

Using AutoInstall to Remotely Configure Cisco Networking Devices

AutoInstall enables remote, automatic configuration of networking devices. AutoInstall is typically used to set up new networking devices remotely. You can, however, use AutoInstall to configure existing networking devices after you remove the configuration file from their NVRAM. The AutoInstall process uses preexisting configuration files that are stored on a TFTP server.

In this module the term networking device means a router that runs Cisco IOS software. Also, the following terms are used interchangeably:

- initial configuration and startup configuration
- *set up* and *configure*

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Restrictions

- DHCP server should be reachable via management interface, that is Gigabit Ethernet 0.
- Only Management interface Gigabit Ethernet 0 is supported.

  When you configure this feature on Cisco ASR 1000 Series Aggregation Services Routers replace Ethernet interface used in the document with Gigabit Ethernet interface.

Information About Using AutoInstall to Remotely Configure Cisco Networking Devices

Services and Servers Used by AutoInstall Dynamic Assignment of IP Addresses

The network must be able to provide the dynamic assignment of an IP address to the networking device that is being configured with AutoInstall. The type of IP address assignment server that is used depends on the type of connection that the networking that is being configured with AutoInstall has to the network.

AutoInstall uses these types of IP address servers:

DHCP Servers

Networking devices using AutoInstall over a LAN connection require a DHCP server to provide an IP address dynamically. This requirement applies to Fast Ethernet, Token Ring, and FDDI interfaces. The network must be configured to provide IP connectivity between the DHCP server and any devices that are using AutoInstall over LAN connections.

DHCP (defined in RFC 2131) is an extension of the functionality provided by the Bootstrap Protocol (defined in RFC 951). DHCP provides the framework for passing configuration information to hosts on a TCP/IP network. DHCP adds the capability of automatic allocation of reusable network addresses and additional configuration options such as a router (gateway) IP address, a TFTP server IP address, the name of a boot file to load, and the domain name to use. DHCP servers can be configured on routers, UNIX servers, Microsoft Windows-based servers, and other platforms.

DHCP servers typically assign IP addresses from a pool of IP addresses randomly. It is possible for a device that uses DHCP to obtain its IP address to have a different IP address every time it is connected to the network. This creates a problem for the AutoInstall process when you want to ensure that a particular device is assigned a specific hostname during the AutoInstall process. For example, if you are installing routers on different floors in a remote site and each router is supposed to be assigned a name that indicates its location, such as **ChicagoHQ-1st** and **ChicagoHQ-2nd**, you need to ensure that each device gets the IP address that will be mapped to its correct hostname.

The process of ensuring that a device is assigned a specific IP address is referred to as *creating a reservation*. A reservation is a manually configured relationship between an IP address and a physical layer address of a LAN interface on the device. Many Cisco IOS XE-based devices do not use their MAC address when they request an IP address via DHCP. They use a much longer client identifier instead. Due to the complexity of identifying the client identifier so that you can preconfigure a reservation, and the complexity of finding out if the new device uses its MAC address or the client identifier, we recommend that you allow a new device to obtain an IP address without using a DHCP reservation first in order to discover if the device is using its MAC address or a client identifier. When you have learned how the new device is identifying itself to the DHCP server, you can make a note of the format and create a reservation for it. The next time the new device is rebooted it should obtain the IP address that you reserved to ensure that the new device is assigned the correct hostname. Refer to the information on creating DHCP reservations that was provided with your DHCP server software. The process for creating reservations using Cisco IOS XE based DHCP servers is explained in the Using AutoInstall to Set Up Devices Connected to LANs: Example module. This section includes instructions for identifying the client identifier before the device is connected to the network so that you can preconfigure the DHCP reservations.

Note This document uses a Cisco router as the DHCP server for using AutoInstall to configure LAN-connected networking devices. If you are using a different device as your DHCP server ensure that you have the user documentation for it available in the event that you need help configuring it.

Note There are several configuration parameters such as TFTP server addresses, DNS server addresses, domain names and so on, that can be provided to LAN-connected clients by DHCP servers during the process of assigning IP addresses to clients. These parameters are not required by AutoInstall, therefore they are not included in this document. If you know how to use these parameters you can include them in your DHCP server configuration when you are using AutoInstall to setup your networking devices.

For more information on DHCP services visit the IETF RFC site (http://www.ietf.org/rfc.html) and look for RFCs about DHCP. Most server operating systems support DHCP servers. Refer to the documentation that was provided with your operating system for more information.

SLARP Servers

A router that is being configured with AutoInstall over a serial interface using HDLC encapsulation will send a Serial Line ARP (SLARP) request for an IP address over the serial interface that is connected to the staging router.

The serial interface of the staging router must be configured with an IP address in which the host portion is 1 or 2, such as 192.168.10.1 or 192.168.10.2. The staging router will send a SLARP response to the router that is being configured with AutoInstall that contains the value that the staging router is not using. For example, if the interface on the staging router that is connected to the router that is being configured with AutoInstall is using 192.168.10.1 as its IP address, the staging router will send a SLARP response with a value of 192.168.10.2 to the router that is being configured with AutoInstall.

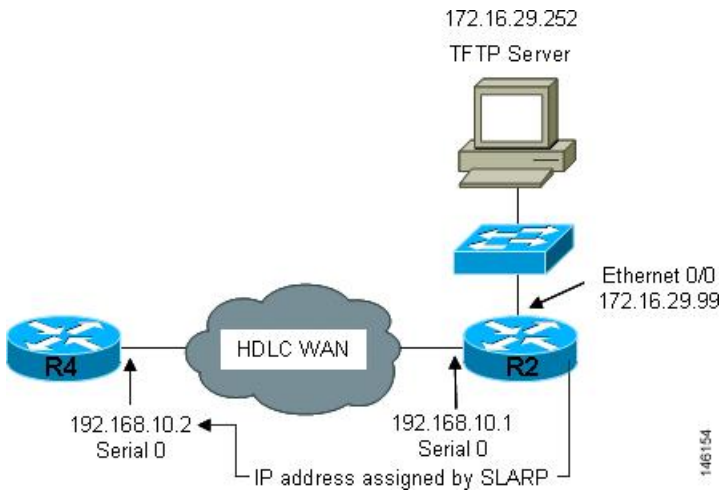
Tip If you are using a mask of 255.255.255.252 on the serial interface of the staging router SLARP will assign the available IP host address to the new device. For example, if you assign IP address 198.162.10.5 255.255.255.252 to serial 0 on the staging router, SLARP will assign 198.162.10.6 to the new device. If you assign IP addresses 198.162.10.6 255.255.255.252 to serial 0 on the staging router SLARP will assign 198.162.10.5 to the new device.

The figure below shows an example of SLARP.

In the figure below, the IP address of serial interface 0 on the staging router (R2) is 192.168.10.1. SLARP therefore assigns the IP address 192.168.10.2 to serial interface 0 on the new device.

Note Replace Ethernet interface used in this figure with Gigabit Ethernet interface, if you plan to use this topology on Cisco ASR 1000 Series Aggregation Services Routers.

Figure 1: Using SLARP to Assign an IP Address to a New Device



Note AutoInstall over a serial interface using HDLC can be performed only over the first serial port on a new device (serial interface 0 or serial interface x/0). The staging router and new device must be directly connected using the first serial interface port on the new device; for example, serial 0/0 or if the first serial port is in the second slot of the device, serial 2/0.

Tip The IP address that is assigned to the router that is being configured with AutoInstall by SLARP from the staging router is the IP address that you must use in the **ip host** *hostname ip-address*command in the AutoInstall network-confg or cisconet.cfg file to ensure that the router that is being configured with AutoInstall is assigned the correct hostname so that it can request its host-specific configuration file.

BOOTP Servers

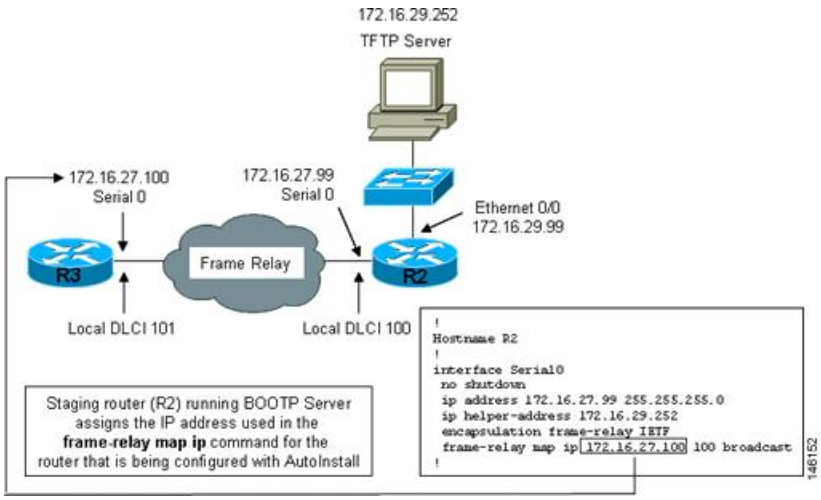
A router that is being configured with AutoInstall over a serial interface using Frame Relay encapsulation will send a BOOTP request for an IP address over the serial interface that is connected to the staging router.

The staging router learns the correct IP address to provide in its BOOTP response to the router that is being configured with AutoInstall by examining the **frame-relay map ip** *ip-address dlci* command that is configured on the interface that it is using to connect to the router that is being configured with AutoInstall.

In the figure below R2 is the staging router. R2 has the **frame-relay map ip 172.16.27.100 100** broadcast command configured on interface serial 0. When R2 receives the BOOTP request for an IP address from R3 during the AutoInstall process, R3 will reply with 172.16.27.100.

Note Replace Ethernet interface used in this figure with Gigabit Ethernet interface, if you plan to use this topology on Cisco ASR 1000 Series Aggregation Services Routers.

Figure 2: Example of Using BOOTP for Autoinstall Over a Frame Relay Network



Tip The limitation imposed by SLARP in which the IP addresses for the new device and the staging router must end in either .1 or .2 does not apply to BOOTP. BOOTP for AutoInstall over Frame Relay supports all host addresses for the IP address subnet that is assigned to the Frame Relay circuit between the router that is being configured with AutoInstall and the staging router.

Tip The IP address that is assigned to the router that is being configured with AutoInstall by BOOTP from the staging router is the IP address that you must use in the **ip host** *hostname ip-address*command in the AutoInstall network-confg or cisconet.cfg file to ensure that the router that is being configured with AutoInstall is assigned the correct hostname so that it can request its host-specific configuration file.

Note AutoInstall over a serial interface using Frame Relay encapsulation can be performed only over the first serial port on a new device (serial interface 0 or serial interface x/0). The staging router and new device must be directly connected using the first serial interface port on the new device; for example, serial 0/0 or if the first serial port is in the second slot of the device, serial 2/0.

Services and Servers Used by AutoInstall IP-to-Hostname Mapping

If you want the networking device to load a full configuration file during the AutoInstall process, the networking device must be able to determine its hostname so that it can request the configuration file that you created specifically for it.

The following caveats apply to the provisioning of IP address to hostname mapping for AutoInstall:

- Any networking device that is being configured with AutoInstall can determine its hostname by loading one of the AutoInstall network configuration files (network-confg or cisconet.cfg) from the TFTP server that contain the **iphost***hostnameip-address* commands. For example, to map host R3 to IP address 198.162.100.3, the network-confg or cisconet.cfg file must contain the **iphostr3198.162.100.3** command.

- A networking device that is being configured with AutoInstall over a LAN interface can also determine its hostname by querying a DNS server. If the DNS server is not connected to the same LAN the device must learn the IP address of the DNS server from the DHCP server during the process of obtaining its dynamically assigned IP address from the DHCP server.

DNS Servers

DNS servers are used to provide a network service that maps hostnames to IP addresses and IP addresses to hostnames (reverse DNS lookups). Anytime that you use a hostname to initiate an IP connection to a host, your PC must determine the IP address that is assigned to the hostname that you want to contact. For example, when you visit Cisco's website (http://www.cisco.com/) your PC sends a DNS query to a DNS server to discover the current IP address that can be used to contact Cisco's website.

For more information on DNS services visit the IETF RFC site (http://www.ietf.org/rfc.html) and look for RFCs about DNS. The Name Server LookUp tool (nslookup) is very useful for learning more about DNS. There are several excellent websites available about nslookup that you can find by searching for them.

Services and Servers Used by AutoInstall Storage and Transmission of Configuration Files

TFTP is a protocol used to transfer files between devices on a network. A TFTP server is a device that uses TFTP to transfer files to devices. TFTP servers can be configured on UNIX servers, Microsoft Windows-based PCs and servers, and other platforms.



Tip If you do not have a TFTP server available you can configure a Cisco IOS-based router as a TFTP server using the **tftp-serverfile-system**:*filename* command. Refer to the Configuring Basic File Transfer Services feature for more information on configuring your router as a TFTP server.

Cisco routers use TFTP to load the configuration files that are required for AutoInstall. You must have a TFTP server deployed in your network to provide file storage and file transmission services to the devices that will be using AutoInstall.

For more information on TFTP services visit the IETF RFC site (http://www.ietf.org/rfc.html) and look for RFCs about TFTP. There are several excellent websites available about TFTP that you can find by searching for them. Several freeware and shareware versions of TFTP servers for various operating systems and hardware platforms are available from the Internet.

The following caveats apply to the provisioning of TFTP servers for AutoInstall:

- Devices using AutoInstall over a LAN--If the TFTP server and the devices using AutoInstall are on different LAN segments, you must either configure the **iphelper-address** *address* command on all of the interfaces that will receive TFTP session initialization requests from the devices that are using AutoInstall.
- Devices using AutoInstall over a WAN--If the devices using AutoInstall are connected to a WAN, you must configure the **iphelper-address** *address* command on all of the interfaces that will receive TFTP session initialization requests from devices that are using AutoInstall.

ip helper-address

If the new device does not learn the IP address of the TFTP server via DHCP option 150, it will transmit the TFTP session initialization requests as network layer broadcasts using the IP destination broadcast address of 255.255.255.255. Routers block network layer broadcast datagrams which prevents the TFTP session initialization requests from reaching the TFTP server, and AutoInstall will fail. The solution to this problem is to use the **ip helper-address** *address* command. The **ip helper-address** *address* command changes the broadcast address of TFTP session initialization request from 255.255.255.255 to the address that is configured with the *address* argument. For example, the **ip helper-address 172.16.29.252** command will change IP destination broadcast address of 255.255.255.255 to 172.16.29.252.

Networking Devices Used by AutoInstall

Device That Is Being Configured with AutoInstall

A device that is being configured with AutoInstall can be any Cisco IOS XE-based router that supports AutoInstall and does not have a configuration file in its NVRAM.

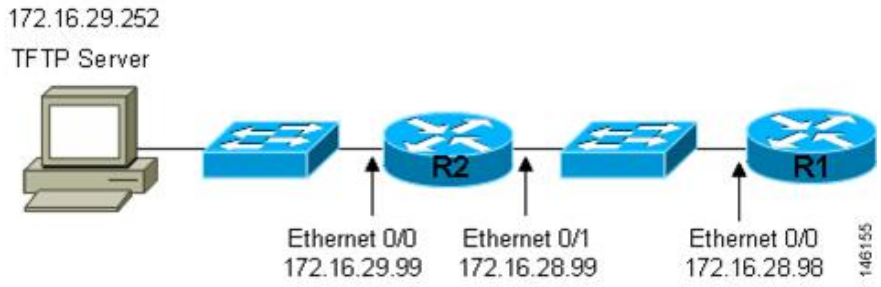
Staging Router

A staging router acts as an intermediary between the TFTP server (to which it must have IP connectivity) and a device that is being configured with AutoInstall when the new device and the TFTP server are connected to different networks. In the figure below R1 requires a staging router because it is connected to a different LAN segment than the TFTP server.

Staging routers are required in the following situations:

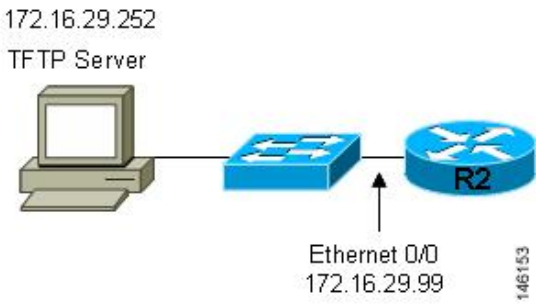
- Devices using AutoInstall over a LAN--If the TFTP and/or DHCP servers and the devices using AutoInstall are on different LAN segments you must use a staging router.
- Devices using AutoInstall over a WAN--If the devices using AutoInstall are connected to a WAN, you must configure the **ip helper-address** *address* command on all of the directly connected interfaces that will receive TFTP session initialization requests from the devices that are using AutoInstall.

Figure 3: Example of AutoInstall That Requires a Staging Router



Staging routers are not required when the new device that is being configured with AutoInstall is connected to the same LAN segment as the TFTP and DHCP servers. In the figure below R2 does not require a staging server to use AutoInstall because it is on the same LAN segment as the TFTP server.

Figure 4: Example of AutoInstall That Does Not Require a Staging Router



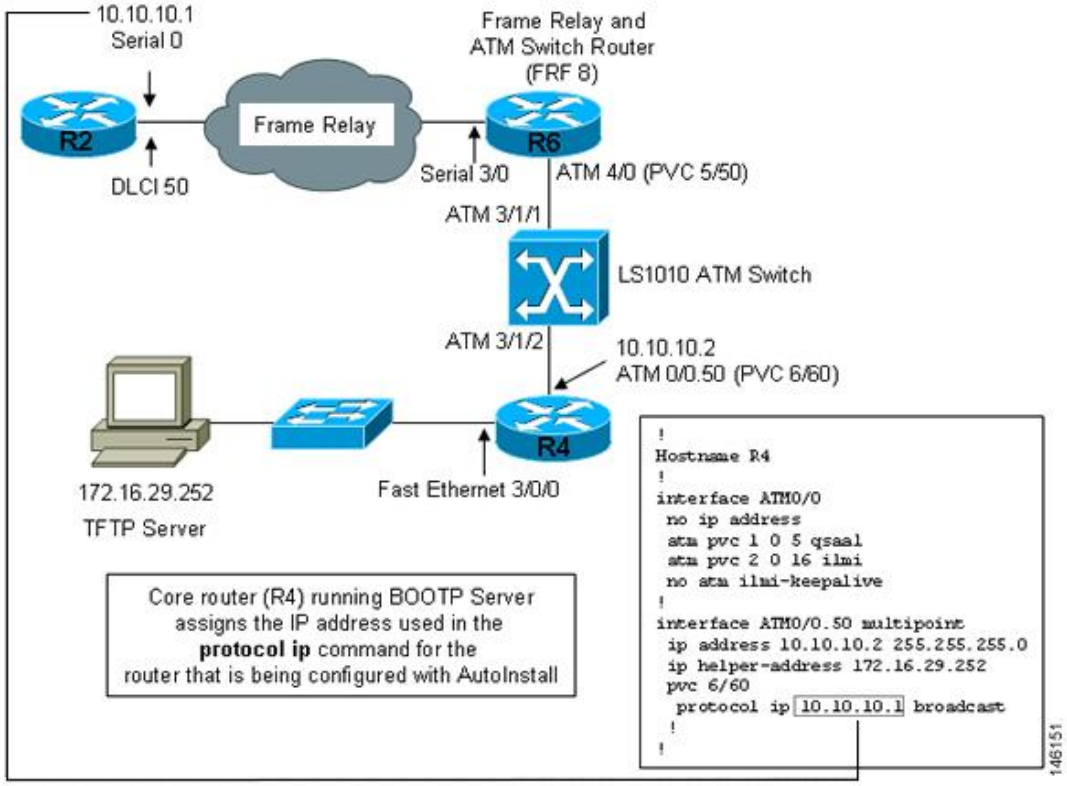
Intermediate Frame Relay-ATM Switching Device

An intermediate Frame Relay-ATM switching device is one that can perform both routing and switching operations. Frame Relay-ATM switching devices are used to connect Frame Relay and ATM networks.

The AutoInstall over Frame Relay-ATM Interworking Connections feature modifies the AutoInstall process to use Frame Relay encapsulation defined by the IETF standard instead of the Frame Relay encapsulation defined by Cisco.

The figure below shows an example topology using AutoInstall over Frame Relay-ATM Interworking Connections. Router R6 does the Frame Relay to ATM Service Internetworking (FRF8) conversion for Frame Relay DLCI 50 to ATM VPI/VCI 5/50. The LS1010 switch routes the VPI/VCI combination used by R6 (5/50) to the VPI/VCI combination used by R4 (6/60).

Figure 5: Example Topology for AutoInstall over Frame Relay-ATM Interworking Connections



Configuration Options for AutoInstall

You can provision your network to support AutoInstall using several different combinations of devices and services. For example:

- You can provision all of the services required for AutoInstall (except dynamic IP address assignment using SLARP or BOOTP that must be preformed by a Cisco router) on one network server, or you can provision each service on a different network server.
- You can provision the DHCP service on a Cisco router.
- The device using AutoInstall can determine its IP address from a DNS server, or you can use one of the AutoInstall network configuration files (network-confg or cisconet.cfg) that contain the **ip host** *hostname ip-address* commands.
- You can use provision AutoInstall to load a full configuration or a partial configuration onto a device that is using AutoInstall.

This module focuses on some of the most common methods for provisioning AutoInstall. Refer to the How to Use AutoInstall to Remotely Configure Cisco Networking Devices module for information on the most common methods for provisioning AutoInstall.

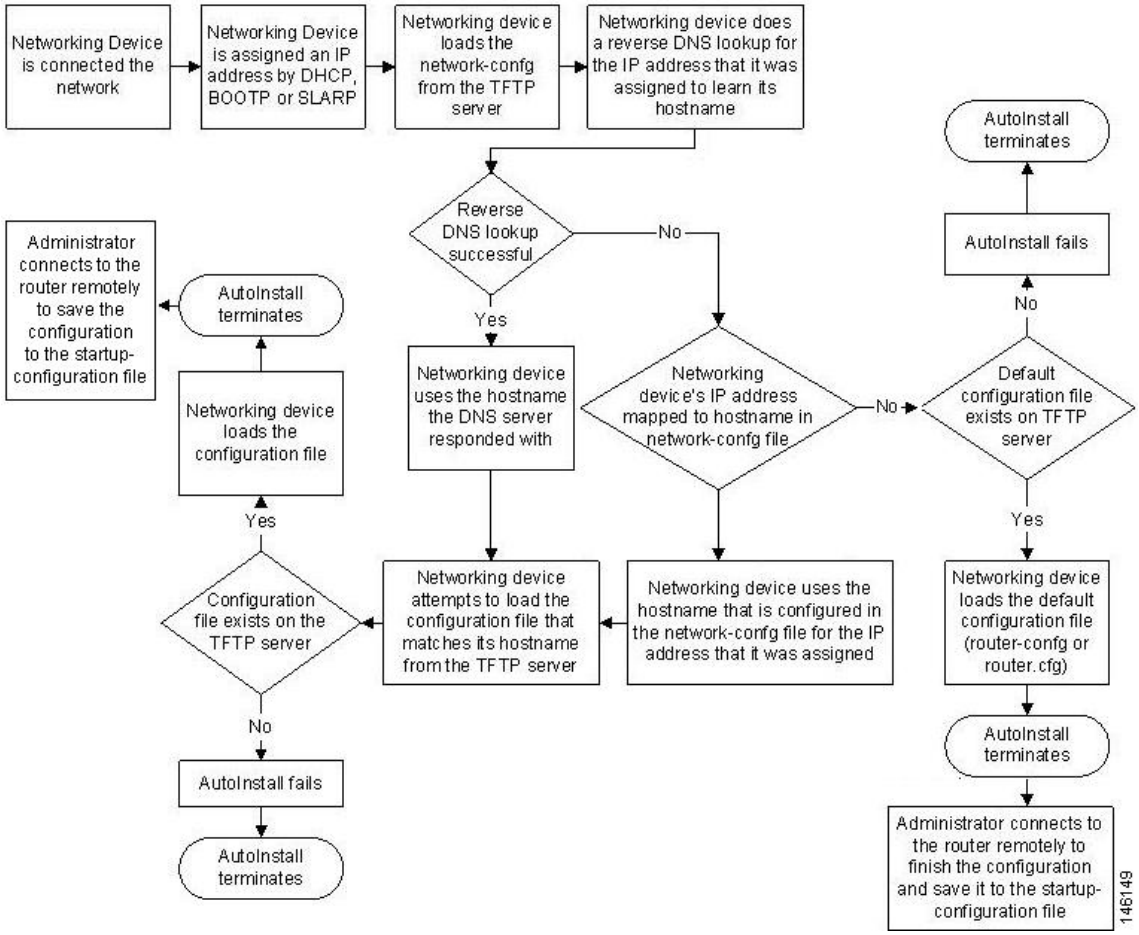
The AutoInstall Process

The AutoInstall process begins when a networking device that does not have any files in its NVRAM is connected to the network.

Timesaver You can decrease the time that the AutoInstall process takes to complete by only connecting the interface on the networking device that you want to use for AutoInstall until the AutoInstall process has finished. For example, if you want the networking device to perform AutoInstall over a WAN interface and you connect its LAN interfaces and its WAN interfaces the networking device will attempt to perform AutoInstall over the LAN interfaces before it attempts to use the WAN interfaces. Leaving the LAN interfaces disconnected until the AutoInstall process is finished causes the networking device to initiate the AutoInstall process over its WAN interface immediately.

The following figure shows the basic flow of the AutoInstall process using the configuration files.

Figure 6: AutoInstall Process Flowchart (Using Configuration Files)



How to Use AutoInstall to Remotely Configure Cisco Networking Devices

This section describes the how to prepare a router for AutoInstall. Additional examples for using AutoInstall for new routers connected to LANs, HDLC WANs, and Frame Relay networks, are provided in the Configuration Examples for Using AutoInstall to Remotely Configure Cisco Networking Devices module.

In most cases you need to configure a staging router through which a new device running AutoInstall sends TFTP, BOOTP, and DNS requests.

Tip In all cases, you must verify and save the configuration on the networking device after the AutoInstall process is complete. If you do not save the configuration, you must repeat the entire process.

Disabling the SDM Default Configuration File

Perform this task if SDM was preinstalled on your device and you want to use Setup to build an initial configuration file. SDM remains on the device.

Perform this task if SDM was pre installed on your device and you want to use AutoInstall to configure the device instead. SDM remains on the device.

SUMMARY STEPS

1. Connect the console cable, shipped with your device, from the console port on the device to a serial port on your PC. Refer to the hardware installation guide for the device for instructions.
2. Connect the power supply to the device, plug the power supply into a power outlet, and turn on the device. Refer to the quick start guide for the device for instructions.
3. Use Hyperterminal or a similar terminal emulation program on your PC, with the following terminal emulation settings, to connect to the device:
4. **enable**
5. **erase startup-config**
6. **reload**

DETAILED STEPS

Procedure

Step 1 Connect the console cable, shipped with your device, from the console port on the device to a serial port on your PC. Refer to the hardware installation guide for the device for instructions.

Step 2 Connect the power supply to the device, plug the power supply into a power outlet, and turn on the device. Refer to the quick start guide for the device for instructions.

Step 3 Use Hyperterminal or a similar terminal emulation program on your PC, with the following terminal emulation settings, to connect to the device:

- 9600 baud
- 8 data bits, no parity, 1 stop bit
- No flow control

Step 4 **enable**

Enter privileged EXEC mode.

enable

Example:

```
Router> enable
Router#
```

Step 5 **erase startup-config**

Erases the existing configuration in NVRAM.

Example:

```
Router# erase startup-config
```

Step 6 **reload**

Initiates the reload process. The router will initiate the AutoInstall process after it finishes the reload process.

Example:

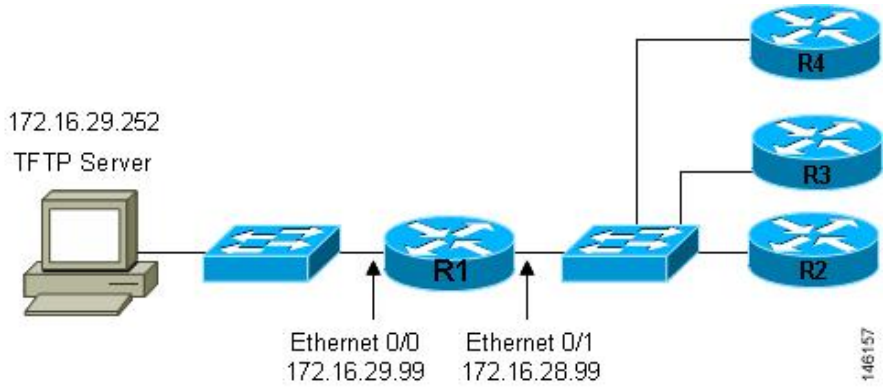
```
Router# reload
```

Configuration Examples for Using AutoInstall to Remotely Configure Cisco Networking Devices

Using AutoInstall to Set Up Devices Connected to LANs Example

This task uses the network in the figure below. This task will show how to use AutoInstall to setup routers R2, R3, and R4. Router R1 is the DHCP server that will be used to assign the IP address for Fast Ethernet 0/0 on the new routers during the AutoInstall process.

Figure 7: Network Topology for Assigning AutoInstall Configuration Files For Specific Devices



Every DHCP client has a unique DHCP client identifier. The DHCP client identifier is used by DHCP servers to keep track of IP address leases and for configuring IP address reservations. You need to know the DHCP client identifier for each of the networking devices that you want to configure with AutoInstall so that you can configure the DHCP IP address reservations which will ensure that each device is provided with the correct IP address, and subsequently its unique configuration file. You can determine the DHCP client identifier manually or automatically.

To use AutoInstall to setup routers R2, R3, and R4, perform following tasks:

Determining the Value for the DHCP Client Identifier Manually

If you want to determine the value for the client identifiers automatically, you do not need to perform this task. Proceed to the Determining the Value for the DHCP Client Identifier Automatically module.

You must know the MAC address of the Fast Ethernet interface that will be used to connect the router to the LAN during the AutoInstall process to determine the client identifier manually. This requires connecting a terminal to the router, and powering it on, so that you can enter the **show interface** *interface-type interface-number* command.

The client-identifier looks like this:

0063.6973.636f.2d30.3030.362e.3533.6237.2e38.6537.312d.4661.332f.30

The format is *nullcisco-0006.53b7.8e71-fa3/0* where *0006.53b7.8e71* is the MAC address and *fa3/0* is the short interface name for the interface that the IP address request is made for.

The values for the short-if-name field can be obtained from an SNMP workstation with the Cisco MIBs installed. This is an example of how to map ifIndex to an interface on Cisco IOS:

```
snmpwalk -c public ponch ifName
IF-MIB::ifName.1 = STRING: AT2/0
IF-MIB::ifName.2 = STRING: Et0/0
IF-MIB::ifName.3 = STRING: Se0/0
IF-MIB::ifName.4 = STRING: BR0/0
```

Use the **show interface** *interface-type interface-number* command to display the information and statistics for a Fast Ethernet interface.

```
R6> show interface fastethernet 3/0
FastEthernet3/0 is up, line protocol is up
  Hardware is AmdFE, address is 0006.53b7.8e71 (bia 0006.53b7.8e71)
```

```
.
.
.
R6>
```

The MAC address for FastEthernet 3/0 on R6 is 0006.53b7.8e71. The format of the client identifier for this interface is nullcisco-0006.53b7.8e71-fa3/0.

Note The short interface name for Fast Ethernet interfaces is fa.

The table below shows the values for converting characters to their hexadecimal equivalents. The last row in the second table below shows the client identifier for Fast Ethernet 3/0 on R6 (nullcisco-0006.53b7.8e71-fa3/0).

Table 1: Hexadecimal to Character Conversion Chart

Hex	Char	Hex	Char	Hex	Char	Hex	Char	Hex	Char
00	NUL	1a	SUB	34	4	4e	N	68	h
01	SOH	1b	ESC	35	5	4f	O	69	I
02	STX	1c	FS	36	6	50	P	6a	j
03	ETX	1d	GS	37	7	51	Q	6b	k
04	EOT	1e	RS	38	8	52	R	6c	l
05	ENQ	1f	US	39	9	53	S	6d	m
06	ACK	20		3a	:	54	T	6e	n
07	BEL	21	!	3b	;	55	U	6f	o
08	BS	22	"	3c	<	56	V	70	p
09	TAB	23	#	3d	=	57	W	71	q
0A	LF	24	$	3e	>	58	X	72	r
0B	VT	25	%	3f	?	59	Y	73	s
0C	FF	26	&	40	@	5a	Z	74	t
0D	CR	27	‘	41	A	5b	[	75	u
0E	SO	28	(	42	B	5c	\	76	v
0F	SI	29	)	43	C	5d	]	77	w
10	DLE	2a	*	44	D	5e	^	78	x
11	DC1	2b	+	45	E	5f	_	79	y
12	DC2	2c	,	46	F	60	`	7a	z

Hex	Char	Hex	Char	Hex	Char	Hex	Char	Hex	Char
13	DC3	2d	-	47	G	61	a	7b	{
14	DC4	2e	.	48	H	62	b	7c	|
15	NAK	2f	/	49	I	63	c	7D	}
16	SYN	30	0	4a	J	64	d	7e	~
17	ETB	31	1	4b	K	65	e	7f	D
18	CAN	32	2	4c	L	66	f		
19	EM	33	3	4d	M	67	g		

Table 2: Conversion of nullcisco-0006.53b7.8e71-fa3/0 To A Client Identifier

00	c	i	s	c	o	-	0	0	0	6	.	5	3	b	7	.	8	e	7	1	-	f	a	3	/	0
00	63	69	73	63	6f	2d	30	30	30	36	2e	35	33	62	37	2e	38	65	37	31	2d	46	61	33	2f	30

R4

Use the **show interface** *interface-type interface-number* command to display the information and statistics for Fast Ethernet 0/0 on R4.

```
R4> show interface FastEthernet 0/0
FastEthernet0 is up, line protocol is up
  Hardware is Lance, address is 00e0.1eb8.eb0e (bia 00e0.1eb8.eb0e)
```

The MAC address for Fast Ethernet 0/0 on R4 is 00e0.1eb8.eb0e. The format of the client identifier for this interface is nullcisco-00e0.1eb8.eb0e-et0.

Note The short interface name for Fast Ethernet interfaces is et.

Using the values for converting characters to their hexadecimal equivalents in the first table above, the client identifier for Fast Ethernet 0/0 on R4 is shown in the last row of the table below.

Table 3: Conversion of null.cisco-00e0.1eb8.eb0e-et0 To A Client Identifier for R4

00	c	i	s	c	o	-	0	0	e	0	.	1	e	b	8	.	e	b	0	e	-	e	t	0
00	63	69	73	63	6f	2d	30	30	65	30	2e	31	65	62	38	2e	65	62	30	65	2d	45	74	30

R3

Use the **show interface** *interface-type interface-number* command to display the information and statistics for Fast Ethernet 0/0 on R3.

```
R3> show interface FastEthernet 0/0
```

```
FastEthernet0 is up, line protocol is up
  Hardware is Lance, address is 00e0.1eb8.eb73 (bia 00e0.1eb8.eb73)
```

The MAC address for Fast Ethernet 0/0 on R3 is 00e0.1eb8.eb73. The format of the client identifier for this interface is: nullcisco-00e0.1eb8.eb73-et0.

Using the values for converting characters to their hexadecimal equivalents in the first table above, the client identifier for Fast Ethernet 0/0 on R3 is shown in the last row of the table below.

Table 4: Conversion of null.cisco-00e0.1eb8.eb73-et0 To A Client Identifier for R3

00	c	i	s	c	o	-	0	0	e	0	.	1	e	b	8	.	e	b	7	3	-	e	t	0
00	63	69	73	63	6f	2d	30	30	65	30	2e	31	65	62	38	2e	65	62	37	33	2d	45	74	30

R2

Use the **show interface** *interface-type interface-number* command to display the information and statistics for Fast Ethernet 0/0 on R2.

```
R2> show interface Fast Ethernet 0/0
FastEthernet0/0 is up, line protocol is up
  Hardware is Lance, address is 00e0.1eb8.eb09 (bia 00e0.1eb8.eb09)
```

The MAC address for Fast Ethernet 0/0 on R2 is 00e0.1eb8.eb09. The format of the client identifier for this interface is nullcisco-00e0.1eb8.eb09-et0.

Using the values for converting characters to their hexadecimal equivalents in the first table above, the client identifier for Fast Ethernet 0/0 on R2 is shown in the last row of the table below

Table 5: Conversion of null.cisco-00e0.1eb8.eb09-et0 To A Client Identifier for R2

00	c	i	s	c	o	-	0	0	e	0	.	1	e	b	8	.	e	b	0	9	-	e	t	0
00	63	69	73	63	6f	2d	30	30	65	30	2e	31	65	62	38	2e	65	62	30	39	2d	45	74	30

You have now determined the values for the client identifiers on each router. The final step is to add a period after each group of four characters working from the left to the right as shown below:

- R4-0063.6973.636f.2d30.3065.302e.3165.6238.2e65.6230.652d.4574.30
- R3-0063.6973.636f.2d30.3065.302e.3165.6238.2e65.6237.332d.4574.30
- R2-0063.6973.636f.2d30.3065.302e.3165.6238.2e65.6230.392d.4574.30

Determining the Value for the DHCP Client Identifier Automatically

If you determined the value for the client identifiers manually, you do not need to perform this task. Proceed to the Creating a Private DHCP Pool for Each of The Routers module.

This task will create a DHCP server on R1 that will provide only one IP address. This IP address will used by each new router in sequence while you determine the value of the router's client identifier. By limiting the IP address scope to a single IP address you avoid any possible confusion about which router you are working on. If somebody powers up another router that attempts to start the AutoInstall process, it will not be able to obtain an IP address.



Tip Do not place the network-confg or router configuration files (r4-confg, r3-confg, or r2-confg) in the root directory of the TFTP server yet. You do not want any of the routers to load these files until you have ensured that each router will obtain the correct IP address from the DHCP server so that the router will load the correct configuration file.

This task is broken down into sub-tasks to make it easier to follow (all sub-tasks are required):

Configuring IP on the Interfaces on R1

Configure IP addresses on the Fast Ethernet interfaces. Configure the **ip helper-address** *ip-address* command on Fast Ethernet 0/1.

```
!
interface FastEthernet0/0
 ip address 172.16.29.99 255.255.255.0
!
interface FastEthernet0/1
 ip address 172.16.28.99 255.255.255.0
 ip helper-address 172.16.29.252
!
```

Configuring a DHCP Pool on R1

Configure these commands to setup the temporary DHCP server on R1.



Note This should be the only DHCP server in operation on R1. This should be the only DHCP server that is accessible by the routers that you will be using AutoInstall to setup.

```
ip dhcp excluded-address vrf Mgmt-intf 172.16.28.1 172.16.28.10
ip dhcp pool DHCP_Pool
vrf Mgmt-intf
network 172.16.28.0 255.255.255.0
bootfile ASR-Bootup.cfg
option 150 ip 1.1.1.1
default-router 172.16.28.1
```

Excluding All But One of the IP Addresses from the DHCP Pool on R1

You need to ensure that there is only one IP address available from the DHCP server at any time. Configure the following command to exclude every IP address except 172.16.28.1 from the DHCP pool.

```
!
ip dhcp excluded-address 172.16.28.2 172.16.28.255
!
```

Verifying The Configuration on R1

Verify that the configuration file for R1 has a DHCP server pool configured to provide a single IP address (172.16.28.1) to a DHCP client.

Verify that the configuration file has the IP addresses for the Fast Ethernet interfaces and the **ip helper-address** *ip-address* command.

```
!
ip dhcp excluded-address 172.16.28.2 172.16.28.255
!
ip dhcp pool get-client-id
   network 172.16.28.0 255.255.255.0
!
interface FastEthernet0/0
 ip address 172.16.29.99 255.255.255.0
!
interface FastEthernet0/1
 ip address 172.16.28.99 255.255.255.0
 ip helper-address 172.16.29.252
!
```

Enabling debug ip dhcp server events on R1

You use the display output from the **debug ip dhcp server events** command on the terminal connected to R1 to identify the value of the client identifier for each router.

Enable the **debug ip dhcp server events** command on R1.

```
R1# debug ip dhcp server events
```

Identifying the Value for the Client Identifier on Each of the Routers

This step is repeated for each of the routers. You should only have one of the routers powered-on at any time. When you have identified the value of the client identifier field for the router, you will turn the router off and proceed to the next router.

R4

Connect R4 to the Fast Ethernet network and power it on. The following message will be displayed on the terminal connected to R1 when R4 is assigned the IP address 172.16.28.1.

```
DHCPD: assigned IP address 172.16.28.1 to client
0063.6973.636f.2d30.3065.302e.3165.6238.2e65.6230.652d.4574.30.
```

Copy the client identifier 0063.6973.636f.2d30.3065.302e.3165.6238.2e65.6230.652d.4574.30 to a text file and save it. Keep the text file open for the next two routers.

Turn off R4

Release the IP address binding for R4 from the DHCP pool on R1 using the **clear ip dhcp binding *** command on R1.

```
R1# clear ip dhcp binding *
R1#
01:16:11: DHCPD: returned 172.16.28.1 to address pool get-client-id.
```

R3

Connect R3 to the Fast Ethernet network and power it on. The following message will be displayed on the terminal connected to R1 when R3 is assigned the IP address 172.16.28.1.

```
DHCPD: assigned IP address 172.16.28.1 to client
0063.6973.636f.2d30.3065.302e.3165.6238.2e65.6237.332d.4574.30.
```

Copy the client identifier 0063.6973.636f.2d30.3065.302e.3165.6238.2e65.6237.332d.4574.30 to the text file and save it. Keep the text file open for the final router.

Turn off R3.

Release the IP address binding for R3 from the DHCP pool on R1 using the **clear ip dhcp binding *** command on R1.

```
R1# clear ip dhcp binding *
R1#
01:16:11: DHCPD: returned 172.16.28.1 to address pool get-client-id.
```

R2

Connect R2 to the Fast Ethernet network and power it on. The following message will be displayed on the terminal connected to R1 when R2 is assigned the IP address 172.16.28.1.

```
DHCPD: assigned IP address 172.16.28.1 to client
0063.6973.636f.2d30.3065.302e.3165.6238.2e65.6230.392d.4574.30.
```

Copy the client identifier 0063.6973.636f.2d30.3065.302e.3165.6238.2e65.6230.392d.4574.30 to the text file and save it.

Turn off R2

Release the IP address binding for R2 from the DHCP pool on R1 using the **clear ip dhcp binding *** command on R1.

```
R1# clear ip dhcp binding *
R1#
01:16:11: DHCPD: returned 172.16.28.1 to address pool get-client-id.
```

Client Identifiers for R4, R3, and R2

You have determined the values for the client identifiers on each router.

- R4-0063.6973.636f.2d30.3065.302e.3165.6238.2e65.6230.652d.4574.30
- R3-0063.6973.636f.2d30.3065.302e.3165.6238.2e65.6237.332d.4574.30
- R2-0063.6973.636f.2d30.3065.302e.3165.6238.2e65.6230.392d.4574.30

Removing the DHCP Pool on R1 for Network 172.16.28.0 24

The temporary DHCP pool on the router is no longer required, and must be removed.

```
R1(config)# no ip dhcp pool get-client-id
```

Removing the Excluded Address Range From R1

The command for excluding all of the IP addresses except 172.16.28.1 from the DHCP pool on the router is no longer required, and must be removed.

R1(config)# **no ip dhcp excluded-address 172.16.28.2 172.16.28.255**

Creating a Private DHCP Pool for Each of The Routers

You need to create the private DHCP address pools for each router to ensure that each router is assigned the IP address that maps to its host name in the network-conf file.

```
!
ip dhcp pool r4
   host 172.16.28.100 255.255.255.0
   client-identifier 0063.6973.636f.2d30.3065.302e.3165.6238.2e65.6230.652d.4574.30
!
ip dhcp pool r3
   host 172.16.28.101 255.255.255.0
   client-identifier 0063.6973.636f.2d30.3065.302e.3165.6238.2e65.6237.332d.4574.30
!
ip dhcp pool r2
   host 172.16.28.102 255.255.255.0
   client-identifier 0063.6973.636f.2d30.3065.302e.3165.6238.2e65.6230.392d.4574.30
```

Creating Configuration Files for Each Router

Create the configuration files for each router and place them in the root directory of the TFTP server.

Tip You must include the commands for configuring passwords for remote Telnet access and access to privileged EXEC mode if you are going to access the routers remotely to save their configuration files to NVRAM.

r2-confg

```
!
hostname R2
!
enable secret 7gD2A0
!
interface FastEthernet0/0
 ip address 172.16.28.102 255.255.255.0
!
interface Serial0/0
 ip address 192.168.100.1 255.255.255.252
 no shutdown
!
interface Serial0/1
 ip address 192.168.100.5 255.255.255.252
 no shutdown
!
no ip http server
ip classless
ip default-network 0.0.0.0
ip route 0.0.0.0 0.0.0.0 FastEthernet0/0
!
line vty 0 4
 password 5Rf1k9
 login
!
end
```

r3-confg

```
!
hostname R3
!
enable secret 7gD2A0
!
interface FastEthernet0/0
 ip address 172.16.28.101 255.255.255.0
!
interface Serial0/0
 ip address 192.168.100.9 255.255.255.252
 no shutdown
!
interface Serial0/1
 ip address 192.168.100.13 255.255.255.252
 no shutdown
!
no ip http server
ip classless
ip default-network 0.0.0.0
ip route 0.0.0.0 0.0.0.0 FastEthernet0
!
line vty 0 4
 password 5Rf1k9
 login
!
end
```

r4-confg

```
!
hostname R3
!
enable secret 7gD2A0
!
interface FastEthernet0/0
 ip address 172.16.28.101 255.255.255.0
!
interface Serial0/0
 ip address 192.168.100.9 255.255.255.252
 no shutdown
!
interface Serial0/1
 ip address 192.168.100.13 255.255.255.252
 no shutdown
!
no ip http server
ip classless
ip default-network 0.0.0.0
ip route 0.0.0.0 0.0.0.0 FastEthernet0/0
!
line vty 0 4
 password 5Rf1k9
 login
!
end
```

Creating the network-confg file

Create the network-confg file with the **ip host** *hostname ip-address* commands that map the IP addresses that you will be assigning with the DHCP server to the hostname.

```
ip host r4 172.16.28.100
ip host r3 172.16.28.101
ip host r2 172.16.28.102
```

Setting Up the Routers with AutoInstall

You are now ready to set up the three routers (R4, R3, and R2) using AutoInstall.

Connect a terminal to the routers if you want to monitor the progress of AutoInstall. Use Hyperterminal or a similar terminal emulation program on your PC, with the following terminal emulation settings, to connect to the device:

- 9600 baud
- 8 data bits, no parity, 1 stop bit
- No flow control

You should have the following files in the root directory of the TFTP server.

- network-confg
- r4-confg
- r3-confg
- r2-confg

The TFTP server must be running.

Power on each router.



Timesaver You can set up all three routers concurrently.

R4

The following is an excerpt of the messages that are displayed on R4's console terminal during the AutoInstall process:

```
Loading network-confg from 172.16.29.252 (via FastEthernet0/0): !
[OK - 76 bytes]
Configuration mapped ip address 172.16.28.100 to r4
Loading r4-confg from 172.16.29.252 (via FastEthernet0/0): !
[OK - 687 bytes]
```

R3

The following is an excerpt of the messages that are displayed on R3's console terminal during the AutoInstall process:

```
Loading network-confg from 172.16.29.252 (via FastEthernet0/0): !
[OK - 76 bytes]
Configuration mapped ip address 172.16.28.101 to r3
Loading r3-confg from 172.16.29.252 (via FastEthernet0/0): !
[OK - 687 bytes]
```

R2

The following is an excerpt of the messages that are displayed on R2's console terminal during the AutoInstall process:

```
Loading network-confg from 172.16.29.252 (via FastEthernet0/0): !
[OK - 76 bytes]
Configuration mapped ip address 172.16.28.102 to r2
Loading r2-confg from 172.16.29.252 (via FastEthernet0/0): !
[OK - 687 bytes]
```

TFTP Server Log

The TFTP server log should contain messages similar to the following text.

```
Sent network-confg to (172.16.28.100), 76 bytes
Sent r4-confg to (172.16.28.100),687 bytes
Sent network-confg to (172.16.28.101), 76 bytes
Sent r3-confg to (172.16.28.101),687 bytes
Sent network-confg to (172.16.28.102), 76 bytes
Sent r2-confg to (172.16.28.102),687 bytes
```

Saving the Configuration Files on The Routers

You must save the running configurations on each router to the startup configuration to ensure that the routers retain their configurations if they are ever power cycled.

R4

```
R1# telnet 172.16.28.100
Trying 172.16.28.100 ... Open
User Access Verification
Password:
R4> enable
Password:
R4# copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
R4# exit
[Connection to 172.16.28.100 closed by foreign host]
R1#
```

R3

```
R1# telnet 172.16.28.101
Trying 172.16.28.101 ... Open
User Access Verification
Password:
R3> enable
```

```
Password:
R3# copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
R3# exit
[Connection to 172.16.28.101 closed by foreign host]
R1#
```

R2

```
R1# telnet 172.16.28.102
Trying 172.16.28.102 ... Open
User Access Verification
Password:
R2> enable
Password:
R2# copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
R2# exit
[Connection to 172.16.28.102 closed by foreign host]
R1#
```

Removing the Private DHCP Address Pools from R1

The final step in the AutoInstall process is to remove the private DHCP address pools from R1.

```
R1(config)# no ip dhcp pool r4
R1(config)# no ip dhcp pool r3
R1(config)# no ip dhcp pool r2
```

This is the final task, and step for Using AutoInstall to Setup Devices Connected to LANs.

Additional References

This section provides references related to the basic configuration of a Cisco networking device.

Related Documents

Related Topic	Document Title
Configuring a networking device for the first time using the Cisco IOS XE software feature AutoInstall.	Using AutoInstall to Remotely Configure Cisco Networking Devices
Configuring a networking device using Cisco IOS XE Setup mode	Using Setup Mode to Configure a Cisco Networking Device
Configuration fundamentals and associated commands	*Cisco IOS XE Configuration Fundamentals Configuration Guide* for your release and the release-independent Cisco IOS Configuration Fundamentals Command Reference

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Feature Information for Using AutoInstall to Remotely Configure a Cisco Networking Device

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 6: Feature Information for Using AutoInstall to Remotely Set Up a Cisco Netowrking Device

Feature Name	Releases	Feature Configuration Information
AutoInstall Using DHCP for LAN Interfaces	Cisco IOS XE Release 2.1	The AutoInstall Using DHCP for LAN Interfaces feature enhances the benefits of AutoInstall by replacing the use of the Bootstrap Protocol (BOOTP) with the use of the Dynamic Host Configuration Protocol (DHCP) for Cisco IOS AutoInstall over LAN interfaces (specifically Fast Ethernet, Token Ring, and FDDI interfaces). In Cisco IOS XE Release 2.1, this feature was introduced on Cisco ASR 1000 Series Routers.
AutoInstall Support for TCL Script	Cisco IOS XE Release 3.3SE	The AutoInstall Using TCL Script feature enhances the AutoInstall feature by providing more flexibility in the installation process. This feature allows the users to program the device to get information about what to download, and to choose the type of file server, and the required file transfer protocol