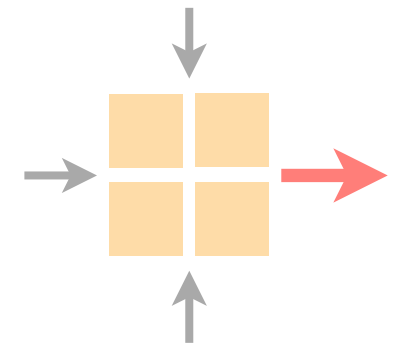


# Communication Networks

Spring 2021



Thomas Holterbach

Rüdiger Birkner

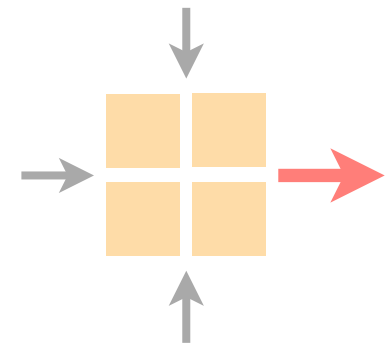
<https://comm-net.ethz.ch/>

ETH Zürich

April 29 2021

# Communication Networks

## Exercise 8

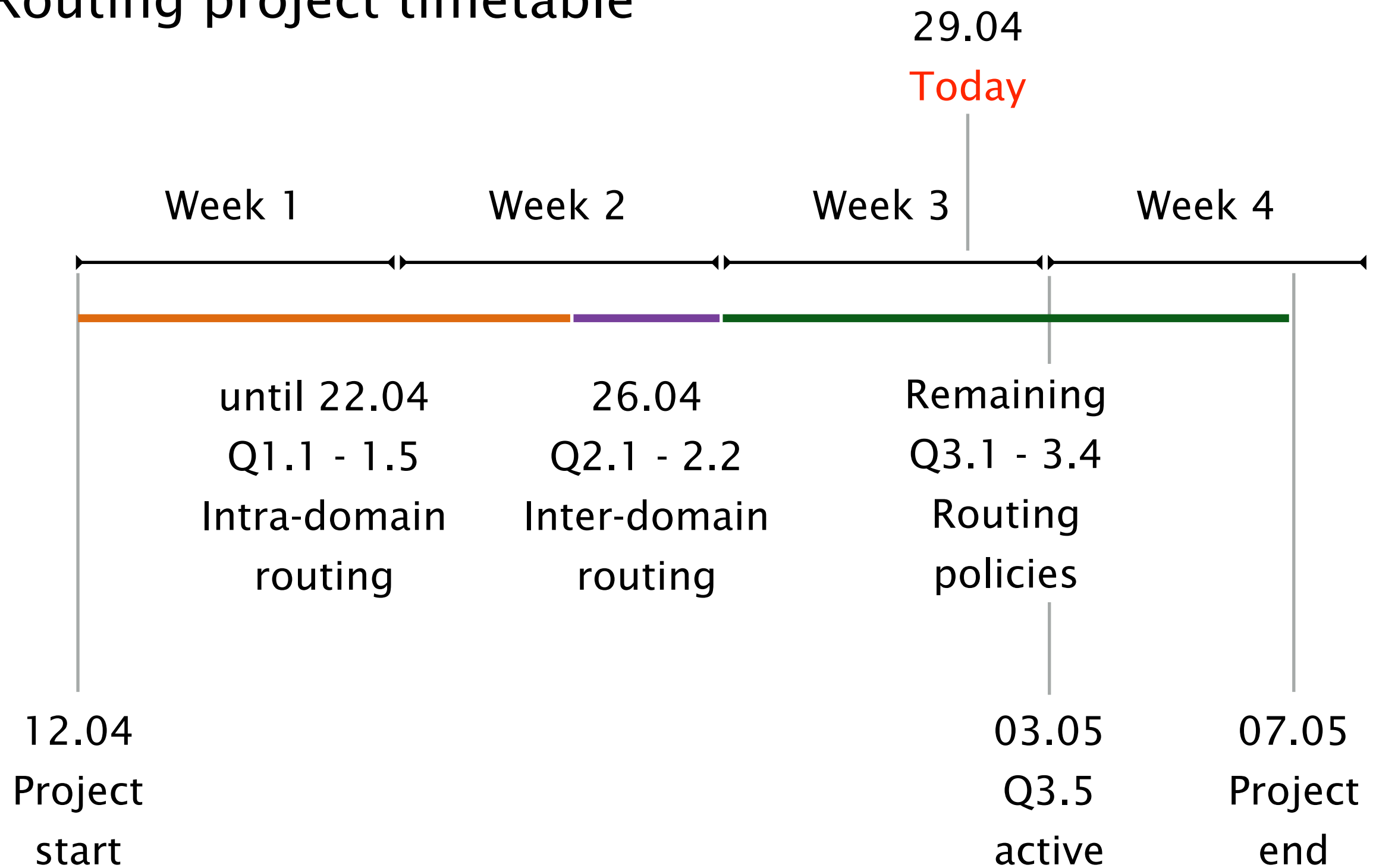


Routing project

Overview current assignment

Solutions will be published next week

# Routing project timetable

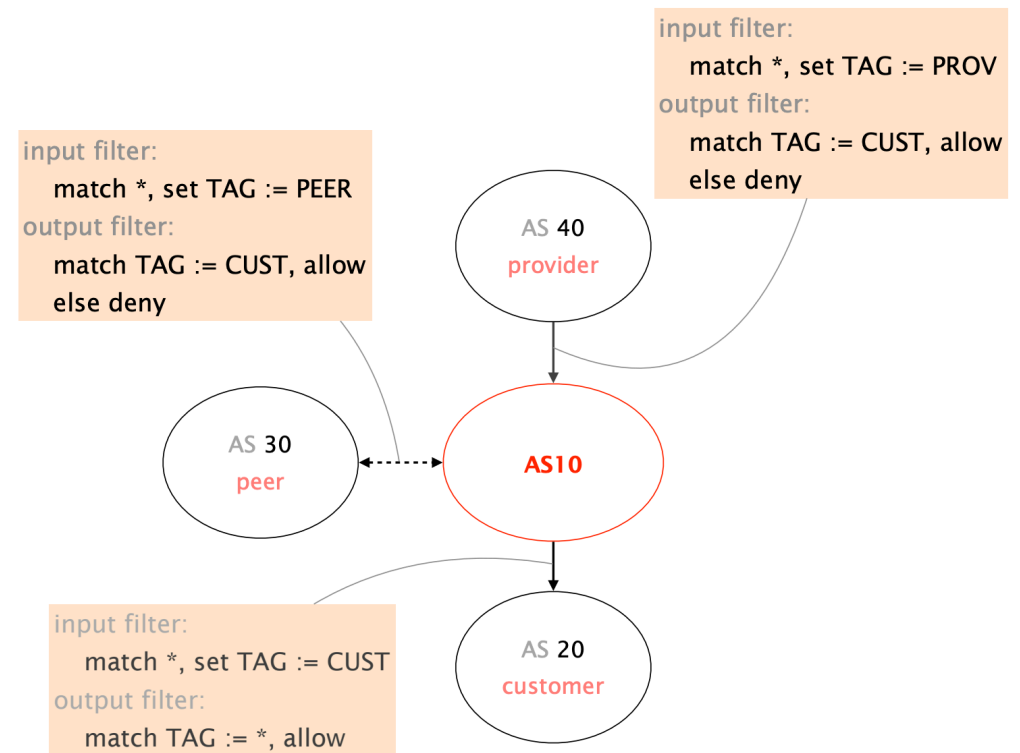




# Route-maps allow you to enforce policies

Routes coming from peers and providers are only propagated to customers

		send to		
		customer	peer	provider
from	customer	✓	✓	✓
	peer	✓	-	-
	provider	✓	-	-



# Route-map basics

On every BGP session, you can have one in and one out route-map

```
router bgp 15  
  neighbor 2.0.0.2 route-map MY_ROUTE_MAP in
```

A route-map allows you to modify or block route announcements

```
route-map MY_ROUTE_MAP permit 10  
  match ...  
  set ...
```

# Anatomy of a route-map

```
route-map MY_ROUTE_MAP permit 10
  match community 1
  match ...

  set local-preference 1000
  set ...
```

# Anatomy of a route-map

route-map name



```
route-map MY_ROUTE_MAP permit 10
  match community 1
  match ...

  set local-preference 1000
  set ...
```



# Anatomy of a route-map

route-map name



```
route-map MY_ROUTE_MAP permit 10
match community 1
match ...

set local-preference 1000
set ...
```

← select announcements

# Anatomy of a route-map

route-map name



```
route-map MY_ROUTE_MAP permit 10
```

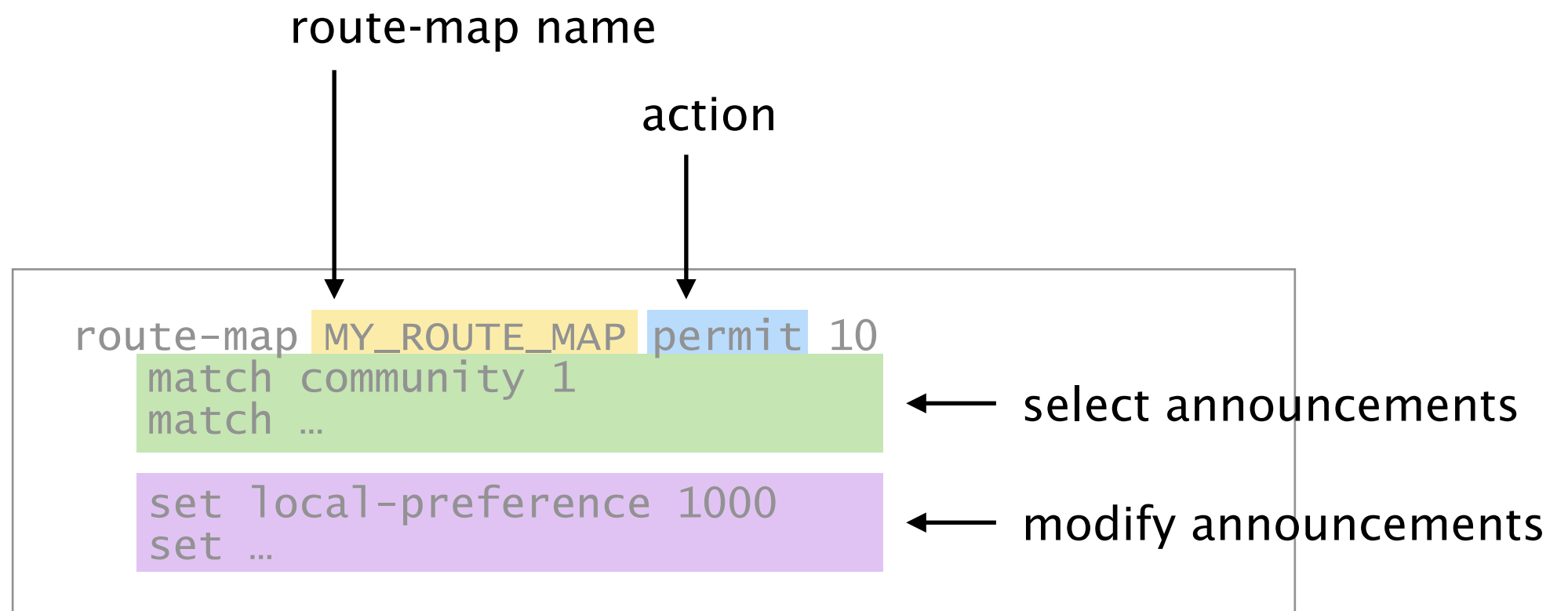
```
match community 1  
match ...
```

← select announcements

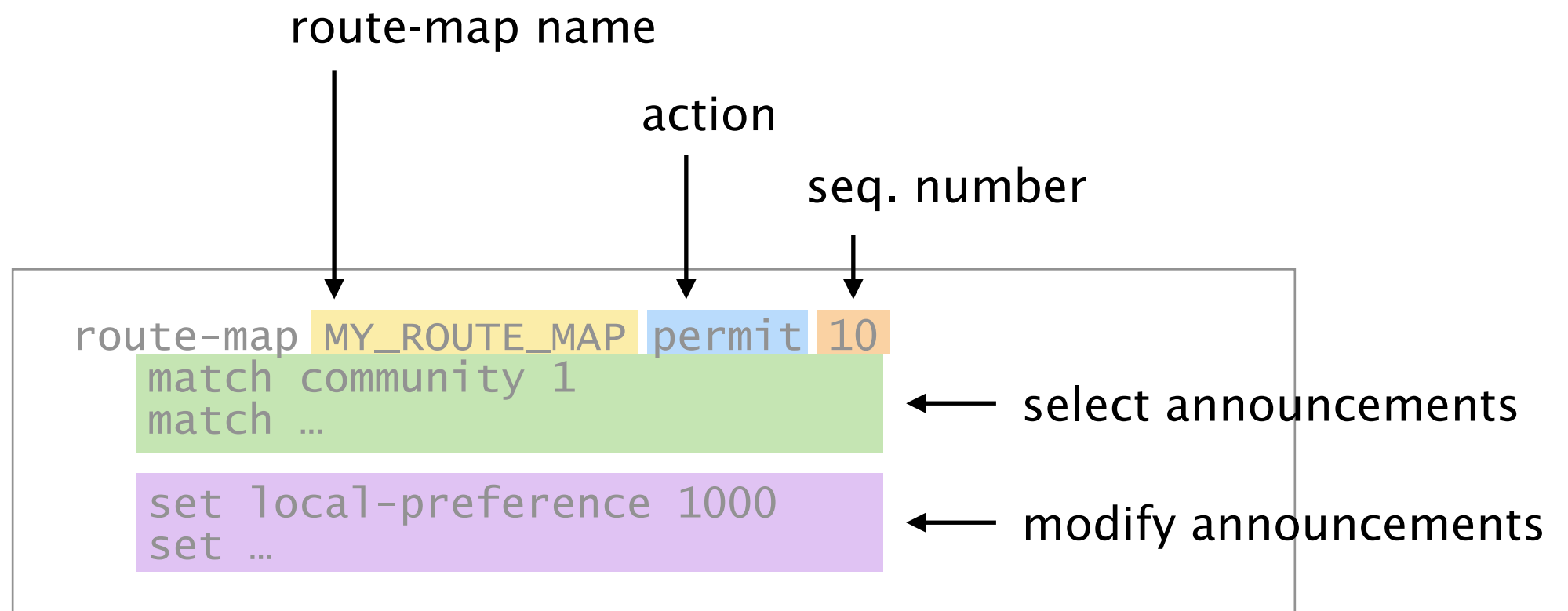
```
set local-preference 1000  
set ...
```

← modify announcements

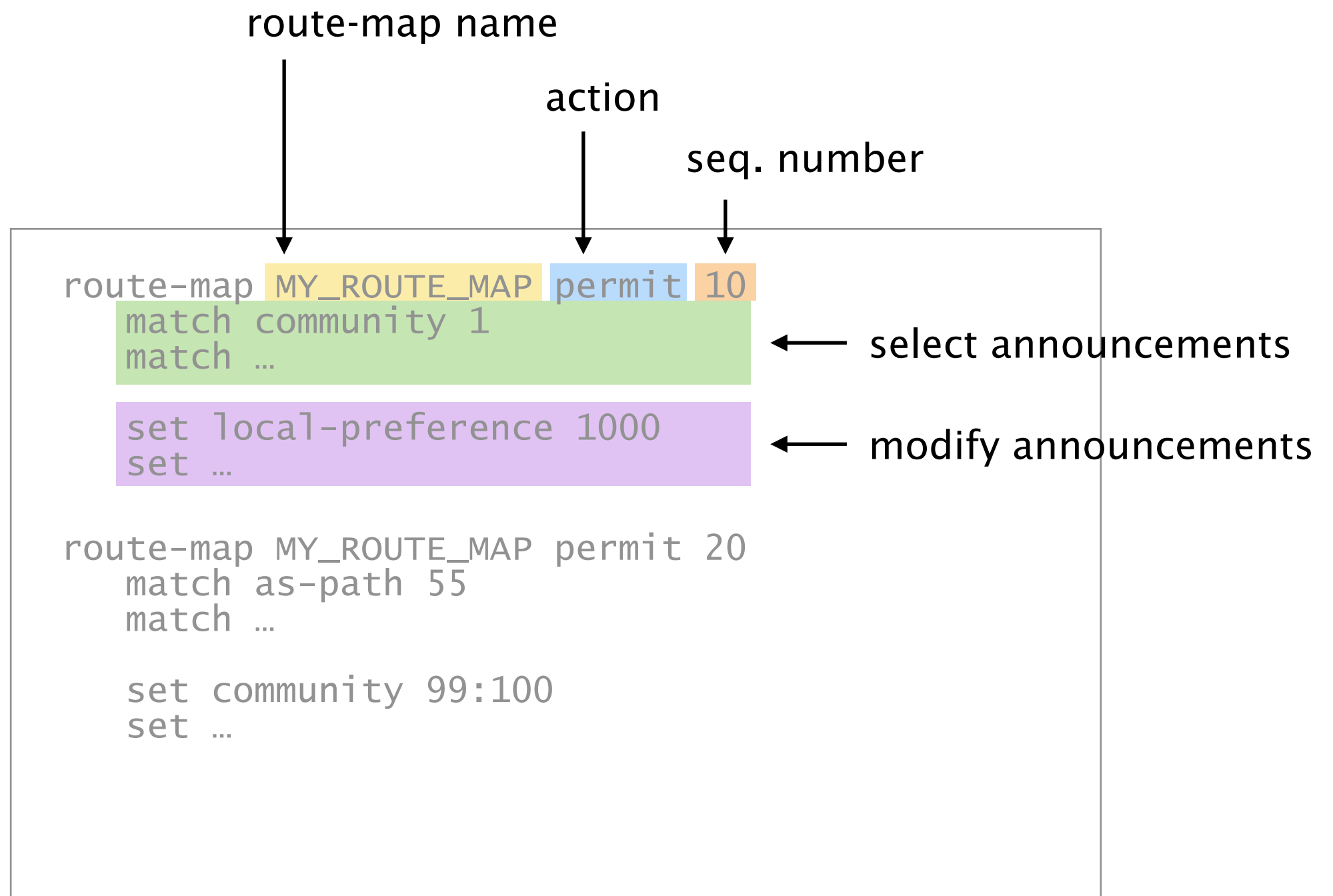
# Anatomy of a route-map



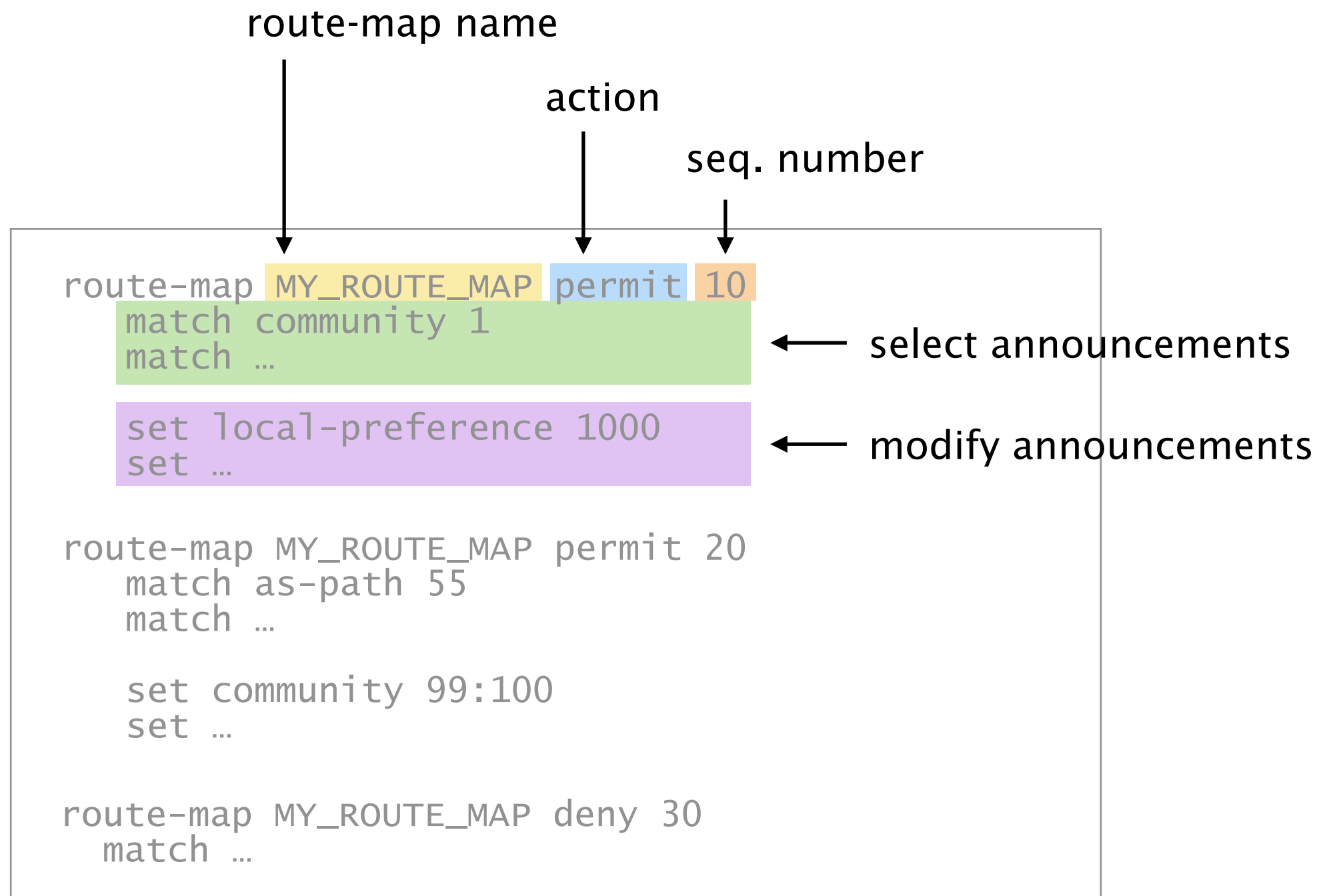
# Anatomy of a route-map



# Anatomy of a route-map



# Anatomy of a route-map



# Route-maps can be seen as if/else-statements

```
route-map MY_ROUTE_MAP permit 10  
  match community 1  
  set local-preference 1000
```

# Route-maps can be seen as if/else-statements

```
route-map MY_ROUTE_MAP permit 10  
  match community 1  
  set local-preference 1000
```



```
if (community 1 in announcement):  
    set local-preference 1000  
    permit
```



# Route-maps can be seen as if/else-statements

```
route-map MY_ROUTE_MAP permit 10  
  match community 1  
  set local-preference 1000
```



```
if (community 1 in announcement):  
  set local-preference 1000  
  permit
```

```
route-map MY_ROUTE_MAP deny 20  
  match as-path 55
```

```
route-map MY_ROUTE_MAP permit 30
```

# Route-maps can be seen as if/else-statements

```
route-map MY_ROUTE_MAP permit 10  
  match community 1  
  set local-preference 1000
```



```
if (community 1 in announcement):  
  set local-preference 1000  
  permit
```

```
route-map MY_ROUTE_MAP deny 20  
  match as-path 55
```



```
elif (as-path matches 55):  
  drop
```

```
route-map MY_ROUTE_MAP permit 30
```

# Route-maps can be seen as if/else-statements

```
route-map MY_ROUTE_MAP permit 10  
  match community 1  
  set local-preference 1000
```



```
if (community 1 in announcement):  
    set local-preference 1000  
    permit
```

```
route-map MY_ROUTE_MAP deny 20  
  match as-path 55
```



```
elif (as-path matches 55):  
    drop
```

```
route-map MY_ROUTE_MAP permit 30
```



```
elif (true):  
    permit
```

# Route-maps can be seen as if/else-statements

```
route-map MY_ROUTE_MAP permit 10  
  match community 1  
  set local-preference 1000
```



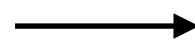
```
if (community 1 in announcement):  
    set local-preference 1000  
    permit
```

```
route-map MY_ROUTE_MAP deny 20  
  match as-path 55
```



```
elif (as-path matches 55):  
    drop
```

```
route-map MY_ROUTE_MAP permit 30
```



```
elif (true):  
    permit
```

```
route-map MY_ROUTE_MAP deny 999
```



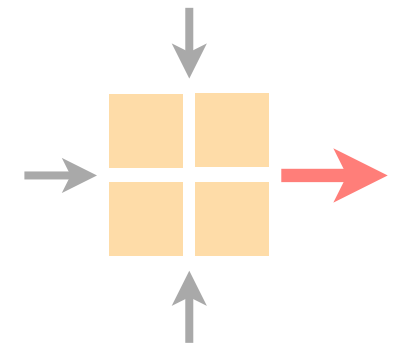
```
else:  
    drop
```



always implicitly added at the end  
(not visible in the config)

# Communication Networks

## Exercise 8

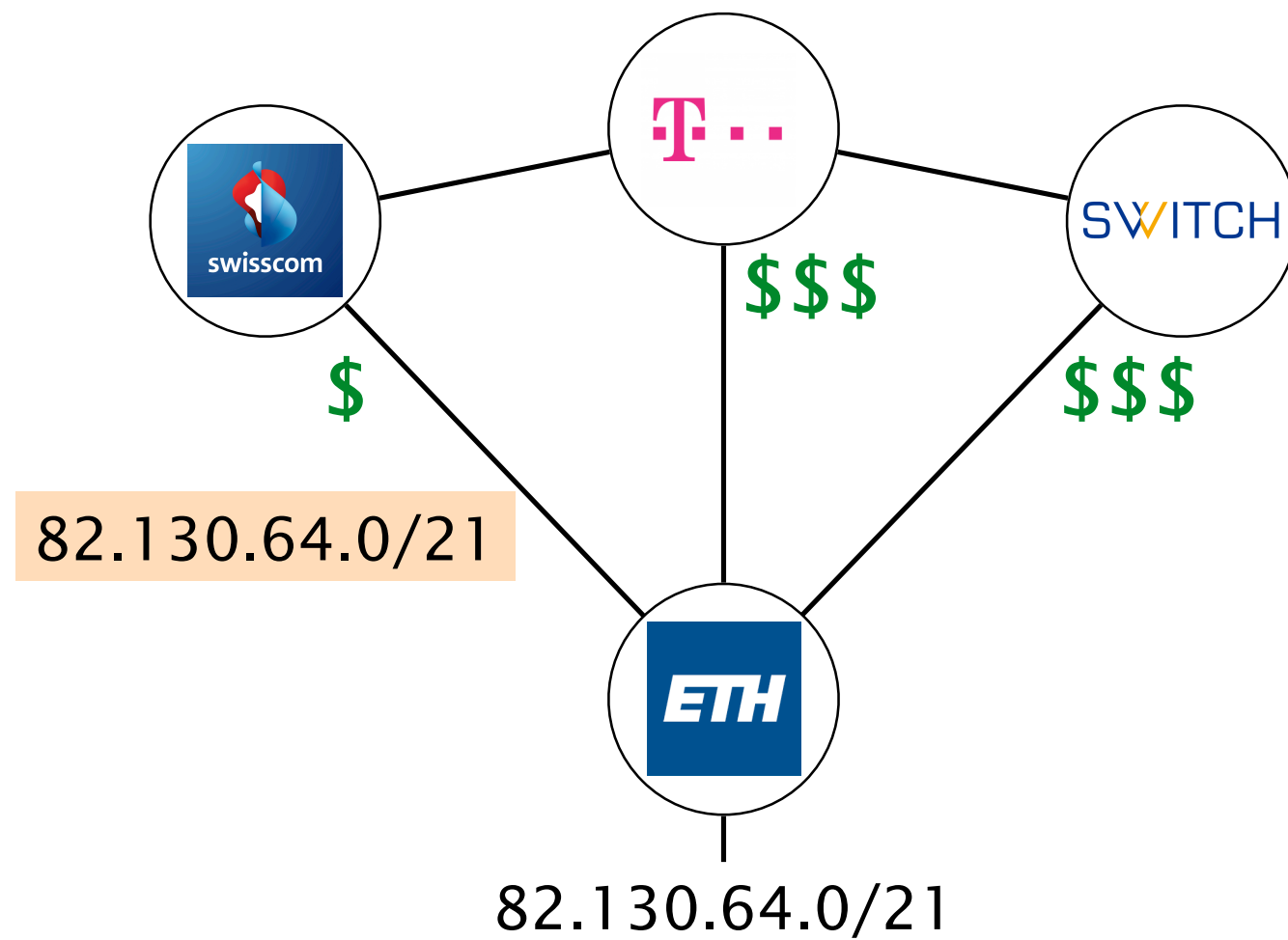


Routing project

Overview current assignment

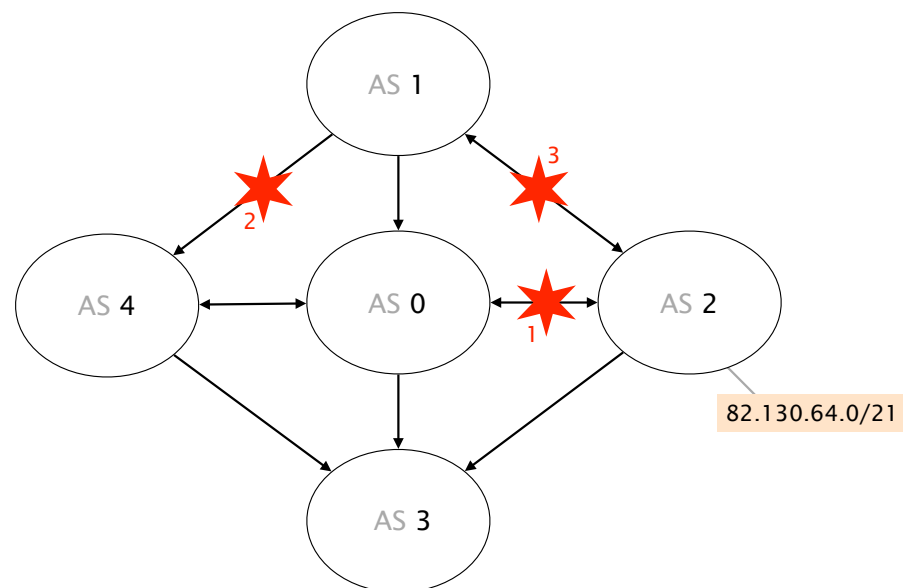
Solutions will be published next week

# Task 1: Traffic Engineering



# Task 2: Not-so-reliable Internet

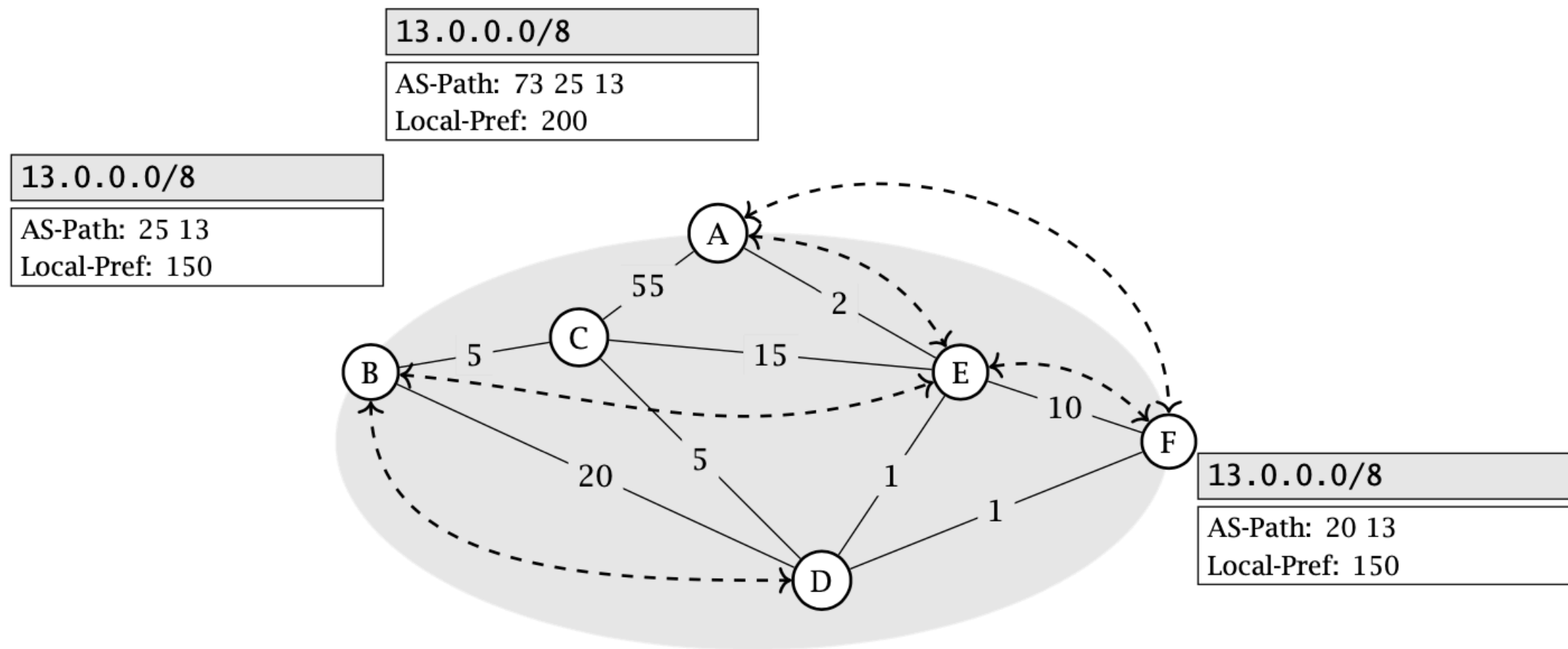
More details: Slides 44-56 (week 9)



On the wire, BGP is a rather simple protocol composed of four basic messages

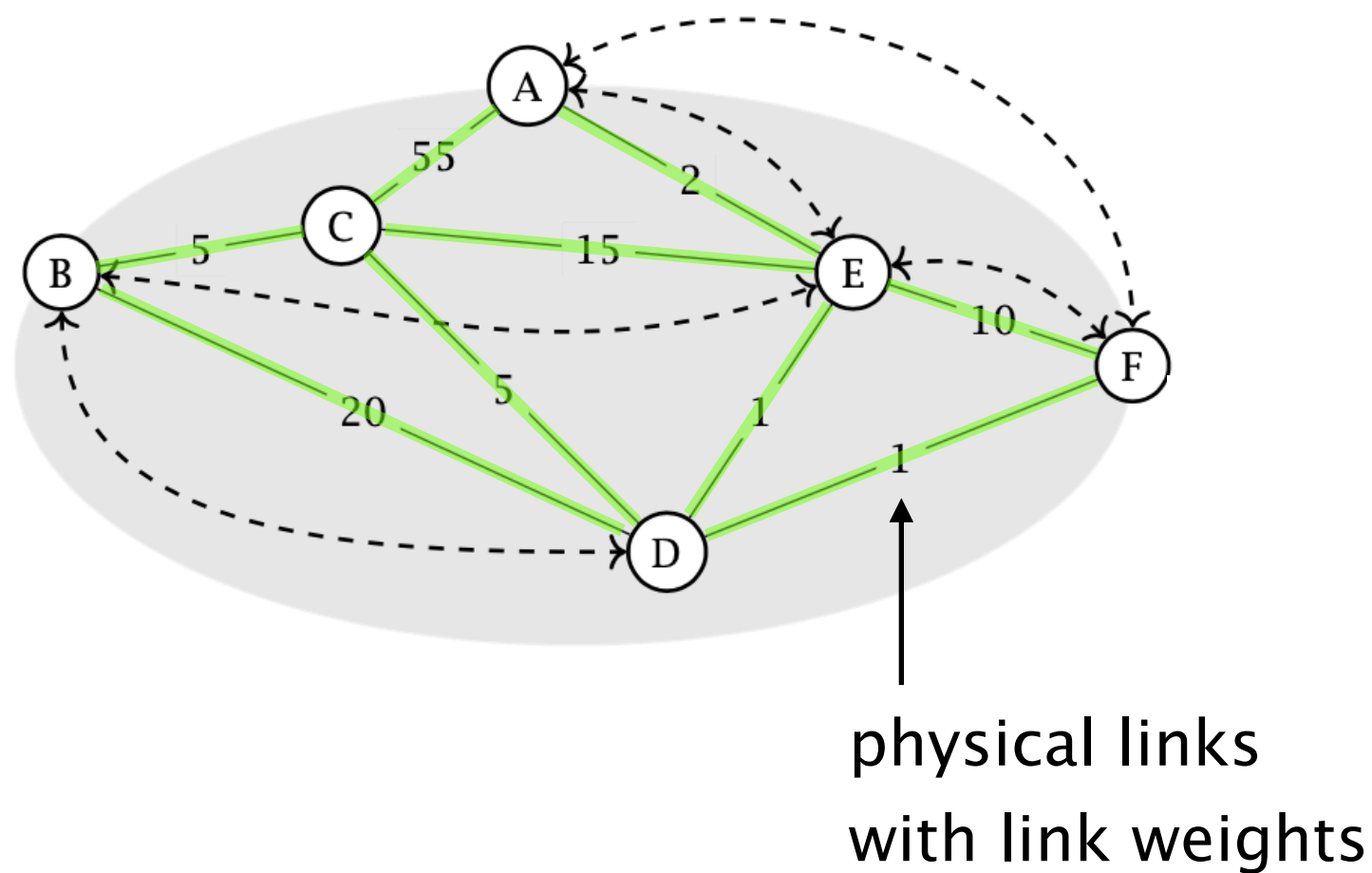
type	used to...
OPEN	establish TCP-based BGP sessions
NOTIFICATION	report unusual conditions
UPDATE	inform neighbor of a new best route a change in the best route the removal of the best route
KEEPALIVE	inform neighbor that the connection is alive

## Task 3: BGP and IGP: Very creative! (Exam 2020)

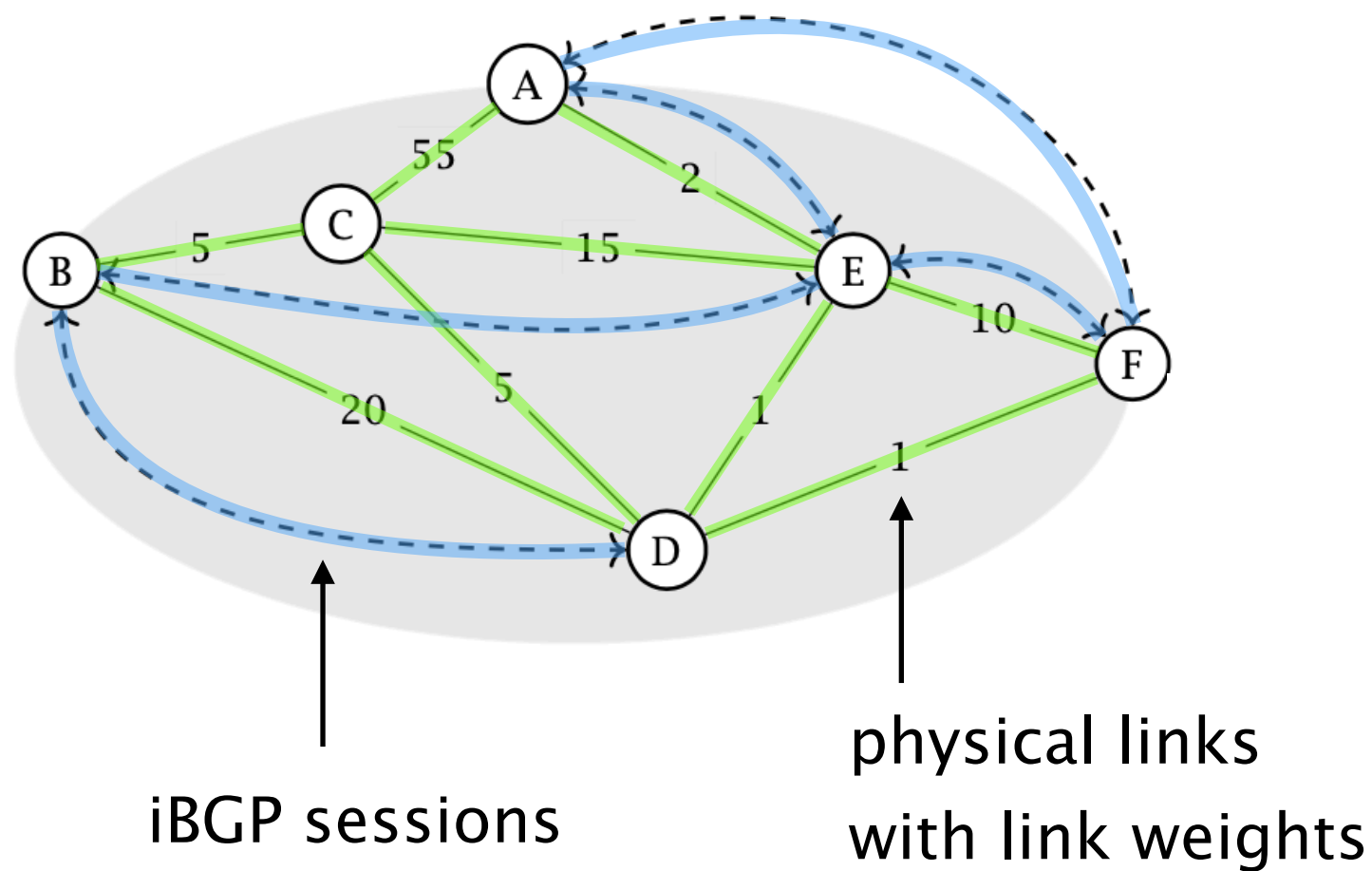




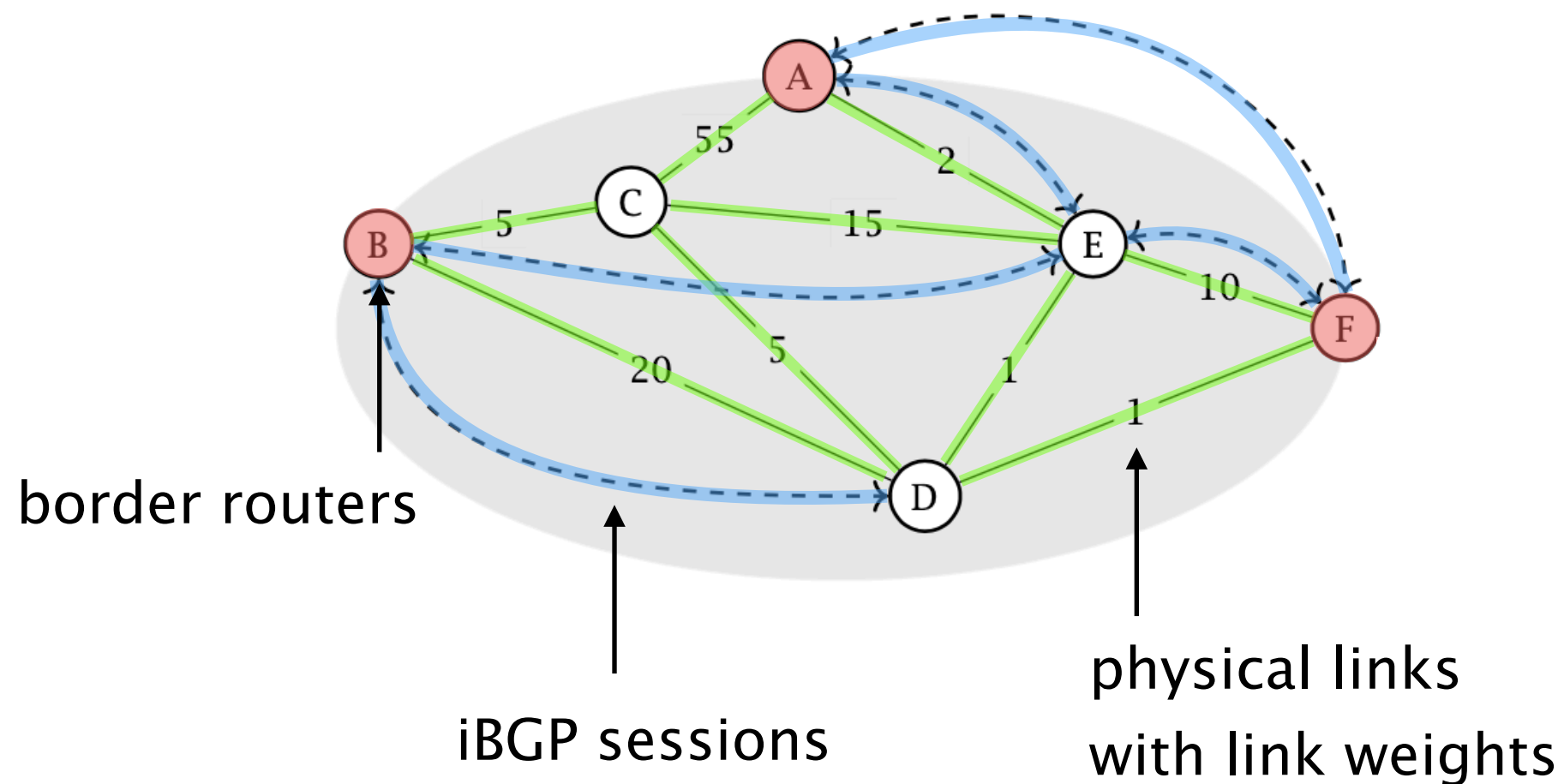
## Task 3: BGP and IGP: Very creative! (Exam 2020)



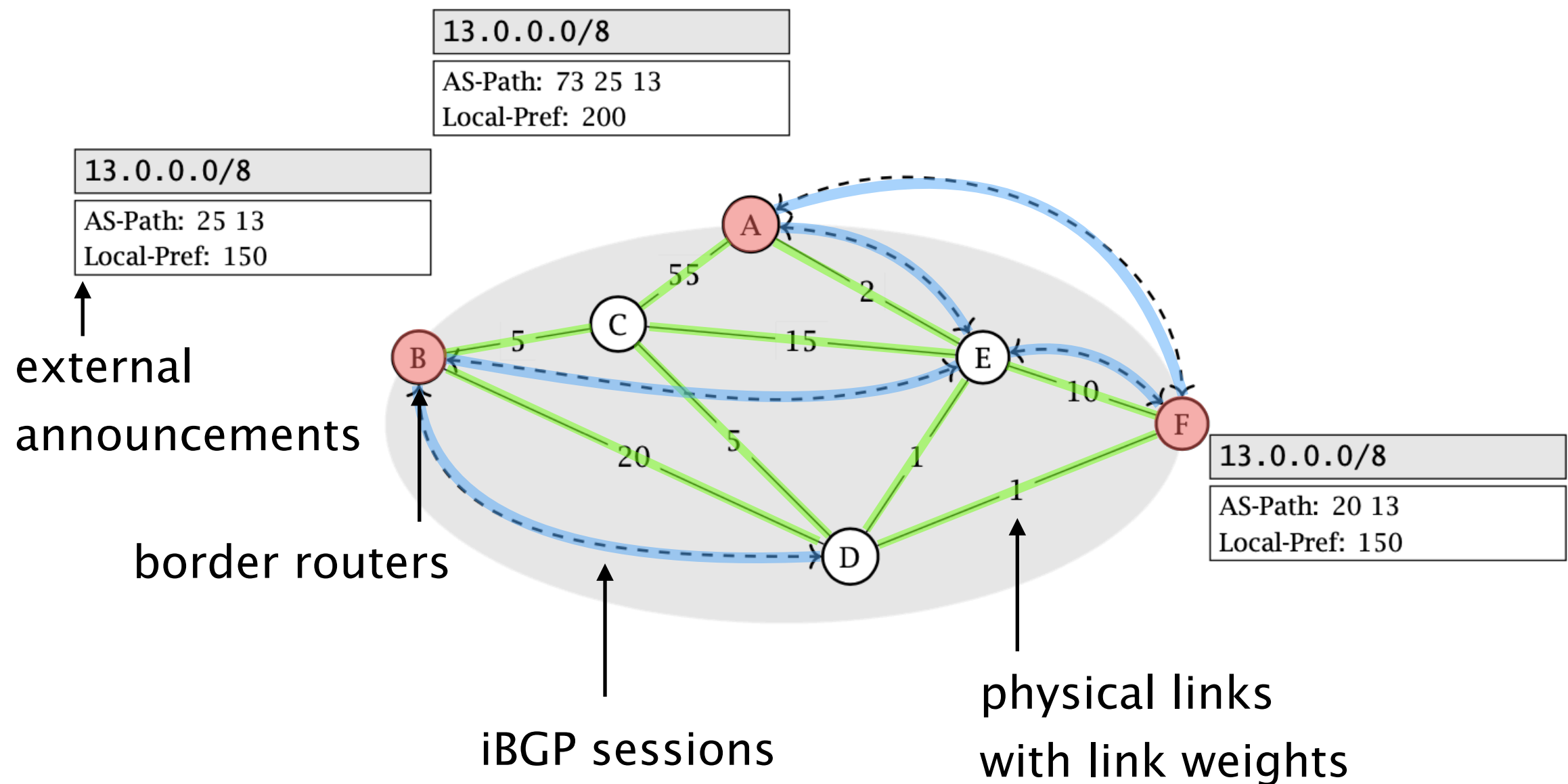
## Task 3: BGP and IGP: Very creative! (Exam 2020)



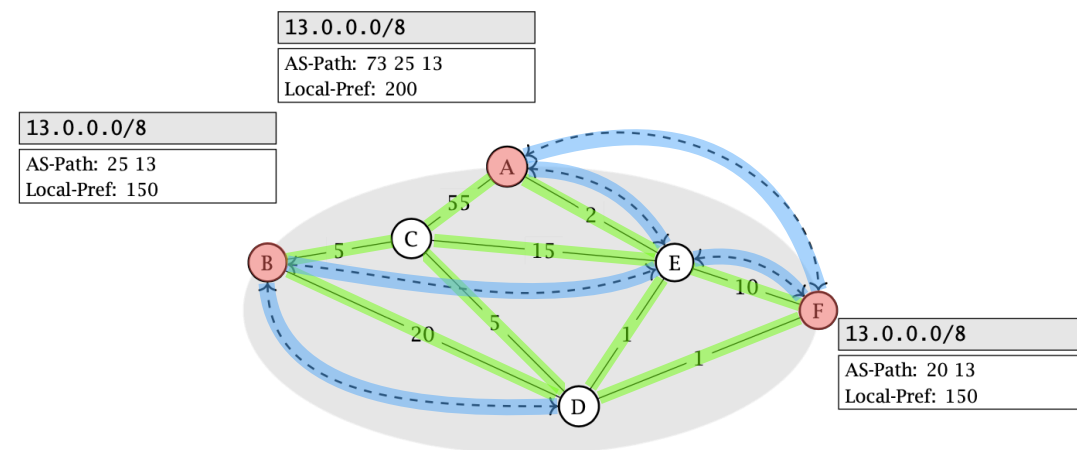
## Task 3: BGP and IGP: Very creative! (Exam 2020)



## Task 3: BGP and IGP: Very creative! (Exam 2020)



# Task 3: BGP and IGP: Very creative! (Exam 2020)



router	BGP next-hop	path taken	reachable
A	?	?	?
B	?	?	?
C	?	?	?
D	?	?	?
E	?	?	?
F	?	?	?

## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

multi-hop BGP sessions

iBGP vs. eBGP route propagation

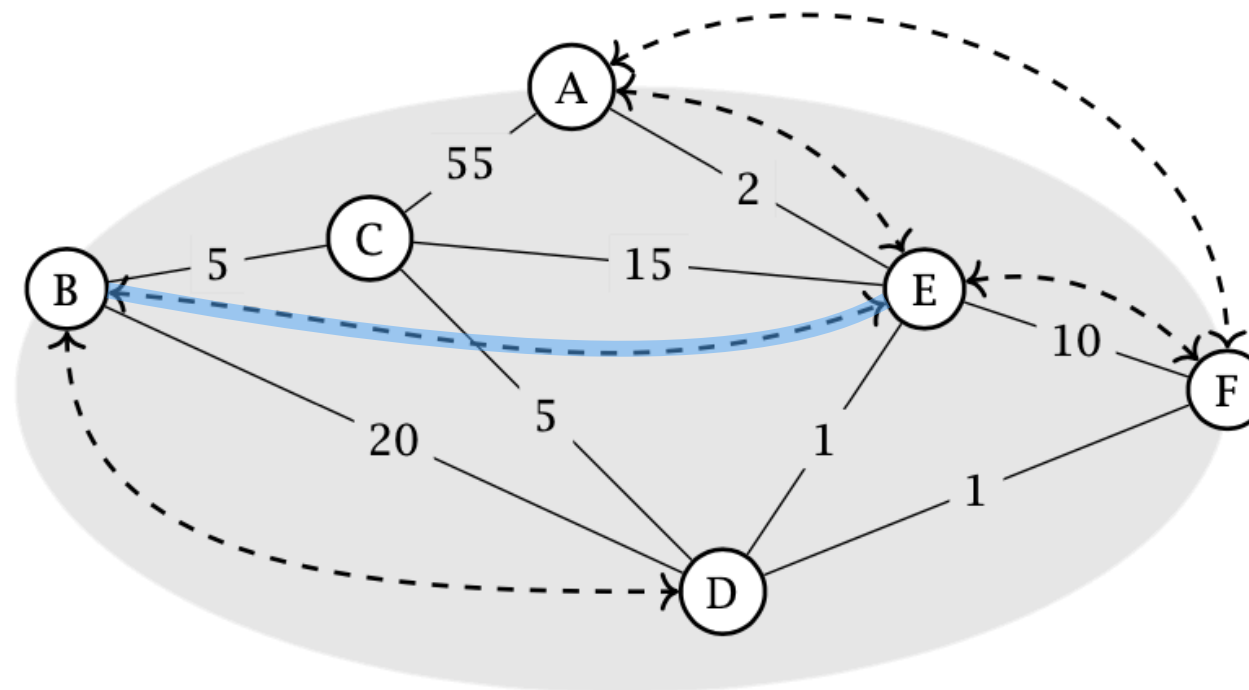
BGP decision process

combination of BGP and IGP

## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

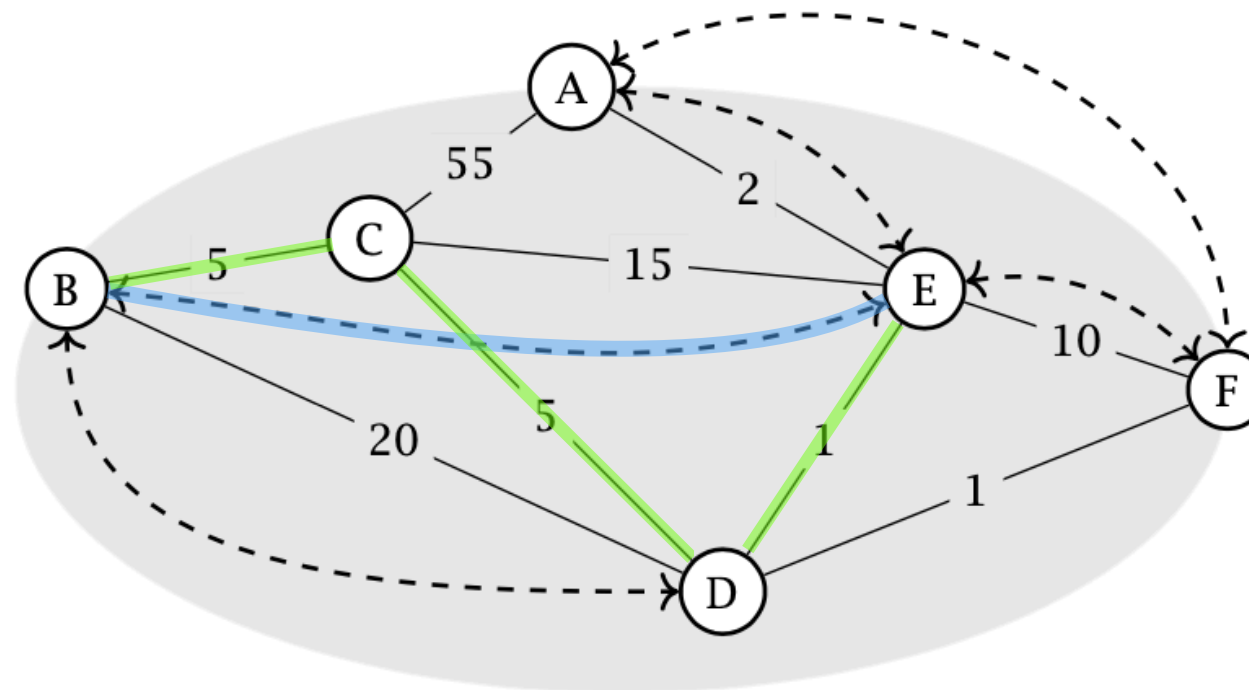
multi-hop BGP sessions



## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

multi-hop BGP sessions





## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

iBGP vs. eBGP route propagation

## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

iBGP vs. eBGP route propagation



## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

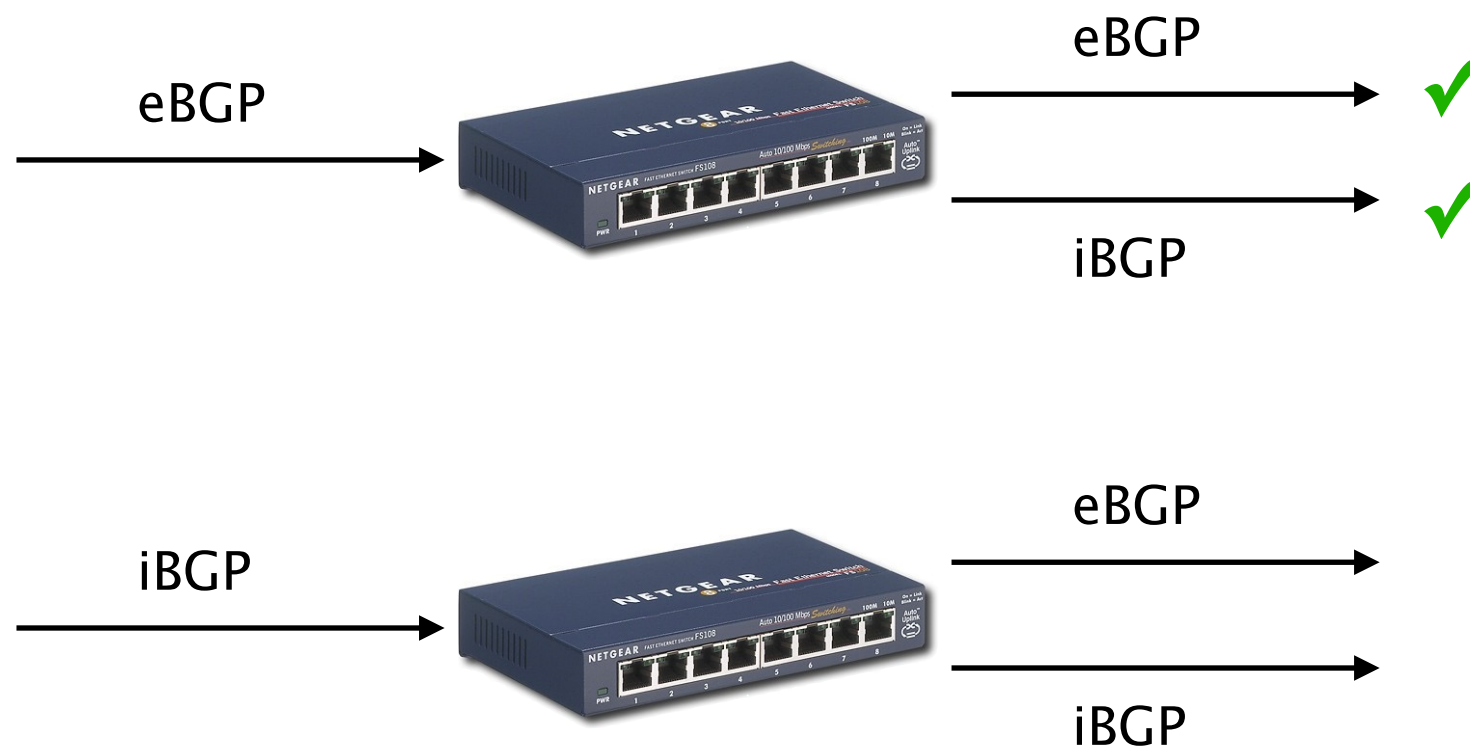
iBGP vs. eBGP route propagation



## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

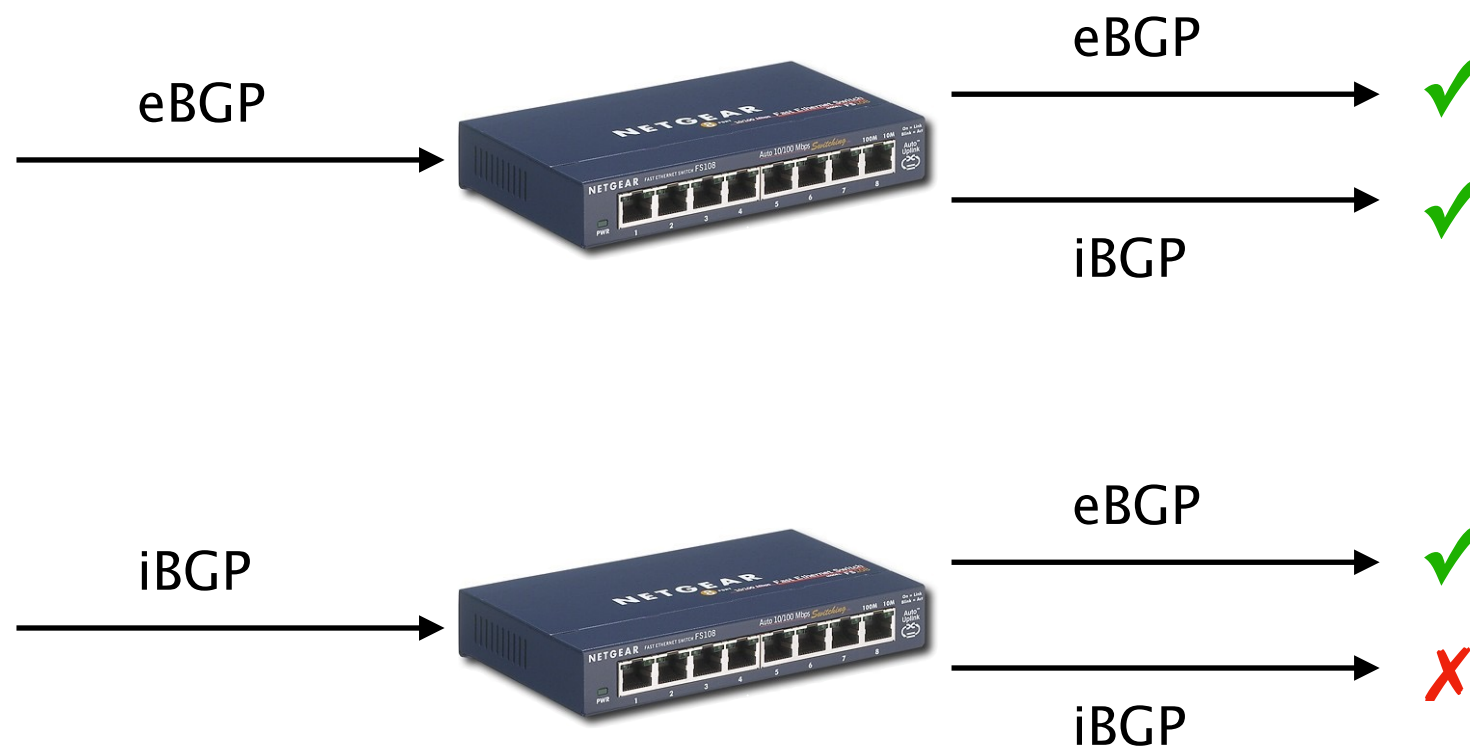
### iBGP vs. eBGP route propagation



## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

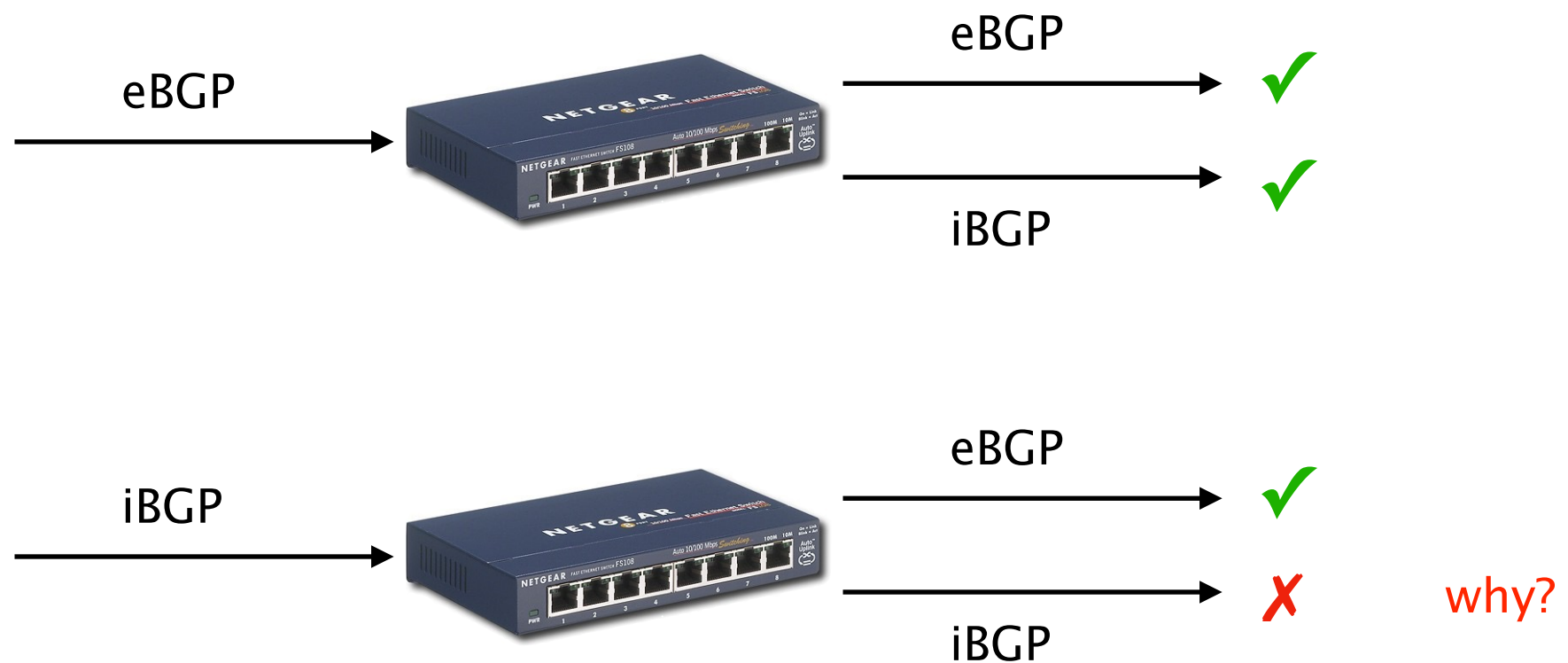
### iBGP vs. eBGP route propagation



## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

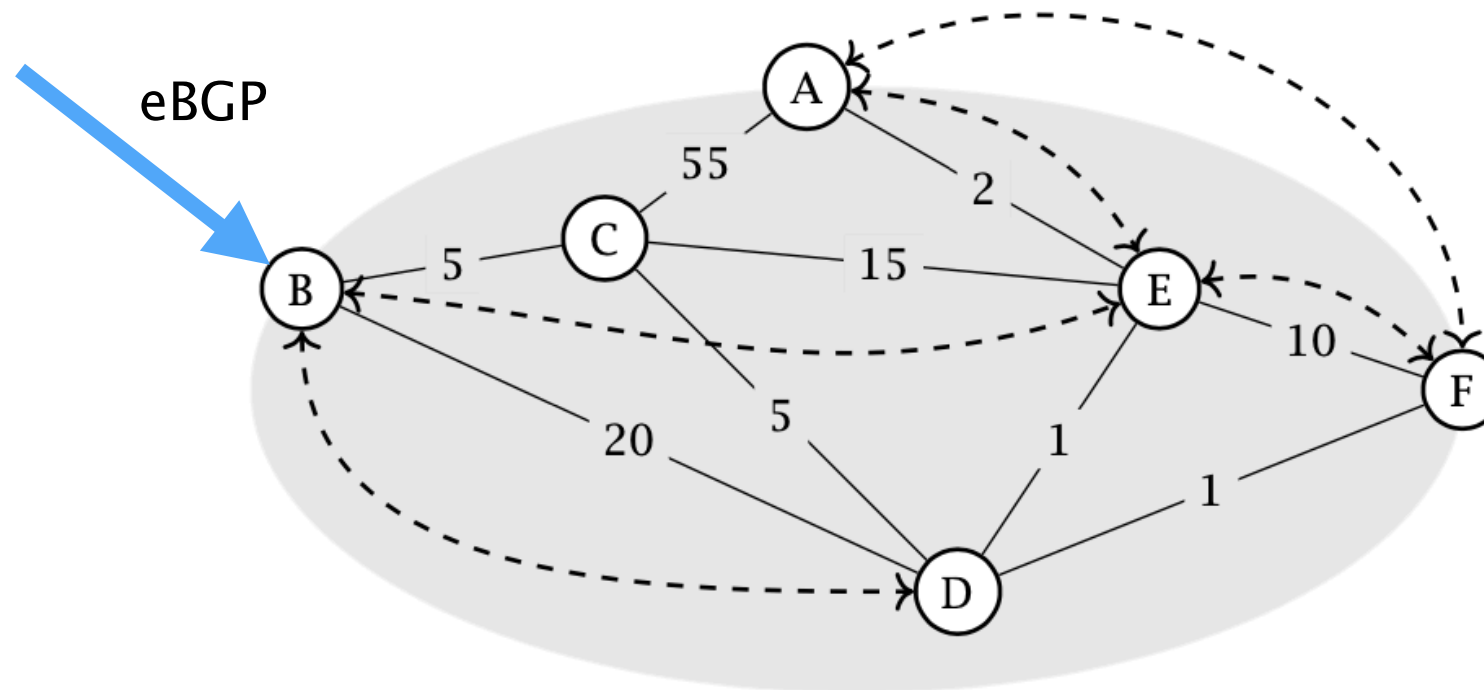
### iBGP vs. eBGP route propagation



## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

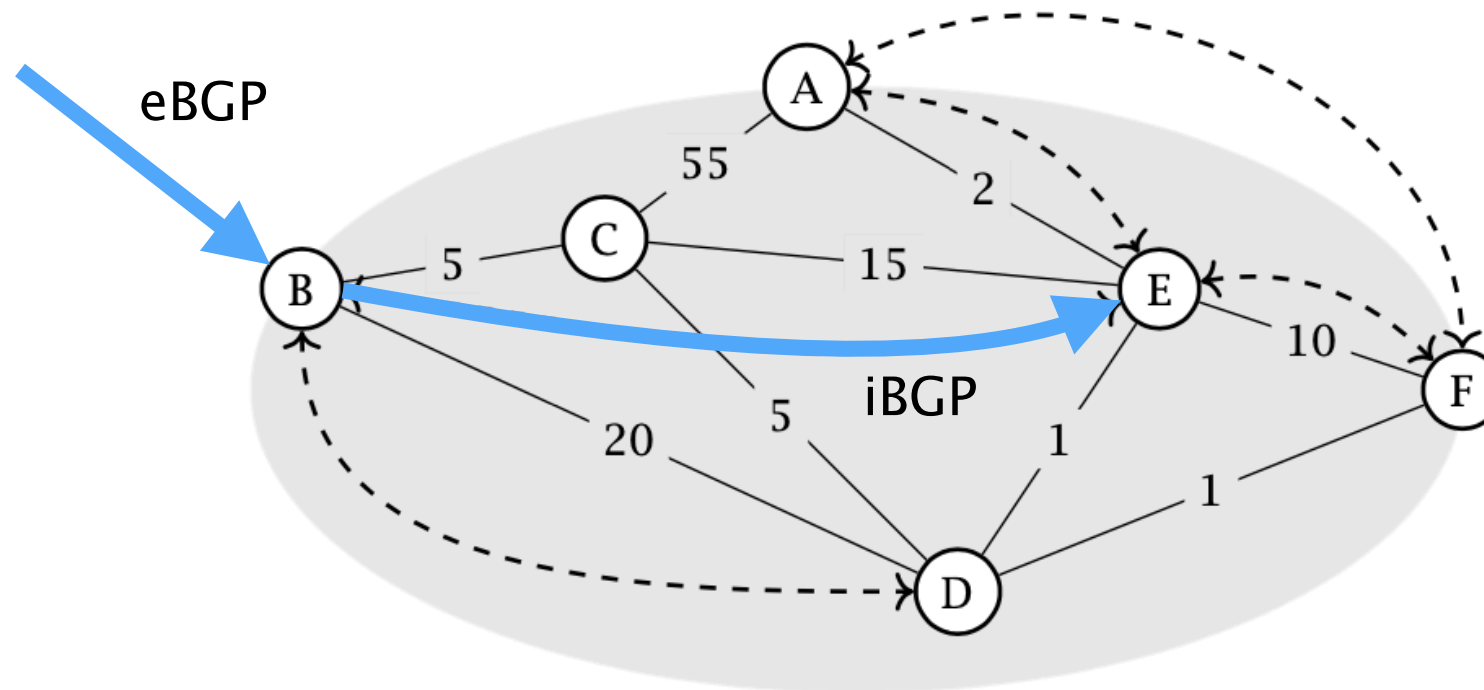
iBGP vs. eBGP route propagation



## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

iBGP vs. eBGP route propagation

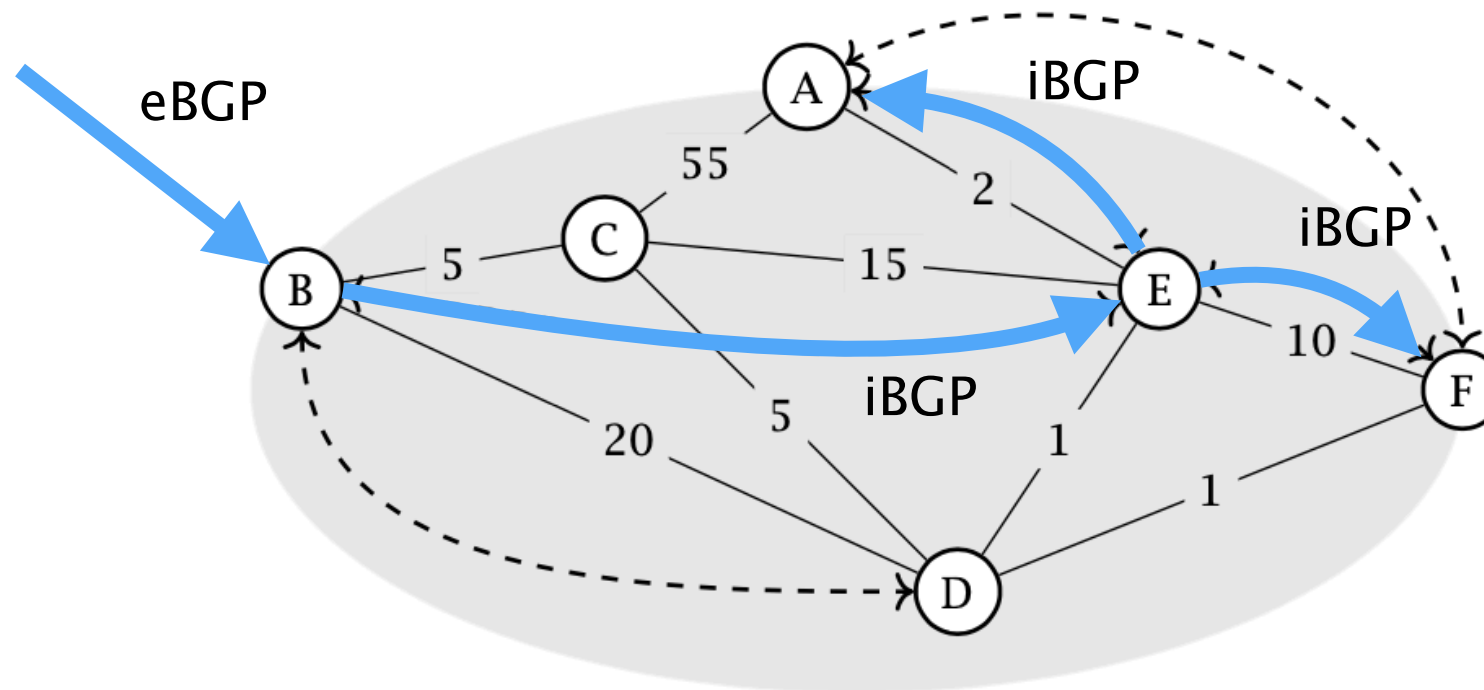




## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

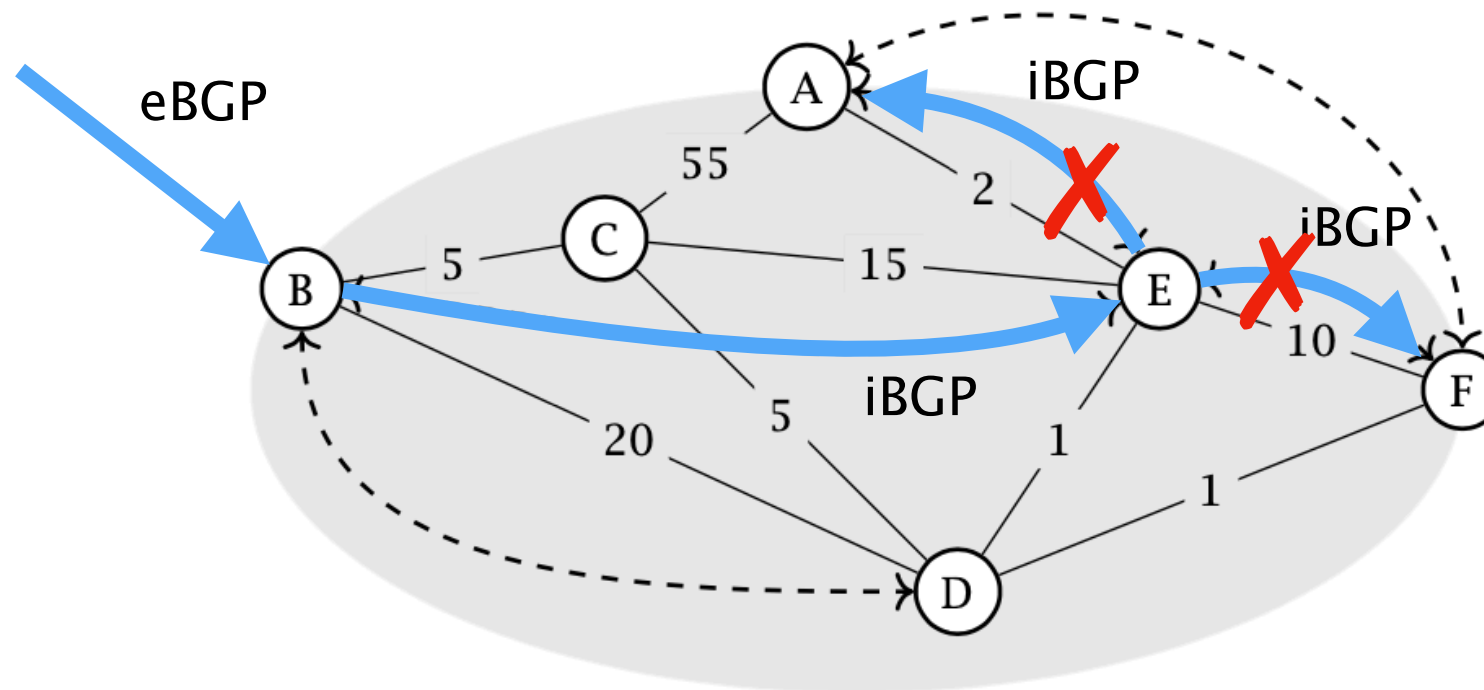
iBGP vs. eBGP route propagation



## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

iBGP vs. eBGP route propagation



## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

BGP decision process

# Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

## BGP decision process

### Slide 87 (week 9)

Prefer routes...

with higher LOCAL-PREF

with shorter AS-PATH length

with lower MED

learned via eBGP instead of iBGP

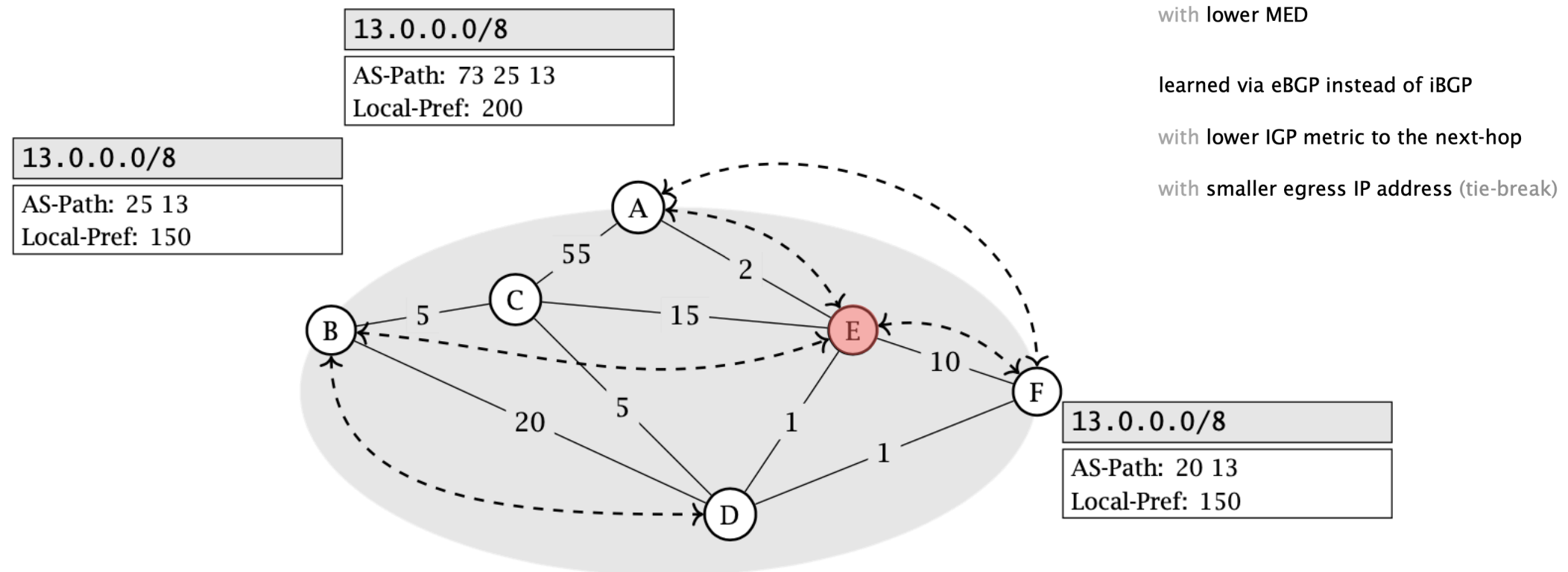
with lower IGP metric to the next-hop

with smaller egress IP address (tie-break)

# Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

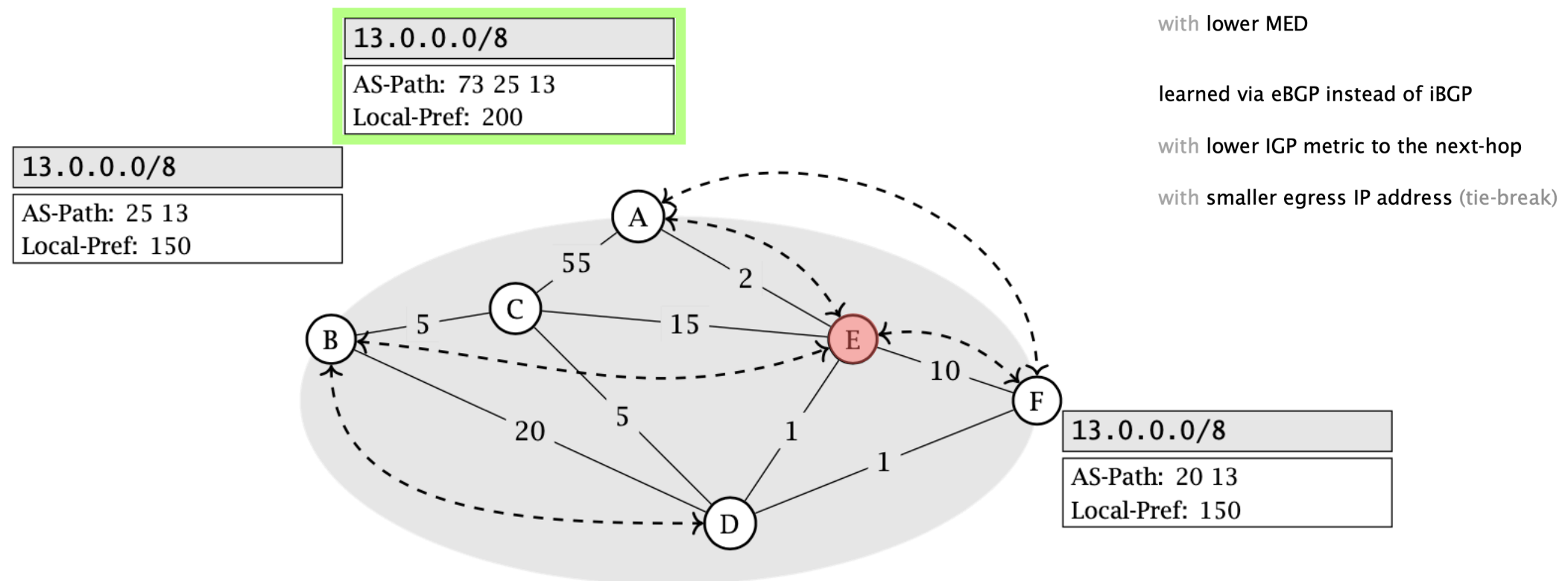
## BGP decision process



# Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

## BGP decision process



# Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

## BGP decision process

Prefer routes...

with higher LOCAL-PREF

with shorter AS-PATH length

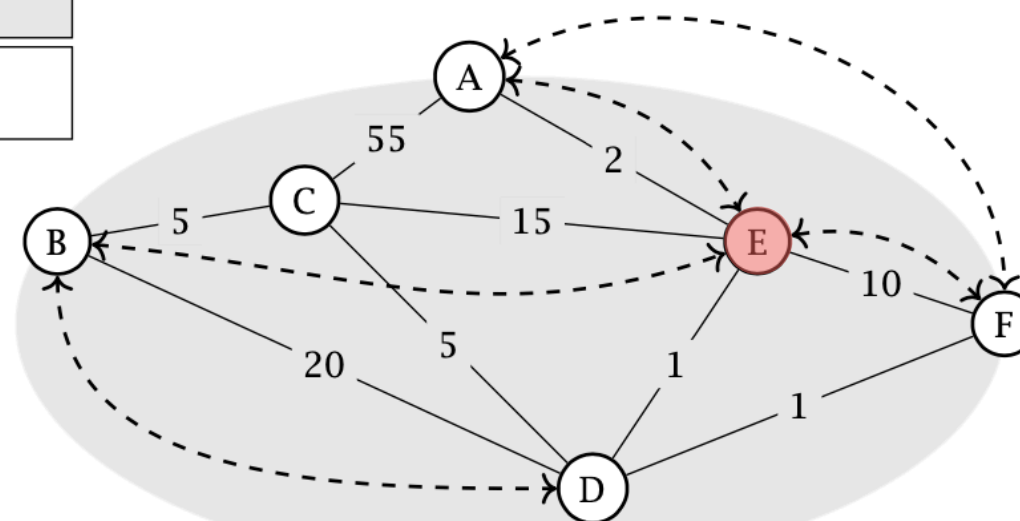
with lower MED

learned via eBGP instead of iBGP

with lower IGP metric to the next-hop

with smaller egress IP address (tie-break)

13.0.0.0/8
AS-Path: 25 13
Local-Pref: 150



13.0.0.0/8
AS-Path: 20 13
Local-Pref: 150

# Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

## BGP decision process

Prefer routes...

with higher LOCAL-PREF

with shorter AS-PATH length

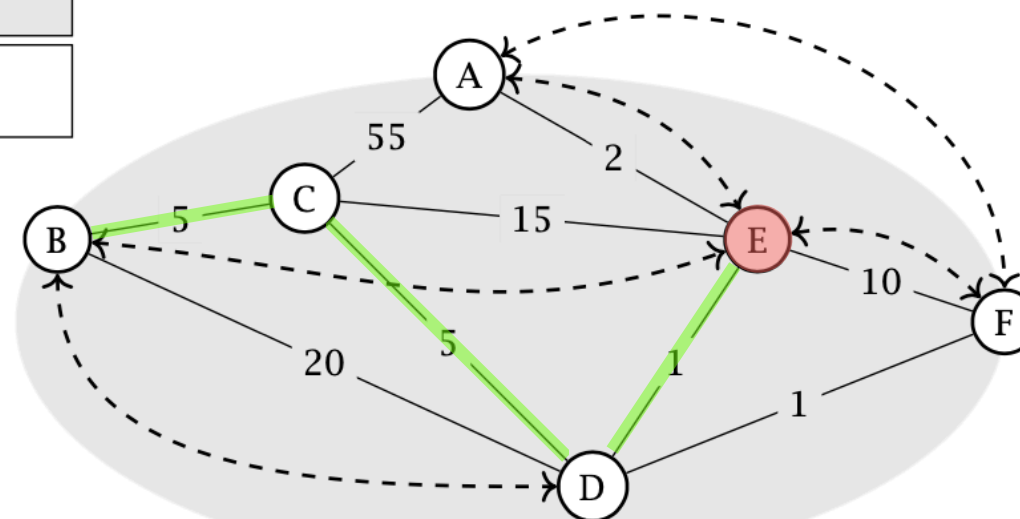
with lower MED

learned via eBGP instead of iBGP

with lower IGP metric to the next-hop

with smaller egress IP address (tie-break)

13.0.0.0/8
AS-Path: 25 13
Local-Pref: 150



13.0.0.0/8
AS-Path: 20 13
Local-Pref: 150



# Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

## BGP decision process

Prefer routes...

with higher LOCAL-PREF

with shorter AS-PATH length

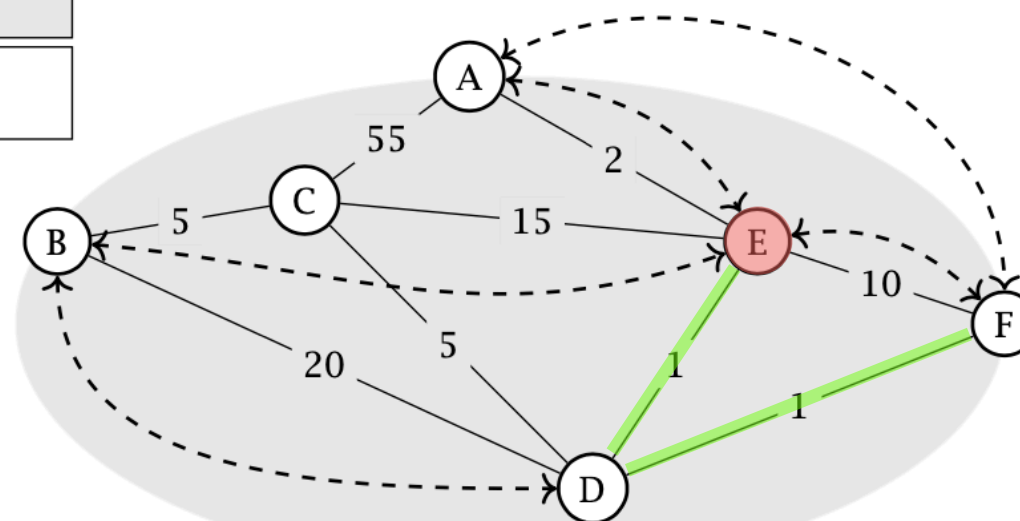
with lower MED

learned via eBGP instead of iBGP

with lower IGP metric to the next-hop

with smaller egress IP address (tie-break)

13.0.0.0/8
AS-Path: 25 13
Local-Pref: 150



13.0.0.0/8
AS-Path: 20 13
Local-Pref: 150

# Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

## BGP decision process

Prefer routes...

with higher LOCAL-PREF

with shorter AS-PATH length

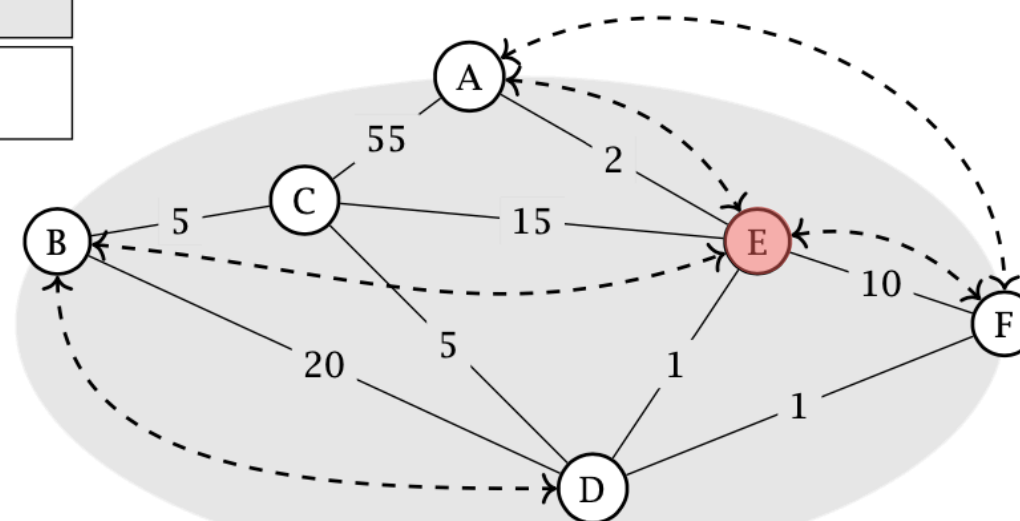
with lower MED

learned via eBGP instead of iBGP

with lower IGP metric to the next-hop

with smaller egress IP address (tie-break)

13.0.0.0/8
AS-Path: 25 13
Local-Pref: 150



13.0.0.0/8
AS-Path: 20 13
Local-Pref: 150

## Task 3: BGP and IGP: Very creative! (Exam 2020)

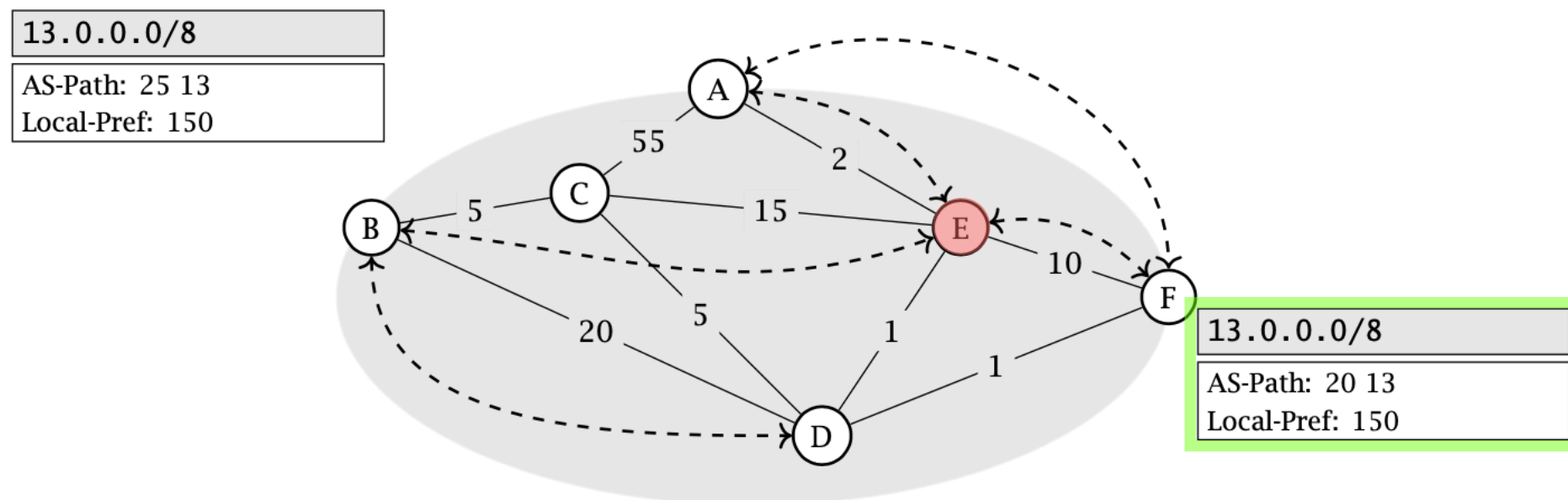
Important concepts:

combination of BGP and IGP

## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

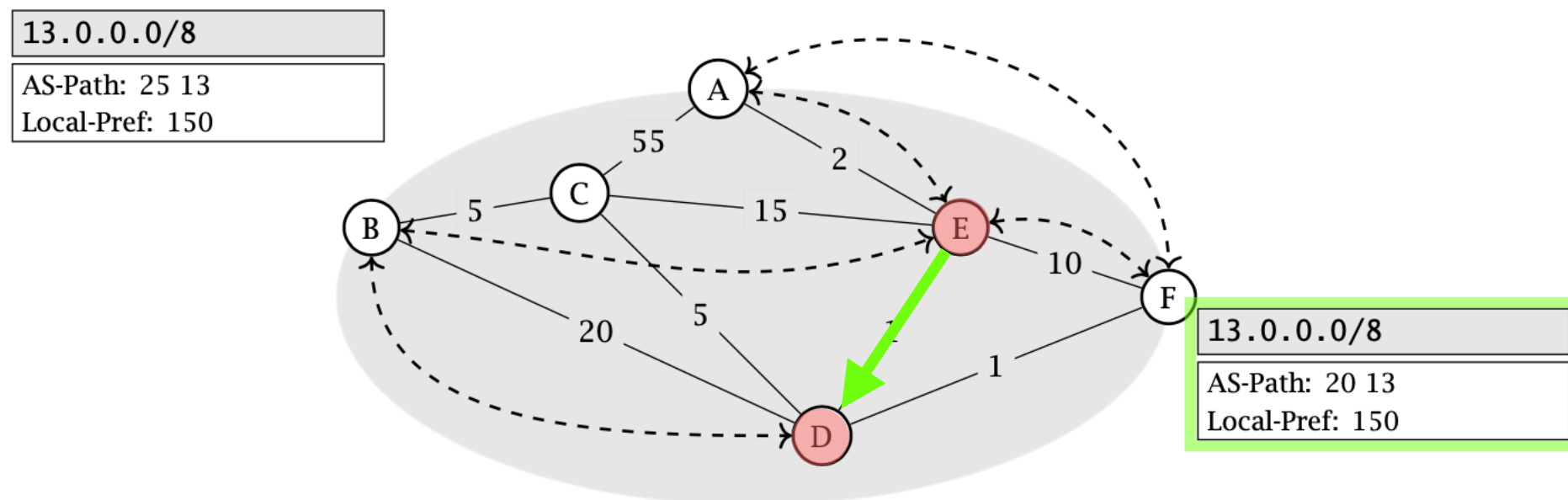
combination of BGP and IGP



## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

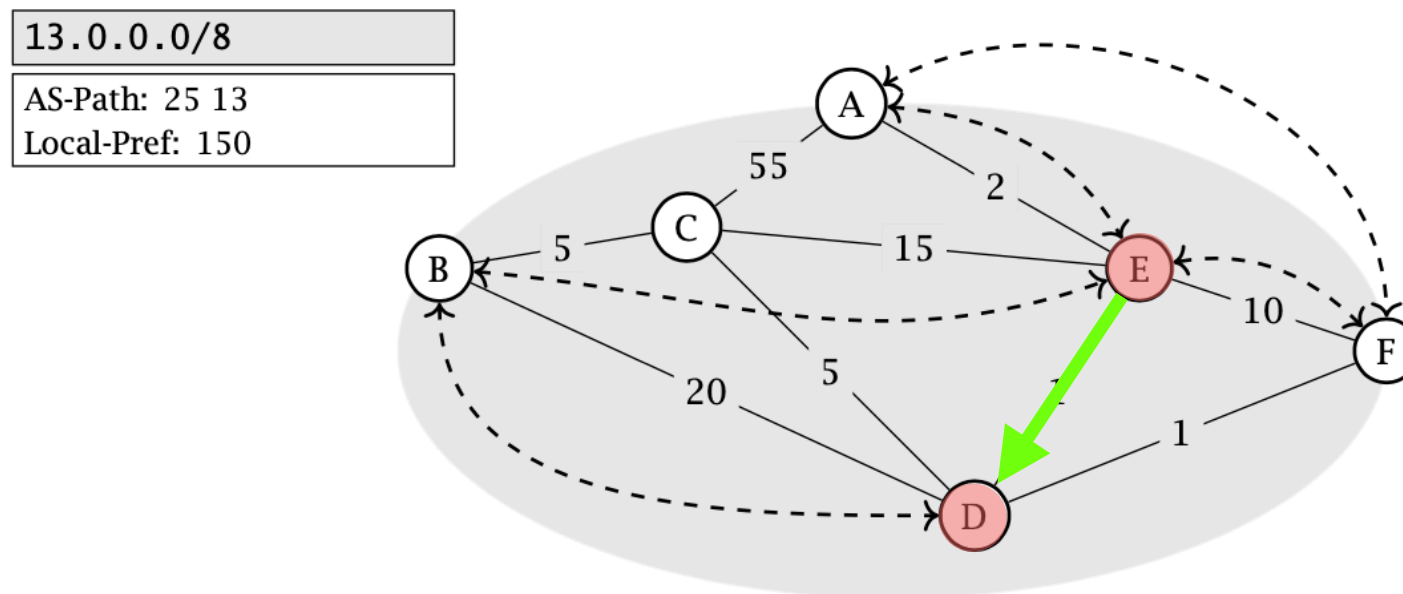
combination of BGP and IGP



## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

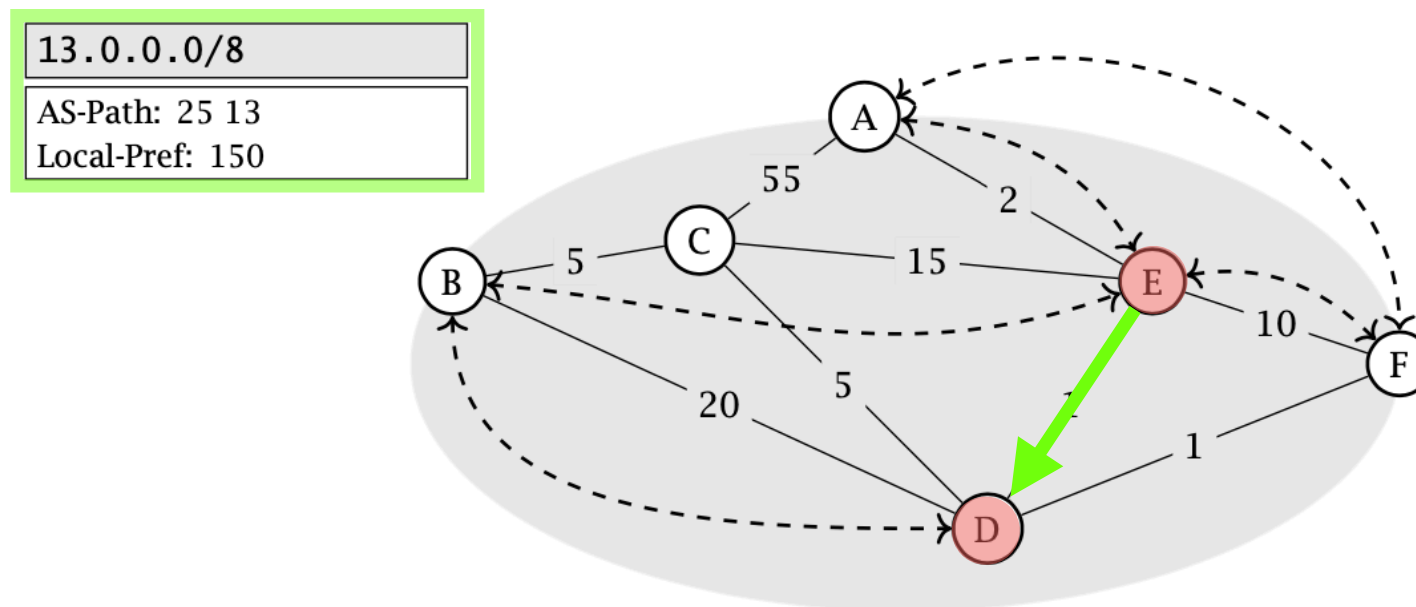
combination of BGP and IGP



## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

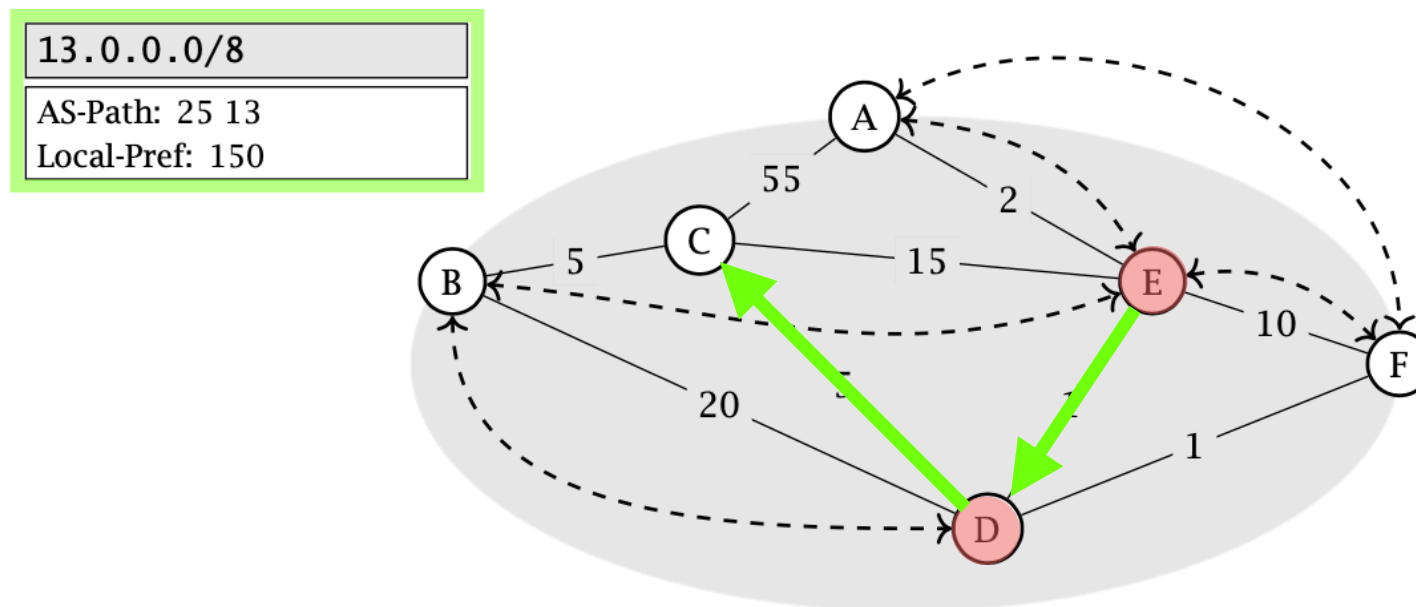
combination of BGP and IGP



## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

combination of BGP and IGP

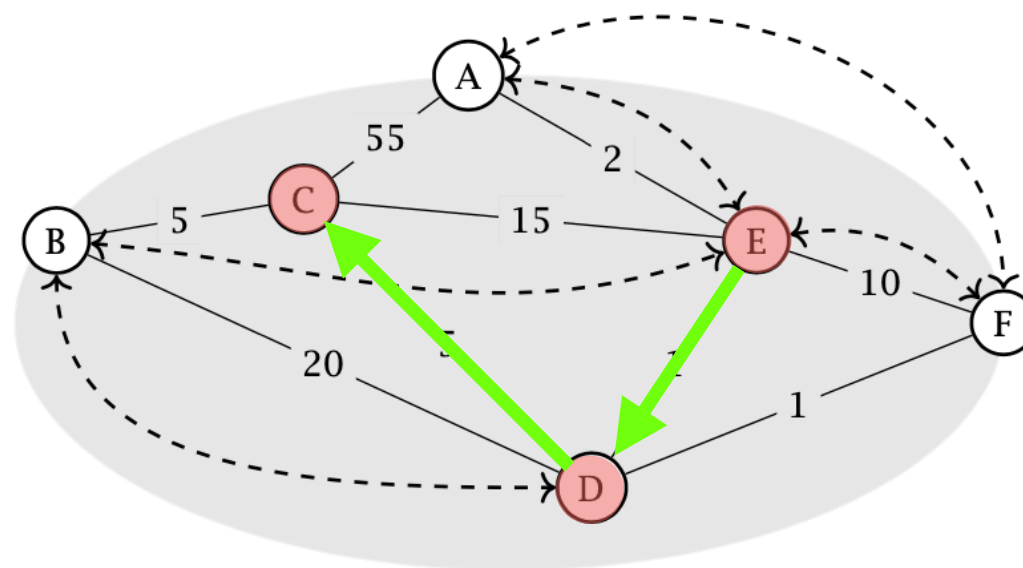




## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

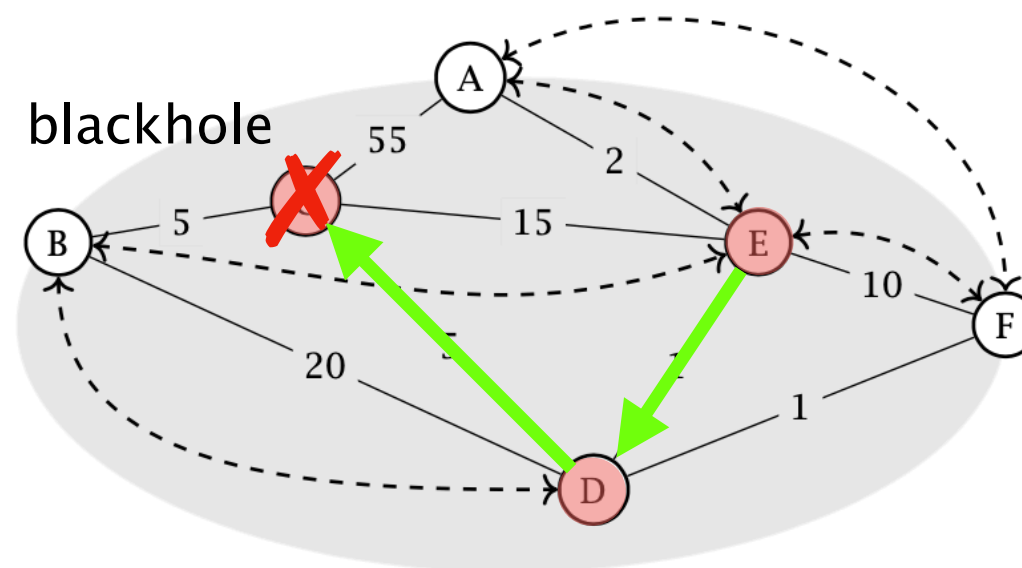
combination of BGP and IGP



## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

combination of BGP and IGP



## Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

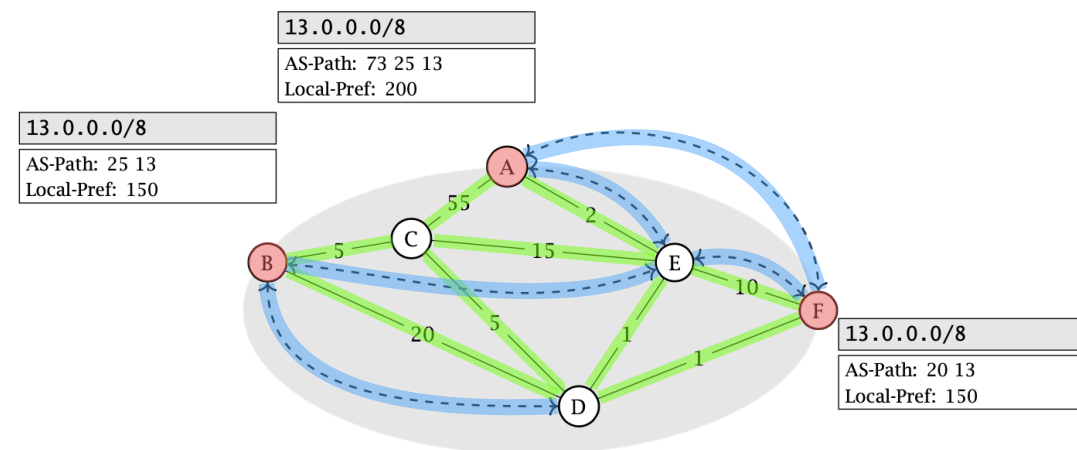
multi-hop BGP sessions

iBGP vs. eBGP route propagation

BGP decision process

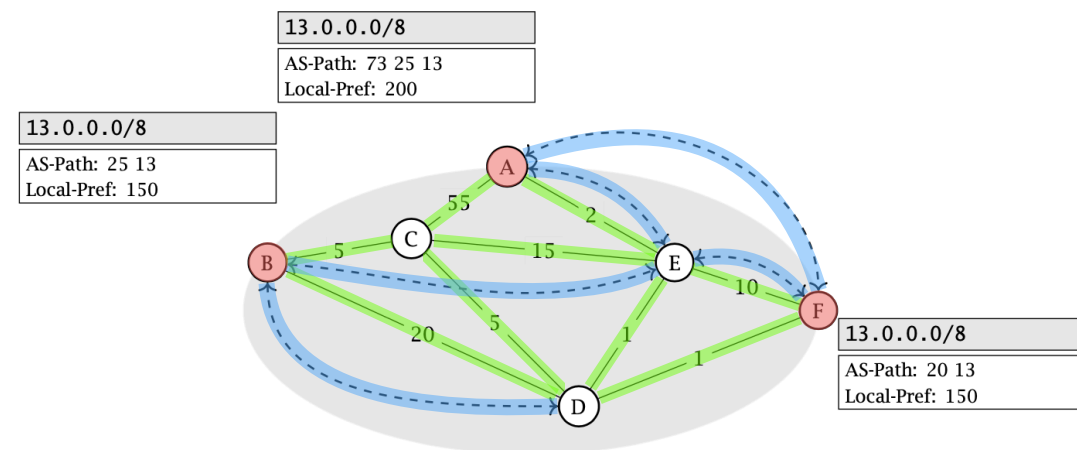
combination of BGP and IGP

# Task 3: BGP and IGP: Very creative! (Exam 2020)



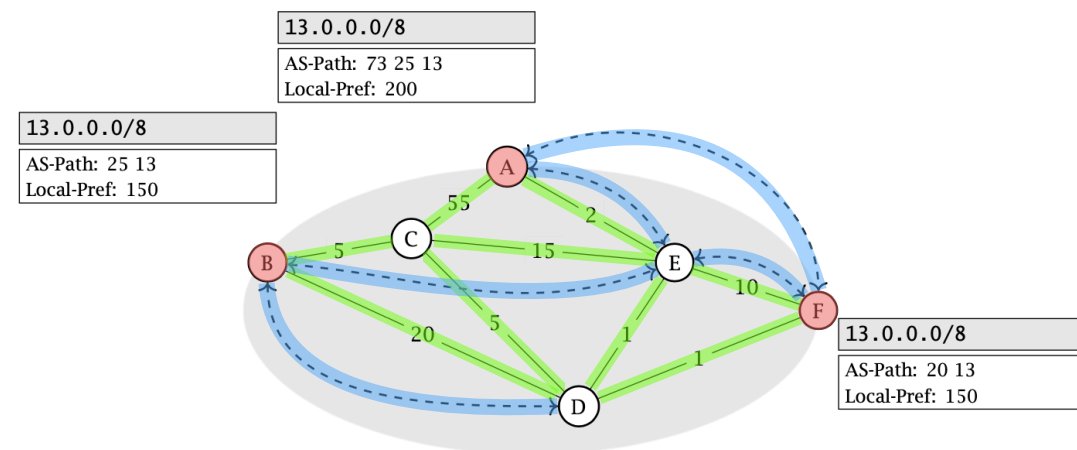
router	BGP next-hop	path taken	reachable
A	?	?	?
B	?	?	?
C	?	?	?
D	?	?	?
E	?	?	?
F	?	?	?

# Task 3: BGP and IGP: Very creative! (Exam 2020)



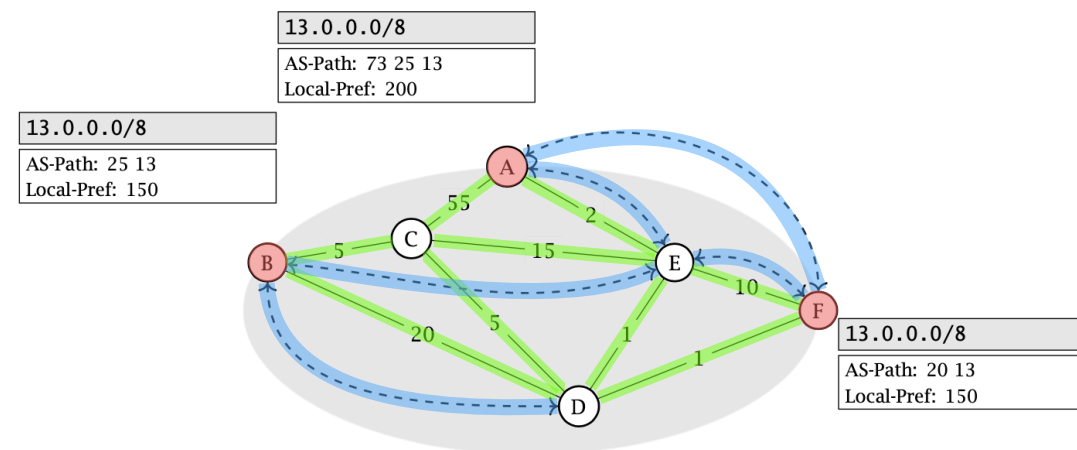
router	BGP next-hop	path taken	reachable
A	EXT	A-EXT	✓
B	?	?	?
C	NO	C-∅	✗
D	?	?	?
E	?	?	?
F	?	?	?

# Task 3: BGP and IGP: Very creative! (Exam 2020)



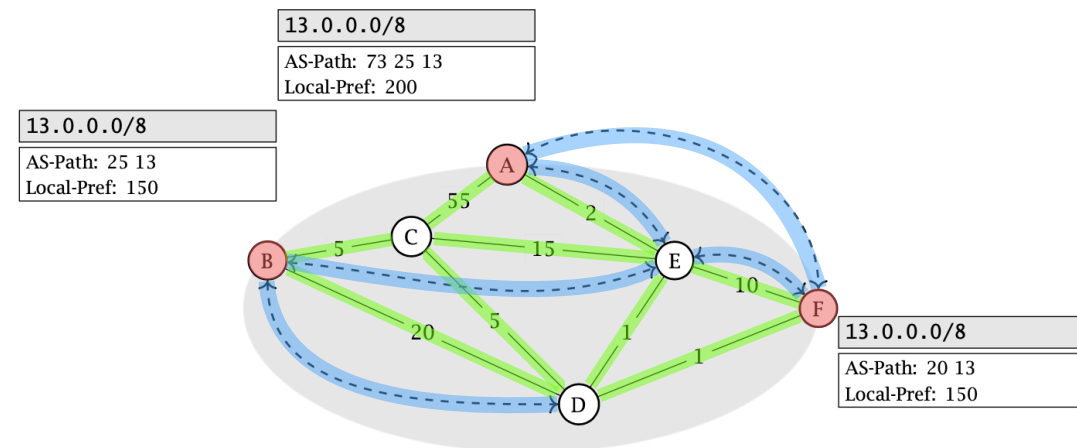
router	BGP next-hop	path taken	reachable
A	EXT	A-EXT	✓
B	EXT	B-EXT	✓
C	NO	C-∅	✗
D	?	?	?
E	?	?	?
F	?	?	?

# Task 3: BGP and IGP: Very creative! (Exam 2020)



router	BGP next-hop	path taken	reachable
A	EXT	A-EXT	✓
B	EXT	B-EXT	✓
C	NO	C-∅	✗
D	B	D-C-∅	✗
E	?	?	?
F	?	?	?

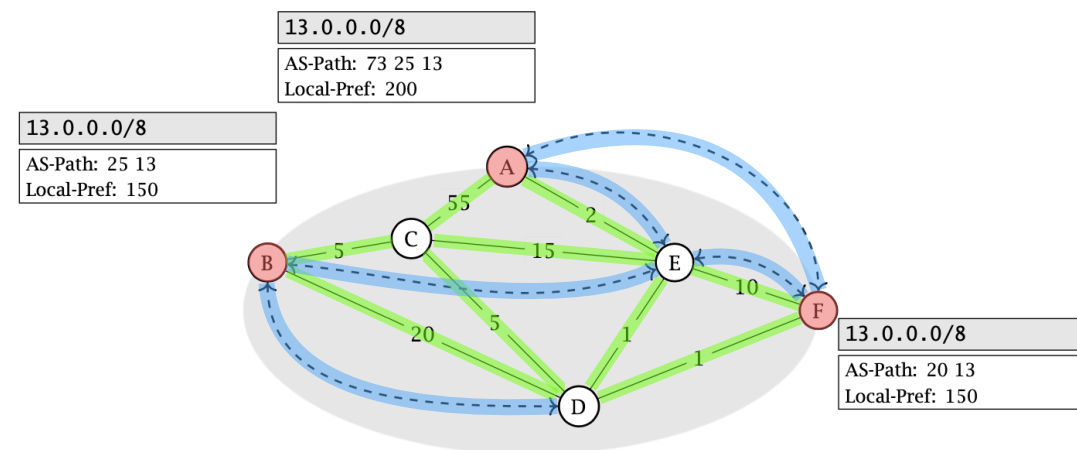
# Task 3: BGP and IGP: Very creative! (Exam 2020)



router	BGP next-hop	path taken	reachable
A	EXT	A-EXT	✓
B	EXT	B-EXT	✓
C	NO	C-∅	✗
D	B	D-C-∅	✗
E	A	E-A-EXT	✓
F	?	?	?



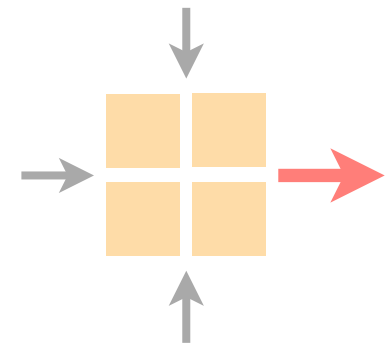
# Task 3: BGP and IGP: Very creative! (Exam 2020)



router	BGP next-hop	path taken	reachable
A	EXT	A-EXT	✓
B	EXT	B-EXT	✓
C	NO	C-∅	✗
D	B	D-C-∅	✗
E	A	E-A-EXT	✓
F	A	F-D-C-∅	✗

# Communication Networks

## Exercise 8



Routing project

Overview current assignment

Solutions will be published next week