# TD-OCC

From our perspective, TD-OCC has following advantage and can increase capacity of SRS efficiently.

First, in the repetition case, due to more than one ports can be multiplexed by TD-OCC even they corresponds to same CS and comb as shown in Table 1, that is TD-OCC can be used with CS and FDM simultaneously, Then the capacity of TD-OCC can be TD-OCC length times of legacy capacity.

Table 1

|  |  |  |  |
| --- | --- | --- | --- |
| SRS port | Comb | CS | TD-OCC |
| 0 | Comb1 | CS0 | [1,1] |
| 1 | Comb1 | CS0 | [1,-1] |
| 2 | Comb1 | CS 2 | [1,1] |
| 3 | Comb1 | CS2 | [1,-1] |

Second, using TD-OCC, two SRS resources with partial frequency overlapping can be in same comb instead of in different combs or different OFDM symbols using legacy method as shown in Figure 1.



**Figure 1:** Two SRS resources can be in same comb even they partial overlap in frequency

Third, in large delay spread case, without TD-OCC, some ports have to be in different combs/in different OFDM symbols. The performance of channel estimation of SRS ports using different CS is worse than the performance of channel estimation of SRS ports using different TD-OCC indexes as shown in Figure 2~4 in this case.

In the second and third case, CDM using different CS is not suitable, then TD-OCC or FDM can be used and TD-OCC have same overhead as FDM. Especially for these cases with repetition ,the overhead of TD-OCC is smaller than FDM/TDM.



 **Figure 2.** MSE comparison between TD-OCC and CS with different comb, and 4 ports in two combs



**Figure 3.** BLER comparison between TD-OCC and CS with different comb, and 4 ports in two combs

**Figure 4.** SE comparison between TD-OCC and CS with different comb, and 4 ports in two combs

Some companies worry the issue of orthogonality in the case where partial SRS ports multiplexed by TD-OCC are dropped. For example as shown in Figure 5, SRS1 of UE1 and SRS2 of UE2 are in same symbol. SRS 1 of UE1 is dropped. UE 1 transmits UL signal 1 , then the UL signal 1 and SRS 2 is not orthogonal regardless which multiple is used for SR1 and SRS2, that is it also exists using legacy method, so this case should be avoided by gNB scheduling. Second this case can also be avoided by allocating multiple TD-OCC to SRS ports in same resource.



**Figure 5**: Only one UE drops in one OFDM symbol

# TRP common SRS

TRP common SRS is very important for CJT.

First, we think that each CJT TRP should allocate orthogonal SRS ports to its target UE including its serving UE and its CJT UE. The SRS from UE1 and UE 2 should be orthogonal if they need to be received by TRP1 on the same OFDM symbol as shown in Figure 6 especially now the CJT case is with ideal backhaul, so the power imbalance between SRS ports from UE1 and UE2 does not impact the channel estimation of these SRS ports at TRP1 side.



 **Figure 6.** Each CJT TRP of one CJT UE should accurately receive SRS transmitted by the CJT UE

***Observation 1:*** *Each TRP should allocate orthogonal SRS ports to its target UEs including its serving UE and its CJT UE, so the power imbalance between SRS ports from serving UE and CJT UE at one TRP does not impact the channel estimation of the SRS ports.*

Second, compared with TRP common SRS, TRP specific SRS will cost more UE power and because the UE needs to transmit one SRS for each CJT TRP respectively, so the TRP common SRS should be first supported compared with TRP-specific SRS. TRP specific power control can not ensure same transmitting power of SRS to different TRPs, but the same transmitting power across SRSs for CSI is very import to let gNB to get the accurate downlink precoding

To support one TRP common SRS resource to be accurately received by multiple coordinated TRPs simultaneously, the SRS power control enhancement should be considered. For example, the UE determines the Tx power of one single SRS resource, e.g., PL estimate, based on multiple downlink reference signals. The PL can be the maximal PL/mean PL among PLs of the multiple downlink reference signals, then it ensures that each CJT TRP can accurately receive the SRS and does not cause strong inter-cell interference because the receiving power of the TRP-common SRS at non serving TRPs is very slow, where the non serving TRP is not the CJT TRP and do not serves the UE. We further provide the simulation result in Figure 7~8. From the results, we can see that the CJT TRP with lower RSRP can not accurately receive the TRP-common SRS if the power of the TRP-common SRS is not enhanced.



**Figure 7.** MSE comparison for different power



**Figure 8.** BLER comparison for different Tx power offset

Of course other issue of TRP common SRS provided by other companies, such as TA, precoded of SRS is also worthy studying.

Some companies suggest the power can be handle by using gNB signaling. From our perspective, it is difficulty considering the gNB does not know the power offset between TRPs and the power offset changes while UE moves. It also brings unnecessary signaling overhead and gNB’s complexity.