Network Time Protocol (NTP)

Previously, DNS name servers were explained as an addressing service that resolves (learn) an IP address from a hostname. There are time servers as well that synchronize clocks on all Cisco network devices. The architecture is based on a centralized public time source that synchronize clocks within a private domain.

The network service is enabled with Network Time Protocol (NTP) that is supported on Cisco IOS. The primary purpose of NTP is to synchronize clocks within a private administrative domain for system messages and time stamps. It is important to accurately record when an event occurred for reporting, auditing and troubleshooting purposes. It extends to applications such as video surveillance, security logs and financial transactions for example.

The idea of an accurate, centralized time source is foundational to time services architecture. Time synchronization is based on Coordinated Universal Time (UTC) for time services globally. The time zone is configured as an offset from UTC. For example, Pacific Standard Time (PST) is represented as UTC -08:00 (eight hours behind UTC).

Stratum Levels

NTP is based on a hierarchy of public and/or private time servers that start from a top-level authoritative time source. The authoritative time source is typically an internet-based public NTP server. The public time servers are connected directly to an atomic clock (stratum 0) and are designated as stratum 1 servers. NTP stratum describes how many hops device is from the authoritative time source. Higher level stratum devices receive updates from same or lower stratum devices. For example, an internet router with a public interface configured to synchronize with an authoritative time server is stratum 2.

The internal clock on that router is updated at regular polling intervals. Any downstream neighbor that is receiving updates from the internet router is assigned stratum 3.

Table 1 Cisco Time Sources

Time Source	Description
private	internal network device
system calendar	initializes software clock after restart
software clock	initially set by hardware clock
public	external time server

There is less reliability and accuracy as the stratum assigned increases. That is important to know since NTP will select the most reliable source for a network device when a primary server is not available. NTP does not permit updates from any source that is assigned stratum level 15. The internal Cisco clock is assigned stratum level 7.

Figure 1 Network Time Protocol
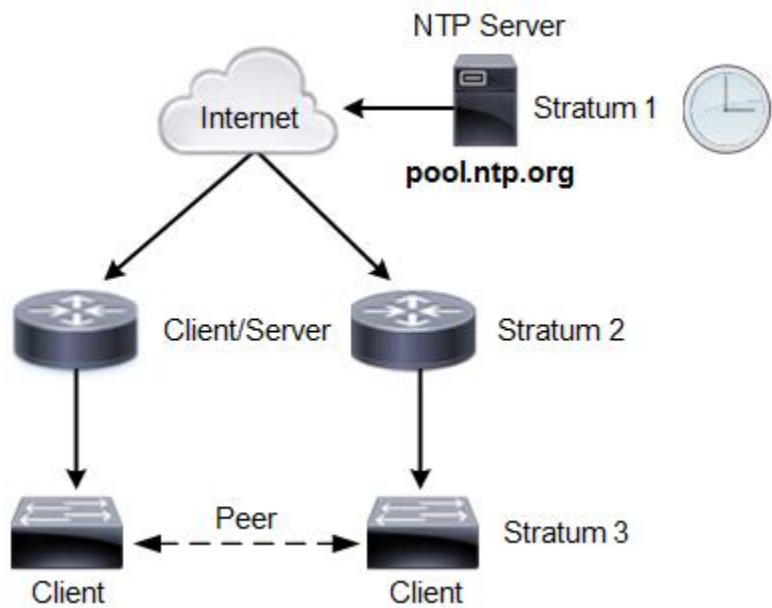
NTP Association Modes

Within NTP configuration, there are various different association modes that can be assigned to Cisco network devices. Each role determines the source of time updates and redundancy enabled.

There is a hierarchy to time services that is created based on the operational role and stratum level assigned. The time sources can be a private network device or public server. Cisco defines the following configuration roles within a private domain. They include server, client, client/server, peer, and master.

Client Mode

This is the most common mode enabled with **ntp server** command. It specifies the IP address of a time source with a lower stratum level. Typically most Cisco network devices point to an internal network device with lower stratum level. At least one internal router is configured with the same command that references a public authoritative time source by hostname (pool.ntp.org).

     router(config)# **ntp server pool.ntp.org**
     router(config)# **ntp server 172.16.3.1**

Client/Server Mode

Cisco support client mode and server mode on the same network device. The local device receives time updates from a lower stratum server and advertises to a higher stratum level device.

Symmetric Mode (Peer)

Mutual clock synchronization of directly connected network devices with each configured as time source. This is enabled with **ntp peer** command along with IP address of peering neighbor device.

     router(config)# **ntp peer 172.16.3.2**

Master Mode

This mode is used commonly as a failover when internet connectivity is not available. It becomes the top-level authoritative time server on a private domain that replaces external public server. There is the option to configure **ntp master** command along with a stratum level.

Internal network devices would derive time synchronization from the clock of that device. Alternatively, you can configure a public hostname on a different internet connection. The default for master mode is stratum level

> router(config)# **ntp master 5**
> router(config)# **ntp master time-a.nist.org**
> router# **show ntp status**
> router# **show ntp associations**

What redundancy is enabled with Network Time Protocol (NTP)?

Answer

The following are all characteristics of NTP network protocol.

- Provides time source for logging and time stamp transactions
- N+1 server redundancy supported (NTP master + failover)
- Reference is UTC coordinated universal time
- DNS is required for resolving time server IP address

What NTP mode polls an external time server?

Answer

The following statement correctly describe NTP operation:

- Server mode routers provide time source to client mode devices
- Stratum level is the distance from NTP authoritative time source
- Server mode routers poll external time server unless ntp master is enabled

The following IOS command is used to show NTP server synchronization status and stratum level for a router.

> router# **show ntp status**

The following IOS command is used to show the NTP association status with neighbors and NTP mode of the local client network device (client/server).

> router# **show ntp associations**