Agenda Item: 14.4

Source: Ericsson

Title: **Value Range for Transport Channel Information Elements**

Document for: Discussion and Decision

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1   Introduction

In this paper the notation for several transport channel information elements and the min and max values for their parameters are discussed. The value ranges are proposed to be included in 25.331. Tabular format according to the result of the email discussion has been used [2].

2   Discussion

Some of the value ranges given here should have extensibility for future releases of the standard. Which parameters and information elements that should have this extensibility is FFS. There should also be a discussion how this extensibility could be expressed in the tabular format.

The presented value ranges are proposed for dedicated transport channels and if the same value ranges are applicable for e.g. RACH or FACH is FFS.

2.1   Transport Format Set

2.1.1   Notation

The transport format set (TFS) is used to specify how the blocks on a transport channel are configured. The TFS consists of a semi-static part and a dynamic part. The semi-static part is fixed and can not vary on a short time basis in between transmission time intervals (TTI). The dynamic part on the other hand consists of several options; i.e. there could be different size and number of transport blocks in a transmission time interval. The transmitter side decides which of these sizes and how many it should transmit for each and every transmission time interval.

In Figure 1 below the dynamic part for three transport channels is illustrated and exemplified. Each dynamic part transport format is given by a square with transport format block size and number of transport blocks in one transmission time interval.

Transport channel 0 has three different transport block sizes, 20, 40 and 160 bits, and only one transport block is transmitted in each transmission time interval.

Transport channel 1 has only one transport block size, 320 bits. However, one or four transport blocks can be transmitted in each transmission time interval, resulting in a transport block set size of 320 or 1280 bits.

Transport channel 2 has two different transport formats, either there is one transport block with 320 bits or there is no transport block at all.
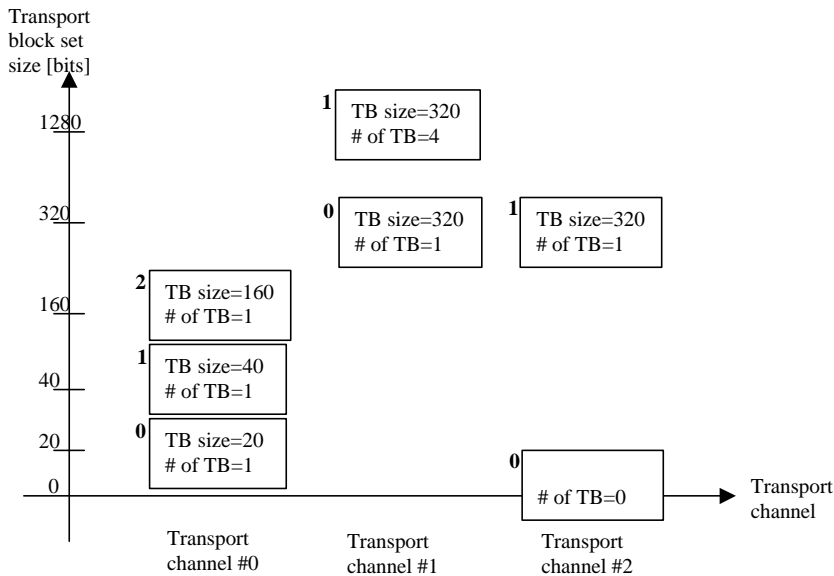
Figure 1. Description of dynamic part of a transport format.

The dynamic part of each transport format needs to be numbered according to a given rule in order to have a reference when the Transport format combination set is configured.

It is proposed that the dynamic part of each transport format is numbered according to the order that they arrive in the message.

2.1.2 Value Range

It was agreed last WG2 meeting that the size for a transport block could vary beteen 1 and 5000 bits with the granularity of one bit. Further, it was said that RRC should set the restriction if that is needed. Between 1 and 5000 bits will at most require 13 bits in signalling.

Note that if 13 bits is found to be a too large field in the messages, predefined ranges could be introduced to have less bits within these ranges. In this way a more compact signalling can be used for transport block sizes that are thought to be used often. However, predefined ranges are not proposed in this contribution.

A question was also raised if 5000 bits only is applicable for turbo coding, since WG1 has defined smaller coding blocks (512 bits including tail bits and CRC) as the maximum size for convolutional coding. This issue needs further discussion.

It was also decided that the transport block set size has a range of between 1 and 200000 bits, in order to be able to have 2 Mbps with a Transmission time interval of 80 ms.

However, since the transport block set size is built with transport blocks it is more convenient to signal the number of transport blocks in a transport block set instead.

If it is assumed that, for 2 Mbps with a TTI of 80 ms (i.e. 163840 bits), the smallest transport block size that will be used is 40 bits; the maximum number of transport blocks in a transmission time interval is 4096. This will require a maximum of 12 bits in the RRC signalling.

For the semi-static part of the transport format set the transmission time interval is agreed to be 10, 20, 40 or 80 ms. Type of channel coding could be turbo or convolutional coding, with the rates ½ or $^1/_3$. It is proposed that an additional information element *coding rate* is included in the transport format set information element.

The rate matching is in WG1 agreed to be an integer weight factor per transport channel, called rate matching attribute. However, the value range for this attribute remains to be decided.

Further, the number of CRC bits that should be used is also signalled in the semi-static part of the transport format. The CRC size could be 0, 8, 16 or 24 bits.

2.2 Transport Format Combination Set

2.2.1 Notation

This describes the combinations of transport formats in between different transport channels that are allowed to be transmitted at the same time. For the example given in 2.1.1 this could be illustrated as in the table below.

The total number of bits per transmission time interval (assumed that this is the same for the three transport channels) is also added in the table as information.

| Transport Format Combination | Used Transport Format | | | Total bits |
	Transport Channel 0	Transport Channel 1	Transport Channel 2	
0	1	1	1	1640
1	0	1	1	1620
2	1	0	1	680
3	2	0	0	480

The numbering of transport format combinations are needed since that reference is used in the Transport format combination subset.

It is proposed that the transport format combinations are numbered according to the order that they arrive in the message. The numbered transport format combinations could also be mapped directly to the numbered code words at L1 sent in the TFCI.

2.2.2 *Value Range*

The number of TFCI bits at the physical layer limits the maximum number of transport format combinations that could be available. WG1 has concluded that there could be up to 10 TFCI bits, giving a maximum of 1024 combinations. This will set a limit of 1024 for the maximum number of rows in the Transport format combinations table shown above.

Further, it must be decided how many different transport formats that it should be possible to have for a single transport channel. The physical layer TFCI bits are also here the limit. However, the RRC connection must be present for all services and will require some of the TFCI bits, therefor 1024 transport formats for one transport channel will not be needed. Of the known services today, AMR which requires 11 different transport formats, is the service that requires the most transport formats. Taking twice what we have today, this leads to the conclusion that a maximum number of 32 transport formats per transport channel should be enough.

Finally there must be a restriction on the maximum number of transport channels for one UE. This will set the limit on the number of columns in the transport format combination table. However, no such restriction is proposed in this paper.

2.3 Transport Format Combination Subset

2.3.1 *Notation*

Transport format combination subset is supposed to limit the table of combinations presented in 2.1.1, so that a UE does not use all combinations in the UL. The most common case is probably that UTRAN wants to limit the UL interference created by a UE and therefor limit its maximum rate. If the Transport format combination set is sorted according to the physical layer required bitrate, it is enough that the lowest number Transport format combination is signalled, indicating that only this and Transport format combinations with higher numbers are allowed.

However, since the numbering of the Transport format combinations is set by the order in the message, it is an operator decision if the transport format combinations is ordered in the order of required bitrate or in another order.

In some scenarios it is however desired that some specific transport channel combinations are allowed, although they require a high physical layer bitrate. To achieve this it must be possible to give a list of transport format combinations in the transport format combination subset.

It is therefor proposed that both of these representations of the transport format combination subset should be possible.

Note that in order to remove a restriction set by a transport format combination subset, a subset with 0 as the lowest allowed transport format combination is signalled.

3 Proposed text to 25.331

10.2.5.1 Transport Format Combination Set

Indicates the allowed combinations of already defined Transport formats.

Information Element/Group name	Presence	Range	IE type and reference	Semantics description
Transport format combination		1 to 1024		
Transport Format Number		1 to maxTrCh	Integer(0..31)	The integer number is a reference to the *Dynamic transport format information*, that arrived at that position in the *Transport Format Set* for that transport channel. The first instance of this IE corresponds to the first transport channel and so on.

Range Bound	Explanation
MaxTrCh	Maximum number of transport channels that could be allocated to one UE.

10.2.5.2 Transport Format Combination Subset

Indicates which Transport format combinations in the already defined Transport format combination set that are allowed.

Information Element/Group name	Presence	Range	IE type and reference	Semantics description
CHOICE Subset representation	M			
Minimum allowed Transport format combination number			Integer(0..1023)	The integer number is a reference to the *Transport format combination,* that arrived at that position in the *Transport Format Combination Set.*
Transport format combination		1 to <maxTFCcount>	Integer(0..1023)	The integer number(s) is a reference to the *Transport format combination,* that arrived at that position in the *Transport Format Combination Set.*

Range Bound	Explanation
MaxTFCcount	Maximum number of Transport Format Combinations that could be sent as the limited set that the UE is allowed to use.

10.2.5.4 Transport Format Set (TFS)

Information Element/Group name	Presence	Range	IE type and reference	Semantics description
Dynamic Transport Format Information		1 to maxTFcount		
Number of Transport blocks size(s)	M		Integer(0..4095)	(dynamic)
Transport Block Set Size(s)	C Blocks		Integer(1..5000)	(dynamic)
Semi-static Transport Format Information				
Transmission time interval	M		Enumerated(10, 20, 40, 80)	(semi-static)
Type of channel coding	M		Enumerated(Convolutional, Turbo)	(semi-static)
Coding Rate	M		Enumerated(1/2, 1/3)	
Rate matching attribute	M		Integer(1..maxRM)	(semi-static)
CRC size	M		Enumerated(0, 8, 16, 24)	

Condition	Explanation
Blocks	Transport block size is only needed if Number of Transport Blocks is greater than 0.

Range Bound	Explanation
MaxTFcount	Maximum number of different transport formats that can be included in the Transport format set for one transport channel is 32.
MaxRM	Maximum number that could be set as rate matching attribute for a transport channel.

4   Proposal

It is proposed that 25.331 [1] is updated according to chapter 3.

5   References

[1] 3GPP TS 25.331 v1.1.0: "RRC Protocol Specification"

[2] Report of the email discussion group - Enhanced RRC message and IE tabular descriptions