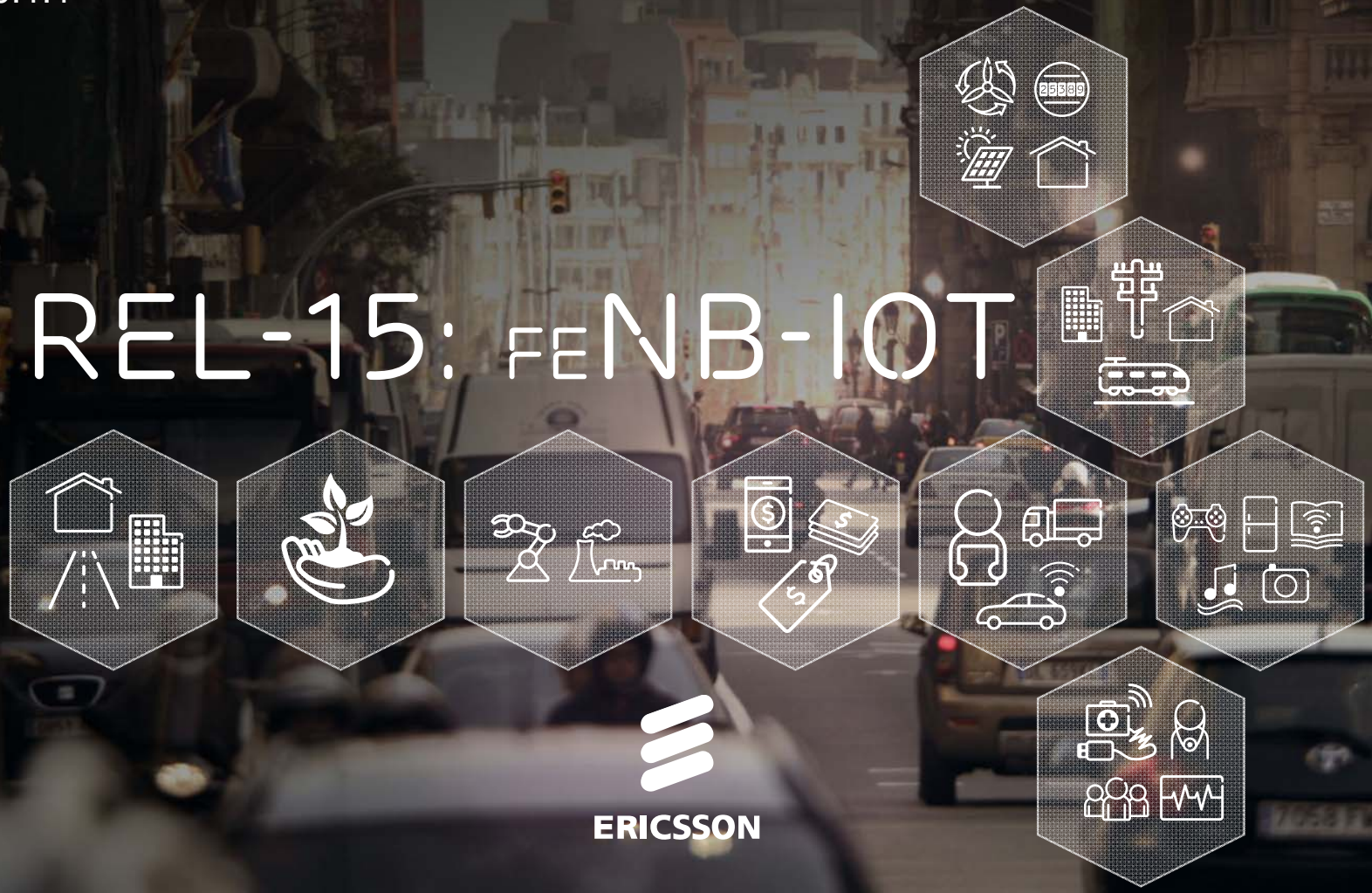
3GPP TSG RAN Meeting #75
Dubrovnik, Croatia, March 6-9, 2017
Agenda item 10.1.1

RP-170508

REL-15: FeNB-IOT



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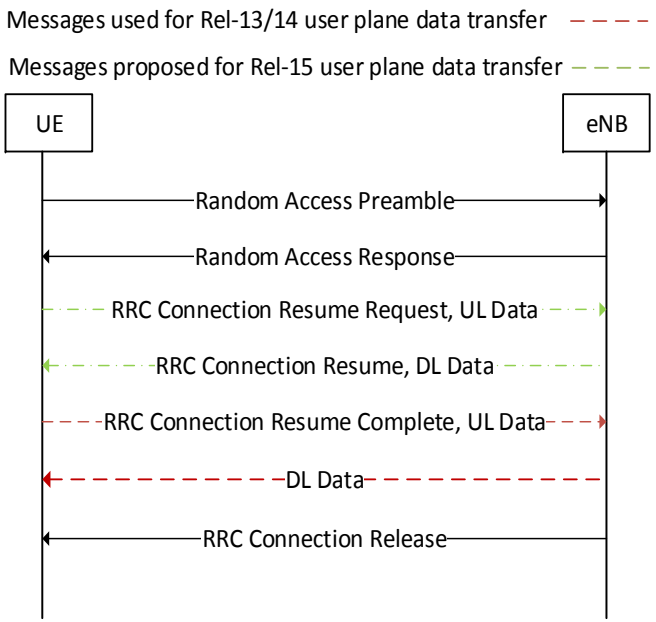
LATENCY REDUCTION
EARLY DATA TRANSMISSION

- Support data transmission on a dedicated resource during the Random Access procedure (after PRACH transmission and before the RRC connection setup is completed) at least in the RRC Suspend/Resume case.
- Example:
  - UL: Data in Msg3. DL: Data in Msg4
  - Latency and battery life improvements estimated assuming:
    - In-band mode of operation.
    - Latency @ 50 bytes UL on top of PDCP.
    - Battery life @ 50 bytes UL and 50 bytes DL on top of PDCP once per day.
    - Significant gains observed for early data transmission.



MCL	Latency	
	RRC Resume	Early data
144	0.5 s	0.4 s
154	1.3 s	0.8 s
164	6.5 s	4.2 s

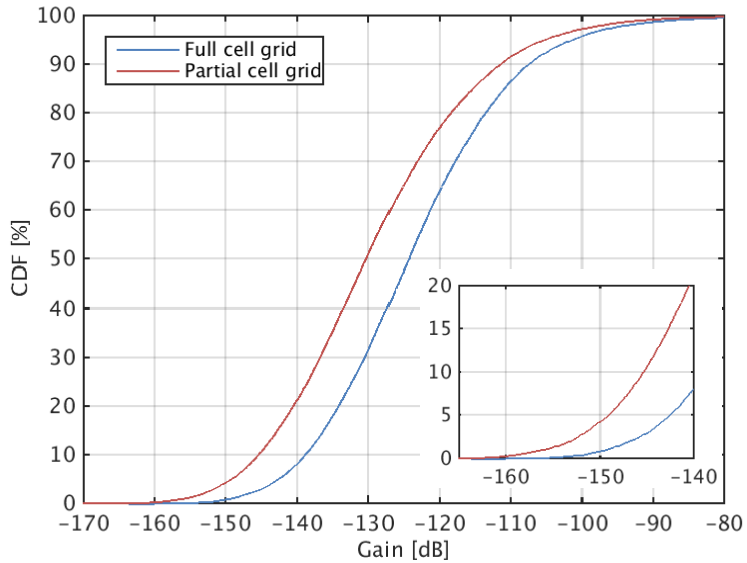
MCL	Battery life	
	RRC Resume	Early data
144	36.1 y	36.4 y
154	32.6 y	33.2 y
164	17.8 y	20.2 y

SYSTEM ACCESS IMPROVEMENTS
IMPROVED ACCESS CONTROL

- NB-IoT supports idle mode Access Barring (AB) which applies to all UEs regardless of CE level.
- A snapshot of the path loss distribution in a NB-IoT system simulator shows a significant change in relative load distribution between CE levels when a cell goes down and its load is spread over six neighbor cells.
- The simulated absolute load increase in CE levels 1 & 2 when a cell goes down and its load is spread across 6 or 3 neighboring cells equals:

Cell outage	Every 6th cell	Every 3rd cell
CE level 1 & 2 load increase	70%	180%

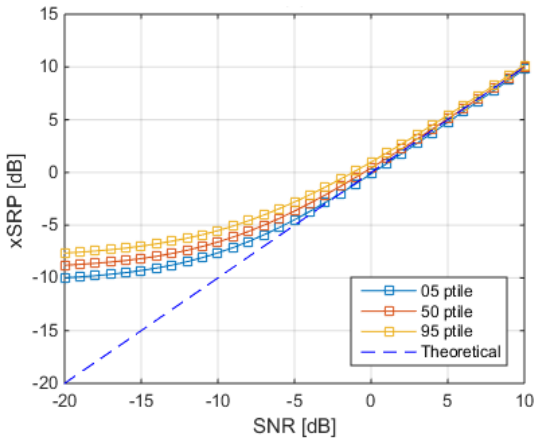
- To handle this and other types of exceptional scenarios where a sudden increase in load on the NPRACH CE levels is experienced access/congestion control on CE level is needed.



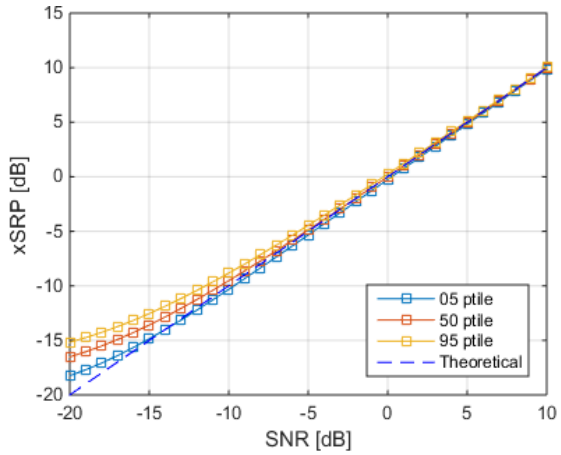
MEASUREMENT ACCURACY IMPROVEMENTS

- NB-IoT cell (re)selection, NPRACH CE level, and UL open loop power control are all based on the UE NRSRP accuracy.
  - Inaccurate NRSRP estimates will lead to inaccurate selection of cell, CE level and uplink power.
  - The NB-IoT NRSRP inaccuracy is above ±10 dB. RAN4 are discussing an UL power inaccuracy in the range of ±15 dB.
- Improved UE RSRSP accuracy is crucial to enhance system robustness and capacity.
- By using signals beyond the NRS, e.g. the NPSS/NSSS, for NRSRP estimation accuracy can be improved.

Accuracy for NRS for a measurement period of 400ms

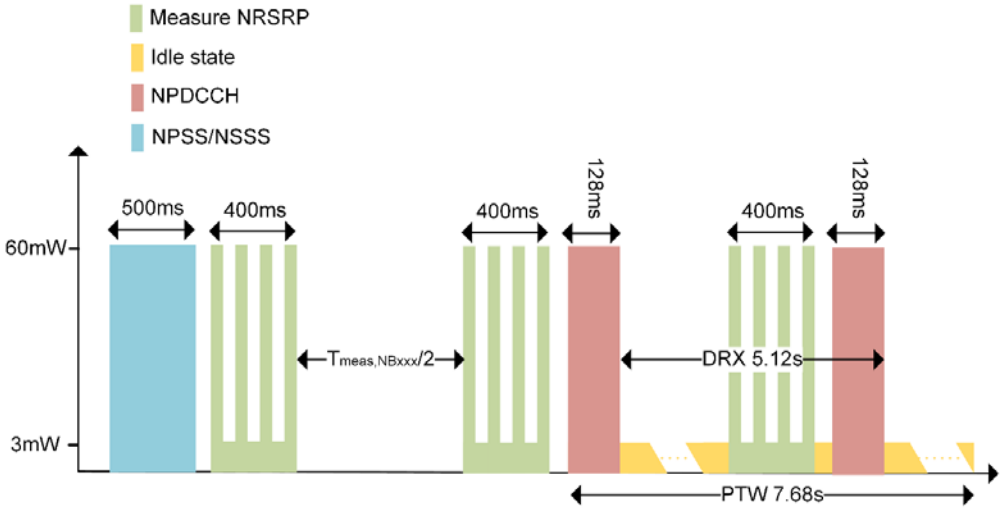


Accuracy with NSSS for a measurement period of 400ms



POWER CONSUMPTION REDUCTION
RELAXED MONITORING FOR CELL RESELECTION

- An device is required to measure NRSRP/NRSRQ for cell reselection once per DRX cycle.
  - Two measurements spaced by half the DRX cycle should be filtered.
  - NB-SIB may indicate 16 neighbors to be measured.
- The RX activity during a PTW is to a significant extent defined by NRSRP/NRSRQ measurements.
  - Coarse illustration of the expected behavior of a device at 164 dB MCL to the right.
- For a low mobility device with high requirements on DL reachability neighbor cell measurements will limit the achievable battery life.



- Reduced idle mode requirements in terms of measurement activity will improve power consumption and facilitate frequent DL reachability.

Aimed for battery life	Energy content	Achievable DRX reachability at different monitoring requirements		
		Only monitor camped on cell	Monitor camped on cell + 5 neighbors	Monitor camped on cell + 10 neighbors
1 year	5 Wh	3.1 min	12.4 min	21.7 min

UE FEEDBACK

- For a NB-IoT device the feedback information is limited to the Data Volume & Power Headroom Report (DPR) in the RRC Connection Request and RRC Connection Resume Request messages and to HARQ signaling.
- This limits the ability to facilitate bidirectional data flows and perform efficient link adaptation for multi-block data transmissions.
  - The DPR is very coarse and needs to be refined to become useful and support link adaptation.

Reported value	Measured value [dB]
PH 0	$-23 \leq PH < 4$
PH 1	$4 \leq PH < 16$
PH 2	$16 \leq PH < 28$
PH 3	$PH \geq 28$

  - To support multi-block data transmissions Power Headroom reports (PHR) subsequent to Msg3 is of high relevance.
  - To make efficient use of radio resources it is relevant to allow the UE to autonomously indicate to the NW an interest to transmit a PHR and/or Buffer Status Report (BSR).

5G mMTC REQUIREMENTS

- 3GPP made a significant effort during Release 13 to develop NB-IoT.
  - NB-IoT is intended to be a carrier for low complexity massive MTC services.
  - It is therefore expected that NB-IoT will have a long life cycle.
- To leverage the Release 13 effort and to secure a longevity of NB-IoT, it is important that the technology is fit to meet the set of NR mMTC requirements (see RP-162560, TR 38.913):
  - Coverage of 164 dB
  - Data rate of 160 bps
  - Latency of 10 sec
  - Battery life of 10-15 years
  - Capacity of 1,000,000 devices per km^2 (maps to an IMT requirement)
- A short study is needed within the feNB-IoT WI to verify the NB-IoT performance.
- If gaps are found between NB-IoT performance and mMTC requirements those should be closed.
  - Our initial assessment is that our enhancements in Release 15 will secure that NB-IoT qualifies for 5G.

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