Übung 3

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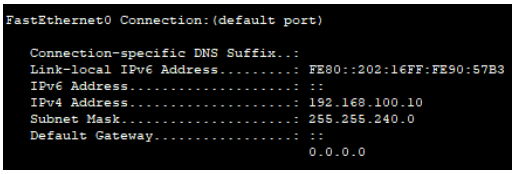
Inhaltsverzeichnis

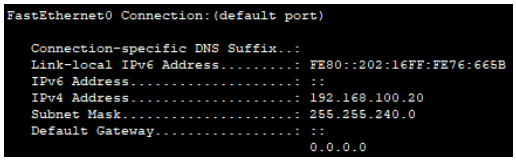
1 Direktverbindungen

1.1 Aufbau des virtuellen Netzwerks

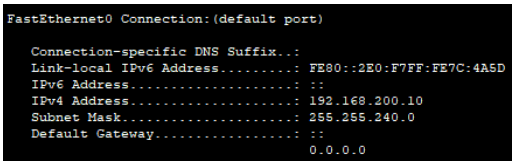
1.1.1 Basis



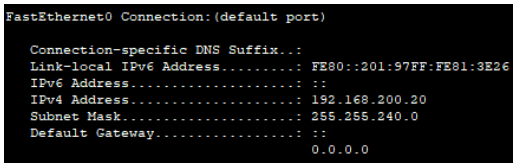
(a) PC0 - 192.168.100.10/20



(b) PC1 - 192.168.100.20/20



(c) PC2 - 192.168.200.10/20



(d) PC3 - 192.168.200.20/20

Abbildung 1: Endsysteme

1.1.2 Servernetzwerk

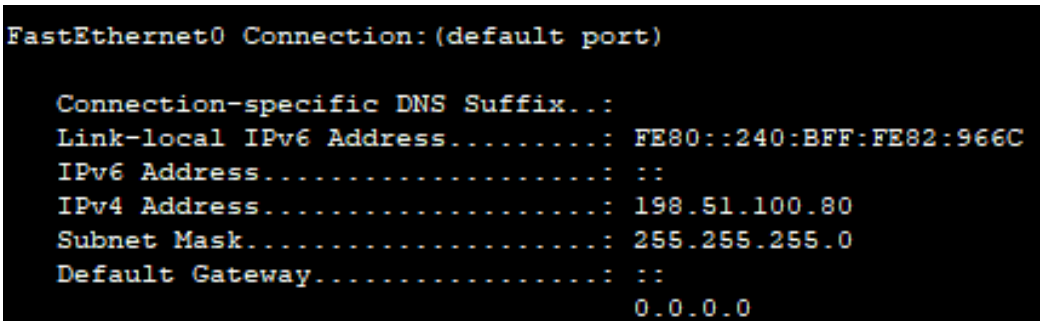


Abbildung 2: Server

index.html

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="utf-8" />
    <!--<link rel="icon" href="/favicon.ico" />-->
    <meta name="viewport"
    content="width=device-width, initial-scale=1" />
    <script type="module">
    async () => {
    if(typeof IntersectionObserver === undefined){
        //import polyfill
        const intersectionPolyfill =
        'https://cdn.jsdelivr.net/npm/
        intersection-observer@0.12.0/
        intersection-observer.min.js';

        window.IntersectionObserver =
        (await import(intersectionPolyfill)).default;
        }
    };
    </script>
</head>
<body>
    <div id="svelte"></div>

    <script>
    const mount = document.getElementById("svelte");
    const h2 = document.createElement("h2");
    h2.innerText = "Shehata loves JS";
    mount.appendChild(h2);
    </script>
</body>
</html>
```

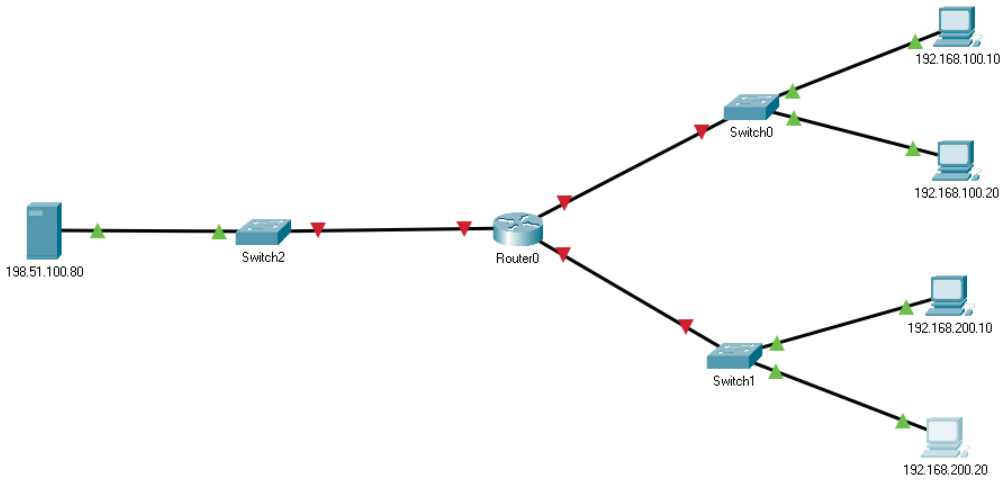


Abbildung 3: Netzwerk

1.2 Konfiguration

1.2.1 Interfaces

zum einschalten der Interfaces habe ich im conf terminal des Routers einfachen die folgenden Befehle eingegeben:

```
Router(config)#int range gig0/0-2
Router(config-if-range)#no shutdown
Router(config-if-range)#end
```

```
interface GigabitEthernet0/0
 ip address 192.168.96.1 255.255.240.0
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 ip address 192.168.192.1 255.255.240.0
 duplex auto
 speed auto
!
interface GigabitEthernet0/2
 ip address 198.51.100.1 255.255.255.0
 duplex auto
 speed auto
!
```

Abbildung 4: Running Config des Routers

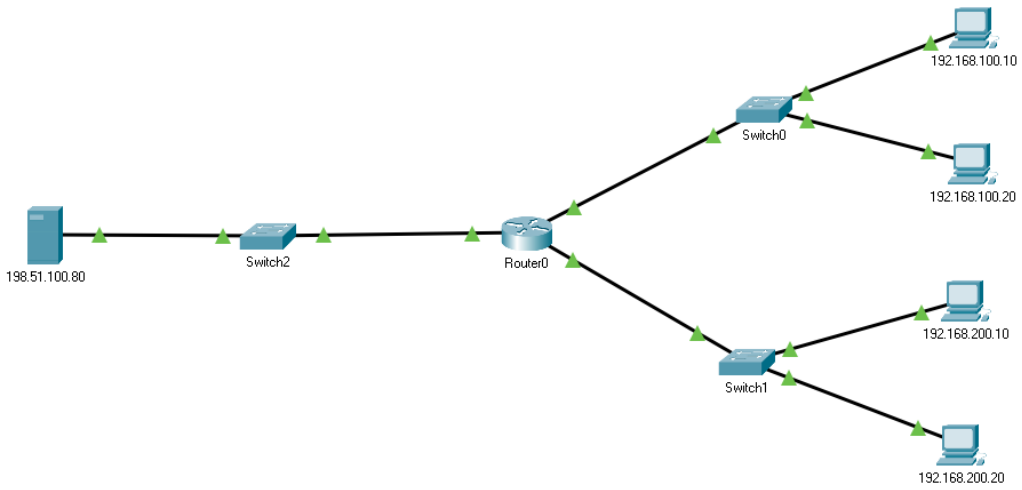


Abbildung 5: Konfiguration nach einschalten des Routers

1.2.2 Frage 1

Frage

Wie kann die niedrigste freie Adresse in einem Netz errechnet werden, und welche Adressen sind das in den gegebenen Netzen?

Antwort

Man berechnet die Subnet Id zuerst. Dies wird ermöglicht in dem man die Netzmaske und die IP Adresse mit einem binären UND rechnet. Das Ergebnis wird um 1 erhöht und das ist die Adresse.
Die Berechnungen habe ich mit einem selbstgeschriebenem TS Programm durchgeführt.
Das Programm befindet sich zur Sicherheit im zip folder.
192.168.100.x/20 = 192.168.96.1
192.168.200.x/20 = 192.168.192.1
198.51.100.x/24 = 198.51.100.1

```
> deno run .\ip.ts
Check file:///C:/Users/abous/OneDrive%20-%20FH%20OOe/NWT/UE3/docs/direct/ip.ts
```

(idx)	Adresse	Maske
Eingaben	"192.168.100.1"	"20"

(idx)	Subnet ID	Host Address Range	Broadcast Address	Wildcard Address	Netmask	CIDR Notation
Ausgabe	"192.168.96.0"	"192.168.96.1 - 192.168.111.254"	"192.168.111.255"	"0.0.15.255"	"255.255.240.0"	"192.168.96.0/20"

(idx)	Adresse	Maske
Eingaben	"192.168.200.1"	"20"

(idx)	Subnet ID	Host Address Range	Broadcast Address	Wildcard Address	Netmask	CIDR Notation
Ausgabe	"192.168.192.0"	"192.168.192.1 - 192.168.207.254"	"192.168.207.255"	"0.0.15.255"	"255.255.240.0"	"192.168.192.0/20"

(idx)	Adresse	Maske
Eingaben	"198.51.100.80"	"24"

(idx)	Subnet ID	Host Address Range	Broadcast Address	Wildcard Address	Netmask	CIDR Notation
Ausgabe	"198.51.100.0"	"198.51.100.1 - 198.51.100.254"	"198.51.100.255"	"0.0.0.255"	"255.255.255.0"	"198.51.100.0/24"

Abbildung 6: Resultate der Berechnungen

1.2.3 IPv6

Die Router Interfaces wurden über die CLI im conf terminal eingestellt.In dem Modus wählt man das jeweilige Interface und stellt mit "ipv6 address xxx/64" die Adresse ein.
Damit IPv6 Routing funktioniert muss im weiters im conf terminal des Routers IPv6 unicasting mit "ipv6 unicast-routing" aktiviert werden.
Der Server wurde über die GUI engestellt.

```
interface GigabitEthernet0/0
 ip address 192.168.96.1 255.255.240.0
 duplex auto
 speed auto
 ipv6 address 2A0C:2343:0:1::1/64
!
interface GigabitEthernet0/1
 ip address 192.168.192.1 255.255.240.0
 duplex auto
 speed auto
 ipv6 address 2A0C:2343:0:2::1/64
!
interface GigabitEthernet0/2
 ip address 198.51.100.1 255.255.255.0
 duplex auto
 speed auto
 ipv6 address 2001:DB8:80::1/64
!
```

(a) Router nach IPv6

```
FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Link-local IPv6 Address.....: FE80::240:BFF:FE82:966C
   IPv6 Address.....: 2001:DB8:80::80
   IPv4 Address.....: 198.51.100.80
   Subnet Mask.....: 255.255.255.0
   Default Gateway.....: 2001:DB8:80::1
                         198.51.100.1
```

(b) Server

1.2.4 Endsysteme

Die PCs wurden über die GUI eingestellt.

```
FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Link-local IPv6 Address.....: FE80::202:16FF:FE90:57B3
   IPv6 Address.....: 2A0C:2343:0:1::10
   IPv4 Address.....: 192.168.100.10
   Subnet Mask.....: 255.255.240.0
   Default Gateway.....: 2A0C:2343:0:1::1
                         192.168.96.1
```

(a) Group 1 - PC1

```
FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Link-local IPv6 Address.....: FE80::202:16FF:FE76:665B
   IPv6 Address.....: 2A0C:2343:0:1::20
   IPv4 Address.....: 192.168.100.20
   Subnet Mask.....: 255.255.240.0
   Default Gateway.....: 2A0C:2343:0:1::1
                         192.168.96.1
```

(b) Group 1 - PC2

```
FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Link-local IPv6 Address.....: FE80::2E0:F7FF:FE7C:4A5D
   IPv6 Address.....: 2A0C:2343:0:2::10
   IPv4 Address.....: 192.168.200.10
   Subnet Mask.....: 255.255.240.0
   Default Gateway.....: 2A0C:2343:0:2::1
                         192.168.192.1
```

(c) Group 2 - PC1

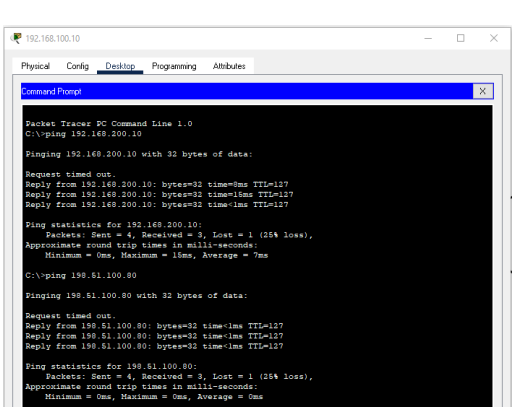
```
FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Link-local IPv6 Address.....: FE80::201:97FF:FE81:3E26
   IPv6 Address.....: 2A0C:2343:0:2::20
   IPv4 Address.....: 192.168.200.20
   Subnet Mask.....: 255.255.240.0
   Default Gateway.....: 2A0C:2343:0:2::1
                         192.168.192.1
```

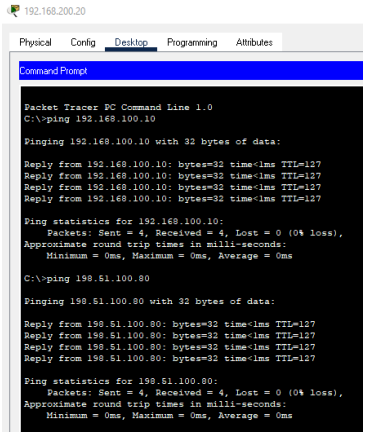
(d) Group 2 - PC2

Abbildung 8: IP-Config

Tests

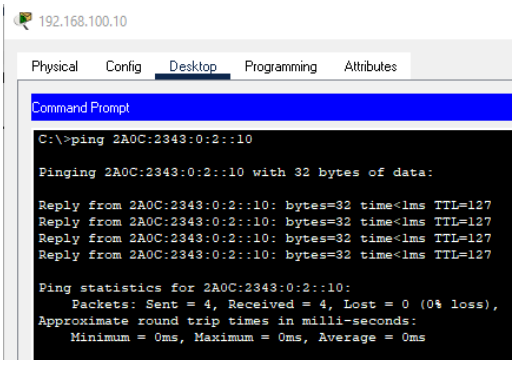


(a) Group 1 zu Group 2 und Server

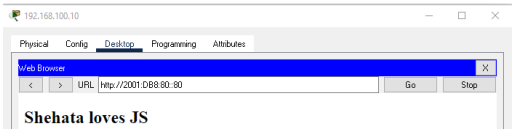


(b) Group 2 zu Group 1 und Server

Abbildung 9: IPv4 Kommunikation



(a) Group 1 zu Group 2 ping



(b) Kommunikation zum Server über den Browser

Abbildung 10: IPv6 Kommunikation

1.2.5 Frage 2

Frage

Warum funktioniert das, obwohl noch keine Routen gesetzt wurden?

Antwort

Weil der Router direkt mit den Systemen verbunden ist, erkennt er die Subnet Id automatisch und kann die Adressen routen.

```
Router#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, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.96.0/20 is directly connected, GigabitEthernet0/0
     192.168.96.0/32 is subnetted, 1 subnets
L       192.168.96.1/32 is directly connected, GigabitEthernet0/0
C    192.168.192.0/20 is directly connected, GigabitEthernet0/1
     192.168.192.0/32 is subnetted, 1 subnets
L       192.168.192.1/32 is directly connected, GigabitEthernet0/1
     198.51.100.0/24 is variably subnetted, 2 subnets, 2 masks
C       198.51.100.0/24 is directly connected, GigabitEthernet0/2
L       198.51.100.1/32 is directly connected, GigabitEthernet0/2
```

Abbildung 11: IPv4 Routes des Routers

```
Router#show ipv6 route
IPv6 Routing Table - 7 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route, M - MIPv6
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       D - EIGRP, EX - EIGRP external
C   2001:DB8:80::/64 [0/0]
     via GigabitEthernet0/2, directly connected
L   2001:DB8:80::1/128 [0/0]
     via GigabitEthernet0/2, receive
C   2A0C:2343:0:1::/64 [0/0]
     via GigabitEthernet0/0, directly connected
L   2A0C:2343:0:1::1/128 [0/0]
     via GigabitEthernet0/0, receive
C   2A0C:2343:0:2::/64 [0/0]
     via GigabitEthernet0/1, directly connected
L   2A0C:2343:0:2::1/128 [0/0]
     via GigabitEthernet0/1, receive
L   FF00::/8 [0/0]
     via Null0, receive
```

Abbildung 12: IPv6 Routes des Routers

2 Statisches Routing

2.1 Aufbau des virtuellen Netzwerkes

2.1.1 Gruppenrouter

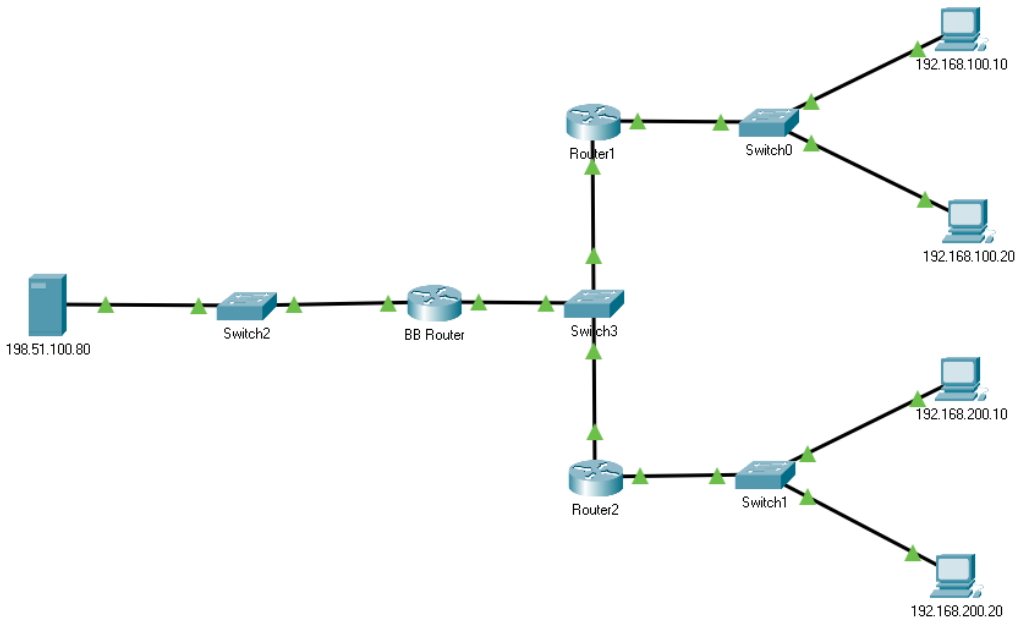


Abbildung 13: Netz nach den Änderungen

2.2 Konfiguration

2.2.1 IP Adressen

Auf dem Backbone Router wurden die Adressen mit “no ip address” und “no ipv6 address xxxx” entfernt.
Bei den neuen Routern wurde auch IPv6 unicasting aktiviert. Die LAN IPv6 werden mit “ ipv6 address 2x:x:x:x::x/64” auf dem Interface konfiguriert.
Die WAN IPv6 wurden im “conf t” wie folgt aktiviert:
int gigx/x; ipv6 enable; ipv6 address fe80::x link-local;

```
interface GigabitEthernet0/0
 ip address 172.16.0.1 255.255.0.0
 duplex auto
 speed auto
 ipv6 address FE80::2 link-local
 ipv6 enable
!
interface GigabitEthernet0/1
 ip address 192.168.96.1 255.255.240.0
 duplex auto
 speed auto
 ipv6 address 2A0C:2343:0:1::1/64
!
interface GigabitEthernet0/2
 no ip address
 duplex auto
 speed auto
 shutdown
!
```

(a) Router 1

```
interface GigabitEthernet0/0
 ip address 172.16.0.2 255.255.0.0
 duplex auto
 speed auto
 ipv6 address FE80::3 link-local
 ipv6 enable
!
interface GigabitEthernet0/1
 ip address 192.168.192.1 255.255.240.0
 duplex auto
 speed auto
 ipv6 address 2A0C:2343:0:2::1/64
!
interface GigabitEthernet0/2
 no ip address
 duplex auto
 speed auto
 shutdown
!
```

(b) Router 2

```
interface GigabitEthernet0/0
 ip address 172.16.0.3 255.255.0.0
 duplex auto
 speed auto
 ipv6 address FE80::1 link-local
 ipv6 enable
!
interface GigabitEthernet0/1
 no ip address
 duplex auto
 speed auto
!
interface GigabitEthernet0/2
 ip address 198.51.100.1 255.255.255.0
 duplex auto
 speed auto
 ipv6 address 2001:DB8:80::1/64
!
```

(c) Backbone Router

Abbildung 14: Config nach den Änderungen

2.2.2 Routen

Die IP Routes wurden wie folgt konfiguriert.

IPv4

BB Router:

```
Switch>en
Switch#conf t
Switch(config)#ip route 192.168.96.0 255.255.240.0 172.16.0.1
Switch(config)#ip route 192.168.192.0 255.255.240.0 172.16.0.2
```

```
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.0.0/16 is directly connected, GigabitEthernet0/0
L       172.16.0.3/32 is directly connected, GigabitEthernet0/0
S    192.168.96.0/20 [1/0] via 172.16.0.1
S    192.168.192.0/20 [1/0] via 172.16.0.2
     198.51.100.0/24 is variably subnetted, 2 subnets, 2 masks
C       198.51.100.0/24 is directly connected, GigabitEthernet0/2
L       198.51.100.1/32 is directly connected, GigabitEthernet0/2
```

Abbildung 15: Routing Tabelle

Router 1:

```
Switch>en
Switch#conf t
Switch(config)#ip route 0.0.0.0 0.0.0.0 172.16.0.3
Switch(config)#ip route 192.168.192.0 255.255.240.0 172.16.0.2
```

```
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.0.0/16 is directly connected, GigabitEthernet0/0
L       172.16.0.1/32 is directly connected, GigabitEthernet0/0
C    192.168.96.0/20 is directly connected, GigabitEthernet0/1
     192.168.96.0/32 is subnetted, 1 subnets
L       192.168.96.1/32 is directly connected, GigabitEthernet0/1
S    192.168.192.0/20 [1/0] via 172.16.0.2
S*   0.0.0.0/0 [1/0] via 172.16.0.3
```

Abbildung 16: Routing Tabelle

Router 2:

```
Switch>en
Switch#conf t
Switch(config)#ip route 0.0.0.0 0.0.0.0 172.16.0.3
Switch(config)#ip route 192.168.96.0 255.255.240.0 172.16.0.1
```

```
Gateway of last resort is 172.16.0.3 to network 0.0.0.0

     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.0.0/16 is directly connected, GigabitEthernet0/0
L       172.16.0.2/32 is directly connected, GigabitEthernet0/0
S    192.168.96.0/20 [1/0] via 172.16.0.1
C    192.168.192.0/20 is directly connected, GigabitEthernet0/1
     192.168.192.0/32 is subnetted, 1 subnets
L       192.168.192.1/32 is directly connected, GigabitEthernet0/1
S*   0.0.0.0/0 [1/0] via 172.16.0.3
```

Abbildung 17: Routing Tabelle

IPv6

BB Router:

```
Switch>en
Switch#conf t
Switch(config)#ipv6 route 2A0C:2343:0:1::/64 GigabitEthernet0/0
FE80::2
Switch(config)#ipv6 route 2A0C:2343:0:2::/64 GigabitEthernet0/0
FE80::3
```

```
C   2001:DB8:80::/64 [0/0]
     via GigabitEthernet0/2, directly connected
L   2001:DB8:80::1/128 [0/0]
     via GigabitEthernet0/2, receive
S   2A0C:2343:0:1::/64 [1/0]
     via FE80::2, GigabitEthernet0/0
S   2A0C:2343:0:2::/64 [1/0]
     via FE80::3, GigabitEthernet0/0
L   FF00::/8 [0/0]
     via Null0, receive
```

Abbildung 18: Routing Tabelle

Router 1:

```
Switch>en
Switch#conf t
Switch(config)#ipv6 route ::/0 GigabitEthernet0/0 FE80::1
Switch(config)#pv6 route 2A0C:2343:0:2::/64 GigabitEthernet0/0
FE80::3
```

```
S    ::/0 [1/0]
      via FE80::1, GigabitEthernet0/0
C    2A0C:2343:0:1::/64 [0/0]
      via GigabitEthernet0/1, directly connected
L    2A0C:2343:0:1::1/128 [0/0]
      via GigabitEthernet0/1, receive
S    2A0C:2343:0:2::/64 [1/0]
      via FE80::3, GigabitEthernet0/0
L    FF00::/8 [0/0]
      via Null0, receive
```

Abbildung 19: Routing Tabelle

Router 2:

```
Switch>en
Switch#conf t
Switch(config)#ipv6 route ::/0 GigabitEthernet0/0 FE80::1
Switch(config)#ipv6 route 2A0C:2343:0:1::/64 GigabitEthernet0/0
FE80::2
```

```
S    ::/0 [1/0]
      via FE80::1, GigabitEthernet0/0
S    2A0C:2343:0:1::/64 [1/0]
      via FE80::2, GigabitEthernet0/0
C    2A0C:2343:0:2::/64 [0/0]
      via GigabitEthernet0/1, directly connected
L    2A0C:2343:0:2::1/128 [0/0]
      via GigabitEthernet0/1, receive
L    FF00::/8 [0/0]
      via Null0, receive
```

Abbildung 20: Routing Tabelle

Interpretation der Tabellen

Die Tabellen zeigen vor jeder Adresse immmer einen Buschstaben, der jeweils für etwas steht. C bedeutet, dass diese Adresse(Interface) verbunden ist. Mit L wird

angegeben, dass es Lokal ist. MIt S werden die statischen Adressen verdeutlicht. Unter der jeweiligen Adresse steht dann die Verbindungsart. Diese ist bei statischen immer eine Adresse und bei link-lokalen ist auch das Interface dabei. Bei automatischen Adresserkennungen steht immer das Interface und dessen Funktion bzw. wie es verbunden ist. IPv4 kann auch die Anzahl der Masken und Subnetze enthalten.

3 Inter VLAN Routing

3.1 Netzwerkaufbau

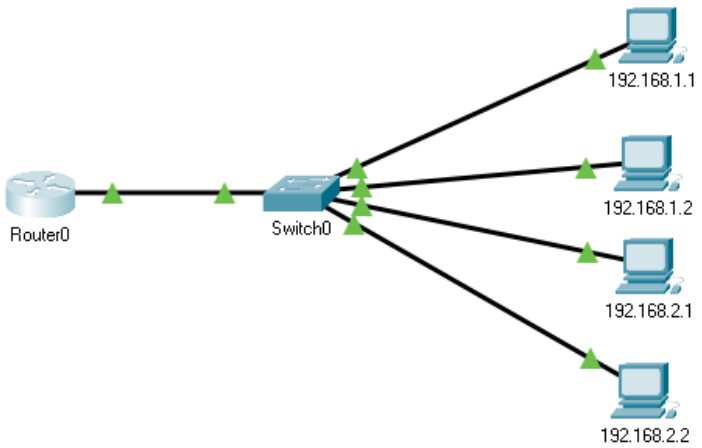


Abbildung 21: Netz

```
C:\>ipconfig

FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Link-local IPv6 Address.....: FE80::202:16FF:FE51:DC9A
   IPv6 Address.....: ::
   IPv4 Address.....: 192.168.1.1
   Subnet Mask.....: 255.255.255.0
   Default Gateway.....: ::
                                 192.168.1.254
```

(a) 192.168.1.1

```
C:\>ipconfig

FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Link-local IPv6 Address.....: FE80::290:21FF:FEA3:7D59
   IPv6 Address.....: ::
   IPv4 Address.....: 192.168.1.2
   Subnet Mask.....: 255.255.255.0
   Default Gateway.....: ::
                                 192.168.1.254
```

(b) 192.168.1.2

```
C:\>ipconfig

FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Link-local IPv6 Address.....: FE80::205:5EFF:FEC9:3A0
   IPv6 Address.....: ::
   IPv4 Address.....: 192.168.2.1
   Subnet Mask.....: 255.255.255.0
   Default Gateway.....: ::
                                 192.168.2.254
```

(c) 192.168.2.1

```
C:\>ipconfig

FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Link-local IPv6 Address.....: FE80::260:70FF:FEB7:4B4B
   IPv6 Address.....: ::
   IPv4 Address.....: 192.168.2.2
   Subnet Mask.....: 255.255.255.0
   Default Gateway.....: ::
                                 192.168.2.254
```

(d) 192.168.2.2

Abbildung 22: Config mit Default Gateway

3.2 Konfiguration

3.2.1 VLAN Konfiguration an der Switch

```
Switch>en
Switch#conf t
Switch(config)#int range fa0/1-2
Switch(config-if-range)#switchport mode access
Switch(config-if-range)#switchport acc vlan 10
Switch(config-if-range)#exit
Switch(config)#int range fa0/3-4
Switch(config-if-range)#switchport mode access
Switch(config-if-range)#switchport acc vlan 20
Switch(config-if-range)#exit
Switch(config)#int gig0/1
Switch(config-if)#switchport mode trunk
Switch(config-if)#switchport trunk allowed vlan none
Switch(config-if)#switchport trunk allowed vlan add 10
Switch(config-if)#switchport trunk allowed vlan add 20
Switch(config-if)#end
```

3.2.2 Konfiguration von Sub-Interfaces am Router

```
Router>en
Router#conf t
Router(config)#int gig0/0.1
Router(config-subif)#
Router(config-subif)#encapsulation dot1Q 10
Router(config-subif)#ip address 192.168.1.254 255.255.255.0
Router(config-subif)#exit
Router(config)#int gig0/0.2
Router(config-subif)#encapsulation dot1Q 20
Router(config-subif)#ip address 192.168.2.254 255.255.255.0
```

3.3 Testen der Verbindungen

3.3.1 Endsystemkommunikation

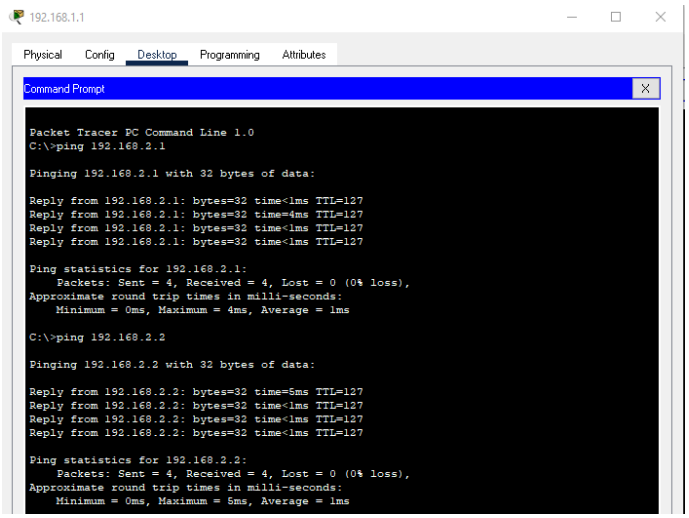


Abbildung 23: Vlan 10 mit Vlan 20

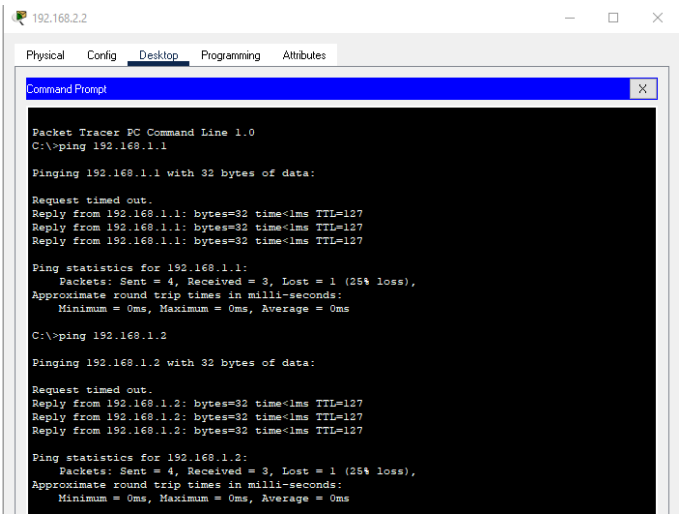


Abbildung 24: Vlan 20 mit Vlan 10

Abbildung 25: Config nach den Änderungen

3.3.2 Routerkommunikation

```
C:\>ping 192.168.1.254

Pinging 192.168.1.254 with 32 bytes of data:

Reply from 192.168.1.254: bytes=32 time<1ms TTL=255
Reply from 192.168.1.254: bytes=32 time<1ms TTL=255
Reply from 192.168.1.254: bytes=32 time<1ms TTL=255
Reply from 192.168.1.254: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.1.254:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 192.168.2.254

Pinging 192.168.2.254 with 32 bytes of data:

Reply from 192.168.2.254: bytes=32 time<1ms TTL=255
Reply from 192.168.2.254: bytes=32 time<1ms TTL=255
Reply from 192.168.2.254: bytes=32 time<1ms TTL=255
Reply from 192.168.2.254: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.2.254:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

Abbildung 26: Ping zu den Subinterfaces

3.3.3 Frage 3

Frage

Wie könnte die Verbindung zwischen verschiedenen VLANs ohne eine Router on a Stick Konfiguration hergestellt werden, und was würde sich ändern, wenn die Switch keinen Trunk Port verwenden würde?

Antwort

Man könnte die Verbindung zu den Endsystemen zu Trunk Port machen, aber das lässt sich nicht so einfach skalieren.
Wenn die Switches keinen Trunk Port verwenden dürfen, können die Geräte ohne Router nicht kommunizieren, da die Switches nur das eingestellte Access VLAN erlauben.