Section 3: Week 6: Clock Synchronization

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TIM-8120: Distributed Systems

October 27th, 2019

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# Clock Synchronization

A common challenge of presenting a single system image across multiple nodes is ensuring that the sequence of events processed, is correct. Many strategies to address this issue focus on time stamps, though this approach has challenges as most clock implementations are imperfect. Clock skew causes these imperfections and needs Clock Synchronization Protocols to mitigate.

## Physical Clocks

Most mechanical devices have timers, not clocks. These timers rely on the oscillation of quartz crystal as a means to decrement a counter, signifying the duration until the clock tick system interrupt occurs (Ubolkosold, Knedlik, & Loffeld, 2005). These crystals “suffer from large frequency shifts due the the high sensitivity to external or internal factors (Zhang, et al., 2019).” According to Zhang et al., atomic clocks rely on energy transitions to achive 100,000 times better precision than quartz after ten days. These more precise instruments are difficult to deploy more broadly due to both their physical size and power consumption. Researchers are continuing to explore methods to reduce these limitations.

As these timers raise clock ticks, the more extensive system needs to report that it is relative to some universal reference point. Universal Coordinated Time (UTC) is the de-facto solution as alternatives, such as regional time zones, are impacted by political cross cutting concerns. For example, Eastern Time in America changes at different points of the year for day light savings. Another solution is to rely on the local time zone of the device. This design introduces additional challeges for systems spanning multiple locations as the value “2019-10-27 10:03:00” occurs numerous times.