Research Project 2
System and Network Engineering

Supervision
Ariën Vijn & Joris Claassen

amsix
amsterdam
internet exchange

Software Defined Internet Exchanges

A feasibility evaluation at the AMS-IX

Siem Hermans, Jeroen Schutrup

Universiteit van Amsterdam

Research Question

What is the feasibility of transitioning the AMS-IX to an Industrial Scale Software Defined Internet Exchange Point?

The Amsterdam Internet Exchange*

*Not only situated in Amsterdam

- Providing peering services
    - Saves costs
    - Resilience
- Common shared Layer 2 Ethernet platform
- Built on top of MPLS/VPLS

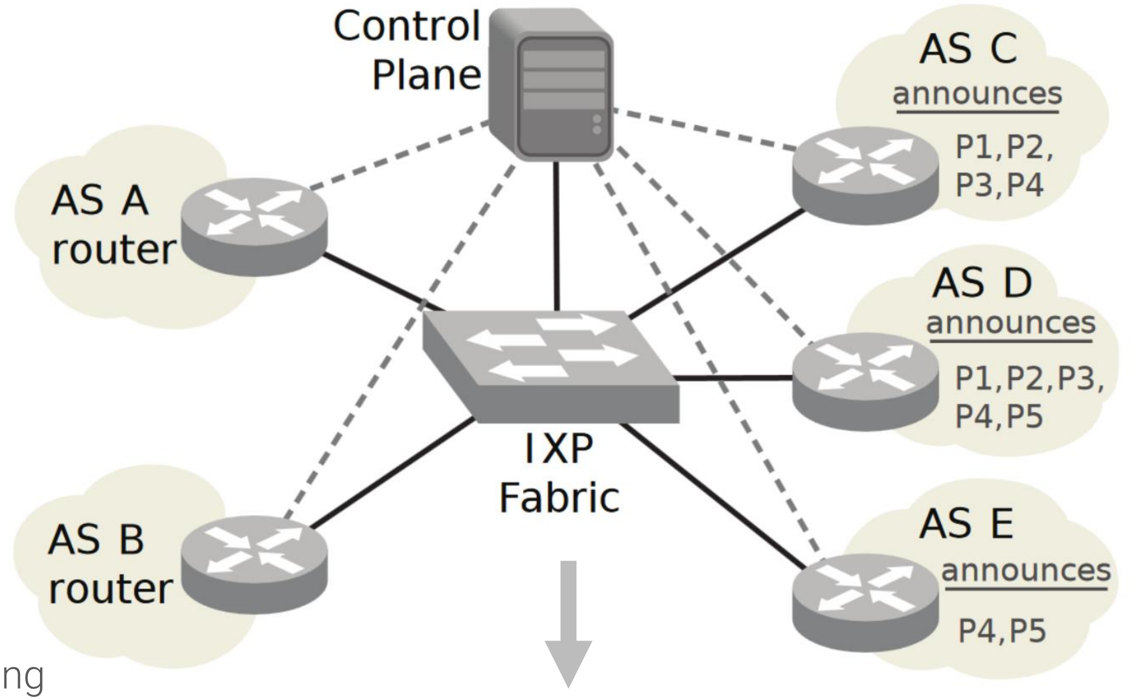
Technical concepts
SDX basics

- BGP Traffic delivery
  - Routing on prefix
  - No end-to-end policies
  - Indirect policies

- SDX leverages OpenFlow
  - Fabric is perceived as a single entity

- Use Cases
  - Application specific peering
  - (D)DoS mitigation
  - Et cetera.

- Primarily helpful for inbound traffic engineering



$\texttt{dIp} \in \{\mathbf{P1}, \mathbf{P2}, \mathbf{P3}, \mathbf{P4}\} \wedge \texttt{dPort=443} \rightarrow \texttt{fwd}(C)$

Sounds familiar...

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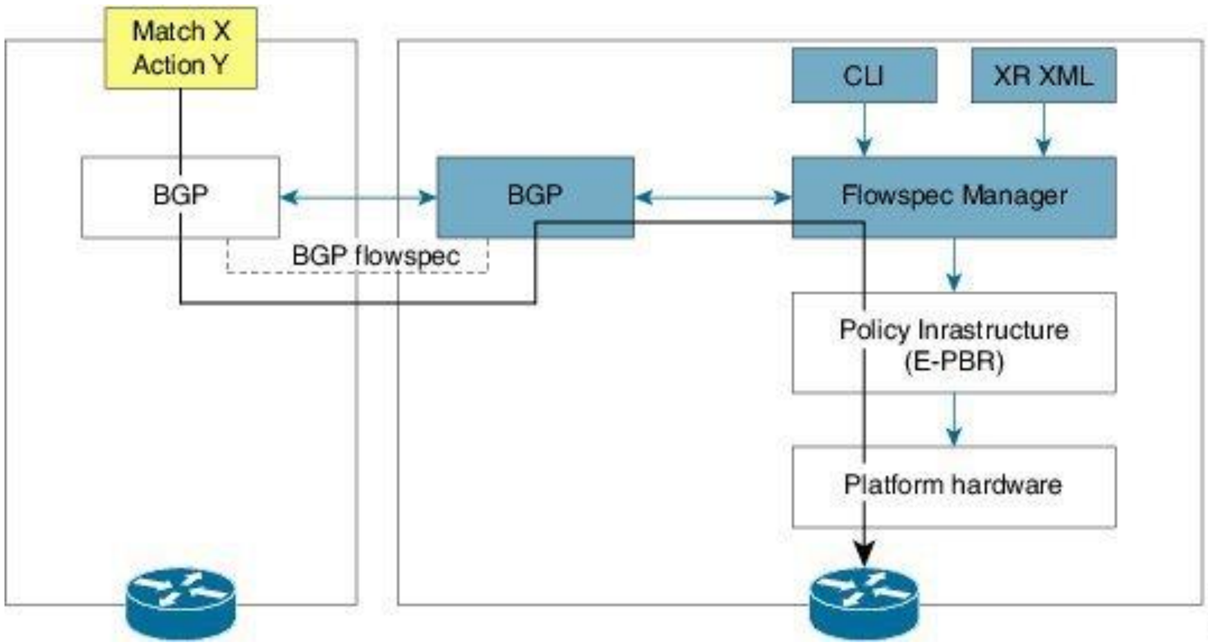
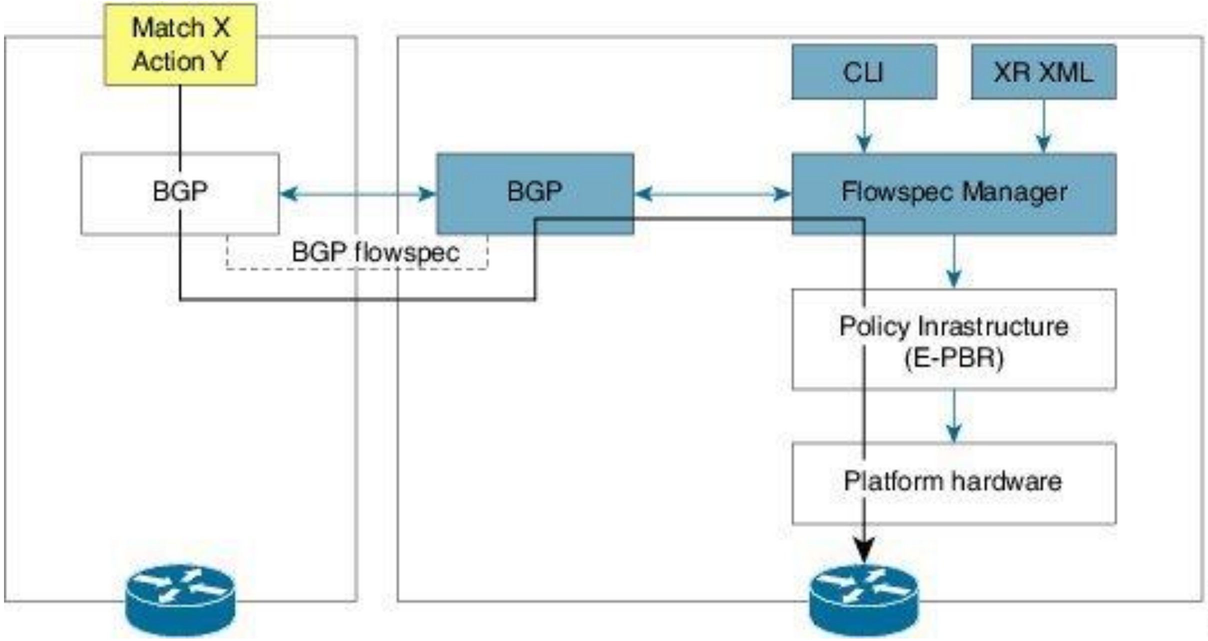
RFC 5575 - *Dissemination of Flow Specification Rules*



Sounds familiar...

RFC 5575 - *Dissemination of Flow Specification Rules*



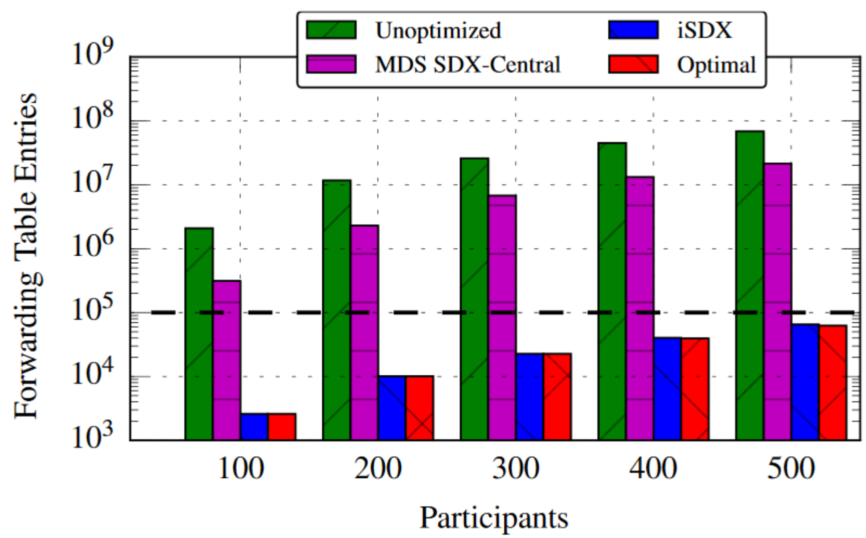
……so why not FlowSpec?

- Not transparent to the participant
- Adoption is limited due to ossification of the Internet
- Scalability issues at large scale
    - TCAM allocation for ACL / PBR rules is limited

Related Work

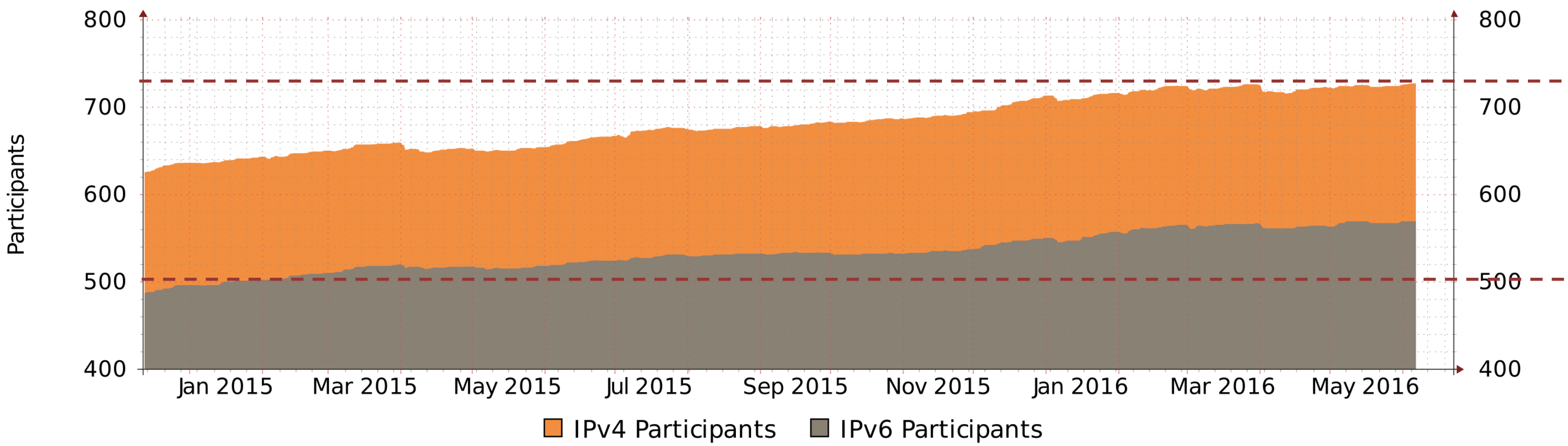
Sources

- Feamster et al. SDX: A Software Defined Internet Exchange". In: Open Networking Summit (2013)
- Gupta et al. An Industrial-Scale Software Defined Internet Exchange Point". In: 13th USENIX Symposium on Networked Systems Design and Implementation (NSDI 16), 2016, pp. 1-14.



(a) *Number of Forwarding Table Entries.*

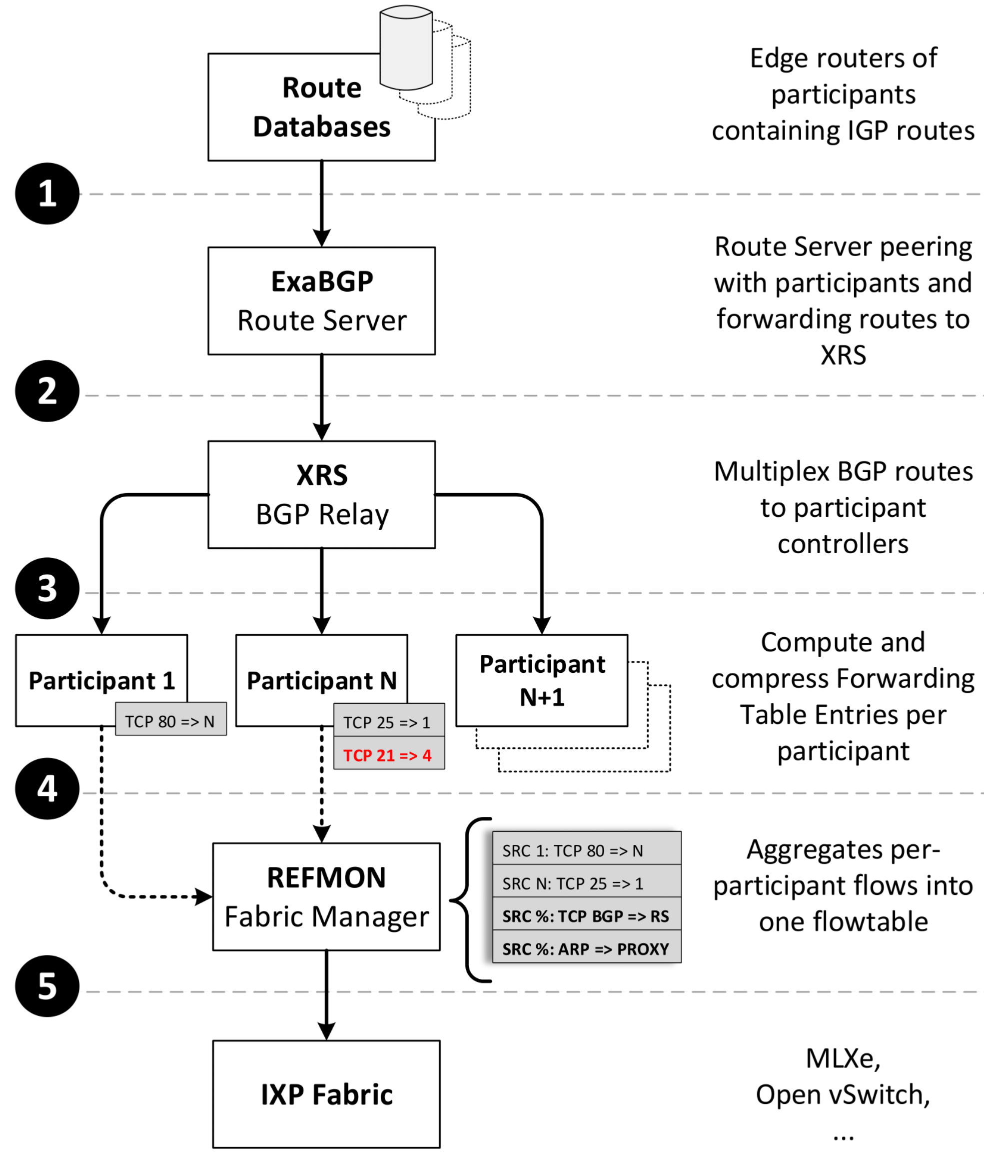
Growth pattern



- Original paper tests up to 500 participants
- AMS-IX is continuously growing
- Growing closer towards 800 unique participants
- Scalability is an important factor for feasibility

Technical concepts
iSDX controller

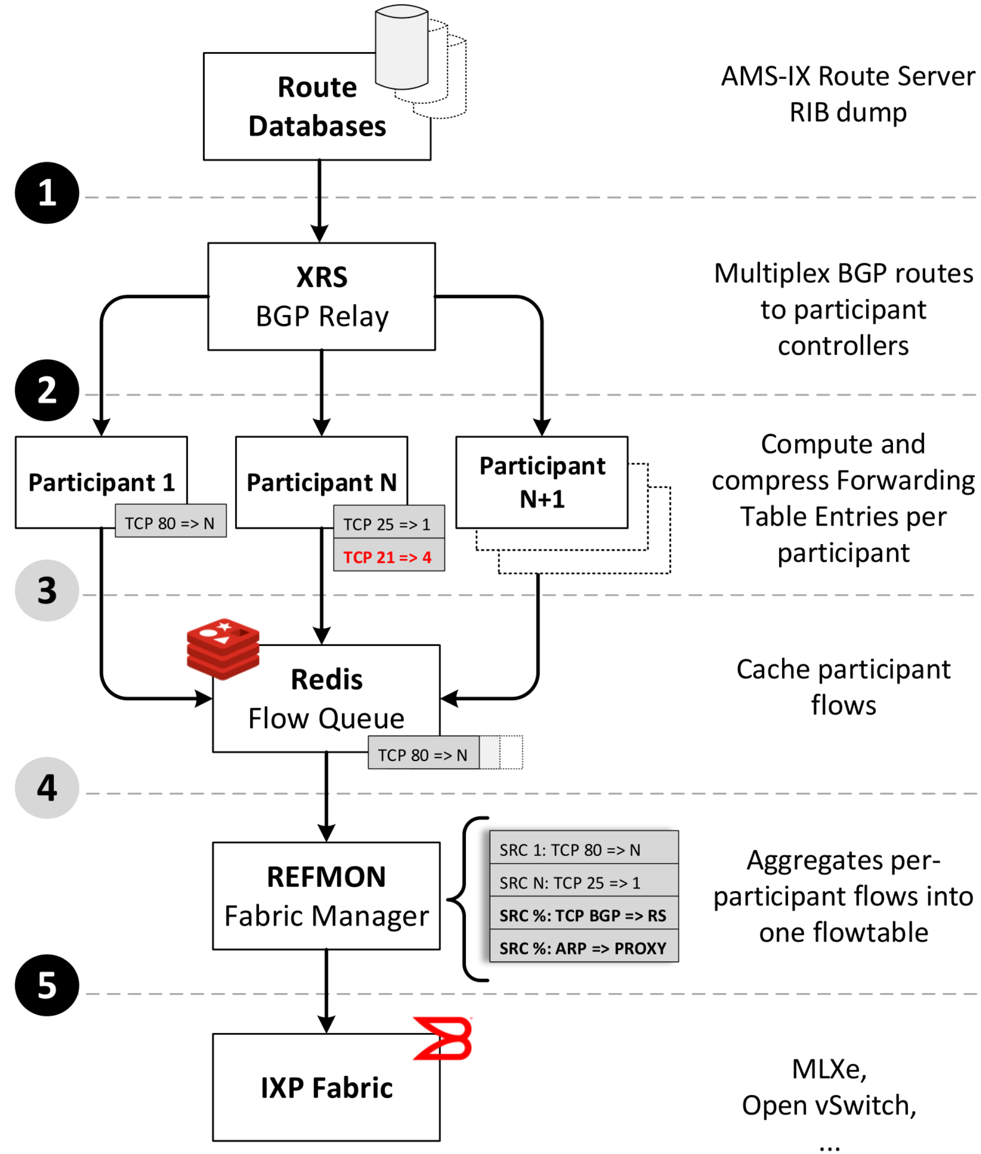
- Traditional route server
- Every participant calculates its own forwarding entries
- Configuration conflicts are resolved by Refmon



Methodology
Controller enhancements

- Enhancements
  - Bypass the route server
  - Fixing program breaking bugs
  - Addition of Redis

- Data set: AMS-IX RIB dump
  - IPv4 ~150k unique prefixes
  - IPv6 ~17k unique prefixes



Methodology
Controller enhancements

- Enhancements
  - Bypass the route server
  - Fixing program breaking bugs (3)
  - Addition of Redis (4)

- Data set: AMS-IX RIB dump
  - IPv4 ~150k unique prefixes
  - IPv6 ~17k unique prefixes

- Limitations
  - iSDX requires multiple tables
  - Switch platform (MLXe)
    - OpenFlow (OF) 1.0 switch
    - NetIron 5.9, OF 1.3 compliant
  - No support for Virtual Chassis
  - Future: *Brocade SLX*
  - Fallback: Open vSwitch

Methodology

Test scenarios

Scenario #1 - *Validation*

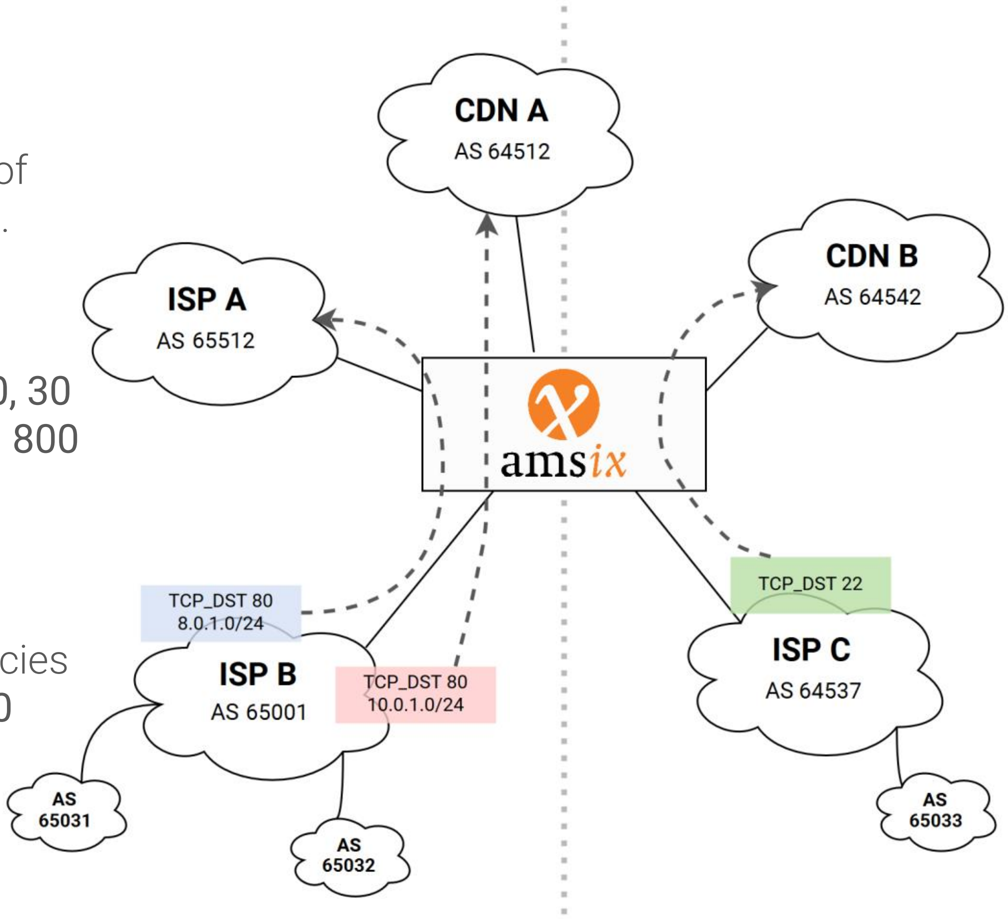
- **Up to four** outbound policies for **10%** of the total participants. Up to **800** peers.

Scenario #2 - *Policy expansion*

- **Up to sixteen** outbound policies for **10, 30 or 50%** of the total participants. Up to **800** peers.

Scenario #3 - *Granular policies*

- **Up to four prefix based** outbound policies for **10%** of the total prefixes. Up to **800** peers.



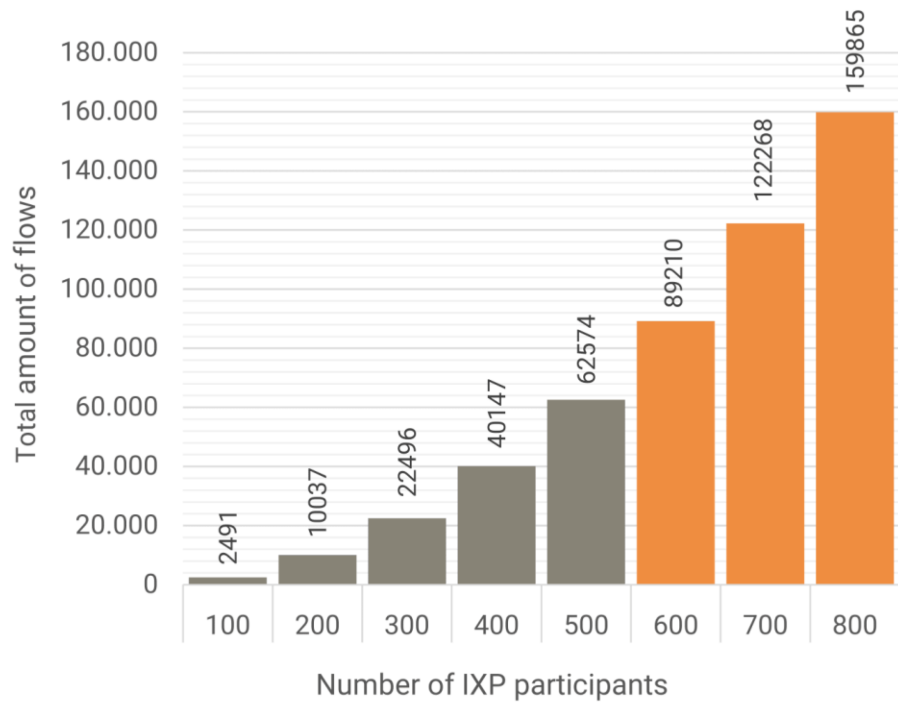
Results

Scenario #1 – Validation

- Reproduction of results
  - Matches original iSDX scalability findings
  - Linear growth pattern perceived as participants increase

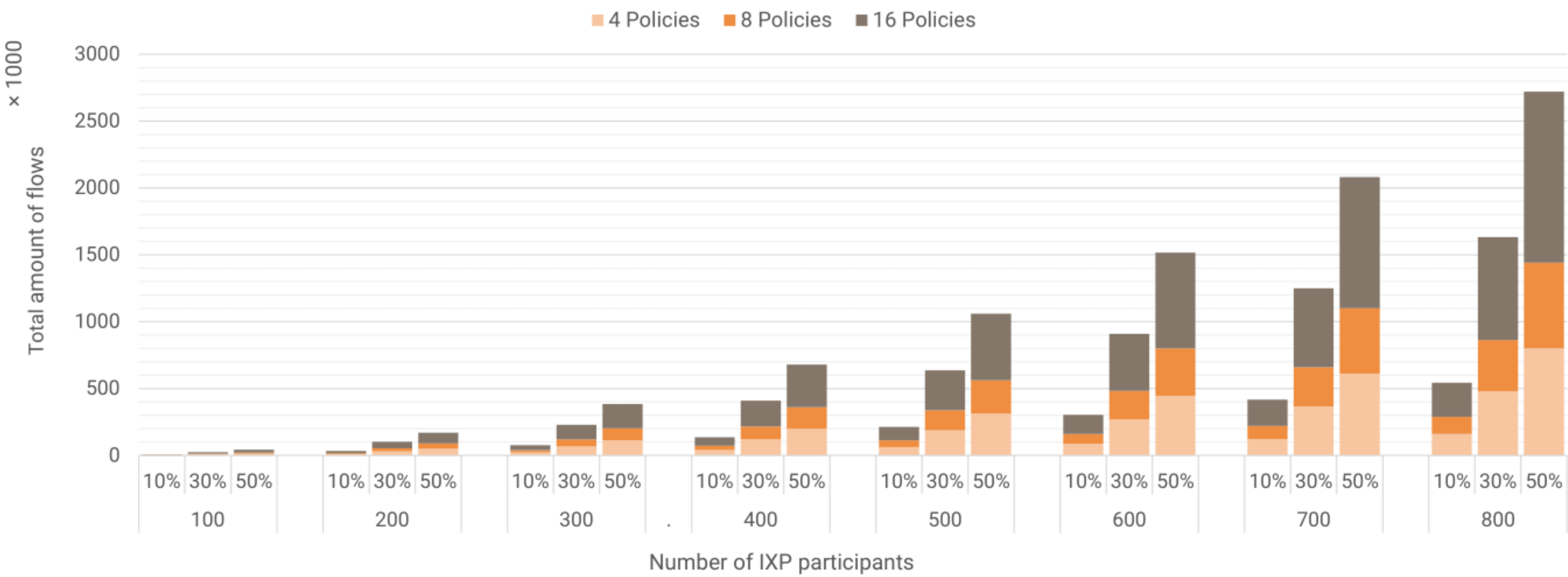
- Maximum supported flows heavily dependent on switch platform
  - Brocade MLXe supports 128,000 flows per chassis

- New Brocade SLX platform
  - More capable Merchant Silicon (Broadcom Tomahawk, Jericho)



Results

Scenario #2 – Policy Validation



- Growth pattern
  - Similar growth pattern perceived as in Scenario #1
  - Amount of flows exceeds current hardware platform

Scalability is heavily tied to constraints set by the IXP (Tolerated amount of policies, port ranges, et cetera.)

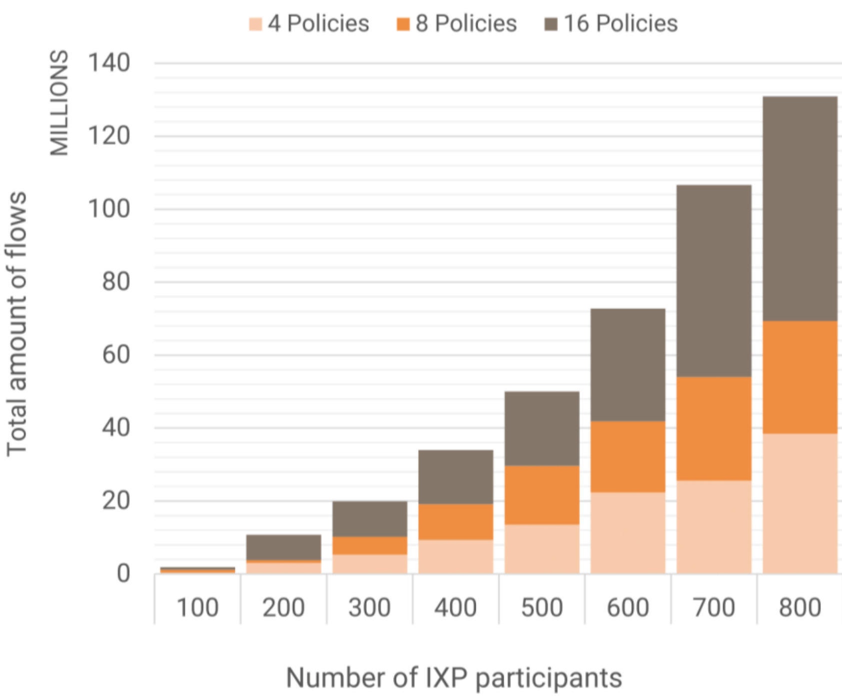
Results

Scenario #3 – Granular policies

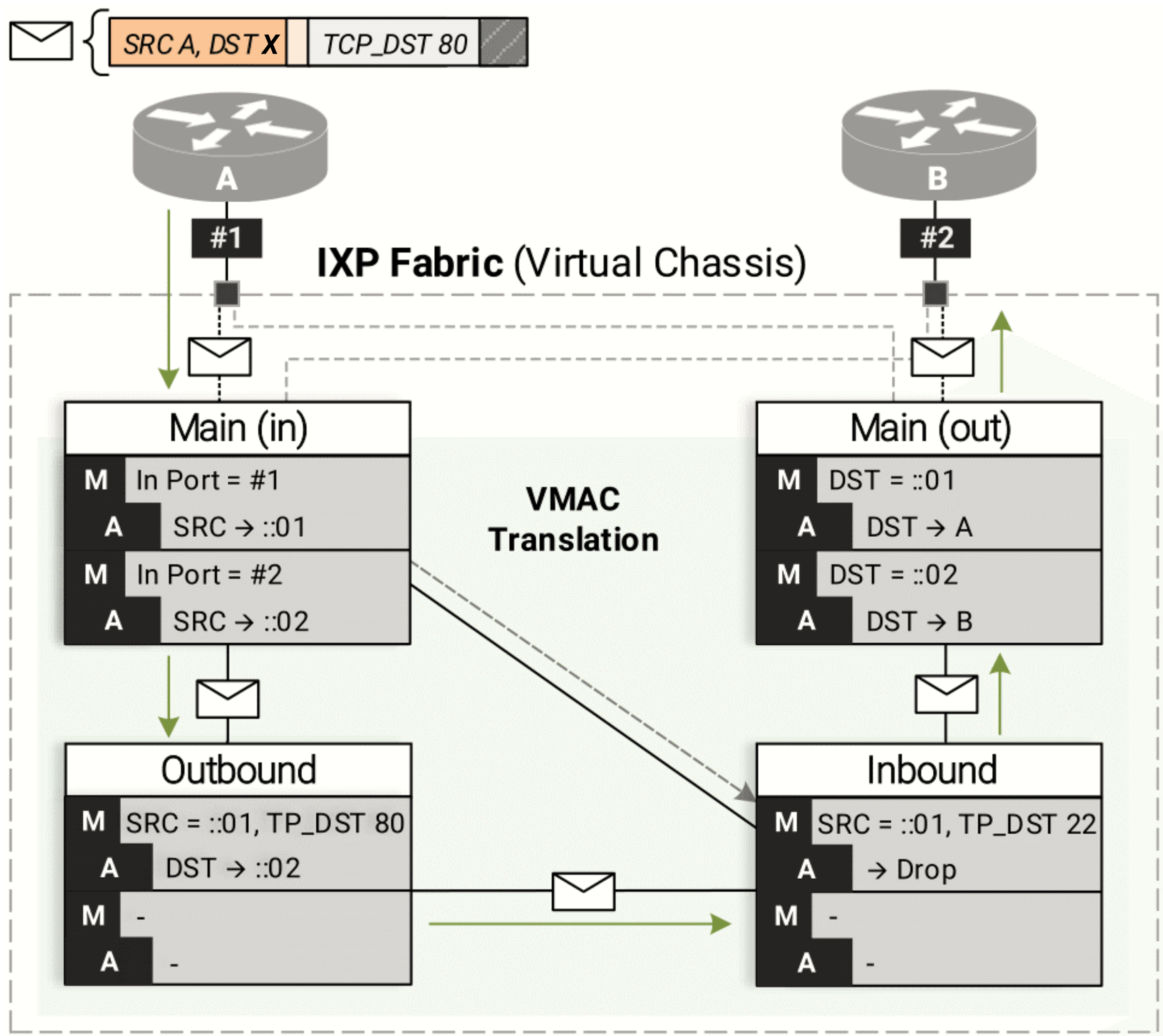
Impact

- Defining policies on destination prefix heavily impacts scalability
- Aggregation is possible but not performed by iSDX

- Total amount of policies for AMS-IX scale exceeds **140 million** flow entries
- Exceeds capabilities of **any** current hardware platform

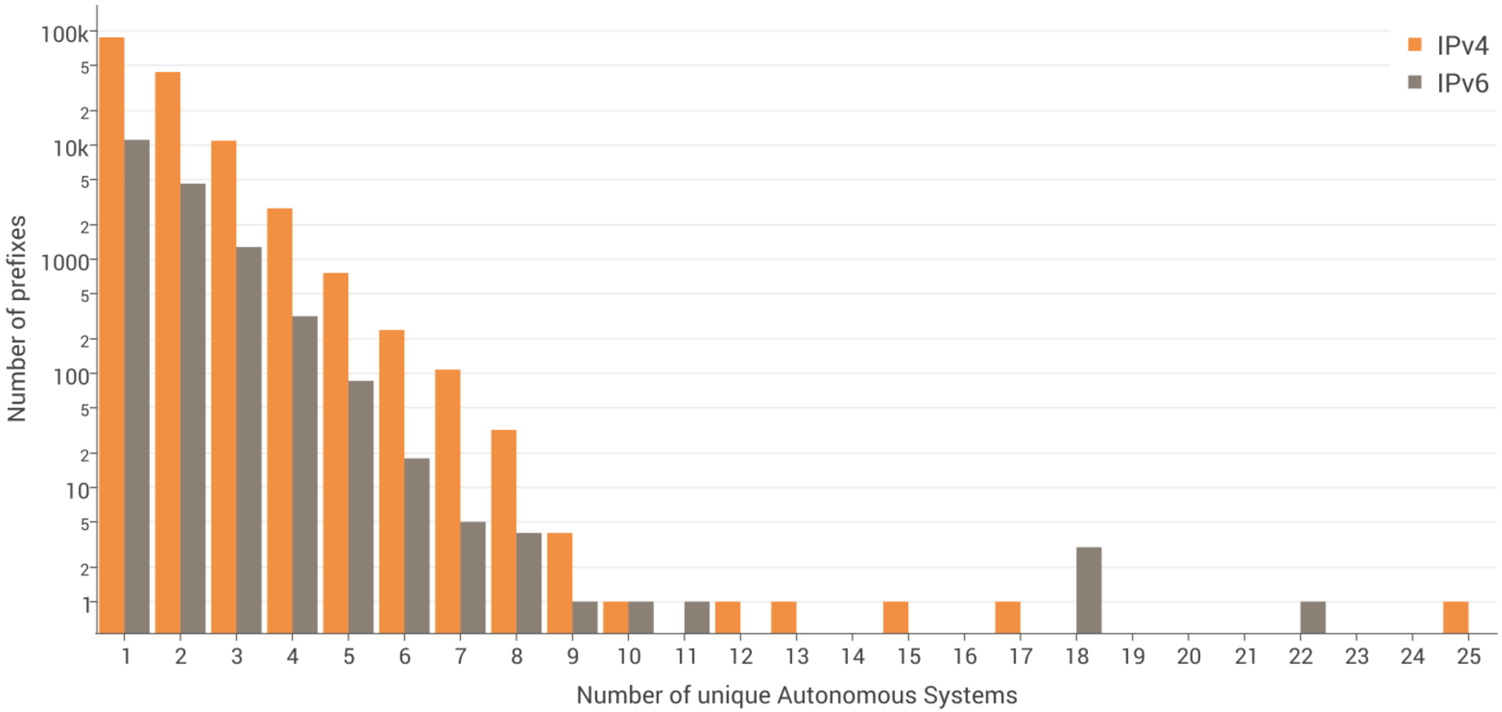


Technical concepts
iSDX Fabric



Results

MAC compression

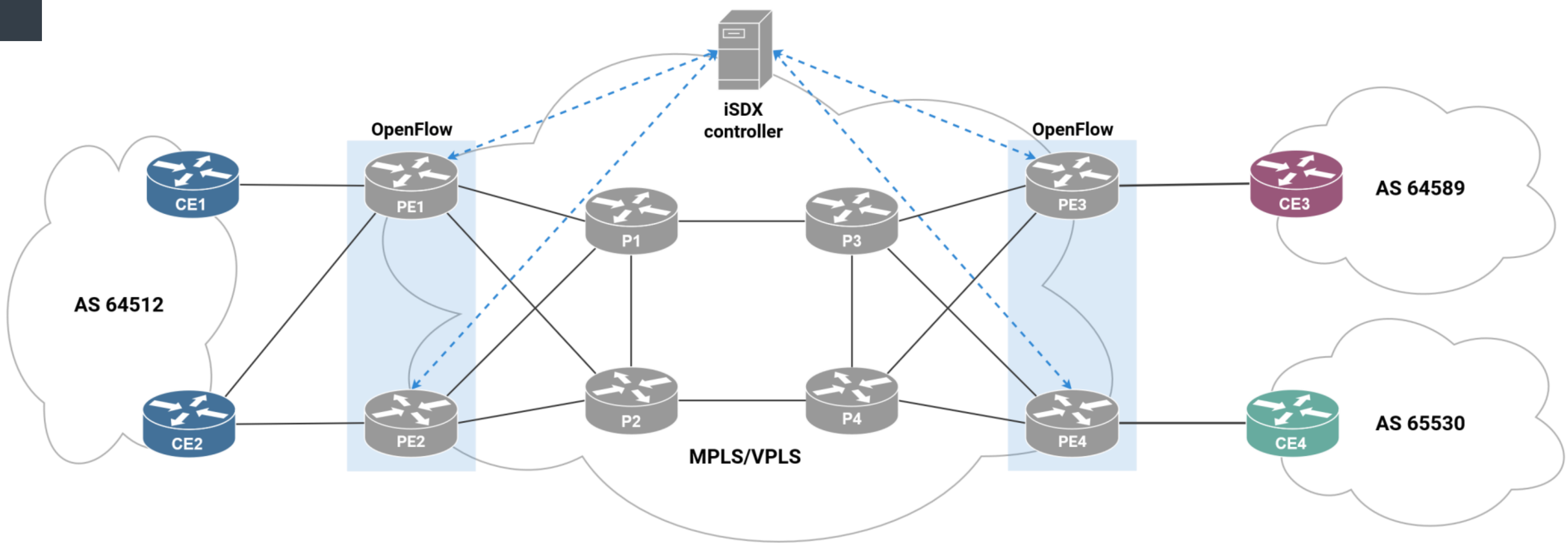


iSDX on the fabric

- Abstracts ASes from ports
- Scales up to 28 ASes in one MAC

- Embeds Next-Hop ASes in MAC address
  - Overriding BGP behavior
  - iSDX design choice

Infrastructural impact



- iSDX was designed for virtual chassis infrastructures
  (Brocade VCS, Cisco VSS/VPC, Juniper VC)
- AMS-IX has MPLS/VPLS multi-hop infrastructure
  - Implementation is still feasible
  - OpenFlow pipeline on the edges
  - Normal MPLS traffic forwarding
  - MAC learning via VPLS infrastructure

Conclusion

- Scalability
  - Compression of flows has limitations
  - Defining fine-grained policies is still limited by hardware at this kind of scale
  - iSDX as a concept is feasible
  - Scalability is feasible if the AMS-IX heavily constrains boundaries
    - Affects neutrality of the IXP

- Deployment impact
  - Allows for gradual transition to iSDX design
  - iSDX can be deployed alongside current MPLS/VPLS infrastructure

Future work

Moving forward

- Rewrite controller software
  - Improve robustness
  - Include support for IPv6
  - Include multi-threading in the Fabric Manager (Refmon)

- More efficient policy distribution over PE switches
  - Allow for extended scalability in multi-hop configurations

- Include MPLS state in iSDX controller
  - Omit the need for a second lookup

- Include support for defining policies per port
  - Work in process:

    ENDEAVOUR project at the University of Louvain (prof. M. Canini)

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Thank you

siem.hermans@os3.nl
jeroen.schutrup@os3.nl

github.com/jeroen92/sdx-ixp

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Questions?

siem.hermans@os3.nl
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