3GPP TSG RAN Meeting #78
Lisbon, Portugal, December 18 - 21, 2017
Agenda item: 9.1.1

RP-172318

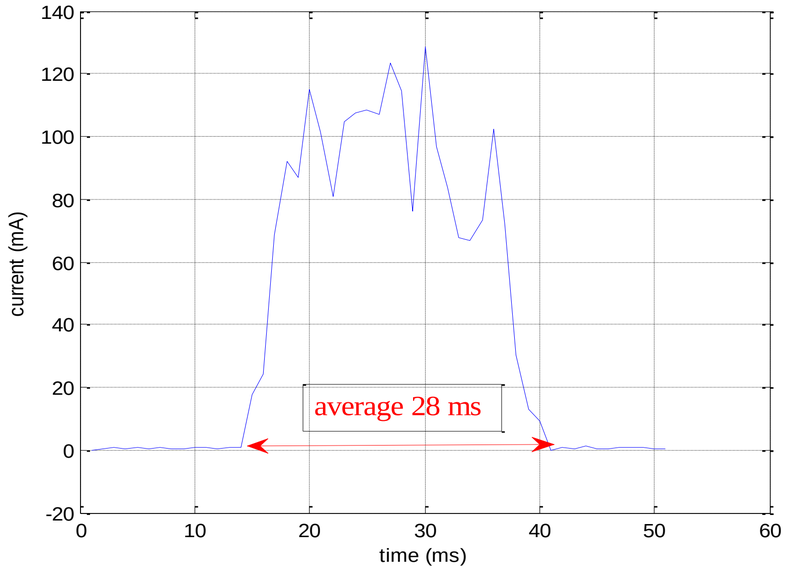
Motivation for New SID: Study on UE Power Saving in NR

General Motivation

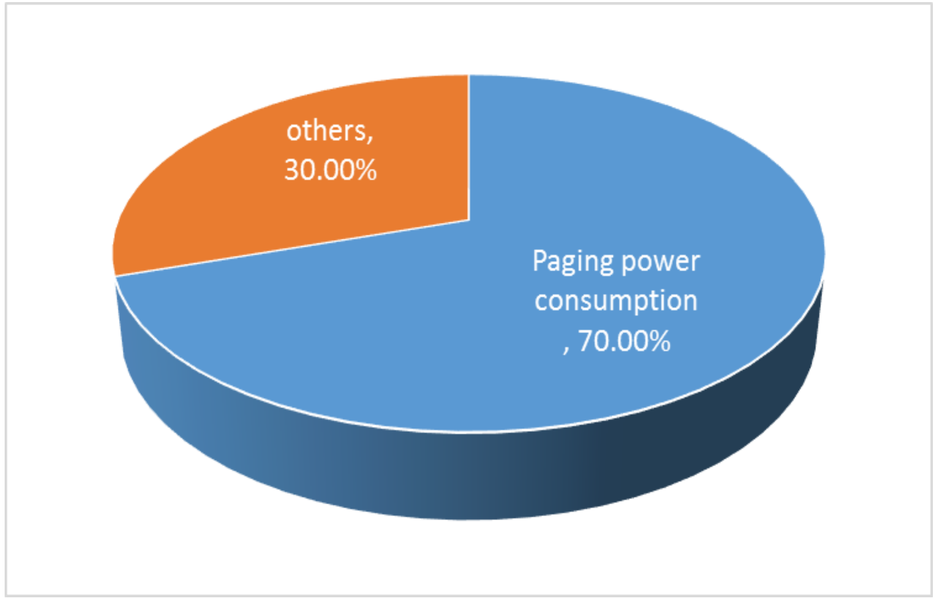
- NR supports advanced features including higher data rate, wider bandwidth and shorter latency, which requires higher UE capability and processing complexity.
- ITU-R defines device energy efficiency as one of the minimum technical performance requirements for IMT-2020 [1]:
  - Efficient data transmission in a loaded case;
  - Low energy consumption when there is no data.
- Currently, UE consumes considerable power on monitoring paging in idle state, and on monitoring PDCCH in active period of CDRX, even when there is no paging or data for the UE and nothing is detected.
- NR need to be enhanced to minimize UE power consumption

Measurements on UE power consumption (1)

- In idle state, the average actual active time for each 1ms paging occasion (1280ms paging cycle) is about 28ms, during which the UE may perfrom DL synchronization, monitoring Paging and RRM measurements, etc.
- 70% of the UE power in idle mode is consumed by the actual active time [2], in most of the time no paging for the UE.



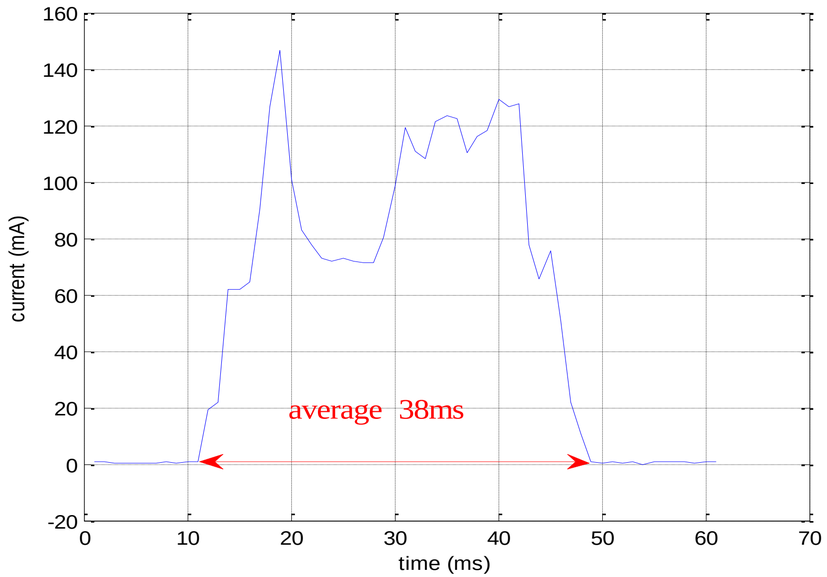
UE active time duration for each paging occasion (1280ms paging cycle) [2]



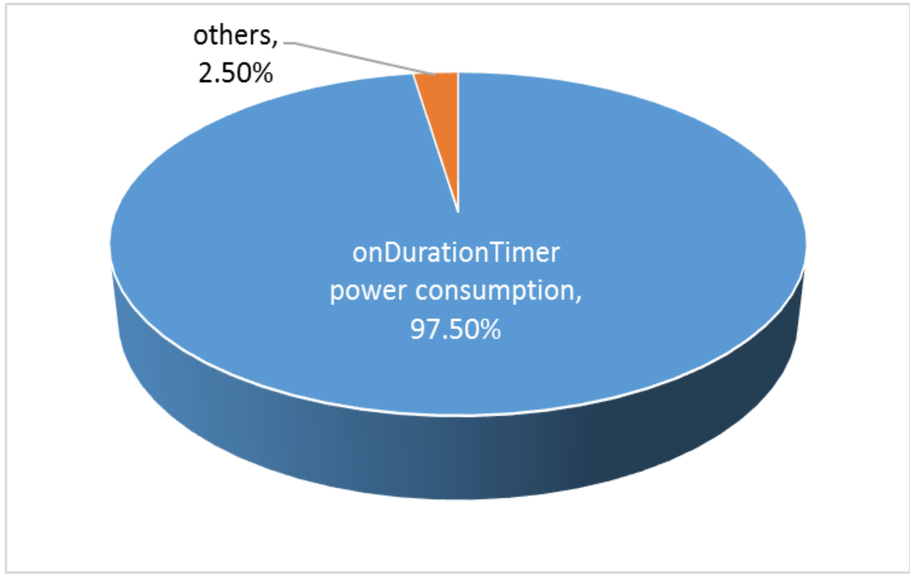
UE power consumption in idle mode paging [2]

Measurements on UE power consumption (2)

- In connected mode DRX, the total actual active time in each DRX cycle is about 38ms (160ms DRX cycle, 1ms onDurationTimer), during which the UE may perform synchronization, monitoring PDCCH and measurements, etc.
- 97% of the UE power in CDRX mode is consumed by the actual active time[2], in most of time no control/data for the UE.



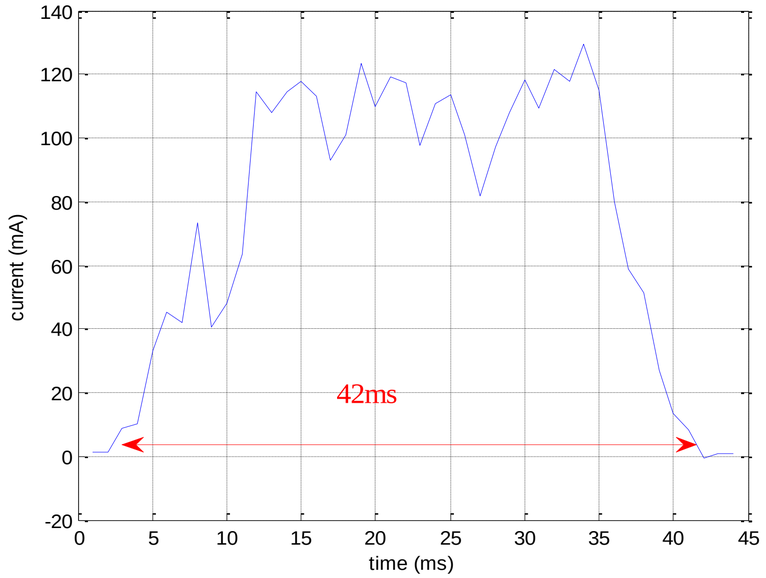
The actual UE active time for one DRX cycle (160ms DRX cycle, 1ms onDurationTimer) [2]



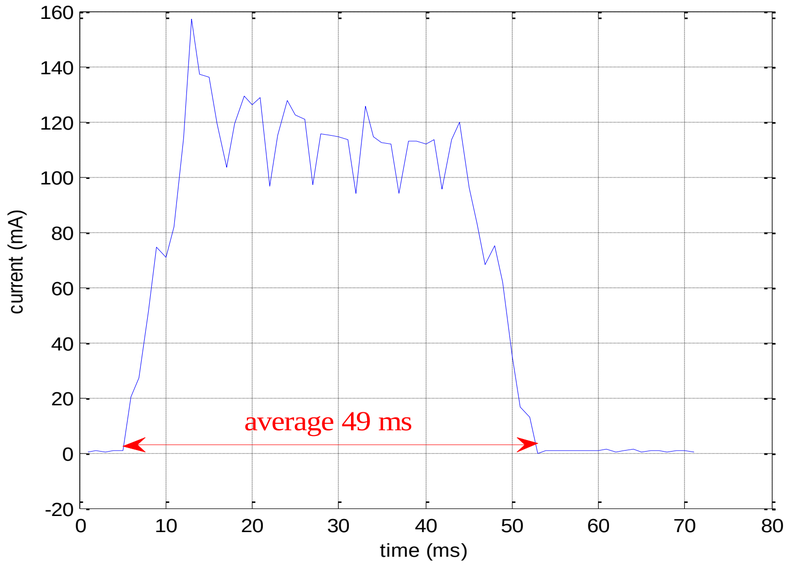
UE power consumption in connected mode DRX [2]

Measurements on UE power consumption (3)

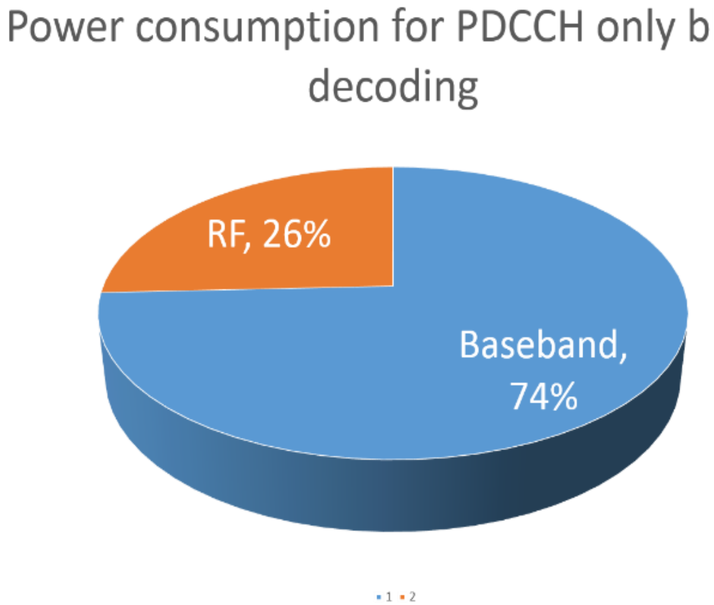
- In connected mode DRX, even longer actual active time is observed with increased onDurationTimer[2].
- For PDCCH monitoring, most of the UE power is consumed by baseband processing [2].



The actual UE active time for one DRX cycle (160ms DRX cycle, 8ms onDurationTimer)[2]



The actual UE active time for one DRX cycle (160ms DRX cycle, 20ms onDurationTimer) [2]



RF and BB power consumption for PDCCH only processing [2]

Observations

- Based on the measurements on current UE power consumption, we observed
  - Most of UE power in idle mode is consumed by the active time
  - Most of UE power in connected mode DRX is consumed by the active time
  - During the active time, the main power consumption components are
    - Synchronization and RRM measurements
    - PDCCH monitoring for paging or scheduling assignments
- Therefore, to reduce the UE power consumption, following can be considered
  - Reduce the unnecessary paging monitoring in idle mode
  - Reduce the unnecessary PDCCH monitoring in connected mode DRX
  - Reduce the unnecessary RRM measurements
- "Wake-up signal" based mechanism can be considered to reduce the unnecessary monitoring in both idle and connected modes
- RRM measurement optimization can be considered. See next slide.

RRM Measurement optimizations

- Currently, stationary UEs and moving UEs (except the high speed case) have the same requirements (e.g. one L3 sample per 200ms) for RRM and idle mode measurement triggering.
- In reality, some measurement is unnecessary for stationary or low-speed UEs, and these measurement consumes significant UE power. In order to further save UE power consumption, some unnecessary measurement can be skipped.
- For example, in connected mode, RRM measurement can be optimized based on information including the surrounding network environment, UE movement, etc.
- In idle mode, different trigger conditions or parameters for neighboring cell measurement can be defined for different UE status.

Proposed objectives of NR UE power saving study

- Study the UE wakeup mechanism in NR framework and identify the scenarios and evaluation methodology for UE power saving study.
  - Focus on NR eMBB use cases
- Identify techniques and associated UE power savings of UE wakeup mechanism in RRC_IDLE, RRC_CONNECTED, and RRC_INACTIVE modes.
- Study the UE power consumption reduction in RRM measurements with network assistance.
- Study the enhancement of paging procedure and DRX configuration with UE wakeup mechanism.

References

[1] ITU-R Report, “Minimum requirements related to technical performance for IMT-2020 radio interface(s)”

[2] R1-1719804, “Measurement results and analysis on UE power consumption”, vivo, 3GPP TSG RAN WG1 Meeting 91, Reno, USA, 27th November – 1st December 2017

[3] R1-1719805, “NR UE power saving”, vivo, 3GPP TSG RAN WG1 Meeting 91, Reno, USA, 27th November – 1st December 2017

[4] RP-172372, “New SID: Study on UE Power Saving and Wakeup Mechanism in NR”, CATT, CMCC, vivo, CATR, Qualcomm, RAN#78, Lisbon, Portugal, December 18 - 21, 2017

Thank you !