Routing project

Overview current assignment

Solutions will be published next week
Routing project timetable

Week 1
- 12.04: Project start
- until 22.04
- Q1.1 - 1.5
  Intra-domain routing

Week 2
- 26.04
- Q2.1 - 2.2
  Inter-domain routing

Week 3
- Remaining
- Q3.1 - 3.4
  Routing policies
- 03.05
  Q3.5 active

Week 4
- 07.05
  Project end
- 29.04
  Today
Route-maps allow you to enforce policies

Routes coming from peers and providers are only propagated to customers

<table>
<thead>
<tr>
<th>send to</th>
<th>customer</th>
<th>peer</th>
<th>provider</th>
</tr>
</thead>
<tbody>
<tr>
<td>customer</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>from</td>
<td>peer</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>provider</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
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

```bash
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 MY_ROUTE_MAP permit 10
match community 1
match ...
set local-preference 1000
set ...

select announcements
modify announcements
Anatomy of a route-map

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

select announcements
modify announcements
Anatomy of a route-map

route-map name

action

seq. number

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

select announcements
modify announcements
Anatomy of a route-map

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

route-map MY_ROUTE_MAP permit 20
  match as-path 55
  set community 99:100
Anatomy of a route-map

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

route-map MY_ROUTE_MAP permit 20
match as-path 55
match ...
set community 99:100
set ...

route-map MY_ROUTE_MAP deny 30
match ...

select announcements
modify announcements
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

```plaintext
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)
Routing project

Overview current assignment

Solutions will be published next week
Task 1: Traffic Engineering

82.130.64.0/21
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

<table>
<thead>
<tr>
<th>Type</th>
<th>Used to...</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPEN</td>
<td>Establish TCP-based BGP sessions</td>
</tr>
<tr>
<td>NOTIFICATION</td>
<td>Report unusual conditions</td>
</tr>
<tr>
<td>UPDATE</td>
<td>Inform neighbor of a new best route</td>
</tr>
<tr>
<td></td>
<td>- A change in the best route</td>
</tr>
<tr>
<td></td>
<td>- The removal of the best route</td>
</tr>
<tr>
<td>KEEPALIVE</td>
<td>Inform neighbor that the connection is alive</td>
</tr>
</tbody>
</table>
Task 3: BGP and IGP: Very creative! (Exam 2020)
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physical links with link weights
Task 3: BGP and IGP: Very creative! (Exam 2020)
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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

- eBGP to eBGP: ✔️
- iBGP to iBGP: ✔️
- iBGP to eBGP: ✔️
- eBGP to iBGP: ✗
Task 3: BGP and IGP: Very creative! (Exam 2020)

Important concepts:

iBGP vs. eBGP route propagation

- eBGP

- iBGP

- eBGP

- iBGP

- eBGP

- iBGP

- eBGP

- iBGP

✓

✓

✓

✗

why?
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)

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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

Prefer routes...
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Important concepts:

BGP decision process

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<tr>
<th>Prefix</th>
<th>AS-Path</th>
<th>Local-Pref</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.0.0.0/8</td>
<td>73 25 13</td>
<td>200</td>
</tr>
</tbody>
</table>

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<tr>
<td>13.0.0.0/8</td>
<td>25 13</td>
<td>150</td>
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Prefer routes...
- with higher LOCAL-PREF
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BGP decision process

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Important concepts:

BGP decision process

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- Prefer routes with shorter AS-PATH length
- Prefer routes with lower MED
- Prefer routes learned via eBGP instead of iBGP
- Prefer routes with lower IGP metric to the next-hop
- Prefer routes with smaller egress IP address (tie-break)
Task 3: **BGP and IGP: Very creative! (Exam 2020)**

**Important concepts:**

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  - with smaller egress IP address (tie-break)
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)*

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Important concepts:

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

**Important concepts:**

**combination of BGP and IGP**

```
13.0.0.0/8
AS-Path: 25 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

blackhole
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
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</tr>
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<td>C</td>
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