

TG3/TG4 FEC Ad-Hoc Group Progress Report

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TG3/TG4 FEC Ad-Hoc Group Progress Report

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TG3/TG4 FEC Ad-Hoc Group Progress Report

Garik Markarian (Dr)

Aim

- To address the following comments:
 - Harmonisation of the puncturing table for convolutional codes in TG3;
 - Reduction in the number of mandatory FEC solutions for TG4;
- To address any other issue related to FEC in TG3 and TG4

House Keeping

- 28 members registered their interest to participate in the Group;
- 4 conference calls (each one with duration almost 2 hours);
- Very active traffic on the reflector;
- Minutes produced within a couple of days after a conference call;
- Decisions were made only during the conference calls;
- In some cases, info from MAC Group and the results of field trials were used in order to make a decision.

Decisions and Actions

Decision: A unanimous decision was made to modify the puncturing table of convolutional codes in OFDM mode of TG3 and make it similar to the SC mode of TG3.

Action: Nico, as an Editor of TG3 has agreed to deal with this issue as an editorial comment.

Decisions and Actions (Cont.)

Decision: After consideration of the presented simulation results for both AWGN and SUI channels, Group has decided to accept concatenated RS and tail biting CC scheme as the mandatory scheme for TG4 FEC (11 for 1 against).

Action: Modified table 192 has been submitted as a recommendation from the FEC Group to the IEEE802.16. Performance figures for low rate coding scheme have been requested;

Decisions and Actions (Cont.)

Decision: After analysing the presented results the proposed low rate concatenated coding scheme has been recommended for submission as a recommendation from the Ad-Hoc Group;

Action:

1. Runcom to submit this document as a recommendation.
2. To ask Runcom to produce simulation results for the same channel but with CC R=1/6 coding scheme only. The results to be discussed during the next IEEE meeting.

Other Issues

- The following issues have been discussed, however, now decision was made:
 - Bit interleaving for SC mode of TG3;

Conclusions

- All the comments assigned to the Group have been resolved and the corresponding recommendations submitted to the IEEE802.16

Ad-Hoc FEC Group Conference Calls Minutes

1 Introduction

The following document details the Ad-hoc FEC group conference calls that were held between session #14 Portland and session #15, Denver.

In total, four conference calls took place. These occurred at the dates and times shown in Table 1.

Conference Call	Date	Time (Pacific Time)
1	23/07/2001	09:00
2	30/07/2001	09:00
3	13/08/2001	09:00
4	27/08/2001	09:00

Table 1 - Conference Call Dates and Times

2 Participants

The list below give the names of all those interested in joining the Ad-hoc FEC group conference calls, and indeed those whom were invited to take part:

Chin-Chen Lee, Radia Communications

Amir Sarajedini, BeamReach Networks, Inc

John Liebetreu, Intersil Corporation

Anader Benyamin-Seeyar, Harris Corporation Inc.

Brian Eidson, Conexant Systems Inc.

David Williams, Advanced Hardware Architectures

Einan Regev, Wavion

Garik Markarian, Adcanced Hardware Architectures

Hikmet Sari, Pacific Broadband Communications

Joseph Hakim, Aperto Networks

Minfei Leng, Clearwire Technologies Inc.

Moshe Ran, TelesciCOM Ltd.
Nico Van Waes, Nokia Networks
Paul Struhsaker, Raze Technologies
Ronald Murias, Wi-LAN Inc.
Sean Sonander, Advanced Hardware Architectures
Tal Kaitz, BreezeCom
Yossi Segal, Runcom Technologies Ltd.
Brian Edmonston, iCoding
Octavian Sarca, Redline Communications Inc.
Jun Shen, Aperto Networks
Manoneet Singh, Radia Communications
Mike Paff, Radia Communications
Ayelet Tiram-Regev, Marconi
Ofer Kelman, Marconi
Charlie Cahn, Western Multiplex
Arthur Wang, Western Multiplex
Wendy W, Aperto Networks

3 Minutes of Conference Call 1

23.07.01, 09:00 am Pacific Time

Present:

Anader, Nico, Brian Eidson, Brian Edmonston, Mink, Tal, Moshe, Garik, Yossi, Charlie, Ofer, Octavian, Paul (sorry I missed somebody);

Agenda:

No modifications to original agenda;

64 bytes of data;

239 bytes of data.

The results to be presented on the 7th of August.

Agenda for the next meeting:

To discuss outer interleaver (Moshe will make a contribution

4 Minutes of Conference Call 2

30.07.01, 09:00 am Pacific Time

Present:

John, Ron, Jun, Tal, Brian Edmonston, Paul, Ofer, Ron, Brian Eidson, Nico, Octavian, Moshe, Charles (sorry I missed somebody);

Agenda:

Puncturing Table for Convolutional Codes:

Brian — Confused on what to include into the table?

Nico — will take care and modify table as an editorial comment.

Interleaver:

Octavian — there are 2 interleavers defined (TG3 and TG4) and the difference is small. TG4 interleaver is easy to generate with almost no memory required. Suggested to use only one interleaver (TG4) for both TG3 and TG4.

Moshe — suggested to add outer interleaver for higher order modulation techniques;

Octavian — TG3 (OFDM) and TG4 have such an interleaver. We need to concentrate on TG4 spec;

Brian — lets keep things simple.

Comparing RS+CC with CC only:

Garik —Runcom made a contribution showing that applying erasure decoding of RS codes could produce up to 0.7 dB performance improvement. Shall we ask Runcom to present the results?

Ron (Runcom) — described the simulation results, confirmed coding gain at PER=1% and suggested to keep RS+CC with tail baiting as the mandatory scheme, similar to TG3.

? (didn't recognise the voice) — how about buffer size for large packets and h/w complexity?

Tal — this solution would require more operations per information bit those increasing the complexity, for very short blocks zero padding is very efficient;

Octavian — tail baiting introduces delay problems;

Ron — as FFT is a parallel process there are no problems with delays;

Octavian — explained his original point (a few times);

? (didn't recognise the voice) — how much complexity adds soft output Viterbi?

Ron — this is very little;

Brian — please clarify frame sizes and modulations;

Ron — 144 bytes, QPSK, erasure helps a lot;

Octavian — last time we discussed that PER =2-3% should be used for comparison., for these PER CC only is better, the results also show a disagreement with Brian's simulation.

Brian — Comparison is between different specs;

Octavian — in real situation (multipath, fading, etc) RSV will perform worse, due to error distribution at the output of CC;

Ron — we need to see simulation results;

Octavian (making a proposal) — for PER=1% difference between RS+CC and CC is very small, however, for higher PERs (2-3%) difference is much bigger in favour of CC only. Lets make CC only mandatory and RS optional.

Ron — do not agree;

Moshe — presented results are interesting, applying erasure decoding gives advantages without rate reduction, PER=1% is very poor and lower PERs should be used for comparison.

Tal — mandatory coding scheme should be the simplest and the best. CC=yes, RS-not.

Octavian — how you indicate erasures?

Ron — 1 bit error in a byte is an erasure

? (didn't recognise the voice) — let's accept CC as the mandatory and TPC as an optional, we don't need RS codes;

Moshe — why not to accept BTC as a mandatory code?

Garik — we have 3 possible solutions:

Similar to TG3, i.e. RS+CC mandatory and CC and turbo codes optional;

CC mandatory, RS and Turbo codes optional;

CC mandatory and Turbo codes optional

The choice will depend on the packet length, as different coding schemes are optimum for different packet lengths.

Octavian — let's take 1k packet, divide it into 256 sub-packets plus a few control packets and apply tail baiting for each symbol.

Octavian — this solution is good RS+CC, not CC alone;

Brian (Connexant) — Disagree .(line is lost)

Ron — I like this proposal;

Garik — can Ron and Octavian run some simulations and show us the results next week?

Octavian — OK, but not next week.

Garik — as many participants will be on vacation, there will be no conference call next week, but a week from now (13th of August) we will have a conference call during which we should make a decision.

Agenda for the next meeting:

To present all simulation results and make a choice between RS+CC and CC only for a mandatory scheme, to choose between tail baiting and zero padding for both mandatory and optional schemes.

5 Minute of Conference Call 3

13.08.01, 09:00 am Pacific Time

Present:

Yossi, Doron, Brian Eidson, Dave, Moshe, Nico, Paul, Ron, Tal, Cheng, Wendy, Jun, Offer, Charlie, Garik, Sean (sorry I missed somebody);

Agenda:

Performance Comparison Between RSV and CC Only Coding Schemes:

Description of Tail Baiting (request from TG1):

AOB:

1. Performance Comparison Between RSV and CC Only Coding Schemes:

Garik: Western Multiplex presented interesting results, showing that at $PER=10^{-2}$ CC only outperforms concatenated RS+CC coding scheme. The results were shown for AWGN. Are there any new results?

Charlie: No new results;

Yossi: presented new results for both AWGN and SUI channels. The model simulates full link with baseband processing, different modulation schemes with variable codes rates. From these simulations it follows that RS with erasures improves performance with minor additional complexity.

Moshe: TG4 channel is different

Yossi: gain will be bigger

Moshe: shortest package in the up-link is 6 bytes, CC only for such short packages are superior;

Paul: we must choose that is the best for average package length, which is approx. 60 bytes;

Brian: short packages should be protected by codes with lower code rates;

Yossi: there is no 6 bytes in 256 FFT;

Brian: 6 bytes is bandwidth request;

Doron: repeated coding can be used for 6 bytes;

Garik: is your proposal similar to that has been proposed during the last call by Octavian?

Yossi: Yes.

Tal: what kind of soft in soft out decoding you use?

Doron: erasure indication only;

Tal: we need to know references. How you indicated byte erasure?

Yossi: 1 erroneous bit in a byte is an erasure;

Tal: Which PER we should use for comparison? We need to have a criteria to evaluate coding gain vs complexity;

Garik: Yossi, could you please comment on Einan s contribution?

Yossi: I believe his simulation is not complete, but it is very difficult to comment without knowing full details;

Moshe: our simulations show that CC is superior. Simulation parameters: OFDM+bit interleaver for SUI4, 128 FFT, 6 MHz bandwidth;

Yossi: TG4 requires 20 MHz and 256 FFT;

Tal: in 4 MHz bandwidth 16QAM 256 FFT SUI channel CC only is better than RSV without erasures;

?: If we have 2 dB improvement from erasure decoding why we need turbo codes?

Yossi: erasure improvement is less than 2 dB, while turbo codes give significantly better improvement;

Sean: our simulations show that for different modulation schemes and $PER=10^{-2}$ TPC give between 1 to 4 dB improvement;

APERTO: our field trials show that $PER=10^{-4}$ must be used for comparison, $PER=10^{-2}$ add huge traffic due to ARQ;

Dave: I agree;

DISCUSSION starts what should be mandatory and optional coding schemes.

Yossi: proposed to accept FEC similar to TG3 coding scheme, i.e. RS+CC with tail biting as the mandatory and turbo codes as optional;

Sean: seconds;

Tal: CC only should be used as the mandatory;

Paul: disagree;

Tal: the proposed solution is not good for short packets;

Brian: we should use lower code rates for short packets. Proposes friendly amendment, i.e. to use FEC similar to TG3 with a modification to use lower rate codes for short packets.

Voting: 11 for, 1 against;

Decision: make a recommendation to 802.16 to accept this solution.

Description of Tail Baiting (request from TG1):

Discussion about differences between tail biting for TG1 and TG3. Yossi and Charlie agreed to provide a description how tail biting works.

Next Meeting — 27.08.01, same time, Garik to provide details for conference call.

6 Minutes of Conference Call 4

27.08.01, 09:00 am Pacific Time

Present:

Jun, Wendy, Garik, John, Paul, Ayelet, Brian Edmonston, Yossi, Sean, Ron, Dave, Brian, Ofer, Charlie, Naftali (sorry I missed somebody);

Agenda:

Criteria for comparison mandatory FEC;

Simulation results for low rate RS+CC coding scheme;

AOB:

1Criteria for comparison mandatory FEC :

Garik: As per our request for contributions APERTO sent an E-mail briefly describing results of their field trials. Do we have a formal contribution to the Group?

Wendy: Report is available but we are not sure where it should be submitted.

Garik: Just distribute it on the reflector. Can you present major results?

Wendy: The results are based on the experiments we were conducting recently. They confirm that $PER=10^{-4}$ should be used for comparison. We will send the report today.

Garik: During our last conference call we made a decision and a recommendation was submitted to IEEE. However, few people questioned this decision by arguing that the wrong set of criteria was used. We all know that we have two possible scenarios with different optimum solutions. Our aim is to find the best compromise solution and for

the criteria that we used we found this solution. Presentation from APERTO confirms that we used the right criteria.

Simulation results for low rate RS+CC coding scheme:

Garik: Following our decision RUNCOM has produced simulation results for low rate RS+CC coding scheme. I must apologise that these results were distributed only today with very short notice. This is my mistake and I hope this does not cause any difficulty.

Yossi: Presents simulation results emphasising that the same coding scheme can be used with higher gains. However, this issue needs to be coordinated with MAC people.

Charlie: How about CC only with rate $R=1/6$?

Yossi: I didn't want to change coding scheme so I simulated only concatenated coding scheme;

John: $R=1/3$ CC only used in repetition format could provide up to 4.8 dB coding gain. Another comment — for $r=16$ parity bytes is RS more difficult?

Ron: Could you please provide information how to generate erasure indication from the Viterbi decoder?

Garik: this was sent to me, but I wanted to discuss it with the Group prior to submission to IEEE.

Yossi: I'll send it to everybody.

Charlie: Question on low coding rates. How do you use them?

Yossi: MAC coordinates it

Charlie: Which coding mode?

Yossi: RS of rate $1/3$ and CC of rate $_$

Charlie: How does receiver know about it?

Yossi: This is under discussion in MAC Group and should be coordinated with them as there is a number of possible solutions.

Brian: How about QPSK rates? There is a mismatch between the UL and DL channels.

Yossi: DL requires very low $PER=10^{-4}$ and the power of RS+CC should be used, the rest of the answer is lost due to poor telephone line

Brian: the chosen concatenated scheme is not the best as if you have rate $_$ CC you should use it and not puncture to rate $2/3$.

Brian: I agree, just for me it is strange puncturing

Charlie: will it be possible to run simulations for low rate CC only?

Yossi: I ll need to build a model. I ll try to do it for the meeting in Denver

?: Are packets IP or PDU oriented?

Paul: There are MAC PDU packets;

Wendy: With ARQ you also need to have AKN and you need good error performance that is why we support RS+CC scheme.

3. Next Meeting —Due to public holiday in the US the next meeting will be held in Denver.