Source Address Validation Solution with OpenFlow/NOX Architecture

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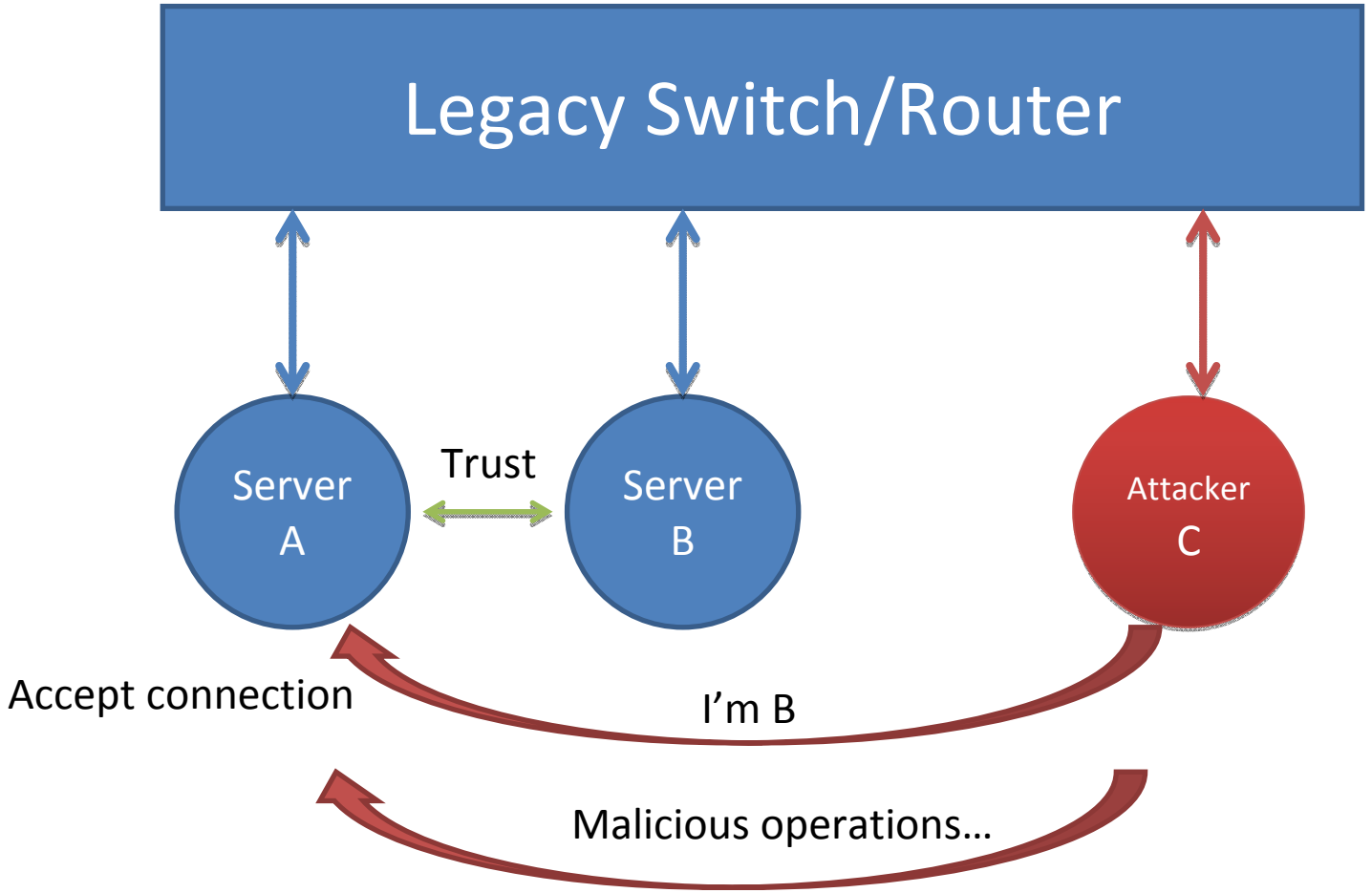
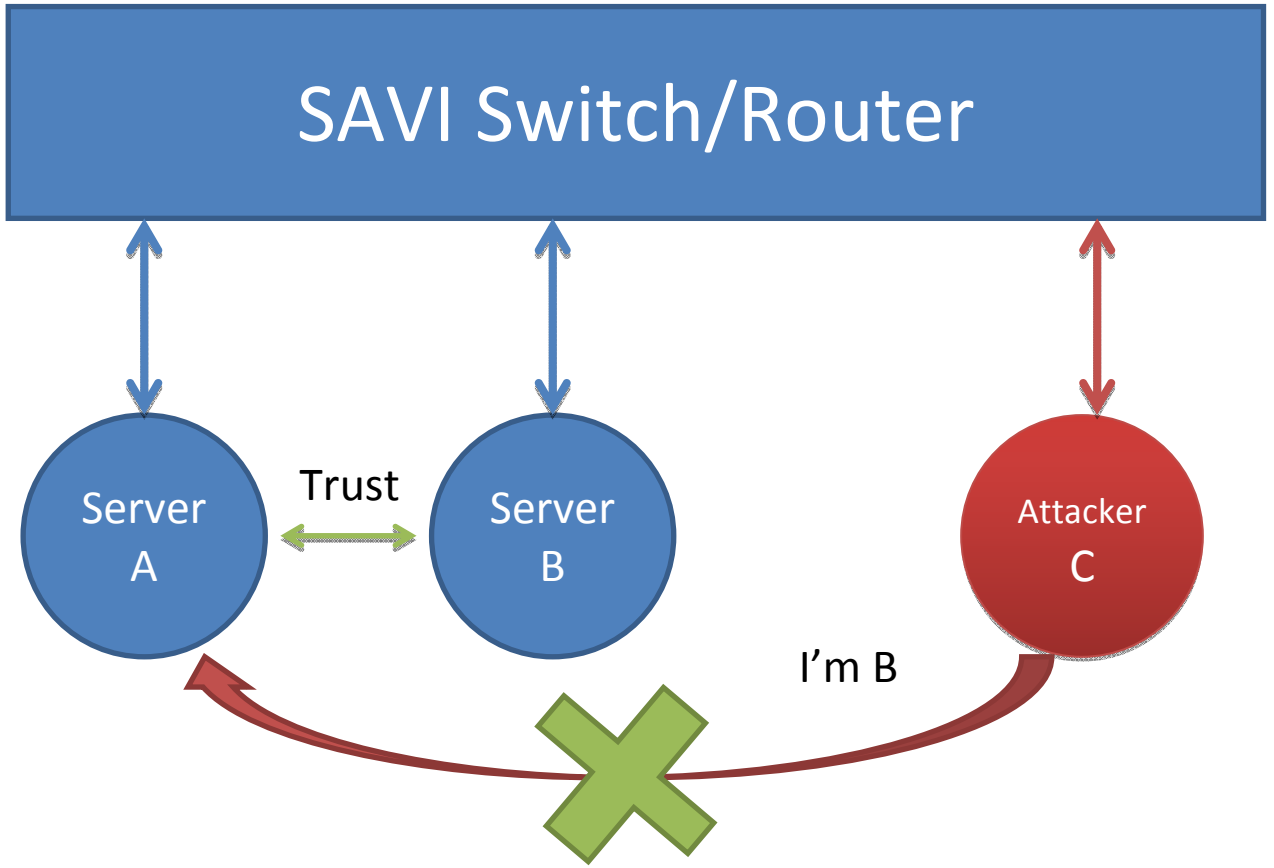
Background

- IETF SAVI WG
  - Formed in 2008
  - Anti-spoofing at Local link
- First Hop device
  - Source address binding based on address assignment snooping and filtering spoofing traffic at the fist hop SAVI device
  - Can not work very well yet if the fist hop is not deployed

IP Spoofing within Single Device Scope

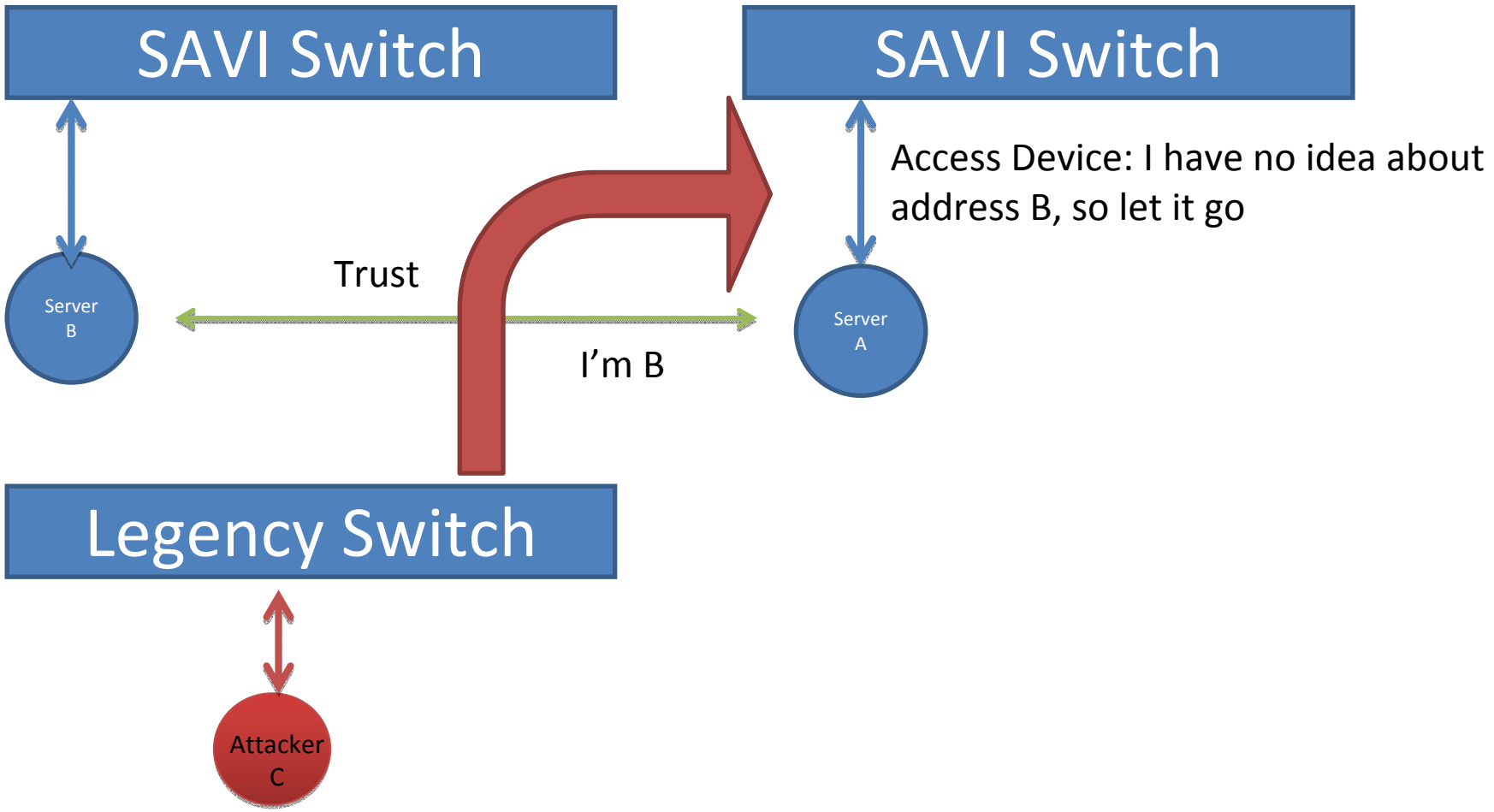


Source Address Validation within Single Device Scope



Access Device: B is on another port, filter the packet

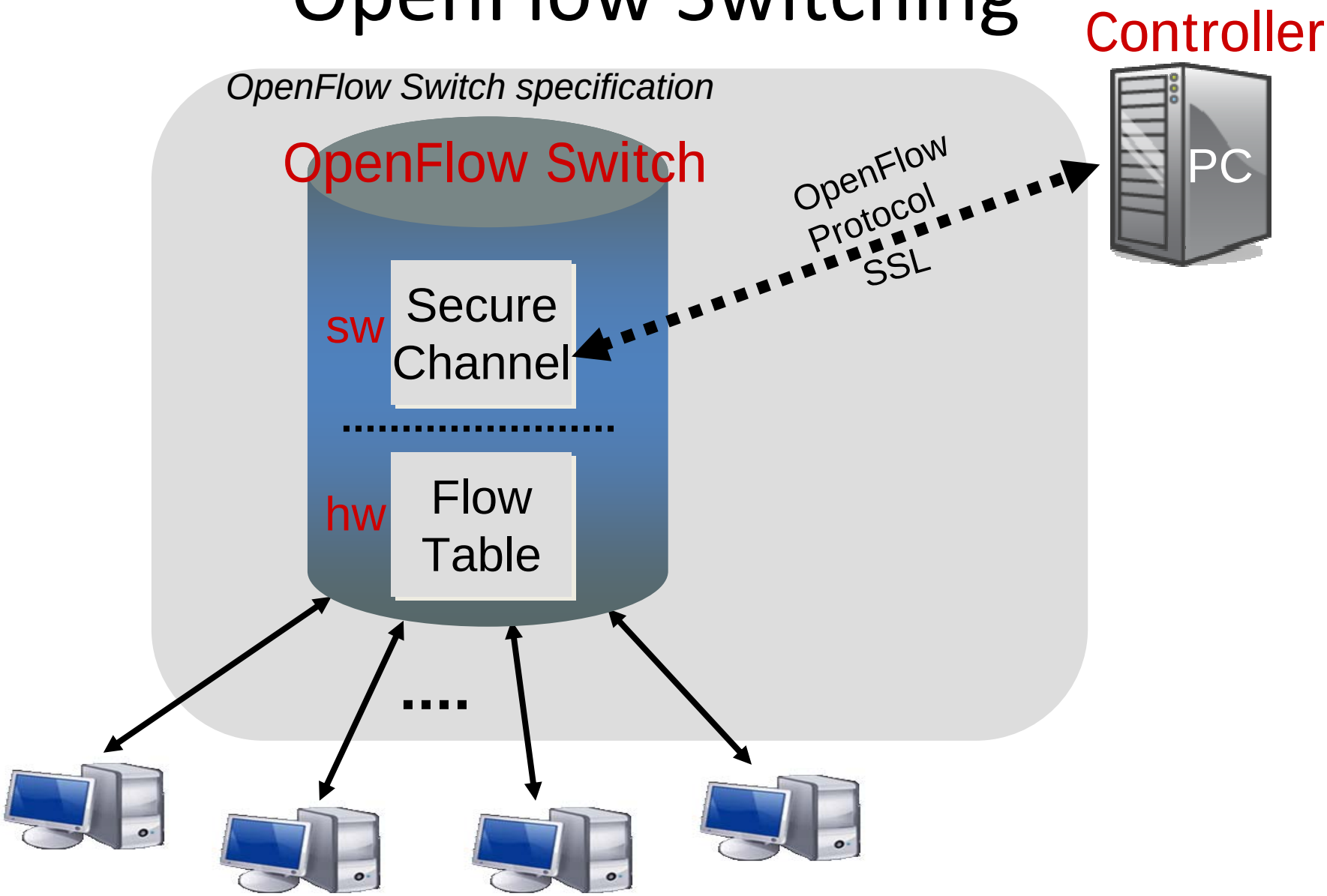
Scenario with Multiple Device



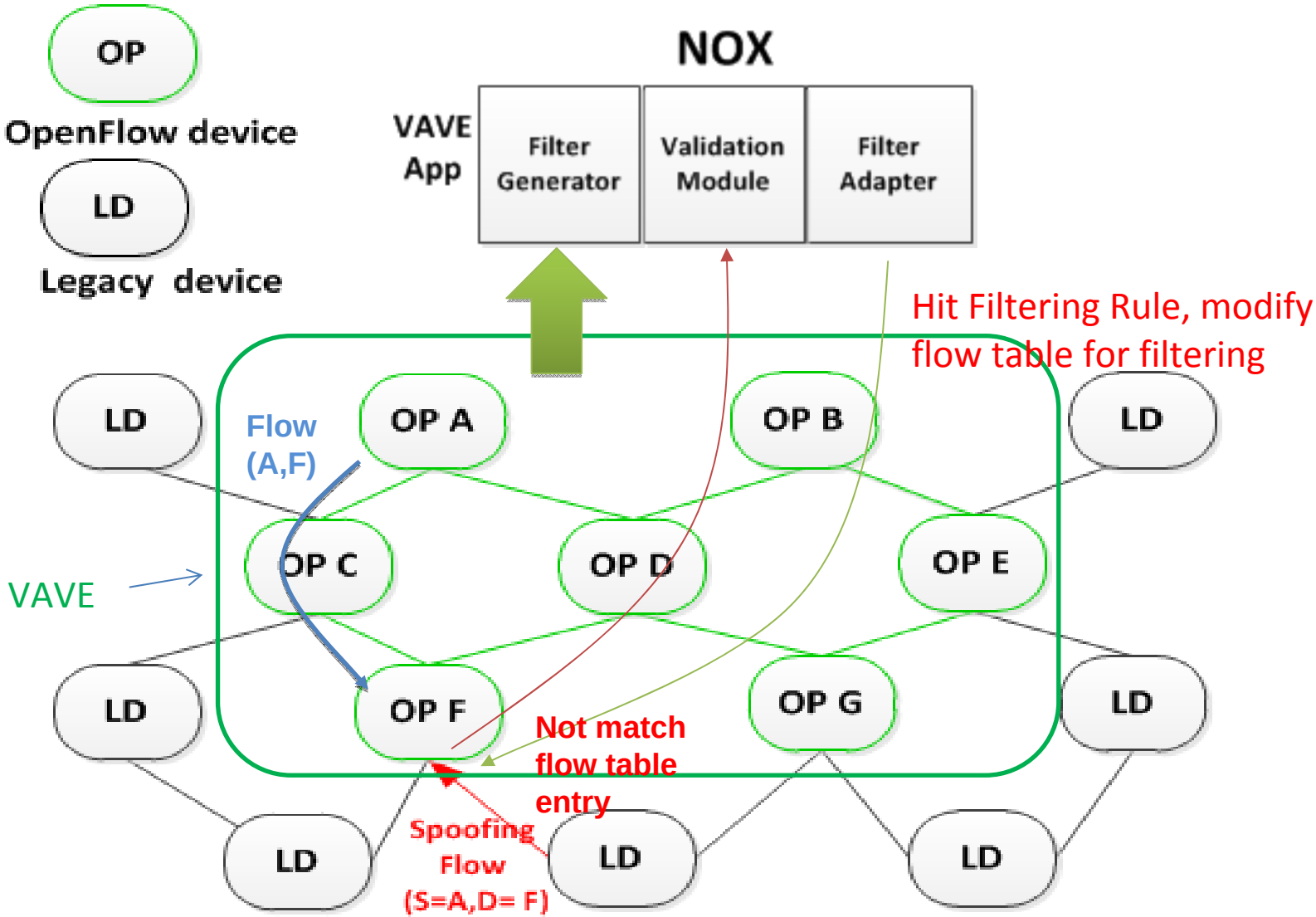
VAVE: Source Address Validation for Multiple Device Scenario with OpenFlow/NOX Architecture

- Problem to solve:
  - Help each device recognize spoofing flows of address assigned on other devices
- Basic mechanism:
  - 1. OpenFlow/NOX architecture
    - The *de facto* network protocol innovation framework
  - 2. Flow path calculation
    - To determine whether a flow is valid or not based on calculated path

OpenFlow Switching



Architecture of VAVE



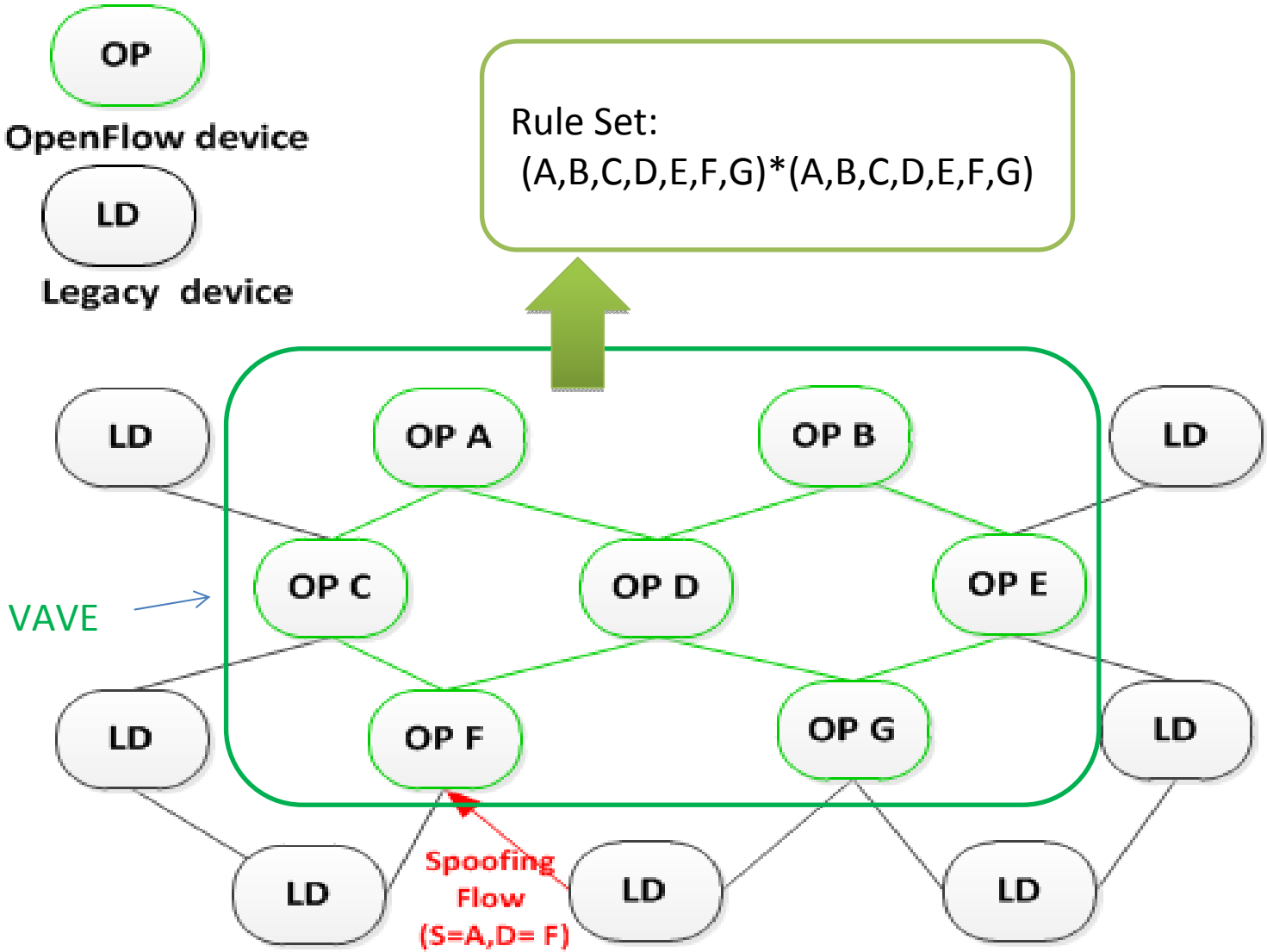
Filter Generator: Principle

- Principle:
  - P1. Filtering on the VAVE edge
    - To filter as early as possible
  - P2. Filtering based on the flow path
    - To filter flows violate calculated path
- P1+P2->Filtering flows whose complete path is inside the VAVE on the edge

Filter Generator: Flow Path Calculation

- Origin discovery:
  - Snooping address allocation protocol(DHCP, SLAAC…) on OpenFlow devices.
- Flow path calculation:
  - OpenFlow device forwards packet based on *FlowTable,* which is configured by Controller.
  - Keep the FlowTable state on the NOX server. Calculate flow path based on FlowTable.

Filter Generator: Flow Path Calculation

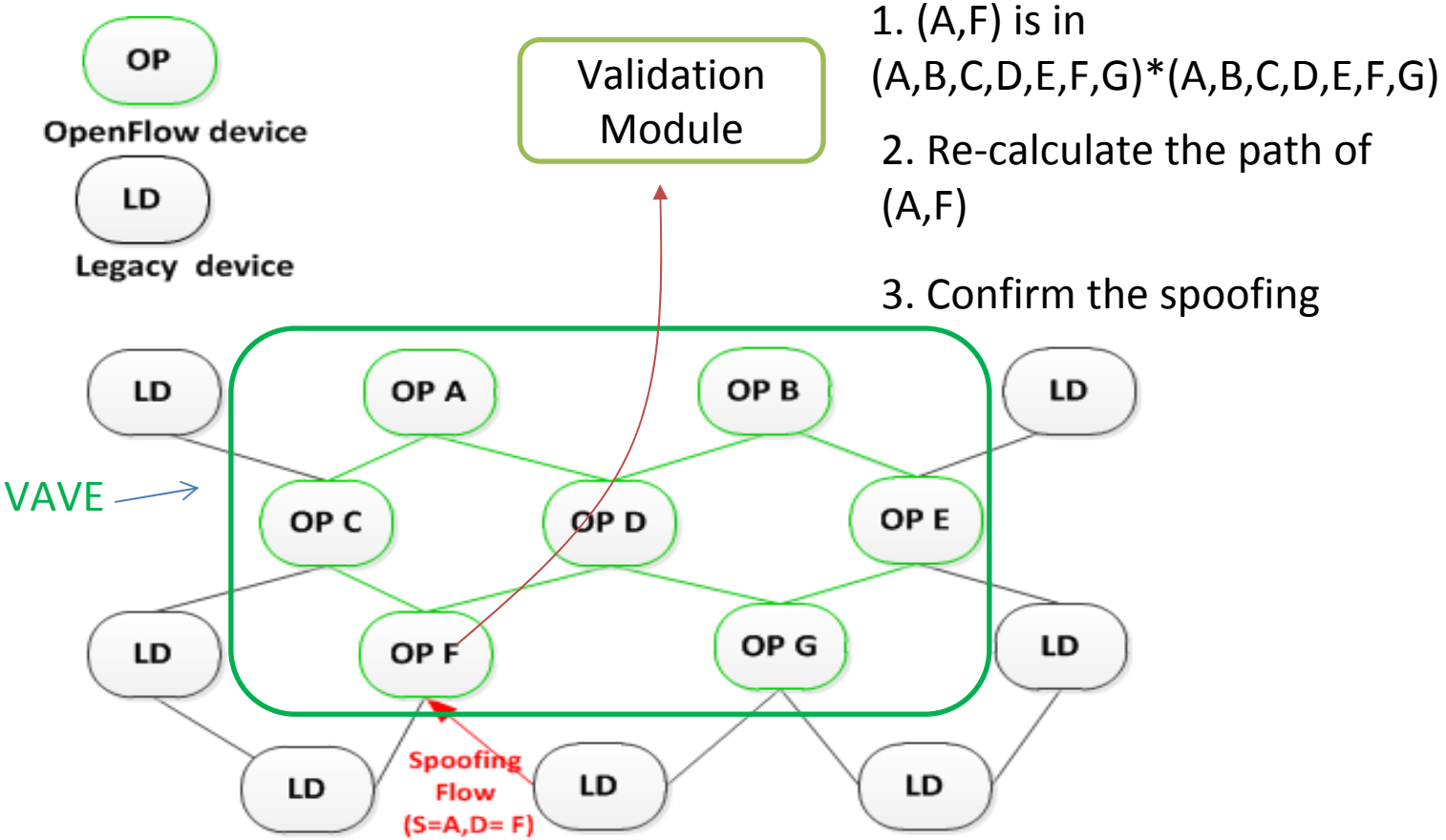


Filter Generator: Re-Calculation on Path Change

- Flow path may change frequently for a lot of requirements: dynamic load balance, route changes, etc.
- Calculate filtering rule frequently on each change will introduce heavy cost.
- Solution:
  - Set a flag for flows whose path is affected by FlowTable chang
  - Re-calculate the path then change flow talbe for filtering, ONLY WHEN the 1st spoofing packet is detected on the edge – Filtering on Demand

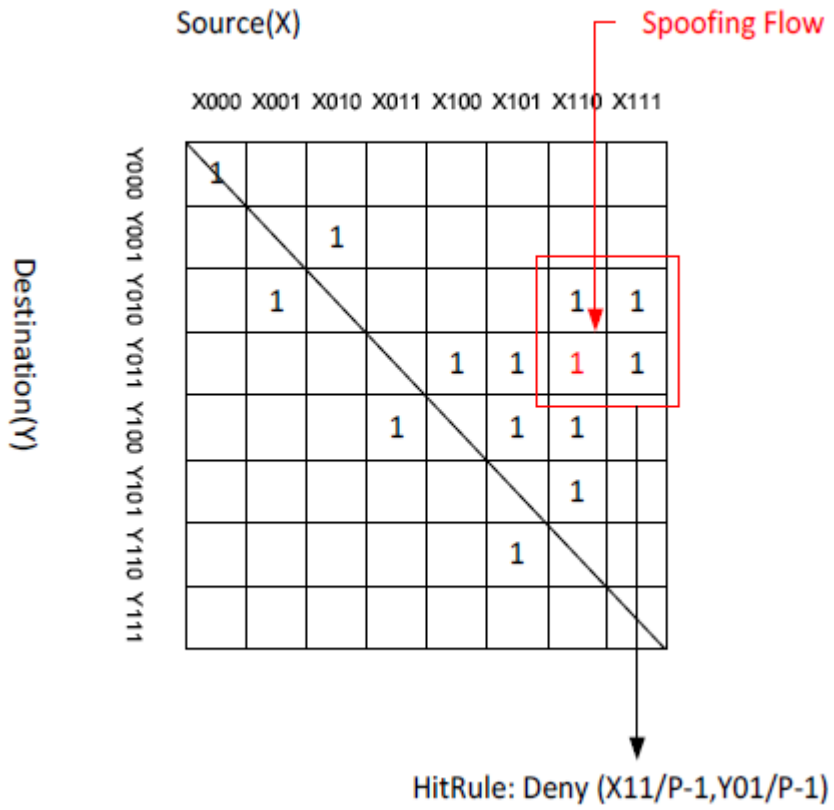
Validation Module

- Validation module processes packet redirected on the edge



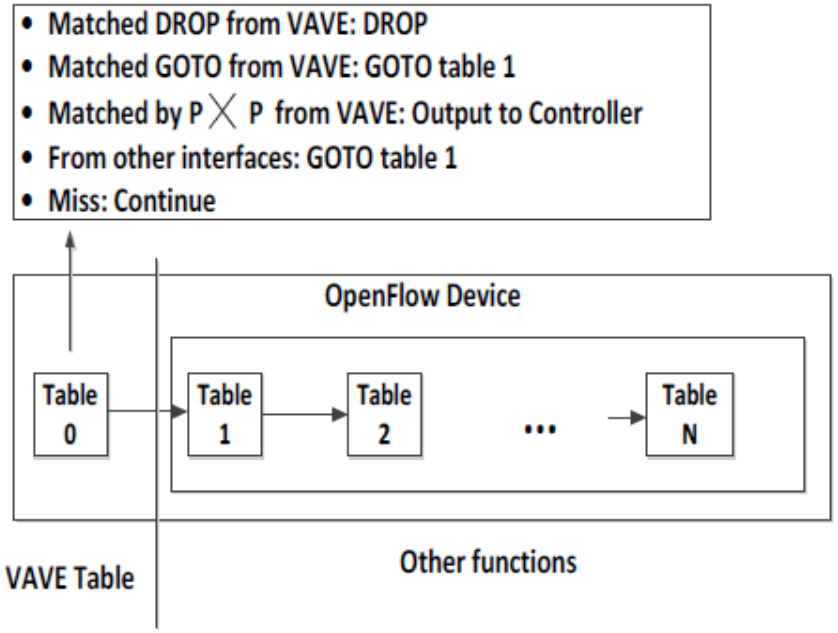
Filter Adapter

- Download filtering table to cut the spoofing flow by using the maximum cover rule



Filter Adapter

- Data plane: rules are configured on the first flow table on device.
- Rules are configured with a timer to cancel filtering after a period.
- A rule is removed if corresponding flow path changes.

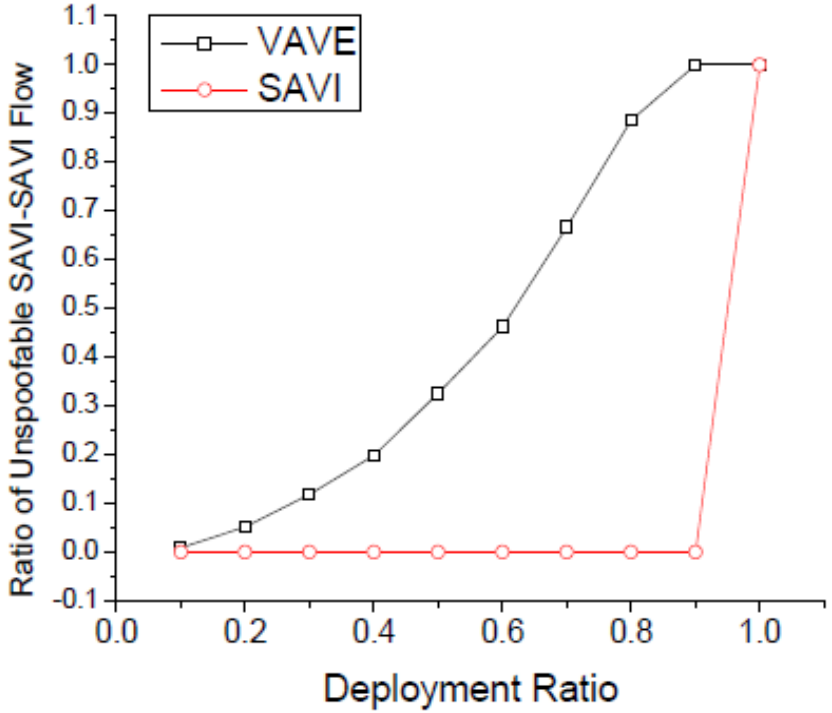


Evaluation

- An inferred topology (RF3755) from rocketfuel project through simulation.
  - Randomly assigned addresses and Shortest Path First algorithm to generate the flow table on each device.
  - Minimal vertex coverage strategy is chosen to generate the set of nodes in VAVE perimeter. There can exist multiple perimeters.

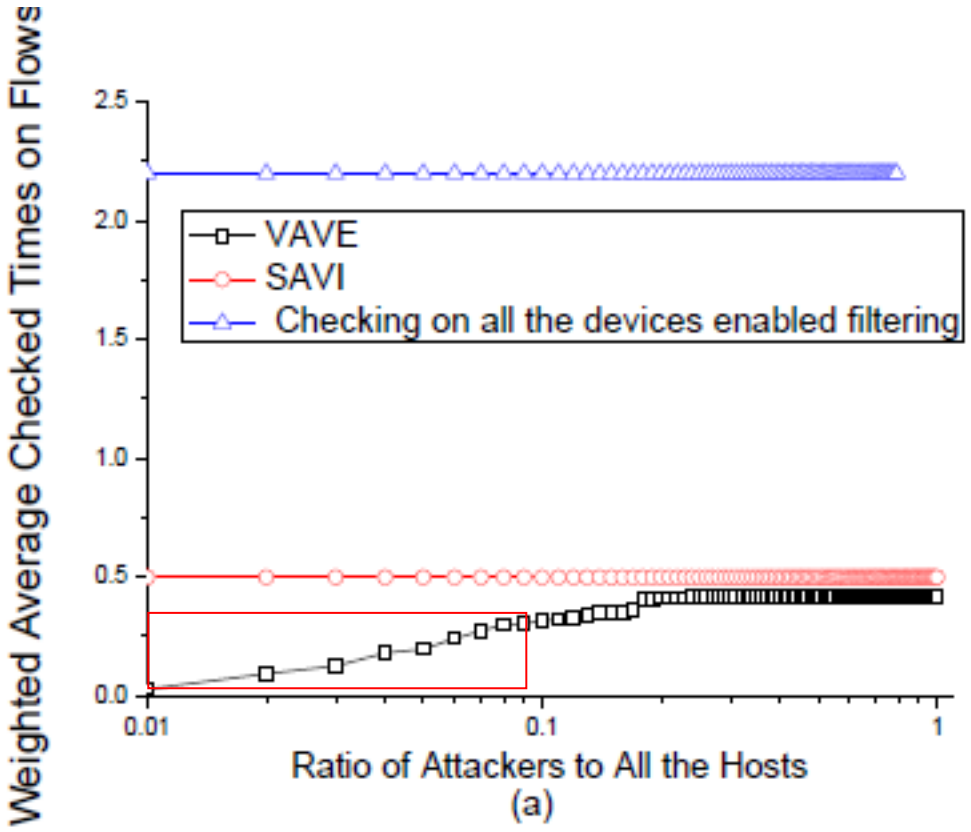
Evaluation

- Protectiveness:
  - The flows in the VAVE (SAVI switch to SAVI switch traffic) area are harder to be forged by attackers outside the edge



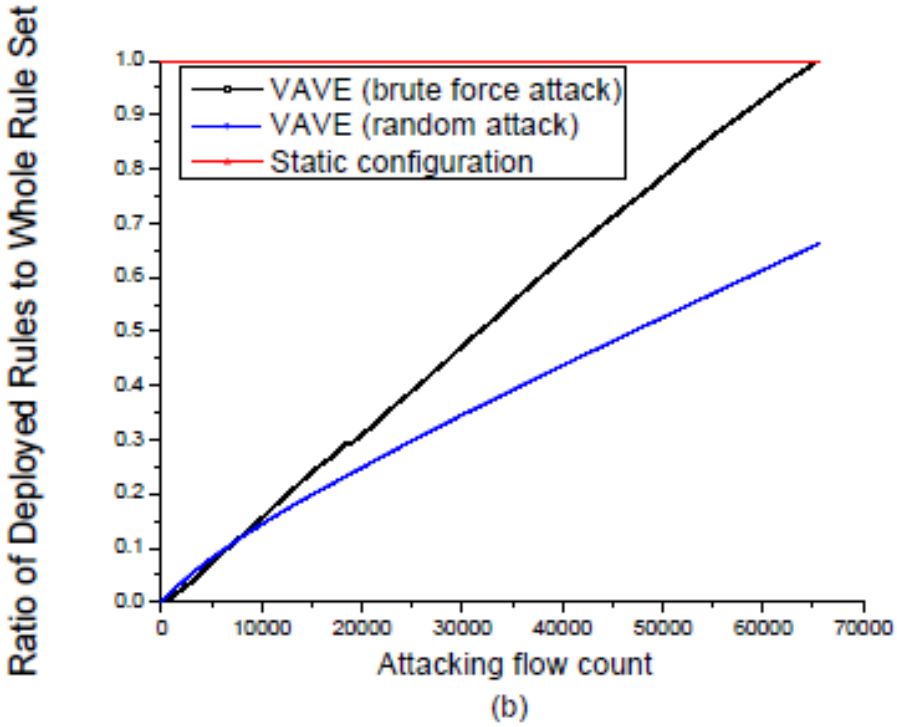
Evaluation

- Cost
  - The average check time on flows is reduced by the filtering-on-demand feature of VAVE



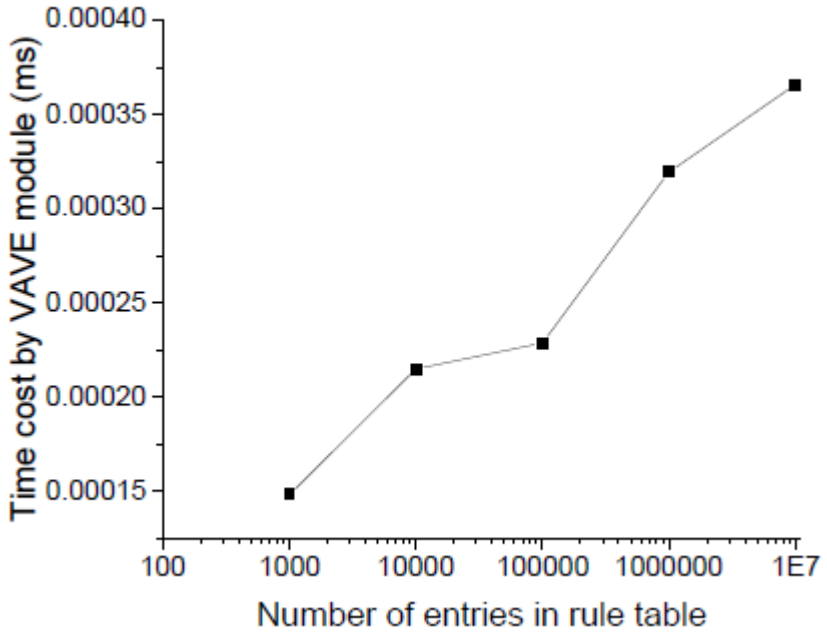
Evaluation

- Cost:
  - The required flow entries on the edge is also reduced greatly by filtering on demand.



Evaluation: Implementation

- Cost:
  - The time required by VAVE module on each packet is trivial (2.66GHZ CPU, 4GB Memory)



Conclusion

- We analyzes the problem of SAVI at multiple devices scenario
- We propose VAVE, which is based on OpenFlow/NOX architecture and calcluated paths to enhance the filtering ability of each device.
- VAVE performs filtering at low cost by introducing filtering on demand.