**3GPP TSG-RAN WG2 Meeting #119bis Electronic R2-22xxx**

**Online Meeting, 10th – 19th Oct 2022**

Agenda Item: 8.12.2

Source: Huawei, HiSilicon

**Title:** Report of [AT119bis-e][021][eIAB] Enhancements for Idle Inactive UE

Document for: Discussion and Decision

# Introduction

This paper aims at capturing the summary of offline discussion.

**[AT119bis-e][021][eIAB] Enhancements for Idle Inactive UE (Huawei)**

Scope: Idle Inactive UEs. Make some assumptions on typical configuration and cell reselection behaviour for legacy UEs, and potential performance issues, reasonable configurations / scenarios with issues etc. List the potential enhancements proposals on the table for enhanced UEs and for such proposals clarify what is the target performance characteristic to enhance and target scenario (if any). Proponents assumed to be initially active. In a second round, Collect evaluation comments (e.g. importance, feasibility, complexity, pros-cons) for the different proposals, and whether some proposal seems unacceptable.

Intended outcome: Report, for online CB, for discussion on exclusion / keep on the table / agreement (if possible) for either issues or solution proposals or both.

Deadline: CB W2 Wed

[R2-2209522](file:///C:\Users\mtk65284\Documents\3GPP\tsg_ran\WG2_RL2\TSGR2_119bis-e\Docs\R2-2209522.zip) Mobile IAB mobility enhancement Huawei, HiSilicon discussion Rel-18 NR\_mobile\_IAB-Core

DISCUSSION 3 & 4 (mobile-IAB-Node to UE indications and UE mobility enhancements).

- Nokia think legacy users need to be able to access, so this contradicts WI statement. HW indicate that this is for UE to prioritize, not access control.

- AT&T think it is useful that UE can know more quickly whether it is on-board.

- IDT think it is useful to optimize measurements, ping-pong, etc.

- NEC think that speed and location may change dynamically and think such info may be out of date when transmitted and think such solution should not be considered. Support proposal 3b.

- ZTE think a bcast indication is needed, to reduce measurement etc, think subscription info etc is needed as onboard indication.

- Apple also think this indication is useful, e.g. for cell reselection.

- QC think that 4c can determine that it is on-board only if there is an indication.

- Chair: a number of comments on Torhu on “on-board”.

- Terminology: Chair think that we can use the “on-board” notation for the sake of discussion, with the loose meaning that a UE is “on-board” when it is suitable for the UE to use a mobile IAB cell. Likely we will not define a state etc with this name, maybe it doesn’t exactly mean on-board.

- TMO don’t want to support any enhancements, as the most important case is for existing UEs, and those UEs shall be IAB-capable. AT&T think there are cases when this is useful and think that at some point in time there will be a majority of UEs Rel-18 and later, and it would also useful for public safety UEs. TMO think only public safety UEs then would IAB capable.

- Chair: The TMO objection to impact UEs and the related assumption that legacy UEs is the most important case is noted and can be taken into account when we decide. There is significant support to make enhancements for better performance for new UEs. On the details there seems to be a number of diverging opinions. In order to make decisions, we need to explore the proposals, to see it there are any enhancements that could be agreeable.

**RAN2 confirms that Mobile IAB need to work with legacy UEs.**

**RAN2 observes that a UE could potentially consider itself on-board of a mobile-IAB cell, if the UE camps on/connects to a mobile IAB cell during a long period (i.e. the UE then need to know that this is such a cell). FFS the time. FFS if this is needed.**

Offline: Outline what would/could be a typical configuration and cell reselection behaviour for legacy UEs. Clarify the potential enhancements on the table for enhanced UEs.

**Contact**

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# Phase 1 discussion

**2.1 Company proposals on this issue**

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| **Tdoc** | **Company** | **Proposals** |
| R2-2209522 | Huawei | Proposal 3a: It is up to UE implementation to use the “mobile-IAB cell” indication during cell (re-)selection, if RAN2 agree to introduce this indication in SI.  Proposal 3b: Not to introduce any broadcasting mobility state/location/speed information by mobile IAB cell, considering the security issue and frequent SI update.  Proposal 4a: No special standard effort is needed to prevent the surrounding UE from accessing the mobile IAB-node.  Proposal 4b: RAN2 to discuss whether to support the identification of on-board UE in following cases:  - Case 1: UE in RRC\_IDLE state (e.g. for cell (re-)selection prioritization)  - Case 2: UE in RRC\_CONNECTED state (e.g. for NW to determine whether it is suitable to configure CHO and RACH-less, in addition to the RSRP measurement reporting) |
| R2-2209616 | ZTE | Proposal 1: UE may prioritize to select the cell with which UE has similar mobility state via stationary or low relative mobility evaluation.  Proposal 2: If the mobile IAB node only allows the restricted access of certain group of on-board UEs, the design of PNI-NPN and CAG (Close Access Group) may be leveraged.  Proposal 3: To avoid unnecessary inter-frequency measurement with high priority, UE camped on mobile IAB cell may regard the frequency which provide mobile IAB cell to be the highest priority. In addition, the relaxed RRM measurement may be enabled for UEs camped on the mobile IAB cells. |
| R2-2209640 | Intel | Proposal 1: Mobility enhancement of mobile IAB-node’s served RRC\_CONNECTED, RRC\_INACTIVE and RRC\_IDLE UEs for handover/cell (re-)selection should be considered for following four scenarios:  Scenario 1: The UE is moving inside the vehicle equipped with a mobile IAB-node  Scenario 2: The UE is moving out of the vehicle equipped with a mobile IAB-node  Scenario 3: The onboard UE is moving together with the vehicle equipped with a mobile IAB-node  Scenario 4: The onboard UE is moving inside the vehicle equipped with multiple mobile IAB-nodes  Proposal 2: For cell (re-)selection, to differentiate from stationary network nodes, mobile IAB-node broadcasts “miab-cell” indication in its system information.  Proposal 3: Mobile IAB-node broadcasts its velocity (details FFS) in its system information to enhance handover, cell (re-)selection decision.  Proposal 4: For Rel-18 UEs, consider new information/measurement event based on mIAB node’s velocity, TA, UE’s relative speed estimated by doppler shift, etc, as mobility enhancement for served UEs during their cell (re)selection, handover and conditional handover. |
| R2-2209699 | AT&T | Proposal 1: RAN2 should discuss what mechanisms, including the use of physical layer measurements such as timing advance, RRM measurements, and other L1 measurements can be used for identification of a set of serving UEs for group mobility procedures associated with a given mobile IAB node. RAN1 may additionally be consulted for input on the feasibility if necessary.  Proposal 2: RAN2 should consider mechanisms to avoid connection (re)establishment of onboard UEs to a virtual DU of a mobile IAB node during a full migration procedure. |
| R2-2209703 | Qualcomm | Proposal 1: The mobile IAB-node cell to broadcast a “mobile-IAB” status indicator. |
| R2-2209763 | Apple | Proposal 1: RAN2 agree the following UE behaviors in cell reselection enhancement of mobile IAB, similar to Rel-17 HSDN:  The UE considers the IAB nodes which are moving together as highest priority  The UE considers the IAB nodes which are not moving together as lowest priority  The UE which is moving together IAB node should consider static cells as lowest priority  Proposal 2: RAN2 reuse the similar solution of NR HSDN to determine whether the UE moves together with a mobile IAB node, i.e. Mobile IAB node can broadcast mobility indication(s) similar to hsdn-Cell-r17 in SIB and it is up to UE implementation to decide whether moving together. FFS signaling and format of the mobility indication(s).  Proposal 3: Following principle captured in clause 5.2.3.1 of TS 38.304, cell selection doesn't need to be enhanced in mobile IAB. |
| R2- 2209953 | Lenovo | Proposal 3: Mobile IAB-node broadcasts its mobile attribute to UEs, e.g., via SIB1.  Proposal 4: To differentiate onboard UEs and surrounding UEs of mobile IAB-node for IAB-donor. |
| R2-2209997 | CANON | Proposal 4: A mobile IAB-node may broadcast some mobile capability signalling towards the UEs in its vicinity using SIB signalling. This Mobile capability signalling may include a mobility profile similar to the one shared with the IAB-donor-CU.  Proposal 5: In case the mobile IAB node is static, the mobile IAB node may inform the UEs in its vicinity about its static status, as well as the duration for which it will remain static. |
| R2-2210778 | Nokia | Proposal 2. Optimizations for cell (re-)selection behaviour can be de-prioritized in Rel.18 |
| R2-2210327 | Ericsson | Proposal 1:RAN2 to discuss the need of provide mobile IAB specific information to the UE, such as mobile IAB’s position, velocity, access class/category and any other parameters to help the UE in performing (or avoiding) certain RRC procedures. |
| R2-2210387 | vivo | Proposal 1 Legacy UE uses the information broadcast by mobile IAB to decide to reselect to the mobile IAB cell  Proposal 2 Release 17 slice aware cell reselection mechanism is reused as baseline for UE reselection to/from a mobile IAB cell. |
| R2-2210429 | Kyocera | Observation 1 The UEs moving together with the IAB-node can stay on the IAB-node, based on the existing radio condition-based cell reselection and the proper frequency priority.  Observation 2 If the UE and the mobile IAB-node stop, the UE cannot decide whether it should reselect the mobile IAB-node or not, unless the UE knows the user’s intention.  Proposal 1 RAN2 should agree that no enhancement is needed for UEs to perform cell reselection to/from the mobile IAB-node. |
| R2-2210447 | Xiaomi | Proposal 2. Through establishing on-board state and reselecting to the mIAB of the vehicle the UE has on-boarded the UE can use this status when stationary or in motion as depicted in scenarios 1, 2 and 3 to maintain connectivity to the mIAB node.  Proposal 3. RAN2 should use the observations (1-4) captured for the scenarios described in this paper as a basis to develop requirements to guide good selection and reselection behaviour for UE vehicle on-boarding, continued connectivity whilst on-board and for leaving a vehicle to efficiently and accurately manage the connectivity to the mIAB.  Scenario 1. Stationary UE connected to external gNB on-boards to UE with mIAB node  Scenario 2. UE connected to mIAB leaves vehicle and connects to external gNB  Scenario 3. UEs on-board vehicle in transit. During the journey mIAB performs full migration to new IAB-CU.  Scenario 4. Lines of similarly moving (or not) vehicles e.g. queuing to exit |
| R2-2210522 | Samsung | Proposal 4. RAN2 discuss whether in idle/inactive mode of access UE, whether access UE’s cell reselection to neighbour cell (out of the IAB node) and again back to the cell of the IAB node could be a problem, and if so, to find the solution for this. |
| R2-2210548 | InterDigital | Proposal 1: A mobile IAB cell broadcasts the current mobility state of the IAB node.  Proposal 2: The granulity of the mobility state information is FFS (e.g., detailed information like speed/direction/trajectory vs less granular information such as static, low mobility, high mobility, etc.,).  Proposal 3: A UE that is connected to a mobile IAB node or camping on a cell of the IAB node in IDLE/INACTIVE can stop or deprioritize neighbor cell measurements depending on the mobility state of the IAB node. Exact details are FFS.  Proposal 4: A UE can stop or deprioritze measurements on nerighbour cells belonging to a mobile IAB node, depending on the mobility state of the IAB node. Exact details are FFS. |
| R2-2210562 | LG Electronics | Proposal 6: If UE determines that it is on-board in a mobile cell, the UE is allowed to consider cell reselection frequency priority of (the frequency of) the mobile cell to be the highest one. FFS how to determine that UE is indeed on-board in a mobile cell or whether it is left to UE implementation. |

**2.2 Legacy UE clarifications**

We first try to clarify the behaviors/impacts of legacy UEs under the mobile IAB cell, i.e. the scope “*Make some assumptions on typical configuration and cell reselection behaviour for legacy UEs*” of this email discussion.

Rapporteur understands there should be no impact to legacy UE working on mobile IAB cell, regardless the enhancement/impact we introduced in R18 for mobile IAB cell. “*RAN2 confirms that Mobile IAB need to work with legacy UEs.*”

Therefore, following assumption should be the common understanding of the UEs working in the mobile IAB cell and the typical configuration of mobile IAB cell for cell (re)selection.

**Assumption 1: From the NW perspective of mobile-IAB cell, the principle of setting the legacy parameters (including cell (re)selection, cell reservations and access restrictions) does not change, compared to the legacy IAB cell.**

**Assumption 2: No spec impact to legacy UEs behaviors.**

**Assumption 3: Any R18 newly broadcasted info of mobile-IAB cell (if agreed) does not forbid/control the access of legacy UEs.**

**Assumption 4: Non-enhanced UEs (including legacy UEs and R18 UEs not supporting the enhancement) just ignore the R18 newly broadcasted info of mobile-IAB cell (if agreed).**

**Q1: Do you agree the above assumptions on legacy UE and typical configuration of mobile IAB cell?**

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| **Companies** | **Yes/No** | **Comments** (indicate which assumption you have comment, or you can add more assumptions if needed) |
| Apple | Yes |  |
| Qualcomm | Yes |  |
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**2.3 Mobile IAB cell broadcasting info and UE behaviors**

### **2.3.1 Mobile IAB cell broadcasting info**

We see following proposals on the mobile IAB cell broadcasting info to assist the R18 UE’s cell (re)selection.

* **Alt.1**: Mobile-IAB cell indication (1bit, i.e. the cell is a R18 mobile-IAB cell or not)
  + HW P1, Intel P2, Lenovo P1, LG P6
* **Alt. 2**: Mobile-IAB cell status indication (1bit, i.e. the mobile IAB cell is moving currently or not)
  + QC P1, Apple P2, CANON P4/5, InterDigital P1
* **Alt. 3**: Mobility state info (e.g. speed, location, direction, trajectory)
  + Yes: Intel P3, Ericsson P1, InterDigital P2.
  + No: HW P3b (*Not to introduce any broadcasting mobility state/location/speed information by mobile IAB cell, considering the security issue and frequent SI update.*)

**Q2: Do you agree the motivation of above alternatives on “Mobile IAB cell broadcasting info” is to help UE to determine “it is on-board of mobile IAB cell”, and then to assist the UE’s cell (re)selection?**

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| **Companies** | **Y/N** | **Comments** (please clarify your motivation of mobile IAB cell broadcasting info) |
| Apple | Y with comments | We agree the broadcast indication is used to assist Rel-18 mobile IAB capable UE's cell (re)selection. But its motivations can include below 2 aspects:  1) Help UE to determine "it is on-board of mobile IAB cell" (as Rapporteur mentioned).  2) Help UE to differentiate the type/status of candidate target cells (at least stationary cell or mobile node) during cell reselection |
| Qualcomm | Yes only for “assist cell (re)selection)” | The broadcast indication aims to assist the UE to perform cell reselection in presence of a mix of mIAB-cells and non-mIAB-cells.  The UE may be able to better determine its relative speed with respect to mIAB-cells vs. non-mIAB-cells.  The UE will not be able to determine if it is “onboard of a vehicle” based on such indication. |
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Rapporteur’s understanding: The basic option will be letting UE know whether the cell is a “mobile-IAB cell type” (the atl.1). In addition, some mobile IAB cell may not always be in the mobility status (like in the train station temporarily). Alt.2 gives more information to UE on whether this mobile IAB cell is currently moving or not. Further, finer granularity information is provided in alt.3 to let UE knows the speed/location/direction/trajectory.

**Q3: Which alternative do you prefer?**

Please clarify how should UE uses this info;

Please clarify why alt.1 is not sufficient if you prefer alt.2, and why alt.1/2 is not sufficient if you prefer alt.3;

Please clarify the security concern by allowing NW broadcasting its speed/location/direction/trajectory and SA3 involvement, if you prefer alt.3;

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| **Companies** | **Alt.** | **Comments** |
| Apple | Alt-2 with comments | For Alt-1, we think it is not sufficient to differentiate below two cases:  1) The vehicle just temporarily stops (e.g. a bus temporarily stops in station but will starts very shortly).  2) The vehicle stops for a long time (e.g. a motor home stops for sleep)  In our understanding, Alt-1 can only set "true" for both above cases while Alt-2 will set "true" for case 1) but "false" for case 2). From cell reselection perspective, we don't case 1) and case 2) should be treated equally.  Meanwhile, we think the granularity of Alt-2 can be further discussed (e.g. low/medium/high). For Alt-3, we disagree to introduce location/direction/trajectory because of security concern raised by Rapporteur. In addition we think absolute speed value is impossible to include in SIB because SIB update is slow, so the quantization of speed is the only option, which is a general form of Alt-2. We can further discuss its granularity. |
| Qualcomm | Alt 1 | We do not support broadcast of dynamically changing information as proposed by Alt 2 and Alt 3. This would imply that SIB will have to frequently change (e.g., at every stoplight), and UEs need to perform frequent SIB updates. This had significant power consumption impact on idle/inactive UEs. |
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**Other solutions are proposed to control the on-board UE access.**

On mobile IAB cell access control, whether to support only allowing on-board UEs to access?

* Yes, e.g. slicing based solution (vivo P1), PNI-NPN and CAG based solution (ZTE P2);
* No. HW P4a (No special standard effort is needed to prevent the surrounding UE from accessing the mobile IAB-node.)

Rapporteur’s understanding:

* The slicing/CAG based solution to control the access is already optionally supported by IAB cell. So, it is up to the NW to determine whether/how to use this feature. The discussion is about whether we should mandate the mobile IAB cell to use slicing/CAG based solution to control the access of on-board/surrounding UEs (otherwise, there is no standard effort).
* Note that it does not work for legacy UEs not supporting slicing/NPN feature. There will be legacy surrounding UEs access to the mobile IAB cell anyway.

**Q4: Which understanding do you agree?**

**Understanding 1: mandate the mobile IAB cell to use slicing/CAG based solution to control the access of on-board/surrounding UEs.**

**Understanding 2: No special standard effort/impact is needed to prevent the surrounding UE from accessing the mobile IAB-node.**

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| **Companies** | **Understanding** | **Comments** |
| Apple | 2 | 1. WID objective has clearly stated that optimization of surrounding UEs is not in scope.  2. We tend to think the below use case mentioned by Proponent is a rare case:  " UEs on other vehicles may have similar speed with the mobile IAB node. These UEs are actually surrounding UEs instead of on-board UE for this vehicle. After a while, these surrounding UEs may be far away from the mobile IAB node since the trajectory of these vehicles are not exactly the same." |
| QC | 2 | Option 1 is not effective in stopping surrounding UEs from accessing the mIAB-node. It only stops access for UEs that use this slice/CAG. UEs that do support the designated slice/CAG may still be outside the vehicle.  The WID explicitly supports connecting surrounding UEs.  The mIAB-DU certainly supports slicing/CAG in the same manner as every legacy gNB-DU. |
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### **2.3.2 R18 enhanced UE behaviors**

As to the enhanced UE behaviors, “*List the potential enhancements proposals on the table for enhanced UEs and for such proposals clarify what is the target performance characteristic to enhance and target scenario (if any)”*, we have following proposals.

* On-board UE considers cell (re)selection prioritization to mobile IAB cell
  + ZTE P1/P3, Apple P1, Xiaomi P2, HW 3a, LG P6
* Nothing to enhance
  + Nokia P2, Kyocera P1

Rapporteur try to collect the company’s views on the enhanced UE behaviors for cell selection by below candidate proposals. Note this proposal does not touch the solution/spec impact of UE “on-board” determination yet. This proposal is only to clarify the UE behaviors if UE determines itself on-board of mobile IAB cell.

**Q5a: Do you agree that “R18 UE may/can prioritize the cell (re)selection to a mobile IAB cell, if the UE determines itself on-board of this mobile IAB cell”?**

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| **Companies** | **Yes/No** | **Comments** |
| Apple | Yes | The intention is to avoid R18 Mobile IAB capable UE to camp in a stationary node, which will result in the consequence that this UE has to reselect to another cell shortly.  Meanwhile, please note that NR has introduced similar cell reselection enhancement to HSDN, V2X and eMBMS. And in LTE, similar solution was also specified in eMBMS/V2X. We never heard complaint about its interoperation issues. So, we don't see any technique issue, including legacy UE impact. |
| Qualcomm | Yes | This is possible by implementation. If the UE observes that it does not move with respect to an mIAB-cell but it moves with respect to non-mIAB-cells, it may conclude that it is “onboard” and select the mIAB-cell |
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Then, the solution of “on-board UE identification” is related/bounded with the above cell (re)selection enhancement. We see very few detailed solution proposal from contributions.

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| **RAN2 observes that a UE could potentially consider itself on-board of a mobile-IAB cell, if the UE camps on/connects to a mobile IAB cell during a long period (i.e. the UE then need to know that this is such a cell). FFS the time. FFS if this is needed.** |

Based on the above agreement and rapporteur understanding, the mobile IAB cell broadcasting info, discussed in Q3, is supposed to help UE to identify it is on-board. For instant, if the alt.1 in Q3 (mobile-IAB cell) is known by UE, UE could potentially/is able to determine itself on-board of a mobile-IAB cell.

In this stage, it is not clear on whether we should have spec impact or leave it to UE implementation. But, there is no harm to share the views on this.

**Q5b: Do you agree with below understanding/proposal?**

**Based on the mobile IAB cell broadcasting info, agreed in Q3, R18 UE is able to determine whether it is on-board of mobile IAB cell. FFS if any spec impact or purely UE implementation.**

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| **Companies** | **Yes/No** | **Comments** (you can also provide your views on the spec impact vs. UE implementation)(also it is good for proponents to clarify how exactly UE determines it is on-board) |
| Apple | Yes | It is clear that some current smart phone can already identify whether it is on-board in a vehicle via its implementation. So, we don't see technique issue for this proposal. Note that the mobile status indication in SIB is still needed for the UE to differentiate the candidate target cells in cell reselection.  On whether any spec impact, we think at least UE implementation can work but we are open to discuss specified solution. However, from history of 3GPP similar discussions, it will be hard to converge to a specified speed estimation solution because 3GPP can only specify air interface related solution but UE can rely on other techniques (e.g. its sensor info). |
| Qualcomm | Yes | A Rel-18 UE, that observes low/no mobility to an mIAB cell and high mobility with respect to non-mIAB cells, would understand that it is moving together with the mIAB cell (i.e., be “onboard”). The legacy UE would not be able to interpret the conflicting mobility measurements, and therefore not know which mobility state it is in.  A Rel-18 UE, that observes high mobility to an mIAB cells and low/no mobility with respect to non-mIAB cells, would understand that it is stationary and not moving with the mIAB cell (i.e., non “onboard”). The legacy UE would not be able to interpret the conflicting mobility measurements, and therefore not know which mobility state it is in. |
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# Phase 2 discussion

TBC

# Conclusion and proposals

Based on the above summary, following proposals are given

**TBD**

# Reference

1. R2-2209522 Mobile IAB mobility enhancement Huawei, HiSilicon
2. R2-2209616 Discussion on mobility enhancement for mobile IAB ZTE, Sanechips
3. R2-2209640 Mobility Enhancement of mobile IAB-node and served UEs Intel Corporation
4. R2-2209699 Mobility enhancements for group mobility AT&T
5. R2-2209703 Enhancements for IAB-node mobility Qualcomm Inc.
6. R2-2209763 Mobility enhancement in mobile IAB Apple
7. R2-2209953 Mobility enhancements for mobile IAB-node and its served UE Lenovo discussion Rel-18
8. R2-2209997 Discussion on mobility enhancements for mobile IAB CANON Research Centre France
9. R2-2210778 RAN impacts due to IAB-node mobility Nokia, Nokia Shanghai Bell
10. R2-2210327 Mobility enhancements for mIAB node Ericsson
11. R2-2210387 Discussion on mobile IAB open issues vivo
12. R2-2210429 Mobility enhancements for mobile IAB Kyocera
13. R2-2210447 Scenarios for consideration in mIAB cell selection and reselection Beijing Xiaomi Mobile Software
14. R2-2210522 Discussion on the enhancement of IAB node mobility Samsung R&D Institute UK
15. R2-2210548 IAB node mobility state and UE measurements InterDigital, Inc.
16. R2-2210562 Handover and cell reselection enhancements for on-board UE mobility LG Electronics