3GPP TSG RAN WG1 Meeting #85 **R1-165055**
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Source: Cohere Technologies

Title: Discussion on Frame Structure for NR

Agenda item: 7.1.4

Document for: Discussion and Decision

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1 Introduction

The design of the frame structure of New Radio (NR) needs to consider other aspects of the system, some of which have been listed in the frame structure discussion emails summarized in [1]. Among the parameters that need to be accounted for in the design of the frame structure are:

- Numerology(ies)
- Selected waveform(s)
- Latency requirements
- Reference Signals

Due to these dependencies the desired frame structure may be different in different use cases and/or different selected solution (e.g. waveforms and RS).

Numerology is being discussed with no decision yet. On the waveform, the following agreement has been reached in RAN WG1 #84bis meeting [2]:

- Waveform is based on OFDM
    - Multiple numerologies are supported
    - Additional functionality on top of OFDM such as DFT-S-OFDM, and/or variants of DFT-S-OFDM, and/or filtering/windowing, and/or OTFS is further considered
        - Complementary non-OFDM based waveform is not precluded for some specific use cases (e.g., mMTC use case)

The user plane latency requirements are specified in [3] as 0.5ms for URLLC and 4ms for eMBB.

Reference signals (RS) have not been discussed yet, and it is not clear what their structure will be.

In this contribution we discuss some of the frame structure parameters and propose a way forward that will allow making progress in defining the frame structure while still considering the different dependencies.

2 Discussion

The design of the NR frame structure is tightly coupled with other essential building blocks including the numerology and waveform. As such, it is difficult to finalize details on the frame structure without taking into account the other design aspects. With that said, some requirements on the frame structure can be established as long as they can accommodate different numerologies, waveforms, and reference signal (RS) design.

A main factor impacting data plane latency in a communication system is the round trip time duration consisting of the control message transmission scheduling a downlink (DL) or uplink (UL) transmission to the HARQ-ACK feedback transmission duration. As the HARQ-ACK feedback is only necessary for acknowledgement-based transmission, the minimum PHY latency in a system is driven by the mapping of a scheduling message and the corresponding data transmission/reception.

In this contribution we shall define a subframe as the minimum time interval over which a UE receives a DL scheduling message and may transmit or receive a data packet. This minimum time interval is driven by the tightest latency requirements as defined in [3]. Furthermore, the size of the subframe should be an integer number of OFDM-based symbols that depends on the numerology selected for the target use case. Figure 1 is an illustration of the basic concept of a subframe as used in this contribution. In this figure the DCI is shown at the beginning of the DL transmission just for illustration purposes; other ways of mapping the DCI in DL transmissions are not precluded and are FFS.

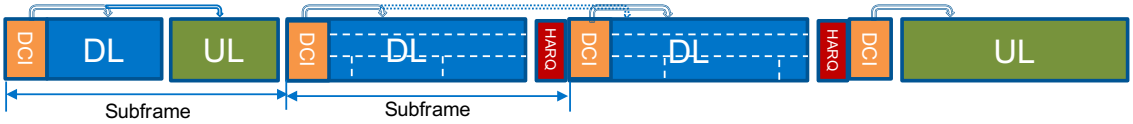

Figure 1: Basic concept of a subframe consisting of DL scheduling information and DL data with HARQ, UL data, or a combination of DL and UL data.

It is envisioned that use cases with different latency requirements may coexist on the same carrier. Restricting each constituent data transmission to the minimum possible duration would limit flexibility in supporting different delay spreads, and perhaps more importantly, may result in very high control overhead for short packet transmissions. Therefore, it should be possible for a base station to schedule UL or DL transmissions with varying transmission time intervals. Specifically, a scheduled transmission may extend over more than one subframe.

Regarding data demodulation, it is also necessary to discuss the placement of RS. In LTE Release 8 DL, the CRS provides a demodulation phase reference both for data demodulation and radio resource management (RRM). From LTE Release 10 onwards, CSI-RS and DMRS were introduced for CSI measurement and data demodulation respectively. For the NR, we believe that common and dedicated RS should be supported. The DMRS may be transmitted within the bandwidth and time duration of a scheduled data transmission. On the other hand, the common RS may be wideband and periodic to support initial access in standalone systems as well as for RRM procedures. In addition, the common RS may be supported for data demodulation (e.g. as proposed in [4]).

3 Conclusions

Based on the above, we would like to propose the following:

Proposal 1: RAN1 agrees to allow the discussions on waveforms, numerologies, and reference signals to conclude and reach agreements before finalizing the frame structure requirements.

Proposal 2: NR will define a subframe (temporary name, final name FFS) that meets the following requirements:

- The subframe will be composed of an integer number of equally spaced OFDM-based symbols
- Each subframe will include a DL control message carrying scheduling information

Proposal 3: Scheduled transmissions may extend over more than one subframe

Proposal 4: Common and dedicated RS are supported in the NR frame structure. Mapping to time-frequency grid is FFS.

4 References

[1] RAN1 Email Discussion [84b-15, v.26], “Frame Structure for NR,” Qualcomm Incorporated

[2] R1-163961, “Draft Report of 3GPP TSG RAN WG1 #84bis v0.2.0 (Busan, Korea, 11th – 15th April 2016),” MCC Support

[3] 3GPP TR 38.913 v0.3.0 (2016-03), 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Study on Scenarios and Requirements for Next Generation Access Technologies (Release 14)

[4] R1-163619, “OTFS Modulation Waveform and Reference Signals for New RAT,” Cohere Technologies, AT&T, CMCC, Deutsche Telekom, Telefonica, Telstra