Jumpstarting BGP Security

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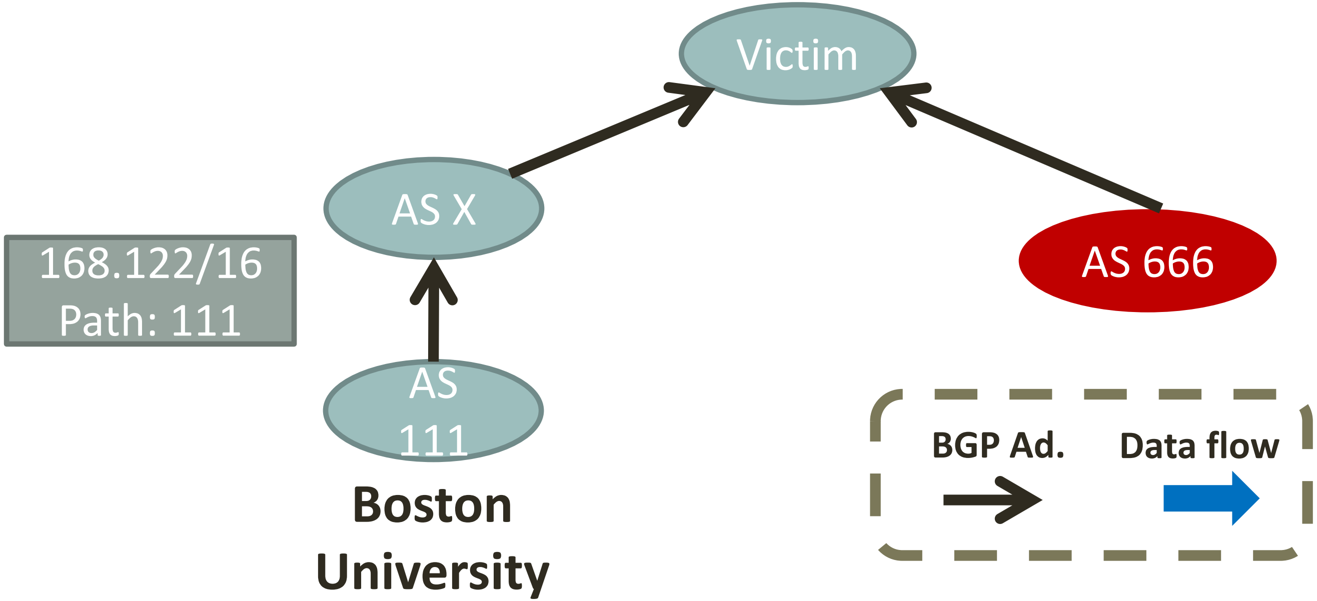
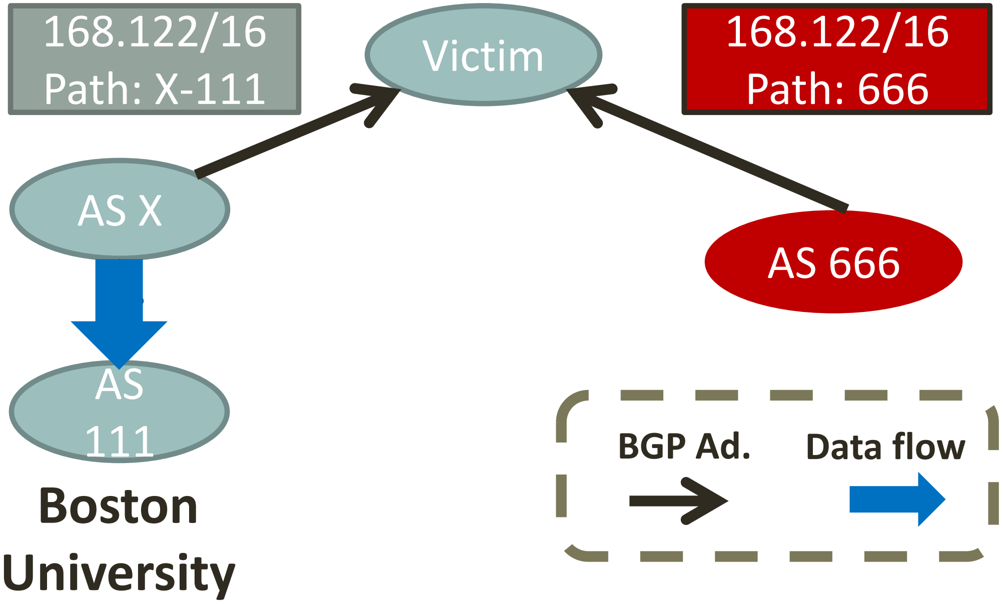
Joint work with: Avichai Cohen, Amir Herzberg, and Michael Schapira

Prefix hijacking



Prefix hijacking



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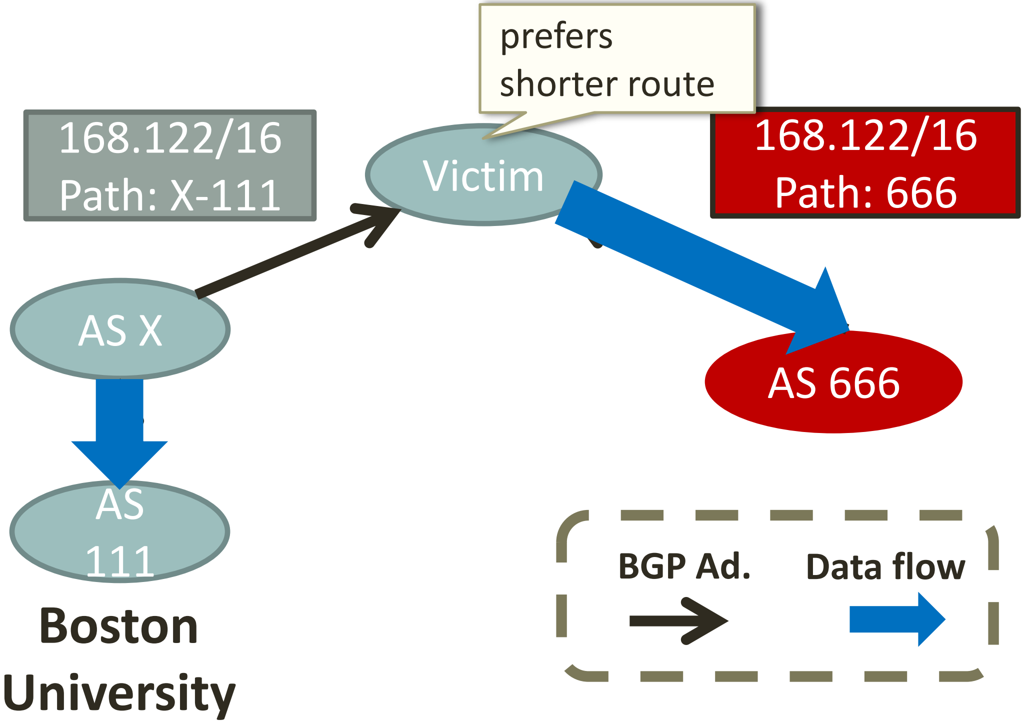


Resource Public Key Infrastructure (RPKI)

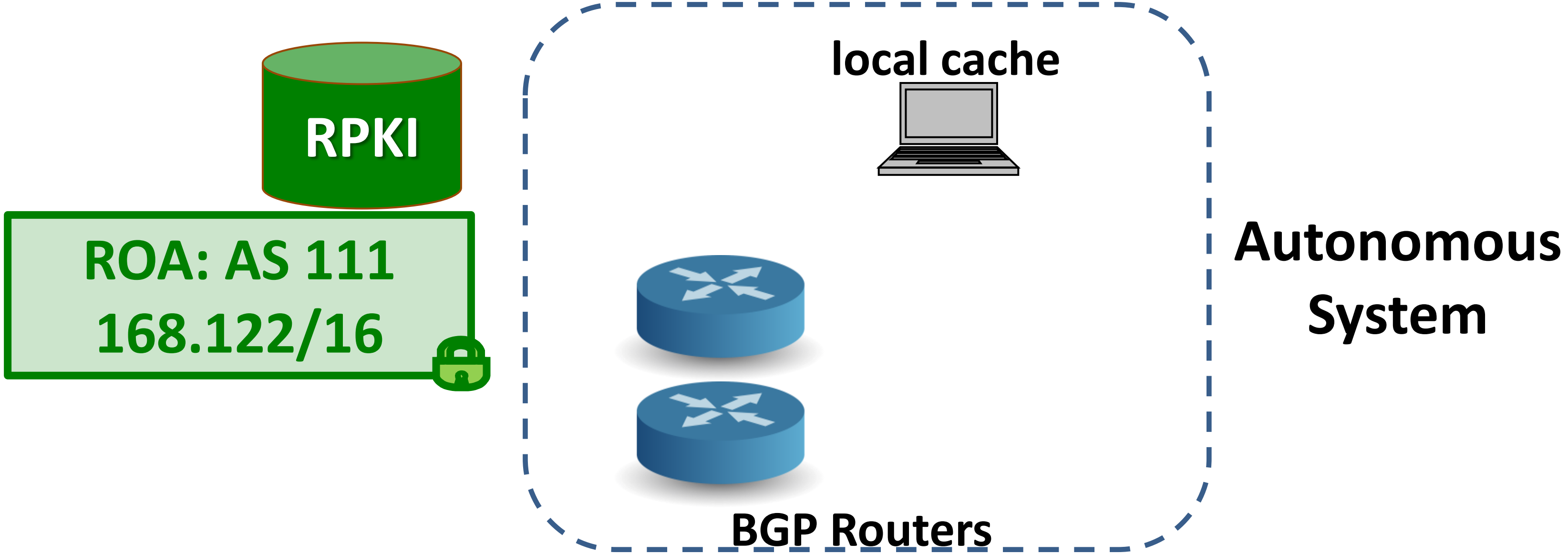
The Resource Public Key Infrastructure (RPKI) maps IP prefixes to organizations that own them [RFC 6480]

- Provides origin authentication to prevent hijacks

- Lays the foundation for protection against more sophisticated attacks on interdomain routing
  - e.g., required for BGPsec

Resource Public Key Infrastructure (RPKI)

- Origin Authentication
  - Protects against hijacks
  - Slowly gaining traction (6% of prefixes covered)



RPKI

ROA: AS 111
168.122/16

local cache

Autonomous System

BGP Routers

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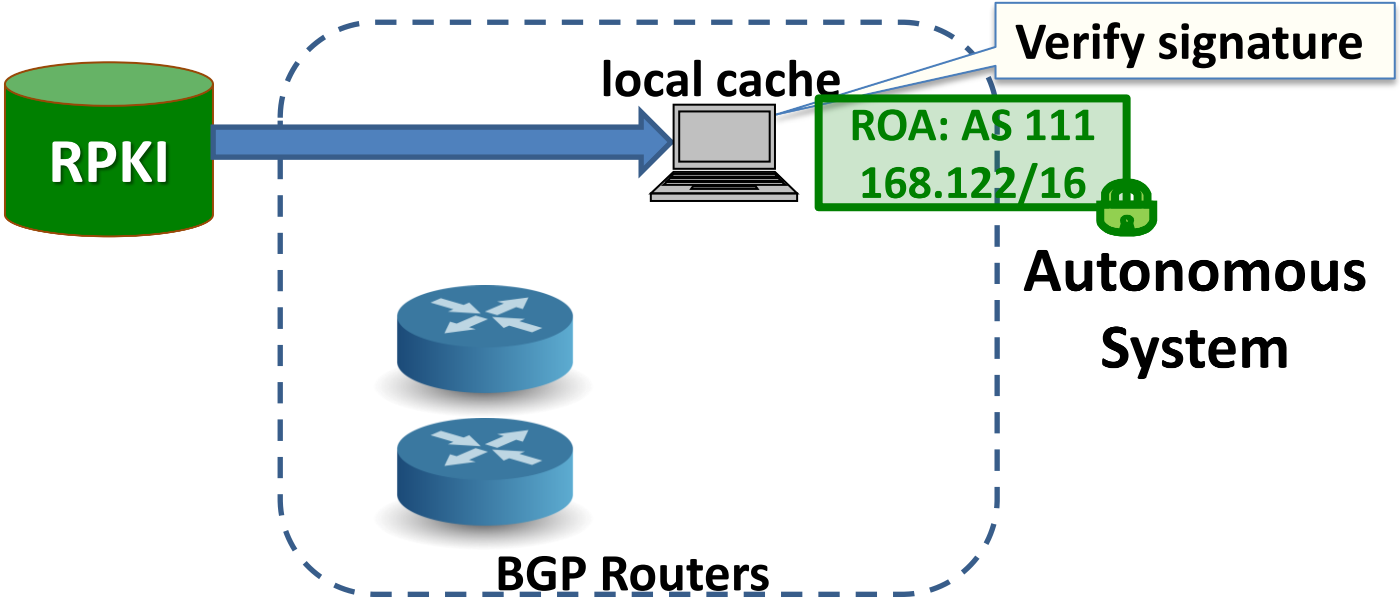

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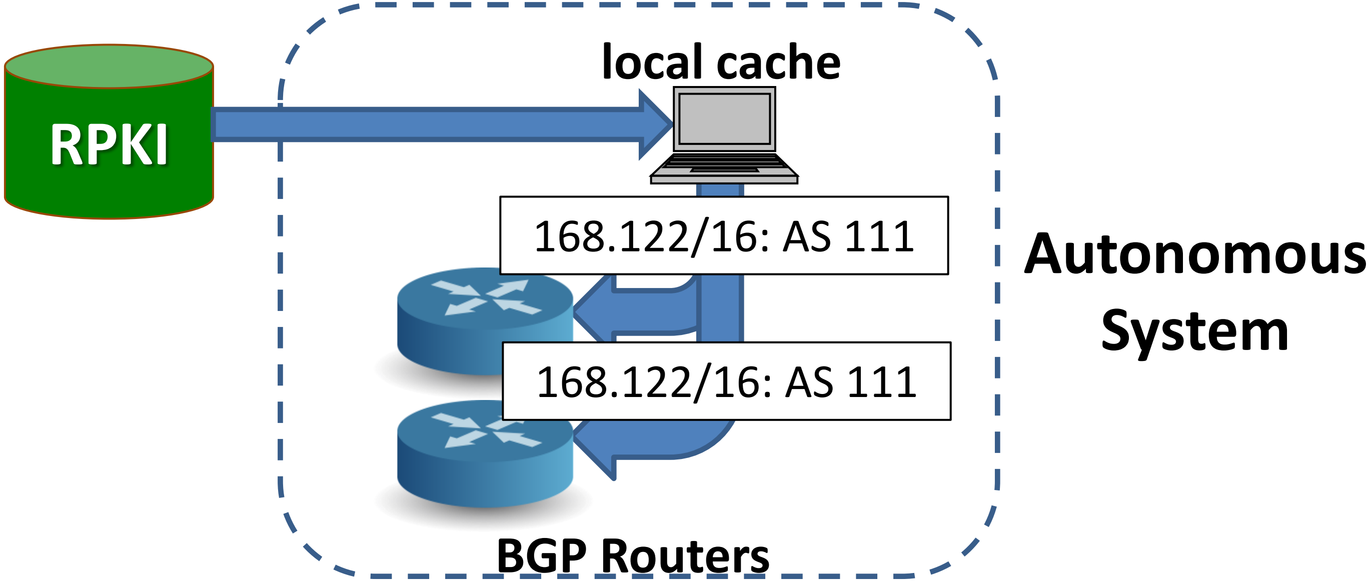
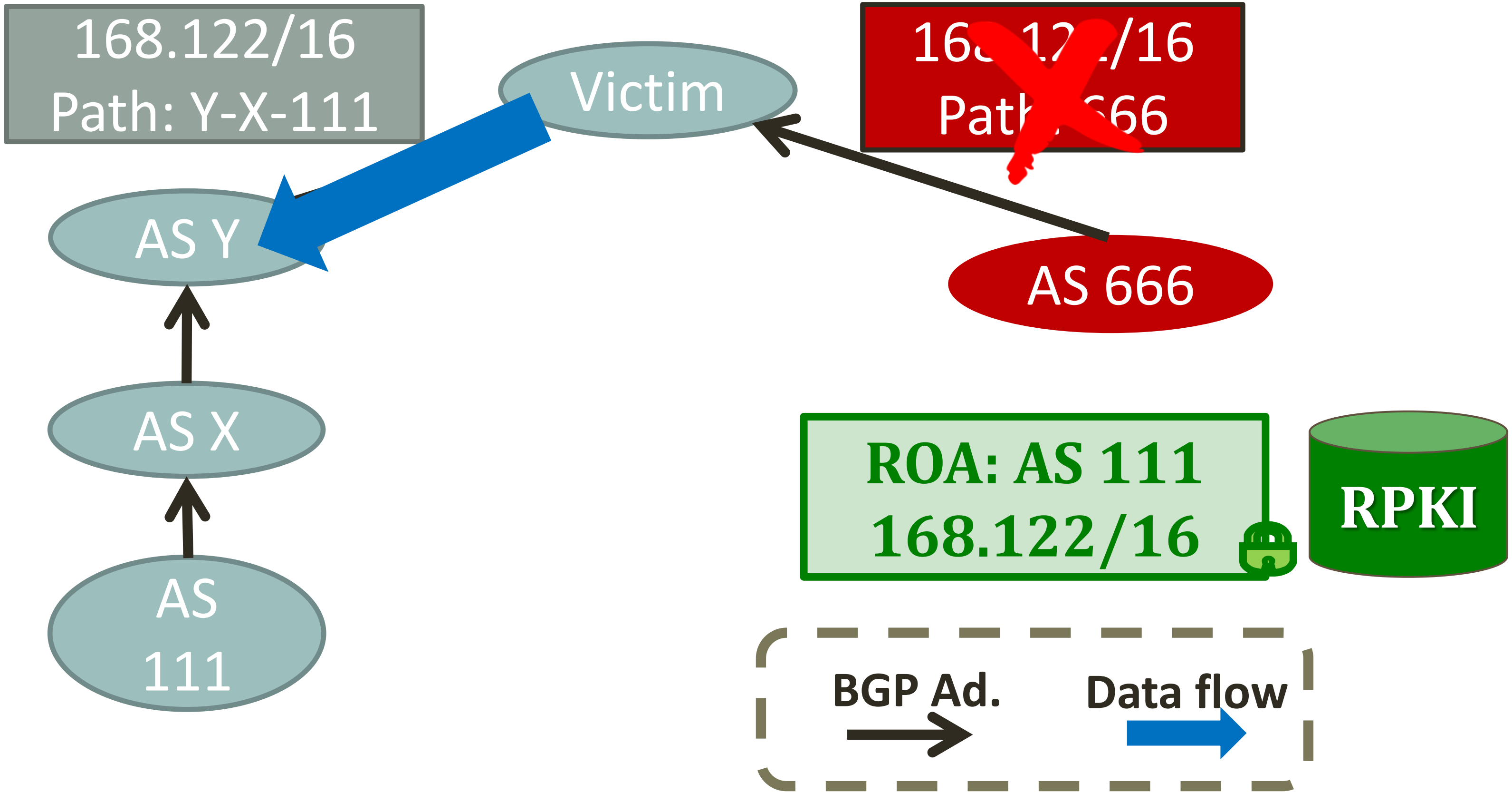
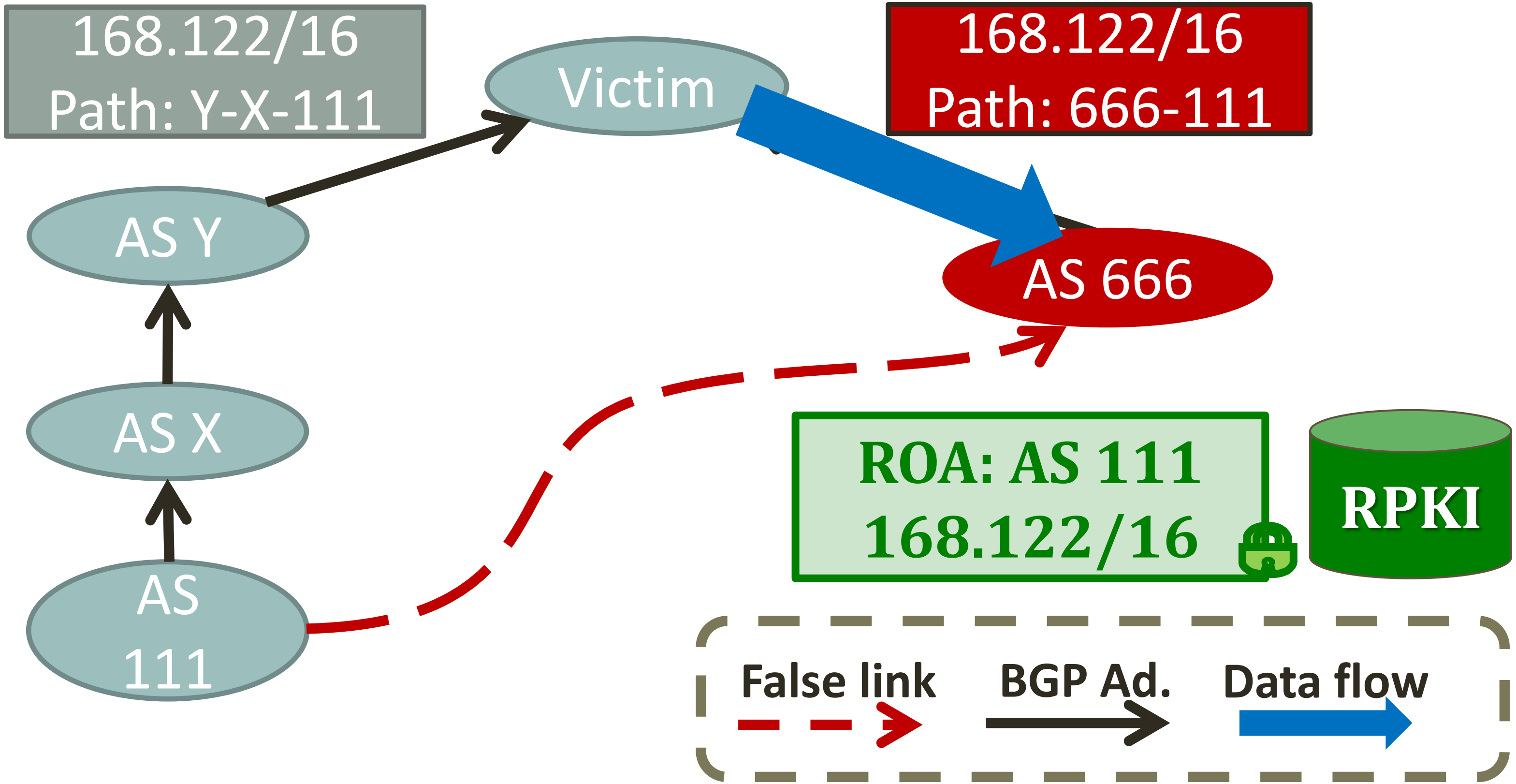


RPKI prevents prefix hijacks

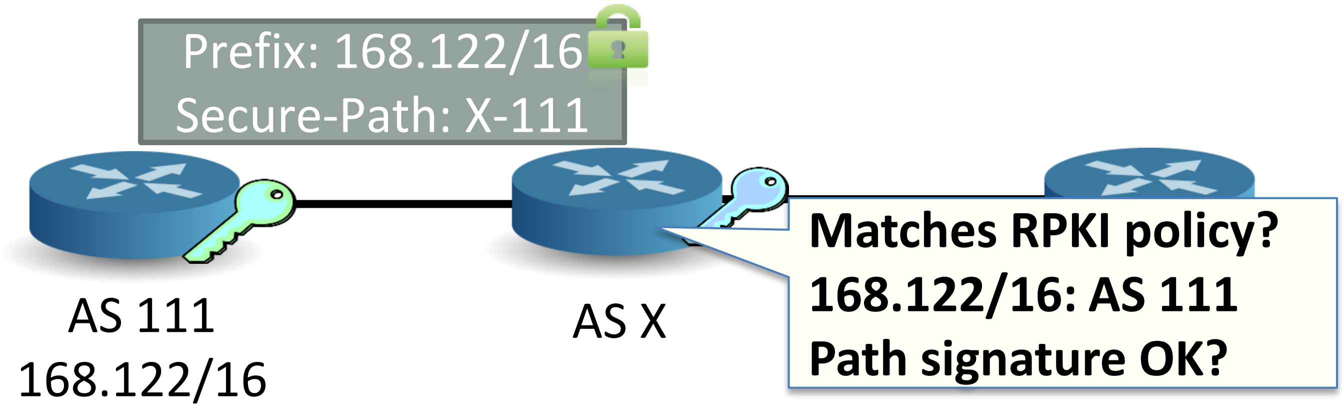


Forged origin circumvents RPKI



Current paradigm: a two step solution

- First, RPKI against hijacking
- Then, add BGPsec
  - – Protects against ``false links” in the route



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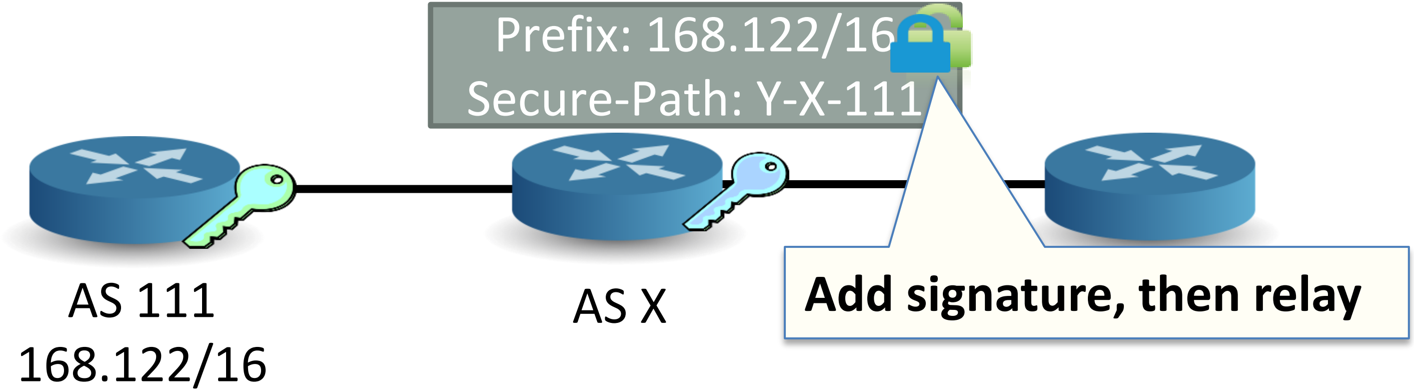
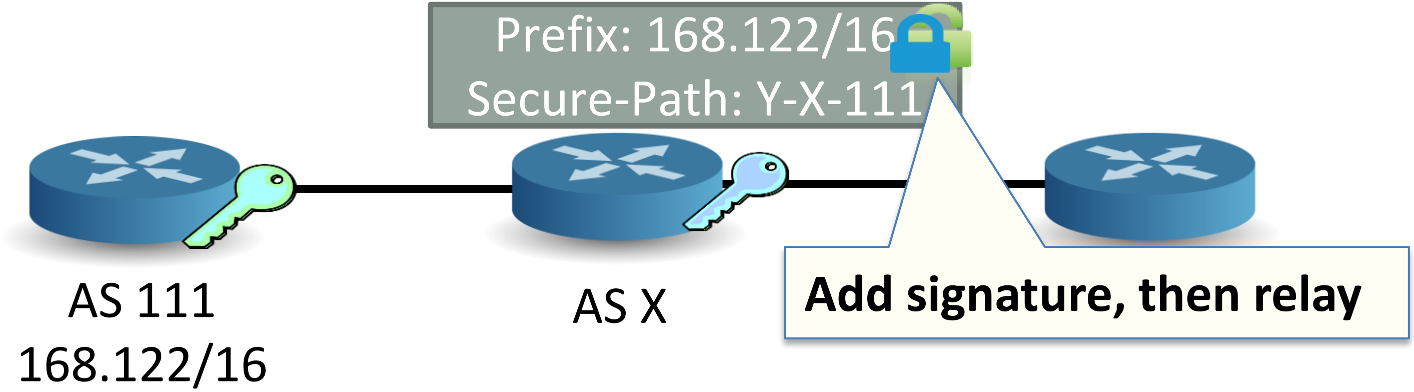


Add signature, then relay

Current paradigm: a two step solution

- First, RPKI against hijacking
- Then, add BGPsec
  - Protects against ``false links" in the route
  - Deployment challenge:
    - Real-time signature and validation
    - Different message format



Prefix: 168.122/16

Secure-Path: Y-X-111

AS 111

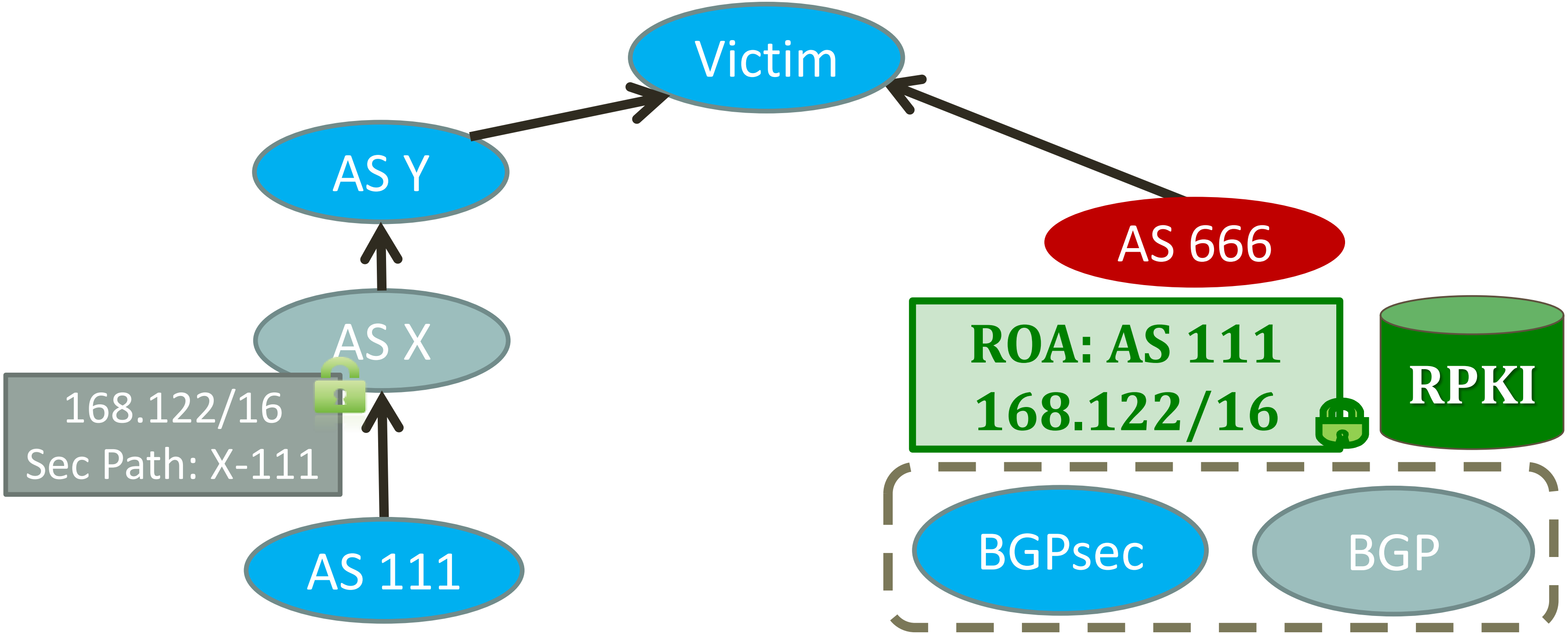
168.122/16

AS X

Add signature, then relay

BGPsec in partial adoption?

Meager benefits [Lychev et al., SIGCOMM'13]



BGPsec in partial adoption?

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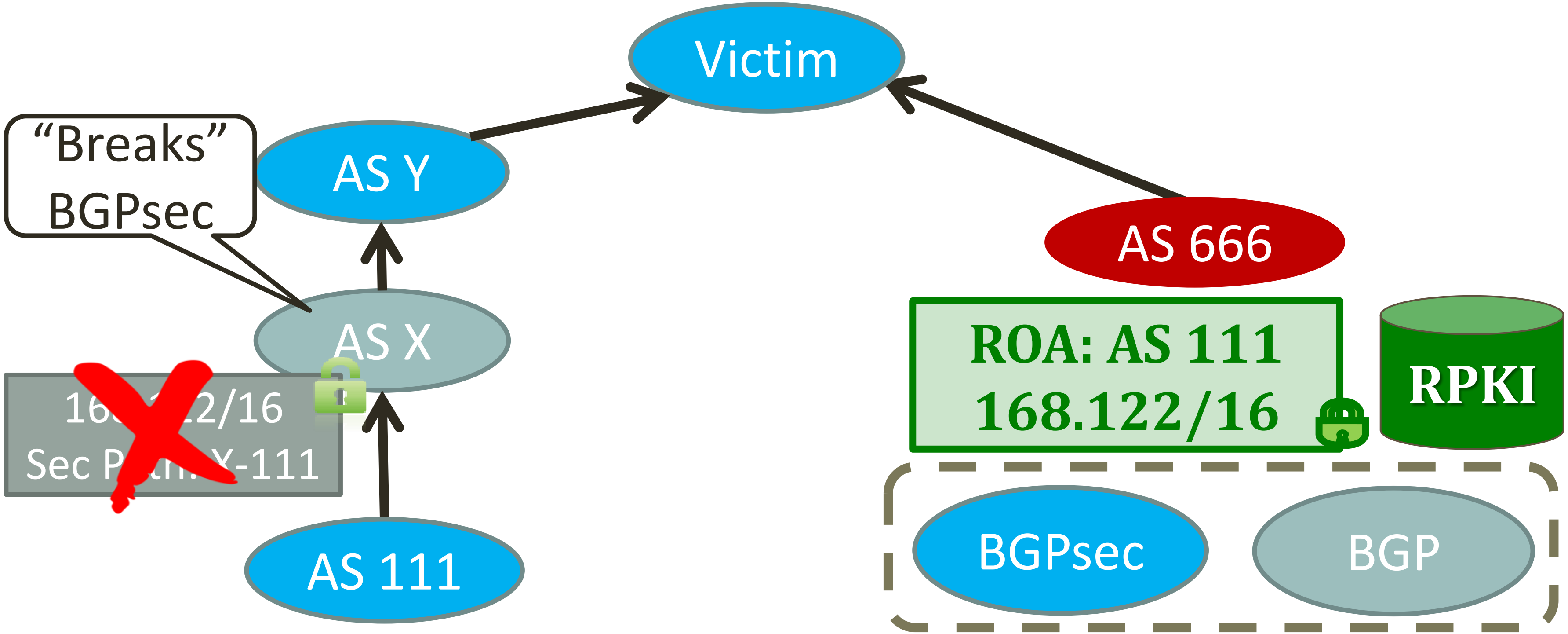

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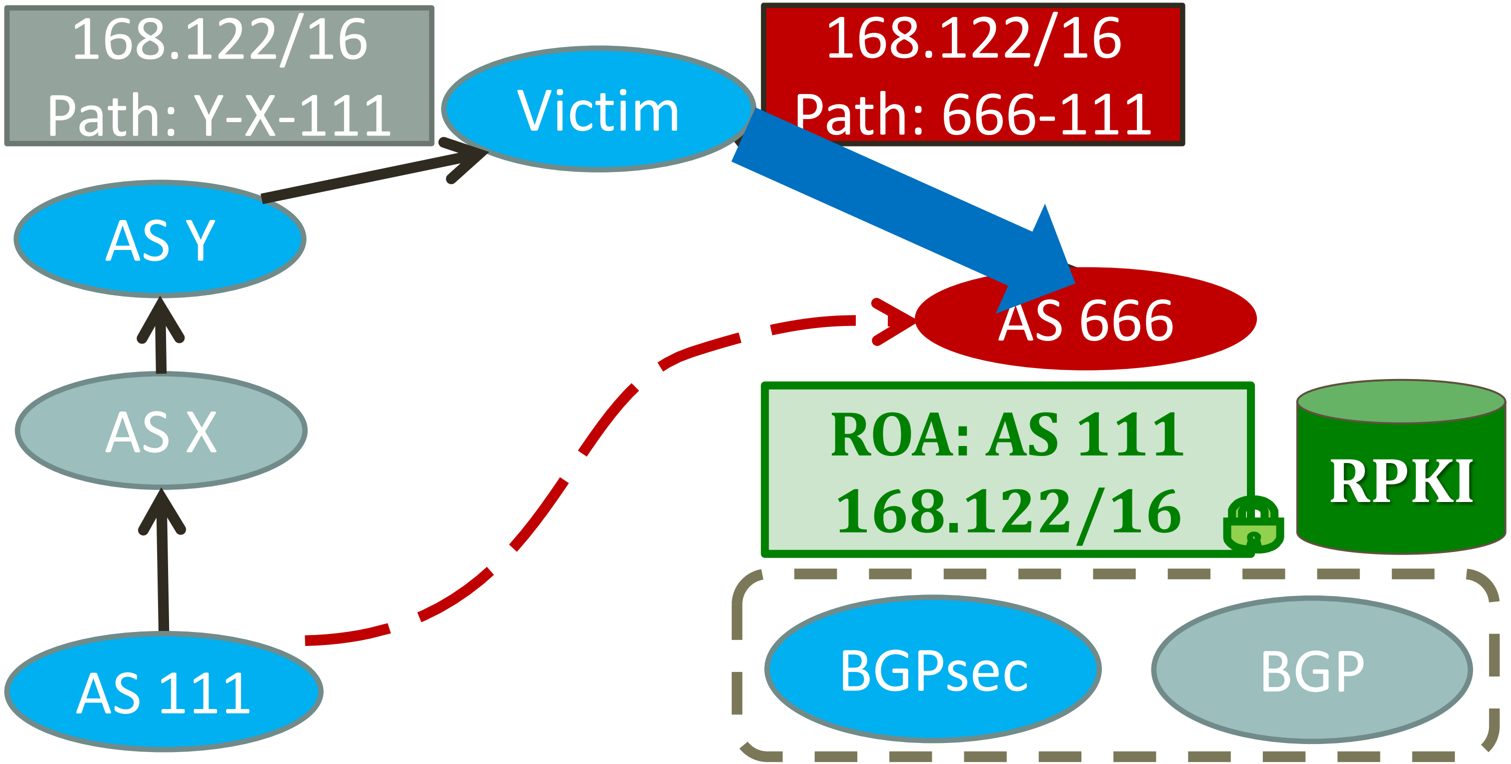


Our Goals

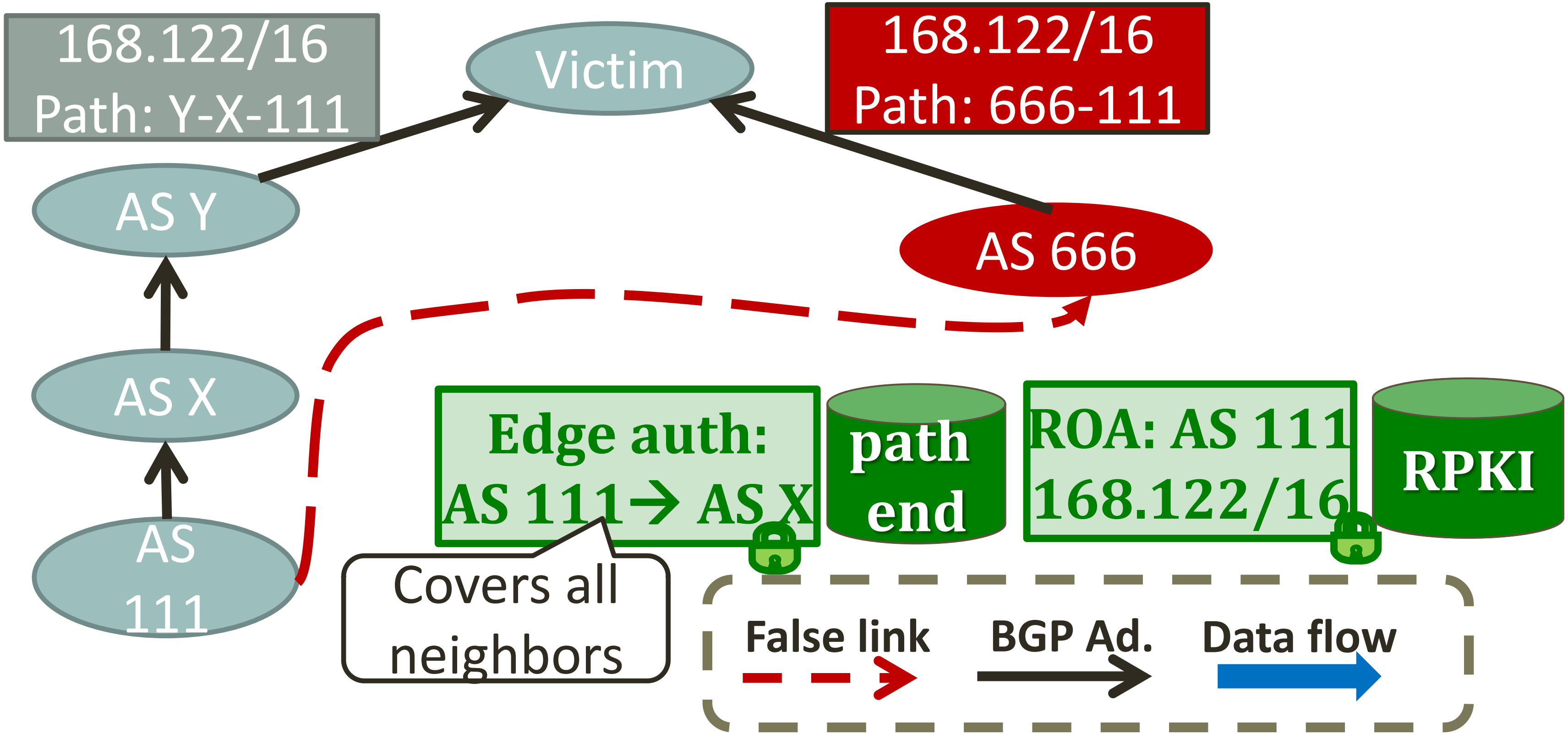
Security:

- Protect against “forged origin” in BGP advertisements
- Significant benefits in partial deployment
  - In contrast to BGPsec

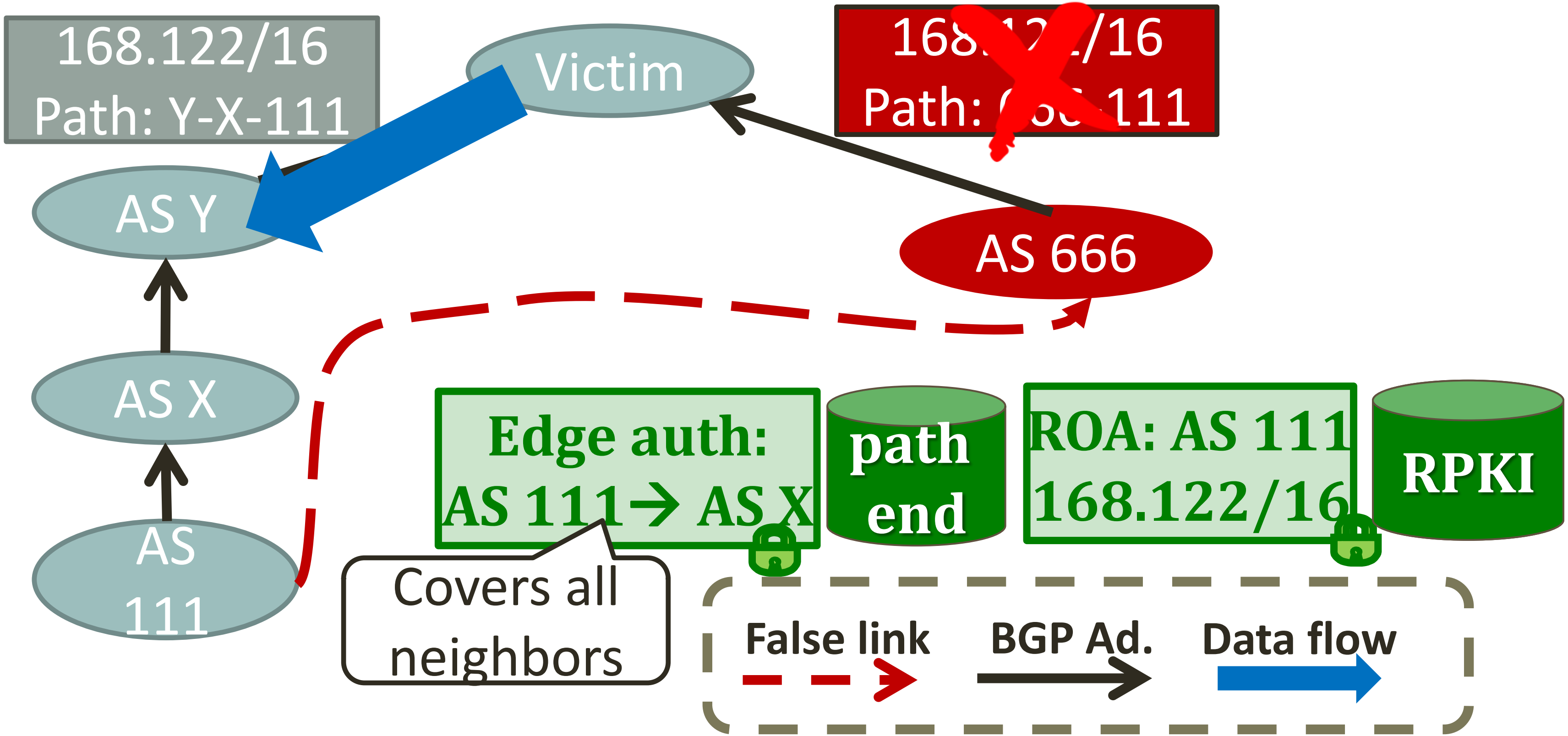
Deployment:

- Minimal computation overhead
  - Signatures and verifications: only **offline, off-router**
- No changes to BGP messages
- Similar to RPKI

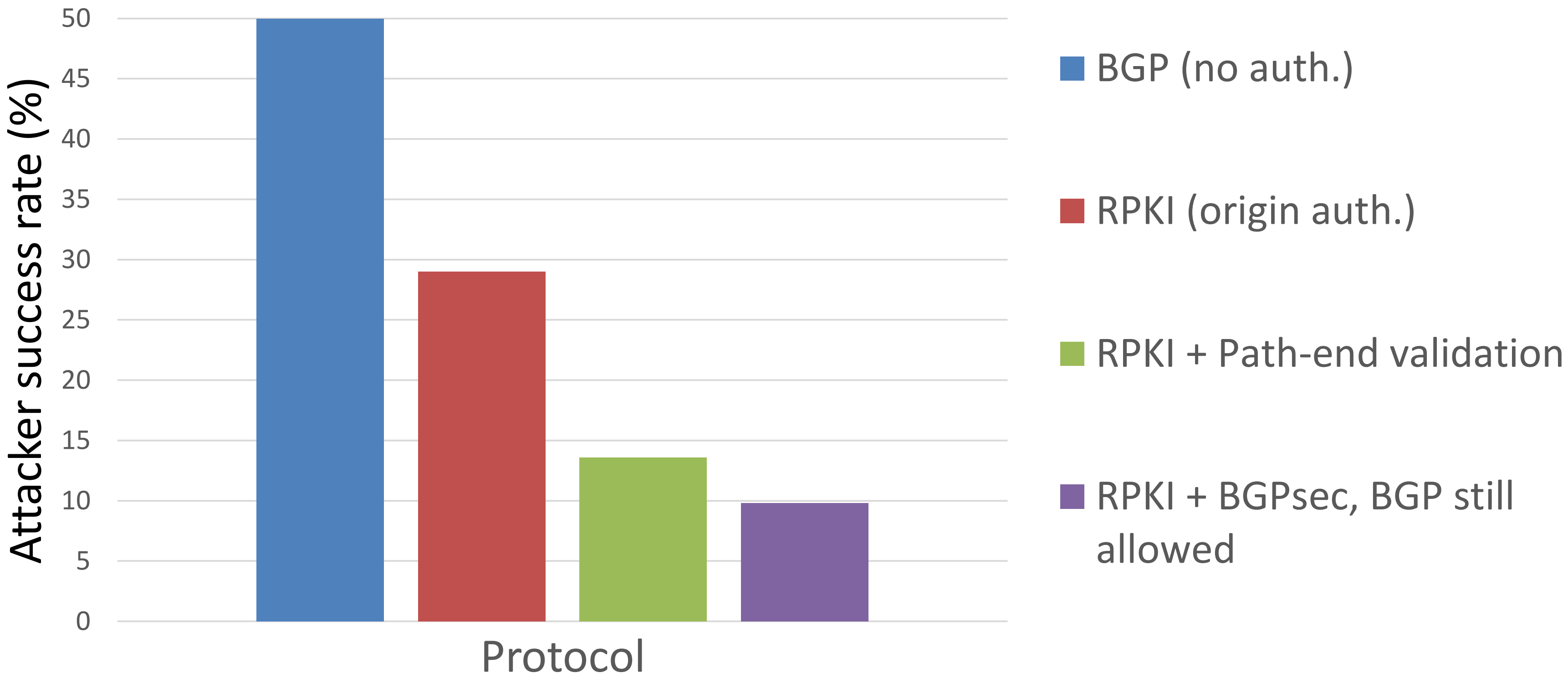
Path-end validation



Path-end validation



Inter domain routing security: Mechanism comparison



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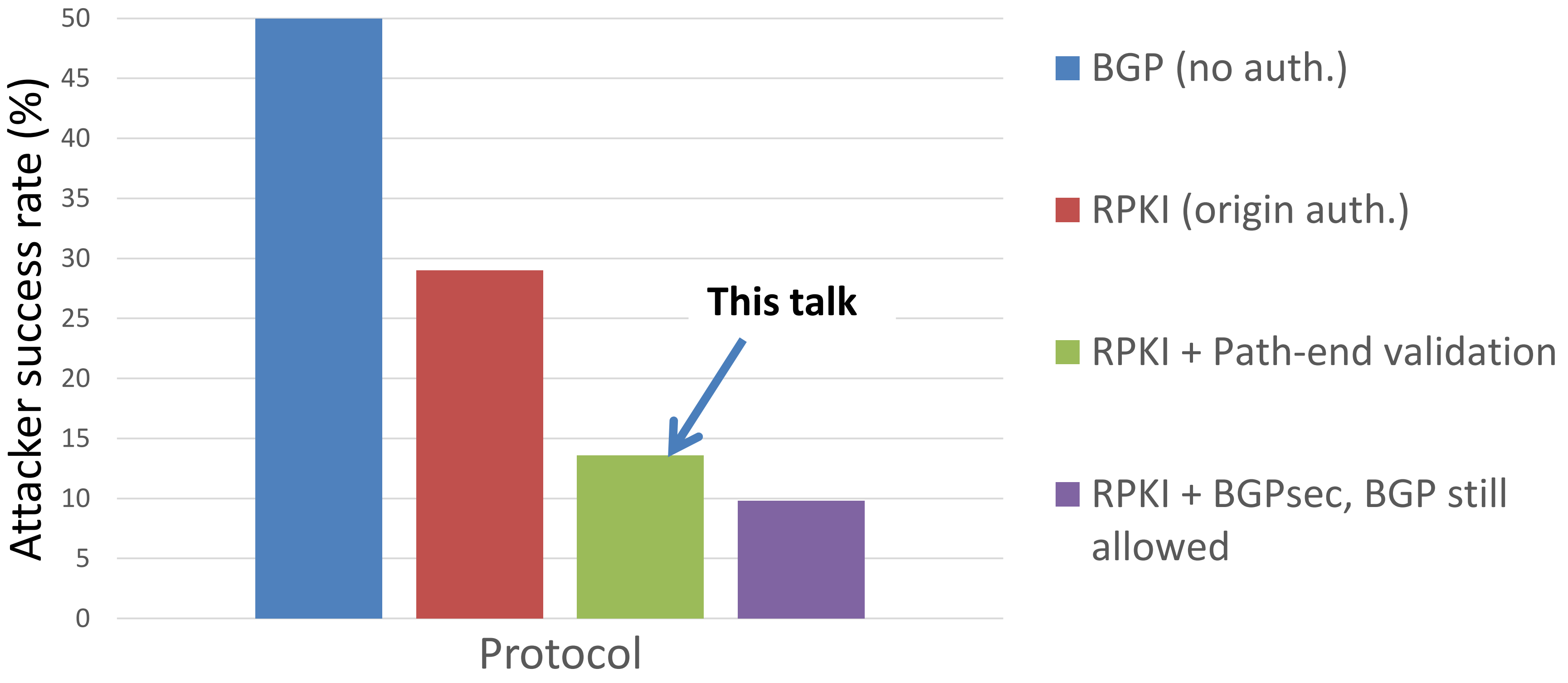
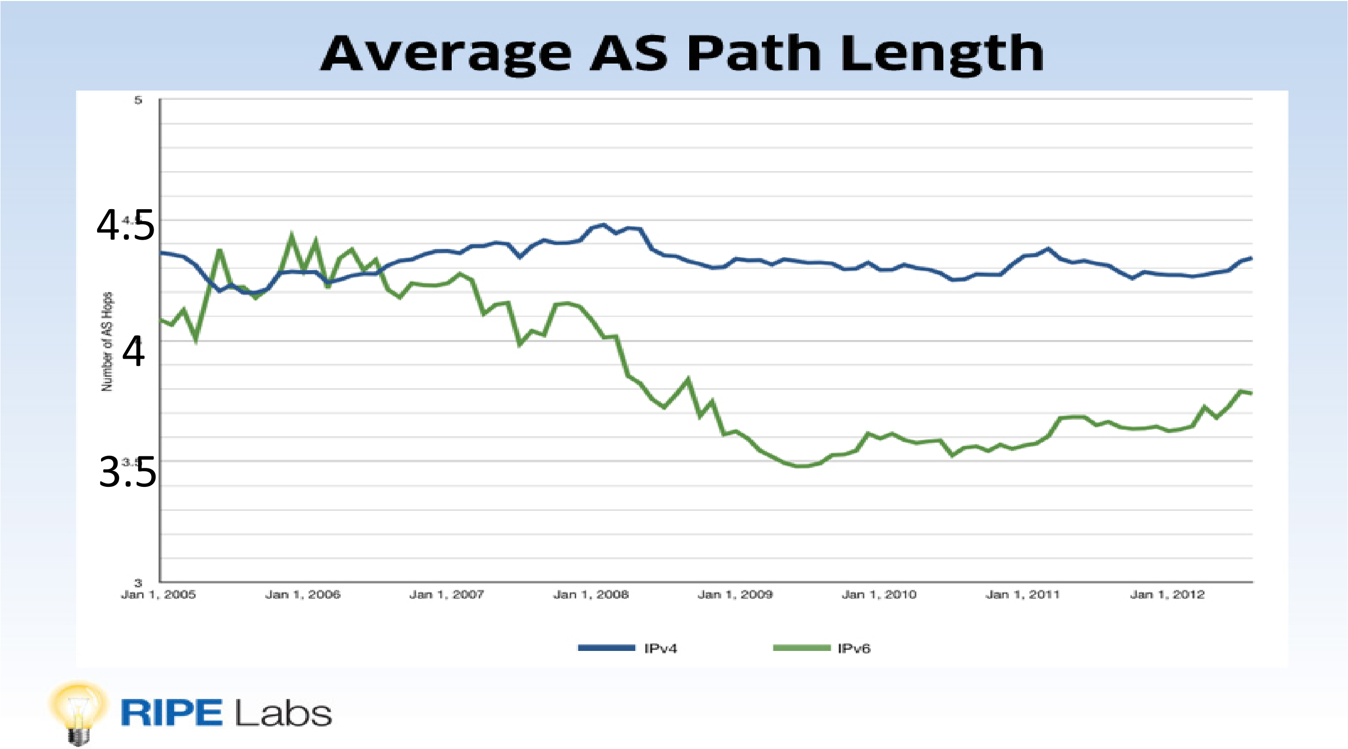
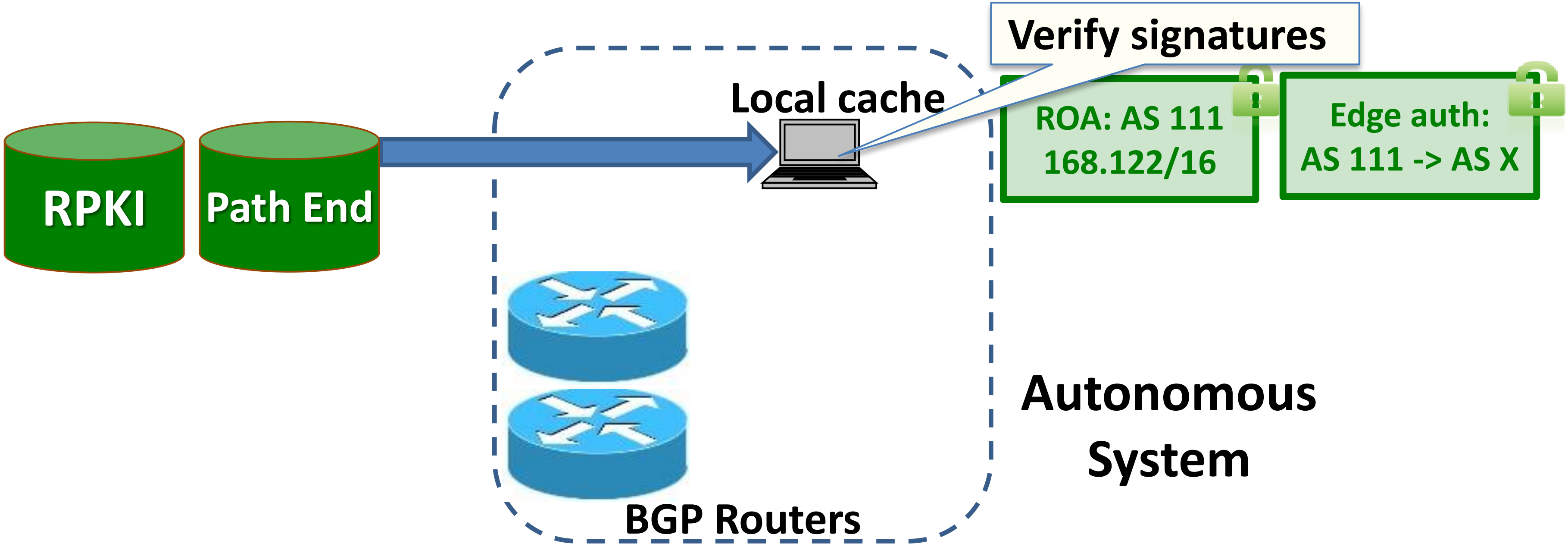


Path-end validation: Intuition



Deployment

- Similar to RPKI



Deployment

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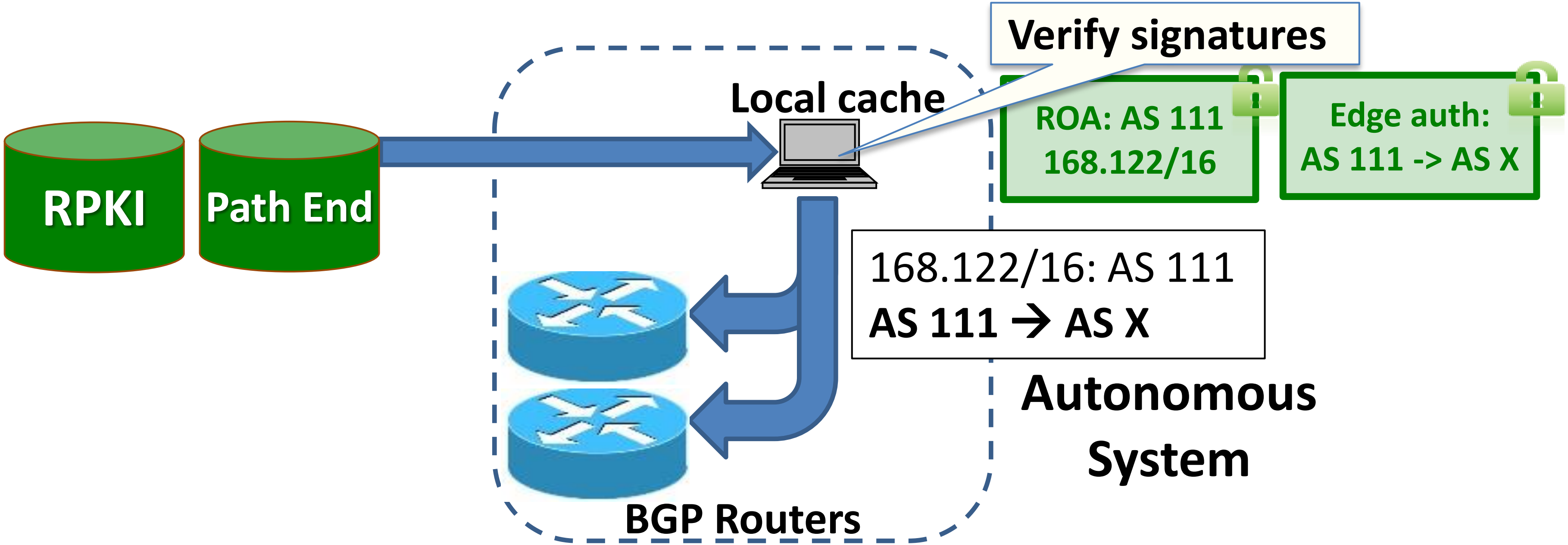


Deployment

```
ip as-path access-list as1 deny _[^X]_111_
```

- Use existing Access List interface
- Validated suffix extends automatically with adoption

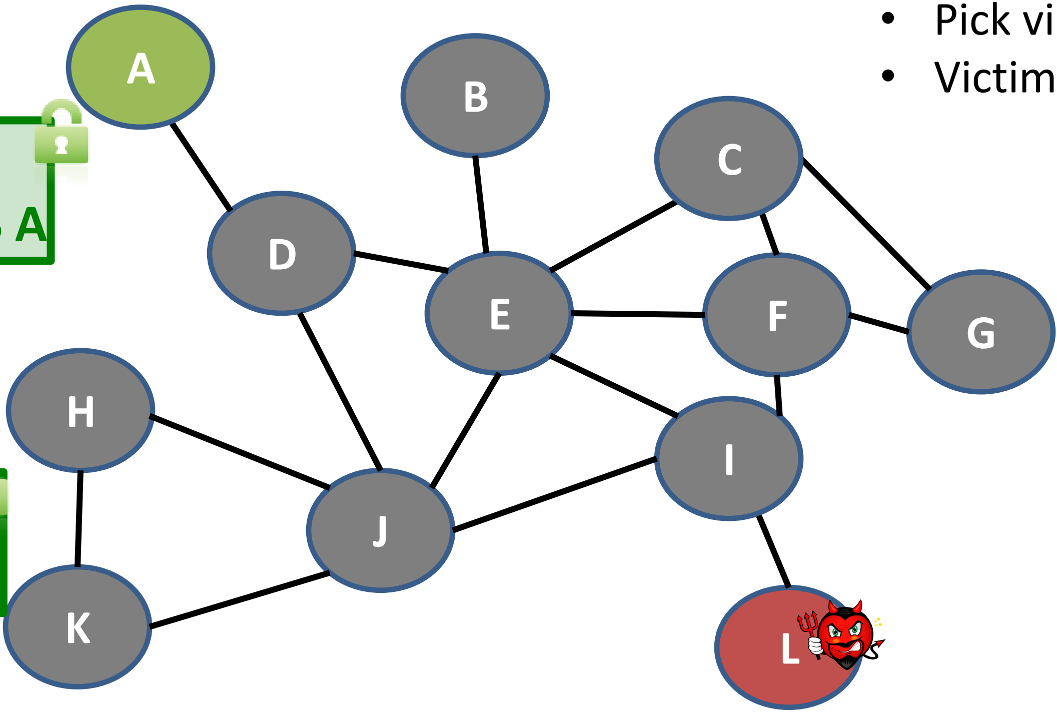
Security in partial adoption: Simulation framework

RPKI

ROA:
1.2.0.0/16 → AS A

Path End

Edge auth:
AS A → AS D

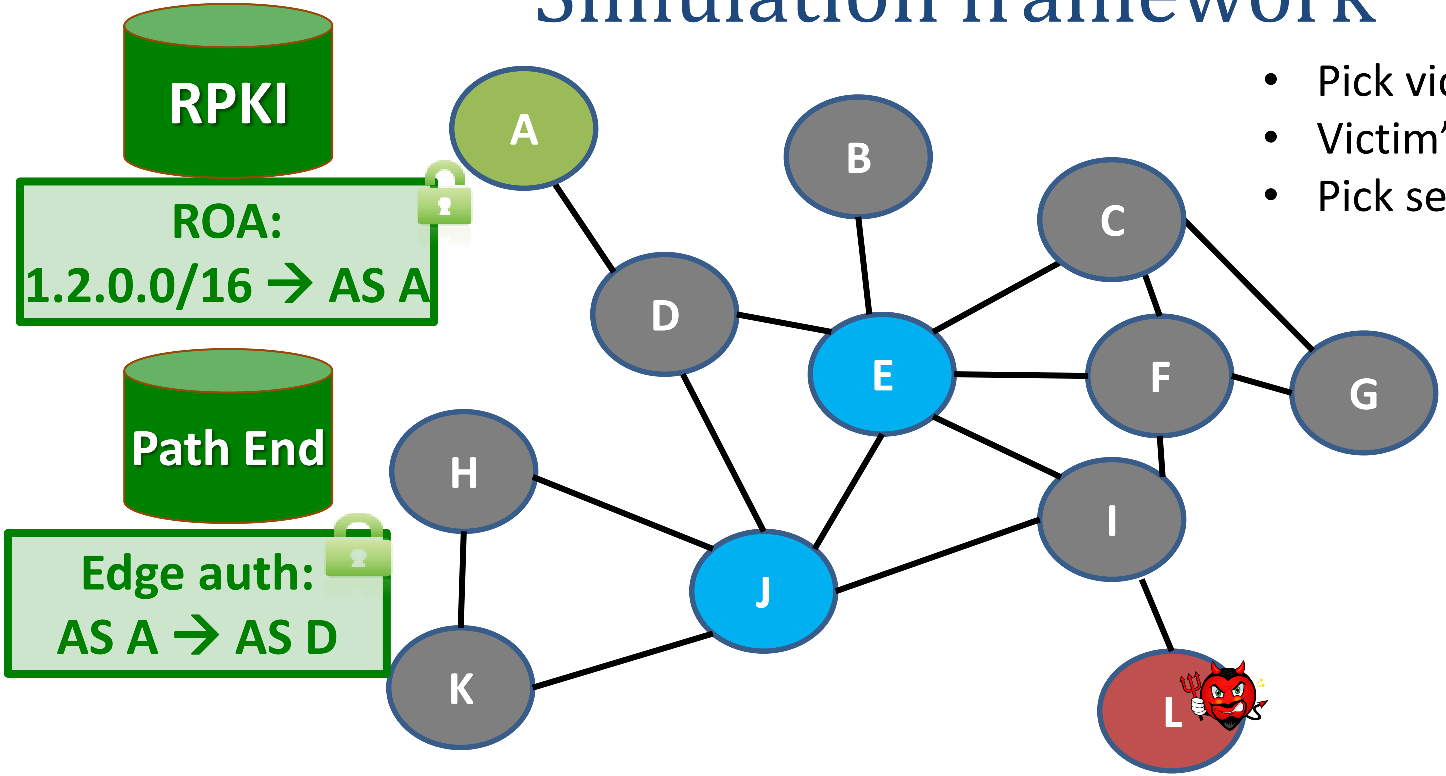


- Pick victim & attacker
- Victim's prefix has a ROA+EA

Empirically-derived AS-level network from CAIDA

Including inferred peering links [Giotsas et al., SIGCOMM'13]

Security in partial adoption: Simulation framework



- Pick victim & attacker
- Victim's prefix has a ROA+EA
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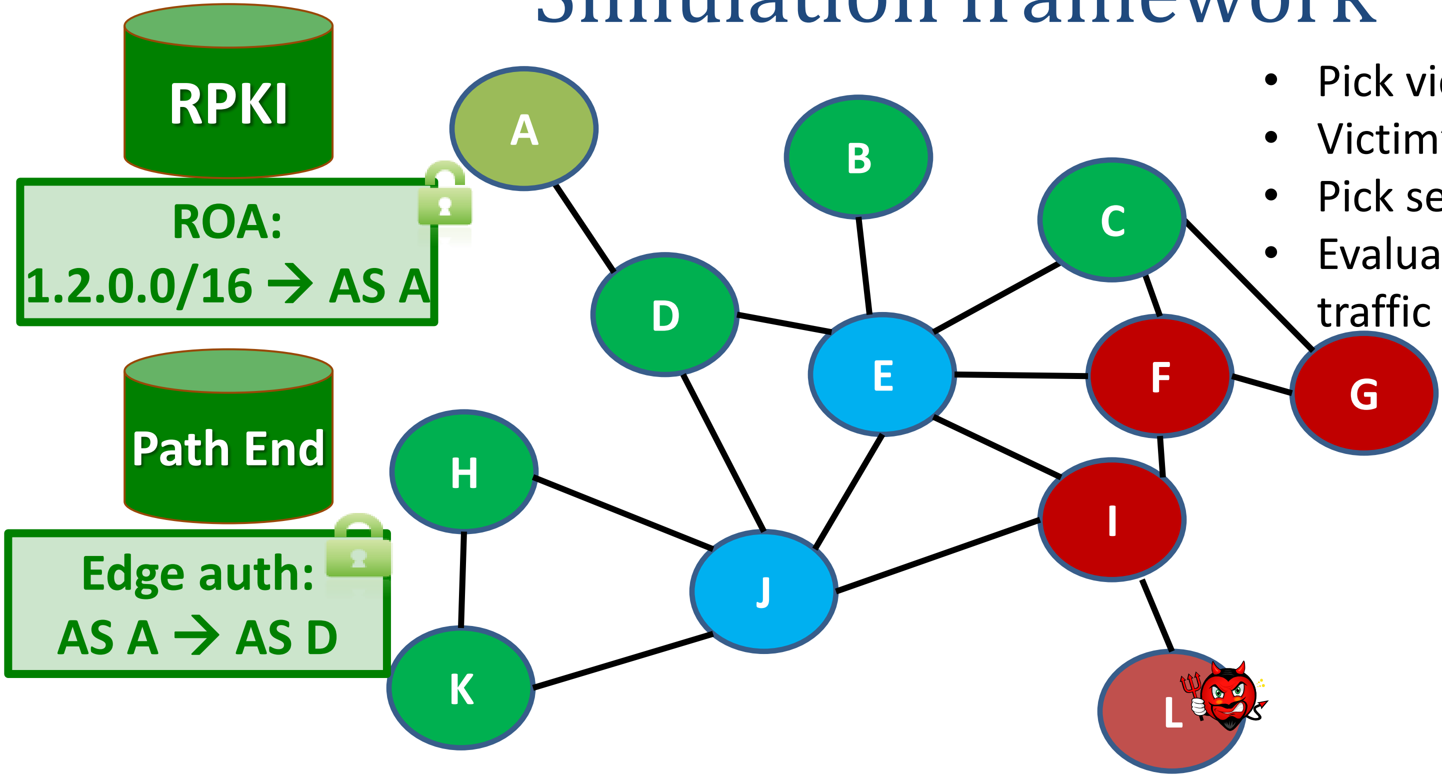
Security in partial adoption: Simulation framework



RPKI

ROA:
1.2.0.0/16 → AS A

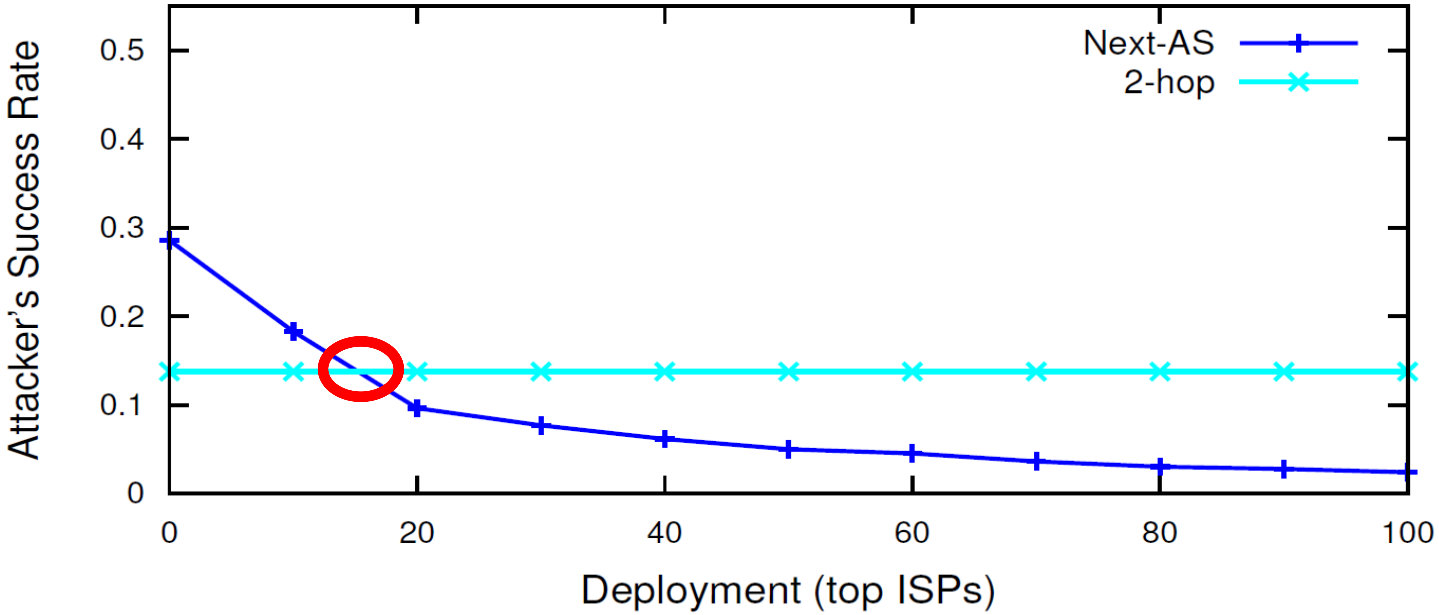
Path End

Edge auth:
AS A → AS D

- Pick victim & attacker
- Victim’s prefix has a ROA+EA
- Pick set of filtering ASes
- Evaluate which ASes send traffic to the attacker

Empirically-derived AS-level network from CAIDA
Including inferred peering links [Giotsas et al., SIGCOMM’13]

Simulation results



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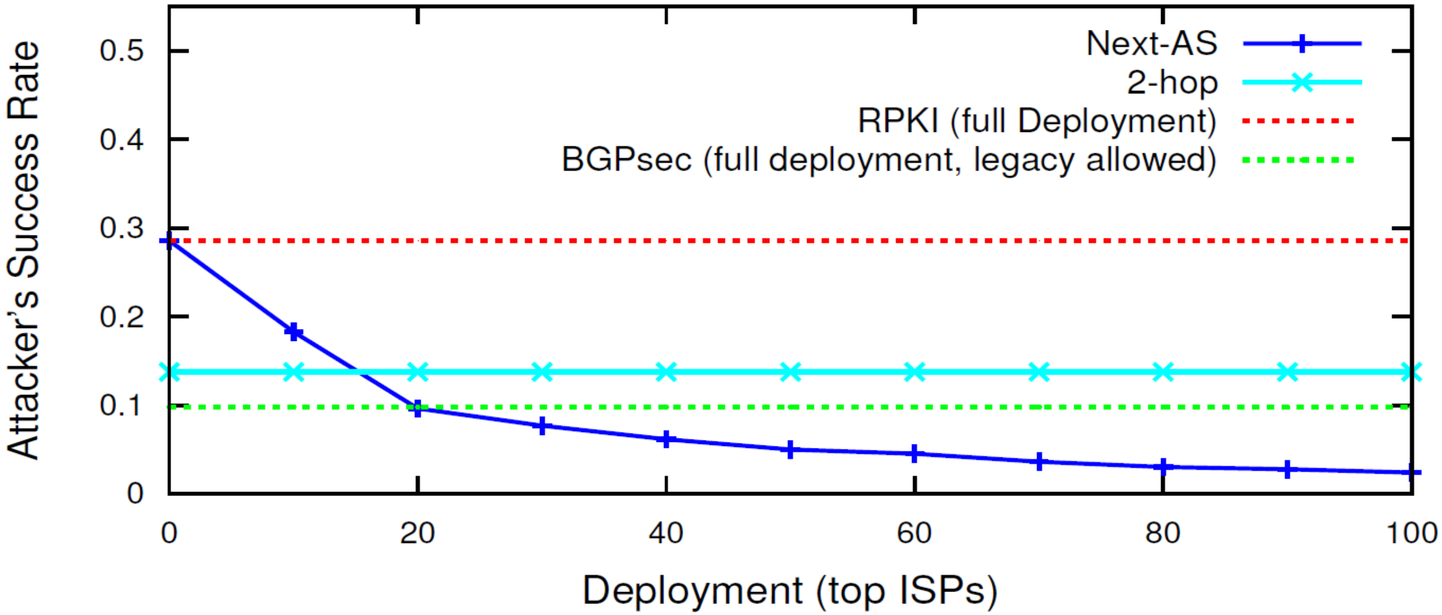

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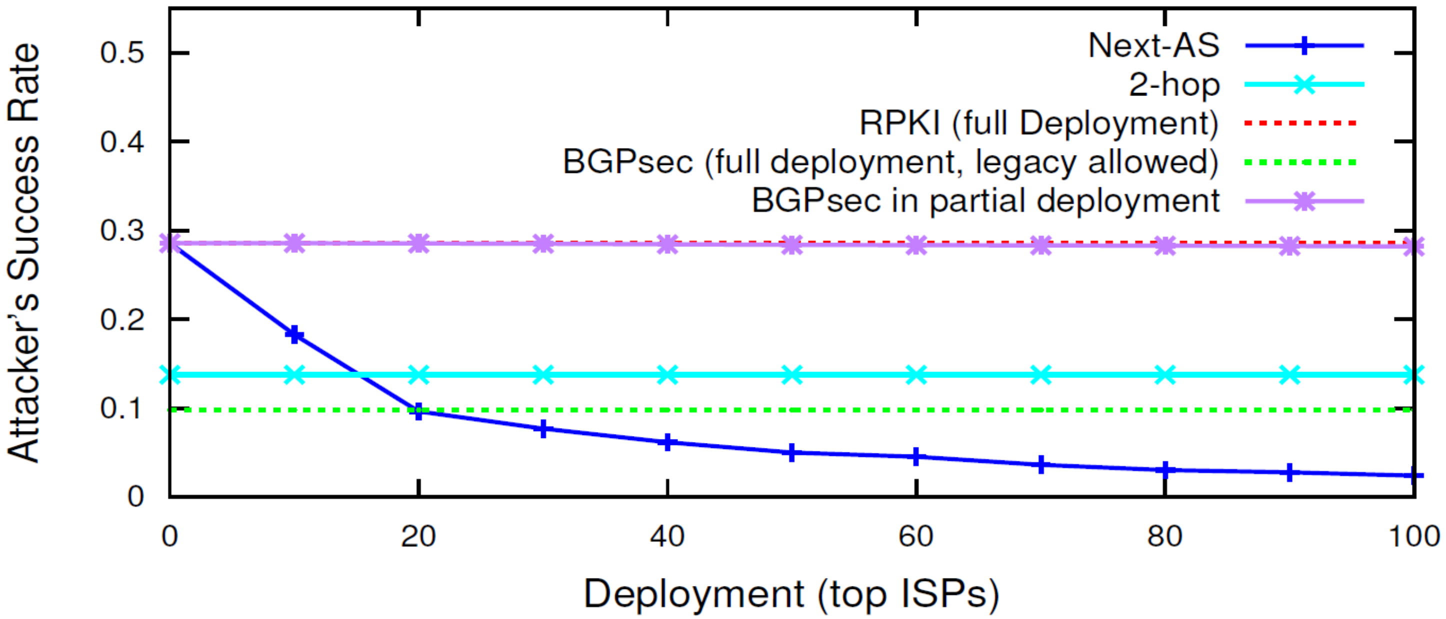
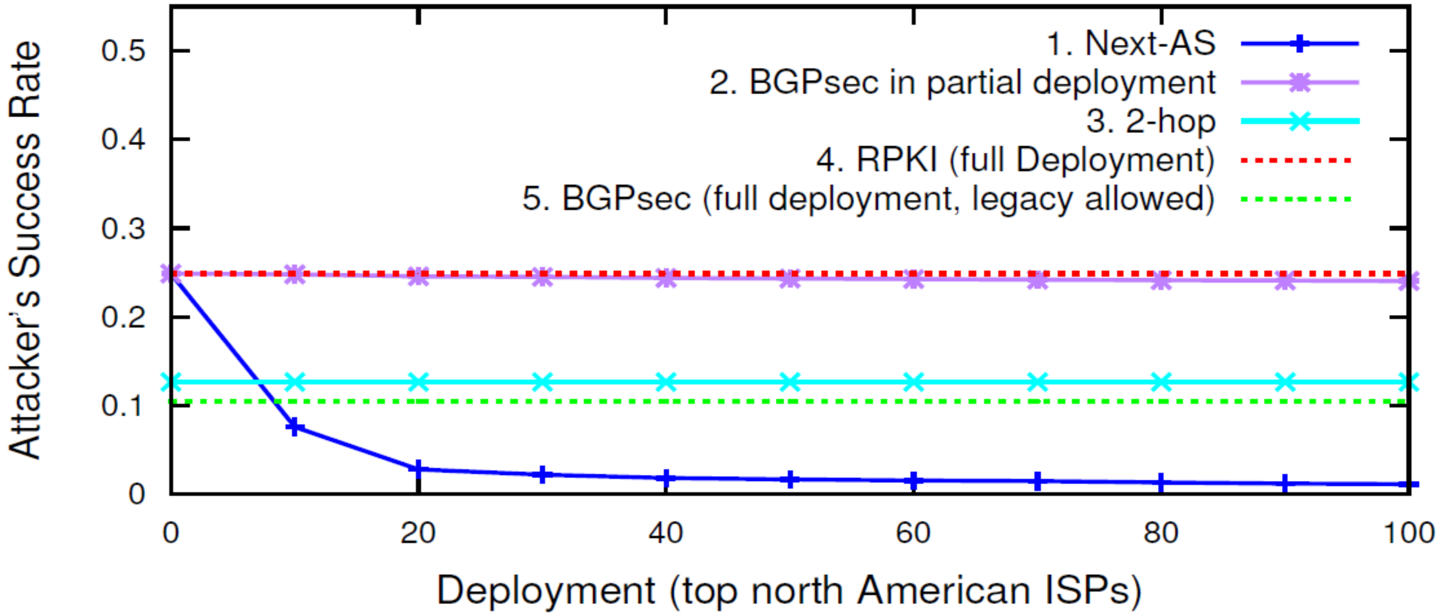
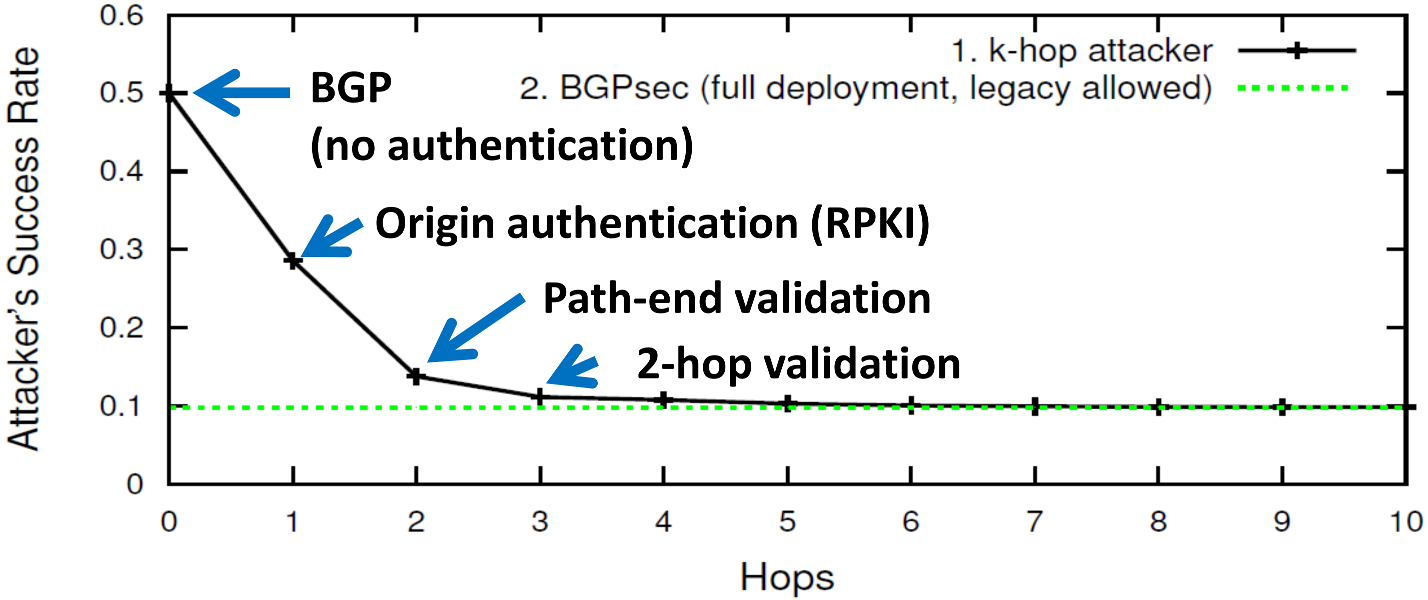


Local deployment & local benefits



Impact of authenticating hops



BGP (no authentication)

Origin authentication (RPKI)

Path-end validation

2-hop validation

More results

- Large content providers are better protected
- Path-end validation mitigates high profile incidents
- Security monotone
  - BGPsec is not [Lychev et al., SIGCOMM’13]

Conclusion

- Path-end validation
  - Can significantly improve inter-domain routing security while avoiding BGPsec’s deployment hurdles

- We advocate
  - Extending RPKI to support path-end validation
  - Regulatory/financial efforts on gathering critical mass of adopters

Thank You