

## Support for eMTC in OAI

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# Overview of this talk

- **Objectives**
- **Brief overview of LTE-M**
- **OAI Development status**
- **Testing Framework**
- **Outlook**

# Objectives

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- Integration of Rel-13/14 support for Cat-M1 (and later M2) devices
- Experimental Analysis of coverage extension capabilities for LTE-M in comparison to legacy LTE
- Joint LTE/LTE-M Scheduler design

# LTE-M

- **Support for lower bandwidth devices on a common LTE Carrier (BR/BL)**
  - Overcomes the basic “problem” in Rel 8-12 LTE specifications whereby all UEs need to use the full system bandwidth to communicate with the eNodeB => in LTE-M (Cat-M1) all devices are half-duplex using 6 PRBs in a given subframe
- **Support for significant coverage extension over legacy LTE (CE)**
  - Up to 21 dB better sensitivity through
    - repetition of all basic physical channels
    - Frequency-hopping
- **Current major trial in USA on Verizon national network**

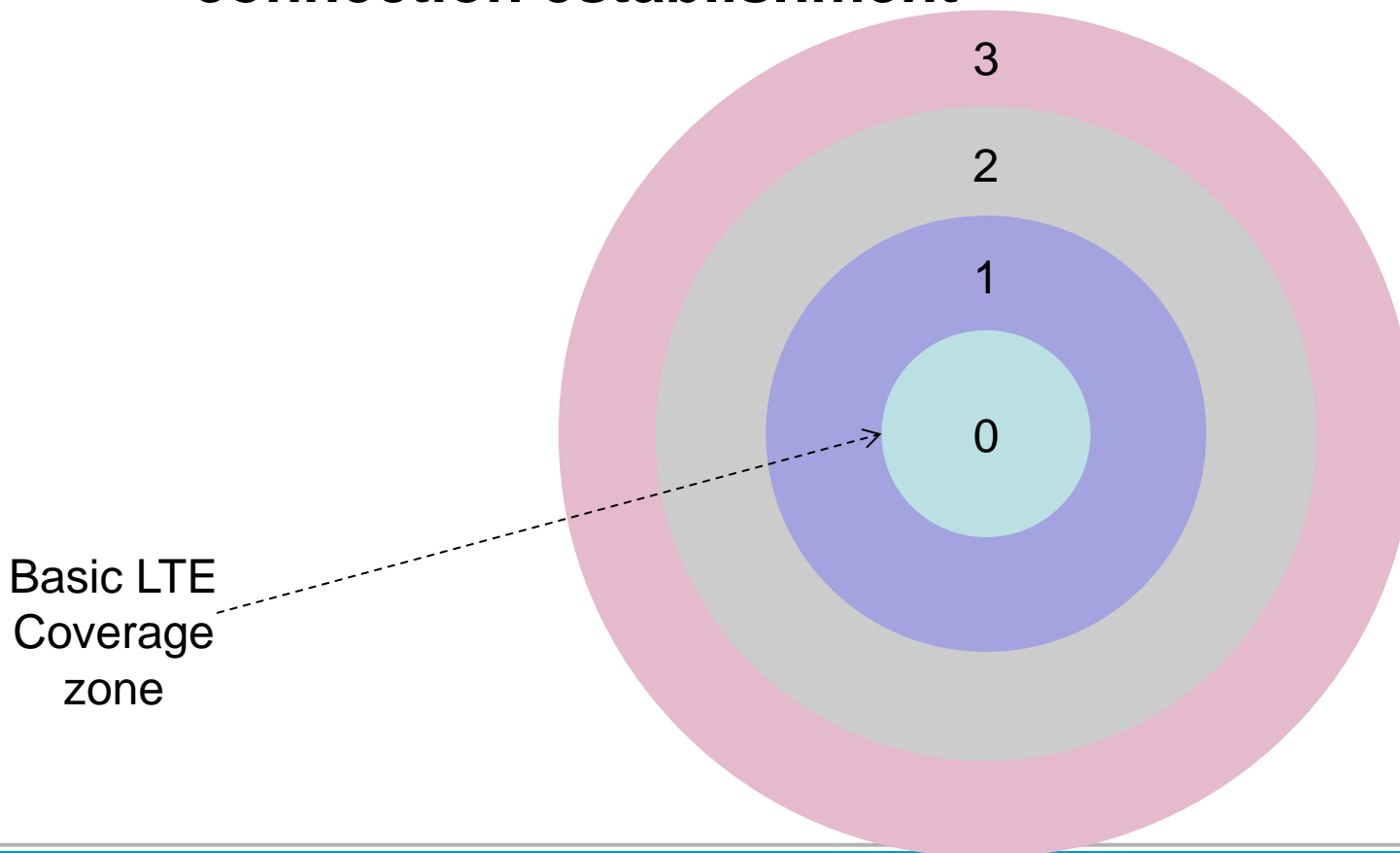
# Narrowbands

- Parts of LTE spectrum which are shared with eMTC UE (example 2 narrowbands and frequency-hopping)



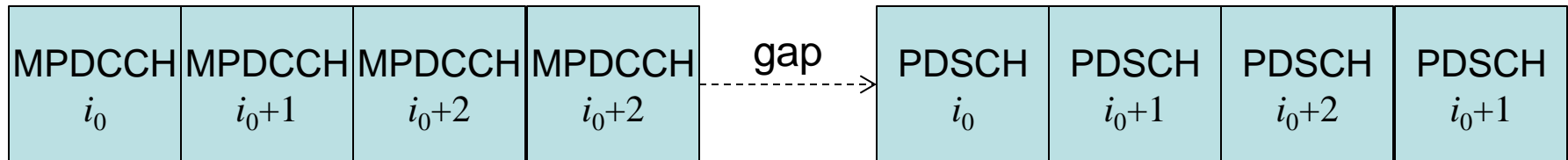
# CE Levels / Modes

- 4 Configurable levels of coverage extension based on RSSI/RSRP measurements of UE during connection establishment



# Repetitions

- Basic UL/DL physical channels have repetitions in order to collect significantly more energy over time (much lower throughput but much higher sensitivity)



# Ideal Coverage Extension in Mode B

LTE-M CHANNEL	MCL	PERFORMANCE	MAX MODE B REPEATS
PSS/SSS	164 dB	Acquisition Time=850 ms (90 <sup>th</sup> %'tile)	-
PBCH	164 dB	Acquisition Time=240 ms (90 <sup>th</sup> %'tile)	5
MPDCCH	164 dB	99% detection using 128 repeats	256
PDSCH	164 dB	1400 bps using 512 repeats	2048
PUSCH	164 dB	250 bps using 1536 repeats	2048
PRACH	164 dB	90% detection using 64-128 Repeats	128
PUCCH	164 dB	90% detection using 16-32 Repeats	32

Table 7: Summary of Performance at 164 dB MCL

<https://altair-semi.com/wp.../Coverage-Analysis-of-LTE-CAT-M1-White-Paper.pdf>

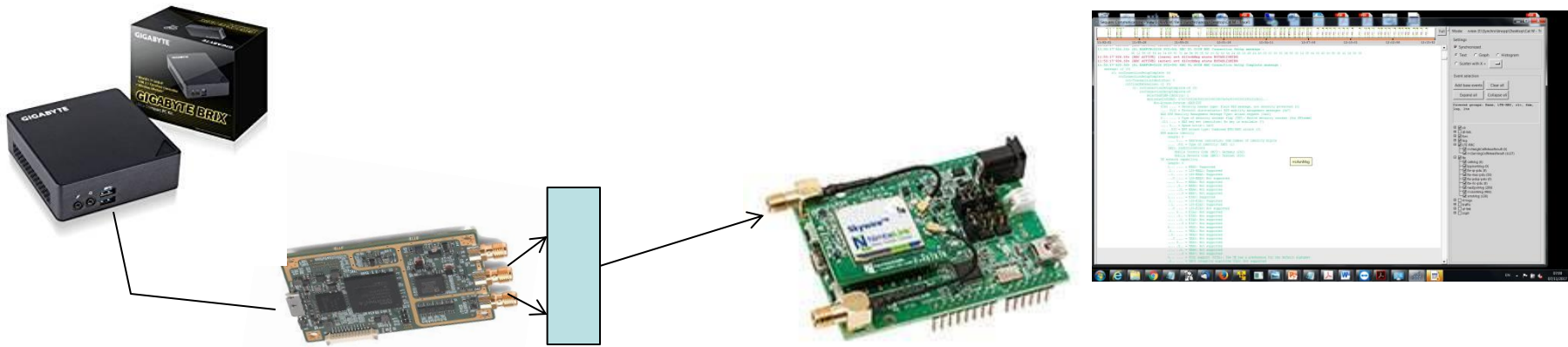


# Support of eMTC in OAI

- **Currently limited (testing) to CEMode A (CE Levels 0,1)**
- **What was currently implemented**
  - Configuration: lots of new eMTC-related parameters to be fed to L1/L2 stack (in current develop branch)
  - System Information handling (in current develop branch)
    - Extra bits in MIB
    - SIB1/SI : Quite Different from legacy LTE (repetitions, frequency-hopping, no DCI)
  - PRACH handling (in current develop branch)
    - Support for up to 4 CE levels: different number of repetitions per level => signal combining across repetitions for each level
    - New thread for eMTC PRACH (different parametrization in LTE Cell for eMTC)
  - MPDCCH (in current develop branch)
    - Support for EPDCCH allocation (only in MPDCCH configuration for now)
    - 3 new DCI formats
    - New procedures (search space, etc.)
    - Repetitions
  - DLSCCH/PDSCH (in current develop branch)
    - Repetitions
  - PUSCH (in current develop branch)
    - Repetitions
  - PUCCH (in current develop branch)
    - Repetitions (removal of slot-frequency hopping)
  - MAC (in current develop branch)
    - RA procedures for eMTC
    - Basic scheduler for testing
  - RRC (in private branch for now ...)
    - Handling of Rel-13 information elements for eMTC
    - eMTC System Information handling

# Testing Framework

- Standard OAI 50 PRB B200/210 configuration, band 13 (751 MHz), EPC
- Nimbelink Cat-M1 module (Sequans chipset) + Sequans tracing software



# Outlook

- **Testing of MCL with real modules**
- **Integration of IoT applications / MEC.**
- **Experimental deployment in Sophia Antipolis (need frequency allocation in UHF)**
- **Design of joint LTE/LTE-M scheduling framework**
  - How to share resources efficiently
  - Need UE stub for testing scalability (minimal Cat-M1 functionality in OAI UE)