**3GPP TSG RAN WG2#127 R2-240xxxx**

**Maastricht, Netherlands, Aug 19th – 23rd, 2024**

**Title: [Draft] LS on beam management UE-sided model LCM**

**Release: Rel-19**

**Work Item: NR\_AIML\_air-Core**

**Source: Intel Corporation (to be TSG RAN WG2)**

**To:** **TSG RAN WG1**

**Contact person: Ziyi Li, ziyi.li@intel.com**

1 Overall description

To support beam management UE-side model life cycle management, RAN2 has studied and worked on the signalling procedure of applicable functionality reporting.

RAN2 has made following agreements and signalling procedure (see the attached figure) on LCM for beam management UE-sided model:



* **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**”: Following configurations are provided from NW to UE:

1) The network configuration enabling the UE to do UAI reporting via OtherConfig.

2) Network may provide NW-side additional condition. FFS on the RRC signalling and whether it is mandatory or optional.

3) FFS on configuration (e.g. inference configuration) of supported functionalities. FFS on the content of configuration.

* (**between “Step 3” and “Step 4”**) UE decides the applicable functionalities based on NW-side additional conditions (if provided), UE-side additional conditions (internally known by UE) and model availability in device. FFS whether other configuration can considered by UE (e.g. inference configuration). FFS how the applicable functionality is decided if NW-side additional condition is not provided in step 3.
* “**Step 4**”: UE reports applicable functionality in the following scenarios:

1) Upon being configured to provide applicable functionality and upon change of applicable functionality via UAI

2) As response to NW-side additional condition when the network requests applicable functionality reporting in step 3, FFS in response to other network configuration (e.g. inference configuration).

* **Step 5**:

1) Network configures inference configuration to UE after applicable functionality reporting, if inference configuration based on supported functionality is not provided in Step 3 (i.e. inference configuration is provided in Step 5).

2) If inference configuration based on supported functionality is provided in Step 3, it is up to network implementation whether to provide an updated configuration or not.

RAN2 also agreed the applicable functionality may be activated by receiving its inference configuration when it is provided in Step 5. FFS the initial activation state. FFS on initial state of applicable functionality if inference configuration of supported functionality is provided in Step 3. FFS on additional L1/L2 signaling for activation/deactivation. FFS if multiple applicable functionalities can be activated at the same time. FFS what is the granularity of functionality.

The above agreements were made based on the following assumptions:

NW-side additional condition is assumed as associated ID in RAN2 (which is used by majority of companies). Other inference configuration (e.g. CSI-RS resource configuration, etc) is considered separately from NW-side additional condition, i.e. it is not considered as part of NW-side additional condition in below proposals. It is up to RAN1 about the details of NW-side additional condition and other inference configuration, and the relationship between them.

Furthermore, RAN2 also agreed the following understandings on terminologies:

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| **Supported functionalities** refer to functionalities that UE can indicate by using UE capability information (via RRC/LPP signalling)**Applicable functionalities** refers to functionalities that the UE is ready to apply for inference**Activated functionalities** refers to functionalities already enabled for performing inference |

To further progress life cycle management for beam management UE-sided model, RAN2 has following questions for which RAN2 would like to check RAN1’s understanding:

On General

* Q1: What is the granularity of supported functionality expressed in the UE capability? For example, whether it is a use case (e.g. beam management), whether it is a sub-use case (e.g. beam management Case 1), or others?
* Q2: If multiple functionalities are defined per use case or sub-use case, whether multiple functionalities can be applicable concurrently for a sub-use case, across sub-use case of a use case, or across different use cases? Whether multiple applicable functionalities can be activated at the same time?

On NW-side additional condition and configuration

* Q3: What is the format of NW-side additional condition, i.e. is it correct the RAN2 assumption of a NW-side additional condition assumed as associated ID? Which is the signalling framework (e.g. CSI) to be used to signal the NW-side additional condition?
* Q4: ~~For UE evaluating applicable functionality reporting~~, what is the relationship between NW-side additional condition and inference configuration in Step 3? For example, NW-side additional condition is part of inference configuration, or NW-side additional condition is separate from inference configuration, etc?
* Q5: What is needed by UE to decide whether a functionality is applicable before Step 4 (e.g. NW-side additional condition and/or inference configuration from network in step-3)?
	+ Q5-1: Is it feasible for UE to decide the applicable functionalities without NW-side additional condition? If yes, what information does UE use to decide applicable functionality?
	+ Q5-2: Is it feasible for gNB to provide inference configuration UE in Step 3 to applicable functionalities?
	+ Q5-3: If inference configuration is provided in Step 3 based on supported functionality reported in UE capability, what is the content of inference configuration (e.g., set A and/or set B configuration, associated ID, etc) ?
	+ Q5-4: If inference configuration is not provided in Step 3, what is the content of inference configuration in Step 5?
		- Q5-5: What is the delta between configuration in Step 3 (if provided) and Step 5?
* Q6: Whether NW-side additional condition is functionality specific?

On Functionality Activation

* Q7: What is the initial activation state of UE-sided functionality before Step 3?
* Q8: Is L1/L2 signalling for functionality activation/deactivation needed?

2 Actions

**To RAN1**

**ACTION:** RAN2 kindly requests RAN1 to take the above RAN2 agreements into consideration and inform RAN2 in case issues are identified, and kindly reply with RAN1 understanding to enable RAN2 further progress in beam management UE-sided model LCM.

3 Dates of next TSG RAN WG2 meetings

TSG-RAN WG2 Meeting #127bis Oct 14th – Oct 18th, 2024 Hefei, CN

TSG-RAN WG2 Meeting #128 Nov 19th – Nov 22nd, 2024 Orlando, US

4 Comment (to be deleted after RAN2 discussion)

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| **Company** | **Comment (suggestions and other questions)** |
| OPPO | * We think Q4 should be merged with Q5-2, because Q4 is based on the assumption that inference configuration is provided in step 3, otherwise, there is no relationship between NW-side additional condition and inference configuration in Step 3. More addition, Q5-3 is also based on the assumption that inference configuration is provided in step 3, better to merge with Q5-2 as well for simplicity. So we suggest to delete Q4 and Q5-3, and revise Q5-2 as the following:
	+ Q5-2: Is it feasible for gNB to provide inference configuration to UE in Step 3 to determine applicable functionalities at UE side? If feasible, what is the content of inference configuration in Step 3 based on supported functionality? what is the relationship between NW-side additional condition and inference configuration in Step 3? NW-side additional condition is part of inference configuration, or NW-side additional condition is separate from inference configuration, etc?
* For Q5-4, to make the question clear enough, we suggest to revise Q5-4 as the following:
	+ Q5-4: If inference configuration is not needed in Step 3, i.e. inference configuration is provided in step 5, what is the content of inference configuration in Step 5? what is the relationship between NW-side additional condition and inference configuration in Step 5? NW-side additional condition is part of inference configuration, or NW-side additional condition is separate from inference configuration, etc?
* For Q5-5, we understand it should be merged into Q5-2 or put under Q5-2 as one additional question, it’s not relevant to Q5-4, so better not to put Q5-5 under Q5-4.
* For Q7, we think the question may have logic problem as there may be no inference configuration before Step 3, so suggest to revise Q7 as the following to make it clear:

Q7-1: If inference configuration is needed in Step 3, what is the initial activation state of UE-sided model upon receiving Step 3? Q7-2: If inference configuration is not needed in Step 3, what is the initial activation state of UE-sided model upon receiving Step 5? |
| vivo(Boubacar) | 1. We should have a question addressing:
* “FFS on the RRC signalling and whether it is mandatory or optional.” e.g. Qx-y: Whether Network providing NW-side additional condition in step 3 is mandatory or optional?
* “FFS on initial state of applicable functionality if inference configuration of supported functionality is provided in Step 3”
1. Suggest to put these definitions on top of the discussion:

Furthermore, RAN2 also agreed the following understandings on terminologies:

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| --- |
| **Supported functionalities** refer to functionalities that UE can indicate by using UE capability information (via RRC/LPP signalling)**Applicable functionalities** refers to functionalities that the UE is ready to apply for inference**Activated functionalities** refers to functionalities already enabled for performing inference |

1. On Q3, we understand we are interested at knowing the content of NW-side additional condition, not the format, right?. So, we suggest:
* Q3: What is the content ~~format~~ of NW-side additional condition?
1. On Q4:
* Step 3 simply uses configuration and FFS about the content, thus “inference” is not used in the current sentence and the following ones.

On “NW-side additional condition is part of inference configuration, or NW-side additional condition is separate from inference configuration, etc?” we think we should also consider that “inference configuration is part of NW-side additional condition”1. Q5-2, Is “applicable functionalities” referring to “supported functionalities”?
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| Google | 1. For Q3 and Q6, they are related to the information of NW-side additional condition and should be merged or put together. Besides, the wording “format” is a bit ambiguous and may be wrongly considered as the ASN.1 format in RRC or other format in L1/L2 signalling. We prefer to revise Q3 and Q6 as the following part:* Q3: What is the form/content of NW-side additional condition? Whether NW-side additional condition is functionality specific?

2. For Q4, we should focus on the relationship discussion between NW-side additional condition and inference configuration. The description of Q4 should be general without considering the detailed cases or steps. Besides, as vivo suggested, we also need to consider the third option for the relationship. Thus, Q4 can be revised as showed below:* Q4: what is the relationship between NW-side additional condition and inference configuration? NW-side additional condition is part of inference configuration, or NW-side additional condition is separate from inference configuration, or inference configuration is part of NW-side additional condition etc?

3. For Q5, we want to know whether NW-side additional condition and/or inference configuration are needed before step 4. Moreover, RAN1 is also expected to provide the answer to the content of the inference configuration. For Q5-2, as indicated above, the wording is unclear and need to be updated. For Q5-3 and Q5-5, they are for the same case and should be put under the same branch. In a summary, the Q5 can be revised below:* Q5: What is needed from NW side by UE to decide applicable functionality before Step 4 (e.g. NW-side additional condition and/or inference configuration from network)?
	+ Q5-1: Is it feasible for UE to decide the applicable functionalities without NW-side additional condition? If yes, what information does UE use to decide applicable functionality?
	+ Q5-2: Is it feasible for gNB to provide inference configuration in Step 3 for UE to determine applicable functionalities?
	+ Q5-3: If inference configuration is needed in Step 3:
		- Q5-3-1: what is the content of inference configuration in step 3 based on supported functionality?
		- Q5-3-2: If inference configuration is updated in step5, what is the delta between configuration in Step 3 and Step 5?
	+ Q5-4: If inference configuration is not needed in Step 3, what is the content of inference configuration in Step 5?

4. For Q7, the “initial activation state” may mislead that the initial state is activation. So, we prefer to reword it as “the initial state”. Besides, we agree with OPPO on the updates of Q7. Consequently, the Q7 can be updated below:Q7-1: If inference configuration is needed in Step 3, what is the initial state of UE-sided model upon receiving Step 3? Q7-2: If inference configuration is not needed in Step 3, what is the initial state of UE-sided model upon receiving Step 5? |
| NEC | Basically, we think it is good to instruct RAN2 questions based on FFS (highlighted in yellow). Comments for “General Questions”1. Suggest removing “For examples,” part as below. Since the question is straight forward, RAN1 can understand easily.Q1: What is the granularity of supported functionality? ~~For example, per use case (e.g. beam management), per sub-use case (e.g. beam management Case 1), or others?~~
2. Wording suggestion: change “the same use case” to “ the same conditions” as below. Since applicable functionalities is assumed to be decided based on NW-side additional conditions (if provided), UE-side additional conditions (internally known by UE) and model availability in device.

 Q2: Whether multiple applicable functionalities under the same ~~use cases~~ conditions are supported or not? Comments on NW-side additional condition and configuration1. Before Q2, we think it is also good to check RAN1 view on “associated ID”, so we suggest adding following question to Q3.Q3: What is the definition and format of NW-side additional condition? Is RAN2 assumption (NW-side additional condition is assumed as associated ID) correct? If yes, how UE to know/understand NW-side additional condition via associated ID?
2. Question on “what is the relationship between NW-side additional condition and inference configuration in Step 3?” in Q4. How does this question come from? I guess this is from the below agreement:

2) As response to NW-side additional condition requesting applicable functionality reporting in step 3, FFS other network configuration (e.g. inference configuration). Suggest changing to:Whether UE needs to report applicable functionality with regard to other network configuration in step 3 (e.g. inference configuration)?1. “NW-side additional condition is part of inference configuration, or NW-side additional condition is separate from inference configuration, etc? ” in Q4 will mislead RAN1, suggest removing this part.
2. Q5-2, Q5-3, Q5-4 and Q6 should be asked before Q4.
3. Suggest changing “applicable” in Q5-2 to “supported” since in Step 3, NW only knows the supported functionalities reported by UE in Step 2.
4. Suggest adding “supported” as below in Q6.

- Q6: Whether NW-side additional condition is supported functionality specific? |
| Samsung | Q1: we are not sure to limit to “supported” functionality. Rather we first need to ask the general functionality. We prefer to remove “supported” and naturally don’t need to add “UE capability”. Q3: RAN2 understand that associated ID can be configured to indicate NW-side additional conditions. Is this question to ask what additional information is included for NW-side additional conditions? The more detailed content would be good but we feel that it might not be so urgent for now. If companies want to ask, we would be ok. Q4: for the first sentence, this question is a bit confusing. Is it to confirm RAN2 agreement “UE decides the applicable functionalities based on NW-side additional conditions (if provided), UE-side additional conditions (internally known by UE) and model availability in device.” ? Otherwise, we prefer to remove it. Q4: for the second sentence, is it to ask what kind of additional condition is needed in Step 3 in addition to NW-side additional conditions? If yes, it might be overlapped with Q5-1 and Q5-2?Q5: Is this question related to Q5-1-4? * Q5. What information can be provided to UE in Step 3, in order for UE to decide applicable functionality before Step 4? The following are more specific questions.

Q5-1: we would suggest the following update. * “Q5-1: In RAN2, it is FFS whether NW-side additional condition is mandatory or optional. In order to discuss further, RAN2 would like to understand whether it is feasible for UE to decide the applicable functionalities without NW-side additional condition. If yes, what information does UE use to decide applicable functionality?

Q5-2: we would suggest to clarify Q5-2 more as follows. * Q5-2: In RAN2, it is FFS whether inference configuration (e.g. inference configuration) other than NW-side additional condition can be included in Step 3. Is it feasible for gNB to provide inference configuration UE in Step 3 in order to configure applicable functionalities?

Q5-3 & 4: we feel that it is not so urgent. If it is preferred to ask, we could just merge them by asking what is the content of inference configuration to enable applicable functionality at UE side? Inference configuration would not change in Step 3 and Step 5. Q7: the question can be clarified as follows. * If inference configuration is provided in Step 3, what is the initial state (activated or deactivated) of the configured functionality?

Q8: the question can be clarified as follows. * If more than one applicable functionalities are configured in Step 5, whether all the functionality can be activated?
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| Nokia | We suggest the following changes and have a few comments.* Change the LS title to “LS on LCM for beam management UE-sided model”
* In the call flow, there is a typo in the word “enquiry”.
* **Step 1**: Network sends *UECapabilityEnquiry* message to initiate the procedure ~~to a~~ for UE reporting of its AI/ML supported functionalities.
* “**Step 3**”: Following configurations are provided from NW to UE:

1) Whether UE is allowed to do UAI reporting via OtherConfig.2) ~~Network may provide~~ NW-side additional condition(s). FFS on the RRC signalling and whether it is mandatory or optional. 3) FFS on configuration (e.g. inference configuration) of supported functionalities. FFS on the content of configuration.* (**between “Step 3” and “Step 4”**) UE decides the applicable functionalities based on NW-side additional conditions (if provided), UE-side additional conditions (internally known by UE) and model availability in device. FFS whether other configuration can be considered by UE (e.g. inference configuration). FFS how the applicable functionality is decided if NW-side additional condition is not provided in step 3.
* “**Step 4**”: UE reports applicable functionality in the following scenarios:
1. Upon being configured to provide applicable functionality report

2) ~~and u~~Upon change of applicable functionality(ies)~~via UAI~~~~2)~~3) As response to NW ~~side additional condition~~ requesting applicable functionality reporting in step 3, FFS other network configuration (e.g. inference configuration). **We propose splitting 1) into two bullets and either rewording or removing the last bullet since it is captured by “upon change of applicable functionality’.*** **Step 5**:
1. Network ~~configures~~provides inference configuration to UE after applicable functionality reporting, if inference configuration based on supported functionality is not provided in Step 3 (i.e. inference configuration is provided in Step 5).
* NW-side additional condition is assumed to be identified by an ~~as~~ associated ID (which is ~~used~~ assumed by majority of companies). Other inference configuration (e.g. CSI-RS resource configuration, etc) is considered as separate~~ly~~ from NW-side additional condition, i.e. it is not considered as part of NW-side additional condition in below proposals. It is up to RAN1 about the details of NW-side additional condition.
* For Q1, could we also add “per configuration”, and could we also ask about the positioning use case? We also agree with Samsung’s comment that we don’t need to limit this to “supported” functionalities. We need a firm definition for “functionality”, anyway.
* For Q3, could we also ask about “content” in addition to format? Perhaps this definition could be one we could use in the normative phase already.
* Q4: For UE evaluating and reporting applicable functionalit~~y reporting~~ies, what is the relationship between NW-side additional condition(s) and inference configuration in Step 3? Are NW-side additional conditions ~~is~~ part of inference configuration, or are NW-side additional conditions ~~is~~ separate from inference configuration, etc?
* Q5: What is needed by UE to decide applicable functionality before reporting applicable functionality in Step 4 (e.g. NW-side additional condition and/or inference configuration from network)?
* Q5-3: If inference configuration is ~~needed~~ provided in Step 3, what is the content of inference configuration based on supported functionality?
* Q5-4: If inference configuration is not ~~needed~~ provided in Step 3, what is the content of inference configuration in Step 5?
* Q6: ~~Whether~~ Are NW-side additional condition(s) ~~is~~ functionality specific?
* Q7: What is the initial ~~activation~~ state of UE-sided ~~model~~ applicable functionality ~~before~~ after Step 3?
* Q8: Is L1/L2 signalling for functionality activation/deactivation ~~needed~~supported?

**ACTION:** RAN2 kindly requests RAN1 to take the above RAN2 agreements into consideration, and kindly reply with RAN1 understanding to enable RAN2 further progress in LCM for beam management UE-side~~d~~ model~~LCM~~. |
| Apple | First, we don’t agree to make change on agreed description of step 1-5 (as RAN2#127 agreement). If company have concern on the wording, they should raise online.Secondly, we think the agreement on 3 definitions can also be included.Then, we provide comments for each question:* Q1: I tend to agree with Rapporteur original version. We understand the intention of this question is related to Step 1 and 2 on UE capability contents (i.e. supported functionality). If we extend to “functionality”, we think RAN1 may misunderstand it is general question of definition which is usually hard to converge in RAN1. Meanwhile, step 1 and 2 have clearly mentioned “supported functionality in capability signalling”. So, it seems to be redundant to add “expressed in capability”.
* Q2: we agree with Samsung’s suggestion that it is more readable if it is moved to questions on “On Functionality Activation”. For example:

Q9 If more than one applicable functionalities are configured in Step 5, whether all the functionality can be activated?* Q3: we suggest to remove this question. If the intention is to confirm associated ID, I think the NOTE has clearly explained all the RAN2 agreements are based on associated ID. If RAN1 have concern, they can raise it in response.
* Q4: we agree with other company to remove the first sentence. To make it more readable, we suggest to rephase it as follows:

Q4: ~~For UE evaluating applicable functionality reporting~~, In RAN2, it is FFS whether inference configuration (e.g. inference configuration) other than NW-side additional condition can be included in Step 3. In order to discuss further, RAN2 would like to understand, if inference configuration is provided in step 3, what is the relationship between NW-side additional condition and inference configuration in Step 3? NW-side additional condition is part of inference configuration, or NW-side additional condition is separate from inference configuration, etc?* Q5/5-1/5-2: we basically agree with Samsung’s suggestion. In detail, we prefer below change (some rephasing in Q5-2):
* Q5. What information can be provided to UE in Step 3, in order for UE to decide applicable functionality before Step 4? The following are more specific questions.
	+ Q5-1: In RAN2, it is FFS whether NW-side additional condition is mandatory or optional. In order to discuss further, RAN2 would like to understand whether it is feasible for UE to decide the applicable functionalities without NW-side additional condition. If yes, what information does UE use to decide applicable functionality?
	+ Q5-2: In RAN2, it is FFS whether inference configuration (e.g. inference configuration) other than NW-side additional condition can be included in Step 3. Is it feasible for gNB to provide inference configuration ~~UE~~ in Step 3 for the UE to determine applicable functionalities?
* Q5-5: we suggest not to put Q5-5 under Q5-4. It can be independent with Q5-4.
* Q7: We agree with the formulation suggested by OPPO, but we think “initial activation status” should be changed to “initial status (activation or deactivation)”. And “needed” should be replaced with “provided”. So, we suggest below change:

Q7-1: If inference configuration is provided in Step 3, what is the initial state (activation or deactivation) of UE-sided model upon receiving Step 3? Q7-2: If inference configuration is not provided in Step 3, what is the initial state (activation or deactivation) of UE-sided model upon receiving Step 5? |
| Xiaomi | Since we agreed the LCM shall be under NW control, the key point is how NW can be aware of the applicable functionality. In case NW additional condition is not provided to UE, our understanding is UE first report the functionality, which fulfils the UE side additional condition and model availability. Note the reported functionality can be a super set of the ‘applicable’ functionality. NW can further determine the applicable functionality based on the reported functionality. In current question, RAN1 may be confused how UE can decide applicable functionality without NW side additional condition. With above assumption, we suggest to further clarify how the procedure works in this case.The key question is whether it’s feasible to determine the applicable functionality in a joint way, i.e. UE reports the functionality which fulfils the UE side additional condition and model availability, then NW decides the applicable functionality based on the report.* + Q5-1: In RAN2, it is FFS whether NW-side additional condition is mandatory or optional. In order to discuss further, RAN2 would like to understand whether it’s feasible to determine the applicable functionality in a joint way, i.e. UE reports the functionality which fulfils the UE side additional condition and model availability, then NW decides the applicable functionality based on the report.
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