Flow-tools Tutorial

Mark Fullmer
maf@splintered.net

Agenda

- Network flows
- Cisco / Juniper implementation – NetFlow
- Cisco / Juniper Configuration
- flow-tools programs overview and examples from Abilene and Ohio-Gigapop

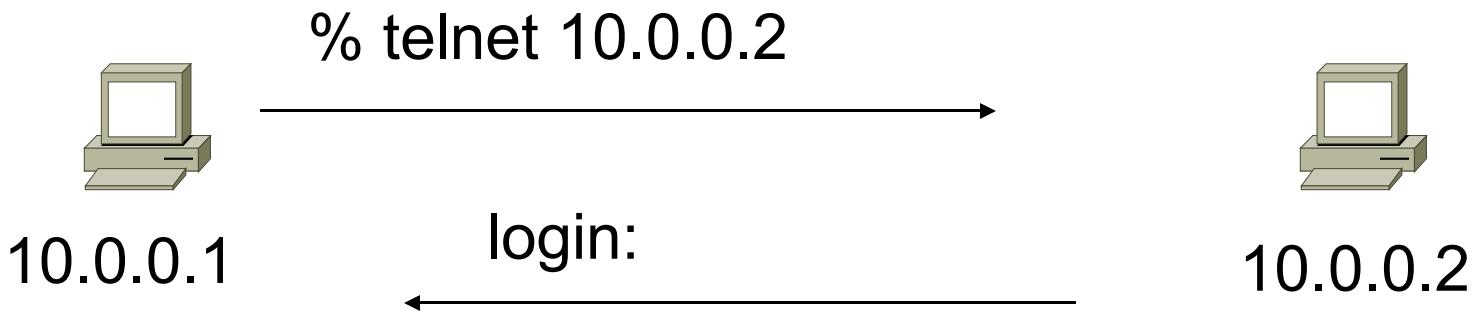
Network Flows

- 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.

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.

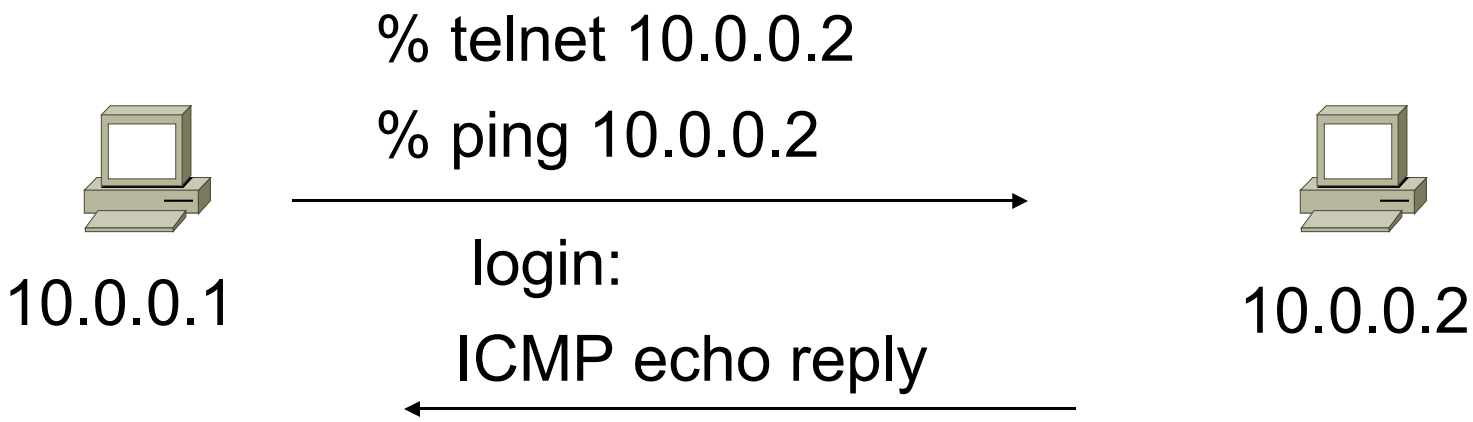
Unidirectional Flow with Source/Destination IP Key



Active Flows

Flow	Source IP	Destination IP
1	10.0.0.1	10.0.0.2
2	10.0.0.2	10.0.0.1

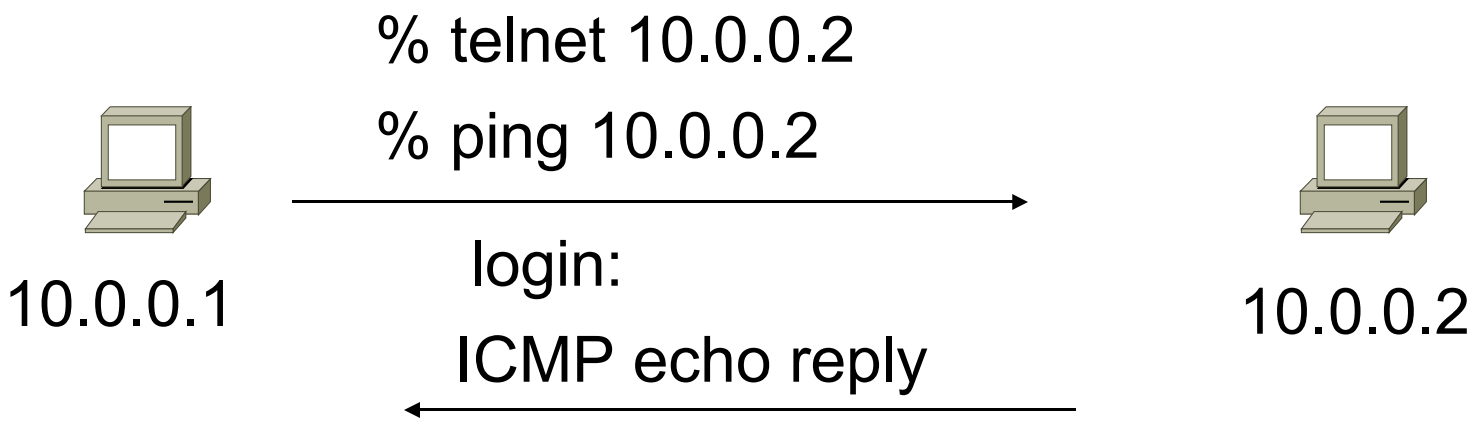
Unidirectional Flow with Source/Destination IP Key



Active Flows

Flow	Source IP	Destination IP
1	10.0.0.1	10.0.0.2
2	10.0.0.2	10.0.0.1

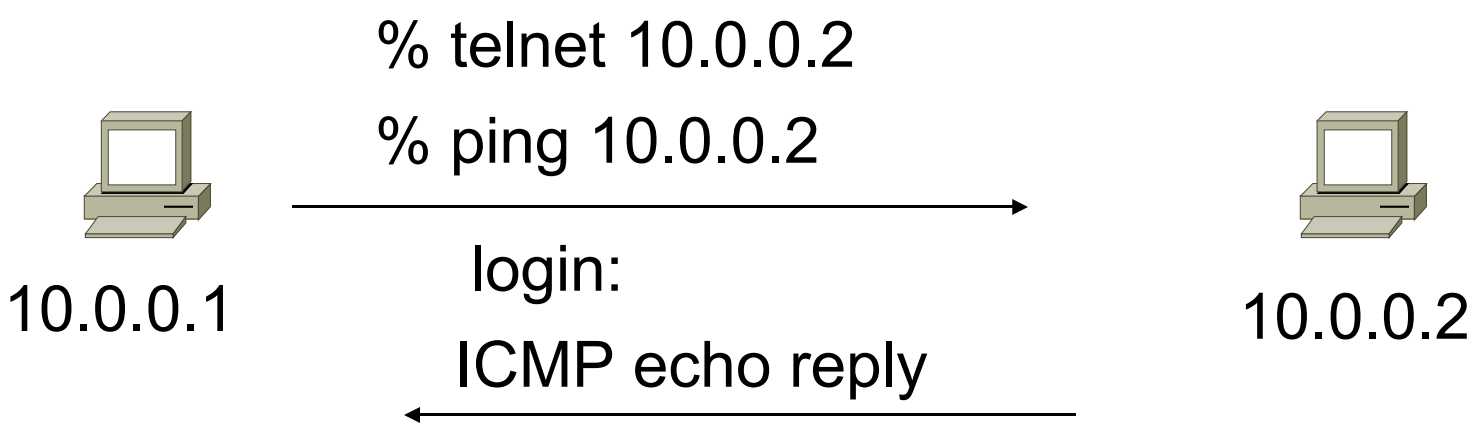
Unidirectional Flow with IP, Port,Protocol Key



Active Flows

Flow	Source IP	Destination IP	prot	srcPort	dstPort
1	10.0.0.1	10.0.0.2	TCP	32000	23
2	10.0.0.2	10.0.0.1	TCP	23	32000
3	10.0.0.1	10.0.0.2	ICMP	0	0

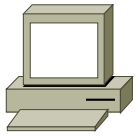
Bidirectional Flow with IP, Port,Protocol Key



Active Flows

Flow	Source IP	Destination IP	prot	srcPort	dstPort
1	10.0.0.1	10.0.0.2	TCP	32000	23
2	10.0.0.1	10.0.0.2	ICMP	0	0

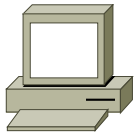
Application Flow



10.0.0.1

% netscape http://10.0.0.2/9090

Web server on Port 9090



10.0.0.2

Content-type:

Active Flows

Flow	Source IP	Destination IP	Application
1	10.0.0.1	10.0.0.2	HTTP

Aggregated Flow

Main Active flow table

Flow	Source IP	Destination IP	prot	srcPort	dstPort
1	10.0.0.1	10.0.0.2	TCP	32000	23
2	10.0.0.2	10.0.0.1	TCP	23	32000
3	10.0.0.1	10.0.0.2	ICMP	0	0
4	10.0.0.2	10.0.0.1	ICMP	0	0

Source/Destination IP Aggregate

Flow	Source IP	Destination IP
1	10.0.0.1	10.0.0.2
2	10.0.0.2	10.0.0.1

Flow Descriptors

- A Key with more elements will generate more flows.
- Greater number of flows leads to more post processing time to generate reports, more memory and CPU requirements for device generating flows.
- Depends on application. Traffic engineering vs. intrusion detection.

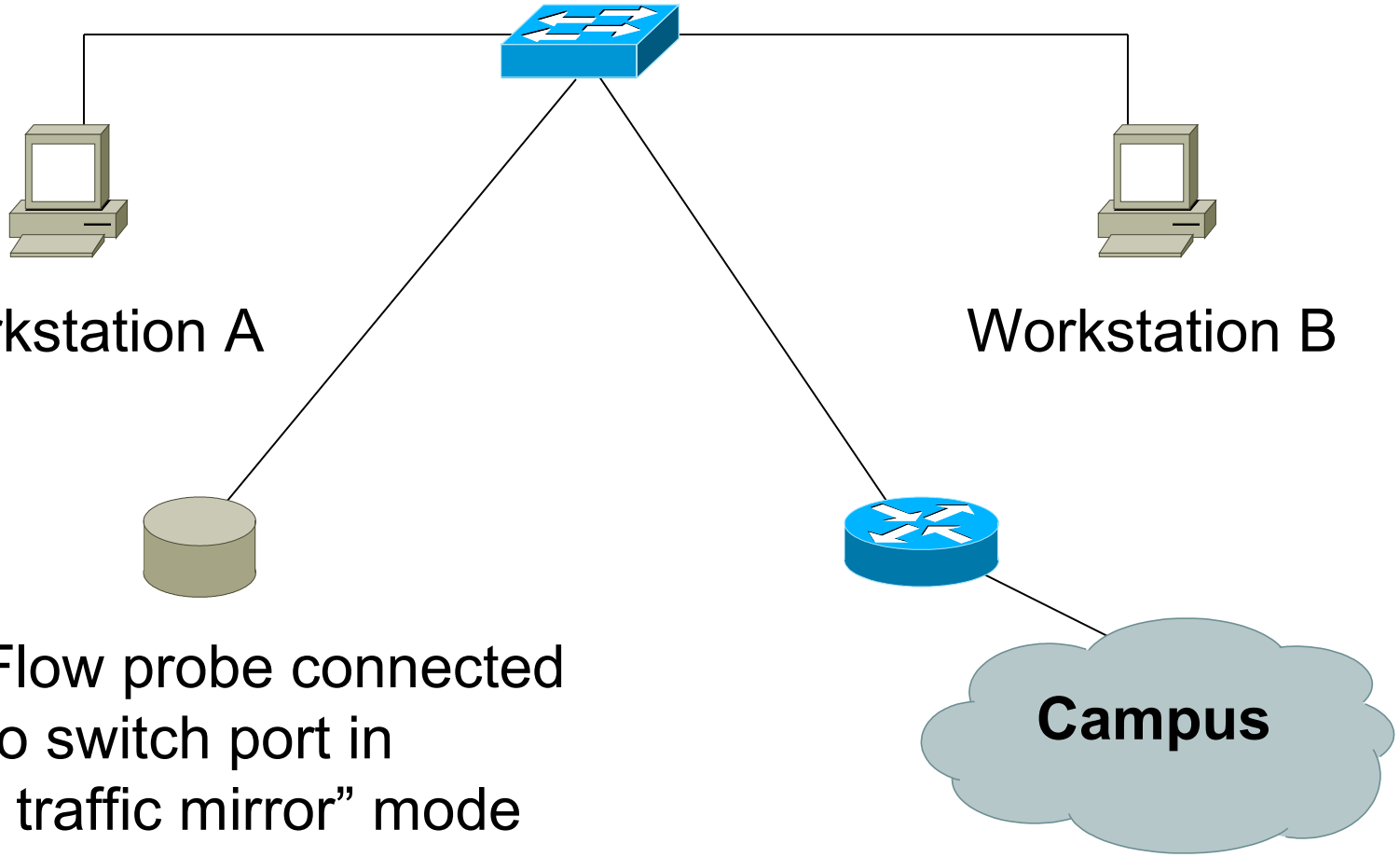
Flow Accounting

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

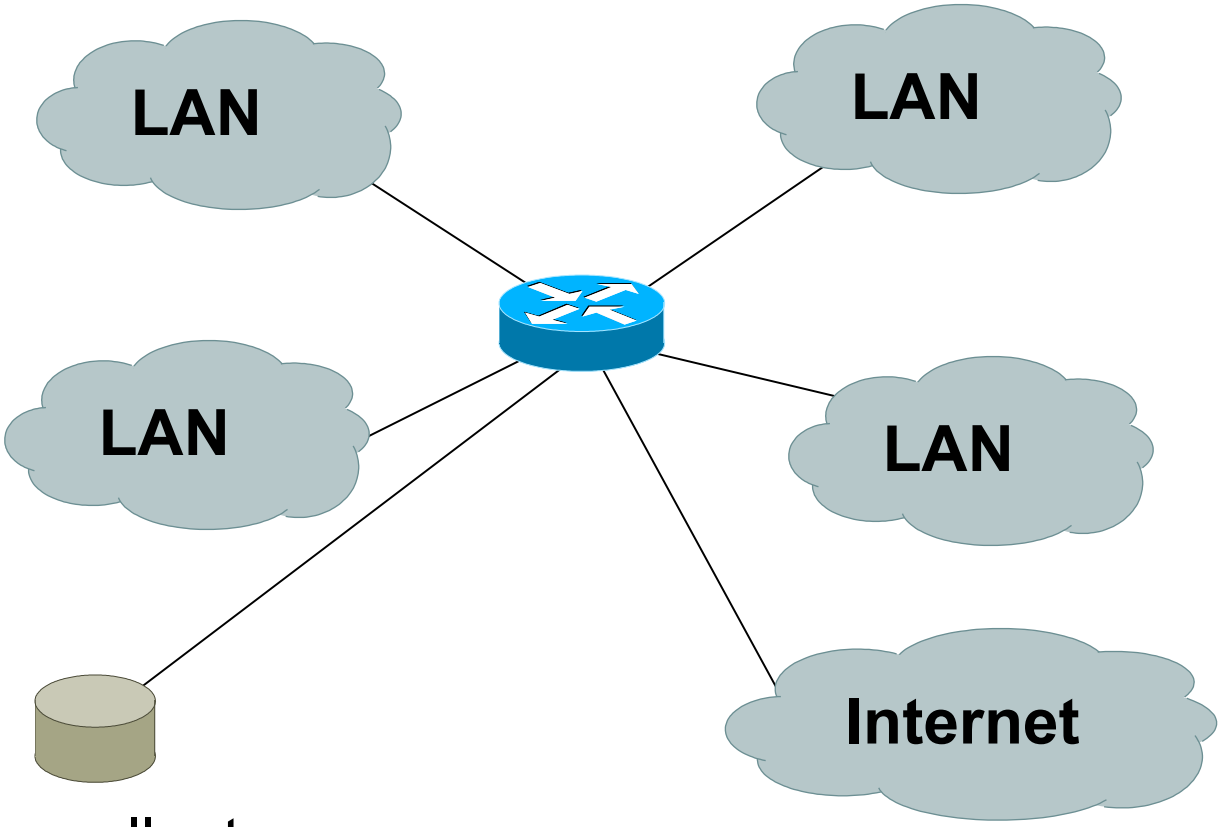
Flow Collection

- Passive monitor.
- Router other existing network device.

Passive Monitor Collection



Router Collection



Flow collector
stores exported flows from router.

Passive Monitor

- Directly connected to a LAN segment via a switch port in “mirror” mode, optical splitter, or repeated segment.
- Generate flows for all local LAN traffic.
- Must have an interface or monitor deployed on each LAN segment.
- Support for more detailed flows – bidirectional and application.

Router Collection

- Router will generate flows for traffic that is directed to the router.
- Flows are not generated for local LAN traffic.
- Limited to “simple” flow criteria (packet headers).
- Generally easier to deploy – no new equipment.

Cisco NetFlow

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

Cisco NetFlow Versions

- 4 Unaggregated types (1,5,6,7).
- 14 Aggregated types (8.x).
- 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 v1

- 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.

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.

NetFlow v8

- Aggregated v5 flows.
- 3 Catalyst 65xx specific that correspond to the configurable flow mask.
- Much less data to post process, but lose fine granularity of v5 – no IP addresses.

NetFlow v8

- AS
- Protocol/Port
- Source Prefix
- Destination Prefix
- Prefix
- Destination (Catalyst 65xx)
- Source/Destination (Catalyst 65xx)
- Full Flow (Catalyst 65xx)

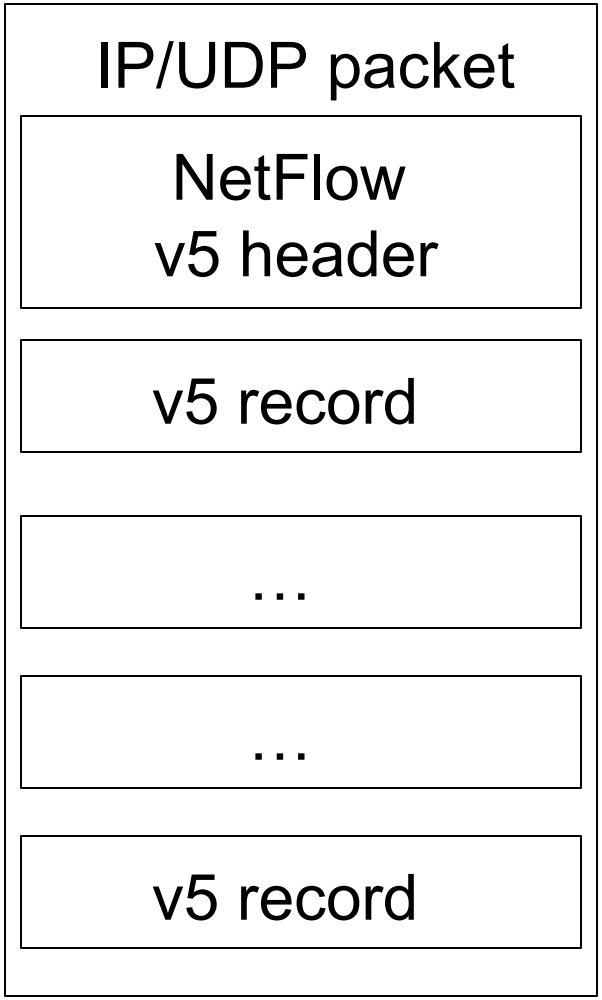
NetFlow v8

- ToS/AS
- ToS/Protocol/Port
- ToS/Source Prefix
- ToS/Destination Prefix
- Tos/Source/Destination Prefix
- ToS/Prefix/Port

NetFlow Packet Format

- Common header among export versions.
- All but v1 have a sequence number.
- Version specific data field where N records of data type are exported.
- N is determined by the size of the flow definition. Packet size is kept under ~1480 bytes. No fragmentation on Ethernet.

NetFlow v5 Packet Example



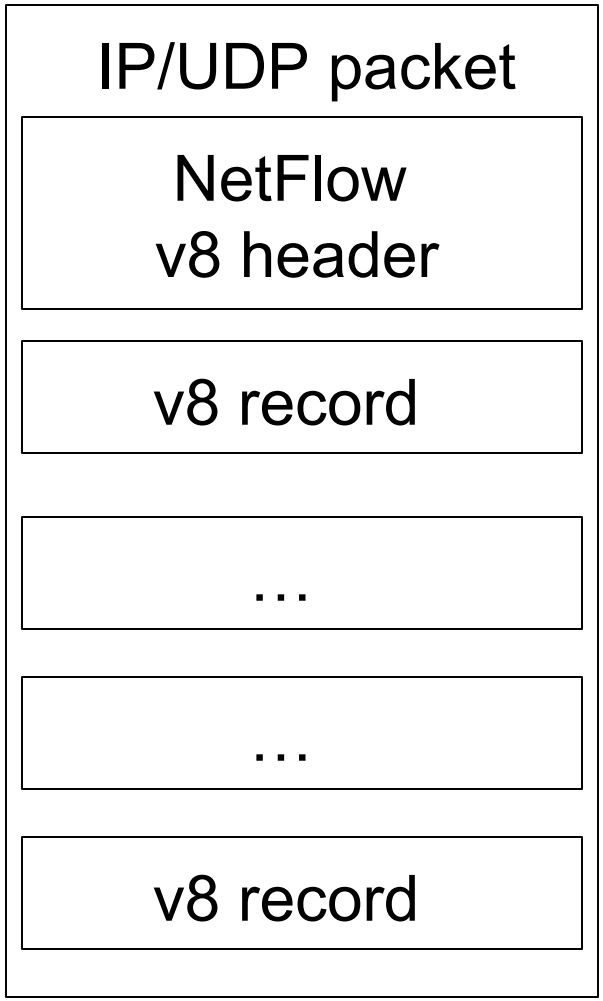
NetFlow v5 Packet (Header)

```
struct ftpdu_v5 {
  /* 24 byte header */
  u_int16 version;       /* 5 */
  u_int16 count;         /* The number of records in the PDU */
  u_int32 sysUpTime;     /* Current time in millisecs since router booted */
  u_int32 unix_secs;     /* Current seconds since 0000 UTC 1970 */
  u_int32 unix_nsecs;    /* Residual nanoseconds since 0000 UTC 1970 */
  u_int32 flow_sequence; /* Seq counter of total flows seen */
  u_int8  engine_type;   /* Type of flow switching engine (RP,VIP,etc.) */
  u_int8  engine_id;     /* Slot number of the flow switching engine */
  u_int16 reserved;
```

NetFlow v5 Packet (Records)

```
/* 48 byte payload */
 struct ftrec_v5 {
   u_int32 srcaddr;    /* Source IP Address */
   u_int32 dstaddr;    /* Destination IP Address */
   u_int32 nexthop;    /* Next hop router's IP Address */
   u_int16 input;      /* Input interface index */
   u_int16 output;     /* Output interface index */
   u_int32 dPkts;      /* Packets sent in Duration */
   u_int32 dOctets;    /* Octets sent in Duration. */
   u_int32 First;      /* SysUptime at start of flow */
   u_int32 Last;       /* and of last packet of flow */
   u_int16 srcport;    /* TCP/UDP source port number or equivalent */
   u_int16 dstport;    /* TCP/UDP destination port number or equiv */
   u_int8  pad;
   u_int8  tcp_flags;  /* Cumulative OR of tcp flags */
   u_int8  prot;       /* IP protocol, e.g., 6=TCP, 17=UDP, ... */
   u_int8  tos;        /* IP Type-of-Service */
   u_int16 src_as;     /* originating AS of source address */
   u_int16 dst_as;     /* originating AS of destination address */
   u_int8  src_mask;   /* source address prefix mask bits */
   u_int8  dst_mask;   /* destination address prefix mask bits */
   u_int16 drops;
 } records[FT_PDU_V5_MAXFLOWS];
```

NetFlow v8 Packet Example (AS Aggregation)



NetFlow v8 AS agg. Packet

```
struct ftpdu_v8_1 {
  /* 28 byte header */
  u_int16 version;        /* 8 */
  u_int16 count;          /* The number of records in the PDU */
  u_int32 sysUpTime;      /* Current time in millisecs since router booted */
  u_int32 unix_secs;      /* Current seconds since 0000 UTC 1970 */
  u_int32 unix_nsecs;     /* Residual nanoseconds since 0000 UTC 1970 */
  u_int32 flow_sequence; /* Seq counter of total flows seen */
  u_int8  engine_type;    /* Type of flow switching engine (RP,VIP,etc.) */
  u_int8  engine_id;      /* Slot number of the flow switching engine */
  u_int8  aggregation;    /* Aggregation method being used */
  u_int8  agg_version;    /* Version of the aggregation export */
  u_int32 reserved;
  /* 28 byte payload */
  struct ftrec_v8_1 {
    u_int32 dFlows;      /* Number of flows */
    u_int32 dPkts;       /* Packets sent in duration */
    u_int32 dOctets;     /* Octets sent in duration */
    u_int32 First;       /* SysUpTime at start of flow */
    u_int32 Last;        /* and of last packet of flow */
    u_int16 src_as;      /* originating AS of source address */
    u_int16 dst_as;      /* originating AS of destination address */
    u_int16 input;       /* input interface index */
    u_int16 output;      /* output interface index */
  } records[FT_PDU_V8_1_MAXFLOWS];
```

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

```
interface FastEthernet0/0/0
 ip address 10.0.0.1 255.255.255.0
 no ip directed-broadcast
 ip route-cache flow

interface ATM1/0/0
 no ip address
 no ip directed-broadcast
 ip route-cache flow

interface Loopback0
 ip address 10.10.10.10 255.255.255.255
 no ip directed-broadcast

ip flow-export version 5 origin-as
ip flow-export destination 10.0.0.10 5004
ip flow-export source loopback 0

ip flow-aggregation cache prefix
 export destination 10.0.0.10 5555
 enabled
```

Cisco IOS Configuration

```
krc4#sh ip flow export
Flow export is enabled
  Exporting flows to 10.0.0.10 (5004)
  Exporting using source IP address 10.10.10.10
  Version 5 flow records, origin-as
  Cache for prefix aggregation:
    Exporting flows to 10.0.0.10 (5555)
    Exporting using source IP address 10.10.10.10
  3176848179 flows exported in 105898459 udp datagrams
  0 flows failed due to lack of export packet
  45 export packets were sent up to process level
  0 export packets were punted to the RP
  5 export packets were dropped due to no fib
  31 export packets were dropped due to adjacency issues
  0 export packets were dropped due to fragmentation failures
  0 export packets were dropped due to encapsulation fixup failures
  0 export packets were dropped enqueuing for the RP
  0 export packets were dropped due to IPC rate limiting
  0 export packets were dropped due to output drops
```

Cisco IOS Configuration

```
krc4#sho ip ca fl
IP packet size distribution (106519M total packets):
   1-32   64   96  128  160  192  224  256  288  320  352  384  416  448  480
   .002 .405 .076 .017 .011 .010 .007 .005 .004 .005 .004 .004 .003 .002 .002

    512  544  576 1024 1536 2048 2560 3072 3584 4096 4608
   .002 .006 .024 .032 .368 .000 .000 .000 .000 .000 .000

IP Flow Switching Cache, 4456704 bytes
  36418 active, 29118 inactive, 3141073565 added
  3132256745 ager polls, 0 flow alloc failures
  Active flows timeout in 30 minutes
  Inactive flows timeout in 15 seconds
  last clearing of statistics never
Protocol         Total    Flows   Packets Bytes  Packets Active(Sec) Idle(Sec)
--------         Flows     /Sec     /Flow  /Pkt     /Sec     /Flow     /Flow
TCP-Telnet     2951815      0.6        61   216     42.2      26.6      21.4
TCP-FTP       24128311      5.6        71   748    402.3      15.0      26.3
TCP-FTPD       2865416      0.6       916   843    611.6      34.7      19.8
TCP-WWW      467748914    108.9        15   566   1675.8       4.9      21.6
TCP-SMTP      46697428     10.8        14   370    159.6       4.0      20.1
TCP-X           521071      0.1       203   608     24.7      24.5      24.2
TCP-BGP        2835505      0.6         5    94      3.3      16.2      20.7
```

Cisco IOS Configuration

```
krc4#sho ip ca fl

TCP-other    1620253066    377.2         47   631   18001.6       27.3       23.4
UDP-DNS       125622144     29.2          2    78      82.5        4.6       24.7
UDP-NTP        67332976     15.6          1    76      22.0        2.7       23.4
UDP-TFTP          37173      0.0          2    76       0.0        4.1       24.6
UDP-Frag          68421      0.0        474   900       7.5      111.7       21.6
UDP-other     493337764    114.8         17   479    1990.3        3.8       20.2
ICMP          243659509     56.7          3   166     179.7        3.3       23.3
IGMP              18601      0.0         96    35       0.4      941.4        8.1
IPINIP            12246      0.0         69    52       0.1      548.4       15.2
GRE              125763      0.0        235   156       6.9       50.3       21.1
IP-other        75976755     17.6          2    78      45.4        3.9       22.8
Total:       3176854246    739.6         33   619   24797.4       16.2       22.6

SrcIf          SrcIPaddress    DstIf          DstIPaddress    Pr SrcP DstP  Pkts
AT5/0/0.4      206.21.162.150  AT1/0/0.1      141.219.73.45   06 0E4B A029   507
AT4/0/0.10     132.235.174.9   AT1/0/0.1      137.99.166.126  06 04BE 074C     3
AT4/0/0.12     131.123.59.33   AT1/0/0.1      137.229.58.168  06 04BE 09BB   646
AT1/0/0.1      137.99.166.126  AT4/0/0.10     132.235.174.9   06 074C 04BE     3
```

Juniper Configration

- Sample packets with firewall filter and forward to routing engine.
- Sampling rate is limited to 7000pps. Fine for traffic engineering, but restrictive for DoS and intrusion detection.
- Juniper calls NetFlow cflowd.

Juniper Configration

Firewall filter

```
firewall {
    filter all {
        term all {
            then {
                sample;
                accept;
            }
        }
    }
}
```

Enable sampling / flows

```
forwarding-options {
    sampling {
        input {
            family inet {
                rate 100;
            }
        }
        output {
            cflowd 10.0.0.16{
                port 2055;
                version 5;
            }
        }
    }
}
```

Juniper Configration

Apply firewall filter to each interface.

```
interfaces {
    ge-0/3/0 {
        unit 0 {
            family inet {
              filter {
                    input all;
                    output all;
                }
                address 192.148.244.1/24;
            }
        }
    }
```

Flow-tools

- Collection of programs to post process Cisco NetFlow compatible flows.
- Written in C, designed to be fast (scales to large installations).
- Includes library (ftlib) for custom applications.
- Installation with configure;make;make install on most platforms (FreeBSD, Linux, Solaris, BSDi, NetBSD).

flow-capture

- Collect NetFlow exports and stores to disk.
- Built in compression.
- Manages disk space by expiring older flow files at configurable limits.
- Detects lost flows by missing sequence numbers and stores with flow metadata.

flow-fanout

- Replicate NetFlow UDP streams from one source to many destinations.
- Destination may be a multicast address.

flow-expire

- Expire (remove) old flow files based on disk usage.
- Same functionality built in to flow-capture.
- Used when managing disk space in a distributed environment.

Abilene Configuration

- Collect and process flows for Abilene routers.
- Use sampled NetFlow.
- Distribute flows to Asta and Arbor Networks.
- Nightly usage reports.
- Archive of raw anonymized flows.

Collector Placement and configuration

- NetFlow is UDP so the collector should ideally be directly connected to the router to minimize packet loss and IP spoofing risks.
- No flow control. Undersized collector will drop flows. Monitor netstat –s | grep buf and configure syslog so dropped flows will be logged.

flow-print

- Formatted output of flow files.

```
eng1:% flow-print < ft-v05.2002-01-21.093345-0500 | head -15
srcIP            dstIP            prot  srcPort  dstPort  octets packets
131.238.205.199  194.210.13.1     6     6346     40355    221          5

192.5.110.20     128.195.186.5    17    57040    33468    40           1

128.146.1.7      194.85.127.69    17    53       53       64           1

193.170.62.114   132.235.156.242  6     1453     1214     192          4

134.243.5.160    192.129.25.10    6     80       3360     654          7

132.235.156.242  193.170.62.114   6     1214     1453     160          4

130.206.43.51    130.101.99.107   6     3226     80       96           2
```

flow-cat

- Concat many flow files or directories of files.

```
eng1:% ls
ft-v05.2002-01-21.160001-0500   ft-v05.2002-01-21.170001-0500
ft-v05.2002-01-21.161501-0500   ft-v05.2002-01-21.171501-0500
ft-v05.2002-01-21.163001-0500   ft-v05.2002-01-21.173001-0500
ft-v05.2002-01-21.164501-0500   tmp-v05.2002-01-21.174501-0500

eng1:% flow-cat . | flow-print

srcIP            dstIP            prot  srcPort  dstPort  octets packets
138.26.220.46    192.5.110.20     17    62242    33456    40           1

143.105.55.23    18.123.66.15     17    41794    41794    40           1

129.15.134.66    164.107.69.33    6     1214     2222     4500         3
```

flow-merge

- Flow-merge is similar to flow-cat except it maintains relative ordering of flows when combining the files.
- Typically used when combining flows from multiple collectors.

flow-filter

- Filter flows based on port, protocol, ASN, IP address, ToS bits, TCP bits, and tags.

```
eng1% flow-cat . | flow-filter -P119 | flow-print | head -10

srcIP            dstIP            prot  srcPort  dstPort  octets      packets
155.52.46.50     164.107.115.4    6     33225    119      114         2
128.223.220.29   129.137.4.135    6     52745    119      1438382     1022
155.52.46.50     164.107.115.4    6     33225    119      374         6
164.107.115.4    192.58.107.160   6     60141    119      5147961     8876
128.223.220.29   129.137.4.135    6     52745    119      1356325     965
128.223.220.29   129.137.4.135    6     52714    119      561016      398
130.207.244.18   129.22.8.64      6     36033    119      30194       121
155.52.46.50     164.107.115.4    6     33225    119      130         2
198.108.1.146    129.137.4.135    6     17800    119      210720652   216072
```

flow-split

- Split flow files into smaller files.
- Typically used with flow-stat and graphing. For example if flow files are 1 hour and want 5 minute data points in graph, flow-split can take the 1 hour flow files and generate 5 minute files.

flow-tag

- Adds a tag field to flows based on IP exporter, IP prefix, Autonomous System, or next hop.
- Like flow-filter used with other tools.
- Used to manage groups of prefixes or ASN’s.

flow-header

- Display meta information in flow file.

```
eng1:% flow-header < ft-v05.2002-01-21.093345-0500
#
# mode:                 normal
# capture hostname:     eng1.oar.net
# exporter IP address:  0.0.0.0
# capture start:        Mon Jan 21 09:33:45 2002
# capture end:          Mon Jan 21 09:45:01 2002
# capture period:       676 seconds
# compress:             on
# byte order:           little
# stream version:       3
# export version:       5
# lost flows:           0
# corrupt packets:      0
# sequencer resets:     0
# capture flows:        341370
#
```

flow-stat

- Generates reports from flow files.
- Output is readable and easily imported into graphing programs (gnuplot, etc).
- IP Address, IP address pairs, ports, packets, bytes, interfaces, next hop, Autonomous System, ToS bits, exporter, and tags.

flow-stat - summary

```
Total Flows                          : 24236730
Total Octets                         : 71266806610
Total Packets                        : 109298006
Total Time (1/1000 secs) (flows)     : 289031186084
Duration of data  (realtime)         : 86400
Duration of data (1/1000 secs)       : 88352112
Average flow time (1/1000 secs)      : 11925.0000
Average packet size (octets)         : 652.0000
Average flow size (octets)           : 2940.0000
Average packets per flow             : 4.0000
Average flows / second (flow)        : 274.3201
Average flows / second (real)        : 280.5177
Average Kbits / second (flow)        : 6452.9880
Average Kbits / second (real)        : 6598.7781
```

flow-stat – Source AS % Total

# src AS	flows	octets	packets	duration
NSFNETTEST14-AS	6.430	6.582	7.019	5.693
ONENET-AS-1	2.914	4.417	3.529	3.566
UONET	0.600	4.052	2.484	1.979
UPITT-AS	1.847	3.816	2.697	2.552
CONCERT	1.786	2.931	2.391	1.955
OHIOU	3.961	2.601	2.140	1.655
CMU-ROUTER	1.962	2.577	2.349	2.075
BOSTONU-AS	1.503	2.126	1.665	1.914
PURDUE	2.185	1.994	2.157	2.507
STANFORD	2.124	1.950	2.270	2.636
UR	1.809	1.919	1.652	1.532
UMN-AGS-NET-AS	1.612	1.895	1.788	1.938
RISQ-AS	1.086	1.849	1.378	1.367
PENN-STATE	2.845	1.641	2.666	2.190
RIT-ASN	0.796	1.601	1.414	0.830

flow-stat – Dest AS % Total

# dst AS	flows	octets	packets	duration
NSFNETTEST14-AS	6.202	9.564	8.005	6.762
PENN-STATE	2.037	3.774	2.712	2.153
CONCERT	2.628	3.133	2.888	2.326
ONENET-AS-1	2.818	2.434	2.906	3.000
STANFORD	1.915	2.360	2.122	2.195
JANET	2.508	2.319	2.150	2.485
0	0.831	2.187	2.431	2.910
DFN-WIN-AS	2.349	2.099	1.938	2.359
CMU-ROUTER	1.383	2.090	1.972	1.960
UONET	0.537	2.067	1.699	1.397
PURDUE	2.029	1.934	1.983	2.177
UMN-AGS-NET-AS	1.608	1.784	1.664	1.681
UPITT-AS	1.507	1.707	2.067	2.288
MIT-GATEWAYS	0.677	1.425	1.175	0.806
RIT-ASN	0.644	1.313	1.243	0.868
INDIANA-AS	0.899	1.285	0.996	0.781

flow-stat – Src/Dest AS % Total

# src AS	dst AS	flows	octets	packets	duration
GEORGIA-TECH	PENN-STATE	0.030	0.965	0.459	0.071
NWU-AS	0	0.008	0.734	0.379	0.170
UONET	CONCERT	0.064	0.698	0.438	0.290
UCLA	NSFNETTEST14-AS	0.037	0.568	0.269	0.111
CONCERT	UONET	0.052	0.543	0.364	0.221
BCNET-AS	MIT-GATEWAYS	0.019	0.538	0.274	0.134
UONET	0	0.015	0.536	0.318	0.200
MIT-GATEWAYS	STANFORD	0.032	0.477	0.245	0.073
ONENET-AS-1	NSFNETTEST14-AS	0.140	0.451	0.263	0.159
UONET	PENN-STATE	0.019	0.439	0.200	0.063
NOAA-AS	NOAA-FSL	0.018	0.438	0.255	0.031
DENET	UONET	0.032	0.410	0.189	0.188
NSFNETTEST14-AS	UC-DOM	0.022	0.365	0.244	0.081
ITALY-AS	UONET	0.016	0.358	0.228	0.117
NSFNETTEST14-AS	CONCERT	0.322	0.349	0.335	0.228
UONET	ITALY-AS	0.022	0.349	0.210	0.130

flow-stat – Src Port % Total

# port	flows	octets	packets	duration
1214	31.480	25.875	22.251	24.554
ftp-data	0.325	4.043	2.417	1.240
http	2.386	2.855	1.729	1.040
6346	4.124	2.224	3.619	5.886
unidata-ldm	0.105	0.893	0.526	0.384
synoptics-trap	0.214	0.844	0.994	1.016
ftp	0.326	0.616	0.386	0.324
6347	0.573	0.572	0.617	0.856
4662	0.293	0.505	0.363	0.524
0	0.015	0.460	0.217	0.099
ssh	0.117	0.411	0.329	0.173
873	0.014	0.371	0.173	0.086
5501	0.008	0.322	0.161	0.092
6701	0.008	0.320	0.153	0.085
aol	0.048	0.316	0.257	0.159
6699	0.106	0.280	0.215	0.269

flow-stat – Dst Port % Total

# port	flows	octets	packets	duration
nntp	0.731	15.726	6.860	2.894
1214	32.274	11.156	20.411	21.875
6346	4.032	2.701	4.155	6.625
synoptics-trap	0.301	2.109	1.104	1.167
ftp-data	0.246	1.088	1.160	0.674
5020	0.003	0.892	0.359	0.023
55524	0.374	0.863	1.665	2.492
6347	0.680	0.488	0.643	0.972
vlsi-lm	0.016	0.447	0.190	0.029
42002	0.103	0.381	0.467	0.679
6699	0.196	0.332	0.300	0.382
4662	0.229	0.301	0.260	0.338
3534	0.013	0.243	0.109	0.037
netview-aix-3	0.024	0.221	0.102	0.048

flow-stat – IP protocol % Total

# protocol	flows	octets	packets	duration
tcp	93.877	97.143	93.326	91.589
udp	4.257	2.466	5.932	8.286
icmp	1.337	0.368	0.576	0.117
169	0.500	0.019	0.155	0.002
gre	0.010	0.002	0.006	0.005
pim	0.012	0.002	0.004	0.001
ipv6	0.004	0.000	0.001	0.000
ax.25	0.001	0.000	0.000	0.000
ipencap	0.001	0.000	0.000	0.000
igmp	0.000	0.000	0.000	0.000
ospf	0.001	0.000	0.000	0.000
rsvp	0.000	0.000	0.000	0.000

flow-stat –Src/Dst Prefix % Total

# Source Prefix	Destination Prefix	flows	octets	packets	duration
130.207/16	128.186/16	0.016	3.091	1.321	0.100
130.207/16	130.203/16	0.019	2.110	0.904	0.113
198.108/24	130.207/16	0.023	2.097	0.855	0.194
169.232/16	128.169/16	0.086	1.420	0.644	0.428
134.79/16	65.118.160/20	0.008	1.158	0.467	0.031
18/8	130.207/16	0.030	1.042	0.572	0.141
129.171.96/19	128.223/16	0.019	0.848	0.341	0.142
138.26/16	193.190/15	0.006	0.574	0.245	0.046
128.109/16	146.229/16	0.014	0.558	0.231	0.078
128.109/16	170.140/16	0.014	0.536	0.221	0.063
130.207/16	18/8	0.034	0.493	0.416	0.134
128.223/16	130.207/16	0.017	0.476	0.200	0.118
128.109/16	131.96/16	0.018	0.463	0.190	0.096

flow-stat – ifIndex % Total

# in	out	flows	octets	packets	duration
3	2	12.556	12.568	12.574	11.991
2	3	9.557	11.644	10.313	9.716
4	2	8.172	8.896	8.274	8.528
6	4	14.815	8.712	10.820	11.394
2	4	9.131	8.033	8.565	9.162
4	6	9.433	6.797	7.526	8.197
8	3	2.085	3.245	2.317	2.105
2	75	0.055	3.110	1.382	0.158
6	2	2.759	3.024	2.855	2.950
9	3	1.792	2.992	2.133	1.908
3	91	1.002	2.361	1.595	1.284
9	4	2.057	2.132	1.967	2.105
2	6	2.301	1.698	2.463	3.010
3	9	1.713	1.447	1.760	1.697
3	8	1.614	1.311	1.639	1.698

flow-stat – Next-Hop % Total

# IPaddr	flows	octets	packets	duration
0.0.0.0	37.738	43.011	41.829	41.883
198.32.8.66	30.848	22.665	25.417	26.778
198.32.8.41	16.807	22.348	18.870	17.164
198.32.8.33	13.363	9.943	11.361	12.582
199.77.193.9	0.775	1.037	1.697	1.069
192.80.53.46	0.132	0.532	0.279	0.108
192.80.53.42	0.073	0.211	0.185	0.159
131.247.47.246	0.103	0.100	0.105	0.080
192.111.110.5	0.044	0.079	0.052	0.050
198.32.252.253	0.082	0.059	0.182	0.105
192.208.151.9	0.022	0.012	0.018	0.018
131.95.1.25	0.008	0.003	0.004	0.004
192.208.151.13	0.002	0.001	0.001	0.000
192.80.53.44	0.000	0.000	0.000	0.000
131.247.47.244	0.000	0.000	0.000	0.000
198.32.11.72	0.000	0.000	0.000	0.000

flow-stat – Multicast S,G % Total

# src IPaddr	dst IPaddr	flows	octets	packets	duration
141.117.45.72	233.2.171.38	2.455	13.233	4.169	3.734
198.49.215.223	224.2.177.155	2.437	8.630	5.859	4.433
131.193.77.102	224.2.177.155	2.249	8.369	4.340	4.066
192.88.194.131	224.2.177.155	2.278	6.381	4.407	4.059
206.75.91.24	224.2.177.155	2.241	6.111	4.876	4.086
128.163.209.73	233.2.171.38	1.304	5.784	3.349	2.546
140.221.8.157	224.2.177.155	2.280	5.245	4.435	4.085
128.3.10.50	224.2.177.155	2.261	5.177	4.660	4.071
128.135.152.209	224.2.177.155	2.281	4.716	4.494	4.111
130.111.39.202	224.2.177.155	1.222	3.876	2.696	2.345
129.79.245.225	233.2.171.38	1.125	3.715	2.521	2.063
199.104.137.2	224.2.177.155	2.283	2.964	4.461	4.096
192.231.212.52	224.2.177.155	0.560	2.865	1.319	1.007
128.182.61.42	233.2.171.38	1.691	2.687	3.267	3.012

flow-stat – ToS % Total

# ToS	flows	octets	packets	duration
0	96.178	93.067	93.752	94.926
32	1.196	2.230	2.524	1.788
64	1.031	1.822	1.475	1.675
16	0.324	1.535	0.838	0.427
8	0.104	0.698	0.588	0.321
96	0.166	0.182	0.147	0.093
36	0.349	0.149	0.226	0.275
128	0.117	0.070	0.108	0.151
224	0.130	0.036	0.079	0.100
192	0.221	0.033	0.087	0.022
200	0.004	0.016	0.009	0.006
232	0.001	0.014	0.007	0.005
244	0.012	0.012	0.013	0.024
236	0.012	0.009	0.011	0.020
24	0.010	0.008	0.008	0.013

flow-stat – ToS 0010000xx % Total

# Source Prefix	Destination Prefix	flows	octets	packets	duration
128.186/16	131.193/16	0.270	8.619	3.243	1.344
146.201/16	141.213/16	0.547	7.105	2.689	2.444
128.186/16	129.252/16	0.349	5.958	2.455	1.609
128.186/16	152.7/16	0.638	3.960	1.592	0.848
128.186/16	141.213/16	0.314	3.037	1.240	1.152
128.186/16	129.21/16	1.280	2.416	2.132	1.632
128.186/16	128.239/16	0.824	2.394	1.050	0.806
128.186/16	130.207/16	1.679	2.322	29.290	7.148
128.186/16	199.240/18	0.151	2.082	0.785	0.719
128.186/16	130.108/16	0.295	2.036	0.767	1.213
128.186/16	128.227/16	0.569	2.034	0.988	1.375
128.186/16	139.78/16	0.321	1.962	1.047	0.938

flow-dscan

- DoS detection / network scanning tool.
- Flag hosts which have flows to many other hosts.
- Flag hosts which are using a large number of TCP/UDP ports.
- Works better on smaller networks or with flow-filter to limit traffic. For example filter TCP port 25 to detect hosts infected with e-mail worm.

flow-gen

- Debugging tool to generate flows.

```
eng1:% flow-gen -V8.1 | flow-print | head -10

srcAS   dstAS   in      out     flows       octets      packets     duration
0       65280   0       65280   2           1           1           4294901760
1       65281   1       65281   4           2           2           4294901760
2       65282   2       65282   6           3           3           4294901760
3       65283   3       65283   8           4           4           4294901760
4       65284   4       65284   10          5           5           4294901760
5       65285   5       65285   12          6           6           4294901760
6       65286   6       65286   14          7           7           4294901760
7       65287   7       65287   16          8           8           4294901760
8       65288   8       65288   18          9           9           4294901760
```

flow-send

- Transmit flow files with NetFlow protocol to another collector.
- Can be used to take flow-tools files and send them to other NetFlow compatible collector.

flow-receive

- Like flow-capture but does not manage disk space. Output is to standard out and can be used directly with other flow-tools programs.
- Typically used for debugging.

```
eng1:% flow-receive 0/0/5555 | flow-print
flow-receive: New exporter: time=1011652474 src_ip=199.18.112.114
 dst_ip=199.18.97.102 d_version=8
srcPrefix           srcAS  dstPrefix           dstAS  input  output flows
143.105/16          600    128.9/16            4      48     25     1
140.141/16          600    150.216/16          81     48     25     4
132.235/16          17135  130.49/17           4130   38     25     25
131.123/16          11050  129.59/16           7212   42     25     1
206.21/16           600    128.239/16          11975  48     25     2
199.218/16          600    128.255/16          3676   48     25     1
```

flow-import

- Import flows from other formats into flow-tools.
- Currently supports ASCII and cflowd formats.

flow-export

- Export flows from flow-tools files to other formats.
- Currently supports ASCII and cflowd formats.
- ASCII output can be used with perl or other scripting languages (with a performance penalty).

flow-xlate

- Translate flows among NetFlow versions.
- Originally intended for use with Catalyst switches since they export some flows in version 7 and others in version 5 format.

References

- flow-tools: http://www.splintered.net/sw/flow-tools
- NetFlow Applications http://www.inmon.com/technology/netflowapps.php
- Netflow HOW-TO http://www.linuxgeek.org/netflow-howto.php
- IETF standards effort: http://ipfix.doit.wisc.edu

References

- flow-tools:
  http://www.splintered.net/sw/flow-tools
- Abilene NetFlow page
  http://www.itec.oar.net/abilene-netflow
- Flow-tools mailing list:
  flow-tools@splintered.net
- Cisco Centric Open Source Community
  http://cosi-nms.sourceforge.net/related.html