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Further details on DSCH operation with DCH

Introduction

In the current version of 3GPP specification, the DSCH operation is given on a rather high level and several issues, although discussed earlier, are missing from the specifications. This contribution provides further details on the following areas with respect to the DSCH operation:

- The timing between DCH and DSCH
- The power control operation with DSCH
- The channel coding & multiplexing with DSCH
- The DSCH operation with adaptive antennas
- DSCH signalling alternatives on DCH when DCH is in soft handover state
- When to mandate DSCH operation for a UE

Text proposals are given in annex for issues where the issues are expected to clear enough. Apparently the last item is relevant to Ad Hoc 11 discussions and should be discussed there based on the view from Ad Hoc 14.

The timing between DCH and DSCH

It has been stated earlier that DCH and DSCH are operated in asynchronous manner as different DCH channels have different timing with respect to each other. The timing constraints are clarified in this and it is given what extra is required from UE with multi-code capability to support also DSCH operation.

As users in UTRA FDD are not slot or frame synchronised to each other, all the common channel are naturally not synchronised to DCH operation either. When having DSCH in use, the existence of data, when associated with DCH, is indicated with DCH allocated for a given user. In order to be able to decode the data correctly from DSCH, relative timing needs to be known for UE.

Having the DSCH timing inline with Primary Common Control Channel, gives explicit timing information for UE where frame boundaries occur on DSCH. The timing difference is when not allowing any restrictions for UE timing , is thus less than one frame (10 ms). To map that to practical operation not requiring really extra from the UE buffering etc, it is proposed here to adopt the following timing principle:

- The DSCH frame indicated on the DCH for UE shall be within + 1 slot and – 15 slots with respect to DCH timing. Basically this could be also tied to the range on 0 to 16 slots which would need less buffer as proposed over the Ad Hoc 14 email discussions.

- DSCH frame timing is mapped to the 10 ms cell specific scrambling code period.

This is needed to be defined as there are UE implications with respect how much buffer there would be for the UE for decoding the DSCH. One extra slot will not be a significant increase but buffering a whole frame would increase the memory use significantly when compared to implementing the same service with DCH. If the range is 0 to 16 we still need most likely have possibility to have in general DSCH ahead of maybe one symbol due possibly different timings of multiple DCH due possible soft handover.

Having the DSCH timing tied to the cell scrambling code will give a UE an explicit reference without any extra signaling needs.

The proposed modification to S1.11 is given in Annex.

Power control operation with DSCH

The fast power control operation with DSCH can basically follow three principles

- Node B lets the DSCH to follow the DCH power control commands send by UE

- Node B fixes the DSCH power level based on the DCH power level when initiating the transmission to UE on DSCH. A special case with this is to use fixed power level as the exact algorithm in Node B being an implementation issue. (The fixed power level approach would be the case when DSCH would be associated with a DSCH control channel.)

  It is proposed to mention these options in the specification but to leave the selection to operators and manufacturers. The outer loop power control operation from DSCH shall be defined in WG2. The power control issues for DSCH are proposed to be handled in S1.14, see detailed text in annex.

The channel coding & multiplexing with DSCH

The multiplexing with DSCH is very straightforward. The service using DSCH is interleaved over the 10 ms DSCH frame and coded with the Turbo coding (here assumption DSCH not used below single data packet with 320 bits packet size per 10 ms frame). The turbo interleaving is over the 10 ms, with exception when exceeding maximum turbo code block size (proposed to be 8192) after which segmentation to smaller block sizes below 8192 bits would take place. It is proposed for simplicity to use the same channel interleaver definition principle as with a DCH.

All the PDUs received from higher layer for a service (class) that is allocated to use a DSCH will be mapped to the DSCH separately for the PDUs of other services being mapped to DCH. With this respect the multiplexing rules for DSCH operation are quite simple.

From the Layer 1 point of view, DSCH does not see the contents in the packets in terms of which service they belong to. Layer 1 however provides error indication based in CRC (currently 16 bit CRC used) to indicated packet error to layers above along with the decoded data. As normal ARQ operation is not a layer 1 function, it is handled in higher layers, thus not havimg impact in WG1 definitions.

The rate matching is done with respect the (fixed) DSCH channel bit rates (32, 64, 128, 256, 512, 1024 etc) as DSCH contains only DPDCH field.

The error indication is provided based on the same (current working assumption is 16 bits) CRC as is done with DSC as well. The data decoded as well as indication whether there was an error or not is provided to higher layers (Layer 1 issue is not to determine what to do with data being in error, this will be handled by higher layers depending on the particular application.).

There is no need for DSCH modifications due slotted mode when the principle is used that DSCH is not transmitted during the frames when DCH is in slotted mode and DSCH would not be able to transmit the whole 10 ms frame.

The DSCH operation with adaptive antennas

When operated with adaptive antennas, the UE shall assume that same antenna weighting factors are applied to DSCH as with the DCH on which the channel estimation is based on.

This is important for UE know that it ca use same channel estimation results for DSCH detection as well for DCH detection.

DSCH signalling alternatives on DCH when DCH is in soft handover state

The area that has been discussed in other working groups with DSCH (at least in WG2) is what will happen when DCH is in soft handover (and DSCH is not). Basically different cases can be separated:

- Single RNC is involved (i.e. controlling and serving RNC are the same)
- Multiple RNCs are involved, but controlling and serving RNC is the same for DSCH.
- Multiple RNCs are involved, but controlling RNC is not the same for DSCH as the serving RNC (Drift RNC)

In two cases the signaling basically does not differ from the single cell case, the relevant interfaces in the network need to carry the relevant signaling information regardless whether the signaling is done with TFCI or with higher layer signaling.

The third case causes some differences with the alternatives being now:

- Communication with serving RNC (SRNC) and drift RNC (DRNC) in a way that TFCI can be formed from SRNC. This causes extra delay from interface between RNCs.
- Same as above but with DSCH control with higher layer signaling on DCH. Same mutual signaling needs as with TFCI signaling exists there as well.
- Use of different radio links.

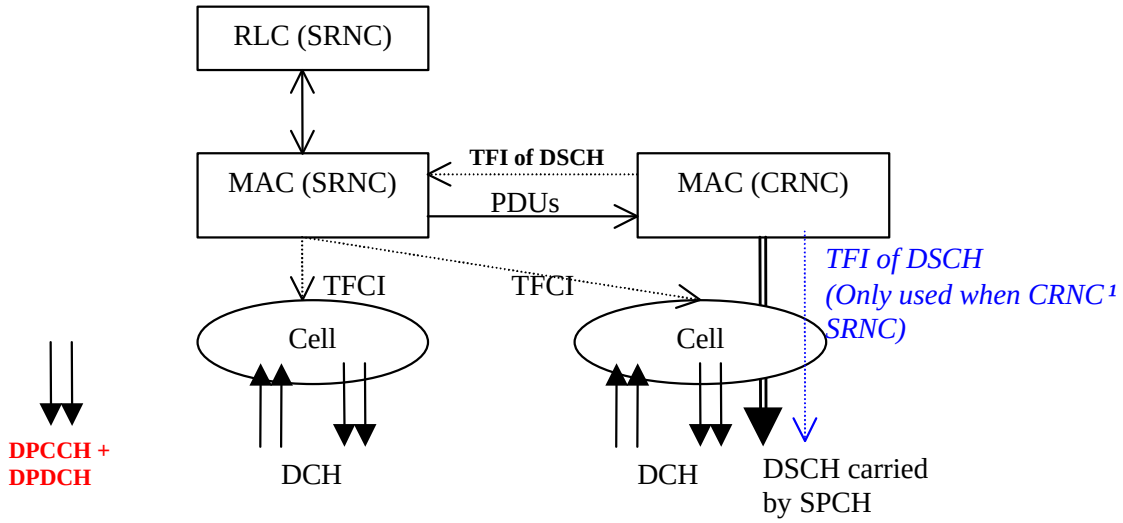

Figure 1. DSCH & DCH operation from network side with different SNRC & CRNC.

When to mandate DSCH operation for UE

When to support DSCH in UE should basically be aligned with the multicode reception capability as the “delta” from DSCH and DCH to DCH is very marginal. The main difference comes from two factors:

- Timing difference, DCH and DSCH are not time aligned. This means less than 10 % increase in the buffer channel per code channel, imposed only to DSCH part, thus overall RAKE buffer size increase well below 5 %.

- Different spreading factors. DCH and DSCH have typically, not necessary different spreading factors, depending on what DCH is expected to carry. As multicode DCH is with a single spreading factor and there also channel estimation is based on one of the DPCCH fields, the added complexity on DCH and DSCH side is in Layer 1 control part of UE, not in the actual RAKE processing. The same control resource (depending on the implementation) should be able to handle smaller symbol rate channels when compared to multicode DCH.

This has been proposed during the Ad Hoc 11 discussions and DSCH capability is evidently something coming along as service capability dependant issues. The beneficial feature with DSCH is that with the code multiplexing principle and different spreading factors, terminals with different reception capability in terms of multicode and spreading factor capability can shared the same DSCH structure. This is especially important from the service capability evolution point of view as defining a 1 Mbits/s pipe from day one would mean long time before UE capabilities could be offered to utilize DSCH.

CONCLUSIONS

In this contribution several smaller details on DSCH has been discussed and text proposals have been given. Comments are invited on the presented topics and on the issues where there exists common understanding how matters should be specified, the attached text proposal are recommended to be included in relevant volumes to progress the work on DSCH to enable efficient support for packet data in UTRA.

ANNEX: Text proposal on DSCH to S1 documents.

To section 5.3.2.5.1 (DSCH associated with a DCH) in S1.11

Keep existing text and ad:

The DSCH transmission with associated DCH is a special case of multicode transmission, the channels do not have necessary the same spreading factor and for DSCH the spreading factor may vary from frame to frame. The relevant Layer 1 control information is transmitted on DCH, the PDSCH does not contain DPCCH information.

For DSCH the allowed spreading factors may vary from 256 to 4. DSCH may consist of multiple parallel codes as well as negotiated at higher layer prior starting data transmission. In such a case the parallel codes shall be operated with frame synchronisation between each other.

To section 7.2.8.3 in S1.12 (new section under multirate transmission)

7.2.8.3 DSCH multirate transmission when associated with DCH

The data stream on DSCH shall be transmitted continuously over the 10 ms allocation period with no DTX on slot period.

The spreading factor is indicated with the TFCI or with higher layer signalling on DCH.

Rate matching is implemented as in uplink, when there is data to transmit the 10 ms frame is fully filled with no DTX. The rates for the data as well as rate matching parameters are pre-negotiated at higher layers and are all part of the TFCI indication for particular data rate with particular spreading code.

Coherent detection is done based on the associated DCH carrying PDCCH data.

To section 5.2 (New section under Downlink Power Control) in S1.14

5.2.4 Power Control with DSCH

The DSCH power control can be based on the following solutions, which are selectable by the network.

- Fast closed loop power control based on the power control commands send by the UE on the uplink DPCCH.
- Slow power control

To section 7 (Timing Relationship between physical channels) in S1.11

Keep existing material and ad:

The relative timing between a DSCH and DCH is given as follows:

- DSCH timing is identical to the cell primary CCPCH
- DCH timing is asynchronous with max 1 slot (0.625 ms) ahead or respectively max 15 slots (15 times 0.625 ms behind), this determines explicitly which frame on DSCH carries the user data based on the TFCI or higher layer signalling on DCH.