Network Time Protocol

NTP synchronizes network infrastructure (routers and switches) and computers (PCs and servers) to a single clock on the network, known as the *clock master*. NTP is essential to Cisco Unified Communications deployments.

An NTP network usually gets its time from an authoritative time source. This source can be a radio clock or an atomic clock attached to a time server. NTP then distributes this time across the network. An NTP client initiates a transaction with its server with a polling interval that ranges from 64 to 1,024 seconds. This interval dynamically changes over time, depending on the network conditions between the NTP server and the client. No more than one NTP transaction per minute is needed to synchronize two machines.

One of the strengths of NTP is that it uses Coordinated Universal Time (UTC), which is easily accessed through the GPS satellite system. Because UTC is the same worldwide, networks synchronized to UTC avoid interoperability problems with other networks. This synchronization is particularly important when administrators are troubleshooting IP telephony traffic and need to compare log files from various networks. The time of the internal clock of the Cisco Unified Communications call control platform and the network infrastructure components should be synchronized with an NTP server.

The `clock timezone` *`zone hours-offset`* command sets the time zone and number of hours that the time zone is offset from the UTC (formerly Greenwich Mean Time [GMT]). This command allows the Cisco router to define the operating time zone. If daylight saving time occurs in the area where the system is located, you must configure it using the `clock summer-time` *`zone`* `recurring [`*`start-date end-date`*`]` command.

Because Cisco Unified Communications call control can run on multiple platforms, the method for enabling NTP varies. To keep the correct time based on the time of a more authoritative source than its own system, perform the following:

- **Cisco IOS router:** The `ntp server` *`ip-address`* command configures the Cisco router to synchronize with the NTP server specified by the *`ip-address`* parameter.
- **LINUX-based servers:** Linux-based versions of Cisco Unified Communications Manager have a web-based interface that you can use to set the NTP server to which they can synchronize.
- **Windows-based servers:** Windows-based versions of Cisco Unified Communications Manager can be set from the command line.

Listing 7.7 sets a Cisco router to Pacific Standard Time with daylight saving time configured and synchronizes the router's system time to an NTP server with an IP address of 10.1.2.3.

Listing 7.7. Configuring NTP and Clock Settings

```
Router(config)# clock timezone PST -8
Router(config)# clock summer-time PDT recurring first sunday april 02:00
   last sunday october 02:00
Router(config)# ntp server 10.1.2.3
```

Understanding the Phone Bootup Process

After completing the configuration of the switch and activating DHCP, the Cisco IP phone proceeds through the standard bootup cycle.

After an IP phone receives power, the following happens:

1. Power-on self-test (POST): The phone performs a set of tests to ensure basic functionality.
2. The phone begins the boot process.
3. The phone uses Cisco Discovery Protocol to learn the voice VLAN.
4. The phone initializes a basic IP stack.
5. The IP phone (DHCP client) sends a DHCPDISCOVER request to the 255.255.255.255 broadcast address.
6. A DHCP server returns a DHCPOFFER message and assigns the following for the requested scope: a free IP address, the subnet mask, the default gateway, the DNS server (optional), and the TFTP server (option 150) for the scope. This information is sent to the DHCP client (the IP phone) using the broadcast address 255.255.255.255 (the router

uses the IP phone MAC address at Layer 2).
7. The IP phone takes the values received from the DHCP response and applies them to the IP stack of the IP phone.
8. The IP phone uses the value received in option 150 to attempt to retrieve a configuration file from the TFTP server.

The IP phone is prepared and ready to operate on the network, but it needs its unique identity and operating parameters. When the TFTP request for configuration files is issued, there is a sequence of requests issued in an attempt to register with a call agent and operate. The following sections cover the configuration files.

Installing Cisco IP Phone Firmware and XML Configuration Files

Certain files are necessary for the proper operation of a Cisco IP phone or analog device so that it can register successfully with a Cisco Unified Communications call control device. These files are not installed on the Cisco router and must be installed from an external source. The file types are as follows:

- **Firmware:** The firmware is loaded into flash memory on the IP phone and can survive a reboot.
- **SEP*AAAABBBBCCCC*.cnf.xml:** This XML configuration file is specific to one device, and the *AAAABBBBCCCC* part of the name is the MAC address of the device.
- **XMLDefault.cnf.xml:** This XML configuration file specifies the proper firmware and the call agent's address and port, which the new phone needs to register.

The following sections describe each file type in greater detail.

Firmware

Install the firmware required by the Cisco IP phones in the flash memory of the Cisco Unified Communications Manager Express systems. There are two commands required to provide access to these firmware files:

- **tftp-server flash:*firmware-file-name*:** Use this global command to make the file available.
- **load *phone-type firmware-file*:** Use this telephony-service command to associate a type of phone with a firmware file.

All the necessary firmware files for Cisco IP phones are stored internally in the flash memory of the Cisco Unified Communications Manager Express router, so an external database or file server is not required. During registration, Cisco IP phones use TFTP to download firmware files from the router's flash memory. All Cisco Unified Communications Manager Express configuration and language files are located in the memory of the router in the `system:/its/` directory.

To make the firmware file(s) available through a TFTP server, use the `tftp-server flash:`*`firmware-file-name(s)`* command on the Cisco Unified Communications Manager Express router. The `load` *`phone-type firmware-file`* command under telephony service is also required to associate the model of IP phone with the appropriate firmware file(s).

For Cisco Unified Communications Manager, the firmware files are installed on the server(s) in the cluster that run the TFTP service.

Device Configuration XML File

The XML file `SEP`*`AAAABBBBCCCC`*`.cnf.xml` (where *AAAABBBBCCCC* is the MAC address of the IP phone) contains the call agent IP address and port, firmware, locale, directory URL, and many other pieces of information. This file is present when the IP phone has been added to the configuration.

Listing 7.8 shows a configuration file that contains the phone model (7931), IP address (10.6.150.1), and port (2000) for registering; the firmware filename; the language (English United States); and additional information for proper IP phone operation.

Listing 7.8. SEP*AAAABBBBCCCC*.cnf.xml File (*AAAABBBBCCCC* = the MAC Address)

```
<device>
<versionStamp>{7931 Aug 06 2008 14:23:48}</versionStamp>
```

```
<devicePool>
<dateTimeSetting>
<dateTemplate>M/D/YA</dateTemplate>
<timeZone>Eastern Standard/Daylight Time</timeZone>
</dateTimeSetting>
<callManagerGroup>
<members>
<member  priority="0">
<callManager>
<ports>
<ethernetPhonePort>2000</ethernetPhonePort>
</ports>
<processNodeName>10.6.150.1</processNodeName>
</callManager>
</member>
</members>
</callManagerGroup>
</devicePool>
<commonProfile>
<callLogBlfEnabled>3</callLogBlfEnabled>
</commonProfile>
<loadInformation>SCCP31.8-3-3S</loadInformation>
<userLocale>
<name>English_United_States</name>
<langCode>en</langCode>
</userLocale>
<networkLocale>United_States</networkLocale>
<networkLocaleInfo>
<name>United_States</name>
</networkLocaleInfo>
<idleTimeout>0</idleTimeout>
<authenticationURL>http://10.6.4.2/voiceview/authentication/authenticate.do
  </authenticationURL>
<directoryURL>http://10.6.150.1:80/localdirectory</directoryURL>
<idleURL></idleURL>
<informationURL></informationURL>
<messagesURL></messagesURL>
<proxyServerURL></proxyServerURL>
<servicesURL>http://10.6.150.1:80/CMEserverForPhone/serviceurl</servicesURL>
<capfAuthMode>0</capfAuthMode>
<capfList>
<capf>
<phonePort>3804</phonePort>
<processNodeName></processNodeName>
</capf>
</capfList>
<deviceSecurityMode>1</deviceSecurityMode>
</device>
```

Default XML File

IP phones and devices that do not find the more specific `SEP`*`AAAABBBBCCCC`*`.cnf.xml` file can use the `XMLDefault.cnf.xml` file if they have never registered before and an autoregistration method has been enabled. IP phones that download this XML file through TFTP learn the IP address and port to send Skinny Client Control Protocol (SCCP) messages to when attempting

to register. The IP phones also learn the version of firmware that is required to function properly with the Cisco Unified Communications call control product to which the phone is registering. Cisco IP phone models 7931 and 7961 are highlighted.

Listing 7.9 shows a default configuration file.

Listing 7.9. `XMLDefault.cnf.xml` File

```
<Default>
<callManagerGroup>
<members>
<member  priority="0">
<callManager>
<ports>
<ethernetPhonePort>2000</ethernetPhonePort>
</ports>
<processNodeName>10.6.150.1</processNodeName>
</callManager>
</member>
</members>
</callManagerGroup>
<loadInformation124  model="Cisco IP Phone 7914 14-Button Line Expansion
  Module"></loadInformation124>
<loadInformation227  model="Cisco IP Phone 7915 12-Button Line Expansion
  Module"></loadInformation227>
<loadInformation228  model="Cisco IP Phone 7915 24-Button Line Expansion
  Module"></loadInformation228>
<loadInformation229  model="Cisco IP Phone 7916 12-Button Line Expansion
  Module"></loadInformation229>
<loadInformation230  model="Cisco IP Phone 7916 24-Button Line Expansion
  Module"></loadInformation230>
<loadInformation30008  model="Cisco IP Phone 7902"></loadInformation30008>
<loadInformation20000  model="Cisco IP Phone 7905"></loadInformation20000>
<loadInformation369  model="Cisco IP Phone 7906"></loadInformation369>
<loadInformation6  model="Cisco IP Phone 7910"></loadInformation6>
<loadInformation307  model="Cisco IP Phone 7911"></loadInformation307>
<loadInformation30007  model="Cisco IP Phone 7912"></loadInformation30007>
<loadInformation30002  model="Cisco IP Phone 7920"></loadInformation30002>
<loadInformation365  model="Cisco IP Phone 7921"></loadInformation365>
<loadInformation348  model="Cisco IP Phone 7931">SCCP31.8-3-3S</loadInformation348>
<loadInformation9  model="Cisco IP Conference Station 7935"></loadInformation9>
<loadInformation30019  model="Cisco IP Phone 7936"></loadInformation30019>
<loadInformation431  model="Cisco IP Conference Station 7937"></loadInformation431>
<loadInformation8  model="Cisco IP Phone 7940"></loadInformation8>
<loadInformation115  model="Cisco IP Phone 7941"></loadInformation115>
<loadInformation309  model="Cisco IP Phone 7941GE"></loadInformation309>
<loadInformation434  model="Cisco IP Phone 7942"></loadInformation434>
<loadInformation435  model="Cisco IP Phone 7945"></loadInformation435>
<loadInformation7  model="Cisco IP Phone 7960"></loadInformation7>
<loadInformation30018  model="Cisco IP Phone 7961">SCCP41.8-3-3S</loadInformation30018>
<loadInformation308  model="Cisco IP Phone 7961GE"></loadInformation308>
<loadInformation404  model="Cisco IP Phone 7962"></loadInformation404>
<loadInformation436  model="Cisco IP Phone 7965"></loadInformation436>
<loadInformation30006  model="Cisco IP Phone 7970"></loadInformation30006>
<loadInformation119  model="Cisco IP Phone 7971"></loadInformation119>
```

```
<loadInformation437  model="Cisco IP Phone 7975"></loadInformation437>
<loadInformation302  model="Cisco IP Phone 7985"></loadInformation302>
</Default>
```

Exam Prep Questions

1. What are the reasons for using 802.1Q? (Choose two.)

○	**A.**	Standards based multi-VLAN trunking
○	**B.**	To allow clients to see the 802.1Q header
○	**C.**	To provide inter-VLAN communications over a bridge
○	**D.**	To load-balance traffic between parallel links using STP
○	**E.**	To provide a voice and data VLAN on a shared connection

2. Which of the following describes the endless flooding or looping of frames in a Layer 2 switched environment?

○	**A.**	Flood storm
○	**B.**	Loop overload
○	**C.**	Broadcast storm
○	**D.**	Broadcast overload

3. Which command correctly connects an Ethernet subinterface to VLAN 50 using 802.1Q trunking?

○	**A.**	`Router(config) # encapsulation 50 dot1Q`
○	**B.**	`Router(config) # encapsulation 802.1Q 50`
○	**C.**	`Router(config-if) # encapsulation dot1Q 50`
○	**D.**	`Router(config-if) # encapsulation 50 802.1Q`

4. Which of the following is a Cisco recommendation for IP addressing deployment?

○	**A.**	Statically apply IP addresses to IP phones to ensure stability.
○	**B.**	Apply public IP addresses to IP phones so that they can be reached from the PSTN.
○	**C.**	Add IP phones with DHCP as the mechanism for obtaining IP addresses.
○	**D.**	Deploy IP phones on the same subnet as data devices.

5. Why would you need to implement a DHCP relay server?

○	**A.**	If the DHCP server does not have a local interface on the network with the DHCP clients
○	**B.**	Because the DHCP request and response process is not broadcast
○	**C.**	To relay the proprietary DHCP request of an IP phone to the standard DHCP request understood by the Cisco IOS Software
○	**D.**	If an IP phone, a data device, and a DHCP server all reside on the same subnet

6. Which protocol do IP phones use during registration to download firmware files from the flash memory of the router?

○	**A.**	HTTP
○	**B.**	DHCP
○	**C.**	FTP
○	**D.**	TFTP

7. Which of the following statements accurately describe NTP? (Choose all that apply.)

○	**A.**	NTP is used to synchronize syslog time stamps.
○	**B.**	NTP is used to synchronize call detail records.
○	**C.**	NTP is used to minimize errors during TFTP downloads.
○	**D.**	The time displayed on the IP phones must come from an NTP server.
○	**E.**	Cisco Unified Communications Manager Express can synchronize its clock to an NTP server.
○	**F.**	NTP requires the purchase of an atomic or radio clock.

8. Which of the following filenames could be used by a Cisco IP phone to synchronize its firmware with the call agent? (Choose two.)

○	**A.**	`XMLdefault.cnf.xml`
○	**B.**	`ephone-1.cnf.xml`
○	**C.**	`SEP001BD5086771.cnf.xml`
○	**D.**	`SEP001BB35853C.cnf.xml`
○	**E.**	`XMLDefault.cnf.xml`

9. Which of the following commands would be used to deliver firmware file `SCCP41.8-3-3S.loads` at the request of a Cisco IP phone?

○	**A.**	`ftp-server flash:/SCCP41.8-3-3S.loads`
○	**B.**	`tftp-server flash:/SCCP41.8-3-3S.loads`
○	**C.**	`tftp-server flash:/SCCP41.8-3-3S`
○	**D.**	`tftp-server SCCP41.8-3-3S.loads`

10. DHCP services can be configured on which of the following devices? (Choose two.)

○	**A.**	Cisco IOS routers
○	**B.**	Cisco IP phones
○	**C.**	Cisco IOS Layer 3 switches

○	**D.**	Cisco IOS Layer 2 switches

Answers to Exam Prep Questions

1. **A and E.** 802.1Q is a standards-based trunking protocol and shares a single physical connection for voice and data traffic. End users typically are not permitted to access the network over multiple VLANs, so answer B is incorrect. Answer C is incorrect; VLANs isolate traffic at Layer 2. Multiple VLANs are not used for load balancing because end stations can only access one VLAN at a time, so answer D is incorrect.

2. **C.** Broadcast storm describes the endless flooding of frames in a Layer 2 switched environment. Answers A, B, and D are incorrect. None of those terms have meaning in the Ethernet switch environment.

3. **C.** The `encapsulation` command followed by the *`encapsulation type`* and the *`VLAN number`*. Answers A and B are incorrect; the answers are in global mode, not interface mode. Answer D has the parameters of the encapsulation command backward.

4. **C.** Deploy IP phones using DHCP. Statically applying IP addresses is time consuming and error prone, so answer A is incorrect. Using public IP addresses for phones opens a security threat, so answer B is incorrect. Answer D is incorrect; the goal is to separate voice and data traffic.

5. **A.** No direct connection to the DHCP server. The IP phone DHCP request is a broadcast, so answer B is incorrect. The IP phone uses standard DHCP services, so answer C is incorrect. If the DHCP server is directly attached to the same IP subnet or VLAN, there is no reason to use DHCP relay, so answer D is incorrect.

6. **D.** TFTP is used to provision Cisco IP phones. HTTP, DHCP, and FTP are not used during the automatic provisioning and registration process, so answers B, C, and D are incorrect.

7. **A, B, and E.** NTP is the source for syslog and CDR time stamps, and for Cisco Unified Communications call agent synchronization. NTP is not used during TFTP downloads to minimize errors, so answer C is incorrect. The time displayed on the IP phones comes from the call agent, so answer D is incorrect. There are many free-access NTP servers on the Internet that have atomic clocks and are typically used as NTP sources, so answer F is incorrect.

8. **C and E.** `SEP<`*`12 hex digit MAC address`*`>.cnf.xml` and `XMLDefault.cnf.xml` (case sensitive) are valid files. Answer A is incorrect; file requests are case sensitive and the *d* in default is lowercase. Answer B is an invalid filename and is incorrect. Answer D has only 11 hex digits for the MAC address, not the normal 12, and is incorrect.

9. **B.** The complete filename using the TFTP protocol. FTP service is not supported for firmware upgrades, so answer A is incorrect. The complete filename including extension must be referenced by the `tftp-server` command. The full directory and filename must be defined, not default locations.

10. **A and C.** Layer 3 devices can provide DHCP services. Answer B is incorrect; IP phones cannot provide DHCP services. Answer D is incorrect; Layer 2 devices cannot provide DHCP services.

Suggested Reading and Resources

1. Droms, R. RFC 2131, "Dynamic Host Configuration Protocol." http://www.ietf.org/rfc/rfc2131.txt, March 1997.
2. Mills, David L. RFC 1305, "Network Time Protocol (Version 3) Specification, Implementation and Analysis." http://www.ietf.org/rfc/rfc1305.txt, March 1992.
3. Rekhter, Y., B. Moskowitz, D. Karrenberg, G. J. de Groot, and E. Lear. RFC 1918, "Address Allocation for Private Internets." http://www.ietf.org/rfc/rfc3551.txt, February 1996.
4. IEEE. Information on IEEE 802.1Q and IEEE 802.1af. http://www.ieee.org.