ASPA Verification Procedures: Enhancements and RS Considerations

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Overview

• ASPA and RS considerations: summarize WG discussions on the list
• Prior work: A shortcoming in the ASPA downstream procedure – fixed in March 2021


• Here we present a description of refined/enhanced ASPA upstream and downstream procedures
  ✓ Incorporates the above fix from IETF 110
  ✓ Route server (RS) is properly accommodated
  ✓ Takes care of necessary special/corner cases
  ✓ Ready for updating the ASPA verification draft
ASPA and Route Server (RS) Considerations

- WG discussions/suggestions on email list incorporated

WG discussion threads:

https://mailarchive.ietf.org/arch/browse/sidrops/?gbt=1&index=eAvyo_zOw_LfHMlY1gjJRQNqehI

https://mailarchive.ietf.org/arch/browse/sidrops/?gbt=1&index=Ul8oaSGq39N_ya13m2K6xJWcRec
Route Server

- Control plane:
  - Transparent RS: Does not insert its ASN in the AS path (common)
  - Non-Transparent RS: Inserts its ASN in the AS path (rare/abnormal?)
- Data plane:
  - RS passes the NEXT_HOP attribute unmodified to its RS-clients so the data plane connection is direct between the RS-clients [RFC7947].
- RS-client to RS is like a Customer-to-Provider (C2P) relationship
- RS-clients AS1 and AS3 are effectively lateral peers (p2p)
ASPA-based Route Leak Detection Considering RS

• We solve the problem for transparent RS
• The solution for non-transparent RS comes with it
  ➢ No extra effort involved
RS-client includes the RS ASN in its ASPA

• ASPAs:
  {AS1, AS2} – AS1 attests AS2 (RS) as a provider
  {AS3, AS2} – AS3 attests AS2 (RS) as a provider
  {AS2, AS 0} – RS (AS2) creates an ASPA with AS 0 (see note*)

• If AS3 leaks the route to AS4 (a lateral peer), then AS4 can detect the leak based on either of these AS paths:
  o AS4 AS3 AS1 (transparent RS)
  o AS4 AS3 AS2 AS1 (non-transparent RS)

* Note: The ASAP verification draft already specifies IXP-RS to create an ASPA with AS 0.
Solution Description/Discussion

• Each RS-client registers ASPA including the RS ASN in the SPAS*
  ➢ In theory, it is sufficient that each RS-client has an ASPA just including the ASN(s) of its providers (other than the RS)
  ➢ But some RS-clients may not have any “provider” other than the RS
  ➢ Plus including the RS ASN in the SPAS has diagnostic value for trouble shooting, etc.

* SPAS: Set of Provider ASes
RS-client applies only the Downstream Verification Procedure

• When a validating AS has RS-client role, it determines whether the most recently added AS in the AS_PATH equals the sender’s (i.e., RS’s) AS number.
• If not equal, it confirms that the RS is transparent.
• Then the RS ASN is added to the AS_PATH (for ASPA verification purposes only) and the downstream verification procedure is applied.*

➢ With this alternative approach we can simplify draft-08 by deleting Section 5.3.

* Suggestion from Nick Hilliard
Refined/Enhanced ASPA Upstream and Downstream Verification Procedures
1. If the validating AS’s role is RS-client and the RS ASN is not in the AS path, then add the RS ASN to the AS_PATH’s AS_SEQUENCE (for the purposes of this procedure only).

2. If there is an AS_SET present in the AS_PATH, then set AS_SET_Flag = 1, else set AS_SET_Flag = 0.

3. If there is not an AS_SEQUENCE present* but only an AS_SET, then the procedure halts with outcome “Unverifiable”. Else, continue.

4. Collapse prepends in the AS_SEQUENCE(s) in the AS_PATH (i.e., keep only the unique AS numbers). Let the resulting ordered sequence be represented by \{AS(1), AS(2), ..., AS(N-1), AS(N)\}, where AS(1) is the first-added AS in the AS_SEQUENCE and AS(N) is the last-added and neighbor to the receiving/validating AS.

5. If N ≤ 2, then jump to Step 12. Else, continue.

6. At this step, N ≥ 3. For 2 ≤ i ≤ N, determine the smallest i for which AS(i) is attested “not Provider” by its left neighbor AS(i-1). Denote such i as i_min. If i_min does not exist, then set i_min = N+1. For 1 ≤ j ≤ N-1, determine the largest j for which AS(j) is attested “not Provider” by its right neighbor AS(j+1). Denote such j as j_max. If j_max does not exist, then set j_max = 0. If i_min ≤ j_max, then the procedure halts with outcome “Invalid”. Else, continue to Step 6.

* Note: Since AS_PATH is a mandatory attribute in eBGP, it will have an AS_SEQUENCE, or AS_SET, or both.
7. Up ramp: For $2 \leq i \leq N$, determine the largest $i$ (call it $K$) such that $AS(i)$ is attested Provider by its left neighbor $AS(i-1)$ for each $i \leq K$. If such $K$ does not exist, then set $K = 1$.

8. If $K \geq N-1$, then jump to Step 12. Else, continue.

9. Down ramp: For $1 \leq j \leq N-1$, determine the smallest $j$ (call it $L$) such that $AS(j)$ is attested Provider by its right neighbor $AS(j+1)$ for each $j \geq L$. If no such $L$ exists, then set $L = N$.

10. If $L-K \leq 1$, then jump to Step 12. Else (i.e., $L-K \geq 2$), continue.

11. If $AS\_SET\_Flag = 0$, then the procedure halts with outcome “Unknown”. Else (i.e., $AS\_SET\_Flag = 1$), the procedure halts with outcome “Unverifiable”.

12. If $AS\_SET\_Flag = 0$, then the procedure halts with outcome “Valid”. Else (i.e., $AS\_SET\_Flag = 1$), the procedure halts with outcome “Unverifiable”.
Upstream Procedure (when UPDATE is received from a Lateral Peer, Customer, or RS-client)

1. If there is an AS_SET present in the AS_PATH, then set AS_SET_Flag = 1, else set AS_SET_Flag = 0.

2. If there is not an AS_SEQUENCE present but only an AS_SET, then the procedure halts with outcome “Unverifiable”. Else, continue.

3. Collapse prepends in the AS_SEQUENCE(s) in the AS_PATH (i.e., keep only the unique AS numbers). Let the resulting ordered sequence be represented by \{AS(1), AS(2), ..., AS(N-1), AS(N)\}, where AS(1) is the first-added AS in the AS_SEQUENCE and AS(N) is the last-added and neighbor to the receiving/validating AS.

4. If N = 1, then jump to Step 8. Else, continue.

5. At this step, N ≥ 2. For 2 ≤ i ≤ N, if there is an i for which AS(i) is attested “not Provider” by its left neighbor AS(i-1), then the procedure halts with outcome “Invalid”. Else, continue.

6. For 1 ≤ i ≤ N-1, if there is an i for which AS(i) has no ASPA, then continue to the next step. Else, jump to Step 8

7. If AS_SET_Flag = 0, then the procedure halts with outcome “Unknown”. Else (i.e., AS_SET_Flag = 1), the procedure halts with outcome “Unverifiable”.

8. If AS_SET_Flag = 0, then the procedure halts with outcome “Valid”. Else (i.e., AS_SET_Flag = 1), the procedure halts with outcome “Unverifiable”.
Implementation

• Pointers to NIST BGP-SRx where the enhanced ASPA procedures have been implemented* and tested (also includes rpki-rtr extensions, test tools and data sets):

* The RS-related details are still to be incorporated

QR Code: BGP-SRx suite
QR Code: ASPA examples