A characterization of routing dynamics between neighbor ASes

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Agenda

- Interactions between neighbor ASes
- Case study: GEANT and Abilene
- Methodology
- Results
- Implications
- Conclusions
Interactions between neighbor ASes
Interactions between neighbor ASes

- **Egress router for** $p$: router that receives a best route
- **Egress-set for** $p$: set of egress routers for $p$
- $P_{X \rightarrow Y}$: set of prefixes advertised by $X$ to $Y$
- $P_{X \rightarrow Y} = \{p1,p3,p4\}$
- $P_{Y \rightarrow X} = \{p2,p3\}$
Case study: GEANT and Abilene
GEANT and Abilene: interconnectivity

\[ \# P_{\text{Abilene}\rightarrow\text{GEANT}} = 5770 \]
\[ \# P_{\text{GEANT}\rightarrow\text{Abilene}} = 2200 \]
GEANT and Abilene: measurement infrastructure

Abilene (AS11537)

- **Routing:** 1 collector per POP (BGP + ISIS)
- **Netflow:** 1/100 sampling

GEANT (AS20695)

- **Routing:** 1 collector in the network (BGP, ISIS)
- **Netflow:** 1/1000 sampling
Methodology
Methodology: egress-set changes

- *Egress-set change* ≡ BGP event that changes the egress-set for *p*
- BGP path exploration => many transient states to egress-set
- Filtering of BGP changes: group transient egress-set changes close in time (75% filtered)
Methodology: taxonomy

- **Prefix down for X**: $\Delta \#P_{X \rightarrow Y} \downarrow$
- **Prefix up for X**: $\Delta \#P_{X \rightarrow Y} \uparrow$
- **Egress-set change for X**: $\Delta \#P_{X \rightarrow Y} = 0$
Methodology: correlating egress-set changes

- AS X is said *source* of egress-set change if routing change observed first at AS X and then at AS Y (*destination*)

- Correlating algorithm:
  1. Selection of relevant egress-set change
  2. Identification of the time window T
  3. Matching related egress-set changes
Methodology: selection of relevant egress-set changes

- Considered prefixes:
  - \( P_{G \rightarrow A} \cup P_{A \rightarrow G} \)
  - Select prefixes whose BGP messages contain the other network as next hop

- If \( P_{G \rightarrow A} \cap P_{A \rightarrow G} \neq \emptyset \) then causal relationship is unclear
Methodology: identification of time window $T$

- Propagation of BGP messages takes time:
  - route flap damping: avoid propagating messages for flapping prefix
  - out-delay (Juniper): delay messages before sending them
  - router’s load: largely depends on number of prefixes and peers

- $T_{A,G} > 90$ min (lots of prefixes, out-delay and damping)

- $T_{G,A} = 0$ (no out-delay, lightly loaded)
Methodology: matching related egress-changes

- Order egress-changes in *destination* with time
- Look for events at *source* that might have triggered change at *destination*
- **Compatible change:** for each change of type $c$ at *destination* at time $t$, an event of type $c'$ at source is *compatible* if $t \leq t' \leq t+T(p)$ and if $c'$ is compatible with $c$
Results: mutual impact between GEANT and Abilene
## Analysis of mutual impact

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Propagation time

No delay from Abilene to GEANT

NL out-delay

DE2 out-delay
Implications
Implications on inter-AS diagnosis

- Diagnosing routing changes between neighbor ASes using egress-change sharing:
  - type of change
  - list of concerned prefixes
  - time of observation
  - traffic ? (rank in top hitters)

- **Interest:**
  - Based on this information, operators might decide what is a routing anomaly that propagated across their network
  - Bounds on events propagation: proposed methodology can be used recursively from observation AS to originating AS
Conclusions
Conclusions

- Most interactions between GEANT and Abilene are reachability events
- Key aspects: network engineering, configuration and peers
- Impossible to understand impact from one AS only
- Better understanding of AS interactions requires finer matching of routing data from multiple vantage points