IEEE BTS Chapter
Radio Implementation Presentation
San Diego, CA

Monday March 21, 2016
Who am I?

Paul Shulins
Director of Technical Operations
for Greater Media Boston, MA
U.S.A.
My Background:

• Graduated from the University System of New Hampshire, Plymouth NH, USA, 1979
• Laconia, NH Engineer 1979-1981
• Springfield, MA Chief Engineer 1981-1985
• Rochester, NY Chief Engineer 1985-1987
• Boston MA, Director of Technical Operations 1987-Present (28 Years)
Responsibilities

- Oversee Engineering /IT Departments
- 4 Engineers
- 1 Digital Playout Specialist
- 1 IT Desktop Support Person
- Consulting firm employed for higher level Network Issues
Today’s Presentation

- Orientation of where I am from
- RF Systems for FM Transmission
- Studio Design Considerations
- Digital Radio Features
- Safety Procedures
- AOIP Considerations
Part 1

Where am I from?
City of Boston Massachusetts
<table>
<thead>
<tr>
<th>MKT CODE</th>
<th>RANK</th>
<th>TYPE</th>
<th>FREQ</th>
<th>MARKET</th>
<th>DST</th>
<th>METRO 12+ POPULATION</th>
<th>HISPANIC 12+ POPULATION</th>
<th>BLACK 12+ POPULATION</th>
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Greater Media Boston Group of 5 FM Stations
5 Analog + HD1 and 5 HD 2 Stations
Part 2

RF Systems
Transmitter  Studio (5 Stations)
Today’s Multi-Purpose STL’s

- IP Based Connectivity (two way)
- Remote Controls
- HD Radio feeds to Importers/Exporters
- RDS Encoder Feeds
- Audio Processor Remote Control
- OPX Telephones
- General Internet Access at Transmitter Sites
Part 101 STL Systems

Frequency and Dish Size Selection Criteria

- 6, 11, 18, and 21 GHz
- Larger Dish sizes allow longer distances (6’ 10’)
- 18 and 21 GHz more susceptible to rain fade
- 6 and 11 GHz generally offer longer range
Advantages of Audio over IP for STL’s

- Increased payload capacity
- Most modern STL’s are designed for digital delivery
- No degradation in audio quality
- Ability to transport bi-directional audio and data from site to site
- Ability to design redundant systems efficiently (i.e. sonnet rings, parallel radios with auto switching)
BANDWIDTH MAX CAPACITY
30MHZ - 155MB/S

19,965 Gzh
100 MB Eth
16 T1
30 MHZ

NEEDHAM
TRANSMITTER SITE

19,600 Gzh
50 MB Eth
16 T1
40 MHZ

BANDWIDTH MAX CAPACITY
40MHZ - 155MB/S

NEWTON AUX
TRANSMITTER SITE

11,605 Gzh
100 MB Eth
16 T1
30 MHZ

STUDIO

BANDWIDTH MAX CAPACITY
30MHZ - 155MB/S

PRUDENTIAL
TRANSMITTER SITE

11,525 Gzh
100 MB Eth
16 T1
30 MHZ

BANDWIDTH MAX CAPACITY
30MHZ - 155MB/S
Ring Architecture Advantages

• Self Healing Design
• Redundant Equipment
• Instant Switching (clockwise/counter-clockwise)
• Email alarms
• RPU Audio (both directions)
• 2 Way Radio Repeater Voter Audio
• General Purpose Internet Access at Transmitter Sites
• IP Camera Connections
• Audio Processor Remote Control
FM Master Antenna Systems
Prudential Building Transmitter Site

UPPER ANTENNA ➔

LOWER ANTENNA ←
Why use an FM Combiner?

- Use a single Antenna System to serve multiple radio stations
- Pooling resources allows for a much higher budget to invest in a better performing antenna system
- Real estate on a tower or tall building is limited and expensive
- Intermodulation products can be reduced or eliminated
- Suppression from lightning damage is generally increased
- Ability to construct a backup antenna or a lower/upper antenna array is much more practical and affordable
- Ability to design the antenna for RFR Suppression is increased
Typical Transmitter Site Overview

Greater Media Boston, Prudential Transmitter Site

DUAL FEED ANTENNA

TO LOWER ANTENNA

CIRCULATOR

BIRD BPME 3126

DIELECTRIC 6000 SERIES COAX SWITCH

BIRD BPME 3129

DUMMY LOAD

BE FM 20T

BE Fmi 703
FM Combiner System
FM Combiner System
FM Combiner System
Use True averaging power meters for digital signal
Redundant UPS Systems
Make before break Bypass Switch
UPS Bypass Switch

Caution!! LIVE POWER INSIDE!

Make sure to remove power and lock out transmitter while working on transmitter.

Transmitter A

Transmitter B
Modulation Monitoring

- Critical to adjust and verify Modulation Levels
- Critical to adjust and verify pilot injection levels
- Important tool for making audio performance measurements
- RDS Monitor to maintain and verify RDS Injection levels, and RDS Content
- Most accurate when coupled directly to a transmission line sample
- Off the air samples feeding modulation monitors are subject to many variables that can potentially cause inaccurate measurements especially if not carefully planned.
VSWR Protection
VSWR Protection

- Protecting the Transmission Line and Antenna is obviously critical.
- Antenna / Transmission line repairs are expensive, time consuming, weather dependent, and can keep your site out of commission for long periods of time!
- Do not rely on Integrated Transmitter VSWR Fold back Systems to protect your antenna and transmission live systems.
- Interlock All Transmitters feeding the antenna.
- If part of a combiner system, make certain each station is interlocked to a master protection system and do an “interlock check” routinely to verify compliance.
Part 3

Studio Design Considerations
Typical Studio Layout
• Analog Audio
• Digital Audio (AES)
• VOIP (Voice Over IP)
Advantages of Audio over IP:

- Scalable to just about any size facility
- Ultimate in flexibility
- Distributed architecture
- Easy to stock generic spare parts
- Simplified wiring
- Seamless audio distribution between physical facilities.
- Audio quality is virtually perfect unless compression algorithms are used that either are inappropriate, or cascaded.
Dangers of Audio over IP within a plant:

- Separate traffic from business network traffic (QoS) This increases the cost of the overall network (i.e. layer 3 switches)
- Latency issues
- Requires IT professional skill set and test equipment to deploy and maintain
- Higher cost to install than conventional wires (depending on the scale of the facility)
Things to consider when contemplating and AOIP plant:

- Are you constructing a new facility?
- How much flexibility do you require?
- What is the budget?
- How likely are you to expand the physical plant in the next 5-10 years?
- What kind of access do you have to expert IT support?
Redundant Digital Playout Computers
Master Control Area
Wall with central monitoring
Centralized UPS system
Advantages of Centralized UPS

- Simplifies maintenance
- Saves space, cleaner installation
- Saves money
- Especially efficient for larger plants
- Highly reliable
- Extra capacity for heavy loads
- Highly advanced diagnostics and battery monitoring capabilities
UPS Battery Monitoring
Shop Cross Connects
BURK REMOTE CONTROL TELEMETRY READINGS SCREEN
OFF-AIR PPM MONITORING
Studio Considerations
For PPM rated markets

1. Provide enough monitoring for all PPM sources
   STL feeds, HD1, HD2, Streams
2. Include monitoring for all Internet Streams
4. Provide adequate PPM alarm enunciation in control rooms
5. Provide Timely PPM alarm alerts to staff
   E-Mail, Paging, Text Message, Growl Alert
<table>
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<tr>
<th></th>
<th>105.7 WROR</th>
<th>MAGIC 106.7</th>
<th>Country 102.5</th>
<th>Radio 92.9</th>
<th>HOT 96.9</th>
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<td>OPX/ISDN</td>
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<td>OPX/ISDN</td>
<td>OPX/ISDN</td>
<td>OPX/ISDN</td>
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<tr>
<td>HD2 Vault Primary</td>
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<td>HD2 Vault Primary</td>
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<tr>
<td>ON Air Vault Backup</td>
<td>ON Air Vault Backup</td>
<td>ON Air Vault Backup</td>
<td>ON Air Vault Backup</td>
<td>ON Air Vault Backup</td>
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LED LIGHTING

• Green Initiative
• Save on maintenance Costs
  • LED technology is rated for 10X longer than incandescent lighting
• Save on Energy Costs
• LED’s produce much less heat than incandescent lights – cooler working environment
• Smart fixtures take advantage of natural light and occupancy within a space and adjust accordingly
• New Wireless technology allows for fixtures be configured and controlled via PC or remote devices
• Allows for flexible lighting changes with area re-configurations
Existing Annual kwh Usage 272,978

Proposed Annual kwh Usage 61,377

Today Costs $36,852

Proposed Annual Cost $8,286
LED Lighting Retrofit for Studios

<table>
<thead>
<tr>
<th>Before Retrofit</th>
<th>After Retrofit</th>
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<tbody>
<tr>
<td>Load: 67,725 KWh</td>
<td>Load: 15,820 KWh</td>
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<tr>
<td>Annual KW 65.73</td>
<td>Annual KW: 15.82</td>
</tr>
<tr>
<td>Annual Lighting Cost: $36,852</td>
<td>Annual Lighting Cost: $8,286</td>
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<tr>
<td>(assuming energy cost $0.135)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduction/Year: 49.91 KW</td>
</tr>
<tr>
<td></td>
<td>Reduction/Year: 211,601 KWh</td>
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# LED Lighting Retrofit for Studios

<table>
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<th>Category</th>
<th>After Retrofit</th>
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<tr>
<td>Maintenance Savings/Year</td>
<td>$3,850</td>
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<td>Electrical Savings/Year</td>
<td>$28,566</td>
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<td>Project Cost</td>
<td>$186,153</td>
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<td>Utility Incentive</td>
<td>$74,060</td>
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<td>Cost After Incentive</td>
<td>$112,092</td>
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<tr>
<td>Estimated ROI</td>
<td>29%</td>
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<td>Monthly Energy Savings</td>
<td>$2,381</td>
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Conclusions

- LED Lighting retrofit makes sense for most installations
- Payback in 3 years or less
- Financing arrangements can allow for positive cash flow
- Substantial incentives from utilities
- Save on maintenance costs
- Save on energy costs
- Ability to reconfigure lighting for different office layouts as your needs change and people move
- Centralized lighting control possible
Part 4

Digital Radio Broadcasting
HD Radio Installation considerations

Studio Considerations

1. STL Bandwidth
2. Provide OFF AIR Enunciation to Control rooms
3. Purchase HD radios for Air monitoring of each stations HD Signal.
4. Silence Sense monitoring of each Station feed for Audio/Carrier Loss
Transmitter Control Considerations

1. RF isolation Protection
2. Proper interlock for Coax Switches
3. Proper interlock for Reject Loads
4. Proper interlock for VSWR
5. Deploy control system with remote control capability via Smartdevice, Secured Web page, Telephone interface
Audio Diversity Delay

1. Ability to take delay alignment readings
2. Ability to calibrate Diversity delay remotely
3. New Software revisions for Exporter and HD

Audio processing usually employ improved changes in delay times.
FM HD Radio Hybrid Mode

ANALOG HOST SIGNAL
(STEREO OR MONO)

10 PARTITIONS

-20dBc

199 KHz
130 KHz
0 Hz
130 KHz
199 KHz

100 kbps Throughput
(96 kbps Audio, 4 kbps Ancillary)

191 Subcarriers

LOWER DIGITAL SIDEBAND

UPPER DIGITAL SIDEBAND

PRIMARY

10 PARTITIONS

-20dBc

191 Subcarriers
FM HD Radio Extended Hybrid Mode (MP3)

151 kbps Throughput
(96 kbps Audio, 55 kbps Ancillary)

0.8 dB Extra Transmitter Power Needed
The Artist Experience (TAE) is a method by which “album art” and station logos, and other graphic images can be associated with broadcast events, embedded in a HD Radio broadcast and displayed on compatible receivers.
The Artist Experience

Image of a car dashboard with 'Artist Experience' text and options like HD Radio, FM1, All Roads Lead to You, Lost in Los Angeles, LiLA.
The Artist Experience Enabled Radios
Part 5
Safety Procedures
Tower Site Security and identification
SAFETY

• Secure loose tanks to Wall
SAFETY

• Clearly identify all circuits
SAFETY

- Battery operated
  Emergency lighting
Outside RF indicators
RF Exposure Meter
### RF Exposure

**FCC Maximum Exposure Limits (Occupational/Controlled) Exposure**

<table>
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<tr>
<th>Frequency Range (MHz)</th>
<th>Electric Field Strength (V/m)</th>
<th>Magnetic Field Strength (A/m)</th>
<th>Power Density $E^2$ (mW/cm$^2$)</th>
<th>Averaging Time (minutes)</th>
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<td>900/f</td>
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<td>.163</td>
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<td>300-1500</td>
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</table>
Typical RF Signs

**NOTICE**

Non-ionising radiation fields beyond this point may exceed general public exposure limit.

Obey all posted signs and site guidelines for working in radio frequency environments.

**WARNING**

Radio Frequency Energy Hazard Inside
Do Not Enter!
Risk of Serious Injury or Death
Use exposure control procedures.
Refer to site policy.

**ADVERTENCIA**

Riesgo de energía de radiofrecuencia en el interior.
¡No entre!
Riesgo de una lesión grave o muerte.
Siga los procedimientos para controlar su exposición.
Consulte las políticas de sus instalaciones.
Thank you!
Questions?