3GPP TSG-RAN WG2 Meeting #116bis-e R2-22xxxxx

Electronic, January 17 – January 25, 2022

Agenda item: 8.24.1

Source: Apple

Title: Summary of [AT116bis-e][038][NR17] FR2 UL Gap (Apple)

Document for: Discussion

# 1 Introduction

This is the summary of following email discussion.

* [AT116bis-e][038][NR17] FR2 UL Gap (Apple)

 Scope: Treat R2-2200122, R2-2201105. Aim to clarify what is needed in R2, determine agreeable parts, open points, pave the way for online disc.

 Intended outcome: Report

 Deadline: CB online Mon W2.

[1] R2-2200122 LS on UL gap in FR2 RF enhancement (R4-2120058; contact: Apple) RAN4 LS in Rel-17 NR\_RF\_FR2\_req\_enh2-Core To:RAN2

[2] R2-2201105 RAN2 impact from UL gap in FR2 RF enhancement Apple discussion NR\_RF\_FR2\_req\_enh2

# 2 Contact info

|  |  |  |
| --- | --- | --- |
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# 3 Phase 1 Discussion

## 3.1 FR2 UL gap configuration in SA deployment scenario

For timing reference of FR2 UL gap, [2] presents the following, which follows legacy FR2 gap design.

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| **Proposal 3: In SA deployment scenario, for synchronous FR2 CA configuration, the SFN and subframe of any FR2 serving cell can be used in the gap calculation.****Proposal 4: In SA deployment scenario, for asynchronous FR2 CA configuration, the SFN and subframe of the serving cell on FR2 frequency indicated by the *refFR2ServCellAsyncCA* is used in the gap calculation.** |

**Question 1: In SA deployment, for timing reference in synchronous FR2 CA configuration, do companies agree that the SFN and subframe of any FR2 serving cell can be used in the gap calculation?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | Yes |  |
| vivo | Yes  |  |
| ZTE | Yes |  |
| Intel | Yes |  |
| Nokia, Nokia Shanghai Bell | Yes as long as the reference source is clear | It's **feasible** to use any FR2 serving cell for the timing reference, but **which** FR2 serving cell is used must be unambiguous. So we assume NW indicates which cell is used as timing reference for the UL gap configuration.[Apple response]: If it’s synchronous CA, NW can ignore the field then UE would use any FR2 serving cell as reference. |
| CATT | Yes |  |
| Apple | Yes |  |

**Question 2: In SA deployment, for timing reference in asynchronous FR2 CA configuration, do companies agree to introduce *refFR2ServCellAsyncCA* in FR2 UL gap configuration?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | Yes |  |
| vivo | Yes  |  |
| ZTE | Yes |  |
| Intel | Yes |  |
| Nokia, Nokia Shanghai Bell | Yes but not necessarily the same field | An indication of the SFN reference is needed. We need a new field for that since the existing field has a meaning already, but otherwise we agree the same structure is fine (i.e. the serving cell ID used as reference for gap timing is given for UL gaps). |
| CATT | Yes |  |
| Apple | Yes | We are fine with either the same or different field name. |

## 3.2 FR2 UL gap handling in MR-DC scenario

In last RAN plenary meeting, it was agreed that MR-DC scenario is included. It was also captured in the revised WID RP-213666 that eNB operation or LTE RRC should not be impacted.

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| The purpose of this work item is to specify the following FR2 UE features and associated requirements:<text omitted>* UL gaps for self-calibration and monitoring. [RAN4 RF/RRM, RAN2] Study and, if feasible, introduce UE specific and NW configured gap for general self-calibration and monitoring purposes including
	+ - UE Tx power management
		- Coherent uplink MIMO
	+ **Phase 1:** Study and clearly identify the performance gain over the current baseline (Rel.16 requirements) Study of RF performance evaluation/testability related to UE self-calibration and monitoring. Study network impact of UE emissions during UL gap, if any.
	+ **Phase 2:** Specify the UL gap configuration(s), related UE capability and interruptions, if needed, based on the identified performance gain in Phase 1 and UE fall back behaviour i.e. if gaps are not available for UE requesting gaps. Discussion on release independence aspects.
	+ Note: The work of FR2 UL gaps includes (NG) EN-DC, NE-DC, NR-DC and SA. FR2 UL gap operation shall have no impacts to eNB operation or LTE RRC.
 |

Before RAN2 receives RAN4 reply to LS R2-2111575, the moderator would like to discuss the NR-DC scenarios with and without FR2-FR2 BC separately in parallel. For NR-DC, the potential agreements yet to conclude in Section 3.2.1 and 3.2.2 are exclusive to each other. RAN2 can adopt one set of agreements once receiving RAN4 feedback.

### 3.2.1 Support on EN-DC, NE-DC, NR-DC without FR2-FR2 BC scenarios

**Topic 1: Responsible network entity on FR2 UL gap configuration**

[2] presents the following proposals. For EN-DC and NE-DC, they follow legacy FR2 gap configuration design while for NR-DC it deviates a little from legacy FR2 gap design.

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| **Proposal 8: The activated UL gap applies to all FR2 cells inside the CG with FR2 bands, thus:*** **EN-DC: FR2 UL gap is configured by SN to UE.**
* **NE-DC: FR2 UL gap is configured by MN to UE.**
* **NR-DC without FR2-FR2: Either MN or SN can configure UL gap to UE, depending on which CG is configured with FR2 bands.**
 |

**Question 3: Do companies agree with the responsible network entity on FR2 UL gap configuration listed below.**

**- EN-DC: SN**

**- NE-DC: MN**

**- NR-DC: The network entity whichever configures UE with FR2 bands**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | See comments | For NR-DC, it is a bit unclear which scenario is addressed here. Is it referring to FR1+FR2 DC case, or even FR2+FR2 DC is considered? We are fine to consider FR1+FR2 DC only to reduce the complexity. We are also not sure whether NE-DC is a real deployment option to be supported.[Apple response]: This is to discuss the NR-NR DC without FR2-FR2, thus it could be FR1+FR2/FR2+FR1 NR-NR DC. |
| Vivo  | Yes for EN-DC and NE-DC No for NR-DC | For NR-DC, we prefer MN to configure gap, because the existing inter-node coordination can cover the information exchange. It is also same procedure for FR1+FR2 NR DC and FR2+FR2 NR DC, otherwise we will have different procedure for FR1+FR2 NR DC and FR2+FR2 NR DC and existing procedure with other FR2 gap in NR-DC. |
| ZTE | Yes for EN-DC and NE-DCFFS for NR-DC | For EN-DC and NE-DC, only one node can configure FR2 serving cells, so the legacy principle can be applied. While for NR-DC, actually it doesn’t make much sense to define two different solutions for “without FR2-FR2” case and “with FR2-FR2” case. [Apple response] It’s not to define two different solutions. The intention is to discuss them separately in RAN2 first and then take one set of solution once RAN4 concludes on FR2-FR2 NR-DC.If RAN2 or RAN4 can conclude that FR2-FR2 NR-DC will never be considered in UL FR2 gap, or if RAN4 can conclude that MN and SN can configure two independent FR2 UL gaps for MCG and SCG, then we are fine to go for a simple solution (as proposed by rapporteur).  |
| Intel | Yes for EN-DC and NE-DC | Thanks ZTE point out the support of FR2-FR2. In general, we prefer to follow NR-DC Rel15 where MN configure the gap and coordinate with SN.  |
| Nokia, Nokia Shanghai Bell | Yes | For EN-DC and NE-DC, it's the gNB (MN or SN) since LTE doesn't support FR2.For NR-DC, agree with proposal.  |
| CATT | Yes for EN-DC and NE-DC | We also prefer to use the same framework for NR-DC with FR1+FR2 or FR2+FR2, i.e. the MN is responsible for the UL gap configuration. But we have a question on whether it is feasible for MN with FR1 to configure the UL gap for SN with FR2. |
| Apple | Yes | For NR-NR DC without FR2-FR2, our preference is to simplify the design.  |

**Topic 2: MN/SN coordination on FR2 UL gap**

[2] presents the following proposal with the reason that the FR2 UL gap is restricted in one CG.

|  |
| --- |
| **Proposal 9: In EN-DC, NE-DC and NR-DC without FR2-FR2 BC, there is no need to coordinate UL gap configuration between MN and SN.** |

**Question 4: Do companies agree that in EN-DC, NE-DC and NR-DC without FR2-FR2 BC, there is no need to coordinate UL gap configuration between MN and SN?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | Yes | This is also the reason that we think Q3, NR-DC without FR2-FR2 is a reasonable scope to avoid complicated coordination between MN and SN. |
| Vivo  | No  | For NR-DC, we prefer MN to configure gap, because the existing inter-node coordination can cover the information exchange. It is also same procedure for FR1+FR2 NR DC and FR2+FR2 NR DC, otherwise we will have different procedure for FR1+FR2 NR DC and FR2+FR2 NR DC and existing procedure with other FR2 gap in NR-DC. |
| ZTE | Yes for EN-DC and NE-DC;FFS for NR-DC | For NR-DC, please see our comment to Q3.  |
| Intel | Yes for EN-DC and NE-DC | See comment above |
| Nokia, Nokia Shanghai Bell | See comments  | If SN uses FR2 UL gaps, it can indicate that to MN and vice versa. If MN has configured FR2 UL gaps, SN cannot configure them. |
| CATT | Yes for EN-DC and NE-DC | See comment above |
| Apple | Yes | For Nokia’s comment, since FR2 bands are restricted in one CG, we don’t quite see the need to inform the other node on the UL FR2 gap.  |

**Topic 3: Timing reference of FR2 UL gap**

[2] presents the following proposal.

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| **Proposal 10: In EN-DC, NE-DC and NR-DC without FR2-FR2 BC, use FR2 serving cell inside the CG with FR2 band as timing reference for the SFN and subframe calculation in FR2 UL gap calculation.** |

**Question 5: Do companies agree that in EN-DC, NE-DC and NR-DC without FR2-FR2 BC, use FR2 serving cell inside the CG with FR2 band as timing reference for the SFN and subframe calculation in FR2 UL gap calculation?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | Yes | We think the principle is the same as Q2. |
| vivo | Yes  |  |
| ZTE | Yes |  |
| Intel | Yes |  |
| Nokia, Nokia Shanghai Bell | Yes but (see Q1/2) | We should keep the timing reference inside the same CG, but in case we allow FR2 cells in both MN and SN, this might not need to be restricted. |
| CATT | Yes |  |
| Apple | Yes | For Nokia’s comment, since FR2 bands are restricted in one CG, we don’t quite see the need to inform the other node on the UL FR2 gap.  |

### 3.2.2 Support on NR-DC with FR2-FR2 BC scenarios

**Topic 1: Responsible network entity on FR2 UL gap configuration**

[2] has the following proposal, which aligns with legacy FR2 gap configuration.

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| **Proposal 11: In NR-DC with FR2-FR2 BC, FR2 UL gap is configured by MN.** |

**Question 6: Do companies agree that in NR-DC with FR2-FR2 BC, MN is responsible for FR2 UL gap configuration?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | Yes | We think we should use the same framework as before. But we are not in favour of supporting this scenario. |
| vivo | Yes  | For NR-DC, we prefer MN to configure gap, because the existing inter-node coordination can cover the information exchange. It is also same procedure for FR1+FR2 NR DC and FR2+FR2 NR DC, otherwise we will have different procedure for FR1+FR2 NR DC and FR2+FR2 NR DC and existing procedure with other FR2 gap in NR-DC. |
| ZTE | Yes | If RAN4 confirms only one FR2 UL gap pattern can be configured for FR2-FR2 NR-DC, then the legacy framework can be reused. But we should avoid introducing different solutions for different NR-DC cases. |
| Intel | Yes | Agree with HW and ZTE, we should have the same framework |
| Nokia, Nokia Shanghai Bell | Yes but | In case there are no FR2 cells in MN, SN is allowed to configure UL gaps, i.e. unless MN indicates UL gaps are configured, SN is allowed to configure them.  |
| CATT | Yes |  |
| Apple | Yes | Only if RAN4 agrees to support FR2-FR2 NR-DC, should this be considered. |

**Topic 2: MN/SN coordination on FR2 UL gap**

[2] explains that MN is aware of the FR2 bands configured by SN to UE from selectedBandCombination in CG-Config, thus MN has a good knowledge whether FR2 UL gap is required by SN or not. It is then proposed in [2] that in NR-DC with FR2-FR2 BC, MN informs SN the gap pattern for FR2 UL gap. But SN does not need to indicate gap request to MN.

|  |
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| **Proposal 12: In NR-DC with FR2-FR2 BC, MN informs SN the gap pattern for FR2 UL gap.** |

**Question 7: Do companies agree that in NR-DC with FR2-FR2 BC, MN informs SN the gap pattern for FR2 UL gap?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | Yes | We think we should use the same framework as before. But we are not in favour of supporting this scenario. |
| vivo | Yes  | For NR-DC, we prefer MN to configure gap, because the existing inter-node coordination can cover the information exchange. It is also same procedure for FR1+FR2 NR DC and FR2+FR2 NR DC, otherwise we will have different procedure for FR1+FR2 NR DC and FR2+FR2 NR DC and existing procedure with other FR2 gap in NR-DC. |
| ZTE | Yes | If RAN4 confirms only one FR2 UL gap pattern can be configured for FR2-FR2 NR-DC, then the legacy framework can be reused. But we should avoid introducing different solutions for different NR-DC cases. |
| Intel | Yes |  |
| Nokia, Nokia Shanghai Bell | No | If only SN has FR2 cells, why would MN provide FR2 gaps instead of SN? Also, MN only know which bands SN is using, not whether FR2 UL gaps are actually needed (i.e. UEs should not need the UL gaps all the time)[Apple response]: Regarding this issue, our view is in order to simply the complicated possible cases below, it would be much easier to leave the gap decision to MN. Otherwise, MN and SN need to handshake which node can be the decisive node.1. Switching from only SN has FR2 cells to both MN and SN configures FR2 cells.
2. Both MN and SN has FR2 cells but only FR2 cells (band) in SN needs UL gap.
3. Both MN and SN has FR2 cells but only MN FR2 cells need UL gap.
 |
| CATT | Yes |  |
| Apple | Yes |  |

**Topic 3: Timing reference of FR2 UL gap**

[2] proposed that to follow the legacy FR2 gap in NE-DC and NR-DC, where the *refServCellIndicator* is used to indicate PCell, PSCell, or MCG-FR2 cell to UE as timing reference. Thus, [2] has the following proposal.

|  |
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| **Proposal 13: In NR-DC with FR2-FR2 BC, introduce *refServCellIndicator* to indicate the reference serving cell. Meanwhile introduce the following notes in TS38.331.****NOTE 1: For *gapUL* configuration with synchrnonous CA, for the UE in NR-DC with FR-FR2 band combination configured, the SFN and subframe of the serving cell indicated by the *refServCellIndicator* in *gapUL* is used in the gap calculation. Otherwise, the SFN and subframe of a serving cell on FR2 frequency is used in the gap calculation.** **NOTE 2: For *gapUL* configuration with asynchronous CA, for the UE in NR-DC with FR2-FR2 band combination configured, the SFN and subframe of the serving cell indicated by the *refServCellIndicator and refFR2ServCellAsyncCA* in *gapUL* is used in the gap calculation. Otherwise, the SFN and subframe of a serving cell on FR2 frequency indicated by the *refFR2ServCellAsyncCA* in *gapUL* is used in the gap calculation.**  |

**Question 8: Do companies agree that in NR-DC with FR2-FR2 BC, *refServCellIndicator* is used to indicate the timing reference serving cell?**

**- For FR2 UL gapconfiguration with synchrnonous CA, for the UE in NR-DC with FR-FR2 band combination configured, the SFN and subframe of the serving cell indicated by the *refServCellIndicator* is used in the gap calculation.**

**- For FR2 UL gap configuration with asynchronous CA, for the UE in NR-DC with FR2-FR2 band combination configured, the SFN and subframe of the serving cell indicated by the *refServCellIndicator and refFR2ServCellAsyncCA* is used in the gap calculation.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | Yes |  |
| vivo | Yes  |  |
| ZTE | Yes |  |
| Intel | Yes |  |
| Nokia, Nokia Shanghai Bell | No | It's cleaner to just define a new field for this purpose. That avoids any issues with reusing the field.[Apple response]: Does this new field serve the same purpose, i.e. only with a new name? |
| CATT | Yes |  |
| Apple | Yes |  |

## 3.3 UE indication on the need of UL gap activation/deactivation

Since RAN4 last time agreed in the WF R4-2119962 that UE can explicitly indicate to NW on “need for UL gap” and “no need for UL gap”, [2] presents the following proposal.

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| --- |
| **Proposal 7: In TS 38.331, capture that UE explicitly indicates the need of FR2 UL gap activation/deactivation using UAI message.** |

**Question 9: Do companies agree to confirm to support that UE explicitly indicates the need of FR2 UL gap activation/deactivation using UAI message.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | Yes |  |
| vivo | Yes |  |
| ZTE | Yes | But the content of UAI need further discussion, e.g. whether it is 1 bit activation or deactivation indication? Or UE preferred gap pattern? |
| Intel | Yes | If activation and deactivation is supported, we think that it will be good to check if the same frame work can be reused as MGE WI pre-configuration measurement gap. |
| Nokia, Nokia Shanghai Bell | Yes but | UE indicates request to UL gap activation or deactivation, but it's up to network whether to activate or deactivate the UL gaps. |
| CATT | Yes | FFS for the details. |
| Apple | Yes |  |

## 3.4 FR2 UL gap activation/deactivation

RAN4 agreed that the configuration and deconfiguration of FR2 UL gaps at the same time activates and deactivates the FR2 UL gap.

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| --- |
| On UL gap configuration and activation:* UL gaps are configured by the network using RRC configuration upon UE request.
* UL gaps are deconfigured by the network using RRC configuration.
* Related to activation and deactivation of UL gaps:
* The UL gaps can be activated when configured (using RRC signalling).
* FFS: The UL gaps can additionally and optionally be activated and deactivated using MAC command after UL gap is configured by RRC Signaling
* The UL gaps are deactivated when deconfigured (using RRC signalling).
 |

Besides, [2] proposes to also support MAC CE based FR2 UL gap activation/deactivation, which was discussed once in last RAN2 meeting. The main motivation mentioned in [2] is when the benefit of P-MPR reduction is limited, UL gap should be de-activated, to avoid overall throughput loss due to UL gap overhead.

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| **Proposal 5: Enable dynamic activation and de-activation of UL gap via MAC CE.****Proposal 6: MAC CE design should guarantee that the activation/deactivation on UL gap apply to all FR2 serving cells.**  |

**Question 10: Do companies agree to support MAC CE based FR2 UL gaps activation/deactivation?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | No | We do not see much need to use MAC CE. We understand RAN2 usually defines gaps via RRC and such gap configuration does not require dynamic (de)activation via MAC. Thus the motivation is not clear. |
| vivo | No  |  |
| ZTE | No |  |
| Intel | No |  |
| Nokia, Nokia Shanghai Bell | No | We think this is a minor optimization don't see a need to define this in Rel-17.To assess the gains:* MAC CE takes ~3ms to (de)activate UL gaps (in addition to RRC configuration that is done previously)
* RRC reconfiguration processing delay is 10ms (see clause 12 in 38.331)
* Thus, the total delay reduction from using MAC CE is ~7ms, which is not very large given that the MPE evaluation period is in the order of seconds.
* Assuming we agree on UAI for gap activation/deactivation request, it's the RRC that processes the UL gaps anyway

Based on the above analysis, we see RRC-based mechanism for UL gap (de)activation as sufficient for this in Rel-17. |
| CATT | No |  |
| Apple | Yes | The most critical scenario we are thinking is to deactivate the UL gap timely. For example if UE moves from cell edge to cell center, normally UE don’t need do power backoff any longer. The UL gap configured can be deactivated to let UE benefit from higher throughput. |

## 3.5 UE capability on FR2 UL gap

[2] mentions that RAN4 has agreed that UE supporting UL gap should support MPE mandatorily in LS[1].

On P-MPR reporting:

It has been agreed that P-MPRgapon is part of the UL gap requirement via existing PHR MAC CE.

* UE will report P-MPRgapon when UL gap is activated
	+ At most UE should report 0~3dB P-MPR in the PHR

Therefore, UE supporting UL gap shall also support R16 MPE reporting at least when UL gap is activated.

[2] also explains that all UL gap patterns are optional and UE reports UE capability which UL gap configurations are supported. The reported UL gap patterns also indicate FR2 UL gap is supported by UE.

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| --- |
| **Proposal 14: UE supporting FR2 UL gap should also support R16 MPE reporting.****Proposal 15: All UL gap patterns are optional and UE reports the supported UL gap configurations through UE capability report to indicate that FR2 UL gap is supported.**  |

**Question 11: Do companies agree that UE supporting FR2 UL gap should also support R16 MPE reporting?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | Yes | Better RAN4 can send RAN2 feature list to capture this. |
| vivo |  | Wait for RAN4  |
| ZTE | Yes | We understand it is already clear based on RAN4 LS.Therefore, UE supporting UL gap shall also support R16 MPE reporting at least when UL gap is activated. |
| Intel |  | FFS for RAN4 |
| Nokia, Nokia Shanghai Bell | Yes | The reason for using UL gaps is to evaluate MPE. The reason for R16 MPE reporting is to indicate that UE requires MPE. Hence, both features relate to the same thing. |
| CATT | Yes |  |
| Apple | Yes | The P-MPR reporting text in RAN4 LS actually implies this. |

**Question 12: Do companies agree that all UL gap patterns are optional and UE reports the supported UL gap configurations through UE capability report to indicate that FR2 UL gap is supported?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | Yes | Better RAN4 can send RAN2 feature list to capture this. |
| vivo |  | Wait for RAN4  |
| ZTE | Yes | We understand UE will indicate the supported FR2 UL gap patterns in Ue capability, but it is ok to wait for RAN4’s feature list.  |
| Intel | Yes |  |
| Nokia, Nokia Shanghai Bell | No | We should rather define common **minimum set** of supported UL gap patterns that all UEs support. We would prefer that all UEs support all gap patterns, but can understand that may not be practical in all case.  |
| CATT | Yes |  |
| Apple | Yes |  |

## 3.6 Others

For any other issues not covered above, please feel free to indicate them into the following table.

|  |  |  |
| --- | --- | --- |
| Company | Discussion points | Comments |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

# 4 Phase 2 Discussion

[TBA]

# 5 Conclusion

Based on the discussion above, below are the proposals.