Zero Touch Auto-IP

The Zero touch Auto-IP feature enables automatic allocation and configuration of IP addresses for nodes in a ring topology. The IP addresses are allocated from a pool of IP addresses that is predefined by you.

The advantages of Zero Touch Auto-IP over Auto-IP are:

- IP addresses can be configured automatically on ring nodes. Manual IP address configuration is not required on each node.
- IP addresses are allocated from a common IP address pool, and the IP address range can be predefined by you.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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.

Prerequisites for Zero Touch Auto-IP

- Link Layer Discovery Protocol (LLDP) must be enabled on all the Auto-IP ring device ports.

- In an Auto-IP ring, you must identify one Auto-IP device as an Auto-IP server.

- None of the ports identified to be part of the Zero Touch Auto-IP ring should be manually configured with the Auto-IP functionality. If a port that is identified for Zero touch Auto-IP configuration has a manual Auto-IP configuration, disable the manual Auto-IP configuration on that port.

Restrictions for Zero Touch Auto-IP

- Zero Touch Auto-IP and Auto-IP cannot coexist. To implement Zero Touch Auto-IP functionality, all the ports of the Auto-IP ring have to be configured as Zero Touch Auto-IP ports.

- Zero Touch Auto-IP works if the designated Auto-IP server is in an autonomic network.

Information About Zero Touch Auto-IP

The Zero Touch Auto-IP feature uses Autonomic Networking and Link Layer Discovery Protocol (LLDP) to achieve the objective of automatic IP address configuration on nodes in a ring network.

Consider the topology for Zero Touch Auto-IP configuration. The devices R1, R2, R3 and R4 are connected in a ring network and LLDP is enabled on all the ring ports.

Figure 1: Zero Touch Auto-IP Topology
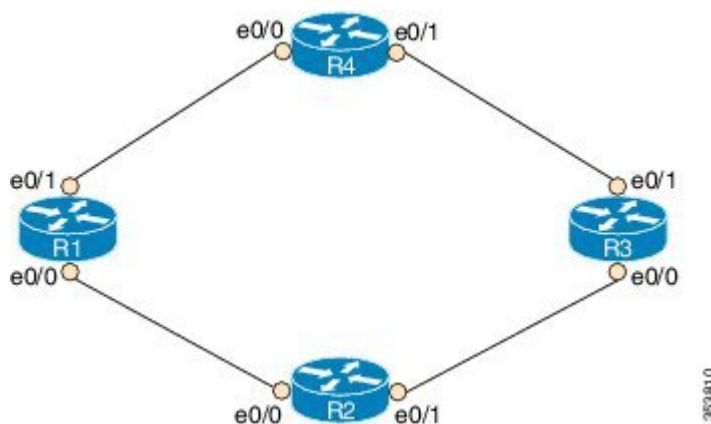
To know about and configure the Zero touch Auto-IP functionality, use the information given below:

1 Associate one device in the ring network (say R1) to the autonomic network. Enable autonomic status for the other Auto-IP devices. For more information on autonomic networks, refer Autonomic Networking.

```
R1(config)# autonomic registrar
R1(config-registrar)# domain-id auto-addressing.com
R1(config-registrar)# no shutdown
```

```
R1(config-registrar)# CA local
R1(config-registrar)# exit
R1(config)# autonomic


R2(config)# autonomic
R3(config)# autonomic
R4(config)# autonomic
```

Note that R1 is configured on the registrar and receives a certificate. The remaining devices are configured as autonomic devices.

2 Enable the *auto* mode on all the ports in the ring to enable automatic IP address configuration. Auto mode must be enabled on the e0/0 and e0/1 ports on R1, R2, R3 and R4. For ports of the same device, the ring ID must be identical.

```
Device(config-if)# auto-ip-ring 1 ipv4-auto
```

3 Configure the device added to the autonomic network (R1) as the Auto-IP server. The server stores a pool of IP addresses.

```
R1(config)# auto-ip-ring server
```

4 Reserve a pool of IP addresses on the Auto-IP server for IP address allocation to the ring ports.

Note In Zero Touch and manual Auto-IP configuration, a /31 subnet is created for a pair of owner and nonowner ports (each device will have a owner and non owner port). An odd-numbered IP address (such as 10.1.1.11) is issued to an owner port and an even-numbered IP address (10.1.1.10) is reserved for a nonowner port. Therefore, specify the first IP address in the range along with the number of devices (or /31 subnets) that make up the Auto-IP ring

```
R1(config-auto-ip-server)# ipv4-address-pool 10.1.1.10 6
```

Result—A range of IP addresses from 10.1.1.10 to 10.1.1.21 is allocated for the Auto-IP ring. The Auto-IP server is added to the autonomic network and is reachable by other nodes in the autonomic network.

Note IP addresses for six devices will be reserved (though the requirement is for four devices); the additional IP addresses will be allocated when you add new devices to the ring.

5 Auto-IP negotiation process— IP addresses are allocated to the Auto-IP ring nodes through a negotiation process. To initiate the process, configure one port as the seed port in the Auto-IP ring.

```
R1(config-if)# auto-ip-ring 1 ipv4-seed
```

The negotiation process is explained below:

1 The priority of the seed port (a port on R1, for example) is set to 2 and it is made an owner port. An IP address from the reserved pool is configured on the port.

2 The seed port advertises its priority (2) to its connected neighbor, and makes the neighbor port a non owner. The seed port assigns an IP address to the neighbor port and the neighbor port's priority is changed to 0.

3 Each owner port in the ring gets an IP address from the Auto IP server. The owner port, in turn, assigns an IP address to the connected neighbor port.

6 Auto-IP communication—After initial configuration, each owner port sends periodic messages to the Auto-IP server to continue preserving its IP address. If there is no message from the owner port to the Auto-IP server for 15 minutes, the server moves the IP address to the pool of free IP addresses.

The following are some points to keep in mind in the context of Zero Touch Auto-IP configuration:

• LLDP has to be enabled on all the Auto-IP ring ports before Auto-IP configuration.

• Before you insert a new interface into the ring, configure auto mode on the ring ports.

• For Zero Touch Auto-IP configuration, the number of devices (or /31 subnets) that make up the Auto-IP ring must be between 1 and 128.

• When you specify a pool of IP addresses, ensure that IP addresses in the specified range are not already in use.

• Ensure that you reserve some additional IP addresses for the Auto-IP ring, in case more devices are added to the ring topology at a later point in time.

• The starting IP address used for the Auto-IP address pool reservation must be an even number. For example, 10.1.1.10 is a valid IP address but 10.1.1.9 is not.

• If you remove a device from an Auto-IP ring, the Auto-IP addresses are released back to the Auto-IP server.

How to Configure Zero Touch Auto-IP

Associating an Auto-IP Server with an Autonomic Network

The Auto-IP server (R1) must be associated with the autonomic network, and configured in the Autonomic Network registrar. The other devices in the network (R2, R3, and R4) must be enabled with the autonomic status.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **autonomic registrar**
4. **domain-id auto-addressing.com**
5. **no shutdown**
6. **CA local**
7. **exit**
8. **autonomic**
9. **autonomic**
10. **autonomic**
11. **autonomic**
12. **exit**

DETAILED STEPS

	Command or Action	**Purpose**
Step 1	**enable** **Example:** R1> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** R1# configure terminal	Enters global configuration mode.
Step 3	**autonomic registrar** **Example:** R1(config)# autonomic registrar	Enables the Auto-IP server in the Autonomic Network registrar and enters registrar configuration mode.
Step 4	**domain-id auto-addressing.com** **Example:** R1(config-registrar)# domain-id auto-addressing.com	Represents a common group of all devices registering with the registrar. **Note** If R1 is configured on the AN registrar, then R1 represents the Auto-IP ring devices R2, R3, and R4.
Step 5	**no shutdown** **Example:** R1(config-registrar)# no shutdown	Enables the autonomic registrar.
Step 6	**CA local** **Example:** R1(config-registrar)# CA local	Issues a Local CA certificate to the Auto-IP server.
Step 7	**exit** **Example:** R1(config-registrar)# exit	Exits registrar configuration mode and enters global configuration mode.
Step 8	**autonomic** **Example:** R1(config)# autonomic	Configures the Auto-IP server as an autonomic device. **Note** You should associate the remaining devices (R2, R3, and R4) in the Auto-IP ring with the autonomic network, as given in the next few steps.

	Command or Action	Purpose
Step 9	**autonomic** **Example:** `R2(config)# autonomic`	Configures R2 as an autonomic device.
Step 10	**autonomic** **Example:** `R3(config)# autonomic`	Configures R3 as an autonomic device.
Step 11	**autonomic** **Example:** `R4(config)# autonomic`	Configures R4 as an autonomic device.
Step 12	**exit** **Example:** `Device(config)# exit`	Exits global configuration mode and enters privileged EXEC mode.

What to Do Next

Enable *auto* mode on Auto-IP ring ports

Enabling Auto Mode on Auto-IP Ring Ports

Before You Begin

Identify the ports that will be part of the Auto-IP ring. Remember that you must enable Auto mode on all the ports in an Auto-IP ring.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **lldp run**
4. **interface** *type number*
5. **auto-ip-ring** *ring-id* **ipv4-auto**
6. **exit**
7. Repeat steps to configure auto mode on each Auto-IP ring port.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** Device# configure terminal	Enters global configuration mode.
Step 3	**lldp run** **Example:** Device(config)# lldp run	Enables Link Layer Discovery Protocol (LLDP) for the device.
Step 4	**interface** *type number* **Example:** Device(config)# interface ethernet 0/0	Specifies an interface type and number, and enters interface configuration mode.
Step 5	**auto-ip-ring** *ring-id* **ipv4-auto** **Example:** Device(config-if)# auto-ip-ring 1 ipv4-auto	Configures auto mode on the Auto-IP ring port.
Step 6	**exit** **Example:** Device(config-if)# exit	Exits interface configuration mode and enters global configuration mode.
Step 7	Repeat steps to configure auto mode on each Auto-IP ring port.	---

What to Do Next

Configure an Auto-IP server and reserve a pool of IP addresses for the Auto-IP ring ports.

Configuring an Auto-IP Server and Reserving a Pool of IP Addresses on the Server

Before You Begin

Ensure that all ports of the ring are identified and auto mode is enabled on the ports.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **auto-ip-ring server**
4. **ipv4-address-pool** *auto-ipv4-address number-of-subnets*
5. **exit**

DETAILED STEPS

	Command or Action	**Purpose**
Step 1	**enable** **Example:** Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** Device# configure terminal	Enters global configuration mode.
Step 3	**auto-ip-ring server** **Example:** Device(config)# auto-ip-ring server	Configures the device as an Auto-IP server and enters Auto-IP server configuration mode.
Step 4	**ipv4-address-pool** *auto-ipv4-address number-of-subnets* **Example:** Device(config-auto-ip-server)# ipv4-address-pool 10.1.1.10 6	Reserves a pool of IP addresses on the Auto-IP server. The number of subnets should, at a minimum, be the total number of owner ports or devices in the ring. The odd-numbered IP addresses are assigned to the owner ports, and each non owner port fetches its IP address from the owner port through LLDP
Step 5	**exit** **Example:** Device(config-auto-ip-server)# exit	Exits Auto-IP server configuration mode and enters global configuration mode.

What to Do Next

Configure a seed port to start the Auto-IP negotiation process.

Configuring a Seed Port

Before You Begin

Ensure all the Auto-IP ports are in auto mode, and a pool of IP addresses is reserved for the Auto-IP ports.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **auto-ip-ring** *ring-id* **ipv4-seed**
5. **exit**
6. **end**
7. **show auto-ip-ring** [*ring-id*][**detail**]

DETAILED STEPS

	Command or Action	**Purpose**
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface ethernet 0/1`	Specifies an interface type and number, and enters interface configuration mode.
Step 4	**auto-ip-ring** *ring-id* **ipv4-seed** **Example:** `Device(config-if)# auto-ip-ring 1 ipv4-seed`	Designates the port as the seed port and initiates the Auto-IP negotiation process.

	Command or Action	Purpose
Step 5	**exit** **Example:** Device(config-if)# exit	Exits interface configuration mode and enters global configuration mode.
Step 6	**end** **Example:** Device(config-if)# end	Returns to privileged EXEC mode.
Step 7	**show auto-ip-ring** [*ring-id*][**detail**] **Example:** Device# show auto-ip-ring 4 detail	Displays auto-IP information.

What to Do Next

Verify if the IP addresses have been configured.

Verifying and Troubleshooting Zero Touch Auto-IP

Perform this task to verify Zero touch Auto-IP functions.

Note   The commands are not in any specific order.

SUMMARY STEPS

1. **enable**
2. **show auto-ip-ring** [*ring-id*][**detail**]
3. **show autonomic service**
4. **show autonomic device**
5. **show autonomic neighbors**
6. **debug auto-ip-ring** {*ring-id* {**errors** | **events**} |**errors** | **events**}

DETAILED STEPS

Step 1   **enable**

Enables privileged EXEC mode.

Example:
```
Device> enable
```

Step 2   **show auto-ip-ring** [*ring-id*][**detail**]

This command displays Auto-IP ring information for a specific device or Auto-IP ring. The sample output given below displays two ports representing a ring, their IP addresses, and the connected ports and IP addresses (neighboring port information is denoted by Rx).

Example:

```
Device# show auto-ip-ring 1

Auto-IP ring 1

 Auto-IP Address         : 10.1.1.11

 Ring Port0              : Ethernet0/1
 My Current-IP           : 10.1.1.11
 My Priority             : 2

 Rx Auto-IP Address      : 10.1.1.13
 Rx Current-IP           : 10.1.1.12
 Rx-Priority             : 0

 Ring Port1              : Ethernet0/0
 My Current-IP           : 10.1.1.10
 My Priority             : 0

 Rx Auto-IP Address      : 10.1.1.17
 Rx Current-IP           : 10.1.1.17
 Rx-Priority             : 2
```

Step 3   **show autonomic service**

The following is sample output from this command, and it displays autonomic services configured on a device connected to an autonomic network.

Example:

```
Device# show autonomic service

Service                   IP-Addr
Autonomic registrar       FD53:EE55:A541:0:AABB:CC00:100:1
ANR type                  IOS CA
Auto IP Server            FD53:EE55:A541:0:AABB:CC00:100:1
```

Step 4   **show autonomic device**

The following is sample output from this command, and it displays autonomic network configuration credentials for a device that is connected to the autonomic network. Details like unique identifier (UDI), device identifier (Device ID), associated domain (Domain ID), and so on, are displayed.

Example:

```
Device# show autonomic device

        UDI                       PID:Unix SN:655773698
        Device ID                 aabb.cc00.0100-2
        Domain ID                 auto-networking.com
        Domain Certificate        (sub:) ou=abcd.com+serialNumber=PID:Unix
SN:655773698,cn=aabb.cc00.0100-2
        Certificate Serial Number 03
        Device Address            FD53:EE55:A541:0:AABB:CC00:100:2
        Domain Cert is Valid
```

Step 5   **show autonomic neighbors**

The following is sample output from this command, and it displays autonomic configuration details of connected, neighbor devices. Details such as unique identifier (UDI), device identifier (Device ID), and associated domain (Domain ID), are displayed.

Example:

```
Device# show autonomic neighbors

        UDI                                  Device-ID          Domain      Interface
---------------------------------------------------------------------------
PID:Unix SN:655773697                        aabb.cc00.0100-1   abcd.com
Ethernet0/0
PID:Unix SN:655773699                        aabb.cc00.0100-4   abcd.com   Ethernet0/1
```

Step 6   **debug auto-ip-ring** {*ring-id* {**errors** | **events**} |**errors** | **events**}

The following is sample output from this command, and it displays debug errors and events for the specified Auto-IP ring.

Note   A conflict is detected in the sample debug output below because the priority in the Auto-IP Type Length Value (TLV) that is sent from the interface and the priority that is received from the neighbor interface are the same.

Example:

```
Device# debug auto-ip-ring 2 errors

Auto IP Ring errors debugging is on for the ring id : 2
*Jul 26 11:30:40.541: (Ethernet0/0) priority (value:1) conflict detected,  need admin intervention
```

Configuration Examples for Zero Touch Auto-IP

Example: Associating an Auto-IP Server with an Autonomic Network

Auto-IP server (R1) is associated with the autonomic network. The other devices in the network (R2, R3, and R4) are enabled with the autonomic status.

```
R1(config)# autonomic registrar
R1(config-registrar)# domain-id auto-addressing.com
R1(config-registrar)# no shutdown
R1(config-registrar)# CA local
R1(config-registrar)# exit
R1(config)# autonomic


R2(config)# autonomic
R3(config)# autonomic
R4(config)# autonomic
```

Example: Enabling Auto Mode on Auto-IP Ring Ports

```
Device> enable
Device# configure terminal
Device(config)# lldp run
Device(config)# interface ethernet 0/0
Device(config-if)# auto-ip-ring 1 ipv4-auto
Device(config-if)# exit

Repeat the preceding steps to configure the auto mode on each Auto-IP ring port
```

Example: Configuring an Auto-IP Server and Reserving a Pool of IP Addresses on the Server

```
Device> enable
Device# configure terminal
Device(config)# auto-ip-ring server
Device(config-auto-ip-server)# ipv4-address-pool 10.1.1.10 6
Device(config-auto-ip-server)# exit
```

Example: Configuring a Seed Port

```
Device> enable
Device# configure terminal
Device(config)# interface e0/0
Device(config-if)# auto-ip-ring 1 ipv4-seed
Device(config-if)# exit
```

Additional References for Zero Touch Auto-IP

Related Documents

Related Topic	Document Title
Auto-IP	IP Addressing: IPv4 Addressing Configuration Guide
Configuring IPv4 Addresses	IP Addressing: IPv4 Addressing Configuration Guide
Using Link Layer Discovery Protocol in Multivendor Networks	Carrier Ethernet Configuration Guide
IPv4 Addressing commands	Cisco IOS IP Addressing Services Command Reference
Cisco IOS commands	Cisco IOS Master Command List, All Releases

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for Auto-IP

Table 1: Feature Information for Auto-IP

Feature Name	Releases	Feature Information
Zero Touch Auto-IP		The Zero Touch Auto-IP feature enables automatic allocation and configuration of IP addresses for nodes in an Auto-IP ring. The IP addresses are allocated from a pool of IP addresses. The following commands were introduced or modified: **auto-ip-ring ipv4-auto**, **auto-ip-ring ipv4-seed**, **auto-ip-ring server**, **ipv4-address-pool**.