



Motivation for new WI proposal on NR spectrum utilization efficiency enhancements

Huawei, HiSilicon



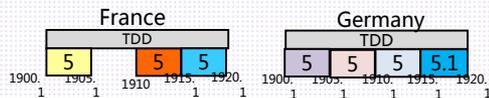
Introduction

- NR has a unique value in providing a solution for utilizing any spectrum more efficiently than LTE
 - No CRS, bandwidth parts, higher number of PRBs in a given bandwidth, multiple numerologies, SUL, mmw, etc
- Rel-16 should continue enhancing this unique value
 - Completing the design of mixing multiple numerologies
 - Completing the support of multiple active bandwidth parts
 - Expanding the use of SUL carrier with mmw bands
- Rel-16 NR can also offer opportunities for more efficiently using non-contiguous and irregular blocks of spectrum within one band, including small portions of spectrum

Expanding the use of Supplemental Uplink

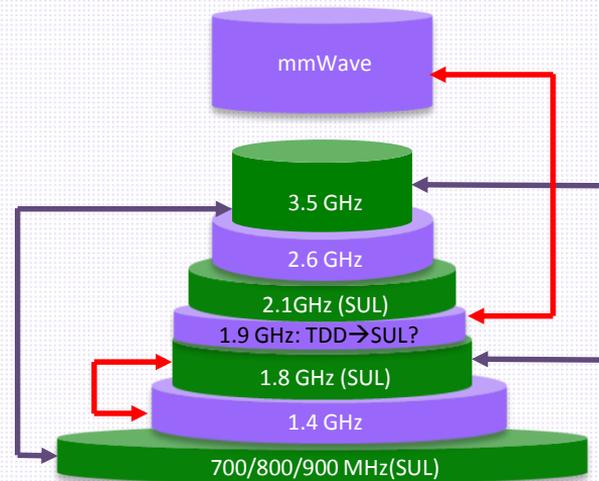
- More SUL band combinations, examples:

- mmWave (60/120kHz) + sub-6GHz SUL (15kHz)
- L-Band (DL-only or TDD) + SUL
- Potential common dedicated SUL Band: 1.9GHz?



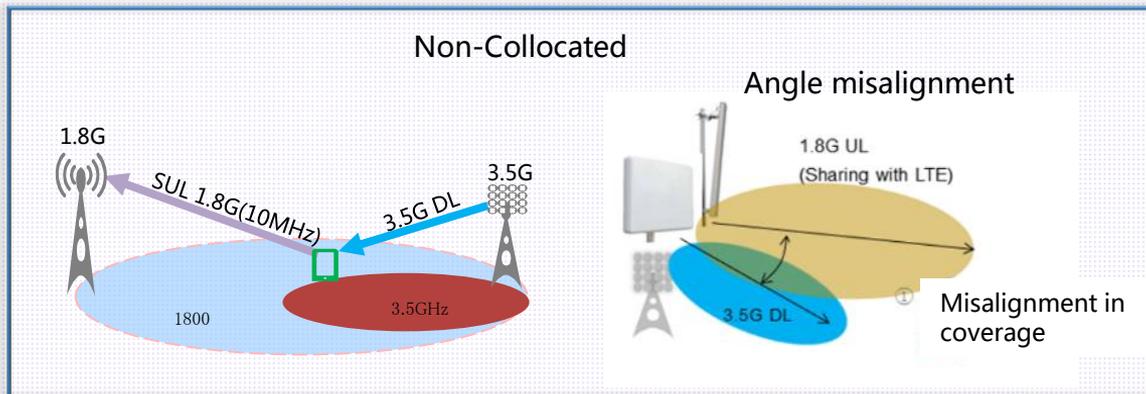
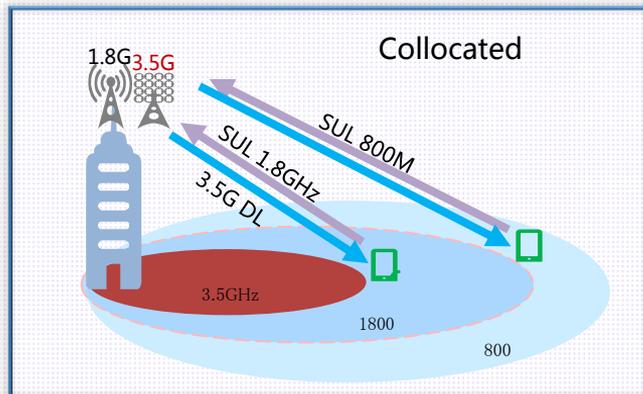
- PHY-layer:

- Multiple SULs selection/switching for network load balancing
- Different numerologies in TDD DL/UL & SUL
- Collocated and non-collocated scenarios



Examples of possible SUL band combinations

SUL pairing in co-located & non-collocated scenarios



Common for collocated and non-collocated:

- Mechanism to identify and select multiple UL-only frequencies
- Mechanism to justify and trigger UL switch

Non-collocated specific design:

- Mechanism to ensure HARQ timing (if the non-ideal backhaul scenario is targeted)
- Mechanism to do measurements for mobility and power control
- Mechanism to support SUL carriers in different TAGs

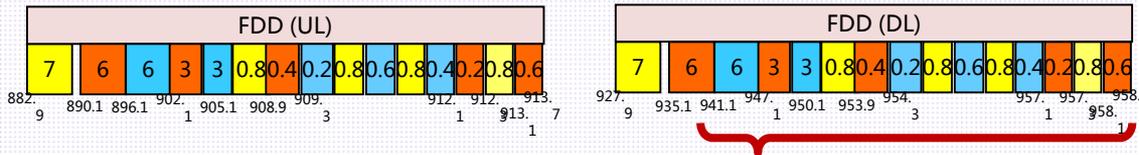
Spectrum Utilization Enhancements: possible WID objectives (1/1)

- Enhanced SUL operation, incl. mmWave NR paired with sub-6GHz SUL [RAN1, RAN2, RAN4]
 - Support pairing DL 60&120 kHz SCS for mmWave with SUL 15 kHz SCS
 - Support both collocated and non-collocated scenarios, with ideal backhaul
 - Support multiple TAG in one cell with SUL, at least for the non-collocated scenarios
 - Study the necessity of multiple TAGs in one cell with SUL for the collocated scenarios
 - Specify, if necessary, enhancements to HARQ, power control, mobility for those scenarios
 - Support more than one SUL in a cell, including
 - Support signaling of multiple SULs in system information for UE initial access and mobility, and specify mechanisms (including trigger mechanisms) for UE to select among multiple SULs
 - Support configurations of multiple SULs in a serving cell for a UE, and specify the necessary data/control transmission mechanism

Scattered spectrum Scenarios 1: 2G/3G/4G re-farming

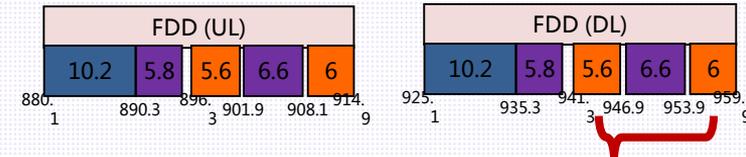
- Licensed for 2G/3G FDD spectrum will gradually expire
 - 2G/3G use narrow bandwidth, non-continuous spectrum at 900MHz, 1.8GHz & 2.1GHz
 - A single-operator owns multiple non-continuous small spectrum blocks within one band
 - Intra-band CA requirement for 4G are long and complex to define

900MHz @ Slovakia, License expire@2025



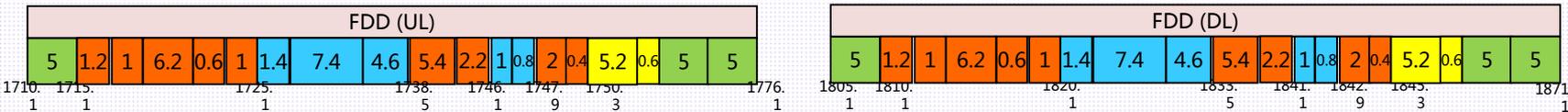
Can we have 1 NR CC? (6+3+0.4+0.2+0.6MHz)

900MHz @ Belgium, License expire@2021

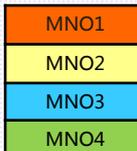
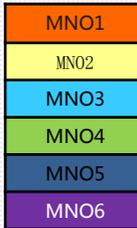
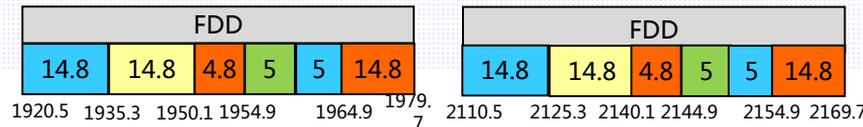


1 NR CC? (5.6+6MHz)

1800MHz@Slovakia, License expire@2025



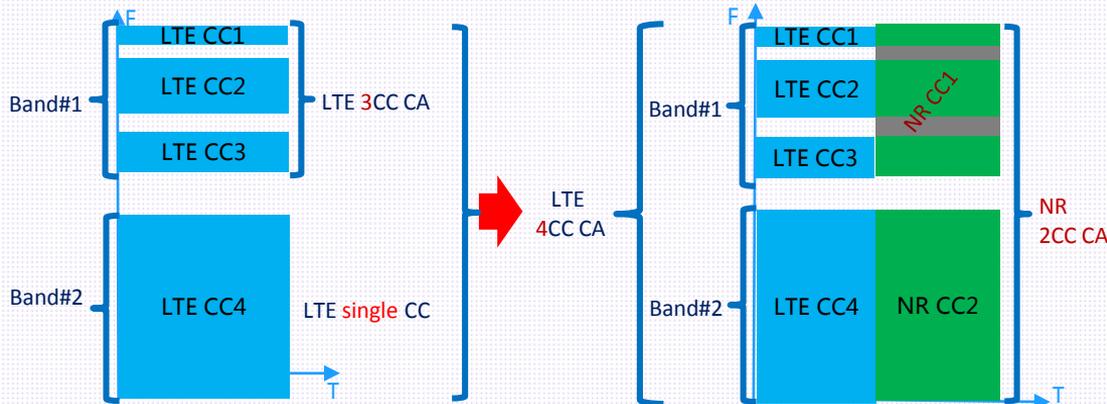
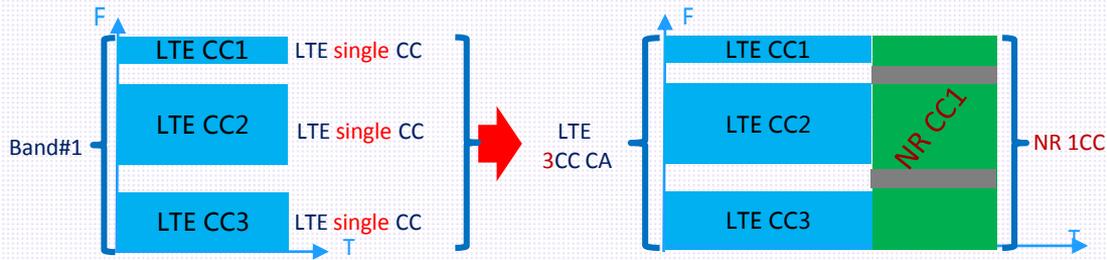
2100MHz@France



Scattered Spectrum Utilization: Simplified Design

Low Peak Rate

High Peak Rate



CA Drawbacks for scattered spectrum

- High overhead:
 - Multiple PDCCHs
 - More carrier addition/activation signaling
- High UE power consumption
 - More PDCCH blind detection
- Complicated RAN4 spec
 - Many intra-&inter-band CA combinations

Rel-16: single carrier for scattered spectrum

- Single carrier for scattered spectrum
 - Combination of non-continuous small spectrum (at least within same band)
 - Single carrier indication of scattered spectrum position and bandwidth, PRB mapping, sub-band CSI, RRM measurement
 - Support of additional irregular carrier bandwidths (e.g. 2.4, 4.6, 7.2 MHz)
 - Applicable with coordination/sharing among operators licensed in the spectrum

Spectrum Utilization Enhancements: possible WID objectives (2/2)

- Support of scattered and irregular spectrum within a band [RAN1, RAN2, RAN4]
 - The solution should support the case where the scattered spectrum of each operator includes many irregular non-contiguous spectrum blocks, with at least one contiguous spectrum larger than the NR SS block bandwidth for each operator.
 - Select which approach(es) to support scattered and irregular spectrum, e.g. including
 - Intra-band non-contiguous CA
 - One carrier covering the scattered non-contiguous spectrum blocks of one operator in the band
 - One carrier covering the scattered non-contiguous spectrum blocks of all operators in the band
 - Specify the necessary mechanism for the selected approach(es), considering configuration and signaling overhead, complexity of the RAN4 work, implementation complexity, etc.
- Extended support of multiple numerologies from UE perspective within a carrier [RAN1, RAN2]
 - Support more than one active BWP at the same time for a UE, with same or different numerologies among the multiple active BWPs

Conclusion

- Rel-16 should continue enhancing NR's unique value for utilizing any spectrum
 - Complete the design of mixing multiple numerologies
 - Complete the support of multiple active bandwidth parts
 - Expand the use of SUL carrier with mmw bands
 - Design more efficient use of non-contiguous and irregular blocks of spectrum