SAV Open Playground
& the Real Path Discovery Protocol

Libin Liu, Li Chen
Zhongguancun Laboratory

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Problem with SAV Research

When researching SAV, we find that we, and maybe the entire SAV community, is in need of:

**Goals & Requirements**

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<thead>
<tr>
<th>A reference/starter project</th>
<th>For development of new SAV technologies</th>
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<tr>
<td></td>
<td>Ideally built with open-source software router with high scalability</td>
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<tr>
<td>An experimentation environment</td>
<td>For network operators to test their configurations</td>
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<td></td>
<td>Container-based virtual network topologies</td>
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<td>A visualization tool</td>
<td>For networking professionals to understand different SAV mechanism</td>
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<td>Ideally a web application</td>
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<td>An education platform</td>
<td>For reproducible SAV experiments</td>
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<td>For students to learn about SAV</td>
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SAV Open Playground (SAVOP)

- A development and simulation platform for new SAV technologies
- An experimentation environment for network operators to test their configuration
- A web application that helps networking professionals understand different SAV mechanism
- An education platform for students to learn about SAV
We develop SAV Open Playground (SAVOP) project to close these gaps. SAVOP is open-source: https://github.com/SAV-Open-Playground/savop

Four core components:

- SAV Reference Router
- Virtual Network Manager
- Browser-based Visualization
- Scenario Replay

SAVOP Architecture

Web App visualizes the workings of SAV mechanisms in a scenario.

Config DB stores the SAV scenarios for replaying on the web app.

Simulated SAV Scenario

A reference SAV agent for BIRD router, which can implement all SAV mechanisms.

Virtual Network Manager setup container network for SAV scenarios.
SAV Agent with BIRD

- **SAV Agent** extracts relevant information for SAV from BIRD using command line and BIRD native extensions.

- **SAV App** guides what information within the SIB will be used and how to use the information to generate SAV rules.

- **SAV Table Manager**, based on SIB, manipulates the IP tables in the Linux data path to achieve SAV.

**Why BIRD?**
- BIRD is an open-source implementation of software IP router.
- BIRD is used in several Internet exchanges, such as the London Internet Exchange (LINX), LONAP, DE-CIX and MSK-IX as a route server, where it replaced Quagga because of its scalability issues.
- According to the 2012 Euro-IX survey, BIRD is the most used route server amongst European Internet exchanges.

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Data Plane Packets

IP Tables

Permit/Deny

Routing

Linux User Space

Linux Kernel Space
SAV agent enables quick development of new SAV mechanisms.

- Real Path Discovery Protocol (RPDP) is a good example.

**Main idea**

- RPDP is a hop-by-hop SAV information propagation protocol.
- Origin AS advertises its preferred AS paths to other ASes by RPDP messages.
- Other ASes learn the incoming directions of the origin AS through received RPDP messages.

**The illustration of RPDP process**

- AS1 sends RPDP messages hop by hop to tell AS4 the paths.
- AS4 learns that AS3 and AS6 are valid incoming directions for P1, and all other neighbors are invalid.

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Relationships of AS4 and its neighbors: any one of c2p, p2c, or p2p

Accept P1 from AS3 and AS6
Block P1 from all other neighbors
RPDP message
```
Developing RPDP in SAVOP SAV Agent

SAV Agent
- SAV Apps
  - EFP-uRPF
  - BAR-SAV
  - RPDP
- SAV Information Base
- IPtables Command Executer

BIRD
- RPDP Protocol Executor

Linux User Space
- SAV Agent
- BIRD
- Linux Kernel Space

IP Tables
- Permit/Deny
- Routing

Data Plane Packets
- RPDP Protocol Msg.
Virtual Network Manager

User Input

Simulation Initial Settings
- Initial SIB
- Initial SAV Tables
- Static Routes
- SAV Mechanism

Backend

SAV Scenario Simulation
Visualization & Scenario Replay

- **Network Model 1:** [https://ki3.org.cn:45679/#/sav?id=62b075de-41e9-4d2e-b458-db5d84f8ee2a](https://ki3.org.cn:45679/#/sav?id=62b075de-41e9-4d2e-b458-db5d84f8ee2a)

- **Network Model 2:** [https://ki3.org.cn:45679/#/sav?id=4f69374c-df10-4a59-af46-d9fc7a9ddf81](https://ki3.org.cn:45679/#/sav?id=4f69374c-df10-4a59-af46-d9fc7a9ddf81)

- The nodes, RIB, FIB, SIB in Network Model 1 are listed below.
SAVOP Future Development

- More SAV mechanisms
  - Done: RPDP, strict uRPF, loose uRPF
  - To do: FP-uRPF, VRF uRPF, EFP-uRPF, BAR-SAV, ...

- More protocol extensions
  - Partially done: BGP
  - To do (following WG Charter): BGP-LS, OSPF, ISIS, RIFT

- More routers
  - Open source software router: Quagga
  - Commercial routers: Huawei, H3C, Cisco, etc.
Thanks!