PTP vs NTP Time Servers

Time synchronization is critical within any network to operate efficiently and effectively for your business. If devices are not synchronized within your network, complications can arise. While using a public internet time server is one option that can be considered, there are caveats to using an external time source including security concerns and network latency issues. For financial and scientific institutions, time synchronization must be accurate to a billionth — or in some specific cases even a trillionth — of a second, but even commercial and industrial organizations are starting to push for synchronization accuracy in the sub-millisecond range.

To use a public time source your infrastructure adds in switches, routers, and other network gear that all add a tenth of a second and that multiplies several times over. Without specialized equipment, your network is suddenly off by the better part of a second from NIST or NPL in the UK.

Of even greater concern is synchronizing different clients within the same network. Imagine a financial institution that has exactly 100 shares of Company X's stock. Big news breaks concerning Company X, and the financial institution sells those 100 shares not to just one investor but several over the span of a second, but because the institution's servers aren't synchronized with one another, there is no way to tell which buy order came first.

The most secure method for network time synchronization is through the use of a local GNSS time server as your master network clock. A GNSS network time server provides you a Stratum 1 time source within your internal network that will be reliable, and unlike a public time server, is not impacted if the internet goes down. If you decide to use a GNSS time server for your network time synchronization, you have choices to make: should you use an NTP time server or a PTP time server, and what’s the real difference?

Both NTP and PTP time servers use network time protocols to serve time to other devices on the network and achieve time synchronization. Below we will discuss the basic differences between NTP and PTP time servers to help you make decisions on the best choice for your business needs, and ultimately it comes down to the accuracy you need.

NTP Servers

Network Time Protocol, or NTP, is one of the oldest Internet protocols still in use today. An NTP server is directly connected to a highly accurate timekeeping source, the GNSS satellite networks. The server receives time information from the GNSS satellites, uses algorithms to process the information, and then broadcasts it to all devices on the network that are requesting time information. NTP servers can synchronize clocks and other local network devices within microsecond accuracy, which suits most business and industrial needs for time serving accuracy.

NTP, or Network Time Protocol, has been widely adopted as a means of network timekeeping, and it's currently in its fourth major version. The hierarchical system has different layers called strata. Stratum 0 devices at the very top include atomic clocks, like those in GNSS satellites.

Stratum 1, or primary time servers, each have a one-on-one direct connection with a Stratum 0 clock, achieve microsecond-level synchronization with Stratum 0 clocks, and connect to other Stratum 1 servers for quick sanity tests and data backup. Stratum 2 servers can connect to multiple primary time servers for tighter synchronization and improved accuracy, and so on and so forth. NTP supports up to a maximum of 15 strata, but every stratum slightly decreases client synchronization from Stratum 0.

A 64-bit timestamp as currently implemented is split up into two equal 32-bit parts:

- The first half counts the number of seconds up to just over 136 years
- The second half express fractions of a second down to the picosecond scale

A proposed update to 128-bit timestamps to NTPv4 would increase the time scale to just under 600 billion years and the time resolution to less than a femtosecond.

However, if greater than microsecond synchronization accuracy is required, a PTP server might be the best bet.

PTP Servers

PTP, or Precision Time Protocol, is another network-based time synchronization standard, but instead of millisecond-level synchronization, PTP networks aim to achieve nanosecond- or even picosecond-level synchronization. For most commercial and industrial applications, NTP is more than accurate enough, but if you need even tighter synchronization and timestamping, you'll need to migrate to a PTP server. With the introduction of faster digital networks such as 5G a PTP network is mandatory.

Why is PTP timestamping so accurate? It uses hardware timestamping instead of software, and like any other fine scientific instrument, PTP equipment is dedicated to one specialized purpose: keeping devices synchronized. For that reason alone, PTP networks have much sharper time resolutions, and unlike NTP, PTP devices will actually timestamp the amount of time that synchronization messages spend in each device, which accounts for device latency.

Every PTP sequence involves a series of four messages between master and slave, and this sequence produces four different timestamps. The master sends all four timestamps to the slave during the delay response phase, and the slave is able to calculate the network latency between the master and slave in both directions. By having specialized hardware fetch timestamps from the local clock, slave devices can avoid extra latency introduced by the local operating system.

NTP networks have extra latency and less accuracy simply because they're software-based, and all timestamp requests have to wait for the local operating system. For most companies, NTP provides a sharp enough time resolution to resolve conflicts in a timely manner, but certain organizations including the aforementioned physics laboratories require a far greater level of synchronization.

Why Do We Need a Time Server?

Timestamping and client synchronization is vital for your network, but some network engineers still feel like they can get away with simply syncing their servers to a public internet clock. While perfectly fine for consumer devices like smartphones, internet clocks are poorly suited for business networks for one simple reason: security.

To connect your server to an internet clock requires you to first open up port 123 on your firewall. Will something horrible happen as a result? We don't know, but we don't know in the same way that we don't know if a burglar will break in because you left the front door unlocked on your home. Why take the chance? A dedicated NTP server keeps your network secure while providing more accurate timestamping.

What Happens If My Time Server Is Disconnected?

No network is perfect, and all you can hope to do is minimize downtime instead of eliminating it. If your NTP or PTP time server is unable to connect to a GPS satellite or other input for whatever reason, you can rest assured that it will continue to synchronize your devices and maintain accurate timestamping.

For example, all Trimble precision time receivers have Hold Over capability that can provide time stability for up to a 24-hour period. This is achieved by using an internal oscillator, in the case of the Thunderbolt this is a double oven-controlled crystal oscillator with very high stability.

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