More, More, More

- More flexibility
- More services
- More robust delivery
- More platforms

More signal strength

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How much signal strength is required?

- Outdoor reception of the Bootstrap signal: 48 dBu
- 25 Mbit Deep indoor mobile to small handheld receiver: 95 dBu
Boosting the signal strength

1. Increase transmitter power
2. Increase beam tilt
3. Increase null fill
4. Add a SFN
5. Provide diversity gain through MISO

Effect of heavy beam tilt

Effect of heavy null fill
Provide even distribution of high signal strength

- Saturate in the vicinity of the main antenna by increasing the null fill
- Add SFN sited around coverage perimeter to boost the signal strength outside of the high null fill area
In anticipation of ATSC 3.0 services, future proofing should be considered if purchasing an antenna now.

“FutureFill”

Simply increase the null fill of your antenna later

Field convertible null fill antenna

- Simple
- Short conversion time
- VSWR performance is unaffected

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Superimposing an out of phase excitation

If phase disturbance is 180 degrees then the starting beam tilt is unaffected.

All high power UHF antennas will have the FutureFill feature.

Lead to the development of custom illuminations with standard null fill that react positively to this theory.
“FutureFill”

Boosting the signal strength

Field convertible high null fill antenna using a future proof illumination

- Simple
- Short conversion time
- VSWR performance is unaffected

Trusted for Decades. Ready for Tomorrow.
Boosting the signal strength

First shipped antenna with FutureFill

KPPX – TFU-23 JTH/VP-R O4 channel 31 – Phoenix AZ.

Measured results

7 dB avg. increase in null fill

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Adding Null Fill and a SFN
Planning the ATSC 3.0 Network

Example – WNUV, Baltimore
WNUV ATSC 3.0 Network Example

- CRC propagation model
  - Communication Research Center – Canada
  - More realistic than Longley Rice
  - Uses clutter data
- Services - RSS needed at 30’ receive antenna height
  - Analysis to cover 48dBu < RSS < 95dBu
- Network areas limited within the FCC 41dBu contour or 103km from main antenna
  - 47 CFR 73.626 – DTV distributed transmission systems
- SFN Tower search
  - All towers in the search are available
  - Towers located >10 km inside 103km circle
  - Restricted to tower heights > 60 m
- PROGIRA plan network planning tool
**WNUV ATSC 3.0 Network Example**

**Goal**
- Boost signal strength and provide more services to more people

**Assume**
- Replace antenna with a high null fill field convertible antenna
- Main antenna retains full ERP - 845 kW
- Main antenna remains at full HAAT - 1200'
- Strategically add SFN to coverage area using existing towers.
Benchmark - Existing service after ATSC 3.0 switchover

<table>
<thead>
<tr>
<th>RSS (dBu)</th>
<th>Population Served</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>6,121,162</td>
</tr>
<tr>
<td>56</td>
<td>4,940,909</td>
</tr>
<tr>
<td>65</td>
<td>3,788,584</td>
</tr>
<tr>
<td>80</td>
<td>1,905,382</td>
</tr>
<tr>
<td>86</td>
<td>1,429,098</td>
</tr>
<tr>
<td>95</td>
<td>658,493</td>
</tr>
</tbody>
</table>

- Total population inside 41 dBu curve is 7.9M
- Services are inclusive
Replacing the Main Antenna with a Field Convertible High Null Fill Antenna

“FutureFill”
Effect of increasing the null fill by simple field conversion

<table>
<thead>
<tr>
<th>RSS (dBe)</th>
<th>Population Served</th>
<th>Future High Null Fill Converted</th>
<th>% Change</th>
<th>Population Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>4,940,909</td>
<td>4,847,172</td>
<td>-2%</td>
<td>-93,737</td>
</tr>
<tr>
<td>65</td>
<td>3,788,584</td>
<td>3,716,684</td>
<td>-2%</td>
<td>-71,900</td>
</tr>
<tr>
<td>80</td>
<td>1,905,382</td>
<td>1,896,801</td>
<td>0%</td>
<td>-8,581</td>
</tr>
<tr>
<td>86</td>
<td>1,429,098</td>
<td>1,527,028</td>
<td>7%</td>
<td>97,930</td>
</tr>
<tr>
<td>95</td>
<td>658,493</td>
<td>1,001,992</td>
<td>52%</td>
<td>343,499</td>
</tr>
</tbody>
</table>

Lose 174k consumers using lower RSS services in outer coverage areas

Gain 441k consumers using data intensive services in near in coverage areas
Effect of increasing the null fill by simple “FutureFill” field conversion

- Slight loss in consumers serviced by lower bit rates
- Significant gain in consumers serviced with higher bit rates
Adding SFN Sites to the Existing Main Antenna
Adding 50 kW ERP SFN sites with theoretical antenna patterns

Each site begins omnidirectional then applies power reductions to meet FCC 41 limits.
Effect of adding theoretical SFN sites to the main antenna with standard null fill elevation pattern

<table>
<thead>
<tr>
<th>RSS (dBu)</th>
<th>Population Served</th>
<th>Standard Elevation Pattern</th>
<th>% Change</th>
<th>Population Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>4,940,909</td>
<td>5,405,598</td>
<td>9%</td>
<td>464,689</td>
</tr>
<tr>
<td>65</td>
<td>3,788,584</td>
<td>4,189,184</td>
<td>11%</td>
<td>400,600</td>
</tr>
<tr>
<td>80</td>
<td>1,905,382</td>
<td>2,157,756</td>
<td>13%</td>
<td>252,374</td>
</tr>
<tr>
<td>86</td>
<td>1,429,098</td>
<td>1,702,093</td>
<td>19%</td>
<td>272,995</td>
</tr>
<tr>
<td>95</td>
<td>658,493</td>
<td>734,238</td>
<td>12%</td>
<td>75,745</td>
</tr>
</tbody>
</table>

Gain 1.46M consumers throughout service offerings
WNUV ATSC 3.0 Network Example

Effect of adding theoretical SFN sites to the main antenna with standard elevation pattern

- Significant gain in consumers serviced by lower bit rates
- Slight gain in consumers serviced with higher bit rates
Converting to High Null Fill and Adding SFN Sites
### WNUV ATSC 3.0 Network Example

Effect of adding SFN sites and increasing the null fill of the main antenna

<table>
<thead>
<tr>
<th>RSS (dBu)</th>
<th>Existing Main Antenna</th>
<th>Future High Null Fill Converted + SFN</th>
<th>% Change</th>
<th>Population Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>4,940,909</td>
<td>5,283,509</td>
<td>7%</td>
<td>342,600</td>
</tr>
<tr>
<td>65</td>
<td>3,788,584</td>
<td>4,099,525</td>
<td>8%</td>
<td>310,941</td>
</tr>
<tr>
<td>80</td>
<td>1,905,382</td>
<td>2,142,988</td>
<td>12%</td>
<td>237,606</td>
</tr>
<tr>
<td>86</td>
<td>1,429,098</td>
<td>1,760,761</td>
<td>23%</td>
<td>331,663</td>
</tr>
<tr>
<td>95</td>
<td>658,493</td>
<td>1,077,222</td>
<td>64%</td>
<td>418,729</td>
</tr>
</tbody>
</table>

Gain 1.64M consumers throughout service offerings.

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Effect of adding SFN sites and increasing the null fill of the main antenna

- Significant gain in consumers serviced by both lower and high bit rates

Trusted for Decades. Ready for Tomorrow.
• ATSC 3.0 services will require a new definition of received signal strengths

• Through the use of high null fill plus the addition of SFN sites, these required signal strengths can be achieved
THANKS FOR YOUR TIME!
ANY QUESTIONS?

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