# Verifiable Data Plane

**Thesis Mid-Defense**

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**Committee**
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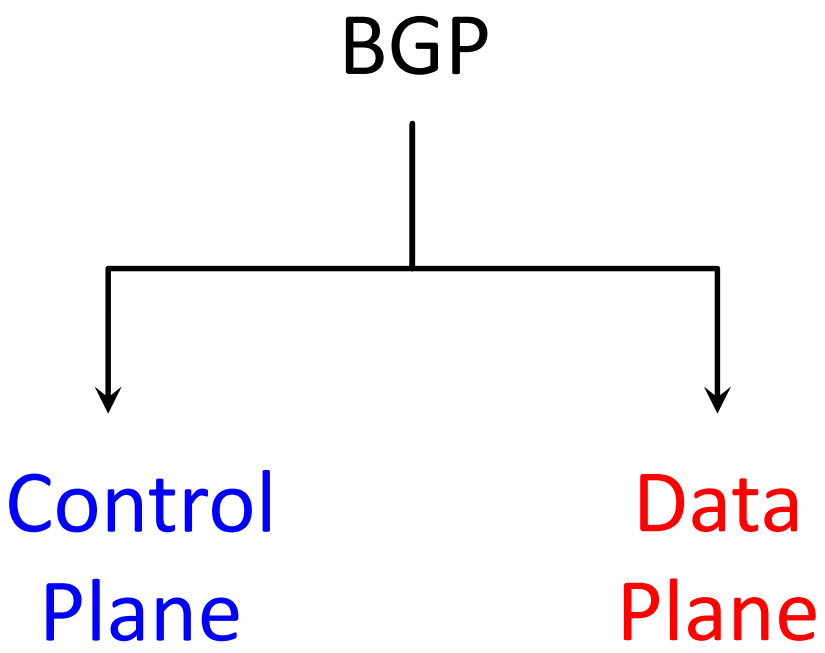
Olivier Bonaventure
Pascal Merindol
Cristel Pelsser

msii ÉCOLE DOCTORALE

Université de Strasbourg

iCUBE

# Why Verifiable Data Plane?



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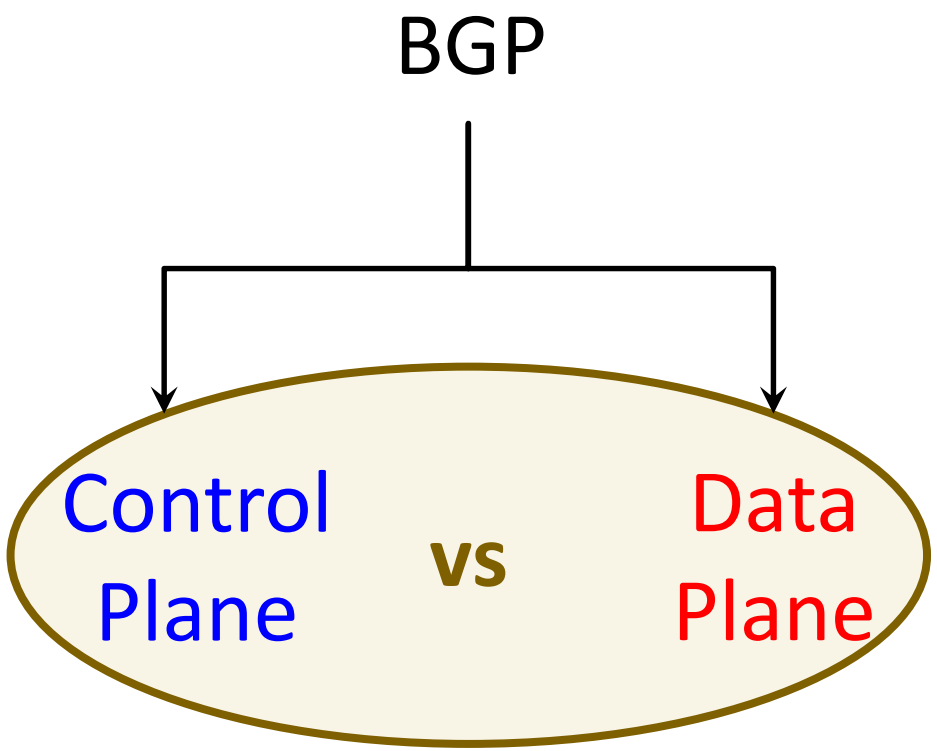

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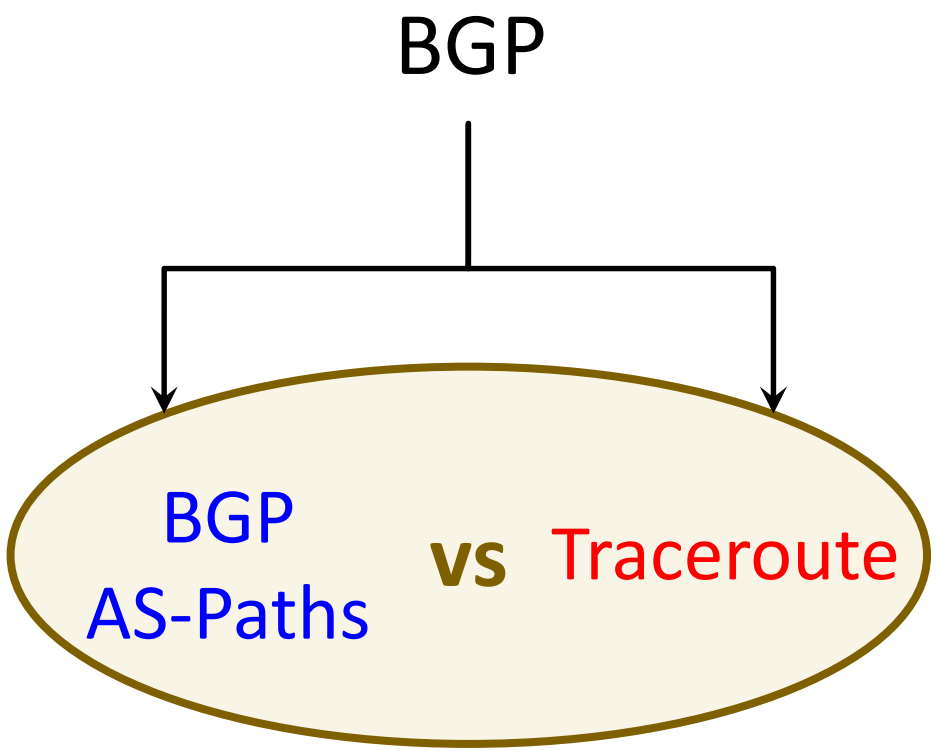

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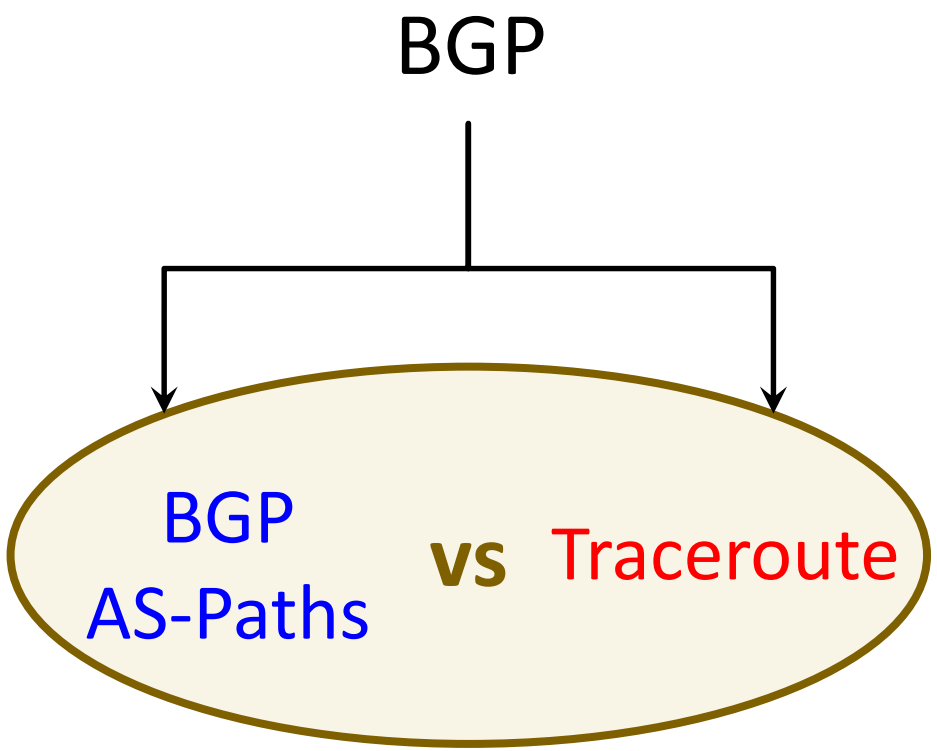


**Are BGP AS Paths being followed?**

- ✓ What generates discrepancies?
- ✓ Can we see it in the wild?

**Are technical limitations common?**

- ✓ How do they affect the forwarding?
- ✓ How can we detect them?

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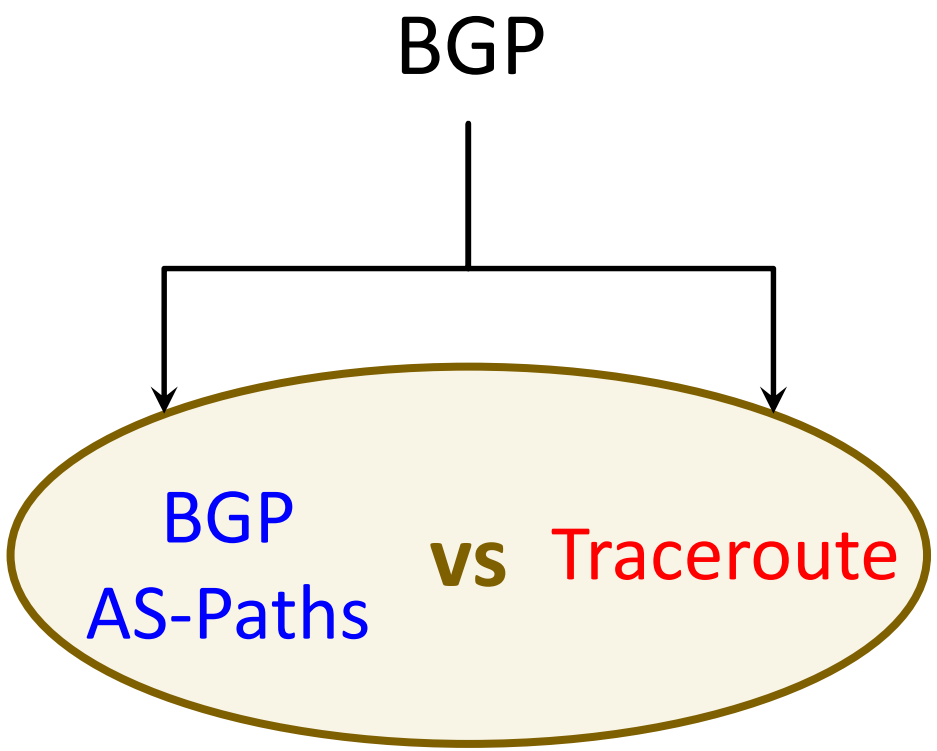


## TMA 2019

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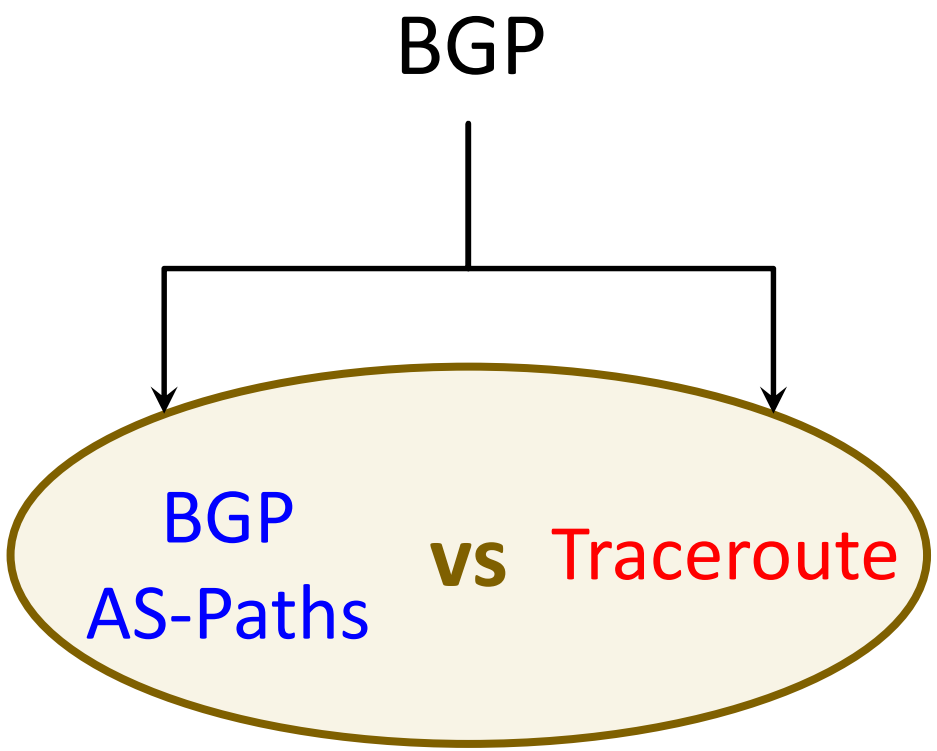


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## CoNext 2019…?

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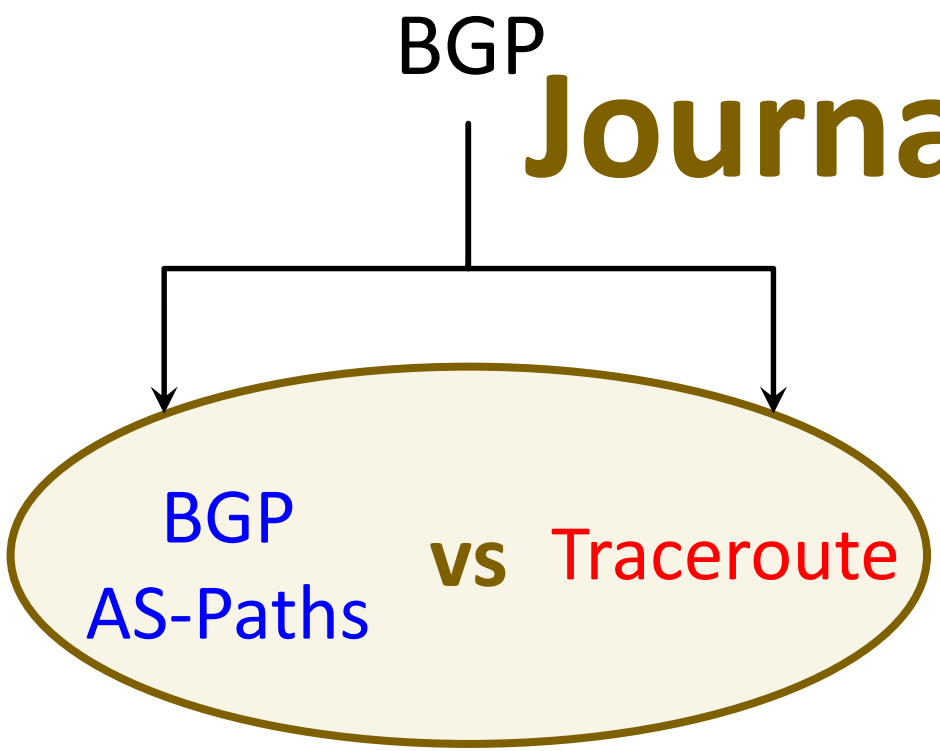


**Journal…?**

**TMA 2019**

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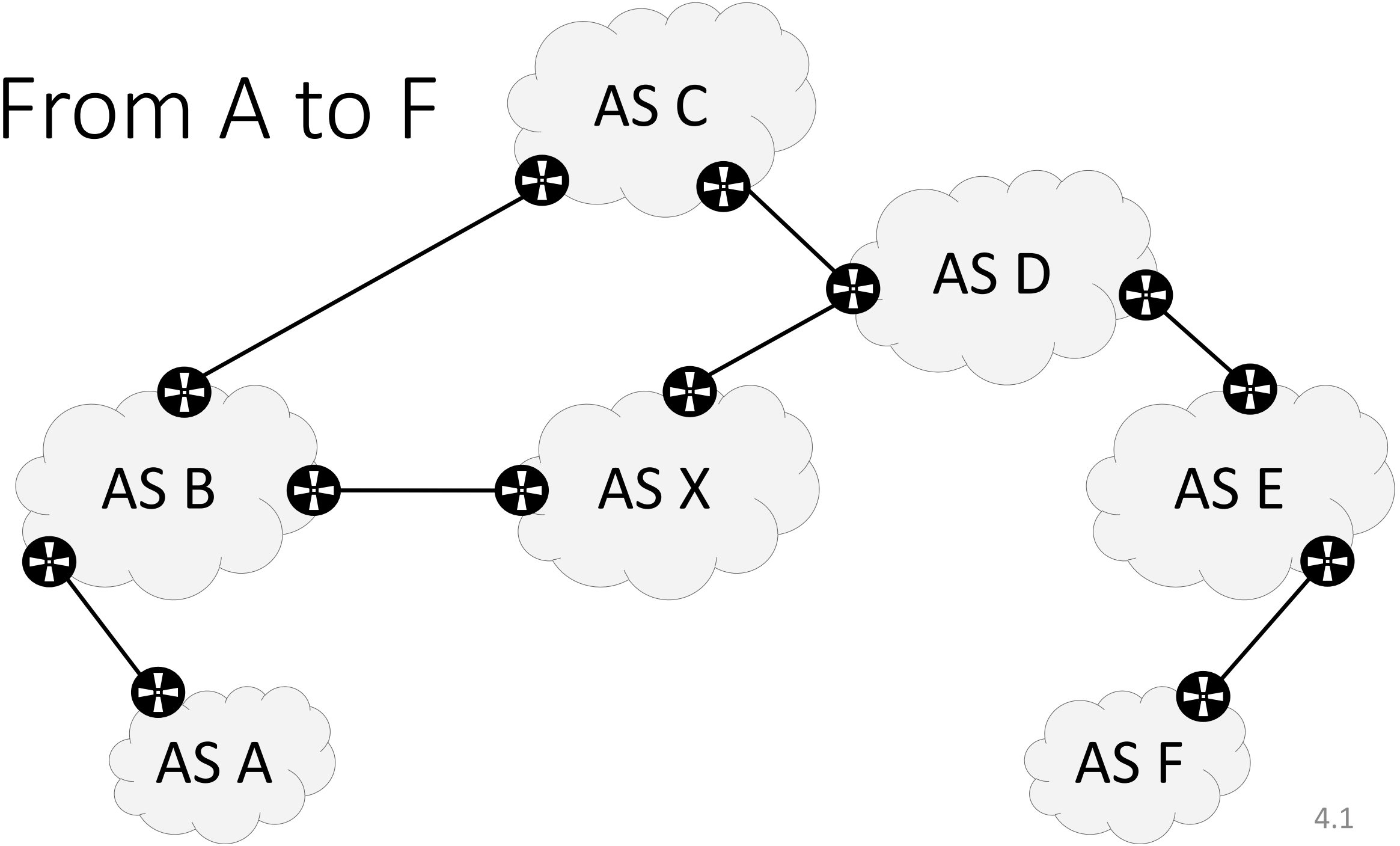
**CoNext 2019…?**

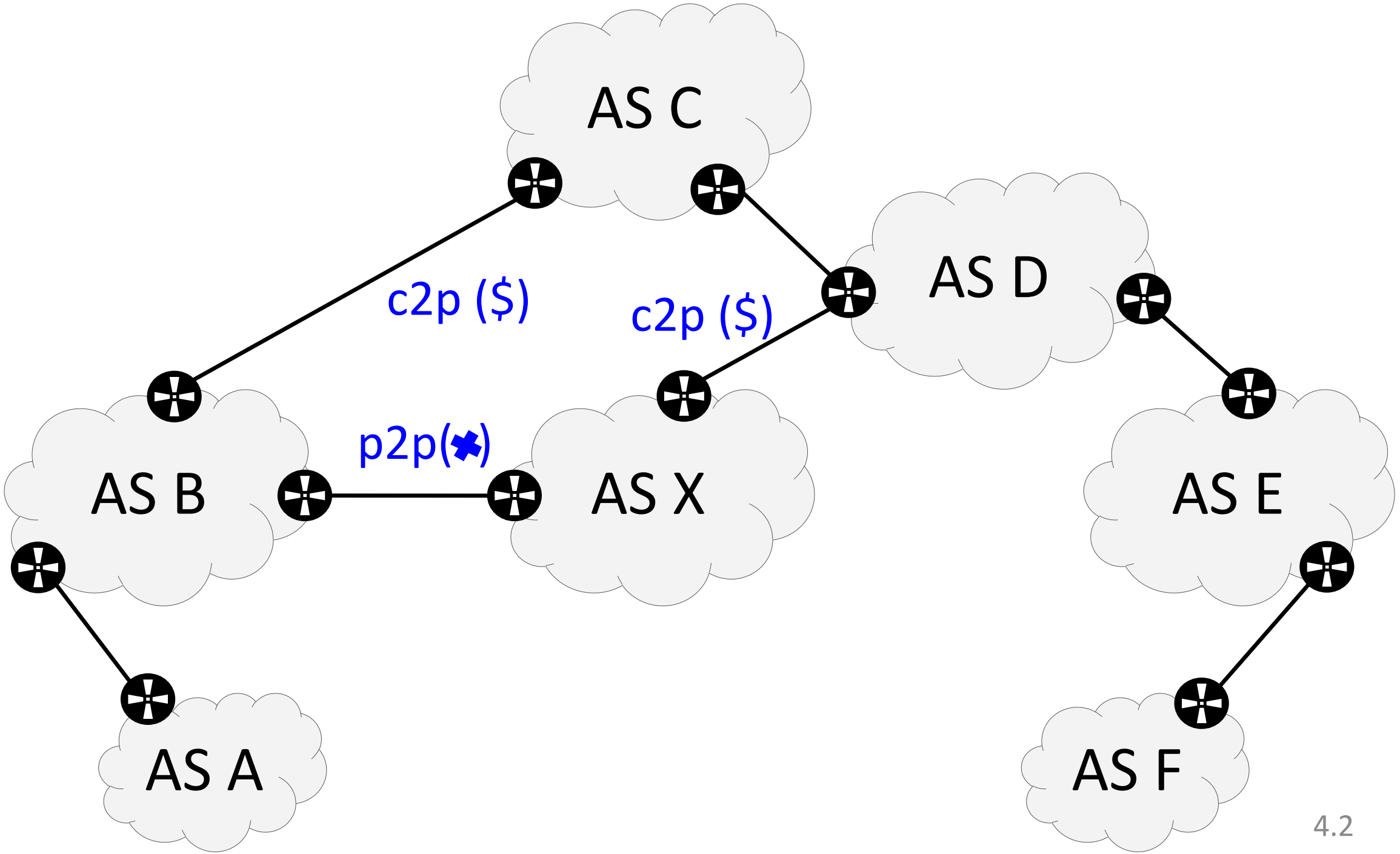
# TMA 2019

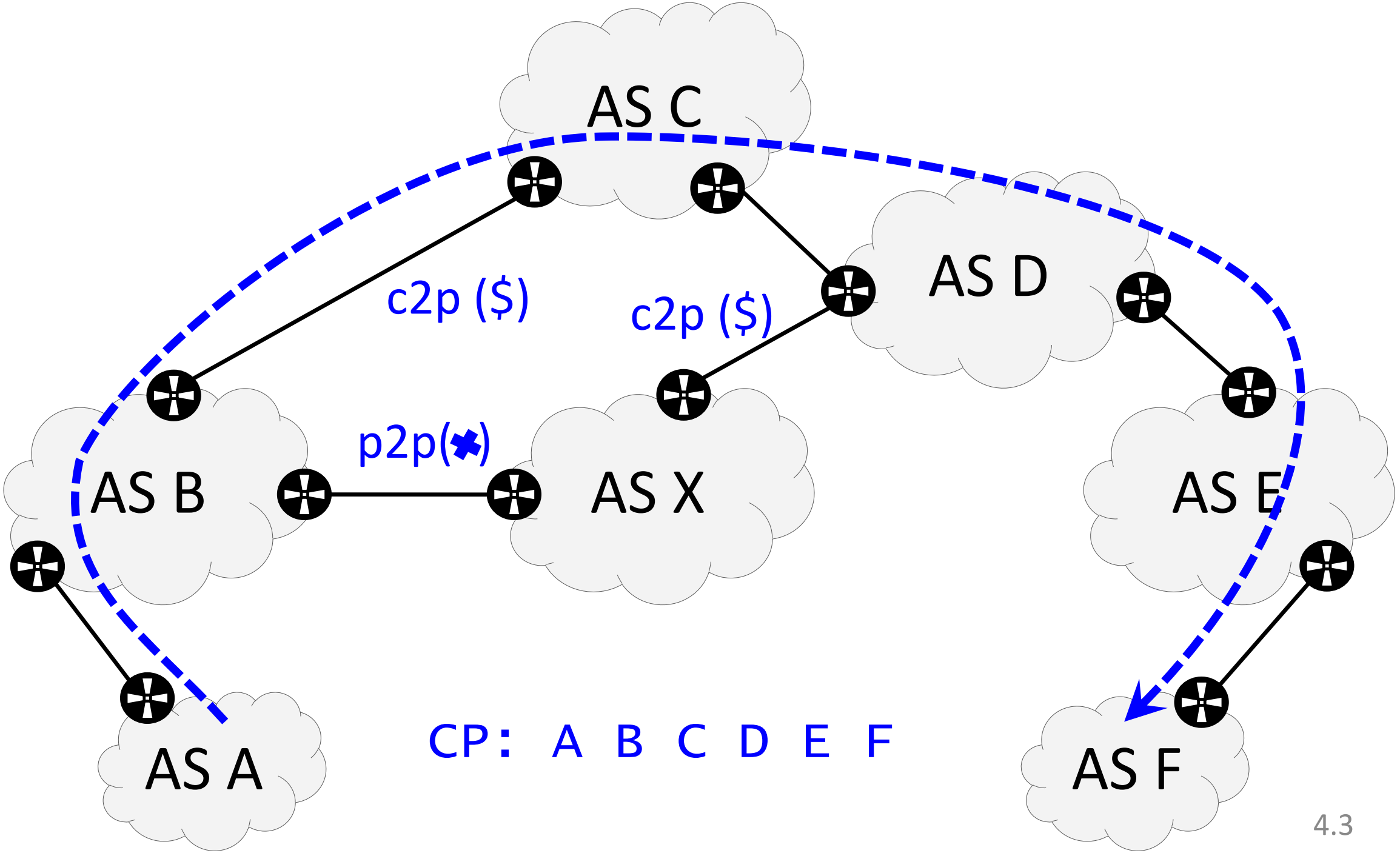
*“Filtering the Noise to Reveal Inter-Domain Lies”*

**Julian M. Del Fiore**, Pascal Merindol, Valerio Persico
Cristel Pelsser, Antonio Pescape

# From A to F




AS C
AS D
c2p ($)
c2p ($)
p2p(✖)
AS B
AS X
AS E
AS A
AS F


AS C
AS D
AS B
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AS E
AS A
AS F
c2p ($)
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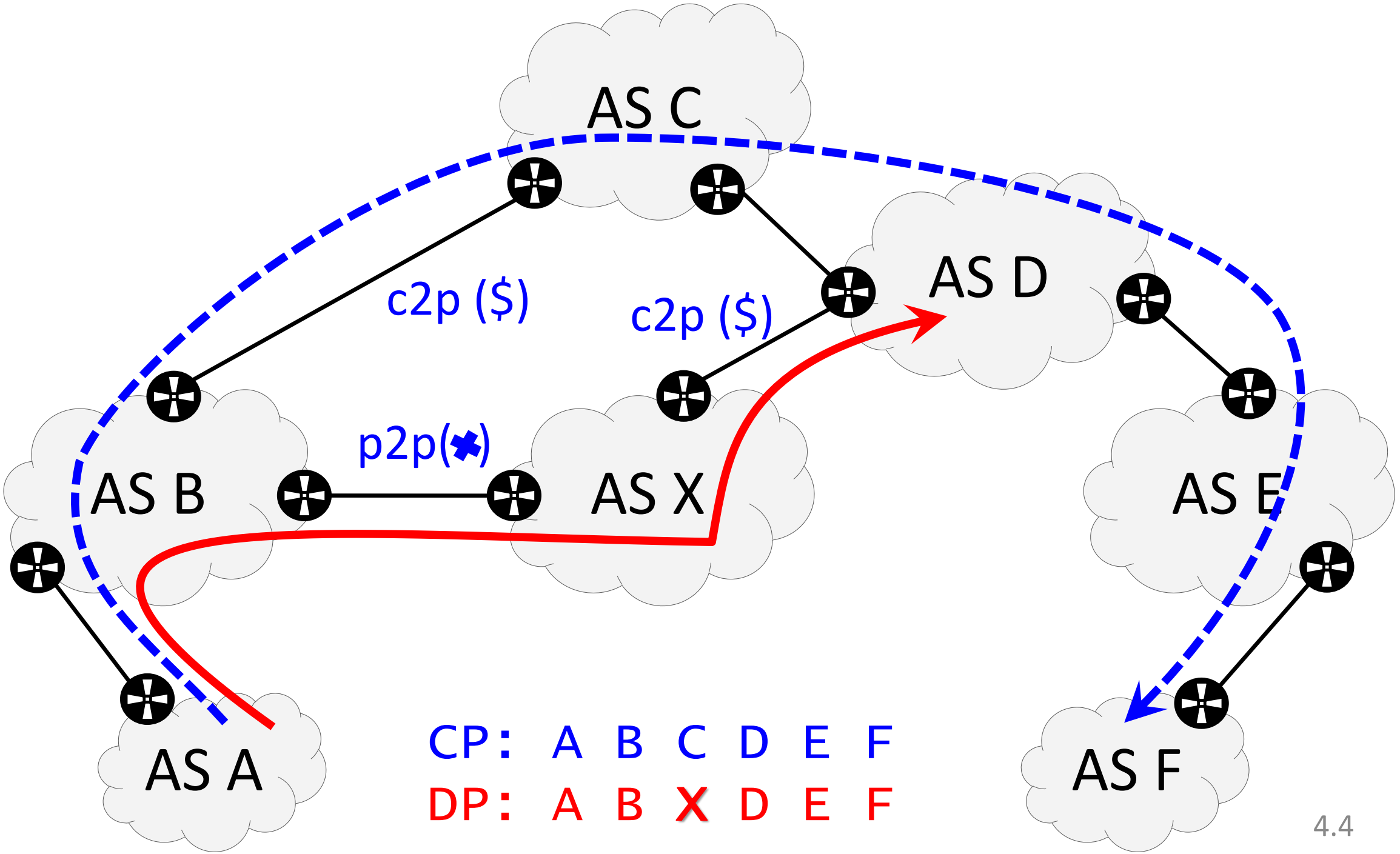
CP: A B C D E F


AS C
AS D
AS B
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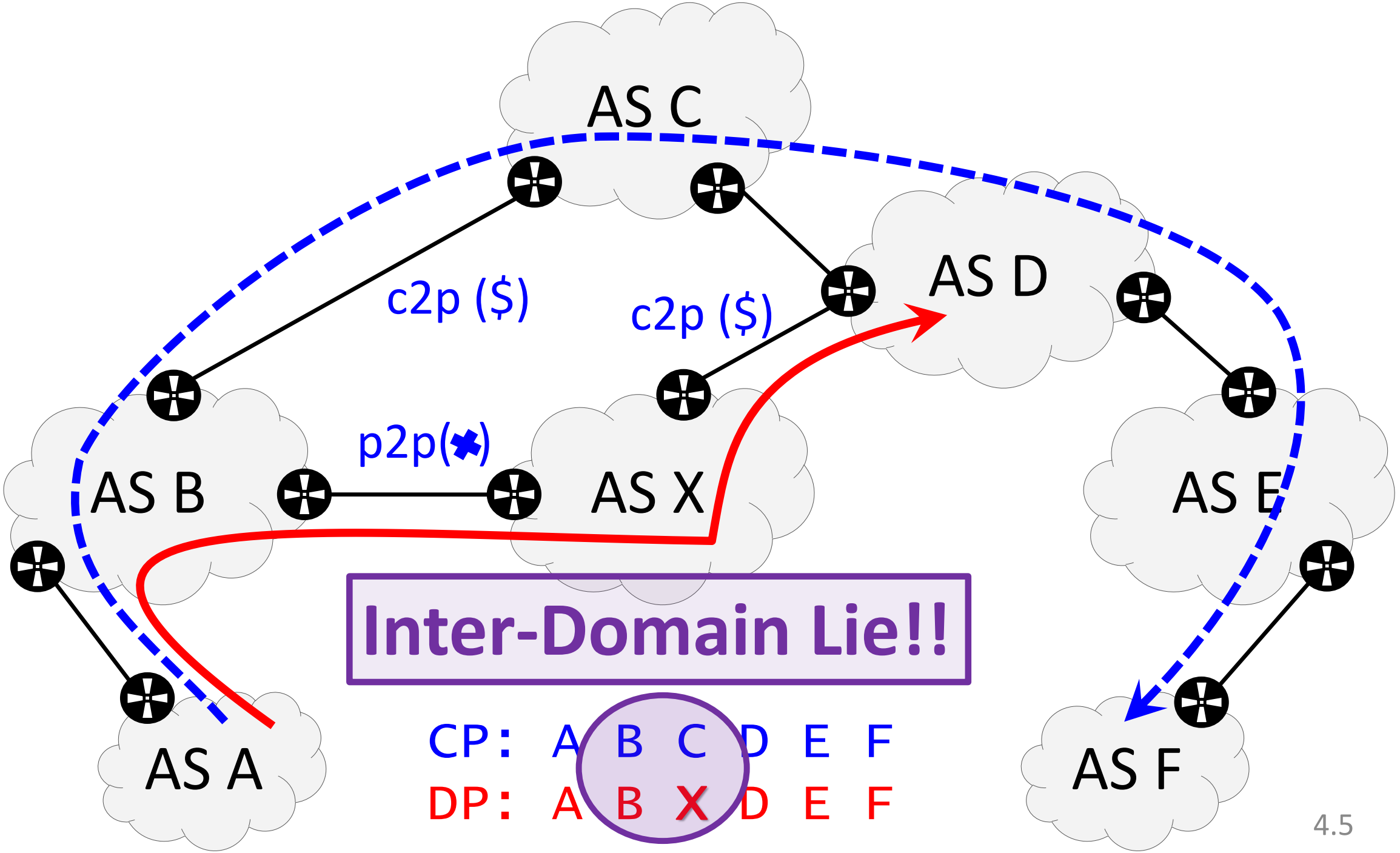
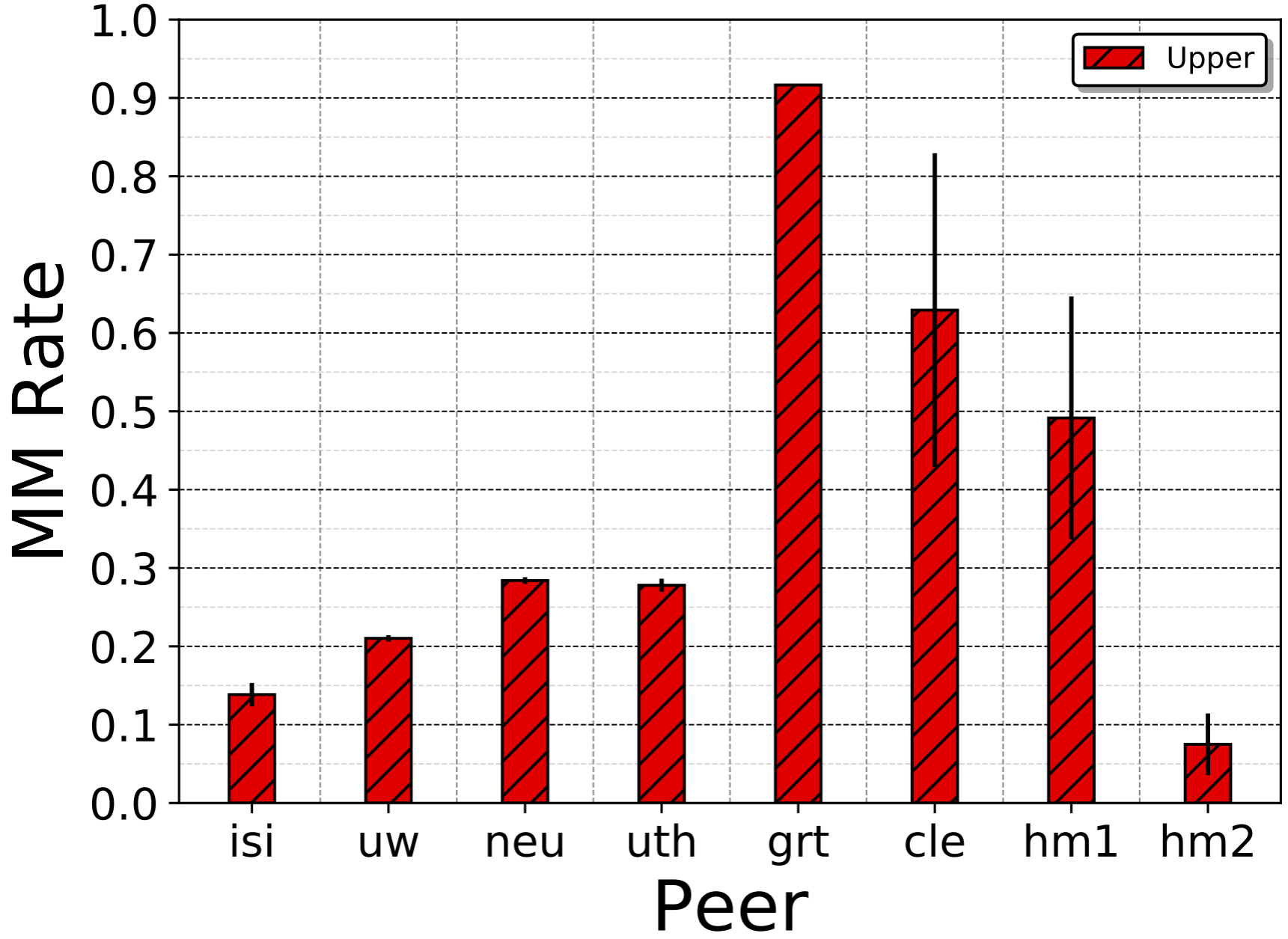
AS A
AS F
c2p ($)
c2p ($)
p2p(✖)
CP: A B C D E F
DP: A B X D E F


AS C
AS D
AS B
AS X
AS E
AS A
AS F
c2p ($)
c2p ($)
p2p(✖)
Inter-Domain Lie!!
CP: A B C D E F
DP: A B X D E F

# Internet Measurements

…

# Mismatches (MMs) in the Wild



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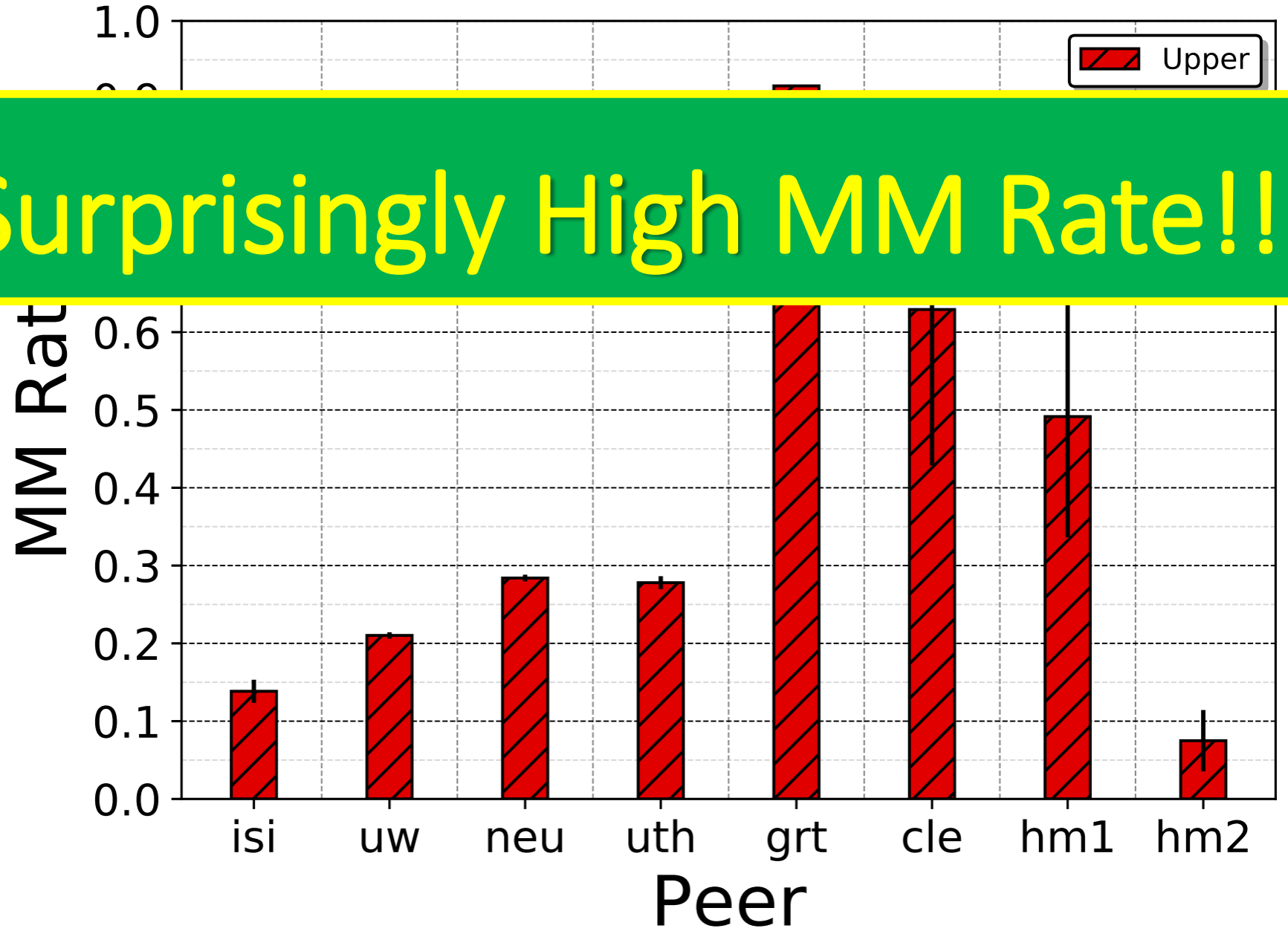


**Surprisingly High MM Rate!! ☹**

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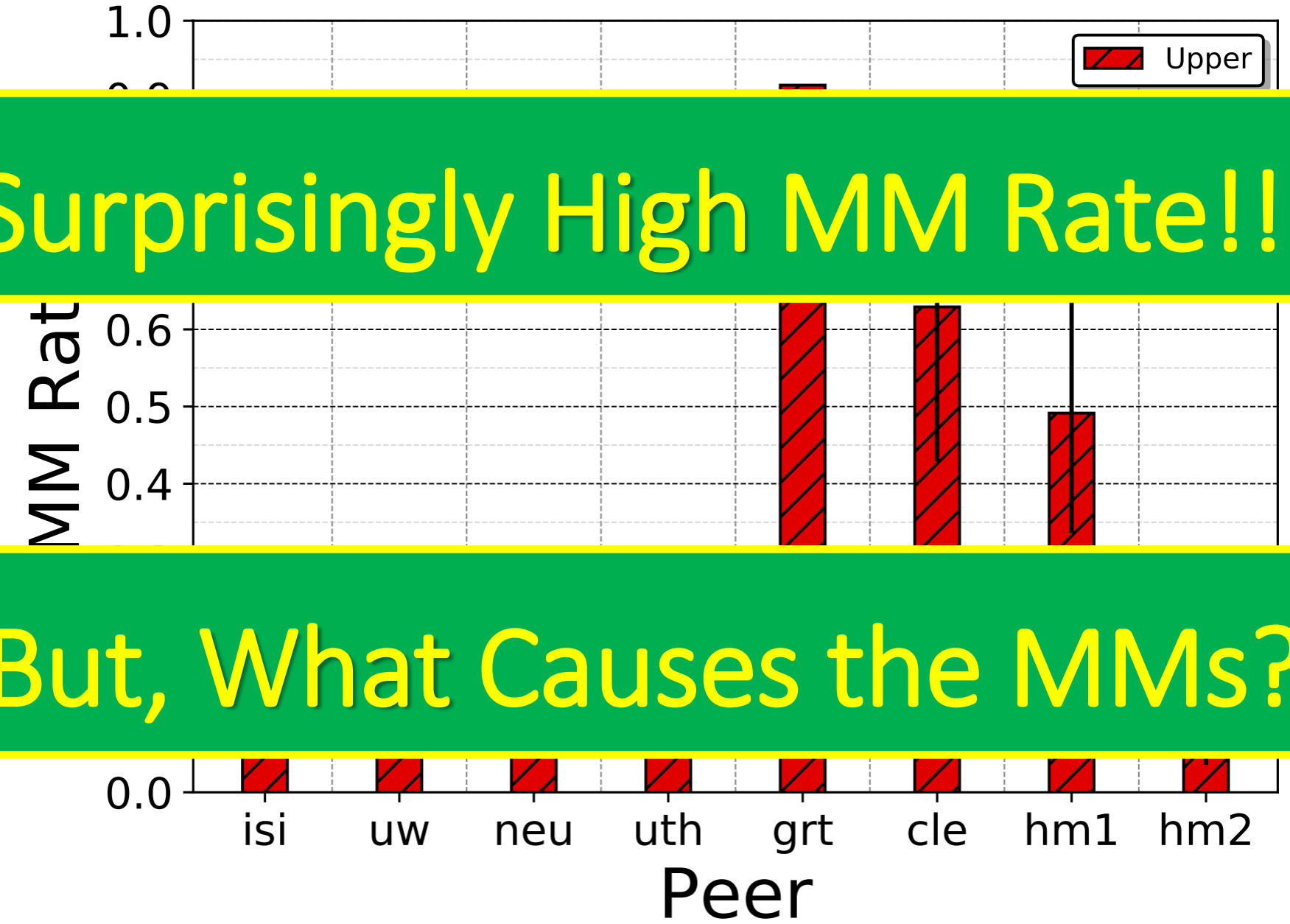
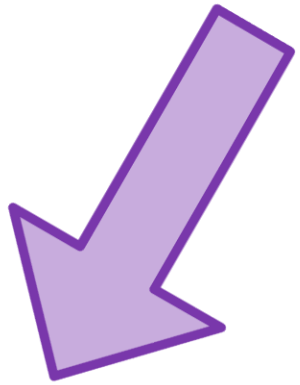



**Surprisingly High MM Rate!! ☹**

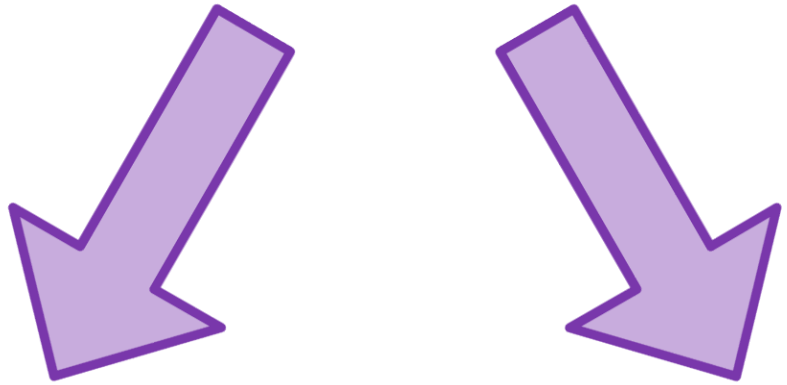
**But, What Causes the MMs? :/**

# MMs Reasons



Lies

# MMs Reasons



Lies

Noise

# MMs Reasons

Are we Just Capturing Noise? :S

Lies

Noise

# MMs Reasons

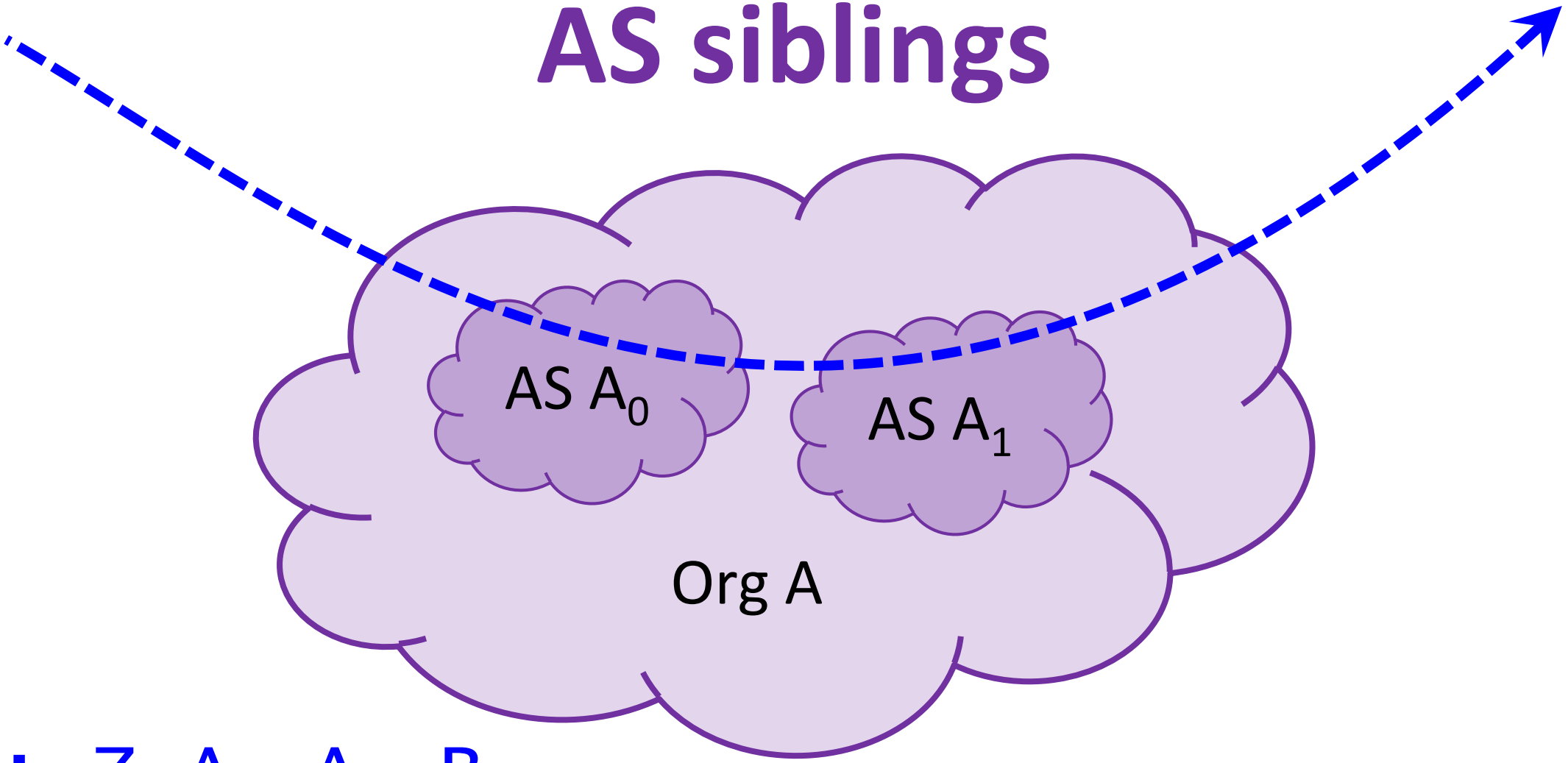
Are we Just Capturing Noise? :S

**Lies** **Noise**

Please, Define Noise ☺

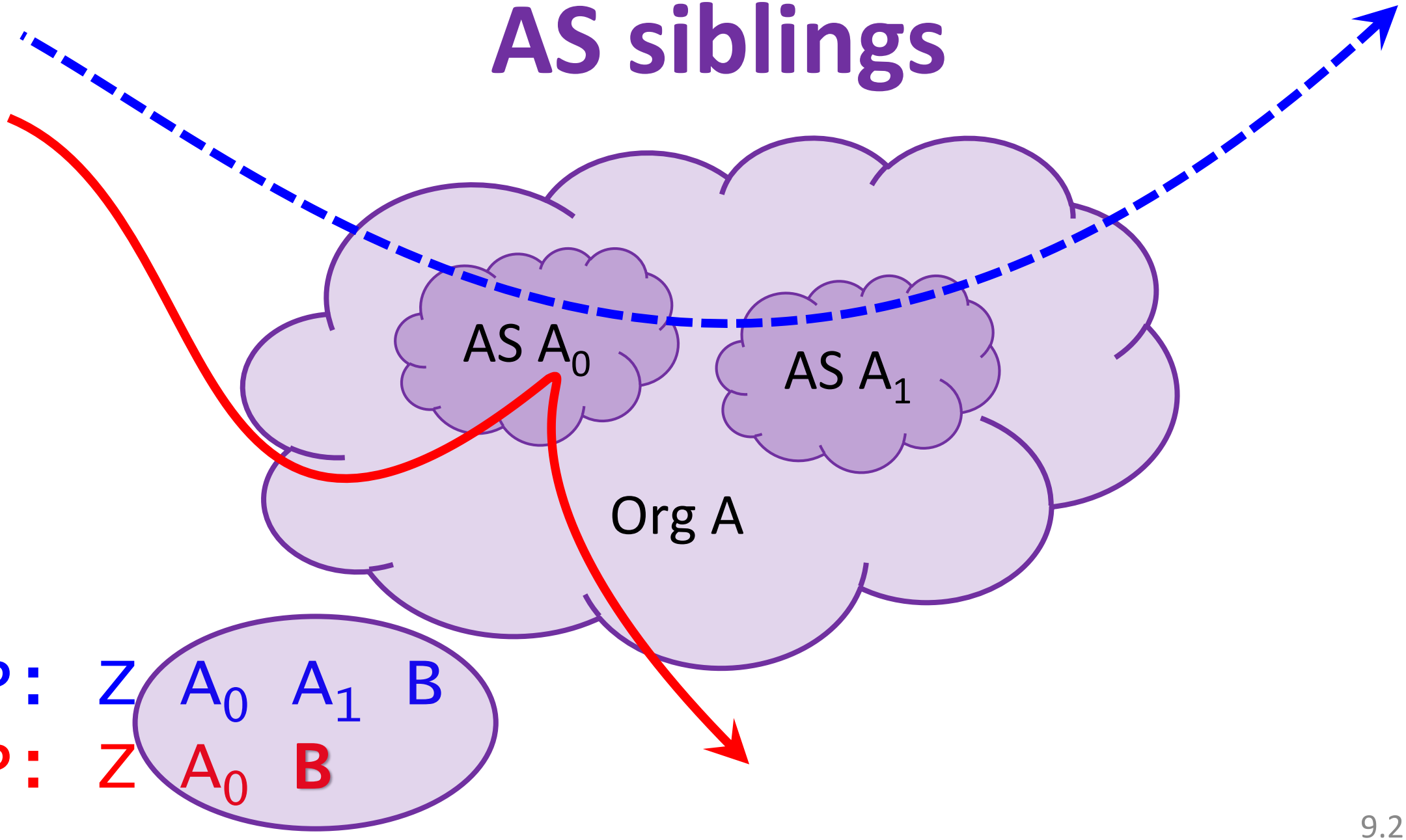
Noise
AS siblings
Third-Party Addresses (TPAs)
Wildcards (e.g. missing hops)

# AS siblings

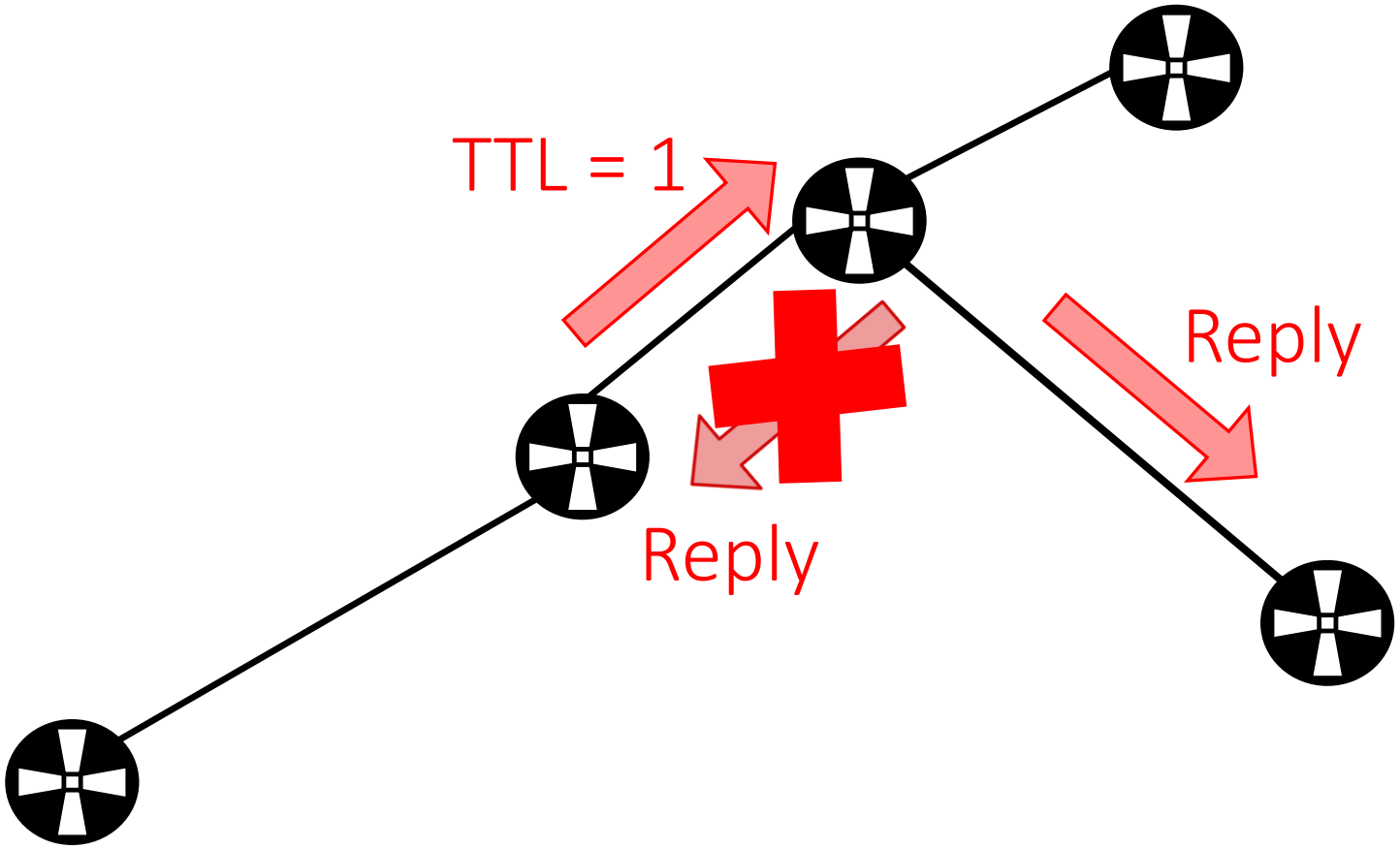



CP: Z $A_0$ $A_1$ B

# AS siblings



# TPAs



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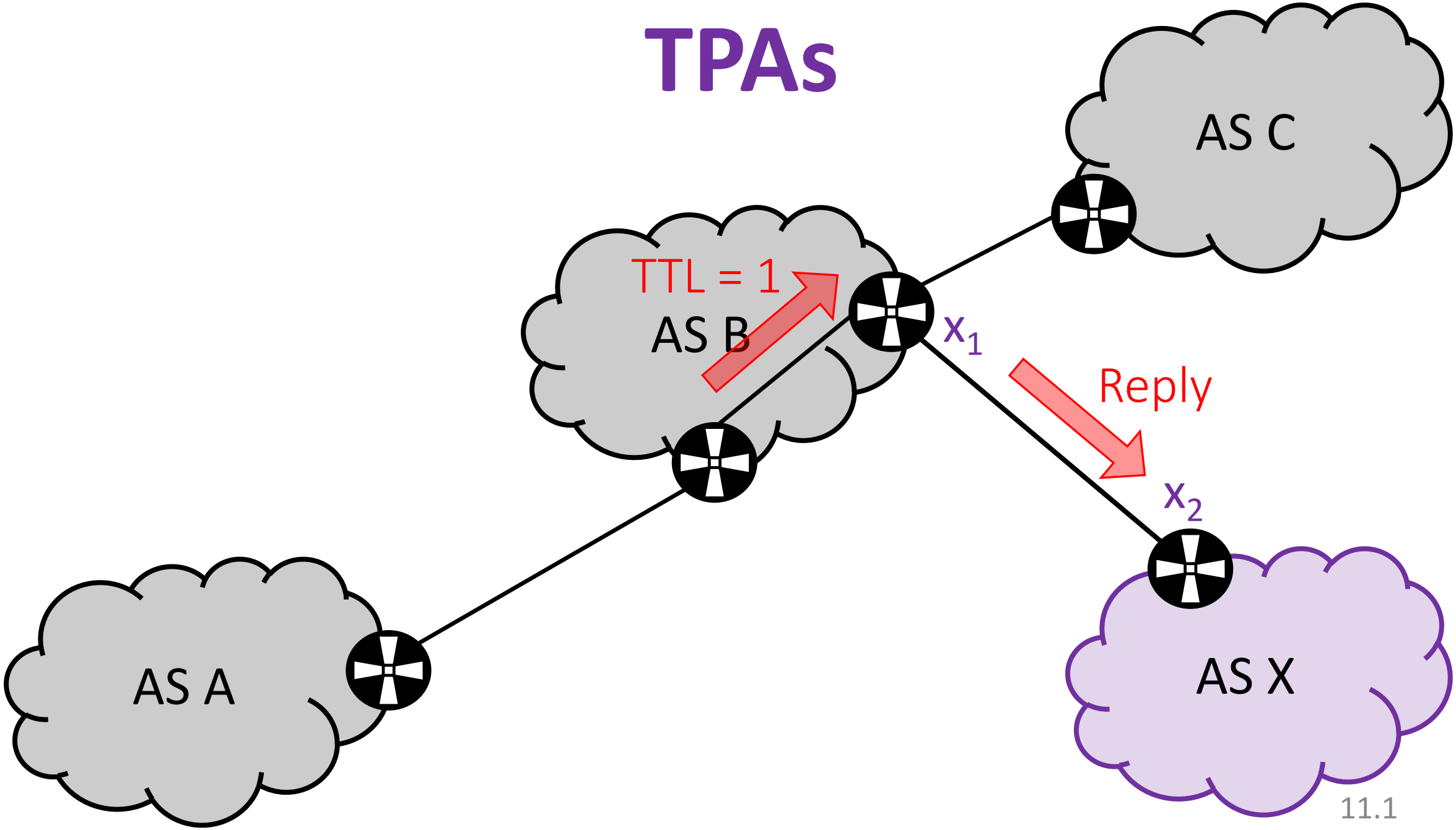
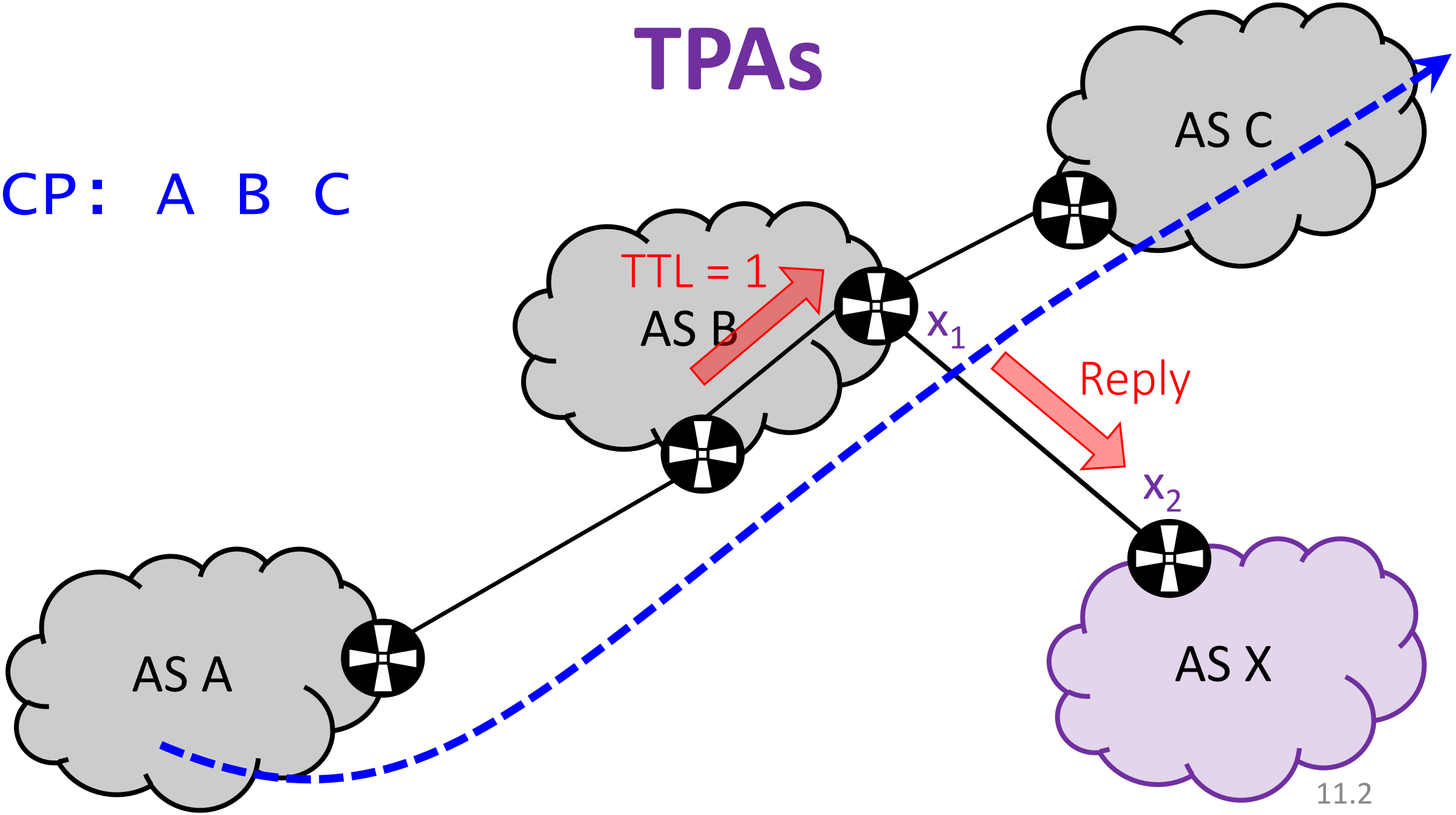


# TPAs

CP: A B C



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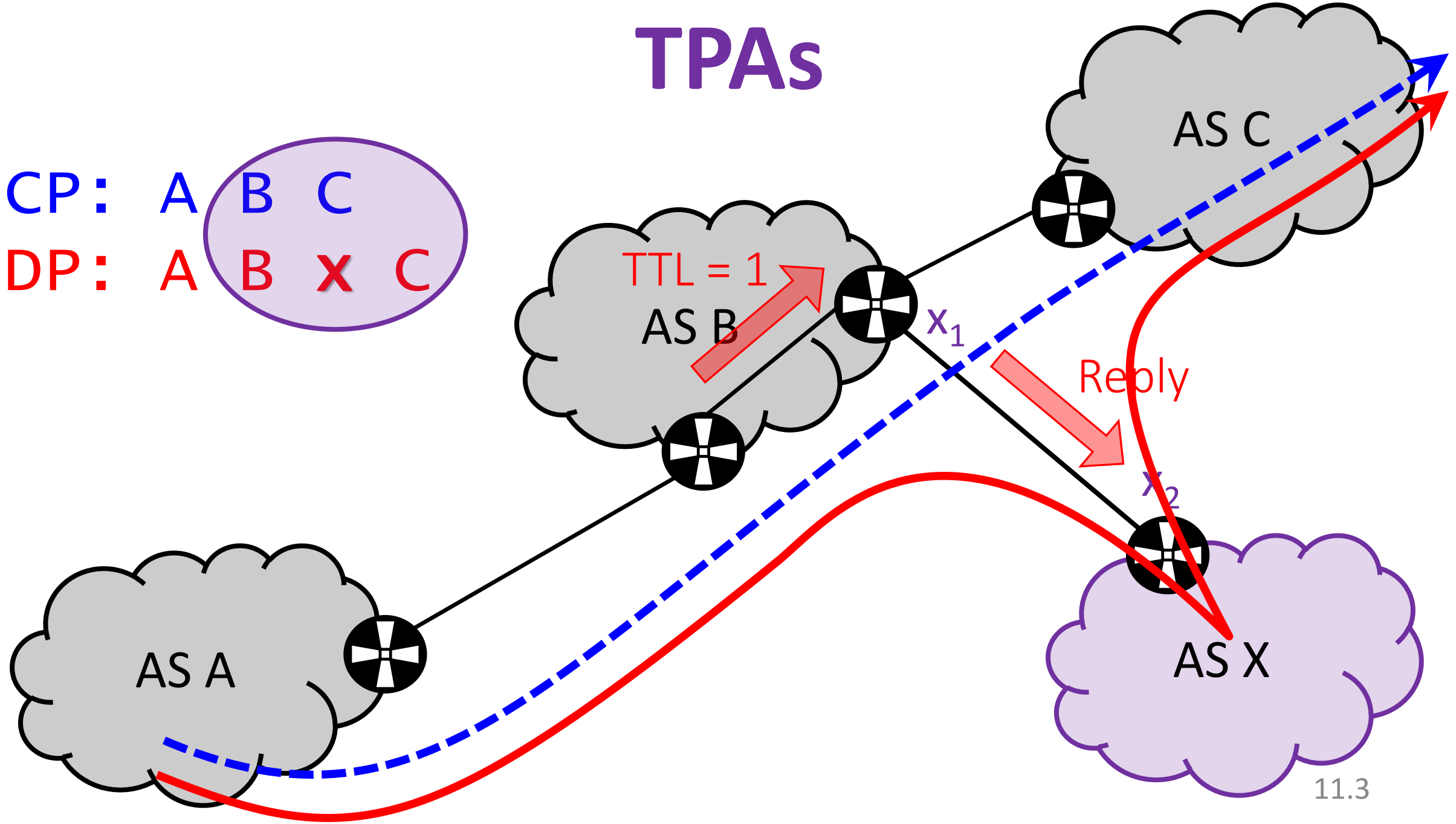
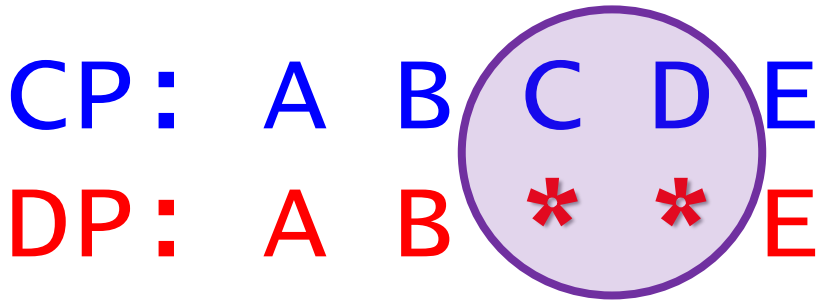


# Wildcards

Missing hops

Private IP Addresses

IP-to-AS mapping undefined

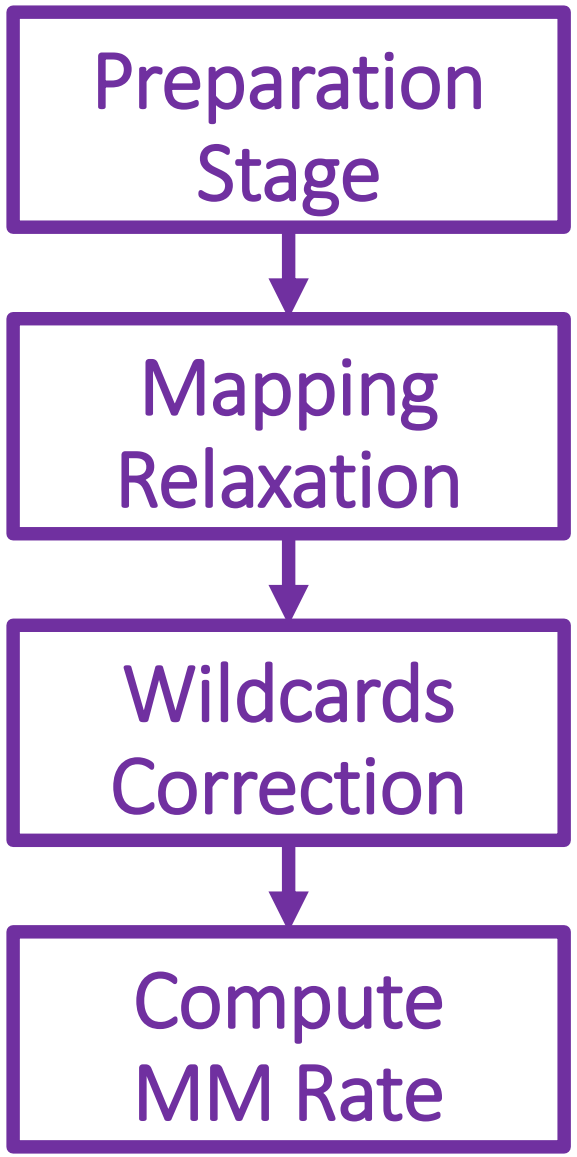


…

# **Filtering** The Noise to Reveal Inter-Domain Lies

…

# A Framework


Preparation Stage
Mapping Relaxation
Wildcards Correction
Compute MM Rate

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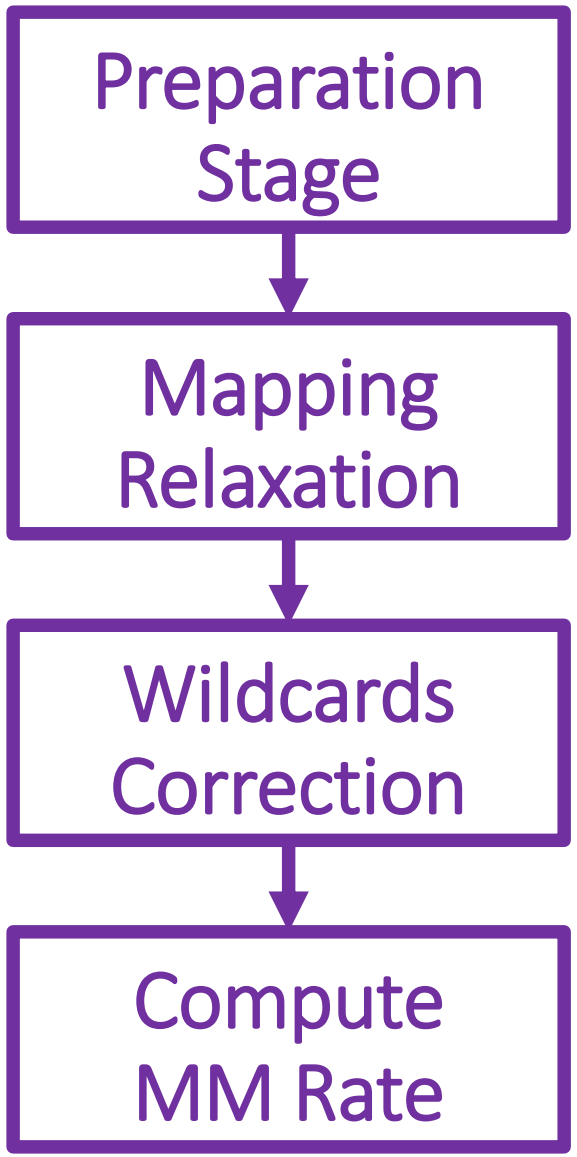


## Mapping Relaxation

**SIB**: AS-to-ORG mapping

**TPA**: Remove candidate TPAs

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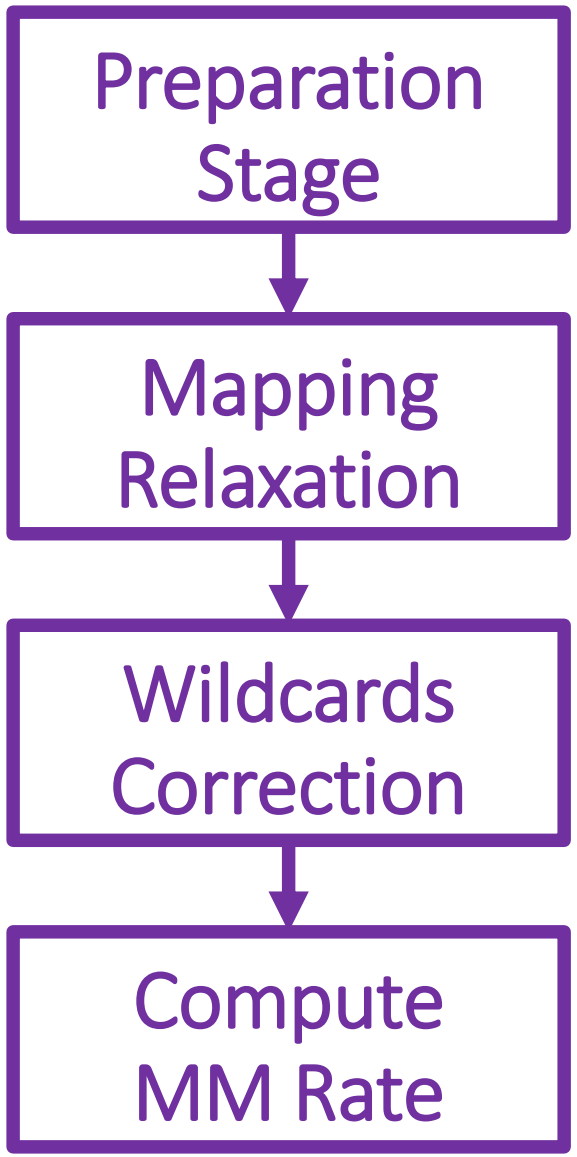


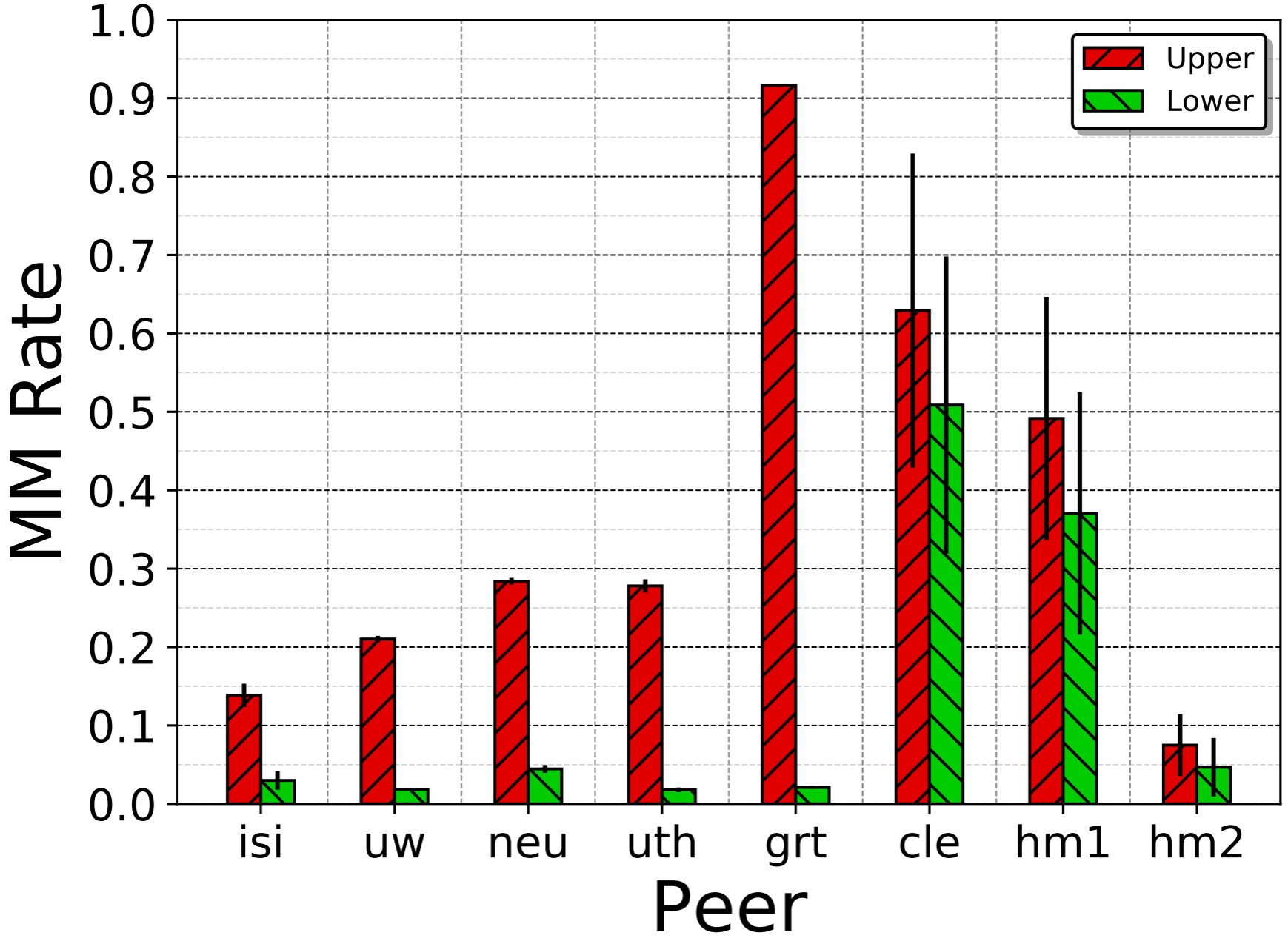

## Mapping Relaxation

**SIB**: AS-to-ORG mapping
**TPA**: Remove candidate TPAs

## Wildcards Correction

**match*:** replace wildcards
**nomatch*:** remove wildcards

# MMs Bounds in the Wild



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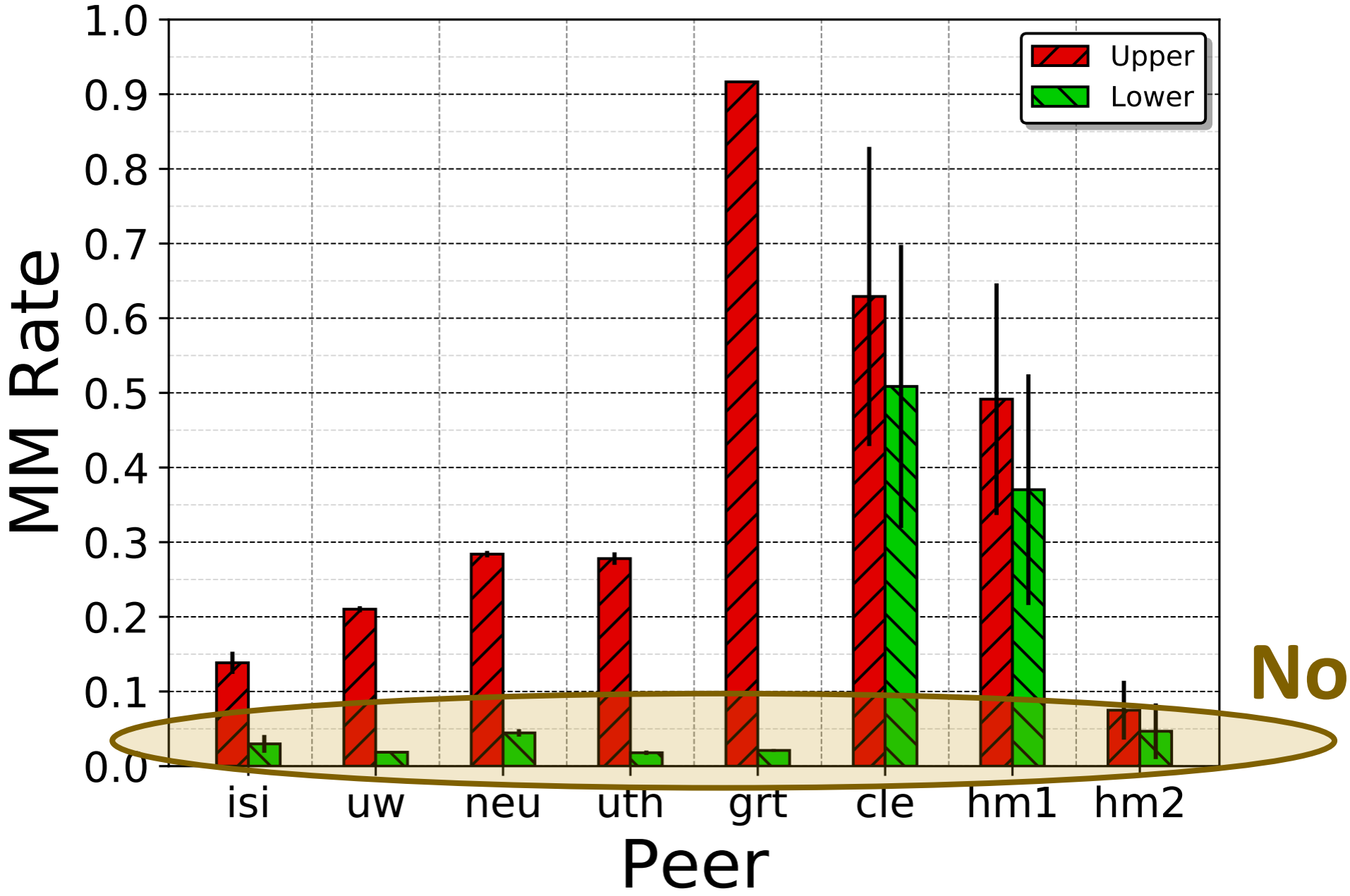
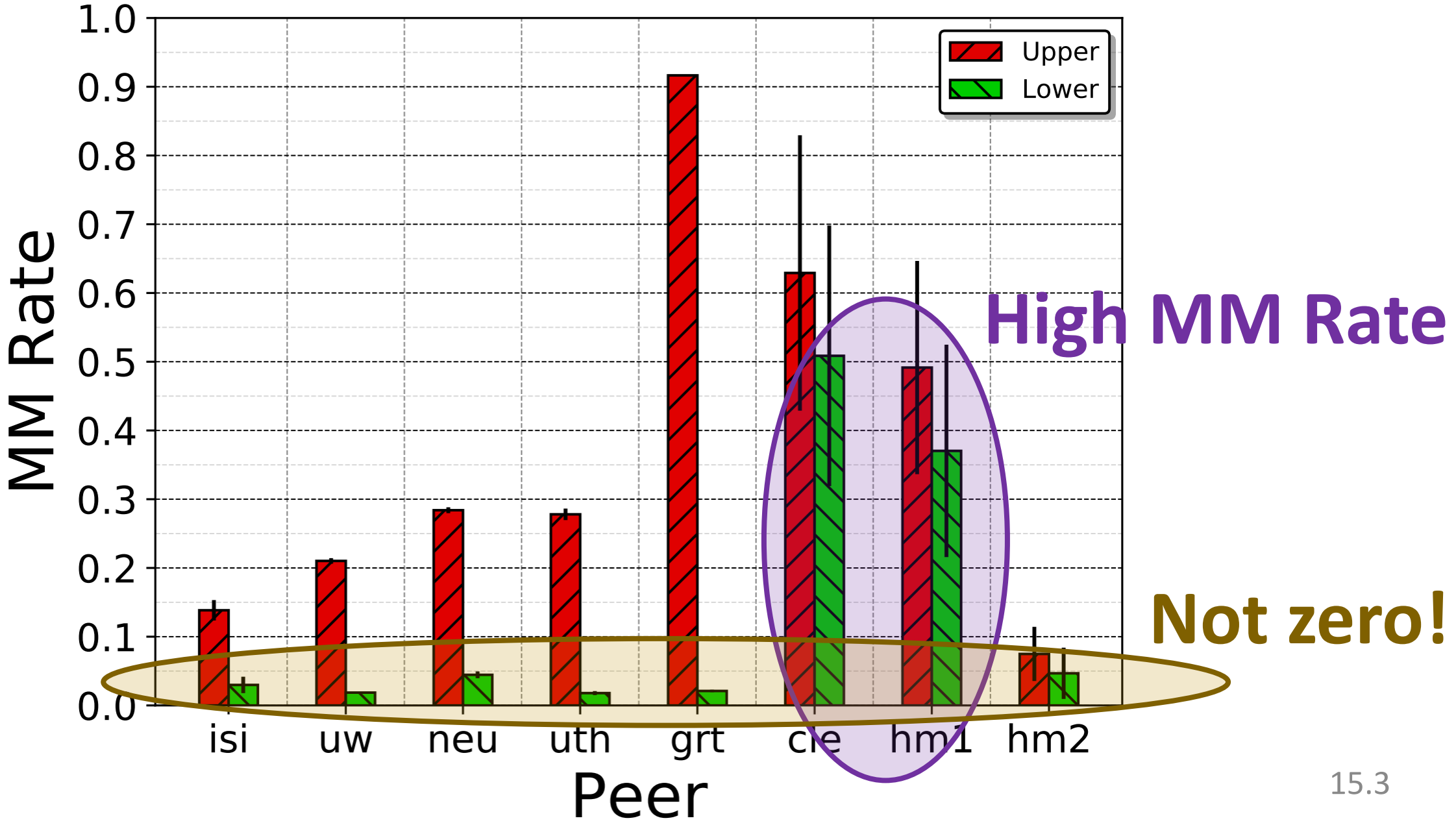



**Not zero!**

# MMs Bounds in the Wild



# Conclusions

The Lower Bound of MMs
**is not negligible**

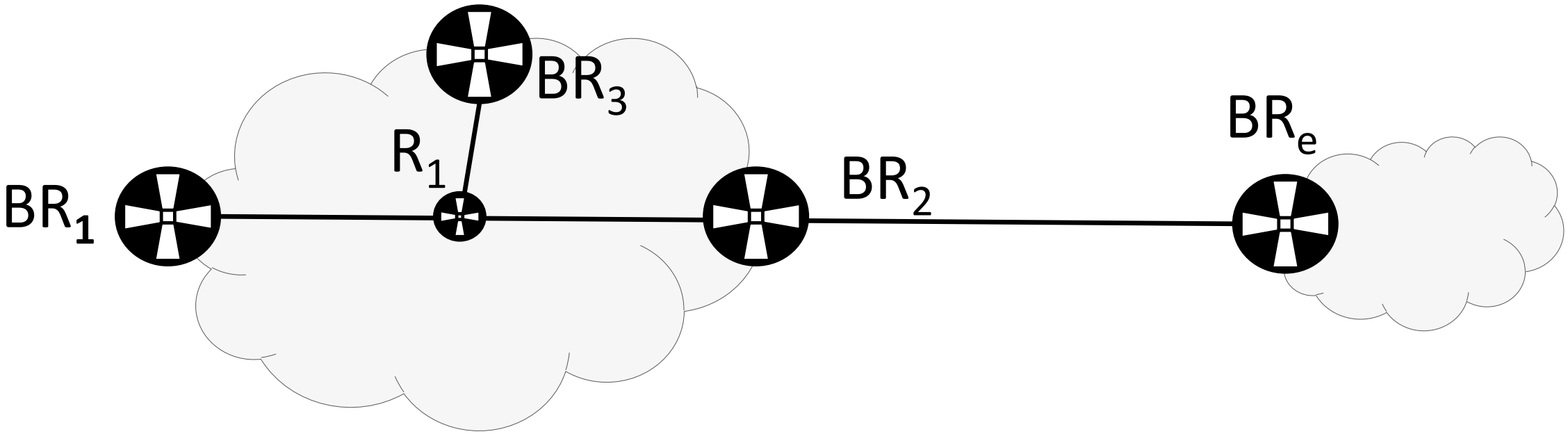
Noise usually **does not** include
AS siblings and TPAs
**at the same time**

# Conext 2019…?

*“Routing Inconsistencies at the FIB Level”*

**Work In Progress**

# What is a **routing inconsistency (RI)**?



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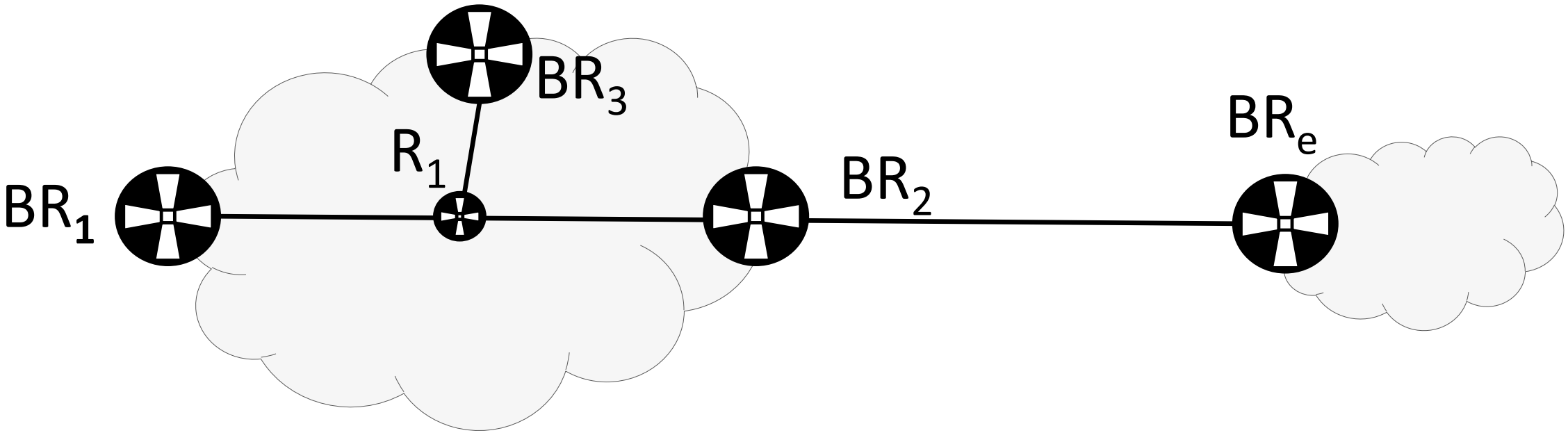

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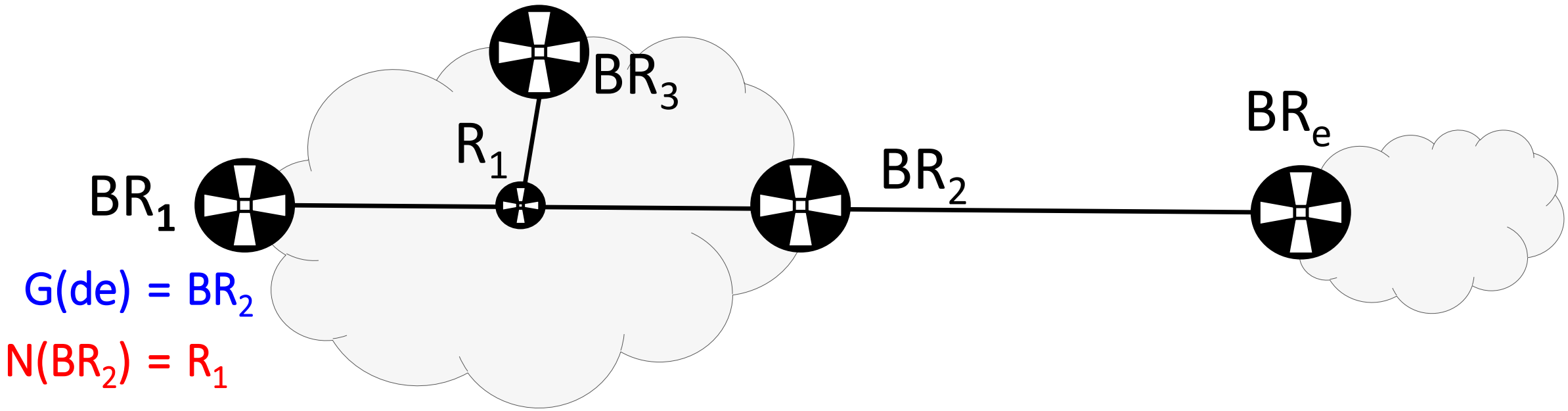

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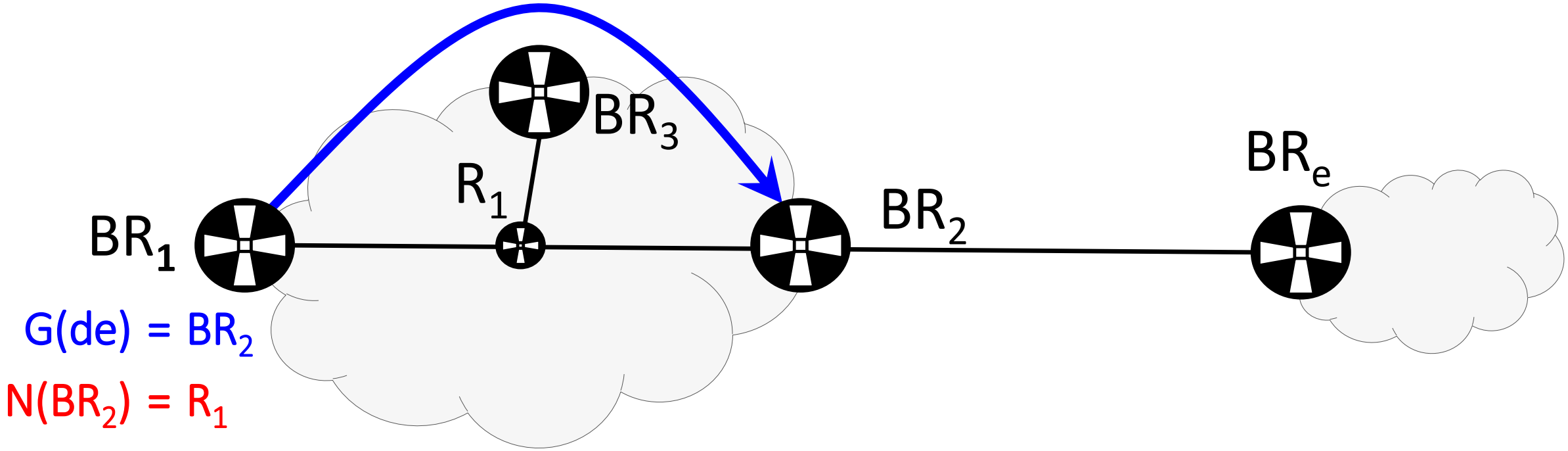

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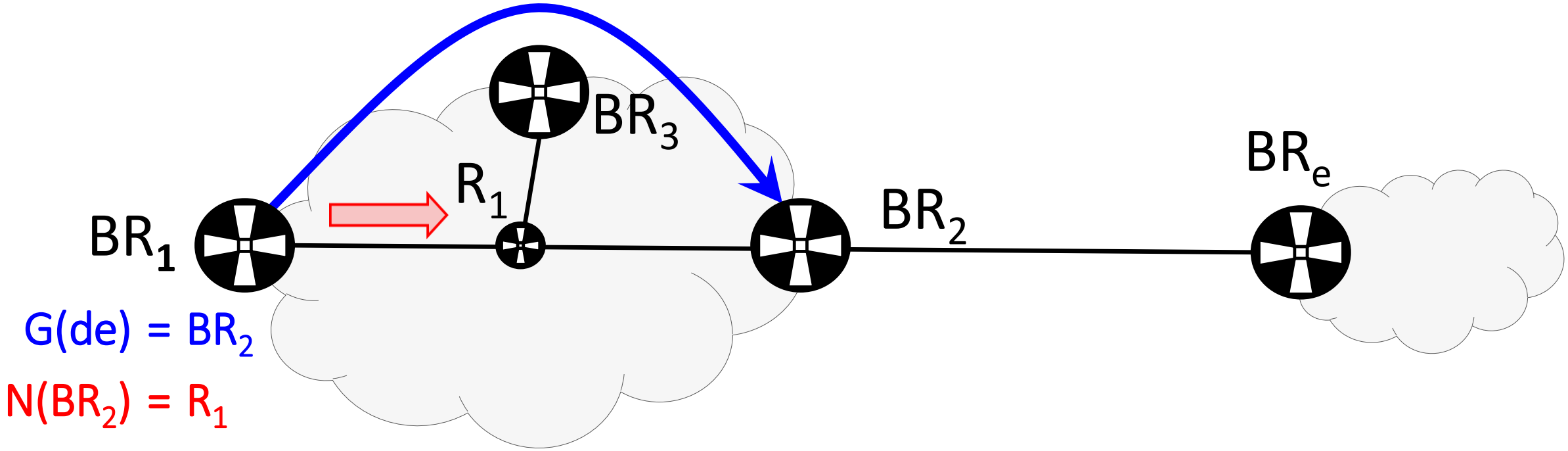

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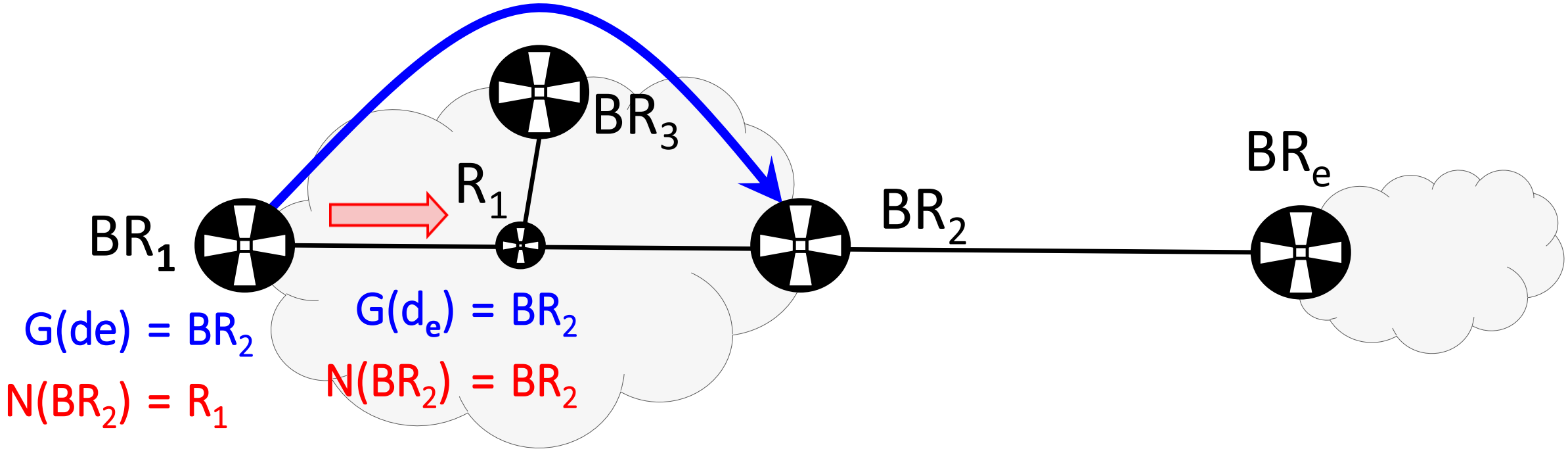

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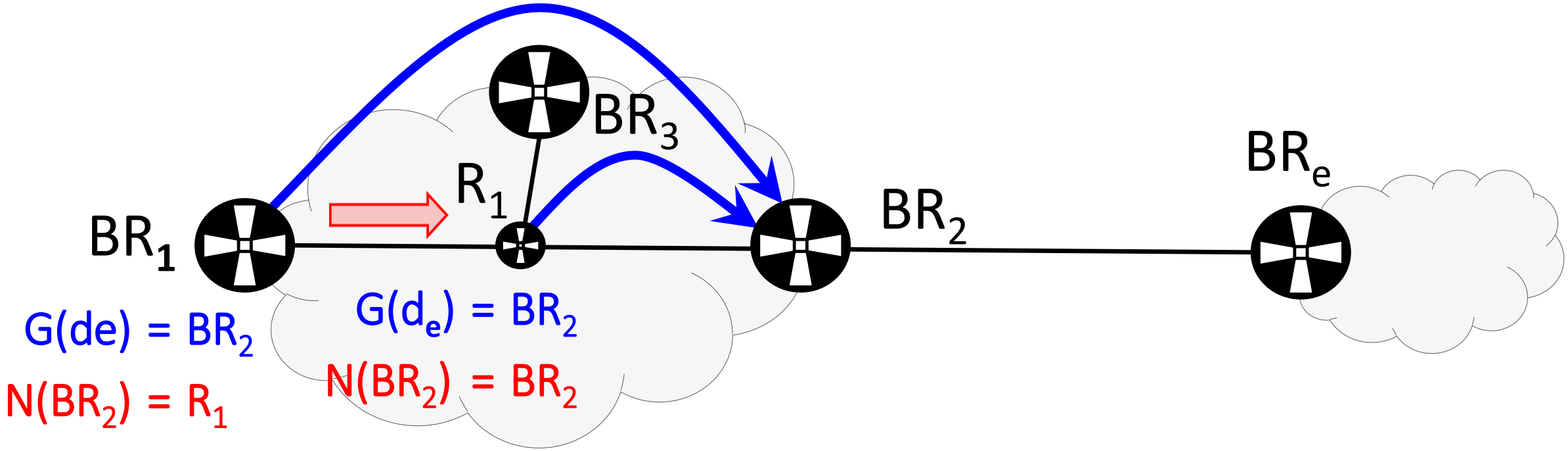

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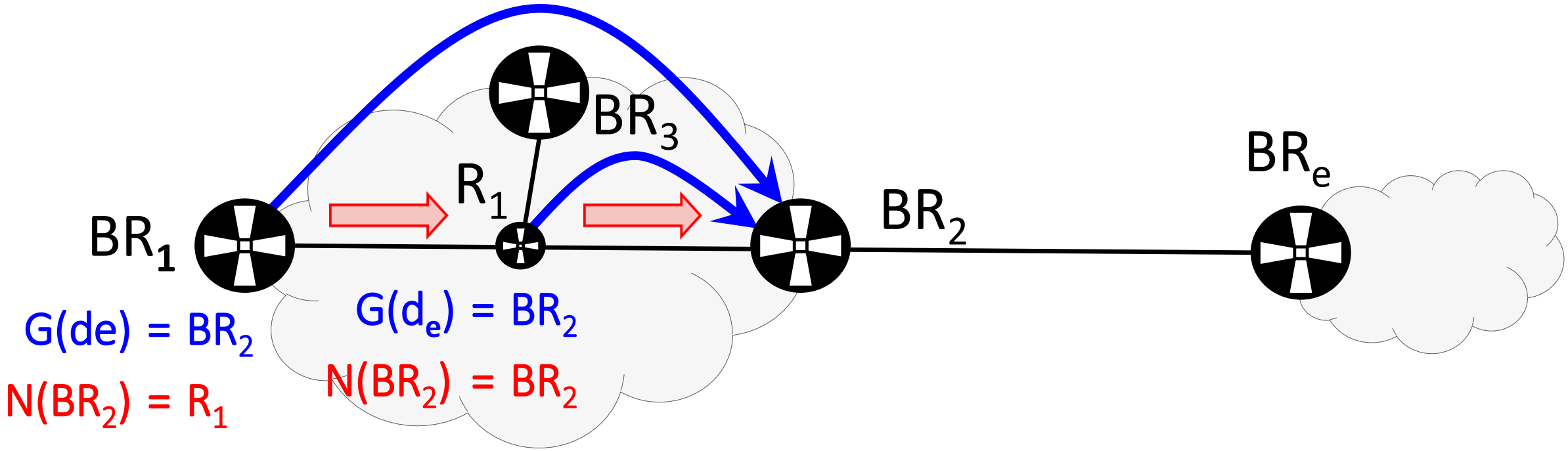

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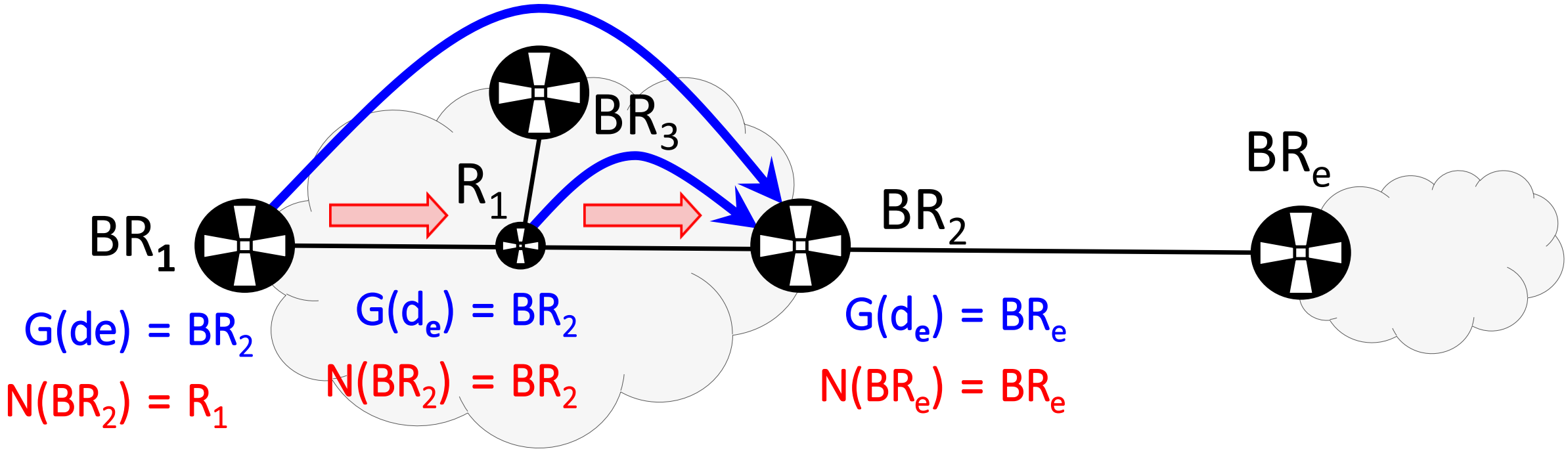

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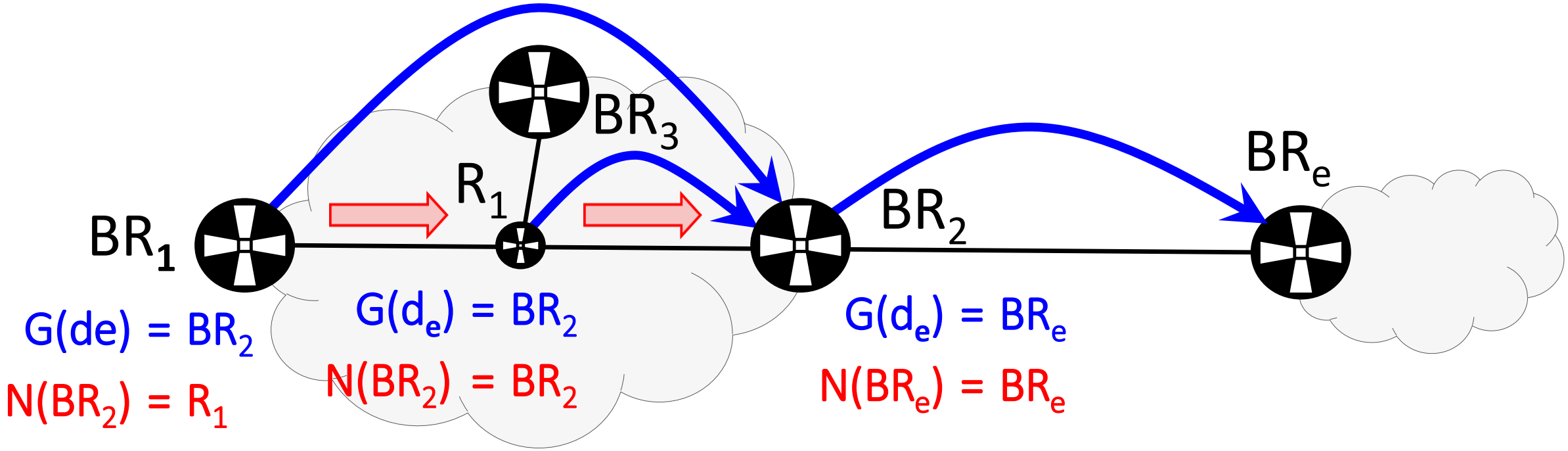

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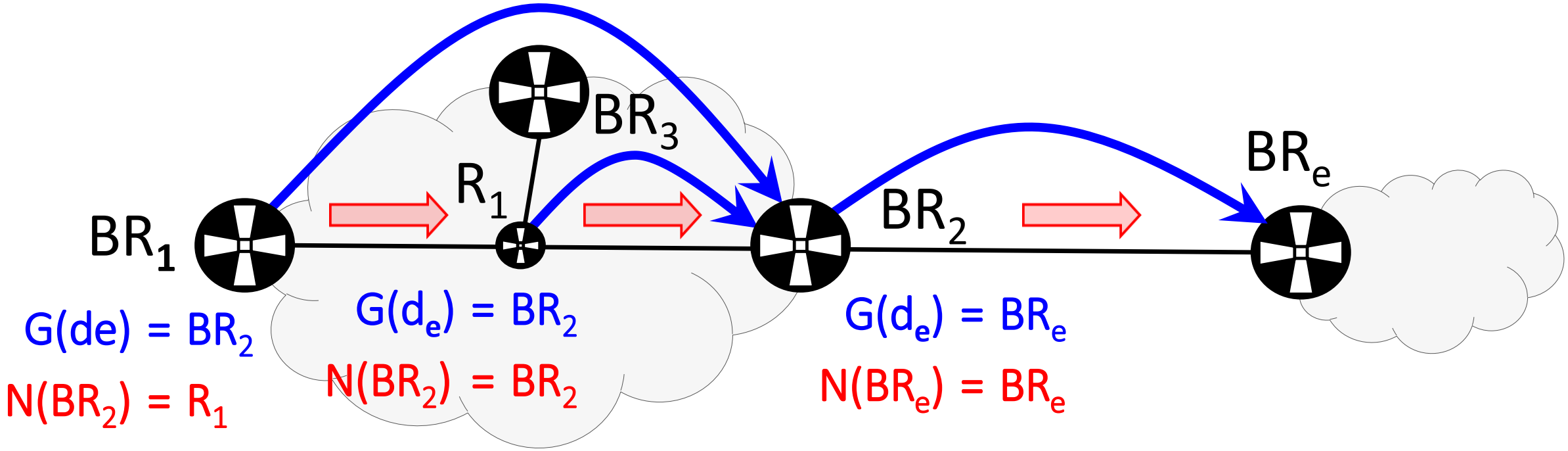

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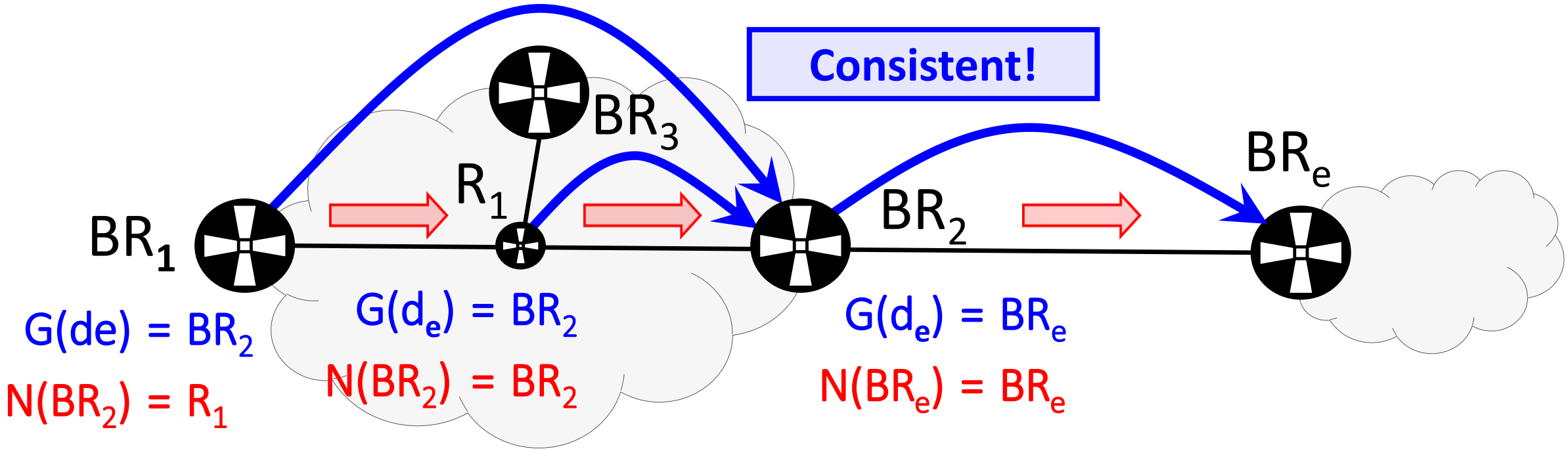

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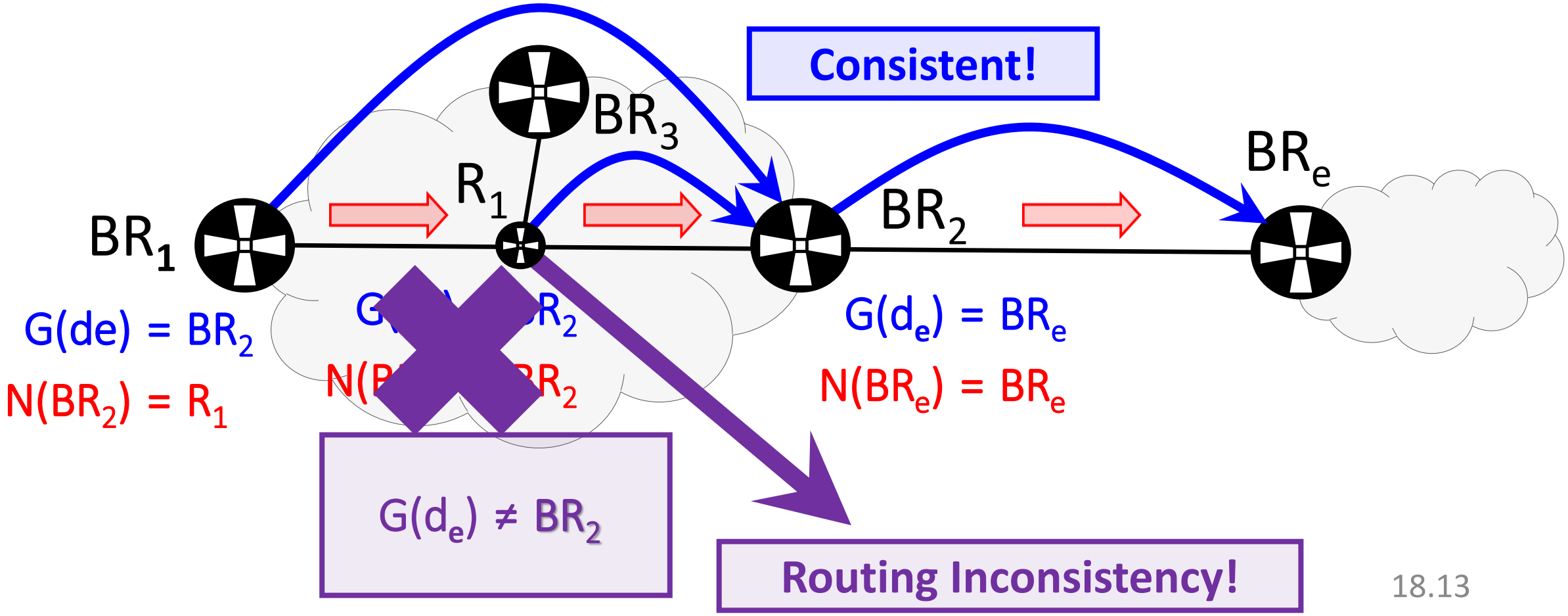
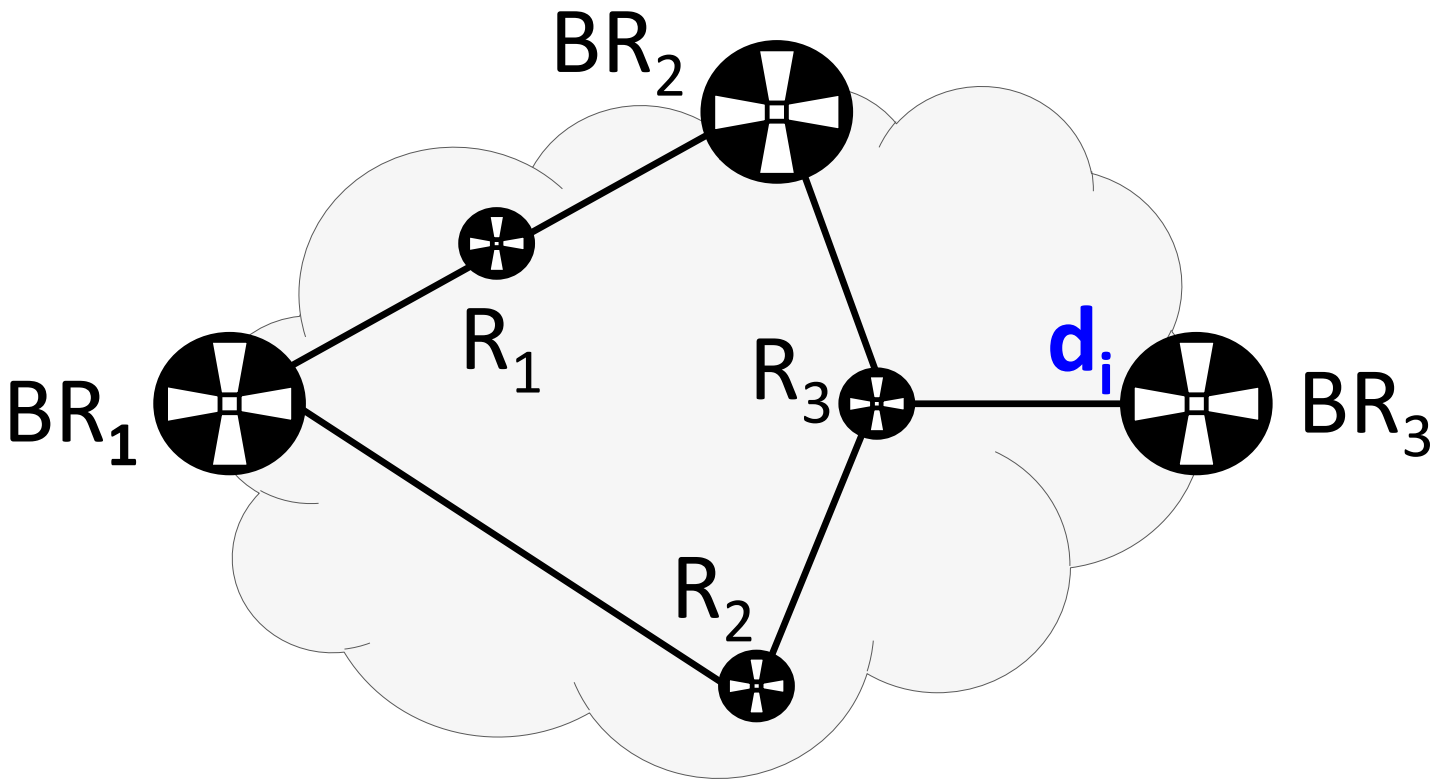


# What are the **effects** of RIes?

**Dest -> d**



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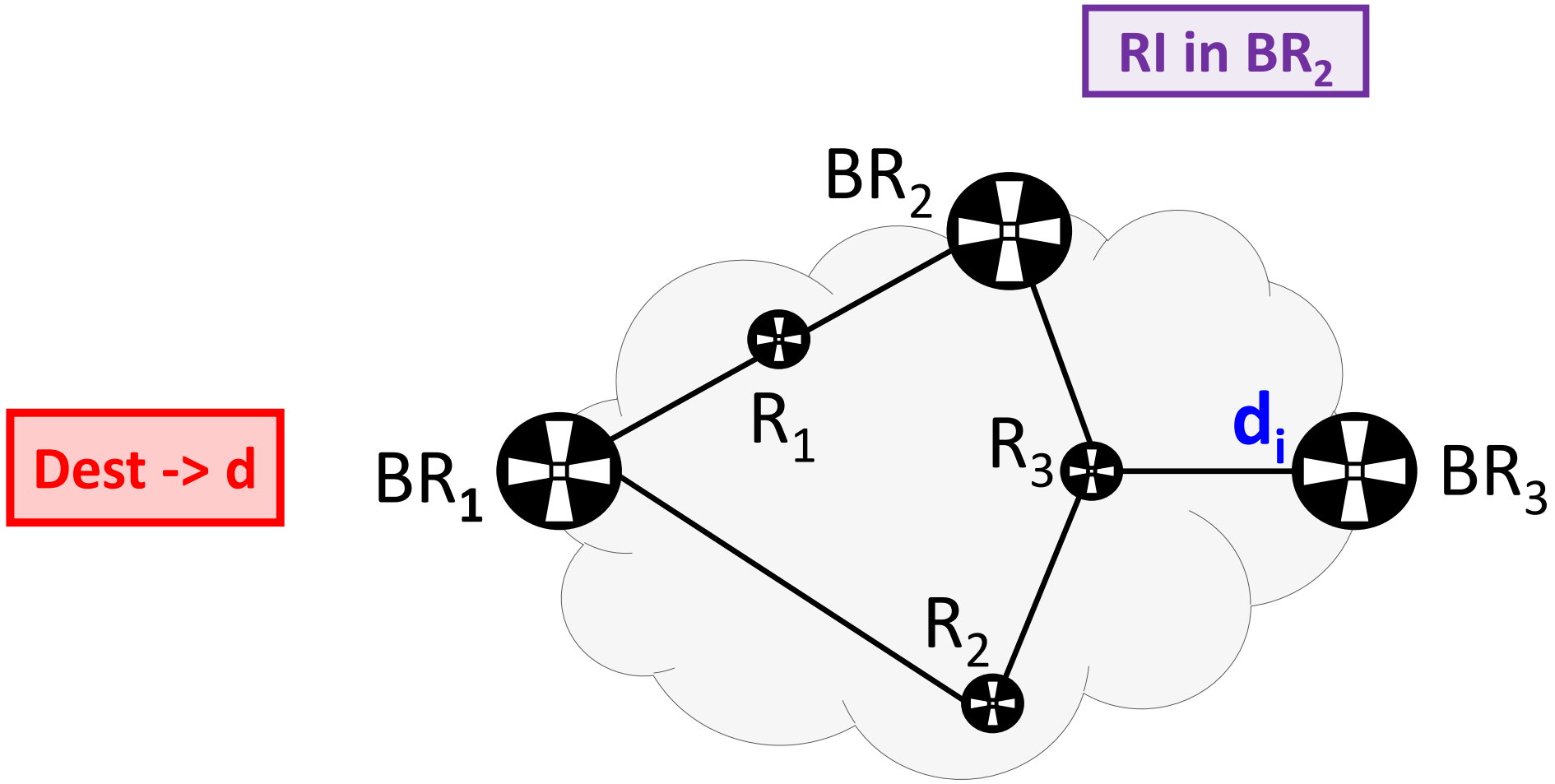

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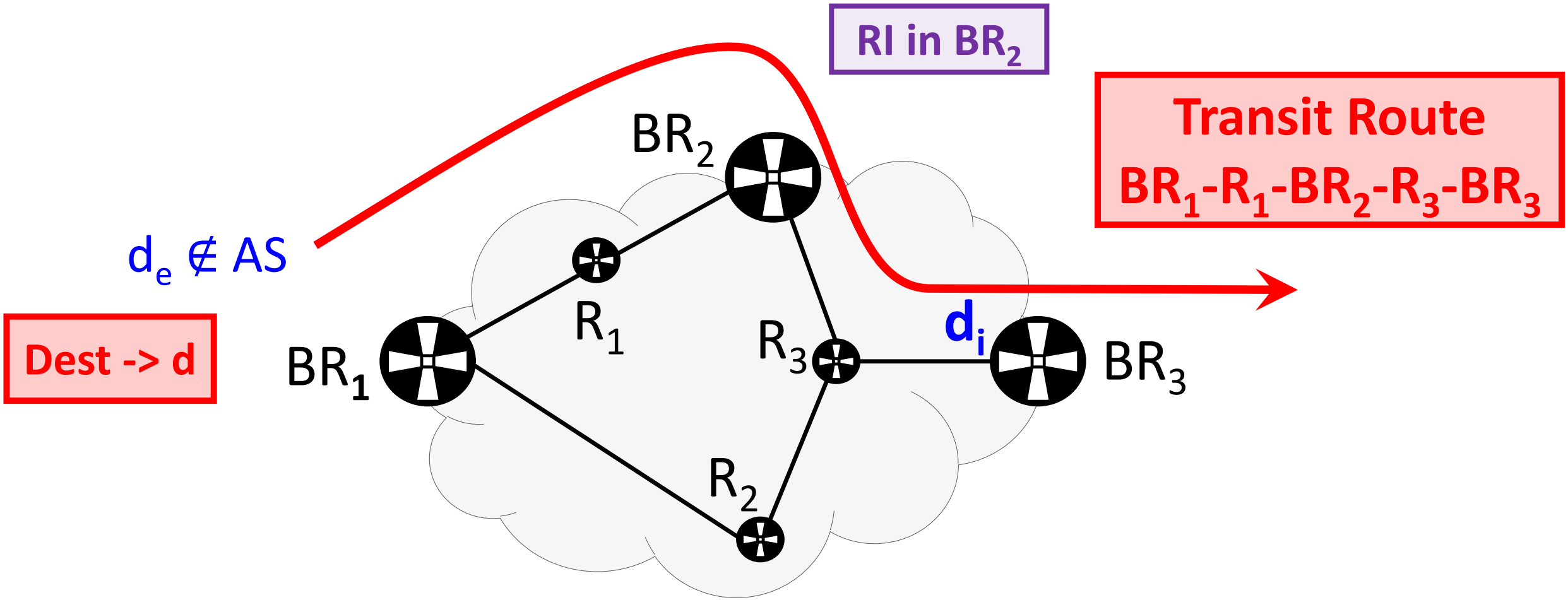

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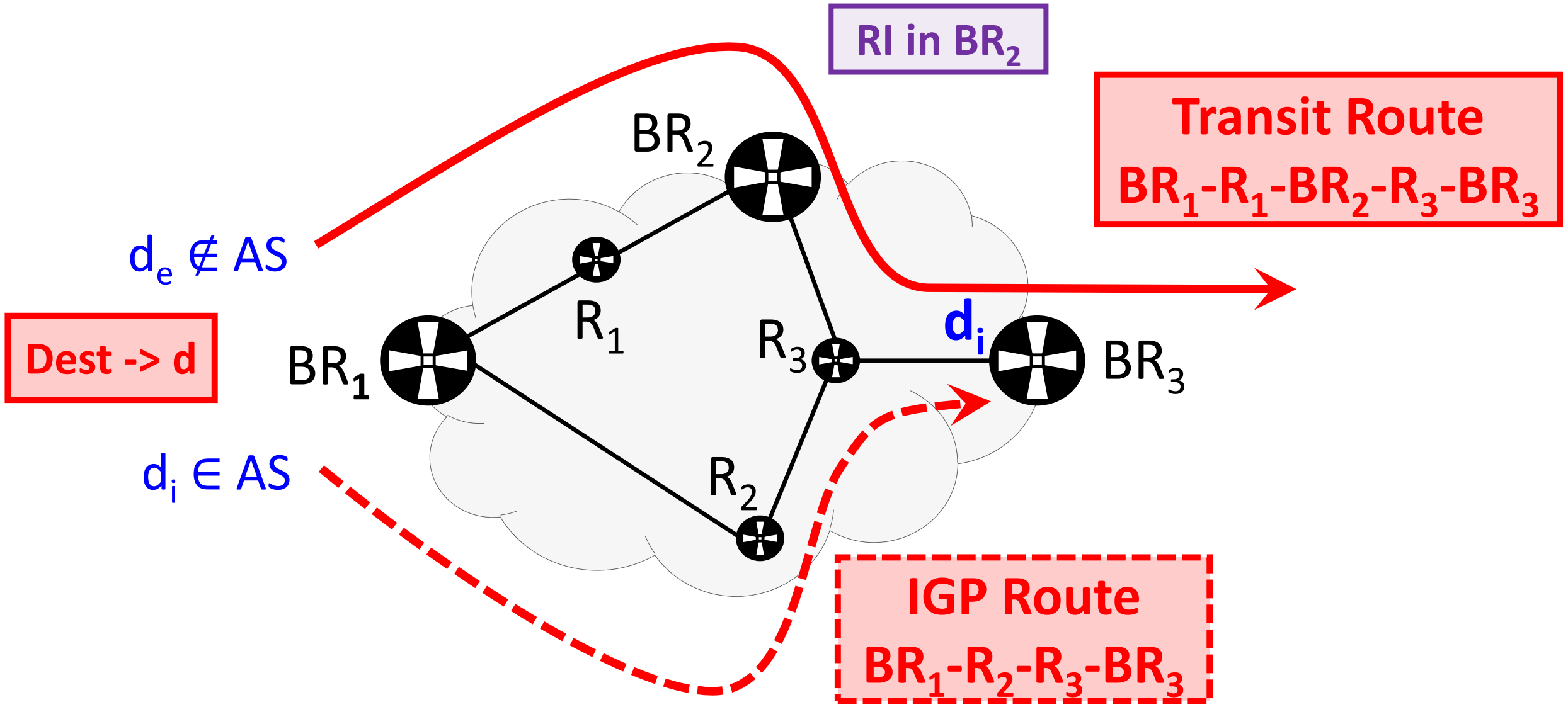

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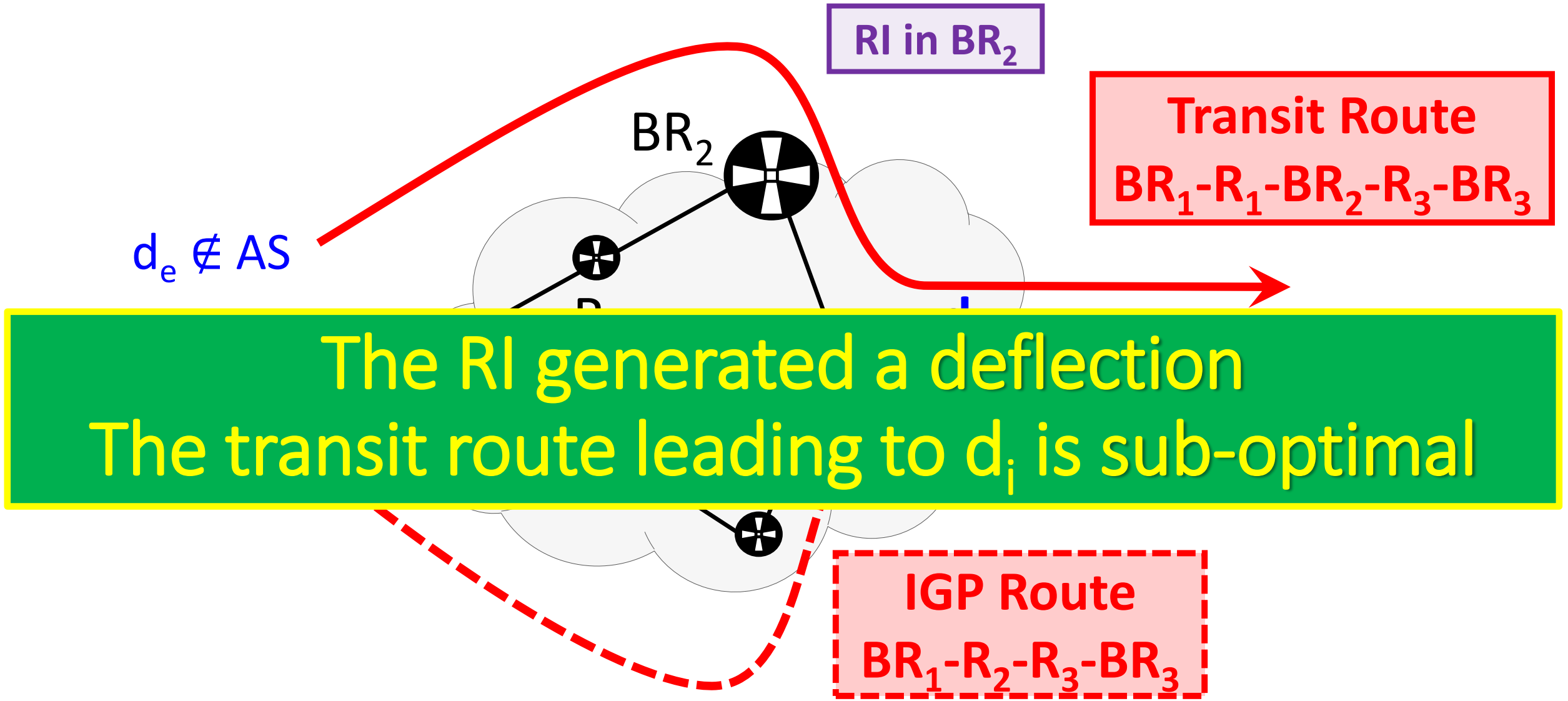
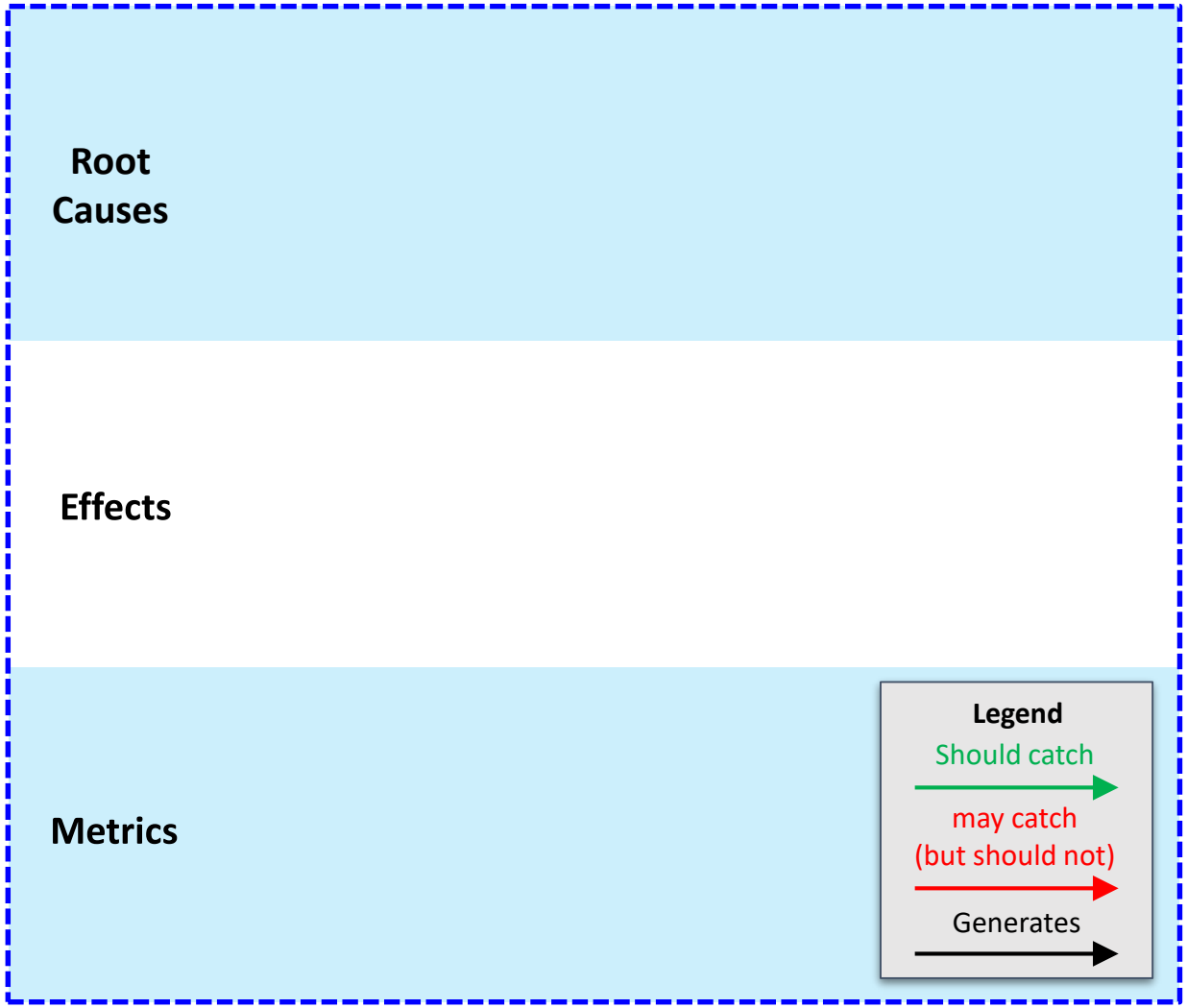


# A **challenging** problem



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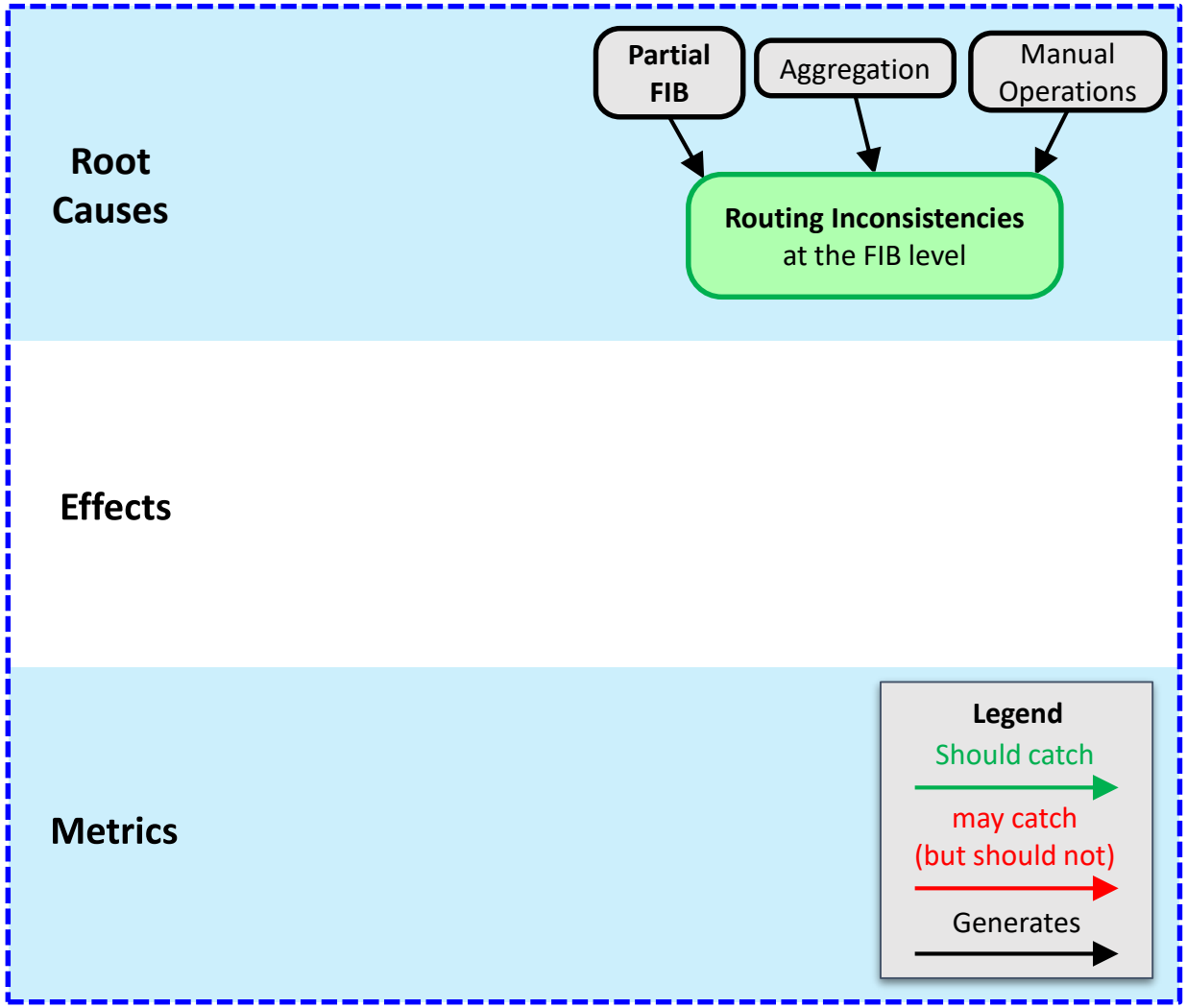

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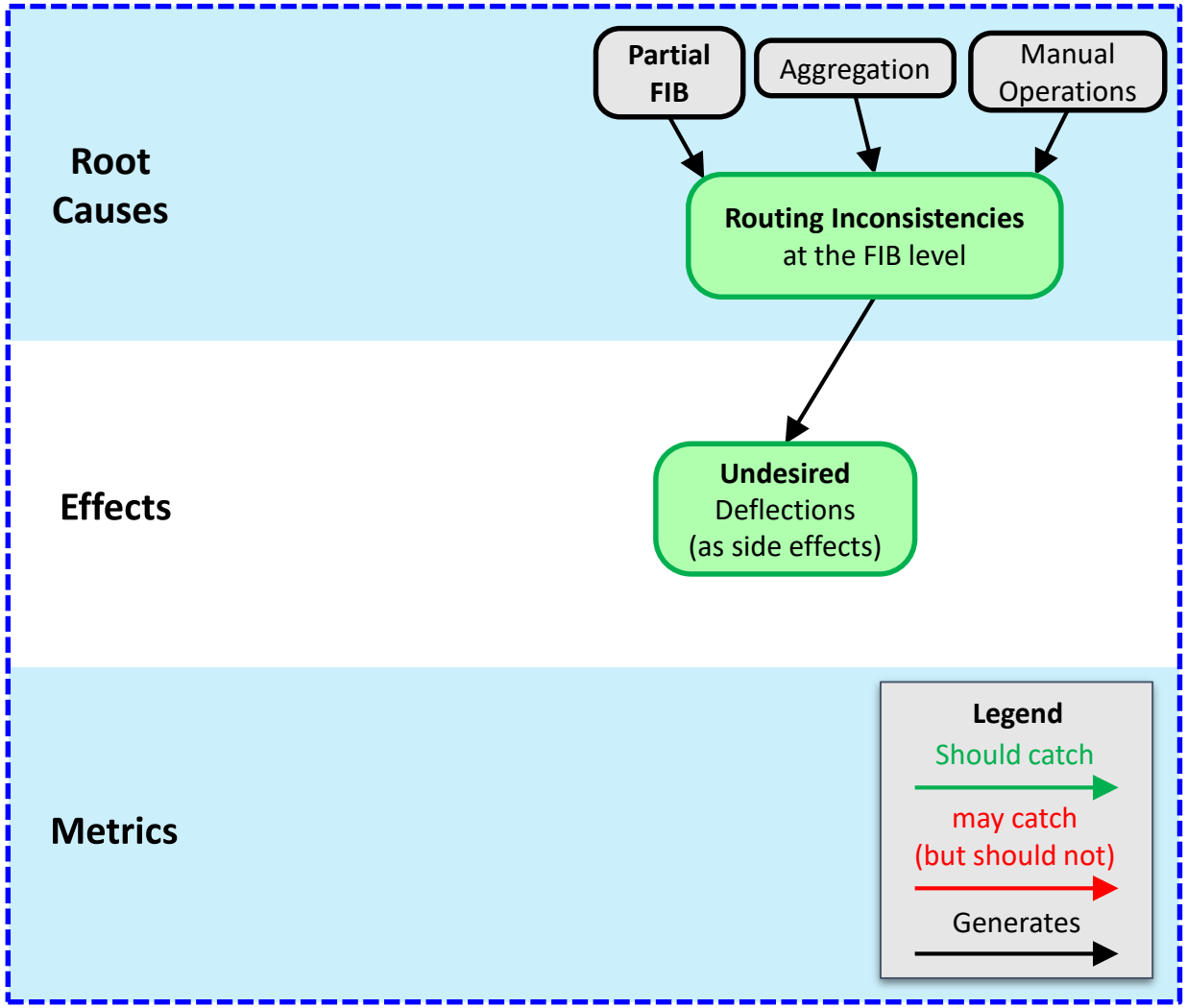

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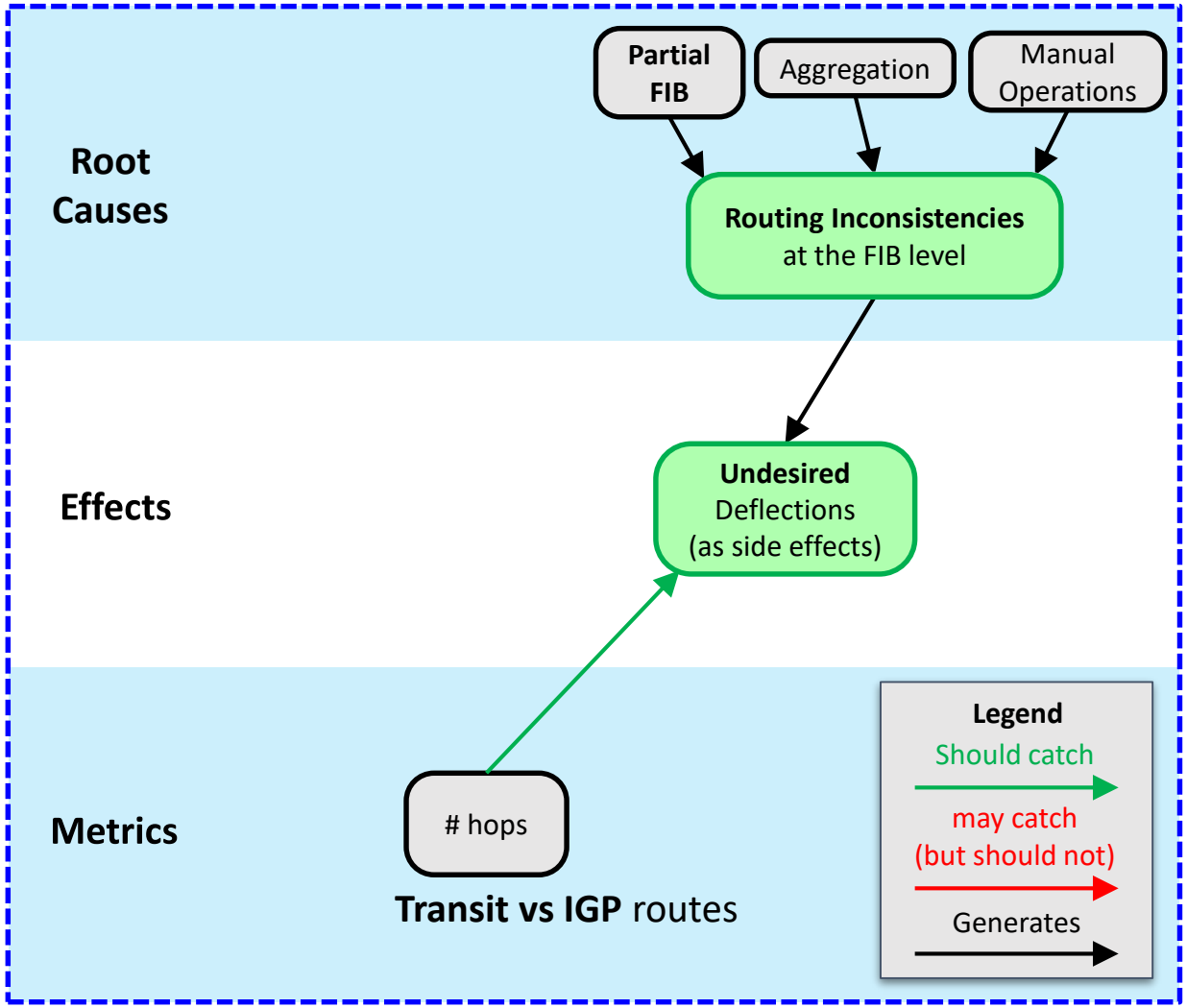

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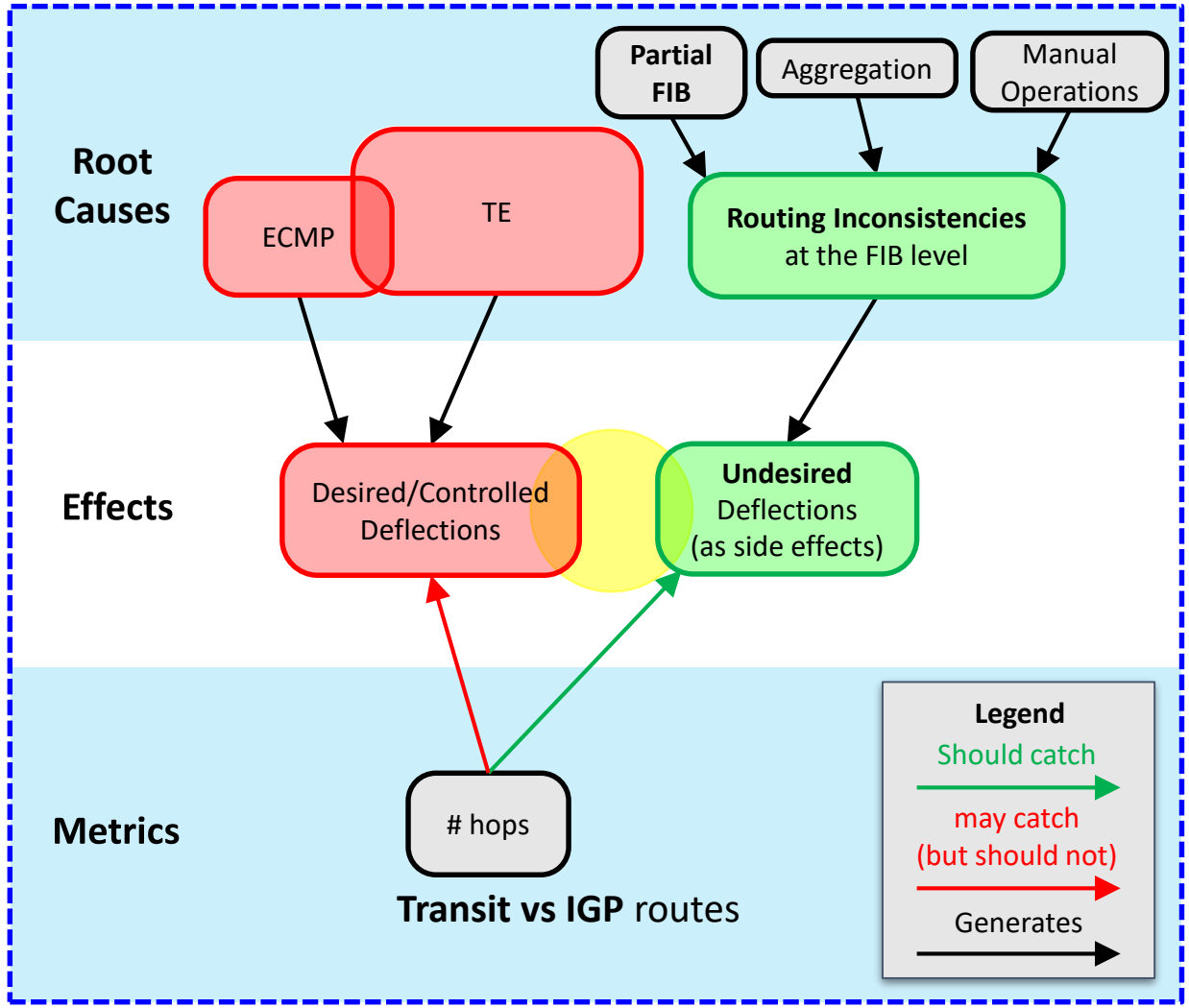

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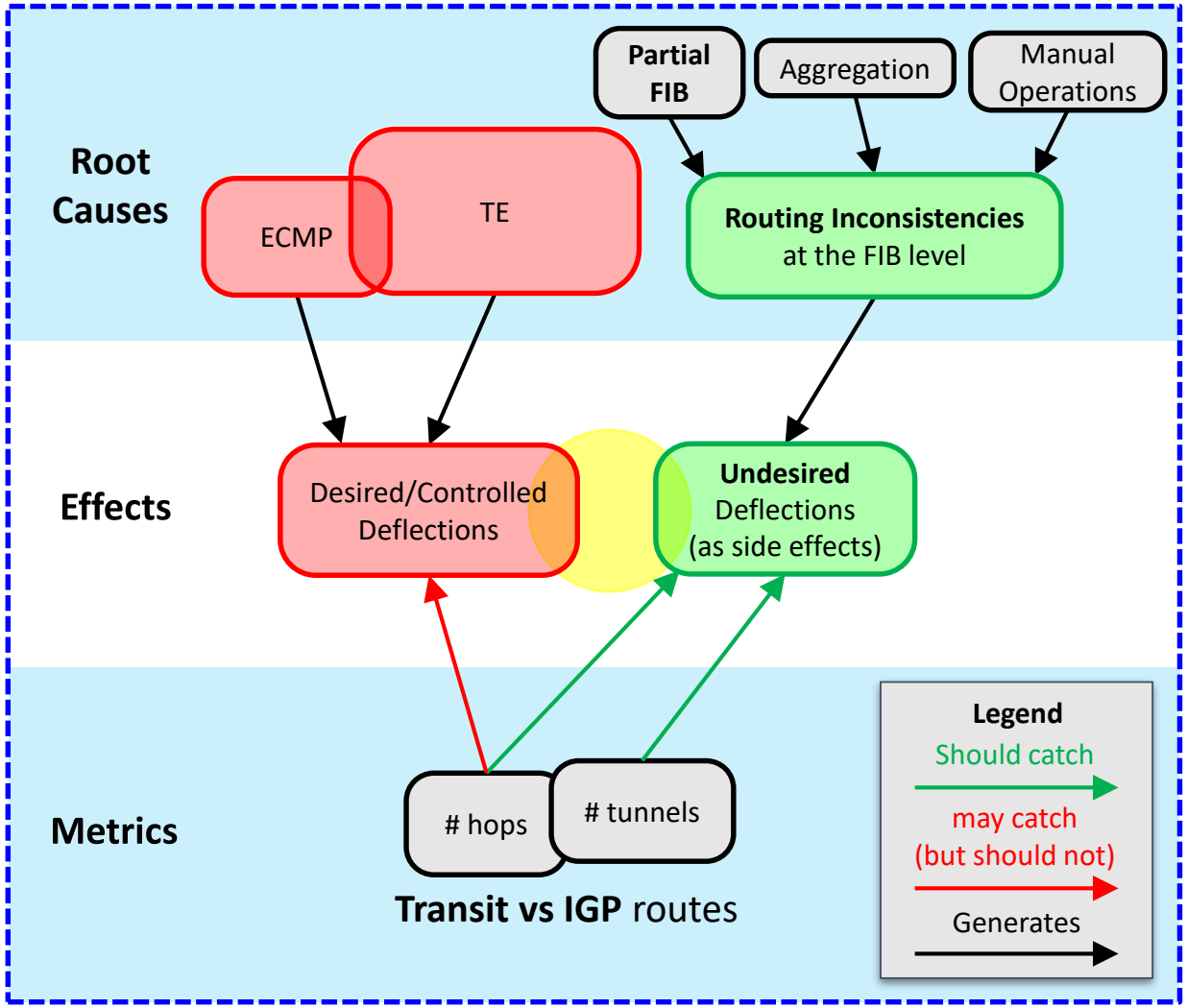
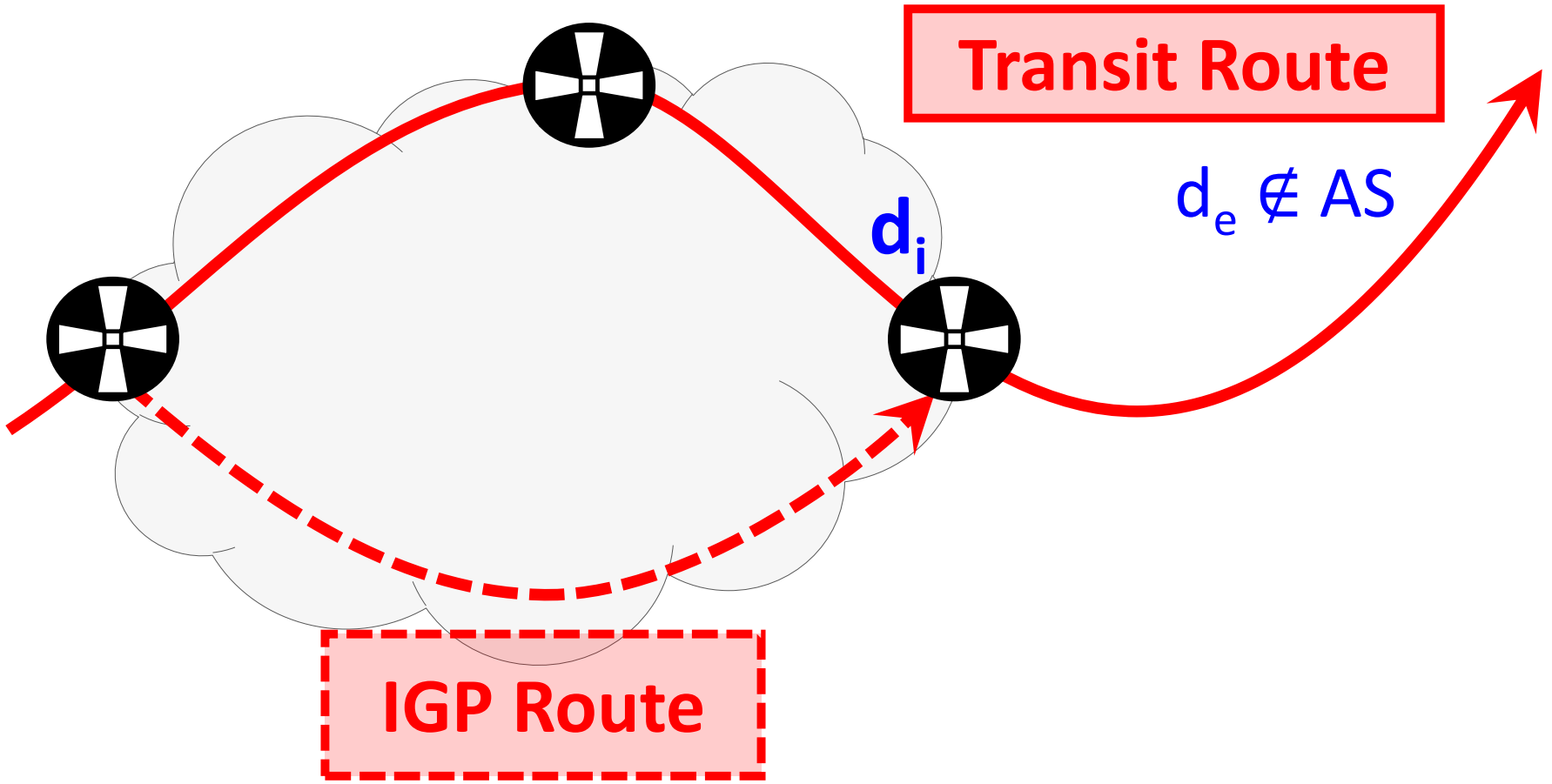
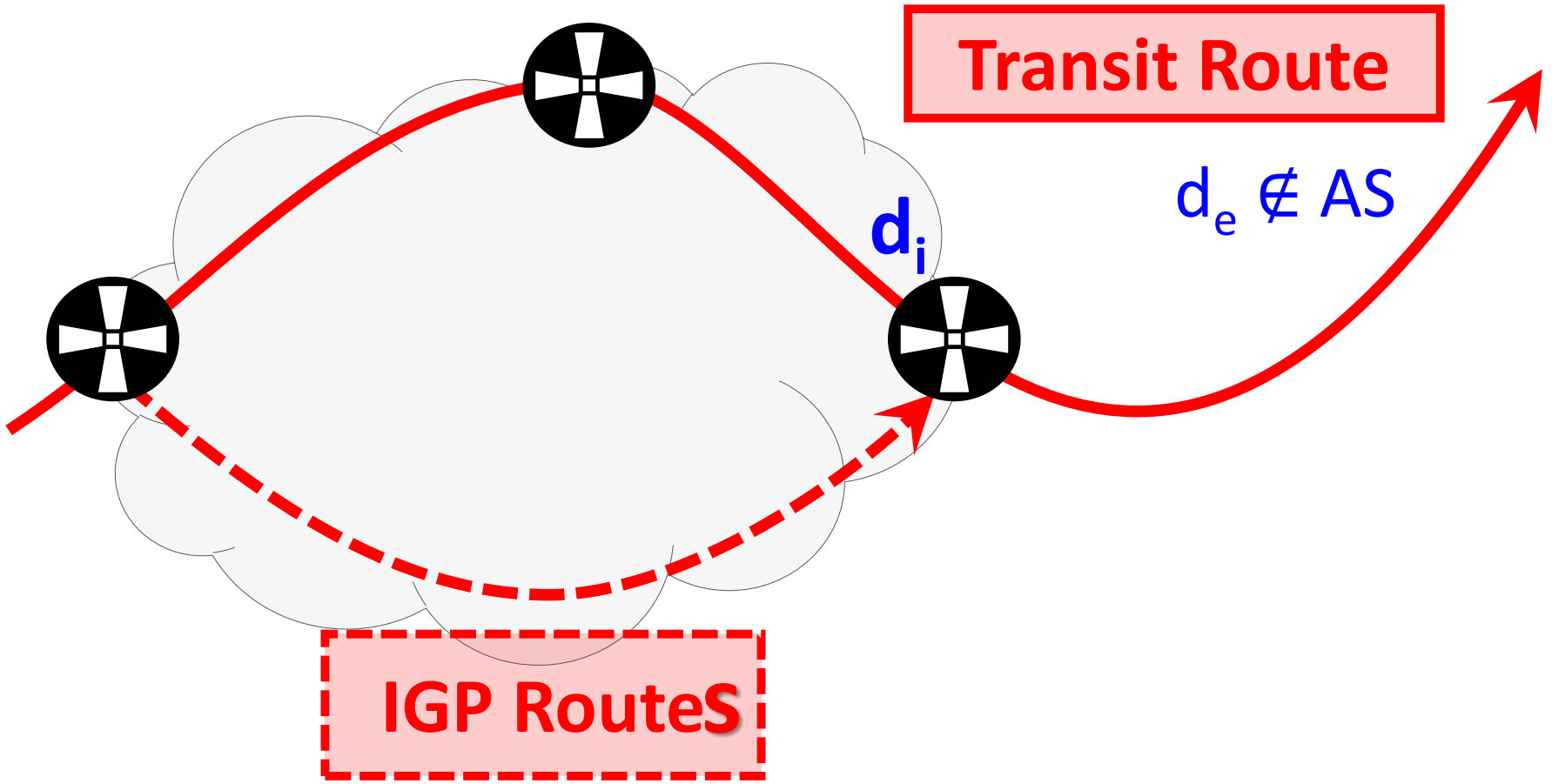


# How to Overcome ECMP?



# How to Overcome ECMP?

## Detect all IGP routes with **MDA-traceroute**



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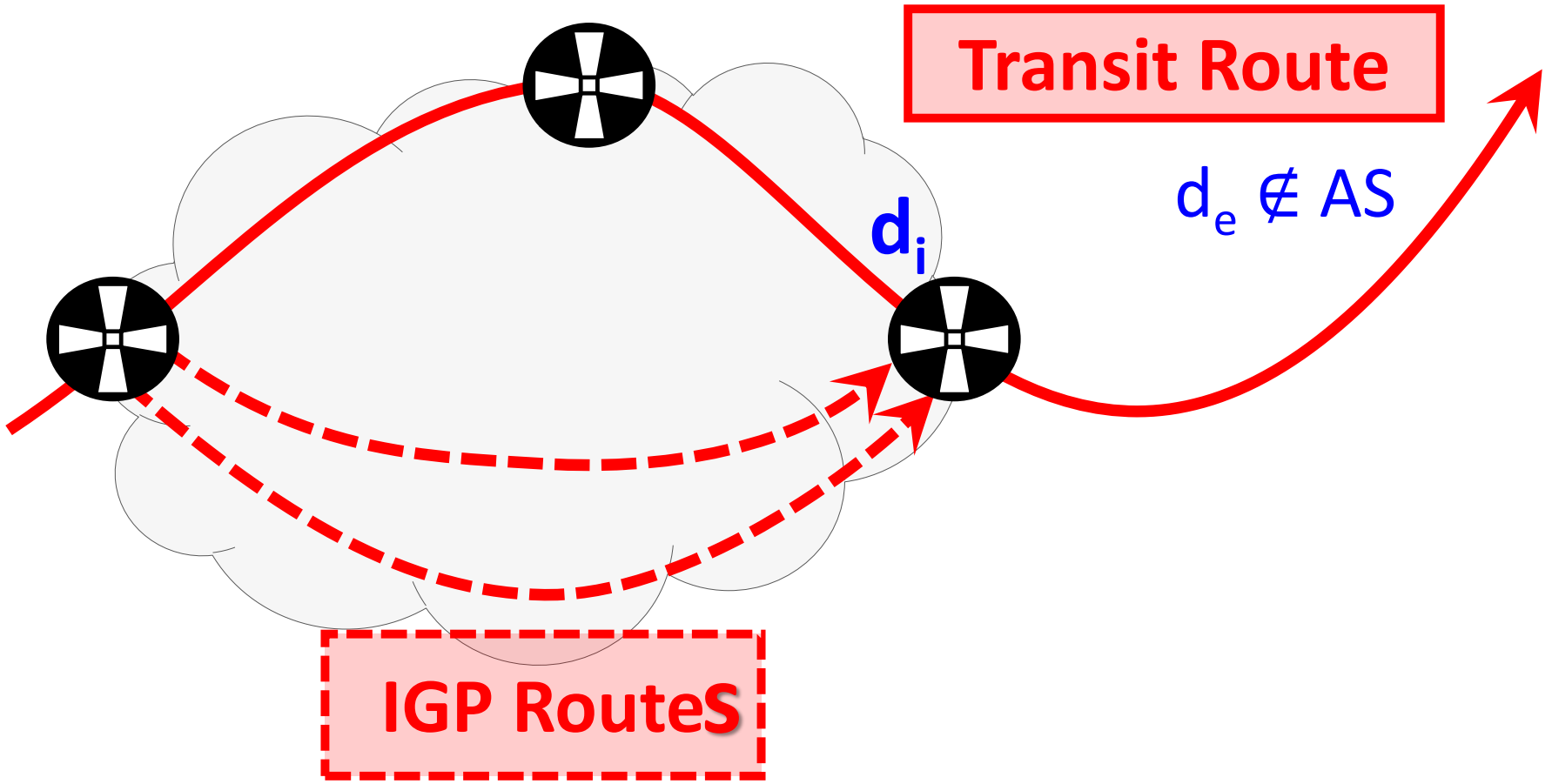

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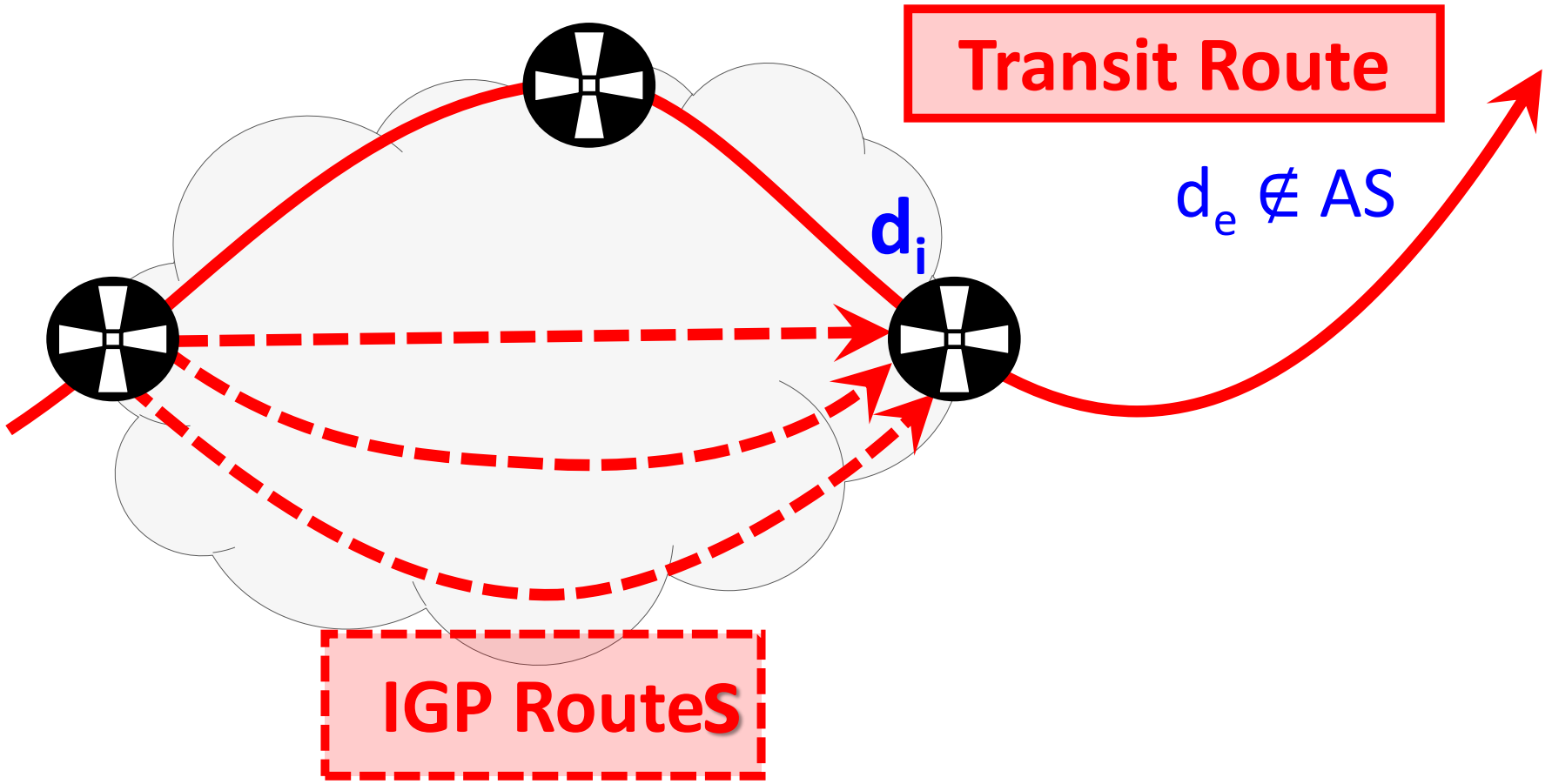

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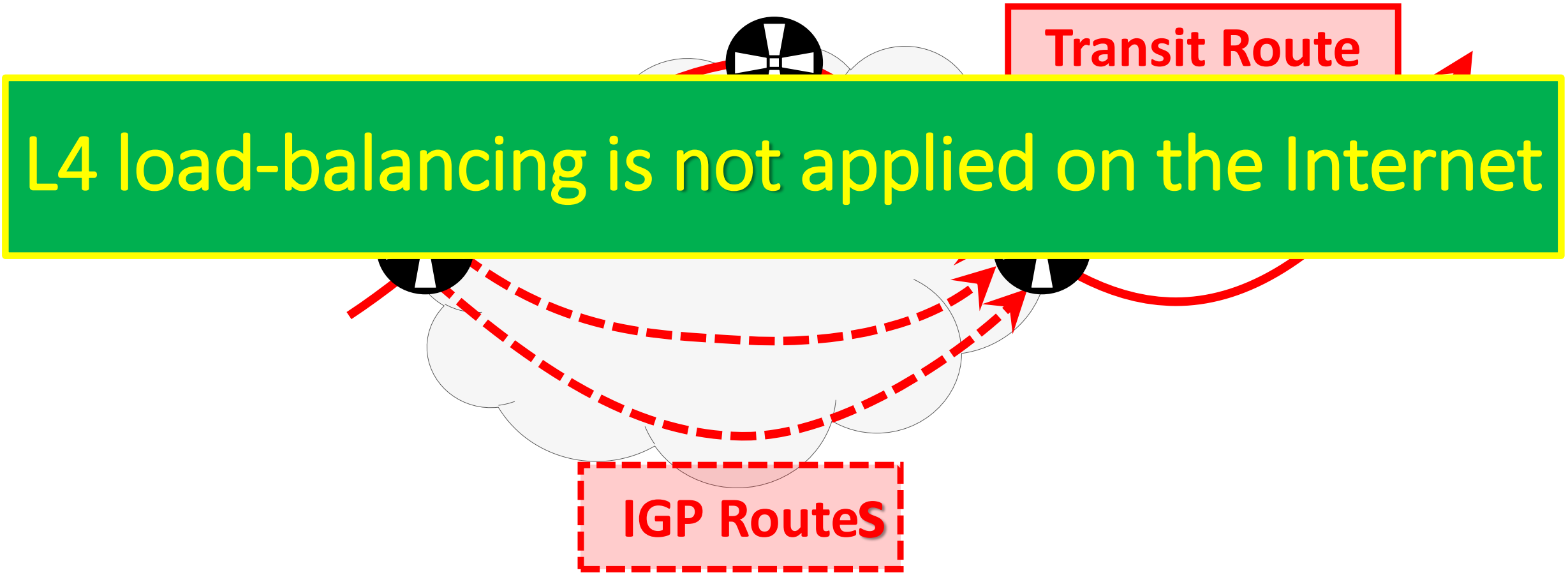
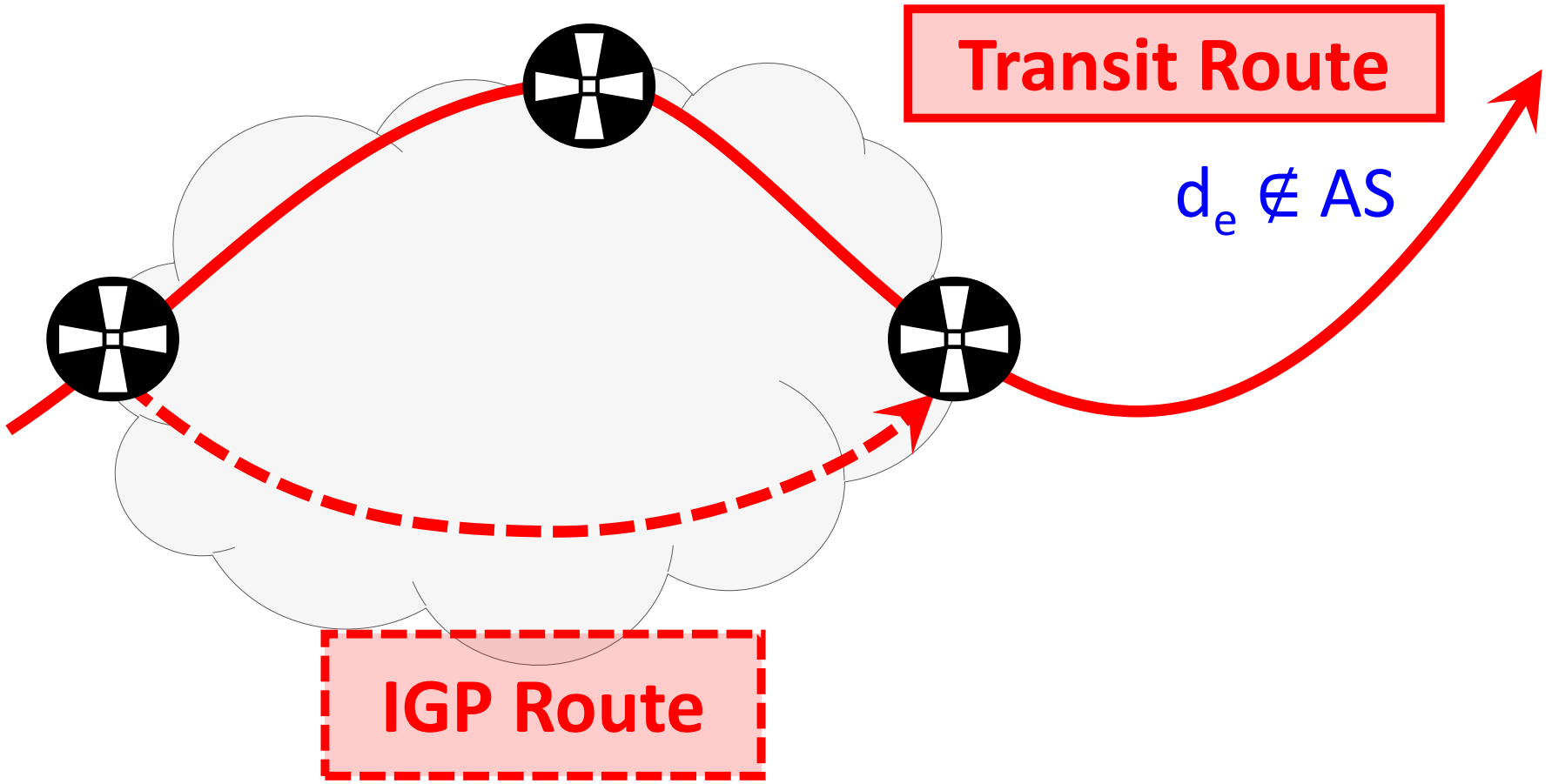


# Per-Destination MDA-Traceroute



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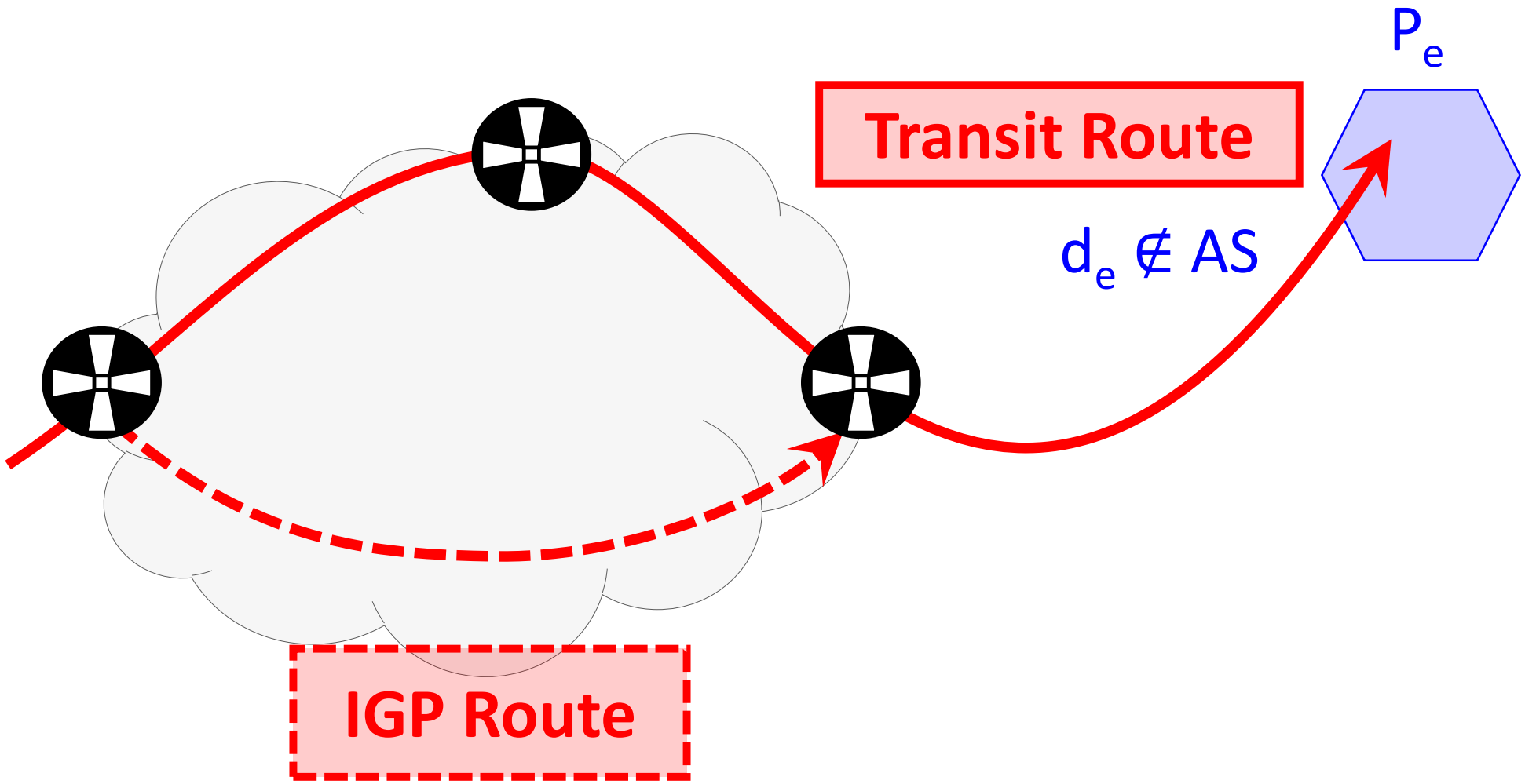

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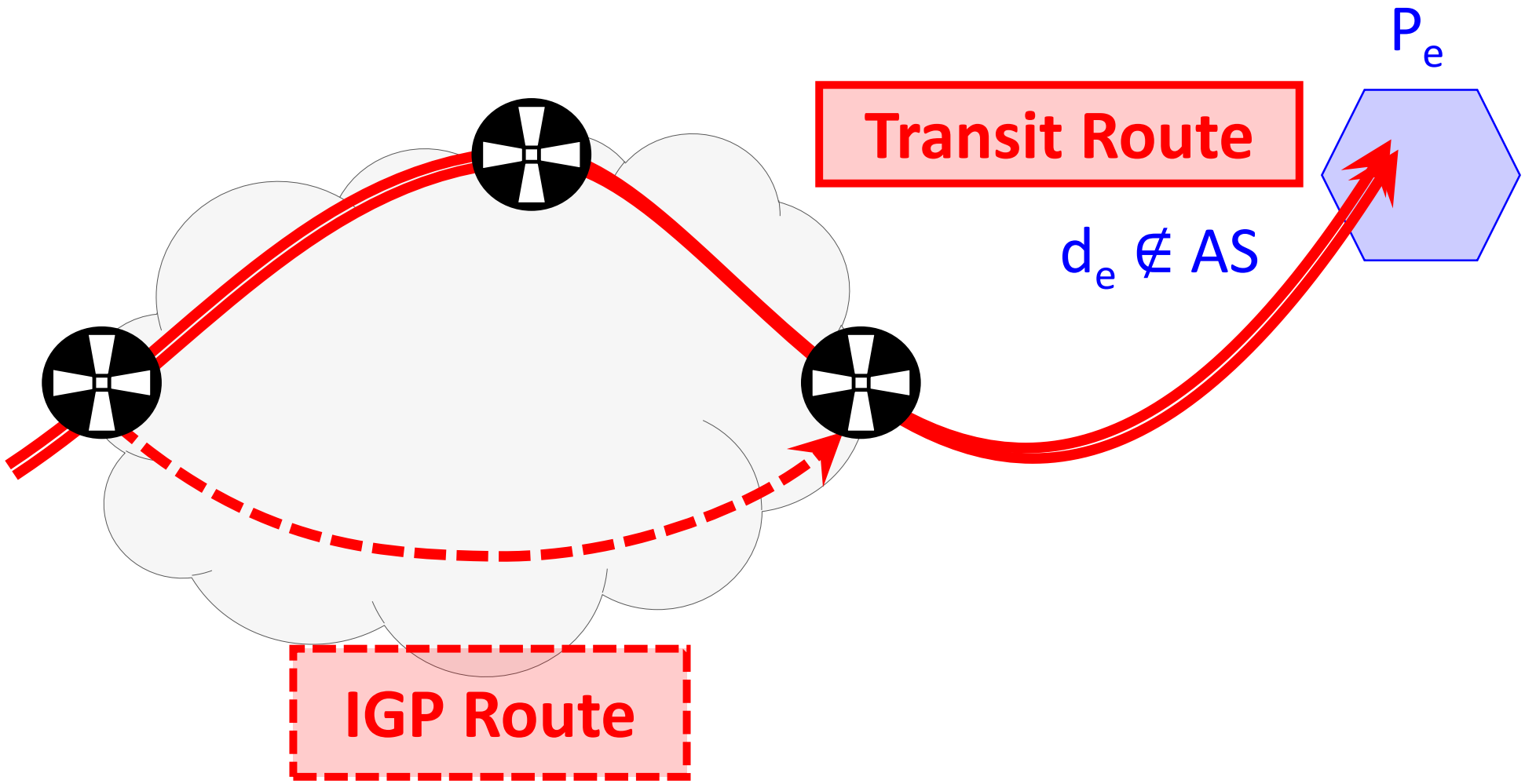

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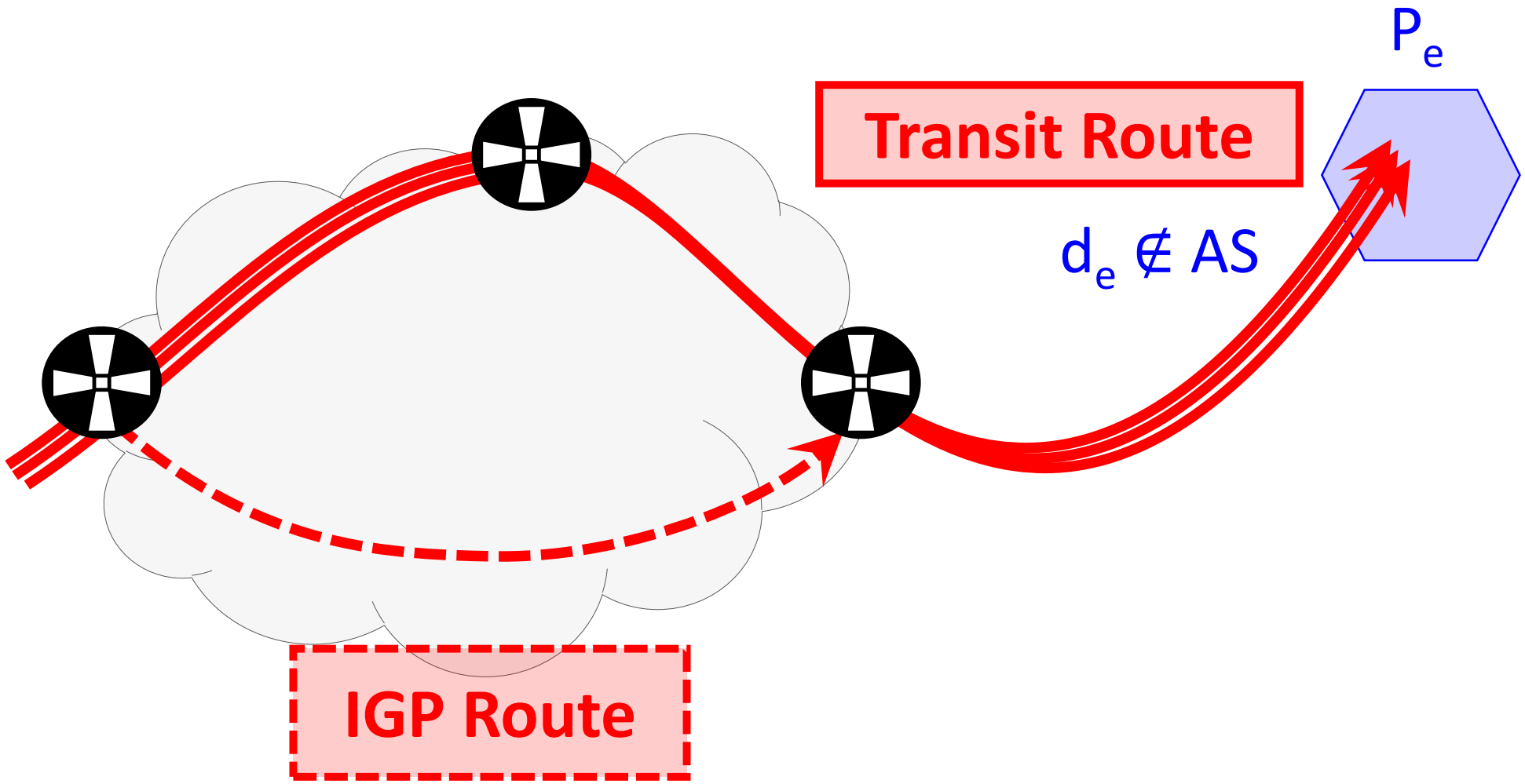
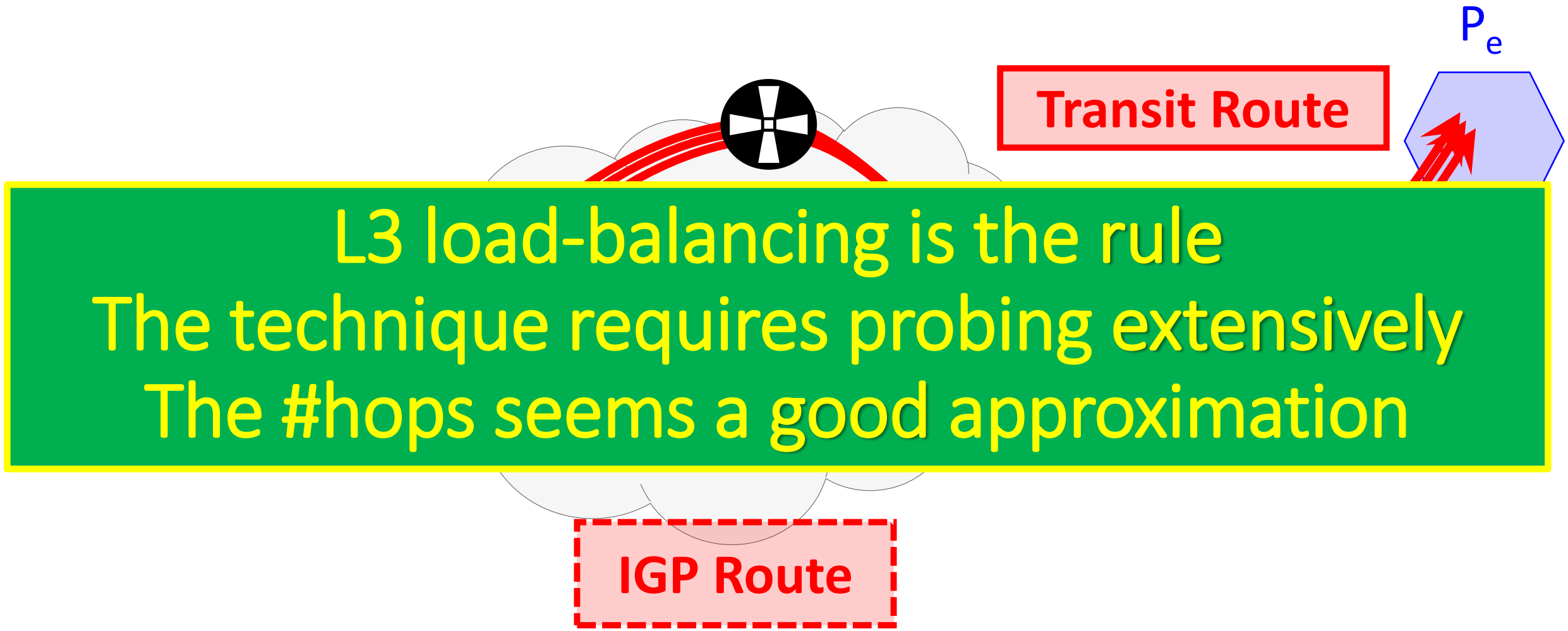


# **Per-Destination** MDA-Traceroute



# Preliminary Results

- 23-25% of 85 ASes raise a RI alarm
- #tunnels metric not so useful

| N | ASN | #transit traces | #hops (%) | #tunnels (%) | OR (%) |
|---|---|---|---|---|---|
| 1 | 20773 | 28 | 100 | 0.00 | 100 |
| 2 | 12965 | 445 | 61.35 | 35.73 | 66.74 |
| 3 | 3491 | 18.655 | 40.20 | 0.00 | 40.20 |
| 4 | 174 | 148.308 | 9.05 | 0.00 | 9.05 |
| 5 | 1299 | 106.421 | 2.82 | 1.81 | 3.00 |

- Many ASes deploy MPLS
- Each VP allows to measure “well” up to 3 ASes.
- It is not so clear that len(Transit)>len(IGP)

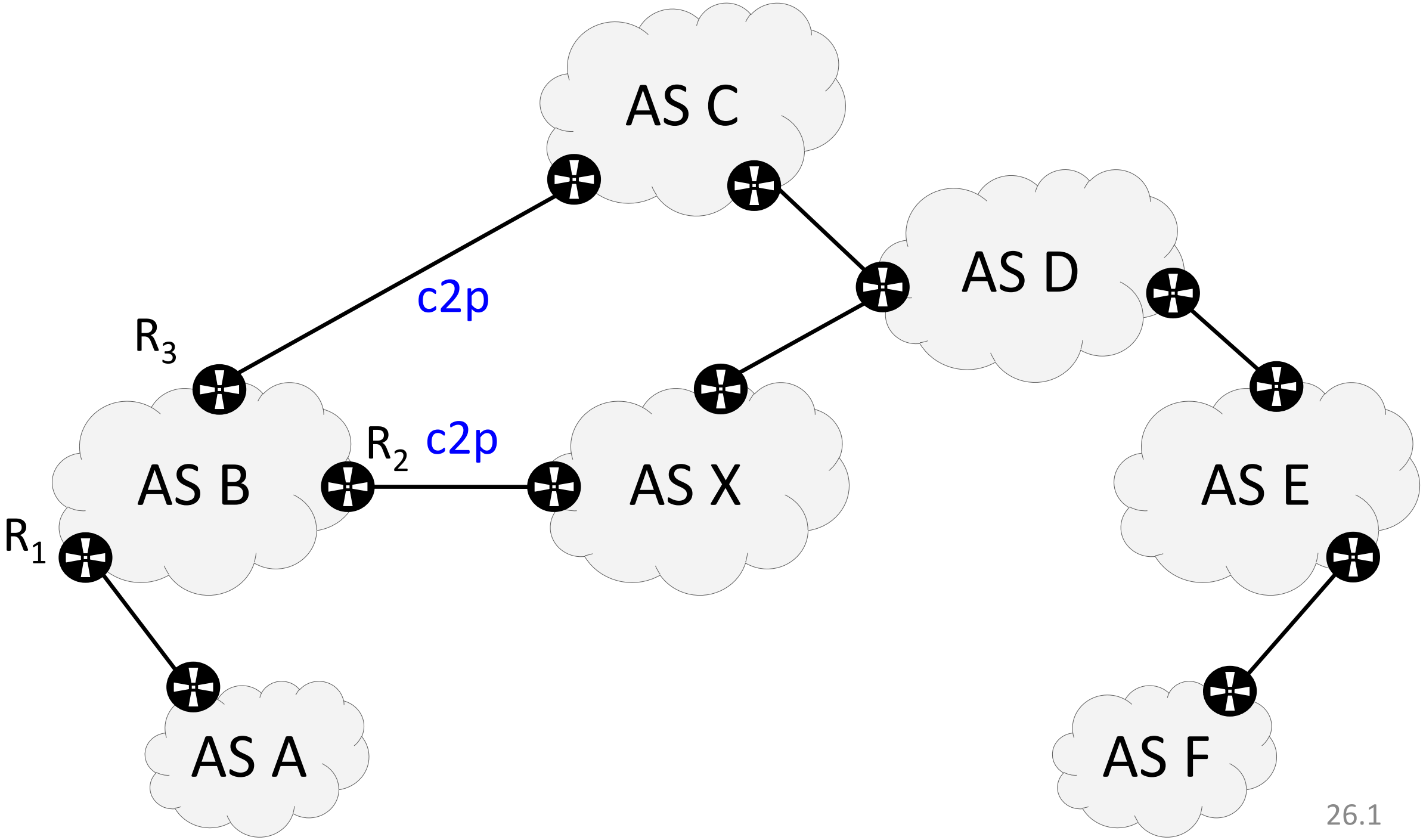
# Journal…?

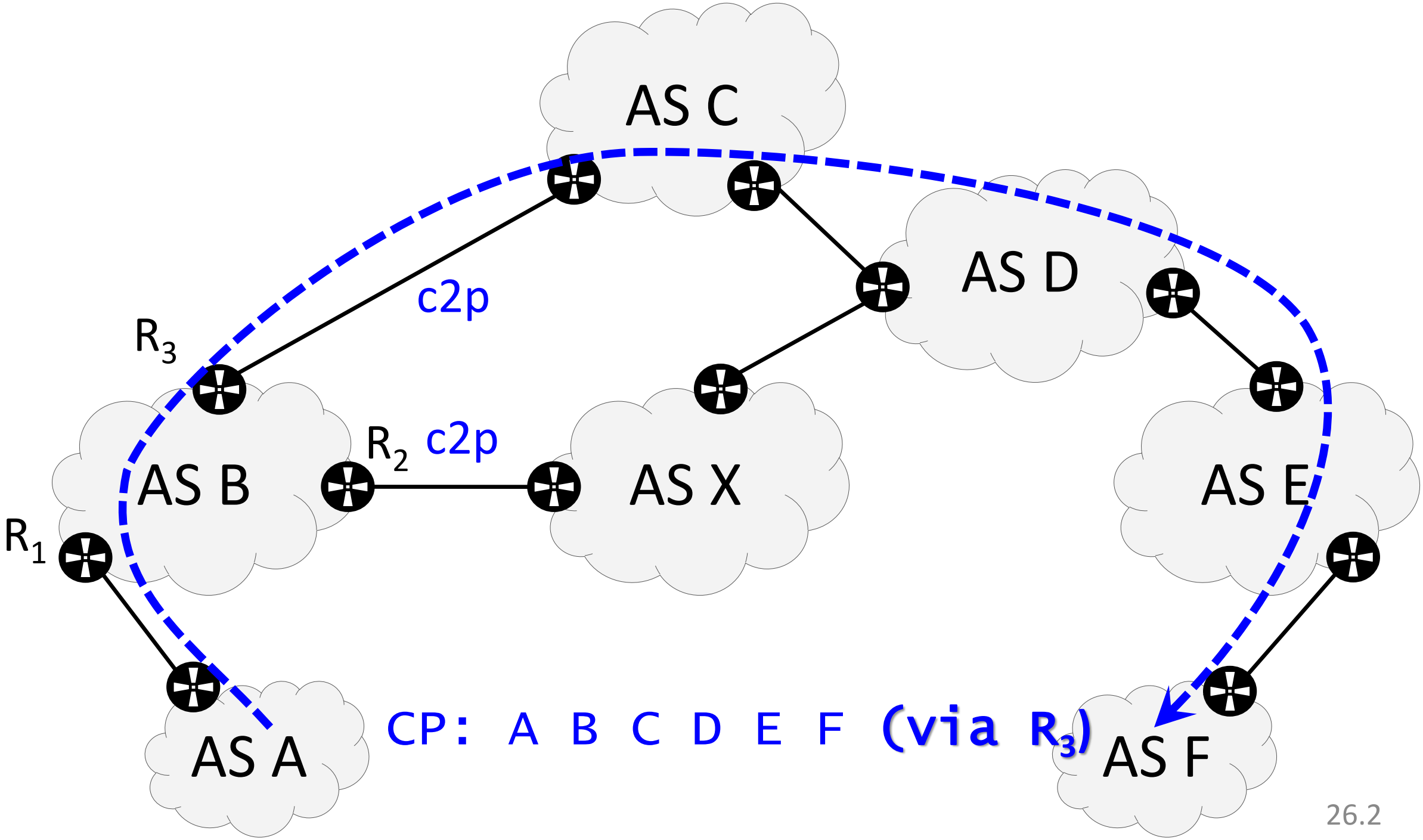
Coming soon

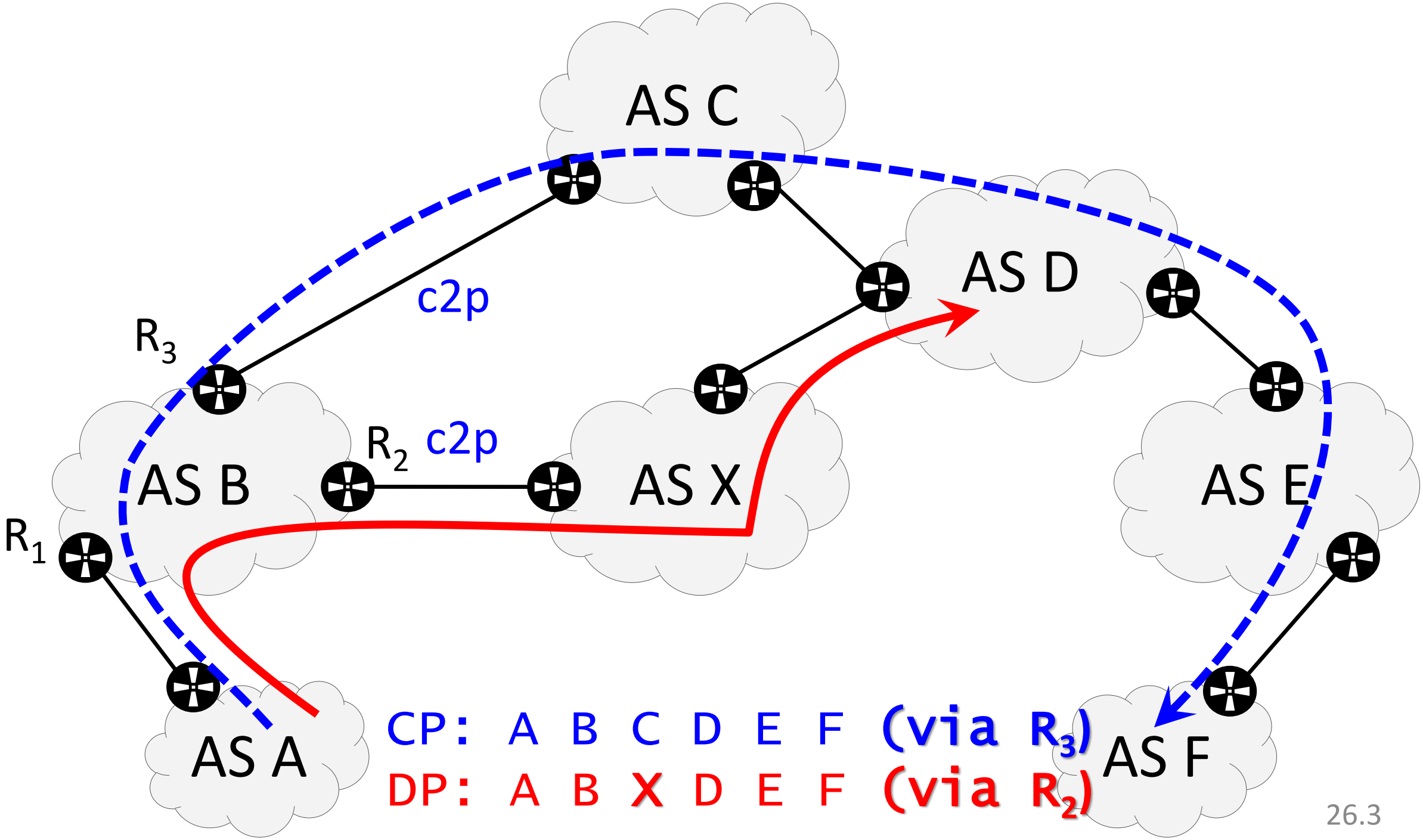
…

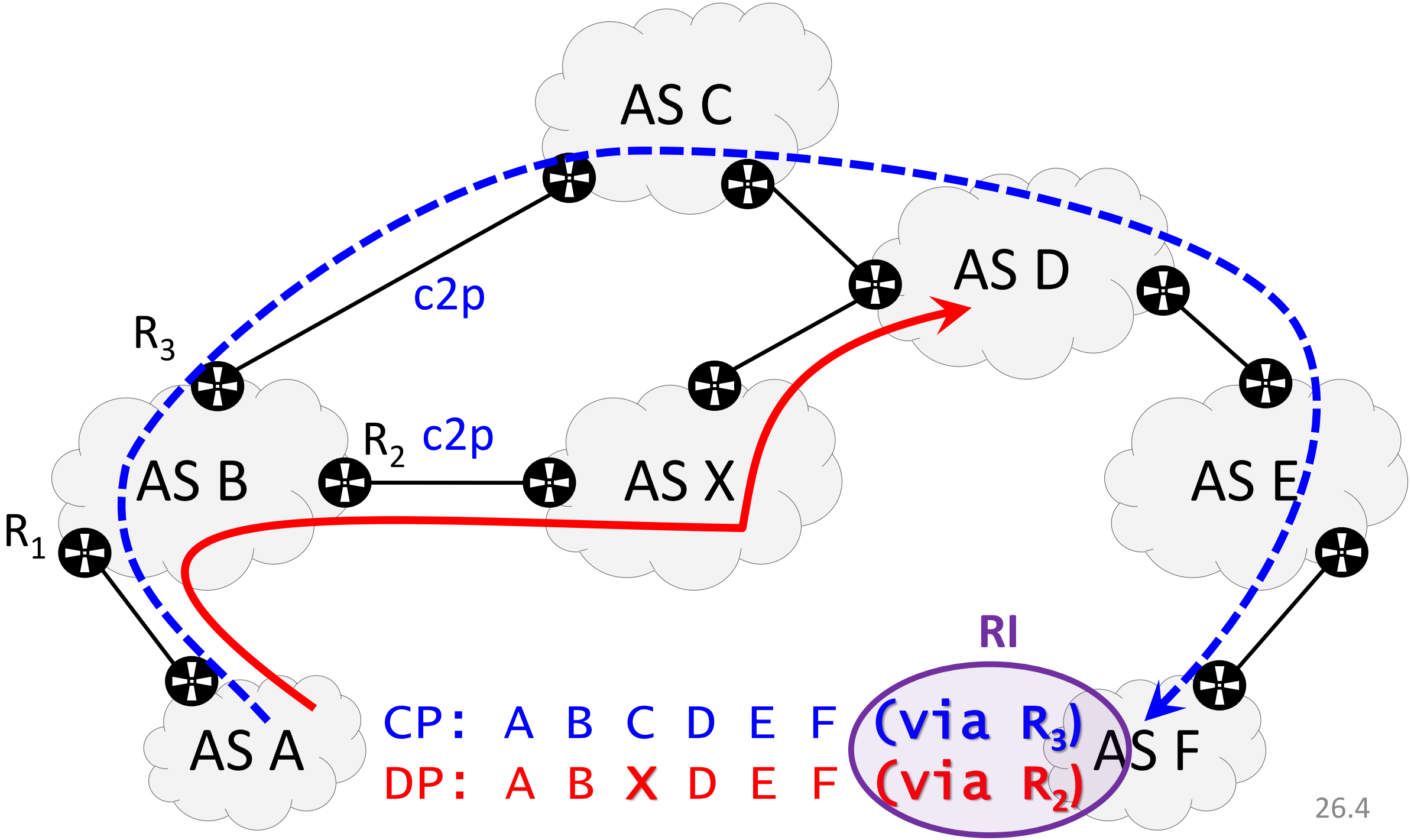
# RIes might generate Inter-Domain Lies

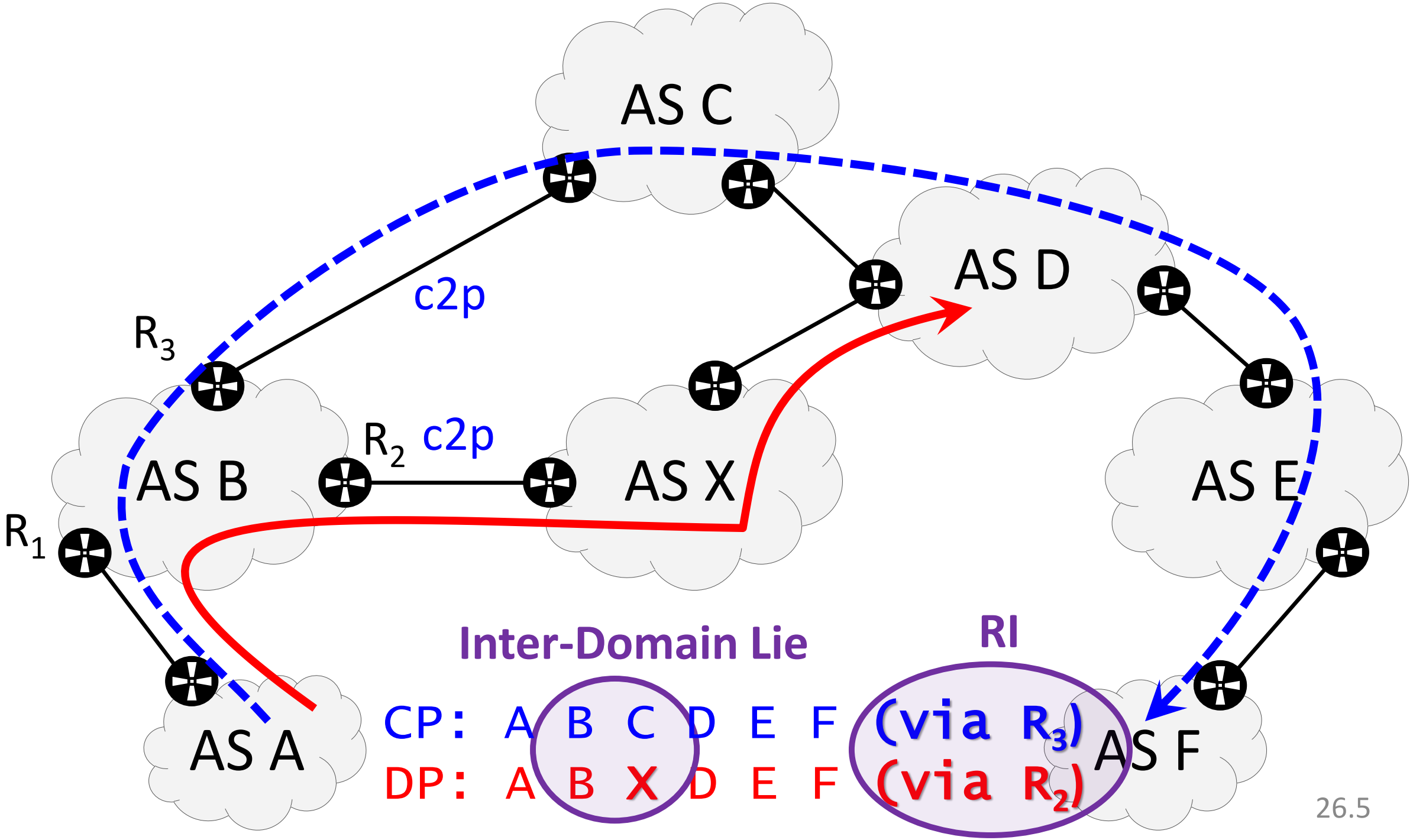
…


AS C
AS D
c2p
$R_3$
$R_2$
c2p
AS B
AS X
AS E
$R_1$
AS A
AS F


AS C
AS D
AS B
AS X
AS E
AS A
AS F
c2p
c2p
$R_3$
$R_2$
$R_1$
CP: A B C D E F (via $R_3$)


AS C
AS D
AS B
AS X
AS E
AS A
AS F
c2p
c2p
$R_3$
$R_2$
$R_1$
CP: A B C D E F (via $R_3$)
DP: A B X D E F (via $R_2$)


AS C
AS D
AS B
AS X
AS E
AS A
AS F
c2p
c2p
$R_3$
$R_2$
$R_1$
RI
CP: A B C D E F (via $R_3$)
DP: A B X D E F (via $R_2$)


AS C
AS D
AS B
AS X
AS E
AS A
AS F
c2p
c2p
$R_3$
$R_2$
$R_1$
Inter-Domain Lie
RI
CP: A B C D E F (via $R_3$)
DP: A B X D E F (via $R_2$)

# Work Extension

1. How to **discriminate** TE
2. **Pinpoint** the deflection point
3. Detect the **type** of RI (p-FIBs, …)
4. Determine if lie is **deliberate** or not
5. **RTT** Analysis: High vs Low TTL

# Final Goal

## Security Mechanism/Protocol

- Consider **sophisticated** liars:
  - Traffic vs Traceroute DPs
  - Liars cannot “hide” in the noise

# The work of the PhD

***"Filtering the Noise to Reveal Inter-Domain Lies",*** TMA 2019
University of Strasbourg/ICube, University of Napoli Federico II

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***"Routing Inconsistencies at the FIB level",*** Under submission in ???
University of Strasbourg/ICube, University of Napoli Federico II

***"A first Look at The Latin American IXPs",*** Under submission in IMC 2019
University of Buenos Aires/CONICET, University of Strasbourg/ICube, University Diego Portales

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64 hs lessons
Attended TMA PhD School 2018, 2019 (Presented Posters)
20 day internship in University of Napoli Federico II
Organized a Seminar on Crytocurrencies
3-month Internship in Telefonica Research (coming soon)

# The End
# Questions?