Time Synchronization: Progress Report

Fasika Assegei

June 14, 2008

Absolute time ...

"A man with a watch knows what time it is. A man with two watches is never sure."

Segal's Law

¡¡¡¡¡¡¡ .mine

=======

1. Frequency Offset
2. Intermediate Results
3. Discussion Points

¿¿¿¿¿¿¿ .r35

Clock Drift

$$f_i(t) = f_o + \Delta f + f_d(t - t_o) + f_e + f_r(t) \tag{1}$$

where

f_i = phase, or time error

f_0 = nominal frequency of the clock - $32768KHz$

Δf = calibration error - $30ppm$

f_d = the frequency drift due to aging - $3ppm$ per year

f_e = frequency variation due to temprature - $-0.035ppm/C^2$

f_r = short-term frequency instability due to noise

Frequency variation with Temperature

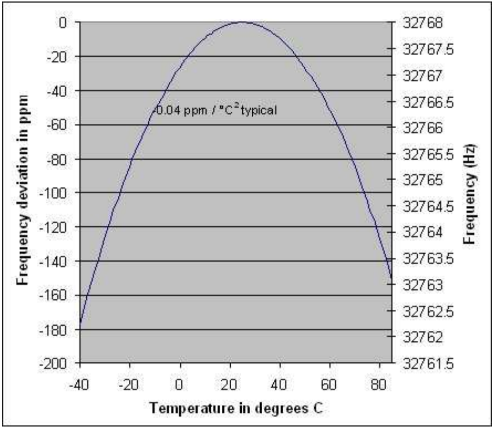
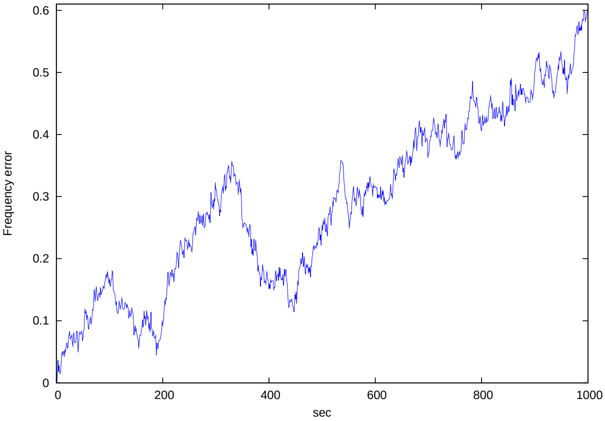


Figure: Frequency variation with temperature

Clock Drift

¡¡¡¡¡¡¡ .mine



=======

Worst Case Scenarios

$$f_i(t) = f_o + \Delta f + f_d(t - t_o) + f_e + f_r(t) \tag{2}$$

Assuming the maximum deviations ,

$$\Delta f_{max} = 1.0117 Hz \tag{3}$$

for a slow clock and

$$\Delta f_{min} = 0.95436 Hz \tag{4}$$

for a fast clock.

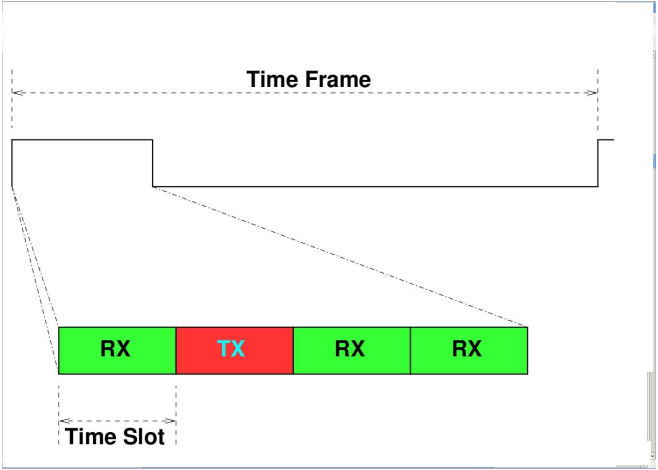


Figure: TDMA Slot

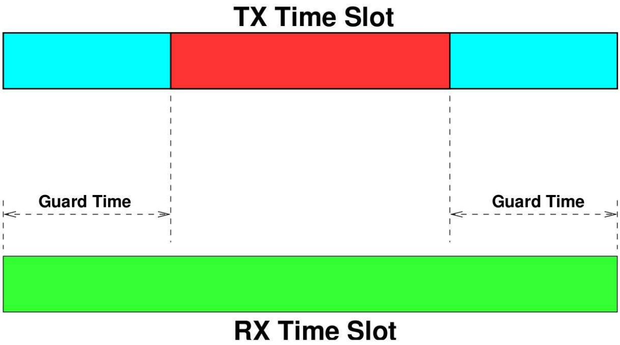


Figure: TDMA guard time

Frequency of Synchronization

Worst case scenario - Clocks drifting in opposite directions

$$t_{guard} = f_{sy}[\Delta f_{sl} + \Delta f_{fa}] \quad (5)$$

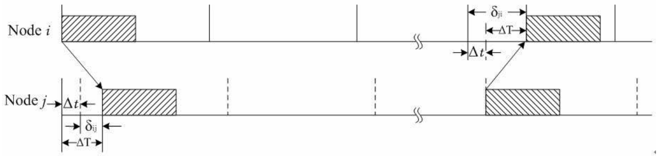
$where$

$$t_{guard} = 274.6575 \mu s \quad (6)$$

The maximum value will be

$$f_{sy} = 4$$

Node Time



ΔT is the time difference between the nodes firing times
Δt is the delay(transmitting , receiving and propagation delay)
δ_{ij} is the net difference in time

Adjusting the error

$$\tilde{t}_i = I_i + \frac{f_i(t)}{f_o} t + D_i, \tag{7}$$

where
I_i *is the initial firing time of the node ,*
f_i *is the frequency of the node at time t ,*
f_o *is the nominal frequency of the node's clock ,*
D_i *is the processing time(Upon receiving and transmitting) plus the delay in propagation*

Adjusting the error

$$\Delta t_{ij} = \tilde{t}_i - \tilde{t}_j, \tag{8}$$

$$\Delta t_{ij} = (I_i - I_j) + (D_i - D_j) + t(f_i - f_j), \tag{9}$$

$$\tilde{t}_i = t_i + O_i, \tag{10}$$

where O_i is given by

$$O_i = f(\Delta t_{ij}), \tag{11}$$