3GPP TSG RAN WG1 Meeting #84 **R1-160710**
3GPP TSG RAN WG4 Meeting #78 **R4-160293**
St. Julian's, Malta, 15th – 19th February 2016

Source: **SoftBank**
Title: **Flexible duplex gap for in-band NB-IoT**
Agenda Item: **6.23.1**
Document for: **Discussion and Decision**

1. Introduction

A RAN1 contribution [1] discusses about the necessity of flexible duplex gap for NB-IoT, namely:

> In the previous discussion, the DL frequency raster was discussed. As for the DL-UL frequency separation, for half-duplex devices, a flexible duplex gap does not add any UE complexity as the UE is anyway retuning between the UL and DL frequencies, but at the cost of requiring more system information. The UL is more prone to coexistence issues and a flexible duplex gap can help alleviating this. Hence, it is proposed to allow pairing of any UL PRB to the DL PRB used for NB-IoT.
>
> ***Proposal 3:*** *Flexible duplex gap is supported in NB-IoT.*

The same content was also discussed in RAN4 NB-IoT Ad Hoc meeting, but no consensus has been reached yet. In this contribution, we explain the necessity of flexible duplex gap for in-band operation from an operator's point of view, especially a spectrum management perspective. This contribution is mainly aiming at a RAN1 discussion and approval, but is also input to RAN4 for information.

2. Discussions

2.1. NB-IoT RB arrangements for uplink

One interesting uplink carrier assignment for in-band NB-IOT is the edge of PUSCH region, as shown in Figure 1. The reason is legacy UEs don't support non-contiguous resource allocation (RA) and it is highly desired for LTE UEs to be assigned the RBs on NB-IoT carrier and PUSCH region simultaneously without spectrum fragmentation. Even when non-contiguous RA is supported by UEs, contiguous RA is more appropriate and straightforward because no additional PA-backoff needs to be considered.

2.2. NB-IoT RB arrangements for downlink

Meanwhile, downlink NB-IoT RB assignment has stringent constraints differently from uplink: (1) anchor carrier cannot be assigned on central-6RB, and (2) centre frequency of anchor NB-IoT RB need to satisfy 100 kHz channel raster. Even though the relaxed offset value may be introduced, it is anticipated that limited number of BRs can be used as an anchor NB-IoT RB, as illustrated in Figure 2.

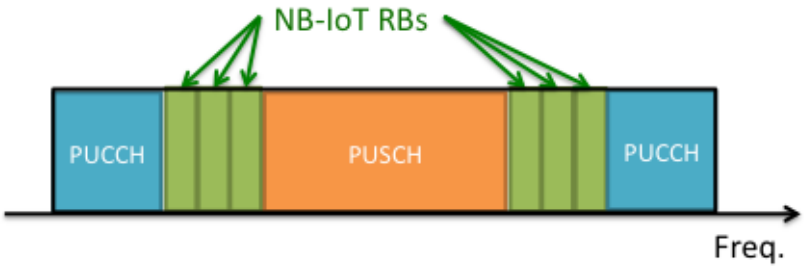

Figure 1. Desirable uplink RB arrangements for in-band operations

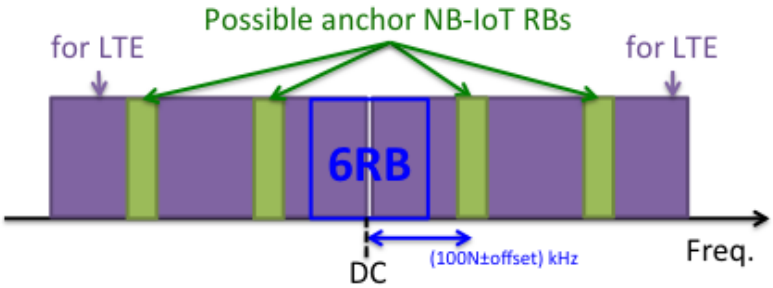

Figure 2. Possible downlink RB arrangements for in-band operations due to the constraints

2.3. Discussions

Considering the desired NB-IoT RB arrangement for uplink in Figure 1 and downlink in Figure 2, it is obvious that both preferences don't agree and hence the fixed duplex gap (i.e. use the band-specific gap in TS36.101) is not suitable for NB-IoT in-band operations. Though there could be another potential solution, it would be safer and agile to employ flexible duplex gap because:

- Rel-13 deadline is approaching,
- Retuning is anyway introduced due to half-duplex operation, and
- LTE has a signaling container to indicate corresponding uplink carrier by ARFCN in SIB2.

Meanwhile, ARFCN will not perfectly fit to the indication of uplink NB-IoT RB because the frequency granularity is 0.1MHz. Hence, an additional signalling and/or a new interpretation may be needed. The detailed mechanism may be discussed and specified in either of RAN1 and RAN2, but the introduction of flexible duplex gap should be firstly agreed in RAN1 because this requirement comes from radio resource management of physical layer.

<u>Proposal:</u>

- **Flexible duplex gap is introduced for NB-IoT in-band operation.**
  - **The indication of linked uplink RB is cell-specifically signalled by SIB2**

3. Conclusion

In this contribution, we shared our views on the necessity of flexible duplex gap for in-band NB-IoT. Our proposal is summarized as follows:

<u>Proposal:</u>

- **Flexible duplex gap is introduced for NB-IoT in-band operation.**
  - **The indication of linked uplink RB is cell-specifically signalled by SIB2**
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4. References

[1] R1-160082, “NB-IoT - Channel raster”, Ericsson