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RRC INACTIVE-SOME SYSTEM ASPECTS

R3-174864

BACKGROUND

- The RRC_INACTIVE properties state shall meet the following objectives:
- TR 38.804:
  - *A UE in RRC_INACTIVE should incur minimum signalling to fulfil the control latency requirement and minimise power consumption comparable to LTE RRC_IDLE and resource costs in the RAN/CN making it possible to maximise the number of UEs utilising and benefiting from this state.*
- TR 23.799:
  - *RAN WG2 is expected to define means for a UE in MM Registered CN Connected state not transmitting or receiving data to achieve a comparable power efficiency to that of a UE in CN Idle state.*

⇒ Overall expectation is that RRC_INACTIVE reduces signaling overhead and improves CP latency significantly.

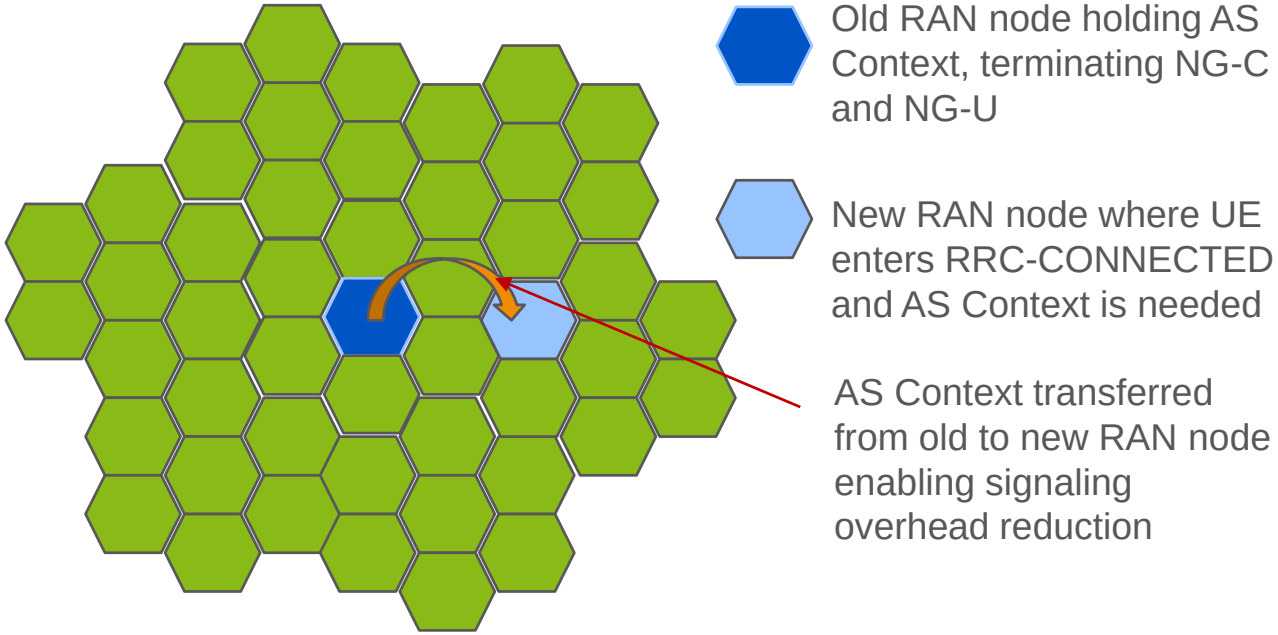
REALIZATION

- RRC Inactive state properties:
  1. NG-C and NG-U kept connected while UE in RRC Inactive state;
     - MT User/Control plane data triggers RAN Paging.
  2. To minimize signaling, Access Stratum Context stored in RAN and the UE;

  ⇒ 1. RAN approach is that RAN paging shall be as reliable as CN paging. This requires that RAN paging covers UE's location.

  ⇒ 2. In order to avoid NAS recovery, the AS Context needs to be transfer-able from the old serving RAN node to the RAN node where UE resumes to RRC_CONNECTED state.

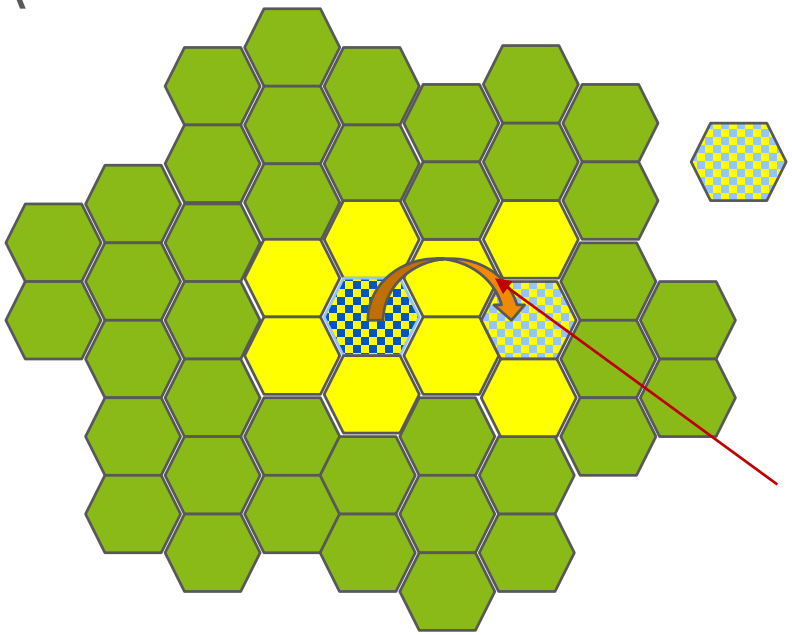
REQUIREMENTS (1)



To enable benefits from RRC Inactive state at UE mobility in RRC Inactive, support for AS Context transfer between old and new RAN node is required.

REQUIREMENTS (2)

UE's RNA



Old RAN node holding AS Context, terminating NG-C and NG-U. RAN Paging triggering node.

New RAN node configured with the cell that UE is currently camping on while in RRC Inactive state.

RAN Paging from old to new RAN node enabling UE reachability while in RRC Inactive state.

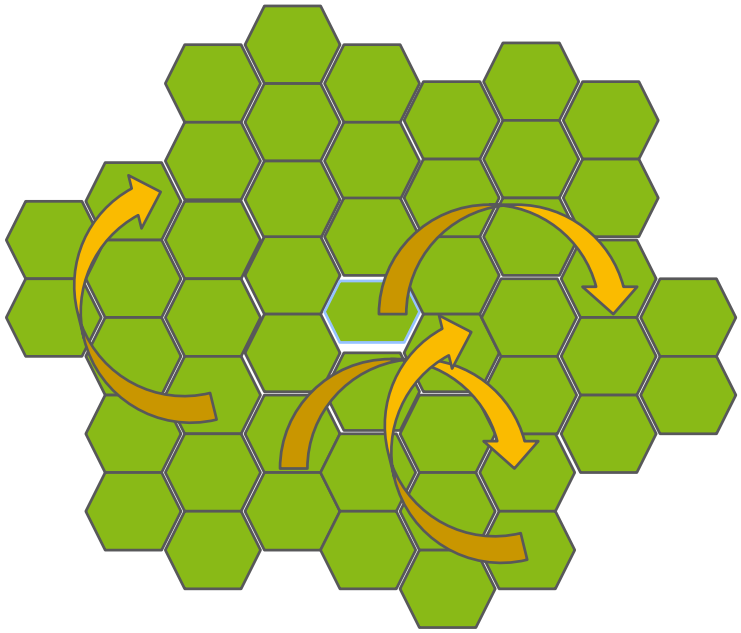
To enable UE reachability while in RRC Inactive state for MT sessions, support for RAN Paging from old to RAN node(s) providing radio coverage for that UE is required.

SOLUTIONS

- RAN Paging reliability and AS Context transfer relies on connectivity between old and new RAN.
- Two solutions:
  1. RAN Notification Area* limited by Xn connectivity;
  2. RAN Notification Area extending beyond Xn connectivity by CN relay, if Xn not available (Ericsson et al**,***);

- *"RAN Notification Area": configured by serving RAN node, either list of cells, or RAN Area (broadcast) or List of TAIs (CN Registration Area).
- **pCR "RRC Inactive state – new procedures in 23.502", S2-178561, Ericsson, Verizon, Telia, Vodafone, T-Mobile USA, Cisco.
- ***RAN3 papers, stage 2 pCRs 38.300, R3-174734/R3-174735: "RAN Paging/UE Context Retrieval in the absence of Xn connectivity" (Ericsson, Vodafone)

SOLUTION-1 (1)

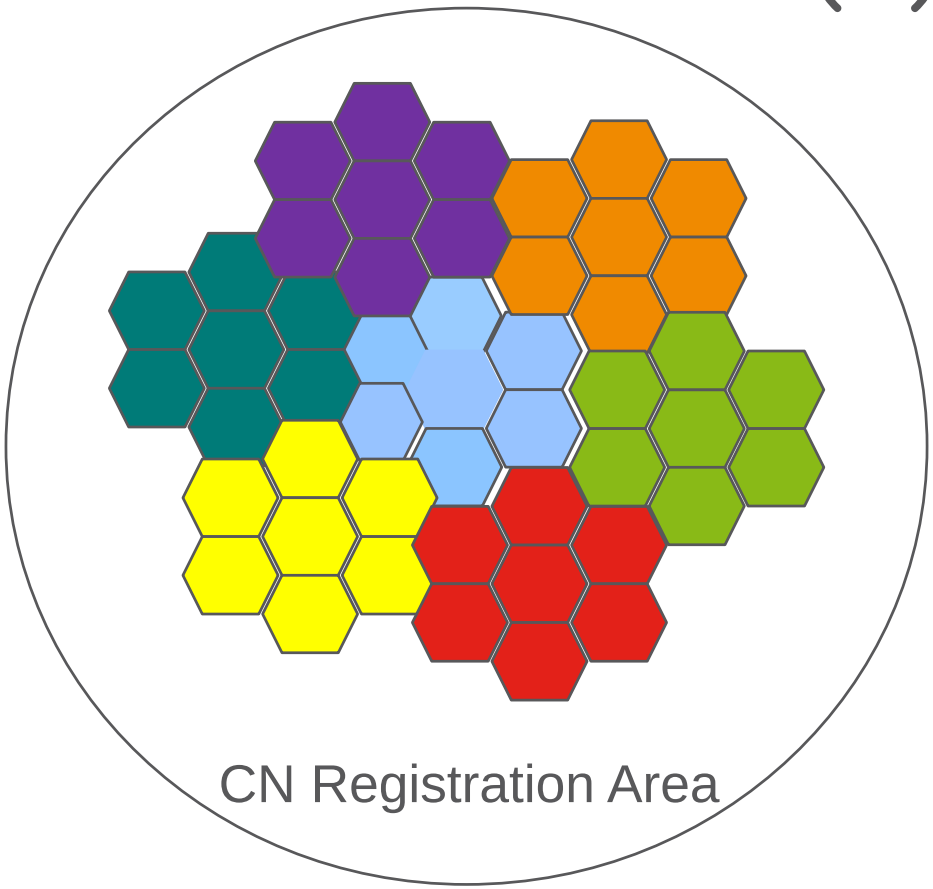


RAN Paging reliability relies on Xn connectivity between the old RAN node and any arbitrary RAN node within the RNA.

Consequences:

- this requires either a fully meshed RAN, i.e. Xn connectivity between all RAN nodes within an RNA + RAN neighbouring nodes;
- or will result in rather small RNAs, due to realistic deployments with limited Xn connectivity and hence increased area update signaling.

SOLUTION-1 (2)



Fully meshed RAN with Xn connectivity is challenging to achieve because:

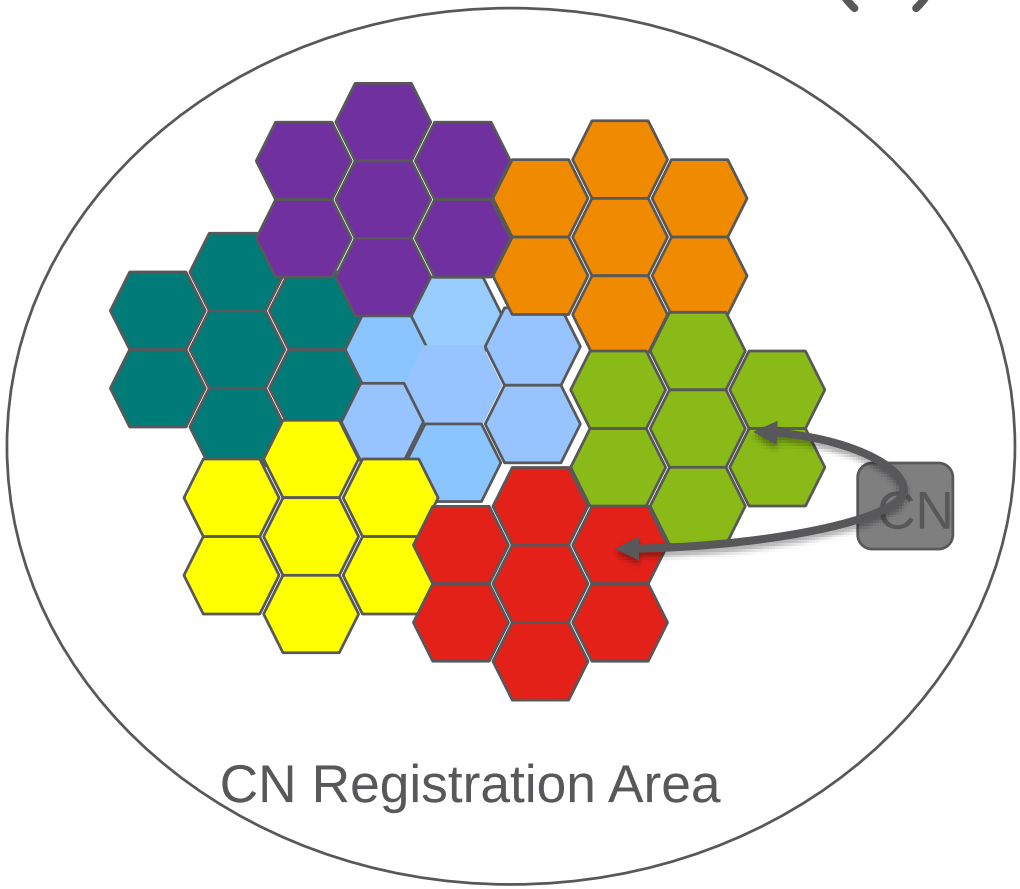
- Xn is setup based on UE measurement, there are no measurements for far distanced RAN nodes.
- Configuring Xn with 2nd and 3rd tier neighboring RAN nodes increases radically the number of Xn interfaces required to be supported.
- Limitation to underlying infrastructure

⇒ Solution 1 typically results in RNAs configured certainly smaller than UE's CN Registration Area

⇒ Configuring rather small RNAs only recommended for UEs with known and limited mobility

⇒ Limiting RRC Inactive to the fraction of UEs with known and limited mobility contradicts basic design criteria, see requirements on slide 2.

SOLUTION-2 (1)



RAN Notification Area extended beyond Xn connectivity by NG i/f relay:

- In case Xn connectivity not available:
  - AS Context transfer via NG-C.
  - RAN Paging relayed via NG-C.
- NOTE: AMF only relays, i.e. stateless approach: XnAP messages <u>are not processed, only routed by AMF</u>
  ⇒ no significant delay added.

⇒ NG relay allows configuration of larger RNAs, even without meshed Xn connectivity, to accommodate UEs with unknow or any mobility patterns, see slide 2 requirements.

NOTE: even when following current RAN3 WA, AS Ctxt transfer via NG-C is needed, when UE leaves an RNA.

SUMMARY

Main requirements	Solution-1	Solution-2 (Ericsson)
• minimise power consumption • maximising number of UEs utilising and benefit from RRC INACTIVE • support possible RNA configurations (cell-list, RAN area, TAI list) • support realistic RAN deployments (limited Xn connectivity)	• additional signalling load in RAN (RNA Update due to smaller RNAs) • forcing UEs to recover through IDLE, additional NAS signalling • impact on UE battery due to above • smaller fraction of UEs for which RRC_INACTIVE is advantageous • RRC INACTIVE only applicable to limited RAN deployments (relatively large nodes) • Requirement on operators to configure RNAs	• Updates to the RAN/CN interface for performing AS Context/RAN Paging relay; • “complete” solution for all UE mobility profiles • not significant additional signaling load on the RAN-CN i/f for a fraction of UEs • no significant delay added

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