Configure Subnet Zero and All-Ones Subnet

Contents

Introduction

This document describes the use of subnet zero and the all-ones subnet.

Prerequisites

Requirements

There are no specific requirements for this document.

Components Used

This document is not restricted to specific software and hardware versions.

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, ensure that you understand the potential impact of any command.

Conventions

For more information on document conventions, refer to the [Use Format Conventions for Technical Tips and Other Content](#).

Background Information

Subnetting breaks down a given network address into smaller subnets. Coupled with other technologies like Network Address Translation (NAT) and Port Address Translation (PAT), it

allows for the more efficient use of available IP address space and greatly alleviates the problem of address depletion. Subnetting has guidelines that cover the use of the first and the last subnets, known as subnet zero and the all-ones subnet, respectively.

Subnet Zero

If a network address is subnetted, the first subnet obtained after subnetting the network address is called subnet zero.

Consider a Class B address, 172.16.0.0. By default, the Class B address 172.16.0.0 has 16 bits reserved to represent the host portion, thus it allows 65534 (2^{16}-2) valid host addresses. If network 172.16.0.0/16 is subnetted because it borrows three bits from the host portion, eight (2^3) subnets are obtained. This table is an example that shows the subnets obtained by subnetting the address 172.16.0.0, the resultant subnet mask, the associated broadcast addresses, and the range of valid host addresses.

Subnet Address	Subnet Mask	Broadcast Address	Valid Host Range
172.16.0.0	255.255.224.0	172.16.31.255	172.16.0.1 to 172.16.31.254
172.16.32.0	255.255.224.0	172.16.63.255	172.16.32.1 to 172.16.63.254
172.16.64.0	255.255.224.0	172.16.95.255	172.16.64.1 to 172.16.95.254
172.16.96.0	255.255.224.0	172.16.127.255	172.16.96.1 to 172.16.127.254
172.16.128.0	255.255.224.0	172.16.159.255	172.16.128.1 to 172.16.159.254
172.16.160.0	255.255.224.0	172.16.191.255	172.16.160.1 to 172.16.191.254
172.16.192.0	255.255.224.0	172.16.223.255	172.16.192.1 to 172.16.223.254
172.16.224.0	255.255.224.0	172.16.255.255	172.16.224.1 to 172.16.255.254

In the previous example, the first subnet (subnet 172.16.0.0/19) is called subnet zero.

The class of the network subnetted and the number of subnets obtained after subnetting do not determine the subnet zero. It is the first subnet obtained when subnetting the network address. Also, when you write the binary equivalent of the subnet zero address, all the subnet bits (bits 17, 18, and 19 in this case) are zeros. Subnet zero is also known as the all-zeros subnet.

All-Ones Subnet

When a network address is subnetted, the last subnet obtained is called the all-ones subnet.

With reference to the previous example, the last subnet obtained when subnetting network 172.16.0.0 (subnet 172.16.224.0/19) is called the all-ones subnet.

The class of the network subnetted and the number of subnets obtained after subnetting do not determine the all-ones subnet. Also, when you write the binary equivalent of the subnet zero address, all the subnet bits (bits 17, 18, and 19 in this case) are ones, hence the name.

Problems with Subnet Zero and All-Ones Subnet

Traditionally, it was strongly recommended that subnet zero and the all-ones subnet are not used for IP addresses. Based on RFC 950, "It is useful to preserve and extend the interpretation of these special (network and broadcast) addresses in subnetted networks. This means the values of all zeros and all ones in the subnet field must not be assigned to actual (physical) subnets." This is the reason why network engineers required to calculate the number of subnets obtained when it borrows three bits would calculate 2^3-2 (6) and not 2^3 (8). The -2 knows that subnet zero and the all-ones subnet are not used traditionally.

Subnet-Zero Issues

The use a subnet zero for IP addressing was discouraged because of the confusion inherent with a network and a subnet with indistinguishable addresses.

With reference to the previous example, consider the IP address 172.16.1.10. If you calculate the subnet address associated to this IP address, the answer you find is subnet 172.16.0.0 (subnet zero). Notice that this subnet address is identical to network address 172.16.0.0, which was subnetted in the first place, so whenever you perform subnetting, you get a network and a subnet (subnet zero) with indistinguishable addresses. This was formerly a source of great confusion.

Prior to Cisco IOS® Software Release 12.0, Cisco routers, by default, did not allow an IP address that belongs to subnet zero to be configured on an interface. However, if a network engineer that works with a Cisco IOS software release older than 12.0 finds it safe to use subnet zero, the **ip subnet-zero** command in the global configuration mode can be used to overcome this restriction. As of Cisco IOS Software Release 12.0, Cisco routers now have **ip subnet-zero** enabled by default, but if the network engineer feels that it is unsafe to use subnet zero, the **no ip subnet-zero** command can be used to restrict the use of subnet zero addresses.

In versions prior to Cisco IOS Software Release 8.3, the**service subnet-zero**command was used.

All-Ones Subnet Issues

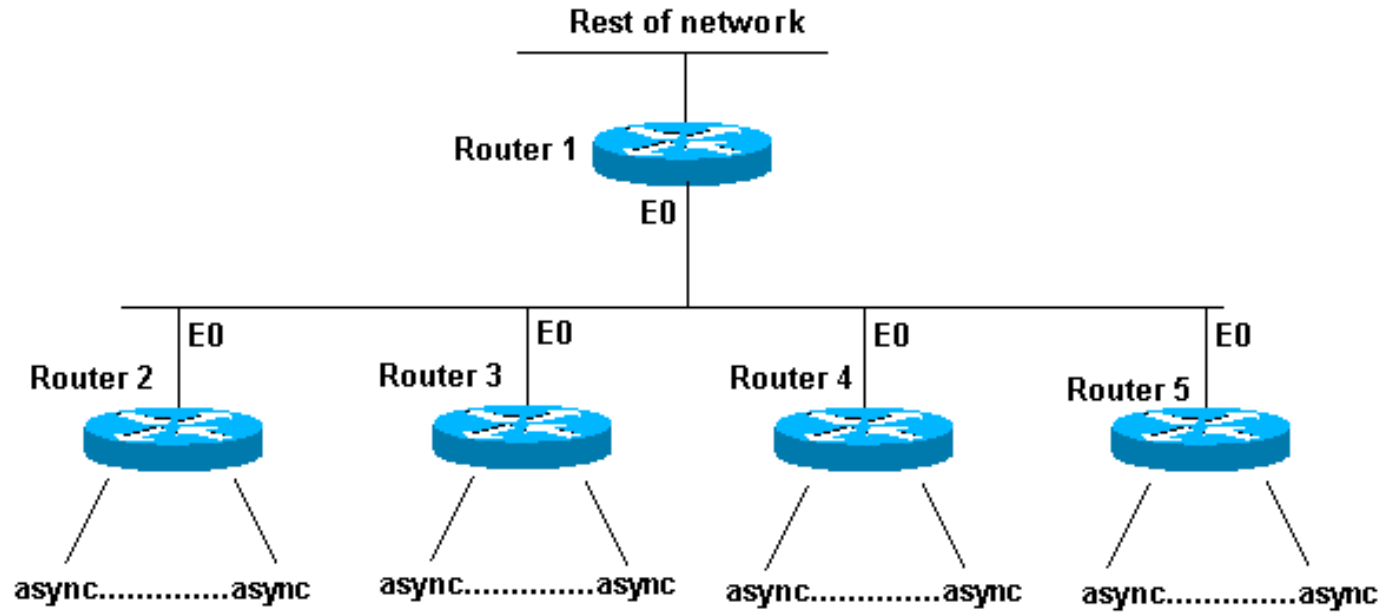
Use of the all-ones subnet for IP addressing has been discouraged in the past because of the confusion inherent with a network and a subnet with identical broadcast addresses.

With reference to the previous example, the broadcast address for the last subnet (subnet 172.16.224.0/19) is 172.16.255.255, which is identical to the broadcast address of the network 172.16.0.0, which was subnetted in the first place, so whenever you perform subnetting you get a network and a subnet (all-ones subnet) with identical broadcast addresses. In other words, a network engineer could configure the address 172.16.230.1/19 on a router, but if that is done, he can no longer differentiate between a local subnet broadcast (172.16.255.255 (/19)) and the complete Class B broadcast (172.16.255.255(/16)).

Although the all-ones subnet can now be used, misconfigurations can cause problems.

> **Note**: See Host and Subnet Quantities for details.

To give you an idea of what can happen, consider:



Misconfigured All-in-One Subnet

Routers 2 through 5 are access routers that each have several incoming asynchronous (or ISDN) connections. The network (192.168.1.0/24) is broken up into four pieces for these incoming users. Each piece is given to one of the access routers. Also, the asynchronous lines are configured**ip unnum e0**. Router 1 has static routes that point at the correct access router, and each access router has a default route points at Router 1.

The Router 1 routing table looks like this:

```
C  192.168.2.0/24   E0
      S  192.168.1.0/26   192.168.2.2
      S  192.168.1.64/26  192.168.2.3
      S  192.168.1.128/26 192.168.2.4
      S  192.168.1.192/26 192.168.2.5
```

The access routers have the same connected route for the Ethernet, the same default route and several host routes for their asynchronous lines (courtesy of Point-to-Point Protocol (PPP)).

```
Router 2 routing table:

      C  192.168.2.0/24   E0
      S  10.0.0.0/0      192.168.2.1
      C  192.168.1.2/32   async1
      C  192.168.1.5/32   async2
      C  192.168.1.8/32   async3
      C  192.168.1.13/32   async4
      C  192.168.1.24/32   async6
      C  192.168.1.31/32   async8
      C  192.168.1.32/32   async12
      C  192.168.1.48/32   async15
      C  192.168.1.62/32   async18
```

```
Router 3 routing table:

      C  192.168.2.0/24   E0
      S  10.0.0.0/0      192.168.2.1
      C  192.168.1.65/32   async1
      C  192.168.1.68/32   async2
      C  192.168.1.74/32   async3
      C  192.168.1.87/32   async4
      C  192.168.1.88/32   async6
      C  192.168.1.95/32   async8
      C  192.168.1.104/32   async12
      C  192.168.1.112/32   async15
      C  192.168.1.126/32   async18
```

```
  Router 4 routing table:

      C  192.168.2.0/24   E0
      S  10.0.0.0/0      192.168.2.1
      C  192.168.1.129/32   async1
      C  192.168.1.132/32   async2
      C  192.168.1.136/32   async3
```

```
Router 5 routing table:

      C  192.168.2.0/24   E0
      S  10.0.0.0/0      192.168.2.1
      C  192.168.1.193/32   async1
      C  192.168.1.197/32   async2
      C  192.168.1.200/32   async3
```

```
C  192.168.1.141/32   async4                C  192.168.1.205/32   async4
C  192.168.1.152/32   async6                C  192.168.1.216/32   async6
C  192.168.1.159/32   async8                C  192.168.1.223/32   async8
C  192.168.1.160/32   async12               C  192.168.1.224/32   async12
C  192.168.1.176/32   async15               C  192.168.1.240/32   async15
C  192.168.1.190/32   async18               C  192.168.1.252/32   async18
```

What if the hosts are configured incorrectly on the asynchronous lines to have a 255.255.255.0 mask instead of a 255.255.255.192 mask? Everything works fine?

Take a look at what happens when one of these hosts (192.168.1.24) does a local broadcast (NetBIOS, WINS). The packet looks like this:

```
s: 192.168.1.24 d: 192.168.1.255
```

The packet is received by Router 2. Router 2 sends it to Router 1, which sends it to Router 5, which sends it to Router 1, which sends it to Router 5, and so on, until the Time To Live (TTL) expires.

This is another example (host 192.168.1.240):

```
s: 192.168.1.240  d: 192.168.1.255
```

This packet is received by Router 5. Router 5 sends it to Router 1, which sends it to Router 5, which sends it to Router 1, which sends it to Router 5, and so on, until the TTL expires. If this situation occurs, you could think you were under a packet attack. Given the load on Router 5, this would not be an unreasonable assumption.

In this example, a routing loop has been created. Because Router 5 handles the all-ones subnet, it gets blasted. Routers 2 through 4 see the "broadcast" packet only once. Router 1 is hit, too, but what if it is a Cisco 7513, which can handle this situation? In that case, you need to configure your hosts with the correct subnet-mask.

To protect against hosts that are not configured correctly, create a loopback interface on each access router with a static route 192.168.1.255 to the loopback address. You could use the Null0 interface, but this causes the router to generate Internet Control Message Protocol (ICMP) "unreachable" messages.

Use Subnet Zero and All-Ones Subnet

It must be noted that even though it was discouraged, the entire address space that includes subnet zero and the all-ones subnet have always been usable. The use of the all-ones subnet was explicitly allowed and the use of subnet zero is explicitly allowed since Cisco IOS Software Release 12.0. Even prior to Cisco IOS Software Release 12.0, subnet zero could be used if the **ip subnet-zero** global configuration command is entered

Refer toRFC 1878on the issues of subnet zero and the all-ones subnet usage. Currently, the use of subnet zero and the all-ones subnet is generally accepted, and most vendors support their use. However, on certain networks, particularly the ones that use legacy software, the use of subnet zero and the all-ones subnet can lead to problems.

Note: Only registered Cisco users can access internal Cisco tools and information.

Related Information

- **IP Routed Protocols Technical Support Page**
- **Cisco Technical Support & Downloads**