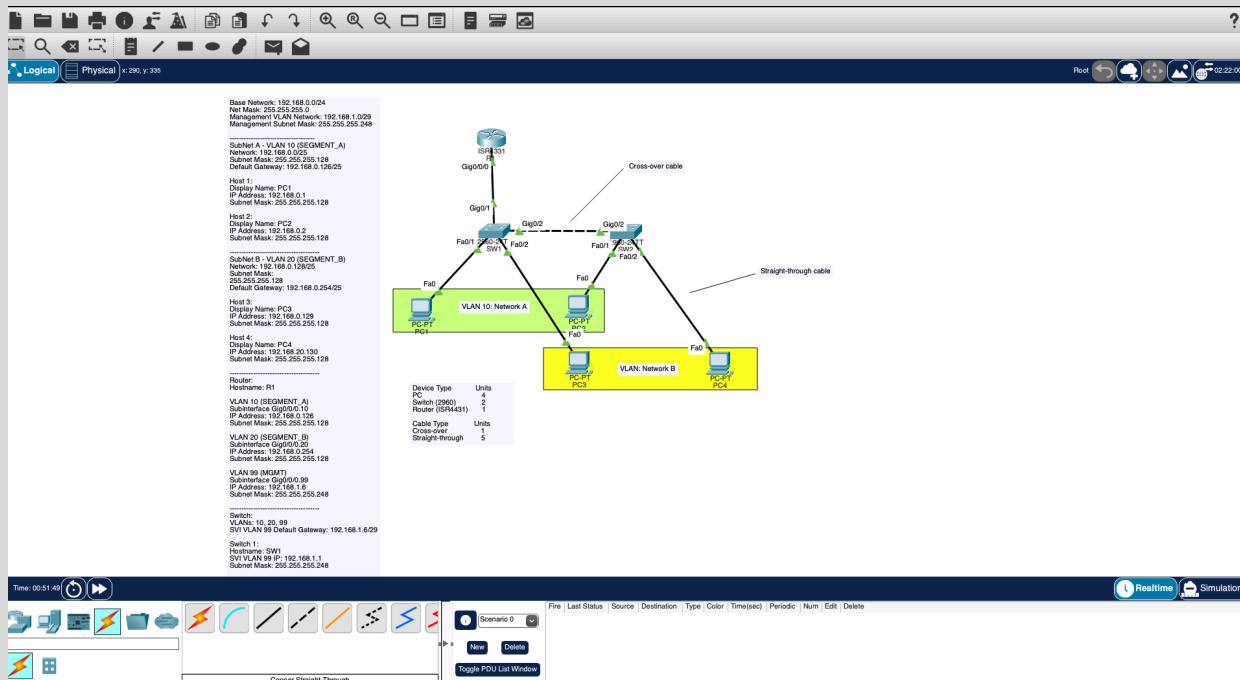


Lab 1: Subnetting, VLAN & Trunk Configuration, Router-on-a-Stick Inter-VLAN Routing, NTP, and Secure Device Access

This lab focuses on implementing foundational Layer 2 and Layer 3 networking concepts by configuring VLANs, trunking, and inter-VLAN routing using Router-on-a-Stick. The lab begins with initial device setup, including hostnames, clock configuration, and NTP synchronization, followed by VLAN creation and access port assignment on switches. Trunk links are configured using 802.1Q with a reassigned native VLAN to enhance security. Inter-VLAN communication is enabled by configuring router subinterfaces, each mapped to a specific VLAN and serving as the default gateway for hosts. Connectivity and functionality are verified through interface, VLAN, trunk, and end-to-end communication testing.

Network Topology:



Network Addressing Plan (Subnetting):

Overall Network:

<u>Parameter</u>	<u>Value</u>
Base Network	192.168.0.0/24
Subnet Mask	255.255.255.0
Management VLAN Network	192.168.1.0/29
Management Subnet Mask	255.255.255.248

Subnet A – VLAN 10 (SEGMENT_A)

<u>Parameter</u>	<u>Host 1 (PC1)</u>	<u>Host 2 (PC2)</u>
IP Address	192.168.0.1	192.168.0.2
Subnet Mask	255.255.255.128	255.255.255.128
Default Gateway	192.168.0.126	192.168.0.126
VLAN	10	10
Network	192.168.0.0/25	

Subnet B – VLAN 20 (SEGMENT_B)

<u>Parameter</u>	<u>Host 3 (PC3)</u>	<u>Host 4 (PC4)</u>
IP Address	192.168.0.129	192.168.0.130
Subnet Mask	255.255.255.128	255.255.255.128
Default Gateway	192.168.0.254	192.168.0.254
VLAN	20	20
Network	192.168.0.128/25	

Router – R1

<u>Interface</u>	<u>Subinterface</u>	<u>IP Address</u>	<u>Subnet Mask</u>	<u>VLAN / Purpose</u>
Gig0/0/0	.10	192.168.0.126	255.255.255.128	VLAN 10 / SEGMENT_A DGW
Gig0/0/0	.20	192.168.0.254	255.255.255.128	VLAN 20 / SEGMENT_B DGW
Gig0/0/0	.99	192.168.1.6	255.255.255.248	VLAN 99 / MGMT DGW

Switch 1 – SW1

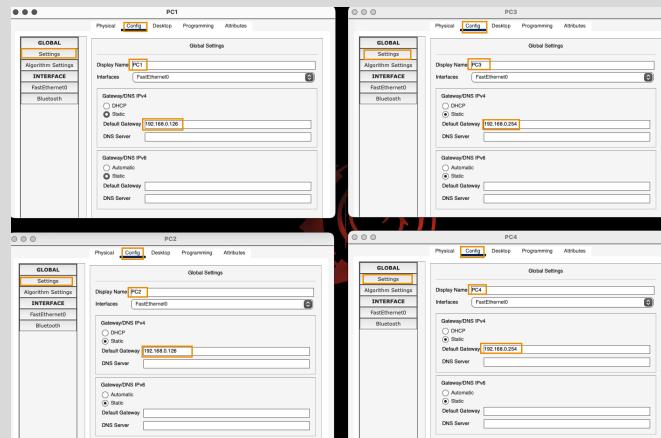
<u>Parameter</u>	<u>Value</u>
Hostname	SW1
VLANs	10, 20, 99
SVI VLAN 99 IP Address	192.168.1.1 /29
Default Gateway	192.168.1.6

Switch 2 – SW2

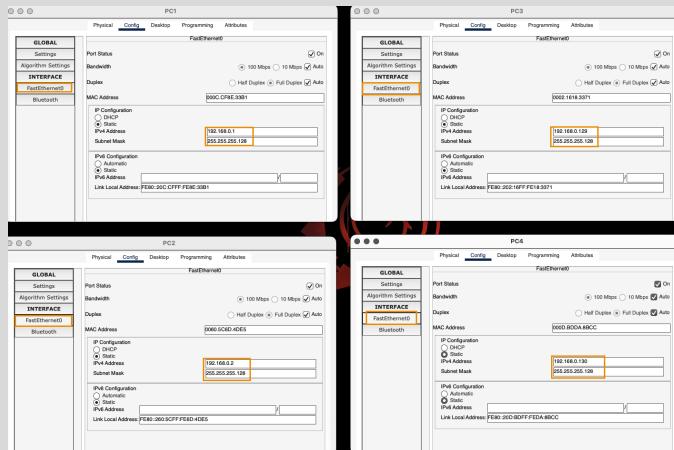
<u>Parameter</u>	<u>Value</u>
Hostname	SW2
VLANs	10, 20, 99
SVI VLAN 99 IP	192.168.1.2 /29
Default Gateway	192.168.1.6

Initial Endpoints (PC1, PC2, PC3, & PC4) Setup:

- Configure Display Name & Default Gateway



- Configure IP Address & Subnet Mask



Initial Router & Switches Setup

- Configure hostnames
- Set system clock
- Configure NTP for time synchronization
- Secure device access (console & VTY)
- Save configurations

Router Configuration:

```
R1
Physical Config CLI Attributes
IOS Command Line Interface

R1>enable
R1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#hostname R1
R1(config)#exit
R1#
%SYS-5-CONFIG_I: Configured from console by console

R1#clock set 17:22:00 Jan 27 2026
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#clock timezone EST -5
R1(config)#interface loopback0
R1(config-if)# ip address 1.1.1.1 255.255.255.255
R1(config-if)# no shutdown
R1(config)#ntp master 3
R1(config)#ntp authentication-key 1 md5 myKey
R1(config)#ntp trusted-key 1
R1(config)#ntp pool secret p$ssword4en
R1(config-line)# line vty 0 4
R1(config-line)# password p@ssword4coN
R1(config-line)# login
R1(config-line)# exec-timeout 30
R1(config-line)# logging synchronous
R1(config-line)# exit
R1(config)#service password-encryption
R1(config)#username jul secret p$ssword
R1(config)#ip domain-name jcag.com
R1(config)#crypto key generate rsa
% RSA keys already defined named R1.jcag.com .
% Do you really want to replace them? [yes/no]: yes
The name for the keys will be: R1.jcag.com
Choose the size of the key modulus in the range of 360 to 4096 for your
General Purpose Keys. Choosing a key modulus greater than 512 may take
a few minutes.

How many bits in the modulus [512]: 1024
% Generating 1024 bit RSA keys, keys will be non-exportable...[OK]

R1(config)#ip ssh version 2
*Jan 27 12:36:0.184: %SSH-5-ENABLED: SSH 2 has been enabled
R1(config)#line vty 0 4
R1(config-line)# login local

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```

Would you like to enter the initial configuration dialog? [yes/no]: no

! Enter privileged EXEC mode

enable

! Enter global configuration mode

configure terminal

! Set hostname

hostname R1

! Set system clock and timezone

```

exit
clock set 17:22:00 Jan 27 2026      → configure on privilege exec mode
conf t
clock timezone EST -5                → configure on global config mode
! Configure loopback 0 interface (for NTP source)
interface loopback0
  ip address 1.1.1.1 255.255.255.255
  exit
! Configure NTP master with authentication
ntp master 3                         → optional stratum number
ntp authentication-key 1 md5 myKey
ntp trusted-key 1
! Set enable secret with scrypt (Type 9)      → not an option for ISR4331 Router
enable algorithm-type scrypt secret p@ssword4en
! Set enable secret with MD5 (Type 5)
enable secret p@ssword4en
! Configure console access (set password, standby time, sync with log output)
line con 0
  password p@ssword4coN
  login
  exec-timeout 30
  logging synchronous
  exit
! Encrypt all existing and future plain-text passwords (Type 7)
service password-encryption
! Create local username and secret for login (Type 5)
username jul secret p@ssword
! Configure domain name for crypto keys (needed for SSH)
ip domain-name jcag.com
! Generate RSA keys for SSH
crypto key generate rsa
! When prompted, choose default [512]          → enter 1024 bits (at least 768 bits size for SSH v2)
! Force SSH version 2
ip ssh version 2
! Configure VTY lines (set VTY line for up to 5 simultaneous users, login to use local DB for user &
password, transport input SSH only (no Telnet or AUX), standby time, sync to log output)
line vty 0 4
  login local
  transport input ssh
  exec-timeout 30
  logging synchronous
  exit
! Save configuration
do write memory

```

Switch Configuration:

```

SW1>enable
SW1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)#hostname SW1
SW1(config)#ntp server 1.1.1.1
SW1(config)#ntp authentication-key 1 md5 myKey
SW1(config)#ntp trusted-key 1
SW1(config)#enable secret p@ssword4en
SW1(config)#line con 0
SW1(config-line)# password p@ssword4coN
SW1(config-line)# login
SW1(config-line)# exec-timeout 30
SW1(config-line)# logging synchronous
SW1(config-line)# exit
SW1(config)#service password-encryption
SW1(config)#username jul secret p@ssword4ssh
SW1(config)#ip domain-name jcag.com
SW1(config)#crypto key generate rsa
The name for the keys will be: SW1.jcag.com
Choose the size of the key modulus in the range of 360 to 4096 for your
General Purpose Keys. Choosing a key modulus greater than 512 may take
a few minutes.

How many bits in the modulus [512]: 1024
% Generating 1024 bit RSA keys, keys will be non-exportable...[OK]
SW1(config)#ip ssh version 2
*Mar 2 18:42:46.637: SSH-5-ENABLED: SSH 1.99 has been enabled
SW1(config)#line vty 0 4
SW1(config-line)# login local
SW1(config-line)# transport input ssh
SW1(config-line)# exec-timeout 30
SW1(config-line)# logging synchronous
SW1(config-line)# exit
SW1(config)#do write memory
Building configuration...
[OK]

```

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! Enter privileged EXEC mode

enable

! Enter global configuration mode

configure terminal

! Set hostname

hostname SW1

→ run hostname SW2 for Switch 2

! Configure NTP server with authentication

ntp server 1.1.1.1

ntp authentication-key 1 md5 myKey
ntp trusted-key 1

! Set enable secret with scrypt (Type 9 hash)

→ not an option for Layer 2 Switches

enable algorithm-type scrypt secret p@ssword4en

! Set enable secret with MD5 (Type 5)

enable secret p@ssword4en

! Configure console access

line con 0

password p@ssword4coN
login
exec-timeout 30
logging synchronous
exit

! Encrypt all plain-text passwords (service password-encryption)

service password-encryption

! Create local user for SSH login (Type 5 secret)

username jul secret p@ssword4ssh

! Configure domain name for crypto keys (needed for SSH)

ip domain-name jcag.com

! Generate RSA keys for SSH

crypto key generate rsa

! When prompted, choose default [512]

→ enter 1024 bits (at least 768 bits size for SSH v2)

! Force SSH version 2

ip ssh version 2

→ failed to enable on L2 Switch (2960), 1.99 enabled

! Configure VTY lines (set VTY line for up to 5 simultaneous users, login to use local DB for user & password, transport input SSH only (no Telnet or AUX), standby time, sync to log output)

```

line vty 0 4
  login local
  transport input ssh
  exec-timeout 30
  logging synchronous
  exit
! Save configuration
do write memory

```

! Configure Switch 2 (change input entry accordingly)

Switching (Layer 2)

- Create VLANs
- Assign access ports to VLANs
- Verify VLAN membership
- Configure management VLAN

Switch Configuration:

```

SW1(config)#vlan 10
SW1(config-vlan)#name SEGMENT_A
SW1(config-vlan)#exit
SW1(config)#vlan 20
SW1(config-vlan)#name SEGMENT_B
SW1(config-vlan)#exit
SW1(config)#vlan 99
SW1(config-vlan)#name MGMT
SW1(config-vlan)#exit
SW1(config)#int f0/1
SW1(config-if)#switchport mode access
SW1(config-if)#switchport access vlan 10
SW1(config-if)#exit
SW1(config)#int f0/2
SW1(config-if)#switchport mode access
SW1(config-if)#switchport access vlan 20
SW1(config-if)#exit
SW1(config-if)#int vlan 99
SW1(config-if)#exit
SW1(config-if)#ip add 192.168.1.1 255.255.255.248
SW1(config-if)#do show vlan br

```

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! VLAN Creation

```

vlan 10
  name SEGMENT_A
  exit
vlan 20
  name SEGMENT_B
  exit
vlan 99
  name MGMT
  exit

```

! Assign VLANs to Access Ports

```

interface fastEthernet 0/1
  switchport mode access
  switchport access vlan 10
  exit
interface fastEthernet 0/2
  switchport mode access
  switchport access vlan 20
  exit

```

! Configure Management VLAN SVI

```
interface vlan 99
```

```

ip address 192.168.1.1 255.255.255.248 → change IP to 192.168.1.2 for SW2
no shutdown
exit
! Verify VLANs
do show vlan brief
! Verify Interfaces IP Addressing & Status
do show ip interface brief

```

! Configure SW2 (change input entry accordingly)

Trunking

- Configure 802.1Q trunk links
- Reassign native VLAN (non-default VLAN)
- Allow required VLANs on trunks
- Verify trunk status

Switches Configuration:

```

SW1
Physical Config [CLI] Attributes
IOS Command Line Interface

SW1(config)#int g0/2
SW1(config-if)#switchport mode trunk

SW1(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan99, changed state to up

SW1(config-if)#
SW1(config-if)#
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on GigabitEthernet0/2 (1000), with Switch GigabitEthernet0/%
% Incomplete command.
SW1(config-if)#
SW1(config-if)#
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on GigabitEthernet0/2 (1000), with Switch GigabitEthernet0/2 (1).

% Incomplete command.
SW1(config)#do show int trunk
Port      Mode       Encapsulation  Status      Native vlan
Gig0/2    on        802.1q         trunking    1000
          Ports allowed on trunk
          Gig0/2      10,20,99
          Ports      Vlans allowed and active in management domain
          Gig0/2      10,20,99
          Port      Vlans in spanning tree forwarding state and not pruned
          Gig0/2      10,20,99

[Output Censored]

```

! Configure Trunk on SW1

```

interface gigabitEthernet0/2
switchport mode trunk
switchport trunk native vlan 1000
switchport trunk allowed vlan 10,20,99
exit

```

! Verification

```
do show interfaces trunk
```

! Configure Switch 2

Inter-VLAN Routing

- Configure Router-on-a-Stick (ROAS)
 - Create router subinterfaces
 - Assign VLAN tags to subinterfaces
 - Configure default gateways for hosts
 - Verify inter-VLAN connectivity

Router Configuration:

R1		
Physical	Config	CLI
IOS Command Line Interface		
R1(config)#int g0/0/0		
R1(config-if)#no shut		
R1(config-if)#		
%LINK-5-CHANGED: Interface GigabitEthernet0/0/0, changed state to up		
R1(config-if)#exit		
R1(config)#int g0/0/0.10		
R1(config-subif)#		
%LINK-5-CHANGED: Interface GigabitEthernet0/0/0.10, changed state to up		
R1(config-subif)#encapsulation dot1q 10		
R1(config-subif)#ip add 192.168.0.126 255.255.255.128		
R1(config-subif)#no shutdown		
R1(config-subif)#exit		
R1(config)#int g0/0/0.20		
R1(config-subif)#		
%LINK-5-CHANGED: Interface GigabitEthernet0/0/0.20, changed state to up		
R1(config-subif)#encapsulation dot1q 20		
R1(config-subif)#ip add 192.168.0.254 255.255.255.128		
R1(config-subif)#no shutdown		
R1(config-subif)#exit		
R1(config)#int g0/0/0.99		
R1(config-subif)#		
%LINK-5-CHANGED: Interface GigabitEthernet0/0/0.99, changed state to up		
R1(config-subif)#encapsulation dot1q 99		
R1(config-subif)#ip add 192.168.1.6 255.255.255.248		
R1(config-subif)#no shutdown		
R1(config-subif)#exit		
R1(config)#do show ip int br		
Interface	IP-Address	OK? Method Status
Protocol		
GigabitEthernet0/0/0	unassigned	YES NVRAM up down
GigabitEthernet0/0/0.10	192.168.0.126	YES manual up down
GigabitEthernet0/0/0.20	192.168.0.254	YES manual up down
GigabitEthernet0/0/0.99	192.168.1.6	YES manual up down
<input type="button" value="Copy"/>		<input type="button" value="Paste"/>

! Enable physical interface

```
interface GigabitEthernet0/0/0
    no shutdown
    exit
```

! Configure subinterface for VLAN 10

```
interface GigabitEthernet0/0/0.10
    encapsulation dot1q 10
    ip address 192.168.0.126 255.255.255.128
    no shutdown
exit
```

! Configure subinterface for VLAN 20

```
interface GigabitEthernet0/0/0.20
    encapsulation dot1q 20
    ip address 192.168.0.254 255.255.255.128
    no shutdown
exit
```

! Configure subinterface for VLAN 99 (Management)

```
interface GigabitEthernet0/0/0.99
    encapsulation dot1q 99
    ip address 192.168.1.6 255.255.255.248
    no shutdown
exit
```

! Verify interfaces

do show ip interface brief

SW1 Configuration:

```

R1
Physical Config CLI Attributes
IOS Command Line Interface

R1(config)#int g0/0/0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#int g0/0/0.10
R1(config-subif)#exit
R1(config)#int g0/0/0.20
R1(config-subif)#exit
R1(config)#int g0/0/0.99
R1(config-subif)#exit
R1(config-subif)#
R1(config-subif)encapsulation dot1q 10
R1(config-subif)ip add 192.168.0.126 255.255.255.128
R1(config-subif)no shut
R1(config-subif)exit
R1(config)#int g0/0/0.20
R1(config-subif)#
R1(config-subif)encapsulation dot1q 20
R1(config-subif)ip add 192.168.0.254 255.255.255.128
R1(config-subif)no shut
R1(config-subif)exit
R1(config)#int g0/0/0.99
R1(config-subif)#
R1(config-subif)encapsulation dot1q 99
R1(config-subif)ip add 192.168.1.6 255.255.255.248
R1(config-subif)no shut
R1(config-subif)exit
R1(config)#do show ip int br
Interface          IP-Address      OK? Method Status
Protocol
GigabitEthernet0/0/0 unassigned     YES NVRAM   up
GigabitEthernet0/0/0.10192.168.0.126 YES manual   up
GigabitEthernet0/0/0.20192.168.0.254 YES manual   up
GigabitEthernet0/0/0.99192.168.1.6  YES manual   up

```

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! Configure Trunk on SW1

```

interface gigabitEthernet0/2
switchport mode trunk
switchport trunk native vlan 1000
switchport trunk allowed vlan 10,20,99
exit

```

! Verification

```
do show interfaces trunk
```

Verification & Testing

- Verify configurations (VLANs, trunking, and interfaces)
- Test end-to-end connectivity using ping
- Validate routing between VLANs

Category	Command	Notes / What It Shows
Interface & IP	show ip interface brief	Displays IP addresses, interface status (up/down), and protocol status.
Routing/Inter-VLAN	show running-config	Confirm subinterfaces, VLAN encapsulation, and IP assignments.
VLANs	ping <destination_IP>	Verify inter-VLAN routing is working.
SVI/Mgmt VLAN	show vlan brief	Displays VLAN IDs, names, status, and assigned ports.
Trunking	show ip interface brief	Shows SVI IP address, status, and protocol.
	ping <SVI_IP>	Confirms switch management connectivity to router.
	show interfaces trunk	Displays trunk status, encapsulation, native VLAN, and allowed VLANs.
	show interfaces <int> sw	Shows mode (access/trunk), native VLAN, and operational details.
CDP/Neigh Discovery	show cdp neighbors	Displays connected Cisco devices, local interface, remote device, and capabilities.
	show cdp neighbors detail	Displays IP addresses of neighbors and more detailed info.
NTP	show ntp associations	Displays NTP associations and stratum info.
	'show running-config'	include ntp'

Device Security	'show running-config 'show running-config 'show running-config show startup-config ping <neighbor_IP> ping <PC_in_other_VLAN>	include username' include enable' section line vty' Confirms configuration was written to NVRAM. Confirms connectivity to switches, PCs, or other routers. Verifies that Router-on-a-Stick routing is working.
General Verification		

Successful Pings from PC1 (VLAN 10):

192.168.0.2 (PC2: VLAN 10)
 192.168.0.129 (PC3: VLAN 20)
 192.168.0.130 (PC\$: VLAN 20)

Successful SSH from PC1 to R1:

```
ssh -l jul 192.168.1.6
password: p@ssword
```



```
PC1
Physical Config Desktop Programming Attributes

Command Prompt
Reply from 192.168.0.2: bytes=32 time<1ms TTL=128
Reply from 192.168.0.2: bytes=32 time=1ms TTL=128
Reply from 192.168.0.2: bytes=32 time<1ms TTL=128
Reply from 192.168.0.2: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.0.2:
  Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
  Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 2ms, Average = 0ms

C:\>cls
Invalid Command.

C:\>ping 192.168.0.129

Pinging 192.168.0.129 with 32 bytes of data:

Request timed out.
Reply from 192.168.0.129: bytes=32 time<1ms TTL=127
Reply from 192.168.0.129: bytes=32 time<1ms TTL=127
Reply from 192.168.0.129: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.0.129:
  Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
  Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 192.168.0.130

Pinging 192.168.0.130 with 32 bytes of data:

Request timed out.
Reply from 192.168.0.130: bytes=32 time<1ms TTL=127
Reply from 192.168.0.130: bytes=32 time<1ms TTL=127
Reply from 192.168.0.130: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.0.130:
  Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
  Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ssh 192.168.0.126 -l jul 192.168.1.6
Invalid Command.

C:\>ssh -l jul 192.168.1.6

Password:

R1>
```

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