**3GPP T****SG-RAN WG2 Meeting #121-bis R2-2304257**

**E-Meeting: April 17-26, 2023**

**Agenda item: 7.6.3.1**

**Source: Qualcomm Incorporated**

**Title: [offline-114] Neighbour cell measurements**

**Document for: Discussion and Decision**

# Introduction

This document provides the report of the following email discussion.

* [AT121bis-e][114][IoT NTN Enh] Neighbour cell measurements (Qualcomm)

Scope: Discuss the remaining proposals from R2-2303652 and whether recent RAN2#121bis-e agreements for NR NTN can be extended to IoT-NTN

Intended outcome: Summary of the offline discussion with e.g.:

* List of proposals for agreement (if any)
* List of proposals that require online discussions
* List of proposals that should not be pursued (if any)

Deadline for companies' feedback: Tuesday 2023-04-25 02:00 UTC

Deadline for rapporteur's summary (in R2-2304257): Tuesday 2023-04-25 04:00 UTC

Proposals marked "for agreement" in R2-2304257 not challenged until Tuesday 2023-04-25 20:00 UTC will be declared as agreed via email by the session chair (for the rest the discussion might continue online in the Wednesday CB session).

# Discussion

Following agreement is made.

Agreements:

1. New SIBxx is introduced to broadcast the neighbor cell/satellite information.

Following is the proposal 1 from R2-2303652.

Proposal 1 In addition to ephemeris and optional epoch time of the satellite associated with a neighbor cell, following parameters can be optionally broadcast as neighbor cell assistance information:

- (15/18) Validity duration.

- (15/18) Common TA parameters.

- (12/18) For fixed cell, cell start time.

- (9/18) FFS, cell stop time for fixed cell.

- (8/18) FFS, reference location and distance threshold for moving cell.

1. **Do you agree Common TA parameters are needed as assistance information for neighbor cell measurements? If No, please elaborate how does UE track neighbor cell timing drift.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Detail comments |
| Samsung | LS to RAN4 | In RAN4 LS (R2-2211171) they mention that the same elements as in NR NTN would be needed. The reason why it would be needed in our understanding would be to enable tracking of neighbour cell reference signals. But the reference signals are different in LTE compared to NR where for instance CRS is transmitted in every frame. There may also be a difference how this works in eMTC and NB-IoT that RAN2 may miss.  We should trigger an LS to RAN4 with RAN1 in CC. Important to get this right as common TA consumes a lot of bits. |
| Apple | Yes | We checked with our RAN4 colleague. Our understanding is Common TA is needed because UE needs to track the subframe boundary to measure CRS because satellite movement can cause drift. Though there is no SMTC in LTE, UE behavior is similar as in NR. |
| ZTE | Fine to ask RAN4 | Considering the detect procedure for serving cell when UE power up, we feel this assistance information of Common TA of neighbour cells is not so important. But if RAN4 confirms that this is helpful for detecting neighbour cells, we are fine to add it. |
| Xiaomi | Yes | Agree with apple that common TA is used for UE identify the frame boundary, it will be useful for the subsequent neighbor cell measurement as UE is no longer needed to search for PSS/SSS again. |
| Panasonic | Yes | We see no reason for deviating from NR-NTN here. |
| Lenovo | Yes | Align with NR NTN. |
| InterDigital | Yes |  |
| Huawei, HiSilicon | Yes | Even though CRS is transmitted in each subframe, tracking neighbour cell’s timing drift requires a finer granularity than 1ms. We still think it is necessary and it is already clear in RAN4 LS that the same satellite assistance information as NR NTN is required. |
| MediaTek | Yes | Common TA can help to track neighbor cell timing drift.  We are also fine to send LS to RAN4. |

1. **Do you agree validity duration is needed for the neighbor cell ephemeris as this information is carried in new SIBxx?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Detail comments |
| Samsung | No | In NR NTN, for the cell assistance information used for neighbour cell measurements, we have introduced validity duration per neighbour cell via NTN-config. Our understanding is that it is up to UE implementation to ensure that the neighbour cell ephemeris is kept up to date. This in practice would likely mean that the NR NTN UE will re-acquire SIB19 when the validity duration of a neighbour cell is about to expire.  However, in IoT NTN, the situation is different as UE cannot be expected to read any SIB in connected mode. This means that we cannot leave it up to UE implementation how to deal with having valid neighbour cell information, because a UE cannot read any SIB in connected mode. This is exactly the reason why we have T317 and T318 in IoT NTN and not in NR NTN.  Furthermore, consider the complexity of IoT NTN UE having to read SIBxx at different times if the validity duration is different for different neighbour cell satellites.  Thus we agree that we need some type of way to ensure that the UE has valid neighbour cell ephemeris, but having it per neighbour cell assistance / satellite would not be consistent with IoT NTN operation defined so far. |
| Apple | See comments | We think validity duration is needed as UE needs this info to determine whether to re-acquire neighbour cell’s ephemeris data. And ephemeris data should be valid for UE to perform measurement on neighbour cell.  But we also see the concern from Samsung. In order to avoid frequently reading SIBxx to update neighbour cell’s ephemeris data, it is good to ensure the validity duration of neighbour cell the same as serving cell. |
| ZTE | The validity duration is not so critical, fine to either way, having it or without it. | For IoT NTN, even for serving cell, the validity duration for UE in RRC\_IDLE is not so critical. For UE in RRC\_IDLE, even the T317 may expire after it starts for the first time, UE is not required to reacquire SIB31. The main usage of T317 is to trigger UE to reacquire SIB31 when it expires during RRC\_CONNECTED mode.  We think similar assumption can be applied to SIBxx. Even we introduce validity duration for each set of neighbour satellite assistance information, UE in RRC\_CONNECTED is not required to reacquire SIBxx if this validity duration timer expires. UE can just assume this neighbour satellite assistance information is no longer valid. It’s also ok to only introduce one validity duration for whole SIBxx, then UE can just stop using of SIBxx when this validity duration timer expires.  As we assume SIBxx is less important than SIB31, if validity duration timer expires during connected mode, UE can also just stop using of SIBxx, e.g., no need to reacquire it. We assume only the neighbour cell measurement performance may be impacted a little. |
| Xiaomi | See comments | As we explained in Q1, UE needs to know whether the ephemeris of neighbor cell is still valid to calculate the frame boundary. But it doesn’t mean that UE needs to reaquire SIBxx if the validity duration timer expires. |
| Panasonic | Yes | Once again, we see no reason for deviating from NR-NTN here. |
| Lenovo | Yes | Prefer to align with NR NTN, i.e., validity duration of neighbour cell ephemeris is optionally provided. And if not, UE considers that the validity duration of neighbour cell ephemeris is the same as that of the serving cell ephemeris. |
| InterDigital | Yes |  |
| Huawei, HiSilicon | See comments | We see some divergence here, on whether a valid version of neighbor cell ephemeris needs to be maintained by the UE.  We agree with Apple that the neighbor cell satellite assistance information is critical to mobility performances. And we don’t like the NR NTN design where each neighbor cell has a separate validity duration and the maintenance of such validity timer is quite complicated so NR NTN eventually left the maintenance of neighbor cell validity timer to UE implementation.  Apart from reusing the validity duration of SIB31, an alternative is to use legacy SI modification to update the new SIBxx. We think it’s a bit early to select from the two methods since we may introduce other assistance information in R18 and put them in SIBxx. |
| MediaTek | Yes | Per our understanding, the new SIBxx provides assistant information that can help UE to perform neighbor cell measurement. We assume it is not an essential SIB. Without this SIB, UE can still work properly.  The validity duration is needed to keep the neighbor cell ephemeris valid. Whether and when UE needs to re-acquire the new SIBXX is another question.  We also think the validity duration can be optional. When it is absent, the validity duration in SIB31 is used. |

1. **If the answer to Q2 is No, how does UE know it is time to update neighbor cell ephemeris as it is in new SIBxx not in existing SIB?**

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| --- | --- | --- |
| Company | Yes/No | Detail comments |
| Samsung |  | This is what RAN2 has to discuss, but having validity duration for different neighbouring cells in SIBxx will not work for IoT NTN.  We assume other companies have yet to consider this, but for discussion we can list a number of options:   * Use same validity duration as SIB31 * Single validity duration for all of SIBxx * No validity duration for SIBxx, UE only acquires SIBxx before connecting to cell |
| Apple |  | Using same validity duration as SIB31 is good. |
| ZTE |  | Even validity duration might be introduced for SIBxx, or for the IEs in SIBxx, we assume the expiration of validity duration would not cause UE to update SIBxx (for UE power saving).  We are also fine to discuss to let UE in RRC\_IDLE follow the legacy SIB update procedure to update SIBxx (even we also think it’s not so necessary). Then no validity duration is needed for SIBxx. This may be similar as SIB32. |
| Xiaomi |  | No need to update the SIBxx. |
| Huawei, HiSilicon |  | Reuse validity timer of SIB31, or use legacy SI update procedure. As commented in Q2, we would prefer to postpone it. |

1. **Please indicate Yes/No for if followings are needed as neighbor cell assistance information ?**
2. **Kmac**
3. **For fixed cell, cell start time**
4. **For fixed cell, cell stop time**
5. **For moving cell, reference location and distance threshold**

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| --- | --- | --- | --- | --- | --- |
| Company | (1) | (2) | (3) | (4) | Detail comments |
| Samsung | See Q1 | N | N | N | (1) Is needed for the same reason as for common TA in our understanding. We should trigger LS to RAN4 on this.  (2-4) we have not agreed what they are used for. In the discussions below, we only talk about triggering measurements based on serving cell conditions. If we agree something different, we can always include them. |
| Apple | Yes | No | Yes | FFS | For Kmac, same as in NTN discussion, if the compensation of Kmac is done at UE, it would be also needed. |
| ZTE | See Q1 | Y | N | N | The intention of introducing this neighbour cell assistance information is to help UE detecting neighbour cell, either in RRC\_IDLE or RRC\_CONNECTED mode. So we think the cell start time of a neighbour fixed cell would be helpful for UE to determine the suitable timing for starting to detect a neighbour fixed cell. It's simple for both UE and eNB.  We assume (4) has similar intention as (2). But as it would cause complicated processes in UE and also more signalling overhead in SIB, we think it is not worth introducing compared to benefits it can bring.  For (3), is there any consideration that UE can choose to detect/camp the neighbour cell which has later stop time? We think it’s very less needed. The radio quality of the neighbour cell should still be the main consideration factor. |
| Xiaomi | Yes | Yes | No | FFS | (1)See Q1  (2-3): It would be beneficial UE to decide when to do the measurement. But the stop time may be less necessary. |
| Panasonic | Yes | Yes (already available with *T-ServiceStart-r17* in SIB32) | Yes | Yes (already available with *referencePoint-r17* and *radius-r17* in SIB32) | We assume that “fixed cell” means quasi-fixed cell. |
| Lenovo | Yes | Yes | No | Yes | Can reuse as in *T-ServiceStart-r17*, *referencePoint-r17* and *radius-r17* in SIB32. |
| InterDigital | Y | Y | Y | Y | All of these have merit |
| Huawei, HiSilicon | Y | N | N | N |  |
| MediaTek | N | Y | Y | Y | We don’t see how Kmac can be needed. We are fine to send LS to RAN4 to check this.  2,3,4 can be used for trigger neighbour cell measurement. |

Proposal 2 (15/18) In SIB, list of neighbor satellites is provided. For each satellite, list of frequencies/cells is included. FFS on clarification of the absence case of ephemeris and frequencies/cells.

* QC thinks this the simplest but indeed the list of frequencies consume a large number of bits
* ZTE agrees that the list of frequencies consume a large number of bits and wonders if the UE would also have to acquire SIB5 in this case. QC thinks this is the case.
* Apple wonders if adding a satellite ID to the frequency lists in SIB5 would impact of UE not supporting NTN
* HW wonders if it’s possible to have NTN and TN on the same frequency. QC thinks this scenario would have to be avoided.
* Continue offline

The ARFCN-ValueEUTRA-r9 is 18 bits (> 2 bytes) and PhysCellId is 9 bits (> 1 byte). Issue is size of list of frequencies and size of list of PCIs for each frequency.

1. **How to associate list of frequencies/cells with the satellite?**

Option #1: For each satellite, list of frequencies/cells is included

Option#2: Satellite indication in SIB5

Option#3: others

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| --- | --- | --- |
| Company | Which Option | Detail comments |
| Samsung | Option 3 (Probably similar intention as option 2) | We assume what is meant is that there is an indication of the satellite Id in the frequency lists of SIB4 and SIB5. This means for intra-frequency the IE *IntraFreqNeighCellInfo* of SIB4 includes an ID of the neigh cell assistance in SIBxx, and for inter-frequency the IE *InterFreqCarrierFreqInfo* includes an ID of the neigh cell assistance in SIBxx. |
| Apple | See comments | First, we want to confirm this is only about NTN cell, right?  For TN cell, we see there are some discussions in NR NTN on how to provision neighbour NTN cell’s config via TN cell. I guess it is not relevant to this issue.  Secondly, the issue of mixed deployment of NTN and TN on the same frequency has not been discussed/resolved properly. For example, it is not clear at least to us, for a given frequency contained in both SIB5 and SIBxx, does UE only perform NTN based measurement? Indicating satellite in SIB5 definitely has the same issue. |
| ZTE | Option 2 or Option 3 | According to RAN4 latest progress, we understand specific/dedicated frequency band(s) would be applied to IoT NTN. We think no need to discuss the mixed deployment issue.  As signalling overhead in SIB is very sensitive to IoT NTN, we should try to avoid (large) redundant information provided in several different SIBs.  Therefore, we are open to discuss following way:   * Firstly, several sets of neighbour satellite assistant information can be defined in SIBxx. Each set of information can be tagged with a satellite ID or neighbour satellite configuration ID. Simply, each set of information can be mapped to one neighbour satellite. It may be also possible that several sets are mapped to one neighbour satellite. That means, one neighbour satellite can provide several different configurations, e.g., for different frequencies. * Secondly, the neighbour cell info in SIB4/SIB5 can be extended to include satellite ID or neighbour satellite configuration ID. By this way, we can correlate the existing neighbour carriers/cells information with the needed neighbour satellite assistant information. |
| Xiaomi | See comment | We need first to know whether it is a valid deployment that TN and NTN are deployed in the same frequency for IOT NTN. |
| Lenovo | See comments | Agree with Apple. |
| InterDigital | Option 2 |  |
| Huawei, HiSilicon | Option 1 | Option 2 may save some signaling overhead, but we think some more justification/details are needed.  1) Whether it is possible to have TN cell and NTN cells on the same frequency. If yes, how to associate the PCIs to the NW type.  From our perspective, it seems not reasonable to have both TN and NTN cells on the same frequency in the same region/location. But in NR NTN, similar discussion is taking place (in [AT121bis-e][107], there is discussion on how to know the NW type).  2) Whether it is possible to have multiple satellites on the same frequency. If yes, how to associate the PCIs to the corresponding satellite. |
| MediaTek | Option 1 | To avoid coupling with SIB5, option 1 is preferred. |

1. **Introduce satellite ID for the satellite in a list?**

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| --- | --- | --- |
| Company | Agree/Disagree | Detail comments |
| Samsung | Agree | Seems this can be used. Consider re-naming it to something more specific “ntn-NeighCellAssistanceId” (to avoid calling it “satellite”) and not mix it up with discontinuous coverage. |
| ZTE | Agree | Naming can be further discussed. |
| Panasonic | Agree | Already used in SIB32 with *satelliteId-r17*. |
| Lenovo | Agree |  |
| InterDigital | Agree |  |
| Huawei, HiSilicon |  | Depends on the outcome of Q5. |
| MediaTek | Agree |  |

\*\*\* Check whether recent agreements for NR NTN mobility enhancements can also be applied to IoT NTN enhancements \*\*\*

- RAN2#121 agreements for IoT NTN enhancements:

1. Location-based connected mode measurement initiation is supported in quasi-Earth-fixed cell (UE is not required to update the GNSS location for this). A serving cell reference location and a distance threshold/radius for detecting when to trigger connected mode measurements will be broadcast for quasi-Earth-fixed cell. FFS on whether the R17 IEs are reused or not. FFS if the same mechanism can also be used in idle (like in NR-NTN)

* Continue offline on the highlighted FFS (i.e. if the same mechanism can also be used in idle)

1. **For fixed cell, do you agree the same mechanism of location-based connected mode measurement initiation can also be used in RRC\_IDLE (like in NR-NTN)?**

|  |  |  |
| --- | --- | --- |
| Company | Agree/Disagree | Detail comments |
| Samsung | Agree | We assume like how we specified neighbour cell measurements in Rel-17 NB-IoT, some of the conditions for enabling connected mode measurements are specified in idle mode specs. So this means that we can do the same in IoT NTN and get the idle mode location-based connected mode measurements for free. |
| Apple | Agree | Just want to say the left questions that whether the conditions (channel quality, channel variance, location based, time based) are independently or jointly used, can be discussed separately for idle mode measurement. |
| ZTE | Agree in principle | Similar view as Samsung. Since more companies may agree to provide location-based connected mode measurement configuration via SIB (e.g., SIB3 in our assumption), we think it’s no need to restrict such assistant information can only be used for connected mode. UE in RRC\_IDLE can also make use of this information to determine the timing for detecting the neighbour cells more accurately.  Bur for IoT NTN, as we have no intention/objective to optimize cell selection/reselection in RRC\_IDLE, We suggest not to expand the discussion to any enhancements for cell selection/reselection. |
| Xiaomi |  | It is out of the WI scope |
| Panasonic | Agree | Yes, like NR-NTN. “fixed cell” means quasi-fixed cell we assume. |
| Lenovo | Agree | Align with NR NTN. |
| InterDigital | Agree |  |
| Huawei, HiSilicon | Agree | OK to have. In R17, the main reason for not having location-based reselection enhancements for IoT NTN is to avoid GNSS updates for UEs in RRC\_IDLE. But from our perspective, the UE still needs a valid location for time/frequency compensation, so GNSS is inevitable even for UEs in RRC\_IDLE. |
| MediaTek | Agree |  |

2. Location-based connected mode measurement initiation is supported in earth-moving cell (UE is not required to update the GNSS location for this). A serving cell reference location and a distance threshold/radius for detecting when to trigger connected mode measurements will be broadcast for earth-moving cell. FFS on whether the R17 IEs are reused or not. FFS on whether additional information needs to be broadcast to inform the UE how the reference location moves over time or if this can be derived from other information (e.g. Epoch time and ephemeris). FFS if the same mechanism can also be used in idle (like in NR-NTN)

* Continue offline on the highlighted FFSs, taking into account the recent RAN2#121bis-e agreements for NR NTN

1. **For moving cell, do you agree the same mechanism of location-based connected mode measurement initiation can also be used in RRC\_IDLE (this should be optional feature in IDLE mode)?**

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| --- | --- | --- |
| Company | Agree/Disagree | Detail comments |
| Samsung | Agree | Same reasoning as above |
| Apple | Agree |  |
| ZTE | Agree in principle | Same comments as Q7. |
| Xiaomi |  | It is out of the WI scope. And it requires UE to acquire GNSS location, which consumes UE power. |
| Panasonic | Agree | If “no movement” can be detected (via e.g. acceleration sensors), there is no need for obtaining UE’s position again and again by GNSS means. |
| Lenovo | Agree | Align with NR NTN. |
| InterDigital | Agree |  |
| Huawei, HiSilicon | Agree |  |
| MediaTek | Disagree | This will lead serious power consumption issue in IoT UEs, which is disastrous for IoT-NTN in Idle mode. If the NB-IoT UE frequently acquires GNSS location, it will drain out its battery power. This is different from NR-NTN, as NB-IoT devices need to have very long battery life (in order of weeks or even months) and cannot afford to do frequent GNSS check and match its location. |

- RAN2#121bis-e agreements for NR NTN enhancements:

1. RAN2 understands that for earth-moving cell reselection, the UE can derive the trajectory of serving cell with rough accuracy based on serving satellite ephemeris and epochTime, with the assumption that the serving cell reference location broadcast by the network is the one at Epoch time (FFS whether a new epochTime IE is needed). RAN2 understanding is that both PVT and orbital parameters can be used for this. FFS if additional information is needed to allow more accurate measurements.

* Check offline if this can be extended to IoT NTN

1. **For moving cell, do you agree the UE can derive the trajectory of serving cell with rough accuracy based on serving satellite ephemeris and epochTime, with the assumption that the serving cell reference location broadcast by the network is the one at Epoch time (like in NR-NTN)?**

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| --- | --- | --- |
| Company | Agree/Disagree | Detail comments |
| Samsung | Agree | We can of course check more, but this is a good start |
| Apple | Agree |  |
| ZTE | Agree | With this clarification information and also with consideration that IoT satellite may be simpler on beam management aspect than NR satellite, we assume no any additional information is needed for location-based measurement configuration for serving cell in earth-moving cell case. |
| Xiaomi | Yes |  |
| Panasonic | Agree | Yes, like NR-NTN. A reference location still needs to be added to SIB31 – see our reply to Q10 below, as well (or his this been agreed already?). |
| Lenovo | See comments | Can accept to have this with the clarification information. But even for NR NTN the derivation for moving cell reference location has not decided. |
| InterDigital | Agree |  |
| Huawei, HiSilicon | Agree |  |
| MediaTek | Agree |  |

2. For earth-moving cell, new IE is introduced to indicate the reference location of serving cell.

* No need to check this (broadcast of serving cell reference location for earth-moving cell has already been agreed also for IoT-NTN, and clearly this will be a new IE)

3. For cell (re)selection in earth-moving system, a distance threshold is introduced for location-based measurement initiation, which reuses distanceThresh in SIB19.

* Check offline if “distanceThresh in SIB19” can also be used for IoT-NTN

1. **Should SIB31 be extended to include distanceThresh?**

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| --- | --- | --- |
| Company | Agree/Disagree | Detail comments |
| Samsung | Agree |  |
| Apple | Agree |  |
| ZTE | Disagree | For IoT NTN, anyway we need to define a brand new location-based measurement configuration for serving cell. Within this location-based measurement configuration, a distance threshold parameter is needed.  We prefer to put this location-based measurement configuration in SIB3/SIB3-NB, e.g., at the same place as *t-Service* of serving cell.  This location-based measurement configuration can be defined with CHOICE type which can be used for either earth-fixed cell case or earth-moving cell case. |
| Xiaomi | Disagree | See our comment to Q8 |
| Panasonic | Agree | Besides *distanceTresh-r18* SIB31 shall also feature *referenceLocation-r18* (or has this been agreed already?). Once again, we see no reason for a concept deviating from NR-NTN here. |
| Lenovo | Agree |  |
| InterDigital | Agree |  |
| Huawei, HiSilicon | Disagree | This is a bit tricky, because the ephemeris and epochTime are in SIB31, while the parameters for measurement initiation (at least the R17 RSRP based parameters) are in SIB3. SIB31 is updated based on validity timer while SIB3 relies on legacy SI modification procedure.  Since the threshold will be used for both measurement initiation in RRC\_CONNECTED and RRC\_IDLE, maybe SIB3 is a better solution. |
| MediaTek | Agree |  |

4. For cell (re)selection in earth-moving system, time-based measurement initiation is used to address feeder-link switch case.

* Check offline if this can be extended to IoT NTN

1. **For cell (re)selection in earth-moving system, time-based measurement initiation is used to address feeder-link switch case.**

|  |  |  |
| --- | --- | --- |
| Company | Agree/Disagree | Detail comments |
| Samsung | Disagree | This we think IoT NTN needs to think a bit more about. |
| Apple | Agree |  |
| ZTE | Disagree | This is a new topic for IoT NTN. We agree with Samsung that more check is needed. We can discuss this issue in next meeting. |
| Xiaomi | Disagree | It is out of WI scope. Byt we are ok to keep this FFS |
| Panasonic | Agree | We see no reason for deviating from NR-NTN here. |
| Lenovo | See comments | We need to decide how to indicate feeder link switch time first. |
| InterDigital | Postpone | Agree with others that we can consider this further in the next meeting. |
| Huawei, HiSilicon | Agree |  |
| MediaTek | Agree |  |

# Conclusion

[to be updated]

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