Radio Air-Chain INNOVATION

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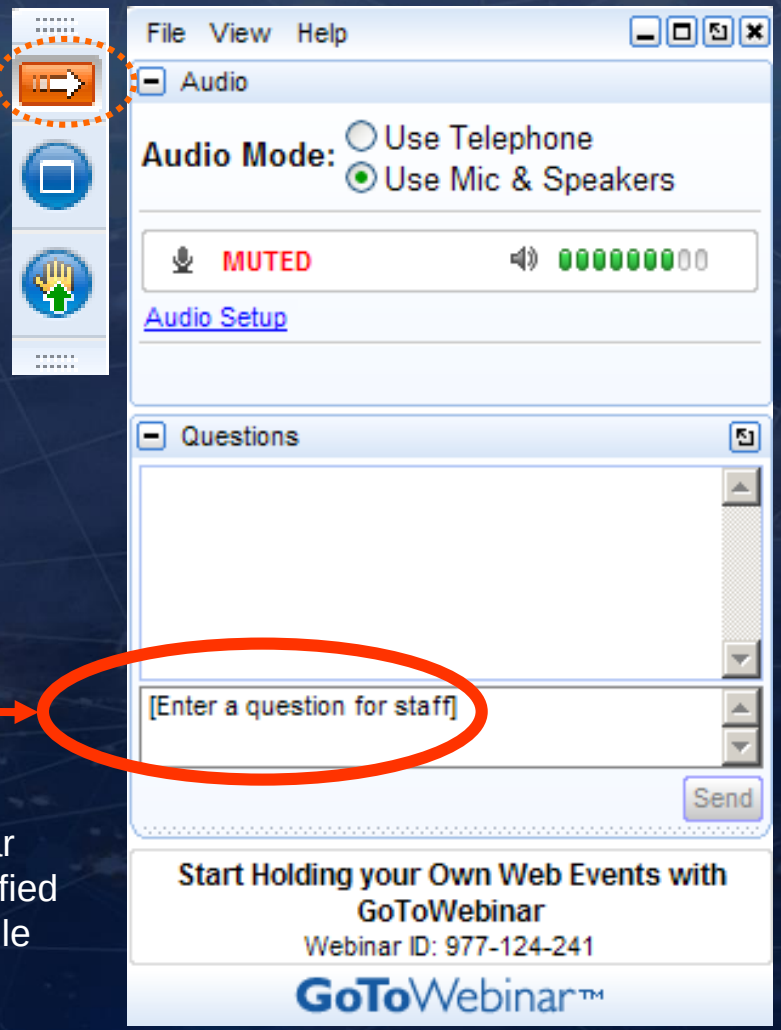
Webinar 1 of 3

August 13, 2020

Your questions please?

(if you don't see the control panel, click on the orange arrow icon to expand it)

Please enter your questions in the text box of the webinar control panel (remember to press send)



Remember: The completion of a Nautel webinar qualifies for ½ SBE re-certification credit, identified under Category I of the Re-certification Schedule for SBE Certifications.

Host Jeff Welton
Sales Manager, Central USA

Panelist Frank Foti
Executive Chairman and
Founder of Omnia

Panelist Geoff Steadman
Omnia Product Manager

Panelist Philipp Schmid
Nautel Chief Technology Officer

Panelist John Whyte
Nautel Head of Marketing

Radio Air-Chain
INNOVATION

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Today's topics

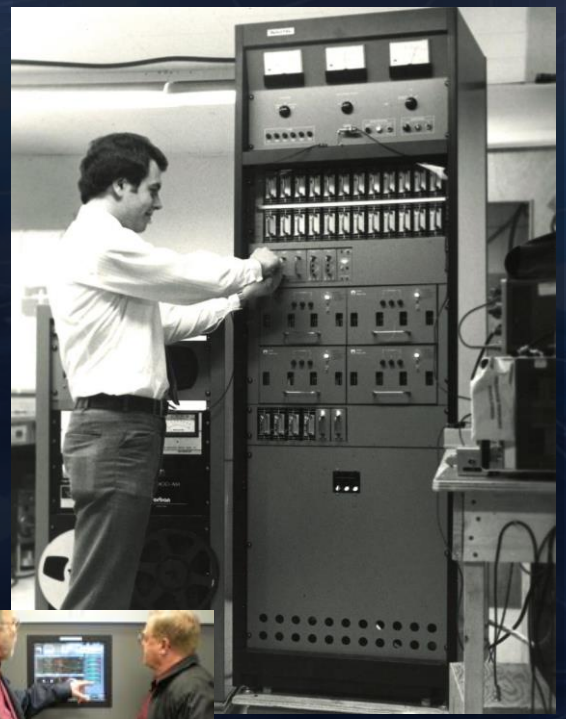
- What is the collaboration and why?
- Radio Air-Chain challenges
- Technologies that can help
- "Made for Radio" standards
- Examples of fresh approaches

So why this current collaboration and why now?

- Two companies passionate about innovation
- Industry, technology changing
- Broadcasters facing challenges
- There is a great opportunity for fresh approaches

Five decades of Nautel innovation

- 1st commercially successful Solid-State Radio Transmitter
- More recent innovations:
  - NV Series: 1st affordable high-power solid-state FM transmitters
  - Advanced User Interface(AUI) for control/instrumentation/access
  - HD Radio innovations
    - HD PowerBoost
    - Spectrum Efficiency Optimizer
    - Reliable HD Transport
    - 1st HD Radio SFN
    - HD Multiplex: All Digital FM HD Radio
    - All Digital AM



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Telos Alliance Innovation

Digital Signal Processing

- World's first DSP adaptive telephone hybrid for radio broadcast
- First to license MP3 in the United States, used in the Telos Zephyr for ISDN
- First all-digital DSP FM Stereo generator
- First all-digital FM audio processor, and first MPX on AES3

AoIP

- First AoIP console using standard IT-based technologies
- First fully AoIP broadcast intercom
- Livewire®, first fully broadcast-capable AoIP system (audio, control, and advertising)

Innovative Solutions for Broadcasters

- Linear Acoustic addresses Calm Act using DSP processing
- Solutions for file-based processing with Minnetonka Audio
- Voltair challenged the status quo in the radio ratings watermarking game

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Nautel/Telos Alliance Collaboration Legacy

- 2010 VS first transmitter with Livewire audio over IP input
- 2012 “Omnia Direct” First MPX over AES
- 2016 uMPX demonstration
  - Moseley
  - Telos
  - Nautel

µMPX™

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Radio’s 1st Composite FM Codec

High quality MPX over a 320kbps IP connection

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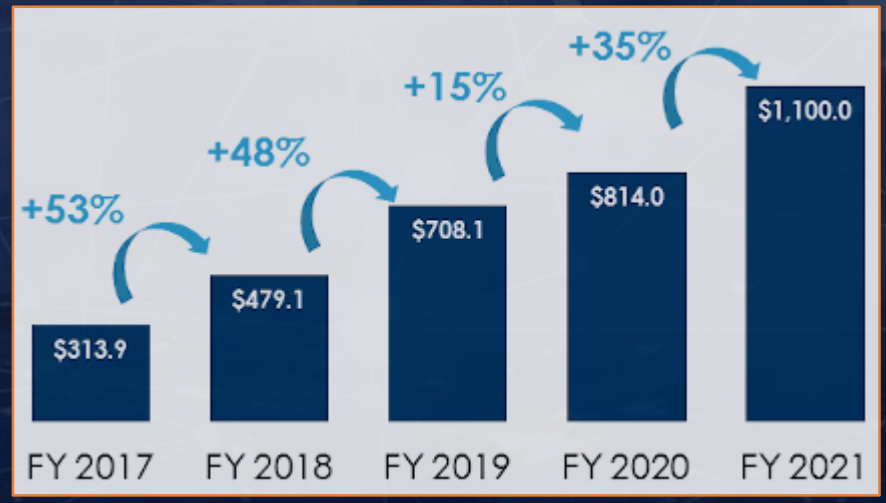
Technological, Competitive and Regulatory Change

- COVID forced extreme and urgent change
  - Remote becomes normal
  - Portions of the air-chain are virtualized
- Main studio rule removed
- Competing for the listener's ear
  - Fragmenting listener base
  - Battle for the car dashboard
  - Podcasts becoming a factor
- Managing technological complexity

Podcasts to break $1B in 2021



Source: Interactive Advertising Bureau and PricewaterhouseCoopers.

Digital Radio matters more now

- 65 Million HD Radio cars
- Opportunities:
  - Podcasts/Streams On-Air
  - Ethnic broadcasting
  - Leased channels
  - Sports coverage
- Over 2300 HD Radio stations
  - but 13,000 Analog only
- Challenging for many:
  - Too complex? Too expensive? ROI?

So why this current collaboration and why now?

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- Passion
- Innovation

- Technology
- Industry
- Regulation

- New approaches
- New technologies
- Hide complexity
- Drive out costs

Cheaper, Easier, More Flexible Air-Chain Solutions

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Radio Air-Chain Challenges

Typical FM Radio Air-Chain

Has become increasingly complex over time
Multiple purpose-built boxes to be configured/managed
Studio better location for complexity, but…

- Audio processor at studio or transmitter
- FM STL: licensed RF, unlicensed RF, T1 telco, IP based
  - Analog L/R audio or stereo composite
  - Digital L/R audio or IP codecs

Typical FM Radio Air-Chain

… but where does the equipment go if the local studio goes away?

HD Radio adds even more complexity and cost

Initially Importer and Exporter at studio to minimize HD STL bandwidth
Often a 2nd STL and even a 2nd transmitter required

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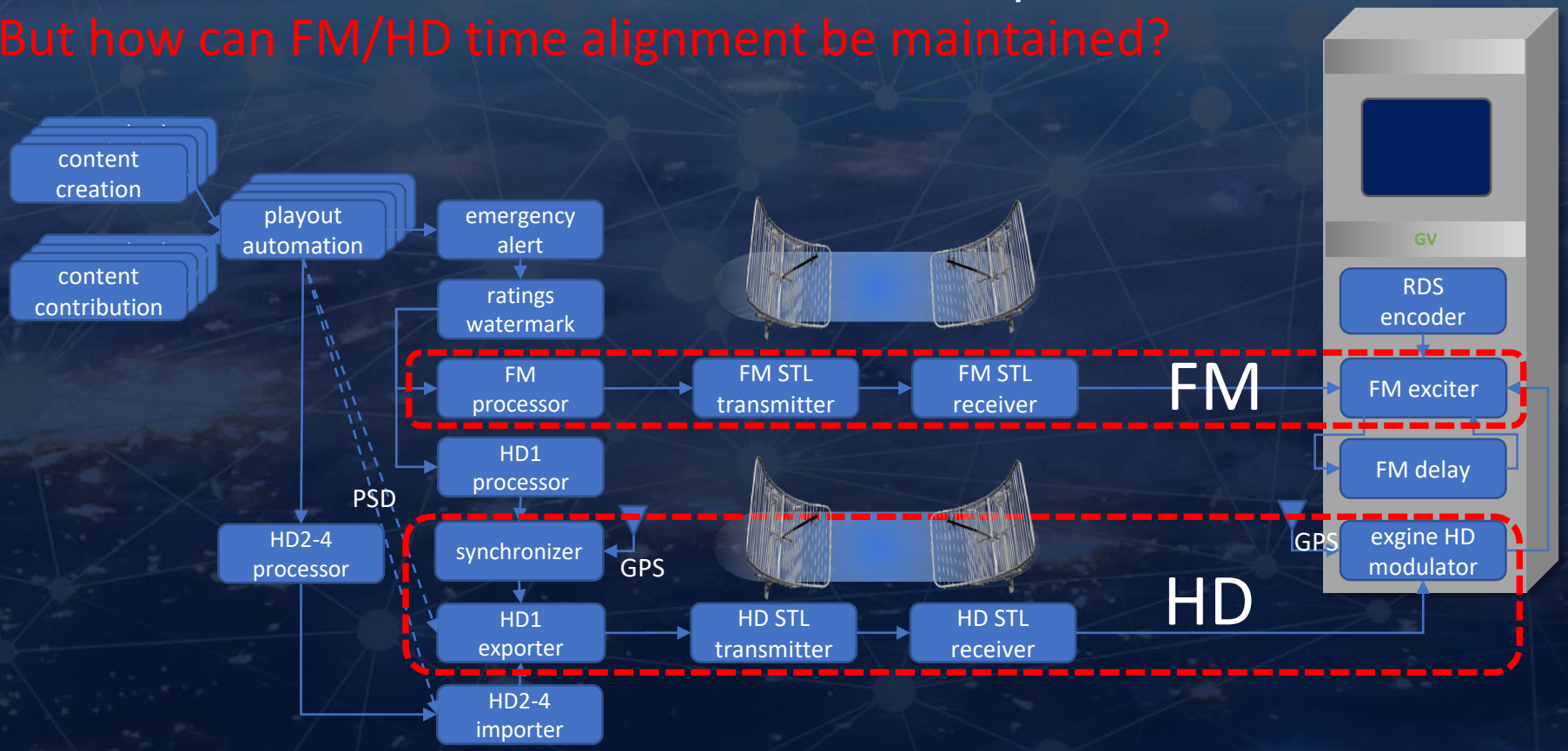
HD Radio adds even more complexity and cost

Initially Importer and Exporter at studio to minimize HD STL bandwidth

Often a 2nd STL and even a 2nd transmitter required

But how can FM/HD time alignment be maintained?



FM and HD audio must be within **3 audio samples**

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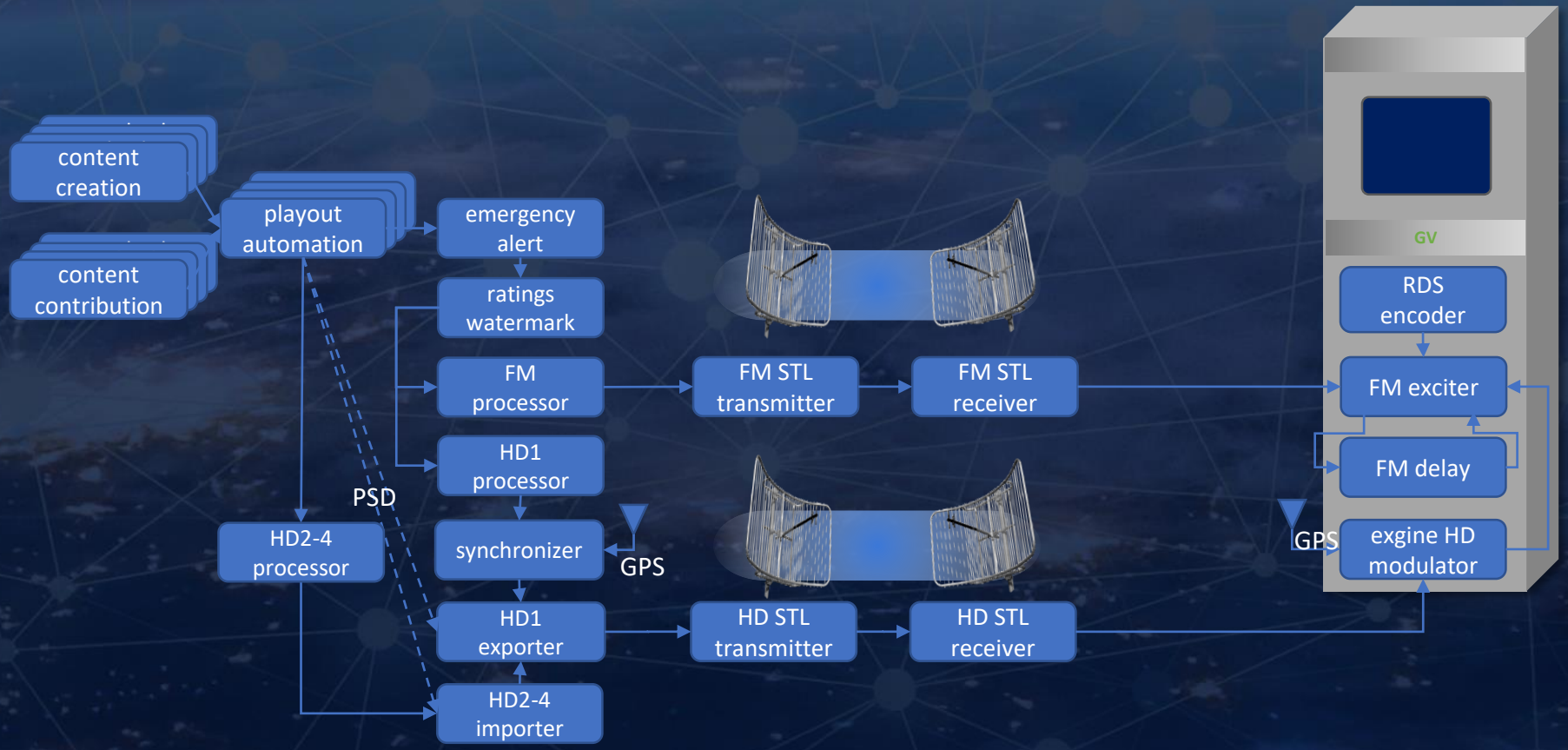
Approaches for Optimizing FM/HD Blend Experience

All HD equipment AND audio processor is suggested to be at the transmitter site*



*NRSC-G203 NRSC IBOC Time and Level Alignment Guideline

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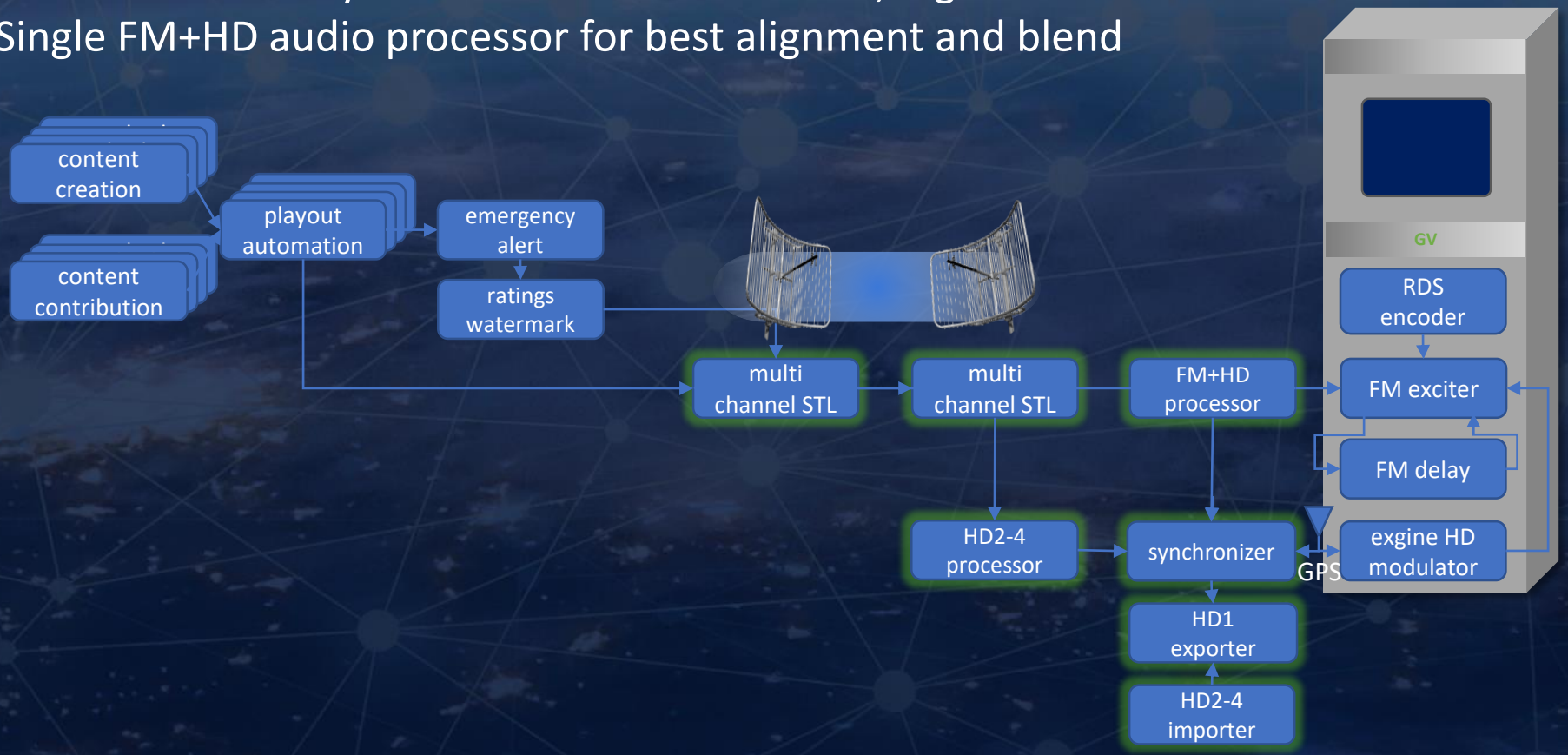
Approaches for Optimizing FM/HD Blend Experience

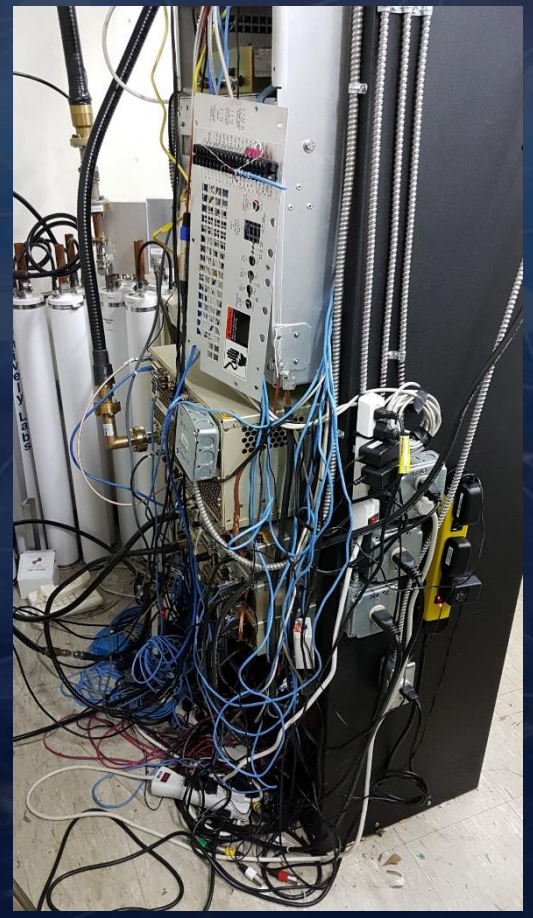
All HD equipment AND audio processor is suggested to be at the transmitter site*
STL must now carry all HD1-HD4 audio streams, high bandwidth
Single FM+HD audio processor for best alignment and blend



*NRSC-G203 NRSC IBOC Time and Level Alignment Guideline

Radio Air-Chain Challenges Summary

- Analog Air-Chain is complex, many purpose-built boxes
- HD Radio adds even more complexity
  - HD is often bolted on to existing sites
  - HD diversity delay
  - Complexity is located at the remote Tx site
  - Not easily scalable for fleet upgrades and maintenance of HD Radio
- High investment for HD conversion
  - Additional content creation for HD2,HD3,HD4
  - HD transmitter, importer, exporter, additional audio processing
  - STL requirements: changing FM air-chain to fit HD
    - Main channel audio + Secondary audio + Data services
- Industry is looking for solutions to simplify the radio air-chain



What technologies can help the FM Radio Air-Chain?

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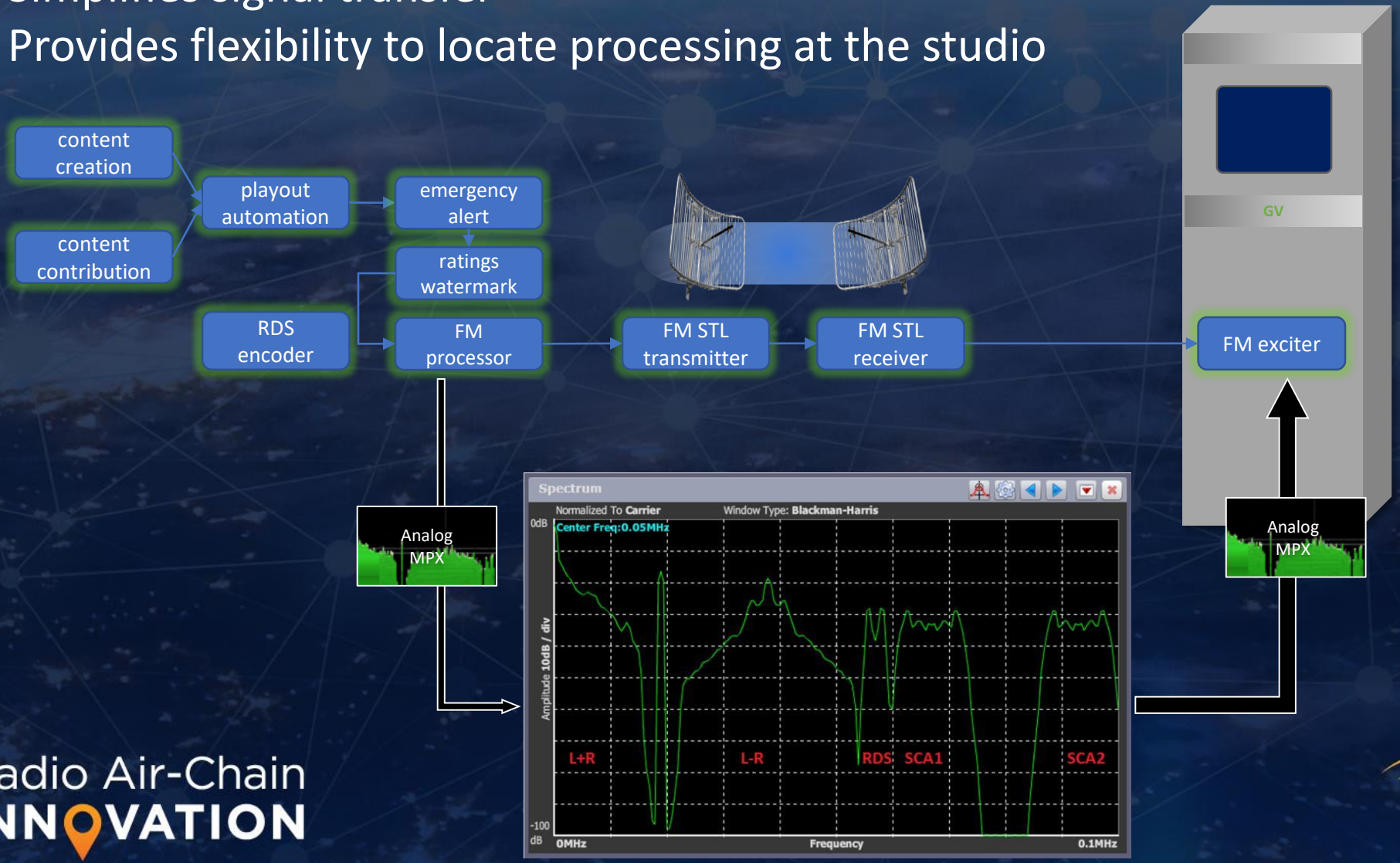
Made for Radio: MPX over IP

Composite signal carries all FM signal components
Simplifies signal transfer
Provides flexibility to locate processing at the studio



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Analog versus Digital MPX across the STL

- Analog STL interference impacts audio quality

Analog MPX STL

- Loudest & cleanest audio
- No noise with digital MPX

Digital MPX STL

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Omnia MPX Node (µMPX) Studio Transmitter Link

FM Processor
w/ Stereo Generator

Analog
MPX

µMPX Encode to IP

Private IP Link
Public Internet
WAN, etc.

Analog
MPX

IP Decode to MPX

- Modest bandwidth required:
  Under 400 kbps
- No FCC license for this STL
- May be used as Main or Backup
- Cleaner than an analog STL system
- Transports RDS / RBDS data
- No modulation-robbing overshoots
- No psychoacoustic encoding artifacts

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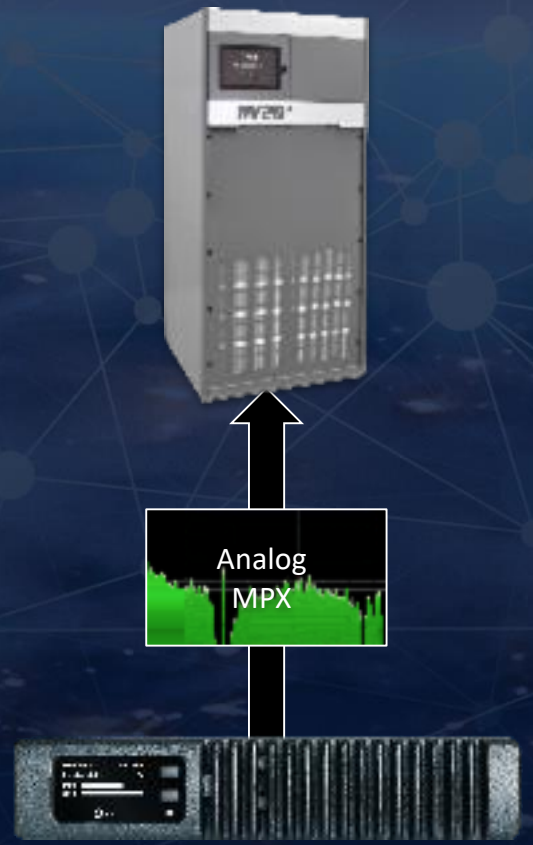
Telos Omnia.9 with µMPX Encoding

Omnia.9 MKII
FM Processor
With µMPX Option

Private IP Link
Public Internet
WAN, etc.



IP Decode to MPX

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Omnia.9 I/O

L/R Input types

- Analog
- AES Digital
- Livewire+ AES67

Omnia.9 MKII
FM Processor

Processed Output Types

- L/R
  - Analog
  - AES
  - Livewire +AES67
- Composite
  - Analog MPX
  - AES MPX
  - MPX over IP
  - µMPX

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Omnia.9 I/O

Broadcast industry has moved towards IP based I/O for all Air-Chain components

L/R Input types

- Livewire+ AES67

Omnia.9 MKII
FM Processor

Processed Output Types

- Livewire +AES67
- Composite
  - MPX over IP
  - µMPX

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New! Omnia Enterprise 9s (a virtualized Omnia.9)

Broadcast industry can now move to virtualized software Air-Chain components
https://www.telosalliance.com/Omnia/Omnia-Enterprise-9s

L/R Input types

- Livewire+ AES67

Omnia Enterprise 9s
FM / HD Processor

Processed Output Types

- Livewire +AES67
- Composite
  - MPX over IP
  - µMPX

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Benefits of Virtualized Omnia Processing

- Enabled by standards based IP audio
- Leverages scalable IP Infrastructures
- Ability to run multiple instances on a single server
- Ability to host the server on premises or in the cloud
- Facilitates resiliency/failover
- Ability to integrate processing within other workflows

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What technologies can help the HD Radio Air-Chain?

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Gen4 HD Radio Architecture Improvements

Combined Importer Exporter platform
New exciter hardware platform options for manufacturers
Remote capture clients

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Made for Radio: Gen4 IBOC Architecture

Manufacturer Platform Options:

1. Fixed Purpose built Gen4 embedded systems
2. Flexible Gen4 Open OS platform
   - Allows an eco system of broadcast apps
     - Integrated audio processing
     - Integrated audio over IP
     - Integrated playout
     - Disaster recovery
3. Software only Gen4 Platform

DTS/Xperi provides standard IP building blocks for vendor interoperability

Open Operating System: Nautel HD MultiCast+

Transforms embedded purpose-built Gen4 hardware into open operating system Gen4

Flexible Gen4 Open OS approach

Allows an ecosystem of broadcast apps:

- Integrated audio processing
- Integrated audio over IP
- Integrated playout
- Disaster recovery

Facilitates virtualization

Exporter 2 Exgine Link (E2X)

4th Generation HD Radio System Architecture

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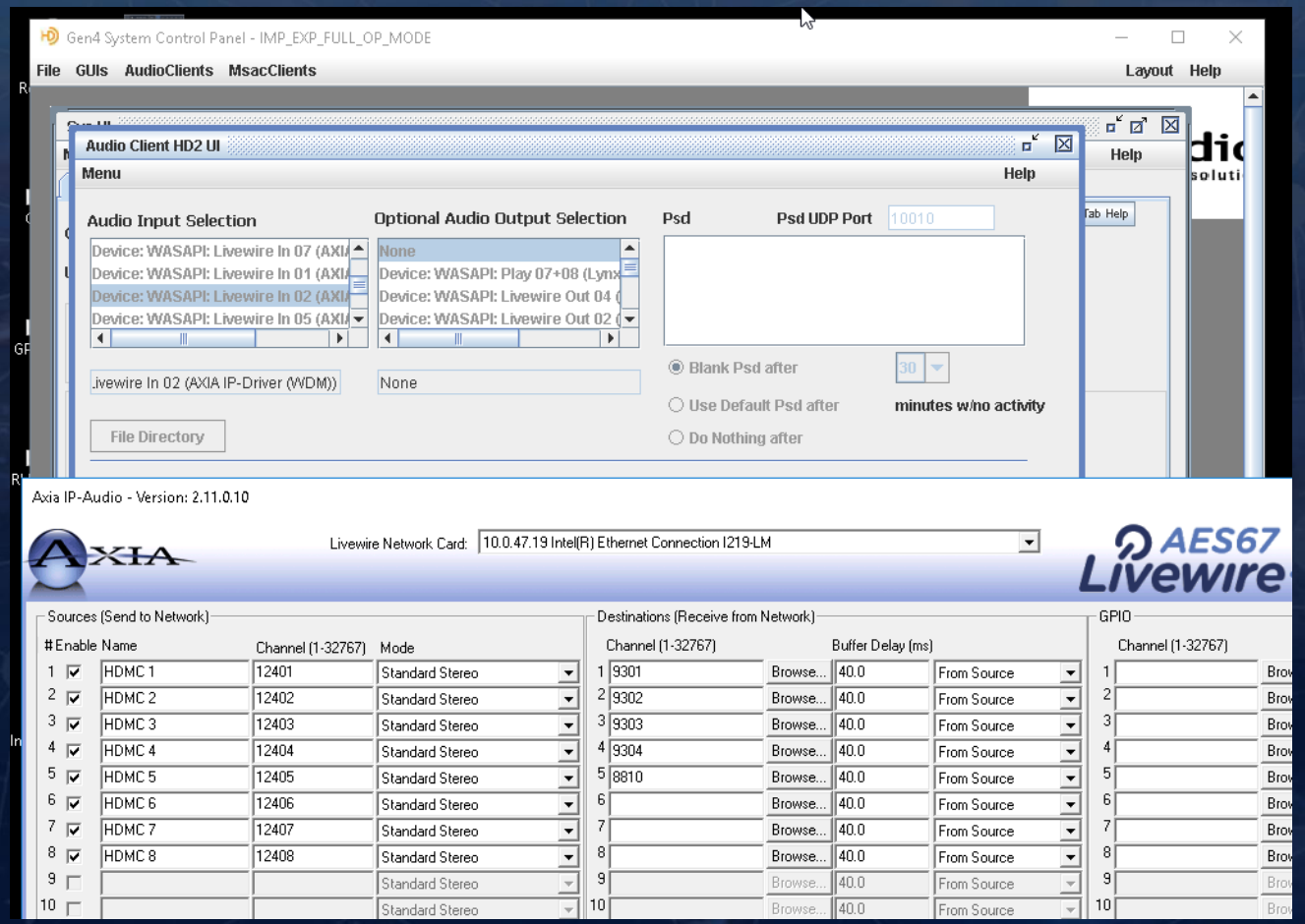
Open OS Approach: Livewire+ on HD MultiCast+

AES67 / Livewire+ driver plug & play for HD2, 3, 4
Free on HD MultiCast+ for Livewire users *



NEW

Radio Air-Chain INNOVATION

* Limited time offer, conditions apply, contact your Nautel sales representative

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Open OS approach: Omnia Enterprise 9s for HD2-4

Omnia Enterprise 9s

- HD2-4 processing in a single instance
- Supports µMPX for translators
- GEN4 Importer/Exporter
  - interface GEN4 audio clients
- HD MultiCast+
  - Ample CPU power

More to come in the following webinars …

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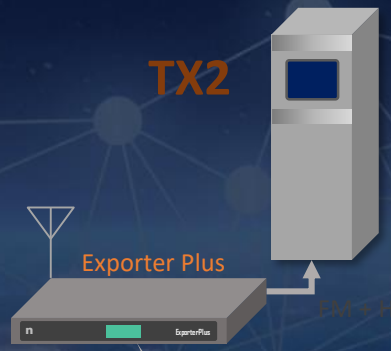
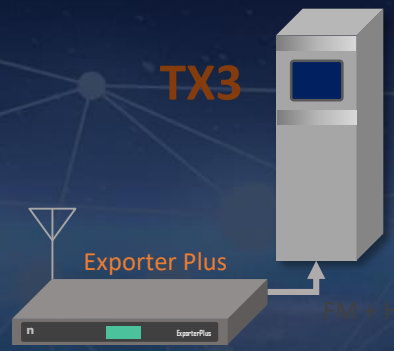
6 Virtual Importers
Single HDMC+





Audio Inputs

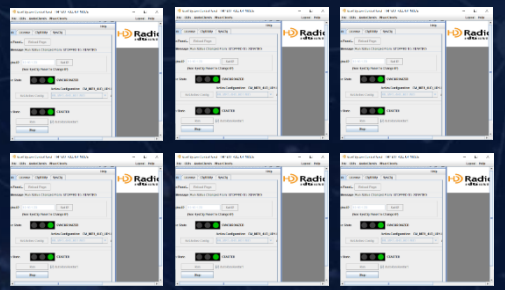
HD2

HD3

HD MultiCast+ Multi-Importer

- 6 Importer instances
- 12 audio clients
- 5 discreet sites being fed from common system + 1 test system

Public Internet with VPN to TX Sites



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Customer Story: New Hampshire Public Radio

Test transmitter at Nautel

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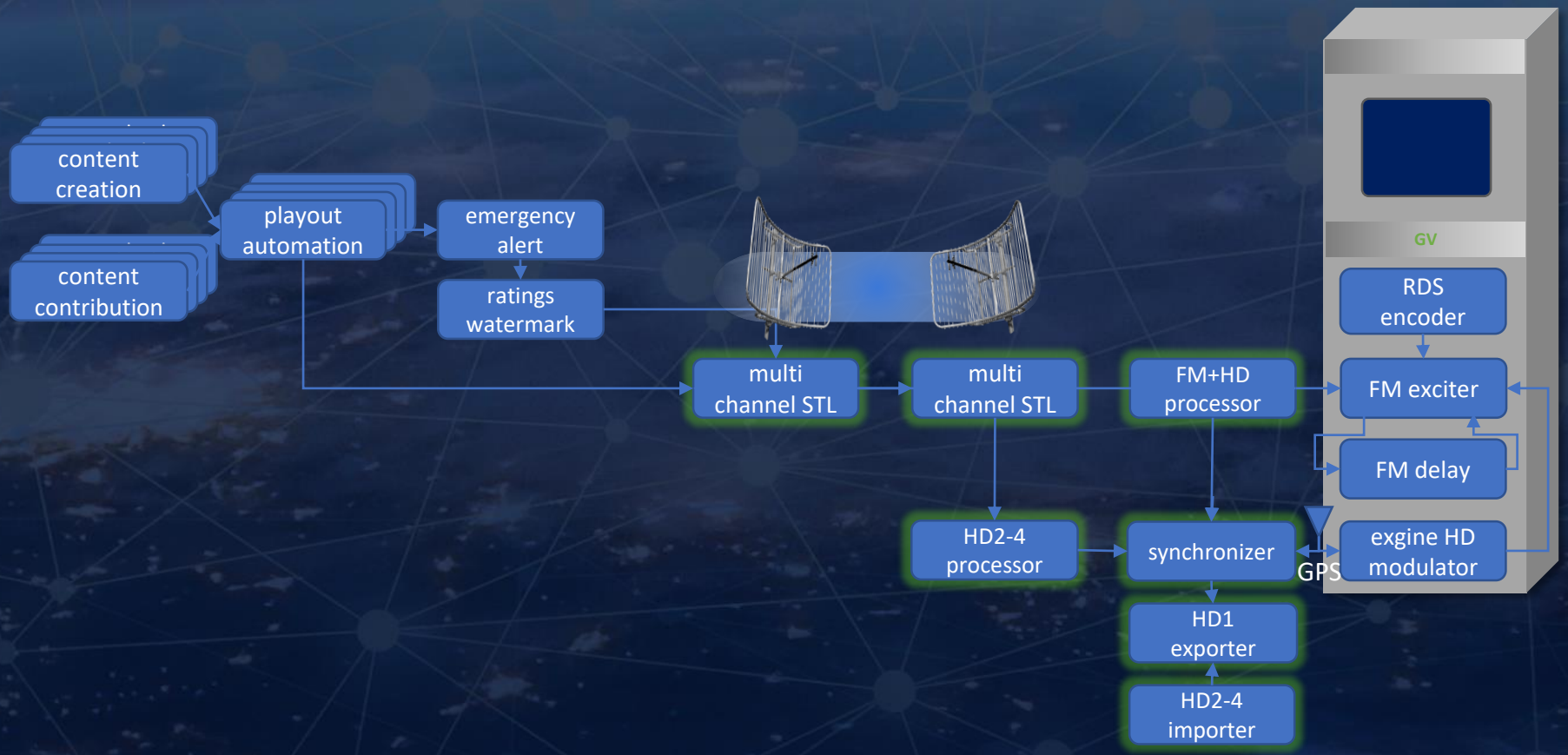
What if the HD Radio Air-Chain moved back to the studio?

Reduce TX site complexity and centralize HD Radio equipment



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What if the HD Radio Air-Chain moved back to the studio?

Reduce TX site complexity and centralize HD Radio equipment

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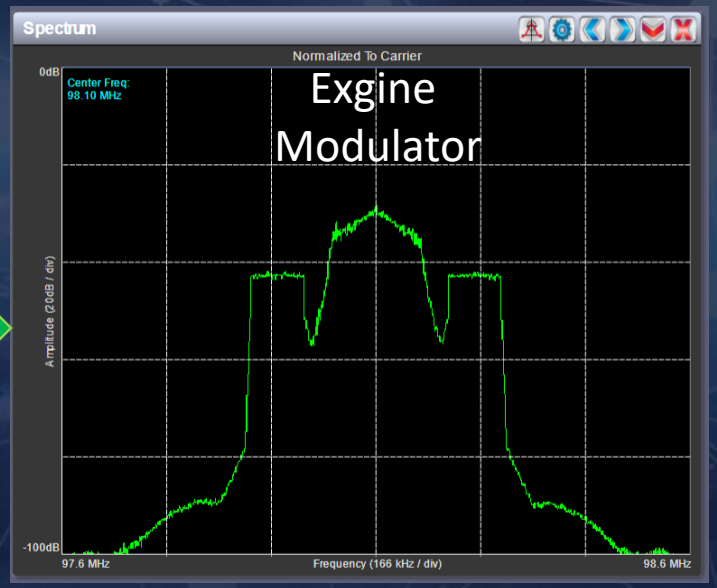
Made for Radio: Exporter 2 Exgine (E2X) link

UDP or TCP



- Connects exporter to exgine modulator over Ethernet
  - Carries HD Radio content ONLY, no FM content
  - Designed for IP STL transmission, low bandwidth
- Accepted “de-facto” industry standard
  - Not defined in NRSC specification … but everyone uses it
  - Interoperability with all major vendors
  - Backwards compatibility
  - Nautel Reliable HD Transport improves E2X transmission reliability

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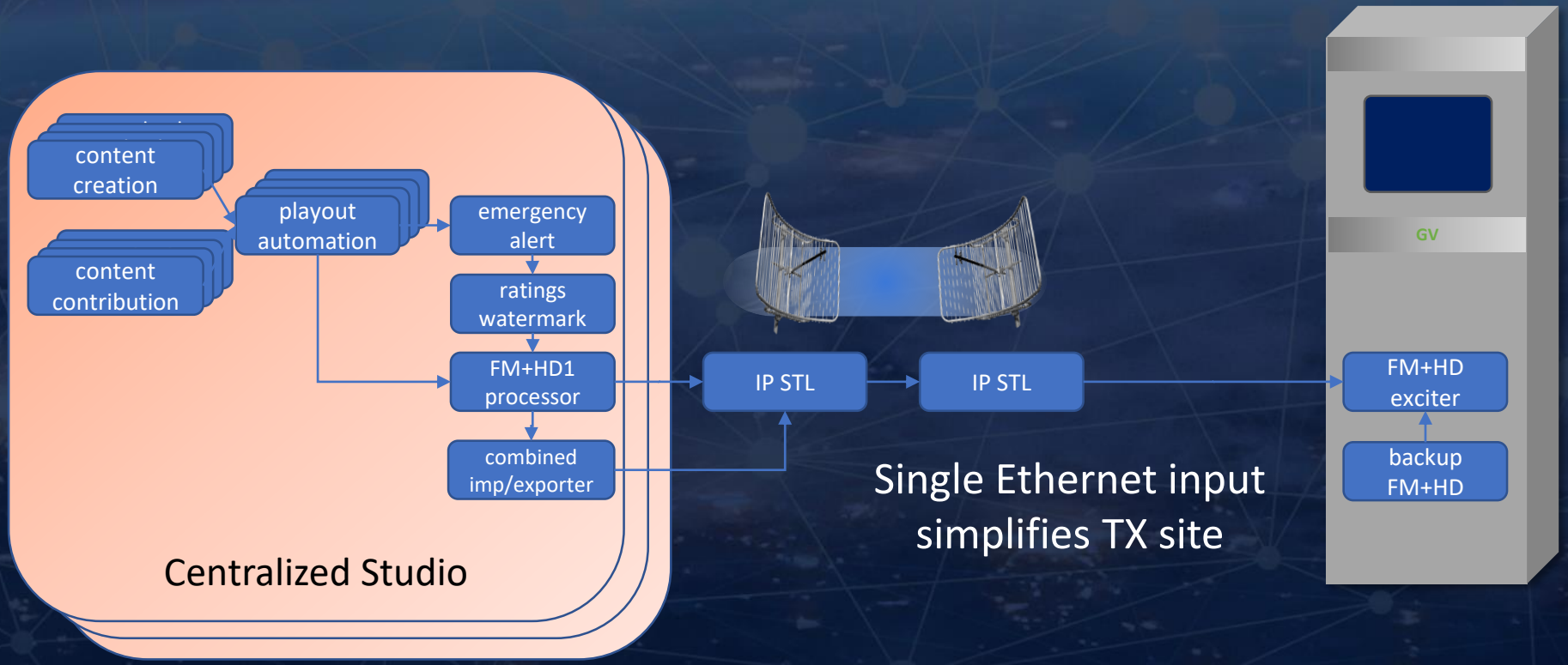
Can we Centralize the Entire Radio Air-Chain?

Can we move the FM and HD Air-Chains together?
Can we utilize "Made for Radio" standards & technologies?



Tune in to our following webinars …

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Summary: Setting the stage for change

- A collaboration by two innovators
  - We believe there are significant gains possible that can create easier and cheaper approaches for broadcasters.
- Challenges in the Air-Chain, especially the HD Radio Air-Chain
  - Complexity and where to place it
- Toolkit of “Made for Radio” standards and technologies
- Some examples of fresh technological approaches
- Please join us again in two weeks for more fresh approaches and demos


AUG 27
Problem Solved
Live Demo #1
SEPT 10
A New Way Forward
Live Demo #2
?
AUG 13
Made for Radio Standards*
1
2
3

There will be a lot of HD but rethink and application to FM air chain

Why 3 webinars?

Frank where does this collaboration fit in for you?