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Agenda item:

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Title: Some notational problems in FDD specification

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Introduction

There are aspects of channel specification in the RAN1 documentation that are not complete. This paper seeks to identify those areas, outline the weaknesses and encourage consensus in order to prepare the way for an agreed CR (or CRs) of a purely corrective nature that will not change any agreed functionality.

The current FDD specification set is derived from the UTRA FDD and ARIB W-CDMA specification sets.

During the standards development phase leading to 3GPP physical channel descriptions were made in a mixture of ways. Channels bearing bit oriented entities were described in Boolean terms. Channels purely concerned with layer 1 functions, such as SCH, were described in chip terms. It was understood by the developers that a process of repetition and mapping from Boolean to real-value notation took place. Indeed there were several notes to that effect left in strategic places.

As this was not suitable for final specification these notes were removed and some fairly diligent attempts to specify transformations was made. However due to the pressure to complete R99 not all transformations were documented. Also the specification of what a physical channel is has not been adequately finalised.

The 3GPP specification are influenced to some degree by the GSM specifications. The GSM analogue to 25.211 (in which the bulk of our problems lie) is 05.02. In 05.02 channels are denoted in Boolean notation and converted to modulated signals only within 05.04 (which is an approximate equivalent to 25.213). This outline used to be followed by the documents inherited by WG1 (with the exception of SCH).

Then came the AICH.

When AICH was introduced the process of mapping between acquisition indicators (AIs) and chip values was specified in 25.211. That is to say a channel which performed "layer1 to layer1 signalling" was specified in a way that by-passed the "conventional" spreading and modulation entity in 25.213. Also the functionality of the AICH, that of signalling purely within layer 1, was so useful that it was followed by it's imitators: AP-AICH, CD-ICH, PICH and CSICH. Yet unlike the mapping of transport channels to physical channels the specification of these new entities did not clearly distinguish between the **meaning** of the signalling and the **method**. This signalling gradually took on significance to layer 2 as state-based behaviour introduced in layer 1 was transferred to the higher layer.

In retrospect, as some delegates have said in the past, perhaps AICH could have been done another way. However our objective is to find the optimum way to make the current specification consistent with minimum disruption.

A consequence of the introduction of AICH was to re-define the 'input format' of 25.213 from Boolean notation to 'real-valued' notation. This is dealt with in more detail below.

This is the situation we have now:

- inadequate defintion of a physical channel,
- inconsistent conventions of signal notation,
- a concept of "low layer signalling" specified piece by piece.

Physical Channel Concept

The current definition of a physical channel is:

Physical channels typically consist of a layered structure of radio frames and time slots, although this is not true for all physical channels. Depending on the channel bit rate of the physical channel, the configuration of slots varies.

Radio frame: A radio frame is a processing unit which consists of 15 slots. The length of a radio frame corresponds to 38400 chips.

Slot: A slot is a unit which consists of fields containing bits. The length of a slot corresponds to 2560 chips. The number of bits per slot may be different for different physical channels and may, in some cases, vary in time.

And the definition of the physical resource is:

The basic physical resource is the code/frequency plane. In addition, on the uplink, different information streams may be transmitted on the I and Q branch. Consequently, a physical channel corresponds to a specific carrier frequency, code, and, on the uplink, relative phase (0 or $\pi/2$).

Compare this with the definition of the GSM physical channel from 05.02:

A physical channel uses a combination of frequency and time division multiplexing and is defined as a sequence of radio frequency channels and time slots. The complete definition of a particular physical channel consists of a description in the frequency domain, and a description in the time domain.

It is clear that FDD lacks a true definition of a physical channel. A satisfactory definition of the FDD physical channel would specify the dimensions of:

- frequency
- time (active duration, in the sense of time-multiplexing)
- scrambling code
- channelisation code(s)

The definition in regard to code /frequency is well established. However the time multiplexing element, essential for an adequate description of SCH/P-CCPCH or PICH/CSICH, is currently lacking.

This forms a necessary requirement for any CR seeking to correct this situation.

Signal Flow

In figure 1 below a simplistic but useful signal flow for FDD transmission is shown. It is interesting that such an overview has not been made explicit in RAN1 before. It may be that not all delegates have realised the current assumptions made about signal flow in the specifications.

In particular the notational change made by R1-00-0578 may be seen to bring 25.211 partly into line with the signal flow notation that followed the change of the input format of 25.213.

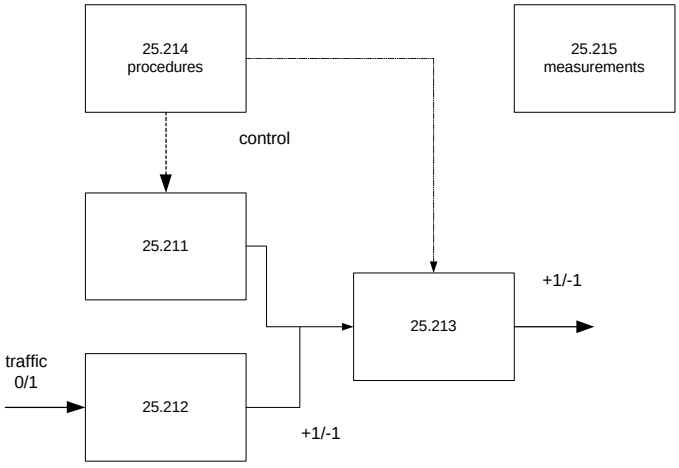

Figure 1 - signal flow in FDD

This figure can help delegates less familiar with the specification detail appreciate the significance of some issues which arise. For instance at WG1#12 the valid point was made that a transformation to real-values must be made "at the end of" 25.212. This is correct as inspection of figure 1 will show.

There is a minor point in that 25.212 now deals with values in sets such as { 0, 1, δ } however by generalising the type Boolean to 'set notation' this is not a problem. Set notation is rather more constrained than real-values which helps reduce the ambiguity in specifications. This is an important consideration in a global standard.

Low Level Signalling

Before the innovation of AICH the operation of the layer 1 was somewhat passive. The UE layer 1 synchronised to the cell and the (then un-ramped) RACH would attempt access.

Following that time the array of AI, AP, CD, PI and CS signals have been added.

- for clear definition of the low level signalling across the Uu interface it is desirable that these signals and their realtionship to physical channels be listed

A Way Ahead

Given the above observations it is desirable that a consensus be found using the reflector as to which clarifications are acceptable to the group. As many delegates are righly wary of radical changes to the specifications only widely supported changes with clear corrective justification should appear as CRs at meeting WG1#13.