**3GPP TSG RAN WG2 Meeting #126 R2-24xxxx**

Fukuoka, Japan, May 20th– 24th, 2024

Agenda Item: 8.1.2.2

Source: Intel Corporation

Title: Report of [POST126][032][AI/ML PHY] LCM (Intel/Samsung)\_Phase 2

Document for: Discussion and Decision

# Introduction

This report provides a summary for the following post-meeting email discussion:

* [POST126][032][AI/ML PHY] LCM (Intel/Samsung)

Intended outcome:

Phase 1: Agreable definitions (Samsung)

Phase 2: Reach common understanding of reactive/proactive framework for applicable functionality.

Deadline: long

Deadline for providing initial comments for phase 2 is July 26th, 2024, 10:00 UTC.

Deadline for final comments based on rapporteur’s phase 2 summary is Aug 2nd, 2024, 10:00 UTC.

Companies providing input to this email discussion are requested to leave contact information below.

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| --- | --- | --- |
| **Company** | **Name** | **Email Address** |
| OPPO | Jiangsheng Fan | fanjiangsheng@oppo.com |
| Xiaomi | Xing Yang | Yangxing1@xiaomi.com |
| Futurewei | Chunhui (Allan) Zhu | chunhui.zhu@futurewei.com |
| NEC | Satoaki Hayashi | Satoaki-hayashi@nec.com |
| vivo | Boubacar Kimba | kimba@vivo.com |
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# Phase 2 Discussion

During phase 1 discussion, following definitions of functionalities (with majority view) are summarized:

Supported functionalities refer to functionalities that UE can indicate by using UE capability signalling.

Applicable functionalities refer to functionalities that the UE is ready to apply for model inference.

Activated functionalities refer to functionalities already activated and performing inference.

In phase 2, we will mainly focus on the signaling framework for applicable functionality reporting. To facilitate the discussion, following assumptions are considered:

* The discussion in Section 2.1 and Section 2.2 first focuses on beam management use case. Whether the conclusion for beam management can also be applicable to positioning use cases will be discussed in Section 2.4.
* The applicability reporting is only focusing on model inference purpose first, according to the observation from companies’ feedback in phase 1 Q3.

Before discussing the signaling framework, rapporteur would like to first discuss the understanding of NW-side and UE-side additional condition.

As we discussed in NW-sided model, UE-side additional condition may refer to UE speed, scenario, hardware capabilities, etc. The understanding of UE-side additional condition for UE-sided model is the same as NW-sided model. However, it is not clear what is the exact meaning of NW-side additional condition.

RAN1 summarized NW-side additional conditions in summarized in R1-2405680 :

* Mapping relationship of Set A and Set B, including ordering to (a set of ID, or resource )
* Consistency of downlink spatial domain transmission filters corresponding to the beams in Set A and Set B.
* QCL assumption
* The order of model input and model output.
* between RS and Tx beams can be pre-defined.
* Transmission power
* UE distribution
* antenna height
* Deployment scenarios (e.g., ISD, Umi/Uma)
* ensure consistency across different cells.

Note that it’s not rapporteur’s intention to discuss what is considered as NW-side additional condition or the definition of NW-side additional condition in this discussion. However, considering RAN2 is focusing on signaling framework of proactive/reactive reporting, it’s good to understand how this information is reflected in RRC signaling, if NW-side additional condition needs to be signaled over the air interface.

Therefore, rapporteur would like to collect companies’ view on what is the NW-side additional condition first before discussing the signaling procedure.

#### Q0-1: What is the representative of NW-side additional condition of a functionality in RRC signaling (e.g. network supported functionalities, network supported AI/ML resource configurations of the supported functionality, etc)?

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| **Company** | **Comment** |
| OPPO | In our view, NW side resource configurations can be divided into two categories:  Category A1(specified configurations used by UE for specific functionality but needs alignment with NW): the configurations configured to UE via dedicated signaling or broadcast signaling or default manner, i.e. Category A1 resource configurations can be known by UE via 3GPP specified method. For instance, BWP configuration, RB configuration, gap configuration and so on.  Category A2(specified configurations used by NW for specific functionality without UE involvement): the configurations are not configured to UE but specified via some spec e.g. NG, Xn, F1 and E1 spec. For instance, load info, interference coordination info and so on.  Category B1(NW implementation-based configurations which can impact inference performance for UE sided model): the configurations are not configured to UE, i.e. Category B1 resource configurations cannot be known by UE via 3GPP specified method but such configuration can significantly impact the inference performance of UE sided model. For instance, beam and Tx port mapping relationship, NW antenna shape, Antenna dip angle, height of gNB and so on.  Category B2(NW implementation-based configurations which has no impact on inference performance for UE sided model): the configurations are not configured to UE, i.e. Category B2 resource configurations cannot be known by UE via 3GPP specified method and such configuration has no significant impact on the inference performance of UE sided model. For instance, the algorism configuration for HO decision and so on.  In our view, when we’re talking about NW-side additional condition, it’s in relation with Category B1 resource configurations above. Because for Category A1 resource configurations, based on UE capability reporting, NW usually knows which specified data can be workable from UE point of view. As for Category A2/B2 resource configurations, it has no impact on inference performance for UE sided model, which is not related to UE side applicable functionality judgement.  More specific, from UE perspective, NW configured inference configuration includes two parts:  Part 1: Category A1 configurations, i.e. Normal specified functionality configurations, e.g. set A and/or set B resources for BM inference.  Part 2: Category B1 configurations, based on RAN1 progress, RAN1 has intention to introduce associated ID to implement Category B1 configurations, which can address the privacy concerns from NW vendor.  Based on above, we have the following definition for NW-side additional condition:   * **NW implementation-based configurations which can impact the consistency between training and inference for UE sided model**;   OPPO2：Thanks Rapp to give more info from RAN1 for NW-side additional conditions, but I would like to clarify the bullets listed here has no consensus by RAN1, RAN1 just lists all the possibility raised up by companies, some bullets even only supported by one company, so the bullets here are just for information to know all the possibility raised up by companies.  I was a little confused by the clarification from Rapp adding later, if we don’t touch what is considered as NW-side additional condition, how can we justify that UE capability signalling is not enough, anyway we should clarify the relationship between UE capability and additional condition reporting. We understand UE capability reporting+ additional condition reporting can tell NW the information needed to configure UE properly. For instance, UE reports its supporting two beam prediction functionalities: 4(input)-to-8(output) prediction and 8-to-16, based on UE capability signalling, at this stage (NW only obtains UE AI functionality capability), NW already knows which RS resources can be configured to UE side based on UE capability signalling, there is no need for NW to ask for the applicability of a specific RS resources again based on UAI, this is also the logic we follow for legacy non-AI feature, what NW does not know is the NW-side additional condition associated with UE sided model, because UE can know the NW-side additional condition associated with UE sided model only when the corresponding model is available at UE side, NW cannot get this dynamic info in advance without UE reporting. So NW should ask for such info (NW-side additional condition) via non-UE capability signalling, after this step, all info is ready from NW point of view, NW can do the configuration properly. |
| Xiaomi | We agree NW side additional condition is necessary to determine the functionality applicability. But we understand the exact meaning of NW side additional condition is up to RAN1. It’s not clear whether 3GPP would define the exact meaning of NW side additional condition. One example of NW side additional condition can be antenna pattern.  The general definition of NW side additional condition is already specified in the TR as following,  For an AI/ML-enabled feature/FG, *additional conditions* refer to any aspects that are assumed for the training of the model but are not a part of UE capability for the AI/ML-enabled feature/FG. It does not imply that *additional conditions* are necessarily specified. *Additional conditions* can be divided into two categories: NW-side additional conditions and UE-side additional conditions. Note: whether specification impact is needed is a separate discussion. |
| Futurewei | It is not very clear to us what “representative” means. To our understanding, additional conditions are the configurations under which a model was trained. Note although we are talking about functionality-based LCM, we all understand a functionality is always supported by one or more models. Therefore, NW-side additional condition are not “network supported functionalities”. These additional conditions are provided to the UE to ensure the NW and the UE are aligned on the conditions the model(s) is trained so that the UE/functionality can pick the right model for inference, for the current environment and configurations. |
| NEC | For BM-Case1 and BM-Case2 with a UE-side AI/ML model, the necessity and potential BM-specific conditions/additional conditions for functionality(ies) and/or model(s) are considered at least from the following aspects:  - information regarding model inference  - Set A / Set B configuration  - performance monitoring  - data collection  - assistance information  Among the above aspects listed in the TR, we understand consistency of Set B beams and Set A beams across training and inference would be a valid NW-sided additional condition. Followings are some examples:  ・Set size consistency for Set B, Set A: consistency in number of beams and/or associated resources for Set B and Set A, across training and inference  ・periodicity consistency for Set B, Set A: consistency in periodicity of beams and/or associated resources for Set B and Set A, across training and inference  ・relationship of Set A/ Set B (Set B is a subset of Set A or not): consistency in relationship of beams and/or associated resources for Set B and Set A, i.e, whether Set B is a subset of Set A, across training and inference |
| vivo | Tending to agree with Rapp to have general understanding on the NW-side additional conditions in RAN2 to facilitate the discussion on signalling procedure. The detailed additional conditions can be left to RAN1 to decide.  From our understanding, the NW-side additional conditions can be categorized as two types:  - **Type 1**: Beam characteristics, e.g., beam boresight direction (azimuth and elevation), 3dB beamwidth. This information can be agnostic to UE, thus can be implicitly indicated to UE as associated ID.  - **Type 2**: Set A/Set B related info, e.g., the beam index of set B. This information should be explicitly sent to UE for model inference. |
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Furthermore, based on how the UE trains each functionality, different functionalities may have their corresponding different NW-side additional conditions.

#### Q0-2: Do you think 1) NW-side additional condition of the functionality supported by the UE needs to be signalled to the network? 2) If it is signalled to network, is it include as part of UE capability, or as part of other RRC signaling (other than UE capability)? 3) If it is not signalled to network, what is the expectation from companies?

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| Company | **1) Yes/No** | **2) UE cap/other RRC signaling** | **3) Behavior if it’s not signalled to network** |
| OPPO | Yes with comments  This can be achieved via explicit or implicit way.  For explicit way, UE report info associated to NW-side additional condition if NW does not indicate filtering info associated to NW-side additional condition;  For implicit way, UE report Yes/No info associated to NW-side additional condition if NW indicates filtering info associated to NW-side additional condition. | Other RRC signaling (other than UE capability) is better.  Based on RAN2 previous agreement, UE should report functionality applicability only when the corresponding model(s) is available, but the model availability status can be changed in a short time, e.g. serving cell change, in this case, UE may need to update the reported functionality applicability based on the latest NW side additional condition. UE capability signaling is not suitable for such dynamic reporting procedure, so other RRC signaling (other than UE capability) is better for NW-side additional condition reporting. |  |
| Xiaomi | Yes,  We understand it’s essential for NW to know the NW-side additional condition of the functionality in following scenarios,  1) if NW is the node to determine functionality applicability,  2) if NW would like to modify the NW side additional condition to enable certain functionality applicable. | If the model/functionality is trained by UE, the associated NW-side additional condition is reported by UE.  If the model/functionality is trained by NW, the associated NW-side additional condition doesn’t need to be reported by UE.  If we focus on the first case, other signalling is preferred.  As defined in the TR, the additional condition is determined by the training data. If UE collects more training data, the associated NW-side additional condition may change. Therefore, legacy capability signalling is not applicable to carry such information. |  |
| Futurewei | Yes (in general) | Because some of the conditions may change dynamically, they should not be included in UE capability. In addition, they are called “additional” conditions for a reason; they are not part of UE capabilities. |  |
| NEC | Yes | We think it is reasonable to allow the UE to report its supported NW-side additional condition of the functionality.  We understand different cells may have different NW-side additional condition. However, from UE perspective, some “UE supported NW-side additional condition”  (for example, Set A and Set B configurations used for UE-side model training) could be static. We think such static “UE supported NW-side additional condition” can be included as a part of UE capability.  Moreover, including static “UE supported NW-side additional condition” as a part of capability can reduce AI/ML configuration latency and configuration overhead. |  |
| vivo | Yes, for Type 2 additional condition i.e., Set A/Set B related info. For example, NW may have to further assess the additional condition applicability. | Other RRC signaling |  |
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## Proactive Reporting

It was agreed in RAN2 #125bis and #126 meeting that supported functionalities (may or may not have available models) are reported in UE capability, while the existing UE assistance information (UAI) procedure is used for applicable functionality reporting in proactive reporting.

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| **RAN2 #125bis meeting:**   1. Which AI/ML-enabled Features/FGs and functionalities are supported should be standardized. The details wait for RAN1’s progress. “supported” means that the UE is capable of supporting the functionality and doesn’t mean neccesarily that the UE has the model available. FFS what functionality refers to. 2. Supported AI/ML-enabled Features/FGs and supported functionalities are included in UE capability. 3. Support proactive reporting of UE-sided applicable functionality, e.g., the UE reports its applicable AI/ML functionalities via UAI message/LPP message.   **RAN2 #126 meeting:**   1. For BM use case, As a baseline the UE determines whether a functionality is applicable. Existing UAI framework is used at least for proactive reporting of applicable functionality. FFS reactive |

According to the above agreements and companies’ inputs to RAN2 #126 meeting, rapporteur summarizes below signaling framework as an example of proactive reporting for discussion:



**Step 1**: Network sends *UECapabilityEnqiry* message to initiate the procedure to a UE reporting its AI/ML supported functionalities.

**Step 2**: UE sends *UECapablityInformation* message to network, containing supported functionalities at the UE side.

**Step 3**: Network configures UE that it is allowed to provide its applicable functionalities.

**Step 4**: UE sends applicable functionalities to network upon change of applicable functionality/condition.

**Step 5**: Network sends inference configuration for the applicable functionalities to the UE.

**Step 6**: Start inference/monitoring based on network/UE activation/deactivation.

In rapporteur’s understanding, in existing UAI framework, UE can only send UAI if configured to do (basic behaviour with UAI). Hence, the network shall at least configure the UE to provide assistance information, i.e. configure UE whether it is allowed to do UAI reporting or not.

#### Q1-1. Do you agree network shall at least configure the UE via *OtherConfig* whether it is allowed to do UAI reporting before applicable functionality reporting?

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| **Company** | **Yes/No** | **Comment** |
| OPPO | Yes | This is the basic logic as in legacy, we support this.  One more thing is that whether NW can configure something more, e.g. filtering info, to limit the reporting overhead in UL. Of course, this can be evaluated as the second step. |
| Xiaomi | Yes | Aligned with current UAI procedure. |
| Futurewei | Yes | Reasonable. |
| NEC | Yes | Follow current UAI framework. |
| vivo | Yes |  |
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As agreed in RAN2 #126 meeting, applicable functionality is determined by UE as baseline.

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| For BM use case, As a baseline the UE determines whether a functionality is applicable. |

After the UE is configured to provide applicable functionality information, the UE first needs to decide which applicable functionalities should be included in UAI and report to the network. Furthermore, as discussed in [6] and [12], the network may also be able to determine whether a functionality is applicable or not, according to NW-side additional conditions (i.e. without sending NW-side additional conditions to UE).

According to companies’ inputs to RAN2 #126 meeting, rapporteur summarizes below options on how UE/network decide the applicable functionalities:

* **Option 1: Joint decision by UE and NW**

In this option, UE-side additional conditions are known by UE internally, and NW-side additional conditions are known at network-side internally. First of all, UE decides UE-considered applicable functionalities based on UE-side additional conditions (e.g. UE speed, scenario, hardware capabilities, model availability, etc). UE reports **UE-considered** applicable functionalities to network. Network further checks its NW-side additional conditions by implementation and decides the **final** applicable functionalities by providing the corresponding configuration in Step 5.

However, the UE may also need to include NW-side additional condition of the corresponding reported UE-considered applicable functionalities in Step 4. Example of Step 3-5 of Option 1 is shown as below:



* **Option 2: UE decision**

**UE decides** the applicable functionalities based on UE-side additional conditions (internally known by UE) and NW-side additional conditions. This option seems to be a special case for Option 2, where network sends NW-side additional conditions to UE in Step 3 in advance for applicable functionality determination. Example of Step 3-5 of Option 2 is shown as below:



* **Option 3: NW decision**

**NW decides** the applicable functionalities based on UE-side additional conditions and NW-side additional conditions. In this option, the UE needs to report its UE-side additional conditions to NW via UAI. In rapporteur’s understanding, for proactive reporting, network only needs to provide network configurations to functionalities with available models at the UE side. Therefore, in this option, rapporteur assumes UE only needs to report UE-side additional conditions of available models in Step 3, while the network doesn’t need to know the exact model used by the UE. However, the UE may also need to include NW-side additional condition of the corresponding reported UE-considered applicable functionalities in Step 4. Example of Step 3-5 of Option 3 is shown as below:



#### Q1-2. Regarding to applicable functionalities determination, which option do you agree? Please also list any missing information that you think needs to be transferred to UE or reported to NW in Step 3/4 for applicable functionality determination.

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| **Company** | **Option 1/2/3** | **Comment (Is there any other information needed? why it’s essential?)** |
| OPPO | Option1/2 | For Option1, functionality filtering info may also be optionally included in step3, i.e. other config, to limit the reporting scope from UE side. This filtering info is supported by many UAI features in legacy, better to keep the door open for now.  For Option2, we’re wondering whether the NW-side additional condition included in step3 is configured per functionality or per cell, this may impact the reporting format in UAI from UE side. Of course, this may somehow touch stage3.  Both Option1 and Option2 can be workable. For Option1, the scalability may be better than Option2 considering mobility scenario, for Option2, NW may configure the latest NW-side additional condition in other config again to trigger UE reporting updated UAI while Option1 may still survive after serving cell change as all supported NW-side additional reporting reported from UE will transfer to target cell during HO.  For Option2, the Yes/No info in UAI may save some overhead compared to Option1.  Option3 is not workable from our side unless UE reports both UE side and NW-side additional condition and then NW make the decision. If UE only reports UE side additional condition, we don’t know how NW can know NW-side additional condition associated with UE side functionality. |
| Xiaomi | Comments | Option 3 is not preferred since it’s difficult to standardize and report all UE side additional condition. Many factors are up to implementation.  The key difference of option 1 and 2 is whether UE can obtain the NW side additional condition. It’s still under RAN1 discussion whether NW should provide NW side additional condition to UE.  We understand UE shall determine functionality applicability at least based on UE side additional condition. If UE can obtain the NW side additional condition, UE shall also consider the NW side additional condition. It’s unnecessary for UE to ignore the available NW side additional condition.  In short, UE shall determine the functionality applicability based on UE side additional condition and NW side additional condition if available. Option 1 and 2 can be merged. |
| Futurewei | Comments | We think it is important to separate the discussions for NW-side functionality and UE-side functionality; each may prefer different options. For example, for UE-side functionality/model, Option 2 may be preferred while for NW-side functionality/model, Option 3 may be preferred. |
| NEC | Option 2 | Phase 1 has the agreement that “Applicable functionalities refer to functionalities that the UE is ready to apply for model inference.”, therefore we think Option 2 is a straightforward solution.  Option 1: Regarding the NW-side additional conditions, if there are no information from NW side, seems the UE shall report UE-considered applicable functionalities and all corresponding UE-considered NW-side additional conditions which may not match with the current gNB additional conditions at all.  Option 3: This option against the baseline we agreed at RAN2#126,  As a baseline the UE determines whether a functionality is applicable.  Moreover, it is not clear that whether NW has full knowledge on the UE-side additional conditions to make a proper determination of applicable functionalities. |
| vivo | Option 1/2 | For step 3, the NW-side additional conditions can be broadcast as system information, e.g., associated ID |
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#### Q1-3. Any other comment on the above signaling flow of proactive reporting?

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| **Company** | **Comment** |
| OPPO | See answer in Q1-2. |
| Xiaomi | Option 1 and 2 can be merged. UE shall first determine the functionality applicability based on UE side additional condition and NW side additional condition if available. After report, NW can further choose the functionality based on NW side additional condition, which is not provided to UE. |
| NEC | For activating UE-sided model, at least two RRCReconfig are needed, the first one for applicable functionality UAI report and the second one for full AI/ML configuration. Not sure are there any concerns on latency. |
| vivo | Option 1 and 2 can be merged, for example in case NW side additional conditions are available and NW can include them in step 3 of Option 1, i.e., along the configuration to allow UE performing UAI reporting. |
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## Reactive Reporting

According to companies’ inputs to RAN2 #126 meeting, it seems companies’ understanding on reactive reporting is whether the applicable functionality reporting is considered as a response to network configuration. The network can either provide AI/ML resource configuration for multiple functionalities or some initial query (with some initial configuration) of applicable functions to UE. UE then reports applicable functionalities in response, either indicating acceptance of certain configurations or request for detailed network configurations for applicable functionalities.

From signaling procedure point of view, rapporteur summarizes below example for reactive reporting. The overall signaling procedure is similar to proactive reporting. However, there are some differences in terms of signaling content and detailed information, for example, the network needs to provide configurations to UE before UE reports applicable functionalities.



**Step 1**: Network sends UECapabilityEnquiry message to initiate the procedure to a UE reporting its AI/ML supported functionalities.

**Step 2**: UE sends *UECapablityInformation* message to network, containing supported functionalities at the UE side.

**Step 3**: Network provides network configurations and initiates UE to report its applicable functionalities.

**Step 4**: UE sends applicable functionalities to network.

**Step 5**: Network sends updated inference configuration for applicable functionalities reported in Step 4 to the UE. (see Q2-6)

**Step 6**: Start inference/monitoring based on network/UE activation/deactivation.

Following agreement was reached in RAN2 #125bis meeting:

1. Support reactive reporting of UE-sided applicable functionality. The NW configures AI/ML functionalities via RRC/LPP message. FFS what the configuration contains. FFS how to report applicable functionality and what is applicable functionality

In rapporteur’s understanding, network can provide configurations (e.g. beam resource configuration of Set A and Set B) for supported functionalities in Step 3.

#### Q2-1. In Step 3 of reactive reporting, do you agree that network can provide some configurations (e.g. AI/ML beam resource configuration of Set A and Set B) for functionalities? Please also provide an example of configuration for functionalities other than AI/ML beam resource configuration, if applicable.

NOTE: NW-side additional condition will be discussed in Q2-2.

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| **Company** | **Yes/No** | **Comment** |
| OPPO | No | As analysed in Q0-1, NW will definitely know which specified configuration, i.e. Category A1 resource configurations in Q0-1, is or is not applicable to UE side based on UE capability reporting, this is the logic we always follow in legacy, what is the strong motivation to break this principle for AIML? why NW should ask again when already known via UE capability reporting? What NW does not know is the NW side additional condition associated to UE side functionality, that’s why we need NW side additional condition reporting from UE to NW.  Based on above, we don’t think this kind of reacting method is workable.  From our side, reacting method have another understanding, like proactive method listed above, NW configure other config via RRCReconfiguration message, UE responses with RRCReconfigurationcomplete message including applicable functionality, the three options introduced for proactive method above is also valid for this reacting method. |
| Xiaomi | Yes with comments | This is related to the granularity of functionality, which is under RAN1’s discussion. It’s up to RAN1 whether the beam resource configuration of set A and B can identify a functionality. If functionality is agnostic to configuration of set A and B, there is no need to provide such configuration to trigger reactive report.  NW can already obtain the supported functionality via UE capability signalling, as concluded in phase 1. NW may just indicate the ID of the supported functionality. And UE response with the applicability of the indicated functionality. |
| Futurewei | Yes. | NW-side additional conditions/configurations will help the UE to determine its available functionality. |
| NEC | Maybe Yes | We understand the rapporteur intention here is to provide some configurations related to NW-side addition conditions. If Set A / Set B configurations can be considered/defined as NW-side additional conditions, then “AI/ML beam resource configuration of Set A and Set B” can be used to present NW-side additional condition related information. Based on this understanding, we think the answer may be “Yes”.  Basically, we think Step 3 can only include configurations related to NW-additional condition (e.g., configurations which used to present NW-additional conditions). Full configuration of the AI/ML, e.g., configuration for inference and/or performance monitoring, etc. of the applicable functionality should be provided after receiving UE applicable functionality reporting (i.e., Step 5). |
| vivo | Yes, with Type 1 i.e., Beam characteristics, no for type 2 i.e., Set A/Set B related info | - Type 1: Beam characteristics, e.g., beam boresight direction (azimuth and elevation), 3dB beamwidth. This information can be agnostic to UE, thus can be implicitly indicated to UE as associated ID.  - Type 2: Set A/Set B related info, e.g., the beam index of set B. This information should be explicitly sent to UE for model inference. |
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According to UE capability reported by the UE, network can provide network configuration (discussed in Q2-1) to all/subset of supported functionalities.

Based on current NW-side additional conditions, network can filter a list of functionalities from supported functionalities according to network implementation, and then provide configurations for those NW-considered applicable functionalities. Alternatively, similar as proactive reporting, in addition to network configuration (discussed in Q2-1), network can provide NW-side additional condition explicitly in Step 3, and let UE decide applicable functionality based on both NW-side and UE-side additional condition.

In the end, considering this configuration is provided by network based on UE supported functionalities, in rapporteur’s understanding, all of the functionalities configured by network in Step 3 may or may not have an available model, and may or may not be applicable at the UE side.

#### Q2-2. In Step 3 of reactive reporting,

**1) is there any other information (e.g. NW-sided additional condition) you think the network can provide except AI/ML resource configuration of NW-considered applicable functionalities (i.e. subset of supported functionalities based on NW-side additional condition)**

**2) those functionalities may or may not have an available model, and may or may not be applicable at the UE side?**

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| Company | **1) Yes/No** | **2) Yes/No** | **Comment** |
| OPPO |  |  | See answer in Q2-1 |
| Xiaomi | Yes | Yes | We agree with rapp NW may provide the NW side additional condition to UE. UE can response with the applicable functionality under the corresponding NW side additional condition. Such information is useful for NW to decide the appropriate NW configuration and activated functionality. |
| NEC | Maybe No | Yes | We are a bit confused with the relationship between “AI/ML beam resource configuration of Set A and Set B” in Q2-1 and “AI/ML resource configuration of NW-considered applicable functionalities” here.  If the former one is just an example of the latter wording, we have no idea on any other information besides “AI/ML resource configuration of NW-considered applicable functionalities”.  Step 3 only provides NW-sided additional condition, therefore, those functionalities may or may not have an available model, and may or may not be applicable at the UE side. |
| vivo | Left to RAN1 | Yes |  |
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Then UE can decide the final applicable functionalities based on its UE-side additional condition:



#### Q2-3. Do you agree UE reports final applicable functionalities (applicable based on both UE and NW side additional condtion) in Step 4, as a response to Step 3?

NOTE: Non-applicable functionality with available model reporting in Step 4 will be discussed in Q2-7.

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| **Company** | **Yes/No** | **Comment** |
| OPPO |  | See answer in Q2-1 |
| Xiaomi | Yes with comments | We suggest to remove the ‘final’. Because NW may further determine the applicable functionality based on NW side additional condition or other implementation factors. UE just need to reports the applicable functionalities from UE point of view. |
| Futurewei | Yes. |  |
| NEC | Yes |  |
| vivo | No | Agree with Xiaomi to remove “final” as “~~final~~ applicable functionalities” |

In below sections, let’s have some initial discussion on candidate RRC signalings used for Step 3-4. According to the contributions submitted RAN2#126 meeting. There are mainly two options proposed by companies:

**Option 1:** RRCReconfiguration/ RRCReconfigurationComplete (including RRCResume /RRCResumeComplete, etc) [1][9][15][18][21]

In this option, *RRCReconfigurationComplete* message is directly used to report the applicable functionalities in response to *RRCReconfiguration* in Step 3. Furthermore, [9][18][21] also mentioned that complete messages can be used when synchronization is lost between UE and NW, RRC state transition, etc.

**Option 2:** UAI (i.e. same as Approach #1 (proactive reporting), OtherConfig in RRCReconfiguration and UAI) [2][5][10][19][25]

In this option, UAI message can also be used in response to configurations received by UE in Step 3, indicating the applicable functionalities, i.e. reuse the same signaling as proactive reporting. By using UAI framework for reactive reporting, it also means network also needs at least configure the UE whether it is allowed to do applicable functionality reporting in Step 3.

#### Q2-4. Which option do you agree as signalings for Step 3 and Step 4?

**Option 1: RRCReconfiguration/ RRCReconfigurationComplete (including RRCResume /RRCResumeComplete, etc)**

**Option 2: UAI (i.e. same as Approach #1 (proactive reporting), OtherConfig in RRCReconfiguration and UAI)**

**Option 3: Others (please list the signaling message)**

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| --- | --- | --- |
| **Company** | **Option 1/2/3** | **Comment** |
| OPPO | Option1 | See answer in Q2-1, only Option1 is applicable for reactive method. |
| Xiaomi | 1/2 | No strong view. Both options are feasible. |
| Futurewei | 2 | Option 2 can work for both proactive and reactive cases. Option 1 works too. But we have agreed to use Option 2 for the proactive case. We should use the same approach for both cases. |
| NEC | - | Option 1: On the top of reporting UE supported NW-side additional conditions via UE capability signalling and proactive applicable functionality reporting, we don’t see motivations to introduce this reactive reporting via RRCReconfiguration/ RRCReconfigurationComplete (including RRCResume /RRCResumeComplete, etc).  Option 2, we are OK with Option 2, however, it is the same as proactive reporting.  See answer in Q0-2, we think it would be good to use UE capability signalling to reduce AI/ML configuration latency and configuration overhead. |
| vivo | Option2/3 | Prefer to have unified procedure for reactive and proactive reporting, specifically, A UE have applicable functionalities may initiate the UAI procedure if it was configured to do so, upon it was configured to provide applicable functionalities, or upon change of applicable functionalities.  The former case (initial report) can be regarded as reactive reporting and the latter ones (upon change) can be regarded as proactive reporting.  We are also OK for the separate procedures. But we do not think Option 1, is appropriate for applicable functionality reporting. *UEInformationRequest /response* can be considered, which is used by the network to request the UE to report information. |

#### Q2-5. Please also list any missing information that you think needs to be transferred to UE or reported to NW in Step 3/4. If none, please skip this question.

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| **Company** | **Comment** |
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After Step 4 and determination of applicable functionalities, it is not clear whether the network needs to provide an update of network configurations or not.

The update of network configuration may not be needed, considering the UE itself knows the applicable functionalities and can directly use the network configuration in Step 3 without further update from network. On the other hand, the network may not have provided the full AIML resource configuration in Step 3 and may need to provide an updated configuration to UE according to the final applicable functionalities reported by the UE.

#### Q2-6. Do you think Step 5 is needed in reactive reporting? if yes, please comment on what is the difference with Step 3.

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| **Company** | **Yes/No** | **Comment** |
| OPPO |  | See answer in Q2-1 |
| Xiaomi | Up to NW | NW may send *RRCReconfiguration* to update the NW configuration or other configuration. We don’t need to restrict NW implementation. |
| Futurewei | No | Does not seem necessary; does it provide any new information that the UE does not know? And how the UE is going to use it? |
| NEC | Yes | Step3 only configures NW-side additional condition related configurations (e.g., AI/ML beam resource configuration of Set A and Set B) whereas Step 5 should provide a full configuration for the activated functionality, for example, inference and/or performance monitoring related configurations, etc. |
| vivo | Yes | Especially for the type 2 conditions.  - Type 2: Set A/Set B related info, e.g., the beam index of set B. This information should be explicitly sent to UE for model inference. |
|  |  |  |

During RAN2 #126 meeting, it was agreed that, for a functionality to be applicable, it should have at least one model available within it. It is straightforward to conclude that applicable functionalities reported in Step 4 has an available model. During phase 1 discussion, companies have different understanding on whether to define available functionalities separately from applicable functionalities. Then, the question is whether a UE can report its non-applicable functionalities but with an available model via the same message used for applicable functionality reporting or not.

#### Q2-7. For reactive reporting, do you think UE can also include non-applicable functionalities with an available model in Step 4?

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| OPPO | Yes if reactive method definition is based on our understanding in Q2-1 | See answer in Q2-1 |
| Xiaomi | Comment | In current procedure, UE reports the applicable functionality or non-applicable functionality. Does rapp intend to introduce a new type of functionality? We don’t see the need to introduce more types of non-applicable functionality. |
| Futurewei | Comment | We don’t quite understand the question; why we want to report a non-applicable functionality with an available model? |
| NEC | No | Both proactive and reactive reporting are limited to applicable functionalities. |
| vivo | no |  |
|  |  |  |

#### Q2-8. Any other comment on the above signaling flow of reactive reporting?

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| **Company** | **Comment** |
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## Others

proactive vs. reactive

After discussing the above signaling, hope companies now have a clear understanding of what is proactive and reactive reporting. Based on above assumptions, the key differences between proactive and reactive reporting can be summarized as below:

|  |  |  |
| --- | --- | --- |
|  | **What is the trigger applicable functionality reporting?** | **Sequence between configuration and applicable functionality reporting** |
| **Proactive reporting** | Upon a change of condition(s) | Applicable functionality reporting -> Configuration |
| **Reactive reporting** | As a response to network configuration | Configuration -> Applicable functionality reporting |

#### Q3-1. Do you agree the key differences between proactive and reactive reporting are:

1. **trigger of applicable functionality reporting: upon a change of condition(s) (proactive) or as a response to network configuration (reactive)**
2. **whether the configuration of functionalities is provided after applicable functionality reporting (proactive) or before (reactive)**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| OPPO | No | See answer in Q2-1 |
| Xiaomi | Comment on the proactive trigger | We understand the trigger of proactive reporting upon a change of functionality applicability, rather than the condition. Because the condition change may not necessarily result in functionality applicability change. Upon condition change, UE shall first determine whether functionality applicability changes. If yes, trigger proactive report. If no, no need to trigger proactive report.  We are fine with other parts. |
| NEC | Partially Yes | For reactive reporting, sequence should be  NW-side additional condition related configuration -> Applicable functionality reporting -> full configuration |
| vivo | Yes for 1,  No for 2 |  |
|  |  |  |

Initial Activation/Deactivation

During RAN2 #126 meeting discussion, following agreements are captured on applicable functionalities and activated functionalities:

|  |
| --- |
| RAN2 will support functionality activation/deactivation after inference configuration. FFS initial state of configuration and how activation/deactivation is achieved. |

After applicable functionality reporting, it is not clear what is the initial state (active/deactive) of the functionality after Step 5, and how an applicable functionality becomes an activated functionality. There are three options:

**Option 1**: The applicable functionality is activated by receiving configuration for applicable functionalities in Step 5 (if needed). If configuration is not provided by the network, it means the functionality is not activated.

**Option 2**: The applicable functionality is automatically activated if it is included in applicable functionality reporting (assuming the network configuration received in Step 3 is directly applied and the functionality is activated).

**Option 3:** A functionality is activated based on a field in RRCReconfiguration in Step 3 or Step 5 (indicating the functionality activation status), and additionally via L1/L2 based activation/deactivation signaling. L1/L2 based activation/deactivation signaling is up to RAN1.

#### Q3-2. Which option do you agree that an applicable functionality initially becomes an activated functionality after receiving configuration in Step 5?

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| --- | --- | --- | --- |
| **Company** | **Proactive reporting:**  **Option 1/2/3** | **Reactive reporting:**  **Option 1/2/3** | **Comment** |
| OPPO | Option1/3 | Option1/3 | Option1 should be the baseline. Option3 can be considered for model switching/deactivation/activation. |
| Xiaomi | 1 | 1 | Option 1 is used for initial activation. Option 3 is used for subsequent activation/deactivation.  Although the same RRC message may be used in step 3 and 5, e.g. *RRCReconfiguration*, different IEs would be used to indicate the functionality in step 3 and 5. In step 3, the purpose is not to activate the functionality. |
| NEC | Option 3 | Option 3 | Should be in Step 5. |
| vivo | 1 or 3 | 1 or 3 |  |
|  |  |  |  |

## Positioning

During RAN2 #126 meeting online discussion, following agreements on positioning Case 1 were made:

1. The LPP Capability Transfer procedures (RequestCapabilities/ProvideCapabilities messages) are used to indicate supported AI/ML positioning capabilities. FFS how to handle dynamic capabilities, depending on further RAN1 progress and understanding of the functionality.
2. wait for RAN1 for associate ID discussion

Considering the exact signaling needs further RAN1 inputs, rapporteur suggests to only focus on the **general principle** for positioning during this discussion, e.g. exact LPP signaling (whether existing signaling or new enhancement) and NW-side/UE-side additional condition will **not** be discussed in this email discussion.

It was agreed in RAN2 #125bis meeting that proactive reporting and reactive reporting are applicable for both beam management and positioning use cases.

**Agreements for positioning and beam management**

1. Support proactive reporting of UE-sided applicable functionality, e.g., the UE reports its applicable AI/ML functionalities via UAI message/LPP message.
2. Support reactive reporting of UE-sided applicable functionality. The NW configures AI/ML functionalities via RRC/LPP message. FFS what the configuration contains. FFS how to report applicable functionality and what is applicable functionality

Based on the discussion of beam management, it seems there are some commonalities between positioning and beam management in terms of proactive/reactive reporting. Following assumptions for beam managements are also applicable for positioning, except the protocol is LPP between UE and LMF:

* + - 1. The key difference between proactive and reactive reporting is the trigger of applicable functionality reporting, and whether the configuration of functionalities is provided after applicable functionality reporting or before. This seems can also be applicable for positioning Case 1: i.e.

1) in **proactive reporting**, UE can report a change in applicable functionality/condition by sending applicable functionalities upon change via LPP signaling, network provides configurations of functionalities via LPP signaling **after** NW knowing applicable functionalities

2) in **reactive reporting**, applicable functionality reporting is provided as **a response to** the network configuration, where network provides configurations of functionalities via LPP signaling **before** NW receiving applicable functionalities.

* + - 1. Depends on Q2-7 if agreed, UE also sends functionalities with available model, but not applicable via LPP signaling in the same message used for applicable functionality reporting.
      2. Depends on Q3-2, the configuration after NW receiving applicable functionality reporting may or may not means the functionality is activated.

#### Q4-1. For positioning Case 1, do you agree with the above assumptions?

NOTE: Exact LPP signaling (whether existing signaling or new enhancement) and NW-side/UE-side additional condition will **not** be discussed in this email discussion.

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| OPPO | Yes for assumption 2 and 3 | For assumption 1, we have different view as commented in Q2-1 |
| Xiaomi | Comments for assumption 1  Yes for assumption 2 and 3 | We have the following understandings regarding the functionality reporting for positioning:   * The UE reports the applicable functionality, not the condition. * Proactive reporting implies that the reporting occurs without a network request, whereas reactive reporting is based on a network request. * The LPP is used between the UE and the LMF, we suggest using ‘LMF’ instead of ‘network’.   Therefore, we make some changes as below:  1) in **proactive reporting**, UE can report a change in applicable functionality/condition by sending applicable functionalities upon change via LPP signaling without LMF request, LMF network provides configurations of functionalities via LPP signaling **after** LMF NW knowing applicable functionalities  2) in **reactive reporting**, applicable functionality reporting is provided as **a response to** the network configuration LMF request, where LMF network provides configurations of functionalities via LPP signaling **before** LMF NW receiving applicable functionalities. |
| vivo | Yes for 1 with comments.  No for 2  Yes for 3 | For 1) and 2), We think the description can be simplified as:  1) in **proactive reporting**, UE can report a change in applicable functionality~~/condition~~ by sending applicable functionalities upon change via LPP signaling, ~~network provides configurations of functionalities via LPP signaling~~ **~~after~~** ~~NW knowing applicable functionalities~~  2) in **reactive reporting**, applicable functionality reporting is provided as **a response to** the network request ~~configuration, where network provides configurations of functionalities via LPP signaling~~ **~~before~~** ~~NW receiving applicable functionalities~~. |
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#### Q4-2. For positioning Case 1, any other information needs to be considered during proactive/reactive reporting?

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| **Company** | **Yes/No** | **Comment** |
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# Conclusion

# Reference

[1] R2-2404151 LCM for UE-sided model for Beam Management use case OPPO

[2] R2-2404185 Beam management UE-sided model LCM signaling Intel Corporation

[3] R2-2404275 On LCM for UE-sided model for Beam Management use case Qualcomm Incorporated

[4] R2-2404341 Discussion on the LCM for UE-sided model for Beam Management Fujitsu

[5] R2-2404370 LCM for UE-sided model for Beam Management use case TCL

[6] R2-2404390 Discussion on LCM for UE-sided model for Beam Management vivo

[7] R2-2404503 LCM for UE-sided model for Beam Management use case Interdigital Inc.

[8] R2-2404599 Discussion on LCM for UE-sided model for BM Xiaomi

[9] R2-2404637 LCM procedure of UE-sided model for AI/ML based beam management Apple

[10] R2-2404691 Discussion on LCM for UE-sided model for Beam Management use case CATT

[11] R2-2404816 LCM for AIML based beam management with UE-sided model Lenovo

[12] R2-2404817 Discussion on applicability-related information and additional condition Lenovo

[13] R2-2404902 UE side model functionality definition Sony

[14] R2-2404933 Discussion on LCM for UE-sided model Spreadtrum Communications

[15] R2-2404941 Functionality based LCM related to UE-side models for BM Nokia

[16] R2-2404957 Functionality identification and applicability related report LG Electronics

[17] R2-2404958 Functionality management for UE-sided model LG Electronics

[18] R2-2405025 Discussion on LCM for UE-sided model for BM CMCC

[19] R2-2405073 Discussion on LCM for UE-sided model NEC

[20] R2-2405180 Functionality-based LCM for UE sided model Samsung

[21] R2-2405184 Considerations on LCM for UE side Model for AIML Based BM ZTE Corporation

[22] R2-2405246 LCM Framework for UE-sided model SHARP Corporation

[23] R2-2405266 LCM for UE-side models for beam management Ericsson discussion

[24] R2-2405274 Discussion on LCM for UE-Side Models Futurewei Technologies

[25] R2-2405337 Discussion on functionality based LCM for UE-sided model for BM Huawei, HiSilicon

[26] R2-2405536 Considerations for moving forward with Functionality-based LCM Kyocera

[27] R2-2405665 Discussion on applicable functionality NTT DOCOMO, INC.

# Annex – RAN2 agreements on UE-sided model LCM

RAN2 #125bis meeting

**Agreements**

1. Which AI/ML-enabled Features/FGs and functionalities are supported should be standardized. The details wait for RAN1’s progress. “supported” means that the UE is capable of supporting the functionality and doesn’t mean neccesarily that the UE has the model available. FFS what functionality refers to.

2. Supported AI/ML-enabled Features/FGs and supported functionalities are included in UE capability.

**Agreements for positioning and beam management**

1. Support proactive reporting of UE-sided applicable functionality, e.g., the UE reports its applicable AI/ML functionalities via UAI message/LPP message.
2. Support reactive reporting of UE-sided applicable functionality. The NW configures AI/ML functionalities via RRC/LPP message. FFS what the configuration contains. FFS how to report applicable functionality and what is applicable functionality

3 FFS how the two approaches will be specified and whether we can combine them into one procedure. FFS how to report applicable functionality, what is applicable functionality, how the UE determines which function is applicable or not (if it is needed)

**Agreements:**

1 For UE-sided model, for the functionality management, the “network decision, network-initiated” AI/ML management is supported as a baseline. The following can be considered further “UE autonomous, decision reported to the network”, “Network decision, UE-initiated” (i.e. proactive approach).

2 “UE-autonomous, UE’s decision is not reported to the network” is not considered for Rel-19

RAN2 #126 meeting

**Agreements**

1 RAN2 will support functionality activation/deactivation after inference configuration. FFS initial state of configuration and how activation/deactivation is achieved. FFS what Deactivation refers to: examples discussed: 1) fallback to legacy 2) switching, etc.

2 We will work offline on the definitions for functionality types and define what is availability.

3 The UE will indicate the gNB/LMF whether the AI/ML functionality is available/applicable. For a functionality to be applicable at least there should at least one model available within it. FFS other details on what is applicability/non-applicability.

4 For NW-side additional conditions, RAN2 assumes that RRC signaling from gNB to UE can be designed for consistency between inference and training. RAN2 will wait for RAN1 input for further details. FFS if the same applies to positioning

5 For BM use case, As a baseline the UE determines whether a functionality is applicable. Existing UAI framework is used at least for proactive reporting of applicable functionality. FFS reactive