

Выдача статических адресов на портах маршрутизаторов (статически)

R1

```
interface g0/0
 ip address 192.168.1.1 255.255.255.0
 no shut
```

```
interface g2/0
 ip address 192.168.2.1 255.255.255.0
 no shut
```

```
interface g1/0
 ip address 192.168.3.1 255.255.255.252
 no shut
```

R2 (DHCP сервер)

```
interface g0/0
 ip address 192.168.3.2 255.255.255.252
 no shut
```

Настройка DHCP на R2 для адресных пространств LAN1 и LAN2

R2

Отключаем выдачу адреса на линке LAN3

```
conf t
interface g0/0
 no ip dhcp client request
```

DHCP pool для LAN1

```
ip dhcp pool LAN1
 network 192.168.1.0 255.255.255.0
 default-router 192.168.1.1
 dns-server 8.8.8.8
```

DHCP pool для LAN2

```
ip dhcp pool LAN2
 network 192.168.2.0 255.255.255.0
 default-router 192.168.2.1
 dns-server 8.8.8.8
```

Исключаем адреса портов маршрутизатора R1 для выдачи
ip dhcp excluded-address 192.168.1.1
ip dhcp excluded-address 192.168.2.1

Так как DHCP-сервер в подсети, отдельной от LAN1 и LAN2, для корректной работы необходимо конкретно указать порт DHCP-сервера:

На интерфейсе LAN1
interface g0/0
ip helper-address 192.168.3.2

На интерфейсе LAN2
interface g0/1
ip helper-address 192.168.3.2

Статическая маршрутизация

R2 — маршруты к LAN1 и LAN2
ip route 192.168.10.0 255.255.255.0 192.168.30.1
ip route 192.168.20.0 255.255.255.0 192.168.30.1

Проверка работоспособности

```
PC1> ip dhcp
DORA IP 192.168.1.3/24 GW 192.168.1.1
```

Рисунок 1 – Запрос ip для PC1

```
PC2> ip dhcp
DDORA IP 192.168.1.4/24 GW 192.168.1.1
```

Рисунок 2 – Запрос ip для PC2

```
PC3> ip dhcp
DORA IP 192.168.2.2/24 GW 192.168.2.1
```

Рисунок 3 – Запрос ip для PC3

```
PC4> ip dhcp
DORA IP 192.168.2.3/24 GW 192.168.2.1
```

Рисунок 4 – Запрос ip для PC4

```
PC1 - PuTTY
```

PC1> ping 192.168.1.4

84 bytes from 192.168.1.4 icmp_seq=1 ttl=64 time=11.144 ms
84 bytes from 192.168.1.4 icmp_seq=2 ttl=64 time=0.713 ms
84 bytes from 192.168.1.4 icmp_seq=3 ttl=64 time=0.795 ms
84 bytes from 192.168.1.4 icmp_seq=4 ttl=64 time=0.558 ms
84 bytes from 192.168.1.4 icmp_seq=5 ttl=64 time=0.782 ms

PC1> ping 192.168.2.2

84 bytes from 192.168.2.2 icmp_seq=1 ttl=63 time=30.202 ms
84 bytes from 192.168.2.2 icmp_seq=2 ttl=63 time=14.827 ms
84 bytes from 192.168.2.2 icmp_seq=3 ttl=63 time=15.893 ms
84 bytes from 192.168.2.2 icmp_seq=4 ttl=63 time=15.953 ms
84 bytes from 192.168.2.2 icmp_seq=5 ttl=63 time=14.802 ms

PC1> ping 192.168.2.3

84 bytes from 192.168.2.3 icmp_seq=1 ttl=63 time=28.755 ms
84 bytes from 192.168.2.3 icmp_seq=2 ttl=63 time=14.356 ms
84 bytes from 192.168.2.3 icmp_seq=3 ttl=63 time=15.411 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=63 time=15.317 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=63 time=15.081 ms

PC1> [REDACTED]

```
PC3 - PuTTY
```

PC3> ping 192.168.2.3

84 bytes from 192.168.2.3 icmp_seq=1 ttl=64 time=4.119 ms
84 bytes from 192.168.2.3 icmp_seq=2 ttl=64 time=2.698 ms
84 bytes from 192.168.2.3 icmp_seq=3 ttl=64 time=0.687 ms
84 bytes from 192.168.2.3 icmp_seq=4 ttl=64 time=2.936 ms
84 bytes from 192.168.2.3 icmp_seq=5 ttl=64 time=0.564 ms

PC3> ping 192.168.1.3

84 bytes from 192.168.1.3 icmp_seq=1 ttl=63 time=19.652 ms
84 bytes from 192.168.1.3 icmp_seq=2 ttl=63 time=15.729 ms
84 bytes from 192.168.1.3 icmp_seq=3 ttl=63 time=16.142 ms
84 bytes from 192.168.1.3 icmp_seq=4 ttl=63 time=15.518 ms
84 bytes from 192.168.1.3 icmp_seq=5 ttl=63 time=16.037 ms

PC3> ping 192.168.1.4

84 bytes from 192.168.1.4 icmp_seq=1 ttl=63 time=21.158 ms
84 bytes from 192.168.1.4 icmp_seq=2 ttl=63 time=14.541 ms
84 bytes from 192.168.1.4 icmp_seq=3 ttl=63 time=15.926 ms
84 bytes from 192.168.1.4 icmp_seq=4 ttl=63 time=17.399 ms
84 bytes from 192.168.1.4 icmp_seq=5 ttl=63 time=15.447 ms

PC3> [REDACTED]

Рисунок 5 – Проверка доступности между компьютерами

| | | | | | | | |
|-----|-----------|-------------|-----------------|------|-----|---------------|-----------------------------|
| 104 | 94.070208 | 0.0.0.0 | 255.255.255.255 | DHCP | 406 | DHCP Discover | - Transaction ID 0x7f77a16f |
| 105 | 94.096856 | 192.168.1.1 | 192.168.1.3 | DHCP | 342 | DHCP Offer | - Transaction ID 0x7f77a16f |
| 106 | 94.096883 | 192.168.1.1 | 192.168.1.3 | DHCP | 342 | DHCP Offer | - Transaction ID 0x7f77a16f |
| 107 | 94.097541 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP Offer | - Transaction ID 0x7f77a16f |
| 108 | 94.097558 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP Offer | - Transaction ID 0x7f77a16f |
| 109 | 94.097564 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP Offer | - Transaction ID 0x7f77a16f |
| 110 | 94.097577 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP Offer | - Transaction ID 0x7f77a16f |
| 111 | 94.097582 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP Offer | - Transaction ID 0x7f77a16f |
| 112 | 94.097587 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP Offer | - Transaction ID 0x7f77a16f |
| 113 | 94.097591 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP Offer | - Transaction ID 0x7f77a16f |
| 114 | 94.097596 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP Offer | - Transaction ID 0x7f77a16f |
| 115 | 94.097608 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP Offer | - Transaction ID 0x7f77a16f |
| 116 | 94.097613 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP Offer | - Transaction ID 0x7f77a16f |
| 117 | 94.097617 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP Offer | - Transaction ID 0x7f77a16f |
| 118 | 94.097621 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP Offer | - Transaction ID 0x7f77a16f |

| | | |
|---|---------------------------------|----------|
| Destination Address: 255.255.255.255 | 0000 ff ff ff ff ff ff ff 00 50 | 79 66 68 |
| [Stream index: 0] | 0001 01 88 00 00 00 00 10 11 | a9 56 00 |
| > User Datagram Protocol, Src Port: 68, Dst Port: 67 | 0020 ff ff 00 44 00 43 01 74 | c9 84 01 |
| Dynamic Host Configuration Protocol (Discover) | 0030 a1 6f 00 00 00 00 00 00 | 00 00 00 |
| Message type: Boot Request (1) | 0040 00 00 00 00 00 00 00 50 | 79 66 68 |
| Hardware type: Ethernet (0x01) | 0050 00 00 00 00 00 00 00 00 | 00 00 00 |
| Hardware address length: 6 | 0060 00 00 00 00 00 00 00 00 | 00 00 00 |
| Hops: 0 | 0070 00 00 00 00 00 00 00 00 | 00 00 00 |
| Transaction ID: 0x7f77a16f | 0080 00 00 00 00 00 00 00 00 | 00 00 00 |
| Seconds elapsed: 0 | 0090 00 00 00 00 00 00 00 00 | 00 00 00 |
| > Bootp flags: 0x0000 (Unicast) | 00a0 00 00 00 00 00 00 00 00 | 00 00 00 |
| Client IP address: 0.0.0.0 | 00b0 00 00 00 00 00 00 00 00 | 00 00 00 |
| Your (client) IP address: 0.0.0.0 | 00c0 00 00 00 00 00 00 00 00 | 00 00 00 |
| Next server IP address: 0.0.0.0 | 00d0 00 00 00 00 00 00 00 00 | 00 00 00 |
| Relay agent IP address: 0.0.0.0 | 00e0 00 00 00 00 00 00 00 00 | 00 00 00 |
| Client MAC address: Private_66:68:00 (00:50:79:66:68:00) | 00f0 00 00 00 00 00 00 00 00 | 00 00 00 |
| Client hardware address padding: 00000000000000000000000000000000 | 0100 00 00 00 00 00 00 00 00 | 00 00 00 |
| Server host name not given | 0110 00 00 00 00 00 00 63 82 | 53 63 35 |
| Boot file name not given | 0120 43 31 3d 07 01 00 50 79 | 66 68 00 |
| Magic cookie: DHCP | 0130 00 00 00 00 00 00 00 00 | 00 00 00 |
| > Option: (53) DHCP Message Type (Discover) | 0140 00 00 00 00 00 00 00 00 | 00 00 00 |
| > Option: (12) Host Name | 0150 00 00 00 00 00 00 00 00 | 00 00 00 |
| > Option: (61) Client identifier | 0160 00 00 00 00 00 00 00 00 | 00 00 00 |
| > Option: (255) End | 0170 00 00 00 00 00 00 00 00 | 00 00 00 |
| Padding: 00 | 0180 00 00 00 00 00 00 00 00 | 00 00 00 |
| | 0190 00 00 00 00 00 00 00 00 | 00 00 00 |

Рисунок 6 – Содержимое DHCP Discover

| 120 | 94.097629 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP Offer | - Transaction ID 0x7f77a16f |
|-----|-----------|-------------|-----------------|------|-----|--------------|-----------------------------|
| 121 | 95.070285 | 0.0.0.0 | 255.255.255.255 | DHCP | 406 | DHCP Request | - Transaction ID 0x7f77a16f |
| 122 | 95.101359 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP ACK | - Transaction ID 0x7f77a16f |
| 123 | 95.101373 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP ACK | - Transaction ID 0x7f77a16f |
| 124 | 95.101378 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP ACK | - Transaction ID 0x7f77a16f |
| 125 | 95.101383 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP ACK | - Transaction ID 0x7f77a16f |
| 126 | 95.101390 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP ACK | - Transaction ID 0x7f77a16f |
| 127 | 95.101397 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP ACK | - Transaction ID 0x7f77a16f |

| | |
|---|--------------------------------------|
| Hardware address length: | 6 |
| Hops: | 0 |
| Transaction ID: | 0x7f77a16f |
| Seconds elapsed: | 0 |
| > Bootp flags: 0x8000, Broadcast flag (Broadcast) | |
| Client IP address: | 0.0.0.0 |
| Your (client) IP address: | 192.168.1.3 |
| Next server IP address: | 0.0.0.0 |
| Relay agent IP address: | 192.168.1.1 |
| Client MAC address: | Private_66:68:00 (00:50:79:66:68:00) |
| Client hardware address padding: | 000000000000000000000000 |
| Server host name not given | |
| Boot file name not given | |
| Magic cookie: | DHCP |
| > Option: (53) DHCP Message Type (Offer) | |
| > Option: (54) DHCP Server Identifier (192.168.3.2) | |
| > Option: (51) IP Address Lease Time | |
| > Option: (58) Renewal Time Value | |
| > Option: (59) Rebinding Time Value | |
| > Option: (1) Subnet Mask (255.255.255.0) | |
| > Option: (3) Router | |
| > Option: (6) Domain Name Server | |
| > Option: (15) Domain Name | |
| > Option: (255) End | |
| Padding: | 0000 |

| | | |
|------|-------------------------|----------|
| 0000 | ff ff ff ff ff ff cc 01 | 10 44 00 |
| 0010 | 01 48 03 34 00 00 ff 11 | f5 c7 c0 |
| 0020 | ff ff 00 43 00 44 01 34 | b0 0c 02 |
| 0030 | a1 6f 00 00 80 00 00 00 | 00 00 c0 |
| 0040 | 00 00 c0 a8 01 01 00 50 | 79 66 68 |
| 0050 | 00 00 00 00 00 00 00 00 | 00 00 00 |
| 0060 | 00 00 00 00 00 00 00 00 | 00 00 00 |
| 0070 | 00 00 00 00 00 00 00 00 | 00 00 00 |
| 0080 | 00 00 00 00 00 00 00 00 | 00 00 00 |
| 0090 | 00 00 00 00 00 00 00 00 | 00 00 00 |
| 00a0 | 00 00 00 00 00 00 00 00 | 00 00 00 |
| 00b0 | 00 00 00 00 00 00 00 00 | 00 00 00 |
| 00c0 | 00 00 00 00 00 00 00 00 | 00 00 00 |
| 00d0 | 00 00 00 00 00 00 00 00 | 00 00 00 |
| 00e0 | 00 00 00 00 00 00 00 00 | 00 00 00 |
| 00f0 | 00 00 00 00 00 00 00 00 | 00 00 00 |
| 0100 | 00 00 00 00 00 00 00 00 | 00 00 00 |
| 0110 | 00 00 00 00 00 00 63 82 | 53 63 35 |
| 0120 | a8 03 02 33 04 00 01 51 | 3c 3a 04 |
| 0130 | 04 00 01 27 14 01 04 ff | ff ff 00 |
| 0140 | 01 06 04 08 08 08 08 0f | 0a 61 66 |
| 0150 | 63 61 6c ff 00 00 | 00 |

Рисунок 7 – Содержимое DHCP Offer

Рисунок 8 – Содержимое DHCP Request

| | | | | | | | |
|--|-------------------------|-------------------|----------------------------|------|-----|------------------------|-----------------------------|
| 137 | 95.101448 | 192.168.1.1 | 255.255.255.255 | DHCP | 342 | DHCP ACK | - Transaction ID 0x7f77a16f |
| 138 | 95.518709 | 0c:ac:f3:76:00:00 | CDP/VTB/DTP/PAgP/UD... DTP | | 60 | Dynamic Trunk Protocol | |
| | 120 05 5187A1 | Ar+sc+fr:76:00:00 | CND/UTD/DTD/DAD/DIN DTD | | 0A | Dynamic Trunk Protocol | |
| Dynamic Host Configuration Protocol (ACK) | | | | | | | |
| Message type: Boot Reply (2) Hardware type: Ethernet (0x01) Hardware address length: 6 Hops: 0 Transaction ID: 0x7f77a16f Seconds elapsed: 0 Bootp flags: 0x8000, Broadcast flag (Broadcast) Client IP address: 192.168.1.3 Your (client) IP address: 192.168.1.3 Next server IP address: 0.0.0.0 Relay agent IP address: 192.168.1.1 Client MAC address: Private_66:68:00 (00:50:79:66:68:00) Client hardware address padding: 000000000000000000000000 Server host name not given Boot file name not given Magic cookie: DHCP > Option: (53) DHCP Message Type (ACK) > Option: (54) DHCP Server Identifier (192.168.3.2) > Option: (51) IP Address Lease Time > Option: (58) Renewal Time Value > Option: (59) Rebinding Time Value > Option: (1) Subnet Mask (255.255.255.0) > Option: (3) Router > Option: (6) Domain Name Server ` Option: (15) Domain Name | | | | | | | |
| 0000 | ff ff ff ff ff ff cc 01 | 10 44 00 | | | | | |
| 0010 | 01 48 03 64 00 00 ff 11 | f5 97 c0 | | | | | |
| 0020 | ff ff 00 43 00 44 01 34 | 49 60 02 | | | | | |
| 0030 | a1 6f 00 00 80 00 c0 a8 | 01 03 c0 | | | | | |
| 0040 | 00 00 c0 a8 01 01 00 50 | 79 66 68 | | | | | |
| 0050 | 00 00 00 00 00 00 00 00 | 00 00 00 | | | | | |
| 0060 | 00 00 00 00 00 00 00 00 | 00 00 00 | | | | | |
| 0070 | 00 00 00 00 00 00 00 00 | 00 00 00 | | | | | |
| 0080 | 00 00 00 00 00 00 00 00 | 00 00 00 | | | | | |
| 0090 | 00 00 00 00 00 00 00 00 | 00 00 00 | | | | | |
| 00a0 | 00 00 00 00 00 00 00 00 | 00 00 00 | | | | | |
| 00b0 | 00 00 00 00 00 00 00 00 | 00 00 00 | | | | | |
| 00c0 | 00 00 00 00 00 00 00 00 | 00 00 00 | | | | | |
| 00d0 | 00 00 00 00 00 00 00 00 | 00 00 00 | | | | | |
| 00e0 | 00 00 00 00 00 00 00 00 | 00 00 00 | | | | | |
| 00f0 | 00 00 00 00 00 00 00 00 | 00 00 00 | | | | | |
| 0100 | 00 00 00 00 00 00 00 00 | 00 00 00 | | | | | |
| 0110 | 00 00 00 00 00 00 63 82 | 53 63 35 | | | | | |
| 0120 | a8 03 02 33 04 00 01 51 | 80 3a 04 | | | | | |
| 0130 | 04 00 01 27 50 01 04 ff | ff ff 00 | | | | | |
| 0140 | 01 06 04 08 08 08 08 0f | 0a 61 66 | | | | | |
| 0150 | 63 61 6c ff 00 00 | | | | | | |

Рисунок 9 – Содержимое DHCP Acknowledgement

Суть протокола DHCP заключается в следующем:

Клиент загружается или подключается к сети, у него нет IP-адреса (0.0.0.0), поэтому он отправляет DHCP DISCOVER пакет на широковещательный адрес.

DHCP сервер получает DISCOVER пакет, проверяет свою базу данных: есть ли резервация для этого MAC, какой адрес из пула свободен? Проверяет, не используется ли адрес (ping проверка). После этого сервер формирует DHCP OFFER пакет с предложением нового адреса.

Когда DHCP OFFER пакет доходит до клиента, он отправляет обратно DHCP REQUEST на широковещательный адрес, показывая всем возможным серверам, что согласен занять данный ip-адрес.

Если другой клиент не успел прислать DHCP REQUEST быстрее, исходный клиент получит DHCP ACKNOWLEDGEMENT, выдающий в аренду ранее согласованный ip-адрес.