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Broadcast Antenna Design To Support Future Transmission Technologies

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Future next generation broadcast system

Assumptions based on broad industry consensus

- Based on OFDM
- Synchronous SFN's
- Higher bit capacity
- Central high power antenna. Full ERP. Multiple gap fillers
- Post auction repack - more co-located antenna sharing
  - Requires broadband antenna systems
- Use of PLP's
  - Allowing tailoring coverage areas for fixed, nomadic or mobile services

Antenna will have to adapt to provide the necessary field strength in the desired locations

Signal strength approximations

Purpose is not to establish next generation planning factors

FCC ATSC A/53 minimum field strength	41 dBu
Reduce antenna height 30ft. to 8ft.	7 dB[1]
Building wall attenuation	10-28 dB [2]
Smaller inefficient receive antenna gain (-3 dBd)	9 dB
Dynamic multipath (Ricean to Rayleigh)	9 dB[3]
Minimum required field strength for an indoor NG broadcast service to support a data rate based on 15 dB C/N	94 dBu

Based on
- Outdoor
- Fixed antenna at 30’
- 6dB gain (10dB-4dB down lead)
- C/N 15 dB

[1] iBLAST DATA BROADCASTING FIELD TESTS
“A Study to Understand and Quantify Reception of the ATSC Signal”, Andrew Miller, Steve Lacey, Jerry Glaser, Mike Stauffer, and Pete Ludé, 23 April, 2001
[2] TV Technology: “DTV in the House, Part1”, Doug Lung, Sept 5, 2007
[3] IEEE Transactions on Broadcasting (Impact Factor 2.09) 04/2009
“Analysis of DVB-T signal variation for indoor portable reception”, A Martinez, D. Zabala, I. Pena, P. Angueira, M. Velez, A Arrinda, D.de la Vega, J.L. Ordiales

Physical Layer Pipes

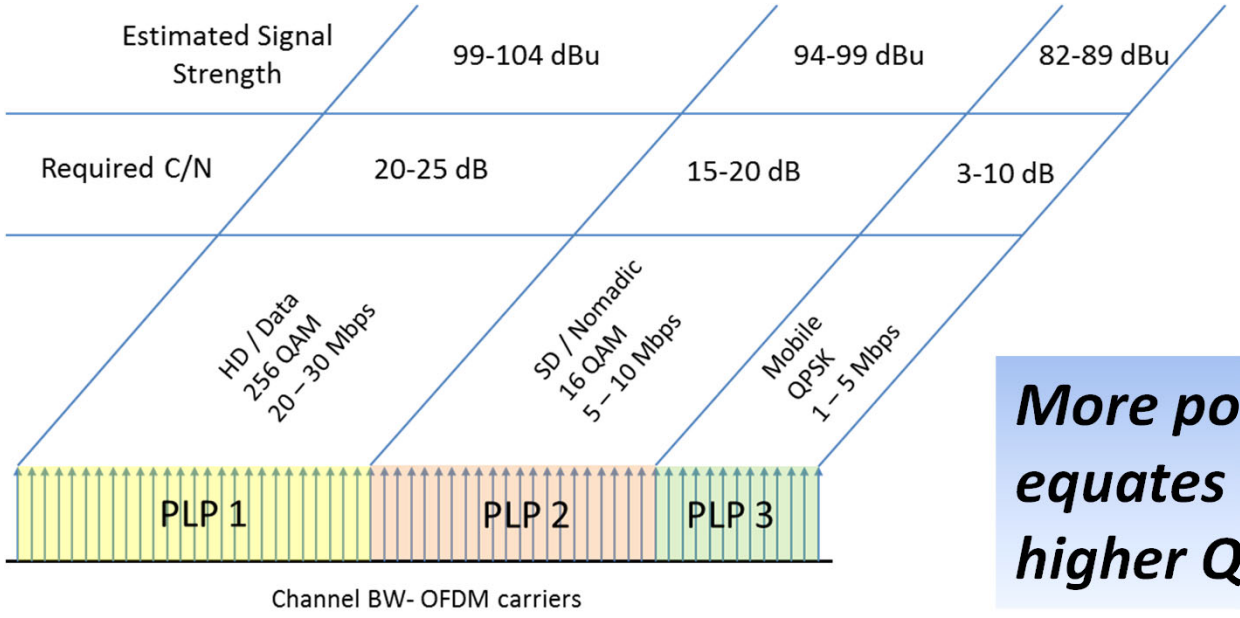
- Allows broadcaster to offer variety of business models within coverage area

PLP

Modulation

FEC

Different levels of robustness and QoS



More power equates to higher QoS

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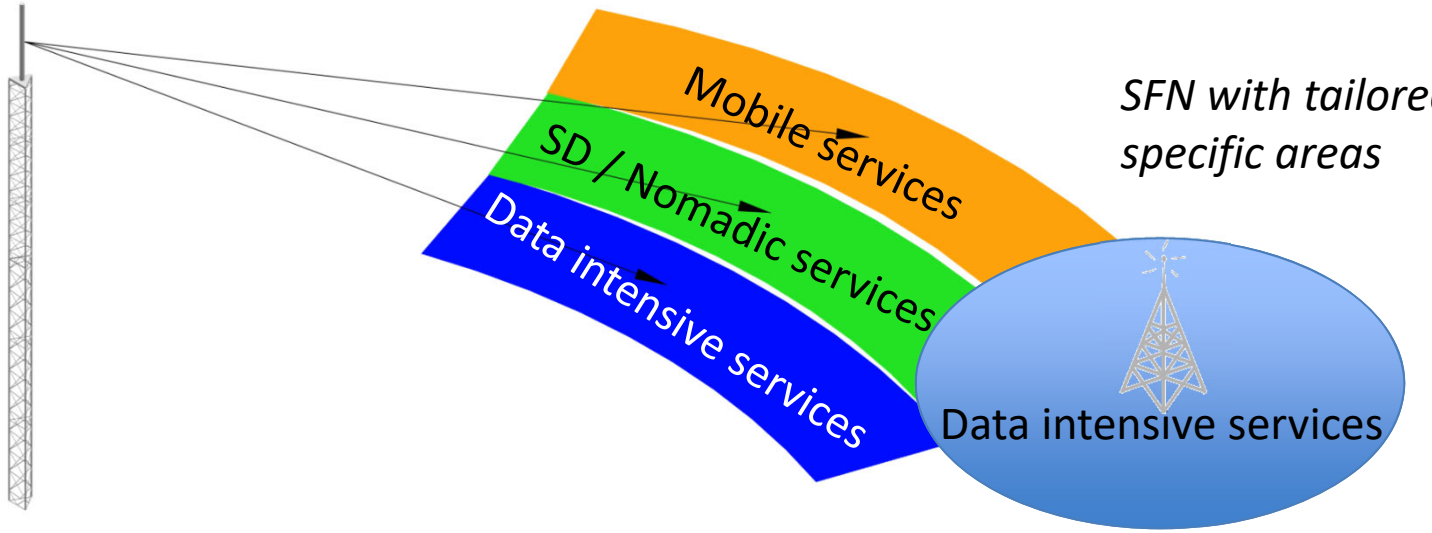
Next generation network

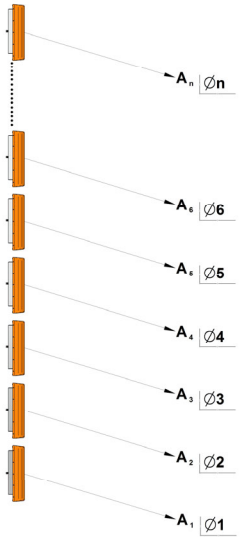
In the future, in order to take advantage of the PLP's, the signal strength versus distance from the antenna must be a controllable feature of the antenna



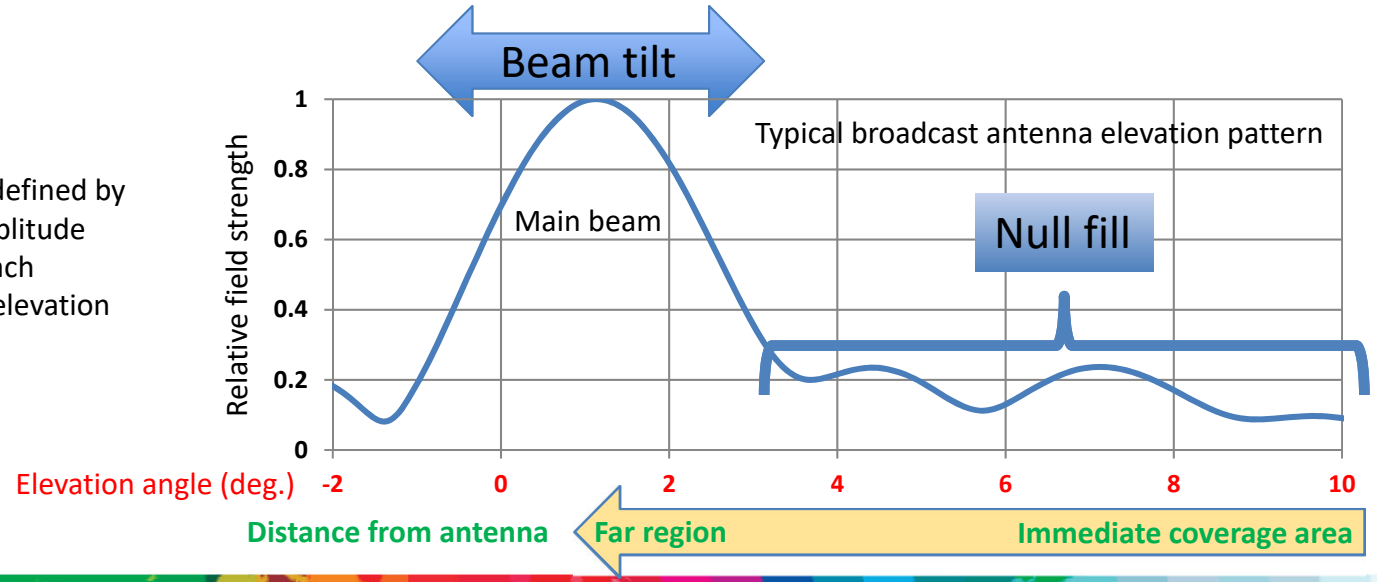
SFN with tailored services to specific areas

Next generation antennas

Given a constant input power, the signal strength vs. distance from the antenna is controlled by beam tilt and null fill



Illumination is defined by the relative amplitude and phase of each radiator in the elevation plane.



Next generation antennas

In anticipation of next generation services, future proofing should be considered if purchasing an antenna now.

- Consider the design of a field convertible beam tilt or null fill antenna
  - Design goals
    - Broadband to support co-located antenna sharing
    - Increase signal strength in specific areas with minimal gain loss in other regions
    - **Method must be simple!**
      - Do not add complexity
      - Short conversion time

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Possibility of a field convertible beam tilt antenna

Wireless industry and RET

Use of RET is common practice to control signal strength vs. distance from the tower

Unfortunately for broadcasters

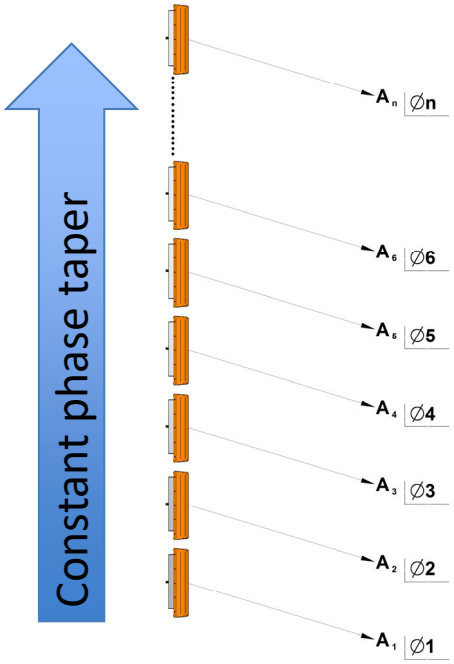
- Higher gain antennas
- Narrower beam widths
- Higher elevations

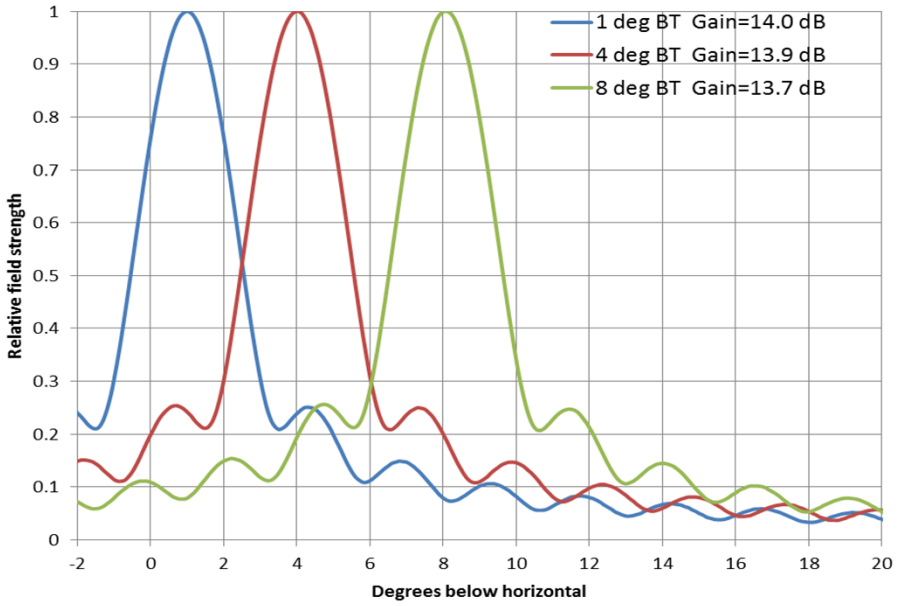
Makes increasing the beam tilt an inefficient method to produce signal saturation in desired locations

Effect of beam tilt on coverage using high gain antenna

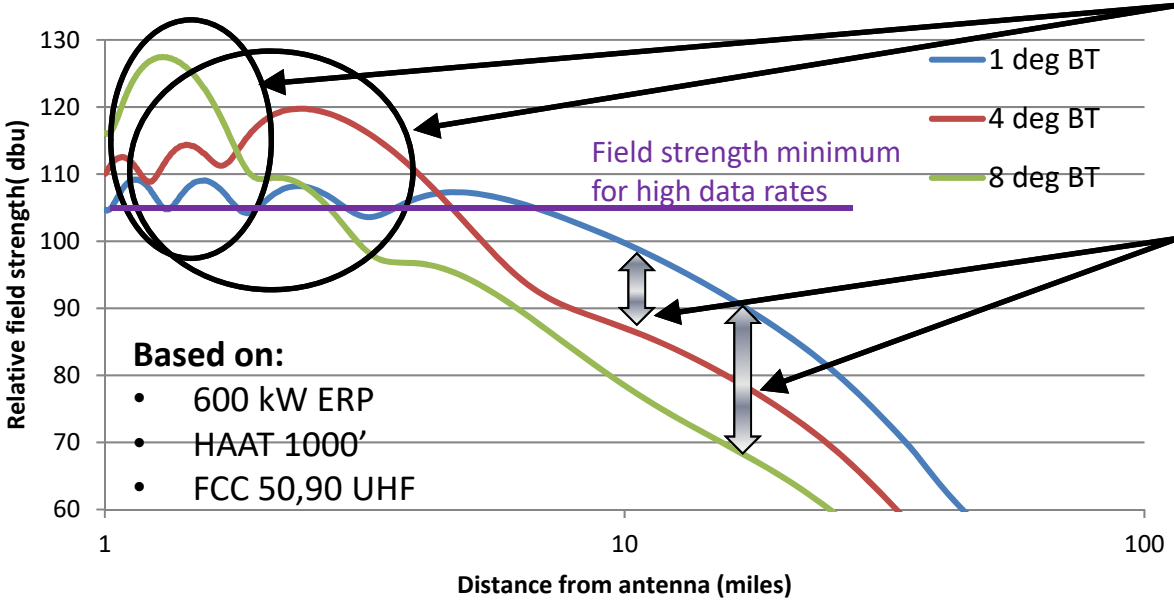
Addition of phase shifters to control beam tilt

Not trivial….





Effect of beam tilt on coverage using high gain antenna



20 dB increase over very limited distance

20 dB loss over most of the coverage area

Not acceptable in next generation networks since a large amount of gap fillers will be required to increase the signal strength outside of the saturated coverage area.

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Possibility of a field convertible null fill antenna

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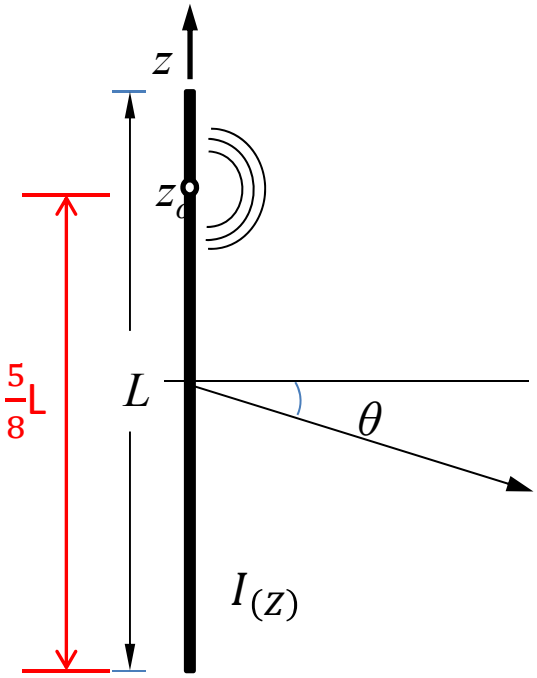
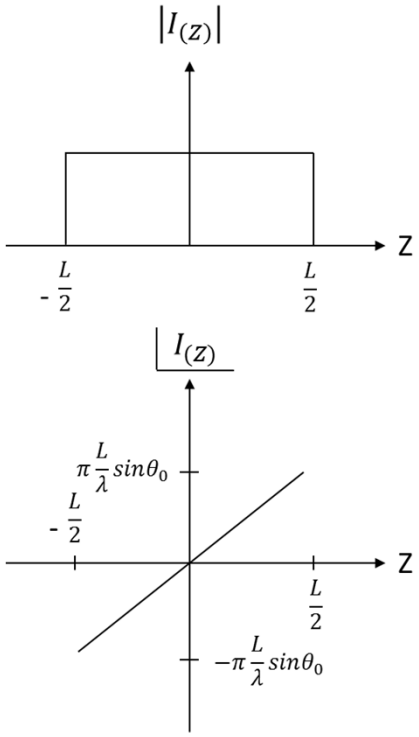
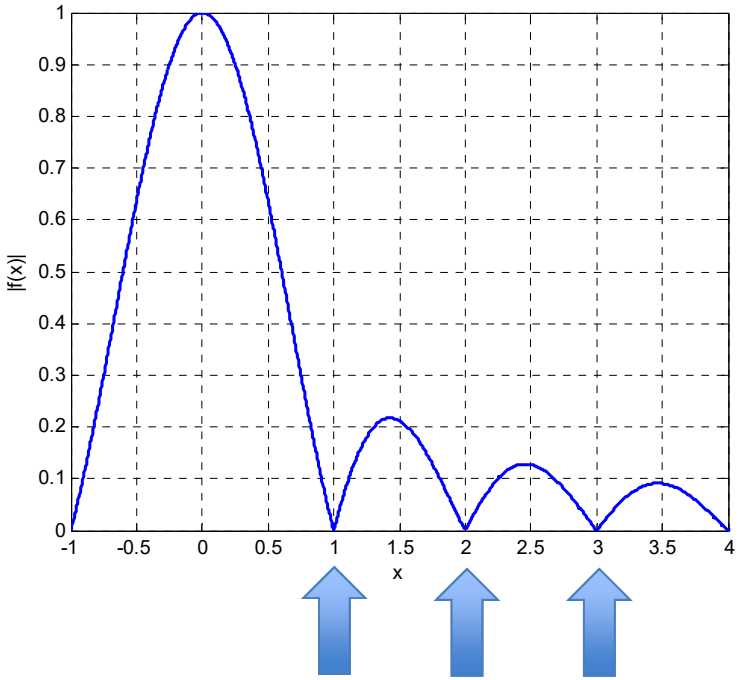
Null fill





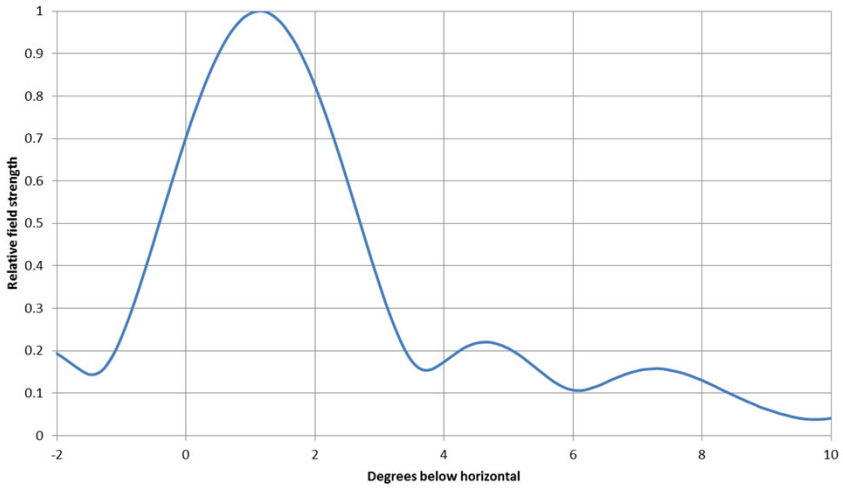


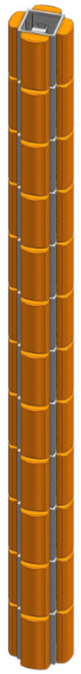
Field convertible null fill antenna

- Lead to the development of custom illuminations with standard null fill that react positively to this theory.
- Produce heavy null fill with a **simple** adjustment to the antenna.

Example:

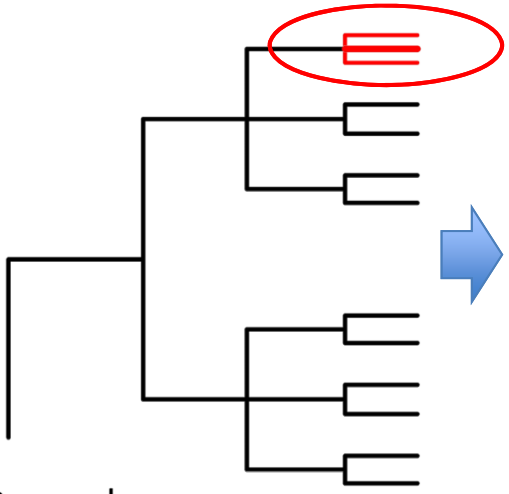
- 24 layer broadband panel antenna
- 12 vertical panels
- Beam tilt 1 degree
- Null fill 15%-10%-5%
- Elevation gain 25 (14.0 dB)

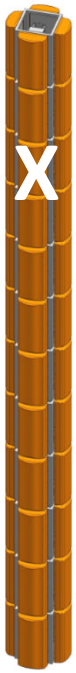




Field convertible null fill antenna

Turning one panel layer off

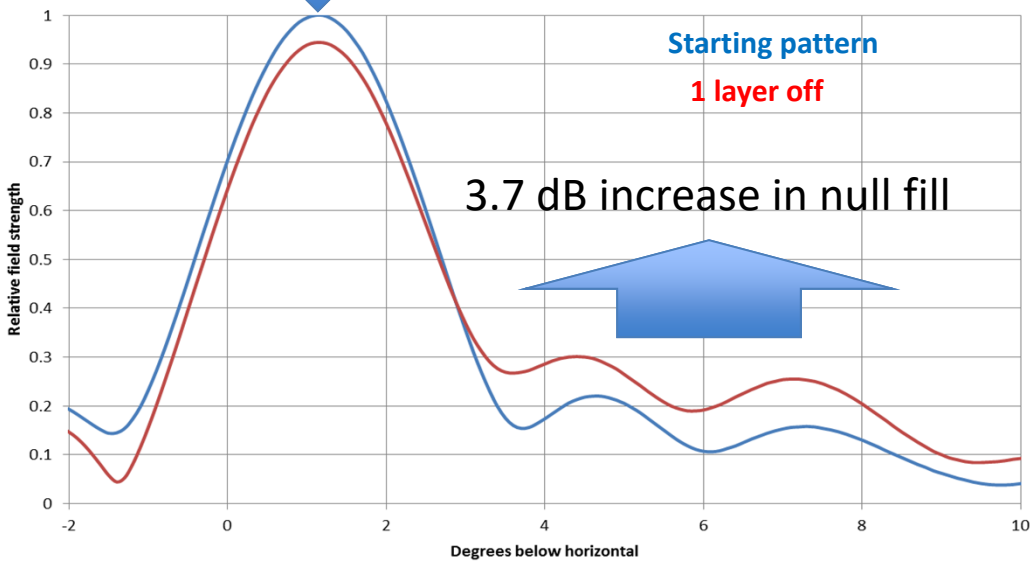




Procedure:

1. Remove one power divider
2. Re-connect a layer of feed lines

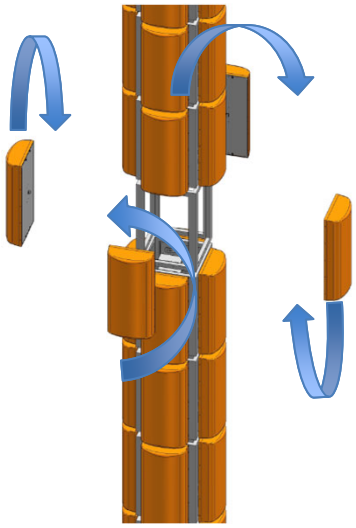
.5 dB reduction in gain

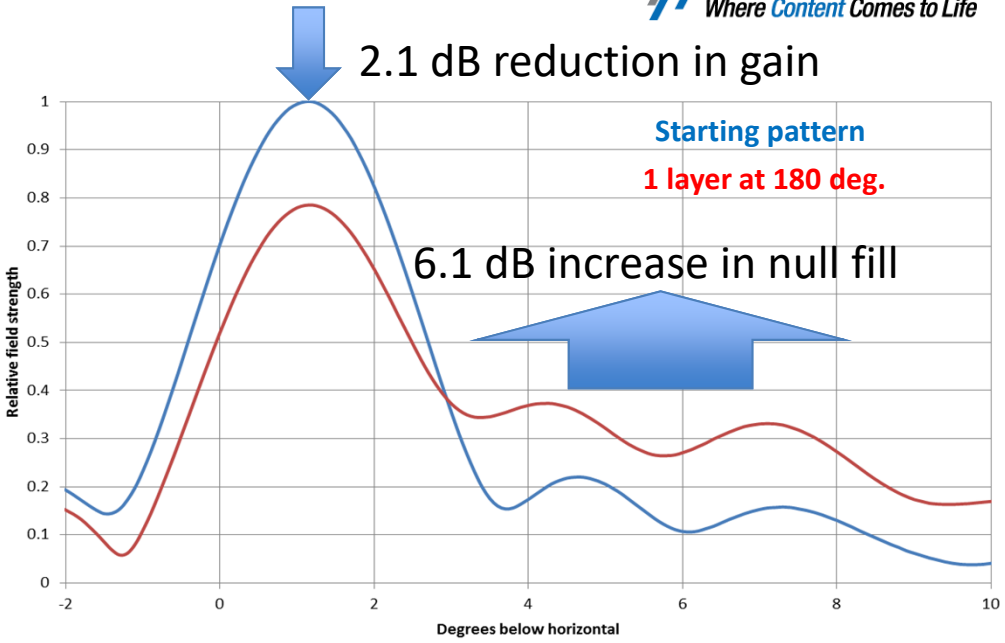


Assuming same input power, taking into account slight power division created by de-activating one panel and the gap left in the vertical array

Field convertible null fill antenna

Re-phasing one panel layer 180 degrees





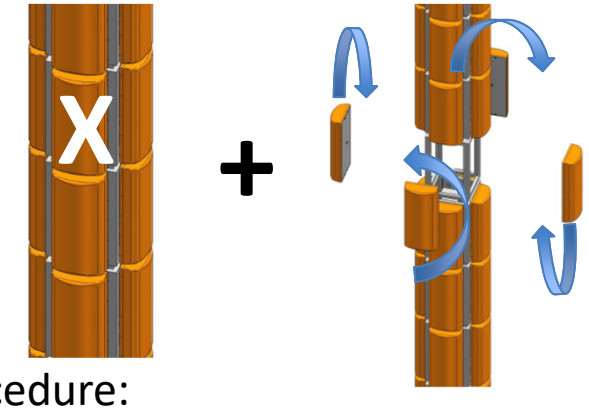
Procedure:

1. Flip one layer of panels upside down

Assuming same input power.

Field convertible null fill antenna

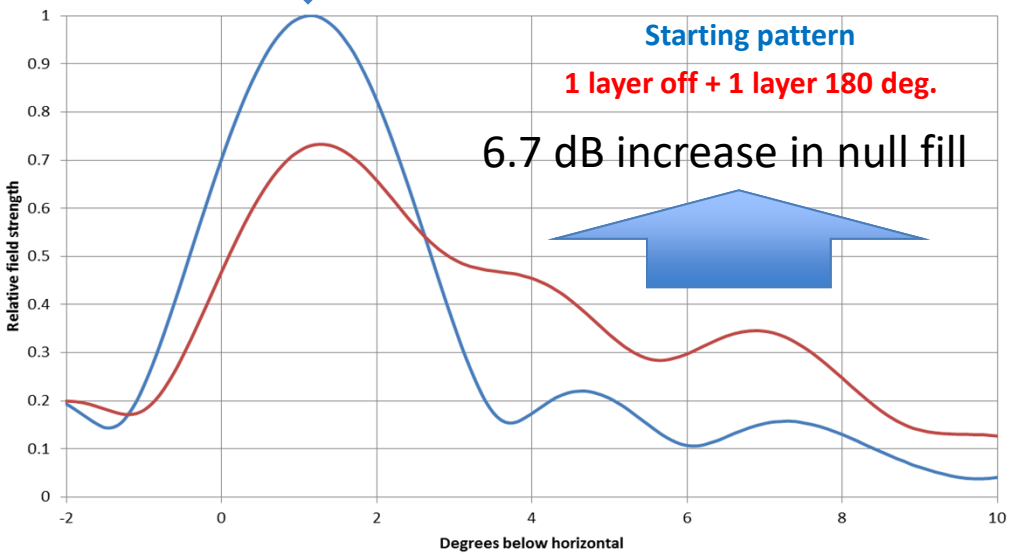
Combination re-phasing one panel layer 180 degrees and one layer off



Procedure:

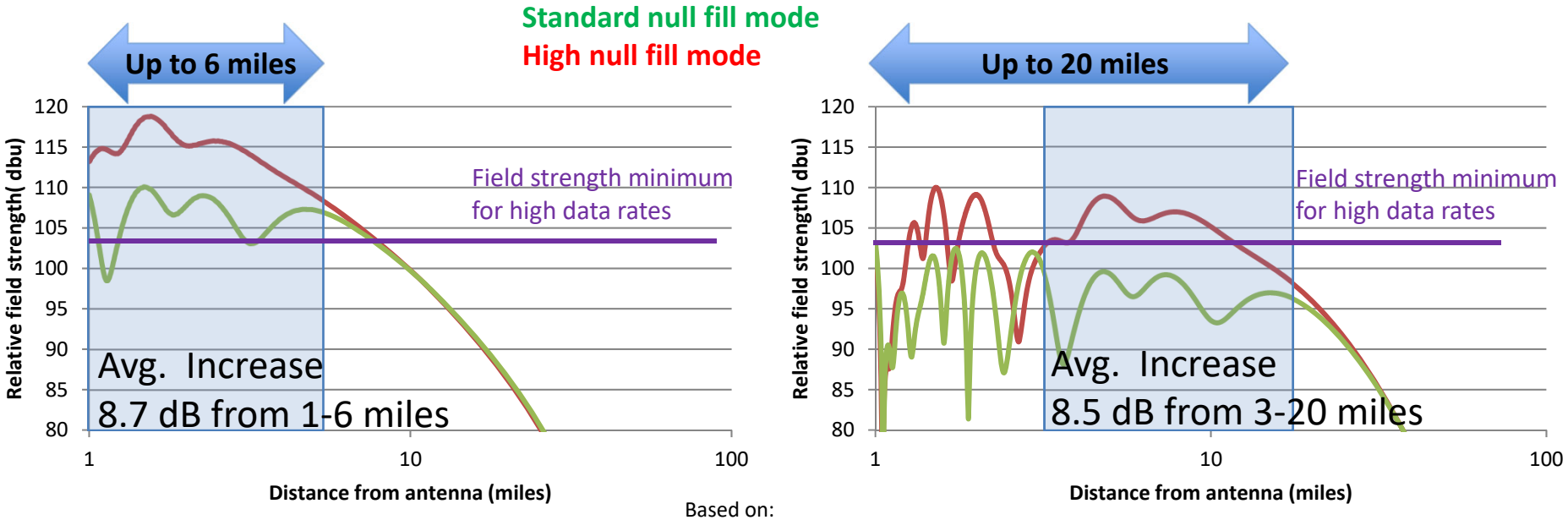
1. Remove one power divider
2. Connection of one feed line
3. Flip one layer of panels upside down

2.7 dB reduction in gain



Assuming same input power, taking into account slight power division created by de-activating one panel and the gap left in the vertical array

Effective saturation range



HAAT = 1000’

Based on:

- 600 kW ERP
- FCC 50,90 UHF

HAAT = 3200’

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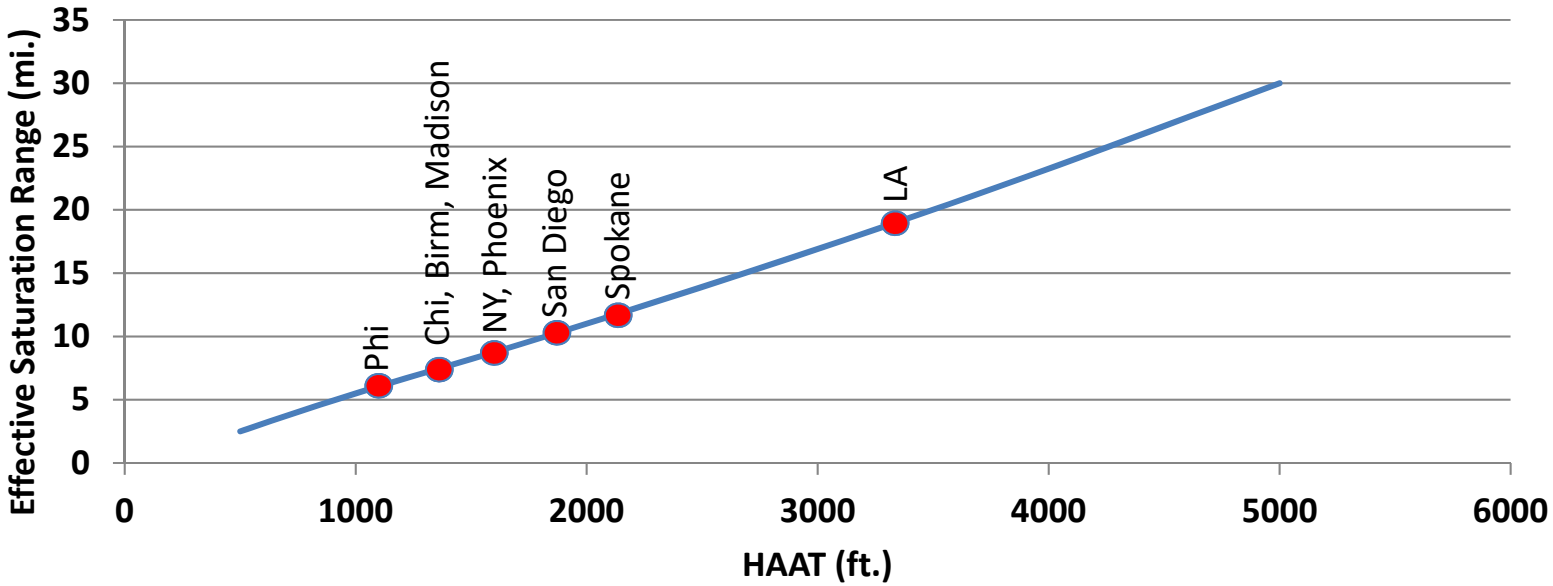
Market opportunity

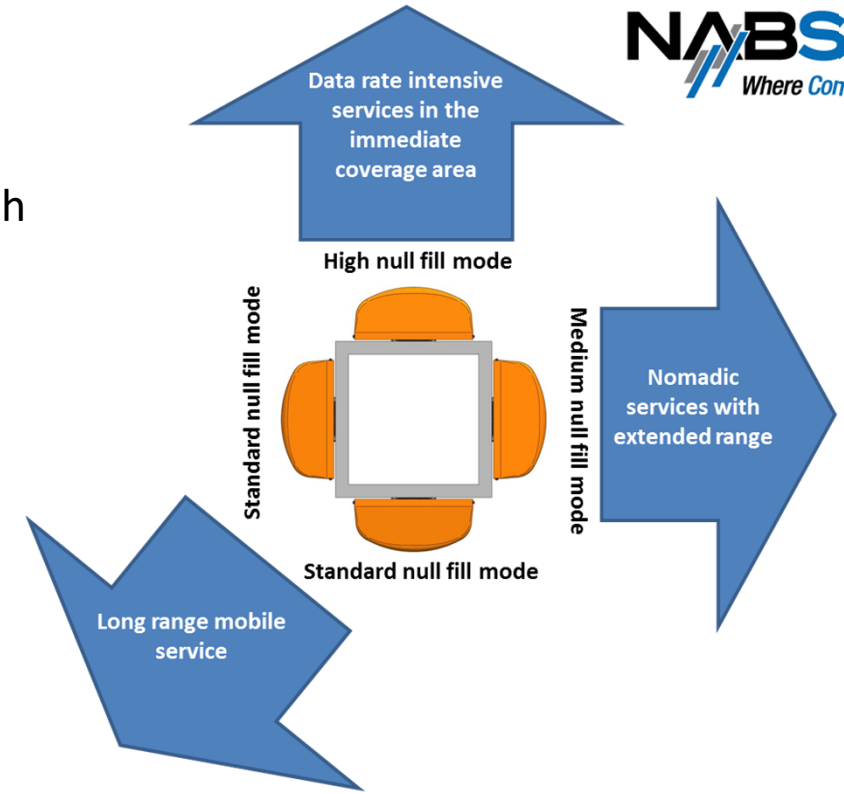
Some top markets with major populations within effective saturation range



Direction specific services

Panel antennas provide the capability of customizing the elevation pattern on each face of the azimuth

Adds another level of flexibility to next generation network planning



Conclusion

- Next generation broadcast will most likely be based on OFDM SFN networks
  - Flexibility to support future capacity growth
- More co-located antenna sharing
  - Broadband antenna solutions
- PLP's
  - Tailoring of service area specific robustness
- Launch of new services will require modification of the signal strength delivered to specific areas

Consider the use of predetermined illuminations with broadband antennas that can be easily modified in the field to customize the null structure at a future date.

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Thank you

Questions?

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Visit us at our booth C1707

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