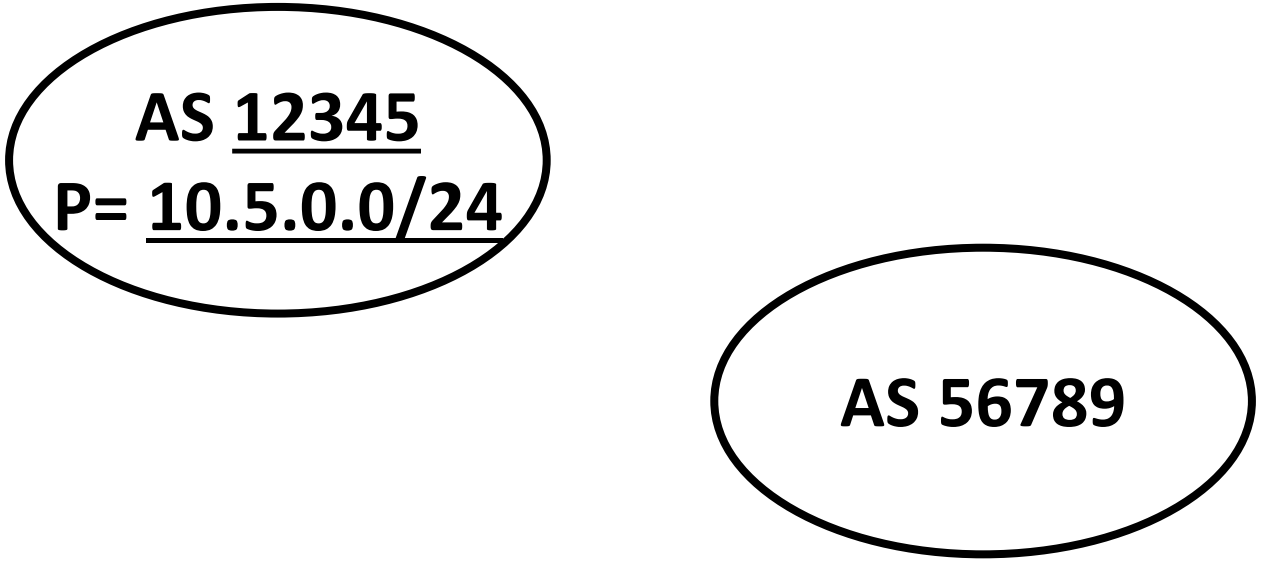
iROV: Breaking the Silence of RPKI with Interactive Validation

Younsoo Kim, Seungjin Baek, Weitong Li, Taejoong Chung, and Min Suk Kang

KAIST

VIRGINIA TECH

BGP is Vulnerable to Hijacking Attacks



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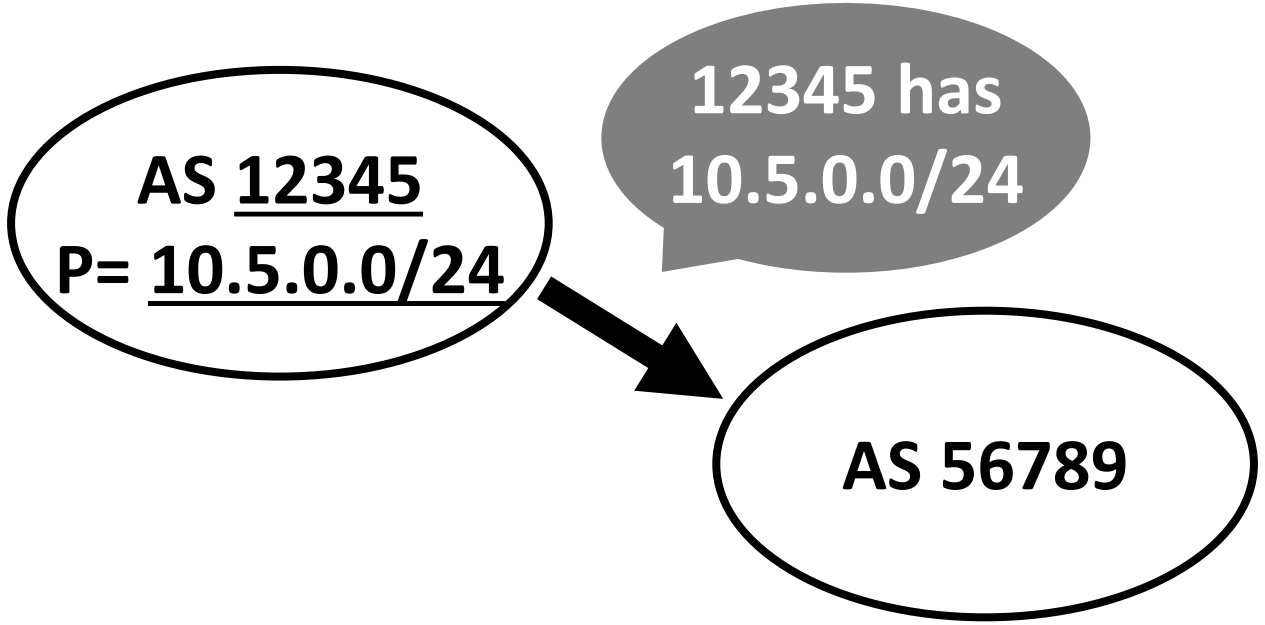

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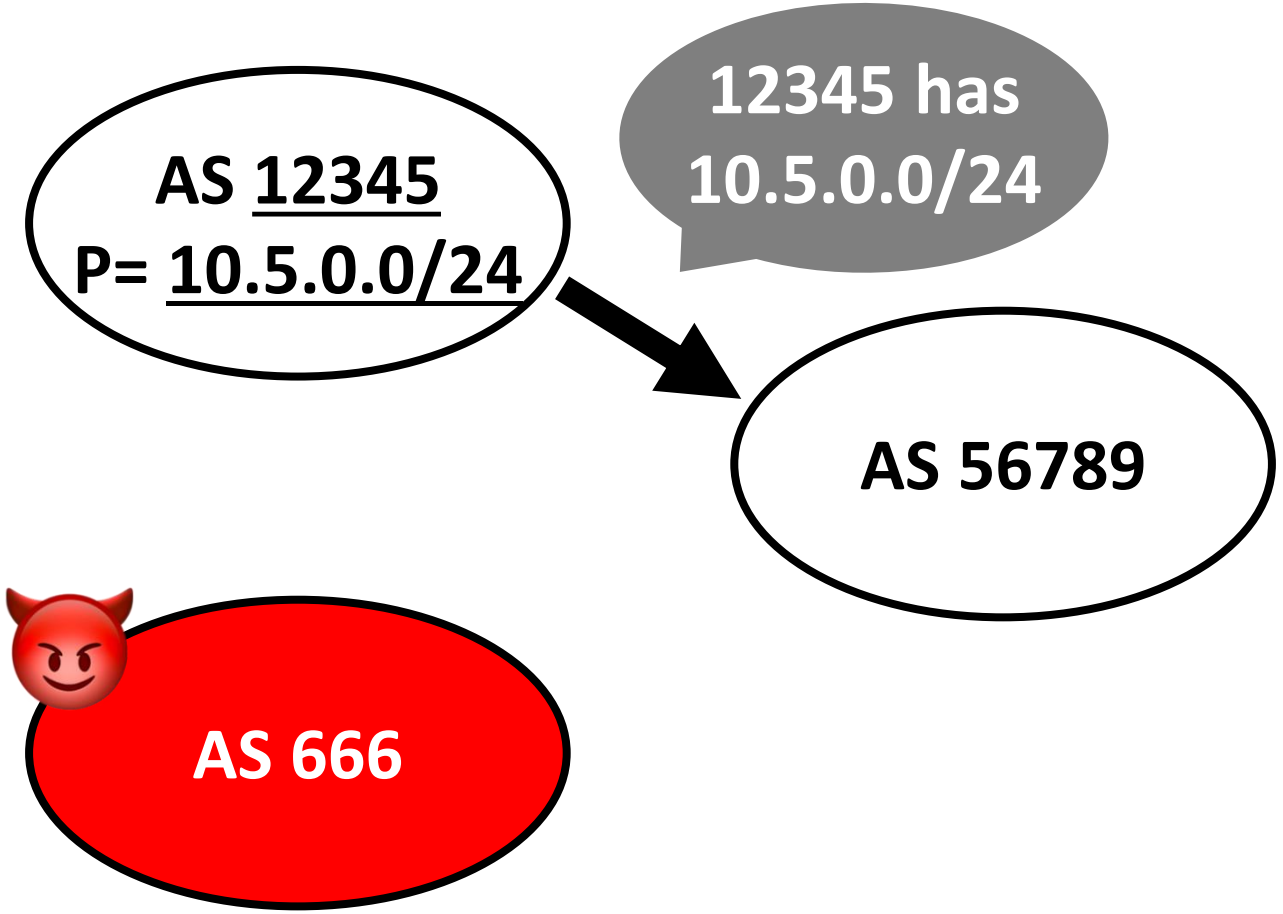

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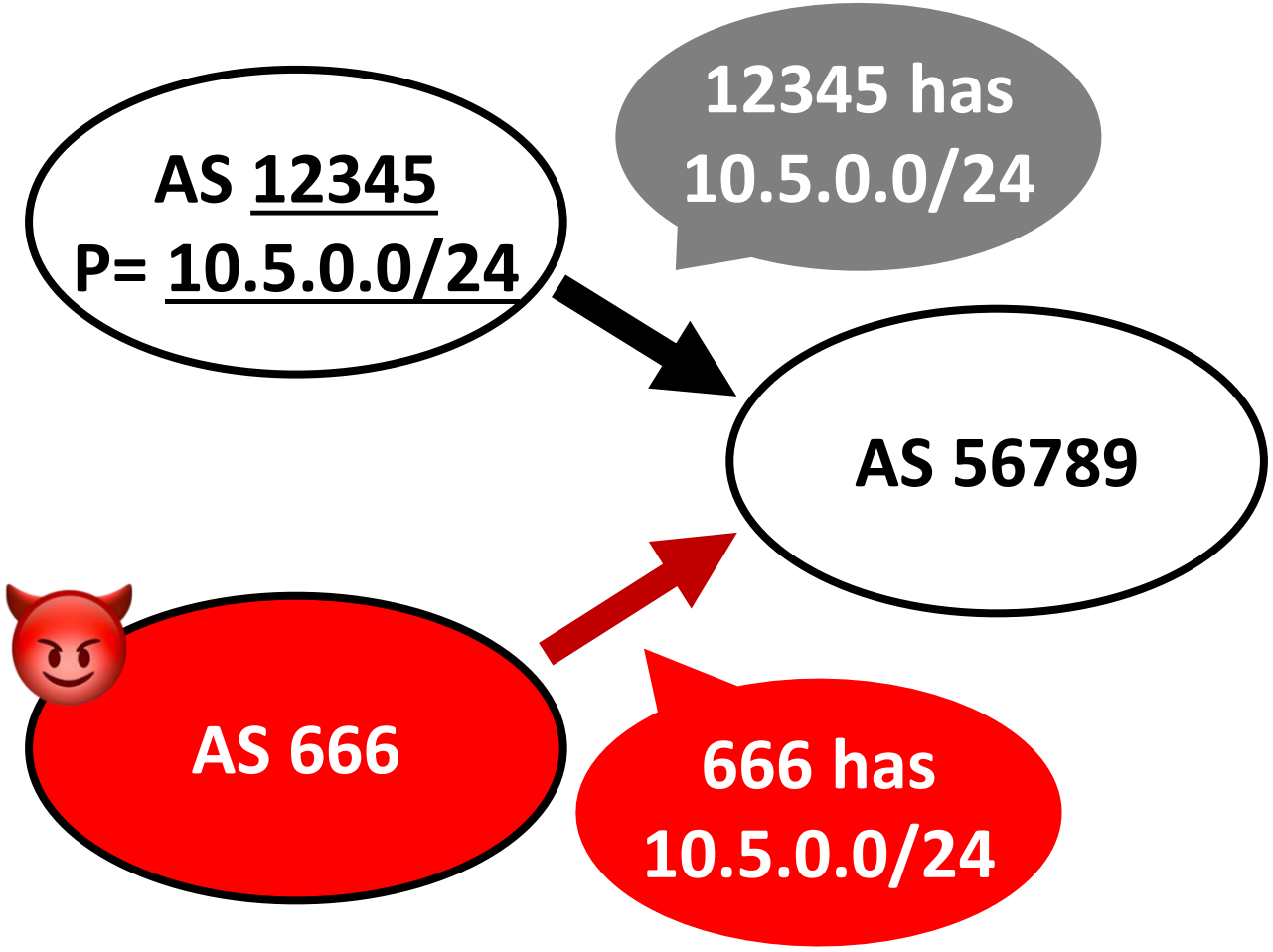

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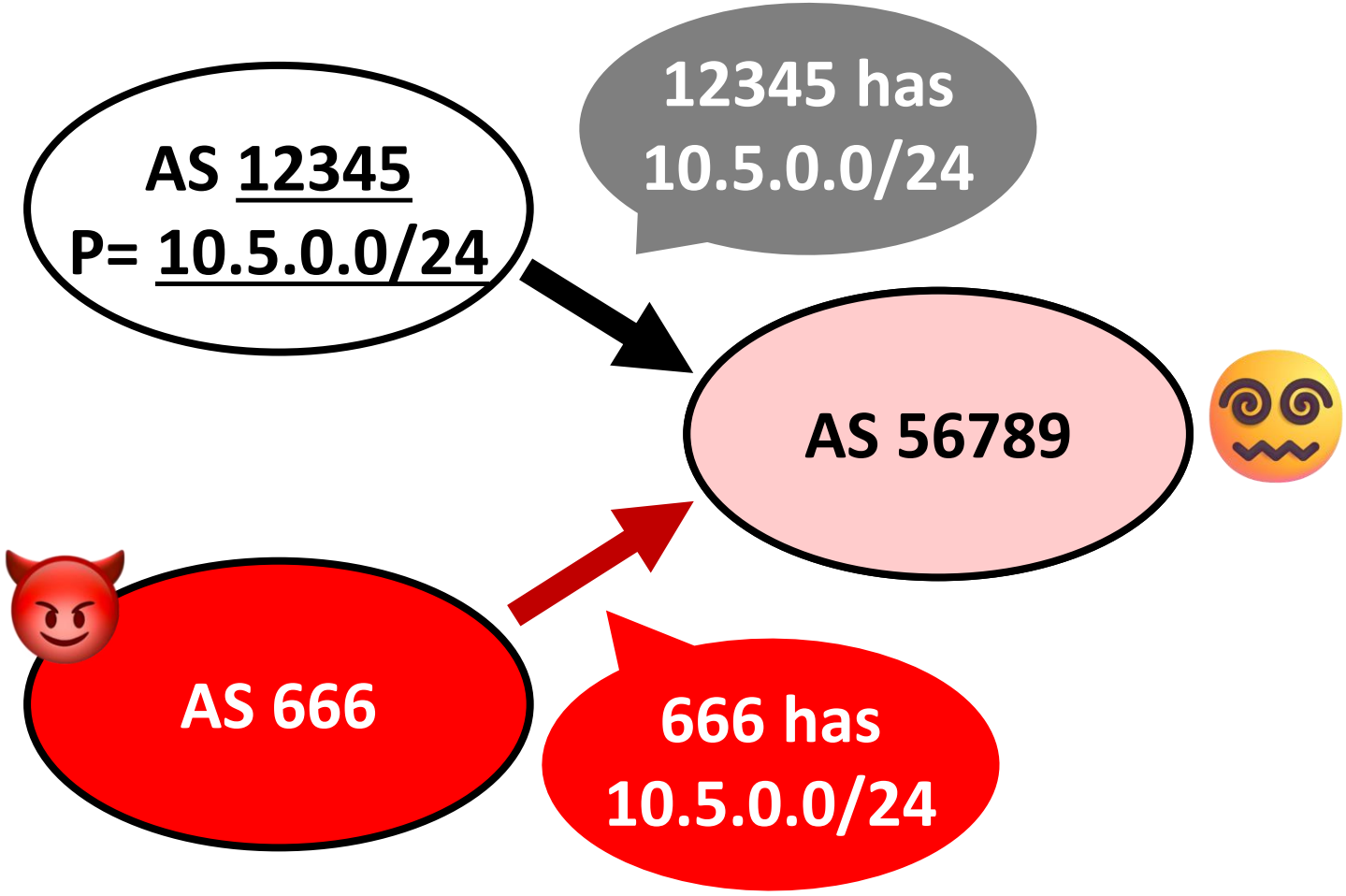
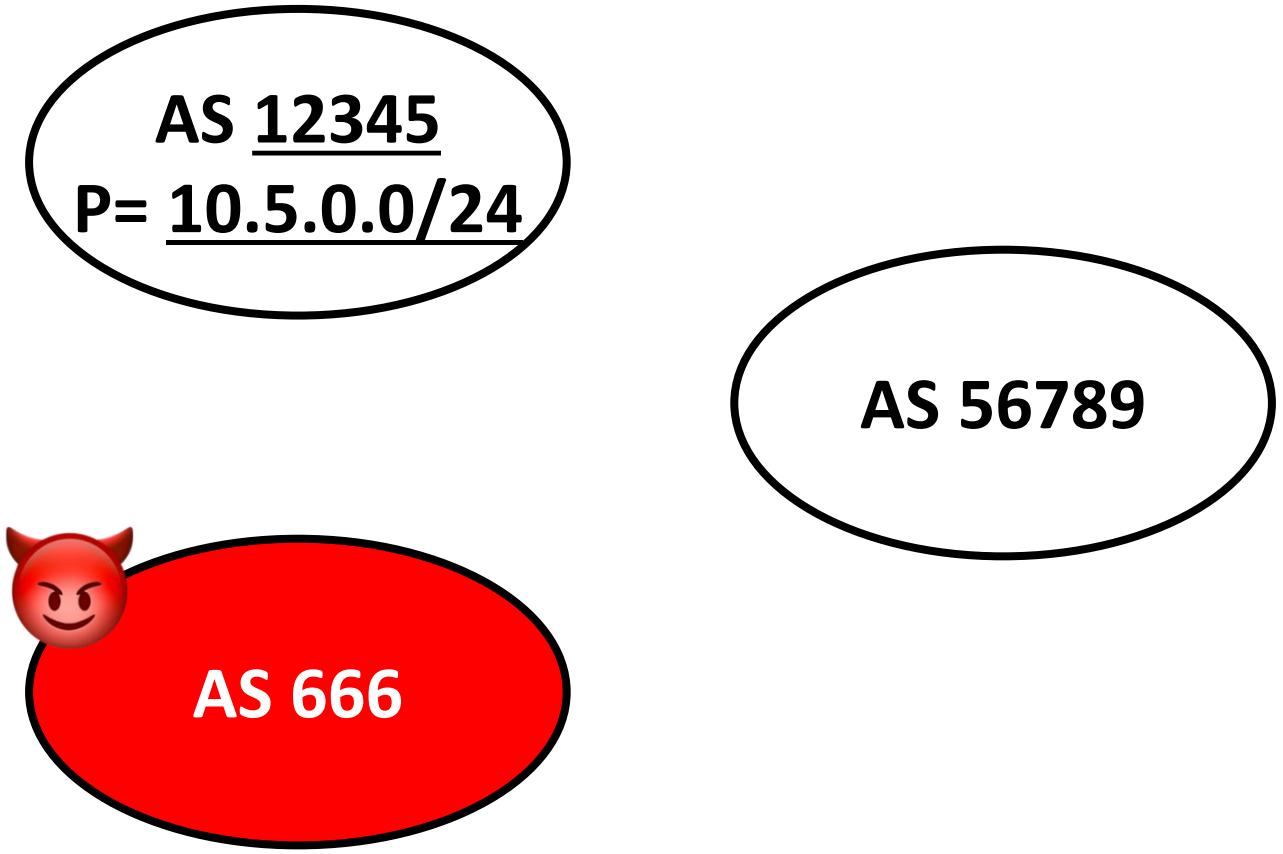


RPKI/ROV Prevents Prefix Hijacking Attacks



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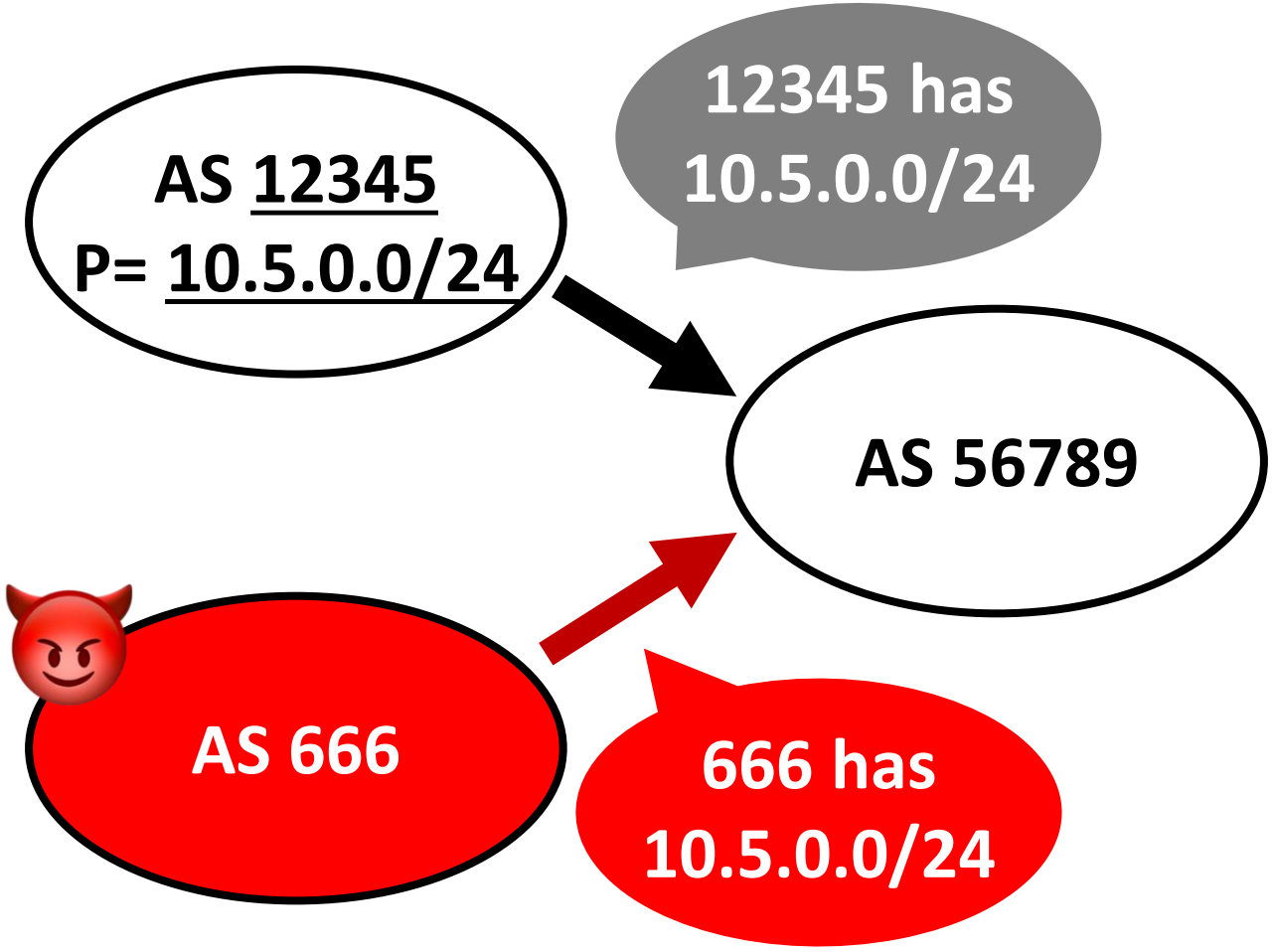

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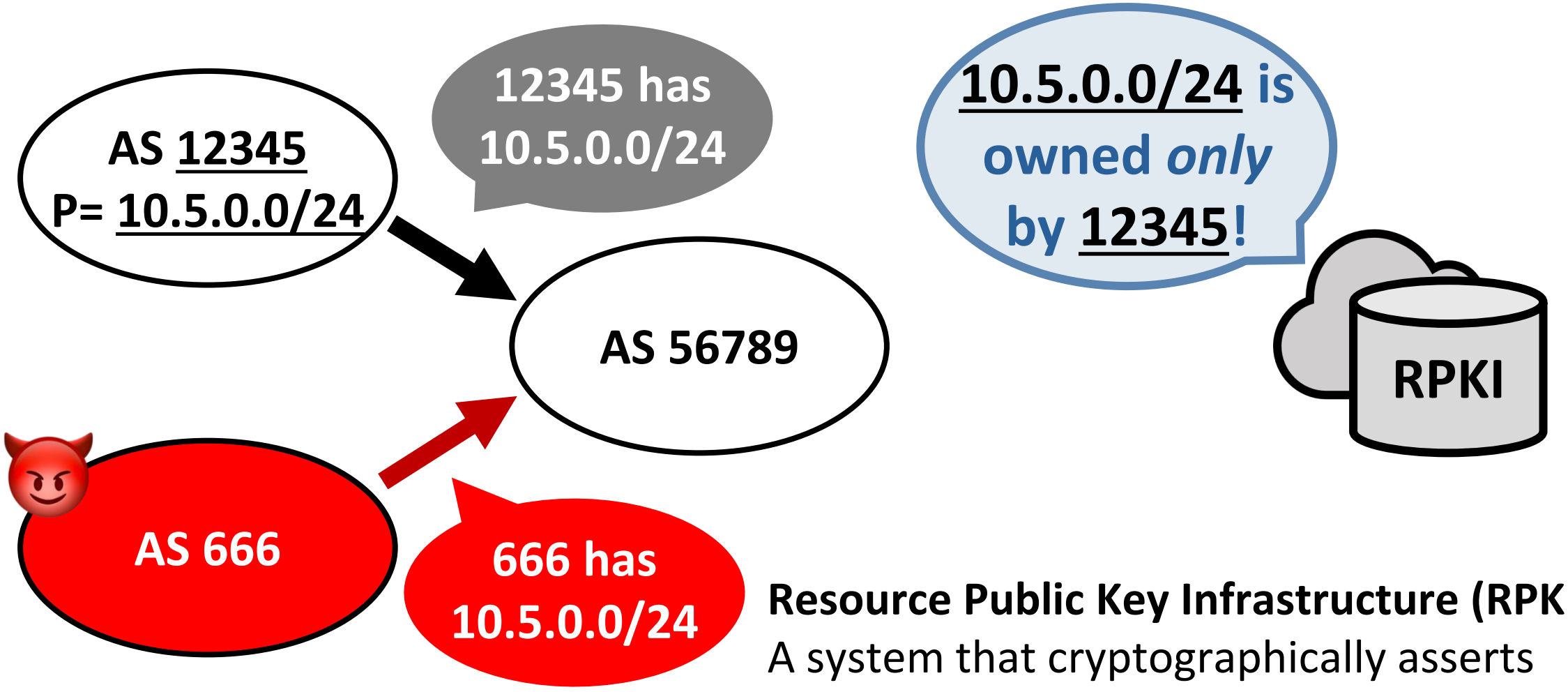

Resource Public Key Infrastructure (RPKI):
A system that cryptographically asserts Internet Number Resource (INR) ownership

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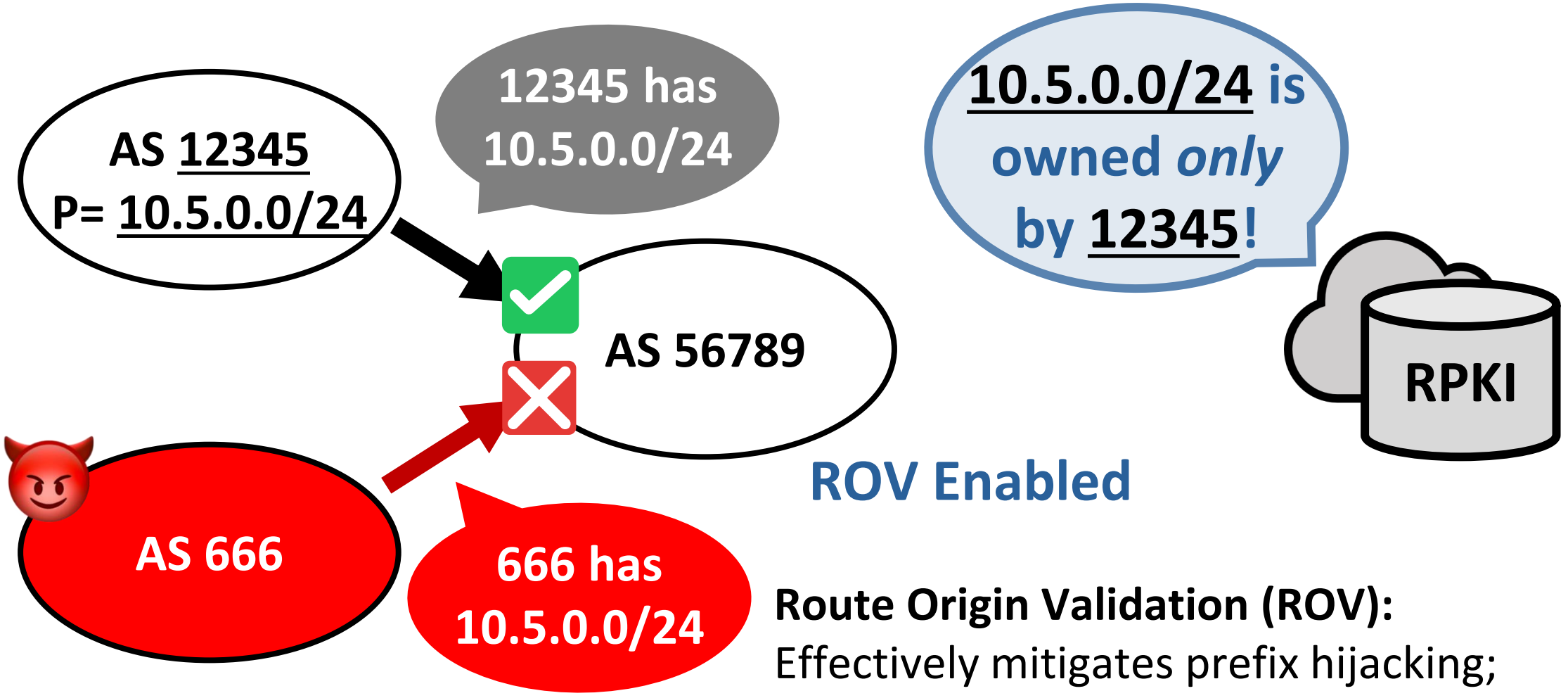

Route Origin Validation (ROV):
Effectively mitigates prefix hijacking;
its global adoption is steadily increasing
every year

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(Defense incompatibility)

[C3] DoS defense (traffic redirection) is disrupted by ROV





e.g., Cloudflare

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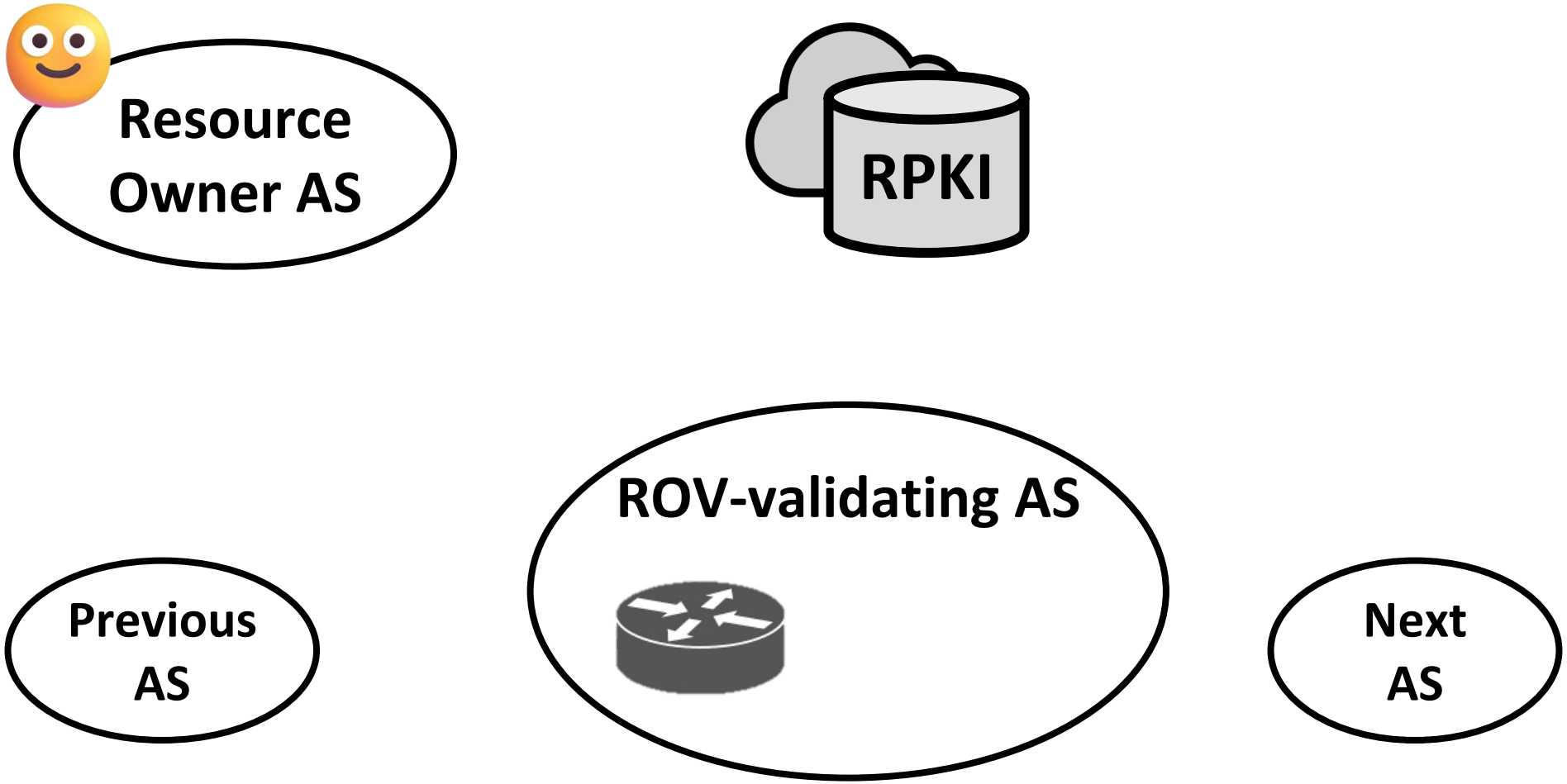

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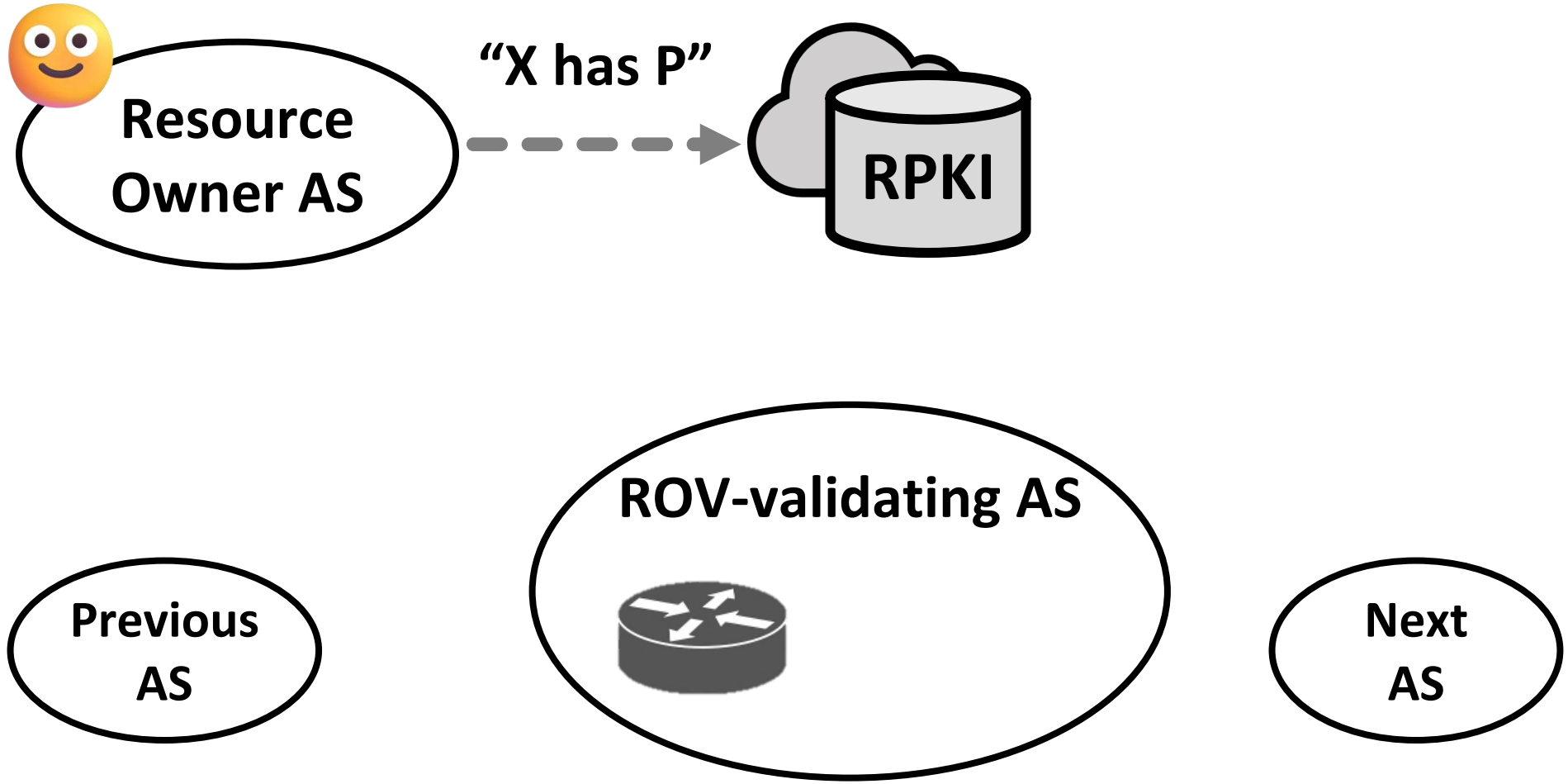

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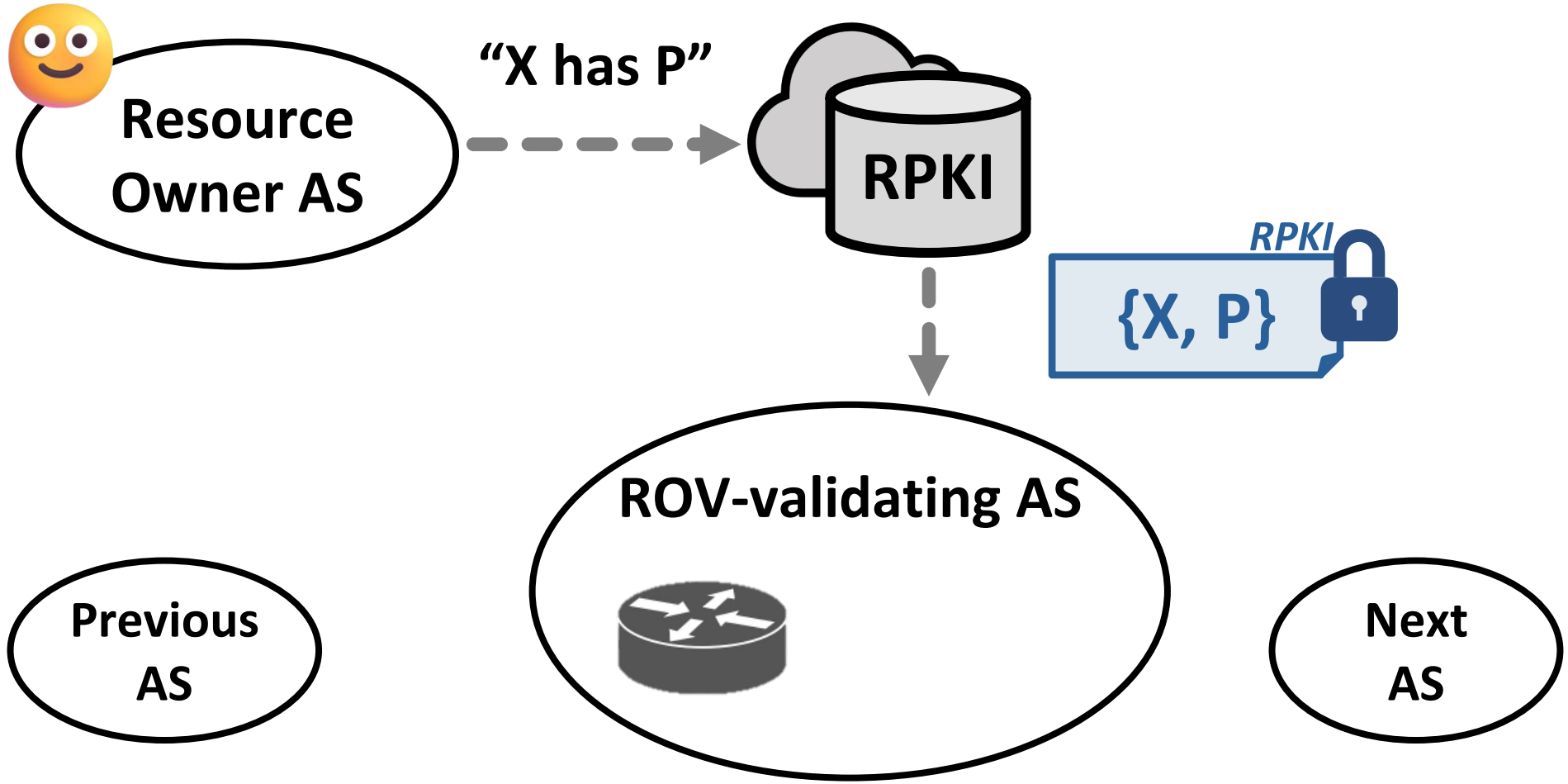

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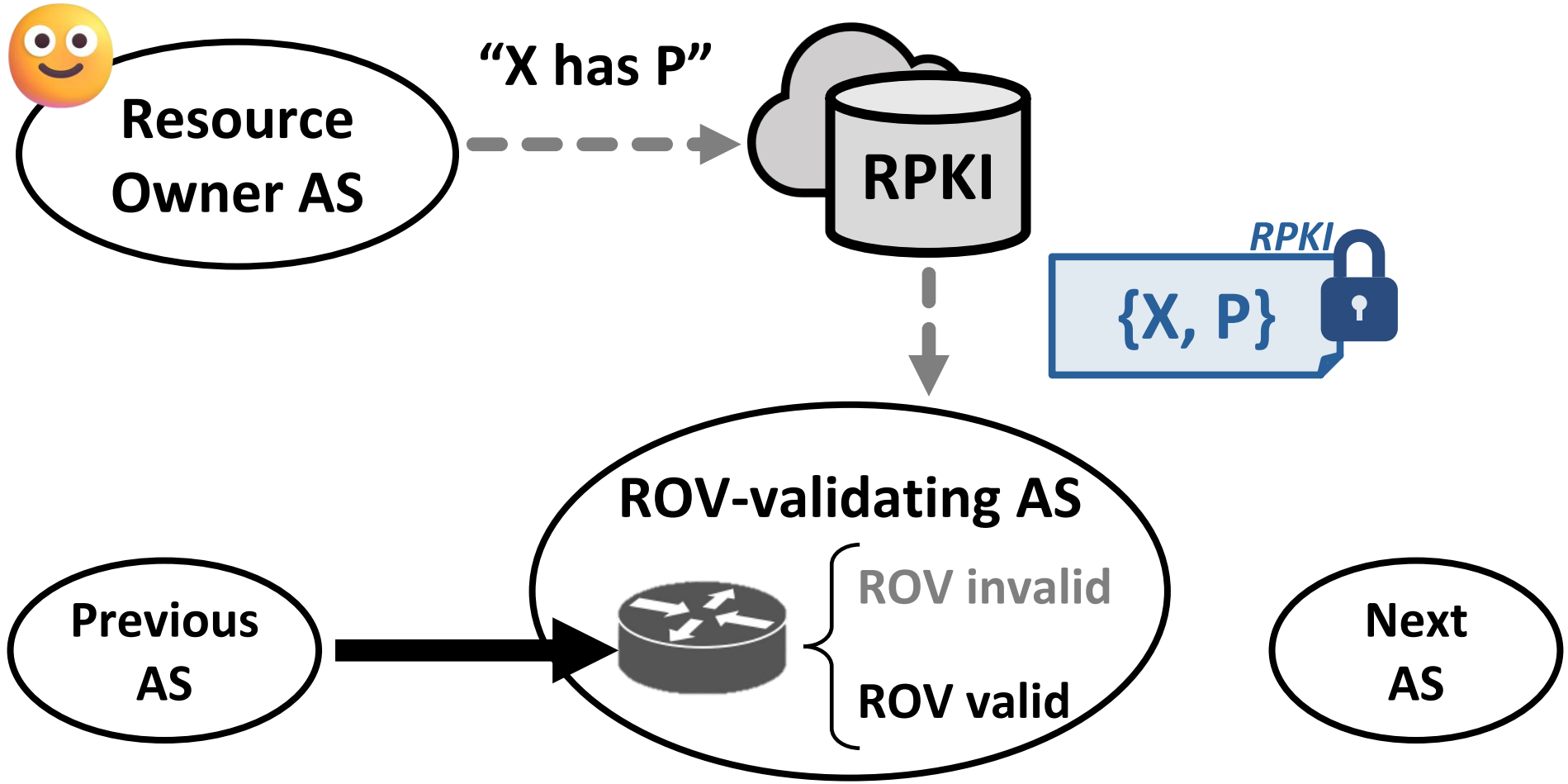

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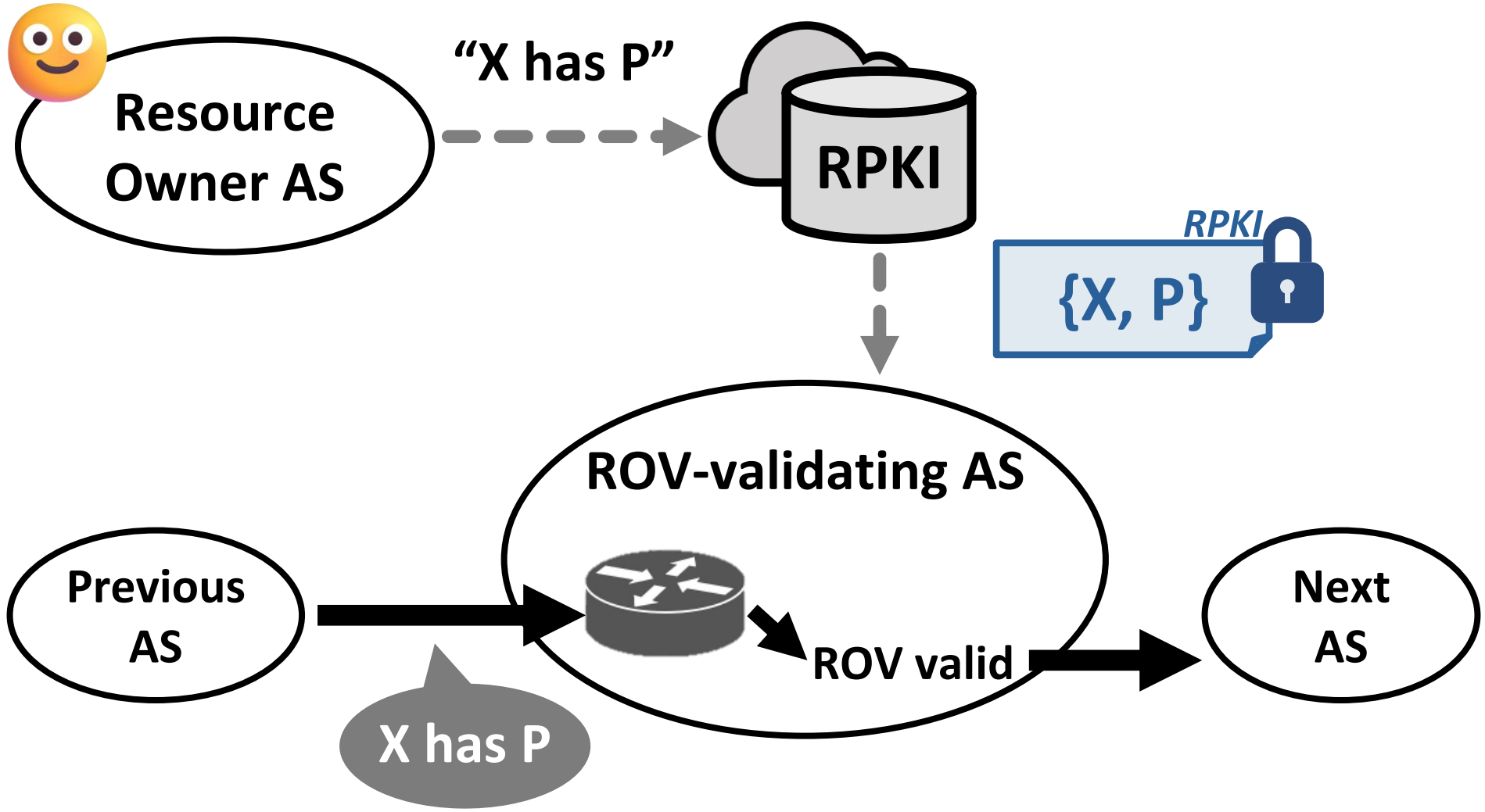

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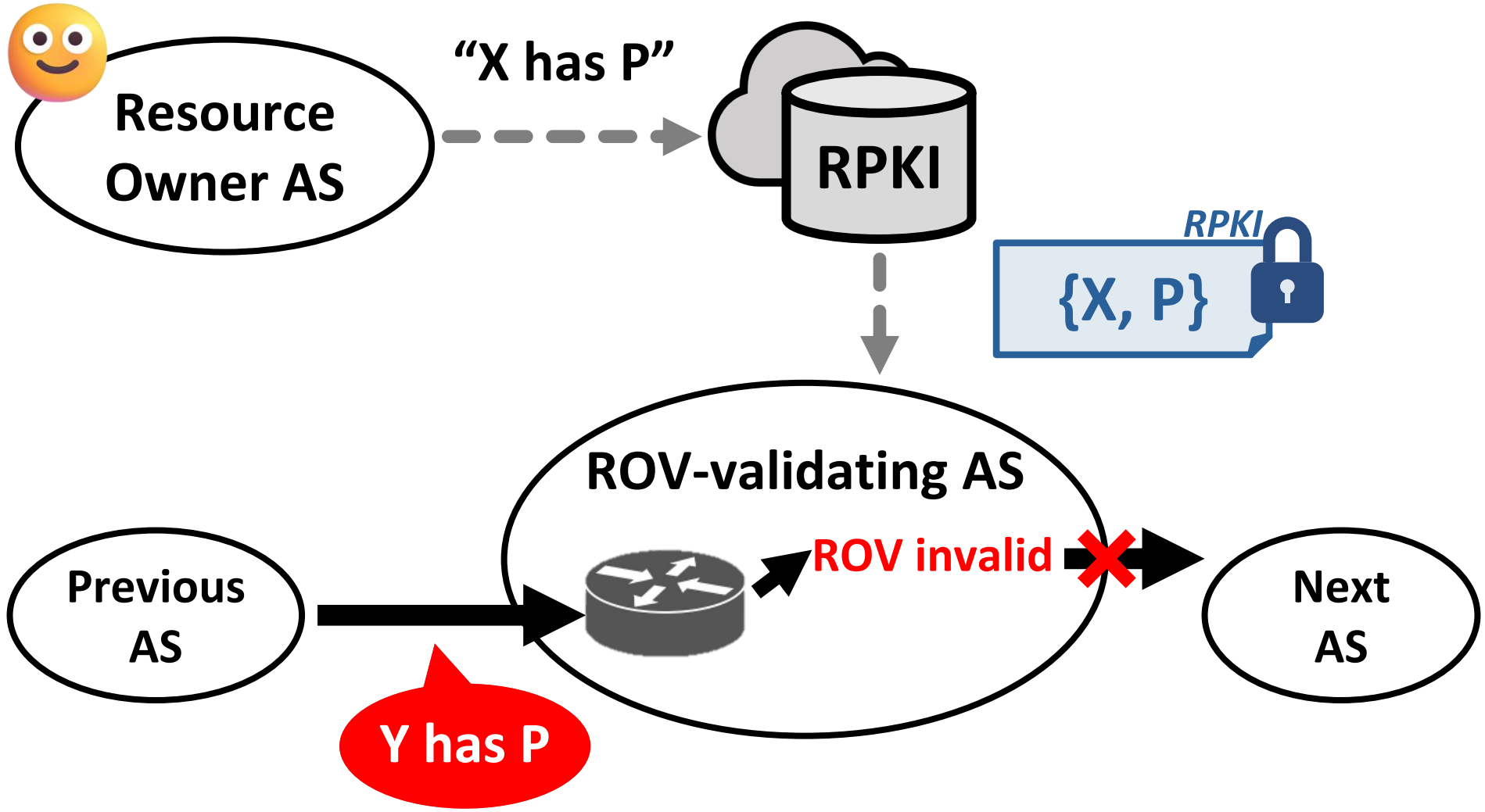

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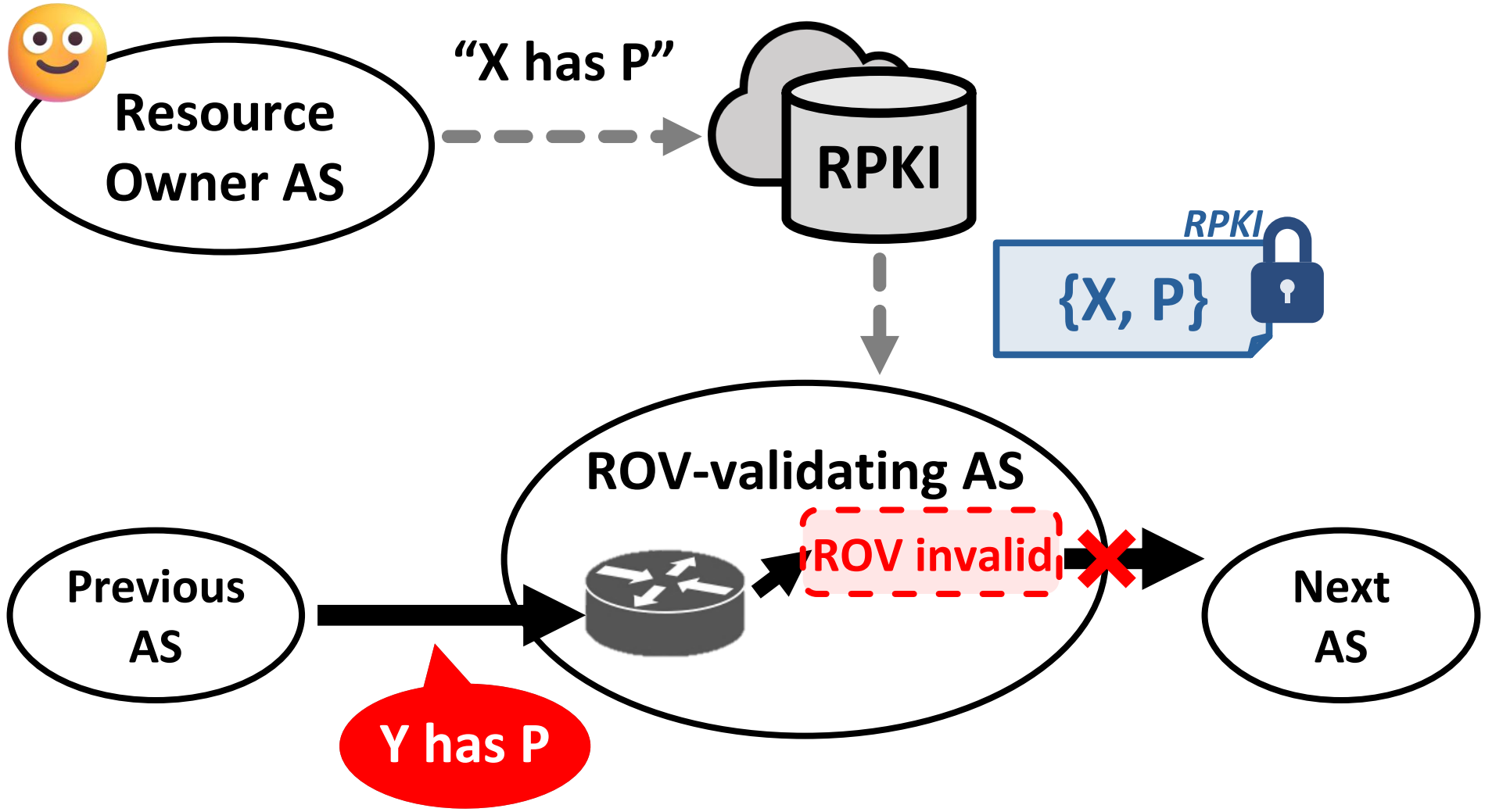

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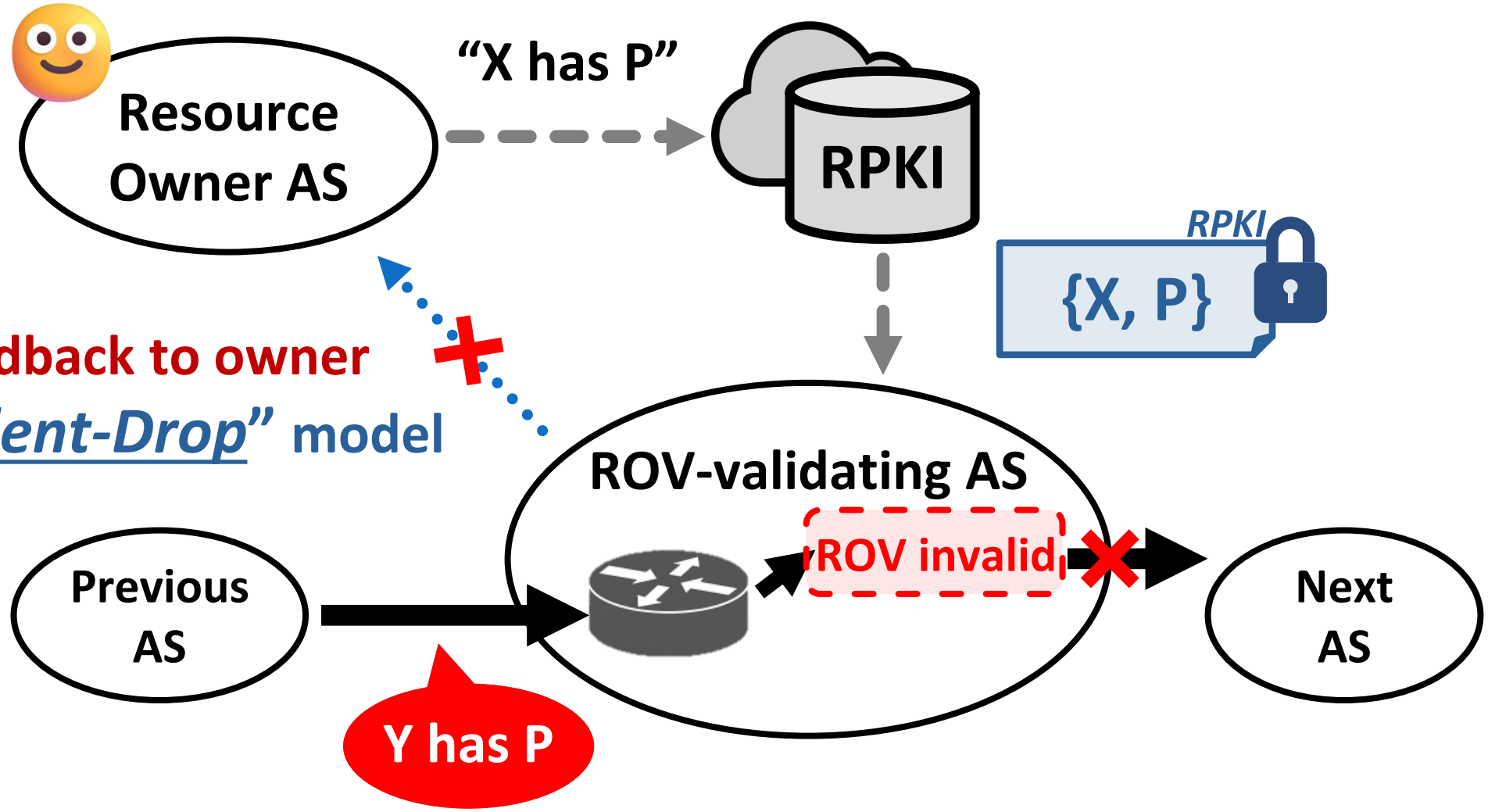

Challenges Due to ROV's Silent-Drop Model

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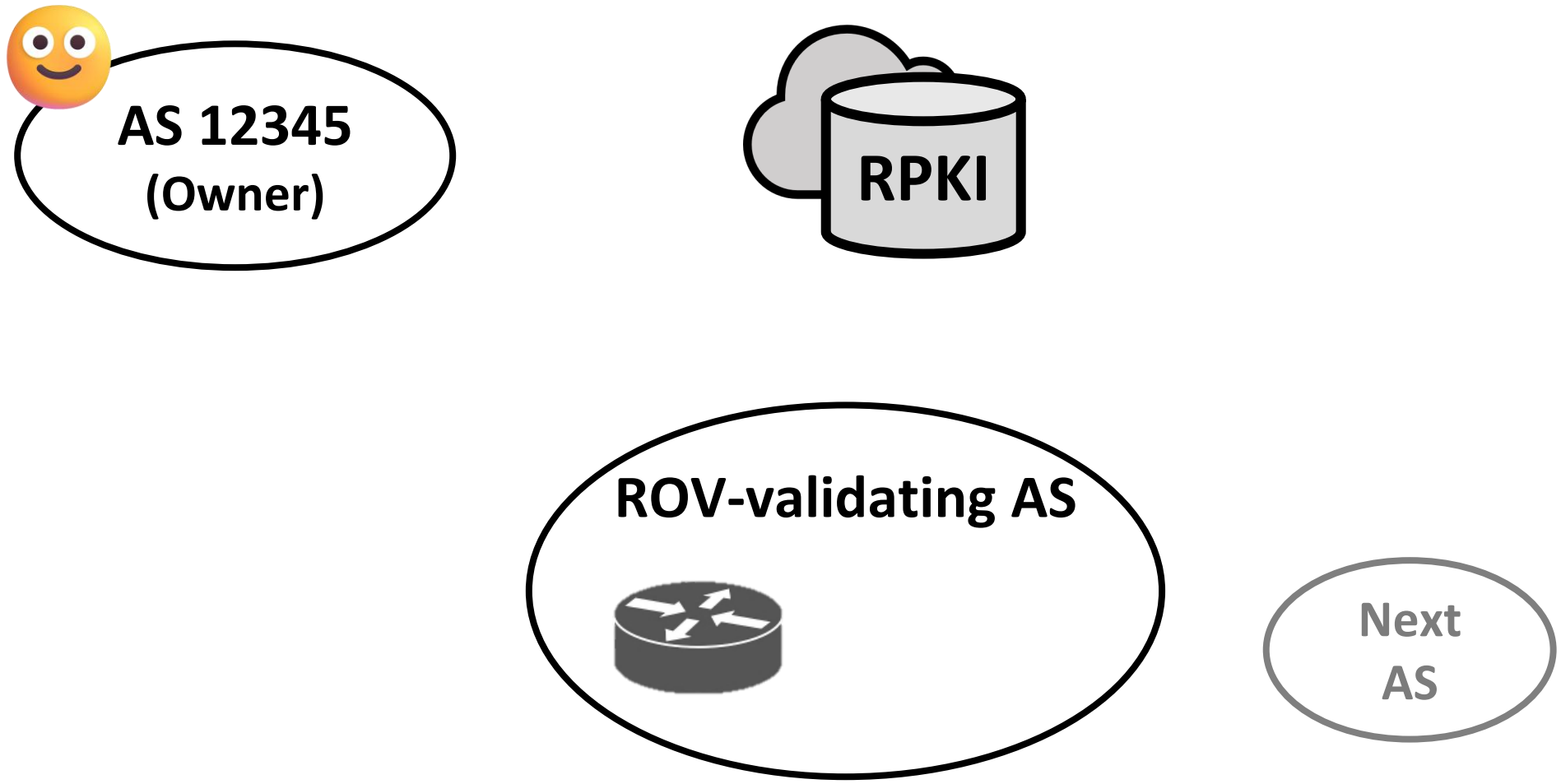

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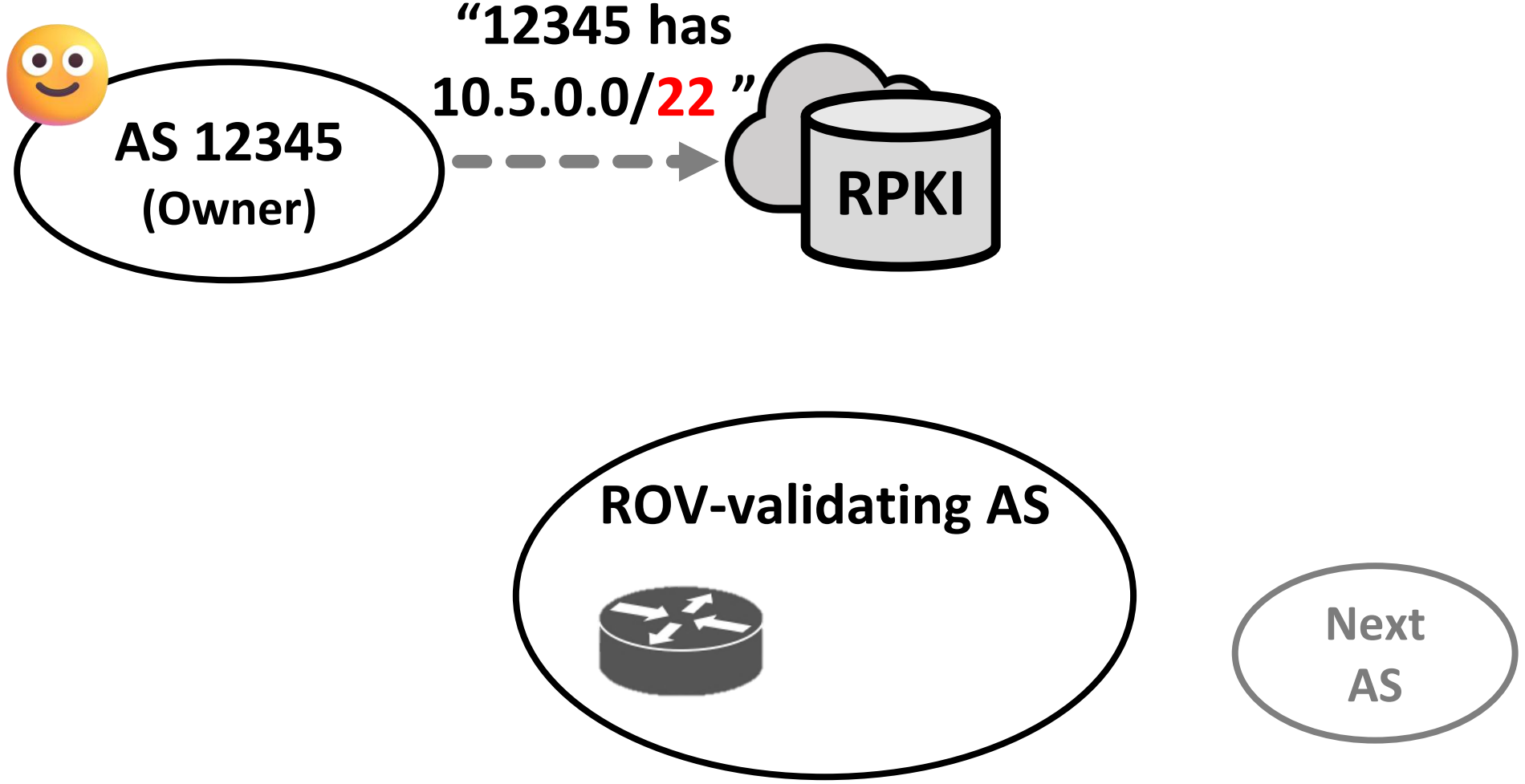

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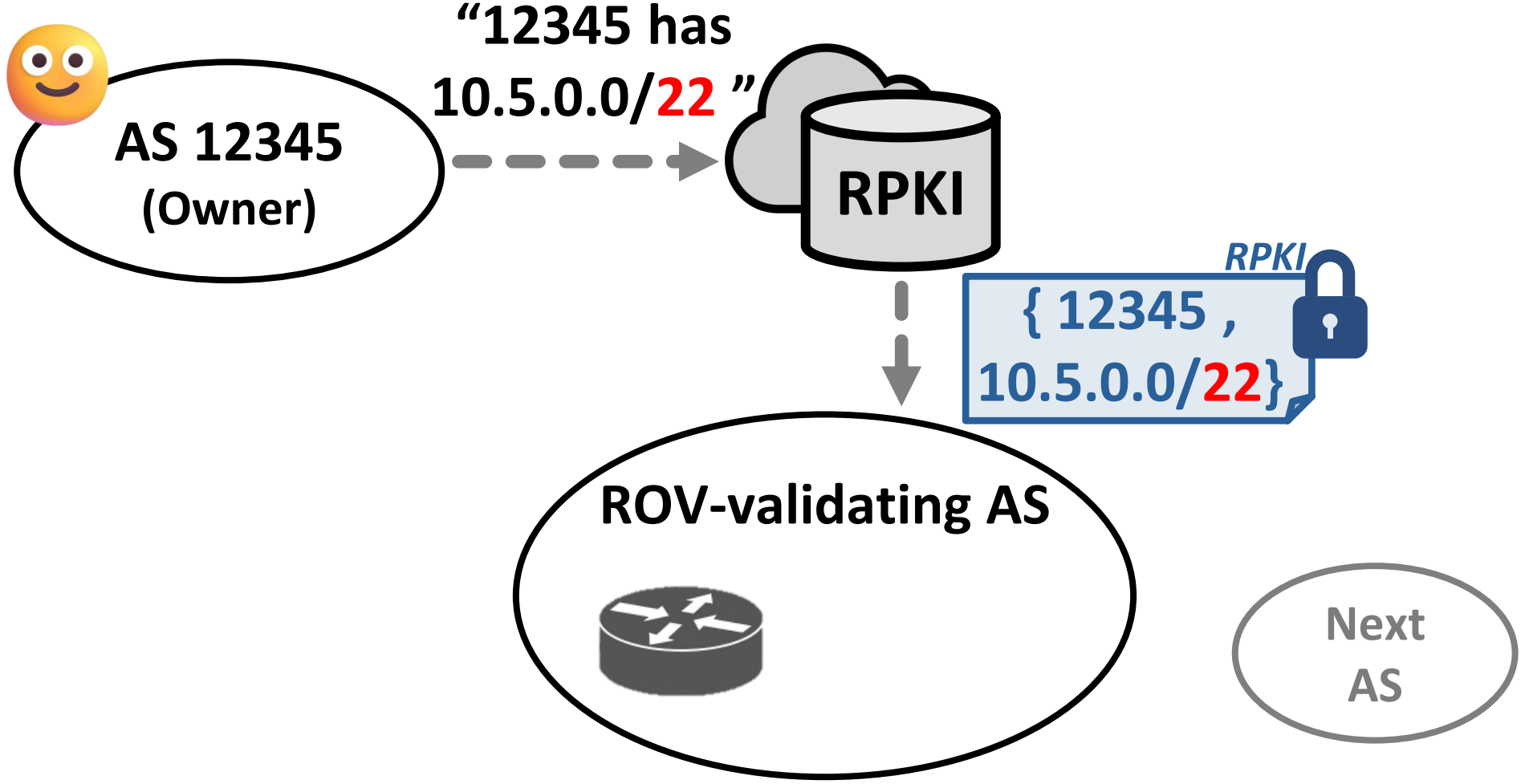

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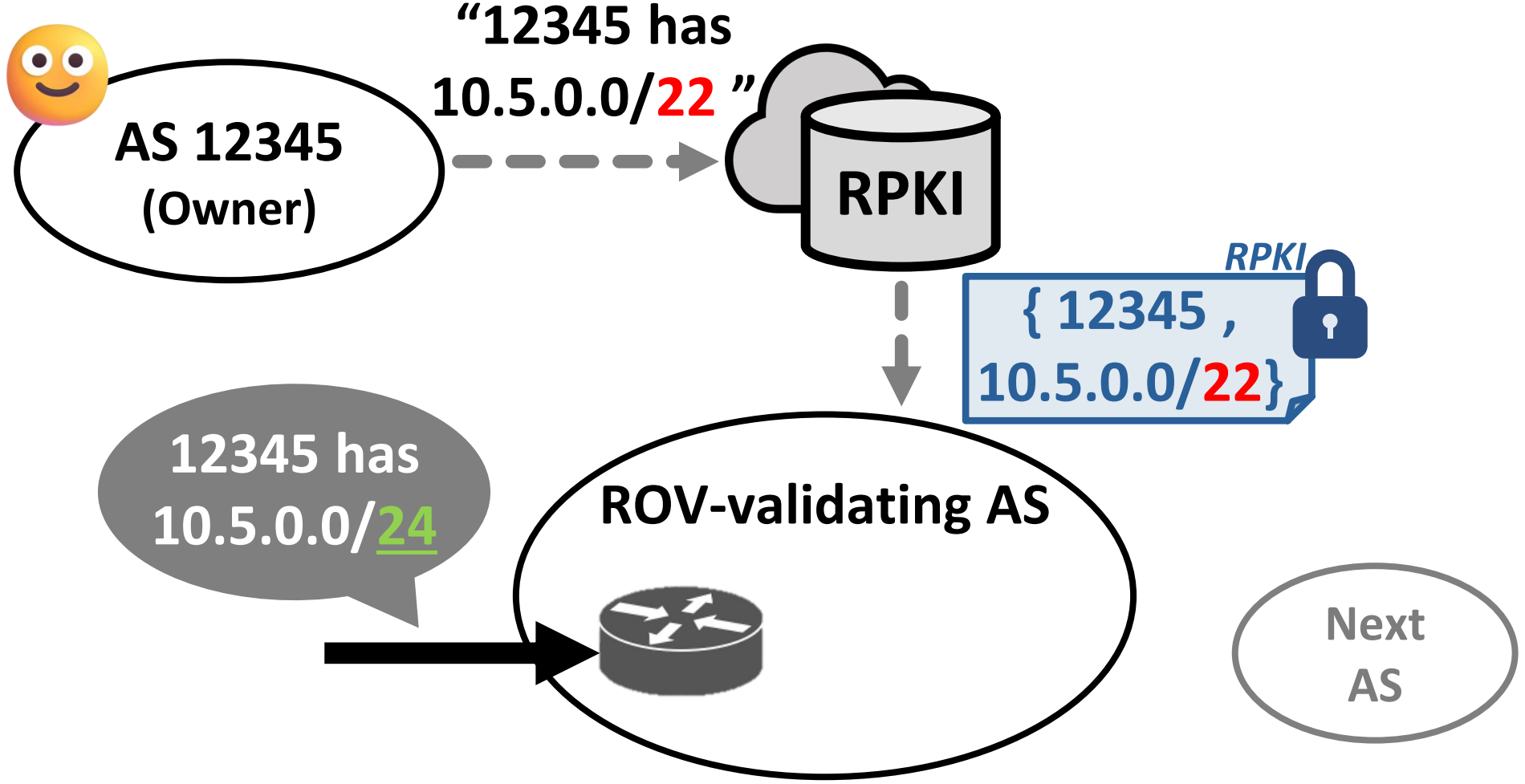

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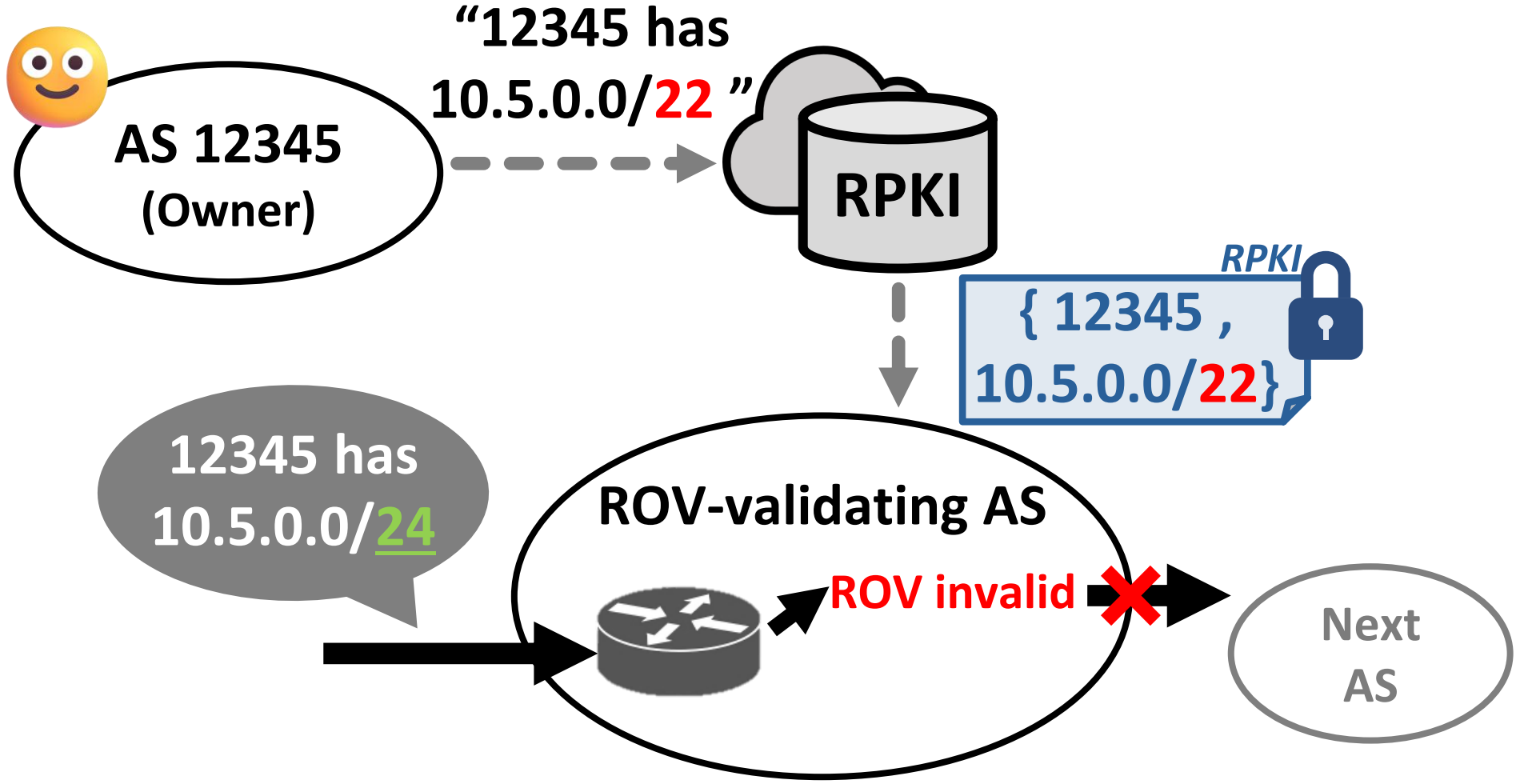

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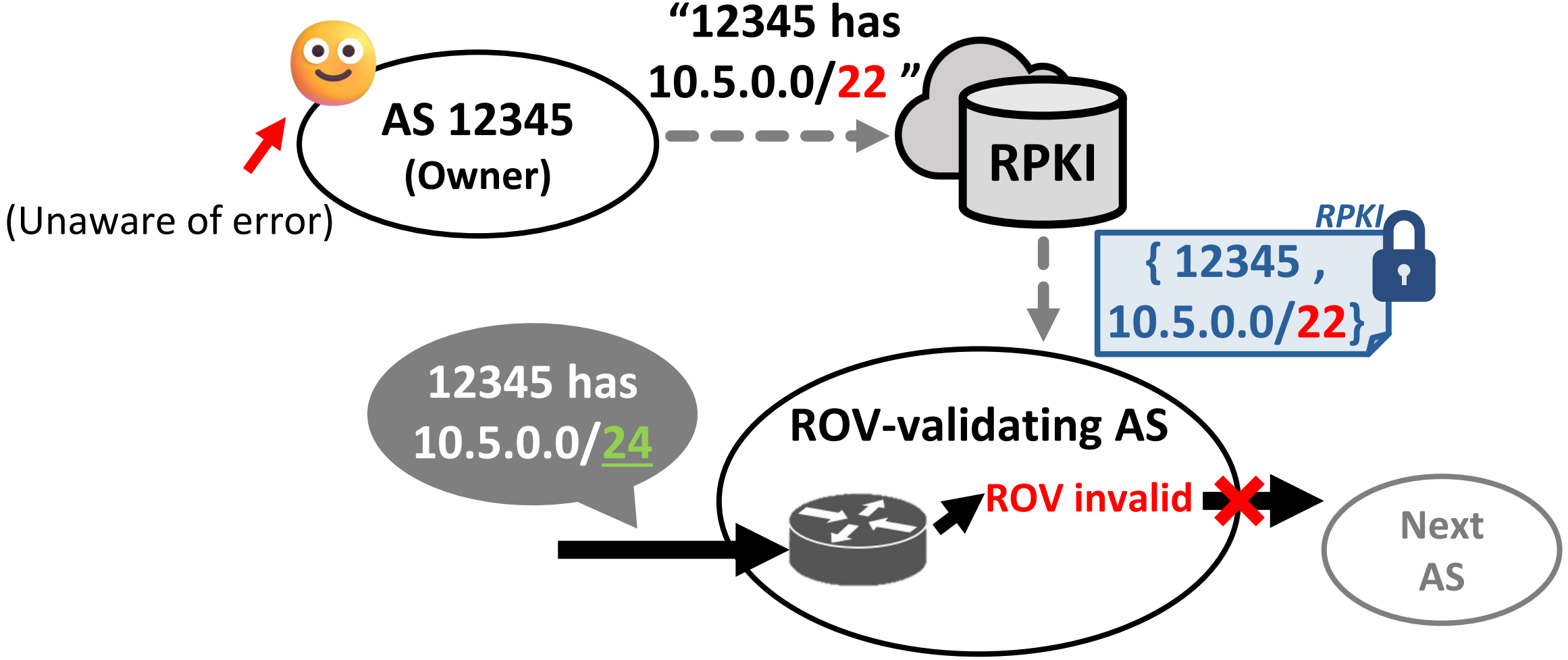

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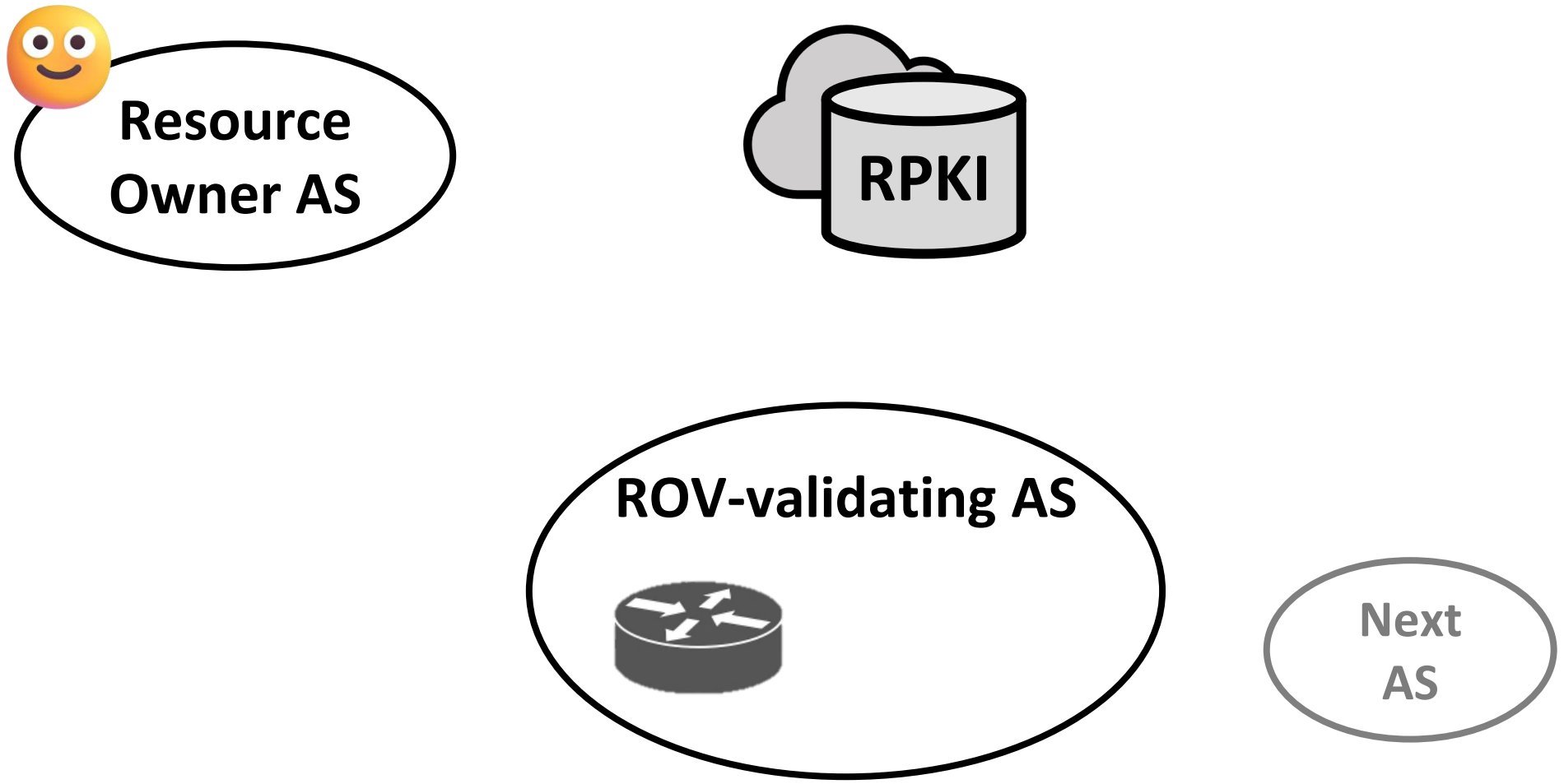

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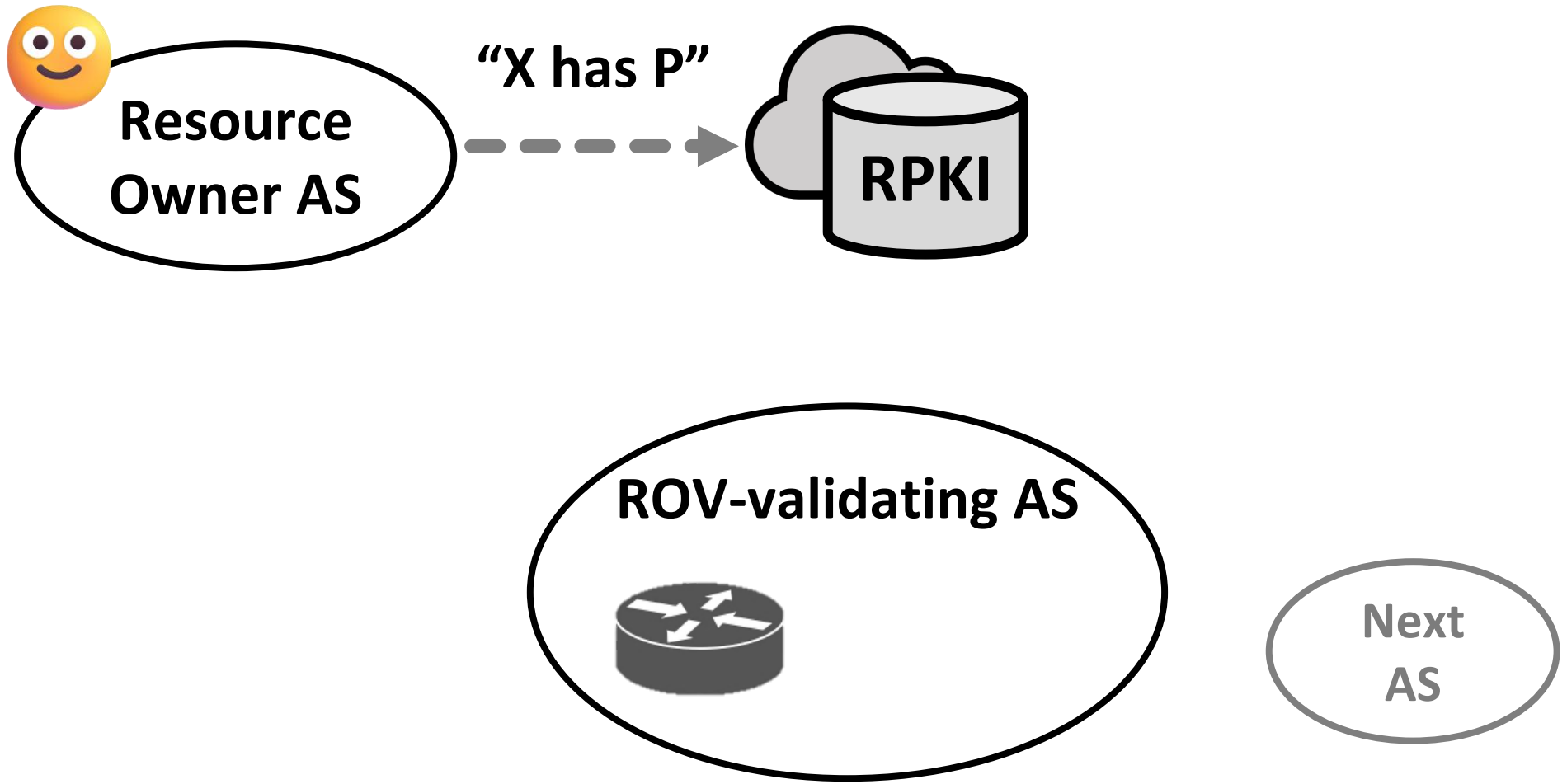

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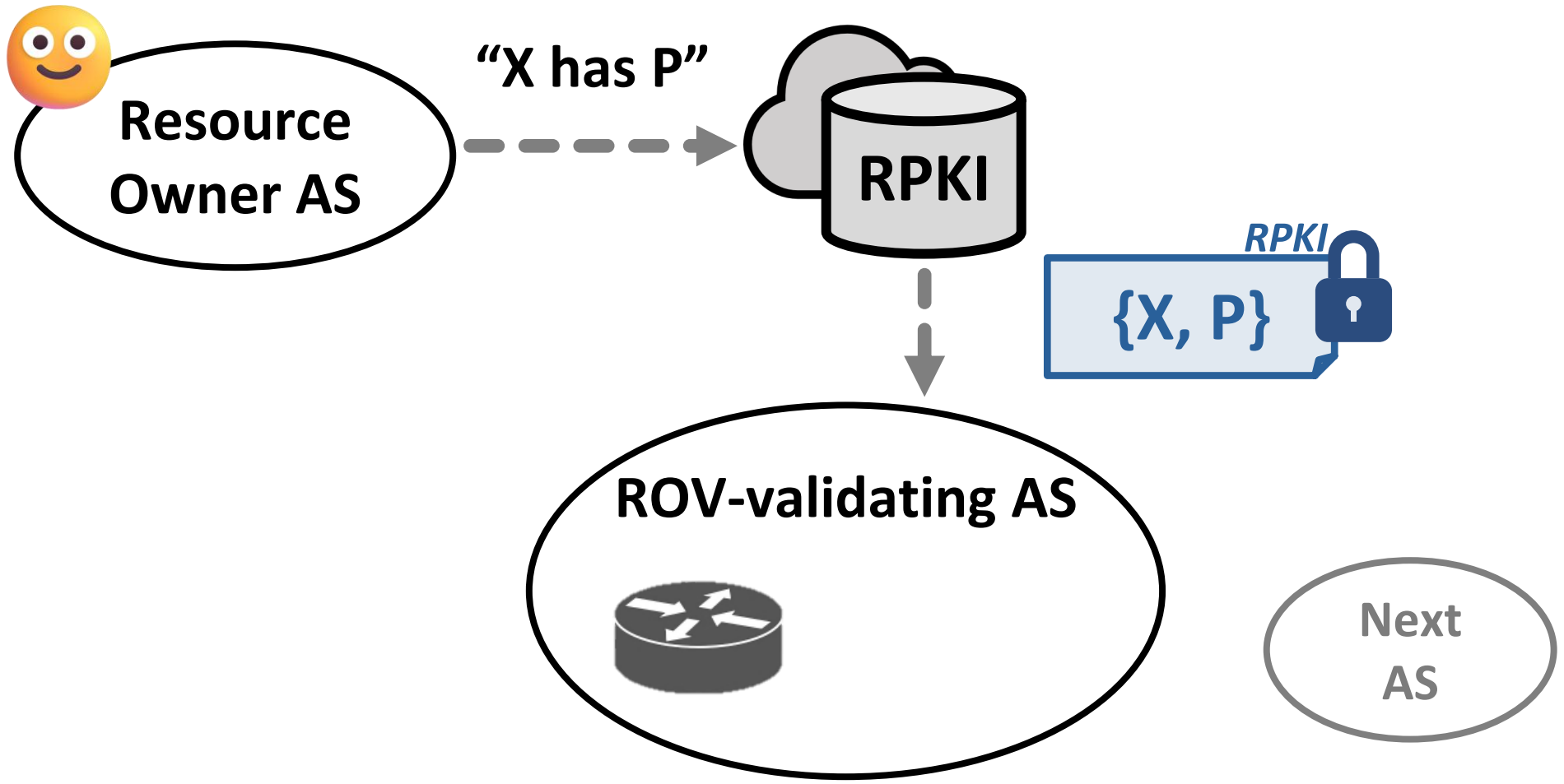

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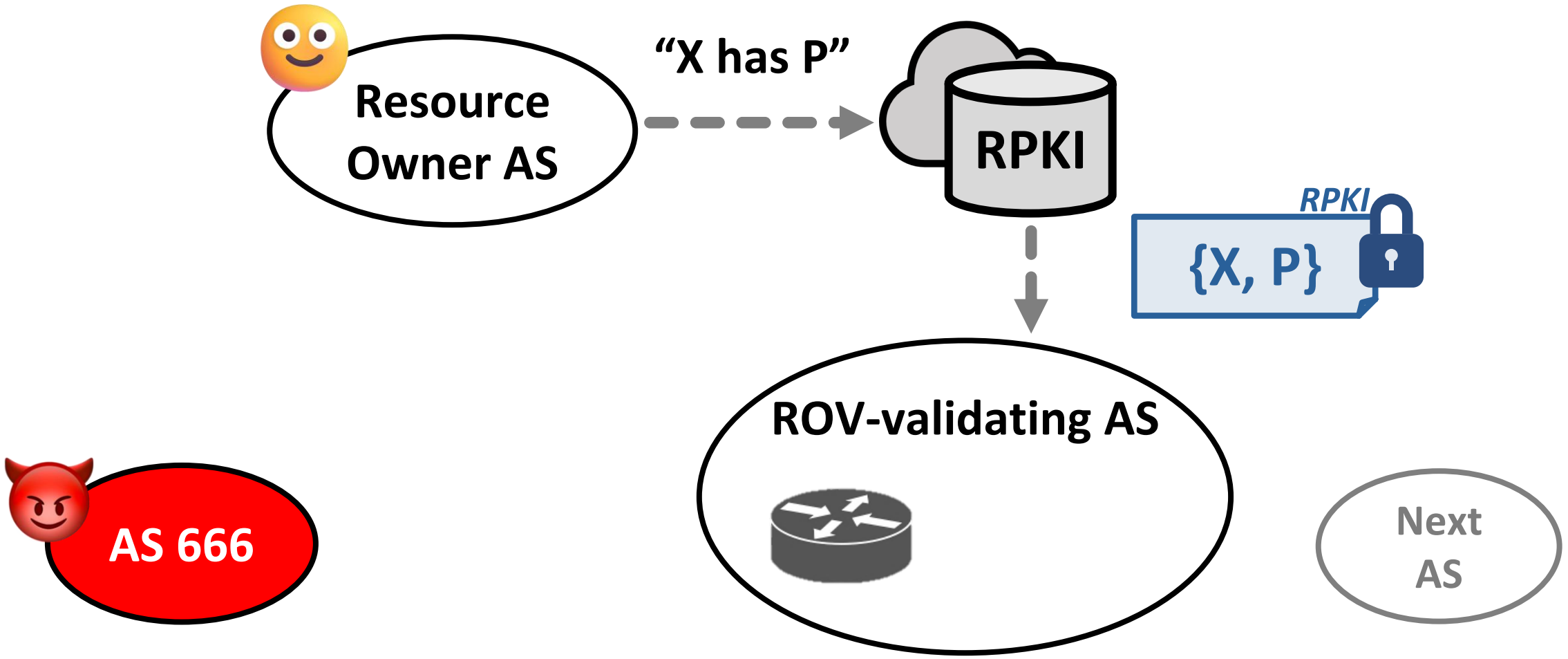

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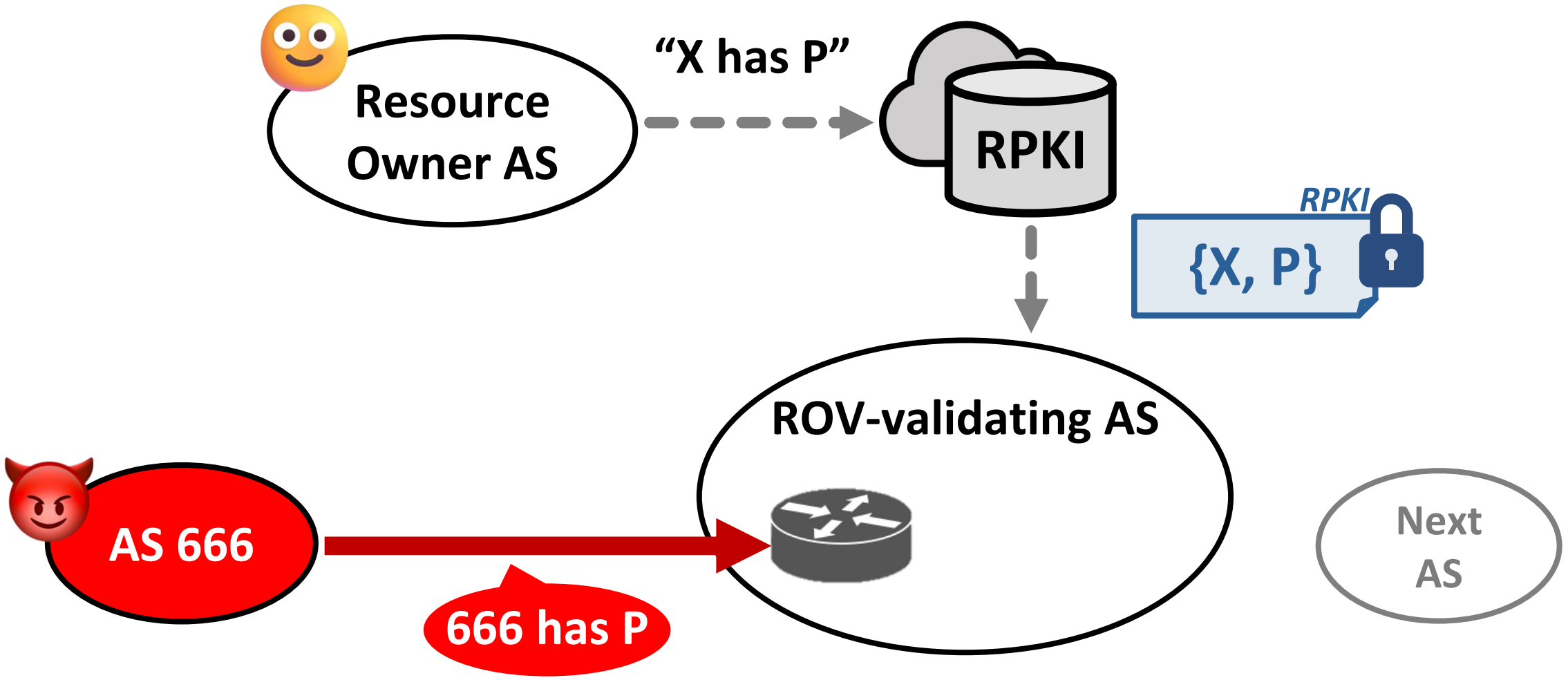

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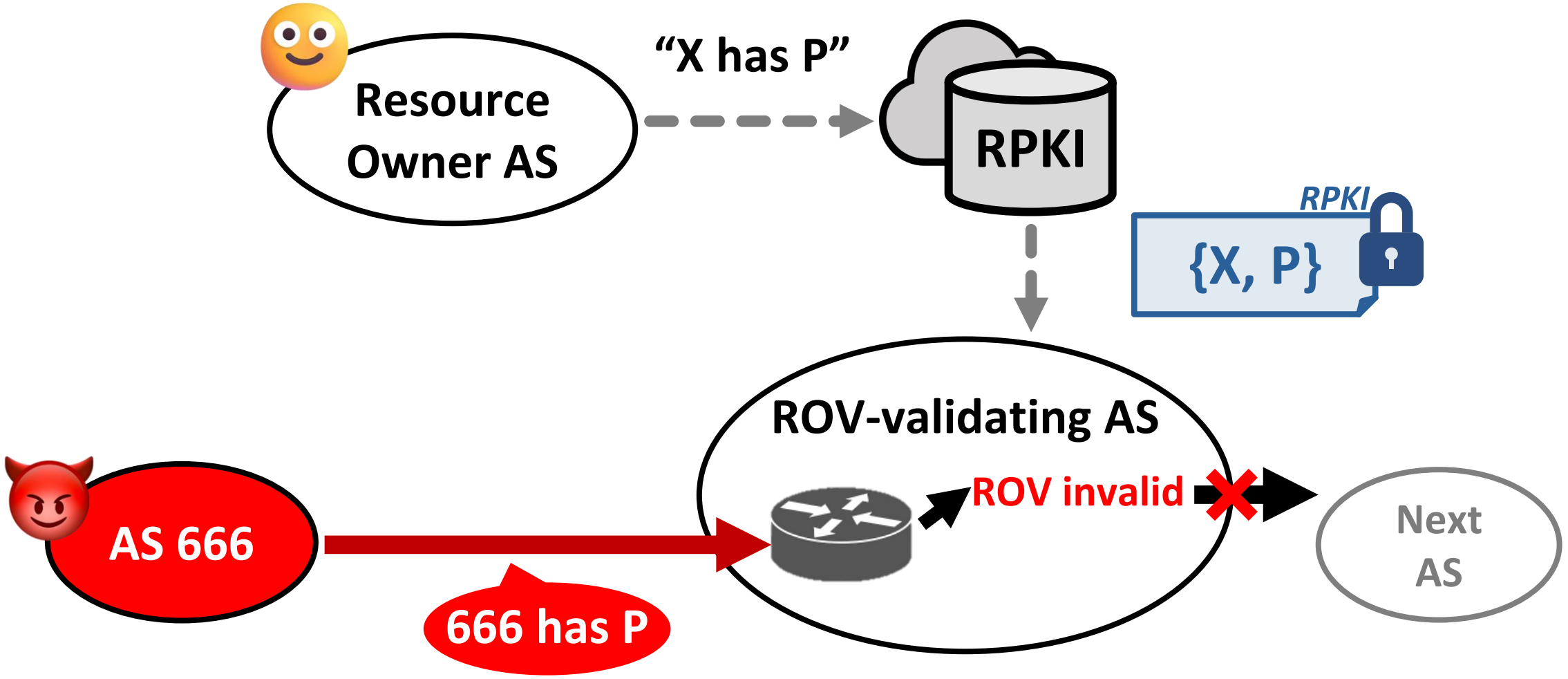

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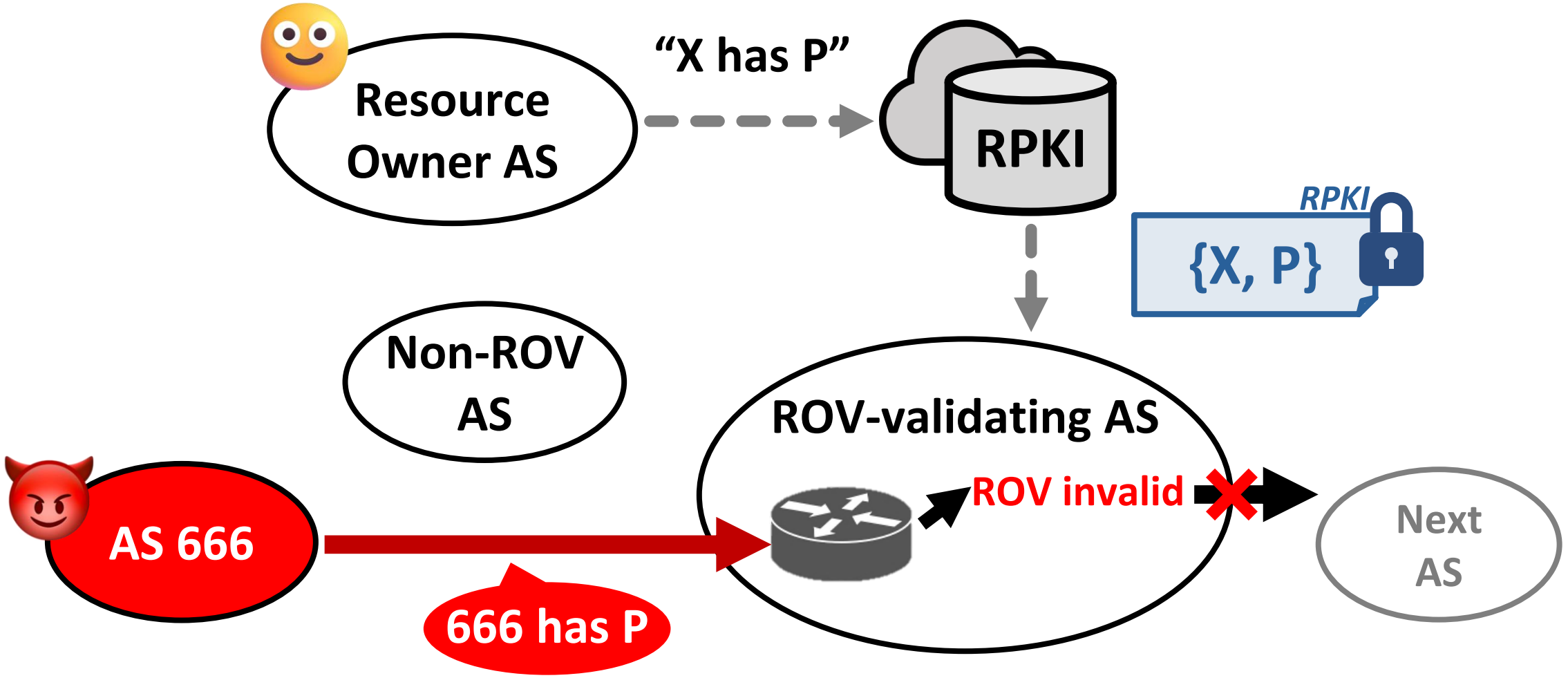

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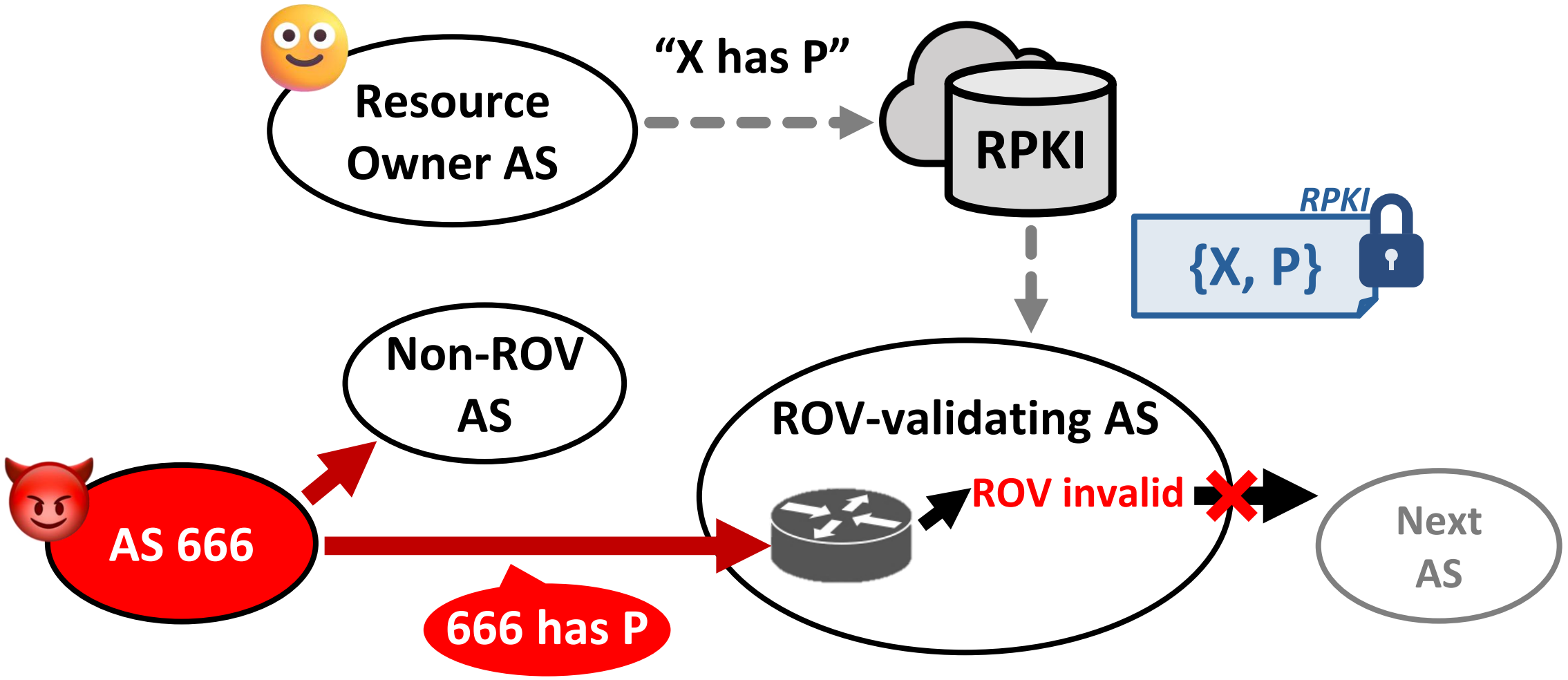

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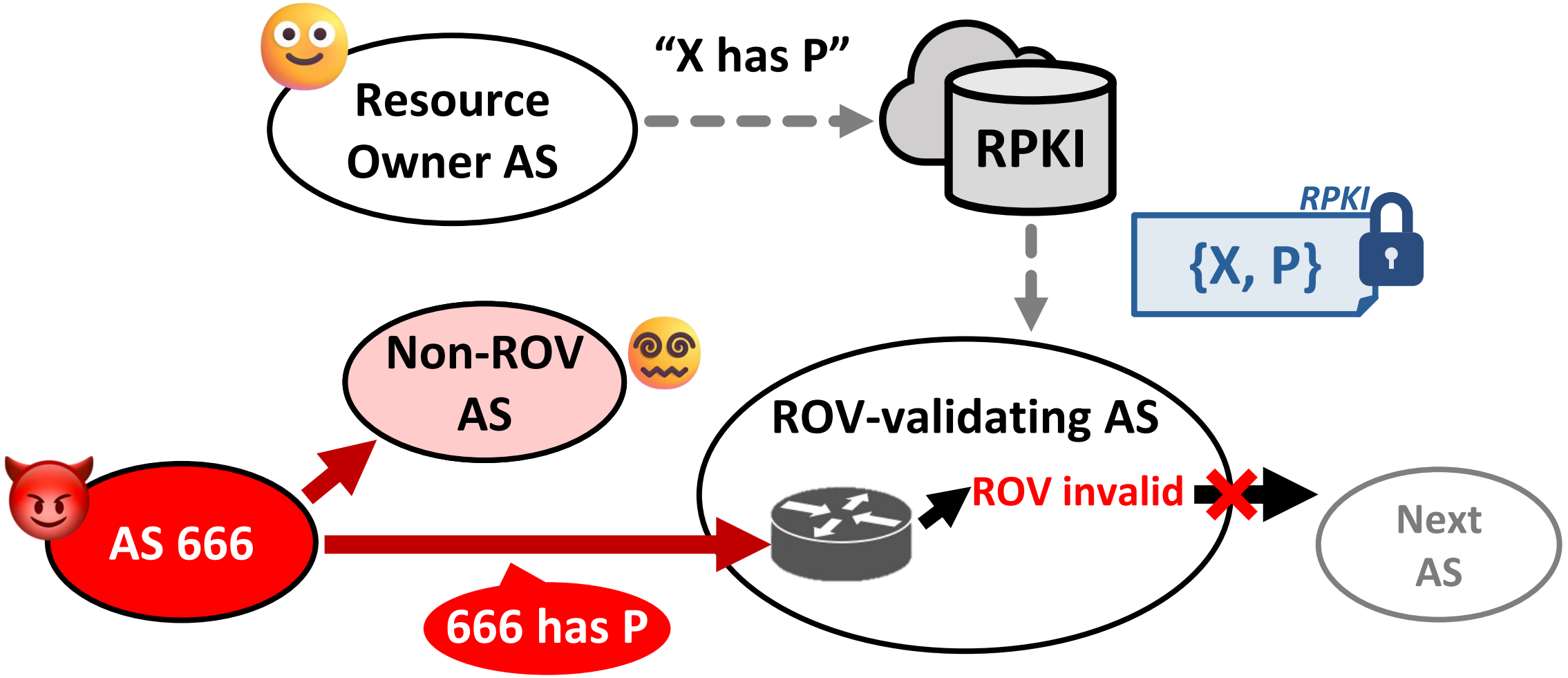

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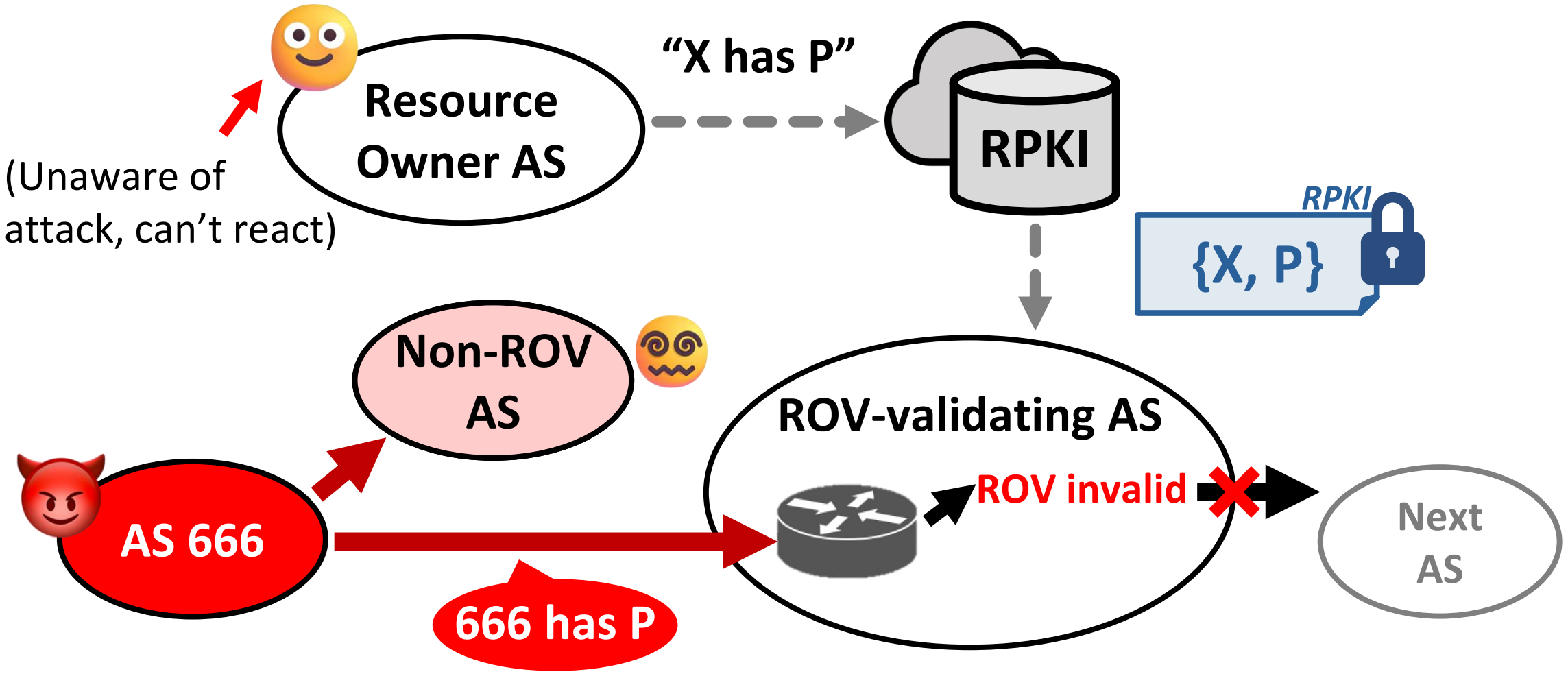

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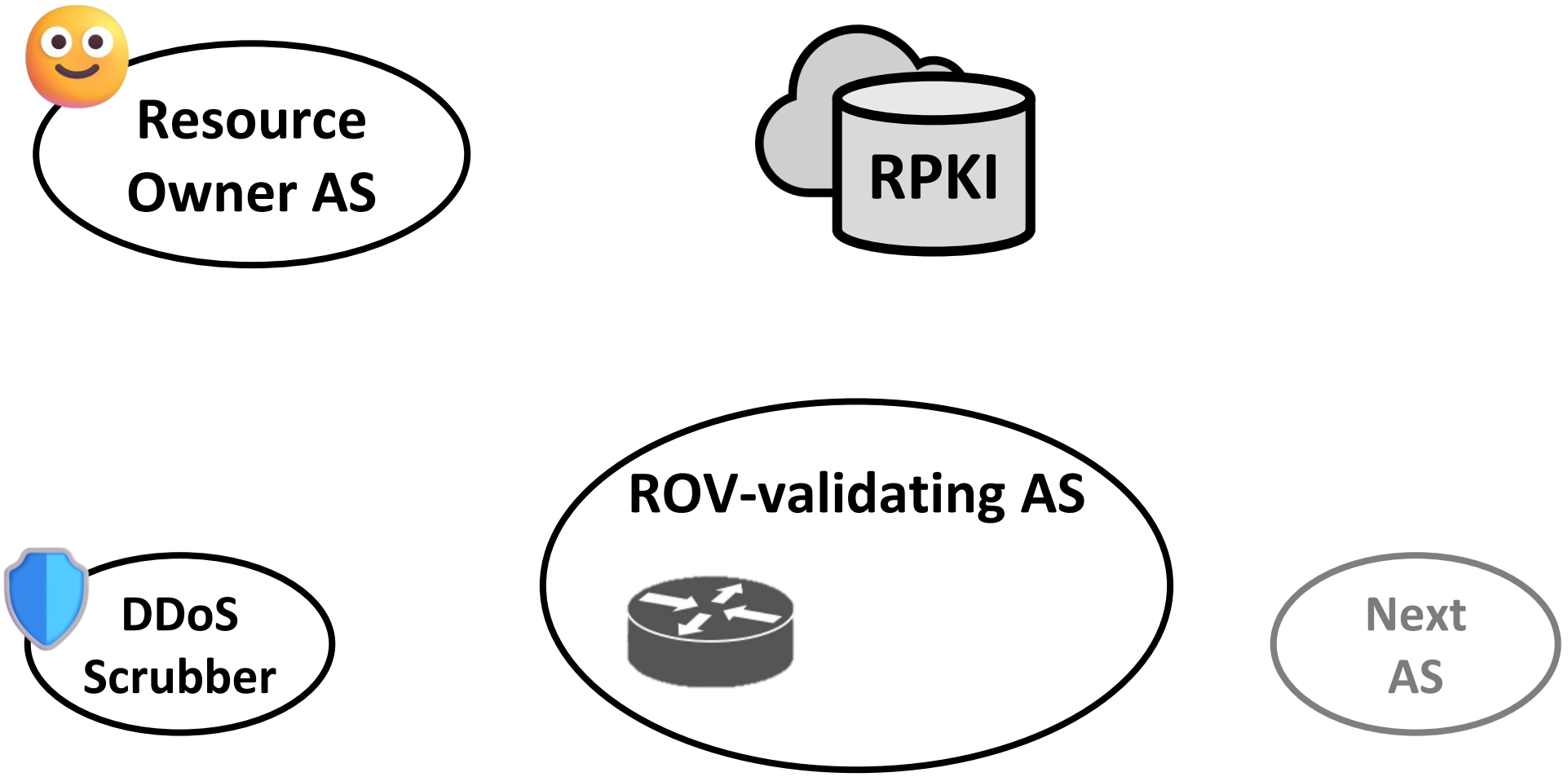

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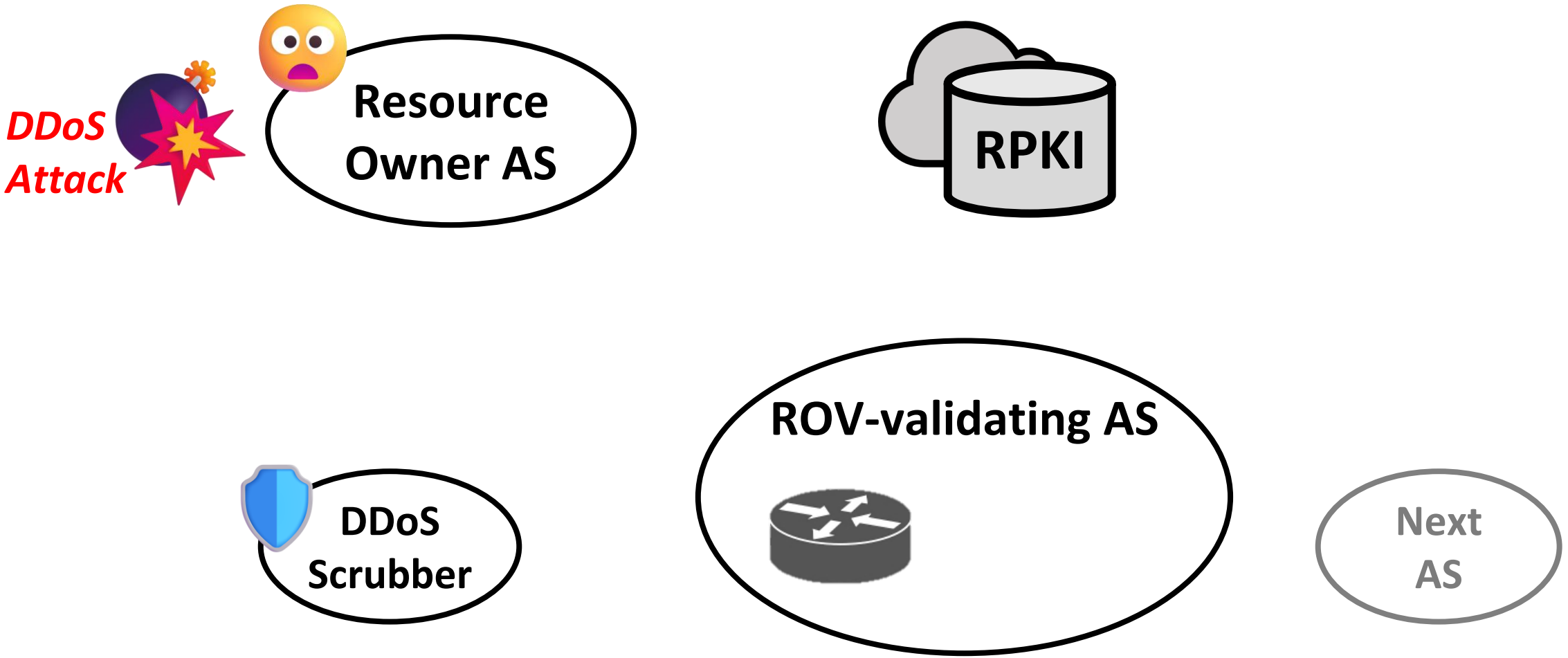

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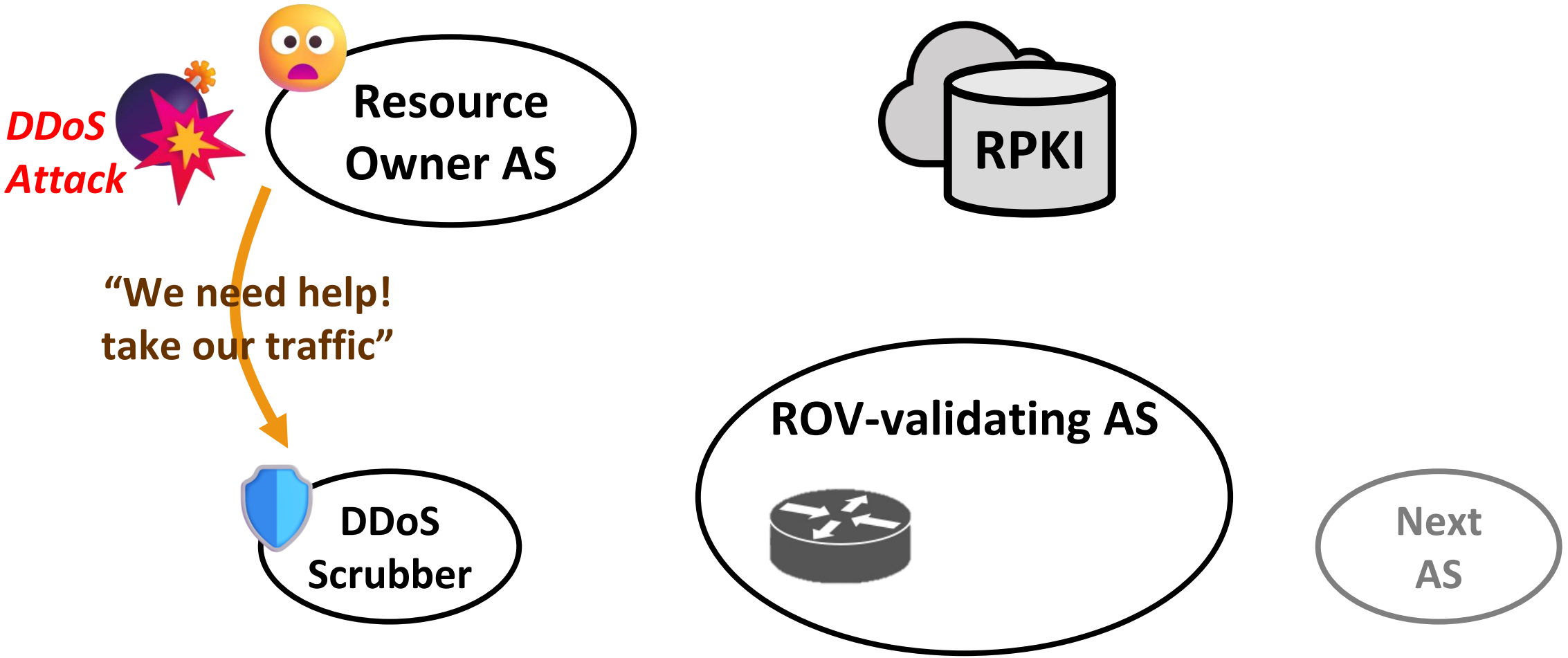

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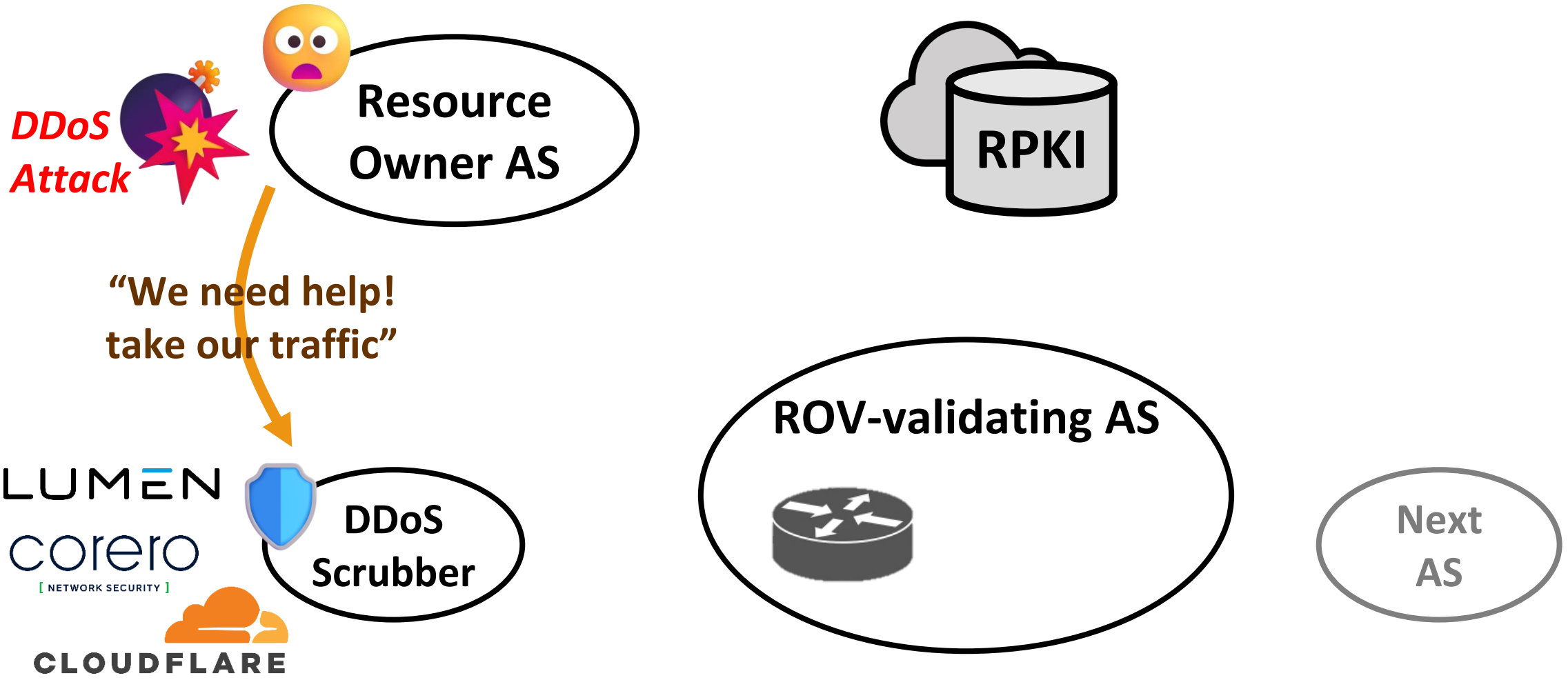

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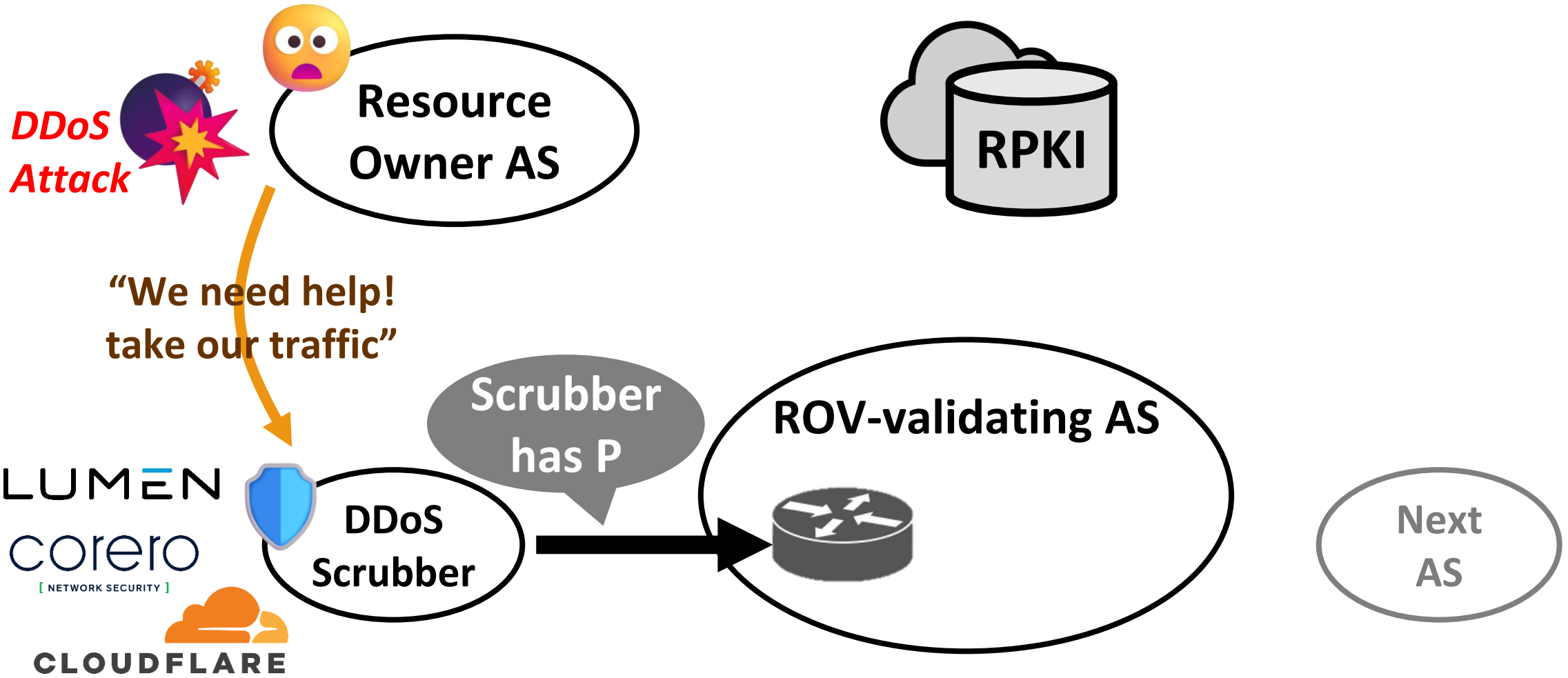

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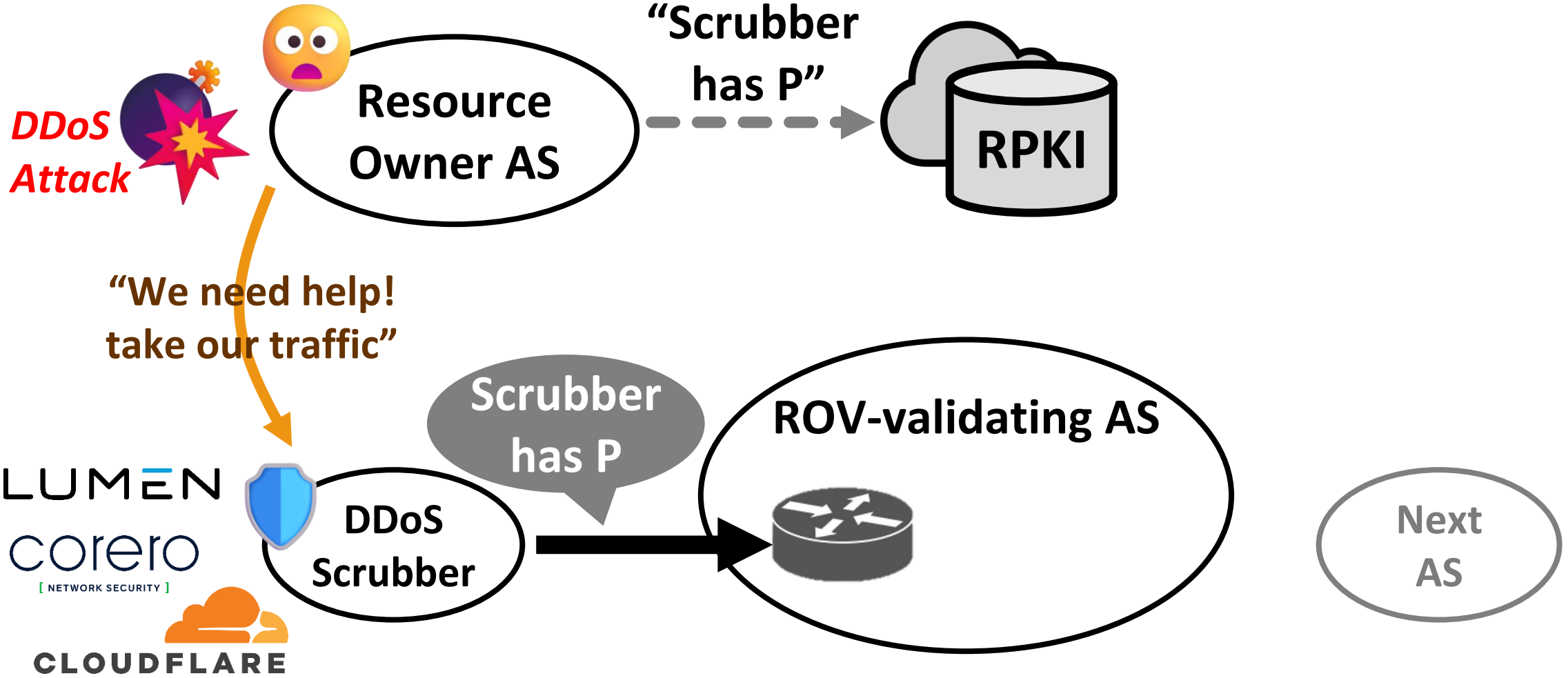

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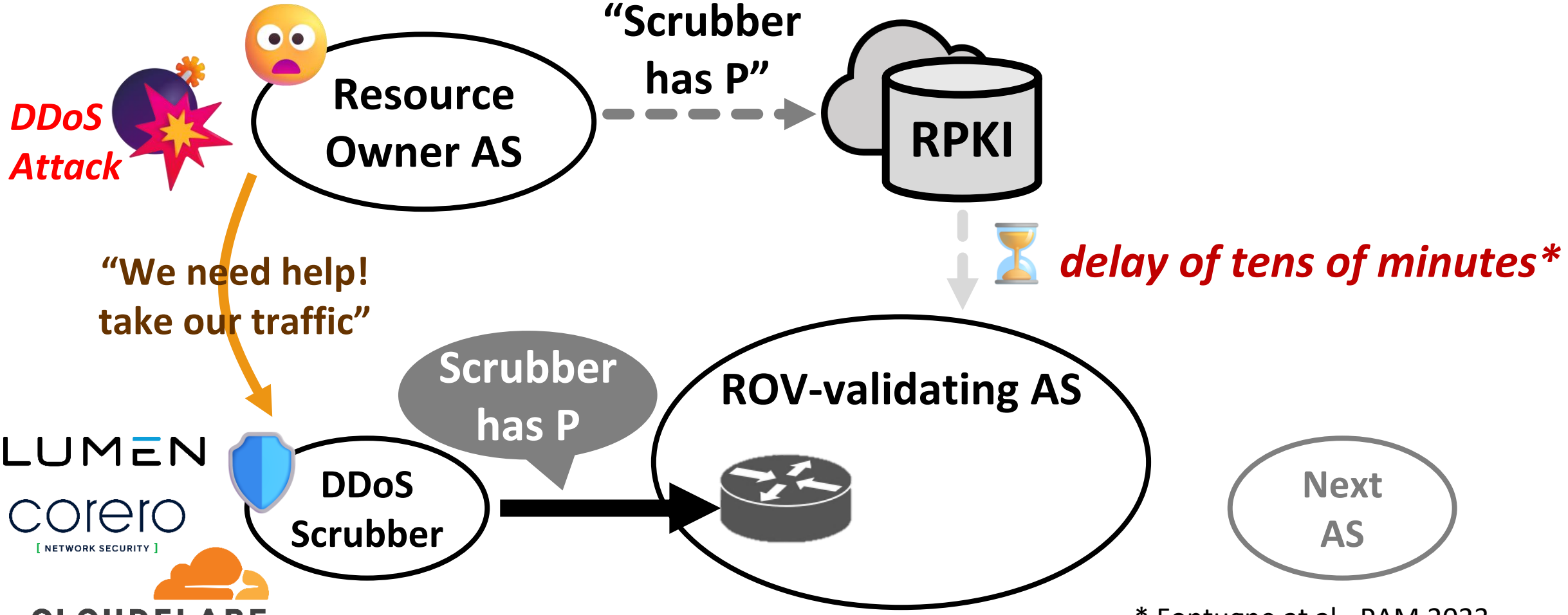

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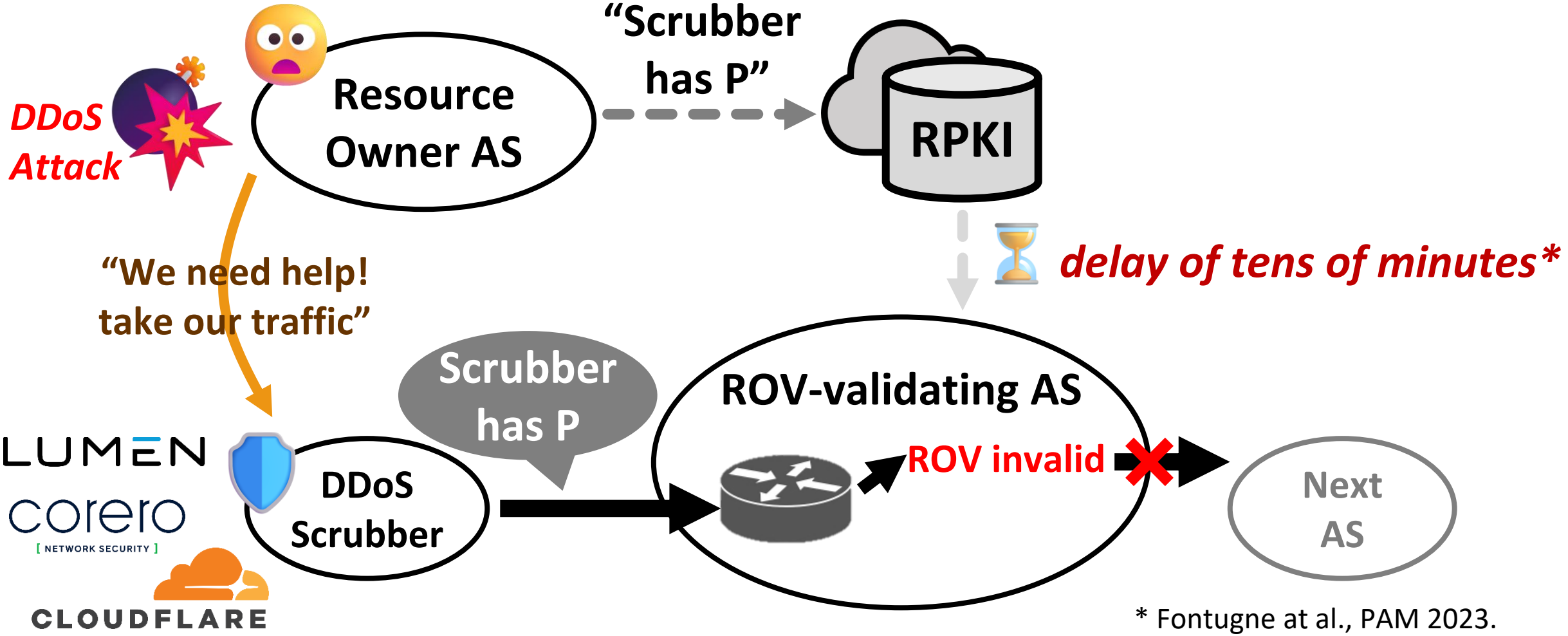

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RPKI and Cloud DDoS Protection

Cloud DDoS protection is a popular mitigation strategy for ensuring service continuity against volumetric DDoS attacks that risk bandwidth or resource saturation. This is most commonly accomplished by using BGP advertisements to redirect traffic through the cloud DDoS provider either on-demand or at all times.

As RPKI Validation becomes more common, it's important to understand the implications of using a BGP-based cloud DDoS solution.

Most of these cloud DDoS services will include guidance or requirements for RPKI ROAs. This is important, as incorrect or misconfigured ROAs can at least reduce the efficacy of the cloud DDoS protection, or at worst cause actual harm to normal traffic.

https://www.corero.com/rpki-and-cloud-ddos-protection/

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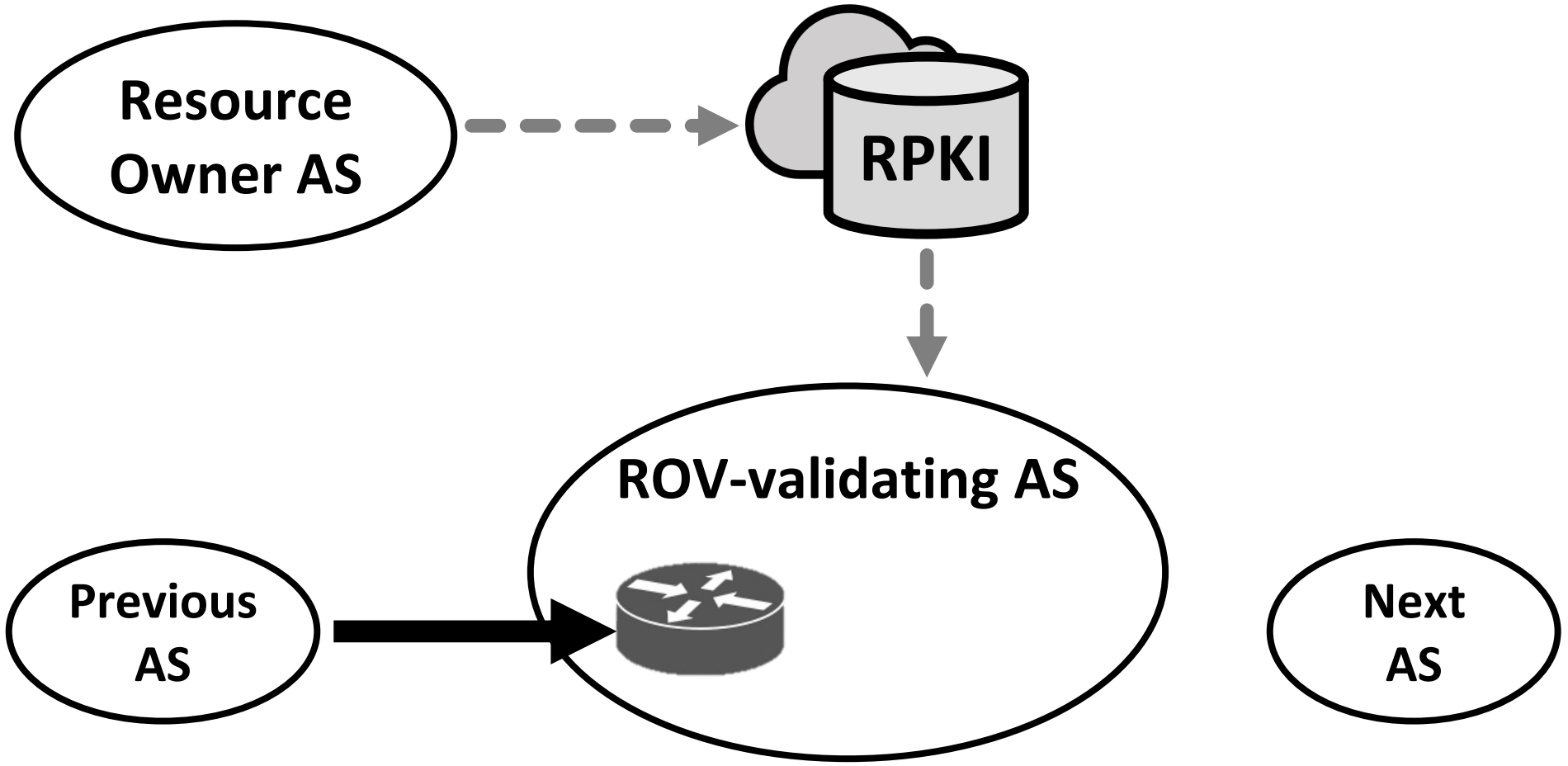
To address these challenges, we introduce:



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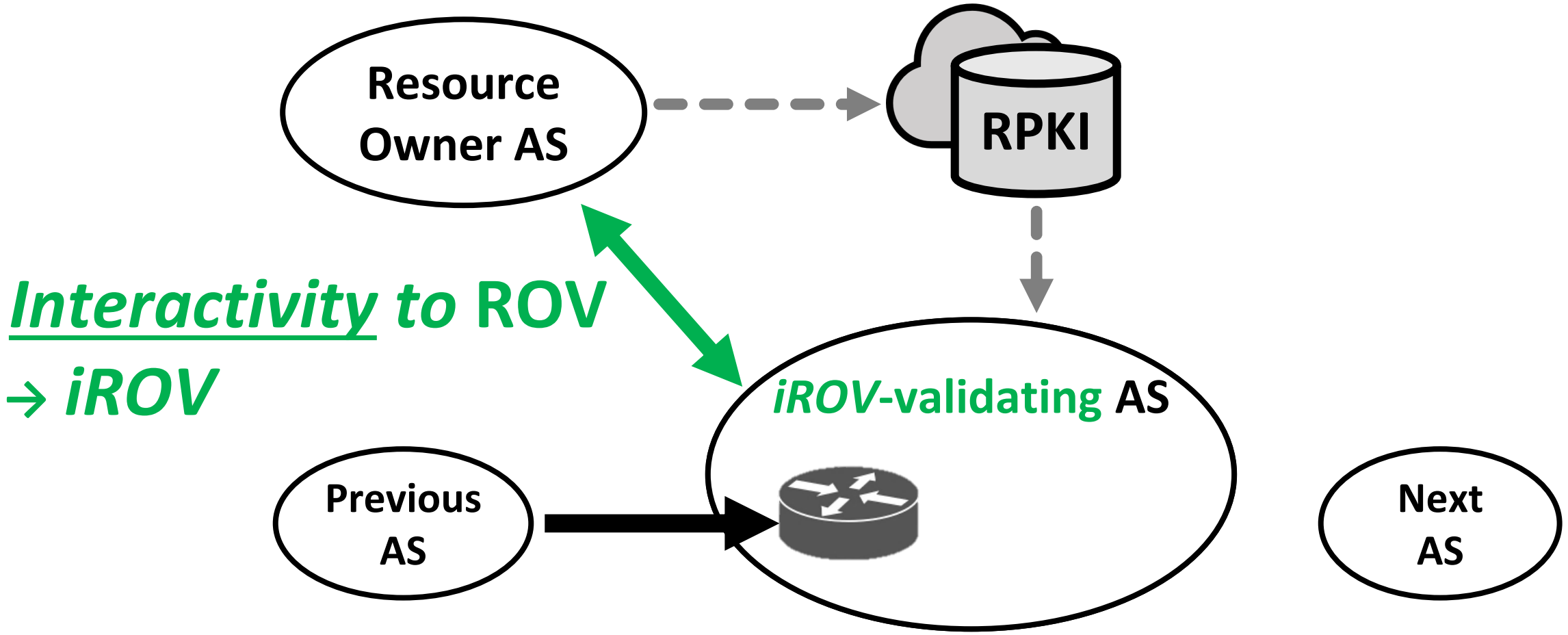

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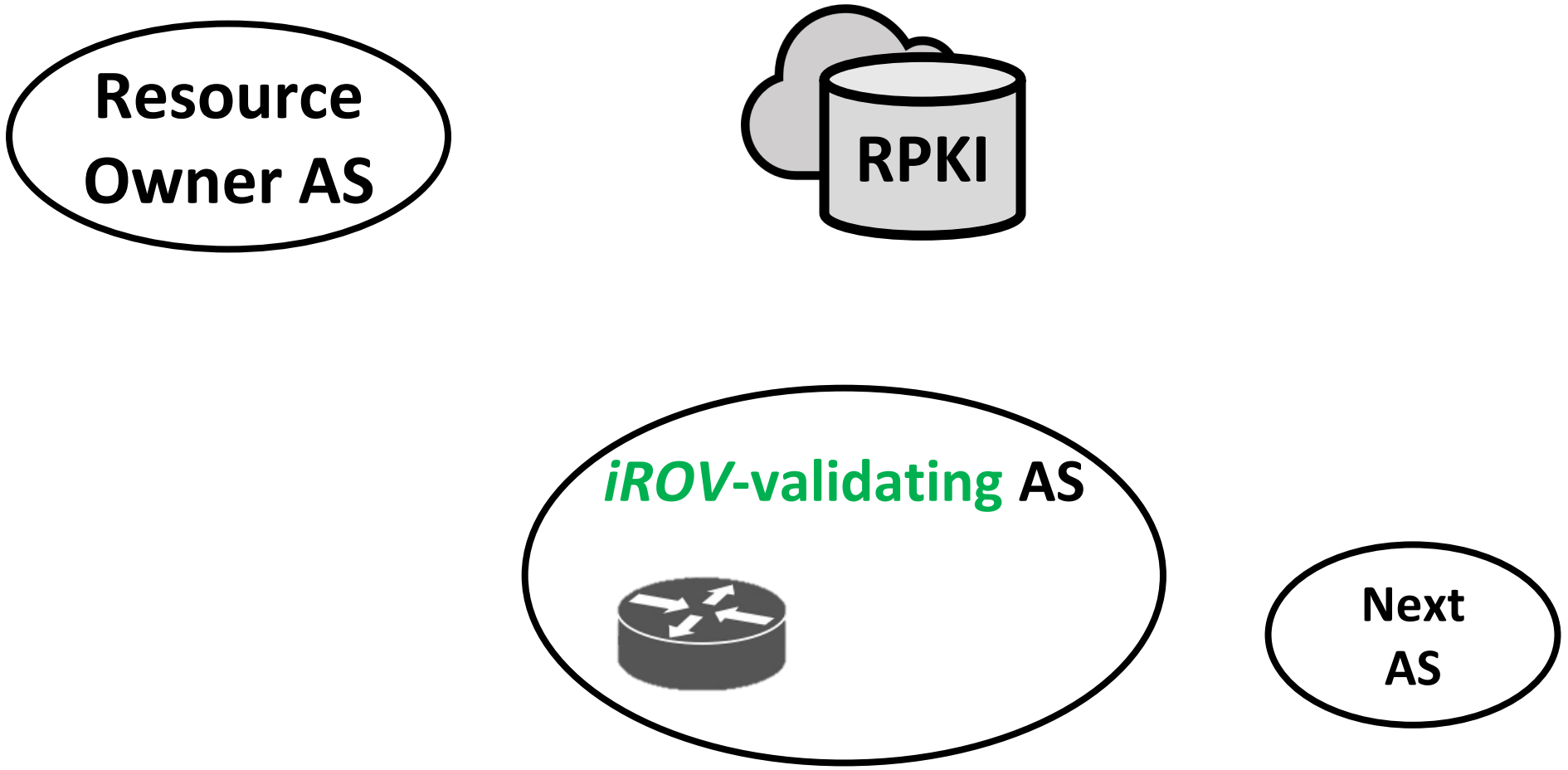

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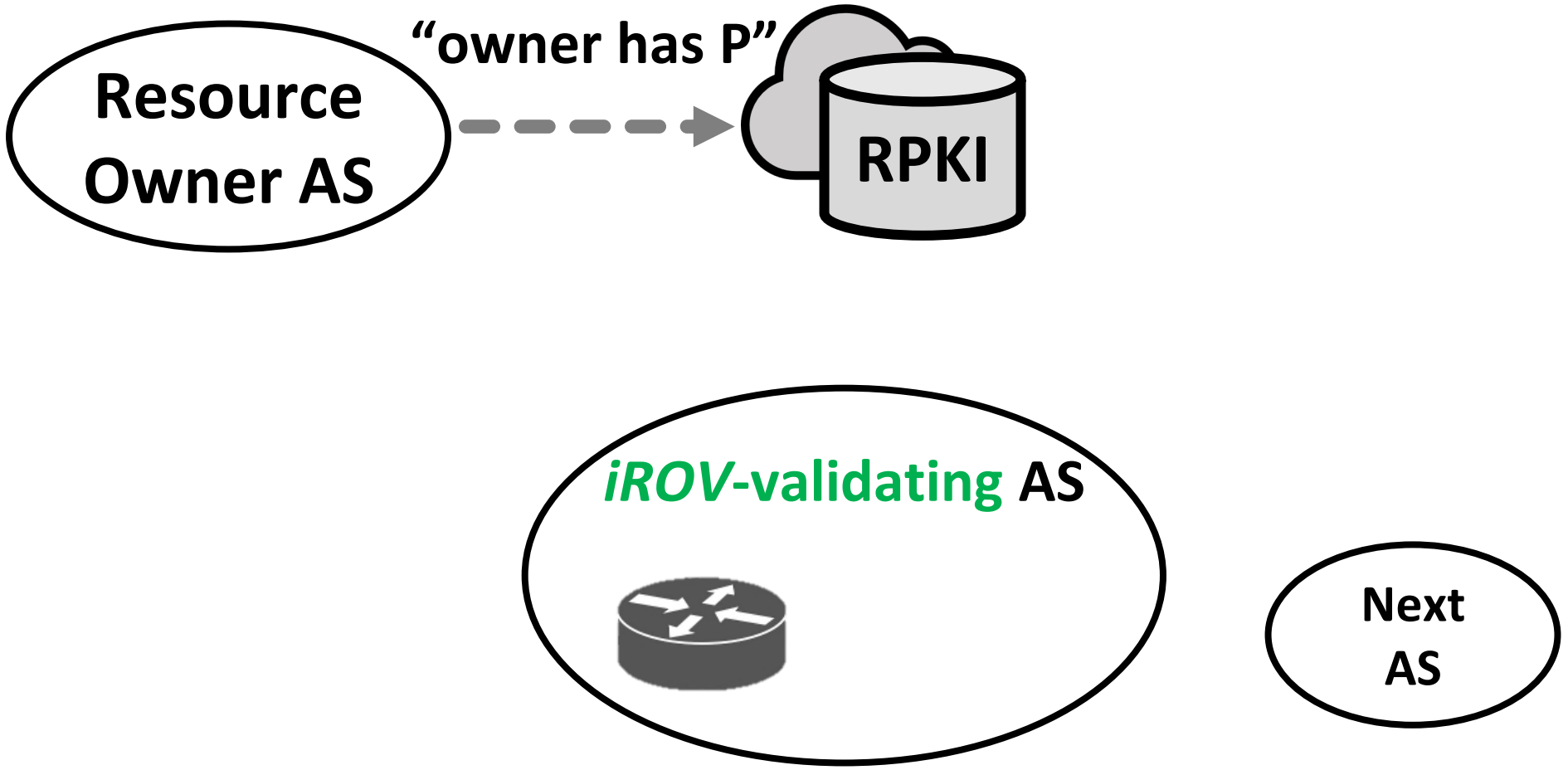

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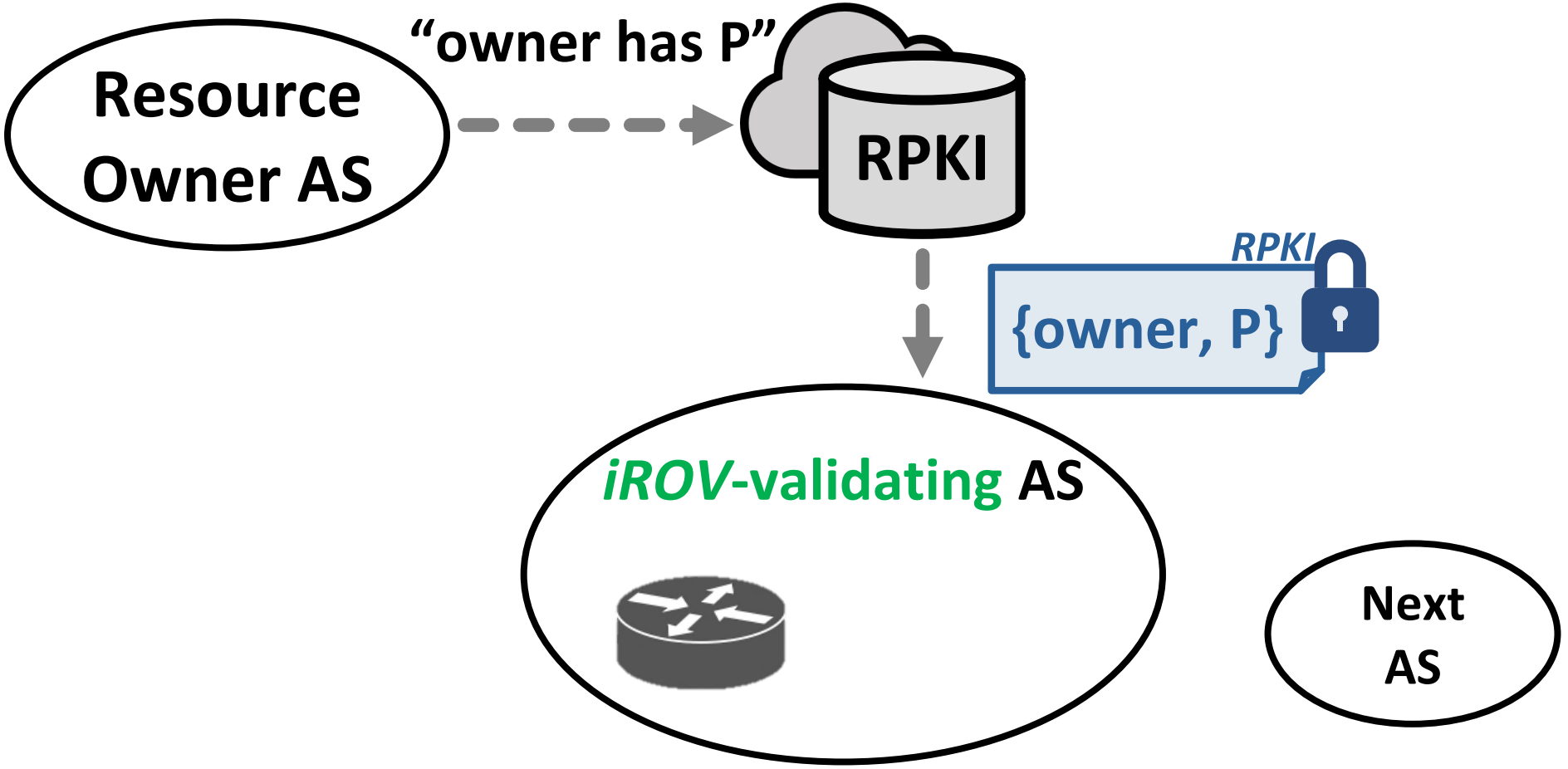

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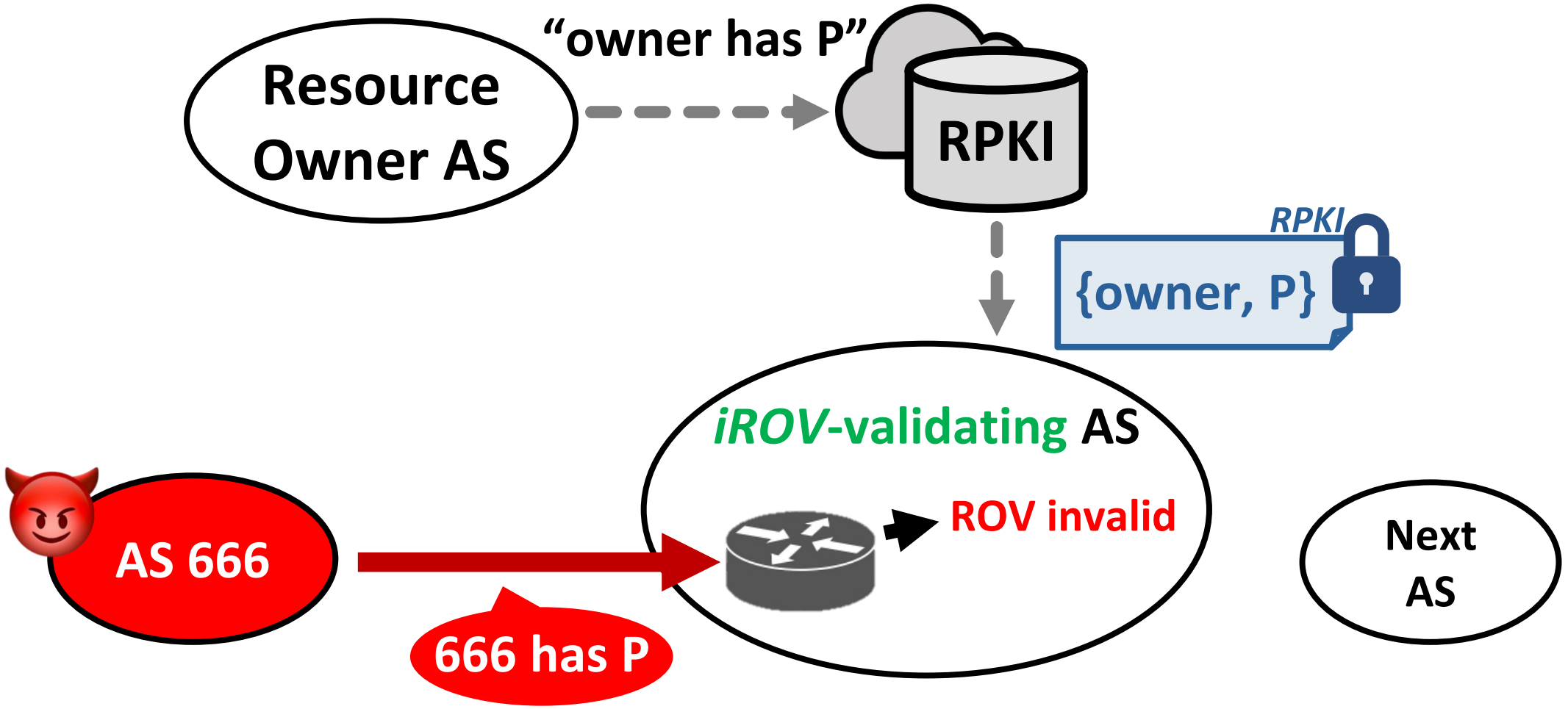

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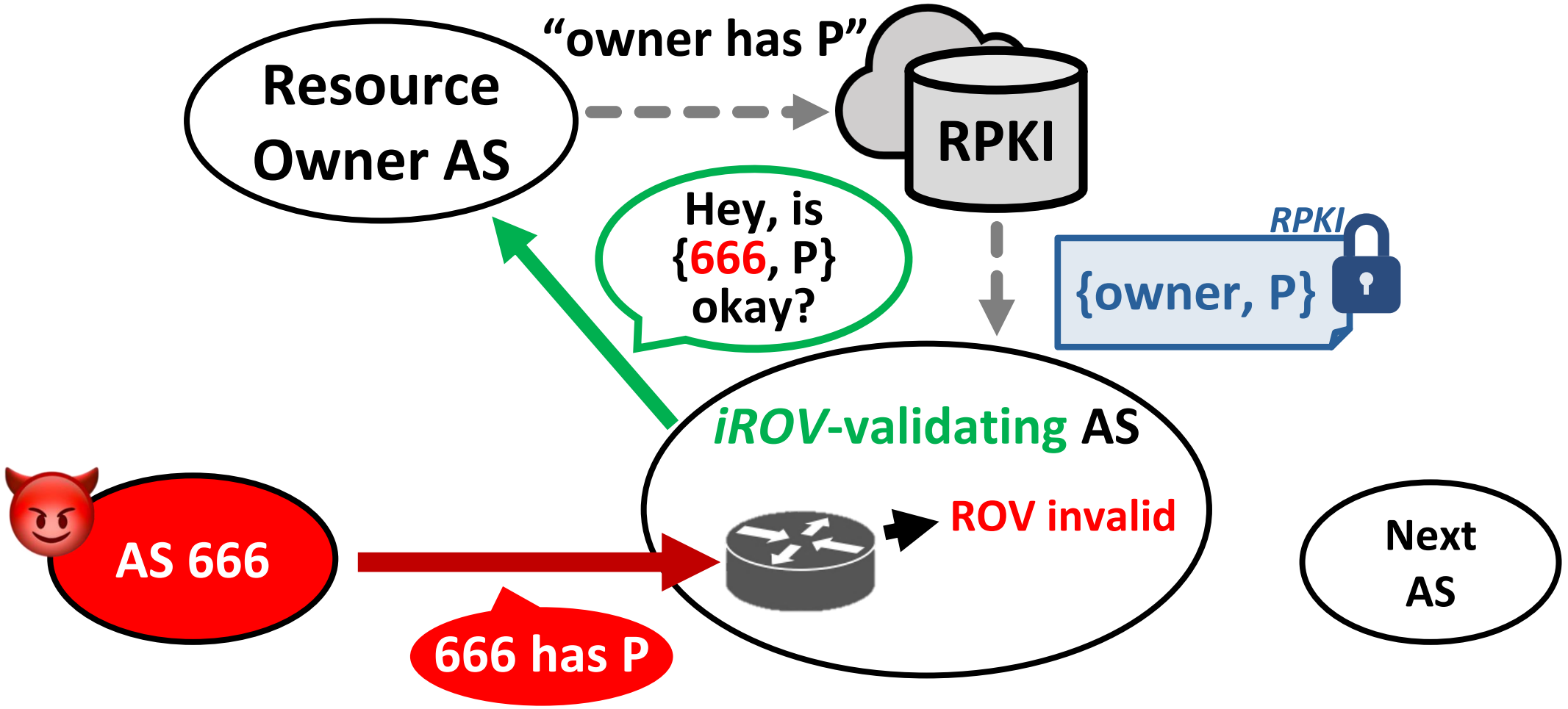

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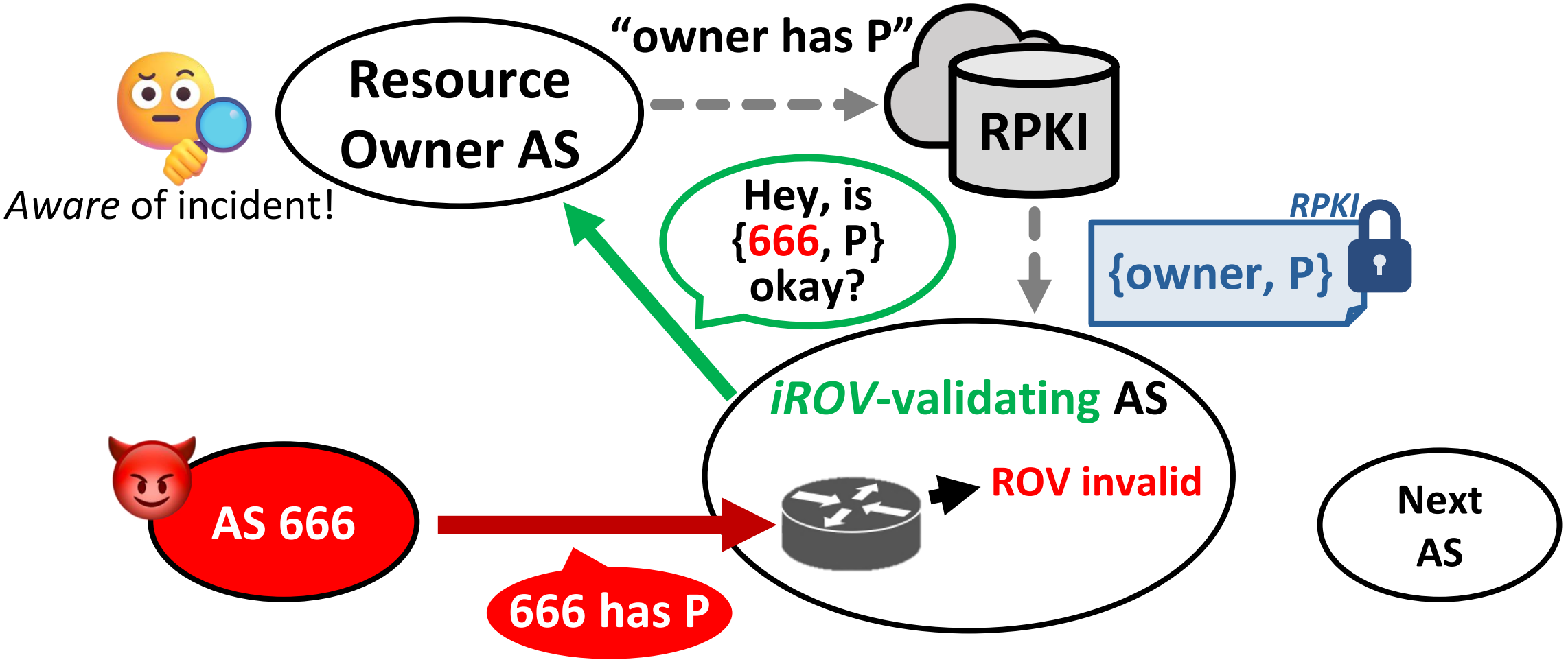

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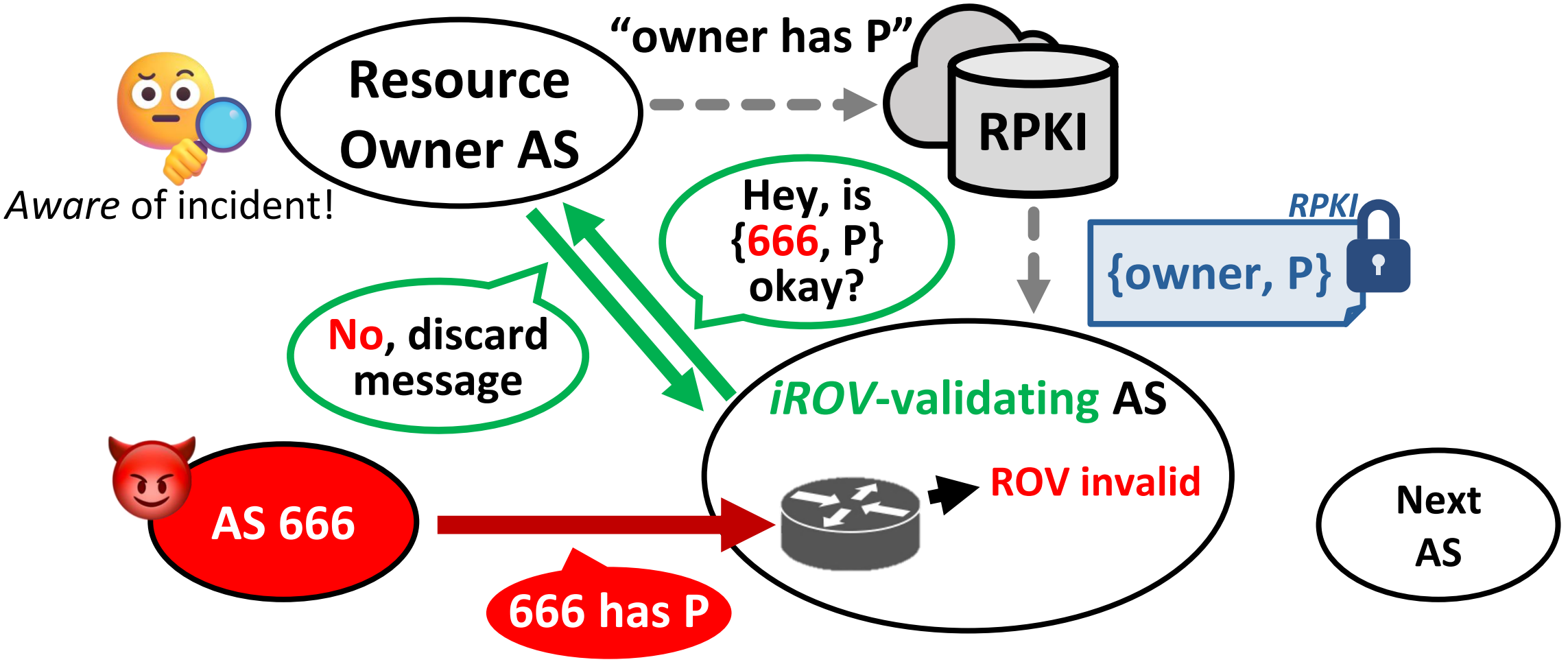

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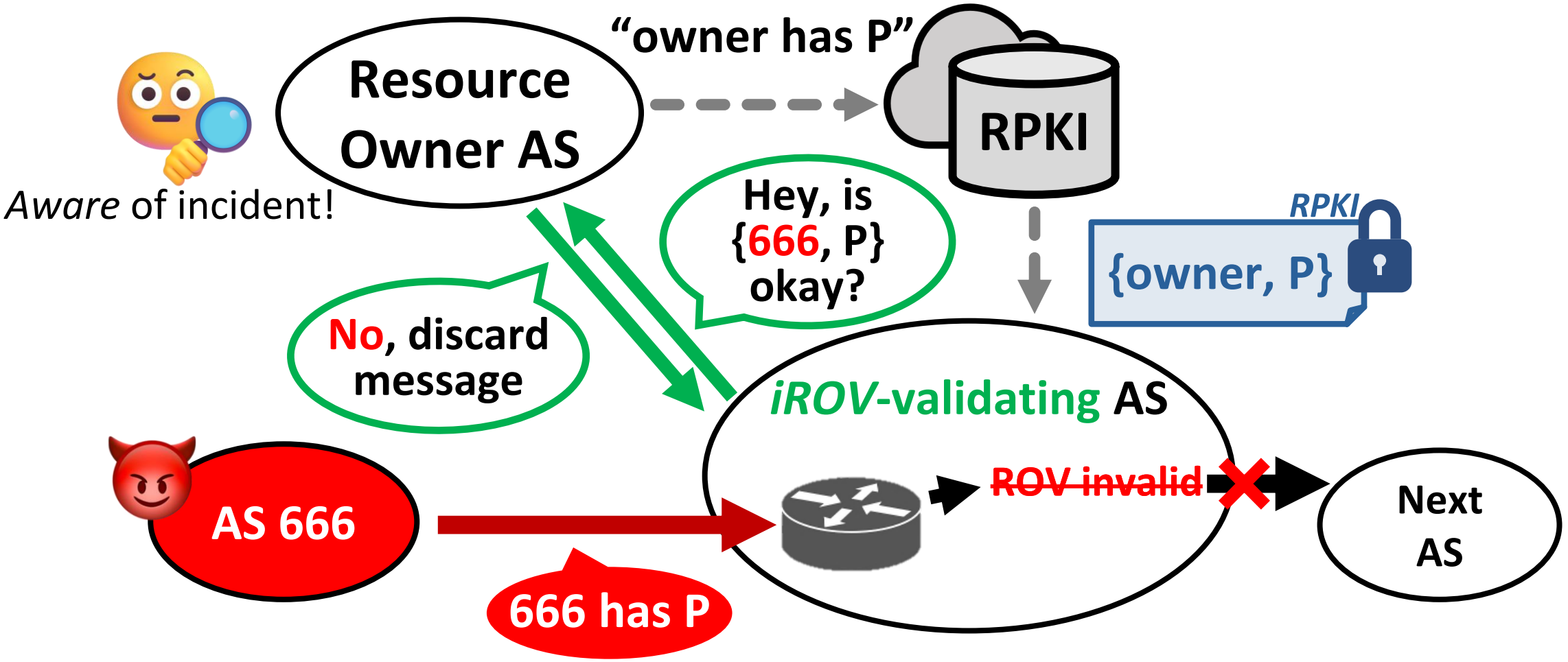
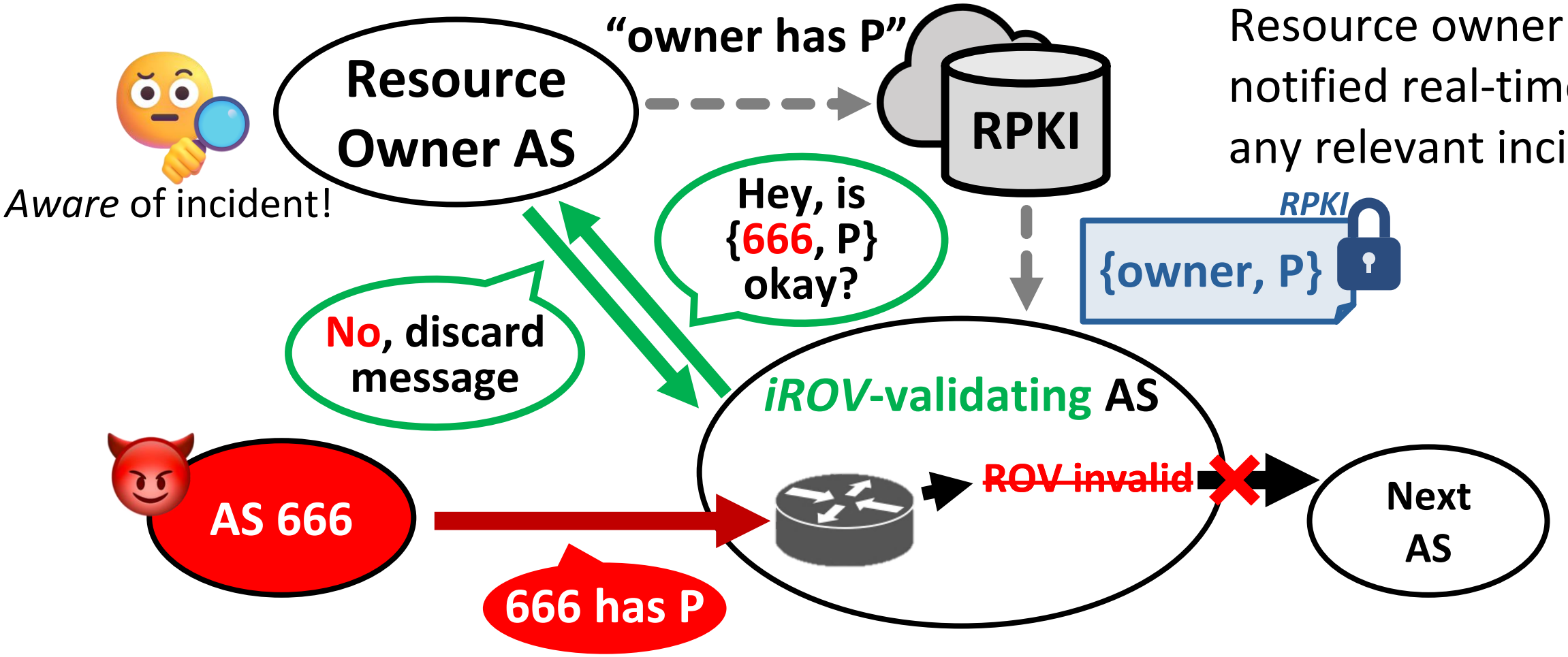


How *Interactivity* addresses **C1** and **C2**

iROV gives visibility:

Resource owner is notified real-time of any relevant incidents



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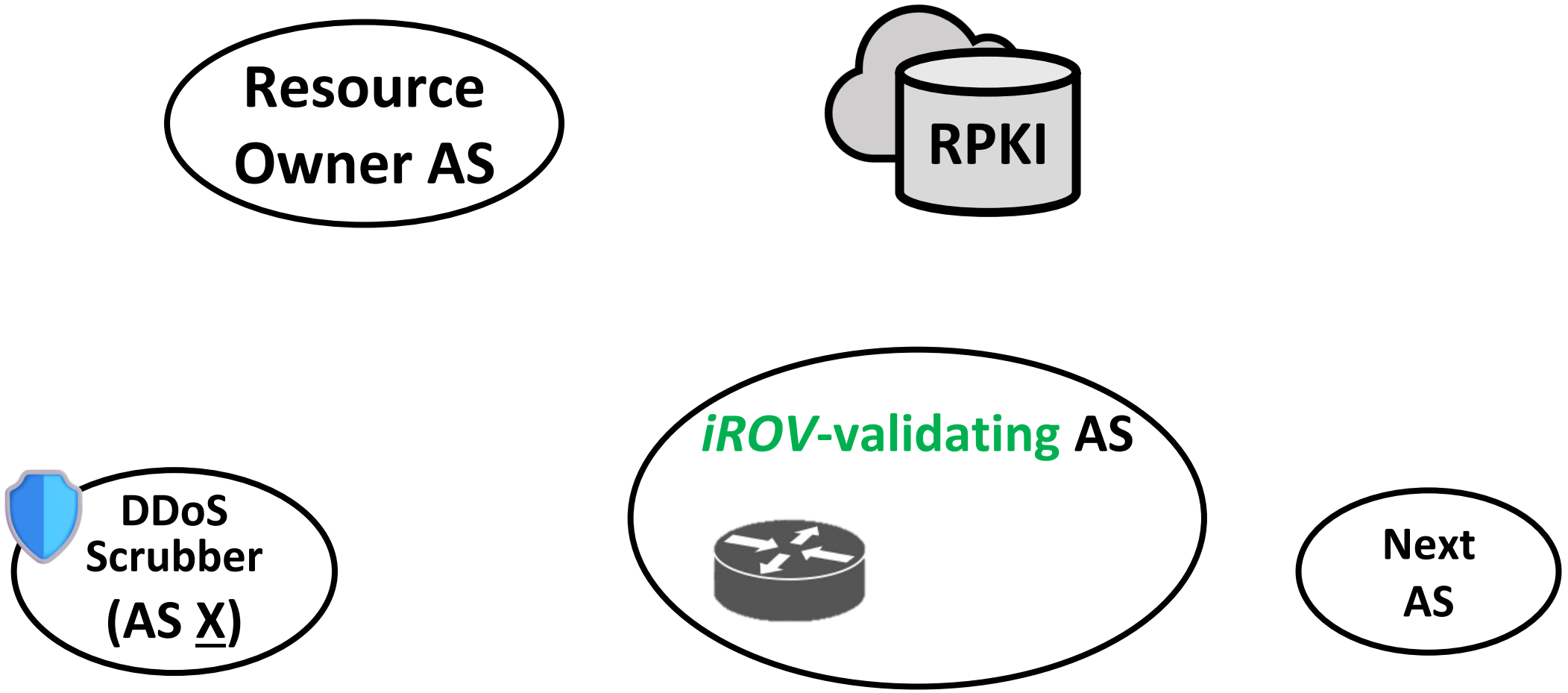

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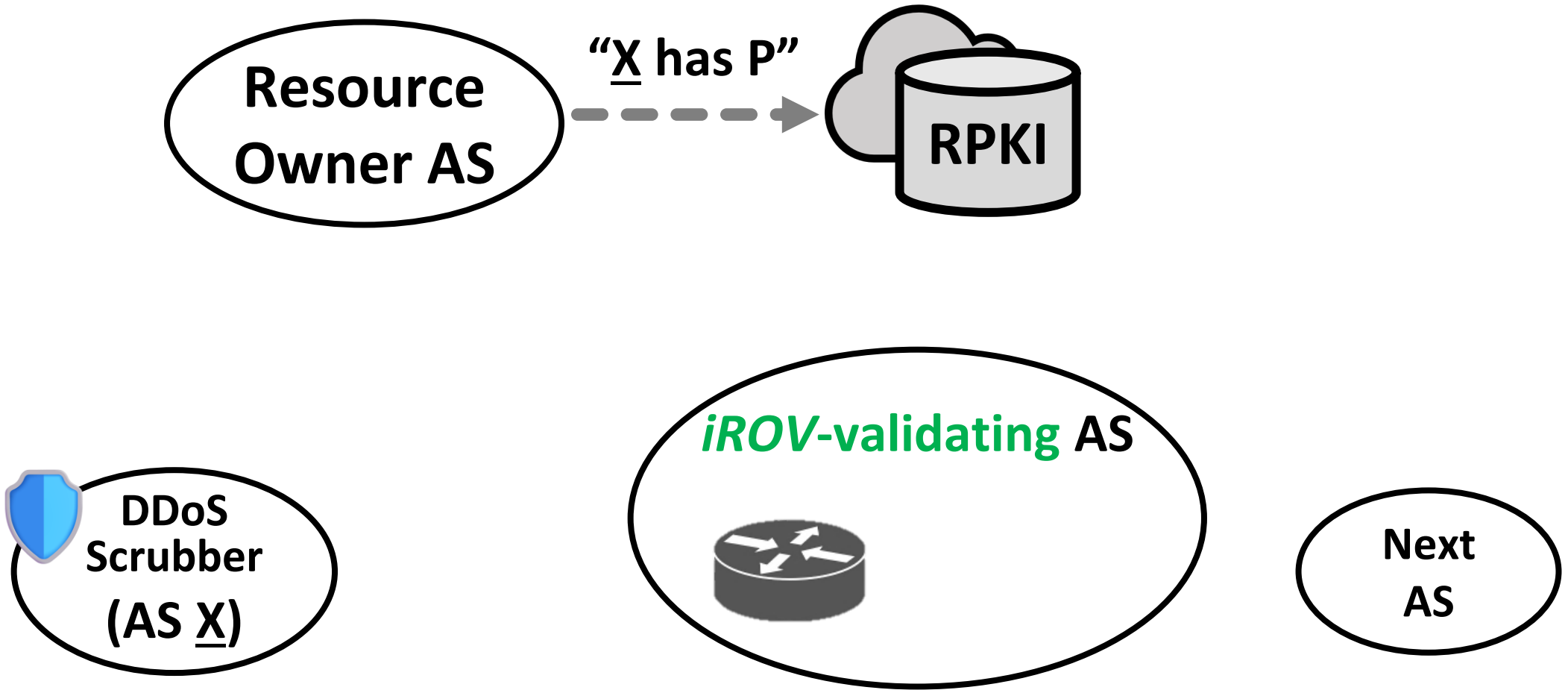

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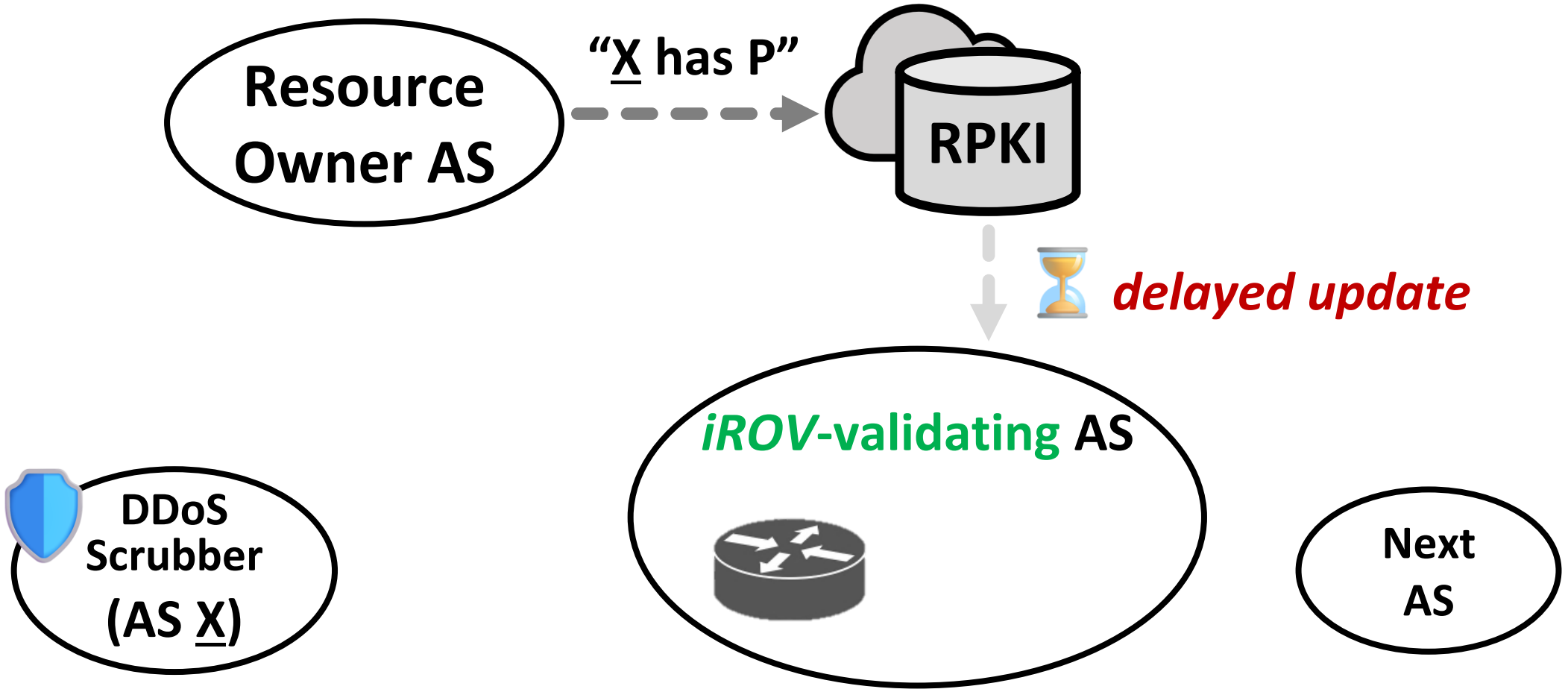

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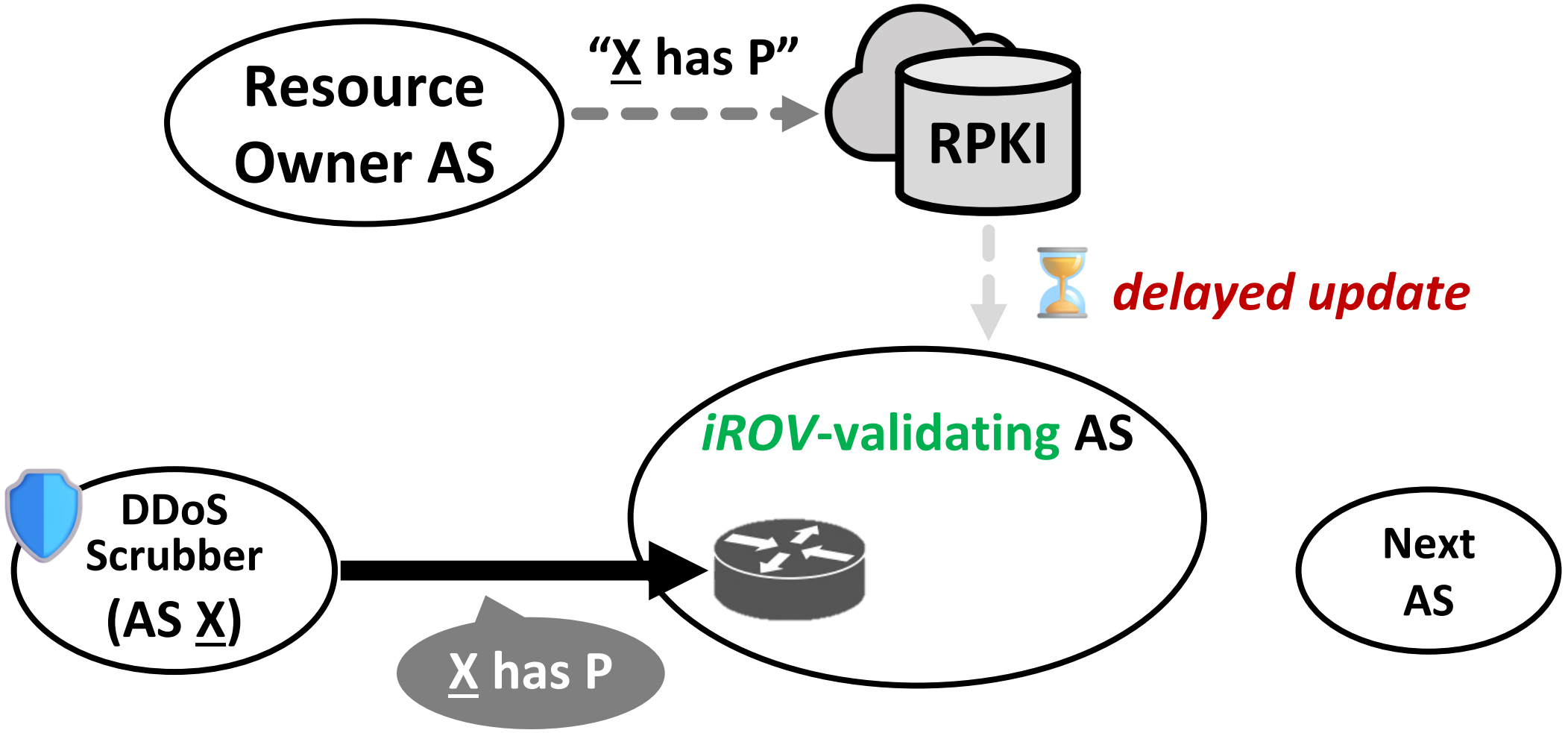

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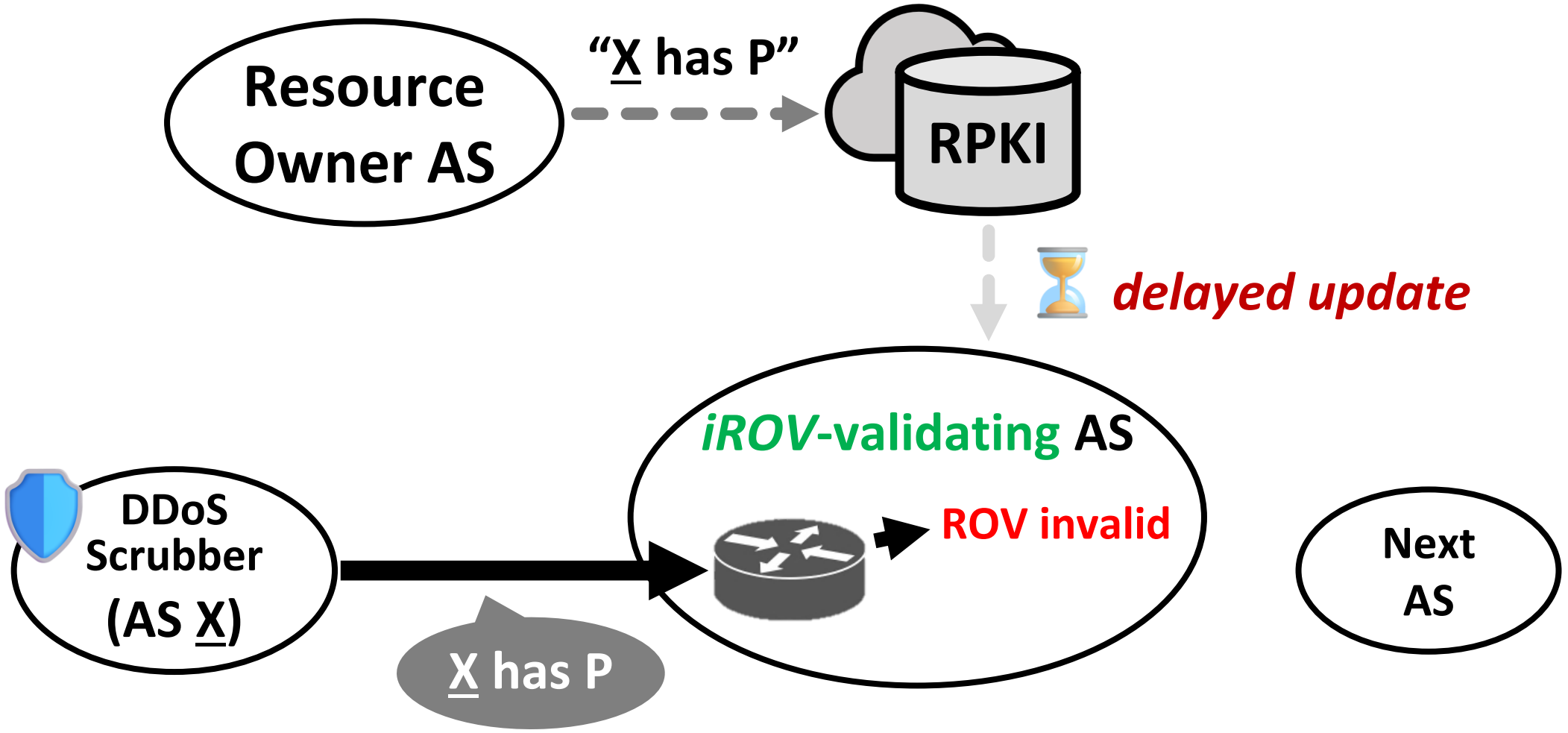

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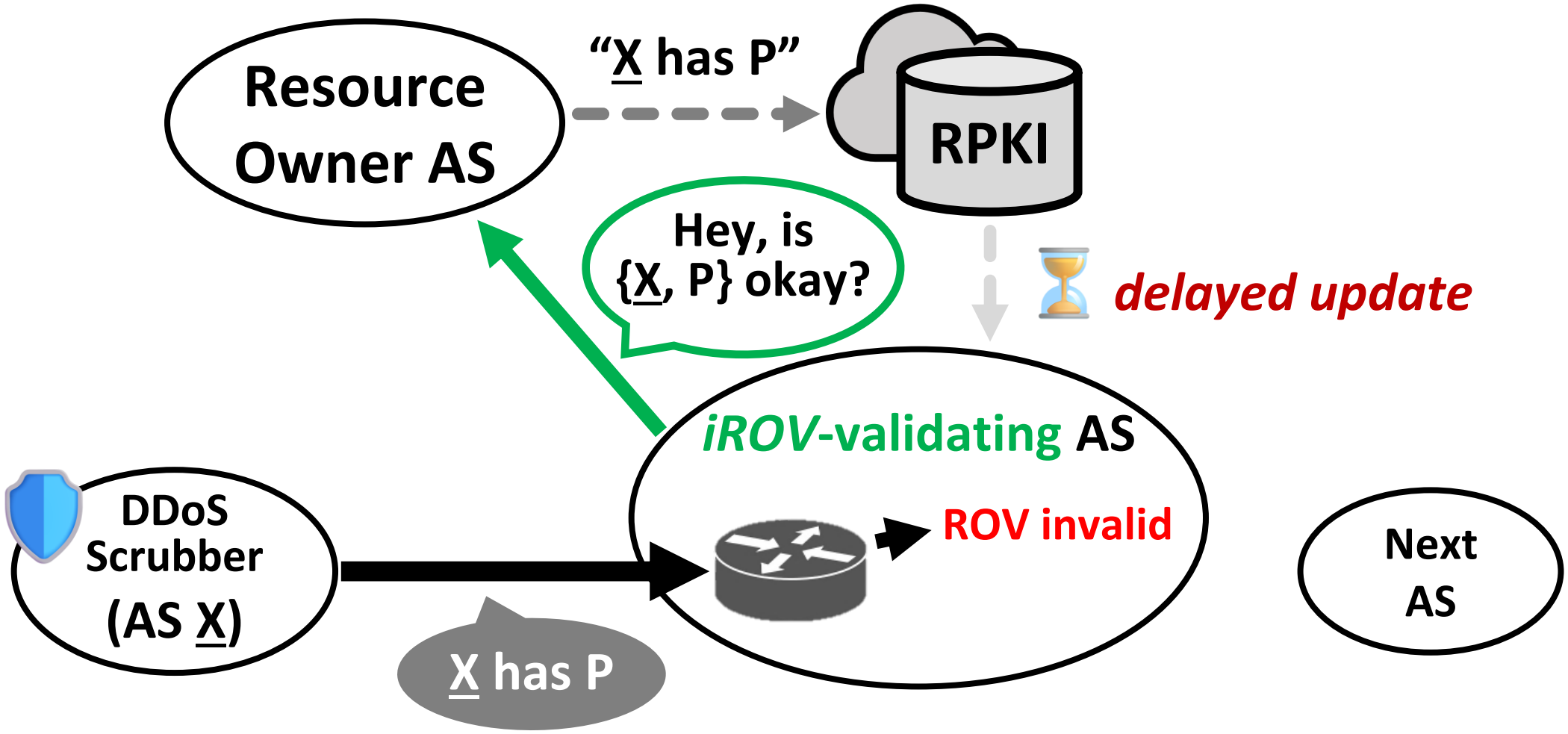

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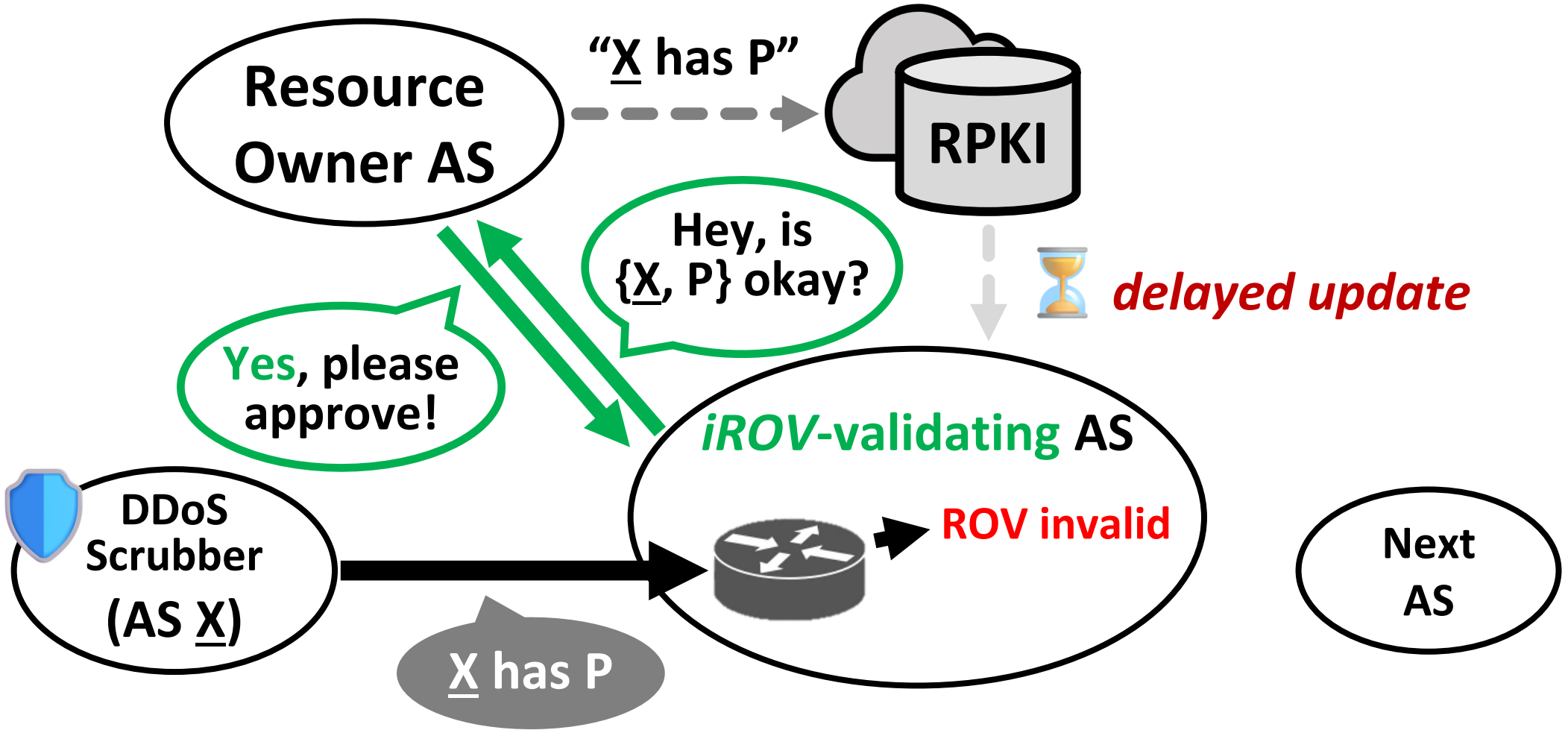

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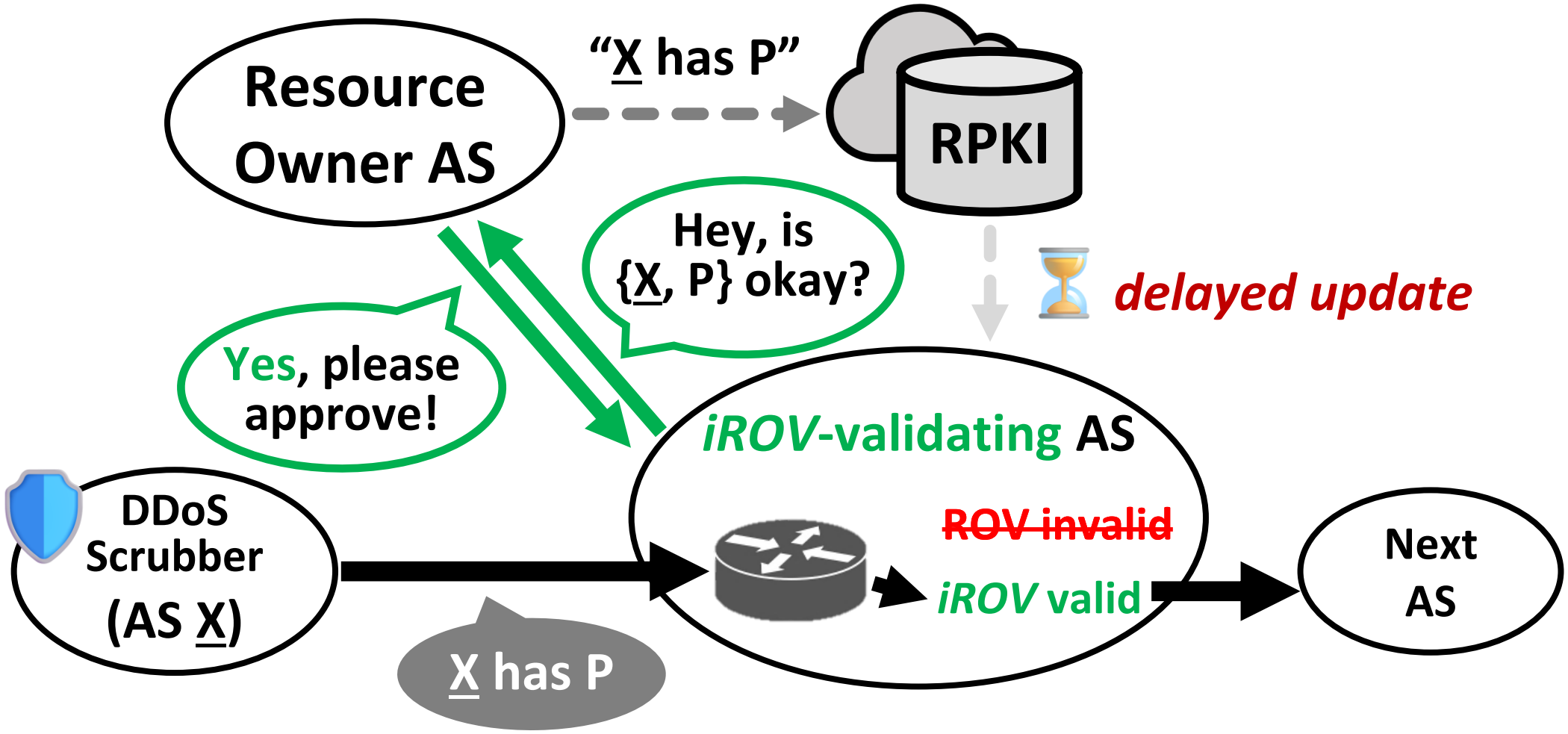

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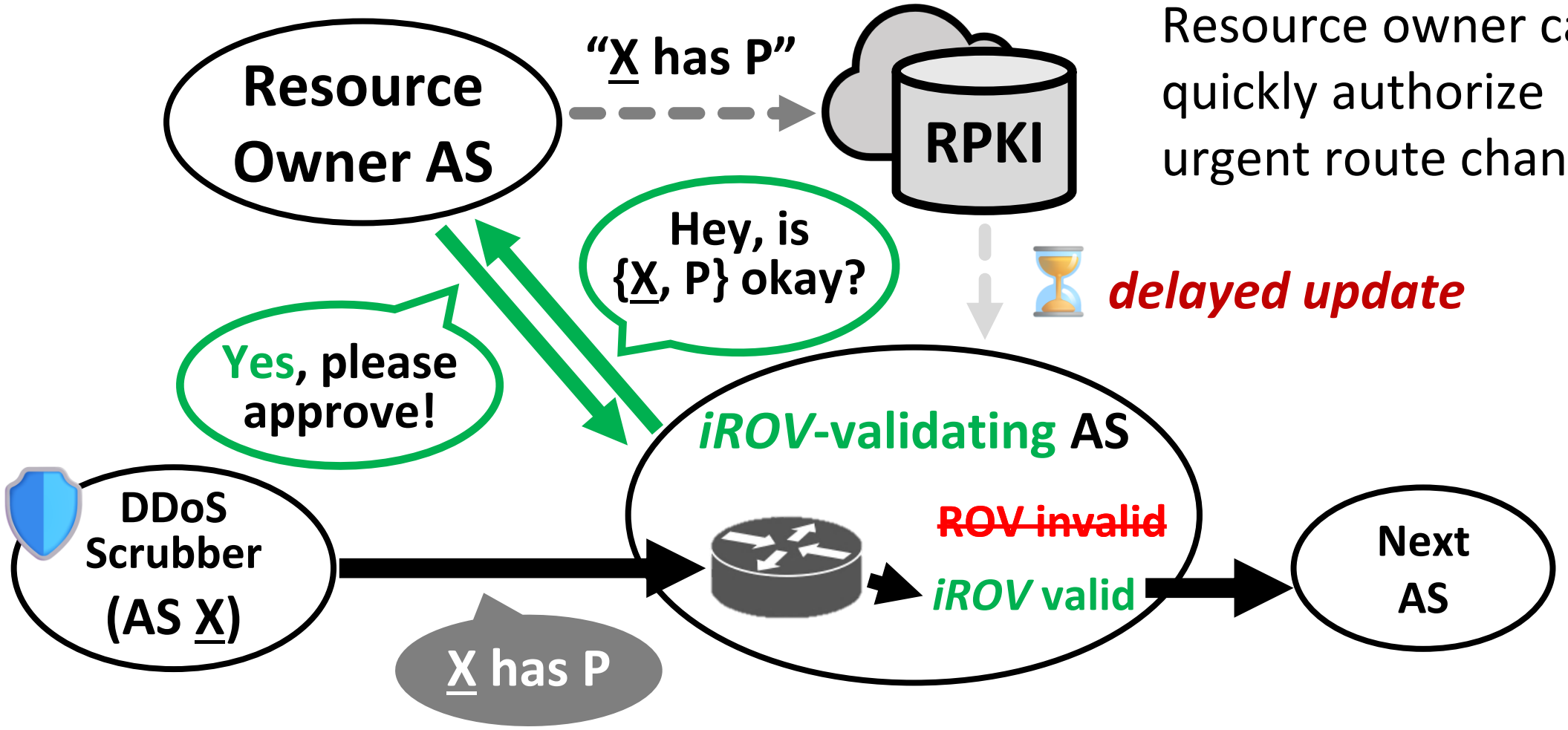
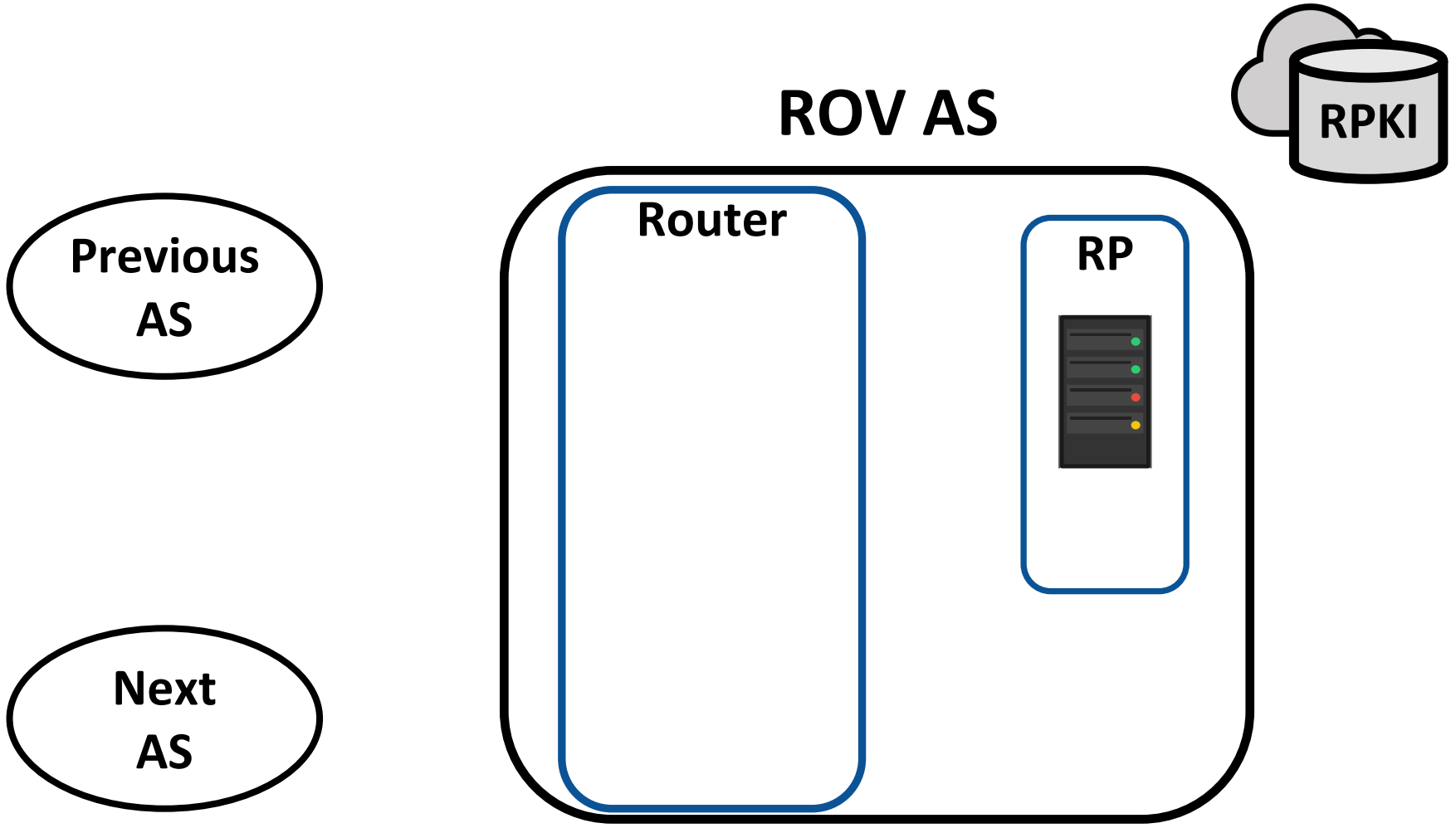


iROV gives agility:

Resource owner can quickly authorize urgent route changes

iROV Overview



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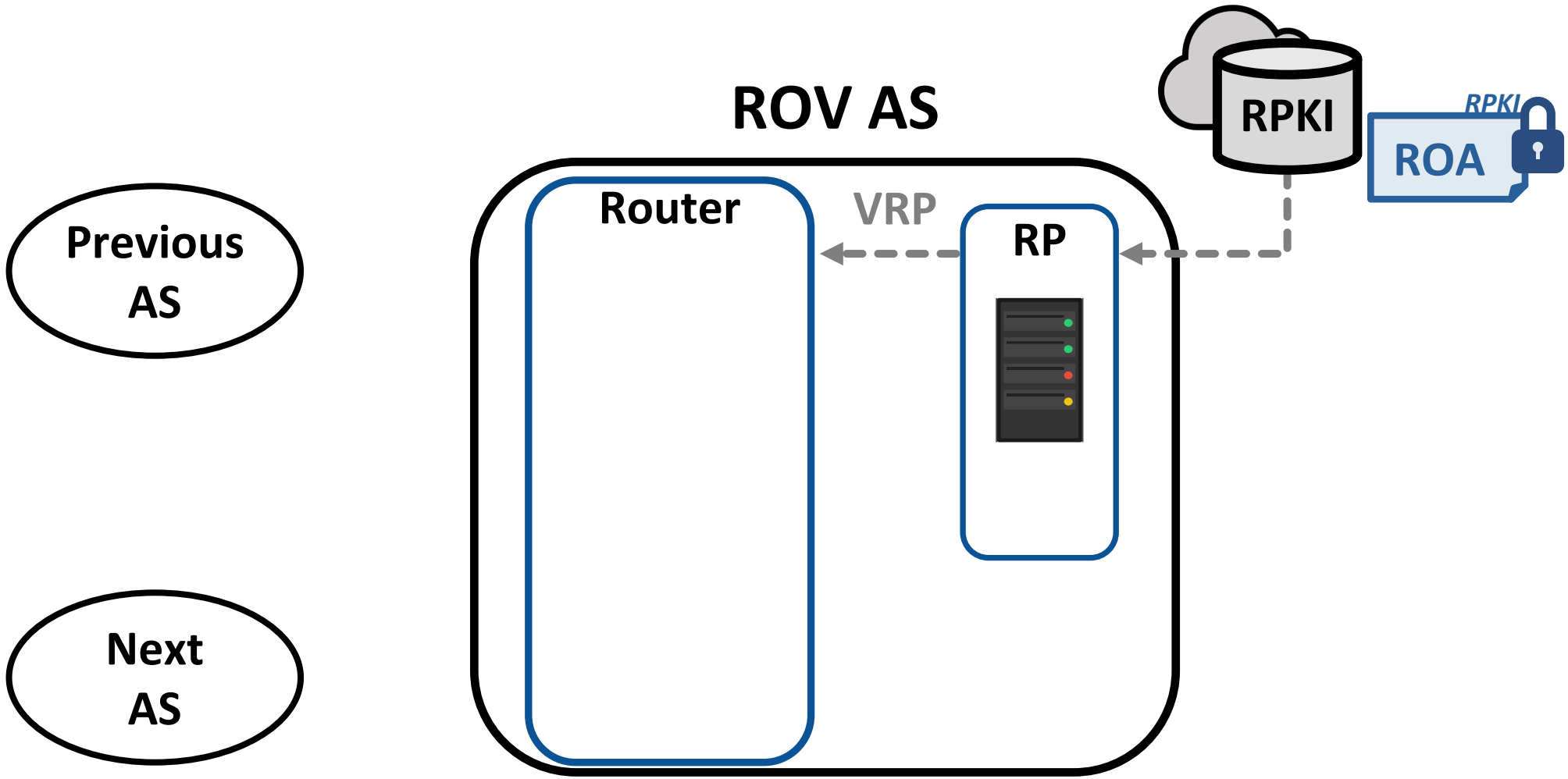

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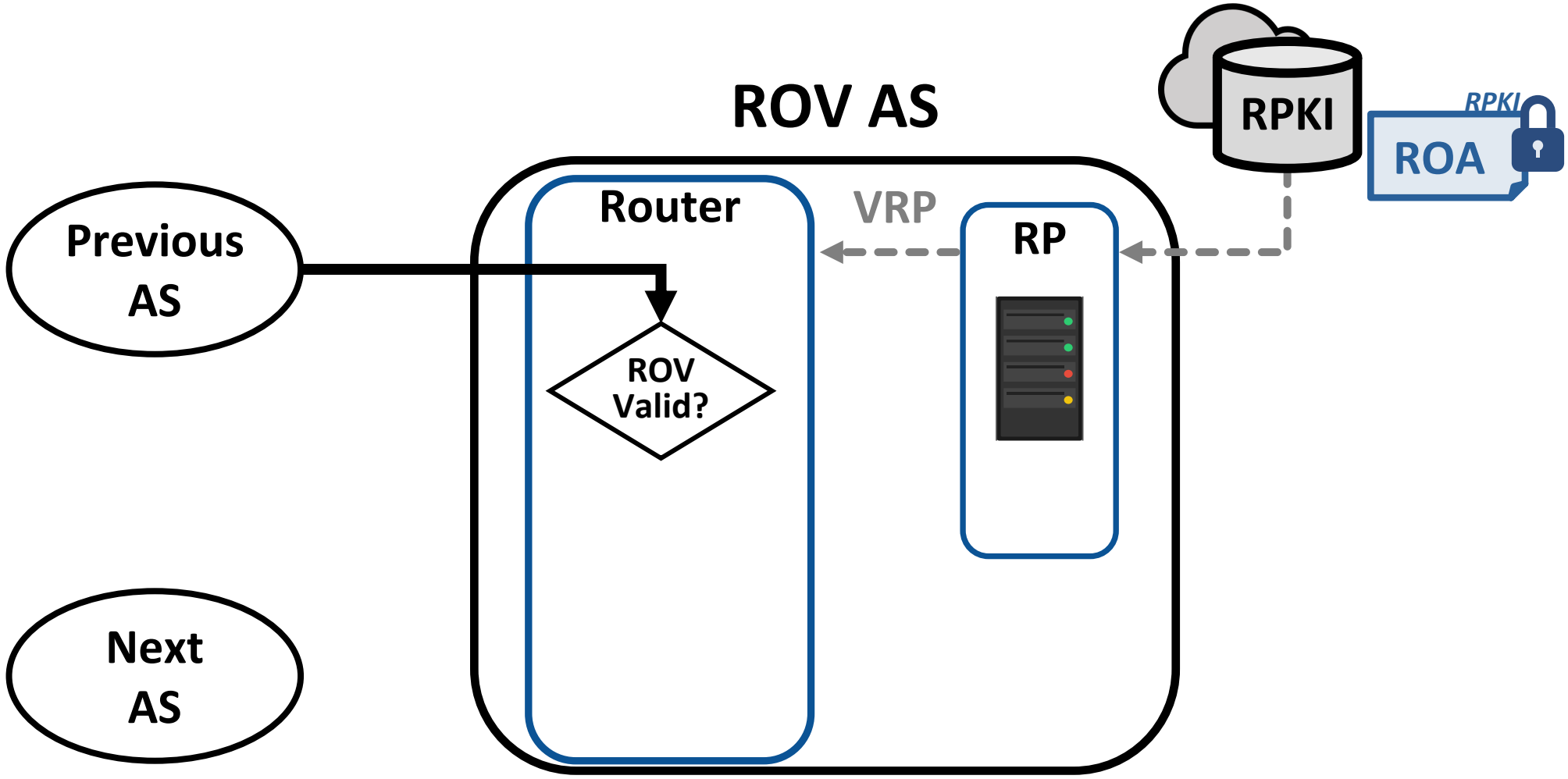

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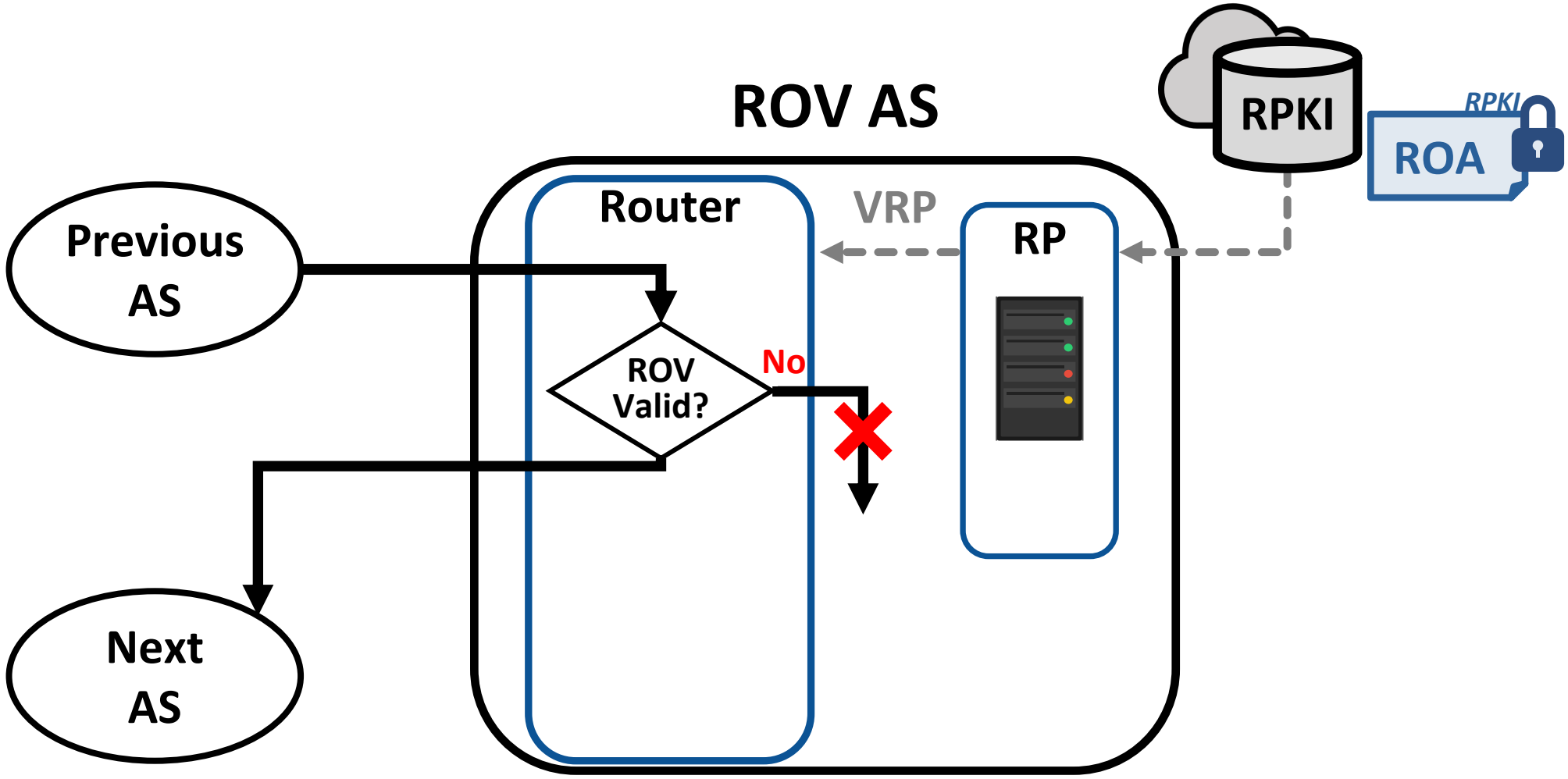

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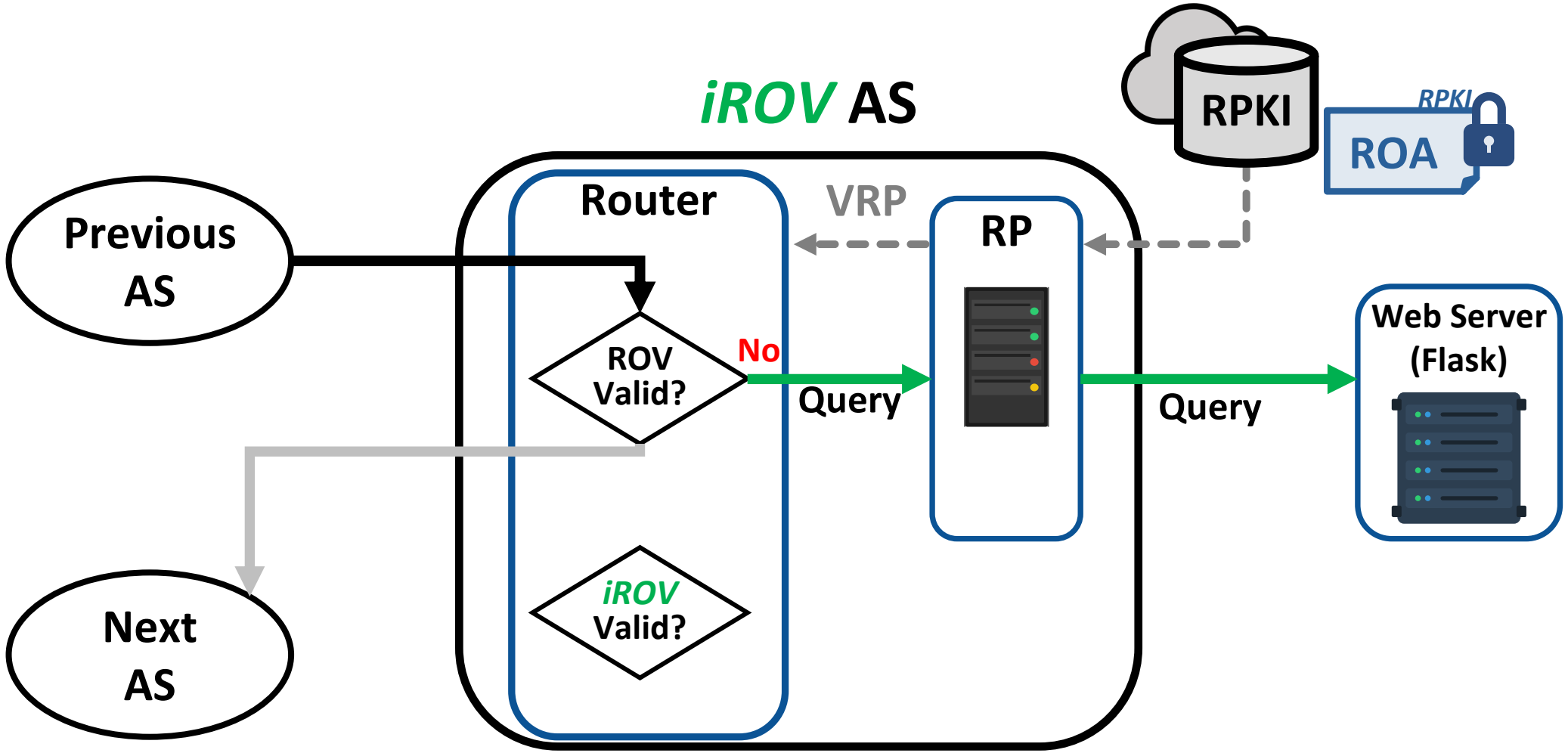

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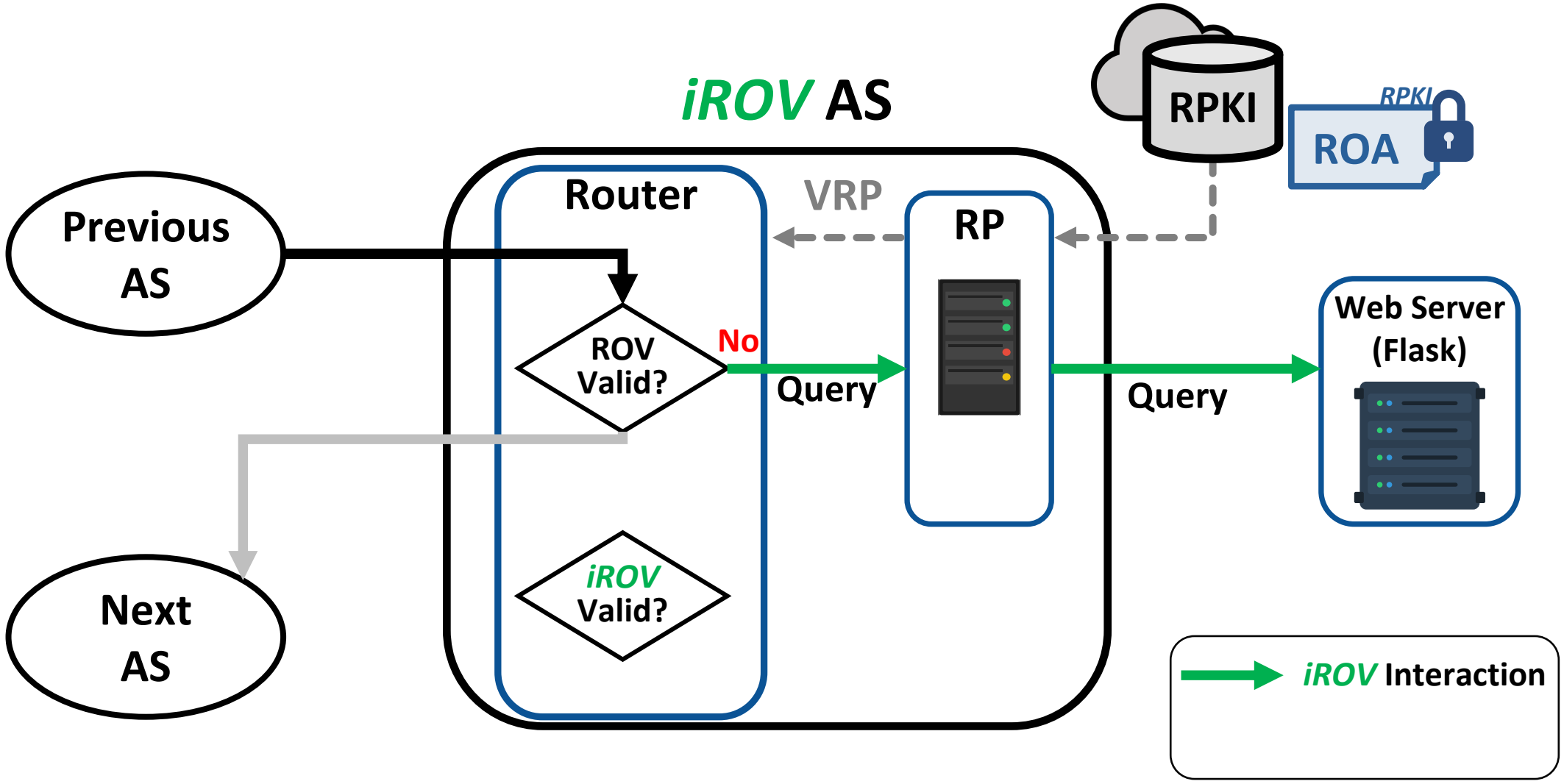

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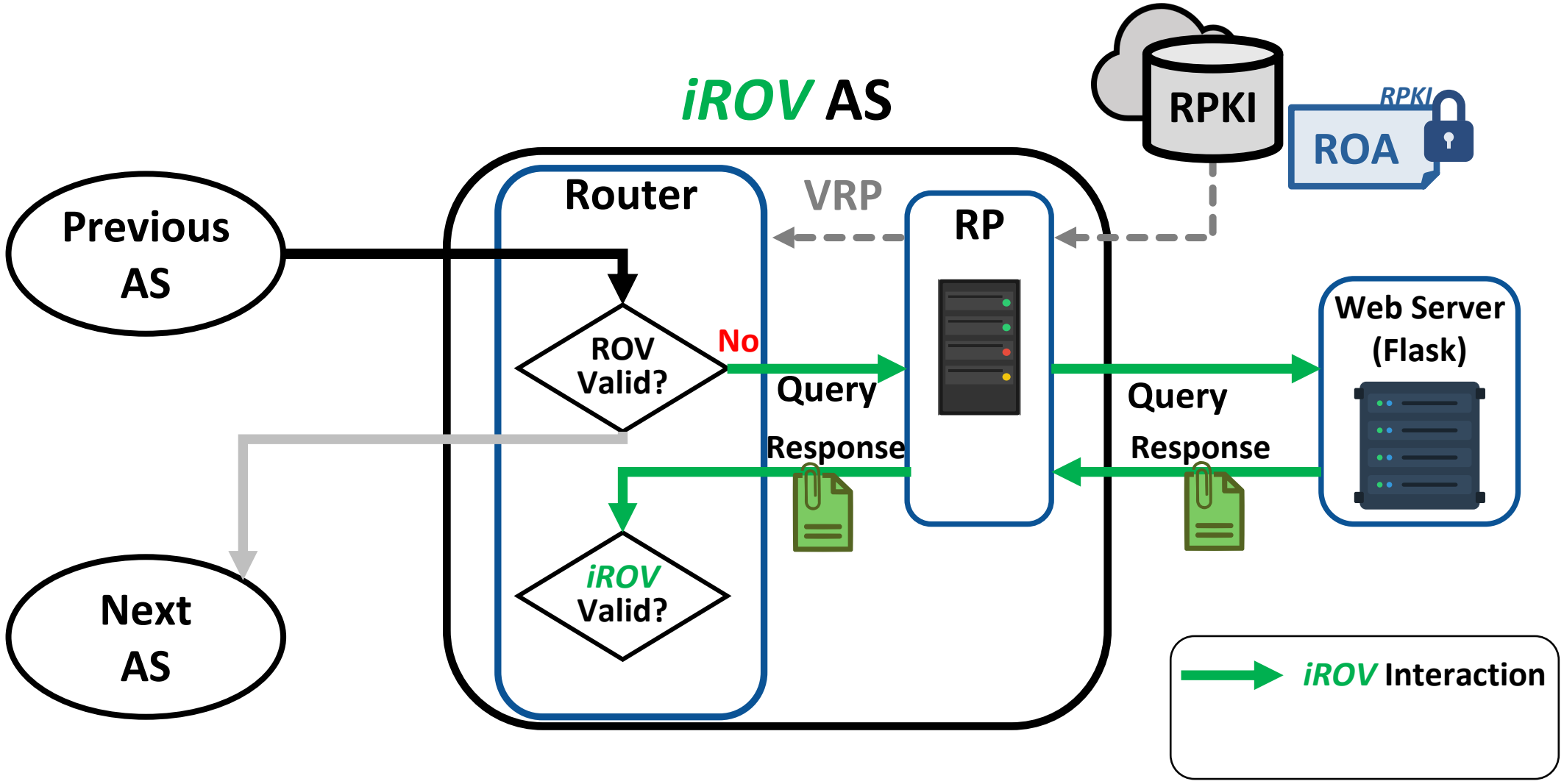

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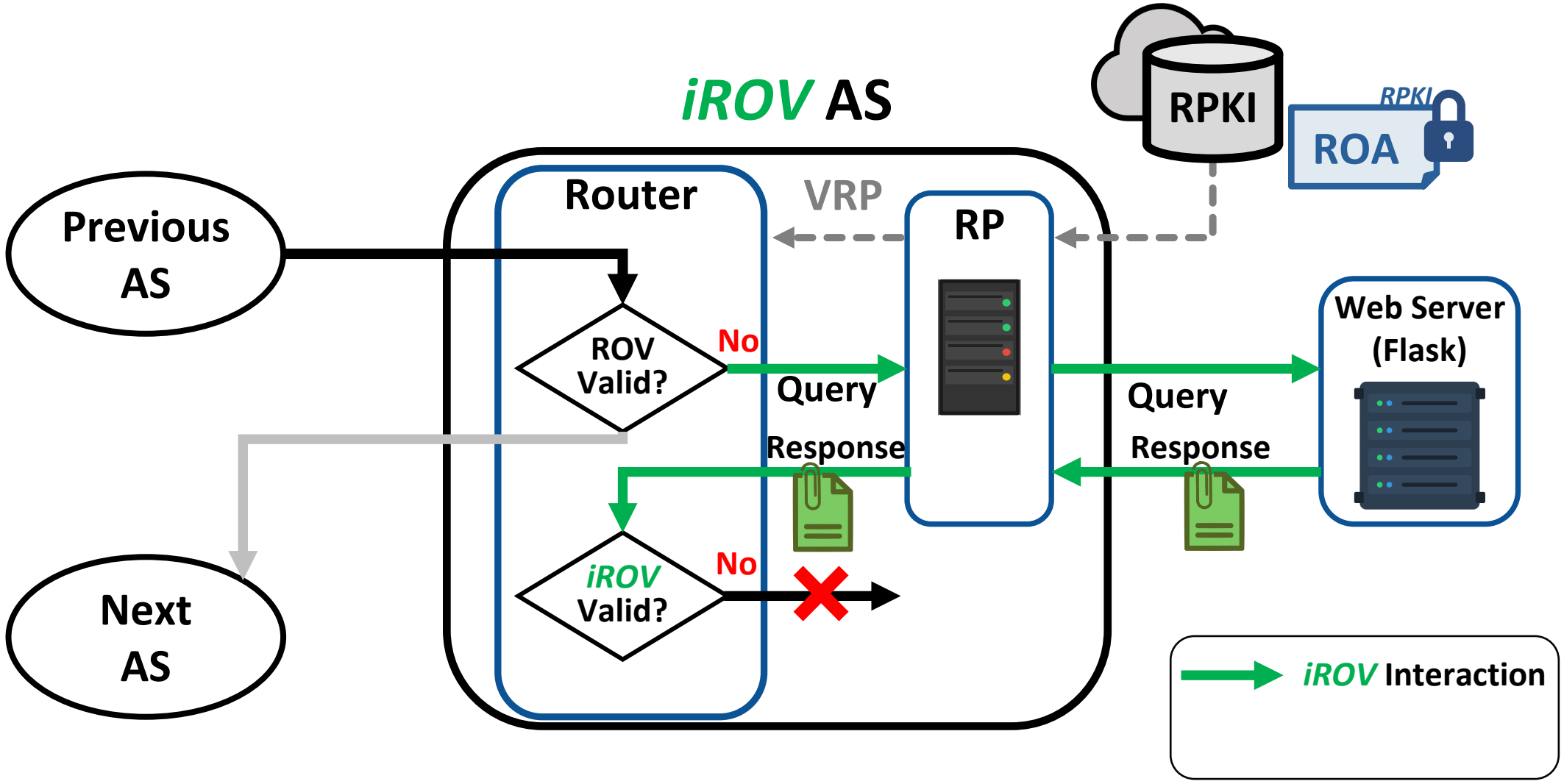

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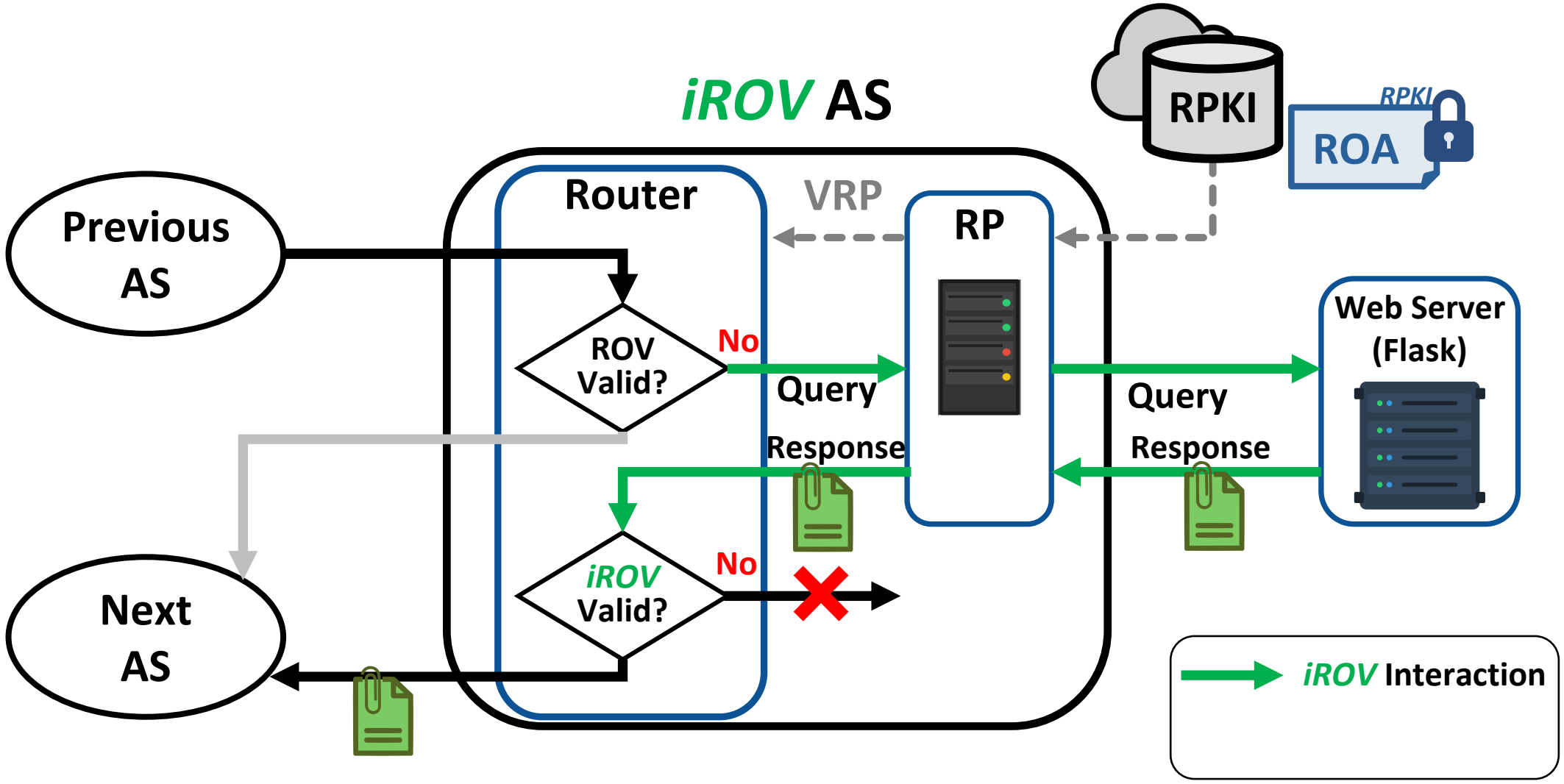

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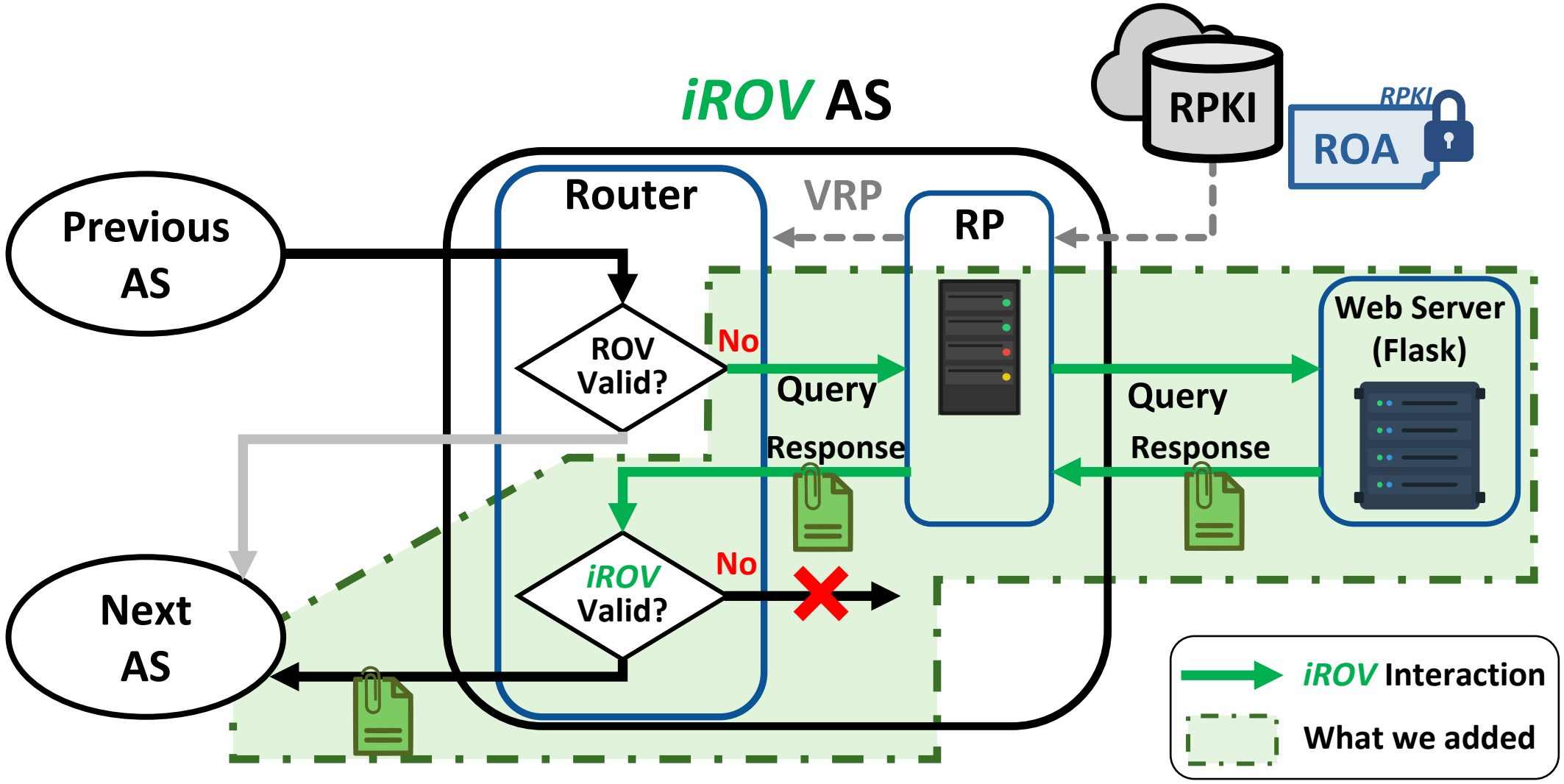

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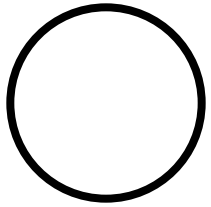
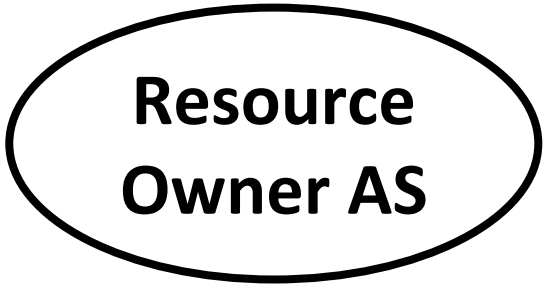
Is it really that simple? Any pitfalls? 🤔

Interactivity Can Overwhelm Owners





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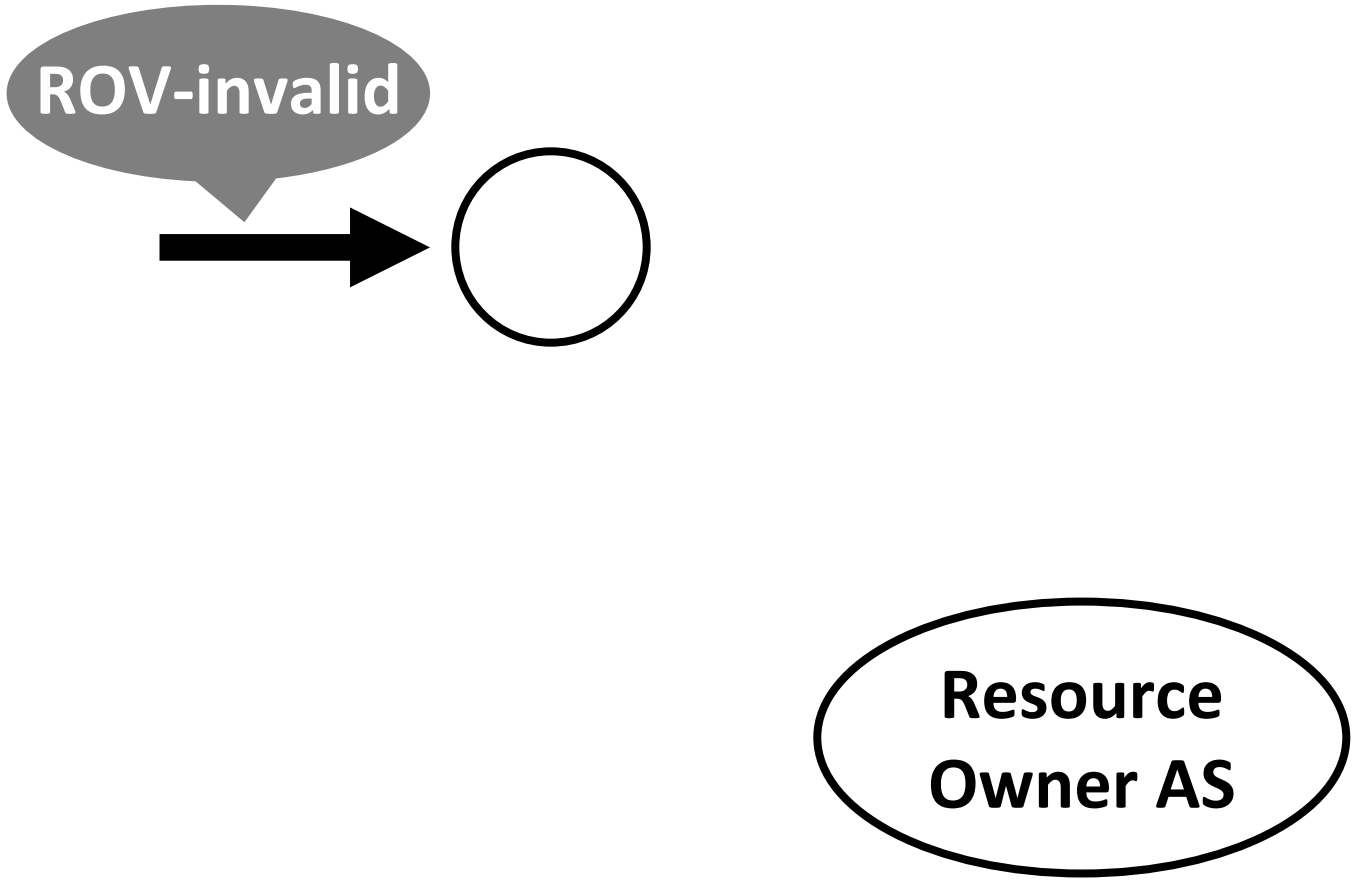

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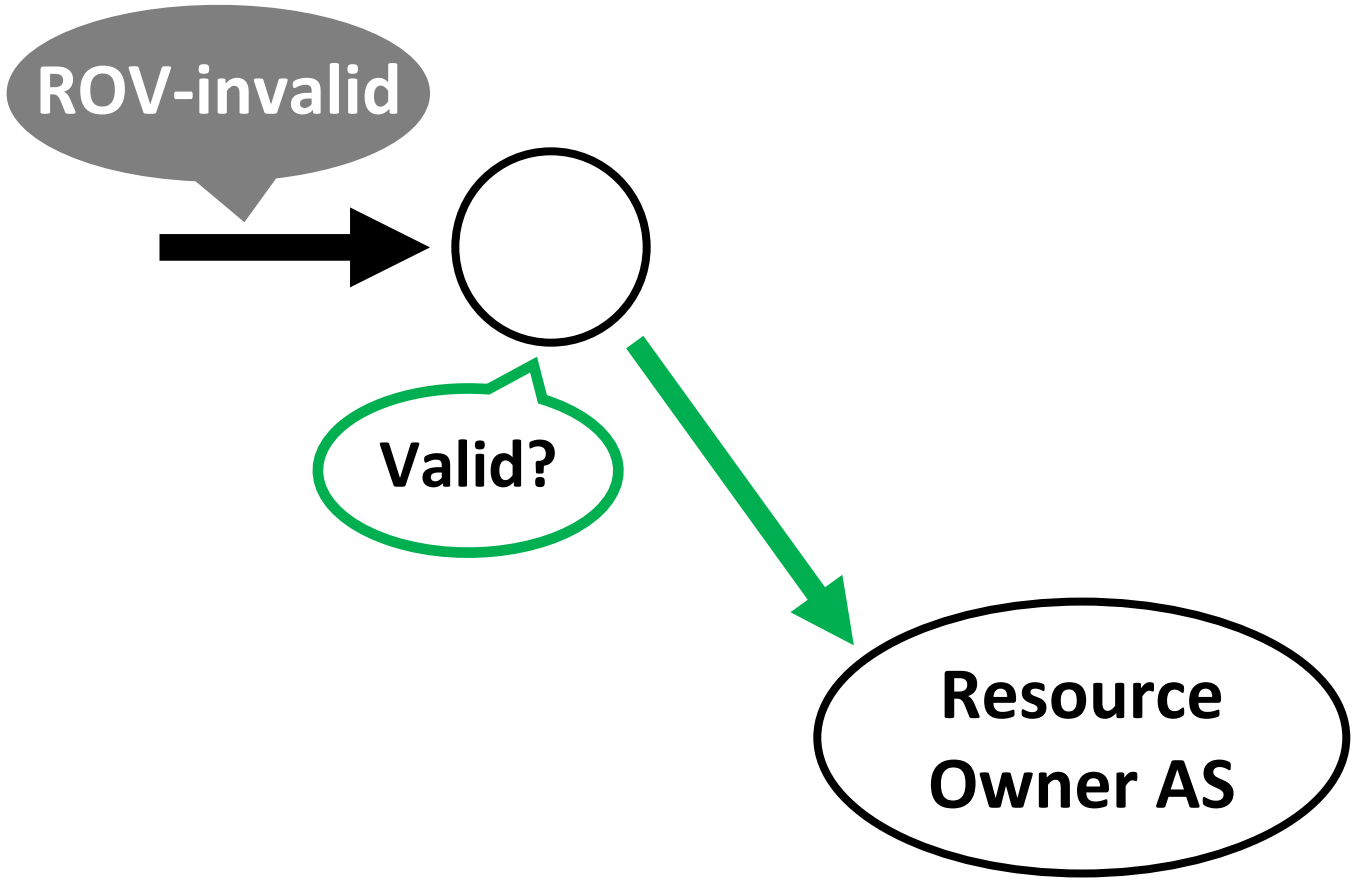

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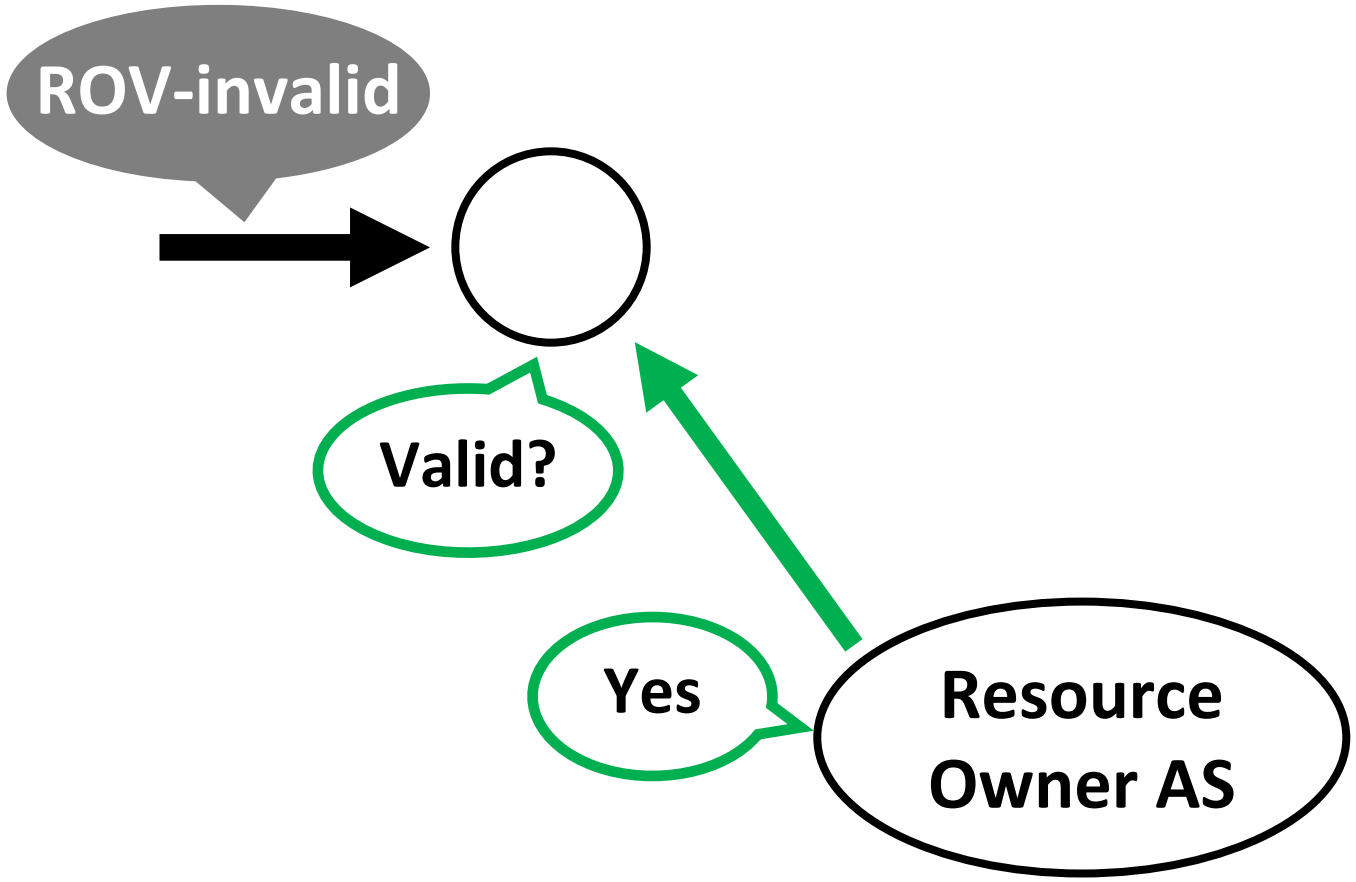

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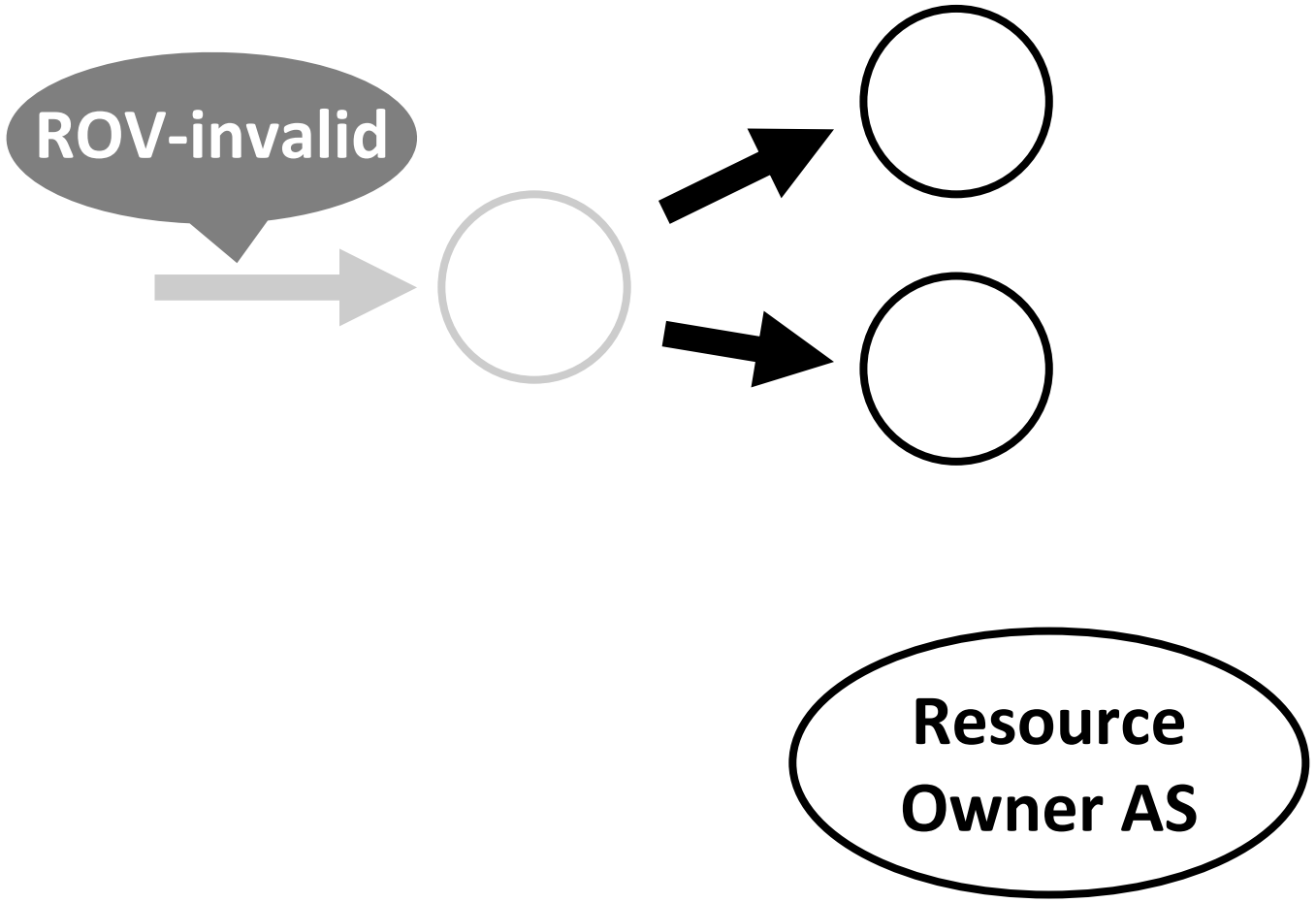

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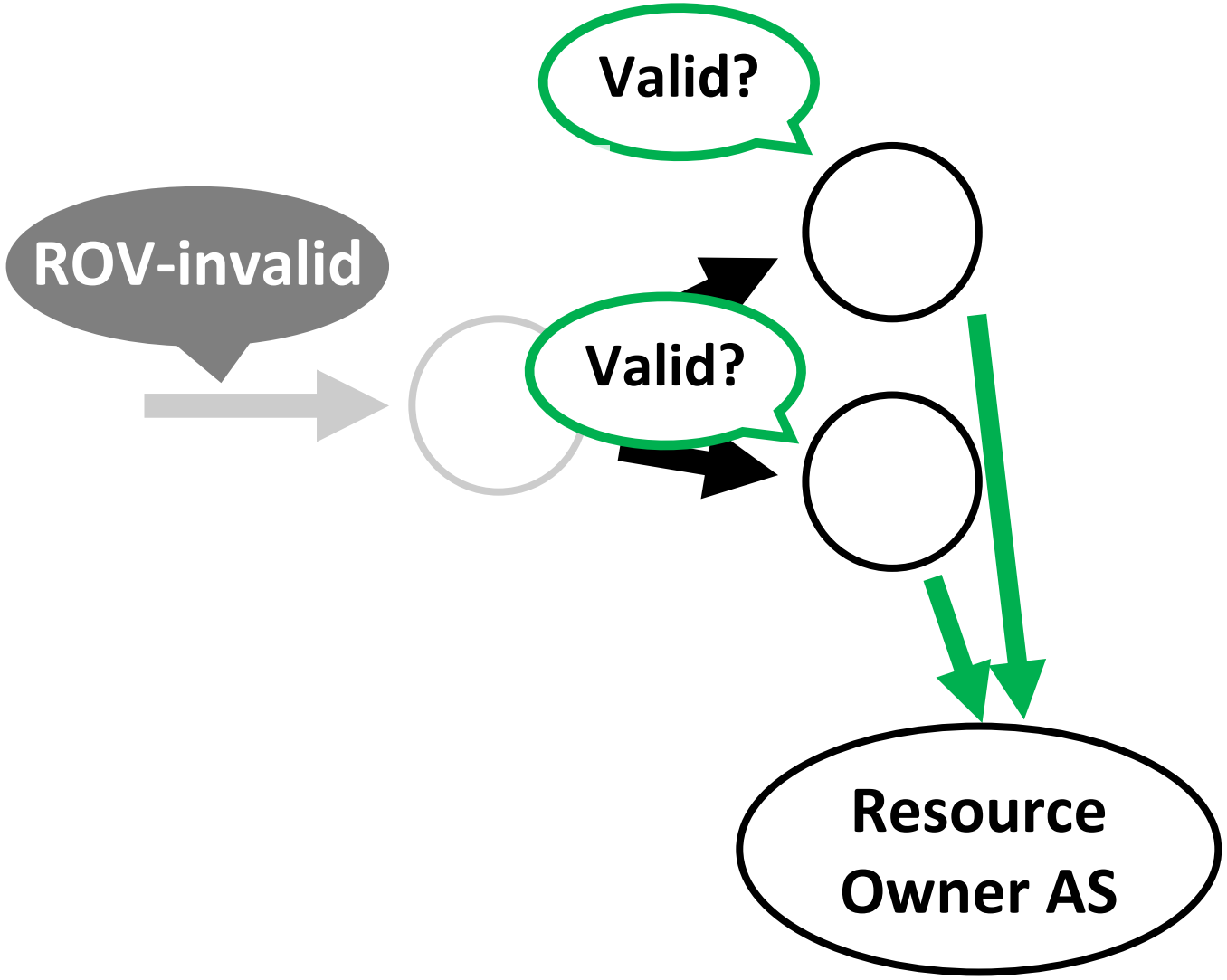

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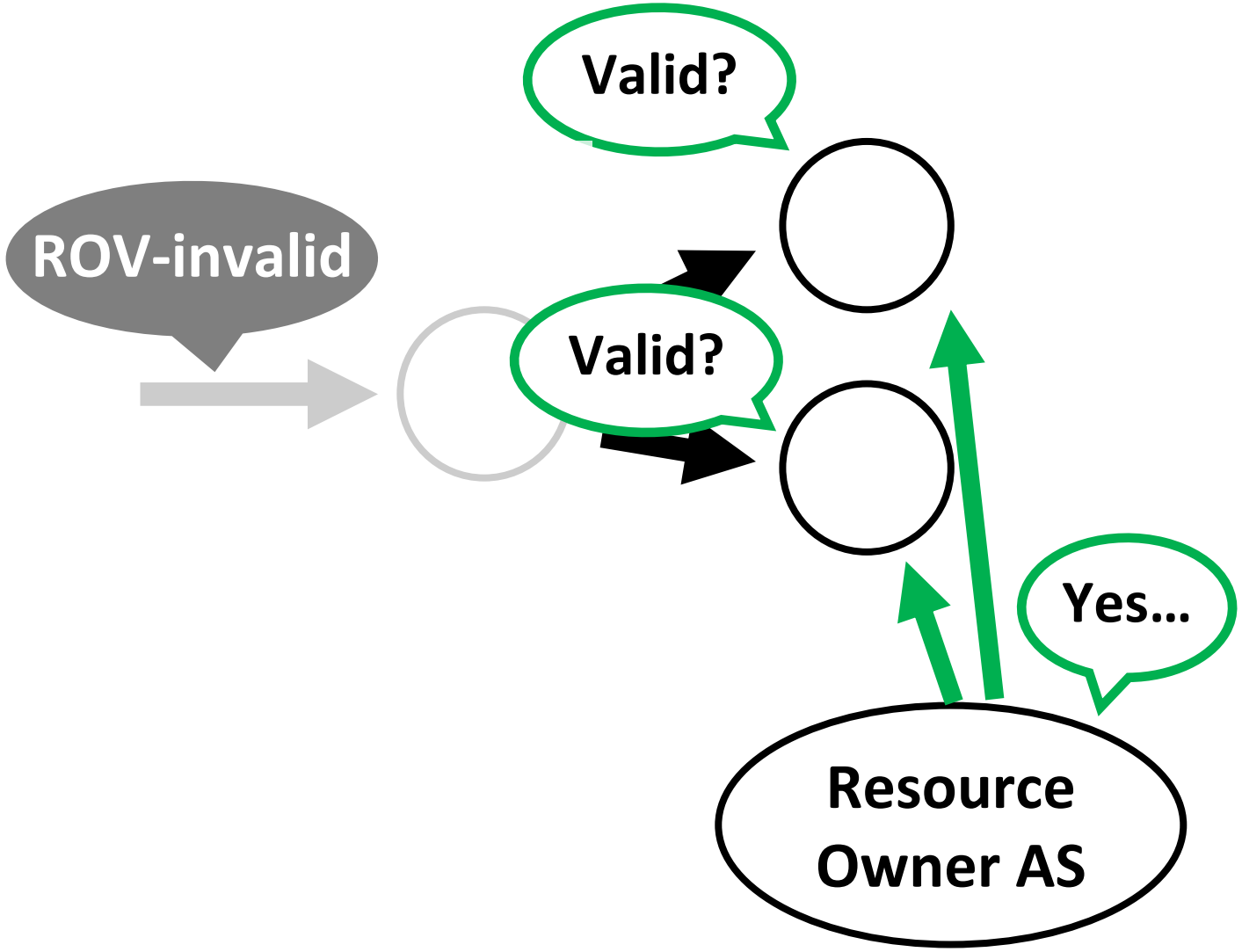

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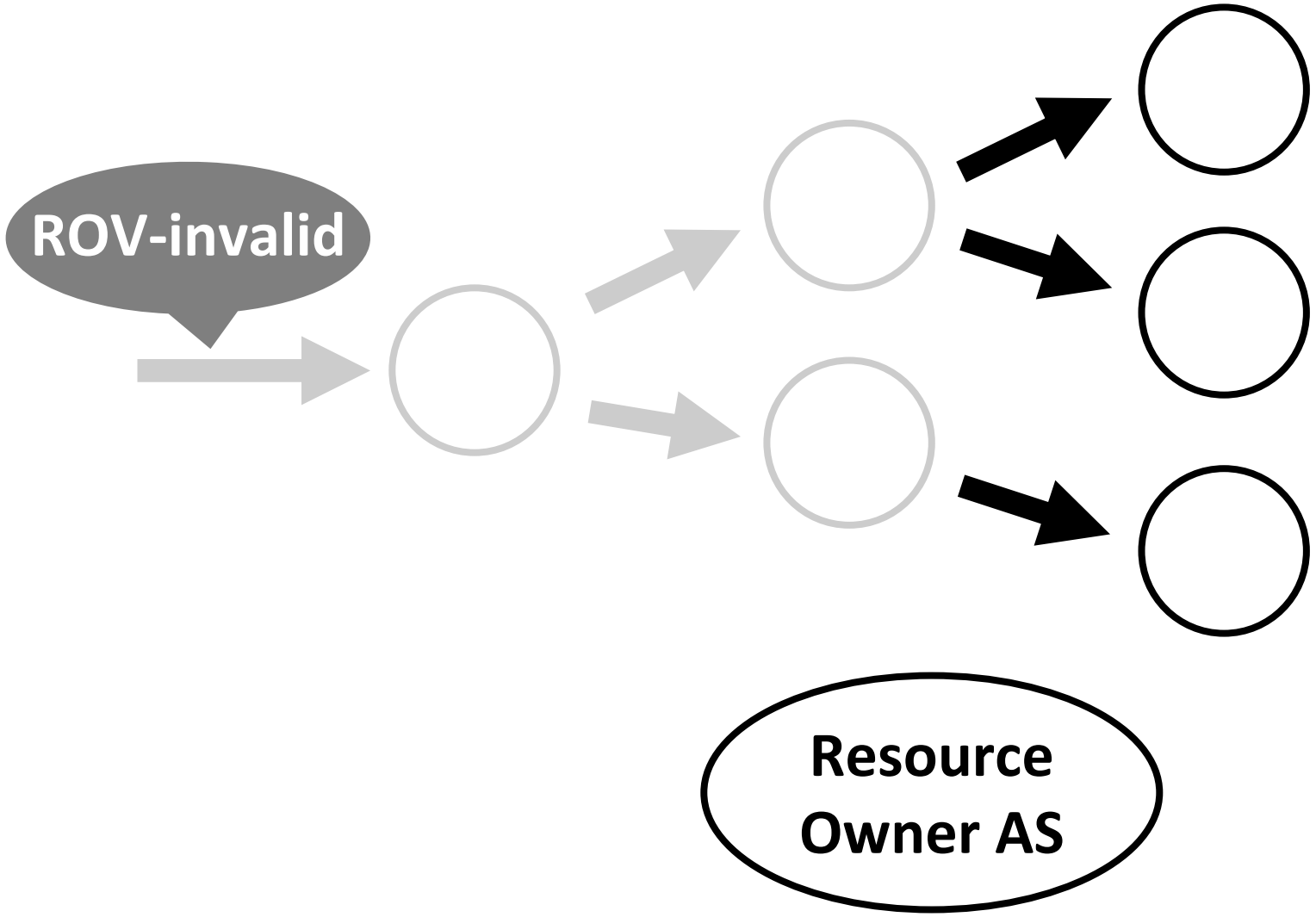

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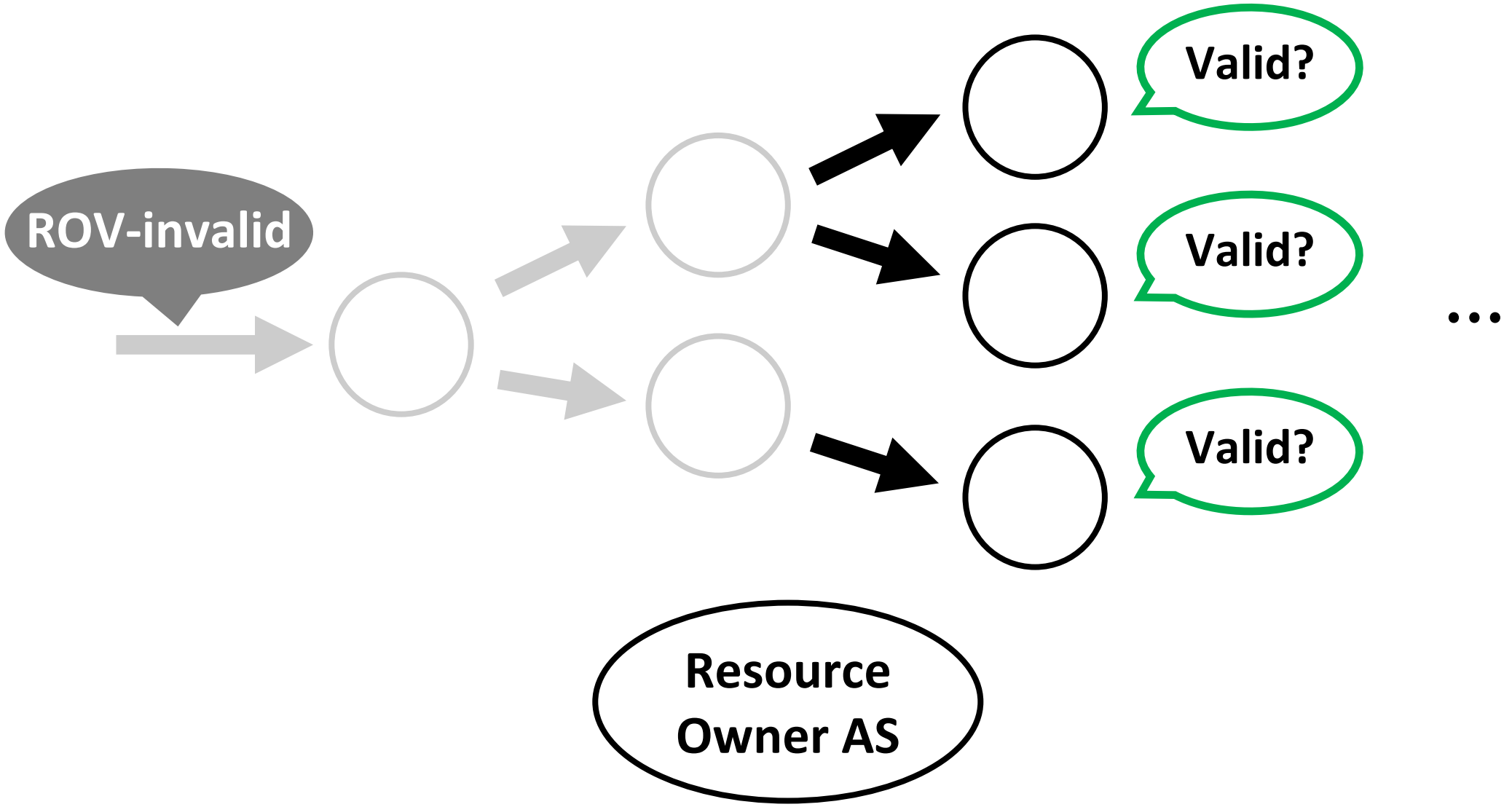

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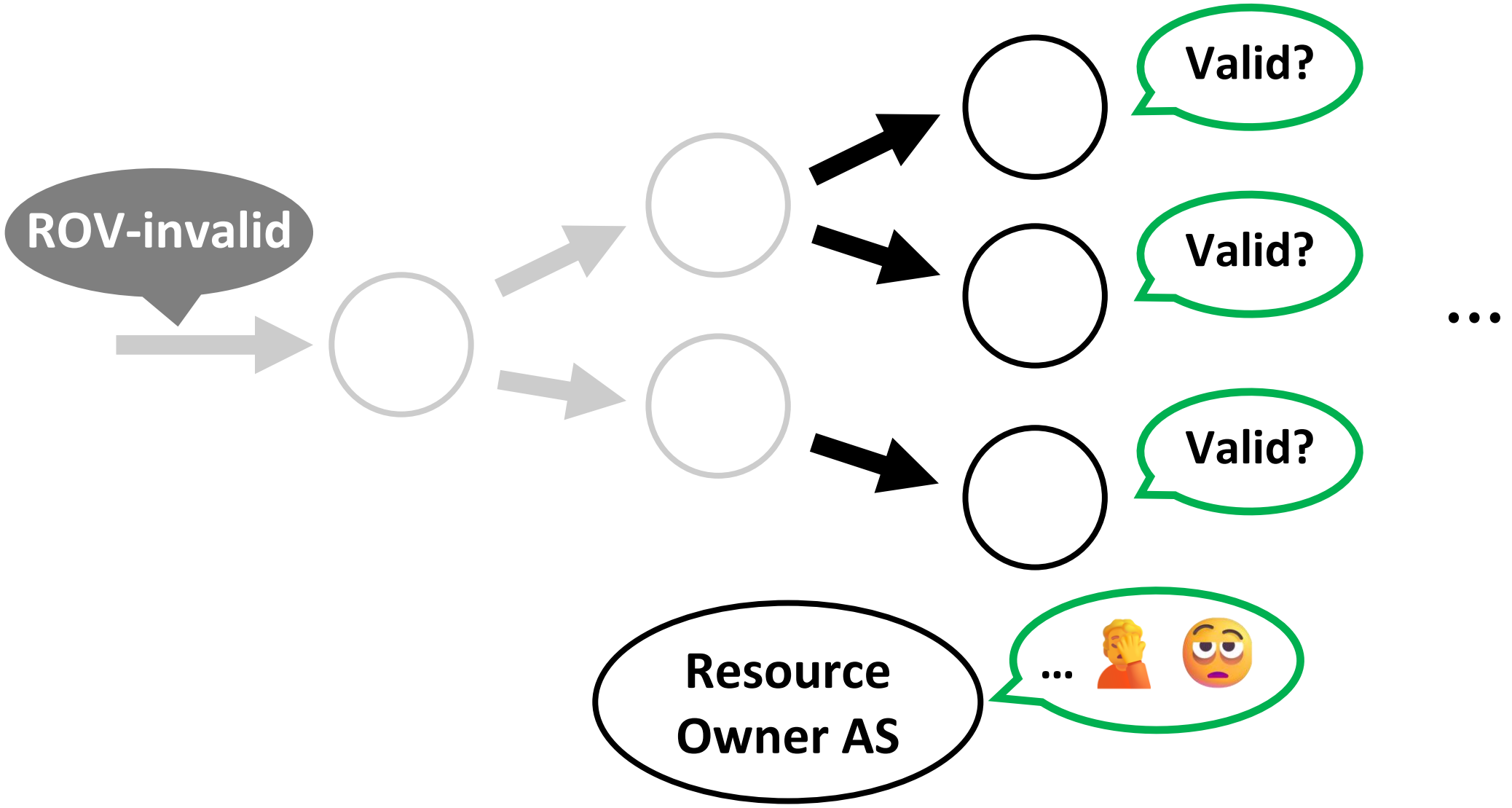

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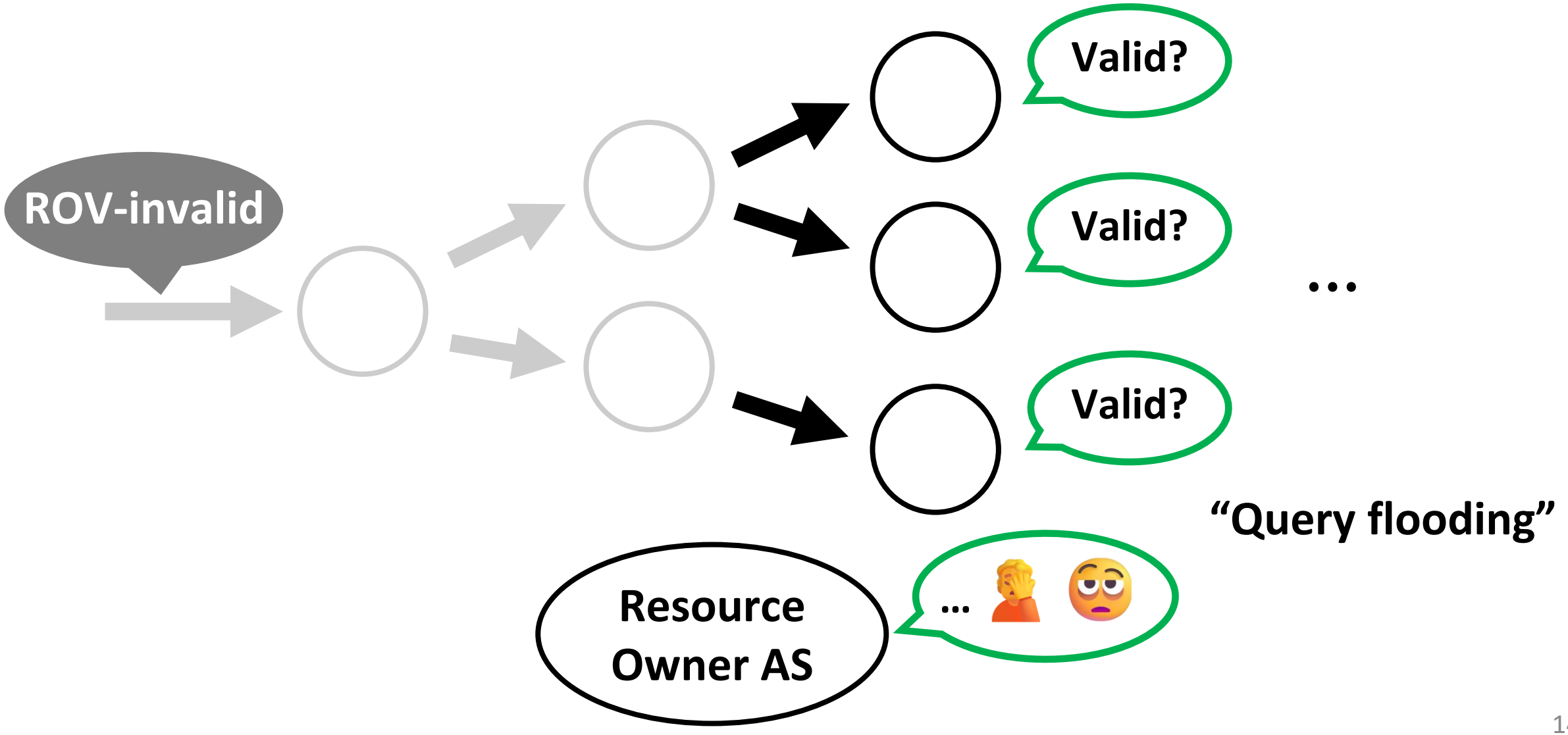
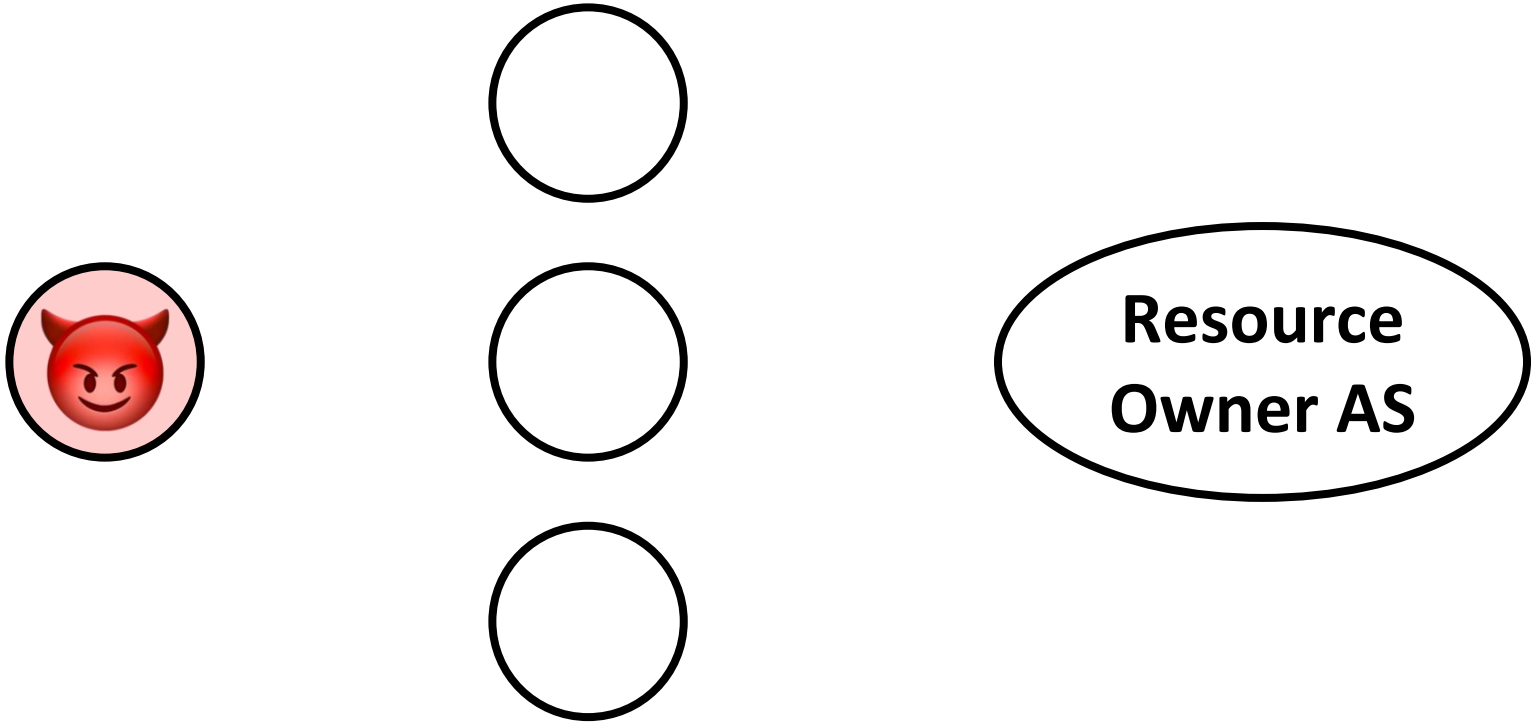


Interactivity Can Be Abused



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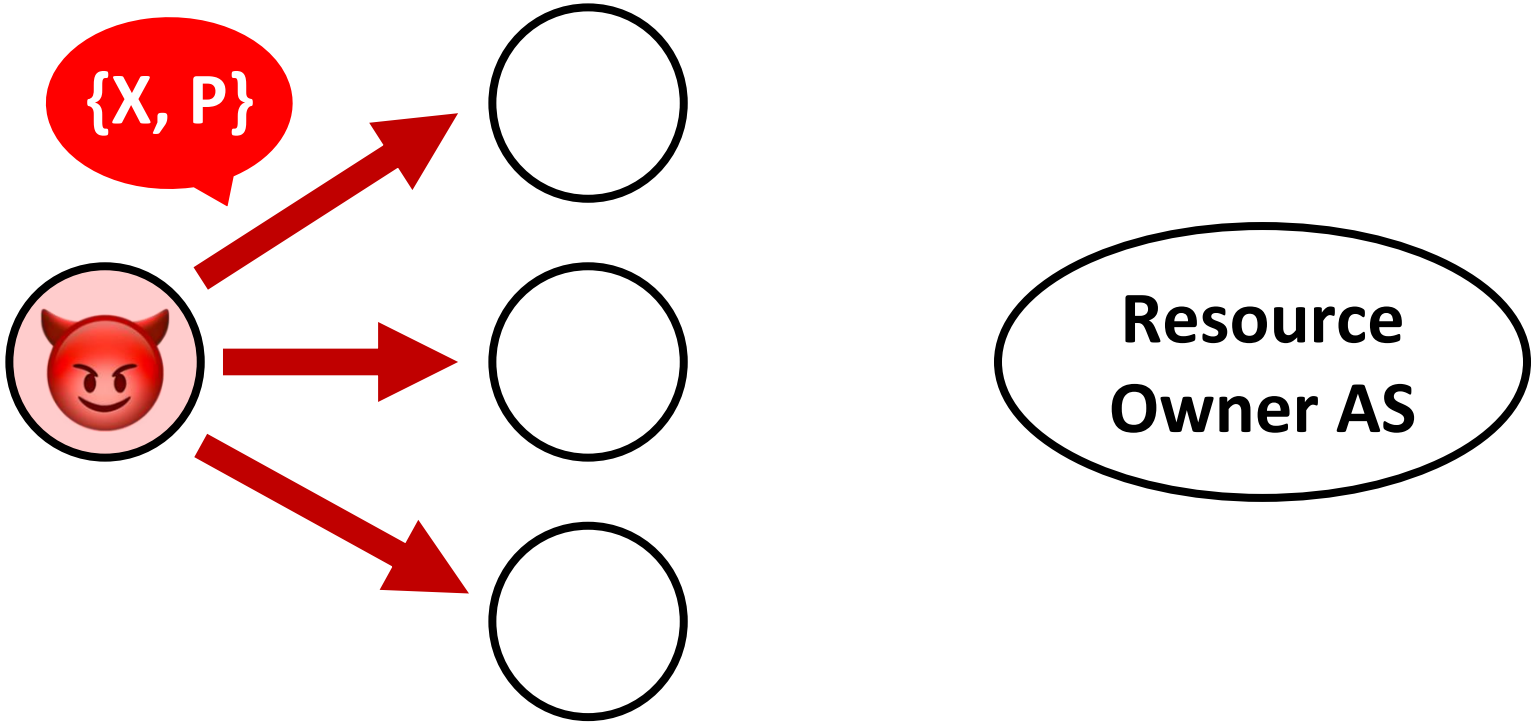

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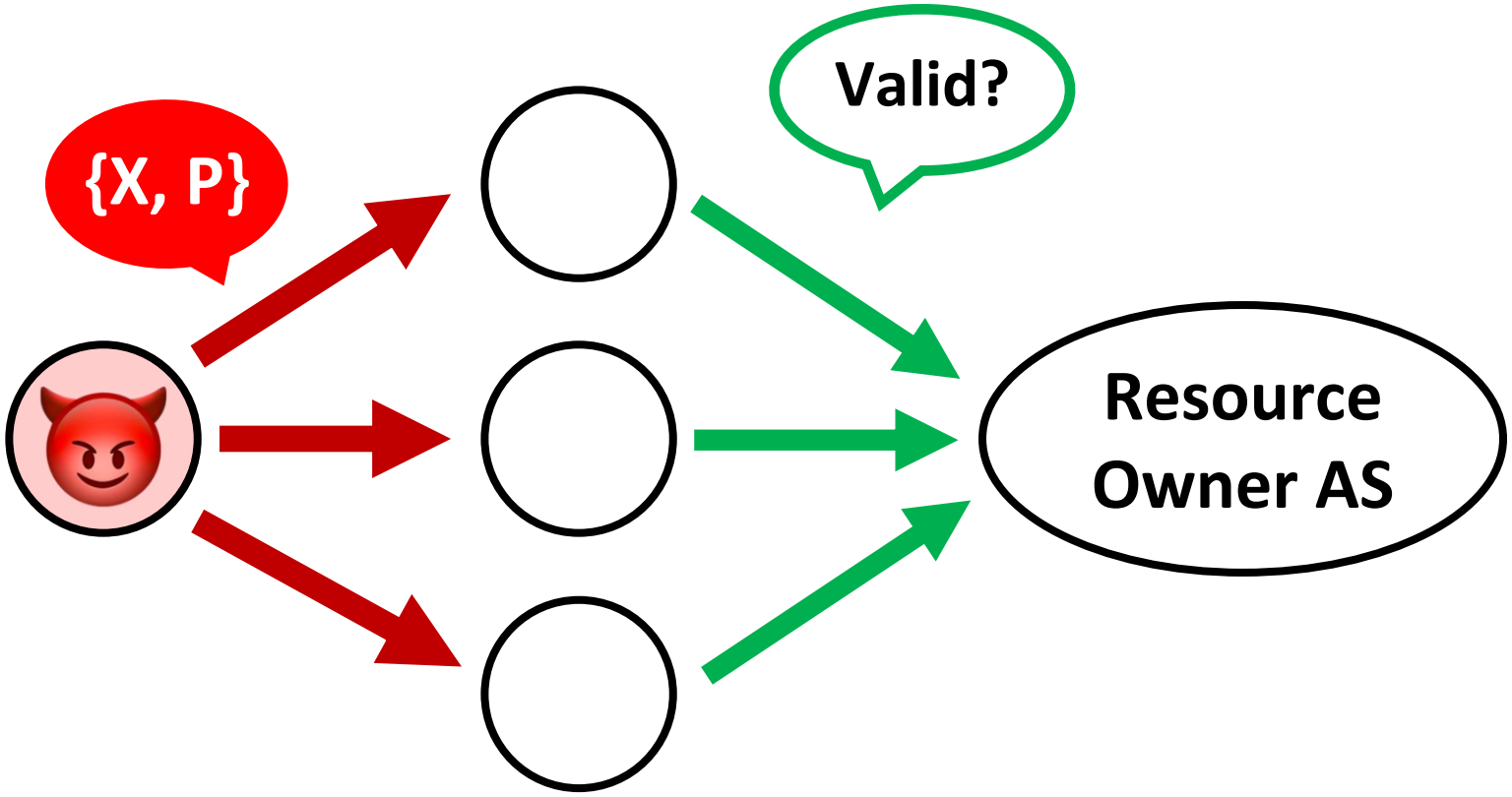

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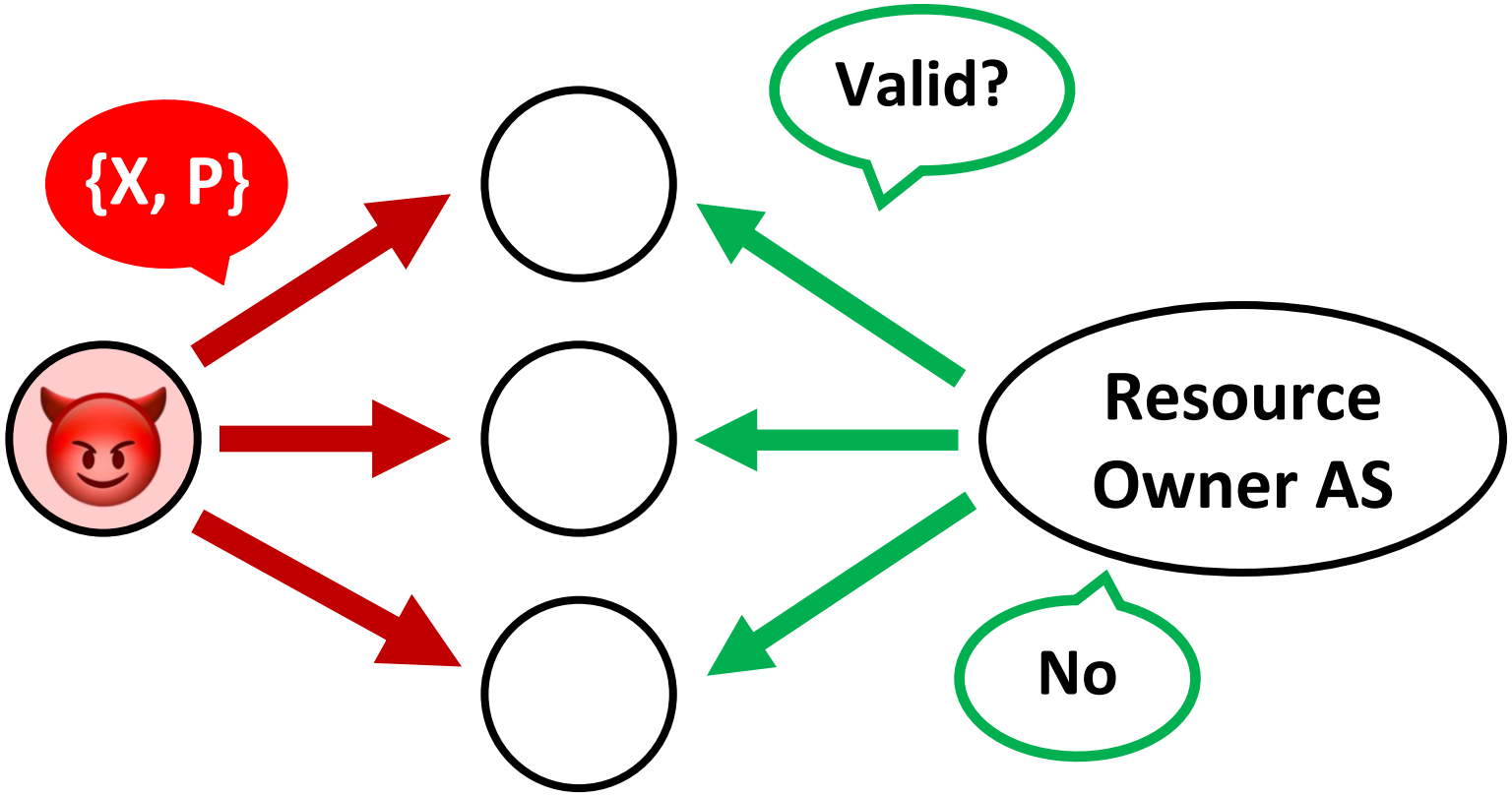

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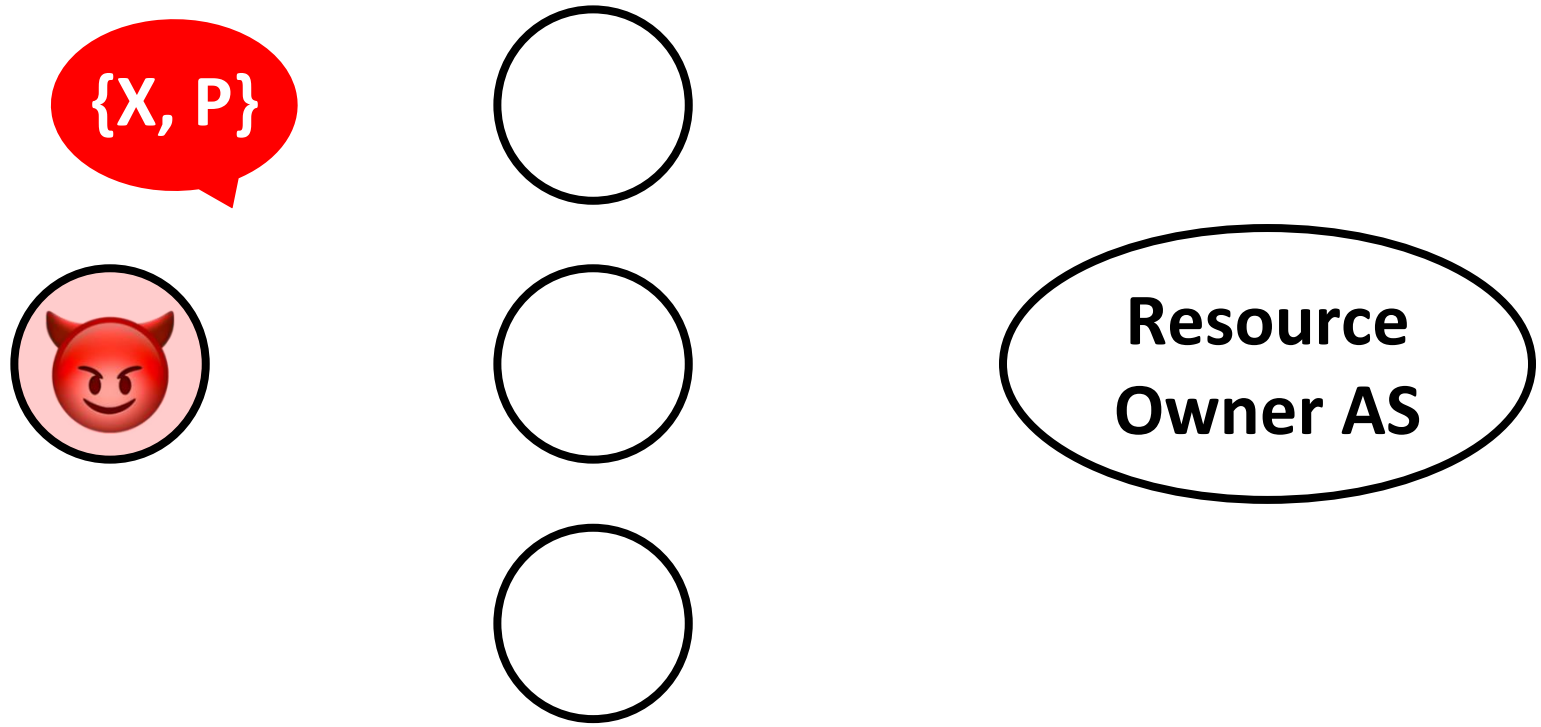

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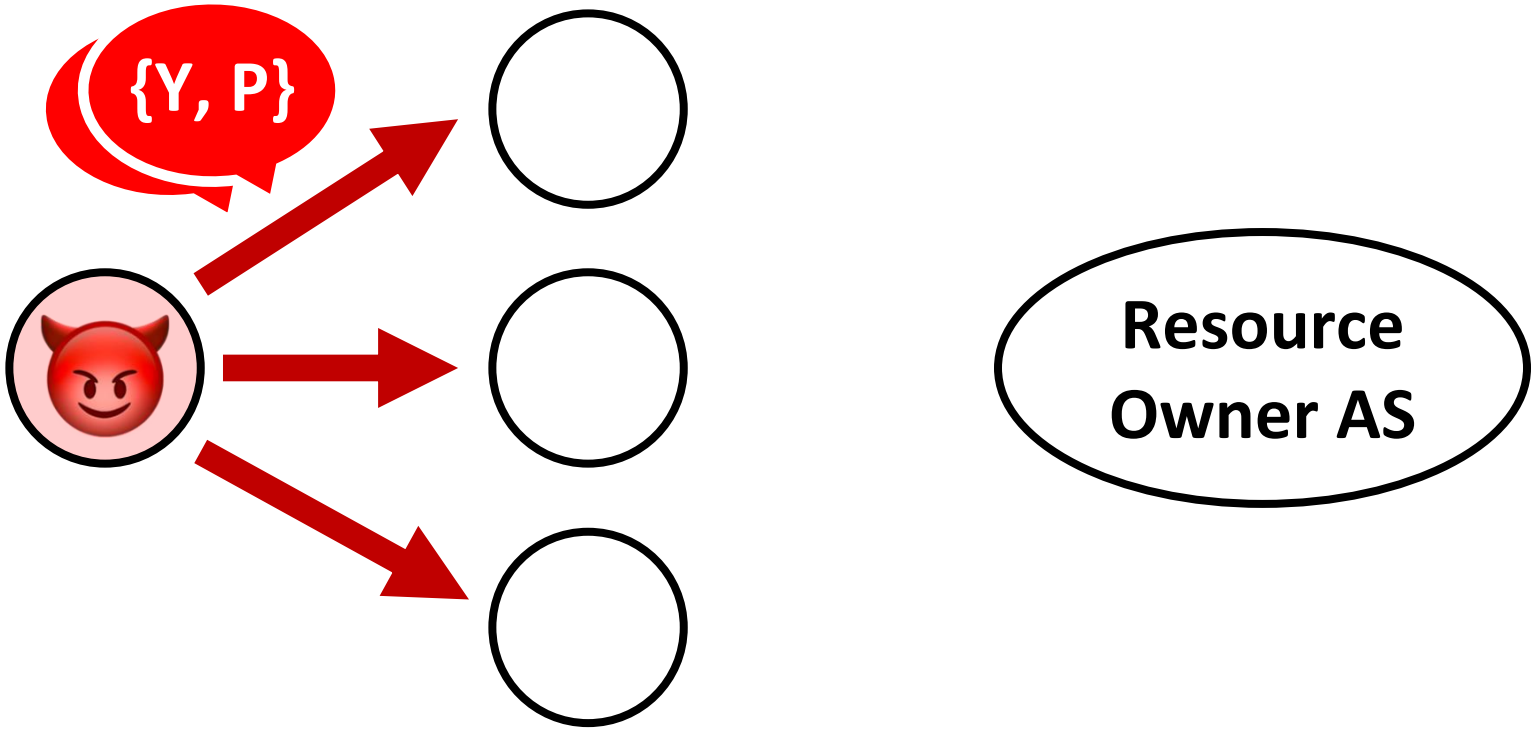

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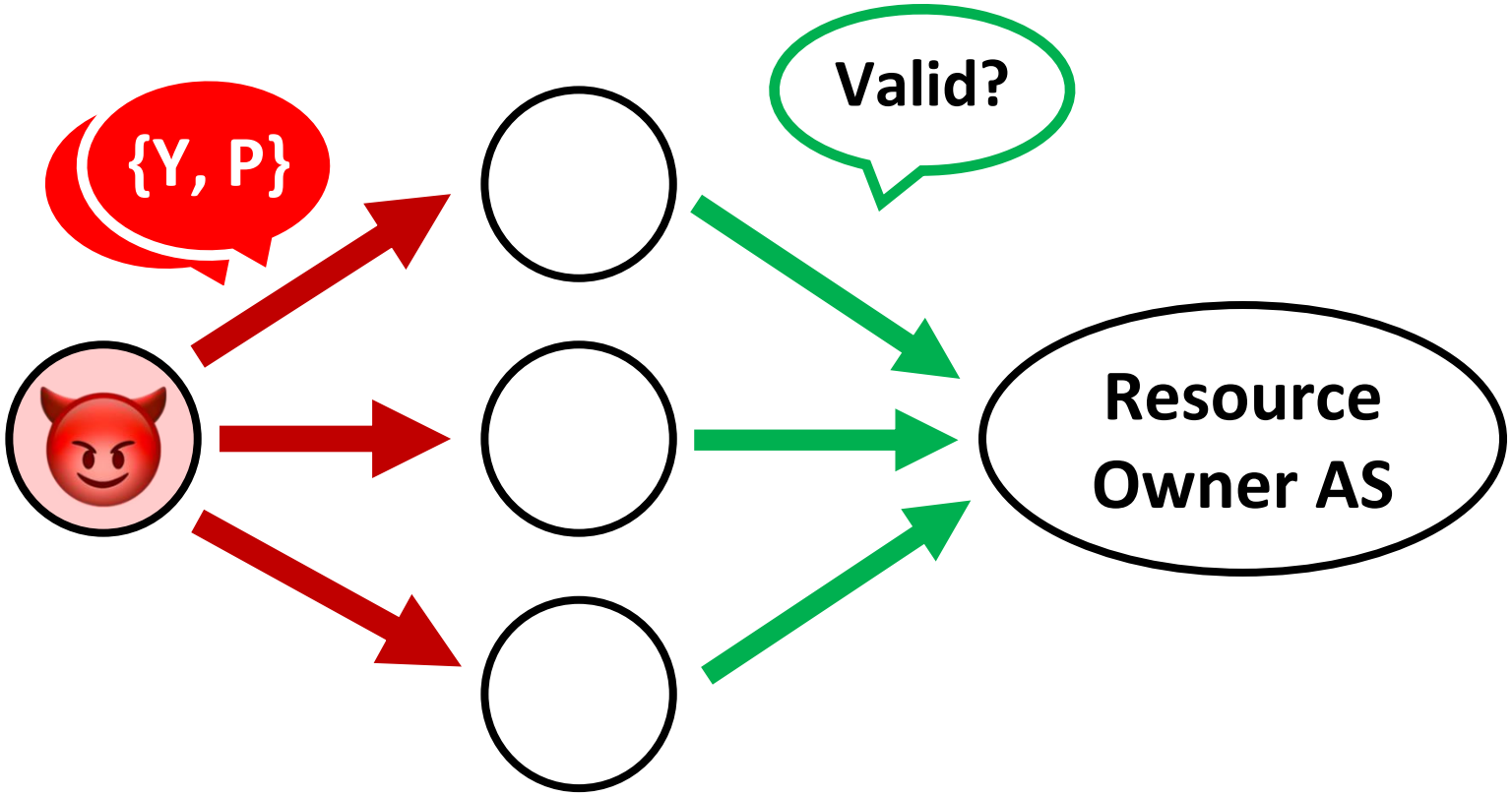

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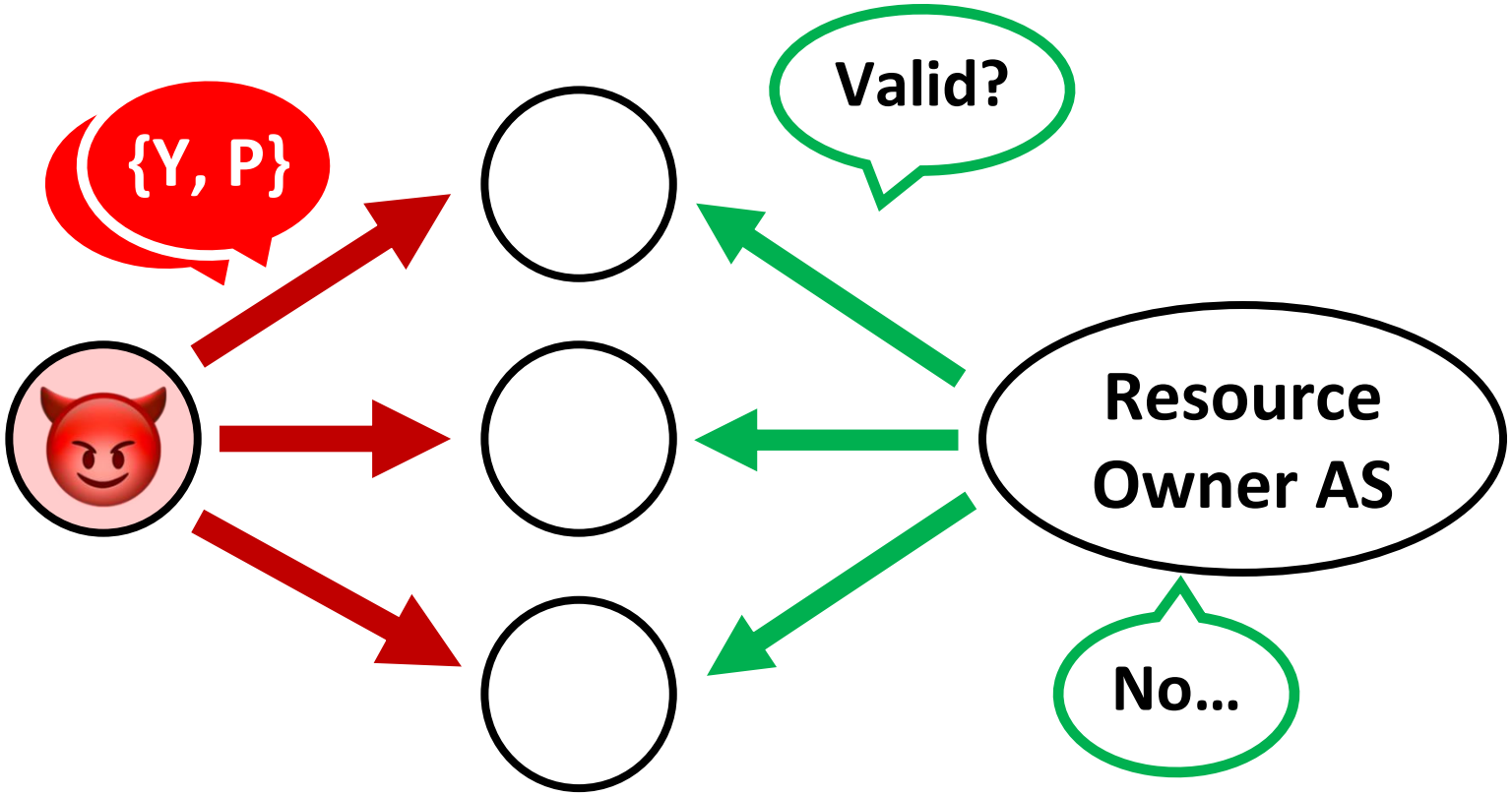

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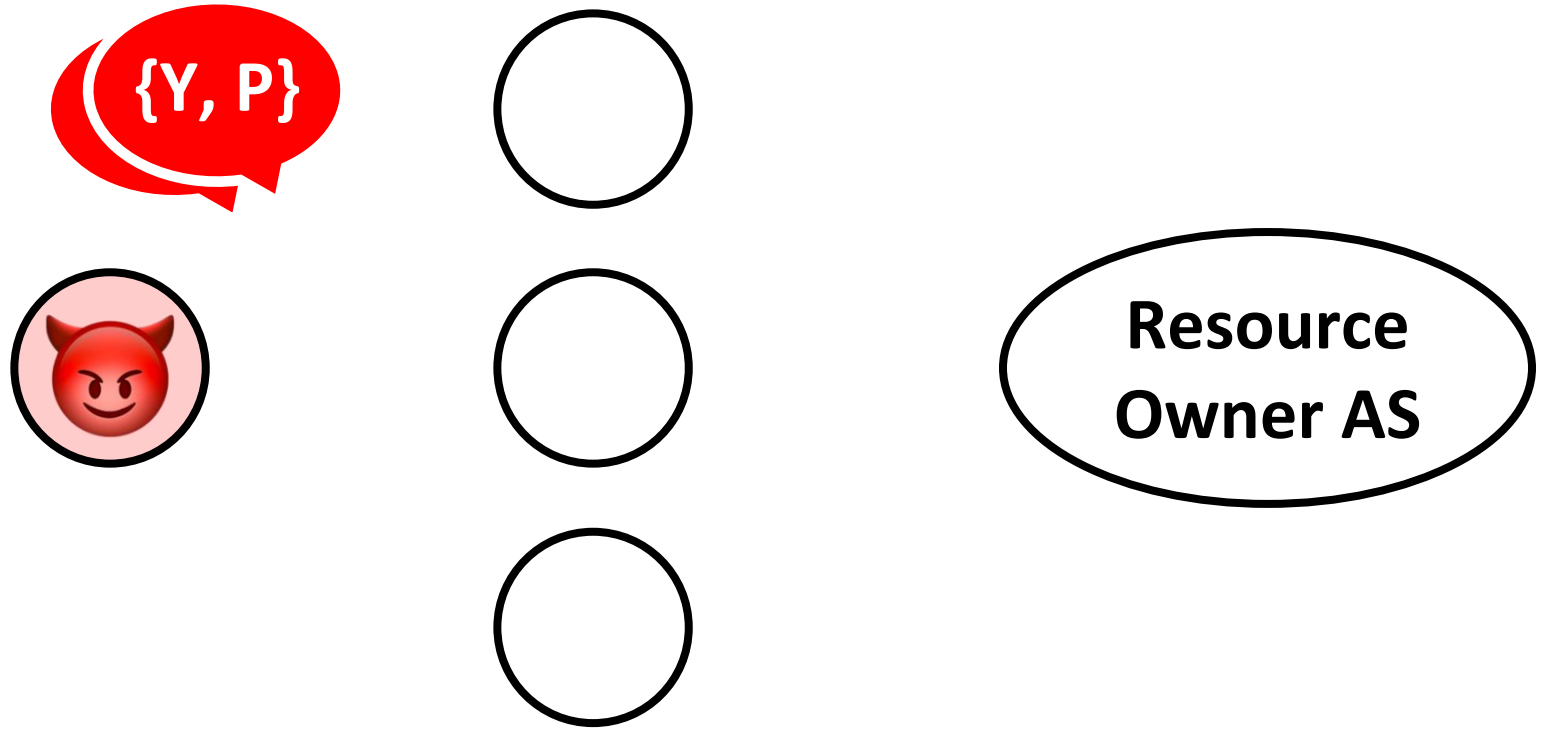

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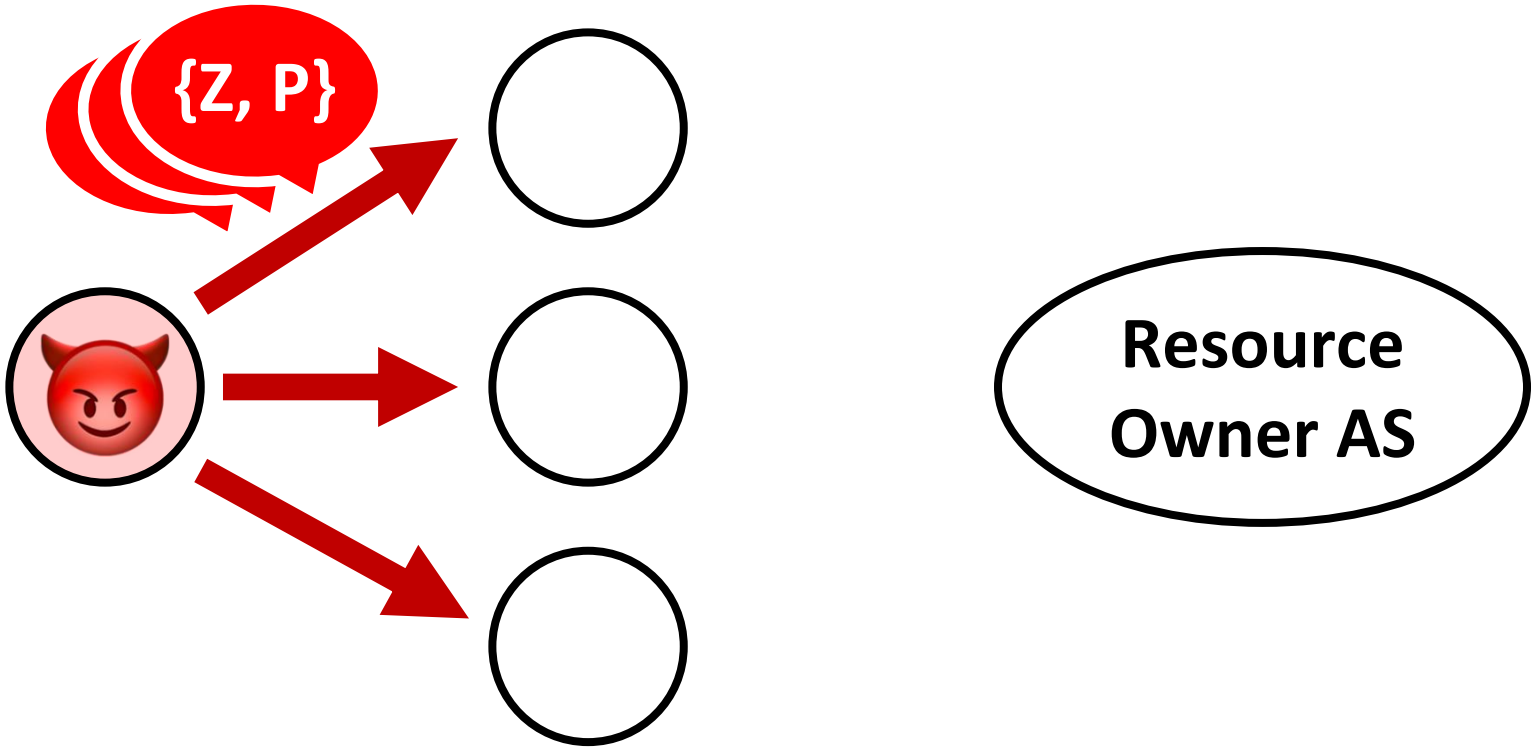

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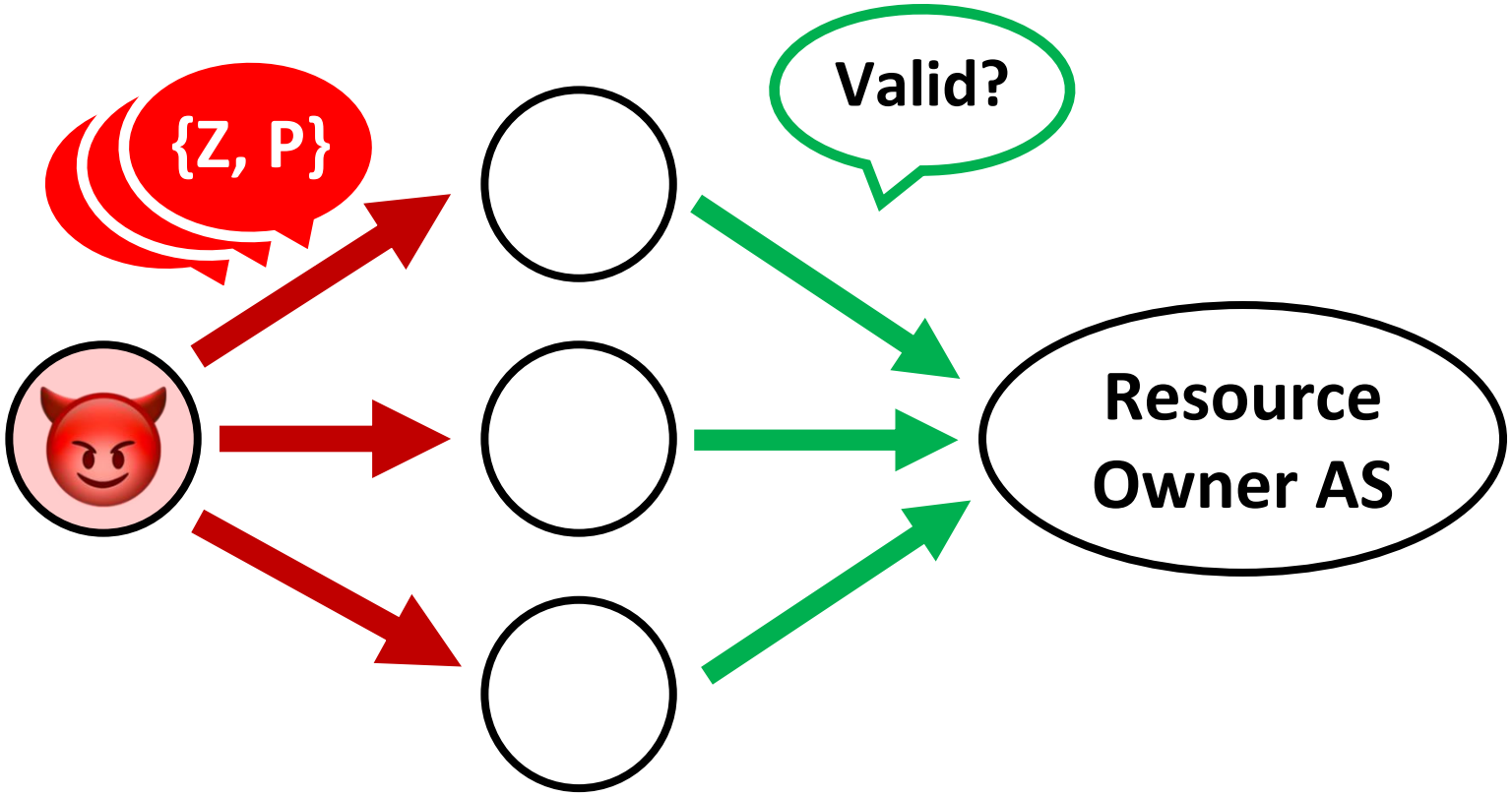

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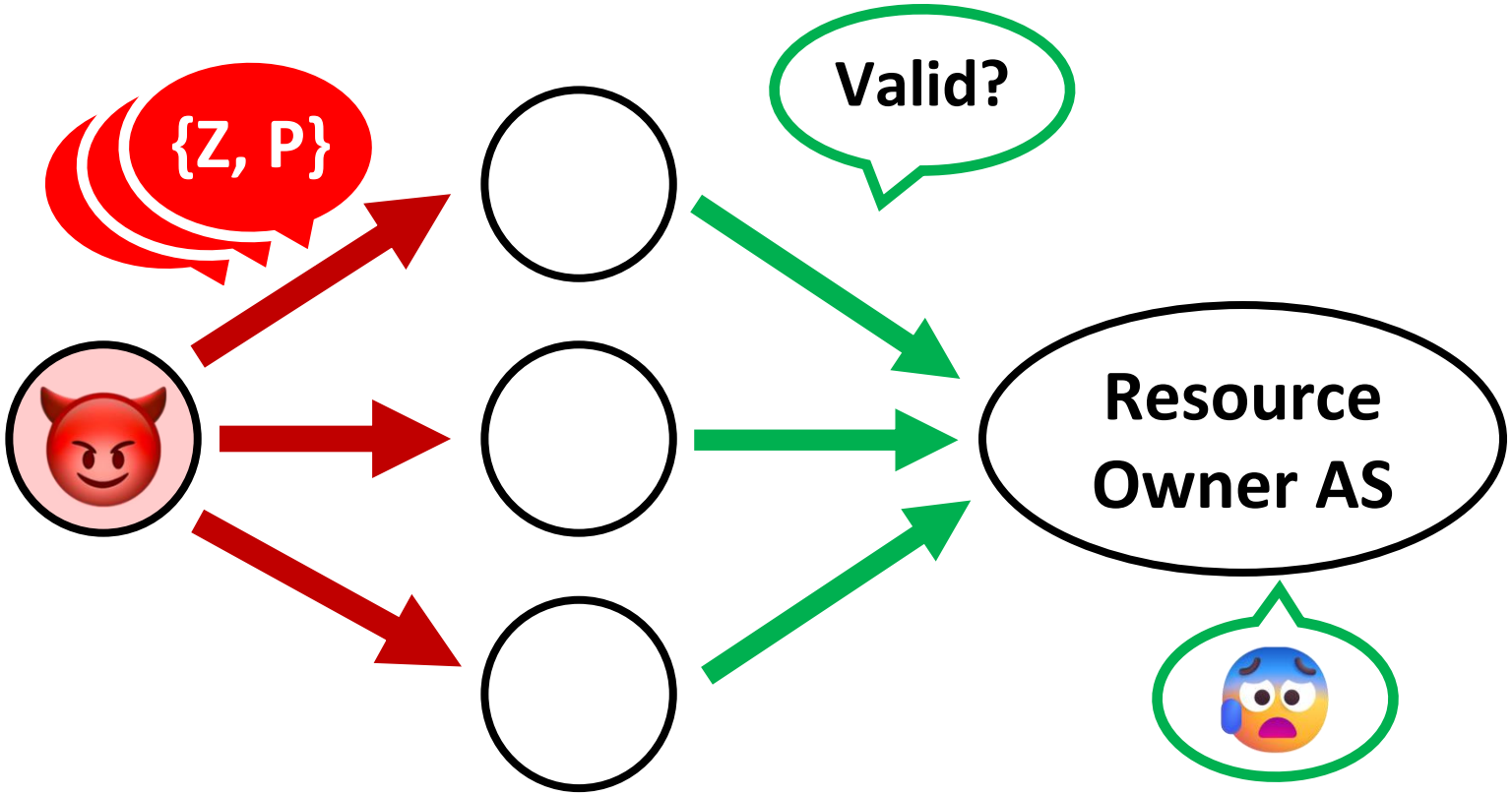

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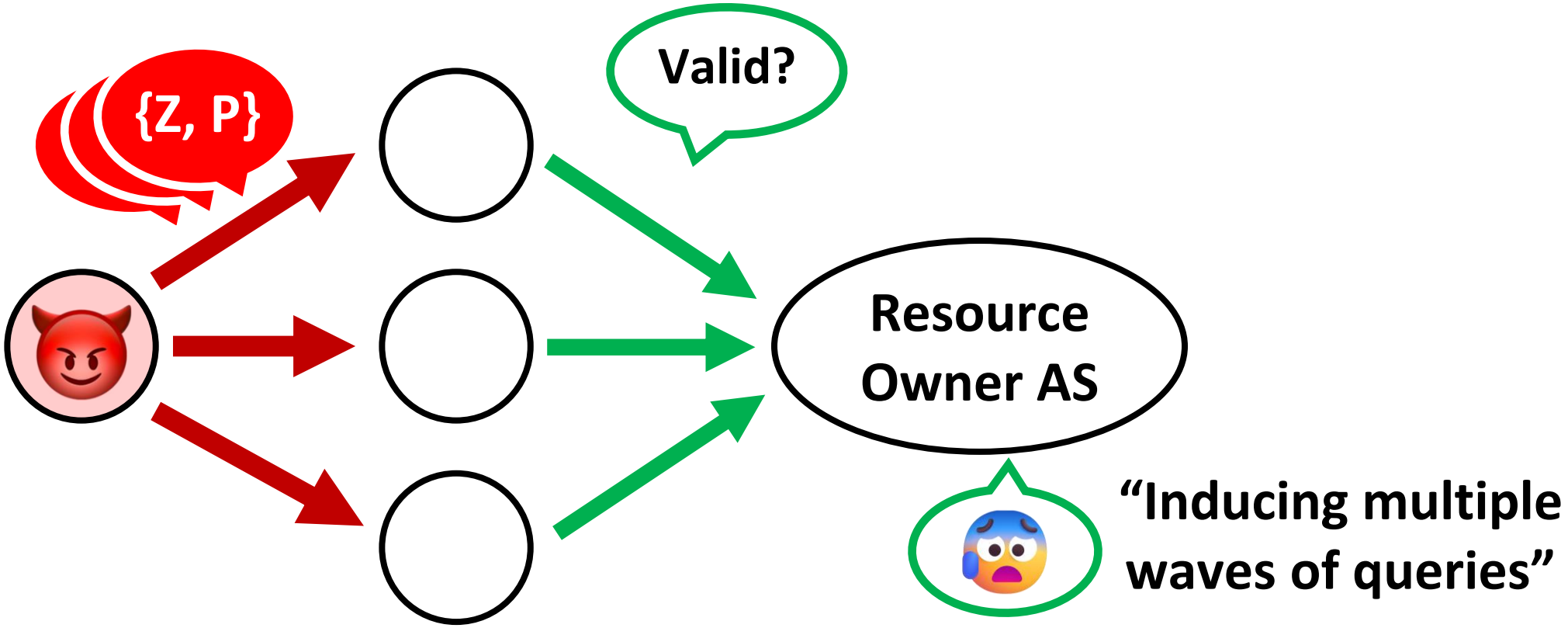
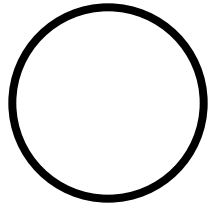
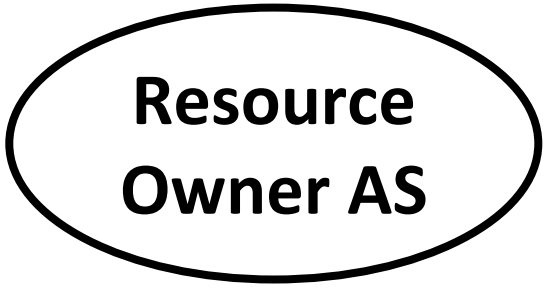


iROV Prevents Query Flooding and Abuse





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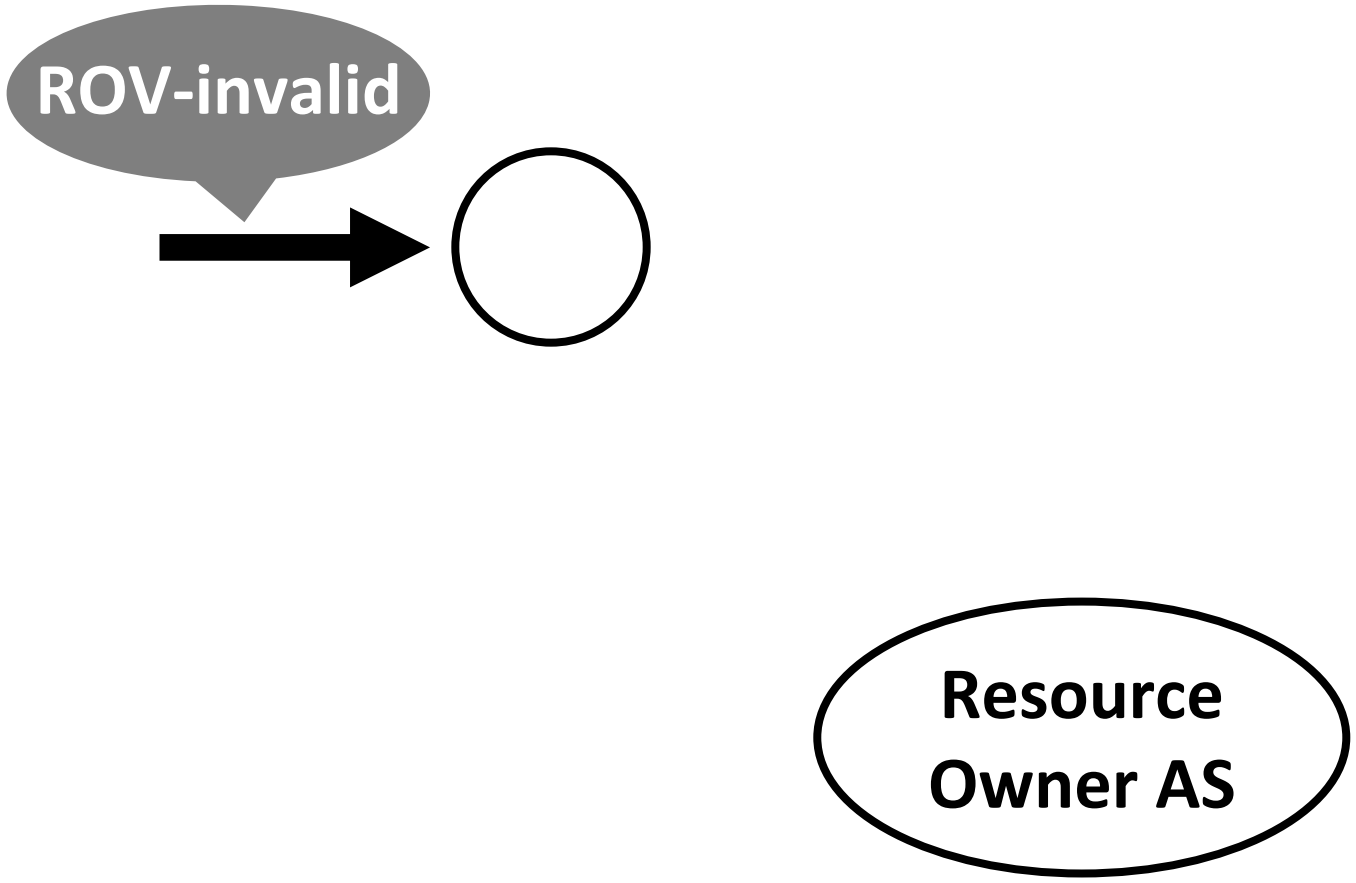

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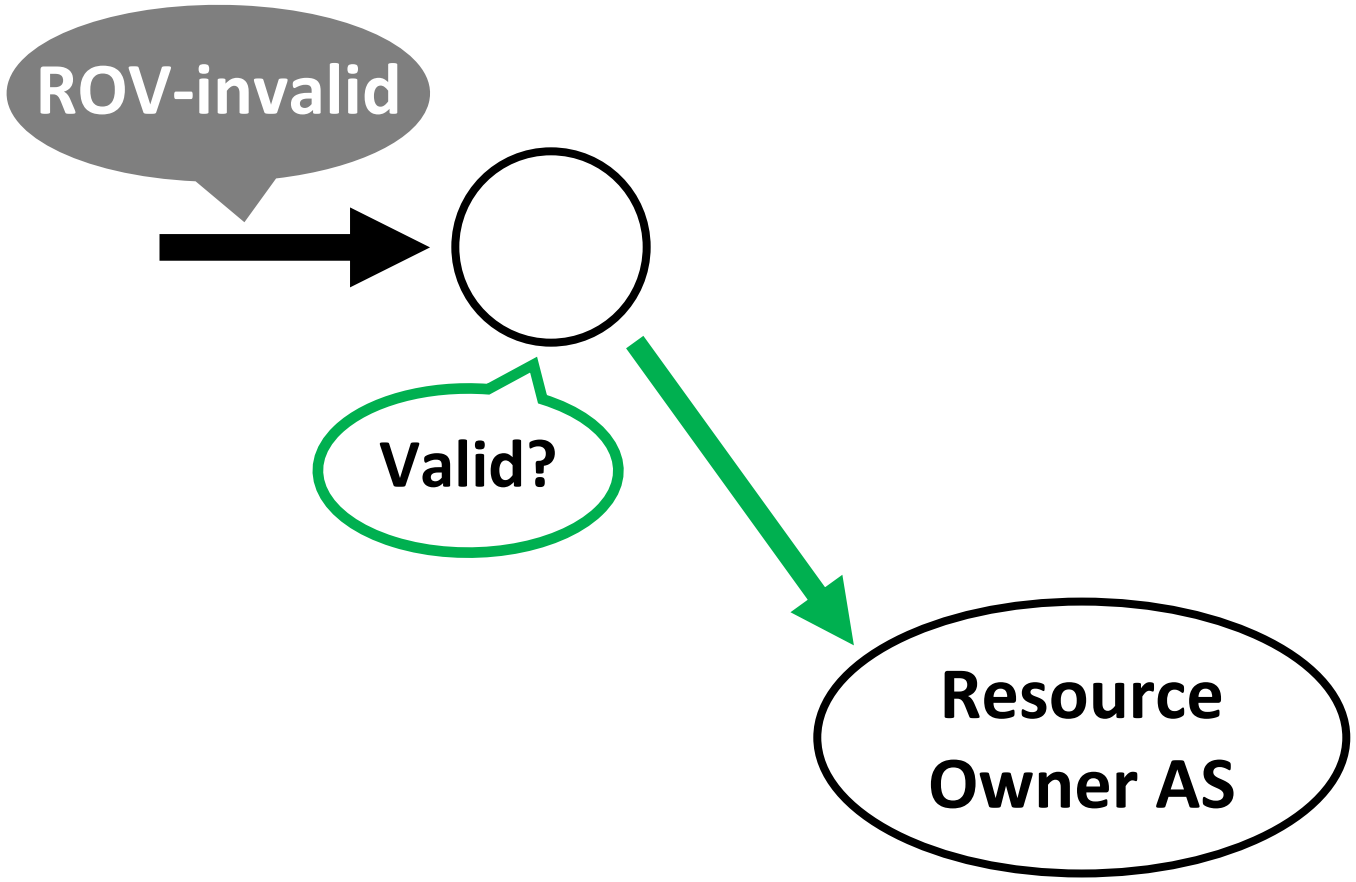

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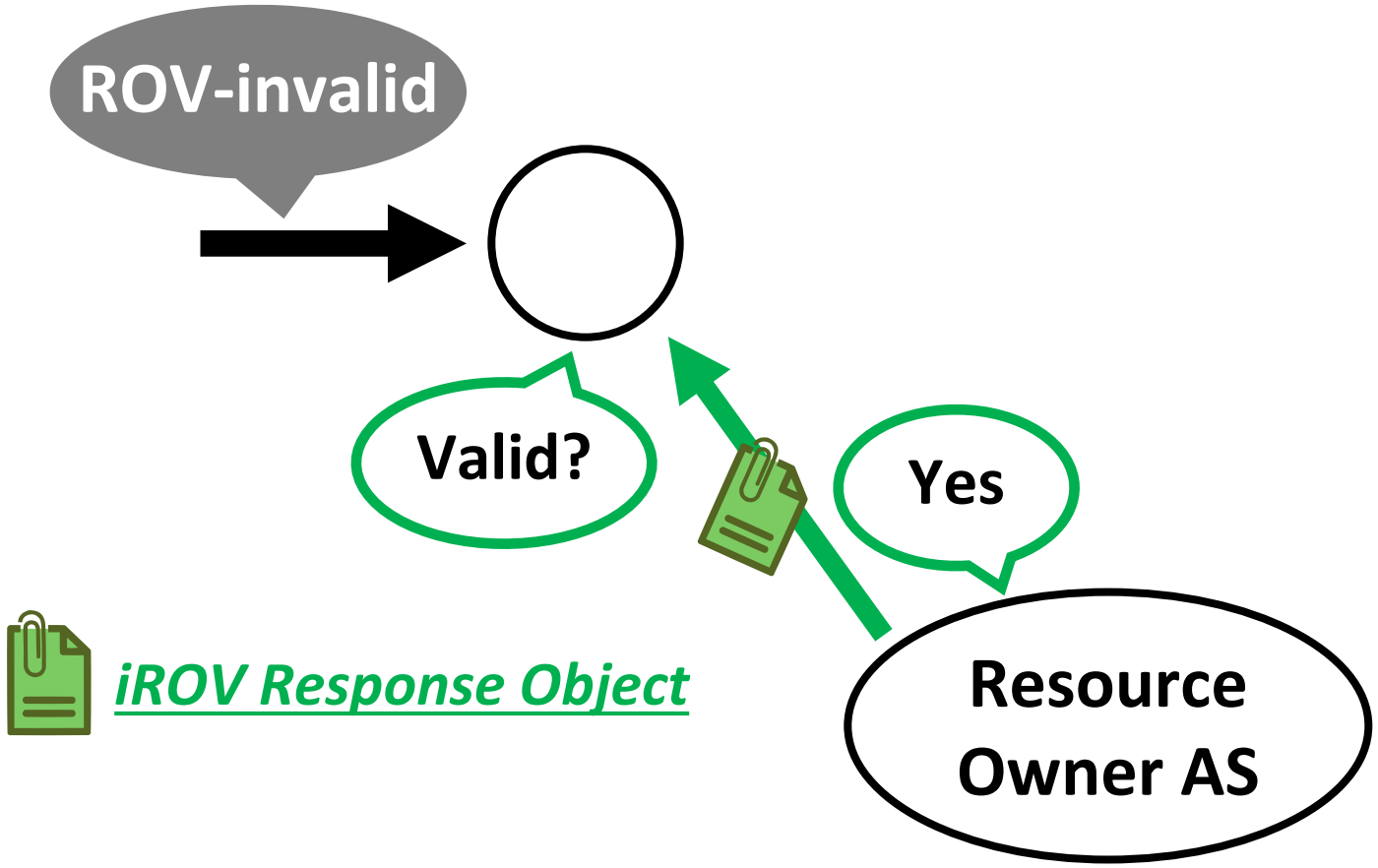

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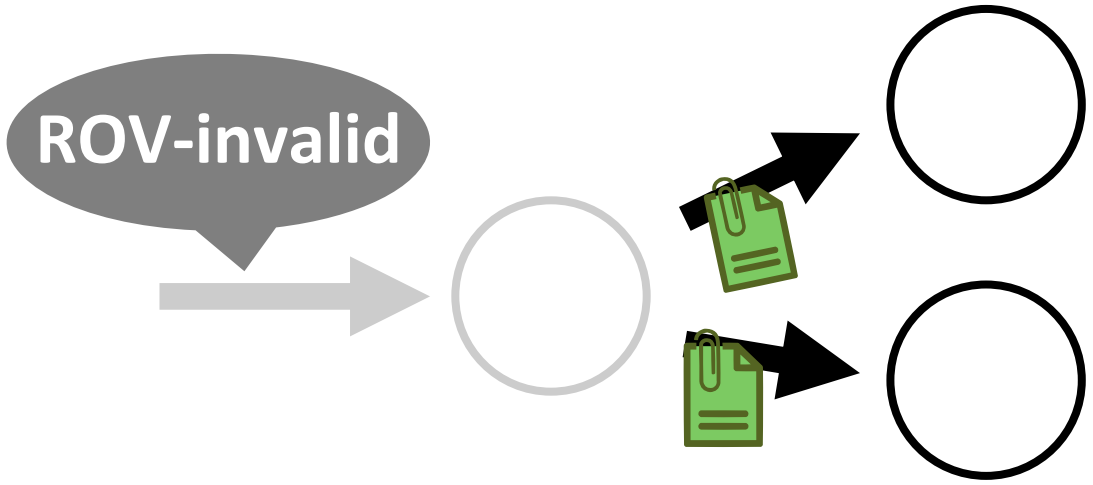
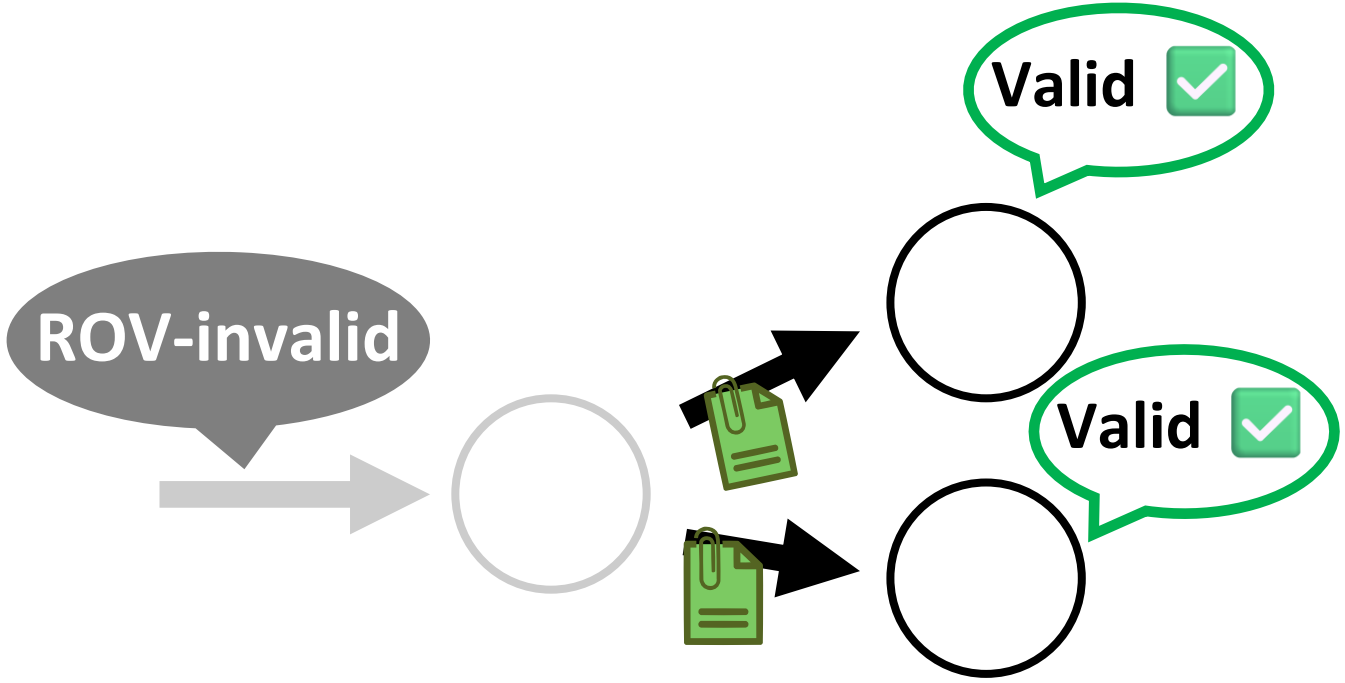


iROV Response Object

Resource Owner AS

iROV Prevents Query Flooding and Abuse



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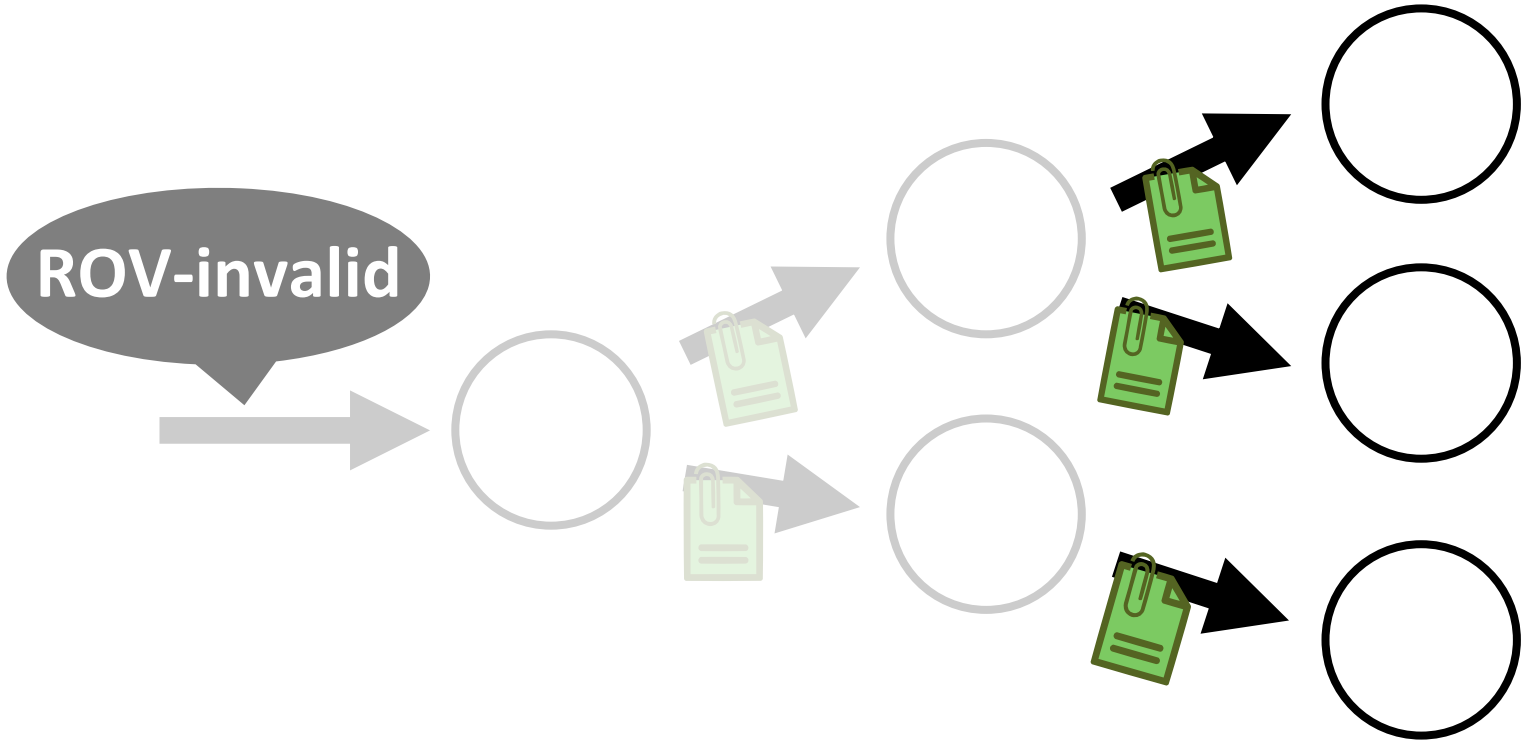
Resource Owner AS

iROV Prevents Query Flooding and Abuse



iROV Response Object

Resource Owner AS

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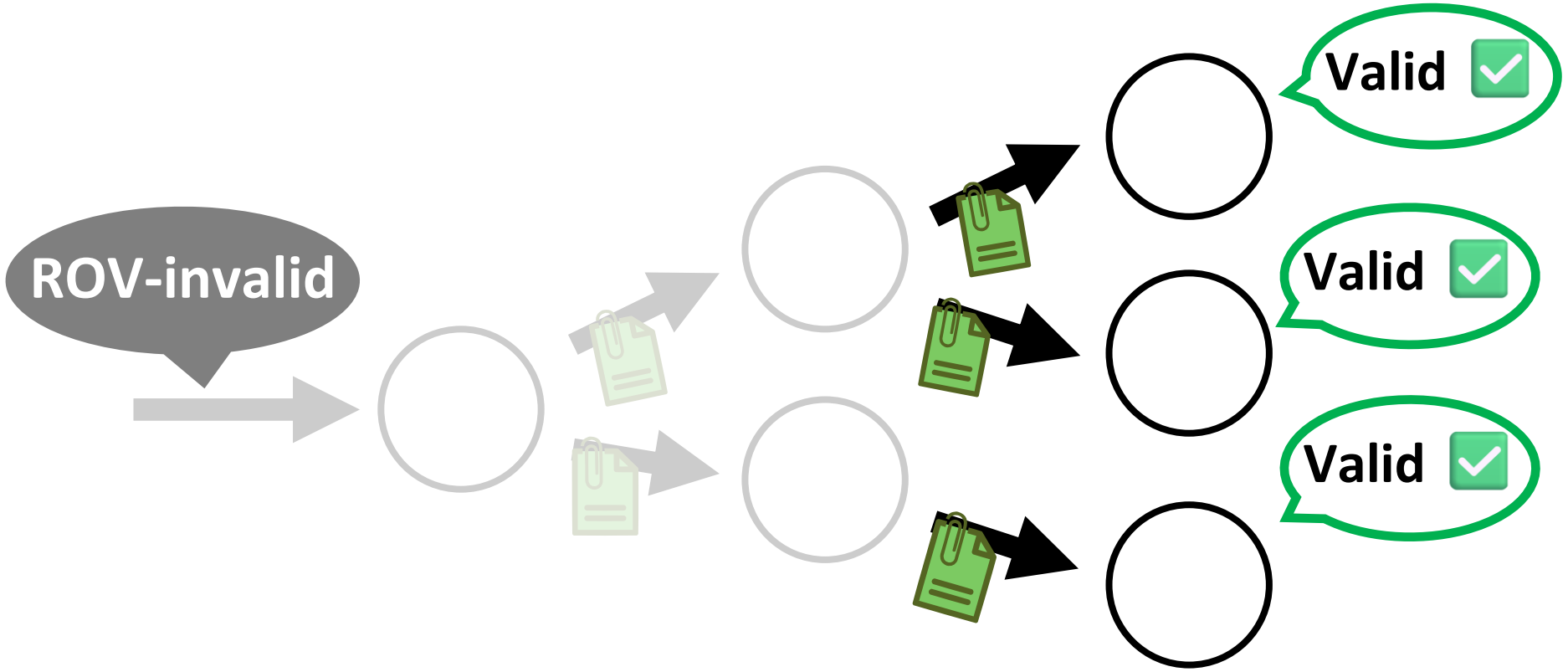

iROV Response Object

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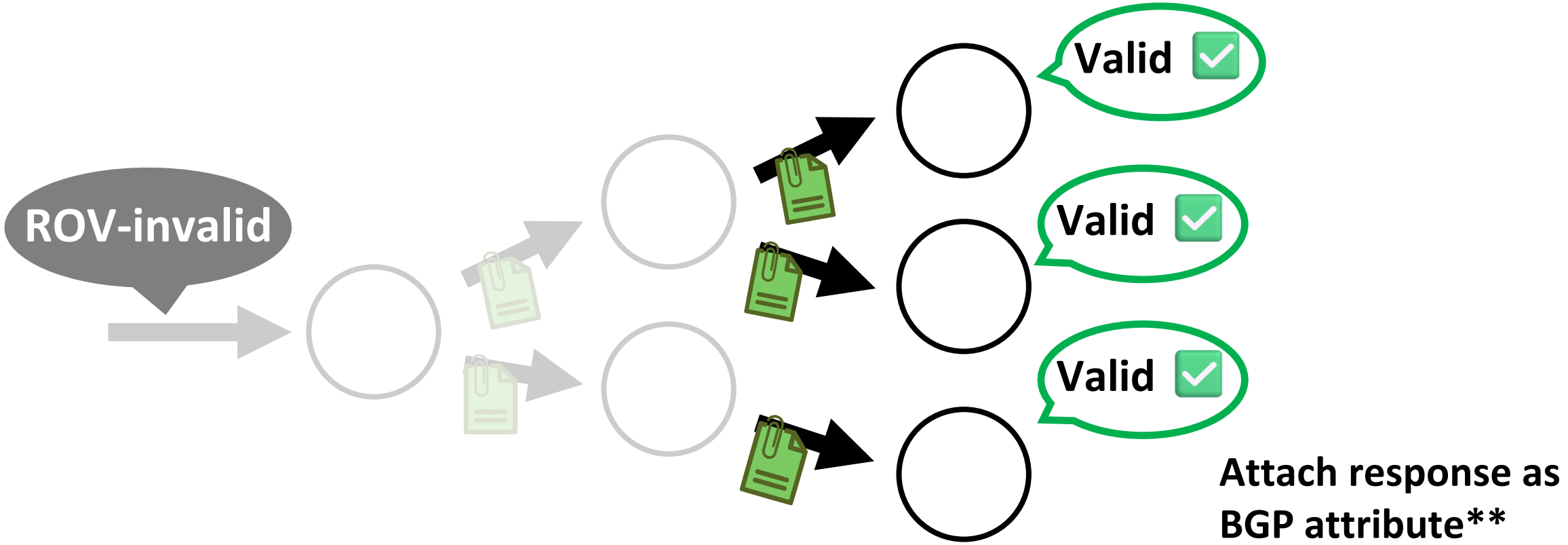
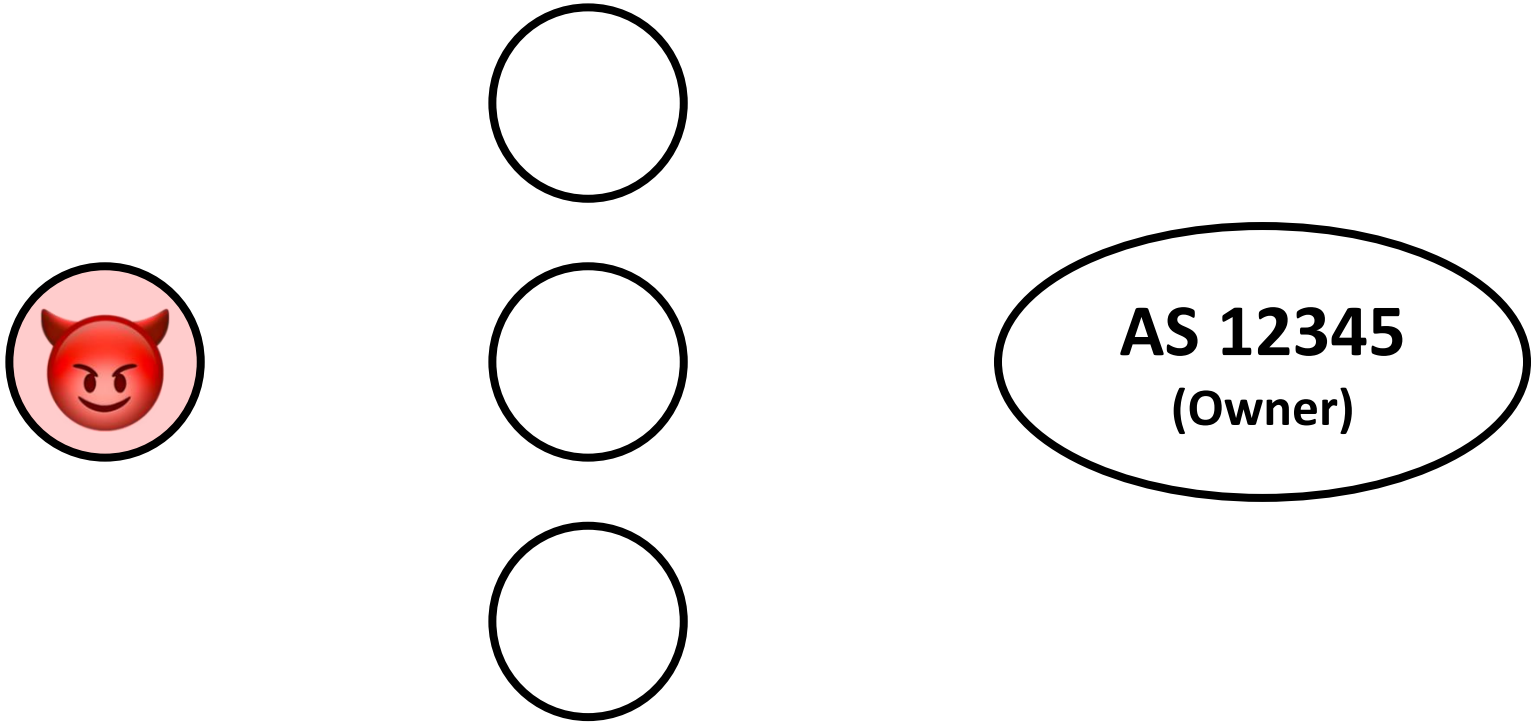


iROV Response Object

Resource Owner AS

Attribute is set as **optional and transitive such that non-ROV ASes will propagate attribute even if they do not recognize it

iROV Prevents Query Flooding and Abuse



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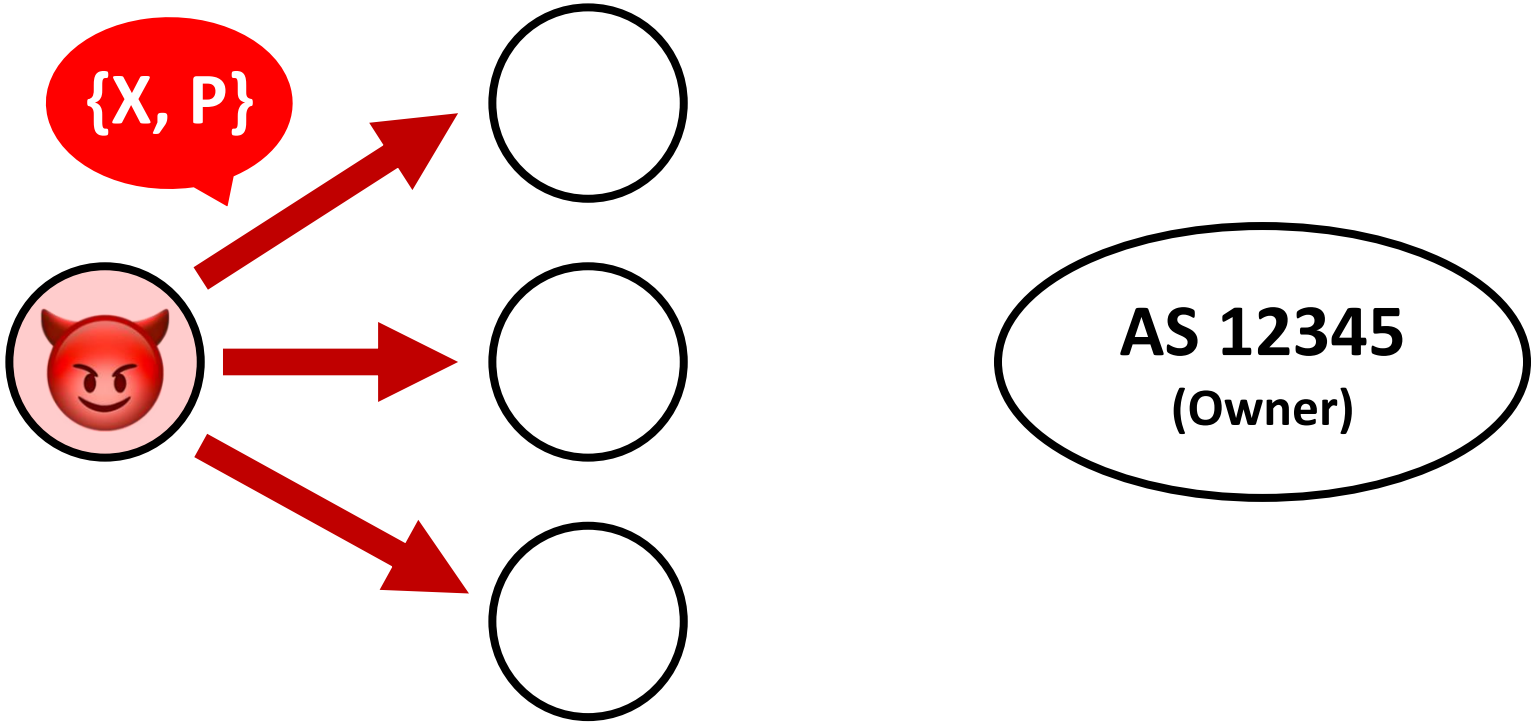

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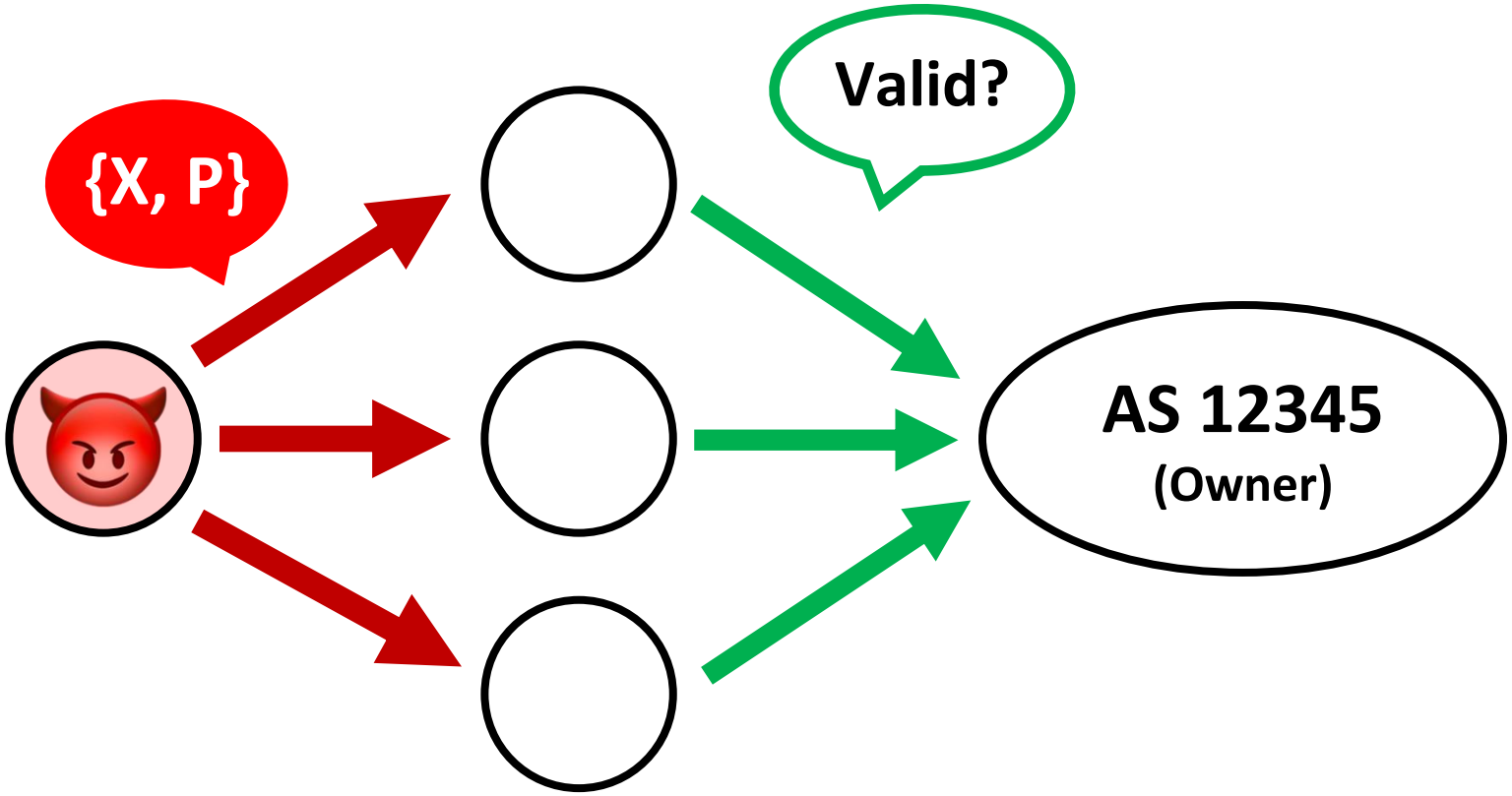

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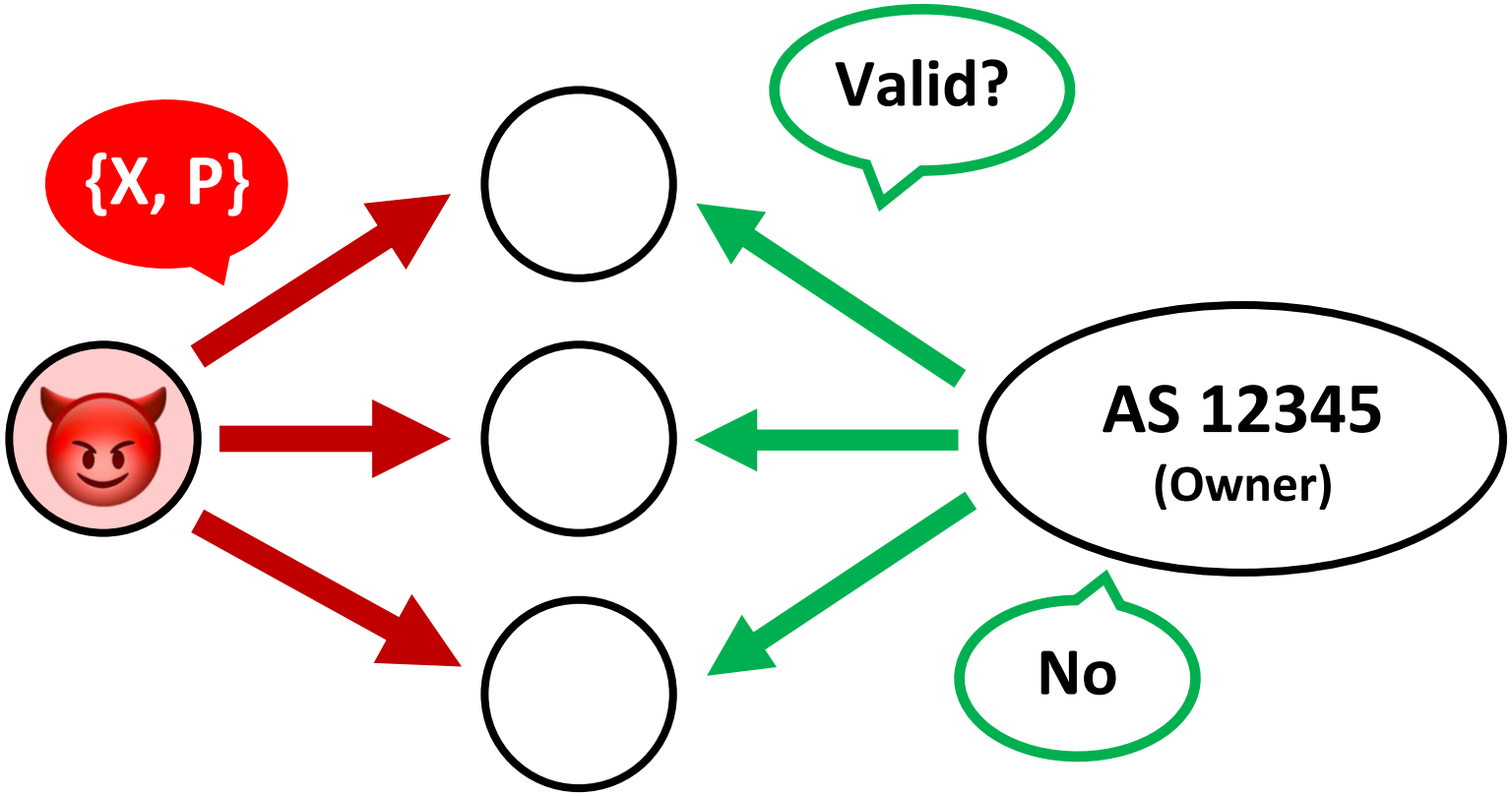

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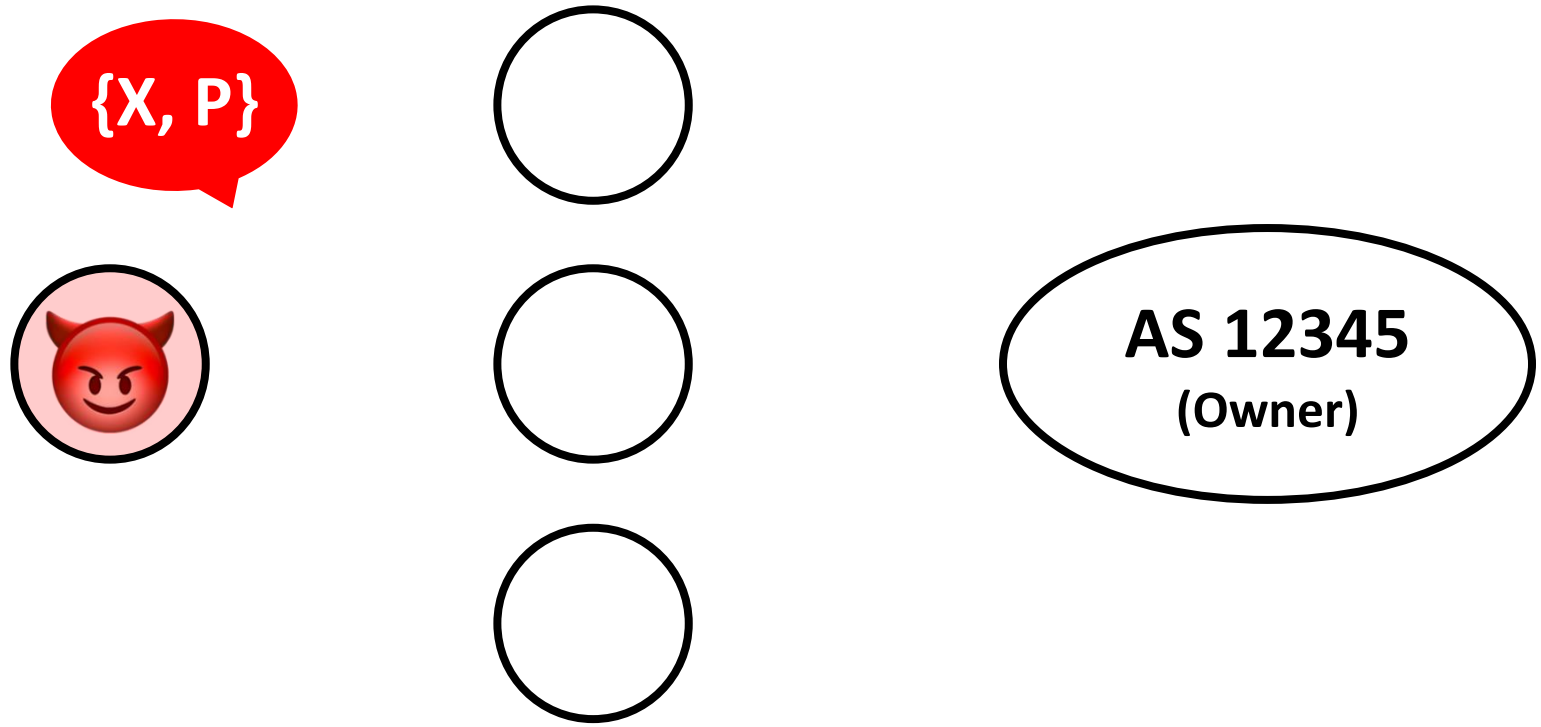

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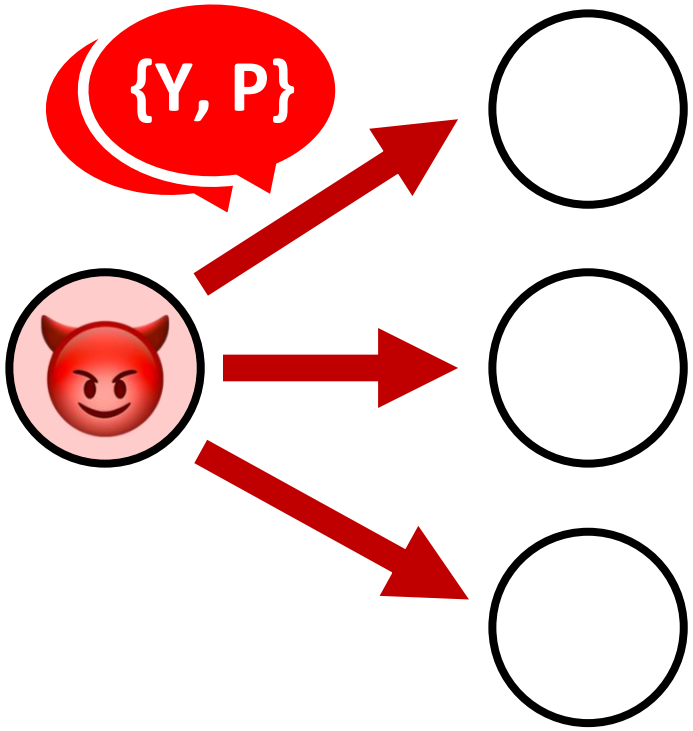

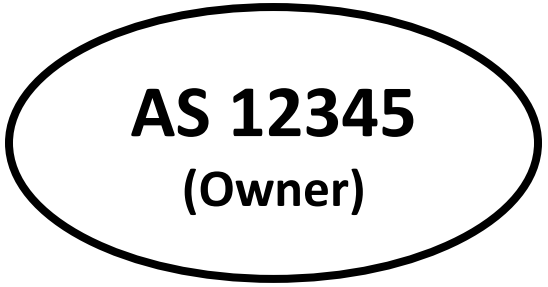

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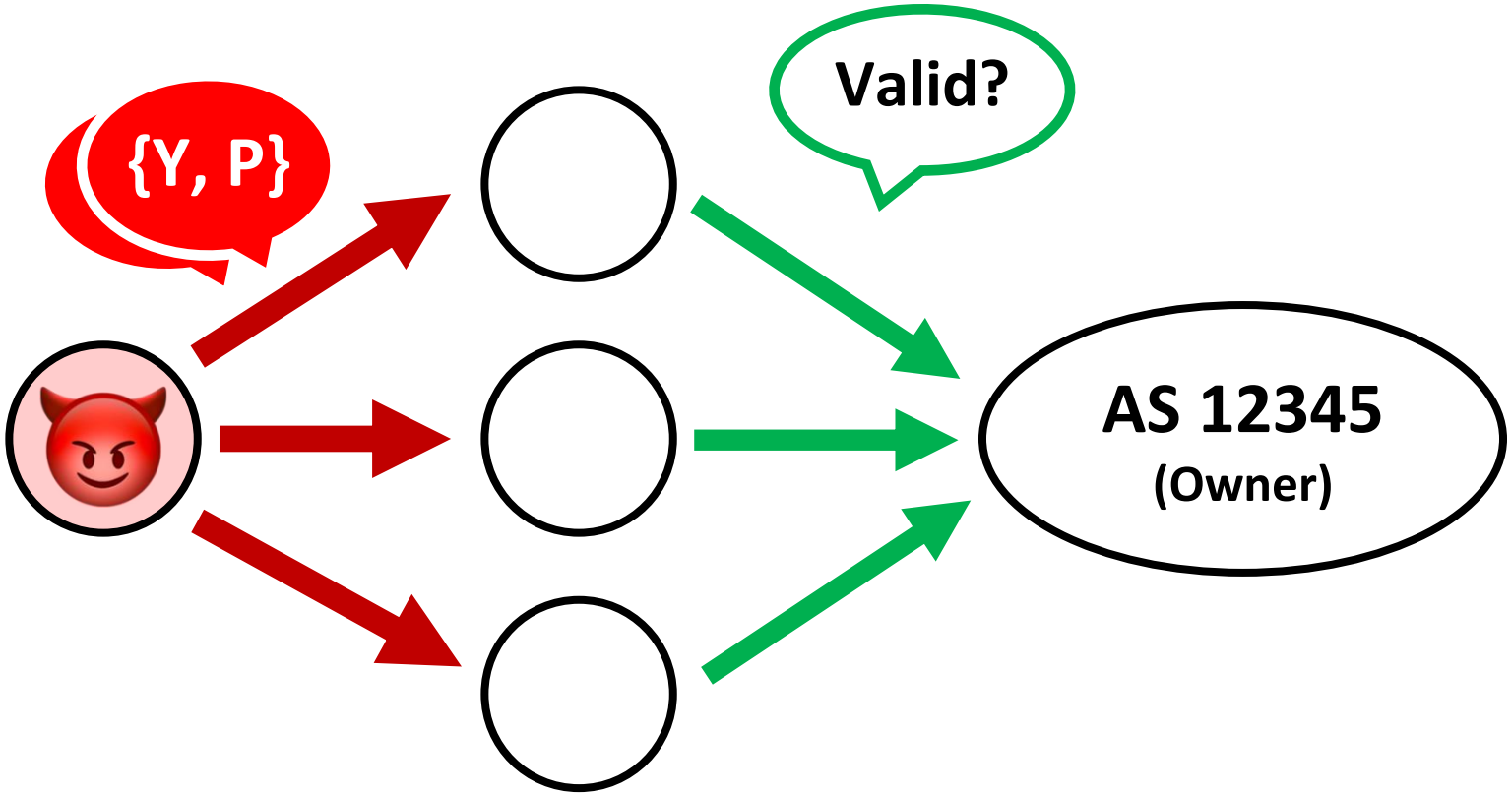

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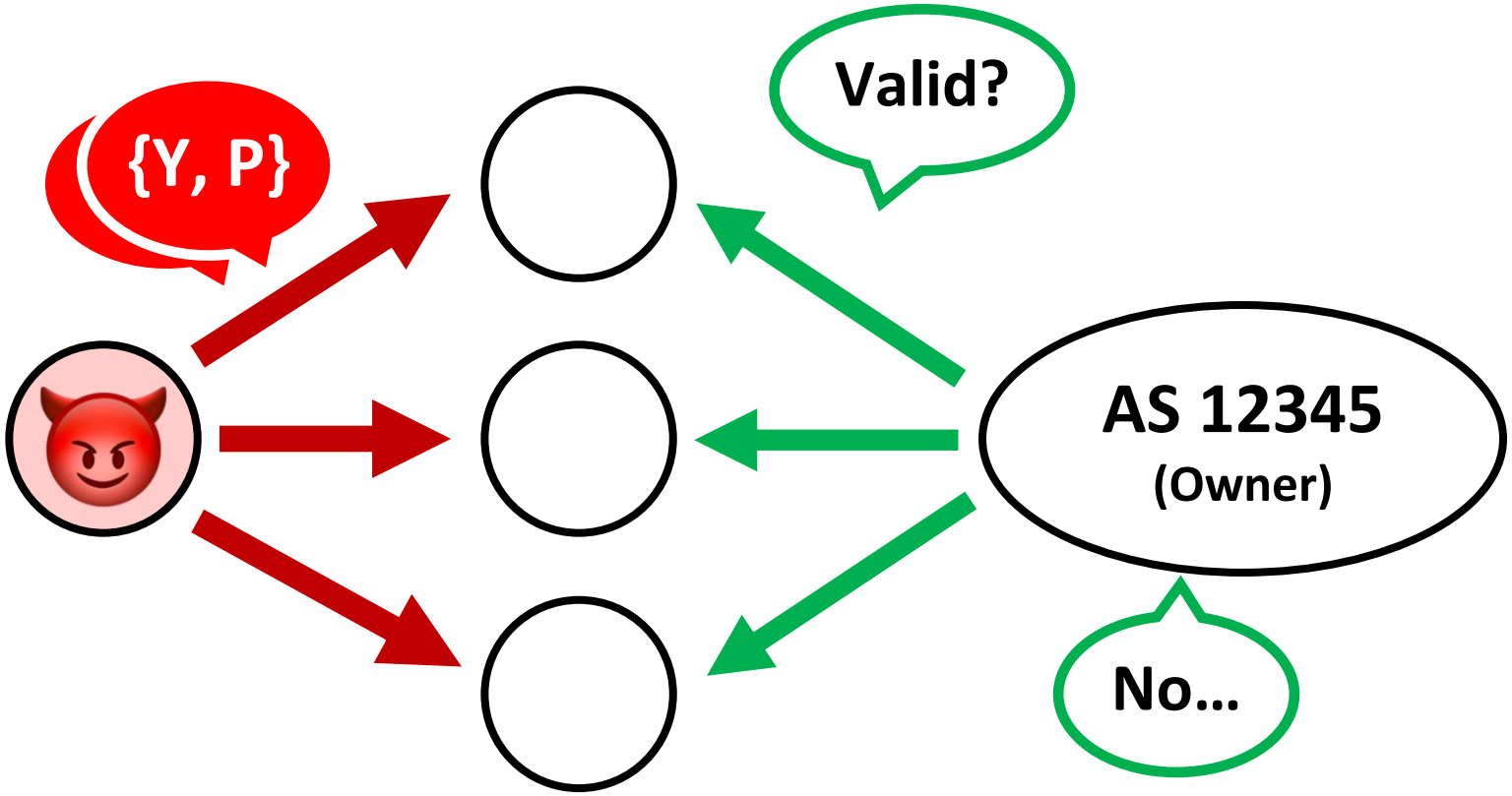

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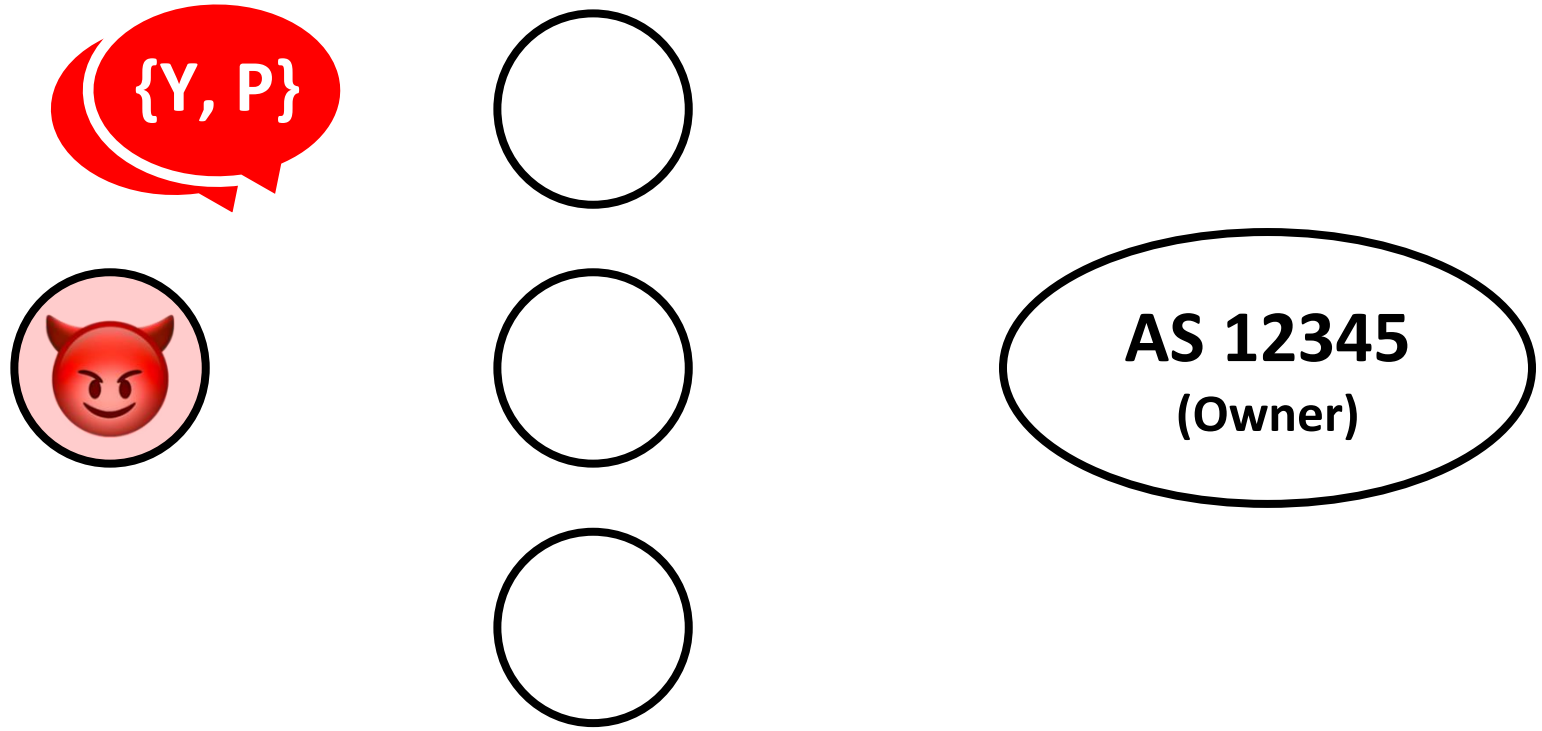

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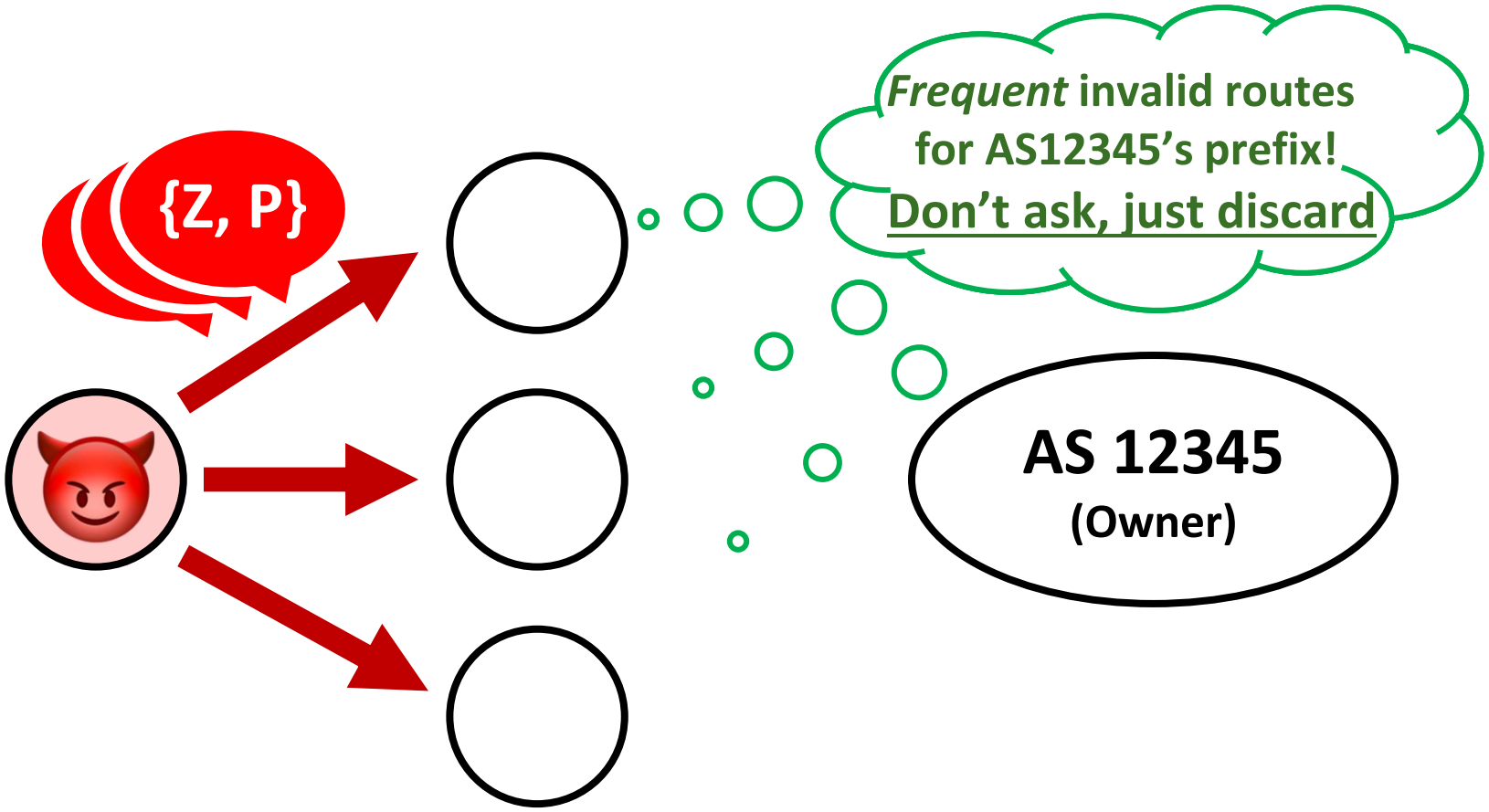

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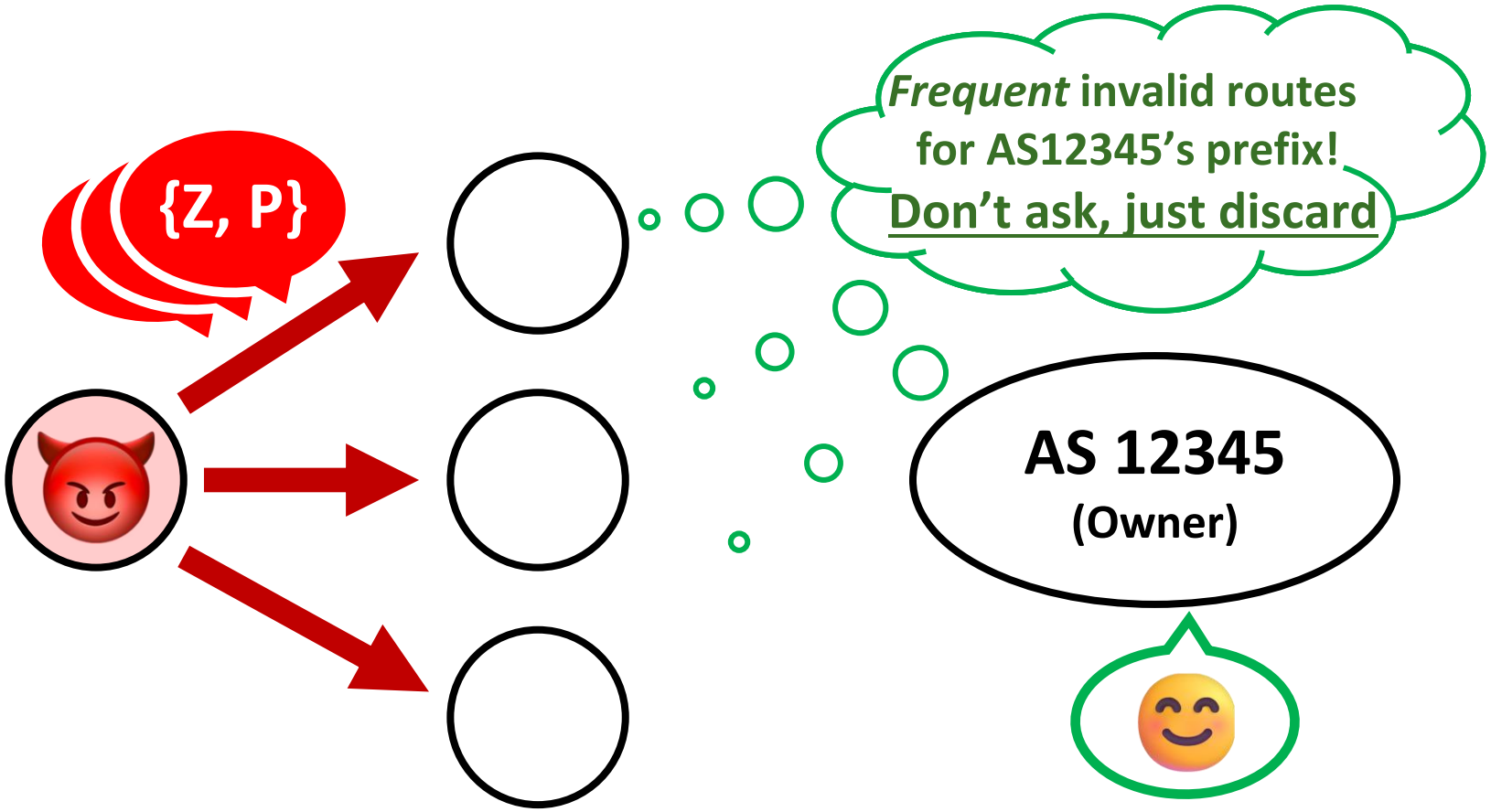

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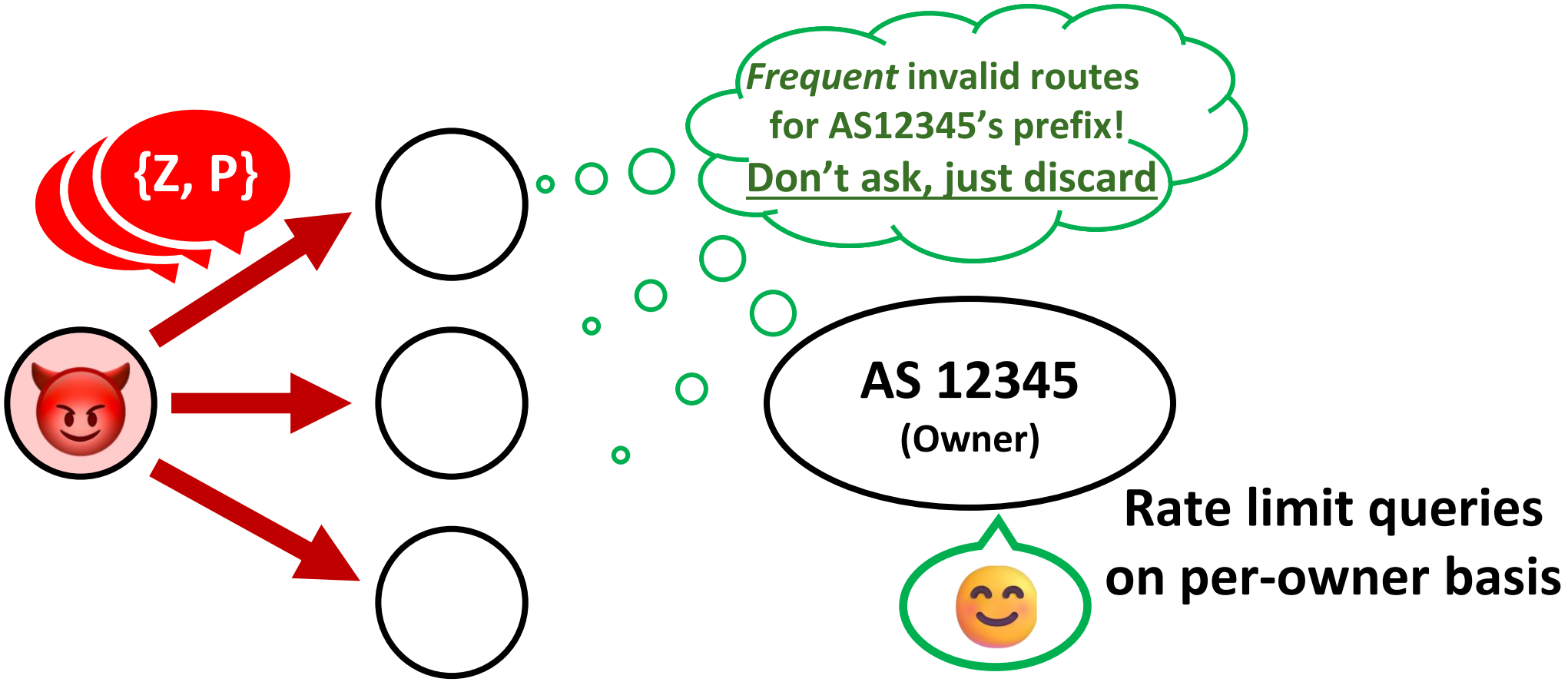
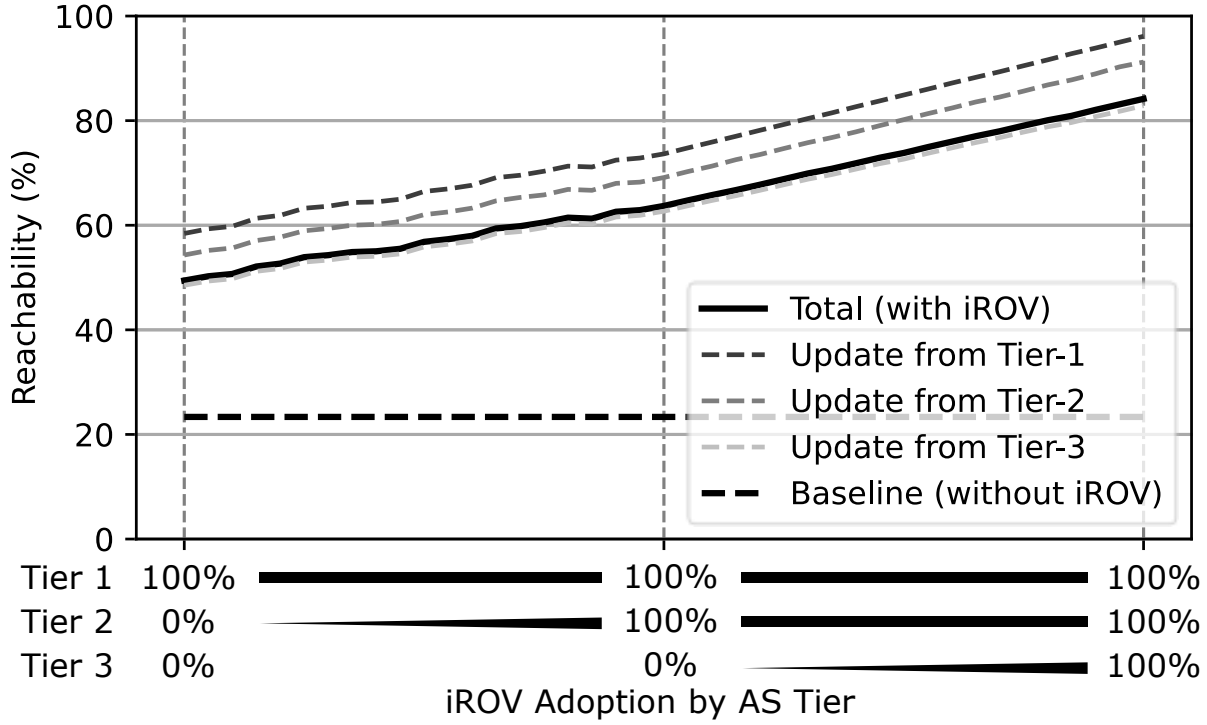


iROV Is Effective Even In Partial Adoption

Extensively propagating urgent route changes

Per an extensive BGP Simulation based on Sep. 2025 CAIDA AS Relationship Dataset



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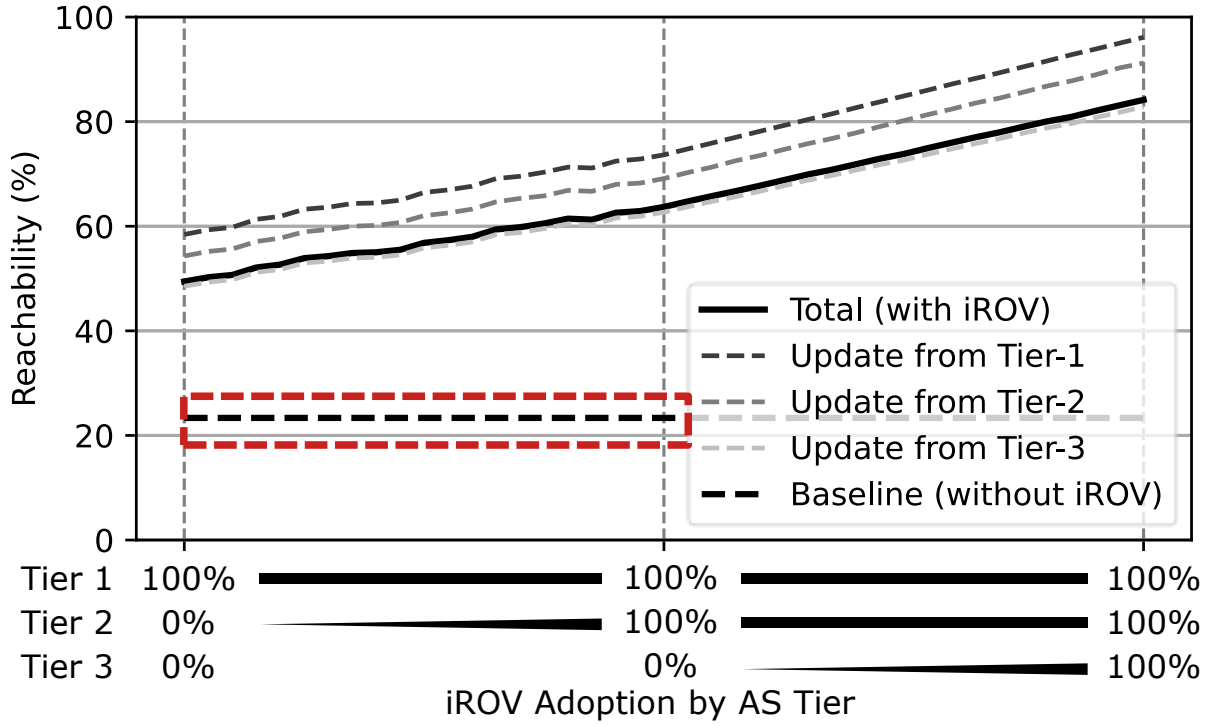
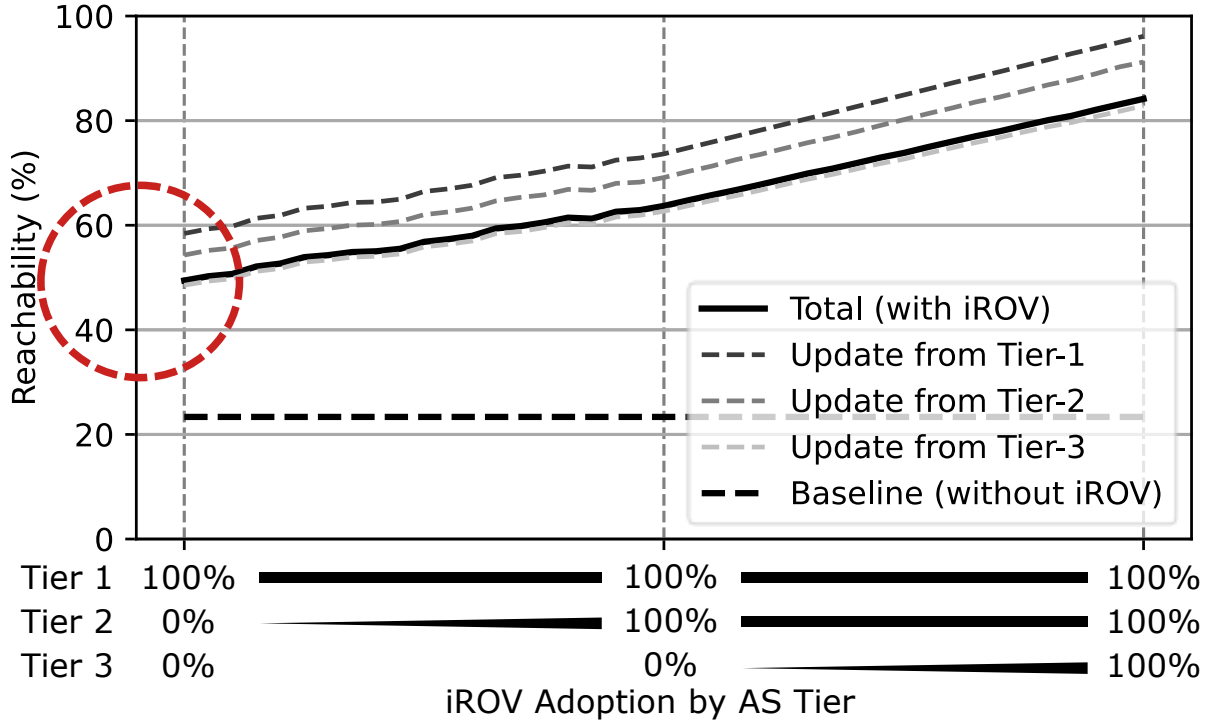


- Baseline urgent route change: reaches **23%** of ASes (No iROV deployed)

iROV Is Effective Even In Partial Adoption

Extensively propagating urgent route changes

Per an extensive BGP Simulation based on Sep. 2025 CAIDA AS Relationship Dataset

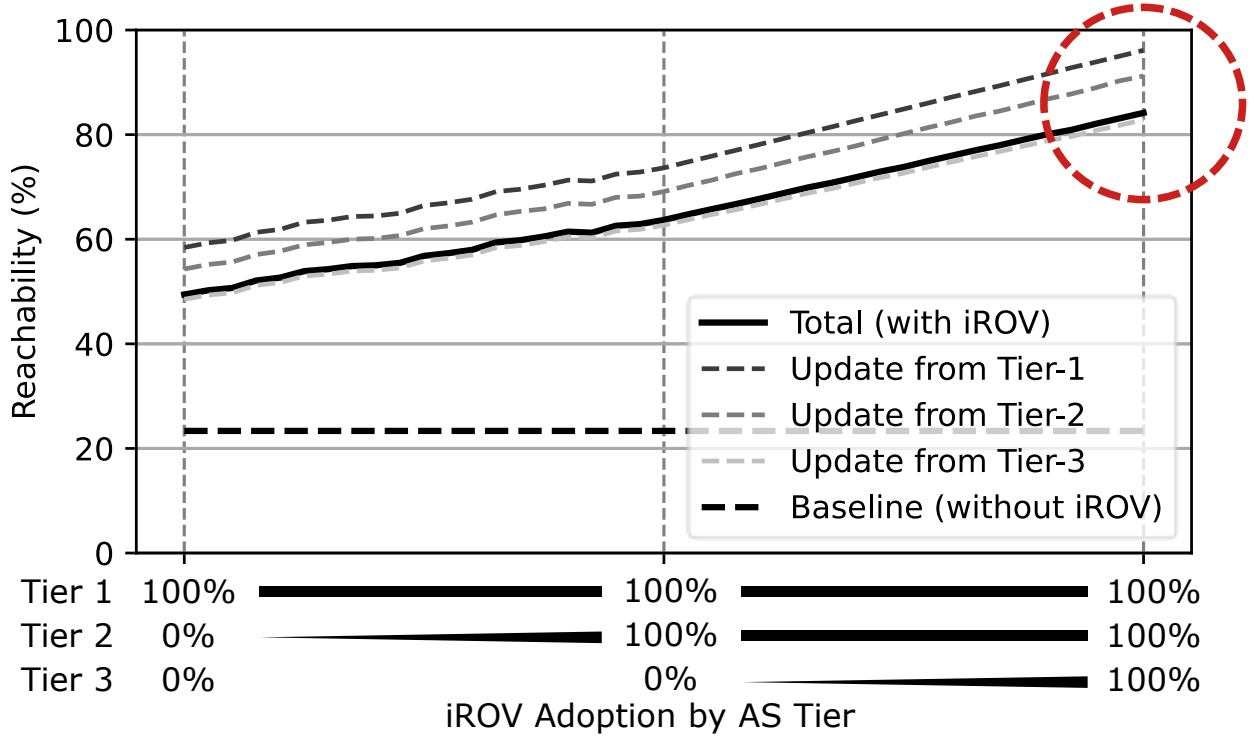


- Early tier-1 only adoption: reaches **49%** of ASes (**> 2x reachability** for early partial adoption)

iROV Is Effective Even In Partial Adoption

Extensively propagating urgent route changes

Per an extensive BGP Simulation based on Sep. 2025 CAIDA AS Relationship Dataset

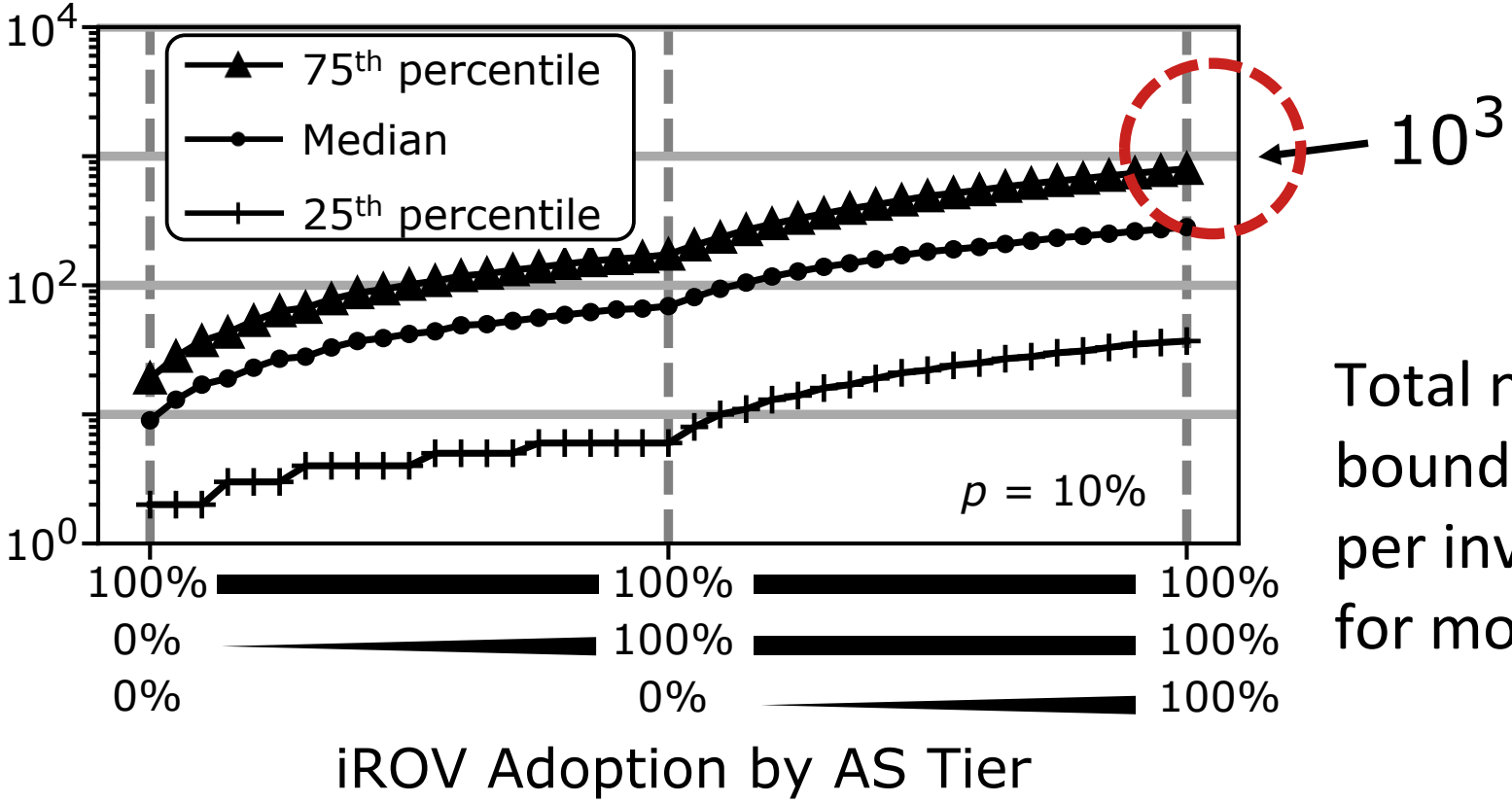


- Full adoption: nearly **90%** of Ases (**Near full eventual reachability**)

iROV Incurs Minimal Overhead

Effectively bounding owner-side query pressure

Per an extensive BGP Simulation based on Sep. 2025 CAIDA AS Relationship Dataset

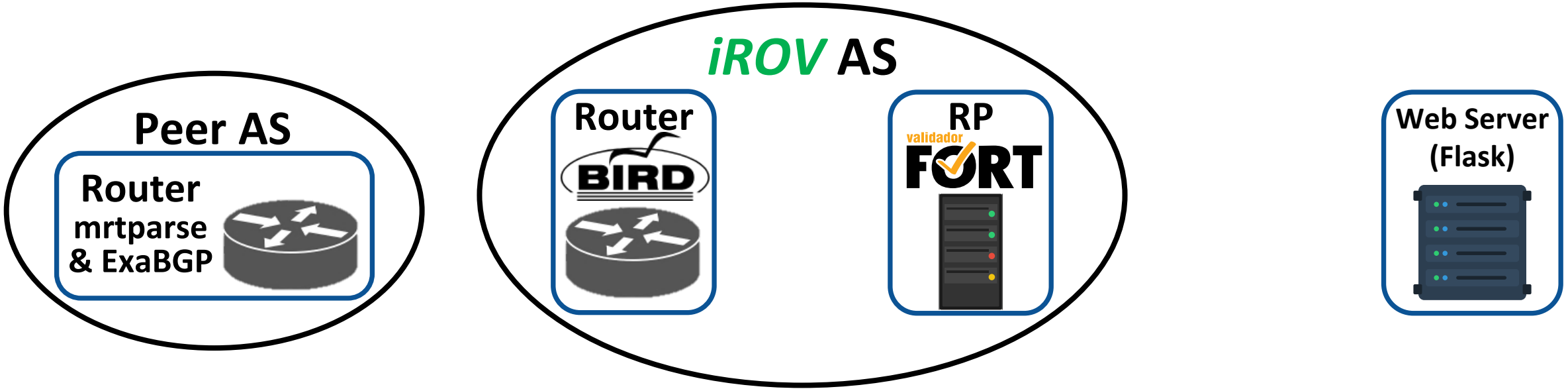


Total number of queries is bounded to **~1,000** per invalid announcement for most cases

iROV Incurs Minimal Overhead

Negligible performance overhead: prototype implementation

Modified BIRD (router) and FORT Validator (RP)



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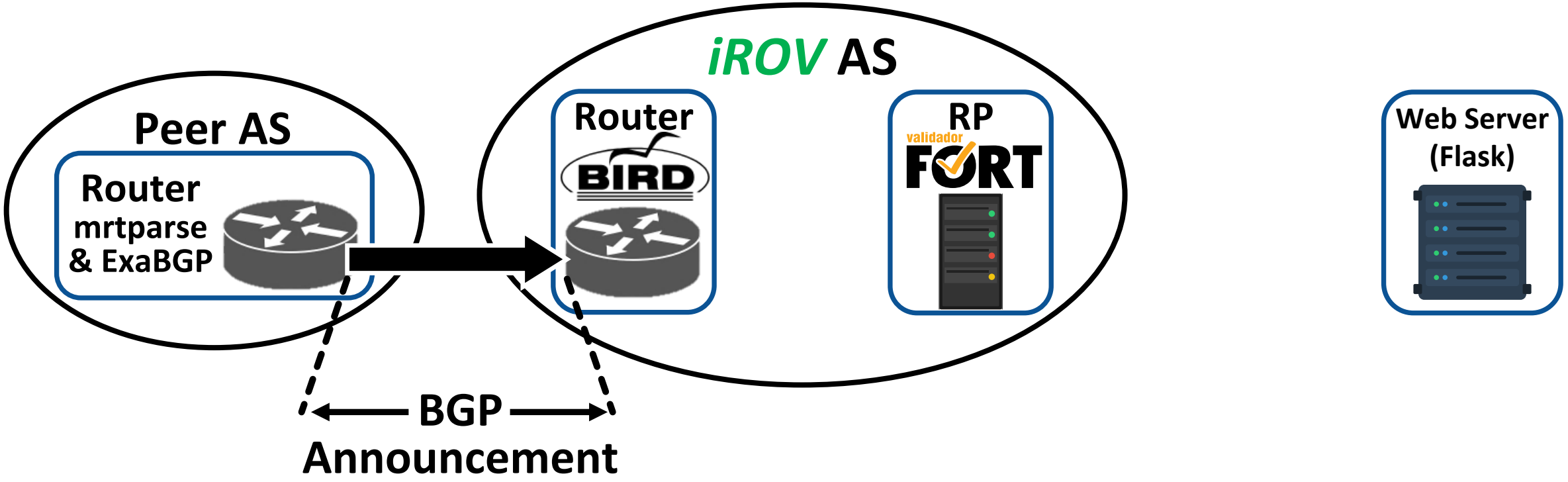

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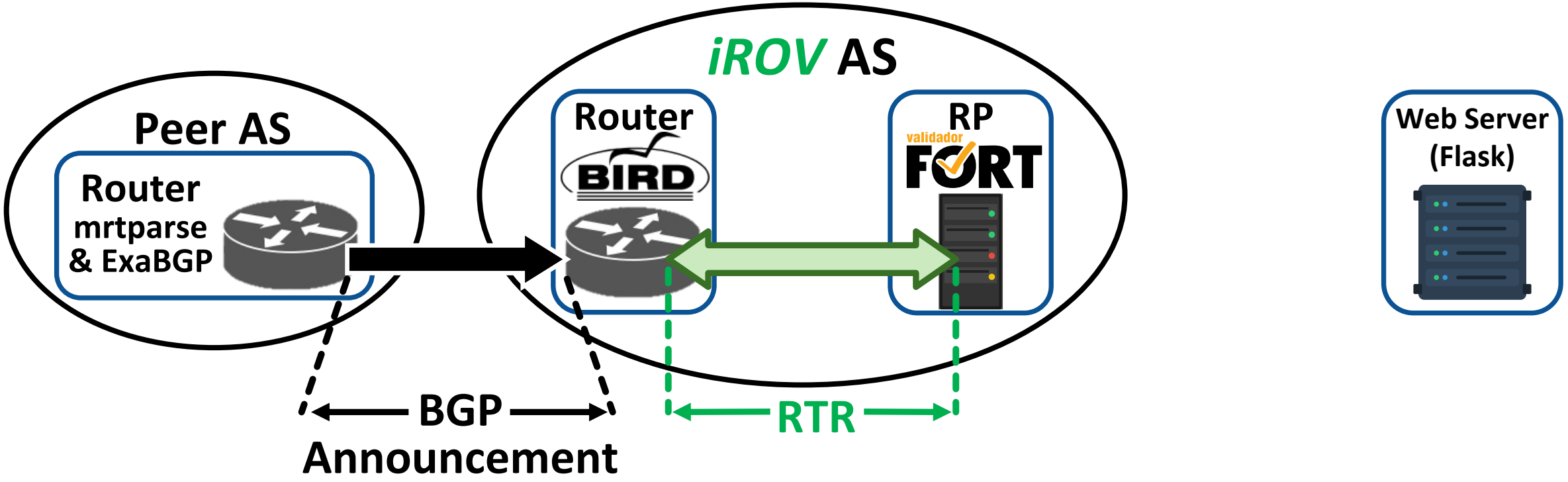

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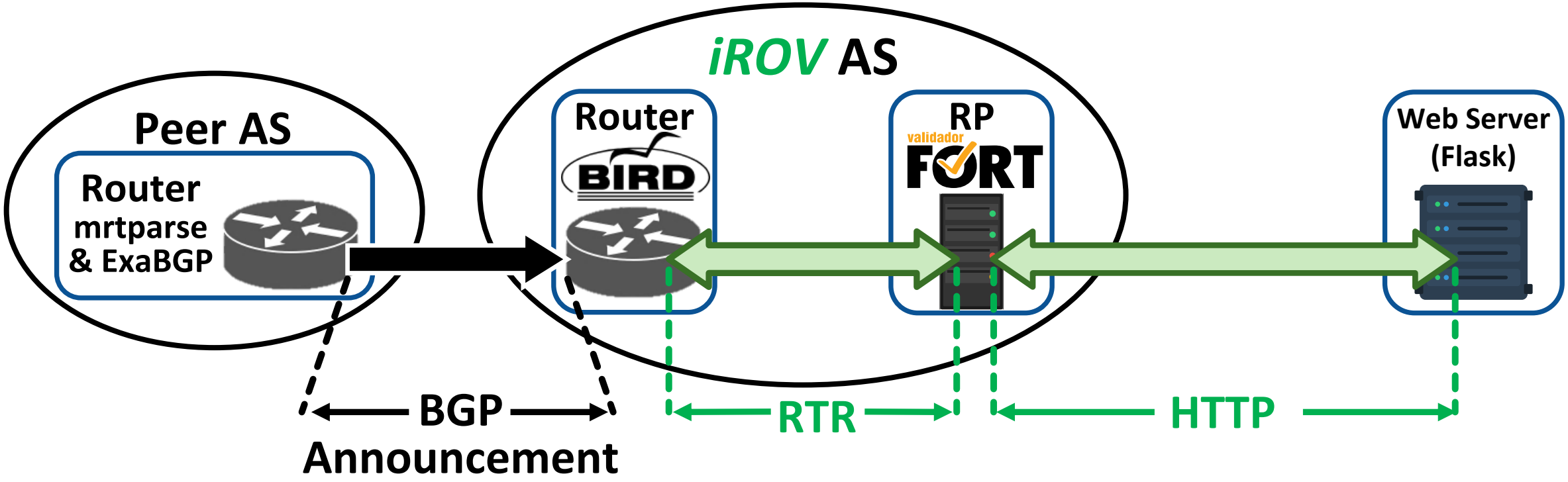

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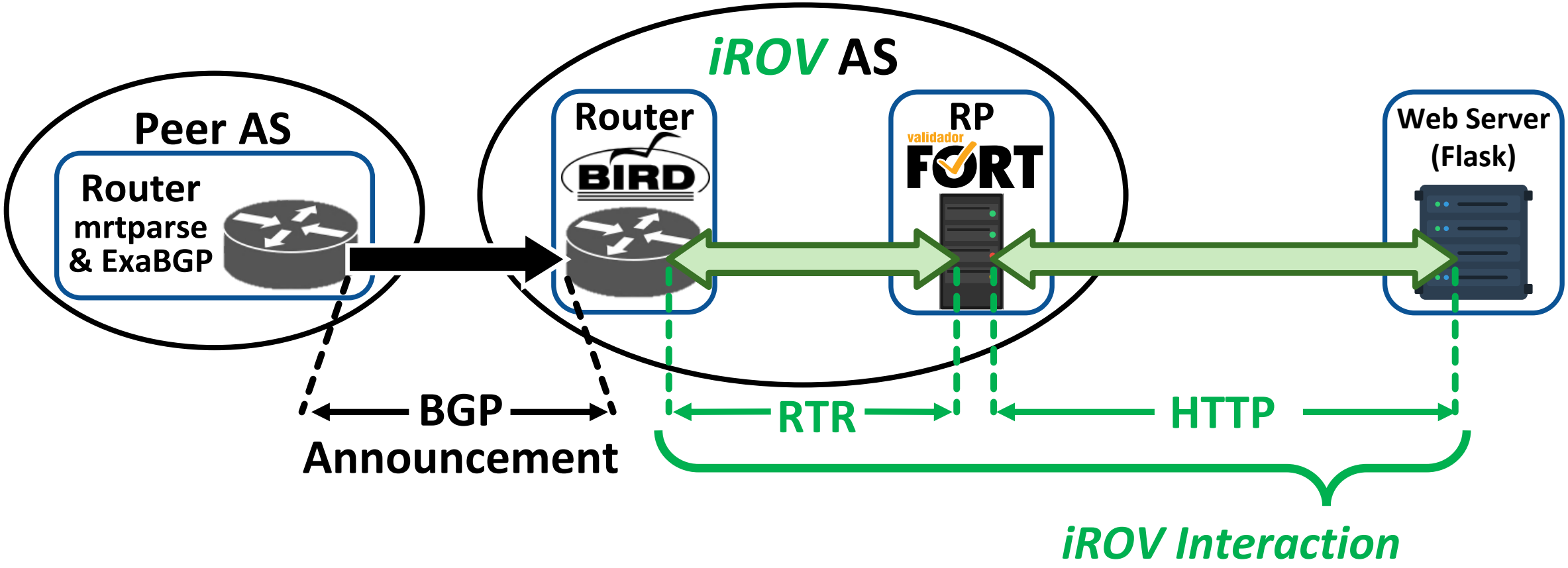

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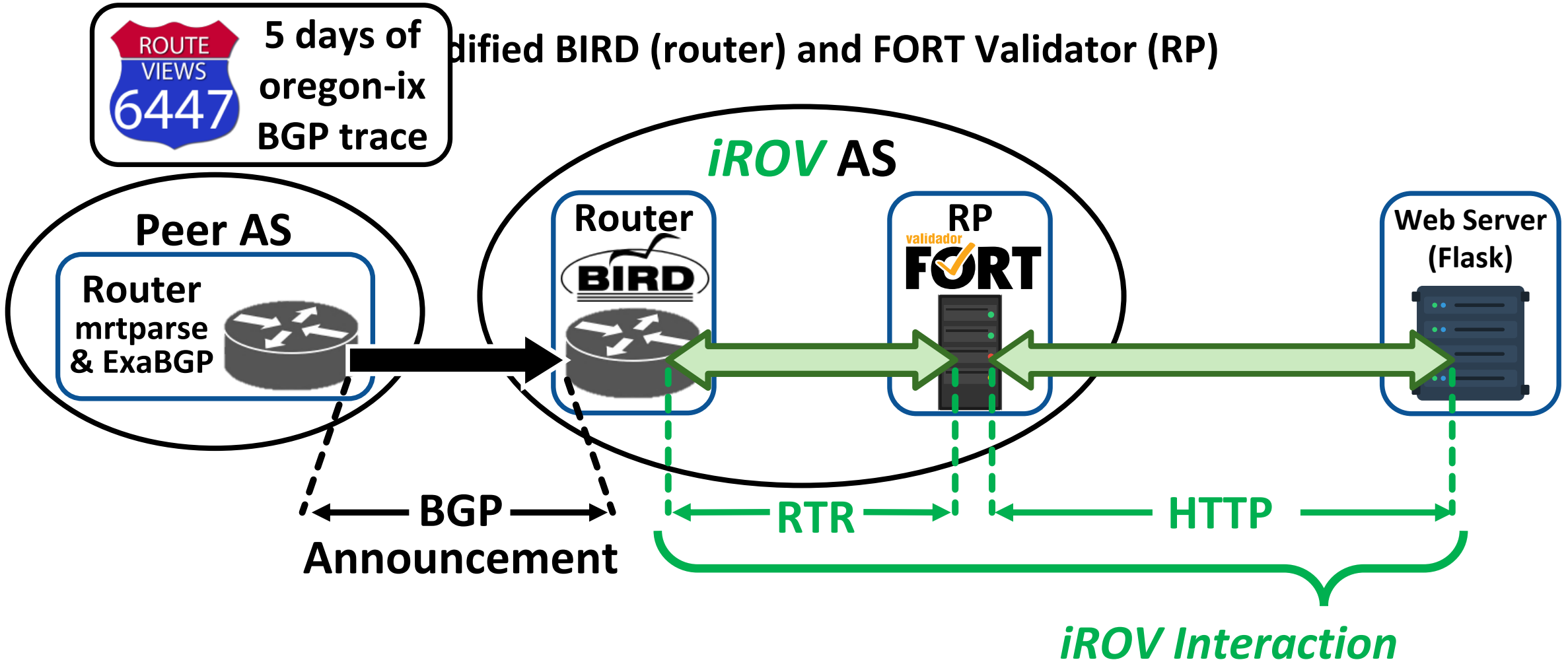

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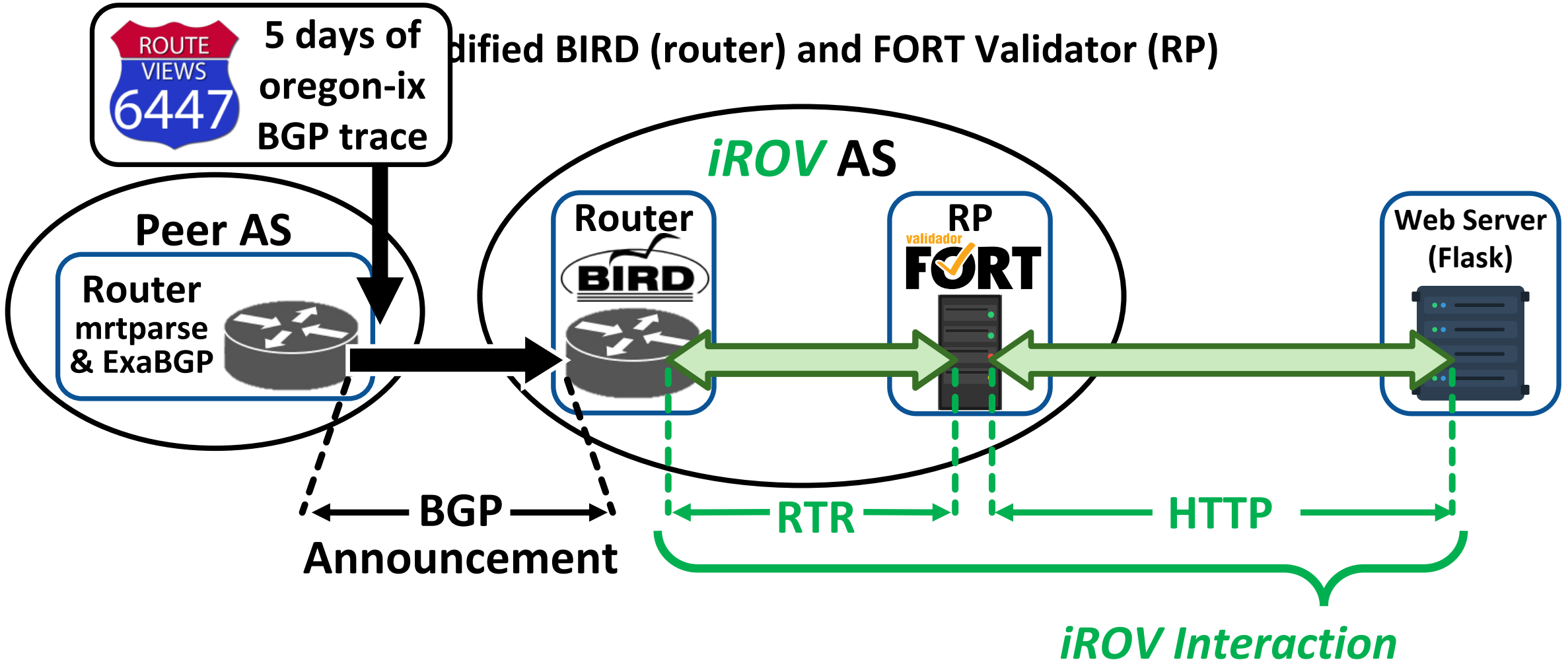

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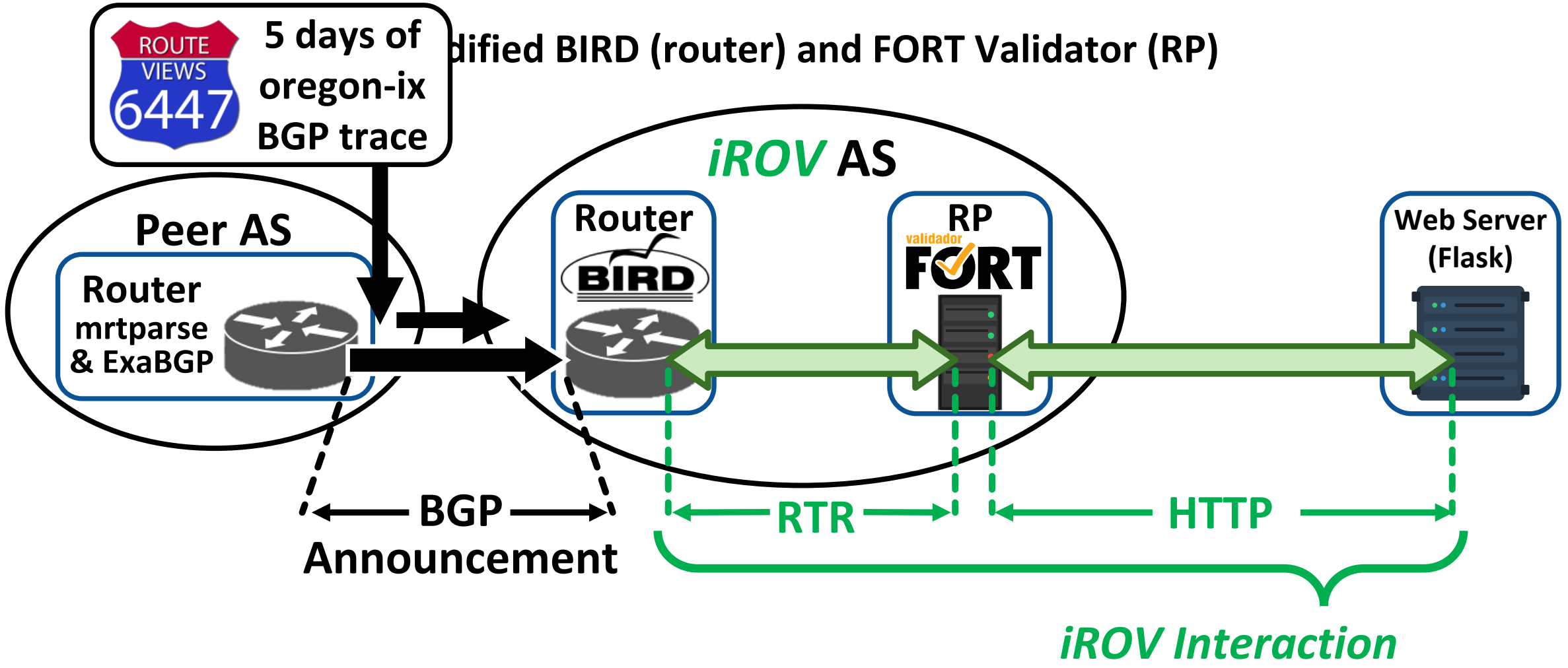

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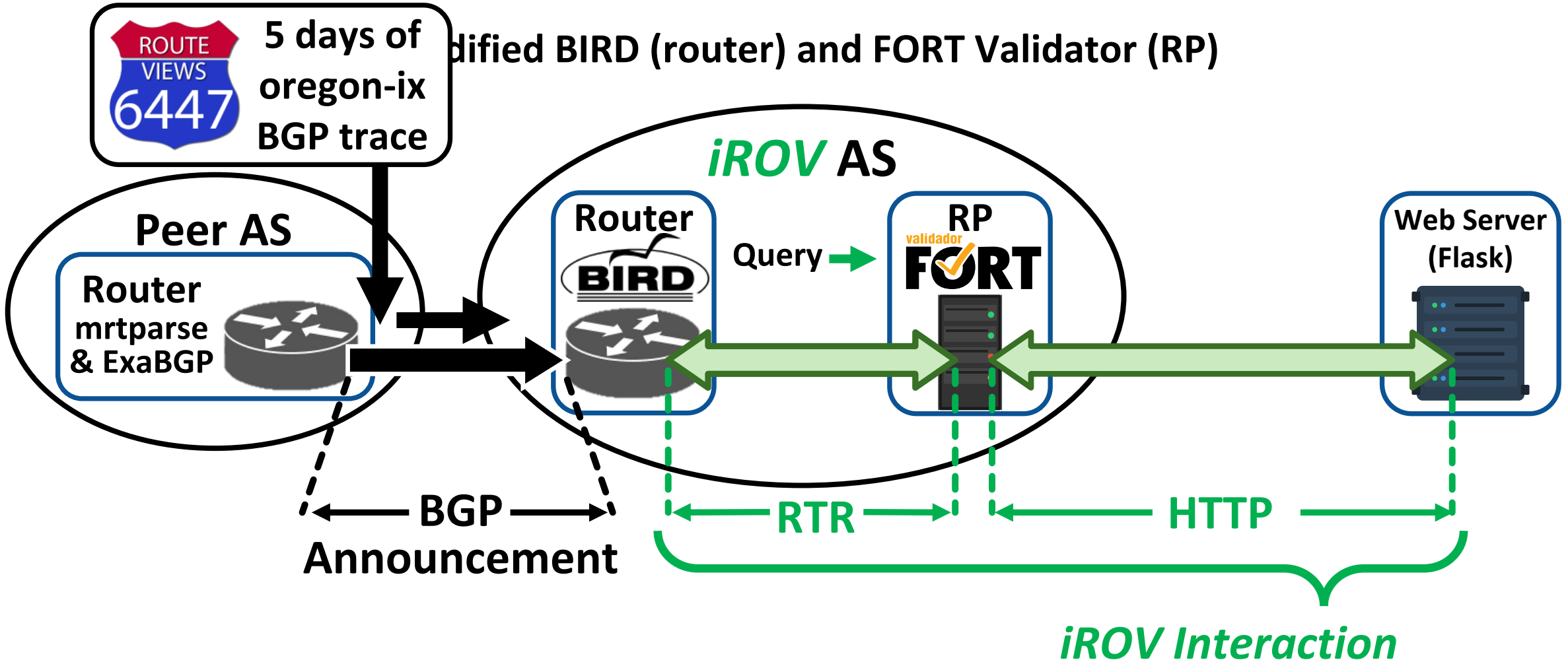

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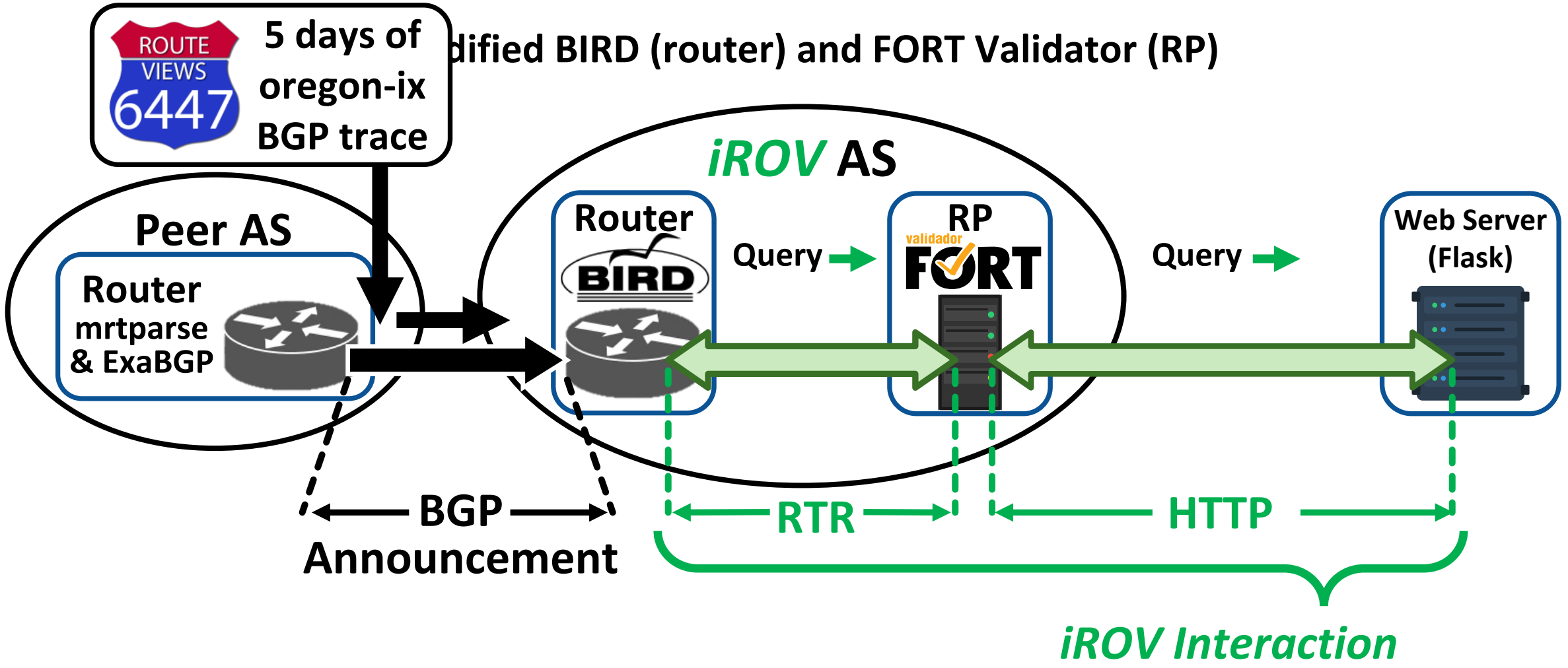

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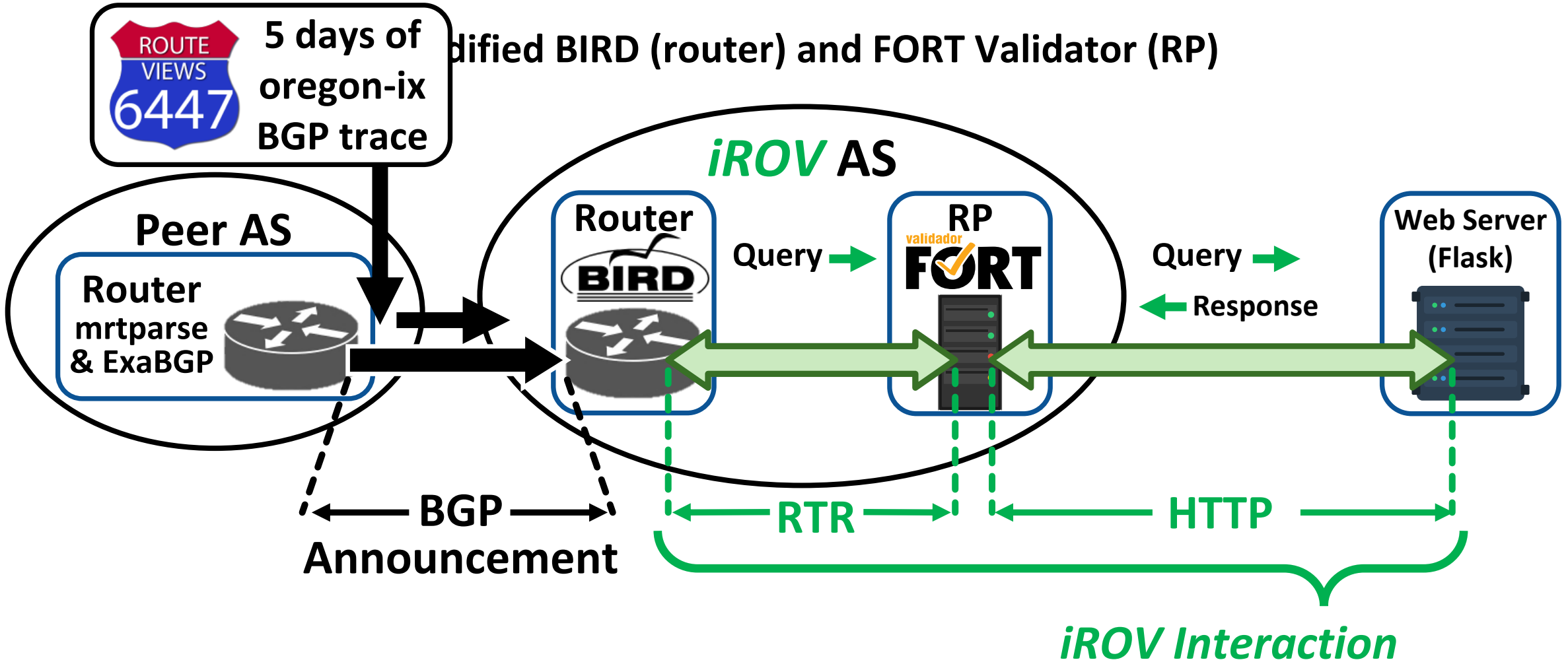

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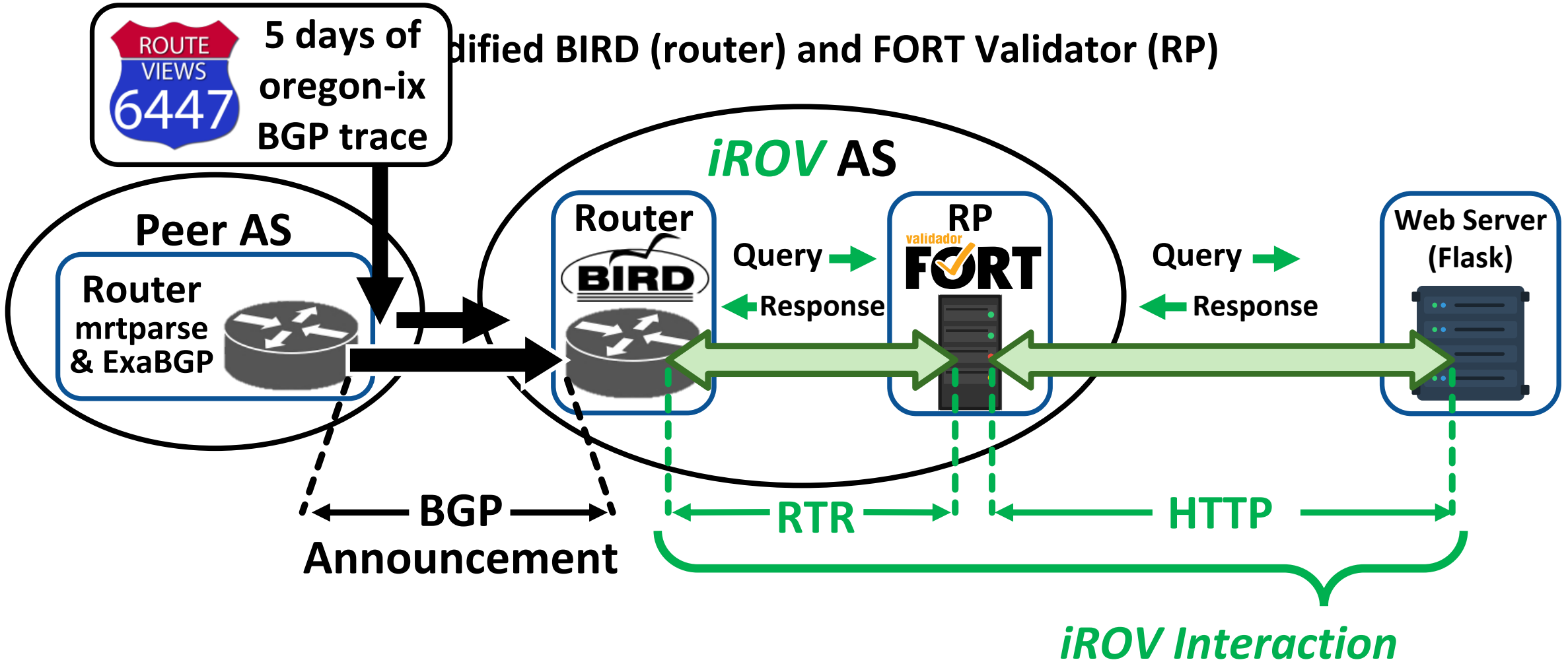
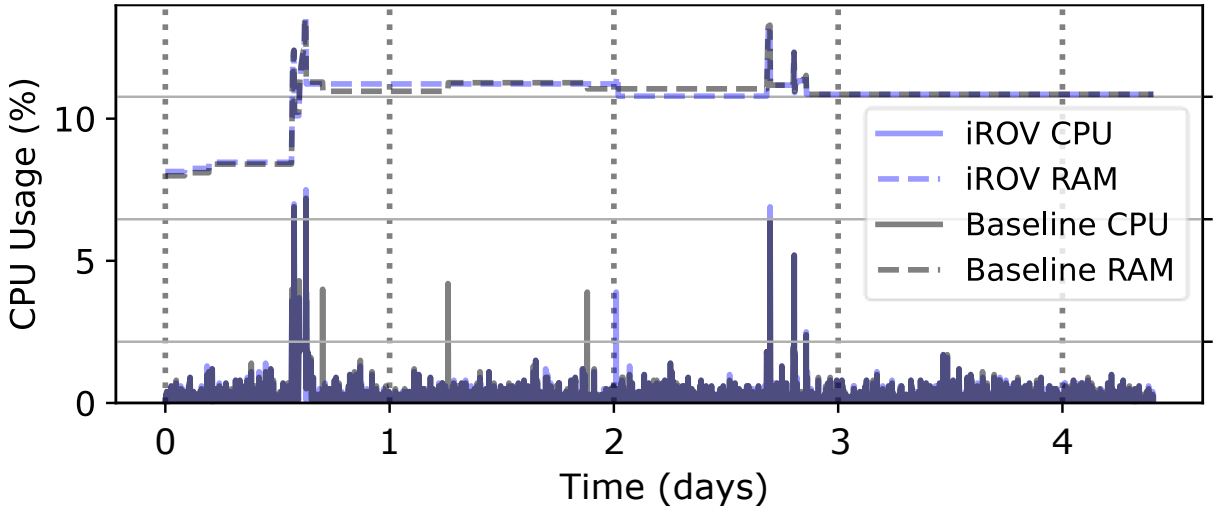


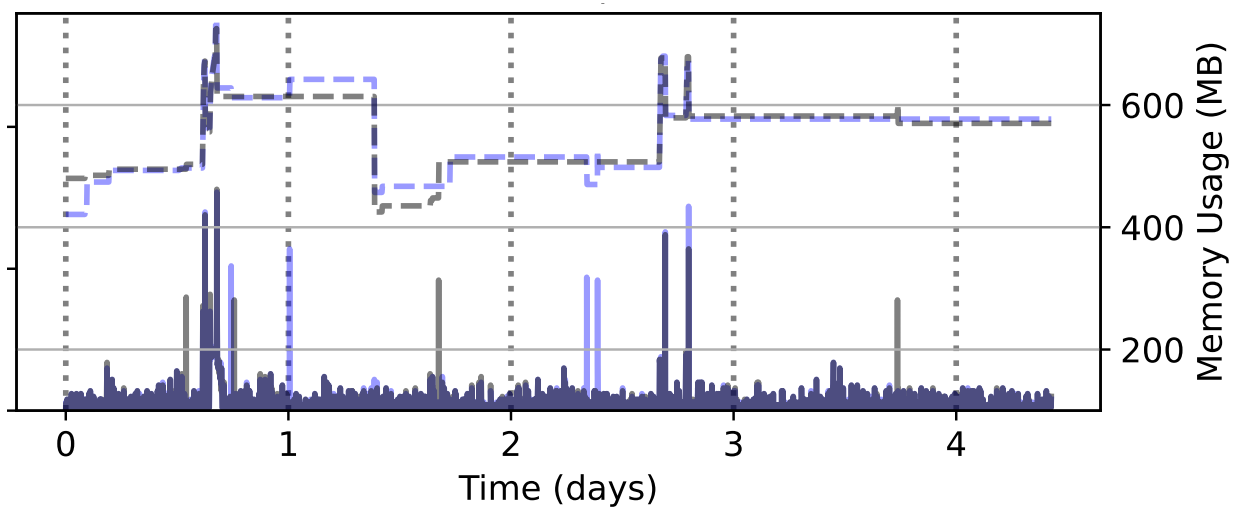
iROV Incurs Minimal Overhead

Negligible performance overhead: prototype implementation

Per prototype implementation and evaluation under real-world BGP trace
(~5 days of Route-Views2.oregon-ix.net)



(a) Initial-inquiry mode



(b) Read-stapled mode

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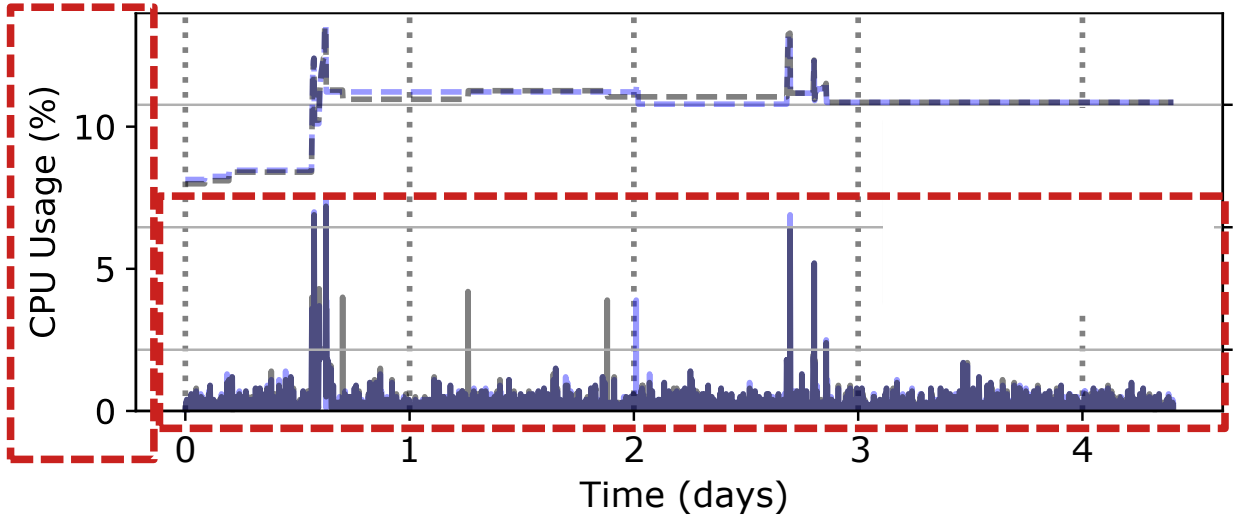

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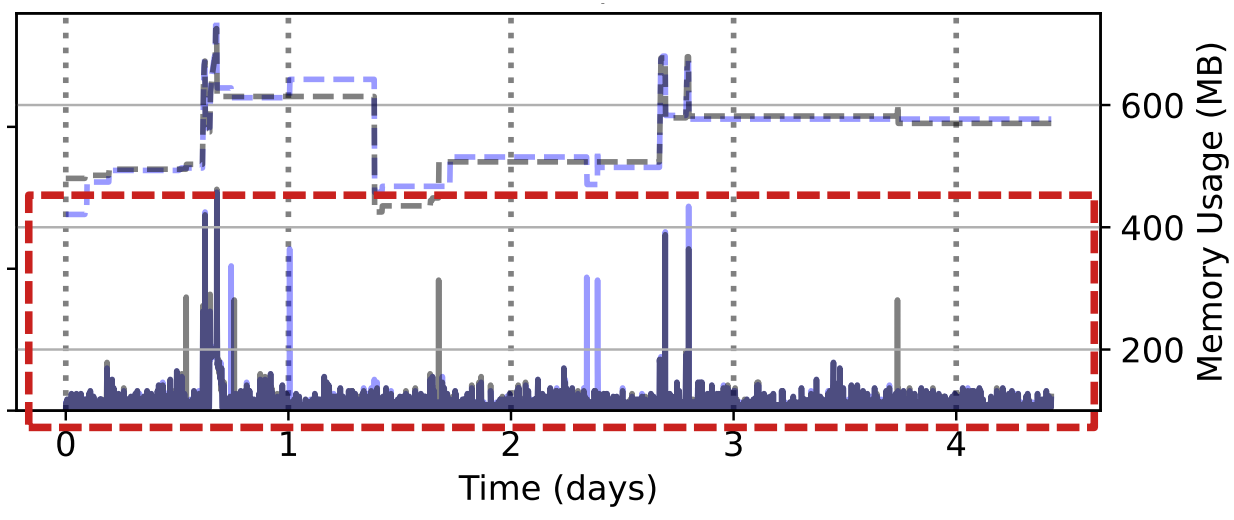

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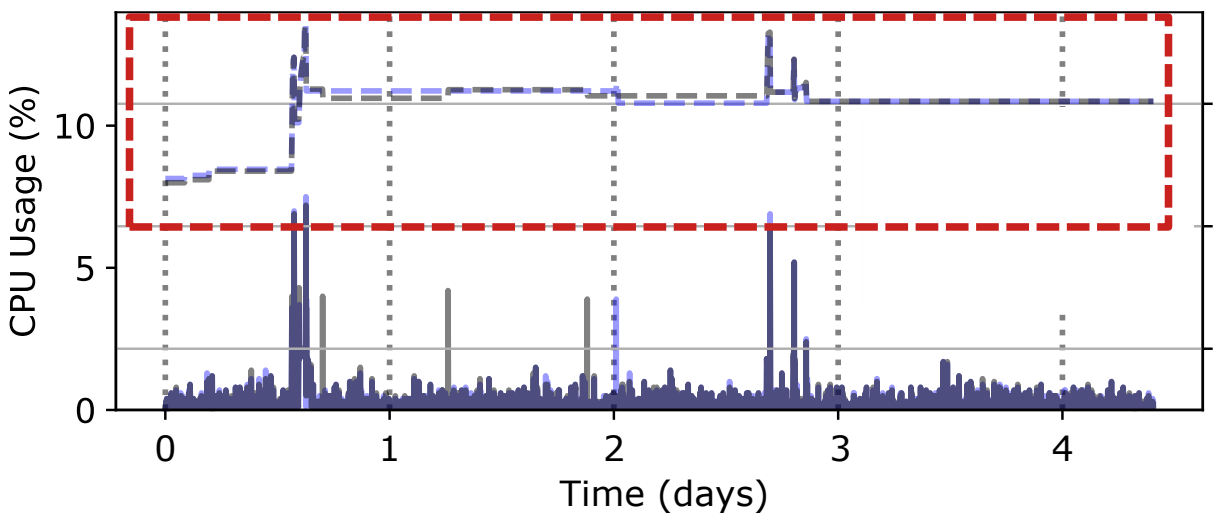

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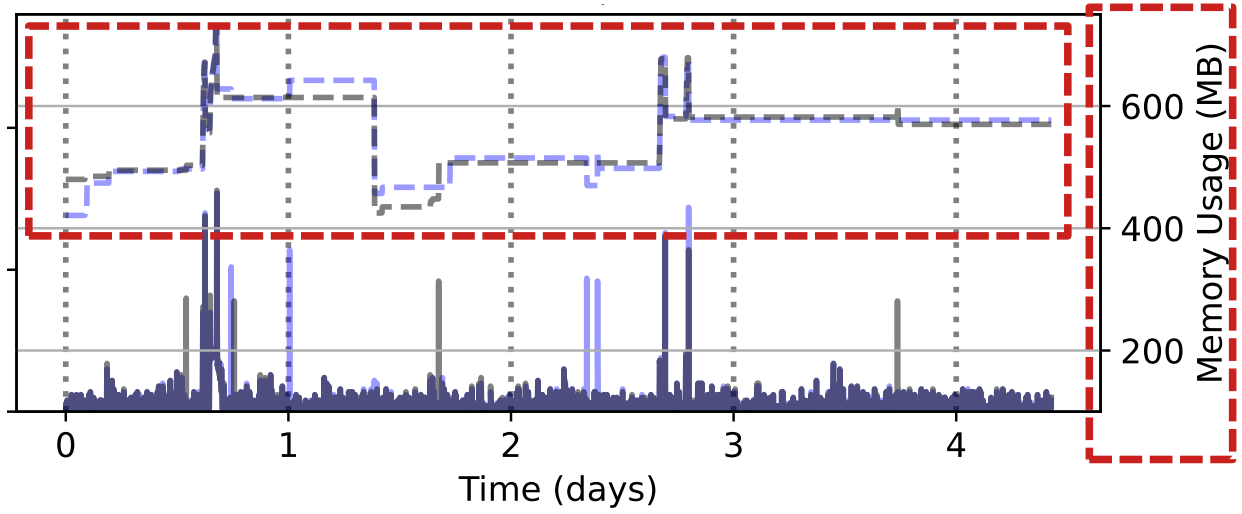

(b) Read-stapled mode

Conclusion

- RPKI ROV's silent-drop model creates critical operational challenges (**Lack of visibility** into incidents, **incompatibility** with DDoS defense)
- iROV solves these challenges via ***interactivity***
- iROV also addresses challenges inherent to interactivity itself, ensuring **safety** and **efficacy** from the earliest stages of adoption
- iROV prototype demonstrates **minimal performance overhead**

Thank you