THE PRODUCTION MEDIA DATA CENTER

MONITORING AND ORCHESTRATION
FOR ALL-IP FACILITIES

Thomas Gunkel, Market Director Broadcast
Thomas.Gunkel@skyline.be
WHY ALL-IP?

BROADCASTING GOES IP – IT’S NOT ABOUT REPLACING CABLES

- application flexibility
- multi-format media
- use of COTS hardware
- software-defined networking
- virtualization of network & applications
- converged data center infrastructure
- private – public – xAAS cloud deployments
new network technologies and topologies are challenging and do not always behave as they should

- frame drops, packet reorder, packet loss, packet retransmission, packet delay variation (PDV)
- network congestion, bursts, latency & overhead
- packet jitter – large variances of inter-packet arrival times
- need for forward error correction & error concealment
- multi-layer (MAC, IP, UDP, RTP, SMPTE 2xxx mapping, video/audio essence)
- how can signals within streams be identified?

large media flows require special attention

- need to transmit in real time
- need to be PTP-synced
- require IP traffic shaping
- need hitless protection
- need to switch fast, frame-accurate, seamless, or a mix of all this
TRENDS & CHALLENGES: CONTENT AND NETWORK SECURITY

HIGH-VALUE MEDIA CONTENT NEEDS HIGH LEVEL OF PROTECTION

new situation: no more closed ecosystems
• on-premises, off-premises and hybrid installations
• need to integrate third-party networks & providers
• multi-vendor, multi-tenant networks
• protocols have “no boundaries” (e.g. IGMP)
• external & cloud-based license services for microservices and applications
• many supporting microservices (e.g. DCHP, DNS, ...) in the infrastructure in addition to the core services (e.g. transcode)

strategies & protection technologies
• traditional routing
• software-defined (SDN) & proprietary network access control protection (e.g. ACL lists)
• need to adopt standard IT cyber security guidelines (EBU R146 and others)
• network traffic & content encryption (not yet available for uncompressed media)
• fine-grained authorization and authentication mechanisms
TRENDS & CHALLENGES: SWITCHING OF UNCOMPRESSED IP STREAMS

THERE IS NO “ONE-FITS-ALL” WORKFLOW

- industry still settling on best practices
- use of standard routing protocols
  - limited IGMP tie-line control
  - content and infrastructure security vulnerabilities
- a variety of SDN-controlled switch algorithms emerge
  - source-based switching
    - source MC address natting
  - switch-timed switching
    - not compatible with COTS approach
  - destination-based switching (IGMP)
    - SMPTE 2022-7 stream redundancy (BW * 2)
- switch fabric orchestration
  - IGMP or static multicast routes
  - combined with orchestration of port admin status and ACL lists for security and reliability
- scheduled frame-accurate switching (header timestamps)
- vendor-proprietary SDN controllers
  - live production: fast and quasi frame-accurate switching using proprietary and optimized protocols for the specific hardware
  - vendor lock-in
  - multicast only (siloed operation)
  - most often run on non-blocking spine/leaf ($$$)
## Control Plane Interoperability Is Lagging

### Good Industry Adaption
- **Baseline for Interoperability**: SMPTE 2022-6
- **Enable IP Streaming of Audio**: AES67
- **Support Split Video and Audio Routing**: VSF TR-04
- **Add Video Bandwidth Efficiency to Split Video, Audio and ANC Data Routing**: VSF TR-03
- **Enable Discovery and Registration of Compliant Streams**: IS-04
- **Sender & Receiver Connection Management**: IS-05

### Slow Industry Adaption
- **Baseline for Interoperability**: SMPTE 2022-6
- **Enable IP Streaming of Audio**: AES67
- **Support Split Video and Audio Routing**: VSF TR-04
- **Add Video Bandwidth Efficiency to Split Video, Audio and ANC Data Routing**: VSF TR-03
- **Enable Discovery and Registration of Compliant Streams**: IS-04
- **Sender & Receiver Connection Management**: IS-05

### No Industry Adaption (Draft)
- **Baseline for Interoperability**: SMPTE 2022-6
- **Enable IP Streaming of Audio**: AES67
- **Support Split Video and Audio Routing**: VSF TR-04
- **Add Video Bandwidth Efficiency to Split Video, Audio and ANC Data Routing**: VSF TR-03
- **Enable Discovery and Registration of Compliant Streams**: IS-04
- **Sender & Receiver Connection Management**: IS-05
- **Network Control – Reserve and Secure Services**: IS-06

### Data Plane Interoperability

### Orchestration (ongoing for > 2 years)

- SMPTE 2022-6
- AES67
- TR04
- SMPTE 20110
- AES67
- TR03
- SMPTE 2059
- SMPTE 2059
ORCHESTRATION FOR THE PRODUCTION MEDIA DATA CENTER

ESSENTIALS FOR TRUE ORCHESTRATION

DYNAMICALLY ORCHESTRATE YOUR RESOURCES AND MEDIA SERVICES

MONITOR AND CONTROL YOUR INFRASTRUCTURE AND MEDIA FLOWS

DETECT AND PROVISION YOUR INFRASTRUCTURE
ORCHESTRATION FOR THE PRODUCTION MEDIA DATA CENTER
ESSENTIALS FOR TRUE ORCHESTRATION

DYNAMICALLY ORCHESTRATE YOUR RESOURCES AND MEDIA SERVICES

MONITOR AND CONTROL YOUR INFRASTRUCTURE AND MEDIA FLOWS

DETECT AND PROVISION YOUR INFRASTRUCTURE
true orchestration starts with infrastructure discovery and provisioning:

- automated and rule-based inventory discovery workflows
- zero-touch provisioning of inventory
- management of element configurations
- automated upload of software images
- plug ‘n play creation graphical views from locations down to highly detailed rack views
IDP IS AN ESSENTIAL PART FOR TRUE ORCHESTRATION

- discover new, well-known or external devices
- use secured VLANs for new devices
- check against ACL lists and policies
- check firmware and upload default software base settings
- publish device as "ready for production"
ORCHESTRATION FOR THE PRODUCTION MEDIA DATA CENTER

ESSENTIALS FOR TRUE ORCHESTRATION

- Detect and provision your infrastructure
- Monitor and control your infrastructure and media flows
- Dynamically orchestrate your resources and media services
• traditional broadcast & broadcast-IT equipment:
  - multi-viewers
  - monitors
  - cameras
  - graphics devices
  - video servers
  - audio processing
  - video processing
  - ...

• IT-equipment:
  - network infrastructure
  - storage nodes
  - OS, virtual machines
  - microservices
  - ...

END-TO-END MONITORING AND ORCHESTRATION – ANY VENDOR, ANY PROTOCOL, ANY TECHNOLOGY
INFRASTRUCTURE MANAGEMENT – COMBINE BROADCAST & IT
END-TO-END MONITORING AND ORCHESTRATION
INFRASTRUCTURE MANAGEMENT - SWITCHES
WORKFLOW MONITORING – MULTICAST PATH RESOLUTION
MEDIA FLOW PATH DETECTION AND VISUALIZATION

• typical media flow issues in ALL-IP:
  - source: multicast-transmit-IP does not match with SDN-database
  - source device does not create stream
  - destination: multicast-receive-IP does not match with SDN crosspoint state
  - IGMP join or leave does not work
  - IGMP snooping issues
  - static multicast routes mismatches
  - and much more...

compare cross point status
(where are my streams supposed to be)

versus aggregated real-time data
(where are my streams in reality and how is the exact flow through the network)
ORCHESTRATION FOR THE PRODUCTION MEDIA DATA CENTER

ESSENTIALS FOR TRUE ORCHESTRATION

DYNAMICALLY ORCHESTRATE YOUR RESOURCES AND MEDIA SERVICES

MONITOR AND CONTROL YOUR INFRASTRUCTURE AND MEDIA FLOWS

DETECT AND PROVISION YOUR INFRASTRUCTURE
from signal switching to SDN service orchestration

- agnostic to switching technologies (source-, switch-, destination-based)
- needs customizable software router control panels
- integrates southbound with 3rd party SDN controllers and broadcast router controllers
- can integrate northbound with 3rd party broadcast control systems

ALL-IP: must have SDN features

- configures and manages endpoints
- manages capacity in blocking / non-blocking architectures
- manages connections
- manages multicast-address pools
- manages security and ACLs
- knows exact flow path
- avoids link fragmentation
- built-in service-aware monitoring
DATAMINER ORCHESTRATION – THOUGHTFUL SWITCHING

MEDIA WORKFLOW ORCHESTRATION – SRM

- Customizable UI
- OSS / BSS
- 3rd party broadcast controller

**Orchestration layer (Service and Resource Management)**

- signal switching
- has its own ‘router DB’
- E2E service orchestration
- multi-vendor
- soft router control panels (IP and SDI)
- capacity mgmt in blocking/non-blocking
- avoid link fragmentation
- security & access control sources/flows
- sflow and netflow monitoring
- policy management
- centralized label mgmt
- unicast & multicast
- IP address mgmt
- converged media and IT infrastructure
- inventory management
- ancillary functions mgmt (PTP, BGP, …)
- optional support for SDN controllers (Cisco Arista, …)
DATAMINER ORCHESTRATION – MORE THAN A CONTROLLER

SERVICE AND RESOURCE MANAGEMENT (SRM)

- Flexible workflow editor
- End-to-end service life cycle management
- Virtualize elementary functions
- Agnostic to underlying technology
- Manage physical capacity
- Bookings and reservations
- Manage physical connectivity & tie lines
- Understands IGMP, SMPTE2022, SMPTE2110, ...
- Flexible automation on Network Elements (NEs)
- Managed redundancy, new device workflows
- Schedule events on NEs and services
- Schedule operational workflows

1. Service Manager
2. Virtualization Engine
3. Resource Manager
4. Profile Manager
5. Connectivity Framework
6. Automation Engine
7. Scheduling Engine
MEDIA WORKFLOW ORCHESTRATION WITH SRM
SERVICE DEFINITIONS, RESOURCES AND PROFILES
MEDIA WORKFLOW ORCHESTRATION
BLOCKING IP FABRIC – CAPACITY CONSTRAINTS HANDLING
THE PRODUCTION MEDIA DATA CENTER

CUSTOMER REFERENCES

TPC SWITZERLAND

ALL-IP SMPTE 2110 INFRASTRUCTURE AND MEDIA-OVER-IP FLOW MONITORING

Thomas Gunkel, Market Director Broadcast
Thomas.Gunkel@skyline.be
• SMPTE 2110 - 2160p/50

• IP backbone: Arista 7504R
• SDNO: Imagine Magellan
• Control system: Lawo VSM
• Audio: Stagetec Nexus and Avatus console
• Mixer: Sony XVS8000 & XVS6000
• LSM: EVS-XT-3 and/or XT-4K
• Multi-viewer: Imagine EPIC MV
• Cameras: Sony HDC4300 & F65
TPC - SWITZERLAND - ALL-IP SMPTE 2110 INFRASTRUCTURE AND MEDIA-OVER-IP FLOW MONITORING

TRUCK - HIGH LEVEL ARCHITECTURE

SDI devices

IP Gateways

SDN Controller

Broadcast Controller

Core Network Main

Core Network Backup

Monitor / Multi-viewer

E2E Monitoring

“MONITORING” PLANE
DATA PLANE
“CONFIGURATION” PLANE
Problem:

• complex products and workflows require powerful APIs
  • APIs were late or are still under construction
  • APIs do not give access to all essential parameters &
    configuration data
  
  workarounds & delays

Recommendation & lesson learned:

• look at the monitoring from the early beginning of a
  project and treat it as an essential part, not just as a gap
  filler

• talk to your vendors and let them know that their APIs
  must include the same features and parameters they
  expose via their own web UIs and tools

• add this requirement to your tender documents
Problem:
• operators need to use several tools from multiple vendors to check the truck’s health status

Solution:
• merge broadcast and IT monitoring into a single user interface
  • constantly monitor and visualize system health status
  • show the most severe alarms on the landing page
    • critical hardware failures
    • 2022-7 redundancy
    • PTP status
    • network interface status
    • SDI input loss
  • create equipment groups, drill down to individual elements for details
  • naming conventions – use broadcast controller labels
Problem:
• with PTP boundary clock, the switches or a slave device sometimes have the wrong PTP settings – truck is out of sync – receivers fail switching signals

Solution:
• constantly monitor PTP status & PTP settings of every device
  • Tektronix PTP grandmaster
  • Arista boundary clocks
  • PTP slaves
• check for correct PTP grandmaster, PTP clock domain, ...
Problem:
• network traffic or dedicated flows need to be analyzed and recorded
• how to record an uncompressed UHD stream for a longer time?

Solution:
• Analyze: Tektronix Prism integration
  • send single flow or signal group to Prism
  • create dynamic ACL lists so as not to interfere with other streams
• Record: Wireshark integration
  • integrate Arista TAP aggregation to mirror traffic of any interface
    • record complete traffic
    • record single flow or group of streams
    • optionally truncate data, send and record headers only
Problem:

- neither SDN controller nor broadcast controller monitors main and backup flows (40,000+ flows)
- how to check crosspoint status versus reality?

Solution:

- integrated real-time flow monitoring: detect and track flows from source to destination
- two use cases:
  - permanent automatic background flow availability check for main and backup streams after every switch command
  - APP for in-depth flow checks
TPC - SWITZERLAND - ALL-IP SMPTE 2110 INFRASTRUCTURE AND MEDIA-OVER-IP FLOW MONITORING

FLOW MONITORING APP

TPC Truck Application

Source

1. Select a family
- EVS

2. Select a group

Incoming Flows

- Filter

Outgoing Flows

- Filter

Arista Main 7504
- IP Address: 234.5.0.186
- Ingress Stream

Arista Backup 7504
- IP Address: 234.8.206
- Ingress Stream

Receivers

- Filter

- Flow Monitoring App
THE PRODUCTION MEDIA DATA CENTER

CUSTOMER REFERENCES

TELSTRA AUSTRALIA

SDN ORCHESTRATION
DISTRIBUTED PRODUCTION NETWORK

THE PROJECT CUSTOMER AND OTHER PARTIES

• Distributed Production Network (subject)
  • End-to-end IP network, custom-built for the media industry
  • Covering over 29 different venues across Australia
  • Supporting live production at a distance

• Telstra (our customer)
  • Largest Australian telco and media company
  • International presence with focus on APAC
  • Headquartered in Melbourne

• Fox Sports (Telstra’s customer)
  • Owning the rights for live coverage of major sports competitions incl. A-League
  • Set to cover approx. 520 tier-one events per year using DPN

• NEP (subcontractor to Fox)
  • Major broadcast production company
  • Using the Telstra DPN to produce for Fox Sports

THE PROJECT CUSTOMER AND OTHER PARTIES

• Telstra (our customer)
  • Largest Australian telco and media company
  • International presence with focus on APAC
  • Headquartered in Melbourne

• Fox Sports (Telstra’s customer)
  • Owning the rights for live coverage of major sports competitions incl. A-League
  • Set to cover approx. 520 tier-one events per year using DPN

• NEP (subcontractor to Fox)
  • Major broadcast production company
  • Using the Telstra DPN to produce for Fox Sports

THE PROJECT CUSTOMER AND OTHER PARTIES

• Telstra (our customer)
  • Largest Australian telco and media company
  • International presence with focus on APAC
  • Headquartered in Melbourne

• Fox Sports (Telstra’s customer)
  • Owning the rights for live coverage of major sports competitions incl. A-League
  • Set to cover approx. 520 tier-one events per year using DPN

• NEP (subcontractor to Fox)
  • Major broadcast production company
  • Using the Telstra DPN to produce for Fox Sports

THE PROJECT CUSTOMER AND OTHER PARTIES

• Telstra (our customer)
  • Largest Australian telco and media company
  • International presence with focus on APAC
  • Headquartered in Melbourne

• Fox Sports (Telstra’s customer)
  • Owning the rights for live coverage of major sports competitions incl. A-League
  • Set to cover approx. 520 tier-one events per year using DPN

• NEP (subcontractor to Fox)
  • Major broadcast production company
  • Using the Telstra DPN to produce for Fox Sports

THE PROJECT CUSTOMER AND OTHER PARTIES

• Telstra (our customer)
  • Largest Australian telco and media company
  • International presence with focus on APAC
  • Headquartered in Melbourne

• Fox Sports (Telstra’s customer)
  • Owning the rights for live coverage of major sports competitions incl. A-League
  • Set to cover approx. 520 tier-one events per year using DPN

• NEP (subcontractor to Fox)
  • Major broadcast production company
  • Using the Telstra DPN to produce for Fox Sports
DISTRIBUTED PRODUCTION NETWORK

SOME CHARACTERISTICS

- Type
  - End-to-end IP, redundant
  - High capacity, low latency
  - Supporting transport of uncompressed HD

- Network aggregation & leaf switches
  - Arista DCS-7280SR/QR

- Video/audio edge
  - Aperi A1105 platform

- Venue:
  - Cameras only
SERVICE AND RESOURCE MANAGER (SRM)

BOOKING CREATION

- Select a service (e.g. passthrough, SMPTE 2110)
- Start time, stop time
- VLAN ID (Arista switch fabric)
- Source, destination
• Deploy software during preroll phase on Aperi endpoints

• Service chain will be created and managed automatically once a booking gets active

• Orchestrator resolves network topology and creates redundant paths between two sites

• Every signal runs on an individual VLAN through multiple Arista switches

• Orchestrator uses the Dijkstra algorithm to find the shortest path for main and backup once the service starts (takes port status and bandwidth into account)

• Service aware monitoring: checks port status and bitrate on only those ports which are part of that booking

• Orchestrator root cause analysis: uses defined rule set to indicate root cause alarms
THANK YOU