LTE: Tracking Area (TA) and Tracking Area Update (TAU)

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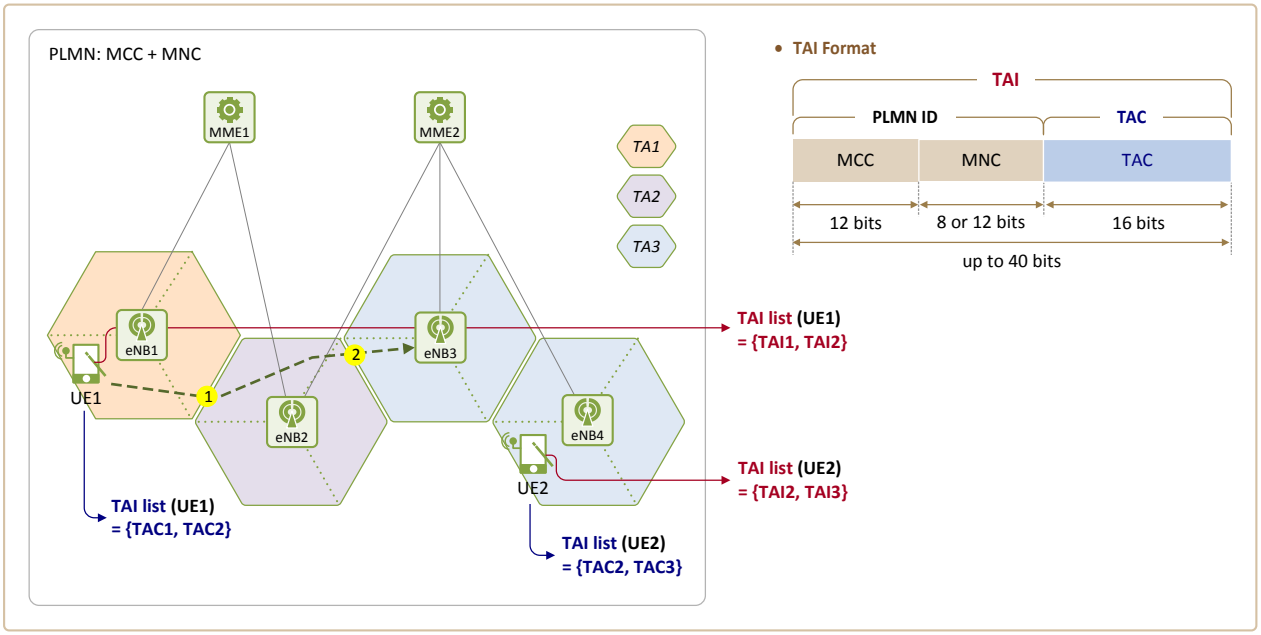
This time we will give you a brief overview of an LTE Tracking Area (TA) and Tracking Area Update (TAU).

While an LTE device (UE) is in active state (i.e. while communicating, or while in EMM-Registered/ECM-Connected/RRC-Connected state in LTE terms), its location is known by the LTE network at cell level (i.e. on a cell granularity), e.g. in cell2 in eNB1.
However, while the UE is in idle state (i.e. while not communicating, or while in EMM-Registered/ECM-Idle/RRC-Idle state in LTE terms), its location is known by the LTE network at TA level (i.e. on a TA granularity), instead of cell level. An operator defines a group of neighbor eNBs as a TA (These grouping are performed at the initial deployment of the network. Each eNB is configured with its own TA.). A TA can be made up of cells or eNBs, but only those made up of eNBs will be used here in this post. For example, eNBs in A neighborhood are defined as TA1, those in B neighborhood as TA2, those in C neighborhood as TA3, and so on.

Why do we need TAs?

If there is data traffic heading to a UE in idle state (e.g. if someone sends a text message to a UE), the LTE network has to wake up the UE so that it can receive the data. Here, this "waking up (called paging)" is performed TA-wide. Let's say a UE is located in C neighborhood. Then, the network considers the UE is located in TA3. So, when the network has to wake up the UE as some data for the UE is being received, it sends a paging message to every eNB in TA3. Then each eNB broadcasts the paging message over the radio link to wake up the UE. A UE in idle state wakes up at certain periods to check for a paging message to see if there is any incoming data. If the UE finds it has been paged by an eNB, it turns back to active state to receive the data.



Let's take a look at the format of TAs.

In the right side of the figure are a Tracking Area Identifier (TAI) and a Tracking Area Code (TAC). A TAC is the unique code that each operator assigns to each of their TAs (e.g. TA1=0x0001 for A neighborhood, TA2=0x0002 for B neighborhood, etc.). A TAI consists of a PLMN ID and a TAC. Here, a PLMN ID, a combination of a Mobile Country Code (MCC) and a Mobile Network Code (MNC), is the unique code assigned to each operator in the world. Korea's MCC is 450, and SKT's MNC is 05. So, SKT, a Korean operator, has an MCC of 450 and an MNC of 05. This format of assigning makes a TAI uniquely identified globally.

We will go further and learn about Tracking Area Update (TAU).

As seen above, the LTE network (the MME, to be accurate) has to have updated location information about UEs in idle state to find out in which TA a particular UE is located. For this, the UE notifies the LTE network (MME) of its current location by sending a TAU message (TAU Request message) every time it moves between TAs.

To explain this process further, a UE obtains a TAI list when it attaches to an LTE network. This list shows the tracking areas where the LTE network believes a UE is located and within which a UE can travel without TAU. In the example shown in the figure above, the TAI list has {TAC1, TAC2}. This means the UE does not have to send a TAU message to the MME as long as it stays in TA1 or TA2, but it has to send one to the MME when it moves to a new TA other than the two (e.g. TA3). The MME is supposed to provide the UE with a new TAI list reflecting the specific details of the UE's move (e.g. new location, moving speed, etc.) for more efficient paging.

One more thing worth mentioning is Periodic TAU, through which a UE in idle state sends a TAU message (TAU Request message) to an MME periodically even when the UE stays within a TA in the TAI list. If a UE in idle state has stayed in one location (or moved within the TAs in the TAI list) and has not notified the MME of its current location, the network cannot tell whether the UE is still in idle state, or is not able to communicate. So, the UE, even when the TA is not changed, sends TAU Request messages to the MME periodically to announce "it is able to receive data". Otherwise, the network believes the UE is not able to receive data and does not perform paging even when there is data traffic heading to the UE.

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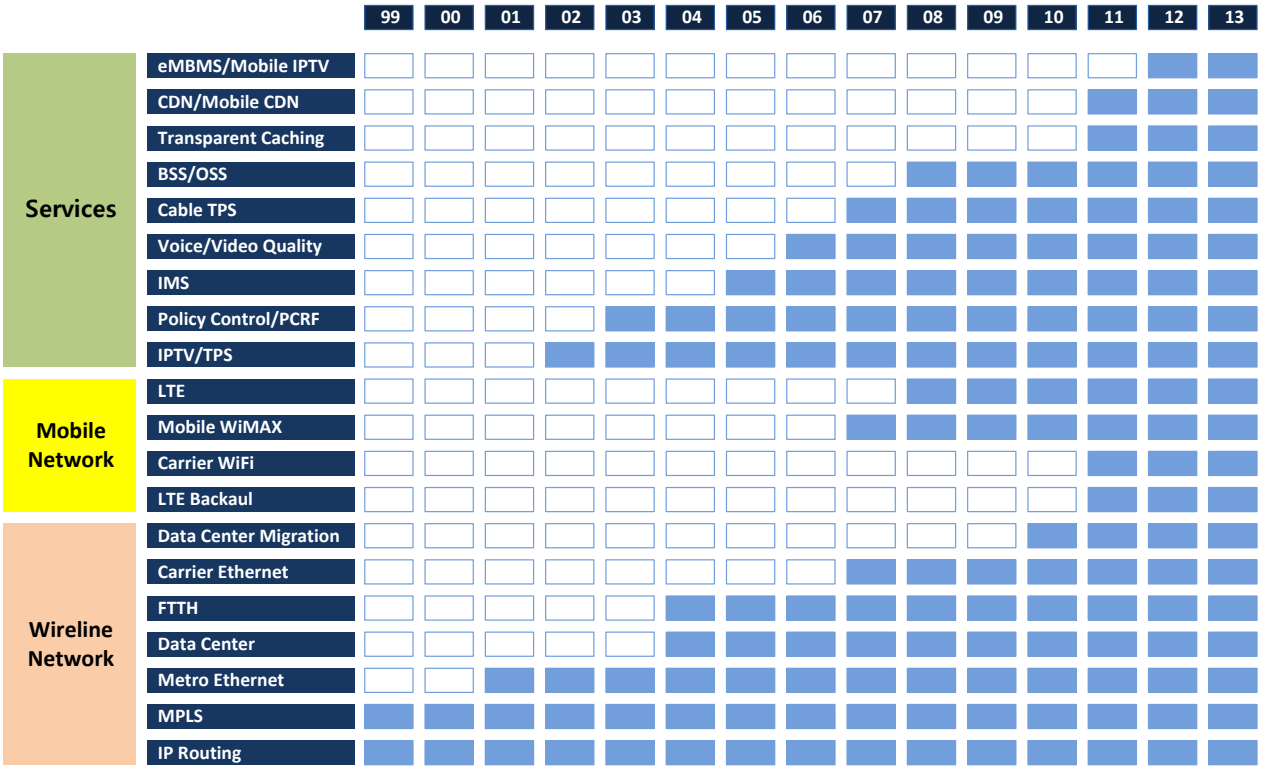

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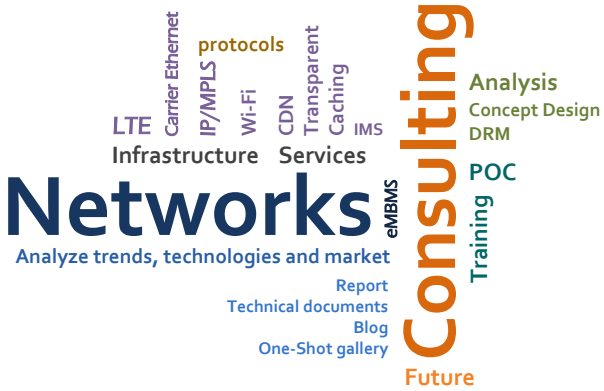

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