Costs and Time Constants Determined By Clock Steering Strategies

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An important issue in using proportional steering to control clocks is to set the gain, which is a vector that is multiplied (via dot-product) with your best estimate of your clock's state vector (phase and frequency with regards to the reference) to determine the magnitude of your steer. This applies in steering a remote clock to a master clock, and to some extent in steering a timing lab's clocks to UTC. If there is no delay between measurement and the implementation, one can chose the gain to minimize a combination of frequency RMS, phase RMS, and control effort, which is defined as the RMS of the steering corrections and which determines the degree to which the controlled clock is disciplined. Alternately, one could set the gain functions so as to set the time constant. These two approaches have been described in Koppang, Metrologia 42, 2016. In our presentation we provide a pictorial representation that describes both these classes of quantities in terms of any set of gains. We also show how other quantities, such as the Allan Deviations and the frequencies in the oscillatory regime can be found. Although there will be no equations solved in the presentation, the text will outline the equations required for the underlying analysis; these can be generalized to more complex state and steering functions, such as those characterized by phase, frequency, and drift.