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Title: Proposed Clock Model for Node B Synchronization over the Air:
Document for: Discussion

1 Introduction

This paper proposes a clock model for analysis on Node B Synchronization studies. Reference [3], Node B synchronisation for TDD, TSGR1#10(00)0074, Beijing, China, January 18-21 2000 provided performance results for Node B synchronization over the air. The clock model of reference [3] is included in the table below, copied from the reference for convenience.

Parameter	Value
Initial Timing Error	Uniform Random Distribution over ± 50 ms
Initial Clock Rate Error	Uniform Random Distribution over ± 0.050 ppm
Measurement Resolution	¼ chip
Clock Variance	$10^{-17}sec^2/sec$

It is a concern that the clock variance of $10^{-17}sec^2/sec$ may be too well behaved to serve as a realistic assumption. This model suggests that time drift will grow as a random walk and would take 100,000 seconds, or over one day to grow by 1 microsecond 1 sigma.This paper proposes a clock model that creates a more dynamically changing random component.

2 Proposed Model

2.1 Input Parameters

The model uses the following input parameters
Time interval for simulation = tint:
Typical value = 1 second (could be 20 seconds)

RMS frequency uncertainty, long term= sserror
Typical Value = .05 ppm =5 x 10-8

Short Term Frequency uncertainty ; e.g. over 1 second:= shterror
This is the Allen Variance; the expected value of the RMS change in frequency with each sample, normalized by the oscillator frequency. where the sample interval is specified; e.g. 1 second or 20 seconds. Note that the term, variance is often used, although the value is usually quoted as the RMS value.
Typical value = 10-10

Random Walk Component = sigmarw

Typical Value = 10-17 sec2/sec

2.2 Derived Parameters

Calculate the parameters alpha and gain from the following:

alpha = (shterror) * (shterror) / (2 * sserror * sserror)

gain = SQR((2 - alpha) / alpha) * sserror

sigmatau=sigmrq/sqr(tint)

2.3 Generating expressions

For each time interval:
Generate x, a random variable from gaussian distribution:
Mean=0
Sigma=1

x1 = x * gain
freq = freq + alpha * (x1 - freq)

tau1 = tau1 + freq*tint

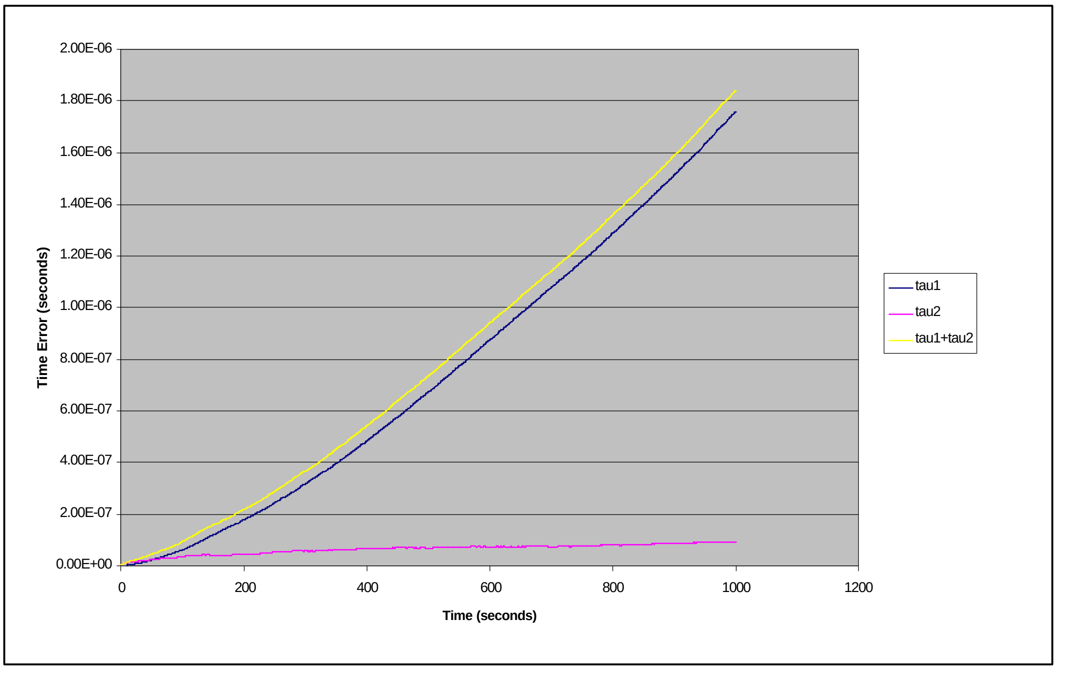
tau2 = tau2 + x * sigmatau*tint

tau3 = tau1 + tau2

3 Typical Results

The following figure shows simulated results for the rms value for tau1,tau2, and tau1+tau2 as function of time for the typical values. The assumption for these curves is that

- Both Frequency and time offset have been estimated correctly up to the time, t=0.
- Time drift shown in the figure represents the deviation from the values which would be predicted based on the estimates which were correct at t=0; i.e. this is the contribution due to the unprediceted random drift.



Observe that this example simulates almost 2 microseconds of clock drift after 1000 seconds, while the random walk model of reference [3] caused only about 0.1 microseconds of random drift.

Note also that these curves represent the drift of one clock from ideal. The relative drift between two non-ideal clocks would be the appropriately larger.

4 Conclusions

We have suggested a clock model to serve as the basis for continuing simulation work for the Node B synchronization studies. It may not be totally realistic but it does provide for a greater level of stress to the synchronization process than the original model in reference [3].

However, we encourage other companies to propose a realistic clock model, if available.

5 References

[1] Synchronization of TDD Cells, TSGR3#6(99)905, Sophia Antipolis, France,August 23-27, 1999, InterDigital Comm. Corp.

[2] NBAP & RNSAP Procedure for TDD Synchronization (some additions/modifications to R3-99905)TSGR3#6(99) 882, Italtel / Siemens, August 23rd 1999,Sophia Antipolis, France

[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