Inter-domain Source Address Validation (SAVNET) Architecture

Jianping Wu, Dan Li, Mingqing Huang, Li Chen,
Nan Geng, Libin Liu, Lancheng Qin

Mar 29, 2023

Introduction

- Inter-domain SAV is important for mitigating source address spoofing attacks
  - Preventing traffic that forges other ASes' source addresses from entering the AS that deploys inter-domain SAV
- However, existing inter-domain SAV mechanisms have limitations
  - uRPF-related SAV mechanisms have improper block or improper permit problems
  - ACL-based SAV mechanisms have high operational overhead problems
- To address the limitations,
  - Inter-domain source address validation (SAVNET) architecture provides a framework for developing new SAV mechanisms

Design Goals

Inter-domain SAVNET architecture aims to enhance accuracy and facilitate partial deployment with low operational overhead

- Accurate SAV at peer and customer interfaces
  - Accurately learn the valid source addresses that should be **permitted** and block packets with the learned invalid or other unknown source addresses
- Accurate SAV at provider interfaces
  - Accurately learn the invalid source addresses that should be **blocked** and permit packets with the learned valid or other unknown source addresses
- Automatic update
  - Adapt to dynamic networks and asymmetric routing scenarios automatically
- Working in partial deployment
  - Provide protection for the source prefixes of deployed ASes in partial deployment scenario

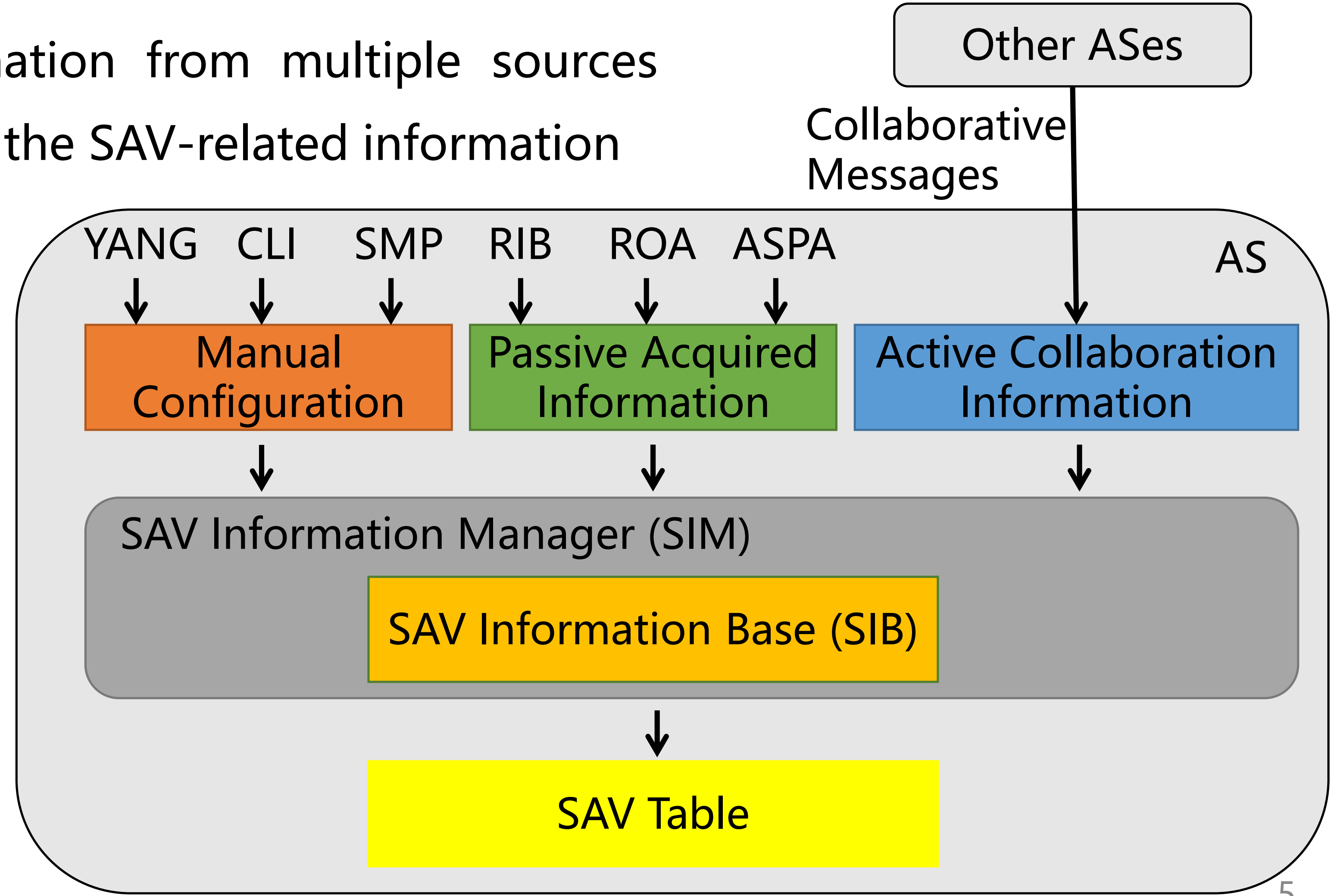
Scope

Different from Version-00 which focuses on the specific new SAV mechanism, Version-01 focuses on high-level architecture

- This draft focuses on
  - ◆High-level architecture designs that enable an AS to generate accurate SAV rules by using SAV-related information from various sources
- This draft does not include
  - ◆Protocol designs or protocol extensions
  - ◆Detailed solutions for reducing operational overhead, since they should be considered in specific SAV mechanisms
  - ◆Detailed solutions for collecting and updating SAV-related information from different sources

Inter-domain SAVNET Architecture

- Basic idea
  - ◆Consolidate SAV-related information from multiple sources and generate SAV rules based on the SAV-related information
- Main components
  - ◆SAV-related information sources
  - ◆SAV Information Manager (SIM)
  - ◆SAV Information Base (SIB)
  - ◆SAV table



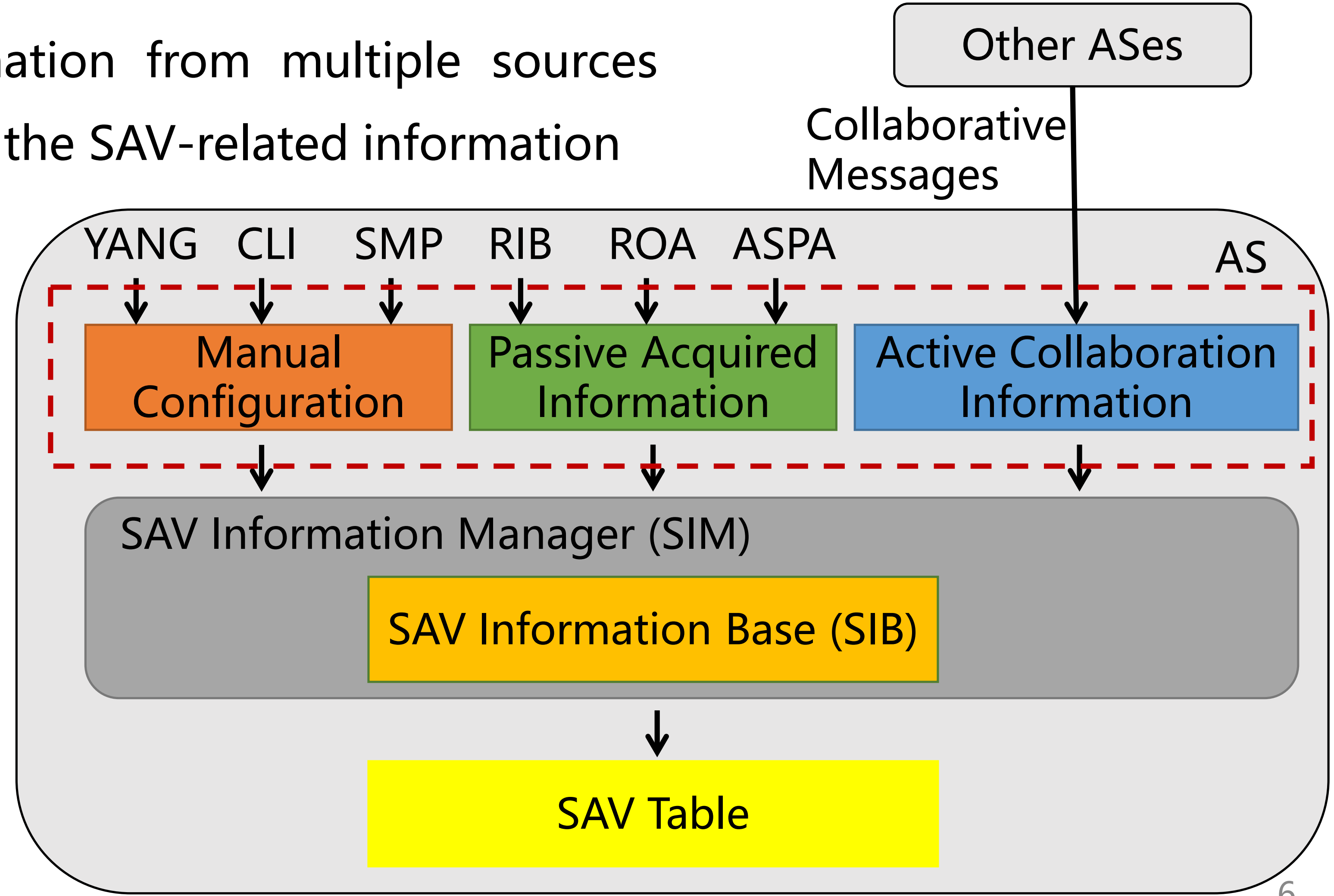
Inter-domain SAVNET Architecture

Basic idea

- Consolidate SAV-related information from multiple sources and generate SAV rules based on the SAV-related information

Main components

- SAV-related information sources
- SAV Information Manager (SIM)
- SAV Information Base (SIB)
- SAV table

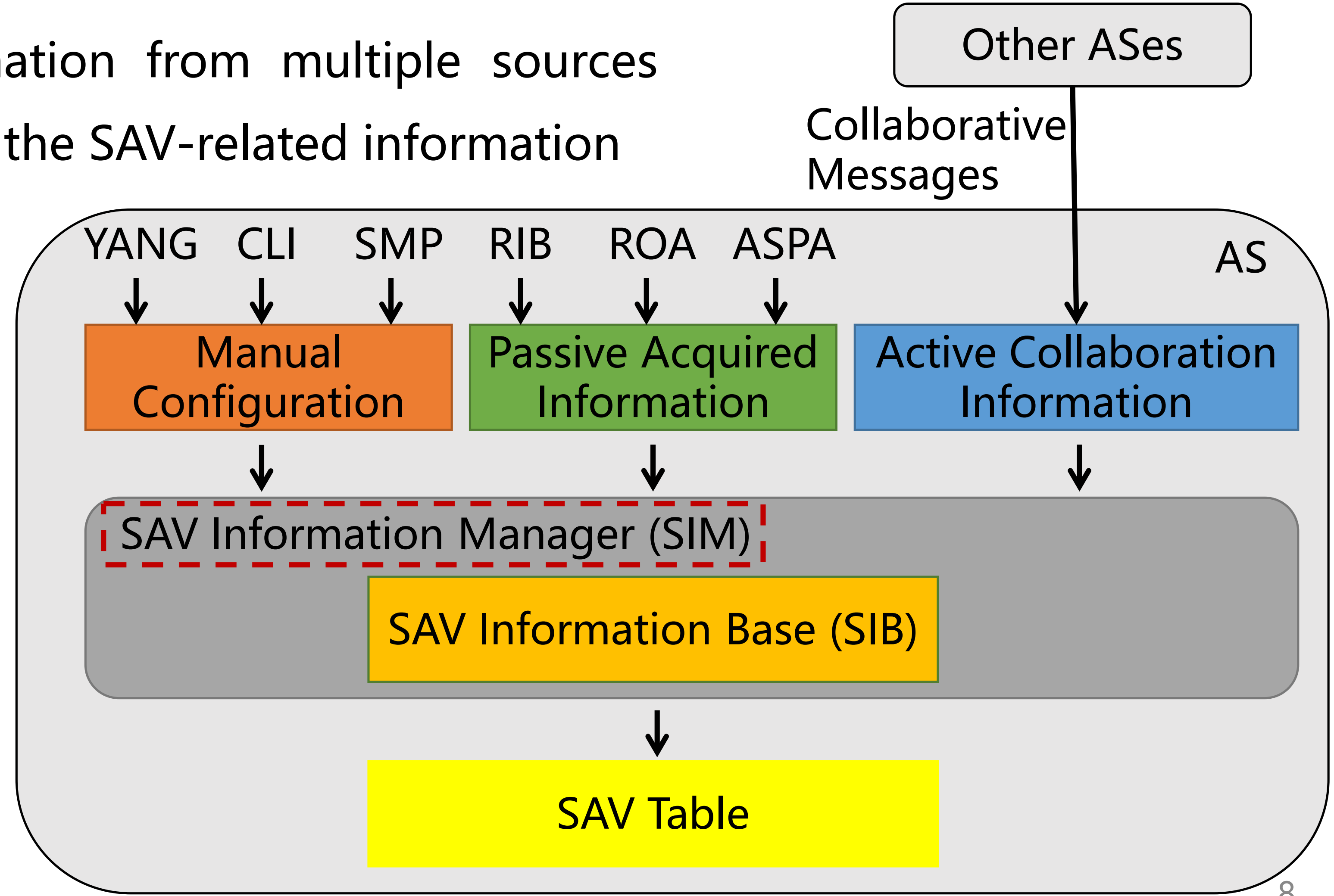


SAV-related Information Sources

- SAV-related information that specifies the valid incoming interfaces for a source prefix can be learned from
  - Manual Configuration
    - SAV-related configurations from YANG, command-line interface (CLI), and protocols such as remote triggered black hole (RTBH) and Flowspec
  - Passive Acquired Information
    - Topological and routing information from Routing Information Base (RIB), Routing Information Messages, RPKI ROA objects, and RPKI ASPA objects
  - Active Collaboration Information
    - Real forwarding paths of prefixes transmitted by Collaborative Messages from other ASes
- All sources are optional depending on the availability of them and operational needs

Inter-domain SAVNET Architecture

- Basic idea
  - Consolidate SAV-related information from multiple sources and generate SAV rules based on the SAV-related information
- Main components
  - SAV-related information sources
  - SAV Information Manager (SIM)
  - SAV Information Base (SIB)
  - SAV table

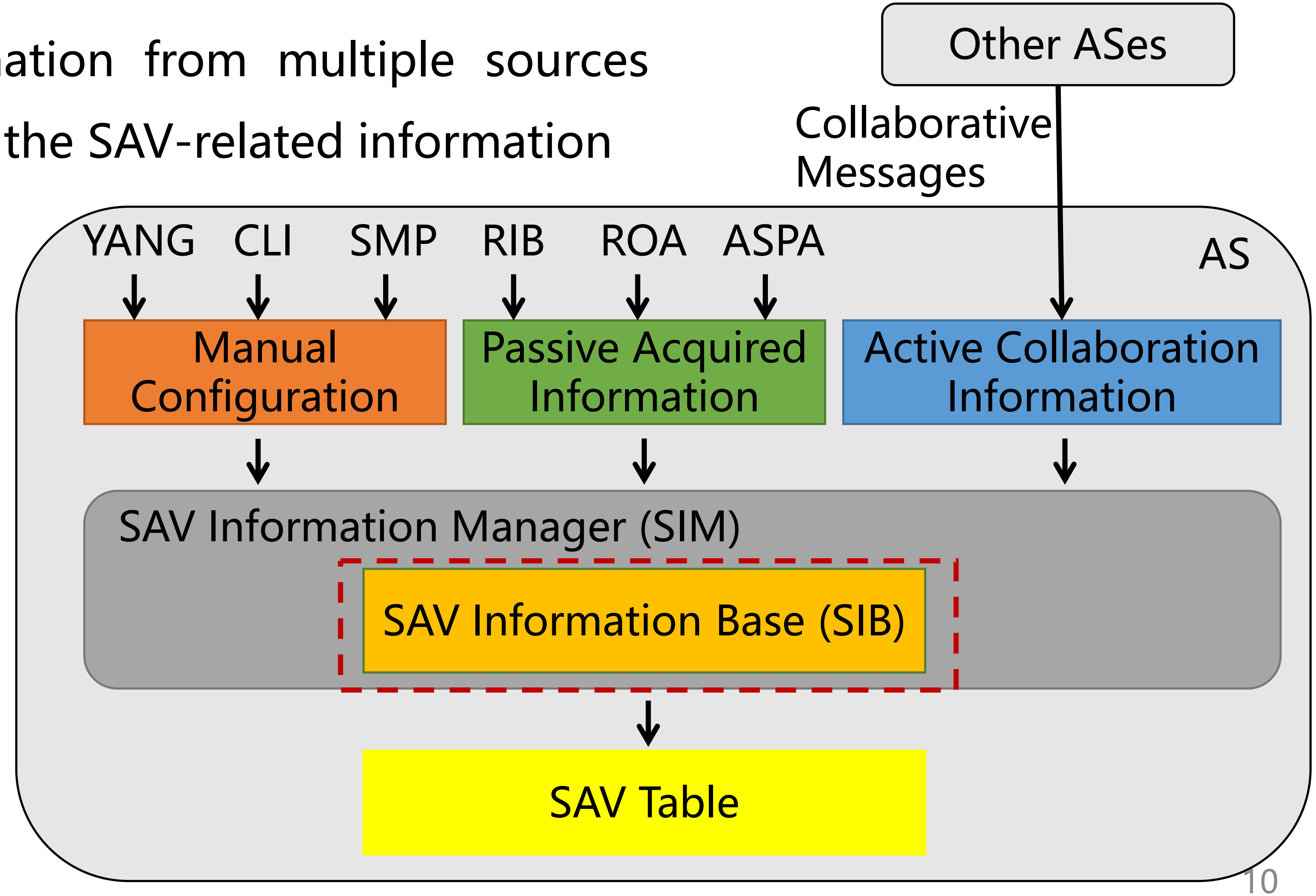


SAV Information Manager (SIM)

- Function #1
  - ◆Maintain the Source Information Base (SIB) by consolidating SAV-related information collected from multiple sources
- Function #2
  - ◆Generate SAV rules to fill out the SAV table in data plane based on the SIB

Inter-domain SAVNET Architecture

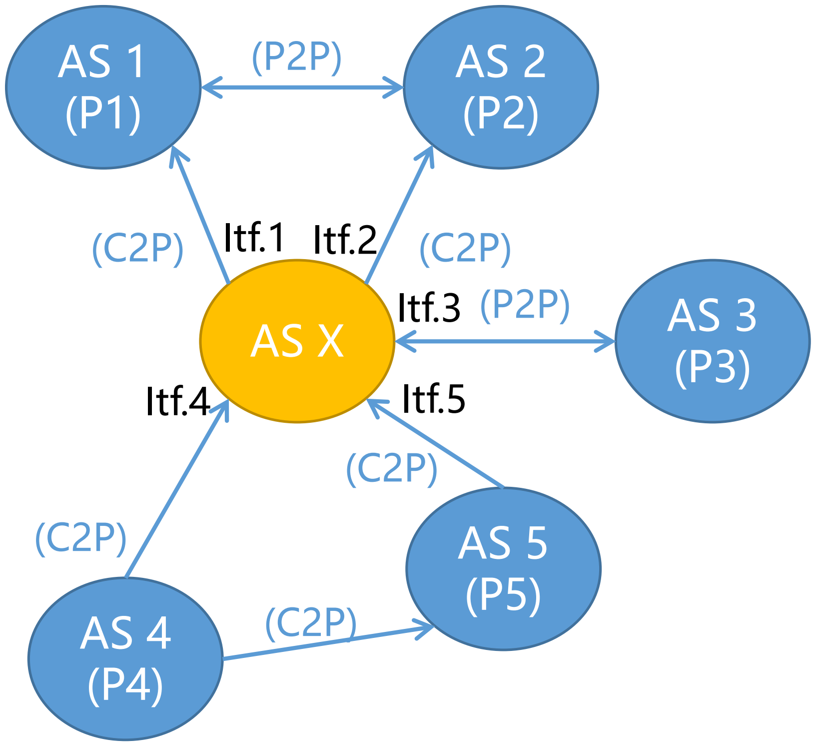
- Basic idea
  - ◆Consolidate SAV-related information from multiple sources and generate SAV rules based on the SAV-related information
- Main components
  - ◆SAV-related information sources
  - ◆SAV Information Manager (SIM)
  - ◆SAV Information Base (SIB)
  - ◆SAV table



SAV Information Base (SIB)

Data structure of SIB

- Each row records the index, the prefix, the prefix's valid incoming interface, the prefix's incoming direction, and the corresponding information source
- Different information sources may specify different incoming interfaces for the same prefix



SAV Information Base for AS X

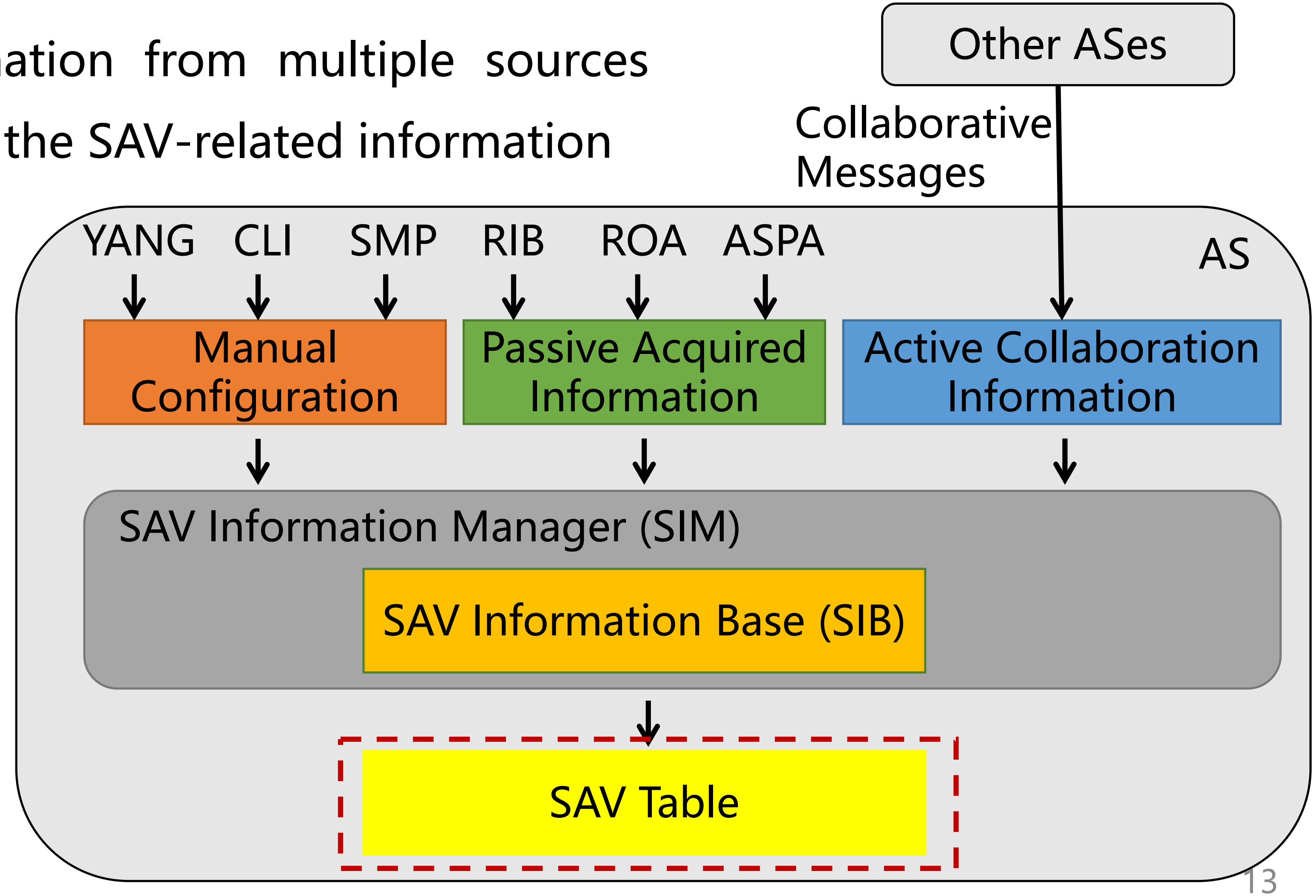
Index	Prefix	AS-level Interface	Direction	Information Source
0	P1	Itf.1	Provider	Collaborative Message, Routing Information Message
1	P1	Itf.2	Provider	Routing Information Message, RIB
2	P2	Itf.2	Provider	Manual Configuration
3	P3	Itf.3	Peer	Collaborative Message, RPKI ROA objects, RPKI ASPA objects
4	P4	Itf.4	Customer	Collaborative Message
5	P4	Itf.5	Customer	Routing Information Message, RIB
6	P5	Itf.5	Customer	Routing Information Message, RIB

SAV Information Base (SIB)

- Data structure of SIB
  - Each row records the index, the prefix, the prefix's valid incoming interface, the prefix's incoming direction, and the corresponding information source
  - Different information sources may specify different incoming interfaces for the same prefix
- How to identify the most accurate incoming interfaces from multiple information sources?
  - Finer-grained information source can help generate more accurate SAV rules
  - Operators are allowed to specify how to use the SAV-related information in the SIB by their local configurations

Inter-domain SAVNET Architecture

- **Basic idea**
  - ◆Consolidate SAV-related information from multiple sources and generate SAV rules based on the SAV-related information
- **Main components**
  - ◆SAV-related information sources
  - ◆SAV Information Manager (SIM)
  - ◆SAV Information Base (SIB)
  - ◆SAV table



SAV Table

- Data structure of SAV table
  - Each row (i.e., SAV rule) records the most accurate incoming interfaces for each learned source prefix

SAV Information Base for AS X				
Index	Prefix	AS-level Interface	Direction	Information Source
0	P1	Itf.1	Provider	Collaborative Message, Routing Information Message
1	P1	Itf.2	Provider	Routing Information Message, RIB
2	P2	Itf.2	Provider	Manual Configuration
3	P3	Itf.3	Peer	Collaborative Message, RPKI ROA objects, RPKI ASPA objects
4	P4	Itf.4	Customer	Collaborative Message
5	P4	Itf.5	Customer	Routing Information Message, RIB
6	P5	Itf.5	Customer	Routing Information Message, RIB

SAV Table for AS X	
Source Prefix	Incoming Interface
P1	Itf.1
P2	Itf.2
P3	Itf.3
P4	Itf.4
P5	Itf.5

SAV Table

- By checking the source address and the actual incoming interface of each packet against the SAV table, the validity state of each packet can be considered “valid”, “invalid”, or “unknown”
  - Packets with “valid ” state should be permitted
  - Packets with “invalid” state should be blocked
  - Packets with “unknown” state can be blocked or permitted according to the SAV configurations
- More details about how to use the SAV table can be found in [draft-huang-savnet-sav-table]

Considerations

- Working in partial deployment
  - Some information sources may not provide SAV-related information for all source prefixes in partial deployment scenario
  - New Inter-domain SAV mechanisms must support partial deployment
- Security considerations
  - Using active collaboration information faces the same security threats as those of BGP, including session security threats and content security threats
  - Existing BGP security mechanisms can be used to secure Collaborative Protocols
    - An independent security mechanism is needed when some BGP security mechanisms are not widely deployed

Conclusion

- Define the high-level inter-domain SAVNET architecture
  - Use SAV-related information from multiple sources to generate accurate SAV rules
- Leave open design space for new SAV mechanisms
  - How to select appropriate information sources?
  - How to collect and update the needed SAV-related information from selected sources?
  - How to use the SIB to identify the most accurate incoming interfaces?

Next Step

- Solicit comments and refine the draft
  - Many thanks to Igor Lubashev for the helpful revision suggestions
  - Your comments are welcome!
- Seek cooperation
  - Refining the draft
  - Detailed designs for the new inter-domain SAV mechanism
  - ……

Thanks!

Backup slides

Collaborative Messages

- Basic idea
  - The Collaborative Messages propagate or originate the real forwarding paths of prefixes between the Collaborative Protocol Speakers in different ASes
- The detailed designs for collaborative messages and protocol extensions are in the works
  - Seek cooperation
  - Carried out in the working groups responsible for the corresponding protocols

Three Validity States

- “Valid” means
  - There is a source prefix in SAV table covering the source address of the packet, and the valid incoming interfaces cover the actual incoming interface of the packet
- “Invalid” means
  - There is a source prefix in SAV table covering the source address of the packet, but the actual incoming interface of the packet does not match any valid incoming interface
- “Unknown” means
  - There is no source prefix in SAV table covering the source address of the packet