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## 1. Introduction

One of the remaining issues on the topic of cell search (and the related issue of inter- and intra-frequency measurements) is resolving the ambiguity surrounding the cyclic prefix (CP) length or lengths associated with the target carrier frequency or layer. This contribution proposes a simple and straightforward approach to resolving at least a portion of that ambiguity.

## 2. Discussion

RAN1#47 determined that the P-SCH and S-SCH are to be allocated to the same sub-frame of a radio frame. An example of the adopted radio frame structure, consistent with the RAN1#47 working assumptions appears in Figure 1.

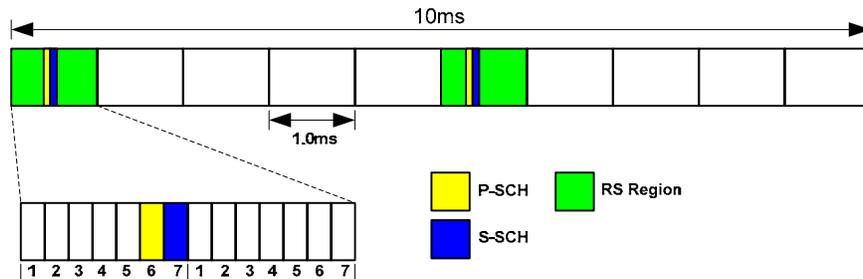


Figure 1 – Radio frame structure showing SCH and related content.

Of course, when processing the P/S-SCH and related reference symbols (RS) to determine the cell ID, the UE must resolve the ambiguity associated with the normal and extended CP length. A number of options exist for achieving this, including S-SCH related signalling, or UE autonomous determination of the CP length by e.g. hypothesis testing. While certainly manageable, these techniques add some additional complexity via either S-SCH modulation or multiple FFT processing.

As an alternative, while [1] makes no association between the CP length and a physical channel type, most discussion on the use of the extended CP option has centred on its application to multi-cell (SFN) MCH transmission. At the same time, in practical cases of unicast/MBMS-mixed operation [2], at least some of the downlink physical resource must be reserved for cell-specific transmissions, such as PCH and BCH, and DL-SCH traffic for dedicated signalling. If, say, the subframes containing SCH symbols were not assignable to MCH use, the maximum allocation of downlink resource to the MCH would then be 80% of the total carrier or layer resource.

In that case, sub-frames containing SCH symbols could be assumed to be reserved for cell-specific transmission and hence always associated with the normal CP length. The remaining sub-frames comprising the radio frame could be allocated with either the normal or extended CP length. The associated signalling could then be delivered via the secondary BCH, or some other means.

Clearly, the cost of this simplification is the inapplicability of the extended CP to at most 20% of the downlink resources, and a limitation on the length of the CP associated with any physical channel – such as, say, the primary BCH – located in the same sub-frames as the SCH symbols. The potential benefit lies in the simplification of initial and – perhaps more importantly – non-initial cell search, where measurement of the reference symbols located in the same subframe as the SCH symbols could be executed without the CP length identification step. This could be beneficial when seeking to minimise the time before an initial report of a frequency layer associated with a large neighbour list is made available.

While simplifying some aspects of cell search, the approach is potentially problematic in unicast channels with large delay spreads. If constraining SCH-associated subframes to always be subject to the normal CP is considered too restrictive, a less restrictive approach would be to associate all sub-frames not associated with MCH use to be subject to the same CP length as the SCH-associated subframes, regardless of whether the SCH-associated subframes are using the normal or extended CP length. That is, once the CP length associated with the SCH-bearing subframes is identified, all subframes bearing only unicast physical channels can be assumed to use the same CP length. For the purpose of non-initial cell measurements the UE would then be free to assume that all subframes unicast by a specific cell would use the same CP-length as the SCH-associated subframes.

This still leaves some ambiguity in the CP length identification process since any subframe associated with an MCH transmission could apply the extended CP length. Some simplification in UE processing, again with emphasis on non-initial cell search and measurement, can be obtained by requiring that the CP length used in any subframe associated with MCH transmission is equal to or greater than that of the SCH-associated subframes (and hence unicast transmissions from the same cell). For example, the use of extended CP length for unicast transmission implies that subframes associated with MCH transmission also use the extended CP length, and the UE can safely make this assumption during any measurement processing.

### 3. Conclusion

A simple and straightforward approach to simplifying initial and non-initial cell search from the perspective of the UE is to specify that:

- a) both subframes in a radio frame containing SCH symbols should be associated with the normal CP length.

or, if this is considered too restrictive, then:

- b)
  - a. both subframes in a radio frame containing SCH symbols must use the same CP length,
  - b. all subframes containing only unicast downlink physical channels must use the same CP length as that used by subframes containing SCH symbols, and
  - c. all subframes containing a MCH-related transmission must always use a CP length equal to or greater than subframes containing only non-MCH related transmissions

## **4. References**

- [1] 3GPP TS 36.211, “Physical Channels and Modulation”
- [2] 3GPP TS 36.300, “Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2”