TSG-RAN Working Group1 meeting #12 R1(00)0469
Seoul, Korea 10-13 April, 2000
Source: InterDigital Communications Corporation
Title: Node Sync Tracking Simulation: Impact of TOA measurement accuracy

Document for: Discussion

1 Introduction

This document presents preliminary Node Synchronization tracking accuracy results. In particular, the results of this contribution illustrate the impact of Time of Arrival (TOA) measurement accuracy and short term stability effects.

A representative test case was simulated under two assumptions of TOA measurement accuracy and two assumptions on short term stability,

For both cases of short term stability, the long term rms frequency difference between two clocks was the same; 05ppm.

It is shown that, while the smaller measurement error provides for better tracking performance, it is possible to achieve acceptably small steady state errors with TOA measurement errors as large as 1 microsecond (1 sigma).

It is also shown that the short term stability of the clocks can have more significant impact on tracking performance than does the measurement accuracy.

2 Test Case Scenario

The simulation modeled one Node B tracking a second Node B.

Tracking interval: 20 seconds
Clock Drift Model (based on the drift model of reference [8]):
A representative test case was simulated under two assumptions of TOA measurement accuracy and two assumptions on short term stability (see reference [8]).

- Measurement Accuracy
  - 1 microsecond (1 sigma)
  - 1/4 microsecond (1 sigma)
- Short Term Stabiliy
  - 10-10
  - 10-9

For both cases of short term stability, the long term rms frequency difference between two clocks was .05ppm.

We believe that 10-10 stability is a representative value, but it is important to give this parameter a critical review, considering practical frequency sources.

It is assumed that, at t=0, the two clocks are nominally synchronized and their drift rates are estimated correctly. Then a random frequency shift occurs, and the two clocks start to drift apart. The tracking algorithm is updated by a measurment once per 20 seconds.

3 Results

Figure 1 shows drift between the two clocks and tracking accuracy. It is seen that, without tracking, the two clocks drift apart by 3 microseconds in 1000 seconds in one case and by 5 microseconds in the other case. The residual tracking errors are shown to be quite small. Figure 2 removes the absolute drift and shows the same data for the residual tracking errors, with a scale change.

It can be seen that for the case 10-10 short term stability, the tracking errors are:
1 microsecond TOA measurement error:
    Steady state errror = 0.4.microseconds (1 sigma)
0.25 microsecond TOA measurement error.
    Steady state error = 0.2 microseconds (1 sigma)

For the case 10-9 short term stability, the tracking errors are on the order of 1 to 1.5 microseconds, with only a small improvement due to the more exact measurement error. While we believe that this parameter is unrealistically high, this analytic exercise illustrates the importance of using the correct value in the design and in subsequent analyses.

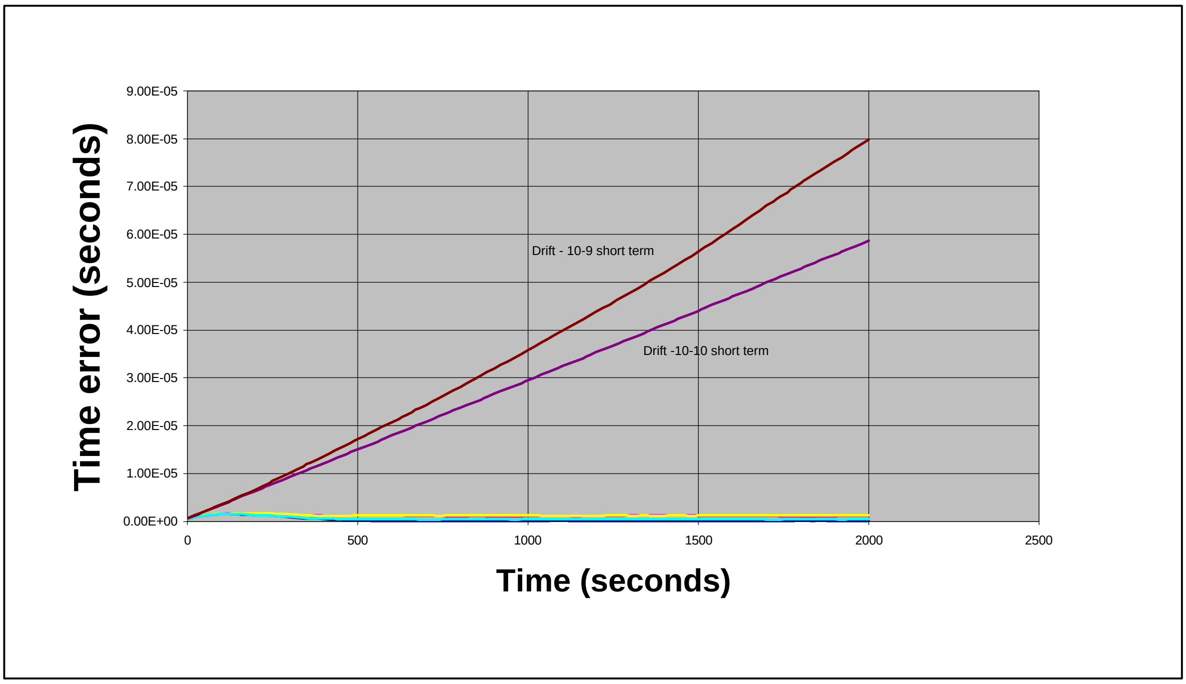

Figure 1 - Clock Drift and Tracking Accuracy

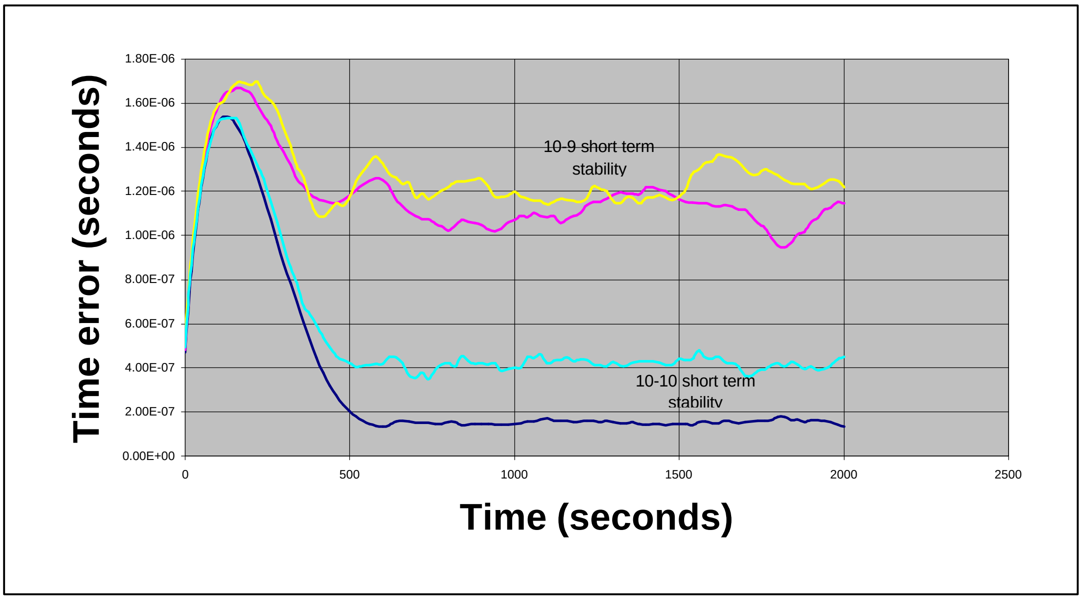

Figure 2 - Tracking Accuracy

4 Conclusion

Steady state errror of less than 1 microsecond can be achieved with an update rate of one measurement per 20 second; even with 1 microsecond (4 chip) TOA measurement error. With further optimization it may be possible to increase the update interval to greater values. It is anticipated that the process will tolerate missed detections and occasional large measurement errors.

Based on these preliminary results there is no motivation to design for very accurate TOA measurments (e.g. less than 1 chip). It is very likely that the required measurements will be acheivable by the Node B using the same cell search processing used by UEs.

Finally, it is important to refine our clock models, as results can be sensitive to the short term drift characteristics.

5 References

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[3]Node B synchronisation for TDD, Siemens, TSGR1#10(00)0074, Beijing, China, January 18-21 2000

[4] Synchronisation of Node B's in TDD via Selected PRACH Time Slots, Siemens, TSG RAN WG1 (99)G42, New York, USA, October 12 - 15, 1999

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Preliminary Comparison of Alternatives , InterDigital Communications Corporation, R1(00)0468, Soeul, Korea 10-13 April, 2000:

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[8] Proposed Clock Model for Node B Synchronization over the Air: R1(00)0467, InterDigital Communciations Corporation, Soeul, Korea 10-13 April, 2000