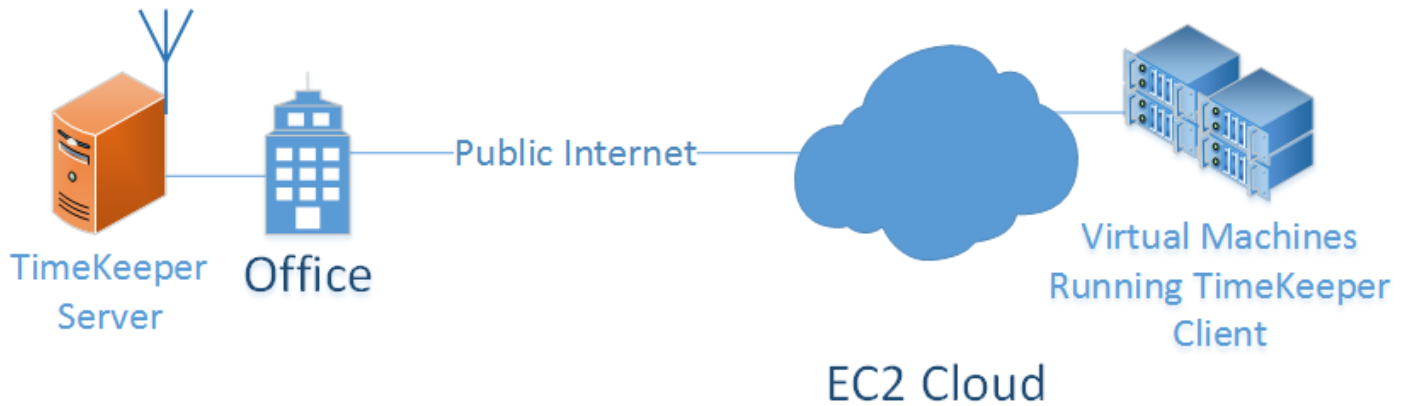
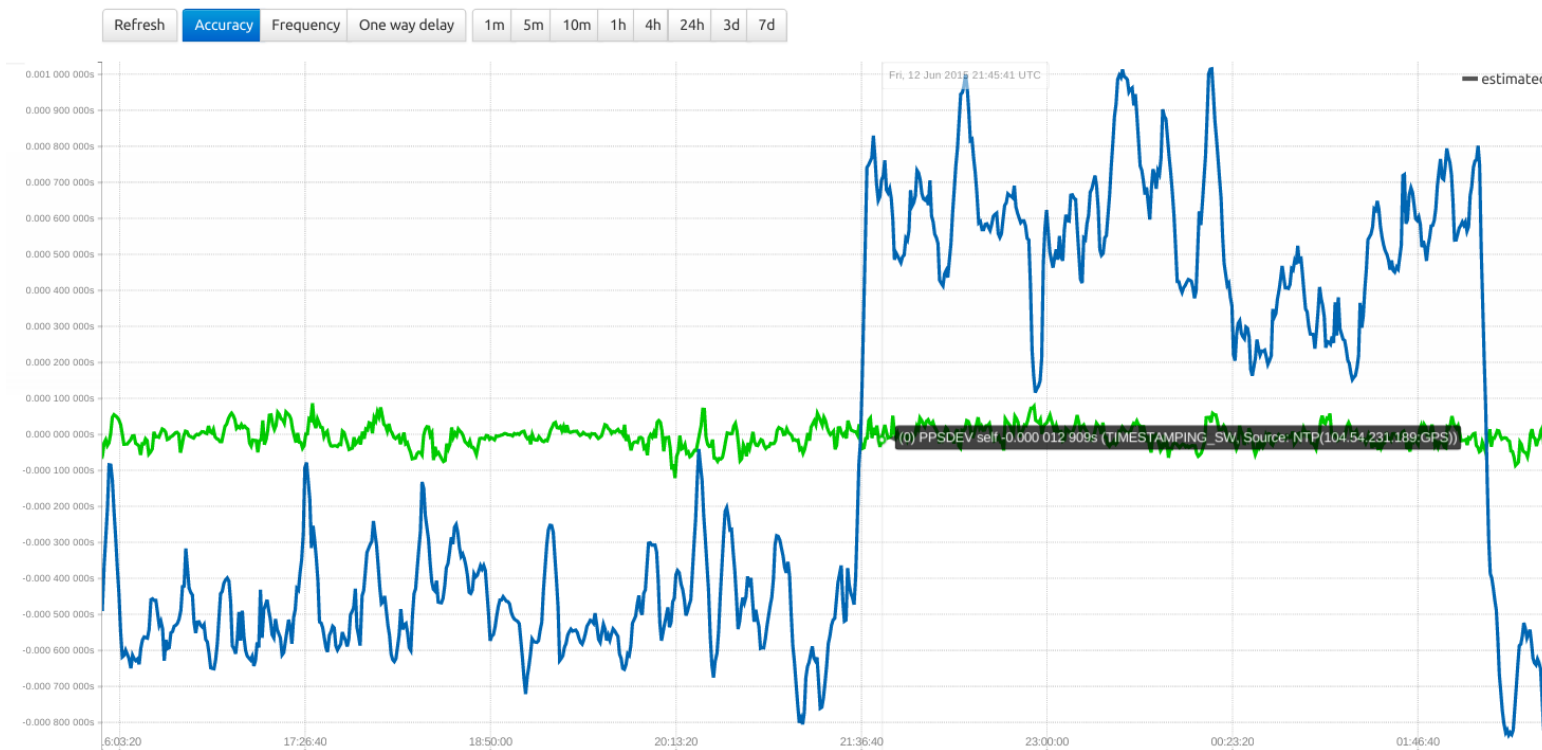


15 Microsecond Time Synchronization in the Cloud



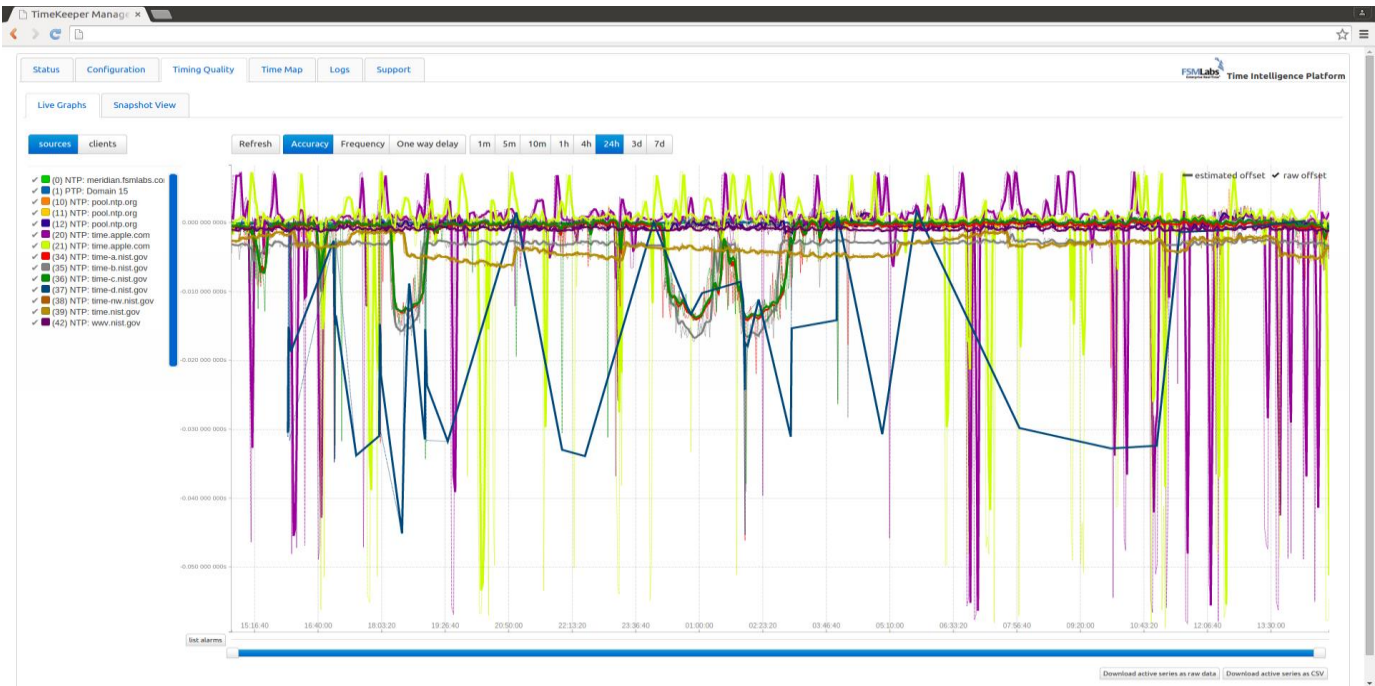
The clocks on Cloud Virtual Machines are notoriously inaccurate and hard to synchronize with legacy technology but can be tightly controlled using TimeKeeper. One simple method is synchronize TimeKeeper enabled cloud VMs to an external TimeKeeper reference. Our tests show that clocks remain within 15-25 microseconds of reference in such a setup even with standard Internet access. The result is to make practical, high precision time accuracy a low cost, trivial to implement, utility on the Cloud.



The screenshot above shows a EC2 Linux instance running in Virginia while Timekeeper tracks two time sources: the green one is NTP from a TimeKeeper GPS server in Austin Texas and the blue one is Google's public NTP time service (which is the best public time source we have found). The graph shows a wobble of about 200 microseconds up and down on the TimeKeeper source and over a millisecond on the Google NTP source. TimeKeeper Client is able to lock the local clock to within 15 microseconds (standard deviation over 24 hours) from the Timekeeper NTP feed by smart filtering and smoothing algorithms.

Accuracy is measured by taking advantage of TimeKeeper's unique multi-source capability. The cloud TimeKeeper instance serves time back to the GPS Server which then compares the feed from the cloud to reference GPS clock time.

The screen-shot below shows TimeKeeper on lower quality EC2 Linux system tracking a number of time sources: multiple "pool" NTP servers which are the usual sources and single off-site TimeKeeper Server serving NTP and PTP - that one is in the center, rock solid. This is a 24 hour test.

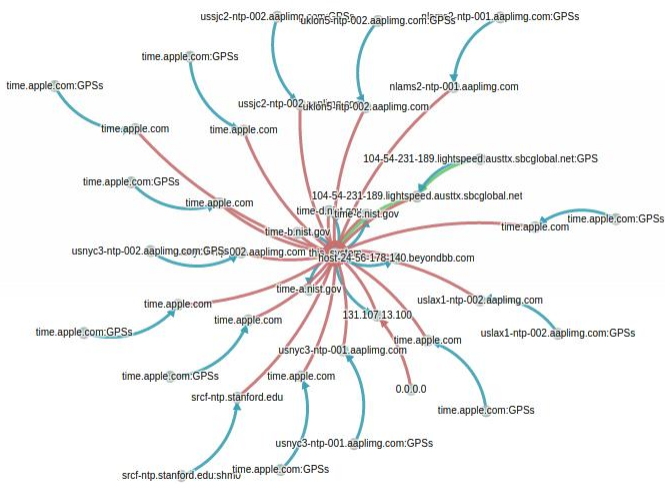


- The pool sources wander off by tens of milliseconds due to variable network delays and the limitations of the NTPd software serving that time.
- The TimeKeeper server is in an office in Texas with a 1 GB basic Internet connection. The server is reading time from GPS clock and serving NTP and PTP (TimeKeeper is protocol agnostic).

A detailed look (on the right) at just TimeKeeper’s NTP source shows that internet variability and virtualization causes reference time updates to be up to 200 microseconds off of the expected time. TimeKeeper smart smoothing keeps the clock within about 25 microseconds of the GPS Reference on this test.

The graph below shows what the time network looks like from the EC2 instance during this test.

TimeKeeper’s analytics and visualization make simple to understand how a system is configured and where any problems might be coming from. The EC2 instance is in the center. The red lines show NTP sources. The single green line shows the PTP unicast. The blue lines show time sources – in this case mostly GPS sources.



TimeKeeper is the most advanced time synchronization software in the world and is trusted by Wall Streets most technically advanced trading companies to track their high speed automated trading and market data systems. Whether you are running trading applications, Cassandra or other database instances that depend on timestamps, distributed gaming applications or sophisticated IOT systems – TimeKeeper can lock down time so your applications can run reliably. Precise

The test configuration

TimeKeeper has a unique capability of testing accuracy by comparing multiple sources of time against each other. This capability is at the heart of the validation and traceable audit features required by our Financial Trading customers and also permit validation of time accuracy in other domains. The screen shot below shows NTP coming back from a cloud instance (blue) versus the time from a local GPS source (green).

