**3GPP TSG-RAN WG4 Meeting #** **99-e R4-2108131**

**Electronic Meeting, May. 19-27, 2021**

**Agenda item:** 5.1.3.1, 5.1.3.2.2.1, 5.1.3.2.2.3, 5.1.3.2.2.6

**Source:** Moderator (ZTE Corporation)

**Title:** Email discussion summary for [99-e][207] NR\_RRM\_Enh\_2

**Document for:** Information

# Introduction

TDocs submitted to the following agenda items will be treated:

- 5.1.3.1 RRM core requirements maintenance (38.133)

- 5.1.3.2.2.1 SRS carrier switching requirements

- 5.1.3.2.2.3 CGI reading requirements with autonomous gap

- 5.1.3.2.2.6 Mandatory MG patterns

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

* 1st round: Companies provide comments on CRs and discuss open issues
* 2nd round: Finalize on the open issues. Check if revised CRs can be agreed.

# Topic #1: Core Maintenance

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| **[R4-2109564](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109564.zip)** | Qualcomm, Inc. | CR:Correction on SRS carrier switching |
| R4-2111497 | Qualcomm, Inc. | (R17mirror) CR:Correction on SRS carrier switching |
| **[R4-2109986](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109986.zip)** | Ericsson, Mediatek Inc. | CR on TS38.133 mandatory gaps - r16 |
| R4-2109987 | Ericsson, Mediatek Inc. | CR on TS38.133 mandatory gaps - r17 |
| **[R4-2109923](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109923.zip)** | vivo, Qualcomm, Huawei, HiSilicon, MediaTek Inc., Apple, Nokia | CR to 38.133 correction on SRS carrier based switching core requirements |
| R4-2109924 | vivo, Qualcomm, Huawei, HiSilicon, MediaTek Inc., Apple, Nokia | CR to 38.133 correction on SRS carrier based switching core requirements |
| **[R4-2109925](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109925.zip)** | vivo | CR to 38.133 correction on SRS carrier based switching test cases |
| R4-2109926 | vivo | CR to 38.133 correction on SRS carrier based switching test cases |
| **[R4-2110388](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110388.zip)** | Huawei, HiSilicon | Correction on SRS carrier switching |
| R4-2110431 | Huawei, HiSilicon | Correction on SRS carrier switching |

## Open issues summary

*No open issues. Companies are encouraged to directly comment on the CRs.*

### 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** |
| **[R4-2109564](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109564.zip)** | QC: If this is agreeable, it can be merged to R4-2110388 |
| Huawei: The changes are fine |
| Apple: OK with the CR. |
| vivo: The changes in the CR are fine. |
| Ericsson: We are in principle fine with the CR, but have a slight preference for the corresponding CR 0388 from Huawei. Merge? |
| Nokia: We understood this bullet is intended for SSB/CSI-RS based L3 measurement on both serving and neighbor cells. While the other measurements in serving cell e.g. L1-RSRP is addressed in previous bullet as the priority handling is defined in RAN1. At least in RAN1, SRS carrier switching is not always prioritized. So we suggest below changes:  - the SRS switching is not colliding with any other transmission with higher priority defined in TS 38.214 [26].  - the SRS switching is not colliding with any SSB/CSI-RS based L3 measurements, including serving and neighboring cellsin SCG. |
| QC: To Nokia, our understanding of previous agreement includes RLM/BFD and L1-RSRP measurement to be prioritized over SRS carrier switching. Do you have different understanding? We agree that SRS carrier switching is not prioritized, instead, RLM/BFD and L1-RSRP is prioritized. |
| **[R4-2109986](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109986.zip)** | QC: We don't see issue for repeating RAN2 spec in RAN4 for clarification purpose. Removing color part is fine. |
| Apple: OK with the CR. |
| Nokia: Removing the text may make the future readability more difficult. We do not see any issue keeping the text unless keeping it is incorrect as stated in the cover page? |
| Ericsson2:  @Qualcomm: In our view it is not correct to define ‘supportedGapPattern-NRonly’ in Table 9.1.2-2 for UE in the EN-DC or NE-DC. Rather, ‘supportedGapPattern-NRonly’ can only be applied for UE in NR SA and NR-DC, as stated in TS38.306. |
| **[R4-2109923](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109923.zip)** | Apple: support the CR |
| vivo: This is formal CR of the endorse draft CR R4-2106611. |
| Ericsson: We are fine with the CR. |
|  | Nokia: agreeable (endorsed CR) |
| **[R4-2109925](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109925.zip)** | vivo: This is formal CR of the endorse draft CR R4-2105763. |
| Ericsson: We are fine with the CR. |
| Nokia: agreeable (endorsed CR) |
| **[R4-2110388](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110388.zip)** | Apple: similar with [R4-2109564](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109564.zip). Changes are fine. |
| Ericsson: We are fine with the CR. |
| Nokia: agreeable (endorsed CR) |

## Summary for 1st 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** |
| **[R4-2109564](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109564.zip)** | To be merged into R4-2110388 |
| **[R4-2109986](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109986.zip)** | *Return to* |
| **[R4-2109923](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109923.zip)** | *Agreeable* |
| **[R4-2109925](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109925.zip)** | *Agreeable* |
| **[R4-2110388](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110388.zip)** | *To be revised to contain agreeable content in* **[R4-2109564](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109564.zip).** Qualcomm can be added as a co-sourcing company. |

## Discussion on 2nd round (if applicable)

# Topic #2: CGI reading requirements with autonomous gap (Perf)

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| **[R4-2109573](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109573.zip)** | Qualcomm, Inc. | CR: CGI reading test |
| R4-2111499 | Qualcomm, Inc. | (R17mirror) CR: CGI reading test |

## Open issues summary

Companies are encouraged to provide feedback directly for the CR.

## Companies views’ collection for 1st round

### 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** |
| **[R4-2109573](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109573.zip)** | QC: This is an endorsed CR |
| Ericsson: We have some questions for clarifications. Some texts are in red. What is the meaning of 'allow 260ms.' in test requirement formula?    Format of A.6.6.7.2.2 seems incorrect. |
| QC: We corrected the color and format, and uploaded a new version to draft folder. The allow x ms is not added in this CR. Based on our understanding, we round up to 5 or 10 ms in the CGI test requirement. |
|  |
|  |

## Summary for 1st round

### 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** |
| **[R4-2109573](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109573.zip)** | 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”.*

# Topic #3: Mandatory MG patterns (Perf)

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| **[R4-2108767](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2108767.zip)** | ZTE Corporation | **Proposal 1: R15 test cases on mandatory gap patterns shall be inherited completely to R16 specifications, and R16 UEs shall pass all test cases.**  **Observation 1:** Whether to skip R15 TCs is beyond the scope of this WI (R16 RRM Enhancement). |
| **[R4-2109312](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109312.zip)** | Apple | CR for test applicability for mandatory gap patterns |
| **[R4-2110970](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110970.zip)** | Ericsson | **Observation 1:** The newly defined test cases for mandatory measurement gap take approximately 10 minutes each for FR1 and FR2 which is an extremely small part of the total UE RRM certification testing time  **Observation 2:** It is not desirable to eliminate test coverage based on assumptions and pre-conceptions about likely failure modes in a very complicated implementation and system such as NR  **Observation 3:** Test case lists are developed and maintained by many bodies and organisations within the industry who do not expect that test coverage will be removed in a future release  **Observation 4:** The business incentive to develop and certify test implementation is less if they are only used for testing a single release of UE  **Proposal 1: A release 16 UE is expected to pass tests with release 15 MG patterns, and additionally the tests defined for release 16 mandatory gap patterns. This corresponds to Option 2 in the WF.** |
| **[R4-2111278](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2111278.zip)** | Nokia, Nokia Shanghai Bell | 1. RAN4 shall not introduce conditional skipping of test cases with fallback pass of legacy tests. 2. If any Rel-15 legacy test case is agreed redundant due to introduction of new Rel-16 test case, the UE will fail if the UE fails to pass the new Rel-16 test case. 3. No legacy test cases are skipped due to passing new Rel-16 test cases. 4. A Rel-16 UE shall pass all existing Rel-15 related measurement gap test cases and new Rel-16 defined measurement gap test cases. |
| **[R4-2111324](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2111324.zip)** | Ericsson | Correction to beam assumptions in FR2 tests on Rel-16 Mandatory gaps |
| R4-2111325 | Ericsson | Correction to beam assumptions in FR2 tests on Rel-16 Mandatory gaps |

## 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 3-1 Allowing UEs to skip R15 TCs?

*Sub-topic description:*

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

**Issue 3-1: Whether to allow R16 UEs to skip some of R15 TCs**

* Proposals
  + Option 1: No (ZTE, Ericsson, Nokia)
  + Option 2: Yes, partly (Apple)
* Recommended WF
  + Discussion is needed

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | Issue 3-1: We believe that the issue if out of the scope of this WI since the WI focuses on R16 enhancements. Technically, we’re concerned on the possibility that certain parameters would trigger a bug depending on UE implementation even if generally a shorter MG can be seen as a stricter requirement. |
| QC | The arguments presented by the proponents of option 1 are almost the same as the contribution from the previous meeting. We commented these in the following, but haven’t seen them being addressed in the new contribution in this meeting. Hence we post the comments revised from the previous meeting below to support option 2:  #0 Test coverage  We want to emphasized that the with option 2, all the mandatory gap patterns in R15 are still covered by many tests. The test coverage from mandatory gap pattern perspective is still complete, every gap patterns are tested in multiple measurement test cases including inter-frequency and inter-RAT.  #1 Testing time difference is not large  Despite the fact that the individual tests are not long, option 2 can saves a lot of testing time, considering that multiple entities (UE vendor internal, OEM etc) are doing multiple rounds of the RRM tests.  **#**2 Test coverage  From measurement gap perspective, the test coverage is still complete with the proposed applicability rule. We use the example given in the contribution to explain. The issue “UE could easily have a bug in the implementation of measurement starting or ending time which only became apparent when the effective gap length was not a multiple of 5ms” is easily caught by any test using gap pattern 0 and MGL 6ms in R15, as R4-2104862 pointed out, there are still plenty of them after the applicability rule is agreed.  #3 R15 test maintenance  Option 2 isn’t to remove the test, this is just an applicability rule to skip the old release tests for new release UEs. The tests are still there for R15 UEs. Skipping SC tests are a more general approach which has significant impact. However, the proposed applicability rule is specifically targeting mandatory gap pattern, and for any applicability rule based on similar test configuration argument should be treated case by case. Agreeing this applicability rule doesn’t mean the “similar test configuration” argument to introduce applicability rule can immediately apply to other test cases except mandatory gap pattern tests discussed in R16.  #4 Business incentives to implement test  The R15 tests, as Ericsson argued in R4-2106686, are developed and currently maintained by many bodies already. We are not introducing applicability rule to new tests that are still required different entities to develop it. The applicability rule applies to existing tests, therefore, business incentive of developing tests is not a concern here.  #5 Test applicability rule  We want to re-iterate that there are a lot of applicability rules, e.g. demod 2Rx and 4Rx test applicability rule, which allows UE to skip mandatory 2Rx tests when 4Rx tests are passed. These rules are introduced without a WID specifically referring to it. |
| Apple | In previous RAN4 meeting we gave several examples that in RAN4 history we did allow UE to skip some mandatory test in earlier release if UE can survive the more demanding test in later release. No one has any concern on that. Therefore, we believe the negative impact mentioned in contributions from proponents of option 1 are not valid. |
| Ericsson | We support Option 1. The risk for the mobility function in existing deployments is too large compared to the gain in reduced testing time. |
| Nokia | We did not address #4 and #5 in our paper but we did take a more detailed look at the commonality, or lack thereof, between the existing Rel-15 proposed skipped and the new Rel-16 tests proposed to substitute the Rel-15 TCs. In the paper we summarize FR1 and FR2:   * FR1: we do not see that A.6.6.2.9 and A.6.6.2.1 are covering the same. We believe the actual test settings have been selected in such a way that the tests are not overlapping but instead ensures the test coverage of the new mandatory GPs. * FR2: we do not see that test A.7.6.2.9 is fully the same as the two proposed tests to skipped: A.7.6.2.1 and A.7.6.2.5. The settings are different and in one case the PCell is in FR1. Also, for FR2 we see that test settings in the newly introduced test case have been selected such that the test is not overlapping but instead ensures the test coverage of the new mandatory GPs.   Hence, we do not see that the new test cases can substitute the existing Rel-15 test cases as the test cases are not covering same settings. They are designed to increase the test coverage and new UE functionality. |

### 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** |
| **[R4-2109312](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109312.zip)** | Ericsson: The CR is not agreeable to us. |
| Nokia: Principle is still under discussion and therefore CR cannot be agreed. |
|  |
| **[R4-2111324](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2111324.zip)** | Nokia: CR is agreeable. |
|  |
|  |
|  |

## 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** |
| **Issue 3-1** | *Candidate options:*  *Option 1: No, not allowed to skip ant test case*  *Option 2: UE shall be allowed to skip some of the TCs*  *Recommendations for 2nd round: continue discussion. Companies can analyze in detail the test configurations and see whether R16 TCs can cover R15 TCs.* |

### 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** |
| **[R4-2109312](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109312.zip)** | Return to |
| **[R4-2111324](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2111324.zip)** | *agreeable* |

## Discussion on 2nd round (if applicable)

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | Issue 3-1: I think Nokia raised a good point that the test configurations are not quite the same for R15 and R16 TCs so we cannot say that some of the R15 TCs are effectively covered by R16 TCs. We suggest not to allow UE to skip any test. |
|  |  |

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on SRS carrier switching and mandatory gap patterns | ZTE corporation |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| **[R4-2109564](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109564.zip)** | CR:Correction on SRS carrier switching | Qualcomm, Inc. | To be merged |  |
| R4-2111497 | (R17mirror) CR:Correction on SRS carrier switching | Qualcomm, Inc. | withdrawn |  |
| **[R4-2109986](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109986.zip)** | CR on TS38.133 mandatory gaps - r16 | Ericsson, Mediatek Inc. | Return to |  |
| R4-2109987 | CR on TS38.133 mandatory gaps - r17 | Ericsson, Mediatek Inc. | Return to |  |
| **[R4-2109573](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109573.zip)** | CR: CGI reading test | Qualcomm, Inc. | revised |  |
| R4-2111499 | (R17mirror) CR: CGI reading test | Qualcomm, Inc. | Return to |  |
| **[R4-2109312](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109312.zip)** | CR for test applicability for mandatory gap patterns | Apple | Return to |  |
| **[R4-2111324](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2111324.zip)** | Correction to beam assumptions in FR2 tests on Rel-16 Mandatory gaps | Ericsson | *agreeable* |  |
| R4-2111325 | Correction to beam assumptions in FR2 tests on Rel-16 Mandatory gaps | Ericsson | *agreeable* |  |
| **[R4-2109923](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109923.zip)** | CR to 38.133 correction on SRS carrier based switching core requirements | vivo, Qualcomm, Huawei, HiSilicon, MediaTek Inc., Apple, Nokia | agreeable |  |
| R4-2109924 | CR to 38.133 correction on SRS carrier based switching core requirements | vivo, Qualcomm, Huawei, HiSilicon, MediaTek Inc., Apple, Nokia | agreeable |  |
| **[R4-2109925](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109925.zip)** | CR to 38.133 correction on SRS carrier based switching test cases | vivo | agreeable |  |
| R4-2109926 | CR to 38.133 correction on SRS carrier based switching test cases | vivo | agreeable |  |
| **[R4-2110388](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110388.zip)** | Correction on SRS carrier switching | Huawei, HiSilicon | revised | *To be revised to contain agreeable content in* **[R4-2109564](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109564.zip).** Qualcomm can be added as a co-sourcing company. |
| R4-2110431 | Correction on SRS carrier switching | Huawei, HiSilicon | Return to |  |

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 |  |
|  |  |  |  |  |
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|  |  |  |  |  |

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