3GPP TSG-RAN WG2 Meeting #118-e ***R2-220wxyz***

Electronic Meeting, May 9–20, 2022

**Agenda item: 6.1.4**

**Source: MediaTek**

**Title: [AT118-e][033][MBS] UE capabilities (MediaTek)**

**Document for:**  **Discussion**

# 1. Introduction

This paper is to trigger the part 2 discussion of the following email discussion of UE capabilities in MBS:

* [AT118-e][033][MBS] UE capabilites (MediaTek)

Scope: Part 1 Treat [R2-2204625](file:///C:\Users\mtk65284\Documents\3GPP\tsg_ran\WG2_RL2\TSGR2_118-e\Docs\R2-2204625.zip), [R2-2204907](file:///C:\Users\mtk65284\Documents\3GPP\tsg_ran\WG2_RL2\TSGR2_118-e\Docs\R2-2204907.zip), [R2-2205541](file:///C:\Users\mtk65284\Documents\3GPP\tsg_ran\WG2_RL2\TSGR2_118-e\Docs\R2-2205541.zip), [R2-2205746](file:///C:\Users\mtk65284\Documents\3GPP\tsg_ran\WG2_RL2\TSGR2_118-e\Docs\R2-2205746.zip), [R2-2205750](file:///C:\Users\mtk65284\Documents\3GPP\tsg_ran\WG2_RL2\TSGR2_118-e\Docs\R2-2205750.zip), [R2-2205855](file:///C:\Users\mtk65284\Documents\3GPP\tsg_ran\WG2_RL2\TSGR2_118-e\Docs\R2-2205855.zip), [R2-2205939](file:///C:\Users\mtk65284\Documents\3GPP\tsg_ran\WG2_RL2\TSGR2_118-e\Docs\R2-2205939.zip), [R2-2206114](file:///C:\Users\mtk65284\Documents\3GPP\tsg_ran\WG2_RL2\TSGR2_118-e\Docs\R2-2206114.zip). Collect one round of comments, pave the way for on-line agreement (identify agreeable points, discussion points), Part 2, draft CRs (for merge w mega CRs)

Intended outcome: Report, endorsed Draft CRs (for merge)

Deadline: Part 1 CB W1 Thu, CB W2 Tue, Part 2: EOM (no post disc)

## 1.2 Background

The discussion was taken online based on the P4 within the summary of R2-2206405 for non serving cell based broadcast reception (see Annex). The discussion minutes is as below:

*P4*

* *Huawei think we may need to specify a UE capability in any case. Huawei think MII would be used in this case.*
* *QC think this capability is needed. QC thought the network should know this.*
* *Ericsson think that the network would not know what to do.*
* *MTK agrees that this does not need network support, no MII signalling, or other signalling. May bring lots of new discussion.*
* *LGE think this capability is as for LTE, think that the network should configure a Scell for the UE.*
* *Chair: think there might be some confusion about what is allowed to be indicated in the MII.Nokia wonder what is the intention whith this capability.*

*Chair think the following is a source of confusion:*

1. *Assumption: A UE that need support (or may need support) from the network to receive Bcast in connected is assumed to use MII, and for such reception we assume there are UE cap.*
2. *Assumption: There may be UEs that need no support from the network to receive Bcast in connected and will not use the MII, and for such reception there is no need for UE caps.*

* *Huawei think we are discussing Assumption 1, i.e. that the network need to refrain from using certain configuration for connected mode configuration to allow UE to receive Bcast. e.g. that non-serving cell reception can only work for certain Band-combination configurations in connected.*
* *MTK think then the discussion may become difficult, Our previous assumption was that for R17, UEs with separate MBS receiver can receive MBS on non-serving cell, i.e. that we only support non-serving cell Bcast reception following assumption 2.*

*Chair: P4: continue discussion. Now there is a lot of support for the Huawei view, so lets continue the discussion along those lines, to see if something sufficiently simple can be found. it seems we need to both discuss Cap and MII. If too complex, we can revert to that Bcast reception on non-serving cell is only support acc to assumption 2 above.*

# 2. Discussion

## 2.1 Implementation based broadcast reception on non-serving cell

According to the RAN1 agreement, the broadcast reception on non-serving cell is up to UE implementation and transparent to the network.

Agreement (RAN1#107-e meeting):

From RAN1 perspective, it is feasible for UE in RRC\_CONNECTED state to receive MBS broadcast on non-serving cell, which is up to UE implementation and transparent to the network.

·It is assumed in RAN1 that UE receiving MBS broadcast on non-serving cell does not have any impact to operation on serving cell(s), e.g., does not require UE to obtain the related configuration from the serving cell, does not require the network to guarantee the scheduling doesn’t exceed UE’s capability on serving cell, etc.

·RAN1 assumes that receiving MBS broadcast on non-serving cell could be on the same or on a different band, but on a different carrier frequency than a UE’s serving cell

·No RAN1 spec impact and no optimization is pursued in Rel-17 for MBS broadcast reception on non-serving cell.

·The UE capability(ies), if any, is(are) expected to be defined by RAN2.

Following the discussion at RAN1, the likely scenario is that the UE performs the broadcast reception on non-serving cell without any notification to the network (neither capability indication or MII indication). In this manner, the network will not know if the UE performs the broadcast reception on non-serving cell. The network will not configure such cell as UE’s SCell (which resolves the concerns made by the company during online discussion). The rapporteur thinks this is feasible solution since MII is anyway not mandatory report from the UE. This is pure UE implementation behaviour.

The benefit of this implementation based broadcast reception on non-serving cell is that there are lots of flexibility for the UE. For example, the UE may refrain from receiving the broadcast service on non-serving cell, when the network schedules it to receive unicast via serving cell(s), in order to ensure the reception performance of serving cell(s). This means that the broadcast reception on non-serving cell may be a best efforts behaviour and not prioritized. In another example, the UE may prioritize receiving the broadcast service on non-serving cell over unicast via serving cell(s). In this case, some legacy UE capability change procedure may be triggered to notify the network to downgrade the scheduling. In summary the UE operation may be transparent to the network and lots of flexibility is allowed.

Then there is an observation like below:

**Observation 1: UE implementation based broadcast reception on non-serving cell provides UE lots of flexibility and is transparent to the network.**

#### Question 1: Do companies agree that UE implementation based broadcast reception on non-serving cell provides UE lots of flexibility and is transparent to the network.?

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| **Company** | **Answer (Yes/No)** | **Comments** |
| Qualcomm | No | It is better to indicate UE capability as explained in last phase and in Q3 below for full network flexibility. |
| Ericsson | Yes | We are of course fine to support this option, i.e. when the UE supports BC on non-serving cell(s), the UE does not signal MII/MBS capability (i.e. no NW action), and reception is left to UE implementation.  But we have a question for clarification: currently the UE can indicate in MII message to be interested to receive BC on a frequency where no serving cell is configured. This then implies that the NW has to configure an SCell on that frequency to enable the BC reception, correct?  PS: we did not understand the second example provided by the rapporteur above: in our understanding the UE cannot change UE capability while in connected mode, and the UE has to fullfill the PDCCH unicast monitoring requirements on serving cells (when it prioritizes BC on non-serving cell). |
| Intel | No | Defining UE capability is helpful to provide gNB configuration flexibility. |
| CATT | No | Same comments as Q5 in Annex |
| Huawei, HiSilicon | No | It is actually the opposite – it gives no flexibility at all. If we assume the UE can receive MBS on non-serving cell regardless of its configuration, it means such UE needs to have a completely separate hardware for MBS, which brings the cost of the UE up, but not sure how it gives any flexibility. If there is a capability, then the UE may share its unicast hardware with MBS broadcast (TRX, baseband) by implicitly requesting the network to adjust the UE’s configuration, which is the flexibility we should aim for. If the UE is equipped with a separate hardware for MBS broadcast, then the only additional impact on UE implementation would be to signal this capability to the network which is a minor thing. |
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## 2.2 Capability based broadcast reception on non-serving cell

The broadcast reception on non-serving cell was discussed for LTE eMBMS. Both *mbms-NonServingCell-r11* and *scptm-NonServingCell-r13* were introduced to indicate whether the UE in RRC\_CONNECTED supports MBMS or SC-PTM reception on a frequency indicated in an MII message.

**mbms-NonServingCell**

This parameter defines whether the UE in RRC\_CONNECTED supports MBMS reception via MBSFN on a frequency indicated in an *MBMSInterestIndication* message, where (according to *supportedBandCombination* and to network synchronization properties) a serving cell may be additionally configured, as specified in TS 36.331 [5]. If this is supported, the UE shall also support MBMS reception via MBSFN on a frequency when an SCell is configured on that frequency (regardless of whether the SCell is activated or deactivated), as specified in TS 36.331 [5].

**scptm-NonServingCell-r13**

This parameter defines whether UEs supporting SC-PTM support in RRC\_CONNECTED, MBMS reception via SC-PTM on a frequency indicated in an MBMSInterestIndication message, where (according to supportedBandCombination and to network synchronization properties) a serving cell may be additionally configured, as specified in TS 36.331 [5]. If this is supported, the UE shall also support MBMS reception via SC-PTM on a frequency when an SCell is configured on that frequency (regardless of whether the SCell is activated or deactivated), as specified in TS 36.331 [5].

It should be highlighted that the introduction of *mbms-NonServingCell-r11* and *scptm-NonServingCell-r13* isused toindicate to the network that no SCell needs to be configured to perform broadcast reception in a particular frequency, since *mbms-NonServingCell-r11* and *scptm-NonServingCell-r13* are actually an additional UE capability on top of *mbms-SCell-r11/scptm-SCell-r13*.

However it would be also important to highlight that for LTE eMBMS/SC-PTM, both *mbms-NonServingCell-r11* and *scptm-NonServingCell-r13* were defined per UE, not per BC/per frequency.

For LTE eMBMS/SC-PTM, based on UE capability report and MII, the network will know the UE capability and its willingness to receive the broadcast service on non-serving cell. Some companies think that it would be helpful for the network to know if there is a need to configure SCell based broadcast reception for the UE on the specific frequency to enable such broadcast reception.

It should be noted that the with the existing LTE eMBMS/SC-PTM capability based broadcast reception on non-serving cell, there is an issue when multiple frequencies are report via MII, since the UE never knows which is appliable to the non-serving cell based on broadcast reception. For example, there are three frequencies reported (F1, F2 and F3). But actually UE only supports non-serving cell based on broadcast reception over F3. With NR MBS definition, only one frequency can be enabled for broadcast reception, then only F1 is selected as the broadcast configuration for the UE according to the priority order. If the network assume F1’s broadcast service can be received by the UE in non-serving cell manner. This may not the correct configuration, since UE only supports non-serving cell based on broadcast reception over F3. In rapporteur understanding, the existing LTE eMBMS/SC-PTM capability based broadcast reception on non-serving cell may need to improve for NR MBS.

**Observation 2: the existing LTE eMBMS/SC-PTM capability based broadcast reception on non-serving cell may need to improve for NR MBS.**

With regards to the improvement, one way can be to limit the UE MII report for non-serving cell based broadcast reception. For example, when the UE indicates the capability to perform non-serving cell based broadcast reception, the UE can only report one frequency to enable network to avoid unnecessary SCell configuration. The shortage is that when such restriction is set, the UE can only always report one frequency if non-serving cell based broadcast reception capability is reported.

#### Question 2: Do companies agree that the existing LTE eMBMS/SC-PTM capability based broadcast reception on non-serving cell may need to improve for NR MBS?

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| **Company** | **Answer (Yes/No)** | **Comments** |
| Qualcomm | Yes | See answer to Q3 |
| Ericsson | See comments | In the CR that introduced these capabilities in LTE ([RP-141028](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_64/Docs/RP-141028.zip)) it is explained that this concerns IOT testing:  Capability bits are introduced for indicating if the UE has implemented and was tested for   * MBMS reception on an SCell when the UE is configured with CA * MBMS reception on a cell that is not configured as an SCell   In our understanding we are not talking about IOT issues here. We assume that the UE has properly tested the feature when it indicates the preference to receive BC on serving/non-serving cell frequencies in the MII message.  We also assume that the MII and UE capability signalling are aligned, i.e. when the UE indicates to be interested to receive BC on a serving cell frequency, then the UE also indicates to support ***Broadcast-Scell***. We would be happy to understand better what the capability signalling adds to the MII signalling? The capability info can be present early during connection setup when UE comes for Inactive mode, but we are not sure how the capability is used, i.e. the capability only indicates generally what the UE is capable of, not specifically what the UE is currently interested in.  In case we introduce the LTE capability, what does it mean when the UE signals it: the NW can configure SCell on the non-serving cell frequency, but is not required to do so to enable BC reception on that frequency? It is not clear what "willingness to receive the broadcast service on non-serving cell" exactly means. Capability should be about capability and not preference/willingness…? |
| Intel | Maybe | We’re OK with per UE capability as in LTE. If most companies prefer to have finer granularity, per FSPC capability (similar to *broadcastSCell-r17*) is also fine to us. |
| CATT | Maybe | Same view as intel |
| Huawei, HiSilicon |  | If what is meant by “improve” is to specify it per BC or FSPC, then we agree.The current procedures allow the UE to receive on multiple frequencies if its capabilities allow it to do so. In MII the UE only signals multiple frequencies in case it can receive on all of them simultaneously. The Scell and non-serving cell reception capabilities are an additional information to the network about what kind of cell the UE can accept (i.e. either PCell or Scell or non-serving cell can be used). |
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## 2.3 Way forward

There are several alternative ways to consider on the issue.

Alternative 1: adopt the UE implementation based broadcast reception on non-serving cell as explained in section 2.1.

Alternative 2: adopt the existing LTE eMBMS/SC-PTM capability based broadcast reception on non-serving cell as explained in section 2.2.

Alternative 3: Enhanced capability based broadcast reception on non-serving cell using LTE eMBMS/SC-PTM soluiton as baseline. (please specify your preferred enhancement if any)

#### Question 2: Which alternative do you prefer for the way forward of broadcast reception on non-serving cell for NR MBS?

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| **Company** | **Answer (Alt1/2/3)** | **Comments** |
| Qualcomm | 2/3 | We think UE capability is needed and beneficial for network. For example, if a UE is indicating support of certain CC for bcast reception as SCell (using broadcast-SCell-r17) and there is no other capability, then netowk does not know whether the UE supports reception using non-serving cell mode. However, if UE also indicates support of the same CC for bcast reception via non-serving cell mode, and MII indicates the interested frequency for that CC, then it gives the network full flexibility to make the decision on whether to configure the particular CC as SCell solely for the purpose of reception of bcast by the particular UE, or just provide the service in non-serving-cell mode.  The capability can be similar to broadcast-SCell-r17, i.e. FSPC. This way, the network knows which frequencies can be used for providing broadcast service via non-Serving Cell.  38.331:  FeatureSetDownlinkPerCC-v1700 ::= SEQUENCE {  supportedMinBandwidthDL-r17 SupportedBandwidth-v1700 OPTIONAL,  broadcastSCell-r17 ENUMERATED {supported} OPTIONAL,  broadcastNonServingCell-r17 ENUMERATED {supported} OPTIONAL  }  38.306:   | ***broadcastNonServingCell-r17***  Indicates whether the UE supports MBS reception via broadcast without being configured as a serving cell in RRC\_CONNECTED on this component carrier. | FSPC | No | No | No | | --- | --- | --- | --- | --- | |
| Ericsson | Alt 1, see comments | Proponents argue that this capability adds flexibility to the NW, but why would the NW configure SCell, needed for BC only, when the UE can receive BC via non-serving cell mode? In case the SCell is not needed for unicast, it would add to the NW power consumption. An the UE only supports BC reception on one SCell frequency, i.e. SCell configuration limits the number of simultaneous receptions in the UE? |
| Intel | Alt 2 or 3 | We’re OK with per UE capability as in LTE. If most companies prefer to have finer granularity, per FSPC capability (similar to *broadcastSCell-r17*) is also fine to us. |
| CATT | Alt 2 or 3 |  |
| Huawei, HiSilicon | Alt. 2/3 | As mentioned above, the only improvement that is needed is to specify the capability per BC or per FSCC. Other than that, nothing more is needed. Also, please note that the only difference between Alt. 1 and Alt. 3 is the additional capability signalling, which is a simple thing. Also, if the UE can always receive MBS, regardless of the configuration used for unicast, then there is no need for any MBS related signalling from such UE (neither MII nor capability). But since we specify it all, probably we believe that there will be not many such super-UEs produced.  However, in case companies believe such UEs can be implemented in real life, then we propose the following way forward in order to support both types of UEs (such that require network assistance and such that do not):   * + - 1. We introduce a capability signaling for non-serving cell reception of MBS broadcast.       2. At the same time, we add a note in 38.331/38.306 that if a UE supports non-serving cell reception regardless of its unicast configuration (e.g. it has a separate hardware for MBS broadcast), then such a UE does not have to provide MII nor MBS broadcast capabilities to the network (as it will never require any network assistance). |
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# 3. Final Summary and Proposal

Based on the email discussion, the following proposals are made for MBS UE capbility:

**TBD**

# 4. Reference

[1] R2-2206405 Summary of [AT118e] [033] R17 MBS UE capabilities (MediaTek)

# 5. Annex: Part I discussion on Broadcast reception on non-serving cell (R2-2206405)

## 2.2 Broadcast reception on non-serving cell

According to the contributions submited, some companies suggest to introduce UE capability for Broadcast reception via non-serving cell. However, at meeting RAN2#117e, there was a discussion on whether it is optional (with UE capabilities) to support the broadcast reception on non-serving cell, and majorities agree that the reception in non-serving cell can be fully up to UE implementation without spec change. Rapporteur would like to check again if this is the majority views.

#### Question 5: Do companies agree to that the reception in non-serving cell can be fully up to UE implementation without spec change?

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| **Company** | **Answer (Yes/No)** | **Comments** |
| Ericsson | Yes | Capability signalling can indicate if the UE is capable to receive MBS broadcast via non-serving cell, but does not indicate if the UE currently wants to receive MBS via non-serving cell, nor which service the UE is interested in.  Furthermore the expected NW actions are not clear to us, i.e. in our understanding MII signalling + SCell capability can be used to configure SCell. What use case is missing? |
| Huawei, HiSilicon | No | Question is rather unclear. Obviously, the reception on non-serving cell is up to UE implementation. The main point for introducing the capability signalling is to let the network know that the UE can receive a service on a non-serving cell so that the UE does not have to be configured with a PCell or an SCell on this frequency. Without the capability signalling, even if the UE supports reception on non-serving cell, the network will have to configure a serving cell which makes the feature rather useless. We are not sure what the issue with introducing the capability signalling is. And of course the network needs to consider MII together with UE capabilities.  @Ericsson: The case you are missing is, e.g. MII + non-serving cell reception capability means that the network does not have to configure SCell. |
| Samsung | Yes |  |
| CATT | No | Agree with Huawei that capability signalling on non-serving cell is necessary,same as in LTE SC-PTM. |
| Qualcomm | No | We also think question is unclear/confusing. We assume the question is about capability, so there is impact – to introduce the UE capability.  As per RAN1 discussions, Broadcast UEs can receive Broadcast service via non-serving cell and is based on UE capability. R17 UEs supporting Broadcast service reception via non-serving cell has to be based on capability because depending on UEs interested broadcast service reported via MBS Interest Indication and UE’s indicated capability on broadcast service reception on non-serving cell, network can decide whether to configure a specific frequency as SCell or not. I.e., no other spec impact. |
| Nokia | Yes | UE is allowed to receive MBS from any cell as long as it does not interfere specified UE behaviour. |
| OPPO | Yes |  |
| Xiaomi | No | We share the same view with Huawei and Qualcomm. |
| MediaTek | Yes | According to the agreement of RAN2:   * If supported by the UE implementation, the idle/inactive UE may receive MBS broadcast service from non-serving cell (no network impact).   It is assumed the UE receiving non-serving cell is fully up to UE implementation. In that case, UE receives broadcast service as idle/inactive UE without signaling, and network is not aware of the existence of UE.  If we introduce capability signling, it is not only the UE’s behavior, but also with network impact, and extra MII reporting/scell receiving may be introduced. This go against with the previous RAN2 agreement.  Any enhancement of broadcast reception on non-serving cell can be discussed in Rel-18. |
| Intel | See comments | Whilte MBS reception on non-serving cell is up to UE implementation, the capability signalling is needed so that gNB can configure CA/DC properly. This is similar to LTE, which defined these capabilities: *mbms-NonServingCell-r11*, and *scptm-NonServingCell-r13*. |
| vivo | No | We agree with Qualcomm. |
| Spreadtrum | No | We agree with Qualcomm. |
| Futurewei | Yes | In the scenario that there is broadcast service already existing on the cells of the coverage and the UE is capable to listen the broadcast service at a neighboring non-serving cell. The UE can go ahead to listen the service by itself. This is purely depending on the implemented UE capability. No spec enhancement is needed. The network would decide the broadcast coverage based on other factors such as user density rather than UE capability on SCell broadcast reception. |
| Lenovo | Yes | The UE receiving non-serving cell is fully up to UE implementation. |
| LGE | See comments | The reception in non-serving cell is up to UE implementation, which is already clear.  If we are discussing the capability similar to *mbms-NonServingCell-r11 and scptm-NonServingCell-r13 for LTE, we think such capability is beneficial because network can decide whether to configure SCell necessarily or not on the frequency of UE’s interest based on the capability.* At the same time, it may be good to clarify the difference w.r.t. UE capabilities between case A and B, where   * Case A: For MBS reception on a frequency, SCell shal be configured on that freuqency, * Case B: For MBS reception on a frequency, SCell does not have to be configured on that frequency. |
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Summary :

According to the comments, there are diverse views on the broadcast reception on non-serving cell. Some companies think UE receiving broadcast via non-serving cell should be fully up to UE without network impact. While other companies think the network may not configure UE a non-serving cell without capability signaling, meanwhile UE may need to indicate the interest service to network via MII for better scheduling.

From the rapporteur’s understanding, the previous RAN2 agreements shows that the supporting of non-serving cell reception should be a UE’s behavior without network impact. In that case, the UE’s behavior is like broadcast reception in idle/inactive state without signling interaction (it is confirmed that UE can receive broadcast service without notifying the network). Network should not be aware of the existence of UE, and any optimization is not needed. Otherwise, it may bring impact to the current receiving, which will raise extra discussion.

Consider the time limit and the WI is already in Rel-18, Rapporteur would like to suggest to keep the agreement in RAN2#116e and not pursue further enhancement.

**Proposal 4: No additional specification work in RAN2 to support broadcast reception on non-serving cell. The agreement of RAN2#116e is kept.**

If supported by the UE implementation, the idle/inactive UE may receive MBS broadcast service from non-serving cell (no network impact).