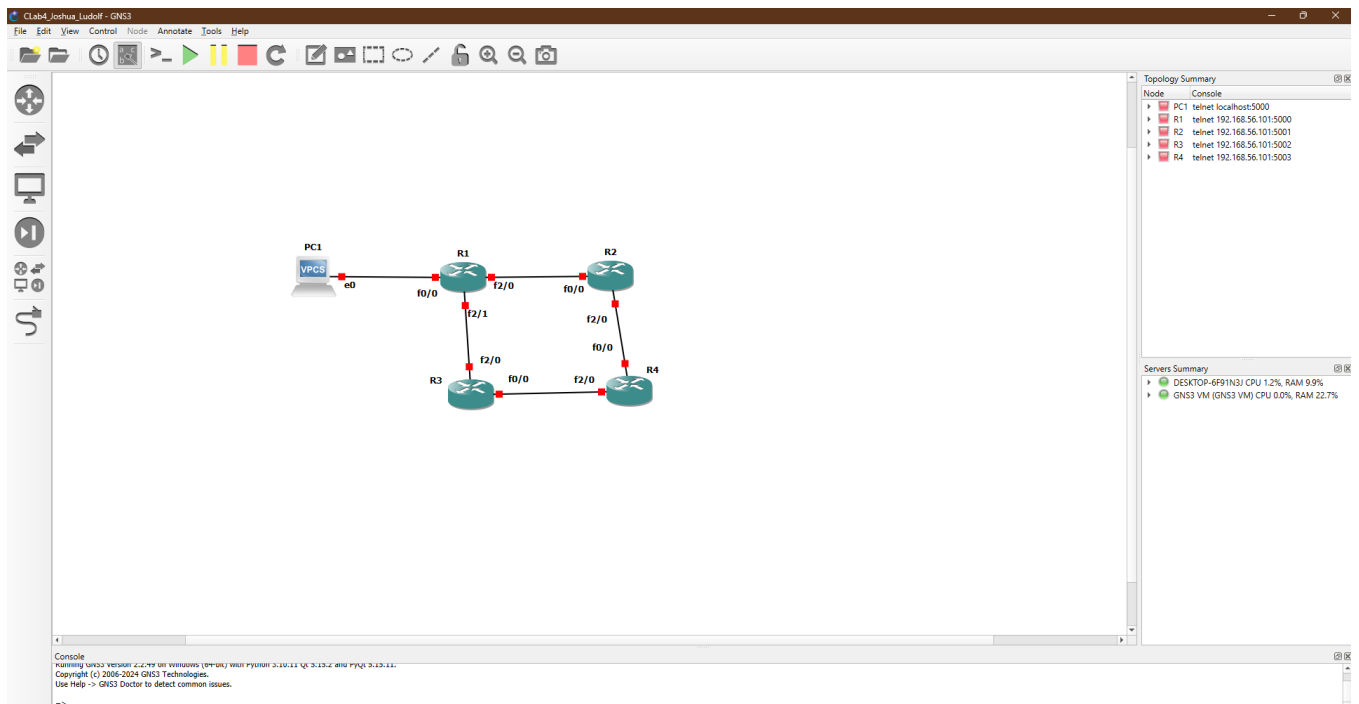


CLab #4: Routers with Access Lists

CSCI 4406 – Computer Networks

Joshua Ludolf

❖ I started this lab by building a topology that had one PC and four routers.



❖ Next, I configured the Internet Protocol (IP) address for PC1 to start the



The screenshot shows a SolarWinds Solar-PuTTY terminal window with a dark background and yellow text. The window has a title bar with tabs for PC1, R1, R2, R3, and R4. The PC1 tab is active. The terminal output shows the following text:

```
Welcome to Virtual PC Simulator, version 0.6.2
Dedicated to Daling.
Build time: Apr 10 2019 02:42:20
Copyright (c) 2007-2014, Paul Meng (mirnshi@gmail.com)
All rights reserved.

VPCS is free software, distributed under the terms of the "BSD" licence.
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC1> ip 192.168.1.2/24 192.168.1.1
Checking for duplicate address...
PC1 : 192.168.1.2 255.255.255.0 gateway 192.168.1.1

PC1> save
Saving startup configuration to startup.vpc
. done

PC1> 
```

The bottom of the window shows the SolarWinds logo and the text "Solar-PuTTY free tool" on the left, and "© 2019-2024 SolarWinds Worldwide, LLC. All rights reserved." on the right.

networking.

❖ Then I configured the routers IP Addresses:

- Router 1 (R1) to connect to Router 2 (R2) and Router 3 (R3)

```

R1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#interface f0/0
R1(config-if)#ip address 192.168.1.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#
*Sep 25 15:31:15.355: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Sep 25 15:31:16.355: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config)#interface f2/0
R1(config-if)#ip address 192.168.12.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#
*Sep 25 15:32:31.191: %LINK-3-UPDOWN: Interface FastEthernet2/0, changed state to up
*Sep 25 15:32:32.191: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up
R1(config)#interface f2/1
R1(config-if)#ip address 192.168.13.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#
*Sep 25 15:33:24.135: %LINK-3-UPDOWN: Interface FastEthernet2/1, changed state to up
*Sep 25 15:33:25.135: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/1, changed state to up

```

- **Router 2 (R2) to connect to Router 1 (R1) and Router 4 (R4)**

```

R2#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#interface f2/0
R2(config-if)#ip address 192.168.24.1 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#exit
R2(config)#interf
*Sep 25 17:01:21.699: %LINK-3-UPDOWN: Interface FastEthernet2/0, changed state to up
R2(config)#interface
*Sep 25 17:01:22.699: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up
R2(config)#interface f0/0
R2(config-if)#ip address 192.168.12.2 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#exit
R2(config)#
*Sep 25 17:01:51.515: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Sep 25 17:01:52.515: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config)#

```

- **Router 3 (R3) to connect to Router 1 (R1) and Router 4 (R4)**

```

R3#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#interface f0/0
R3(config-if)#ip address 192.168.34.2 255.255.255.0
R3(config-if)#no shutdown
R3(config-if)#exit
R3(config)#
*Sep 25 15:46:37.011: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Sep 25 15:46:38.011: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config)#interface f2/0
R3(config-if)#ip address 192.168.13.2 255.255.255.0
R3(config-if)#no shutdown
R3(config-if)#exit
R3(config)#
*Sep 25 15:47:47.823: %LINK-3-UPDOWN: Interface FastEthernet2/0, changed state to up
*Sep 25 15:47:48.823: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up
R3(config)#

```

- **Router 4 (R4) to connect to Router 3 (R3) and Router 2 (R2)**

```
R4#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#interface f0/0
R4(config-if)#ip address 192.168.24.2 255.255.255.0
R4(config-if)#no shutdown
R4(config-if)#exit
R4(config)#
*Sep 25 15:49:46.807: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Sep 25 15:49:47.807: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R4(config)#interface f2/0
R4(config-if)#ip address 192.168.34.1 255.255.255.0
R4(config-if)#no shutdown
R4(config-if)#e
*Sep 25 15:51:07.163: %LINK-3-UPDOWN: Interface FastEthernet2/0, changed state to up
*Sep 25 15:51:08.163: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up
R4(config-if)#
```

- ❖ **After configuring the routers, I configured a loopback in Router 4 (R4)**

```
R4(config-if)#exit
R4(config)#interface Loopback0
R4(config-if)#
*Sep 25 15:51:45.351: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R4(config-if)#ip address 4.4.4.4 255.255.255.255
R4(config-if)#
```

- ❖ **Configuring OSPF on all the routers**

- **Router 1 (R1)**

```
R1(config)#router ospf 1
R1(config-router)#network 192.168.1.0 0.0.0.255 area 0
R1(config-router)#network 192.168.12.0 0.0.0.255 area 0
R1(config-router)#network 192.168.13.0 0.0.0.255 area 0
R1(config-router)#
```

- **Router 2 (R2)**

```
R2(config)#router ospf 1
R2(config-router)#network 192.168.12.0 0.0.0.255 area 0
R2(config-router)#
*Sep 27 15:21:05.791: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.13.1 on FastEthernet0/0 from LOADING to FULL, Loading Done
R2(config-router)#network 192.168.24.0 0.0.0.255 area 0
R2(config-router)#network 192.168.34.0 0.0.0.255 area 0
R2(config-router)#
```

- **Router 3 (R3)**

```
R3(config)#router ospf 1
R3(config-router)#network 192.168.13.0 0.0.0.255 area 0
R3(config-router)#network 192.168.
*Sep 27 15:24:42.211: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.13.1 on FastEthernet2/0 from LOADING to FULL, Loading Done
R3(config-router)#network 192.168.34.0 0.0.0.255 area 0
R3(config-router)#
```

- **Router 4 (R4)**

```
R4(config)#router ospf 1
R4(config-router)#network 192.168.24.0 0.0.0.255 area 0
R4(config-router)#network 1
*Sep 27 15:27:41.699: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.24.1 on FastEthernet0/0 from LOADING to FULL, Loading Done
R4(config-router)#network 192.168.34.0 0.0.0.255 area 0
R4(config-router)#network 4.4.4.4
*Sep 27 15:28:09.911: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.34.2 on FastEthernet2/0 from LOADING to FULL, Loading Done
R4(config-router)#network 4.4.4.4 0.0.0.0 area 0
R4(config-router)#
```

❖ **IP Address routes of all the Routers:**

- **Router 1**

```
R1(config-router)#exit
R1(config)#exit
R1#sh
*Sep 27 15:32:23.787: %SYS-5-CONFIG_I: Configured from console by console
R1#show ip route
Codes: L - local, C - connected, S - static, 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
        i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
        + - replicated route, % - next hop override

Gateway of last resort is not set

    4.0.0.0/32 is subnetted, 1 subnets
O       4.4.4.4 [110/3] via 192.168.13.2, 00:03:57, FastEthernet2/1
          [110/3] via 192.168.12.2, 00:03:57, FastEthernet2/0
    192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.1.0/24 is directly connected, FastEthernet0/0
L       192.168.1.1/32 is directly connected, FastEthernet0/0
    192.168.12.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.12.0/24 is directly connected, FastEthernet2/0
L       192.168.12.1/32 is directly connected, FastEthernet2/0
    192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.13.0/24 is directly connected, FastEthernet2/1
L       192.168.13.1/32 is directly connected, FastEthernet2/1
O       192.168.24.0/24 [110/2] via 192.168.12.2, 00:10:14, FastEthernet2/0
O       192.168.34.0/24 [110/2] via 192.168.13.2, 00:07:24, FastEthernet2/1
R1#
```

○ Router 2 (R2)

```
R2(config-router)#exit
R2(config)#exit
R2#show
*Sep 27 15:37:46.779: %SYS-5-CONFIG_I: Configured from console by console
R2#show ip route
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      4.0.0.0/32 is subnetted, 1 subnets
O       4.4.4.4 [110/2] via 192.168.24.2, 00:09:22, FastEthernet2/0
O       192.168.1.0/24 [110/2] via 192.168.12.1, 00:16:45, FastEthernet0/0
       192.168.12.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.12.0/24 is directly connected, FastEthernet0/0
L       192.168.12.2/32 is directly connected, FastEthernet0/0
O       192.168.13.0/24 [110/2] via 192.168.12.1, 00:16:45, FastEthernet0/0
       192.168.24.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.24.0/24 is directly connected, FastEthernet2/0
L       192.168.24.1/32 is directly connected, FastEthernet2/0
O       192.168.34.0/24 [110/2] via 192.168.24.2, 00:09:42, FastEthernet2/0
R2#
```

○ **Router 3 (R3)**

```
R3(config-router)#exit
R3(config)#exit
R3#sho
*Sep 27 15:38:40.175: %SYS-5-CONFIG_I: Configured from console by console
R3#show ip route
Codes: L - local, C - connected, S - static, 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
        i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
        + - replicated route, % - next hop override

Gateway of last resort is not set

      4.0.0.0/32 is subnetted, 1 subnets
O       4.4.4.4 [110/2] via 192.168.34.1, 00:10:13, FastEthernet0/0
O       192.168.1.0/24 [110/2] via 192.168.13.1, 00:13:54, FastEthernet2/0
O       192.168.12.0/24 [110/2] via 192.168.13.1, 00:13:54, FastEthernet2/0
        192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
C         192.168.13.0/24 is directly connected, FastEthernet2/0
L         192.168.13.2/32 is directly connected, FastEthernet2/0
O       192.168.24.0/24 [110/2] via 192.168.34.1, 00:10:33, FastEthernet0/0
        192.168.34.0/24 is variably subnetted, 2 subnets, 2 masks
C         192.168.34.0/24 is directly connected, FastEthernet0/0
L         192.168.34.2/32 is directly connected, FastEthernet0/0
R3#
```

- **Router 4 (R4)**

```
R4(config-router)#exit
R4(config)#exit
R4#
*Sep 27 15:39:39.339: %SYS-5-CONFIG_I: Configured from console by console
R4#show ip route
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      4.0.0.0/32 is subnetted, 1 subnets
C       4.4.4.4 is directly connected, Loopback0
O       192.168.1.0/24 [110/3] via 192.168.34.2, 00:11:34, FastEthernet2/0
        [110/3] via 192.168.24.1, 00:11:54, FastEthernet0/0
O       192.168.12.0/24 [110/2] via 192.168.24.1, 00:11:54, FastEthernet0/0
O       192.168.13.0/24 [110/2] via 192.168.34.2, 00:11:34, FastEthernet2/0
        192.168.24.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.24.0/24 is directly connected, FastEthernet0/0
L       192.168.24.2/32 is directly connected, FastEthernet0/0
        192.168.34.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.34.0/24 is directly connected, FastEthernet2/0
L       192.168.34.1/32 is directly connected, FastEthernet2/0
R4#
```

- ❖ Then I wanted to test PC1 connection to the Loopback that's connected to Router 4 (R4)

```
PC1> ping 4.4.4.4

84 bytes from 4.4.4.4 icmp_seq=1 ttl=253 time=131.037 ms
84 bytes from 4.4.4.4 icmp_seq=2 ttl=253 time=146.562 ms
84 bytes from 4.4.4.4 icmp_seq=3 ttl=253 time=174.941 ms
84 bytes from 4.4.4.4 icmp_seq=4 ttl=253 time=115.958 ms
84 bytes from 4.4.4.4 icmp_seq=5 ttl=253 time=112.523 ms
```

- ❖ Changing the routing path to control all of ICMP traffic from PC1 going to the Loopback (4.4.4.4) to cross the link between Router 1 (R1) and Router 3

(R3)

```
R1#show route-map
R1#config
Configuring from terminal, memory, or network [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#ip access-list extended ICMP_H1
R1(config-ext-nacl)#permit icmp host 192.168.1.100 host 4.4.4.4
R1(config-ext-nacl)#exit
R1(config)#PBR_H1 permit 10
      ^
% Invalid input detected at '^' marker.

R1(config)#route-map PBR_H1 permit 10
R1(config-route-map)#match ip address ICMP_H1
R1(config-route-map)#set ip next-hop 192.168.13.2
R1(config-route-map)#exit
R1(config)#ip local policy route-map PBR_R1
R1(config)#show route-map
      ^
% Invalid input detected at '^' marker.

R1(config)#exit
R1#show
*Sep 27 15:45:58.803: %SYS-5-CONFIG_I: Configured from console by console
R1#show route-map
route-map PBR_H1, permit, sequence 10
  Match clauses:
    ip address (access-lists): ICMP_H1
  Set clauses:
    ip next-hop 192.168.13.2
  Policy routing matches: 0 packets, 0 bytes
R1#
```

❖ **Finally, I tested the new route mapping policy**

```
PC1> ping 4.4.4.4

84 bytes from 4.4.4.4 icmp_seq=1 ttl=253 time=174.132 ms
84 bytes from 4.4.4.4 icmp_seq=2 ttl=253 time=177.237 ms
84 bytes from 4.4.4.4 icmp_seq=3 ttl=253 time=146.605 ms
84 bytes from 4.4.4.4 icmp_seq=4 ttl=253 time=132.807 ms
84 bytes from 4.4.4.4 icmp_seq=5 ttl=253 time=116.393 ms
```

❖ **What I learned from this lab:**

In this Lab, I learned how to configure a router to have a Loopback mechanism; this mechanism is very important if I came across a situation where there is only one personal computer device connected to the network with a few routers. Additionally, how to create the policy for rerouting Internet Control Messaging Protocol (ICMP) from a personal computer device to itself (via 4.4.4.4 – the loopback). The policy for Internet Control Messaging Protocol is very useful for protecting device errors from getting to a hacker.

