On the sensitivity of transit ASs to internal failures

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Agenda

- Network robustness of transit ASs
- Sensitivity to internal failures
- Sensitivity of the GEANT network
- Route-reflection
- Further work
Designing robust transit ASs

- **IGP topology**: spreading the load of the traffic over the available shortest paths
- **iBGP sessions**: distributing the available BGP routes inside the AS
- **eBGP routes**: rarely designed but imposed by economical constraints
Toy example transit AS with iBGP full-mesh
Previous work

- Potential sensitivity of a large tier-1 due to hot-potato disruptions [Teixeira et al., SIGMETRICS'04]
- Metrics to capture sensitivity to internal failures [Teixeira et al., SIGCOMM'04]
- Routing changes can have a significant impact on the traffic matrix [Teixeira et al., PAM'05]
Reproducing the routing of a transit AS

- **Announce eBGP routes**: important to have the actual diversity of the routes inside an AS
- **Propagate routes inside iBGP structure**
- **Compute state of the Adj-RIB-ins** of each BGP router

Reproducing the routing of an AS with C-BGP
Sensitivity metrics to internal failures

- Consider a class of graph transformations on the graph $G$ (denoted by $\Delta G$)
- Compute whether BGP changes its best route to reach prefix $p$ after each graph transformation $\partial G$
- Metrics measure how graph transformations affect the graph (*impact*) and how each router is impacted (*sensitivity*)
Data from the GEANT network

- The GEANT network:
  - 23 POPs, 76 links, tens of eBGP peerings
  - iBGP full mesh
- 1 month of routing and traffic data in 2004:
  - ISIS and BGP capture
  - Netflow capture at all ingress interfaces
Routing impact of node failures

![Graph showing the impact of node failures on routing, with percentage of prefixes on the y-axis and node failures on the x-axis. The graph includes data for worst-case and average scenarios.]

Critical router failures
Router sensitivity to node failures

Node routing impact (router failures)

Percent of prefixes

max
average

insensitive routers

Routers
Router sensitivity to link failures

Node routing impact (link failures)

Percent of prefixes

Routers

max

average

insensitive routers
Insight from sensitivity analysis

- Identifying critical links and routers
- Highly related to IGP weights setting (concentration of shortest IGP paths)
- Good enough for simple iBGP structures (full-mesh), helps find out whether to change network topology
- What about complex transit ASs with route-reflection?
Toy example transit AS with route-reflection
Dealing with complex ASs

- iBGP structure has non-trivial impact on best BGP routes choice inside AS
- RR initially introduced for scalability (limit number of iBGP sessions)
- RR performs tricky choice route selection and propagation inside large ASs
- No understanding today of how to design iBGP
Current and further work

- Need to understand what iBGP actually does
- Route-reflection is a necessity in large ASs
- Impact of RR unclear today, but it's not just about reducing number of iBGP sessions:
  - route diversity
  - sub-optimality of best routes
  - convergence in case of failures