Communication Networks

Spring 2019

Rüdiger Birkner, Tobias Bühler

nsg.ee.ethz.ch

ETH Zürich (D-ITET)

May 27 2019

Last week on

Communication Networks

Networking is on the verge of a paradigm shift towards *deep* programmability

Why? It's really a story in 3 stages

Stage 1

The network management crisis

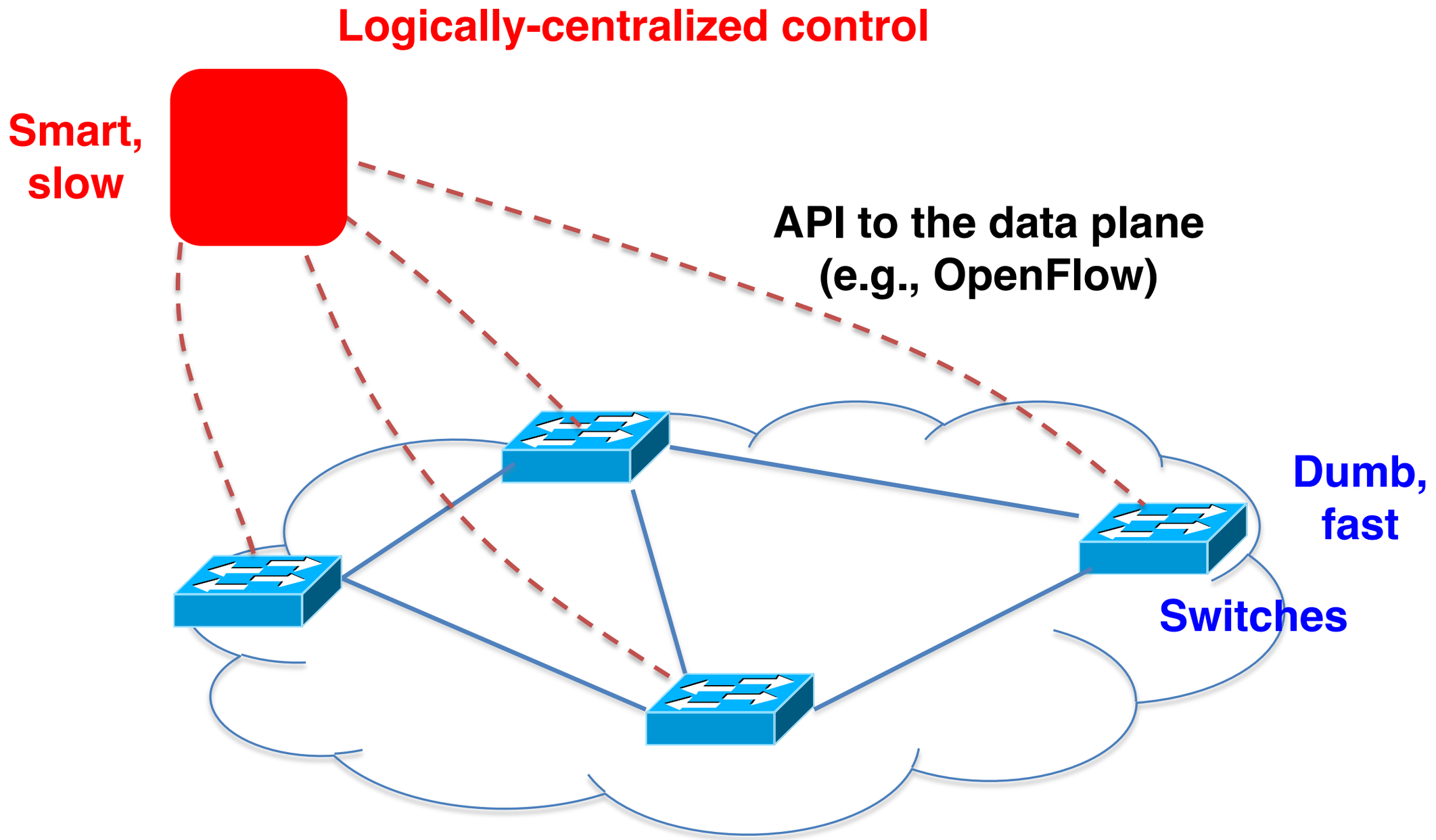
“Human factors are responsible for 50% to 80% of network outages”

Juniper Networks, *What’s Behind Network Downtime?*, 2008

Stage 2

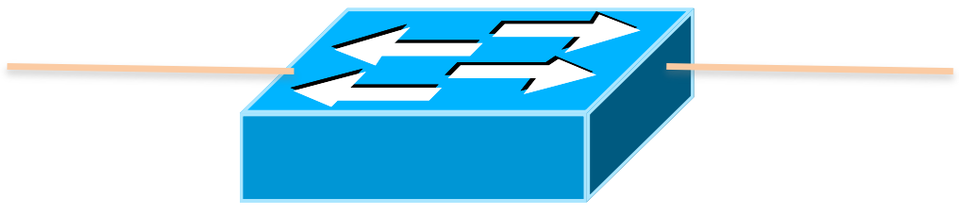
Software-Defined Networking

Software Defined Networking (SDN)



OpenFlow is an API to a switch flow table

- Simple packet-handling rules
  - Pattern: match packet header bits, i.e. flowspace
  - Actions: drop, forward, modify, send to controller
  - Priority: disambiguate overlapping patterns
  - Counters: #bytes and #packets



10. src=1.2.*.*, dest=3.4.5.* → drop
05. src = *.*.*.*, dest=3.4.*.* → forward(2)
01. src=10.1.2.3, dest=*.*.*.* → send to controller

Stage 3

Deep Network Programability

OpenFlow is not all roses

The protocol is too complex (12 fields in OF 1.0 to 41 in 1.5)

switches must support complicated parsers and pipelines

The specification itself keeps getting more complex

extra features make the software agent more complicated

consequences

Switches vendor end up implementing parts of the spec.

which breaks the abstraction of one API to *rule-them-all*

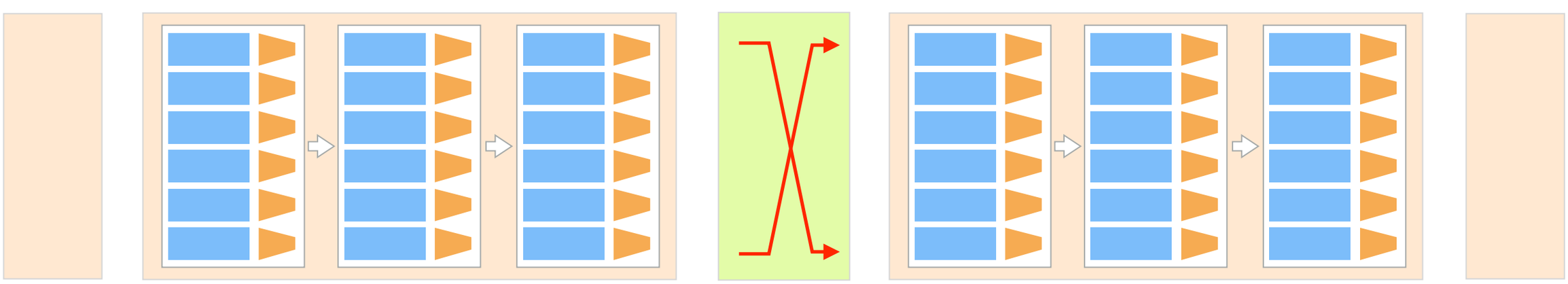
P4 is a high-level language for programming protocol-independent packet processors

Ingress

Match-Action Pipeline

Egress

Match-Action Pipeline



Parser

Switching logic

crossbar, shared buffers, …

Deparser

This week on

Communication Networks

BGP exam question

One of the main lecture topics

What is next?

Important information

Work on the project

Deadline this Friday

BGP exam question

What is next?

Work on the project

One of the main lecture topics

Let's take a look at the exam

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

TIK Institut für Technische Informatik und Kommunikationsnetze

Department ITET — Prof. Dr. Laurent Vanbever
August 2018 — Tobias Bühler, Rüdiger Birkner, Thomas Holterbach, Roland Meier

Exam: Communication Networks

22 August 2018, 14:00–16:30, Room HIL G 61

General Remarks:

- Write your **name** and your **ETH student number** below on this front page and **sign it**.
- Put your **legitimation card** on your desk.
- Check if you have received **all task sheets** (Pages **1 - 29**).
- Do **not separate** the **task sheets**.

- Write your answers directly on the task sheets.
- **All answers fit within the allocated space and often in much less.**
- If you need more space, please use your own extra sheets, in which case use a **new sheet of paper** for **each task** and write your name and the exam task number in the **upper right corner**.

- **Read each task completely before you start solving it.**

Let’s take a look at the exam

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Exam: Communication Networks

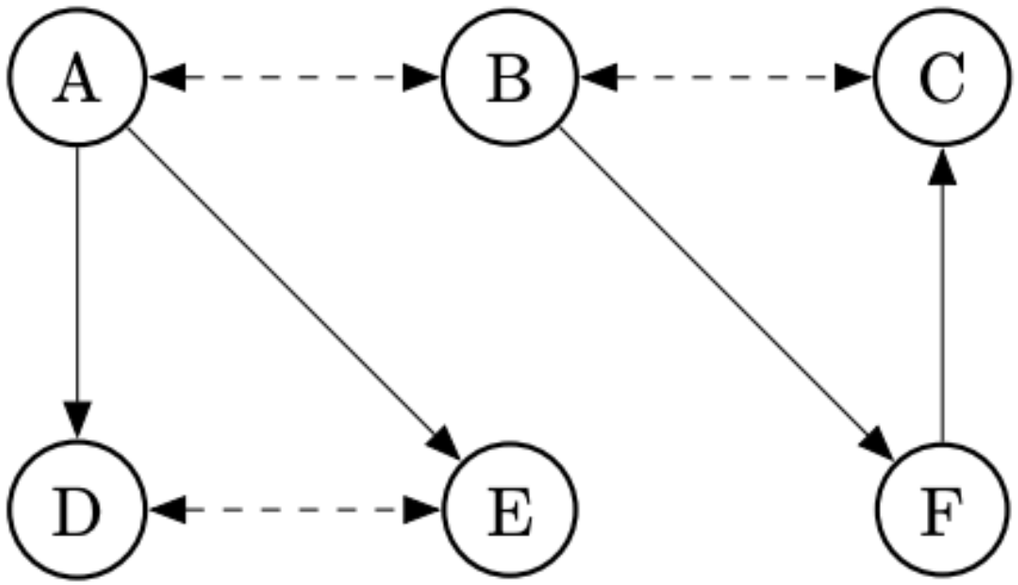
Multiple sections

Ethernet & Switching, Inter/Intra-domain Routing, …

Two parts per section

True/False to warm up, then exercise-style questions

Inter-domain routing: Warm-up



true ☐ false ☐ AS D has two routes available to B: $A\ B$ and $E\ A\ B$.

true ☐ false ☐ AS B prefers the route $F\ C$ to AS C over the shorter direct one C.

true ☐ false ☐ Every AS has at least one route to every other AS.

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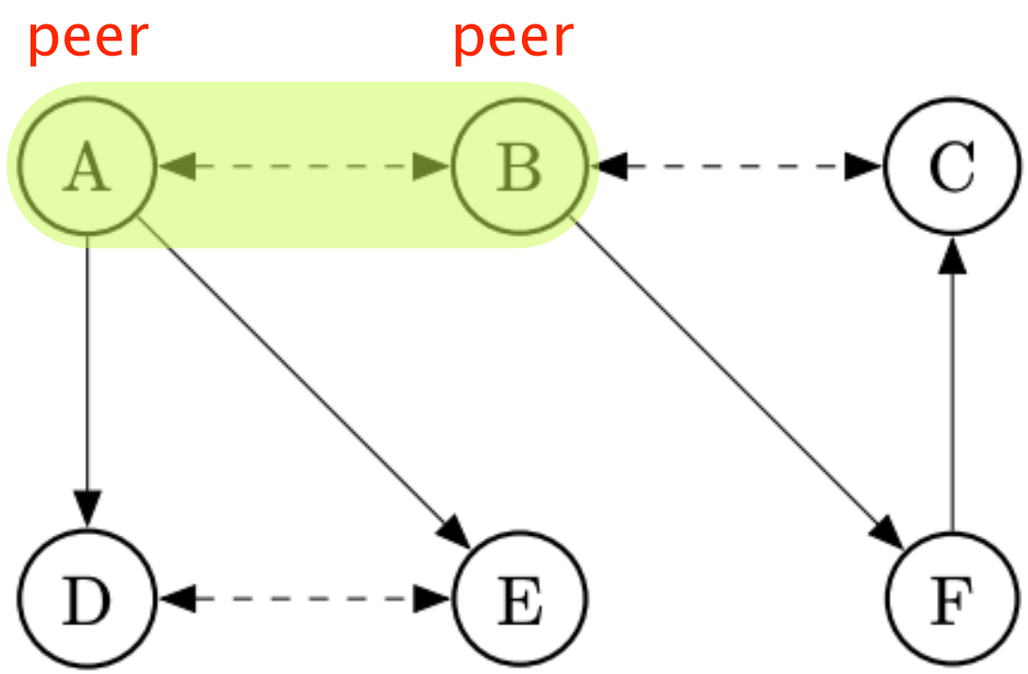

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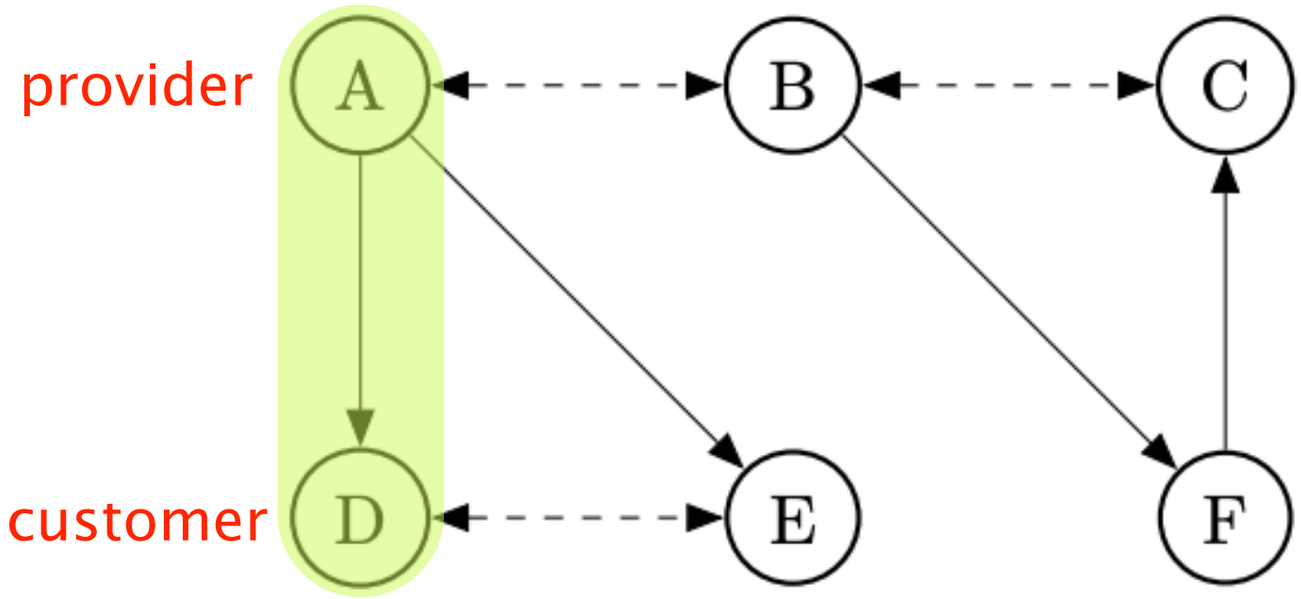

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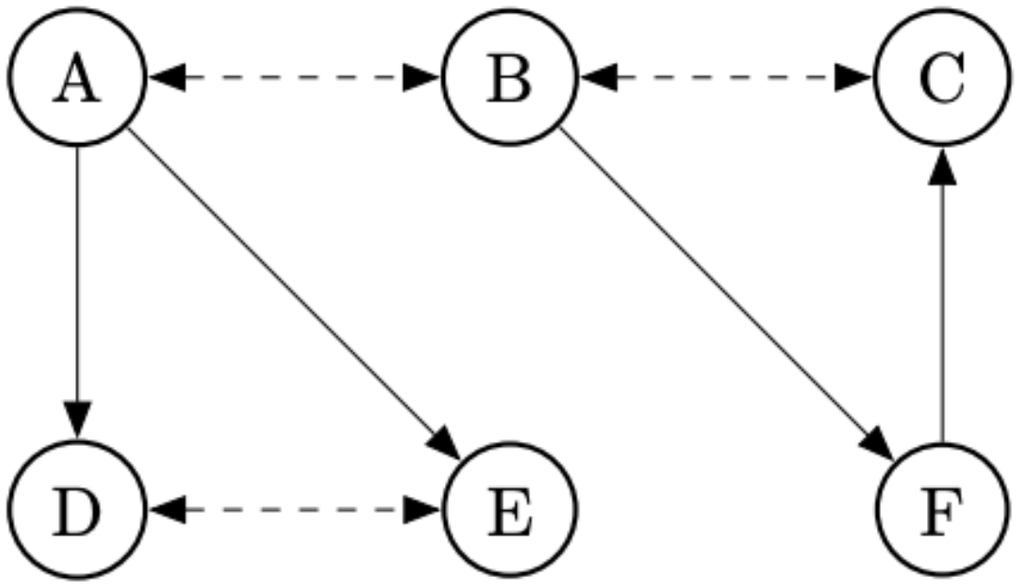

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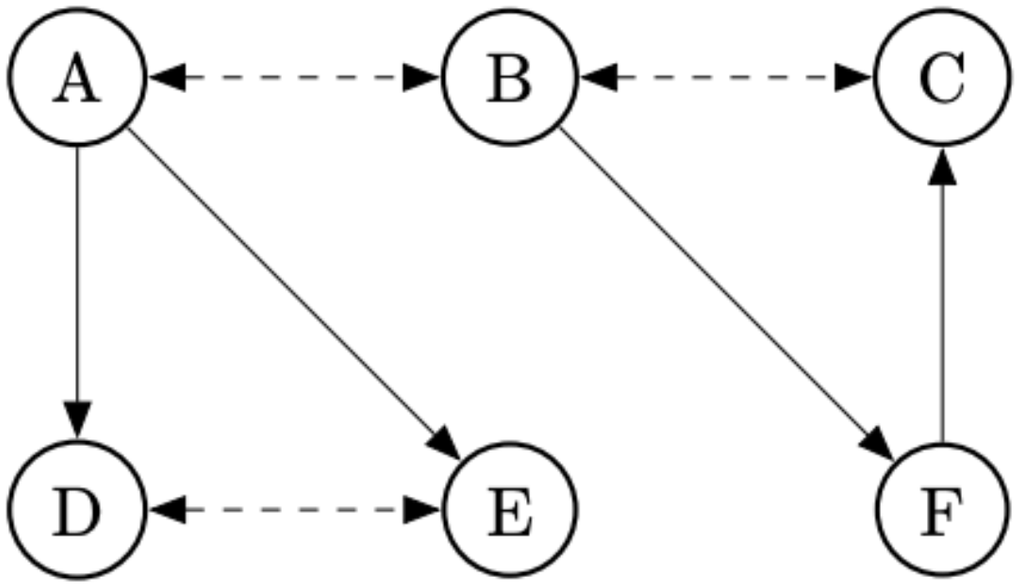

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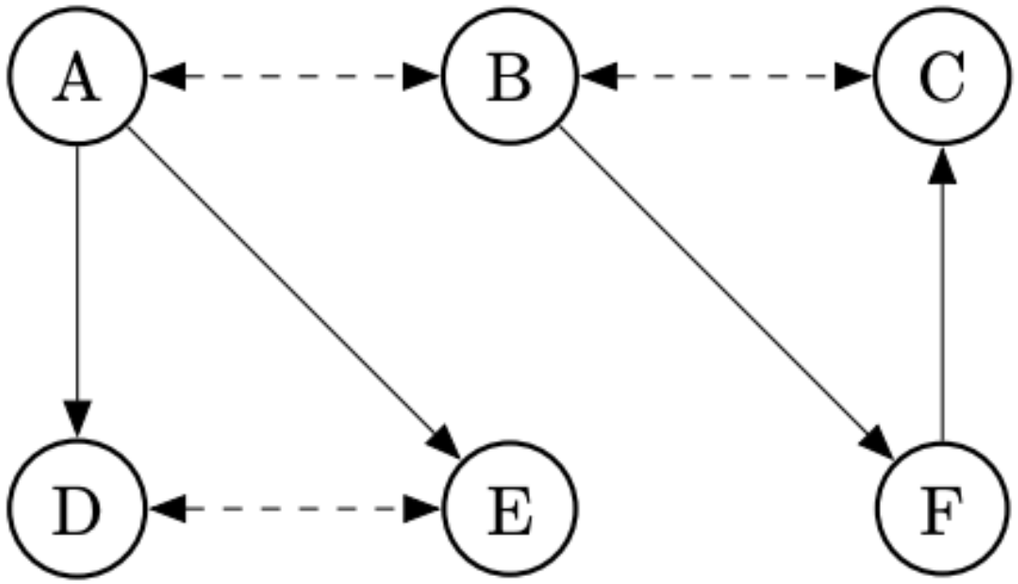

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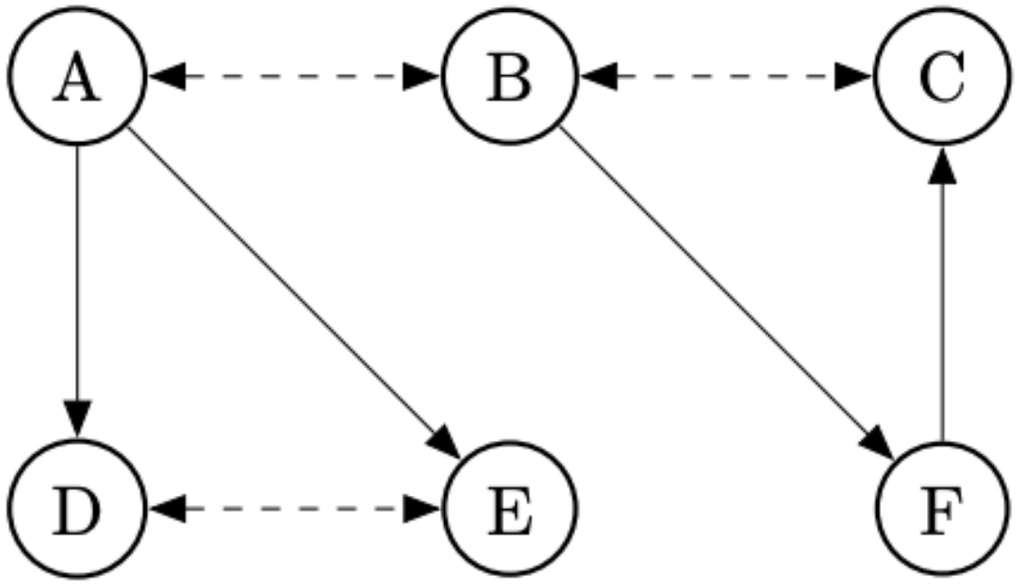

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Inter-domain routing: Path Selection

b) Path Selection **(6 Points)**

leave blank

Consider the AS in Figure 6. It has three border routers (A, B and C) and three internal routers (D, E, F). The routers are connected through an iBGP full-mesh. OSPF is used internally with the given link weights. Each border router receives two eBGP advertisements from its eBGP neighbors with the depicted attributes (AS path, MED and local-pref).

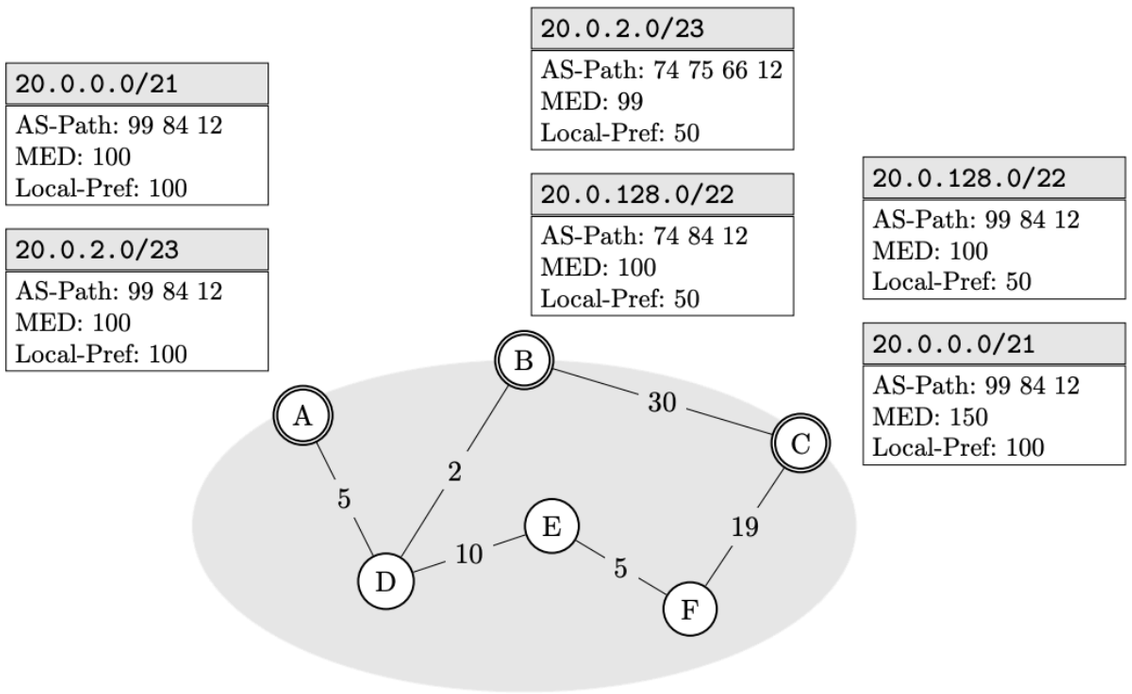

Abbildung 6: A simple BGP network forming an iBGP full-mesh.

Complete the routing table of each router by indicating the router ID of the selected egress (A, B, C) using the provided template:

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Prefix	Egress

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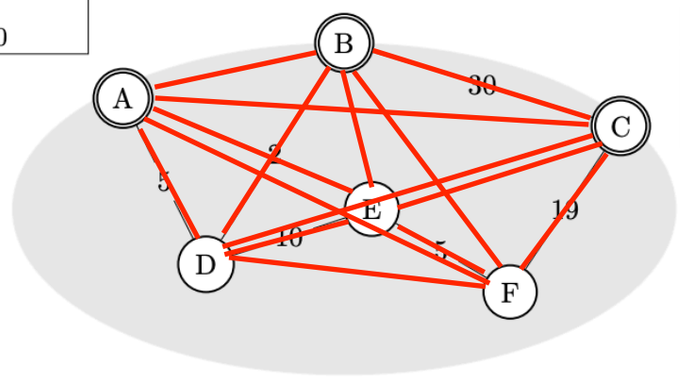
AS-Path: 99 84 12 MED: 100 Local-Pref: 100

20.0.2.0/23
AS-Path: 74 75 66 12 MED: 99 Local-Pref: 50

20.0.128.0/22
AS-Path: 74 84 12 MED: 100 Local-Pref: 50

20.0.128.0/22
AS-Path: 99 84 12 MED: 100 Local-Pref: 50

20.0.0.0/21
AS-Path: 99 84 12 MED: 150 Local-Pref: 100



iBGP full-mesh

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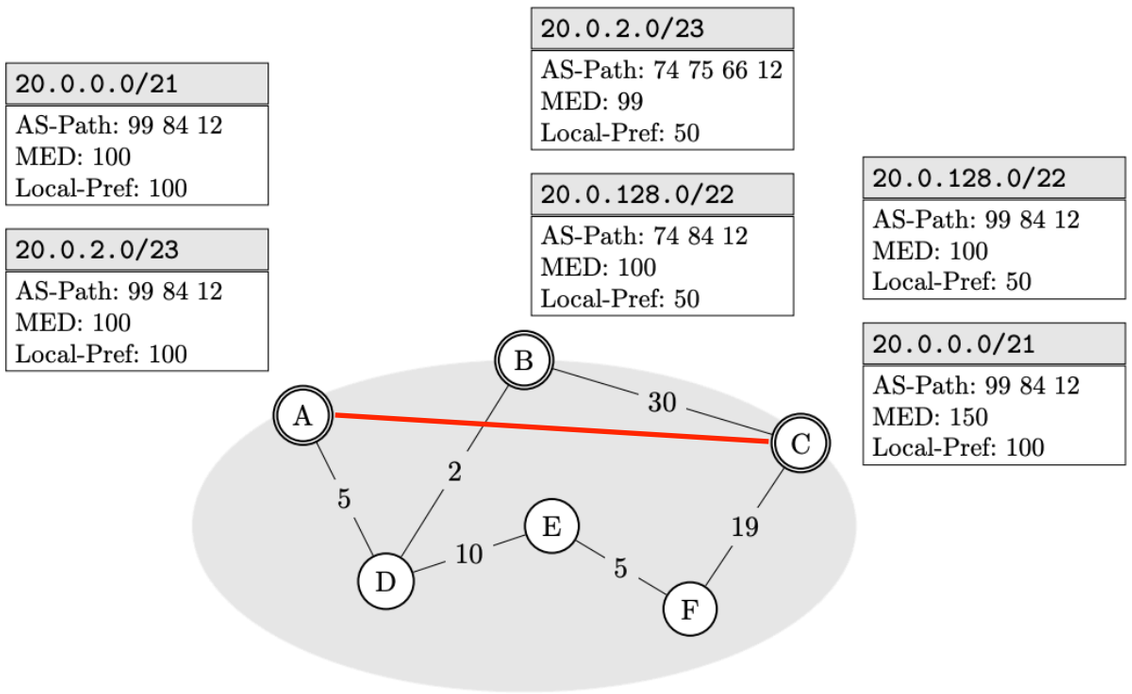

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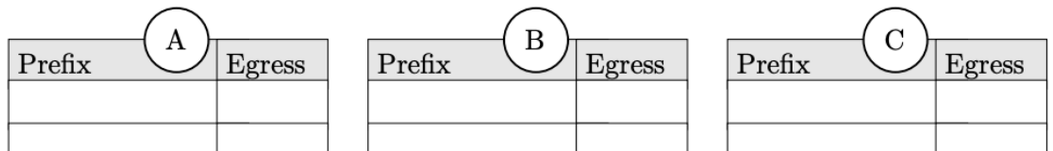

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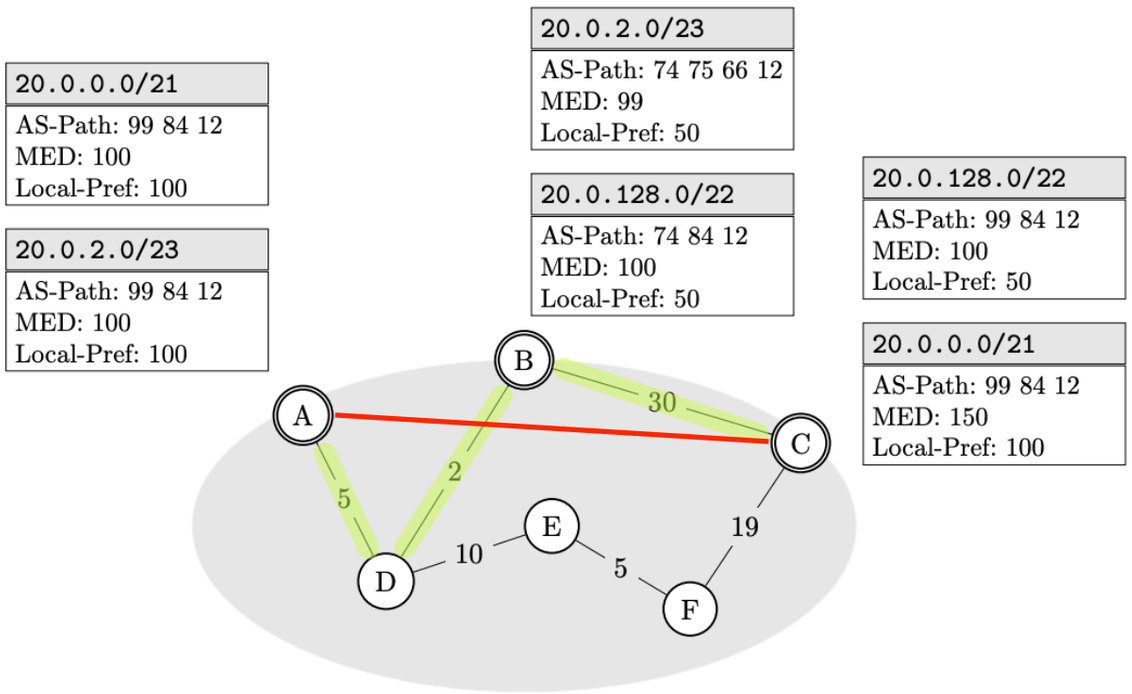

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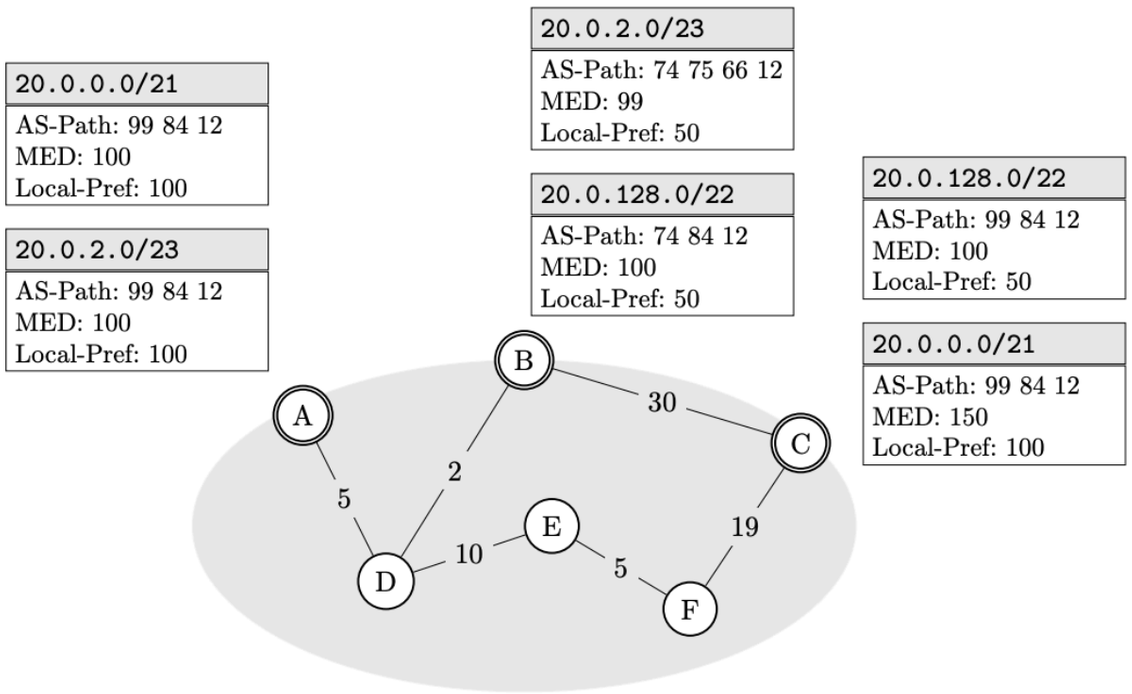

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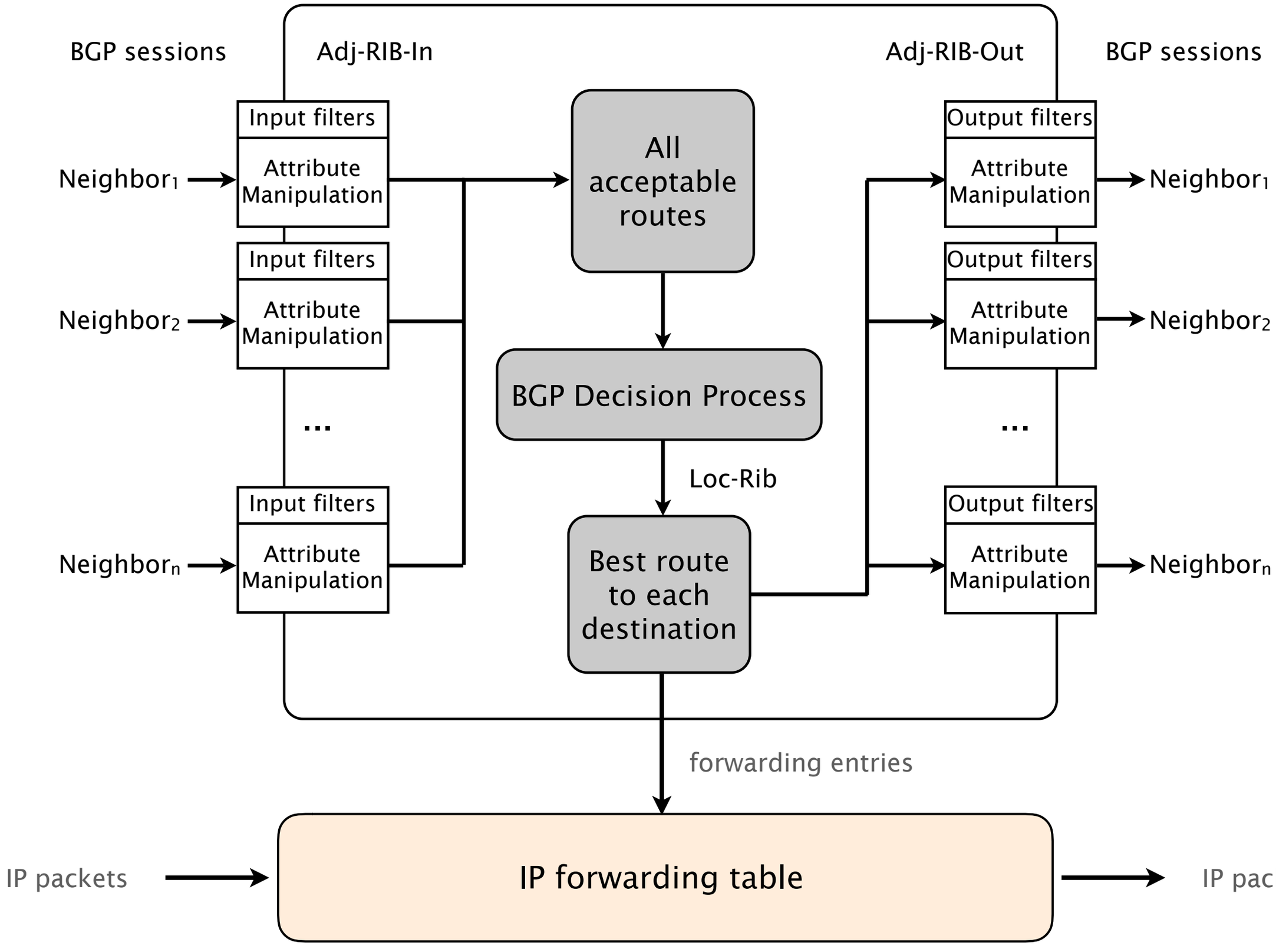

BGP sessions
Adj-RIB-In
Adj-RIB-Out
BGP sessions
Input filters
Attribute Manipulation
Neighbor1
Input filters
Attribute Manipulation
Neighbor2
...
Input filters
Attribute Manipulation
Neighborn
All acceptable routes
BGP Decision Process
Loc-Rib
Best route to each destination
Output filters
Attribute Manipulation
Neighbor1
Output filters
Attribute Manipulation
Neighbor2
...
Output filters
Attribute Manipulation
Neighborn
forwarding entries
IP packets
IP forwarding table
IP packets

Prefer routes…

with higher LOCAL-PREF

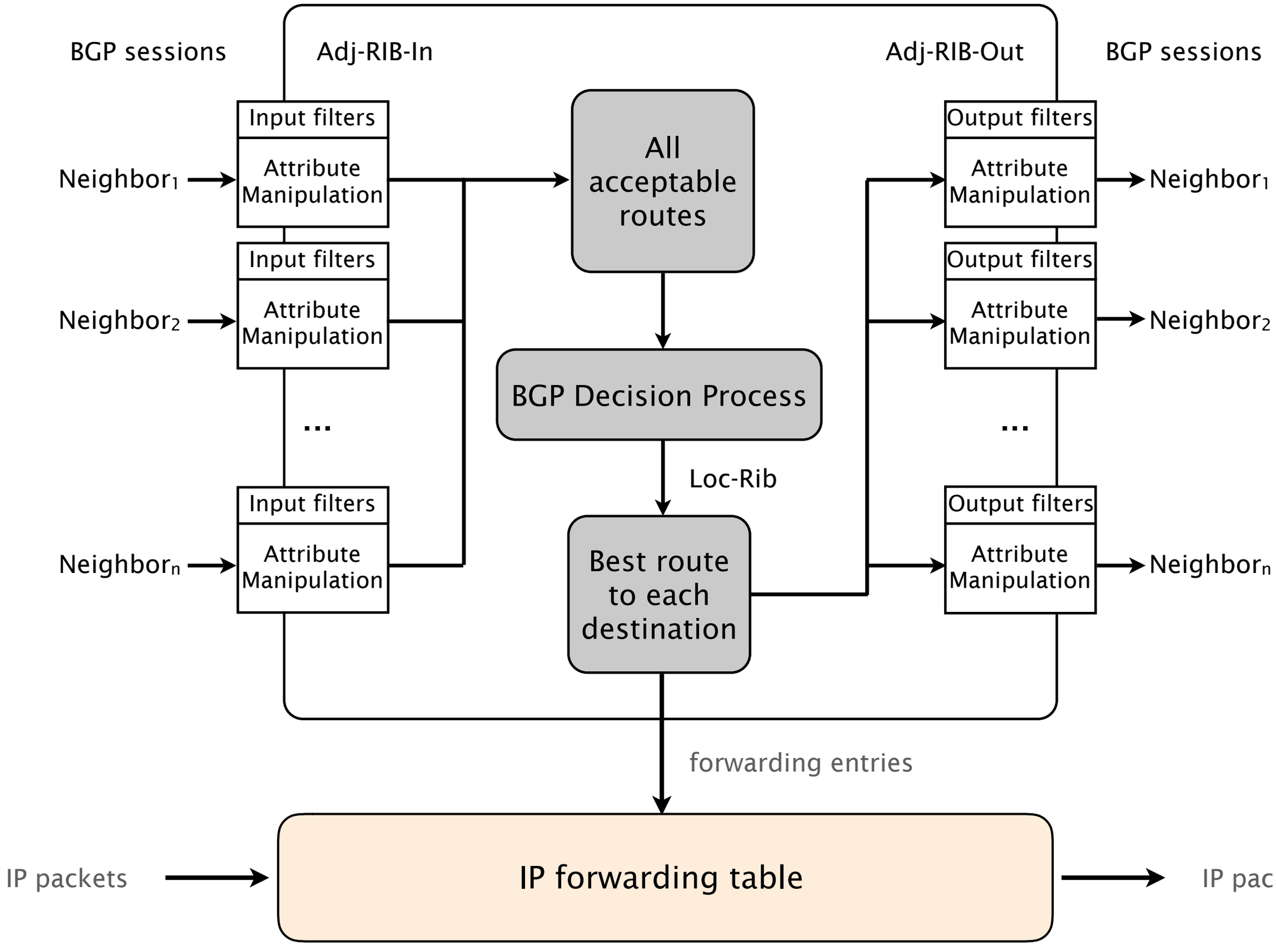
with shorter AS-PATH length

with lower MED

learned via eBGP instead of iBGP

with lower IGP metric to the next-hop

with smaller egress IP address (tie-break)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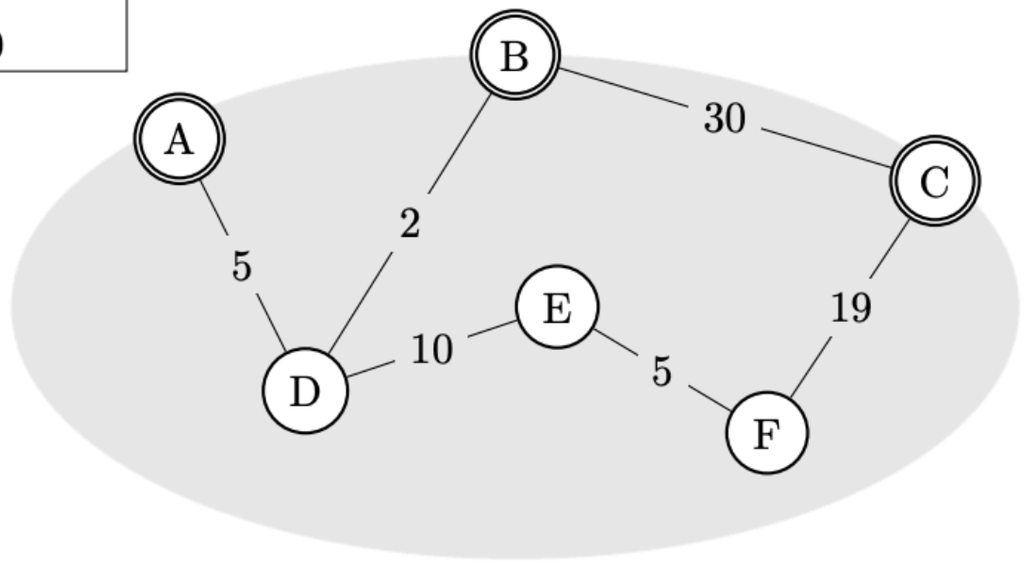

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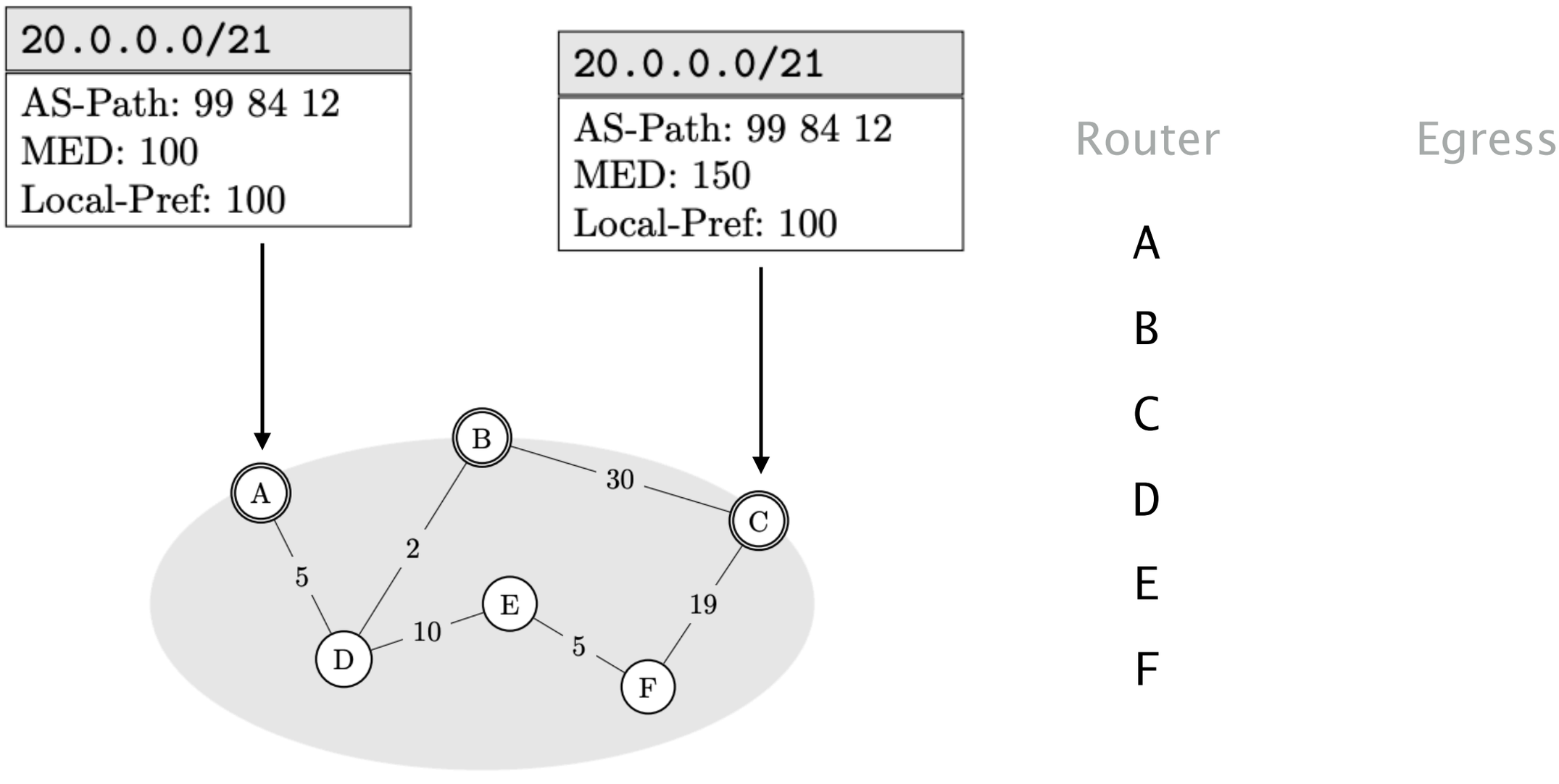


Router Egress

A

B

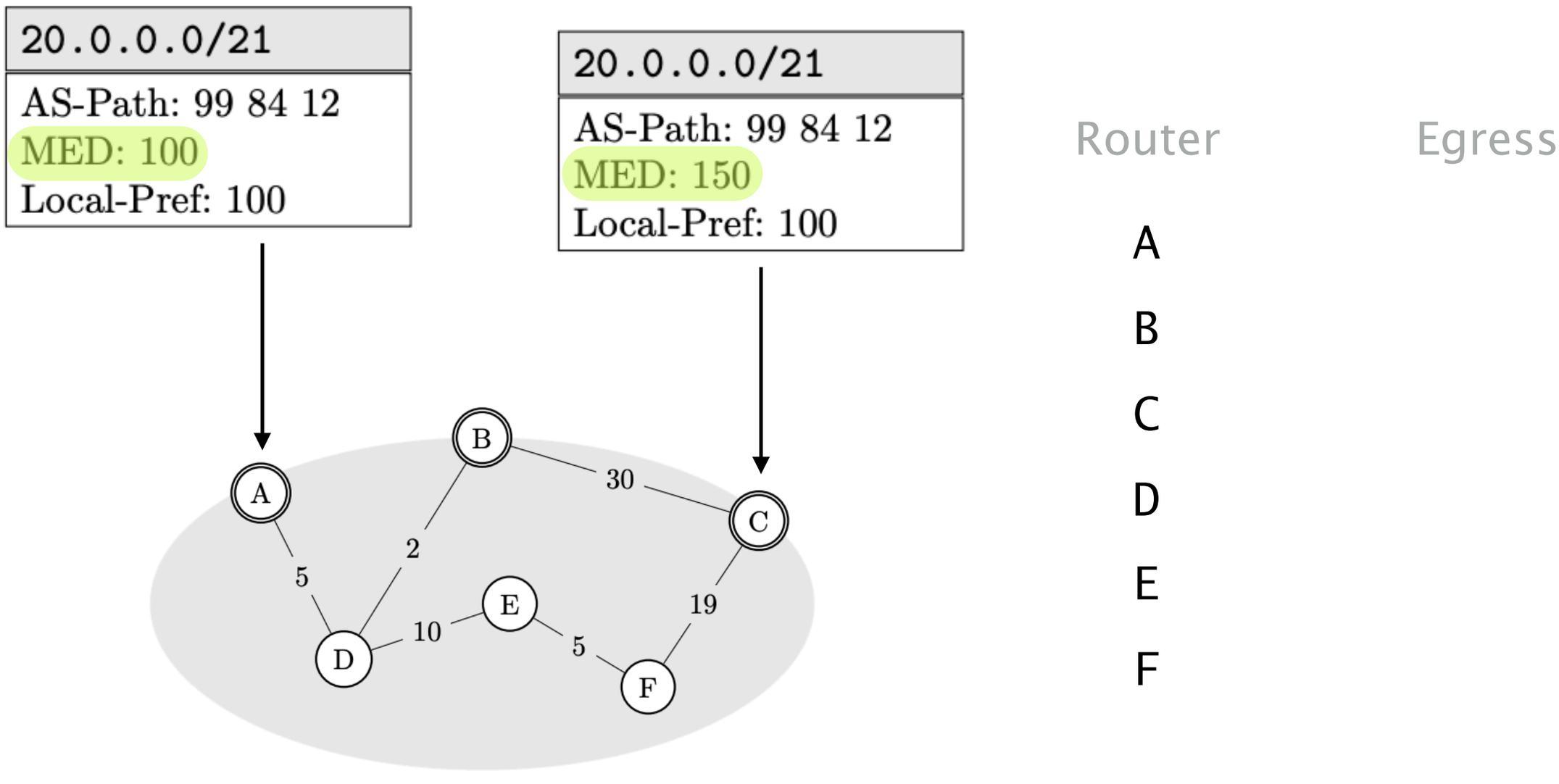
C

D

E

F

Inter-domain routing: Path Selection



Router Egress

A

B

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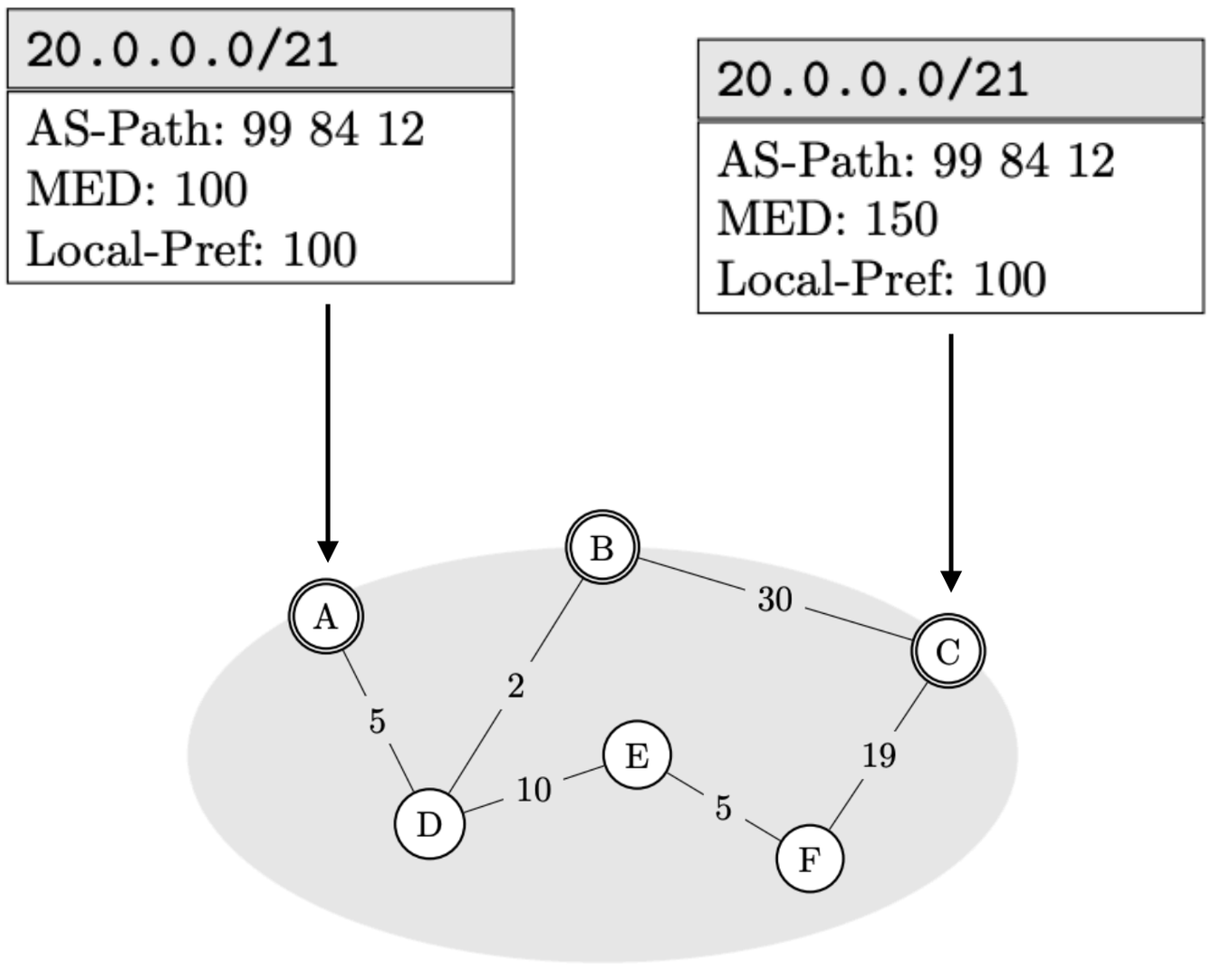
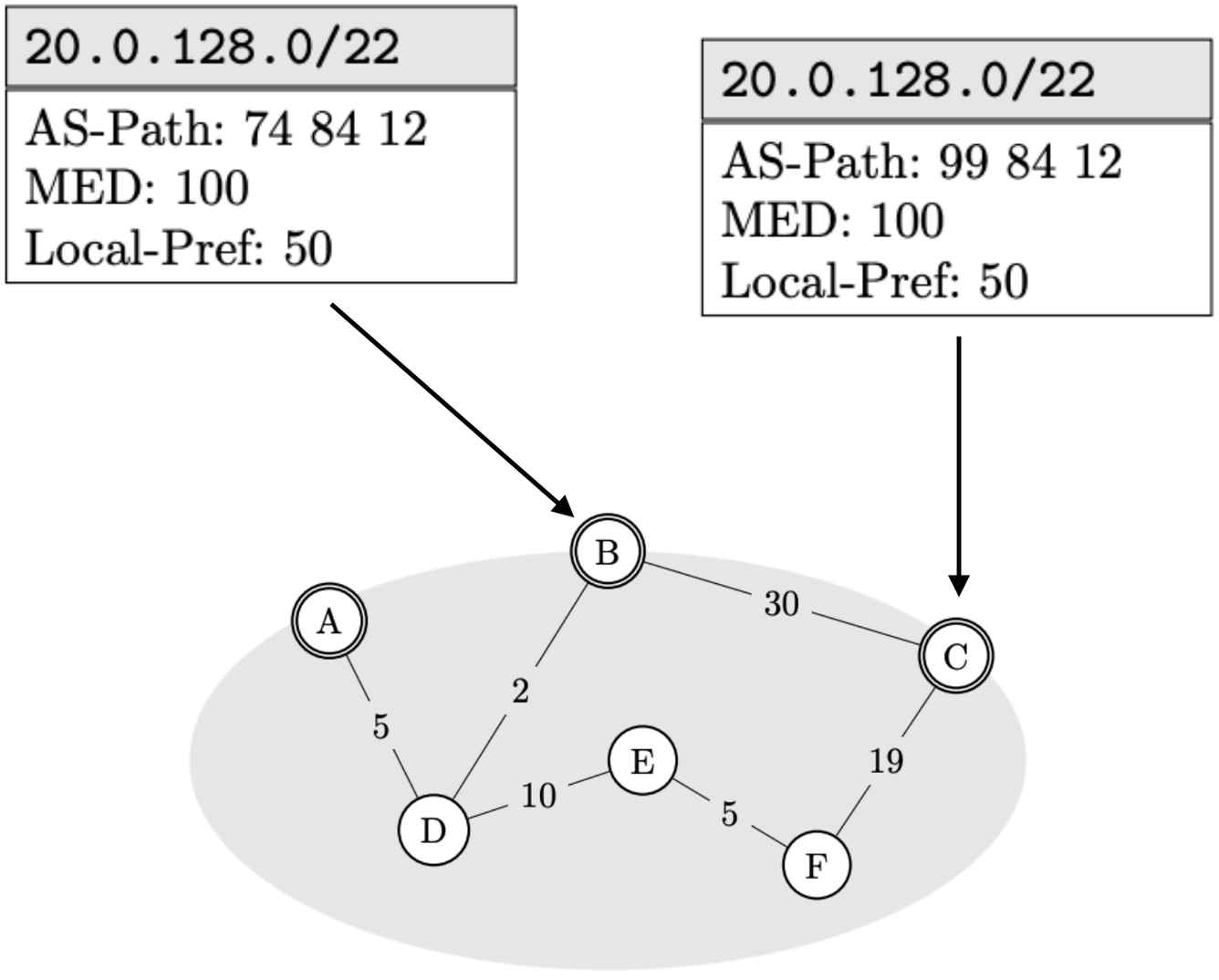
Inter-domain routing: Path Selection



Router	Egress
A	A
B	A
C	A
D	A
E	A
F	A

Inter-domain routing: Path Selection



Router

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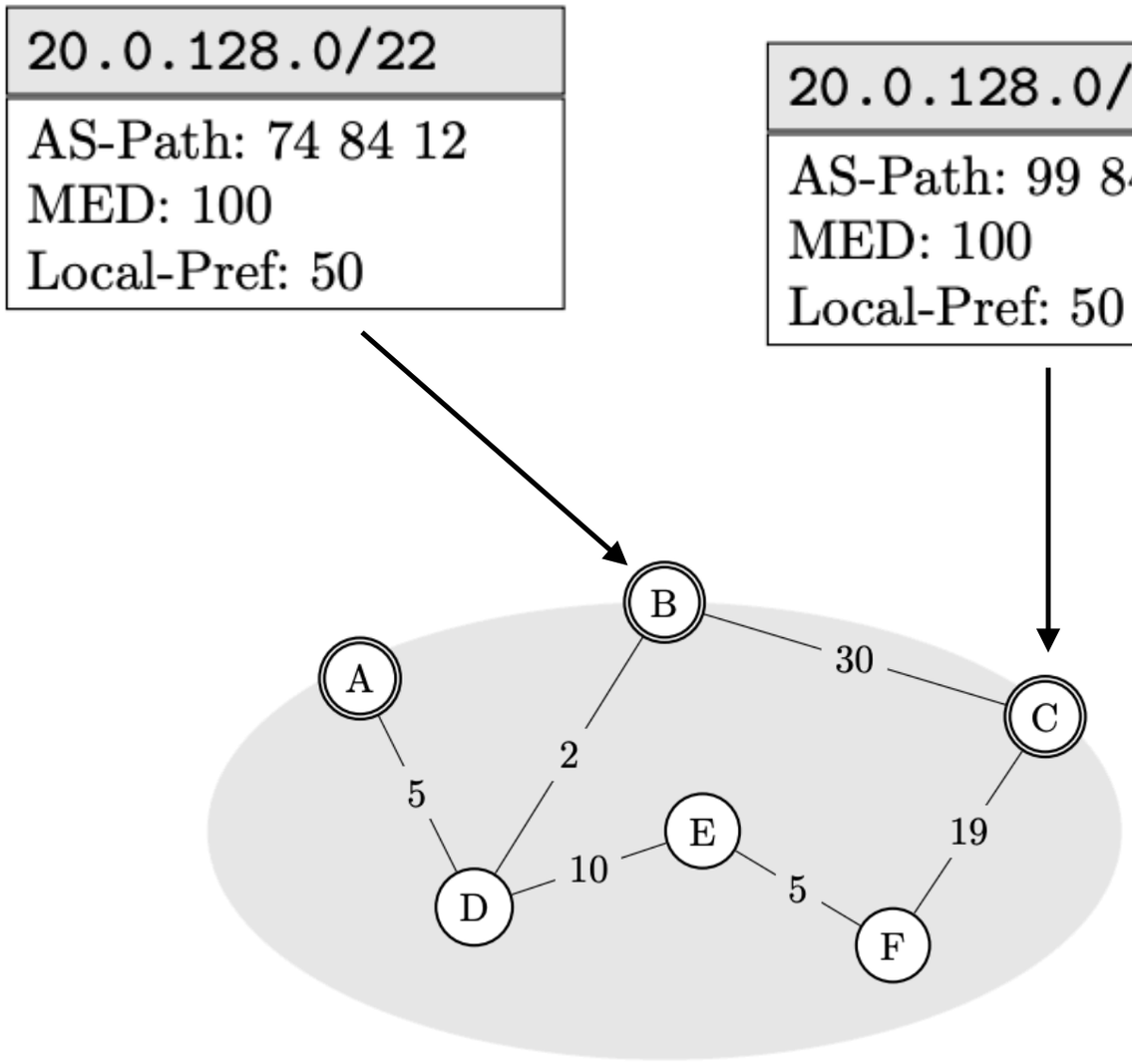
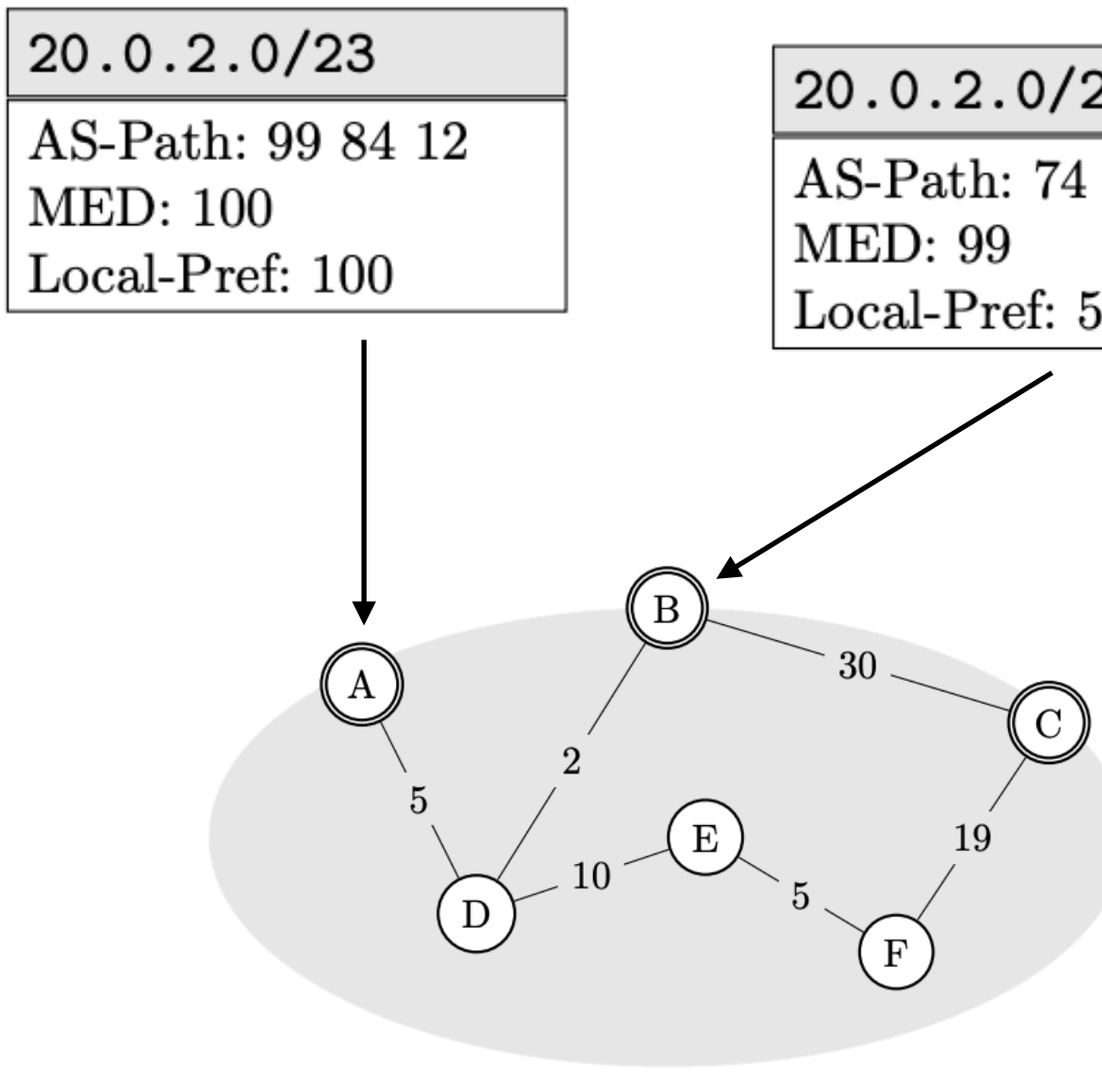


Router	Egress
A	B
B	B
C	C
D	B
E	B
F	B

Inter-domain routing: Path Selection



Router Egress

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D

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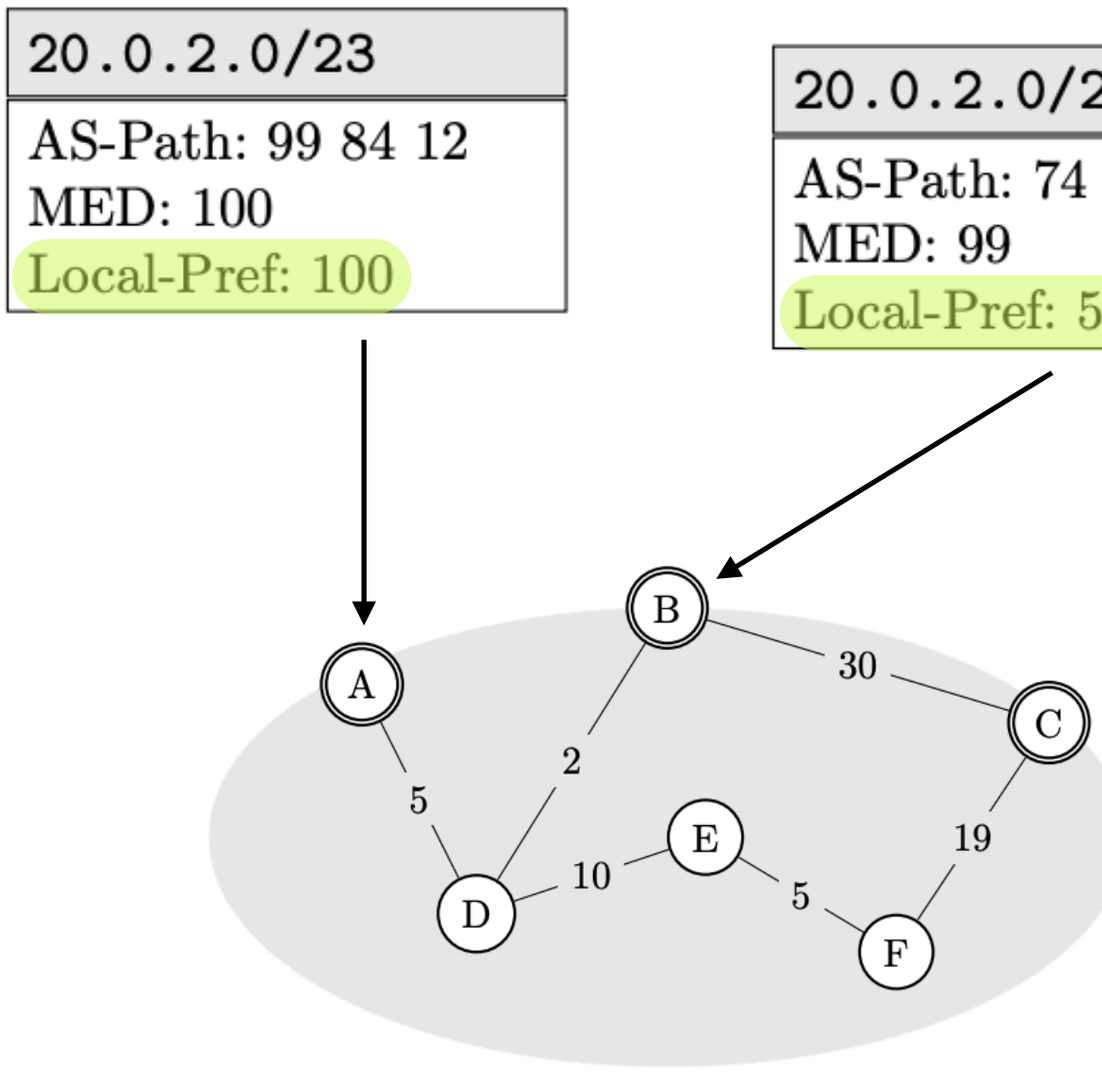
F

Inter-domain routing: Path Selection



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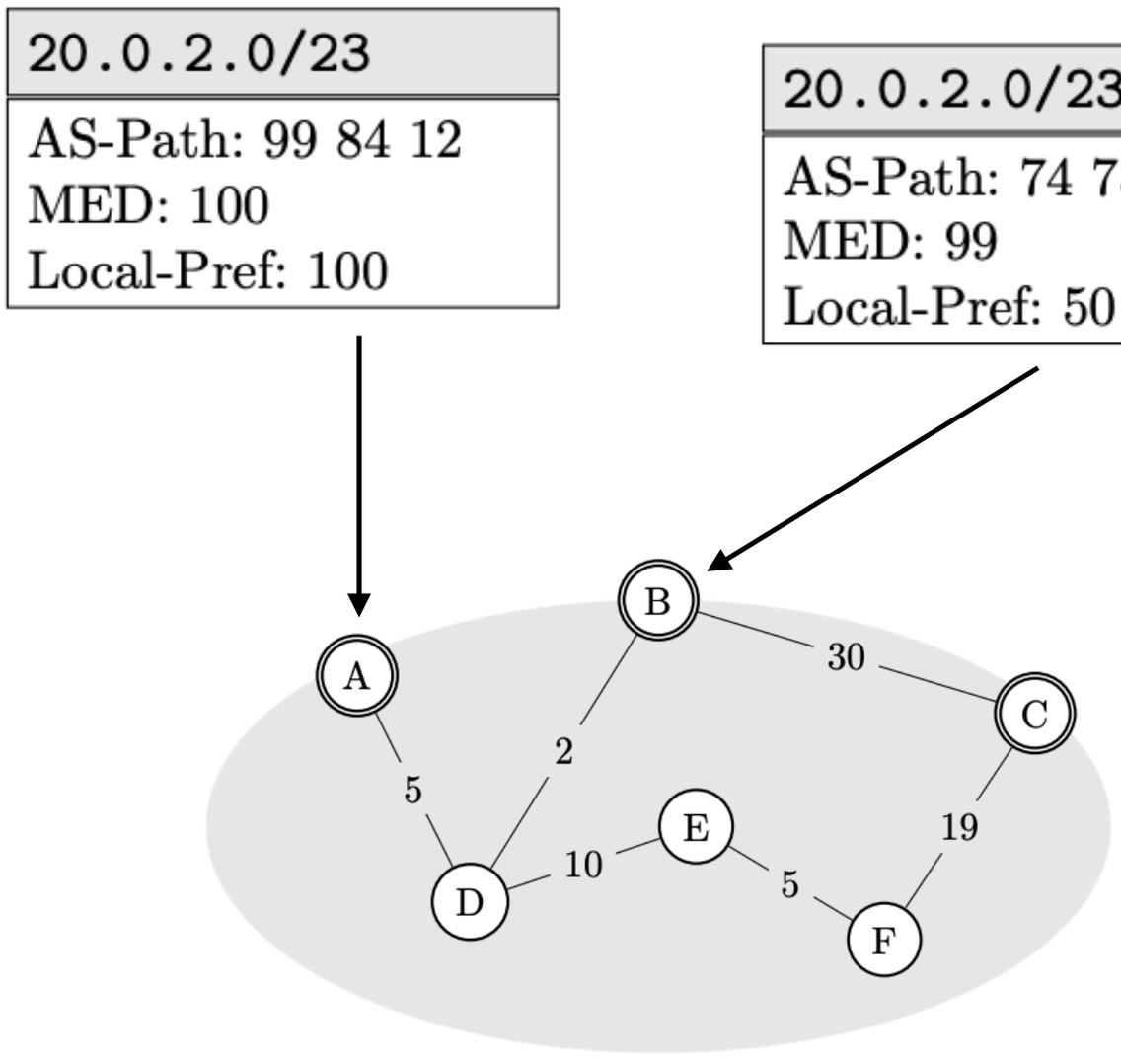

Router	Egress
A	A
B	A
C	A
D	A
E	A
F	A

BGP exam question

What is next?

Work on the project

Important information

If you have questions during
the exam preparation time

Ask on Slack or send us an email

Please use the #exam_preparation channel

We will not provide solutions to old exams

Feel free to discuss with other students

Come to our Q&A session

Exam preparation Q&A session

Probably beginning of August

We will send you an email with further details

To provide good answers,

send us your questions beforehand

We will stop answering exam questions
a week before the actual exam

At this point, the exam is finalized

We do not want to leak information

We will send you another reminder

BGP exam question

What is next?

Work on the project

Deadline this Friday

Common mistakes in the previous years

Part of the SACK header is sent all the time

Test with other groups to detect that

Out-of-order buffer is not cleared completely

Problems after the sequence number overflow

Report is incomplete

Don’t forget to answer to the theoretical questions

Deadline this Friday at 11.59pm

Thursday is Ascension day

Slower response time to questions

Make sure that you submit the correct version

Sender/receiver code and your report

Correction roughly two weeks after the deadline

Hopefully we see some of you again

In the Advanced Topics lecture

Focus on programmable networks (P4)

In the Communication Networks seminar

We will read and discuss important papers

For semester or master thesis

Have a look on our website or send us an email

Communication Networks

Spring 2019

Rüdiger Birkner, Tobias Bühler

nsg.ee.ethz.ch

ETH Zürich (D-ITET)

May 27 2019