A Practical Approach to ATSC M/H and Single Frequency Networks

CCBE

John Lynch | Axcera

17 September 2010

Axcera

the rf experts

Overview

- What is ATSC M/H?
- Terminology
- Major components of DTV system
  - Fixed and Mobile DTV
- Transmitter system design options
  - Single- vs. multi-transmitter
- Conclusions

Axcera.

the rf experts

ATSC M/H Mobile DTV – What is it?

- Mobile/Handheld or Mobile DTV
- Backward compatible with fixed ATSC (A/53)
  - Existing TVs and STBs still work, but cannot display M/H content

- Uses existing RF channel, existing DTV transmitter
  - Apportions 19.39 Mbps bitstream between “fixed” (A/53) and Mobile DTV (A/153) streams
- Same physical layer as A/53 (8-VSB)
- Additional coding and training signals on mobile streams
  - More robust for mobile
    - Can receive approx. 4 dB C/N vs. 15 dB for standard ATSC
  - Trades spectral efficiency for robustness
    - ¼ rate coding – 4 bits out for 1 content bit
    - ½ rate coding – 2 bits out for 1 content bit

Axcera.

the rf experts

ATSC M/H Mobile DTV – What is it?

- IP-based mobile baseband signals
  - Easily supports streaming (real-time) and file-based (non real-time) delivery
  - Common protocol for various file types
- Mobile signals use more efficient encoding/compression than fixed
  - MPEG-4/H.264 for video
  - HE AACv2 for audio
- Service protection capability
  - Based on OMA BCAST DRM profile (Open Mobile Alliance – Mobile Broadcast Services)
- Electronic Service Guide
  - Based on OMA BCAST Service Guide standards

Axcera.

the rf experts

ATSC Mobile DTV Consumer Devices

Axcera.

the rf experts

Terminology

- ATSC Main or “Fixed” service (“Legacy”)
  - ATSC A/53
  - ATSC broadcast signal to stationary receivers
- ATSC M/H or ATSC Mobile DTV
  - ATSC A/153
  - Allows a portion of the signal, currently up to 75%, to be used for delivery to portable and mobile devices, with the balance for delivery to existing receivers
  - Bandwidth can be allocated based on individual station requirements
  - SFCMM (Scalable Full Channel Mobile Media)

Equipment

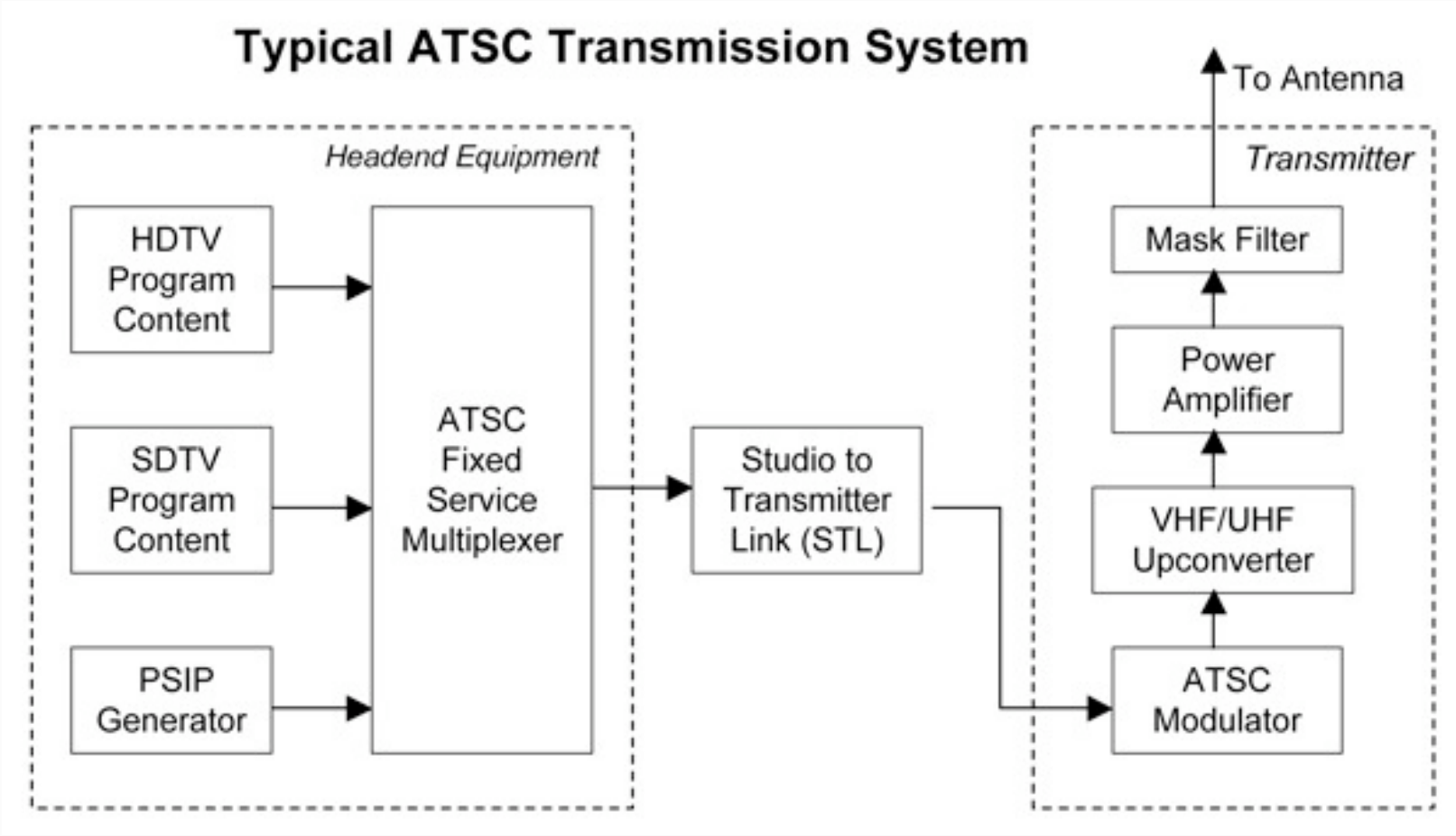
Axcera

the rf experts

Major Components of DTV Transmission Facility

- Three general blocks for ATSC fixed service:
  - Program Headend Equipment
    - Encoders, multiplexers, PSIP generator, etc.
  - Studio to Transmitter Link (STL)
    - Fiber, microwave, satellite, etc.
  - Digital Transmitter
    - Modulator, upconverter, RF power amplifier(s), mask filter, etc.

Major Components of DTV Transmission Facility



Axcera.

the rf experts

Major Components of DTV Transmission Facility

Fixed Encoding and PSIP

- MPEG-2 encoding equipment for fixed HDTV and SDTV programs
- Static and/or dynamic PSIP generation
- Can be separate equipment or integrated into service MUX
- Remains in service after M/H conversion, but only for fixed program content

Axcera.

the rf experts

ATSC Mobile DTV Hardware

Mobile DTV Encoders

- One required for each mobile program/channel
- Provides MPEG-4 (a.k.a. AVC, H.264) encoding for mobile programs
- Scales resolution to 416 x 240
- Ideally repurposed for viewing on small screen, but can be simulcast
- IP output feeds preprocessor/MUX
- Currently stand-alone equipment

Axcera.

the rf experts

ATSC Mobile DTV hardware

Mobile DTV Electronic Service Guide (ESG) Generator

- Provides program guide and overall navigation GUI for mobile device
- Creates M/H service signaling channel (SSC), providing structure of transmitted services and decoding parameters for video and audio
- Independent of fixed PSIP generation, but some existing PSIP equipment can be extended
- IP output
- Can be stand-alone equipment

Axcera.

the rf experts

ATSC Mobile DTV hardware

Axcera.

the rf experts

Major Components of DTV Transmission Facility

Fixed Service Multiplexer

- Various options
  - SDTV and/or HDTV capability
  - Number of program streams
  - Static or dynamic multiplexing
  - Other features…
- Remains in service after M/H conversion, but only for fixed program content

Axcera.

the rf experts

ATSC Mobile DTV hardware

ATSC Mobile DTV Multiplexer (Pre-processor)

- Combines Mobile DTV content with fixed ATSC transport stream
- Placed downstream of the service MUX; Accepts inputs from service MUX, M/H encoders and ESG generator
- Preprocessor provides M/H data structure, adds additional FEC and training processes, and encapsulates the data into MHE (M/H ensemble) transport stream packets
- Mobile MUX allocates bandwidth between mobile content and main (fixed) service data
- Typically includes ASI and/or SMPTE 310 input for fixed content, IP input for M/H content; Output can be ASI or SMPTE 310
- Supports both internally generated and external service signaling

Axcera.

the rf experts

ATSC Mobile DTV hardware

Total capacity for all streams remains at 19.39 Mbps

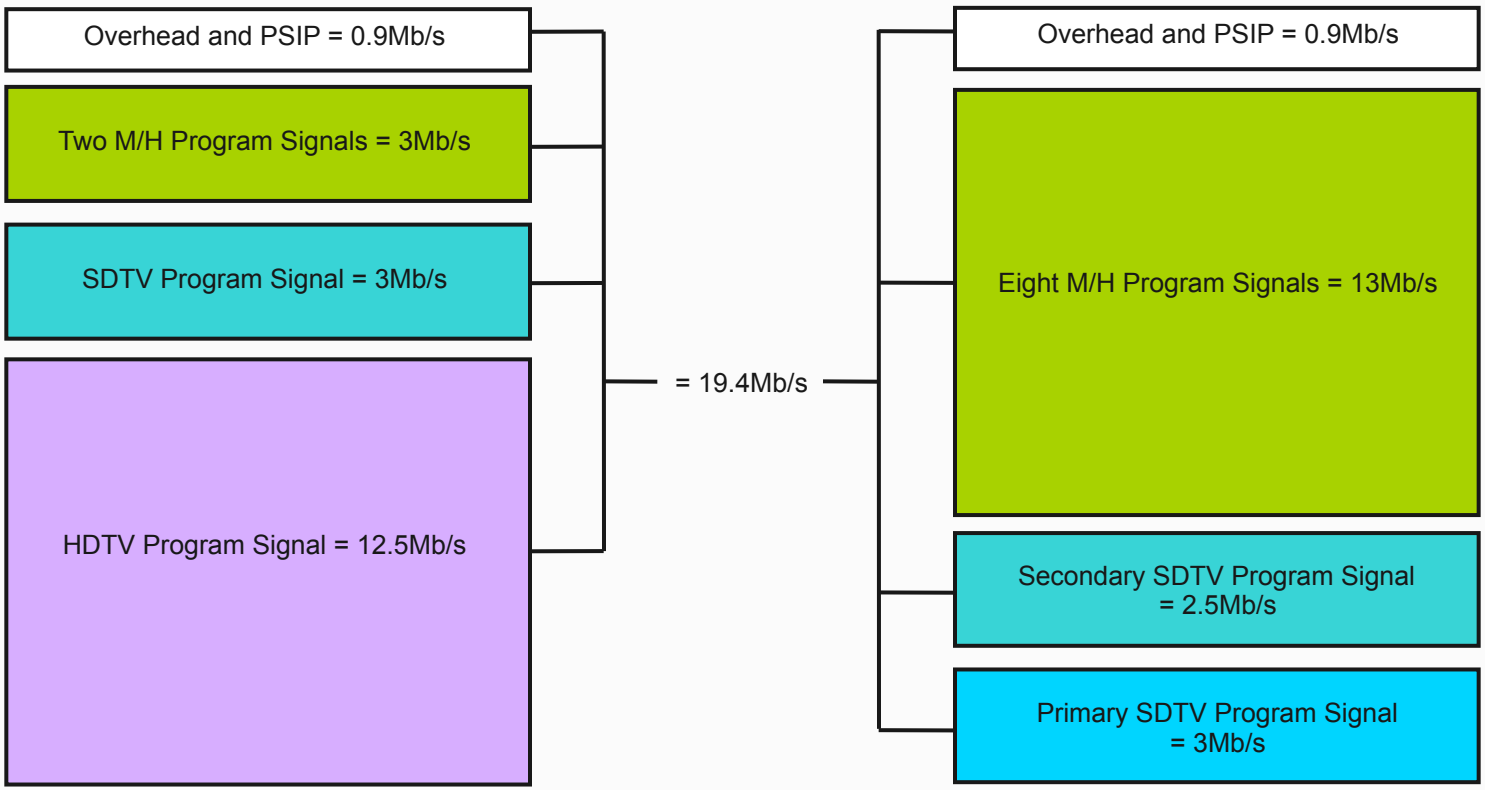
- HD stream consumes ~10-14 Mbps
- SD stream consumes ~3-4 Mbps
- PSIP consumes ~ 0.5 Mbps
- Each Mobile DTV program consumes approx. 1-2 Mbps (assuming 500kbps payload, ¼ rate or ½ rate coding)

Axcera.

the rf experts

ATSC Mobile DTV hardware

Fixed/Mobile Bandwidth Examples



a) HD Example

b) Multicast Example

Axcera

the rf experts

Major Components of DTV Transmission Facility

Studio to Transmitter Link (STL)

- Typically point-to-point microwave or fiber, but can be satellite or even IP
- Addition of M/H does not increase bandwidth requirements, so existing digital STLs should continue to work
- Choosing to deploy M/H in a multi-transmitter network may require additional STLs, depending upon technology selected

Axcera.

the rf experts

Transmitter Equipment

Axcera

the rf experts

Major Components of DTV Transmission Facility

ATSC Fixed Exciter

- ATSC and RF signal generation section of transmitter, includes…
  - ATSC Modulator – Accepts ATSC-compliant ASI or SMPTE310M bitstream and typically modulates to an intermediate frequency (IF)
  - Upconverter – Converts the IF signal to the desired VHF or UHF channel frequency
  - Downconverter – Required for systems employing adaptive pre-correction

Axcera.

the rf experts

ATSC Mobile DTV hardware

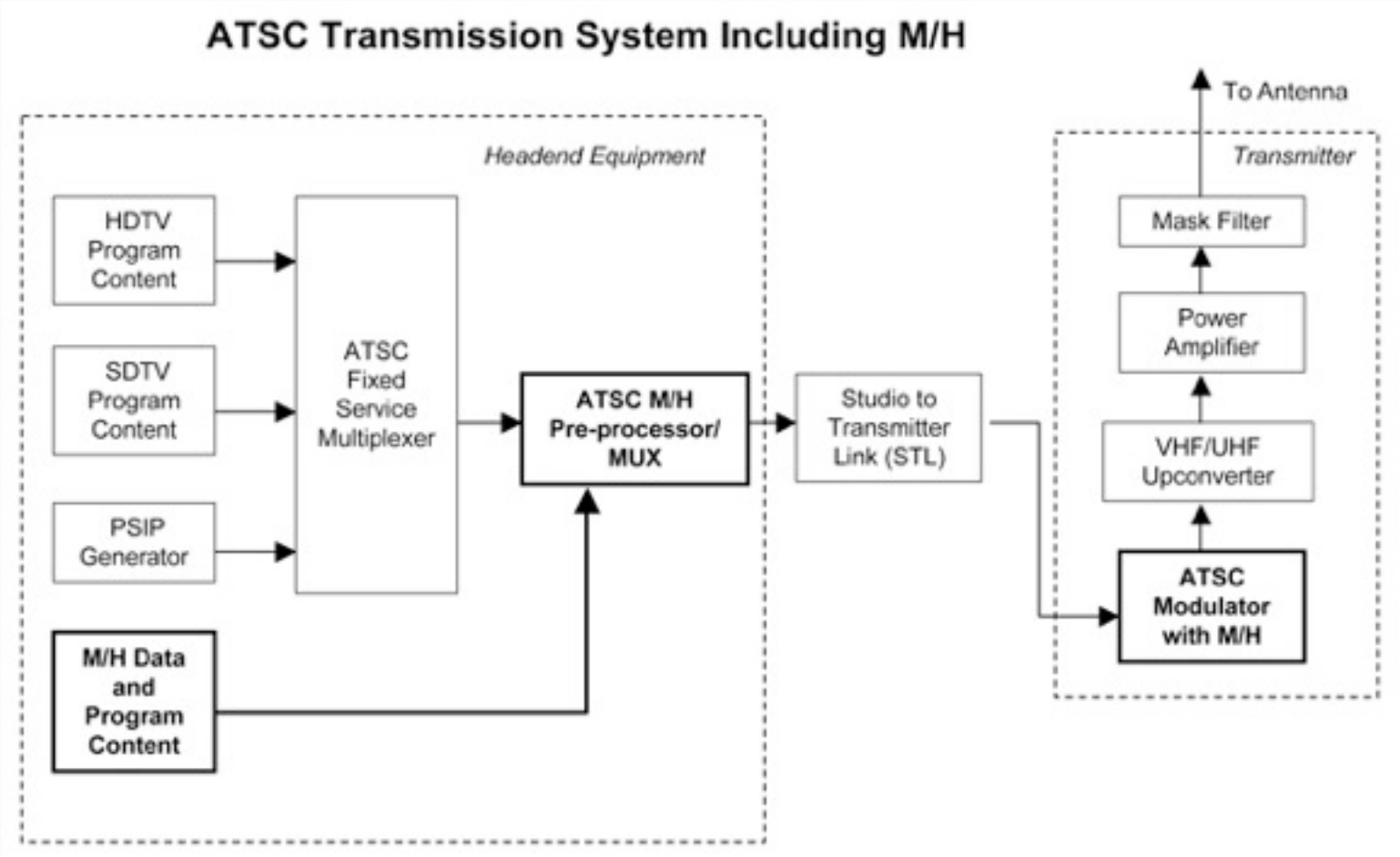
ATSC Mobile Exciter

- ATSC exciter components generally capable of operating with M/H, except modulator
- For M/H operation, modulator requires post-processor to ensure main service data compatibility with fixed receivers
- Depending upon brand and vintage, modulator will be firmware upgradeable to M/H or will require replacement
- M/H exciter retrofits are available

Axcera.

the rf experts

Major Components of ATSC Mobile DTV Transmission Facility



Axcera.

the rf experts

Mobile DTV System Considerations

Axcera

the rf experts

System Considerations

- UHF is best for Mobile DTV
  - Receive antennas too large/gain too small at VHF
- Circular/elliptical polarization benefits mobile reception
  - Even if transmitter power is not increased – benefit is more than 3 dB
  - Some studies have shown that elliptical polarization with ~33% vertical is optimum
- Mobile Coverage requirements differ substantially from broadcasting to fixed receivers

System Considerations

Terrain Shielding and Mobile DTV

- Can be better controlled in fixed installations
  - Viewers in shadowed areas expect and compensate for low or no signal (better antenna system or cable)
- Greater issue for mobile television
  - Transient service
  - Larger number of viewers experience coverage gap
  - Viewers cannot compensate for gap and many times are unable to anticipate gap
  - Will expect Mobile DTV wherever phone service works
  - May cause frustration and suppress desire for service

System Considerations

Fringe Area Signal Levels and Mobile DTV

- Can be better controlled in fixed installations
  - Suburban and rural viewers expect and compensate for low signal (better antenna system or cable)
- Greater issue for mobile television
  - M/H very advantageous in low signal areas, but reception can still be challenging
    - Typically handheld receivers
    - Relatively small antennas only a few feet from ground
    - Can be oriented in any plane, indoors or outdoors
  - May cause frustration and suppress desire for service

Single Transmitter vs. Multi-Transmitter Network

Single Transmitter Approach

- Simplest
- Lowest cost
- Can cover majority of contour
- Possibly most attractive for initial mobile DTV deployment
- Drawbacks include coverage gaps and lower signal levels as distance from transmitter increases

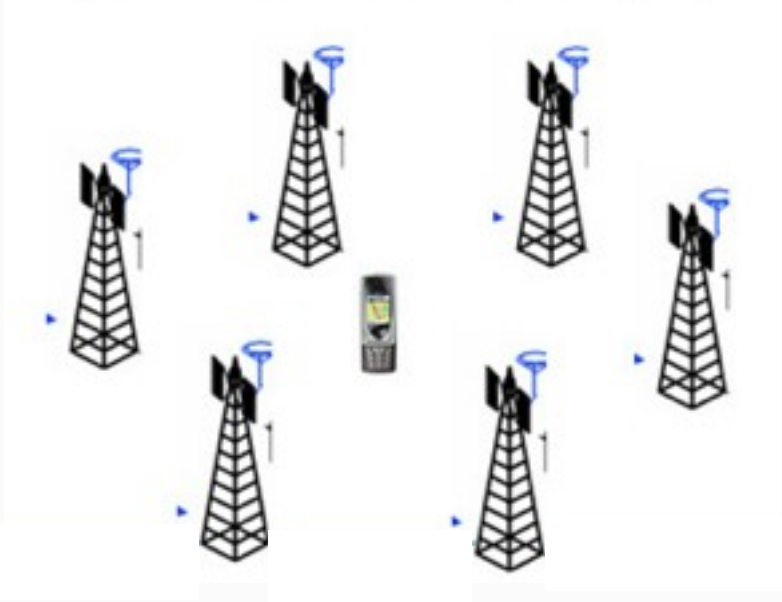
Axcera.

the rf experts

Single Transmitter vs. Multi-Transmitter Network

Multi-Emitter Approach

- Multiple emitters provide greater signal strength and transmit diversity to help overcome…
  - Omni, low gain receive antenna on mobile - compared to higher gain outdoor directional
  - Receivers typically only a few feet from the ground – compared to outdoor rooftop
  - Doppler effect of movement increases required C/N
  - Movement behind buildings, obstructions



Axcera.

the rf experts

Multi-Emitter Solutions

Axcera

the rf experts

Multi-Transmitter Network

On-channel “gap fillers”

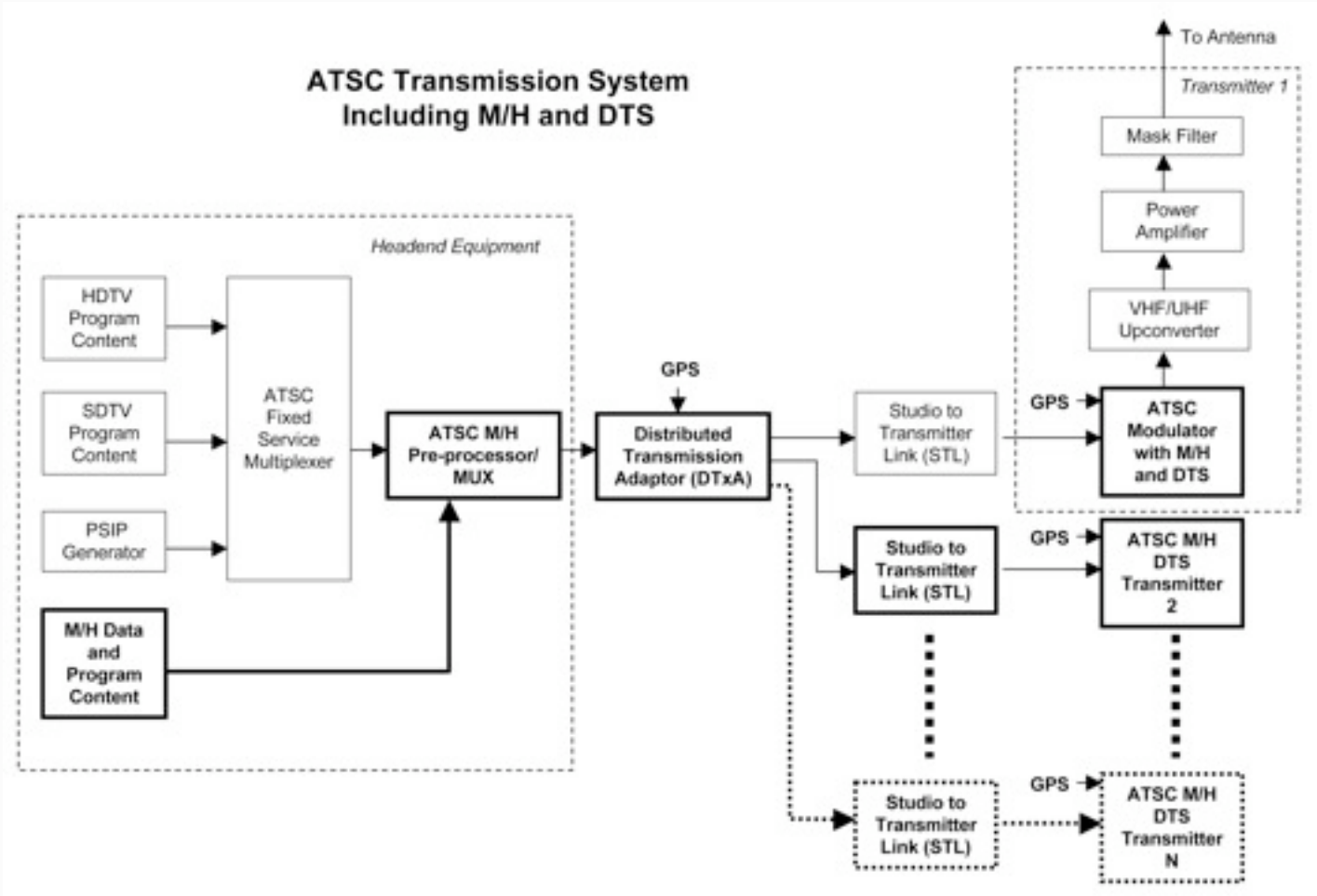
- Serial boosters/repeaters receive and rebroadcast main transmitter signal on same channel
- Can improve coverage in shadowed areas
- Echo-cancelling versions can ease system design

Multi-Transmitter Network

Distributed Transmission System (DTS)

- Identical, originating signal from each transmitter in network
- Timing/delay adjustment provides control of signal overlap areas
- Allows lower power transmitters to be used with a high power transmitter to fill coverage gaps
- Can eliminate need for high power transmitter and optimize signal levels throughout licensed contour

DTS Equipment



Axcera.

the rf experts

DTS Equipment

Starting with single transmitter architecture and upgrading to DTS…

- Prepare by choosing M/H exciter that is firmware upgradeable to A/110B-compliant DTS
- DTxA can easily be installed in the signal path downstream of the M/H pre-processor/MUX
- Distribution system and slave transmitters can be added as necessary
- Some solid-state transmitters can even be broken down for use at multiple sites

Axcera

the rf experts

DTS Equipment

Distributed Transmission Adaptor

- Inserts timing and synchronizing information for multi-transmitter systems operating in a single frequency network (SFN)
- Used for fixed multi-transmitter networks (DTS or A/110), or fixed/ mobile networks (ATSC Mobile DTV or A/153)
- Software upgradable between modes – can use for DTS, then upgrade to Mobile DTV

Axcera.

the rf experts

Conclusion

- Mobile DTV offers a great new revenue opportunity for broadcasters
- Technical challenges exist, but can be overcome with forethought and planning for successful deployments
- Most any existing ATSC transmission system can be upgraded to incorporate Mobile DTV
- Multi-transmitter technologies can enhance coverage and improve user experience
- Planning can make it possible to efficiently migrate from fixed to M/H to multi-transmitter system

Conclusions

ATSC Fixed and Mobile Demo
Incospec Communications Inc.
Suite #315

Axcera.

the rf experts

Thank You!

John Lynch | Regional Sales Manager
jlynch@axcera.com
1-724-873-8100 x156

Axcera
103 Freedom Drive, PO Box 525, Lawrence, PA 15055
t: 724.873.8100 | f: 724.873.8105 | www.axcera.com

Axcera.

the rf experts