An Analysis of ISP Backbone Availability

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● All results in this talk are based only with the IS-IS messages provided by Internet2 observatory. Therefore, the results of specific links and nodes in this presentation are not directly reflect the quality of its service, and/or of its equipment.
How much availability in ISP infrastructure.

• Your ISP offers 99.9% SLA for intra-ISP,
  • really premium?
  • valuable to pay more?
• Just presenting infrastructure availability, not taking into account:
  • Any convergence delay of routing protocol
  • Packet behavior
Breakdown network failures into its causes:

- Routing and centralized-NMS (Labovitz ’99)

A lot of BGP activities

- BGP failures affects world wide Internet system
- BGP can be seen by other ISP’s
- BGP continues to be recorded as UO’s RouteViews
ISP infrastructure: viewpoint from IGP

- Fewer IGP activities than BGP
  - IS-IS on Qwest, Alaettinoglu (‘02)
  - OSPF on Michi-Net, Watson (‘03)
- required to install collector ISP network inside.
- IGP dataset will disclose ISP backbone quality.
- or, It is not a news network is working fine :)
- IGP message represents infrastructure events
  - Lost adjacency, ext. route: circuit / switch / interface down
  - Est. adjacency, ext. route: circuit / switch / interface up
  - Lost LSP/LSA: router down
  - Reset LSP/LSA seq.: router up
IS-IS collector in Abilene

- IS-IS collector is part of I2 Abilene observatory activity.
  - http://ndb2-blmt.abilene.ucai.edu/isis/
  - Contributed by Shu Zhang [ZK06]
- Deployed all Abilene nodes for multi observation points.
- Synchronized with CDMA timer (GPS based)
- From Aug. ’04 to Apr. ’07 data set is available.

Abilene Network Map

11 nodes with T640 routers, and 14 OC192 circuits.
Abilene IS-IS operation

- 9 sec. Hello interval, lost ISIS adjacency after missing 3 hellos
  - 22.5 sec. failure detection delay is supposed.
  - More faster failure detection is possible, e.g., shorter hello interval, BFD, carrier loss with circuit failure.

- IGP maintains infrastructure information only.
  - Minimize IGP database
  - Not import any BGP route into IS-IS.
• Network availability in hereafter:
  • All network works without any failure.
    • From Network operator’s viewpoint.
  • Don’t care specific source destination path availability.
    • Not from customer’s viewpoint.
• Timeframe:
  • May include more than one event at same time.
Abilene IS-IS overview ’05-’06

- Node failure: timeout node LSP, or seq. number reset.
  - Only 1 times on ’05 (53 sec. downtime), 2 on ’06 (1,298 sec.)

- Circuit failure: adjacency away from list in LSP
  - Usually found, 635 timeframe on ’05, 513 on ’06.

- Ext. route failure: Route away from LSP
  - Represent edge troubles?
  - Difficult to identify whether serious or trivial.
Lost adjacency event


single-failure
Monitor duration: 365 (days)
Total disrupt(count): 635, Availability: 0.95443

2006/Jan.-Dec.

single-failure
Monitor duration: 365 (days)
Total disrupt(count): 513, Availability: 0.98424

Note that above histograms are drawn with IS-IS captured data at Atlanta. Few details are different with other IS-IS observatory point.
Breakdown in ‘05

ATLA−IPLS
Monitor duration: 365 (days)
Disrupt(count) 288, Avail: 0.99137

CHIN−IPLS
Monitor duration: 365 (days)
Disrupt(count) 34, Avail: 0.99981

CHIN−NYCM
Monitor duration: 365 (days)
Disrupt(count) 64, Avail: 0.99947

DNVR−KSCY
Monitor duration: 365 (days)
Disrupt(count) 4, Avail: 0.99997

DNVR−SNVA
Monitor duration: 365 (days)
Disrupt(count) 12, Avail: 0.99302

DNVR−STTL
Monitor duration: 365 (days)
Disrupt(count) 8, Avail: 0.99997
Availability Map (05/01-12)

Availability / Disrupt count / Longest down time (sec.)

Hurricane Katrina
Aug. ‘05
### Yearly summary ’05 - ’06

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<td><strong>Total(*)&amp;</strong></td>
<td>0.9544</td>
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Critical events.

- 2 or more lost adjacency at same timeframe
  - Some combination makes serious impact. But, not all event lead split graph condition.
- 32 timeframes (47 disrupt) in ’05, 58 (61) in ’06
- 26/47 timeframes in ’05, 49/61 in ’06, are attributed as missing a node in LSP database.
2 or more links failure (2)
- Missing node -

Missing IPLS router at
...........
06/02/19 05:31-05:56
06/02/19 06:30-06:35
06/02/19 15:47-15:51
............
Two or more failure in ‘05


- Single-failure
  - Monitor duration: 365 (days)
  - Total disrupt(count): 637, Availability: 0.95435

- Double-failure
  - Monitor duration: 365 (days)
  - Total disrupt(count): 47, Availability: 0.99976

All lost adjacency events

Two or more missing
Two or more failure in ‘06

2006/Jan.-Dec.

- **Single-failure**
  - Monitor duration: 365 (days)
  - Total disrupt(count): 514, Availability: 0.98419

- **Double-failure**
  - Monitor duration: 365 (days)
  - Total disrupt(count): 61, Availability: 0.99959

All lost adjacency events

Two or more missing
Single link failure is trivial? (1)

- Lost two or more adjacency events are rare, more than 99.95% availability, < 5 hours/year downtime.
- More than 500 lost single adjacency are founded.
  - 637 times in ’05, and 514 in ’06
- 3-4 hours/year downtime are estimated:
  - Only suppose 22 sec. downtime for each lost adjacency.
  - Other delays, i.e., routing convergence, degrade it more.
Single link failure is trivial? (2)

- 22 sec. downtime for each lost adjacency is overestimated?
  - Router can detect circuit failure more faster triggered with lower layer information, e.g., loss of optical, framer error.
  - IGP timer hack or BFD provide faster failure detection as sub-second or less [AC02].
  - Sub-second is derived from propagation delay limit, impossible to reduce it.
  - IP FRR would help more.
Conclusion

• ’05-’06 Full-year availability evaluation using Abilene ISIS trace data:
  • > 99.95 % backbone network viewpoint from IGP.
  • Better than real one.
    • routing convergence delay / access link
  • Abilene backbone is over-provisioned bandwidth.
  • It is not a news network worked fine :-)

• Thanks for Shu Zhang, Randy Bush, and Xing Li