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Title: **Structure of System Information**

Document for: Discussion

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1 Introduction

This document describes a mechanism for structuring the transmission of system information. The mechanism provides high flexibility, low UE power consumption, low access delay, and low resource requirements on the air interface.

2 Discussion

System information includes various kinds of information elements that need to be accessible to all UEs in the system. The information elements differ in how often they are updated, how quickly they have to be accessed by the UEs, and how much they vary between cells.

A mechanism for broadcasting system information needs to fulfil the following basic requirements:

- The UEs shall be able to read the required system information with minimal power consumption. This is particularly important in idle mode.
- The UEs shall be able to acquire necessary time critical system information without significant delay. A typical example is when a random access message is to be sent just after a cell change.
- The resources required for system information shall be minimised.

Furthermore, new information elements are likely to be introduced in future evolution of UTRAN, possibly with new requirements. To cope with such changes, the following requirements are also essential:

- It shall be possible to add new system information in an efficient way (i.e., without compromising the requirements stated above).
- It shall be possible to increase the capacity for system information.

To fulfil all these requirements, it is necessary to be able to group the system information in blocks that are broadcast differently, regarding e.g. repetition rate and updating mechanism. In addition, this structure should be adaptable by the network operator and by future standard evolution.

The following general concept is proposed.

2.1 System information concept

The system information elements are broadcast in *system information blocks*. Different system information blocks may have different characteristics, e.g. regarding their repetition rate and the requirements on UEs to update the system information blocks. A *master information block* is used to specify what system information blocks are in use in a cell, and how they should be accessed. Figure 1 illustrates the relation between the master information block and the system information blocks in a cell.

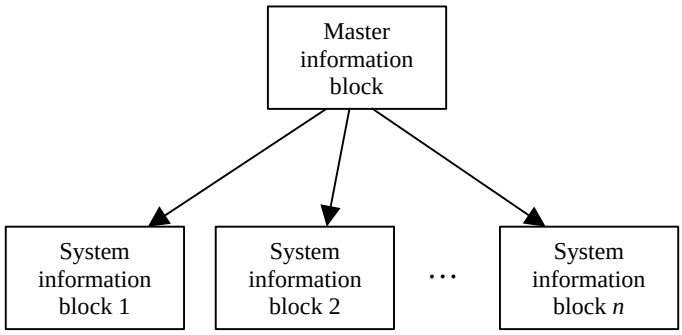

Figure 1 The overall structure of system information.

2.1.1 System information blocks

A system information block contains the following fields:

- Block type
- Expiration time (optional)
- Value tag (optional)
- Actual system information elements

The *block type* refers to a block type definition that specifies what system information elements are included in the system information block, as well as a default expiration time, the size of the value tag, and the scope of the system information block. The *scope* is the area where the system information block may potentially be used; it may be either the cell where the system information block is broadcast or the PLMN. In the case of PLMN scope, the system information block may be used in other cells in the same PLMN, depending on the value tags (see further below).

The *expiration time* indicates how long the information may be used by a UE without being re-read. If this field is not present in a system information block, the default expiration time for the block type should be used.

The *value tag* is related to the values of the information elements in a system information block. The presence and size of the value tag is given by the definition of the block type.

The purpose of the expiration time and the value tag is to avoid re-reading system information blocks unnecessarily. The UE may use the information in an already received system information block as long as all the following conditions hold:

- The expiration time has not passed
- The current cell is within the scope of the system information block
- The block type and value tag (if present) are currently in use in the current cell (this is indicated in the master information block, see below)

Note that the UE has the possibility to use a system information block that was broadcast in a different cell than the current cell, if the scope is PLMN and the block type and value tag is in use in the current cell. The purpose is to allow a group of cells to share a single system information block, in order to let the UE avoid re-reading the information when changing cells within the cell group.

2.1.2 Master information block

At each time instant, a set of system information blocks is in use in a cell. A list of these system information blocks is repeatedly broadcast on the BCCH, in the form of a *master information block*. The master block contains the following fields:

- PLMN id. This is needed since the value tags are only valid within the PLMN where they are broadcast
- A list of system information blocks currently in use in the cell, for each specifying:
  - Block type
  - Value tag (if present in the system information block)
  - Scheduling information (when and where the system information block is broadcast)

The UEs should be notified, for instance on the PCH, if the master information block is changed.

2.1.3 Scheduling of blocks on the BCCH

The master information block and all system information blocks that are in use in a cell should be repeatedly broadcast in the cell on the BCCH, to be used by UEs either in idle or in connected mode. The master information block should be broadcast with a relatively high, pre-defined repetition rate. Different system information blocks may be broadcast with different repetition rates. The actual scheduling of the system information blocks should be indicated in the master information block.

It shall be possible to broadcast large amounts of system information at low repetition rates without interfering with the broadcasting of blocks that use higher repetition rates, such as the master information block.

2.1.4 Scheduling of blocks on the DCCH

The network may send system information to a UE in connected mode, using the DCCH. For instance, an update of a system information block on the BCCH may be indicated to a UE in connected mode by sending the master information block on the DCCH. It is also possible to send actual system information blocks on the DCCH, in which case the scheduling information in the master information block may inform the UE that it should read system information blocks on the DCCH.

2.1.5 Block types

A block type definition includes the following:

- The scope of the system information blocks of this type. May be either cell scope or PLMN scope.
- A default expiration time, to be used if the expiration time field is absent in a system information block of this type.
- The value tag size for system information blocks of this type. May be set to zero, indicating that value tags are not used for this block type.
- A definition of the information elements included in system information blocks of this type.

A set of block types should be specified in the standard. The parsing mechanism for these system information blocks should allow UEs to continue operating correctly if new information elements are later included in the system information blocks.

The network operator may define additional block types to be used in a PLMN. The block type definitions should then be sent on the broadcast channel. Such block types are valid in the entire PLMN. The necessity and mechanism for such block type definitions is for further study.

2.2 Example usage

To see how the described broadcast mechanism fulfils the requirements stated in the introduction to this section, three use cases showing different kinds of system information are described below. Note that the examples included are very terse, since each example only includes a single block type.

2.2.1 Cell-specific configuration information

Many cell specific system information elements are updated relatively seldom. This includes e.g. neighbour cell relations and some physical channel parameters. Such information should in general only have to be read at cell change, unless the cell is reconfigured in which case all UEs should be forced to re-read that system information. To facilitate this behaviour, the information should be placed in one or several system information blocks with the following characteristics:

- Cell scope
- Relatively small value tag size (e.g. two bits)
- Long expiration time

A UE entering a cell will detect the presence of such a system information block by reading the master information block. Then, it will read the system information block once and use it for a relatively long time without re-reading it.

If the information has to be changed because of reconfiguration, the value tag of the system information block is changed and the master information block is updated accordingly. Then, the UEs are paged with an indication to re-read the master information block. The changed value tag instructs the UEs to discard the old system information block and read the new one.

Figure 2 illustrates an example of how cell-specific information may be updated in this way.

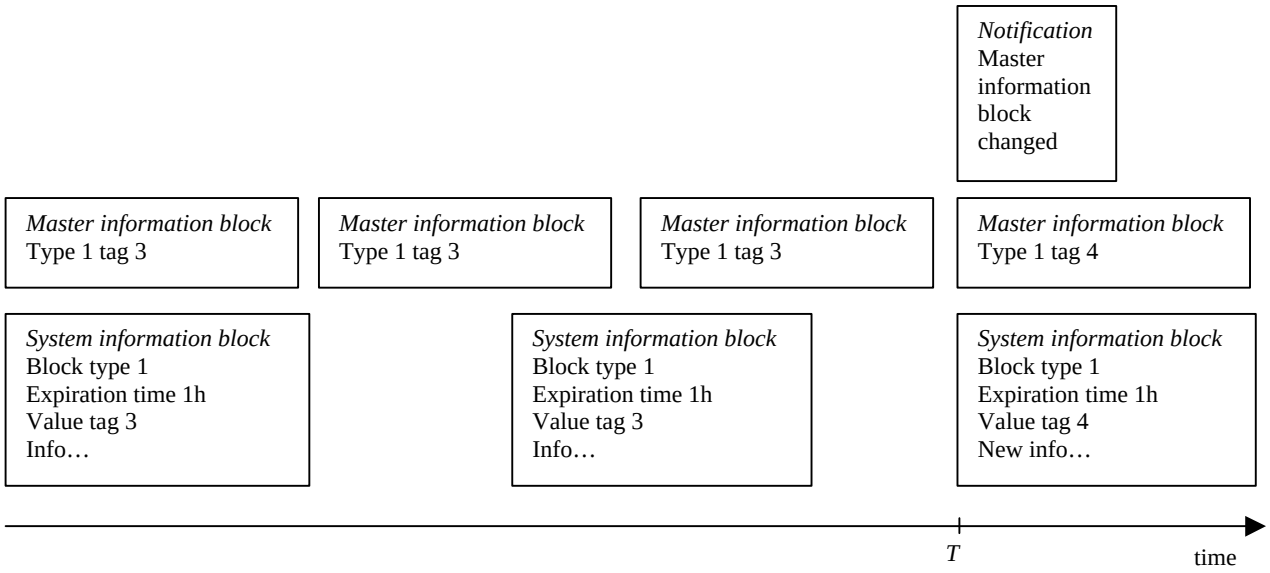

Figure 2 Example of changing system information using value tags. At time *T*, the information in the system information block of type 1 is changed. To force the UEs to re-read the block, a new tag value is used and the master information block is updated accordingly. Finally, all UEs are notified, e.g. on the PCH, to force re-reading of the master information block.

2.2.2 System information with periodic updates

Some system information elements are updated periodically, e.g., as a result of interference or traffic measurements. Such information may only be valid for a short time and should be re-read by the UEs when it is needed. This behaviour is achieved by placing the system information elements in one or several system information blocks with the following characteristics:

- Cell scope
- No value tag
- Short expiration time
- High repetition rate

Figure 3 illustrates an example of this usage.

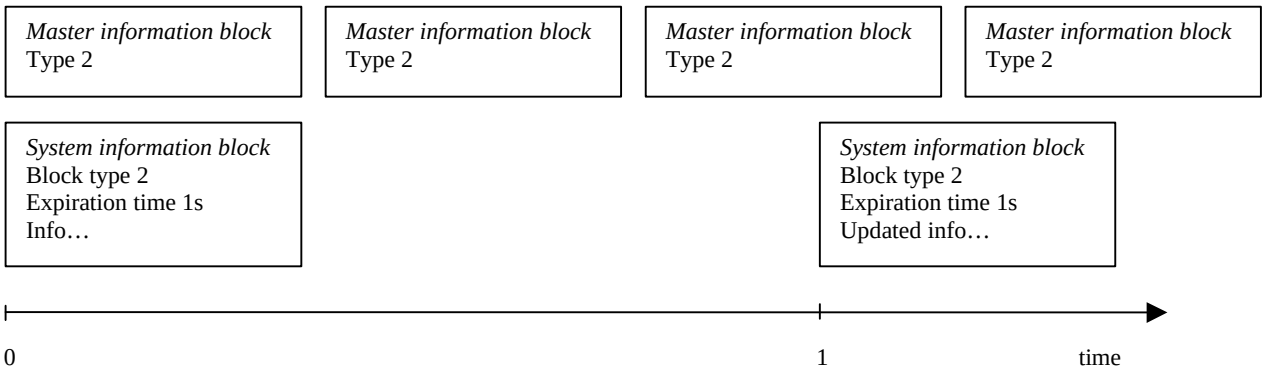

Figure 3 Example of system information with periodic updates. The expiration time of block type 2 is set to 1 second to force UEs to always use up-to-date information. The broadcasting repetition interval is set to the same value in this example; if desired, the broadcasting repetition interval may actually be shorter, e.g. to reduce the access delay for newly arrived UEs.

2.2.3 Sharing system information over cell borders

Some kinds of system information are typically the same in many cells, for example core network information. To avoid re-reading such information at cell change, system information blocks with the following characteristics should be used:

- PLMN scope
- Relatively large value tags
- Long expiration time

By using the same value tags in cells that are similarly configured, UEs may avoid re-reading these system information blocks at cell change. The exact areas that share information are determined by the usage of the value tags. By using relatively large value tags, many areas with mutually different information may be formed. Changing this kind of system information is done by changing the value tag and paging the UEs, as described in Section 2.2.1. Figure 4 illustrates a case with shared system information.

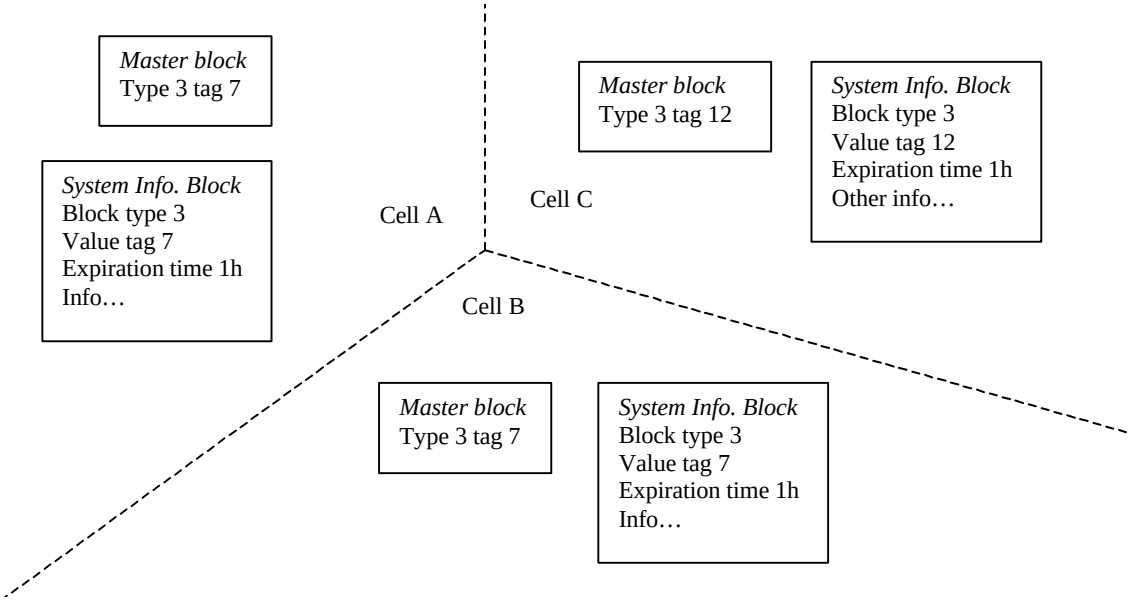

Figure 4 Example of system information sharing between cells. In this case, cell A and cell B use the same values in the system information blocks of type 3, sharing the value tag 7, while cell C uses different values and thus has a different value tag, 12. UEs moving between cell A and cell B do not have to re-read the system information block of type 3.

3 Conclusion

The proposed concept allows UEs to avoid re-reading system information whenever possible, thus reducing the power consumption. It also supports system information that has to be updated regularly, as well as time critical system information that may have to be read with a short delay.

By sharing system information between cells, it is possible to reduce the access delay and/or reduce the resources required for system information.

Furthermore, the concept provides a high degree of flexibility, since it allows different block types to be specified with different grouping of system information elements, as well as providing a flexible choice of repetition rate and transmission order.