Case Studies in Intra-Domain Routing Instability

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Overview

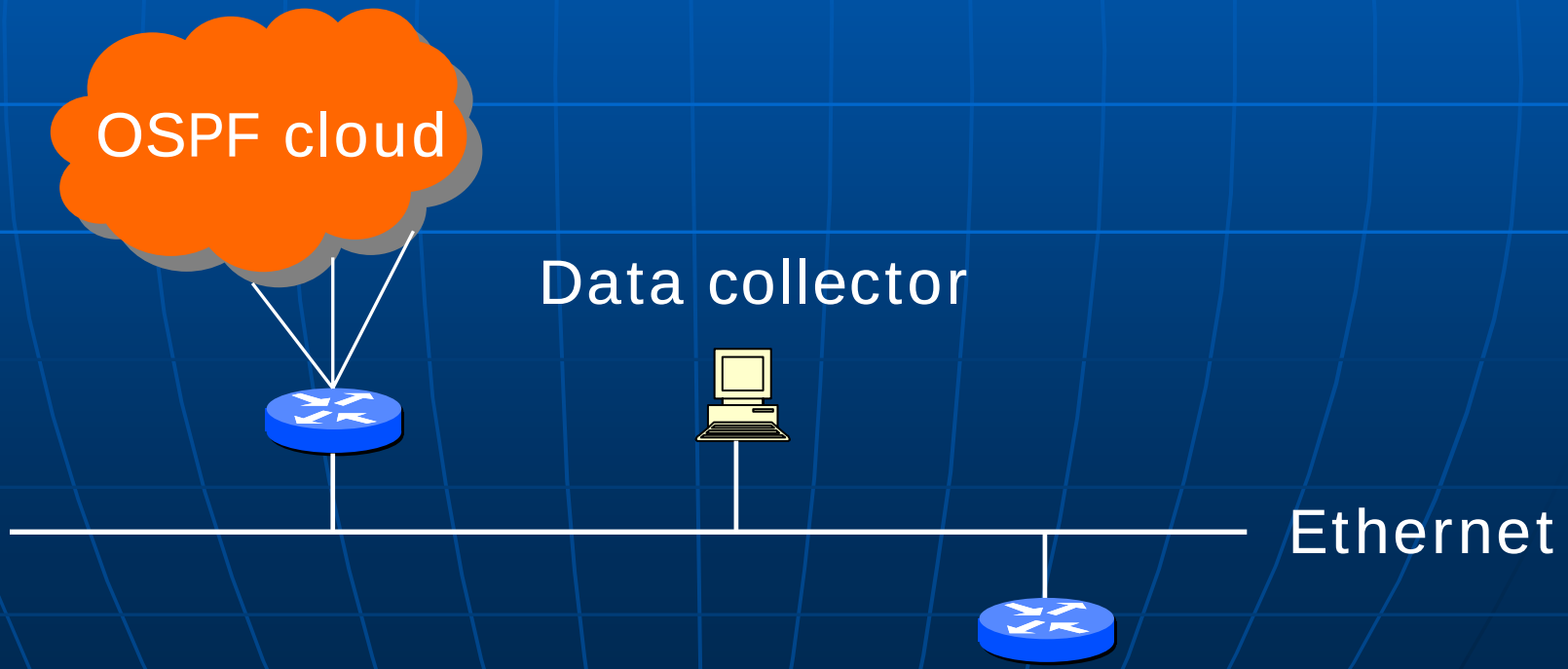
- Intra-domain routing instability
- Measurements of intra-domain routing instability
  - WIDE Internet and APAN Tokyo-XP network
- Dealing with intra-domain routing instability
  - Detection and troubleshooting
- Conclusions

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



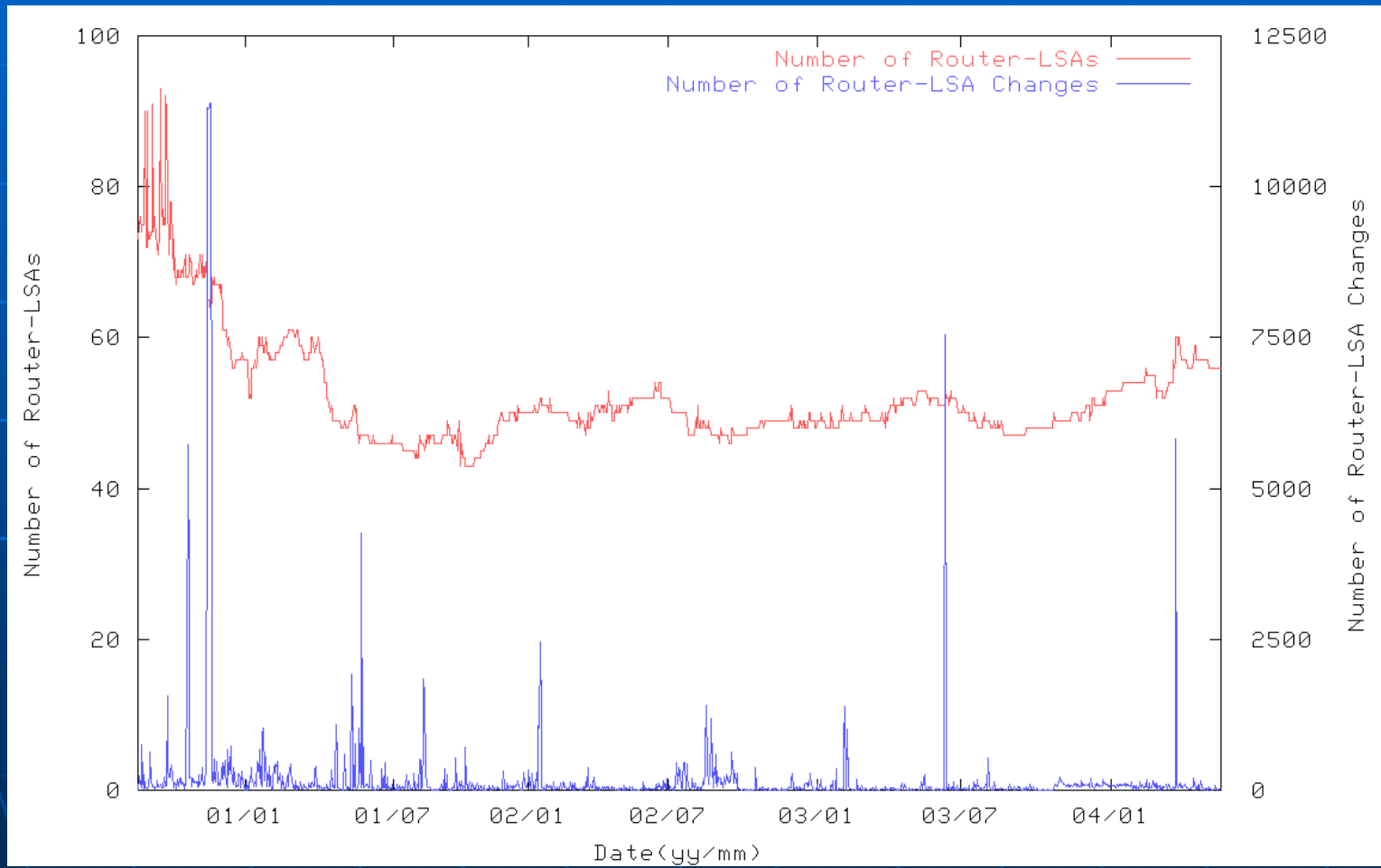
Measurement Methodology (Cont'd)

- 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



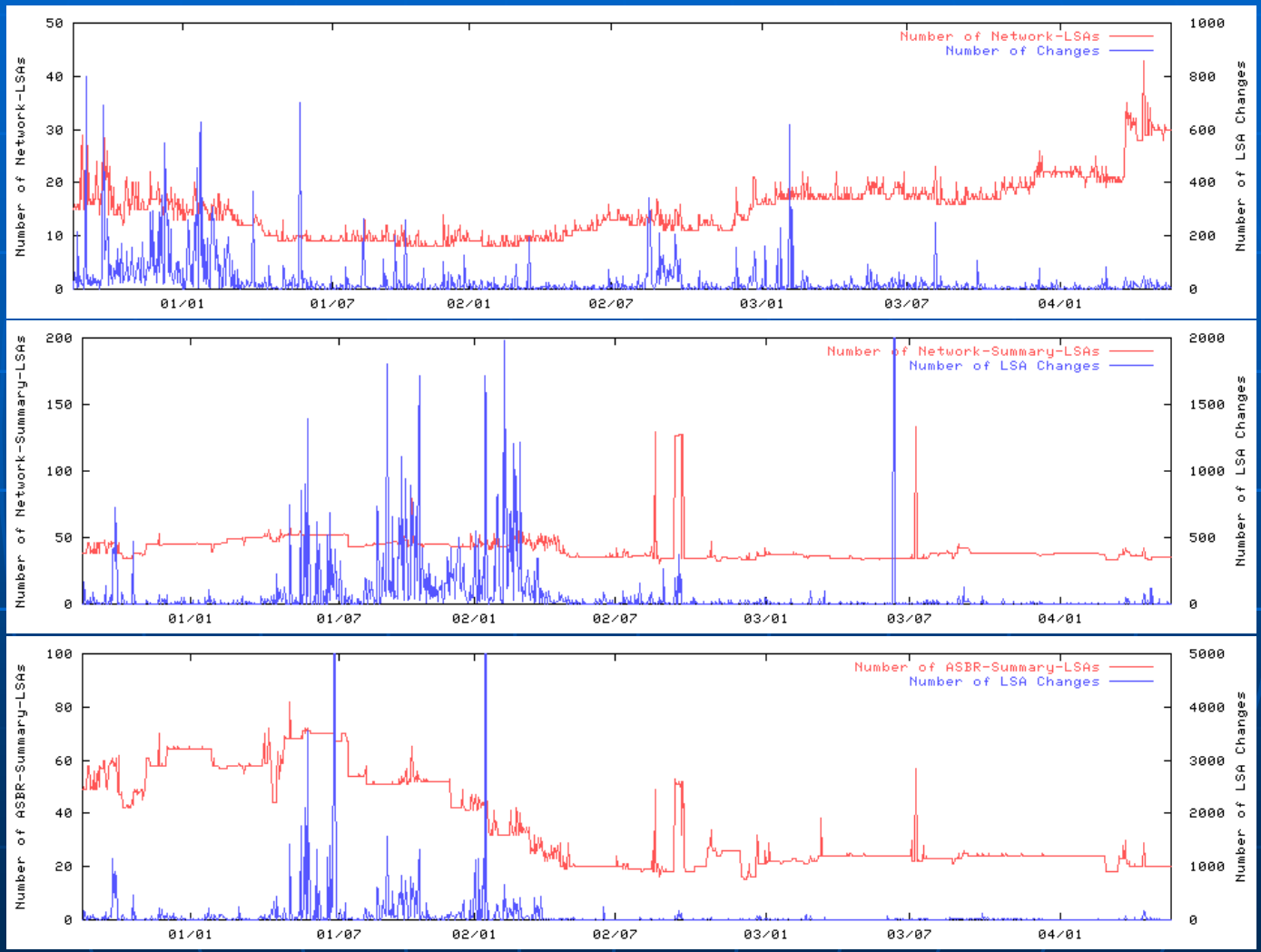
Period: August 2000 – May 2004

Measurement of the WIDE Internet (Cont'd)

Network-LSA

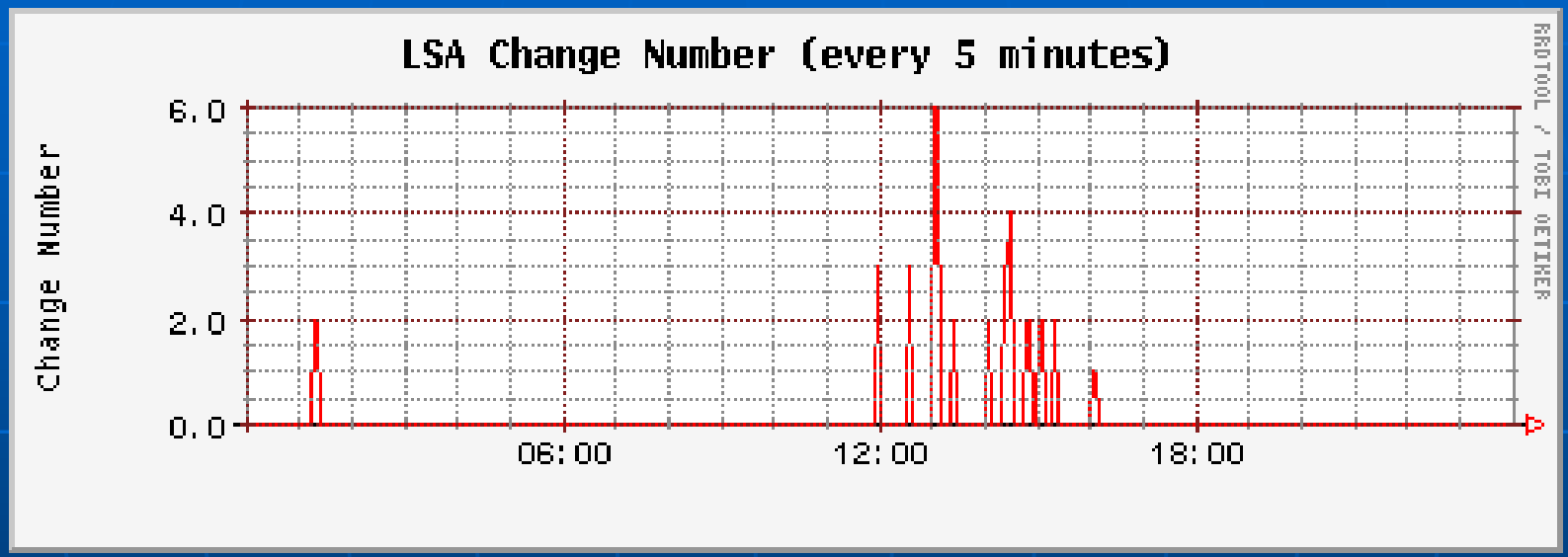
Network-Summary-LSA

ASBR-Summary-LSA



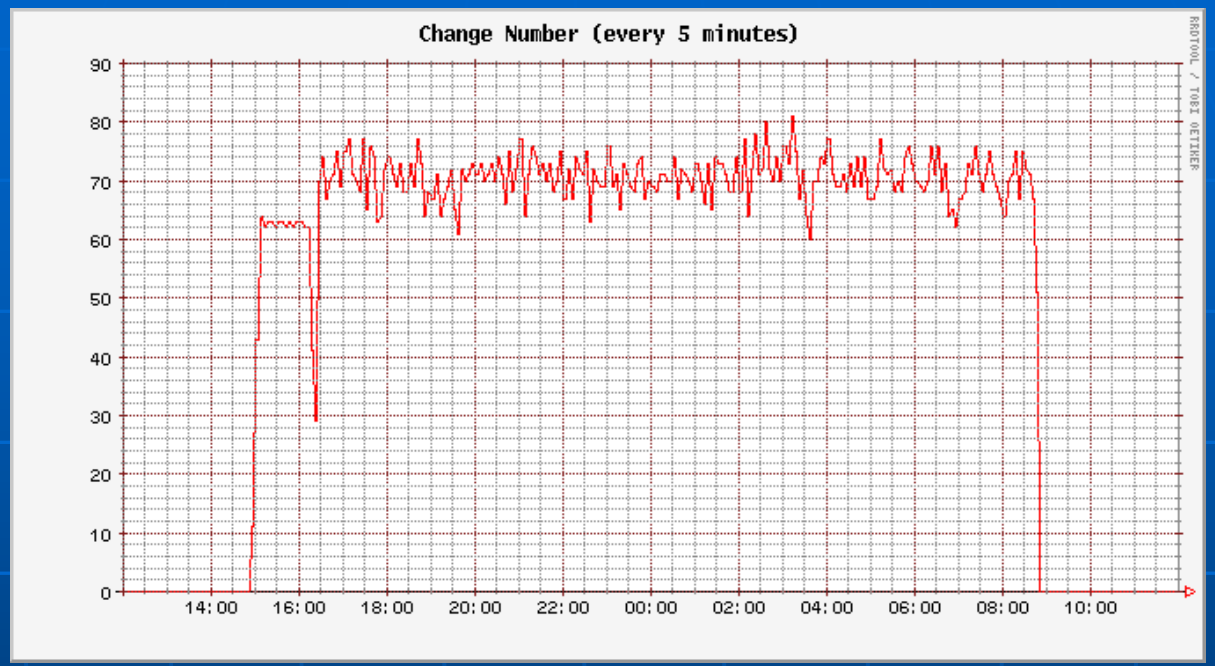
Period: August 2000 – May 2004

Example of a Typical LSA Oscillation



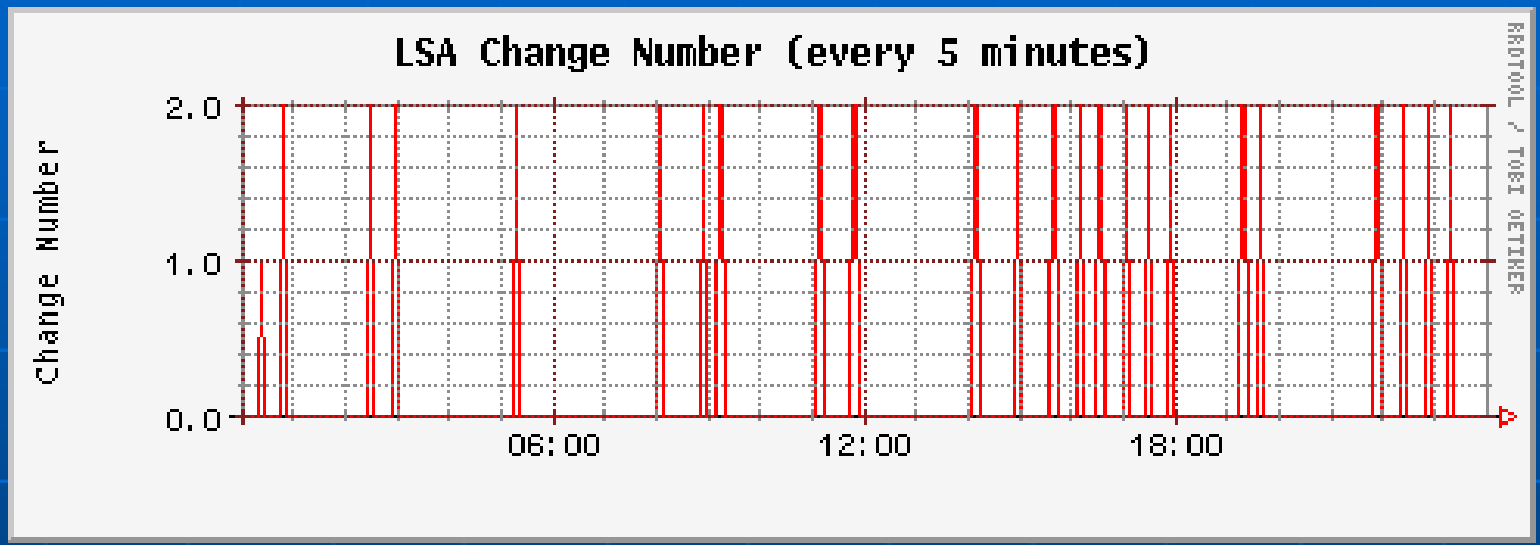
- Relatively frequent changes in short term
  - A router in Fukuoka (WIDE), 5/7/2004, lasted for about 4 hours
- Usually caused by congestion

Example of Serious Oscillation



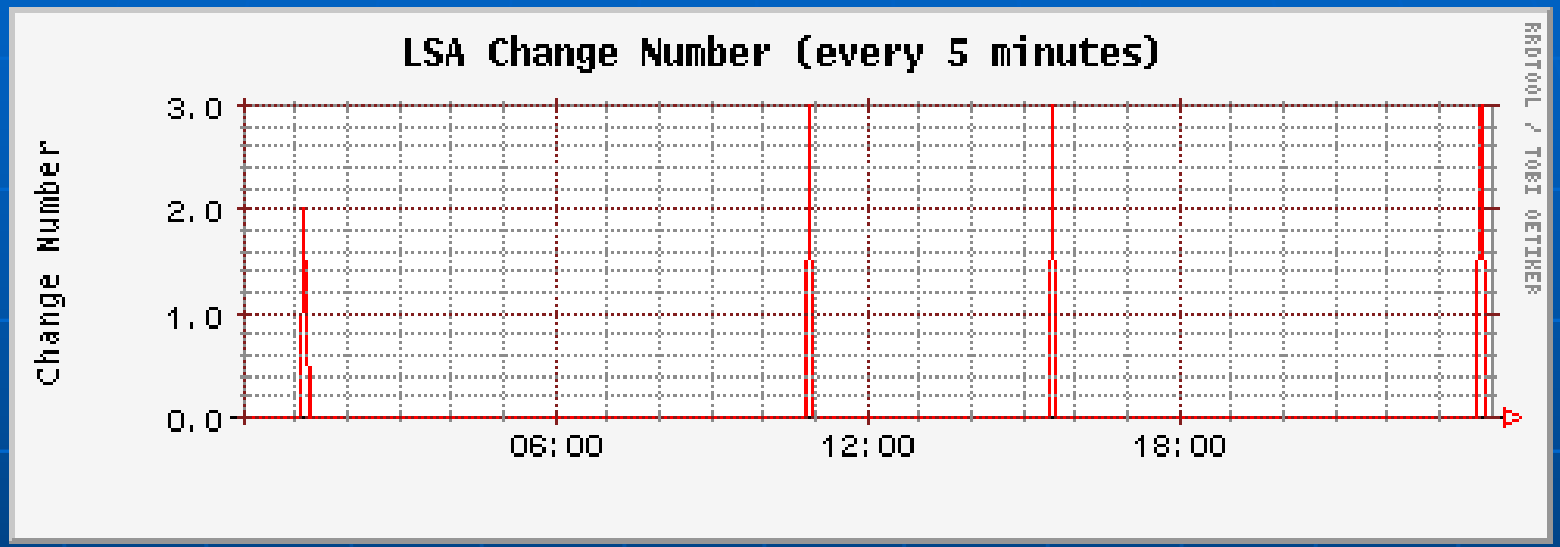
- Frequent changes in short term
  - An L3 switch, 6/12/03-6/13/03, lasted for about 18 hours
- Observed for several times
  - Most of them were caused by problems of p2p links or misconfiguration of using the same router ID on two routers

Long-Term Changes



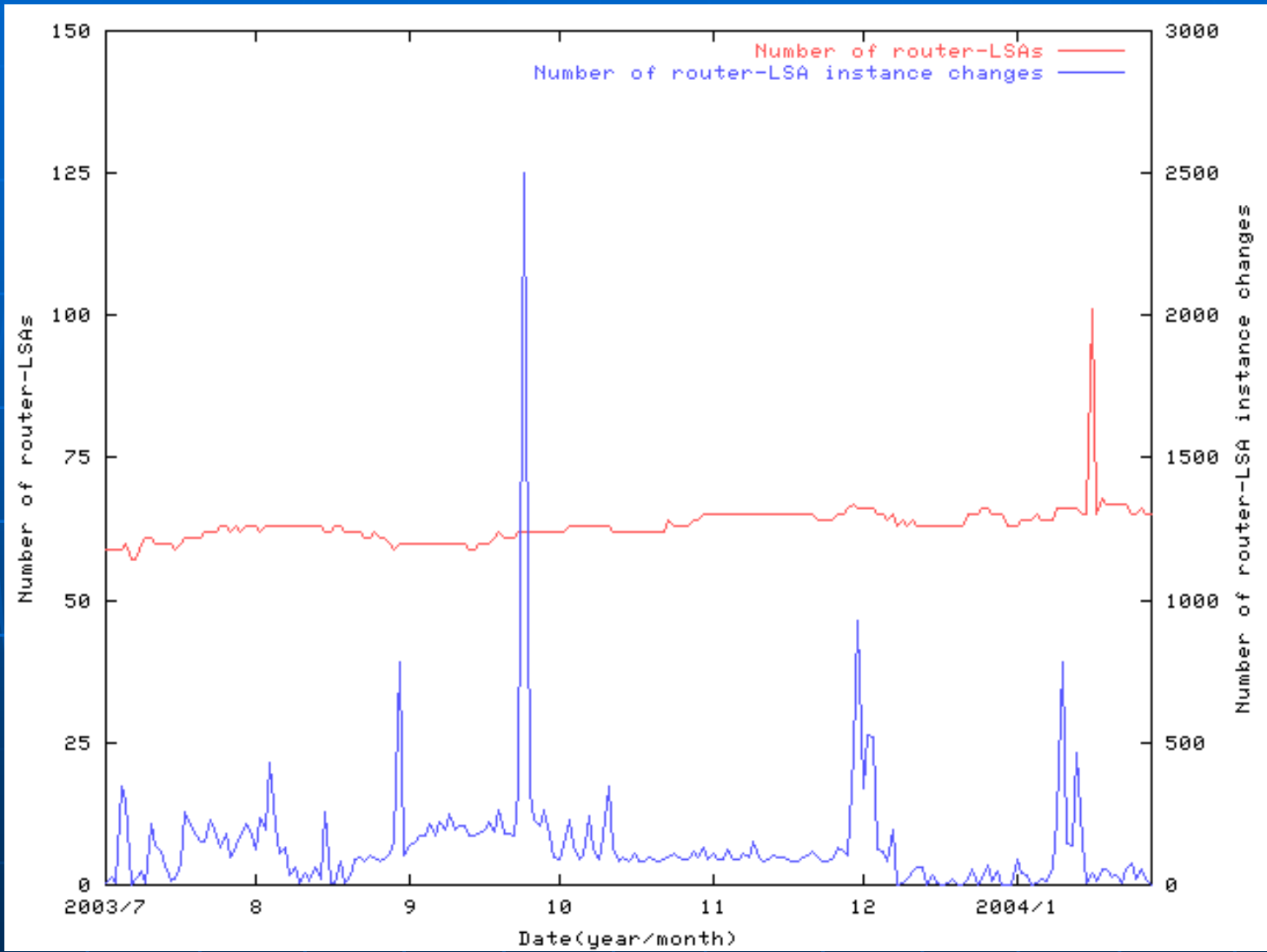
- Relatively frequent changes
  - A router in SF, lasted for 5 months (10/23/03-4/1/04)
    - Considered due to a switch problem

Long-Term Changes (Cont'd)



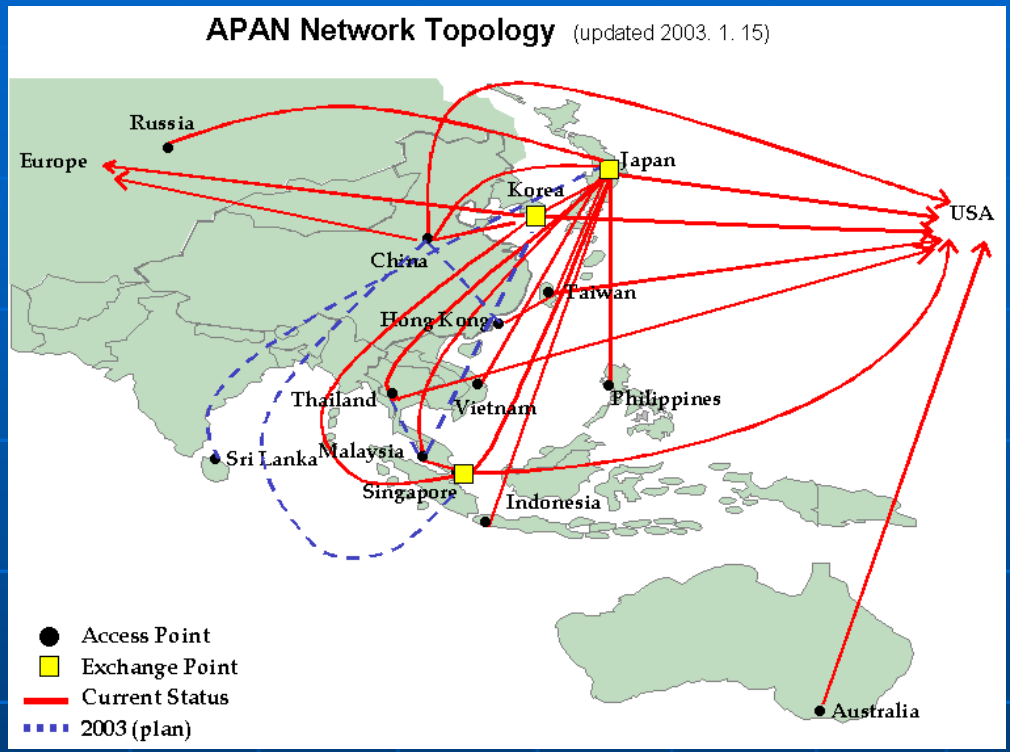
- Slow changes
  - A router in Kyoto, has persisted since this March
- Some of them were caused by interface problems

The Case of OSPFv3



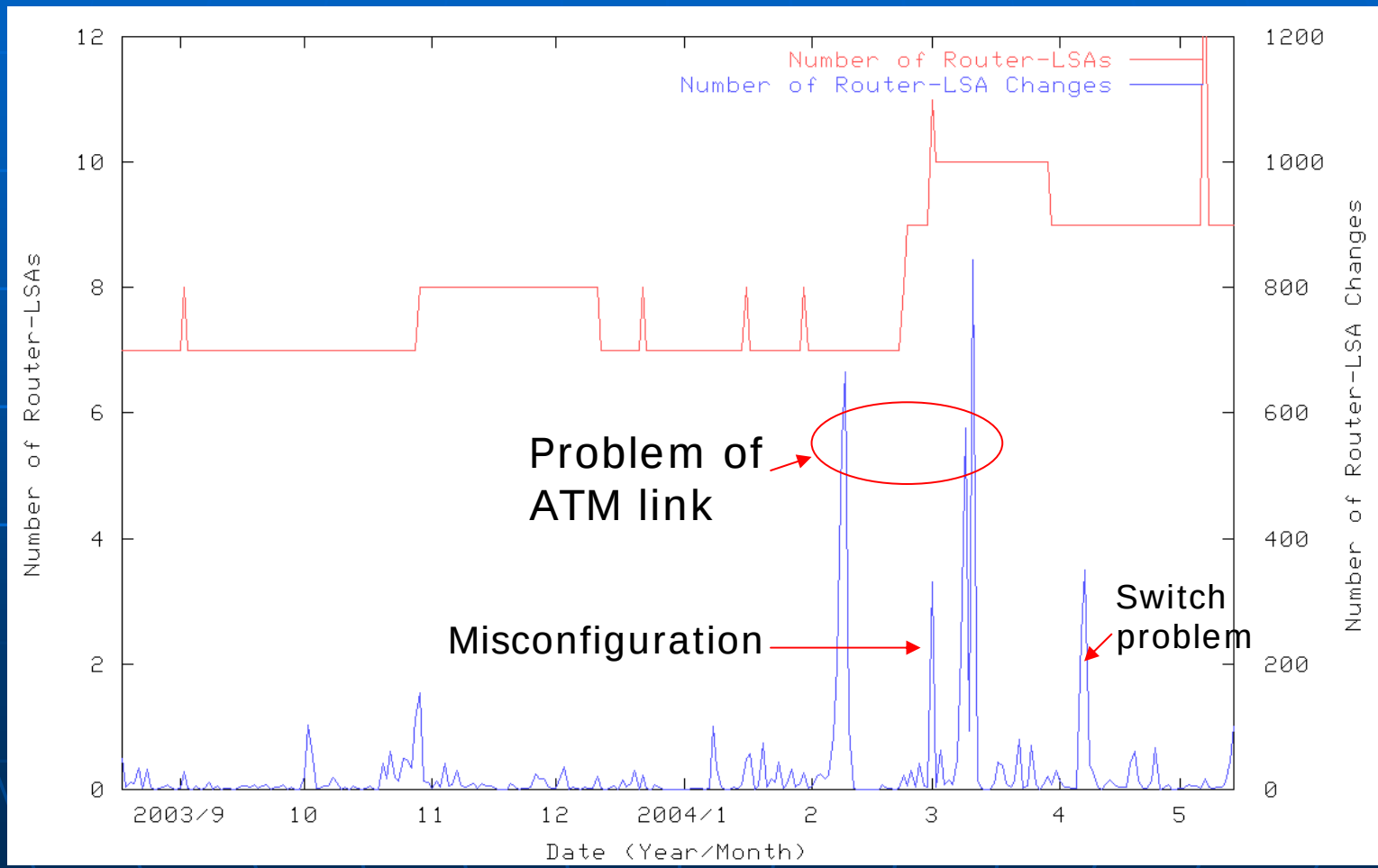
Period: July 2003 – January 2004

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)



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

Acknowledgements

- My thanks to
  - WIDE Project and Nara Institute of Science and Technology
  - Operators of APAN Tokyo-XP network
  - Prof. Youki Kadobayashi for the idea on troubleshooting

- 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
  - zhang@koganei.wide.ad.jp

Thank you!