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Source: Nokia

Transmitting AMR and signaling on SF=256 in downlink

1. Introduction

Our opinion is that there should be a possibility to fit AMR to SF=256 in downlink. This possibility would be needed in capacity limited situation, i.e. in spreading factor limited situations.

We show some calculations how this could be achieved. Also there are some thoughts how the signaling channel could then be transmitted along with the speech.

The conclusion is that if we would like to have this possibility , we need to add to the specs:

- additional slot structure for SF=256 in downlink , which contains 2 pilot symbols per slot. This would be in addition to the present slot structure at SF=256 , with 4 pilot symbols per slot

- the requirement that it is mandatory for the UEs to support BRD (blind rate detection) in the case where we have two transport channels for AMR and signaling , using flexible positions in the frame.

2. Calculations which AMR mode will fit to SF=256

Table 1 shows how many DPDCH bits we have per frame at SF=256 in downlink, both for the present slot structure, with 4 pilot symbols per slot, and for new proposed slot structure, with 2 pilot symbols per slot. Table 2 shows how many bits per frame different AMR modes require, depending on the coding rate and puncturing ratio. The assumption in the calculations was, EEP, 16 bit CRC, 8 bit tail, for simplicity.

# of pilot symbols/ slot	TFCI bits	DPCCH bits / frame	DPDCH bits / frame
4	Yes	180	120
	No	150	150
2	Yes	120	180
	No	90	210

Table 1. Number of DPDCH bits per frame, SF=256.

AMR mode	1/3 coding, No puncturing: DPDCH bits / frame	1/3 coding, 20 % puncturing : DPDCH bits / frame	½ coding, no puncturing: DPDCH bits /frame
12.2	402	321	268
10.2	342	273	228
7.95	275	220	184
7.40	258	207	172
6.70	237	190	158
5.90	213	171	142
5.15	191	153	128
4.75	179	143	120

Table 2. How many bits per frame different AMR modes require.

Table 3 shows which AMR mode fits to SF=256, when looking at different slot structure possibilities.

# of pilot symbols/ slot	TFCI bits	DPCCH bits / frame	1/3 coding no puncturing	1/3 coding 20 % punct.	½ coding no puncturing
4	Yes	120	-	-	AMR 4.75
	No	150	-	AMR 4.75	AMR 5.9
2	Yes	180	AMR 4.75	AMR 5.9	AMR 7.4
	No	210	AMR 5.15	AMR 7.4	AMR 7.95

Table 3. Which AMR mode will fit to SF=256.

This will mean that:

a) With 4 pilot symbols per slot:

With 1/3 coding and 20 % puncturing, only lowest mode of AMR 4.75 kbit/s will fit to SF=256 and only if no TFCI is used. This is not an applicable case, since then frame stealing would be needed during signaling. And frame stealing means bad voice quality. With ½ coding we could fit there 5.9 kbit/s mode, but then even by using "dim and burst"- method, there would be only about 1 kbit/s rate left for signaling purposes. "Dim and burst" means that voice rate is lowered temporarily to its lowest mode, 4.75 kbit/s, in order to fit the signaling to the same frame together with voice.

b) With 2 pilot symbols per slot:

b1) With TFCI bits

With 1/3 coding and 20 % puncturing, AMR 5.9 kbit/s mode will fit to SF=256. Then when signaling is transmitted, we again use "dim and burst" method. Thus during signaling we have: 4.75 kbit/s voice + about 1.2 kbit/s rate signaling channel, with having the assumption that signaling would use about the same coding rate as voice. This signaling rate of around 1 kbit/s is not sufficient. With ½ coding we can fit there 7.4 kbit/s mode. So with that mode + "dim and burst" we can fit 4.75 kbit/s voice + about 2 kbit/s signaling rate to the same frame. This 2 kbit/s signaling rate sounds better, but with this scheme we are limited to using always ½ coding at SF=256.

B2) Without TFCI bits

With 1/3 coding and 20 % puncturing, AMR 7.40 kbit/s mode will just fit to SF=256. Then when signaling is transmitted, we use "dim and burst" -method, meaning that during signaling we have: 4.75kbit/s voice + > 2 kbit/s signaling channel. This sounds like a scheme all UEs should support. Otherwise we do not achieve all three targets: 1) fitting both AMR + voice to SF=256 in capacity limited case, 2) have 1/3 coding to get the best Eb/N0 performance 3) have high enough rate for signaling

3. Thoughts about blind rate detection complexity with "dim and burst"

In the previous section the calculations showed that it would be very beneficial to have a following case for AMR supported by all UEs: SF=256, 1/3 coding, 2 pilot symbols per slot, and no TFCI, because then we can achieve following targets:

1) fit both AMR + voice to SF=256 to support capacity (spreading factor) limited case

2) have 1/3 coding to get the best Eb/N0 performance

3) have high enough bit rate for signaling (>2 kbit/s)

This means however using "dim and burst" method, where voice data rate is temporarily lowered in order to fit both voice + signaling to the same frame. Our idea is that the voice data rate would be lowered down to 4.75 kbit/s every time the signaling message would be transmitted. Another option would be to use frame stealing, so that the whole frame would be stolen for sending signaling message. Our opinion is however, that frame stealing means bad voice quality. Which means that we think that "dim and burst" method should be used at SF=256.

If we don't have TFCI bits , "dim and burst" will mean BRD (blind rate detection) for two transport channels with flexible positions. Up until now, there has always been the assumption that BRD is required only in case of fixed positions, so that BRD needs to handle only one transport channel. Our opinion is, however, that the key issue which defines the complexity of the blind rate detection, is the data rate . In case of AMR + signaling the data rate is so low that it does not increase the complexity of BRD; even if we have 2 transport channels using flexible positions. The idea in BRD with the flexible positions is that the two transport channels are decoded sequentially, one after another. First do the BRD for voice, and after the rate is known, then it is possible to decode the signaling transport channel. Here we should of course have a requirement that there is only one allowed rate for signaling, to simplify the decoding process.

So since the BRD for two transport channels with flexible positions is not too complex, we should have it mandatory for all UEs which have AMR capability.

4. Comments about delay from "dim and burst" method

It should be understood that "dim and burst " method proposed for SF=256 will introduce additional delay for signaling , since RNC has to command the transcoder to change the mode before signaling can be transmitted. Our understanding is that this additional delay due to mode change is still marginal compared to e.g. total handover delay. Seems that this is the penalty we have to pay in order to fit the AMR to SF=256.

However, due to the delay, we should not use "dim and burst" method in the basic case, SF=128, in downlink. Because there it should be possible to fit both AMR + signaling to the same frame with out the need of "dim and burst" method. So the basic case SF=128 should be designed so that signaling delay is minimised.

5. Conclusion and proposal

- We propose to add a slot structure to SF=256 in downlink, where there are 2 pilot symbols per slot. This slot structure should be available both with and without TFCI field.

Otherwise we are not able to fit AMR to SF=256 in downlink.

- We propose that it is mandatory for the terminal to support BRD for 2 transport channels : voice + signaling channel , which use flexible positions in the frame.

Otherwise we cannot have 1/3 coding and sufficient signaling rate. If ½ coding is seen to be sufficient for SF=256 then this 'BRD support'-requirement is not so critical. But our opinion at the present is that there should be a possibility to have 1/3 coding also at SF=256.

6. Text proposal

------------------------following proposal to TS 25.211, section 5.3.2, table 9--------------

Table 1: DPDCH and DPCCH fields

Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Frame			Bits/ Slot	DPDCH Bits/Slot		DPCCH Bits/Slot		
			DPDCH	DPCCH	TOT		N_{Data1}	N_{Data2}	N_{TFCI}	N_{TPC}	N_{Pilot}
15	7.5	512	60	90	150	10	2	2	0	2	4
15	7.5	512	30	120	150	10	0	2	2	2	4
30	15	256	150	150	300	20	2	12	0	2	4
30	15	256	150	180	300	20	0	12	2	2	4
30	15	256	150	150	300	20	2	8	0	2	8
30	15	256	120	180	300	20	0	8	2	2	8
60	30	128	450	150	600	40	6	24	0	2	8
60	30	128	420	180	600	40	4	24	2	2	8
120	60	64	900	300	1200	80	4	56	8*	4	8
240	120	32	2100	300	2400	160	20	120	8*	4	8
480	240	16	4320	480	4800	320	48	240	8*	8	16
960	480	8	9120	480	9600	640	112	496	8*	8	16
1920	960	4	18720	480	19200	1280	240	1008	8*	8	16

* If no TFCI, then the TFCI field is blank.

------------------------following proposal to TS 25.212, section 4.2.13.1 --------------

4.2.13.1 Blind transport format detection

Examples of blind transport format detection methods are given in Annex A.

The support of Blind transport format detection is mandatory for UEs in the case of two DCHs: DCH1 for AMR and DCH2 for signaling, with the following requirements:

- These DCHs, DCH1 and DCH2, can have either fixed or flexible positions in the frame, meaning that the starting position of DCH1 is always at the beginning of the frame, and the starting position of DCH2 in the frame is flexible.

- DCH1, carrying AMR, can have 9 possible data rates during the connection. However, the same rate matching factor is used for all 9 data rates within DCH1.

- DCH2, carrying signaling, has one possible data rate during the connection.