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Title: **Node B Synchronization using Sync Burst: False Detection Reduction**
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1 Introduction

This paper clarifies the processing concept for Node B/Cell synchronisation using the Synchronisation Channel. It demonstrates that the occurrence of false detections is negligible and therefore removes one of the potential risk areas, identified for this concept.

2 Background

The concept of Node B synchronisation using the Sync Channel has been documented in several sources; see references [1],[2]. The essence of the approach is quoted from reference [1],

> *The principal feature is based on each Node B occasionally monitoring a designated neighboring Node's Synchronization Channel (SCH), measuring the Time of Arrival (TOA), confirming the identity, and sending this information to the Controlling RNC*

References [3] and [4], which advocate Node B synchronisation using the RACH approach, have identified the possibilities of false detections as a rationale for the introduction of its new, 2400 chip synchronisation burst.

In supporting the need for the new 2400 chip RACH waveform, Siemens has elaborated on the concerns over the possibility of false detections:
Quoting from reference [5],

> *Taking into account, that the PSCH is transmitted together with other interfering 'data' codes and adding multipath effects, our simulations have shown, that the misdetection rate for the SCH is 22 % and goes up to 34 % in case of added receiver noise.*

The main body of this contribution responds to the concern about the risk of high rate of misdetections.

3 Analysis

We have not replicated the simulation conditions that have yielded the misdetection rates identified in reference [5]; i.e. 22%, 34%, but these values appear to be consistent with the process of detecting the correct correlation peak for the primary synchronsation channel.

For the purpose of this analysis we will assume that scenarios exist, where the probability is as much as 34% that a time-sidelobe has been identified as the primary peak for a detection process for the primary sync channel.

We now recall that the proposed concept also includes the confirmation of identity. This process includes at least the derivation of the cell parameters through processing of the three secondary synchronisation codes. This is equivalent to selecting a 7 bit number. Given that the wrong time of arrival was selected; i.e. a time-sidelobe happened to be stronger than the valid correlation peak for the primary synchronisation code, it is extremely unlikely that the secondary sync channel processing would select the correct 7 bit parameter set designation. Then, when the derived cell parameters are compared to the anticipated cell parameters, there would not be a match. Therefore, while the measurement attempt would not be successful, it would not yield a false input to the tracking algorithm.

Assuming that a hypothesis (one of 128) is always selected, the probability that it coincidentally matches the correct value is 1/128.

Therefore, while the probability of failing to detect the desired signal may be as high as 34%, the probability of erroneously processing the output is on the order of 0.3%.

A clock tracking algorithm can easily function with a missed detection rate of 50 % or higher as long as it avoids falls detections.

4 Additional techniques for false alarm reduction

In the analysis of the previous section, we have used a simple model; i.e. a hypothesis (1 of 128) is always selected, and assuming a random selection process, there is 1 chance in 128 of a false primary code detection accidentally appearing to be valid.

There are a number of techniques used to further reduce false alarms. These are well known in other technology applications; e.g. Sonar, Radar, etc. Their use may or may not be incorporated in the RNC algorithm. This is not a Standards issue; it would be a proprietary feature, selected by the developer.

Figure 1 shows a notional flow for a generic detection and false alarm reduction process.

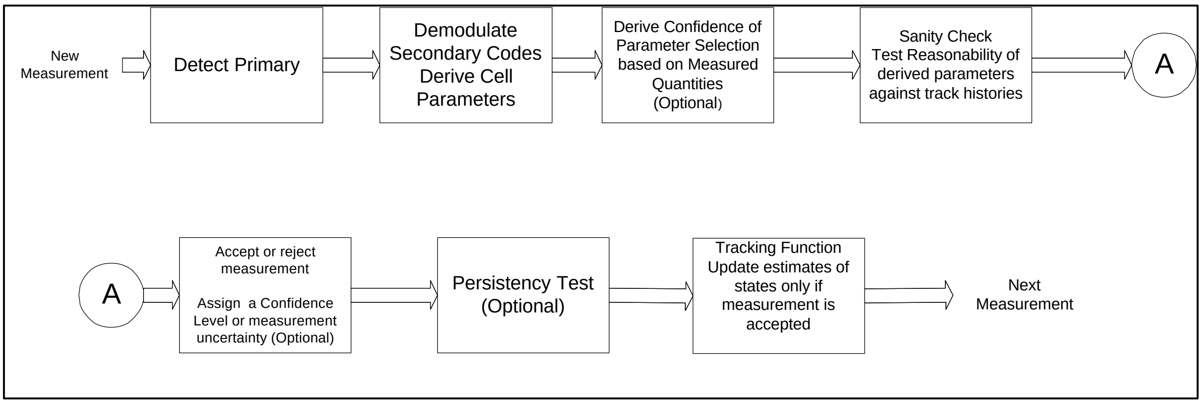

Figure 1 Detection and False Alarm Reduction Process

For each measurement, the process first detects the primary sync channel. Then it processes the secondary codes. The basis of this process is the correct identification of the time of arrival of the burst, as derived from the primary detection process. If this point is more than 1 chip in error, then all future correlation's will be incorrect. The process could force a selection, independent of the outputs of the component correlation's. It could, however, observe that these correlation's fail to achieve a post-despreading signal to noise ratio. Thus the process could apply a criterion that the output of each secondary code correlation be greater than a specified threshold. This could further reduce false detections, at the cost of some modest additions to complexity and some (negligible) increase in probability of rejection of a valid result.

The next block is the “sanity check”. This is the basis of the simplest approach. The derived output is compared to the expected output. If it does not match, it is rejected.

Another optional feature would assign a confidence level to a measurement. It can take many forms and it can be based on many criteria. As a trivial example, a measurement whose SNR exceeds a treashshold, but only slightly, may have a lower confidence than one which has a much stronger SNR.

Another optional feature is a persistency test. This process operates on several of the most recent measurements, and tests consistency; e.g. do the last five measurements of a neighbor cell’s sync burst, show a well behaved trend in drift? This process can be used as a pre-filter for the actual system tracker.

The next stage is the actual tracker. It maintains estimates of all relevant states; e.g. the clock offset of each sell in its control with respect to the master, and also the drift rates for each of these clocks.

This process could update states with variable gains that reflect the confidence in the measurements and the confidence in the prior estimates of the states. These trackers are typically based on Kalman Filters. The real world version will include various ad-hoc refinements to deal with practical issues.

Thus, depending on the sophistication of the process, there are numerous techniques to reduce the impact of false measurements.

5 Conclusion

The Sync Channel approach to Node B/Cell Synchronisation is not susceptible to system failures due to false detections. While there may be an occasional missed detection, the inherent redundancy of the RNC tracking algorithm will make the system performance insensitive to these individual missed detections.

6 References

[1] R1-00-0471, “Synchronization of TDD Cells”, InterDigital Comm. Corp., Seoul, Korea, April 10 -13, 2000.
[2] R3-99905, “Synchronization of TDD Cells”, InterDigital Comm. Corp., Sophia Antipolis, France, August 23-27, 1999.
[3] R1-00-0074 “Node B synchronisation for TDD”, Siemens, Beijing, China, January 18-21, 2000
[4] R1-99G42 “Synchronisation of Node B’s in TDD via Selected PRACH Time Slots”, Siemens, New York, USA, October 12 - 15, 1999.
[5] e-mail discussion paper, Siemens, entitled “Critical points for node B Synchronisation”
[6] R1-00-0957, “Proposed TR on Node B Synchronisation for TDD”, Oulu, Finland, July 4-7, 2000.
[7] R1-00-0770, “Criteria for TDD cell synchronization methods Tokyo”, Siemens, InterDigital Comm. Corp. Japan, 22-25 May, 2000.
[8] R1-00-1076, “Node B Synchronisation Link Analysis”, InterDigital Comm. Corp. Berlin, Germany, 22-25 August, 2000.