**3GPP TSG-RAN WG2 Meeting #111 electronic Draft R2-2008191**

**Elbonia, Aug 17th – 28th 2020**

**Agenda item:** 8.11.12.1

**Source:** Intel Corporation

**Title:** Summary of discussion [109][REDCAP] Reduced capability signalling framework (Intel)

**Document for:**  Discussion and decision

# Introduction

This is the summary of below offline discussion:

**[AT111e][109][REDCAP] Reduced capability signalling framework (Intel)**

Scope: Discuss the proposals in [R2-2006751](file:///C%3A%5CData%5C3GPP%5CExtracts%5CR2-2006751-redcap-capabilty-framework.docx), [R2-2006911](file:///C%3A%5CData%5C3GPP%5CExtracts%5CR2-2006911%20Framework%20and%20Principles%20for%20Reduced%20Capability.docx) and [R2-2006605](file:///C%3A%5CData%5C3GPP%5CExtracts%5CR2-2006605_Defining%20and%20constraining%20UEs%20with%20reduced%20capabilities.docx). The intention is to identify design alternatives, collect company views and, whenever possible, also narrow down the proposals.

Initial intended outcome: summary of the offline discussion with e.g.:

  List of agreeable proposals (if any)

  List of proposals that require online discussions

Initial deadline (for companies' feedback): **Monday 2020-08-24 22:00 UTC**

Initial deadline (for rapporteur's summary in R2-2008191):  Tuesday 2020-08-25 02:00 UTC

Status: Ongoing

# Discussion

To make it easier to find the correct contact delegate in each company for potential follow-up questions, the rapporteur encourages the delegates who provide input to provide their contact information in this table:

|  |  |
| --- | --- |
| Company | Delegate contact |
| COMPANY\_NAME | NAME (email@address.com) |
| Intel | yi.guo@intel.com |
| Qualcomm | Linhai He, linhaihe@qti.qualcomm.com |
|  |  |
| Nokia | Jussi Koskinen (jussi-pekka.koskinen@nokia.com) |
| OPPO | lihaitao@oppo.com |
| Xiaomi | liyanhua1@xiaomi.com |
| Futurewei | Hao Bi, hao.bi@futurewei.com |
| Ericsson | tuomas.tirronen@ericsson.com |
| Convida Wireless | Joe Murray (murray.joseph@convidawireless.com) |
| Apple | Naveen Palle (naveen.palle@apple.com) |
| Sequans | noam.cayron@sequans.com |
| NEC | Hisashi Futaki (hisashi.futaki[at]nec.com) |
| Samsung | Jaehyuk JANG (jack.jang@samsung.com) |
| CATT | Erlin Zeng (erlin.zeng@catt.cn) |
| Huawei, HiSilicon | baokun.shan@huawei.com |
| MediaTek | pradeep[dot]jose[at]mediatek[dot]com |
| vivo | Chenli (chenli5g@vivo.com) |
| Lenovo | shijie4@lenovo.com |
| Fujitsu | luyang@cn.fujitsu.com |
| CTC | wuzp@chinatelecom.cn |
| Spreadtrum | Xiangdnog Zhang(Xiangdong.Zhang@unisoc.com)  |
| LG Electronics | stella.choe@lge.com |
| InterDigital | Dylan Watts (Dylan.watts@interdigital.com) |
| ZTE | Jianxun Ai(ai.jianxun@zte.com.cn) |
| Telecom Italia | damiano.rapone@telecomitalia.it |

As indicated by chairman, following contributions are considered in this offline discussion:

[1] R2-2006751 Reduced capability signalling framework Intel Corporation discussion Rel-17 FS\_NR\_redcap

[2] R2-2006911 Framework and Principles for Reduced Capability Ericsson discussion FS\_NR\_redcap

[3] R2-2006605 Defining and constraining UEs with reduced capabilities Qualcomm Inc discussion Rel-17 FS\_NR\_redcap

Based on the study item scope as below, two aspects need to be discussed, i.e. how to define the reduced capabilities, and how to ensure reduced capabilities are only used for intended use cases.

*Study standardization framework and principles for how to define and constrain such reduced capabilities – considering definition of a limited set of one or more device types and considering how to ensure those device types are only used for the intended use cases [RAN2, RAN1].*

## **How to define the reduced capabilities**

**Question 2.1-1 The need of device type**

As mentioned in the SID “considering definition of a limited set of one or more device types”;

[3] mentioned “*Since the SID requires RedCap UEs to be explicitly identifiable, we think they should be explicitly defined too*.”;

[1] mentioned “*defining device types can make it easier for access restrictions and check device use. It is also conceptually simpler, especially as an industry, to define certain device types for certain applications such as wearables, video surveillance and the device capability reduction that is allowed for these device types. Care should be taken though to minimise the number of device types that need to be defined to avoid long discussions as with LTE UE categories.*”

[2] mentioned “*Although these are strictly market-related strategies and discussions, 3GPP can facilitate the market development by defining specific device types with limited range of possible configurations.*

*3GPP could introduce a definition of a RedCap UE with certain capabilities (or certain combinations of capabilities) or the standard can allow any combination taking into account the minimum requirements and further leave it for markets to avoid the production of RedCap chipsets with multiple combinations of capabilities.*”

**Summary**, [1] [2] [3] all considered to have device type concept. Device type can be used:

* access restriction;
* check the intended use cases;
* avoid fragmented market by limited number of device type;

**Potential conclusion 1:** **Device types concept is introduced for RedCap devices.**

**Question 2.1-1: Companies are invited to provide view on potential conclusion 1.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree or disagree** | **Remark**  |
| Qualcomm | Agree | We agree with all the arguments cited above. |
| Nokia | Disagree | It is not clear to us what is meant by “device type concept” and wording of the proposal is not acceptable. However UE capabilities needs to be introduced for REDCAP UEs. RAN2 needs to agree needed functionality for REDCAP UEs and related capabilities can be introduced later. In some scenarios early capability indications might be needed e.g. in cases where UE capabilities are not available in the gNB during connection establishment etc. |
| OPPO | Agree |  |
| Xiaomi | - | I check the [R2-2006751](file:///C%3A%5CData%5C3GPP%5CExtracts%5CR2-2006751-redcap-capabilty-framework.docx), and it seems a little confused me by the “device type concept”. Does this mean the “UE categories” like in LTE to define UE capabilities as compared to the explicit capability signalling in NR? If so, I guess the existing UE capability signalling can be used as baseline to indicate reduced capabilities for RedCap UE；To introduce the “UE categories” as in LTE can be further considered.[Rapp] this is not our intention. As clarified, the purpose of the device type is for * access restriction;
* check the intended use cases;
* avoid fragmented market by limited number of device type;

Or does that mean the early capability indications of Redcap devices for initial access that the network can identify it? If so, I guess it will depends on more RAN1’s input. The RAN1 is discussing whether early identification is needed or not and how to achieve this. See our more comments on Q3. |
| Futurewei | Agree with comments | We see this more as an indication that UE would have reduced capability than normally required (# of antenna, BW, etc). It can be used with UE’s subscription to authorize the reduction of capabilities. It can also be used for access restriction and control.We don’t see “types” defined for different use cases, or different sets of capabilities.  |
| Ericsson | Disagree | We don't agree to the current formulation in the proposal. As pointed out by Nokia, the formulation is unclear on what a "device type concept" actually is, so it would not be clear what we agree to. We think the existing capability signaling framework should be taken as baseline, and new capabilities characteristic to Redcap UE should be defined where needed, e.g. for maximum BW of 20 MHz (for FR1). UE with such capability, or minimum set of capabilities, would then correspond to a "Redcap UE", a concept which can be used e.g. in AS signaling when checking for access restriction. There should be no need for more than one type of Redcap UE from AS signaling/procedures perspective. On top of that, we don't see a need to define a broader "device type concept".  |
| Convida Wireless | Agree | The exact definition of device types and how they are specified can be done during the Work Item. |
| Apple | Agree with comments | We are not keen on defining types to be used in RAN2 signaling extensively, but rather for marketing, and for “broader” restriction. We think the NWs are already flexible in handling a variety of UEs and the relaxation of many capabilities that will be part of RedCap do not require that the NW “broadcast” it’s filtering of what sort of RedCap UEs it supports by listing a big list of these capabilities in broadcast, for defining access restriction. We think probably BW and SCS limitations are important and so a broad types (2 or 3) based on these can be defined.  |
| Sequans | Disagree | This is too general a comment. If RAN1 decisions make it extremely convenient or necessary, we can decide to introduce types later. For now existing capability signaling framework can be used as baseline. |
| NEC | Agree |  |
| Samsung | Disagree | As indicated in email discussion [108], we are not sure whether a separate 'device type' should be defined. For all the features from RedCap, we could follow the legacy principle (to have a separate capability), and a few features among the features that impact to initial access can be reported earlier to the network without introducing such a separate 'device type'. |
| CATT | See comments | In our view it is generally OK that we somehow define the device type in this SI/or potential WI after that. The device type should mainly be used for identification and access control, but it should be not require/cause any change to the existing ue cap framework. In our view R2 should progress on the two main topic at the same time- general ue cap framework of redcap devices- device type.It is a bit unclear how to decide one without discussing the other.  |
| Intel | Agree | To our understanding, the device type can be used for:- access restriction including initial access;- check the intended use cases;- avoid fragmented market by limited number of device type;The number of device type depends on the purpose and RAN1 discussion and only one or two device types are expected to be defined UE capability signalling will continue to be used for signalling the detailed UE capability for these devices.Can companies agree:**Device type could be used for access restriction (including initial access), check the intended use cases; FFS on the signaling details, e.g. 1 bit, cause value, etc in AS layer or NAS layer;** |
| Huawei, HiSilicon | Agree | Agree with the summarized arguments. In addition, we think the definition of “device type” should be linked to the mandatory/minimum set of UE capabilities, e.g. maximum bandwidth of 20 MHz (for FR1), etc.  |
| MediaTek | See comment | While we agree with the uses for the ‘device type’, the actual proposal itself is unclear to us, so we’re unsure on what is being agreed here.We should first define what a ‘device type’ is, i.e. an identifier associated with a minimum set of capabilities that [is/will be] defined as part of the RedCap work. Then we can agree that this identifier can be used for:* *access restriction;*
* *check the intended use cases;*
* *avoid fragmented market by limited number of device type;*
 |
| vivo | Agree | Considering that the service requirements of various RedCap UEs can be quite different, it will be beneficial to introduce the device type concept for access restriction and access control. For example, we can divide the RedCap UEs into IIOT device type and wearable device type. Anyway, the number of device types can be discussed further based on the reduced capability defined in RAN1 and RAN2. But whether the device type needs to be indicated to the network explicitly can be further discussed, based on the detailed design for access control and access restriction.  |
| Lenovo | Agree | Agree with above conclusion. One or two UE types could be defined to the RedCap UEs for above requirement. |
| Fujistu | Agree | Agree that the intention of the RedCap device type can be for RedCap device identification, access restriction or making sure the intended use cases.  |
| CTC | Agree with comments | We think the “device type” should mainly be used for identification or in marketing, but it should not require changes to the existing UE cap framework.  |
| Spreadtrum | Agree | Device type, maybe related with some capabilities, can provide convenience for access control and UE capability identification in very initial stage.  |
| LG | Agree | We need to discuss whether single UE can be configured with more than one level of reduced capabilities.  |
| InterDigital | Agree | Agree with the view in [1] i.e. it would simplify access restrictions and check device use, however the number of device types should be limited. |
| ZTE | Agree with comments | Device type can be define as grouping of UE capabilities, to avoid random combination of reduced capabilities in product design. And Redcap UE type is generally useful for the purpose list above, which are the main motivation to introduce device type. But how to capture and apply the device type needs more discussion. |
| Telecom Italia | Agree, but | We think that for operators it is important to define a REDCAP device type indication(s) to be explicitly indicated to the network for checking access restrictions (especially at very initial stages) as well as the intended use case/requested service. Then, once such indication(s) has(-ve) been defined, the current signaling framework can be exploited for the network to actually gather the REDCAP UE’s capabilities.On the number of device types we think that we should strive to define not too many types (one type should be sufficient), as the way to handle such devices in the network could still rely on the signaling framework already developed for NR.  |

**Question 2.1-2 The relationship between device type and capabilities**

[1], *This gives two options on how device types are used and signalled.*

*Option 1) Certain UE capabilities are only captured in the device type definition*

*Option 2) UE capabilities are always signalled explicitly and device type is an additional concept*

*There is no fundamental reason to move away from the legacy NR method of explicitly signalling UE capability. The main motivation for using device type is to make it easier to control access and for industry classification. If device types are used to define UE capabilities, it becomes similar to UE categories of LTE and can quickly result in increasing number of types and fragmentation. However, there is no need to define a device type for every UEs – it only needs to be done where there is a need to identify or restrict UE access based on some limited reduced capabilities and only a small number of device types need to be defined.*

[2] “*Observation 4 The existing UE capabilities framework can be reused to enable, beside the minimum set of capabilities RedCap UEs, more advanced features in RRC\_CONNECTED.”*

[3] also mentioned “*We think this verification can be done by performing a capability match between UE’s reported radio capability and the set of radio capabilities used in defining UE’s RedCap type. The rationale behind this check is that even if a UE falsely reports its UE type, it is less likely that it would falsely report its radio capabilities to gNB.*”

**Summary**, [1] [2] [3] proposed the similar way on the relationship between device type and the UE capabilities, i.e.the existing UE capabilities framework can be reused,  UE capabilities on redcap are always signalled explicitly and device type is an additional concept.

**Potential conclusion 2:** **The existing UE capabilities framework can be reused, UE capabilities on redcap are always signalled explicitly and device type is an additional concept.**

**Question 2.1-2: Companies are invited to provide view on potential conclusion 2.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree or disagree** | **Remark**  |
| Qualcomm | Agree | We agree with all the arguments cited above.  |
| Nokia | Disagree | We think that traditional UE capability framework is sufficient, and we see no motivation to introduce new device type concept. |
| OPPO | Agree |  |
| Xiaomi | - | See above. |
| Futurewei | Agree |  |
| Ericsson | Partly agree | The existing UE capabilities framework can be re-used. Not clear what "UE capabilities on redcap are always signaled explicitly" means – we think the existing capability signaling procedures can be re-used. Possible need for early signaling needs to be studied, and if such is needed, then implicit or explicit indication that the UE is a Redcap UE would be needed.[Rapp] "UE capabilities on redcap are always signaled explicitly" aligned with existing UE capability frame work, i.e. UE capabilities are signaled explicitly. The indication on Redcap UE can be used for initial access/access control and check the intended use cases;We don't see additional device type concept on top of our reply to Q2.1-1 is needed.  |
| Convida Wireless | Agree |  |
| Apple | Agree | Device type (if we agree to it) is an additional concept, but the existing UE cap framework can easily handle the RedCap UE requirements. Only access restriction needs to be addressed, and here we prefer a very smple device type definition.  |
| Sequans | Partially agree | We agree the existing capabilities framework should be used as baseline. It’s unclear to us what “UE capabilities on redcap are always signalled explicitly and device type is an additional concept” means exactly; presumably device types would remove at least part of the need to signal capabilities. And, this may not cover the early/initial capability case. |
| NEC | Agree | we assume explicit signaling would include a possibility to use UE radio capability ID introduced in Rel-16 RACS. |
| Samsung | Disagree | Same view as Nokia. |
| CATT | agree | As commented in the previous question we should discuss in this way.We think this proposal makes more sense.  |
| Intel | Agree | Device type can be discussed separately, the potential conclusion can be changed as**The existing UE capabilities framework can be reused to indicate reduced UE capabilities, i.e. UE capabilities on redcap are always signalled explicitly ~~and device type is an additional concept~~.**  |
| Huawei, HiSilicon | See comment  | We agree to use existing UE capabilities framework as a baseline with the following comments:* New capability (or new value for certain capability) for REDCAP UE may need to be added if it is not supported by the current capability signalling (if agreed by RAN1, e.g. HD-FDD).
* Agree with Ericsson that the device type needs to be indicated to the network in some way, e.g. via RACH procedure or capability reporting, details can be further discussed.
* We agree to consider the current signalling structure as a baseline, but we think the capabilities restriction for the defined device type should be specified very clearly in the specification (maybe separate section in TS38.306) to avoid unnecessary complexity for the UE and gNB to implement corresponding capabilities, including:
* Mandatory/Minimum set of capabilities for the defined device type
* Capabilities (or specific values for certain capability) that only apply to the defined device type
* Capabilities (or specific values for certain capability) not apply to the defined device type
 |
| MediaTek | Partially agree | We agree that UE capability framework is reused, but we also see the ‘device type’ identifier as part of the UE capability framework. For example, as part of the current NR capabilities we have:1. Min capabilities all UEs support (not signaled explicitly)
2. Optional capabilities (signaled explicitly)

Similarly, for RedCap we expect:1. Min capabilities all RedCap UEs support (only identifier needs to be signaled)
2. Optional capabilities (signaled explicitly)
 |
| vivo | Agree | See the detailed answer in last question, whether the device type needs to be indicated to the network explicitly can be further discussed. But the current UE capability framework can be reused for RedCap UEs. Thus, the above updated proposal provided by Intel is fine with us.  |
| Lenovo | Agree | The existing UE capabilities framework is considered as baseline, UE capabilities on redcap could be signalled explicitly. |
| Fujitsu | Partly agree | We agree traditional UE capability procedure can be reused. The RedCap type can represents the minimum supported capabilities including such as minimal number of antenna or bandwidth supported, existing UE capabilities should be signalled through the legacy procedure. An indicator or a cause may be signaled to indicate the RedCap type. If the RedCap UE is identified through msg1/msg3, depending on RAN1 discussion result, the explicit indicator is not needed. |
| CTC | Agree | The existing UE capabilities framework is reused as baseline. |
| Spreadtrum | Agree |  |
| LG | Agree | Existing UE capabilities framework can be used as baseline. |
| InterDigital | Agree | Same view as [3]. The existing NR capability framework is sufficient. |
| ZTE | Partly agree | The existing UE capabilities framework can be reused. UE capabilities should be indicated in the capability signaling explicitly.On top of the capability signaling, whether device type concept is also indicated depends on the definition of device type and how to use the device type indication. Decision can be made after this concept is clearer. |
| Telecom Italia | Partially agree | We see the REDCAP device indication not as additional concept but an important mean for the operator to properly handle the device especially at the very initial stages (refer to Q2.1-1), i.e. access restrictions, and such indication should be explicitly known to the network ASAP. Then the actual capabilities can be sent to the network once the operator allowed such REDCAP UE to operate in the network itself  |

**Question 2.1-3 How to define the device type**

[1] “*However, there is no need to define a device type for every UEs – it only needs to be done where there is a need to identify or restrict UE access based on some limited reduced capabilities and only a small number of device types need to be defined.*

*Proposal #3: The number of device types should be minimised and* ***introduced only where essential to control UE accesses and industry classification*.**”

[2] “*It is possible that the definition of RedCap UEs will diverge in terms of features, capabilities and constraints regarding FR1 and FR2. For this reason, we believe two device types should be defined, one for each Frequency Range.*

*Proposal 1 One RedCap device type is defined per frequency range,* ***corresponding to minimum set of capabilities addressing the RedCap use cases****.”*

[3]” *One approach is to define them in specifications based on a set of radio capabilities that differentiate them from legacy R15/16 UEs, e.g. number of Tx/Rx antennas, maximum supportable BW, etc. The exact composition of this set can be discussed by RAN1.*

*For example, if only a single RedCap type is defined, we may define its feature set targeting a high-end use case (e.g. smart watch) and have low-end UEs (e.g. sensors) use radio capabilities to omit features that they do not support. That would enable a single UE implementation supporting wide range of use cases. If two RedCap types are defined, we can define one type targeting high-end UEs (e.g. smart watch) and the other for low end UEs (e.g. sensors).*

*Proposal 1. Only one, or at most two, RedCap type(s) needs to be defined in Rel-17,* ***based on a set of radio capabilities that differentiate them from legacy R15/16 UEs****.”*

**Summary**: [1] [2] [3] proposed similar way, i.e.

* The number of device types should be minimised and introduced only where essential to control UE accesses and industry classification, e,g, differentiate them from legacy R15/16 UEs, ( number of Tx/Rx antennas, maximum supportable BW, etc.). The exact composition of this set can be discussed by RAN1.

**Potential conclusion 3:** **The number of device types should be minimised and introduced only where essential to control UE accesses and industry classification, e,g, differentiate them from legacy R15/16 UEs, ( number of Tx/Rx antennas, maximum supportable BW, etc. ). The exact composition of this set can be discussed by RAN1.**

**Question 2.1-3: Companies are invited to provide view on potential conclusion 3.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree or disagree** | **Remark**  |
| Qualcomm | Agree | As to the number of UE types, we think what goes into the definition of a UE type can depend on frequency range, but the number of UE types does not have to depend on how many FRs we have. Because the main use of UE type is for access restriction and access control. For that purpose, a serving cell never has to deal with two FRs at the same time. So one UE type is enough. As to the defining capabilities, we think the general guideline is that they should define the **envelop** of capabilities that differentiate RedCap from legacy R15/15 UEs. Hence within this set, we may need to include some “minimum capabilities” too. For example, we need to define the minimum bandwidth that RedCap UEs need to support so that they can reuse Rel-15 SSB bandwidth and share the same network with legacy UEs.  |
| Nokia | Disagree | See earlier comments  |
| OPPO | Agree | We think at most two UE types should be introduced to avoid market fragmentation.  |
| Xiaomi | - | It seem that the device type mentioned here is for early capability indications of Redcap devices for initial access as the rapporteur mentioned to “differentiate them from legacy R15/16 UEs “.If RAN1 confirmed that the early identification is needed, we guess only one UE type for Redcap UE(e.g. NR-Redcap UE) is need and sufficient.This” NR-Redcap UE” could let itself be identified by the network during the initial access with a minimum set of Redcap UE capabilities. i.e., a set of capabilities in terms of the minimum bandwidth, MIMO layer and modulation order etc. For other capabilities beyond the minimum set can at least be supported by the current NR capability framework. To introduce the “UE categories” as in LTE can be further considered. |
| Futurewei  | Agree | One type, or an indication, can be used for Redcap UE to indicate reduced capability than normally required (# of antenna, BW, etc). Network use it to let RAN provide service to UE of lower capabilities. It can also be used for access restriction and control.The traditional capability signalling is still used for Redcap UE to report its actual capabilities. There would be a new “minimum” capability (# of Antennas, BW, etc) defined for Redcap UE.  |
| Ericsson | Agree | Similar view as Futurewei. See also our earlier comments. We don't see need to have more than one general definition of a RedCap UE corresponding to minimum capability/capabilities such UEs would support (there might be need to separate FR1/FR2 with regards to some capabilities). Additional capabilities may be signaled on top, per existing framework. A type definition could also include some restrictions on what a Redcap UE should be able to support – e.g. to avoid advanced UEs to be identified as Redcap UEs. This requires further discussion though. |
| Convida Wireless | Agree | We should strive to minimize the number of device types. The definition of each device type requires discussion, but in our view a maximum of 2 device types for each FR should be sufficient. |
| Apple  | Agree | We agree with potential conclusion 3. We also agree that this needs to be discussed in RAN1, but RAN2 can provide guidance as well. If we really want to minimize the device types, we think the minimum BW support is a good starting point. |
| Sequans | Agree | Agree with Futurewei and Ericsson |
| NEC | Agree | Agree to minimize the number of device types to avoid much fragmentation. Also agree that this would highly depend on RAN1 study. |
| Samsung | Disagree | See our comments for Question 2.1-1 above. |
| CATT | Agree | Yes, see our comments to Q1 and Q2. |
| Intel | Agree | Considering the purpose of the device type, limited number is desirable. But the exactly number also needs RAN 1 inputs. -access restriction including initial access;- check the intended use cases;- avoid fragmented market by limited number of device type; |
| Huawei, HiSilicon | Agree | From RAN2 perspective, we think only one UE device type is enough to cover all intended use cases of REDCAP UEs.The exact number needs to be decided by RAN1 according to the conclusion of reduced capabilities. |
| MediaTek | Agree | Agree with Futurewei.We would like to stress the point on ‘avoiding market fragmentation’ as this is key to lowering device costs. To enable this, we think that just one ‘device type’ should be defined to cover all intended use-cases of RedCap. |
| vivo | Agree  | Firstly, we agree the number of device types should be minimized and introduced only where essential to control UE accesses and industry classification, considering the economics of scale and in order to avoid market fragmentation. As we all know, the use cases and corresponding requirements are quite diverse for RedCap devices.If we only define one device type or category for all use cases, e.g., if one RedCap UE type is defined for the high-end use case assuming the higher data rate (e.g. 150Mbps DL and 50Mbps in UL), it will be challenging to achieve the target on power efficiency for sensors and low-end wearable devices. Thus, it is necessary to introduce two RedCap device types: one device type is to cover the low-end use cases e.g., industrial sensor, economic video surveillance, low-end wearable use cases; while the other device type is for high-end use cases e.g., high-end wearable and high-end video surveillance use cases.We also think the RedCap UE type can be defined based on the UE capabilities/features. Thus, we need to wait for more progress from RAN1.  |
| Lenovo | Agree | Since the access control for RedCap UEs is to differentiate RedCap UEs from legacy UEs, one RedCap UE type associated the minimum capabilities can work. And the full capabilities can be reported during or after the initial RACH procedure based on the further discussion. |
| Fujitsu | Agree |  |
| CTC | Agree | Agree with HiSilicon. |
| Spreadtrum | - |  Waiting for RAN1 progress.  |
| LG | Agree |  |
| InterDigital | Agree | Introduction of one type i.e. “RedCap UE” can be baseline, and additional device type(s) to differentiate among RedCap UEs can be further studied if there is strong motivation e.g. access restriction, where under loaded cell NW may want to bar some RedCap UEs like industrial sensors but allow access for more critical devices like health sensors. |
| ZTE | Agree  | We agree that the less number of device type, the better to avoid market fragmentation. Thus the number of redcap device type should be minimized.There are several matrix on how to define device types, e.g. link the device type directly to use case(s), based on different peak bit rate requirement, based on granularity for access control, etc. RAN2 may start discussion from these options. We can also accept there is only one device type.After all, because most reduced capabilities are related to physical layer, the exact definition of redcap device should be discussed by RAN1. |
| Telecom Italia | Agree | We would like to stress the fact that the number of REDCAP UE types should be minimized as much as possible. On type should be enough as it should be used mainly for access restriction/access control and we think a minimum set of capabilities being common for all REDCAP UEs, which is linked to the REDCAP UE type indication, could be defined. Other capabilities can be signaled by leveraging the current NR framework |

**Question 2.1-4 How to capture the device type**

[1] “*Further, there has to be an unambiguous understanding of the capability associated with the device type when used to control access to the network. Only the capabilities that are reduced for this device types should be captured. It is proposed:*

*Proposal #4:* ***Device type and its associated capabilities (the reduced set of capabilities) is captured in specifications****.”*

[2] “ *As a final remark, the exact details of how to capture such device types in the specifications can be left for normative phase after the study item has completed. The study should focus on discussion of the possible number of different device types and whether there is need to (normatively) restrict the number of possible capability combinations, as discussed in Section 2.1.*

*Observation 6* ***The exact definition of device types and how they are captured in the standard is determined in the normative phase****.*

**Question 2.1-4: companies are invited to provide view on how to capture the device type:**

* **Option 1: Device type and its associated capabilities (the reduced set of capabilities) is captured in specifications.;**
* **Option 2: Discuss in normative phase;**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option 1 or option 2** | **Remark**  |
| Qualcomm | Option 1 | We are not sure if these two options are exclusive. We think device type and its associated capabilities have to be defined in specs. We don’t expect how other means (e.g. dynamic signaling?) would work.We also tend to agree with the assessment in [2] that the study phase can focus on discussion on possible number of device types and general guideline on how to define them.  |
| Nokia | Option 2 | UE capability discussion are normally done in the late phase of the work item and we think we should follow that principle. |
| OPPO | Option 2 | After RAN1 studies what reduced set of capabilities are related to RedCap UEs, we can capture the device type in the normative phase. |
| Xiaomi | Option 2 |  |
| Futurewei | Option 2 | As commented before, we don’t see a linkage between a type and a set of capabilities, or something similar to the LTE UE “category” concept.We see an indication to alert RAN of a lowered minimum UE capability. |
| Ericsson | Option 2 | Note that "how to capture device type" is premature as it is not yet clear what is needed.  |
| Convida Wireless | Option 2 |  |
| Apple | Option 1, but | Similar views as Qualcomm. |
| Sequans | Option2 |  |
| NEC | Option 2 | Considering a short SI, it seems not a good idea to spend on discussing this detail (e.g. option 1). anyway Option 1 is not precluded. |
| Samsung | Option 2 | Again, the question is subject to earlier our comments. We also think that the actual capability can be discussed in the normative phase, assuming we follow the legacy principle for the capabilities. |
| CATT | Option 2 | The detailed specification can be in stage 3. But first let’s discuss and agree on some high level principles such as existing ue cap framework is reused., or whether ue type needs to know until when. These can based on discussions on use case and requirements, without going into signaling details.  |
| Intel | Option 1 | Similar view as Qualcomm. We do not see other way around to capture device type. But would be fine to decide this once the reduce capability is clear.  |
| Huawei, HiSilicon | Option 1 | We agree that the details of capabilities can be discuss in normative phase. But the general guideline on the relation between device type and capabilities can be discuss in study phase, see our comment to Question 2.1-2. |
| MediaTek | Option 1 | Agree with Qualcomm and we also do not see the two options as mutually exclusive. Option 1 is a recommendation (that we would like to see as an outcome of the SI), while option 2 covers implementation aspects. |
| vivo | Option 1/2 | It seems that Option 1 is the only simple way to capture the device type. Otherwise, we need to define the association between different device types and UE capabilities, which is not helpful for the access control and restriction for RedCap UEs. But we also think in the SI phase, we should not spend much time on this, as it is the work for stage-3. |
| Lenovo | Option 2 | Agree with Nokia and OPPO. |
| Fujitsu | Option 2 | The exact device type and the associated capabilities are studied in the study item phase. They are specified in normative phase. |
| ctc | Option 2 | Agree with Nokia and OPPO. |
| Spreadtrum | Option 2 |  |
| LG | Option 1 | We have similar view with Qualcomm |
| InterDigital | Option 2 |  |
| ZTE | Option 2 | We agree the device type can its associated capabilities will be captured in specifications. During the SI phase, we can focus on the device type number and how to define device type. How to capture the device type can be postponed to WI phase. |
| Telecom Italia | Option 1 | It would be better to start by defining at most a unique UE type indication (with associated minimum set of capabilities being common to all REDCAP UEs) already in the SI. In the WI phase we could confirm such assumption made during the SI or revise it (provided that a clear benefit for this arose) |

**Question 2.1-5 How to indicate the device type**

[1] “*On the other hand, signalling device type explicitly can help with verification of device type and its capability. As it is only a few bits, it is proposed:*

*Proposal #5:* *Device type is signalled as part of UE capability in addition to the full UE capabilities*.”

**Question 2.1-5: companies are invited to provide view on whether device type is signalled as part of UE capability in addition to the full UE capabilities:**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or no** | **Remark**  |
| Qualcomm | No | In our view, the main purpose of device type indication is for access restriction and access control. So UE signals its RedCap type during connection setup with core network, which then verifies it against UE’s subscription information. This core network entity typically does not need to know details of UE’s radio capabilities (e.g. # of antennas, max number of HARQ processes, etc). Therefore, device type is not signalled as a part of the legacy UE radio capability.  |
| Nokia | no | We are not convinced that device type needs to be signalled in addition to traditional capabilities. It should be sufficient that the network is aware of supported features by the UE. |
| OPPO | No, but  | We are not sure for the moment, in addition to the existing full UE capabilities, what else information is required in the network side to control RedCap UE’s access. At least we think the definition of RedCap device type should be specified, but wonder about the need to signal the device type to network.Maybe this can be discussed in the normative phase and if companies all think a few bits do not matter, we are also ok to have it. |
| Xiaomi | - | See above.If the the main purpose of device type indication is for initial access, RAN1 is discussing how to achieve that. If early identification can let UE be identified by the network as Redcap UE, we are not sure why the “*Device type*”needs to be signalled to the network？ |
| Futurewei | No | It is related to UE capability, but it is used more for authorizing UE’s permission of using reduced capability, and for access restriction and control of UE with reduced capabilities. The exact signaling of this indication can be determined in WI phase. |
| Ericsson | No | On top of existing capability signaling, we don't think an explicit "Redcap" capability is needed. It can be further discussed whether there is need to signal the type separately e.g. for early indication. Especially if an early indication is needed (FFS) and specified, what would be the reason to have an additional separate UE capability? |
| Convida Wireless |  | We believe this can be discussed further during the SI to help develop a common RAN2 understanding, and then the detail of the signalling can be finalized in the normative phase. |
| Apple | No |  |
| Sequans | No | Not clear that anything more than capabilities signalling is needed, and that should be determined at a later stage |
| NEC | FFS | this is depending on a usage of device type. If it is used only for access control in RAN, there is no need to make it visible to 5GC and we agree with proposal. Otherwise (e.g. should be visible to 5GC so that the 5GC is responsible to ensure intended use case only), it would be better to leave it open and further discuss. |
| Samsung | No | See our comments for Question 2.1-1 above. |
| CATT | see our comments to the previous question |  |
| Intel |  | Device type is needed for access restriction including initial access, and also can be used to check intended use case. It is related the solution on how to check the intended use cases and access restriction. Would be fine to discuss this later.  |
| Huawei, HiSilicon | TBD | We think the gNB needs to be aware of a REDCAP UE to check whether the reported capabilities are aligned with the capability restriction defined for the device type. Reporting the device type as part of capability could be one option. If the gNB can identify the REDCAP UE in other way, e.g. during RACH procedure, the reporting in UE capability maybe not needed. |
| MediaTek | See response to Q2.1-2 | We see the device type identifier as part of the UE capability framework as explained in response to Q2.1-2. In short, along the following lines:1. Min capabilities all RedCap UEs support (only identifier needs to be signaled)
2. Optional capabilities (signaled explicitly)
 |
| vivo | Yes/No | As we mentioned above in Q1, whether the device type needs to be indicated to the network explicitly can be further discussed, based on the detailed design for access control and access restriction. Thus, we think it is too early to make the decision whether device type signaling is needed or not.  |
| Lenovo | No | In our understanding, the type is used to control the access of RedCap UEs. And for the full UE capabilities reporting, reuse the legacy mechanisms is a simple and feasible way. |
| Fujitsu | No | The device type can indicate a set of reduced capabilities and it is used for access restriction for RedCap UEs as well. For an access restriction usage, the RedCap device type should be signaled at early stage for network to identify the RedCap UE and check whether the connection setup is allowed. |
| CTC | TBD | RAN1 is discussing how to identify REDCAP UE at initial access, and maybe we can identify the REDCAP UE during RACH procedure. |
| Spreadtrum | - | Depending on the function of the device type, maybe device type need to be reported to network before legacy UE capability report.  |
| LG | No | Device type can be used as part of UE capability but signaling of the full UE capabilities with device type may not be needed. |
| InterDigital | No | Agree with Qualcomm |
| ZTE | -  | Whether device type concept is indicated in capability signaling depends on the definition of device type and how to use the device type indication. Decision can be made after this concept is clearer. |
| Telecom Italia | - | It depends on whether a REDCAP device type indication will be defined and its intended use. At least in the SI phase we should list all the pros/cons of having such indication available as part of the UE capability signalling framework, so to avoid discussions during the WI phase |

## **How to ensure those device types are only used for the intended use cases**

[1] “*As the UE signals its capabilities to the network irrespective of the solution chosen, it is possible for the network to check the device capability or type against intended use cases. This check could be by means of QoS of the bearers used by the device, checking against subscription parameters or PDU session types. The actual details of the checking can be handled by the network.*

*The SI objective of “checking device is used only as intended” can be met using existing capabilities or a device type.* “

[2] “*RAN can already reject an RRC connection establishment attempt e.g. based on the establishment cause provided in Msg3 or through higher layer mechanisms. Further access attempts can be delayed if rejected and it can be discussed whether these mechanisms should be updated or extended.*

*Observation 7 If UE requires a service which is not intended for RedCap UEs, the request can be rejected. RAN2 should further study whether the existing mechanisms should be extended*.”

[3] “*Proposal 2. Network should validate a UE’s RedCap indication against UE’s subscription to ensure it does not receive services unintended for RedCap UEs.*

*Proposal 3. Network can additionally perform capability match procedure between UE’s reported radio capabilities and the set of capability criteria associated with UE’s RedCap type, to prevent a hacked or misconfigured UE from falsely reporting as a RedCap UE.* ”

**Summary**: Based on [1], [2] and [3], checking device is used only as intended can be met by using existing capabilities or a device type or cause value, etc., E.g: the network to check the device capability, device type or cause value against intended use cases based on subscription checking, rejection access requests etc..

**Potential conclusion 4:** The SI objective of “**checking device is used only as intended” can be met by using existing capabilities signaling, a device type, UE subscription or cause value, etc.. Solution details need further discussion.**

**Question 2.2-1: Companies are invited to provide view on potential conclusion 4.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree or disagree** | **Remark**  |
| Qualcomm | Agree |  |
| Nokia | disagree | We are not sure whether this requirement can be met by using existing capabilities or a device type etc. We think that RAN2 should discuss whether traditional devices are allowed to indicate the support for REDCAP functionality. [Rapp] This is related to the relationship between Redcap UE and associated capabilities. Should be discussed in RAN1? Or need inputs from RAN1.  |
| OPPO | Agree |  |
| Xiaomi | Agree |  |
| Futurewei | Agree with clarification | We assume that the term “existing capabilities” mean “existing capability signaling”. We also assume UE’s subscription is taken into account as well, though it is an operation done mainly in Core network.[Rapp] Yes, based on existing capability signaling, and subscription could be used. Has updated. |
| Ericsson | Disagree | Establishment cause is one tool, but especially in case such would not be used, further study is needed. In particular, as the intended use or service cannot be determined by RAN alone, we think SA/CT should be involved when discussing such mechanism(s), and how and if to specify such.[Rapp] We agree NAS needs to be involved. The potential conclusion try to make it more generic, i.e. did not mentioned how to archive this. For instance, the device type can be used by CN or RAN for access restriction. Also add subscription. |
| Convida Wireless | Agree | RAN2 can discuss what enhancements, if any, should be made to improve how this is done. |
| Apple | Agree | In addition, we think NAS signaling can also contribute to this, during registration.  |
| Sequans | Partially agree | These solutions will certainly be the main ones, but it is not clear some additional solutions are needed. “used as intended” should also be considered on how it applies to regular UEs which want to operate as REDCAP ones |
| NEC | Agree |  |
| Samsung | Disagree | We have same view as Nokia. |
| CATT | Agree | In general we think the procedure/signaling that we define should be use case agnostic. In the discussions/specifications of ue cap and device type, we can take into account the need of potentially interested use cases. In this sense we think this proposal makes sense.  |
| Intel | Agree | As replied to Ericsson, we try to make the potential conclusion more generic. The device type can still be checked by CN or RAN for access restriction. Agree with FutureWei, subscription could be one way.  |
| Huawei, HiSilicon | Agree |  |
| MediaTek | Agree | We also agree with Ericsson that SA/CT should be involved in these discussions. |
| vivo | Agree | We agree to have a generic agreement by now. Beside, we wonder whether RAN2 should make the decision firstly on the issue “checking device is used only as intended”, and involve CT/SA later or we should check with CT/SA before we make the decision? |
| Lenovo | Agree |  |
| Fujitsu | Agree  | Agree the network need to check the type to allow or reject access for intended use cases. The exact method should be further discussed.  |
| CTC | Agree |  |
| Spreadtrum | Agree |  |
| LG | Agree |  |
| InterDigital | Agree | However, we also agree with Ericsson comment that SA/CT should be involved in this decision. |
| ZTE | Partly Agree | RRC rejection can be applied if RedCap UE initiates RRC connection with establishment cause not supported for the RedCap device. However, because RAN has little information except the device type, it is hard for RAN to make such decision.We think whether a service can be supported by a REDCAP UE is some kind of NAS information (e.g. subscription information), which is well known by CN. Therefore we think SA/CT should be involved in the discussion (e.g. CN can reject the service request if the services requested can not match the device type) |
| Telecom Italia | Agree | We should list all possible solutions to achieve such requirement as clearly requested by the SID. Then, based on the outcome of the SI, we can down-select in the normative phase |

**Potential solutions on how to ensure** **redCap device types are only used for the intended use cases:**

**Option 1**: RAN can already reject an RRC connection establishment attempt e.g. based on the establishment cause provided in Msg3 or through higher layer mechanisms.

**Option 2:** Network to validate a UE’s RedCap indication against UE’s subscription to ensure it does not receive services unintended for RedCap UEs.

**Option 2a**. Network can additionally perform capability match procedure between UE’s reported radio capabilities and the set of capability criteria associated with UE’s RedCap type, to prevent a hacked or misconfigured UE from falsely reporting as a RedCap UE. ”

**Option x**:

**Question 2.2-2: companies are invited to provide view on solutions ensure redCap device types are only used for the intended use cases:**

|  |  |
| --- | --- |
| **Company** | **Views on potential solutions** |
| Qualcomm | We think both Option 2 and 2a are necessary. Option 1 alone is not sufficient.If we understood correctly how Option 1 works, it may meet the requirement in a robust way – for example, a hacked RedCap UE may not report itself as RedCap in establishment cause and then get services that it is not intended for. Therefore, in addition to some type of indication by UE itself, network has to perform capability match procedure to ensure UE is telling the truth.  |
| Nokia | We think that RAN2 should discuss whether traditional UE can indicate support for REDCAP functionality. However such discussion can take place in the work item phase.  |
| OPPO | We think all these solutions can be considered in the normative phase. Option 1 may have RAN2 impact on defining the new establishment cause. Option 2 and 2a may mainly have RAN3/SA2 impact. |
| Xiaomi | We are also open to discuss these solutions. But I guess Option 2 and 2a may have RAN3/SA2 impact even SA3 if security is involved. |
| Futurewei | Option 2 + Option 1 can be a starting point, and further details can be worked out in WI phase.We are negative on Option 2a, as we don’t envision a type to be associated with a set of UE capabilities, leading us back to something similar to LTE UE category. |
| Ericsson | Option 1 is existing RAN2 tool, which can be discussed further.Option 2 is not in RAN2 scope and requires coordination with SA. Also "Redcap indication" is questionable at this point as it is not clear if and how such would be used.Option 2a is a possibility, but requires further discussion on what capability combination is allowed for Redcap – i.e. whether there is some "upper limit" on what such UE should support to be categorized as Redcap UE. It would seem more reasonable to consider approach where capability is matched against subscription information but this again requires coordination with SA.  |
| Convida Wireless |  Option 2 and 2a seem necessary in addition to Option 1. Details of the option 2 &2a solutions need to be coordinated with SA2. |
| Apple | Option 2 is the starting point and option-1 is viable, but we are not sure about the rejection at MSG3. We assume RAN already has access-barring of some sort, and anyway RAN obtains the capability.  |
| Sequans | Option 1 can be used but does not seem sufficient. It may be better if we can limit the addition to option 2a without the need to involve other WGs |
| NEC | Option 2 will work well together with option 2a.For Option 1, more study (or work) would be required to identify its necessity on top of Option 2&2a. |
| Samsung | We think Option 1 should be the baseline, but RAN2 can discuss all the options at this stage. |
| CATT | Option 1 and 2 can both be considered.  |
| Intel | Agree the comments from Ericsson on these three options. We think all of them should be used to ensure redCap is only used for intended use cases. But option 2/2a need the coordination with SA2. We should trigger the discussion in SA2 in some point.  |
| Huawei, HiSilicon | We think at least Option 1+2 are needed. |
| MediaTek | Options 1 and 2 can be considered, and both need to be discussed together with SA.Given that Option 2a is an erroneous case, is it really important to discuss this in RAN at this time? |
| vivo | We think all the options should be considered in this stage, as they can be applicable to different use cases. In SI phase, we should make a high-level conclusion that existing solution can be considered for RedCap UEs. While the detailed solutions can be discussed and decided in WI phase. Besides, considering that the solution is generally associated with the use cases, and some of them are related to NAS. Thus, we think further discussion with SA/CT is needed in WI phase. |
| Lenovo | We think all these solutions are needed. |
| Fujitsu | For there is several options to deliver the RedCap device type including msg1/msg3/msg5, we think option 1 is pending for discussion. The motivation for network checking the parameters other than the device type is not clear, option 2a may not be necessary. There may be advantage in option 2 to validate a UE with its subscription information to make sure the intended case is used, but it’s not RAN’s scope and the impact to RAN is ambiguous. |
| CTC | We think all these solutions can be discussed at this stage. |
| Spreadtrum | Agree with Nokia. |
| LG | Option 1 and Option 2 are potential solutions.  |
| InterDigital | Option 1 would need to be combined with at least Option 2. We are open to discussion Option 2a as well. |
| ZTE | **Option 1:** Existing RRC reject can be used to prevent redcap UE from initiating access with some existing RRC setup causes if these causes are not supported for the redcap device. Except that, RAN has little information on service, thus it is hard for RAN to perform such kind of check. **Option 2:** NAS layer mechanism is more suitable than RRC layer mechanism. NAS layer is in response for QoS and PDU session configuration, and it is aware of subscription information. Thus it is more easier for NAS layer to check the requested service against subscription and capabilities. (but device type is not necessarily needed)**Option 2a:** This solution is useful to prevent mismatching between device type and radio capabilities. It requires redcap device type and full capabilities are included in capability signaling.  |
| Telecom Italia | A combination of both Option 1 and Option 2 can be considered. Option 2a would not be needed if we assume that a unique REDCAP UE type (with associated minimum set of capabilities being common to all REDCAP UEs) is defined. |

# Summary

To be added: