Geographic Locality of IP Prefixes

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Joint work with
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Internet Measurement Conference ‘05
Motivation

- Autonomous Systems (ASes)
- IP Prefixes in BGP messages
- “Routing handles”
- Granularity of routing handle – tradeoff between routing table size and ability to control traffic
- Is prefix the right granularity?
Too fine-grained?

- Discontiguous prefixes from same location
- Likely to share fate
- Multiple routing table entries to be updates
- Close in geography, far in IP space → fine-grained
Too coarse-grained?

- Contiguous prefixes from different locations
- Aggregate → less control over traffic
- Artificially inflates “opportunities” for aggregation
- Close in IP space, far geographically → coarse-grained
Questions we investigate

<table>
<thead>
<tr>
<th>IP space</th>
<th>Geography</th>
<th>Granularity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Far</td>
<td>Close</td>
<td>Fine-grained</td>
</tr>
<tr>
<td>Close</td>
<td>Far</td>
<td>Coarse-grained</td>
</tr>
</tbody>
</table>

How often do ASes announce discontiguous prefixes from same location?

How often do ASes announce contiguous prefixes from different locations?

Correlation - locality in IP space & geographic locality
Major Findings

- Discontiguous prefixes, close geographically
  - 70% of discontiguous prefix pairs
  - Fragmented allocation to fate-sharing entities
- Contiguous prefixes, far geographically
  - 25% of contiguous prefix pairs
  - Unsuitable to express traffic control policy
GOAL: Associate an IP prefix with a set of locations (cities)

Prefixes too fine-grained

- Analyzed top 20 <AS, location> pairs
- 23% of them allocated on the same day

70% of discontiguous prefixes have the same location

65% due to fragmented allocation
Implications

- Renumber?
- Change granularity of routing??
  - Eg: PoP level

```
  A
  <A,location>
  10.1.0.0/16
  10.3.0.0/16
  10.5.0.0/16

  B
  <A,location>
  10.1/16
  10.3/16
  10.5/16
```
Prefixes too coarse grained

- 25% of contiguous prefixes - different location
- CIDR Report\textsuperscript{[4]}

<table>
<thead>
<tr>
<th>Prefix</th>
<th>AS Path</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0/15</td>
<td>A B C D</td>
<td></td>
</tr>
<tr>
<td>10.1/16</td>
<td>A B C D</td>
<td></td>
</tr>
</tbody>
</table>

64% reduction

- Same AS path + close geographically

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</thead>
<tbody>
<tr>
<td>10.1/16</td>
<td>A B C D</td>
<td>L1</td>
</tr>
<tr>
<td>10.0/16</td>
<td>A B C D</td>
<td>L1</td>
</tr>
</tbody>
</table>

20% reduction

\textsuperscript{[4]} http://www.cidr-report.org
Implications

- Potential for aggregation over-stated
- Aggregate too coarse grained – poor traffic control
Take-home lessons

- Is prefix the right granularity for routing?
- Prefix too fine-grained
  - Discontiguous prefixes from same location
  - Causes many routing table updates
  - Change routing granularity: group by shared fate?
- Prefix too coarse-grained
  - Contiguous prefixes from different locations
  - Potential for aggregation is overstated
  - Aggregate prefix unfit for traffic control

Questions?