**3GPP TSG-RAN WG4 Meeting # 99-e R4-21xxxx**

**Electronic Meeting, 19th – 27th May, 2021**

**Agenda item:** 13.2

**Source:** Moderator (ZTE)

**Title:** Email discussion summary for [99-e][160] NR\_reply\_LS\_RF\_Part2

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion (e.g. list of treated agenda items) and provide some guidelines for email discussion if necessary.*

*List of candidate target of email discussion for 1st round and 2nd round*

* 1st round: TBA
* 2nd round: TBA

The following reply LSs are discussed per Chairman’s arrangement:

|  |  |  |
| --- | --- | --- |
| **Tdoc number** | Company | Notes |
| [**R4-2109417**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109417.zip) | ZTE Wistron Telecom AB | Discussion and Response to R2-2104550 on the intra-band and inter-band (NG)EN-DC or NE-DC Capabilities |
| [**R4-2109687**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109687.zip) | vivo | Response to R2-2104550 on the intra-band and inter-band (NG)EN-DC or NE-DC Capabilities |
| [**R4-2111450**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2111450.zip) | Huawei,HiSilicon | Response to R2-2104550 on the intra-band and inter-band (NG)EN-DC or NE-DC Capabilities |
|  |  |  |
| [**R4-2109685**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109685.zip) | vivo | Response to R5-211609 Clarification on exception requirements for Intermodulation due to Dual uplink (IMD) |
| [**R4-2110198**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110198.zip) | Xiaomi | Discussion and Response to R5-211609 Clarification on exception requirements for Intermodulation due to Dual uplink (IMD) |
| [**R4-2110437**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110437.zip) | ZTE | Discussion and Response to R5-211609 Clarification on exception requirements for Intermodulation due to Dual uplink (IMD) |
| [**R4-2111105**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110959.zip) | Ericsson | Discussion on exception requirements for Intermodulation due to Dual uplink (IMD) |
| [**R4-2110806**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110806.zip) | Oppo | Discussion on exception requirements for Intermodulation due to Dual uplink (IMD) |
| [**R4-2110396**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110396.zip) | Huawei | Discussion and Response to R5-211609 Clarification on exception requirements for Intermodulation due to Dual uplink (IMD) |
|  |  |  |
| [**R4-2110597**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110648.zip) | ZTE | Per Chairman’s suggestion, the corresponding SI is closed and no TR is allowed, so the Tdoc will not be discussed. |

# Topic #1: Reply to R2-2104550 on the intra-band and inter-band (NG)EN-DC or NE-DC Capabilities

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2109417**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109417.zip) | ZTE Wistron Telecom AB | Discussion and Response to R2-2104550 on the intra-band and inter-band (NG)EN-DC or NE-DC Capabilities |
| [**R4-2109687**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109687.zip) | vivo | Response to R2-2104550 on the intra-band and inter-band (NG)EN-DC or NE-DC Capabilities |
| [**R4-2111450**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2111450.zip) | Huawei,HiSilicon | Response to R2-2104550 on the intra-band and inter-band (NG)EN-DC or NE-DC Capabilities |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

*In RAN2’s LS R2-2104550, 5 types of band combinations are defined:*

* Type 1: Intra-band (NG)EN-DC/NE-DC combination without additional inter-band NR and LTE CA component, e.g. DC **41A\_n41A**
* Type 2: Intra-band (NG)EN-DC/NE-DC combination supporting both UL and DL intra-band (NG)EN-DC/NE-DC parts with additional inter-band NR/LTE CA component, e.g. *DC\_25A\_****41A\_n41A***
* Type 3: Intra-band (NG)EN-DC/NE-DC combination without supporting UL in both the bands of the intra-band (NG)EN-DC/NE-DC UL part, e.g. DC\_**25A**\_41A\_**n41A**
* Type 4: Inter-band (NG)EN-DC/NE-DC combination without Intra-band component, in short we call it as Inter-band (NG)EN-DC/NE-DC combination.
* Type 5: Inter-band (NG)EN-DC combination configurations where the frequency range of the E-UTRA band is a subset of the frequency range of the NR band, e.g., DC\_B42\_n77 and DC\_B42\_n78.



*And there are IEs in the questions where two of them are RAN1 capabilities, and the rest three are RAN4 capabilities:*

| R1: 6-24 | Applying the same UL timing between NR and LTE | ***ul-TimingAlignmentEUTRA-NR***  ***Indicates whether to apply the same UL timing between NR and LTE for dynamic power sharing capable UE operating in a synchronous intra-band contiguous (NG)EN-DC. If this field is absent, UE shall be capable of handling a timing difference up to applicable MTTD requirements when operating in a synchronous intra-band contiguous (NG)EN-DC network, as specified in TS 38.133 [5]. If this capability is included in an inter-band (NG)EN-DC BC with an intra-band (NG)EN-DC BC part, this capability is used to indicate the restriction to the intra-band (NG)EN-DC BC part.*** |
| --- | --- | --- |
| R1: 6-23 | Incapability motivated by impacts of PA phase discontinuity with overlapping transmissions with non-aligned starting or ending times or hop boundaries across carriers for intra-band EN-DC, intra-band CA, and FDM based ULSUP | ***pa-PhaseDiscontinuityImpacts***  ***Indicates incapability motivated by impacts of PA phase discontinuity with overlapping transmissions with non-aligned starting or ending times or hop boundaries across carriers for intra-band (NG)EN-DC/NE-DC, intra-band CA and FDM based ULSUP.*** |
| R4: 2-16 | PA architectures for intra-band EN-DC | ***dualPA-Architecture***  ***For an intra-band band combination, this field indicates the support of dual PAs. If absent in an intra-band band combination, the UE supports single PA for all the ULs in the intra-band band combination. For other band combinations, this field is not applicable.*** |
| R4:2-4 | Simultaneous reception and transmission for inter-band EN-DC (TDD-TDD or TDD-FDD) | ***simultaneousRxTxInterBandENDC***  ***Indicates whether the UE supports simultaneous transmission and reception in TDD-TDD and TDD-FDD inter-band (NG)EN-DC/NE-DC. It is mandatory for certain TDD-FDD and TDD-TDD band combinations defined in TS 38.101-3 [4].*** |
| R4:2-6 | Asynchronous FDD-FDD intra-band EN-DC DC | ***asyncIntraBandENDC***  ***Indicates whether the UE supports asynchronous FDD-FDD intra-band (NG)EN-DC with MRTD and MTTD as specified in clause 7.5 and 7.6 of TS 38.133 [5]. If asynchronous FDD-FDD intra-band (NG)EN-DC is not supported, the UE supports only synchronous FDD-FDD intra-band (NG)EN-DC.*** |

### Sub-topic 1-1

*Sub-topic description:*

*Applicability of capability IEs for different types of band combinations corresponding to Question 1 in the LS.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Type 1 | Type 2 | Type 3 | Type 4 | Type 5 |
| ***dualPA-Architecture*** |  |  |  |  |  |
| ***simultaneousRxTxInterBandENDC*** |  |  |  |  |  |
| ***asyncIntraBandENDC*** |  |  |  |  |  |
| ***ul-TimingAlignmentEUTRA-NR*** |  |  |  |  |  |
| ***pa-PhaseDiscontinuityImpacts*** |  |  |  |  |  |

*Open issues and candidate options before e-meeting:*

**Issue 1-1-1: Whether or not to include the two RAN1 capabilities, i.e.,** **ul-TimingAlignmentEUTRA-NR and pa-PhaseDiscontinuityImpacts in the RAN4’s reply LS?**

* Proposals
  + Option 1: Yes
  + Option 2: No
* Recommended WF
  + TBA

**Issue 1-1-2: Which type(s) of band combination is *dualPA-Architecture* applicable to?**

* Proposals
  + Option 1: Type 1, Type 2 and Type 5
  + Option 2: Type 1 and Type 2
* Recommended WF
  + TBA

**Issue 1-1-3: Which type(s) of band combination is *simultaneousRxTxInterBandENDC* applicable to?**

* Proposals
  + Option 1: Type 2, Type 3 and Type 4
  + Option 2: Type 2, Type 3, Type 4 and Type 5
  + Option 3: Type 3 and Type 4
* Recommended WF
  + TBA

**Issue 1-1-4: Which type(s) of band combination is *asyncIntraBandENDC* applicable to?**

* Proposals
  + Option 1: Type 1, Type 2, Type 3 and Type 5
  + Option 2: Type 1, Type 2 and Type 5
  + Option 3: Type 1 and Type 2
  + Option 4: Type 1, Type 2, Type 3
* Recommended WF
  + TBA

**Issue 1-1-5: If included in the RAN4’s reply LS, which type(s) of band combination is *ul-TimingAlignmentEUTRA-NR* applicable to?**

* Proposals
  + Option 1: Type 1, Type 2 and Type 5
  + Option 2: Type 1 and Type 2
* Recommended WF
  + TBA

**Issue 1-1-6: If included in the RAN4’s reply LS, which type(s) of band combination is *ul-*** ***pa-PhaseDiscontinuityImpacts* applicable to?**

* Proposals
  + Option 1: Type 1 and Type 2
  + Option 2: Type 1 and Type only for E-UTRA FDD-NR FDD intra-band EN-DC
* Recommended WF
  + TBA

### Sub-topic 1-2

*Sub-topic description*

*If capabilities (ul-TimingAlignmentEUTRA-NR/ pa-PhaseDiscontinuityImpacts /**ul-dualPA-Architecture/ asyncIntraBandENDC) are applicable to Type1/2/3, whether or not are they used to indicate the restriction to the intra-band part (corresponding to Question 2 in the LS)?*

*Open issues and candidate options before e-meeting:*

**Issue 1-2-1: If *ul-dualPA-Architecture* is applicable to Type 1/2/3, is it used to indicate the restriction to the intra-band (NG)EN-DC/NE-DC BC part?**

* Proposals
  + Option 1: Yes
  + Option 2: No
* Recommended WF
  + TBA

**Issue 1-2-2: If *asyncIntraBandENDC* is applicable to Type 1/2/3, is it used to indicate the restriction to the intra-band (NG)EN-DC/NE-DC BC part?**

* Proposals
  + Option 1: Yes
  + Option 2: No
* Recommended WF
  + TBA

**Issue 1-2-3: If *ul-TimingAlignmentEUTRA-NR* is included in the RAN4’s reply LS and applicable to Type 1/2/3, is it used to indicate the restriction to the intra-band (NG)EN-DC/NE-DC BC part?**

* Proposals
  + Option 1: Yes
  + Option 2: No
* Recommended WF
  + TBA

**Issue 1-2-4: If *pa-PhaseDiscontinuityImpacts* is included in the RAN4’s reply LS and applicable to Type 1/2/3, is it used to indicate the restriction to the intra-band (NG)EN-DC/NE-DC BC part?**

* Proposals
  + Option 1: Yes
  + Option 2: No
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

Sub topic 1-1

**Issue 1-1-1: Whether or not to include the two RAN1 capabilities, i.e.,** **ul-TimingAlignmentEUTRA-NR and pa-PhaseDiscontinuityImpacts in the RAN4’s reply LS?**

* Proposals
  + Option 1: Yes
  + Option 2: No

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Option 1 |
| Qualcomm | Option 2. Since the capabilities are introduced by RAN1, RAN1 should reply on applicability. |
| ZTE | Option 2, similar view as Qualcomm. |
| vivo | Both options are ok. |

**Issue 1-1-2: Which type(s) of band combination is *dualPA-Architecture* applicable to?**

* Proposals
  + Option 1: Type 1, Type 2 and Type 5
  + Option 2: Type 1 and Type 2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Option 2 |
| Qualcomm | Option 1 |
| ZTE | Option 1. |
| vivo | Option 1 |

**Issue 1-1-3: Which type(s) of band combination is *simultaneousRxTxInterBandENDC* applicable to?**

* Proposals
  + Option 1: Type 2, Type 3 and Type 4
  + Option 2: Type 2, Type 3, Type 4 and Type 5
  + Option 3: Type 3 and Type 4

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Option 2 |
| Qualcomm | Option 3. If Option 2 is chosen then why wouldn’t this apply to Type 5 also? |
| ZTE | Option 1. The capability is applicable to inter-band CA cases, and Type 5 is more or less actually an “intra-band” case. |
| vivo | Option 3 |

**Issue 1-1-4: Which type(s) of band combination is *asyncIntraBandENDC* applicable to?**

* Proposals
  + Option 1: Type 1, Type 2, Type 3 and Type 5
  + Option 2: Type 1, Type 2 and Type 5
  + Option 3: Type 1 and Type 2
  + Option 4: Type 1, Type 2, Type 3

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Option 3 or option 4. There is ambiguity based on previous RAN4 discussion, whether intra-band combination without UL support can be considered as intra-band EN-DC. |
| Qualcomm | Option 1. Type 5 should be treated as intraband because the RF implementation is basically the same as intra-band |
| ZTE | Option 1. Similar view as Qualcomm, Type 5 is actually an “intra-band” case. |

**Issue 1-1-5: If included in the RAN4’s reply LS, which type(s) of band combination is *ul-TimingAlignmentEUTRA-NR* applicable to?**

* Proposals
  + Option 1: Type 1, Type 2 and Type 5
  + Option 2: Type 1 and Type 2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Option 2 |
| Qualcomm | Option 1 |
| ZTE | Option 1. |
| vivo | Option 1 |

**Issue 1-1-6: If included in the RAN4’s reply LS, which type(s) of band combination is *ul-*** ***pa-PhaseDiscontinuityImpacts* applicable to?**

* Proposals
  + Option 1: Type 1 and Type 2
  + Option 2: Type 1 and Type only for E-UTRA FDD-NR FDD intra-band EN-DC

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Option 1 |
| Qualcomm | Neither of these options, type 1, Type 2 and Type 5. |
| ZTE | Type 1, Type 2 and Type 5 since the capability is applicable to intra-band cases. |
| vivo | Type 1, Type 2, Type 5. |

Sub topic 1-2

**Issue 1-2-1: If *ul-dualPA-Architecture* is applicable to Type 1/2/3, is it used to indicate the restriction to the intra-band (NG)EN-DC/NE-DC BC part?**

* Proposals
  + Option 1: Yes
  + Option 2: No

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Option 1. Since this capability for intra-band MR-DC, for the band combination which is inter+intra, the capability is also applicable for the intra part. |
| Qualcomm | Dual PA architecture |
| ZTE | Option 1. |
| vivo | Option 1. |

**Issue 1-2-2: If *asyncIntraBandENDC* is applicable to Type 1/2/3, is it used to indicate the restriction to the intra-band (NG)EN-DC/NE-DC BC part?**

* Proposals
  + Option 1: Yes
  + Option 2: No

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Option 1. Since this capability for intra-band MR-DC, for the band combination which is inter+intra, the capability is also applicable for the intra part. For type 3 UE, the condition is that if there is no UL support for the intra part, the intra combination can still be considered as intra-band EN-DC. |
| Qualcomm | Option 1. it should apply to the intra-band part within the combo. |
| ZTE | Option 1. |
| vivo | Option 1 |

**Issue 1-2-3: If *ul-TimingAlignmentEUTRA-NR* is included in the RAN4’s reply LS and applicable to Type 1/2/3, is it used to indicate the restriction to the intra-band (NG)EN-DC/NE-DC BC part?**

* Proposals
  + Option 1: Yes
  + Option 2: No

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Option 1. Since this capability for intra-band MR-DC, for the band combination which is inter+intra, the capability is also applicable for the intra part. |
| Qualcomm | Option 1 |
| ZTE | Option 1 |

**Issue 1-2-4: If *pa-PhaseDiscontinuityImpacts* is included in the RAN4’s reply LS and applicable to Type 1/2/3, is it used to indicate the restriction to the intra-band (NG)EN-DC/NE-DC BC part?**

* Proposals
  + Option 1: Yes
  + Option 2: No

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Option 1. Since this capability for intra-band MR-DC, for the band combination which is inter+intra, the capability is also applicable for the intra part. |
| Qualcomm | Option 1. |
| ZTE | Option 1. |
| vivo | Option 1 |

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic #1** | * *Issue 1-1-1: 4 companies commented, where 1 company suggests to include two RAN1 capabilities, 2 companies suggest not to include, and 1 company is ok for both.*   *Moderator’s recommendation: Anyway RAN1 will answer questions related to RAN1 capabilities in the same LS, and for RAN1 capabilities it is more meaningful for RAN2 to refer to RAN1’s reply, and RAN4 can focus on answers related to RAN4 capabilities.*  *Suggest to agree to answer questions related to RAN4 capabilities in RAN4’s reply LS.*   * *Issue 1-1-2: 4 companies commented, where 1 company for Option 2, and 3 companies for Option 1. The key point here is whether or not to treat Type 5 as an “intra-band” case.*   *Moderator’s recommendation: Discuss in the second round on whether or not to treat Type 5 as an “intra-band” case. If there is a consensus reached that Type 5 should be treated as an “intra-band” case, then it means Option 1 to this issue, i.e., RAN4’s view dualPA-Architecuture as Type 1, Type 2 and Type 5 band combinations.*   * *Issue 1-1-3: 4 companies commented, with sided views (1 for Option 2, 1 for Option 1, and 2 for Option 3).*   *Type 3 and Type 4 should be included. The main points: 1) If treating Type 5 as “intra-band”, Type 5 is excluded since the IE indicates inter-band capability, so Option 2 can be excluded; 2) In Type 2, there are 3 bands (band X+Y+Z, where band Y contains intra-band EN-DC), in the BC, however, the IE simultaneousRxTxInterBandENDC may indicate the simultaneous Rx Tx capability for Band X and Band Z, so Type 2 should be included.*  *Moderator’s recommendation: Discuss whether or not the IE simultaneousRxTxInterBandENDC can indicate the capability for Band X and Band Z in Type 2. If yes, then it means Option 1 to this issue.*   * *Issue 1-1-4: 3 companies commented, where 1 company for Option 3 or 4, and 2 companies for Option 1.*   *Moderator’s recommendation: The point here is similar to Issue 1-1-2, should Type 5 be treated as an “intra-band” case? If yes, it means the answer to this issue is Option 1.*   * *Issue 1-1-5 and Issue 1-1-6 related to RAN1 capabilities, 3 companies go for “Type1, Type 2 and Type 5” , and 1 company goes for “Type 1 and Type 2”.*   *Moderator’s recommendation: with agreement in Issue 1-1-1, we agree to skip Issue 1-1-5/1-1-6 in the second round and the reply LS does not include the two RAN1 capabilities.*  *Tentative agreements:*   * *Agree to answer questions related to RAN4 capabilities in the RAN4 reply LS.* * *Continue further discussion on the two new issues below in the second round.*   *Candidate options:*  *Issue 1-1-8: Should we treat Type 5 BC as an intra-band case?*  *Option 1: yes*  *Option 2: no*  *Issue 1-1-9: Can the IE simultaneousRxTxInterBandENDC indicate the capability for Band X and Band Z in Type 2?*  *Option 1: yes*  *Option 2: no*  *Recommendations for 2nd round:*   * Discuss Issue 1-1-8 and 1-1-9 as listed in Candidate options: * Drafting the reply LS based on the answers to Issue 1-1-2/3/4 according to the consensus on Issue 1-1-8/9. For example, if Option 1 is agreed finally for both Issue 1-1-8 and 1-1-9, then it means:   dualPA-Architecture: Type 1,2,5  simulataneousRxTxInterBandENDC: Type 2,3,4  asyncIntraBandENDC: Type 1,2,5. |
| **Sub-topic #2** | * *Issue 1-2-1: 4 companies commented, and unanimously go for Option 1.* * *Issue 1-2-2: 4 companies commented and unanimously go for Option 1.* * *Issue 1-2-3/4 (RAN1 capabilities): unanimously go for Option 1,*   *Tentative agreements:*   * *Confirm RAN4 capabilities in Question 2 of the RAN2 LS that ul-dualPA-Architecture/ asyncIntraBandENDC used to indicate the restriction to the intra-band (NG)EN-DC/NE-DC BC part* * *Do not discuss this sub-topic in the second round.* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

**Issue 1-1-8: Should we treat Type 5 BC as an intra-band case?**

* **Option 1: yes**
* **Option 2: no**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Option 2. For the example band combinations in the RAN2 LS, i.e.g DC\_B42\_n77 and DC\_B42\_n78, it clarified in RAN4 spec that the LTE band 42 does not support UL, and the band combination is only part of a superset inter-band combination. Though the requirements of intra-band are applied for the band combination, we are not sure all the intra-band specific UE capability are applicable for this type of band combination. |
| ZTE | Option 1 since RF implementation is basically the same and intra-band requirements apply. From RAN4 perspective, it is enough to treat it as an intra-band case.  Regarding the example on LTE band 42, which does not support UL. It is just one of the two possible UL configurations for two band case, the other one is 2 UL, just as any other intra-band BC may have one or both UL configurations, not new at all. We don’t see any issue with this. |

**Issue 1-1-9: Can the IE simultaneousRxTxInterBandENDC indicate the capability for Band X and Band Z in Type 2?**

* **Option 1: yes**
* **Option 2: no**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Option 1. As confirmed in other RAN2 LS, if the fallback band pairs have different simultaneousRx/Tx capabilities, the capability should be reported additionally. Thus the **simultaneousRxTxInterBandENDC** is also applied for Band X and Band Y in type 2. |
| ZTE | Option 1. |

# Topic #2: Response to R5-211609 Clarification on exception requirements for Intermodulation due to Dual uplink (IMD)

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2109685**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109685.zip) | Vivo | Response to R5-211609 Clarification on exception requirements for Intermodulation due to Dual uplink (IMD) |
| [**R4-2110198**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110198.zip) | Xiaomi | Discussion and Response to R5-211609 Clarification on exception requirements for Intermodulation due to Dual uplink (IMD) |
| [**R4-2110437**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110437.zip) | ZTE | Discussion and Response to R5-211609 Clarification on exception requirements for Intermodulation due to Dual uplink (IMD) |
| [**R4-2111105**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110959.zip) | Ericsson | Discussion on exception requirements for Intermodulation due to Dual uplink (IMD) |
| [**R4-2110806**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110806.zip) | Oppo | Discussion on exception requirements for Intermodulation due to Dual uplink (IMD) |
| [**R4-2110396**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110396.zip) | Huawei | Discussion and Response to R5-211609 Clarification on exception requirements for Intermodulation due to Dual uplink (IMD) |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 2-1

*Sub-topic description:*

*This sub-topic addresses the answer to Q1 in RAN5 LS R5-211609:*

*RAN4 to clarify if the EN-DC IMD exceptions are applicable only when the IMD product falls into the victim carrier, and if SA requirements apply otherwise in the case of 2UL.*

*And options to this question listed in R4-2105438 are:*

* *Option 1: Yes, SA requirements shall be applied for dual UL carrier frequency combinations when no IMD product (up to 5th orders) falls into the victim’s RX CBW*
* *Option 2: No, the EN-DC IMD exceptions are defined as worse case among all IMD orders, which means if having other orders IMD product (up to 5th orders) falls into the victim RX CBW, the SA requirements still can’t be applied.*
* *Option 3: Others*

*Open issues and candidate options before e-meeting:*

**Issue 2-1-1: Is Option 2 to Question 1 in R4-2105438 a correct description?**

* Proposals
  + Option 1: Yes
  + Option 2: No, since it just describes only one of three types of IMD exception requirements
    - Note: The other two types are: 1) multiple MSDs are specified for the same set of (UL carrier frequency, DL carrier frequency, UL channel bandwidth, DL channel bandwidth); and 2) no MSD requirement is specified even there is an IMD issue
* Recommended WF
  + TBA

**Issue 2-1-2: Answer to Question 1 “if the EN-DC IMD exceptions are applicable only when the IMD product falls into the victim carrier, and if SA requirements apply otherwise in the case of 2UL?”**

* Proposals
  + Option 1: Yes, SA requirements shall be applied for dual UL carrier frequency combinations when no IMD product (up to 5th orders) falls into the victim’s RX CBW
  + Option 2: Yes, SA requirements shall be applied for dual UL carrier frequency combinations when no IMD product (up to 5th orders) falls into the victim’s RX CBW. It should be noted for some band combinations, when one band is subject to multiple orders (up to 5th) of IMD, only one worst case MSD value is specified in the RAN4 spec, other MSD value can be larger than zero but not specified.
  + Option 3: Yes, SA requirements shall be applied for dual UL carrier frequency combinations when no IMD product (up to 5th orders) falls into the victim’s RX CBWand no EN-DC exception requirements are defined for harmonics.
* Recommended WF
  + TBA

### Sub-topic 2-2

*Sub-topic description:*

*This sub-topic addresses the answer to Q2 in RAN5 LS R5-211609:*

*RAN4 to clarify* *the criteria that need to be fulfilled in order for MSD=0 to apply.*

*And options to this question listed in R4-2105438 are:*

* *Option 1: When carrier frequencies and bandwidths are selected such that there is no overlapping interference based on the equations defined in TR37.863, MSD=0 could be applied*
  + *Option 1b: the equations in TR 37.863 need to be further check in this case*
* *Option 2: Only test the IMD exceptions due to IMD interference defined in RAN4 spec. MSD=0 case is not tested for band combinations having IMD exceptions*
* *Option 3: Others*

*In R4-2110437 one issue on calculating the center frequency of the interferer is identified: there are two different equations specified in TS 38.101-3 and TR37.863-01-01:*

*Equation (1): fIBW = |a \* f1 + b \* f2| (where f1 and f2 are two UL Tx frequencies)*

*Equation (2): fINT = a\*fTX1+b\*fRX1+c\*fTX2+d\*fRX2*

*This is not directly related to the reply LS, however, companies are encouraged to have further check on this issue.*

*Open issues and candidate options before e-meeting:*

**Issue 2-2-1: Should Option 2 to Question 2 in R4-2105438 be revised since testing requirements is not the scope of RAN4?**

* Proposals
  + Option 1: No
  + Option 2: Yes
    - Option 2a: revised to “there are no requirements without MSD in this scenario, i.e. refsens is defined only with the specific test frequency settings in tables under section 7.3B.2.3.5 of TS38.101-3 if 2 UL are active”
* Recommended WF
  + TBA

**Issue 2-2-2: Answer to Question 2 “ what is the criteria that need to be fulfilled in order for MSD=0 to apply?”**

* Proposals
  + Option 1: MSD=0 case is not tested for band combinations having IMD exceptions.
  + Option 2: When carrier frequencies and bandwidths are selected such that there is no overlapping interference based on the equations defined in TR37.863, MSD=0 could be applied, and only test the IMD exceptions due to IMD interference defined in RAN4 spec. MSD=0 case is not tested for band combinations having IMD exceptions
  + Option 3: RAN4 to select some severe MSD cases and add another setting in clause 7.3B.2.3.5 of TS38.101-3 with lower (or 0 dB) MSD. This is in alignment with how it is already specified for 2nd order harmonics in clause 7.3B.2.3.1 of TS38.101-3.
  + Option 4: RAN4 to indicate that if one UL CC is transmitting at Pmin, the high MSD value is not applicable and MSD=0 shall apply instead.
  + Option 5: no IMD products fall into the victim carrier, however, whether it is meaningful to do this analysis is up to RAN5
  + Option 6: In RAN4 specs, no general criteria is defined in which REFSENS can be fulfilled with MSD=0 for the EN-DC combinations which have MSD exceptions due to IMD interference (2 UL active) and RAN4 kindly recommend RAN5 to only test the worst-case self-desensitization for MSD exception due to IMD interference.
* Recommended WF
  + TBA

**Issue 2-2-3: For the two different equations to calculate interference center frequency specified in TS 38.101-3 and TR37.863-01-01, i.e., Equation (1) fIBW = |a \* f1 + b \* f2| (where f1 and f2 are two UL Tx frequencies), and Equation (2) *fINT = a\*fTX1+b\*fRX1+c\*fTX2+d\*fRX2*, which should be considered?**

* Proposals
  + Option 1: Equation (1) since intermodulation only caused by 2 UL Tx is checked.
  + Option 2: Equation (2) since it is more generic.
* Recommended WF
  + TBA
* Note: This issue is not directly related to the reply LS, but it is good to clarify and reach a common understanding within the group

## Companies views’ collection for 1st round

### Open issues

Sub topic 2-1

**Issue 2-1-1: Is Option 2 to Question 1 in R4-2105438 a correct description?**

* Proposals
  + Option 1: Yes
  + Option 2: No, since it just describes only one of three types of IMD exception requirements
    - Note: The other two types are: 1) multiple MSDs are specified for the same set of (UL carrier frequency, DL carrier frequency, UL channel bandwidth, DL channel bandwidth); and 2) no MSD requirement is specified even there is an IMD issue

|  |  |  |
| --- | --- | --- |
| **Company** |  | **Comments** |
| Huawei | Option 1 |  |
| AT&T | It is not clear as to the intent of Issue 2-1-1 since it does not consider all of the options for answering the RAN5 question. |  |
| Xiaomi | Option 2 |  |
| Qualcomm | Yes, the previous WF 2nd option is a correct description with some additional factors when an additional TX component carrier is activated that was not mentioned. |  |
| ZTE | Option 2. |  |
| OPPO | Option 1 |  |
| vivo | Option 2 |  |

**Issue 2-1-2: Answer to Question 1 “if the EN-DC IMD exceptions are applicable only when the IMD product falls into the victim carrier, and if SA requirements apply otherwise in the case of 2UL?”**

* Proposals
  + Option 1: Yes, SA requirements shall be applied for dual UL carrier frequency combinations when no IMD product (up to 5th orders) falls into the victim’s RX CBW
  + Option 2: Yes, SA requirements shall be applied for dual UL carrier frequency combinations when no IMD product (up to 5th orders) falls into the victim’s RX CBW. It should be noted for some band combinations, when one band is subject to multiple orders (up to 5th) of IMD, only one worst case MSD value is specified in the RAN4 spec, other MSD value can be larger than zero but not specified.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| AT&T | Option 1. |
| Skyworks | We would like to propose option 4 = option 3 + 2 other types of MSD: “Yes, SA requirements shall be applied for dual UL carrier frequency combinations when no IMD product (up to 5th orders) falls into the victim’s RX CBW and no other EN-DC exception requirements are defined, ie no exception due to 1) harmonics (Tx or RX), 2) cross-band isolation, 3) counter-intermodulation (C-IM) interference. For example, DC\_3\_n1 suffers from MSD due to 1) dual UL IMD3, 2) cross band isolation and 3) C-IM interference. |
| Xiaomi | Option 2 |
| Qualcomm | As Skyworks mentioned, there are not enough options for issue 2-1-2. So, when another uplink is activated,  SA requirements are defined for a particular UL configuration depending of the whether the band is FDD/TDD and duplex spacing and TX-RX gap. The IMD test points are specified at full UL configuration for minimum supported BW. So, there are cases where you will have impact of the not only the wanted UL, but also the unspecified IMD impact, as well as possible issue of the effect of other UL such as cross modulation effect and cross band noise effect. These effects are obscured by the dominant intermodulation effect. This is why it is not easy to specify a MSD=0 value for 2 active uplinks.  Going forward, there maybe cases to specify that MSD=0, but all the factors listed in previous paragraph must be considered before issuing a MSD=0 blank check. |
| CHTTL | Option 2 |
| ZTE | Prefer Option 1.  For Option 2, for this sentence “ other MSD value can be larger than zero but not specified.”, does it mean the MSD= N/A value? If it is yes, we think it can be seen as exceptional cases but it still meet the condition that there are no IMD product (up to 5th orders) falls into the victim’s RX CBW.  For option 3 above, no need to mention “no EN-DC exception requirements are defined for harmonics.” since the LS is for intermodulation MSD caused by 2ULs. |
| MediaTek | Agree with Skyworks proposal. |
| OPPO | Others, agree with Skyworks comments. |
| vivo | share Skyworks’ view |

Sub topic 2-2

**Issue 2-2-1: Should Option 2 to Question 2 in R4-2105438 be revised since testing requirements is not the scope of RAN4?**

* Proposals
  + Option 1: No
  + Option 2: Yes
    - Option 2a: revised to “there are no requirements without MSD in this scenario, i.e. refsens is defined only with the specific test frequency settings in tables under section 7.3B.2.3.5 of TS38.101-3 if 2 UL are active”

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Option 1 |
| AT&T | We do not support Option 2 as the answer to Question 2 in R4-2105438. |
| CHTTL | same view as AT&T. |
| ZTE | Option 1. |
| OPPO | Option 1. |
| Ericsson | We do not support Option 2 as the answer to Question 2 in the WF R4-2105438. |
| Orange | We share the same view as Ericsson. |
| vivo | Option 1 |

**Issue 2-2-2: Answer to Question 2 “ what is the criteria that need to be fulfilled in order for MSD=0 to apply?”**

* Proposals
  + Option 1: MSD=0 case is not tested for band combinations having IMD exceptions.
  + Option 2: When carrier frequencies and bandwidths are selected such that there is no overlapping interference based on the equations defined in TR37.863, MSD=0 could be applied, and only test the IMD exceptions due to IMD interference defined in RAN4 spec. MSD=0 case is not tested for band combinations having IMD exceptions
  + Option 3: RAN4 to select some severe MSD cases and add another setting in clause 7.3B.2.3.5 of TS38.101-3 with lower (or 0 dB) MSD. This is in alignment with how it is already specified for 2nd order harmonics in clause 7.3B.2.3.1 of TS38.101-3.
  + Option 4: RAN4 to indicate that if one UL CC is transmitting at Pmin, the high MSD value is not applicable and MSD=0 shall apply instead.
  + Option 5: no IMD products fall into the victim carrier, however, whether it is meaningful to do this analysis is up to RAN5
  + Option 6: In RAN4 specs, no general criteria is defined in which REFSENS can be fulfilled with MSD=0 for the EN-DC combinations which have MSD exceptions due to IMD interference (2 UL active) and RAN4 kindly recommend RAN5 to only test the worst-case self-desensitization for MSD exception due to IMD interference.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Option 6 or Option 1 |
| AT&T | Option 3 or another option that leaves the test point definition to RAN5 for MSD=0 case which is similar to Option 5 but we would prefer draft LS text to know for sure.  For the alternate option, additional guidance can be provided to RAN5 for determination of the test points. We support Proposal 2 in the Ericsson contribution in R4-2111105 for the reply LS which does not seem to be listed as an option for the answer to Question 2.  We do think that consistency in the handling of core requirements between IMD and harmonic cases is needed. |
| Skyworks | Option 6. |
| Xiaomi | Prefer option 6, but option 1 or 2 is also OK |
| CHTTL | Similar as AT&T’s view. Option 3 or another option that leaves the test point definition to RAN5 for MSD=0 case which is similar to Option 5 |
| ZTE | Option 1 or option 6.  Actually option 2 is more detail, but there are two different equations defined in TR37.863, it is unclear which one should be used.  (1):  (2): fIBW = |a \* f1 + b \* f2| |
| CMCC | Similar as AT&T and CHTTL s view. Option 3 or another option that leaves the test point definition to RAN5 for MSD=0 case which is similar to Option 5 |
| Qualcomm | Option 6. |
| MediaTek | Option 6 – it is the only option that directly answers the question. |
| OPPO | Option 5 or 6 |
| vivo | Option 6 |

**Issue 2-2-3: For the two different equations to calculate interference center frequency specified in TS 38.101-3 and TR37.863-01-01, i.e., Equation (1) fIBW = |a \* f1 + b \* f2| (where f1 and f2 are two UL Tx frequencies), and Equation (2) *fINT = a\*fTX1+b\*fRX1+c\*fTX2+d\*fRX2*, which should be considered?**

* Proposals
  + Option 1: Equation (1) since intermodulation only caused by 2 UL Tx is checked.
  + Option 2: Equation (2) since it is more generic.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Option 1 |
| Skyworks | Option 1 |
| ZTE | Option 1.  We think it is more reasonable to use the equation of center frequency of IBW defined in TS38.101-3 since here we only check the intermodulation caused by dual Tx. |
| OPPO | Option 1. |
| vivo | Option 1 |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | * *Issue 2-1-1: 7 companies commented with sided views, where 3 go for Option 1, 3 go for Option 2:*   *The purpose of listing this issue is to make the option described correctly. However, with the tentative agreement, we can live with the sided views on this option description.*   * *Issue 2-1-2: 9 companies commented with a slight majority view, where 2 go for Option 1, and 2 go for Option 2, and 4 go for “revised Option 3” as: Yes, SA requirements shall be applied for dual UL carrier frequency combinations when no IMD product (up to 5th orders) falls into the victim’s RX CBW and no other EN-DC exception requirements are defined, i.e. no exception due to 1) harmonics (Tx or RX), 2) cross-band isolation, 3) counter-intermodulation (C-IM) interference.*   *Technically the revised option is correct, and conveys most related helpful information.*  *Tentative agreements:*   * *Agree a revised option as the answer to Question 1: Yes, SA requirements shall be applied for dual UL carrier frequency combinations when no IMD product (up to 5th orders) falls into the victim’s RX CBW and no other EN-DC exception requirements are defined, i.e. no exception due to 1) harmonics (Tx or RX), 2) cross-band isolation, 3) counter-intermodulation (C-IM)*   *Candidate options:*  *Recommendations for 2nd round:*  With the tentative agreement, no further discussion needed in the second round. |
| **Sub-topic #2** | * *Issue 2-2-1: 8 companies commented, where 4 go for Option 1, and the other 4 share same view that Option 2 should not be the answer to Question 2.*   *The purpose of this issue is to describe the open option correctly. However, since the option is not in down selected options for the second round discussion, we can live as it is now on this issue.*   * *Issue 2-2-2: 11 companies commented and many of them provide multiple options, where Option 6 has support from 8 companies, and Option 3 or Option 5 has support from 3 companies.*   *Tentative agreements:*  *Continue discussion on Issue 2-2-2 in the second round with down selected two alternatives:*   * + *Alt. #1: Option 6*   + *Alt. #2: Option 3 or Option 5* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

**Continue discussion on Issue 2-2-2 in the second round with down selected two alternatives:**

* + **Alt. #1: Option 6**
  + **Alt. #2: Option 3 or Option 5**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | By choosing Alt #1, RAN4 are saying that there are no requirements in situations where many deployments are likely to occur, which might send the message that the performance in these deployments are not important  Therefore, we prefer Alt#2. Option 5 requires no effort on RAN4 and puts the burden to analyze the test parameters to RAN5 guided by TR37.863, which is our preferred approach. Option 3 can also be acceptable. |
| Xiaomi | Thanks Ericsson’s comments. As commented from other company, option 3 doesn’t directly answer the question from RAN5. And for option 5 it says MSD=0 can be applied when no IMD products fall into the victim carrier. In our view, this is not clear. For example, how many orders are considered and how to verify the IMD not falling into RX carrier. Based on the majority views from companies, it is hard to get a clear criteria for MSD=0 to apply. Actually, this is also the most aligned with the current RAN4 spec. Therefore we think **Alt. #1** option 6 is the best option and don’t understand your comments on option6. |

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| Reply LS to R2-2104550 on the intra-band and inter-band (NG)EN-DC or NE-DC Capabilities | ZTE |  |
| Reply LS to R5-211609 on exception requirements for Intermodulation due to Dual uplink (IMD) | Xiaomi |  |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| **[R4-2109417](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109417.zip)** |  | ZTE Wistron Telecom AB | Noted |  |
| **[R4-2109687](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109687.zip)** |  | vivo | Noted |  |
| **[R4-2111450](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2111450.zip)** |  | Huawei,HiSilicon | Noted |  |
| **[R4-2109685](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109685.zip)** |  | vivo | Noted |  |
| **[R4-2110198](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110198.zip)** |  | Xiaomi | Noted |  |
| **[R4-2110437](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110437.zip)** |  | ZTE | Noted |  |
| **[R4-2111105](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110959.zip)** |  | Ericsson | Noted |  |
| **[R4-2110806](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110806.zip)** |  | Oppo | Noted |  |
| **[R4-2110396](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110396.zip)** |  | Huawei | Noted |  |
| **[R4-2110597](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110648.zip)** |  | ZTE | Not pursued |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents