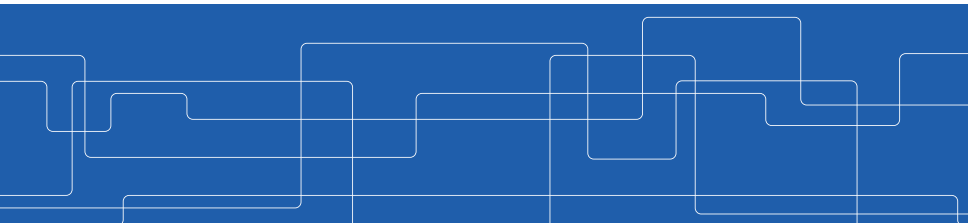# Spectral efficiency in NB-IoT

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Assumptions

The type of NB-IoT is the one where it is coexisting with LTE i.e. the NB-IoT uses the LTE control resource blocks (RB) to transmit [Schlienz, 2016].

There are number of coverage classes, each with its own transmission time interval (TTI) repetition pattern i.e. how many TTI the UE gets assigned in a given cycle.

The repetition pattern is fixed for each class and the challenge is to assign a class to the UE's to maximize efficiency.

Problem statement

NB-IoT uses the same signalling structure as LTE, which is a finite resource in terms of capacity. When the number of UE's increases in the cell, efficiency of the scheduling becomes more important.

The UE's are located at different distance from the base station (BS) with different radio conditions which they compensate for with having different coverage classes. Each coverage class is assigned a different number of TTIs in each cycle.

The challenge is to assign the correct class to the UE's to maximize data capacity and number of served UE's.

The goal of the project is:

- ▶ Establish an understanding of the capacity of NB-IoT
  - • Show with simulations how close to the theoretical capacity is possible to reach
- ▶ Apply reinforcement learning algorithm on the scheduler
  - • The goal is trying to increase the capacity or get closer to the theoretical limit

Topics to be covered

- ▶ NB-IoT
  - Structure and usage
  - Coexistence with LTE
- ▶ Capacity and congestion
  - Establish levels where service begins to degrade
- ▶ Machine learning (ML)
  - Reinforcement learning

Work to be done

- ► Simulate usage
  - • Create simulation with load around the maximum capacity
  - • Monte carlo ?
- ► Apply ML techniques on the simulation
  - • Verify if it increases capacity

Notes

Action points regarding scoping of the project

How to adapt to the traffic for scheduling allocation of shared channel resources

- ▶ learning is from the view of the BTS

- ▶ different classes should have different TTI i.e. how many TTI per class

- ▶ Use traffic pattern from human2human (H2H) traffic

- ▶ create simulation data from that

Thoughts and points

The NB-IoT radio interface has to be described and put into context of existing systems [use Schlienz, 2016].

Identify when the load is such that efficiency starts to become an issue [Harwahyu, 2017].

Work from that result and start making adjustements on the access of different coverage classes.

Dig further into the problem of having multiple coverage classes. Identify if it is a near far problem or something else [use Azari. 2019].

Thanks!