ATSC M/H Mobile DTV: What, Why and How?

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Overview

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

ATSC M/H Mobile DTV – What is it?

- Mobile/Handheld or Mobile DTV
- Backward compatible with original 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 and mobile streams
  - Allows for both “fixed” (A/53) and Mobile DTV (A/153) programs
- 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

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

ATSC Mobile DTV Consumer Devices

Valups Tivizen

Power Acoustik DTV-MH

Cydle i30 Cradle

Coby TV-To-Go

LG DP570MH

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History and Current Status

- Two groups originally proposed compatible mobile technologies
  - A-VSB (Samsung) – started development in 2005
  - MPH (LG/Zenith) – first introduced in 2007
- Extensive lab and field tests were conducted on both systems
- May 2008
  - Broadcast industry group Open Mobile Video Coalition (OMVC) recommended MPH as the most viable technology
  - ATSC accepted recommendation to base M/H standard on MPH
- ATSC appointed subcommittee to develop and codify standard
  - ATSC TSG-S4 subcommittee; A/153 standard
- November 2008
  - A/153 elevated to Candidate Standard
- October 2009
  - A/153 Mobile DTV standard approved by ATSC

Terminology

- ATSC Legacy, Main or “Fixed” service
  - 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

Why Mobile DTV?

- Spectrum Utilization
  - Telecoms argue that broadcast spectrum is not fully utilized
  - Public Safety Spectrum and Wireless Innovation Act
  - FCC proposed channel-sharing and nationwide SFN to reclaim broadcast spectrum

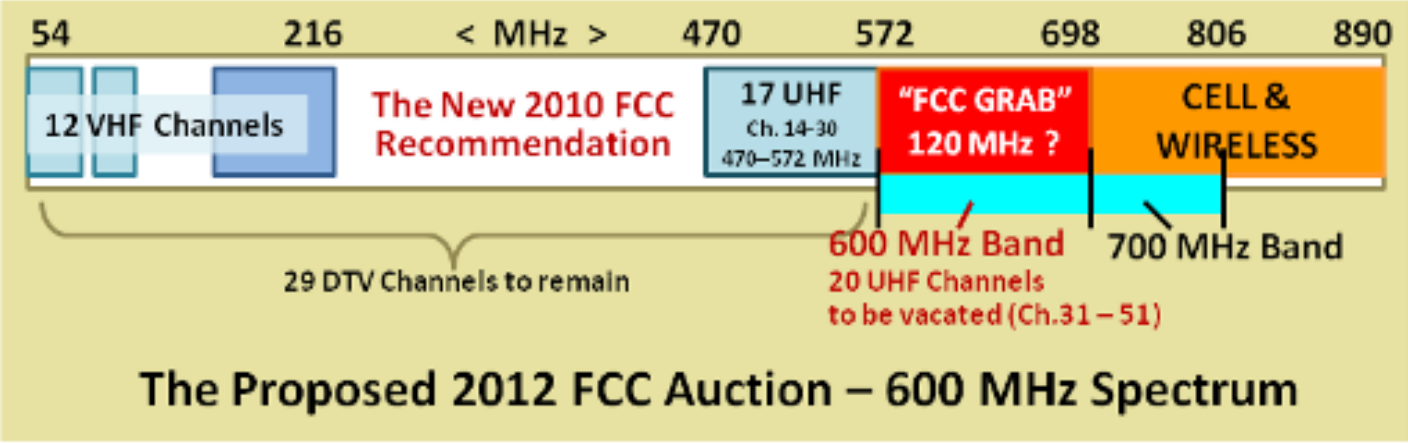


Image courtesy of usjvc.com

Why Mobile DTV?

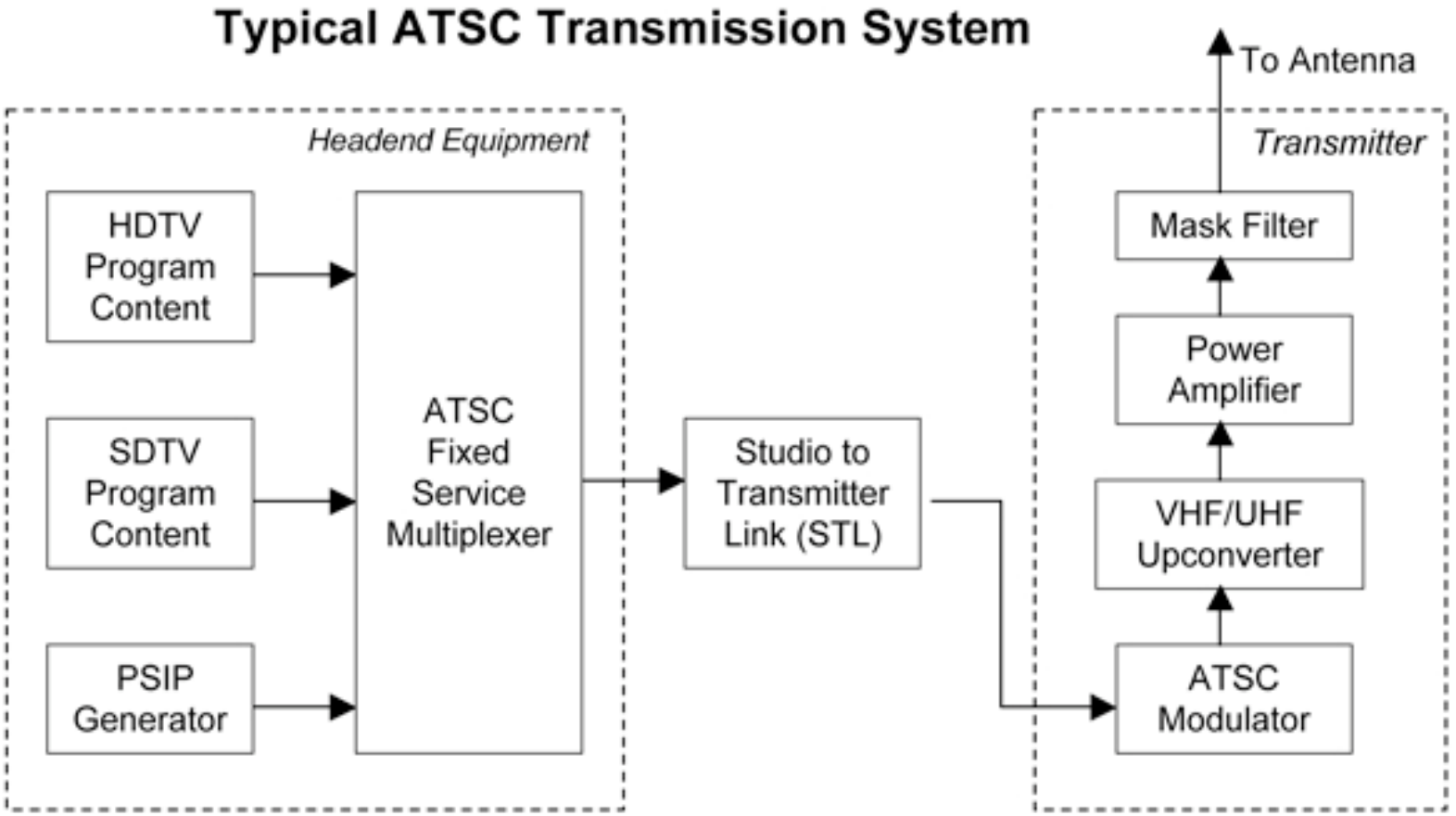
- Mobile DTV Advantage
  - Addition of mobile will increase usage
  - Reinventing broadcast for younger generations
  - Homeland security
- New Revenue Stream
  - OMVC (Open Mobile Video Coalition)
    - Comprised of over 900 commercial and public stations
    - Targeting 2/3 of current TV viewers by mid-2012
  - Mobile 500 Alliance
    - Includes over 420 commercial and public stations
  - Business Models
    - Commercial, subscription or both?
    - Billing?
    - Content

Equipment

Major Components of DTV Transmission Facility

- Three general blocks for ATSC fixed service:
  - Program Headend Equipment
    - Multiplexers, encoders, 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



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

ATSC Mobile DTV Hardware

- Mobile DTV Encoders
  - One required for each mobile program/channel, some offer multi-program capability
  - 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

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

ATSC Mobile DTV hardware

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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

ATSC Mobile DTV hardware

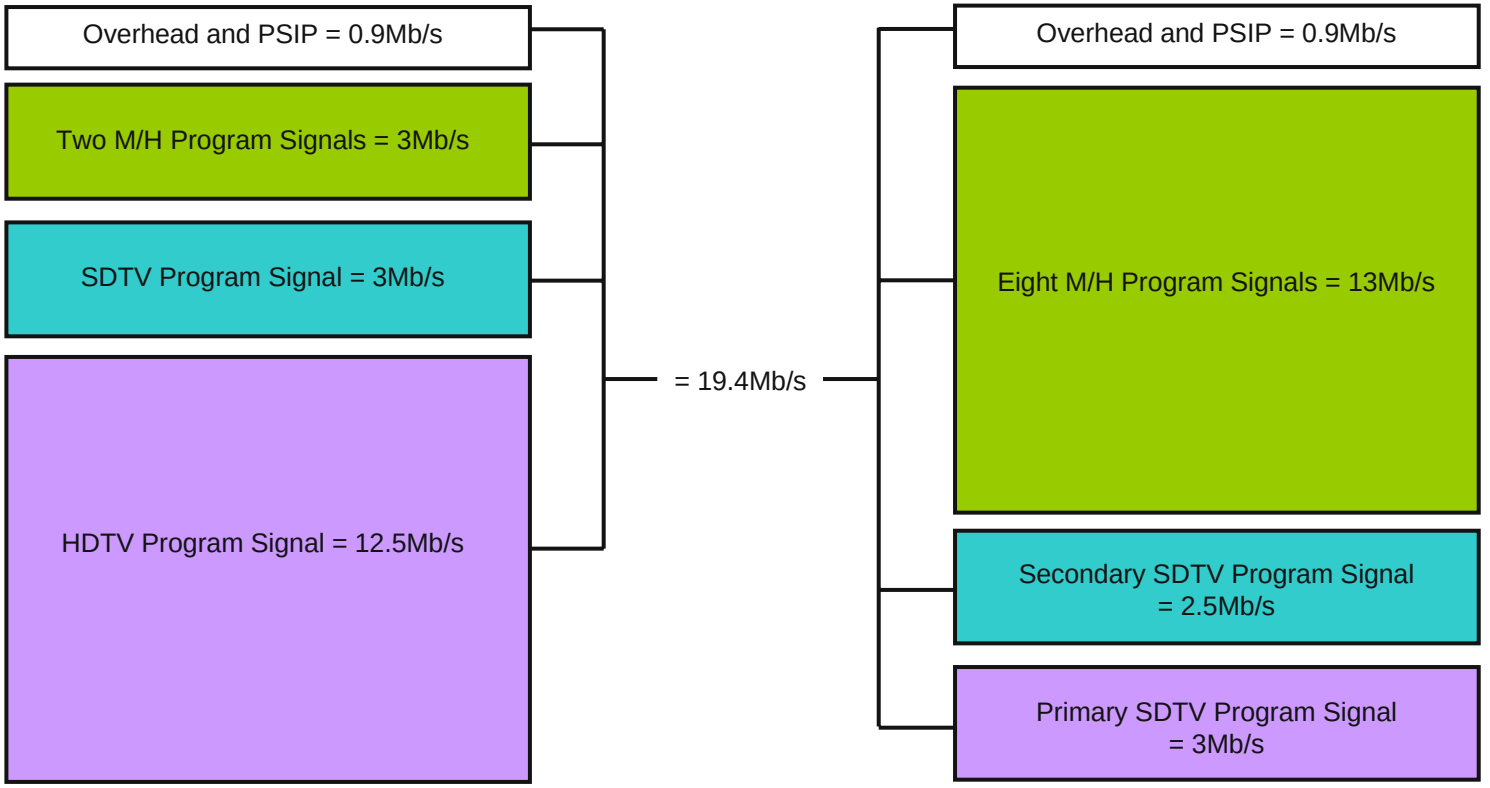
- ATSC Mobile DTV Multiplexer (Pre-processor)
  - Combines Mobile DTV content with fixed ATSC transport stream
  - Placed downstream of the service MUX; Accepts inputs from service MUX, M/H encoders and ESG generator
  - Preprocessor provides M/H data structure, adds additional FEC and training processes, and encapsulates the data into MHE (M/H ensemble) transport stream packets
  - 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
  - Supports both internally generated and external service signaling

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 (assume 500kbps payload, ¼ rate or ½ rate coding)

ATSC Mobile DTV hardware

Fixed/Mobile Bandwidth Examples



a) HD Example

b) Multicast Example

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

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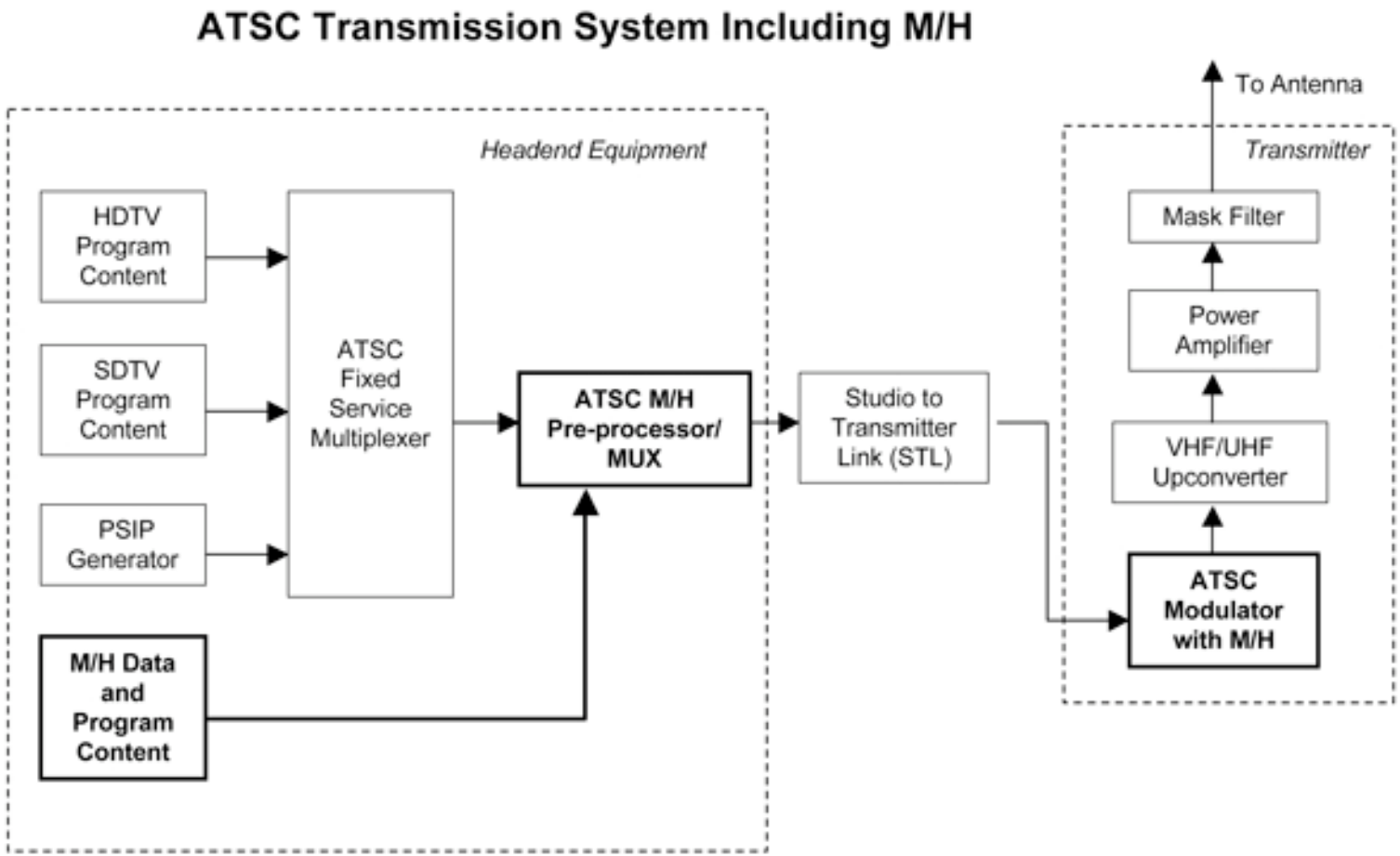
Major Components of DTV Transmission Facility

- Fixed ATSC 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

ATSC Mobile DTV hardware

- M/H ATSC 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

Major Components of ATSC Mobile DTV Transmission Facility



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Mobile DTV System Considerations

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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
- 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

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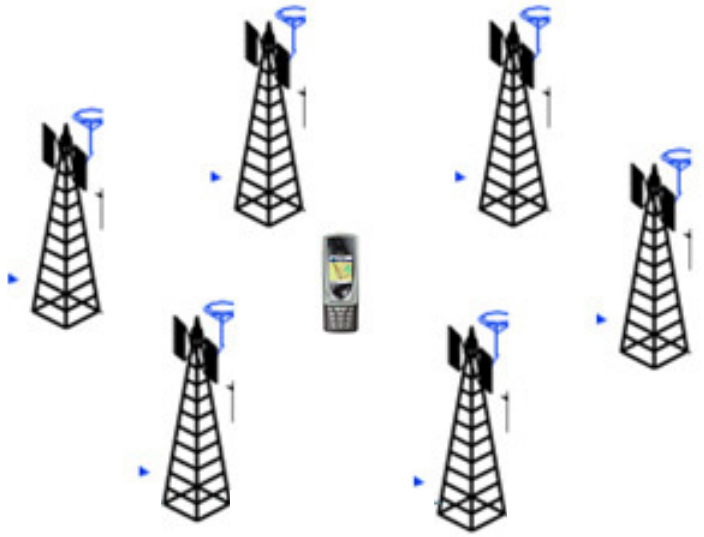
Single Transmitter vs. Multi-Transmitter Network

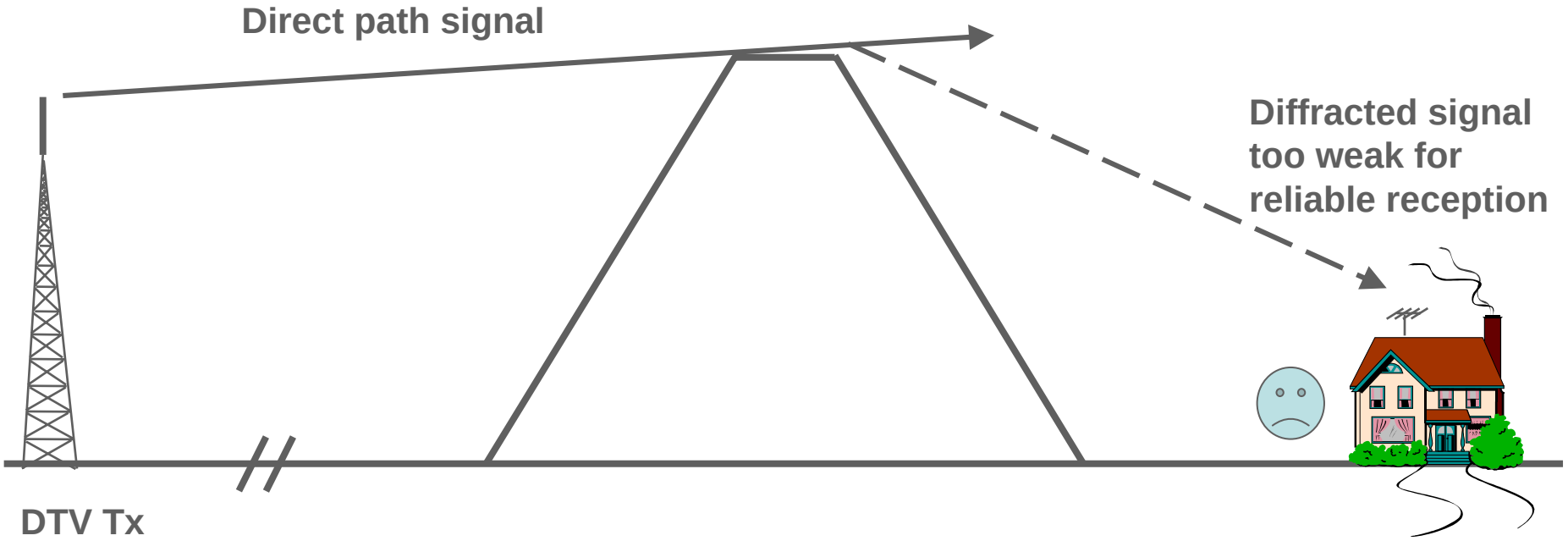
- Multi-Emitter Approach
  - Multiple emitters provide greater signal strength and transmit diversity to help overcome…
    - Omni, low gain receive antenna on mobile - compared to higher gain outdoor directional
    - Receivers typically only a few feet from the ground – compared to outdoor rooftop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



Benefits of Multi-Transmitter Networks

Single Transmitter

Terrain Shielding



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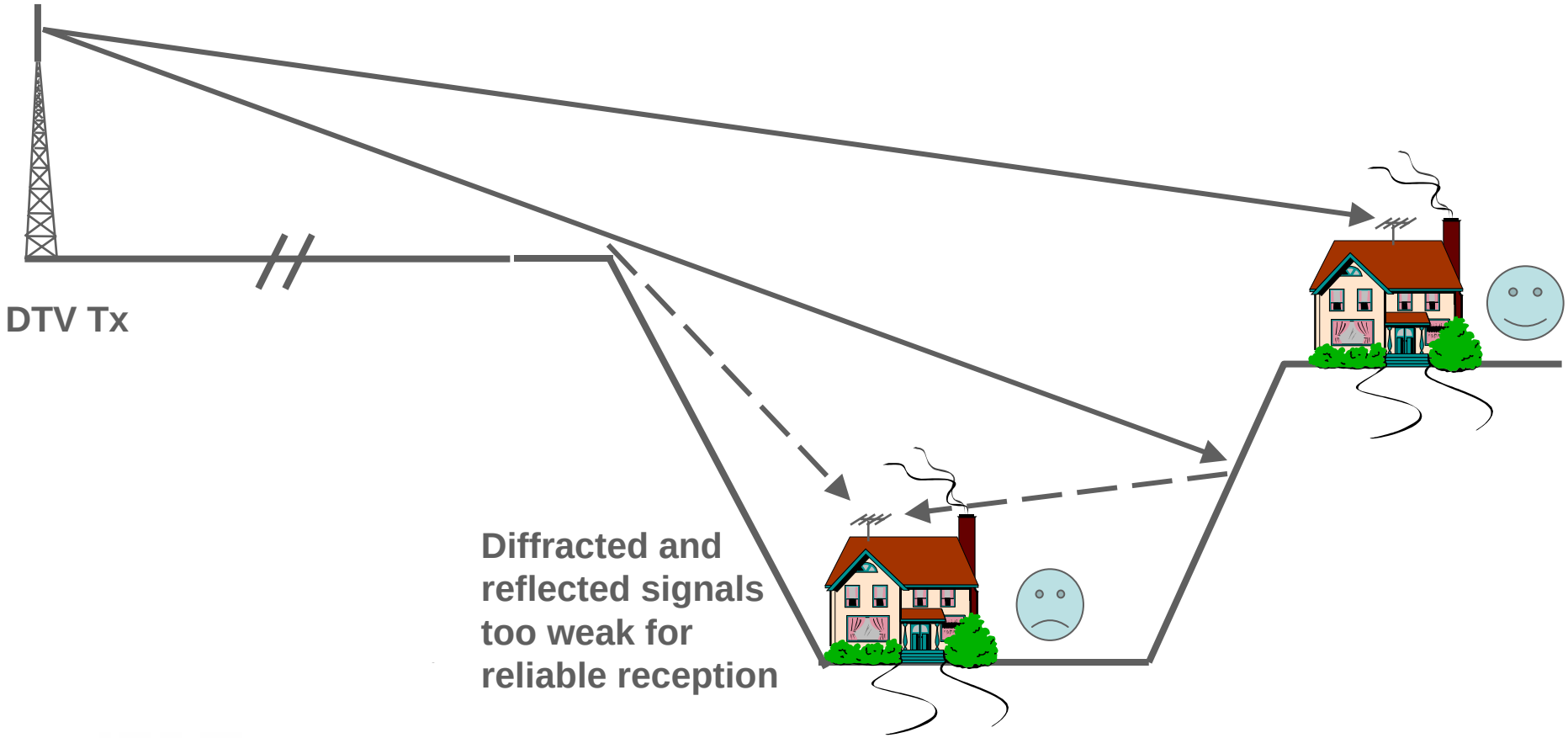
Benefits of Multi-Transmitter Networks

Single Transmitter

Terrain Shielding



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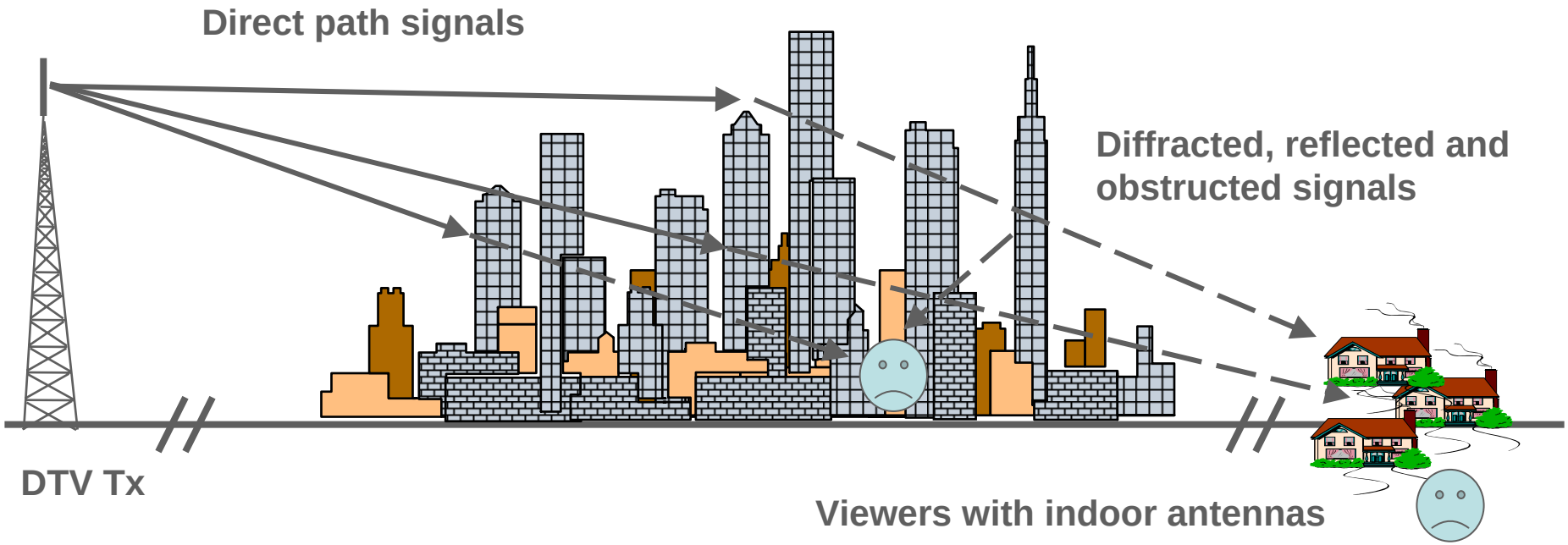
Benefits of Multi-Transmitter Networks
Single Transmitter

Urban Shielding



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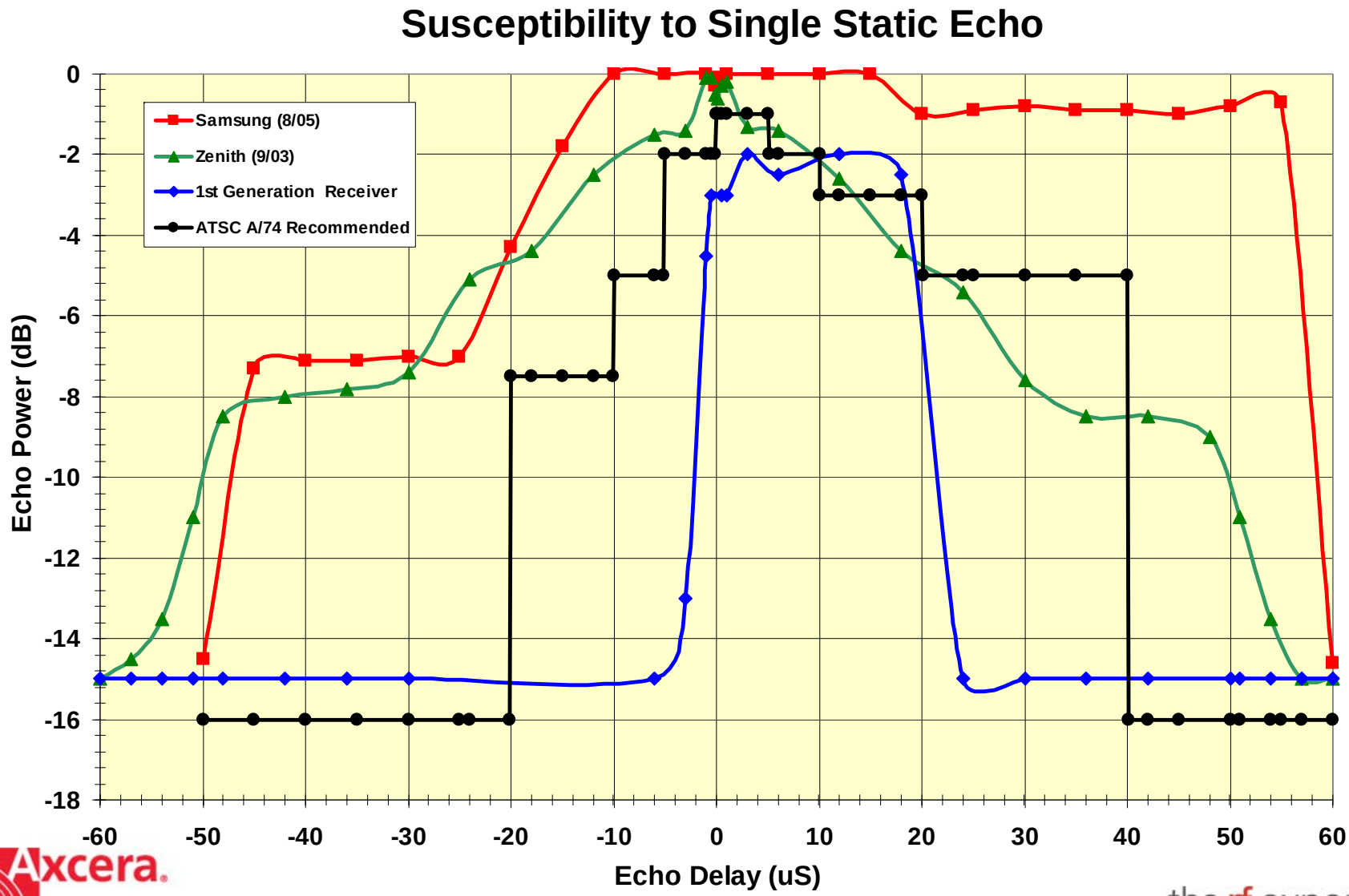
Receiver Affects Coverage (Fixed Receivers)



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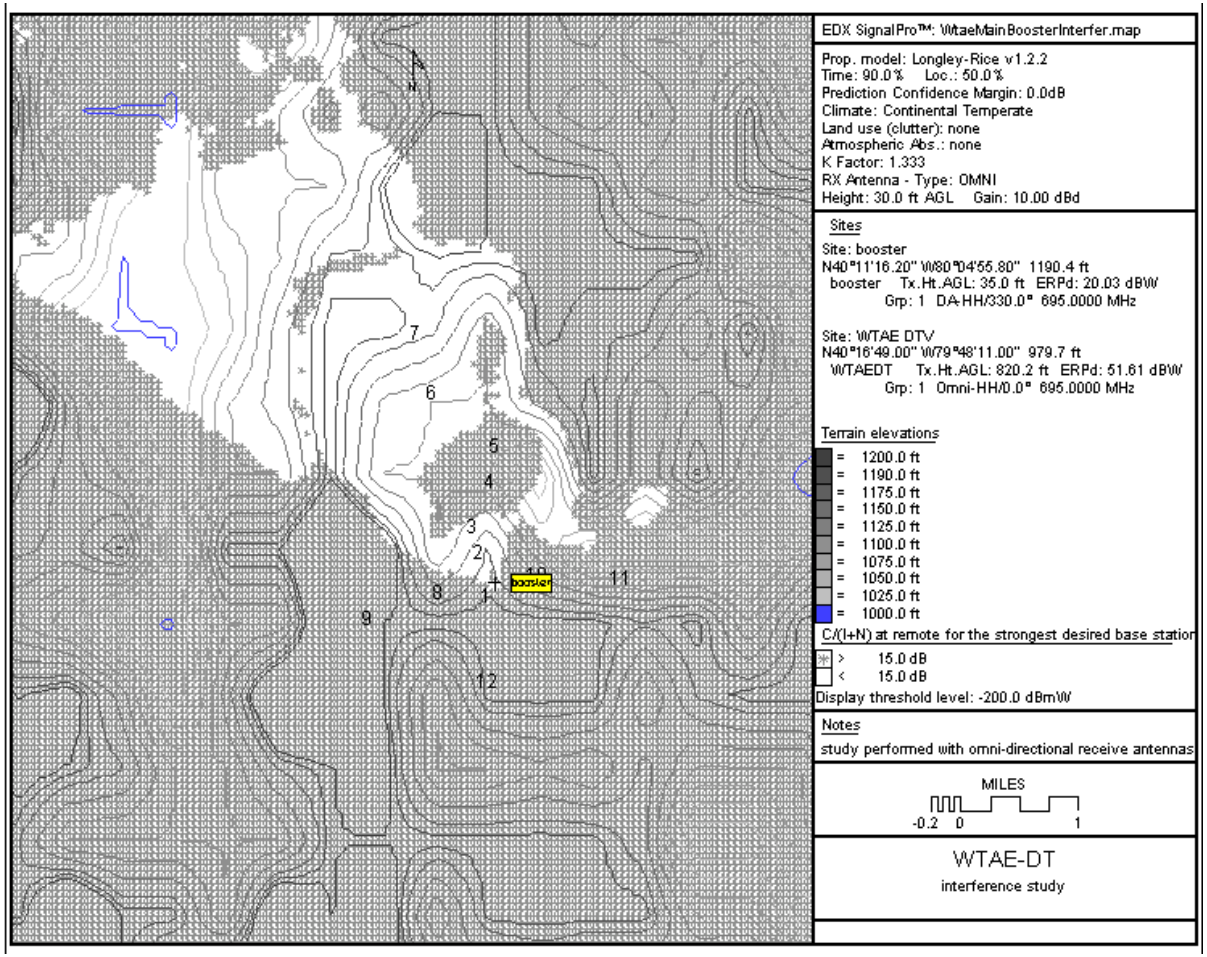
Receiver Affects Coverage



White areas indicate unacceptable interference levels between DTV transmitter and booster.

Omni receive antenna, relative delay **outside** of equalizer range

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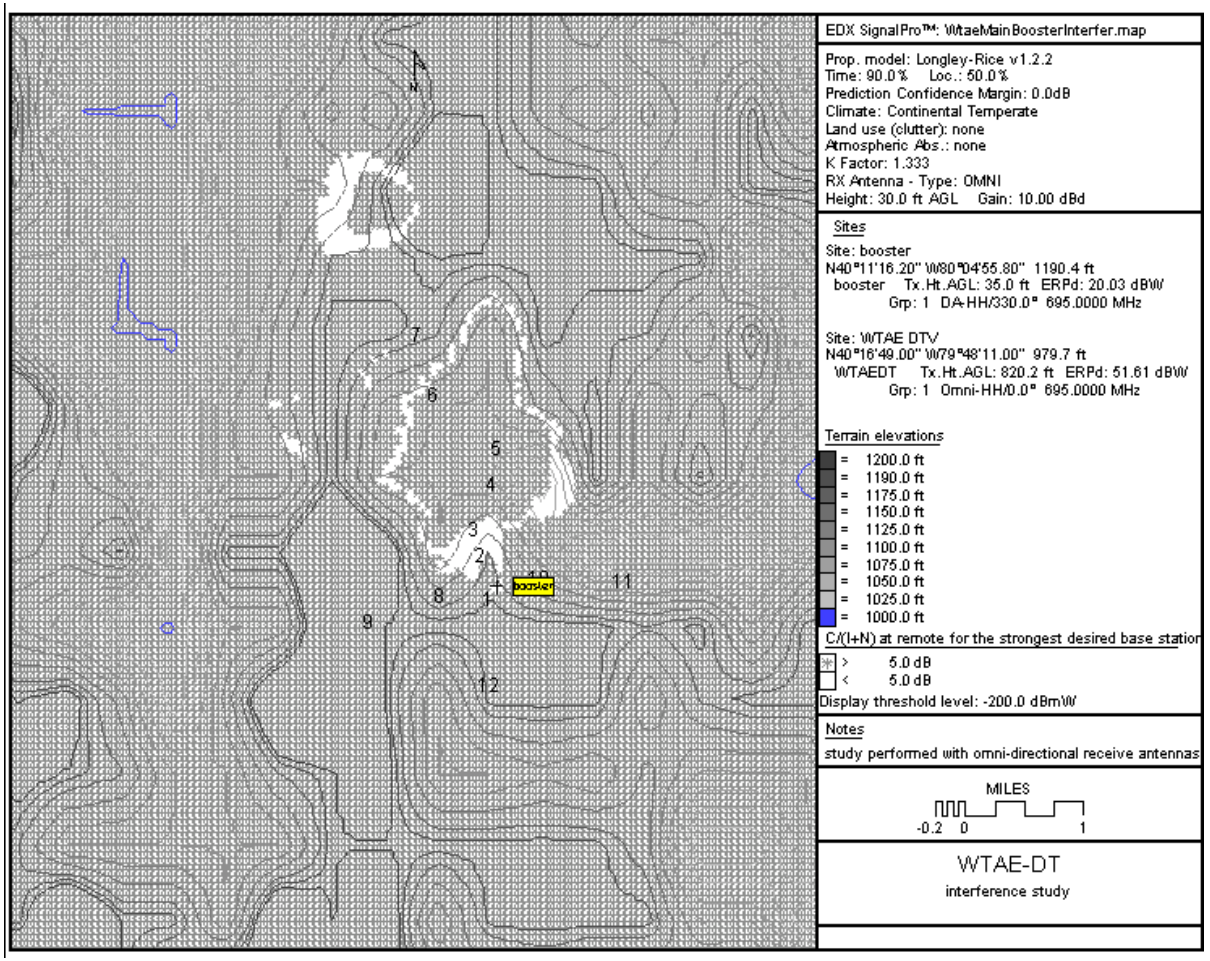
Receiver Affects Coverage



White areas indicate unacceptable interference levels between DTV transmitter and booster.

Omni receive antenna, relative delay **within** equalizer range

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Benefits of Multi-Transmitter For Mobile DTV Networks

- Terrain and urban shielding can be overcome
- Transmit diversity
- Signal strength more consistent throughout the coverage area
- Can target population centers with stronger signals
- Careful system design can support fixed and mobile DTV

Equipment

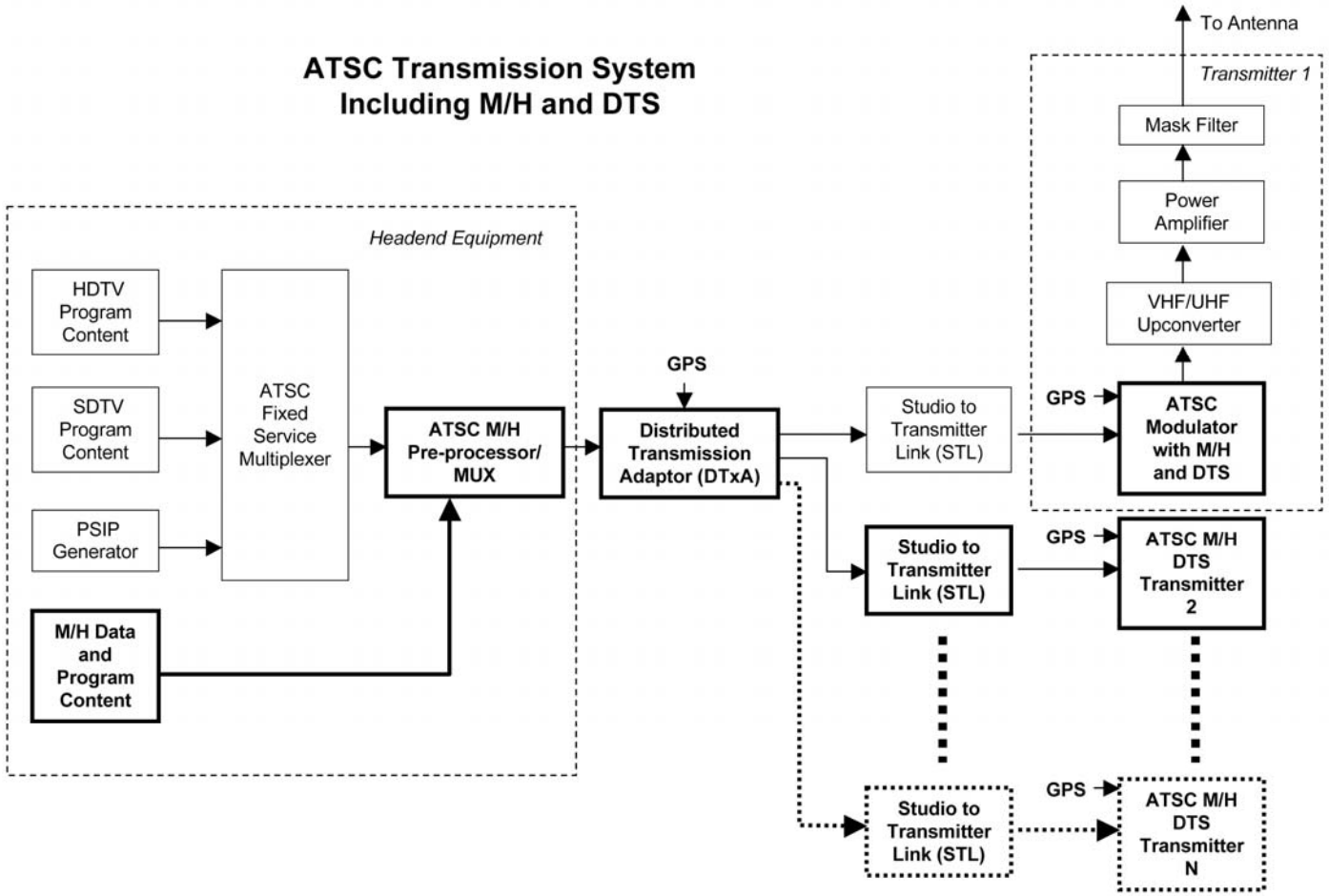
Multi-Transmitter Network

- 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



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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

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

System Design Considerations

- Terrain and Propagation
  - Network coverage analysis; Microwave/STL design
- Combine on-channel technologies
- Interference issues
  - Transmit/receive isolation
  - Co-Channel to own main transmitter signal (Mutual Interference)
  - Co-Channel to adjacent service areas
  - Adjacent-Channel in same service area
  - Timing requirements (DTx)

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 architectures

Thank You!

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