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Agenda Item: Synchronisation ad-hoc, 4

Source: Nokia

Title: Model and parameters for UE-UTRAN frame synchronisation

Document for: Approval

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1 Introduction

This paper contains the text from R3-99980, revised in order to reflect the agreement in the discussion during the synchronisation ad-hoc. It gives a general description on the UE-UTRAN synchronisation model and parameters. It is proposed to include the whole chapter 2 in 25.401, to replace chapters 9.5, 9.6, 9.7.

2 Frame Synchronisation

The UE-UTRAN synchronisation consist of two different aspects: a L2 (or transport channel synchronisation) and a L1 synchronisation.

2.1 Transport Channel synchronisation

The L2 (or transport channel) synchronisation provides a L2 common frame numbering between UTRAN and UE (frame synchronisation between the L2 entities). This frame number is the Connection Frame Number (CFN), and it is associated at L2 to every TBS and passed to L1: the same CFN is received on the other side associated with the same TBS.

The CFN is not transmitted in air interface, but mapped by L1 to the Cell SFN of the first radio frame used for the transmission of the TBS (the Cell SFN is broadcast at L1 in the BCH). The mapping I sperformed via the OFF parameter.

In case of soft handover, the OFFs of the radio links are selected in order to have timed transmission of the diversity branches in the air interface.

A L1-MAC primitive is defined to allow the L1 to indicate to MAC the necessity to adjust the timing of the DL transmission, in order to control and minimise the transmission delay. The primitive in UTRAN side is carried in the user plane by Frame Protocol procedures.

Transport channel synchronisation mechanism is valid for all the transport channels, in FDD and TDD modes.

Note that the CFN counter of the transport channel synchronisation mechanism, may be extended by a L2 counter (HFN, Hyper frame number), to be used for example for ciphering. The initialisation of this counter is done at RRC level, and the parameter is not visible at lower layer.

Parameters for transport channel synchronisation are defined as follows:

2.1.1 CFN

CFN is the frame counter used for the L2/transport channel synchronisation between UE and UTRAN. A CFN value is associated to each TBS and it is passed together with it through the MAC-L1 SAP. CFN

provides a common frame reference (at L2) to be used for ciphering and synchronised transport channel reconfiguration, for example.

Since the CFN is mapped into one SFN and defines a specific time instance for the transmission in air interface, some L1-MAC primitives are defined to minimise the buffering time for the transmission in air interface (i.e. to ensure that the TBS does not arrive too much in advance respect to the transmission time), and, in general, to control the delays in the transport channel.

In UTRAN side, those primitives are carried by the User plane Frame Protocol procedures in Iub/Iur interfaces. The procedures defined in the FP and internal algorithms in the SRNC are used to determine the optimum transmission time of the DL frames from the SRNC.

The duration of the CFN cycle shall be longer that than the maximum allowed transport delay between MAC and L1 (in UTRAN side, between SRNC and Node B, because the L1 functions that handle the transport channel synchronisation are in the Node B). Furthermore the CFN shall be shorter, or at most equal to the Cell SFN. Currently the Cell SFN is 12 bits long, and the proposal is to adopt 8 bits (2.56 seconds) for the CFN.

The range of CFN is 0…255 (integer value).

Note: it shall be considered if the CFN for the PCH shall be extended to 12 bits, for long sleepmode paging.

2.1.2 OFF

OFF is a radio link specific L1 parameter used to map the CFN, used in the transport channel, into the cell SFN transmitted between UE and UTRAN at L1.

At the L1/L2 interaction, the mapping is performed as:

Cell SFN = CFN - OFF (from L2 to L1)

CFN = Cell SFN + OFF (from L1 to L2)

OFF and CFN have same range (8 bits, 0…255) and only the 8 least significant bits of the Cell SFN are used. The subtractions above are modulo 256, i.e. 256 is added if the result is negative and subtracted if the result is above 255.

OFF for one RL is defined as follows:

- RL in the cell is a common resource (UE RACH and FACH):

  OFF = 0 default parameter (not signalled).

  Note: This is necessary in order to ensure that same OFF is used by all the UE using the same common channel (because OFF is unique in the transport channel).

- The RL in the cell is a UE dedicated resource (at least one DCH is setup in this cell), and this is the first dedicated radio link of the UE (ex: transition from RACH/FACH to DCH):

  OFF = 0 … 7 set by the SRNC in order to distribute evenly the frame timing of the DCHs in the cell.

- The RL in the cell is a UE dedicated resource (at least one DPCCH is setup in this cell), and the UE has already one 'dedicated' RL in another cell (ex: an additional RL in soft handover or new radio link in hard handover). UE selects the OFF in order to have synchronised transmission among all the branches (in case of soft handover) or in order to avoid discontinuity in the CFN cycle (in case of hard handover). The OFF of the target cell is calculated as follow:

  OFFtarget = (Cell SFNsource - Cell SFNtarget) + OFFsource (modulo 256)

  Cell SFNsource and OFFsource are selected from one of the RL in the initial active set.

  The difference Cell SFNsource - Cell SFNtarget is calculated as the integer number of frames, with approximation to the lower integer number (*the exact definition of the difference is TBD*).

OFF is either measured by the UE or calculated by UTRAN (in case the difference between the Cell SFN of the two cells is known). In the neighbouring cell list, UTRAN indicates for each cell is the OFF is known or shall be measured.

<add the definition of the other relevant parameters (Cell SFN), or reference to them>

2.2 L1 synchronisation

As shown above, the transport channel synchronisation mechanism defines the first radio frames where the TBS shall be transmitted. From this reference point, other parameters are used to define the exact timing of the radio frame transmission. Those parameters are the time slot, in case of TDD, and the DOFF, Td in case of FDD (FDD parameters are defined with different names in WG1, WG2 and WG3, and a common definition of the parameters is proposed below, to be used in all TSG RAN documents).

The L1 parameters are defined/measured by the UE L1 but also assigned/modified by RRC for RRM reason.

In case of soft handover, the L1 parameters of the radio links are selected in order to have timed transmission of the diversity branches in the air interface.

Note that L1 parameters are defined independently of the OFF parameters used for the transport channel synchronisation (those are used for different functions at different layers of the protocol stack).

<Add parameters definition, or reference to them>