

Protocol Optimization for Voice over Wireless IP networks-- CRC improvement in ROHC

By: Zizhi Qiao September 2001


MSc Integrated Services & Intelligent
Networks Engineering

D.C.E.E. University of Plymouth





Topics:

- Background and introduction
 - ROHC study
 - CRC and one-bit correction study
 - Test and simulation
 - Reaction steps modifications
 - Conclusions
- 



Background and introduction

Two ways to transport voice:

- **Circuit switching**

Setup -- transport -- release


High QoS and high usage of bandwidth

- **Packet switching**

Packet headers include full information for delivery in the network.

Several applications in one carrier, high bandwidth efficiency

But: Pack/unpack delay, queuing delay, wrong sequence, jitter etc.





Problem definition

A big problem in voice transport over IP networks is that the full protocol headers (IP/UDP/RTP header) is much bigger than the the voice information payload. That means the bandwidth efficiency is not very good.

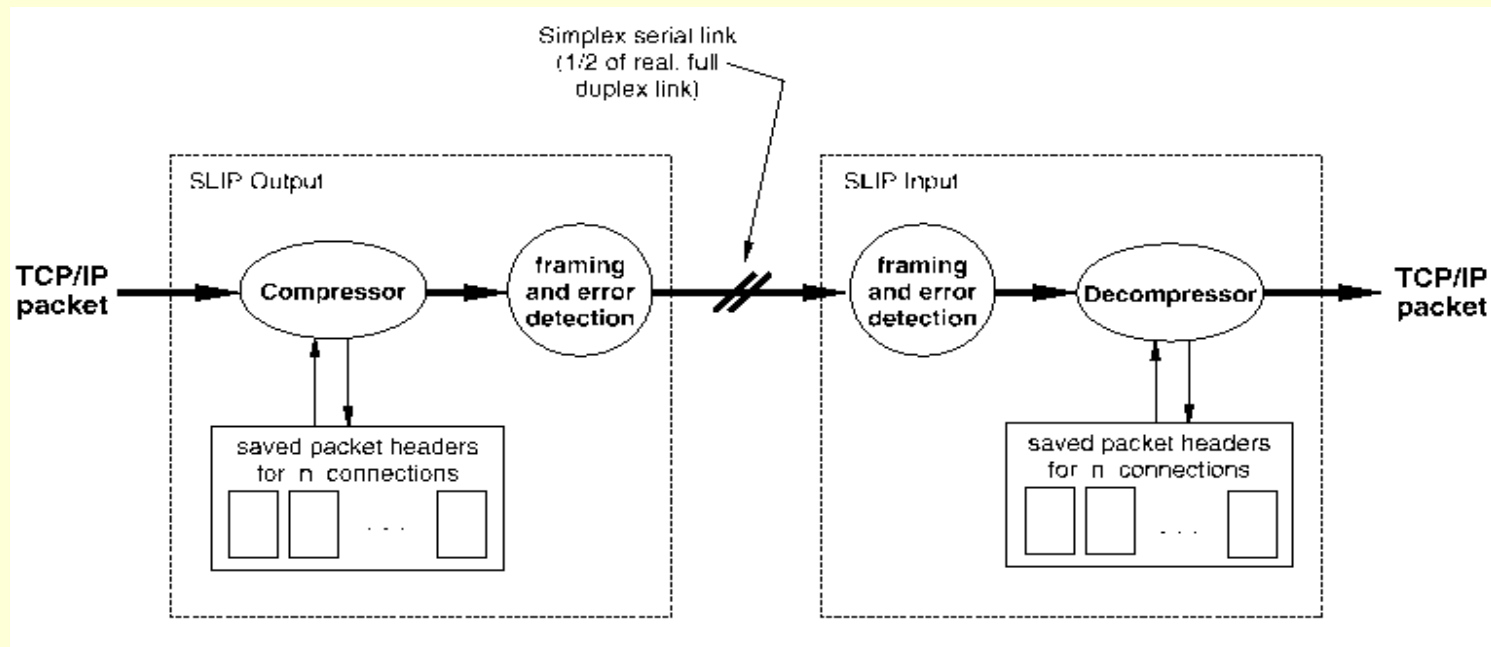
Headers for a 20 ms packet:

$(20+8+12)*8=320$ bits

Common payload size: 171 bits from 3GPP2



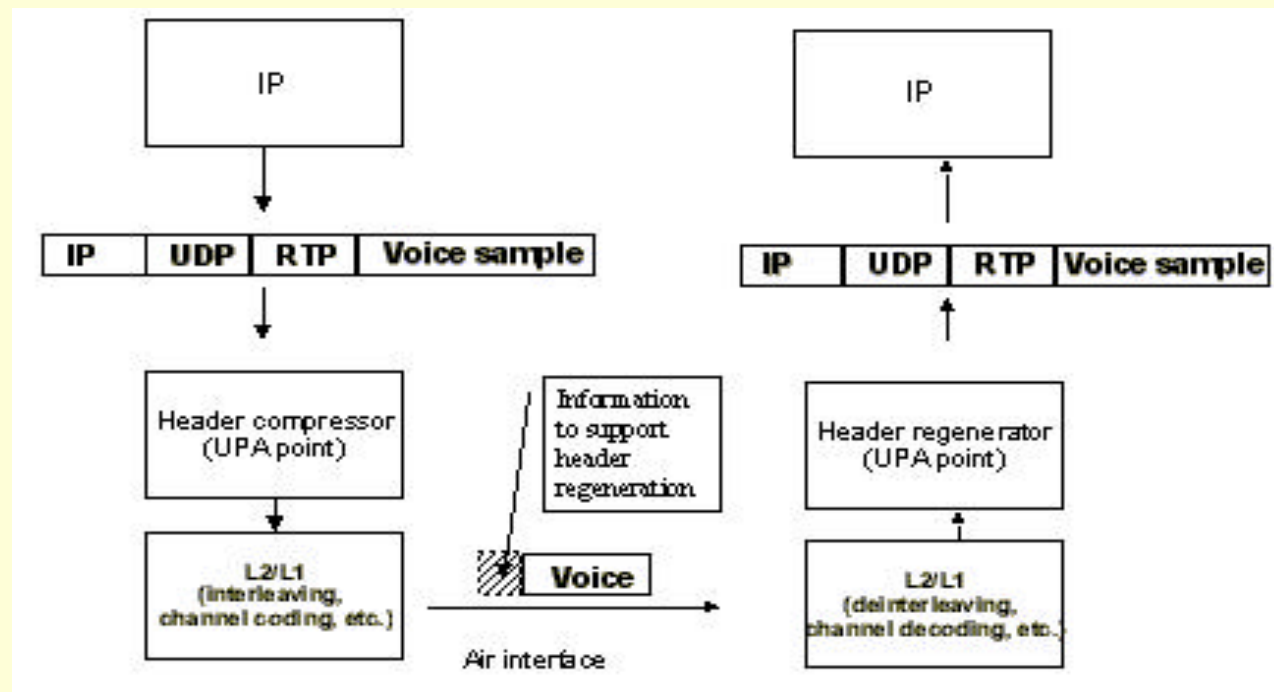
Header compression: The basic header compression idea in SLIP (RFC1144)



Save the redundant information in the context, send the packets with compressed header and decompress the header using the context.

Header stripping

Source: 3GPP Architecture for all IP networks






Introduction for ROHC

ROHC protocol specifies a highly robust and efficient header compression scheme for RTP/UDP/IP (Real-Time Transport Protocol, User Datagram Protocol, Internet Protocol), UDP/IP, and ESP/IP (Encapsulating Security Payload) headers.

It is specifically dealing with links with significant error rates like the wireless links and long round-trip times.





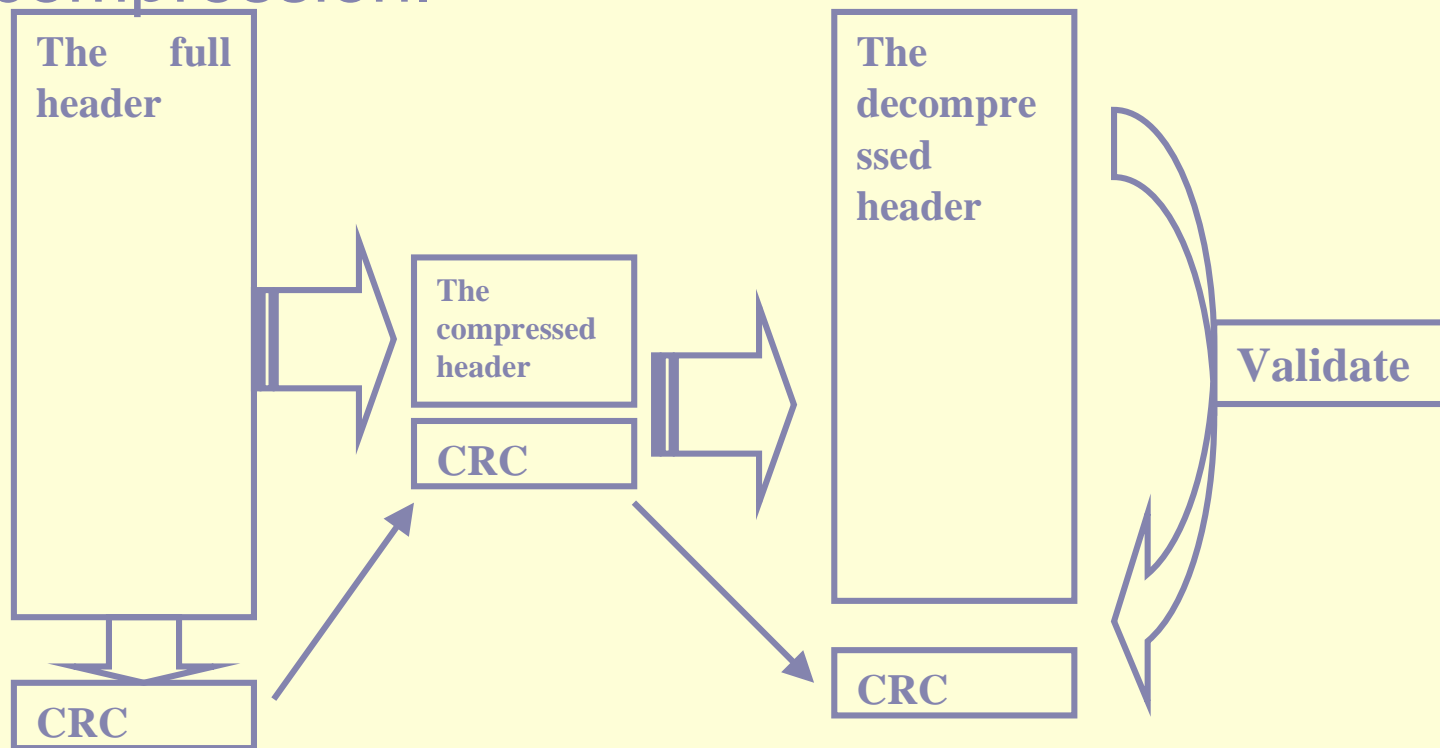
Introduction for ROHC (Cont.)

- Modes and states, compressor and decompressor
 - 3 working modes U, O and R
 - IR, FO, SO states
 - No context, static context and full context in decompressor
- The improvement compared with RFC 1144:
 - Local repair instead of retransmit
 - step-by-step state backward instead of sudden stop



CRC in ROHC

CRC plays a very important role in the ROHC. It is used to validate the header after decompression.






CRC and One bit correction CRC

- **Original CRC**-- easy, fast, no correction ability
 - Simply mode 2 division
 - Could be done by using hardware SR
 - No correction ability, checking only
- **Methods**
 - If there is error in the message, the remainder of the mode 2 division should be different
 - The CRC field in the message set all zero before the mode 2 division





CRC and One bit correction CRC (2)

- The one bit correction method
 - The CRC can be used to correct one-bit error
 - Based on the finite field theory
 - What does the “**one-bit**” mean?
 - If there is no error, the same as CRC
 - If there is one bit error in the CRC protected field, it will be located and corrected.
 - If there is more than one error, the decoder will locate the error place incorrectly.
- 



CRC and One bit correction CRC (3)

- How it works
 - There is a lookup table based on the finite field theory
 - One column in the lookup table is the remainder and the other column in the table is the location of the one-bit error
 - The lookup table will catch all one-bit error but multi-errors will be looked as one-bit error and cause mistakes






CRC and One bit correction CRC (4)

- Advantages and limits
 - The correction ability with minimal changes to the CRC
 - But the correction can only correct one-bit error, and multi-errors will be wrongly corrected
 - The covering field is limited to $2^m - 1$, m is the length of CRC field.






Test and simulation

- The test for CRC and One-bit correction
CRC
 - Test the method working well
 - The simulation in the channel
 - The goal of the simulation is to
 - find what is the behavior of the headers transported in the channels.
 - Find what is the distribution of errors in the header
 - Find how many one-bit errors will occur in the channel
- 

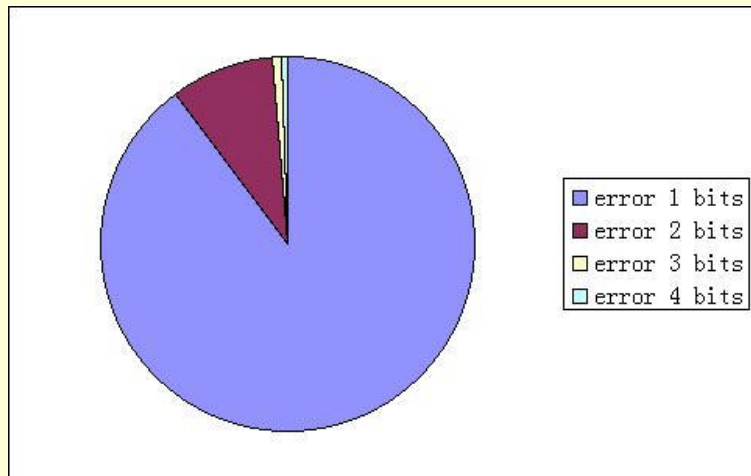


Test and simulation (2)

- Simulation methods and channels
 - There are 3 channels simulated in this project
 - The basic Poisson noise channel used to build the basic idea about the error distribution
 - The Gaussian noise channel
 - The fading channel
 - All channels simulated by Matlab
 - Random data source, pieced every 24 bits as 3-bytes headers. Count the error numbers in the 3-bytes header and find how many one-bit error are there in the hundreds of headers
- 

Test and simulation (3)

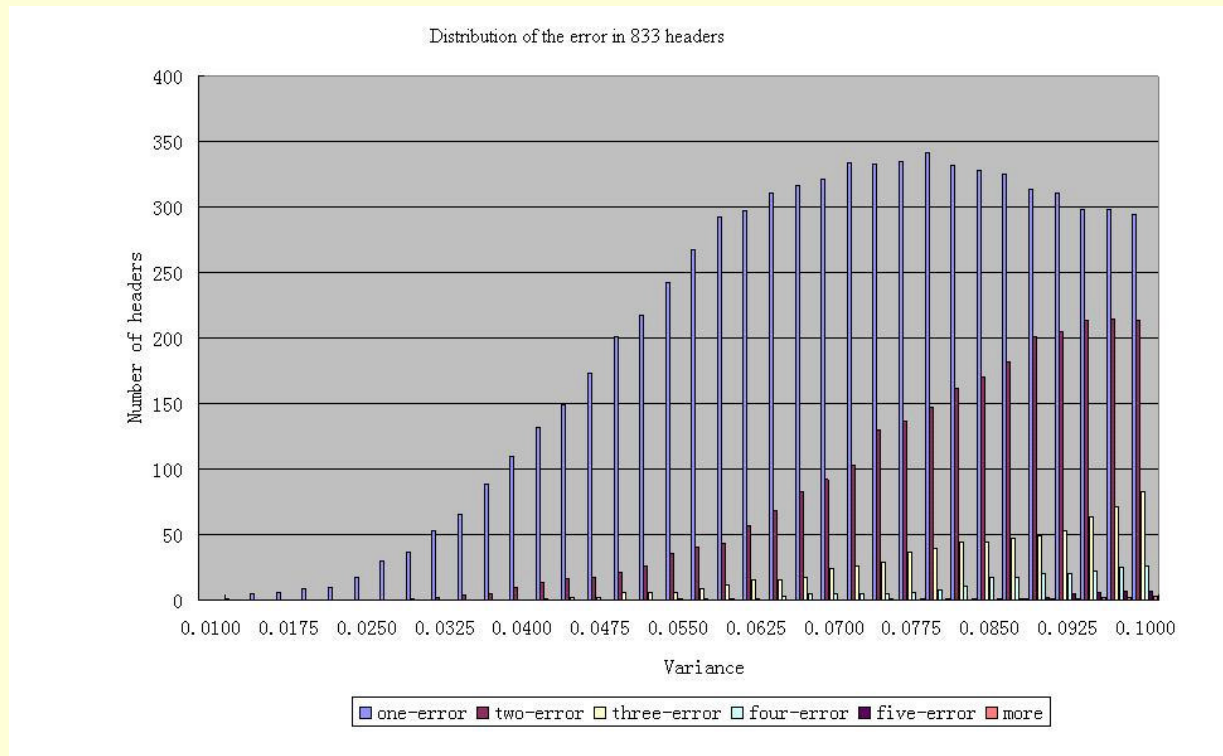
- The basic picture from the Poisson channel
 - The BER increases with the noise level
 - The one-bit error is the major error in the headers when the bit error rate is not so high (4%-5%)



The picture in the left shows the distribution of errors when lambda is 0.01. The one-bit error is the most frequently occurring one

Test and simulation (4)

- The Gaussian channel

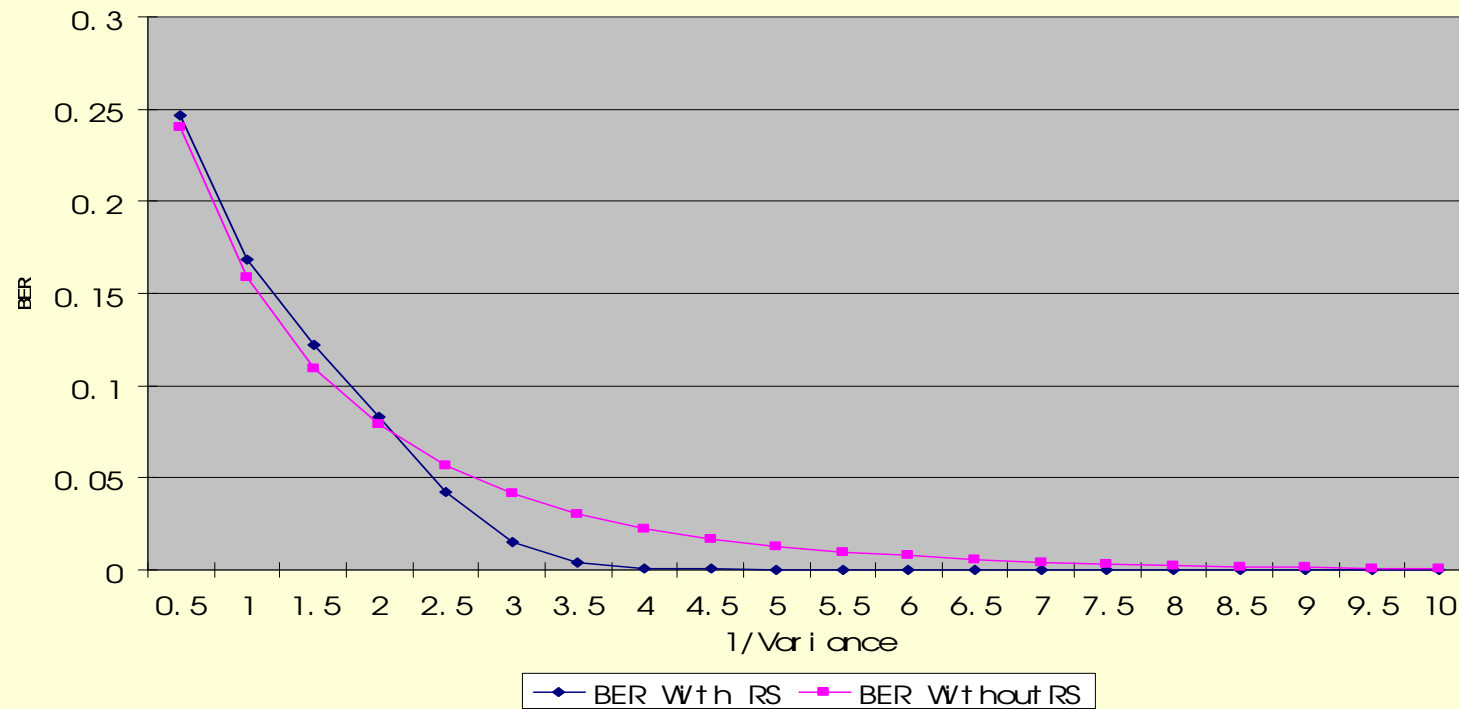


The plot shows that the one-bit error is the most frequently error when the Variance is less than 0.08

Test and simulation (5)

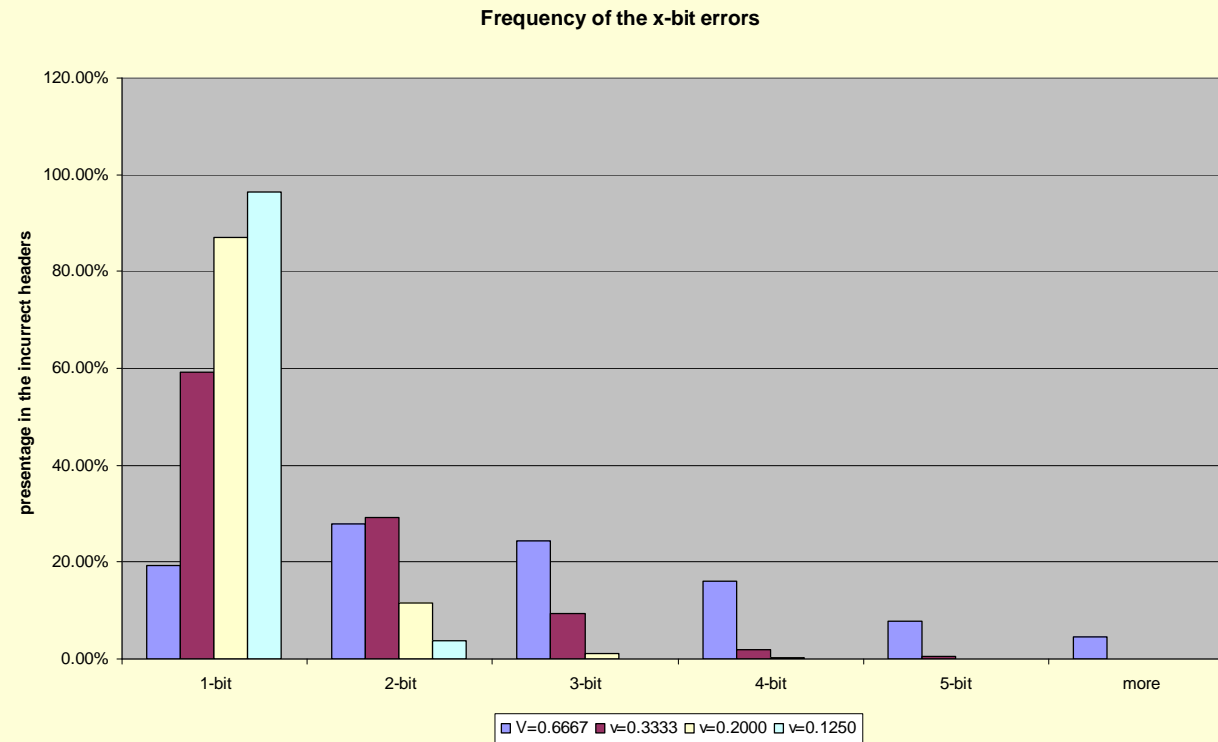
- The fading channel

The BER in fading channel with and without RS




Test and simulation (6)

- The fading channel





Simulation Result

- A general conclusion about the simulation in the channels is that the distribution of the errors is directly related to the bit error rate. When the bit error rates are small enough, the one-bit error occurs most frequently in all the x-bit errors. When the BER is about 4%-5%, the one-bit error occurs a little more than half in all the errors.
- 



Modification to the ROHC (1)

- **Two kinds of modification----**
 - The double one-bit correction method
 - The single one-bit correction method






Modification to the ROHC (2)

- **The double one-bit correction CRC method**
 - Use 2 one-bit correction CRC field and the decompressor knows what kind of error(s) are there.
 - If the two CRC field locate the same one-bit error, the decompressor will correct it and go ahead to the next steps without waiting for validation.
 - **Fast decision and save the waiting time.**
 - **But the header will be rearranged.**





Modification to the ROHC (3)

- **The single one-bit correction method**
 - Minimised modification to the original ROHC protocol.
 - The validation to the correction and local repair must be done in co-operation with the original reaction steps to the CRC failure.
 - Packet corrected need to wait in the buffer until next validation.
- 



Conclusion

- This project is based on the detailed study about the ROHC and it introduces a simple and efficient way to improve the performance of the ROHC over the wireless channels.
 - The method is to add some correction ability to the CRC fields in the transferred headers to correct and validate the decompressed headers.
 - The idea is supported by the test of the CRC correction ability, the simulation and analysis of the header transport behaviour in the channels.
 - The result is that the correction ability in the CRC field could improve the efficiency of the header compression when the noise level is not very high. The method will work well when the BER is lower than 4-5%.
- 