MSTV
MAXIMUM SERVICE TELEVISION

NAB
NATIONAL ASSOCIATION OF BROADCASTERS

Broadband Brown Bag Review of FCC's Engineering Forum

September 10, 2010

Broadband Brown Bag

- Review the conclusions of the working group panels from the FCC's Engineering Forum
  - Advancements in Compression Technology
  - Methodologies for Repacking the TV Band
  - Improvements in VHF Reception
  - Cellularization of Broadcast Architecture
  - Slides: http://reboot.fcc.gov/workshops/broadcast-engineering-forum
- Video: http://reboot.fcc.gov/video-archives

Advancements in Compression Technology

FCC Broadcast Engineering Forum
June 25, 2010

Richard Chernock, **Triveni Digital**
David Converse, **ABC**
Greg Coppa, **CBS**
Sterling Davis, **Cox**
Matthew Goldman, **Tandberg / Ericsson**
Brett Jenkins, **ION**
Glenn Reitmeier, **NBC Universal**
Mark Richer, **ATSC**
*Andrew Setos**, **FOX Broadcasting**
Peter Sockett, **Capitol Broadcasting**

*** Presenter**

MPEG-2 Video Improvements

1. Standard was mostly completed in 1992, and **published in 1994**
   -- Must maintain backwards compatibility
2. Compression efficiency improvement **gains mostly flattened out by ~2004**
3. **Step change in compression efficiency occurred in 2009** due to technology advances
   -- Fully exploits MPEG-2 algorithms to achieve optimum picture quality at selected bandwidth use
4. As such, **no meaningful efficiency improvements anticipated** for MPEG-2 Video

Channel Sharing with MPEG-2

1. FCC OBI proposed scenario: **1 HD service from each of 2 different licensees in same RF channel**
2. **With MPEG-2, one or both of the HD services will be significantly degraded**
   1. Examples today are done with extensive planning, constraints, in a dual network affiliation, under single ownership
   2. Requires severe constraints on programming options
   3. Reduces picture quality
   4. Forces "winner" v "loser" when complexity of one instantaneously exceeds available bandwidth
3. **Not viable for 2 different licensees**

Channel Sharing with Statmux

1. Statistical multiplexing ("statmux") is a technique that can improve bandwidth efficiency
2. Statmux efficiency is dependent on the mix of content bandwidth requirements on a frame-by-frame basis
   -- Content bandwidth requirements are not under broadcaster control
   -- Bandwidth requirements of commercial advertisements are not under broadcaster control
3. Statmuxing of 2 HD services requires picking a "winner" and a "loser"
4. Which of the 2 licensees picks the "winner"?
   -- The "loser" will be put at a commercial disadvantage
   -- The consumer suffers loss of services
5. Statmux efficiencies are lost with 2 separate licensees

Current Service Models

1. 6MHz RF channel bandwidth is used for **more than just a single primary HD service**
2. Other current service models
   - -- HD + multi-service programming
   - -- HD + Mobile DTV
   - -- HD + multi-service + Mobile DTV
3. Other current service models are not possible with channel sharing, even with statmuxing
   - **-- Bandwidth constraints are exacerbated beyond the 2 HD scenario**
4. **Bandwidth demands will continue to increase due to mandated and competitive services**

Migration to a more efficient coding technology

1. Technology exists to produce products that support both MPEG-2 and a newer, more efficient coding technology
2. Current TV receivers and converter boxes will not be able to display newer coding technology, so **a second digital transition plan would be required**
   - -- Likely will take more than 13 years to migrate
     - -- Regulatory, legislative, standards setting, and grace period
     - -- Receiver replacement cycle
     - -- Requires another converter box program
   - -- New receivers need to support both MPEG-2 and newer compression technology
   - -- In that timeframe, a newer compression technology (beyond MPEG-4 AVC / H.264) may occur

Channel Pairing

The OBI observes that **there may be opportunities to pair HD and SD-only stations in order to achieve channel sharing**

- Can't rely on SD content being available
- Licensees are still migrating to HD
- **Industry trend is to 100% HD**

Panel on Methodology for Repacking

Members:

Lynn Claudy
Bruce Franca
Mel Frerking
Ira Goldstone
John McCloskey
William Meintel
James Ocon
Joseph Snelson
Byron St. Clair
John Viall

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Question 1

- Summarize status of our new modeling efforts and review assumptions behind them
- OBI study presents two scenarios:
  - 2:1 Channel Sharing
    - 120 to 60 MHz recovered
  - Repacking (without channel sharing)
    - 42 to 6 MHz recovered

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Review of OBI Study Assumptions

- Considers only full power DTV stations
  - Different Number of Stations in All Six Results
- Does not take into account Class A TV stations, LPTV or translators
- Lists amount of "recoverable spectrum" but not its location (VHF or UHF or both?)
- Uses three U.S. Border conditions
  - No restrictions and protecting only current "active" allotments appear unrealistic
- Unclear whether results include Public Safety/Land Mobile protection

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Population Losses from OBI Studies

Scenario	Border Condition	Recoverable Spectrum	Stations with Service Loss	Ave. Pop. Loss/Station	Total Pop. Loss* (Millions)
OBI 2:1 Sharing Results	Treaty/ Agreements	**60**	**558**	**37,741**	**21.0**
	Active allotments	**72**	**629**	**43,097**	**27.1**
	No Border Restrictions	**120**	**884**	**56,904**	**50.3**
OBI Repacking Results	Treaty/ Agreements	**6**	**130**	**18,084**	**2.35**
	Active allotments	**42**	**394**	**37,978**	**14.9**
	No Border Restrictions	**42**	**386**	**38,859**	**15**

*Population Loss is equal to stations with service loss multiplied by average population loss per station. Viewers losing multiple channels are counted based on the number of channels lost. Therefore, a viewer that losses two channels is counted the same as two people that lose 1 channel each.

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What's Missing/Needed from Analysis?

- A complete scenario that assesses impact by progressively adding conditions
- What is the impact of recovering 120 MHz from UHF band?
- Factors considered
  - 1735 full power DTV stations*
  - Protection of Public Safety/Land Mobile
  - 520 class A LPTV stations*
  - Canada/Mexico treaty obligations
- Determine what the impact is and where it occurs?
  - Goal is to determine trends

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Industry Repacking Studies

- Study Assumptions:
  - Locate all broadcast operations between TV channels 2 and 30
  - Retain existing TV channel 2 to 6 stations operations (but do not add more low VHF operations)
  - *Full Repacking* allowed within channels 7 to 30
    - Repacking based on reduced station spacings
      - (190 km for both low and high VHF and 180 km for UHF, adjacent channel 10 -70 km)
  - All studies protect existing LM operations
  - Studies done with and without class A TV stations
  - Studies done with and without protection of border operations

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Industry Study Results

- How many stations can not be given a channel assignment and must share with another station?

Scenario	Stations Not Accommodated and Required to Share Channel with Another Station
Full Power, LM, No Class A, No Border Protection	124
Full Power, LM, Class A, No Border Protection	281
Full Power, LM, Class A, Border Protection	366

- Minimum number of stations that must share are two times the number shown in second column
  - 124 X 2 = 248 stations compares closely with 204 stations in OBI study

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Industry Study Results

- How many DMAs are impacted and have stations that must share channels?
  - More complete impact of channel sharing covered in Question 6

Scenario	Stations Required to Share Channel with Another Station	Number (Percentage) of DMAs where Sharing Required
Full Power, LM, No Class A, No Border Protection	124	42 (20%)
Full Power, LM, Class A, No Border Protection	281	66 (31%)
Full Power, LM, Class A, Border Protection	366	85 (40%)

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Summary of Industry Results

- Adding Class A has impact similar to border protection
  - More than doubles number of stations required to share
  - Markets impacted increase from 20% to 31%
- Protecting Class A stations and protecting border stations
  - Increases the number of stations that must share from 124 to 366 (factor of 3)
  - Increases the number of markets where sharing occurs from 20% to 40%
- All scenarios include markets where greater than 2:1 sharing is required and markets where 100% of stations must share

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Question 6

- What are the impacts on channel-sharing?
- OBI Report:
  - "We are not suggesting that channel sharing would be the right approach for all broadcast stations ..." p. 23

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Impact of Channel Sharing

Scenario	Stations Required to Share Channel	Number/ (Percentage) of Markets where Sharing Required	Number of Markets where Greater than 2:1 Sharing Required	Number of Markets where 100% of Stations Required to Share 2:1	Number of Markets where 80% or more Stations Required to Share 2:1
Full Power, LM, No Class A, No Border Protection	124	42 (20%)	4	5	8
Full Power, LM, Class A, No Border Protection	281	66 (31%)	5	10	18
Full Power, LM, Class A, Border Protection	366	85 (40%)	12	21	29

- Channel sharing required in many markets
- In some markets, all or most stations have to share

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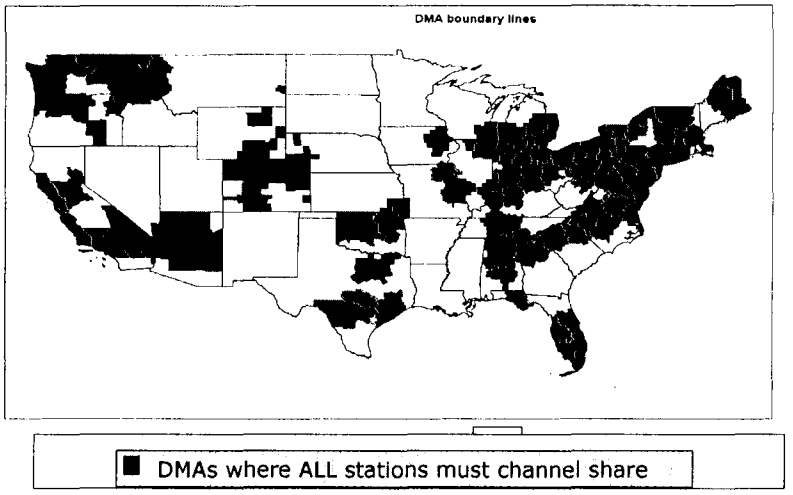
DMAs Where Sharing Required

Full Power, LM, Class A, Border Protection



Question 6 Response

- Amount of channel sharing required is related to the amount of spectrum recovered and the protections included
- Channel sharing impacts large number of stations especially in the larger DMAs
  - Impacts or eliminates current and future DTV services

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VHF Reception Panel

William Belt, Consumer Electronics Association
Greg Best, Greg Best Consulting
Charles Cooper, duTreil, Lundin and Rackley
Kerry Cozad, Dielectric Communications
Ross Heide, Cohen, Dippell and Everist
Ralph Hogan, Society of Broadcast Engineers
Jeff Johnson, Gannett
Dave Young, Antennas Direct
Victor Tawil, MSTV
Kelly Williams, NAB

Background - *VHF Station Statistics*

- Few Stations Operate in Low VHF
  - 39 full power stations
  - 2% of all DTV Stations Operate in Low VHF
- Significant Number of Stations in High VHF
  - 425 Stations
  - 25% of all DTV Stations Operate in High VHF
  - Since transition, 16 stations have received authorization to move to UHF channel

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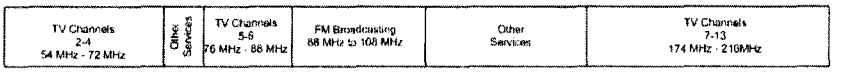
Background- *Television Bands*

- Low VHF (channels 2 to 6)
  - *Frequency: 54 to 88 MHz*
  - *Wavelength: 5.55 to 3.41 meters (18.2 to 11.19 feet)*
- High VHF (channels 7 to 13)
  - *Frequency: 174 to 216 MHz*
  - *Wavelength: 1.72 to 1.39 meters (5.64 to 4.56 feet)*

VHF BROADCAST FREQUENCY BAND PLAN



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Background – *Consumer Antenna*

- Consumers avoid large antennas due to aesthetic reasons and Code and Covenant Restriction/Deed Restrictions
- Few Low VHF stations, no consumer demand
- No retail option due to revenue density requirements, return rates, shipping costs
- Multiple televisions in different rooms pose additional problems

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Low VHF Environment

- Evidence suggest Low-Band VHF has reception issues using indoor and outdoor type receiving antennas
  - Reception previously possible with analog facility on same RF channel
  - DTV Reception Issues
    - Man-Made Electrical Noise
    - Atmospheric Noise
    - Inefficient Receiving Antenna
    - Transmit Power Increase to reduce the significance of these issues is 15 to 20 dB

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High VHF Environment

- Evidence presented suggest High-Band VHF has reception issues using indoor type receiving antennas
  - DTV Reception Issues
    - Man-Made Electrical Noise
    - Inefficient Receiving Antenna
    - Transmit Power Increase to reduce the significance of these issues is likely on the order of 10 dB or more

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Background – *VHF Transmitters*

- To improve Low VHF reception by 20 dB would be impractical
  - Would need to increase the TPO to 240 kW
  - Over 20 cabinets using liquid cooled transmitters would be needed
  - AC to RF efficiency of around 20%
- To improve High-VHF Improvement of 10 dB would be doable, but difficult
  - Would need to increase TPO to 27 kW
  - 3 cabinets using liquid cooler transmitter
  - AC to RF efficiency of approximately 20%

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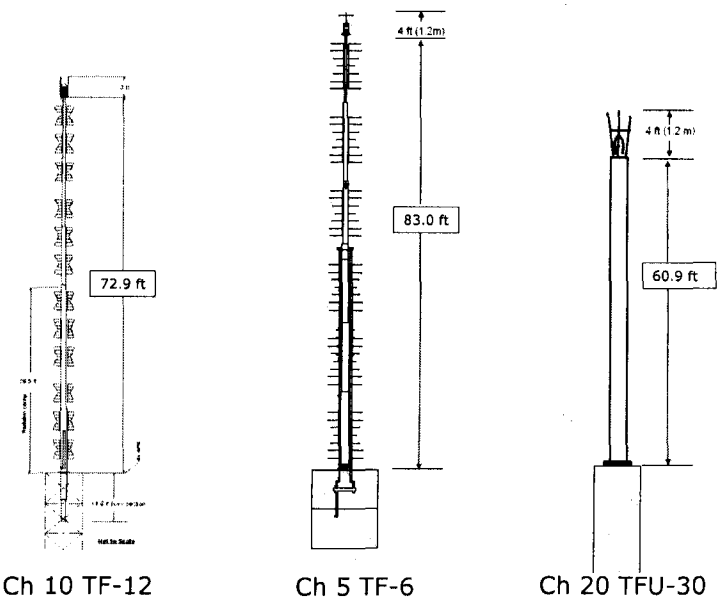
Antenna Length Comparison



Ch 10 TF-12
Gain ~ 12x

Ch 5 TF-6
Gain ~ 6x

Ch 20 TFU-30
Gain ~ 26x

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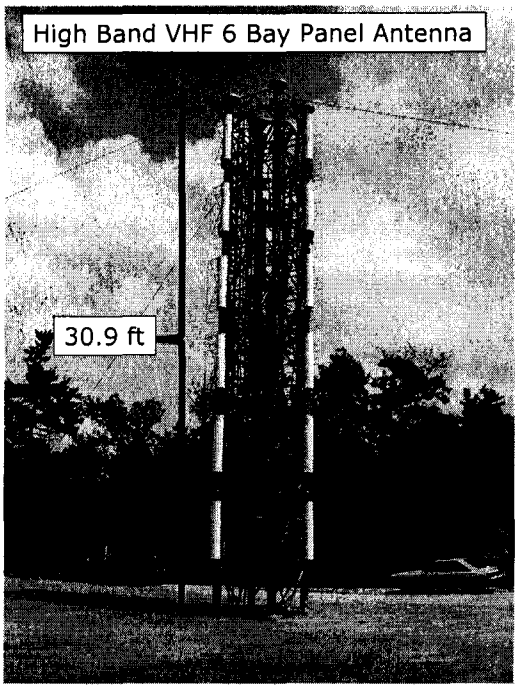

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Background – *Consumer Antenna*

- Consumers avoid large antennas due to aesthetic reasons and Code and Covenant Restriction/Deed Restrictions
- Few Low VHF stations, no consumer demand
- No retail option due to revenue density requirements, return rates, shipping costs
- Multiple televisions in different rooms pose additional problems

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Question no. 1

- *What changes could be made to VHF station transmissions (power, antenna and others) to improve the reception of their signals within their service areas?*
- *Limited options to improve the VHF service:*
  - *Low VHF*
    - *Power increases will help, but there are physical and practical limitations to achieve any significant reception improvement*
  - *High VHF*
    - *Power increases will improve reception in some cases. However increase power can lead to increase interference to other stations. Implementation constraints will have to be taken into account.*

Question no. 2

- *Have improvements in technology made it possible to improve consumer receiver/antenna performance, especially for indoor reception?*
- There are no "silver bullets" that will offer dramatic improvements in DTV for the VHF bands. Antenna size will continue to limit Low VHF improvements
- Improvements in computer simulation and design technology have allowed incremental improvement of antennas. To date however, most of these incremental improvements have been realized in antennas that operate in the UHF and High VHF bands. While antenna companies could realistically make additional incremental improvements in the size and performance of Low VHF antennas, known physical laws preclude radical "order of magnitude" type improvements

Question no. 2 (continued)

- Indoor reception problem is probably the best candidate for a high technology solution. Options such as ***smart antennas*** or the use of wireless repeater systems to make it easy for consumers to relay signals from compact outdoor antennas through the roof or a wall to indoor televisions. Development of solutions such as these often depend on the cooperation of the television manufacturers to implement a new feature or technology in their flat panel televisions. This is a difficult since television ***manufacturers are reluctant to add additional cost to their products***. It is unlikely that any new technology for improving reception will occur in the near future.

Question no. 2 (continued)

- In the receiver signal path, improvements to shielding, input filtering and overload resistance and linearity may help relieve some reception issues. None of these improvements however will offer the radical improvements necessary ensure good performance in the Low VHF band
- ***Reducing the spurious and out of band emissions from consumers devices may help***

Question no. 3

- *Should the FCC set consumer antenna performance standards? Increase maximum power limits?*
- ***FCC should not set consumer antenna performance standards***. The universe of antenna characteristics including, gain vs frequency, VSWR, bandwidth, and other technical characteristics, coupled with the variability of the individual viewer's geography, make a one size fits all performance standard difficult and impractical
- Need to standardize descriptive terminology and performance measurement standards could be helpful to manufacturers, retailers and consumers

Question no.3 (continued)

- *Should the FCC set consumer antenna performance standards? Increase maximum power limits?*
  - Yes, increasing maximum power limits will improve reception, especially at High VHF for indoor reception. Power increases however increase the interference distance, and are limited by physical, and practical constraints

Question no. 4

- *What options are available for improving TV service in the lower VHF band?*

- ☐ There are currently ***very few, if any***, avenues for improving TV service in the Low VHF band. Practical power increases will marginally improve reception, but given the increased RF noise level in the band, and physical limitations on the size and efficiency of the transmit and receive antennas, the increase is not sufficient to compensate for these deficiencies
- ☐ ***Reducing the spurious and out of band emissions from consumers devices may help***

Question no. 5

- *What is the most optimal use of the lower VHF band?*
- There are several options for sharing the Low VHF band with existing broadcast licensees. Options include:
  - Designate it as a Spectrum Innovation Band and Permit alternative uses of Low-VHF band, such as:
    - » Long distance digital data back hauls
    - » Rural law enforcement and local emergency responders
    - » Others, where use is to be determined by entrepreneurs

Question no. 6

- *How should we be thinking about the VHF band in general – what is the best use of that spectrum?*

- *Low VHF*
  - *The answer is highlighted in question no.5*

- *High VHF*
- *Other than the current use of the band, Group did not have an opinion on this question*

Final Thoughts

- Improvement in VHF reception is difficult and limited by:
  - The laws of Physics
  - RF environment
  - Practical limitation of transmitting and receiving equipment design

Engineering Forum - Cellularization of Broadcast Architecture / Distributed Antenna Systems

Panelists

- **Jay Adrick**, Harris Corporation
- **Mark Aitken**, Sinclair Broadcasting
- **Rick Engelman,** Sprint
- **Vern Fotheringham**, CTB Networks
- **Bob Seidel,** CBS
- **Dennis Wallace**, Meintel, Sgrignoli & Wallace
- **Merrill Weiss**, Merrill Weiss Group

Questions

- How could this be used to improve spectrum efficiency in the TV bands?
- Could we recover any spectrum, or could we get improved spectrum efficiency in other ways?
- Could DAS be used to provide stronger signals in the outer portions of a station's service area without causing interference?
- What are the practical issues involved in implementing DAS operations?
- What would stakeholders get out of a cellularized broadcast architecture?
- Is this feasible, promising?
- How many stations could share a cellular system?
- What would be the channel re-use rate?
- Could more stations operate under a cellular system than under the conventional single transmitter model?
- What is the role for wireless carriers?
- What is the opportunity for a return path?

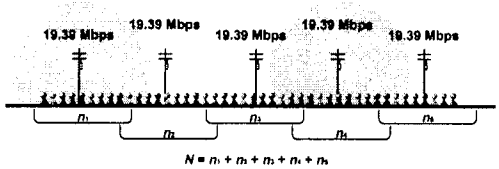
MFN vs. SFN

CTB Group

- **Multi-Frequency Network (MFN)**

ADVANTAGES:
- Unlimited Bandwidth by Frequency Reuse.
- Scales to Demand.
- Enables Micro-Location Based Services.

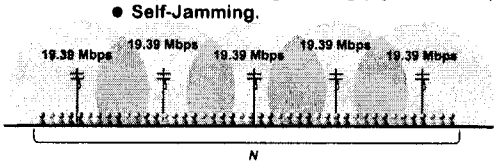
DISADVANTAGE:
- Requires Multiple Channel Licenses.



- **Single Frequency Network (SFN)**

ADVANTAGE:
- Uses Only One Channel.

DISADVANTAGE:
- Fixed and Limited Bandwidth.
- High Cost of Engineering (Synchronous).
- Self-Jamming.



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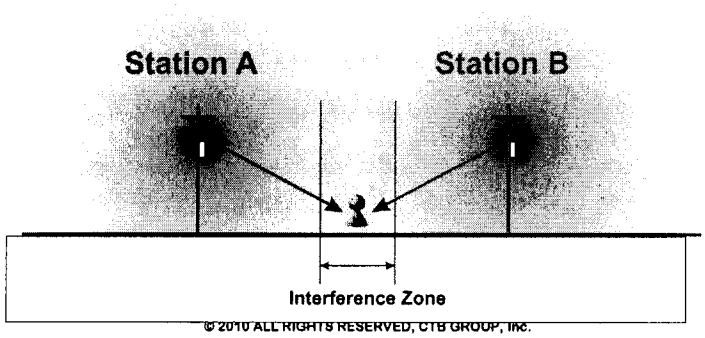
Problems with SFN Systems

- Self-Jamming.
  Signals from the other DTS stations create noise.
- Higher Cost of Engineering and Deployment (Synchronous).
  In order to avoid the self jamming, the other stations must be precisely coordinated and transmit their signals synchronously.
- Constrained by limited bandwidth, NO Frequency Reuse.
  The signal and contents for these stations must be identical.



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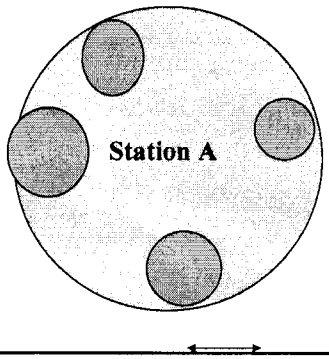
Distributed Transmission Systems (DTS)

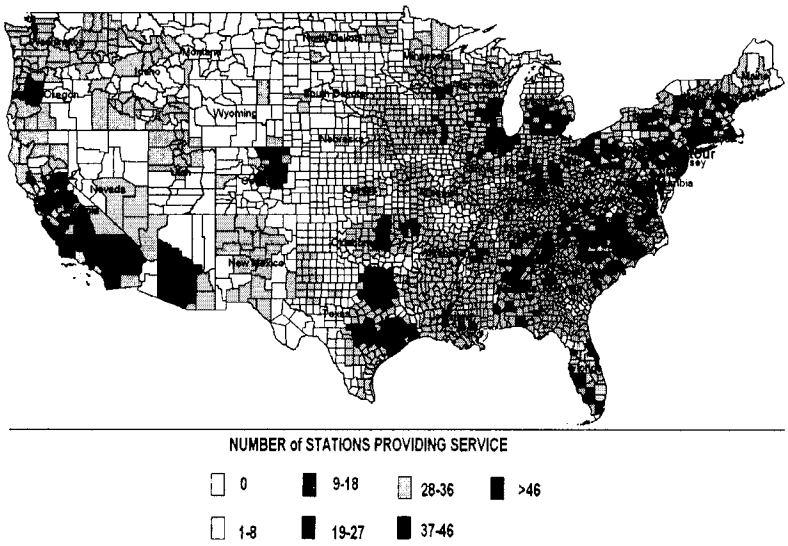
- Multiple distributed transmission points each using a dedicated and synchronized transmitter
- May be one high power master site and multiple lower power supplemental sites or a group of equal power level sites but in each case, all synchronized.



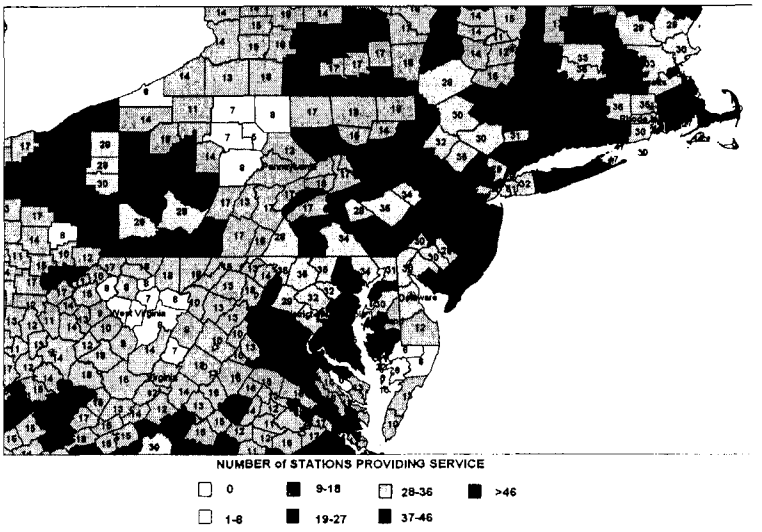
Description of Analysis

- The analysis attempted to determine the number of Full Power TV channels, and Class A that are being received for every county in the US. The analysis also include in the count the existing Land mobile channels in the top 11 markets. (not including LPTV or translators)
- The purpose of the analysis is to show that in large metro areas on the East coast, California, Chicago, etc. the number of channels required to serve these counties is large.
- The data is plotted in the following slides:

Nationwide No. of TV channels (stations) received by County



East Coast # of TV channels (stations) received by County



Conclusions

- The is little or no UHF television spectrum that can be efficiently re-harvested.
- Broadcasting is part of the solution for the National Broadband Plan
  - Broadcasting is the original broadband
- Government receives five percent of the broadcast ancillary service revenue
  - The Broadcast industry is investing in the broadband future
- MFN cellularization is complementary to traditional broadcast and wireless broadband.

Conclusions (cont'd)

- The NTIA sponsored New York City Distributed Transmission System (DTS) test by the Metropolitan Television Authority found:
  - At best, the performance of the SFN/DTS system was marginal.
  - The SFN/DTS created self-induced interference, which hampered the reception of the DTV signals from the Empire State building.
- There are no mandated consumer receiver requirements for ghost canceling or antennas, which makes designing a DTS impractical.

Conclusions (cont'd)

- The operating expense of a SFN/DTS Cellular Transmission System for traditional television broadcasters makes it economically unviable for even the large market TV stations.
- Since the major population centers have large numbers of Full power and Class-A stations (24, 26 or more channels per market), and overlapping coverage areas (ex, Washington/Baltimore), cellular Distributed Transmission System (DTS) <u>likely will NOT recover spectrum in areas where it is most needed.</u>

Thank You