Update on the IAB Routing and Addressing Workshop

David Meyer/Chris Morrow
IAB Plenary
IETF67
San Diego, CA
Agenda

• Why Hold This Workshop?
• Logistics
• Workshop Objectives
• Participant Perspective: Chris Morrow
• Key Findings
• Workshop Recommendations
Why Hold This Workshop?

- The Internet’s routing system is facing a set of serious scaling problems, and...
- We are the IAB, after all, and...
  - “A is for Architecture” -- Leslie Daigle
- And importantly...
  - There is a shared opinion among many backbone operators that none of the existing IETF efforts provides a complete set of solutions
Logistics

• The workshop was held in Amsterdam, Netherlands on October 18-19, 2006

• 38 attendees
  • Focused on backbone operators
  • Also a few h/w designers, enterprise types
  • 18 (of the 38) were IESG, IAB, or IRTF
  • One scribe

• Many thanks to ISOC/RIPE NCC/NLnet Labs/Cisco

• And everyone who made the trip to help us think about these issues
Workshop Objectives

• To develop a shared understanding of the problems that operators are facing with today’s routing and addressing system, and

• To use that information to inform the IETF process
Participant Perspectives: Chris Morrow
Problem Statement

• Current trends in the growth of routing and addressing state on the global Internet are not scalable (in the long term)

• Among the major causes of this growth are multihoming and traffic engineering, which themselves are growing

• IPv6 is not significantly different than IPv4 – it shares many of the same properties and scaling characteristics
Estimated IPv4+IPv6 Routing Table
(Jason Schiller, 11/06)

Assume that tomorrow everyone does dual stack...

Current IPv4 Internet routing table: 199K routes

New IPv6 routes (based on 1 prefix per AS): + 23K routes

Intentional de-aggregates for IPv4-style TE: + 69K routes

Internal IPv4 customer de-aggregates + 50K to 150K routes

Internal IPv6 customer de-aggregates + 40K to 120K routes

( projected from number IPv4 of customers)

Total size of tier-1 ISP routing table 381K to 561K routes
Future Projection of Combined IPv4 and IPv6 Internet Growth

IPv4 + IPv6 Internet routes

Number of Active routes

Date

Legend
Inside a “tier-1” is even more “interesting”…
What About Moore’s Law?

• Applicable to high volume components - think PC’s: CPUs, main (DRAM) memories, and disk drives

• Critical router components (TCAM, SRAM) are low-volume and have much lower growth rates

• Forwarding ASICs already push limits of technology

• Memory speeds improve at about 10% per year

• Bottom line: state growth in excess of 1.3x every 2 years is problematic (translation: expensive)
Hardware growth vs. routing state growth

Tier 1 IPv4 + IPv6 projected routes

Legend
- Internal IPv4 + IPv6 routes
- Internal IPv4 + IPv6 routes
- projected IPv4 + IPv6 linear regression
- projected IPv4 + IPv6 Power Regression
- projected IPv4 + IPv6 quadratic regression
- projected IPv4 + IPv6 cubic regression
- projected IPv4 + IPv6 linear regression
- projected IPv4 + IPv6 Power Regression
### Some Interesting Numbers/Projections

<table>
<thead>
<tr>
<th>Route type</th>
<th>11/01/06</th>
<th>5 years</th>
<th>7 years</th>
<th>10 Years</th>
<th>14 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPv4 Internet routes</td>
<td>199,107</td>
<td>285,064</td>
<td>338,567</td>
<td>427,300</td>
<td>492,453</td>
</tr>
<tr>
<td>IPv4 CIDR Aggregates</td>
<td>129,664</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPv4 intentional de-aggregates</td>
<td>69,443</td>
<td>144,253</td>
<td>195,176</td>
<td>288,554</td>
<td>362,686</td>
</tr>
<tr>
<td>Active Ases</td>
<td>23,439</td>
<td>31,752</td>
<td>36,161</td>
<td>42,766</td>
<td>47,400</td>
</tr>
<tr>
<td>Projected ipv6 Internet routes</td>
<td>92,882</td>
<td>179,481</td>
<td>237,195</td>
<td>341,852</td>
<td>423,753</td>
</tr>
<tr>
<td>Total IPv4/ipv6 Internet routes</td>
<td>291,989</td>
<td>464,545</td>
<td>575,762</td>
<td>769,152</td>
<td>916,589</td>
</tr>
<tr>
<td>Internal IPv4 (low est)</td>
<td>48,845</td>
<td>101,390</td>
<td>131,532</td>
<td>190,245</td>
<td>238,275</td>
</tr>
<tr>
<td>Internal IPv4 (high est)</td>
<td>150,109</td>
<td>311,588</td>
<td>404,221</td>
<td>584,655</td>
<td>732,915</td>
</tr>
<tr>
<td>Projected internal ipv6 (low est)</td>
<td>39,076</td>
<td>88,853</td>
<td>117,296</td>
<td>173,422</td>
<td>219,627</td>
</tr>
<tr>
<td>Projected internal ipv6 (high est)</td>
<td>120,087</td>
<td>273,061</td>
<td>360,471</td>
<td>532,955</td>
<td>675,325</td>
</tr>
<tr>
<td>Total IPv4/ipv6 routes (low est)</td>
<td>381,989</td>
<td>654,788</td>
<td>824,590</td>
<td>1,132,819</td>
<td>1,374,223</td>
</tr>
<tr>
<td>Total IPv4/ipv6 routes (high est)</td>
<td>561,989</td>
<td>1,049,194</td>
<td>1,340,453</td>
<td>1,886,762</td>
<td>2,324,483</td>
</tr>
</tbody>
</table>
Thanks!
(darrel/dave/jason/ted/vince/vijay)
Key Workshop Findings

- The scalability of the routing system is an urgent problem

- Super-linear RIB growth is a great concern
  - Increased BGP convergence times and associated costs
  - RIB (UPDATE) dynamics also an issue (cf deaggregation)

- Questions about the applicability of Moore’s Law to high-end routers (in particular, FIB memories)

- And of course, along with all of the various constraints e.g., no provider lock (PA/CIDR), TE, multihoming, ...

- Shared problem between IPv{4,6}
  - Larger IPv6 address space exacerbates these problems
Key Workshop Findings

- The use of IP addresses for both ID and Locator is a problem
  - Workshop participants felt that a solution to this overloading may solve the mobility and multihoming problems
  - Examined the tradeoffs inherent in SHIM6 and GSE
  - Long term solutions need to consider the anticipated “orders of magnitude” growth in new mobile end devices
Key Workshop Findings

• Costs and Benefits in current practices are not aligned
  • Canonical example: multihoming

• Cost/Benefit curves vary by stakeholder
  • An enterprise may have a very different view of the cost/benefit tradeoffs of a given solution set than say, content provider might
Personal Observations

• The workshop generated a nice enthusiasm, and ...

• Everyone seemed to leave with a new energy around the problem

• Some folks who hadn’t engaged with IETF leadership recently (or ever before) re-engaged

• A lot of positive socialization occurred

• So the time for decisive action is now
Workshop
Recommendations

• These problems are urgent
  • Need to start working on solutions now

• Need to reach out to all stakeholders
  • In addition to backbone providers, we need to reach out to the content providers, enterprises, applications folks, vendors,...
Workshop Recommendations

• We must develop solutions in an open & transparent way, engaging the broad community

• Engaging research community as well

• Look into whether interim solutions are necessary to buy us a little time
Workshop

Recommendations

• Need to develop a clear and coordinated approach to solutions development

• Roadmap

• Near, intermediate, and long term steps from current state to solutions
Questions/Comments?

Thanks!