Bootstrapping evolvability for inter-domain routing

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Inter-domain routing is stagnant

Many proposed fixes/replacements for BGP
E.g., LISP [RFC 6830], S-BGP [SAC’00], Wiser, R-BGP [NSDI’07]

Many proposed value-added protocols
E.g., MIRO [SIGCOMM’06], Arrow [SIGCOMM’14]

Almost no new protocols deployed
(partly) because
BGP does not support evolution
BGP **does not** support evolution

E.g., new protocols cannot be used across gulfs
1. ID’d requirements for evolvability

2. Proposed two modifications to BGP
   - Pass-through support
   - Integrated advertisements (IAs)
How we identified evolvability requirements

LISP [RFC 6830]
SCION [SP’11]

S-BGP [SAC’00]
Wiser [NSDI’07]

MIRO [SIGCOMM’06]
NDN [CCR’14]

Deployment methods
Differ in routing consistency provided

BGP
Critical fix

BGP
Custom protocol

BGP
New-paradigm protocol

Reqs

Reqs

Reqs
MIRO suffers from lack of routing consistency
Problem 1: Routing across gulfs

MIRO (provides alternate paths to BGP)

BGP

Intended MIRO path

BGP best path

Unwanted Hybrid
Problem 2 - Routing within islands

- MIRO (provides alternate paths to BGP)
- BGP

M 1

M 2

Unwanted Hybrid

AS 2

Src AS

Dest AS

Intended MIRO path

BGP best path
# The three deployment methods

<table>
<thead>
<tr>
<th>Consistency</th>
<th>Hybrid</th>
<th>Best used for</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistency</td>
<td></td>
<td>BGP ➔ Critical fix</td>
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<tr>
<td>Across gulfs</td>
<td>×</td>
<td>Wiser [NSDI’07], R-BGP [NSDI’07], S-BGP [SAC’00]</td>
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<td>Within islands</td>
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<td>Cross gulfs</td>
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</table>
Wiser can be deployed using Hybrid routing

Requirements: Cross gulfs, Deprecate BGP
### The three deployment methods

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<tr>
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<tr>
<td>Across gulfs</td>
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<td>Within islands</td>
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<table>
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<th>Best used for</th>
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<th>BGP □ Custom protocol</th>
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<tbody>
<tr>
<td>Examples</td>
<td>Wiser [NSDI’07], R-BGP [NSDI’07], S-BGP [SAC’00]</td>
<td>MIRO [SIG06], SCION [SP14], Pathlets [SIG09]</td>
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<table>
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<tr>
<th>Reqs</th>
<th>Cross gulfs</th>
<th>Off-BGP-path discovery</th>
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<tbody>
<tr>
<td></td>
<td>Deprecate BGP</td>
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</table>
MIRO can be deployed using custom routing

Requirements: Off-BGP-path discovery
The three deployment methods

<table>
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<tr>
<th>Consistency</th>
<th>Hybrid</th>
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<td>✔️</td>
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<tr>
<td>Within islands</td>
<td>✗</td>
<td>✗</td>
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</table>

**Best used for**

- **Hybrid**: BGP ➔ Critical fix
- **Consistent**: BGP ➔ Custom protocol
- **Exclusive**: BGP ➔ New-paradigm

**Examples**

- **Hybrid**: Wiser [NSDI’07], R-BGP [NSDI’07], S-BGP [SAC’00]
- **Consistent**: MIRO [SIG06], SCION [SP14], Pathlets [SIG09]
- **Exclusive**: “”

**Reqs**

- **Hybrid**: Cross gulfs
- **Consistent**: Off-BGP-path discovery
- **Exclusive**: Scalable dissemination
This talk: Adding evolvability support to BGP

1. ID’d requirements for evolvability

2. Proposed two modifications to BGP
   - Pass-through support
   - Integrated advertisements (IAs)
Pass-throughs & IAs overview

Replace BGP’s advs. & processing
Can be implemented in routers or SDNs

Limited to path-vector protocols

Enable evolvability for hybrid routing by:

Enabling protocols across gulfs

Supporting BGP’s gradual deprecation
Pass-through modules

Protocols’ decision modules

- Import filter
- RIB
- Algorithm
- Export filter

Pass-through processing

Router or SDN apps

Data plane

Unsupported control info copied over

IA

Critical fix (E.g., Wiser)
IA data-structure goals

1. State protocols on routing paths
2. Be expressive enough
3. Detect loops across all protocols
4. Limit message sizes
## IA data structure

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<thead>
<tr>
<th>A:</th>
<th>Path IDs</th>
<th>Protocol(s)</th>
<th>Field(s)</th>
<th>Value(s)</th>
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<td>Path desc.</td>
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<td>AS 3168</td>
<td>AS 4027</td>
<td>MIRO</td>
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</tbody>
</table>
Open questions

What are expressiveness limits?

How does aggregation affect IA sizes?

How to handle differing timing reqs?
Summary

Inter-domain routing is not evolvable

ID’d requirements for enabling evolvability

Pass-throughs / IAs sufficient to satisfy them

[NSDI’07, R-BGP]: R-BGP: Staying Connected In a Connected World. Nate Kushman, Srikant Kandula, Dina Katabi, Bruce M. Maggs. NSDI’07.

References (II)


References (III)

[SIGCOMM’06]: MIRO: Multi-path Interdomain ROuting. Wen Xu, Jennifer Rexford. SIGCOMM’06.


[SIGCOMM’14]: One Tunnel is (Often) Enough. Simon Peter, Umar Javed, Qiao Zhang, Doug Woos, Thomas Anderson, Arvind Krishnamurthy. SIGCOMM’14.