INTERVLAN routing

Understanding Inter-VLAN Routing: How a Layer 3 Switch Connects Your Networks

1. The Challenge: Isolated Virtual Worlds (VLANs)

Virtual Local Area Networks (VLANs) are a fantastic tool for organizing devices into logical groups, improving security and network efficiency. However, this organization creates a common challenge: by default, devices in different VLANs are completely isolated and cannot communicate with each other.

Imagine a network setup with two distinct groups of PCs, each in its own virtual world:

- **VLAN 10:** For devices like PC0 and PC2.
- **VLAN 20:** For devices like PC1 and PC3.

Without a way to bridge these virtual worlds, a user on PC0 (VLAN 10) could never send a file or a message to a user on PC1 (VLAN 20). This is where the hero of our story, the **Layer 3 Switch**, comes in. Its purpose is to solve this isolation problem and enable seamless communication between these two VLANs. This approach is a modern and efficient alternative to older methods like 'router-on-a-stick,' as it integrates routing directly into the core of the network.

So, how does this 'hero' device bridge the gap between our isolated VLANs? Let's meet the key components involved in this process.

2. The Key Players in Our Network

To understand the solution, we first need to understand the roles of the different devices in the network topology. Each component has a specific job to do.

1. **The Access Switches (Layer 2)** These switches are the first point of connection for our end devices. Their primary job is to assign each PC to its correct VLAN. The ports connecting to the PCs are configured as **access ports**, meaning they belong to a single VLAN (e.g., VLAN 10). The port connecting up to the Layer 3 switch is configured as a **trunk port**, which is a special type of port capable of carrying traffic for *all* VLANs simultaneously.
2. **The End Devices (PCs)** These are the computers in VLAN 10 and VLAN 20 that ultimately need to communicate with each other. They are configured with IP addresses specific to their own VLAN.
3. **The Hero (Layer 3 Switch)** This is a powerful, multi-layer switch (like the Cisco 3560 model used in the example) that acts as the central brain of the network. It has a special ability: it can perform standard Layer 2 switching (just like the access switches) *and* Layer 3 routing. This routing capability is the key to our solution, as it allows the switch to make intelligent decisions about where to send traffic between different networks, eliminating the need for a separate, traditional router.

Now that we've met the cast, let's look at the three magic steps the Layer 3 switch performs to connect everything together.

3. The Three Steps to Enabling Communication

Configuring the Layer 3 switch is a logical, step-by-step process. By performing these three actions, we can transform it from a simple switch into a powerful inter-network router.

1. **Step 1: Activating the 'Routing Brain'** By default, a Layer 3 switch behaves just like a regular Layer 2 switch—it can't route traffic between different VLANs. The first and most critical step is to enable its routing capabilities. This is done with a single command: ip routing. Before this command, the switch's IP routing table is inactive. After enabling it, the switch is ready to build a routing table and make Layer 3 decisions, as can be verified with the show ip route command.
2. **Step 2: Creating a Virtual Gateway for Each VLAN (SVIs)** Before we can create a virtual gateway, the Layer 3 switch must first be aware of the VLANs themselves. This is done by creating the Layer 2 VLANs (e.g., vlan 10 and vlan 20) on the device. Once the VLANs exist, we give the switch a presence in each one by creating a **Switched Virtual Interface (SVI)**. Think of an SVI as a **virtual Layer 3 interface** that lives inside the switch. While it has no physical port, it is logically tied to a specific VLAN, allowing the switch to have an IP address within that VLAN's network.
    - interface Vlan 10: The virtual gateway for all devices in VLAN 10.
    - interface Vlan 20: The virtual gateway for all devices in VLAN 20.
3. The most important part of this step is assigning each SVI an IP address. This IP address becomes the official **default gateway** for all PCs within that VLAN.
4. **Step 3: Telling the PCs Where to Go (Configuring the Default Gateway)** Finally, the PCs need to be told how to send traffic to other networks. For a PC in VLAN 10 to send a packet to a PC in VLAN 20, it must first send that packet to its gateway. The gateway address configured on each PC is simply the IP address of the SVI we created on the Layer 3 switch for its specific VLAN.
5. This critical relationship is summarized below:

Device's VLAN	Default Gateway Address (SVI IP)
VLAN 10	10.1.1.1
VLAN 20	20.1.1.1

With the routing brain active and the gateways in place, let's trace a packet's journey to see how this all works in practice.

4. A Packet's Journey from VLAN 10 to VLAN 20

Let's follow a ping request from PC0 (10.1.1.100 in VLAN 10) to PC1 (20.1.1.100 in VLAN 20) to see the process in action.

1. PC0 checks the destination IP address (20.1.1.100) and realizes it is not on its local network (10.1.1.0). Because the destination is external, PC0 sends the packet to its configured default gateway: 10.1.1.1.
2. The packet travels from PC0, through the access switch, and up to the Layer 3 switch, where it arrives at the virtual interface Vlan 10.
3. The switch's 'routing brain' (its IP routing table) examines the packet's destination. Because we created the interface Vlan 20 with the IP address 20.1.1.1, the routing table now

contains an entry showing that the 20.1.1.0/24 network is 'directly connected.' The switch knows exactly how to reach this network.

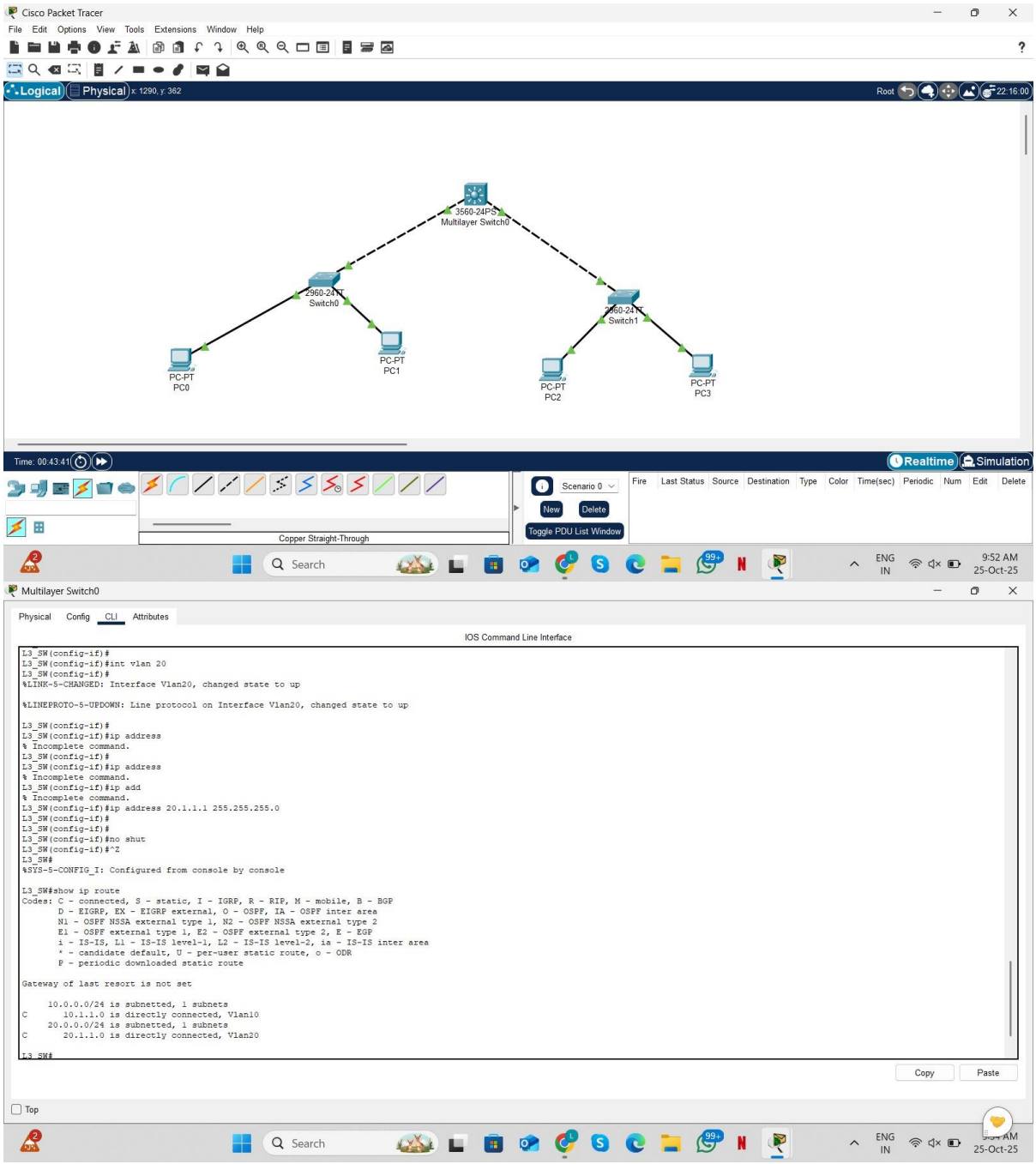
4. The switch makes a routing decision. It forwards the packet internally from its VLAN 10 interface to its VLAN 20 interface.
5. The packet is now on the VLAN 20 network and is sent out of the switch towards its final destination, PC1, which receives the ping successfully.

This successful journey demonstrates the power of the Layer 3 switch, leading us to our final conclusion.

5. Conclusion: The Hero's Victory

A Layer 3 switch elegantly solves the problem of VLAN isolation by simplifying network design. It achieves this by combining the Layer 2 functions of a traditional switch with the Layer 3 functions of a router into a single, powerful device.

The main takeaway is clear: by enabling the ip routing command and creating a Switched Virtual Interface (SVI) to act as a unique gateway for each VLAN, a Layer 3 switch can seamlessly route traffic between otherwise isolated networks. Understanding this process is a foundational and powerful concept in modern networking.


Cisco Packet Tracer
File Edit Options View Tools Extensions Window Help
Logical Physical x: 1290, y: 362
Root 22:16:00
3560-24PS
Multilayer Switch0
2960-24TT
Switch0
2960-24TT
Switch1
PC-PT
PC0
PC-PT
PC1
PC-PT
PC2
PC-PT
PC3
Time: 00:43:41
Realtime Simulation
Copper Straight-Through
Scenario 0
New
Delete
Toggle PDU List Window
Fire Last Status Source Destination Type Color Time(sec) Periodic Num Edit Delete
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Multilayer Switch0
Physical Config CLI Attributes
IOS Command Line Interface
L3_SW(config-if)#
L3_SW(config-if)#int vlan 20
L3_SW(config-if)#
%LINK-5-CHANGED: Interface Vlan20, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan20, changed state to up
L3_SW(config-if)#
L3_SW(config-if)#ip address
% Incomplete command.
L3_SW(config-if)#
L3_SW(config-if)#ip address
% Incomplete command.
L3_SW(config-if)#ip add
% Incomplete command.
L3_SW(config-if)#ip address 20.1.1.1 255.255.255.0
L3_SW(config-if)#
L3_SW(config-if)#
L3_SW(config-if)#no shut
L3_SW(config-if)#^Z
L3_SW#
%SYS-5-CONFIG_I: Configured from console by console
L3_SW#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route
Gateway of last resort is not set
10.0.0.0/24 is subnetted, 1 subnets
C 10.1.1.0 is directly connected, Vlan10
20.0.0.0/24 is subnetted, 1 subnets
C 20.1.1.0 is directly connected, Vlan20
L3_SW#
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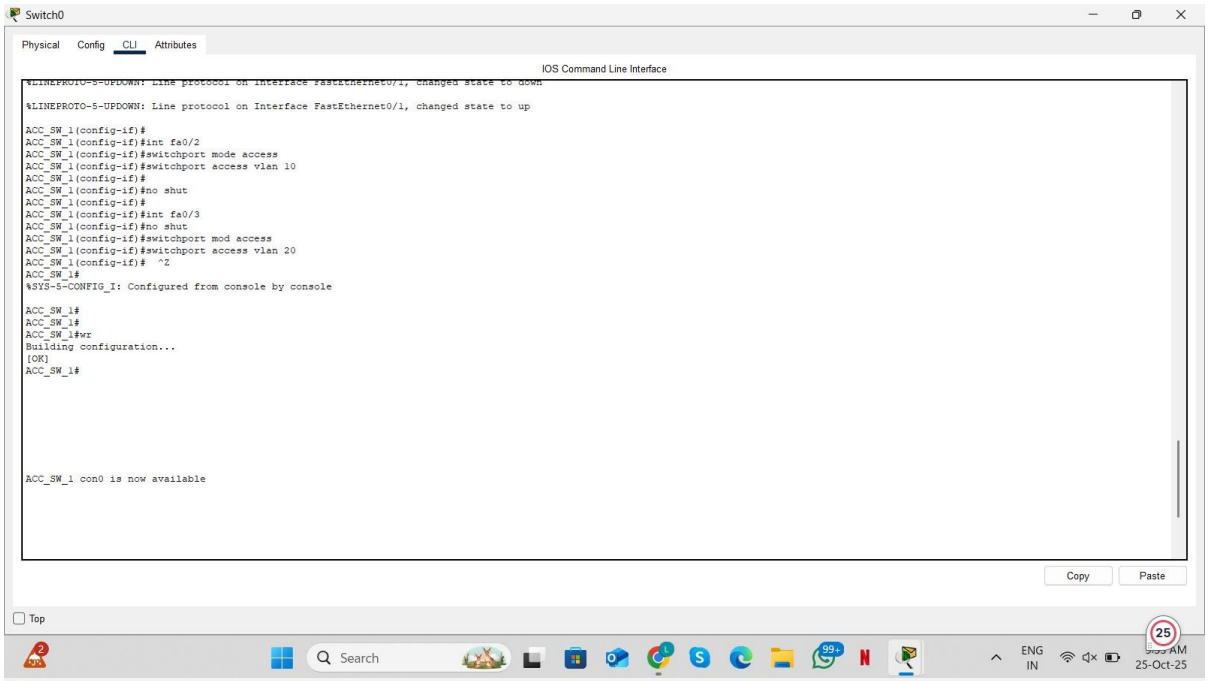
Switch0
Physical
Config
CLI
Attributes
IOS Command Line Interface
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
ACC_SW_1(config-if)#
ACC_SW_1(config-if)#int fa0/2
ACC_SW_1(config-if)#switchport mode access
ACC_SW_1(config-if)#switchport access vlan 10
ACC_SW_1(config-if)#
ACC_SW_1(config-if)#no shut
ACC_SW_1(config-if)#
ACC_SW_1(config-if)#int fa0/3
ACC_SW_1(config-if)#no shut
ACC_SW_1(config-if)#switchport mod access
ACC_SW_1(config-if)#switchport access vlan 20
ACC_SW_1(config-if)# ^Z
ACC_SW_1#
%SYS-5-CONFIG_I: Configured from console by console
ACC_SW_1#
ACC_SW_1#
ACC_SW_1#wr
Building configuration...
[OK]
ACC_SW_1#
ACC_SW_1 con0 is now available
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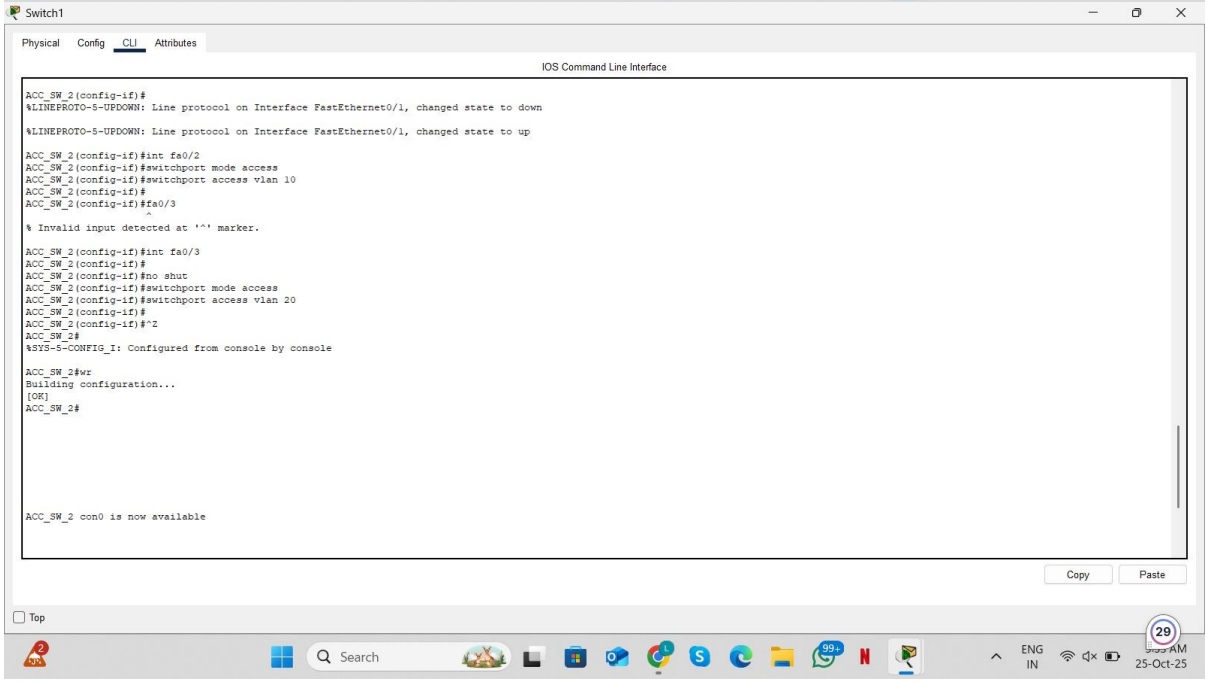
Switch1
Physical
Config
CLI
Attributes
IOS Command Line Interface
ACC_SW_2(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
ACC_SW_2(config-if)#int fa0/2
ACC_SW_2(config-if)#switchport mode access
ACC_SW_2(config-if)#switchport access vlan 10
ACC_SW_2(config-if)#
ACC_SW_2(config-if)#fa0/3
^
% Invalid input detected at '^' marker.
ACC_SW_2(config-if)#int fa0/3
ACC_SW_2(config-if)#
ACC_SW_2(config-if)#no shut
ACC_SW_2(config-if)#switchport mode access
ACC_SW_2(config-if)#switchport access vlan 20
ACC_SW_2(config-if)#
ACC_SW_2(config-if)#^Z
ACC_SW_2#
%SYS-5-CONFIG_I: Configured from console by console
ACC_SW_2#wr
Building configuration...
[OK]
ACC_SW_2#
ACC_SW_2 con0 is now available
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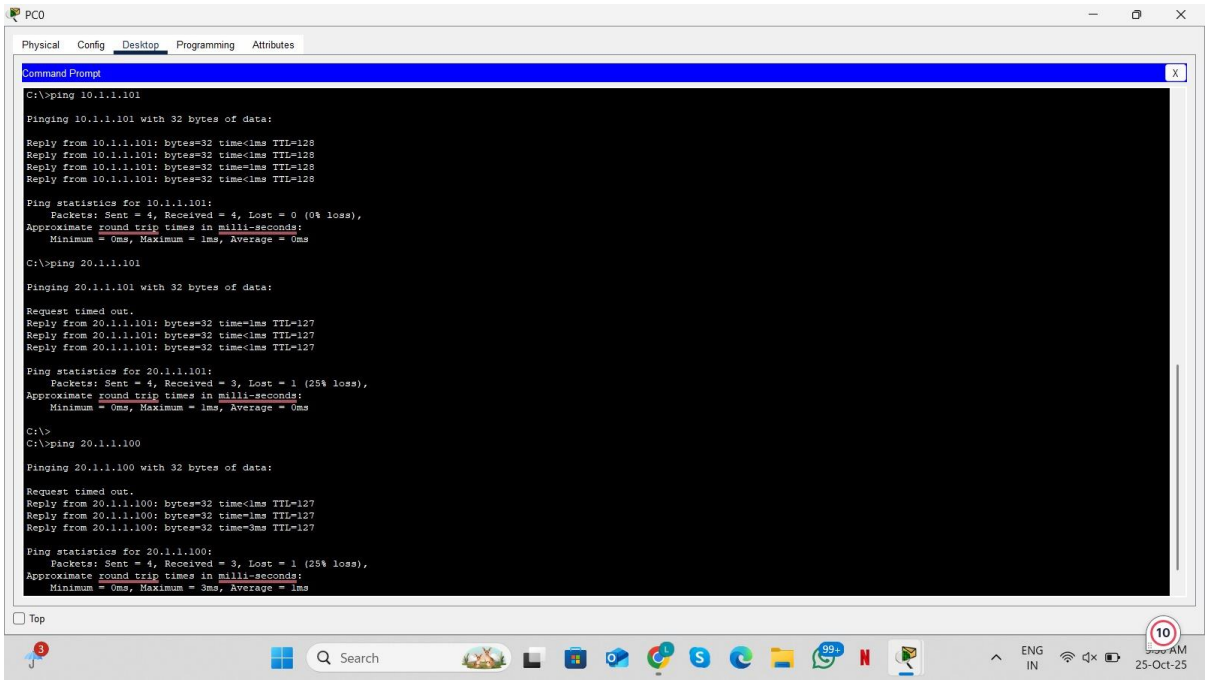
PC0
Physical
Config
Desktop
Programming
Attributes
Command Prompt
C:\>ping 10.1.1.101
Pinging 10.1.1.101 with 32 bytes of data:
Reply from 10.1.1.101: bytes=32 time<1ms TTL=128
Reply from 10.1.1.101: bytes=32 time<1ms TTL=128
Reply from 10.1.1.101: bytes=32 time=1ms TTL=128
Reply from 10.1.1.101: bytes=32 time<1ms TTL=128
Ping statistics for 10.1.1.101:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 1ms, Average = 0ms
C:\>ping 20.1.1.101
Pinging 20.1.1.101 with 32 bytes of data:
Request timed out.
Reply from 20.1.1.101: bytes=32 time=1ms TTL=127
Reply from 20.1.1.101: bytes=32 time<1ms TTL=127
Reply from 20.1.1.101: bytes=32 time<1ms TTL=127
Ping statistics for 20.1.1.101:
Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 1ms, Average = 0ms
C:\>
C:\>ping 20.1.1.100
Pinging 20.1.1.100 with 32 bytes of data:
Request timed out.
Reply from 20.1.1.100: bytes=32 time<1ms TTL=127
Reply from 20.1.1.100: bytes=32 time=1ms TTL=127
Reply from 20.1.1.100: bytes=32 time=3ms TTL=127
Ping statistics for 20.1.1.100:
Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 3ms, Average = 1ms
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