

High Definition meets High Performance Networking

Farouk Hirji, Consulting Engineer

June 15 2017



2016 US election results

Updated Nov 9, 2016 3:02 PM HKT

• Live

President

55 electoral votes still available



Clinton

218

Trump

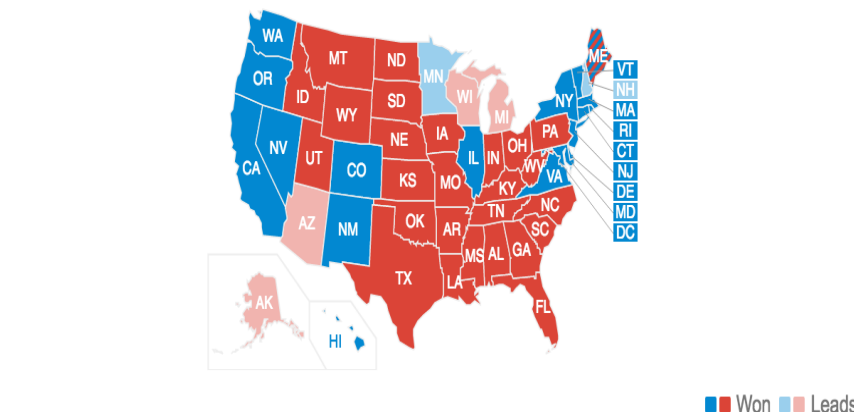
265



52 needed

270 to win

5 needed



84% reporting

Votes

Election Night

Inbox x

Bryan Obeldzinski

5:59 AM (5 hours ago)

to mediaent, jl, Will, Aman, Edison

Tonight all of ABC News Times Square set is powered by Arista as is their VIZRT graphics.

Bryan

Sent from my iPhone

Kevin McCabe <kevin@arista.com>

6:14 AM (5 hours ago)

to Bryan, mediaent, jl, Will, Aman, Edison

We are at CNN ctr with the .com team. Expecting 3.2M streams tonight. CNN.com all arista.

K

Sent from my iPhone

Aman Shah <aman@arista.com>

6:17 AM (5 hours ago)

to Kevin, Bryan, mediaent, jl, Will, Edison

Amazing !! I am going to be onsite at Time Square tonite for ABC.

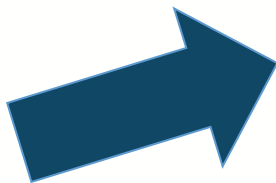
Market & Technology Drivers

- Take advantage of the marketplace **economics of IT** Technology;
- Make use of the extensive and well trained base of **design and maintenance personnel** available in this field;
- Deploy enterprise-class capabilities and **redundancy options**;
- Use any one of a number of monitoring, **diagnostic and troubleshooting tools** that currently exist for enterprise deployments of IT infrastructure;
- **Facilitate higher resolution and transport bit rates with 10/25/40/50/100G Ethernet**

Standard	Name	Introduced	Bitrates	Example video formats
SMPTE 259M	SD-SDI	1989 ^[2]	270 Mbit/s, 360 Mbit/s, 143 Mbit/s, and 177 Mbit/s	480i, 576i
SMPTE 344M	ED-SDI		540 Mbit/s	480p, 576p
SMPTE 292M	HD-SDI	1998 ^[2]	1.485 Gbit/s, and 1.485/1.001 Gbit/s	720p, 1080i
SMPTE 372M	Dual Link HD-SDI	2002 ^[2]	2.970 Gbit/s, and 2.970/1.001 Gbit/s	1080p60
SMPTE 424M	3G-SDI	2006 ^[2]	2.970 Gbit/s, and 2.970/1.001 Gbit/s	1080p60
SMPTE ST-2081	6G-SDI	2015 ^[4]	6 Gbit/s	4Kp30
SMPTE ST-2082	12G-SDI	2015 ^[5]	12 Gbit/s	4Kp60
SMPTE ST-2083*	24G-SDI		24 Gbit/s	4Kp120



Business Drivers for Transition **SDI** to IP/Ethernet

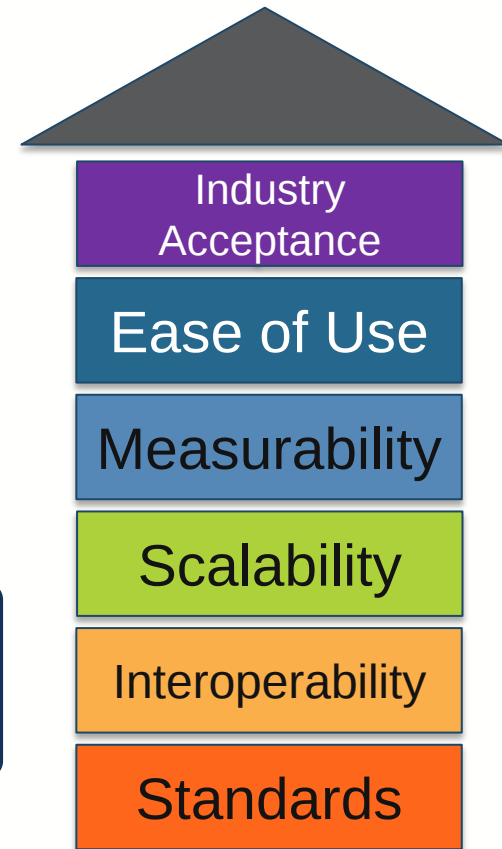


Bespoke Broadcast hardware
SDI Cabling – Die in Place
Parallel Infrastructure
Forklift as formats change

- Data Center
Servers & Switches & Storage
Ethernet Economics
- Flexible - formats, productions, facilities, workflows
 - New revenue opportunities

Arista M&E Standards Participation

- Widely adopted standards promote interoperability, innovation and reduces cost.
- Arista's commitment to the media and entertainment standards bodies ensure a solid foundation and interoperability.



Arista Standards & Industry Involvement

- **Video Services Forum**

- VidTrans Conferences
- VSF TR-04, TR-03



- **Society of Motion Picture & Television Engineers**

- TC-32NF-WG Video over IP
- TC-32NF-60 DG Studio Video over IP (SVIP)
- TC-32NF-80 WG Time Labeling and Synchronization
- TC-32NF-80 DG 2059 Interoperability Testing
- TC-32CS Media Systems, Control and Services
- TC-32NF SG Flow Management in Professional Media Networks



- **Alliance for IP Media Solutions (AIMS)**



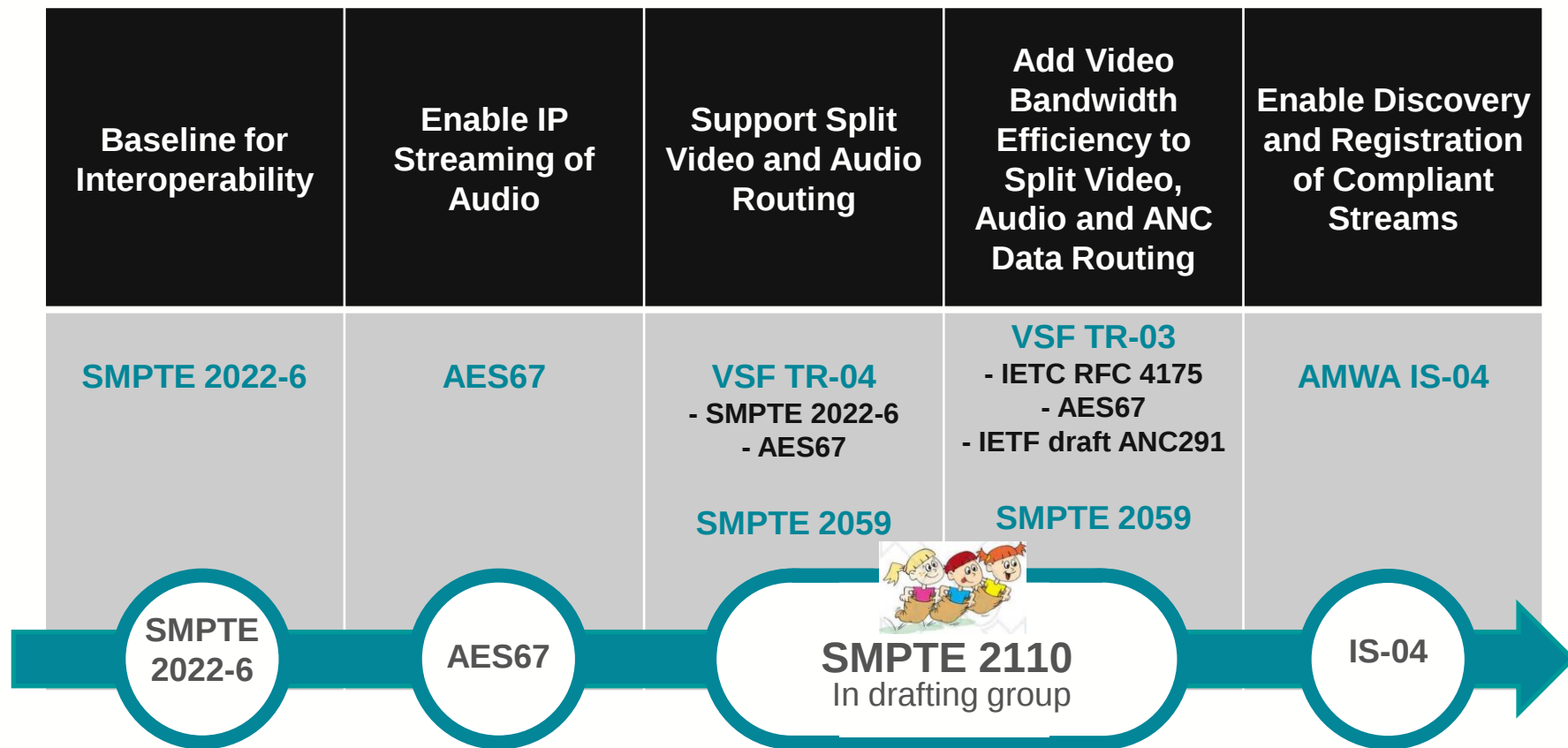
- **Advance Media Workflow Association / Network Media Open Specifications (AMWA / NMOS)**



- **AVnu Alliance / Audio Video Bridging**



AIMS (Alliance for IP Media Solutions) Roadmap



TC-32NF-60 DG Studio Video over IP



IP Media Inter-Networking with Separate Essence Flows:

- **2110-10:** System Timing and Definitions
- **2110-20:** Uncompressed Active Video
- **2110-21:** Timing Model for Uncompressed Active Video
- **2110-30:** PCM Digital Audio
- **2110-40:** Ancillary Data
- **2110-50:** Embedded Essence with 2022-6 Transport
- **2210-21:** Compressed Video
- **2110-31:** Full AES-3 Transport

SMPTE 2059-2:2015 and AES67-2013 Support (4.18.0F)

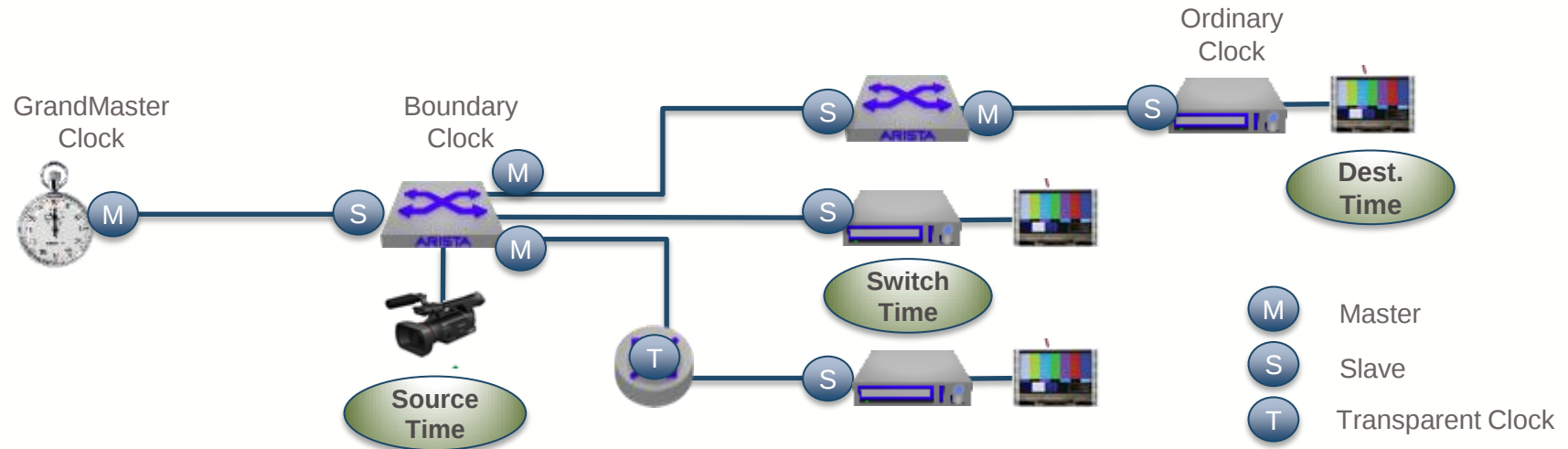
- The SMPTE ST 2059-2:2015 and AES67-2013 standards define PTP profiles specifically developed for synchronization of audio and video streams being transported over an IP network. Each of these PTP profiles leverage the existing IEEE-1588 standards and vendor implementations while defining message rates and management messages unique to the requirements of rapid synchronization of end points for media streams.

Expanded Maximum PTP Message Rates

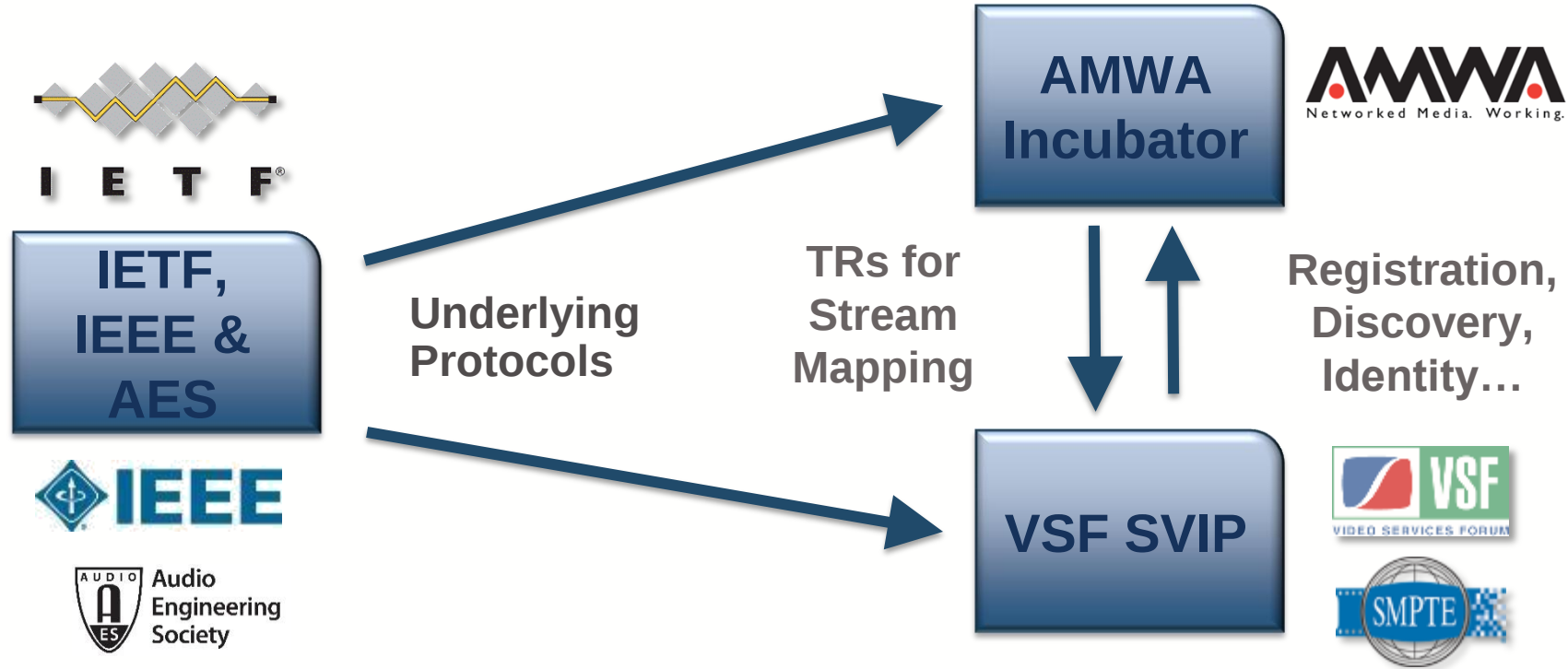
- Both SMPTE ST 2059-2:2015 and AES67-2013 enhanced faster message rates are supported.

Video Frame Accuracy Switching

- Source-Timed Switching (Output Flow)
- Destination-Time Switching (Destination Node)
- Switch-Time Switching (SDN Network Infra)

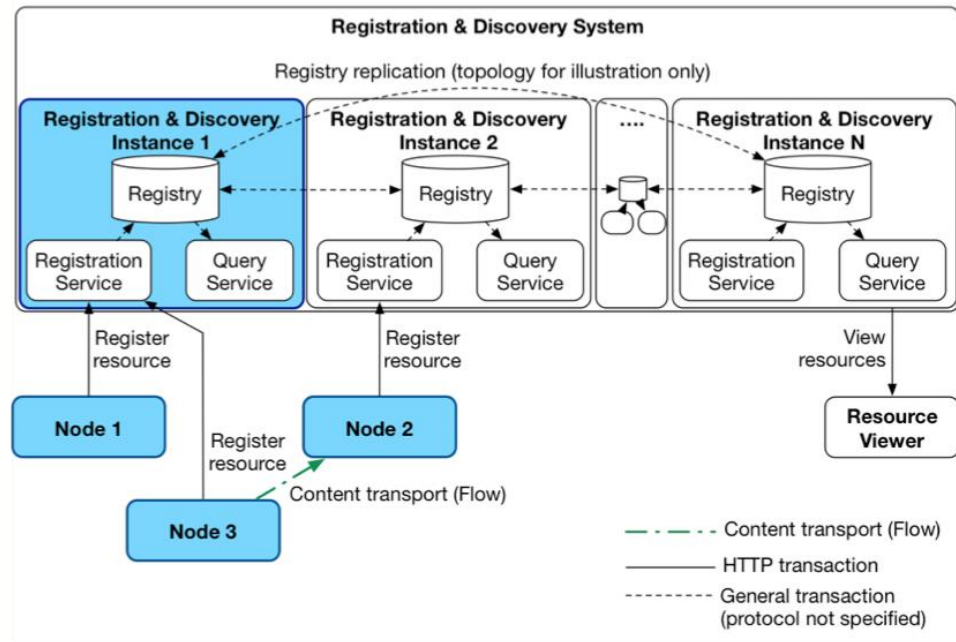


Collaboration is the key to success : SMPTE, VSF, IETF and AMWA



NMOS - Networked Media Open Specifications

- Two current specifications:
 - Discovery and Registration**
(Focus of Phase 1)
 - In-stream Identity & Timing**
(Future Phase)
- HTTP-based JSON API**
- Media Nodes implement the API
- Service **lacks network-level state** - Arista value-add!



Advance Media Workflow Association

Network Media Open Specification



✓ Standard LLDP Neighbor Information

```
Arista-7050TX-64#show lldp neigh
```

```
Last table change time   : 0:13:38 ago
Number of table inserts  : 69
Number of table deletes  : 64
Number of table drops    : 0
Number of table age-outs : 1
```

Port	Neighbor Device ID	Neighbor Port ID	TTL
Et5	f8ca.b864.c1e4	f8ca.b864.c1e4	3601
Et19	ap-z420-2.rd.bbc.co.uk	2c44.fd15.121f	120
Et29	d0bf.9c20.fcf0	d0bf.9c20.fcf0	3601
Et48	ap-z440-3.rd.bbc.co.uk	5065.f34e.d007	120
Et50/1	Arista-7150S-64	Ethernet50/1	120



✓ Combine with NMOS JSON Output to Combine Data Sets for Endpoint Association

```
Arista-7150S-64-1#show nmos-tracer nodes
```

Device Name	Interface	MAC Address	TX - bits/s	RX - bits/s	URL
ap-z420-2.rd.bbc.co.uk	Ethernet19	2c44.fd15.121f	6772.34	2396156054.76	http://192.168.16.104:12345/
Pana 50i Node_01	N/A	N/A	N/A	N/A	http://192.168.15.114:12345/
kaleido-ip node receiver	N/A	N/A	N/A	N/A	http://192.168.16.50:12345/



Why is High Performance Networking Relevant?

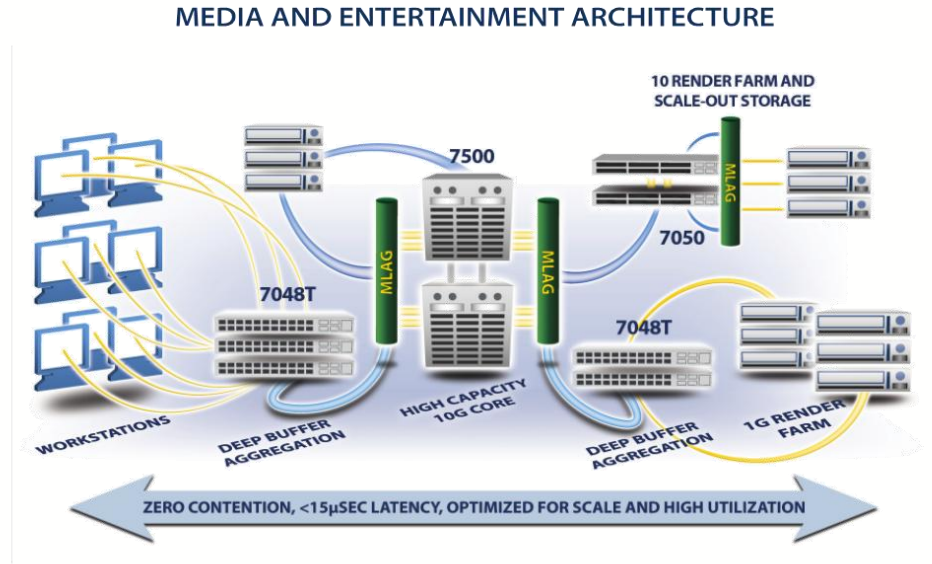
Network features for **Broadcasters**

- Low latency
 - Real time, Uncompressed
- Multicast
 - IP Video is Multicast
- AVB (802.1Q)
 - Bandwidth Reservation for Lossless Transport
- SMPTE 2022-6, 2110-x, and 2059-2
 - HD-SDI over IP & Synchronization
- Automation and Control
 - Broadcast Control Systems (BCS)
- 25G/50G/40G/100G



Network Features for File Based Workflows

- Buffering
 - Microbursts, Fan-in, Speed changes
- ECMP
 - Aggregation / Resiliency
 - Easy Maintenance
- 40G / 100G
 - Storage / Distribution Connectivity
 - Formats Keep Growing
- Migrating 1Gb to 10G UTP
 - Node Connectivity



HIGH SPEED NETWORKING FOR DIGITAL MEDIA CREATION,
POST
PRODUCTION, AND CENTRALIZED CONTENT MANAGEMENT
http://solutions.arista.com/hubfs/Arista/White_Papers/ME_SolutionGuide_1.pdf

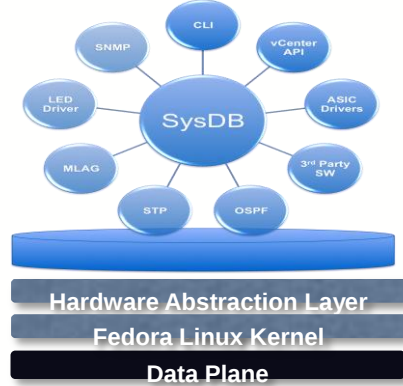
The Expectation is that IP Network will be provide ...

- ***Availability***
 - 24x7x365 with Seamless Maintenance activity
- ***Reliability Network and PTP Timing***
 - No single point of failure – Self-healing is a functional requirements at all levels
 - 2110-x and 2059-2
- ***Lossless, Low Latency Fabric***
 - Maintain real-time end user experience
- ***Visibility***
 - Analytics and telemetry are functional to continuous operation
- ***Automation***
 - means programmability end-to-end
- ***Scalability***
 - 4k, 8k ... 10G/25GE/50GE/100GE ... Moore's Law



Arista EOS = Availability and Reliability

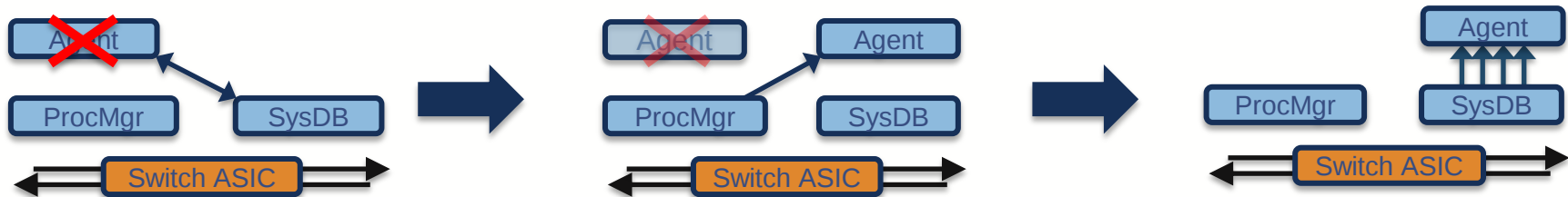
Resiliency – EOS Software Architecture



- Linux kernel Fedora image - **Untouched**
- Agent – separation of processes, each within its own protected user address space (online patching)
- Sysdb – is an address space (similar to a database) that purely holds state information on each agent
- Architecture - Publish-Subscribe-Notify model (state updates from one agent to another)

Resiliency in EOS:

- In-service software patching - Ability to upgrade individual processes without system interruption
- Software Fault Containment (SFC)
- Stateful Fault Repair (SFR)

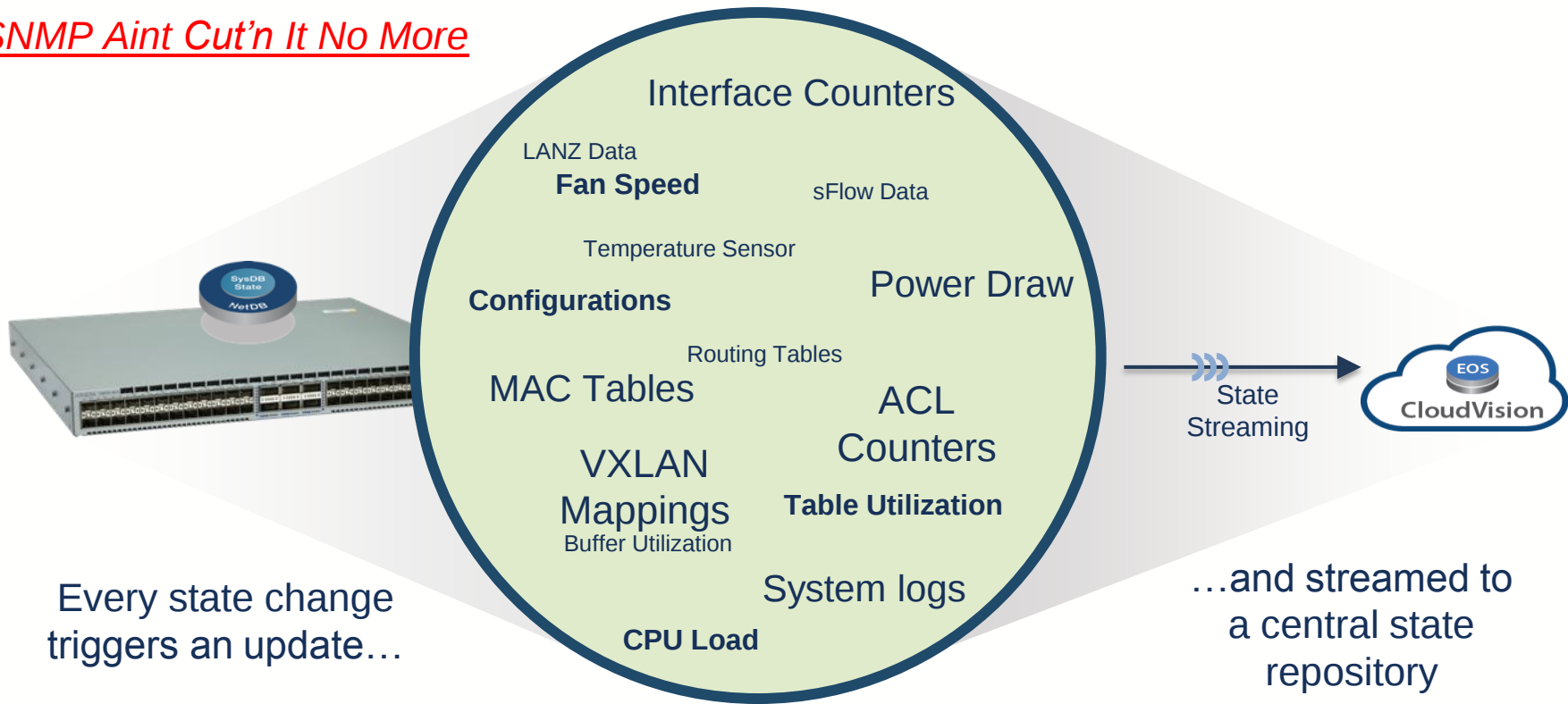




Arista EOS = Visibility and Automation

Value of State Streaming

SNMP Aint Cut'n It No More



Every SysDB state change. From every device. Instantaneously.

Advanced Event Management (AEM)

- Reduce data volumes
- Customize notifications
- Simpler network operations
- Solve scalability challenges
- Automate responses
- Predict faults



Event
Manager



Event
Monitor



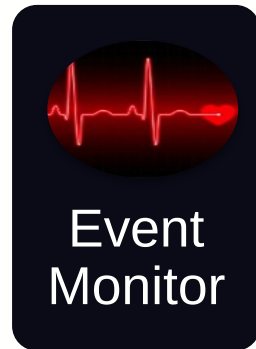
CLI
Scheduler



Linux
package
extension

Event Manager - provides the ability to execute a Linux bash command in response to specific system event
Event Monitor - stores system event records to local files for historical access by SQLite database commands
CLI Scheduler - Schedule periodically the execution of a particular CLI command
Linux Packages Extensions - Such as **RPMS (Splunk Forwarder App)**

Arista is Simple to Operate = Helpful features built-in



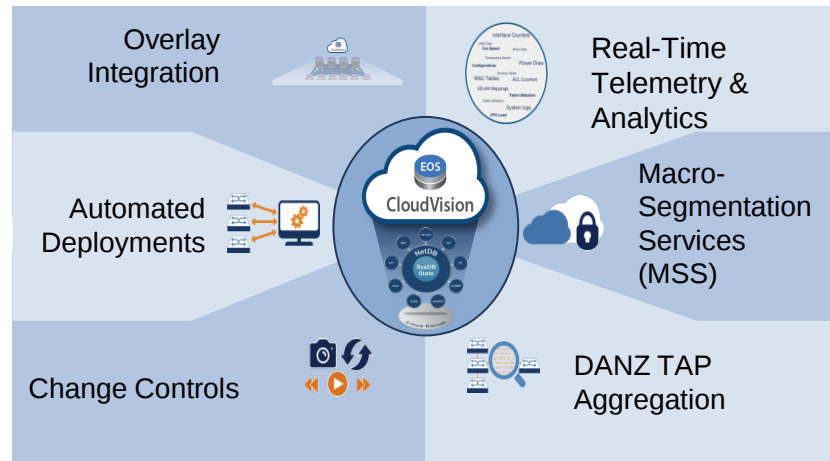
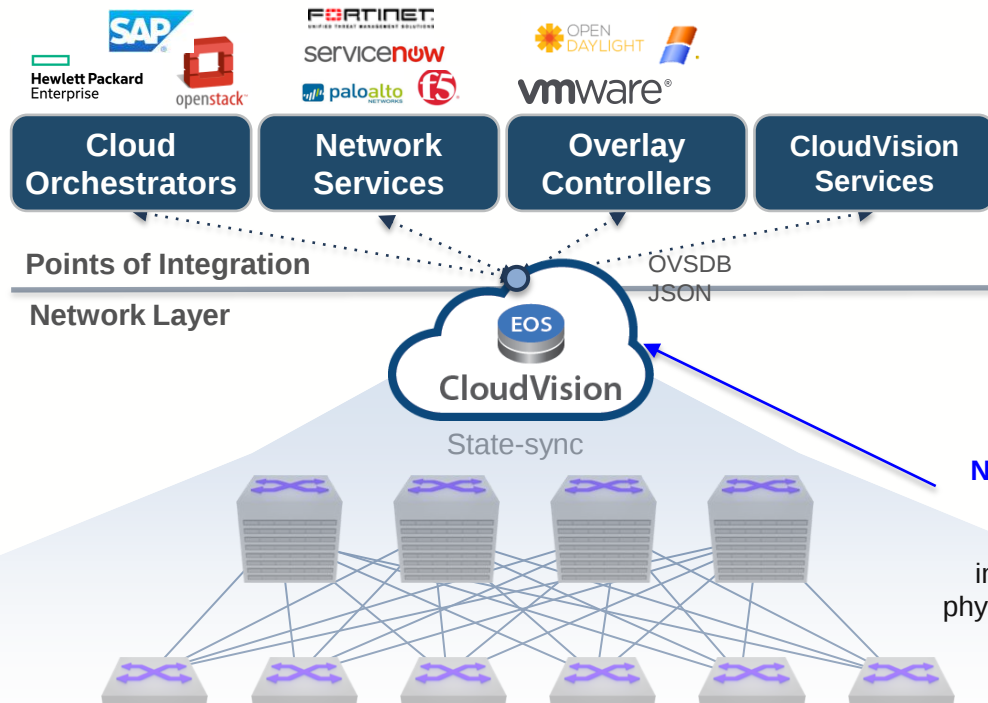
```
Spine01#show event-monitor ?
arp           Monitor ARP table events
igmpsnooping Monitor IGMP snooping table events
mac           Monitor MAC table events
mroute        Monitor mroute table events
route         Monitor routing events
sqlite        enter a sqlite statment
```

```
Spine01#show event-monitor route | i bgp
2016-10-05 00:46:57|192.168.1.17/32|ebgp|0|20|added|68
2016-10-05 00:46:57|192.168.1.17/32|ebgp|0|20|changed|69
2016-10-05 00:47:16|192.168.1.19/32|ebgp|0|20|added|76
2016-10-05 00:47:16|192.168.1.19/32|ebgp|0|20|changed|77
2016-10-05 00:47:20|192.168.1.24/32|ebgp|0|20|added|78
2016-10-05 00:47:25|192.168.1.16/32|ebgp|0|20|added|79
2016-10-05 00:47:25|192.168.1.16/32|ebgp|0|20|changed|80
2016-10-05 00:47:28|192.168.1.23/32|ebgp|0|20|added|81
2016-10-05 00:47:28|192.168.1.23/32|ebgp|0|20|changed|82
2016-10-05 00:47:30|192.168.1.19/32|ebgp|0|20|changed|83
2016-10-05 00:47:30|192.168.1.19/32|ebgp|0|20|changed|84
2016-10-05 00:49:29|10.14.14.0/24|ebgp|0|20|added|109
2016-10-05 00:49:29|172.16.120.0/24|ebgp|0|20|added|110
2016-10-05 00:49:29|172.16.121.0/24|ebgp|0|20|added|111
2016-10-05 00:49:29|172.16.122.0/24|ebgp|0|20|added|112
2016-10-05 00:49:29|172.16.123.0/24|ebgp|0|20|added|113
2016-10-05 00:49:31|192.168.1.15/32|ebgp|0|20|added|116
2016-10-05 00:49:31|192.168.1.15/32|ebgp|0|20|changed|117
2016-10-05 00:49:33|192.168.1.15/32|ebgp|0|20|changed|118
2016-10-05 00:49:33|192.168.1.15/32|ebgp|0|20|changed|119
```

LAB-SP01(s1) #show event-monitor mroute

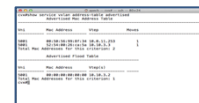
```
2017-03-07
15:27:39|default|0.0.0.0/0|225.0.0.2/32|Ethernet3|oif|join|0
2017-03-07 15:27:39|default|0.0.0.0/0|225.0.0.2/32|||added|1
2017-03-07
15:27:59|default|1.1.1.1/32|225.0.0.2/32|Ethernet3|oif|join|2
2017-03-07 15:27:59|default|1.1.1.1/32|225.0.0.2/32|||added|3
2017-03-08
12:00:37|default|1.1.1.1/32|225.0.0.2/32|Ethernet10|iif|leave|4
2017-03-08
12:00:37|default|1.1.1.1/32|225.0.0.2/32|Ethernet3|oif|leave|5
2017-03-08 12:00:37|default|1.1.1.1/32|225.0.0.2/32|||removed|6
2017-03-08
18:08:39|default|0.0.0.0/0|225.0.0.2/32|Ethernet3|oif|leave|7
2017-03-08 18:08:39|default|0.0.0.0/0|225.0.0.2/32|||removed|8
```

Integration Point to the Underlay



Network Control Point

Single point of integration to the physical infrastructure



CLI



Web-based GUI

Platform for Automation and Visibility across the Network

CloudVision Telemetry Apps – Granular and Complete

Devices

Showing **44** devices. Select a device to view detailed telemetry.

Q

angkor
JAS11300002



ankara
JPE13370497



athens
JPE13370441



bangkok
JAS14210057



belfast
JPE13262292

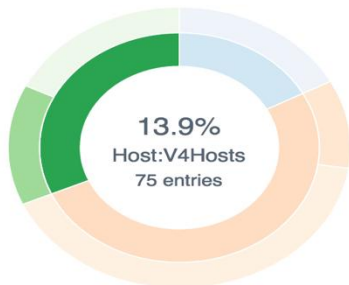


berlin
JSH11420017



Hardware Table Capacity

L3



Interfaces

← Devices

Ethernet Interface Statistics

	Bitrate In	Bitrate Out	Unicast Packets In	Unicast Packets Out	Multicast Packets In	Multicast Packets Out	Errors In	Errors Out
Ethernet1/1	0 Mbps	0 Mbps	0 kpps	0 kpps	0 kpps	0 kpps	0 errors/sec	0 errors/sec
Ethernet1/2	0 Mbps	0 Mbps	0 kpps	0 kpps	0 kpps	0 kpps	0 errors/sec	0 errors/sec
Ethernet1/3	0 Mbps	0 Mbps	0 kpps	0 kpps	0 kpps	0 kpps	0 errors/sec	0 errors/sec
Ethernet1/4	0 Mbps	0 Mbps	0 kpps	0 kpps	0 kpps	0 kpps	0 errors/sec	0 errors/sec
Ethernet2/1	0.03 Mbps	0 Mbps	0.35 kpps	0.17 kpps	0.01 kpps	0 kpps	0 errors/sec	0 errors/sec
Ethernet2/2	0 Mbps	0 Mbps	0 kpps	0 kpps	0 kpps	0 kpps	0 errors/sec	0 errors/sec
Ethernet2/3	0 Mbps	0 Mbps	0 kpps	0 kpps	0 kpps	0 kpps	0 errors/sec	0 errors/sec
Ethernet2/4	0 Mbps	0 Mbps	0 kpps	0 kpps	0 kpps	0 kpps	0 errors/sec	0 errors/sec
Ethernet3/1	0.01 Mbps	0.79 Mbps	0.07 kpps	4.27 kpps	0 kpps	0 kpps	0 errors/sec	0 errors/sec

Routing Table Changes

172.20.253.100/31 modified
Feb 22, 2017 13:30:57

172.20.254.24/31 modified
Feb 22, 2017 13:30:57

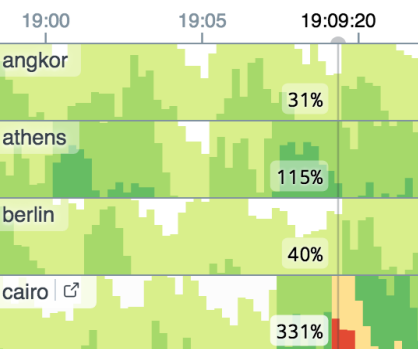
172.20.132.0/24 modified
Feb 22, 2017 13:30:57

172.20.0.0/23 modified
Feb 22, 2017 13:30:57

172.20.254.2/31 modified
Feb 22, 2017 13:30:57

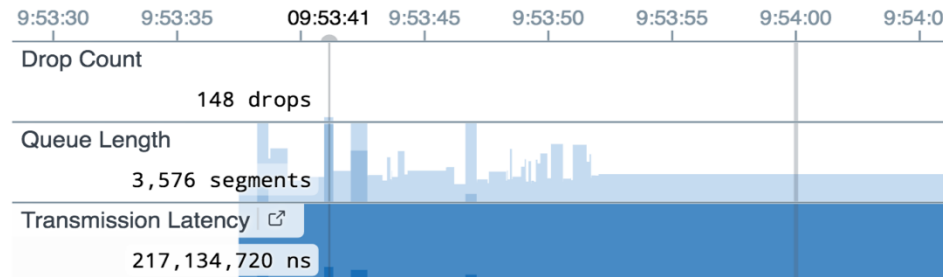
172.20.254.2/32 modified
Feb 22, 2017 13:30:57

CPU Usage



Latency Analysis

LANZ



EOS: Provides unmatched flexibility

Right tool for the job....

EOS SDK

Native applications
Abstraction of event driven data base
Manipulate and react to switch state
Focused at software developers

eAPI

Easy to use
Abstraction of the CLI
JSON via HTTP or HTTPS
Focused at network admin

Linux APIs

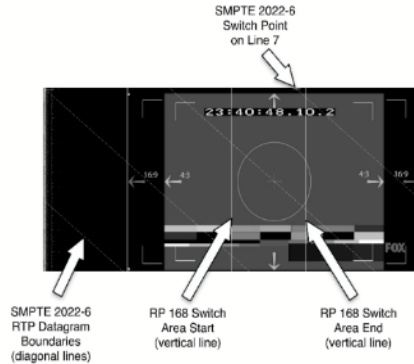
Existing applications that run in Linux
Direct access to the Linux subsystem
No custom compiling
Focused at Linux admin

Cloud Vision

Dev Ops Automation
Turn Key Deployment Model
Telemetry and Analysis
Customize Development with Open Standards

Seamless Switching

- Channel change needs to feel immediate upon button push
- IGMP join/leave not as fast as analog
- Partners need a better mode of operation
- EOS extensibility to the rescue



For 720p/59.94, there are 2249 SMPTE 2022-6 RTP datagrams per frame, and the datagrams should be transmitted approximately every 7.4μs.

Seamless Switching via Automation/Programmability

(Switch-Time Switching)

EOS SDK Integration

- Rewrite multicast MAC table using our speedy SDK
- Direct integration with their control software
- Provides seamless switching without requiring IGMP

EAPI Integration

- Arista EOS CS supplied extension with it's own API
- Programs static IGMP snooping entries
- Less overhead than eAPI, more batch-friendly, much faster than IGMP or eAPI



<http://sportv.globo.com/site/>



Arista Switching = Low Latency, Lossless, and Scalability

Arista Product Overview - 2016

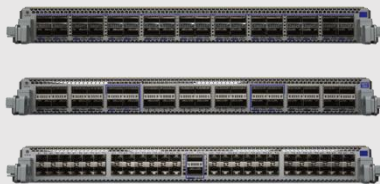


Next Generation 7500R and 7280R Deep Buffer Systems

**Common single EOS
image, Deep Buffer,
Lossless
Architecture, Large
Tables**

**Choice of form
factors, density and
port speeds for
varying use cases**

**Standards based
switching for reliable
deployments**



10G, 40G and 100G
Line cards



7504R and 7508R Systems



24 40G and 12 100G QSFP



48 100G and 8 40G QSFP



48 10G-T and 6 100G



48 10G-SFP and 6 100G

The Need for Large Switch Buffers

- Congestion is inherent in large networks
 - Speed Changes from High to Low
 - Storage Targets
- Bursty Traffic and Micro-Burst
 - Simultaneous Storage Requests – Read and Write
 - Multicast and other bursty traffic behavior
- Without sufficient buffering, packets will be dropped (this in normal)...
 - Leads to unfair bandwidth allocations to flows, and
 - Results in unpredictable overall performance

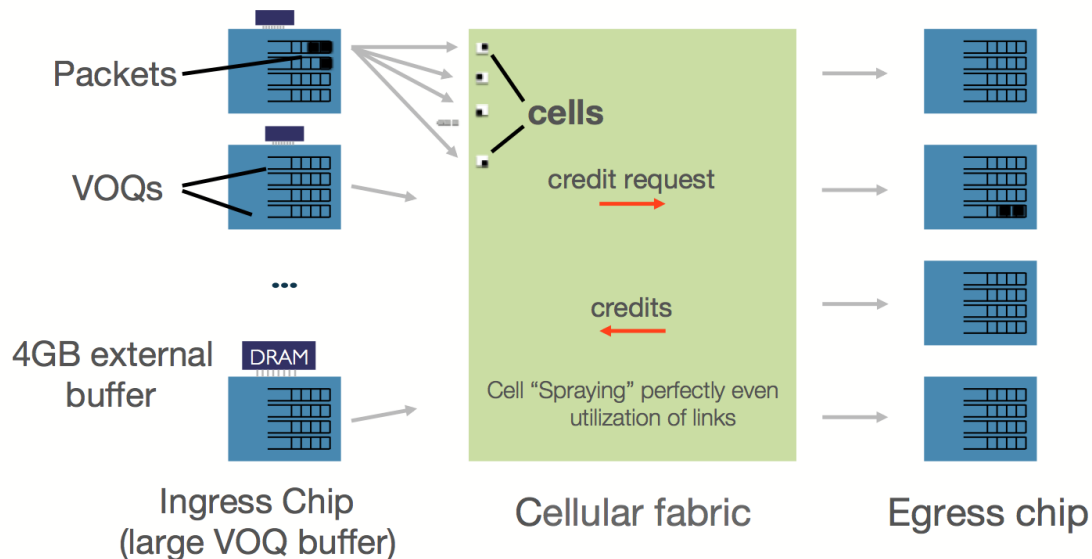


<http://www.arista.com/assets/data/pdf/Whitepapers/BigDataBigBuffers-WP.pdf>

Networks Should Enable High Throughput

Truly Lossless Architecture

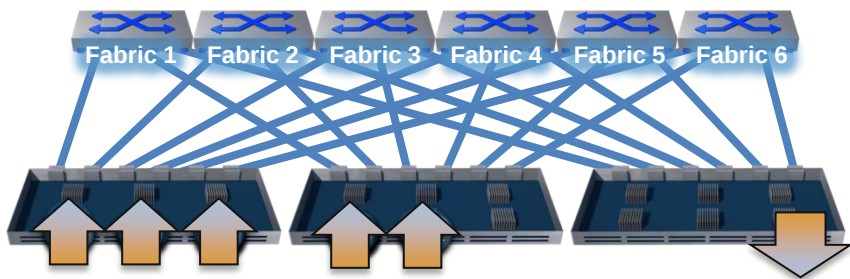
- *VoQ/Deep buffer architecture is unique in the industry*
- Ready for any file or stream based workflow
- Available on our M&E focused 7500R and 7280R series products



Cell Based Fabric: Always 100% Efficient

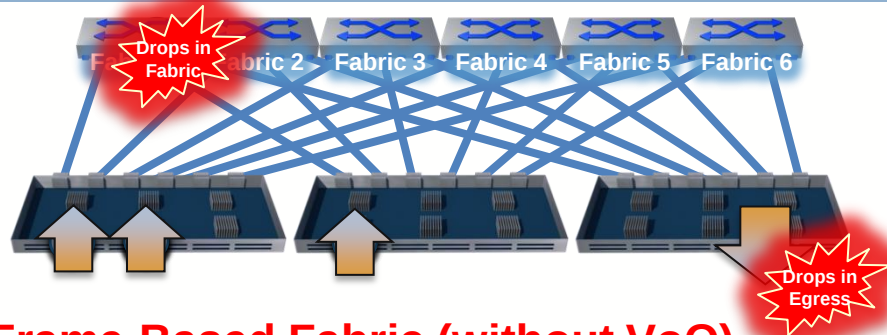
Truly Lossless Architecture

- **Fairness & No Hot Spots:** VoQ notification from egress to ingress
- Avoids inefficient “flow” based hashing or “super-framing” algorithms



Cell-Based with VoQ

- Buffer size tied to speed of output port
- Egress port schedules based on fairness & QoS
- Never any hot spots
- Fabric N+1 redundancy



Frame-Based Fabric (without VoQ)

- Input forwards to output without visibility into output queue (limited output queuing)
- Input forwards to fabric without any visibility into fabric (Fabric hot spots)
- Fabrics aren't N+1 redundant



Production Use Case

“Proof is in the Pudding – Production Use Cases”

Media Customer Reference

Vancouver Olympics 2010 / iStreamPlanet (7500+7048)
Weta (7500) - Lord of the Rings, Hobbit, Prometheus, Tin
Walt Disney (7500)
PIXAR (7500)
Deluxe (7500) - Mad Max being done right now
Bell Media (formerly CTV) – 7508*4
ESPN (7500)
KABC (7500)
Hat Trick Productions (7500)
Double Negative (7500)
FrameStore (7500)
Chimney Pot (7500)
Mwnci (7500)
Whiskytree (7500)
Comcast
GloboSat (Olympic 2016)

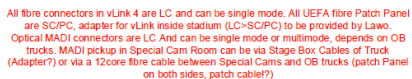


Euro 2016



- Biggest Sports Event Worldwide
- Olympic Games 2016 in Brazil
- FIFA world championship soccer – Germany won 2014 in Brazil
- UEFA EURO 2016 European championship soccer all 4 years
 - June 10th to July 10th in France
 - 24 Participating Nations
 - 10 Stadiums
 - Spain is Current Master

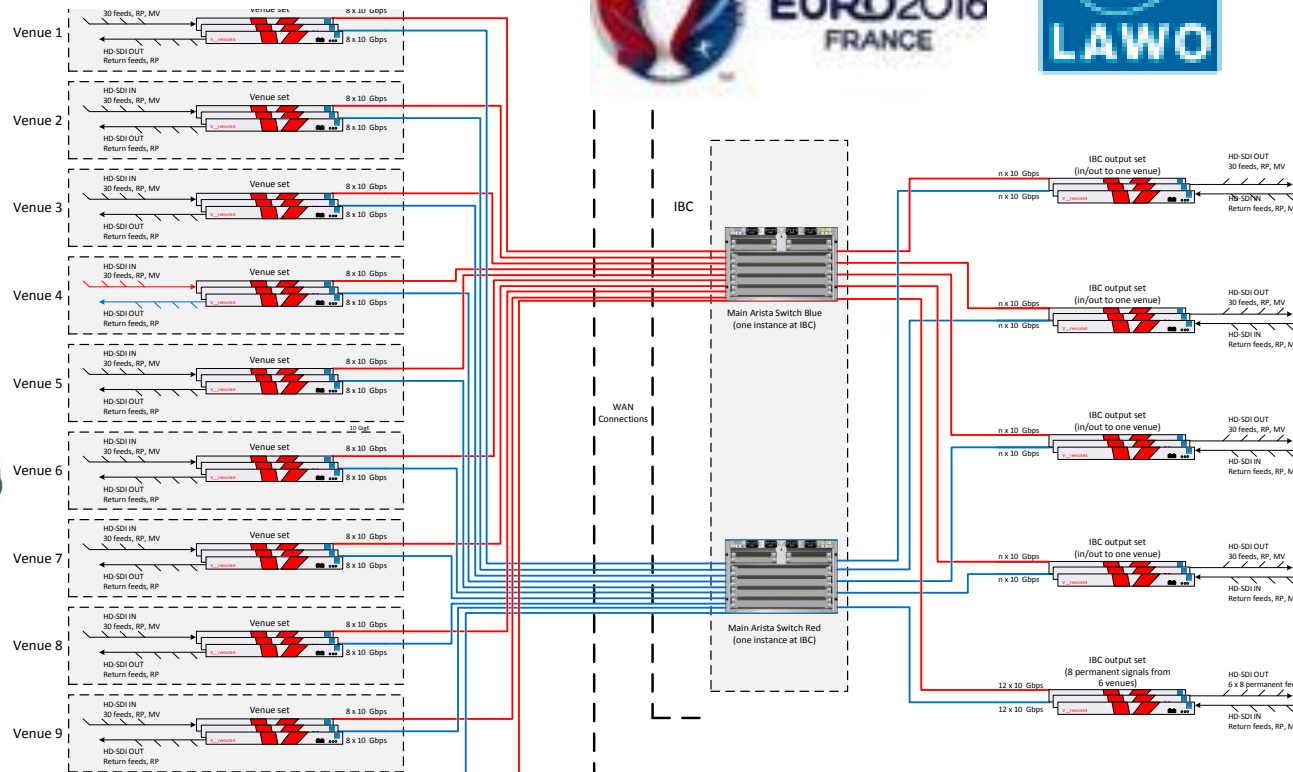




	Fibre Network Venue	
	General Overview	
Owner: SHU	Design:	Rev:
Date: 25/01/2016	Author: J. B.	Revised: J. B.

- 2x 7150 per stadium for live video and audio broadcast to connect all 32 cameras and all microphones
- 2x 7150 per stadium for all commentary boxes / speakers
- 2x 7504E at IBC Paris to connect all broadcasters and radios
- Every picture and audio you will see at EURO 2016 is delivered through Arista only
- This is the first IP only live event worldwide

The diagram illustrates the IBC Paris network topology. At the center is a server icon labeled "IBC Paris". Surrounding it are 11 French cities, each represented by a stadium icon: Lille, Lens, Saint-Denis, Paris, Lyon, Nice, Saint-Étienne, Marseille, Toulouse, Bordeaux, and Lille. Each city is connected to the central IBC Paris server via a bidirectional link. The links are labeled with "8x10Gbps" in blue and red text, indicating the network capacity for each connection.



Seamless Protection Switching, SMPTE

2016 Summer Olympics Rio - Globosat

- Largest live broadcast event ever executed on an all IP infrastructure to date
- AES67 audio and 2022-6 uncompressed video + compressed
- 96 live HD channels simultaneously
- 200+ Gbp/s of concurrent media traffic
- Direct API integration for SDN control with multiple partners
- IP video mixing, return
- Partners: Imagine, Lawo, Embrionix, Tektronix

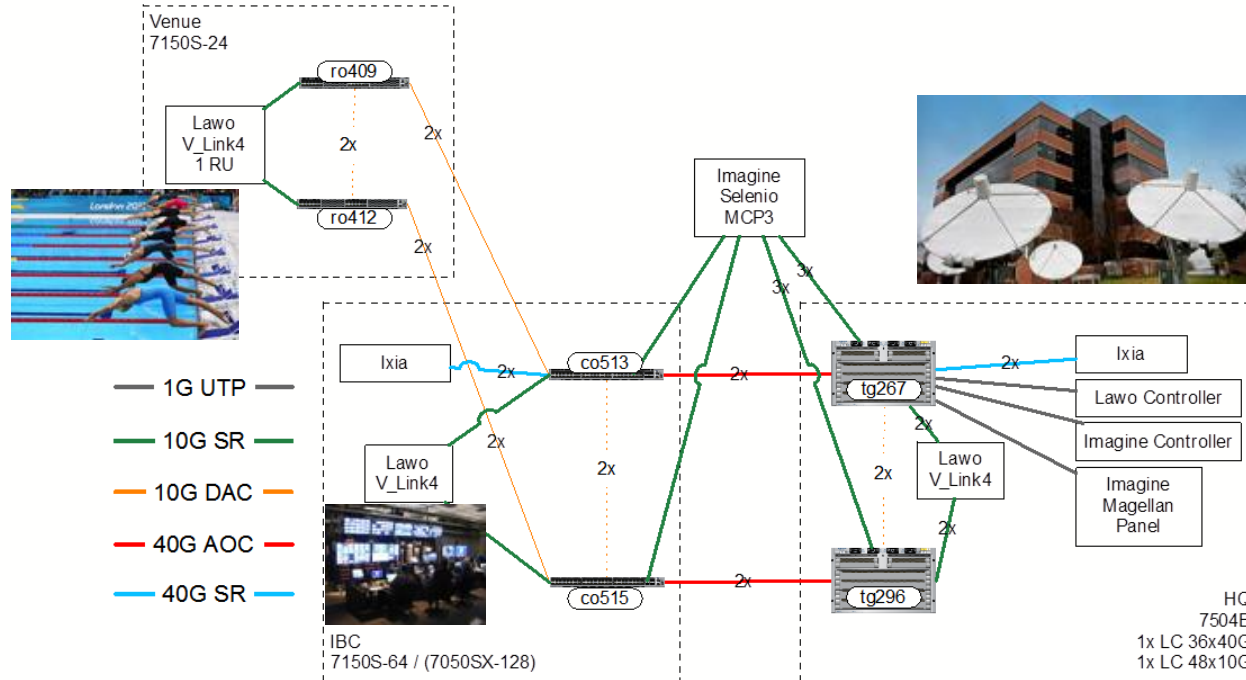


2016 Olympics

LOBOSAT



Imagine
COMMUNICATIONS.



Multiple POP's

- PTP Boundary and transparent modes deployed campus wide
- Geographically distributed deployment
- Centralized distribution

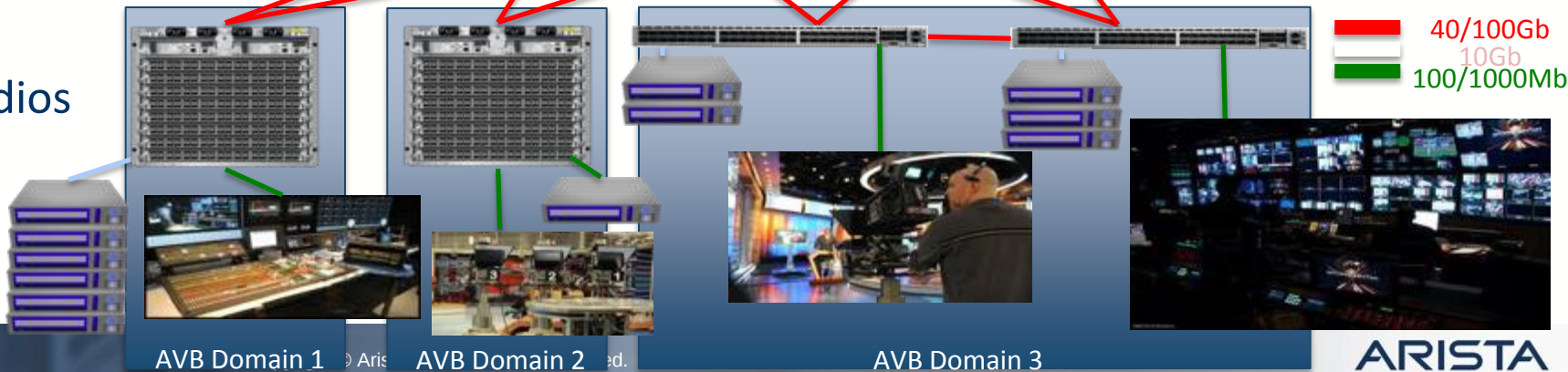
One Big Sports TV Customer

Broadcast Core

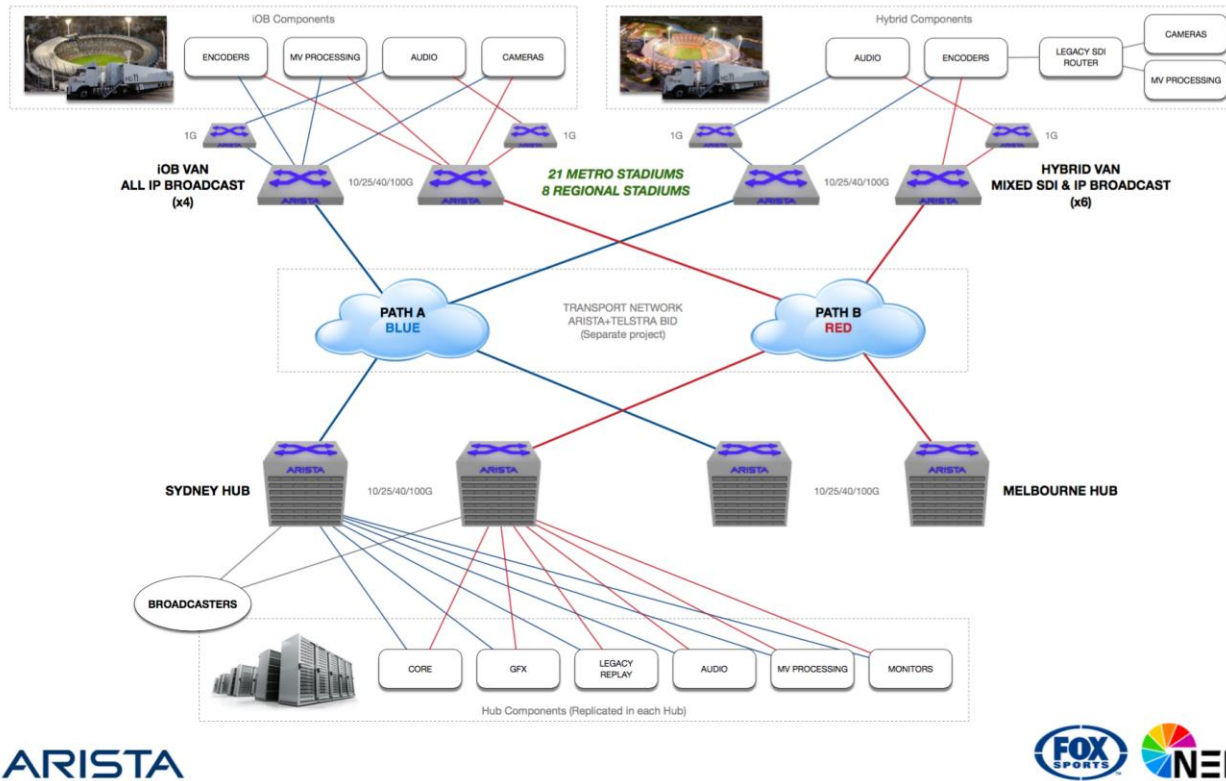
2304 x 10Gbps ports
46 Tbps, non-blocking
Supports > 50,000 signals
(traditional ~1150)
Format agnostic
SD, HD, 3G, 4K, 8K....
Any/All compression codecs
Ethernet MPEG2 -TS, multi-cast
All signals everywhere

Current
88 concurrent inbound recording paths
~2,500 hours of storage
Goal
200 concurrent paths initially
Easily expandable to 400+
20,000+ hours of on-line storage

Studios



NEP AUSTRALIA IP BROADCAST NETWORK



ARISTA



http://www.nepinc.com/about/news_and_press/nep_australia_selects_arista_networks_for_core_networking_at_new_production_hubs

Arista – Foundation for Media & Entertainment

“Are you trying to bring relevancy to your product? Or, trying to build relevant products?” – Entertainment. Co. CIO

PTP / RFC 1588
Boundary and
Transparent Mode
AVB gPTP
SMPTE 2059-2
Scalable Multicast
Lossless IP Network



Automation (eAPI,
Extensions, Linux)
SDN Partners
Hitless Upgrades
RPM Patching
Fewer or No “Bug Scrubs”
Reliability
Stability

Universal Cloud Network
Low Latency
Virtual Output Queues
Large Buffers
DirectFlow
Static Multicast

An Arista architecture, enables you to move faster, with software that has greater stability. “The bug is in their architecture.”

Thank You

www.arista.com

- A**gile One "Open" system needs to support legacy & new Multi vendor initiatives and uninterrupted growth ; Applications, Compute, Storage, Video, Security
- R**obust The systems must simply be "on & available " 24/7.
- I**ntant Facilitate immediate & harmonious change without disruption ; new apps, servers, sites, users, growth, etc
- S**table The quality of the software must be the very best available in the industry & minimize the "forklift upgrade" !
- T**raceable Information about application performance is tracked in real time .
- A**utomated The ability to remove the mundane & repetitive tasks with programmable scripts based on standards.