به نام خدا

گزارش پروژه ۲ شبکه های کامپیوتری

Introduction to GNS3

دانشگاه تهران

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دانشکده مهندسی برق و کامپیوتر

۱. مقدمه و نصب ابزار

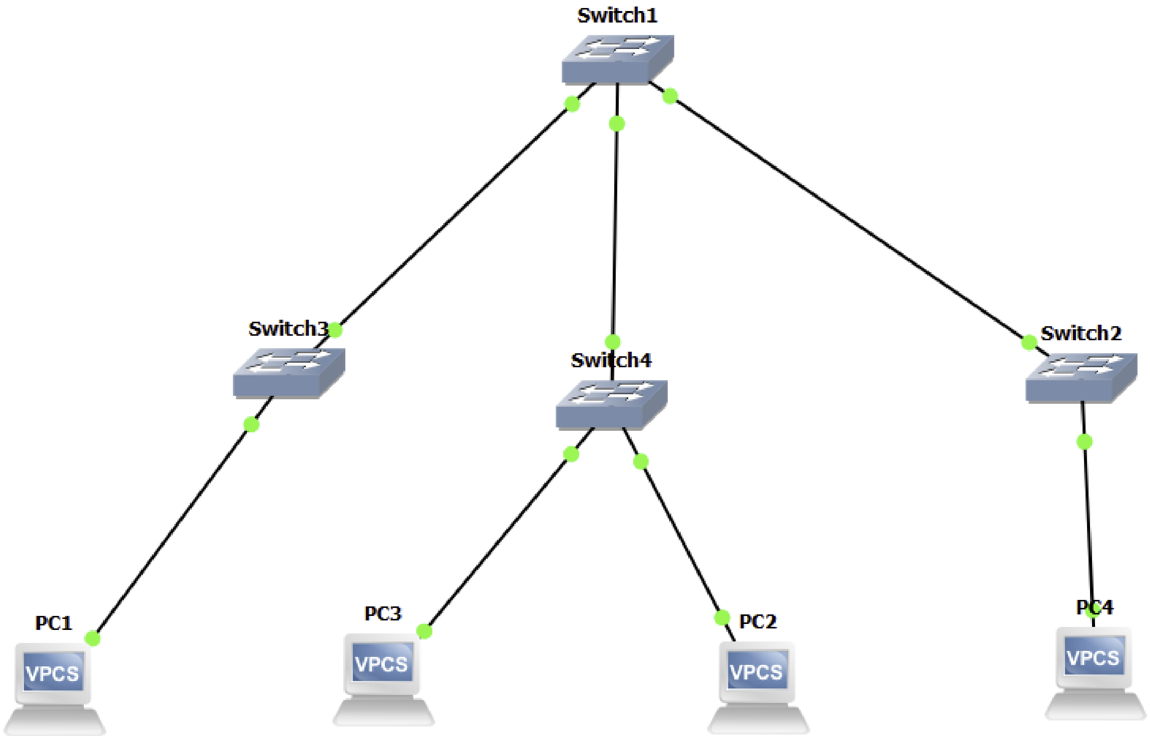
توضیحات Slot در تنظیم روتر:

اسلات‌ها بخش‌هایی از سخت‌افزار روتر هستند که ماژول‌های مختلف مانند InterFace های اترنت روی آن‌ها نصب می‌شوند و به روتر اجازه می‌دهند تا با انواع مختلفی از شبکه‌ها ارتباط برقرار کرده و ترافیک داده را بین دستگاه‌ها مسیریابی کند.

همچنین ۲ نوع PA-2FE-TX و PA-4T داریم که اولی معمولا برای مدیریت ارتباط اترنت در LAN و دومی معمولا برای مدیریت ارتباط های سریال در شبکه WAN کاربرد دارد.

مزایا: انعطاف پذیری در تغییر پورت ها، شبیه سازی نزدیک به واقعیت و امکان اتصال چندین شبکه و دستگاه.

۲. آشنایی با نرم افزار

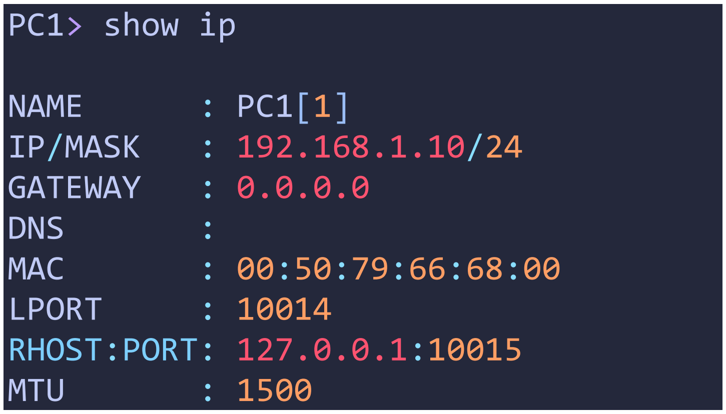


توپولوژی شبکه

Topology Summary:

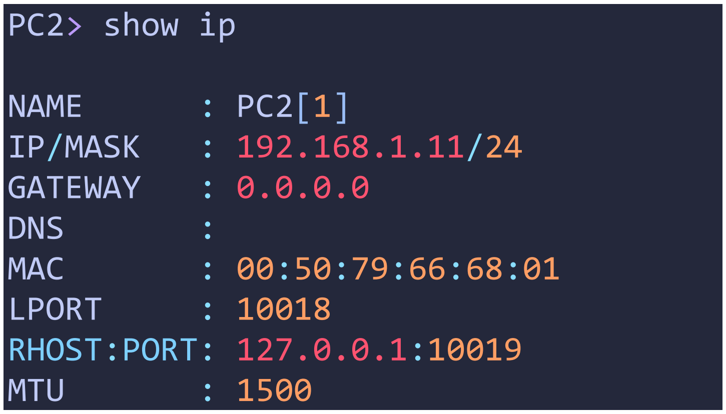
- **Switch1** connected to **Switch2**, **Switch3**, and **Switch4**.
- **PC1** connected to **Switch3**.
- **PC2** and **PC3** connected to **Switch4**.
- **PC4** connected to **Switch2**.
- IP Range: **192.168.1.0/24**

أ. ابتدا با دستور IP مقدار IP هر PC را ست میکنیم و اطلاعات آنرا بررسی میکنیم.



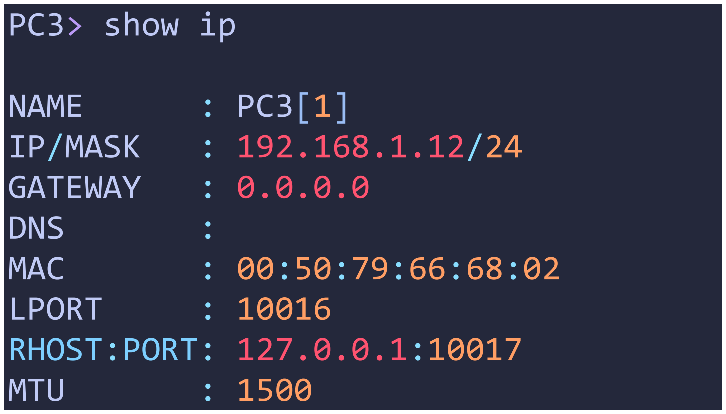
```
PC1> show ip

NAME        : PC1[1]
IP/MASK     : 192.168.1.10/24
GATEWAY     : 0.0.0.0
DNS         :
MAC         : 00:50:79:66:68:00
LPORT       : 10014
RHOST:PORT  : 127.0.0.1:10015
MTU         : 1500
```

IP-PC1



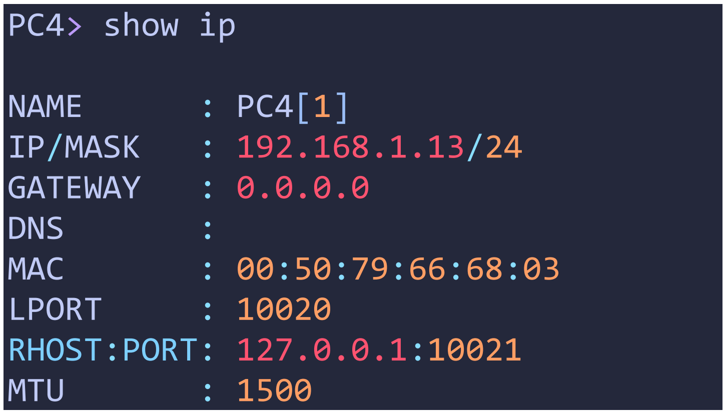
```
PC2> show ip

NAME        : PC2[1]
IP/MASK     : 192.168.1.11/24
GATEWAY     : 0.0.0.0
DNS         :
MAC         : 00:50:79:66:68:01
LPORT       : 10018
RHOST:PORT  : 127.0.0.1:10019
MTU         : 1500
```

IP-PC2



```
PC3> show ip

NAME        : PC3[1]
IP/MASK     : 192.168.1.12/24
GATEWAY     : 0.0.0.0
DNS         :
MAC         : 00:50:79:66:68:02
LPORT       : 10016
RHOST:PORT  : 127.0.0.1:10017
MTU         : 1500
```

IP-PC3



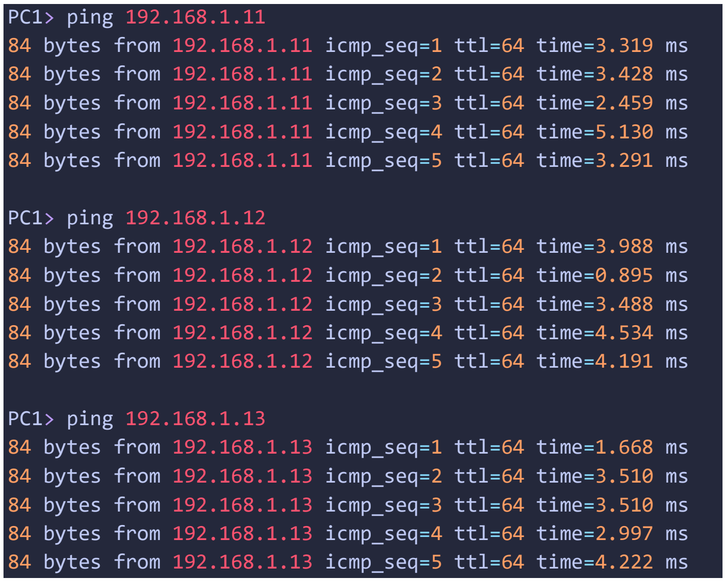
```
PC4> show ip

NAME        : PC4[1]
IP/MASK     : 192.168.1.13/24
GATEWAY     : 0.0.0.0
DNS         :
MAC         : 00:50:79:66:68:03
LPORT       : 10020
RHOST:PORT  : 127.0.0.1:10021
MTU         : 1500
```

IP-PC4

همانطور که مشخص است برای هر یک از PC ها یک مقدار IP مشخص داریم که در ادامه به عنوان شناسه هر سیستم از آن استفاده میکنیم و ping هر کدام را با دیگری بررسی میکنیم. (خلاصه دستورات وارد شده نیز در پایین آمده)

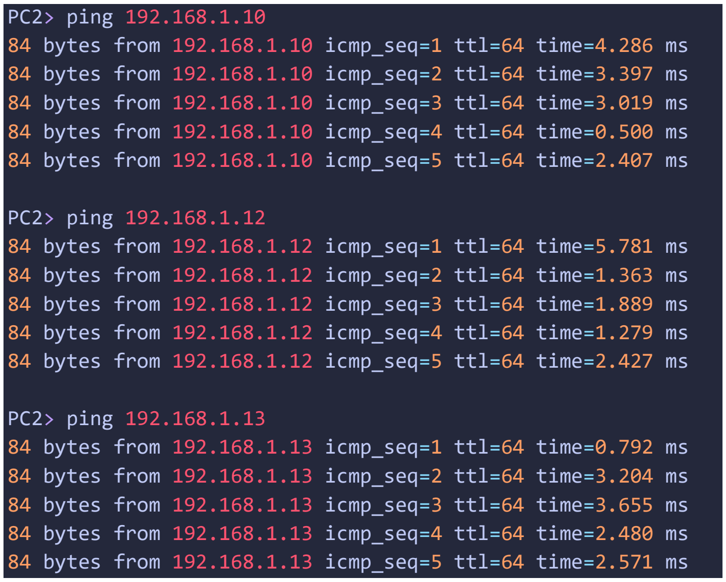
Device	Command	Purpose
PC1	`ip 192.168.1.10 255.255.255.0`	Set IP address for PC1
	`save pc1_config.txt`	Save PC1 configuration
PC2	`ip 192.168.1.11 255.255.255.0`	Set IP address for PC2
	`save pc2_config.txt`	Save PC2 configuration
PC3	`ip 192.168.1.12 255.255.255.0`	Set IP address for PC3
	`save pc3_config.txt`	Save PC3 configuration
PC4	`ip 192.168.1.13 255.255.255.0`	Set IP address for PC4
	`save pc4_config.txt`	Save PC4 configuration
All PCs	`ping [target IP]`	Test connectivity between devices in the network

ب. بررسی ping هر PC با تمام PC های دیگر



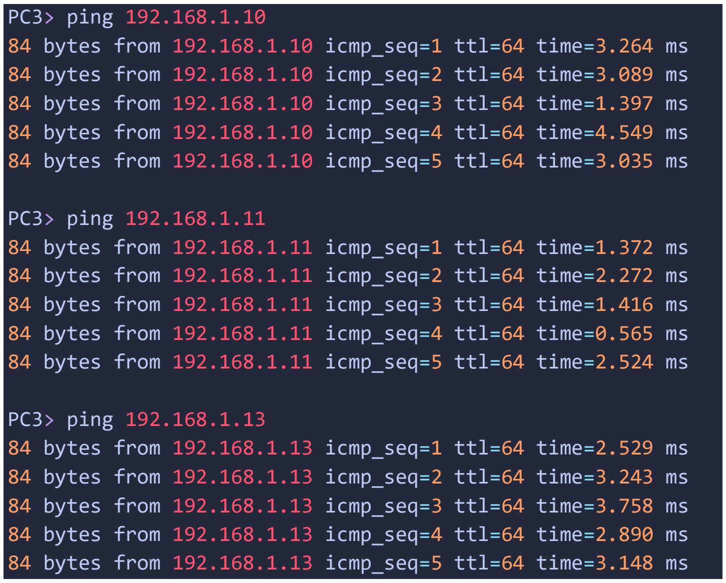
```
PC1> ping 192.168.1.11
84 bytes from 192.168.1.11 icmp_seq=1 ttl=64 time=3.319 ms
84 bytes from 192.168.1.11 icmp_seq=2 ttl=64 time=3.428 ms
84 bytes from 192.168.1.11 icmp_seq=3 ttl=64 time=2.459 ms
84 bytes from 192.168.1.11 icmp_seq=4 ttl=64 time=5.130 ms
84 bytes from 192.168.1.11 icmp_seq=5 ttl=64 time=3.291 ms

PC1> ping 192.168.1.12
84 bytes from 192.168.1.12 icmp_seq=1 ttl=64 time=3.988 ms
84 bytes from 192.168.1.12 icmp_seq=2 ttl=64 time=0.895 ms
84 bytes from 192.168.1.12 icmp_seq=3 ttl=64 time=3.488 ms
84 bytes from 192.168.1.12 icmp_seq=4 ttl=64 time=4.534 ms
84 bytes from 192.168.1.12 icmp_seq=5 ttl=64 time=4.191 ms

PC1> ping 192.168.1.13
84 bytes from 192.168.1.13 icmp_seq=1 ttl=64 time=1.668 ms
84 bytes from 192.168.1.13 icmp_seq=2 ttl=64 time=3.510 ms
84 bytes from 192.168.1.13 icmp_seq=3 ttl=64 time=3.510 ms
84 bytes from 192.168.1.13 icmp_seq=4 ttl=64 time=2.997 ms
84 bytes from 192.168.1.13 icmp_seq=5 ttl=64 time=4.222 ms
```

PC1 Ping with others



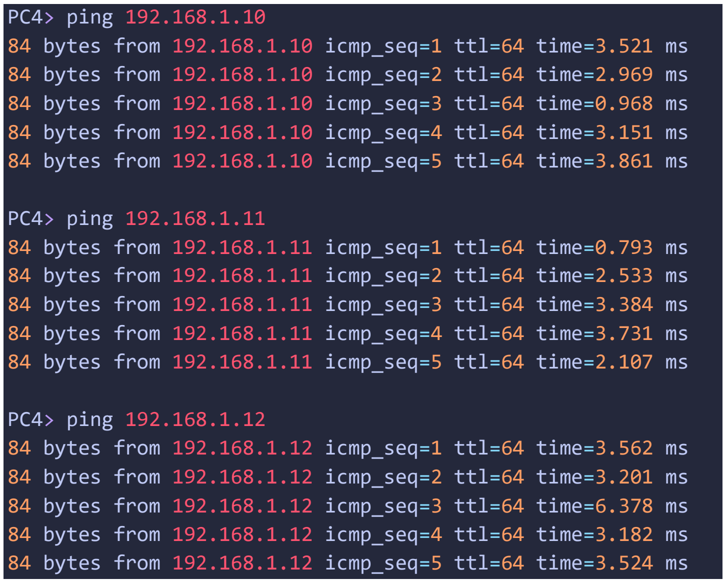
```
PC2> ping 192.168.1.10
84 bytes from 192.168.1.10 icmp_seq=1 ttl=64 time=4.286 ms
84 bytes from 192.168.1.10 icmp_seq=2 ttl=64 time=3.397 ms
84 bytes from 192.168.1.10 icmp_seq=3 ttl=64 time=3.019 ms
84 bytes from 192.168.1.10 icmp_seq=4 ttl=64 time=0.500 ms
84 bytes from 192.168.1.10 icmp_seq=5 ttl=64 time=2.407 ms

PC2> ping 192.168.1.12
84 bytes from 192.168.1.12 icmp_seq=1 ttl=64 time=5.781 ms
84 bytes from 192.168.1.12 icmp_seq=2 ttl=64 time=1.363 ms
84 bytes from 192.168.1.12 icmp_seq=3 ttl=64 time=1.889 ms
84 bytes from 192.168.1.12 icmp_seq=4 ttl=64 time=1.279 ms
84 bytes from 192.168.1.12 icmp_seq=5 ttl=64 time=2.427 ms

PC2> ping 192.168.1.13
84 bytes from 192.168.1.13 icmp_seq=1 ttl=64 time=0.792 ms
84 bytes from 192.168.1.13 icmp_seq=2 ttl=64 time=3.204 ms
84 bytes from 192.168.1.13 icmp_seq=3 ttl=64 time=3.655 ms
84 bytes from 192.168.1.13 icmp_seq=4 ttl=64 time=2.480 ms
84 bytes from 192.168.1.13 icmp_seq=5 ttl=64 time=2.571 ms
```

PC2 Ping with others



```
PC3> ping 192.168.1.10
84 bytes from 192.168.1.10 icmp_seq=1 ttl=64 time=3.264 ms
84 bytes from 192.168.1.10 icmp_seq=2 ttl=64 time=3.089 ms
84 bytes from 192.168.1.10 icmp_seq=3 ttl=64 time=1.397 ms
84 bytes from 192.168.1.10 icmp_seq=4 ttl=64 time=4.549 ms
84 bytes from 192.168.1.10 icmp_seq=5 ttl=64 time=3.035 ms

PC3> ping 192.168.1.11
84 bytes from 192.168.1.11 icmp_seq=1 ttl=64 time=1.372 ms
84 bytes from 192.168.1.11 icmp_seq=2 ttl=64 time=2.272 ms
84 bytes from 192.168.1.11 icmp_seq=3 ttl=64 time=1.416 ms
84 bytes from 192.168.1.11 icmp_seq=4 ttl=64 time=0.565 ms
84 bytes from 192.168.1.11 icmp_seq=5 ttl=64 time=2.524 ms

PC3> ping 192.168.1.13
84 bytes from 192.168.1.13 icmp_seq=1 ttl=64 time=2.529 ms
84 bytes from 192.168.1.13 icmp_seq=2 ttl=64 time=3.243 ms
84 bytes from 192.168.1.13 icmp_seq=3 ttl=64 time=3.758 ms
84 bytes from 192.168.1.13 icmp_seq=4 ttl=64 time=2.890 ms
84 bytes from 192.168.1.13 icmp_seq=5 ttl=64 time=3.148 ms
```

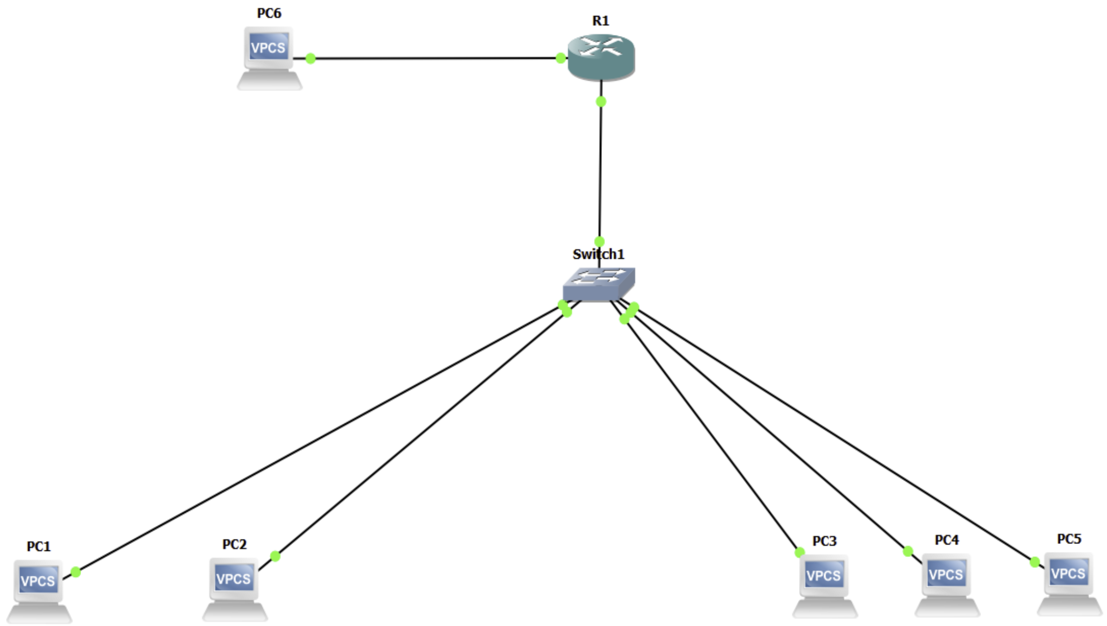
PC3 Ping with others



```
PC4> ping 192.168.1.10
84 bytes from 192.168.1.10 icmp_seq=1 ttl=64 time=3.521 ms
84 bytes from 192.168.1.10 icmp_seq=2 ttl=64 time=2.969 ms
84 bytes from 192.168.1.10 icmp_seq=3 ttl=64 time=0.968 ms
84 bytes from 192.168.1.10 icmp_seq=4 ttl=64 time=3.151 ms
84 bytes from 192.168.1.10 icmp_seq=5 ttl=64 time=3.861 ms

PC4> ping 192.168.1.11
84 bytes from 192.168.1.11 icmp_seq=1 ttl=64 time=0.793 ms
84 bytes from 192.168.1.11 icmp_seq=2 ttl=64 time=2.533 ms
84 bytes from 192.168.1.11 icmp_seq=3 ttl=64 time=3.384 ms
84 bytes from 192.168.1.11 icmp_seq=4 ttl=64 time=3.731 ms
84 bytes from 192.168.1.11 icmp_seq=5 ttl=64 time=2.107 ms

PC4> ping 192.168.1.12
84 bytes from 192.168.1.12 icmp_seq=1 ttl=64 time=3.562 ms
84 bytes from 192.168.1.12 icmp_seq=2 ttl=64 time=3.201 ms
84 bytes from 192.168.1.12 icmp_seq=3 ttl=64 time=6.378 ms
84 bytes from 192.168.1.12 icmp_seq=4 ttl=64 time=3.182 ms
84 bytes from 192.168.1.12 icmp_seq=5 ttl=64 time=3.524 ms
```

PC4 Ping with others

۳. VLAN



توپولوژی شبکه

توپولوژی مشخص‌شده شامل چند سوئیچ، روتر، و کامپیوتر است که هر VLAN در یک رنج آی‌پی قرار دارد:

- **VLAN 30**: با آدرس شبکه **192.168.30.0/24**.
- **VLAN 40**: با آدرس شبکه **192.168.40.0/24**.
-

مراحل Switch Configuration:

بخشی از این مراحل به صورت دستی در نرم افزار انجام شده که به صورت زیر میباشد:
برای اضافه کردن **VLAN** ، وارد بخش تنظیمات (Config) سوییچ شده و **VLAN 30** را ایجاد می‌کنیم.
برای تنظیم حالت **Trunk** ، در قسمت مربوط به سیم، نوع (Type) را روی **dot1q** قرار می‌دهیم.

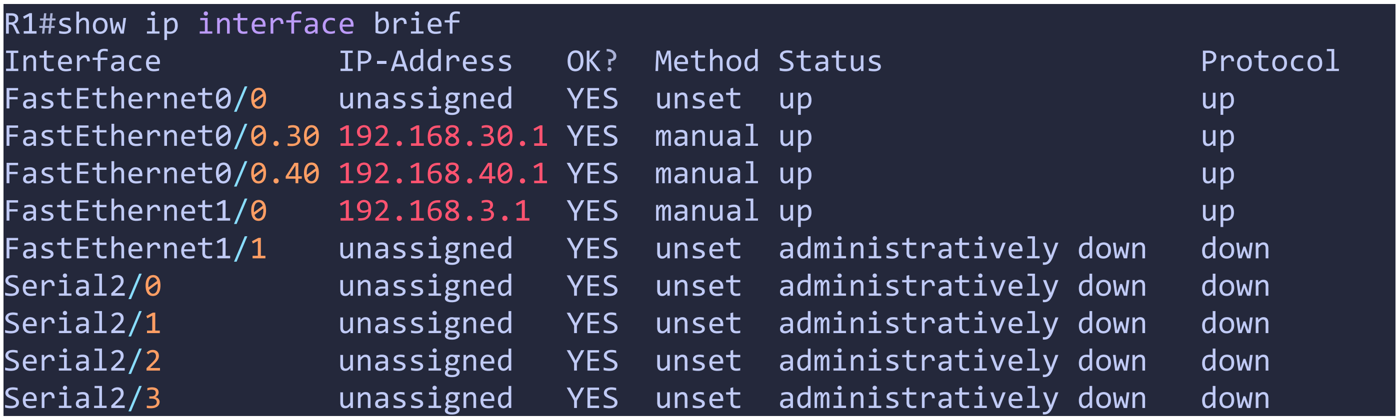
1. **راه اندازی VLANs**
2. **کانفیگ Access Points**
3. **کانفیگ Trunk Link**

مراحل Router Configuration:

1. **کانفیگ Sub-Interfaces و Inter-VLAN**
2. **کانفیگ Interface برای شبکه PC6**

مراحل تست و صحت سنجی:

۱. وضعیت Interface ها

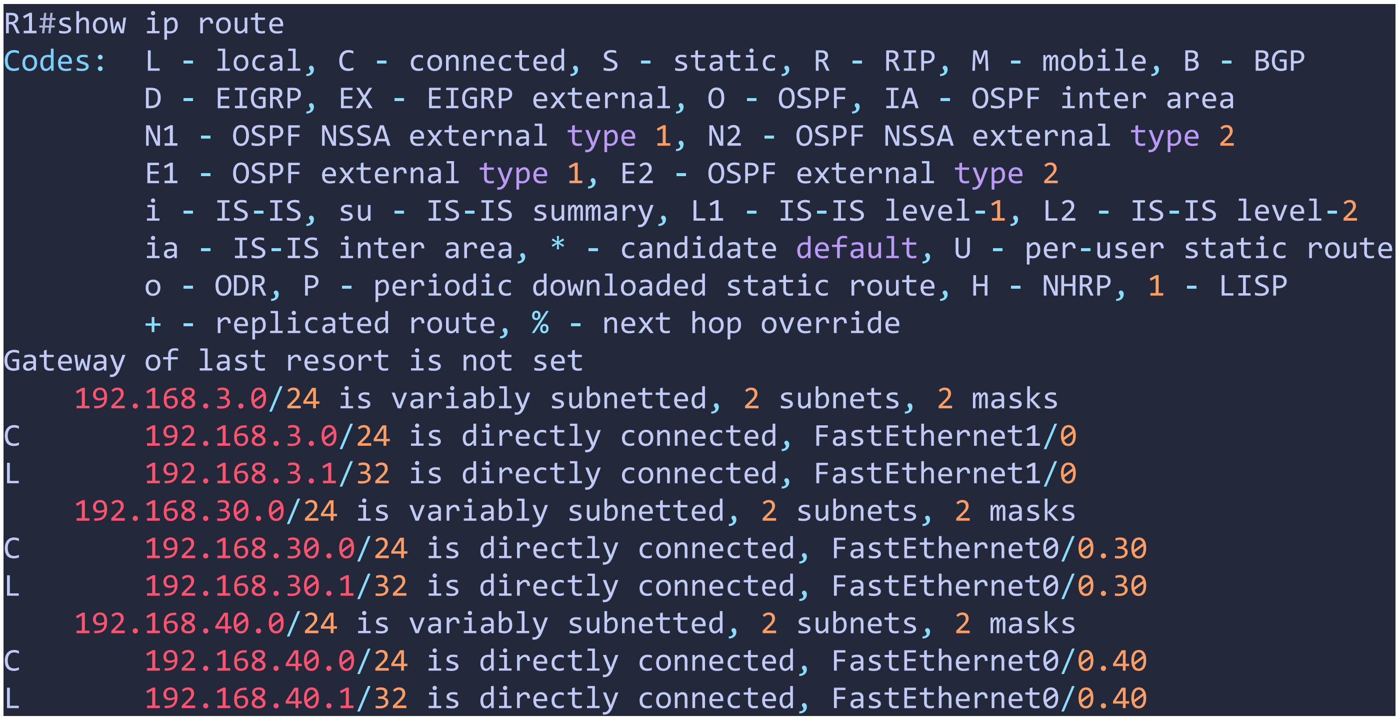


```
R1#show ip interface brief
Interface          IP-Address    OK?  Method Status                 Protocol
FastEthernet0/0    unassigned    YES  unset  up                     up
FastEthernet0/0.30 192.168.30.1 YES  manual up                     up
FastEthernet0/0.40 192.168.40.1 YES  manual up                     up
FastEthernet1/0    192.168.3.1  YES  manual up                     up
FastEthernet1/1    unassigned    YES  unset  administratively down  down
Serial2/0          unassigned    YES  unset  administratively down  down
Serial2/1          unassigned    YES  unset  administratively down  down
Serial2/2          unassigned    YES  unset  administratively down  down
Serial2/3          unassigned    YES  unset  administratively down  down
```

IP Interface

این خروجی وضعیت کلی اینترفیس‌های روتر را نشان می‌دهد، از جمله آدرس‌های IP ، وضعیت عملیاتی (up یا down) و پروتکل‌ها. برای هر اینترفیس مشخص می‌کند که آیا فعال است یا خیر و به چه شبکه‌ای متصل شده است.

۲. وضعیت Routing Table

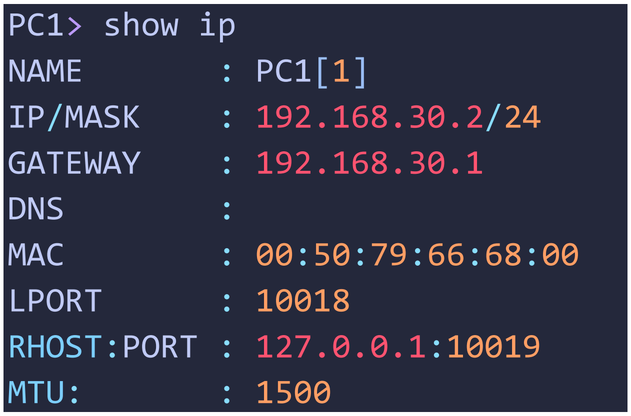


```
R1#show ip route
Codes:  L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
        D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        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
    192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.3.0/24 is directly connected, FastEthernet1/0
L       192.168.3.1/32 is directly connected, FastEthernet1/0
    192.168.30.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.30.0/24 is directly connected, FastEthernet0/0.30
L       192.168.30.1/32 is directly connected, FastEthernet0/0.30
    192.168.40.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.40.0/24 is directly connected, FastEthernet0/0.40
L       192.168.40.1/32 is directly connected, FastEthernet0/0.40
```

Routing Table

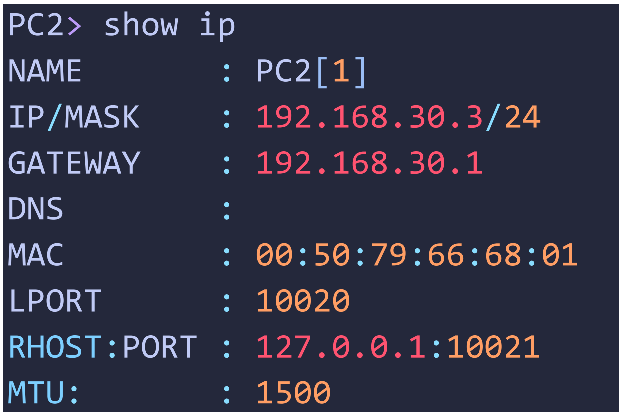
این جدول مسیرهای موجود در روتر را نمایش می‌دهد. مسیرهای متصل مستقیم (C) و آدرس‌های محلی (L) نشان می‌دهد که این شبکه‌ها یا اینترفیس‌ها به صورت مستقیم به روتر وصل شده‌اند. این خروجی، نحوه مسیریابی روتر برای دسترسی به شبکه‌های VLAN و سایر بخش‌های متصل را نشان می‌دهد.

۳. مشاهده PC IP ها



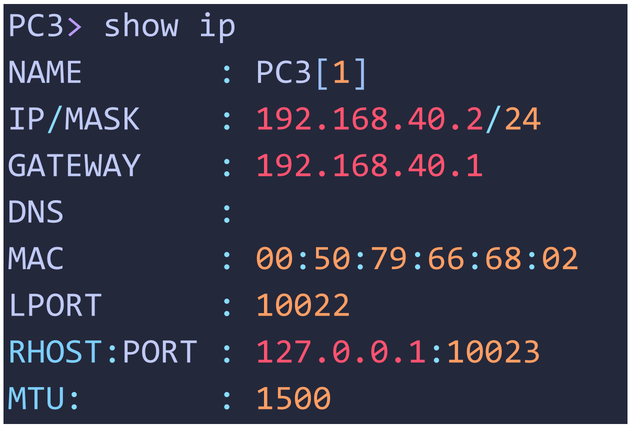
```
PC1> show ip
NAME        : PC1[1]
IP/MASK     : 192.168.30.2/24
GATEWAY     : 192.168.30.1
DNS         :
MAC         : 00:50:79:66:68:00
LPORT       : 10018
RHOST:PORT  : 127.0.0.1:10019
MTU:        : 1500
```

IP-PC1



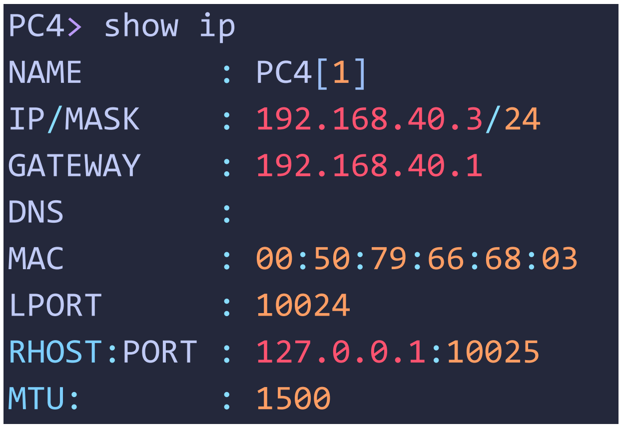
```
PC2> show ip
NAME        : PC2[1]
IP/MASK     : 192.168.30.3/24
GATEWAY     : 192.168.30.1
DNS         :
MAC         : 00:50:79:66:68:01
LPORT       : 10020
RHOST:PORT  : 127.0.0.1:10021
MTU:        : 1500
```

IP-PC2



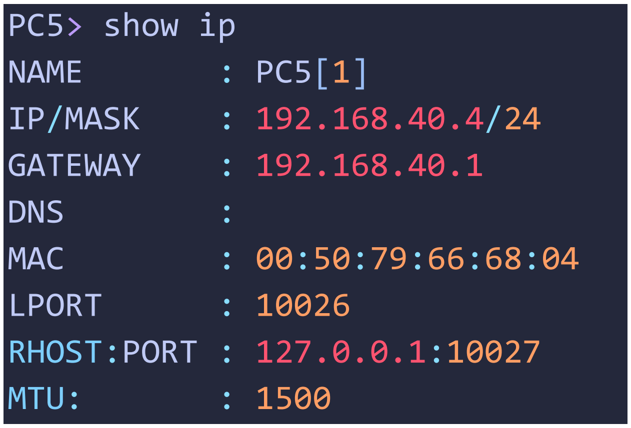
```
PC3> show ip
NAME        : PC3[1]
IP/MASK     : 192.168.40.2/24
GATEWAY     : 192.168.40.1
DNS         :
MAC         : 00:50:79:66:68:02
LPORT       : 10022
RHOST:PORT  : 127.0.0.1:10023
MTU:        : 1500
```

IP-PC3



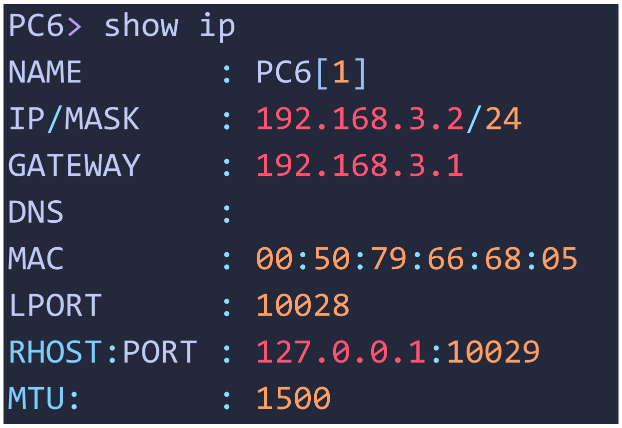
```
PC4> show ip
NAME        : PC4[1]
IP/MASK     : 192.168.40.3/24
GATEWAY     : 192.168.40.1
DNS         :
MAC         : 00:50:79:66:68:03
LPORT       : 10024
RHOST:PORT  : 127.0.0.1:10025
MTU:        : 1500
```

IP-PC4



```
PC5> show ip
NAME        : PC5[1]
IP/MASK     : 192.168.40.4/24
GATEWAY     : 192.168.40.1
DNS         :
MAC         : 00:50:79:66:68:04
LPORT       : 10026
RHOST:PORT  : 127.0.0.1:10027
MTU:        : 1500
```

IP-PC5



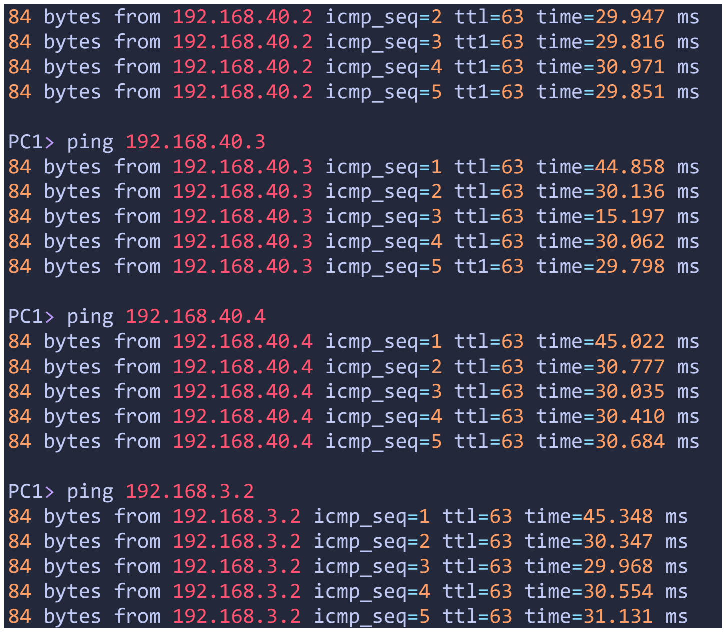
```
PC6> show ip
NAME        : PC6[1]
IP/MASK     : 192.168.3.2/24
GATEWAY     : 192.168.3.1
DNS         :
MAC         : 00:50:79:66:68:05
LPORT       : 10028
RHOST:PORT  : 127.0.0.1:10029
MTU:        : 1500
```

IP-PC6

۴. پینگ PC های یک VLAN با PC های VLAN دیگر

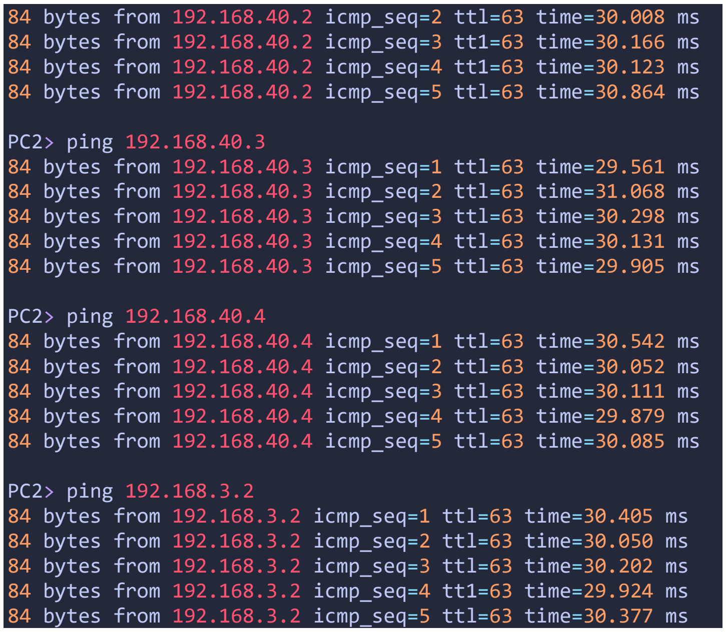
```
PC1> ping 192.168.40.2
84 bytes from 192.168.40.2 icmp_seq=1 ttl=63 time=60.935 ms
```

```
PC2> ping 192.168.40.2
84 bytes from 192.168.40.2 icmp_seq=1 ttl=63 time=31.135 ms
```



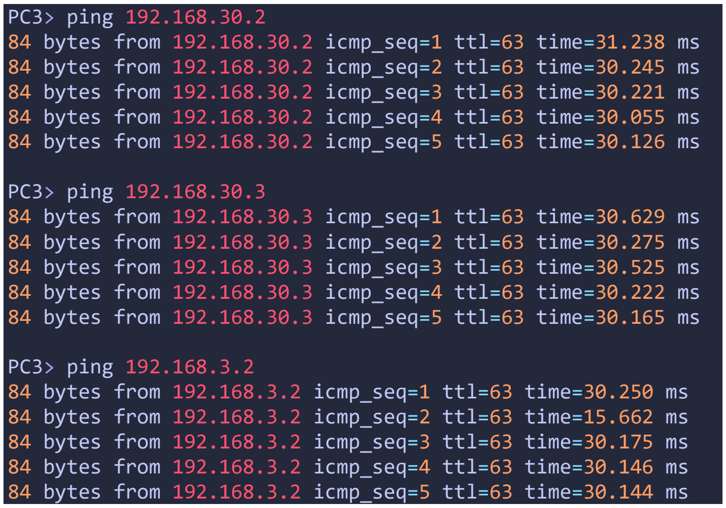
```
84 bytes from 192.168.40.2 icmp_seq=2 ttl=63 time=29.947 ms
84 bytes from 192.168.40.2 icmp_seq=3 tt1=63 time=29.816 ms
84 bytes from 192.168.40.2 icmp_seq=4 tt1=63 time=30.971 ms
84 bytes from 192.168.40.2 icmp_seq=5 tt1=63 time=29.851 ms

PC1> ping 192.168.40.3
84 bytes from 192.168.40.3 icmp_seq=1 ttl=63 time=44.858 ms
84 bytes from 192.168.40.3 icmp_seq=2 ttl=63 time=30.136 ms
84 bytes from 192.168.40.3 icmp_seq=3 ttl=63 time=15.197 ms
84 bytes from 192.168.40.3 icmp_seq=4 ttl=63 time=30.062 ms
84 bytes from 192.168.40.3 icmp_seq=5 tt1=63 time=29.798 ms

PC1> ping 192.168.40.4
84 bytes from 192.168.40.4 icmp_seq=1 ttl=63 time=45.022 ms
84 bytes from 192.168.40.4 icmp_seq=2 ttl=63 time=30.777 ms
84 bytes from 192.168.40.4 icmp_seq=3 ttl=63 time=30.035 ms
84 bytes from 192.168.40.4 icmp_seq=4 ttl=63 time=30.410 ms
84 bytes from 192.168.40.4 icmp_seq=5 ttl=63 time=30.684 ms

PC1> ping 192.168.3.2
84 bytes from 192.168.3.2 icmp_seq=1 ttl=63 time=45.348 ms
84 bytes from 192.168.3.2 icmp_seq=2 ttl=63 time=30.347 ms
84 bytes from 192.168.3.2 icmp_seq=3 ttl=63 time=29.968 ms
84 bytes from 192.168.3.2 icmp_seq=4 ttl=63 time=30.554 ms
84 bytes from 192.168.3.2 icmp_seq=5 ttl=63 time=31.131 ms
```

PC1 Ping with others



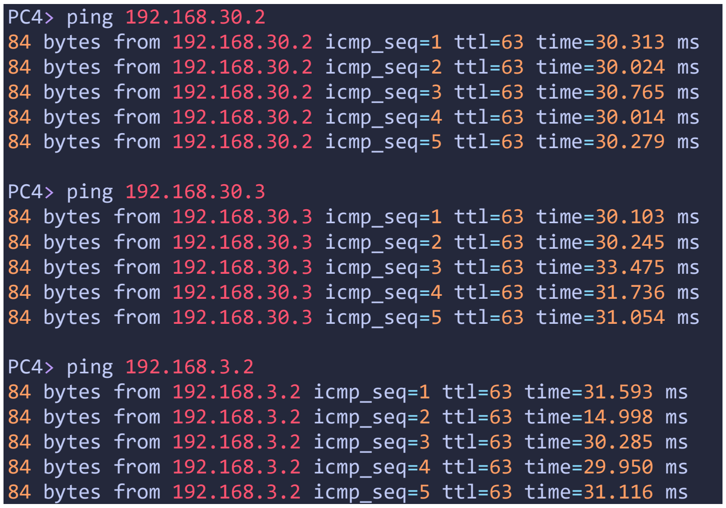
```
84 bytes from 192.168.40.2 icmp_seq=2 ttl=63 time=30.008 ms
84 bytes from 192.168.40.2 icmp_seq=3 ttl=63 time=30.166 ms
84 bytes from 192.168.40.2 icmp_seq=4 ttl=63 time=30.123 ms
84 bytes from 192.168.40.2 icmp_seq=5 ttl=63 time=30.864 ms

PC2> ping 192.168.40.3
84 bytes from 192.168.40.3 icmp_seq=1 ttl=63 time=29.561 ms
84 bytes from 192.168.40.3 icmp_seq=2 ttl=63 time=31.068 ms
84 bytes from 192.168.40.3 icmp_seq=3 ttl=63 time=30.298 ms
84 bytes from 192.168.40.3 icmp_seq=4 ttl=63 time=30.131 ms
84 bytes from 192.168.40.3 icmp_seq=5 ttl=63 time=29.905 ms

PC2> ping 192.168.40.4
84 bytes from 192.168.40.4 icmp_seq=1 ttl=63 time=30.542 ms
84 bytes from 192.168.40.4 icmp_seq=2 ttl=63 time=30.052 ms
84 bytes from 192.168.40.4 icmp_seq=3 ttl=63 time=30.111 ms
84 bytes from 192.168.40.4 icmp_seq=4 ttl=63 time=29.879 ms
84 bytes from 192.168.40.4 icmp_seq=5 ttl=63 time=30.085 ms

PC2> ping 192.168.3.2
84 bytes from 192.168.3.2 icmp_seq=1 ttl=63 time=30.405 ms
84 bytes from 192.168.3.2 icmp_seq=2 ttl=63 time=30.050 ms
84 bytes from 192.168.3.2 icmp_seq=3 ttl=63 time=30.202 ms
84 bytes from 192.168.3.2 icmp_seq=4 tt1=63 time=29.924 ms
84 bytes from 192.168.3.2 icmp_seq=5 ttl=63 time=30.377 ms
```

PC2 Ping with others



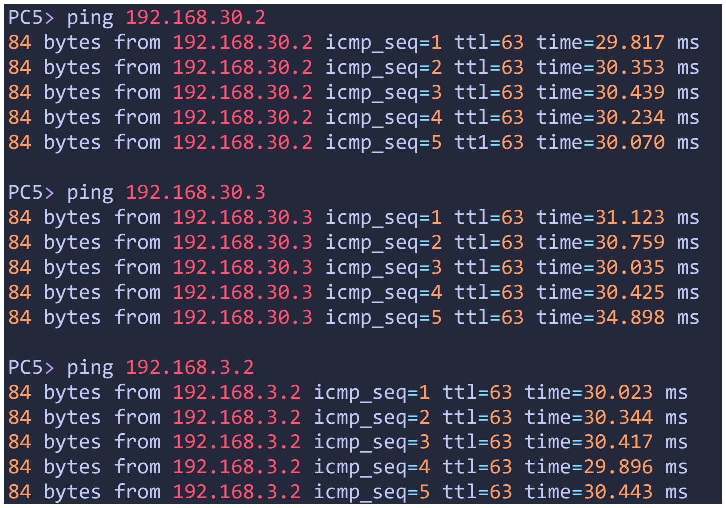
```
PC3> ping 192.168.30.2
84 bytes from 192.168.30.2 icmp_seq=1 ttl=63 time=31.238 ms
84 bytes from 192.168.30.2 icmp_seq=2 ttl=63 time=30.245 ms
84 bytes from 192.168.30.2 icmp_seq=3 ttl=63 time=30.221 ms
84 bytes from 192.168.30.2 icmp_seq=4 ttl=63 time=30.055 ms
84 bytes from 192.168.30.2 icmp_seq=5 ttl=63 time=30.126 ms

PC3> ping 192.168.30.3
84 bytes from 192.168.30.3 icmp_seq=1 ttl=63 time=30.629 ms
84 bytes from 192.168.30.3 icmp_seq=2 ttl=63 time=30.275 ms
84 bytes from 192.168.30.3 icmp_seq=3 ttl=63 time=30.525 ms
84 bytes from 192.168.30.3 icmp_seq=4 ttl=63 time=30.222 ms
84 bytes from 192.168.30.3 icmp_seq=5 ttl=63 time=30.165 ms

PC3> ping 192.168.3.2
84 bytes from 192.168.3.2 icmp_seq=1 ttl=63 time=30.250 ms
84 bytes from 192.168.3.2 icmp_seq=2 ttl=63 time=15.662 ms
84 bytes from 192.168.3.2 icmp_seq=3 ttl=63 time=30.175 ms
84 bytes from 192.168.3.2 icmp_seq=4 ttl=63 time=30.146 ms
84 bytes from 192.168.3.2 icmp_seq=5 ttl=63 time=30.144 ms
```

PC1 Ping with others



```
PC4> ping 192.168.30.2
84 bytes from 192.168.30.2 icmp_seq=1 ttl=63 time=30.313 ms
84 bytes from 192.168.30.2 icmp_seq=2 ttl=63 time=30.024 ms
84 bytes from 192.168.30.2 icmp_seq=3 ttl=63 time=30.765 ms
84 bytes from 192.168.30.2 icmp_seq=4 ttl=63 time=30.014 ms
84 bytes from 192.168.30.2 icmp_seq=5 ttl=63 time=30.279 ms

PC4> ping 192.168.30.3
84 bytes from 192.168.30.3 icmp_seq=1 ttl=63 time=30.103 ms
84 bytes from 192.168.30.3 icmp_seq=2 ttl=63 time=30.245 ms
84 bytes from 192.168.30.3 icmp_seq=3 ttl=63 time=33.475 ms
84 bytes from 192.168.30.3 icmp_seq=4 ttl=63 time=31.736 ms
84 bytes from 192.168.30.3 icmp_seq=5 ttl=63 time=31.054 ms

PC4> ping 192.168.3.2
84 bytes from 192.168.3.2 icmp_seq=1 ttl=63 time=31.593 ms
84 bytes from 192.168.3.2 icmp_seq=2 ttl=63 time=14.998 ms
84 bytes from 192.168.3.2 icmp_seq=3 ttl=63 time=30.285 ms
84 bytes from 192.168.3.2 icmp_seq=4 ttl=63 time=29.950 ms
84 bytes from 192.168.3.2 icmp_seq=5 ttl=63 time=31.116 ms
```

PC1 Ping with others



```
PC5> ping 192.168.30.2
84 bytes from 192.168.30.2 icmp_seq=1 ttl=63 time=29.817 ms
84 bytes from 192.168.30.2 icmp_seq=2 ttl=63 time=30.353 ms
84 bytes from 192.168.30.2 icmp_seq=3 ttl=63 time=30.439 ms
84 bytes from 192.168.30.2 icmp_seq=4 ttl=63 time=30.234 ms
84 bytes from 192.168.30.2 icmp_seq=5 tt1=63 time=30.070 ms

PC5> ping 192.168.30.3
84 bytes from 192.168.30.3 icmp_seq=1 ttl=63 time=31.123 ms
84 bytes from 192.168.30.3 icmp_seq=2 ttl=63 time=30.759 ms
84 bytes from 192.168.30.3 icmp_seq=3 ttl=63 time=30.035 ms
84 bytes from 192.168.30.3 icmp_seq=4 ttl=63 time=30.425 ms
84 bytes from 192.168.30.3 icmp_seq=5 ttl=63 time=34.898 ms

PC5> ping 192.168.3.2
84 bytes from 192.168.3.2 icmp_seq=1 ttl=63 time=30.023 ms
84 bytes from 192.168.3.2 icmp_seq=2 ttl=63 time=30.344 ms
84 bytes from 192.168.3.2 icmp_seq=3 ttl=63 time=30.417 ms
84 bytes from 192.168.3.2 icmp_seq=4 ttl=63 time=29.896 ms
84 bytes from 192.168.3.2 icmp_seq=5 ttl=63 time=30.443 ms
```

PC5 Ping with others

بررسی Ping PC3 :

به ترتیب Ping دستگاه با دستگاه های **PC1** ، **PC2** و **PC6** به ترتیب مورد بررسی قرار گرفته شده.

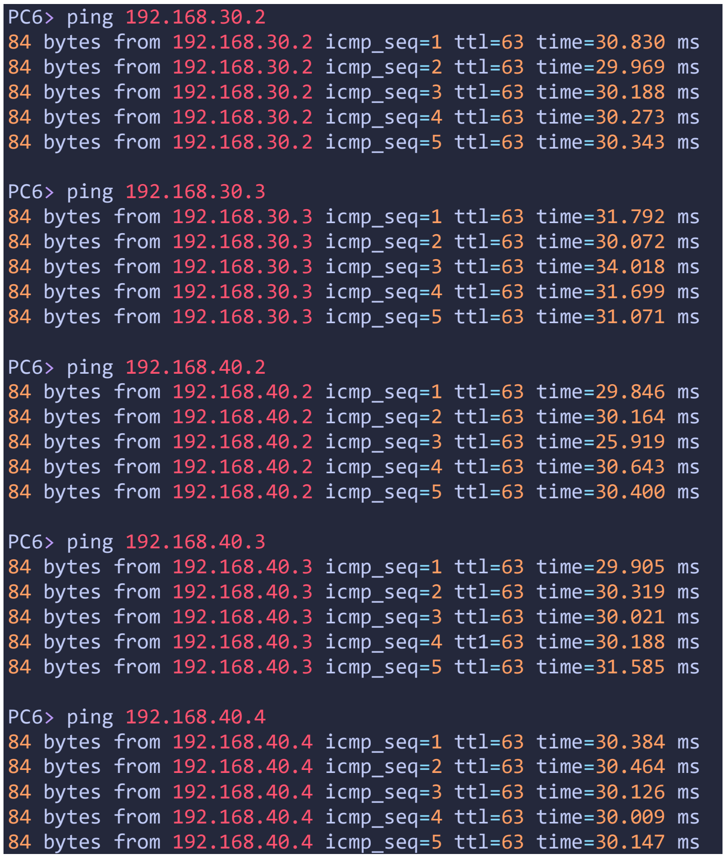
از بسته های **ICMP** برای بررسی پینگ میان دستگاه ها استفاده میشود که در هر بررسی اندازه آن 84 Bytes میباشد و شامل یک header کوچک و مقداری داده میباشد.

Sequence Number نیز عددی برای ردیابی درخواست ها و پاسخشان میباشد.

Time to Live مقدار زمانی که بسته مجاز است در شبکه انتقال داده شود.

Round Trip Time مدت زمان رسیدن بسته به مقصد و دریافت Ack آن در مبدا میباشد.

برای هر PC نیز تلاش شده تا پینگ آن با دستگاه هایی از VLAN های دیگر بررسی شود تا صحت کل شبکه مطمئن شویم.



```
PC6> ping 192.168.30.2
84 bytes from 192.168.30.2 icmp_seq=1 ttl=63 time=30.830 ms
84 bytes from 192.168.30.2 icmp_seq=2 ttl=63 time=29.969 ms
84 bytes from 192.168.30.2 icmp_seq=3 ttl=63 time=30.188 ms
84 bytes from 192.168.30.2 icmp_seq=4 ttl=63 time=30.273 ms
84 bytes from 192.168.30.2 icmp_seq=5 ttl=63 time=30.343 ms

PC6> ping 192.168.30.3
84 bytes from 192.168.30.3 icmp_seq=1 ttl=63 time=31.792 ms
84 bytes from 192.168.30.3 icmp_seq=2 ttl=63 time=30.072 ms
84 bytes from 192.168.30.3 icmp_seq=3 ttl=63 time=34.018 ms
84 bytes from 192.168.30.3 icmp_seq=4 ttl=63 time=31.699 ms
84 bytes from 192.168.30.3 icmp_seq=5 ttl=63 time=31.071 ms

PC6> ping 192.168.40.2
84 bytes from 192.168.40.2 icmp_seq=1 ttl=63 time=29.846 ms
84 bytes from 192.168.40.2 icmp_seq=2 ttl=63 time=30.164 ms
84 bytes from 192.168.40.2 icmp_seq=3 ttl=63 time=25.919 ms
84 bytes from 192.168.40.2 icmp_seq=4 ttl=63 time=30.643 ms
84 bytes from 192.168.40.2 icmp_seq=5 ttl=63 time=30.400 ms

PC6> ping 192.168.40.3
84 bytes from 192.168.40.3 icmp_seq=1 ttl=63 time=29.905 ms
84 bytes from 192.168.40.3 icmp_seq=2 ttl=63 time=30.319 ms
84 bytes from 192.168.40.3 icmp_seq=3 ttl=63 time=30.021 ms
84 bytes from 192.168.40.3 icmp_seq=4 tt1=63 time=30.188 ms
84 bytes from 192.168.40.3 icmp_seq=5 ttl=63 time=31.585 ms

PC6> ping 192.168.40.4
84 bytes from 192.168.40.4 icmp_seq=1 ttl=63 time=30.384 ms
84 bytes from 192.168.40.4 icmp_seq=2 ttl=63 time=30.464 ms
84 bytes from 192.168.40.4 icmp_seq=3 ttl=63 time=30.126 ms
84 bytes from 192.168.40.4 icmp_seq=4 ttl=63 time=30.009 ms
84 bytes from 192.168.40.4 icmp_seq=5 ttl=63 time=30.147 ms
```

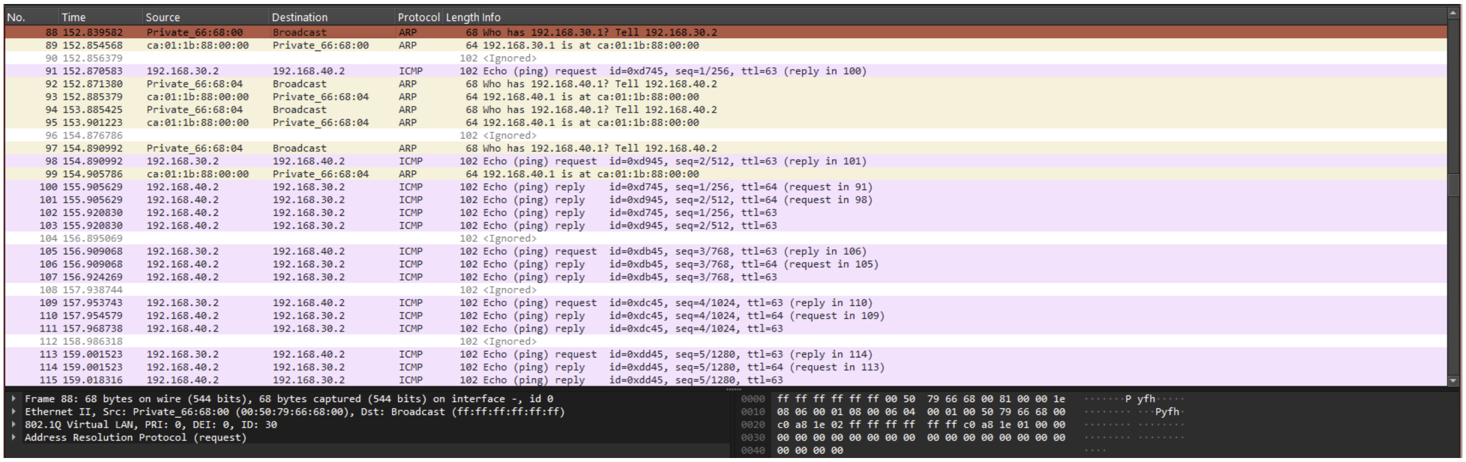
PC6 Ping with others

برای جزییات بیشتر میتوان خروجی های WireShark را بررسی کرد:

ICMP Request/Reply :

- **Echo Request** : بسته های ارسال شده از مبدا به مقصد
- **Echo Reply** : بسته های برگردانده شده از مقصد به مبدا
- **VLAN Tagging** : در بسته هایی که جزییات ارسال آنها ضبط شده، اگر از لینک trunk عبور کرده باشد با یک Tag همراه خواهند بود که شماره VLAN را مشخص خواهد کرد.

۵. خروجی های Wireshark



```
No.  Time        Source             Destination        Protocol Length Info
  88 152.839582  Private_66:68:00   Broadcast          ARP        68 Who has 192.168.30.1? Tell 192.168.30.2
  89 152.854568  ca:01:1b:88:00:00  Private_66:68:00   ARP        64 192.168.30.1 is at ca:01:1b:88:00:00
  90 152.856379                                                  102 <Ignored>
  91 152.870583  192.168.30.2       192.168.40.2       ICMP      102 Echo (ping) request  id=0xd745, seq=1/256, ttl=63 (reply in 100)
  92 152.871380  Private_66:68:04   Broadcast          ARP        68 Who has 192.168.40.1? Tell 192.168.40.2
  93 152.885379  ca:01:1b:88:00:00  Private_66:68:04   ARP        64 192.168.40.1 is at ca:01:1b:88:00:00
  94 153.885425  Private_66:68:04   Broadcast          ARP        68 Who has 192.168.40.1? Tell 192.168.40.2
  95 153.901223  ca:01:1b:88:00:00  Private_66:68:04   ARP        64 192.168.40.1 is at ca:01:1b:88:00:00
  96 154.876786                                                  102 <Ignored>
  97 154.890992  Private_66:68:04   Broadcast          ARP        68 Who has 192.168.40.1? Tell 192.168.40.2
  98 154.890992  192.168.30.2       192.168.40.2       ICMP      102 Echo (ping) request  id=0xd945, seq=2/512, ttl=63 (reply in 101)
  99 154.905786  ca:01:1b:88:00:00  Private_66:68:04   ARP        64 192.168.40.1 is at ca:01:1b:88:00:00
 100 155.905629  192.168.40.2       192.168.30.2       ICMP      102 Echo (ping) reply    id=0xd745, seq=1/256, ttl=64 (request in 91)
 101 155.905629  192.168.40.2       192.168.30.2       ICMP      102 Echo (ping) reply    id=0xd945, seq=2/512, ttl=64 (request in 98)
 102 155.920830  192.168.40.2       192.168.30.2       ICMP      102 Echo (ping) reply    id=0xd745, seq=1/256, ttl=63
 103 155.920830  192.168.40.2       192.168.30.2       ICMP      102 Echo (ping) reply    id=0xd945, seq=2/512, ttl=63
 104 156.895069                                                  102 <Ignored>
 105 156.909068  192.168.30.2       192.168.40.2       ICMP      102 Echo (ping) request  id=0xdb45, seq=3/768, ttl=63 (reply in 106)
 106 156.909068  192.168.40.2       192.168.30.2       ICMP      102 Echo (ping) reply    id=0xdb45, seq=3/768, ttl=64 (request in 105)
 107 156.924269  192.168.40.2       192.168.30.2       ICMP      102 Echo (ping) reply    id=0xdb45, seq=3/768, ttl=63
 108 157.938744                                                  102 <Ignored>
 109 157.953743  192.168.30.2       192.168.40.2       ICMP      102 Echo (ping) request  id=0xdc45, seq=4/1024, ttl=63 (reply in 110)
 110 157.954579  192.168.40.2       192.168.30.2       ICMP      102 Echo (ping) reply    id=0xdc45, seq=4/1024, ttl=64 (request in 109)
 111 157.968738  192.168.40.2       192.168.30.2       ICMP      102 Echo (ping) reply    id=0xdc45, seq=4/1024, ttl=63
 112 158.986318                                                  102 <Ignored>
 113 159.001523  192.168.30.2       192.168.40.2       ICMP      102 Echo (ping) request  id=0xdd45, seq=5/1280, ttl=63 (reply in 114)
 114 159.001523  192.168.40.2       192.168.30.2       ICMP      102 Echo (ping) reply    id=0xdd45, seq=5/1280, ttl=64 (request in 113)
 115 159.018316  192.168.40.2       192.168.30.2       ICMP      102 Echo (ping) reply    id=0xdd45, seq=5/1280, ttl=63
```

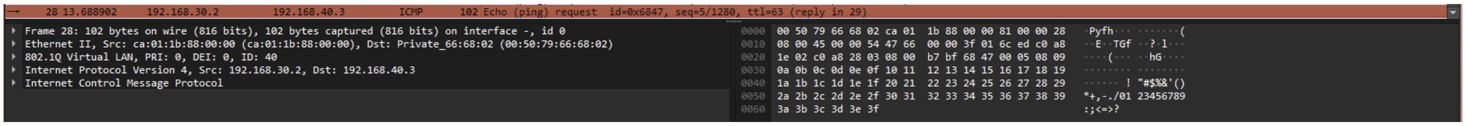
```
▸ Frame 88: 68 bytes on wire (544 bits), 68 bytes captured (544 bits) on interface -, id 0
▸ Ethernet II, Src: Private_66:68:00 (00:50:79:66:68:00), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
▸ 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 30
▸ Address Resolution Protocol (request)
```

```
0000  ff ff ff ff ff ff 00 50  79 66 68 00 81 00 00 1e   ·······P yfh····
0010  08 06 00 01 08 00 06 04  00 01 00 50 79 66 68 00   ········ ···Pyfh·
0020  c0 a8 1e 02 ff ff ff ff  ff ff c0 a8 1e 01 00 00   ········ ········
0030  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ········ ········
0040  00 00 00 00                                        ····
```

WireShark

Wireshark یک ابزار تحلیلگر بسته‌های شبکه است که برای مشاهده و بررسی ترافیک داده‌ها در شبکه استفاده می‌شود. به ما این امکان را می‌دهد که بسته‌های داده بین VLAN های مختلف را بررسی وکنیم.

در جدول با مشاهده جزییات (شامل مبدا و مقصد و پروتوکل و ...) میتوان دید که ارسال داده ها در محدوده شبکه اتفاق افتاده و داده از طریق مسیر صحیح و تنظیم شده عبور می‌کند.



```
→    28 13.688902     192.168.30.2      192.168.40.3      ICMP     102 Echo (ping) request  id=0x6847, seq=5/1280, ttl=63 (reply in 29)
▸ Frame 28: 102 bytes on wire (816 bits), 102 bytes captured (816 bits) on interface -, id 0
▸ Ethernet II, Src: ca:01:1b:88:00:00 (ca:01:1b:88:00:00), Dst: Private_66:68:02 (00:50:79:66:68:02)
▸ 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 40
▸ Internet Protocol Version 4, Src: 192.168.30.2, Dst: 192.168.40.3
▸ Internet Control Message Protocol

0000  00 50 79 66 68 02 ca 01  1b 88 00 00 81 00 00 28   ·Pyfh··· ·······(
0010  08 00 45 00 00 54 47 66  00 00 3f 01 6c ed c0 a8   ··E··TGf ··?·l···
0020  1e 02 c0 a8 28 03 08 00  b7 bf 68 47 00 05 08 09   ····(··· ··hG····
0030  0a 0b 0c 0d 0e 0f 10 11  12 13 14 15 16 17 18 19   ········ ········
0040  1a 1b 1c 1d 1e 1f 20 21  22 23 24 25 26 27 28 29   ······ ! "#$%&'()
0050  2a 2b 2c 2d 2e 2f 30 31  32 33 34 35 36 37 38 39   *+,-./01 23456789
0060  3a 3b 3c 3d 3e 3f                                  :;<=>?
```

WireShark Packet

وقتی Wireshark شروع به ضبط ترافیک می‌کند، هر بسته‌ای که در یک اینترفیس شبکه جابه‌جا می‌شود، در قالب یک ردیف در جدول Wiresharkثبت می‌شود. این بسته‌ها نشان‌دهنده جریان ترافیک شبکه هستند.

چه چیز هایی نشان میدهد:

- **مبدا و مقصد:** : آدرس‌های IP یا MAC دستگاه‌های ارسال‌کننده و دریافت‌کننده بسته را نشان می‌دهد.
- **Protocol**: پروتکل مورد استفاده در بسته، مثلTCP ، UDP، یا ICMP را نشان می‌دهد..
- **VLAN ID**: در packet های tagged VLAN ID مشخص شده که نشان میدهد بسته متعلق به کدام VLAN است.
- **Packet Size**: تعداد بایت‌های موجود در بسته مشخص می‌شود. اندازه بسته می‌تواند برای تحلیل عملکرد شبکه مفید باشد.
- **Timestamp**: زمان دقیق ارسال یا دریافت بسته ثبت می‌شود که برای تحلیل تأخیر شبکه و کیفیت ارتباط مفید است.

مراحل ثبت خروجی ها :

۱. ذخیره کانفیگ روتر ها

۲. ذخیره کانفیگ PC ها

توضیحات mode های access و dot1q(802.1Q):

- **حالت Access**: یک پورت سوئیچ فقط به یک VLAN خاص اختصاص داده می‌شود و تنها ترافیک این VLAN می‌تواند از طریق آن پورت عبور کند. این حالت اغلب برای اتصال دستگاه‌هایی مانند کامپیوترها، پرینترها، یا end devices به کار می‌رود.
  - ترافیک ارسال شده به این پورت untagged است.
  - ساده ترین حالت پیکر بندی برای دستگاه های معمولی.
  - مناسب برای زمانی که نیازی به دسترسی دستگاه به VLANهای دیگر وجود ندارد.
- **حالت Trunk**: به یک پورت سوئیچ اجازه می‌دهد تا ترافیک چندین VLAN را مدیریت کند. برای مشخص کردن اینکه هر فریم به کدام VLAN تعلق دارد، tagging بر اساس استاندارد 802.1Q استفاده می‌شود. این حالت معمولاً برای ارتباط بین سوئیچ‌ها یا سوئیچ و روتر استفاده می‌شود.
  - می‌تواند چندین VLAN را از طریق یک پورت انتقال دهد.
  - مناسب برای گسترشVLAN ها در چندین سوئیچ

دستورات و کد وارد شده در هر مرحله :

Step		Command	Explanation

Switch Configuration	Setting Up VLANs	`enable`
		`configure terminal`
		`vlan 30`
		`name VLAN_30`
		`exit`
		`vlan 40`
		`name VLAN_40`
		`exit`
			create **VLAN30** and **VLAN40** on the switch, segmenting the network into two logical networks.

	Configuring Access Ports	`interface FastEthernet0/1`
		`switchport mode access`
		`switchport access vlan 30`
		`exit`
		
		`interface FastEthernet0/2`
		`switchport mode access`
		`switchport access vlan 30`
		`exit`
		
		`interface FastEthernet0/3`
		`switchport mode access`
		`switchport access vlan 40`
		`exit`
		
		`interface FastEthernet0/4`
		`switchport mode access`
		`switchport access vlan 40`
		`exit`
		
		`interface FastEthernet0/5`
		`switchport mode access`
		`switchport access vlan 40`
		`exit`
			configure the switch ports connected to PCs to **access mode** and assigned them to the correct VLANs:
			• **VLAN30** for **PC1** and **PC2**
			• **VLAN40** for **PC3**, **PC4**, **PC5**

	Configuring the Trunk Link	`No Code XD!`	Configure **Port0** on the switch (connected to the router) as a **trunk port** with **dot1Q encapsulation**. This allowed it to carry traffic for both VLAN 30 and VLAN 40 to the router.

Router Configuration	**Configuring SubInterfaces for InterVLAN Routing**	`enable`
		`configure terminal`
		
		`interface FastEthernet0/0.30`
		`encapsulation dot1Q 30`
		`ip address 192.168.30.1 255.255.255.0`
		`exit`
		
		`interface FastEthernet0/0.40`
		`encapsulation dot1Q 40`
		`ip address 192.168.40.1 255.255.255.0`
		`exit`
			Sub-interfaces **FastEthernet0/0.30** for VLAN30 and **FastEthernet0/0.40** for VLAN40 on router with appropriate IP addresses.
			The **encapsulation dot1Q** commands assign VLAN tags to each sub-interface, allowing the router to route between VLANs.

	Configure the Interface for PC6s Network	`interface FastEthernet1/0`
		`ip address 192.168.3.1 255.255.255.0`
		`no shutdown`
		`exit`
			Configure **FastEthernet1/0** with an IP address of **192.168.3.1** to allow PC6 (in a separate network) to communicate with other devices through the router.

Testing & Verification	**Verify Interface Status**	`show ip interface brief`	Display the status and IP assignments of all interfaces, confirming that **FastEthernet0/0.30**,**FastEthernet0/0.40** and **FastEthernet1/0** were all up and configured correctly.
	Verify Routing Table	`show ip route`	Display the router’s routing table, showing direct connections to **192.168.30.0/24**, **192.168.40.0/24**, and **192.168.3.0/24**, verifying inter-VLAN routing.

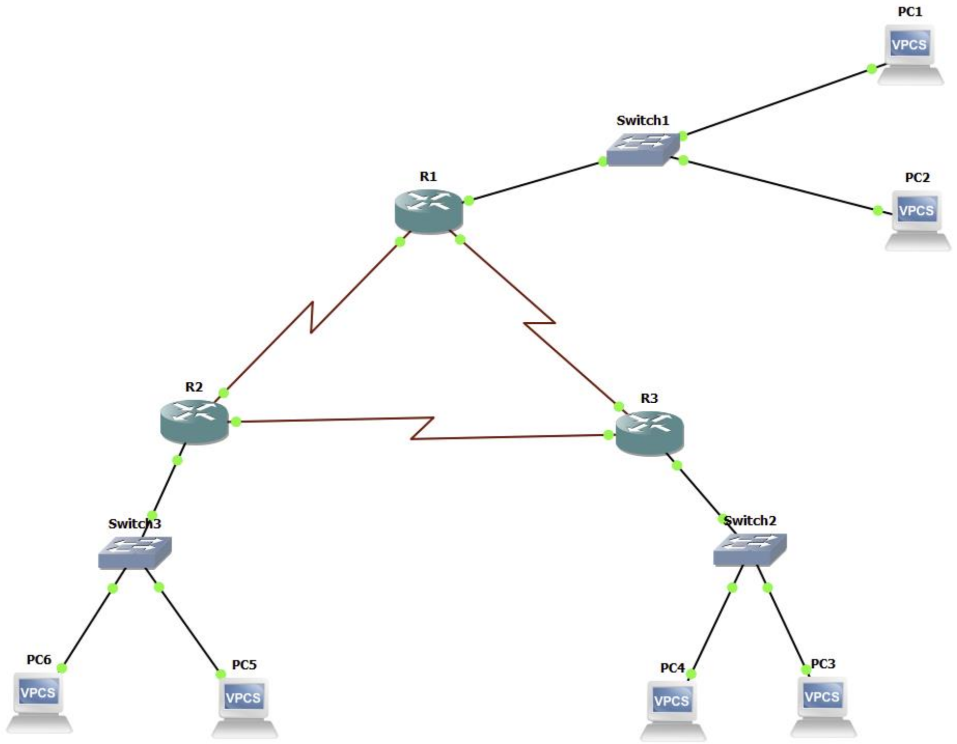
	Test Connectivity with Ping	`ping 192.168.40.2`
		`# From PC1 to PC3`
		
		`ping 192.168.30.2`
		`# From PC3 to PC1`
			Send ICMP Echo Requests from PCs in VLAN30 to PCs in VLAN40 to verify successful communication between VLANs(and vice versa).

Saving Configurations	**Save Router Configuration**	`write memory`
		
		Alternative:
		`copy running-config startup-config`
			Saved the current router configuration to NVRAM to ensure it persists after a reboot.

	Save PCs Configuration	`save pc1_config.txt`
		`save pc2_config.txt`
		`save pc3_config.txt`
		`save pc4_config.txt`
		`save pc5_config.txt`
		`save pc6_config.txt`
			Saved each PC’s configuration to a file (e.g., pc1_config.txt) to preserve IP and gateway settings.

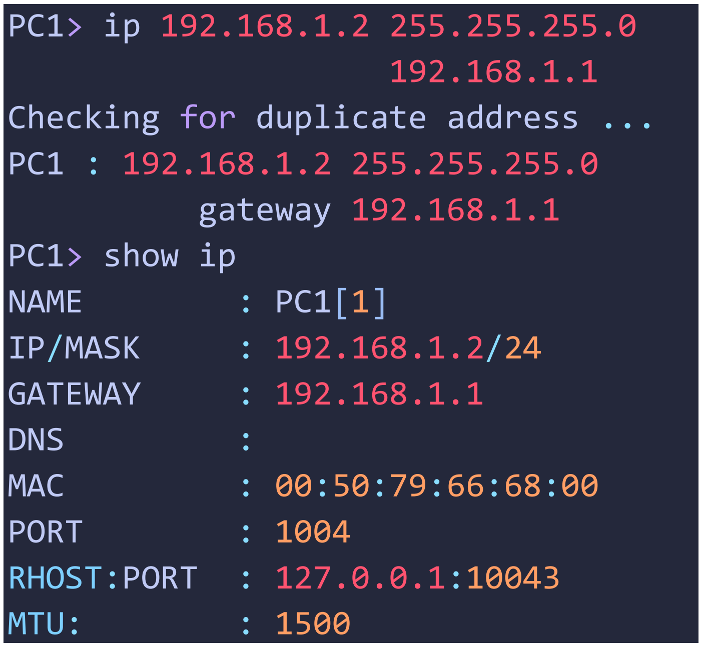
۴. Static Routing

هدف پیکربندی مسیریابی استاتیک با افزونگی در شبکه ای از سه روتر (R1، R2 و R3) و سه زیر شبکه است که به ترافیک اجازه می‌دهد در صورت خرابی لینک، مسیر خود را تغییر داده و اتصال مداوم در سراسر شبکه را تضمین کند.



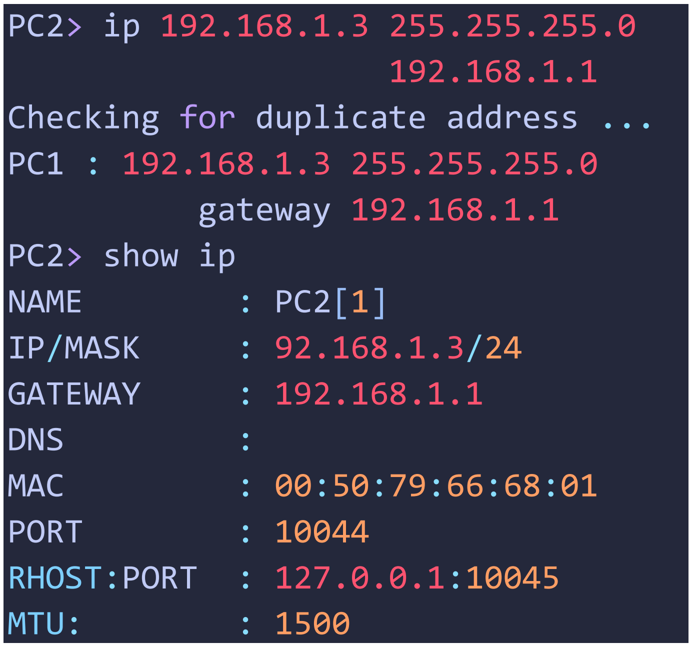
توپولوژی شبکه

أ. ست کردن IP هر سیستم و بررسی آنها



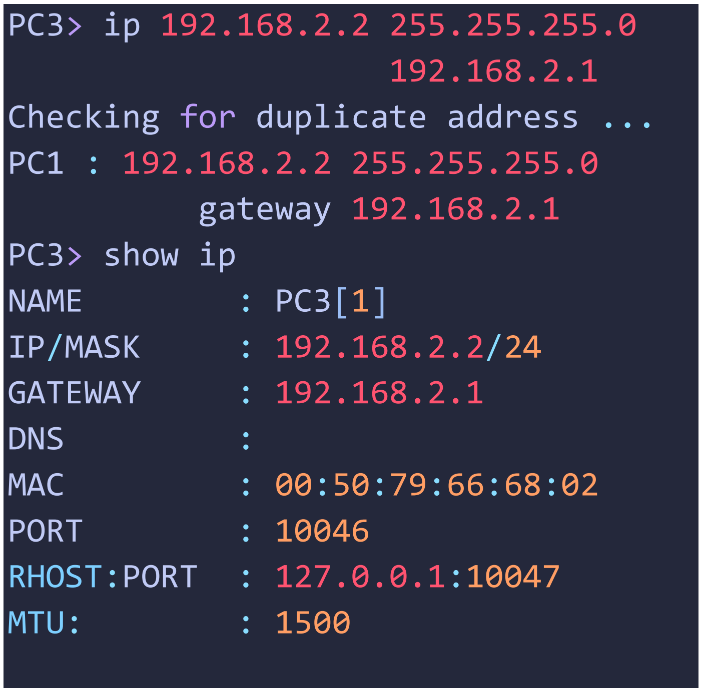
```
PC1> ip 192.168.1.2 255.255.255.0
                    192.168.1.1
Checking for duplicate address ...
PC1 : 192.168.1.2 255.255.255.0
         gateway 192.168.1.1
PC1> show ip
NAME         : PC1[1]
IP/MASK      : 192.168.1.2/24
GATEWAY      : 192.168.1.1
DNS          :
MAC          : 00:50:79:66:68:00
PORT         : 1004
RHOST:PORT   : 127.0.0.1:10043
MTU:         : 1500
```

IP-PC1



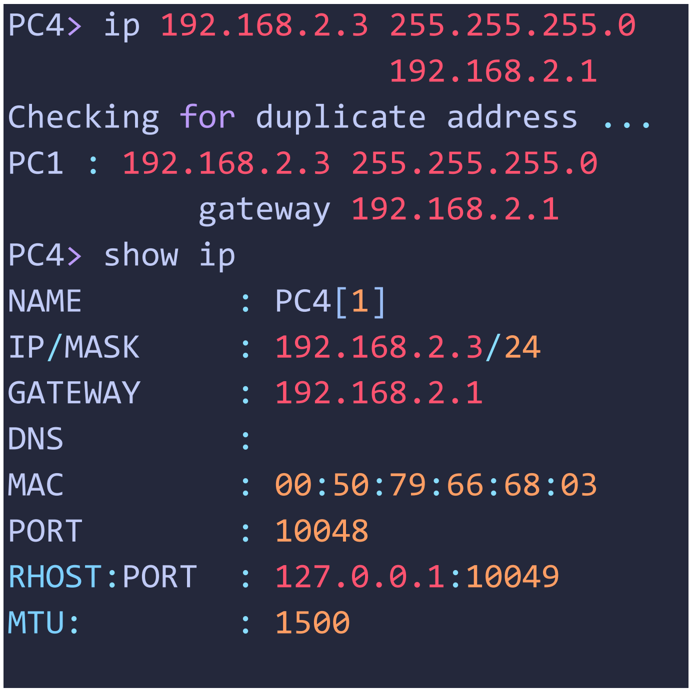
```
PC2> ip 192.168.1.3 255.255.255.0
                    192.168.1.1
Checking for duplicate address ...
PC1 : 192.168.1.3 255.255.255.0
         gateway 192.168.1.1
PC2> show ip
NAME         : PC2[1]
IP/MASK      : 92.168.1.3/24
GATEWAY      : 192.168.1.1
DNS          :
MAC          : 00:50:79:66:68:01
PORT         : 10044
RHOST:PORT   : 127.0.0.1:10045
MTU:         : 1500
```

IP-PC2



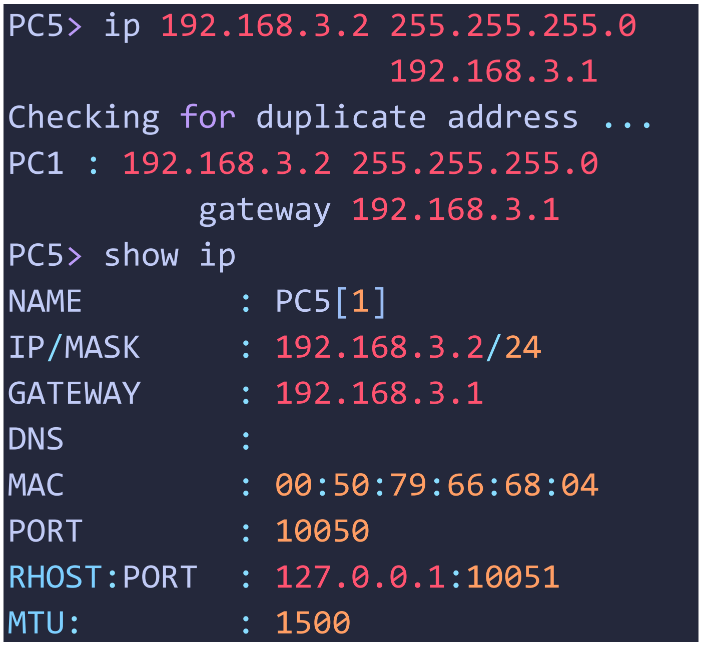
```
PC3> ip 192.168.2.2 255.255.255.0
                    192.168.2.1
Checking for duplicate address ...
PC1 : 192.168.2.2 255.255.255.0
          gateway 192.168.2.1
PC3> show ip
NAME         : PC3[1]
IP/MASK      : 192.168.2.2/24
GATEWAY      : 192.168.2.1
DNS          :
MAC          : 00:50:79:66:68:02
PORT         : 10046
RHOST:PORT   : 127.0.0.1:10047
MTU:         : 1500
```

IP-PC3



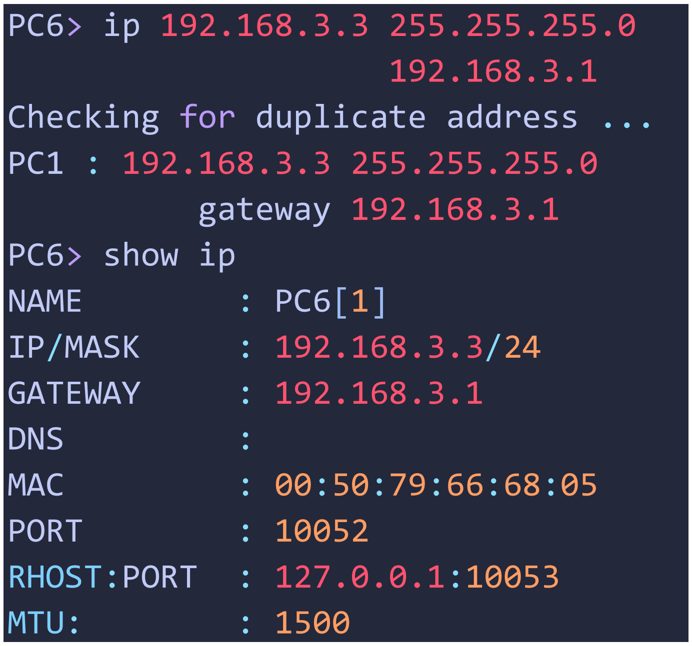
```
PC4> ip 192.168.2.3 255.255.255.0
                    192.168.2.1
Checking for duplicate address ...
PC1 : 192.168.2.3 255.255.255.0
          gateway 192.168.2.1
PC4> show ip
NAME         : PC4[1]
IP/MASK      : 192.168.2.3/24
GATEWAY      : 192.168.2.1
DNS          :
MAC          : 00:50:79:66:68:03
PORT         : 10048
RHOST:PORT   : 127.0.0.1:10049
MTU:         : 1500
```

IP-PC4



```
PC5> ip 192.168.3.2 255.255.255.0
                    192.168.3.1
Checking for duplicate address ...
PC1 : 192.168.3.2 255.255.255.0
          gateway 192.168.3.1
PC5> show ip
NAME         : PC5[1]
IP/MASK      : 192.168.3.2/24
GATEWAY      : 192.168.3.1
DNS          :
MAC          : 00:50:79:66:68:04
PORT         : 10050
RHOST:PORT   : 127.0.0.1:10051
MTU:         : 1500
```

IP-PC5

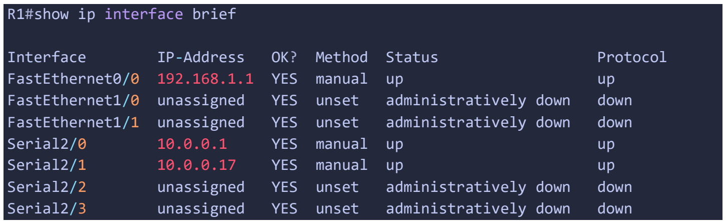


```
PC6> ip 192.168.3.3 255.255.255.0
                    192.168.3.1
Checking for duplicate address ...
PC1 : 192.168.3.3 255.255.255.0
          gateway 192.168.3.1
PC6> show ip
NAME         : PC6[1]
IP/MASK      : 192.168.3.3/24
GATEWAY      : 192.168.3.1
DNS          :
MAC          : 00:50:79:66:68:05
PORT         : 10052
RHOST:PORT   : 127.0.0.1:10053
MTU:         : 1500
```

IP-PC6

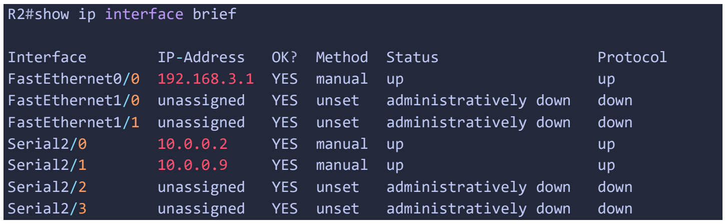
ب. بررسی پینگ بین PC ها و مشاهده Routing Table ها

IP Interfaces:



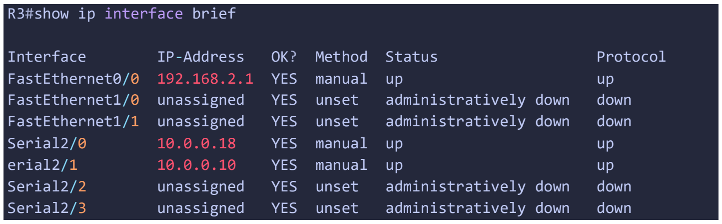
```
R1#show ip interface brief

Interface        IP-Address   OK?  Method  Status                 Protocol
FastEthernet0/0  192.168.1.1  YES  manual  up                     up
FastEthernet1/0  unassigned   YES  unset   administratively down  down
FastEthernet1/1  unassigned   YES  unset   administratively down  down
Serial2/0        10.0.0.1     YES  manual  up                     up
Serial2/1        10.0.0.17    YES  manual  up                     up
Serial2/2        unassigned   YES  unset   administratively down  down
Serial2/3        unassigned   YES  unset   administratively down  down
```

IP InterFace R1



```
R2#show ip interface brief

Interface        IP-Address   OK?  Method  Status                 Protocol
FastEthernet0/0  192.168.3.1  YES  manual  up                     up
FastEthernet1/0  unassigned   YES  unset   administratively down  down
FastEthernet1/1  unassigned   YES  unset   administratively down  down
Serial2/0        10.0.0.2     YES  manual  up                     up
Serial2/1        10.0.0.9     YES  manual  up                     up
Serial2/2        unassigned   YES  unset   administratively down  down
Serial2/3        unassigned   YES  unset   administratively down  down
```

IP InterFace R1



```
R3#show ip interface brief

Interface        IP-Address   OK?  Method  Status                 Protocol
FastEthernet0/0  192.168.2.1  YES  manual  up                     up
FastEthernet1/0  unassigned   YES  unset   administratively down  down
FastEthernet1/1  unassigned   YES  unset   administratively down  down
Serial2/0        10.0.0.18    YES  manual  up                     up
erial2/1         10.0.0.10    YES  manual  up                     up
Serial2/2        unassigned   YES  unset   administratively down  down
Serial2/3        unassigned   YES  unset   administratively down  down
```

IP InterFace R1

Routing Tables:

```
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, 1 - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       10.0.0.0/30 is directly connected, Serial2/0
L       10.0.0.1/32 is directly connected, Serial2/0
C       10.0.0.16/30 is directly connected, Serial2/1
L       10.0.0.17/32 is directly connected, Serial2/1
    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
S   192.168.2.0/24 [1/0] via 10.0.0.18
                   [1/0] via 10.0.0.2
S   192.168.3.0/24 [1/0] via 10.0.0.18
                   [1/0] via 10.0.0.2
```

IP Route R1

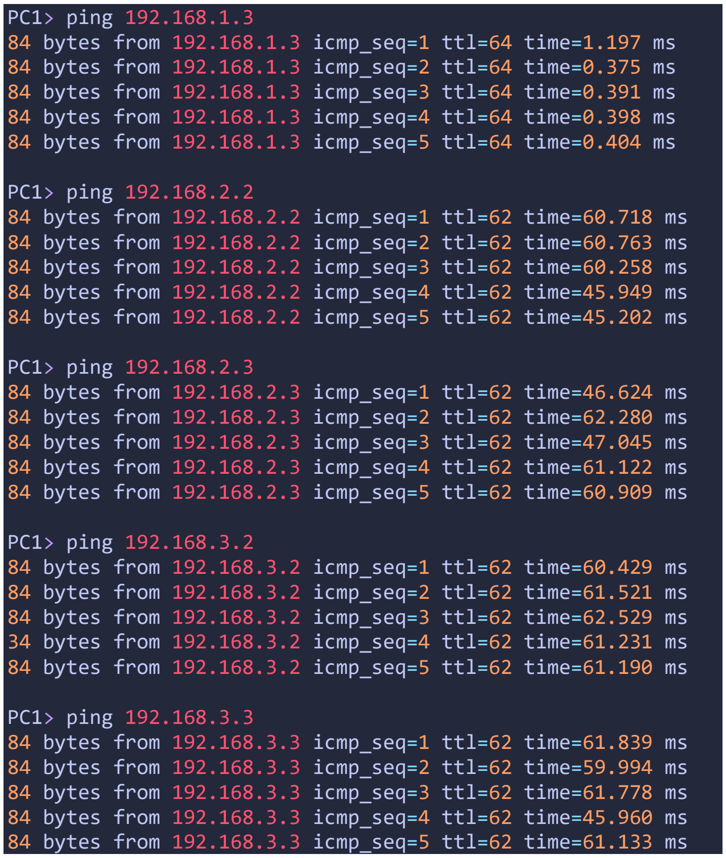
```
R2#show ip route

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       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, 1 - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       10.0.0.0/30 is directly connected, Serial2/0
L       10.0.0.2/32 is directly connected, Serial2/0
C       10.0.0.8/30 is directly connected, Serial2/1
L       10.0.0.9/32 is directly connected, Serial2/1
S   192.168.1.0/24 [1/0] via 10.0.0.10
                   [1/0] via 10.0.0.1
S   192.168.2.0/24 [1/0] via 10.0.0.10
                   [1/0] via 10.0.0.1
    192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.3.0/24 is directly connected, FastEthernet0/0
L       192.168.3.1/32 is directly connected, FastEthernet0/0
```

IP Route R2

```
R3#show ip route

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, 0 - OSPF, IA - OSPF inter area
       1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       1 - 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, 1 - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       10.0.0.8/30 is directly connected, Serial2/1
L       10.0.0.10/32 is directly connected, Serial2/1
C       10.0.0.16/30 is directly connected, Serial2/0
L       10.0.0.18/32 is directly connected, Serial2/0
S   192.168.1.0/24 [1/0] via 10.0.0.17
                   [1/0] via 10.0.0.9
    192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.2.0/24 is directly connected, FastEthernet0/0
L       192.168.2.1/32 is directly connected, FastEthernet0/0
S   192.168.3.0/24 [1/0] via 10.0.0.17
                   [1/0] via 10.0.0.9
```

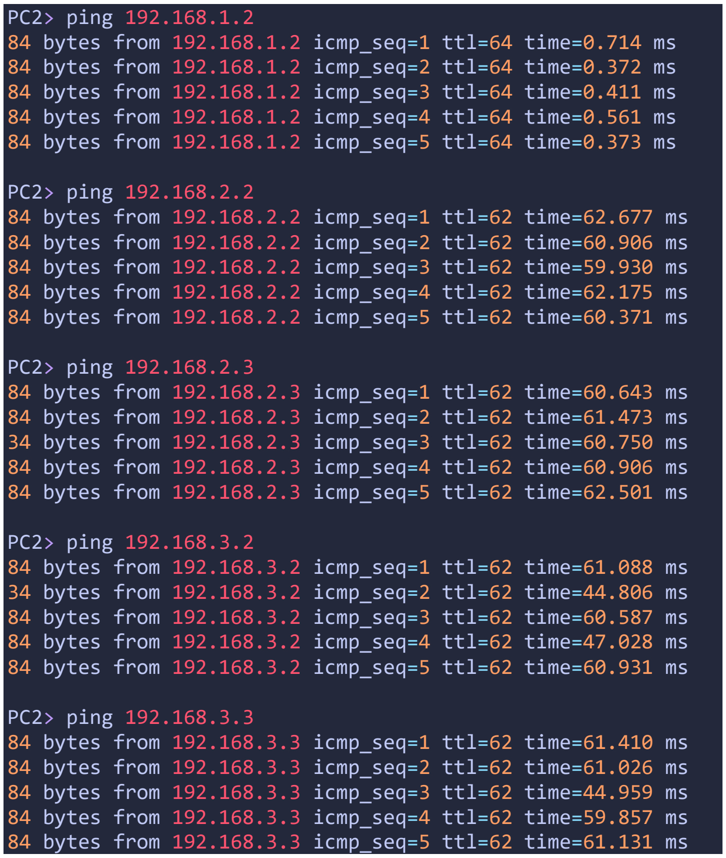
IP Route R3

PC Pings:



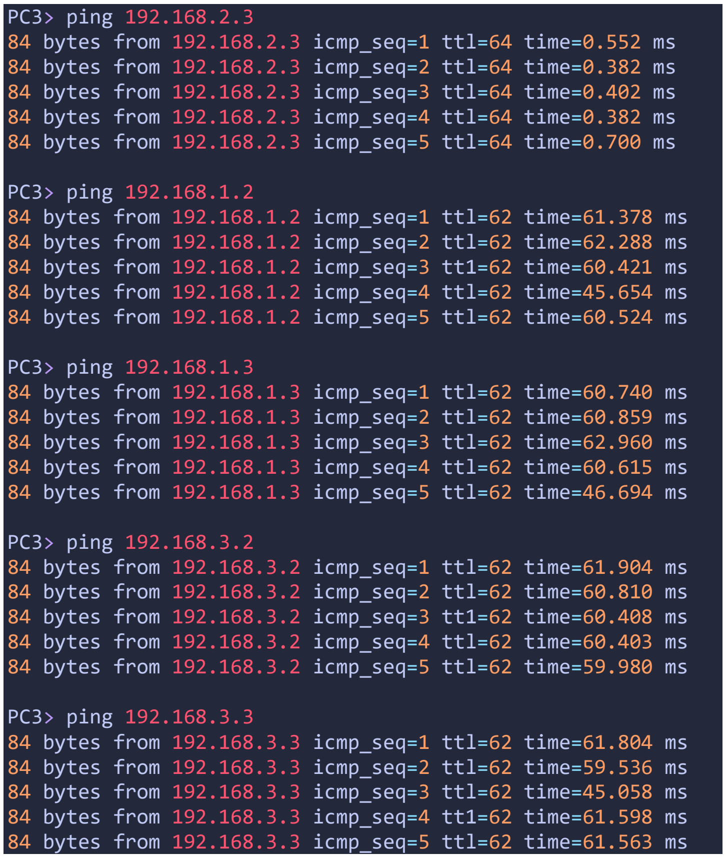
```
PC1> ping 192.168.1.3
84 bytes from 192.168.1.3 icmp_seq=1 ttl=64 time=1.197 ms
84 bytes from 192.168.1.3 icmp_seq=2 ttl=64 time=0.375 ms
84 bytes from 192.168.1.3 icmp_seq=3 ttl=64 time=0.391 ms
84 bytes from 192.168.1.3 icmp_seq=4 ttl=64 time=0.398 ms
84 bytes from 192.168.1.3 icmp_seq=5 ttl=64 time=0.404 ms

PC1> ping 192.168.2.2
84 bytes from 192.168.2.2 icmp_seq=1 ttl=62 time=60.718 ms
84 bytes from 192.168.2.2 icmp_seq=2 ttl=62 time=60.763 ms
84 bytes from 192.168.2.2 icmp_seq=3 ttl=62 time=60.258 ms
84 bytes from 192.168.2.2 icmp_seq=4 ttl=62 time=45.949 ms
84 bytes from 192.168.2.2 icmp_seq=5 ttl=62 time=45.202 ms

PC1> ping 192.168.2.3
84 bytes from 192.168.2.3 icmp_seq=1 ttl=62 time=46.624 ms
84 bytes from 192.168.2.3 icmp_seq=2 ttl=62 time=62.280 ms
84 bytes from 192.168.2.3 icmp_seq=3 ttl=62 time=47.045 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=62 time=61.122 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=62 time=60.909 ms

PC1> ping 192.168.3.2
84 bytes from 192.168.3.2 icmp_seq=1 ttl=62 time=60.429 ms
84 bytes from 192.168.3.2 icmp_seq=2 ttl=62 time=61.521 ms
84 bytes from 192.168.3.2 icmp_seq=3 ttl=62 time=62.529 ms
34 bytes from 192.168.3.2 icmp_seq=4 ttl=62 time=61.231 ms
84 bytes from 192.168.3.2 icmp_seq=5 ttl=62 time=61.190 ms

PC1> ping 192.168.3.3
84 bytes from 192.168.3.3 icmp_seq=1 ttl=62 time=61.839 ms
84 bytes from 192.168.3.3 icmp_seq=2 ttl=62 time=59.994 ms
84 bytes from 192.168.3.3 icmp_seq=3 ttl=62 time=61.778 ms
84 bytes from 192.168.3.3 icmp_seq=4 ttl=62 time=45.960 ms
84 bytes from 192.168.3.3 icmp_seq=5 ttl=62 time=61.133 ms
```

PC1 Ping with others



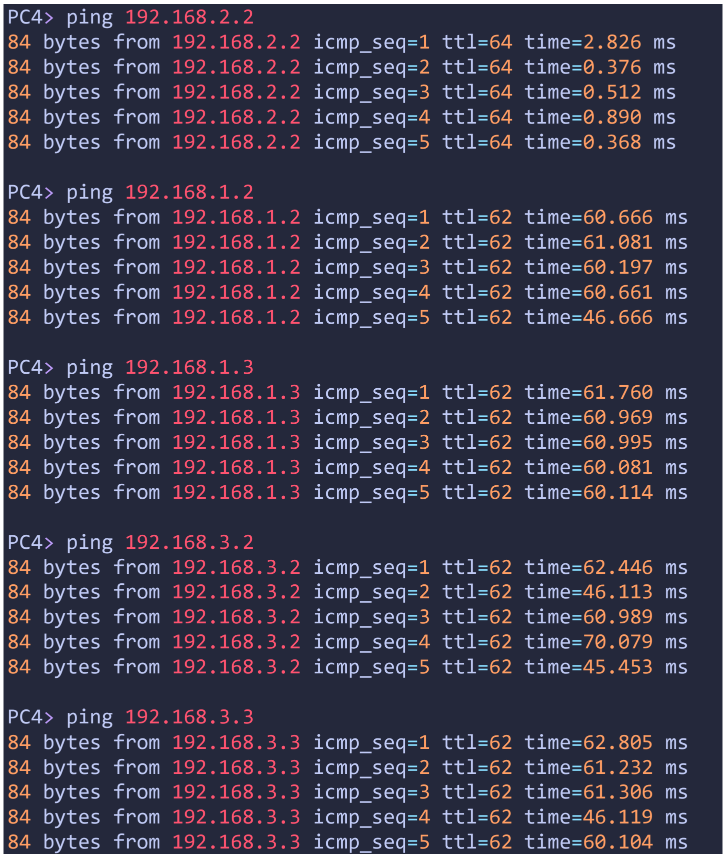
```
PC2> ping 192.168.1.2
84 bytes from 192.168.1.2 icmp_seq=1 ttl=64 time=0.714 ms
84 bytes from 192.168.1.2 icmp_seq=2 ttl=64 time=0.372 ms
84 bytes from 192.168.1.2 icmp_seq=3 ttl=64 time=0.411 ms
84 bytes from 192.168.1.2 icmp_seq=4 ttl=64 time=0.561 ms
84 bytes from 192.168.1.2 icmp_seq=5 ttl=64 time=0.373 ms

PC2> ping 192.168.2.2
84 bytes from 192.168.2.2 icmp_seq=1 ttl=62 time=62.677 ms
84 bytes from 192.168.2.2 icmp_seq=2 ttl=62 time=60.906 ms
84 bytes from 192.168.2.2 icmp_seq=3 ttl=62 time=59.930 ms
84 bytes from 192.168.2.2 icmp_seq=4 ttl=62 time=62.175 ms
84 bytes from 192.168.2.2 icmp_seq=5 ttl=62 time=60.371 ms

PC2> ping 192.168.2.3
84 bytes from 192.168.2.3 icmp_seq=1 ttl=62 time=60.643 ms
84 bytes from 192.168.2.3 icmp_seq=2 ttl=62 time=61.473 ms
34 bytes from 192.168.2.3 icmp_seq=3 ttl=62 time=60.750 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=62 time=60.906 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=62 time=62.501 ms

PC2> ping 192.168.3.2
84 bytes from 192.168.3.2 icmp_seq=1 ttl=62 time=61.088 ms
34 bytes from 192.168.3.2 icmp_seq=2 ttl=62 time=44.806 ms
84 bytes from 192.168.3.2 icmp_seq=3 ttl=62 time=60.587 ms
84 bytes from 192.168.3.2 icmp_seq=4 ttl=62 time=47.028 ms
84 bytes from 192.168.3.2 icmp_seq=5 ttl=62 time=60.931 ms

PC2> ping 192.168.3.3
84 bytes from 192.168.3.3 icmp_seq=1 ttl=62 time=61.410 ms
84 bytes from 192.168.3.3 icmp_seq=2 ttl=62 time=61.026 ms
84 bytes from 192.168.3.3 icmp_seq=3 ttl=62 time=44.959 ms
84 bytes from 192.168.3.3 icmp_seq=4 ttl=62 time=59.857 ms
84 bytes from 192.168.3.3 icmp_seq=5 ttl=62 time=61.131 ms
```

PC2 Ping with others



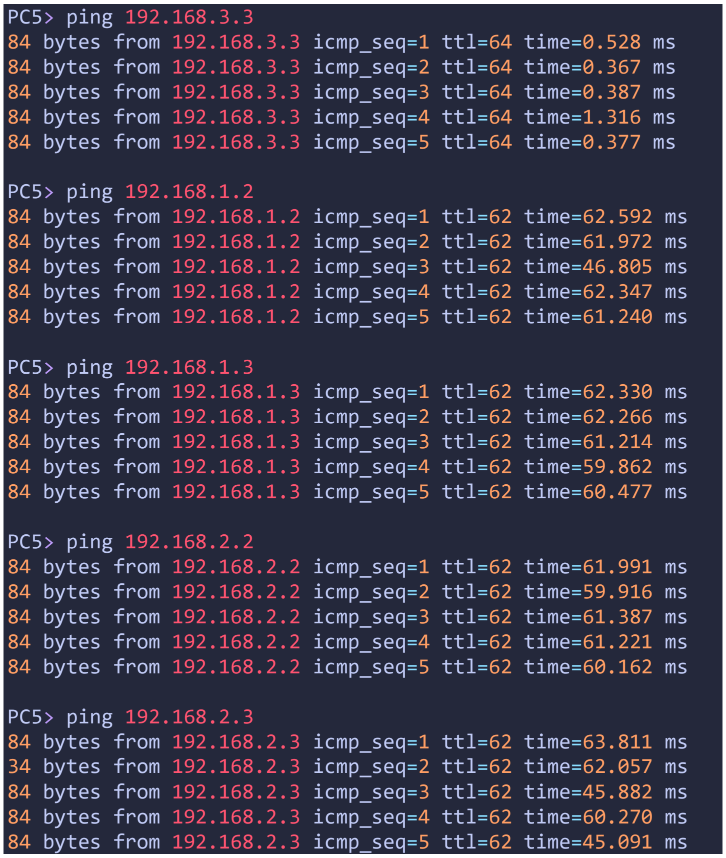
```
PC3> ping 192.168.2.3
84 bytes from 192.168.2.3 icmp_seq=1 ttl=64 time=0.552 ms
84 bytes from 192.168.2.3 icmp_seq=2 ttl=64 time=0.382 ms
84 bytes from 192.168.2.3 icmp_seq=3 ttl=64 time=0.402 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=64 time=0.382 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=64 time=0.700 ms

PC3> ping 192.168.1.2
84 bytes from 192.168.1.2 icmp_seq=1 ttl=62 time=61.378 ms
84 bytes from 192.168.1.2 icmp_seq=2 ttl=62 time=62.288 ms
84 bytes from 192.168.1.2 icmp_seq=3 tt1=62 time=60.421 ms
84 bytes from 192.168.1.2 icmp_seq=4 ttl=62 time=45.654 ms
84 bytes from 192.168.1.2 icmp_seq=5 ttl=62 time=60.524 ms

PC3> ping 192.168.1.3
84 bytes from 192.168.1.3 icmp_seq=1 ttl=62 time=60.740 ms
84 bytes from 192.168.1.3 icmp_seq=2 ttl=62 time=60.859 ms
84 bytes from 192.168.1.3 icmp_seq=3 ttl=62 time=62.960 ms
84 bytes from 192.168.1.3 icmp_seq=4 ttl=62 time=60.615 ms
84 bytes from 192.168.1.3 icmp_seq=5 ttl=62 time=46.694 ms

PC3> ping 192.168.3.2
84 bytes from 192.168.3.2 icmp_seq=1 ttl=62 time=61.904 ms
84 bytes from 192.168.3.2 icmp_seq=2 ttl=62 time=60.810 ms
84 bytes from 192.168.3.2 icmp_seq=3 tt1=62 time=60.408 ms
84 bytes from 192.168.3.2 icmp_seq=4 ttl=62 time=60.403 ms
84 bytes from 192.168.3.2 icmp_seq=5 ttl=62 time=59.980 ms

PC3> ping 192.168.3.3
84 bytes from 192.168.3.3 icmp_seq=1 ttl=62 time=61.804 ms
84 bytes from 192.168.3.3 icmp_seq=2 ttl=62 time=59.536 ms
84 bytes from 192.168.3.3 icmp_seq=3 ttl=62 time=45.058 ms
84 bytes from 192.168.3.3 icmp_seq=4 tt1=62 time=61.598 ms
84 bytes from 192.168.3.3 icmp_seq=5 ttl=62 time=61.563 ms
```

PC3 Ping with others



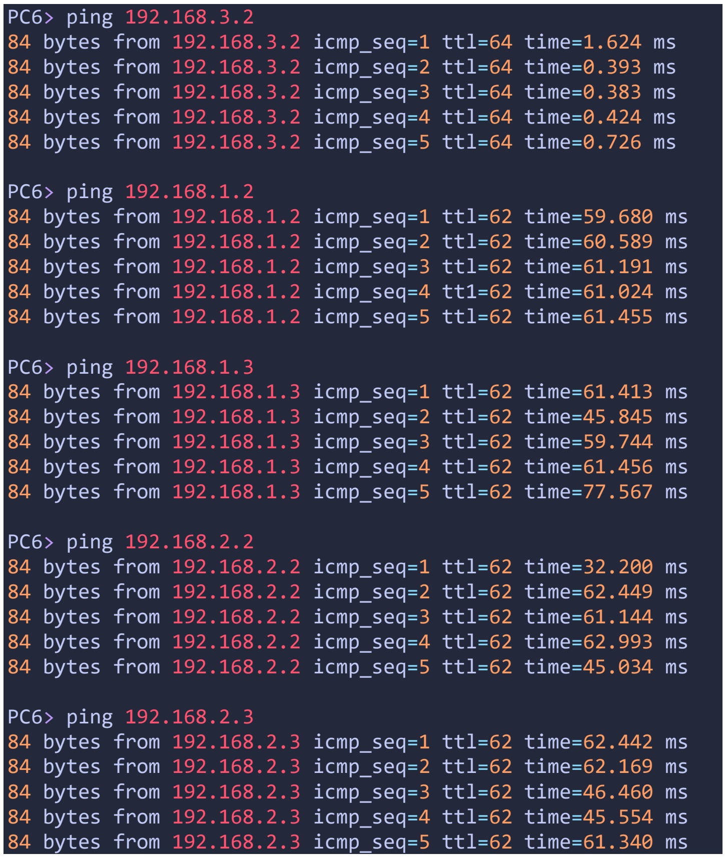
```
PC4> ping 192.168.2.2
84 bytes from 192.168.2.2 icmp_seq=1 ttl=64 time=2.826 ms
84 bytes from 192.168.2.2 icmp_seq=2 ttl=64 time=0.376 ms
84 bytes from 192.168.2.2 icmp_seq=3 ttl=64 time=0.512 ms
84 bytes from 192.168.2.2 icmp_seq=4 ttl=64 time=0.890 ms
84 bytes from 192.168.2.2 icmp_seq=5 ttl=64 time=0.368 ms

PC4> ping 192.168.1.2
84 bytes from 192.168.1.2 icmp_seq=1 ttl=62 time=60.666 ms
84 bytes from 192.168.1.2 icmp_seq=2 ttl=62 time=61.081 ms
84 bytes from 192.168.1.2 icmp_seq=3 ttl=62 time=60.197 ms
84 bytes from 192.168.1.2 icmp_seq=4 ttl=62 time=60.661 ms
84 bytes from 192.168.1.2 icmp_seq=5 ttl=62 time=46.666 ms

PC4> ping 192.168.1.3
84 bytes from 192.168.1.3 icmp_seq=1 ttl=62 time=61.760 ms
84 bytes from 192.168.1.3 icmp_seq=2 ttl=62 time=60.969 ms
84 bytes from 192.168.1.3 icmp_seq=3 ttl=62 time=60.995 ms
84 bytes from 192.168.1.3 icmp_seq=4 ttl=62 time=60.081 ms
84 bytes from 192.168.1.3 icmp_seq=5 ttl=62 time=60.114 ms

PC4> ping 192.168.3.2
84 bytes from 192.168.3.2 icmp_seq=1 ttl=62 time=62.446 ms
84 bytes from 192.168.3.2 icmp_seq=2 ttl=62 time=46.113 ms
84 bytes from 192.168.3.2 icmp_seq=3 ttl=62 time=60.989 ms
84 bytes from 192.168.3.2 icmp_seq=4 ttl=62 time=70.079 ms
84 bytes from 192.168.3.2 icmp_seq=5 ttl=62 time=45.453 ms

PC4> ping 192.168.3.3
84 bytes from 192.168.3.3 icmp_seq=1 ttl=62 time=62.805 ms
84 bytes from 192.168.3.3 icmp_seq=2 ttl=62 time=61.232 ms
84 bytes from 192.168.3.3 icmp_seq=3 ttl=62 time=61.306 ms
84 bytes from 192.168.3.3 icmp_seq=4 ttl=62 time=46.119 ms
84 bytes from 192.168.3.3 icmp_seq=5 ttl=62 time=60.104 ms
```

PC4 Ping with others



```
PC5> ping 192.168.3.3
84 bytes from 192.168.3.3 icmp_seq=1 ttl=64 time=0.528 ms
84 bytes from 192.168.3.3 icmp_seq=2 ttl=64 time=0.367 ms
84 bytes from 192.168.3.3 icmp_seq=3 ttl=64 time=0.387 ms
84 bytes from 192.168.3.3 icmp_seq=4 ttl=64 time=1.316 ms
84 bytes from 192.168.3.3 icmp_seq=5 ttl=64 time=0.377 ms

PC5> ping 192.168.1.2
84 bytes from 192.168.1.2 icmp_seq=1 ttl=62 time=62.592 ms
84 bytes from 192.168.1.2 icmp_seq=2 ttl=62 time=61.972 ms
84 bytes from 192.168.1.2 icmp_seq=3 ttl=62 time=46.805 ms
84 bytes from 192.168.1.2 icmp_seq=4 ttl=62 time=62.347 ms
84 bytes from 192.168.1.2 icmp_seq=5 ttl=62 time=61.240 ms

PC5> ping 192.168.1.3
84 bytes from 192.168.1.3 icmp_seq=1 ttl=62 time=62.330 ms
84 bytes from 192.168.1.3 icmp_seq=2 ttl=62 time=62.266 ms
84 bytes from 192.168.1.3 icmp_seq=3 ttl=62 time=61.214 ms
84 bytes from 192.168.1.3 icmp_seq=4 ttl=62 time=59.862 ms
84 bytes from 192.168.1.3 icmp_seq=5 ttl=62 time=60.477 ms

PC5> ping 192.168.2.2
84 bytes from 192.168.2.2 icmp_seq=1 ttl=62 time=61.991 ms
84 bytes from 192.168.2.2 icmp_seq=2 ttl=62 time=59.916 ms
84 bytes from 192.168.2.2 icmp_seq=3 ttl=62 time=61.387 ms
84 bytes from 192.168.2.2 icmp_seq=4 ttl=62 time=61.221 ms
84 bytes from 192.168.2.2 icmp_seq=5 ttl=62 time=60.162 ms

PC5> ping 192.168.2.3
84 bytes from 192.168.2.3 icmp_seq=1 ttl=62 time=63.811 ms
34 bytes from 192.168.2.3 icmp_seq=2 ttl=62 time=62.057 ms
84 bytes from 192.168.2.3 icmp_seq=3 ttl=62 time=45.882 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=62 time=60.270 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=62 time=45.091 ms
```

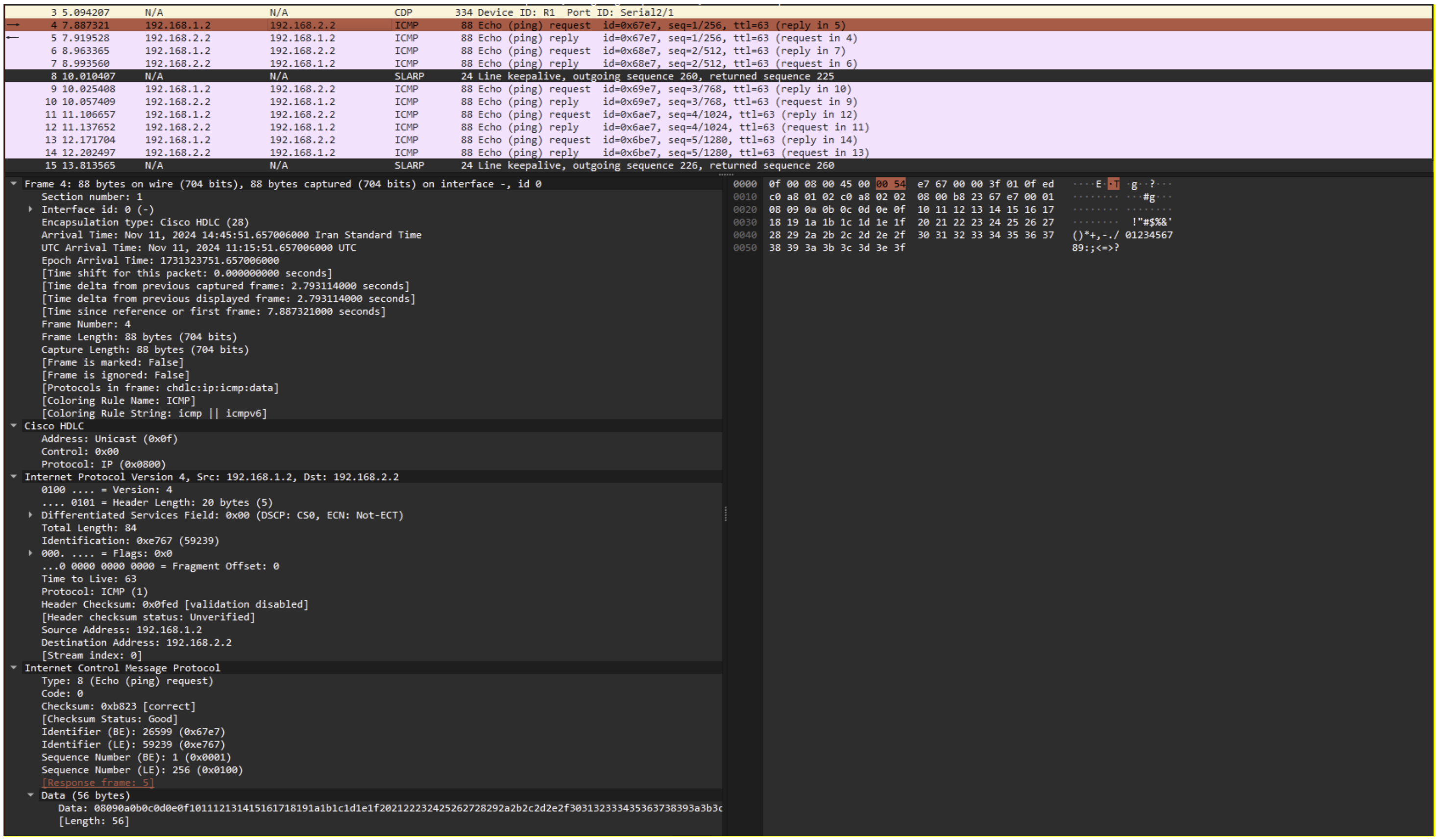
PC5 Ping with others



```
PC6> ping 192.168.3.2
84 bytes from 192.168.3.2 icmp_seq=1 ttl=64 time=1.624 ms
84 bytes from 192.168.3.2 icmp_seq=2 ttl=64 time=0.393 ms
84 bytes from 192.168.3.2 icmp_seq=3 ttl=64 time=0.383 ms
84 bytes from 192.168.3.2 icmp_seq=4 ttl=64 time=0.424 ms
84 bytes from 192.168.3.2 icmp_seq=5 ttl=64 time=0.726 ms

PC6> ping 192.168.1.2
84 bytes from 192.168.1.2 icmp_seq=1 ttl=62 time=59.680 ms
84 bytes from 192.168.1.2 icmp_seq=2 ttl=62 time=60.589 ms
84 bytes from 192.168.1.2 icmp_seq=3 ttl=62 time=61.191 ms
84 bytes from 192.168.1.2 icmp_seq=4 tt1=62 time=61.024 ms
84 bytes from 192.168.1.2 icmp_seq=5 ttl=62 time=61.455 ms

PC6> ping 192.168.1.3
84 bytes from 192.168.1.3 icmp_seq=1 ttl=62 time=61.413 ms
84 bytes from 192.168.1.3 icmp_seq=2 ttl=62 time=45.845 ms
84 bytes from 192.168.1.3 icmp_seq=3 ttl=62 time=59.744 ms
84 bytes from 192.168.1.3 icmp_seq=4 ttl=62 time=61.456 ms
84 bytes from 192.168.1.3 icmp_seq=5 ttl=62 time=77.567 ms

PC6> ping 192.168.2.2
84 bytes from 192.168.2.2 icmp_seq=1 ttl=62 time=32.200 ms
84 bytes from 192.168.2.2 icmp_seq=2 ttl=62 time=62.449 ms
84 bytes from 192.168.2.2 icmp_seq=3 ttl=62 time=61.144 ms
84 bytes from 192.168.2.2 icmp_seq=4 ttl=62 time=62.993 ms
84 bytes from 192.168.2.2 icmp_seq=5 ttl=62 time=45.034 ms

PC6> ping 192.168.2.3
84 bytes from 192.168.2.3 icmp_seq=1 ttl=62 time=62.442 ms
84 bytes from 192.168.2.3 icmp_seq=2 ttl=62 time=62.169 ms
84 bytes from 192.168.2.3 icmp_seq=3 ttl=62 time=46.460 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=62 time=45.554 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=62 time=61.340 ms
```

PC6 Ping with others

ج. خروجی های WireShark



```
    3 5.094207   N/A           N/A           CDP     334 Device ID: R1  Port ID: Serial2/1
→   4 7.887321   192.168.1.2   192.168.2.2   ICMP     88 Echo (ping) request  id=0x67e7, seq=1/256, ttl=63 (reply in 5)
←   5 7.919528   192.168.2.2   192.168.1.2   ICMP     88 Echo (ping) reply    id=0x67e7, seq=1/256, ttl=63 (request in 4)
    6 8.963365   192.168.1.2   192.168.2.2   ICMP     88 Echo (ping) request  id=0x68e7, seq=2/512, ttl=63 (reply in 7)
    7 8.993560   192.168.2.2   192.168.1.2   ICMP     88 Echo (ping) reply    id=0x68e7, seq=2/512, ttl=63 (request in 6)
    8 10.010407  N/A           N/A           SLARP    24 Line keepalive, outgoing sequence 260, returned sequence 225
    9 10.025408  192.168.1.2   192.168.2.2   ICMP     88 Echo (ping) request  id=0x69e7, seq=3/768, ttl=63 (reply in 10)
   10 10.057409  192.168.2.2   192.168.1.2   ICMP     88 Echo (ping) reply    id=0x69e7, seq=3/768, ttl=63 (request in 9)
   11 11.106657  192.168.1.2   192.168.2.2   ICMP     88 Echo (ping) request  id=0x6ae7, seq=4/1024, ttl=63 (reply in 12)
   12 11.137652  192.168.2.2   192.168.1.2   ICMP     88 Echo (ping) reply    id=0x6ae7, seq=4/1024, ttl=63 (request in 11)
   13 12.171704  192.168.1.2   192.168.2.2   ICMP     88 Echo (ping) request  id=0x6be7, seq=5/1280, ttl=63 (reply in 14)
   14 12.202497  192.168.2.2   192.168.1.2   ICMP     88 Echo (ping) reply    id=0x6be7, seq=5/1280, ttl=63 (request in 13)
   15 13.813565  N/A           N/A           SLARP    24 Line keepalive, outgoing sequence 226, returned sequence 260
```

```
Frame 4: 88 bytes on wire (704 bits), 88 bytes captured (704 bits) on interface -, id 0
    Section number: 1
    Interface id: 0 (-)
    Encapsulation type: Cisco HDLC (28)
    Arrival Time: Nov 11, 2024 14:45:51.657006000 Iran Standard Time
    UTC Arrival Time: Nov 11, 2024 11:15:51.657006000 UTC
    Epoch Arrival Time: 1731323751.657006000
    [Time shift for this packet: 0.000000000 seconds]
    [Time delta from previous captured frame: 2.793114000 seconds]
    [Time delta from previous displayed frame: 2.793114000 seconds]
    [Time since reference or first frame: 7.887321000 seconds]
    Frame Number: 4
    Frame Length: 88 bytes (704 bits)
    Capture Length: 88 bytes (704 bits)
    [Frame is marked: False]
    [Frame is ignored: False]
    [Protocols in frame: chdlc:ip:icmp:data]
    [Coloring Rule Name: ICMP]
    [Coloring Rule String: icmp || icmpv6]
Cisco HDLC
    Address: Unicast (0x0f)
    Control: 0x00
    Protocol: IP (0x0800)
Internet Protocol Version 4, Src: 192.168.1.2, Dst: 192.168.2.2
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
    Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 84
    Identification: 0xe767 (59239)
    000. .... = Flags: 0x0
    ...0 0000 0000 0000 = Fragment Offset: 0
    Time to Live: 63
    Protocol: ICMP (1)
    Header Checksum: 0x0fed [validation disabled]
    [Header checksum status: Unverified]
    Source Address: 192.168.1.2
    Destination Address: 192.168.2.2
    [Stream index: 0]
Internet Control Message Protocol
    Type: 8 (Echo (ping) request)
    Code: 0
    Checksum: 0xb823 [correct]
    [Checksum Status: Good]
    Identifier (BE): 26599 (0x67e7)
    Identifier (LE): 59239 (0xe767)
    Sequence Number (BE): 1 (0x0001)
    Sequence Number (LE): 256 (0x0100)
    [Response frame: 5]
    Data (56 bytes)
        Data: 08090a0b0c0d0e0f101112131415161718191a1b1c1d1e1f202122232425262728292a2b2c2d2e2f303132333435363738393a3b3c
        [Length: 56]
```

```
0000  0f 00 08 00 45 00 00 54  e7 67 00 00 3f 01 0f ed   ····E··T ·g··?···
0010  c0 a8 01 02 c0 a8 02 02  08 00 b8 23 67 e7 00 01   ········ ···#g···
0020  08 09 0a 0b 0c 0d 0e 0f  10 11 12 13 14 15 16 17   ········ ········
0030  18 19 1a 1b 1c 1d 1e 1f  20 21 22 23 24 25 26 27   ········  !"#$%&'
0040  28 29 2a 2b 2c 2d 2e 2f  30 31 32 33 34 35 36 37   ()*+,-./ 01234567
0050  38 39 3a 3b 3c 3d 3e 3f                            89:;<=>?
```

WireShark Intact

تحلیل و توضیح Wireshark برای شبکه با لینک سالم(Intact)

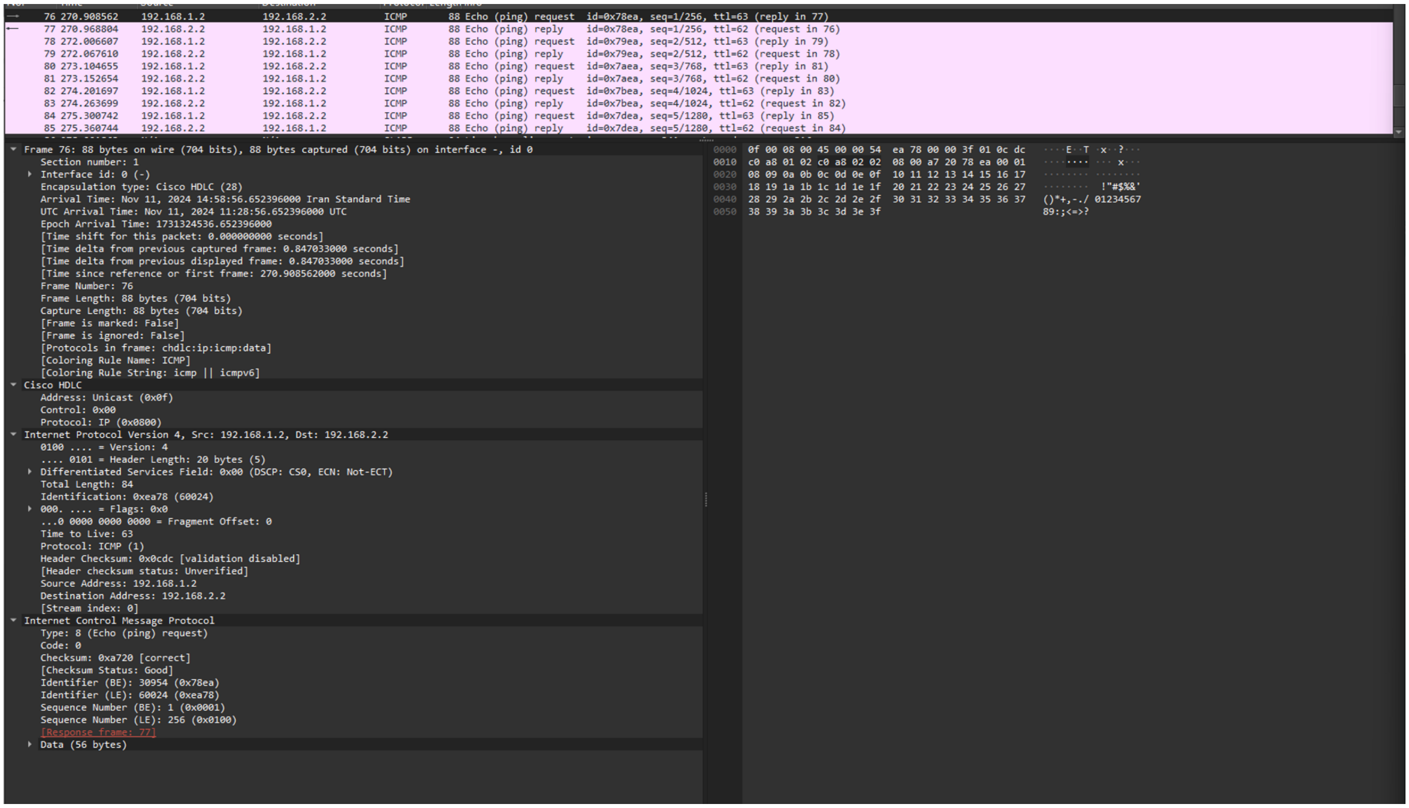
در خروجی Wireshark برای زمانی که لینک بین R1 و R3 فعال است، موارد زیر مشاهده می‌شود:

۱. **ICMP Request و ICMP Reply** :
   - بسته‌های ارسالی (ICMP Echo Request) از (PC1) **192.168.1.2** به (PC3) **192.168.2.2** ارسال می‌شوند.
   - پاسخ‌ها (ICMP Echo Reply) از **192.168.2.2** به **192.168.1.2** بازگردانده می‌شوند.
   - TTL نشان می‌دهد که بسته‌ها از **R1** مستقیماً به **R3** ارسال شده‌اند (از طریق اینترفیس سریال Serial2/1 روی R1).

۲. **آدرس مقصد و منبع:**
   - **آدرس IP منبع:** (PC1) **192.168.1.2**
   - **آدرس IP مقصد:** (PC3) **192.168.2.2**

۳. **مسیر بسته‌ها:**
   - مسیر مستقیم بین R1 و R3 برای رسیدن به مقصد استفاده شده است.
   - این مسیر به دلیل فعال بودن لینک مستقیم بین این دو روتر انتخاب شده است.

زمانی که لینک بین R1 و R3 فعال است، شبکه بسته‌ها را مستقیماً از این مسیر ارسال می‌کند و مسیر پشتیبان استفاده نشده است.

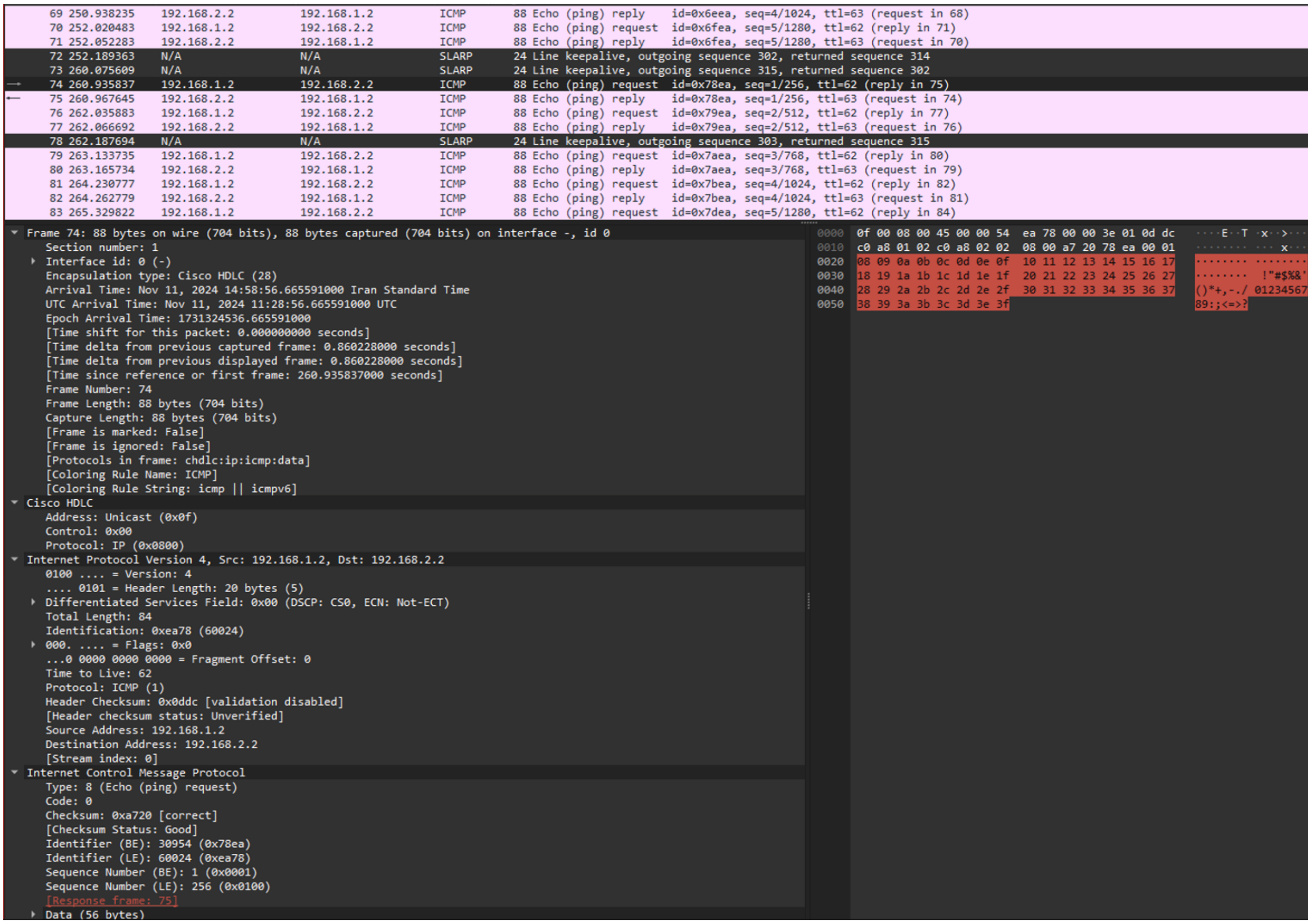


```
→     76 270.908562   192.168.1.2     192.168.2.2     ICMP     88 Echo (ping) request  id=0x78ea, seq=1/256, ttl=63 (reply in 77)
←     77 270.968804   192.168.2.2     192.168.1.2     ICMP     88 Echo (ping) reply    id=0x78ea, seq=1/256, ttl=62 (request in 76)
      78 272.006607   192.168.1.2     192.168.2.2     ICMP     88 Echo (ping) request  id=0x79ea, seq=2/512, ttl=63 (reply in 79)
      79 272.067610   192.168.2.2     192.168.1.2     ICMP     88 Echo (ping) reply    id=0x79ea, seq=2/512, ttl=62 (request in 78)
      80 273.104655   192.168.1.2     192.168.2.2     ICMP     88 Echo (ping) request  id=0x7aea, seq=3/768, ttl=63 (reply in 81)
      81 273.152654   192.168.2.2     192.168.1.2     ICMP     88 Echo (ping) reply    id=0x7aea, seq=3/768, ttl=62 (request in 80)
      82 274.201697   192.168.1.2     192.168.2.2     ICMP     88 Echo (ping) request  id=0x7bea, seq=4/1024, ttl=63 (reply in 83)
      83 274.263699   192.168.2.2     192.168.1.2     ICMP     88 Echo (ping) reply    id=0x7bea, seq=4/1024, ttl=62 (request in 82)
      84 275.300742   192.168.1.2     192.168.2.2     ICMP     88 Echo (ping) request  id=0x7dea, seq=5/1280, ttl=63 (reply in 85)
      85 275.360744   192.168.2.2     192.168.1.2     ICMP     88 Echo (ping) reply    id=0x7dea, seq=5/1280, ttl=62 (request in 84)
```

```
▾ Frame 76: 88 bytes on wire (704 bits), 88 bytes captured (704 bits) on interface -, id 0
    Section number: 1
  ▸ Interface id: 0 (-)
    Encapsulation type: Cisco HDLC (28)
    Arrival Time: Nov 11, 2024 14:58:56.652396000 Iran Standard Time
    UTC Arrival Time: Nov 11, 2024 11:28:56.652396000 UTC
    Epoch Arrival Time: 1731324536.652396000
    [Time shift for this packet: 0.000000000 seconds]
    [Time delta from previous captured frame: 0.847033000 seconds]
    [Time delta from previous displayed frame: 0.847033000 seconds]
    [Time since reference or first frame: 270.908562000 seconds]
    Frame Number: 76
    Frame Length: 88 bytes (704 bits)
    Capture Length: 88 bytes (704 bits)
    [Frame is marked: False]
    [Frame is ignored: False]
    [Protocols in frame: chdlc:ip:icmp:data]
    [Coloring Rule Name: ICMP]
    [Coloring Rule String: icmp || icmpv6]
▾ Cisco HDLC
    Address: Unicast (0x0f)
    Control: 0x00
    Protocol: IP (0x0800)
▾ Internet Protocol Version 4, Src: 192.168.1.2, Dst: 192.168.2.2
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  ▸ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 84
    Identification: 0xea78 (60024)
  ▸ 000. .... = Flags: 0x0
    ...0 0000 0000 0000 = Fragment Offset: 0
    Time to Live: 63
    Protocol: ICMP (1)
    Header Checksum: 0x0cdc [validation disabled]
    [Header checksum status: Unverified]
    Source Address: 192.168.1.2
    Destination Address: 192.168.2.2
    [Stream index: 0]
▾ Internet Control Message Protocol
    Type: 8 (Echo (ping) request)
    Code: 0
    Checksum: 0xa720 [correct]
    [Checksum Status: Good]
    Identifier (BE): 30954 (0x78ea)
    Identifier (LE): 60024 (0xea78)
    Sequence Number (BE): 1 (0x0001)
    Sequence Number (LE): 256 (0x0100)
    [Response frame: 77]
  ▸ Data (56 bytes)
```

```
0000  0f 00 08 00 45 00 00 54  ea 78 00 00 3f 01 0c dc   ····E··T ·x··?···
0010  c0 a8 01 02 c0 a8 02 02  08 00 a7 20 78 ea 00 01   ········ ··· x···
0020  08 09 0a 0b 0c 0d 0e 0f  10 11 12 13 14 15 16 17   ········ ········
0030  18 19 1a 1b 1c 1d 1e 1f  20 21 22 23 24 25 26 27   ········  !"#$%&'
0040  28 29 2a 2b 2c 2d 2e 2f  30 31 32 33 34 35 36 37   ()*+,-./ 01234567
0050  38 39 3a 3b 3c 3d 3e 3f                            89:;<=>?
```

WireShark DC pt.1



```
   69 250.938235   192.168.2.2      192.168.1.2      ICMP      88 Echo (ping) reply    id=0x6eea, seq=4/1024, ttl=63 (request in 68)
   70 252.020483   192.168.1.2      192.168.2.2      ICMP      88 Echo (ping) request  id=0x6fea, seq=5/1280, ttl=62 (reply in 71)
   71 252.052283   192.168.2.2      192.168.1.2      ICMP      88 Echo (ping) reply    id=0x6fea, seq=5/1280, ttl=63 (request in 70)
   72 252.189363   N/A              N/A              SLARP     24 Line keepalive, outgoing sequence 302, returned sequence 314
   73 260.075609   N/A              N/A              SLARP     24 Line keepalive, outgoing sequence 315, returned sequence 302
   74 260.935837   192.168.1.2      192.168.2.2      ICMP      88 Echo (ping) request  id=0x78ea, seq=1/256, ttl=62 (reply in 75)
   75 260.967645   192.168.2.2      192.168.1.2      ICMP      88 Echo (ping) reply    id=0x78ea, seq=1/256, ttl=63 (request in 74)
   76 262.035883   192.168.1.2      192.168.2.2      ICMP      88 Echo (ping) request  id=0x79ea, seq=2/512, ttl=62 (reply in 77)
   77 262.066692   192.168.2.2      192.168.1.2      ICMP      88 Echo (ping) reply    id=0x79ea, seq=2/512, ttl=63 (request in 76)
   78 262.187694   N/A              N/A              SLARP     24 Line keepalive, outgoing sequence 303, returned sequence 315
   79 263.133735   192.168.1.2      192.168.2.2      ICMP      88 Echo (ping) request  id=0x7aea, seq=3/768, ttl=62 (reply in 80)
   80 263.165734   192.168.2.2      192.168.1.2      ICMP      88 Echo (ping) reply    id=0x7aea, seq=3/768, ttl=63 (request in 79)
   81 264.230777   192.168.1.2      192.168.2.2      ICMP      88 Echo (ping) request  id=0x7bea, seq=4/1024, ttl=62 (reply in 82)
   82 264.262779   192.168.2.2      192.168.1.2      ICMP      88 Echo (ping) reply    id=0x7bea, seq=4/1024, ttl=63 (request in 81)
   83 265.329822   192.168.1.2      192.168.2.2      ICMP      88 Echo (ping) request  id=0x7dea, seq=5/1280, ttl=62 (reply in 84)
```

```
Frame 74: 88 bytes on wire (704 bits), 88 bytes captured (704 bits) on interface -, id 0
   Section number: 1
   Interface id: 0 (-)
   Encapsulation type: Cisco HDLC (28)
   Arrival Time: Nov 11, 2024 14:58:56.665591000 Iran Standard Time
   UTC Arrival Time: Nov 11, 2024 11:28:56.665591000 UTC
   Epoch Arrival Time: 1731324536.665591000
   [Time shift for this packet: 0.000000000 seconds]
   [Time delta from previous captured frame: 0.860228000 seconds]
   [Time delta from previous displayed frame: 0.860228000 seconds]
   [Time since reference or first frame: 260.935837000 seconds]
   Frame Number: 74
   Frame Length: 88 bytes (704 bits)
   Capture Length: 88 bytes (704 bits)
   [Frame is marked: False]
   [Frame is ignored: False]
   [Protocols in frame: chdlc:ip:icmp:data]
   [Coloring Rule Name: ICMP]
   [Coloring Rule String: icmp || icmpv6]
Cisco HDLC
   Address: Unicast (0x0f)
   Control: 0x00
   Protocol: IP (0x0800)
Internet Protocol Version 4, Src: 192.168.1.2, Dst: 192.168.2.2
   0100 .... = Version: 4
   .... 0101 = Header Length: 20 bytes (5)
   Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
   Total Length: 84
   Identification: 0xea78 (60024)
   000. .... = Flags: 0x0
   ...0 0000 0000 0000 = Fragment Offset: 0
   Time to Live: 62
   Protocol: ICMP (1)
   Header Checksum: 0x0ddc [validation disabled]
   [Header checksum status: Unverified]
   Source Address: 192.168.1.2
   Destination Address: 192.168.2.2
   [Stream index: 0]
Internet Control Message Protocol
   Type: 8 (Echo (ping) request)
   Code: 0
   Checksum: 0xa720 [correct]
   [Checksum Status: Good]
   Identifier (BE): 30954 (0x78ea)
   Identifier (LE): 60024 (0xea78)
   Sequence Number (BE): 1 (0x0001)
   Sequence Number (LE): 256 (0x0100)
   [Response frame: 75]
   Data (56 bytes)
```

```
0000  0f 00 08 00 45 00 00 54  ea 78 00 00 3e 01 0d dc   ····E··T ·x··>···
0010  c0 a8 01 02 c0 a8 02 02  08 00 a7 20 78 ea 00 01   ········ ··· x···
0020  08 09 0a 0b 0c 0d 0e 0f  10 11 12 13 14 15 16 17   ········ ········
0030  18 19 1a 1b 1c 1d 1e 1f  20 21 22 23 24 25 26 27   ········  !"#$%&'
0040  28 29 2a 2b 2c 2d 2e 2f  30 31 32 33 34 35 36 37   ()*+,-./ 01234567
0050  38 39 3a 3b 3c 3d 3e 3f                            89:;<=>?
```

WireShark DC pt.2

تحلیل و توضیح Wireshark برای شبکه با لینک قطع‌شده(Disconnected)

در خروجی Wireshark برای زمانی که لینک بین R1 و R3 قطع شده است (اینترفیس Serial2/1 در R1 غیرفعال شده است)، موارد زیر مشاهده می‌شود:

۱. **ICMP Request و ICMP Reply** :
   - بسته‌های ارسالی همچنان از (PC1) **192.168.1.2** به (PC3) **192.168.2.2** ارسال می‌شوند.
   - پاسخ‌ها نیز از **192.168.2.2** به **192.168.1.2** بازگردانده می‌شوند.
   - TTL تغییر یافته است، زیرا بسته‌ها مسیر دیگری را طی می‌کنند.

۲. مسیر بسته‌ها:

- به دلیل قطع بودن لینک بین **R1** و **R3** ، بسته‌ها از مسیر زیر عبور می‌کنند :
  - **R1 → R2 → R3**
- این موضوع در Wireshark قابل مشاهده است، زیرا بسته‌ها از طریق اینترفیس سریال **Serial2/0** در R1 به سمت R2 ارسال می‌شوند.

۳. آدرس مقصد و منبع:

- آدرس IP منبع و مقصد مانند حالت سالم باقی مانده است :
  - **آدرس IP منبع:** (PC1) **192.168.1.2**
  - **آدرس IP مقصد:** (PC3) **192.168.2.2**

٤. نتیجه‌گیری:

- زمانی که لینک مستقیم بین R1 و R3 قطع می‌شود، شبکه با استفاده از مسیر پشتیبان همچنان ارتباط را حفظ می‌کند. (R1 → R2 → R3)
- این رفتار اثباتی بر صحت پیکربندی مسیریابی استاتیک با مسیرهای پشتیبان است.

نتیجه‌گیری کلی

- در حالت لینک سالم(Intact) ، بسته‌ها از مسیر مستقیم **R1 → R3** عبور می‌کنند که سریع‌تر و بهینه‌تر است.
- در حالت لینک قطع‌شده(Disconnected) ، مسیر پشتیبان **R1 → R2 → R3** به طور خودکار فعال می‌شود و ارتباط بین شبکه‌ها بدون مشکل برقرار می‌ماند.

توضیحات پیاده سازی:

۱. کانفیگ Routers InterFaces:

هر روتر با یک آدرس IP بر اساس توپولوژی شبکه ارائه شده کانفیگ شده. از دستورات زیر برای تخصیص IP و فعال سازی اینترفیس استفاده شده است:

- **Enter global configuration mode:**

```
enable
configure terminal
```

- **Routers(E.g. Router 1):**

```
interface f0/0
ip address 192.168.1.1 255.255.255.0
no shutdown
exit
interface s2/0
ip address 10.0.0.1 255.255.255.252
no shutdown
exit
interface s2/1
ip address 10.0.0.17 255.255.255.252
no shutdown
exit
```

برای روتر های دیگر نیز به همین روال است.

۲. کانفیگ Static Route:

مسیرهای ثابت روی هر روتر کانفیگ شده اند تا ترافیک را به زیر شبکه های دیگر هدایت کنند. مسیرهای اضافی برای فعال کردن Failover در صورت خرابی پیوند اضافه شدند.

- **Router R1**:

```
ip route 192.168.2.0 255.255.255.0 10.0.0.18  # Primary route via R3
ip route 192.168.3.0 255.255.255.0 10.0.0.2   # Primary route via R2
ip route 192.168.2.0 255.255.255.0 10.0.0.2   # Backup  route via R2
ip route 192.168.3.0 255.255.255.0 10.0.0.18  # Backup  route via R3
```

۳. ذخیره کانفیگ ها:

- **Save Configs**:

```
write memory
```

۴. کانفیگ PC ها: (مانند بخش های قبل)

- **PC IP Configs**:

```
ip 192.168.1.2 255.255.255.0 192.168.1.1
save pc1_config.txt
```

۵. کانفیگ PC ها:

- **PC IP Configs (E.g. PC1)**:

```
ip 192.168.1.2 255.255.255.0 192.168.1.1
save pc1_config.txt
```

۶. تست و Verification :

- **Ping Test**:

```
ip 192.168.1.2 255.255.255.0 192.168.1.1
save pc1_config.txt
```

- **InterFace Status & Routing Tables**:

```
show ip interface brief
```

تایید همه اینترفیس ها

```
show ip route
```

تأیید وجود مسیرهای اصلی و پشتیبان

- **Failover Testing**:

```
interface s2/1
shutdown
```

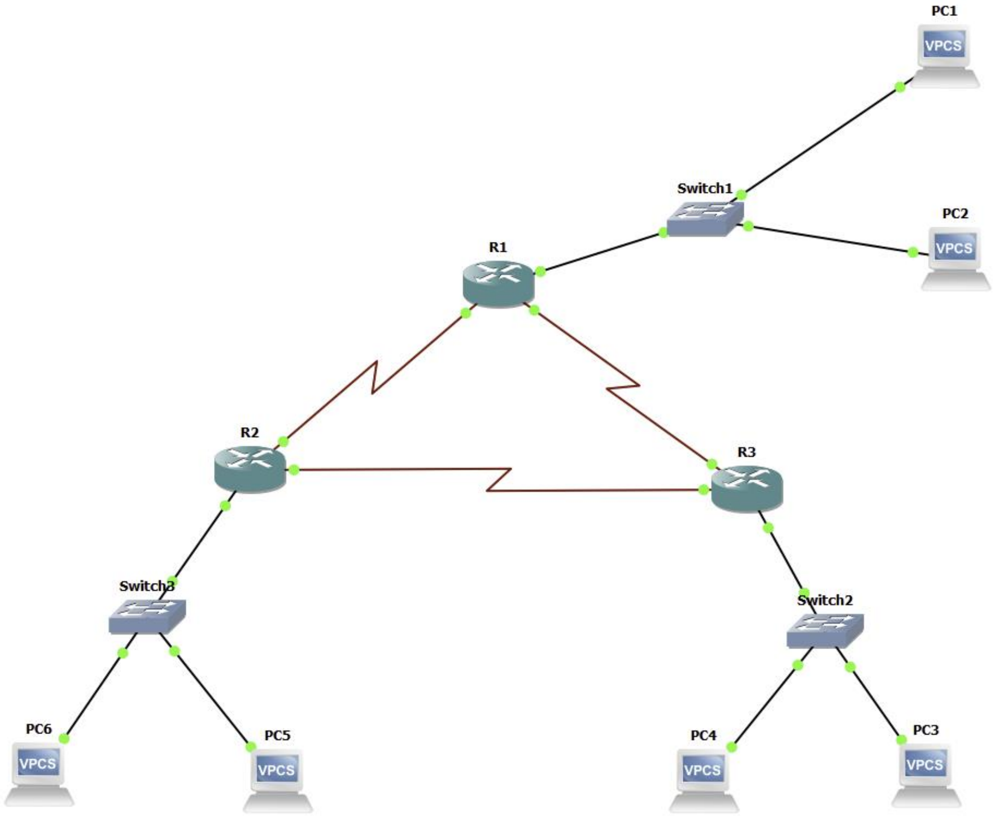
شبیه سازی از بین رفتن لینک به صورت خاموش کردن یک اینترفیس مشخص

```
interface s2/1
no shutdown
```

و پس از تایید شکسته شدن ارتباط آن را دوباره فعال کردیم

این شبکه راه‌اندازی شده ،مسیریابی استاتیک قابل اعتماد و مطمئنی فراهم می کند که برای شبکه‌های کوچک مناسب است و با بهره‌مندی از مسیر یابی مجدد در صورت شکست کاربرد های فراوانی در راه اندازی شبکه ها دارد.

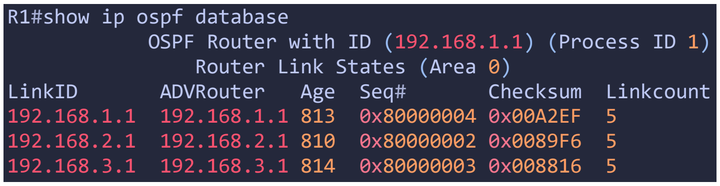
۵. Dynamic Routing



توپولوژی شبکه

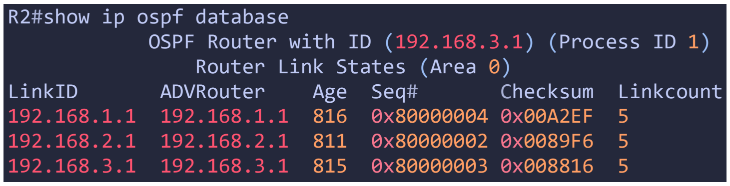
خروجی ها:

OSPF DataBase:



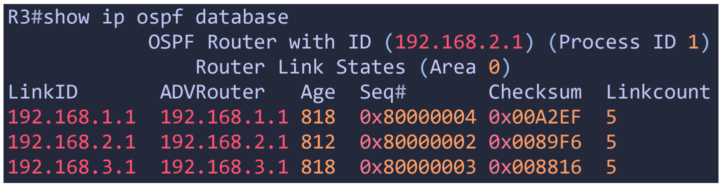
```
R1#show ip ospf database
            OSPF Router with ID (192.168.1.1) (Process ID 1)
                Router Link States (Area 0)
LinkID         ADVRouter    Age  Seq#        Checksum  Linkcount
192.168.1.1    192.168.1.1  813  0x80000004  0x00A2EF  5
192.168.2.1    192.168.2.1  810  0x80000002  0x0089F6  5
192.168.3.1    192.168.3.1  814  0x80000003  0x008816  5
```

OSFPDB R1



```
R2#show ip ospf database
            OSPF Router with ID (192.168.3.1) (Process ID 1)
                Router Link States (Area 0)
LinkID         ADVRouter      Age  Seq#        Checksum  Linkcount
192.168.1.1    192.168.1.1    816  0x80000004  0x00A2EF  5
192.168.2.1    192.168.2.1    811  0x80000002  0x0089F6  5
192.168.3.1    192.168.3.1    815  0x80000003  0x008816  5
```

OSFPDB R2

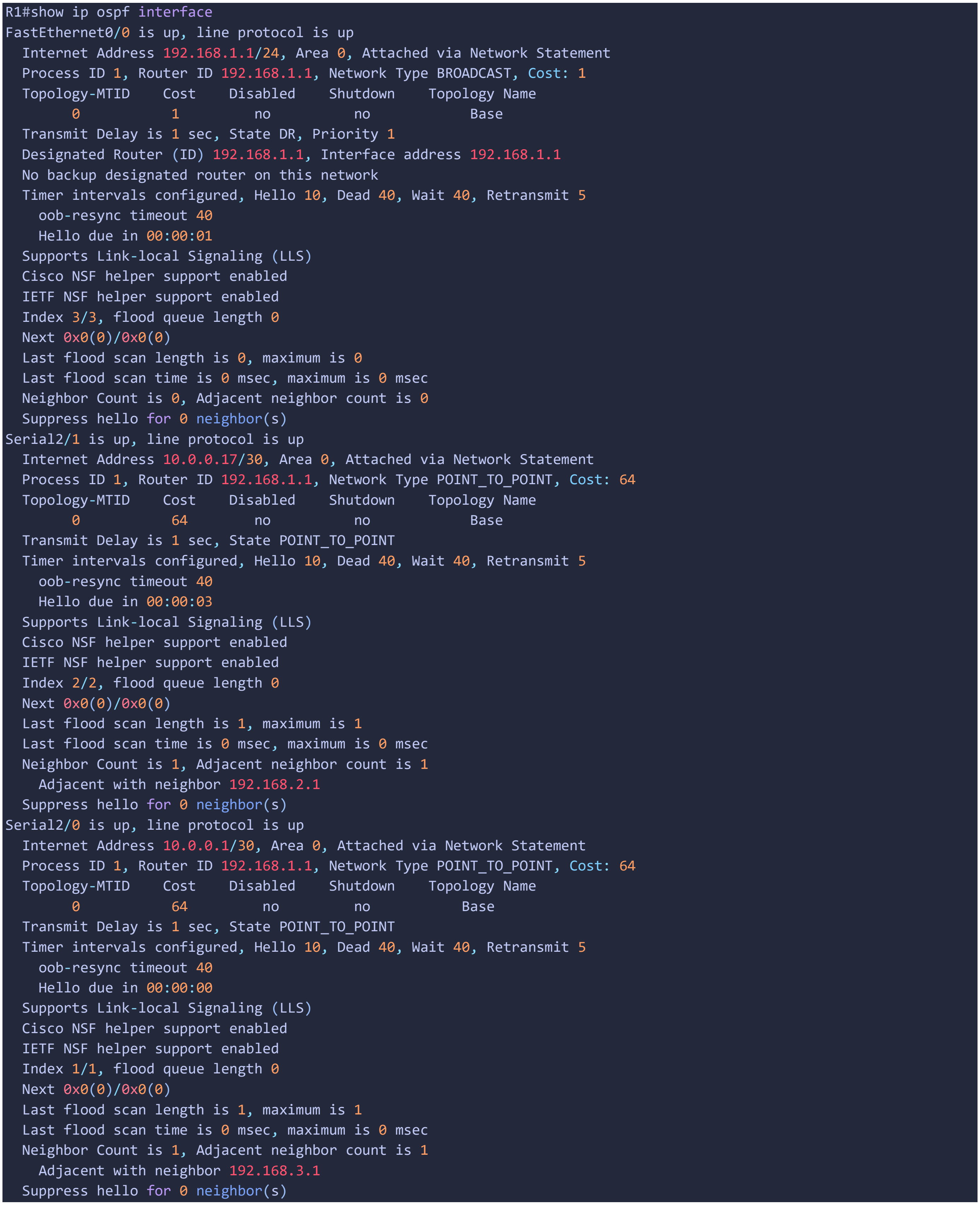


```
R3#show ip ospf database
            OSPF Router with ID (192.168.2.1) (Process ID 1)
                Router Link States (Area 0)
LinkID         ADVRouter    Age  Seq#        Checksum  Linkcount
192.168.1.1    192.168.1.1  818  0x80000004  0x00A2EF  5
192.168.2.1    192.168.2.1  812  0x80000002  0x0089F6  5
192.168.3.1    192.168.3.1  818  0x80000003  0x008816  5
```

OSFPDB R3

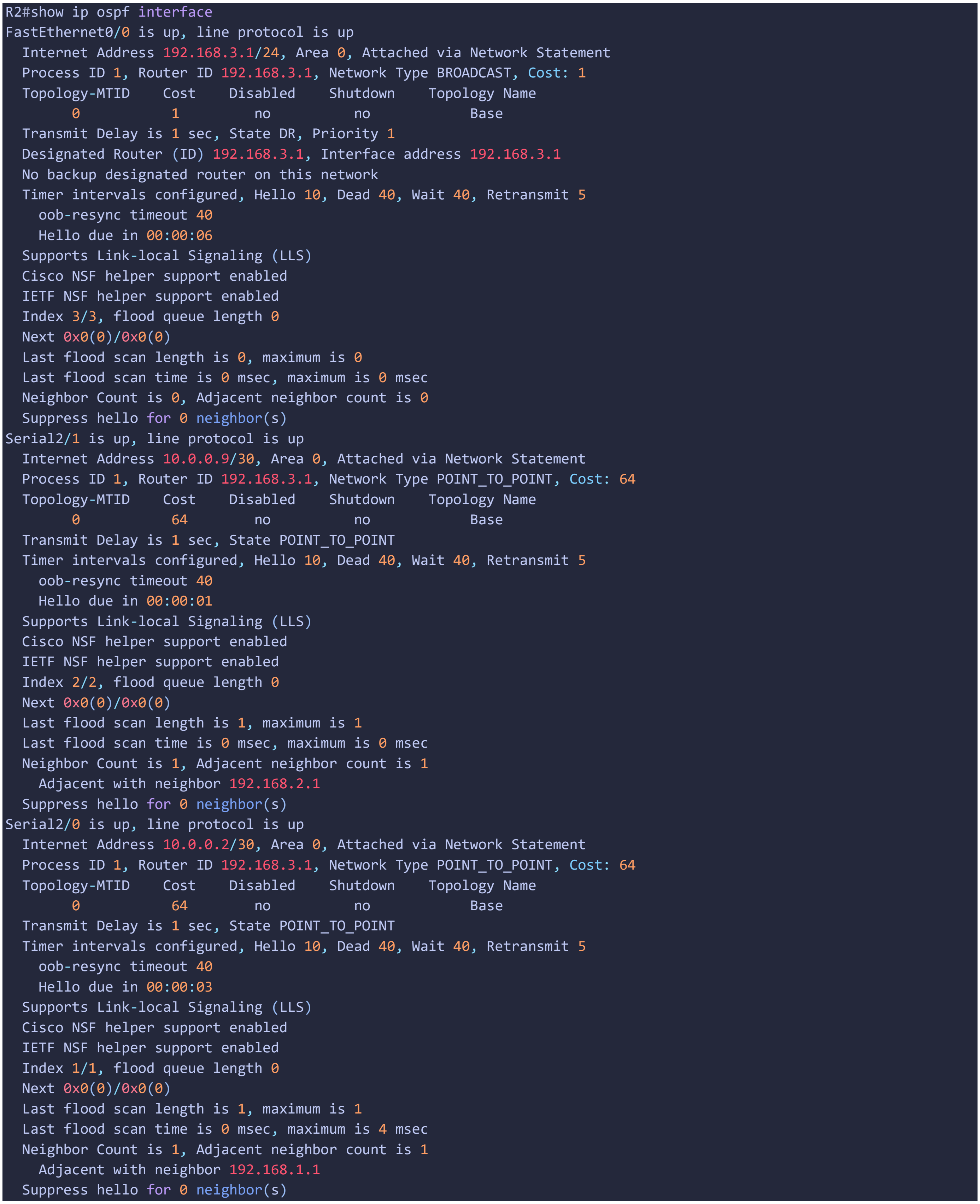
این جدول نمای کلی از **Link-State Database** را نشان می‌دهد که شامل اطلاعاتی درباره توپولوژی شبکه است. این اطلاعات توسط روترهای OSPF از طریق پیام‌های مبادله شده ساخته می شود و از آن برای ایجاد Routing Table استفاده می‌گردد. جدول نشان می‌دهد که روتر چه گره‌ها و اتصالاتی را در شبکه می‌شناسد.

OSPF InterFace:



```
R1#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet Address 192.168.1.1/24, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.1.1, Network Type BROADCAST, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown    Topology Name
        0           1         no          no            Base
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.1.1, Interface address 192.168.1.1
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 3/3, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 0
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
Serial2/1 is up, line protocol is up
  Internet Address 10.0.0.17/30, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.1.1, Network Type POINT_TO_POINT, Cost: 64
  Topology-MTID    Cost    Disabled    Shutdown    Topology Name
        0           64        no          no            Base
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:03
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.2.1
  Suppress hello for 0 neighbor(s)
Serial2/0 is up, line protocol is up
  Internet Address 10.0.0.1/30, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.1.1, Network Type POINT_TO_POINT, Cost: 64
  Topology-MTID    Cost    Disabled    Shutdown    Topology Name
        0           64         no         no           Base
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:00
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.3.1
  Suppress hello for 0 neighbor(s)
```

OSFP InterFace R1



```
R2#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet Address 192.168.3.1/24, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.3.1, Network Type BROADCAST, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown    Topology Name
        0           1         no          no            Base
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.3.1, Interface address 192.168.3.1
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:06
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 3/3, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 0
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
Serial2/1 is up, line protocol is up
  Internet Address 10.0.0.9/30, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.3.1, Network Type POINT_TO_POINT, Cost: 64
  Topology-MTID    Cost    Disabled    Shutdown    Topology Name
        0           64        no          no            Base
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.2.1
  Suppress hello for 0 neighbor(s)
Serial2/0 is up, line protocol is up
  Internet Address 10.0.0.2/30, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.3.1, Network Type POINT_TO_POINT, Cost: 64
  Topology-MTID    Cost    Disabled    Shutdown    Topology Name
        0           64        no          no            Base
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:03
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 4 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.1.1
  Suppress hello for 0 neighbor(s)
```

OSFP InterFace R2

```
R3#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet Address 192.168.2.1/24, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.2.1, Network Type BROADCAST, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown    Topology Name
        0           1         no          no            Base
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.2.1, Interface address 192.168.2.1
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
   oob-resync timeout 40
   Hello due in 00:00:09
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 3/3, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 0
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
Serial2/1 is up, line protocol is up
  Internet Address 10.0.0.10/30, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.2.1, Network Type POINT_TO_POINT, Cost: 64
  Topology-MTID    Cost    Disabled    Shutdown    Topology Name
        0           64        no          no            Base
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:03
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 192.168.3.1
  Suppress hello for 0 neighbor(s)
Serial2/0 is up, line protocol is up
  Internet Address 10.0.0.18/30, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.2.1, Network Type POINT_TO_POINT, Cost: 64
  Topology-MTID    Cost    Disabled    Shutdown    Topology Name
        0           64        no          no            Base
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 4 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.1.1
  Suppress hello for 0 neighbor(s)
```

OSFP InterFace R3

این جدول وضعیت لینک های شبکه روتر را نمایش می‌دهد که از OSPF استفاده می‌کنند. جزئیاتی مانند IP اینترفیس‌ها، هزینه OSPF ، وضعیت اتصال(up/down) ، و نوع شبکه (broadcast/point-to-point) در این بخش مشخص می‌شود. این اطلاعات برای اطمینان از اینکه OSPF به درستی بر روی اینترفیس‌ها فعال شده است، مهم است.

PC Pings:

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

PC1> ping 192.168.2.2
84 bytes from 192.168.2.2 icmp_seq=1 ttl=62 time=106.298 ms
84 bytes from 192.168.2.2 icmp_seq=2 ttl=62 time=61.231 ms
84 bytes from 192.168.2.2 icmp_seq=3 ttl=62 time=61.222 ms
84 bytes from 192.168.2.2 icmp_seq=4 ttl=62 time=61.043 ms
84 bytes from 192.168.2.2 icmp_seq=5 ttl=62 time=60.386 ms

PC1> ping 192.168.3.2
84 bytes from 192.168.3.2 icmp_seq=1 ttl=62 time=107.753 ms
84 bytes from 192.168.3.2 icmp_seq=2 ttl=62 time=60.547 ms
84 bytes from 192.168.3.2 icmp_seq=3 ttl=62 time=65.028 ms
84 bytes from 192.168.3.2 icmp_seq=4 ttl=62 time=49.317 ms
84 bytes from 192.168.3.2 icmp_seq=5 ttl=62 time=64.837 ms
```

PC1 Ping with others

```
PC2> ip 192.168.1.3 255.255.255.0 192.168.1.1
Checking for duplicate address ...
PC1 : 192.168.1.3 255.255.255.0 gateway 192.168.1.1

PC2> ping 192.168.2.3
84 bytes from 192.168.2.3 icmp_seq=1 ttl=62 time=75.696 ms
84 bytes from 192.168.2.3 icmp_seq=2 ttl=62 time=46.968 ms
84 bytes from 192.168.2.3 icmp_seq=3 ttl=62 time=66.621 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=62 time=62.624 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=62 time=61.343 ms

PC2> ping 192.168.3.3
84 bytes from 192.168.3.3 icmp_seq=1 ttl=62 time=78.369 ms
84 bytes from 192.168.3.3 icmp_seq=2 ttl=62 time=60.616 ms
84 bytes from 192.168.3.3 icmp_seq=3 ttl=62 time=62.011 ms
84 bytes from 192.168.3.3 icmp_seq=4 ttl=62 time=64.505 ms
84 bytes from 192.168.3.3 icmp_seq=5 ttl=62 time=64.180 ms
```

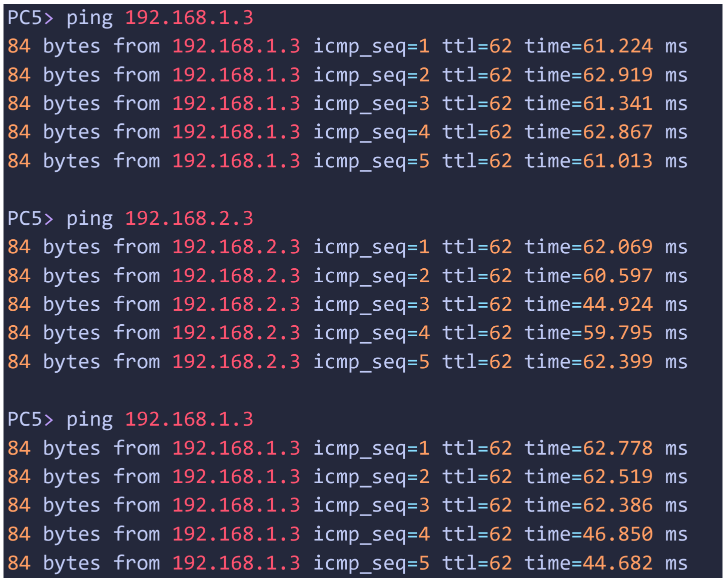
PC1 Ping with others

```
PC3> ip 192.168.2.2 255.255.255.0 192.168.2.1
Checking for duplicate address ...
PC1 : 192.168.2.2 255.255.255.0 gateway 192.168.2.1

PC3> ping 192.168.1.2
84 bytes from 192.168.1.2 icmp_seq=1 ttl=62 time=61.186 ms
84 bytes from 192.168.1.2 icmp_seq=2 ttl=62 time=60.335 ms
84 bytes from 192.168.1.2 icmp_seq=3 ttl=62 time=64.432 ms
84 bytes from 192.168.1.2 icmp_seq=4 ttl=62 time=65.054 ms
84 bytes from 192.168.1.2 icmp_seq=5 ttl=62 time=60.914 ms

PC3> ping 192.168.3.2
84 bytes from 192.168.3.2 icmp_seq=1 ttl=62 time=46.320 ms
84 bytes from 192.168.3.2 icmp_seq=2 ttl=62 time=62.587 ms
84 bytes from 192.168.3.2 icmp_seq=3 ttl=62 time=61.261 ms
84 bytes from 192.168.3.2 icmp_seq=4 ttl=62 time=62.876 ms
84 bytes from 192.168.3.2 icmp_seq=5 ttl=62 time=62.633 ms
```

PC3 Ping with others

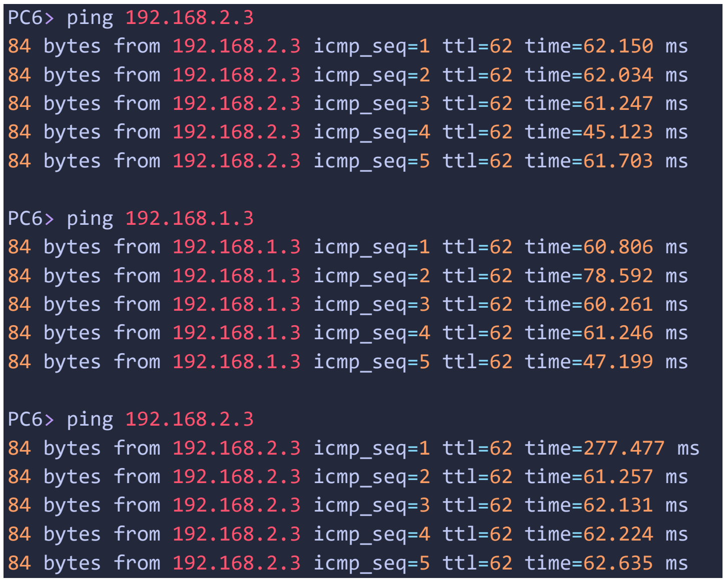
```
PC4> ip 192.168.2.3 255.255.255.0 192.168.2.1
Checking for duplicate address ...
PC1 : 192.168.2.3 255.255.255.0 gateway 192.168.2.1

PC4> ping 192.168.1.3
84 bytes from 192.168.1.3 icmp_seq=1 ttl=62 time=78.998 ms
84 bytes from 192.168.1.3 icmp_seq=2 ttl=62 time=46.270 ms
84 bytes from 192.168.1.3 icmp_seq=3 ttl=62 time=60.029 ms
84 bytes from 192.168.1.3 icmp_seq=4 ttl=62 time=61.326 ms
84 bytes from 192.168.1.3 icmp_seq=5 tt1=62 time=61.104 ms

PC4> ping 192.168.3.3
84 bytes from 192.168.3.3 icmp_seq=1 ttl=62 time=60.814 ms
84 bytes from 192.168.3.3 icmp_seq=2 ttl=62 time=59.570 ms
84 bytes from 192.168.3.3 icmp_seq=3 ttl=62 time=60.635 ms
84 bytes from 192.168.3.3 icmp_seq=4 ttl=62 time=45.537 ms
84 bytes from 192.168.3.3 icmp_seq=5 ttl=62 time=60.786 ms
```

PC4 Ping with others



```
PC5> ping 192.168.1.3
84 bytes from 192.168.1.3 icmp_seq=1 ttl=62 time=61.224 ms
84 bytes from 192.168.1.3 icmp_seq=2 ttl=62 time=62.919 ms
84 bytes from 192.168.1.3 icmp_seq=3 ttl=62 time=61.341 ms
84 bytes from 192.168.1.3 icmp_seq=4 ttl=62 time=62.867 ms
84 bytes from 192.168.1.3 icmp_seq=5 ttl=62 time=61.013 ms

PC5> ping 192.168.2.3
84 bytes from 192.168.2.3 icmp_seq=1 ttl=62 time=62.069 ms
84 bytes from 192.168.2.3 icmp_seq=2 ttl=62 time=60.597 ms
84 bytes from 192.168.2.3 icmp_seq=3 ttl=62 time=44.924 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=62 time=59.795 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=62 time=62.399 ms

PC5> ping 192.168.1.3
84 bytes from 192.168.1.3 icmp_seq=1 ttl=62 time=62.778 ms
84 bytes from 192.168.1.3 icmp_seq=2 ttl=62 time=62.519 ms
84 bytes from 192.168.1.3 icmp_seq=3 ttl=62 time=62.386 ms
84 bytes from 192.168.1.3 icmp_seq=4 ttl=62 time=46.850 ms
84 bytes from 192.168.1.3 icmp_seq=5 ttl=62 time=44.682 ms
```

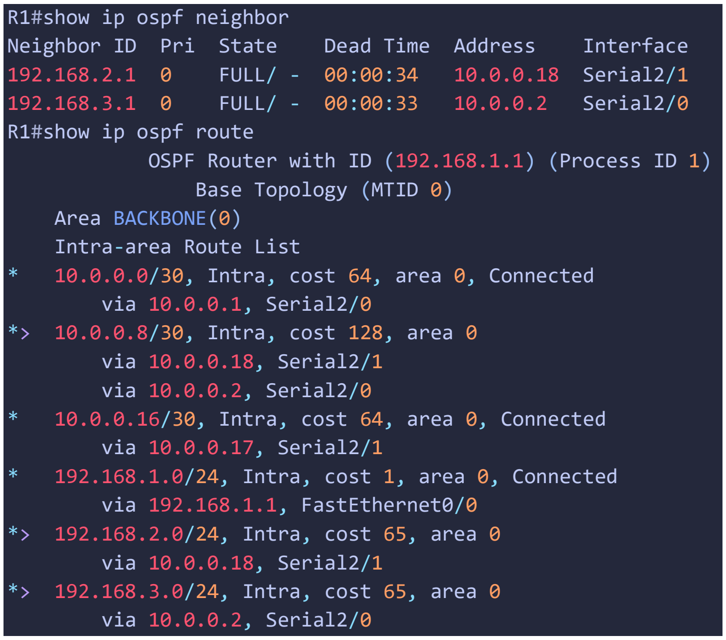
PC5 Ping with others



```
PC6> ping 192.168.2.3
84 bytes from 192.168.2.3 icmp_seq=1 ttl=62 time=62.150 ms
84 bytes from 192.168.2.3 icmp_seq=2 ttl=62 time=62.034 ms
84 bytes from 192.168.2.3 icmp_seq=3 ttl=62 time=61.247 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=62 time=45.123 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=62 time=61.703 ms

PC6> ping 192.168.1.3
84 bytes from 192.168.1.3 icmp_seq=1 ttl=62 time=60.806 ms
84 bytes from 192.168.1.3 icmp_seq=2 ttl=62 time=78.592 ms
84 bytes from 192.168.1.3 icmp_seq=3 ttl=62 time=60.261 ms
84 bytes from 192.168.1.3 icmp_seq=4 ttl=62 time=61.246 ms
84 bytes from 192.168.1.3 icmp_seq=5 ttl=62 time=47.199 ms

PC6> ping 192.168.2.3
84 bytes from 192.168.2.3 icmp_seq=1 ttl=62 time=277.477 ms
84 bytes from 192.168.2.3 icmp_seq=2 ttl=62 time=61.257 ms
84 bytes from 192.168.2.3 icmp_seq=3 ttl=62 time=62.131 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=62 time=62.224 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=62 time=62.635 ms
```

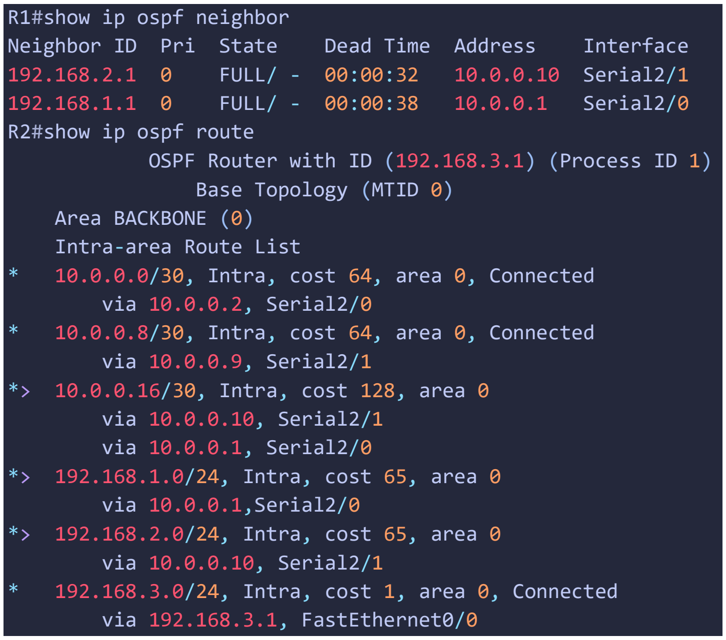
PC6 Ping with others

OSPF Neighbor:



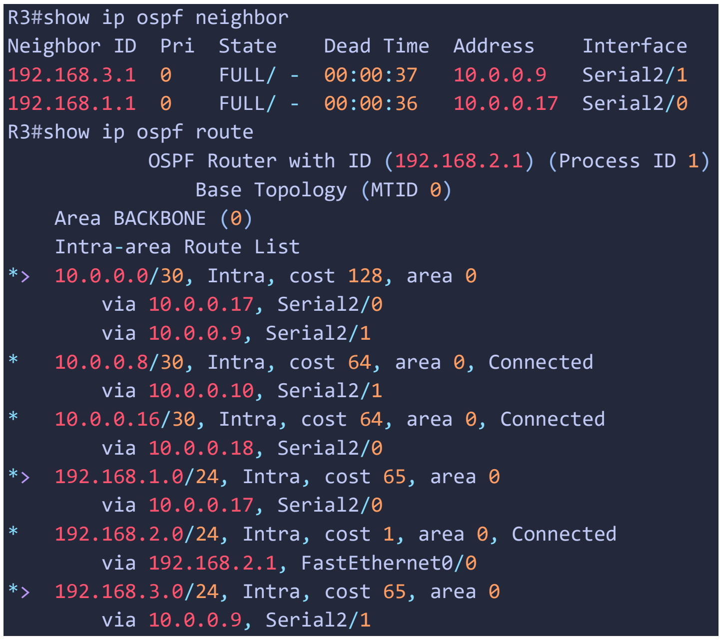
```
R1#show ip ospf neighbor
Neighbor ID  Pri  State    Dead Time  Address    Interface
192.168.2.1  0    FULL/ -  00:00:34   10.0.0.18  Serial2/1
192.168.3.1  0    FULL/ -  00:00:33   10.0.0.2   Serial2/0
R1#show ip ospf route
            OSPF Router with ID (192.168.1.1) (Process ID 1)
                Base Topology (MTID 0)
    Area BACKBONE(0)
    Intra-area Route List
*   10.0.0.0/30, Intra, cost 64, area 0, Connected
        via 10.0.0.1, Serial2/0
*>  10.0.0.8/30, Intra, cost 128, area 0
        via 10.0.0.18, Serial2/1
        via 10.0.0.2, Serial2/0
*   10.0.0.16/30, Intra, cost 64, area 0, Connected
        via 10.0.0.17, Serial2/1
*   192.168.1.0/24, Intra, cost 1, area 0, Connected
        via 192.168.1.1, FastEthernet0/0
*>  192.168.2.0/24, Intra, cost 65, area 0
        via 10.0.0.18, Serial2/1
*>  192.168.3.0/24, Intra, cost 65, area 0
        via 10.0.0.2, Serial2/0
```

OSPF Neighbor R1



```
R1#show ip ospf neighbor
Neighbor ID  Pri  State    Dead Time  Address    Interface
192.168.2.1  0    FULL/ -  00:00:32   10.0.0.10  Serial2/1
192.168.1.1  0    FULL/ -  00:00:38   10.0.0.1   Serial2/0
R2#show ip ospf route
            OSPF Router with ID (192.168.3.1) (Process ID 1)
                Base Topology (MTID 0)
    Area BACKBONE (0)
    Intra-area Route List
*   10.0.0.0/30, Intra, cost 64, area 0, Connected
        via 10.0.0.2, Serial2/0
*   10.0.0.8/30, Intra, cost 64, area 0, Connected
        via 10.0.0.9, Serial2/1
*>  10.0.0.16/30, Intra, cost 128, area 0
        via 10.0.0.10, Serial2/1
        via 10.0.0.1, Serial2/0
*>  192.168.1.0/24, Intra, cost 65, area 0
        via 10.0.0.1,Serial2/0
*>  192.168.2.0/24, Intra, cost 65, area 0
        via 10.0.0.10, Serial2/1
*   192.168.3.0/24, Intra, cost 1, area 0, Connected
        via 192.168.3.1, FastEthernet0/0
```

OSPF Neighbor R2



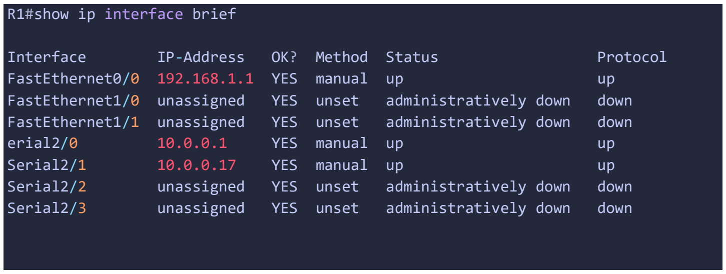
```
R3#show ip ospf neighbor
Neighbor ID  Pri  State    Dead Time  Address    Interface
192.168.3.1  0    FULL/ -  00:00:37   10.0.0.9   Serial2/1
192.168.1.1  0    FULL/ -  00:00:36   10.0.0.17  Serial2/0
R3#show ip ospf route
            OSPF Router with ID (192.168.2.1) (Process ID 1)
                Base Topology (MTID 0)
    Area BACKBONE (0)
    Intra-area Route List
*>  10.0.0.0/30, Intra, cost 128, area 0
        via 10.0.0.17, Serial2/0
        via 10.0.0.9, Serial2/1
*   10.0.0.8/30, Intra, cost 64, area 0, Connected
        via 10.0.0.10, Serial2/1
*   10.0.0.16/30, Intra, cost 64, area 0, Connected
        via 10.0.0.18, Serial2/0
*>  192.168.1.0/24, Intra, cost 65, area 0
        via 10.0.0.17, Serial2/0
*   192.168.2.0/24, Intra, cost 1, area 0, Connected
        via 192.168.2.1, FastEthernet0/0
*>  192.168.3.0/24, Intra, cost 65, area 0
        via 10.0.0.9, Serial2/1
```

OSPF Neighbor R3

این جدول اطلاعاتی در مورد همسایگان OSPF ارائه می‌دهد. هر همسایه یک روتر است که از طریق یک لینک OSPF با روتر فعلی ارتباط دارد. جزئیاتی مانند آدرس روتر همسایه، وضعیت همسایگی (Full/2-Way) ، و شماره روتر ID نشان داده می‌شوند. این جدول تأیید می‌کند که روترها به درستی همدیگر را شناسایی کرده و مسیرها را مبادله می‌کنند.

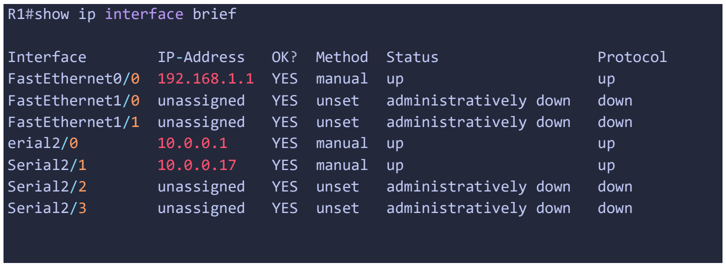
جدول OSPF Route نشان می‌دهد که مسیرهای فعال و معتبر در شبکه از چه نوعی هستند و از کدام لینک‌ها عبور می‌کنند. همچنین این جدول ابزار اصلی روتر برای تصمیم‌گیری درباره ارسال بسته‌ها در شبکه است. اگر لینکی از کار بیفتد، OSPF به‌صورت داینامیک مسیرهای جایگزین را انتخاب کرده و در جدول ثبت می‌کند.

IP InterFace:



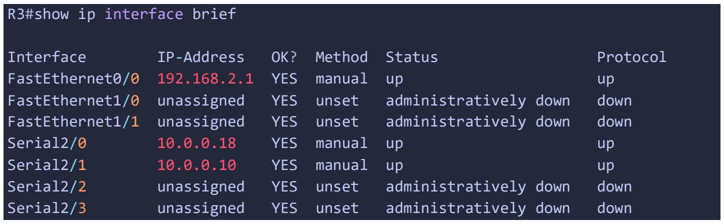
```
R1#show ip interface brief

Interface        IP-Address   OK?  Method  Status                 Protocol
FastEthernet0/0  192.168.1.1  YES  manual  up                     up
FastEthernet1/0  unassigned   YES  unset   administratively down  down
FastEthernet1/1  unassigned   YES  unset   administratively down  down
erial2/0         10.0.0.1     YES  manual  up                     up
Serial2/1        10.0.0.17    YES  manual  up                     up
Serial2/2        unassigned   YES  unset   administratively down  down
Serial2/3        unassigned   YES  unset   administratively down  down
```

IP InterFace R1



```
R1#show ip interface brief

Interface        IP-Address   OK?  Method  Status                 Protocol
FastEthernet0/0  192.168.1.1  YES  manual  up                     up
FastEthernet1/0  unassigned   YES  unset   administratively down  down
FastEthernet1/1  unassigned   YES  unset   administratively down  down
erial2/0         10.0.0.1     YES  manual  up                     up
Serial2/1        10.0.0.17    YES  manual  up                     up
Serial2/2        unassigned   YES  unset   administratively down  down
Serial2/3        unassigned   YES  unset   administratively down  down
```

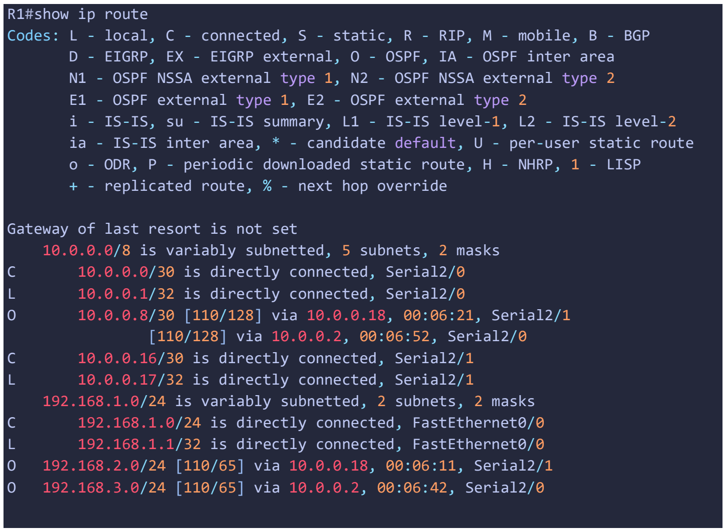
IP InterFace R2



```
R3#show ip interface brief

Interface        IP-Address   OK?  Method  Status                 Protocol
FastEthernet0/0  192.168.2.1  YES  manual  up                     up
FastEthernet1/0  unassigned   YES  unset   administratively down  down
FastEthernet1/1  unassigned   YES  unset   administratively down  down
Serial2/0        10.0.0.18    YES  manual  up                     up
Serial2/1        10.0.0.10    YES  manual  up                     up
Serial2/2        unassigned   YES  unset   administratively down  down
Serial2/3        unassigned   YES  unset   administratively down  down
```

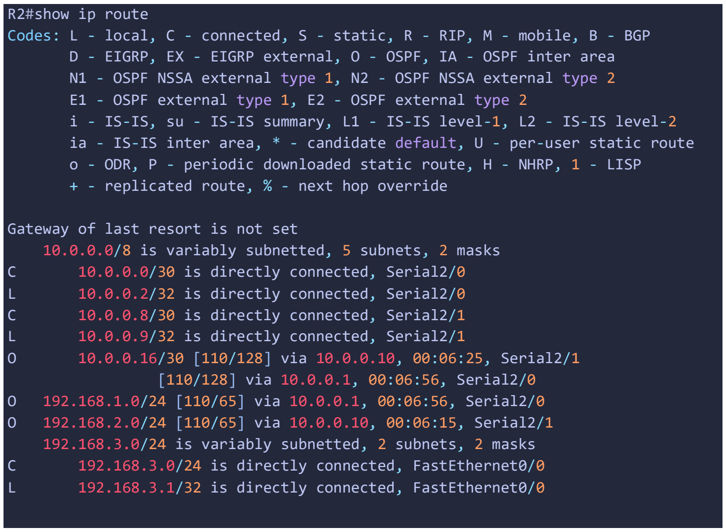
IP InterFace R3

Routing Table:



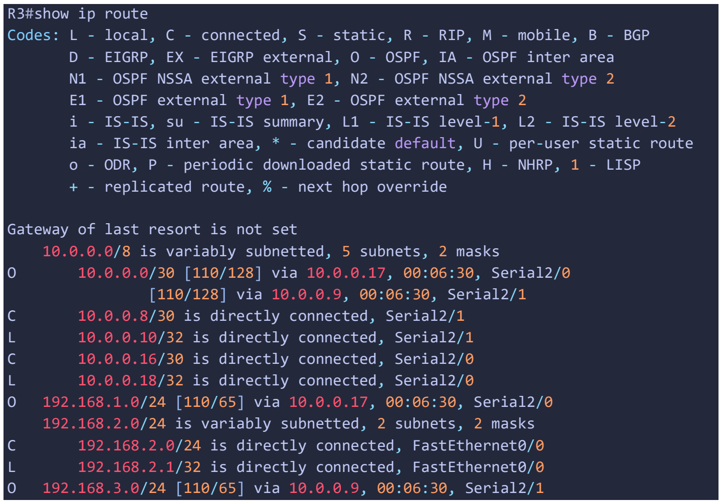
```
R1#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       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, 1 - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set
    10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C       10.0.0.0/30 is directly connected, Serial2/0
L       10.0.0.1/32 is directly connected, Serial2/0
O       10.0.0.8/30 [110/128] via 10.0.0.18, 00:06:21, Serial2/1
                [110/128] via 10.0.0.2, 00:06:52, Serial2/0
C       10.0.0.16/30 is directly connected, Serial2/1
L       10.0.0.17/32 is directly connected, Serial2/1
    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
O    192.168.2.0/24 [110/65] via 10.0.0.18, 00:06:11, Serial2/1
O    192.168.3.0/24 [110/65] via 10.0.0.2, 00:06:42, Serial2/0
```

IP Route R1



```
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, 1 - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set
    10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C       10.0.0.0/30 is directly connected, Serial2/0
L       10.0.0.2/32 is directly connected, Serial2/0
C       10.0.0.8/30 is directly connected, Serial2/1
L       10.0.0.9/32 is directly connected, Serial2/1
O       10.0.0.16/30 [110/128] via 10.0.0.10, 00:06:25, Serial2/1
                 [110/128] via 10.0.0.1, 00:06:56, Serial2/0
O    192.168.1.0/24 [110/65] via 10.0.0.1, 00:06:56, Serial2/0
O    192.168.2.0/24 [110/65] via 10.0.0.10, 00:06:15, Serial2/1
    192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.3.0/24 is directly connected, FastEthernet0/0
L       192.168.3.1/32 is directly connected, FastEthernet0/0
```

IP Route R2



```
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, 1 - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set
    10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
O       10.0.0.0/30 [110/128] via 10.0.0.17, 00:06:30, Serial2/0
                [110/128] via 10.0.0.9, 00:06:30, Serial2/1
C       10.0.0.8/30 is directly connected, Serial2/1
L       10.0.0.10/32 is directly connected, Serial2/1
C       10.0.0.16/30 is directly connected, Serial2/0
L       10.0.0.18/32 is directly connected, Serial2/0
O    192.168.1.0/24 [110/65] via 10.0.0.17, 00:06:30, Serial2/0
    192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.2.0/24 is directly connected, FastEthernet0/0
L       192.168.2.1/32 is directly connected, FastEthernet0/0
O    192.168.3.0/24 [110/65] via 10.0.0.9, 00:06:30, Serial2/1
```

IP Route R3

توضیحات پیاده سازی:

- **دستورات اولیه کانفیگ روتر ها:**

- **Access Configuration Mode:**

```
enable
conf t
```

این دستور برای ورود به حالت اجرایی پیشرفته (enable) و ورود به حالت تنظیمات کلی (conf t) استفاده می‌شوند تا امکان ایجاد تغییرات در سطح سیستم فراهم شود.

- **Set Hostname:**

```
hostname R1   # Repeat as appropriate for R2, R3
```

این دستور نام هر روتر را تنظیم می‌کند (به عنوان مثال R1، R2، R3) تا شناسایی آنها آسان‌تر شود.

- **Interface Configuration and IP Address Assignment:**

```
int s2/0
ip address 10.0.0.1 255.255.255.252
no shutdown
```

دستور int یک اینترفیس مشخص را برای کانفیگ انتخاب می‌کند، IP address ، آدرس IP را به آن اختصاص می‌دهد و no shutdown اینترفیس را فعال می‌کند.

- **کانفیگ OSPF روی روتر ها:**

- **Interface Configuration and IP Address Assignment:**

```
router ospf 1
```

فرآیند OSPF را روی روتر با شناسه فرآیند ۱ فعال می‌کند و مسیریابی دینامیک را در شبکه ممکن می‌سازد.

- **Define Networks for OSPF:**

```
network 10.0.0.0 0.0.0.3 area 0
network 10.0.0.8 0.0.0.3 area 0
network 192.168.1.0 0.0.0.255 area 0
```

این دستورات شبکه‌هایی را مشخص می‌کنند که OSPF باید در منطقه ۰ بگنجاند. این کار امکان ایجاد همسایگی OSPF با روترهای متصل مستقیم را فراهم می‌کند.

- **تایید سنجی و Test کانفیگ OSPF و رفتار آنها:**

دستورات لازم و توضیحات هر کدام به صورت مجرا در پارت های قبل نشان و توضیح داده شده است.