AuditBox: Building An Auditable Network Service Chaining Framework

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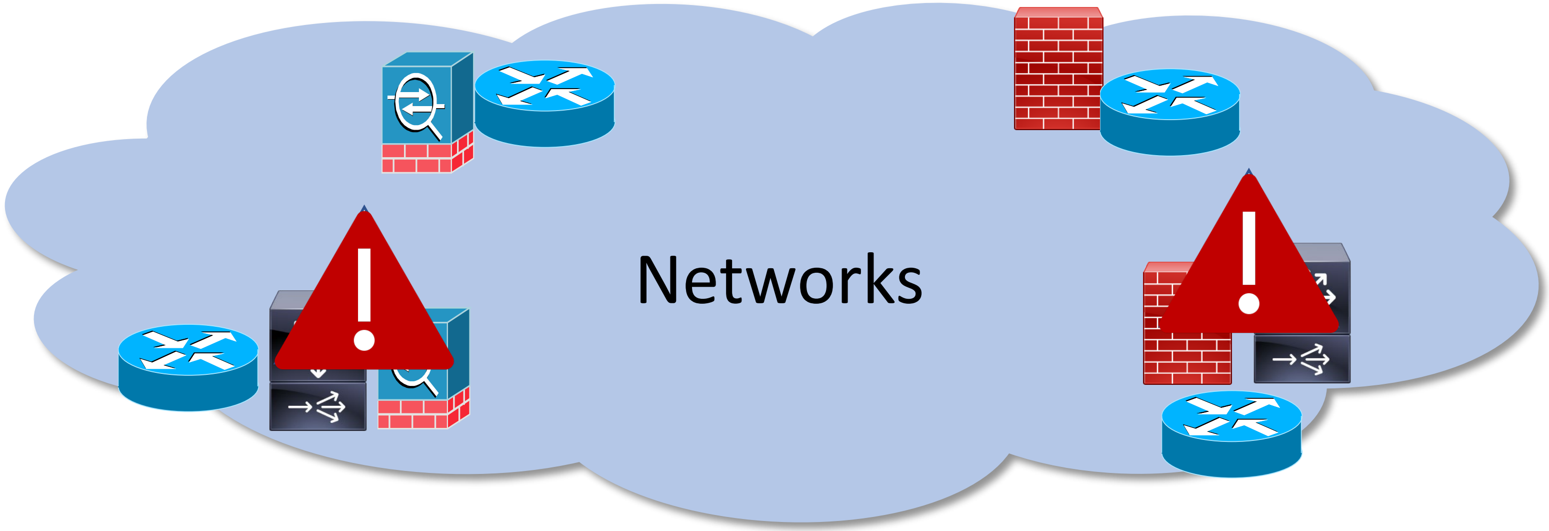
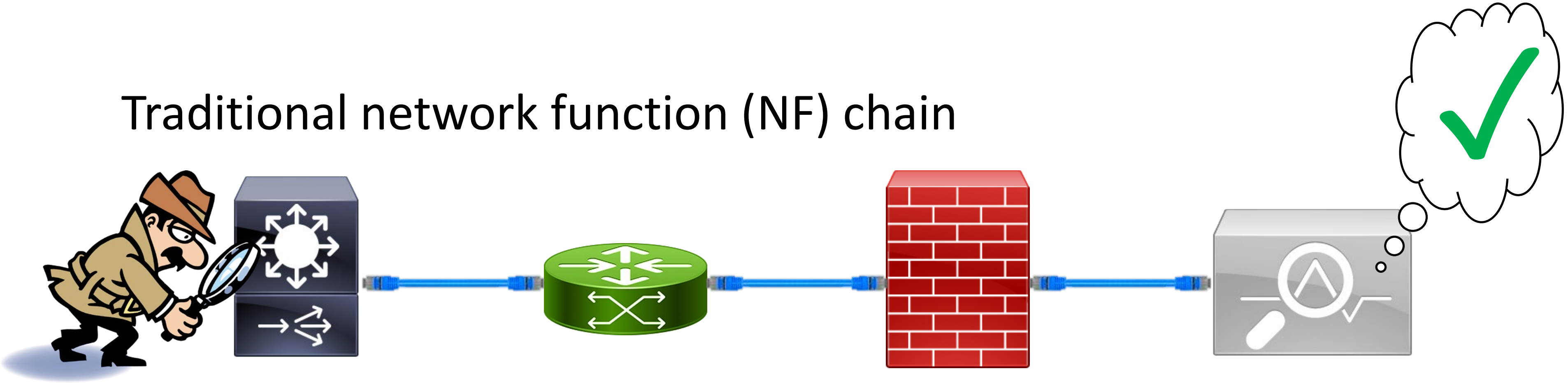
Background: Network Functions

- Network Functions (e.g., Firewalls, Proxies) are crucial for networks.
- Mandated by legal and policy requirements (e.g., HIPAA, GDPR).
- How can we ensure these NFs are operating correctly?

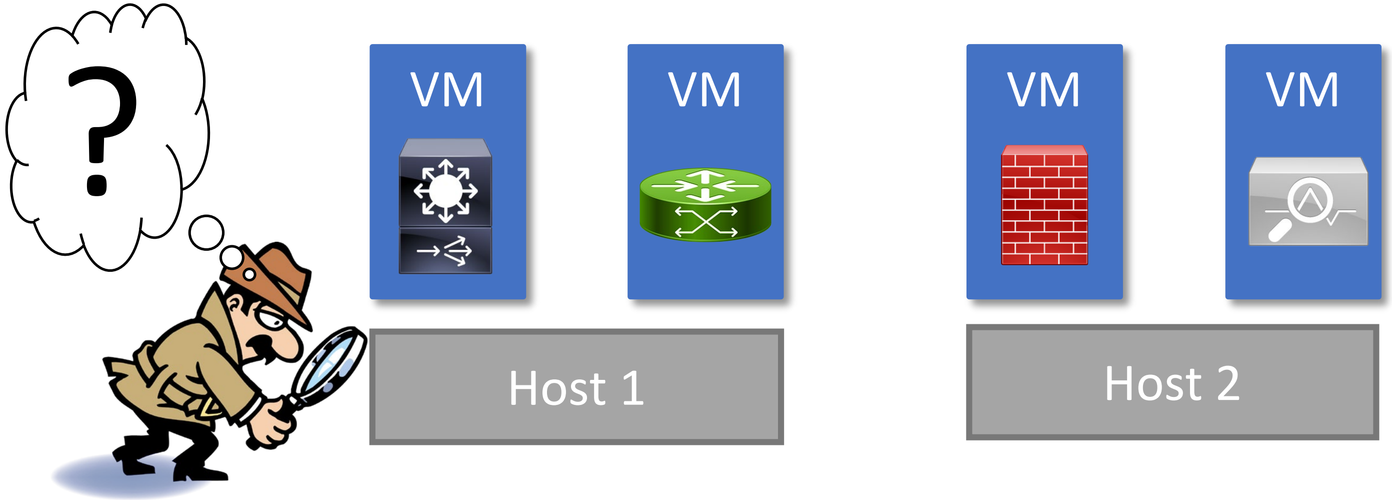


Problem: Virtualized NFs are Hard to Audit

Traditional network function (NF) chain

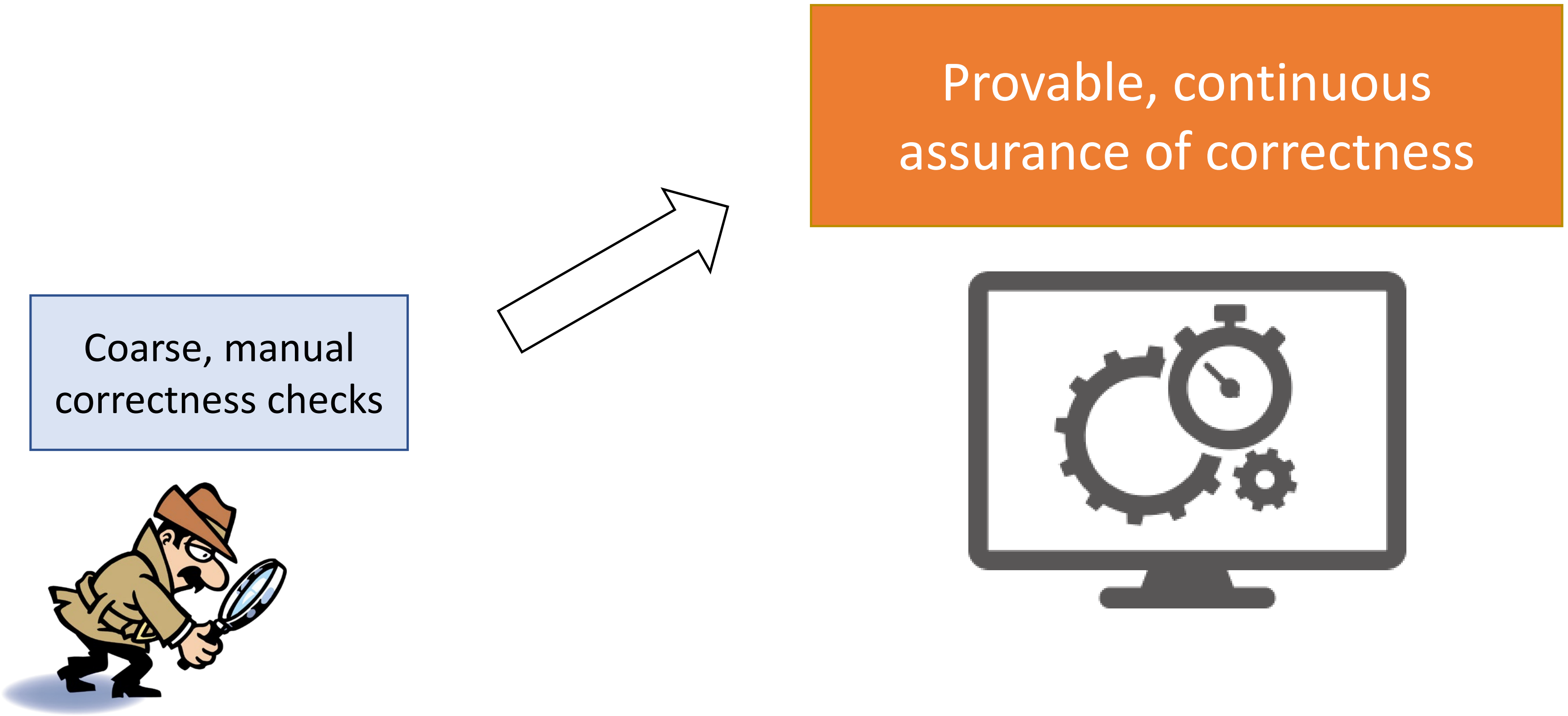


Modern virtualized NF chain



Overarching Goal

- Offer missing capabilities to audit NFV deployments



Coarse, manual correctness checks

Provable, continuous assurance of correctness

Prior Work: Verified Routing Protocols

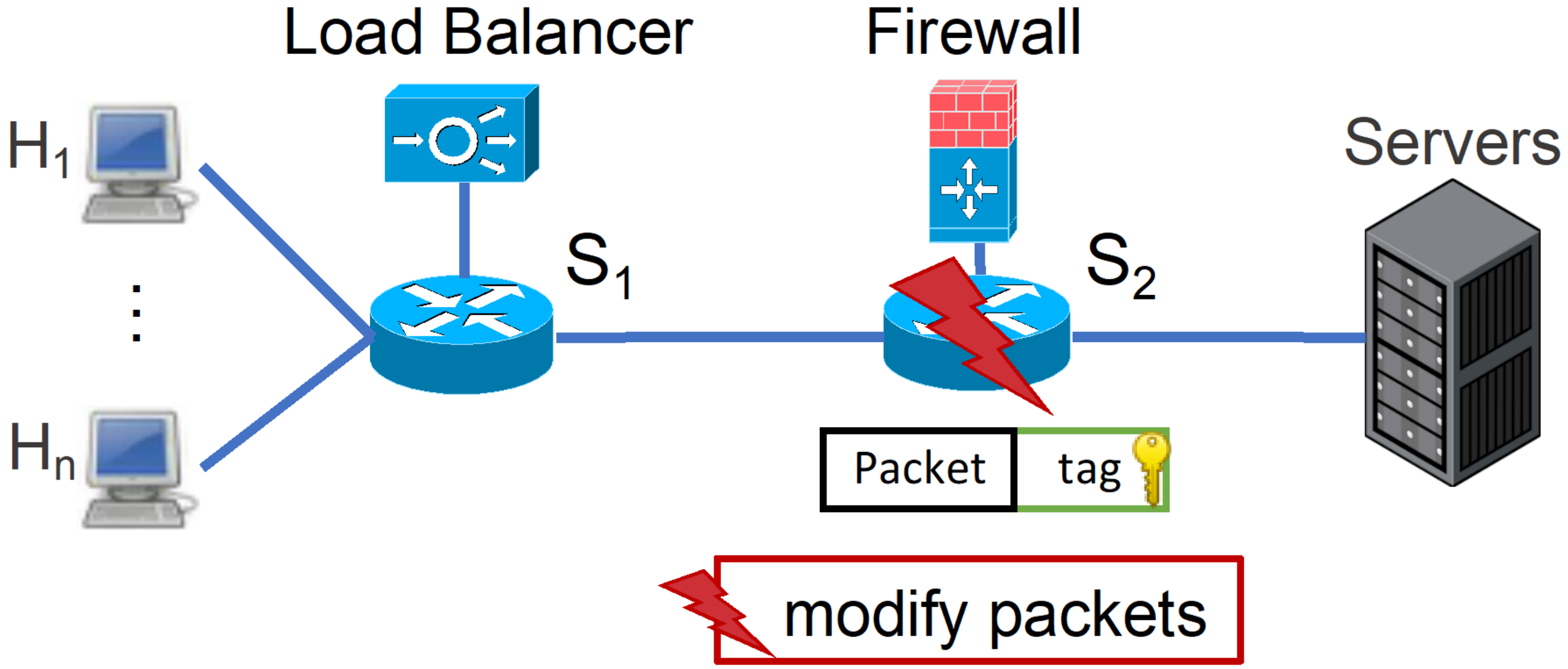
- Long history of work on verifying Internet paths
  [OPT SIGCOMM’14, ICING CoNext’11]

- Too strong:
  - Assumes wild west of the Internet with mutually distrusting ASes

- Too weak:
  - Assumes packet should remain unchanged in transit
  - Assumes intended path known in advance
  - Assumes all forwarding nodes are stateless

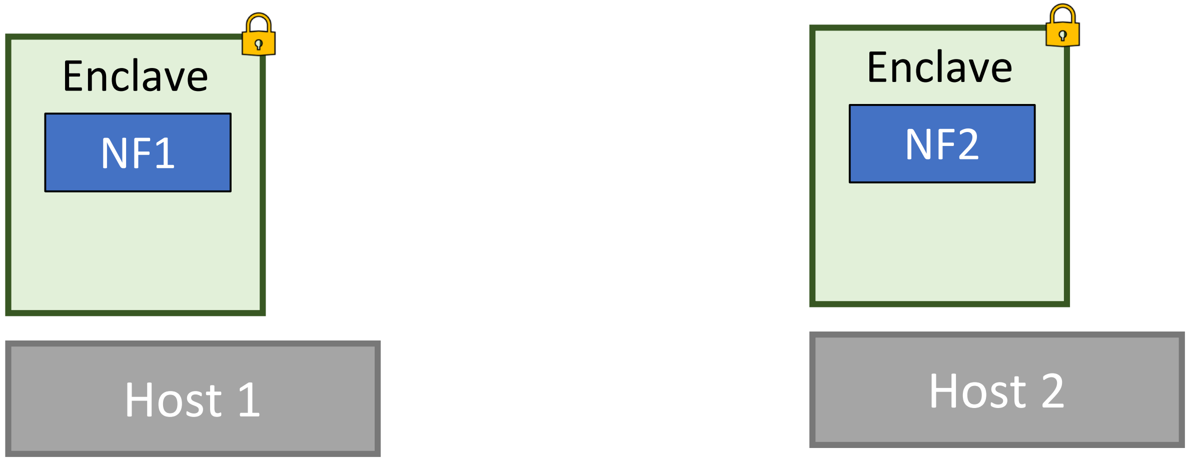
Assumptions
Do not hold
for NFV

Example: Mutable Packets



Our Approach: AuditBox

- Run NFs in trusted execution environments – trusted modifications
    - E.g., Intel SGX or Komodo [SOSP 2017]



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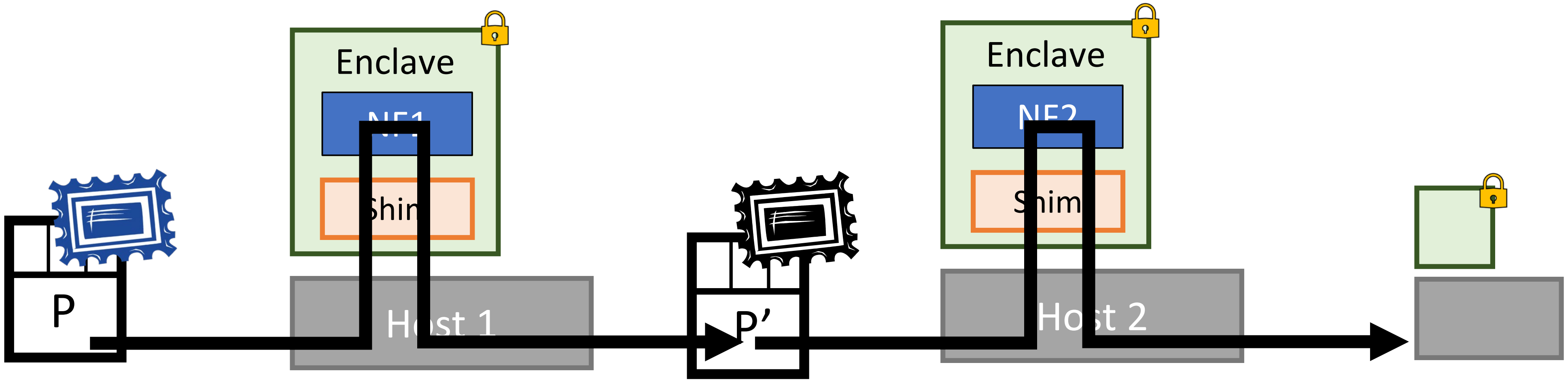
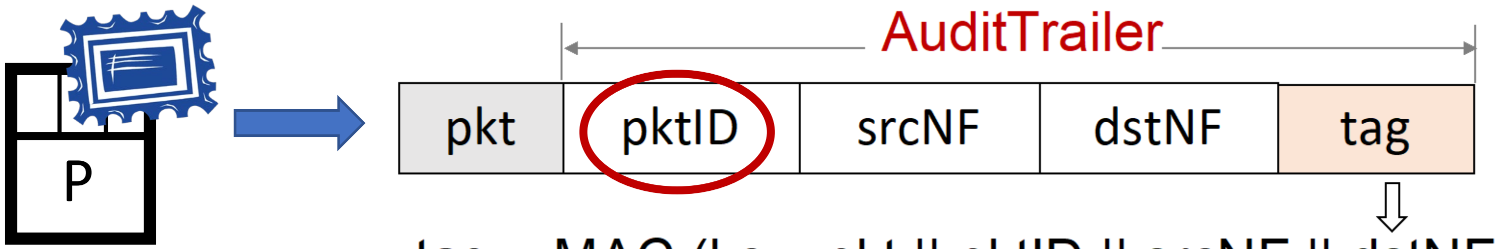
- NF-hop-by-hop attestation: leverage transitive trust to verifiably enforce policy



Transitive attestation

Design: Audit Trailer

- Created by a trusted entry gateway



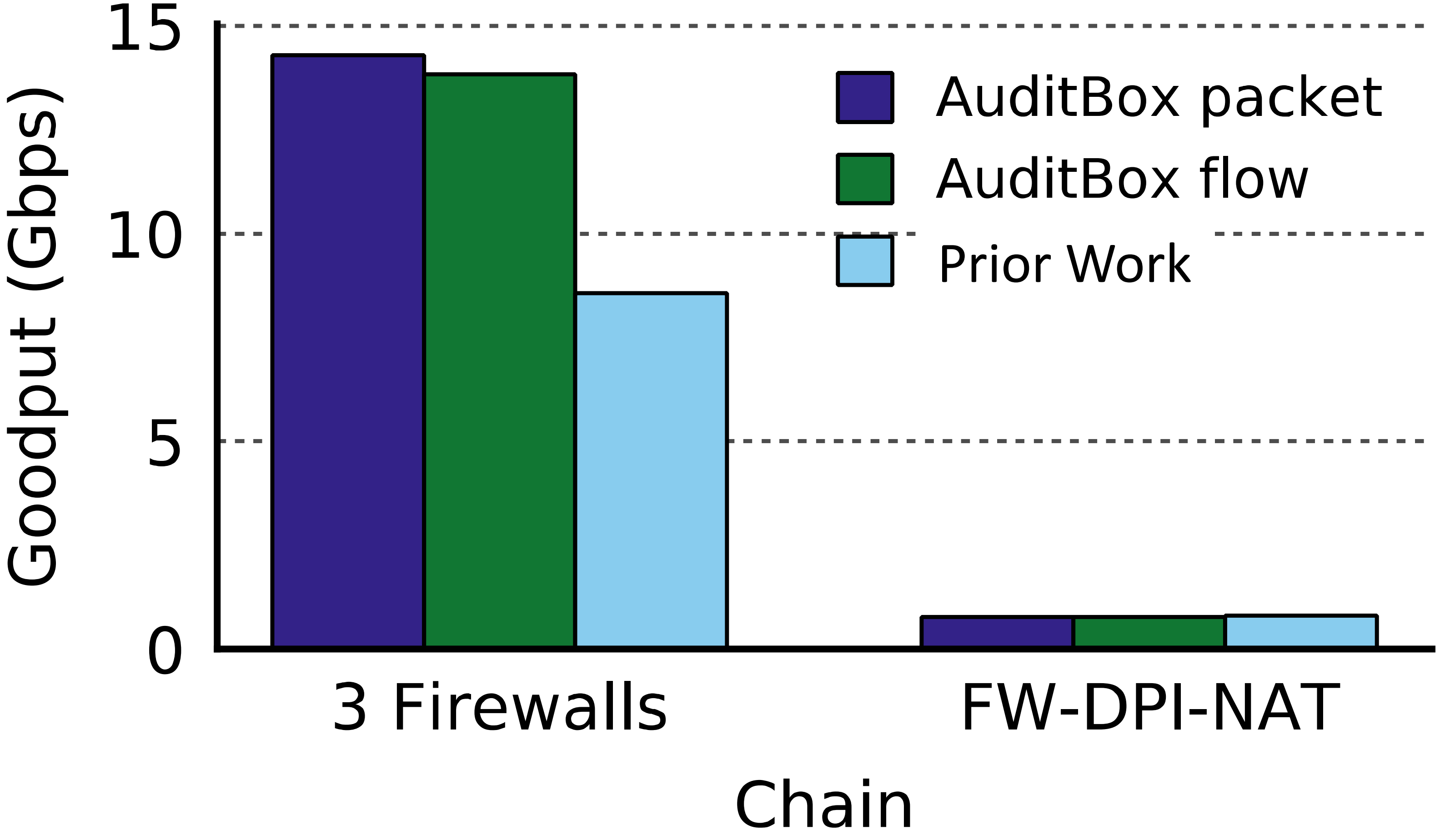
tag = MAC (key, pkt || pktID || srcNF || dstNF)

- Immutable packet ID: create audit trails
- To support flow-level verification:
  - Extend the AuditTrailer with a flow ID and a sequence number

Correctness Guarantees

- Runtime Correctness = Network implements the intended NF forwarding policies
  - Packet correctness: no modification or injection
  - Flow correctness: no modification, injection, reordering, dropping, or duplication.
- Offline Auditability = Must provide an ‘audit trail’
  - Secret logging
- Formal proofs of both runtime and offline properties

Performance Evaluation



Conclusion

- AuditBox offers missing auditing capacities for NFV deployments
- Not only replicates existing manual auditing capacities but *enhances* them with runtime guarantees
- Promote the adoption of NFV

Thank You!

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