S) of the previously received I frame, it can assume that its peer originator has (re-) started retransmission due to the reception of an acknowledgement.

6.2.3.4 Receiving acknowledgements

On receipt of a valid I or S frame , the originator shall, if N(R) is valid, treat the N(R) contained in this frame as an acknowledgement for all the I frames it has transmitted with an N(S) up to and including the received N(R) - 1. A valid N(R) value is one that is in the range V(A) ≤ N(R) ≤ V(S). If N(R) is not valid, then the received SACK bitmap shall be disregarded.

V(A) shall then be set to N(R).

On receipt of a valid I or S frame containing the SACK bitmap, the originator shall consider all I frames with the corresponding bit set to 1 in the SACK bitmap as acknowledged.

If timer T201 is active and associated with an acknowledged I frame, then timer T201 shall be reset.

The originator shall determine which I frames to retransmit by analysing it's I frame transmission sequence history and the acknowledgements received. An unacknowledged I frame that was transmitted prior to an acknowledged I frame shall be considered lost and shall be marked for retransmission. Acknowledged I frames shall be removed from the I frame transmission sequence history.

6.2.4 Termination of acknowledged transfer procedure

6.2.4.1 General

The purpose of the termination of acknowledged transfer procedure is to terminate the acknowledged transmission of information between the UE side and the SCEF or P-GW side. All frames other than U and UI frames received during the termination of acknowledged transfer procedure shall be ignored and all queued I frames shall be discarded.

6.2.4.2 Termination of acknowledged transfer procedure initiation

The originator or receiver shall initiate the termination of acknowledged transfer procedure when upper layers indicate termination of acknowledged operation.

The originator initiates the termination of acknowledged transfer procedure by transmitting a DISCONNECT command. When a single application on the originator conducts data transfer with a single application on the receiver, the Source Port and Destination Port numbers need not be used; otherwise the originator shall set the Source Port to the port number of the source application on the originator and the Destination Port to the port number of the destination application on the receiver. The originator shall reset the retransmission counter and timer T200 shall be set.

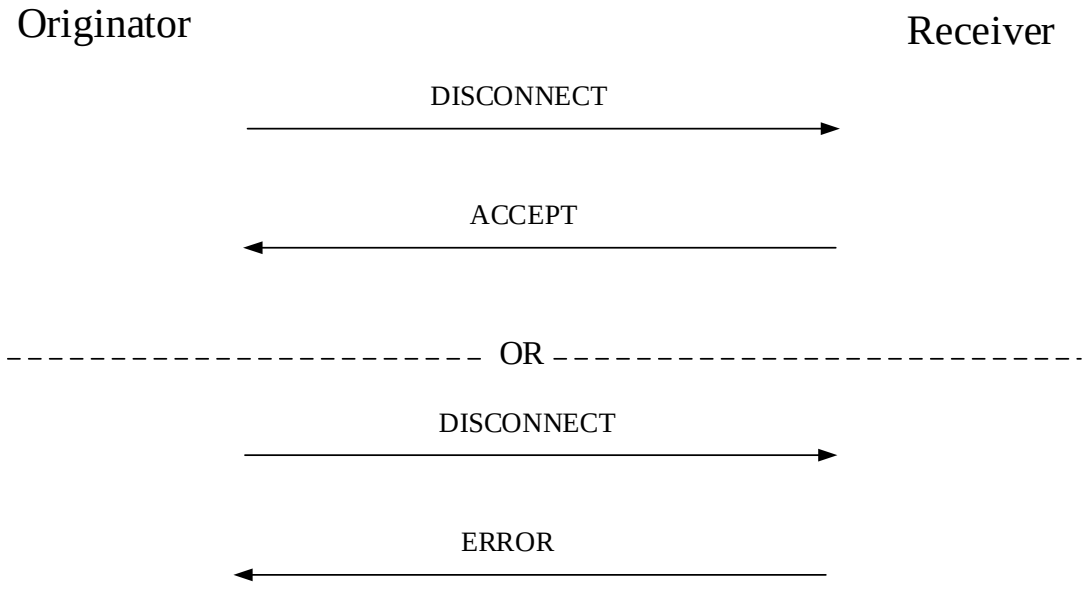

Figure 6.2.4.2-1: Termination of acknowledged transfer procedure

6.2.4.3 Termination of acknowledged transfer procedure accepted by receiver

Upon receiving a DISCONNECT command, the receiver checks if the Destination Port number contained in the DISCONNECT command corresponds to an application on the receiver.

If the check is successful the receiver shall send an ACCEPT response to the originator. When a single application on the originator conducts data transfer with a single application on the receiver, the Source Port and Destination Port numbers need not be used; otherwise the receiver shall set the Source Port to the port number of the application on the receiver and the Destination Port to the port number of the application on the originator.

6.2.4.4 Termination of acknowledged transfer procedure completed by originator

Upon receipt of the ACCEPT response and if the Destination Port number corresponds to the application which initiated the termination of acknowledged transfer procedure, the originator terminates acknowledged transfer mode. The originator shall reset timer T200 if active, and the termination of acknowledged transfer procedure is successfully completed.

6.2.4.5 Termination of acknowledged transfer procedure not accepted by receiver

Upon receiving a DISCONNECT command if the Destination Port number contained in the DISCONNECT command

- is not supported by the receiver; or
- corresponds to an application that is not in acknowledged transfer mode,

then the receiver shall send an ERROR response to the originator.

6.2.5 Unacknowledged information transfer procedure

6.2.5.1 General

The purpose of the unacknowledged information transfer procedure is for the originator to perform unacknowledged transmission of information to the receiver. No error recovery mechanisms are defined for unacknowledged operation

6.2.5.2 Unacknowledged information transfer procedure initiation

The originator shall initiate the unacknowledged information transfer procedure when information from upper layers is to be transmitted using unacknowledged operation. The originator and the receiver negotiate the use of source and destination port numbers before initiating unacknowledged information transfer.

The originator initiates the unacknowledged information transfer procedure by transmitting a UI frame to receiver. When a single application on the originator conducts data transfer with a single application on the receiver, the Source Port and Destination Port numbers need not be used; otherwise the originator shall set the Source Port to the port number of the source application on the originator and the Destination Port to the port number of the destination application on the receiver. The originator shall set the unconfirmed sequence number N(U) in UI frame to the value of unconfirmed send state variable V(U).

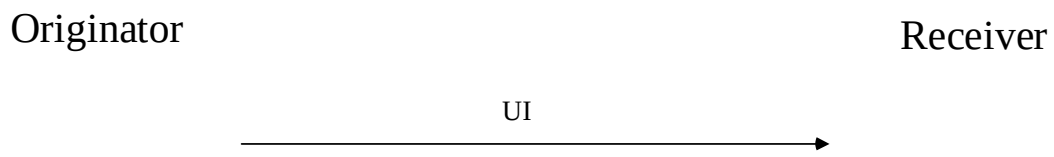

Figure 6.2.5.2-1: Unacknowledged information transfer procedure

6.2.5.3 Unacknowledged information transfer procedure accepted by receiver

Upon receiving a UI frame the receiver passes the contents of the Information field to the appropriate upper layer corresponding to the Destination Port. The receiver shall set the unconfirmed receive state variable V(UR) to N(U) + 1.

6.2.5.4 Unacknowledged information transfer procedure completed by originator

Upon transmission of the UI frame the unacknowledged information transfer procedure is completed by the originator.

6.2.5.5 Unacknowledged information transfer procedure not accepted by receiver

Upon receiving a UI frame,

- if the Destination Port number is not in use by the receiver; or

- if N(U) of the received UI frame is in the range (V(UR) – k') ≤ N(U) < V(UR) and if a UI frame with the same N(U) has already been received,

then the UI frame is discarded by the receiver without any further action. The value of k' may be in the range 1 < k' < MAX SEQUENCE NUMBER/2.

6.3 Abnormal cases

6.3.1 Expiry of timer T200

Timer T200 is set when a U frame with any of the following commands is transmitted.

- SET_ACK_MODE;
- DISCONNECT; and
- SET_PARAMETERS.

If timer T200 expires before a response to the sent command is received then the originator shall retransmit the command, and shall reset and start timer T200 and increment the retransmission counter. After retransmission of the command N200 times, the originator shall abort the operation and notify the upper layers.

6.3.2 Expiry of timer T201

On expiry of timer T201, the originator shall increment by 1 the retransmission count variable for the I frame associated with timer T201. If the value of the retransmission count variable does not exceed N200, the originator shall reset and start timer T201, and retransmit the I frame with the A bit set to 1. If the value of the retransmission count variable exceeds N200, the originator shall send the ERROR command to the receiver and initiate the establishment of acknowledged transfer procedure to re-establish the acknowledged transfer mode with the receiver.

6.4 List of RDS Parameters

6.4.1 General

The following parameters are applicable for Reliable Data Service (RDS).

6.4.2 RDS version number (Version)

The RDS version number (Version) is an RDS layer parameter. The default version number is 0.

6.4.3 Retransmission timers (T200 and T201)

The default value of timers T200 and T201 is 250 seconds.

6.4.4 Maximum number of retransmissions (N200)

The default value of N200 is 3.

6.4.5 Maximum number of outstanding I frames (k)

k is the maximum number of sequentially-numbered I frames that may be outstanding (i.e. unacknowledged) at any given time. k is also denoted as window size. The default value of k is 3. The value of MAX SEQUENCE NUMBER is 8.

6.4.6 Maximum length of Information Field (N201)

The default value of N201 is 1520 octets.

Annex A (informative): Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2017-04	CT1 #103	C1-171464	-	-	-	TS skeleton generated for submission at CT1 #103	0.0.0
2017-04	CT1 #103	-	-	-	-	Incorporated agreed P-CRs for TS 24.250 from CT1 #103 - C1-171467, C1-171618, C1-171619, C1-171621, C1-171930, C1-171932, C1-171933, C1-171935. C1-171936 and editorial clean-up by the rapporteur.	0.1.0
2017-05	CT1 #104	-	-	-	-	Incorporated agreed P-CRs for TS 24.250 from CT1 #104 - C1-172240, C1-172404, C1-172406, C1-172621, C1-172622, C1-172623, C1-172624, C1-172625. C1-172626 and editorial clean-up by the rapporteur.	0.2.0
2017-06	CT-76	CP-171107				Version 1.0.0 created for presentation to TSG CT for information and approval	1.0.0
2017-06	CT-76					Version 14.0.0 created after approval at CT76	14.0.0
2017-12	CT-78	CP-173060	0002		F	RDS handling when retransmission count exceeds N200	14.1.0
2017-12	CT-78	CP-173060	0003	1	F	Max Length of RDS information Field	14.1.0
2017-12	CT-78	CP-173060	0004	1	F	Clarification on SACK bitmap usage	14.1.0
2017-12	CT-78	CP-173060	0006	1	F	Clarification on identification of RDS connections for multiple applications	14.1.0
2017-12	CT-78	CP-173079	0005	1	C	Support for Reliable Data Service with PtP SGi Tunneling	15.0.0
2018-12	CT-82	CP-183075	0008		A	Define variables and parameters for unacknowledged operation	15.1.0

History

Document history		
V15.0.0	July 2018	Publication
V15.1.0	March 2019	Publication