AS_PATH Verifcation Using ASPA

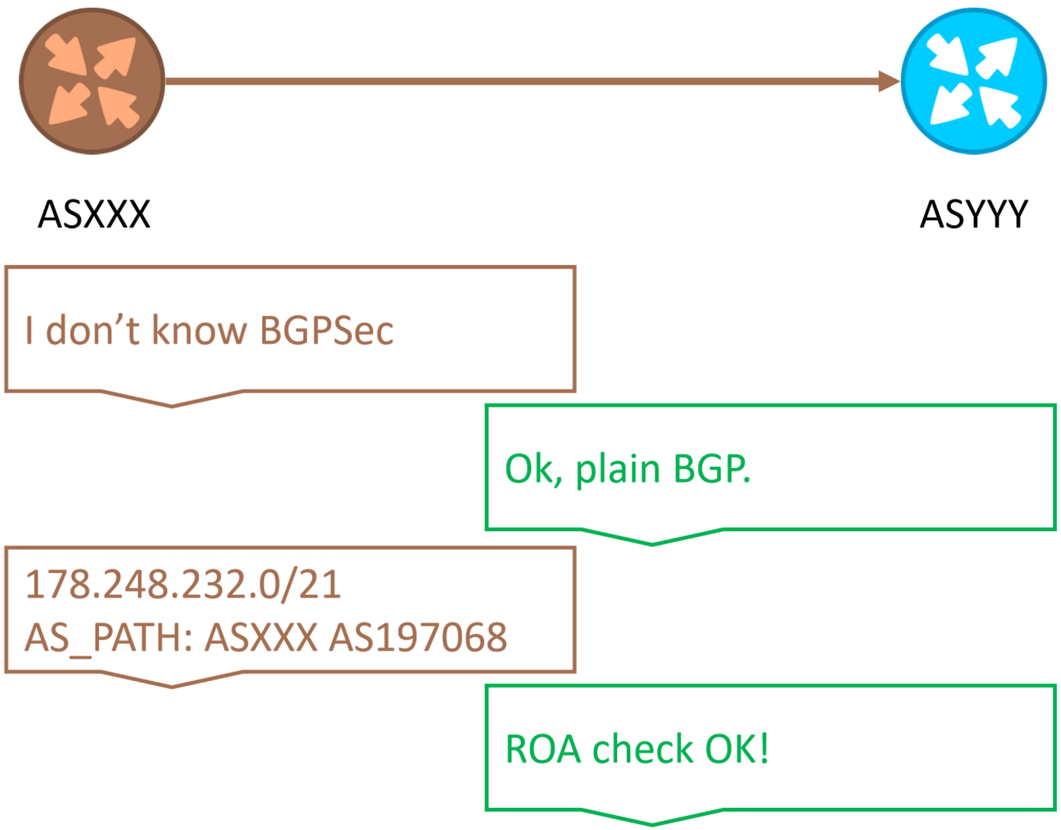
Alexander Azimov aa@qrator.net, Eugene Bogomazov eb@qrator.net,
Eugene Uskov eu@qrator.net, Randy Bush randy@psg.com,
Job Snijders job@ntt.net, Keyur Patel keyur@arrcus.com,
Russ Housley housley@vigilsec.com

BGP Quadrant

	BGP Hijacks	BGP Route Leaks
Mistake	IRR Filters; ROA;	IRR Filters; Route Leak Detection Draft
Malicious	BGPSec	BGPSec

BGPSec: Bypassed

ROA (178.248.232.0/21, 197068, 32)



To secure BGP, do we require attacker to support BGPSec?

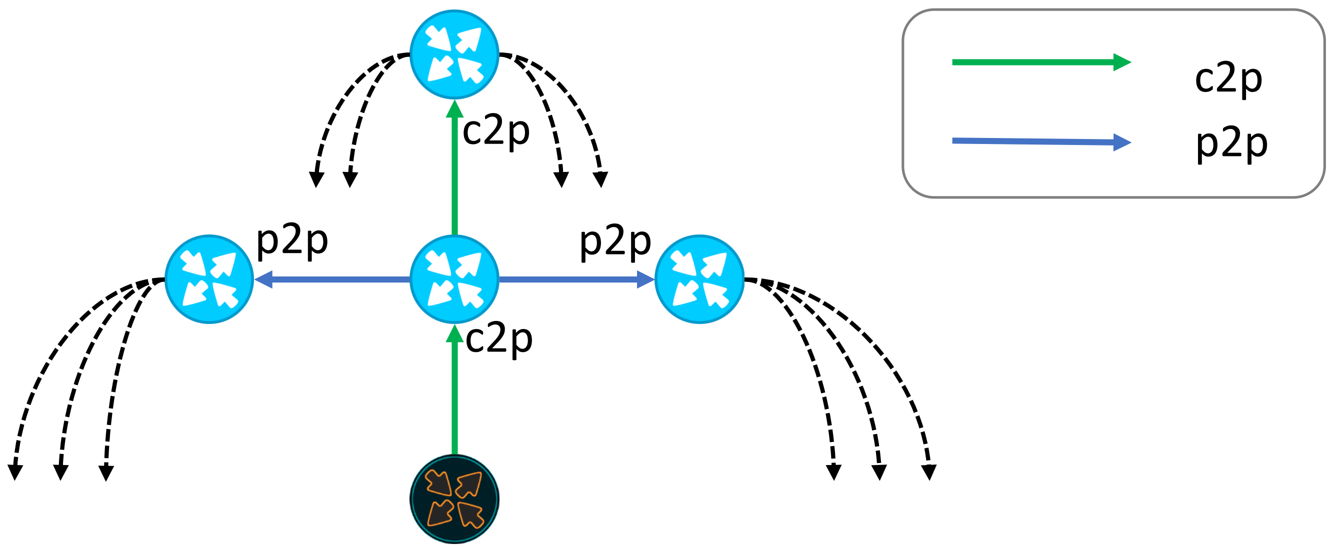
BGP Quadrant

	BGP Hijacks	BGP Route Leaks
Mistake	IRR Filters; ROA;	IRR Filters; [Route Leak Detection Draft]()
Malicious	!	!

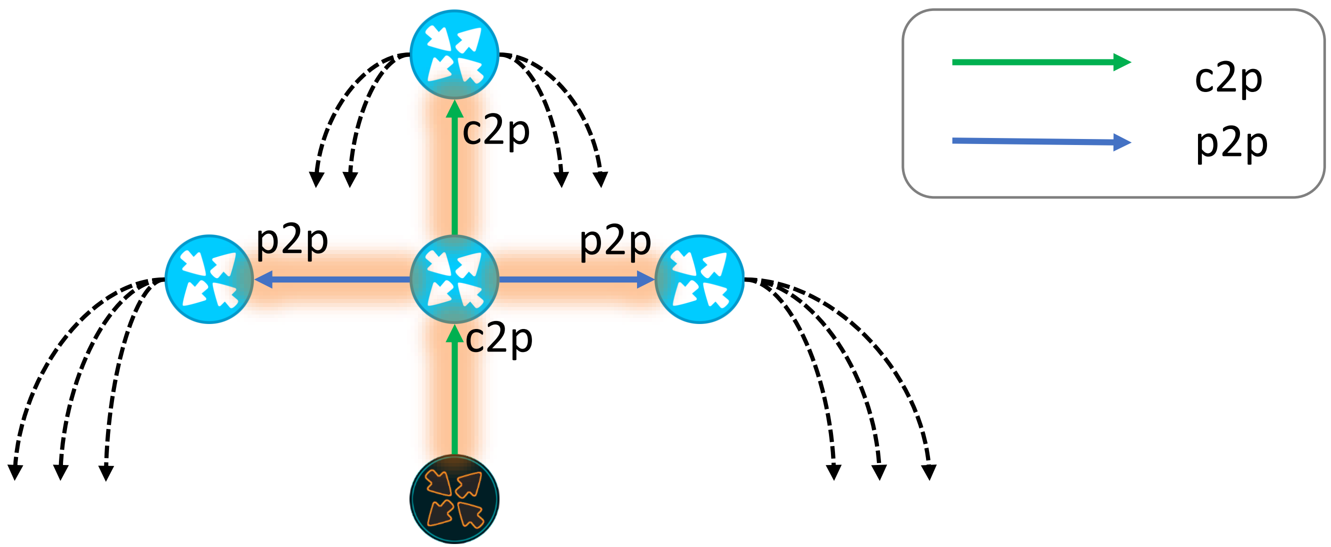
Goals

- Detect invalid AS_PATHs;
- Detect malformed AS_PATHs;
- Incremental Deployment;
- Lightweight
  - Do not add new message types in BGP;
  - Do not add signatures in BGP.

Anomaly Propagation



Anomaly Propagation



If we can stop propagation at the level of c2p and p2p – we are done!

A Beautiful Note

If valid route is received from customer or peer it MUST have only customer-to-provider pairs in its AS_PATH.

Then if we have a validated database of customer-to-provider pairs we will be able to verify routes received from customers and providers!

Autonomous System Provider Authorization ASPA

ASPA := {

customer_asn – signer

provider_asn – authorized to send routes to upper providers or peers

AFI – IPv4 or IPv6

}

Boundary Cases

- Transit-free networks;

  ASPA0 = {AS1, 0};

- Complex relations

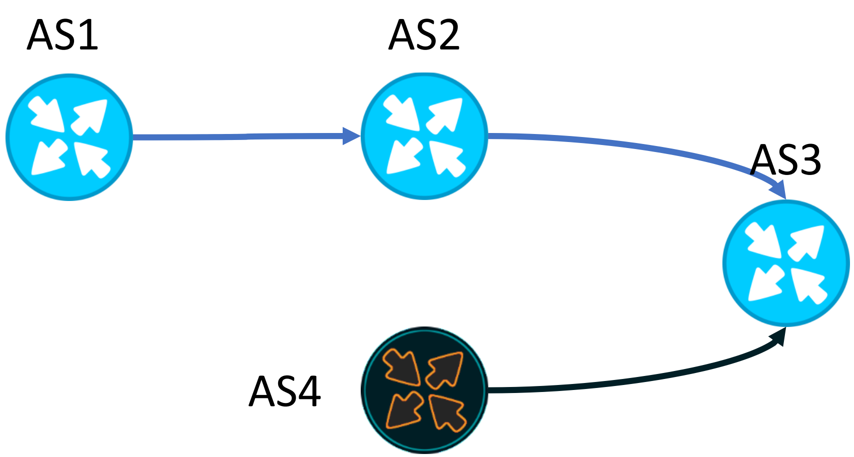
  Symmetric ASPAs: {AS1, AS2}, {AS2, AS1};

Pair Verification (AS1, AS2)

1. Retrieve all cryptographically valid ASPAs in a selected AFI with a customer value of AS1. This selection forms the set of **candidate ASPAs**.
2. If the set of **candidate ASPAs** is empty, then the procedure exits with an outcome of **unknown**.
3. If there is at least one candidate ASPA where the provider field is AS2, then the procedure exits with an outcome of **valid**.
4. Otherwise, the procedure exits with an outcome of **invalid**.

AS_PATH Verification

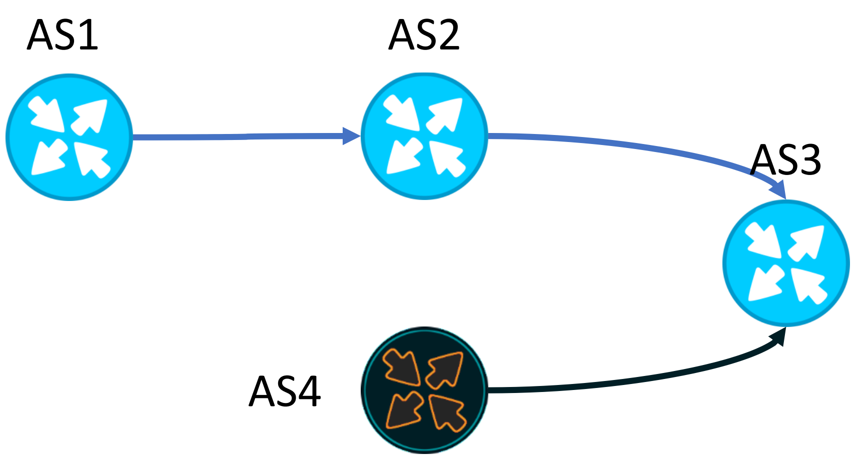
1. If the closest AS in the AS_PATH is not the receiver's neighbor ASN then procedure halts with the outcome "invalid";
2. If in one of AS_SEQ segments there is a pair (AS(I-1), AS(I)) is "invalid" then the procedure also halts with the outcome "invalid";



ROA {x.x.x.x, AS1}
ASPA {AS1, AS2}
ASPA {AS2, AS3}
ASPA {AS3, 0}

AS_PATH Verification

1. If the closest AS in the AS_PATH is not the receiver's neighbor ASN then procedure halts with the outcome "invalid";
2. If in one of AS_SEQ segments there is a pair (AS(I-1), AS(I)) is "invalid" then the procedure also halts with the outcome "invalid";

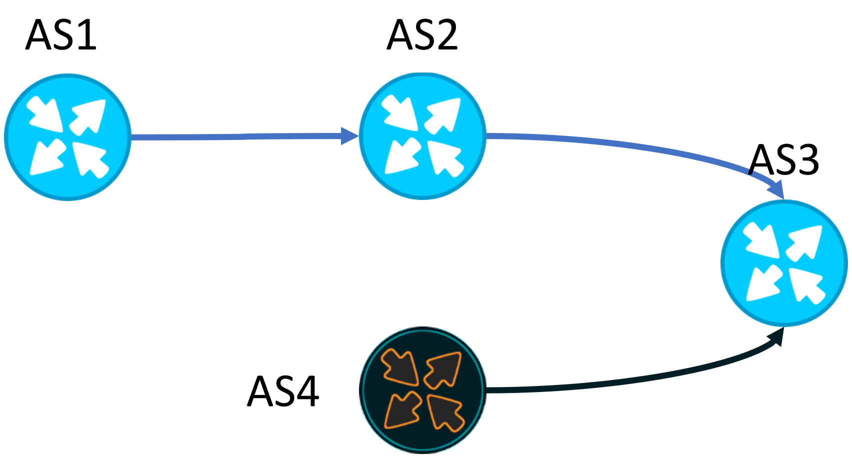


ROA {x.x.x.x, AS1}
ASPA {AS1, AS2}
ASPA {AS2, AS3}
ASPA {AS3, 0}

Route: x.x.x.x
AS_PATH: AS4

AS_PATH Verification

1. If the closest AS in the AS_PATH is not the receiver's neighbor ASN then procedure halts with the outcome "invalid";
2. If in one of AS_SEQ segments there is a pair (AS(I-1), AS(I)) is "invalid" then the procedure also halts with the outcome "invalid";

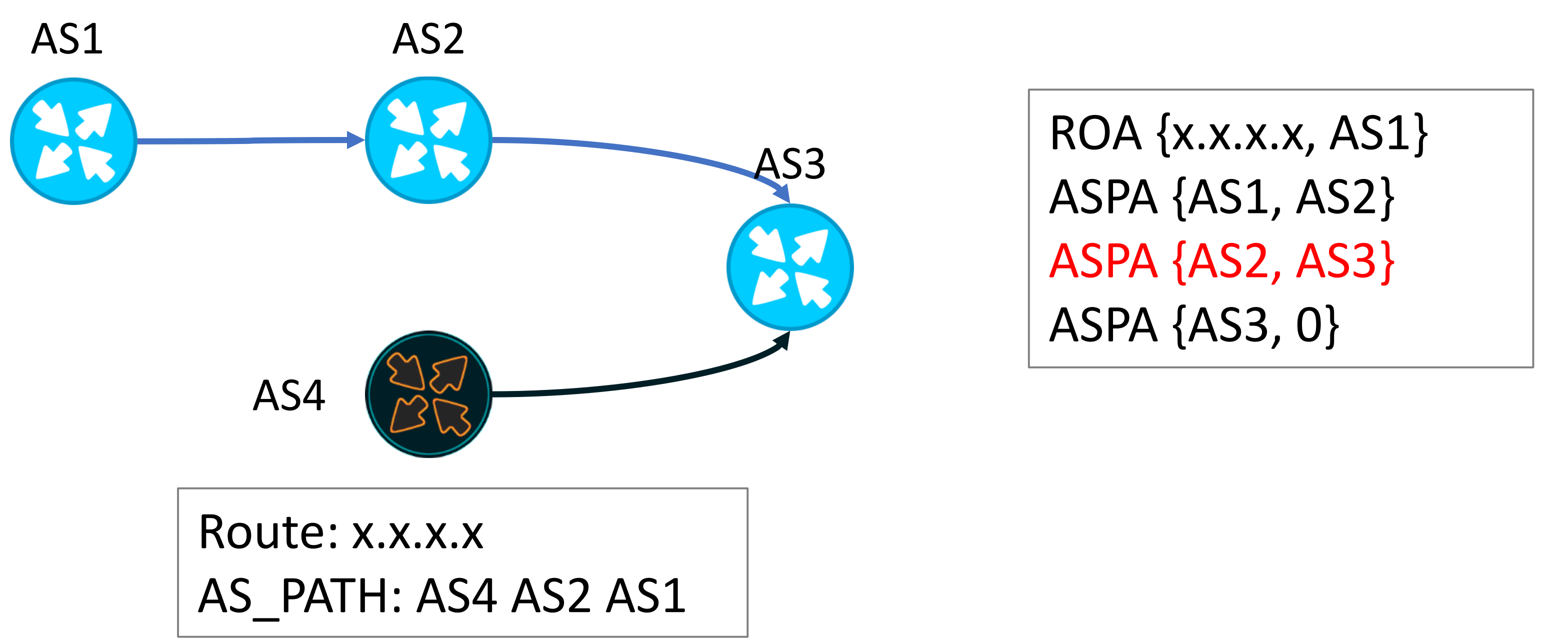


ROA {x.x.x.x, AS1}
ASPA {AS1, AS2}
ASPA {AS2, AS3}
ASPA {AS3, 0}

Route: x.x.x.x
AS_PATH: AS4 AS1

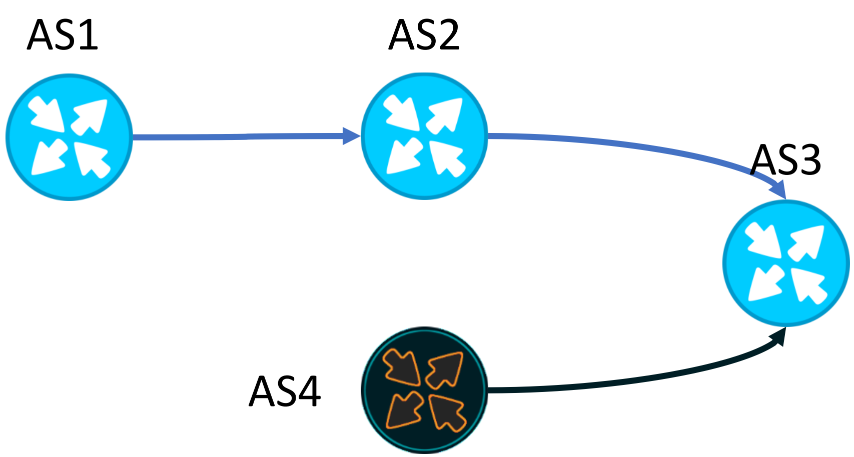
AS_PATH Verification

1. If the closest AS in the AS_PATH is not the receiver's neighbor ASN then procedure halts with the outcome "invalid";
2. If in one of AS_SEQ segments there is a pair (AS(I-1), AS(I)) is "invalid" then the procedure also halts with the outcome "invalid";



AS_PATH Verification

1. If the closest AS in the AS_PATH is not the receiver's neighbor ASN then procedure halts with the outcome "invalid";
2. If in one of AS_SEQ segments there is a pair (AS(I-1), AS(I)) is "invalid" then the procedure also halts with the outcome "invalid";



ROA {x.x.x.x, AS1}
ASPA {AS1, AS2}
ASPA {AS2, AS3}
ASPA {AS3, 0}

Route: x.x.x.x
AS_PATH: AS2 AS1

Automation: BGP Roles

OPEN with
customer role

OPEN with
peer role

Can be fully automated using BGP Roles.

Limitations

- Replay attacks by transit ISPs against it customers;
- Transit ISP can malform AS_PATH that is sent to customers.

Open Questions

- AS_SETs – should we be aggressive?
- Marking malformed routes – attribute vs GRSH?
- ASPA update – how it should affect existing routes?

Summary

- ASPA – it's simple, it scales;
- Works for both route leaks and hijack detection;
- Low computational cost;
- Doesn't change the protocol itself;
- Works on existing RPKI infrastructure;
- Brings benefit at state of partial adoption.

BGP Quadrant: Possible Future

	BGP Hijacks	BGP Route Leaks
Mistake	ROA	ASPA
Malicious	ROA + ASPA	ROA + ASPA