**3GPP TSG RAN Meeting #90e RP-20xxxx**

**Electronic Meeting, December 7 – 11, 2020**

**Agenda item:** 10.4

**Source:** Moderator (AT&T)

**Title:** Moderator's summary for email discussion [90E][37][MBMS\_flexible\_BW]

**Document for:** Discussion

# Introduction

In this document, we will provide a summary for the email discussion on MBMS flexible bandwidth for Rel-16 LTE at RAN#90-e.

# Topic #1: MBMS flexible bandwidth

## Proposed objectives

Topic #1 will capture the outcome of the discussions on the following documents:

1) RP-202793 [1] containing a discussion paper on support of flexible bandwidth for MBMS

2) RP-202412 [2] containing a TS 36.213 Cat-F Rel-16 CR on Flexible bandwidth for MBMS

3) RP-202413 [3] containing a TS 36.331 Cat-F Rel-16 CR on Flexible bandwidth for MBMS.

## Initial round

### Open issues

The following summarizes the key proposal listed in [1].

**Proposal 1: Allow configuring PMCH bandwidth larger than the system bandwidth indicated by MIB. The following PMCH bandwidth values are supported for** $N\_{RB}^{DL}=25$ **:**

* **8MHz:** $N\_{PRB}=40$
* **7MHz:** $N\_{PRB}=35$
* **6MHz:** $N\_{PRB}=30$

### Companies views’ collection

Issue 1: Is Proposal 1 from RP-202793 agreeable?

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| **Company** | **Comments** |
| Qualcomm | We support the CR and proposals as is. We also note the large number of supporting companies from all parts of the broadcasting ecosystem and others. This is an important corrections to ensure 3GPP technologies can proliferate in this vertical |
| EBU | We support the proposal and the associated CRs as they are. The proposal adds an important element to finish off the specification of LTE based 5G terrestrial broadcast (EnTV) which is a prerequisite for successful deployment of this technology for the broadcast vertical. |
| Rohde & Schwarz GmbH | We definitely support the proposal and the associated CRs as they are. The proposal helps finish off the specification of LTE based 5G terrestrial broadcast (EnTV) and enable a prerequisite for successful deployment of this technology for the broadcast vertical. It is highly needed to start commercial deployments. |
| Saankhya Labs | We support the CR and the proposal |
| MediaTek | No. we think the proposal itself is not a small change or simple correction for LTE Rel-16, which has already been technically frozen. In general, there should be a need to take some RAN work group level study (e.g. at RAN1, RAN2 and RAN4) to evaluate the technical requirement and the details of the candidate solutions. On top of that, we may know the feasibility for the flexible bandwidth in context of LTE MBMS operation. |
| IRT | We strongly support the CR and proposals as is. |
| Deutsche Telekom | We do not think that this proposal for Rel-16 should be approved, as Rel-16 is already frozen since a long time. We also do not see any clear motivation for any ongoing release.  |
| Digital Catapult | We support the proposal and the associated CRs. This is an important addition to provide more spectrum options for dynamic broadcast services.  |
| Panasonic | Although Release 16 is frozen, in order to address strong need from the broadcast vertical, our view is the proposal provides the minimized modification to fully utilize 6, 7, 8 MHz band usage for broadcast content (EnTV) as PMCH in order to enable good co-existence with DVB-T2/T, ISDB-T, ATSC 1.0/3.0, ... and 5G Broadcast in UHF. Therefore, we support the proposal. |
| Reliance Jio | We support the Proposal and the associated CRs as it is. |
| TDF | We support the CR and proposal as is. The proposal is an important element towards deploying LTE based 5G terrestrial broadcast (EnTV) technology in the future.  |
| SyncTechno Inc. | We strongly support the CR as well as the proposal. |
| Fraunhofer | We support the proposal and the CRs Potential RAN4 impact should be checked, e.g. for UE/eNB requirements and for coexistence scenarios with DVB-T(2). |
| OneMedia | We support the proposal and the associated CRs. |
| IIT Bombay | We support the proposal and the CR |
| ESA | We support the proposal and the CR |
| ATEME | We support proposal as is.  |
| VTT | We support the proposal and associated CRs. We see the motivation here to support flexibly the terrestrial UHF broadcast and DVB-T/T2 scenarios with MBMS. However, some coexistence scenarios and requirements should be further evaluated also for future use cases.  |
| ORANGE | We oppose to the approval of the CRs as Rel16 is already frozen. The nature of the proposal is not a correction of the Rel16 spec but a more fundamental change that should be discussed as part of a proper WI in Rel17. Besides, as the proposal defines new bandwidths, RAN4 work is also needed. |
| Facebook | We support the proposal and the CR |
| Samsung | We are not supportive of the proposal and the CRThe proposal is not an essential correction but an addition of new functionality. Rel-16 was already frozen and this kind of proposal should be avoided because there is impact on implementation not only at the UE side but also at the base station side. |
| vivo | We are supportive of the proposal and CR.  |
| ABS | We support the CR and proposals as is. We are thinking to make use of 3GPP Release 16 enTV for mobile TV which will be deployed nationwide as a standalone HPHT network running in UHF band. We think the proposal to utilize 6, 7, 8 MHz band for standalone HPHT broadcast have minimal modification to Release 16.  |
| Huawei/HiSilicon | We share similar view with MediaTek, DT and some other companies in that this proposal is not agreeable. Flexible bandwidth is not in the scope of Rel-16 SI/WI on LTE-based 5G Terrestrial Broadcast（EN-TV), and the proposed CRs are to add new function to Rel-16 instead of to correct an existing Rel-16 function. As Rel-16 has been frozen already, it is not proper to add such kind of CRs. |
| ABP | We support the proposal and associated CRs. This proposal provides a minimized modification but enable co-existence with DTT systems such as DTMB with 8 MHz bandwidth in UHF band in China, which is the key for successful deployment. We see clear and strong motivations of many broadcasters and media companies from different countries, finish off the specification of LTE based 5G terrestrial broadcast by adding flexible bandwidth will make this feature truly enable the broadcast vertical. |
| Telecom Italia | We do not agree with the proposal. While we understand the requirement, the proposal introduces a new feature and new bands. It is not a simple correction and cannot be simply added to a closed Release. |
| Xiaomi | We consider that a cross-working group TEI could be used if extending the bandwidth for 6/7/8 MHz band are urgent commercial requirements. The changes are based on the LTE ENTV solution. We need more discussions in specific RAN working groups. RAN1 could discuss whether the bandwidth for PMCH can be extended with/without extending the bandwidth for the PDCCH/PDSCH. RAN2 can discuss the UE capabilities and the signaling designs to ensure backward compatibility, or even forward compatibility when the bandwidth for the PDCCH/PDSCH is not extended according to the CRs, but could be extended in the future release. RAN4 can discuss the performance requirements.  |
| Intel | Although the RAN1/2 spec changes appear to be quite simple, these changes have not been seen by the WGs. Even if the general principle is agreeable in RAN we wonder whether it would be preferable for the CRs to be looked at more carefully by the WGs (e.g. after receiving an endorsement from RAN). We are ok with RAN to endorse the proposal and task RAN1/2 WGs to double check the detailed CRs.In addition, we note that the proposal aims to enable 6, 7, 8 MHz CBW for MBMS from RAN1/2 perspectives. Meantime, the support of these CBW is not possible from RAN4 perspective and further clarifications are needed. Do we correctly understand that there are no plans to introduce new CBW for BS/UE at this moment of time? If so, we propose to clarify that BS and UE can use 10MHz CBW and no new RF requirements will be introduced in Rel-16.  |
| Shanghai Jiao Tong University | We support the proposal and the associated CRs.  |
| Apple | This proposal does not look like a minor change because it effectively a) introduces new channel bandwidths, and b) introduces a new concept when the channel is larger when compared to what is broadcast in the system information. We acknowledge the fact that there are companies willing to make LTE operation more flexible, but things should be done in accordance with what the WI initial objectives are. Were these enhancements discussed in RAN4 and/or did the proponents submit the technical analysis showing that there is no RAN4 related impact? The feasibility of these concepts should be studied and checked by RAN4. |
| Ericsson | We support the introduction of these bandwidths, but we think technical expertise in the working groups should review the CRs. Is it urgent to get this specified now, or can it wait for Rel-17? It is not a correction to Rel-16, but rather adding a new feature.Further questions:1. Does this feature require network signalling support? I.e., does this need to be signalled from the MME to the MCE and from the MCE to the eNB? If so, M2AP and M3AP CRs will be needed (with RAN3 impact).2. Is there a need to develop some requirements in RAN4? |

Issue 2: Is TS 36.213 Cat-F Rel-16 CR RP-202412 agreeable?

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| **Company** | **Comments** |
| Qualcomm | Same as above. The CRs are agreeable |
| EBU | Yes, see issue 1 |
| Rohde & Schwarz GmbH | CRs are agreeable. See issue 1 |
| Saankhya Labs | Support the CR. |
| MediaTek | No |
| IRT | The CRs are agreeable, see issue 1. |
| Deutsche Telekom | We do not see an urgent need that this CR should be approved, as Rel-16 is already frozen since a long time.  |
| Digital Catapult | CRs are agreeable. See issue 1 |
| Panasonic | Yes, agreeable – as the logical consequence of issue 1 above. |
| Reliance Jio | Agreeable, we support the CRs as it is.  |
| TDF | The CRs are agreeable, see issue 1. |
| SyncTechno Inc. | Yes, CRs are agreeable. |
| Fraunhofer  | We support the CR |
| OneMedia | We support the CR |
| IIT Bombay | We support the CR |
| ESA | We support the CR |
| ATEME | The CRs are agreeable, see issue 1. |
| VTT | We support the CR as is, see issue 1 |
| ORANGE | The CRs are not agreeable as explained in Issue 1.  |
| Facebook | We support the CR |
| Samsung | No supportThis seems not Cat-F but Cat-B which should be avoided at this very late stage.Works on RAN1 and RAN2 are marginal as compared to RAN4 work, but the proposal does not say anything about RAN4 work. |
| vivo | We are supportive of the proposal and CR.  |
| ABS | We support the CR. |
| Huawei/HiSilicon | Not support, see reason in issue 1 |
| ABP | The CRs are agreeable, see issue 1. |
| Telecom Italia | The CR is not agreeable (see 1) |
| Xiaomi | See comments in Issue 1. |
| Intel | Same comments as for Issue 1 |
| Shanghai Jiao Tong University | We support the CR. |
| Apple | See comments for issue 1 |
| Ericsson | The CR seems technically correct, however, technical experts in RAN1 should have a look. |

Issue 3: Is TS 36.331 Cat-F Rel-16 CR RP-202413 agreeable?

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| **Company** | **Comments** |
| Qualcomm | Same as above. The CRs are agreeable |
| EBU | Yes, see issue 1 |
| Rohde & Schwarz GmbH | CRs are agreeable. See issue 1 |
| Saankhya Labs | Support the CR |
| MediaTek | No |
| IRT | The CRs are agreeable, see issue 1. |
| Deutsche Telekom | We do not see an urgent need that this CR should be approved, as Rel-16 is already frozen since a long time.  |
| Digital Catapult | CRs are agreeable. See issue 1 |
| Panasonic | Yes, agreeable – as the logical consequence of issue 1 above. |
| Reliance Jio | Agreeable, we support the CRs as it is. |
| TDF | The CRs are agreeable, see issue 1. |
| SyncTechno Inc. | Yes, CRs are agreeable. |
| Fraunhofer  | We support the CR |
| OneMedia | We support the CR |
| IIT Bombay | We support the CR |
| ESA | We support the CR |
| ATEME | The CRs are agreeable, see issue 1. |
| VTT | We support the CR as is, see issue 1 |
| ORANGE | The CRs are not agreeable as explained in Issue 1.  |
| Facebook  | We support the CR |
| Samsung | No supportThis is not Cat-F but Cat-B which should be avoided at this very late stage.Works on RAN1 and RAN2 are marginal as compared to RAN4 work, but the proposal does not say anything about RAN4 work. |
| vivo | We are supportive of the proposal and CR.  |
| ABS | We support the CR. |
| Huawei/HiSilicon | Not support, see reason in issue 1 |
| ABP | The CRs are agreeable, see issue 1. |
| Telecom Italia | The CR is not agreeable (see 1) |
| Xiaomi | See comments in Issue 1. |
| Intel | Same comments as for Issue 1 |
| Shanghai Jiao Tong University | We support the CR. |
| Apple | See our comments for issue 1 |
| Ericsson | We would like RAN2 to have a look at this CR. We have the following questions:1. It seems E-UTRAN includes this field when dl-bandwidth is set to n25. Thus, we wonder how to signal n25 with this new CR implemented? 2. Is there a way (or a need) to prevent UEs not supporting the new BWs from accessing? |

### Summary and recommendation for further discussion

In this section, the summary of comments on Topic#1 and the corresponding recommendations are provided.

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|  | **Summary and recommendation** |
| **Issue 1** | Is Proposal 1 from RP-202793 agreeable?Yes: 21 companies (Qualcomm, EBU, Rohde & Schwarz GmbH, Saankhya Labs, IRT, Digital Catapult, Panasonic, Reliance Jio, TDF, SyncTechno Inc., Fraunhofer, OneMedia, IIT Bombay, ESA, ATEME, VTT, Facebook, vivo, ABS, ABP, Shanghai Jiao Tong University)Possible w/ understanding that details will be discussed at WG level as part of Rel-16 or Rel-17: 4 companies (Xiaomi, Intel, Apple, Ericsson)No: 7 companies (MediaTek, Deutsche Telekom, ORANGE, Samsung, Huawei, HiSilicon, Telecom Italia) |
| **Issue 2** | Is TS 36.213 Cat-F Rel-16 CR RP-202412 agreeable?Acceptance or rejection of the CR follows the feedback concerning Issue 1. Four (4) companies would prefer to see the WGs address the necessary changes. |
| **Issue 3** | Is TS 36.331 Cat-F Rel-16 CR RP-202413 agreeable?Acceptance or rejection of the CR follows the feedback concerning Issue 1. Four (4) companies would prefer to see the WGs address the necessary changes. |
|  | **Moderator Recommendation:**As the support level is high as noted by the feedback as well as the supporting companies on RP-202815 [4] (revision of RP-202793), it is suggested to continue discussions in the intermediate round to work towards a way forward that might eliminate the concerns raised by companies. As the scope of the change is limited to LTE-based 5G broadcast (PMCH channel), companies are encouraged to find a solution with minimal WG impact that will not result in any downscoping of existing WI/SIs. |

## Intermediate round

### Open issues

Please add the company views below referencing the following issue numbers along with your comments.

Issue 4-1: Would you support endorsing the addition of the MBMS flexible BW aspect and tasking the WGs (RAN1, RAN2, RAN3, and RAN4) to define the necessary specification changes under TEI in Rel-16?

Issue 4-2: Would you support endorsing the addition of the MBMS flexible BW aspect and tasking the WGs (RAN1, RAN2, and RAN3) to define the necessary specification changes under TEI in Rel-16 with the assumption that no additional RF requirements would be introduced in Rel-16?

Issue 4-3: Would you support endorsing the addition of the MBMS flexible BW aspect with a follow-on WI for LTE-based 5G Terrestrial Broadcast in Rel-17?

Issue 4-4: Are there any restrictions on use of MBMS flexible bandwidth that could alleviate concerns for objecting companies (broadcast spectrum only, etc.)?

Issue 4-5: Other views on possible way forward?

### Companies views’ collection

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| **Company** | **Comments** |
| Qualcomm | **Issue 4-1**: yes (also, related to Issue 1 above, we would like to note that the original submission, see RP-202210, had **30** supporting companies, a higher number than those that replied on the reflector – as per working procedures, cosigning the document should itself be considered an indication of support)**Issue 4-2**: yes**Issue 4-3**: strong preference to address this in Rel-16 given large support, lack of impact outside of this specific vertical and potential commercial opportunities; in any case, we think this is a small enough change that it can be conducted under TEI**Issue 4-4**: as per the proposed CRs, the change applies only to the PMCH channel AND it applies only to eMBMS in dedicated spectrum. This can be seen in the CR to TS 36.331 in RP-202413 (“*E-UTRAN includes this field only when the cell is a MBMS-dedicated cell*”). Hence this change does NOT apply to non-broadcast LTE and it does not apply to deployments where eMBMS shares spectrum with unicast services.We are open to other indications (in meeting minutes or similar) that this change applies only to LTE-Based 5G Broadcast in dedicated spectrum**Issue 4-5**: Our preference, also given the amount of support, is to approve these changes at this RAN Plenary meeting. If some companies are not ready to do so yet, we propose to endorse the proposal in RP-202210 and task RAN1, RAN2, RAN3 to review corresponding CRs accordingly in the next quarter. We also propose to agree that no new RAN4 requirements will be introduced for Rel-16.  |
| EBU | **Issue 4-1:** yes**Issue 4-2:** yes**Issue 4-3:** our strong preference is to include these changes in Rel-16. This would bring the EnTV WIs to completion as the requested bandwidths are an essential element needed for successfully deployment in due time. Broadcasters around the globe plan to deploy EnTV type networks using existing network infrastructure of conventional terrestrial broadcast networks. This will be done alongside broadcast transmissions. In order to use spectrum efficiently and to take care of compatibility it is necessary to introduce the requested bandwidths. The available bandwidths of LTE would either use spectrum inefficiently, i.e. 5 MHz in a 8 MHz raster, or give rise to compatibility issues, i.e. 10, 15 or 20 MHz overlapping with adjacent TV channels. In order to serve global deployments 6, 7 and 8 MHz carriers are needed, 6 MHz for the US / Canada, 7 MHz for Asia and 8 MHz for Europa and Africa.**Issue 4-4:** support of QC’s view**Issue 4-5:** support of QC’s view |
| SaankhyaLabs | **Issue 4-1**: Yes**Issue 4-2**: Yes**Issue 4-3**: Preference is to add this to Release-16 for LTE-based 5G Broadcast. Proliferation of Deployments early will be enabled due to support of 6,7,8 Mhz carriers. In India, 8Mhz spectrum use is likely to be compatible with existing DTV Channelization.**Issue 4-4**: The Change is applicable to “eMBMS only/Broadcast only Service” as per the CR to TS 36.331 in RP-202413. This it is not applicable for non-broadcast LTE and it does not apply to deployments where eMBMS shares spectrum with unicast services.**Issue 4-5**: Support Qualcomm’s view. |
| Rohde & Schwarz GmbH | **Issue 4-1:** yes**Issue 4-2:** yes**Issue 4-3:** Commercially speaking, our strong recommendation is to include these changes in Rel-16. This would bring the EnTV/5G Broadcast solution to a successful deployment in due time, around the globe. Worldwide Broadcasters and many wireless carriers around the globe plan to deploy EnTV type networks using existing network infrastructure of conventional terrestrial broadcast networks. In order to help real collaborations between BNOs and MNOs via dynamical usage of an highly efficient broadcast spectrum it is necessary to introduce the requested bandwidths ASAP.**Issue 4-4:** support of QC’s view**Issue 4-5:** support of QC’s view |
| OneMedia | **Issue 4-1**: Yes**Issue 4-2**: Yes**Issue 4-3**: Support of Qualcomm’s and Saankhya’s views. Terrestrial broadcasters the world over have substantial UHF spectrum assets that are 6/7/8 MHz channelized. Many are public broadcasters and/or have missions for serving the public with free broadcast services and emergency alerting services that could be enabled on mobile devices sooner than later.**Issue 4-4**: Support of Qualcomm’s view.**Issue 4-5**: Support Qualcomm’s view. |
| IRT | **Issue 4-1:** yes**Issue 4-2:** yes**Issue 4-3:** We strongly prefer to include these changes in Rel-16. This would bring the EnTV-WIs to a conclusion, as the requested bandwidths are an essential element necessary for a successful and timely deployment. Broadcasters around the world are planning to introduce EnTV-type networks using the existing network infrastructure of traditional terrestrial broadcasting networks. This will be done in parallel with broadcasting transmissions. In order to use the spectrum efficiently and ensure compatibility, it is necessary to introduce the required bandwidths. **Issue 4-4:** support of QC’s view**Issue 4-5:** support of QC’s view |
| Digital Catapult | **Issue 4-1:** Yes.Is**sue 4-2:** Yes.**Issue 4-3:** Preference is to include these changes in Rel -16.**Issue 4-4:** Support Qualcomm’s views.**Issue 4-5:** Support Qualcomm’s views. |
| SyncTechno Inc. | **Issue 4-1:** Yes.Is**sue 4-2:** Yes.**Issue 4-3:** We strongly prefer to include these changes in Release 16.**Issue 4-4:** We support Qualcomm’s views.**Issue 4-5:** We supportQualcomm’s views. |
| IIT Bombay | **Issue 4-1: Yes****Issue 4-2: Yes****Issue 4-3: Accommodation in Release 16 would be preferred****Issue 4-4: We support Qualcomm’s view****Issue 4-5: We support Qualcomm’s view** |
| Shanghai Jiao TongUniversity | **Issue 4-1:** yes**Issue 4-2:** yes**Issue 4-3**: We prefer to include these changes in Rel-16, to ensure a in-time doplyment of EnTV in china, if there is any.**Issue 4-4:** support of QC’s view**Issue 4-5:** support of QC’s view |
| MediaTek Inc. | **Issue 4-1:** No. As indicated Rel-16 is out of question for this is not an essential correction. Rel-16 is unreasonable, regardless how many 3GPP IMs are able to voice an opinion in an electronic meeting. A number of proposals were previously excluded from Rel-16, despite having wide support (measured in f2f meetings). In Dec 2020 we ought to acknowledge the window has been long closed for new Rel-16 proposals.The CRs are clearly incomplete (if considering the proposed solution – whilst there may very well be others). RAN4 aspects have been ignored. The only possible consideration is Rel-17 at the earliest, with a necessary technical debate in WGs.**Issue 4-2:** No. This is worse than 4-1. One cannot take the RF requirements away from this proposal – these are fundamental.**Issue 4-3:** We cannot provide a blank check on a proposal that has yet to be formulated.**Issue 4-4:** No. A technical debate would first have to take place where it belongs i.e. WGs.**Issue 4-5:** A well formulated proposal for Rel-17 *at the earliest* that would have to be technically debated in all WGs. We do not see endorsing the technical proposal in RP-202210 is possible at this stage shortcutting technical debate in the WGs.  |
| Samsung | **Issue 4-1: No.** Rel-16 is already frozen and it is too late to introduce a new feature in Rel-16. Further we wonder if there is any critical need for making this proposal so late after Rel-16 was frozen. What is the critical urgency to include this in Rel-16? In our view, the proponent companies should provide very clear and concrete answer to this question to justify their proposal. In our understanding, the current answers from the proponents are very vague and insufficient to justify the urgent need.**Issue 4-2: No.** Our concern on Issue 4-1 applies to Issue 4-2 as well. In addition, RAN4 RF requirement is quite crucial and cannot be neglected to remove the concerns related to Issue 4-1.**Issue 4-3:** This cannot be answered right now. A well-defined proposal for Rel-17 should be submitted for discussion.**Issue 4-4:** **No.** The concerns expressed on Issues 4-1 and 4-2 cannot be removed by a specific limitation.**Issue 4-5:** Do not approve the proposal for Rel-16. Proponents should submit a well-defined Rel-17 WI proposal for discussion. |

### Summary and recommendation for further discussion

In this section, the summary of comments on Topic#1 and the corresponding recommendations are provided.

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|  | **Summary and recommendation** |
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## Fine-tuning round

### Open issues

### Companies views’ collection

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| **Company** | **Comments** |
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### Summary and recommendation for further discussion

In this section, the summary of comments on Topic#1 and the corresponding recommendations are provided.

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|  | **Summary and recommendation** |
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## Final comments

# References

[1] RP-202793: Support of flexible bandwidth for MBMS; European Broadcasting Union (EBU), Academy of Broadcasting Planning (ABP), Academy of Broadcasting Science (ABS), ATEME, Broadcast Networks Europe (BNE) , Cellnex, Coherent Logix, Dolby, DTS/Xperi, Enensys, European Space Agency (ESA), Fraunhofer IIS, IIT Bombay, Institut für Rundfunktechnik (IRT), OneMedia 3.0 LLC, Panasonic, Philips, Qualcomm, Reliance Jio, Rohde&Schwarz, Saankhya Labs, Shanghai Jiao Tong University, SyncTechno Inc, TDF, TNO, University of the Basque Country, Vivo, VTT Technical Research Centre of Finland

[2] RP-202412: Flexible bandwidth for MBMS; European Broadcasting Union (EBU)

[3] RP-202413: Flexible bandwidth for MBMS; European Broadcasting Union (EBU)

[4] RP-202815: Support of flexible bandwidth for MBMS; European Broadcasting Union (EBU), Academy of Broadcasting Planning (ABP), Academy of Broadcasting Science (ABS), ATEME, Broadcast Networks Europe (BNE) , Cellnex, Coherent Logix, Digital Catapult, Dolby, DTS/Xperi, Enensys, European Space Agency (ESA), Facebook, Fraunhofer IIS, IIT Bombay, Institut für Rundfunktechnik (IRT), OneMedia 3.0 LLC, Panasonic, Philips, Qualcomm, Reliance Jio, Rohde&Schwarz, Saankhya Labs, Shanghai Jiao Tong University, SyncTechno Inc, TDF, TNO, University of the Basque Country, Vivo, VTT Technical Research Centre of Finland