Case Studies in Intra-Domain Routing Instability

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Overview

- Intra-domain routing instability
- Measurements of intra-domain routing instability
  - WIDE Internet and APAN Tokyo-XP network
- Dealing with intra-domain routing instability
  - Detection and troubleshooting
- Conclusions
Intra-Domain Routing Instability

- Intra-domain routing instability
  - Unexpected routing changes within an IGP routing domain
  - Causes packet loss, increased router load, and wasted bandwidth

- Why focus on intra-domain routing?
  - Compared with inter-domain routing, research on IGP behaviors is still poor
  - Help operators better understand intra-domain routing instability and learn how to deal with it
Measurement Methodology

- Data collection
  - OSPF
  - Tcpdump
Data analysis

• Counting routing changes
  ■ Changes in the content of an LSA
  ■ LSA flush
  ■ Changes in AS-External LSAs were excluded

• Refreshing LSAs were not counted
Case Study 1/2: WIDE Internet

- **WIDE Internet**
  - WIDE Project (http://www.wide.ad.jp)
  - Connects hundreds of academic organizations
  - About 50 routers in the OSPF backbone area

- **Data collected at NARA-NOC**
  - Located in Nara, Japan
  - Both OSPFv2 and OSPFv3 data collected
Measurement of the WIDE Internet Router-LSA

Period: August 2000 – May 2004
Measurement of the WIDE Internet (Cont’d)

Network-LSA

Network-Summary-LSA

ASBR-Summary-LSA

Period: August 2000 – May 2004
Example of a Typical LSA Oscillation

- Relatively frequent changes in short term
  - A router in Fukuoka (WIDE), 5/7/2004, lasted for about 4 hours
- Usually caused by congestion
Example of Serious Oscillation

- Frequent changes in short term
  - An L3 switch, 6/12/03-6/13/03, lasted for about 18 hours
- Observed for several times
  - Most of them were caused by problems of p2p links or misconfiguration of using the same router ID on two routers
Long-Term Changes

- Relatively frequent changes
  - A router in SF, lasted for 5 months (10/23/03-4/1/04)
    - Considered due to a switch problem
Long-Term Changes (Cont’d)

- Slow changes
  - A router in Kyoto, has persisted since this March
- Some of them were caused by interface problems
The Case of OSPFv3

Period: July 2003 – January 2004
Case Study 2/2: APAN Tokyo-XP

- APAN Tokyo-XP network
  - A transit network located in Tokyo
  - Relatively small in scale, with no more than ten routers in the backbone area
Measurement of APAN Tokyo-XP Network (OSPFv2, Router-LSA)

Problem of ATM link
Misconfiguration
Switch problem

Period: August 2003 – May 2004
Causes of Instability

- Identified causes
  - Congestion
    - DDoS
  - Link failure
  - Software/Hardware bug
  - Misconfiguration

- Most instability is due to other reasons rather than routing protocol problems
Analysis Results

- Observed Routing Instability
  - Instability observed on both the WIDE Internet and the APAN Tokyo-XP network
  - The most typical changes are relatively frequent short-term ones
    - Happen at intervals of 10 - 200s
  - Frequent short-term changes
  - Long-term changes
Analysis Results (Cont’d)

- Changes is decreasing
  - The change in router’s implementation
  - Less network congestion because of the increased bandwidth in recent years

- The causes of many changes are unknown
Rtanaly: A Tool to Detect and Visualize Intra-Domain Routing Instability

- Functions
  - Detection of IGP change in real-time and alert operators
    - Can also be used for offline data analysis
  - Visualization
  - Accessible through the WWW interface

- Currently only supports OSPF
  - IS-IS support will be completed soon
Troubleshooting Routing Instability

- **Why is routing instability troubleshooting difficult?**
  - Problems occur intermittently, so it is difficult to get useful data for troubleshooting

- **Event-driven data collection**
  - Automatically obtain data for troubleshooting when detecting routing changes
Troubleshooting Routing Instability (Cont’d)

- Data that should be collected
  - Traffic volume
  - Interface status
  - Information on the routing protocols

- From where?
  - The router that originated the changing LSA
  - Network equipment connected to the router
    - Switch

- How to collect the data?
  - SNMP
Conclusions

- Routing instability measurements
  - Intra-domain routing instability can occur frequently and persistently
  - Similar phenomenon may occur on other networks
    - It is important to deploy a monitoring system on your own network

- Rtanaly

- Troubleshooting
  - Event-driven data collection
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Intra-domain routing stability measurement project

- http://pe0.koganei.wide.ad.jp/rtanaly

Please contact us if you are interested in conducting an IGP measurement on your network

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Thank you!