

# Last visited registered TAI in 5GSat



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# Background – LVRT in pre-Sat specification (1/2)



- In 5GS, stage 2 the following is specified:

- (23.502, Registration procedure)

“If available, the last visited TAI shall be included in order to help the AMF produce Registration Area for the UE.”

# Background – LVRT in pre-Sat specification (2/2)



- In 5GS, stage 3:
  - (24.501, definitions)  
“**Last visited registered TAI**: A TAI which is contained in the registration area that the UE registered to the network and which identifies the tracking area last visited by the UE.”
  - (24.501, Registration areas)  
“The UE includes the last visited registered TAI, if available, to the AMF. The last visited registered TAI is stored in a non-volatile memory in the USIM if the corresponding file is present in the USIM, else in the non-volatile memory in the ME, as described in annex C.”
  - (24.501, Registration procedure, both initial and mobility)  
“If the last visited registered TAI is available, the UE shall include the last visited registered TAI in the REGISTRATION REQUEST message.”

# Interpretation of pre-5GSat LVRT requirements



- LVRT is stored in the UE
- The stored LVRT value is provided by the UE to the AMF at initial and mobility registration
- The LVRT value corresponds to a TAI in the Registration Area "visited" by the UE:
  - At Registration accept the TAI value of UE location where registration procedure is run is stored
  - At mobility within the Registration Area to a cell with a new TAI value the new value is stored
- At mobility outside the Registration Area and mobility registration is initiated, the LVRT value corresponds to the TAI of the old Registration Area last visited.

## Consequences:

- The UE and AMF know the same TAI after successful registration procedure
- The AMF is informed of the last TAI the UE visited in the old Registration Area in the Registration procedure
- The AMF can use this knowledge to aid in constructing appropriate Registration Areas, following stage 2

# TAI and LVRT requirements for 5GSat (1/2)



- TAs are fixed geographic areas
- A Sat cell can support multiple TAIs
- The cell supported TAIs can change over time
- The UE is not aware of which TA covers its physical location
- Depending on TAI properties the UE considers the properties of one TAI to apply, i.e. The UE determines a "logical location" within the TAs supported by the cell.
- Due to the changing cell supported TAIs and cell reselection to a cell with different supported TAIs, the TAI corresponding to the UE "logical location" can change over time and within the Registration Area, i.e. there is a similar "logical mobility" in 5GSat to the mobility of the pre-Sat cases.

# TAI and LVRT requirements for 5GSat (1/2)



- The same stage 2 and stage 3 requirements apply as for the pre-Sat cases on UE storing and indicating LVRT.
- Additionally, it is specified in stage 2:  
"NOTE 4: With NR satellite access, the last visited TAI can indicate any TAI supported in a radio cell for the RPLMN or equivalent to the RPLMN for the previous UE access that is part of the UE Registration Area."
- Given the above is a note and use of "can" it should not be seen as a normative requirement for flexibility so that the UE may provide any TAI supported by the cell before mobility registration trigger as it would limit the AMF capability to construct appropriate Registration Areas as in the pre-Sat cases
- As the UE anyway needs to assess the 5GSat cell supported TAIs and update the "current TAI" it is reasonable to also update the LVRT value at changes of "current TAI" within the Registration Area
- With the above applied, 5GSat LVRT stored value update corresponds to the pre-Sat cases and equal information is available to the AMF to construct Registration Areas following stage 2:  
"If available, the last visited TAI shall be included in order to help the AMF produce Registration Area for the UE."

# TAI and LVRT requirements for IoT NTN EPS



In SA2#149e the following text was agreed (S2-2201332, 23.401, CR#3683), corresponding to the 5GSat note on LVRT value:

“When indicating a last visited TAI in an Attach Request or a TAU Request, a UE may indicate any TAI supported in the last visited cell for that RPLMN or PLMN equivalent to the RPLMN.”

Following can be noted:

- It is normative text and not a note
- There is no limitation to LVTR value being part of the Registration Area
- There is no timing indicated, i.e. for stage 3 it is unclear when the LVRT value is to be stored (cell supported TAIs may change over time and during the time the UE is located within the Registration Area)

Strictly applying the above text would allow the UE to indicate a LVRT value corresponding to a TAI outside the old Registration Area, and even a forbidden TAI. As this clearly breaks the legacy use of LVRT and also makes it useless to help the MME/AMF construct a new Registration Area.

Thus, the 5GSat and IoT NTN EPS texts on LVRT value should be seen as high-level information on which stage 3 needs to apply more strict requirements for expected functionality to be achieved.

# Conclusion



- It is concluded that 5GSat UE stored LVRT value shall be stored at Registration accept, which aligns UE and MME on the UE applied TAI
- It is concluded that 5GSat UE stored LVRT value shall be updated when the UE determines a new “current TAI” within the Registration Area, which ensures information available at the AMF in a subsequent Registration procedure to help the AMF produce Registration Area for the UE.



# Way forward



- It is proposed to specify that 5GSat UE stores a LVRT value shall at Registration accept
- It is proposed to specify that 5GSat UE updates the LVRT value when the UE determines a new “current TAI” within the Registration Area.

