Collaborative Network Security

Targeting Wide-area Routing and Edge-network Attacks

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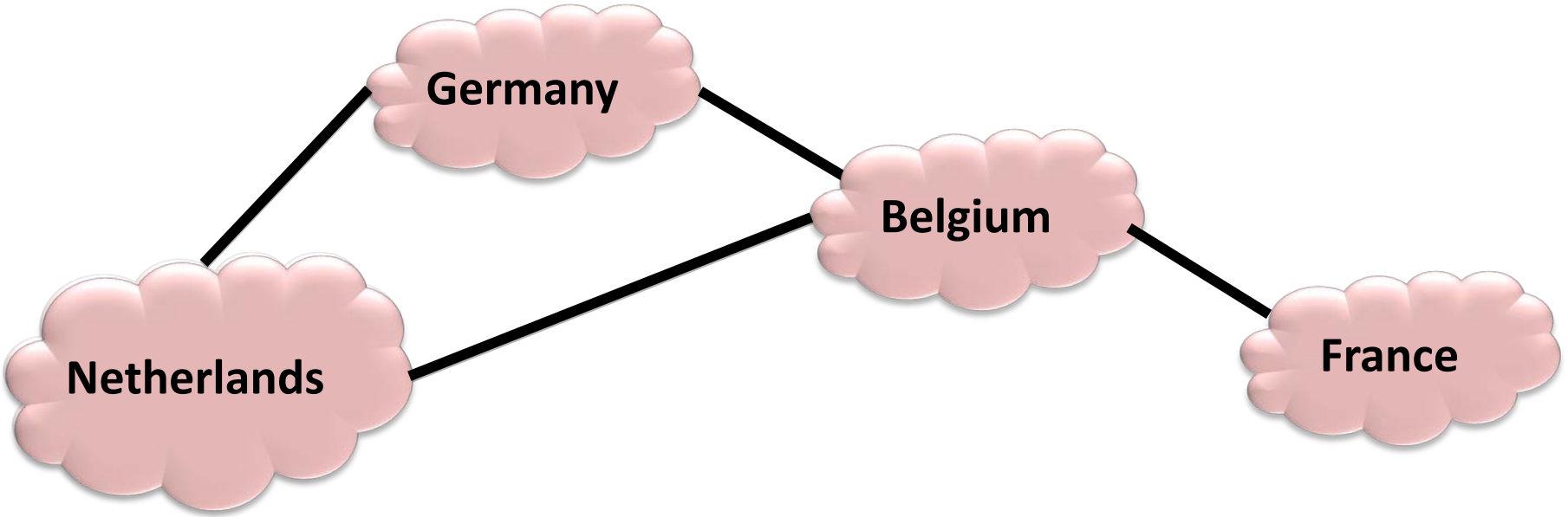
Background

BGP refresher



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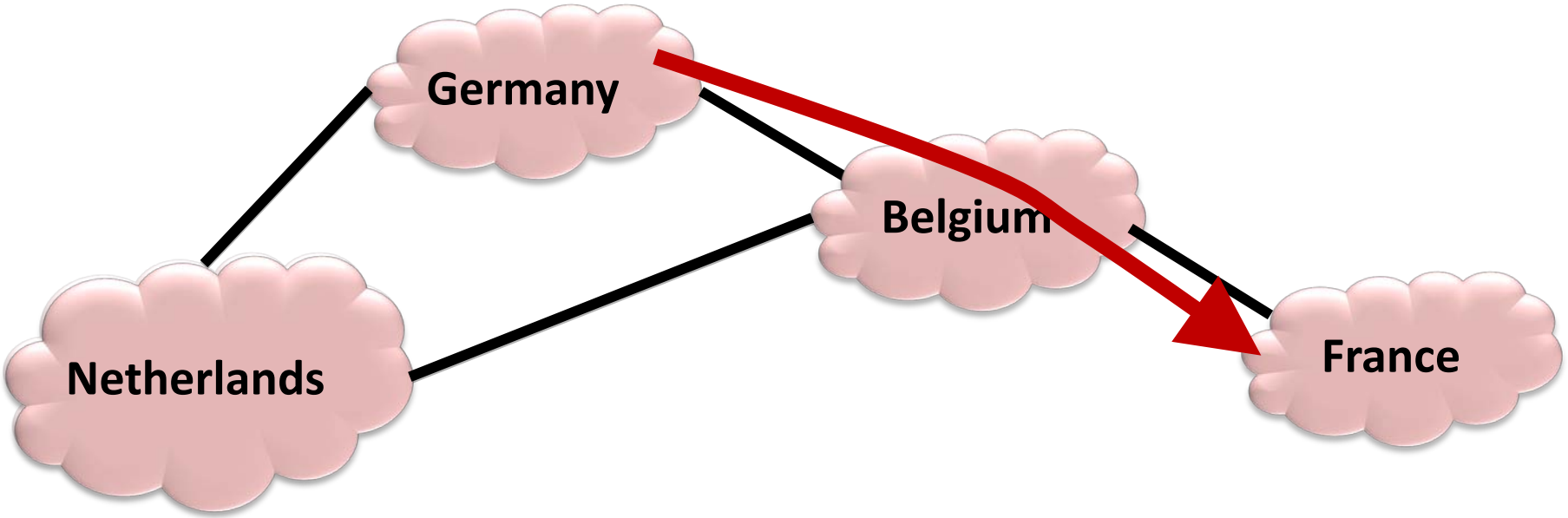

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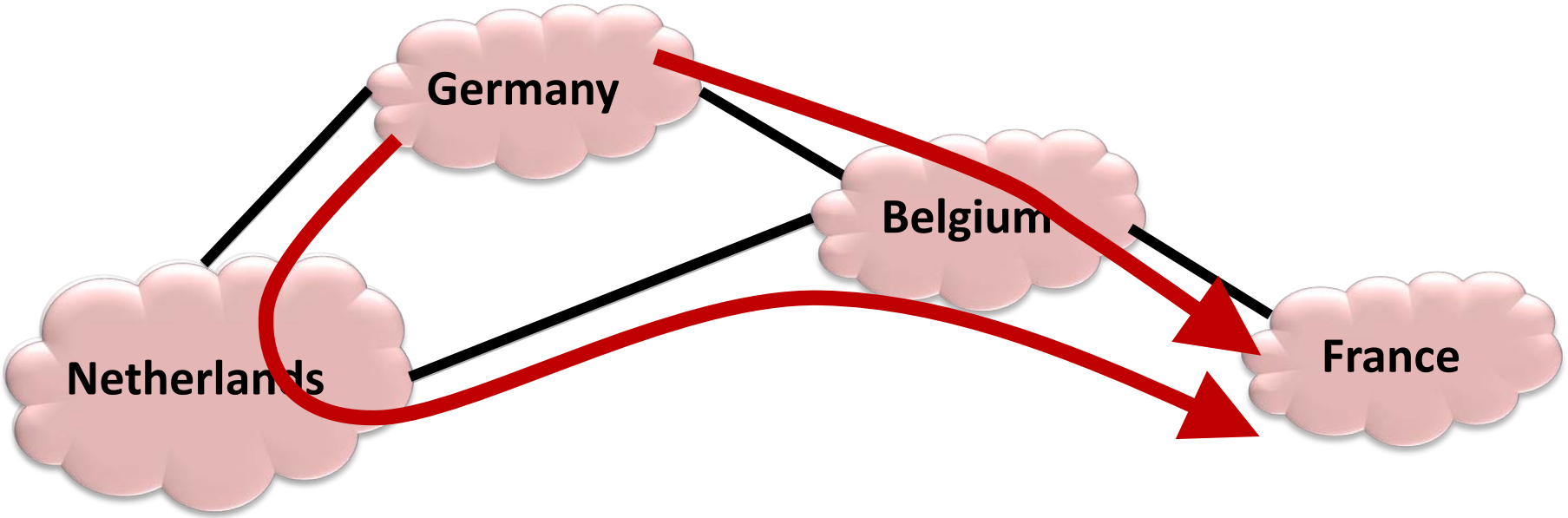

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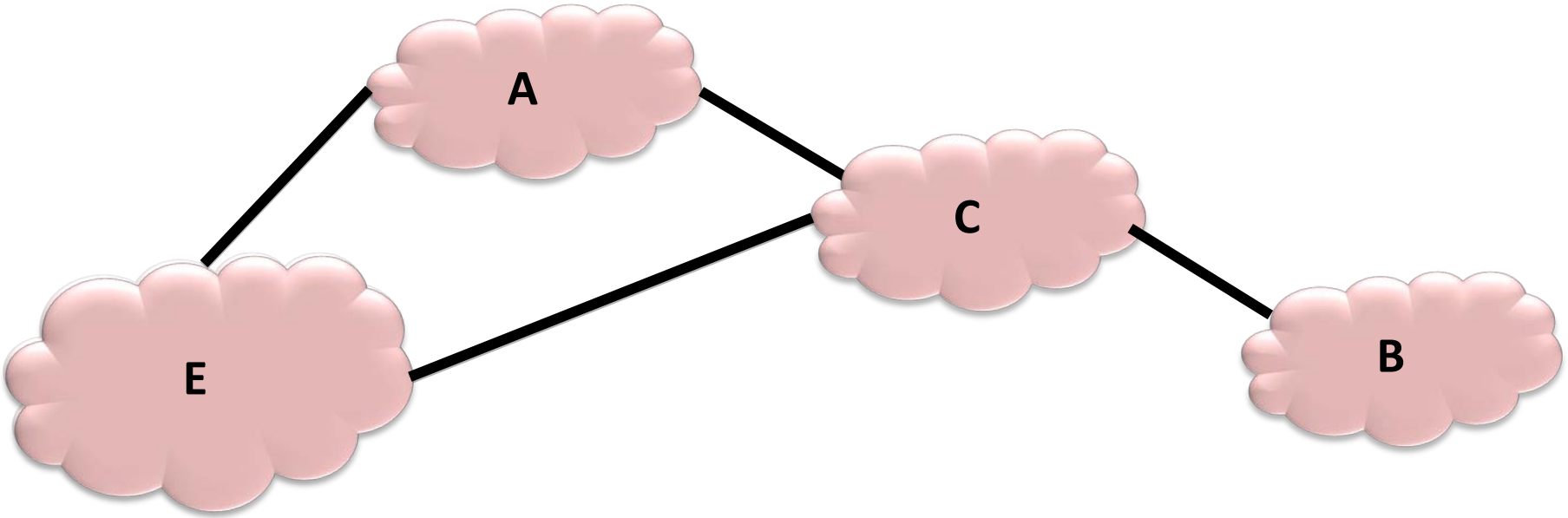

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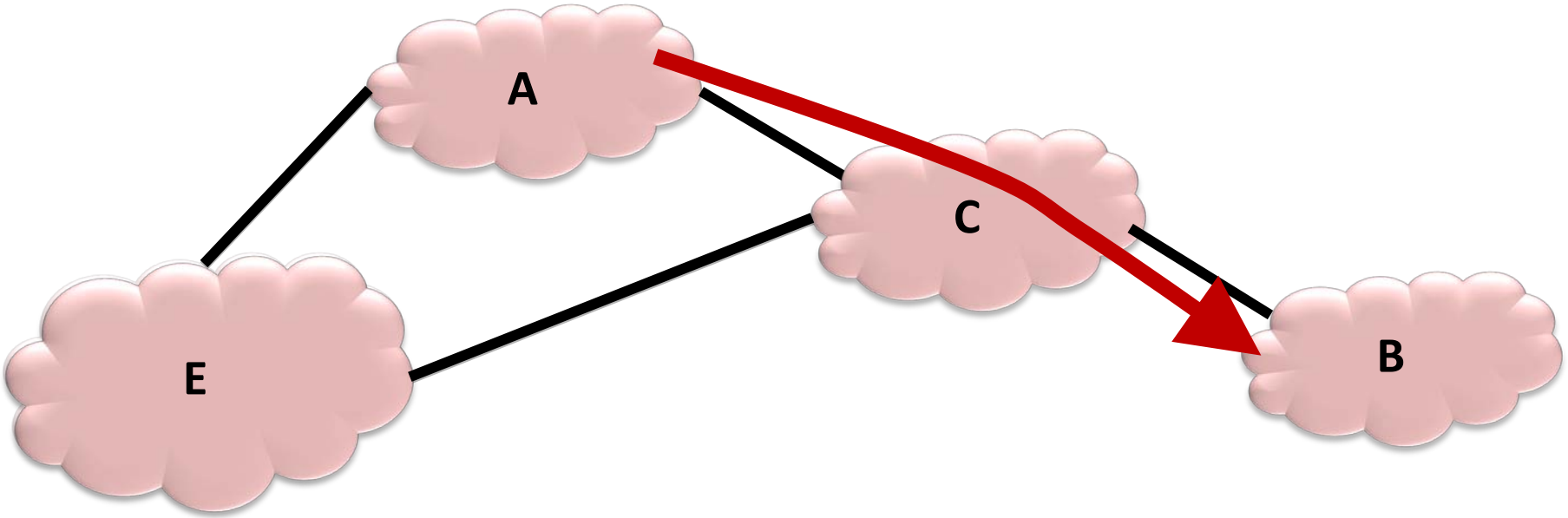

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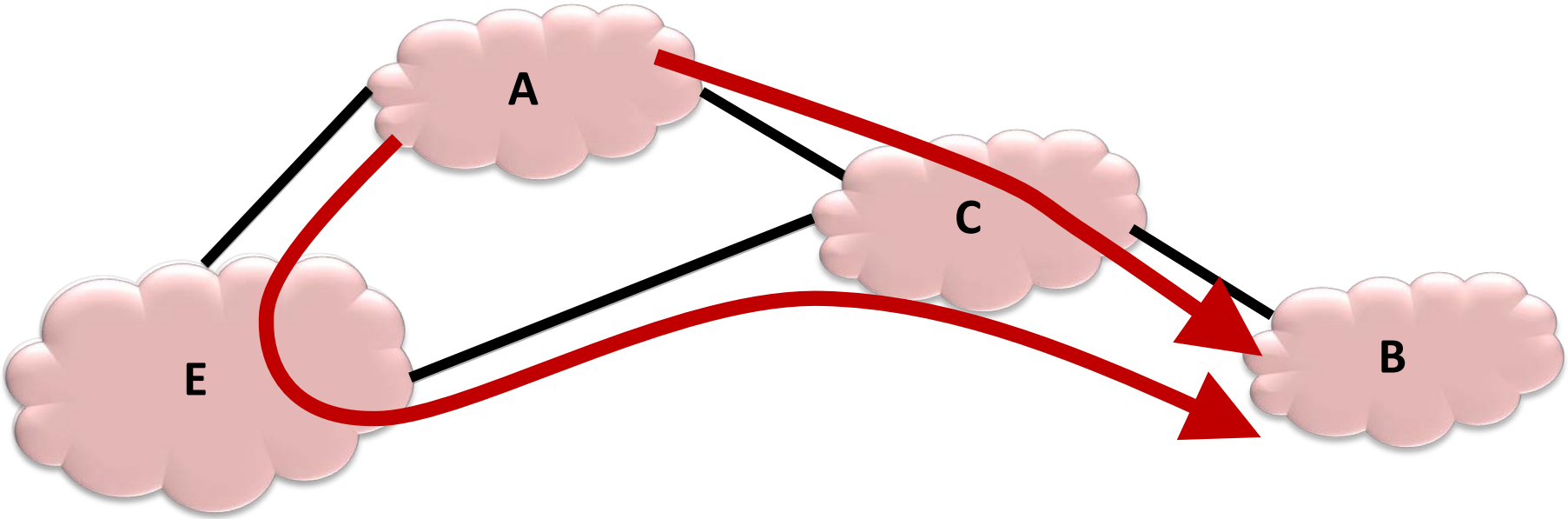

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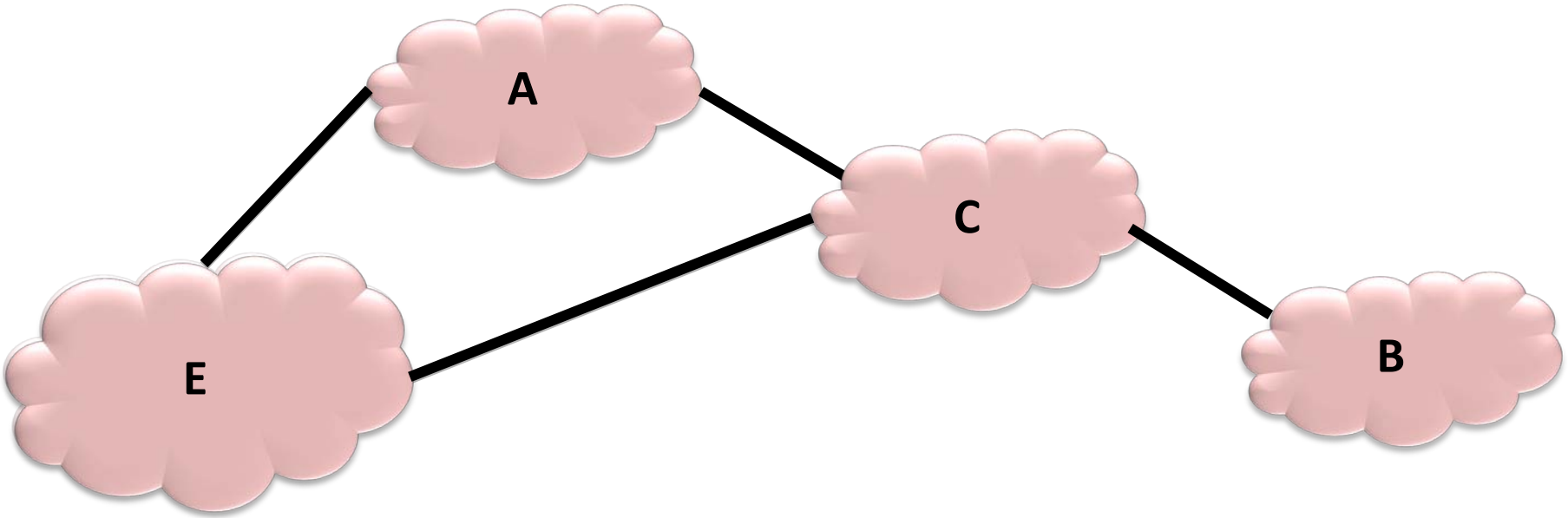

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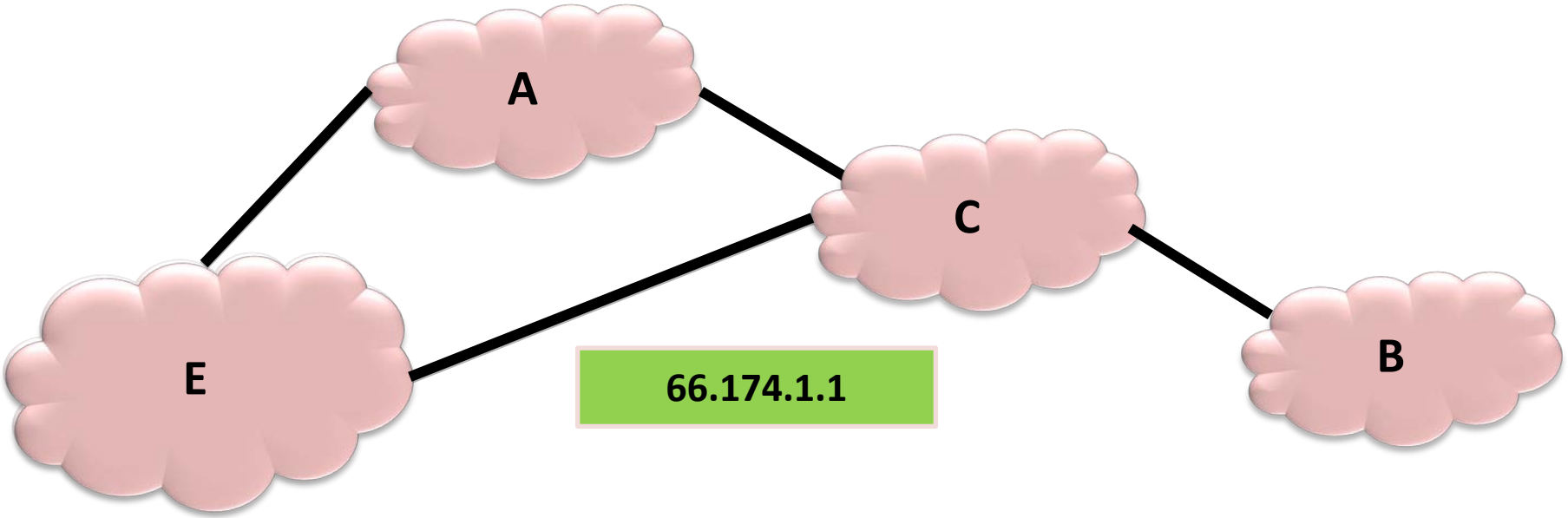

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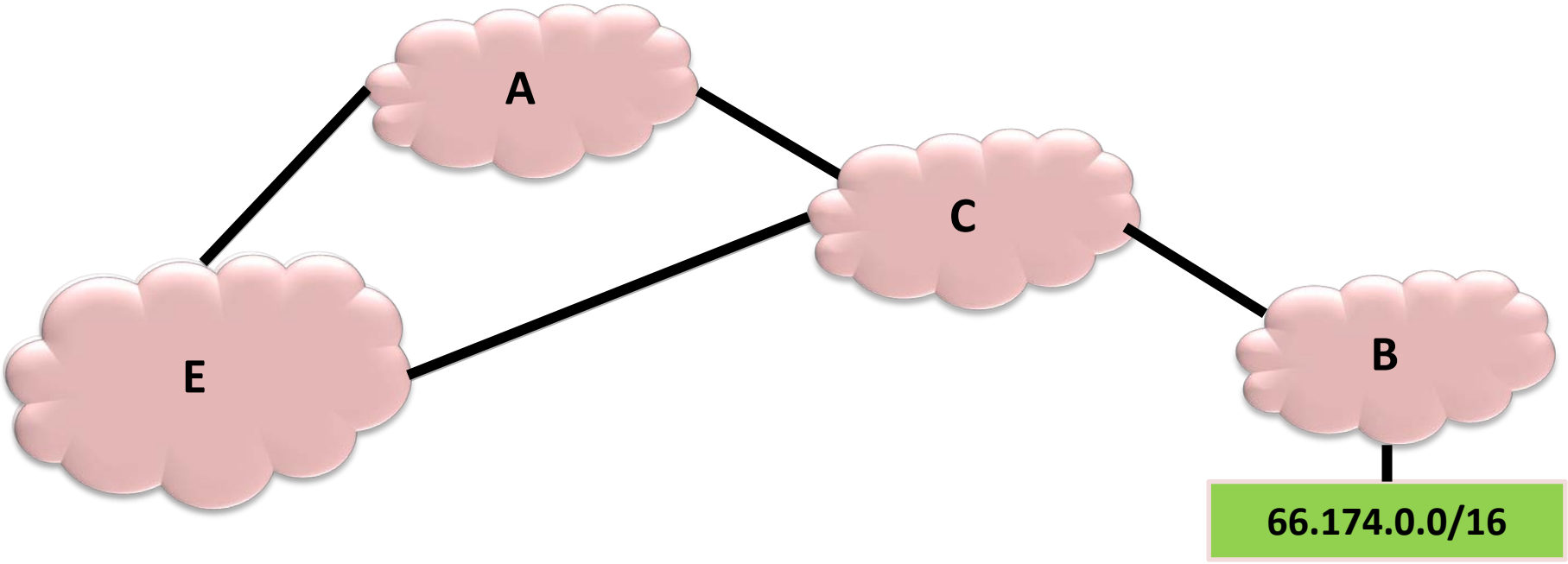

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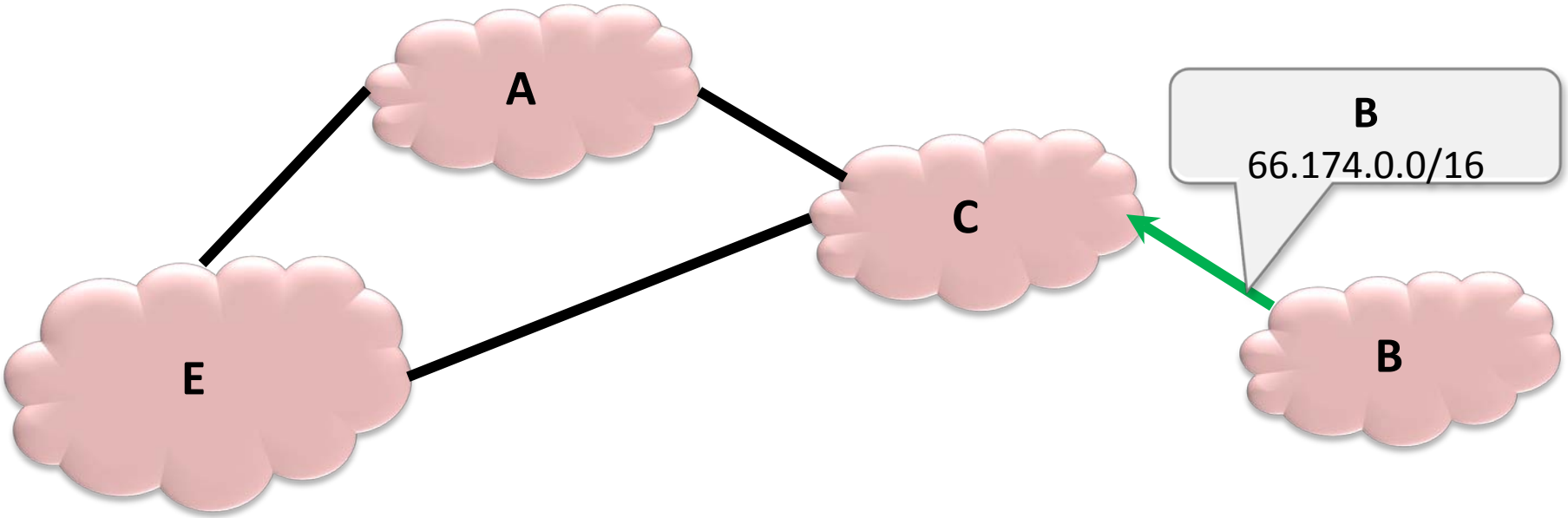

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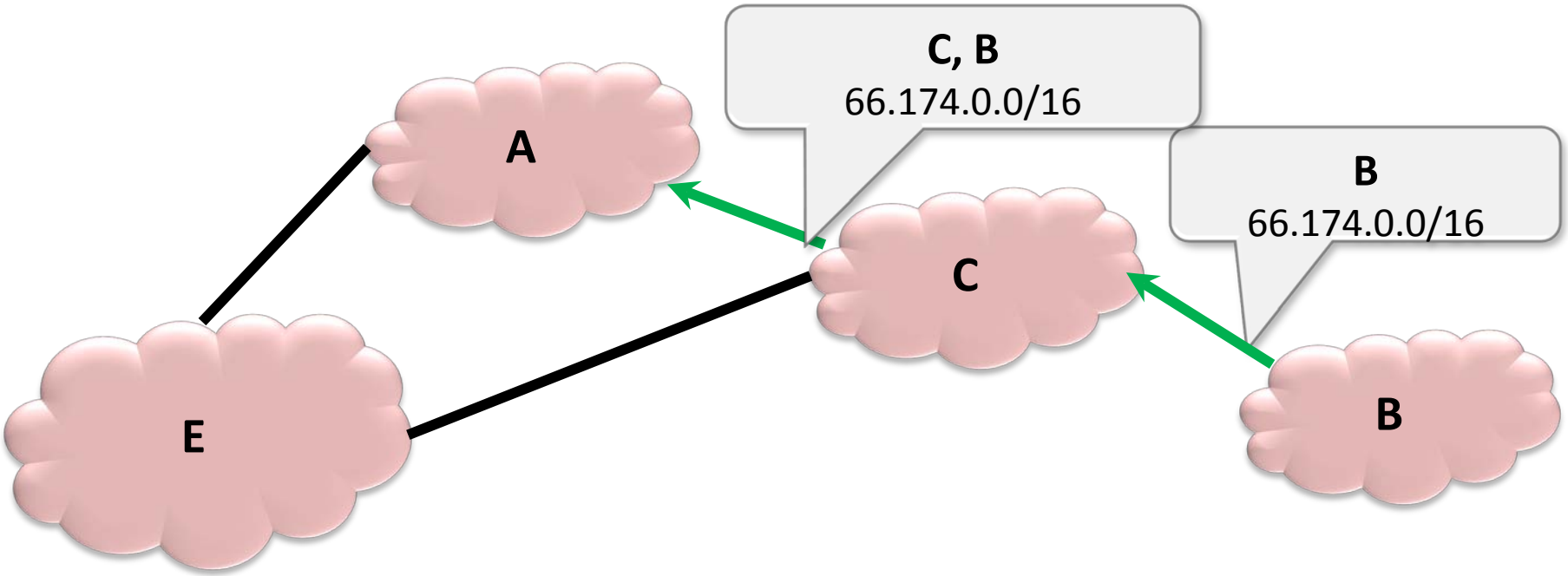

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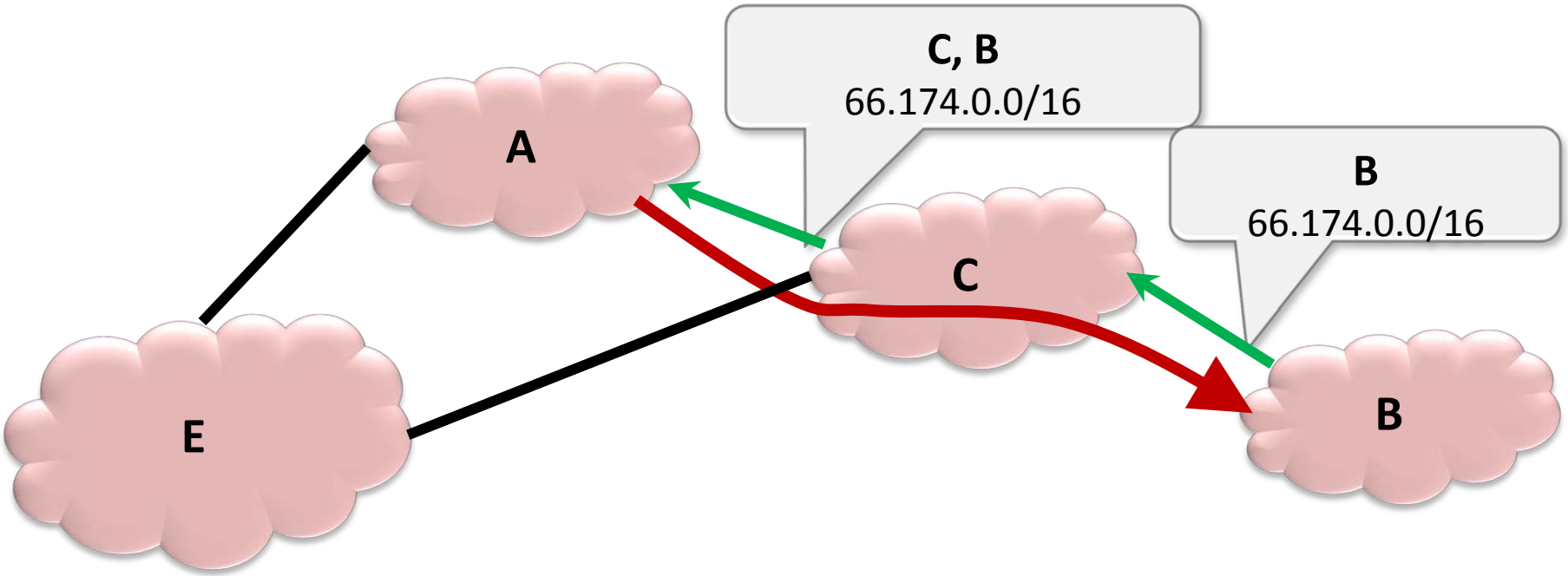

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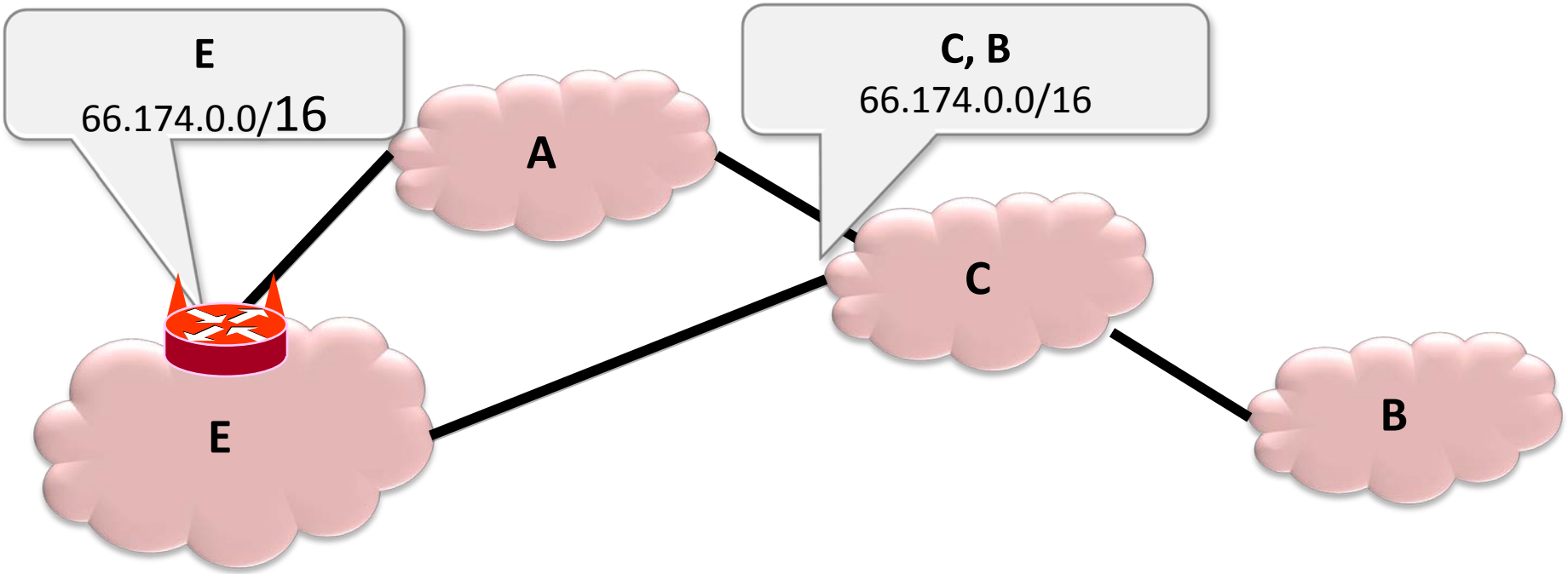
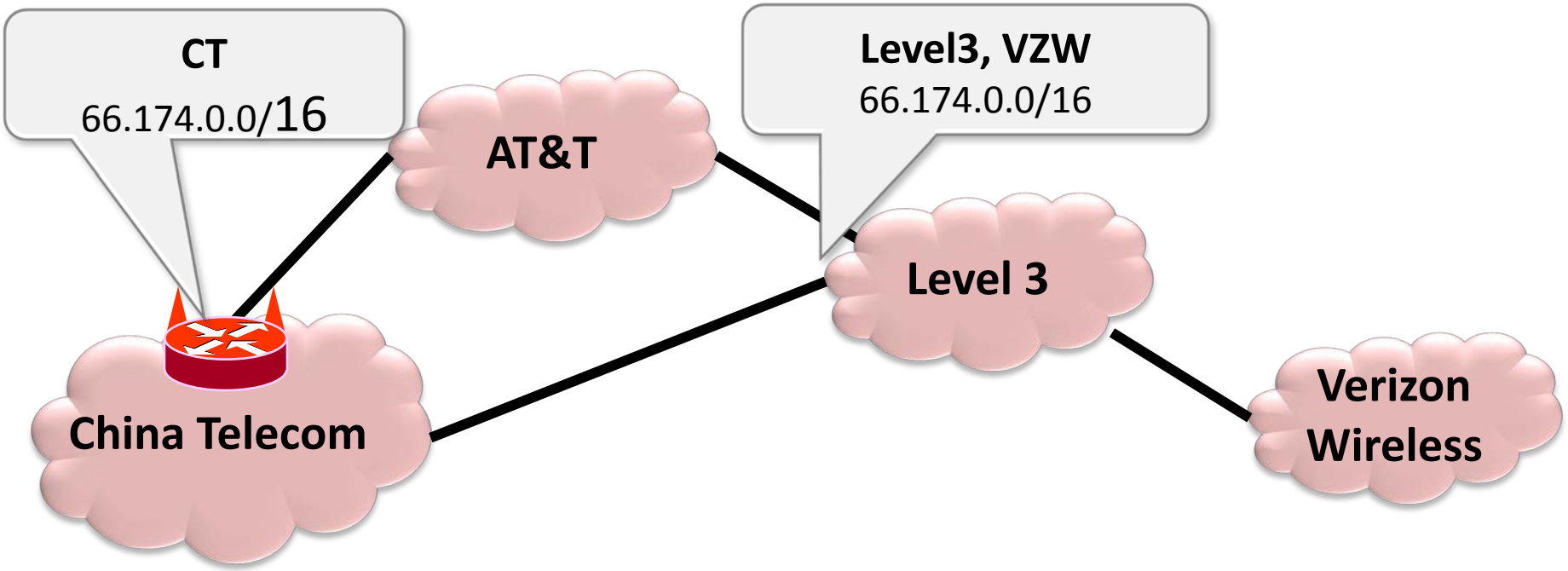


Difficult to check true ownership of prefixes

Prefix hijack attack



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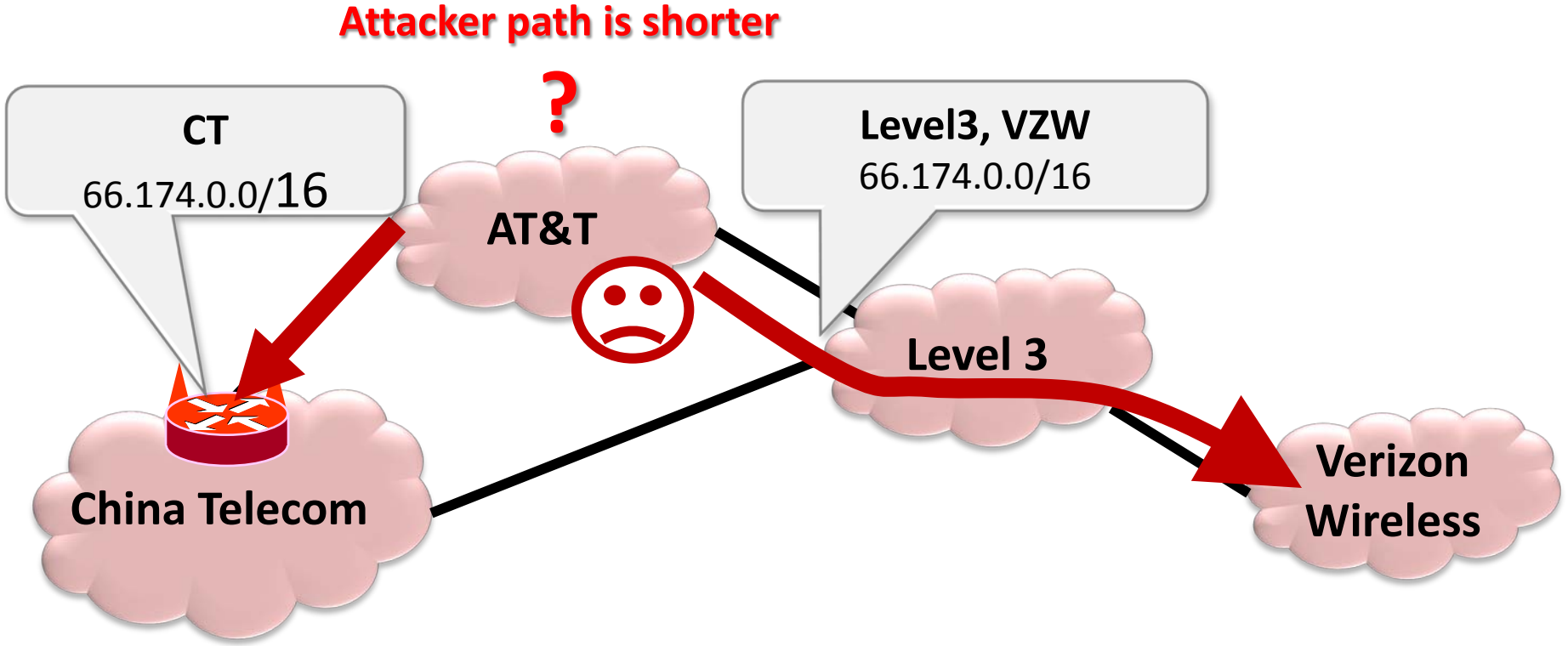
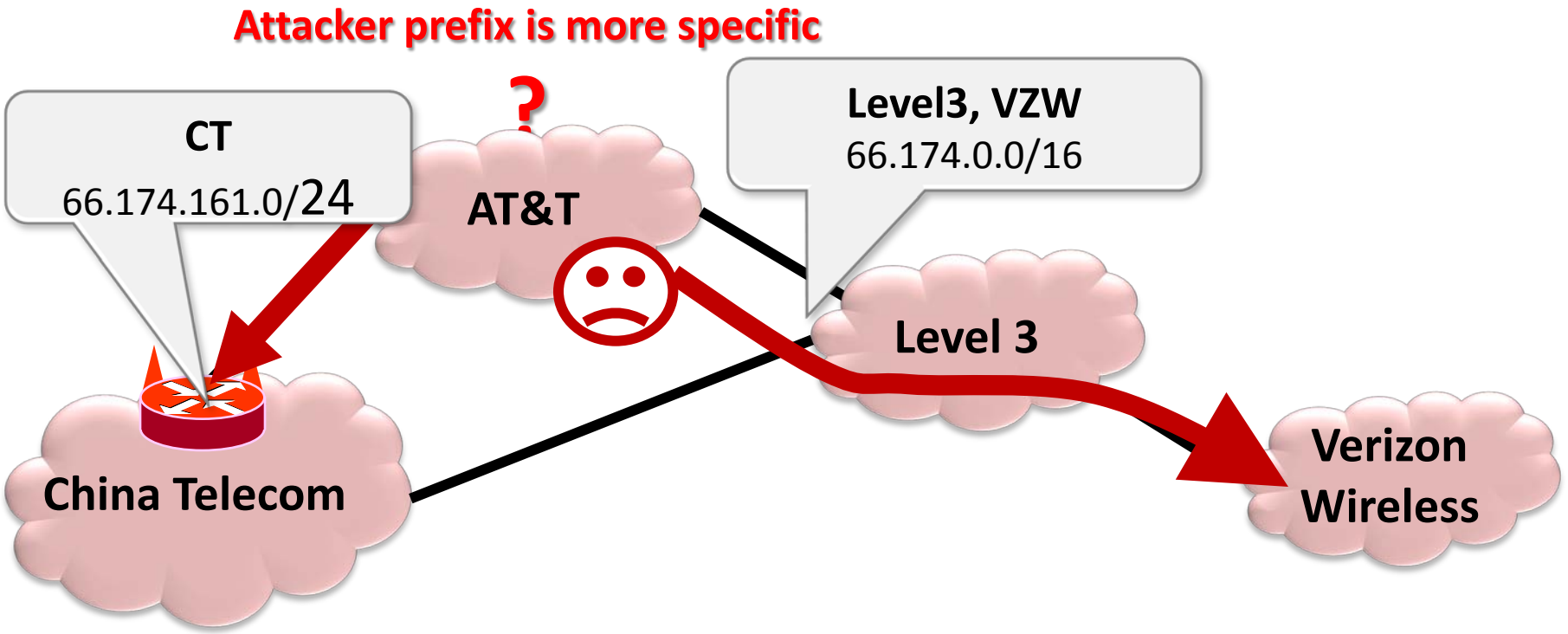
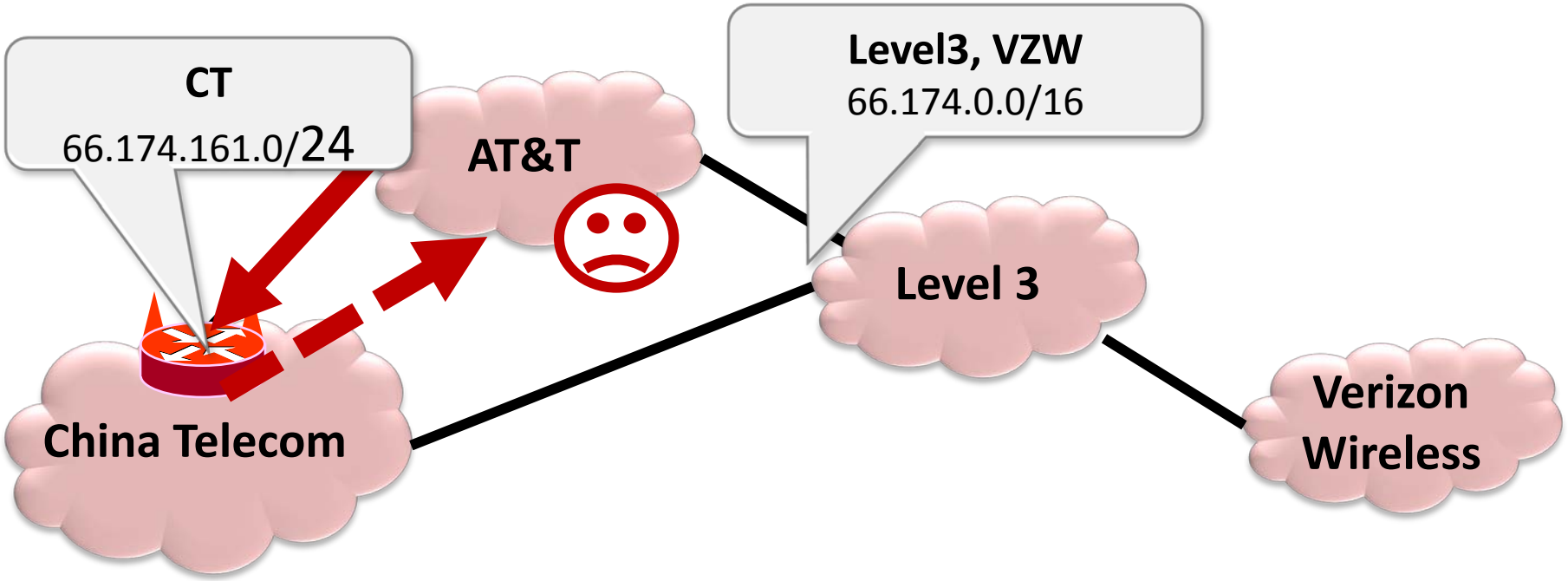


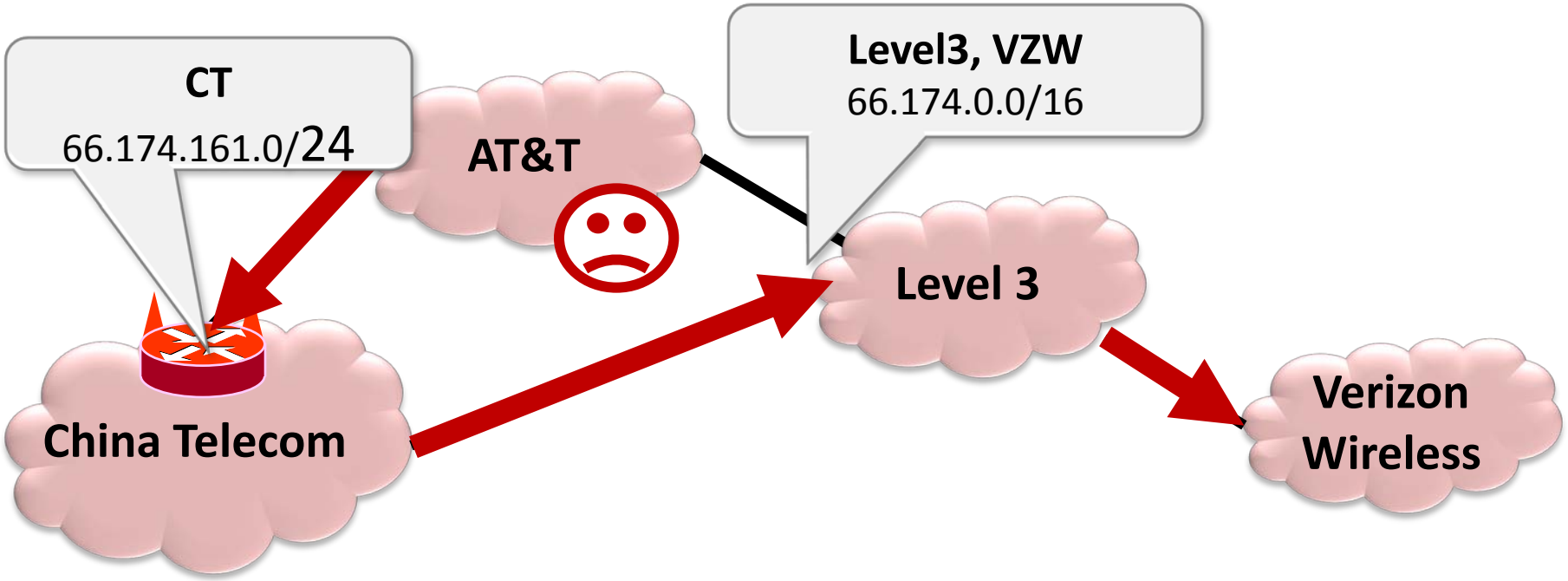
Subprefix hijack attack



Imposture attack



Interception attack



Research questions

Research questions

- What can we learn about large scale routing anomalies using publicly available datasets?
- How can we design scalable mechanisms to raise alerts for routing attacks and malicious edge-network-based activities?
- How are the gains from routing security mechanisms affected by scale, size, and locality aspects of the collaborating ASes?

Contributions

- Characterization of the China Telecom incident
- Decentralized collaborative mechanisms to detect attacks
  - PrefiSec
  - CrowdSec
  - TRAP
- Evaluation of different routing security mechanisms from scale, size, and locality perspective
  - Routepath updates
  - Origin information
  - Traffic properties such as RTT

Contributions

China Telecom incident

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- Decentralized collaborative mechanisms
  - PrefiSec
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Collaborative mechanisms

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Effect of scale, size, locality

China Telecom incident

China Telecom incident

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China denies 'hijacking' internet traffic

US report claims Chinese telecoms company had access to 15% of global traffic, including military emails, for 18 minutes

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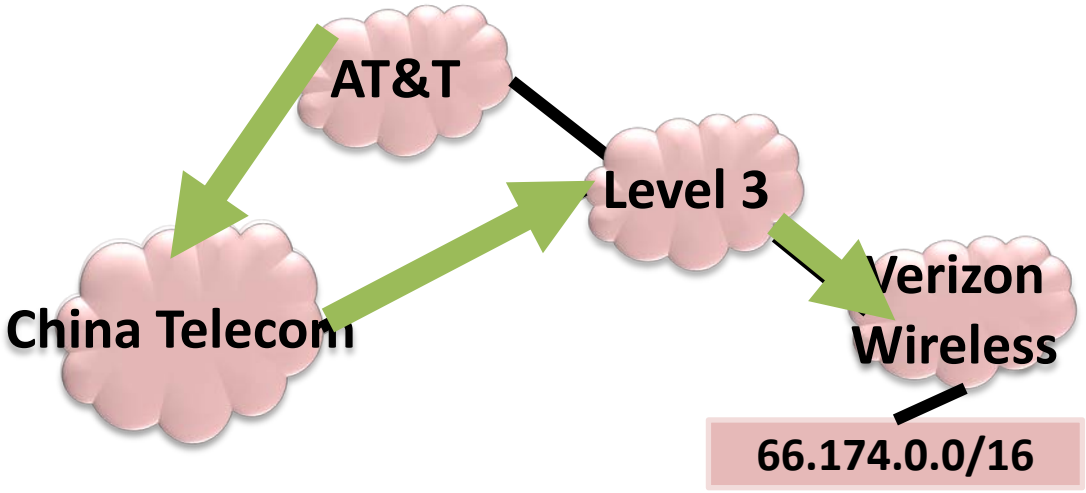
China 'hijacks' 15 per cent of world's internet traffic

China "hijacked" 15 per cent of the world's internet traffic for 18 minutes earlier this year, including highly sensitive email exchanges between senior US government and military figures, a report to the US Congress said.

How did interception occur?

Two routing decisions required for traffic interception:

1. A neighbor routes to China Telecom for hijacked prefix
2. Another neighbor does not do so



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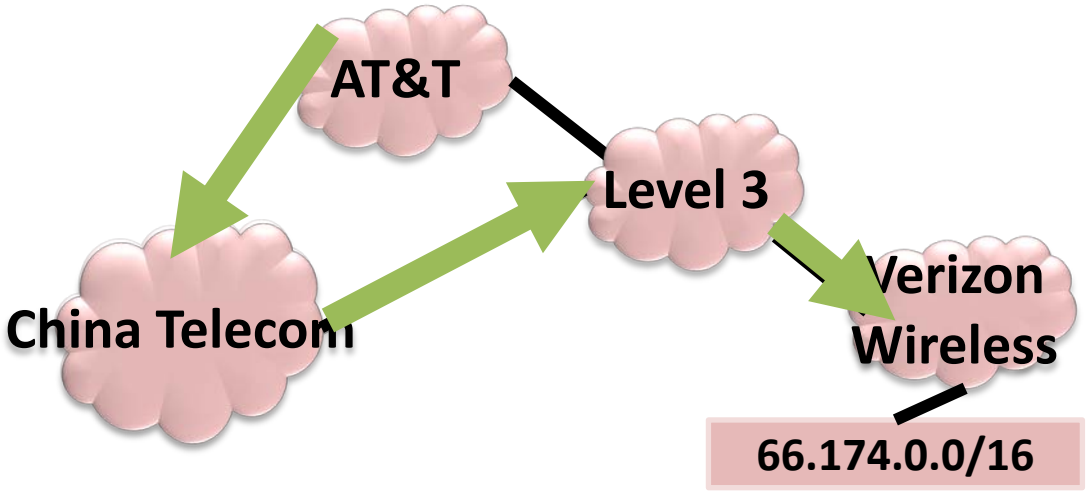

Reasons for not routing to China Telecom

Reason	# of traceroutes	% of traceroutes
Had a customer path	139	39%
Had a shorter path	193	54%
Had an equally good path	18	5%
Other	7	2%

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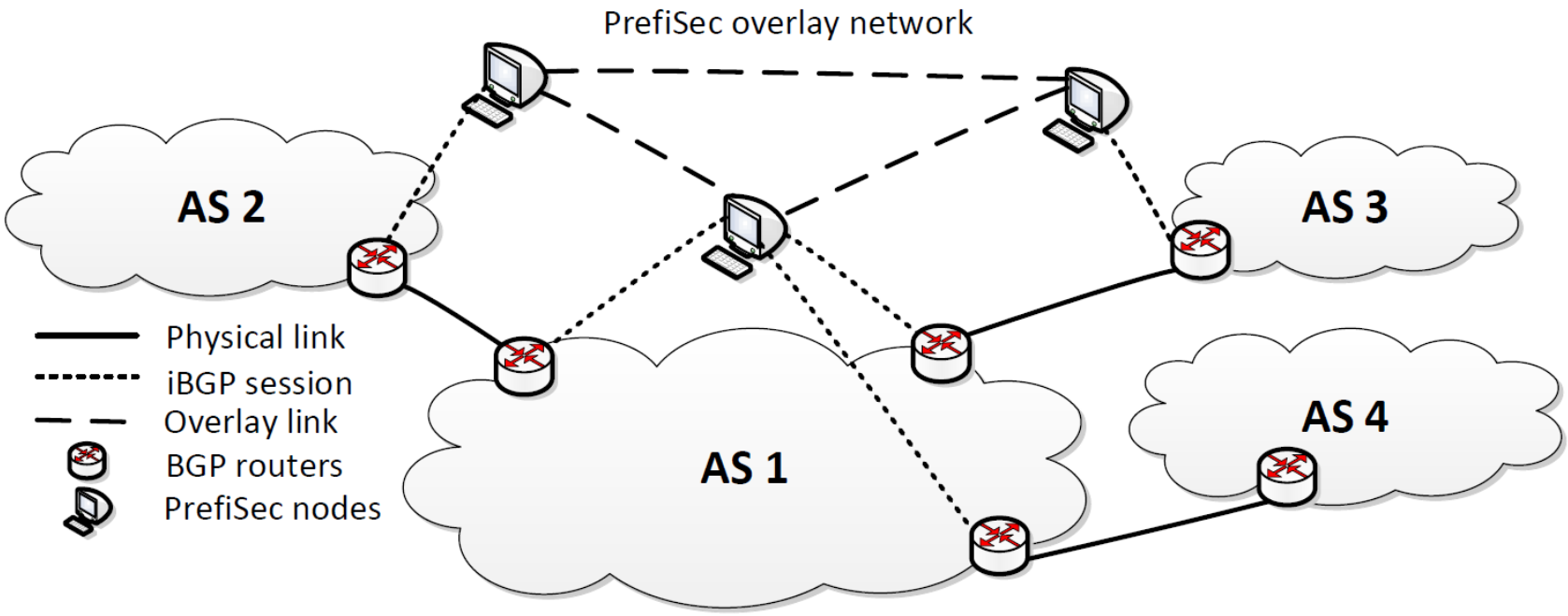
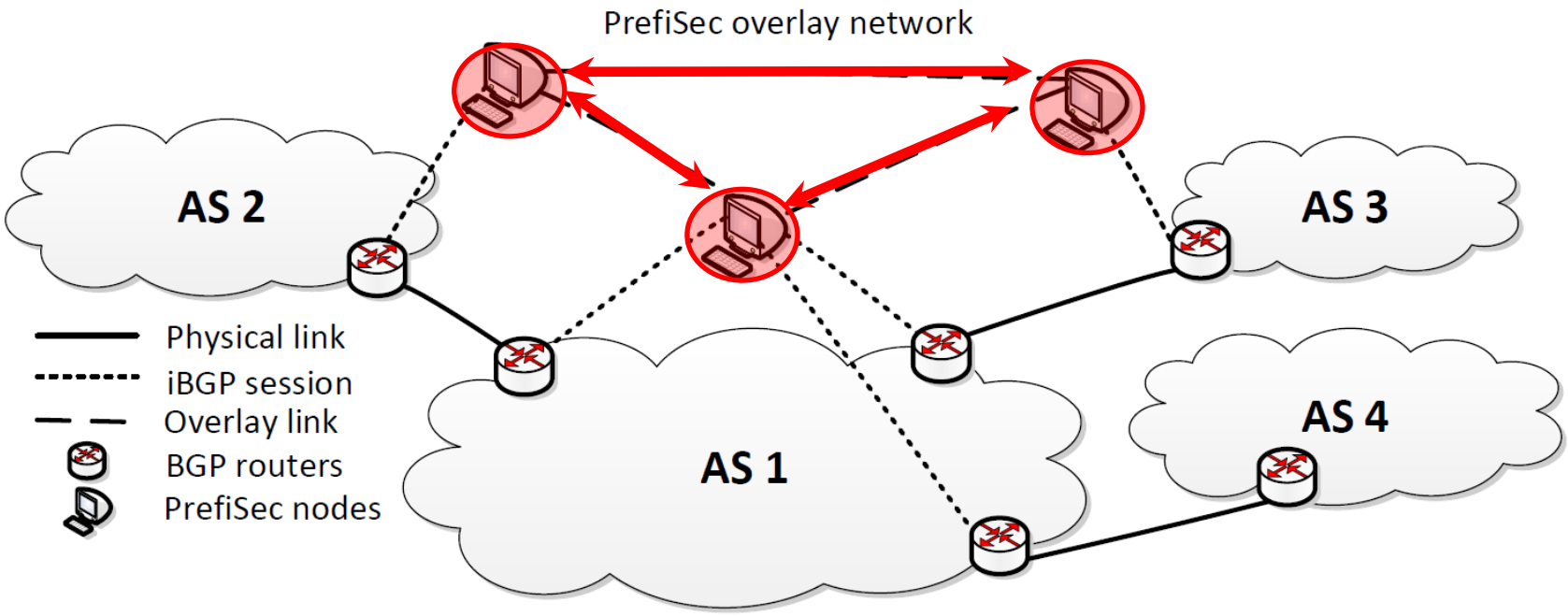
- Decisions made by ASes resulted in interception
- Collaboration important to detect such attacks

Collaborative mechanisms

PrefiSec architecture



PrefiSec architecture



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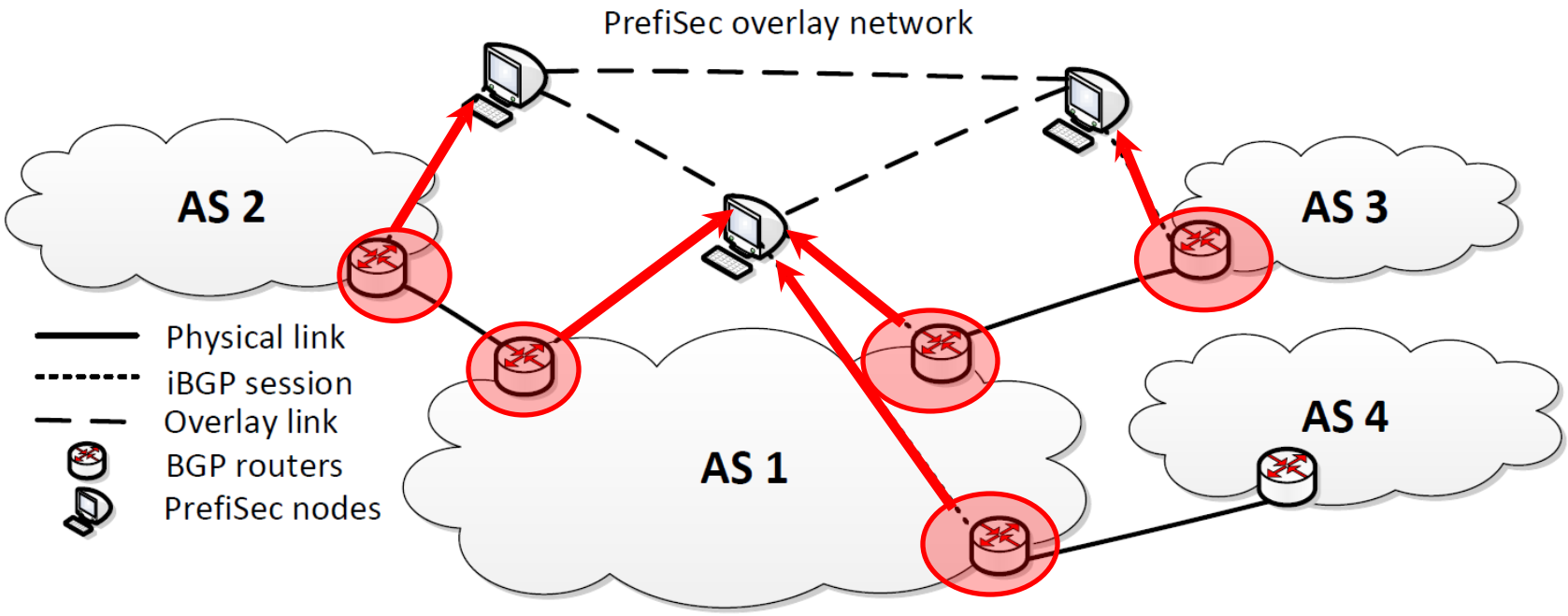

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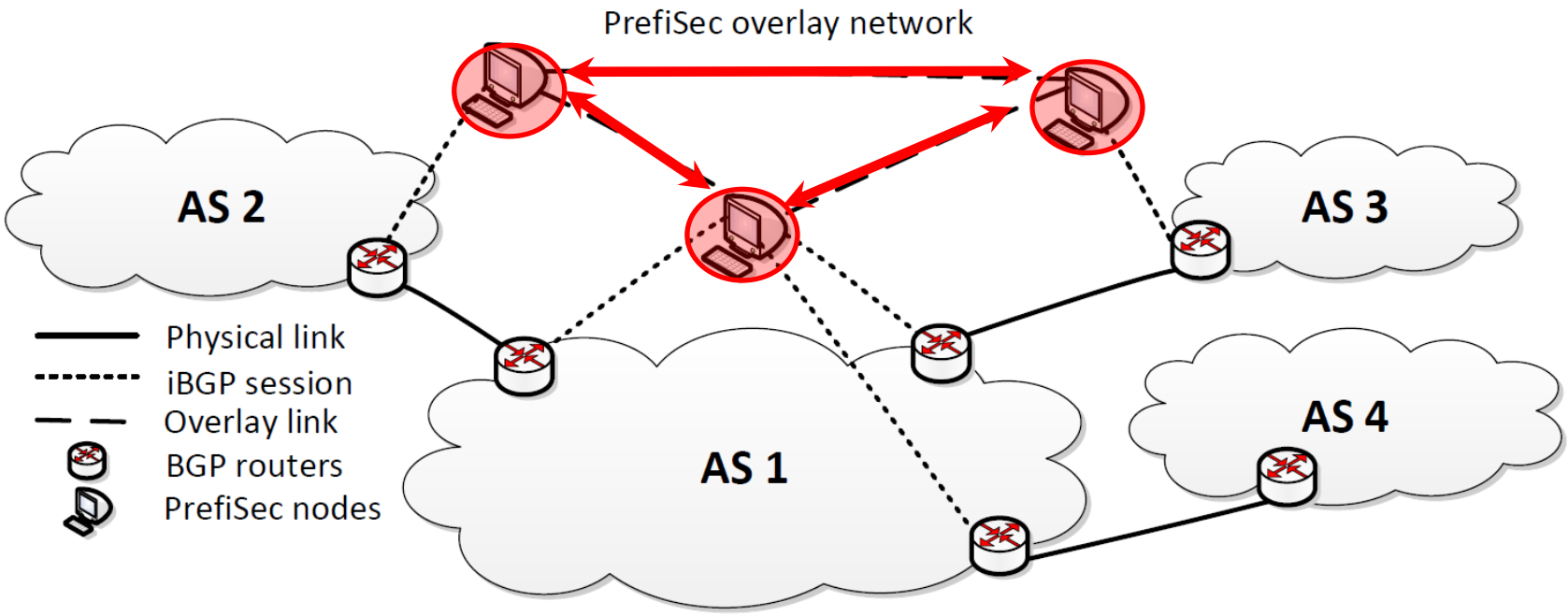
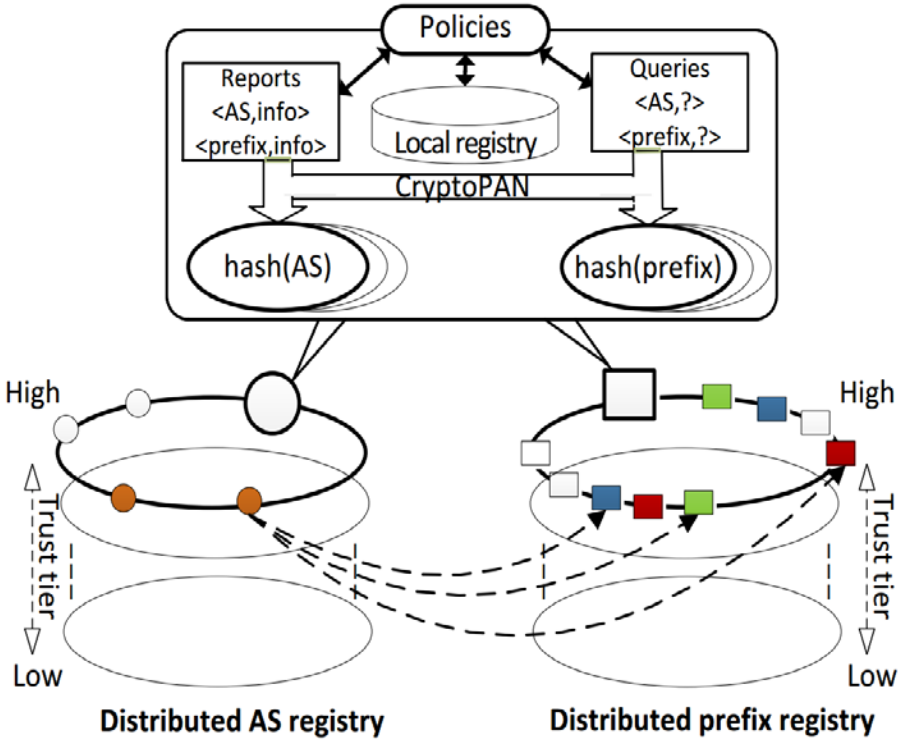


Components and structure



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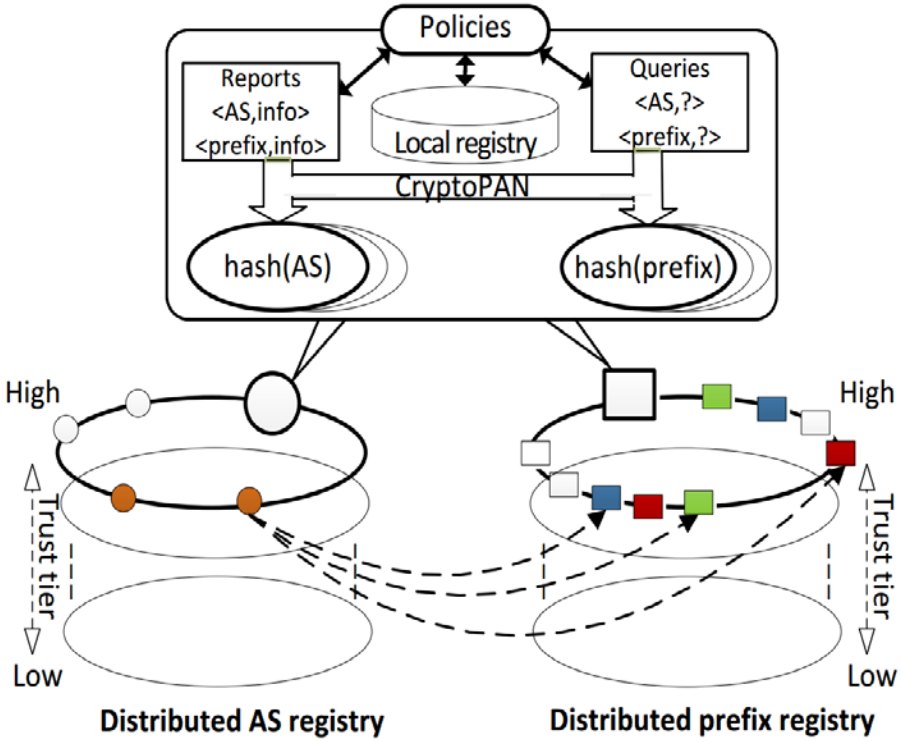

- AS registry
  -Information about ASes, their relationships, and AS-to-prefix mappings
- Prefix registry
  -Prefix origin information (prefix-to-AS mapping), and edge-network activities

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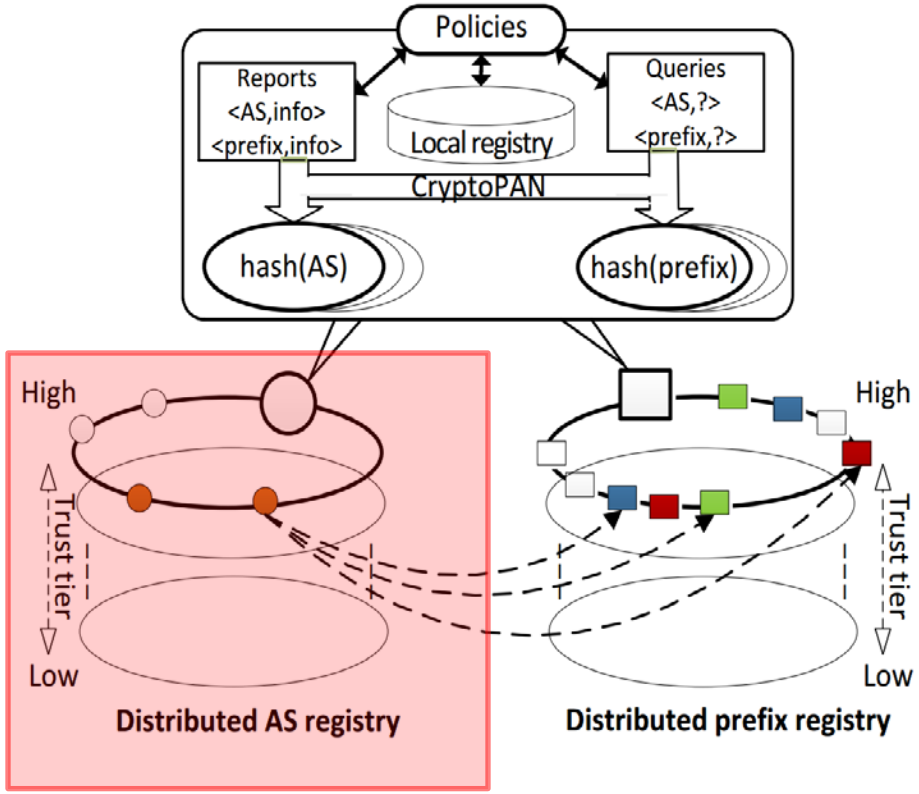

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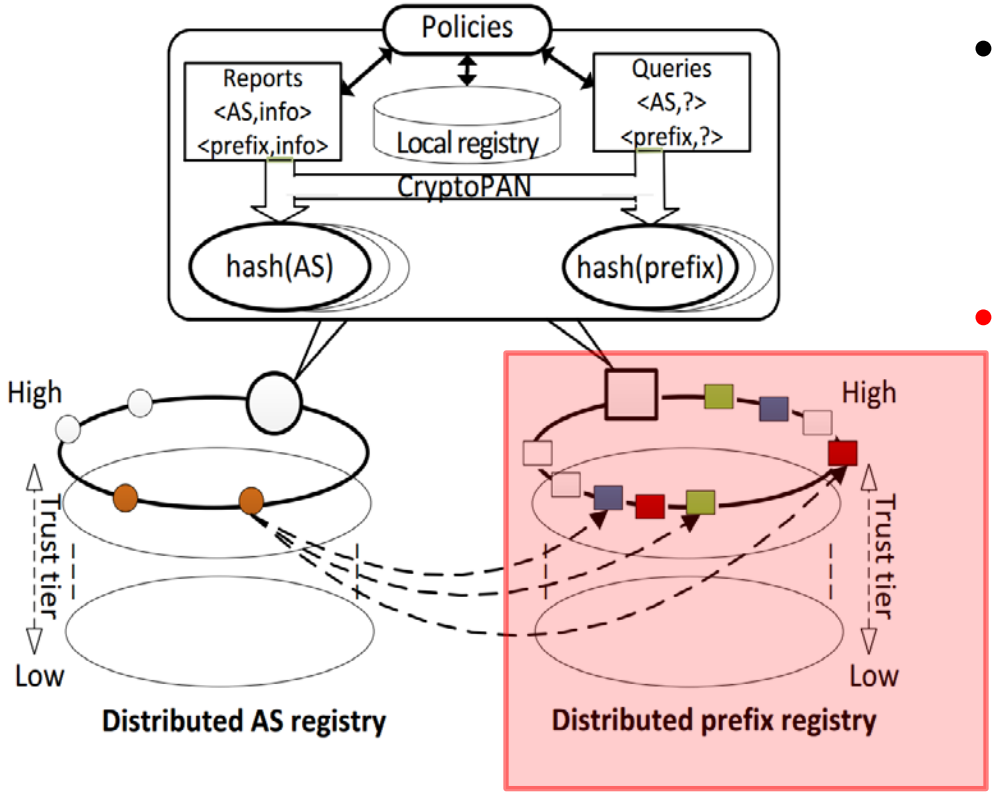

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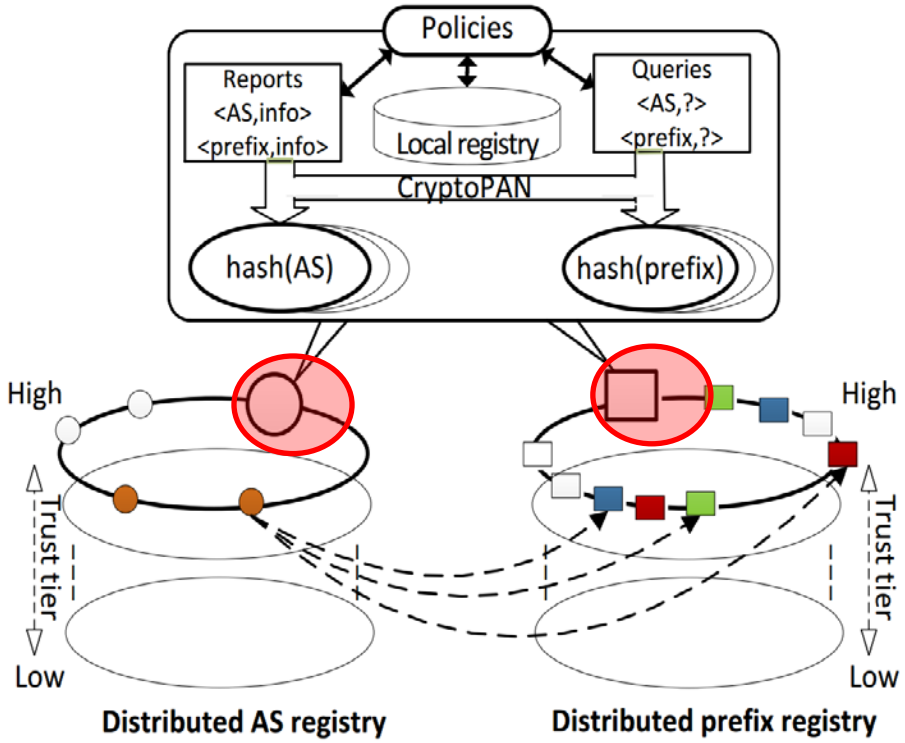
IP 12.12.12.12 maps to prefix 12.12.12.0/24; not prefix 12.12.0.0/16

Components and structure



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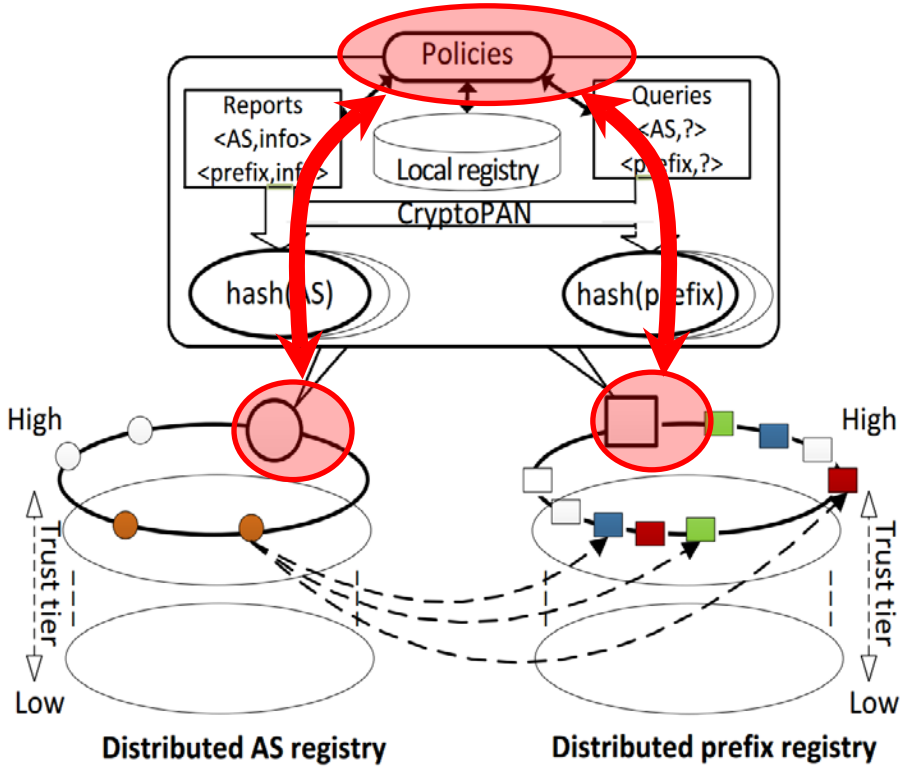

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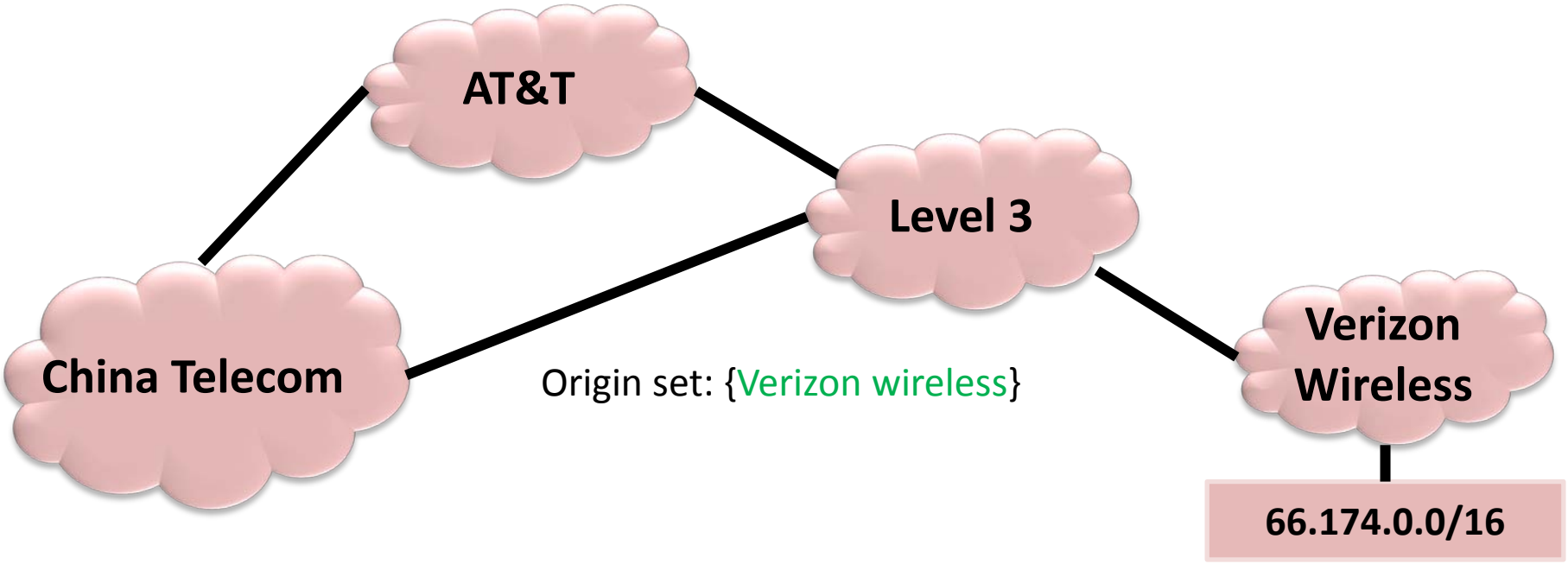
Prefix hijack detection



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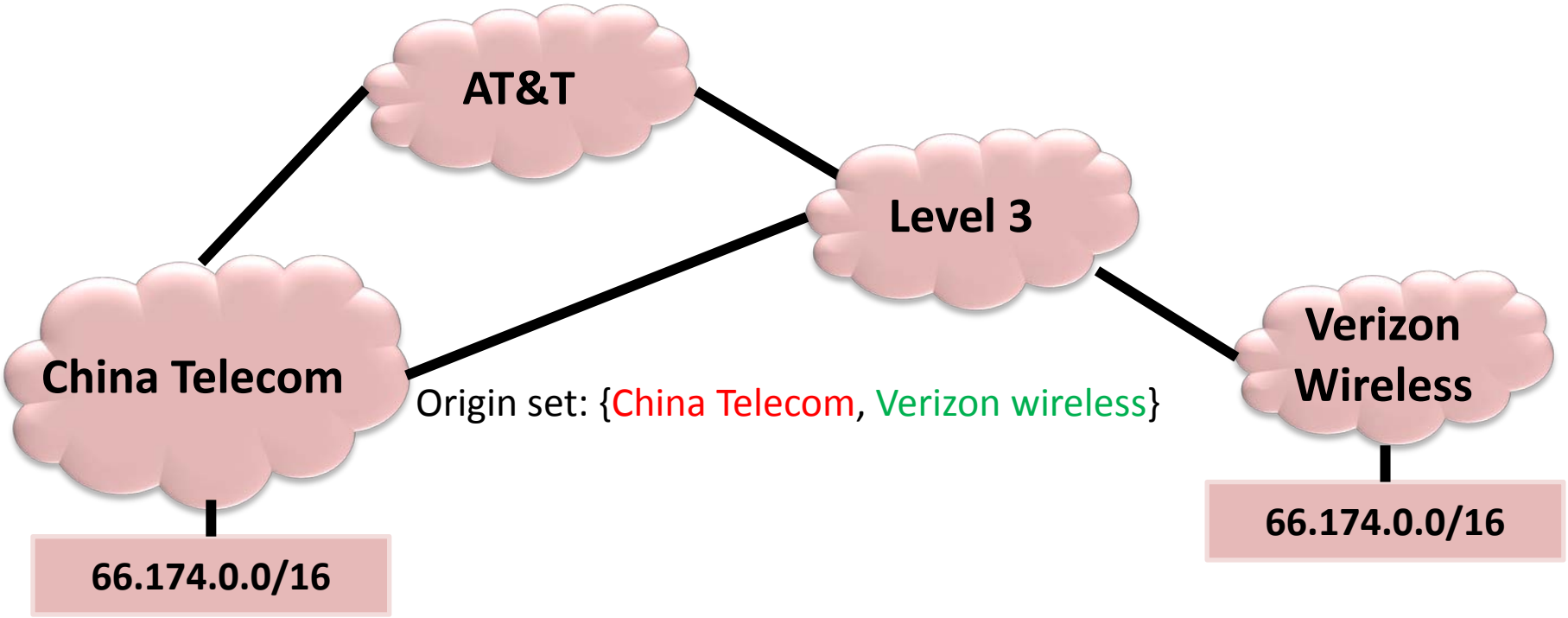

Evaluation

- Performed data-driven analysis
- Used Routeviews data during the time when China Telecom incident occurred
- Simulate the proposed policy on each participating node

Example results

- Overhead small compared to centralized mechanisms
- Day before attack:
  - With all 6 routeviews servers collaborating, approximately 1,500 alerts raised
- Day of attack:
  - Would raise alerts for all 39,094 false announcement made by China Telecom
  - Same alert rate as centralized mechanism

Effect of scale, size, and locality

Mechanisms to secure BGP

- Prefix origin (hijack prevention): Route filtering, RPKI, ROVER
- Route path updates (hijack detection): PHAS, PrefiSec, PG-BGP
- Passive measurements: CrowdSec
- Active measurement: Zheng et al., PrefiSec

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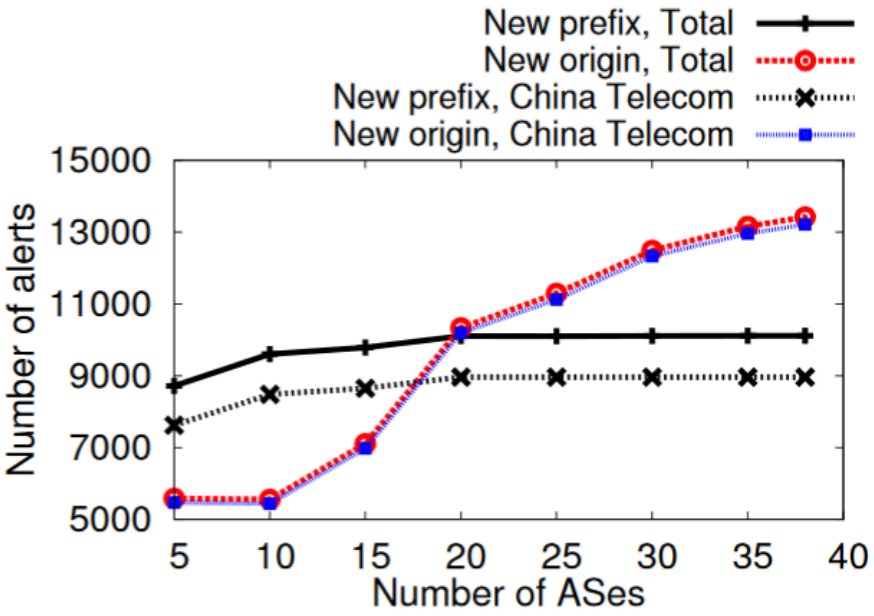
Evaluation aspects

- Locality
  - ASes in specific geographical area: European Union (EU), North America (NA), “rest of the world” and compare with global scenario
- Size
  - Size of an AS is based on the number of neighbors of that AS (termed as degree of AS)
- Scale
  - Number of collaborating ASes

Hijack detection mechanism

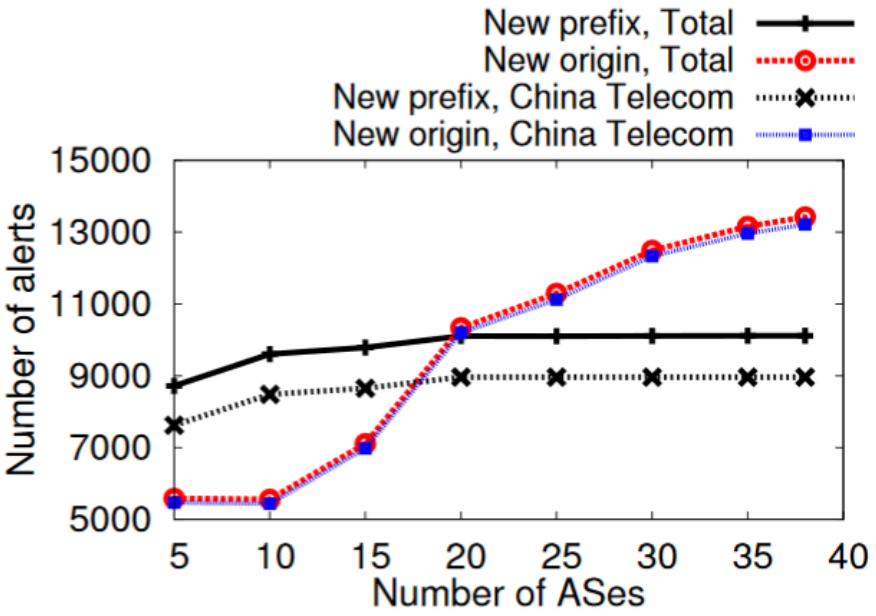
- Evaluation based on PrefiSec
- Instead of collaboration among routers in Routeviews data, we consider collaboration of ASes
- Data around time of the China Telecom incident

Scale and locality

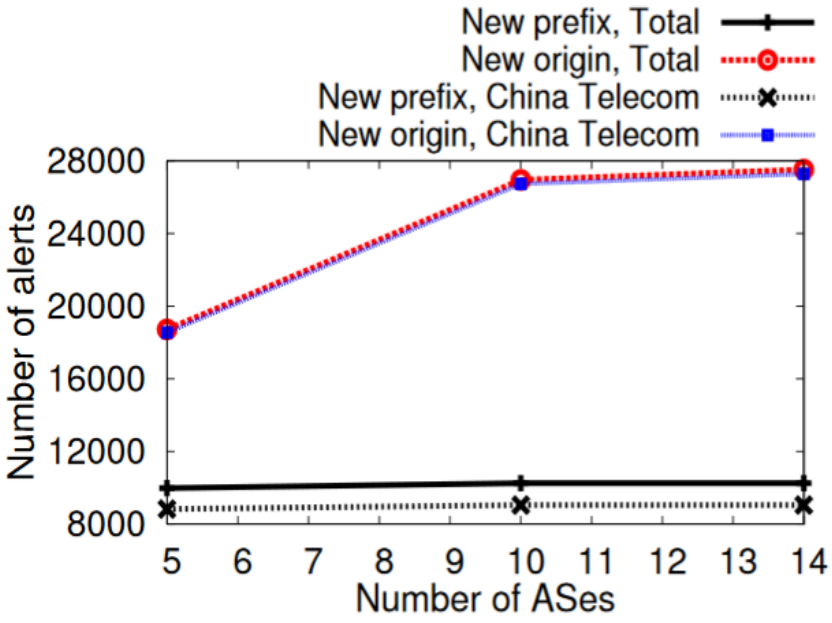


North America (NA)

Scale and locality



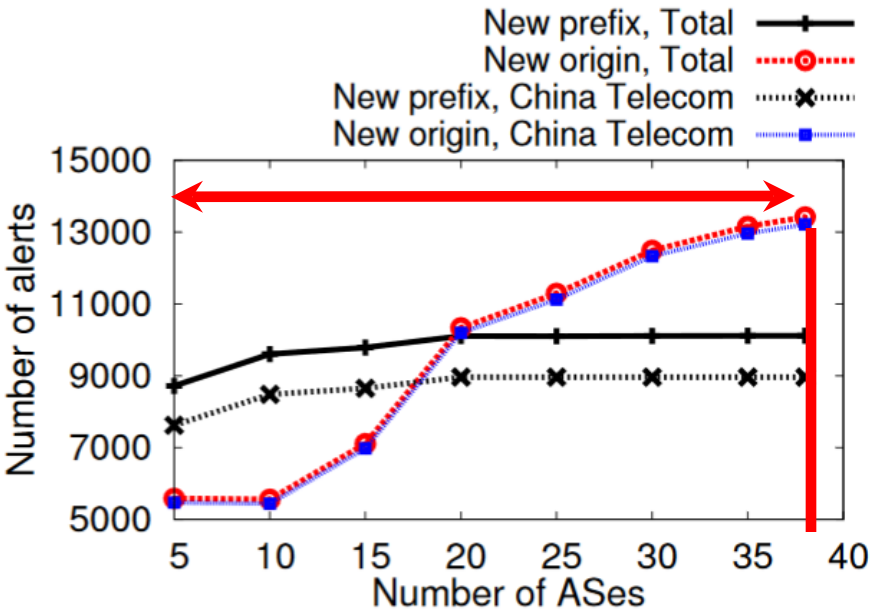
North America (NA)



Rest of the world

- High detection rate in *rest of the world* despite fewer ASes
- Regional deployment along with ASes from other regions

Scale and locality



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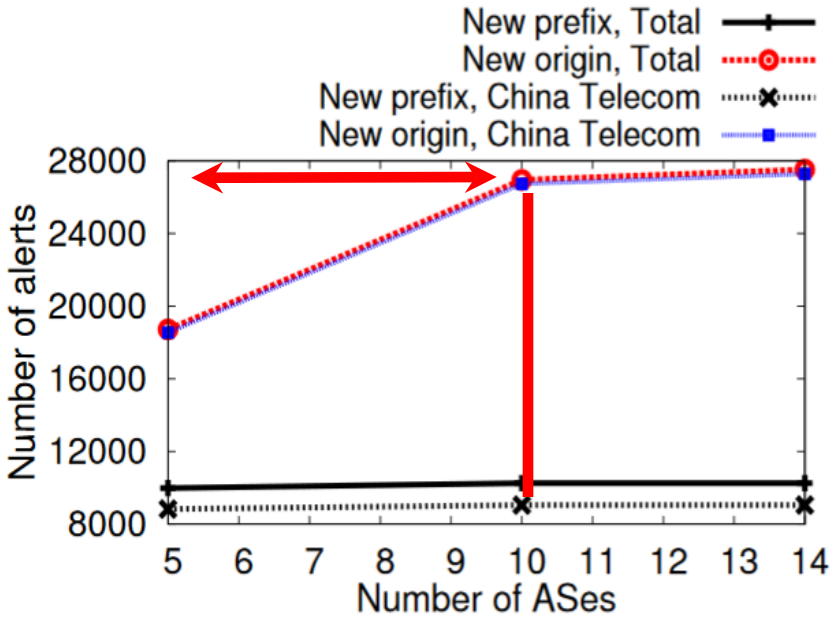

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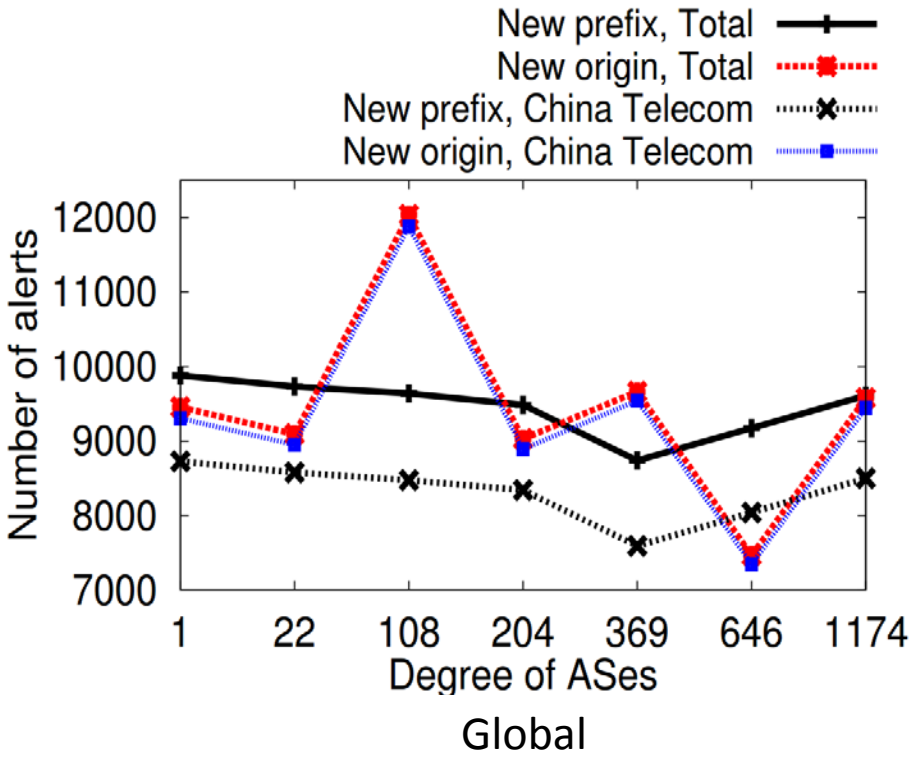

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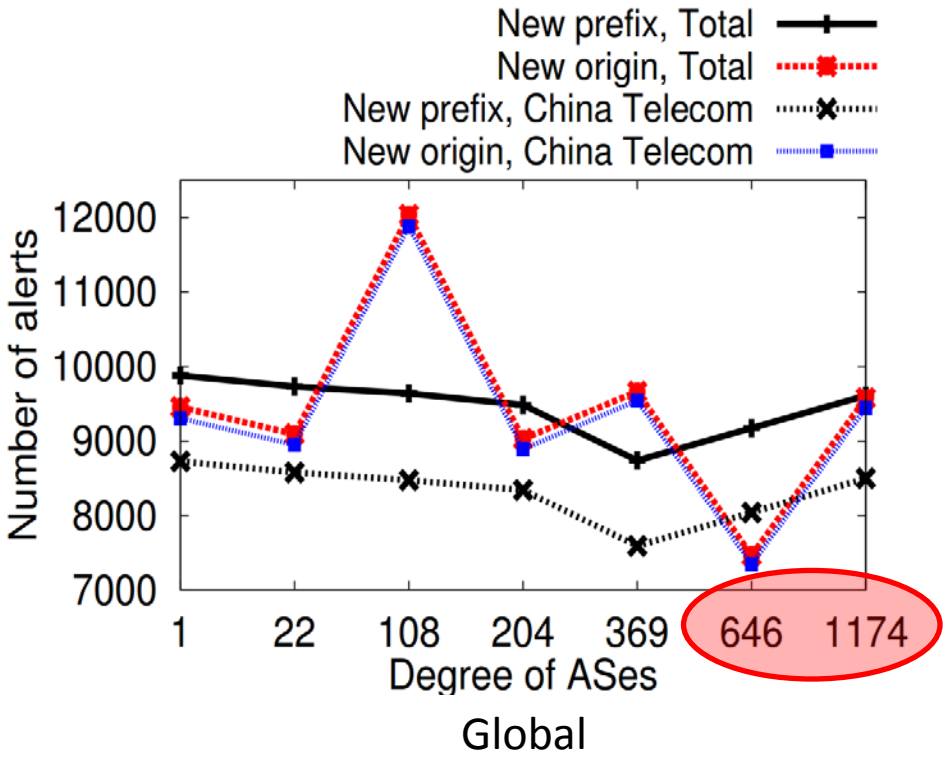

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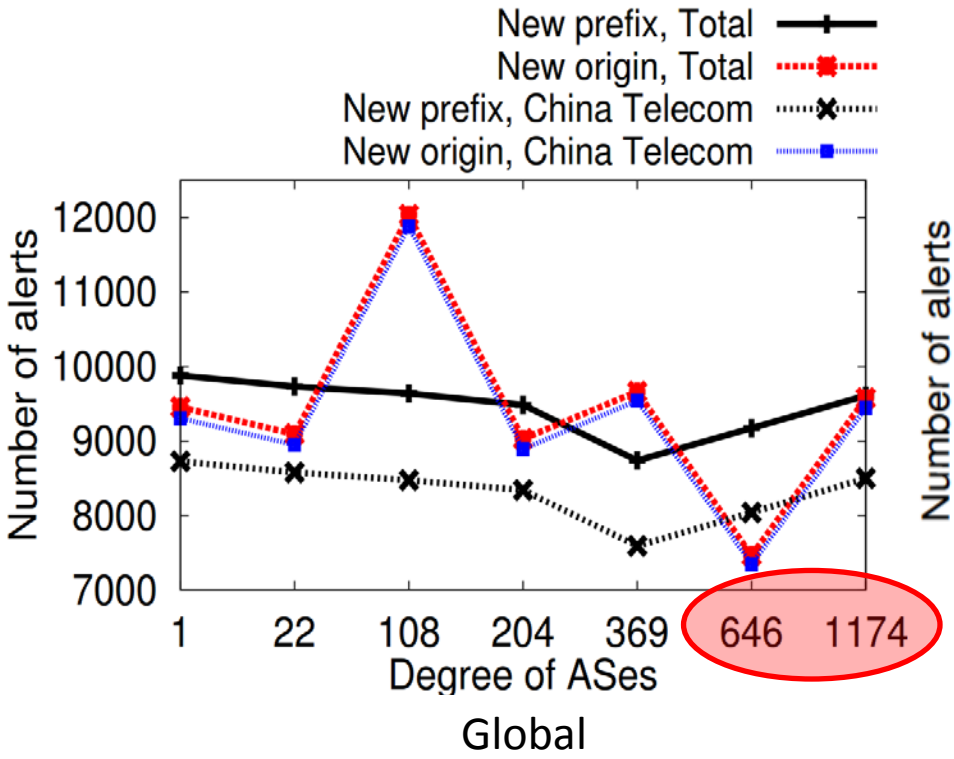
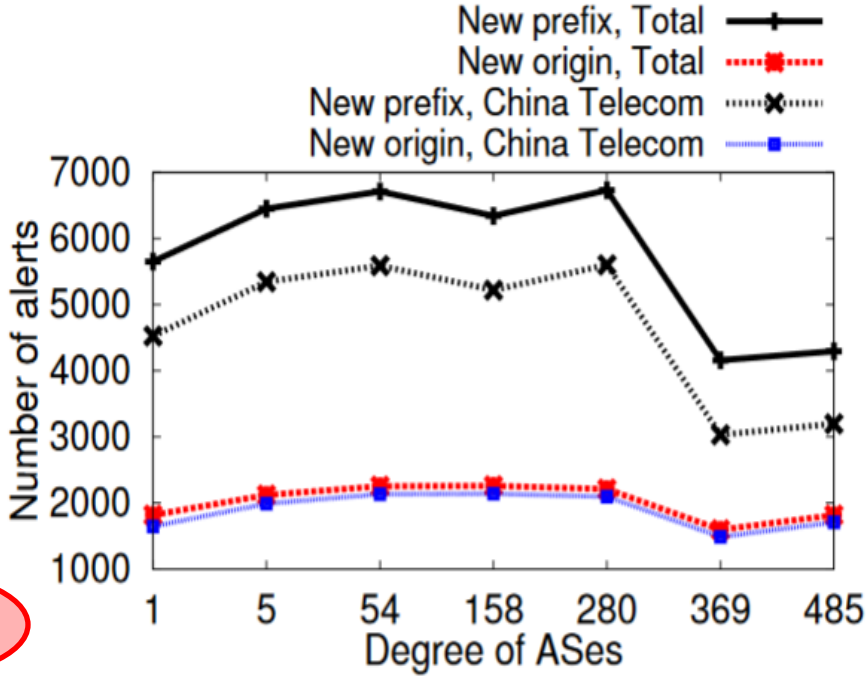
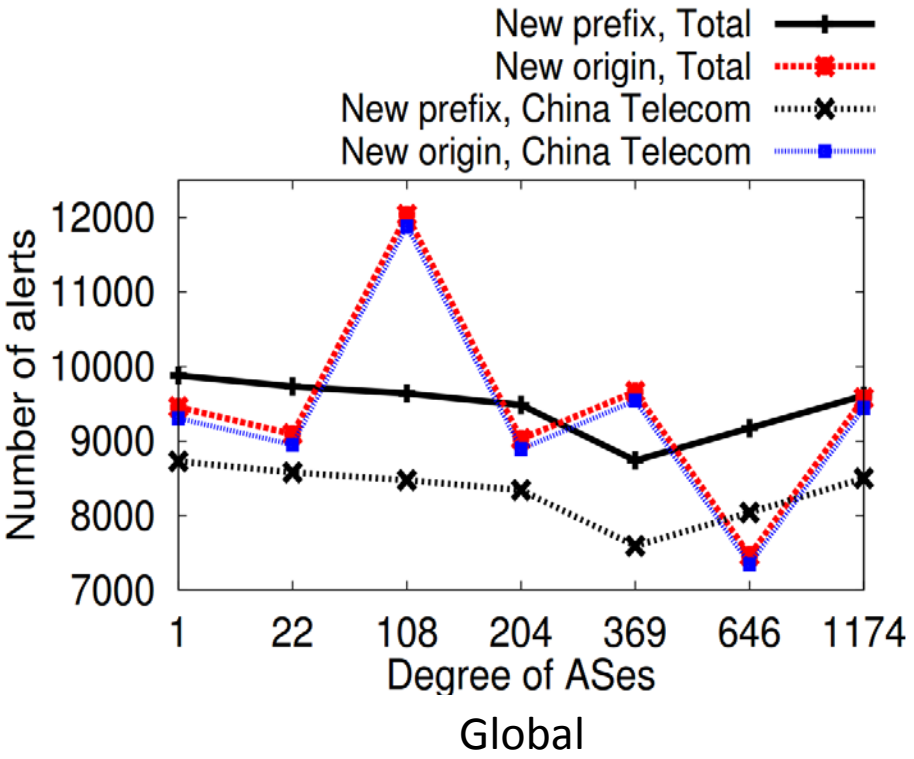


Global

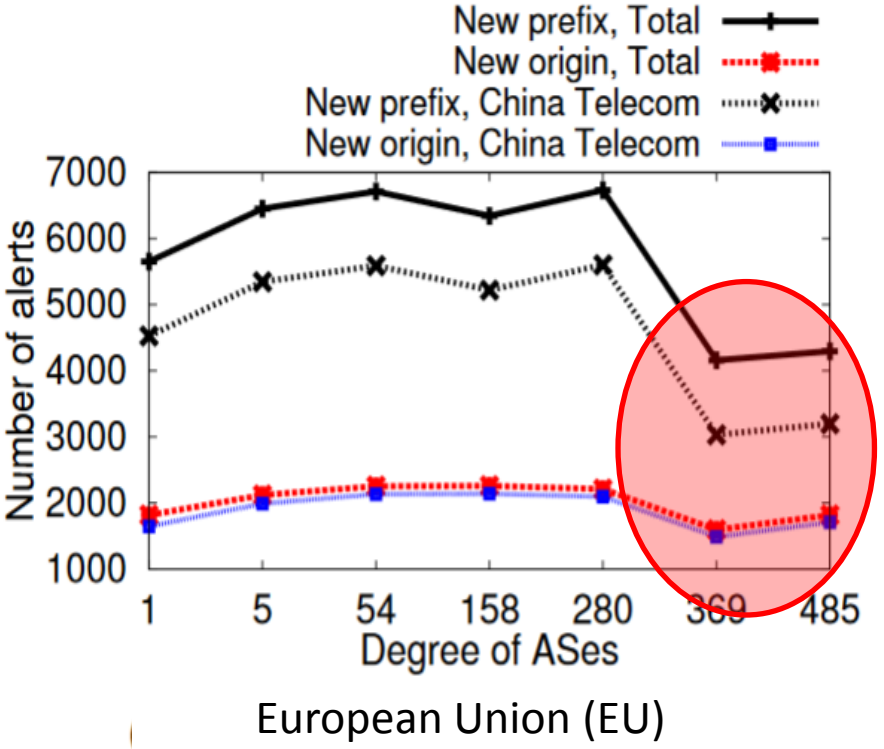


European Union (EU)

Size and locality



Global



European Union (EU)

Summary and contributions

- China Telecom incident characterization
  - Pointers to route leakage but difficult to rule out malicious intent
- On collaboration
  - Design collaborative mechanisms with decentralized operation
  - Targeting different attacks
- On scale, size, and locality
  - Evaluate security gains for a plausible approach to drive the deployment of these mechanisms
  - Smaller networks have important role to play

Collaborative Network Security

Rahul Hiran

- **Does Scale, Size, and Locality Matter? Evaluation of Collaborative BGP Security Mechanisms**, *Proc. IFIP Networking,* 2016
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- **PrefiSec: A Distributed Alliance Framework for Collaborative BGP Monitoring and Prefix-based Security** , Proc. *ACM WISCS @CCS* Scottsdale, AZ, 2014
- **Characterizing Large-scale Routing Anomalies: A Case Study of the China Telecom Incident**, Proc. *PAM,* 2013
- **TRAP: Open Decentralized Distributed Spam Filtering**, Proc. TrustBus, 2011

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CUGS National Graduate School of Computer Science