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R1-157396

ERICSSON

NB-IOT - SUMMARY OF EVALUATIONS FOR STANDALONE DEPLOYMENT

UL OPTION COMPARISON

	SC-FDMA	FDMA with GMSK
Data rate at 164.7 dB coupling loss	436 bps	264 bps
Number of 85 byte packets per unit energy at 164.7 dB coupling loss	1.41 packets/Joule	0.91 packets/Joule
Back-off needed in PA	0.01 dB	0 dB
Maximum spectral efficiency	1.49 bps/Hz	0.51 bps/Hz
UL capacity	207,000 devices/cell	106,000 devices/cell 49,000 devices/cell with reuse 1/3

UL PERFORMANCE

- From R1-157392
- Observation 1
  - For fixed SNRDCP data rate, SC-FDMA achieves better coverage than FDMA with GMSK.
- Observation 2
  - At MCL approximately 164 dB, SC-FDMA has 77% higher data rate than FDMA with GMSK.

UL CAPACITY

- From R1-157398
- Observation 1
  - SC-FDMA has twice the uplink capacity compared to FDMA with GMSK. This is especially the case when comparing purely the UL modulation design options, and keeping all other assumptions, such as frequency reuse factor, are the same.
- Observation 2
  - When SC-FDMA is compared to the main operation mode of reuse 1/3 of FDMA with GMSK, the capacity difference is a factor 4 or more.
- Observation 3
  - SC-FDMA has 3 times higher maximum spectral efficiency, which translates into a capacity advantage.
- Observation 4
  - With the overhead assumed in this contribution, GMSK doesn't fulfil the capacity requirement for reuse 1/3.

UL PA EFFICIENCY

- From R1-157397
- Observation 1
  - SC-FDMA allows power efficient PA operation and integration with single subcarrier transmission since the relative cubic metric increase compared to GMSK is negligible (0.01 dB), and PAPR is less than 0.1 dB.
- Observation 2
  - The back-off required for multi-subcarrier transmission with SC-FDMA and pi/4 QPSK, even with as many subcarriers as 72, is limited to 2.2 dB, which allows multi-subcarrier transmission for most UE locations, reducing the transmission time and thus the power consumption
- Observation 3
  - Although the windowing and overlap method studied reduces PAPR, it has no significant benefit in terms of cubic metric, and may not be needed.

BASE STATION COMPLEXITY

- From R1-157395
- Observation 1
  - Supporting NB-IoT system with 3.75 kHz subcarrier spacing is more costly than supporting NB-IoT system with 15 kHz subcarrier spacing in the guard-band deployment. Due to lacking of information, cost of deploy NB-IoT system with 3.75 kHz subcarrier spacing cannot be estimated.
- Observation 2
  - For in-band and guard-band deployment, NB-IoT system with 15 kHz subcarrier spacing has no increase over LTE IFFT processing, and no additional channel filtering or guard-spacing between the NB-IoT carrier and the LTE carrier are needed. For NB-IoT system with 3.75 kHz subcarrier spacing, at least an addition of 3.944 million operations per second are needed for the IFFT operation, and a 200 kHz guard-spacing is needed in the guard-band deployment.
- Observation 3
  - SC-FDMA design can re-use the processing components in the current MSR BS that supports LTE. But for UL with FDMA, additional development and test costs are foreseeable, especially to support two different classes of UEs.
- Observation 4
  - By using efficient designs at the BS, the computational complexity at the BS receiver is much smaller for SC-FDMA than for FDMA.

DL FILTERING

- From R1-157394
- Observation 1
  - The DL TX filter can be optimized to concentrate more than 99% of the energy within the normal CP used in NB-IoT standalone deployment with 15 KHz subcarrier spacing. This filter also gives enough design margins with respect to the GSM PSD mask.
- Observation 2
  - Comparing to the idea cases, applying a 19-tap FIR filter at the TX has no significant impact on the BLER performance of the MCS used by NB LTE.

BATTERY

- Battery life in R1-157390
- Observations 1 for NB-LTE
  - For all MCL targets, a 10 year battery life is achievable with a reporting interval of one day for both 50 bytes and 200 bytes application payloads.
  - For MCL target 144 dB, a 10 year battery life is achievable with a two hour reporting interval for both 50 bytes and 200 bytes application payloads.
  - For a MCL target 154 dB with 200 byte application payload, or 164 dB with 50 or 200 byte application payload, a 10 year battery life is not achievable for a 2 hour reporting interval.
- Observation 2:
  - For all cases but one, where the difference is negligible, NB-LTE will have longer battery lifetime than NB-CIoT

LATENCY

- Latency in R1-157391
  - Observation 1
    - NB-LTE can me meet the latency target of 10 s for an exception report for all coverage classes
  - Observation 2
    - For 99% confidence level, NB-LTE can have lower latency for an exception report than NB-CIoT for all coverage classes
  - Observation 3
    - NB-LTE can meet the 10 s latency target for MCL 164 dB even with retransmissions

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