Network Management & Monitoring

NetFlow Overview

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Agenda

Netflow

- What it is and how it works
- Uses and Applications

Flow-tools

- Architectural issues
- Software, tools etc

Lab

Network Flows

- Packets or frames that have a common attribute.
- Creation and expiration policy – what conditions start and stop a flow.
- Counters – packets, bytes, time.
- Routing information – AS, network mask, interfaces.

Cisco's Definition of a Flow

Unidirectional sequence of packets sharing

1. Source IP address
2. Destination IP address
3. Source port for UDP or TCP, 0 for other protocols
4. Destination port for UDP or TCP, type and code for ICMP, or 0 for other protocols
5. IP protocol
6. Ingress interface (SNMP ifIndex)
7. IP Type of Service

Network Flows

- Unidirectional or bidirectional.
- Bidirectional flows can contain other information such as round trip time, TCP behavior.
- Application flows look past the headers to classify packets by their contents.
- Aggregated flows – flows of flows.

Working with Flows

- Generate the flows from device (usually a router)
- Export flows from the device to collector
  - Configure version of flows
  - Sampling rates
- Collect the flows
  - Tools to Collect Flows - Flow-tools
- Analyze them
  - More tools available, can write your own

Flow Descriptors

- A Key with more elements will generate more flows.
- Greater number of flows equals:
  - More post processing time to generate reports
  - more memory and CPU requirements for device generating flows
  - More storage needed on the flow processing server
- Depends on application. Traffic engineering vs. intrusion detection.

Flow Accounting

- Accounting information accumulated with flows.
- Packets, Bytes, Start Time, End Time.
- Network routing information – masks and autonomous system number.

Flow Generation/Collection

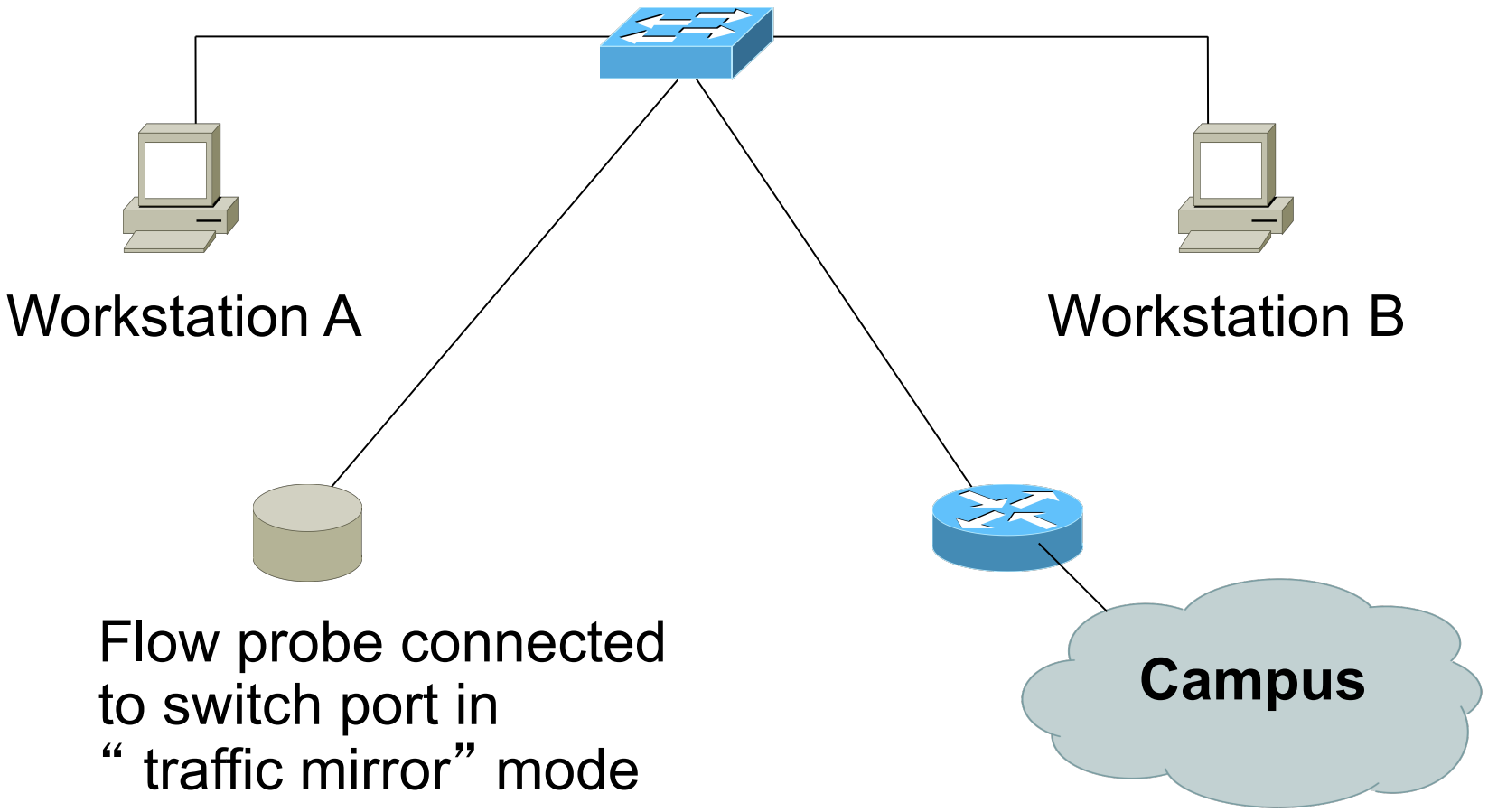
Passive monitor

- A passive monitor (usually a Unix host) receives all data and generates flows.
- Resource intensive

Router or other existing network device

- Router or other existing devices like switch, generate flows.
- Sampling is possible
- Nothing new needed

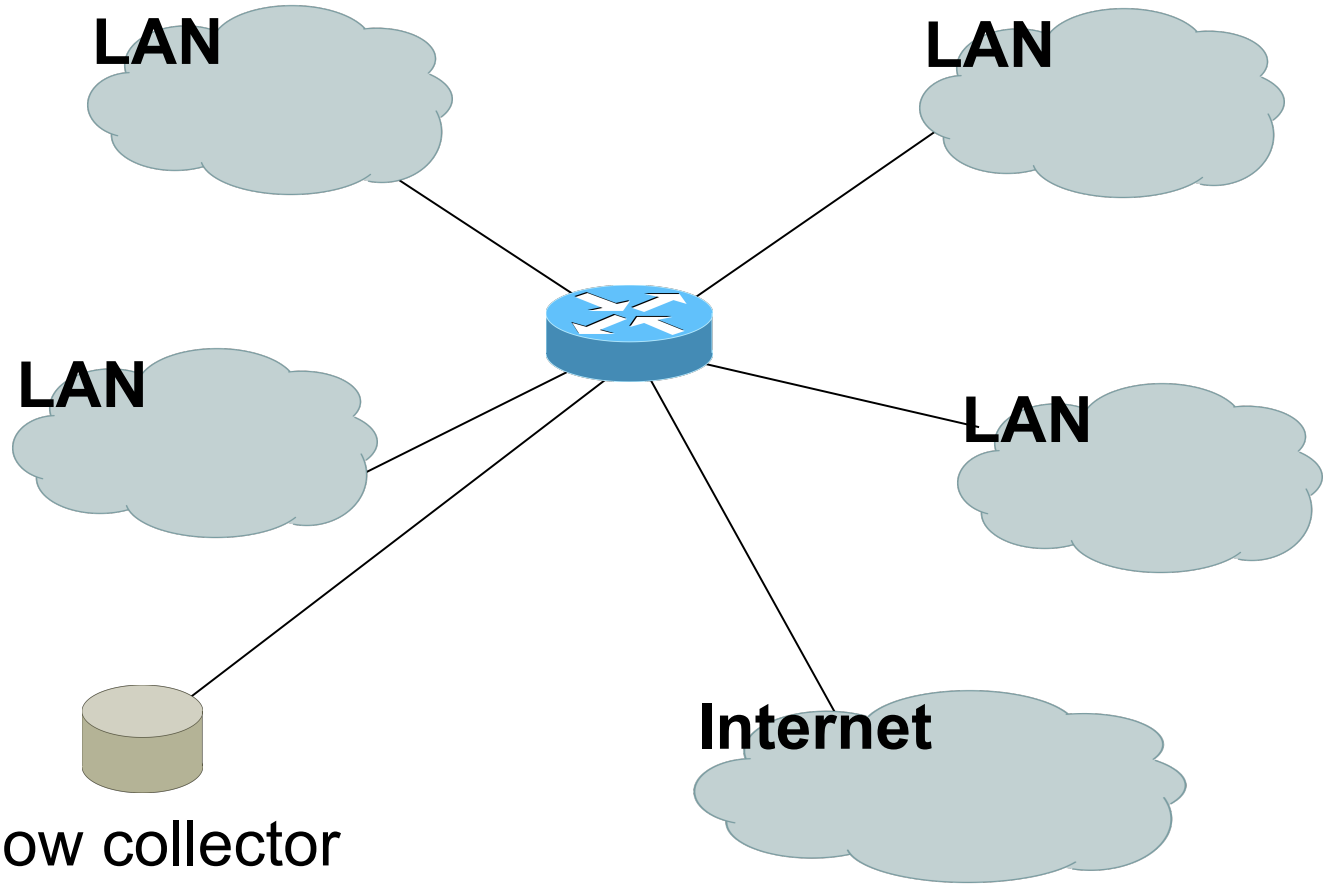
Passive Monitor Collection



Passive Collector

- Using passive collection, not all flows in the network will be seen as opposed to collection from the router
- The collector will only see flows from the network point it is connected on
- However this method does relieve the router from processing netflows and exporting them
- Useful on links with only one entry into the network or where only flows from one section of the network are needed

Router Collection



Flow collector
stores exported flows from router.

Router Collection

- With this method, all flows in the network can be observed
- However, more work for the router in processing and exporting the flows
- Optionally, one can choose on which interfaces netflow collection is needed and not activate it on others
- Also, if there is a router on each LAN, netflow can be activated on those routers to reduce the load on the core router

Cisco NetFlow

- Unidirectional flows.
- IPv4 unicast and multicast.
- Aggregated and unaggregated.
- Flows exported via UDP.
- Supported on IOS and CatOS platforms.
- Catalyst NetFlow is different implementation.

Cisco NetFlow Versions

- 4 Unaggregated types (1,5,6,7).
- 14 Aggregated types (8.x, 9).
- Each version has its own packet format.
- Version 1 does not have sequence numbers – no way to detect lost flows.
- The “version” defines what type of data is in the flow.
- Some versions specific to Catalyst platform.

NetFlow Version 1

- Key fields: Source/Destination IP, Source/Destination Port, IP Protocol, ToS, Input interface.
- Accounting: Packets, Octets, Start/End time, Output interface
- Other: Bitwise OR of TCP flags.
- Obsolete

NetFlow Versions 2-4

- Cisco internal
- Were never released

NetFlow v5

- Key fields: Source/Destination IP, Source/Destination Port, IP Protocol, ToS, Input interface.
- Accounting: Packets, Octets, Start/End time, Output interface.
- Other: Bitwise OR of TCP flags, Source/Destination AS and IP Mask.
- Packet format adds sequence numbers for detecting lost exports.
- IPv4 only

NetFlow v8

- Aggregated v5 flows.
- Not all flow types available on all equipments
- Much less data to post process, but loses fine granularity of v5 – no IP addresses.

NetFlow v9

- IPv6 support
- Additional fields like MPLS labels
- Builds on earlier versions

Cisco IOS Configuration

- Configured on each input interface.
- Define the version.
- Define the IP address of the collector (where to send the flows).
- Optionally enable aggregation tables.
- Optionally configure flow timeout and main (v5) flow table size.
- Optionally configure sample rate.

Cisco IOS Configuration

```
ip flow-top-talkers
 top 10
 sort-by bytes
```

```
gw-169-223-2-0#sh ip flow top-talkers

SrcIf         SrcIPaddress    DstIf         DstIPaddress    Pr SrcP DstP Bytes
Fa0/1         169.223.2.2     Fa0/0         169.223.11.33   06 0050 0B64  3444K
Fa0/1         169.223.2.2     Fa0/0         169.223.11.33   06 0050 0B12  3181K
Fa0/0         169.223.11.33   Fa0/1         169.223.2.2     06 0B12 0050    56K
Fa0/0         169.223.11.33   Fa0/1         169.223.2.2     06 0B64 0050    55K
Fa0/1         169.223.2.2     Local         169.223.2.1     01 0000 0303    18K
Fa0/1         169.223.2.130   Fa0/0         64.18.197.134   06 9C45 0050    15K
Fa0/1         169.223.2.130   Fa0/0         64.18.197.134   06 9C44 0050    12K
Fa0/0         213.144.138.195 Fa0/1         169.223.2.130   06 01BB DC31  7167
Fa0/0         169.223.15.102  Fa0/1         169.223.2.2     06 C917 0016  2736
Fa0/1         169.223.2.2     Local         169.223.2.1     06 DB27 0016  2304
10 of 10 top talkers shown. 49 flows processed.
```

Cisco Command Summary

- Enable CEF (done by default)
  - `ip cef`
- Enable flow on each interface

```
ip route cache flow
OR
ip flow ingress
ip flow egress
```

- View flows
  - `show ip cache flow`
  - `show ip flow top-talkers`

Cisco Command Summary

- Exporting Flows to a collector

```
ip flow-export version 5 [origin-as|peer-as]
ip flow-export destination x.x.x.x <udp-port>
```

- Origin AS will include the origin AS Number in the flow while Peer AS will only include the AS Number of the peering neighbor
- Exporting aggregated flows

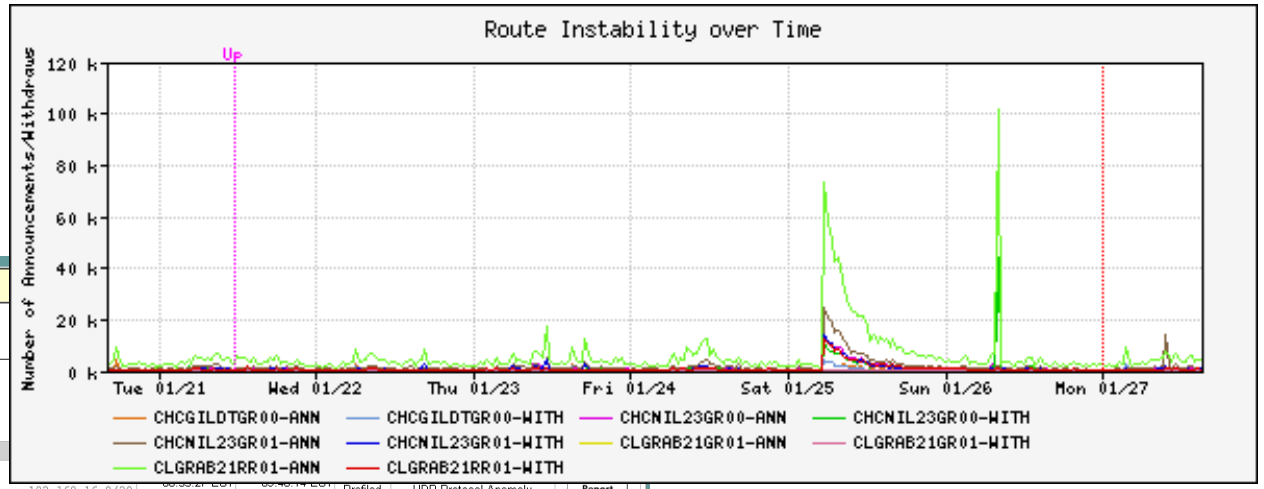
```
ip flow-aggregation cache as|prefix|dest|source|proto
  enabled
  export destination x.x.x.x <udp-port>
```

Flows and Applications

Uses for NetFlow

- Problem identification / solving
  - Traffic classification
  - DoS Traceback (some slides by Danny McPherson)
- Traffic Analysis and Engineering
  - Inter-AS traffic analysis
  - Reporting on application proxies
- Accounting (or billing)
  - Cross verification from other sources
  - Can cross-check with SNMP data

Detect Anomalous Events: SQL “Slammer” Worm*



peakflow DoS

Recent Anomalies : Anomaly 125772 : Detailed Statistics

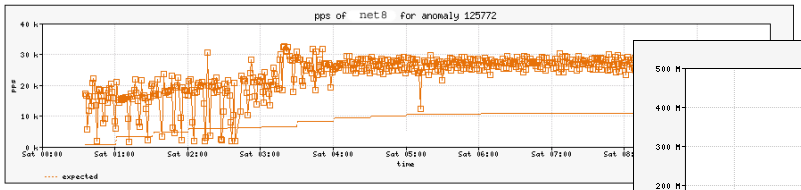
11:51:49 EST 27 Jan 2003

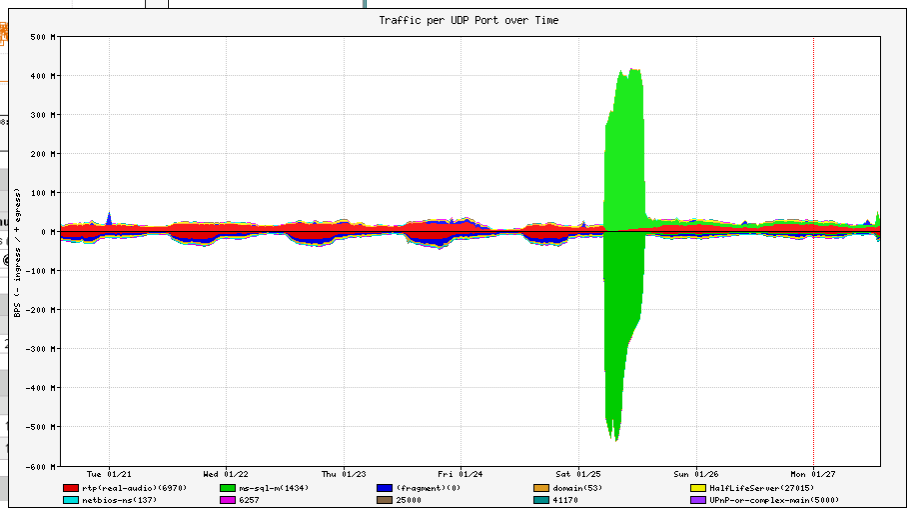
Status | Topology | Ongoing | Recent | Dark IP | Admin | About

Anomaly 125772 Detailed Statistics

ID	Importance	Severity	Duration	Direction
125772	High	958.2% of 3.40 Kpps	09h 06m 47s	Outgoing

192.168.16.0/20 members_misc_nets	25 Jan 2003	25 Jan 2003	Profiled	UDP Protocol Anomaly	Report





Affected Network Elements

Router net8 1.2.3.4

	Triggering	Expected	Difference	Maximu
Bitrate	71.69 Mbps	2.34 Mbps	69.35 Mbps	105.26 Mbps
Packet Rate	22.20 Kpps	712 pps	21.49 Kpps	32.58 Kpps

Summary | Source Addresses | Destination Addresses | Source Ports | Destination Ports | Protocols | Output Interfaces | Input Interfaces | Generate Filter

Summary of all Data Snapshots Collected:

	Bytes	Packets	Bytes/Pkt	bps
	308.01 GB	762,849,500	404 B	76.05 Mbps

Summary | Source Addresses | Destination Addresses | Source Ports | Destination Ports | Protocols | Output Interfaces | Input Interfaces | Generate Filter

Source Addresses

Network / Mask	Bytes	▼Packets	Bytes/Pkt	bps
192.168.20.217/32	168.22 GB	416,436,800	404 B	41.54 Mbps
192.168.18.187/32	139.53 GB	345,372,800	404 B	34.45 Mbps

Summary | Source Addresses | Destination Addresses | Source Ports | Destination Ports | Protocols | Output Interfaces | Input Interfaces | Generate Filter

Destination Addresses

Flow-based Detection (cont)*

Once baselines are built anomalous activity can be detected

- Pure **rate-based** (pps or bps) anomalies may be legitimate or
  malicious
- Many **misuse** attacks can be immediately recognized, even **without** baselines (e.g., TCP SYN or RST floods)
- **Signatures** can also be defined to identify "interesting" transactional data (e.g., proto udp and port 1434 and 404 octets(376 payload) == slammer!)
- Temporal compound signatures can be defined to detect with higher precision

Flow-based Commercial Tools…*

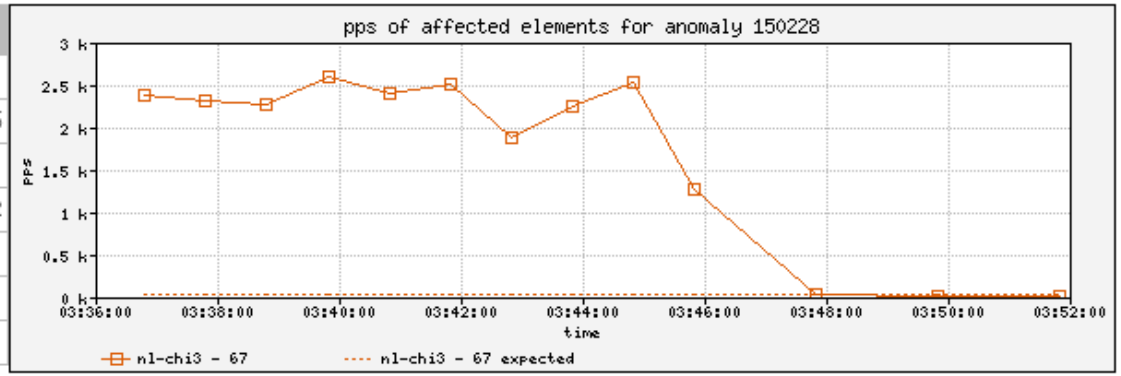
Anomaly 150228

Get Report: PDF XML

ID	Importance	Duration	Start Time	Direction	Type	Resource
150228	High 130.0% of 2 Kpps	17 mins	03:34, Aug 16	Incoming	Bandwidth (Profiled)	Microsoft 207.46.0.0/16 windowsupdate.com

Traffic Characterization

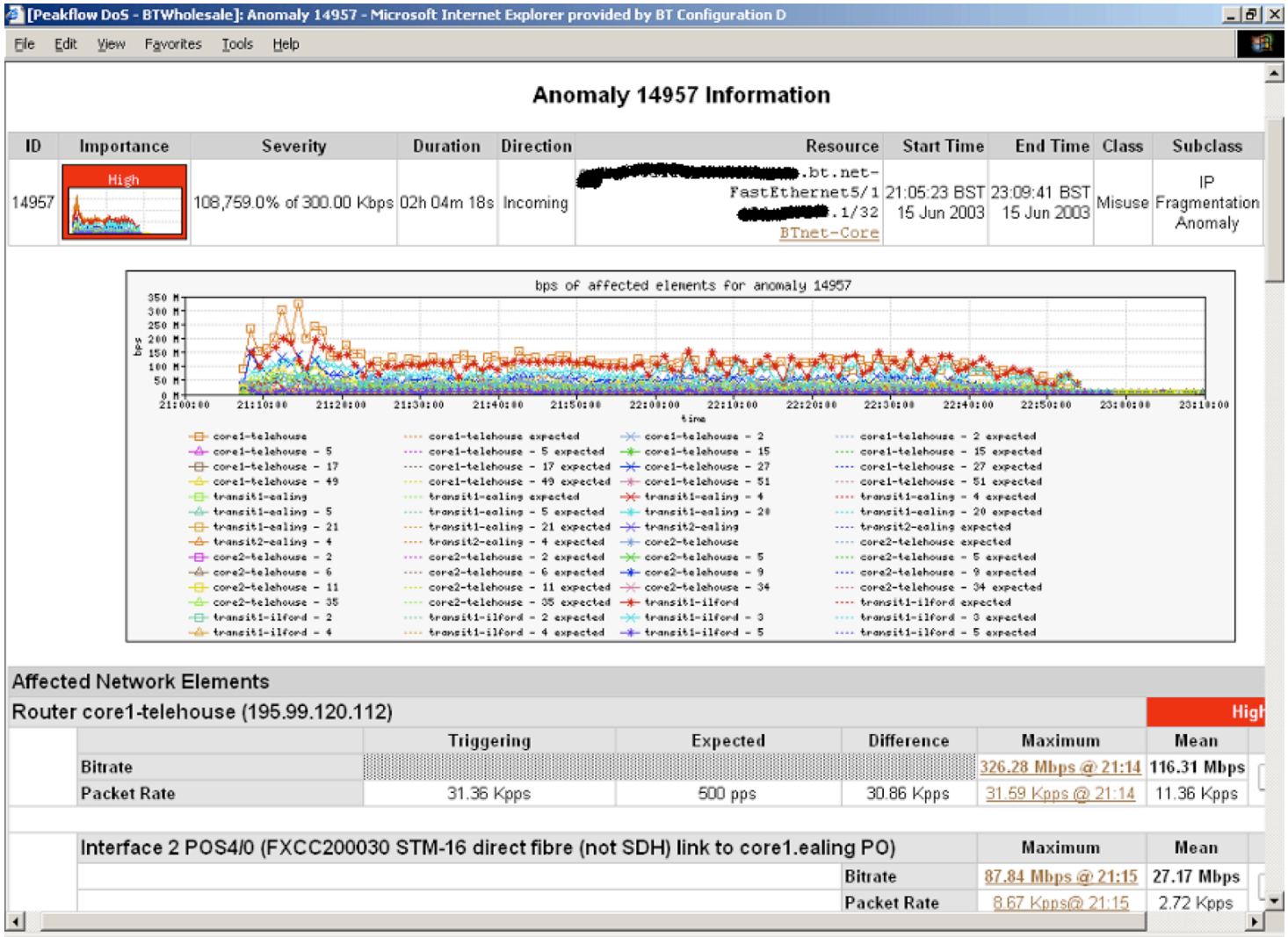
Sources	204.38.130.0/24
	204.38.130.192/26
	1024 - 1791
Destination	207.46.248.234/32
	80 (http)
Protocols	tcp (6)
TCP Flags	S (0x02)



Affected Network Elements	Importance	Expected pps	Observed bps Max	Observed bps Mean	Observed pps Max	Observed pps Mean	
Router nl-chi3 198.110.131.125	High						
Interface 67 at-1/1/0.14 *pvc to WMU*		26	832 K	563.1 K	2.6 K	1.7 K	Details

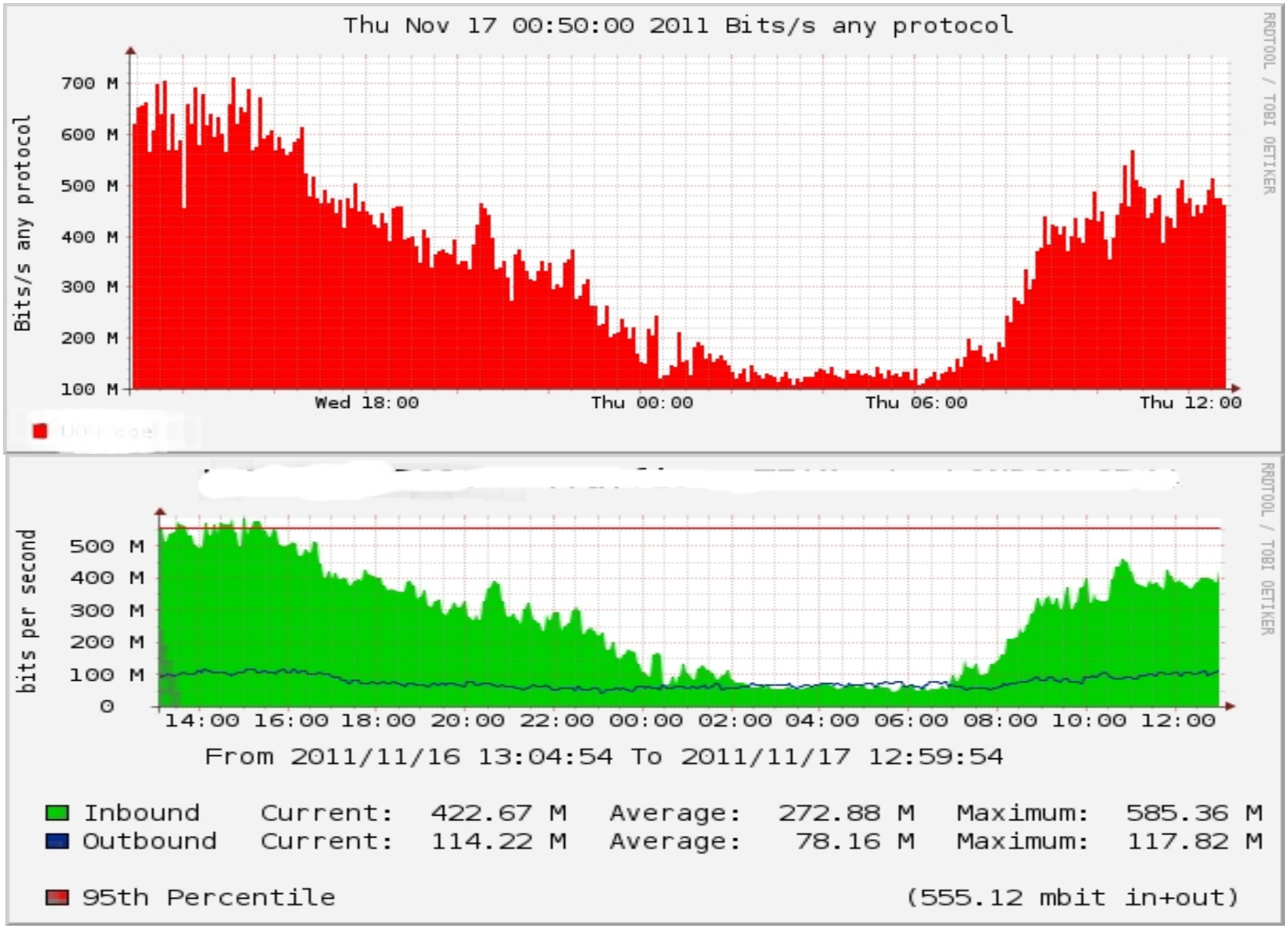
Anomaly Comments

Commercial Detection: A Large Scale DOS Attack



Accounting

Flow based accounting can be a good supplement to SNMP based accounting.


Thu Nov 17 00:50:00 2011 Bits/s any protocol
Bits/s any protocol
700 M
600 M
500 M
400 M
300 M
200 M
100 M
Wed 18:00
Thu 00:00
Thu 06:00
Thu 12:00
RRDTOOL / TOBI OETIKER
bits per second
500 M
400 M
300 M
200 M
100 M
0
14:00 16:00 18:00 20:00 22:00 00:00 02:00 04:00 06:00 08:00 10:00 12:00
From 2011/11/16 13:04:54 To 2011/11/17 12:59:54
Inbound Current: 422.67 M Average: 272.88 M Maximum: 585.36 M
Outbound Current: 114.22 M Average: 78.16 M Maximum: 117.82 M
95th Percentile (555.12 mbit in+out)
RRDTOOL / TOBI OETIKER

References

- flow-tools:
  http://www.splintered.net/sw/flow-tools
- WikiPedia:
  http://en.wikipedia.org/wiki/Netflow
- NetFlow Applications

  http://www.inmon.com/technology/netflowapps.php
- Netflow HOW-TO
  http://www.linuxgeek.org/netflow-howto.php
- IETF standards effort:
  http://www.ietf.org/html.charters/ipfix-charter.html

References

- Abilene NetFlow page
  http://abilene-netflow.itec.oar.net/
- Flow-tools mailing list:
  flow-tools@splintered.net
- Cisco Centric Open Source Community
  http://cosi-nms.sourceforge.net/related.html
- Cisco NetFlow Collector User Guide
  http://www.cisco.com/en/US/docs/net_mgmt/netflow_collection_engine/6.0/tier_one/user/guide/user.html