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Introduction

This document discusses a possible extension of the Channel Assignment concept to allow more flexibility in the use of CPCH. If adopted, this proposal would allow CPCH to be dynamically configured to operate with or without Channel Assignment. No significant changes are required to the physical layer to allow this.

Current proposals

Here we briefly review some of the current CPCH proposals.

As CPCH is currently described in the UMTS specification, the parameters associated with the physical channels or physical resource (e.g. bit rate, scrambling and channelisation codes for uplink and downlink) can be determined by reference to the preamble signature transmitted in the uplink. In principle these parameters might also be determined partly (or possibly entirely) by reference to the sub-channel used for the preamble transmission. In any case a mapping (or mappings) is needed between preamble signatures (and/or sub channel) and corresponding set physical channels. Information describing such a mapping (or mappings) would be broadcast.

The following possible mappings can be distinguished:-

a)	One signature	-->	one physical channel
b)	Several signatures	-->	one physical channel
c)	Several signatures	-->	several physical channels
d)	One signature	-->	several physical channels

In cases a) and b) the physical channel is uniquely determined by the signature, so no channel allocation message is needed. In a particular system deployment, several mappings of type a) and/or b) could be defined, where the different physical channels could have different (or the same) bit rates. This is the original CPCH concept as proposed by GBT

In case c) a channel assignment message is needed, to indicate which particular physical channel is to be used by the MS. In these cases we may also add simplifying restrictions, such as requiring that the bit rates are the same for all the physical channels within one mapping. Case d) is a special case of c) where only one access signature is available. Again, in a given system a number of mappings could be defined for channels (or groups of channels) with different bit rates. This is the CPCH with channel assignment as first proposed by Samsung. The channel assignment concept may also allow operation with only one physical channel. However, in this case (which is equivalent to mappings a) and b)) the channel assignment message is not needed and could be ignored if it is sent.

Flexible Channel Assignment Concept

Now we slightly extend the CPCH concept to provide more flexibility by allowing mappings of all the possible types a) to d) to be defined and used simultaneously in one system.
Keeping the restriction that the physical channel bit rates should be the same within one mapping implies that in order to support more than one bit rate, then more than one mapping must be available simultaneously.
However, we can now describe all the possible cases within one unified framework:

One or more signatures **-->** One or more physical channels with equal bit rates

If the mapping contains more than one physical channel, this implies that a channel assignment message is needed.

As an example of the origninal channel assignment scheme, we could have the following mappings defined in one system configuration, as in Table 1.

Mapping identifier	Signature(s)	Physical Channel identifier(s)	Bit rate (kbps)
0	0	0	960
1	1	1	480
2	2, 3	2	240
3	4, 5	3, 4, 5, 6	60
4	6	7, 8	120

Table 1 Example of signature mappings with channel assignment

As mentioned earlier, a channel assignment message is only needed if the selection of a signature by the MS does not uniquely determine the physical channel.

For the greatest flexibility in deployment by the operator we should allow any combination of mappings between signatures and physical channels, subject to any relevant implementation constraints. Then an example such as shown in Table 2 would be possible.

Mapping identifier	Signature identifier(s)	Physical Channel identifier(s)	Bit rate (kbps)
0	0	0	960
1	1	1	480
2	2, 3	2	120
3	4, 5	3	120
4	6, 7	4	120
5	8, 9, 10, 11	5, 6, 7, 8	60

Table 2 Example of flexible signature mappings

In table 2 we see that four channels with bit rate 60kbps are available using channel assignment (channel selection by the network). However, we also see that three channels of bit rate 120kbps are available without using channel assignment (channel selection by the UE). Note that this latter possibility was not previously considered part of the channel assignment concept, but there seems to be no significant reason not to allow it, and it does give desirable flexibility.

Status Broadcast

Now we consider broadcast of CPCH status. Before making an access attempt the UE checks the status information to confirm that the required channel is available. Based on the Flexible Channel Assignment concept there are various options for this information (considered with respect to the example in Table 2):

1. The availability of each physical channel (requiring 9 bits for 9 channels).
2. Availability indicated if any one of the channels within a mapping is free (6 bits for 6 mappings).
3. The highest bit rate available (2 bits for 4 bit rates).

Option 1 requires the largest number of bits, and sends redundant information for mapping 5.
Option 3 uses the smallest number of bits but would not distinguish between the availability of channels 2,3, or 4.
Option 2 seems the best compromise.

Conclusions

We have shown that with minor extensions to the Channel Assignment concept, CPCH can easily be configured to allow channel selection by the UE, channel selection by the UTRAN, or a combination of both. The configuration can be optimised for the particular traffic scenario and operator requirements.

Annex A

Definition of Mapping Information

There are probably many options for defining the CPCH mapping information. Here we present one possibility, to show that efficient solutions are possible.

First we construct a list of the available preamble signatures.

Signature Identifier	Preamble Signature
0	P_{i0}
1	P_{i1}
2	P_{i2}
.	.
.	.
S-1	P_{iS-1}

Table 3

Here the values of i0, i1, i2, etc correspond to one of the available access preamble signatures, up to the total number S.

Then we construct a list of M mappings, and the number of signatures in each mapping:-

Mapping Identifier	Number of signatures in mapping	Number of physical channels in mapping	Bit rate
0	NS_0	NC_0	BR_0
1	NS_1	NC_1	BR_1
2	NS_2	NC_2	BR_2
.	.	.	.
.	.	.	.
M-1	NS_{M-1}	NC_{M-1}	BR_{M-1}

Table 4

Here the total number of signatures is

$$S = NS_0 + NS_1 + \ldots NS_{M-1}$$

and the total number of physical channels is

$$C = NC_0 + NC_1 + \ldots NC_{M-1}$$

The available signatures are assigned sequentially to each mapping in the order given in Table 3.

Similarly we can construct a list of the C physical channels:-

Channel Identifier	Uplink scrambling code	Uplink channelisation code	Downlink channelisation code
0	US_{i0}	UC_{i0}	DC_{i0}
1	US_{i1}	UC_{i1}	DC_{i1}
2	US_{i2}	UC_{i2}	DC_{i2}
.	.	.	.
.	.	.	.
C-1	US_{iC-1}	UC_{iC-1}	DC_{iC-1}

Table 5

The available channels are assigned sequentially to each mapping in the order given in Table 5

So as an example, if NS_0 = 2 and NC_0=3, then Signatures P_{i0} and P_{i1} are in Mapping 0 which maps them to physical channels with identifiers 0, 1 and 2 which have uplink scrambling codes US_{i0},US_{i1} and US_{i2} etc. Similarly, if NS_{M-1}=1 and NC_{M-1}=1, then Signature P_{iS-1} is mapped to a channel with uplink scrambling code US_{iC-1}.

The contents of Tables 3, 4 and 5 would need to be provided as CPCH parameters, either broadcast or sent to individual UE's using CPCH. Assuming a worst case of 16 rows in each Table and 1 byte for each entry, the total amount of data could be up to around 16 x (1+3+3) = 80 bytes.

Annex B

Mapings in "FR/MRCPCH" Proposal from GBT

Current proposals from GBT seem to suggest two modes of operation. One without channel assignment (FRCPCH) and one where the access preamble signature specifies the requested bit rate (MRCPCH), but the other parameters of the physical channel are indicated by a channel assignment message. This can be viewed as relaxing the restriction of only one bit rate per mapping.

Again there are probably many ways of defining the mappings. One possibility is presented below.

The approach given in Annex A can be modified slightly to accommodate the use of both modes at once as follows:

Signature Identifier	Preamble Signature	Bit rate
0	P_{i0}	BR_0
1	P_{i1}	BR_1
2	P_{i2}	BR_2
.	.	.
.	.	.
S-1	P_{iS-1}	BR_{S-1}

Table 6

Here the values of i0, i1, i2, etc correspond to one of the available access preamble signatures, up to the total number S.

Then we construct a list of M mappings, and the number of signatures in each mapping:-

Mapping Identifier	Number of signatures in mapping	Number of physical channels in mapping
0	NS_0	NC_0
1	NS_1	NC_1
2	NS_2	NC_2
.	.	.
.	.	.
M-1	NS_{M-1}	NC_{M-1}

Table 7

Here the total number of signatures is

$$S = NS_0 + NS_1 + \ldots NS_{M-1}$$

and the total number of physical channels is

$$C = NC_0 + NC_1 + \ldots NC_{M-1}$$

The available signatures are assigned sequentially to each mapping in the order given in Table 7.

In principle Table 7 could be trivial if the two proposed modes are mutually exclusive. In a completely non-channel assignment case, there would only be one physical channel per mapping. With all resources used for channel assignment there could be just one mapping containing all the signatures and all the physical channels.

Similarly we can construct a list of the C physical channels:-

Channel Identifier	Uplink scrambling code	Uplink channelisation code	Downlink channelisation code
0	US_{i0}	UC_{i0}	DC_{i0}
1	US_{i1}	UC_{i1}	DC_{i1}
2	US_{i2}	UC_{i2}	DC_{i2}
.	.	.	.
.	.	.	.
C-1	US_{iC-1}	UC_{iC-1}	DC_{iC-1}

Table 8

The available channels are assigned sequentially to each mapping in the order given in Table 8.

If the status broadcast is to indicate the maximum available bit rate, this seems to imply that either there should be several mappings each with a different bit rate or that all the available physical channels are included within one mapping.