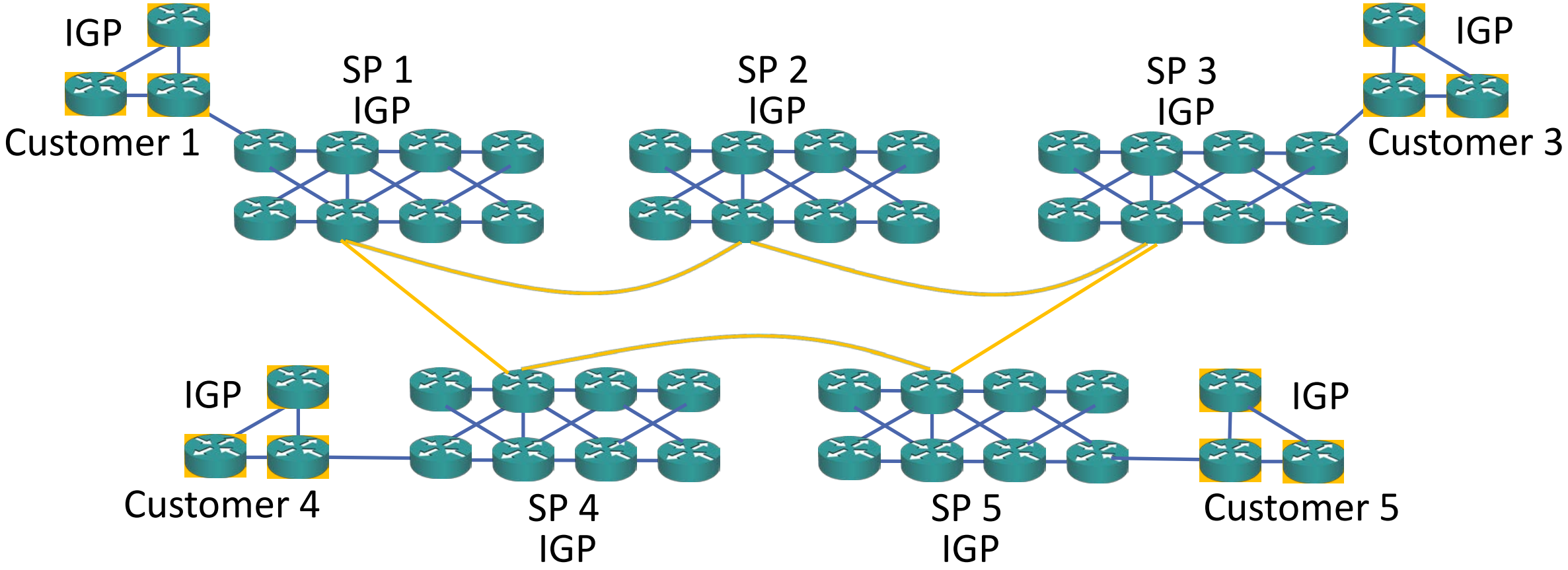
Enterprise Internet Routing

- Internet Service Providers connect to other ISPs and must use BGP for Internet routing
- Enterprises can use either static routes or BGP for their Internet connectivity
- Enabling BGP increases the load on both the routers and the administrators who need to support it

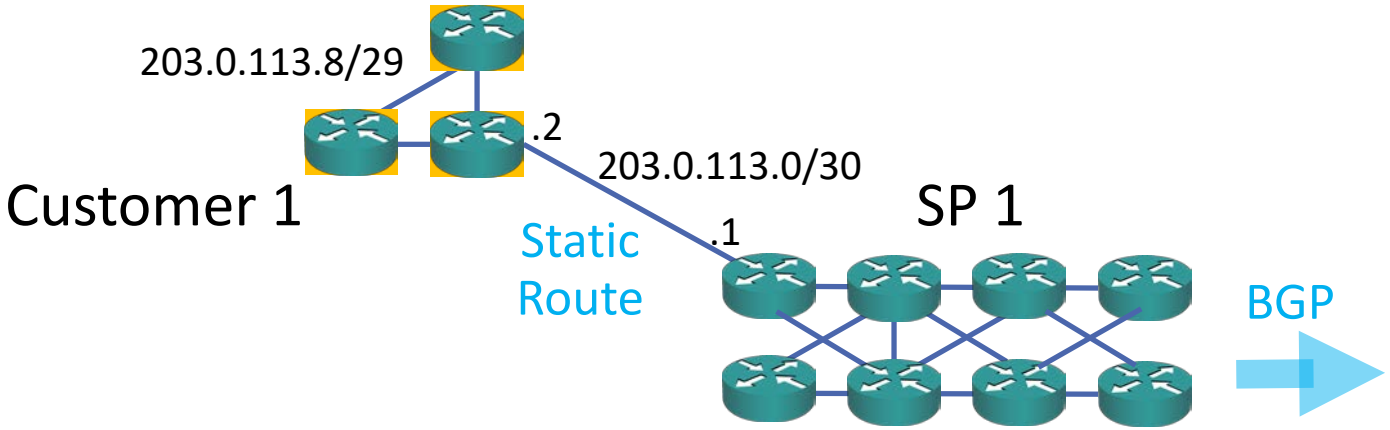
Internet Connectivity – Topology 1



Enterprise Internet Routing

- There is only one path in and out for every customer so there is no need to use anything more complicated than a default static route

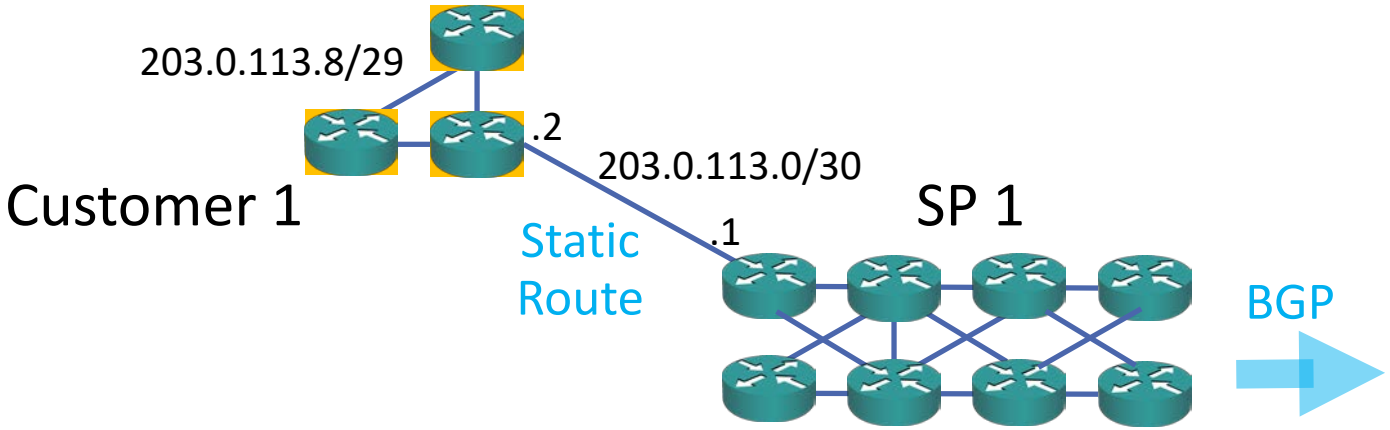
```
Cust1(config)# ip route 0.0.0.0 0.0.0.0 203.0.113.1
SP1(config)#ip route 203.0.113.8 255.255.255.248 203.0.113.2
```



Enterprise Internet Routing

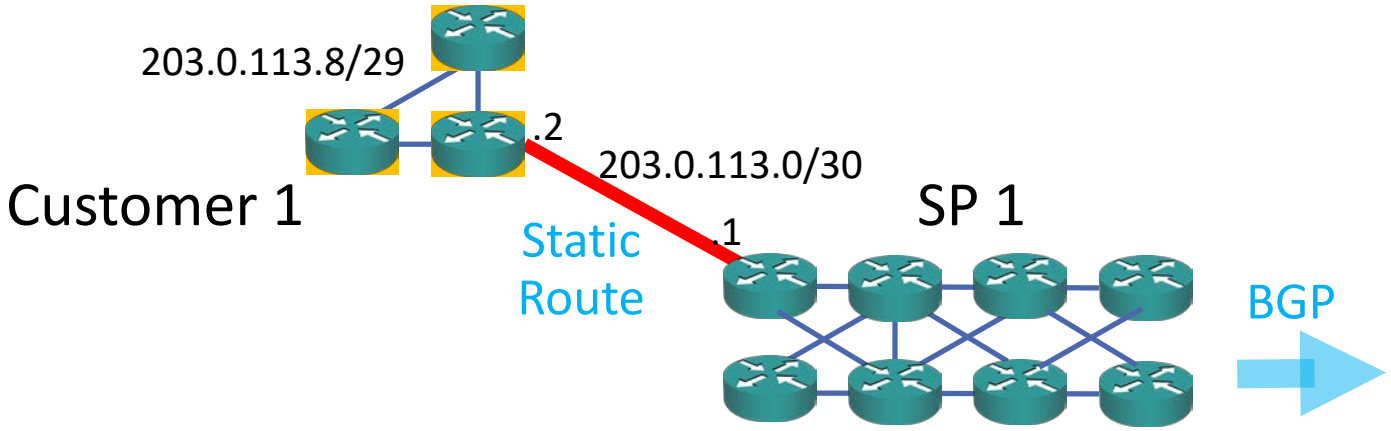
- This topology will sometimes be acceptable for small offices, but larger offices will want redundancy for their Internet connectivity

```
Cust1(config)# ip route 0.0.0.0 0.0.0.0 203.0.113.1
SP1(config)#ip route 203.0.113.8 255.255.255.248 203.0.113.2
```



Single Point of Failure - Link

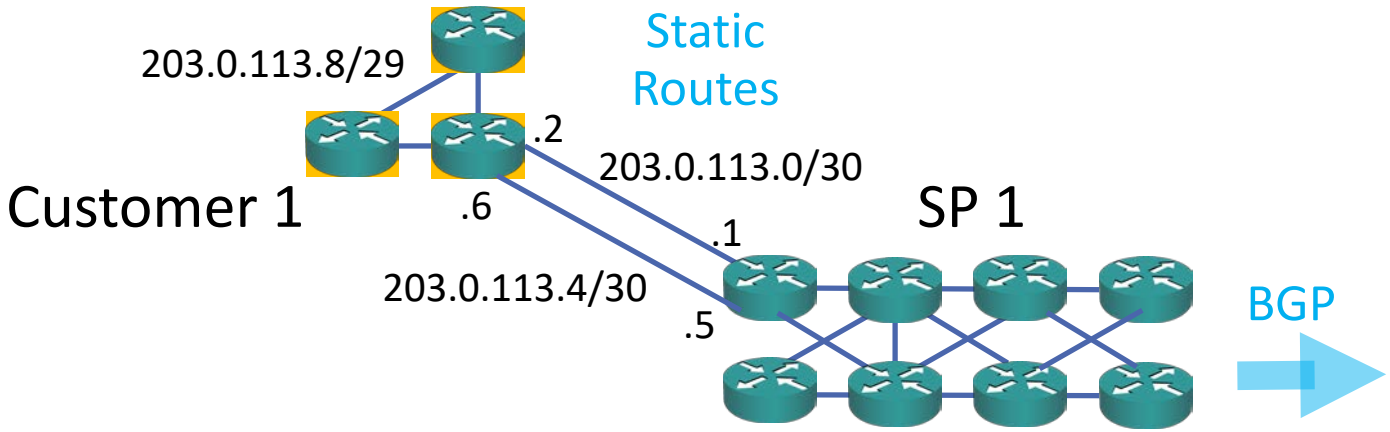
- There is a single link between the customer and provider, this is a single point of failure



Redundant Links

```
Cust1(config)# ip route 0.0.0.0 0.0.0.0 203.0.113.1
Cust1(config)# ip route 0.0.0.0 0.0.0.0 203.0.113.5

SP1(config)# ip route 203.0.113.8 255.255.255.248 203.0.113.2
SP1(config)# ip route 203.0.113.8 255.255.255.248 203.0.113.6
```

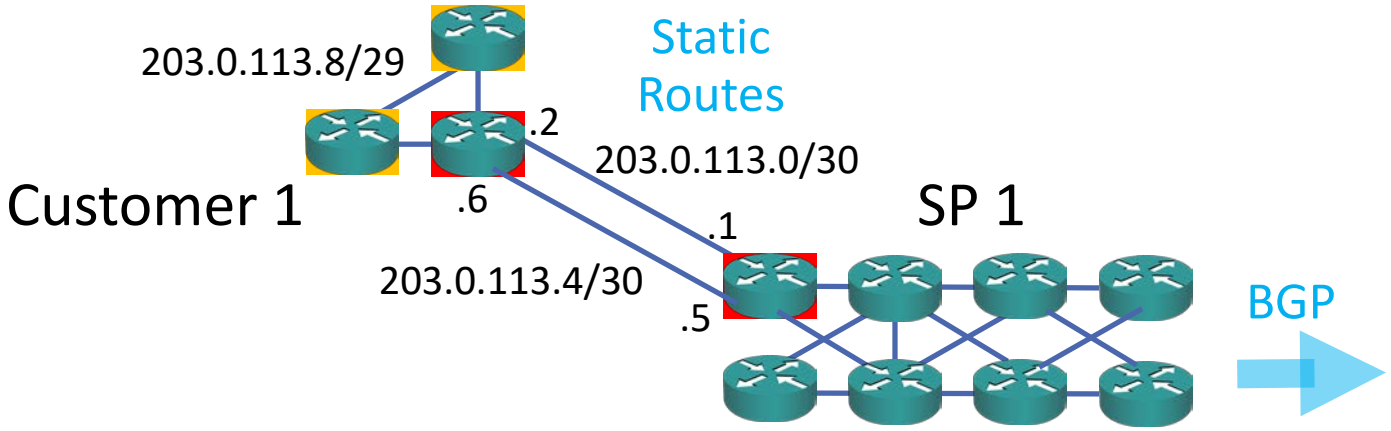


Redundant Links

- All traffic to and from the customer travels via a single AS, so there is no need to configure BGP
- Default static route equal cost load balancing will spread the traffic equally over both links
- If a link fails all traffic will go over the surviving link

Single Point of Failure - Router

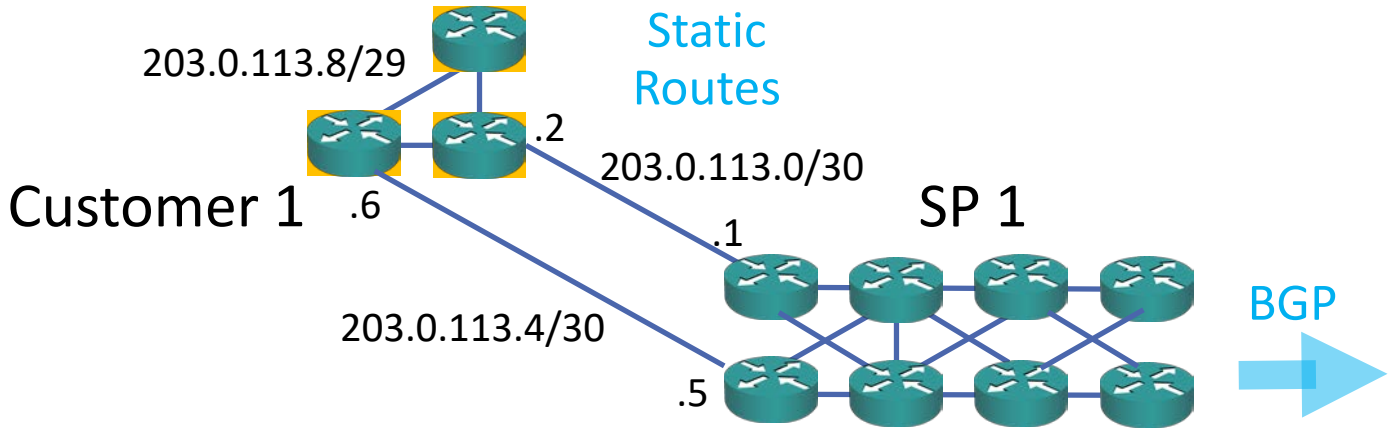
- There are single routers connecting the customer and provider, this is another single point of failure



Redundant Routers

```
Cust1A(config)# ip route 0.0.0.0 0.0.0.0 203.0.113.1
Cust1B(config)# ip route 0.0.0.0 0.0.0.0 203.0.113.5

SP1A(config)# ip route 203.0.113.8 255.255.255.248 203.0.113.2
SP1B(config)# ip route 203.0.113.8 255.255.255.248 203.0.113.6
```



Redundant Routers

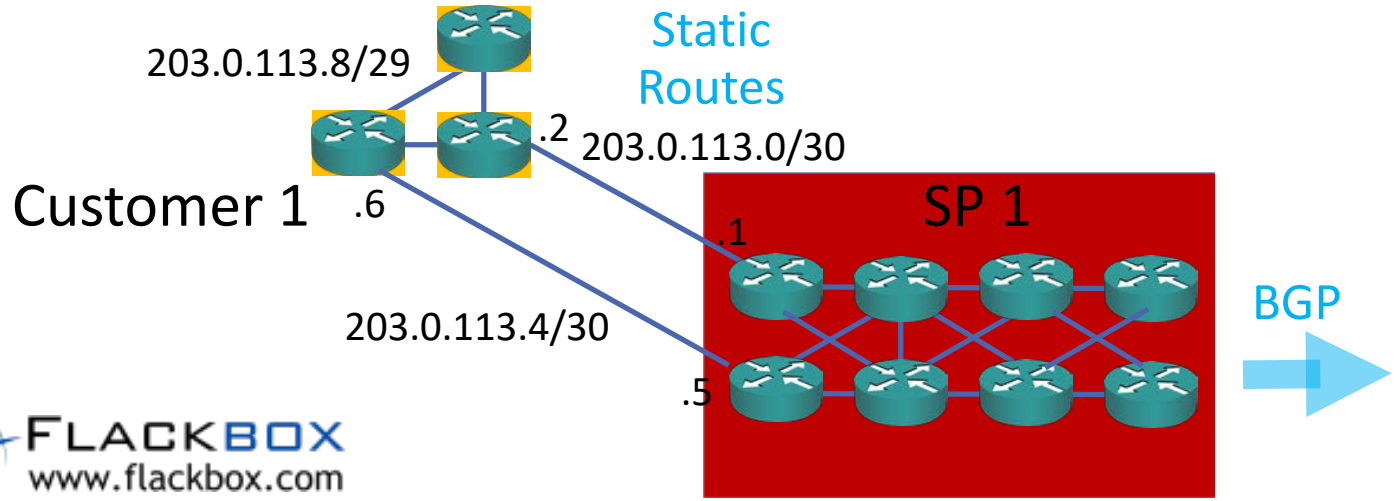
- All traffic to and from the customer travels via a single AS, so there is no need to configure BGP
- Default static route equal cost load balancing will spread the traffic equally over both links
- If a link fails all traffic will go over the surviving link

The Need for Enterprise BGP

- At this point we have eliminated all physical single points of failure for the connection between the customer and provider
- There was no need to implement BGP
- So you're probably thinking, when *would* a customer implement BGP?

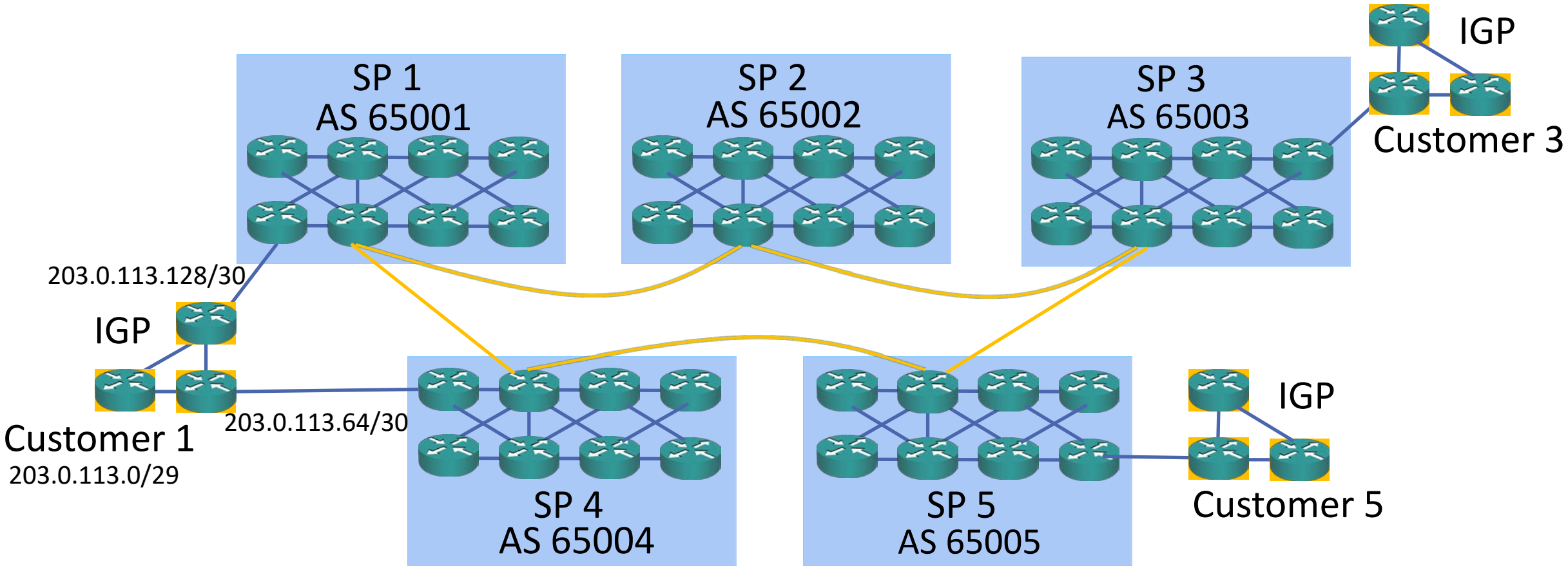
Single Point of Failure – Service Provider

- The Service Provider itself is a single point of failure
- They could have a physical or operational issue which drops their Internet connectivity
- This is not as likely as a link or router failure, but is still a consideration
- Some providers offer redundant physical Internet connectivity paths



Redundant Service Providers

- There is now no single point of failure for Customer 1



Static Routes or BGP

- At this point the customer has the choice of using either default static routes or BGP for their Internet routing
- The benefit of using static routes is that this method is the easiest to implement and support

```
SP4(config)# ip route 203.0.113.0 255.255.255.248 203.0.113.66
SP1(config)# ip route 203.0.113.0 255.255.255.248 203.0.113.130

Cust1A(config)# ip route 0.0.0.0 0.0.0.0 203.0.113.65
Cust1B(config)# ip route 0.0.0.0 0.0.0.0 203.0.113.129
```

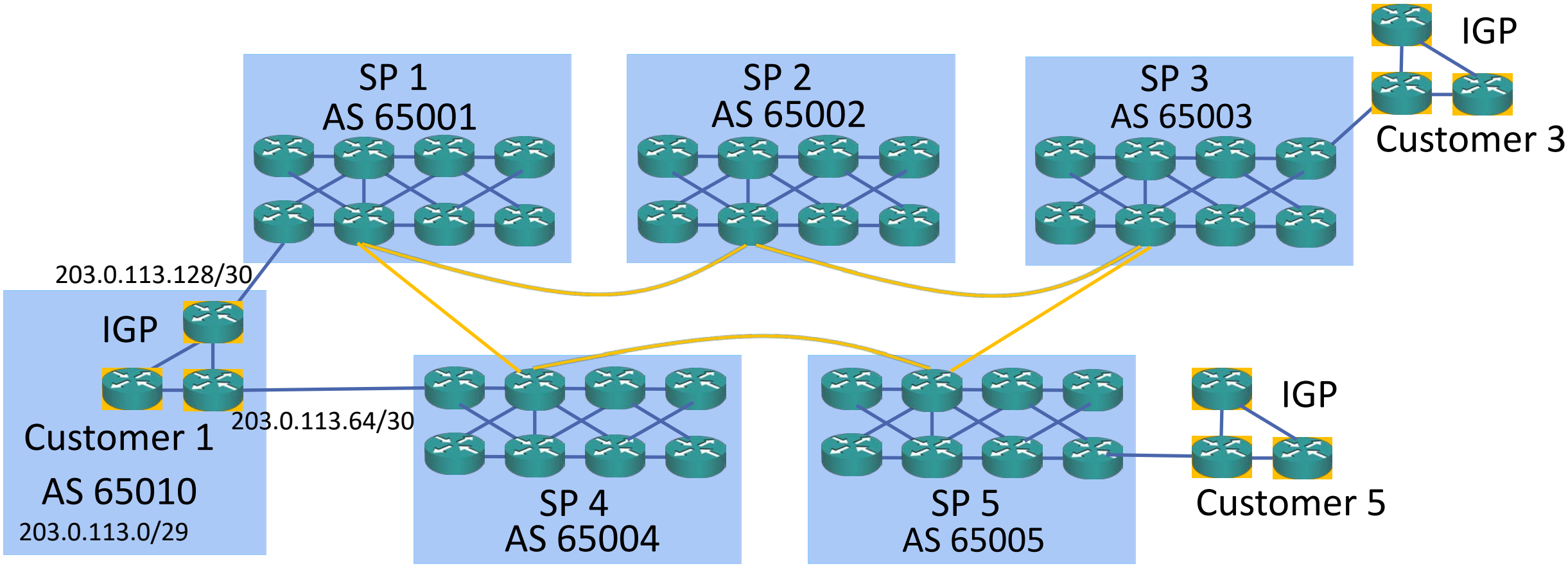
Static Routes Drawback

- The drawback of using Static Routes is that it can lead to suboptimal routing
- In our example network, traffic from Customer 1 to Customer 5 will be load balanced over the links to SP1 and SP4
- SP4 is the optimal path (2 AS hops), SP1 is a suboptimal path (4 AS hops)
- Half the traffic will take a suboptimal path which will increase latency
- Administrators can configure more specific static routes for particular networks but this is not feasible for the entire Internet

Enterprise BGP

- The alternative method is to implement BGP between the customer and the service provider
- The customer should acquire their own BGP AS number and provider independent IP address space (this may not be possible for IPv4 now)
- This enables optimal routing
- The drawback is there is increased load on the router and administrators

Enterprise BGP



Enterprise BGP


```
R1(config)#router bgp 65010
R1(config-router)#neighbor 172.16.0.2 remote-as 65010
R1(config-router)#neighbor 203.0.113.129 remote-as 65001
R1(config-router)#network 203.0.113.0 mask 255.255.255.248

R2(config)#router bgp 65010
R2(config-router)#neighbor 172.16.0.1 remote-as 65010
R2(config-router)#neighbor 203.0.113.65 remote-as 65004
R2(config-router)#network 203.0.113.0 mask 255.255.255.248
```

BGP Filtering

- There are over 600,000 routes in the global Internet routing table
- This will overwhelm many Enterprise class routers
- BGP filtering can be used to only advertise or accept a subset of the entire BGP table, allowing for optimal routing where it is most suitable and a default selection for everything else
- Service Providers will typically implement filtering also to prevent a customer accidentally advertising the entire Internet as being available through themselves