Source Address Validation Using BGP UPDATEs, ASPA, and ROA (BAR-SAV)

https://datatracker.ietf.org/doc/html/draft-sriram-sidrops-bar-sav-00

Kotikalapudi Sriram, Igor Lubashev, and Doug Montgomery

Email: ksriram@nist.gov ilubashe@akamai.com dougm@nist.gov

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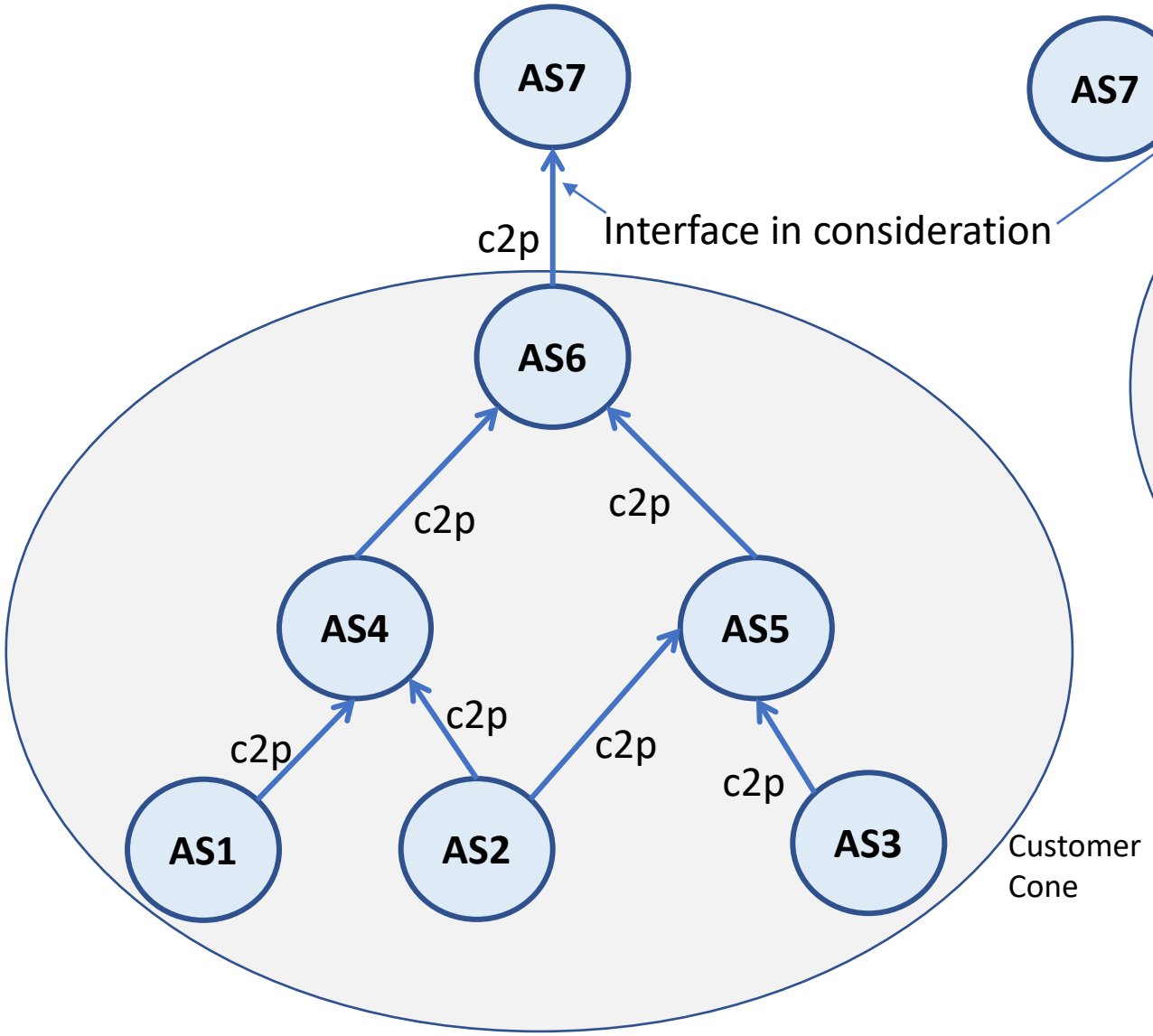
Motivation and Summary

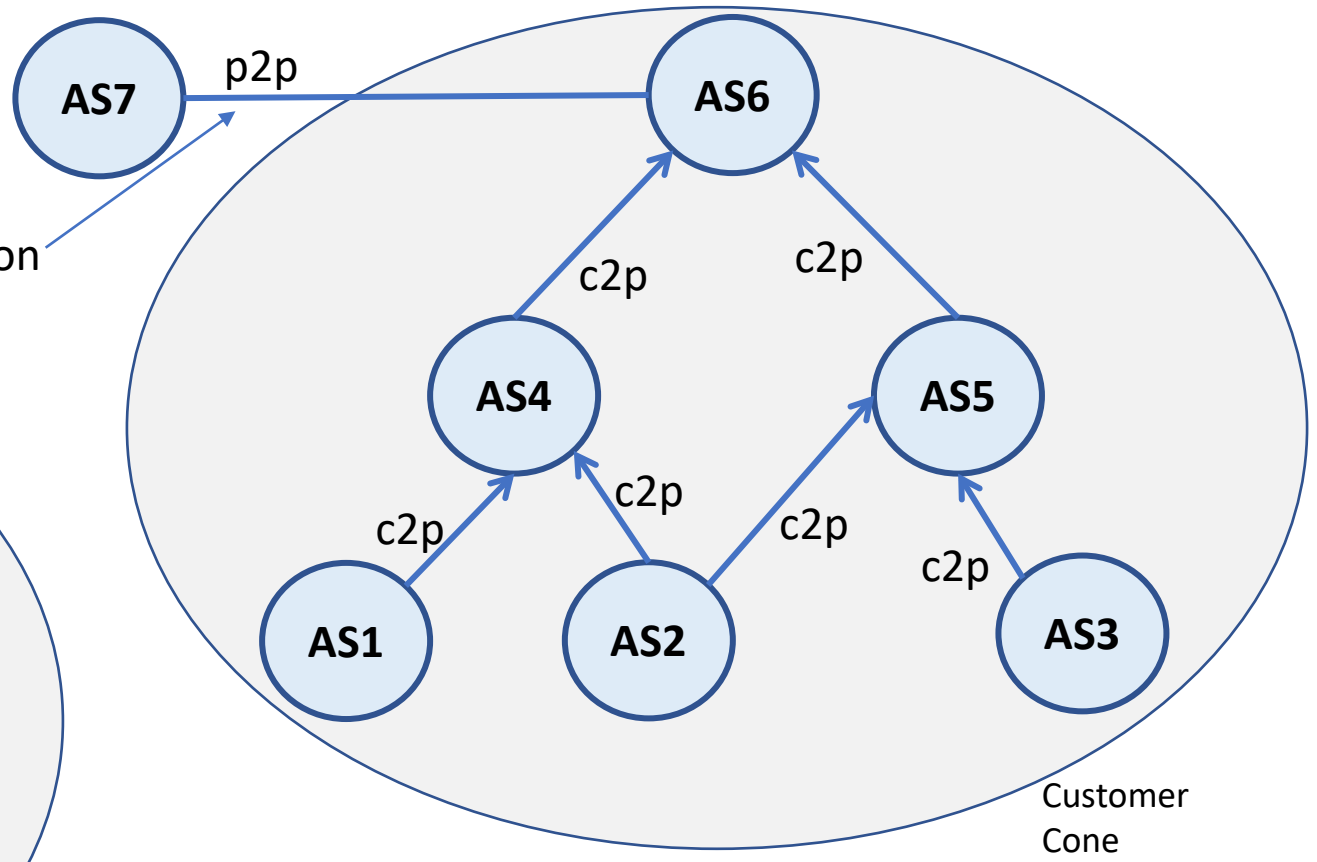
- Much interest seen in the community to improve Source Address Validation (SAV) techniques (e.g., RFC 8704, SAVNET BOFs at IETF 113 and 114)
- There are attempts to further improve upon EFP-uRPF [RFC 8704]
- Proposed new BAR-SAV method makes complementary use of BGP UPDATEs, ASPAs, and ROAs

  New Draft: https://datatracker.ietf.org/doc/html/draft-sriram-sidrops-bar-sav-00
- BAR-SAV advances the technology for SAV filter design
  - ✓ Significantly improves the ability to detect hidden prefixes
  - ✓ Provides a solution to the CDN/Direct Server Return (DSR) problem
- No changes to protocol on the wire
- Offers immediate benefits to early adopters

Goal: Construct Permissible Ingress Prefix List for SAV (at AS7)

The methodology is the same for a Customer or Lateral (i.e., non-transit) Peer* Interface



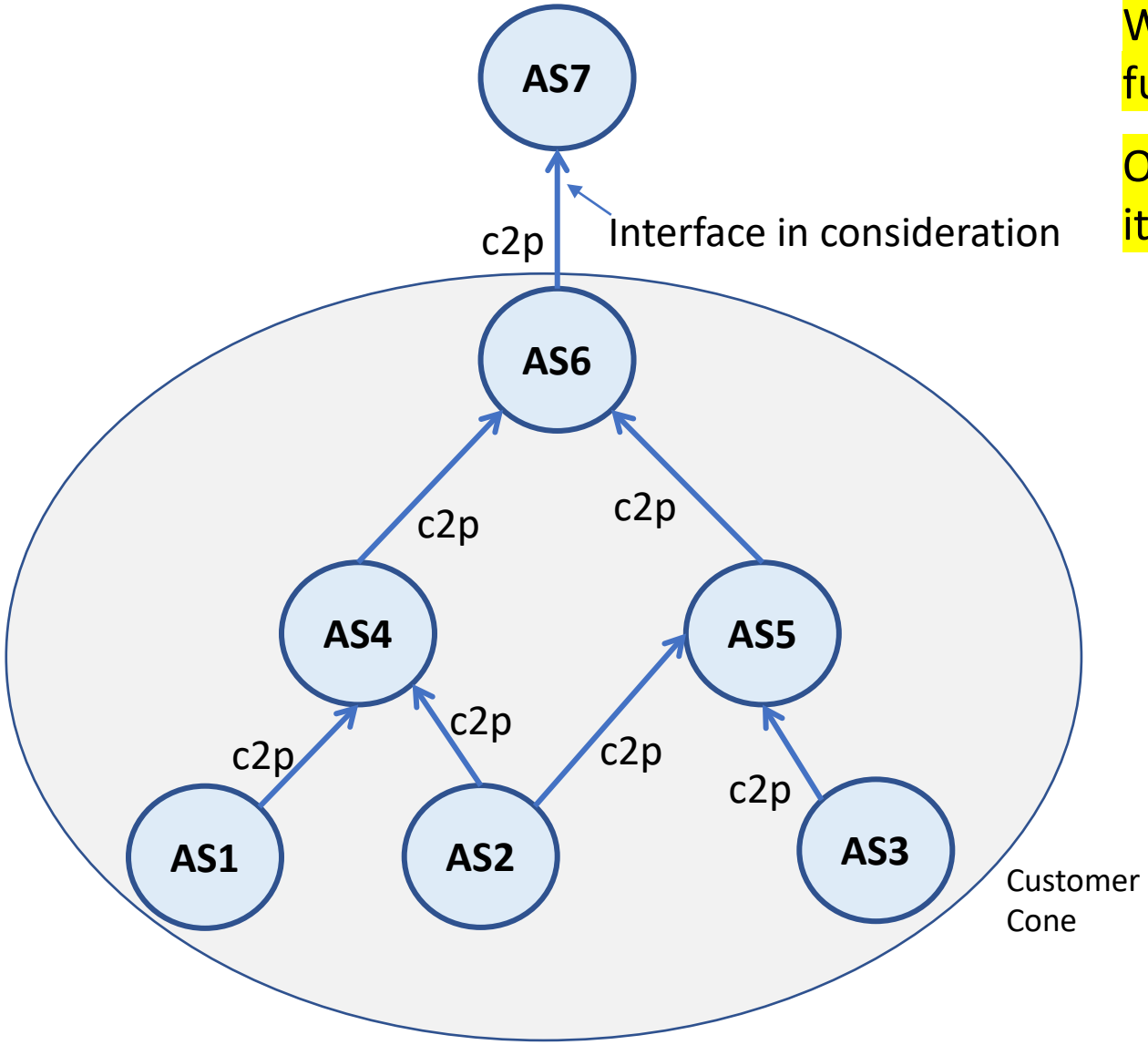


c2p: Customer to Provider
p2p: peer to peer (lateral non-transit)

* See RFC 7908 for definitions of peering relations

SAV Using Only ASPA and ROA (Procedure X)

Construction of Permissible Ingress Prefix List for SAV (at AS7)



When ASPA and ROA adoption is ubiquitous (in the future)

Or an ISP may use Procedure X on customer interfaces if it requires all its customers to register ROAs and ASPAs

A. Obtain the set of ASNs in the Customer's customer cone (CC) using ASPAs
B. Gather all prefixes in ROAs associated with the ASNs found in Step A. Keep only the unique prefixes.
C. The set computed in Step B is the permissible prefix list for SAV for the interface in consideration.

But there will be…

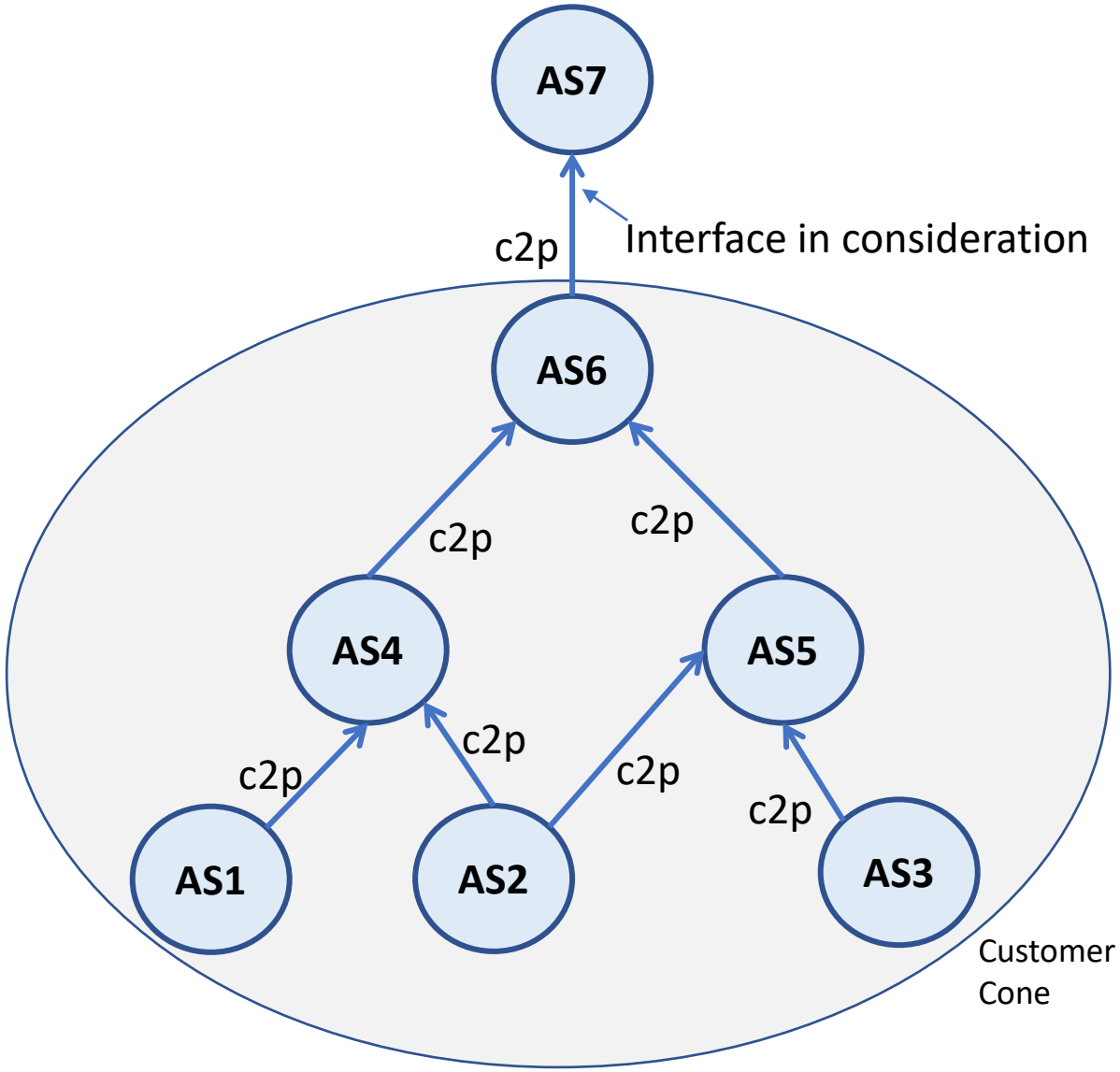
Partial deployment of ROAs and ASPAs for some time

- During that period…
  - ✓ BAR-SAV compensates
  - ✓ Makes complementary use of BGP UPDATEs, ASPA, and ROA
    - Incorporates a refined version of EFP-uRPF*

* Enhanced Feasible Path uRPF (EFP-uRPF) [RFC 8704]

SAV Using ASPA, ROA, and BGP UPDATE (BAR-SAV)

Construction of Permissible Ingress Prefix List for SAV (at AS7)

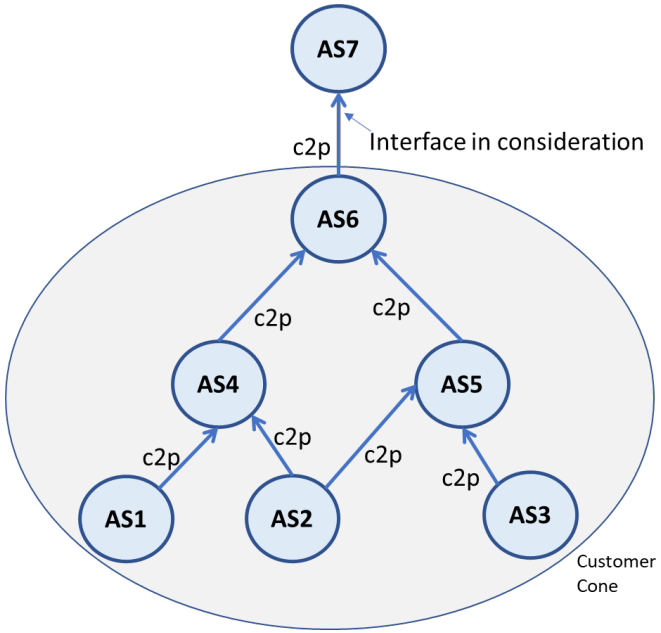


Applicable in the period when ASPA and ROA adoption is not ubiquitous

A. Obtain the set of ASNs in the Customer's customer cone (CC) using ASPAs and AS_PATHs
B. Gather all prefixes in ROAs associated with the ASNs found in Step A.
C. Gather all prefixes in BGP UPDATE messages with originating ASN among ASNs found in Step A.
D. Combine sets found in Steps B and C. Keep only the unique prefixes. This is the permissible prefix list for SAV for the interface in consideration.

A Note on Customer Cone Computation

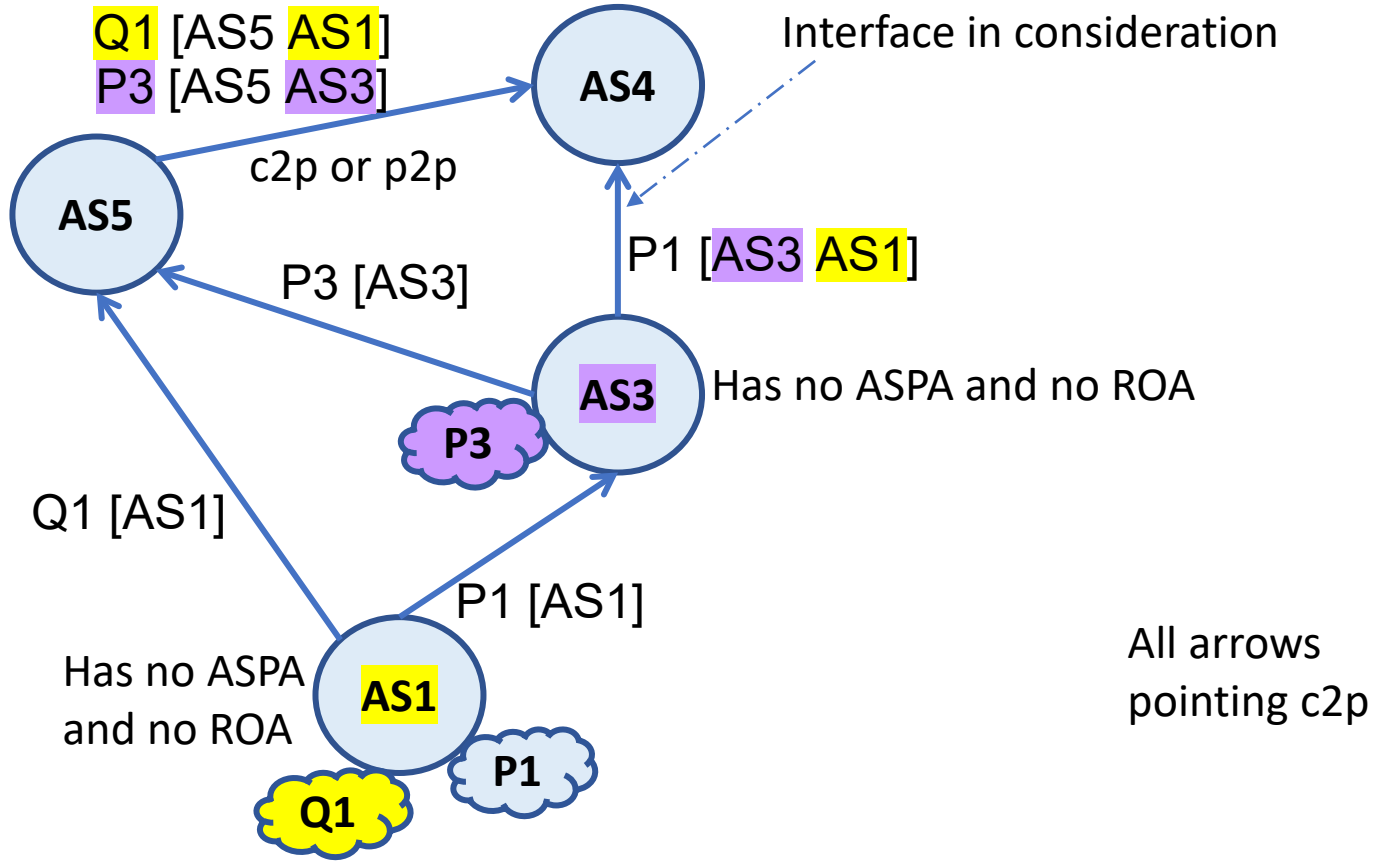
- One should *not* compute a customer cone by separately processing ASPA data and AS_PATH data and then merging the two sets of ASes at the end. Doing so is likely to miss ASes from the customer cone.



- Instead, both ASPAs and AS_PATHs should be used to iteratively expand the discovered customer cone. When new ASes are discovered, both ASPA and AS_PATH data should be used to discover customers of those ASes. This process is repeated for newly discovered customer ASes until there are no new ASes to be found.

Refined Version of Algorithm A of EFP-uRPF [RFC 8704] Incorporated into BAR-SAV

- Only Q1 is detected by Alg. A of RFC 8704
- Both Q1 and P3 are detected by BAR-SAV



EFP-uRPF = Enhanced Feasible Path uRPF

- Much better detection of “Hidden” prefixes in multihoming scenarios by BAR-SAV

Detailed Description of the BAR-SAV Procedure

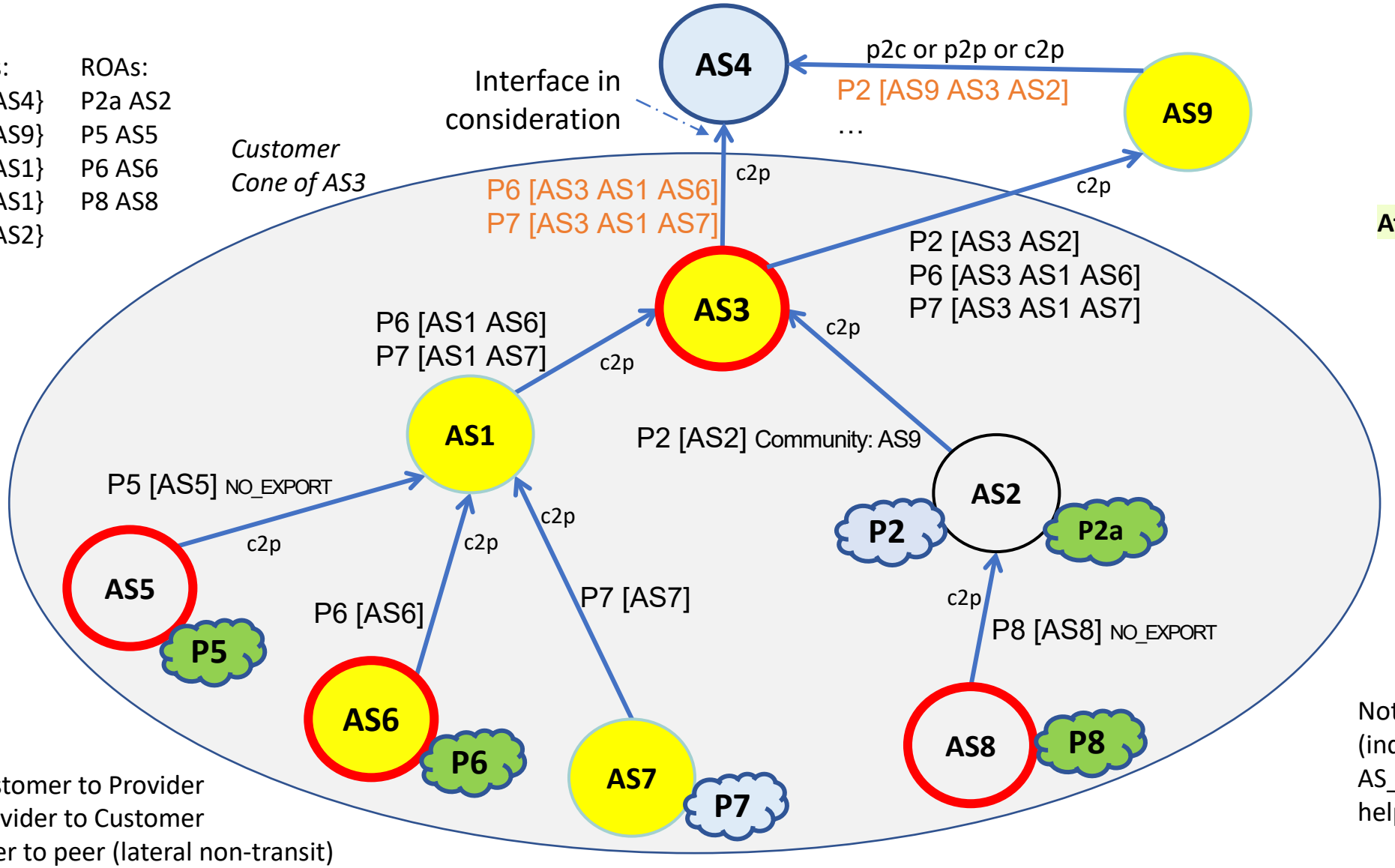
1. Let the Customer or Lateral Peer ASN be denoted as AS-k.
2. Let i = 1. Initialize: AS-set Z(1) = {AS-k}.
3. Increment i to i+1.
4. Create AS-set A(i) of all ASNs whose ASPA data declares at least one ASN in AS-set Z(i-1) as a Provider.
5. Create AS-set B(i) of all "non-ASPA" customer ASNs each of which is a customer of at least one ASN in AS-set Z(i-1) according to unique AS_PATHs in Adj-RIBs-In [RFC4271] of all interfaces at the BGP speaker computing the SAV filter. "Non-ASPA" ASN are ASNs that declare no provider in ASPA data.
6. Form the union of AS-sets A(i) and B(i) and call it AS-set C.
   From AS-set C, remove any ASNs that are present in Z(j), for j=1 to j=(i-1). Call the resulting set Z(i).
7. If AS-set Z(i) is null, then set i_max = i - 1 and go to Step 8. Else, go to Step 3.
8. Form the union of the AS-sets, Z(i), i = 1, 2, ..., i_max, and name this union as AS-set D.
9. Select all ROAs in which the authorized origin ASN is in AS-set D. Form the union of the sets of prefixes listed in the selected ROAs. Name this union set of prefixes as Prefix-set P1.
10. Using the routes in Adj-RIBs-In of all interfaces, create a list of all prefixes originated by any ASN in AS-set D. Name this set of prefixes as Prefix-set P2.
11. Form the union of Prefix-sets P1 and P2. Apply this union set as the list of permissible prefixes for SAV.

The next 4 slides illustrate the details of how BAR-SAV works

How BAR-SAV Works
Finding **All** ASes and Prefixes in Customer's (or Peer's) Customer Cone Using BGP Announcements (as seen at AS4), ASPA, and ROA

ASPAs:
AS3 {AS4}
AS3 {AS9}
AS5 {AS1}
AS6 {AS1}
AS8 {AS2}

ROAs:
P2a AS2
P5 AS5
P6 AS6
P8 AS8



Has ROA Pn

No ROA Pn

At AS4's interface with AS3:

Visible in ASPA and AS_PATH — ASn

Visible only in AS_PATH — ASn

Visible only in ASPA — ASn

Not visible in ASPA (indirectly visible in AS_PATH; BAR-SAV helps find it) — ASn

c2p: Customer to Provider
p2c: Provider to Customer
p2p: peer to peer (lateral non-transit)

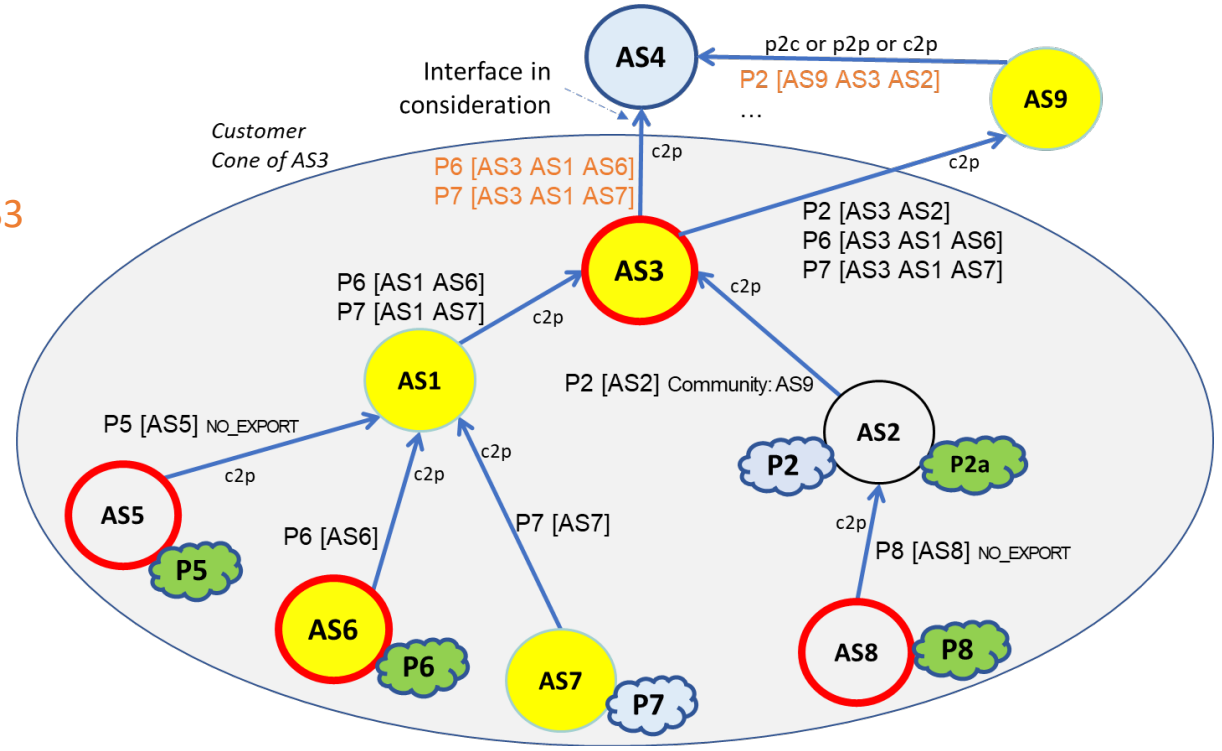
Finding All ASes in the CC using BGP AS_PATH and ASPA

INPUTS

ASPAs:
AS3 {AS4}
AS3 {AS9}
AS5 {AS1}
AS6 {AS1}
AS8 {AS2}

ROAs:
P2a AS2
P5 AS5
P6 AS6
P8 AS8

BGP UPDATE AS_PATHs:
Interface in Consideration: AS3
P6 [AS3 AS1 AS6]
P7 [AS3 AS1 AS7]
Other Interfaces:
P2 [AS9 AS3 AS2]



OUTPUT

Iteration	Customer Cone	New ASes from ASPA	New ASes from AS_PATH
1	AS3	None	P6 [AS3 AS1 AS6] → AS1 P7 [AS3 AS1 AS7] → AS1 P2 [AS9 AS3 AS2] → AS2
2	AS3, AS1, AS2	AS5 {AS1} → AS5 AS6 {AS1} → AS6 AS8 {AS2} → AS8	P6 [AS3 AS1 AS6] → AS6 P7 [AS3 AS1 AS7] → AS7
3	AS3, AS1, AS2, AS5, AS6, AS8, AS7	None	None

Finding All Prefixes in the CC using BGP Routes and ROA

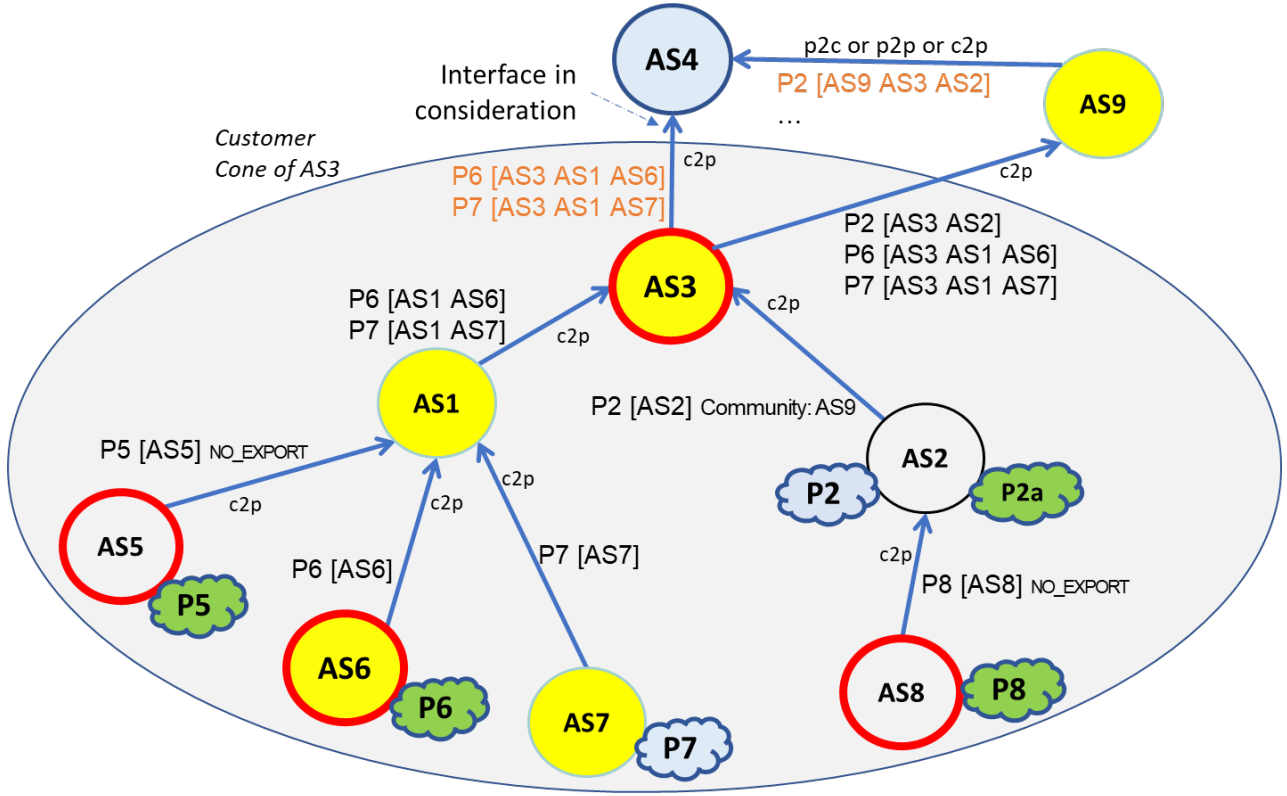
INPUTS

ASPAs:
AS3 {AS4}
AS3 {AS9}
AS5 {AS1}
AS6 {AS1}
AS8 {AS2}

ROAs:
P2a AS2
P5 AS5
P6 AS6
P8 AS8

BGP UPDATE AS_PATHs:
Interface in Consideration: AS3
P6 [AS3 AS1 AS6]
P7 [AS3 AS1 AS7]
Other Interfaces:
P2 [AS9 AS3 AS2]

Customer Cone
AS1, AS2, AS3, AS5, AS6, AS7, AS8



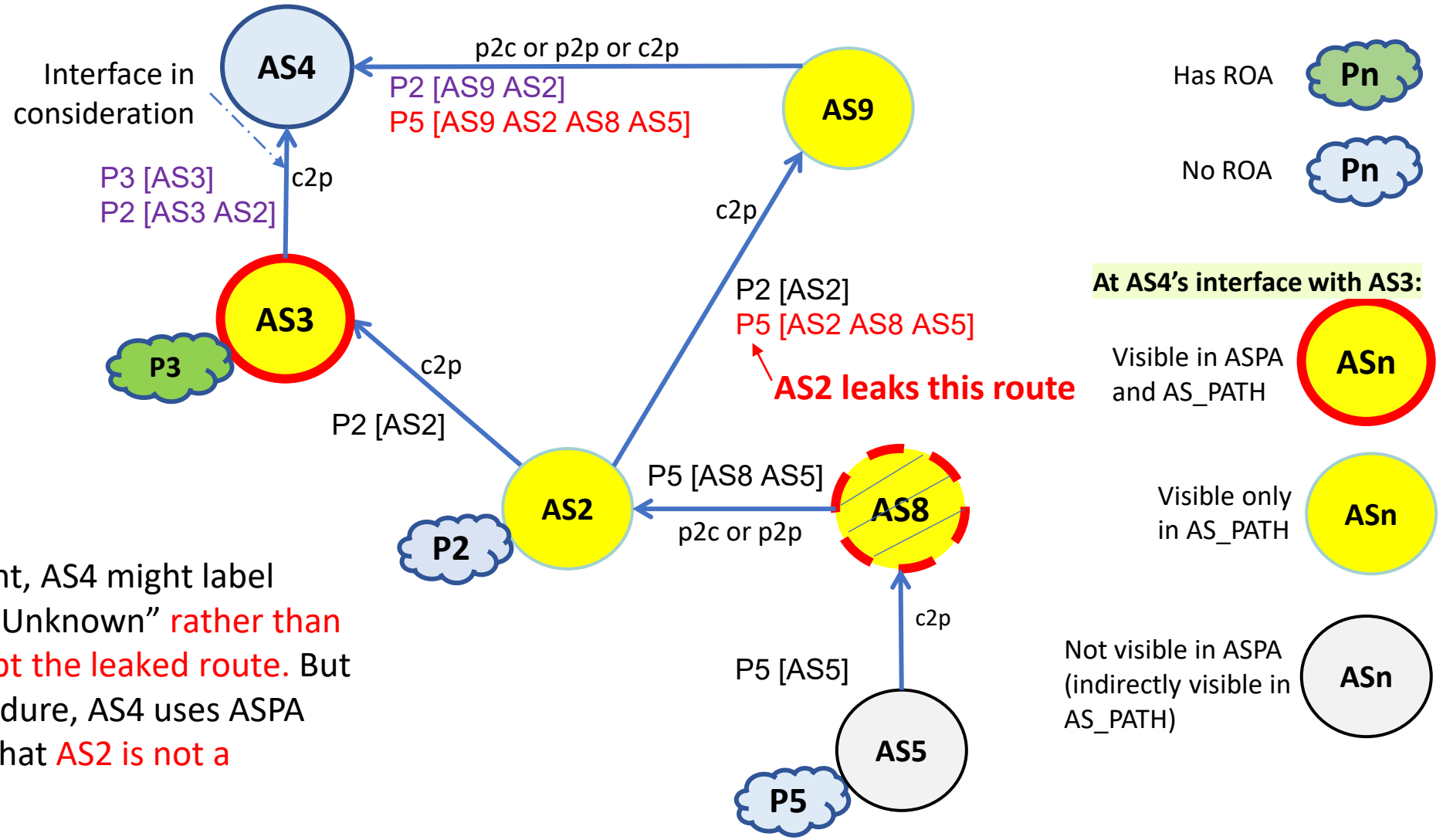
OUTPUT

ASN	Prefixes from ROA	Prefixes from BGP
AS1		
AS2	(P2a AS2) → P2a	P2 [AS9 AS3 AS2] → P2
AS3		
AS5	(P5 AS5) → P5	
AS6	(P6 AS6) → P6	P6 [AS3 AS1 AS6] → P6
AS7		P7 [AS3 AS1 AS7] → P7
AS8	(P8 AS8) → P8	

SAV Prefixes
P2, P2a, P5, P6, P7, P8

Help from ASPA Data to Clean-Up Anomalies in AS_PATH Data

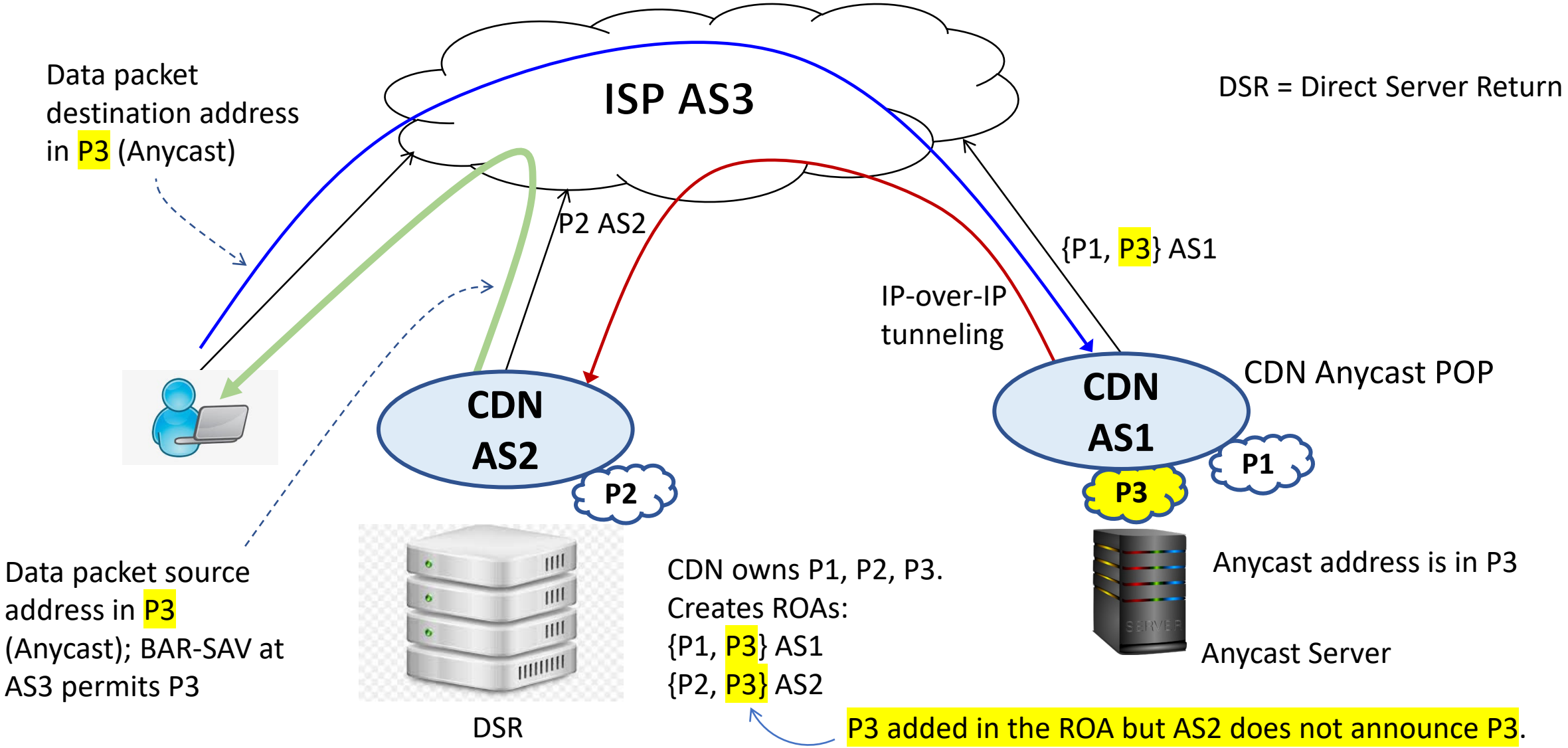
ASPAs:
AS3 {AS4}
AS8 {AS10}



In partial ASPA deployment, AS4 might label P5 [AS9 AS2 AS8 AS5] as "Unknown" rather than "Invalid". AS4 might accept the leaked route. But within the BAR-SAV procedure, AS4 uses ASPA data of AS8 to recognize that AS2 is not a provider of AS8.

Content Delivery Network (CDN) Application

Example of how the BAR-SAV method solves the DSR blocking problem



Backup slides

Detailed Procedure X

Creating the Permissible Prefix List for SAV for a Customer or Lateral Peer using only ASPA and ROA

1. Let the Customer or Lateral Peer ASN be denoted as AS-k.
2. Let i = 1. Initialize: AS-set S(1) = {AS-k}.
3. Increment i to i+1.
4. Create AS-set S(i) of all ASNs whose ASPA data declares at least one ASN in AS-set S(i-1) as a Provider.
5. If AS-set S(i) is null, then set i_max = i - 1 and go to Step 6. Else, go to Step 3.
6. Form the union of the sets, S(i), i = 1, 2, ..., i_max, and name this union as AS-set A.
7. Select all ROAs in which the authorized origin ASN is equal to any ASN in AS-set A. Form the union of the sets of prefixes listed in the selected ROAs. Name this union set of prefixes as P-set.
8. Apply P-set as the list of permissible prefixes for SAV.

Note: Algorithm X is for future use when the deployment of ASPA and ROA is ubiquitous.

Anycast/Edge Hybrid – Direct Server Return

1. Anycast POPs lookup “best” edge POP for each new connection (using the actual user IP)
2. Anycast POPs tunnel packets to edge POPs
3. Edge servers send data to users directly – Direct Server Return (DSR)