Intra-domain Source Address Validation (SAVNET) Architecture

Dan Li, Jianping Wu, Lancheng Qin, Nan Geng, Li Chen, Mingqing Huang, Fang Gao

November 8, 2023
Two Goals of Intra-domain SAV

- **Goal #1: Outbound traffic validation**
  - **Edge routers** should block illegitimate packets coming from the AS’s intra-domain subnets which forge source addresses of other subnets (either within the AS or other ASes)

- **Goal #2: Inbound traffic validation**
  - **Border routers** should block illegitimate packets coming from other ASes which forge internal source addresses
Review of Intra-domain SAV Problem Statement

- Problems of existing intra-domain SAV mechanisms\(^1\)
  - ACL-based SAV requires **high operational overhead**
  - uRPF-based SAV has **improper block or improper permit** problems

- Requirements of the new intra-domain SAV mechanism\(^1\)
  - Automatic update
  - Accurate validation
  - Incremental/partial deployment
  - Convergence
  - Security

[1]: draft-ietf-savnet-intra-domain-problem-statement-02
Background of Intra-domain SAVNET Architecture

- Intra-domain SAVNET architecture aims to achieve accurate SAV in an intra-domain network by an automatic way
  - Address the problems of existing intra-domain SAV mechanisms
  - Meet the requirements proposed in [draft-ietf-savnet-intra-domain-problem-statement]

- Historical versions
  - draft-li-savnet-intra-domain-architecture-00, IETF 115 SAVNET WG
  - draft-li-savnet-intra-domain-architecture-01, IETF 116 SAVNET WG
  - draft-li-savnet-intra-domain-architecture-02, June 1, 2023
  - draft-li-savnet-intra-domain-architecture-03, IETF 117 SAVNET WG
  - draft-li-savnet-intra-domain-architecture-04, Oct. 20, 2023
  - draft-li-savnet-intra-domain-architecture-05, IETF 118 SAVNET WG
Main Updates Compared to Version-03

- Updates in Intra-domain SAVNET Architecture section
  - Clarify the content of SAV-specific information
  - Introduce the SAV rule generation process for edge router and border router, respectively

- Updates in Use Cases section
  - Use the two use cases proposed in [draft-ietf-savnet-intra-domain-problem-statement] to illustrate intra-domain SAVNET achieves more accurate and efficient SAV than existing intra-domain SAV mechanisms

- Add a new section
  - Describe how intra-domain SAVNET meet the five design requirements proposed in [draft-ietf-savnet-intra-domain-problem-statement]
Key Idea of Intra-domain SAVNET Architecture

- Exchange **SAV-specific information** among routers automatically
- Generate SAV rules in routers based on both **SAV-specific information and local routing information**
An intra-domain router can act as one or two roles: source entity or/and validation entity

**Source entity** sends its SAV-specific information to other routers

**Validation entity** receives SAV-specific information from other routers and generates SAV rules based on SAV-related information
SAV-specific Information

- SAV-specific information is specialized for SAV rule generation
  - It carries necessary information which cannot be learned from local routing information in asymmetric routing scenarios, helping generate accurate SAV rules

- Examples of SAV-specific information in intra-domain SAVNET
  - The router’s locally known source prefixes of its connected subnets
  - The ownership of source prefixes, e.g., belonging to a single-homed subnet or belonging to a multi-homed subnet
  - The type of source prefixes, e.g., anycast prefix, hidden prefix, etc.

- A new mechanism (namely, SAV-specific information communication mechanism) is needed to communicate SAV-specific information
SAV-specific Information Communication Mechanism

- Building the communication channel and propagating SAV-specific information from source entity to validation entity
  - Automatic update in a timely manner
  - Session authentication before session establishment

[Diagram showing Source Entity (Router A) with SAVNET Agent and Information Sender connected to Validation Entity (Router B) with SAVNET Agent and Information Receiver, with RIB/FIB and Local routing information.]
Edge routers generate SAV rules and perform outbound SAV

- Obtain the complete source prefixes of each connected subnet based on SAV-specific information and local routing information

Border routers generate SAV rules and perform inbound SAV

- Obtain internal source prefixes of the AS based on SAV-specific information and local routing information
Use Case #1: Outbound SAV at Edge Routers

- **Outbound traffic validation in asymmetric routing scenario**[1]
  - Edge routers 1 and 2 only learn part of source prefixes of Subnet 1 from local routing information in the asymmetric routing scenario

- **If using strict uRPF**
  - Improper block

- **If using intra-domain SAVNET**
  - **Accurate & Automatic outbound SAV**
    - Routers 1 and 2 obtain the complete source prefix of Subnet 1 by exchanging their locally known source prefixes of Subnet 1

[1]: draft-ietf-savnet-intra-domain-problem-statement-02
Use Case #2: Inbound SAV at Border Routers

- **Inbound traffic validation**[1]
  - Border routers 3 and 4 should block inbound packets with source address of internal source prefixes at border routers

- If using ACL-based SAV
  - Manual update when internal prefixes or network topology change dynamically

- If using loose uRPF
  - Large amount of improper permit

- If using intra-domain SAVNET
  - **Accurate & Automatic inbound SAV**
    - Routers 3 and 4 obtain the complete internal source prefix based on SAV-specific information sent by Routers 1, 2, and 5

[1]: draft-ietf-savnet-intra-domain-problem-statement-02
Accurate Validation & Automatic Update

Use Cases #1 and #2 shows that intra-domain SAVNET can achieve more accurate validation and support automatic update.

- Compared with uRPF-based SAV which solely uses local routing information,
  - Intra-domain SAVNET generates SAV rules by using both local routing information and SAV-specific information exchanged among routers, resulting in more accurate SAV validation in asymmetric routing scenarios.

- Compared with ACL-based SAV which requires manual updates,
  - Intra-domain SAVNET generates SAV rules automatically in a distributed way and allows routers to exchange the changes of SAV-specific information among each other automatically.
Incremental/Partial Deployment

- Edge routers and border routers deploying intra-domain SAVNET is enough

- Blocking spoofing traffic in incremental/partial deployment scenarios
  - Outbound SAV: as long as edge routers connected to the same subnet exchange SAV-specific information, that subnet can be accurately prevented from spoofing other subnets
  - Inbound SAV: if a border router only obtains partial internal source prefixes, it can still block inbound packets which forge those prefixes
  - When SAV-specific information is missing, local routing information can be used to generate SAV rules

- More routers deploy intra-domain SAVNET, more benefits
Convergence

- When SAV-related information changes,
  - Source entity MUST send the updated SAV-specific information to validation entity **timely**
  - Validation entity MUST detect the changes of received SAV-specific information and local routing information in time and **update SAV rules with the latest information**

- Propagation speed of SAV-specific information is the main factor that affects the convergence of SAV rule generation
  - SAV-specific information can have a similar propagation speed as routing information
    - if SAV-specific information and routing information of an edge router can be advertised to other routers in a similar way
  - Depending on the design and implementation of the new intra-domain SAV solution
In some unlikely cases, some routers may do harm to other routers within the same domain

- Potential threats: entity impersonating, message blocking, message alteration, message replay, etc.

The above security threats SHOULD be considered when designing the new intra-domain SAV mechanism

- Possible solutions: session authentication, message acknowledge, message integrity verification, duplication detection, etc.
Following this architecture, the new SAV solution can meet the requirements proposed in [draft-ietf-savnet-intra-domain Problem Statement].

- **Requirement #1: Accurate Validation**
  - Generate SAV rules using both SAV-specific information and local routing information.

- **Requirement #2: Automatic update**
  - SAV-specific information exchange is triggered automatically when topology or prefix changes.

- **Requirement #3: Incremental/partial Deployment**
  - When some SAV-specific information is unavailable, local routing information can be used to fill this gap.

- **Requirement #4: Convergence**
  - SAV-specific information and SAV rules can be updated in a timely manner.

- **Requirement #5: Security**
  - Possible security threats should be considered when designing the new SAV solution.
Thanks!