Multicast Network Management

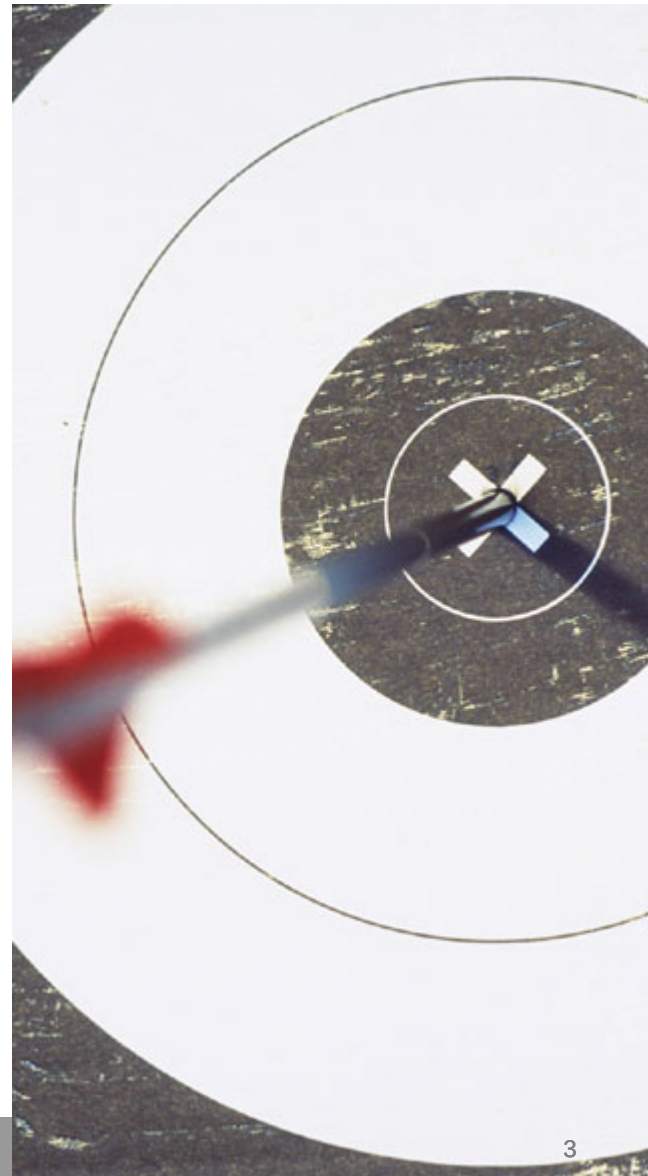
RST-2263

IP Multicast at Networkers 2006

- **RST-1261 Introduction to IP Multicast**
- **RST-2261 Deploying IP Multicast**
- **RST-2262 Multicast Security**
- **RST-2263 Multicast Network Management**
- **RST-3261 Advanced IP Multicast**
- **RST-3262 IP Multicast Architecture & Troubleshooting for the Catalyst 6500**
- **TECRST-1008 Enterprise IP Multicast**

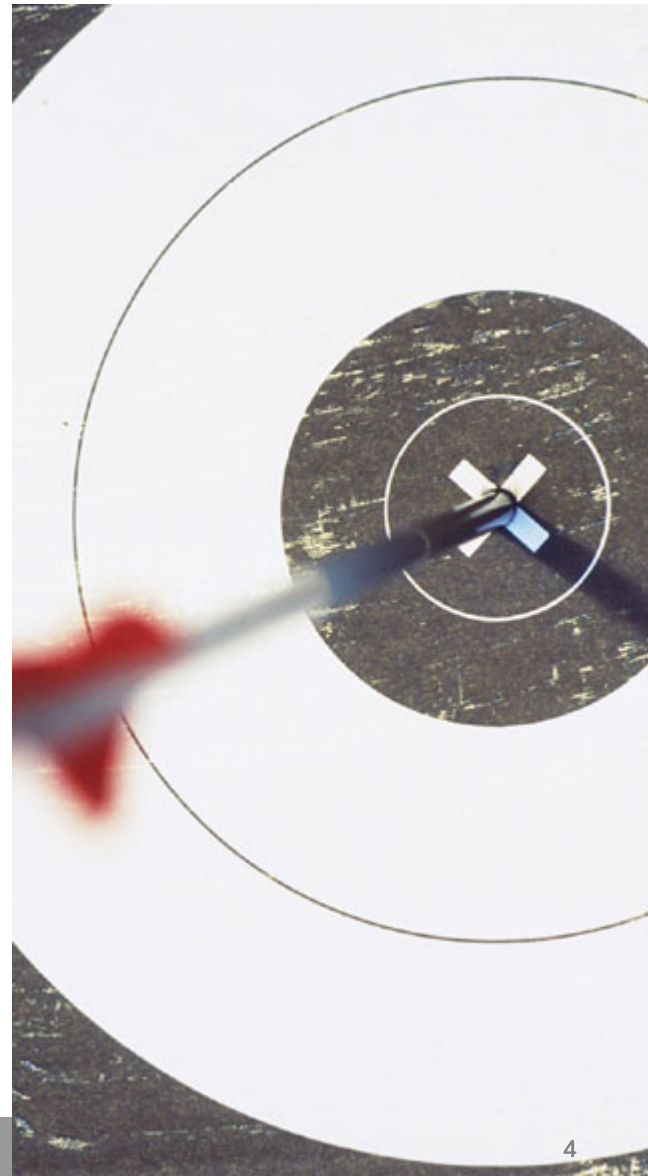
Session Goal

To provide you with a thorough understanding of the tools and facilities available for managing, monitoring and fault isolation of IP Multicast networks



Session Assumptions

- **Working understanding of IPv4 multicast**
- **General knowledge of Troubleshooting concepts**
- **Basic understanding of Network Management facilities**



Agenda

- IP Multicast MIBs
- IP Multicast Syslogs
- IP Multicast NetFlow
- Network Management Systems for IP Mcast
- IP SLAs for IP Multicast
- Monitoring and Trouble shooting Examples

What Is Network Management ?

- **Practically, many people say:**
- **Fault Detection and Isolation**
  - **Are any WAN links flapping ?**
  - **How long has that been happening ?**
- **Monitoring**
  - **Do you know what your network is doing right now ?**
  - **Do you know where your packets are ?**
- **Configuration Management**
  - **Which routers are included in that routing domain ?**
  - **Are there any obvious misconfigurations ?**

What Is Network Management for IPmc?

- **Some people may say....**
  - **How any active mroutes do we have now ?**
  - **What data rates are they running at ?**
  - **Where are the receivers for that group ?**
  - **Is the traffic behaving as expected ?**
  - **Which RP supports that group?**
  - **How does the multicast traffic flow affect other traffic ?**
- **What do you think it includes ?**

Multicast MIBs

Multicast MIBS

MIBs come in 4 main flavors:

Draft

- **MIBs based on IETF draft**

RFC: Experimental

- **MIBs based on IETF RFC that is experimental**

RFC: Proposed Standard

- **MIBs based on IETF RFC that is a proposed standard**

Cisco specific MIBs

- **Extend the capabilities of IP multicast beyond what is defined in the IETF MIBs**
- **For example, Cisco specific configuration and feature elements.**

Multicast MIBS

IGMP	**IGMP-MIB.my** **IGMP-STD-MIB.my**
IGMP Snooping	**CISCO-IGMP-SNOOPING-MIB.my (CatOS only)**
Mroute	**IPMROUTE-MIB.my** **IPMROUTE-STD-MIB.my** **CISCO-IPMROUTE-MIB.my**
PIM	**PIM-MIB.my** **CISCO-PIM-MIB.my**
MSDP	**MSDP-MIB.my**
mVPN	**CISCO-MVPN-MIB.my**

Multicast MIBS IOS Support

	12.1E	12.2SX	12.3	12.4	12.0S
IGMP-MIB	Yes	Yes	No	No	Yes
IGMP-STD-MIB	No	No	Yes	Yes	No
MROUTE-MIB	Yes	Yes	No	No	No
MROUTE-STD-MIB	No	No	Yes	Yes	Yes
CISCO-IPMROUTE-MIB	Yes	Yes	Yes	Yes	Yes
PIM-MIB	Yes	Yes	Yes	Yes	Yes
CISCO-PIM-MIB	Yes	Yes	Yes	Yes	Yes
MSDP-MIB	No	Yes	Yes	Yes	Yes
CISCO-MVPN-MIB	No	No	No	Yes	Yes

IOS-XR MIB Support

- **IPMROUTE-STD-MIB**
- **CISCO-IETF-IPMROUTE-MIB**

  Based on RFC 2932 with IPv6 support
- **CISCO-IETF-PIM-MIB**

  Based on RFC 2934 with IPv6 support
- **CISCO-IETF-PIM-EXT-MIB**

  Extensions to the PIM MIB to support Bidir, DR Priority
- **IPV6-MLD-MIB – based on RFC 3019**

IGMP-STD-MIB

- **Based on RFC 2933**
- **Contains information for IPv4 Multicast Routers, e.g.:**
  - **Address of IGMP Querier**
  - **IGMP version configured on int**
  - **IGMP cache**
- **Does not fully support IGMPv3**
- **Cisco implementation does not support set/create of config objects**

PIM-MIB

- **Based on RFC 2934**
- **Contains PIM Interface info, neighbors and RP info**
  - **pimRPState**
    - **active RPs in system**
    - **similar to “show ip pim rp”**
  - **pimRPSetTable**
    - **mapping info for PIMv2**
    - **similar to “show ip pim rp mapping”**
- **Does not support Static RP ranges – but active groups will show up in pimRPState**
- **Auto-RP group ranges are included in pimRPSetTable**

IP-MROUTE-STD-MIB

- **Based on RFC 2932**
- **Contains information about the status of multicast routing**
- **Traffic statistics**
  - **Packet counters per mroute**
  - **Packet counters per mroute, per outbound interface**
    - **NextHopPkts**
  - **Octet counters per mroute**
  - **Octet counters per interface – in/out**

CISCO-IPMROUTE-MIB

Contains information about mroutes such as flags and traffic counters

- The IPMROUTE-STD-MIB contains counters that are not available in the IPMROUTE-MIB
  - **IPMROUTE-STD-MIB has these objects additional as compared to the IPMROUTE-MIB:**
    1. ipMRouteEntryCount
    2. ipMRouteHCOctets
    3. ipMRouteInterfaceHCInMcastOctets
    4. ipMRouteInterfaceHCOutMcastOctets
    5. ipMRouteScopeNameTable (has 7 objects)
  - **These are available in the CISCO-IPMROUTE-MIB as:**
    1. ciscoIpMRouteNumberOfEntries
    2. ciscoIpMRouteOctets
    3. ciscoIpMRouteIfInMcastOctets
    4. ciscoIpMRouteIfOutMcastOctets
    5. Only available in IPMROUTE-STD-MIB

Packet Counters

IF-MIB (RFC1213)

- ifInMulticastPkts
- ifOutMulticastPkts
- ifHCInMulticastPkts
- ifHCOutMulticastPkts

Multicast In/Out Packets At Interface Level

PIM-SM – all L2 packets are P2P not Mcast

Most Int Types Counters are fine (e.g. GE)

USE New Counters

CISCO-IPMROUTE-MIB

- ciscoIpMRouteIfInMcastPkts
- ciscoIpMRouteIfHCInMcastPkts
- ciscoIpMRouteIfOutMcastPkts
- ciscoIpMRouteIfHCOutMcastPkts

Similar output as:
`show ip pim int count`

CISCO-MVPN-MIB

- **Based on draft-svaidya-mcast-vpn-mib to be re-submitted as L3VPN WG draft**
- **Includes:**

Generic Info

- **Names of Multicast-enabled VRFs**
- **Number of active multicast enabled interfaces per VRF**
- **Object to control trap generation per-mVRF**
- **Last Config Event in each mVRF**

Per-MVRF Information

- **MDT default group address**
- **MDT Data Groups and related Variables**
- **Dynamic mapping between customer multicast groups and Default/Data MDT groups**
- **Mapping between mVRF and MDT tunnel interface**
- **MDT Join TLVs being sent by a device,**
- **MDT-SAFI NLRI (BGP advertisements of MDT groups)**

Traffic Reporting on 6500/7600

- **Cat6500 traffic statistics are collected by hardware counters and updated periodically to MSFC**
- **Native IOS updates 25% of mroutes every 25 seconds**
  - **worse case stats can be 100 seconds old**
  - **in 12.2(18)SX this was changed to 10% with a default of 9 seconds – worse case 90 secs**
- **The stat update time can be adjusted with mls ip multicast flow-stat-timer <secs>**
- **May cause increase in CPU utilization depending on number of mroutes. Use with care.**

Multicast Notifications (Traps)

Mroute	**ciscoIpMRouteMissingHeartBeats**
PIM	**pimNeighborLoss** **ciscoPimRPMappingChange** **ciscoPimInvalidRegister** **ciscoPimInvalidJoinPrune** **ciscoPimInterfaceUp** **ciscoPimInterfaceDown**
MSDP	**msdpEestablished[1]** **msdpBackwardTransition**
mVPN	**ciscoMvpnMvrfChange**

[1]Not supported in IOS

Multicast Traps - Enabling

Traps are enabled by these commands:

```
snmp-server enable traps pim
   invalid-pim-message  Enable invalid pim traps
   neighbor-change      Enable neighbor change trap
   rp-mapping-change    Enable rp mapping change trap
snmp-server enable traps ipmulticast
snmp-server enable traps msdp
snmp-server enable traps mvpn
```

or

```
snmp-server enable traps
```

Will enable ALL traps

Multicast Traps – Enabling (Cont.)

Traps are enabled by these commands:

```
snmp-server enable traps pim invalid-pim-message
```
ciscoPimInvalidRegister
ciscoPimInvalidJoinPrune

```
snmp-server enable traps pim neighbor-change
```
pimNeighborLoss
ciscoPimInterfaceUp
ciscoPimInterfaceDown

```
snmp-server enable traps pim rp-mapping-change
```
ciscoPimRPMappingChange

```
snmp-server enable traps pim
```
Everything above

```
snmp-server enable traps ipmulticast
```
ciscoIpMRouteMissingHeartBeats

```
snmp-server enable traps msdp
```
msdpBackwardTransition

```
snmp-server enable traps mvpn
```
ciscoMvpnMvrfChange

Multicast Heartbeat

- **Sends an SNMP trap when traffic stops for critical group**
- **Troubleshooting Usage:**

  Confirm traffic stream activity

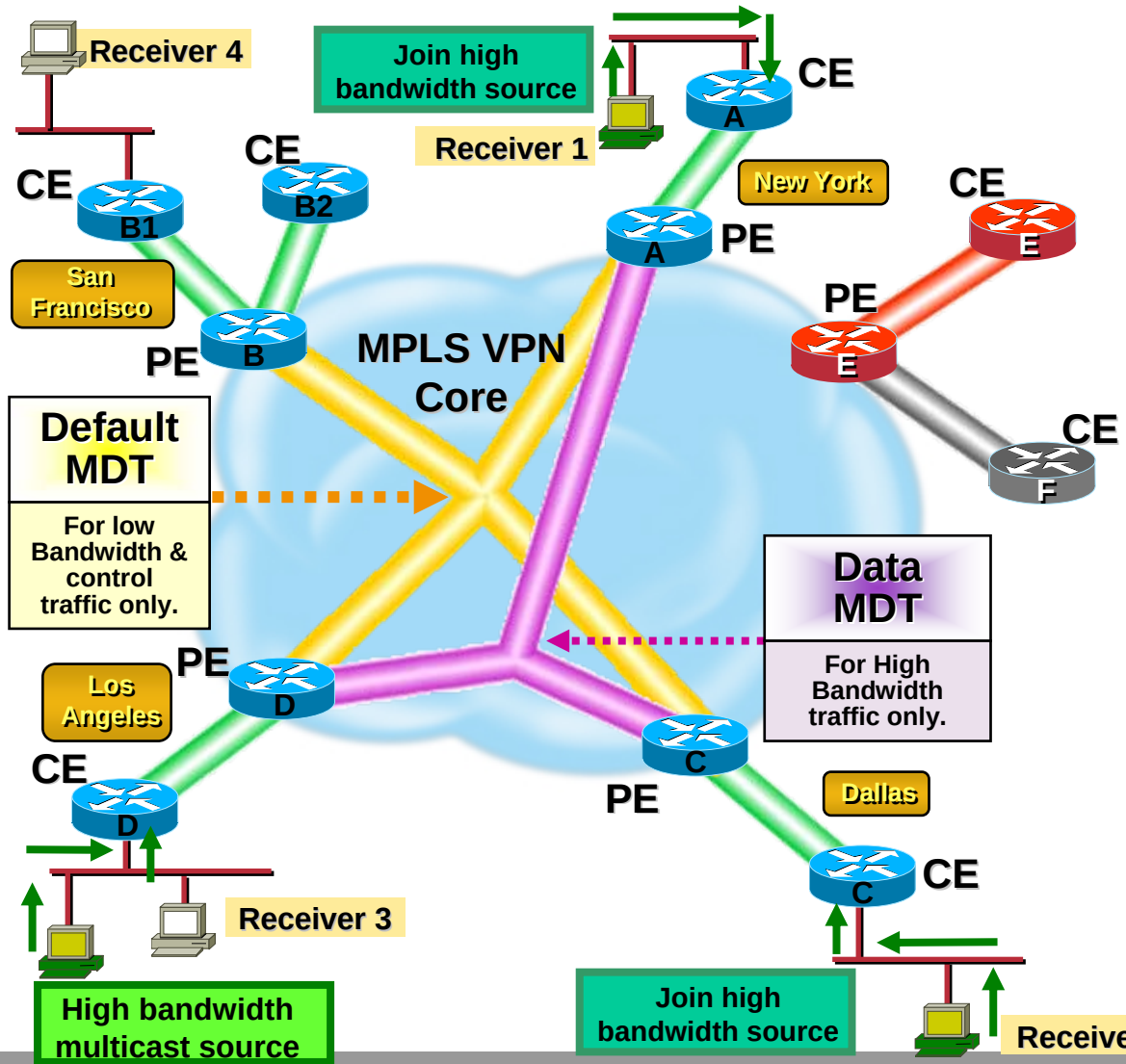
  Requires that downstream router or host has joined group or that a static IGMP has been set – e.g. data path must be through the router configured with heartbeat monitor

Multicast Heartbeat

- **Set the router to send the traps**
- **Set the group**
- **Set the min number of intervals that must have traffic**
- **Set the number of intervals to monitor**
- **Set the length of intervals in seconds**

```
snmp-server enable traps ipmulticast
ip multicast heartbeat 224.0.1.53 1 1 10
```

Multicast VPN (MVPN) Concept and Fundamentals



- Customer CE devices joins the MPLS Core through provider's PE devices
- The MPLS Core forms a Default MDT for a given Customer
- A High-bandwidth source for that customer starts sending traffic
- Interested receivers 1 & 2 join that High Bandwidth source
- Data-MDT is formed for this High-Bandwidth source

What Is VRF Aware?

If a MIB is VRF aware then:

- SNMP gets and sets can be made to the individual VRFs
- The MIB will have the ability to detect conditions for a trap inside of a VRF and lookup the additional information in the VRF context
- Traps will be sent to a manager located inside a VRF

```
snmp-server host 1.1.1.1 vrf blue
```

NOTE: VRF Aware and MIBs

MIBs that are not VRF aware will not be able to report on an event that occurs in a VRF.

They will only report on events in the default/global routing tables.

Only PE routers need to be VRF Aware.

- **These MIBs are NOT VRF Aware:**

  Mroute, PIM, MSDP, IGMP, IGMP Snooping

- **The mVPN MIB is VRF independent and can be used to access information about each VRF.**

New IETF Work on MIBs

- **New PIM MIB**
  - **Current draft: draft-ietf-pim-mib-v2-06.txt**
  - **Working its way through the standards process**
- **New Support**
  - **Static RP group ranges**
  - **Auto-RP group ranges**
  - **Embedded RP**
  - **PIM-Bidir – DF election table**
  - **IPv6 Multicast**

New IETF Work on MIBs (Cont.)

- **IP Multicast MIB**
  - **Replaces IPMROUTE-STD-MIB**
  - **Current Draft: draft-ietf-mboned-ip-mcast-mib-01.txt**
  - **Working its way through the standards process**
- **New Support**
  - **SSM Range Definitions**
  - **PIM-Bidir mroute types**
  - **IPv6 (Address Family Independent)**
  - **Local host information – the mib will report on which groups are joined by router/host**

New IETF Work on MIBs (Cont.)

- **Multicast Group Membership Discovery MIB**
  - **Current Draft: draft-ietf-magma-mgmd-mib-08.txt**
- **Supports**
  - **IGMPv1, IGMPv2, IGMPv3**
  - **MLDv1, MLDV2**
  - **IPv4 and IPv6 membership in one MIB**
  - **Support for hosts and routers**

More Info

- **For more information about IP Multicast MIBs:**

  Search on CCO for "Multicast Network Management"

Or

- **http://www.cisco.com/go/ipmulticast**

  White Papers

  IP Multicast Network Management

Multicast Syslog Messages

Multicast Syslogs

- **There are dozens of multicast Syslog messages in these categories:**
  - **Mroute Messages**
  - **MDS Messages**
  - **PIM Messages**
  - **AUTORP Messages**
  - **MDT Messages**
  - **MSDP Messages**
  - **DVMRP Messages**
  - **MCAST Messages - Layer 2 Multicast**
- **Many customers use a correlation engine to collect and process Syslog messages – such as CNS Notification Engine**

Useful Multicast Syslogs

Invalid RP Register Syslog:

%PIM-1-INVALID_RP_REG: Received Register from 210.0.1.202 for 239.3.3.3 not willing to be RP

This message indicates that an edge router is configured with the wrong RP address. DR addr is 210.0.1.202

Some users confuse the DR addr with the source addr. New format will make the message more readable. Adding address of RP from Reg msg:

%PIM-1-INVALID_RP_REG: Received Register from router 210.0.1.202 for group 239.3.3.3, 210.1.1.3 not willing to be RP

New Syslog Command

Global command:

ip pim log-neighbor-changes

Alerts when the status of a PIM neighbor changes – similar to existing log messages for OSPF and BGP

Integrated into recent releases of 12.3, 12.3T, 12.0S, 12.2S. See CSCee02125

NOTE: VRF Aware and Syslogs

All the Syslog messages ARE VRF aware. They report the name of the VRF in the error message. Available in 12.2SX, 12.3T but not 12.0S images.

Examples of syslogs with VRF information:

```
%PIM-1-INVALID_RP_REG: VRF red: Received Register from
200.1.1.201 for 226.6.6.6, not willing to be RP

%PIM-5-NBRCHG: neighbor 126.1.5.14 UP on interface
GigabitEthernet3/38 (vrf default)
```

Sometimes the VRF info:

- **Is at the beginning of the message, sometimes end**
- **Identifies the default domain, sometimes not**

Work is in progress to make the msgs consistent.

mVPN Management – Data MDT Reuse

mVPN has the option of using a different Data MDT for each high bandwidth customer stream

SPs would like to monitor their VPNs to determine which ones may need more addresses for Data MDTs. This can be done with the mdt reuse syslog:

```
ip vrf blue
  mdt default 232.1.1.1
  mdt data 232.1.200.0 0.0.0.255
  mdt log-reuse
```

This will enable this syslog message:

```
%MDT-5-DATA_MDT_REUSED: VRF blue: Data MDT 232.1.200.0
is reused in VRF blue
```

Multicast NetFlow

NetFlow Origination

- **Developed by Darren Kerr and Barry Bruins at Cisco Systems in 1996**
  - **US Patent 6,243,667**
- **The value of information in the cache was a secondary discovery**
  - **Initially designed as a switching path**
- **NetFlow is now the primary network accounting technology in the industry**
- **Answers questions regarding IP traffic: who, what, where, when, and how**

Principle NetFlow Benefits

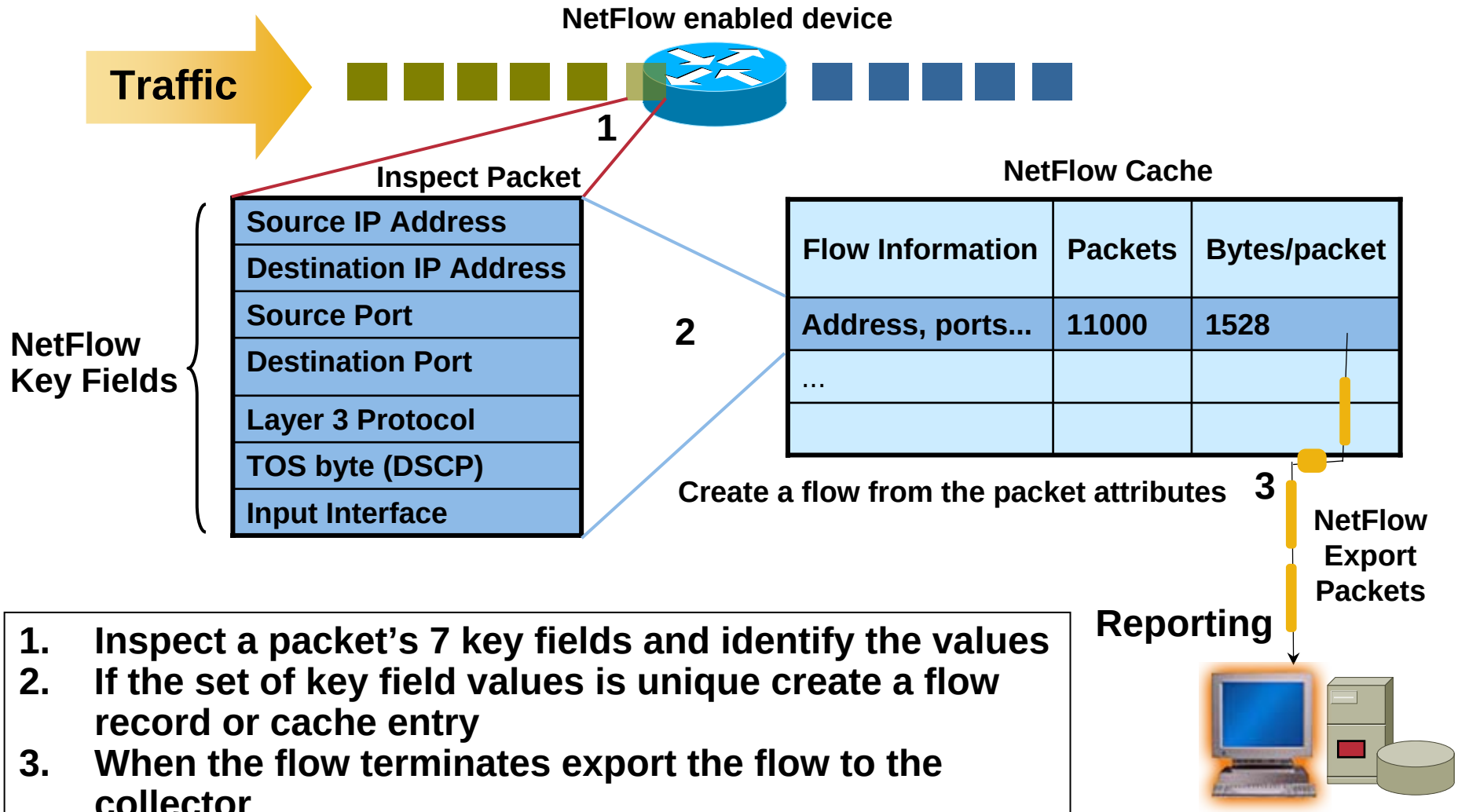
Service Provider

- Peering arrangements
- Network planning
- Traffic engineering
- Accounting and billing
- Security monitoring

Enterprise

- Internet access monitoring (protocol distribution, where traffic is going/coming)
- User monitoring
- Application monitoring
- Charge back billing for departments
- Security monitoring

What is a Traditional IP Flow ?



1. Inspect a packet's 7 key fields and identify the values
2. If the set of key field values is unique create a flow record or cache entry
3. When the flow terminates export the flow to the collector

NetFlow Principles

- **Unidirectional flow**
- **Accounts for both transit traffic and traffic destined for the router**
- **Works with Cisco Express Forwarding or fast switching**
  - **Not a switching path**
- **Supported on all interfaces and Cisco IOS ® Software platforms**
- **Returns the subinterface information in the flow records**
- **Cisco Catalyst® 6500 Series and Cisco 7600 Series enables NetFlow on all interfaces by default**

Traditional Layer 3 NetFlow Cache

1. Create and update flows in NetFlow cache

Key Fields in Yellow
Non-Key Fields white

SrcIf	SrcIPadd	DstIf	DstIPadd	Protocol	TOS	Flgs	Pkts	Src Port	Src Msk	Src AS	Dst Port	Dst Msk	Dst AS	NextHop	Bytes/ Pkt	Active	Idle
Fa1/0	173.100.21.2	Fa0/0	10.0.227.12	11	80	10	11000	00A2	/24	5	00A 2	/24	15	10.0.23.2	1528	1745	4
Fa1/0	173.100.3.2	Fa0/0	10.0.227.12	6	40	0	2491	15	/26	196	15	/24	15	10.0.23.2	740	41.5	1
Fa1/0	173.100.20.2	Fa0/0	10.0.227.12	11	80	10	10000	00A1	/24	180	00A 1	/24	15	10.0.23.2	1428	1145.5	3
Fa1/0	173.100.6.2	Fa0/0	10.0.227.12	6	40	0	2210	19	/30	180	19	/24	15	10.0.23.2	1040	24.5	14

2. Expiration

- Inactive timer expired (15 sec is default)
- Active timer expired (30 min (1800 sec) is default)

SrcIf	SrcIPadd	DstIf	DstIPadd	Protocol	TOS	Flgs	Pkts	Src Port	Src Msk	Src AS	Dst Port	Dst Msk	Dst AS	NextHop	Bytes/ Pkt	Active	Idle
Fa1/0	173.100.21.2	Fa0/0	10.0.227.12	11	80	10	11000	00A2	/24	5	00A2	/24	15	10.0.23.2	1528	1800	4

4. Export version

Non-Aggregated Flows—Export Version 5 or 9

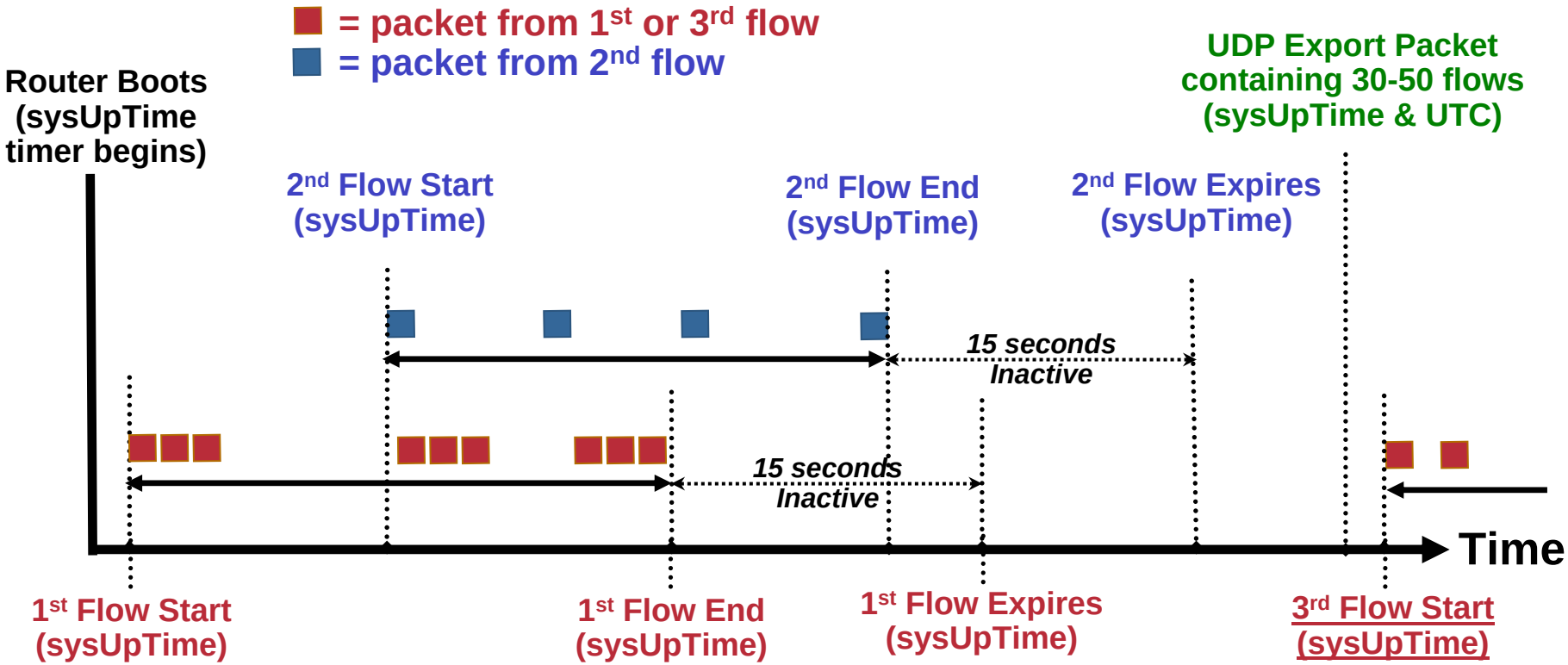
5. Transport protocol

30 Flows per 1500 byte export packet

Export Packet

Flow Timers and Expiration

1st & 3rd Flows – Src 10.1.1.1, Dst 20.2.2.2, Prot 6, Src & Dst port 15, InIF FE0/0, ToS 128
2nd Flow – Src 10.1.1.1, Dst 20.2.2.2, Prot 6, Src & Dst port 15, InIF FE0/0, ToS 192



- SysUptime - Current time in milliseconds since router booted
- UTC - Coordinated Universal Time can be synchronized to NTP (Network Time Protocol)

Multicast NetFlow — Timers

- IP Multicast uses UDP
- UDP flows do not terminate like TCP flows with a RST or a FIN
- UDP flows depend on the aging timers to be exported
- On SW platforms this is controlled by the active timer

```
ip flow-cache timeout active 1
```

Minimum setting is 1 minute

- On 6500/7600 this is controlled by long aging timer

```
mls aging long 64
```

Minimum setting is 64 seconds

NetFlow Export Versions

NetFlow Version	Comments
1	Original
5	Most Common
7	Specific to Cisco C6500 and 7600 Series Switches Similar to Version 5, but Does Not Include AS, Interface, TCP Flag and ToS Information
8	Choice of Eleven Aggregation Schemes Reduces Resource Usage
9	Flexible, Extensible Export Format to Enable Easier Support of Additional Fields and Technologies e.g. MPLS, Multicast, BGP Next Hop, and IPv6. Defined by RFC 3954.

NetFlow v9 Principles

- **Version 9 is an export format**
- **Still a push model**
- **Send the templates regularly (configurable)**
- **Independent of the UDP transport protocol, it is ready for any reliable transport protocol e.g TCP, SCTP,…**
- **Advantage: we can add new technologies/data types very quickly**

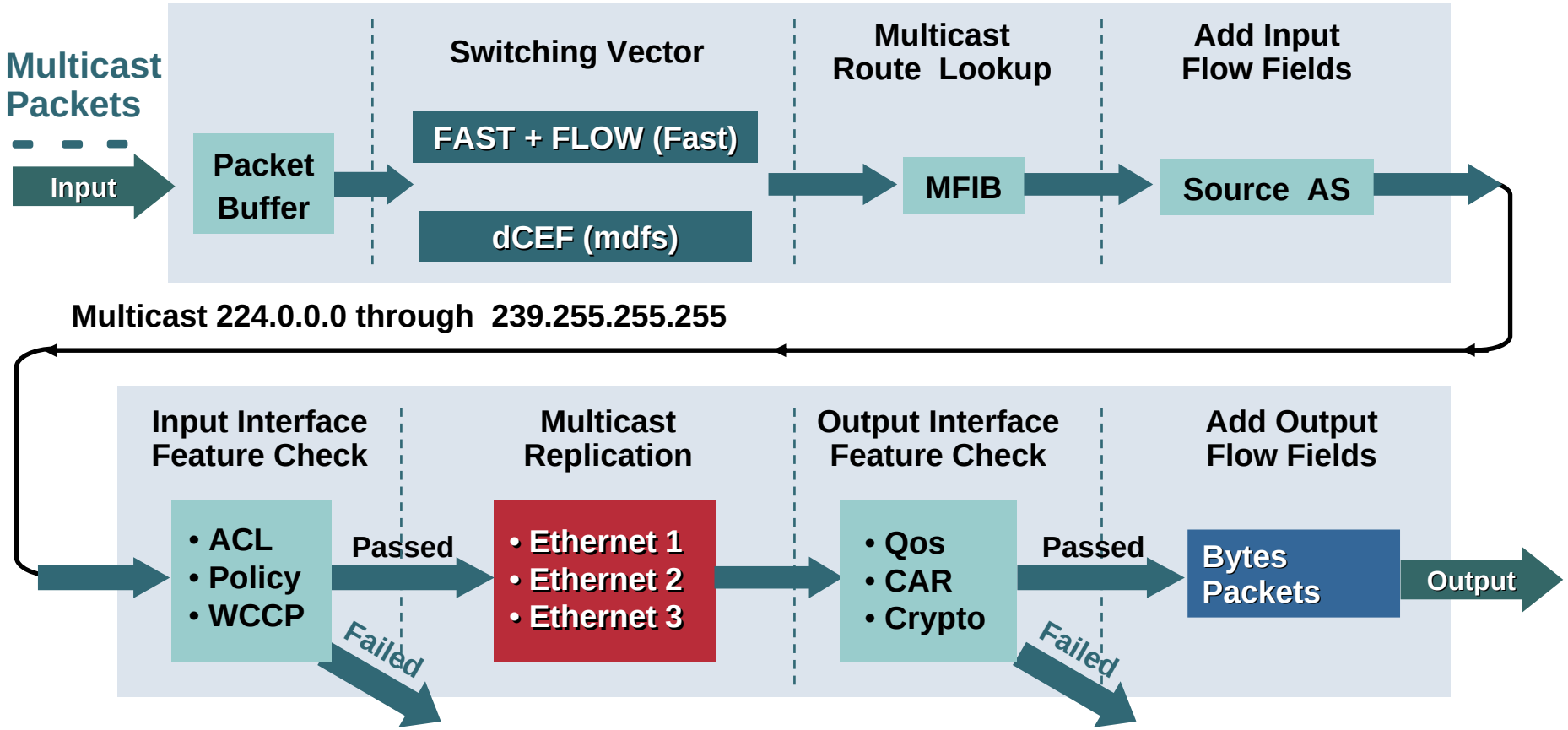
  e.g. MPLS, IPv6, BGP Next Hop, Multicast,…

Multicast NetFlow

Three Types of NetFlow Implementations for Multicast Traffic:

1. **Traditional Ingress NetFlow**
2. **Multicast NetFlow Ingress**
3. **Multicast NetFlow Egress**

Switching Path Implications for NetFlow Multicast



- Does each outgoing interface generate a separate flow?
- Do the bytes and packets reflect input or output numbers?

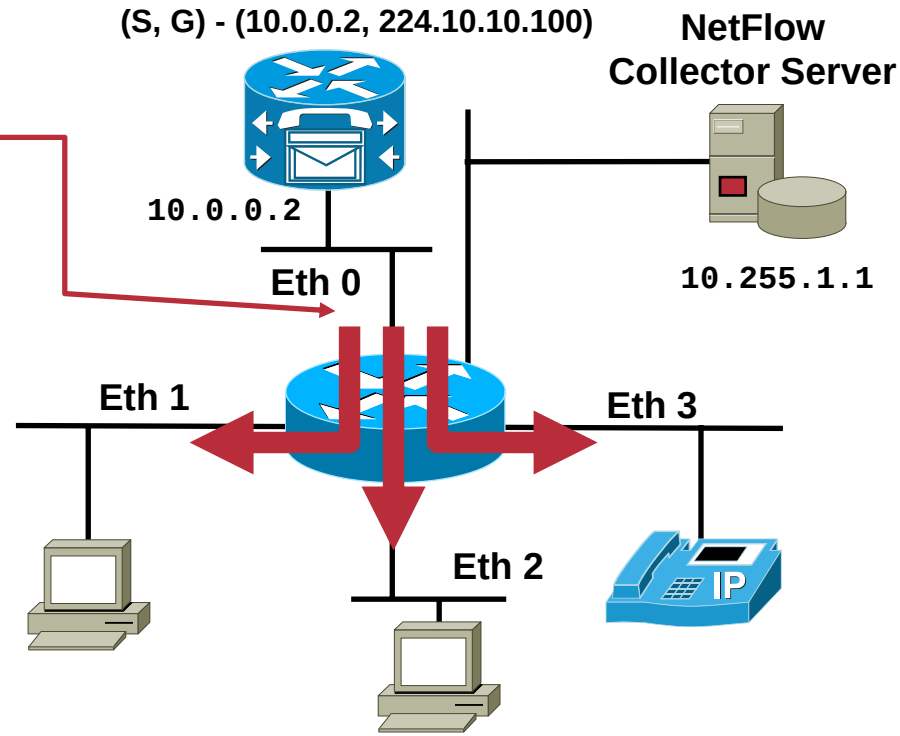
Multicast: Traditional NetFlow

Traditional NetFlow Configuration

```
Interface Ethernet 0
    ip route-cache flow
    or
    ip flow ingress

ip flow-export version 9

ip flow-export destination 10.255.1.1 9995
```



Flow Record Created in NetFlow Cache

SrcIf	SrcIPadd	DstIf	DstIPadd	Protocol	TOS	Flgs	SrcPort	DstPort	Bytes	Packets		
Eth0	10.0.0.2	Null	224.10.10.100	11	80	10	00A2	00A2	23100	21		

- There is only one flow per NetFlow configured input interface
- Destination interface is marked as “Null”
- Bytes and Packets are the incoming values

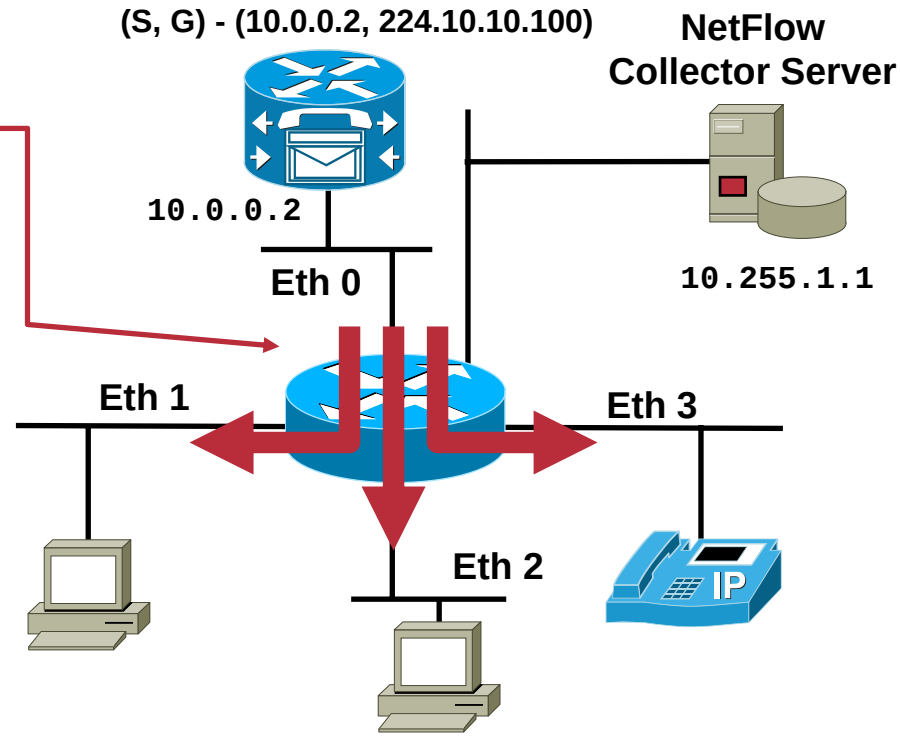
Multicast NetFlow Ingress (v9)

Multicast NetFlow Ingress Configuration

```
Interface Ethernet 0
    ip flow ingress
    ip multicast netflow ingress

ip flow-export version 9

ip flow-export destination 10.255.1.1 9995
```



Flow Record Created in NetFlow Cache

SrcIf	SrcIPadd	DstIf	DstIPadd	Protocol	TOS	Flgs	SrcPort	DstPort	Bytes	Packets	Obytes	Opackets
Eth0	10.0.0.2	Null	224.10.10.100	11	80	10	00A2	00A2	23100	21	69300	63

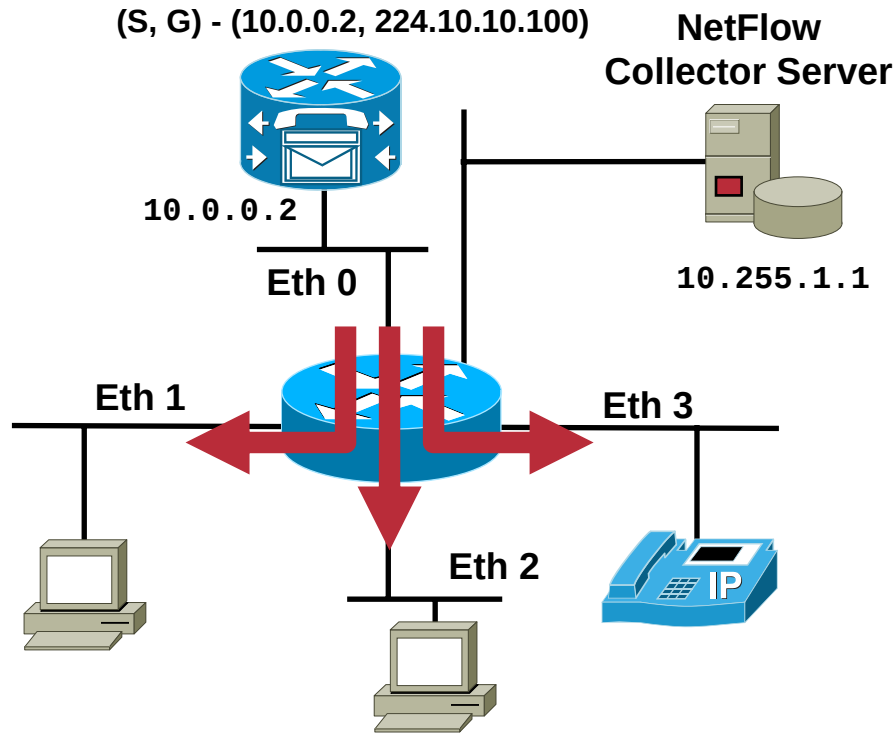
- There is only one flow per NetFlow configured input interface
- Destination interface is marked as “Null”
- Bytes and Packets are the incoming values
- Obytes and Opackets are outgoing values across all interfaces – sw based routers only

Multicast NetFlow Egress (v9)

Multicast NetFlow Egress Configuration

```
Interface Ethernet 1
    ip multicast netflow egress
Interface Ethernet 2
    ip multicast netflow egress
Interface Ethernet 3
    ip multicast netflow egress


ip flow-export version 9
ip flow-export destination 10.255.1.1 9995
```



Flow Records Created in NetFlow Cache

SrcIf	SrcIPadd	DstIf	DstIPadd	Protocol	TOS	Flgs	SrcPort	DstPort	Bytes	Packets		
Eth0	10.0.0.2	Eth1*	224.10.10.100	11	80	10	00A2	00A2	23100	21		
Eth0	10.0.0.2	Eth2*	224.10.10.100	11	80	10	00A2	00A2	23100	21		
Eth0	10.0.0.2	Eth3*	224.10.10.100	11	80	10	00A2	00A2	23100	21		

- There is one flow per Multicast NetFlow Egress configured output interface
- One of the Key fields that define a unique flow has changed from source interface to destination interface
- Bytes and Packets are the outgoing values

Multicast NetFlow: config anomalies

- **`ip multicast netflow ingress`**
  - **enabled by default**
  - **is not nvgened**
  - **if *`ip flow ingress`* is enabled, multicast netflow will be enabled**
- **`ip multicast netflow egress`**
  - **disabled by default**
  - **Unicast netflow must be enabled on at least one interface**

Multicast NetFlow: Minimum Config - Ingress

Software Based Routers (e.g. 7200)

```
interface Ethernet 0
   ip flow ingress
   ip multicast netflow ingress

ip flow-export version 9
ip flow-export destination 10.255.1.1 9995
```

ip multicast netflow ingress **is not nvgened and not required**

Multicast NetFlow: Minimum Config - Egress

Software based routers (e.g. 7200)

```
interface Ethernet 0
   ip flow ingress
   ip multicast netflow egress

ip flow-export version 9
ip flow-export destination 10.255.1.1 9995
```

Multicast NetFlow: Minimum Config - Ingress

6500/7600 - Ingress

```
mls flow ip interface-full
mls nde sender
!
interface Vlan10
 ip flow ingress
 ip multicast netflow ingress
!
ip flow-export version 9
ip flow-export destination 10.255.1.1 9995
```

ip multicast netflow ingress **is not nvgened and not required**

Multicast NetFlow: Minimum Config - Egress

6500/7600 - Egress

```
mls flow ip interface-full
mls nde sender
!
interface Vlan10
 ip flow ingress   # can be configured on any interface
 ip multicast netflow egress
!
ip flow-export version 9
ip flow-export destination 10.255.1.1 9995
```

Multicast NetFlow: Export Format Summary

Software Based Router (e.g. 7200) – Ingress Accounting

SrcIf	SrcIPadd	DstIf	DstIPadd	Bytes	Packets	Obytes	Opackets
Eth0	10.0.0.2	Null	224.1.1.10	23100	21	69300	63

Software Based Router (e.g. 7200) – Egress Accounting

SrcIf	SrcIPadd	DstIf	DstIPadd	Bytes	Packets
Eth0	10.0.0.2	Eth1	224.1.1.10	23100	21
Eth0	10.0.0.2	Eth2	224.1.1.10	23100	21
Eth0	10.0.0.2	Eth3	224.1.1.10	23100	21

6500/7600 – Ingress Accounting

SrcIf	SrcIPadd	DstIf	DstIPadd	Bytes	Packets
Eth0	10.0.0.2	Null	224.1.1.10	23100	21

6500/7600 – Egress Accounting

SrcIf	SrcIPadd	DstIf	DstIPadd	Bytes	Packets
Null	10.0.0.2	Eth1	224.1.1.10	23100	21
Null	10.0.0.2	Eth2	224.1.1.10	23100	21
Null	10.0.0.2	Eth3	224.1.1.10	23100	21

Multicast NetFlow: RPF (Reverse Path Forwarding) Failures

- If “ip multicast netflow rpf-failure” is configured globally packets that have fields that should come from another input interface are blocked e.g. source IP and input interface doesn’t agree with the routing table
- When this feature is enabled globally:

```
Router(config)# ip multicast netflow rpf-failure
```

  the RPF failures are recorded as flows in the NetFlow cache
- Once configured, there will be a new field in the NetFlow cache called “RPF Fail” to count flows that fail and how many times

NetFlow MIB

- **Snapshot of current 'Top Talkers' NetFlow cache via SNMP – Works with PIM-Bidir**
- **Administration and configuration of NetFlow using the MIB interface**
- **NetFlow MIB cannot be used to retrieve all flow information due to scalability**
- **Example objects available:**
  - **Protocol distribution**
  - **Number of bytes/flows exported**
  - **Number of flows in cache**
- **This is targeted at Denial of Service (DoS) attacks, security monitoring and remote locations where export to a local NetFlow collector is not possible**
- **Available now in Release 12.3(7)T and 12.2(25)S**

Multicast NetFlow: Summary

- **Supported via NetFlow version 9 export format**
- **Performance: Ingress vs. Egress**
  - **Multicast NetFlow Ingress and traditional NetFlow will have similar performance numbers**
  - **Multicast NetFlow Egress will have performance impact that is proportional to the number of interfaces on which it is enabled (include input interfaces)**
- **Availability**
  - **Cisco IOS Software Release 12.3(1)**
  - **Cisco 12000 Series Internet Router – see next slide**
- **Cisco Cisco Catalyst 6500 Series and Cisco 7600 Series**
  - **Multicast NetFlow Ingress will be supported on the PFC3A, PFC3B or PFC3B-XL in 12.2(18)SXF**
  - **Multicast NetFlow Egress will require a PFC3B or PFC3B-XL**

Multicast NetFlow: 12000 Series

- **Ingress, Non-Sampled**
  - **Engines 3 and 5 (aggregated NetFlow only)**
  - **(reporting pre-replication counters only and output i/f Null)**
- **Ingress, Sampled mode**
  - **Engines 2, 3, 4+, 5, 6**
  - **(reporting pre-replication counters only and output i/f Null)**
- **Egress, Non-Sampled**
  - **multicast packets are not reported by any engine**
- **Egress, Sampled mode**
  - **Engines 3, 5**
  - **(reporting flows for each replica, i.e. post replication flows)**
- **Netflow on Engine 0 and 1 are not recommended**

Multicast NetFlow 6500/7600 Support

Initial support in 12.2(18)SXF

		NetFlow Accounting Mode		NetFlow v9 Export	View records at CLI
		Ingress	Egress		
Multicast replication mode	Ingress	Yes	Yes*	Yes	Yes
	Egress	Yes	No**	Yes	Yes

* Requires PFC3B/3B-XL
** Planned for Q1CY07

Multicast NetFlow Capacity – 6500/7600

	Size	Efficiency	Effective Utilization
Sup2/PFC2	Multicast NetFlow Not Supported		
Sup720/PFC3A	128K entries	50%	64K entries
Sup720/PFC3B	128K entries	90%	115K entries
Sup720/PFC3BXL	256K entries	90%	230K entries

More Info

For more information about netflow:

http://www.cisco.com/go/netflow

Network Mgmt for PIM-SM

- **RPs can be discovered through MIBs**
- **RP Group Ranges can be discovered for Auto-RP and BSR**
- **RP knows about all active groups**
- **Mroute MIB can retrieve the entire forwarding table**
- **MSDP MIB can show which RPs are running MSDP and their peering status**
- **IGMP MIB can show you which groups have receivers on which interfaces**
- **Multicast NetFlow can be used for traffic analysis**

Network Mgmt for PIM-SSM

- **No RP**
  - **No central place to check for all S,Gs**
- **S,G mroutes can be tracked, measured with IP Mroute MIB**
- **IGMP MIB can give you group membership information**
  - **IGMPv3 is not supported**
  - **No source information**
- **Multicast NetFlow can be used for traffic analysis**

Network Mgmt for Bidir

- **RP knows about all active groups**
- **No S,G Entries**

  Mroute MIB and ‘show ip mroute count’ will not be able to give any info on sources
- ***,G still there – MIBs OK**

  Traffic info is aggregated on a group

  Source only branches

  Use show mls ip multicast rp-mapping gm-cache
- **Need Source info? – Use NetFlow**

  Multicast NetFlow will have all S,G info with traffic rates

Network Mgmt for mVPN

- CE routers use same mgmt tools – no change
- On PE routers the CISCO-MVPN-MIB can provide:
  - A list of all active multicast VRFs
  - How many interfaces are configured for each VRF
  - Which default and data MDTs are in use for each VRF
  - Which P Domain S,Gs are being used for each MDT
  - Which P Domain S,Gs are being used for each C Domain mroute
- The P Domain S,G can be looked up in the IPMROUTE-MIB or IPMROUTE-STD-MIB to collect statistics
- P Domain groups can be managed with normal methods

Network Management Systems (NMS) for IP Multicast

Some Multicast NMS Products

- **Cisco Multicast Manager**

- **HP OpenView NNM Smart Plug-in for IP Multicast**

- **InCharge™ IP Multicast Manager**

- **SPECTRUM® Multicast Manager**

Cisco NetFlow Applications and Partners

Traffic Analysis

Open Source
- Flow-Tools
- FlowMon
- Flowd

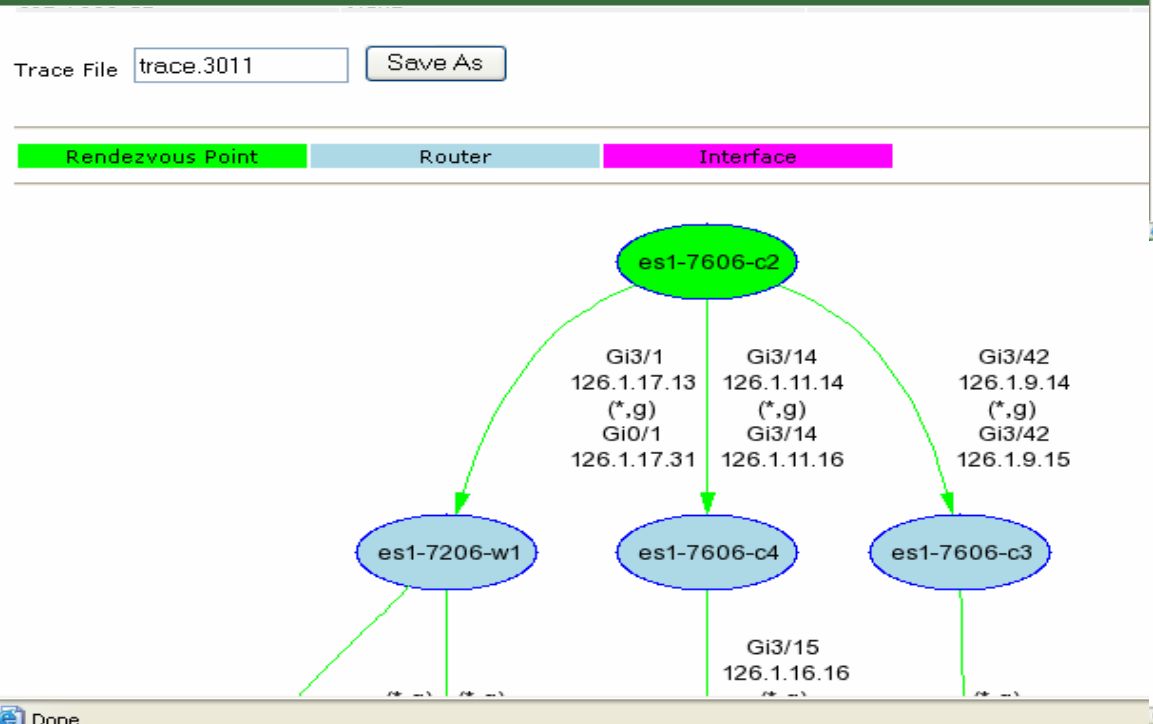
Denial of Service

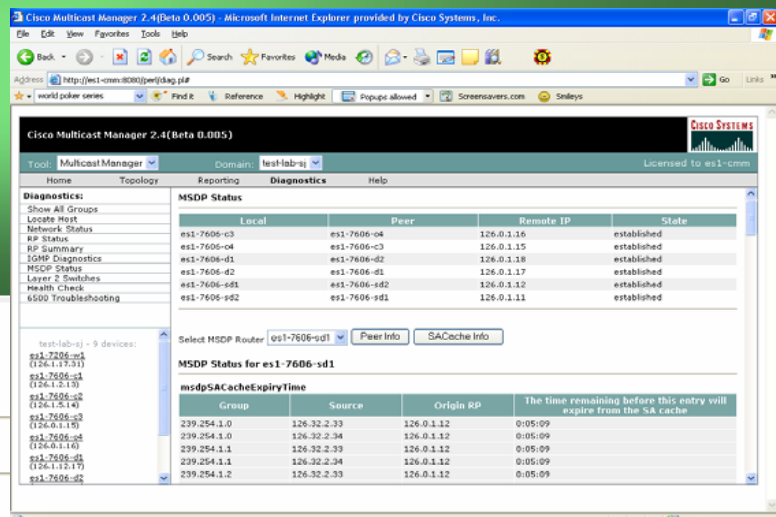
Billing

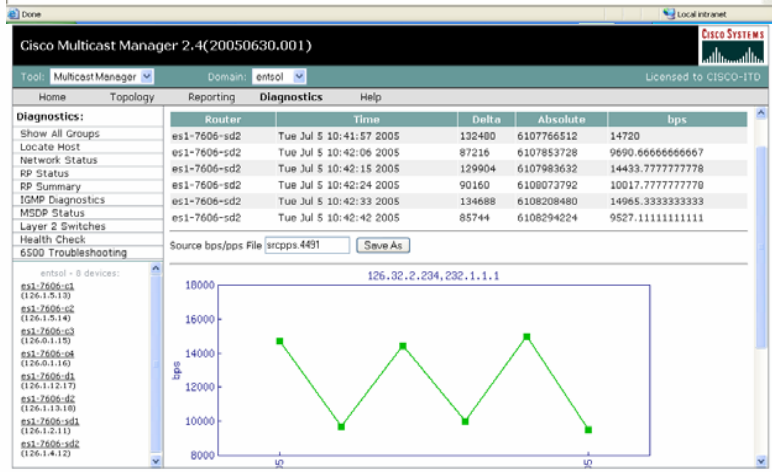
More info: http://www.cisco.com/warp/public/732/Tech/nmp/netflow/partners/commercial/

Cisco Multicast Manager 2.3(3)

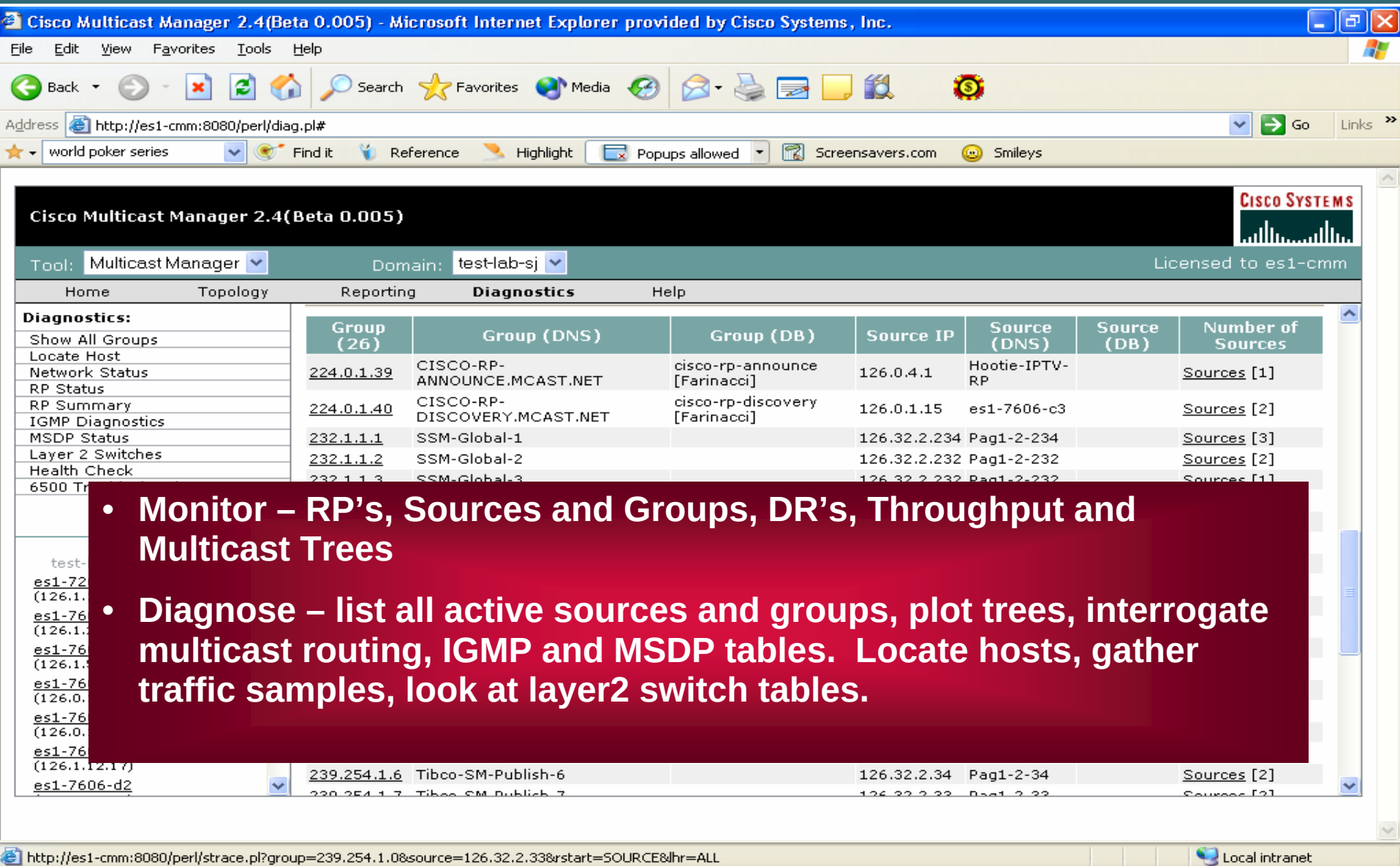
- Web based software application
- Monitor all critical components of the multicast network
- Simplifies troubleshooting tasks
- In-depth multicast diagnostics
- Trending and analysis





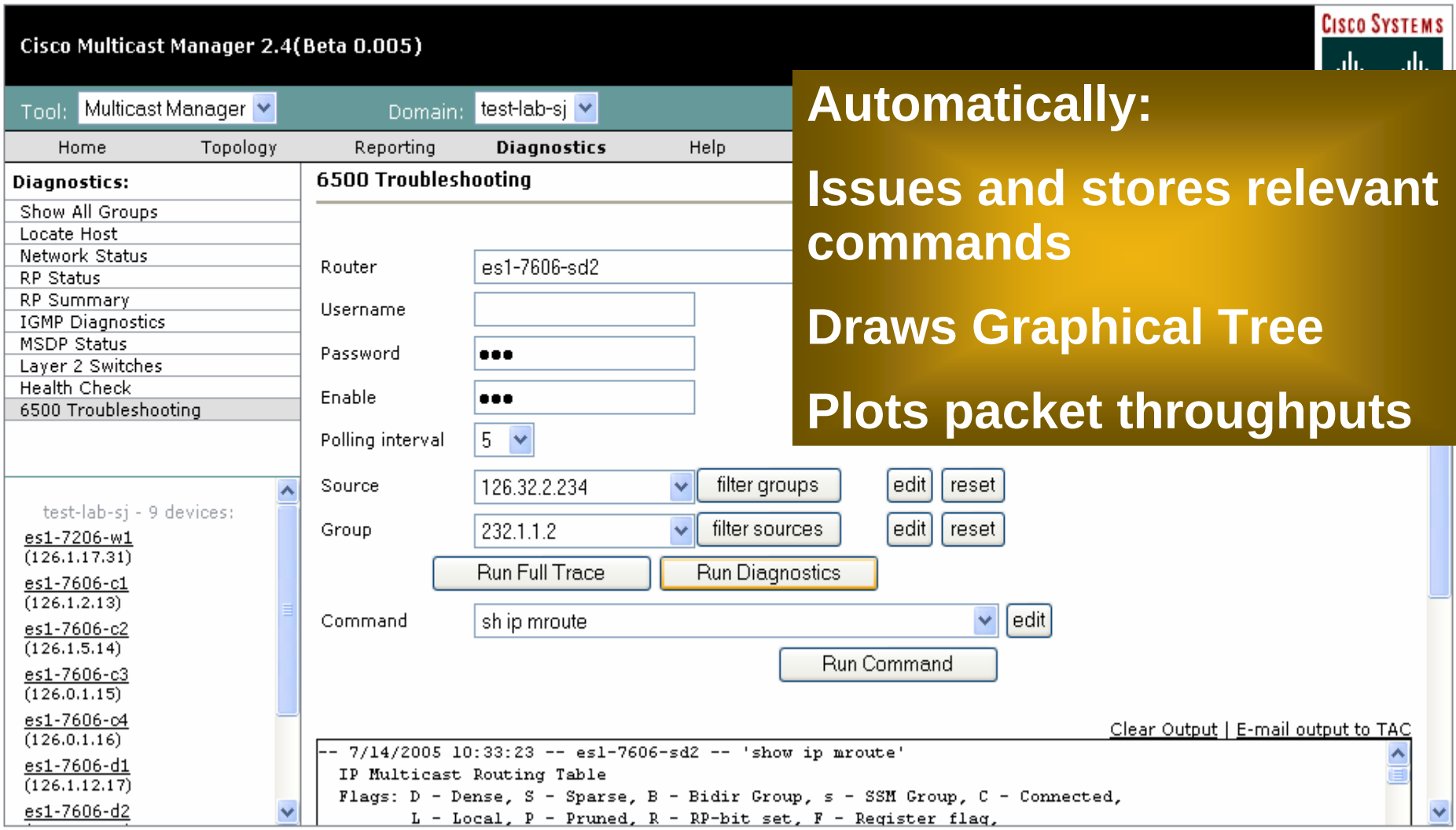


Cisco Multicast Manager 2.3(3)



- **Monitor – RP's, Sources and Groups, DR's, Throughput and Multicast Trees**
- **Diagnose – list all active sources and groups, plot trees, interrogate multicast routing, IGMP and MSDP tables. Locate hosts, gather traffic samples, look at layer2 switch tables.**

Custom Built 6500 Multicast Troubleshooting



Automatically:

Issues and stores relevant commands

Draws Graphical Tree

Plots packet throughputs

Cisco Multicast Manager 2.4(Beta 0.001) - Microsoft Internet Explorer provided by Cisco Syste

Monitoring: P3-msfc-3, Source: 11.51.150.101, Group: 239.224.3.1 - Microsoft Intern...

Device	IP	DR
P3-msfc-3	11.51.129.26	11.51.129.26
Source	**Group**	**RPF**
11.51.150.101	239.224.3.1	11.51.129.25
Incoming Interface	**Packets Received**	**Outgoing Interfaces**
Vlan5	21556335 (14.4/sec)	Vlan32 4/2

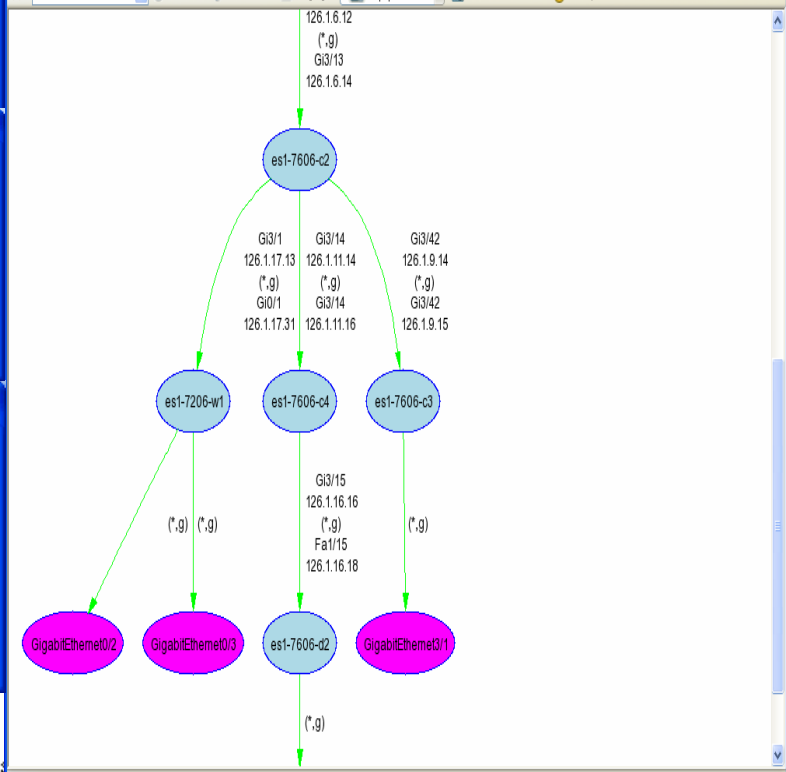
Monitoring: P3-msfc-2, Source: 11.51.150.101, Group: 239.224.3.1 - Microsoft Intern...

Device	IP	DR
P3-msfc-2	11.51.129.6	11.51.150.254
Source	**Group**	**RPF**
11.51.150.101	239.224.3.1	0.0.0.0
Incoming Interface	**Packets Received**	**Outgoing Interfaces**
Vlan310	25017470 (10.2/sec)	Vlan3 1/2 2/3 15/1 Vlan5

Monitoring: P3-msfc-4, Source: 11.51.150.101, Group: 239.224.3.1 - Microsoft Intern...

Device	IP	DR
P3-msfc-4	11.51.129.30	11.51.129.30
Source	**Group**	**RPF**
11.51.150.101	239.224.3.1	11.51.129.29
Incoming Interface	**Packets Received**	**Outgoing Interfaces**
Vlan4	21556074 (9.4/sec)	Vlan30 15/1 4/1

Untitled Document - Microsoft Internet Explorer provided by Cisco Systems, Inc.



IPmcLab - 12 devices:

- P2-7206-1 (11.51.65.1)
- P2-7206-2 (11.51.65.9)
- P2-ntv-1 (11.51.65.2)
- P2-ntv-2 (11.51.80.254)
- P2-ntv-3 (11.51.65.14)
- P2-ntv-4 (11.51.65.22)
- P3-7206-1

```
    Vlan3, Forward/Sparse, 3wld/00:02:54, H

(11.51.130.91, 239.224.100.117), 3w6d/00:03:28, flags
  Incoming interface: Vlan4, RPF nbr 11.51.129.30, R
  Outgoing interface list:
    Vlan3, Forward/Sparse, 3wld/00:02:54, H

(11.51.130.92, 239.224.100.117), 3w6d/00:03:28, flags: T
  Incoming interface: Vlan4, RPF nbr 11.51.129.30, RPF-MFD
  Outgoing interface list:
    Vlan3, Forward/Sparse, 3wld/00:02:54, H

(11.51.130.93, 239.224.100.117), 3w6d/00:03:28, flags: T
  Incoming interface: Vlan4, RPF nbr 11.51.129.30, RPF-MFD
```

Done

Local intranet

Benefits of Deploying CMM

- **Operations and Support teams could monitor all the critical aspects of multicast and be quickly alerted in the event of a problem.**
- **If a problem is found then the Diagnostics part of CMM will provide detailed analysis and statistics that will help locate and identify the problem**
- **Potential problems with the Multicast network can be identified before they become major outages**
- **The End User experience improves dramatically as problems can be found and rectified immediately**

Cisco IP SLAs for Multicast

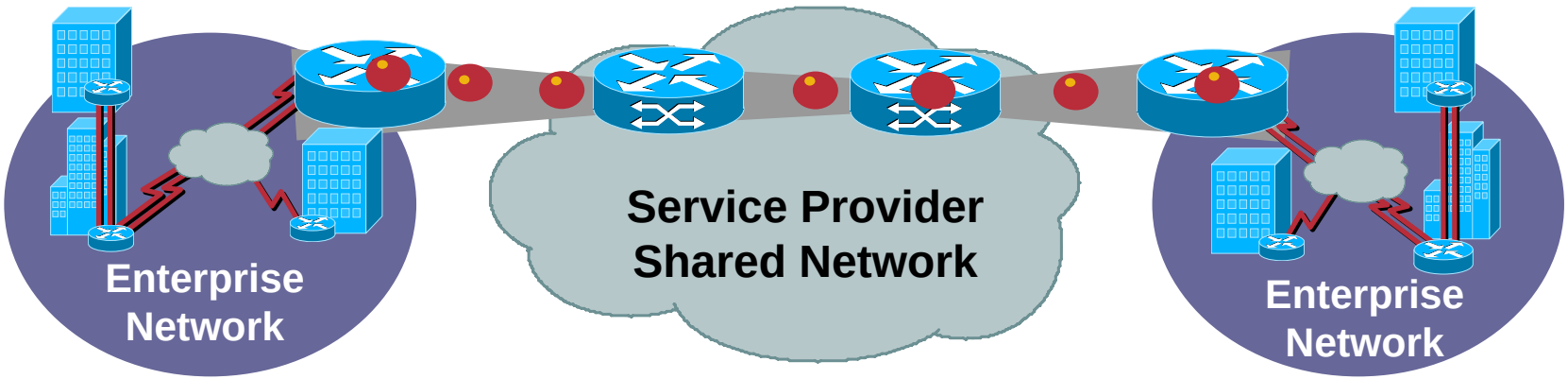
What Is Cisco IP SLAs?

- Cisco IOS Feature for IP SLA measurement
- SLA Stands for Service Level Agreement
- Includes RTT, One-Way Latency, Inter-Arrival Packet Jitter, Packet Loss, and MOS Measurement Statistics
- Many protocols and applications supported
- TCP, UDP, ICMP, HTTP, RTP, FTP, DNS, DHCP, DLSW, LDP, H.323, SIP

SA Agent (IPSLA) and Service Delivery

SLAs Are Becoming an Integral Part of Service Delivery

- **Businesses are relying on them for mission critical applications (voice, clearing,…)**
- **SLA is the cornerstone of carriers' differentiated service offerings**



The Idea Behind IP SLA

- **If you have a running Cisco IOS® router, turn it into an active probing device**

  The smart approach

- **Reuse your current equipment and enhance existing network management applications:**

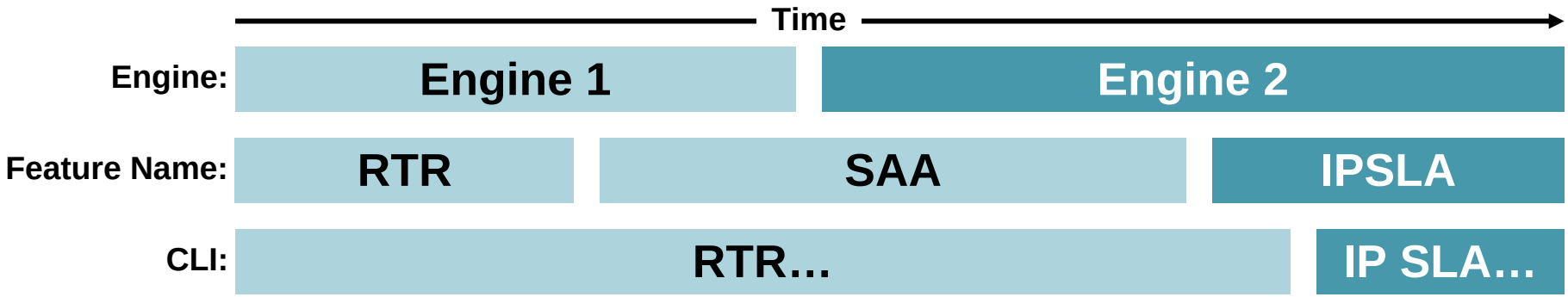
  (CiscoWorks, IP Solution Center (ISC), Cisco InfoCenter)

New Partners 2006

Agilent Technologies

IP SLAs History

- **Used to be called RTR, renamed SAA in 12.0(5)T; we call it “Engine 1”**
- **New “Engine 2” is a major code rewrite introduced initially in 12.2(11)T, and now present in all 12.3 and later trains; engine 2 is faster and consumes less memory**
- **New name for 12.4 release: IP SLA, but still using Engine 2**

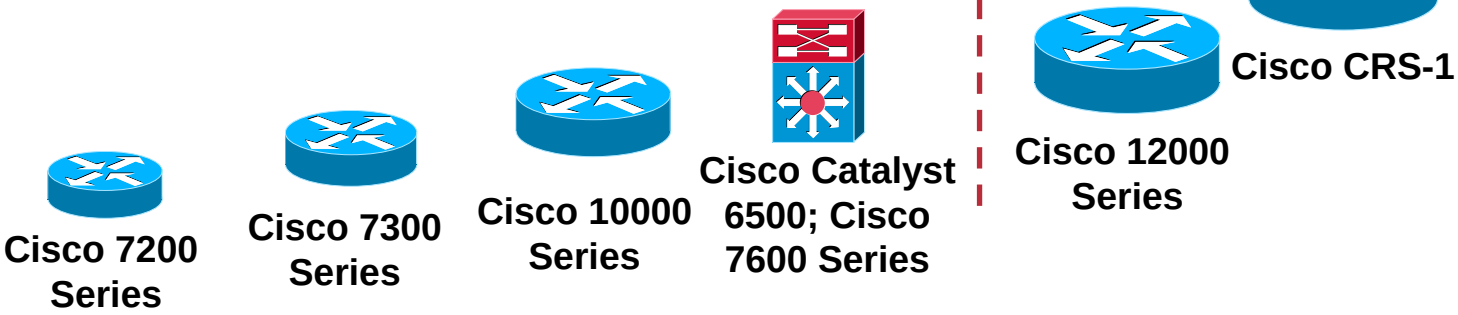


Comprehensive Hardware Support

Enterprise and Aggregation/Edge

Core

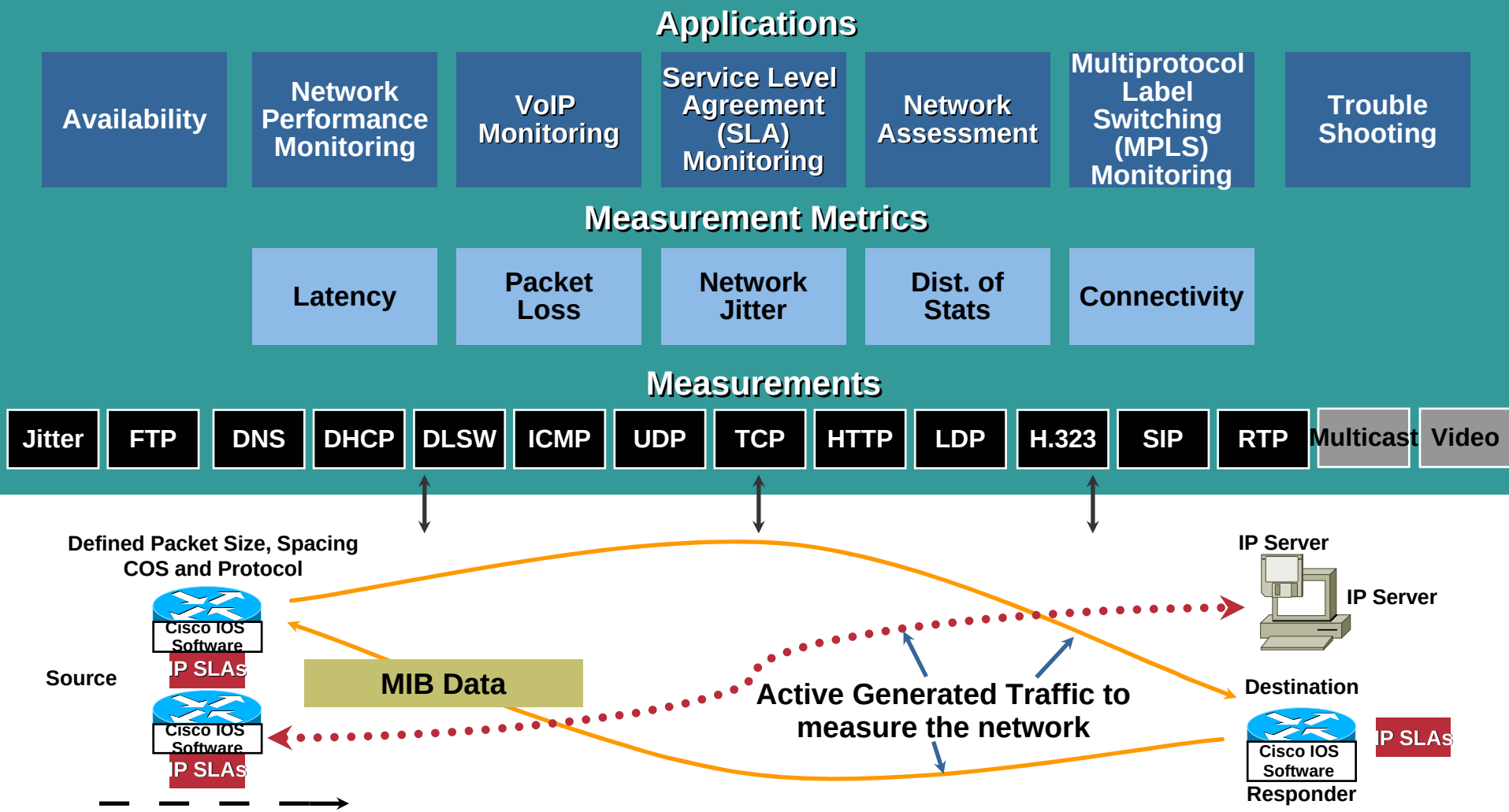
Cisco IOS Software Release 12.2S



Access

Cisco IOS Software Releases 12.3T and 12.4

Multiprotocol Measurement and Management with Cisco IOS IP SLAs

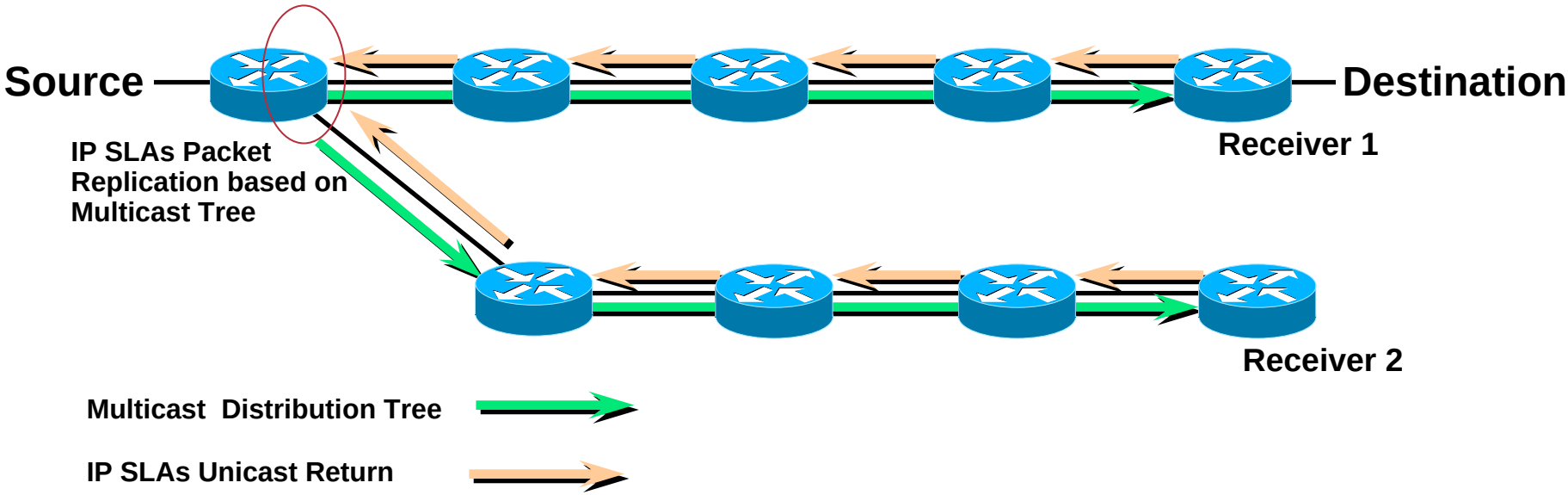


IP SLAs Summary

- **Cisco IOS feature**
- **Provides real-time performance metrics on a wide range of protocols**
- **Millisecond resolution and trend visibility**
- **Already in Cisco IOS for unicast and available on most platforms and interfaces**
- **So what about multicast ?**

IP SLAs for Multicast

- Source uses UDP jitter measurement with responder at receiver
- IP SLAs active measurements send stream of packets
- Packets replicated and follow multicast tree
- Receiver's with responders reply via unicast to source
- Source needs to accumulate statistics and group results



IP SLAs for Multicast: Summary

IP SLAs will allow you to:

- Create multicast state in the network
- Generate multicast traffic for specific groups
- Verify the end to end multicast distribution network in terms of
  - Connectivity
  - Packet Loss
  - Latency
- Available in a future release

More Info

For more information about IP SLAs:

http://www.cisco.com/go/ipsla

Multicast VPN Provisioning

- **Internet Solutions Center (ISC) – MPLS VPN Management**
- **Multicast Address Pools associated to Provider**
  - **Each Pool can be used for Default, Data or both types of MDTs (Multicast Distribution Tree)**
- **VPNs enabled for multicast**
  - **Default and Data MDTs associated with VPN**
- **ISC Configures**
  - **VRF associated to the multicast VPN**
  - **PE and CE interfaces to enable multicast**
  - **Enables multicast routing for VRF**
- **Assumption**
  - **Provider core and Customer sites are pre-setup for multicast**

Monitoring and Troubleshooting Examples

Using CMM to Detect Multicast Faults

- **Many types of multicast networks have fairly static distribution trees during normal operation**
  - **Finance – Market Data**
  - **Video Distribution for cable TV**
- **Network state can be captured and monitored for changes**
- **CMM can send alerts when unexpected changes occur**

Monitoring

CMM can monitor:

- **Availability of RP's**
- **Selected Sources and Groups**
- **Multicast Trees**
- **Designated Routers (DRs)**
- **Layer2 Ports**
  - **High/Low data rate thresholds**

Monitoring — RPs

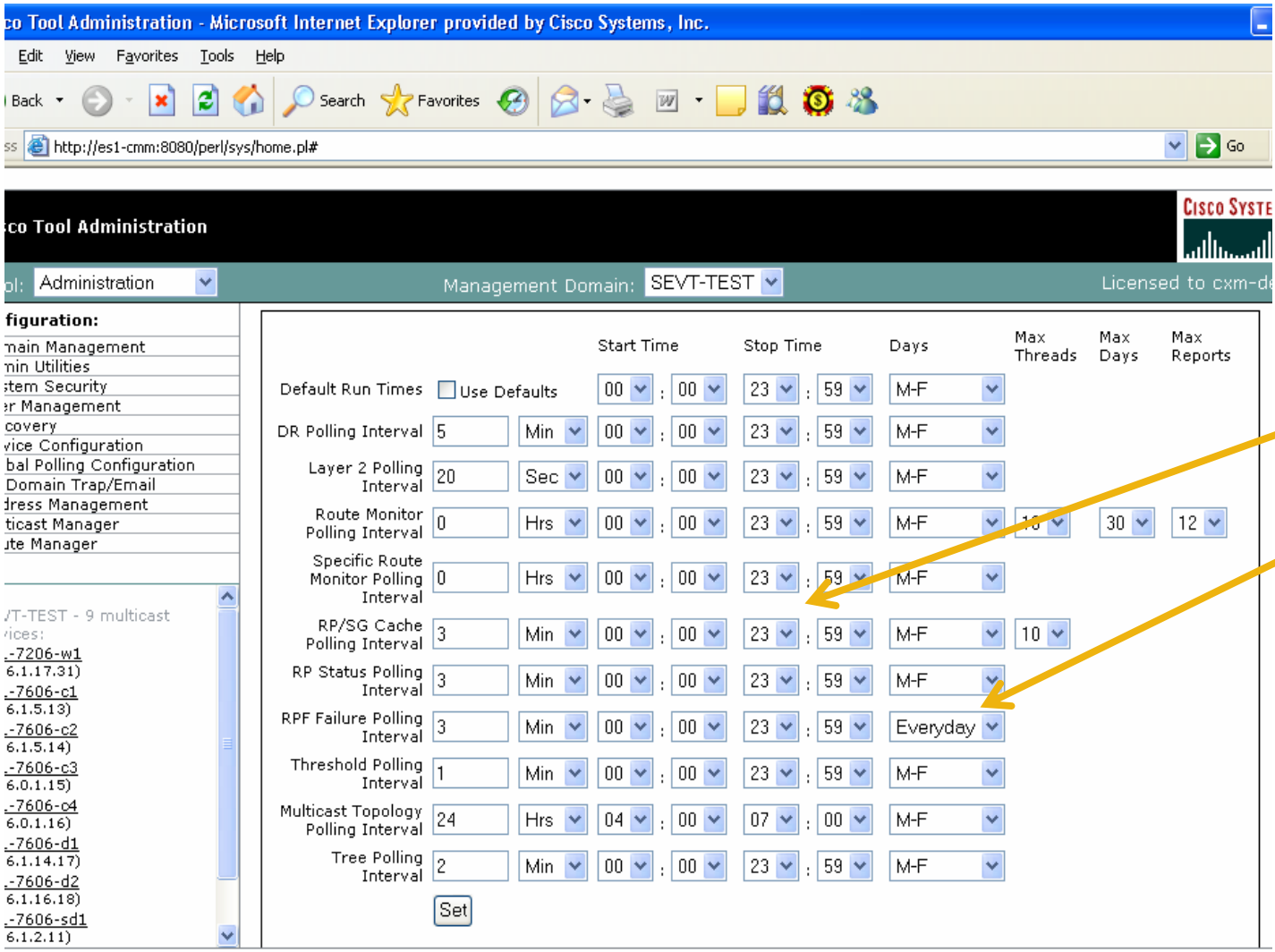
CMM can monitor the RPs:

- Is the RP up and available
- Set a threshold on the number of sources and groups that are registered
- Track all sources and groups that join and leave
- Report any rogue sources and groups joining

Monitoring — S,Gs

- CMM can find all of the active sources and groups
- The S,Gs can be monitored with thresholds for low and high pps
- Start with a large high threshold and a small low threshold number
- CMM will start to monitor the traffic sent by these sources to these groups at the routers you selected
- You can now use the historical reporting function to start base-lining more intelligent thresholds

Polling Configuration

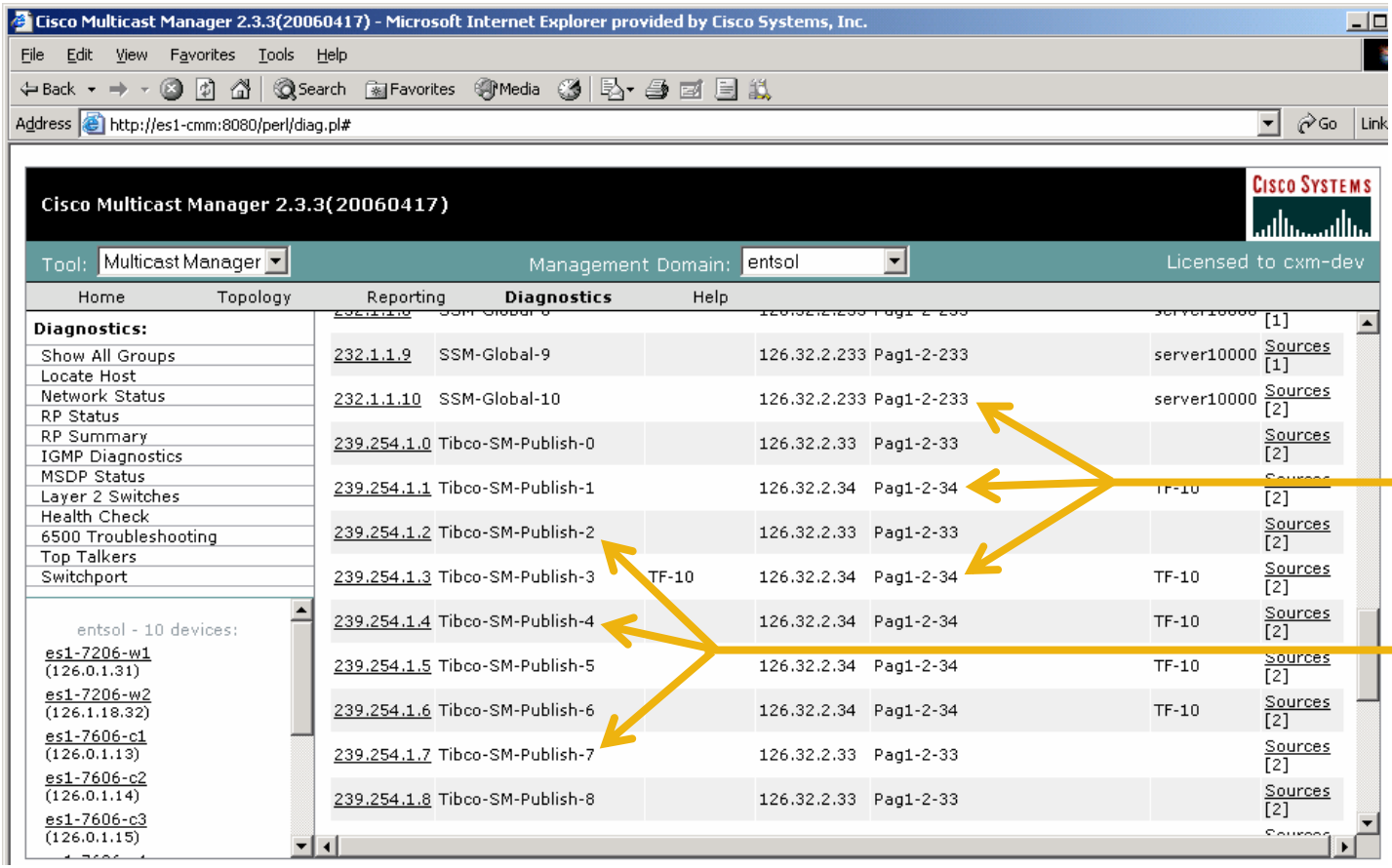


Configure polling intervals by time and day

Monitoring — Multicast Trees

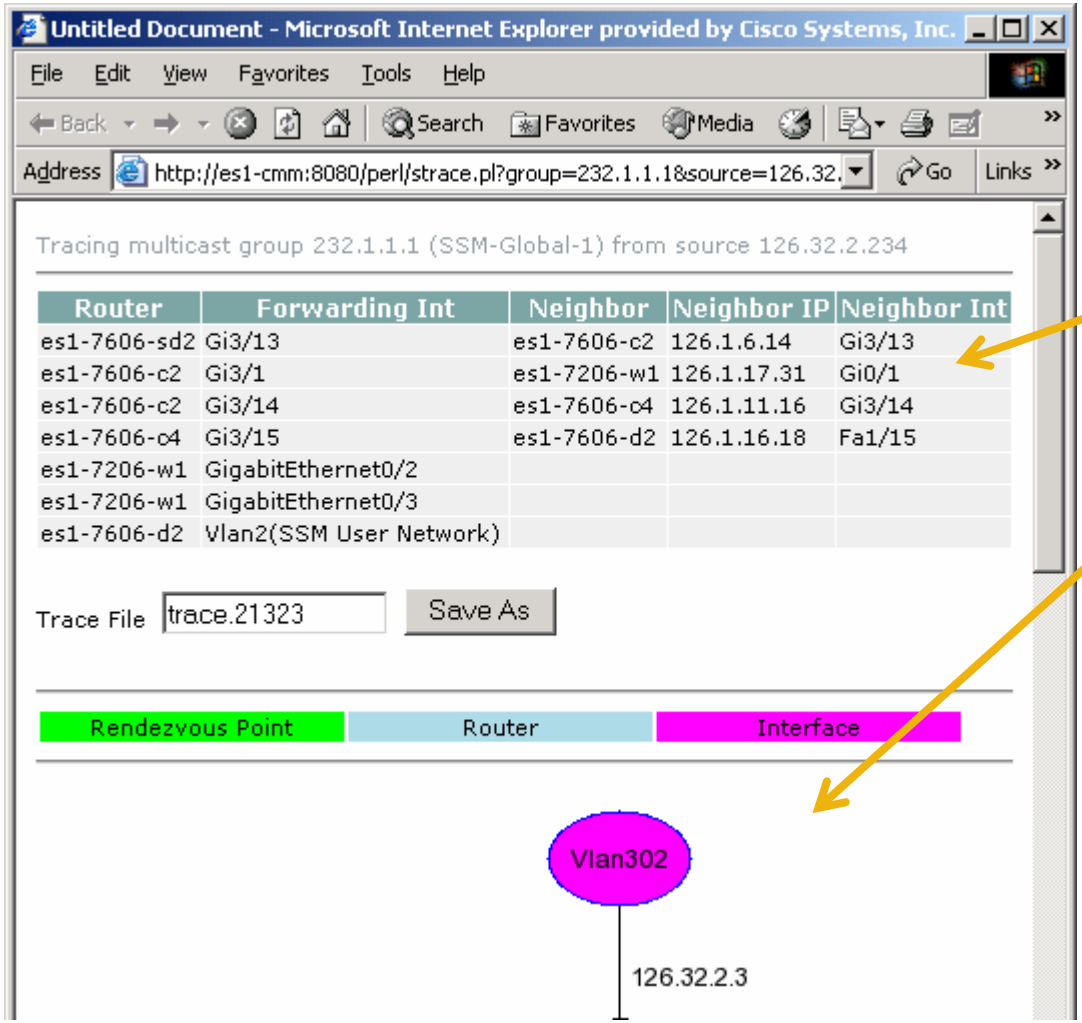
- **CMM can monitor multicast trees and report any changes.**
- **Within CMM you can draw the graphical trees that you want to monitor and save them**
- **These saved trees will then appear under the monitoring trees drop down box. Select the trees that you want to monitor and the polling period.**

Using CMM to Detect Multicast Faults



CMM can discover the active sources and groups

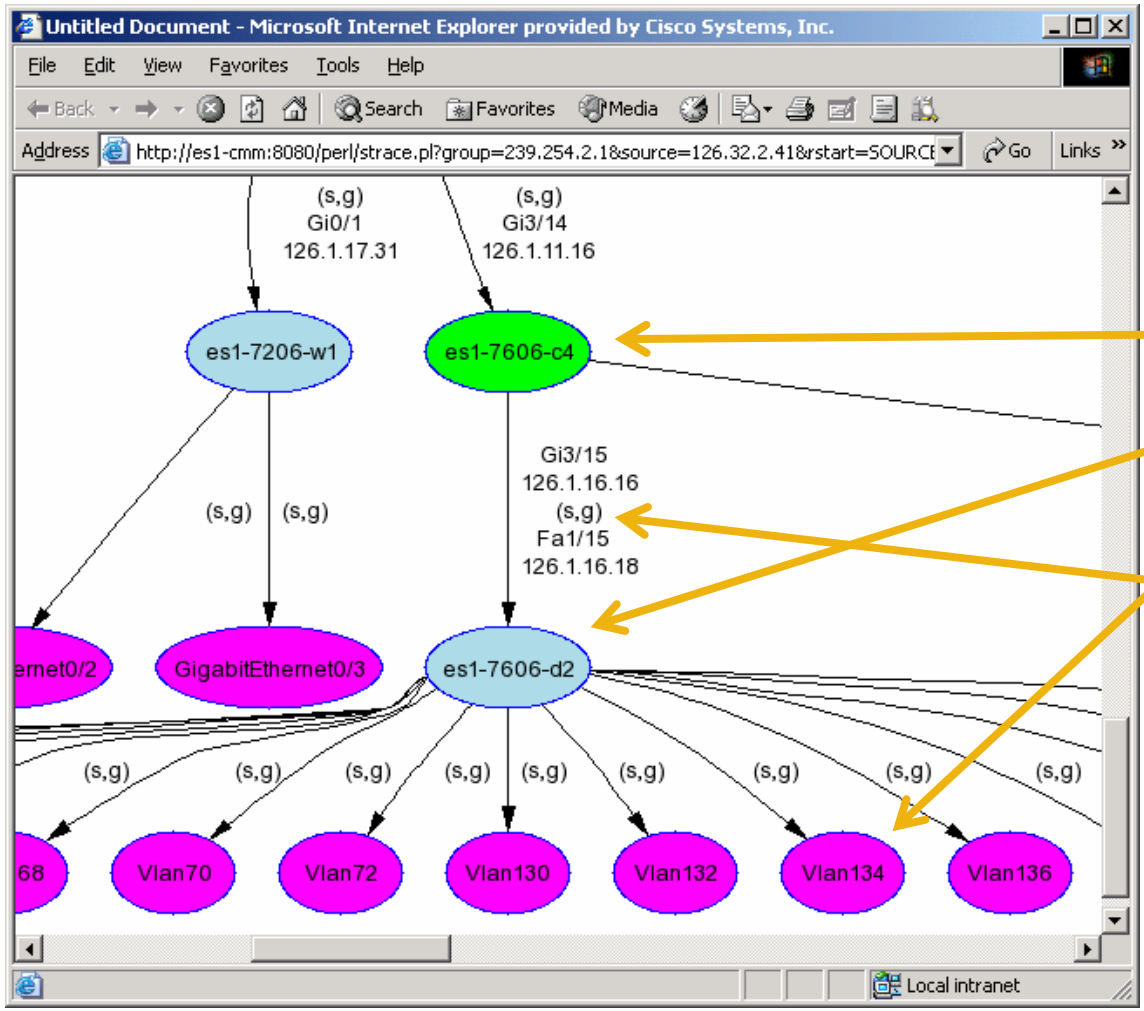
Using CMM to Detect Multicast Faults



The Tree trace produces a text based table and a graphic diagram

The text table is used to compare traces to detect changes

Using CMM to Detect Multicast Faults



- The graphic can be used to quickly identify
  - RPs
  - Routers
  - Interfaces
  - Forwarding state

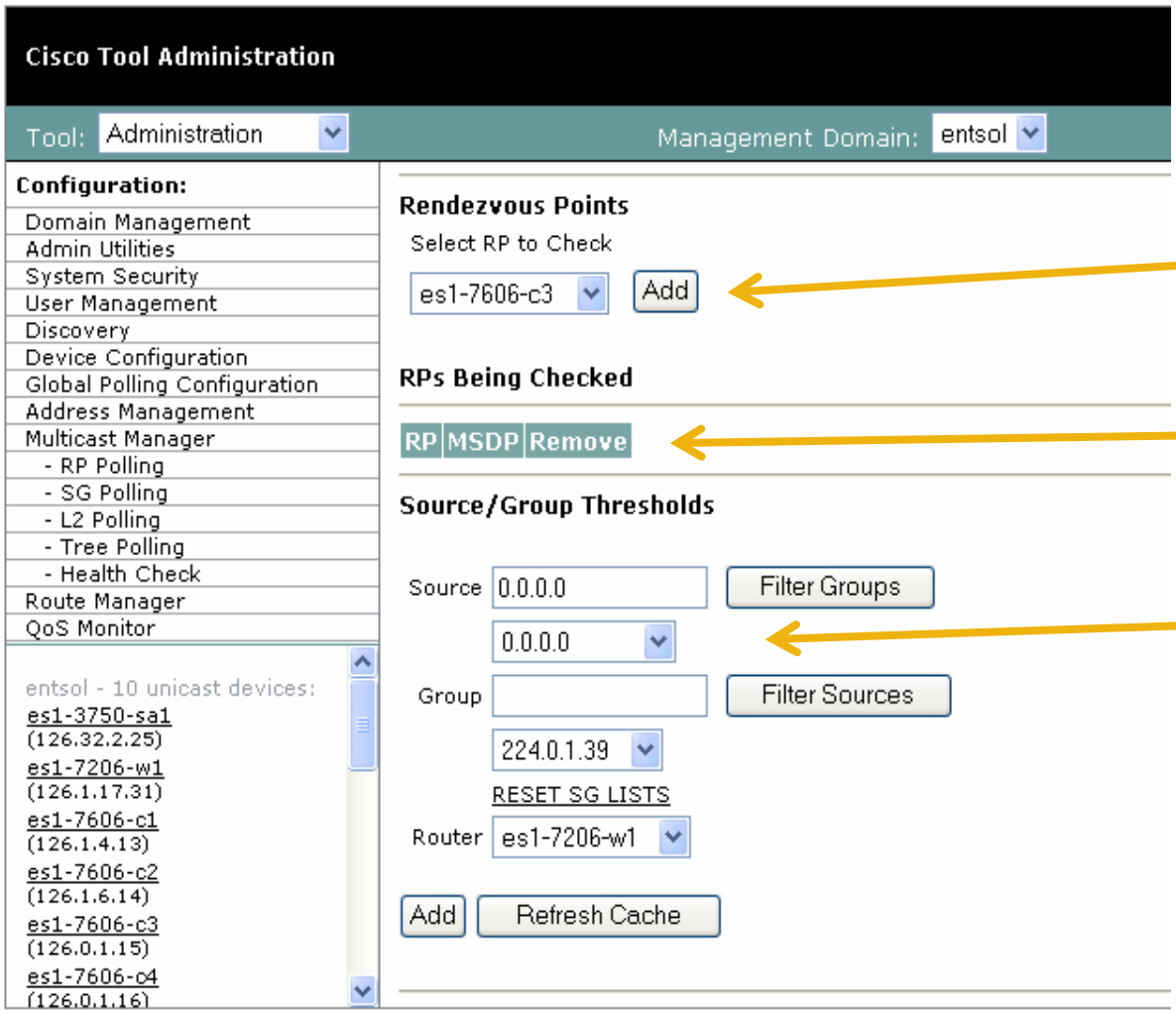
CMM: Health Checks

- **Ability to run pre-configured scripts to**
- **check the status of:**
- **RP's**
  - **sysUpTime is checked**
- **S,G's**
  - **S,G is checked if it exists**
- **MSDP**
  - **Peering sessions are checked for "established"**
- **Multicast Trees**
  - **Tree is compared against baseline**

CMM: Health Checks

- **Health checks can check the status of RP's, MSDP peering, the presence of sources and groups and the status of multicast trees.**
- **Configure a Health Check to check and report upon the critical components of your network**
- **Create a Health Check for every important source and group**
- **In the event of problems run the health checks immediately**

Health Check: Configuration

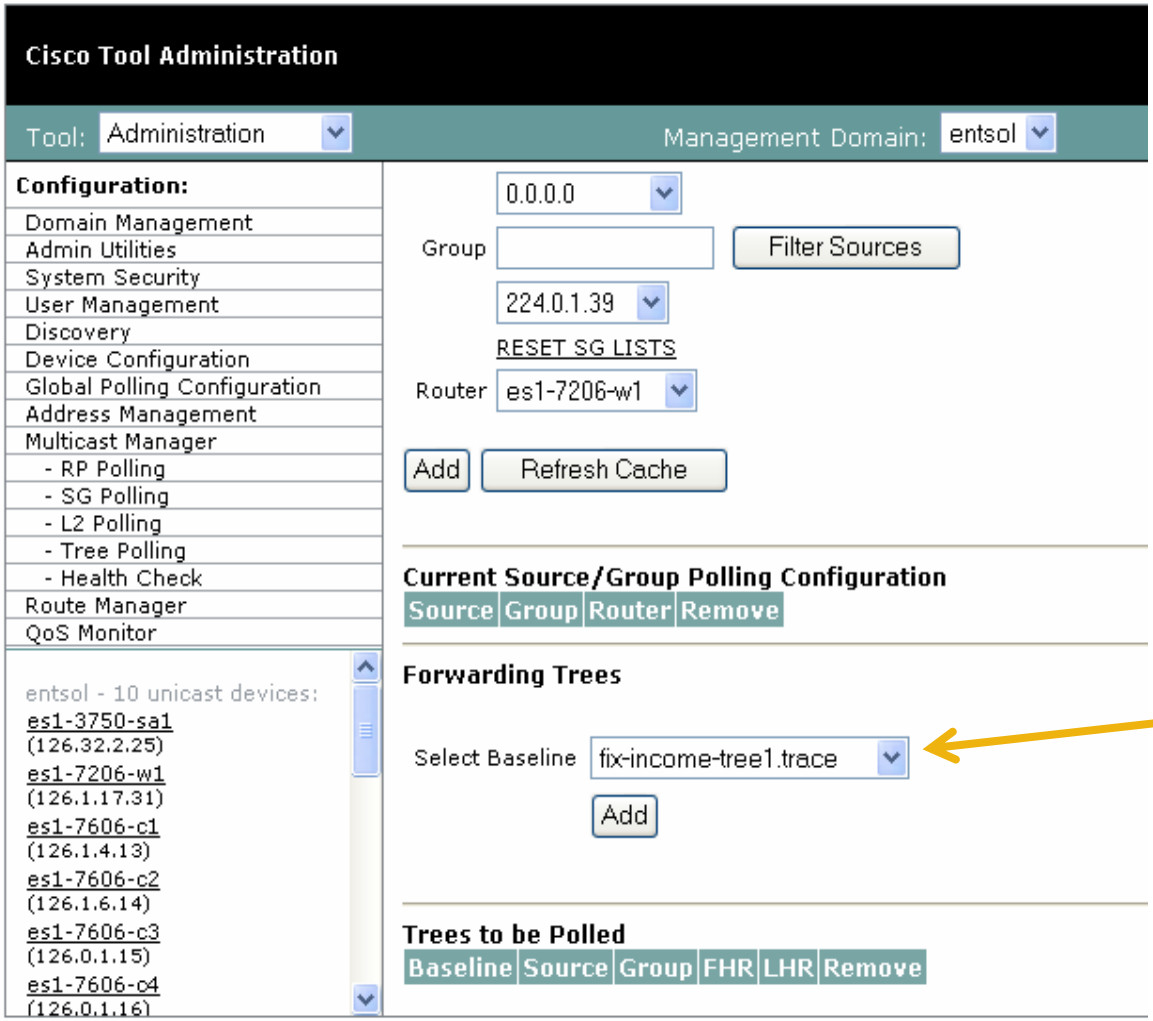


Add RP's to check

Add MSDP checks

Add S,G's to check

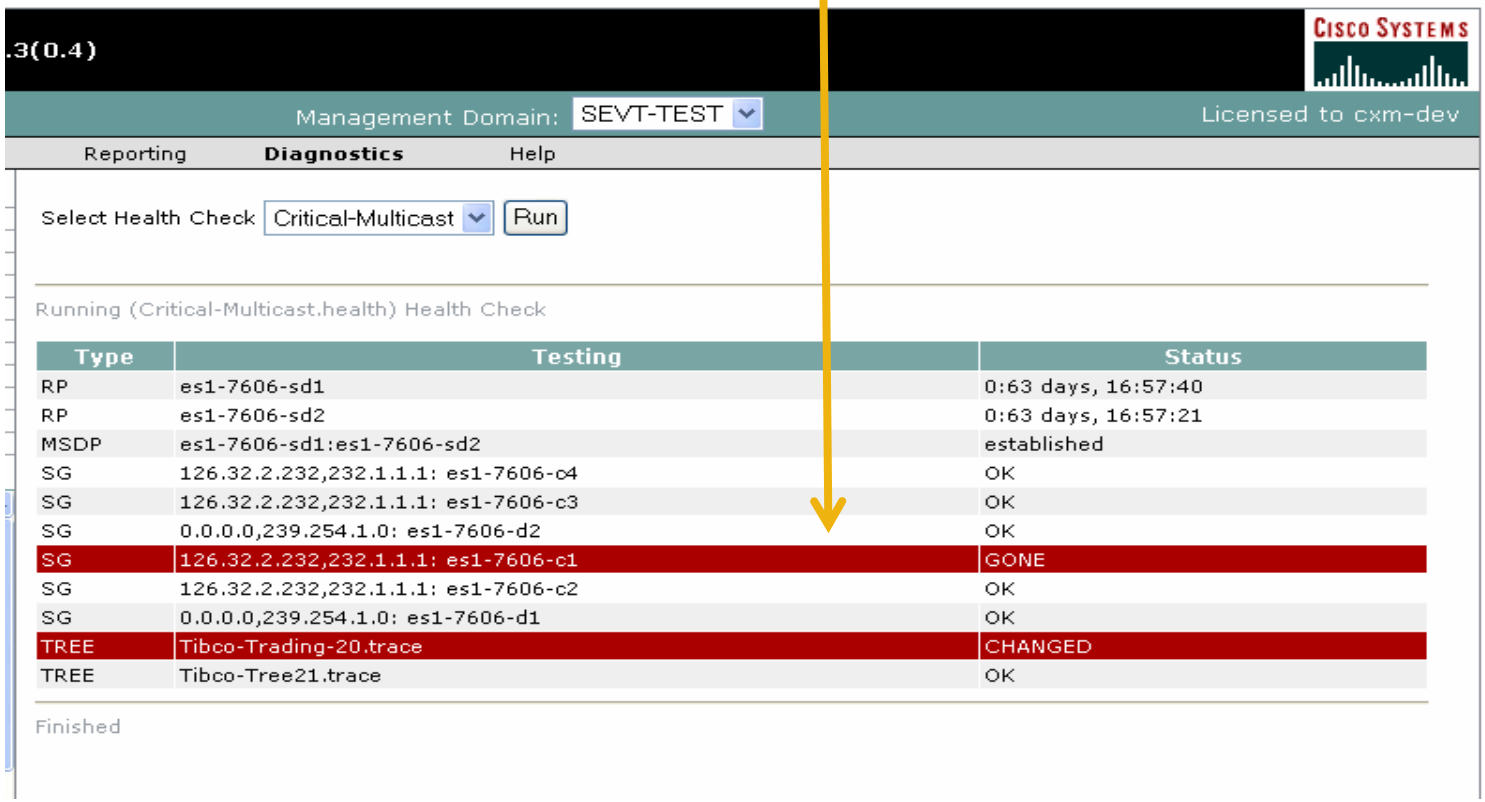
Health Check: Configuration



Add trees to check

Troubleshooting with CMM

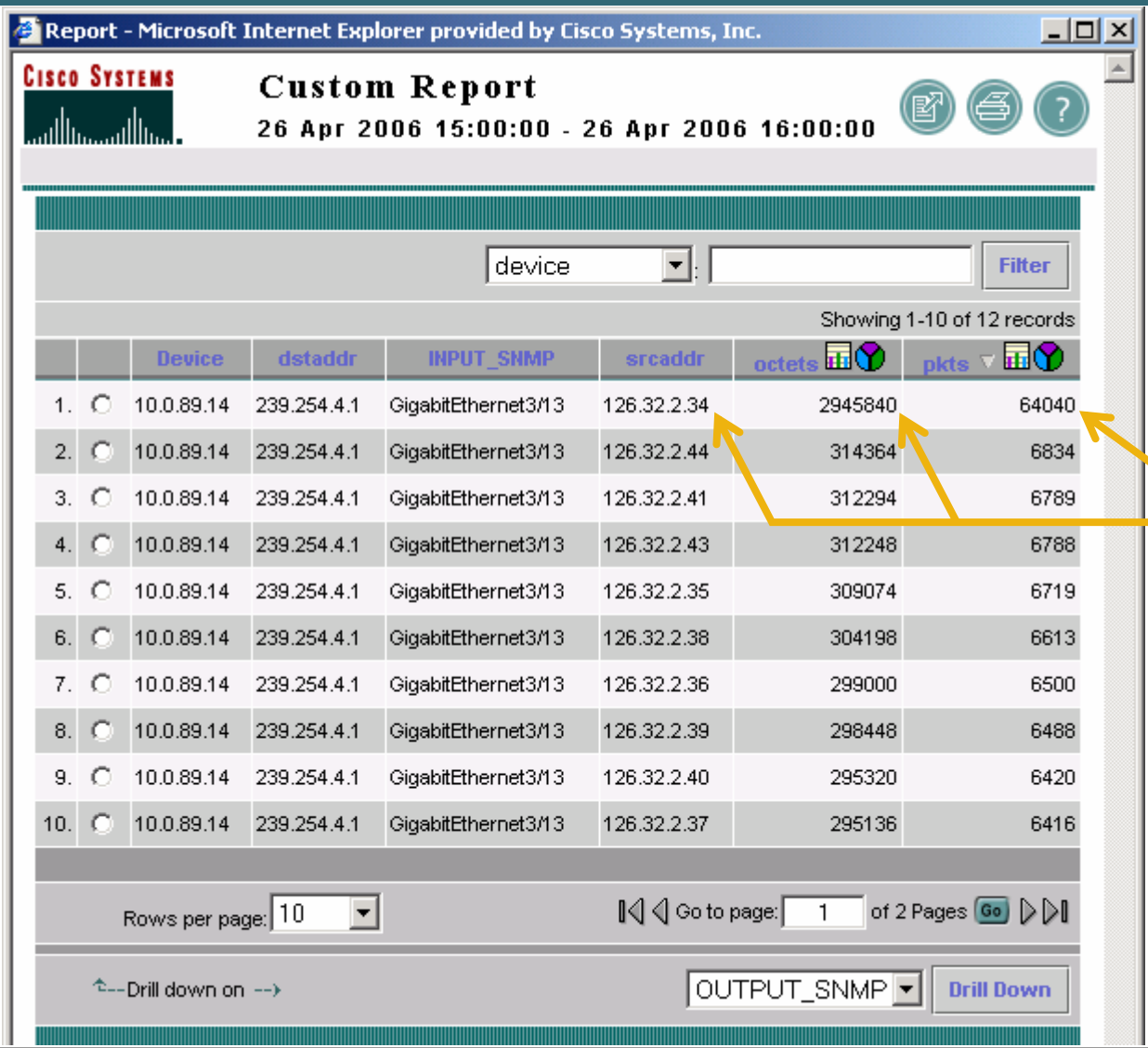
Health Check immediately points out changes from baseline



Bidir Troubleshooting with NetFlow

- **Problem**: A particular Bidir group's traffic levels have jumped dramatically
- Might be a misconfigured source
  - But Bidir sources can't be seen with MIBs
- **Solution**: Use Multicast NetFlow
  - Individual sources can be tracked
  - Collectors can point out high traffic source

Bidir Troubleshooting with NetFlow



- Cisco NFC can capture all traffic to a mcast dest addr
- All sources for a group can be sorted by data rate

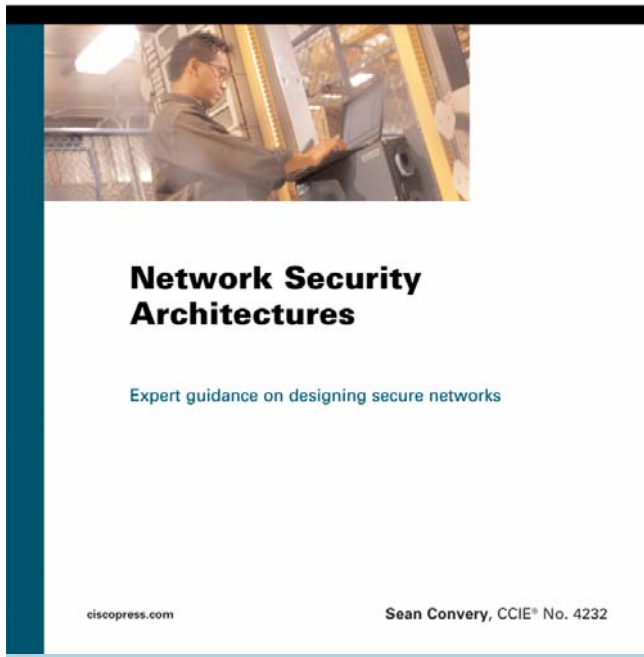
One source is sending significantly more traffic than others

- This host is either misconfigured or its an application problem

Questions?

Recommended Reading

- **Continue your Networkers learning experience with further reading for this session from Cisco Press**
- **Check the Recommended Reading flyer for suggested books**



Available Onsite at the Cisco Company Store

Complete Your Online Session Evaluation

- **Win fabulous prizes; Give us your feedback**
- **Receive ten Passport Points for each session evaluation you complete**
- **Go to the Internet stations located throughout the Convention Center to complete your session evaluation**
- **Drawings will be held in the World of Solutions**

  Tuesday, June 20 at 12:15 p.m.

  Wednesday, June 21 at 12:15 p.m.

  Thursday, June 22 at 12:15 p.m. and 2:00 p.m.