**3GPP TSG-RAN WG2 Meeting #105bis R2-190xxxx**

**Xian, China, 8th – 12th April 2019**

Agenda Item: 11.12.13

Source: MediaTek Inc.

**Title: Summary of email discussion [105#43][NR/RD-CU] Use case of UE energy saving (MediaTek)**

Document for: Discussion and decision

# Introduction

In RAN2 #105, a new use case for RAN-centric data collection and utilization on collecting UE energy efficiency metrics [1] has been presented and discussed, however, consensus was not reached on whether to include the use case to the study. It was agreed to follow up in email discussion.

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| [105#43][NR/RD-CU] Use case of UE energy saving (MediaTek) Identify the use case and benefit of UE energy saving related information collection Intended outcome: Report of email discussion Deadline: Thursday 28/03/2019 |

The target of this discussion is to first increase the understanding on the observations on UE energy efficiency for NR and then discuss the metrics for UE energy efficiency.

# Discussion

## NR UE energy efficiency

According to GTI white paper [2], high-end mobile devices with 5G modem are expected to feature advanced components e.g. display, processors, graphic engine, etc. Added up, these render power management to be very challenging. In other words, power efficiency is critical for every single component, in particular for the modem itself, regardless of the power source used (e.g. battery capacity and technology).

**Battery lifetime is an important criterion directly affecting user experience** – no matter how good the other performance aspects of a device may be, if its battery lifetime is poor, user experience will be greatly impacted. To ensure a smooth migration from 4G to 5G, the battery lifetime should thus be, under similar criteria, on par or better using 5G than 4G.

Therefore, network and UE vendors have a common interest in ensuring that the 5G NR ecosystem is able to maximize battery lifetime for all its users in all conditions. This means network and UE ought to cooperate to ensure lower baseline power and maintain better efficiency with all data rates, as shown below.

3GPP has started an effort, i.e. power saving SI [3], to achieve this target. From the study, reducing the power consumption in RRC\_Connected mode is the primary target. As the UE behavior in RRC\_Connected mode is controlled by the network, the joint role of the UE and the network to reduce power consumption in this state is clear.

**Q1: Do you agree following observations:**

1. **In comparison with LTE, it is critical for NR modem to have lower baseline power and maintain better or at least similar power efficiency per bps with all data rates**
2. **Power saving in RRC\_Connected mode is the main target and power saving requires joint efforts between network and UE.**

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For 5G/NR design, network energy efficiency and UE energy efficiency are listed as two key performance indicators in [4].

For UE energy efficiency, which means the capability of a UE to sustain much better mobile broadband data rate while minimizing the UE modem energy consumption both qualitative and quantitative KPIs are required. Although only a qualitative KPI is captured now, it is also specified that based on the study, more detailed quantitative assessment can be performed and a conclusion on this matter is expected from the on-going power saving study.

**Q2: Do you agree that UE energy efficiency is one of the 5G/NR key performance indicator and a quantitative assessment should be considered? If no, why?**

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## NR UE energy efficiency metrics

On one hand, although it is always possible to measure power consumption of a UE *, in the UE,* it is not sufficient as it is a) vendor dependent, and b) not trackable by operators. On the other hand, as explained above, it is the very power consumption resulting from the usage of 5G NR technology that ought to assessed – as argued above, this is directly linked to how the network operates the UE i.e. what kind of configurations it uses with the UE. Such configurations following 3GPP specifications, their energy efficiency (and in turn UE energy efficiency) can therefore be fully assessed and tracked in a reliable fashion. As a result, it is our understanding that the definition of a reliable UE energy efficiency (UE EE) KPI consistent across UE vendors, and fully trackable in 5G networks by operators is feasible.

The definition of a UE EE KPI would further allow operators to assess the effect of a given feature (e.g. power saving feature) on the UE power consumption. .

**Q3: Do you agree that following requirements for UE energy efficiency metrics? Please add necessary requirements.**

1. **Vendor independent, i.e. standard power consumption model**
2. **Track-able by operators**
3. **Directly related to 5G NR configuration**
4. **Able to assess the power consumption effect of a given feature**
5. **More?**

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On requirement 1), the main difficulty has been lying in the lack of a commonly agreed power consumption model. However, this hurdle has recently been removed with the latest progress of the RAN1 study on NR UE power saving – a UE power consumption model is agreed and captured in TR [5].

**Q4: Do you agree that the result of R1 study on NR UE power saving can be used for NR UE energy efficiency? If no, why?**

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Similar to the definition of network EE KPI, one possible example to represent the UE EE is *bit per Joule.* The metric is defined as below

$$UE\\_EE=\frac{Data Volume}{\sum\_{i=power state}^{}Energy Consumption (i)}$$

* **Data Volume [bit]** represents the traffic volume for the UE for a given duration.
* **Energy Consumption [*estimated* Joule]** represents the total energy consumption of the UE for a given duration, which is the summation of power consumption (i.e. product of Relative Power and time duration) in all **Power State** as defined in [5].

**Q5: Do you agree above metric can objectively represent NR UE energy efficiency? Please list your concerns.**

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**Q6: With link configuration, scheduling record, and throughput/data volume information, do you agree above metric can be calculated by RAN?**

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**Q7: Regarding above metric, do you see the need for UE assistance?**

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**Q8: Do you see other alternative or complementary metrics? Please list alternative.**

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**Q9: Any other aspects for NR UE EE metrics?**

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# Conclusion

# References

1. [R2-1901331](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_105/Docs/R2-1901331.zip) New use case: UE energy saving MediaTek Inc. discussion

1. [GTI Sub-6GHz 5G Device White Paper](http://www.gtigroup.org/d/file/Resources/rep/2018-02-22/c9d31709d72643e625321d6f3724d761.pdf), Chapter 13 Power Consumption
2. RP-181463, WID: Study on UE Power Saving in NR
3. 3GPP TR 38.913, “Study on Scenarios and Requirements for Next Generation Access Technologies”, V14.3.0 (2017-06)
4. Draft TR 38.840 – Study on UE Power Saving (CATT)
5. R1-1901298, Adaptation Designs for NR UE Power Saving, MediaTek Inc.
6. RP-182105, WID: Study on RAN-centric Data Collection and Utilization for LTE and NR