

The vivo logo is positioned in the top left corner of the slide. The background of the entire slide is a dark blue, abstract pattern of light trails and streaks, resembling a starburst or a network of connections.

**3GPP TSG RAN Meeting #93-e**

**RP-212017**

**Electronic Meeting, September 13-17, 2021**

# **Further mobility enhancements in Rel-18**

**Source: vivo**

**Document for: Discussion & Decision**

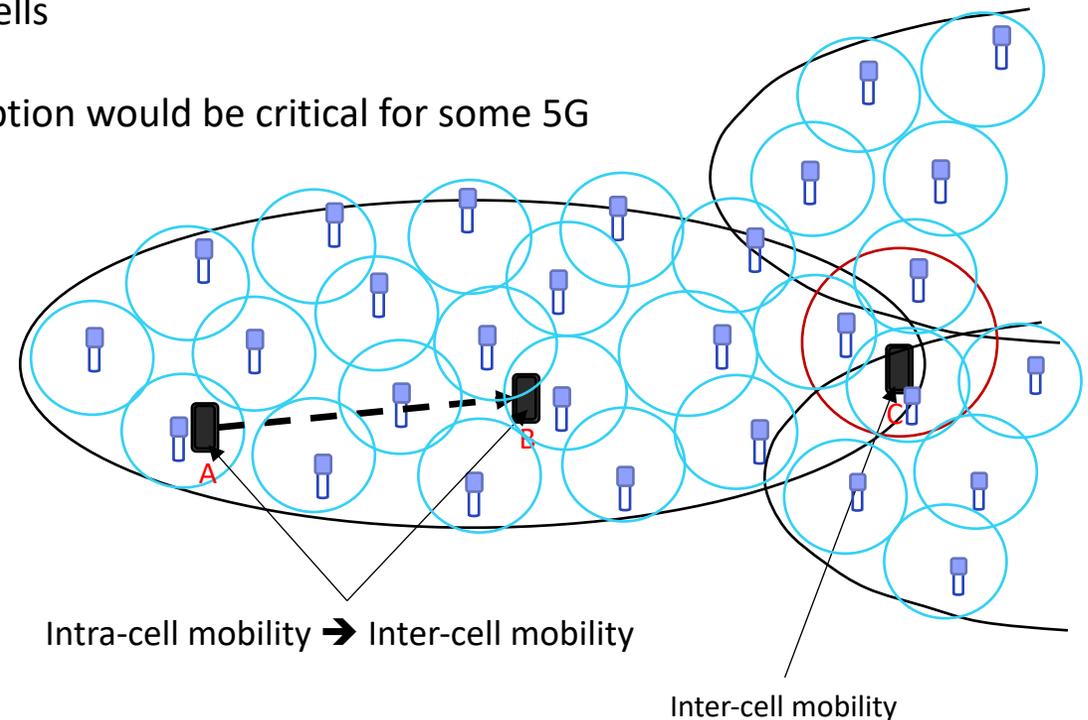
**Agenda Item: 9.0.3**

# Mobility enhancements

## Scenario: Dense 5G deployments

- 5G deployment is expected to be much denser in the future (cell/TRP to UE ratio is higher)
  - For coverage purpose in high frequency, e.g. FR2, or or capacity purpose
- Mobility performance and/or UE power consumption could be an issue
  - UEs perform frequent cell search/ measurement for mobility purpose
  - UEs perform frequent cell (re-) selection/Handover between cells
- Mobility performance on handover failure rate and data interruption would be critical for some 5G services, e.g. XR or Cloud Gaming.

**Observation 1: Mobility enhancements on robustness improvement, interruption reduction, signaling/power consumption reduction would be considered in Rel-18**

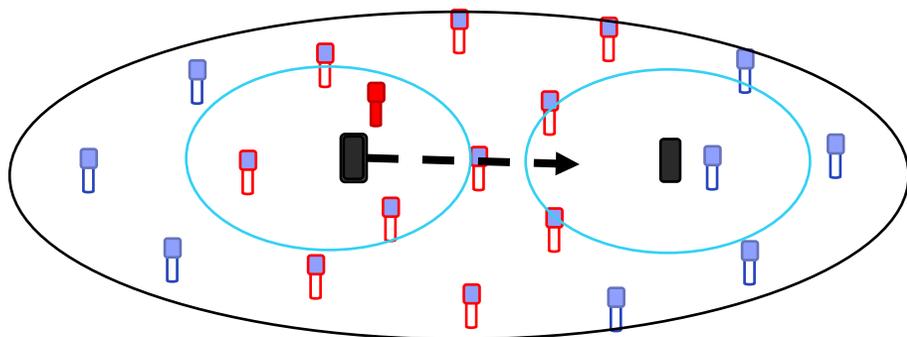


## Contents

- UL Signal based mobility
- L1/L2 inter-cell mobility
- Others
  - CHO/DAPS enhancements

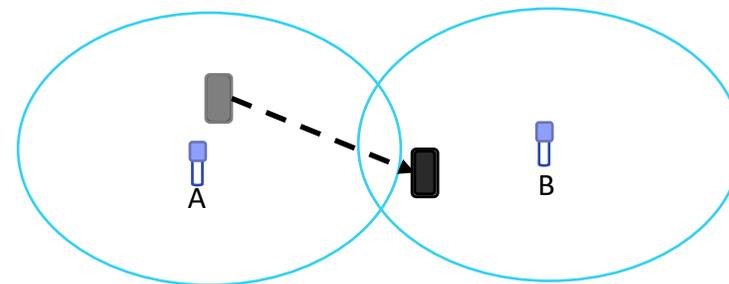
# Mobility enhancements

## Issues and potential solutions



### High UE power consumption

- UEs perform frequent cell search/ measurement for cell (re)-selection in idle mode
- UEs perform frequent measurement and report for handover in connected mode



### Degraded UE mobility performance

- UE already moved to cell B, but due to the L3 filtering of current mobility procedure
  - UE still receive paging from cell A → cell reselection delay, **paging miss**
  - Too late handover → **Handover failure**

- The above issues are similar to what is currently observed in high speed train deployment
- Potential solutions for Rel-18 study
  - SFN based cell camping for UE IDLE mode
    - ✓ UE IDLE mode measurement are performed on SFN based signals -> **for power saving**
    - ✓ SFN-based paging monitoring (and potentially SFN-based SI) -> **for mitigating the paging miss issue**
  - UL signal based mobility procedure
    - ✓ UL signal based mobility procedure in connected mode to **mitigate the handover failure rate**
    - ✓ UL signal based mobility procedure in idle mode to **reduce NW paging load and NW energy consumption**

# Evaluation on paging miss rate

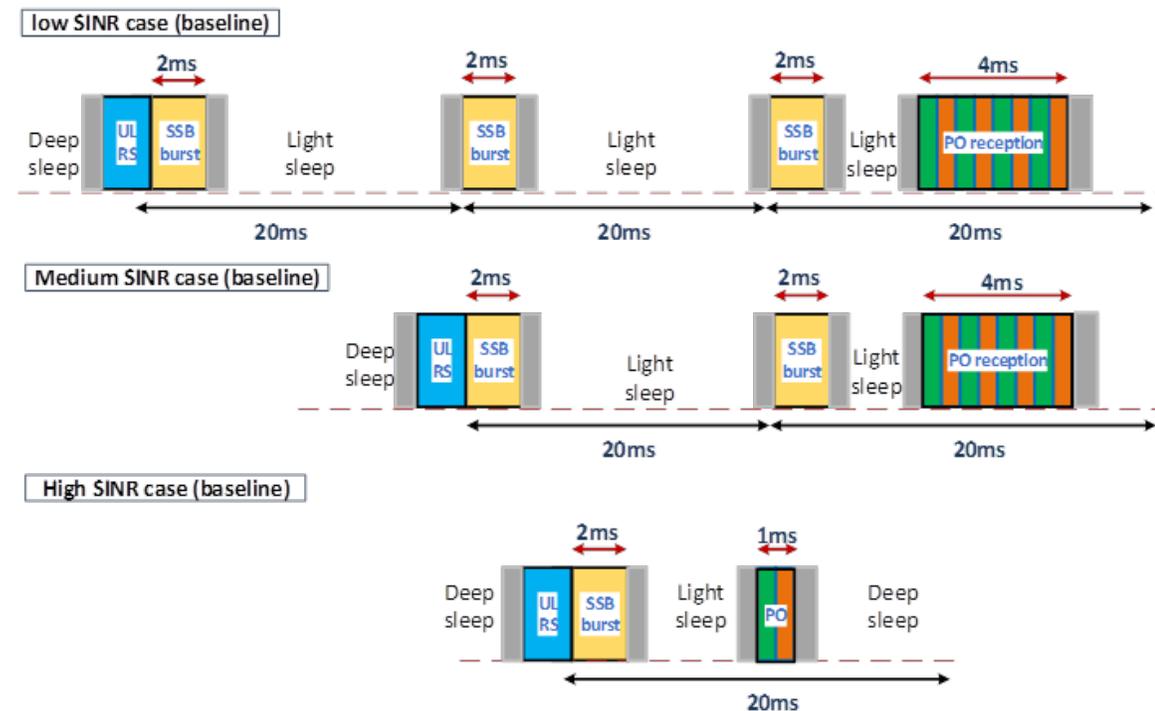
- Evaluated cases:
  - **Baseline case:** UE paging is sent on all cells (57cells). Cell reselection is performed based on DL measurement with L3 filter.
  - **Case 1:** Paging is sent in SFN manner within a cell cluster, paging miss rate is significantly reduced due to SFN gain.
  - **Case 2:** Cell resection based on UL signaling between clusters. NW is aware of the UE location so that paging is sent on the “best cell” only -> lower paging miss rate, lower NW overhead and energy consumption.
- Detailed simulation results (i.e. [miss rate for initial transmission of paging](#)) as below:

Simulation assumption	values
ISD	200m
UE speed	30kmh
Alpha in L3 filter	0.5 <sup>1</sup>
DRX paging cycle	1.28s
UL signaling period	1.28s
MCS for paging	MCS 0

		Cluster size=3	Cluster size=9	Cluster size=14	Cluster size=19	Cluster size=28	Cluster size=57
<b>Baseline</b>	0.1573	N/A	N/A	N/A	N/A	N/A	N/A
<b>SFN based paging (Case 1)</b>	N/A	0.1185	0.0446	0.0359	0.0299	0.0172	0
<b>Paging from the best cell (Case 2)</b>	N/A	0.0905	0.0396	0.0336	0.0306	0.0197	6.9726e-4

# Evaluation on UE power saving gain

- Power model in TR 38.840 is assumed, UE processing timeline (along with UL signaling) as shown in Fig.
- Baseline:** Serving cell measurement is always performed. Neighboring cell (intra-f/inter-f) measurement is controlled by S-measure mechanism.
  - Assuming: 50% High SINR+20% Middle SINR+30% Low SINR
- In SFN mode (**Case 1**),
  - Serving cell measurement is always performed on the SFN layer
  - UEs only need to measure intra-f/inter-f neighboring cell in SFN edge, e.g. controlled by S-measure mechanism.
- Detailed simulation results:

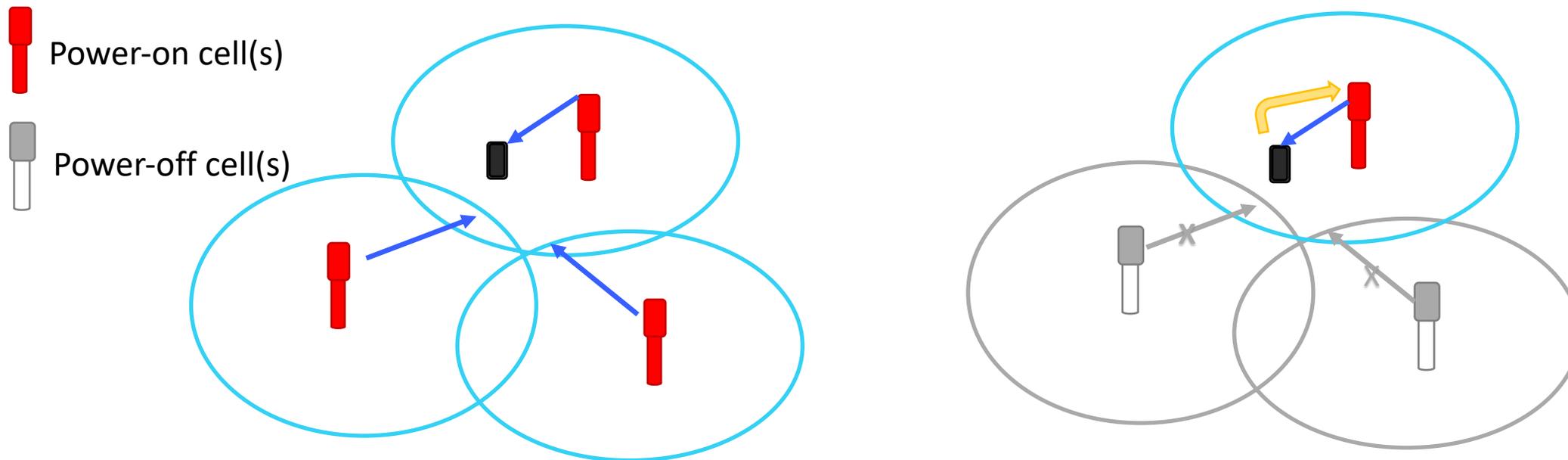


Power saving gain over baseline for SFN	SFN size=3	SFN size=7	SFN size=19	SFN size=57
All UEs	9.44%	14.14%	18.85%	28.28%
Middle & Low SINR UEs	14.72%	22.05%	29.4%	44.1%

Assuming tx power for UL signaling is 23dBm with 2ms duration, **addition 4.7%** power consumption will be increased for UL signaling tx.

# Network overhead reduction and energy saving

- With UL signaling in IDLE/INACTIVE state, network paging overhead and energy consumption can be saved:



## In legacy

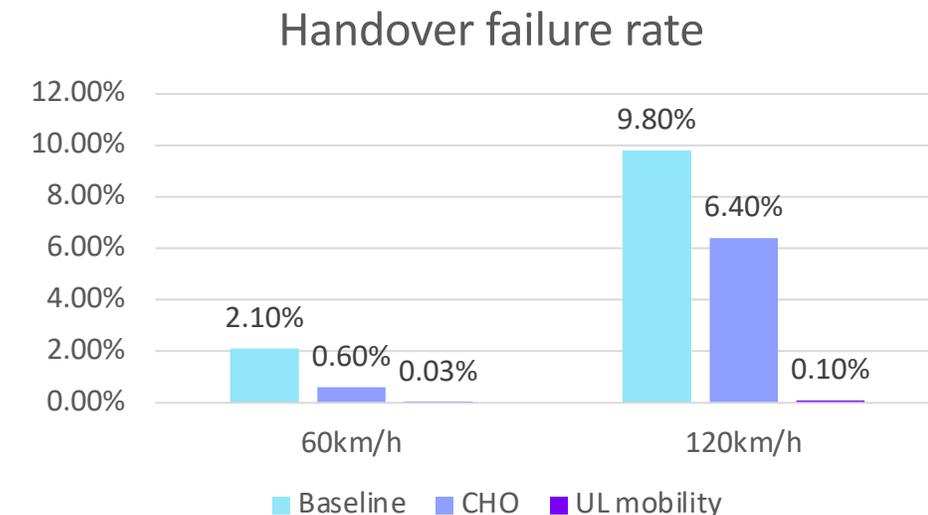
- All cells should be **always power on**
- Paging will be sent on **all cells** in area in idle/inactive

## With UL signaling

- Cells could be **on-demand power on**
- Paging could be sent **only on the cell where UL signal is detected**

# Handover failure rate in connected mode

- **Baseline:** Legacy handover procedure based on DL measurement with L3 filter.
  - Handover model and corresponding metrics on handover failure in TR 36.839 is assumed.
  - Assuming: [ISD=200m, Event A3 is adopted, L3 alpha=0.5].
- **CHO:** Handover is triggered based on DL measurement with condition A3.
- **UL based mobility:** handover is triggered by network side based based on UL measurement.
- UEs with different speeds (middle and high) are evaluated, e.g. 60km/h, 120km/h, 100% outdoor.
- It could be found handover failure rate is significantly reduced by UL based mobility.
- Comparison with CHO: **UL mobility could reduce the overhead between gNB and save reserved resource**
  - CHO will reserve resource and perform (early) data forwarding for all candidate cells



# Potential objectives on UL signal based mobility

## **Proposal 1: The following areas are considered in Rel-18 FeMobility**

- Study and specify IDLE/INACTIVE mode UE power saving and paging performance improvement by SFN based NW transmission, including:
  - How to model SFN, e.g. Configuration of SFN, and impact on RS, SI, Paging, RACH, etc.
  - Cell (re-)selection enhancement including inter-SFN switch, and intra-SFN cell/TRP switch
  - Impact to NW overhead should be carefully considered
- Study and specify UL-based mobility for IDLE/INACTIVE and CONNECTED states, including:
  - Suitable UL signal for UL-based mobility
  - Procedure for mobility enhancement by UL signaling in idle/inactive/connected mode
  - Inter- and intra-cell L1 measurement and reporting based on DL/UL signaling configuration
  - Paging overhead saving and NW energy saving based on UL signaling in IDLE/INACTIVE state
  - Impact to UE power consumption should be considered

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- UL Signal based mobility
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# Motivation on L1/L2 inter-cell mobility

- L1/L2 inter-cell mobility is being discussed in Rel-17, mainly for dense network e.g. with multiple TRP(s), especially for FR2 scenario.
- But due to limited TU and quite wider scope of the topic, it was down scoped to scenario 1 in RAN#92e meeting.
  - The specified scenario, i.e. inter-cell beam management, will not change serving cell when switching TRP(s) associated with different PCI(s)
- Considering L1/L2 inter-cell mobility is beneficial for mobility performance on both data interruption and robustness, further enhancement of L1/L2 inter-cell mobility in Rel-18 is needed.
- A basic and complete mechanism for L1/L2 inter-cell mobility with serving cell change should be specified in Rel-18.
  - [In addition to the aspects listed in \[RAN93e-R18Prep-03\] email discussion. The DL/UL centric L1/L2 measurement and corresponding report for both synchronized and non-synchronized scenarios, and dynamic switch based on DL/UL signals should be studied and specified in Rel-18.](#)
- Scenarios:
  - All scenarios are possible and need to be studied. However, L1/L2 based inter-cell mobility for standalone (not with DC), and intra-DU should be prioritized in Rel-18.
  - Regarding intra-/inter-frequency and FR1/FR2, less impact on procedure is assumed for different scenarios. Hence, both intra-/inter-frequency and FR1/FR2 could be considered in Rel-18.
  - Other deployment options could be considered in later release.

# Potential objectives on L1/L2 inter-cell mobility

## Proposal 2: The following areas are considered in Rel-18 FeMobility

- Measurement enhancement based on both DL measurement and UL measurement, including
  - UL measurement enhancement with UE transmitting towards TRPs with PCI different from serving cell and related procedures
    - ✓ Considering both synchronized and non-synchronized scenarios
  - DL Measurement and report enhancement considering both synchronized and non-synchronized scenarios
    - ✓ Interference measurement due to non-synchronized reception
    - ✓ Timing offset configuration/reporting
    - ✓ Inter-cell measurement latency/overhead/power consumption reduction
- Further enhancement on inter-cell MTRP (simultaneously connected to multi-TRP) including beam management and DL/UL transmission
- L1/L2 based mobility procedure (with serving cell change) through TRP/TCI switch activation/deactivation.
  - Consider both DL-centric and UL-centric, e.g., L1/L2 procedures based on DL measurement or UL measurement;
  - Consider both synchronized and non-synchronized
  - Potential high layer support: MAC (if any), RRC enhancement
  - Consider different scenarios: intra-DU, Inter-/Intra-Frequency, FR1/FR2

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# Others-CHO/DAPS enh.

- CHO and DAPS have been introduced and specified in Rel-16 for the purpose of robustness and reliability, respectively.
  - But due to the limited time, only the basic mechanism has been specified.
  - Some scenarios, e.g. in MR-DC, or combination of different mechanisms, have not been specified.
- During the email discussion in [RAN93e-R18Prep-03], many proposals on different enhancements for CHO and DAPS have been discussed.
- Regarding DAPS enh., considering L1/L2 based inter-cell mobility will be specified in Rel-17/18, which would improve the mobility performance on reliability, e.g. data interruption during cell change could be mitigated with fast switching between pre-configured cells.
  - L1/L2 based inter-cell mobility will be applicable for XR/CG services with requirements of high data rate and low data interruption.
  - Simultaneous tx/rx on multiple TRP(s)/cell(s) could also be possible in L1/L2 based inter-cell mobility.

## **Observation 2: DAPS enhancements for reliability is not so critical on top of L1/L2 based mobility**

- Regarding CHO enh., we think CHO enhancement in FR2 and CHO+CPAC (if not supported in Rel-17) could be considered to improve the mobility robustness in some real 5G deployments, which could improve the mobility robustness.

**Proposal 3: CHO enh. could be considered in Rel-18 if time is allowed, e.g. CHO+MR-DC and CHO+CPAC (if not supported in Rel-17)**

# Conclusions

## **Proposal 1: The following areas are considered in Rel-18 FeMobility**

- Study and specify IDLE/INACTIVE mode UE power saving and paging performance improvement by SFN based NW transmission, including:
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  - Impact to NW overhead should be carefully considered
- Study and specify UL-based mobility for IDLE/INACTIVE and CONNECTED states, including:
  - Suitable UL signal for UL-based mobility
  - Procedure for mobility enhancement by UL signaling in idle/inactive/connected mode
  - Inter- and intra-cell L1 measurement and reporting based on DL/UL signaling configuration
  - Paging overhead saving and NW energy saving based on UL signaling in IDLE/INACTIVE state
  - Impact to UE power consumption should be considered

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  - Potential high layer support: MAC (if any), RRC enhancement
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**THANK YOU.**

**谢谢。**