3GPP TSG RAN WG1 No 7 ***TSGR1#7(99)b44***
30th Aug-3rd Sep, 1999, Hanover, Germany

Agenda item: **Ad-hoc 3**

Source: **Philips**

Title: **Modification to AICH (updated)**

Document for: **Approval**

Summary

This document proposes a modification to the AICH which allows the spreading factor to be increased by a factor of two. It is an updated version of Tdoc (99)825, now including results for sensitivity to phase errors (in Annexes 1 and 2).

Discussion

According to current proposals for CPCH, it may be necessary to use up to three AICH's to provide separate acknowledgement channels for RACH preambles, CPCH access preambles and CPCH collision resolution preambles. With the current definition of AICH this would use three channelization codes with SF=256. This is not a large contribution to code shortage, but it would still be worthwhile reducing this use of channelization code resource.

Fortunately, it appears that the spreading factor of the AICH could be increased from 256 to 512 by using complex signatures instead of real valued ones (which is the implied effect of the current definition in 25.211). The signature would then be of length 8 symbols rather than 16. This change, effectively from BPSK to QPSK modulation, would have no effect on the absolute duration of the signature, or any significant impact on the transmitted power needed to achieve a given detection probability (since Eb/No is the same for BPSK and QPSK, at least in AWGN).

Proposed Solution

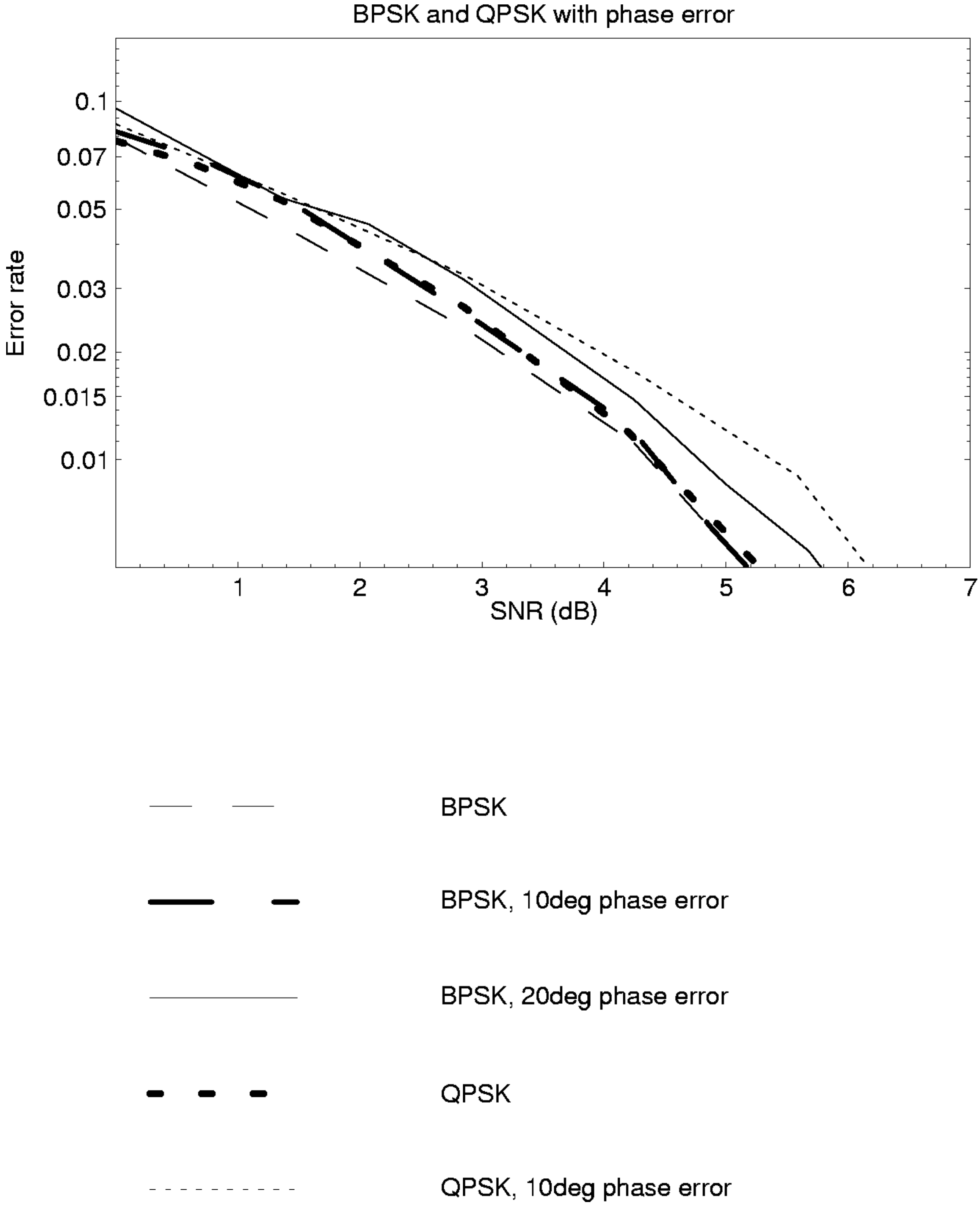
A new set of signatures can be obtained by adding the second half of each of the current signatures to the first half, but with 90^o phase rotation. That is, the signature symbols effectively become modified from the current values of $\pm$(A+B) to $\pm$A$\pm$B where A=1, B=j. If the I and Q parts are detected separately, the orthogonality between signatures is maintained. The effect of realistic phase errors is small, as shown in Annexes 1 and 2.

Recommendation

Since the required allocation of downlink channelization codes is reduced by this proposal without any significant disadvantageous side effects, it should be adopted. The necessary modifications to AICH are detailed in the text proposal in Annex 3.

ANNEX 1 – Sensitivity of QPSK to Phase Errors

One concern raised about this proposal when first presented was that since QPSK is inherently more sensitive to noise and phase errors than BPSK, there could be a problem with phase errors with respect to the Common Pilot Channel. Results for error rate of BPSK and QPSK in AWGN and various static phase offsets are shown below.



It can be seen that QPSK is about twice as sensitive BPSK to large phase errors. However, at the error rates at which the system might operate (e.g. 1-10%), phase errors up to about 10 degrees could be tolerated as this would have a minor effect on performance. These results would also apply to dedicated channels. Therefore larger phase errors than 10 degrees would result in significant degradation in system capacity.

ANNEX 2 – Sensitivity of AICH detection to phase errors

We assume that detection is carried out by cross-correlation between the received signal and each of the possible signature sequences. With the current signatures for AICH, the effect of a static phase error is to slightly reduce the amplitude of the correlation peak.

With the proposed sequences and detection method, a phase error additionally introduces low amplitude correlation sidelobes as shown in Figure 1.

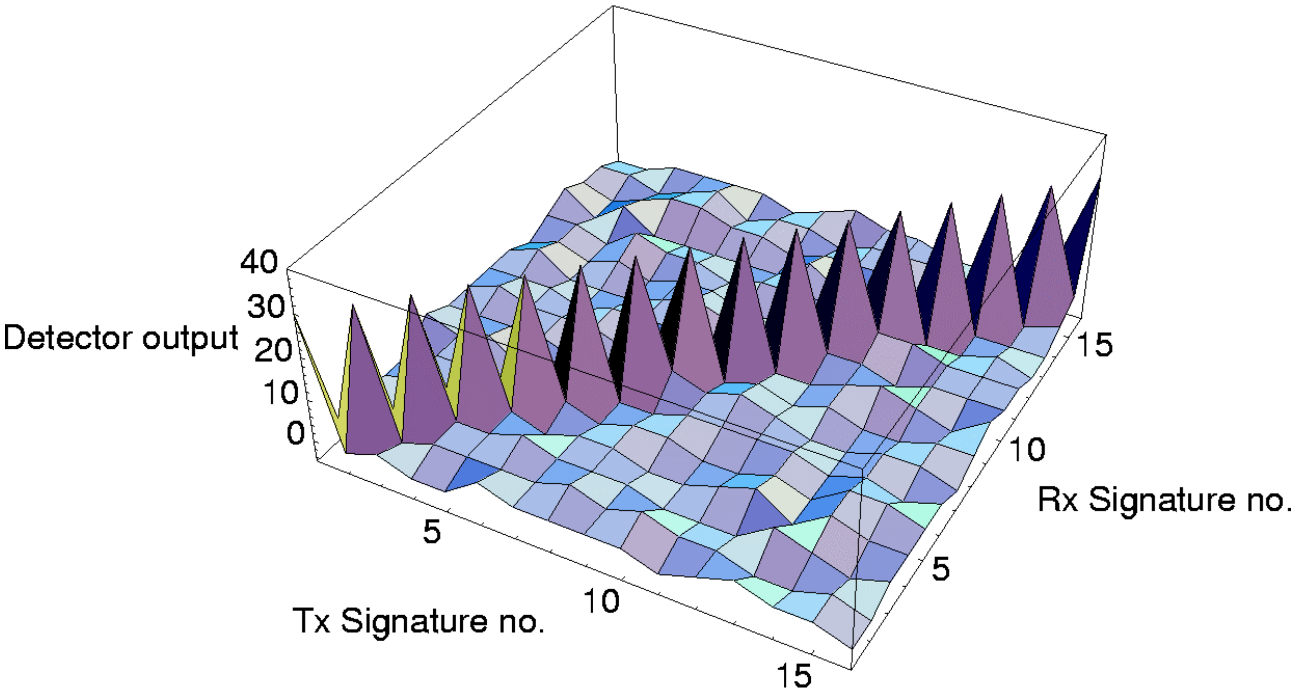


Figure 1: Detector output of proposed AICH sequences with 20degree phase error

These correlation sidelobes reduce the distance between the noise floor and the correlation peak, which means that a greater transmitted power is needed to obtain the same detection performance. The degradation can be estimated considering the average sidelobe level, or considering the worst case sidelobe level, as shown in the Table.

Phase error (degrees)	Current AICH	Proposed AICH (average)	Proposed AICH (worst case)
0	0dB	0dB	0dB
10	0.07dB	0.22dB	0.47dB
20	0.27dB	0.59dB	1.14dB

Degradation in detection performance for different static phase errors.

It is clear that for the proposed AICH the degradation is quite small for phase errors less than about 10 degrees.

ANNEX 3 -Text Proposal for 25.211

5.3.3.7 Acquisition Indication Channel (AICH)

The Acquisition Indicator channel (AICH) is a physical channel used to carry Acquisition Indicators (AI). Acquisition Indicator AI_i corresponds to signature *i*, see further 25.213, Section 4.3.3.2

Figure 2~~Figure 2~~~~Figure 2~~ illustrates the frame structure of the AICH. Two AICH frames of total length 20 ms consist of 15 *access slots* (AS), each of length 1~~2~~0 symbols (5120 chips). Each access slot consists of two parts, an *Acquisition-Indicator* (AI) part and an empty part.

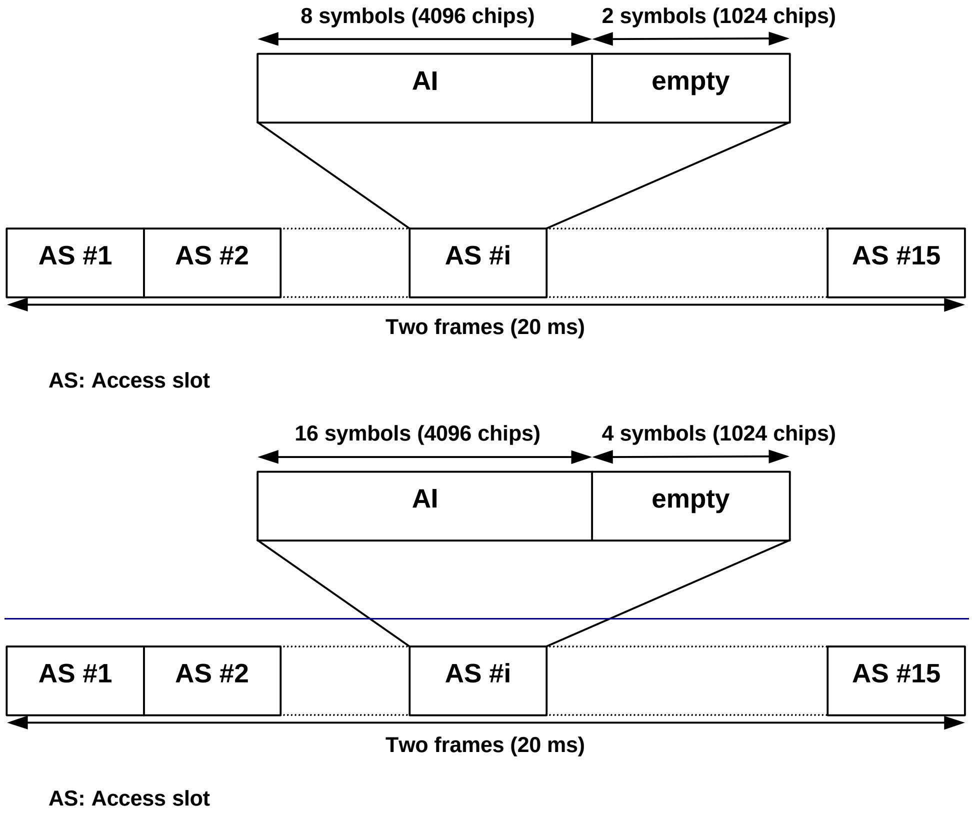


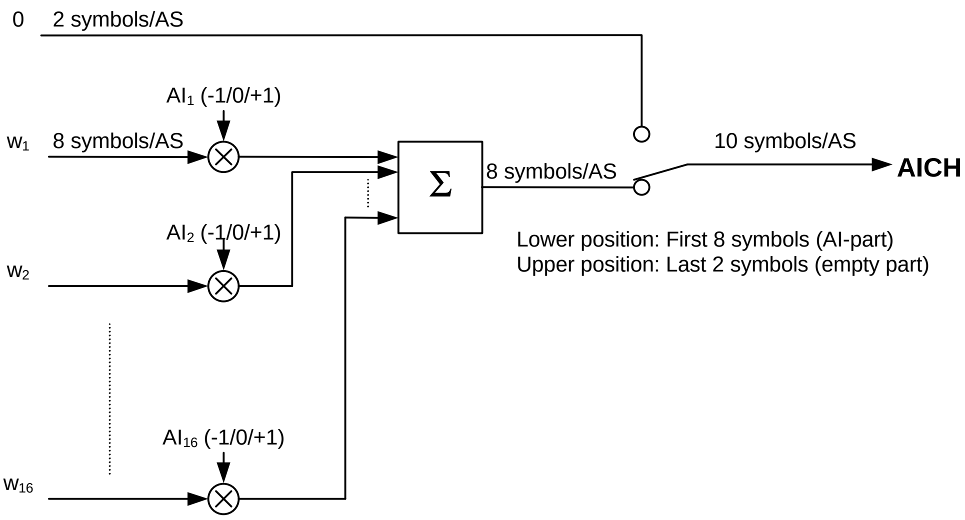
Figure 2: Structure of Acquisition Indicator CHanel (AICH)

Figure 3~~Figure 3~~~~Figure 3~~ illustrates the detailed generation of an AICH access slot. Note that Figure 3~~Figure 3~~~~Figure 3~~ shows an example implementation.

The AI-part of the access slot consists of the symbol-wise sum of up to 16 orthogonal code words w_1-w_{16}, multiplied by the value of the corresponding acquisition indicator AI_i. The orthogonal code words w_1,...,w_{16} are shown in .

The empty part of the access slot consists of 2~~4~~ zeros.

The phase reference for the AICH is the CPICH.



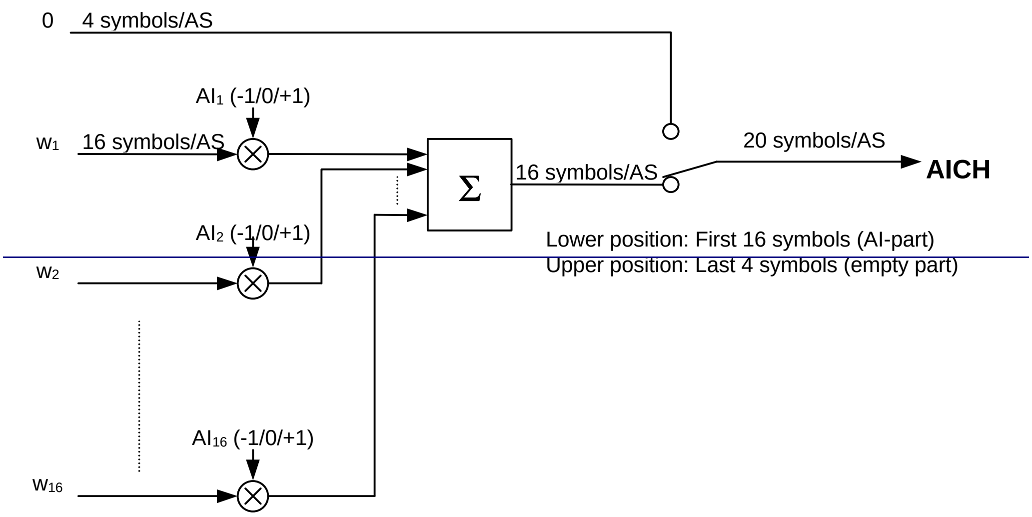


Figure 33~~3~~:Schematic generation of AICH access slots.

~~**Table 1: Definition of orthogonal vectors w_1-w_{16} used inFigure 3; A = (1+j)**~~

I	w_i															
1	A	A	A	-A	-A	-A	A	-A	-A	A	A	-A	A	-A	A	A
2	-A	A	-A	-A	A	A	A	-A	A	A	A	-A	-A	A	-A	A
3	A	-A	A	A	A	-A	A	A	-A	A	A	A	-A	A	-A	A
4	-A	A	-A	A	-A	-A	-A	-A	-A	A	-A	A	-A	A	A	A
5	A	-A	-A	-A	-A	A	A	-A	-A	-A	-A	A	-A	-A	-A	A
6	-A	-A	A	-A	A	-A	A	-A	A	-A	-A	A	A	A	A	A
7	-A	A	A	A	-A	-A	A	A	A	-A	-A	-A	-A	-A	-A	A
8	A	A	-A	-A	-A	-A	-A	A	A	-A	A	A	A	A	-A	A
9	A	-A	A	-A	-A	A	-A	A	A	A	-A	-A	-A	A	A	A
10	-A	A	A	-A	A	A	-A	A	-A	-A	A	A	-A	-A	A	A
11	A	A	A	A	A	A	-A	-A	A	A	-A	A	A	-A	-A	A
12	A	A	-A	A	A	A	A	A	-A	-A	-A	-A	A	A	A	A
13	A	-A	-A	A	A	-A	-A	-A	A	-A	A	-A	-A	-A	A	A
14	-A	-A	-A	A	-A	A	A	A	A	A	A	A	A	-A	A	A
15	-A	-A	-A	-A	A	-A	-A	A	-A	A	-A	-A	A	-A	-A	A
16	-A	-A	A	A	-A	A	-A	-A	-A	-A	A	-A	A	A	-A	A

Table 2: Definition of orthogonal vectors w_1-w_{16} used inFigure 3~~Figure 3~~; A = 1, B=j

i	w_i							
1	A-B	A+B	A+B	-A-B	-A+B	-A-B	A+B	-A+B
2	-A+B	A+B	-A+B	-A-B	A-B	A+B	A-B	-A+B
3	A-B	-A+B	A+B	A+B	A-B	-A+B	A-B	A+B
4	-A-B	A+B	-A-B	A+B	-A-B	-A+B	-A+B	-A+B
5	A-B	-A-B	-A-B	-A+B	-A-B	A-B	A-B	-A+B
6	-A+B	-A-B	A-B	-A+B	A+B	-A+B	A+B	-A+B
7	-A+B	A-B	A-B	A-B	-A-B	-A-B	A-B	A+B
8	A+B	A-B	-A+B	-A+B	-A+B	-A+B	-A-B	A+B
9	A+B	-A+B	A-B	-A-B	-A-B	A+B	-A+B	A+B
10	-A-B	A-B	A+B	-A+B	A-B	A-B	-A+B	A+B
11	A+B	A+B	A-B	A+B	A+B	A-B	-A-B	-A+B
12	A-B	A-B	-A-B	A-B	A+B	A+B	A+B	A+B
13	A+B	-A-B	-A+B	A-B	A-B	-A-B	-A+B	-A+B
14	-A+B	-A+B	-A+B	A+B	-A+B	A-B	A+B	A+B
15	-A-B	-A+B	-A-B	-A-B	A+B	-A-B	-A-B	A+B
16	-A-B	-A-B	A+B	A-B	-A+B	A+B	-A-B	-A+B

The spreading/scrambling of the AICH is done is the same way as the spreading/scrambling of other DL channels, compare 25.213, Section 5.1. The AICH is spread by a channelization code of length 512~~256~~ and subsequently scrambled by the cell-specific scrambling code.