3GPP TSG RAN WG1 Meeting #20 **TSGR1#20(01)0499**
Busan, Korea, 21st-25th May 2001

Source: **Panasonic**
Title: **Discussion on UE capability of HSDPA**
Document for: **Discussion**

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1. Introduction

This document discusses the UE capability of HSDPA terminal on following items and to propose some UE capability class on HSDPA.

- To separate capability of HSDPA from Rel99 capability

- Multi code capability

- ARQ capability

2. To separate capability of HSDPA from Rel99 capability

Release 99 UE capability can be represented by the several parameters. Regarding to the HSDPA UE capability, there seems at least two approaches.

1. The extension of Release 99 capability

This approach is some extent to Release 99 capability. For example, if UE declares 40960 bits as 'Maximum sum of number of bits of all transport blocks being received at an arbitrary time instant ', this UE should receive flexible and arbitrarily combination of transport channel on HS-DSCH and Rel99 TrCHs. One example is whole this capability to HS-DSCH and another example is the ratio between HS-DSCH vs. Rel99 TrCHs is 40320:640.

2. New additional HSDPA capability

This approach is to add new capability of HSDPA. For example, to add new capability parameters of transport channel for HS-DSCH and physical channel for HS-DSCH.

Consideration to both methods

The extension type approach has benefit of the hardware resource sharing with HSDPA and Release 99 function. But it has following problems.

- The extension type approach may requires 2Mbps HSDPA terminal should have 2Mbps release 99 function because the network cannot know how many bit can assign to HSDPA flow and rel99 flow.

- The benefit from the simplification of HSDPA that we discuss e.g. fixed TTI, one HS-DSCH per CCTrCH is lost because of the hardware resource sharing.

- To utilise same hardware with frame based Rel99 function and HSDPA-TTI based function require complex scheduling of same hardware.

Hence we propose to add new additional HSDPA capability on TrCH capability and Physical channel capability. The detail should be more discussed.

3. Multi code capability

It is well known FHT (Fast Hadamard Transform) can reduce the number of calculation. We can reduce the despreading complexity by FHT for multi code case. FHT can reduce the complexity if $m > \log_2 N$ (m: number of multicode, N: spreading factor of HS-DSCH channel). This means over 4 codes transmission in SF=16 and over 5 codes transmission in SF=32. This can be interpret as the despreading complexity from 5 to 16 multi codes transmission are same in SF=16. Weighting and maximum ratio combining is symbol level process and rather small complexity than chip despreading. Therefore we can apply the principle of as many allocating multi code as possible to one UE and the granularity of multi code capability over $\log_2 N$ is not so required.

Table one is the order of despreading calculation in 3 slot TTI. Please note that the actual number of despreading calculation differs from this table because of the complex-valued spreading but the relation is right.

Table 1. The order of despreading calculation in 3 slot TTI

	Normal method	Despread by FHT	
10 codes with SF=16	160x3x16x10 = 76800	160x3x16x4 = 30720	
5 codes with SF=16	160x3x16x5 = 38400	160x3x16x4 = 30720	
20 codes with SF=32	80x3x32x20 = 153600	80x3x32x5 = 38400	
10 codes with SF=32	80x3x32x10 = 76800	80x3x32x5 = 38400	

FHT despreads whole the channelization code output at the same time. So to use many codes at once does not increase power consumption and longer receiving time increases power consumption. So from UE power consumption point of view, shorter TTI with many multi codes seems better solution.

To keep granularity of data size small, one slot HS-DSCH TTI is one idea. But the data size from 20 codes (SF=32) or 10 codes (SF=16) and 1slot TTI is still large, we don't oppose the introduction of code resource sharing (code multiplexed).

To assign as many as possible to one UE and shorter TTI approach will also have benefit for advanced receiver technique such as multi path interference canceller because of the many information goes to one UE in same timing makes easier of the interference estimation. And the estimated interference is used as a receiving signal to same UE has benefit of the power efficiency.

In addition, this approach decreases signalling overhead [1]. This approach can also reduce the number of simultaneous use of common (shared) control channel of TFCI [2][3][4]. Because the number of common control channel is as same as the number of code sharing. This can save the code resource for this TFCI channel.

As we will discuss on section 4 in this document, not assigning successive HSDPA TTI to one UE also reduce the memory size. To assign as many as possible to one UE and shorter TTI approach also fit this.

On the other side, to allow FHT despreading requires all the scrambling code in the one CCTrCH should be same. But we think the gain above discussed justifies this. We propose to all the scrambling code in one CCTrCH shall be same.

4. ARQ capability

As release 99 UE has a capability of RLC AM buffer size, we think HSDPA ARQ should have a capability of ARQ. Hybrid ARQ memory is one of main concern of UE complexity. So we think this should have the capability.

Generally ARQ capability is represented by the size of buffer size but in N-channel stop-and-wait H-ARQ case ARQ capability can be represented by the number of subchannel.

Table 2 is the memory requirement for each combination. This calculation is based on [5] i.e. 16, 10-code channels or 32,20-code channels and 3 slot HSDPA-TTI and only 16QAM case. In previous section, we propose to use 1slot TTI but the effect of reducing the N-channel is similar relation.

Table 2. The memory requirement of each N-sub channel combination

	Buffer at soft combining stage	Memory at the input of turbo decoder (16QAM)(bit storing)	
N=6	57.6 Ksymbols	230.5 Kwords	
N=5	48.0 Ksymbols	192 Kwords	
N=4	38.4 Ksymbols	153.6 Kwords	
N=3	28.8 Ksymbols	115.2 Kwords	
N=2	19.2 Ksymbols	76.8 Kwords	
N=1	9.6 Ksymbols	38.4 Kwords	

Please note introducing sub-channel capability is to keep the system number of subchannel is always same but the subchannel capability of each UE may vary.

The Node B scheduler should consider the above UE capability. If the system is set to six sub-channels and UE declares N-channel SAW capability is five, the six successive assignments to same UE with different sub-channel are prohibited. If UE declares this capability is one, this is same of 1-channel SAW and the service bit rate will decrease with the reduced complexity.

5. Proposal of HSDPA capability

Considering above multi code/ARQ capability discussion and reducing the parameters/combination [6], we propose following combination of UE capability for HSDPA. These combinations should be modified in the later phase as the detailed channel structure and ARQ scheme is selected.

Table 3. HSDPA UE class proposal

Class	Capability
HSDPA class 1	20 code (SF=32) or 10 code (SF=16) with 5 channel SAW
HSDPA class 2	20 code (SF=32) or 10 code (SF=16) with 4 channel SAW

HSDPA class 3	20 code (SF=32) or 10 code (SF=16) with 3 channel SAW
HSDPA class 4	20 code (SF=32) or 10 code (SF=16) with 2 channel SAW
HSDPA class 5	20 code (SF=32) or 10 code (SF=16) with 1 channel SAW
HSDPA class 6	10 code (SF=32) or 4 code (SF=16) with 1 channel SAW
HSDPA class 7	5 code (SF=32) or 2 code (SF=16) with 1 channel SAW

If above combination is still too much flexibility, we propose to remove class 2, class 4 and class 6 in the above combination.

We propose the AMC capability that defines the capability e.g. 64QAM and 16QAM are defined separately. At least, 64QAM capability should be treated separately.

6. Conclusion

We discussed UE capability on HSDPA and we propose following points.

- To propose HSDPA UE capability class which of the combination of multi code capability and SAW capability.

- FHT despreading can reduce the complexity of the despreading and this has a gain in short TTI and many multi codes usage but this requires same scrambling code on one CCTrCH of HS-DSCH.

7. Reference

[1] RAN 1 RAN 2 Joint Ad-Hoc Meeting on HSDPA, 12A010031, Semi-Static Code Space Division of Physical HS-DSCH, Lucent

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[5] RAN 1 RAN 2 Joint Ad-Hoc Meeting on HSDPA, 12A010003, Further buffer complexity and processing time considerations on HARQ, Nokia

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