On multi-exit routings and AS relationships

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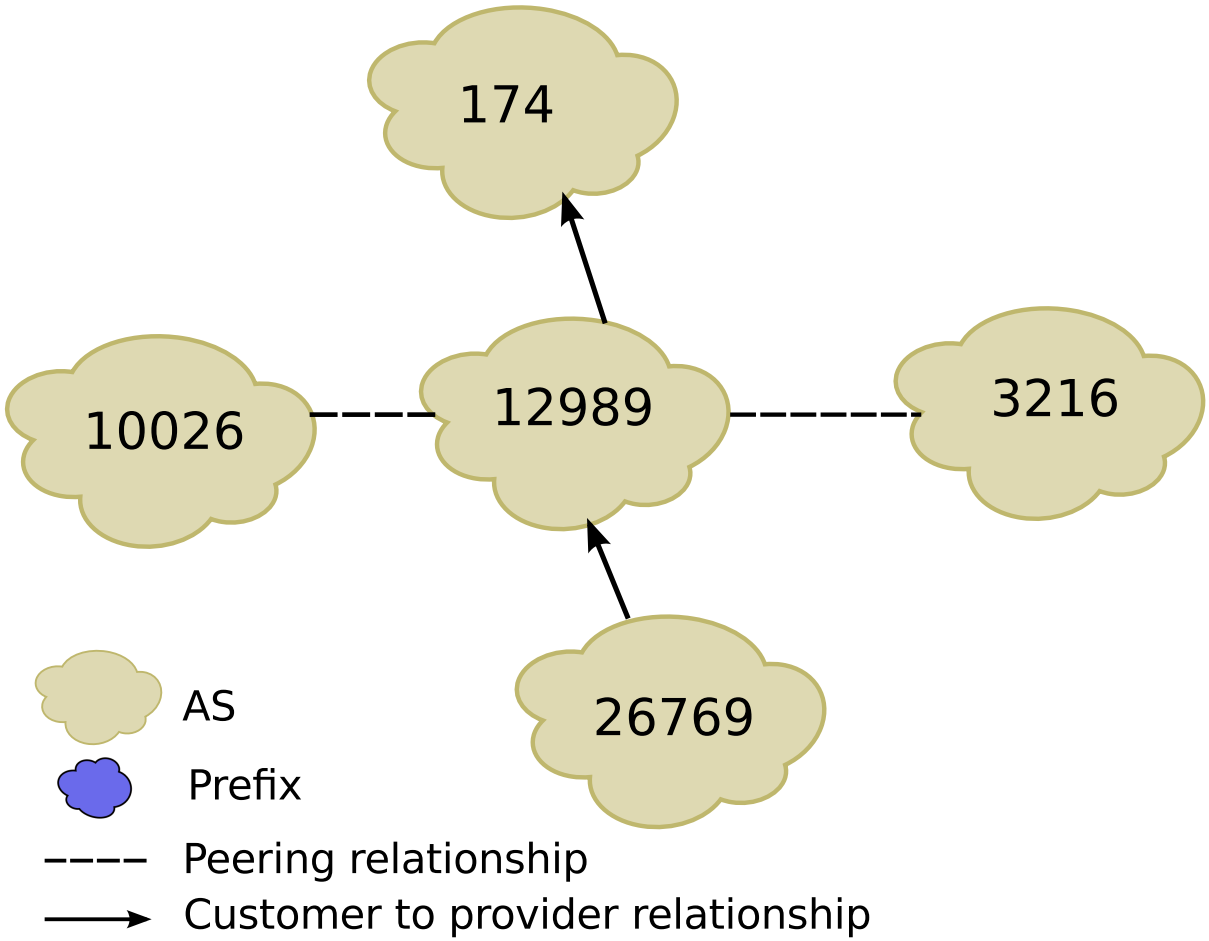
Internet routing example



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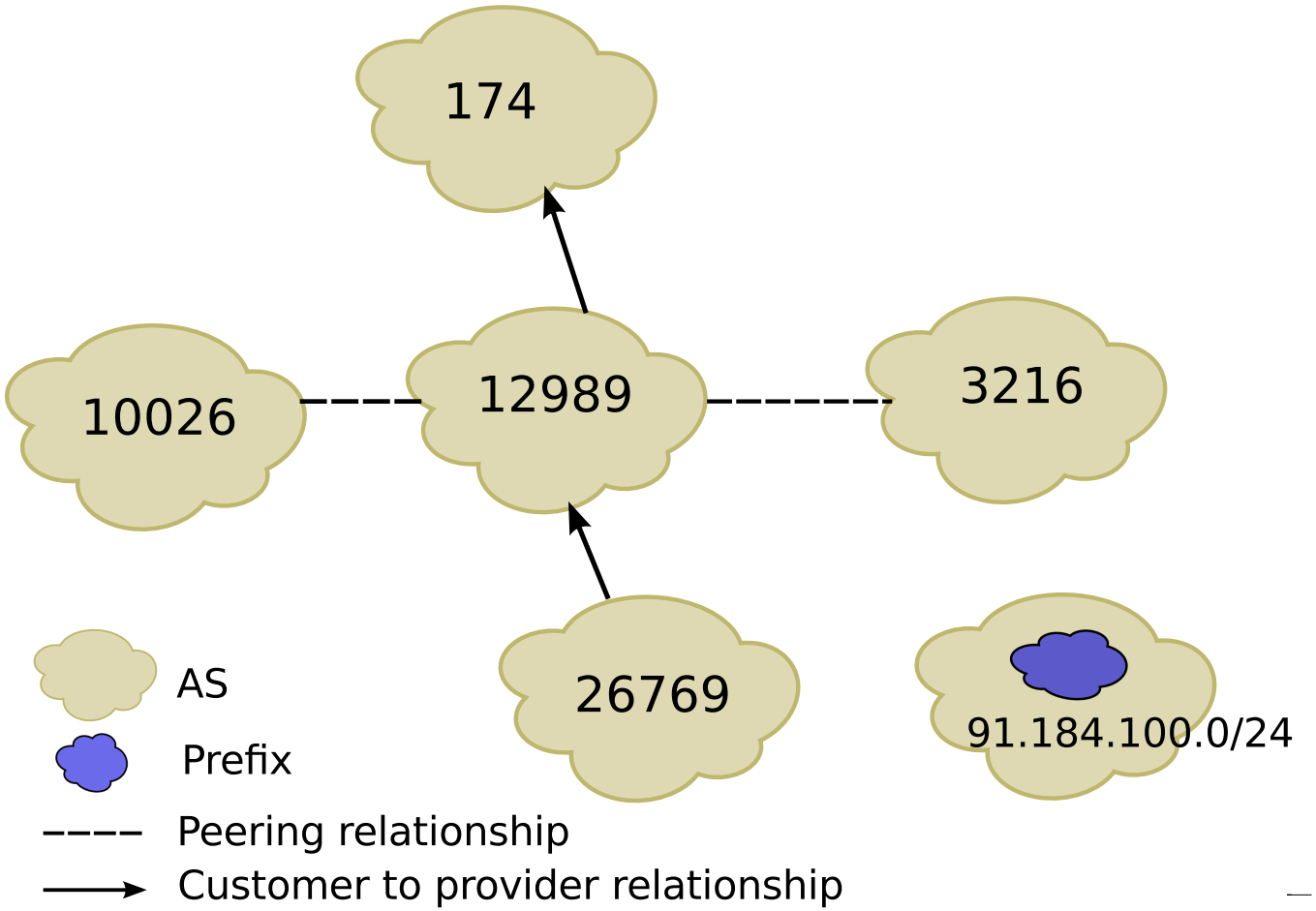
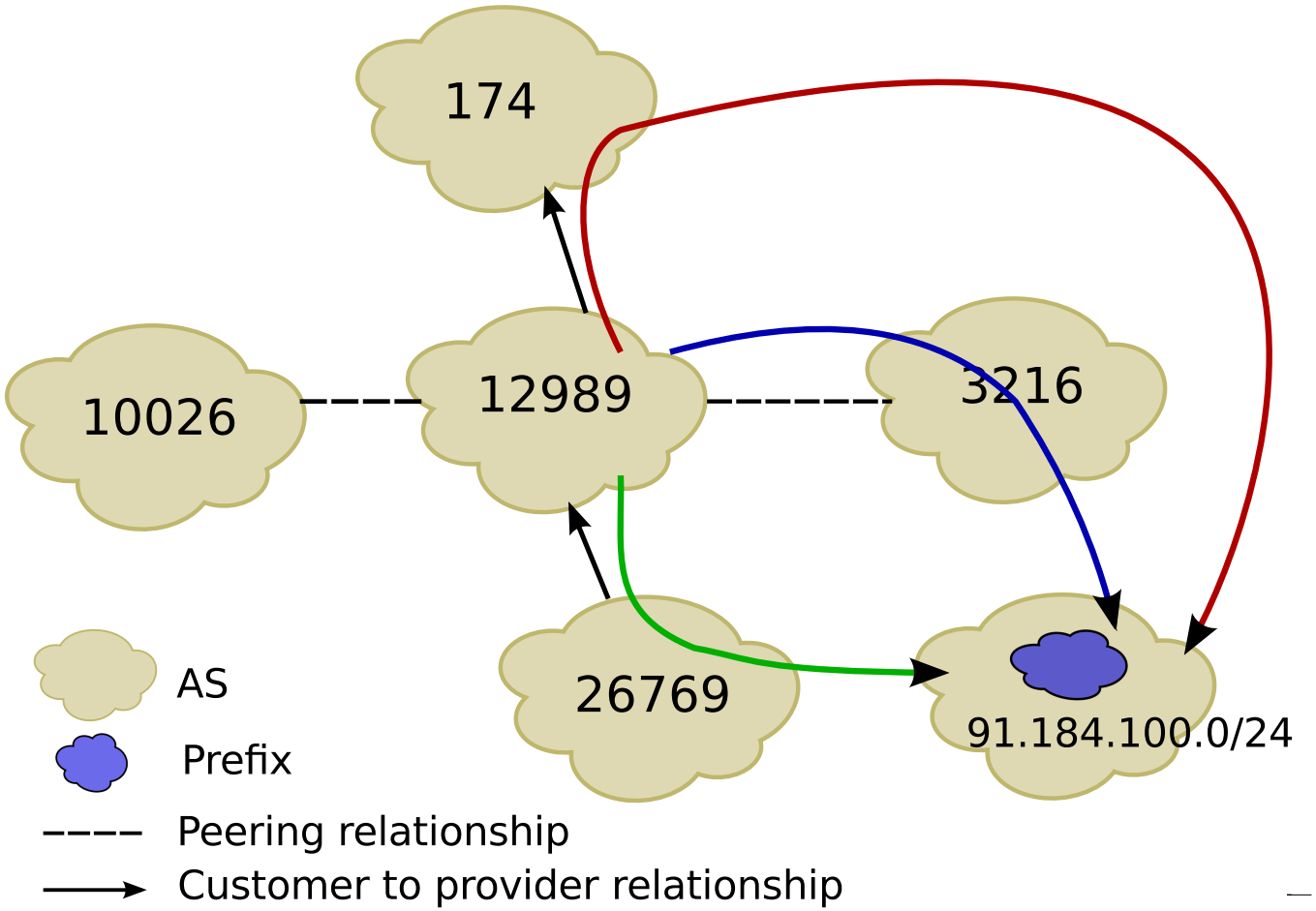
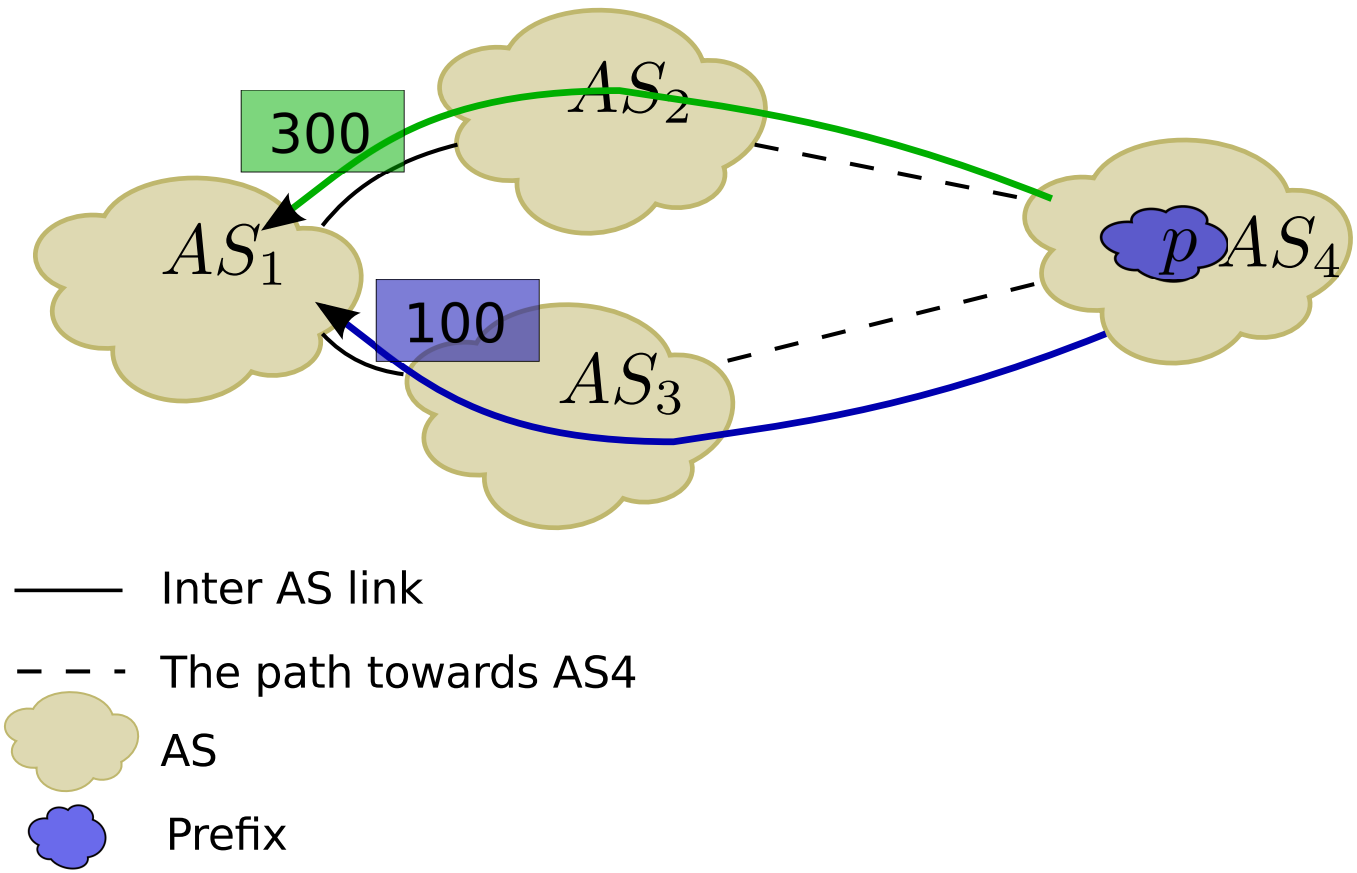


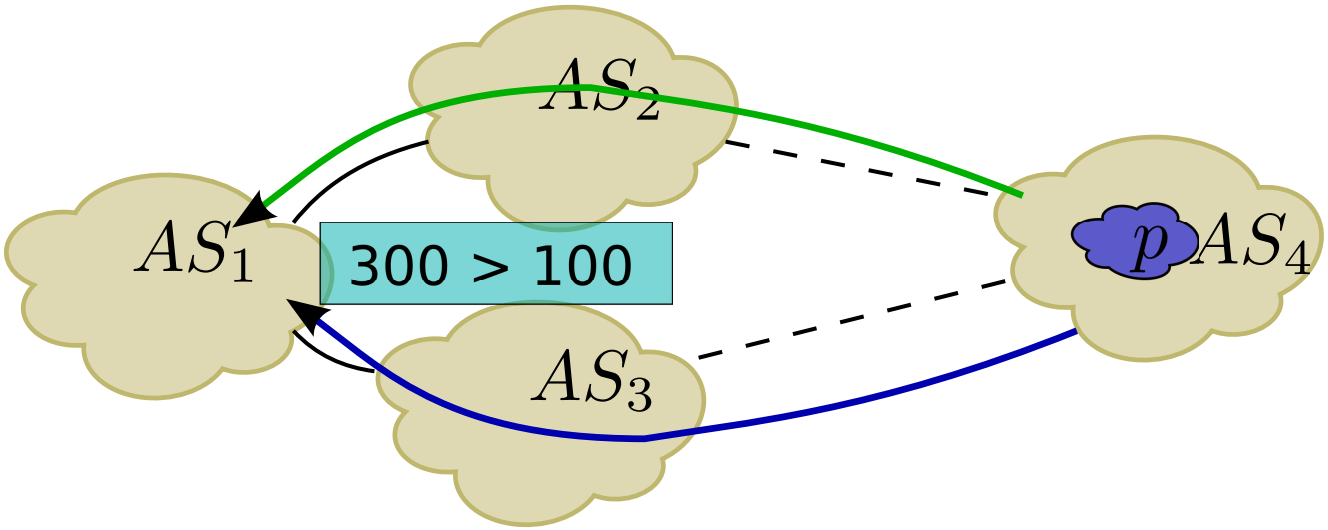
Surprising observations



BGP route with higher LP



A route has a higher LP



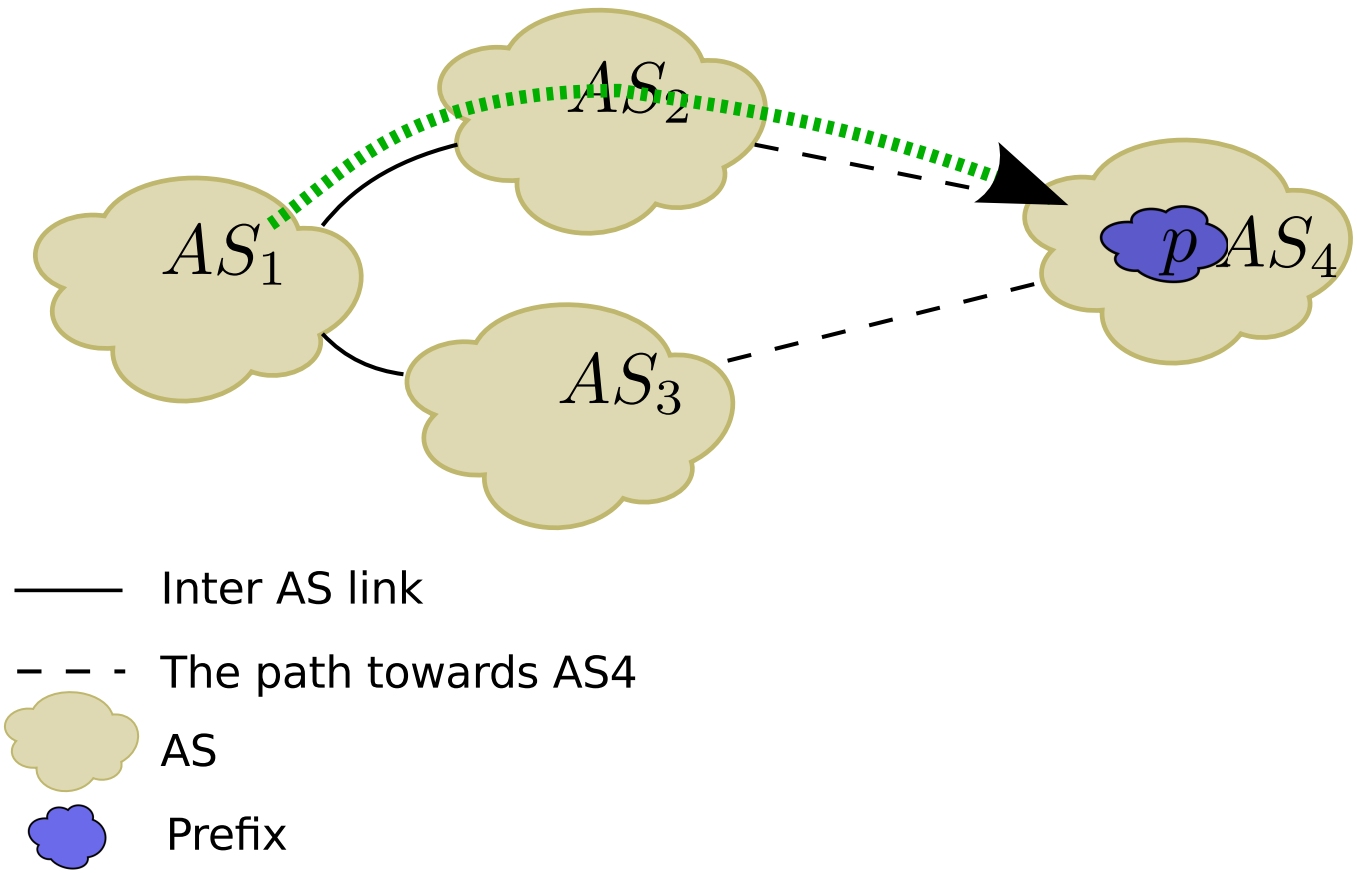
Inter AS link

The path towards AS4

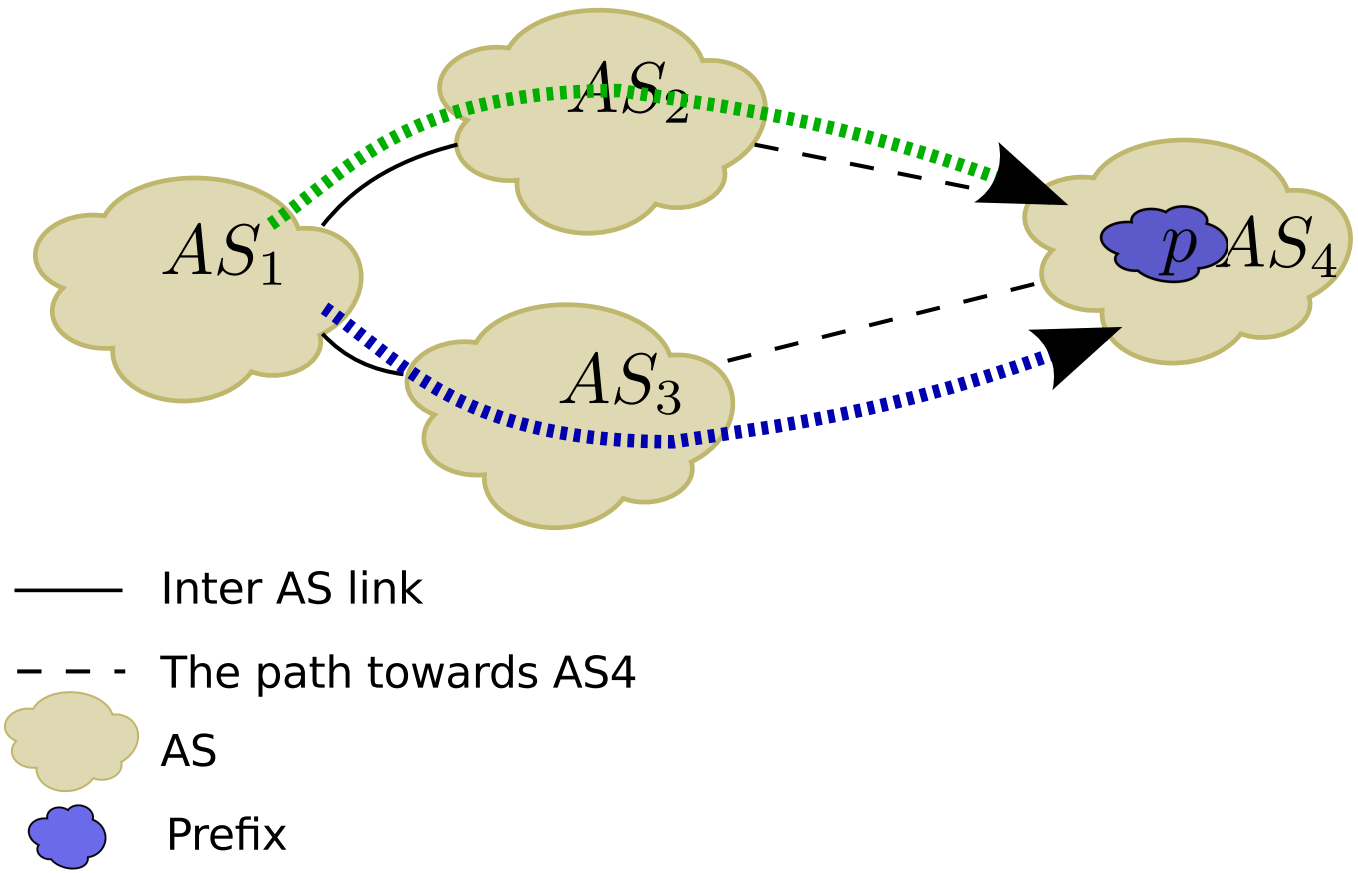
AS

Prefix

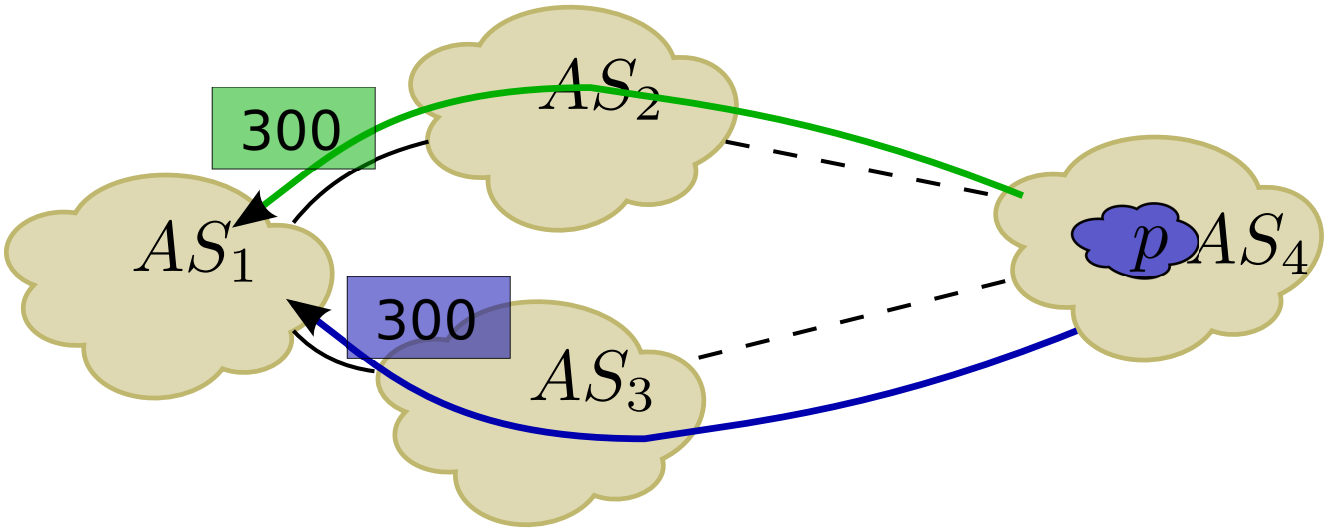
Single next-hop AS



Multi next-hop ASes



Equal LP for all next-hop ASes



Inter AS link

The path towards AS4

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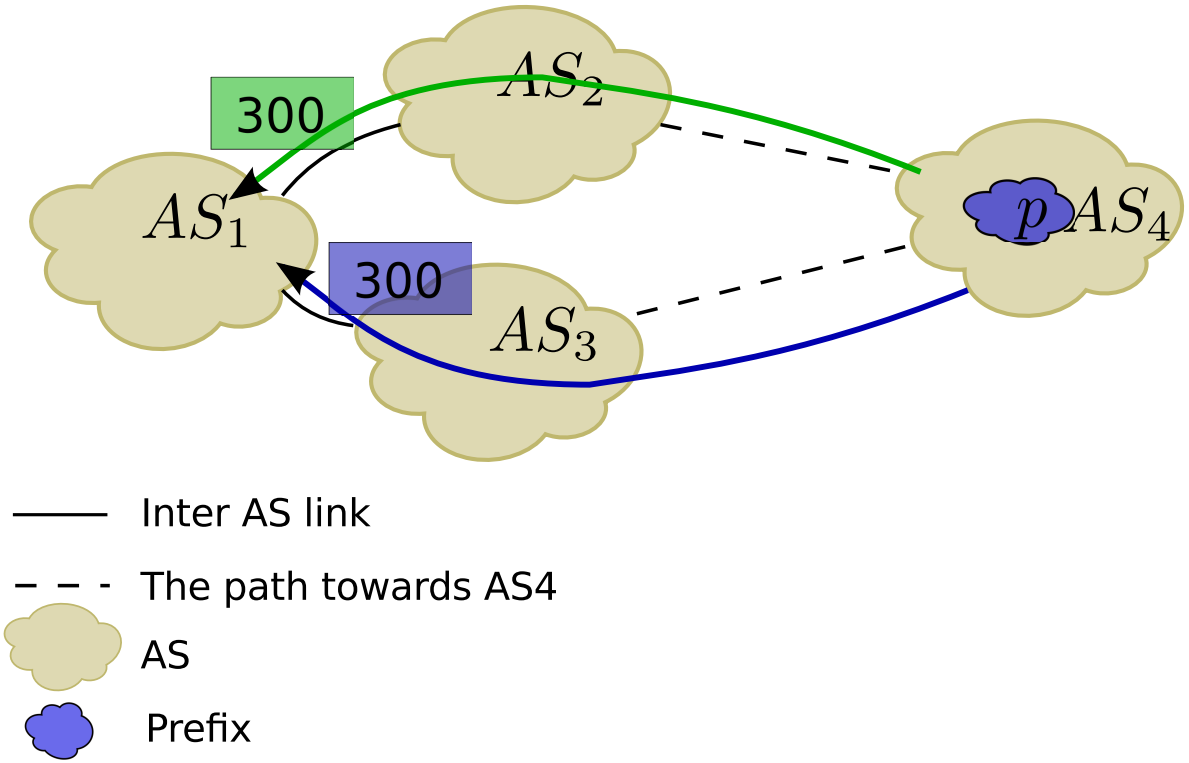
Observed ME $\Longrightarrow$ equal LP for next-hop ASes

Observed ME $\Longrightarrow$ equal LP (ME)

$$ME(AS_1, p) = \{AS_2, AS_3\} \implies LP_{AS_1}(AS_2) = LP_{AS_1}(AS_3)$$



Implementation of AS economical policies

Observed ME $\Longrightarrow$ equal LP (ME)

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Implementation of AS economical policies (POLICY)

$client > peer > provider$

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(ME) + (POLICY)

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Does it work?

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Check with CAIDA's inference dataset

- Get types of relations of cases such between AS_1 and AS_2, AS_3 from CAIDA's inference dataset
- Check whether all of the next-hop ASes have the same relationship

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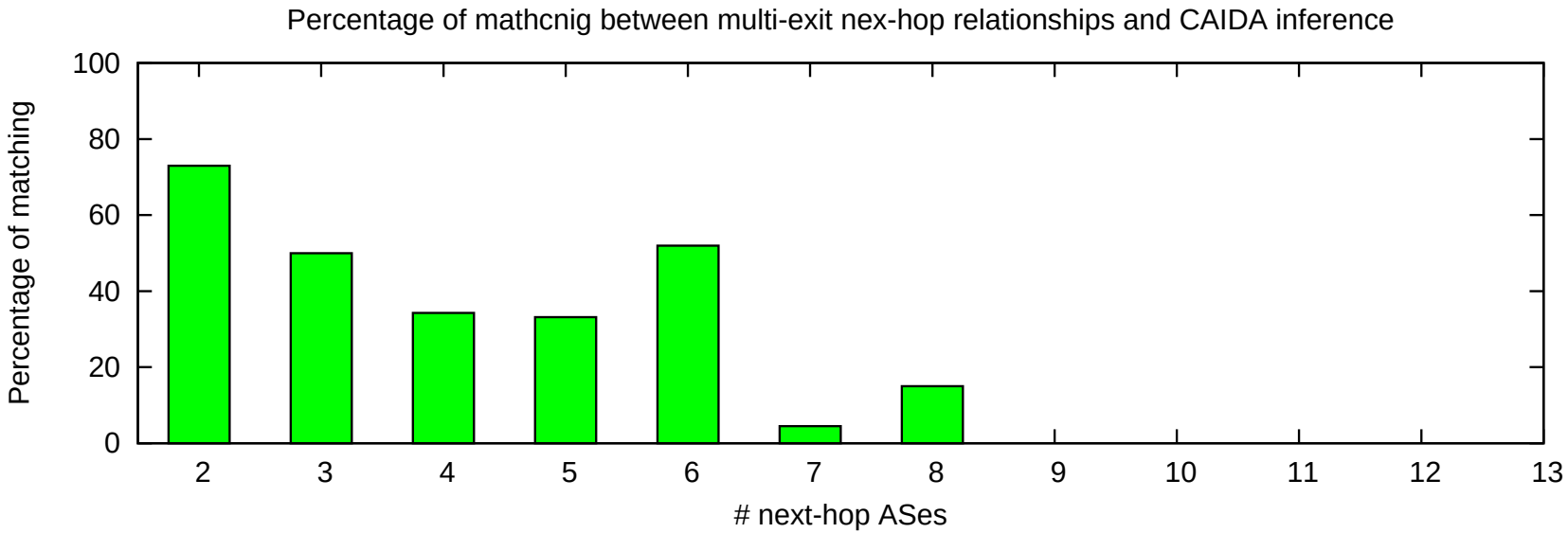
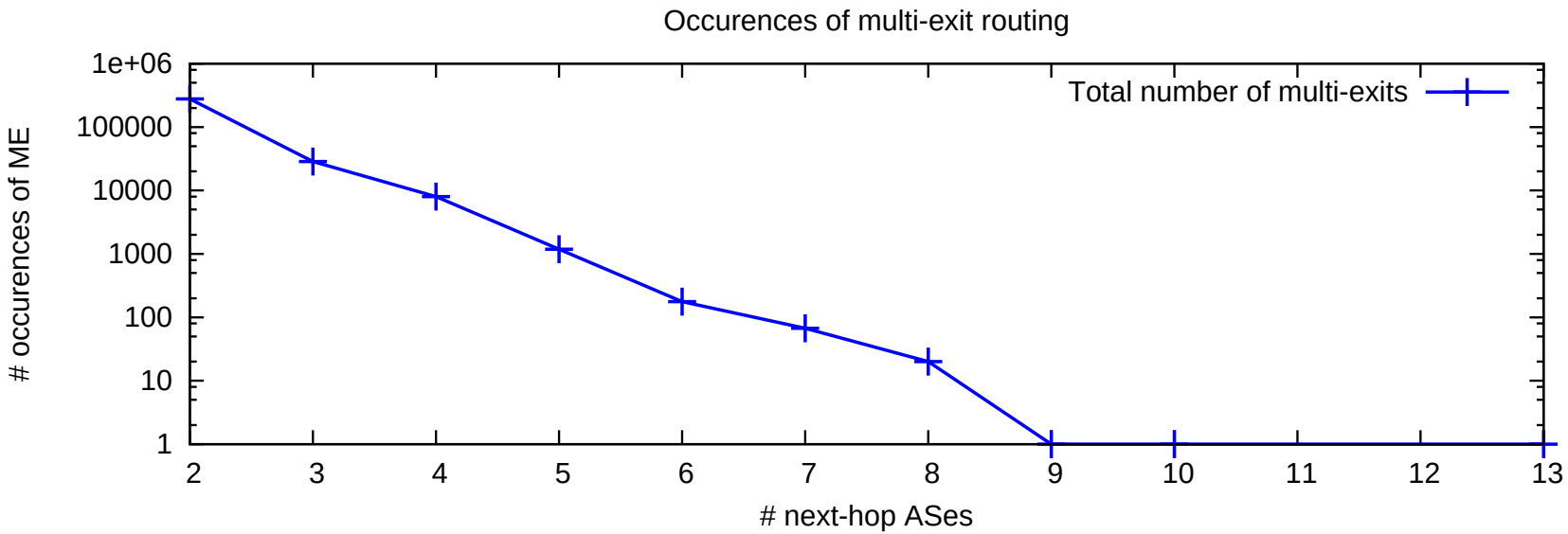
- About 70% matching 30% mismatching

Multi-exit occurrences and relationship matching





Data

Multi-exit discovery:

- BGP: BGPmon, Colorado State University project[1]

[1] http://bgpmon.netsec.colostate.edu/
[2] http://www.top-hat.info/
[3] http://www.team-cymru.org/Services/ip-to-asn.html
[4] http://www.caida.org/data/active/as-relationships/

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AS relationships:

- CAIDA AS relationship inference database[4]

Our data is available on request.

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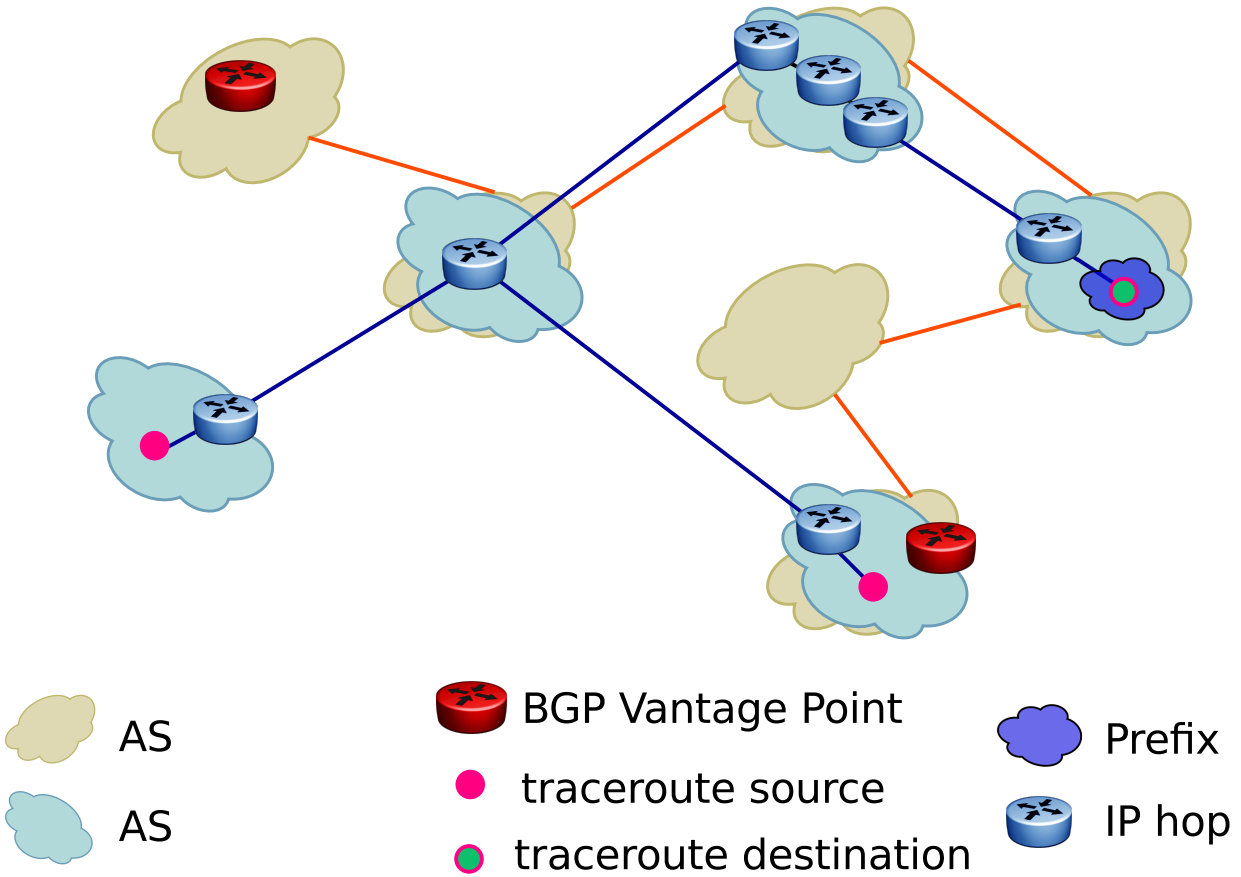
Have another ideas?

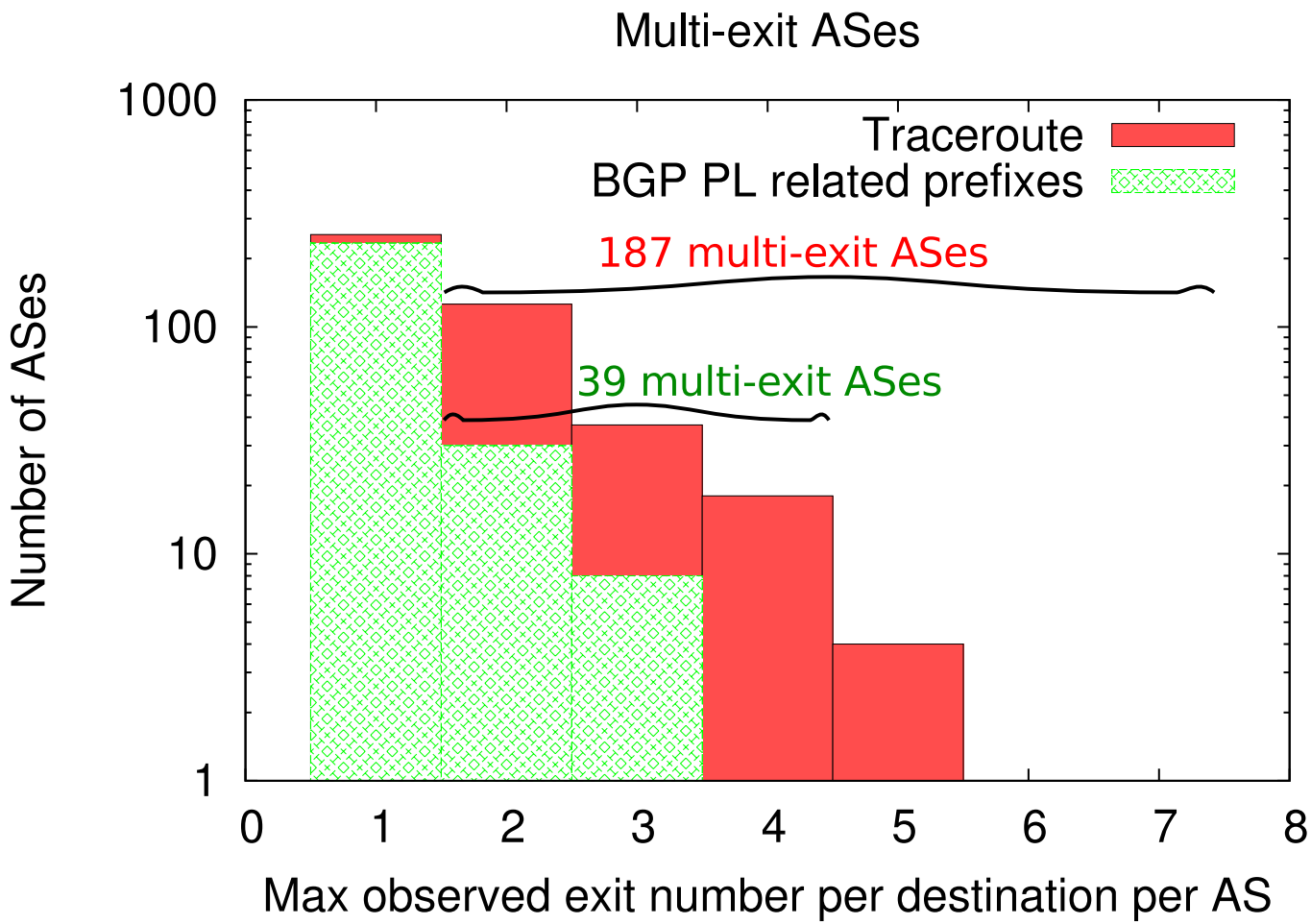
- Feedback about the problem and the analysis process
- Get confirmation about the results (we don't have a ground truth of AS relationships)
- Possible collaborations

Reserved slides...

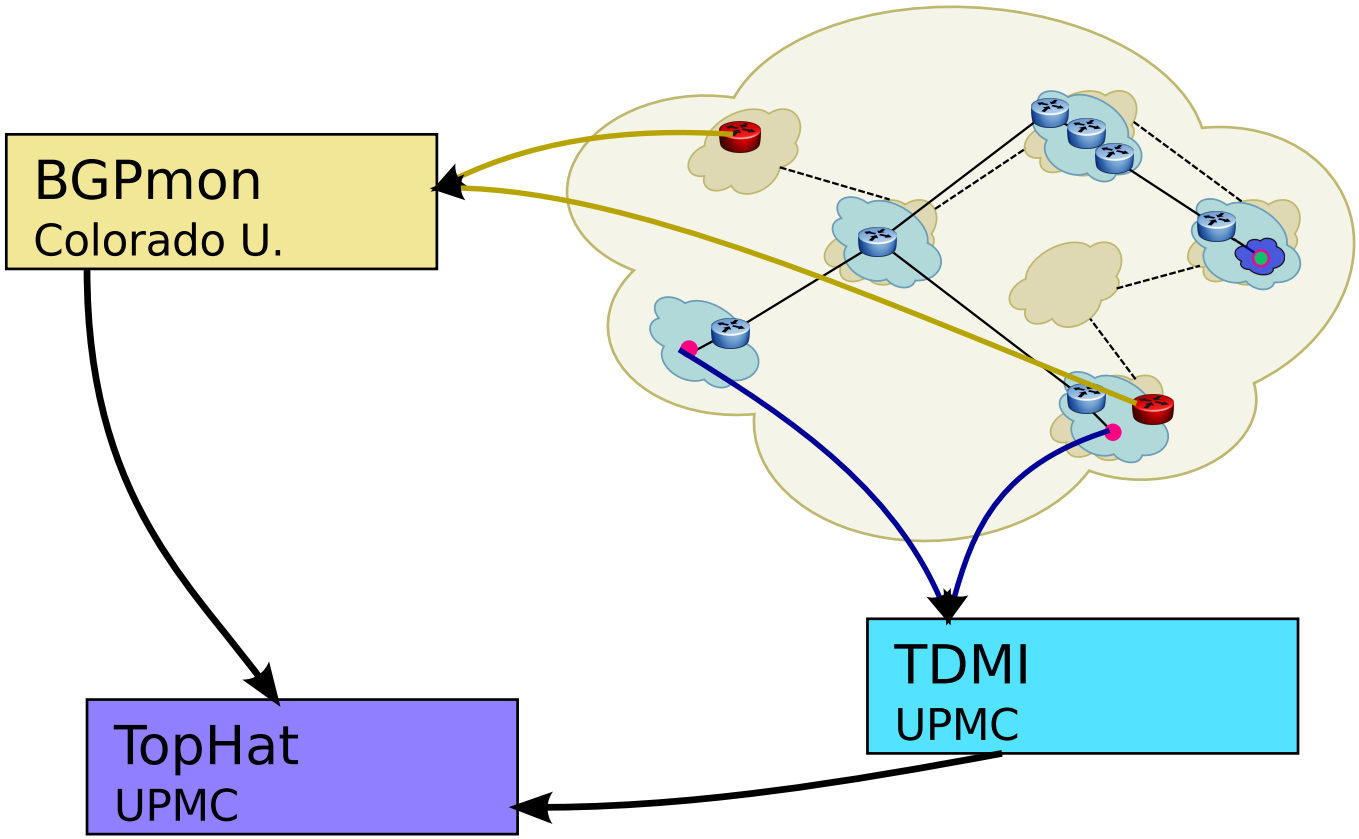
BGP and IP overlap

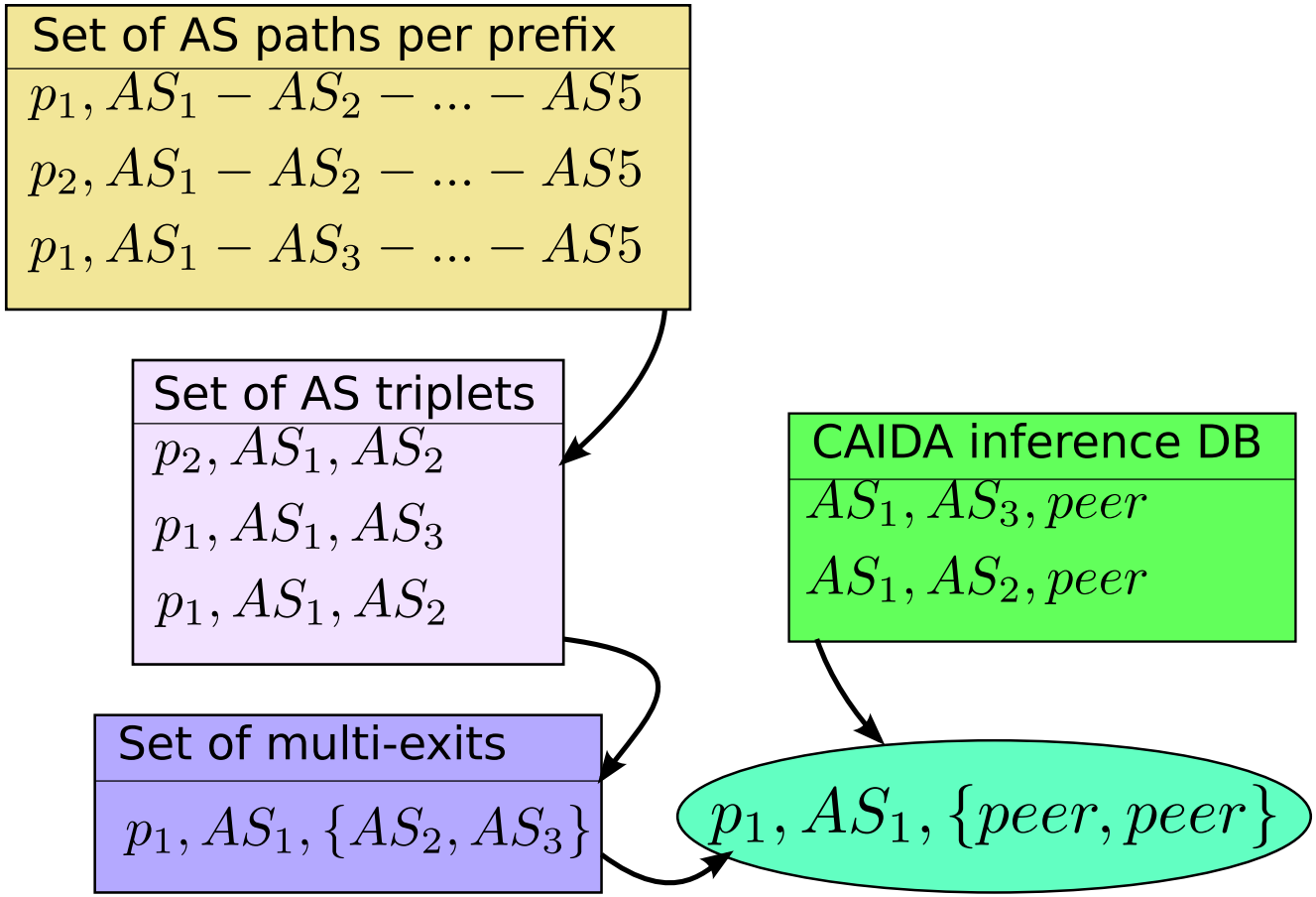


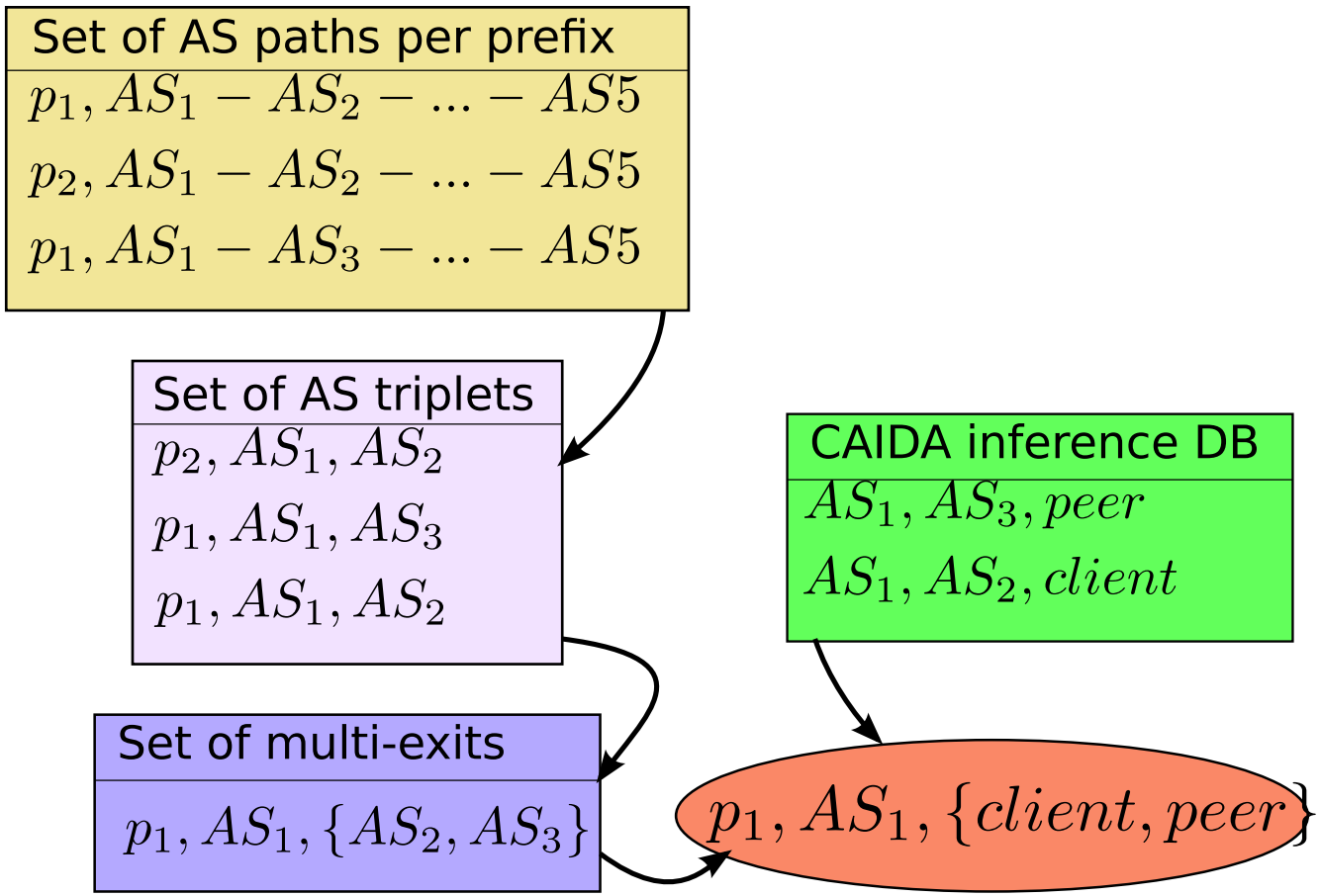
Multi-exit routing, BGP and IP results



TopHat interconnection




Set of AS paths per prefix
$p_1, AS_1 - AS_2 - ... - AS5$
$p_2, AS_1 - AS_2 - ... - AS5$
$p_1, AS_1 - AS_3 - ... - AS5$
Set of AS triplets
p_2, AS_1, AS_2
p_1, AS_1, AS_3
p_1, AS_1, AS_2
CAIDA inference DB
$AS_1, AS_3, peer$
$AS_1, AS_2, peer$
Set of multi-exits
$p_1, AS_1, \{AS_2, AS_3\}$
$p_1, AS_1, \{peer, peer\}$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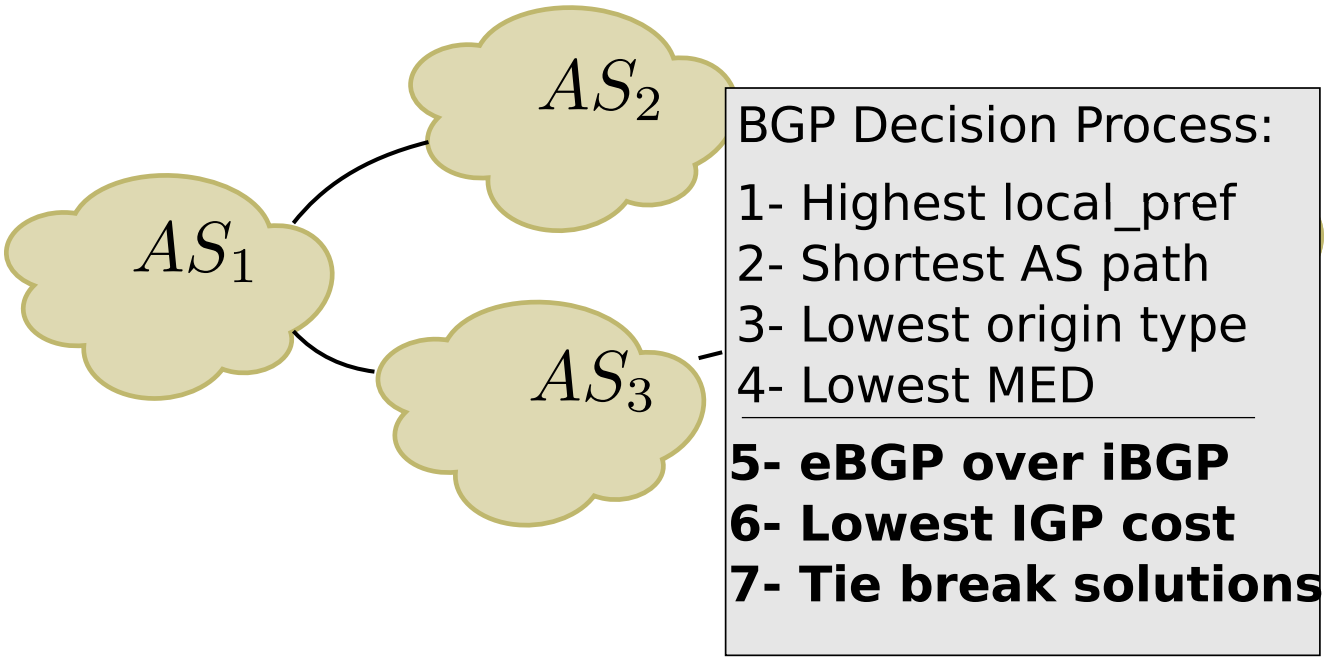
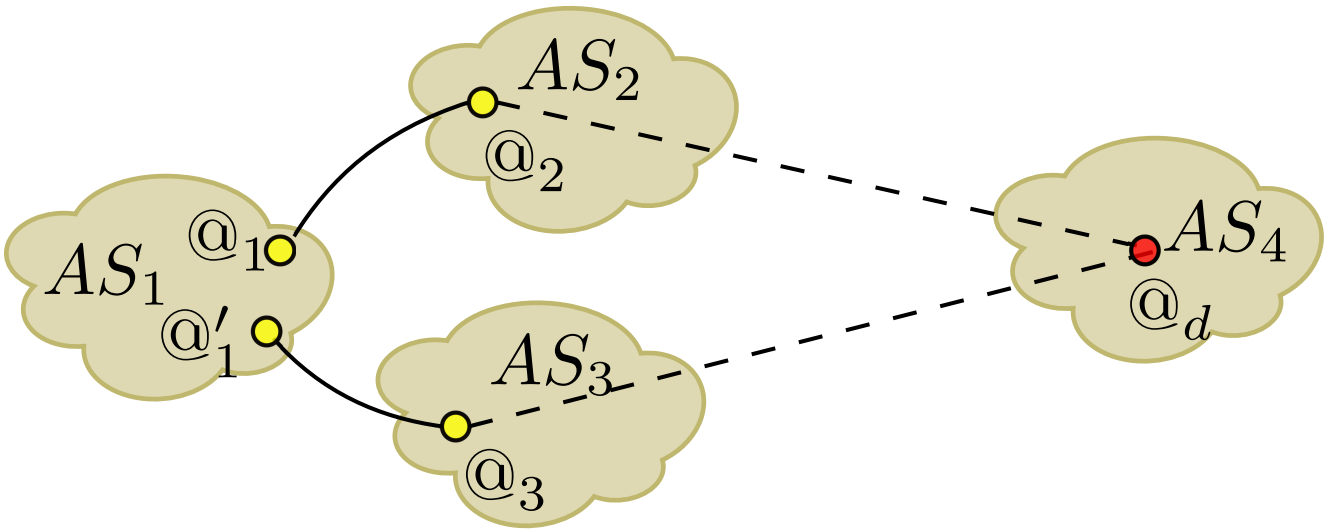


Inter AS link

Continuation of the link to the announcing AS

An Autonomous System (AS)

The destination prefix p



Inter AS link

Continuation of the link to the announcing AS

An Autonomous System (AS)

IP Hop $@_i$

The destination IP address $@_d$