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ROSE-T: Making MANRS Compliance Simple (And Automatic!)

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Why is Routing Security Crucial Nowadays?

Cyber Threats

Business Continuity

Sensitive Data

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Cyber Threats

Business Continuity

Sensitive Data

MANRS

MANRS Guidelines For Network Operators

Coordination

Network operators maintain globally accessible up-to-date contact information

Global Information

Network operators must publicly document their routing policies, ASNs and prefixes

Anti-Spoofing

Prevent packets with spoofed source IP address from entering or leaving the network

Filtering

Prevent propagation of incorrect routing information

MANRS Guidelines For Network Operators

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How Can a Network Operator Ensure the MANRS Compliance?

Anti-Spoofing

Prevent packets with spoofed source IP address from entering or leaving the network

Filtering

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How Can a Network Operator Ensure the MANRS Compliance?

Coordination **Global Validation** **Anti-Spoofing** **Filtering**

⚠ No tool to automatically verify MANRS compliance!

Operators have to check their configurations and routing policies **manually** or with **minimal aid**

⬇

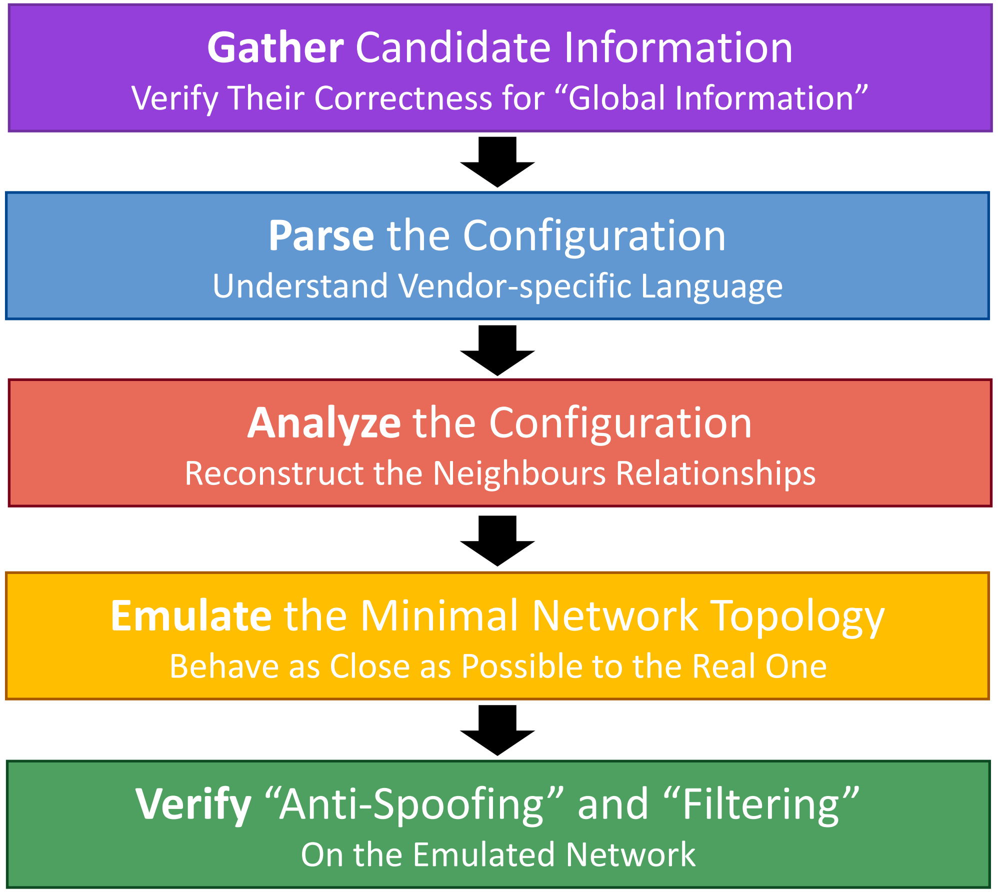
Limited **reproducibility** of the process

⬇

Not an easy task!

ROSE-T: ROuting SEcurity Tool

- The first **open-source** tool to automatically verify MANRS compliance
- **Trust No One** approach
  - Run ROSE-T locally to perform the self-assessment of the configuration



Gather Candidate Information
Verify Their Correctness for “Global Information”

Parse the Configuration
Understand Vendor-specific Language

Analyze the Configuration
Reconstruct the Neighbours Relationships

Emulate the Minimal Network Topology
Behave as Close as Possible to the Real One

Verify “Anti-Spoofing” and “Filtering”
On the Emulated Network

ROSE-T – Step-by-Step

Gather

Parse

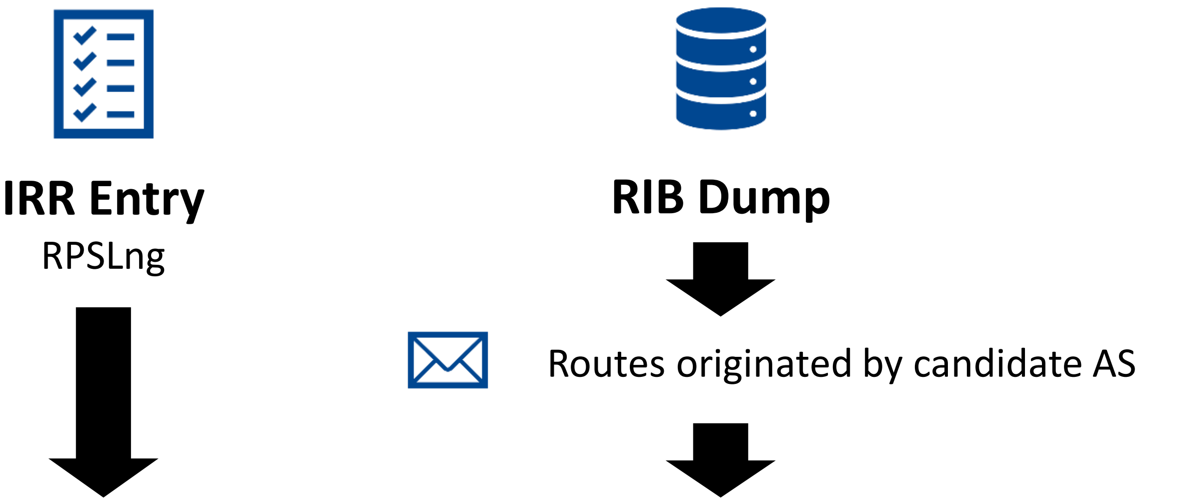
Analyze

Emulate

Verify

ROSE-T – Step-by-Step

Gather Candidate Information
Verify Their Correctness for “Global Information”



IRR Entry
RPSLng

RIB Dump

Routes originated by candidate AS

✓ Verify that the networks announced to transits are in the IRR Entry

✓ Verify that the networks in the IRR Entry are announced to transits

Parse

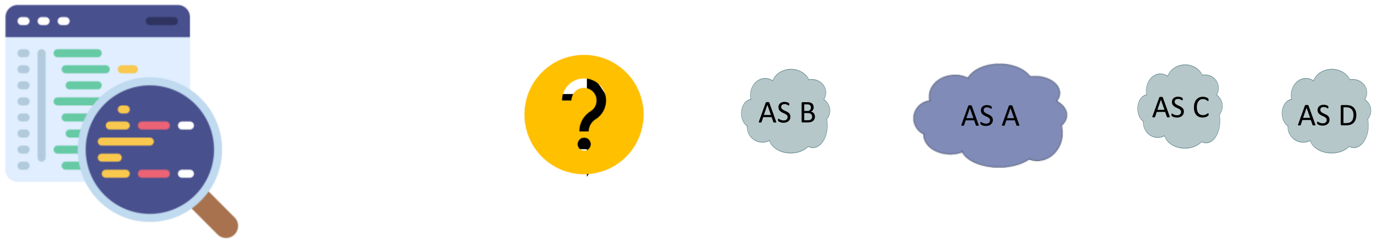
Analyze

Emulate

Verify

ROSE-T – Step-by-Step

Parse the Configuration
Understand Vendor-specific Language



Vendor-specific Configuration

Agnostic Format

Gather

Analyze

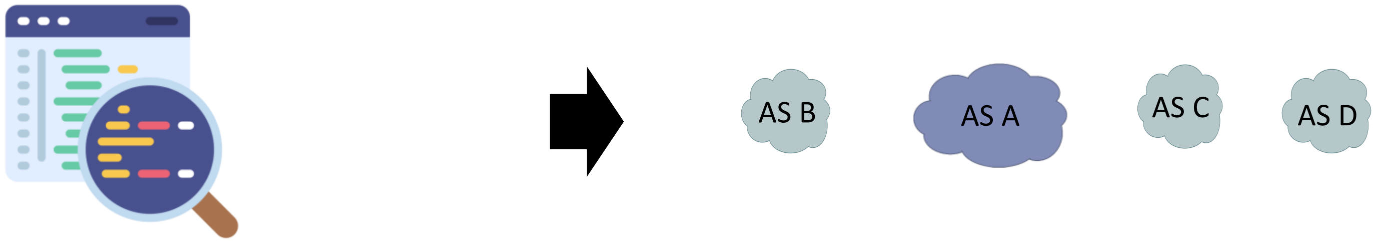
Emulate

Verify

Exploit what Batfish does best: **parsing vendor configurations**

ROSE-T – Step-by-Step

Parse the Configuration
Understand Vendor-specific Language



Vendor-specific Configuration

Agnostic Format

Exploit what Batfish does best: **parsing vendor configurations**

Take Batfish's output as a foundation

Enrich it with missing information

Gather

Analyze

Emulate

Verify

ROSE-T – Step-by-Step

Analyze the Configuration

Reconstruct the Neighbours Relationships

Agnostic Format

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Parse

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Verify

ROSE-T – Step-by-Step

Analyze the Configuration

Reconstruct the Neighbours Relationships

AS B
AS A
AS C
AS D

Agnostic Format

IRR Entry

RPSLng

? What are their relationships?

Gather

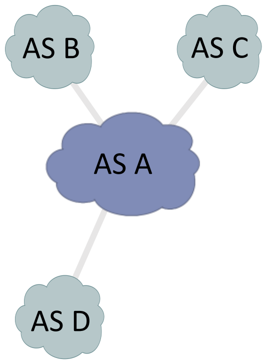
Parse

Emulate

Verify

ROSE-T – Step-by-Step

Analyze the Configuration
Reconstruct the Neighbours Relationships



Intermediate Representation

←

IRR Entry
RPSLng

Gather

Parse

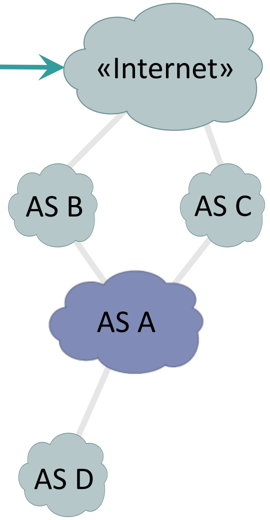
Emulate

Verify

ROSE-T – Step-by-Step

Analyze the Configuration
Reconstruct the Neighbours Relationships

Dummy OTT connected to all providers



Intermediate Representation

IRR Entry
RPSLng

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Parse

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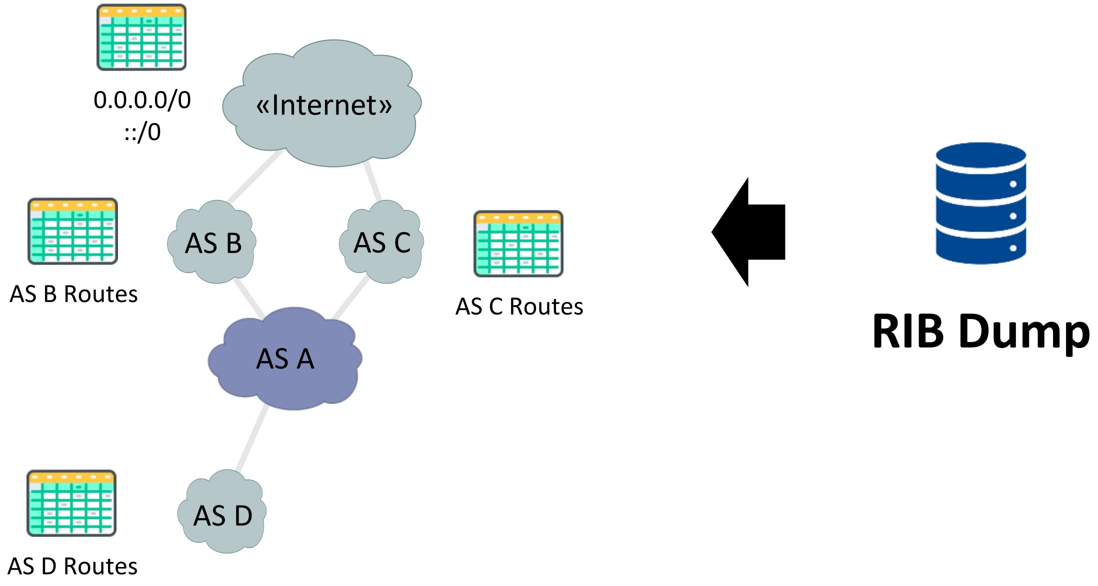


Intermediate Representation

Gather

Parse

Emulate

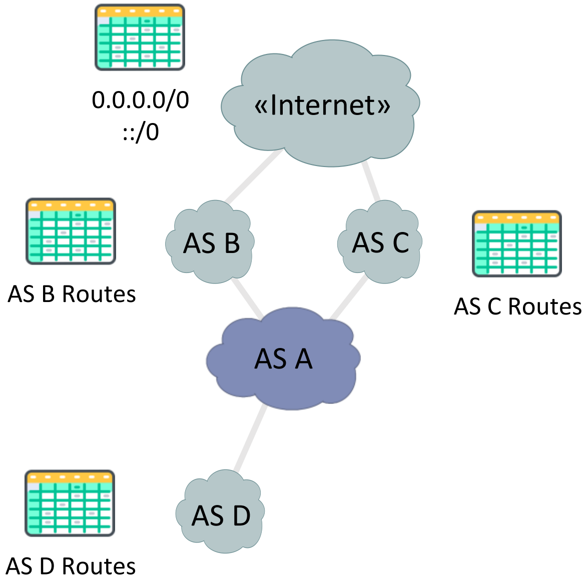
Verify

✓ ROSE-T also supports multi-hop peerings!

ROSE-T – Step-by-Step

Emulate the Minimal Network Topology

Behave as Close as Possible to the Real One



Intermediate Representation

Gather

Parse

Analyze

Verify

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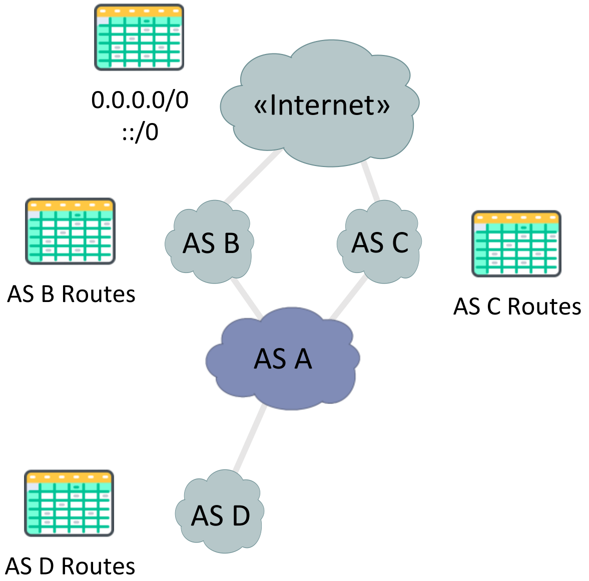

Intermediate Representation

Kathará

Gather

Parse

Analyze

Verify

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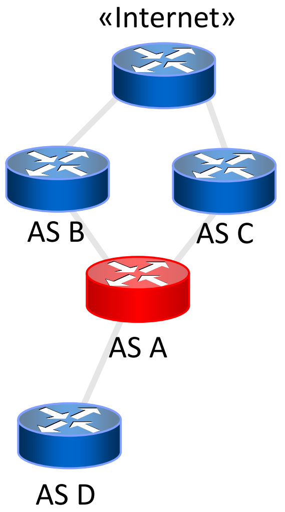

Runnable Network Scenario

← Kathará

Gather

Parse

Analyze

Verify

ROSE-T – Step-by-Step

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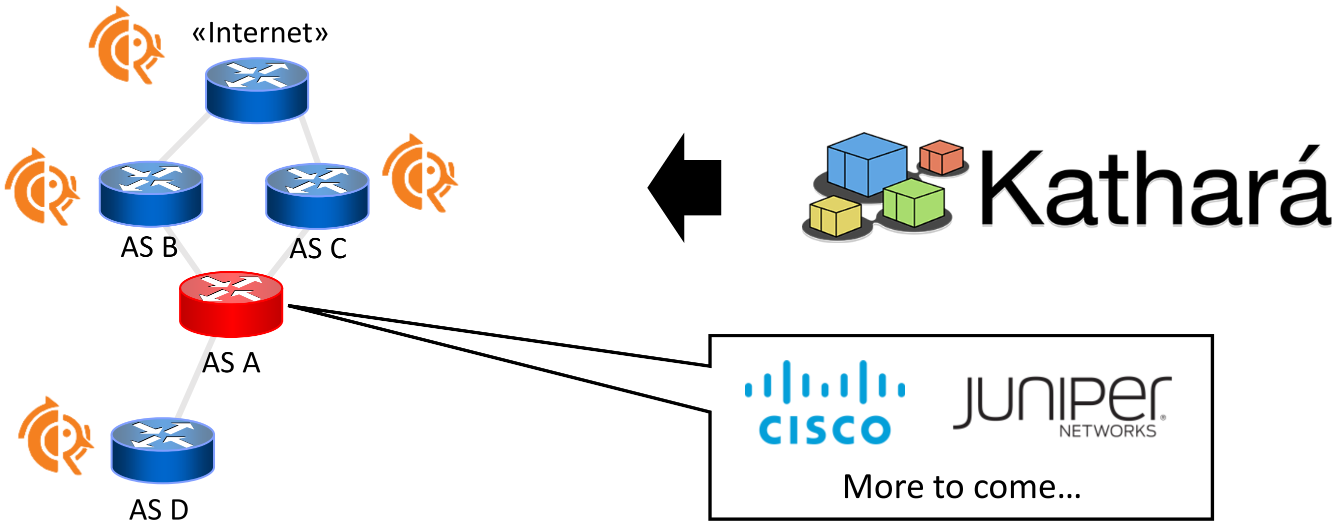


Runnable Network Scenario

Vendor Container

Gather

Parse

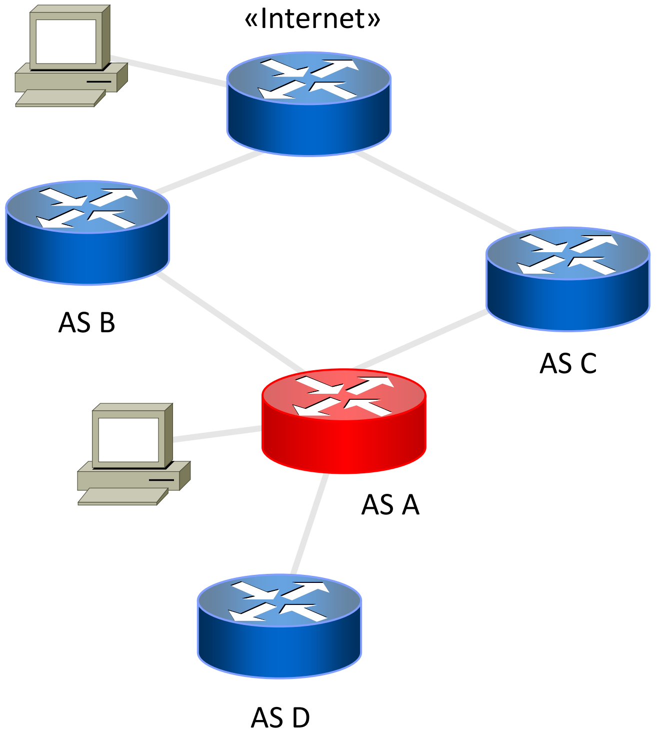
Analyze

Verify

✓ ROSE-T can easily be extended to support other vendors

ROSE-T – Step-by-Step

Verify "Anti-Spoofing" and "Filtering"
On the Emulated Network



Gather

Parse

Analyze

Emulate

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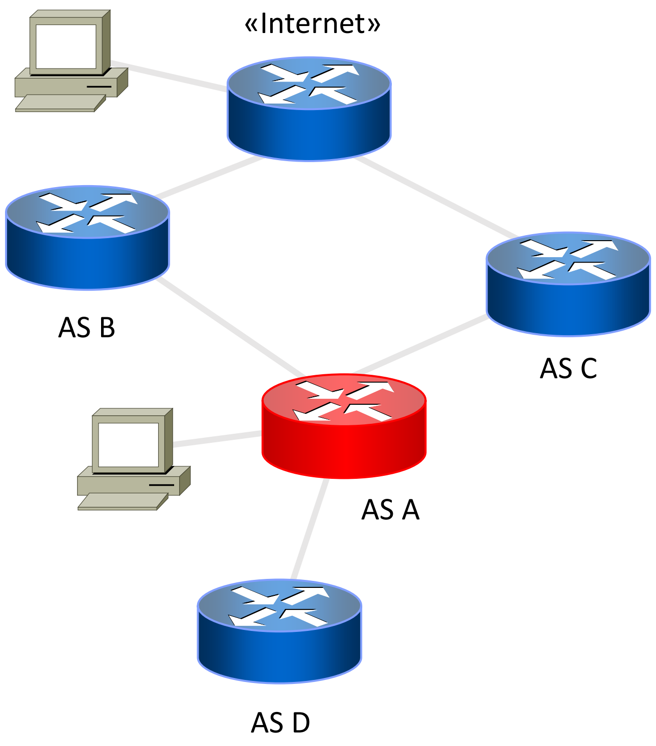

Anti-Spoofing

Gather

Parse

Analyze

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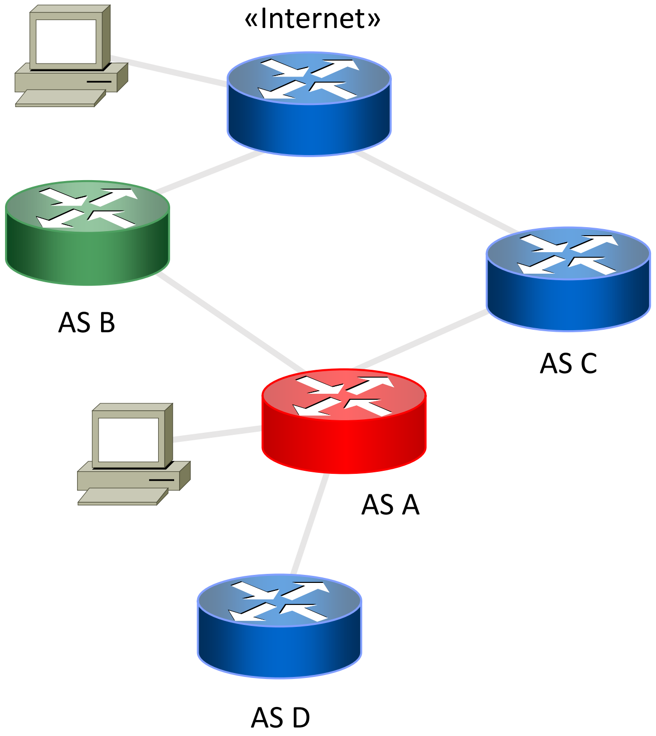

Anti-Spoofing

For each Provider:

Gather

Parse

Analyze

Emulate

ROSE-T – Step-by-Step

Verify "Anti-Spoofing" and "Filtering"
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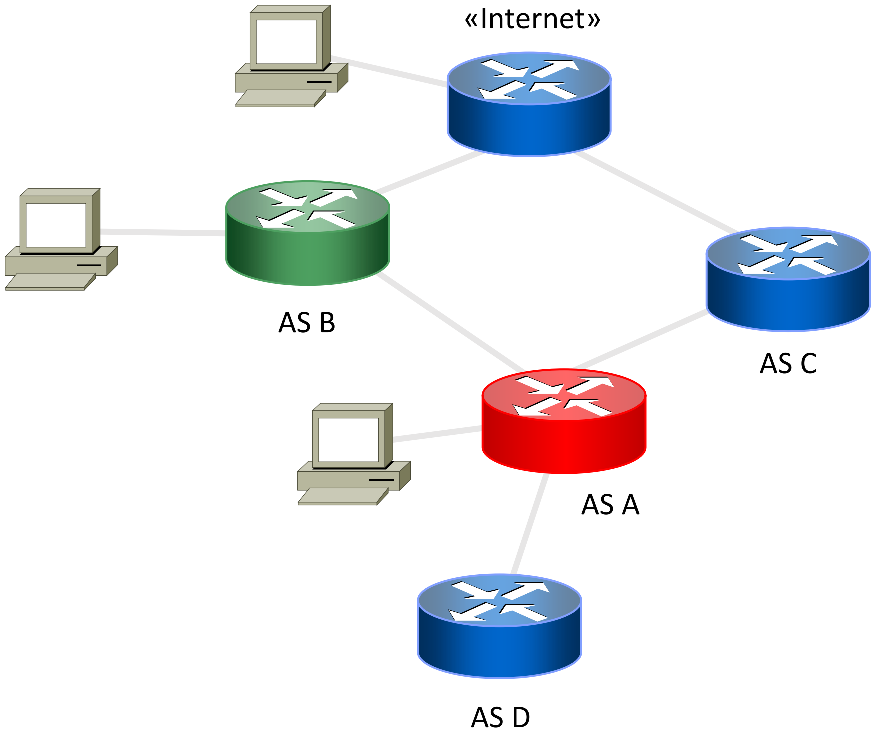


Anti-Spoofing

For each Provider:

1. Insert a Client

Gather

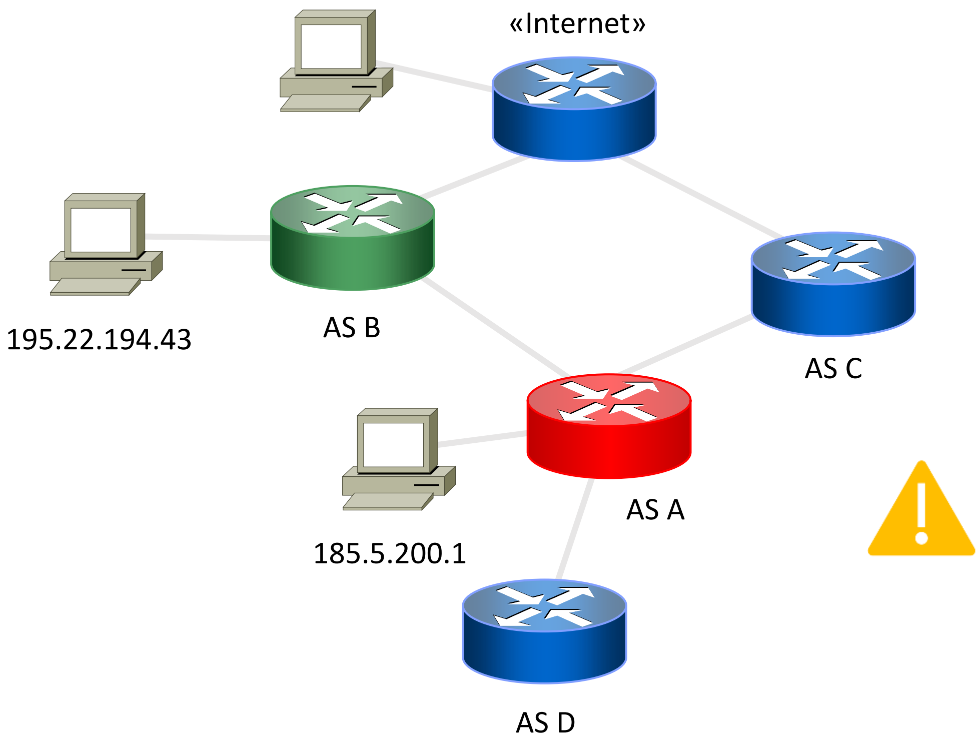
Parse

Analyze

Emulate

ROSE-T – Step-by-Step

Verify “Anti-Spoofing” and “Filtering”
On the Emulated Network



Anti-Spoofing

For each Provider:

1. Insert a Client
2. Assign IPs (v4/v6) to each Client

⚠ Carefully choose subnets that are correctly announced and reachable

Gather

Parse

Analyze

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ROSE-T – Step-by-Step

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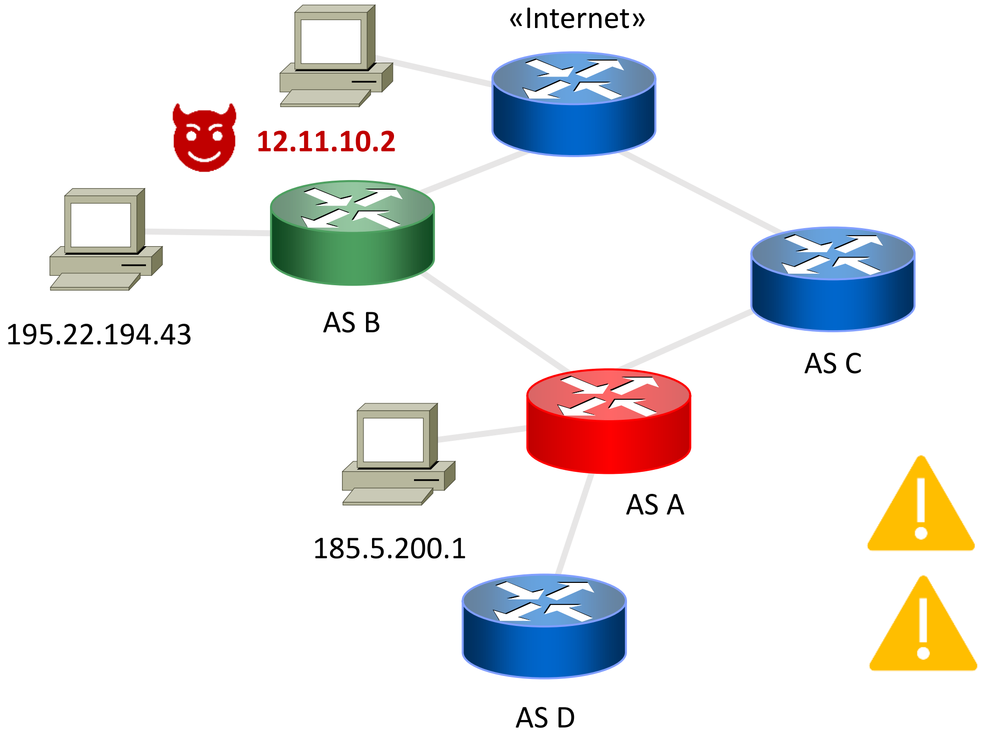

Anti-Spoofing

For each Provider:

1. Insert a Client
2. Assign IPs (v4/v6) to each Client

⚠ Carefully choose subnets that are correctly announced and reachable

⚠ Select a non-overlapping network for the "Internet" host

Gather

Parse

Analyze

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ROSE-T – Step-by-Step

Verify “Anti-Spoofing” and “Filtering”
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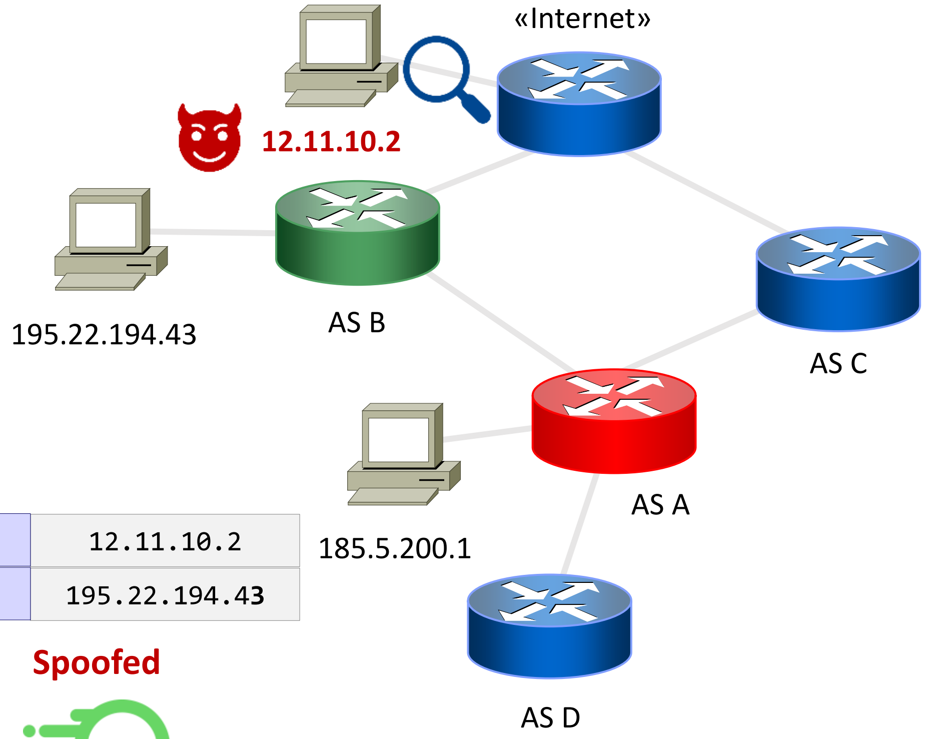

SrcIP	12.11.10.2
DstIP	195.22.194.43

Spoofed

scapy

Anti-Spoofing

For each Provider:

1. Insert a Client
2. Assign IPs (v4/v6) to each Client
3. Send the spoofed ICMP packet

Gather

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ROSE-T – Step-by-Step

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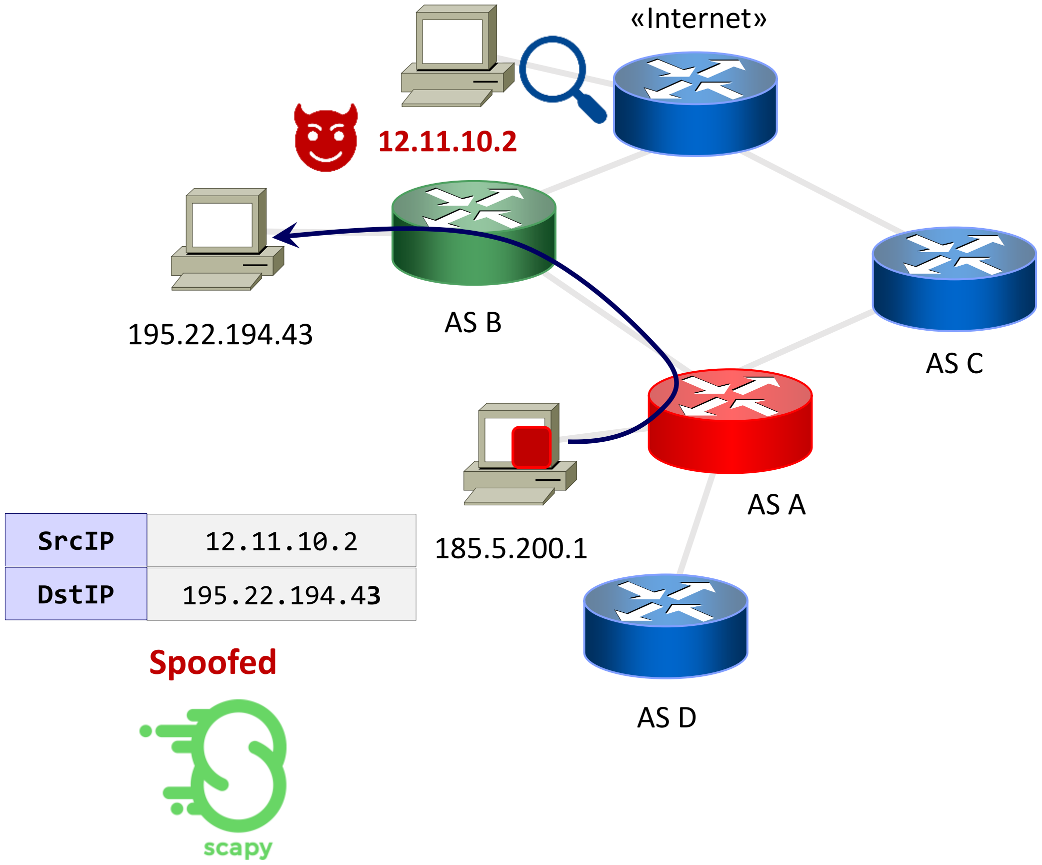

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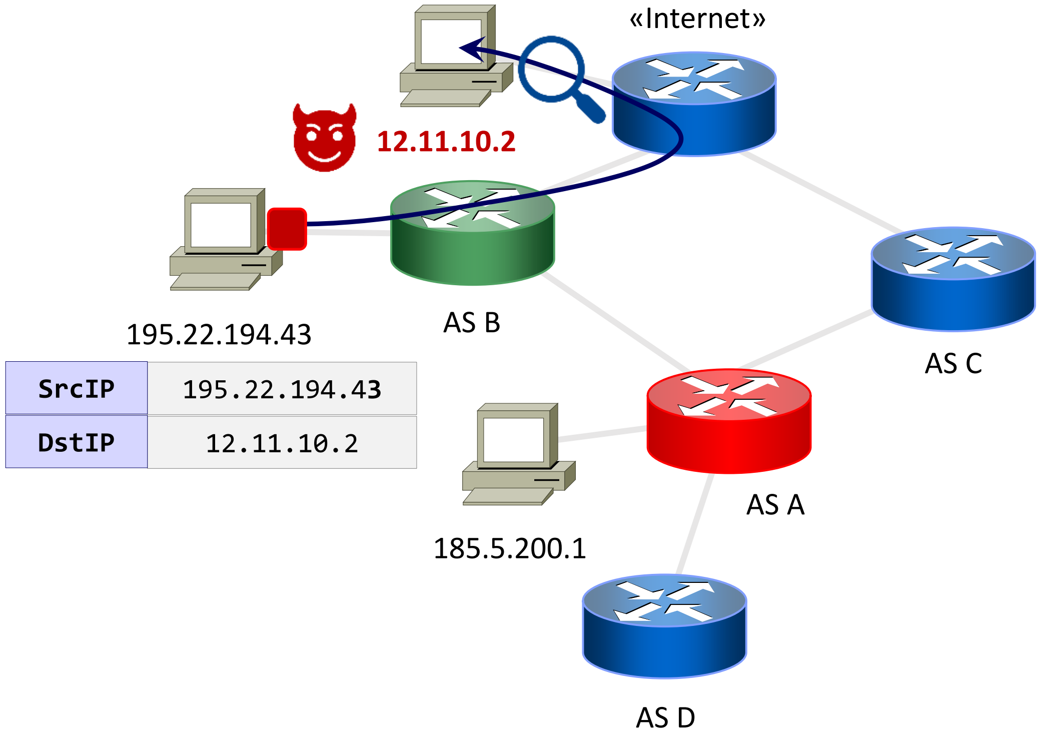

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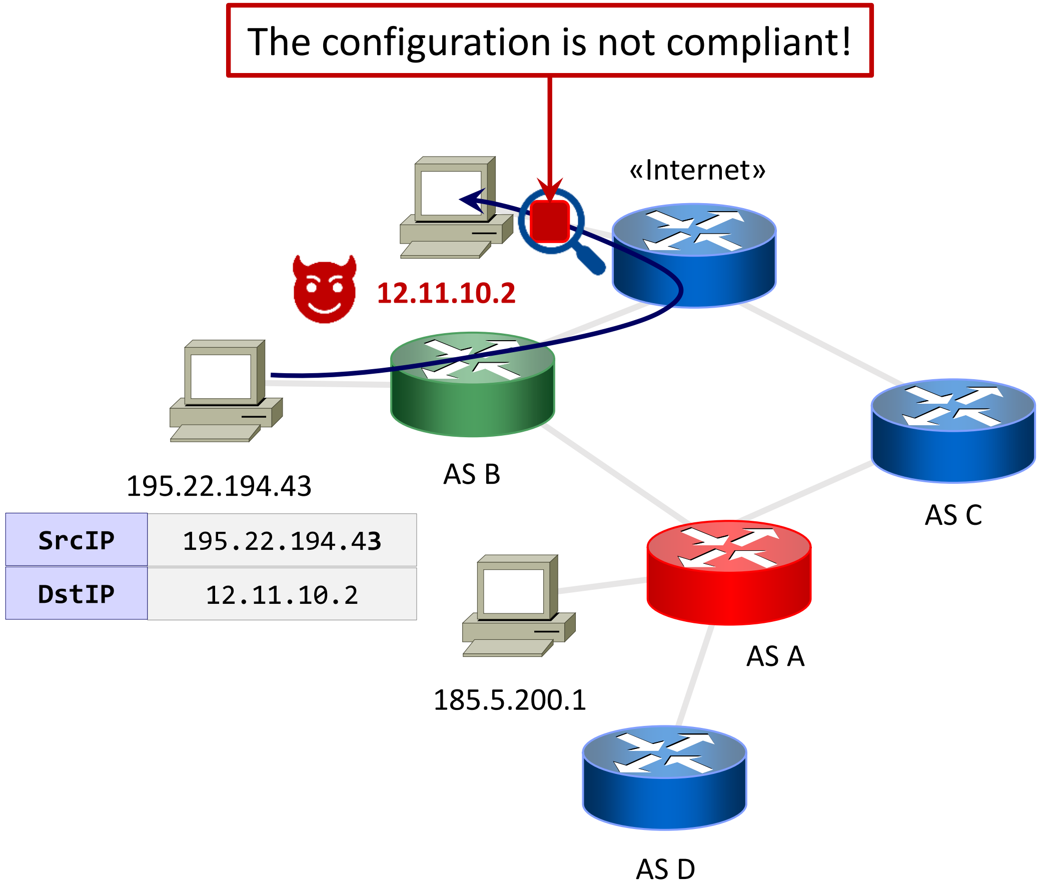

The configuration is not compliant!

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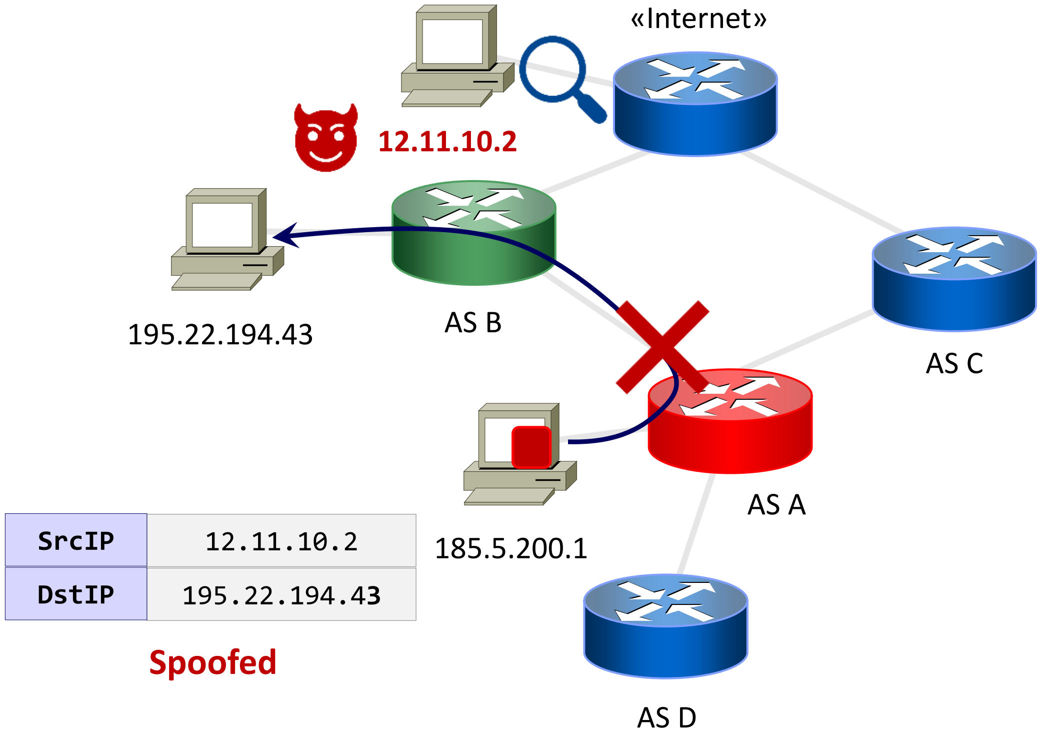

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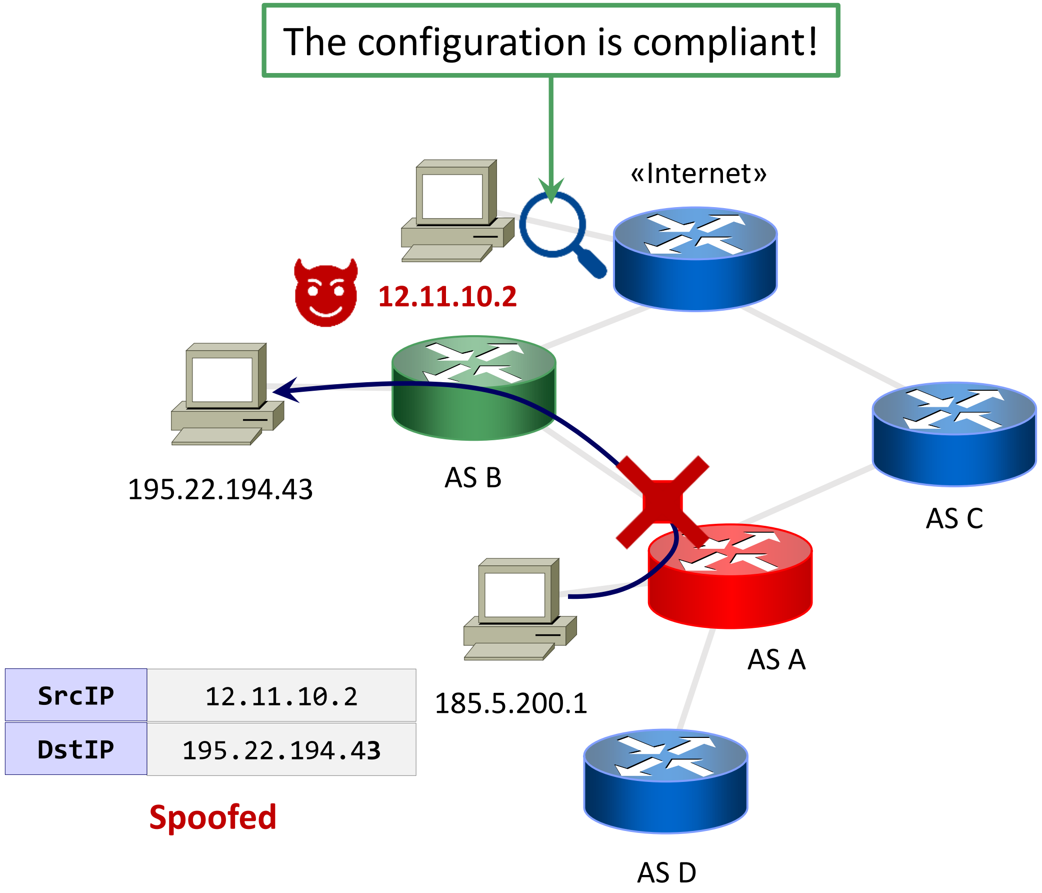

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Conclusions

The **ROSE-T** tool:

- Implements the **first tool** to **automatically** verify MANRS compliance
- Allows network operators to test their configurations without relying on **manual and error-prone** procedures
- **Reduces the time** for MANRS adoption that would lead to a **more secure** global routing infrastructure

Future Work

- Extend verification to multiple routers

- Currently, ROSE-T implements the verification of Network Operators Actions
  - Expand the support to IXPs and CDNs Verification

- ROSE-T aims to verify networks beyond MANRS…
  - Verify RPKI deployments
  - Additional features (*e.g.,* ASPA validation)

- Release a verifiable code to certify MANRS compliance

Contacts

Mariano Scazzariello

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Contribute!