3GPP TSG-RAN WG2 Meeting #58 ***R2-071911***
Kobe, Japan, 7th-11th May 2007 (Update of R2-071377)

Agenda item: **4.5**
Title: **System information structure (with TP)**
Source: **Samsung**
Document for: **Discussion and decision**

1. Introduction

In this paper we have categorised the most time critical system information, considering the main mobility scenarios. This analysis is performed to assist concluding the required BCH periodicity. Furtheremore, based on that conclusion, a proposal is included regarding the organisation of the concerned system information i.e. what information to divide over separate SIBs.

2. Discussion

2.1 Recap of current status and main BCH structuring criteria

During the RAN2#57 meeting it was agreed that:

- BCCH can be mapped to BCH (often referred to as P-BCH) and to DL-SCH (sometimes referred to as D-BCH), while the need for mapping to an S-BCH is FFS
- Scheduling information (starting times) is provided for a group SIBs having the same scheduling requirements, also referred to as a Scheduling Unit (SU). BCH includes the scheduling information of the the most frequently repeated Scheduling Unit (SU-1)
- The high level contents of BCH and SU-1 have been identified

Before summarising the content of BCH and SU-1, we would like to highlight the rationale for including information within BCH, SU-1 or a less frequently transmitted SU. Concerning this rationale, our assumptions are as follows:

BCH should include the following type of information:

- All parameter necessary to perform handover (i.e. step 1 & 2 in sec. 5.1)including the parameters needed to access the target cell, exept for the parameters that may be provided via dedicated signalling e.g. aRACH configuration
- All parameters needed to measure and rank cell re-selection candidates (i.e. step 1 in sec. 6.1)

SU-1 should include the following type of information:

- All parameters needed to validate accessibility of the cell re-selection target (i.e. step 2 in sec. 6.1)

Our assumption is that the other mobility related parameters e.g. common channel configuration information (i.e. related to the cell re-selection step 3 in 5.1) may be included in other SUs, scheduled less frequently. The following section provides further details on the actual information elements

2.2 Further analysis of BCH contents and periodicity

This section summarises our progress in the discussion regarding the transmission requirements for system information.

A. What is needed to measure a neighbouring cell (Cell re-selection)

In summary: To measure neighbouring cells with sufficient performance, it is most important that the UE knows the system bandwidth i.e. from a measurement performance perspective it less essential for the UE to also know the antenna and the control channel configuration

- *Cell identity*: Our assumption is that the SCH- based identity needs to be locally unique, since it determines the scrambling code and the hopping pattern i.e. if two nearby cells use the same SCH based cell id and by accident are time-aligned it will be impossible to measure these cells. In other words: from a measurement cell identification perspective, an additional cell identity on BCH is useless
- *Cell bandwidth*: In our opinion this is the most important parameter from a measurement performance perspective. Our assumption is that it should be provided.
- *Antenna configuration*: RAN1 has not concluded whether the antenna configuration will be signalled via SCH. This parameter could improve the measurement performance, but this is not considered essential provided that the system bandwidth is known. (Our preference is to not signal this via SCH either, since that would increase cell search complexity)
- *Control channel configuration* (i.e. MBSFN and Ext. CP usage): Our assumption is that when the system bandwith is indicated, measurement of the first OFDM symbol may provide sufficient performance. Hence, our assumption is that this information is not essential
- *RS power boosting:* Different cells may apply a different power boosting for the RS. Consequently, if the UE is not informed about the power boosting it may select an incorrect cell.

B. What is needed to rank a neighbouring cell (Cell re-selection)

In summary: To rank neighbouring cells, the UE needs to know the Qoffset and the Suitability parameters i.e. the LTE equivalents of Qqualmin(Ec/No), Qrxlevmin (RSCP) and Maximum allowed UL TX). Only for the for the Qoffset parameter it is common to use cell specific values (intra-frequency only)

- *Suitability*: UTRA includes suitability related parameters i.e. Qqualmin(Ec/No), Qrxlevmin (RSCP) and Maximum allowed UL TX power. In general it seems unlikely that a cell that ranks higher than the current cell is not suitable. If however a Qoffset applies stimulating re-selection, this may not always be the case. Some operators indicated that the suitability parameters are typically common for all neighbouring cells
- *Qoffset*: There seems consensus that this parameter needs to be provided and that it is common to use different values for different intra-frequency neighbouring cells (RAN2 agreed that there is no need for cell specific offset for interfrequency neighbours)

C. What is needed to report measurements (handover)

In summary: Our assumption is that the UE needs to read the Offset of neighbouring cells for measurement reporting (i.e. change of best cell)

- *Qoffset*: Our assumption is that the UE needs to acquire the Qoffset of neighbouring cells to be able to report certain measurement events (in particular: change of best cell)

D. What is needed to perform initial access (handover)

In summary: Our assumption is all RACH related information, including UL interference, is provided via dedicated signalling, implying that the UE need not know the SFN of the target cell

- *System Frame Number (SFN)*: Firstly, we assume than a RACH will be configured in every radio frame, so the UE does not need the SFN to determine in which frame RACH is included. Furthermore, we have not identified a clear need to apply frequency hopping for RACH. Hence, our assumption is that the UE does not need to acquire the SFN of the target cell before performing initial access.
    - According to our earlier load calculations (R2-070206), for a cell with 10MHz bandwith 6 aRACHs would be needed to achieve a collision probability of 0.5% when using 1 info bit and using dedicated signatures for handover. This would translate to 0.75 aRACH for a cell with 1.25 MHZ bandwith. If we tolerate higher collision probabilities e.g. 1%, the aRACH would be overdimensioned considerably. However, our assumption is that the aRACH resources can be utilised for other purposes (UL-SCH transmission) i.e. there is no real drawback in having an aRACH in every radio frame

Review of previous results

In summary: At present, Qoffset is the prime candidate parameter for BCH. Further analysis shows that from a signalling overhead perspective BCH hardly ever 'beats' the serving's NCL. Simplied configuration remains as (only) argument for the BCH. Further analysis shows that for the Qoffset parameter, acquisition delays are not that critical assuming that the UE needs at least 2 measurements sufficiently apart in time (320ms in UTRA)

- In the above, we identified that primarily the following parameters need to be available:
  - System bandwidth, often common for the neighbours
  - Qoffset, often different for the intra-frequency neighbours only
  - Suitability, often common for the neighbours
- RAN2 discussed the principle that parameters that are often different should be carried on (P-)BCH (approach A) while parameters that are hardly ever different (say only in 5% of the cases) should be in the neighbour list of the serving cell (approach B). Accordingly, Qoffset is the only candidate for (P-)BCH. The analysis in the intermezzo below however shows that from a signalling perspective BCH hardly ever 'beats' the serving's NCL. The simplied configuration that applies for the neighbours BCH is assumed to be a somewhat less important factor

Intermezzo: Overhead comparison between target's BCH and serving's neighbour list (NCL)

Assumptions

- *Serving's neighbour list*
  - *The neighbouring cell info is provided on D-BCH, say every 320- 640ms*
  - *The info is provided in several neighbours of the target cell, say 12*
  - *There is additional overhead because the cell identity (9b) needs to be provided*
- *Target cell's BCH*
  - *The information is provided on BCH, say every 10- 20ms*

Example: Single parameter of 4 bits

- *Considering overhead of cell identity*
  - *Serving's neighbour list: (4b + 9b) x 12 every 640ms = 0.24 kbps*
  - *Target cell's BCH: 4b every 20 ms= 0.20 kbps*
- *Not considering overhead of cell identity (If there are several parameters, relative overhead of this reduces):*
  - *Serving's neighbour list: (4b) x 12 every 640ms = 0.07 kbps*

Final remarks:

- *The BCH may include parameters relevant for mobility and parameters not relevant for mobility i.e. with somewhat less stringent delay requirements. In such a case, all parameters need to be considered in the overhead comparison since adding the mobility parameters to BCH also causes the non mobility parameters to be transmitted more frequently*
- *Altogether, the analysis shows that BCH hardly ever 'beats' the serving's NCL from a signalling overhead perspective*

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- *Urgency Qoffset*: It should be possible to read BCH of intra-frequency neighbouring cells prior to the actual re-selection. The ranking of a newly detected cell can only be performed when the Qoffset parameter is known. If this parameter is transmitted every 80ms on BCH, it takes on average 40ms for the UE to acquire this information. Cell re-selection is normally based on at least 2 measurements that are at least a certain amount of time apart (i.e. 320ms for the lower DRX values in UTRA, see 25.133 Table 4.1). Hence, provided BCH is not scheduled too infrequently, it should be possible to acquire the Qoffset parameter prior to the 2nd measurement (i.e. not introducing any re-selection delay). Our assumption is that UEs in connected mode also have to acquire the Qoffset from every detected intra-frequency neighbouring cell (e.g. to be able to report change of best cell correctly). However, for connected mode similar considerations apply
- *Reading of BCH from* multiple cells: As mentioned before, in case BCH is transmitted every 80ms on BCH it takes on average 40ms for the UE to acquire this information. The question is if this acquisition

delay also applies in case multiple neighbouring cells need to be read simultaneously. One could consider that the UE buffers the information received from different cells and then process the information sequentially. In such an implementation scheme, the average delay will not be much higher than 40ms in case of 80ms BCH repetition. We have not concluded if this type of implementation is really feasible. Especially when cells are not synchronised wrt. BCH transmission, the buffer requirements may be excessive. Hence, we are uncertain whether the average delay of 40ms applies in this case

- *Scheduling info*: If BCH is scheduled every 80ms, the UE will have to read BCH for 80ms before 'finding' it. To reduce UE battery consumption, one could consider providing every 10ms an indication of when BCH will be scheduled. This may reduce the average active time with a factor of ~2 (from 4 to 2 frames).
    - A rather rough analysis shows that the BCH reading involves a comparable power consumption as used for neighbouring cell measurement i.e. power consumption seems an issue
        - If the UE measures neighbouring cells once every 1s and re-selects on average once per 20s, it measures 20 times while it measures BCH once. If the UE is active 2ms for every measurement, both are comparable.

Towards a conclusions/ recommendations regarding BCH periodicity

In summary: Our assumption is that the Qoffset parameter of may be rather cell specific. Our analysis shows that the only argument for using the BCH to transmit such a parameter is simplified eNB configuration. On the other hand, the BCH transmission seems to complicate UE implementation and/ or reduce battery lifetime. RAN2 is requested to take these considerations into account when concluding the discussion on BCH periodicity and structure.

2.3 Overview of time critical system information

The following table provides an overview of the most time critical system information. The table showns for each type of information the expected periodicity, the assumed contents and an estimate of the expected size.

Contents	Where	Size	Comment
Physical layer parameters • Bandwidth: 3b i.e. (1.25, 2.5, 5, 10, 15, 20) • Antenna configuration (FFS) • Control channel configuration (FFS) • RS power boosting (FFS)	BCH	*~3b*	
Primary scheduling information i.e. for the urgent system information		*10b*	Size estimate assumes 6b LSB of the common OFF, a 4 bit REP for SU-1. For further details, see [1]
System frame number SFN (FFS)		*12b*	Needed for aRACH access (frequency hopping) i.e. handover step 3 (HO execution). Alternative transmission methods may be possible
Cell measurement and ranking information Offset or Cell class/ (5b) eNB Tx power (5b)		*10b*	Needed for every measured cell ranking (i.e. cell re-selection step 1) Needed to determine pathloss
Cell access related information PLMN identity, TA identity, cell identity* (54-58b, 22- 24b for every additional PLMN identity) Cell barring status (4- 105b)	SU-1	*~64-290b*	Needed for best cell on the frequency, to verify accessibility As in UMTS 1- 17b per up to 6 multiple PLMNs
Secondary scheduling information i.e. for other system information (6b MSB of the common OFF, for 5 SUs a 4 bit REP and a 2b Value Tag)	SU-1	*~36b*	Needed to verify if a change has occured upon return from temporary OOS (mainly for the common channel configuration)

General configuration parameters for common and shared channels aRACH configuration info (e.g. PRB allocation, power ramping, 'AICH' PRB allocation) General UL-SCH & DL-SCH configuration parameters (as well as about the associated control channels) Configuration of common channels: PCCH, MCCH, full BCCH (i.e. Dyanamic BCH) all of which may be mapped on DL-SCCH Difficult to estimate at present. Expected to be less than in UMTS (4 segments as default i.e. ~900b)	SU-2	*~500b*	Needed upon actual cell re-selection (i.e. step 3). For HO this information is provided via dedicated signalling
Neighbouring cell measurement information InterF neighbours Inter RAT neighbours (UMTS, GSM) i.e. ID, neighbour list, quantity and reporting criteria Difficult to estimate but assumed to be less than in UMTS (up to 32 segments or 7kb with SIB11ext)	SU-2	*~1000b*	Needed to start UE mobility measurements

Tab. 1 Time critical system information, allocation and estimated size

The above table is mainly provided for reference, considering that the discussions on the system information transmission scheme have not entirely concluded. TS 36.300 already provides a description of the contents of BCH and SU that is largely in line with the above table.

2.4 Further proposals on use of messages (SIBs)

In case RAN2 concludes a BCH repetion rate lower than 80s, we propose to conclude that:

- There is no need for an S-BCH
- The current BCH organisation with a BCH and an SU-1 is beneficial and should remain

In this case, our proposal is to add some further detail about the organisation of this information. In accordance with our previous paper, our proposal is to introduce separate SIB messages for information for which it is beneficial for the UE to act even if other information in the same SU has not yet been received. Accordingly, our proposal is as follows:

To introduce a '**Master Information Block'** message containing the Primary physical layer parameters, Primary scheduling information, System frame number and Cell measurement and ranking information i.e. the information with periodicity 1 in the above table (aligning with UTRA)

To introduce a '**Scheduling Block'** message, containing the Secondary scheduling information

To introduce a '**System Information Block 1'** message, containing the Cell access related information

To introduce a '**System Information Block 2'** message, containing the Common and shared channel configuration information

To introduce one or more '**System Information Block n'** message(s), containing the Neighbouring cell measurement information

- Whether or not to use multiple messages e.g. separate for inter-frequency and inter-RAT neighbours, should be decided after the discussions regarding the neighbouring cell lists has concluded.

The actual numbering of this SIB may be left open for the moment, i.e. to allow for alignement with UTRA where possible. The proposal is illustrated in the following figure, that also shows how the system information is scheduled when assuming concentrated transmission.

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