# Cisco live!

February 15 - 19, 2016 · Berlin, Germany

We’re ready. Are you?

# Application Visibility and Control in Enterprise WAN

Applications

The Power to Analyze, Visualize and Control ~~Data Traffic~~ in your Enterprise WAN

Murali Erraguntala, Product Manager

# Abstract

In this session we will focus on:

- The application visibility infrastructure with NBAR2 (Network Based Application Recognition) and it's recent advancements
- Various application monitoring techniques (Reactive and Proactive) for data, voice and video traffic
- Strategic QoS leveraging NBAR attributes
- Troubleshooting and fault isolation workflows for applications
- Managing the application aware framework with Cisco & 3rd party solutions

# Agenda

- Application Awareness
  - Why Now? What is the Value?
  - Why End-to-End AVC?
- Application Visibility and Control – Overview
  - AVC Building Blocks (NBAR, Custom Application, PerfMon, FNF etc)
  - Application Recognition
- Application Monitoring
  - Flexible Netflow – Traffic Statistics, Unified Monitoring, Granular Monitoring – URL Statistics
  - Monitoring Voice and Video (PerfMon)
- Application Aware QoS
  - AVC NBAR Attributes
  - Strategic QoS – Business Intent Policy
- AVC  Configuration Made Easy
- AVC Ecosystem Partners
- Summary

# Agenda

- Application Awareness
  - Why Now? What is the Value?
  - Why End-to-End AVC?

WHY we NEED AVC?

- Application Visibility and Control – Overview
  - AVC Building Blocks (NBAR, Custom Applications, PerfMon, FNF etc)
  - Application Recognition

WHAT is AVC?

- Application Monitoring
  - Flexible Netflow – Traffic Statistics, Unified Monitoring, Granular Monitoring – URL Statistics
  - Monitoring Voice and Video (PerfMon)
- Application Aware QoS
  - AVC NBAR Attributes
  - Strategic QoS – Business Intent Policy

HOW AVC is adding VALUE?

- AVC Configuration Made Easy
- AVC Ecosystem Partners
- Summary

# Business and IT are Changing Like Never Before

## Drastic Change in Application Type, Delivery, and Consumption

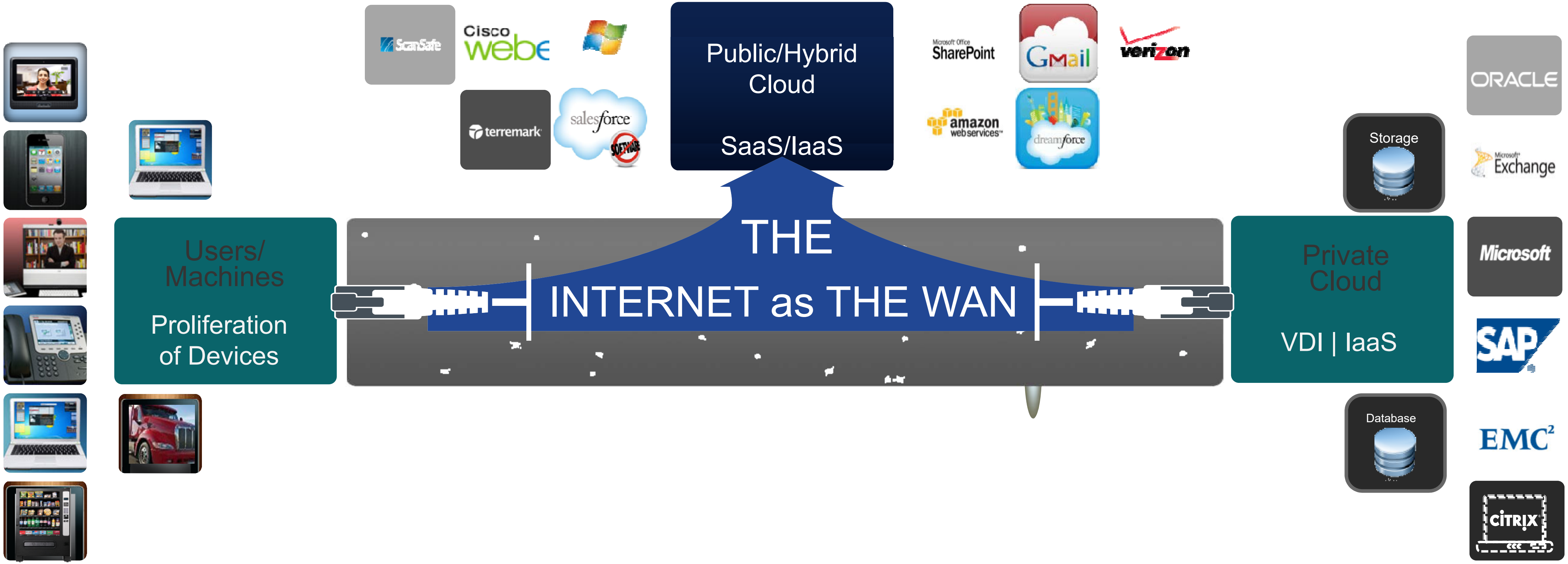
Users/
Machines

Proliferation
of Devices

How Application are Consumed

# Business and IT are Changing Like Never Before

## Drastic Change in Application Type, Delivery, and Consumption



Type of applications

# Challenges for IT and Business

Traffic Explosion in WAN – Demand for Higher BW

Ever-Increasing CAPEX – How to decide whether to upgrade or optimize BW

Migration of applications to cloud – How to measure application performance

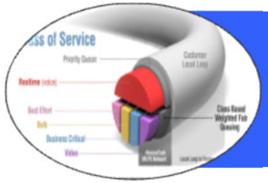
How to ensure SLAs are met for business critical applications

# IT Challenges vs Solutions

Traffic Explosion in WAN – Demand for Higher BW

Application Recognition and BW Monitoring Across Networks (End-to-End)

Ever-Increasing CAPEX – How to decide whether to upgrade or optimize BW



Application Aware QoS for effective Traffic Management

Migration of applications to cloud – How to measure application performance

Application Level Performance Monitoring

How to ensure SLAs are met for business critical applications

Strategic QoS to deliver business intent driven policies across network

# What does Customer need?.. Technology that delivers

Application Recognition (Including HTTPS and Custom apps)

Pervasive Visibility and Reporting

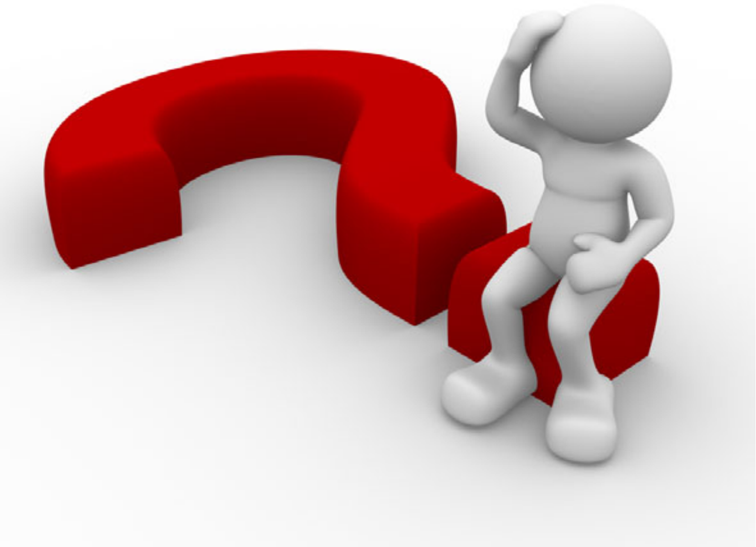
Business policy driven approach to prioritize critical apps

Monitor and troubleshoot application performance

As A Unified Service

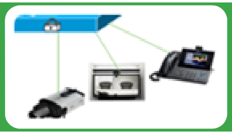
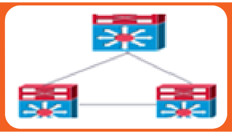
Without Any Overlay Appliances

Across Networks…. Really END-to-END



# But… Why End-to-End?

# Why Need AVC End to End?

| | | |
|---|---|---|
| **Wireless (WLC, AP), Converged Access** | | Shared medium - Bandwidth contention - Rogue users – Most congested medium – Effective traffic management |
| **Wired Access** |  | Closest to end points - access policy enforcement point - Need app based classification (prioritize voice/video, as waiting till WAN is too LATE) |
| **Distribution/ Core** |  | Diagnose core drops - Analyze traffic utilization - Domain based routing (with high traffic rates) |
| **WAN Edge** | CE | Premium links & Limited bandwidth - Capacity planning and optimal allocation for apps |
| **Internet Edge** | CE | Cloud migration – Non-critical traffic in contention with critical traffic - Limited BW – AVC required for DIA and FiF classification for cloud apps |
| **MSP Edge** | | Managed services - Honor application level SLA – Personalized services |
| **Data Center/ Server Farm** | | Servers/apps common source of problem - Multi tiered client/server design - High bandwidth traffic – Need to identify app level performance |
| **Firewall, Security** | | Entry point - Filter applications/ users - Security |

# End to End AVC

## Support Matrix

For Your Reference

| | Visibility | Monitoring | Control |
|---|---|---|---|
| Wireless (WLC, AP) | ✓ | ✓ Limited | ✓ |
| Wired Access | ✗ Roadmap | ✗ Roadmap | ✗ Roadmap |
| Distribution, Core | ✓ | ✓ | ✗ |
| WAN Edge | ✓ | ✓ | ✓ |
| Internet Edge | ✓ | ✓ | ✓ |
| Data Center | ✓ | ✓ | ✗ |
| Firewall & Security | ✓ | NA | ✓ |

# End to End AVC

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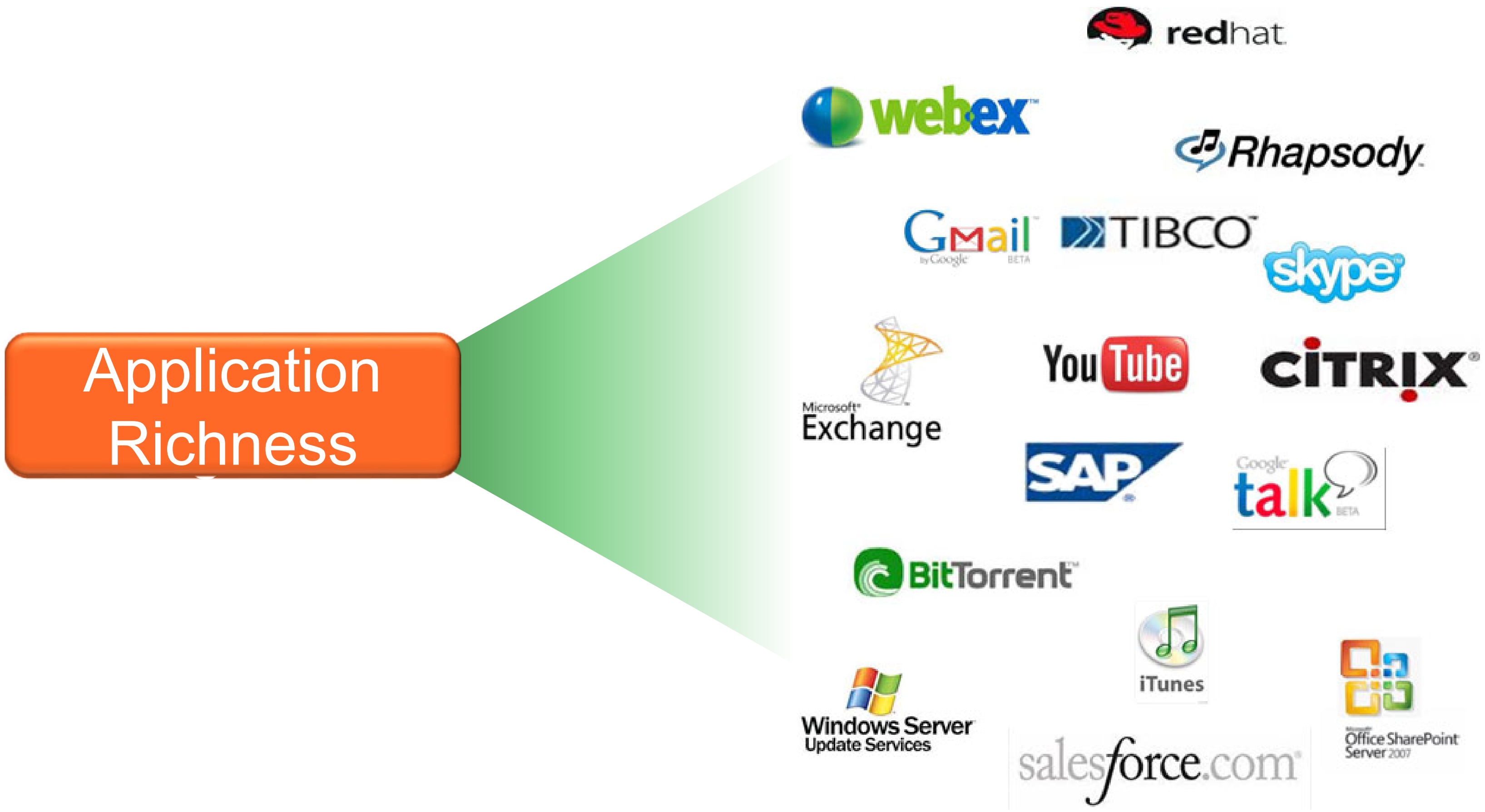
World of Solutions - Consistent Wired and Wireless Experience

# Application Visibility and Control - Overview



Application Richness

1400 + Application

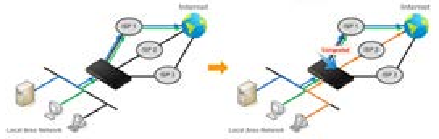
# Application Visibility and Control - Overview

Application Richness

Service Integration

Analytics

Troubleshooting



Policy Driven Routing

Application Recognition

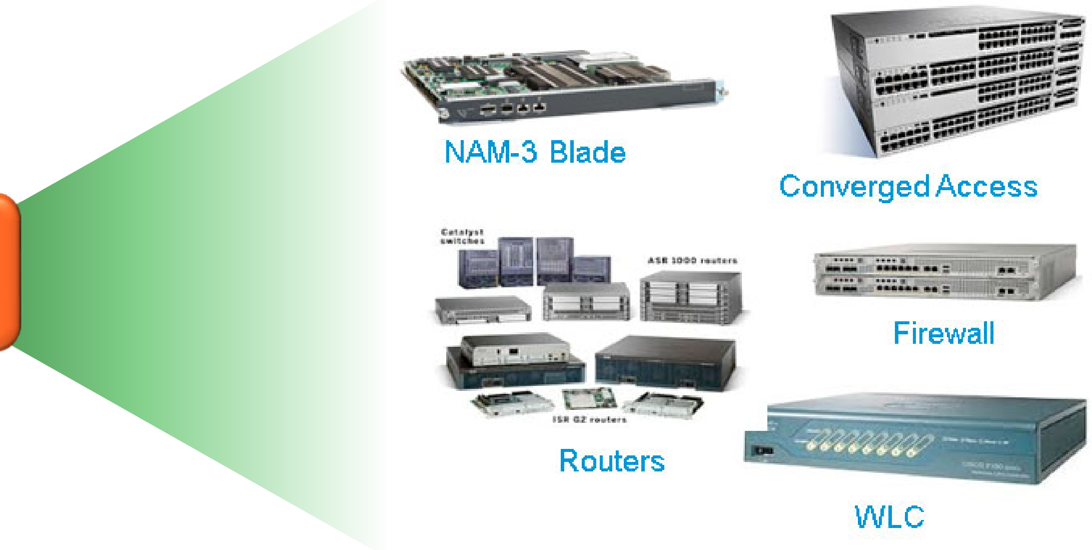
Performance Monitoring

# Application Visibility and Control - Overview

Application Richness

Service Integration

Ubiquity

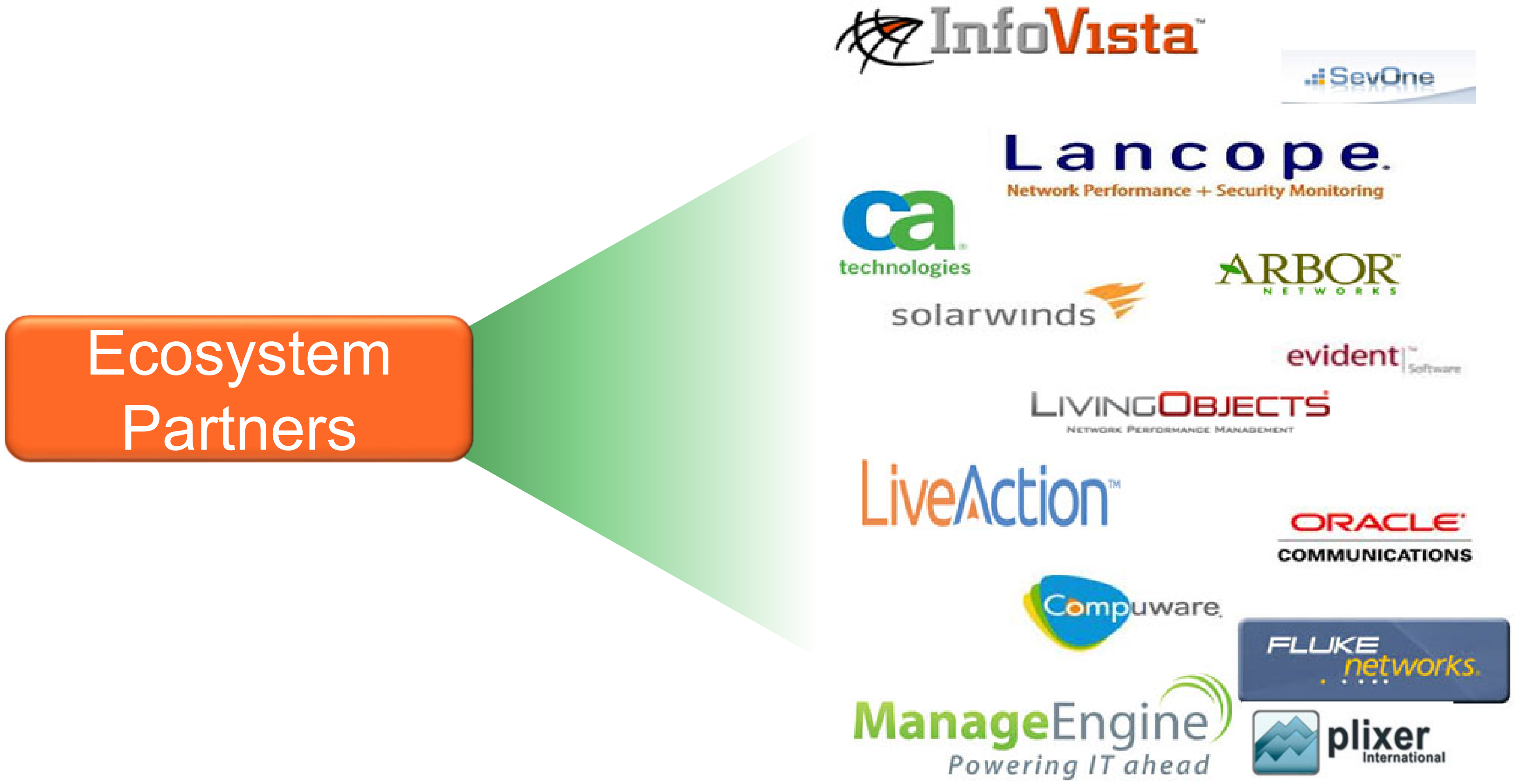


# Application Visibility and Control - Overview

Application Richness

Service Integration

Ubiquity



Analytics

Billing

Security

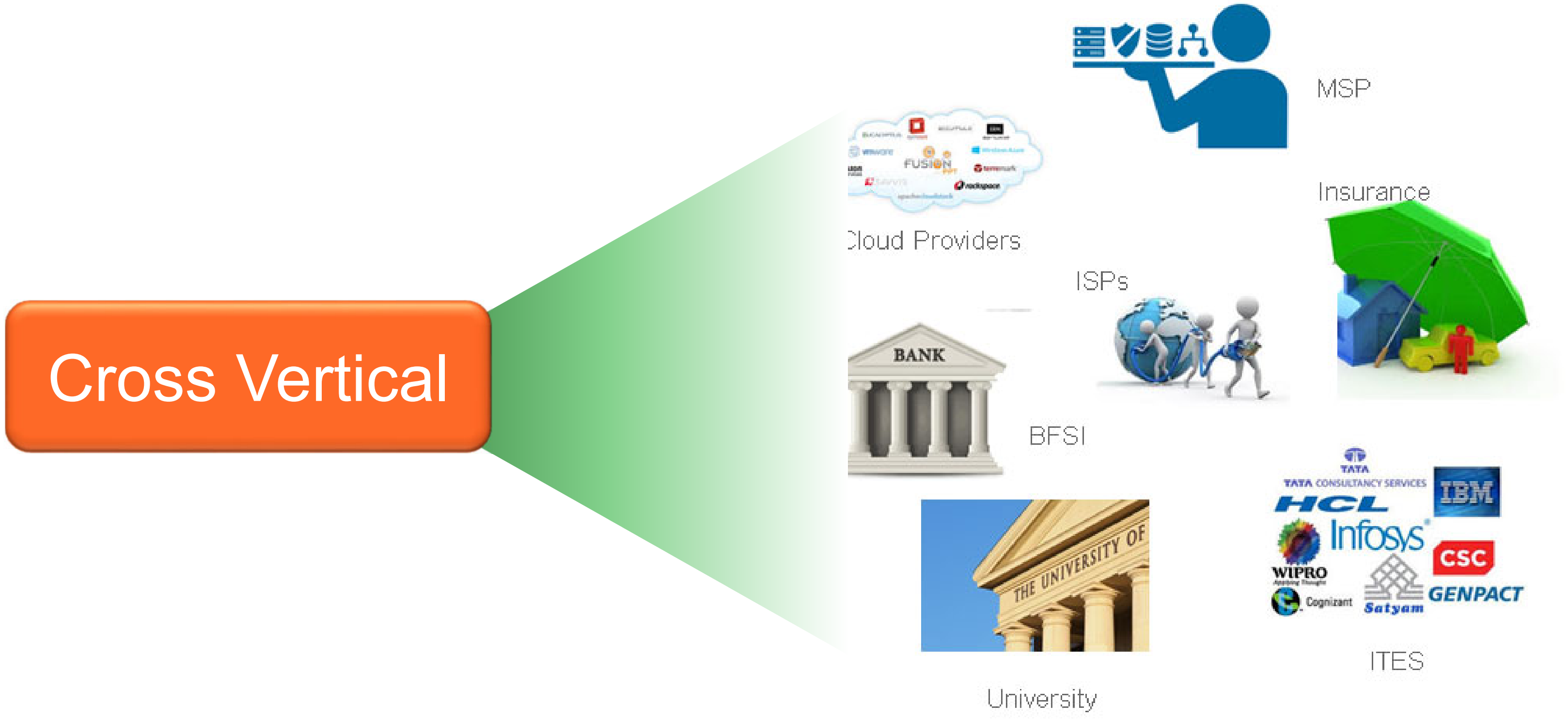
# Application Visibility and Control - Overview

Application Richness

Service Integration

Ubiquity

Ecosystem Partners



Cross Vertical

MSP

Cloud Providers

Insurance

ISPs

BFSI

University

ITES

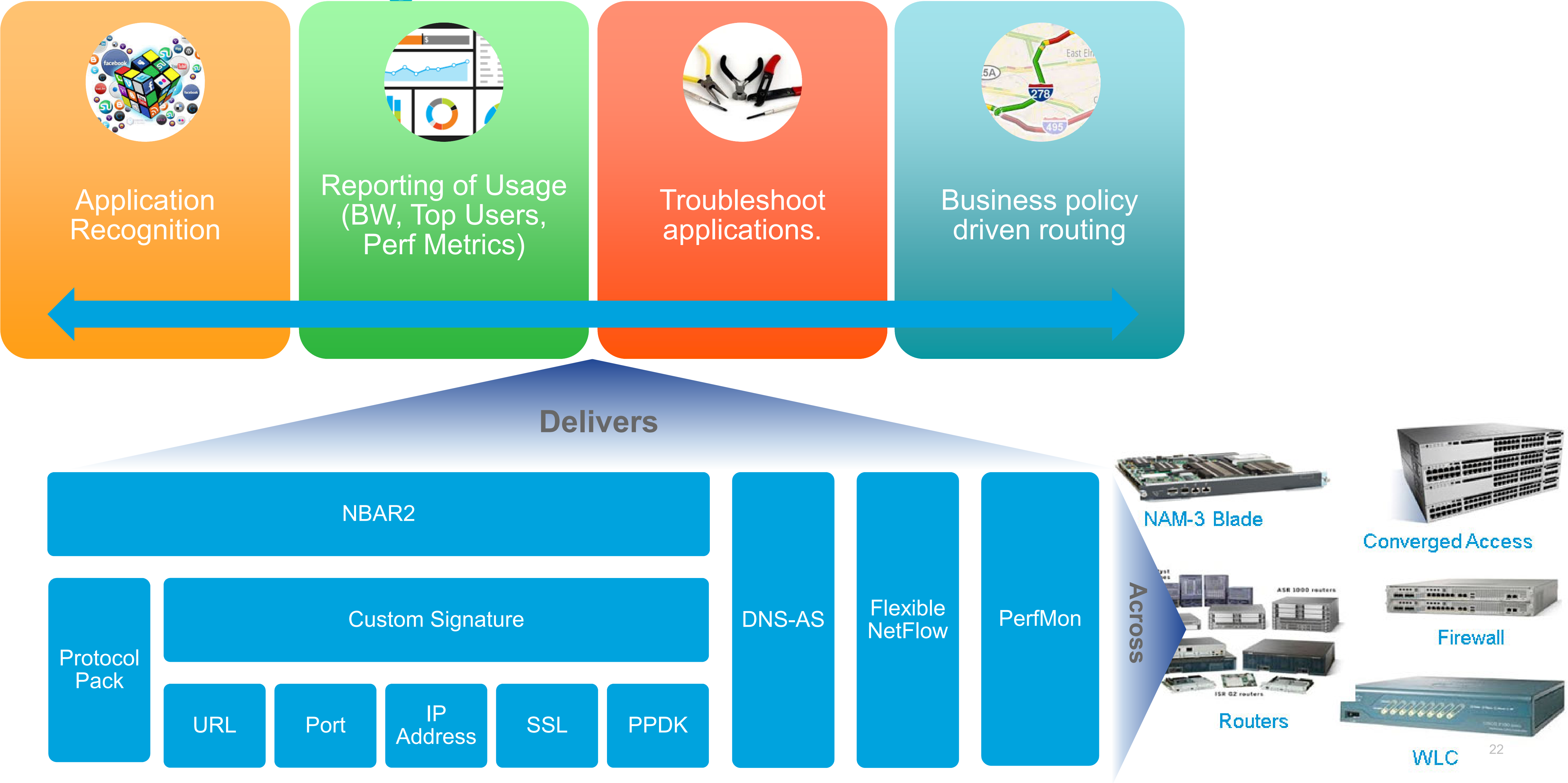
# Application Visibility and Control - Overview

- Application Richness
- Service Integration
- Ubiquity
- Ecosystem Partners
- Cross Vertical

# Application Recognition

Enabling Application Aware Networks

# AVC Building Blocks



Application Recognition

Reporting of Usage (BW, Top Users, Perf Metrics)

Troubleshoot applications.

Business policy driven routing

Delivers

NBAR2

Protocol Pack

Custom Signature

URL

Port

IP Address

SSL

PPDK

DNS-AS

Flexible NetFlow

PerfMon

Across

NAM-3 Blade

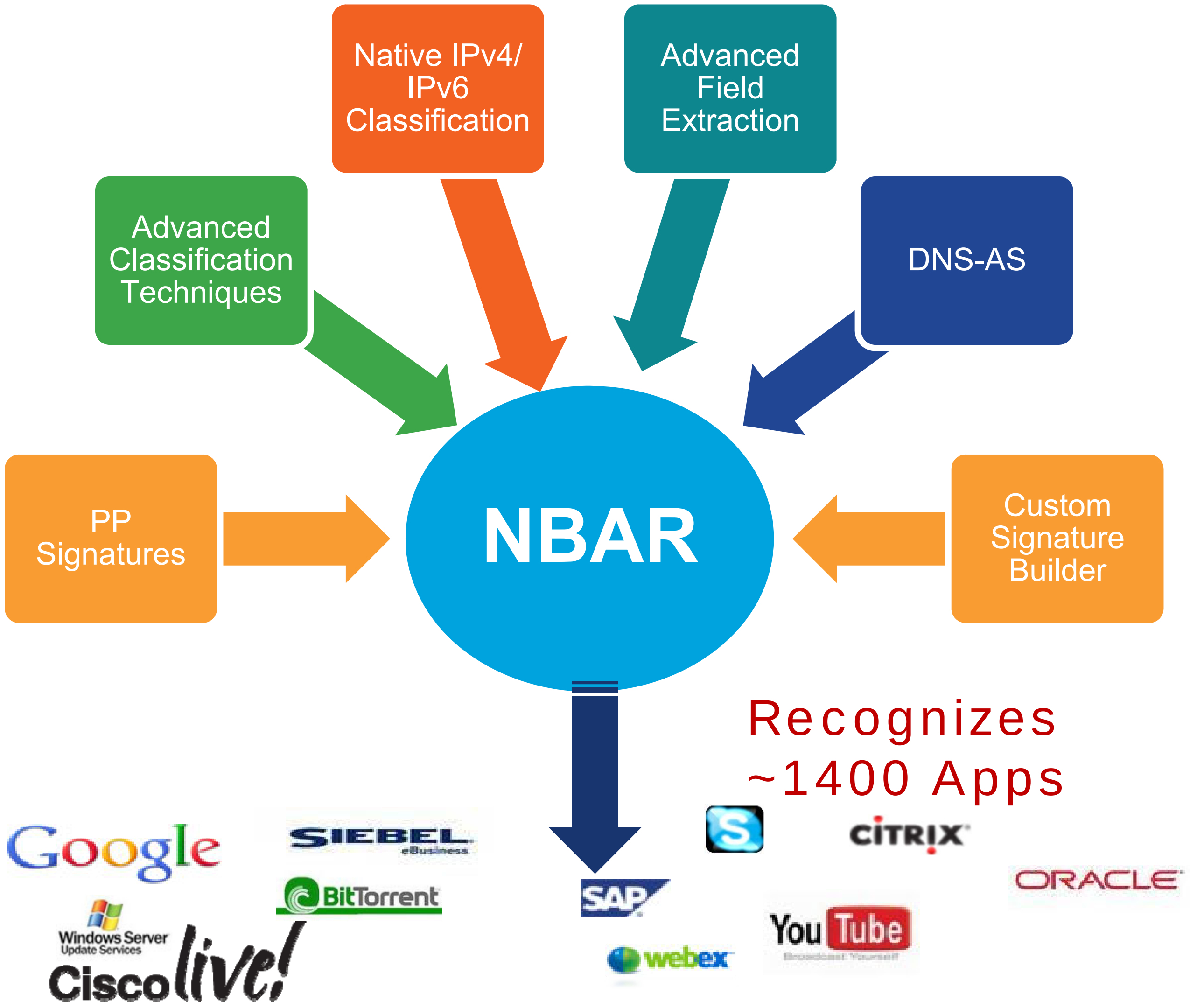
Converged Access

Routers

Firewall

WLC

# Network Based Application Recognition



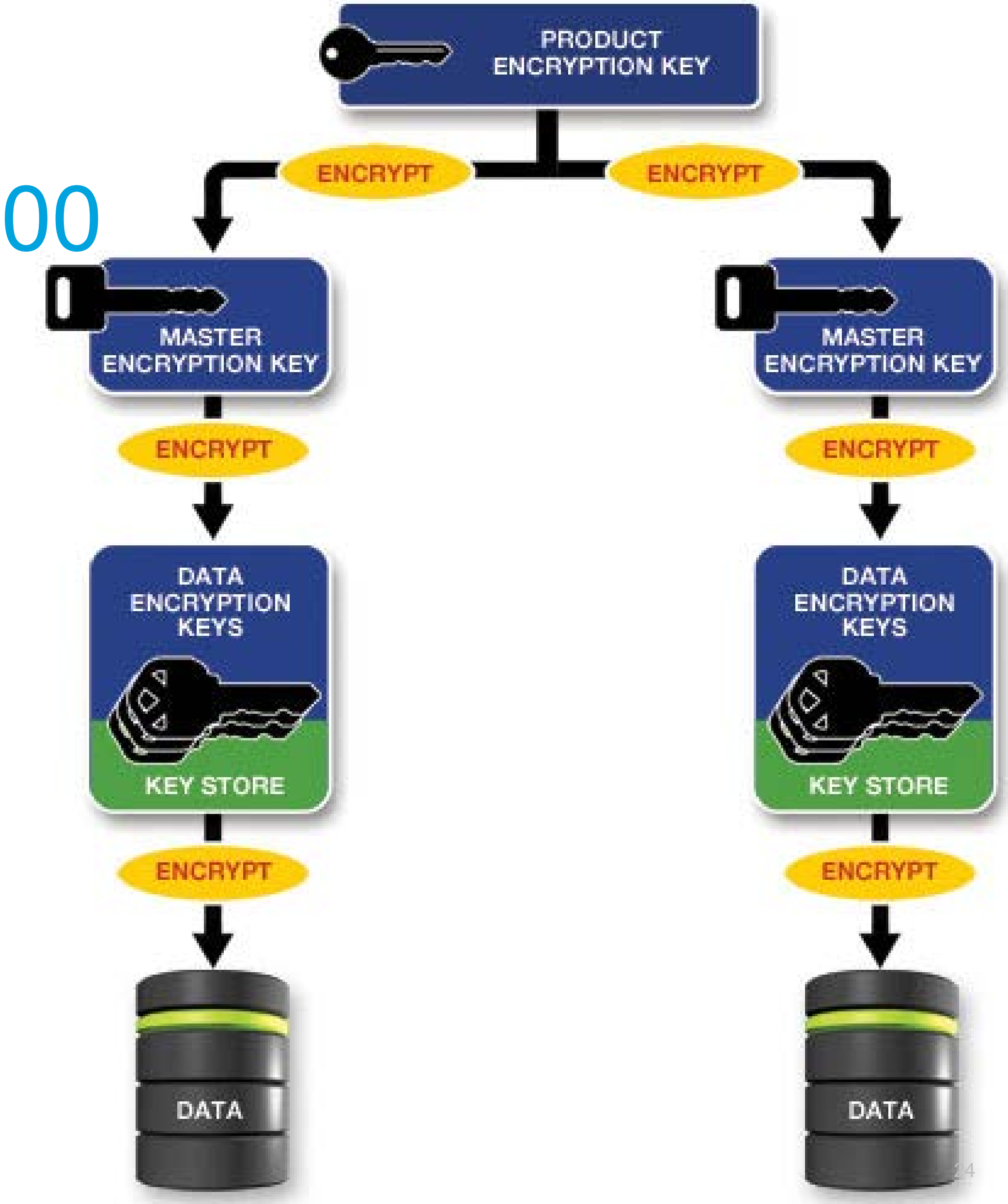
- Can be used with MQC (Modular QoS CLI) to control the traffic patterns in the network

  NBAR helps to identify high priority and low priority traffic, for which appropriate QoS can be applied

- Supported devices: ISR-G2 (86x, 88x, 89x, 19xx, 29xx, 39xx), 44xx, ASR1k, CSR1kV, WLC (2508, 8500, 7500, 55xx), 3850/5760 (AP based)
- Protocol Pack allows adding more applications without upgrading or reloading IOS
- Use heuristic algorithms to recognize encrypted traffic
- And …

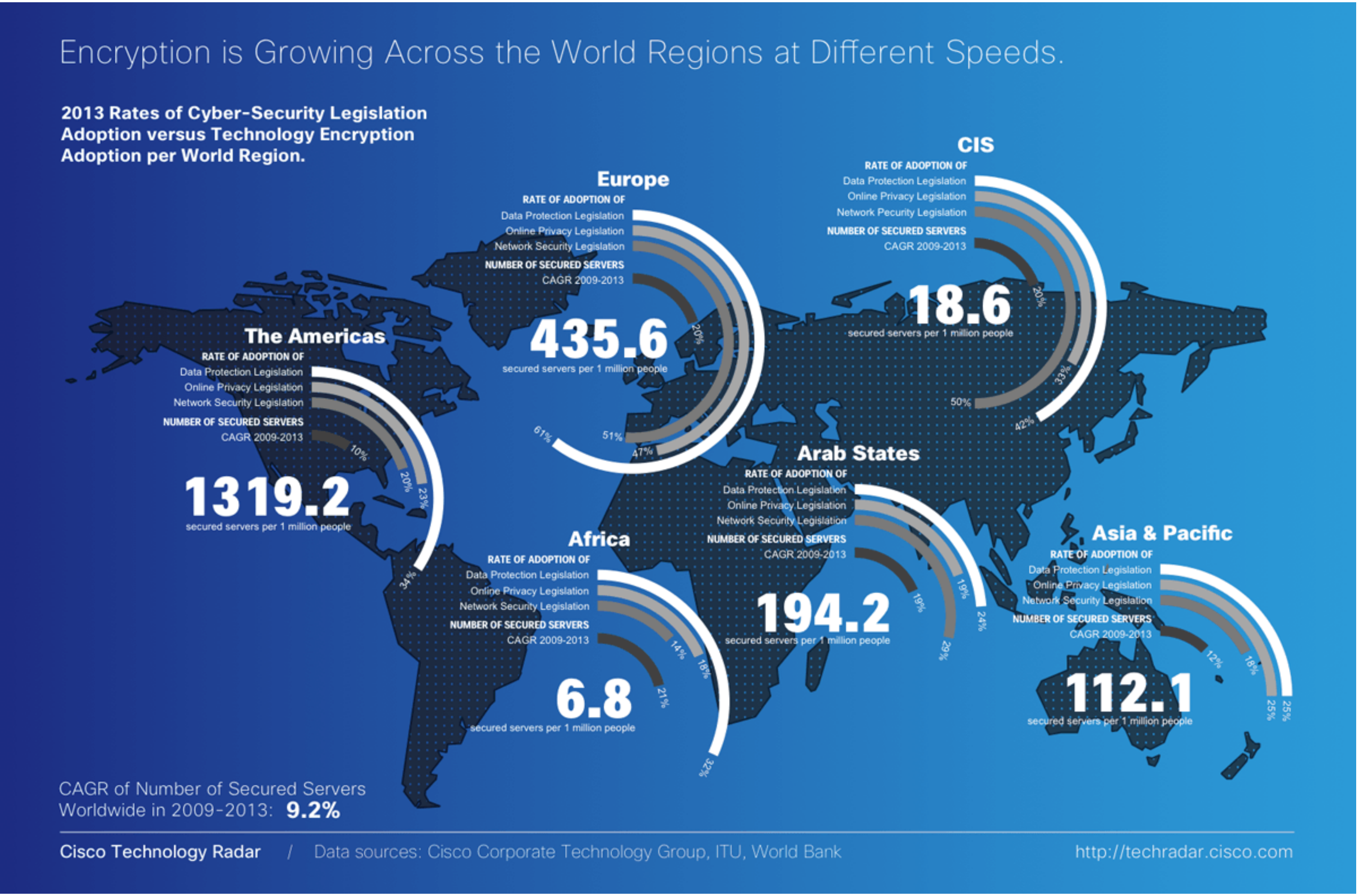
# Oh… AVC is classifying ~1400 applications.. GREAT

But what about encrypted applications?



# The World After “Snowden”

## Growth of Encrypted Network Traffic



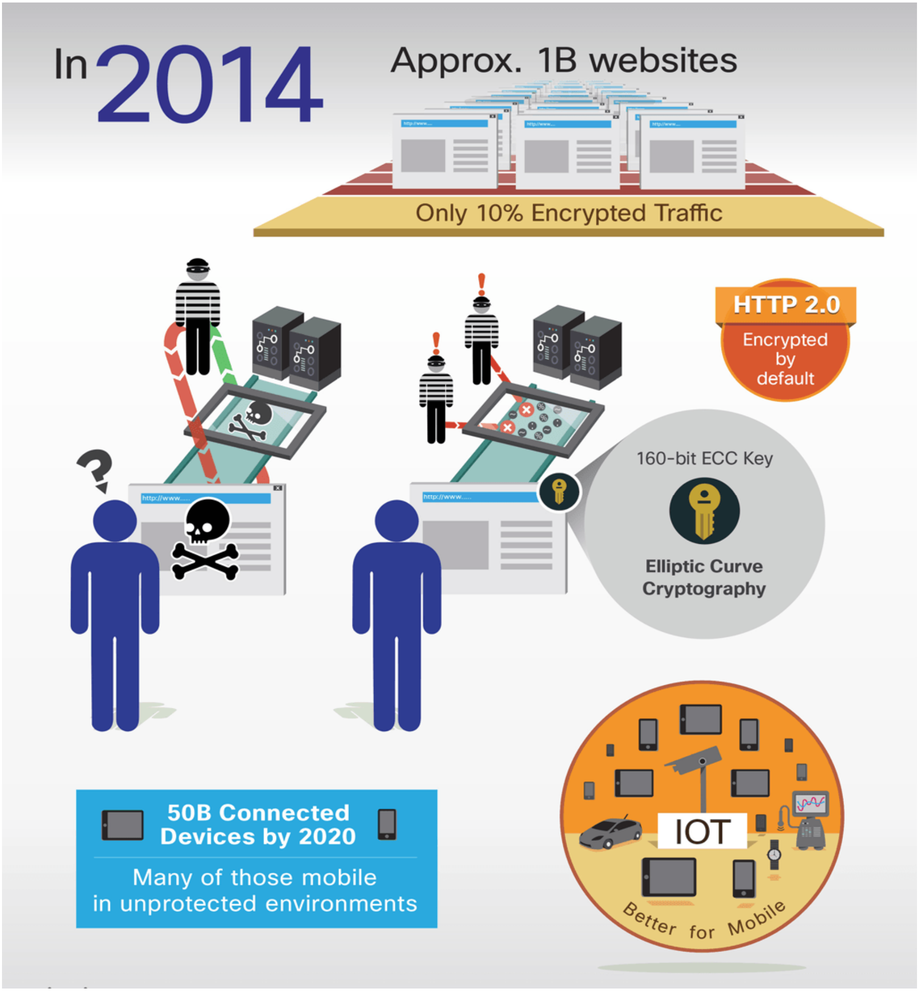
Encryption is Growing Across the World Regions at Different Speeds.

**2013 Rates of Cyber-Security Legislation Adoption versus Technology Encryption Adoption per World Region.**

The Americas
RATE OF ADOPTION OF
Data Protection Legislation
Online Privacy Legislation
Network Security Legislation
NUMBER OF SECURED SERVERS
CAGR 2009-2013
10%
20%
23%
34%
1319.2
secured servers per 1 million people
Europe
RATE OF ADOPTION OF
Data Protection Legislation
Online Privacy Legislation
Network Security Legislation
NUMBER OF SECURED SERVERS
CAGR 2009-2013
20%
61%
51%
47%
435.6
secured servers per 1 million people
CIS
RATE OF ADOPTION OF
Data Protection Legislation
Online Privacy Legislation
Network Pecurity Legislation
NUMBER OF SECURED SERVERS
CAGR 2009-2013
20%
33%
50%
42%
18.6
secured servers per 1 million people
Arab States
RATE OF ADOPTION OF
Data Protection Legislation
Online Privacy Legislation
Network Security Legislation
NUMBER OF SECURED SERVERS
CAGR 2009-2013
19%
19%
24%
29%
194.2
secured servers per 1 million people
Africa
RATE OF ADOPTION OF
Data Protection Legislation
Online Privacy Legislation
Network Security Legislation
NUMBER OF SECURED SERVERS
CAGR 2009-2013
14%
18%
21%
32%
6.8
secured servers per 1 million people
Asia & Pacific
RATE OF ADOPTION OF
Data Protection Legislation
Online Privacy Legislation
Network Security Legislation
NUMBER OF SECURED SERVERS
CAGR 2009-2013
12%
18%
25%
25%
112.1
secured servers per 1 million people

CAGR of Number of Secured Servers Worldwide in 2009-2013: **9.2%**

Cisco Technology Radar / Data sources: Cisco Corporate Technology Group, ITU, World Bank http://techradar.cisco.com



In 2014
Approx. 1B websites
Only 10% Encrypted Traffic
HTTP 2.0
Encrypted by default
160-bit ECC Key
Elliptic Curve Cryptography
50B Connected Devices by 2020
Many of those mobile in unprotected environments
IOT
Better for Mobile

# Living in an after "Snowden" world

It becomes harder and harder for us to "guess"

*"The solution to government surveillance is to encrypt everything"*

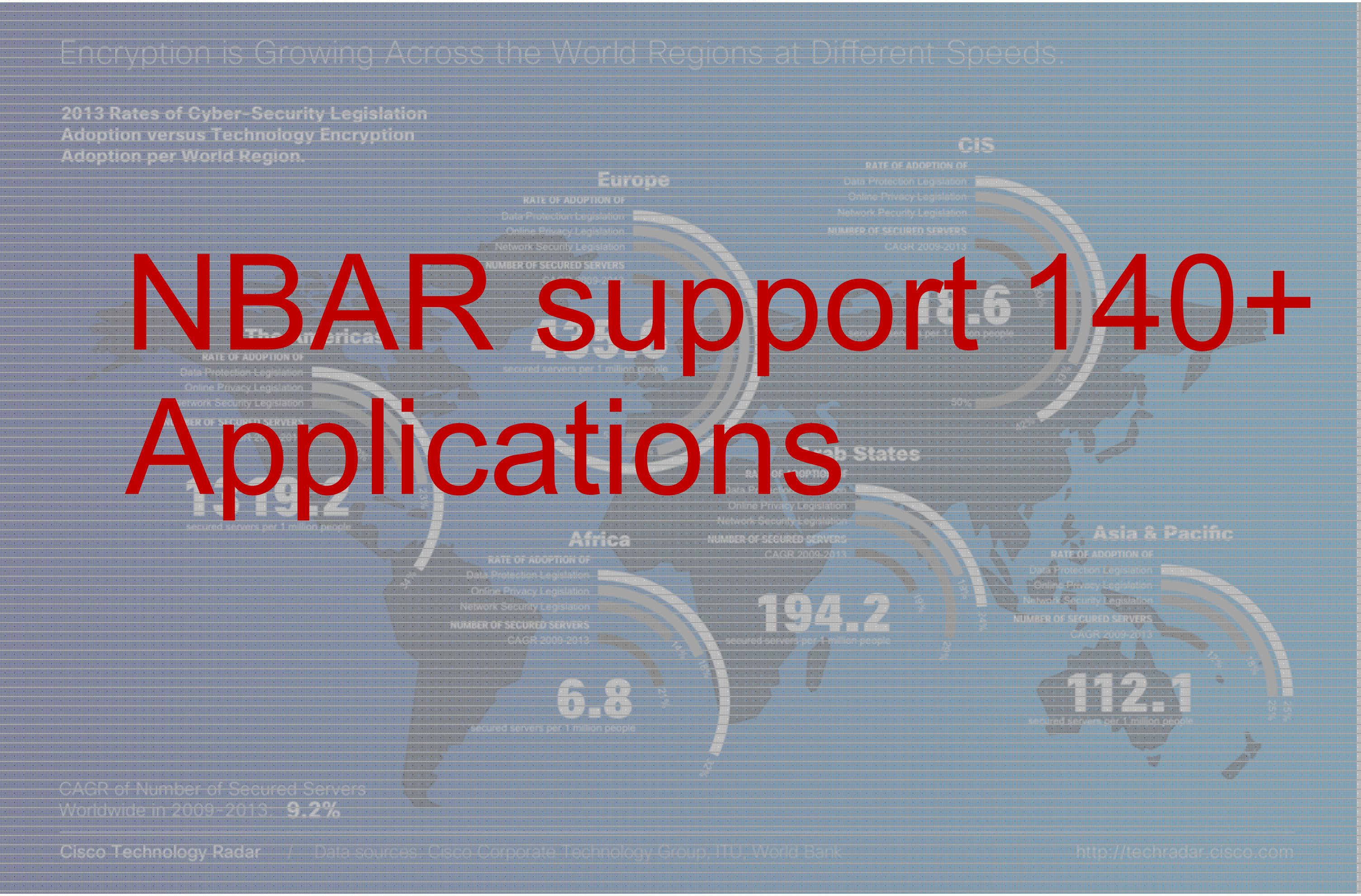
-Eric Schmidt, Former Google CEO

# Oh… AVC is classifying ~1400 applications.. GREAT

But what about encrypted applications?

But what about home grown applications?

# What NBAR Offers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NUMBER OF SECURED SERVERS
CIS
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secured servers per 1 million people
The Americas
1,119.2
Arab States
194.2
Africa
6.8
Asia & Pacific
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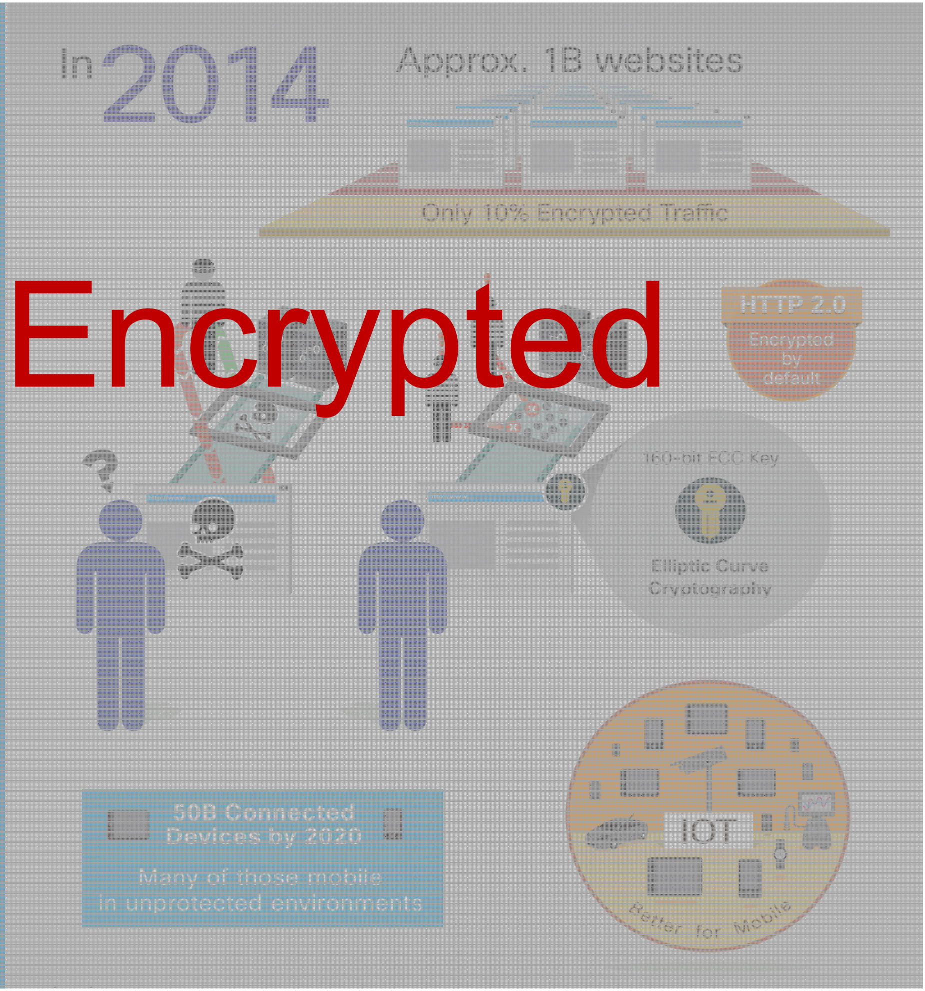
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160-bit ECC Key
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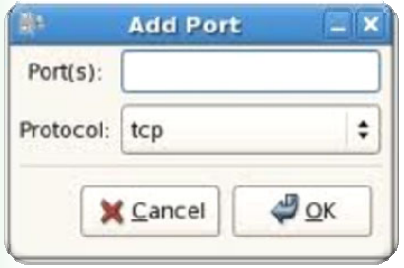
50B Connected Devices by 2020
Many of those mobile in unprotected environments
IOT
Better for Mobile

NBAR support 140+ Encrypted Applications

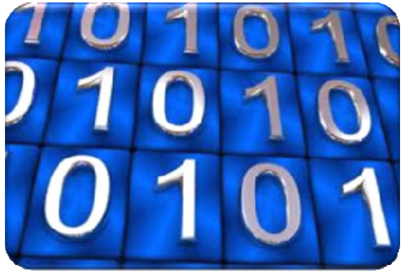
# Custom Signature Builder

Define Apps Based on Port Numbers, Payload, URL

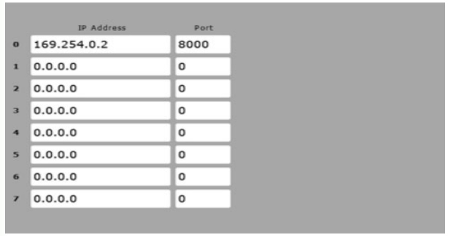

Add Port

Port(s):

Protocol: tcp

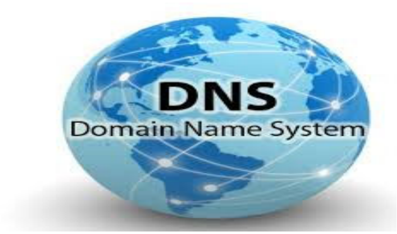


Define Apps Based on IP Address



| | IP Address | Port |
|---|---|---|
| 0 | 169.254.0.2 | 8000 |
| 1 | 0.0.0.0 | 0 |
| 2 | 0.0.0.0 | 0 |
| 3 | 0.0.0.0 | 0 |
| 4 | 0.0.0.0 | 0 |
| 5 | 0.0.0.0 | 0 |
| 6 | 0.0.0.0 | 0 |
| 7 | 0.0.0.0 | 0 |

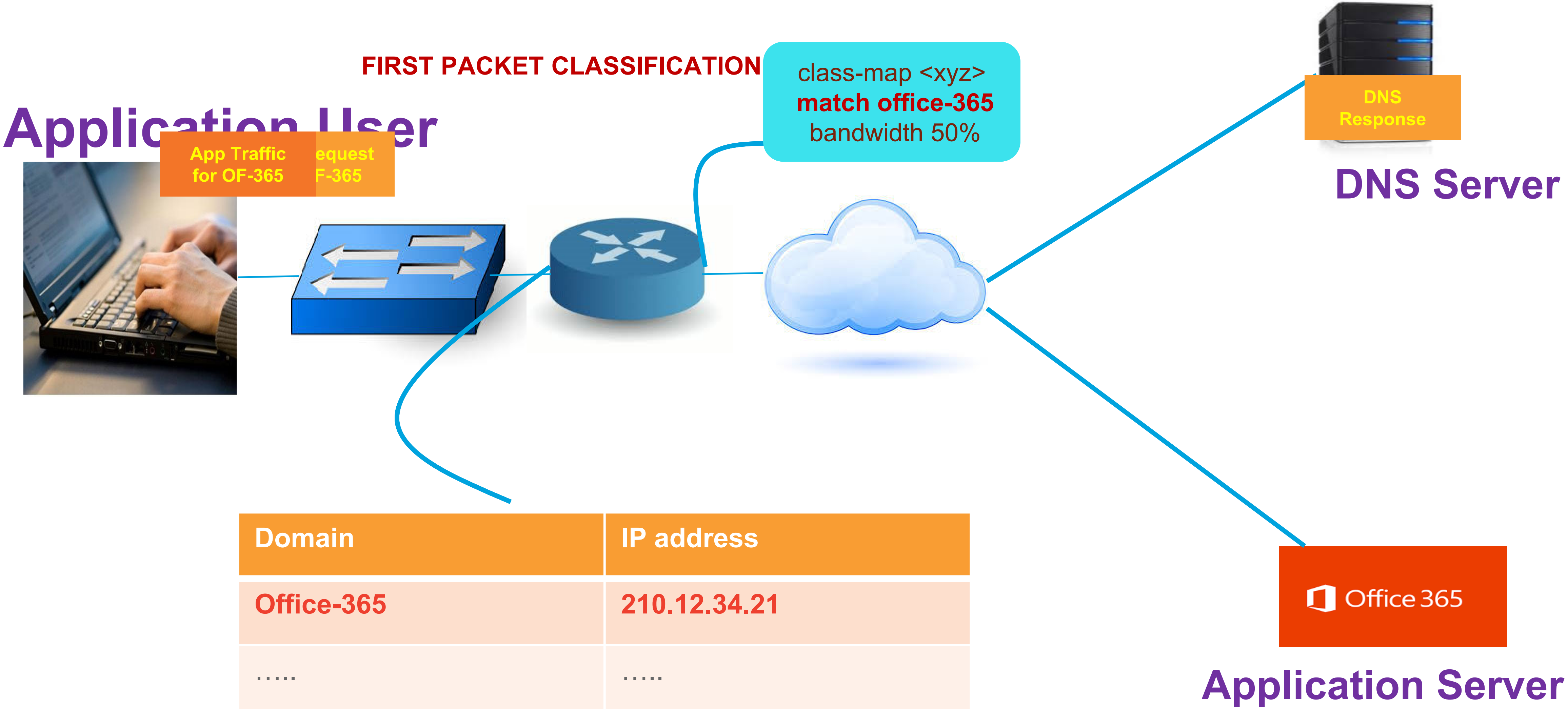
Define Apps Based on SSL, DNS, Server-Name



Create Your own Signature Pack with PPDK!

**Create Your Own Apps – HTTP, RTP, HTTPS!**

# DNS Based Classification – 1st Packet Classification



| Domain | IP address |
|---|---|
| Office-365 | 210.12.34.21 |
| ….. | ….. |

# Custom Protocols

For Your Reference

- HTTP Based Custom Protocols

```
Router(config)#  ip nbar custom  this_page  http url "wikicentral*"  host "*Custom“
```

- Port + payload based custom protocols

```
Router(config)#  ip nbar custom my_app 2 ascii HELLO_MSG tcp 9999
```

- L3/L4 based custom protocols

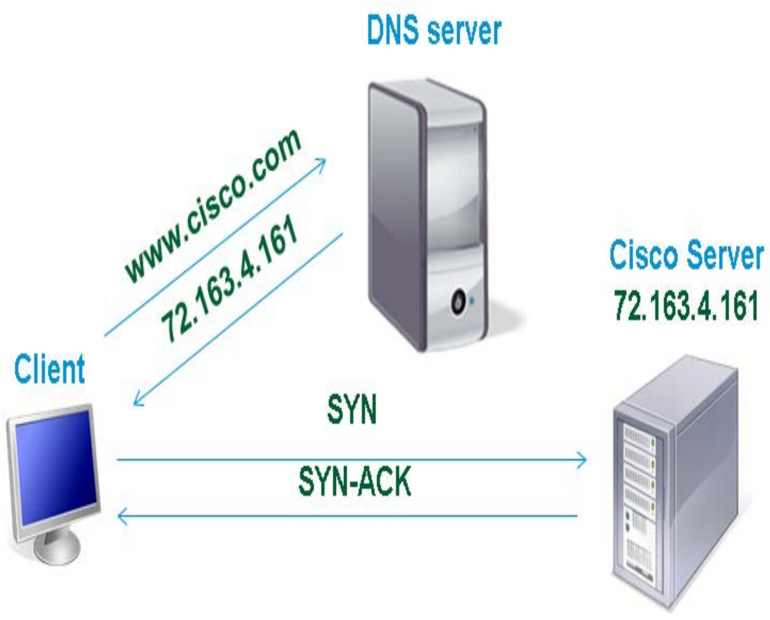
```
Router(config)# ip nbar custom engil_prime_custom transport tcp id 5
Router(config-custom)# ip address 10.210.20.7
Router(config-custom)#direction any
```

# Custom Protocols

## DNS Based Custom Application

1. NBAR2 DNS sniffing

2. Transaction Classification based on DNS information



## SSL Based Custom Application

1. SSL optimized 'C' parser

2. SSL custom application based on unique-name (server-name in client-hello or common-name in certificate)

```
Alpha(config)#ip nbar custom MyExchange ssl unique-name *cisco_exchange
```

## Server Name Based Custom Application

Composite customization – leverages all engines in one command:

- HTTP Engine (host name)
- SSL Engine (unique name)
- DNS Engine (DNS domain/host)

```
Alpha(config)#ip nbar custom myExchange composite server-name *ciscoExchange
```

# DNS-Authoritative Source (DNS-AS)

## Available in Mar ‘16

### What Does DNS-AS Provide?

1 | Visibility of encrypted and internal applications end-to-end in the network

2 | Light-weight application detection process

3 | A scalable means of identifying encrypted & cloud applications in 1st flow

4 | An efficient means to distribute application metadata

5 | No client software requirement

6 | Simplified end-to-end policy enforcement

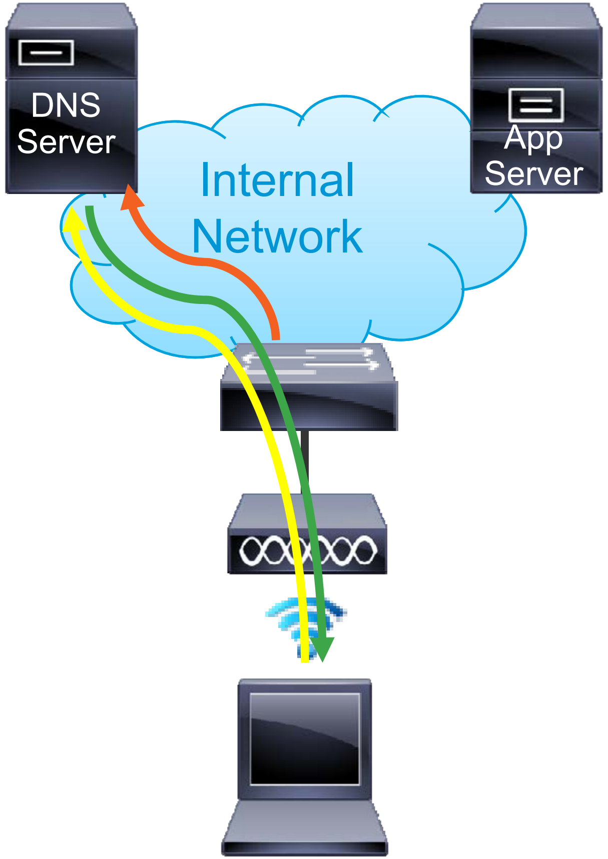
# DNS-AS Operation

DNS Lookup + TXT Record Request:
mail.timco.com

DNS A-Record:
mail.timco.com is 172.16.0.7

## Internal/ Cloud Applications

1) Client requests a DNS Lookup
2) Access Switch intercepts and clones the DNS request
3) Internal DNS Server returns a DNS response (A-Record)
4) Access Switch requests application metadata information (via a TXT record)



# DNS-AS Operation

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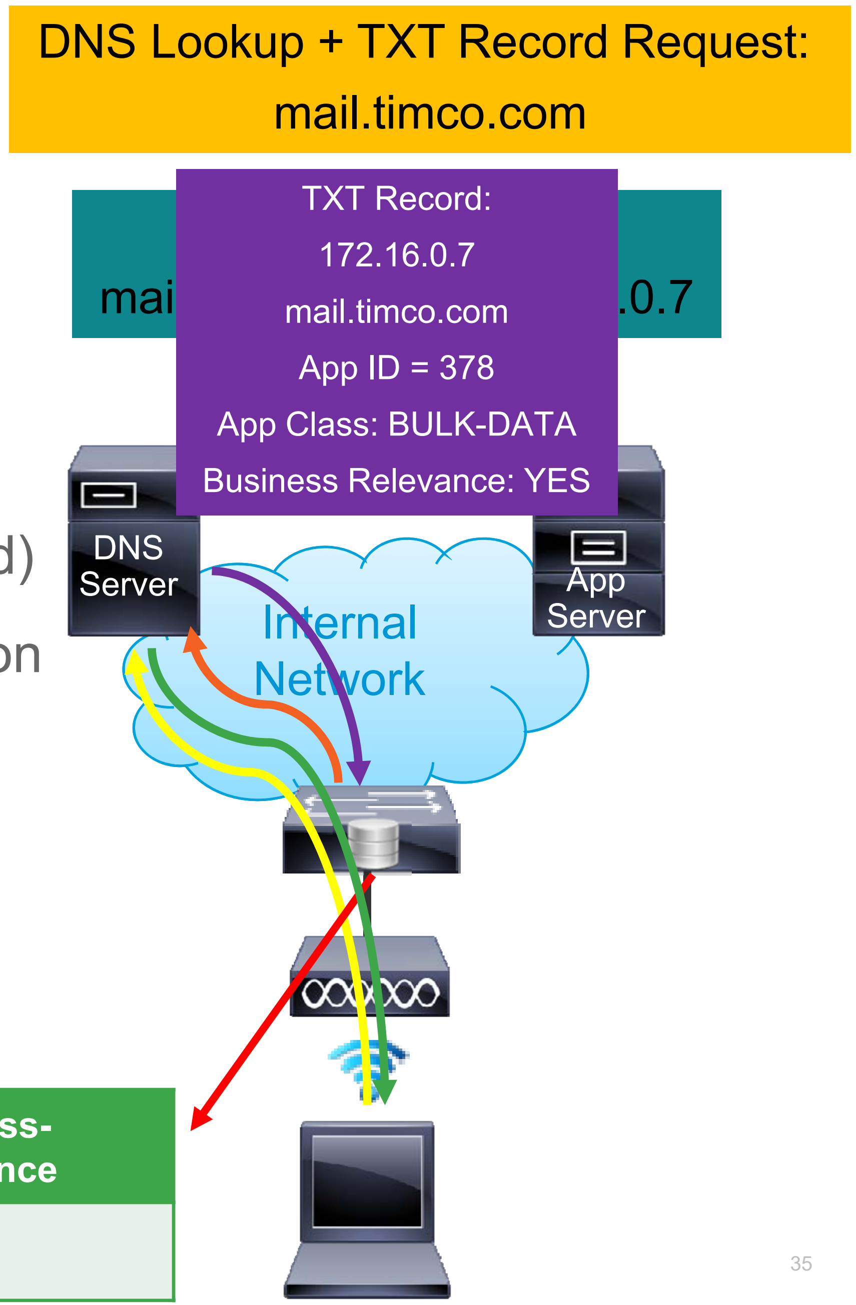
5) Internal DNS Server returns a TXT Record with application metadata
6) Access Switch maintains a Binding Table of application metadata



DNS Lookup + TXT Record Request: mail.timco.com

mai .0.7

TXT Record:
172.16.0.7
mail.timco.com
App ID = 378
App Class: BULK-DATA
Business Relevance: YES

| IP Address | PTR | App-ID | App-Class | Business-Relevance |
|---|---|---|---|---|
| 172.16.0.7 | mail.timco.com | 378 | Bulk Data | YES |

# DNS-AS Operation

DNS Lookup + TXT Record Request:
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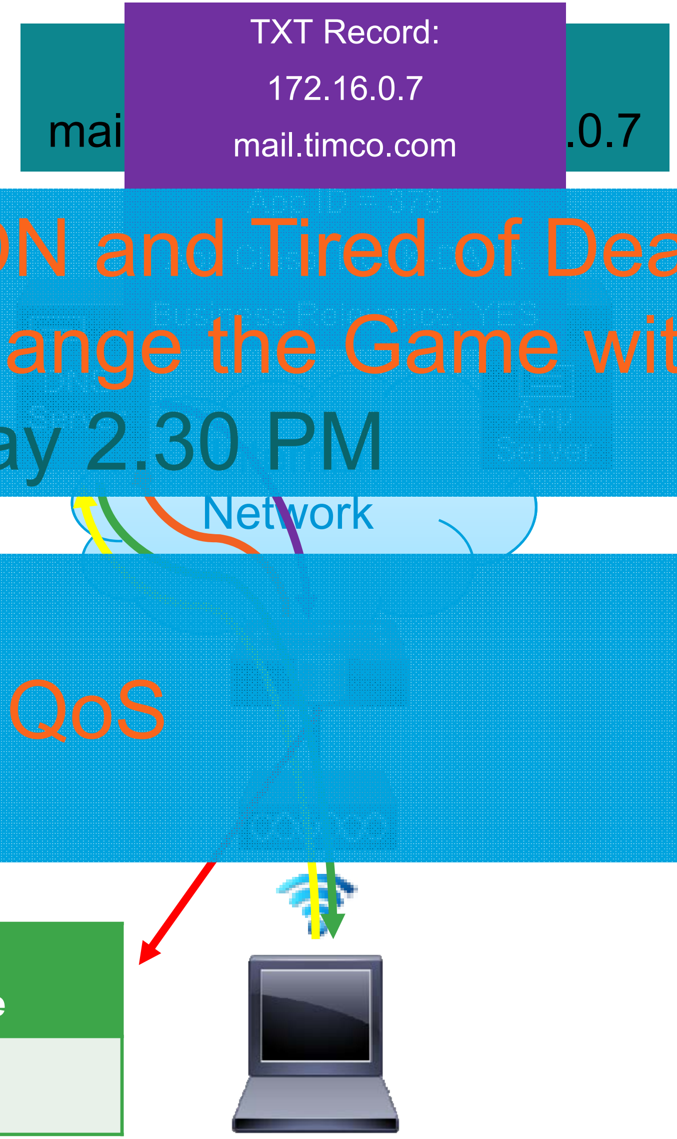
BRKSDN-3004 - DNS-AS: Done with SDN and Tired of Dealing with Snowflake Network Complexity? Change the Game with a Simple TXT String! – Thursday 2.30 PM

Whisper Suites – SDN QoS



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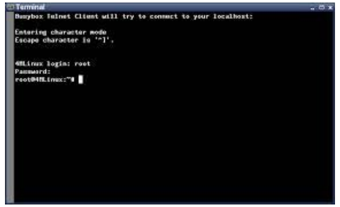
# Automatic Protocol Pack Updates

## Easy Steps



```
Busybox Telnet Client will try to connect to your localhost:

Entering character mode
Escape character is '^]'.


4MLinux login: root
Password:
root@4MLinux:~#
```

Configure NBAR Devices to Auto Download PP Image

Configure the Image Location

Configure the Time of the Day for Auto Download

Auto Download Starts after Availability of Image

Auto Download Completes and Devices Logs the Status of Upgrade

# Application Reporting

Network Wide Visibility

# Flexible Netflow (FNF)

## App discovery (w/ NBAR2) and Bandwidth Usage Report

- NetFlow is the de-facto mechanism to provide visibility on network utilization
- Feature to collect and export network information and usage statistics and performance data
    - Backward compatible with TNF records
    - Flexibility in defining fields and flow record format
    - Utilize Netflow **Version 9 format** which is extensible
    - FNF supports **IPFIX**
- Consist of data collection (flow monitor) and data export (flow export)
- Open-standard, can be analyzed by Cisco Prime NAM, Cisco Prime Assurance Manager, and 3rd Party Tools

### Usage of FNF

- Analytics
- Performance Monitoring
- Billing
- Security
- Peering Traffic Monitoring
- MSP: Multi-Tenant Reports

# Flexible Netflow (FNF)

## App discovery (w/ NBAR2) and Bandwidth Usage Report

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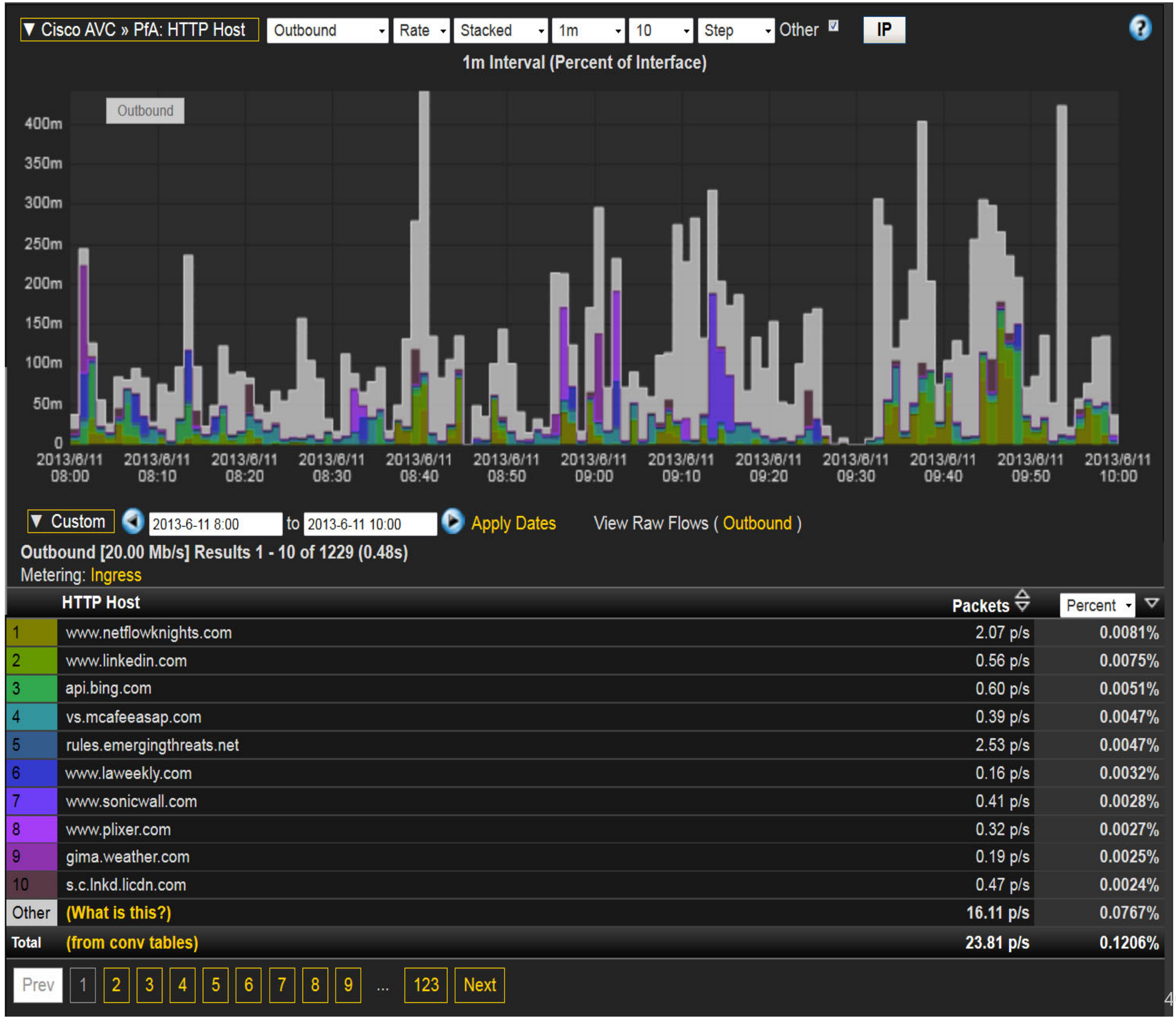


2013-6-11 8:00 to 2013-6-11 10:00

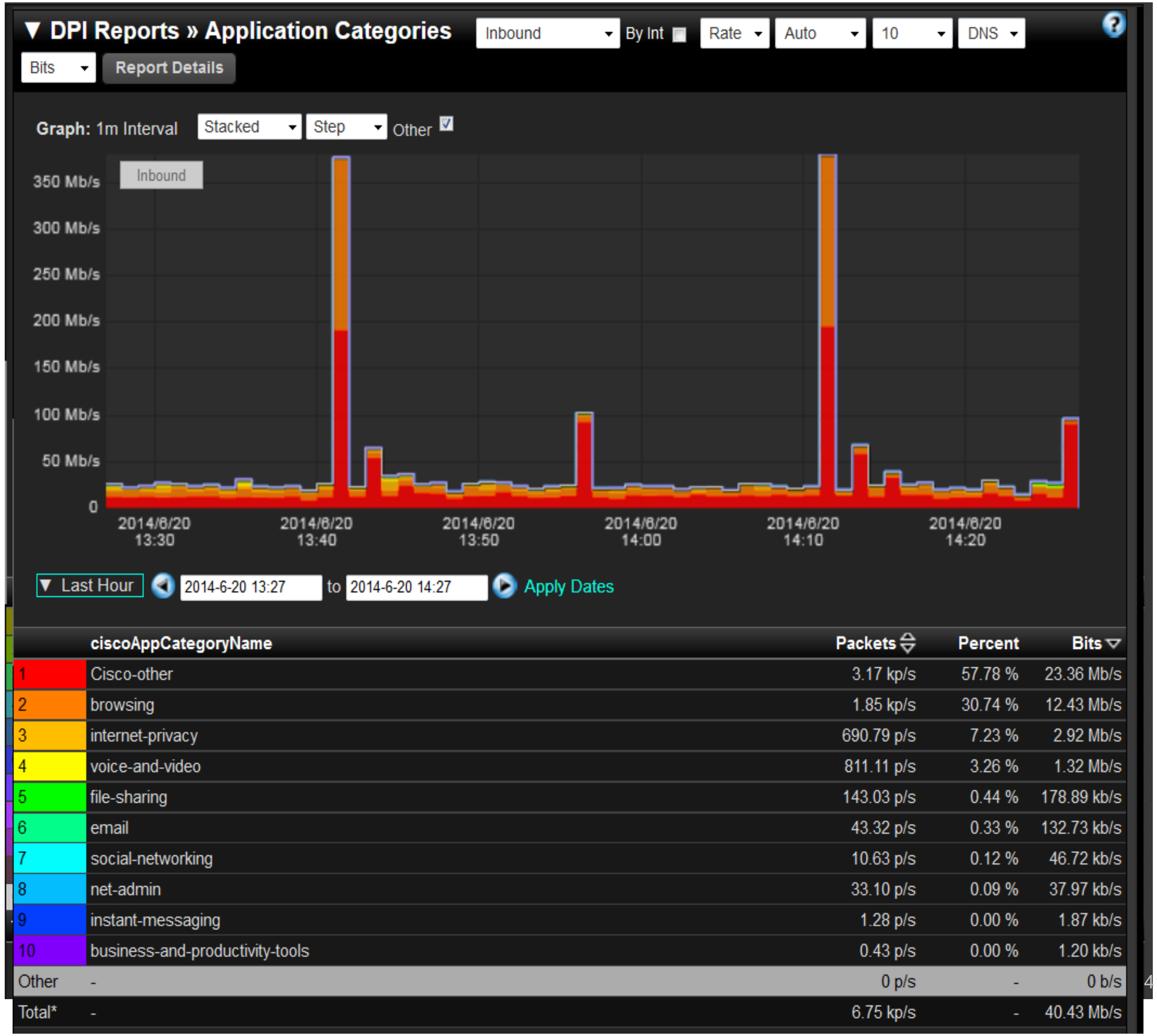
Outbound [20.00 Mb/s] Results 1 - 10 of 1229 (0.48s)
Metering: Ingress

| | HTTP Host | Packets | Percent |
|---|---|---|---|
| 1 | www.netflowknights.com | 2.07 p/s | 0.0081% |
| 2 | www.linkedin.com | 0.56 p/s | 0.0075% |
| 3 | api.bing.com | 0.60 p/s | 0.0051% |
| 4 | vs.mcafeeasap.com | 0.39 p/s | 0.0047% |
| 5 | rules.emergingthreats.net | 2.53 p/s | 0.0047% |
| 6 | www.laweekly.com | 0.16 p/s | 0.0032% |
| 7 | www.sonicwall.com | 0.41 p/s | 0.0028% |
| 8 | www.plixer.com | 0.32 p/s | 0.0027% |
| 9 | gima.weather.com | 0.19 p/s | 0.0025% |
| 10 | s.c.lnkd.licdn.com | 0.47 p/s | 0.0024% |
| Other | (What is this?) | 16.11 p/s | 0.0767% |
| Total | (from conv tables) | 23.81 p/s | 0.1206% |

# Flexible Netflow (FNF)

## App discovery (w/ NBAR2) and Bandwidth Usage Report

- NetFlow is the de-facto mechanism to provide visibility on network utilization
- Feature to collect and export network information and usage statistics and performance data
  - Backward compatible with TNF records
  - Flexibility in defining fields and flow record format
  - Utilize Netflow **Version 9 format** which is extensible
  - FNF supports **IPFIX**
- Consist of data collection (flow monitor) and data export (flow export)
- Open-standard, can be analyzed by Cisco Prime NAM, Cisco Prime Assurance Manager, and 3rd Party Tools



▼ DPI Reports » Application Categories

Inbound ▾ By Int □ Rate ▾ Auto ▾ 10 ▾ DNS ▾

Bits ▾ Report Details

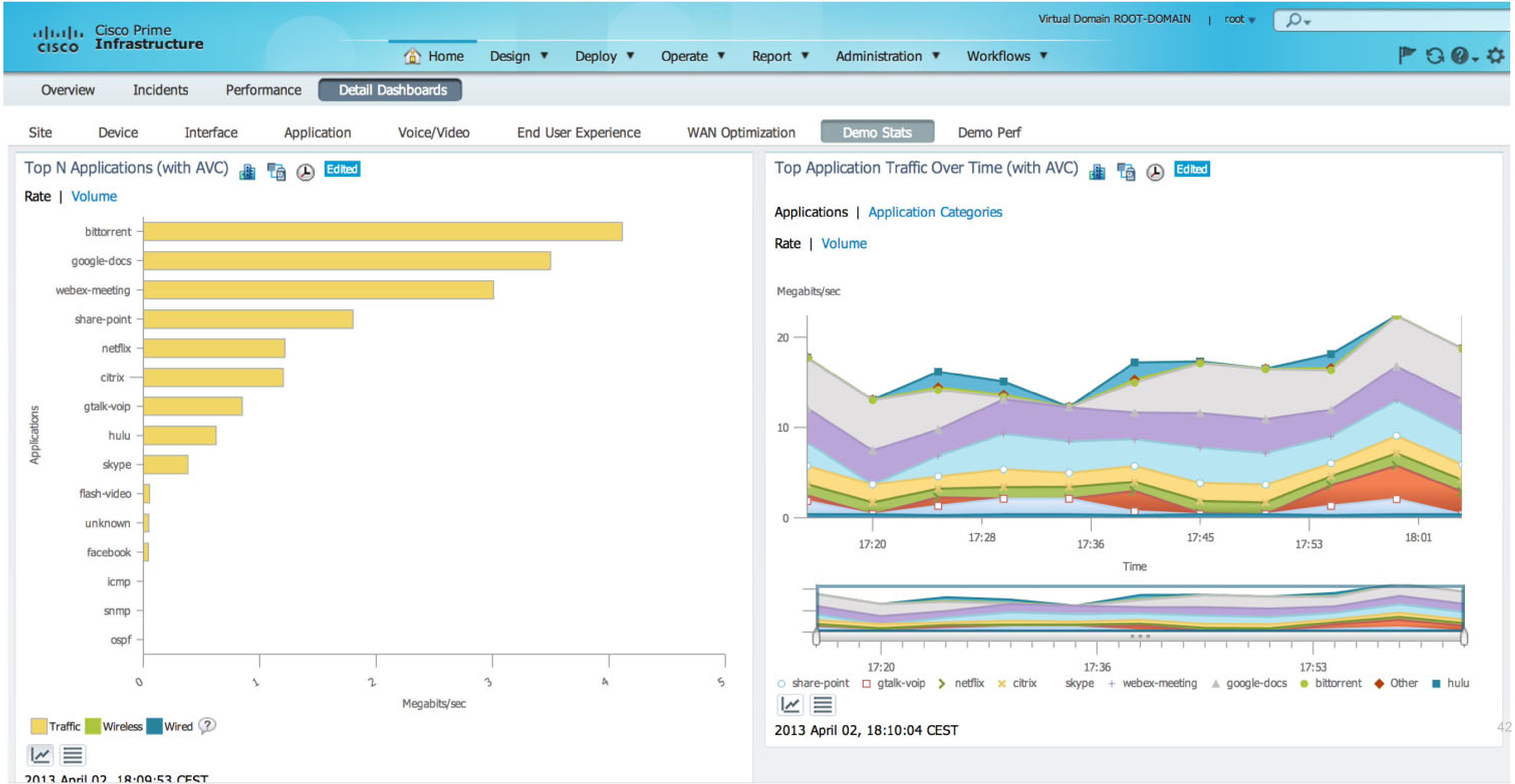
Graph: 1m Interval Stacked ▾ Step ▾ Other ☑

▼ Last Hour 2014-6-20 13:27 to 2014-6-20 14:27 Apply Dates

| | ciscoAppCategoryName | Packets | Percent | Bits |
|---|---|---|---|---|
| 1 | Cisco-other | 3.17 kp/s | 57.78 % | 23.36 Mb/s |
| 2 | browsing | 1.85 kp/s | 30.74 % | 12.43 Mb/s |
| 3 | internet-privacy | 690.79 p/s | 7.23 % | 2.92 Mb/s |
| 4 | voice-and-video | 811.11 p/s | 3.26 % | 1.32 Mb/s |
| 5 | file-sharing | 143.03 p/s | 0.44 % | 178.89 kb/s |
| 6 | email | 43.32 p/s | 0.33 % | 132.73 kb/s |
| 7 | social-networking | 10.63 p/s | 0.12 % | 46.72 kb/s |
| 8 | net-admin | 33.10 p/s | 0.09 % | 37.97 kb/s |
| 9 | instant-messaging | 1.28 p/s | 0.00 % | 1.87 kb/s |
| 10 | business-and-productivity-tools | 0.43 p/s | 0.00 % | 1.20 kb/s |
| Other | - | 0 p/s | - | 0 b/s |
| Total* | - | 6.75 kp/s | - | 40.43 Mb/s |

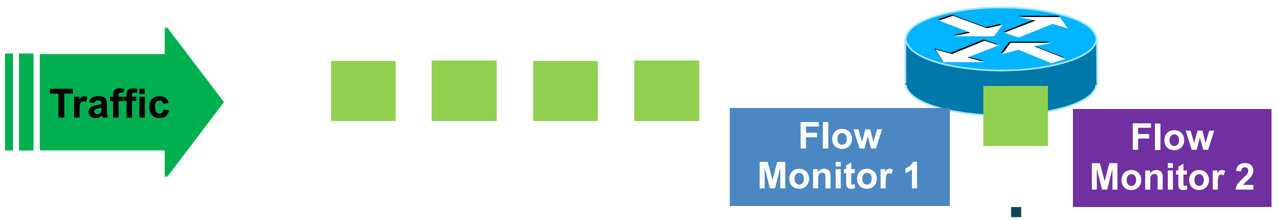
# Flexible Netflow (FNF)

## App discovery (w/ NBAR2) and Bandwidth Usage Report



# Metering Process

## Multiple Monitors with Unique Key Fields



| Key Fields | Packet 1 |
|---|---|
| Source IP | 3.3.3.3 |
| Destination IP | 2.2.2.2 |
| Source Port | 23 |
| Destination Port | 22078 |
| Layer 3 Protocol | TCP - 6 |
| TOS Byte | 0 |
| Input Interface | Ethernet 0 |

| Non-Key Fields |
|---|
| Packets |
| Bytes |
| Timestamps |
| Next Hop Address |

### Traffic Analysis Cache

| Source IP | Dest. IP | Source Port | Dest. Port | Protocol | TOS | Input I/F | … | Pkts |
|---|---|---|---|---|---|---|---|---|
| 3.3.3.3 | 2.2.2.2 | 23 | 22078 | 6 | 0 | E0 | … | 1100 |

| Key Fields | Packet 1 |
|---|---|
| Source IP | 3.3.3.3 |
| Destination IP | 2.2.2.2 |
| Input Interface | Gi0/1 |
| SYN Flag | 0 |

| Non-Key Fields |
|---|
| Packets |
| Timestamps |

### Security Analysis Cache

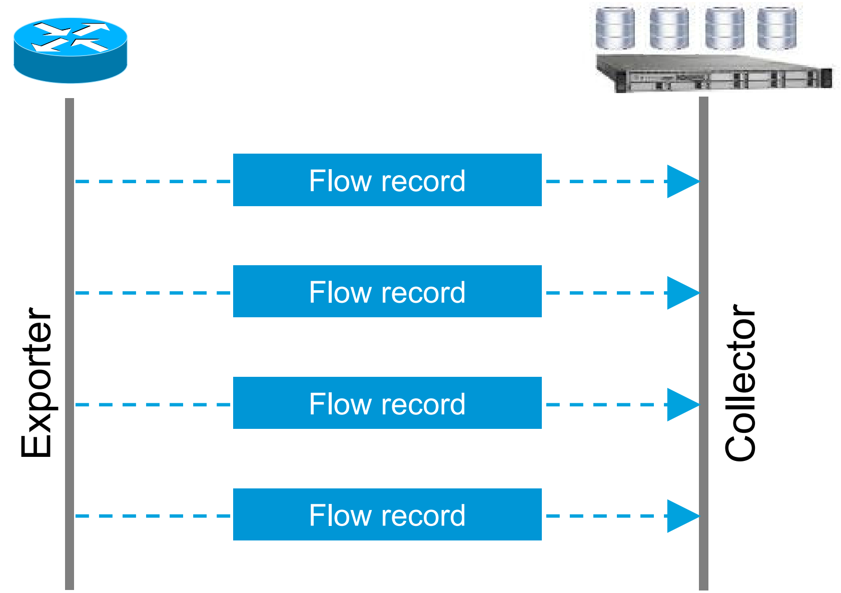
| Source IP | Dest. IP | Input I/F | Flag | … | Pkts |
|---|---|---|---|---|---|
| 3.3.3.3 | 2.2.2.2 | Gi0/1 | 0 | … | 11000 |

# Foundation: Flexible NetFlow (FNF)

## Exporting Process: NetFlow v9 and IPFIX

### Static Flow Export Format

NetFlow Version 5

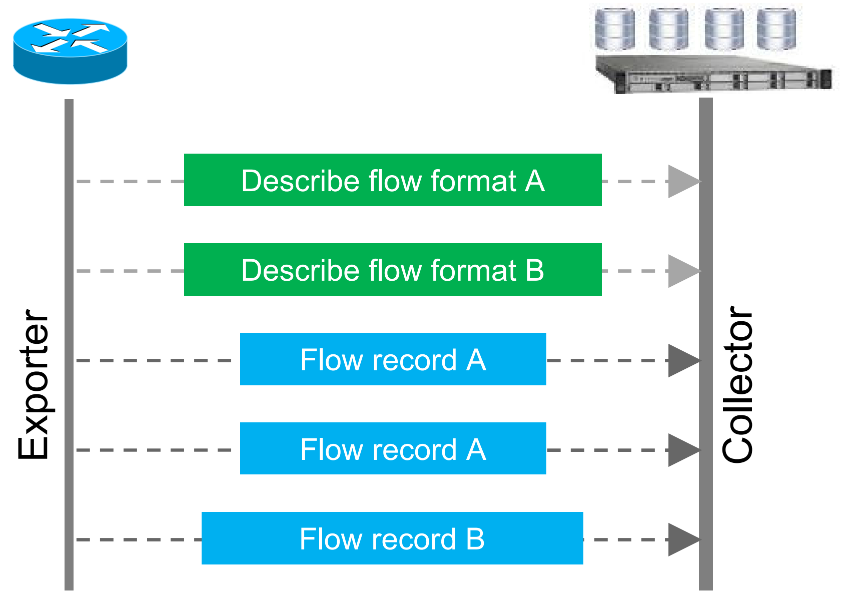


- Fixed number of fields (18 fields)

  e.g. source/destination IP & port, input/output interfaces, packet/byte count, ToS

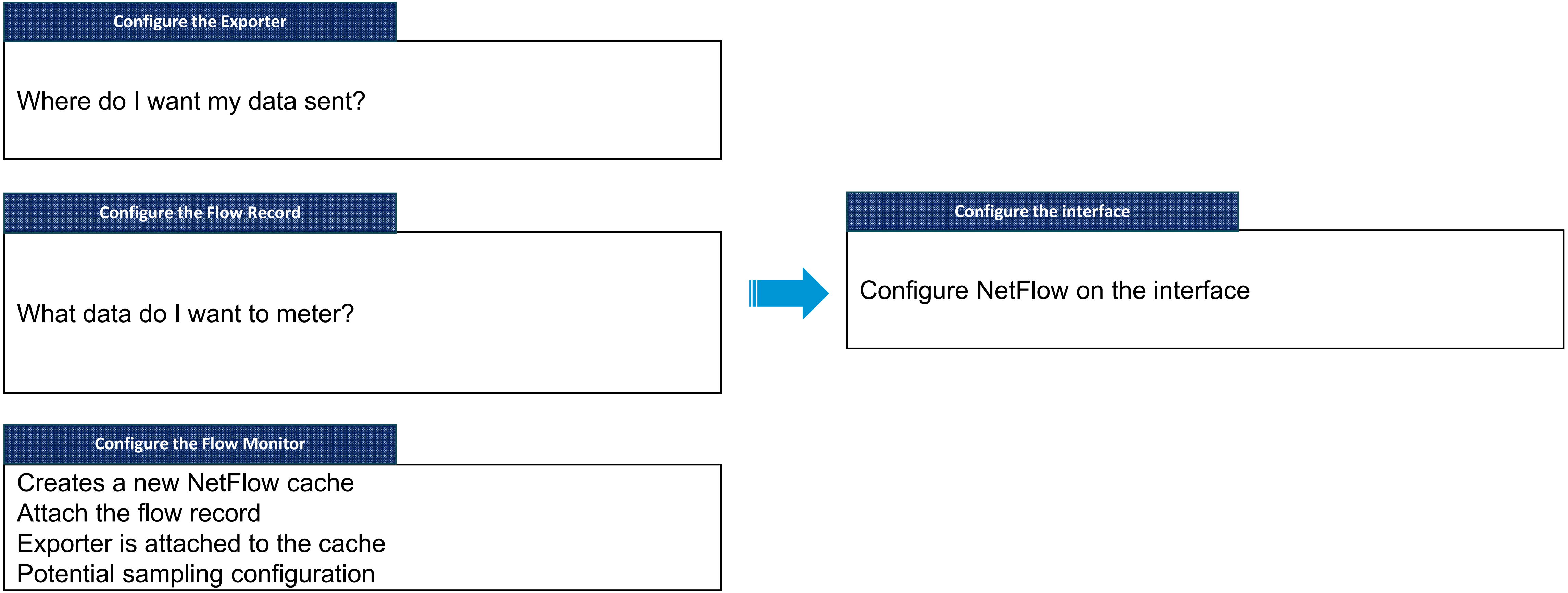
### Flexible & Extensible Flow Export Format

NetFlow v9 / IPFIX



- Users define flow record format
- Flow format is communicated to collector

# Flexible NetFlow – Configuration



**Configure the Exporter**

Where do I want my data sent?

**Configure the Flow Record**

What data do I want to meter?

**Configure the Flow Monitor**

Creates a new NetFlow cache
Attach the flow record
Exporter is attached to the cache
Potential sampling configuration

**Configure the interface**

Configure NetFlow on the interface

# Flexible NetFlow – Configuration

**Configure the Exporter**

```
flow exporter my-exporter
      destination 1.1.1.1
```

**Configure the Flow Record**

```
flow record my-record
      match ipv4 destination address
      match ipv4 source address
      collect counter bytes
```

**Configure the Flow Monitor**

```
flow monitor my-monitor
      exporter my-exporter
      record my-record
```

**Configure the interface**

```
int s3/0
      ip flow monitor my-monitor input
```

# Use Case #1 – Application Client-Server Stats

## Traffic statistics per client and server

```
flow record RECORD-CLIENT-SERVER-STATS
        match ipv4 dscp
        match ipv4 protocol
        match ipv4 source address
        match ipv4 destination address
        match transport source-port
        match transport destination-port
        match interface input
        match flow direction
        match application name [account-on-resolution]
        collect interface output
        collect counter bytes long
        collect counter packets
        (..)
!
```

Watch out for Direction!
In FNF, Direction is not exported by default.

“match application” calls NBAR2
“match application name”: calls NBAR2
“account-on-resolution” (ASR1000): accurate accounting until classification

**Note**:

- In a large scale aggregation, tracking and storing every single flow will severely limit the scalability of the solution.
- Advanced filtering available with MMA (see later)

# Use Case #2 – IP Accounting Replacement

## Collecting Per DSCP Usage – Example

```
flow record RECORD-FNF-DSCP-INGRESS
      match ipv4 dscp
      match interface input
      collect counter bytes long
      collect counter packets long
     !
```

Flow record per DSCP

64-bits counters

```
flow monitor MONITOR-FNF-DSCP-INGRESS
      record RECORD-FNF-DSCP-INGRESS
      exporter EXPORTER-CPI
      cache type permanent
```

Permanent Cache – this replaces the ip accounting feature

```
interface GigabitEthernet0/0/1
      ip flow monitor MONITOR-FNF-DSCP-INGRESS input
```

```
flow exporter EXPORTER-CPI
      destination 10.151.1.131
      source loopback0
      transport udp 9991
      option interface-table
```

# Use Case #2 – IP Accounting Replacement

## Collecting Per DSCP Usage – Outputs

```
1941-7#sh flow monitor MONITOR-FNF-DSCP-INGRESS cache format table
  Cache type:                        Permanent
  Cache size:                        4096
  Current entries:                   2
  High Watermark:                    2

  Flows added:                       2
  Updates sent                       (1800 secs)       4

INTF INPUT                DSCP        bytes long perm       pkts long perm
====================  =======  ====================  ====================
Gi0/0                     0x00         114030514           308376
Gi0/0                     0x08           1590066           8455

1941-7#
```

Max number of flows that have been in the cache at one time.

Flow Keys in Upper Case

# Use Case #3 – QoS Queue Hierarchy Reports

- QoS Class-ID, Queue Drops and Queue Hierarchy Export with FNF

```
policy-map P1
    class C1
        shaping average 16000000
    service-policy child

policy-map child
    class C11
        bandwidth remaining percent 10
    class C12
        bandwidth remaining percent 70
    class class-default
        bandwidth remaining percent 20

class-map match-all C1
    match any
class-map match-all C11
    match ip dscp ef
class-map match-all C12
    match ip dscp cs2
```

```
flow record RECORD-QoS-Hierarchy
    match ipv4 dscp
    match interface input
    collect policy qos class hierarchy
    collect policy qos queue drops
   !
```

| Queue id | Queue packet drops |
|---|---|
| 1 | 100 |
| 2 | 20 |

| Flow | Hierarchy | Queue id |
|---|---|---|
| Flow 1 | P1, C1, C11 | 1 |
| Flow 2 | P1, C1, C11 | 1 |
| Flow 3 | P1, C1, C12 | 2 |

- For each flow, the class hierarchy and queue drops can now be exported through FNF
- Class-ID to Name mapping provided through separate Option Templates

# NBAR2 Field Extraction

## Overview

- Ability to look into specific applications for additional field information
- NBAR2 extracted fields from HTTP, RTP, PCOIP, etc… for QoS configuration
- HTTP Header Fields
- Eases classification of voice and video traffic
  - VoIP, streaming/real time video, audio/video conferencing, Fax over IP
  - Distinguishes between RTP packets based on payload type and CODECS
- Some extracted fields within Flexible NetFlow and Unified Monitoring

| Protocol Fields | Length | FNF Configuration Syntax |
|---|---|---|
| HTTP URL | * | collect application http url |
| HTTP Host | 50 | collection application http host |
| HTTP User-agent | 200 | collection appllication http user-agent |
| HTTP Referer | * | collect application http referer |
| RTSP Host | 50 | collection application rtsp host-name |
| SMTP Server | 50 | collect application smtp server |
| SMTP Sender | 50 | collect application smtp sender |
| POP3 Server | 50 | collect application pop3 server |
| NNTP Group Name | 50 | collect application nntp group-name |
| SIP Source Domain | 50 | collect application sip source |
| SIP Destination Domain | 50 | collect application sip destination |

# NBAR2 Field Extraction

## NBAR RTP Payload Type Classification

- Eases classification of voice and video traffic
  - VoIP, streaming/real time video, audio/video conferencing, Fax over IP
- Distinguishes between RTP packets based on payload type and CODECS

```
Router(config-cmap)# match protocol rtp ?
      audio                 match voice packets
      payload-type          match an explicit PT (Payload Type)
      video                 match video packets
```

| CODEC | Payload Type |
|---|---|
| G.711 (Audio) | 0 (mu-law) 8 (a-law) |
| G.721 (Audio) | 2 |
| G.722 (Audio) | 9 |
| G.723 (Audio) | 4 |
| G.728 (Audio) | 15 |
| G.729 (Audio) | 18 |
| H.261 (Video) | 31 |
| MPEG-1 (A/V)<br>MPEG-2 (A/V) | 14 (Audio), 32 (Video), 33 (A-V) |
| Dynamic | 96–127 |

# URL Collection

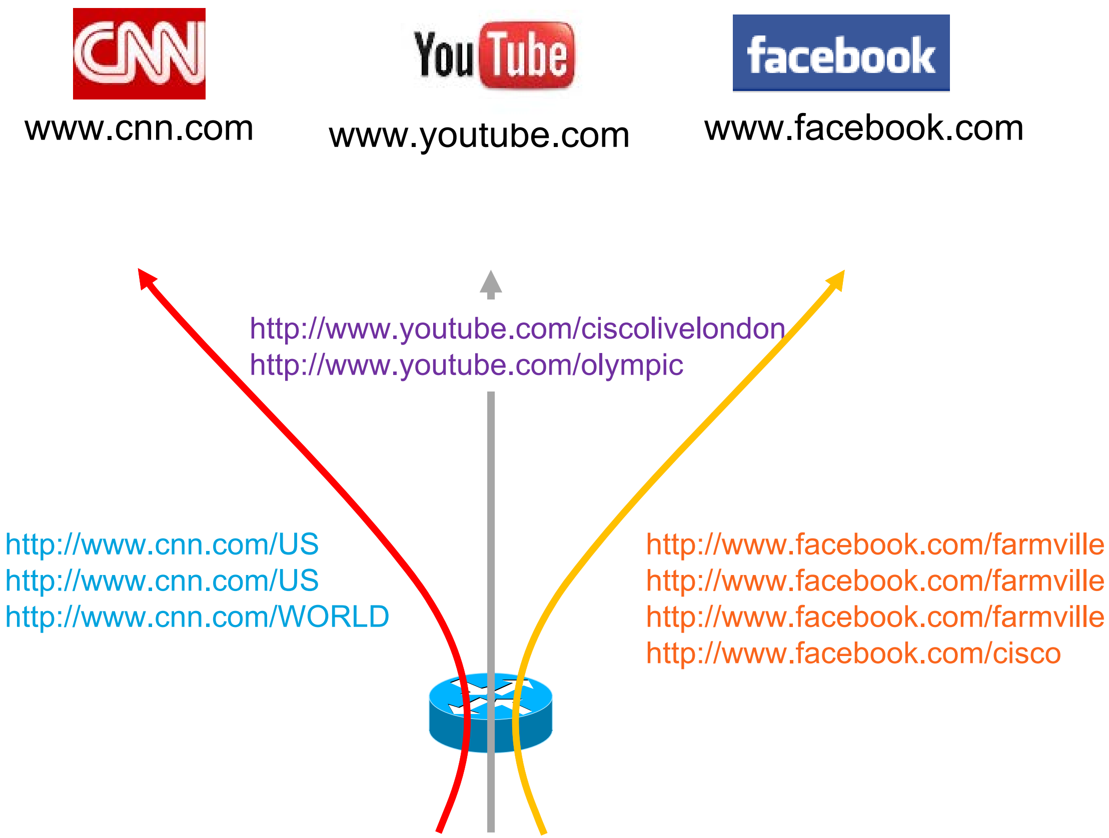
## Top Domain, hit counts

### Key Features

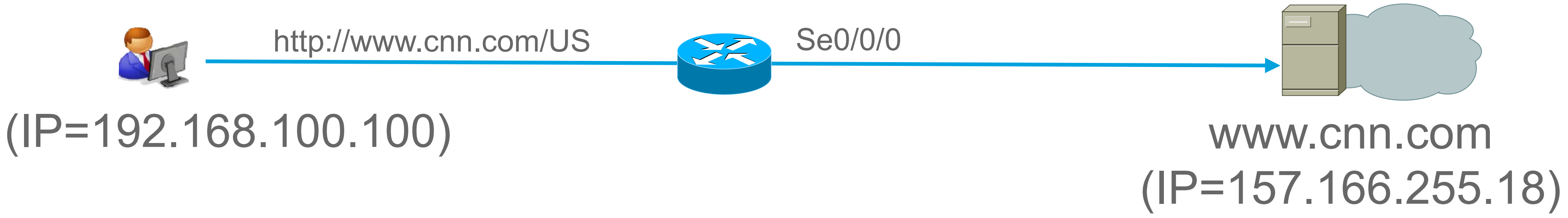
- Provide web browsing activity report
- Standard IPFIX export
- IOS/XE: Unified Monitoring
- Utilize IPFIX Format which is extensible

### Benefits

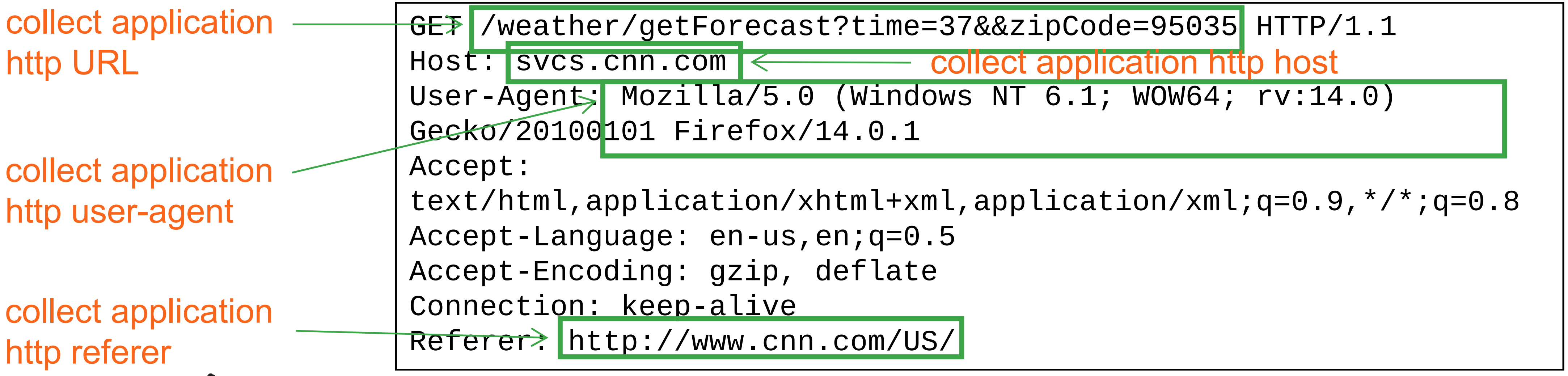
- Visibility into top domains
- Monitors data in Layers 2 thru 7
- Most visited web site
- Most visited URL per site
- How many hits for a particular domain – extracted from HTTP request message


CNN
www.cnn.com
YouTube
www.youtube.com
facebook
www.facebook.com
http://www.youtube.com/ciscolivelondon
http://www.youtube.com/olympic
http://www.cnn.com/US
http://www.cnn.com/US
http://www.cnn.com/WORLD
http://www.facebook.com/farmville
http://www.facebook.com/farmville
http://www.facebook.com/farmville
http://www.facebook.com/cisco

# NBAR2 HTTP Field Extraction



- Ability to extract information from HTTP message



collect application http URL

collect application http host

collect application http user-agent

collect application http referer

```
GET /weather/getForecast?time=37&&zipCode=95035 HTTP/1.1
Host: svcs.cnn.com
User-Agent: Mozilla/5.0 (Windows NT 6.1; WOW64; rv:14.0)
Gecko/20100101 Firefox/14.0.1
Accept:
text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip, deflate
Connection: keep-alive
Referer: http://www.cnn.com/US/
```

# Use Case #4 - Top Domain and URL Hit Count Report

## Configuration Sample

- NBAR extracts fields from flows and exposes it into Application Response Time Engine (ART).
- ISRG2/ASR1k: ART Metrics integrated with Unified Monitoring
- Requires IPFIX export for variable length fields (URL)

**ASR1k – Unified Monitoring**

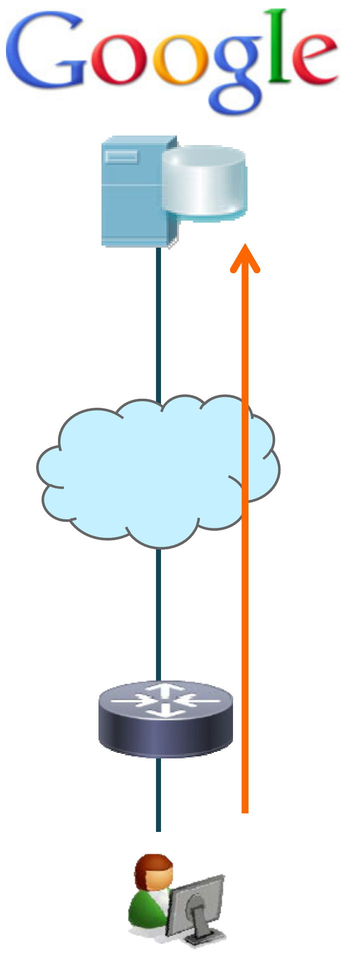
```
flow record type performance-monitor ART-RECORD-URL
      match connection transaction-id
      collect application http url
      collect application http host
```

**ISR-G2k - Unified Monitoring & MACE (backward compatibility)**

```
flow record type mace PA-RECORD
      collect application http uri statistics
      collect application http host
!
```

Using a connection/transaction records with export on transaction-end. So hit count =1, each URL is exported on a different record.

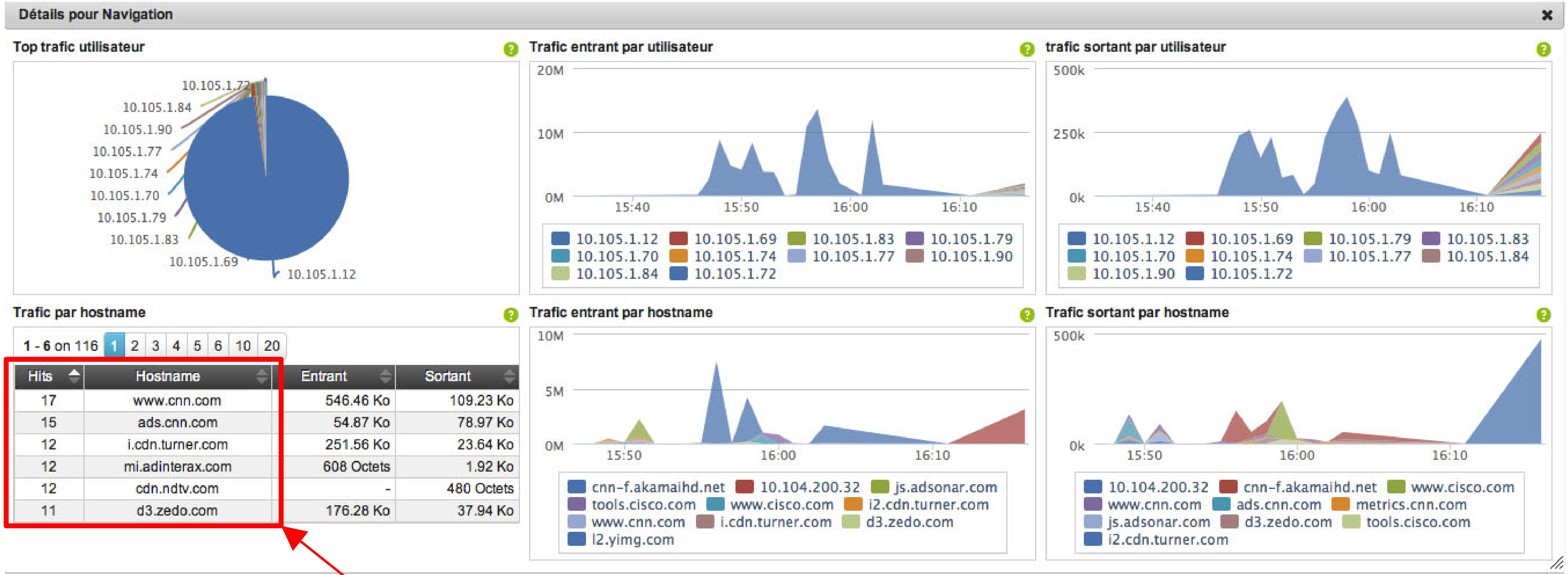
ISRG2 supports MACE also for backward compatibility



# URL Collection

## Top Domain, hit counts

For Your Reference



Détails pour Navigation

Trafic par hostname

1 - 6 on 116 | 1 | 2 | 3 | 4 | 5 | 6 | 10 | 20

| Hits | Hostname | Entrant | Sortant |
|---|---|---|---|
| 17 | www.cnn.com | 546.46 Ko | 109.23 Ko |
| 15 | ads.cnn.com | 54.87 Ko | 78.97 Ko |
| 12 | i.cdn.turner.com | 251.56 Ko | 23.64 Ko |
| 12 | mi.adinterax.com | 608 Octets | 1.92 Ko |
| 12 | cdn.ndtv.com | - | 480 Octets |
| 11 | d3.zedo.com | 176.28 Ko | 37.94 Ko |

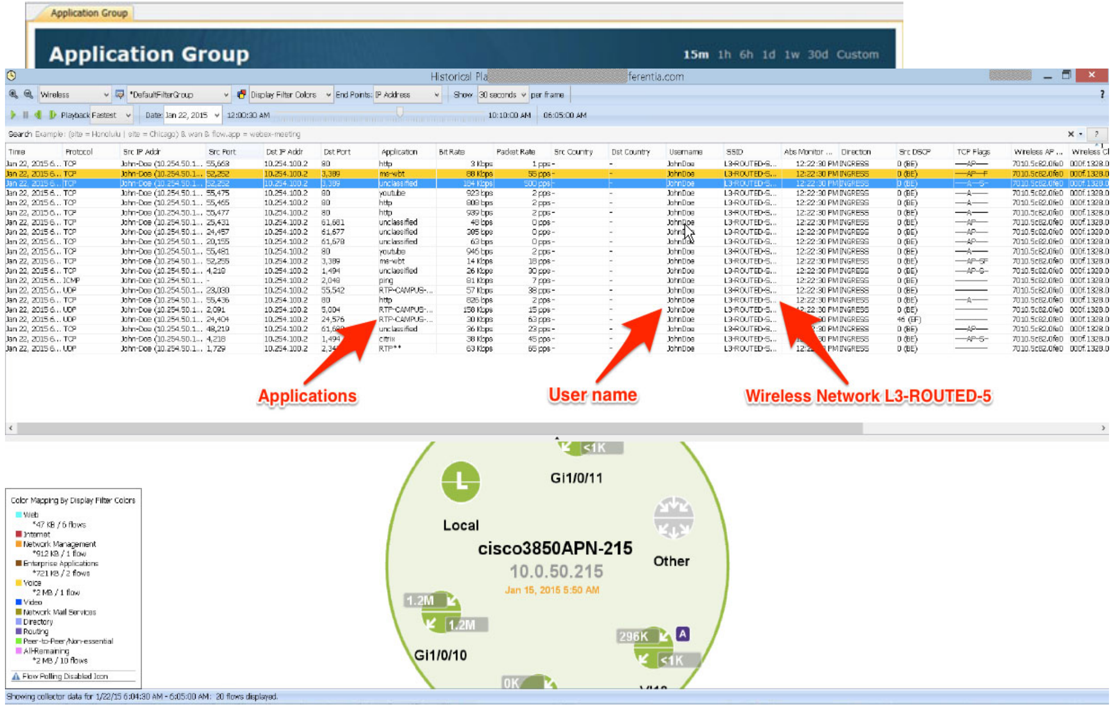
How many hits for a particular domain – extracted from HTTP request message

Courtesy of LivingObjects

# Cisco AVC and LiveAction

## Fully Interactive Application Visibility with QoS & Monitoring

For Your Reference



Application Group

Application Group   15m 1h 6h 1d 1w 30d Custom

Historical Pla[redacted]ferentia.com

Wireless | *DefaultFilterGroup | Display Filter Colors | End Points: IP Address | Show 30 seconds per frame

Playback Fastest | Date: Jan 22, 2015 | 12:00:30 AM | 10:10:00 AM | 06:05:00 AM

Search Example: (site = Honolulu | site = Chicago) & wan & flow.app = webex-meeting

| Time | Protocol | Src IP Addr | Src Port | Dst IP Addr | Dst Port | Application | Bit Rate | Packet Rate | Src Country | Dst Country | Username | SSID | Abs Monitor ... | Direction | Src DSCP | TCP Flags | Wireless AP ... | Wireless Cl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan 22, 2015 6... | TCP | John-Doe (10.254.50.1... | 55,663 | 10.254.100.2 | 80 | http | 3 Kbps | 1 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —AP— | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | TCP | John-Doe (10.254.50.1... | 52,252 | 10.254.100.2 | 3,389 | ms-wbt | 88 Kbps | 55 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —AP—F | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | TCP | John-Doe (10.254.50.1... | 52,252 | 10.254.100.2 | 3,389 | unclassified | 184 Kbps | 500 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —A—S— | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | TCP | John-Doe (10.254.50.1... | 55,475 | 10.254.100.2 | 80 | youtube | 923 bps | 2 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —A— | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | TCP | John-Doe (10.254.50.1... | 55,465 | 10.254.100.2 | 80 | http | 808 bps | 2 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —A— | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | TCP | John-Doe (10.254.50.1... | 55,477 | 10.254.100.2 | 80 | http | 939 bps | 2 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —A— | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | TCP | John-Doe (10.254.50.1... | 25,431 | 10.254.100.2 | 61,681 | unclassified | 48 bps | 0 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —AP— | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | TCP | John-Doe (10.254.50.1... | 24,457 | 10.254.100.2 | 61,677 | unclassified | 385 bps | 0 pps | - | - | JohnD | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —AP— | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | TCP | John-Doe (10.254.50.1... | 20,155 | 10.254.100.2 | 61,678 | unclassified | 63 bps | 0 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —AP— | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | TCP | John-Doe (10.254.50.1... | 55,481 | 10.254.100.2 | 80 | youtube | 946 bps | 2 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —A— | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | TCP | John-Doe (10.254.50.1... | 52,255 | 10.254.100.2 | 3,389 | ms-wbt | 14 Kbps | 18 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —AP-SF | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | TCP | John-Doe (10.254.50.1... | 4,218 | 10.254.100.2 | 1,494 | unclassified | 26 Kbps | 30 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —AP-S- | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | ICMP | John-Doe (10.254.50.1... | - | 10.254.100.2 | 2,048 | ping | 81 Kbps | 7 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —— | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | UDP | John-Doe (10.254.50.1... | 23,030 | 10.254.100.2 | 55,542 | RTP-CAMPUS-... | 57 Kbps | 38 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —— | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | TCP | John-Doe (10.254.50.1... | 55,436 | 10.254.100.2 | 80 | http | 826 bps | 2 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —A— | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | UDP | John-Doe (10.254.50.1... | 2,091 | 10.254.100.2 | 5,004 | RTP-CAMPUS-... | 158 Kbps | 15 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:22:30 PM | INGRESS | 0 (BE) | —— | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | UDP | John-Doe (10.254.50.1... | 24,404 | 10.254.100.2 | 24,576 | RTP-CAMPUS-... | 30 Kbps | 63 pps | - | - | JohnDoe | L3-ROUTED-S... | [illegible]0 PM | INGRESS | 46 (EF) | —— | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | TCP | John-Doe (10.254.50.1... | 48,219 | 10.254.100.2 | 61,6[illegible] | unclassified | 36 Kbps | 23 pps | - | - | JohnDoe | L3-ROUTED-S... | [illegible]:30 PM | INGRESS | 0 (BE) | —AP— | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | TCP | John-Doe (10.254.50.1... | 4,218 | 10.254.100.2 | 1,494 | citrix | 38 Kbps | 45 pps | - | - | JohnDoe | L3-ROUTED-S... | [illegible]0 PM | INGRESS | 0 (BE) | —AP-S- | 7010.5c82.0fe0 | 000f.1328.0 |
| Jan 22, 2015 6... | UDP | John-Doe (10.254.50.1... | 1,729 | 10.254.100.2 | 2,34[illegible] | RTP** | 63 Kbps | 65 pps | - | - | JohnDoe | L3-ROUTED-S... | 12:2[illegible] PM | INGRESS | 0 (BE) | —— | 7010.5c82.0fe0 | 000f.1328.0 |

Applications

User name

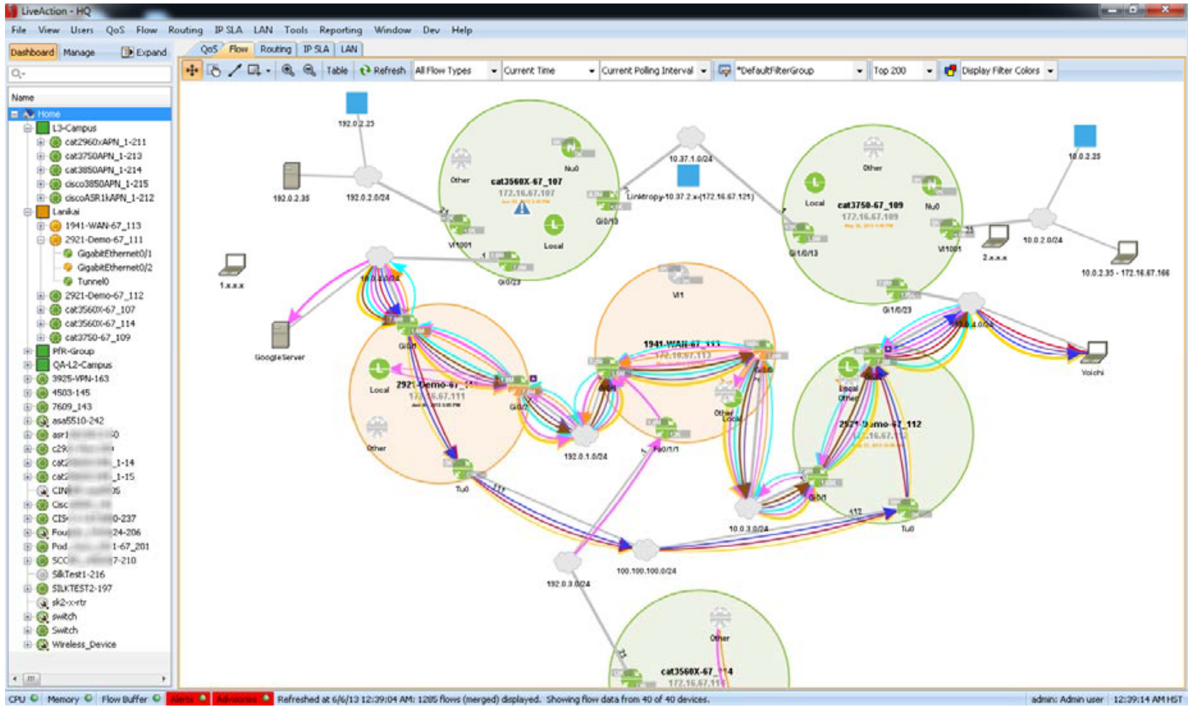
Wireless Network L3-ROUTED-5

Color Mapping By Display Filter Colors

- 🟦 Web
  - *47 KB / 6 flows
- 🟥 Internet
- 🟧 Network Management
  - *912 KB / 1 flow
- 🟫 Enterprise Applications
  - *721 KB / 2 flows
- 🟨 Voice
  - *2 MB / 1 flow
- 🟦 Video
- 🟩 Network Mail Services
- 🟦 Directory
- 🟪 Routing
- 🟩 Peer-to-Peer/Non-essential
- 🟪 All-Remaining
  - *2 MB / 10 flows

⚠ Flow Polling Disabled Icon

Showing collector data for 1/22/15 6:04:30 AM - 6:05:00 AM: 20 flows displayed.



LiveAction - HQ

File View Users QoS Flow Routing IP SLA LAN Tools Reporting Window Dev Help

Dashboard | Manage | Expand

QoS | Flow | Routing | IP SLA | LAN

Table | Refresh | All Flow Types | Current Time | Current Polling Interval | *DefaultFilterGroup | Top 200 | Display Filter Colors

Name

- Home
  - L3-Campus
    - cat2960xAPN_1-211
    - cat3750APN_1-213
    - cat3850APN_1-214
    - cisco3850APN_1-215
    - ciscoASR1kAPN_1-212
  - Lanikai
    - 1941-WAN-67_113
    - 2921-Demo-67_111
      - GigabitEthernet0/1
      - GigabitEthernet0/2
      - Tunnel0
    - 2921-Demo-67_112
    - cat3560X-67_107
    - cat3560X-67_114
    - cat3750-67_109
  - PfR-Group
  - QA-L2-Campus
  - 3925-VPN-163
  - 4503-145
  - 7609_143
  - asa5510-242
  - asr1[redacted]0
  - c29[redacted]
  - cat2[redacted]_1-14
  - cat2[redacted]_1-15
  - CIN[redacted]05
  - Cisc[redacted]
  - CIS[redacted]0-237
  - Fou[redacted]24-206
  - Pod[redacted]1-67_201
  - SCC[redacted]7-210
  - SilkTest1-216
  - SILKTEST2-197
  - sk2-x-rtr
  - switch
  - Switch
  - Wireless_Device

CPU | Memory | Flow Buffer | Alerts | Advisories | Refreshed at 6/6/13 12:39:04 AM: 1285 flows (merged) displayed. Showing flow data from 40 of 40 devices. | admin: Admin user | 12:39:14 AM HST

Reports Display Application Data Categories

End-to-End Usage of Applications

# Application Control

Mark, Shape and Police Applications

# Simplify Application Aware Control - Grouping

## Why NBAR2 attributes

- Performing QoS on each of ~1400 applications is tedious and not realistic
- QoS configuration has to change as new applications emerge or old application deprecate

## Value of NBAR2 attributes

- NBAR2 attribute provides grouping of similar types of applications
- Use attributes to report on group of applications or to simplify QoS classification
- QoS configuration based on attributes could remain static
- 8 pre-defined attributes per application (can be reassigned by users)

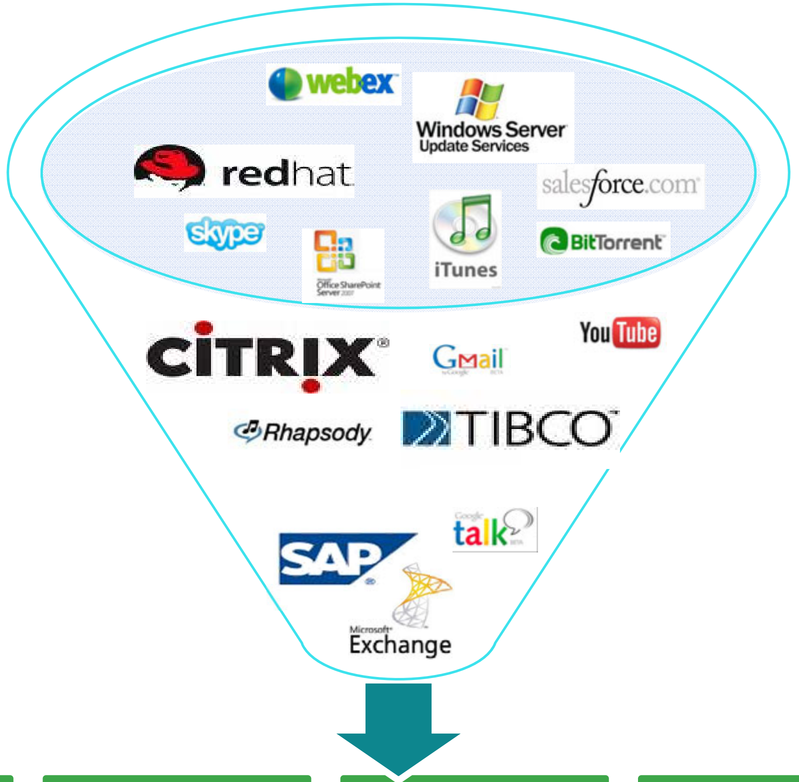
# Simplify Application Aware Control - NBAR2 Attributes

| | |
|---|---|
| Category | First level grouping of applications with similar functionalities |
| Sub-category | Second level grouping of applications with similar functionalities |
| Application-group | Grouping of applications based on brand or application suite |
| P2P-technology? | Indicate application is peer-to-peer |
| Encrypted? | Indicate application is encrypted |
| Tunneled? | Indicate application uses tunnelling technique |
| **Traffic-class** | 12 set of traffic classes defined with pre-defined QoS configuration |
| **Business-Relevance?** | Indicate whether the application is relevant to business |

# Application Aware QoS

## Simplified using Attributes

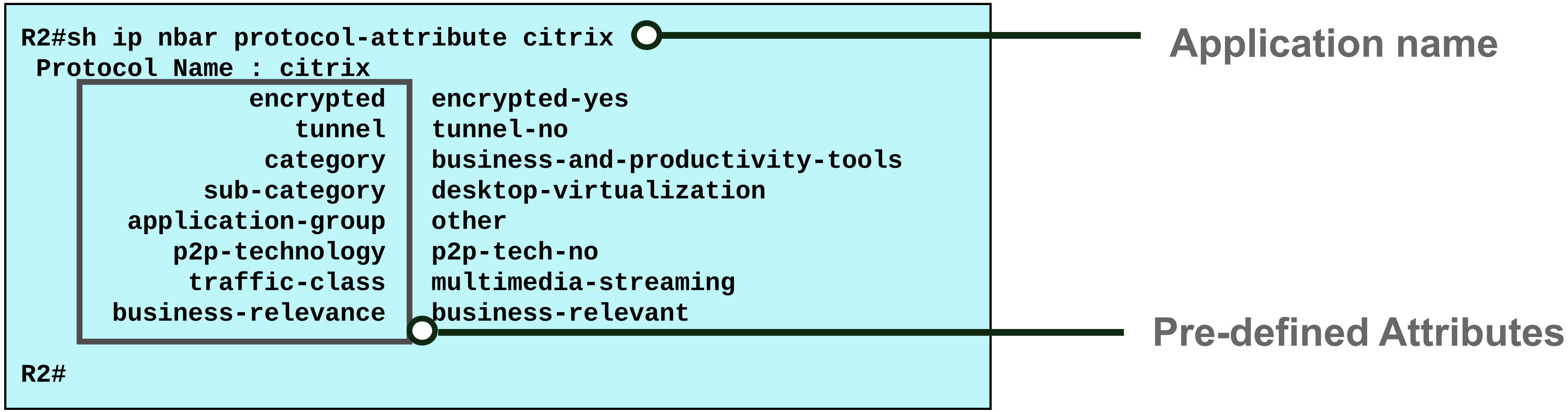
- Application aware QoS (Marking, Control, Block) on any individual 1400+ applications or categories
- All 1400+ are grouped based on functionality, QoS expectations under different categories
- Customers can override existing categorization structure



| Category | Sub Category | Application Category | P2P Technology | Encrypted | Tunneled Traffic | Traffic Class | Business Relevance |
|---|---|---|---|---|---|---|---|
| •Browsing<br>•Voice and Video<br>•Gaming<br>•Email<br>•File Sharing<br>•…. | •Control and Signaling<br>•Voice, Video and Collaboration<br>•Streaming<br>•… | •P2P File Transfer<br>•Skype Group<br>•WebEx Group<br>•... | •Yes<br>•No | •Yes<br>•No | •Yes<br>•No | •VoIP<br>•Real Time<br>•Signaling<br>•…<br>•No | •Relevant<br>•Irrelevant<br>•Default |

For Your Reference

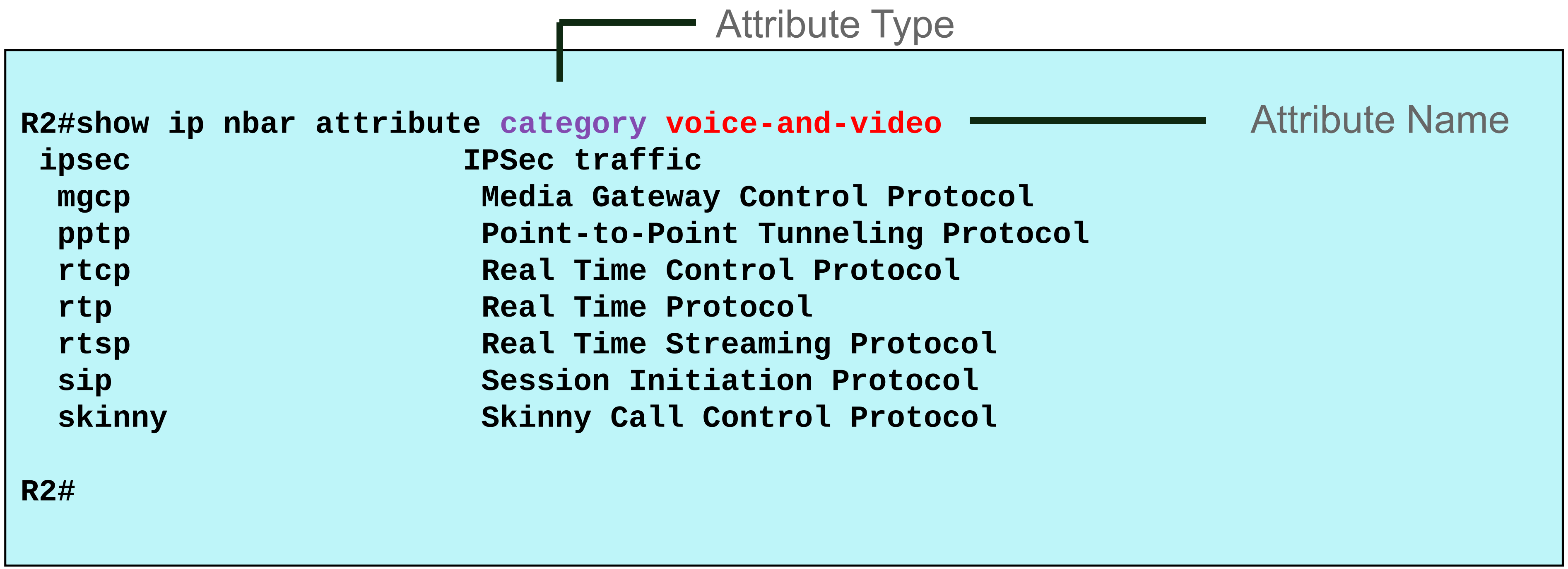
# NBAR2 – Application Attributes



```
R2#sh ip nbar protocol-attribute citrix
 Protocol Name : citrix
                 encrypted   encrypted-yes
                    tunnel   tunnel-no
                  category   business-and-productivity-tools
              sub-category   desktop-virtualization
         application-group   other
            p2p-technology   p2p-tech-no
             traffic-class   multimedia-streaming
        business-relevance   business-relevant

R2#
```

For Your Reference

# NBAR2 – Application Attributes



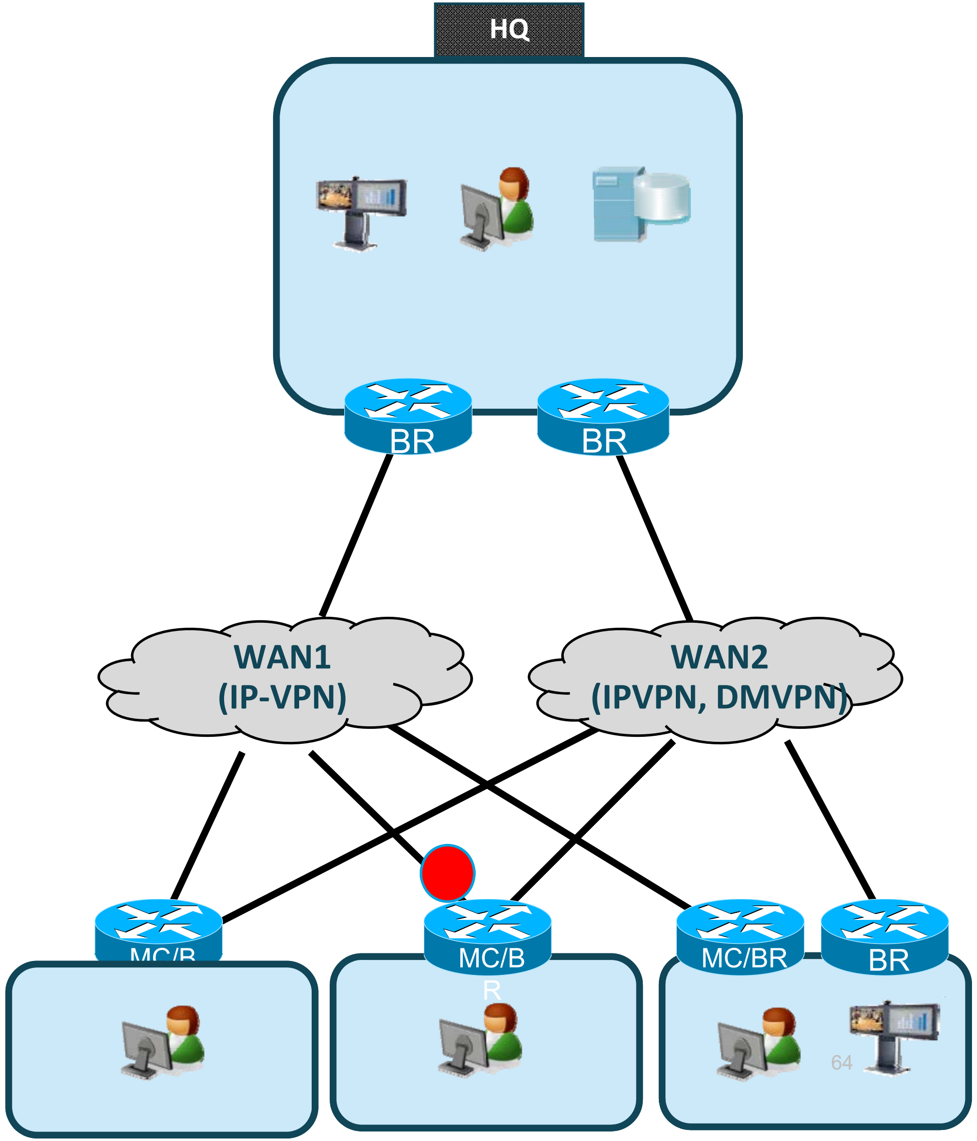
```
R2#show ip nbar attribute category voice-and-video
 ipsec                  IPSec traffic
  mgcp                   Media Gateway Control Protocol
  pptp                   Point-to-Point Tunneling Protocol
  rtcp                   Real Time Control Protocol
  rtp                    Real Time Protocol
  rtsp                   Real Time Streaming Protocol
  sip                    Session Initiation Protocol
  skinny                 Skinny Call Control Protocol

R2#
```

# Modular QoS Traffic Classification

## Simplified Policies using NBAR2 Attributes

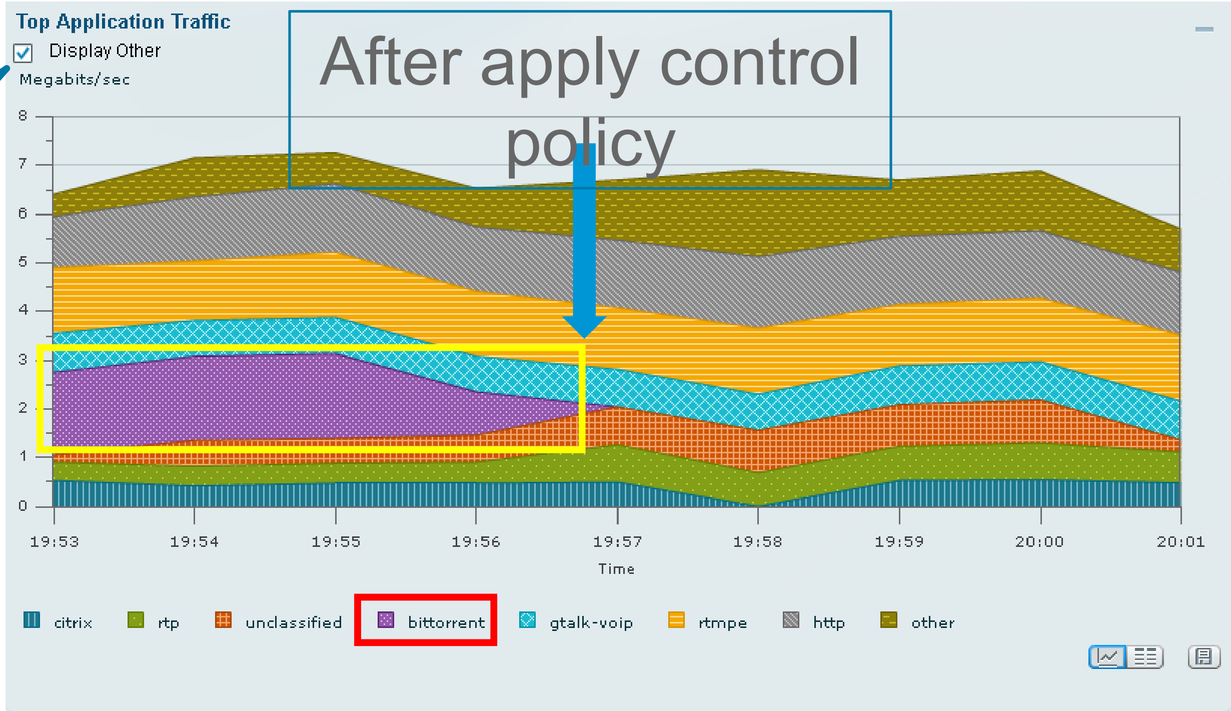
I want to exclude Viber and Skype from sub-category voice-video-chat-collaboration

```
class-map match-any excluded-apps
 match protocol skype
 match protocol viber
class-map match-all voice-video-chat-app
 match protocol attribute sub-category
      voice-video-chat-collaboration
 match not class-map excluded-apps
```



# Example: Stop P2P Applications with AVC

Cisco Prime NAM Top Application Chart



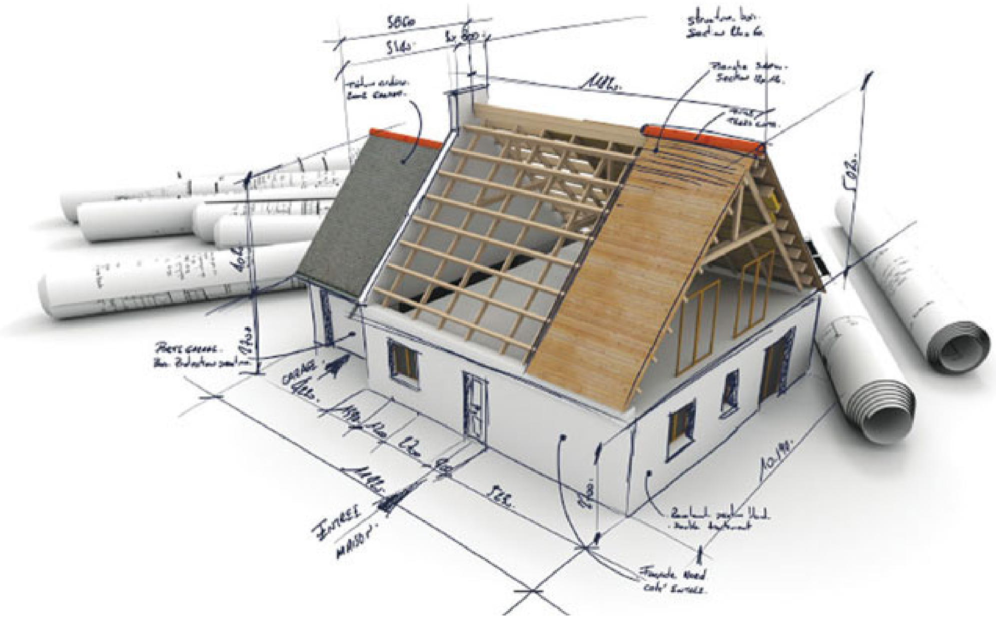
After apply control policy

```
class-map match-all p2p-app
 match protocol attribute p2p-technology p2p-tech-yes
policy-map control-policy
 class p2p-app
  police 8000 conform-action transmit exceed-action drop
```

# Strategic QoS

## The Paradigm Shift

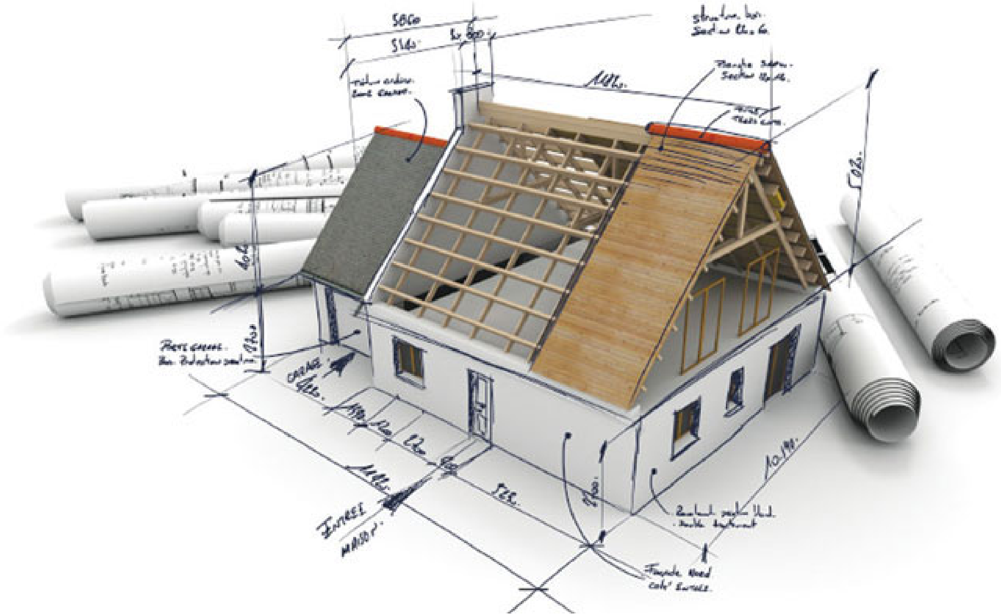
# What Do Customers Consider First?



Business Intent defines QoS Policies

Tools defines QoS Policies

# What Do Customers Consider First?



Always, Always, Always **Start with Defining Your Business Goals of QoS**

Business Intent defines QoS Policies

# Levels of QoS Policy Abstraction

## Strategic vs. Tactical

- Strategic QoS Policy (**WHAT** you want to do)
  - reflects business ***intent***
  - is *not* constrained by any technical or administrative limitation
  - is end-to-end

- Tactical QoS Policy (**HOW** you are going to do it)
  - adapts the strategic business intent to the maximum of platform’s capabilities
  - is limited by various ***tactical constraints***, including:
    - Media constraints (e.g. the WLAN has only 4 levels of service [access categories])
    - Platform constraints (e.g. a Catalyst 3750 has only 4 hardware queues)
    - Interface constraints (e.g. a T1 WAN link has limited bandwidth)
    - Role constraints (e.g. a CE may need to map into a reduced sub-set of SP Classes-of-Service)

# Defining the Strategic QoS Policy

## Three Step Process

1) The administrator decides which applications are business relevant and which are not
2) Once an application has been determined as business-relevant, RFC 4594-based logic can be applied to the application to determine the optimal application class for its servicing
3) The administrator specifies target bandwidth allotments to the application classes

# Applications to NBAR Attribute Mapping

1400 Apps

**Traffic Class**

- VoIP Telephony
- Broadcast Video
- Real-Time Interactive
- Multimedia Conferencing
- Multimedia Streaming
- Network Control
- Signaling
- Ops / Admin / Mgmt (OAM)
- Transactional Data
- Bulk Data
- Best Effort
- Scavenger

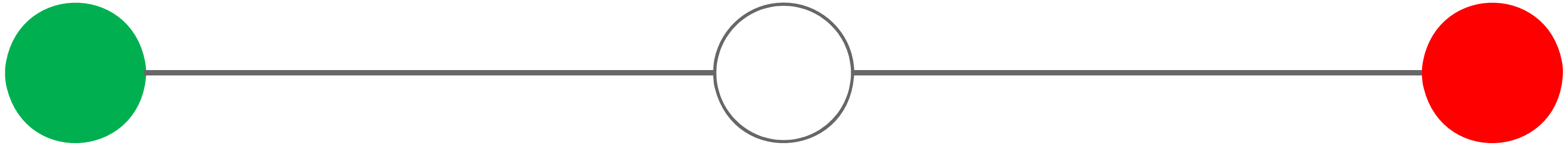
+

**Business Relevance**

- Business Relevant
- Default
- Business Irrelevant

# Determining Business Relevance

## How Important is a Given Application to Business/Organizational Objectives?



### Relevant

- These applications directly supports business objectives
- Applications should be classified and marked according to **RFC 4594-based** rules

### Default

- These applications may/may not support business objectives
  - E.g. HTTP/HTTPS
- Alternatively, administrator may not know the application (or how its being used in the org)
- Applications in this class should be marked DF and provisioned with a **default** best-effort service (**RFC 2474**)

### Irrelevant

- These applications are known and do not directly support any business objectives; this class includes ***all personal/consumer applications***
- Applications in this class should be marked CS1 and provisioned with a “**less-than-best-effort**” service (**RFC 3662**)

# Changing Application Business-Relevance

## Scenario 1: Making an Application **Business-Relevant**

```
ip nbar attribute-map ATTIBUTE_MAP-RELEVANT attribute business-relevance business-relevant
ip nbar attribute-set application-name ATTIBUTE_MAP-RELEVANT
```

## Scenario 2: Making an Application **Best-Effort/Default**

```
ip nbar attribute-map ATTRIBUTE_MAP-DEFAULT attribute business-relevance default
ip nbar attribute-set application-name ATTRIBUTE_MAP-DEFAULT
```

## Scenario 3: Making an Application **Business-Irrelevant**

```
ip nbar attribute-map ATTRBUTE_MAP-SCAVENGER attribute business-relevance business-irrelevant
ip nbar attribute-set application-name ATTRBUTE_MAP-SCAVENGER
```

# Changing Application Business-Relevance

Sce… …nt

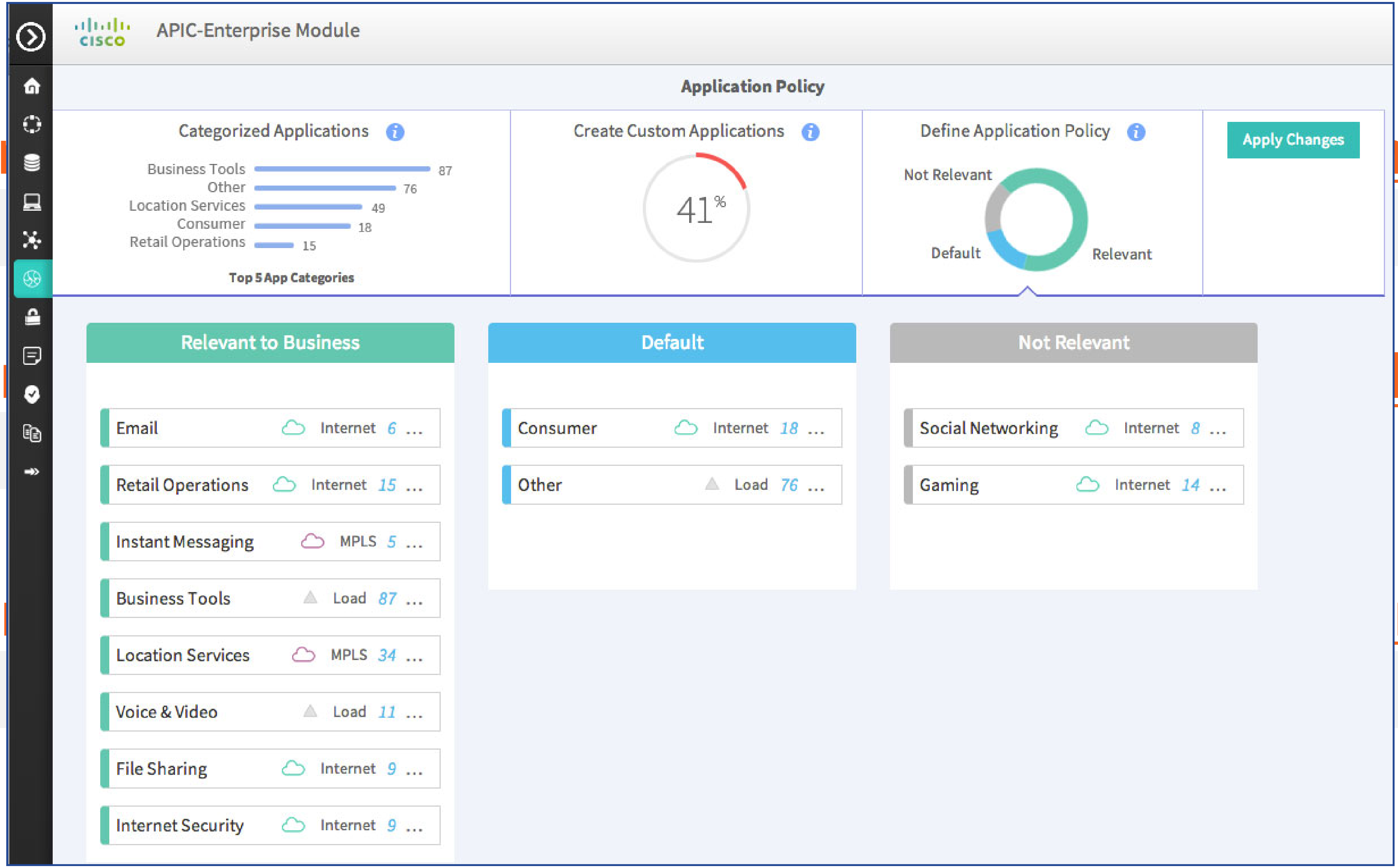
```
ip nbar
ip nbar
```

Sce… …lt

```
ip nbar
ip nbar
```

Sce… …nt

```
ip nbar
ip nbar
```



APIC-Enterprise Module

**Application Policy**

Categorized Applications

| Top 5 App Categories | |
|---|---|
| Business Tools | 87 |
| Other | 76 |
| Location Services | 49 |
| Consumer | 18 |
| Retail Operations | 15 |

Create Custom Applications

41 %

Define Application Policy

Not Relevant

Default

Relevant

Apply Changes

**Relevant to Business**

| | | |
|---|---|---|
| Email | Internet | 6 … |
| Retail Operations | Internet | 15 … |
| Instant Messaging | MPLS | 5 … |
| Business Tools | Load | 87 … |
| Location Services | MPLS | 34 … |
| Voice & Video | Load | 11 … |
| File Sharing | Internet | 9 … |
| Internet Security | Internet | 9 … |

**Default**

| | | |
|---|---|---|
| Consumer | Internet | 18 … |
| Other | Load | 76 … |

**Not Relevant**

| | | |
|---|---|---|
| Social Networking | Internet | 8 … |
| Gaming | Internet | 14 … |

# Strategic QoS Policy Framework

## Cisco’s (RFC 4594-Based) 12-Class QoS Model

| Application Class | Per-Hop Behavior | Queuing & Dropping | Application Examples |
|---|---|---|---|
| VoIP Telephony | EF | Priority Queue (PQ) | Cisco IP Phones (G.711, G.729) |
| Broadcast Video | CS5 | (Optional) PQ | Cisco IP Video Surveillance / Cisco Enterprise TV |
| Real-Time Interactive | CS4 | (Optional) PQ | Cisco TelePresence |
| Multimedia Conferencing | AF4 | BW Queue + DSCP WRED | Cisco Jabber, Cisco WebEx |
| Multimedia Streaming | AF3 | BW Queue + DSCP WRED | Cisco Digital Media System (VoDs) |
| Network Control | CS6 | BW Queue | EIGRP, OSPF, BGP, HSRP, IKE |
| Signaling | CS3 | BW Queue | SCCP, SIP, H.323 |
| Ops / Admin / Mgmt (OAM) | CS2 | BW Queue | SNMP, SSH, Syslog |
| Transactional Data | AF2 | BW Queue + DSCP WRED | ERP Apps, CRM Apps, Database Apps |
| Bulk Data | AF1 | BW Queue + DSCP WRED | E-mail, FTP, Backup Apps, Content Distribution |
| Best Effort | DF | Default Queue + RED | Default Class |
| Scavenger | CS1 | Min BW Queue (Deferential) | YouTube, Netflix, iTunes, BitTorrent, Xbox Live |

# Holy Grail 12-Class SRND Config

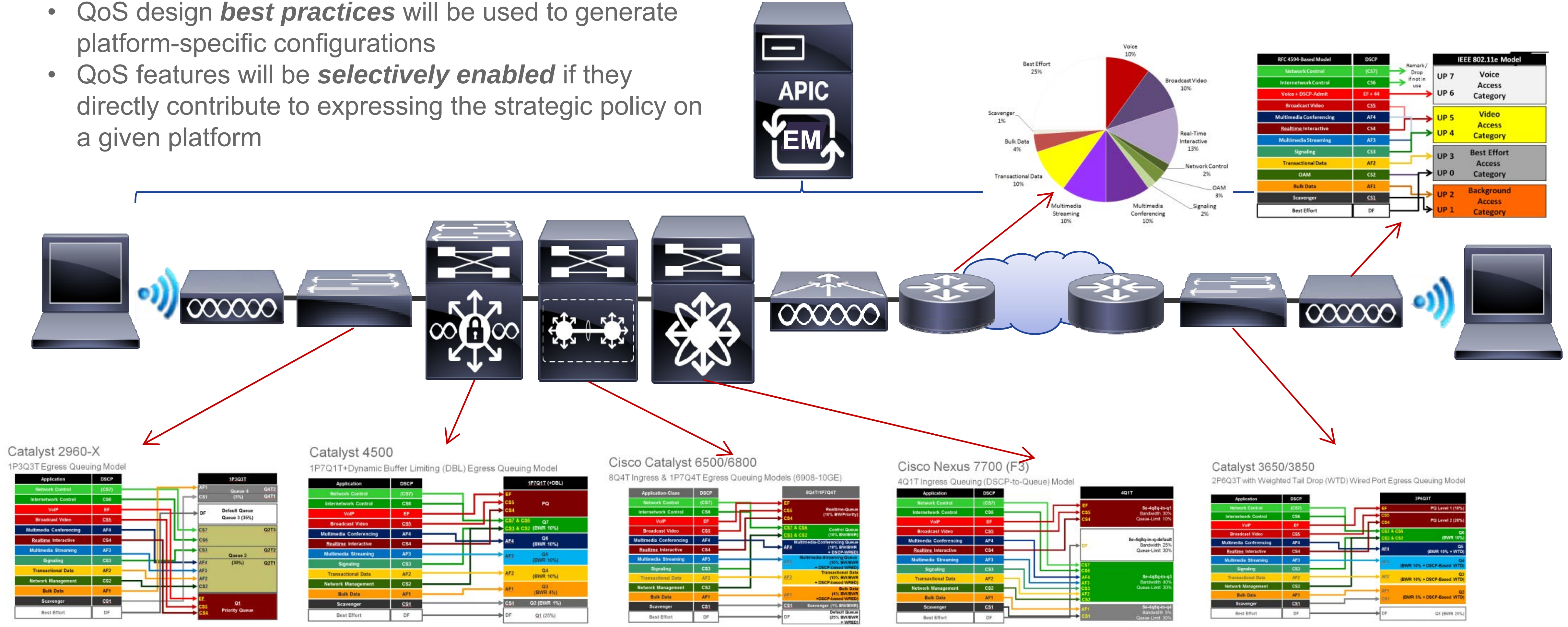
For Your Reference

```
class-map match-all VOICE
   match protocol attribute traffic-class voip-telephony
   match protocol attribute business-relevance business-relevant
class-map match-all BROADCAST-VIDEO
   match protocol attribute traffic-class broadcast-video
   match protocol attribute business-relevance business-relevant
class-map match-all INTERACTIVE-VIDEO
   match protocol attribute traffic-class real-time-interactive
   match protocol attribute business-relevance business-relevant
class-map match-all MULTIMEDIA-CONFERENCING
   match protocol attribute traffic-class multimedia-conferencing
   match protocol attribute business-relevance business-relevant
class-map match-all MULTIMEDIA-STREAMING
   match protocol attribute traffic-class multimedia-streaming
   match protocol attribute business-relevance business-relevant
 class-map match-all SIGNALING
   match protocol attribute traffic-class signaling
   match protocol attribute business-relevance business-relevant
class-map match-all NETWORK-CONTROL
   match protocol attribute traffic-class network-control
   match protocol attribute business-relevance business-relevant
class-map match-all NETWORK-MANAGEMENT
   match protocol attribute traffic-class ops-admin-mgmt
   match protocol attribute business-relevance business-relevant
class-map match-all TRANSACTIONAL-DATA
   match protocol attribute traffic-class transactional-data
   match protocol attribute business-relevance business-relevant
class-map match-all BULK-DATA
   match protocol attribute traffic-class bulk-data
   match protocol attribute business-relevance business-relevant
class-map match-all SCAVENGER
   match protocol attribute business-relevance business-irrelevant
```

```
policy-map MARKING
class VOICE
  set dscp ef
class BROADCAST-VIDEO
  set dscp cs5
class INTERACTIVE-VIDEO
  set dscp cs4
class MULTIMEDIA-CONFERENCING
  set dscp af41
class MULTIMEDIA-STREAMING
  set dscp af31
class SIGNALING
  set dscp cs3
class NETWORK-CONTROL
  set dscp cs6
class NETWORK-MANAGEMENT
  set dscp cs2
class TRANSACTIONAL-DATA
  set dscp af21
class BULK-DATA
  set dscp af11
class SCAVENGER
  set dscp cs1
class class-default
  set dscp default
```

# Conceptual View of EasyQoS

- QoS design ***best practices*** will be used to generate platform-specific configurations
- QoS features will be ***selectively enabled*** if they directly contribute to expressing the strategic policy on a given platform



| RFC 4594-Based Model | DSCP |
|---|---|
| Network Control | (CS7) |
| Internetwork Control | CS6 |
| Voice + DSCP-Admit | EF + 44 |
| Broadcast Video | CS5 |
| Multimedia Conferencing | AF4 |
| Realtime Interactive | CS4 |
| Multimedia Streaming | AF3 |
| Signaling | CS3 |
| Transactional Data | AF2 |
| OAM | CS2 |
| Bulk Data | AF1 |
| Scavenger | CS1 |
| Best Effort | DF |

IEEE 802.11e Model

UP 7, UP 6 — Voice Access Category
UP 5, UP 4 — Video Access Category
UP 3, UP 0 — Best Effort Access Category
UP 2, UP 1 — Background Access Category

## Catalyst 2960-X

1P3Q3T Egress Queuing Model

| Application | DSCP |
|---|---|
| Network Control | (CS7) |
| Internetwork Control | CS6 |
| VoIP | EF |
| Broadcast Video | CS5 |
| Multimedia Conferencing | AF4 |
| Realtime Interactive | CS4 |
| Multimedia Streaming | AF3 |
| Signaling | CS3 |
| Transactional Data | AF2 |
| Network Management | CS2 |
| Bulk Data | AF1 |
| Scavenger | CS1 |
| Best Effort | DF |

1P3Q3T

AF1, CS1 — Queue 4 (5%) — Q4T2, Q4T1
DF — Default Queue Queue 3 (35%)
CS7, CS6 — Q2T3; CS3 — Q2T2; AF4, AF3, AF2, CS2 — Q2T1 — Queue 2 (30%)
EF, CS5, CS4 — Q1 Priority Queue

## Catalyst 4500

1P7Q1T+Dynamic Buffer Limiting (DBL) Egress Queuing Model

| Application | DSCP |
|---|---|
| Network Control | (CS7) |
| Internetwork Control | CS6 |
| VoIP | EF |
| Broadcast Video | CS5 |
| Multimedia Conferencing | AF4 |
| Realtime Interactive | CS4 |
| Multimedia Streaming | AF3 |
| Signaling | CS3 |
| Transactional Data | AF2 |
| Network Management | CS2 |
| Bulk Data | AF1 |
| Scavenger | CS1 |
| Best Effort | DF |

1P7Q1T (+DBL)

EF, CS5, CS4 — PQ
CS7 & CS6, CS3 & CS2 — Q7 (BWR 10%)
AF4 — Q6 (BWR 10%)
AF3 — Q5 (BWR 10%)
AF2 — Q4 (BWR 10%)
AF1 — Q3 (BWR 4%)
CS1 — Q2 (BWR 1%)
DF — Q1 (25%)

## Cisco Catalyst 6500/6800

8Q4T Ingress & 1P7Q4T Egress Queuing Models (6908-10GE)

| Application-Class | DSCP |
|---|---|
| Network Control | (CS7) |
| Internetwork Control | CS6 |
| VoIP | EF |
| Broadcast Video | CS5 |
| Multimedia Conferencing | AF4 |
| Realtime Interactive | CS4 |
| Multimedia Streaming | AF3 |
| Signaling | CS3 |
| Transactional Data | AF2 |
| Network Management | CS2 |
| Bulk Data | AF1 |
| Scavenger | CS1 |
| Best Effort | DF |

8Q4T/1P7Q4T

EF, CS5, CS4 — Realtime-Queue (10% BW/Priority)
CS7 & CS6, CS3 & CS2 — Control Queue (10% BW/BWR)
AF4 — Multimedia-Conferencing Queue (10% BW/BWR + DSCP-WRED)
AF3 — Multimedia-Streaming Queue (10% BW/BWR + DSCP-based WRED)
AF2 — Transactional Data (10% BW/BWR + DSCP-based WRED)
AF1 — Bulk Data (4% BW/BWR +DSCP-based WRED)
CS1 — Scavenger (1% BW/BWR)
DF — Default Queue (25% BW/BWR + WRED)

## Cisco Nexus 7700 (F3)

4Q1T Ingress Queuing (DSCP-to-Queue) Model

| Application | DSCP |
|---|---|
| Network Control | (CS7) |
| Internetwork Control | CS6 |
| VoIP | EF |
| Broadcast Video | CS5 |
| Multimedia Conferencing | AF4 |
| Realtime Interactive | CS4 |
| Multimedia Streaming | AF3 |
| Signaling | CS3 |
| Transactional Data | AF2 |
| Network Management | CS2 |
| Bulk Data | AF1 |
| Scavenger | CS1 |
| Best Effort | DF |

4Q1T

EF, CS5, CS4 — 8e-4q8q-in-q1 Bandwidth 30% Queue-Limit 10%
DF — 8e-4q8q-in-q-default Bandwidth 25% Queue-Limit 30%
CS7, CS6, AF4, AF3, CS3, AF2, CS2 — 8e-4q8q-in-q3 Bandwidth 40% Queue-Limit 30%
AF1, CS1 — 8e-4q8q-in-q4 Bandwidth 5% Queue-Limit 30%

## Catalyst 3650/3850

2P6Q3T with Weighted Tail Drop (WTD) Wired Port Egress Queuing Model

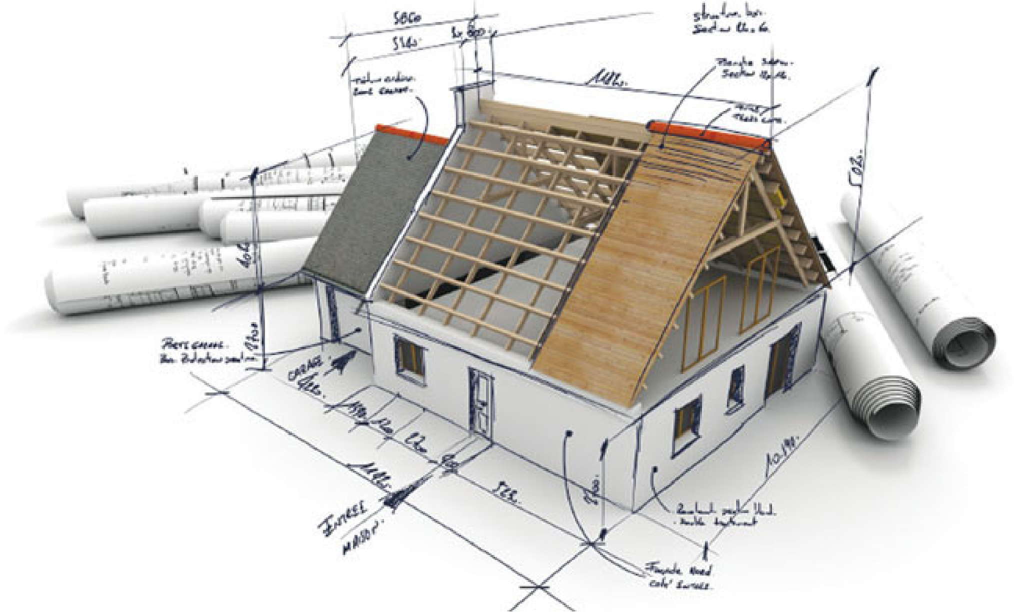
| Application | DSCP |
|---|---|
| Network Control | (CS7) |
| Internetwork Control | CS6 |
| VoIP | EF |
| Broadcast Video | CS5 |
| Multimedia Conferencing | AF4 |
| Realtime Interactive | CS4 |
| Multimedia Streaming | AF3 |
| Signaling | CS3 |
| Transactional Data | AF2 |
| Network Management | CS2 |
| Bulk Data | AF1 |
| Scavenger | CS1 |
| Best Effort | DF |

2P6Q3T

EF — PQ Level 1 (10%)
CS5, CS4 — PQ Level 2 (20%)
CS7 & CS6, CS3 & CS2 — Q6 (BWR 10%)
AF4 — Q5 (BWR 10% + WTD)
AF3 — Q4 (BWR 10% + DSCP-Based WTD)
AF2 — Q3 (BWR 10% + DSCP-Based WTD)
AF1, CS1 — Q2 (BWR 5% + DSCP-Based WTD)
DF — Q1 (BWR 25%)

# Application Aware Strategic QoS – Take Aways

- Conversation shifts from tools (QoS methodologies) to Business Intent
- Customer no more worry about applications
  - New applications are automatically categorized to relevant traffic-class
  - Business relevancy is appropriately marked for all the new applications
- DNS and DNS-AS/ Custom Application Signature to classify all encrypted and home grown applications respectively



# Application Aware Strategic QoS – Take Aways

- Conversation shifts from tools (QoS methodologies) to Business Intent

**BRKSDN-2046 – SDN Enabled QoS-A Deep Dive – Wednesday 9.00 AM**

- Customer no more worry about applications
  - New applications are automatically categorized [illegible]
  - Business relevancy is appropriately marked for all the new applications
- DNS[illegible] Signature to classify all encrypted and home grown applications respectively

**Whisper Suites – NBAR2/ AVC Innovations & EzQoS**

# Application Troubleshooting

Faster Isolation and Resolution

# When users complain about Application Problem

Network is very slow, I am not able to get any work done

ping?

show ip route?

traceroute?

show interface?

I don't see any thing wrong

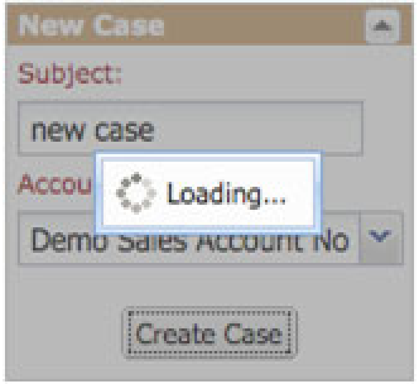
Increased Latency

WAN Problems

Application Problems

Server Problems

User Problems



New Case

Subject:

new case

Accou

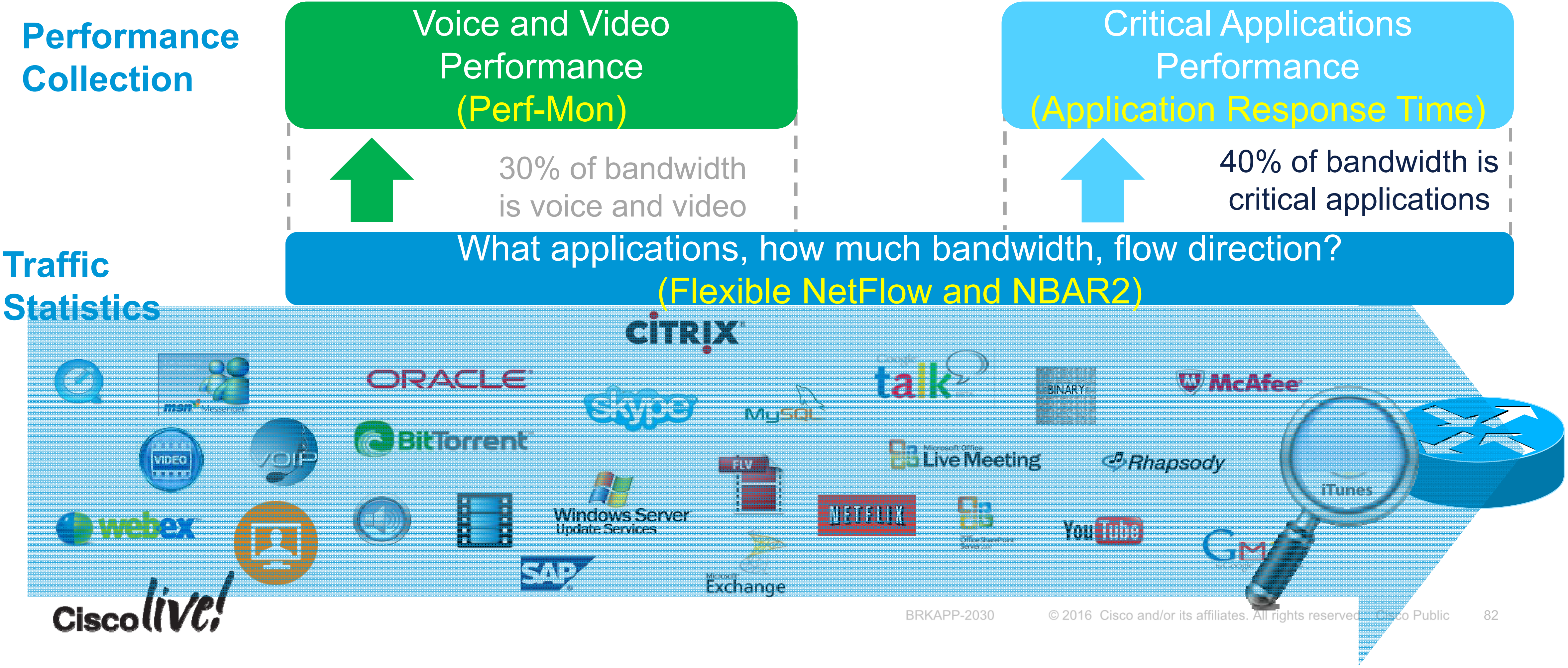
Loading...

Demo Sales Account No

Create Case

# Application Performance Monitoring

- Perf-Mon monitors voice and video application for latency, delay, jitter
- ART monitors TCP applications for network/client/server delay



**Performance Collection**

Voice and Video Performance (Perf-Mon)

30% of bandwidth is voice and video

Critical Applications Performance (Application Response Time)

40% of bandwidth is critical applications

**Traffic Statistics**

What applications, how much bandwidth, flow direction? (Flexible NetFlow and NBAR2)

# Performance Monitoring

## Single Flow Record Type

### Media Monitoring

- RTP SSRC
- RTP Jitter (min/max/mean)
- Transport Counter (expected/loss)
- Media Counter (bytes/packets/rate)
- Media Event
- Collection interval
- TCP MSS
- TCP round-trip time

### Application Response Time

- CND - Client Network Delay (min/max/sum)
- SND – Server Network Delay (min/max/sum)
- ND – Network Delay (min/max/sum)
- AD – Application Delay (min/max/sum)
- Total Response Time (min/max/sum)
- Total Transaction Time (min/max/sum)
- Number of New Connections
- Number of Late Responses
- Number of Responses by Response Time
  - (7-bucket histogram)
- Number of Retransmissions
- Number of Transactions
- Client/Server Bytes
- Client/Server Packets

### Other Metrics

- L3 counter (bytes/packets)
- Flow event
- Flow direction
- Client and server address
- Source and destination address
- Transport information
- Input and output interfaces
- L3 information (TTL, DSCP, TOS, etc.)
- Application information (from NBAR2)
- Monitoring class hierarchy

- All performance metrics are consolidated into one flow record type performance-monitor

# Performance Monitoring

## Single Flow Record Type

### Media Monitoring

Use Case

- Voice, Video Apps
- L4 – L7 Metrics

Platforms

- ISR G2
- ASR1K/ XE
- Cat6K
- Cat4K
- Cat3K
- 3850

### Application Response Time

Use Case

- HTTP, TCP Apps
- L4-L7 Metrics

Platforms

- ISR G2
- ASR1K/ XE
- NAM

### Other Metrics

Use Case

- All IP Apps
- L3-L4 Metrics

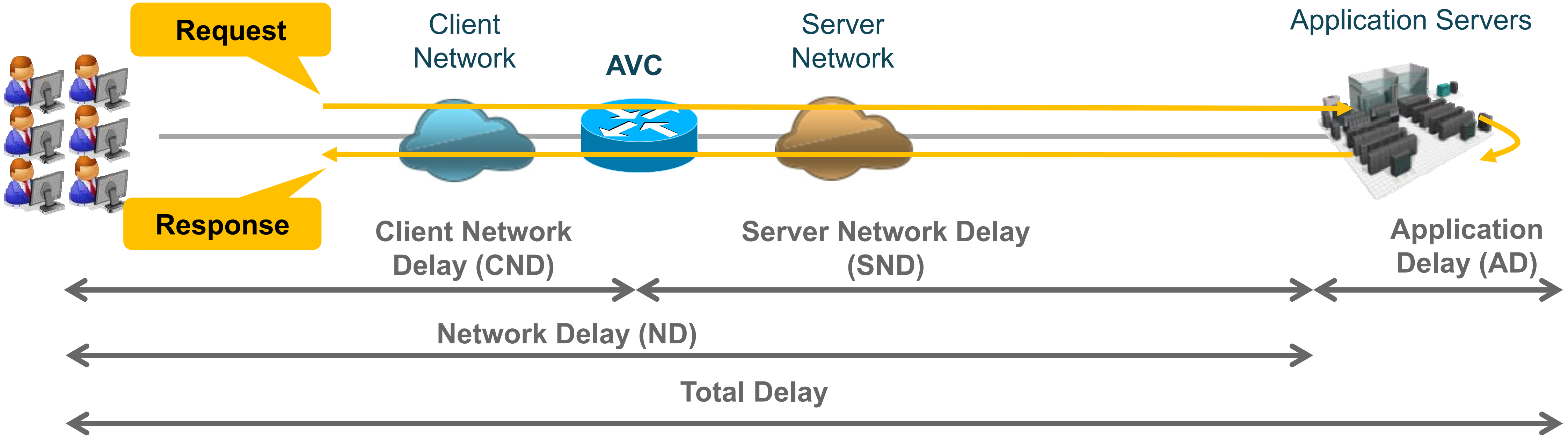
Platforms

- ISR G2
- ASR1K/ XE
- Cat6K
- Cat4K
- 3850
- NAM

- All performance metrics are consolidated into one flow record type performance-monitor

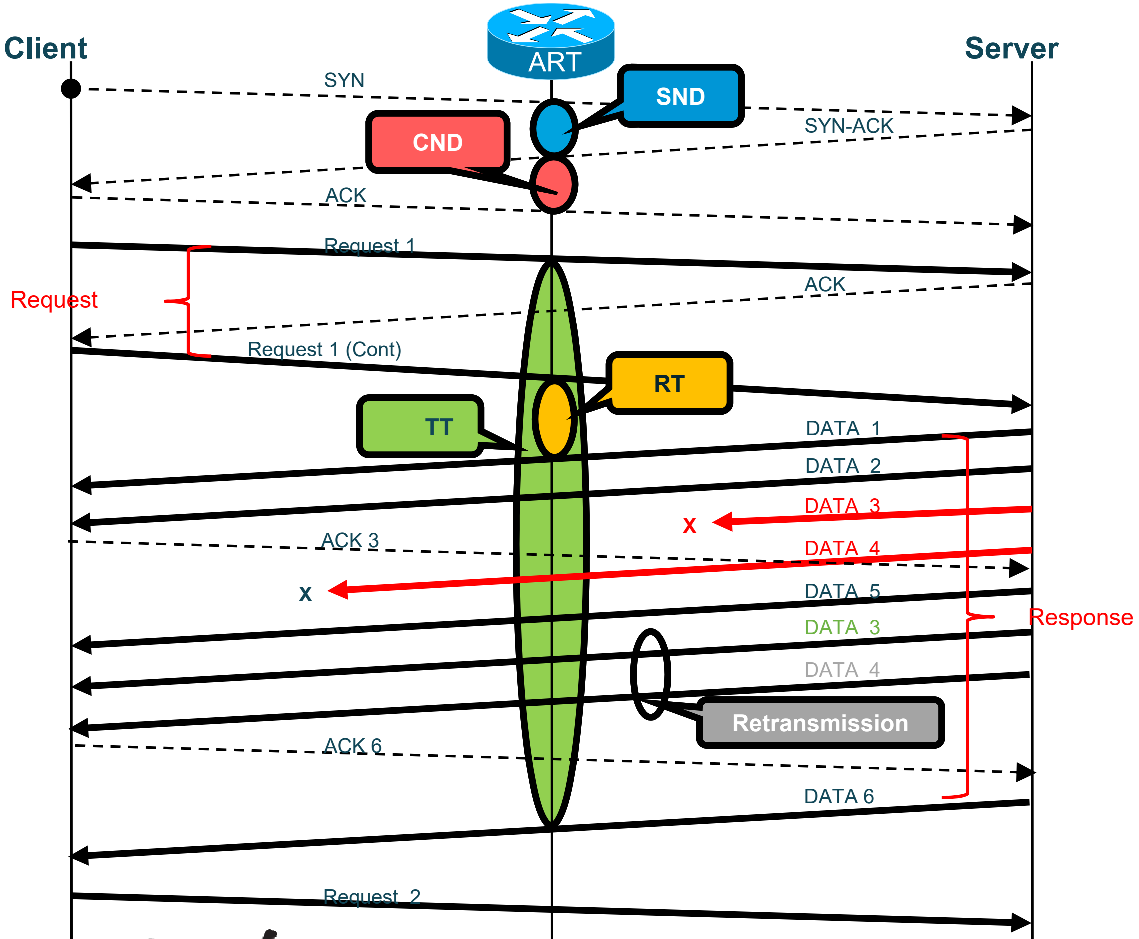
# Application Response Time

## Network Path Segments



- Application response time provides insight into application behavior (network vs server bottleneck) to accelerate problem isolation
- Separate application delivery path into multiple segments
- Server Network Delay (SND) approximates WAN Delay
- Latency per application

# Understand IOS ART Metrics Calculation



| | | |
|---|---|---|
| Network Delay (ND) | ND = CND + SND | |
| Response Time (RT) | t(First response pkt) – t(Last request pkt) | |
| Transaction Time (TT) | t(Last response pkt) – t(First request pkt) | Quantify User Experience |
| Application Delay (AD) | AD = RT – SND | Identify Server Performance Issue |

# Flexible Netflow – Unified Monitoring

## Common CLI and Framework to Export Various Metrics

Netflow

```
flow record RECORD-FNF
 match ipv4 tos
 match ipv4 protocol
 match ipv4 source address
 match ipv4 destination address
 match transport source-port
 match transport destination-port
 match interface input
 match flow direction
 collect interface output
 collect counter bytes long
 collect counter packets
```

Conversation Stats

```
flow record type performance-monitor my-rec
 match routing vrf input
 match ipv4 protocol
 match application name account-on-resolution
 match connection client ipv4 address
 match connection server ipv4 address
 match connection server transport port
 collect connection new-connections
 collect connection sum-duration
 collect connection server counter bytes long
 collect connection server counter packets long
 collect connection client counter bytes long
 collect connection client counter packets long
```

ART

```
flow record type performance-monitor my-rec
 match routing vrf input
 match ipv4 protocol
 match application name
 match connection client ipv4 address
 match connection server ipv4 address
 match connection server transport port
 collect ipv4 dscp
 collect connection delay response to-server sum
 collect connection server counter responses
 collect connection delay network to-server sum
 collect connection delay network to-client sum
```

Perf-Mon

```
flow record type performance-monitor pm-ipv4
  match ipv4 source address
  match ipv4 destination address
  match transport source-port
  match transport destination-port
  match ipv4 protocol
  match transport rtp ssrc
  collect transport packets lost counter
  collect transport packets lost rate
  collect transport rtp jitter mean
  collect transport rtp jitter minimum
  collect transport rtp jitter maximum
  collect application media packets rate
```

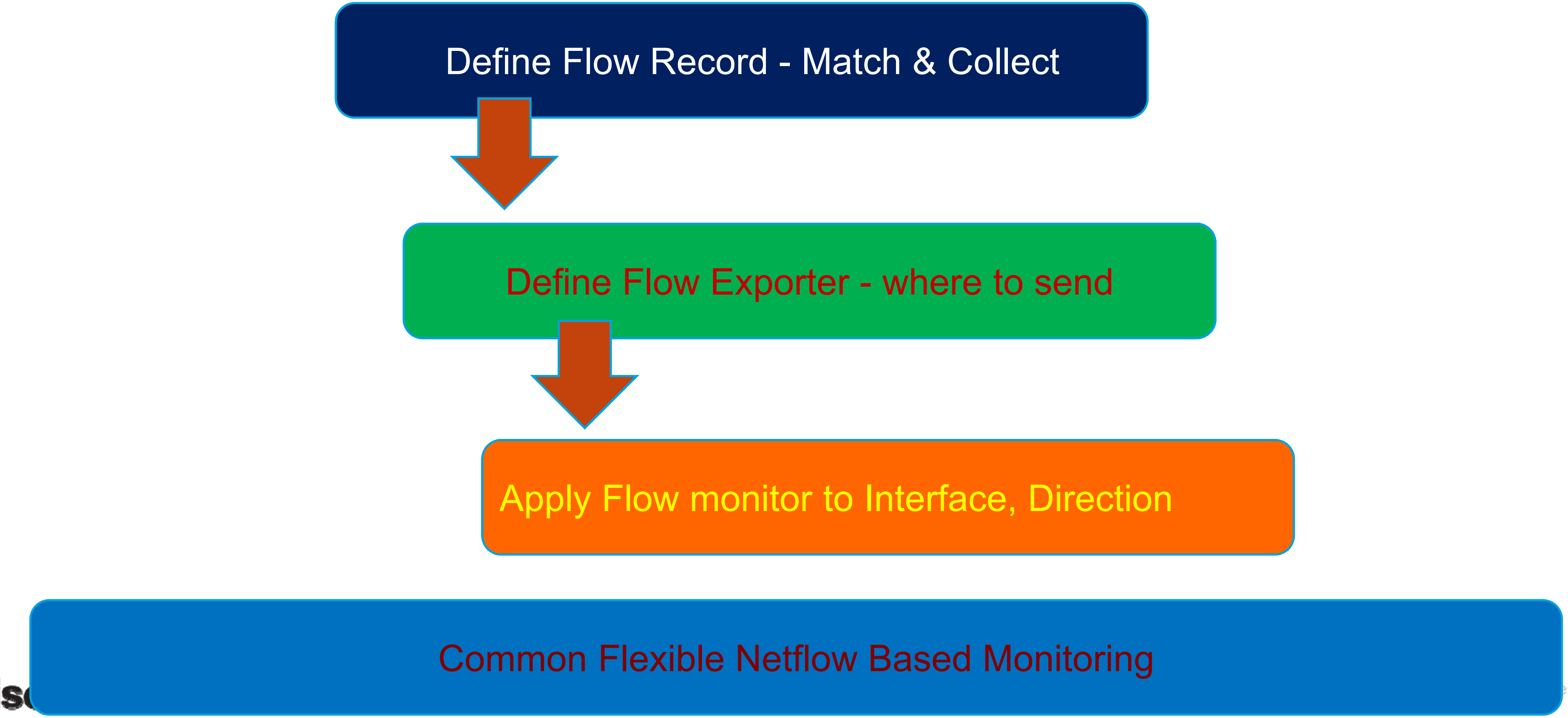
# Flexible Netflow – Unified Monitoring

## Common CLI and Framework to Export Various Metrics

```
flow record type performance-monitor pm-ipv4
  match ipv4 source address
  match ipv4 destination address
  match transport source-port
  match transport destination-port
  match ipv4 protocol
  match transport rtp ssrc
  collect transport packets lost counter
  collect transport packets lost rate
  collect transport rtp jitter mean
  collect transport rtp jitter minimum
  collect transport rtp jitter maximum
  collect application media packets rate
```

# Flexible Netflow – Unified Monitoring

## Common CLI and Framework to Export Various Metrics



Define Flow Record - Match & Collect

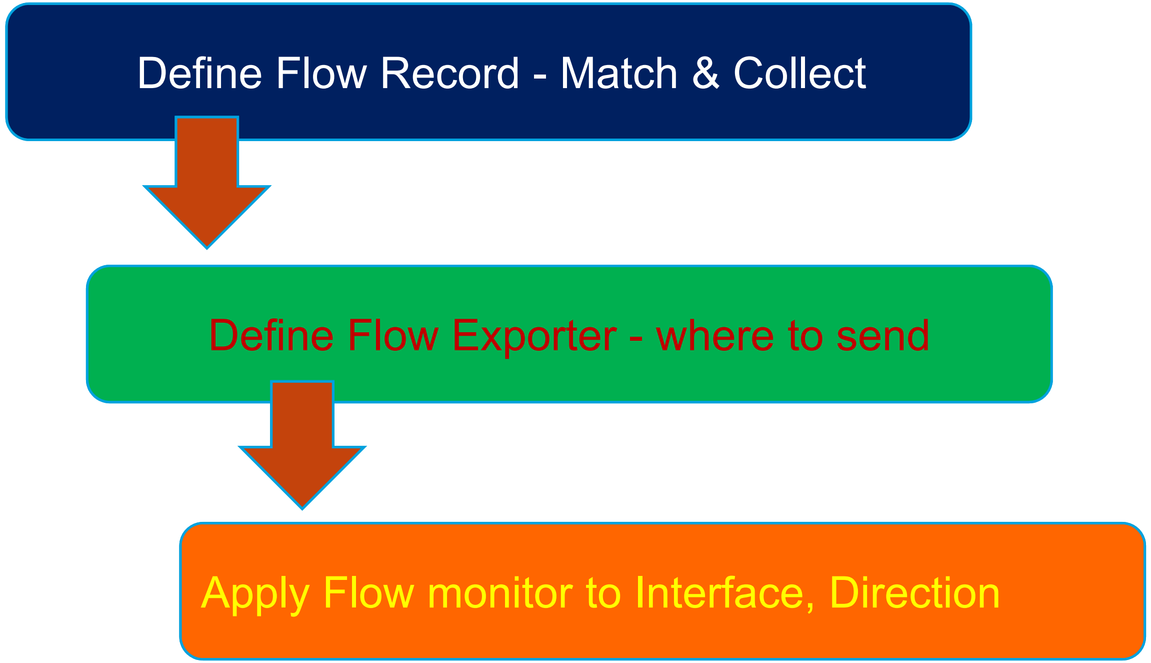
Define Flow Exporter - where to send

Apply Flow monitor to Interface, Direction

Common Flexible Netflow Based Monitoring

# Flexible Netflow – Unified Monitoring

## Common CLI and Framework to Export Various Metrics



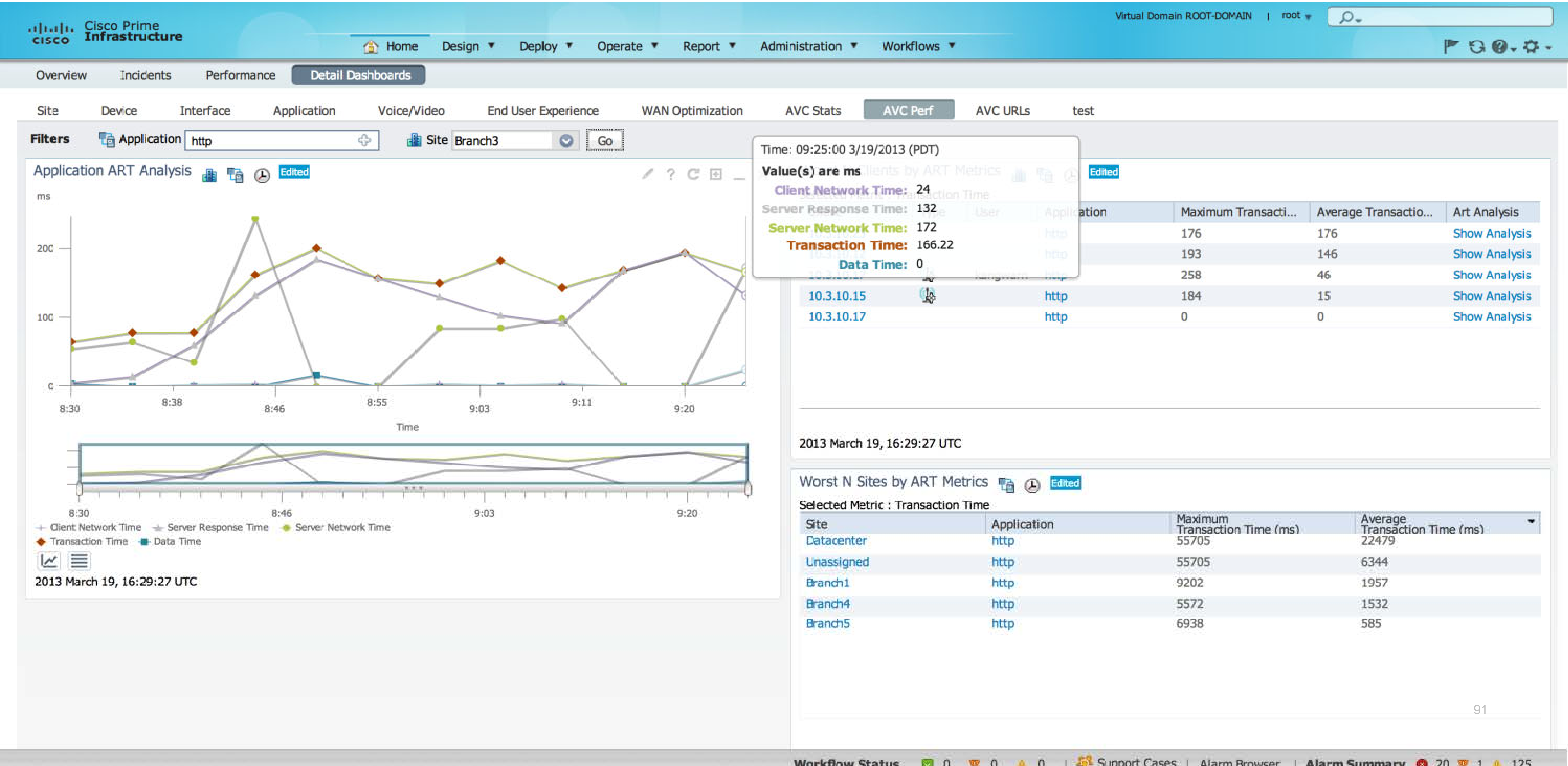
Define Flow Record - Match & Collect

Define Flow Exporter - where to send

Apply Flow monitor to Interface, Direction

Unified Monitoring with Metric Mediation Agent (MMA) is available since 15.4(1)T
Customer are advised to migrate from MACE to MMA

# Prime Infrastructure ART Example



Time: 09:25:00 3/19/2013 (PDT)

**Value(s) are ms**

Client Network Time: 24
Server Response Time: 132
Server Network Time: 172
Transaction Time: 166.22
Data Time: 0

2013 March 19, 16:29:27 UTC

Selected Metric : Transaction Time

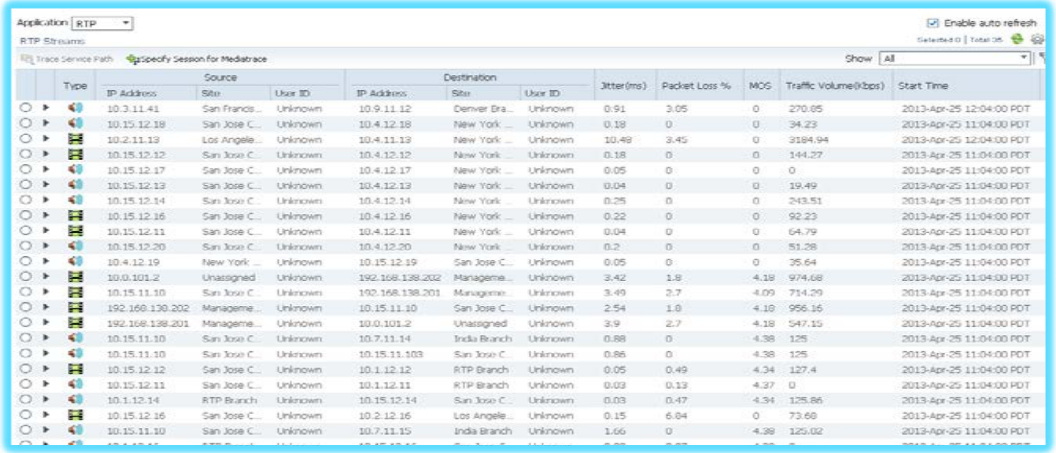
| Client | Type | User | Application | Maximum Transacti... | Average Transactio... | Art Analysis |
|---|---|---|---|---|---|---|
| [illegible] | | | http | 176 | 176 | Show Analysis |
| [illegible] | | | http | 193 | 146 | Show Analysis |
| [illegible] | | [illegible] | http | 258 | 46 | Show Analysis |
| 10.3.10.15 | | | http | 184 | 15 | Show Analysis |
| 10.3.10.17 | | | http | 0 | 0 | Show Analysis |

2013 March 19, 16:29:27 UTC

Selected Metric : Transaction Time

| Site | Application | Maximum Transaction Time (ms) | Average Transaction Time (ms) |
|---|---|---|---|
| Datacenter | http | 55705 | 22479 |
| Unassigned | http | 55705 | 6344 |
| Branch1 | http | 9202 | 1957 |
| Branch4 | http | 5572 | 1532 |
| Branch5 | http | 6938 | 585 |

# Voice/Video Troubleshooting



Application RTP

RTP Streams

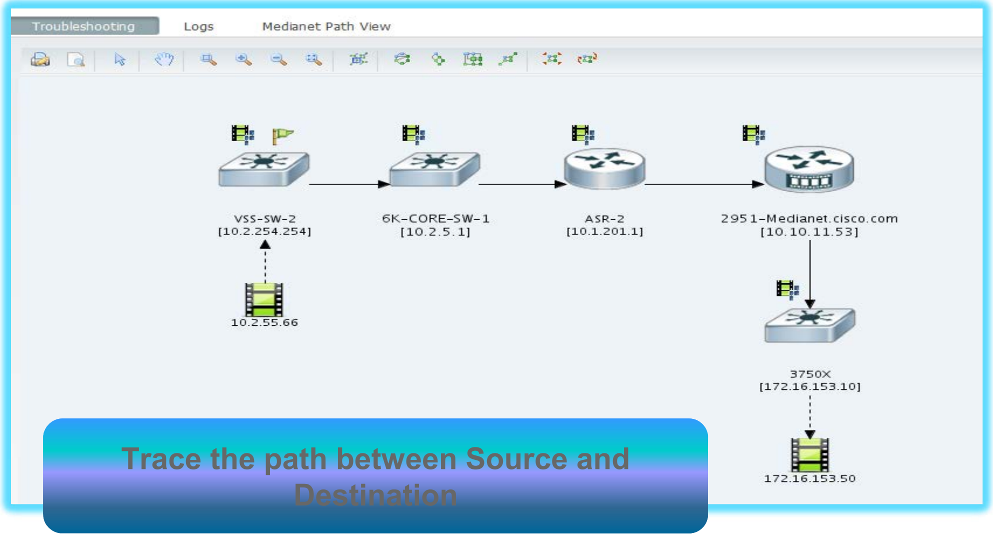
☑ Enable auto refresh

Selected 0 | Total 35

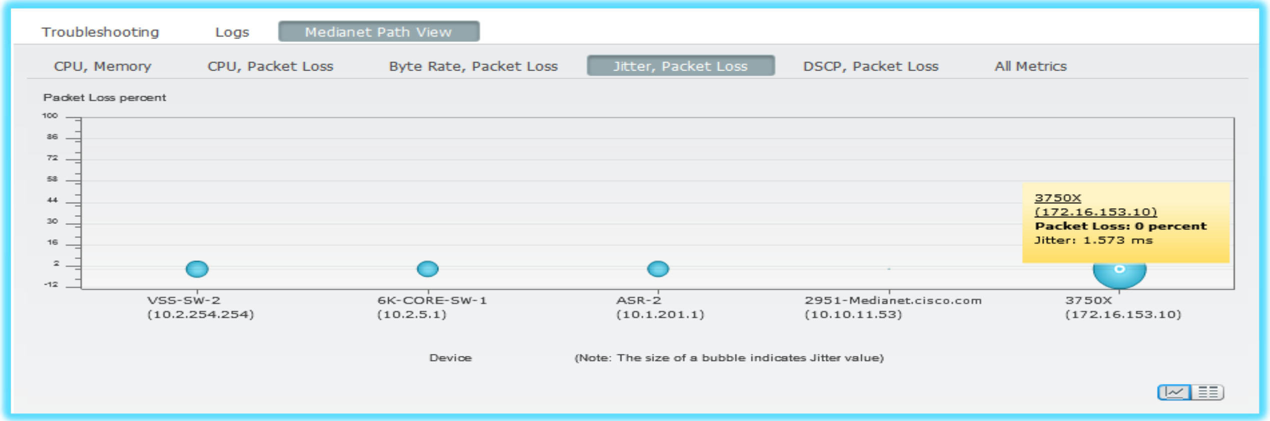
Show All

| | | Type | Source | | | Destination | | | Jitter(ms) | Packet Loss % | MOS | Traffic Volume(Kbps) | Start Time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | IP Address | Site | User ID | IP Address | Site | User ID | | | | | |
| ○ | ▸ | 🔊 | 10.3.11.41 | San Francis... | Unknown | 10.9.11.12 | Denver Bra... | Unknown | 0.91 | 3.05 | 0 | 270.05 | 2013-Apr-25 12:04:00 PDT |
| ○ | ▸ | 🔊 | 10.15.12.18 | San Jose C... | Unknown | 10.4.12.18 | New York ... | Unknown | 0.18 | 0 | 0 | 34.23 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🎞 | 10.2.11.13 | Los Angele... | Unknown | 10.4.11.13 | New York ... | Unknown | 10.48 | 3.45 | 0 | 3184.94 | 2013-Apr-25 12:04:00 PDT |
| ○ | ▸ | 🎞 | 10.15.12.12 | San Jose C... | Unknown | 10.4.12.12 | New York ... | Unknown | 0.18 | 0 | 0 | 144.27 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🔊 | 10.15.12.17 | San Jose C... | Unknown | 10.4.12.17 | New York ... | Unknown | 0.05 | 0 | 0 | 0 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🔊 | 10.15.12.13 | San Jose C... | Unknown | 10.4.12.13 | New York ... | Unknown | 0.04 | 0 | 0 | 19.49 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🔊 | 10.15.12.14 | San Jose C... | Unknown | 10.4.12.14 | New York ... | Unknown | 0.25 | 0 | 0 | 243.51 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🎞 | 10.15.12.16 | San Jose C... | Unknown | 10.4.12.16 | New York ... | Unknown | 0.22 | 0 | 0 | 92.23 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🎞 | 10.15.12.11 | San Jose C... | Unknown | 10.4.12.11 | New York ... | Unknown | 0.04 | 0 | 0 | 64.79 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🔊 | 10.15.12.20 | San Jose C... | Unknown | 10.4.12.20 | New York ... | Unknown | 0.2 | 0 | 0 | 51.28 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🔊 | 10.4.12.19 | New York ... | Unknown | 10.15.12.19 | San Jose C... | Unknown | 0.05 | 0 | 0 | 35.64 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🎞 | 10.0.101.2 | Unassigned | Unknown | 192.168.138.202 | Manageme... | Unknown | 3.42 | 1.8 | 4.18 | 974.68 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🎞 | 10.15.11.10 | San Jose C... | Unknown | 192.168.138.201 | Manageme... | Unknown | 3.49 | 2.7 | 4.09 | 714.29 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🎞 | 192.168.138.202 | Manageme... | Unknown | 10.15.11.10 | San Jose C... | Unknown | 2.54 | 1.8 | 4.18 | 956.16 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🎞 | 192.168.138.201 | Manageme... | Unknown | 10.0.101.2 | Unassigned | Unknown | 3.9 | 2.7 | 4.18 | 547.15 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🔊 | 10.15.11.10 | San Jose C... | Unknown | 10.7.11.14 | India Branch | Unknown | 0.88 | 0 | 4.38 | 125 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🔊 | 10.15.11.10 | San Jose C... | Unknown | 10.15.11.103 | San Jose C... | Unknown | 0.86 | 0 | 4.38 | 125 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🎞 | 10.15.12.12 | San Jose C... | Unknown | 10.1.12.12 | RTP Branch | Unknown | 0.05 | 0.49 | 4.34 | 127.4 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🔊 | 10.15.12.11 | San Jose C... | Unknown | 10.1.12.11 | RTP Branch | Unknown | 0.03 | 0.13 | 4.37 | 0 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🔊 | 10.1.12.14 | RTP Branch | Unknown | 10.15.12.14 | San Jose C... | Unknown | 0.03 | 0.47 | 4.34 | 125.86 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🎞 | 10.15.12.16 | San Jose C... | Unknown | 10.2.12.16 | Los Angele... | Unknown | 0.15 | 6.84 | 0 | 73.68 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▸ | 🔊 | 10.15.11.10 | San Jose C... | Unknown | 10.7.11.15 | India Branch | Unknown | 1.66 | 0 | 4.38 | 125.02 | 2013-Apr-25 11:04:00 PDT |

Choose the session to troubleshoot



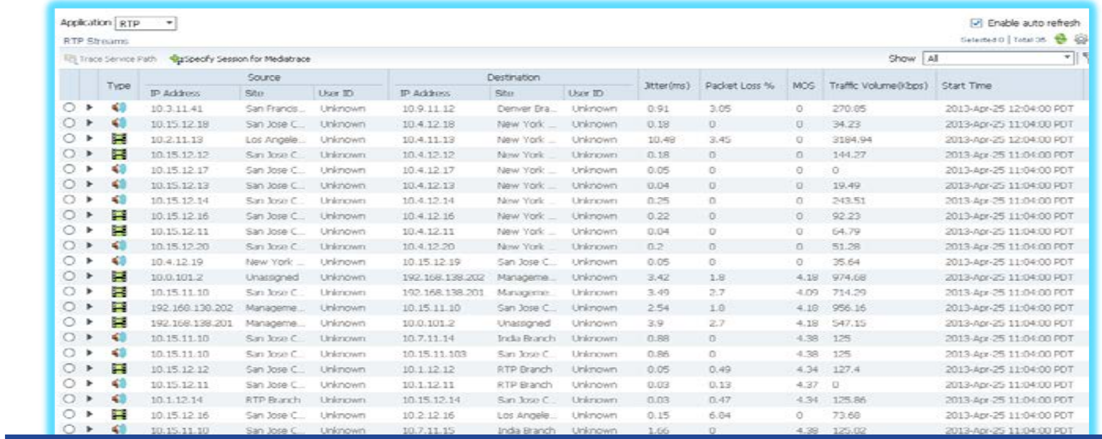
Trace the path between Source and Destination



3750X
(172.16.153.10)
**Packet Loss: 0 percent**
Jitter: 1.573 ms

Pin-point the device which originates jitter

# Voice/Video Troubleshooting



Application RTP

☑ Enable auto refresh

RTP Streams

Selected 0 | Total 35

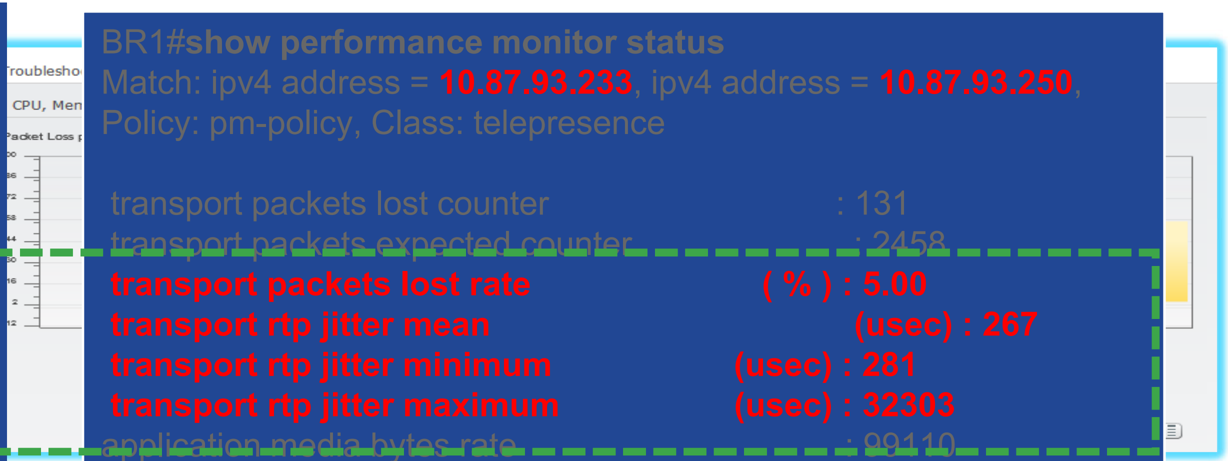
Trace Service Path | Specify Session for Mediatrace

Show All

|  |  | Type | Source |  |  | Destination |  |  | Jitter(ms) | Packet Loss % | MOS | Traffic Volume(Kbps) | Start Time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  | IP Address | Site | User ID | IP Address | Site | User ID |  |  |  |  |  |
| ○ | ▶ | 🔊 | 10.3.11.41 | San Francis... | Unknown | 10.9.11.12 | Denver Bra... | Unknown | 0.91 | 3.05 | 0 | 270.85 | 2013-Apr-25 12:04:00 PDT |
| ○ | ▶ | 🔊 | 10.15.12.18 | San Jose C... | Unknown | 10.4.12.18 | New York ... | Unknown | 0.18 | 0 | 0 | 34.23 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🎞 | 10.2.11.13 | Los Angele... | Unknown | 10.4.11.13 | New York ... | Unknown | 10.48 | 3.45 | 0 | 3184.94 | 2013-Apr-25 12:04:00 PDT |
| ○ | ▶ | 🎞 | 10.15.12.12 | San Jose C... | Unknown | 10.4.12.12 | New York ... | Unknown | 0.18 | 0 | 0 | 144.27 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🔊 | 10.15.12.17 | San Jose C... | Unknown | 10.4.12.17 | New York ... | Unknown | 0.05 | 0 | 0 | 0 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🔊 | 10.15.12.13 | San Jose C... | Unknown | 10.4.12.13 | New York ... | Unknown | 0.04 | 0 | 0 | 19.49 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🔊 | 10.15.12.14 | San Jose C... | Unknown | 10.4.12.14 | New York ... | Unknown | 0.25 | 0 | 0 | 243.51 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🎞 | 10.15.12.16 | San Jose C... | Unknown | 10.4.12.16 | New York ... | Unknown | 0.22 | 0 | 0 | 92.23 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🎞 | 10.15.12.11 | San Jose C... | Unknown | 10.4.12.11 | New York ... | Unknown | 0.04 | 0 | 0 | 64.79 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🔊 | 10.15.12.20 | San Jose C... | Unknown | 10.4.12.20 | New York ... | Unknown | 0.2 | 0 | 0 | 51.28 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🔊 | 10.4.12.19 | New York ... | Unknown | 10.15.12.19 | San Jose C... | Unknown | 0.05 | 0 | 0 | 35.64 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🎞 | 10.0.101.2 | Unassigned | Unknown | 192.168.138.202 | Manageme... | Unknown | 3.42 | 1.8 | 4.18 | 974.68 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🎞 | 10.15.11.10 | San Jose C... | Unknown | 192.168.138.201 | Manageme... | Unknown | 3.49 | 2.7 | 4.09 | 714.29 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🎞 | 192.168.138.202 | Manageme... | Unknown | 10.15.11.10 | San Jose C... | Unknown | 2.54 | 1.8 | 4.18 | 956.16 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🎞 | 192.168.138.201 | Manageme... | Unknown | 10.0.101.2 | Unassigned | Unknown | 3.9 | 2.7 | 4.18 | 547.15 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🔊 | 10.15.11.10 | San Jose C... | Unknown | 10.7.11.14 | India Branch | Unknown | 0.88 | 0 | 4.38 | 125 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🔊 | 10.15.11.10 | San Jose C... | Unknown | 10.15.11.103 | San Jose C... | Unknown | 0.86 | 0 | 4.38 | 125 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🎞 | 10.15.12.12 | San Jose C... | Unknown | 10.1.12.12 | RTP Branch | Unknown | 0.05 | 0.49 | 4.34 | 127.4 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🔊 | 10.15.12.11 | San Jose C... | Unknown | 10.1.12.11 | RTP Branch | Unknown | 0.03 | 0.13 | 4.37 | 0 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🔊 | 10.1.12.14 | RTP Branch | Unknown | 10.15.12.14 | San Jose C... | Unknown | 0.03 | 0.47 | 4.34 | 125.86 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🎞 | 10.15.12.16 | San Jose C... | Unknown | 10.2.12.16 | Los Angele... | Unknown | 0.15 | 6.84 | 0 | 73.68 | 2013-Apr-25 11:04:00 PDT |
| ○ | ▶ | 🔊 | 10.15.11.10 | San Jose C... | Unknown | 10.7.11.15 | India Branch | Unknown | 1.66 | 0 | 4.38 | 125.02 | 2013-Apr-25 11:04:00 PDT |

Choose the session to troubleshoot

```
HQR1#show performance monitor status
Match: ipv4 source = 10.87.93.233, ipv4 address = 10.87.93.250, …
Policy: pm-policy, Class: telepresence

 transport packets lost counter                        : 0
 transport packets expected counter                    : 2589
 transport packets lost rate                ( % ) : 0.00
 transport rtp jitter mean                (usec) : 247
 transport rtp jitter minimum                       (usec) : 312
 transport rtp jitter maximum                       (usec) : 32331
  application media bytes rate                         : 99122
 application media packets counter long                : 2589
 application media packets rate                        : 86
 ip dscp                                               : 0x20
```

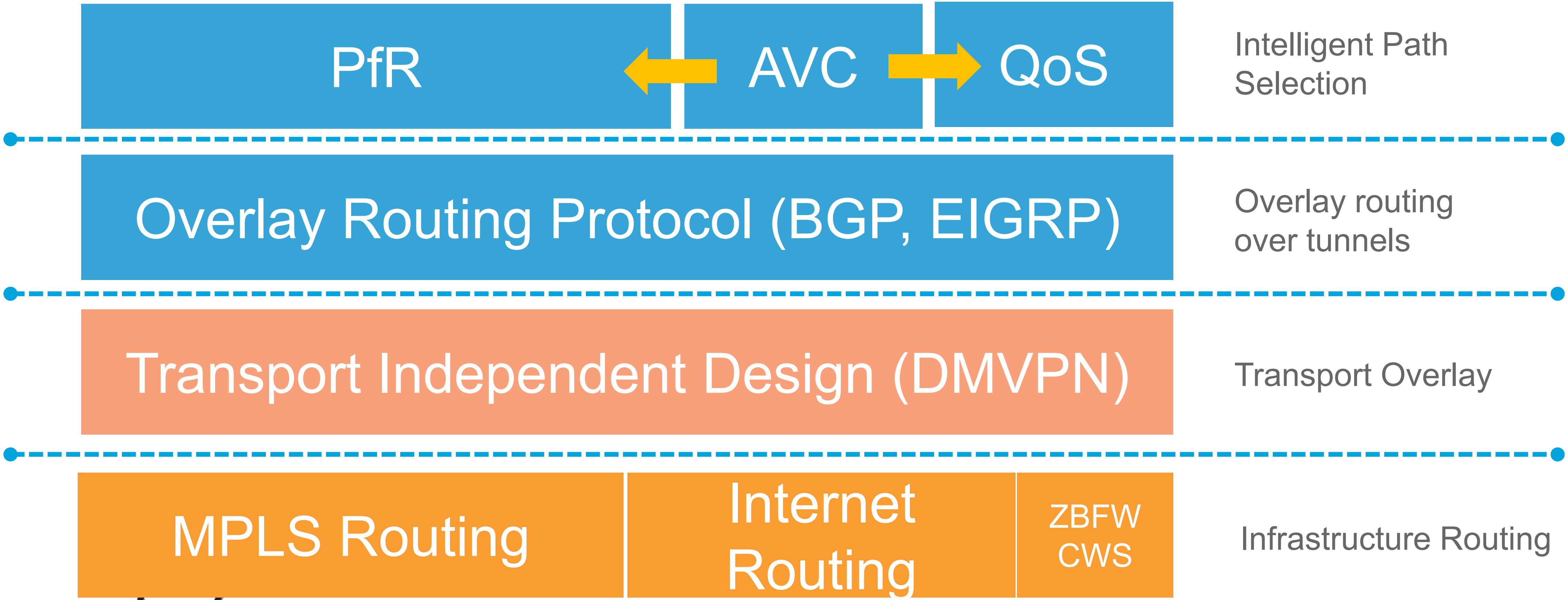


```
BR1#show performance monitor status
Match: ipv4 address = 10.87.93.233, ipv4 address = 10.87.93.250,
Policy: pm-policy, Class: telepresence

 transport packets lost counter                              : 131
 transport packets expected counter                            : 2458
 transport packets lost rate                       ( % ) : 5.00
 transport rtp jitter mean                                   (usec) : 267
 transport rtp jitter minimum                        (usec) : 281
 transport rtp jitter maximum                        (usec) : 32303
application media bytes rate                                 : 99110
 application media packets counter long                       : 2569
 application media packets rate                               : 76
 ip dscp                                                      :0x00
```

# Performance Based Routing

Application Performance Guaranteed

# IWAN Layers – Building Blocks



PfR ← AVC → QoS

Intelligent Path Selection

Overlay Routing Protocol (BGP, EIGRP)

Overlay routing over tunnels

Transport Independent Design (DMVPN)

Transport Overlay

MPLS Routing

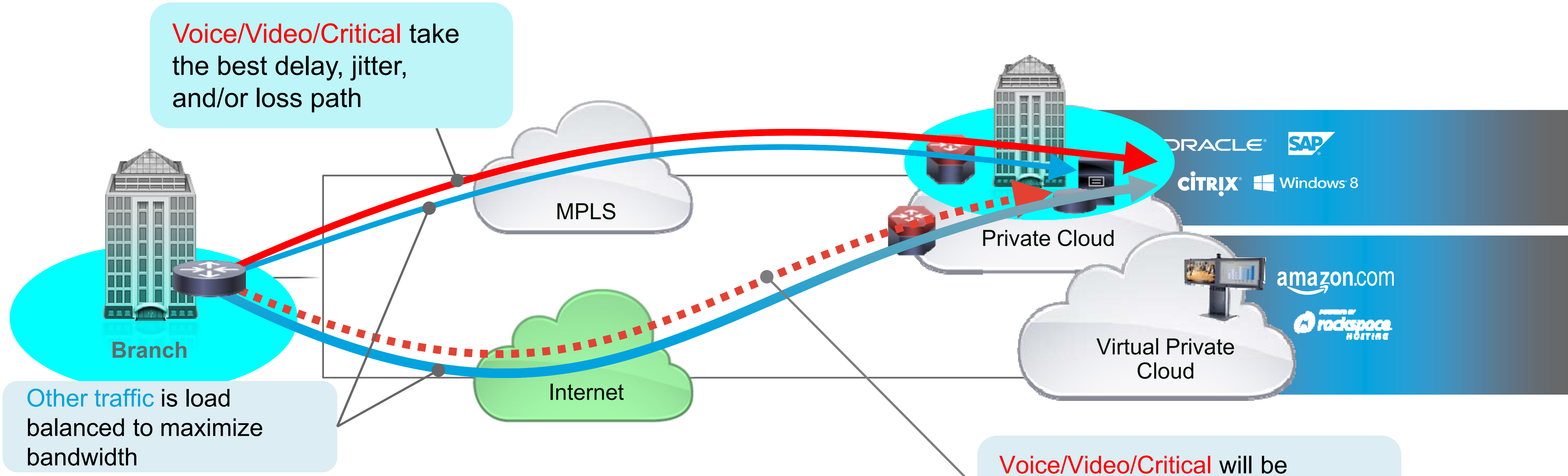
Internet Routing

ZBFW CWS

Infrastructure Routing

# Hybrid WAN: Intelligent Path Control

## Leveraging AVC for offloading applications onto Internet



Voice/Video/Critical take the best delay, jitter, and/or loss path

Other traffic is load balanced to maximize bandwidth

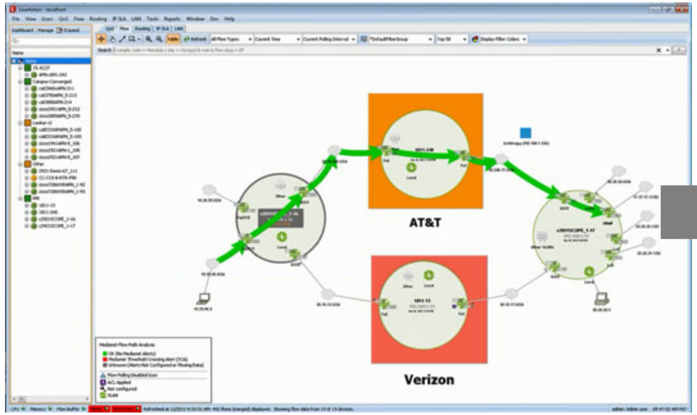
Voice/Video/Critical will be rerouted if the current path degrades below policy thresholds

- PfR leverages AVC to monitor network performance and routes applications based on application performance policies
- AVC recognizes applications and perform domain based routing to route internet based apps on internet path and local apps on MPLS

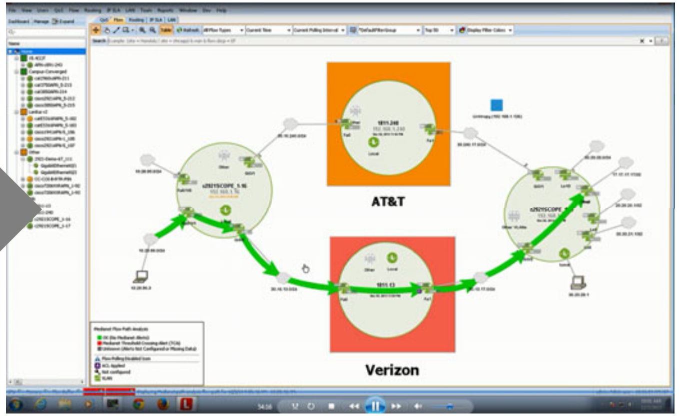
# LiveAction 4.3 and Performance Routing

- PfR path change visualization
- Alert and report on PfR Out of Policy events
- Reports on traffic class/application path changes

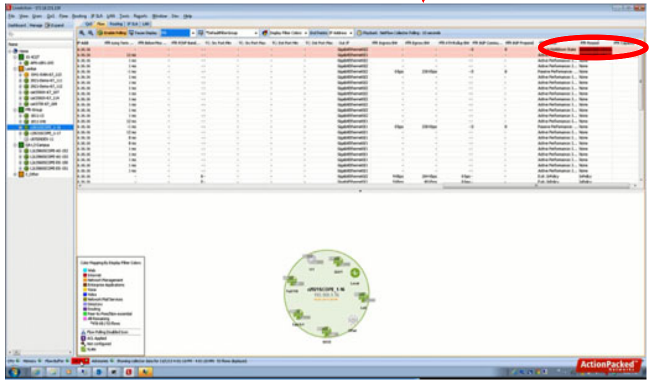
Before Brown-Out (Northern Path)



After Brown-Out (Southern Path)



**Out-Of-Policy**
**Threshold Crossing Alert**

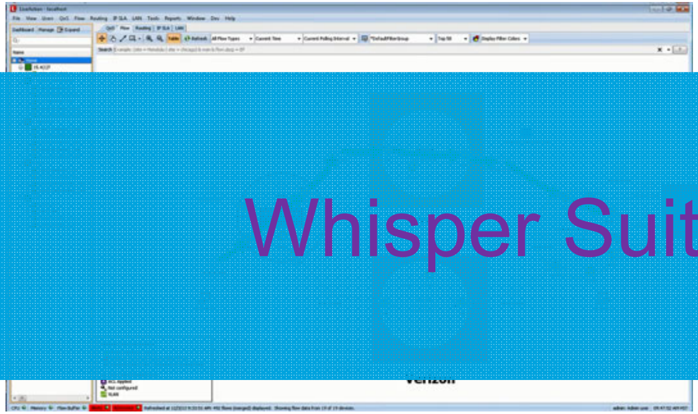


# LiveAction 4.3 and Performance Routing

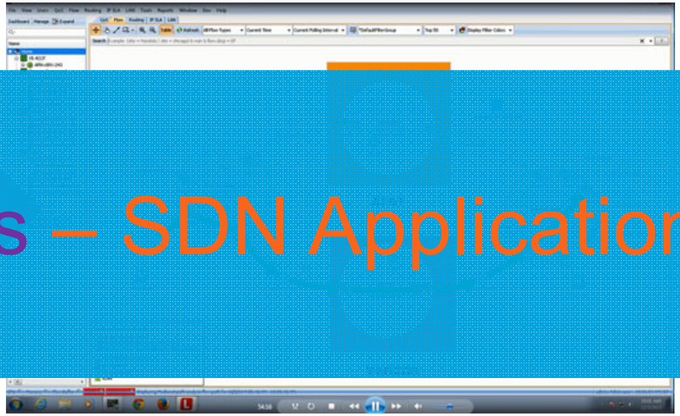
- PfR path change visualization
- Alert and report on PfR Out of Policy events

BRKRST-2362 - IWAN – Implementing Performance Routing (PfRv3) – Wednesday 9.00 AM

Before Brown Out (Northern Path)



After Brown Out (Southern Path)

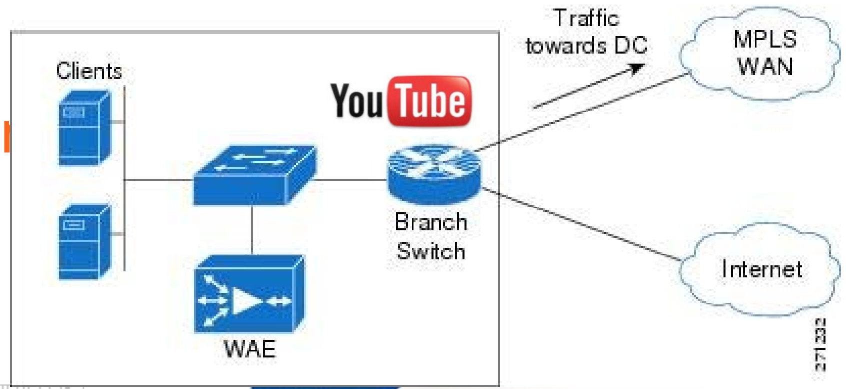


Out of Policy Threshold Crossing Alert

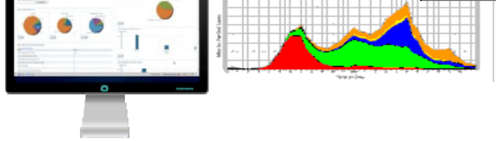
Whisper Suites – SDN Application Protection (PfR)

# AVC in a Nutshell

## Process of Application Visibility, Reporting and Contr

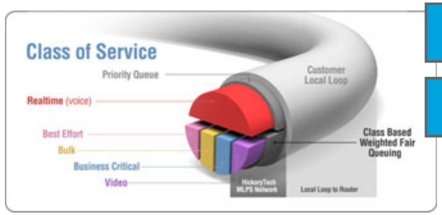


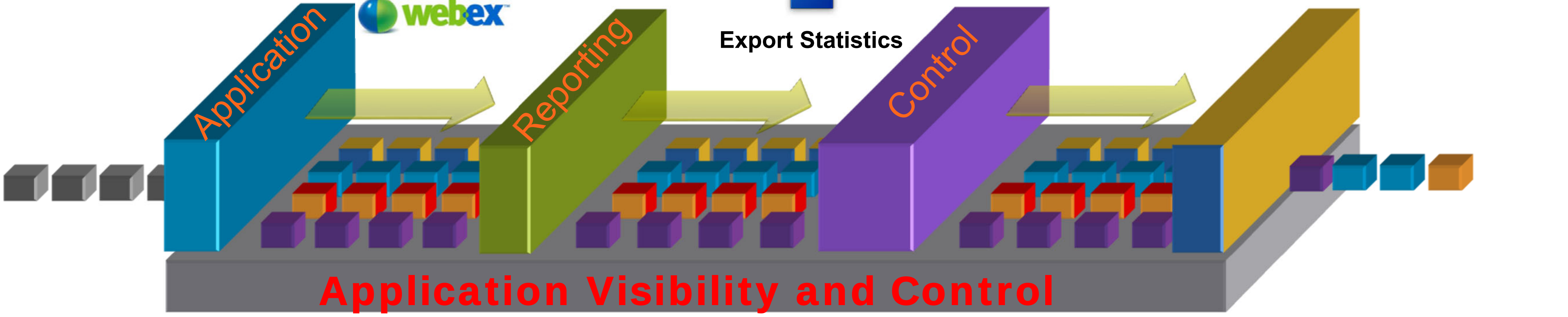
**Prime Infrastructure**
**3rd Party Tools**



**Export Statistics**

- Block
- Prioritize
- Path Control





**Application Visibility and Control**

# NBAR — Dual Modes of Operation

## Passive Mode

- Protocol discovery per interface
  - Discovers and provides real time statistics on applications
  - Per-interface, per-protocol, bi-directional statistics:
  - Bit rate (bps), Packet counts and Byte counts
  - Note: Flexible NetFlow enables protocol discovery

Note: Accounting Functionality Is Provided by “Protocol Discovery” Feature

## Active Mode

- Modular QoS traffic Classification
  - NBAR ensures that network bandwidth is used efficiently (application optimization) with QoS features:
  - Guaranteed bandwidth (CBWFQ)
  - Bandwidth limits
  - Traffic Shaping and Packet coloring (ToS or DSCP)

# NBAR — Dual Modes of Operation

Enable passive discovery of applications on any of the interfaces to quickly validate the application recognition capability of AVC

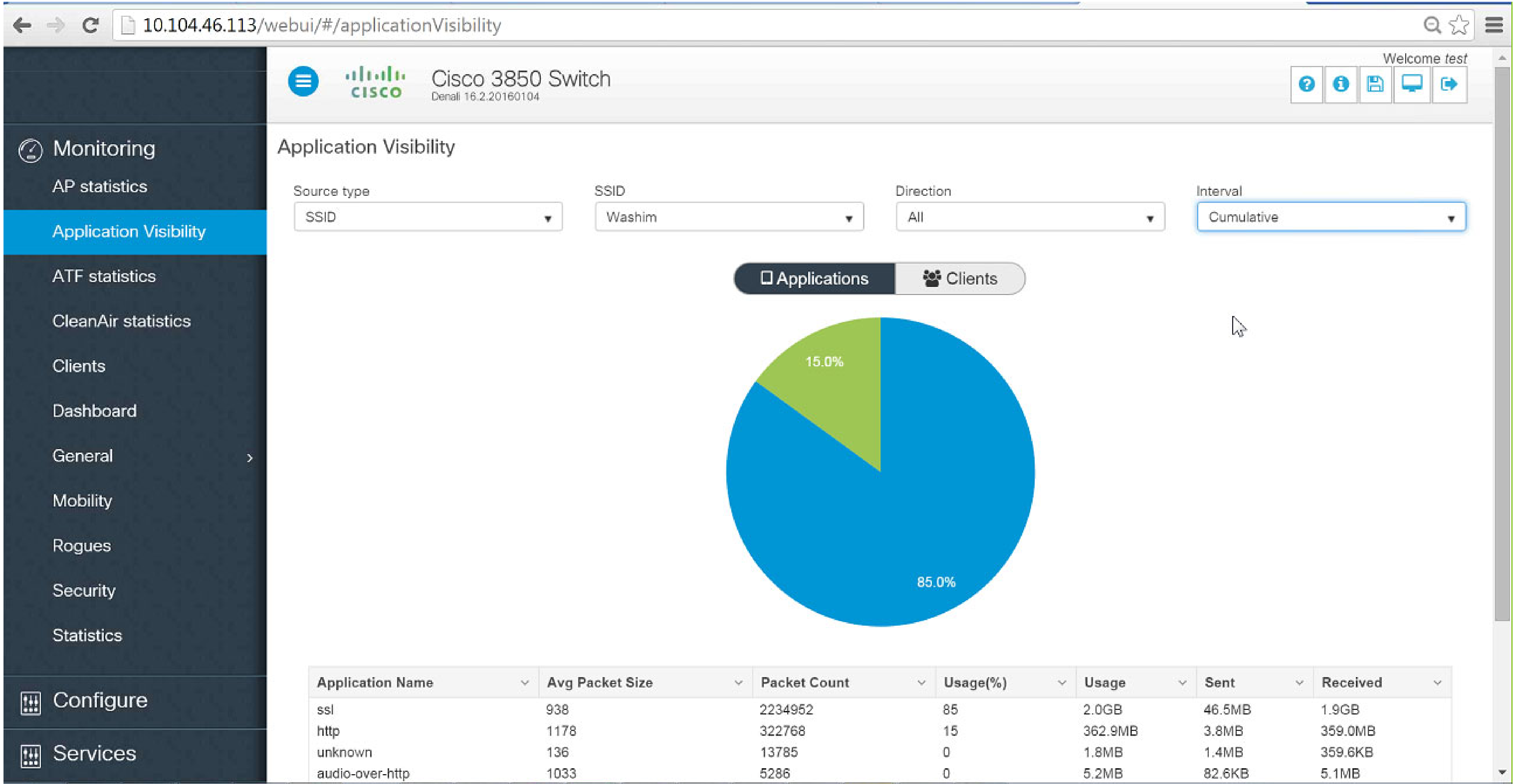
## Configuration

```
Router(config)# interface fastethernet 0/0
Router(config-if)# ip nbar protocol-discovery
```

Note: Accounting Functionality Is Provided by “Protocol Discovery” Feature

```
Router# show ip nbar protocol-discovery top-n 5 GigabitEthernet0
                  Input                    Output
                  -----                    ------
 Protocol         Packet Count             Packet Count
                  Byte Count               Byte Count
                  5min Bit Rate (bps)      5min Bit Rate (bps)
                  5min Max Bit Rate (bps)  5min Max Bit Rate(bps)
 ---------------- ----------------------- -----------------------
  skype           395                        75
                  28539                      6415
                  1000                       1000
              2000                   2000
  icmp            101                        100
                  7360                       6860
                  0                          0
                  0                  0
  snmp            28                         0
                  1988                       0
                  0                          0
              0                      0
  netbios         9                          0
                  738                        0
                  0                          0
              0                      0
  unknown         205                        204
                  14976                      10404
                  0                          0
                  0                          0
  Total           41304                      40944
                  2649809                    2619839
              6000                   6000
                  7000               7000
```

# WebUI – Per Device Analytics/ Config (1/4)



Application Visibility

Source type: SSID

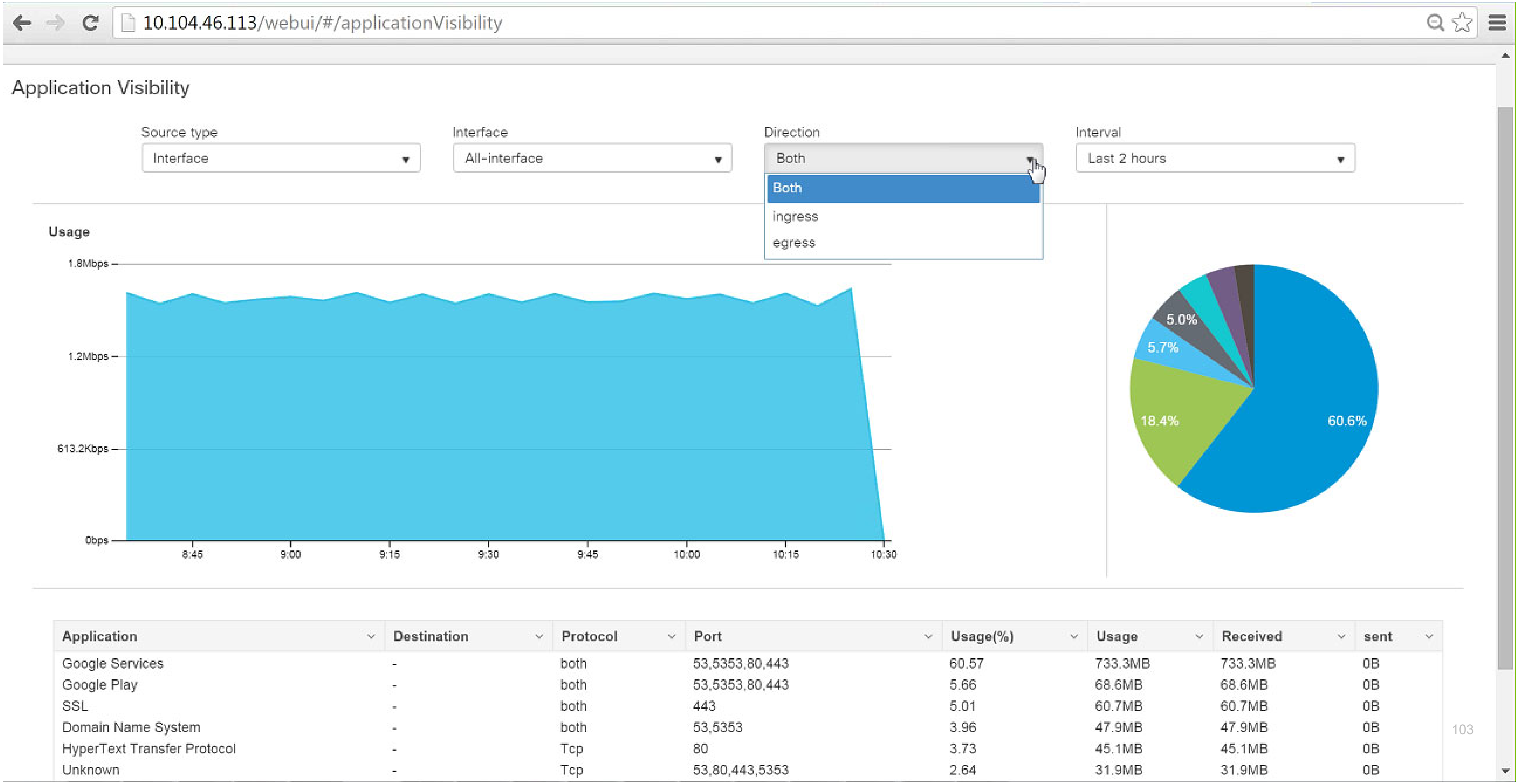
SSID: Washim

Direction: All

Interval: Cumulative

| Application Name | Avg Packet Size | Packet Count | Usage(%) | Usage | Sent | Received |
|---|---|---|---|---|---|---|
| ssl | 938 | 2234952 | 85 | 2.0GB | 46.5MB | 1.9GB |
| http | 1178 | 322768 | 15 | 362.9MB | 3.8MB | 359.0MB |
| unknown | 136 | 13785 | 0 | 1.8MB | 1.4MB | 359.6KB |
| audio-over-http | 1033 | 5286 | 0 | 5.2MB | 82.6KB | 5.1MB |

# WebUI – Per Device Analytics/ Config (2/4)



10.104.46.113/webui/#/applicationVisibility

Application Visibility

Source type: Interface

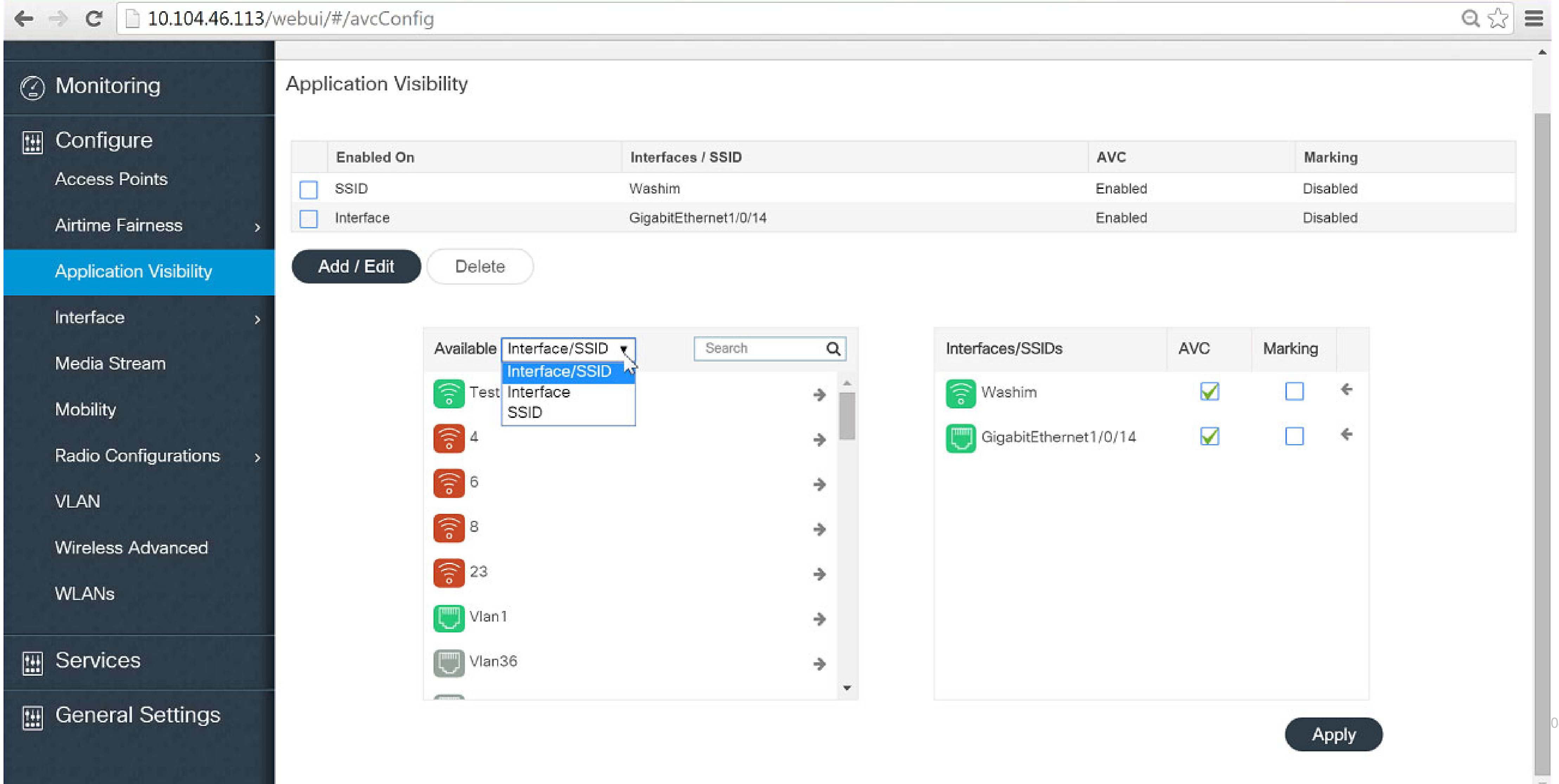
Interface: All-interface

Direction: Both

Interval: Last 2 hours

| Application | Destination | Protocol | Port | Usage(%) | Usage | Received | sent |
|---|---|---|---|---|---|---|---|
| Google Services | - | both | 53,5353,80,443 | 60.57 | 733.3MB | 733.3MB | 0B |
| Google Play | - | both | 53,5353,80,443 | 5.66 | 68.6MB | 68.6MB | 0B |
| SSL | - | both | 443 | 5.01 | 60.7MB | 60.7MB | 0B |
| Domain Name System | - | both | 53,5353 | 3.96 | 47.9MB | 47.9MB | 0B |
| HyperText Transfer Protocol | - | Tcp | 80 | 3.73 | 45.1MB | 45.1MB | 0B |
| Unknown | - | Tcp | 53,80,443,5353 | 2.64 | 31.9MB | 31.9MB | 0B |

# WebUI – Per Device Analytics/ Config (3/4)

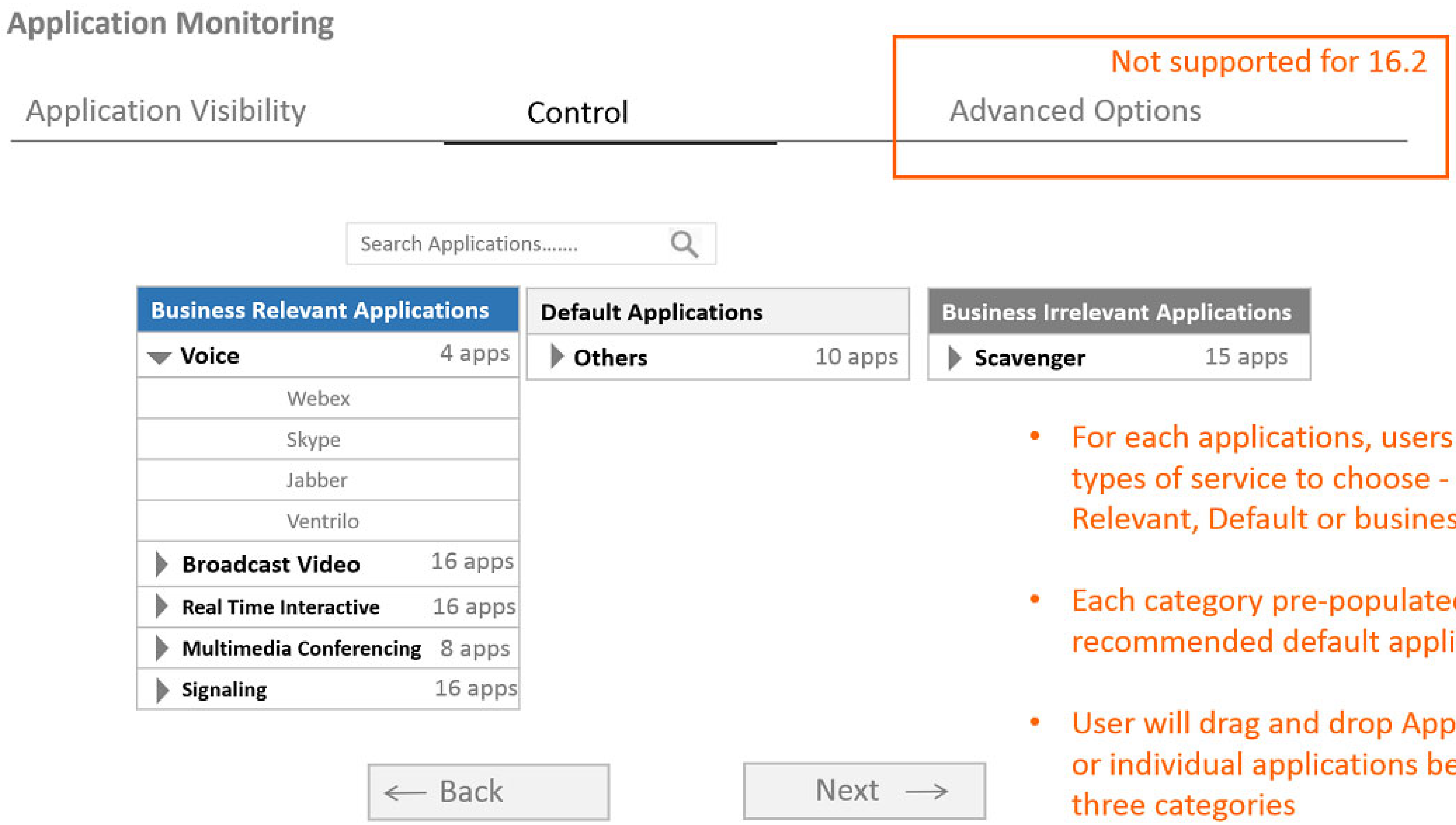


Application Visibility

| | Enabled On | Interfaces / SSID | AVC | Marking |
|---|---|---|---|---|
| □ | SSID | Washim | Enabled | Disabled |
| □ | Interface | GigabitEthernet1/0/14 | Enabled | Disabled |

| Interfaces/SSIDs | AVC | Marking |
|---|---|---|
| Washim | ☑ | □ |
| GigabitEthernet1/0/14 | ☑ | □ |

# WebUI – Per Device Analytics/ Config (4/4)



Application Monitoring

Application Visibility | Control | Advanced Options

Not supported for 16.2

Search Applications.......

Business Relevant Applications
- Voice 4 apps
  - Webex
  - Skype
  - Jabber
  - Ventrilo
- Broadcast Video 16 apps
- Real Time Interactive 16 apps
- Multimedia Conferencing 8 apps
- Signaling 16 apps

Default Applications
- Others 10 apps

Business Irrelevant Applications
- Scavenger 15 apps

- For each applications, users have three types of service to choose - Business Relevant, Default or business Irrelevant
- Each category pre-populated with Cisco recommended default applications
- User will drag and drop Application groups or individual applications between these three categories

# eZPM Profile

## Predefined profiles for monitoring

- Enable ez-PM CLI to get visibility + monitoring stats reported via netflow to prime
- Configures exporters
- Enable / Disables various traffic-monitors (a.k.a tools)
- For each traffic-monitor, overrides some default parameters (IPv4/6, Ingress/Egress, traffic to which the monitor is applied, cache size..)
- Equivalent ~650 lines of configuration

| Monitor Name | Default Traffic Classification |
|---|---|
| Application-Response-Time (ART) | All TCP |
| URL | HTTP applications |
| Media | RTP applications over UDP |
| Conversation-Traffic-Stats | Remaining traffic not matching other classifications |
| Application-Traffic-Stats | DNS and DHT |

# Types of ezPM Profiles

## Application Stats

- application-stats
- application-client-server-stats

## Application Performance

- application-stats
- application-client-server-stats
- application-response-time
- url
- media

## Application Experience

- application-traffic-stats
- conversion-traffic-stats
- application-response-time
- url
- media

# Types of ezPM Profiles

## Application Stats

- Addresses most common deployments (capacity planning)
- Aggregated App level stat (examples - "Top N Apps, BW per App, Top clients/servers per App"
- Per interface/Application statistics
- Per client/server/application/interface statistics

## Application Performance

- Addresses most common deployments (capacity planning) with more details than application-stats profile
- Aggregated App level stat (examples - "Top N Apps, BW per App, Top clients/servers per App"
- Additional metrics, granularity

## Application Experience

- Selectively enable "fine grain" only for critical apps (and not all traffic).
- Performance metrics
- Very detailed

Cisco live!

# ezPM Profile

```
! User defined ezPM context
performance monitor context MYTEST profile application-statistics
 exporter destination 10.10.10.10 source GigabitEthernet0/0/1
 traffic-monitor application-stats
 traffic-monitor application-client-server-stats
!
! Attach the context to the interface
interface GigabitEthernet0/0/2
 performance monitor context MYTEST
!
```

# ezPM Profile

```
! User defined ezPM context
performance monitor context MYTEST profile application-statistics
 e
 t
 t
!
! /
in
 p
!
```

```
! User defined ezPM context
performance monitor context MYTEST profile application-performance
 traffic-monitor url
 traffic-monitor application-client-server-stats
 traffic-monitor application-stats
 traffic-monitor application-response-time
 traffic-monitor media
!
! Attach the context to the interface
interface Ethernet0/0
 performance monitor context MYTEST
!
```

# ezPM Profile

```
! User defined ezPM context
performance monitor context MYTEST profile application-statistics
 e
 t
 t
!
! A
in
 p
!
```

```
! User defined ezPM context
performance monitor context MYTEST profile application-performance
 tr
 tr
 tr
 tr
 tr
!
! A
in
 p
!
```

```
! User defined ezPM context
performance monitor context MYTEST profile application-experience
 traffic-monitor url
 traffic-monitor application-traffic-stats
 traffic-monitor conversation-traffic-stats
 traffic-monitor application-response-time
!
! Attach the context to the interface
interface Ethernet0/0
 performance monitor context MYTEST
```

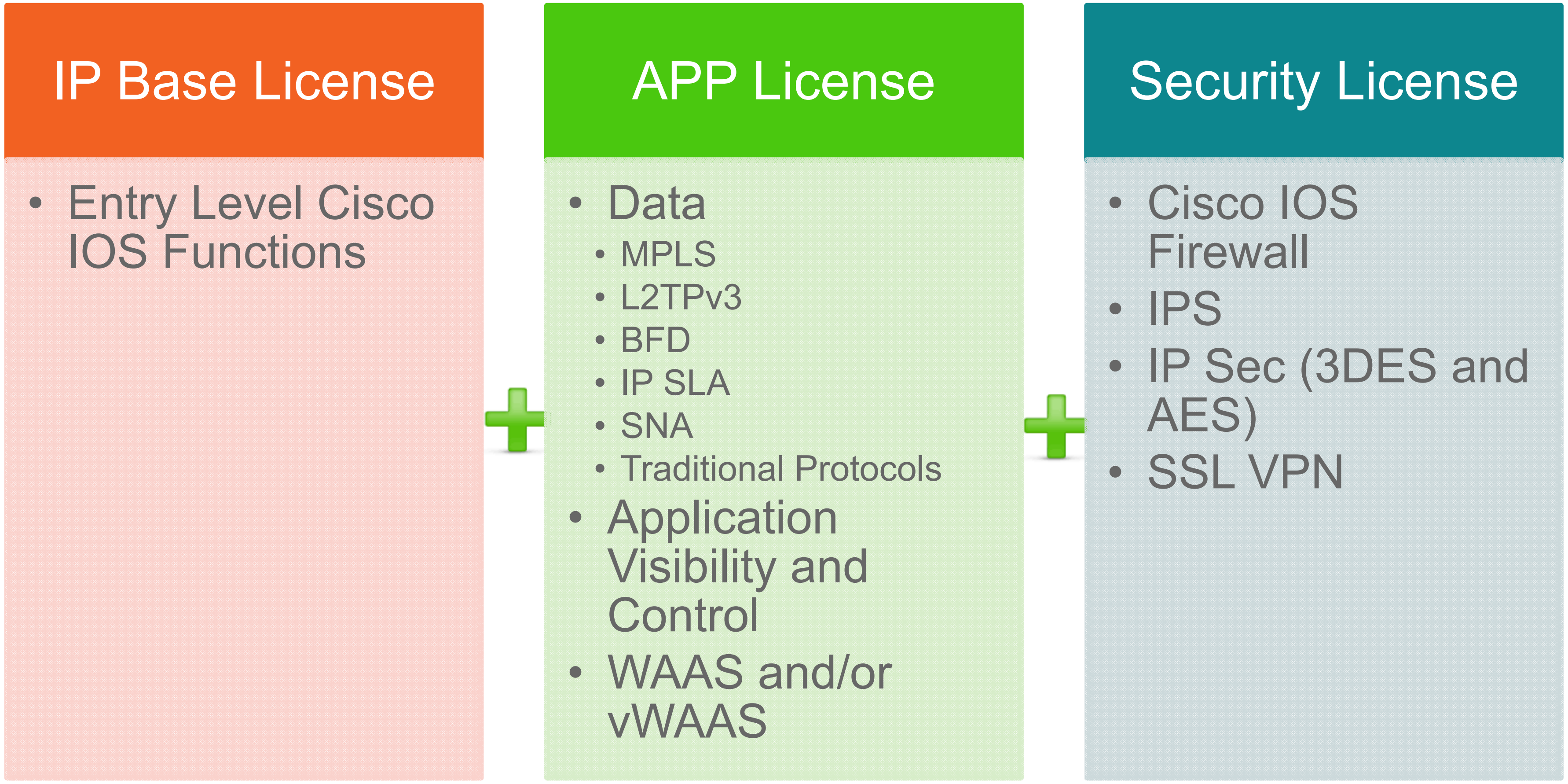
For Your Reference

# AVC Performance

| XE Platform | Traffic Profile | Platfrom Limit | XE316.1<br>NBAR PD (CG) | | XE316.1<br>NBAR QOS (CG) | | XE316.1<br>NBAR QOS (FG) | | XE316.1<br>APP STATS (CG) | | XE316.1<br>APP PERF (FG) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BW | BW | CPU | BW | CPU | BW | CPU | BW | CPU | BW | CPU |
| | | (Gbps) | (Gbps) | (%) | (Gbps) | (%) | (Gbps) | (%) | (Gbps) | (%) | (Gbps) | (%) |
| ISR4321 (Dagger) | Branch | uncapped | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| ISR4331 (Sword) | Branch | uncapped | 0.82 | 96 | 0.67 | 97 | 0.63 | 98 | 0.44 | 97 | 0.24 | 96 |
| ISR4351 (Utah) | Branch | uncapped | 0.98 | 96 | 0.78 | 98 | 0.75 | 98 | 0.53 | 98 | 0.28 | 96 |
| ISR4451-X (Overlord) | Branch | 2 | 2.04 | 53 | 2.04 | 77 | 2.05 | 83 | 1.42 | 99 | FNA | FNA |
| CSR 8 core (Ultra) | DC | 5 | 0.33 | 12 | 0.47 | 20 | 0.39 | 18 | 0.42 | 25 | 0.35 | 35 |
| ASR1001 | DC | 5 | 5.04 | 42 | 5.04 | 50 | 5.04 | 61 | 5.04 | 85 | 2.60 | 98 |
| *ESP 5 | DC | 5 | 5.72 | 73 | 5.65 | 87 | 4.54 | 85 | 3.42 | 93 | 1.49 | 88 |
| *ESP 10 | DC | 10 | 11.45 | 73 | 11.31 | 87 | 9.09 | 85 | 6.84 | 93 | 2.97 | 88 |
| ESP 20 | DC | 20 | 22.89 | 73 | 22.61 | 87 | 18.17 | 85 | 13.68 | 93 | 5.94 | 88 |
| ESP 40 | DC | 40 | 25.92 | 87 | 23.23 | 91 | 17.17 | 82 | 13.14 | 89 | 5.62 | 83 |
| ESP100 | DC | 100 | 85.13 | 92 | 76.18 | 95 | 61.80 | 97 | 52.35 | 97 | 23.58 | 98 |
| ASR1002-X (Kingpin) | DC | 36 | 18.35 | 32 | 18.33 | 38 | 18.33 | 47 | 18.33 | 56 | 13.78 | 99 |

# AVC Licensing

# Software Packaging Model for ISR-AX Routers



## IP Base License

- Entry Level Cisco IOS Functions

+

## APP License

- Data
  - MPLS
  - L2TPv3
  - BFD
  - IP SLA
  - SNA
  - Traditional Protocols
- Application Visibility and Control
- WAAS and/or vWAAS

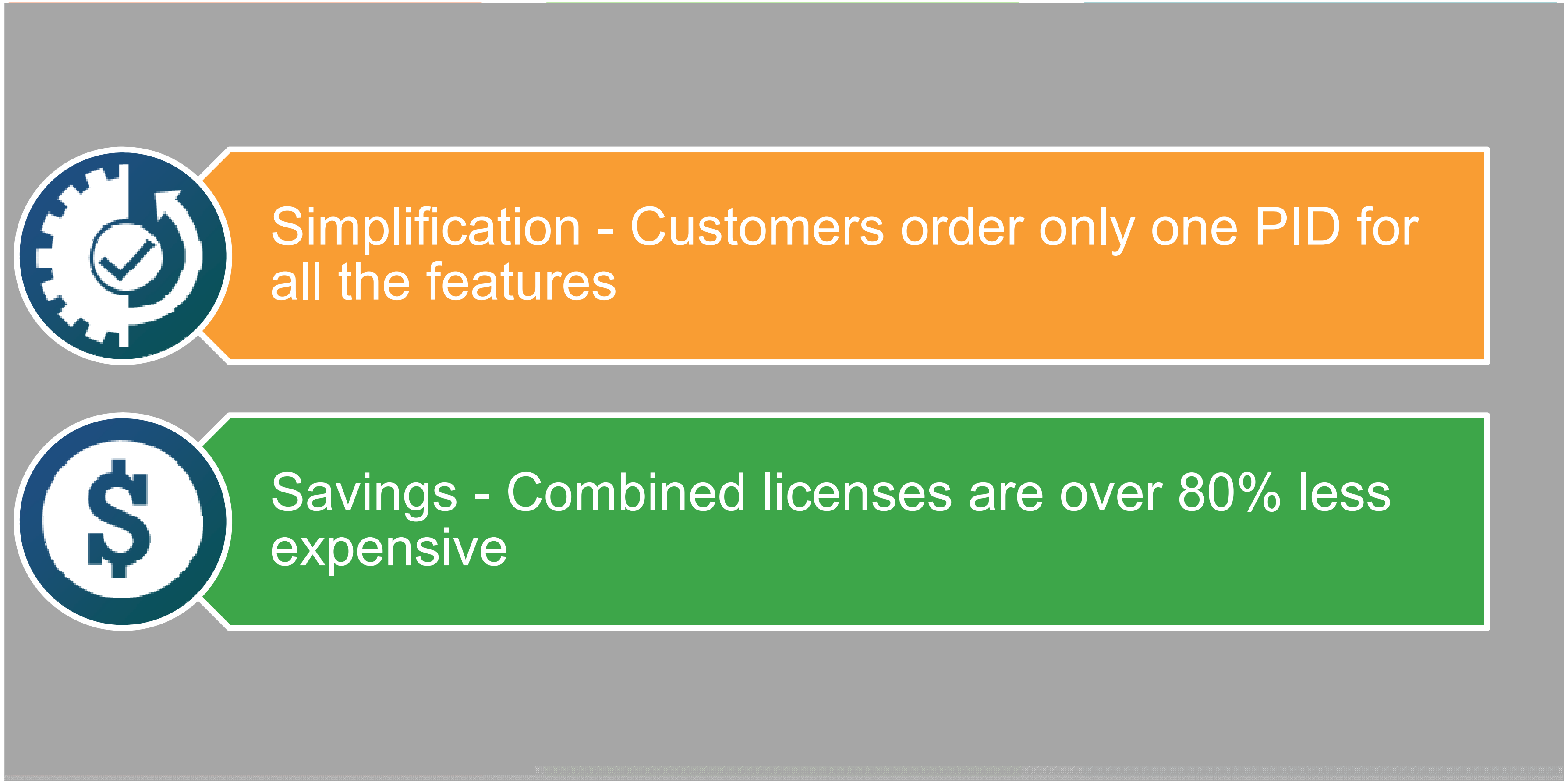
+

## Security License

- Cisco IOS Firewall
- IPS
- IP Sec (3DES and AES)
- SSL VPN

AX (Application Experience) License Bundle includes IP Base + APP + Security License

# Software Packaging Model for ISR-AX Routers



Simplification - Customers order only one PID for all the features

Savings - Combined licenses are over 80% less expensive

AX (Application Experience) License Bundle includes IP Base + APP + Security License

For Your Reference

# AX License Features

|  | AX License |
|---|---|
| Cisco ISR 880 Series | Data + AVC + WAASX + SW Activated DRAM Upgrade |
| Cisco ISR 1900 Series | Data + AVC + WAASX |
| Cisco ISR 2900 Series | Data + AVC + WAASX + WAAS and/or vWAAS up to 1300 connections |
| Cisco ISR 3900 Series | Data + AVC + WAASX + WAAS and/or vWAAS up to 2500 connections |
| Cisco ISR 4400 Series | Data + AVC + WAASX + WAAS and/or vWAAS up to 2500 connections |

The DATA features include: MPLS, BFD, RSVP ,L2VPN, L2TPv3 ,Layer 2 Local Switching , Mobile IP, Multicast Authentication, FHRP-GLBP ,IP SLAs, PfR ,DECnet, RSRB, BIP, DLSw+, FRAS, Token Ring, ISL, IPX ,STUN, SNTP, SDLC, QLLC etc.

# AX License PIDs and Cost for ASR Routers

| License | Description |
|---|---|
| ASR1002X-AIS-AX | ASR1002X AX, AVC, AIS, vWAAS Bundle |
| ASR1002X-AES-AX | ASR1002X AX, AVC, AES, vWAAS Bundle |
| ASR1001-5G-AIS-AX | ASR1001 AX, AVC, AIS, 5G, vWAAS, Bundle |
| ASR1001-5G-AES-AX | ASR1001 AX, AVC, AES, 5G, vWAAS, Bundle |
| ASR1001X-AIS-AX | ASR1001X AX, AVC, AIS, vWAAS Bundle |
| ASR1001X-AES-AX | ASR1001X AX, AVC, AES, vWAAS Bundle |

The above licenses are applicable only to ASR1002-X, ASR1001 and ASR1001-X
With the above licenses customers can purchase WAAS license at discounted price

# AX License PIDs and Cost for ASR Routers

| AIS/ AES License | Description |
|---|---|
| FLASR1-IPB-AESK9 | Cisco ASR 1000 Series IP BASE to ADV ENT SERVICES Upgrade |
| FLASR1-IPB-AISK9 | Cisco ASR 1000 Series IP BASE to ADV INT SERVICES Upgrade |
| FLASR1-IPB-AESK9= | Cisco ASR 1000 Series IP BASE to ADV ENT SERVICES Upgrade (Spare) |
| FLASR1-IPB-AISK9= | Cisco ASR 1000 Series IP BASE to ADV INT SERVICES Upgrade (Spare) |

| AVC License | Description |
|---|---|
| FLSASR1-AVC | Appl. Visibility and Control License for ASR1000 Series |
| FLSASR1-AVC= | Appl. Visibility and Control License for ASR1000 Series (Spare) |
| L-FLSASR1-AVC= | Appl. Visibility and Control License for ASR1000 Series (eDelivery) |

For all the ASR Routers not listed in previous slide, customer has to purchase AIS or AES along with AVC license to enable AVC

# AVC License – Key Points

CSR1000v, ISR4000, Cisco ASR 1001 and Cisco ASR 1002-X routers support **temporary** 90-day activation **license** of AES or AIS features, for evaluation

AVC License for CSR1000v is included in the premium license

AVC License for WLC  is available by default and for Converged Access it is available in IP-BASE license

# Partner Eco-system

# Netflow Partners

For Your Reference

cariden
cisco
ManageEngine
Powering IT ahead
ca technologies
IBM
FLUKE networks.
netusage
hp
SevOne
InfoVista
Caligare
net i monitor
plixer
wiredcity
a division of OSIsoft, Inc.
NetFlowAuditor
POWERED BY DIGITOLL
ARBOR NETWORKS
Compuware
solarwinds

## DDoS Partners

ADVAiCT
Lancope
Network Performance + Security Monitoring
ARBOR NETWORKS
BOEING
NARUS

## Billing

evident Software
ca technologies
ORACLE COMMUNICATIONS

# Call to Action

- Visit the World of Solutions for
  - Cisco Campus – AVC/NBAR2 Innovations Demo (Whisper Suites), EasyQoS Demo (World of Solutions), Consistent Wired and Wireless Experience (World of Solutions)
  - Walk in Labs –
  - Technical Solution Clinics
- Meet the Engineer
- Lunch and Learn Topics
- DevNet zone related sessions

# Complete Your **Online Session Evaluation**

- Please complete your online session evaluations after each session. Complete 4 session evaluations & the Overall Conference Evaluation (available from Thursday) to receive your Cisco Live T-shirt.

- All surveys can be completed via the Cisco Live Mobile App or the Communication Stations

# Thank you

We're ready. Are you?