Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
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Re:	This contribution is response to call for contribution about IEEE 802.16e-D4
Abstract	This document proposes the text for adopting ROHC
Purpose	Discuss and adapt proposed text and message format.
Notice	
Release	
Patent Policy and Procedures	

ROHC for rt-VR service

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1. Introduction

The header compression drastically improves the usage of the radio link. If we consider transmission across the air interface there is a considerable overhead for transmitting the entire header. Considering RTP/UDP/IP packet, the header is 40 bytes but the payload itself is as low as 15 – 20 bytes. From these numbers the need for reducing header sizes for efficiency reasons is obvious.

In IEEE 802.16 system, we have PHS to support header compression in radio resource between MSS and BS. However, there have been studies in more optimized header compression for recent years so that we need to make latest mechanism supported. The ROHC is the one of the latest header compression mechanism standardized in IETF and adapted in 3G system.

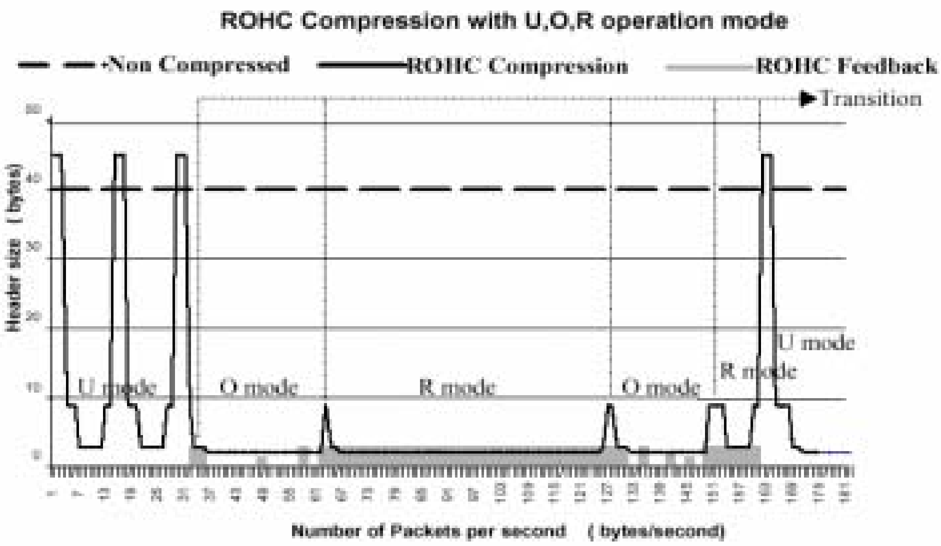
Robust header compression technique is considered the most effective method for better bandwidth utilization in wireless communication. There are other header compression techniques to improve bandwidth utilization. To mention a few: cTCP, cRTP, IPHC, etc. In addition to the above-mentioned techniques, 802.16 standards specifies Header Suppression technique, where in the compression efficiency achieved is nominal

To support ROHC in current version of specification, we proposed texts to describe general ROHC operation and TLV tables to indicate that the ROHC is supported and parameters in 802.16 systems. The overall text in this proposal is based on general ROHC mechanism without any modification or new concept from IETF RFC 3095 (RObust Header Compression).

2. ROHC

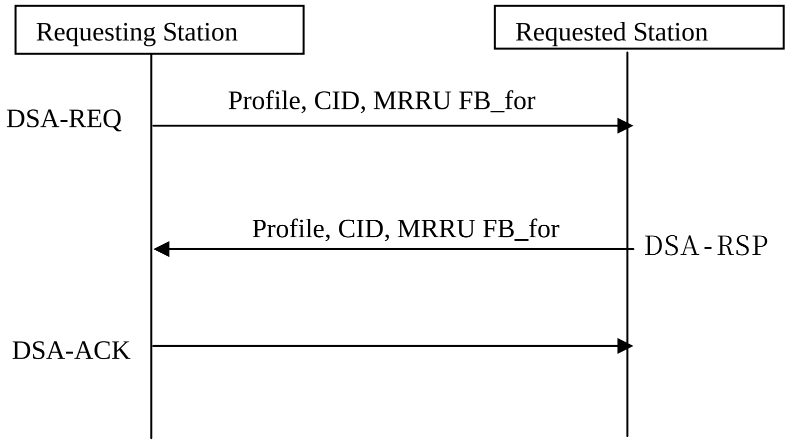
Variable Compression header size

The compressed header size in ROHC is variable depends on the compression mode so that the Uplink bandwidth should be allocated considering the variable packet size. The rt-VR service is appropriate in order to support variable packet size real-time service.



Establishment of ROHC rule

Similar to PHS rule establishment before the suppressing the headers of data packets, another signaling scheme is required to establish between SS & BS before compression using ROHC. This signaling is required to negotiate channel & context parameters (Profile_Type, CID, MRRU, FB_FOR) between the end stations. The following call flow depicts our proposal for signaling between SS & BS, to support ROHC.



Signaling for establishment of a ROHC Rule

A ROHC rule is negotiated between the SS and the BS at the time of a connection establishment. Above figure shows the message flow during a typical ROHC rule establishment.

Whenever a new IP packet arrives at a station and if the station is not able to map it to any existing connections it triggers a DSA-REQ message. The ROHC rule is negotiated in the DSA-REQ/RSP messages. The requesting station sends profile, CID, MRRU, FB_for as a part of DSA-REQ message. The requested station verifies this message and sends back its response in the DSA-RSP message. If the rule is acceptable to the requested station, it sends the response message including the context parameters with the same values as requested. Once the requesting station receives the response from the requested station, it sends across an acknowledgement to the requested station. Once a rule has been established the sending station compresses the packet headers on that connection as defined by the ROHC rules and transmits them. The receiving station retrieves the ROHC rules for the respective connection and reassembles the packets.

Profile Profile is a specification of how to compress the headers of a certain kind of packet stream over a certain kind of link.

MRRU Maximum Reconstructed Reception Unit.

CID connection identifier

FB_for(Feedback for) : Optional reference to the channel in the reverse direction .

3. Proposed Text Changes

5.2.7 ROHC

ROHC (Robust Header Compression) is a compression technique used to compress RTP/UDP/IP header for a VoIP service. Implementation of ROHC is optional. On the uplink, the sending entity is SS and the receiving entity is BS. On the downlink, the sending entity is BS and receiving entity is SS. Enabling ROHC shall be done during MAC connection establishment using DSA-REQ & DSA-RESP messages.

A VoIP Service using ROHC shall be considered under ‘rtPS’ service.

The sending entity uses classifiers to map packets into a service flow. The classifier uniquely maps packets to its associated ROHC profile. The sending entity maintains its state & mode of operation for compressing and the receiving entity maintains its state & mode of operation for decompressing the received packets. Both the entities maintain same mode at any given time, but the states maintained by each entity depends on their own operation. Refer section: 5.2.7.1 for detailed operation of ROHC.

For using ROHC to compress VoIP packets, the frame duration shall be either 5 msec or 10 msec. SS as a sending entity requests, for Bandwidth using BW-REQ message, depending on the size of ROHC packet. BS allocates the requested BW within 20 msec duration for ROHC packet transmission.

5.2.7.1 ROHC Operation

5.2.7.1.1 Uplink data transfer

A VoIP packet containing RTP/UDP/IP header with payload is submitted to packet CS. CS layer applies classifier rules. A match of the rule shall result in a Service Flow, CID (Traffic CID, issued by BS) & ROHC profile. The ROHC rule provides another CID called ROHC_CID, for mapping all the packets in the particular service flow. SS shall check the state of the compressor, select appropriate packet type, apply encoding algorithms and construct ROHC header. SS shall then prefix ROHC Header to PDU (VoIP payload) and present the entire MAC SDU to MAC SAP for uplink transmission.

MAC CPS layer transmits ROHC packet over the air interface after obtaining the required bandwidth from BS. If the available bandwidth is less than the size of ROHC packet, MAC CPS layer shall apply fragmentation and then transmits the PDU to BS.

When MAC PDU is received by BS over the air interface, the MAC CPS layer shall determine the associated CID by examining the generic MAC header. If there are fragmented PDUs, it shall de-fragment the complete packet and then present to IP CS layer with its associated CID. CS layer at BS uses this CID to map to corresponding ROHC profile. It recovers ROHC_CID from the received PDU and decompresses the headers by using its own stored context & state information. After successful decompression, CS layer provides the complete RTP/UDP/IP packet to its higher layer entity and updates its context & state information. If there is a error in decompression of the received packet, CS layer generates a feedback packet and send to SS as a normal ROHC packet. The transmission of feedback packets is similar to downlink packet transmission.

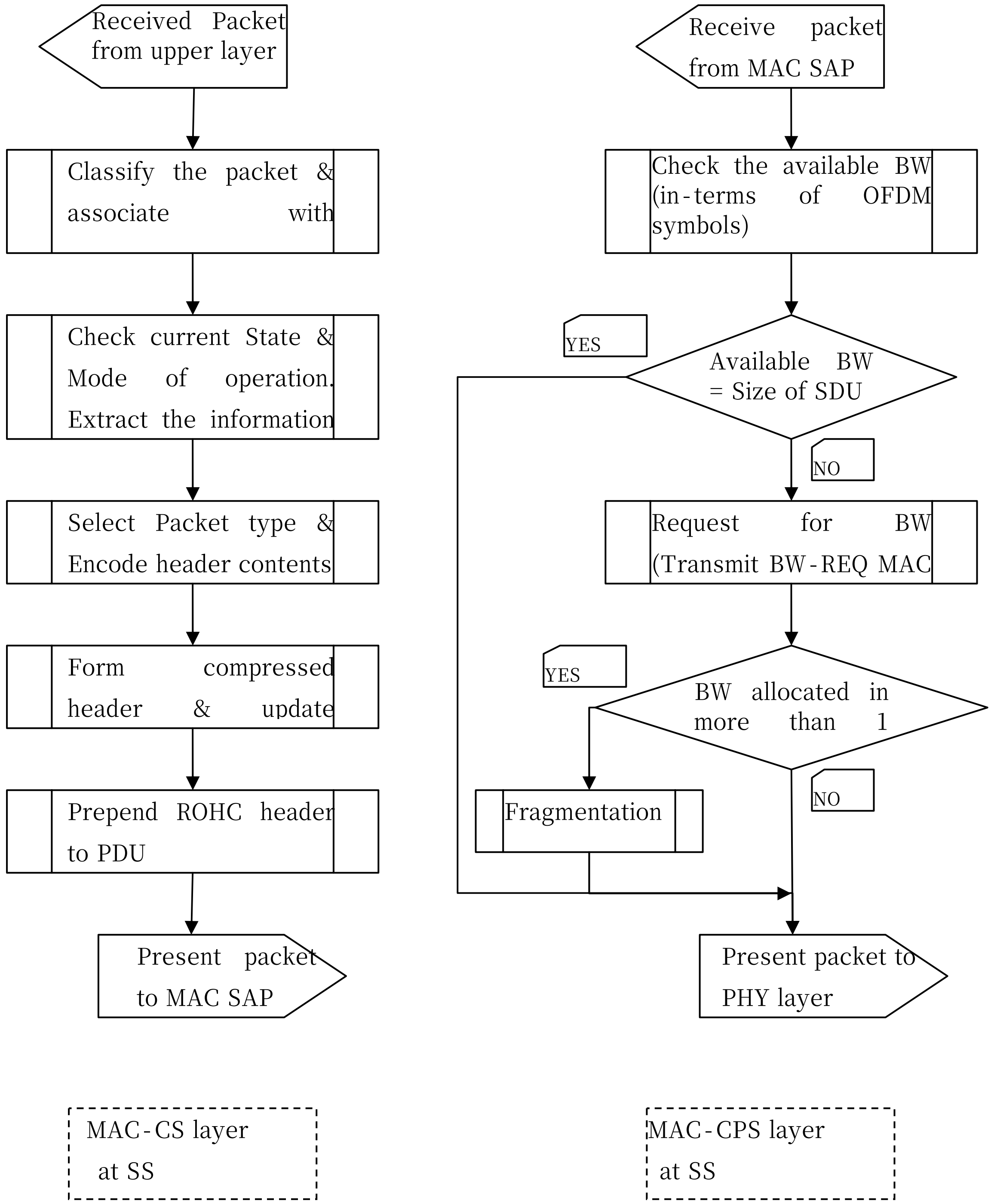
5.2.7.1.2 Downlink data transfer

The downlink data trabsfer operation is similar to uplink data transfer. CS layer at BS receives SDU from its upper layer. CS layer shall apply classification rules to map to its associated ROHC profile. After compressing the received RTP/UDP/IP packet, it shall prefix ROHC header to the payload and transmits the MAC PDU using MAC SAP. MAC CPS shall check the availability of required bandwidth before transmission of the PDU. Fragmentation shall be applied if the required bandwidth for transmission is not available in one frame and then transmits the packet to SS over air interface.

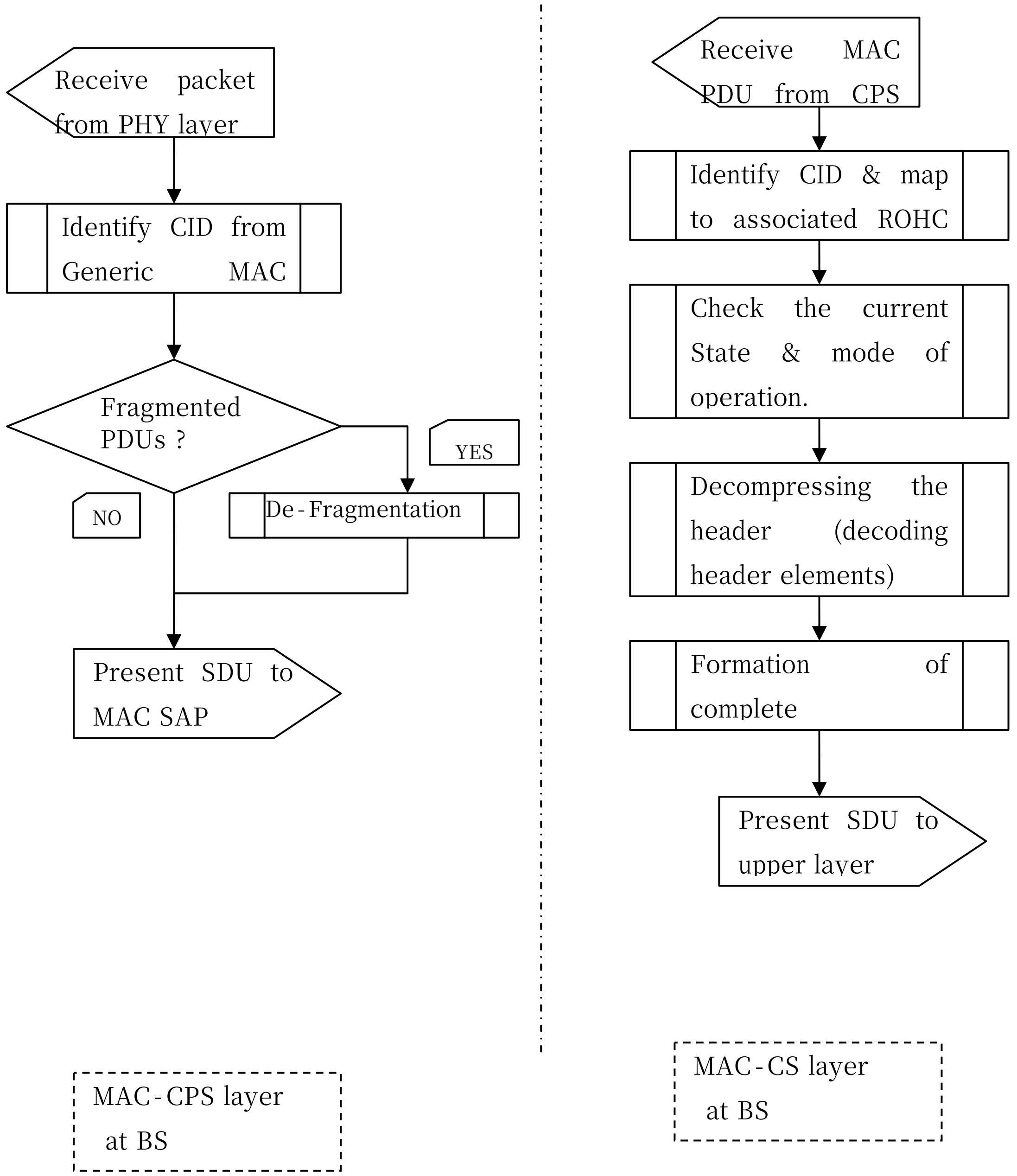
MAC CPS layer at SS receives the MAC PDU from PHY layer via air interface. If required, it shall de-fragment the packet before submitting to MAC CS layer. After receiving the MAC SDU, CS layer shall map to its associated ROHC profile and decompress the packet using information from context database & state machine.

After successful decompression, CS layer shall provide the complete packet to its higher layer entity.

The flow diagram given below describes the data transmission between sender & receiver.



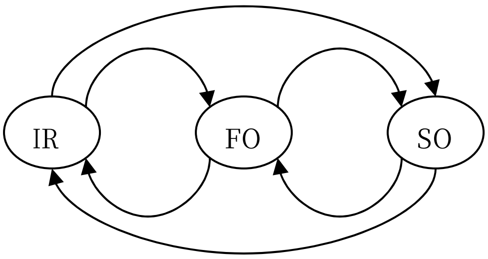
ROHC operation at Sender (SS)



ROHC operation at Receiver (BS)

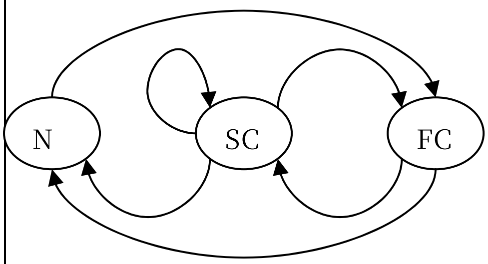
5.2.7.2 States & Modes in ROHC

Sender (compressor) operates in 3 states. IR (Initialization & Refresh), FO (First Order) & SO (Second Order) states.



The compression starts in IR state at the beginning of the session and transit to higher states as the session continues. The most effective compression is achieved in SO state. State transitions can happen in both directions. Successful compression of consecutive packets result in upward state transition and failure of packet compression result in downward state transition. Time out at a particular state also results in downward state transition.

Receiver (decompressor) also maintains 3 states for its operation. NC (No Context), SC (static Context) and FC (Full Context) states.



Decompression always starts from NC state, where there is no context available for decompressor. In this state, compressor sends full header packet. Decompressor stores the context for decompressing consecutive packets. Successful decompression of successive packets results in upward state transition. Failure in decompression results in downward state transition. Most effective compression can be achieved in FC state.

Both Compressor & decompressor operate in 3 modes.

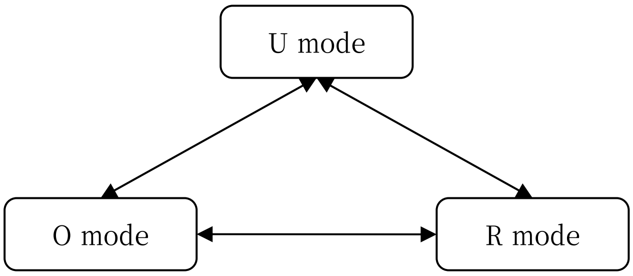
1. Unidirectional Mode U - mode
2. Optimistic Mode O - mode
3. Reliable Mode R – mode

In U-mode operation, both compressor & decompressor operate independently. This mode of operation is used, when the feedback channel is not available. By default, ROHC operation starts from U mode. State transitions are based only on timeout values.

In O-mode operation, feedback channel is used for transmitting error recovery requests from decompressor to compressor. All the upward state transitions are based on optimistic approach.

In R-mode operation, feedback channel is extensively used to inform compressor about the status of decompression. The maximum compression efficiency can be achieved in this mode. Both directions for state transitions are based on feedback packets.

The figure given depicts mode transitions.



5.2.7.3 ROHC Signaling

ROHC signaling shall happen in 2 steps.

5.2.7.3.1 Per channel signaling/Negotiation

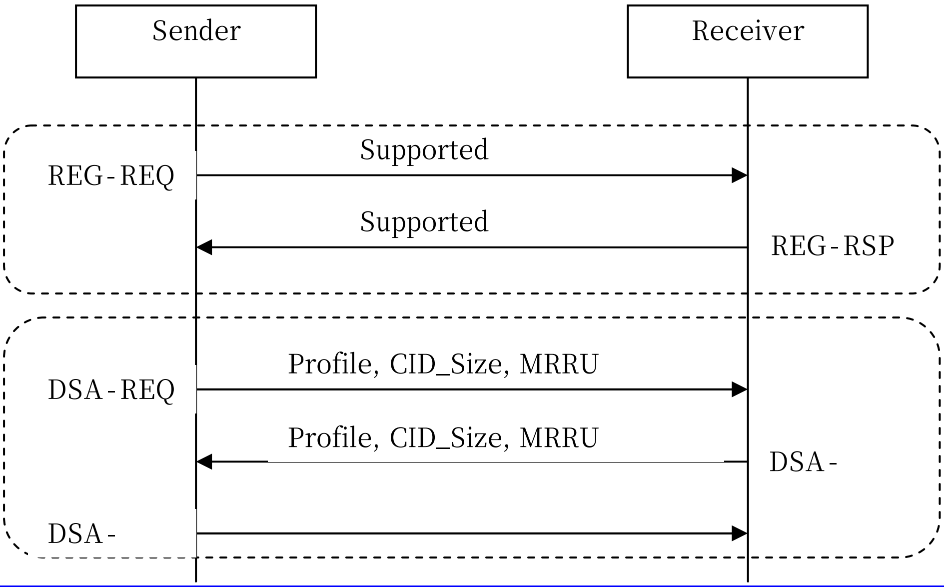
SS shall send the supported ROHC profiles in REG-REQ message during registration procedure. BS shall respond with the profiles which it can support. A particular ROHC profile is possible only if both peers accept. Refer section: 11.7.7.4

5.2.7.3.2 Per session signaling/Negotiation

ROHC rule has to be created using DSA-REQ/RESP messages. The sending entity requests for ROHC rule and the exchanges the session related parameters with receiving entity. The receiving entity either agrees for these profile parameters or modifies and then sends the same to sending entity.

The parameters required for negotiation are:

- Profile (type of session)
- MRRU (maximum reconstructed reception unit)
- CID_Size (Size of Connection identifier)



[Insert after section 11.7.7.3 (OR before section 11.7.8.8)]

11.7.7.4 ROHC Support

Type	Length	Value	Scope
18	1	Bit (0 to 7) = 0 : No ROHC support Bit (0) = 1 : RTP/UDP/IP profile support Bit (1) = 1 : UDP/IP profile support Bit (3) = 1 : ESP/IP profile support Bit (4) = 1 : Uncompressed profile support Bits (5-7) : Reserved	REG-REQ REG-RSP

[Add the following sentence to the first paragraph of section 11.13.11]

11.13.11 Service Flow Scheduling Type

The value of this parameter specifies the scheduling service that shall be enabled for the associated service flow. If the parameter is omitted, BE service is assumed. For VoIP session using ROHC as a compression technique, set the value as 4 (rtPS).

[Modify the following sections as mentioned]

11.13.19.3.5 PHS/ROHC DSC action

When received in a DSC-REQ, this indicates the action that shall be taken with this PHS/ROHC byte string.

Type	Length	Value
[145/146].cst.4	1	0 — Add PHS Rule 1 — Set PHS Rule 2 — Delete PHS Rule 3 — Delete all PHS Rules 4-9 — reserved 10 — Add ROHC Rule 11 — Set ROHC Rule 12 — Delete ROHC Rule 13 — Delete all ROHC Rules

The "Set PHS/ROHC Rule" command is used to add the specific TLVs for an undefined PHS/ROHC rule. It shall NOT be used to modify existing TLVs.

When deleting all PHS Rules any corresponding PHSI shall be ignored.

An attempt to add a PHS/ROHC Rule which already exists is an error condition.

[Insert before section 11.13.19.4]

11.13.19.3.9 ROHC error parameter set

This field defines the parameters associated with ROHC errors.

Type	Length	Value
[145/146].cst.7	Variable	Compound field

A ROHC Error Parameter Set is defined by the following individual parameters:

a) ROHC Profile
b) Errored Parameter
c) Error Code
d) Error Message

The ROHC Error Parameter Set is returned in DSA-RSP and DSC-RSP messages to indicate the recipient's response to a ROHC Rule establishment request in a DSA-REQ or DSC-REQ message.

[Insert after section 11.13.19.3.9]

11.13.19.3.10 ROHC rule

This field defines the parameters associated with a ROHC Rule.

Type	Length	Value
[145/146].cst.8	n	

11.13.19.3.10.1 Profile

This field defines the type of profile required for a particular service/session. The sender shall set this field to one of the values negotiated during REG-REQ/RESP. (see section: 11.7.7.4)

Type	Length	Value
[145/146].cst.8.1	1	

11.13.19.3.10.2 CID_Size

This field identifies the size of CID which is to be used in ROHC compressed packets. It can request either for Zero-CID (No CID) or Small-CID or Large-CID

Type	Length	Value
[145/146].cst.8.2	1	0: ZERO-CID 1: SMALL-CID 2: LARGE_CID

11.13.19.3.10.3 MRRU

The sender shall set this field to the maximum size of PDU, which can be received at receiver.

Type	Length	Value
[145/146].cst.8.3	Variable	

[Modify section 12.1.1.4.7]

12.1.1.4.7 REG-REQ

— Vendor ID Encoding (optional)

— Uplink CID Support

— PKM Flow Control (default = no limit)

— DSx Flow Control (default = no limit)

— MCA Flow Control (default = no limit)

— IP version (default = IPv4)

— MAC CRC support (default = support)

— Multicast Polling Group CID support (default = 4)

— Convergence Sublayer Support (1 instance for each CS supported)

— Maximum number of classifiers (default = 0, no limit)

— PHS support (default = 0, no PHS support)

— ROHC Support (default =0; No ROHC support)

— HMAC Tuple

[Add the following element in section 12.1.1.4.8]

12.1.1.4.8 REG-RSP

— Secondary Management CID

— Uplink CID Support

— Vendor ID Encoding (if present in REG-REQ)

— PKM Flow Control (if present in REG-REQ or changed from default)

— DSx Flow Control (if present in REG-REQ or changed from default)

— MCA Flow Control (if present in REG-REQ or changed from default)

— IP version (if present in REG-REQ or changed from default)

— MAC CRC support (if present in REG-REQ or changed from default)

— Multicast Polling Group CID support (if present in REG-REQ or changed from default)

— Vendor-specific information (Compound, only allowed if Vendor ID present in REG-REQ, and extensions provided)

— Vendor ID

— Vendor-specific extensions

— ROHC Support (default =0; No ROHC support)

— HMAC Tuple

[Add the following elements after PHS parameters in section 12.1.1.6.1(for DSA-REQ)]

— ROHC Profile (s)

— CID_Size

— MRRU

[Add the following elements after PHS parameters in section 12.1.1.6.2 (for DSA-RSP)]

ROHC Error Message

— Errored parameter

— Error code

— Error Message

[Add the following elements after PHS parameters in section 12.1.1.6.3 (for DSC-REQ)]

— ROHC Profile (s)

— CID_Size

— MRRU