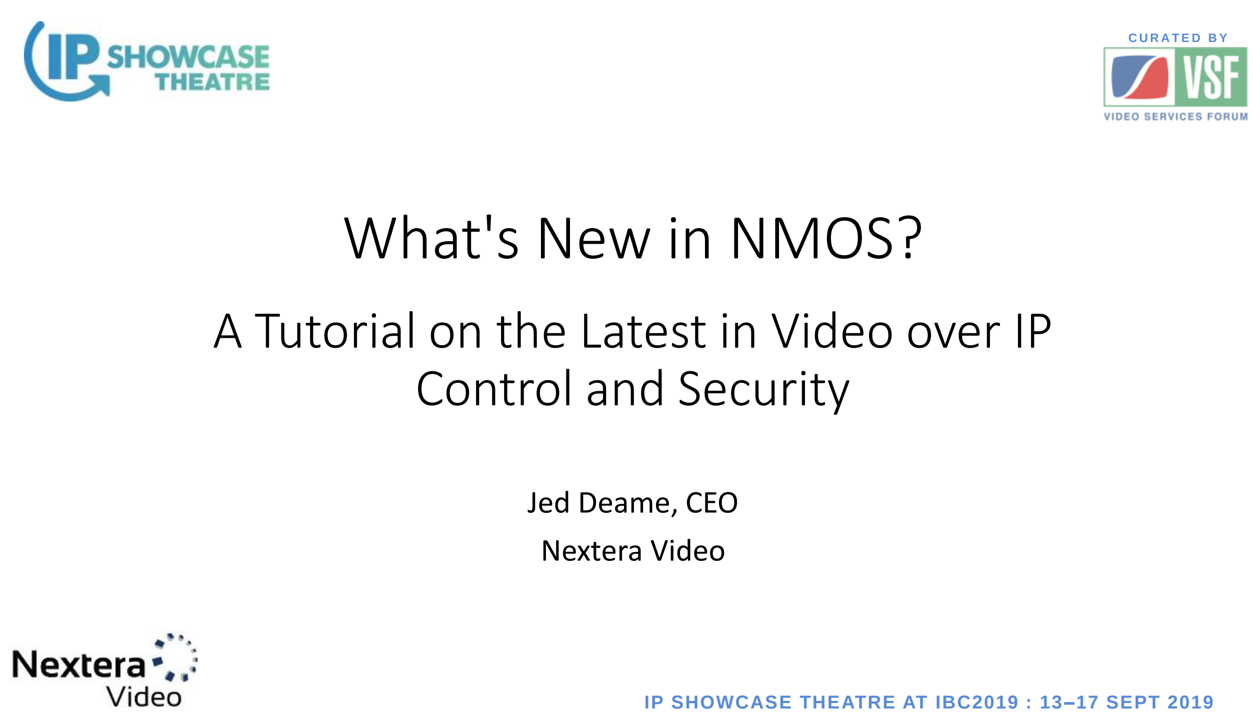

What's New in NMOS?

A Tutorial on the Latest in Video over IP Control and Security

Jed Deame, CEO

Nextera Video

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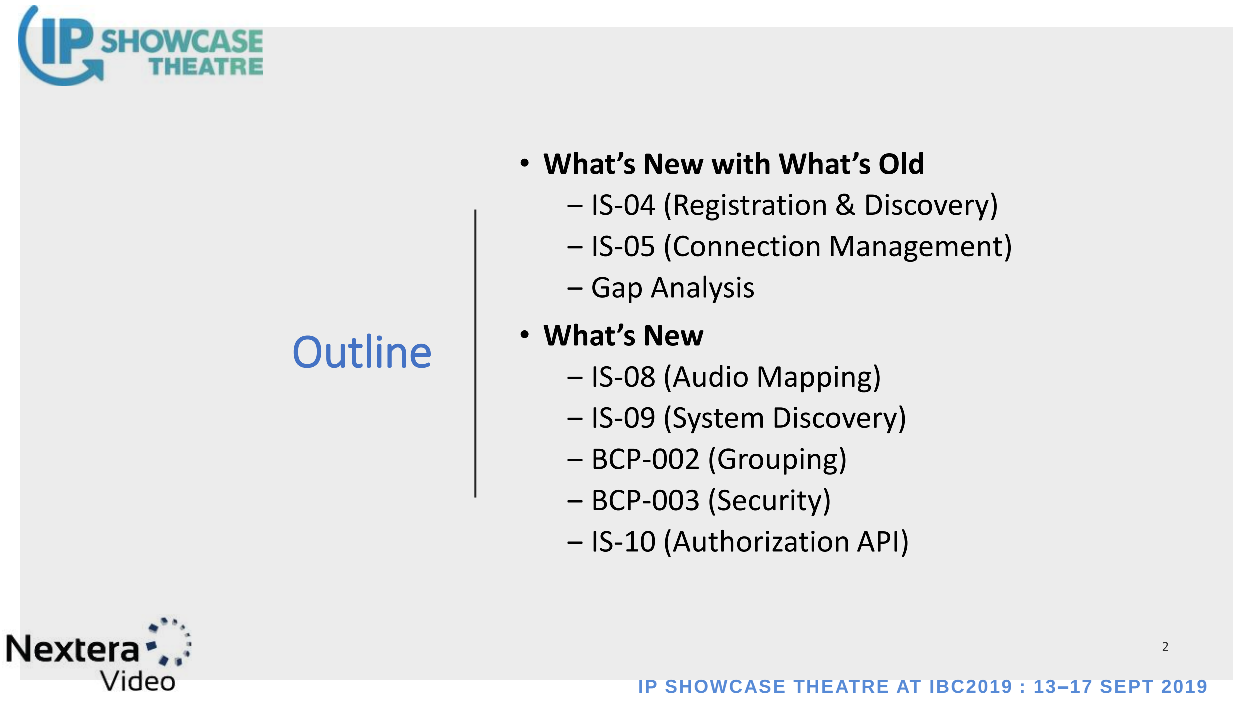

Outline

- **What's New with What's Old**
  - IS-04 (Registration & Discovery)
  - IS-05 (Connection Management)
  - Gap Analysis
- **What's New**
  - IS-08 (Audio Mapping)
  - IS-09 (System Discovery)
  - BCP-002 (Grouping)
  - BCP-003 (Security)
  - IS-10 (Authorization API)

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What is NMOS again?

- NMOS is the Networked Media Open Specification, developed by the Advanced Media Workflow Association (AMWA)
- Delivered in the form of an open specification on the AMWA website
- Enables ST-2110 equipment to seamlessly interoperate across vendors and facilities

➢ Brings push-button simplicity to Video over IP Routing

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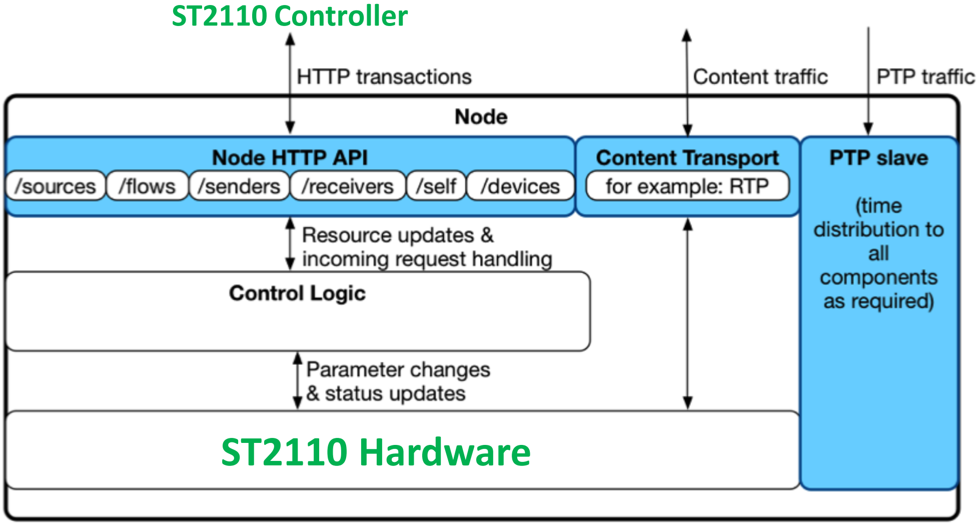
What does NMOS Do?



ST2110 Controller

HTTP transactions

Content traffic

PTP traffic

Node

Node HTTP API

/sources /flows /senders /receivers /self /devices

Content Transport

for example: RTP

PTP slave

(time distribution to all components as required)

Resource updates & incoming request handling

Control Logic

Parameter changes & status updates

ST2110 Hardware

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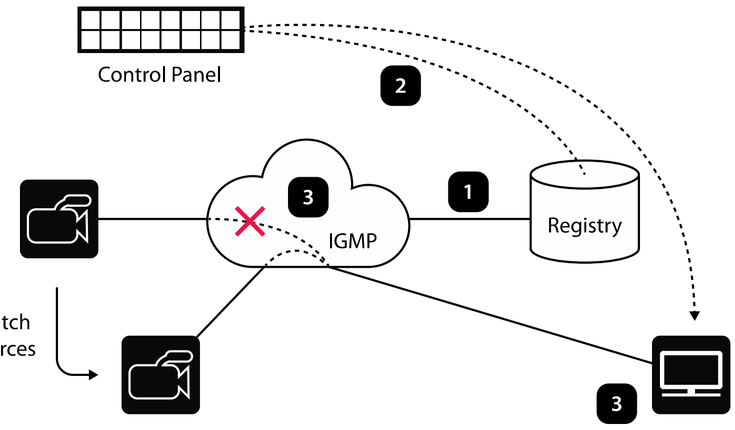
How does NMOS Work?

- Through a set of Application Program Interface (APIs)
- Exposed via http as: *http://<IP Address>/x-nmos /<API Name>/…*
- Examples:
  - http://192.168.10.2/x-nmos/node/v1.2/self
  - http://192.168.10.2/x-nmos/query/v1.2/nodes
  - http://192.168.10.2/x-nmos/channelmapping/v1.0/map
  - http://192.168.10.2/x-nmos/channelmapping/v1.0/outputs
  - http://192.168.10.2/x-nmos/auth/v1.0/certs

The Basics of NMOS

IS-04/05 System Diagram

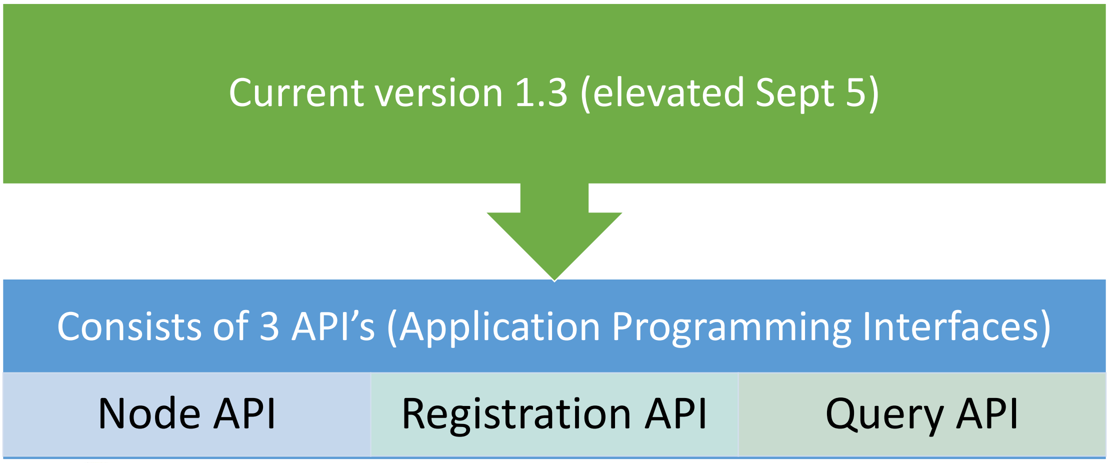


1 Sources automatically register with RDS

2 Control Panel gets list of devices from RDS

3 Upon button press, control system commands receiver to join the new multicast stream and leave the previous one

What's New with What's Old: IS-04 (Registration & Discovery)



Current version 1.3 (elevated Sept 5)

Consists of 3 API's (Application Programming Interfaces)

Node API

Registration API

Query API

Latest IS-04 Feature Support

Feature	v1.0	v1.1	v1.2	v1.3
Core functions including basic queries	x	x	x	x
Peer to peer mode (*Optional from v1.3*)	x	x	x	x
Basic connection management (*Deprecated*)	x	x	-	-
BCP-003-01 HTTPS and secure WebSockets		x	x	x
Multiplexed Flows (ST.2022-6)		x	x	x
Paged queries		x	x	x
Advanced (RQL & ancestry) queries (*Optional*)		x	x	x
Support for IS-05 connection management			x	x
Support for IS-07 and future transports				x
BCP-003-02 Authorization signalling				x

What's New with What's Old : IS-05 (Connection Management)

- Current version 1.1 (elevated Sept 5)
- IS-05 is an API which provides the means to create a connection between Senders and Receivers
- Enables switching through "activations"
- Activations can be immediate, relative, or absolute
- Supports FEC and redundant streams

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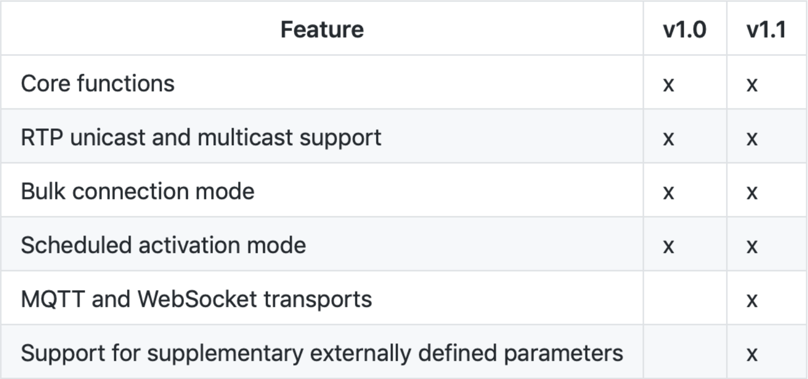
Latest IS-05 Feature Support



Feature	v1.0	v1.1
Core functions	x	x
RTP unicast and multicast support	x	x
Bulk connection mode	x	x
Scheduled activation mode	x	x
MQTT and WebSocket transports		x
Support for supplementary externally defined parameters		x

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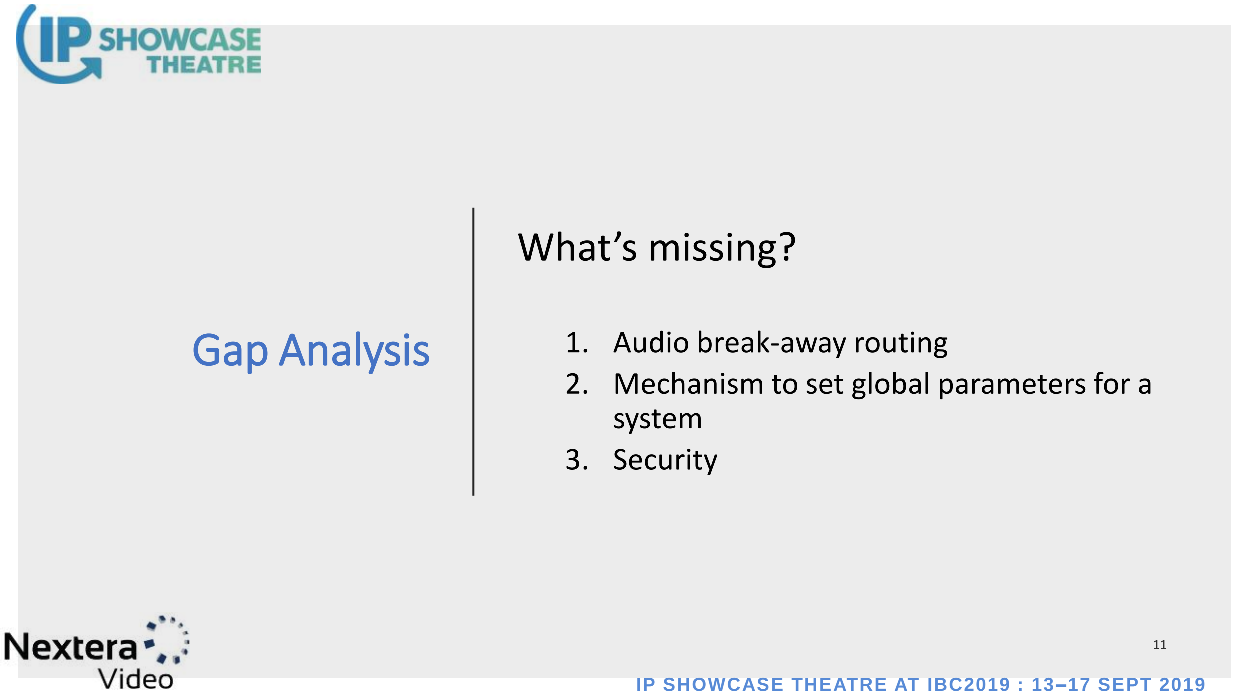

Gap Analysis

What’s missing?

1. Audio break-away routing
2. Mechanism to set global parameters for a system
3. Security

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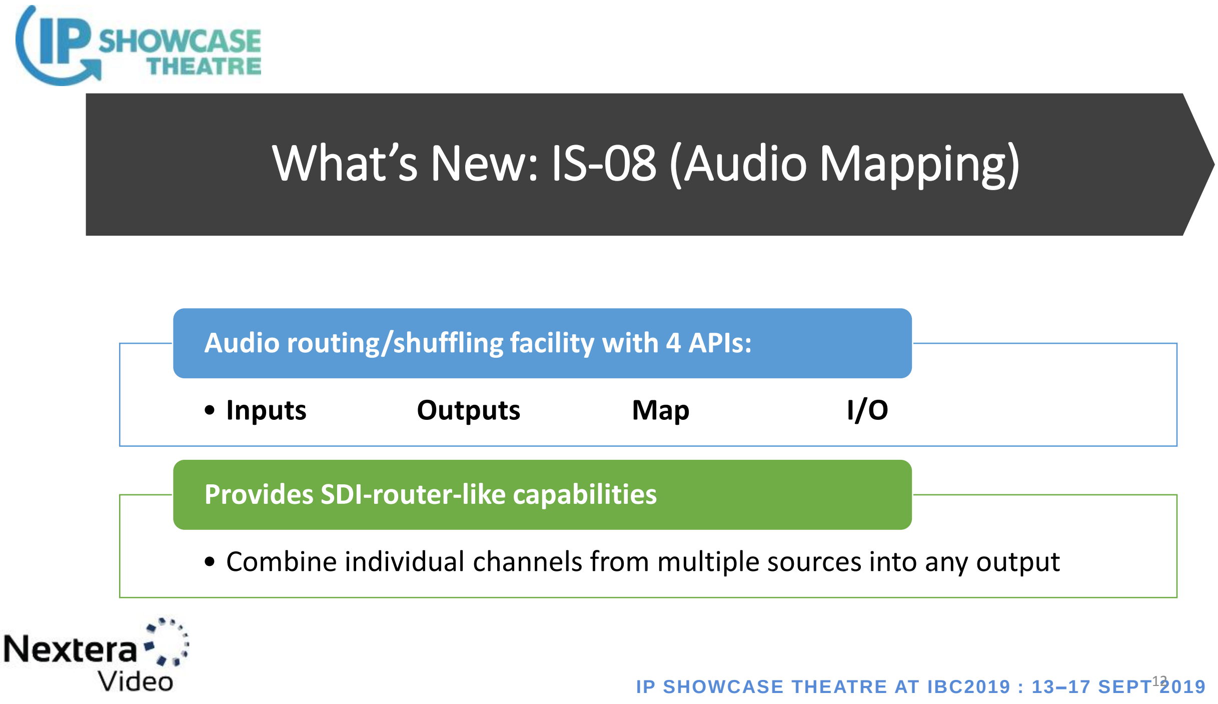

What’s New: IS-08 (Audio Mapping)

Audio routing/shuffling facility with 4 APIs:

- **Inputs** **Outputs** **Map** **I/O**

Provides SDI-router-like capabilities

- Combine individual channels from multiple sources into any output

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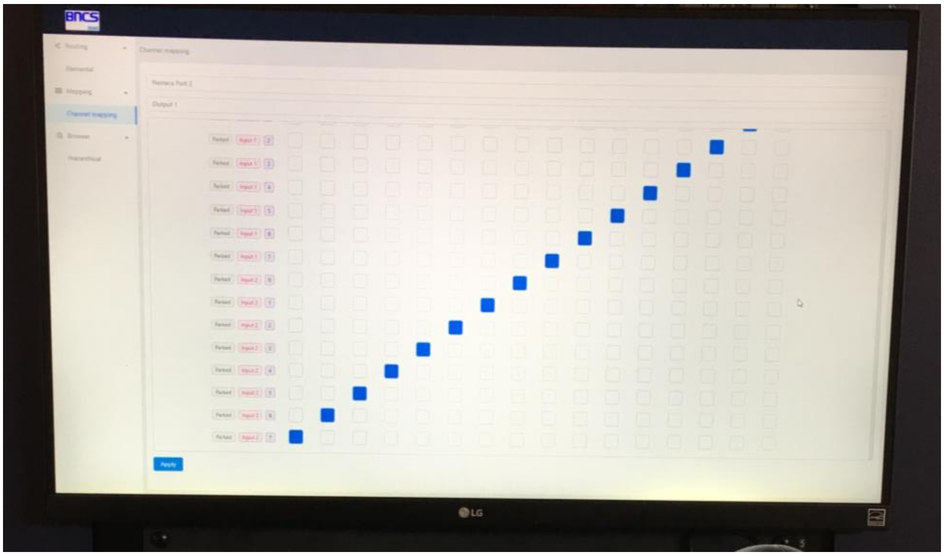
NAB IP Showcase IS-08 Audio Demo

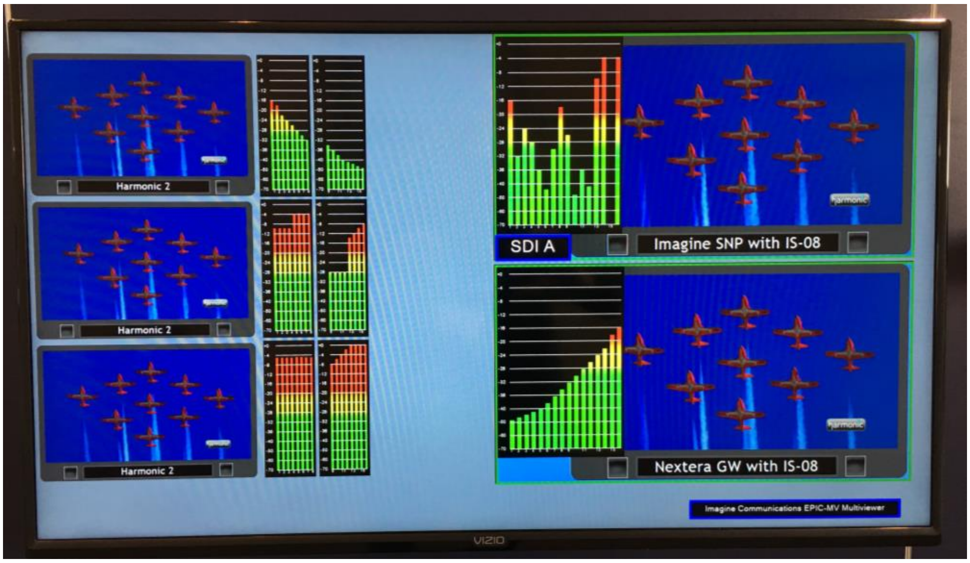
- Multi-vendor demonstration of Audio Mapping
- 3x 16-channel Senders
- 2x 16-channel Receivers

Support Audio Breakaway via an Open Protocol using AMWA NMOS IS-08 Audio Channel Mapping
IS-08 Demo Participants
Adeas
ARISTA
AtoS
Imagine
Nextera Video
RIEDEL
Tektronix

IS-08 Mapping Controls



NAB IP Showcase IS-08 Demo



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What’s New: IS-09 (System Resource)

- Provides a single API resource (via the path /global) with the following:
- “System ID”, assigned randomly at each facility
- Protocol: http or https
- Version: Indicate NMOS API versions supported
- Server Priority: Helps with Bonjour/Avahi discovery
- Extensible for DNS-SD Advertisement of system resources such as RDS (Registration and Discovery Server)

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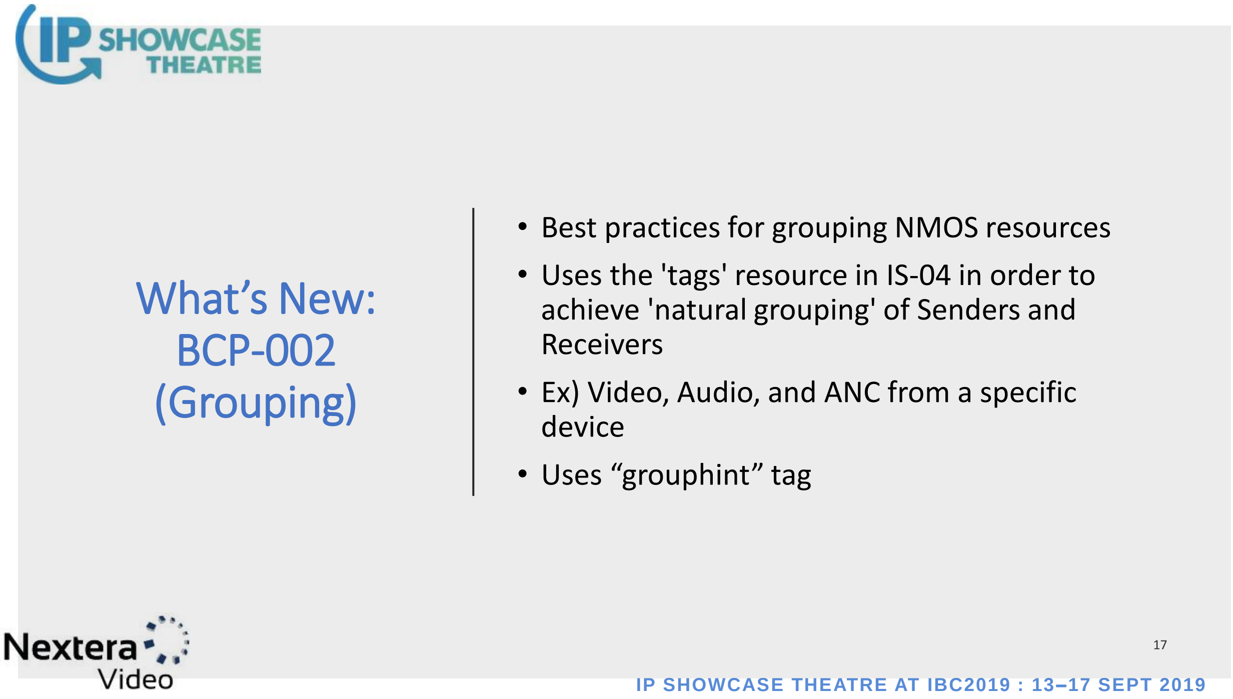

What's New: BCP-002 (Grouping)

- Best practices for grouping NMOS resources
- Uses the 'tags' resource in IS-04 in order to achieve 'natural grouping' of Senders and Receivers
- Ex) Video, Audio, and ANC from a specific device
- Uses "grouphint" tag

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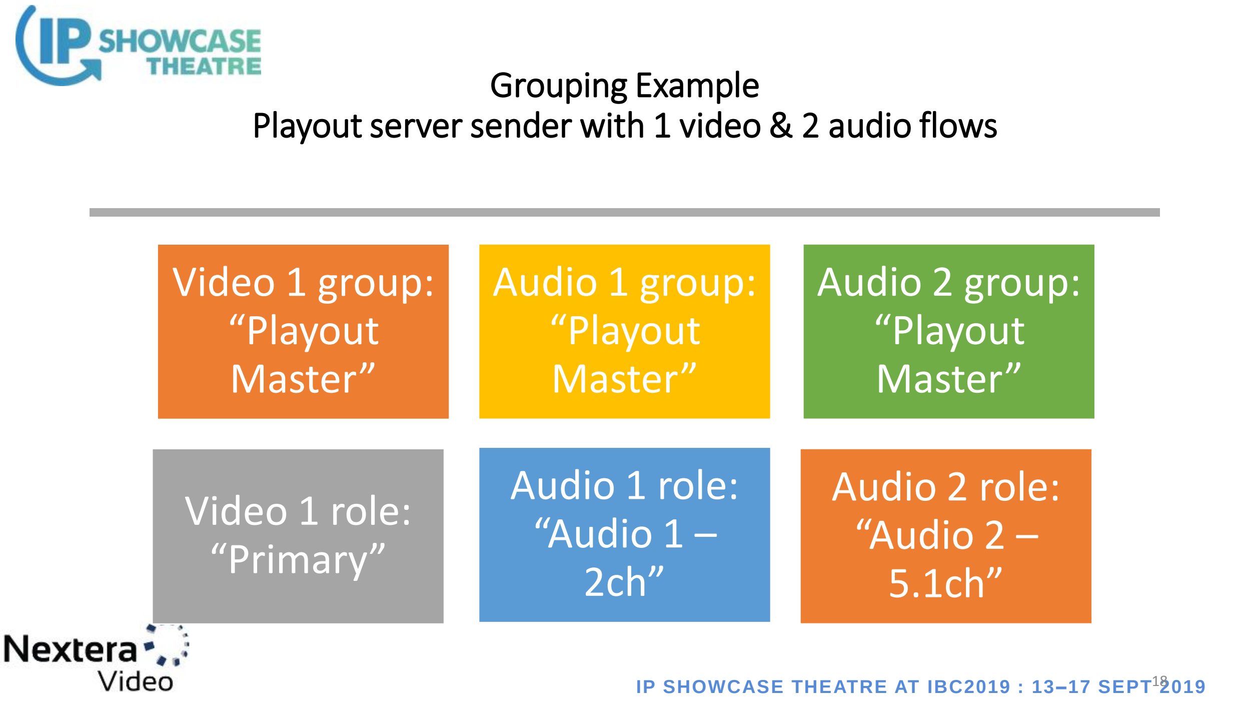

Grouping Example
Playout server sender with 1 video & 2 audio flows

Video 1 group: "Playout Master"	Audio 1 group: "Playout Master"	Audio 2 group: "Playout Master"
Video 1 role: "Primary"	Audio 1 role: "Audio 1 – 2ch"	Audio 2 role: "Audio 2 – 5.1ch"

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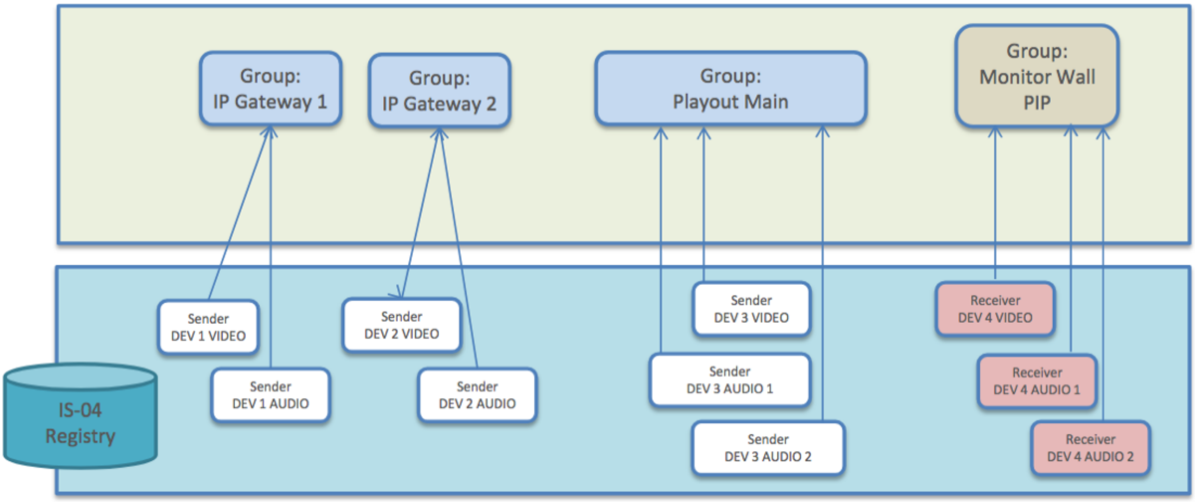
Grouping Example



Group: IP Gateway 1

Group: IP Gateway 2

Group: Playout Main

Group: Monitor Wall PIP

Sender DEV 1 VIDEO

Sender DEV 1 AUDIO

Sender DEV 2 VIDEO

Sender DEV 2 AUDIO

Sender DEV 3 VIDEO

Sender DEV 3 AUDIO 1

Sender DEV 3 AUDIO 2

Receiver DEV 4 VIDEO

Receiver DEV 4 AUDIO 1

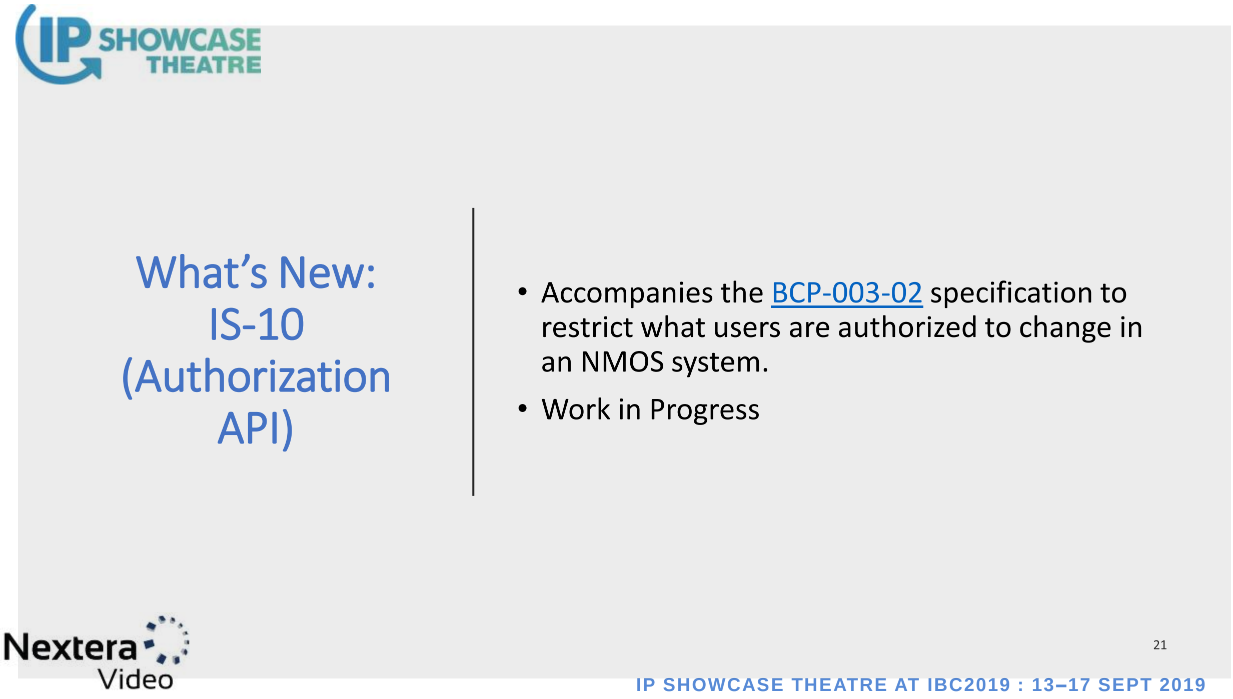
Receiver DEV 4 AUDIO 2

IS-04 Registry

What's New: BCP-003 (Security)

BCP-003-01 — Uses Transport Layer Security (TLS) in order to encrypt communications between API servers and their clients (https)

BCP-003-02 — (Work In Progress) covers client authorization for the NMOS APIs.



What's New: IS-10 (Authorization API)

- Accompanies the BCP-003-02 specification to restrict what users are authorized to change in an NMOS system.
- Work in Progress

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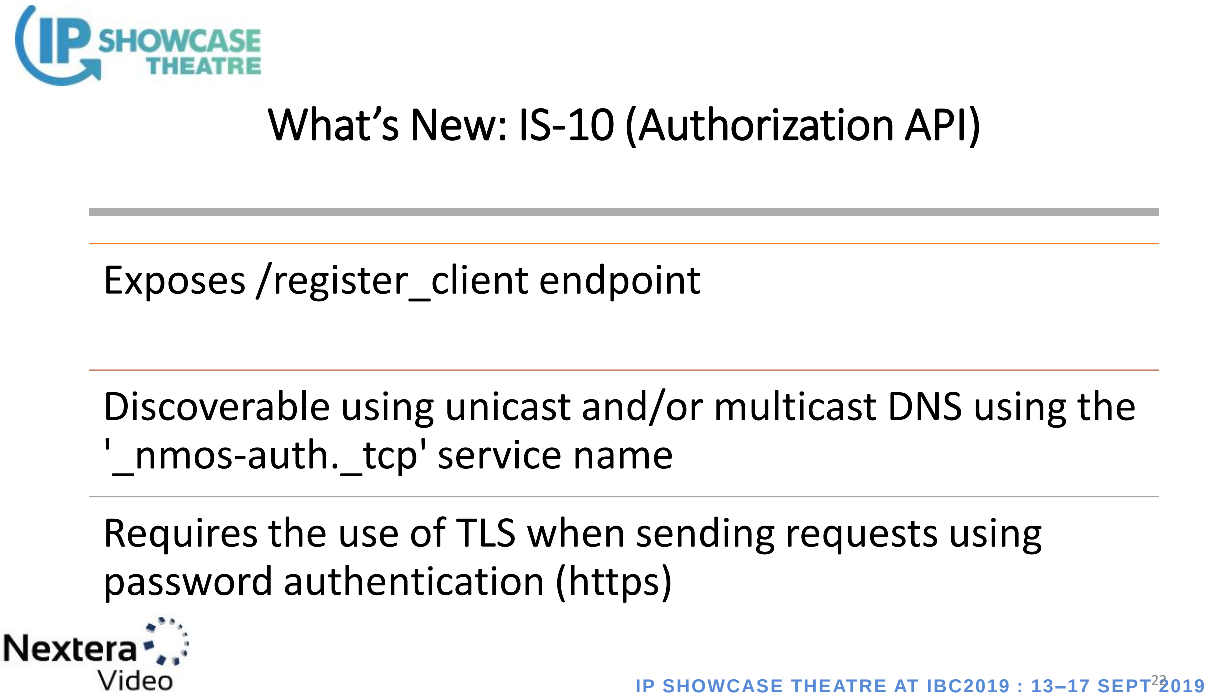

What's New: IS-10 (Authorization API)

Exposes /register_client endpoint

Discoverable using unicast and/or multicast DNS using the '_nmos-auth._tcp' service name

Requires the use of TLS when sending requests using password authentication (https)

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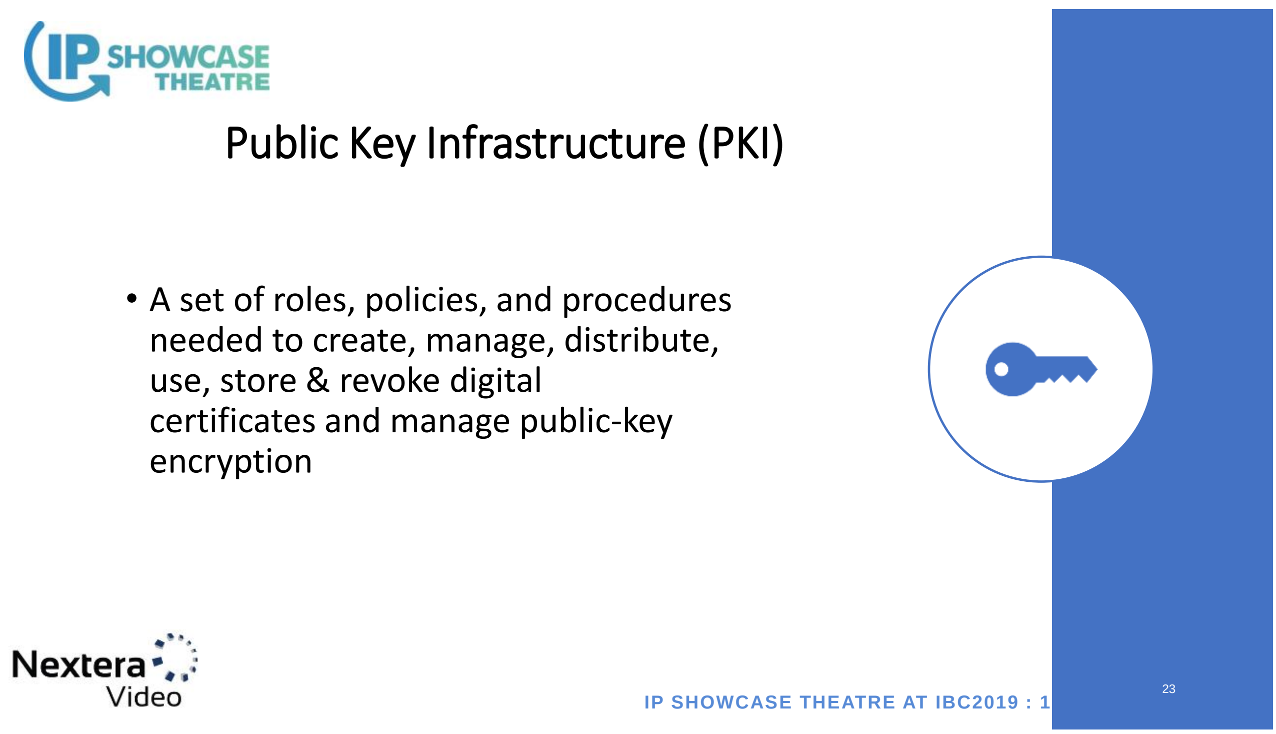

Public Key Infrastructure (PKI)

- A set of roles, policies, and procedures needed to create, manage, distribute, use, store & revoke digital certificates and manage public-key encryption

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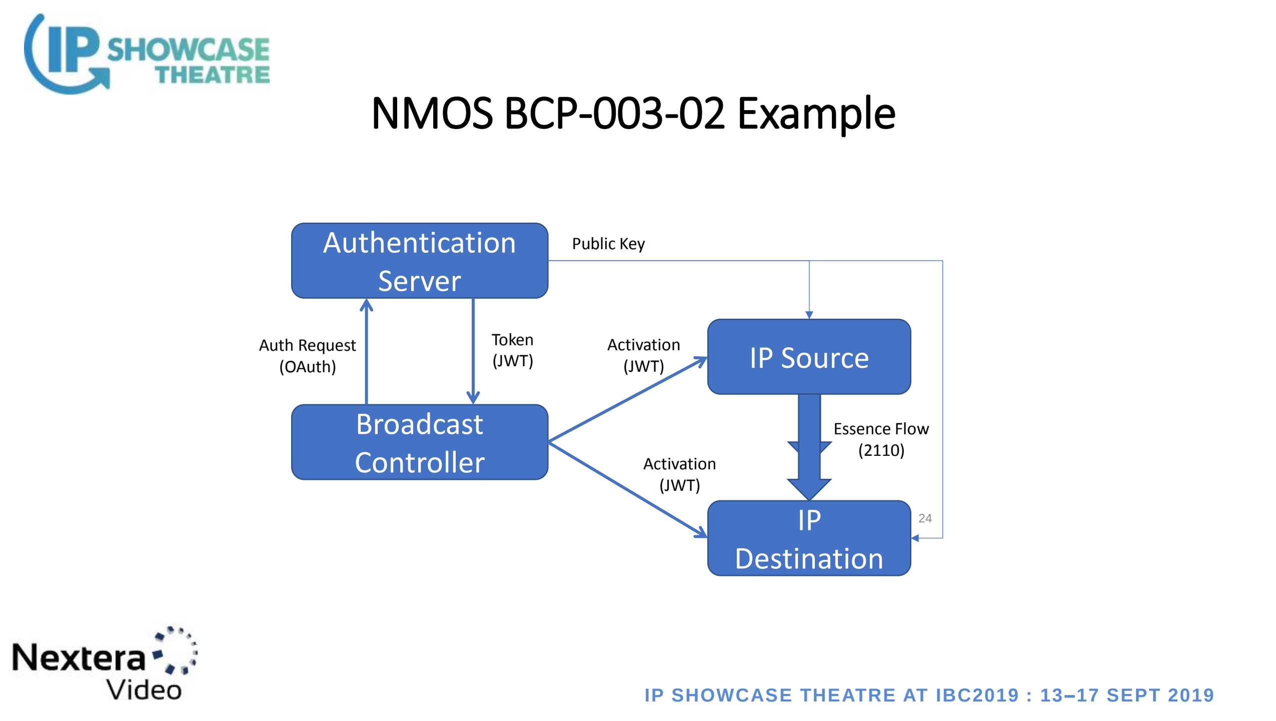

NMOS BCP-003-02 Example

Authentication Server

Public Key

Auth Request (OAuth)

Token (JWT)

Activation (JWT)

IP Source

Broadcast Controller

Essence Flow (2110)

Activation (JWT)

IP Destination

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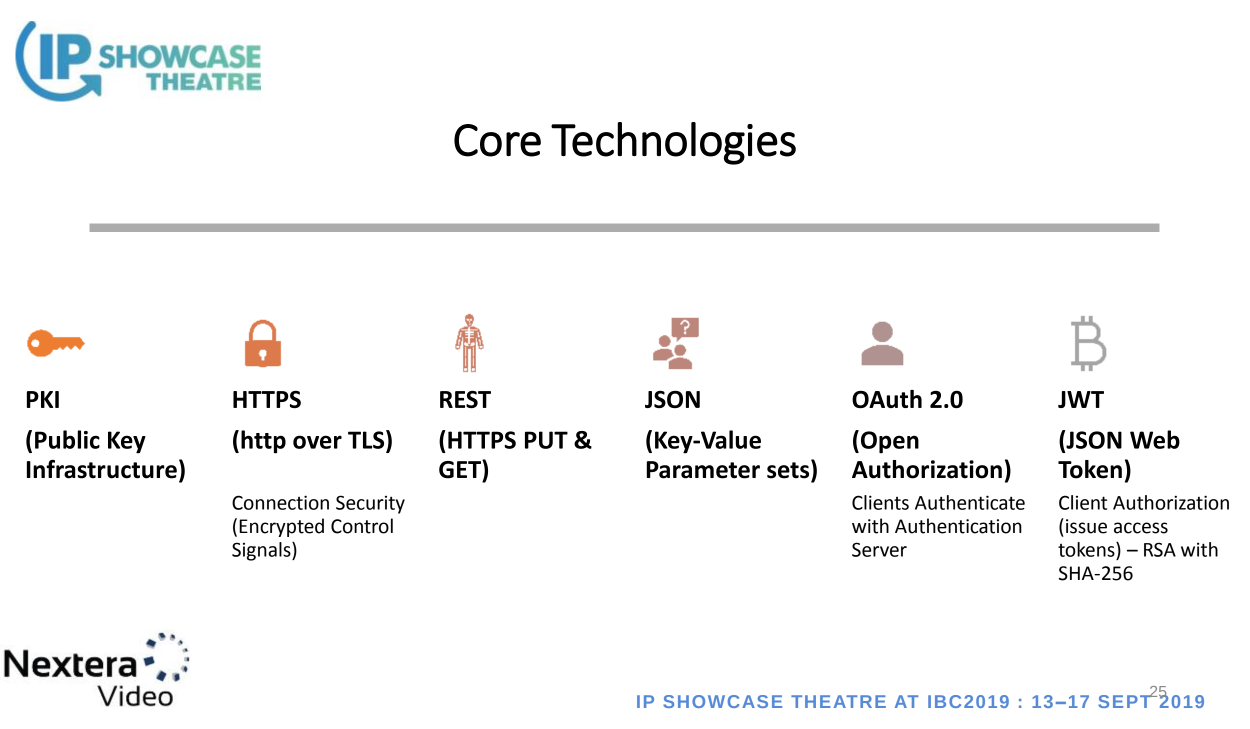

Core Technologies

PKI

(Public Key Infrastructure)

HTTPS

(http over TLS)

Connection Security (Encrypted Control Signals)

REST

(HTTPS PUT & GET)

JSON

(Key-Value Parameter sets)

OAuth 2.0

(Open Authorization)

Clients Authenticate with Authentication Server

JWT

(JSON Web Token)

Client Authorization (issue access tokens) – RSA with SHA-256

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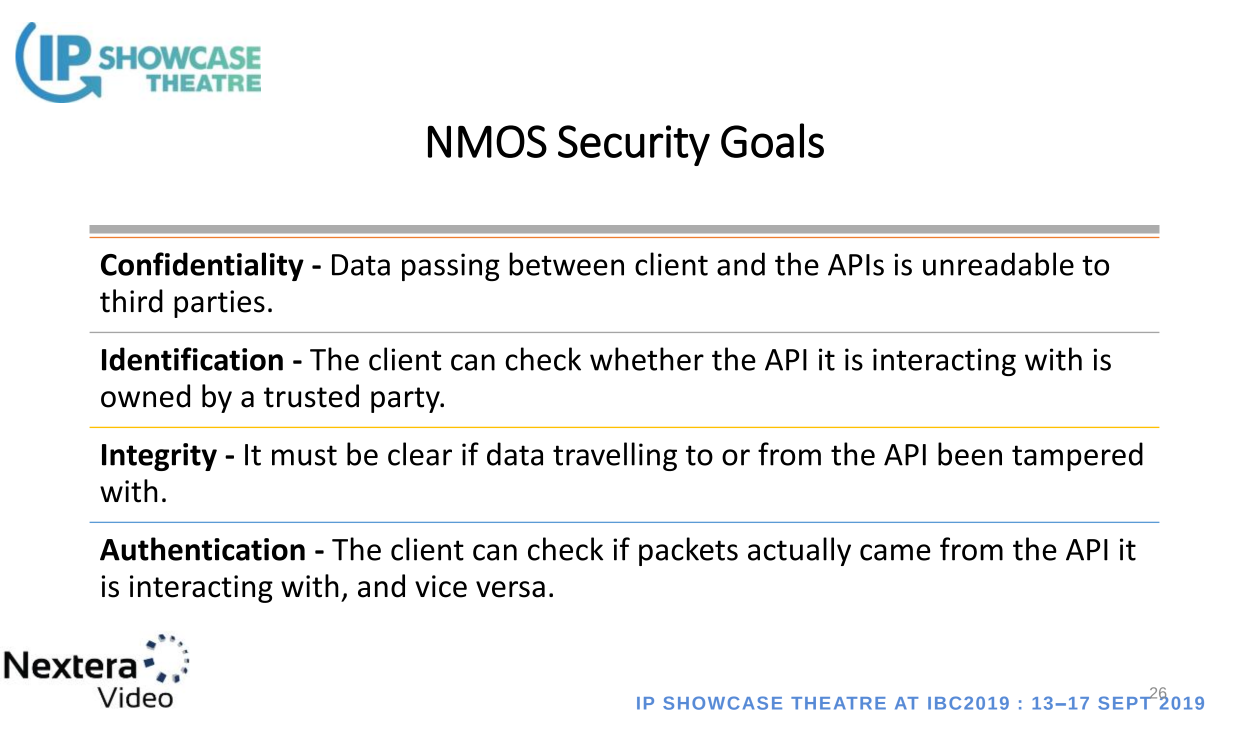

NMOS Security Goals

Confidentiality - Data passing between client and the APIs is unreadable to third parties.

Identification - The client can check whether the API it is interacting with is owned by a trusted party.

Integrity - It must be clear if data travelling to or from the API been tampered with.

Authentication - The client can check if packets actually came from the API it is interacting with, and vice versa.

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NMOS Cipher Suite

- TLS ECDHE ECDSA WITH AES 128 GCM SHA256
- TLS ECDHE ECDSA WITH AES 256 GCM SHA384
- TLS ECDHE ECDSA WITH AES 128 CBC SHA256
- TLS ECDHE ECDSA WITH AES 256 CBC SHA384
- TLS ECDHE RSA WITH AES 128 GCM SHA256
- TLS ECDHE RSA WITH AES 256 GCM SHA384
- TLS DHE RSA WITH AES 128 GCM SHA256
- TLS DHE RSA WITH AES 256 GCM SHA384
- TLS ECDHE RSA WITH AES 128 CBC SHA256
- TLS ECDHE RSA WITH AES 256 CBC SHA384
- TLS DHE RSA WITH AES 128 CBC SHA256
- TLS DHE RSA WITH AES 256 CBC SHA256
- TLS ECDHE ECDSA WITH AES 128 CCM 8 🡐======= **Minimum Requirement**

Johnny Quest Decoder Ring:

TLS	= Transport Layer Security
ECDHE	= Elliptic Curve Diffie-Hellman Ephemeral KE
ECDSA	= Elliptic Curve Digital Signature Algorithm
AES	= Advanced Encryption Standard (#bits)
GCM	= Galois/Counter Mode
CBC	= Cipher Block Chaining (XOR)
SHA	= Secure Hash Algorithm (#bits)
CCM	= Counter with CBC-MAC (Cyber Block Chaining Message Authentication Code)

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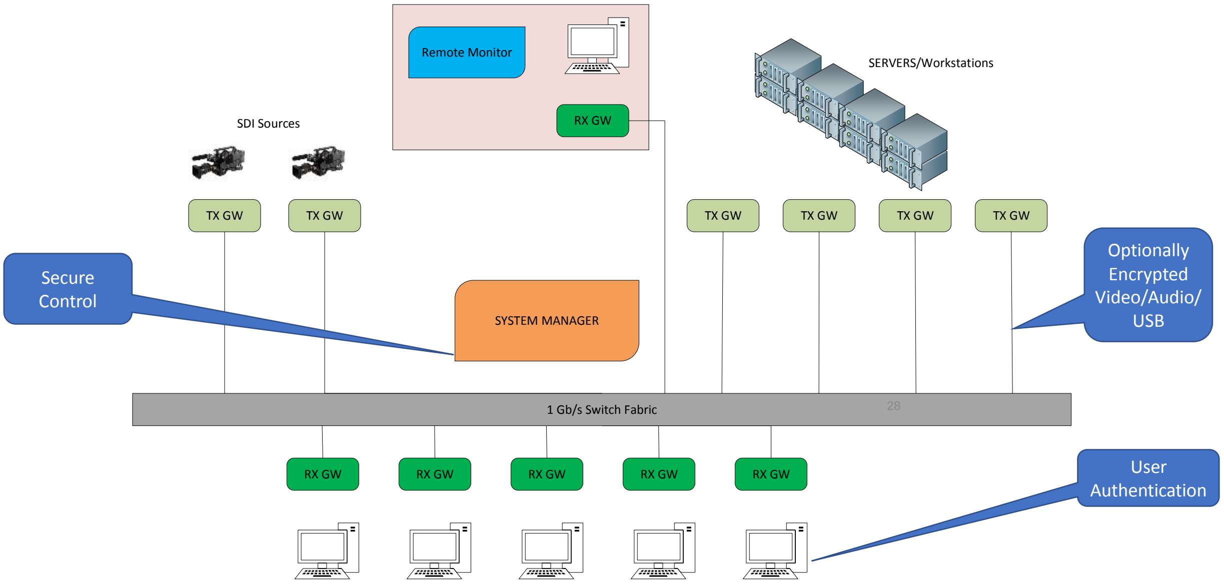
Customer Case Study – Secure KVM



Summary

- NMOS IS-04 & IS-05 are solid, stable, and mature
- They are employed in most all new SMTE 2110 products
- New features like IS-08 (Audio Mapping), IS-09 (System Discovery), and BCP-002 (Grouping) take NMOS to a new level, surpassing the level of control provided in SDI
- BCP-003 (Security) adds a layer of security that has been sorely needed in control systems for quite some time
- NMOS is the glue that holds an ST-2110 environment together and enables extraction of new business value

Thank you

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