

3GPP2 C.S0103-0

Version 1.0

April 2011



**3RD GENERATION
PARTNERSHIP
PROJECT 2
"3GPP2"**

Header Compression for Extended Cell cdma2000 High Rate Packet Data System

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FOREWORD**1 (This foreword is not part of this Standard)**

2 This specification was prepared by Technical Specification Group C with assistance from
3 Technical Specification Group X of the Third Generation Partnership Project 2 (3GPP2).
4 This specification is a companion to the cdma2000^{®1} Extended Cell High Rate Packet Data
5 (xHRPD) specifications. It describes a Header Compression technique that may be employed
6 by the access terminal for applications that require synchronous flow of frames, such as
7 Voice over IP application.

8

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REFERENCES

1 The following documents contain provisions, which, through reference in this text,
2 constitute provisions of this document. References are either specific (identified by date of
3 publication, edition number, version number, etc.) or non-specific. For a specific reference,
4 subsequent revisions do not apply. For a non-specific reference, the latest version applies.
5 In the case of a reference to a 3GPP2 document, a non-specific reference implicitly refers to
6 the latest version of that document in the same Release as the present document.

7 Normative References:

- 8 [1] C.S0098-200-0, Physical Layer for Extended Cell cdma2000 High Rate Packet
9 Data Air Interface Specification, January 2011.
- 10 [2] C.S0098-300-0, Upper Layers for Extended Cell cdma2000 High Rate Packet Data
11 Air Interface Specification, January 2011.
- 12 [3] X.S0011-E, cdma2000 Wireless IP Network Standard : Quality of Service and
13 Header Reduction, November 2009.
- 14 [4] IETF RFC 3550, RTP : A Transport Protocol for Real-Time Applications, July 2003.

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1 INTRODUCTION

1.1 Scope

This specification describes the header compression scheme for xHRPD VoIP application.

1.2 Terms

AN - Access Network

AT- Access Terminal

EMPA - Enhanced Multiflow Packet Application

HSGW- HRPD Serving Gateway

ICI - Initial Context Information

IP - Internet Protocol

MAC – Medium Access Control

PDSN – Public Data Switched Network

QoS – Quality of Service

RLP – Radio Link Protocol

RoHC – Robust Header Compression

RTP - Real Time Protocol

SIP – Session Initiation Protocol

UDP – User Datagram Protocol

VoIP – Voice over IP

xHRPD – Extended Cell High Rate Packet Data

xHSG - xHRPD Header Stripping and Generation

xHSGSP - xHRPD Header Stripping and Generation Signaling Protocol

xHSGBP - xHRPD Header Stripping and Generation Bearer Protocol

1.3 Header Compression Overview

xHRPD reverse link supports removal of all headers for the VoIP packets before transmitting it on the voice dedicated physical layer packets (see [1], [2]). The VoIP RTP packets are passed to the xHRPD Header Stripping and Generation (xHSG) layer which strips off RTP/UDP/IP headers. The packets are then transmitted on voice-dedicated physical layer packets without any air interface header. The RTP/UDP/IP headers are reconstructed at the access network by the xHSG layer from the Initial Context Information (ICI) that is sent by the access terminal to the access network and from the received voice packet related information that is passed by the physical layer.

The xHSG layer employs the Enhanced Multi-Flow Packet Application (EMPA) [2] and consists of xHSG Signalling Protocol (xHSGSP) and xHSG Bearer Protocol (xHSGBP). The

1 xHSGSP uses a dedicated EMPA flow for the signalling packets to setup
2 Compressor/Decompressor context. The xHSGBP uses dedicated EMPA flow for the
3 headerless VoIP packets.

4 xHRPD forward link supports header compression for the forward link VoIP packets using RoHC U-
5 mode [3].

6 **2 HEADER COMPRESSION IN THE FORWARD LINK**

7 In the forward link, the Robust Header Compression (RoHC) protocol [2] shall be used. The
8 RoHC shall be configured to operate in Unidirectional Mode (U-Mode). Once the RoHC
9 Compressor and Decompressor exchange and establish context, packets shall be sent only
10 from the Compressor to the Decompressor.

11 **3 HEADER REMOVAL IN THE REVERSE LINK**

12 The header stripping and generation (HSG) shall be performed between access terminal and
13 access network. At the beginning of a VoIP RTP session, the access terminal shall send N_{ICI}
14 number of ICI messages to the access network using xHSGSP. The access terminal shall
15 remove RTP/UDP/IP headers using xHSGBP, bypass the RLP, Stream and Connection
16 layers and add no MAC header before transmitting the VoIP packet on a voice-dedicated
17 physical layer packet. The access network shall reconstruct Air Interface/RTP/UDP/IP
18 headers based on stored context information and information passed from the physical
19 layer as described in 3.4.1. The header removal and reconstruction shall be transparent to
20 PDSN/HSGW.

21 The header removal protocol consisting of xHSGSP and xHSGBP is shown in Figure 3-1.
22 The Link flow ID for xHSGBP shall be obtained during session negotiation. The xHSGSP
23 shall use Link flow 2 by default.

24

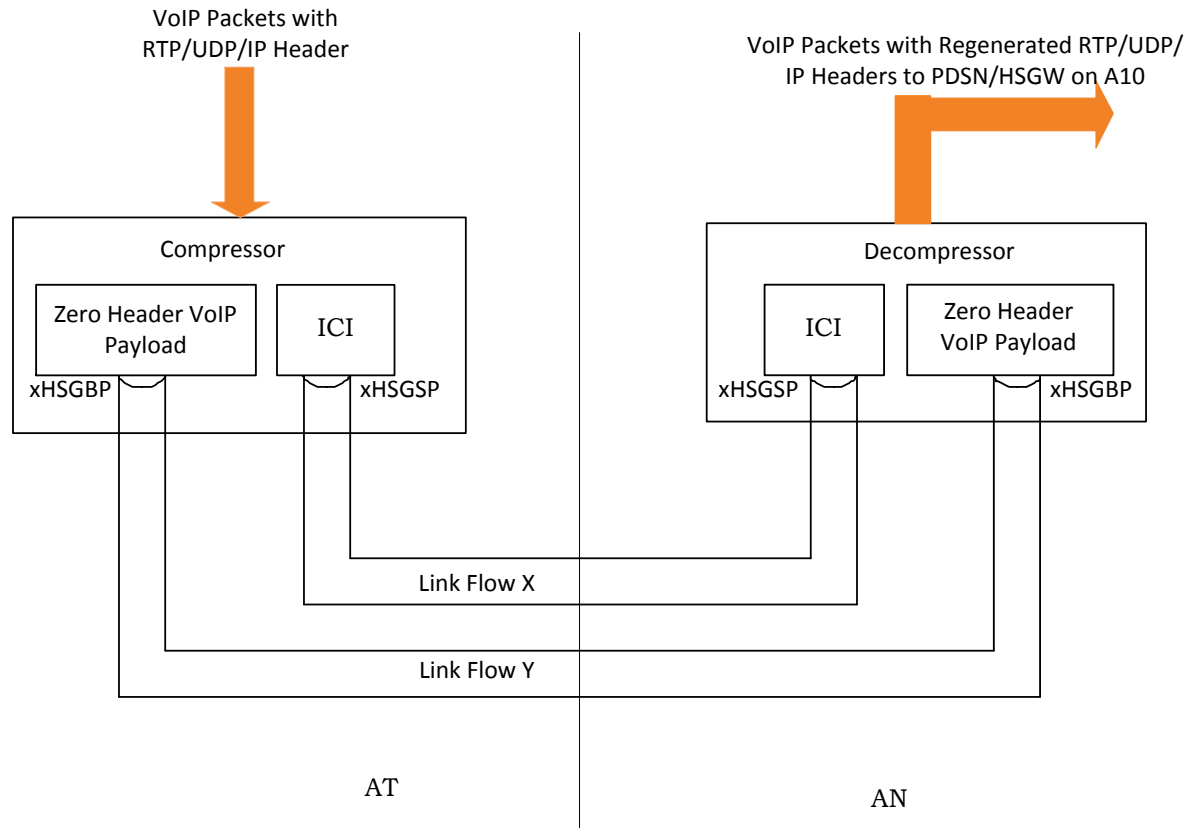


Figure 3-1. Header Removal Protocol

3.1 Compressor

The Compressor performs the header removal operation on the incoming VoIP packets. It constructs and conveys the context information to the Decompressor at the beginning of the VoIP call setup. Furthermore, it maintains the context information during the VoIP call session and performs the header removal on the incoming VoIP packets during the call.

The Compressor operates in one of the three states:

- Context Update State: In this state, the Compressor sends N_{ICI} number of ICI message to the Decompressor.
- Optimistic Compression State: In this state, the Compressor starts sending the header removed VoIP packets to the Decompressor even though it has not yet received ACK for ICI packets.
- Reliable Compression State: In this state, the Compressor continues to send header removed VoIP packets to the Decompressor.

The Compressor's states and the indications and events causing the transition between the states are shown in Figure 3.1-1.

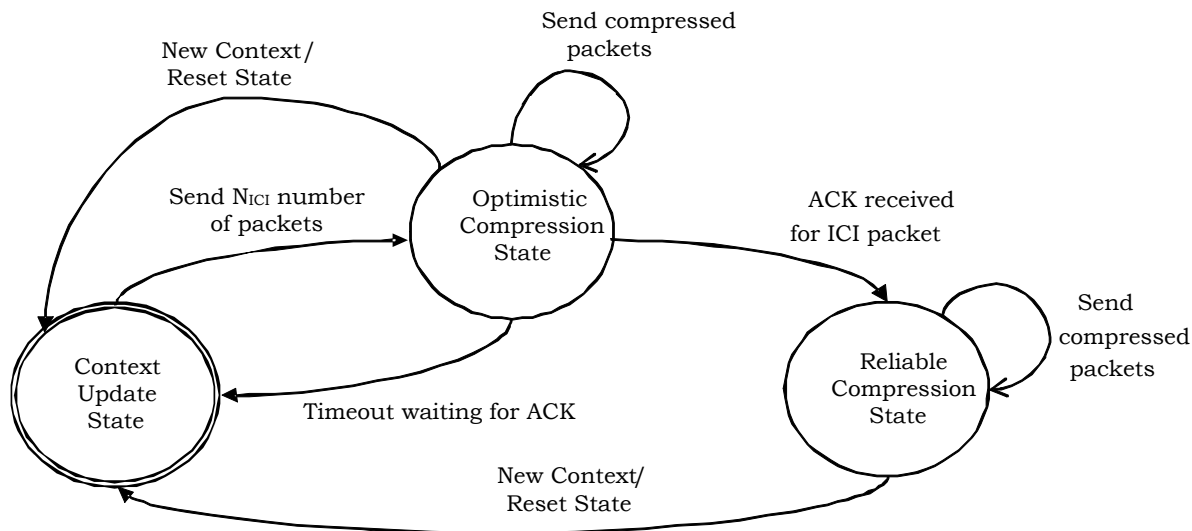


Figure 3.1-1. Header Removal Compressor’s State Machine

3.2 Decompressor

The Decompressor is conveyed the context information by the Compressor at the beginning of VoIP call setup. Using the context information and the information passed from the Physical layer, the Decompressor subsequently performs the RTP/UDP/IP header reconstruction for the incoming zero-header compressed VoIP packets and passes on the full header VoIP packets to the higher layers for further processing.

The Decompressor operates in one of the two states:

- Null Context State: The Decompressor remain in this state until it receives a ICI message.
- Decompression State: In this state, the Decompressor receives ICI and headerless VoIP packets. Upon receiving ICI message, it updates the context and sends ACK to the compressor. Upon receiving headerless VoIP packets, it reconstructs the header.

The Decompressor’s states and the indications and events causing the transition between the states are shown in Figure 3.2-1. Not all state transitions are shown.

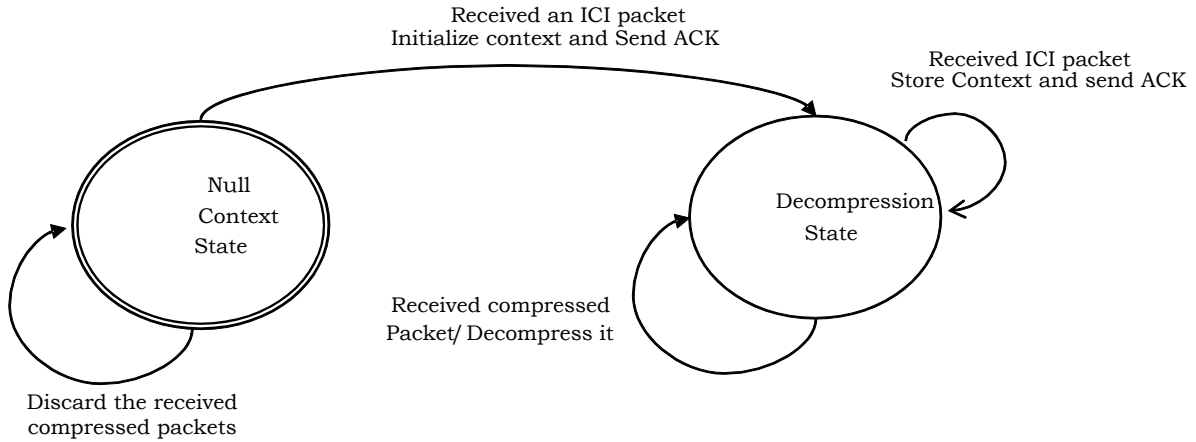


Figure 3.2-1. Header Removal Decompressor's State Machine

3.3 Access Terminal Requirements

The Compressor at the access terminal shall send the context information in the ICI message to the Decompressor at the access network at the beginning of a VoIP RTP session. The Compressor shall send N_{ICI} number of successive ICI messages to the Decompressor. If the Compressor does not receive an ICI ACK within the time interval specified by $T_{ICIAckWait}$, the Compressor shall transmit another set of N_{ICI} ICI messages based on current RTP packet. The Compressor shall repeat these steps till it receives an ICI ACK from the Decompressor, or the user hangs up the call during this process.

After transmitting N_{ICI} number of successive ICI messages to the Decompressor, the Compressor shall perform header removal on the outgoing VoIP packets and transmit the headerless VoIP packets to the Decompressor.

The context shall be applicable only to a current speech session. If the access terminal opens a new speech session, then a new context shall be transmitted.

3.4 Access Network Requirements

3.4.1 Reconstruction of RTP/UDP/IP Header

The Decompressor at the access network shall reconstruct the RTP/UDP/IP header based on context information sent by the Compressor at the access terminal during the context setup and the information passed by the physical layer.

0		8		16		24	
Version		IHL		TOS		Total Length	
IP ID				R	DF	MF	Fragment Offset
TTL		Protocol		Checksum			
Source IP Address							
Destination IP Address							
Source Port				Destination Port			
Length				Checksum			
Version	P	X	CC	M	PT	Sequence Number	
Time Stamp							
SSRC							
CSRC							
.....							

Figure 3.4.1-1. IP/UDP/RTP Header for IPv4

0		8		16		24	
Version		Priority		Flow Label			
Payload Length				Next Header Type		Hop Limit	
Source IP Address							
Destination IP Address							
Source Port				Destination Port			
Length				Checksum			
Version	P	X	CC	M	PT	Sequence Number	
Time Stamp							
SSRC							
CSRC							
.....							

Figure 3.4.1-2. IP/UDP/RTP Header for IPv6

Refer to the IP/UDP/RTP header as shown in Figure 3.4.1-1 and Figure 3.4.1-2 for IPv4 and IPv6, respectively [4]. The following fields shall be obtained directly from the stored context information.

- Source IP address
- Destination IP address
- Source UDP port address
- Destination UDP port address
- Payload type (PT)

The Decompressor shall reconstruct the other fields as follows.

- 1 • RTP sequence number: The Decompressor shall increment the sequence number for
 2 every new packet (both good and erroneous VoIP packets as indicated by CRC pass/fail
 3 from the Physical layer) received, with the initial RTP sequence number obtained from
 4 the latest ICI message sent by the Compressor. Only the good VoIP packet shall be sent
 5 to the higher layer.
- 6 • IP ID: IP ID should be filled with the same value as the RTP sequence number. This field
 7 is used by the IP protocol to identify the fragments of one datagram from those of
 8 another. Since the VoIP packet fits into one physical layer packet, there is no IP
 9 fragmentation and the IP ID field can be set to any unique value for each packet.
- 10 • RTP time stamp: The physical layer provides the Decompressor the CDMA time stamp
 11 (in units of 20 ms) for every new VoIP packet received. The Decompressor shall use this
 12 information to compute the RTP timestamp. The RTP timestamp increases by 160 (8 K
 13 samples/sec * 20 ms) for consecutive packets.
- 14 • The length and checksum fields shall be computed from the other fields.
- 15 • The access network shall set the remaining fields as per the operator's requirements.

16 3.4.2 Reconstruction of Air Interface Header

17 The air interface header consisting of MAC/Connection/Stream/RLP headers shall be
 18 constructed as described in Table 3.4.2-1 for voice-dedicated received physical layer packet
 19 that passes the CRC check.

20 **Table 3.4.2-1. Air Interface Header Reconstruction from Voice-Dedicated Physical**
 21 **Layer Packet**

Layer	Fields	Length (bits)	Values and Meaning
RLP	LinkFlowNumber	5	Obtained from stored context. Link Flow Number associated with headerless VoIP flow
	Route	1	Always 0
	SEQ	6	Always 0 when CRC check passed. The header is constructed only if CRC passed.
	FirstDataUnit	1	1
	LastDataUnit	1	1
Stream	Stream header	2	2 (Stream 2 Application. For this stream, application subtype is set to EMPA)
Connection	Header	0	No header for format A packet
MAC	MAC Trailer	8	b7: Connection Layer format; 0 - indicates format A connection layer packet b6: Transmission Mode; 1 - indicates

Layer	Fields	Length (bits)	Values and Meaning
			Low-Lat transmission mode b5-b0: Not used.

1 3.5 Message Format

2 3.5.1 Initial Context Info for IPv4 (ICiv4) Message

3 The Initial Context Info message is transmitted by the Compressor to the Decompressor to
4 setup the context at the start of a VoIP RTP session.

Field	Length (bits)
MessageID	8
LinkFlowNumber	8
SourceIPAddress	32
DestinationIPAddress	32
SourceUDPPortAddress	16
DestinationUDPPortAddress	16
RTPSequenceNumber	16
PayloadType	7
Reserved	1

5	MessageID	The sender (Compressor) shall set this field 0x00.
6	LinkFlowNumber	The sender shall set this field to Link flow number associated
7		with VoIP RTP flow.
8	SourceIPAddress	The sender shall set this field to Source IP address extracted
9		from IP header.
10	DestinationIPAddress	The sender shall set this field to Destination IP address
11		extracted from IP header.
12	SourceUDPPortAddress	The sender shall set this field to source UDP port address
13		extracted from UDP header.
14	DestinationUDPPortAddress	The sender shall set this field to destination UDP port address
15		extracted from UDP header.
16	RTPSequenceNumber	The sender shall set this field to RTP sequence number
17		extracted from RTP header.
18	PayloadType	The sender shall set this field to payload type extracted from
19		RTP header.

1 Reserved This field shall be set to '0'.

2

3 3.5.2 Initial Context Info for IPv4 ACK (ICIv4 ACK)

4 The ACK packet is sent by the Decompressor to the Compressor to acknowledge the receipt
5 of Initial Context Info message to setup context between the two modules.

Field	Length (bits)
MessageID	8

6 MessageID The sender (Decompressor) shall set this field 0x01.

7 3.5.3 Initial Context Info for IPv6 (ICIv6) Message

8 The Initial Context Info message is transmitted by the Compressor to the Decompressor to
9 setup the context at the start of a VoIP RTP session.

Field	Length (bits)
MessageID	8
LinkFlowNumber	8
SourceIPAddress	128
DestinationIPAddress	128
SourceUDPPortAddress	16
DestinationUDPPortAddress	16
RTPSequenceNumber	16
PayloadType	7
Reserved	1

10 MessageID The sender (Compressor) shall set this field to 0x02.

11 LinkFlowNumber The sender shall set this field to Link flow number associated
12 with RTP flow.

13 SourceIPAddress The sender shall set this field to Source IP address extracted
14 from IP header.

15 DestinationIPAddress The sender shall set this field to Destination IP address
16 extracted from IP header.

17 SourceUDPPortAddress The sender shall set this field to source UDP port address
18 extracted from UDP header.

19 DestinationUDPPortAddress The sender shall set this field to destination UDP port address
20 extracted from UDP header.

Annex A (Informative): Example of xHRPD VoIP Call Setup

The following diagram shows the high level view of VoIP call setup for xHRPD.

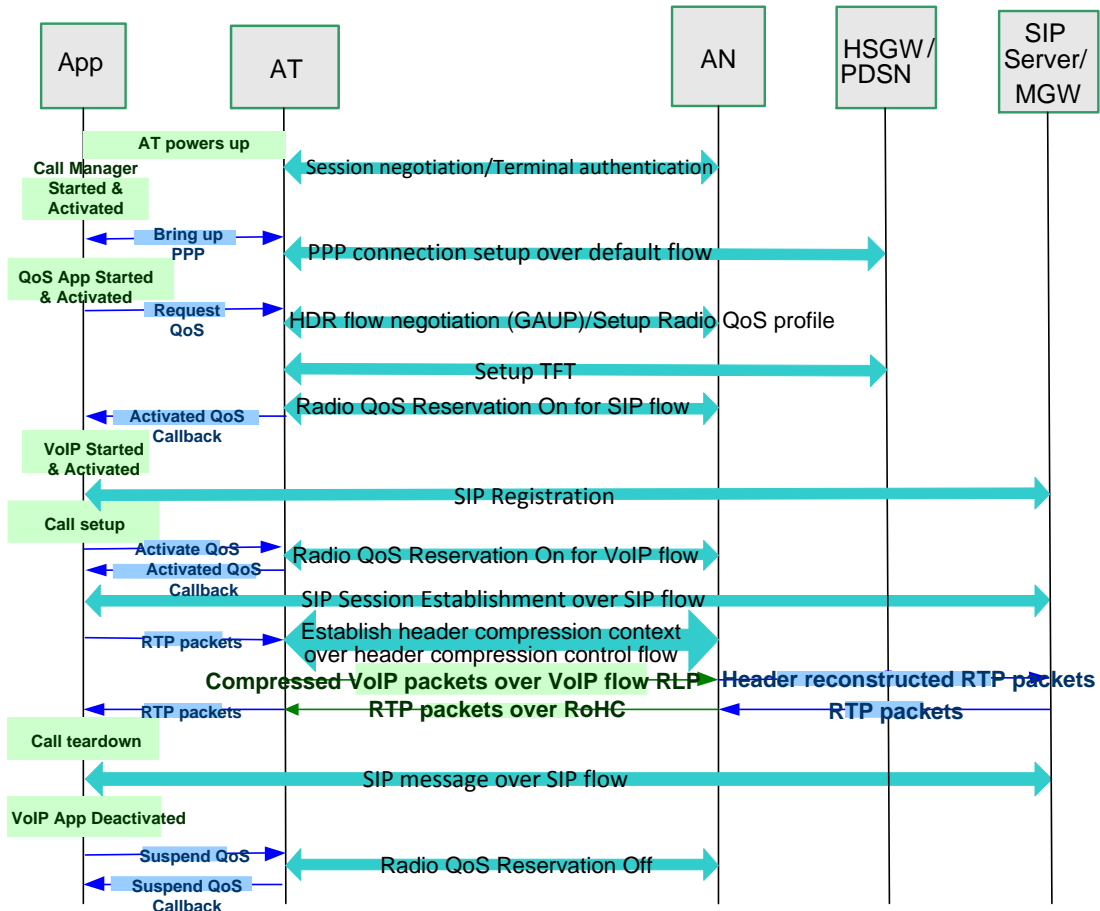


Figure A-1: VoIP Call setup

1. The AT powers up and needs to perform session negotiation.
2. The AT performs session negotiation with the AN.
3. The Call manager sends PPP request to AT. AT establishes PPP session with the HSGW/PDSN.
4. The QoS application sends QoS Request to AT.
5. The AT sends a ReservationKKQoSRequest to the AN. The AN responds with the ReservationKKQoSResponse message, creates and configures the RLP and RTCMAC instance and then binds the RLP instance to the reservation label and the RTCMAC instance to the RLP instance.

- 1 6. The RSVP messaging between the AT and HSGW/PDSN is performed. The AT
- 2 sends a RESV message carrying the TFT/ filter settings. The HSGW/PDSN
- 3 responds with a RESVConf message.
- 4 7. The ReservationLabel is turned on, activating the QoS profile over the radio link.
- 5 8. Successful QoS setup indication is sent to the QoS Application.
- 6 9. The VoIP Application is started and it performs SIP registration with the SIP server.
- 7 10. The VoIP Application initiates call setup using SIP.
- 8 11. At the beginning of voice session, zero-header compression context is established
- 9 between AT and AN.
- 10 12. Once the zero-header compression context is established, compressed RTP packets
- 11 go over voice Link flow.
- 12 13. Forward link RTP packets are compressed using RoHC.
- 13 14. When the user hangs the call, the VoIP application sends call teardown SIP
- 14 messages to SIP server
- 15 15. VoIP application is deactivated by the user.
- 16 16. The QoS application triggers AT to send ReservationOffRequest to deactivate the
- 17 flow. This deactivates the reservation on both AT and AN
- 18 17. The QoS Application is informed of the successful QoS deactivation
- 19