Route Leaks Solution
Merger of RLP and eOTC Drafts

ietf-idr-route-leak-detection-mitigation-09

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Draft Merger Efforts

• Authors from the two drafts met in Chicago (March 2017) and in London (March 2018)
• Support and encouragement from IDR Chairs John and Sue, and Ignas
• Productive authors’ meeting in London (IETF 101) followed by substantial discussions via email
• Authors happy to report on convergence to a merged solution and draft
Merged Solution and Design Discussion Drafts

• Merged Solution:

• Design Discussion:
Format of RLP Attribute
Optional Transitive Attribute

Design A
(original RLP)

<table>
<thead>
<tr>
<th>ASN: N</th>
<th>RLP: N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

Most Recently Added

<table>
<thead>
<tr>
<th>ASN: 2</th>
<th>RLP: 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASN: 1</td>
<td>RLP: 1</td>
</tr>
</tbody>
</table>

Least Recently Added

UP: RLP = 0  DOWN/LATERAL: RLP = 1

Design B

<table>
<thead>
<tr>
<th>ASN: N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

Most Recently Added

<table>
<thead>
<tr>
<th>ASN: 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASN: 1</td>
</tr>
</tbody>
</table>

Least Recently Added

- eOTC: Design B with only one ASN in the attribute is the original eOTC
## Comparison / Tradeoffs

<table>
<thead>
<tr>
<th></th>
<th>Design A (Original RLP)</th>
<th>Design B (Original eOTC)</th>
<th>Original eOTC (Design B with only one ASN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functionality</td>
<td>Detect multiple leaks</td>
<td>Detect multiple leaks</td>
<td>Can’t detect multiple leaks</td>
</tr>
<tr>
<td></td>
<td>Provide up link info also</td>
<td>Only down/peer info</td>
<td>Lack of differentiation in some cases</td>
</tr>
<tr>
<td>Detection / mitigation strength</td>
<td>Best</td>
<td>Very good</td>
<td>See above</td>
</tr>
<tr>
<td>Memory use* (per update)</td>
<td>~ 136 bytes</td>
<td>~ 72 bytes</td>
<td>~ 32 bytes</td>
</tr>
</tbody>
</table>

* Assume average 4 hop AS path
Design B: Example

Two examples

Leak a peer route; or

Propagates a customer-learned route to avoid unreachability

AS7 sees a choice between update with one distant RLP violation vs. update with two closer RLP violations and one distant.
Alexander’s scenario: 
Avoid Persistent Oscillation Possibility

Route 1: \( q \{P_0 X S\} \)

- Based on the route-leak detection theorem, violation of \( [S] \) applies to Route 2 also.
- \( [P_3] \) in Route 2 is expected (good).
- Given both routes are in violation of the same RLP, \( P_2 \) prefers the customer route.

Route 2: \( q \{P_3 P_1 P_0 X S\} \) \( [P_3 S] \)

P1, P2 are aware of eOTC/RLP. P0, P3, P4 may or may not be.

RLP/eOTC

Decision Policy (Algorithm):
- Route 1 clearly violated \( [S] \).
- Based on the route-leak detection theorem, violation of \( [S] \) applies to Route 2 also.
- \( [P_3] \) in Route 2 is expected (good).
- Given both routes are in violation of the same RLP, \( P_2 \) prefers the customer route.
(There is stable convergence.)
Examine Provider Route vis-à-vis Customer’s

• If customer route is a leak, and alternative route via provider includes the customer AS in the path, then prioritize customer route over the provider route.

* Stated simply here. See formal statement and explanation in the drafts.
Next Steps

• Request WG feedback on Design A vs. Design B

  ➢ How much utility for the additional information in the RLP attribute in Design A?
    o Indicating when update is sent to transit provider

• Request WG feedback on Attribute vs. Community

• Prepare a finalized version for WGLC
Backup slides
The only possible way that [X] is not violated in r2 is if the path from B to C consists of C2P links only. But that would violate the “No cycle of customer-provider relationships” requirement [Gao-Rexford].
Route-Leak Detection Theorem

The “Gao-Rexford” Stability Conditions


- Topology condition (acyclic)
  - No cycle of customer-provider relationships

**Route-Leak Detection Theorem**: Let it be given that ISP A receives a route $r_1$ from customer AS C and another route $r_2$ from provider AS B (for the same prefix), and both routes $r_1$ and $r_2$ contain AS C and AS X in the path and also contain [X] in their RLP/eOTC. Then, clearly $r_1$ is in violation of [X]. It follows that $r_2$ is also necessarily in violation of [X].

**Proof**: Let us suppose that $r_2$ is not in violation of [X]. That implies that $r_2$’s path from C to B to A included only P2C links. That would mean that there is a cycle of customer-provider relationships involving the ASes in the AS path in $r_2$. However, any such cycle is ruled out in practice as a necessary stability condition [Gao-Rexford]. QED.
Route-Leak Mitigation Rules

**Rule 1:** If ISP A receives a route r1 from customer AS C and another route r2 from provider (or peer) AS B (for the same prefix), and both routes r1 and r2 contain AS C and AS X (any X not equal to C) in the path and also contain [X] in their RLP, then prioritize the customer (AS C) route over the provider (or peer) route.

(Rationale: This rule is based on the theorem (slide 8). See detailed rationale in Section 3.1 in [1].)

**Rule 2:** If ISP A receives a route r1 from peer AS C and another route r2 from provider AS B (for the same prefix), and both routes r1 and r2 contain AS C and AS X (any X not equal to C) in the path and also contain [X] in their RLP, then prioritize the peer (AS C) route over the provider (AS B) route.

(Rationale: See illustration below. See detailed rationale in Section 3.1 in [1].)

Illustration of Rule 2

Default Route-Leak Mitigation Policy

• **Given a choice between a customer route versus a provider (or peer) route,**
  ▪ if no route leak is detected in the customer route, then prioritize the customer over the provider (or peer);
  ▪ else (i.e., when route leak is detected in the customer route) and the conditions of Rule 1 apply, then too prioritize the customer over the provider (or peer);
  ▪ else (i.e., when route leak is detected in the customer route and the conditions of Rule 1 DO NOT apply), then prioritize the provider (or peer) over the customer.

• **Given a choice between a peer route versus a provider route***,
  ▪ if no route leak is detected in the peer route, then prioritize the peer over the provider;
  ▪ else (i.e., when route leak is detected in the peer route) and the conditions of Rule 2 apply, then too prioritize the peer over the provider;
  ▪ else (i.e., when route leak is detected in the peer route and the conditions of Rule 2 DO NOT apply), then prioritize the provider over the peer.

*Operator MAY override (the second bullet) to prefer provider route over peer route.*
Examples Showing Policy in Action (1 of 2)

Legend:
- Green – not violation
- Red – violation
- Purple – can’t tell

**Scenario 1**
- Preferred route: q \{4 3 2 1\}
- AS does not participate in RLP and/or propagates a route that violates RLP

**Scenario 2**
- Preferred route: q \{5 3 2 1\}
- Rule 2 applied

**Scenario 3**
- Preferred route: q \{4 3 2 1\}
- (Rules 1 and 2 not applicable)
**Scenario 4**

Legend:

- **n**: AS does not participate in RLP and/or Propagates a route that violates RLP

- **Green**: not violation
- **Red**: violation
- **Purple**: can’t tell

**Preferred route:**

q \{4 3 2 1\}

(Rules 1 and 2 not applicable)
Design A – RLP Attribute

- Insert <ASN, 1> if sending to Customer or Peer
- else, insert <ASN, 0>

AS1

P1 originated by AS1

AS2

RLP = <AS1, 1>

AS3

AS3 detects leak; prefers alternate path

RLP = <AS4, 1> <AS1, 1>

AS4

P

RLP = <AS1, 1>

p2p

C2P

AS2 leaks it

C2P

C2P

Route Leak

Detected/
Mitigated 😊
Design B – RLP Attribute

- Insert <ASN> if sending to Customer or Peer
- Else, insert nothing

- **P1 originated by AS1**
- **AS2 leaks it**
- **AS2 leaks it**
- **AS3 detects leak; prefers alternate path**
- **RLP = <AS1>**
- **RLP = <AS1>**
- **RLP = <AS4> <AS1>**
- **Route Leak Detected/Mitigated 😊**

![Diagram showing the routes and leak detection process](image-url)