**3GPP TSG RAN WG1 #103-e R1-200xxxx**

**e-Meeting, October 26th – November 13th, 2020**

**Source: Moderator (NTT DOCOMO, INC.)**

**Title: [draft] Summary #3 on Framework and Principles for Reduced Capability**

**Agenda Item:** **8.6.4**

**Document for:** **Discussion and Decision**

1. **Introduction**

This contribution summarizes the following email discussion in AI8.6.4 regarding the framework and principles for RedCap.

[103-e-NR-RedCap-05] Email discussion for framework and principles for RedCap – Shinya (DCM)

* 1st check point: 10/29
* 2nd check point: 11/5
* Last check point 11/12

1. **Discussion**
   1. **Definition of a limited set of one or more device types**

## How to define UE type for RedCap

In [6, 9, 14, 18], the framework how to indicate the capabilities of RedCap UE is discussed, e.g., existing UE feature/capability framework is assumed as the baseline. As the following agreement, especially highlighted by yellow, was made in RAN2#111-e meeting, FL thinks RAN1 can follow the RAN2 agreement and no additional discussion is necessary in RAN1.

Agreements:

1. At least for device type identification and access restriction (including initial access), the network needs to know whether the UE is redCap UE or not. FFS on whether based on explicit or implicit signalling.
2. The existing UE capabilities framework is used as baseline to indicate the capabilities of a RedCap UE (this does not imply anything on the reporting of the device type, if the need for a device type will be agreed)
3. The number of device types should be minimised, to reduce market fragmentation, and introduced only where essential to control UE accesses and differentiate them from legacy R15/R16 and non-Redcap R17 UEs, (e.g. number of Tx/Rx antennas, maximum supportable BW, etc.). The exact composition of the set of L1 capabilities of the device type can be discussed by RAN1
4. Discuss in normative phase on whether to signal (and in case how) a Device type and its associated capabilities (the reduced set of capabilities) is captured in specifications, and whether device type is indicated as part of UE capability;

### **FL proposal#1:**

* **Defer to RAN2 on the framework how to** **indicate the capabilities of RedCap UE**
  + **Note: RAN1 continues the discussion on the exact composition of the set of L1 capabilities of the RedCap UE type**

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| **Company** | **Agree (Y/N)** | **Comments** |
| FUTUREWEI | Y | No additional discussion needed in RAN1 |
| vivo | Y |  |
| Panasonic | Y |  |
| LG | Y |  |
| QC |  | Thanks FL for drafting the proposal.  As we commented online, early indication of RedCap UE type via initial access is related to coverage recovery on DL and UL, which should be investigated first by RAN1.  On the other hand, the discussion regarding the framework of RedCap UE capabilities indication/signaling after RRC connection can be deferred to RAN2. |
| Moderator | Response to the comments at GTW on 10/26   * Regarding the comment whether the proposal is applied for UEs in connected mode only, FL’ understanding is Yes and early identification, which is discussed in AI8.6.5, is used for UEs in idle mode. To clarify this, FL proposal#1 is updated as below:  **Updated FL proposal#1:**  * **Defer to RAN2 on the framework how to** **indicate the capabilities of RedCap UE in connected mode**   + **Note: Possible early identification is used for UEs in idle mode and is discussed in AI8.6.5**   + **Note: RAN1 continues the discussion on the exact composition of the set of L1 capabilities of the RedCap UE type** * Regarding the comment that how to constrain RedCap devices to be used only for the intended use cases should be discussed together, following agreement was made in the last meeting and no more discussion is necessary in RAN1.   Agreements:  Studying how to constrain RedCap devices to be used only for the intended use cases is deprioritized in RAN1 | |
| OPPO | Y | Agree with Updated FL proposal#1. |
| ZTE | Y | Agree with Updated FL proposal#1. |
| CATT | Y | Support FL’s updated proposal. |
| Xiaomi | Y | Agree with updated FL proposal |
| Samsung | Y | Agree with updated FL proposal #1 |
| CMCC | Y | Agree with Updated FL proposal#1. |
| Sharp | Y | Agree with updated FL proposal |
| Spreadtrum | Y | Agree with Updated FL proposal#1. |
| LG | Y | We are okay with the Updated FL proposal#1. |
| Lenovo, Motorola Mobility | Y | Agree with Updated FL proposal#1. |
| Huawei, HiSilicon |  | The framework how to indicate the capabilities of RedCap UE is associated with the type definition for RedCap since the definition of the RedCap UE will include some reduced capabilities as discussed in FL proposal #3. Considering the type of RedCap UE includes some capabilities which will impact the initial access (such as maximum UE channel bandwidth), how to indicate the reduced capabilities related to RedCap UE type should be discussed first in RAN1.  Additionally, similar view as QC, the discussion regarding the framework of RedCap UE capabilities indication/signaling after RRC connection can be deferred to RAN2. |
| Ericsson | Y | Agree with Updated FL proposal #1 |
| MediaTek | Y |  |
| Apple | Y | Agree with Updated FL proposal #1 |
| Intel | Y |  |
| Nokia, NSB | Y | Agree with updated FL proposal #1 |
| DOCOMO | Y | Agree with updated FL proposal#1 |
| InterDigital | Y | Agree with updated FL proposal#1 |
| Moderator | **Observations:**   * Almost all companies agree with either FL proposal#1 or updated FL proposal#1   Based on the observation above, let’s try to agree on updated FL proposal#1 | |

### **Updated FL proposal#1:**

* **Defer to RAN2 on the framework how to** **indicate the capabilities of RedCap UE in connected mode**
  + **Note: Possible early identification is used for UEs in idle mode and is discussed in AI8.6.5**
  + **Note: RAN1 continues the discussion on the exact composition of the set of L1 capabilities of the RedCap UE type**

If you have strong concern on updated FL proposal#1, please provide comments in the below table with suggestion which is acceptable to all companies.

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| **Company** | **Comments** |
| Ericsson | Agree with Updated FL proposal #1. |
| Xiaomi | OK |
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At the 1st check point (10/29), following conclusion was made:

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| **Conclusion:**   * Defer to RAN2 on the framework how to indicate the capabilities of RedCap UEin connected mode * Note: Possible early identification is used for UEs in idle mode and is discussed in AI8.6.5 * Note: RAN1 continues the discussion on the exact composition of the set of L1 capabilities of the RedCap UE type |

In addition, [4] discusses the potential capability classification for RedCap UEs as below.

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| --- | --- | --- |
| Case | eMBB UEs | RedCap UEs |
| Case 1a | Case 1: Mandatory with/ without capability signaling | Mandatory without capability signaling with the same/different values with eMBB UEs |
| Case 1b | Mandatory with capability signaling with the same/different values with eMBB UEs |
| Case 1c | Optionally supports the feature |
| Case 1d | Does not support the feature |
| Case 2a | Case 2: Optional with capability signaling | Optionally supports the feature |
| *Case 2b* | *Does not support the feature at all* |
| *Case 2c* | *Mandatory with/without capability signalling?* |

Similar discussion is held in RAN2 email discussion [Post111-e][913][REDCAP] and following proposals are captured in the latest draft report:

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| **Proposal 1: RedCap UE capabilities can be categorized as:**   * **Min capabilities all RedCap UEs support (i.e. mandatory for RedCap UE) if identified;**    + **FFS on whether some features are mandatory with signaling for RedCap UE, i.e. IOT bit;**   + **It is up to RAN1 on the number of RedCap UE types and whether different RedCap type UEs may support different value for mandatory features;** * **Optional capabilities (signaled explicitly)**   **Proposal 2: Following scenarios are considered when design the capability signaling for RedCap UE, but FFS on the details, e.g. what each category of features may include:**  For the features that are mandatory for non-Redcap UEs, following scenarios are considered:  Case1: The Redcap UE mandatorily supports the feature with the same value;  Case2: The Redcap UE mandatorily supports the feature, but with different value (e.g. bandwidth value);  Case3: The Redcap UE optionally supports the feature;  Case4: The Redcap UE does not support the feature at all.  For the features that are optional for non-Redcap UEs, following scenario is considered:  Case1: The Redcap UE does not support the feature at all.  Case 2: The RedCap UE supports the feature with different value;  **Proposal 3: Following capability design principle is considered for RedCap UE, but details should be discussed in WI phase:**   * **The UE capability requirements for a RedCap device type, that are different from those for non-RedCap UEs, are listed in the specifications. That is:**   + **Mandatory features for non-RedCap UE that are not supported for RedCap UE;**   + **Mandatory features for non-RedCap UE that are optional for RedCap UE;**   + **Mandatory features for non-RedCap UE that are supported for RedCap UE but with different value;**   + **Optional features for non-RedCap UE that are not supported for RedCap UE;**   + **Optional features for non-RedCap UE that are mandatorily supported for RedCap UE.**   **For a RedCap device type, define new signaling fields in UE Capability for the features that are mandatory w/o capability signaling for non-RedCap UEs but are optional for Redcap UEs, or mandatory with capability signaling for non-RedCap UEs but with different value for RedCap UEs.** |

Therefore, FL thinks that RAN1 can follow the RAN2 discussion and no additional discussion is necessary in this SI in RAN1. Note that the exact components/values for mandatory/optional capabilities for RedCap can be discussed in WI phase.

### **FL proposal#2:**

* **Defer to RAN2 on the signalling of capability classification for RedCap UEs from non-RedCap UEs**
  + **Exact components/values are discussed in WI phase**

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| **Company** | **Agree (Y/N)** | **Comments** |
| FUTUREWEI | Y | Thanks to keep us updated of the RAN2 status. Is proposal 3 agreed or just a proposal still? |
| vivo | Y |  |
| Panasonic | Y |  |
| LG | Y |  |
| Qualcomm | N | We think the minimum/mandatory UE capabilities for RedCap devices should be discussed in RAN1. It is desirable for RAN1 to make this recommendation at the end of SI.  The optional UE capabilities for RedCap devices, which require capability signaling after the establishment of RRC connection, can be deferred to the WI phase and discussed by RAN2. |
| Moderator | * Response to FUTUREWEI: RAN2 has not agreed on these proposals because RAN2 meetings is not started yet   Response to the comments at GTW on 10/26   * Regarding the comment what the relationship among FL proposals#2/3/4 are, FL intention is   + FL proposal#2: Exact components/values of the capabilities of RedCap UEs, which are not included in RedCap UE types, are discussed in WI phase (e.g., mandatory w/o capability signaling for non-RedCap UEs but are optional for Redcap UEs). To clarify this, FL proposal#2 is updated as below:  **Updated FL proposal#2:**  * **Defer to RAN2 on the signalling of capability classification for RedCap UEs from non-RedCap UEs**   + **Exact components/values,** **which are not included in RedCap UE types, are discussed in WI phase**   + **FFS for those included in RedCap UE types**   + FL proposal#3: High-level view on what kind of capabilities should be included in RedCap UE types   FL proposal#4: Detail of what kind of capabilities should be included in RedCap UE types | |
| OPPO | Y | Agree with Updated FL proposal#2. |
| ZTE | Y | Agree with Updated FL proposal#2. |
| CATT | Y | Support FL’s updated proposal. |
| Xiaomi | Y | Agree with Updated FL proposal#2. |
| Samsung | Y | OK for updated FL proposal #2 |
| CMCC | Y | Agree with Updated FL proposal#2. |
| Sharp | Y |  |
| Spreadtrum | Y | Classification should be led by RAN2. |
| LG |  | After further clarification from the FL, we don’t think agreeing on this proposal is needed at this stage. What the main bullet says is what RAN2 is supposed to without any agreement from RAN1, and the first sub-bullet can be discussed within this meeting in RAN1 and may be further discussed in the WI phase. |
| Lenovo, Motorola Mobility | Y | Agree with Updated FL proposal#2. |
| Huawei, HiSilicon | N | As commented in FL proposal #1, since the capability classification for RedCap UEs from non-RedCap UEs includes the reduced capabilities associated with the definition of the RedCap UE, the signalling of these reduced capabilities is suggested to be studied in RAN1 first.  Other optional UE capabilities for RedCap devices, which are different from the capabilities for non-RedCap UE, can be deferred to the WI phase and discussed by RAN2. |
| Ericsson |  | Agree with LG’s comment on Updated FL proposal #2. |
| MediaTek | Partially Y | The signaling framework can be left to RAN2. However, the feature that define a RedCap UE should be decided by RAN1 (as discussed in FL proposal#3).  We don’t see a need for the 1st bullet point (i.e. Exact components/values, which are not included in RedCap UE types, are discussed in WI phase). |
| Apple | Y | FL proposal 2 looks ok for us to clearly lay out the concrete plan for the open issues. |
| Intel |  | Share the view expressed by LGE. |
| Nokia, NSB | Y | Agree with updated FL proposal #2 |
| FUTUREWEI | N | We need to discuss some things here. Not clear what we are deferring, does not seem needed. RAN2 will anyway continue to try to agree on Proposal 3, and we need not agree to let them do it. We also will be spending most of our time trying to figure out what a RedCap UE does support, no need to agree to not discuss what is not included now when we won’t have time anyway. |
| DOCOMO | Y | Agree with updated FL proposal#2 |
| InterDigital | Y | Agree with updated FL proposal#2 |
| Moderator | **Observations:**   * Almost all companies agree with either FL proposal#2 or updated FL proposal#2 * 3 companies (LG, Intel, FUTUREWEI) think no agreement is necessary   + 1 company (MediaTek) thinks the 1st sub-bullet is not necessary.   Based on the observation above, it may be true that no agreement is necessary as RAN1 and RAN2 will discuss the corresponding parts anyway. However, FL thinks it is worth concluding on updated FL proposal#2 to make it clear what RAN1 should do. In that sense, let’s try to agree or conclude on updated FL proposal#2. | |

### **Updated FL proposal#2:**

* **Defer to RAN2 on the signalling of capability classification for RedCap UEs from non-RedCap UEs**
  + **Exact components/values,** **which are not included in RedCap UE types, are discussed in WI phase**
  + **FFS for those included in RedCap UE types**

If you have strong concern on updated FL proposal#2, please provide comments in the below table with suggestion which is acceptable to all companies.

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| **Company** | **Comments** |
| LG | Frankly speaking, I don’t think this agreement is necessary. But, if this proposal is to make it clear what RAN1 should do during this meeting, then slightly changing the order of bullet/sub-bullets seems to be clearer as suggested below:  Exact components/values, which are included in RedCap UE types, are discussed and concluded in this meeting   * Exact components/values, which are not included in RedCap UE types, are discussed in WI phase * [Defer to RAN2 on the signalling of capability classification for RedCap UEs from non-RedCap UEs] |
| Ericsson | Fine with Updated FL proposal #2 (no strong view). |
| FUTUREWEI | Not needed, and may actually hurt us as we try to make recommendations. For example, we may be close to deciding that FR2 RedCap can support 1RX and 2RX as a compromise but that initial access is based on 1RX. Then someone may argue that we cannot agree that 2RX is supported now as depending on some RedCap type definitions (alt 2 versus 4) 2RX would not be part of the RedCap type and therefore 2RX is only allowed in the WI. So better to let RAN2 continue their work and we focus on other proposals. |
| Moderator | Based on the comments so far, FL proposal#2 may not be necessary as RAN1 and RAN2 will discuss the corresponding parts anyway (FL proposals #3/4 from RAN1 perspective). Therefore, no more discussion for proposal#2 will be held in this RAN1 meeting. |
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As shown in the above RAN2 agreement, it is RAN1 task to discuss the exact composition of the set of L1 capabilities of the device type. For high-level, in [1, 3, 13, 14, 18, 19], it is discussed which reduced capabilities should be included in the definition of the RedCap UE types and following alternatives can be considered:

* Alt.1: All the reduced capabilities recommended at the end of the RedCap study: [1]
* Alt.2: Only include the reduced capabilities that the network needs to know during initial access: [1]
* Alt.3: All the recommended reduced capabilities as well as recommended power saving features: [1]
* Alt.4: Minimum (mandatory) capability set: [3, 13, 14, 18, 19]

As there are still divergent views regarding the number of UE types, FL thinks it is beneficial to have common understanding among companies regarding the above aspect and proposes the following:

### **FL proposal#3:**

* **Down select one of the followings to be included in the definition of the RedCap UE types**
  + **Alt.1: All the reduced capabilities recommended at the end of the RedCap study**
  + **Alt.2: Only include the reduced capabilities that the network needs to know during initial access**
  + **Alt.3: All the recommended reduced capabilities as well as recommended power saving features**
  + **Alt.4: Minimum (mandatory) capability set**

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| **Company** | **Agree (Y/N)** | **Comments** |
| FUTUREWEI | N | The text “definition of the RedCap UE type” is still problematic as we will get stuck in the same type discussion. It would be better to follow RAN2’s proposal 3 (agreed?) and for the features discussed in RAN1 we can categorize the features. For example, include in the TR that a feature is mandatory for non-redcap with a different value for redcap. This would apply to both to new complexity reduction features and to existing coverage enhancing features. If we cannot decide now we can list it as a possible it could be an optional non-redcap feature than is mandatory for redcap, and decide as a detail in the WI phase.  The identification question will be discussed elsewhere. |
| vivo |  | We think for a given RedCap UE type, a minimum set of capabilities that a certain RedCap UE type shall mandatorily support, should be identified. This is maybe similar like alt 4?  However, we think the discussion of RedCap UE type can be deferred to the WI phase, as it is not urgent to complete the SI. |
| Panasonic |  | As L1 capability composition, this depends on whether UE identification is needed during initial access. Thus we should focus on that and also the discussion on the reduced complexity feature at first. After that, the exact UE type definition can be discussed. |
| LG | N | Need some clarification on what is the relationship and difference b/w the proposal #3 and #4. From our perspective, it is not a separate discussion. We recommend to address the Proposal #4 first. Once there is a progress, then the L1 capability parameters defining the RedCap UE type should be included in the alternatives. |
| Qualcomm |  | Alt 4 is preferred. |
| Moderator | Response to the comments at GTW on 10/26   * Regarding the comment that Alt.4 seems equivalent to one of Alt.1-3, FL tends to agree with that and Alt.4 is a kind of high-level expression. However, as commented by some companies above, Alt. 4 may be preferred and hence, Alt.4 is kept at this stage. Exact wording can be modified based on input from companies. * Regarding the comment that Alt2 would be appropriate based on RAN2 agreement (RedCap UE types should be introduced only where essential to control UE accesses and differentiate them from legacy R15/R16 and non-Redcap R17 UEs), FL thinks more discussion is necessary regarding the identification of RedCap UEs in AI8.6.5 as the identification after initial access is still one of the options. * Regarding the comment that the discussion of RedCap UE type definition can be deferred to WI phase, FL’s original intention was to conclude in SI phase, at least on recommended number of RedCap UE types and the corresponding L1 capabilities based on the conclusion of the recommended reduced capabilities, but let’s see other companies’ views. | |
| OPPO |  | Alt 4 is preferred. In SI stage, the principle of definition of the RedCap UE types can be agreed as consensus, e.g. Alt 4. The details on minimum capability set can be further discussion in WI stage. |
| ZTE |  | The key components which differentiate the RedCap UE from legacy UE during initial access should be identified at the end of SI. |
| CATT |  | We prefer Alt.4 (though it may be further polished). In our view, definition of RedCap UE type is a concept that should be compared with a normal NR UE. Considering that RedCap UE is aiming at complexity reduction from normal NR UE, it is reasonable to define the RedCap UE type by its minimum capability set mandatory w/o signaling (which may be optional, or mandatory but have different/same value to a normal NR UE).  This may also include the capability that a network needs to know during initial access (Alt.2), but Alt.4 is more straightforward. |
| Xiaomi |  | We prefer alt.4.  In our understanding, alt.1 and alt.3 will result in too many UE types which go against the RAN2 agreement that the number of UE type should be minimized. For alt. 2, since the purpose of defining UE type is to control the UE access as agreed in RAN2. The UE access control procedure not only exist in the initial access phase but also exist in the phase after initial access. So, if we go with alt.2, that may be result in incomplete UE access control. |
| Samsung |  | In principle, it already agreed to reuse the existing UE capabilities framework as baseline to indicate the capabilities of a RedCap UE. No need to agree on the above alternatives.  However, if early capability report in RACH is agreed, we can further discuss what kind of combination need to be report during RACH procedure. |
| CMCC | Y | We think explicit UE type(s) can be used for network to realize access control. The UE type is comprised of a minimum set of UE features/capabilities. Then during the initial access, gNB can make early access control for RedCap UE type or for different RedCap UE types, since the reduced capabilities will consume more network resources than normal devices, to avoid negative impact on normal existing eMBB/URLLC UEs. For example, the network can inform that specific UE type is not allowed to access the cell, and this can happen even before UE’s capability report.  And another intention of the recogonization of RedCap devicess is for gNB to adopt appropriate scheduling schemes for initial access, e.g. common PDCCH, PDSCH, PUSCH scheduling.  Therefore, the reduced capabilities to be included in the definition of the RedCap UE types is alt 4, Minimum (mandatory) capability set, which includes at least reduced capabilities that the network needs to know during initial access, e.g.,alt.2. So far the capability such as Rx number, bandwidth, time processing capability are all related to initial access coexistence.  However, this can be examined at the end of the SI when the reduced capabilities are clearly. |
| Sharp |  | One or two types with mandatory features should be defined in SI and the existing UE feature/capability framework can be reused for other characters. |
| Spreadtrum |  | From the perspective of RAN1, Alt 2 is enough. But from the perspective of RAN2, Alt 4 is preferred. |
| LG | Y | If this is for a high-level view on what kind of capabilities should be included in RedCap UE types, as clarified by the FL, then we think the FL proposal#3 is okay. Our preference is Alt.4. We think not all reduced capabilities need to be included in the definition of the RedCap UE types. |
| Lenovo, Motorola Mobility |  | Alt.2 or Alt.4, depending on how the minimum capability set is defined. |
| Huawei, HiSilicon |  | Support Alt 4.  In our view, the definition of the RedCap UE types should include the minimum (mandatory) capability set for RedCap UE. Furthermore it is unnecessary to report these mandatory capabilities after RRC connection. Otherwise if some of the mandatory capabilities for RedCap UE are reported after RRC connection, it will not only result in overhead but also result in a risk to support these capabilities by optional signaling. |
| Ericsson | N | Since the exact meaning of Alt. 4 is not clear, we think we can wait on this one.  The word “mandatory” may cause confusion in the context of RedCap UE capability discussion. For example, it can be confusing to think about “mandatory reduced capability”. |
| MediaTek |  | The differentiation between RedCap UE and non-RedCap UE should be based on all the reduced mandatory capabilities.  It seems to us that at least Alt.1 and Alt.4 are the same, and both reflect the above understanding. |
| Apple |  | Our preference is Alt.2.  Given the fact that usage of Redcap device type is mainly for identification purpose and UE capability report is always available after RRC\_Connection setup completion, we do not see any reason to consider Alt.1 and Alt.3.  Regarding Alt.2 and Alt.4, again, we do not see clear need to inform gNB about the relaxed capability if it has no impact on initial access procedure, e.g. relaxed processing modulation schemes. These can be reported, if needed, using UE capability framework after initial access phase. |
| Intel | N | Our preference is Alt. 2.  However, we also agree with some of the above comments that we need to have a common understanding on what is meant by “definition of RedCap UE types” and how it is used.  RedCap UEs will naturally be defined based on all the mandatory (and optional) features such UEs may support (this option may be *feasible* if we do not have any early identification of RedCap UEs). However, the answer can be different if early identification is supported – depending on how “RedCap UE types” are used from a functional perspective and the number of RedCap UE types we end up with.  On the other hand, we acknowledge the mutual coupling between different discussions and outstanding decisions related to complexity reduction, RedCap UE early identification, and coverage recovery requirements.  Thus, to make progress here, one way could be to consider different possibilities (e.g., early indication or not, possible variants of RedCap UEs for a given FR or band that may need to be identified by the gNB during initial access, etc.) and accordingly consider different characterizations/features to define RedCap UE types. Otherwise, it seems very difficult to converge. |
| Nokia, NSB | N | RAN1 needs a clear understanding of the capability sets for RedCap devices before we can decide on this issue. |
| FUTUREWEI | N | RedCap UE type is used in RAN2 for initial identification (versus non-redcap) and also for the full set of capabilities associated with RedCap. Alt 2 makes more sense one way and Alt 4 another way. Without understanding what we are talking about it is difficult to agree. |
| DOCOMO |  | Alt.2 if early identification through Msg1/A or Msg3 is selected.  Otherwise no explicit RedCap UE type is necessary. In this case, existing UE capability framework can be used for the identification after RRC connection. |
| InterDigital |  | We preferer alt 4, agreeing the reasons expressed by other companies above. |
| Moderator | **Observations:**   * 7 companies (CMCC, Spreadtrum, Lenovo, Motorola Mobility, Apple, Intel, FUTUREWEI) prefer Alt.2 * 14 companies (vivo, Qualcomm, OPPO, Xiaomi, CMCC, Spreadtrum, LG, Lenovo, Motorola Mobility, Huawei, HiSilicon, FUTUREWEI, InterDigital, CATT) prefer Alt.4. More specifically,   + A minimum set of capabilities that a certain RedCap UE type shall mandatorily support: vivo   + A minimum capability set mandatory w/o signaling (which may be optional, or mandatory but have different/same value to a normal NR UE): CATT   + Not all reduced capabilities need to be included in the definition of the RedCap UE types: LG   + Unnecessary to report these mandatory capabilities after RRC connection: Huawei, HiSilicon * 1 company (Ericsson) thinks the word “mandatory” in Alt.4 may cause confusion in the context of RedCap UE capability discussion, e.g., “mandatory reduced capability” * 1 company (MediaTek) thinks Alt.1 and Alt.4 are the same as the differentiation between RedCap UE and non-RedCap UE should be based on all the reduced mandatory capabilities * 2 companies (Samsung, DOCOMO) thinks none of the alternatives is necessary in addition to existing UE capabilities framework * 9 companies (Panasonic, CMCC, Samsung, DOCOMO, Apple, Intel, Nokia, NSB, FUTUREWEI) think it depends on the conclusions on RedCap UE identification in AI8.6.5 and/or the reduced complexity feature in AI8.6.1 * 2 companies (Lenovo, Motorola Mobility) think it depends on how the minimum capability set is defined * 1 company (FUTUREWEI) thinks it’s better to follow RAN2 direction and categorize features (e.g., those mandatory for non-redcap with a different value for redcap) in RAN1 * 1 company (vivo) thinks this discussion is not urgent and can be deferred to WI phase   Based on the observations above, FL proposal#3 can be further discussed, with modify the wording of Alt.4, adding Alt.5: No explicit definition of the RedCap UE types is necessary, and clarifying that down-selection is done after concluding on the reduced complexity features in AI8.6.1 and RedCap UE identification in AI8.6.5. At the same time, we can discuss the list of capabilities which can be included in RedCap UE types together with FL proposal#4. | |

Note: Companies are also encouraged to show the preferred alternative

### **Updated FL proposal#3:**

* **Down select one of the followings to be included in the definition of the RedCap UE types, after concluding on the reduced complexity features in AI8.6.1 and RedCap UE identification in AI8.6.5**
  + **Alt.1: All the reduced capabilities recommended at the end of the RedCap study**
  + **Alt.2: Only include the reduced capabilities that the network needs to know during initial access**
  + **Alt.3: All the recommended reduced capabilities as well as recommended power saving features**
  + **Alt.4: Minimum ~~(mandatory) capability~~ set of the reduced capabilities that a RedCap UE type shall mandatorily support**
  + **Alt.5: No explicit definition of the RedCap UE types is necessary**

If you have strong concern on updated FL proposal#3, please provide comments in the below table with suggestion which is acceptable to all companies.

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | Alt 1-3 are fine to keep in the list.  Alt 4 is unclear to us. It’s mainly the word “mandatorily” that is problematic for us here. For example, if it is agreed to allow realization of RedCap UEs with a maximum UE bandwidth of 20 MHz, does that mean that the 20-MHz bandwidth is a mandatory feature and that a potential future somewhat more capable UE supporting e.g. 40 MHz should not be covered by the proposed RedCap UE type definition? (Probably not?) We would prefer to remove Alt 4 from the list unless the meaning of “mandatorily” can be clarified further.  [Moderator] My interpretation is that it depends on whether 40 MHz BW is mandatory or optional for the more capable UE. If 40 MHz BW is mandatory capability for that more capable UE in future, the UE is not covered by the RedCap UE type definition with 20 MHz. On the other hand, if it is optional, the UE is still covered by the RedCap UE type definition with 20 MHz.  Alt 5 does not seem realistic, but we can potentially agree that the UE type definition can be sorted out later, perhaps even in the WI phase. Perhaps Alt 5 can be updated to reflect this. |
| FUTUREWEI | Seems not ready yet. Our previous comment was interpreted as we want both alt 2 and alt 4, but the point is we should clarify which usage of type we are trying to work on.  [Moderator] Agree. It should be clarified first, so I added new question below. |
| Xiaomi | For Alt.4, if just the minimum set of the reduced capabilities that a redcap UE should be **mandatorily support**, then there will just one UE type. But now, there is no agreement or conclusion saying that there is only one Redcap. So, we would like to keep the original one.  Btw, can you further clarify how to understand the “(mandatory)” in Alt.4.  [Moderator] My interpretation is Alt.4 does not preclude more than one UE types, as it says minimum set of the reduced capabilities that **a RedCap UE type shall mandatorily support**. Potential different UE types may have different mandatory capabilities. Besides, both original and updated Alt.4 have the same intention, which is clarified by the updated one. Down-selection is proposed to be carried out after concluding on the reduced complexity features in AI8.6.1, so Alt.4 would be a valid option at this stage.  For Alt.5, if there is no explicit definition of Redcap UE type, does that mean there is also no necessity in the related discussion, for example which components should be included in UE type definition, how many UE types should be supported ?  [Moderator] Yes based on the input from proponents, as existing UE capabilities framework can report the reduced capabilities. In that case, what we should do would be to decide the recommended components/values for the reduced capabilities in AI8.6.1. |
| Moderator | Based on the comments so far, it seems companies’ views are still divergent. As commented by FUTUREWEI, it would be beneficial to first clarify the usage of RedCap UE types. Based on the RAN2 agreement below, RedCap UE types would be used for access control and UE identification.   1. The number of device types should be minimised, to reduce market fragmentation, and introduced only where essential to control UE accesses and differentiate them from legacy R15/R16 and non-Redcap R17 UEs, (e.g. number of Tx/Rx antennas, maximum supportable BW, etc.). The exact composition of the set of L1 capabilities of the device type can be discussed by RAN1   Companies are encouraged to provide their views on the following question. |

### **Question related to FL proposal#3:**

* **Are RedCap UE types used for access control and UE identification from RAN1 perspective? If the answer is No, please provide your view on which perspectives should be considered in addition to the above.**
  + **Note: For access control for RedCap UEs, detailed signaling options associated with system information are postponed to the WI phase as concluded in AI8.6.5.**

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| **Company** | **Y/N** | **Comments** |
| CATT | Y | For access control, RedCap UE type(s) may be used in barring/accessing indication specific to RedCap UE;  For UE identification, RedCap UE type(s) may be used in RedCap-specific UL initial BWP definition, or Msg1/3/5 design to distinguish RedCap UE and normal UE when UL initial BWP is shared.  After FL’s careful clarification, we think Alt.4 can be supported to define RedCap type(s) (though our previous view seems missed in the observation above ☹), may be with some modifications like:  **Alt.4: The corresponding ~~M~~minimum set of the reduced capabilities that ~~a~~one RedCap UE type shall mandatorily support.**  Hope this will address the concern that it has not been agreed whether 1 or 2 types will be defined for RedCap UE. If not, we are open to see further polish.  [Moderator] Sorry for capturing your view incorrectly in the observation above. Now I modified the corresponding part. |
| LG | Y | From RAN1 perspective, we tend to agree that the main usage of RedCap UE types would be for access control and UE identification. However, whether its usage is limited to them should still be FFS or wait for RAN2 for further progress. |
| CMCC | Y | Agree with LG |
| ZTE | Y partially | From RAN1 perspective, the RedCp UE type is mainly for UE identification.  The purpose of defining RedCap UE type is to identify the baseline capabilities that do not need explicit capability signaling. |
| Xiaomi | Y | Agree with LG |
| vivo | Y partially | From RAN1 perspective, we can confirm the usage of UE identification. However, access control is RAN2 topic, not sure if RAN1 can confirm anything. |
| Panasonic |  | Our understanding is there are two usage of "RedCap UE types". One is usage case is for access control and UE identification. Or it can be said as "the capabilities of RedCap UE in IDLE mode". The other is use case related discussion, which has been discussed in RAN1. Or it can be said as "the capabilities of RedCap UE in CONNECTED mode" and whether some of the flexibility of capabilities are going to be limited as some types. If the question means RAN1 should not have the discussion on use case related "RedCap UE types" definition, we are negative as the second usage of "RedCap UE type" should be concluded in work item phase. |
| Nokia, NSB | Y |  |
| FUTUREWEI | Y | We should honor the use of RedCap UE type in the RAN2 agreement, and also the agreement made for 8.6.5. |
| Huawei, HiSilicon | Partially Y | From RAN1 perspective, the definition of RedCap UE type is not only used for access control and UE identification but also beneficial for avoiding market fragmentation, as shown in the RAN2 agreement below. Additionally, it is beneficial in terms of signalling overhead and the readability of the set of capability parameters of RedCap devices. Therefore, it is necessary to define the RedCap UE types explicitly.  Agreements:   1. At least for device type identification and access restriction (including initial access), the network needs to know whether the UE is redCap UE or not. FFS on whether based on explicit or implicit signalling. 2. The existing UE capabilities framework is used as baseline to indicate the capabilities of a RedCap UE (this does not imply anything on the reporting of the device type, if the need for a device type will be agreed) 3. The number of device types should be minimised, to reduce market fragmentation, and introduced only where essential to control UE accesses and differentiate them from legacy R15/R16 and non-Redcap R17 UEs, (e.g. number of Tx/Rx antennas, maximum supportable BW, etc.). The exact composition of the set of L1 capabilities of the device type can be discussed by RAN1 4. Discuss in normative phase on whether to signal (and in case how) a Device type and its associated capabilities (the reduced set of capabilities) is captured in specifications, and whether device type is indicated as part of UE capability; |
| Ericsson | Y | Like the view expressed by Huawei, we think it is also beneficial to have UE type for the consideration of (1) reducing market fragmentation and (2) more efficient signaling. |
| Samsung | Y | Agree with LG. |
| OPPO | Y | Agree with LG. |
| Moderator | **Observations:**   * 12 companies (CATT, LG, CMCC, Xiaomi, Nokia, NSB, FUTUREWEI, Huawei, HiSilicon, Ericsson, Samsung, OPPO) think that RedCap UE types are used for access control and UE identification from RAN1 perspective   + 5 companies (LG, CMCC, Xiaomi, Samsung, OPPO) further think RAN1 should wait for RAN2 progress on whether there are any other usage of RedCap UE types   + 3 companies (Huawei, HiSilicon, Ericsson) further think the definition of RedCap UE type is also beneficial for avoiding market fragmentation and for efficient signalling     - 2 companies (Huawei, HiSilicon) further think it is also beneficial in terms of the readability of the set of capability parameters of RedCap device * 2 companies (ZTE, vivo) think that RedCap UE types are used for UE identification from RAN1 perspective * 1 company (Panasonic) thinks following two usages are considered:   + Capabilities of RedCap UE in IDLE mode: Access control and UE identification   + Capabilities of RedCap UE in CONNECTED mode: use case specific RedCap UE types * 1 company (CATT) suggest a modification of Alt.4 in FL proposal#3 to address the concern that it has not been agreed whether 1 or 2 types will be defined for RedCap UE   Based on the observations above and the comments so far, FL proposal#3 is updated as follows | |

### **Latest FL proposal#3:**

* **At least for RedCap UE identification, down select one of the followings to be included in the definition of the RedCap UE types, after concluding on the reduced complexity features in AI8.6.1 and RedCap UE identification in AI8.6.5**
  + **Alt.1: All the reduced capabilities recommended at the end of the RedCap study**
  + **Alt.2: Only include the reduced capabilities that the network needs to know during initial access**
  + **Alt.3: All the recommended reduced capabilities as well as recommended power saving features**
  + **Alt.4: The corresponding m~~M~~inimum set of the reduced capabilities that ~~a~~one RedCap UE type shall mandatorily support**
  + **Alt.5: No explicit definition of the RedCap UE types is necessary**
    - **if early identification is not used for UEs in idle mode**
  + **FFS for other usages**

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| **Company** | **Agree (Y/N)** | **Comments** |
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In [3, 5, 7, 8, 9, 10, 13, 14, 15, 17, 19], the detail of the exact composition of the set of L1 capabilities of the device type is discussed and following are proposed for the capabilities:

* Maximum supported UE BW: [3, 5, 7, 8, 9, 10, 13, 14, 15, 17, 19]
* Number of Rx/Tx: [5, 7, 8, 9, 10, 13, 14, 15, 17, 19]
  + and/or number of MIMO layers: [9, 10, 14, 15]
* FD/HD-FDD [3, 10, 14, 15, 19]
* Processing time capability [8, 15, 19]
* Maximum supported modulation order: [3, 9, 14, 19]
* Small form factor in FR1 [7]
* Power saving features [14, 15]
  + Reduced PDCCH monitoring [14]
  + Extended DRX for RRC Inactive and/or Idle [14]
  + RRM relaxation for stationary devices [14]
* Coverage recovery features [14]
* Small data enhancement [15]
* BWP framework [15]
* Configured grant [15]

While concrete evaluation results and corresponding conclusions would be necessary to determine the exact composition, it seems at least the maximum supported UE BW and the number of Rx/Tx have much support and hence, following is proposed:

### **FL proposal#4:**

* **At least maximum supported UE BW and the number of Rx/Tx are included in the set of L1 capabilities of the device type for RedCap**
  + **FFS others**

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| **Company** | **Agree (Y/N)** | **Comments** |
| FUTUREWEI | N | Our contribution [2] mentions we also need to include existing coverage recovery features in the list.  Not sure how proposal #4 relates to proposal #3 and #5. You are trying to conclude to recommend these two techniques? Proposal #5 says we will need to wait for number of Rx (if reduced). Proposal #3 (reformulated to follow RAN2) will include bandwidth if reduced (mandatory with a different value) and Rx antenna (if reduced).  Suggest we wait. |
| Vivo | Y | Generally fine with the proposal. We are also fine to defer the discussion to the WI phase. |
| Panasonic | Y |  |
| LG | Y | We are not against the proposal, but we would like to mention that if the number of Rx/Tx antennas is not equal to the maximum number of MIMO layers, then the max number of MIMO layers also need to be included, and that the maximum modulation order should also be included if it is supported.  They collectively define the peak bit rate achievable by the RedCap UE type. |
| Qualcomm | Partially Y | We are fine with the FL proposal in general. For clarity, we prefer to use “maximum UE BW on a single carrier” to refer to the BW capability of RedCap devices. |
| Moderator | * Response to FUTUREWEI: As mentioned below, FL’s intention is to determine exact composition of L1 capabilities based on the conclusion of the recommended reduced capabilities. Since it seems that at least maximum supported UE BW and the number of Rx/Tx have much support, FL tried to make agreement on that. If most companies think it’s better to wait the conclusion of the recommended reduced capabilities, we can go that way.   Response to the comments at GTW on 10/26   * Regarding the comment that the discussion of RedCap UE type definition can be deferred to WI phase, FL’s original intention was to conclude in SI phase, at least on recommended number of RedCap UE types and the corresponding L1 capabilities based on the conclusion of the recommended reduced capabilities, but let’s see other companies’ view. | |
| OPPO | Y | We are fine with the FL proposal. |
| ZTE | Y | We think at least a recommendation on the definition of RedCap UE in needed in SI phase. |
| CATT | Partially Y | We think at least the ‘maximum UE BW’ can be included.  Regarding to the Rx antenna number, it is still discussing in 8.6.1. If the Rx antenna number is agreed to be reduced in all the scenarios, the proposal would be fine. If not, the proposal may need some update. |
| Xiaomi | Y |  |
| Samsung | Y |  |
| CMCC | Y | Others can be added later when the SI concludes the reduced capabilities. |
| Sharp |  | Yes, and processing time capability is also required. |
| Spreadtrum | Y |  |
| LG | Y | For the details of what kind of capabilities should be included in RedCap UE types, we are okay with the FL’s proposal. And we would like to repeat that if the number of Rx/Tx antennas is not equal to the maximum number of MIMO layers, then the max number of MIMO layers also need to be included, and that the maximum modulation order should also be included if it is supported.  They collectively define the peak bit rate achievable by the RedCap UE type. |
| Lenovo, Motorola Mobility | Y |  |
| Huawei, HiSilicon | N | As commented in FL proposal #3, the definition of the RedCap UE types should include the minimum (mandatory) capability set for RedCap UE. That is at least the following should be included: maximum UE channel bandwidth, maximum DL&UL MCS, full-duplex. |
| Ericsson | Partially Y | We may want to consider a RedCap device type definition based on the least capable RedCap UE. Note that there may in the end be less capable RedCap Ues and more capable RedCap Ues, and e.g. during initial access, when the detailed RedCap UE capabilities may be unknown to gNB, all RedCap Ues may in some regards need to mimic the least capable RedCap UE. The proposed definition might work if “maximum bandwidth” is changed to something like “smallest possible maximum bandwidth” and “number of Rx/Tx” is changed to “minimum number of Rx/Tx”. |
| MediaTek | N | The differentiation between RedCap UE and non-RedCap UE should be based on ***all*** the reduced mandatory capabilities. |
| Apple | Y | We are fine with FL proposal. As noted by CATT, we assume the number of Rx antenna is added only if RAN1 concluded to reduce it for Redcap compared to normal device. |
| Intel | Y (in part) | We are fine with the general intention here.  To address the comment from Ericsson, perhaps a way could be to add another “FFS” bullet saying something like the following?   * + **FFS: Whether these correspond to the smallest possible values for a given FR or band, or values supported by a RedCap UE** |
| Nokia, NSB | Y |  |
| FUTUREWEI | Partial Y | OK for the maximum supported bandwidth, but not Rx antennas (until we have a recommendation), and not Tx. In the end Rx can only be the min Rx assumed for a band (if reduced). As mentioned before, the basic characteristics of the redcap type should be known from the band. If say in FR2 both 1 and 2 Rx are supported, 1Rx (the min) is assumed and 2Rx capability is learned later. |
| DOCOMO | Y | Yes if explicit RedCap UE type is defined as commented in FL proposal#3. |
| InterDigital | Y |  |
| Moderator | **Observations:**   * ~~20~~ 21 companies (vivo, Panasonic, LG, Qualcomm, OPPO, ZTE, CATT, Xiaomi, Samsung, CMCC, Sharp, Spreadtrum, Lenovo, Motorola Mobility, Ericsson, Apple, Intel, Nokia, NSB, DOCOMO, InterDigital) agree with FL proposal #4 in principle   + 3 companies (CATT, Apple, FUTUREWEI) think whether number of Rx is included or not should be decided after concluding the feature in AI.8.6.1   + 1 company (Qualcomm) suggests to revise “maximum supported UE BW” to “maximum UE BW on a single carrier”   + 1 company (Ericsson) suggests to revise “maximum bandwidth” to “smallest possible maximum bandwidth” and “number of Rx/Tx” to “minimum number of Rx/Tx”     - 1 company (Intel) further suggests to add “FFS: Whether these correspond to the smallest possible values for a given FR or band, or values supported by a RedCap UE” * Following features are proposed to be included as well   + Existing coverage recovery feature: FUTUREWEI   + Maximum number of MIMO layers: LG   + Processing time: Sharp   + Maximum supported modulation order: Huawei, HiSilicon   + FD-FDD: Huawei, HiSilicon   + All the reduced mandatory capabilities: MediaTek * 1 company (vivo) thinks this discussion can be deferred to WI phase   Based on the observations above, at least maximum supported UE BW is agreeable with modifying the wording. Other capabilities need more discussion and hence, listing them is beneficial at this stage as commented to FL proposal#3. | |

### **Updated FL proposal#4:**

* **At least maximum supported UE BW on a single carrier ~~and the number of Rx/Tx are~~ is included in the set of L1 capabilities of the device type for RedCap**
  + **FFS: Whether it corresponds to the smallest possible values for a given FR or band, or values supported by a RedCap UE**
  + **FFS others with the following table as the starting point**

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| --- | --- | --- |
| **Potential capability in RedCap UE types** | **Values for non-RedCap UEs** | **Candidate values for RedCap UEs** |
| Maximum supported UE BW | * 100 MHz for FR1 * 200 MHz for FR2 | * 20 or 40 MHz for FR1 * 50 or 100 MHz for FR2 |
| Number of Rx | * 2 for FR1 FDD * 4 for FR1 TDD * 2 for FR2 | * 1 or 2 for FR1 FDD * 1 or 2 or 4 for FR1 TDD * 1 or 2 for FR2 |
| FD/HD-FDD | * FD-FDD | * FD-FDD, HD-FDD type A, or HD-FDD type B |
| Processing time | * N1/N2 processing time capability 1 * Non-relaxed CSI computation time | * Relaxed N1/N2 processing time or N1/N2 processing time capability 1 * Relaxed CSI computation time or non-relaxed CSI computation time |
| Maximum number of MIMO layers | * 2 for FR1 FDD * 4 for FR1 TDD * 2 for FR2 | * 1 or 2 for FR1 FDD * 1 or 2 or 4 for FR1 TDD * 1 or 2 for FR2 |
| Maximum modulation order | * Max 256QAM in DL / max 64 QAM in UL for FR1 * Max 64QAM in DL / max 64 QAM in UL for FR2 | * Max 64QAM or 256QAM in DL / max 16QAM or 64 QAM in UL for FR1 * Max 16QAM or 64QAM in DL / max 16QAM or 64 QAM in UL for FR2 |

If you have strong concern on updated FL proposal#4, please provide comments in the below table with suggestion which is acceptable to all companies.

|  |  |
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| **Company** | **Comments** |
| LG | If the maximum supported UE BW is the only one that we can have a consensus, then the proposal is okay in principle. However, we think the addition of “**on a single carrier**” is not needed and even confusing as it gives an impression that there can be multi-carriers for RedCap UEs, which is far from our consensus. And for the newly added **FFS: Whether it corresponds to the smallest possible values for a given FR or band, or values supported by a RedCap UE**, I haven’t seen any company proposing different maximum supported UE BWs per band even within an FR. If that is not the intention, the yellow part above should be removed.  And lastly, in the table above, if there is no company proposing 4 Rx in FR1 TDD, then we can remove the 4 Rx in FR1 TDD. |
| Ericsson | The proposal is a bit unclear to us. Does the main bullet mean that e.g. a potential “basic” 20-MHz RedCap UE and a potential future “more advanced” 40-MHz RedCap UE would be different RedCap device types, or how should the main bullet be understood?  [Moderator] Please see the comment to updated FL proposal#3  Also, we would prefer to delete the last sub-bullet (“FFS others with the following table as the starting point”) and the table, since the discussion about the various UE complexity reduction techniques is still ongoing under AI 8.6.1. Also, it may not be entirely correct to say that non-RedCap UEs are required to be equipped with 2 Rx in all FR1 FDD bands and 4 Rx in all FR1 TDD bands, since there are some exceptions from this rule in the RAN4 specification. |
| FUTUREWEI | Agree that 40MHz should be removed as no specific value other than 20MHz is studied. OK to delete the table for now, though thanks to provide as it is a decent overview of the work we still have to do for 8.6.1. |
| Moderator | Based on the comments so far, FL proposal#4 is modified as below. Also the table is deleted because it is still controversial. **Updated FL proposal#4:**  * **At least ~~maximum~~ mandatory supported UE BW ~~on a single carrier and the number of Rx/Tx are~~ is included in the set of L1 capabilities of the device type for RedCap**   + **Note: 20 MHz for FR1 and 50 or 100 MHz for FR2**   + **~~FFS: Whether it corresponds to the smallest possible values for a given FR or band, or values supported by a RedCap UE~~**   + **FFS others ~~with the following table as the starting point~~** |
| CATT | Agree with FL’s updated Proposal#4 in principle.  For the 2nd sub-bullet ‘**FFS others**’, we think the Rx antenna number is more important than other components and is better to be included in type definition. The reduction of Rx antenna number contributes the largest or 2nd largest cost reduction of RedCap, and has significant impact on other aspects (e.g. coverage recovery). The reason we delete it from the main bullet is that the reduced Rx antenna number is still under discussion. It seems not suitable saying nothing about Rx antenna number in the proposal. Maybe we can add the a sub-bullet before ‘**FFS others**’ like:   * **The Rx antenna number will be included after consensus is reached in AI8.6.1** |
| LG | We are generally okay with the formulation of the updated FL proposal#4. But, we seem to need a further clarification on the mandatory supported UE BW. Whether multiple mandatory supported UE BWs are allowed, and whether to include multiple values in the definition of RedCap UE type in that case should be further discussed. If the intention is to report the single (e.g.,) biggest maximum supported UE BW, then consider formulation such as “the maximum supported UE BW among the mandatory supported UE BWs”. |
| CMCC | General agree with FL’s proposal.  But we also seem to need the clarification of mandatory supported UE BW and the motivation of this proposal is also unclear to us.  The proposal of recommendations on the maximum bandwidth for RedCap FR1 UEs in AI 8.6.1 is as the following and seems stable,  **Phase 1: Proposal 7.3.6-1a:**   * Capture the recommendation that maximum bandwidth of a RedCap UE is 20 MHz at least during initial access. * This does not preclude a RedCap UE optionally supporting a maximum bandwidth larger than 20 MHz after initial access.   But, we have not discussed the mandatory supported UE BW in AI 8.6.1 so far. If a RedCap UE support BW larger than 20MHz after initial access, e.g., 40MHz, whether the 40 MHz is a mandatory feature or an optional feature is not clear now.  As ours reply and moderator’s comment in  **Question related to FL proposal#3:**  Based on the comments so far, it seems companies’ views are still divergent. As commented by FUTUREWEI, it would be beneficial to first clarify the usage of RedCap UE types. Based on the RAN2 agreement below, RedCap UE types would be used for access control and UE identification.   1. The number of device types should be minimised, to reduce market fragmentation, and introduced only where essential to control UE accesses and differentiate them from legacy R15/R16 and non-Redcap R17 UEs, (e.g. number of Tx/Rx antennas, maximum supportable BW, etc.). The exact composition of the set of L1 capabilities of the device type can be discussed by RAN1   Companies are encouraged to provide their views on the following question.  RedCap UE types are used for access control and UE identification from RAN1 perspective. It seems the gNB only need to know whether one UE can only support maximum 20MHz during initial access procedure. But if we want to define types of RedCap UE, maximum 20MHz UE and maximum 40MHz UE are two different RedCap UE types and should be distinguished.  Therefore, if the motivation of this proposal is only used to control UE accesses and differentiate them from legacy R15/R16 and non-Redcap R17 UEs, we suggest the following modification:  **At least maximum supported UE BW** **at least during initial access is included in the set of L1 capabilities of the device type for RedCap**  If the motivation of this proposal is used to define and differentiate types of RedCap UE, we suggest the following modification:  **At least maximum supported UE BW is included in the set of L1 capabilities of the device type for RedCap** |
| ZTE | Since we have already had agreement that the baseline UE bandwidth capability for FR1 is 20 MHz, we propose to change ‘**mandatory supported UE BW**’ to ‘**baseline UE bandwidth capability**’. |
| Xiaomi | For the main bullet, we prefer to keep the previous wording. In our understanding, the intension of proposal #4 is to identify which components should be included in the definition of Redcap device type, for example, whether include the maximum UE BW or whether include the number of supported Rx.  While, the exact value of the included component depends on how many device types will be defined and which capabilities will be agreed finally. So that’s another story.  In short, our opinion is just to discuss which components are included in the definition of Redcap device type and don’t further touch the exact value setting for each included component.  Generally, we OK with the CMCC’s proposal. |
| vivo | Agree in principle. If we need to conclude in the SI phase, prefer to keep the FFS Whether it corresponds to the smallest possible values for a given FR or band, or values supported by a RedCap UE and delete the note since the note may be misinterpreted as for FR2 both 50MHz and 100MHz will be supported. |
| Panasonic | As described in our answer #3, our understanding is there are two usage of "RedCap UE types". If this question asks "the capabilities of RedCap UE in IDLE mode", we are ok with 20MHz for FR1 but not ok to support 50MHz for FR2. If this question asks the use case related discussion, we are not so sure to limit 20MHz for now for FR1. |
| Nokia, NSB | We are fine with the FL’s proposal. |
| FUTUREWEI | Generally OK here, but agree with some of the concerns. This does relate more to initial access. The Note could be misinterpreted as both 50 and 100 MHz are supported in FR2. |
| LG | Following the discussions, the “mandatory” supported UE BW seems to cause a lot more divergence. We prefer the previous formulation which is also the same as the second proposal from CMCC for the main bullet. We are okay to remove the note or put FFS for the values. |
| Huawei, HiSilicon | Agree with FL’s proposal in principle but some modifications are suggested.  As replied to Question related to FL proposal#3, the main intension to define RedCap UE types is for access control and UE identification, as well as avoiding market fragmentation. Therefore, we echo CMCC and LG’s comment, we prefer the second proposal from CMCC, i.e.  **At least maximum supported UE BW is included in the set of L1 capabilities of the device type for RedCap**  For the detailed BW value, no consensus was achieved for FR2, so we suggest to make it clear that either 50 or 100MHz for FR2 and the exact one value can be FFS.  In summary we suggest an Updated FL proposal#4 in highlighted as follows:   * **At least maximum supported UE BW ~~on a single carrier and the number of Rx/Tx are~~ is included in the set of L1 capabilities of the device type for RedCap**   + **Note: 20 MHz for FR1 ~~and 50 or 100 MHz for FR2~~**   + **Note: either 50 or 100MHz for FR2, FFS the exact one value.**   + **~~FFS: Whether it corresponds to the smallest possible values for a given FR or band, or values supported by a RedCap UE~~**   + **FFS others ~~with the following table as the starting point~~** |
| Ericsson | Considering the *Updated FL proposal#4* and the various revisions suggested in the comments above, we prefer the *Updated FL proposal#4*. |
| Samsung | We think some clarification is needed before discussing this proposal. Based on the comments from companies for FL proposal #3, different companies may have differenet understanding/expectation for this question, as pointed out by CMCC.  If this is for access control and/or UE identification, we might need to understand where to identify UE and when to barring them. For example, if the UE identification in the end can only be done in Msg 5, we don’t think there is a need to discuss this proposal. NR UE capability framework can be reused. If mandatory features needs to be identified, e.g., a Redcap UE need to be identified during Msg 1/A Msg 3, we might not need to agree on this feature either, since gNB assumes all Redcap UEs support mandatory features before UE capability report, which is similar as current NR UE capability framework. However, if we would agree on to identify some optional features, or define more than one UE category, e.g., 20MHz BW and 40MHz BW during RACH, e.g., Msg1/A/Msg 3, we can discuss this proposal.  Therefore, if so, we suggest to discuss the “potential UE capability set” together with UE capability report, and wait for RAN 2 progress of access control. Alternatively, this issue can be discussed in WI phase.  If this a about how to define redcap UE type, which means more than one UE type, with different mandatory feature set, we agreed to discuss it. If so, we suggest to focus on the main bullet and first FFS, and delete the table. |
| Moderator | Based on the comments so far, most companies are fine with the intention of updated FL proposal#4 but still there are concerns on the wording, as we don’t have conclusion on the maximum supported UE BW in AI8.6.1. Also, as Samsung pointed out, if early identification is not necessary during Msg1/A/3, no exact set of L1 capabilities of the device type for RedCap would be necessary as included in FL proposal#3. Therefore FL proposed to postpone the discussion until concluding on the reduced complexity features in AI8.6.1 and RedCap UE identification in AI8.6.5. |
|  |  |

## Number of UE types

In [1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22], how many UE types are defined for RedCap is discussed as follows:

* Only one device type per frequency band: [1, 2, 3, 13, 16 (for FR2), 17, 18, 19, 22]
* Two device types: [4, 5, 10, 11, 14 (for FR1), 21]
  + low-end use cases (e.g., industrial sensors, economic video, and low-end wearable) and high-end use cases (e.g., high-end wearable and high-end video Surveillance): [4, 11, 12, 21]
  + At least two if coverage enhancement capability is regarded as a component to be included in the definition of the RedCap UEs: [5]
  + Type1 (reduced bandwidth, 1 Rx antenna, no DL MIMO support, and HD-FDD (where applicable)) and Type 2 (reduced bandwidth, 2 Rx antennas, and maximum of 2 DL MIMO layers), both for FR1 FDD, either one for others: [10]
* Should be discussed based on the conclusion of UE complexity reduction techniques: [6, 19]
* Focus on the numbers of device types necessary to be defined from RAN operational need [7]
* Further study how the reduced complexity features is associated with each use cases to meet the performance requirement: [15]

It is FL understanding that concrete evaluation results and corresponding conclusions would be necessary to decide the number of UE types, as pointed out by [6, 19], following is proposed at this stage

### **FL proposal#5:**

* **Decide the number of RedCap UE types after concluding UE complexity reduction features in this RAN1 meeting**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree (Y/N)** | **Comments** |
| FUTUREWEI | Y and N | The RAN2 agreement is to minimize the device types and avoid fragmentation. The ‘two device type’ proposals are directly against this, so we can agree now to ‘only one device type per frequency band’. We do need to progress the complexity reduction feature discussion to know for example whether we consider FR1 as one band or break into low and mid bands. In any case, in the complexity reduction feature discussion we should honor the RAN2 agreement to minimize RedCap UE types and reduce market fragmentation. |
| Vivo |  | Just to clarify, is the intention of the proposal to defer the decision on number of UE types to WI phase, since this is the last meeting for SI phase?  To FUTUREWEI: “minimize” does not mean only single UE type. In our view, having two UE types is already considered as “minimized” given the diverse use cases that are covered by RedCap SI. |
| Panasonic | Y |  |
| LG |  | Not sure if we could be in a better place to make a consensus on this topic after concluding the UE complexity reduction features. We don’t think supporting e.g., 2 UE types is directly against the RAN2 agreement. As we also take care of the diverse use cases in the SID, the two is already a compromise from our perspective. |
| Qualcomm | FFS | In this RAN1 meeting, we think the priority is to discuss/determine the minimum set of UE capabilities for RedCap UE/device type. |
| Moderator | Response to the comments at GTW on 10/26   * Regarding the comment that the discussion of RedCap UE type definition can be deferred to WI phase, FL’s original intention was to conclude in SI phase, at least on recommended number of RedCap UE types and the corresponding L1 capabilities based on the conclusion of the recommended reduced capabilities, but let’s see other companies’ view. | |
| OPPO | FFS | We can first discuss the definition of RedCap UE type, and identify the minimum set of UE capabilities for RedCap UE. After that, we can further discuss the needed number of RedCap UE type. |
| ZTE |  | Depending on the definition of RedCap UE type  The definition of RedCap UE type needs to consider the followings: 1) whether definition of RedCap UE type only includes essential components during initial access; 2) whether RedCap UE needs to support Rel-17 CE feature |
| CATT | Partially Y | We agree that the number of RedCap UE types should be defined a.s.a.p. after concluding UE complexity reduction features. It would be good if the number can be determined in this RAN1 meeting, since RAN2 is waiting for RAN1’s input. But if it cannot be decided within this RAN1 meeting and leave to WI phase, we may further consider what can be concluded and provided to RAN2. |
| Xiaomi | FFS | It seems that we need to wait for a while due the unclear situation of the reduced capability. But before we get conclusion on the reduced capability and start the discussion on the number of UE types, nowwe could work out some principles to guide the discussion of UE type later on. In our opinion, the following 3 principles can be considered   * Principle 1: Avoid the market fragment as indicated in RAN2 agreement * Principle 2: Satisfy the diverse requirement for different use case * Principle 3: On the base of fulfilling the requirement of different use case, compress the cost and power consumption as much as possible.   It is not easy to find a way to fit all the principles above perfectly. But we think it would be a good guidance/ reference to balance the aspects of market, cost, power, and wide application scenario. |
| Samsung |  | Suggest to discuss together in 8.6.1 and/or WI scoping phase. No need to make such conclusion. |
| CMCC | Y | Depending on the cost reduction analysis results, one or two RedCap UE types can be determined based on the candidate values left for each component. This is helpful for WI design. |
| Sharp |  | The complexity reduction features may be extended in future, we think we should clarify the mandatory characters firstly, and then decide the type numbers according the stage for identification of redcap Ues. |
| Spreadtrum | FFS | Depending on how to define the RedCap UE type. |
| LG |  | We have a similar view with the FL in that we need to discuss the number of RedCap UE types as early as possible because it may have an impact on other discussions where considering multiple device types rather than just a single one is appropriate, e.g., per-type access control, per-type configurations, etc. But, as we are not sure if we can decide within this meeting, the FL proposal#5 feels a bit strong. For the number of RedCap UE types, we would like to repeat that supporting e.g., 2 UE types doesn’t seem to be directly against the RAN2 agreement. Considering the diverse use cases in the SID, the two has been already a compromise from our perspective. |
| Lenovo, Motorola Mobility | Y |  |
| Huawei, HiSilicon | N | Prefer to define one RedCap UE type covering all use cases.  From chipset point of view, it would not be promising that a chipset is built only intending a very specific use case. From network point of view, there is no essential demand to differentiate RedCap UE types for specific use cases. On the contrary, such differentiation can cause diverse UE basic capabilities for initial access, resulting in complicate and diverse branches of initial access procedure implemented by networks or limited network accessibility dedicated to single specific UE type. |
| Ericsson | Y | RAN1 can make a recommendation. |
| MediaTek |  | It is essential to limit the number if devices to avoid any market fragmentation. Thus, we should agree to support one device per FR, and there is no need to wait for the conclusion on the UE complexity reduction features. |
| Apple |  | Our understanding is that Redcap UE type is used before RRC Connection completion. Other capability e.g. peak data rate envelope can be reported after RRC connection setup through UE capability signalling. If it is true, then diverse data rate requirements do not necessarily motivate to introduce more than one Redcap device Types. |
| Intel | FFS | This issue is not only dependent on the complexity reduction features defined for RedCap UEs, but is also coupled to the discussion on “definition of RedCap UE types” and the purpose we define UE types for (FL proposal #3), as well as how and when such UE types are identified by the gNB. |
| Nokia, NSB | Y | Based on the complexity analysis, coverage analysis and power savings, RAN1 should be able to make a recommendation on the number of RedCap types. |
| FUTUREWEI | Y and N | Still Y and N. The RAN2 decision is quite clear. “The number of device types should be minimised, to reduce market fragmentation, and introduced only where essential”. Proposals that increase market fragmentation and not essential. |
| DOCOMO | Y |  |
| InterDigital | Y |  |
| Moderator | **Observations:**   * ~~9~~ 10 companies (Panasonic, CATT, CMCC, Lenovo, Motorola Mobility, Ericsson, Nokia, NSB, DOCOMO, InterDigital) agree with FL proposal#5 in principle   + 1 companies (CATT) thinks if it cannot be decided within this RAN1 meeting and leave to WI phase, we may further consider what can be concluded and provided to RAN2 * 5 companies (FUTUREWEI, Huawei, HiSilicon, MediaTek, Apple) propose to agree to only one device type per frequency band   + 1 company (Apple) thinks that Redcap UE type is used before RRC Connection completion, so diverse data rate requirements do not necessarily motivate to introduce more than one Redcap device Types * 2 company (vivo, LG) propose to agree to two device types * 8 companies (Qualcomm, OPPO, ZTE, Xiaomi, Samsung, Sharp, Spreadtrum, Intel) think we should focus on the discussion on the minimum set of UE capabilities for RedCap UE type (or definition of RedCap UE type) at first * 1 company (Samsung) suggests to discuss in WI scoping phase * 1 company (Xiaomi) thinks following 3 principles can be considered for the discussion   + Principle 1: Avoid the market fragment as indicated in RAN2 agreement   + Principle 2: Satisfy the diverse requirement for different use case   + Principle 3: On the base of fulfilling the requirement of different use case, compress the cost and power consumption as much as possible.   Based on the observations above, more discussion regarding UE complexity reduction features seems necessary before discussing the number of UE types. FL tends to agree with the comment from Apple that Redcap UE type is used before RRC Connection completion, i.e, for early identification, but not sure whether companies share the same view. Therefore, FL propose to postpone this discussion until further progress is made for FL proposals #1 to #4. | |
|  |  | |

* 1. **Others**

## Coexistence with legacy UE

In [3, 4, 8, 12, 20], coexistence with legacy UE is discussed including:

* Initial access (SSB/CORESET#0/SIB1/initial BWP/PRACH) and paging: [3, 4, 8, 12, 20]
* Efficient Beam-based operation in FR2: [20]
* Efficient resource usage in FR2: [20]
* How to mitigate the PRACH collision in FR2: [20]

As discussed in the last RAN1 meeting, coexistence issue regarding initial access and paging was also discussed in other AIs for RedCap. So this issue should be discussed in the corresponding AIs.

Regarding the 2nd to 4th points, as these issues have been proposed by only one company from the beginning of this SI but no other companies discussed these aspects in their contributions, following is proposed:

### **FL proposal#6:**

* **Studying following coexistence issues is deprioritized in Rel.17 RedCap SI**
  + **Efficient Beam-based operation in FR2**
  + **Efficient resource usage in FR2**
  + **How to mitigate the PRACH collision in FR2**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree (Y/N)** | **Comments** |
| FUTUREWEI | N | Either we say “not included” or don’t make a conclusion, as no time to do this. Deprioritized could be interpreted as included and possibly in the TR (like half duplex type B and CSI reduced processing time). |
| vivo |  | Similar comment as FUTUREWEI, this is the last meeting of the SI, we should make a clear conclusion. |
| Panasonic |  | The intention of the proposal is a bit not clear to us. Does it mean to defer to a WI phase to discuss or not supported in Rel.17? If we have time to discuss these topics, we can draw a clearer conclusion. If not, we can also live with no conclusion. |
| LG |  | Need clarification on the proposal. Does the “deprioritized” in this framework/principles discussion at this point mean “not treated under this agenda item”? Does that mean “not captured in the TR”? We can provide further inputs after clarification. |
| Qualcomm | N | We think that due to the possibly larger number of RedCap UE concentration (e.g., in industrial sensors) as well as the case of being stationary and using UL heavy traffic pattern, RedCap UEs may have significant coexistence issues with eMBB and if left un-resolved may case eMBB operation degradation. E.g., beam direction blocking, beam overloading, PRACH congestion, etc.. as explained in details in our paper [20]. In addition, due to BM constraints, FR2 specifically may have larger resource utilization and some efficient resource reuse with eMBB is needed to avoid resource utilization issues.  So we still believe some techniques need to be considered in RedCap SI/WI. |
| Moderator | * Response to FUTUREWEI/vivo/Panasonic/LG: FL’s intention is not to discuss in this meeting, which means that nothing is capture in the TR. To clarify this, FL proposal#6 is updated as below:  **Updated FL proposal#6:**  * **~~Studying~~ F~~f~~ollowing coexistence issues are not studied ~~is deprioritized~~ in Rel.17 RedCap SI**   + **Efficient Beam-based operation in FR2**   + **Efficient resource usage in FR2**   + **How to mitigate the PRACH collision in FR2** | |
| OPPO | Y | We are fine with updated FL proposal#6. |
| ZTE | Y | We are fine with the updated FL proposal #6. |
| CATT | Y | Support FL’s updated proposal. |
| Samsung | Y | Support updated FL proposal #6. |
| CMCC | Y | Support FL’s updated proposal. |
| Sharp | Y |  |
| Spreadtrum | Y | Fine with the updated FL proposal #6. |
| LG | Y | We are okay with the Updated FL proposal#6 with the clarification from the FL above. |
| Lenovo, Motorola Mobility |  | We prefer to study how to mitigate the PRACH collision in both FR2 and FR1. |
| Huawei, HiSilicon | Y | OK with the update FL proposal #6. |
| Ericsson | Y | Agree with Updated FL proposal #6 |
| MediaTek | Y | Fine with the updated proposal. |
| Apple | Y | Ok for us considering the timeframe of Redcap Study item. Maybe considered in the future enhanced releases. ☺ |
| Intel | Y | Agree with updated FL proposal #6 |
| Nokia, NSB | Y | Agree with updated FL proposal #6 |
| FUTUREWEI | Y |  |
| DOCOMO | Y | Support Updated FL proposal#6 |
| InterDigital | Y |  |
| Moderator | **Observations:**   * After updating the FL proposal#6, almost all companies agree with updated FL proposal#6   Based on the observation above, let’s try to agree on updated FL proposal#6 | |

### **Updated FL proposal#6:**

* **~~Studying~~ F~~f~~ollowing coexistence issues are not studied ~~is deprioritized~~ in Rel.17 RedCap SI**
  + **Efficient Beam-based operation in FR2**
  + **Efficient resource usage in FR2**
  + **How to mitigate the PRACH collision in FR2**

If you have strong concern on updated FL proposal#6, please provide comments in the below table with suggestion which is acceptable to all companies.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Agree with Updated FL proposal #6. |
| Qualcomm | We do not agree with the proposal. For better coexistence (as explained earlier and detailed in our paper [20]), these need to be considered. We think that these should be kept open for interested companies to discuss and further study. We don’t believe that precluding it helps. |
|  |  |

At the 1st check point (10/29), following conclusion was made:

|  |
| --- |
| **Conclusion:**   * Following coexistence issues are not studied in Rel.17 RedCap SI   + Efficient Beam-based operation in FR2   + Efficient resource usage in FR2   + How to mitigate the PRACH collision in FR2 |

## Other comments

Comments that do not fit in any of the previous sections of this document but related to AI 8.6.4 can be provided in this section.

|  |  |
| --- | --- |
| **Company** | **Comments** |
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* 1. **Topics to be discussed in other AIs**

Potential UE complexity reduction features

In [5], aspect related to potential UE complexity reduction features is discussed, but this should be discussed in AI 8.6.1.

Evaluation methodology

In [22], aspect related to the evaluation methodology is discussed, but this should be discussed in AIs 8.6.1/2/3.

Identification/access control of RedCap UE

In [4, 11, 12, 13, 16, 18, 20], aspect related to identification/access control of RedCap UE are discussed, but this should be discussed in AI 8.6.5.

1. **Conclusion**

To be updated

**Reference**

1. R1-2007532 Framework and principles for RedCap Ericsson
2. R1-2007537 Framework for RedCap UEs FUTUREWEI
3. R1-2007599 Framework and principles for reduced capability devices Huawei, HiSilicon
4. R1-2007671 Framework and Principles for Reduced Capability vivo, Guangdong Genius
5. R1-2007718 Views on Framework and Principles for Reduced Capability ZTE
6. R1-2007865 Framework and principles for reduced capability NR devices CATT
7. R1-2007950 Framework and principles for introduction of RedCap UEs Intel Corporation
8. R1-2008019 Discussion on design principles and definition for RedCap device type CMCC
9. R1-2008051 Consideration on the framework to support reduced capability NR devices LG Electronics
10. R1-2008071 Framework and Principles for Reduced Capability UE Nokia, Nokia Shanghai Bell
11. R1-2008087 Framework and Principles for Reduced Capability Xiaomi
12. R1-2008101 Discussion on Framework and Principles for Reduced Capability Spreadtrum Communications
13. R1-2008173 Framework and Principles for Reduced Capability Samsung
14. R1-2008263 Further considerations on reduced UE capability OPPO
15. R1-2008290 Discussion on Framework and Principles for Reduced Capability Panasonic
16. R1-2008296 Framework and Principles for RedCap Lenovo, Motorola Mobility
17. R1-2008473 Framework and principles for RedCap Apple
18. R1-2008513 On the framework for RedCap UEs MediaTek Inc.
19. R1-2008554 Discussion on framework and principles for RedCap NTT DOCOMO, INC.
20. R1-2008623 Standardization Framework and Design Principles for RedCap Devices Qualcomm Incorporated
21. R1-2008687 Framework and Principles for Reduced Capability InterDigital, Inc.
22. R1-2008741 Framework and principles for RedCap UE Sequans Communications