Interference to Full Power Stations from LPFM

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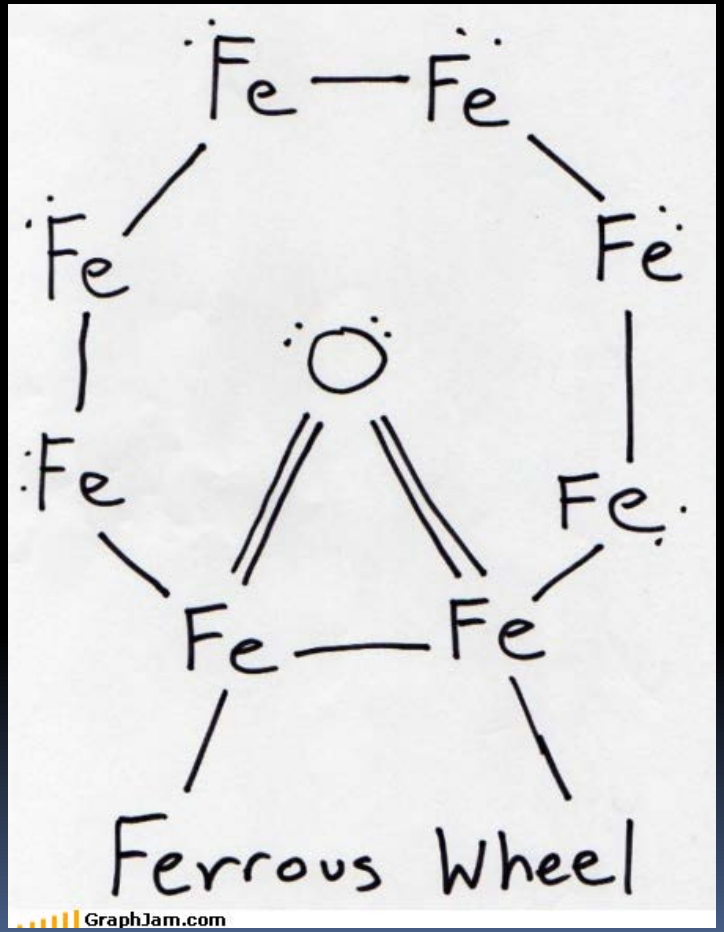
YOU'RE NOT
MY REAL FATHER!
STEP LADDER


STOP
BE
PREPARED
TO STOP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I shot the serif.


DO NOT
SIT ON
FENCE

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Brief LPFM History

- Roots in old Class D FM facilities.
- First class D license issued 1948.
- First licensed at 10 Watts in reserved band.
- Up to 100 Watts subsequently allowed.
- Strictly non-commercial AND “educational”.

Brief LPFM History

- LBJ signs Public Broadcasting Act of 1967.
- Fundamentally changes NCE concept.
- NPR is born three years later.
- Conflict arises between NPR and Class D.
- What IS the definition of NCE station?
- 1972 CPB seeks to standardize NCE Stations.

Brief LPFM History

- 1978 FCC agrees and phases out Class D.
- Translators proliferate in 1980s and 1990s.
- 1987 WTRA goes on air in Springfield, IL.
- 1993 Free Radio Berkley founded.
- 1996 Telecommunications Act.
- Significant consolidation ensued.

Brief LPFM History

- "Microradio" takes to air.
- 1998 LPFM Proposals Filed.
- 1999 FCC Issues MM 99-25.
- Originally called for 10, 100, and 1000 Watts.
- Deleted 2nd and 3rd adjacent protections.
- Intense lobbying takes place.

Brief LPFM History

- 2000 LPFM Service is created.
- 2001 First LPFM filing window.
- 2010 Local Community Radio Act.
- 2013 Second LPFM filing window.
- 2015 Proposal for LP-250 class.

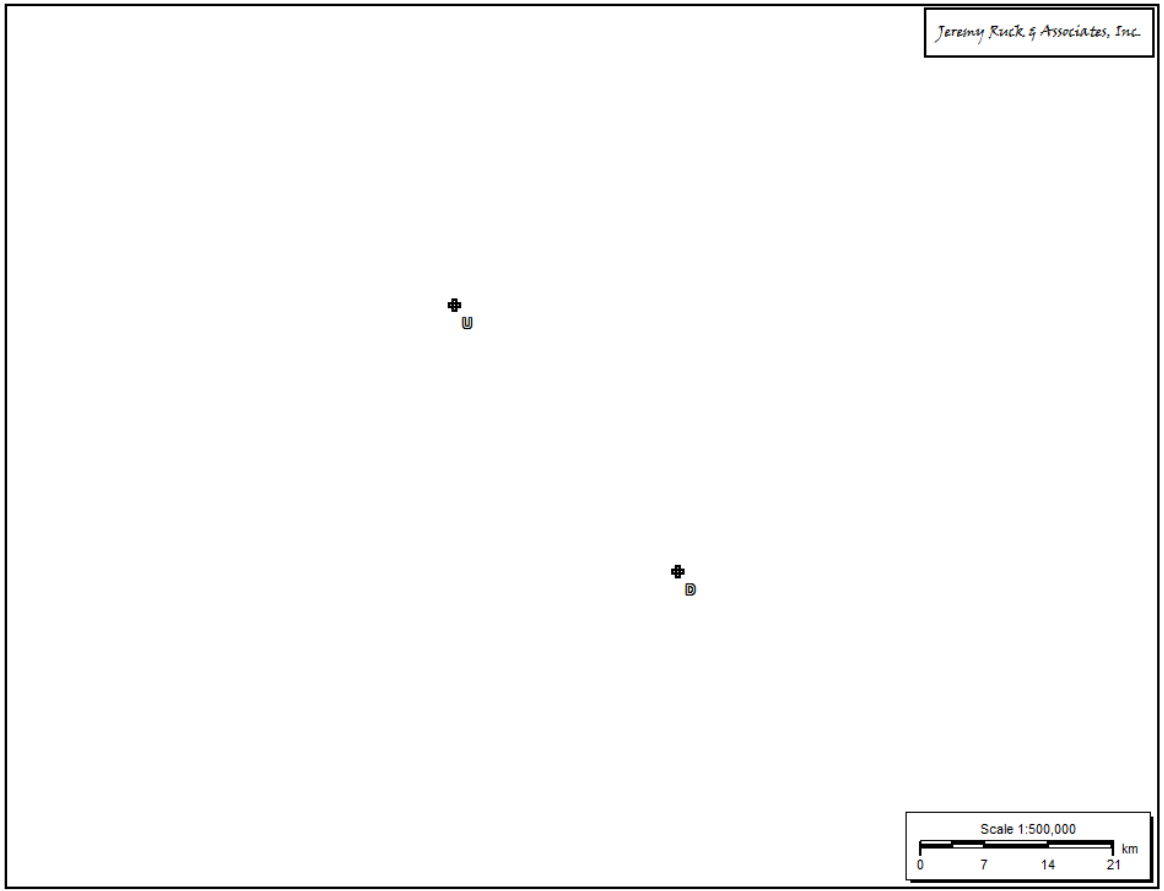
Interference

- Simplest definition is undesired signal exceeds a defined ratio to desired signal.
- Independent of actual signal level.
- City grade signal can receive interference just like a distant signal.
- Defined for +/- 3 and +/- 53 and 54 channels.

Interference

- Two primary methods for considering.
- Simple contour overlap.
- Actual U/D study.
- Contour overlap uses FCC Contours.
- D/U study can take different flavors.

Interference



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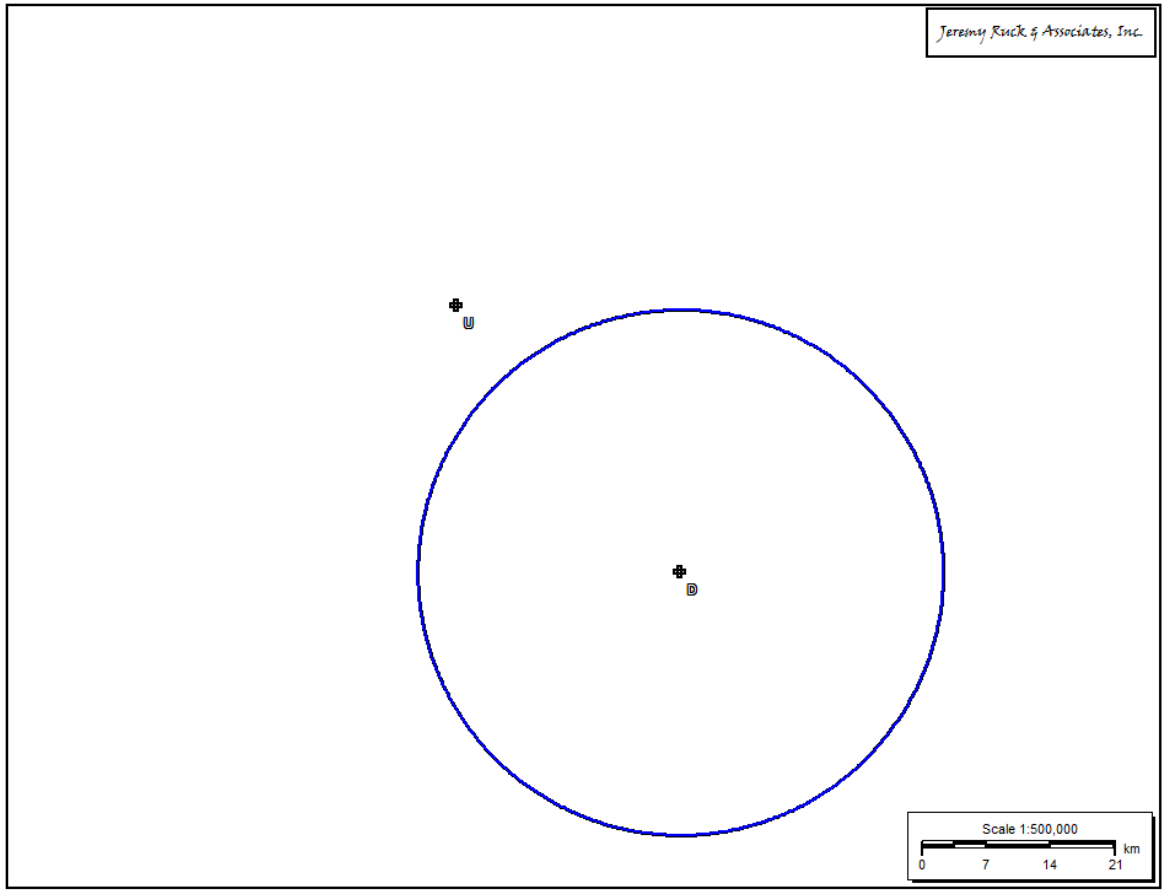

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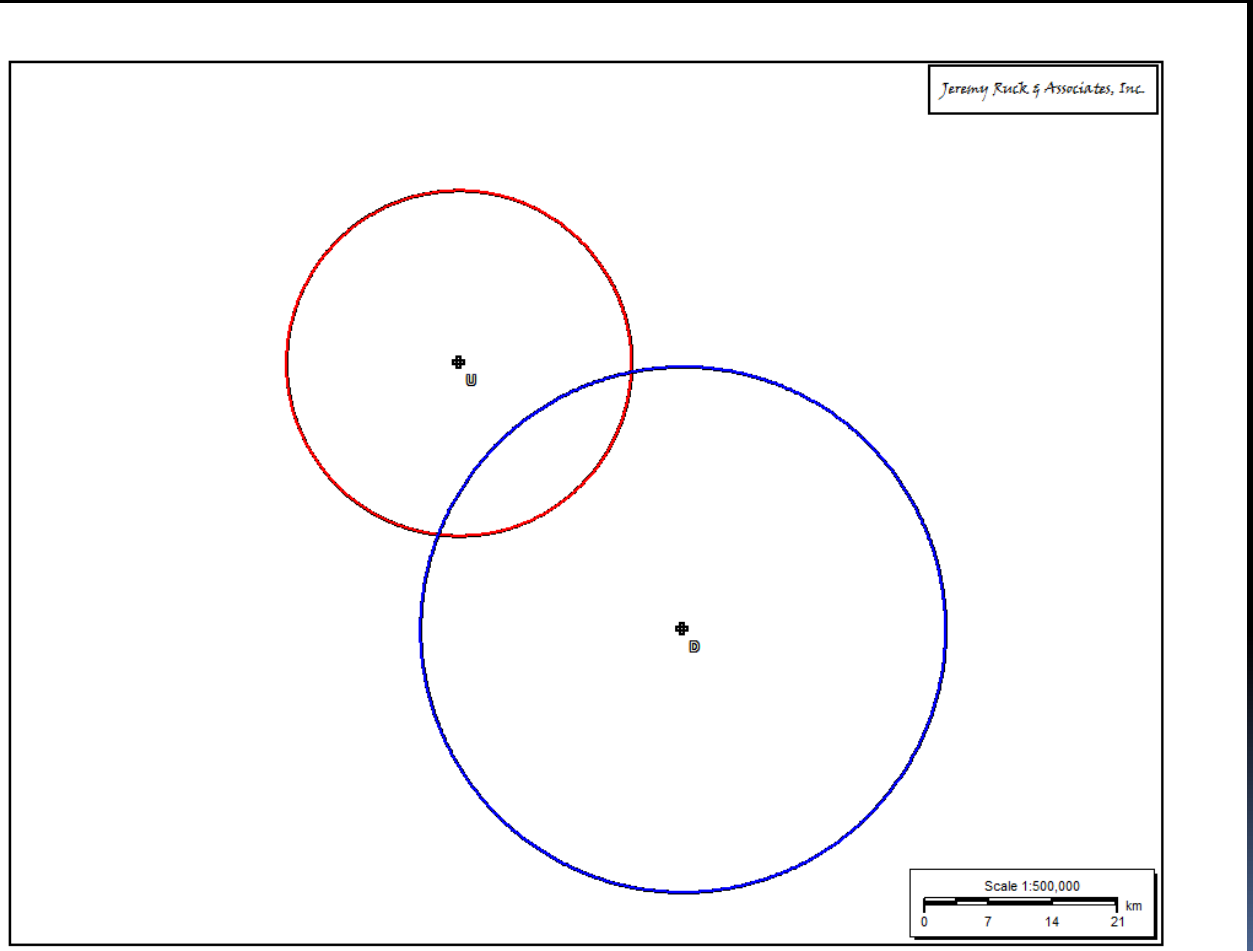

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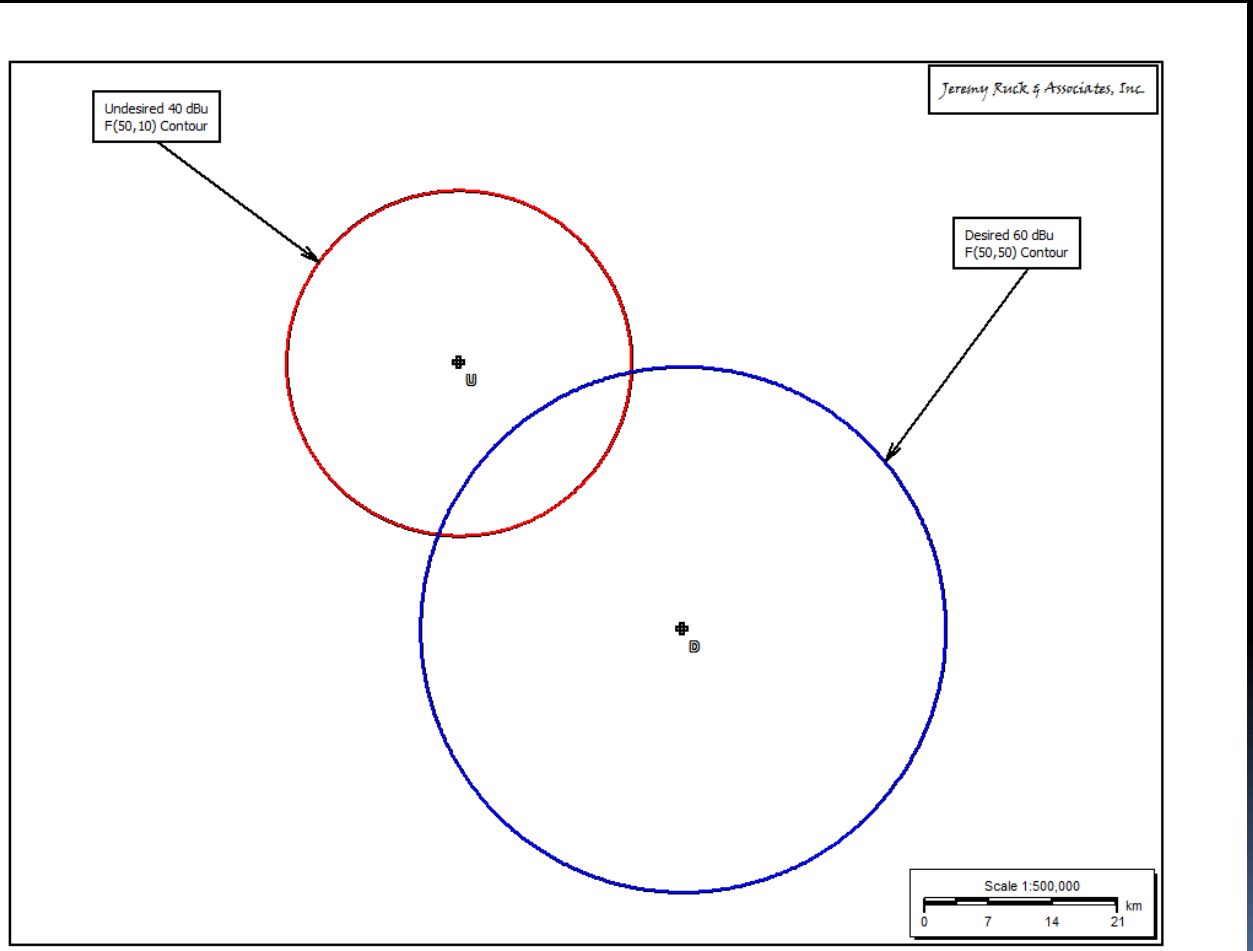

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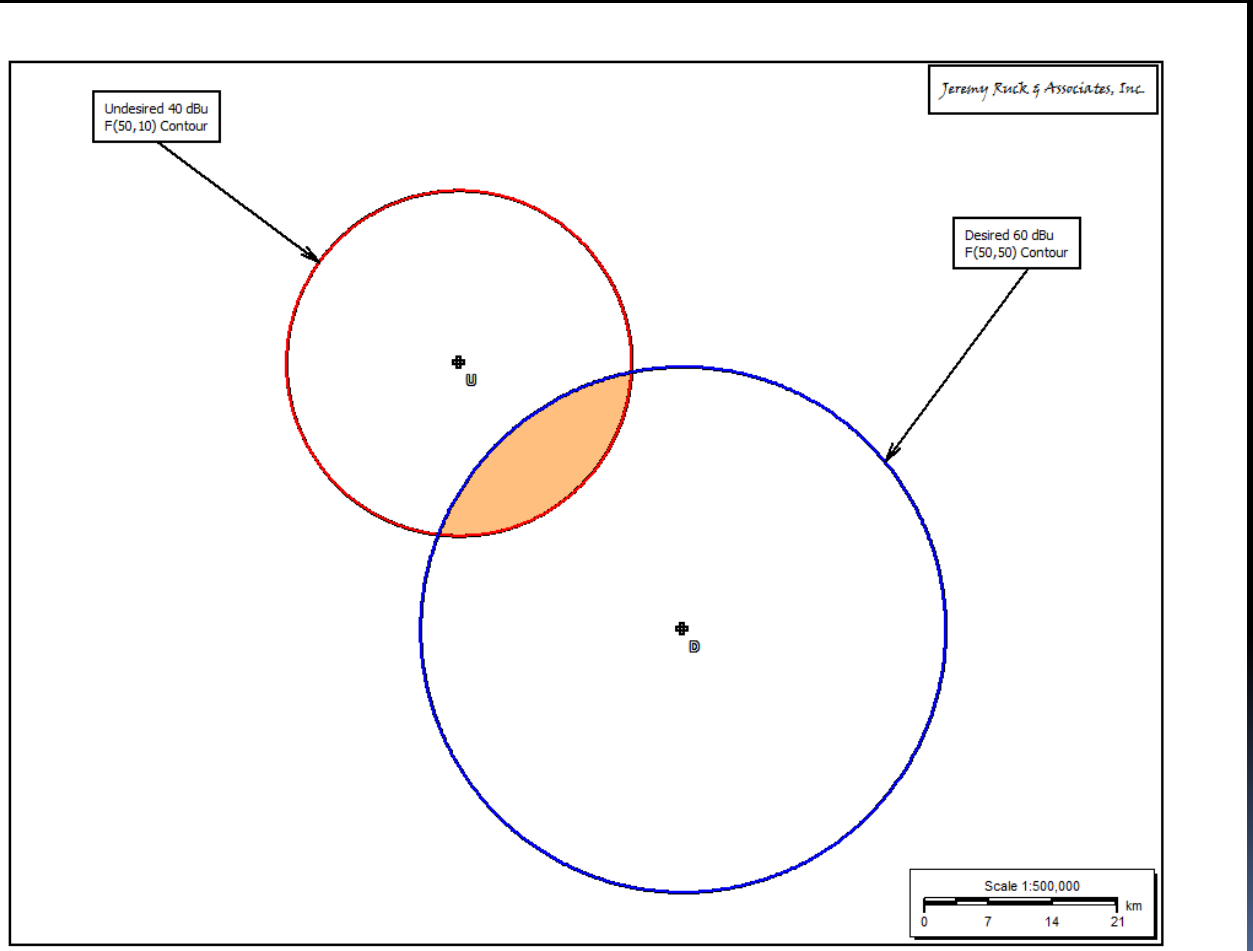

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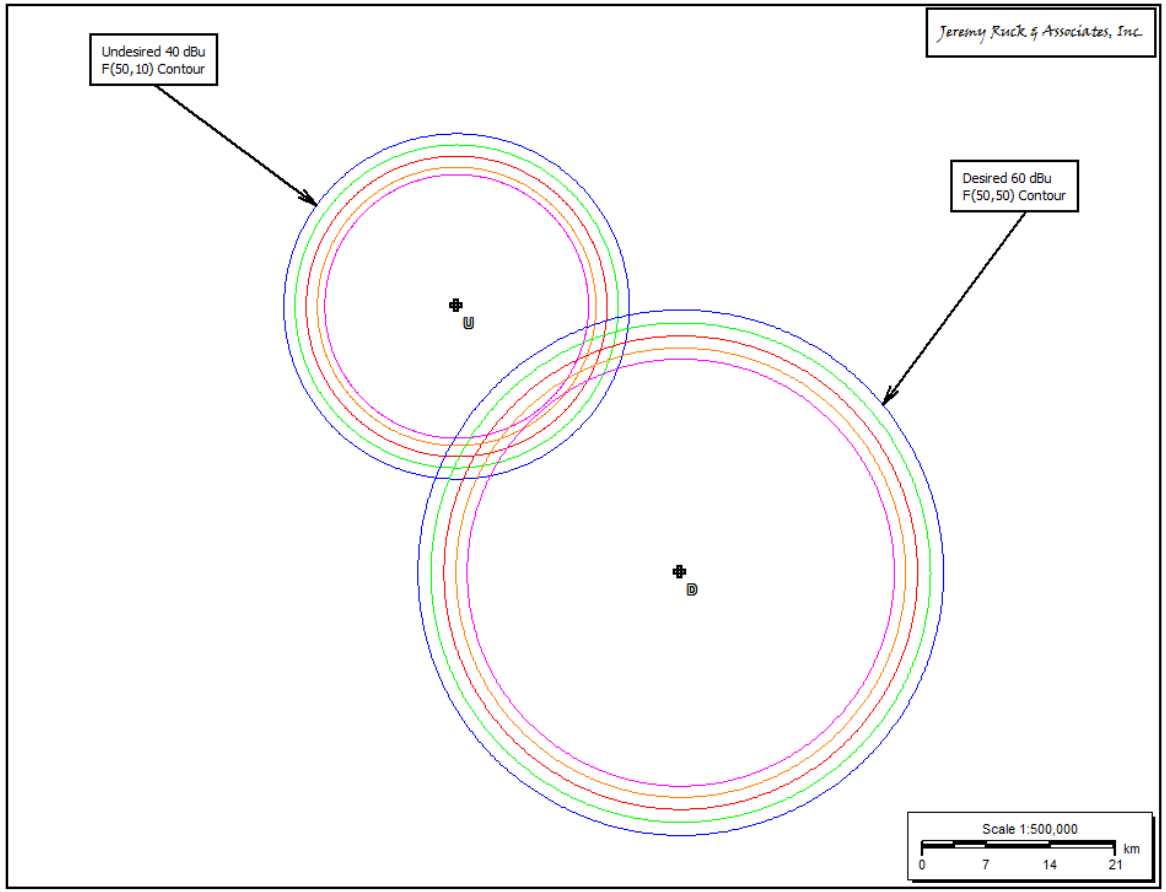

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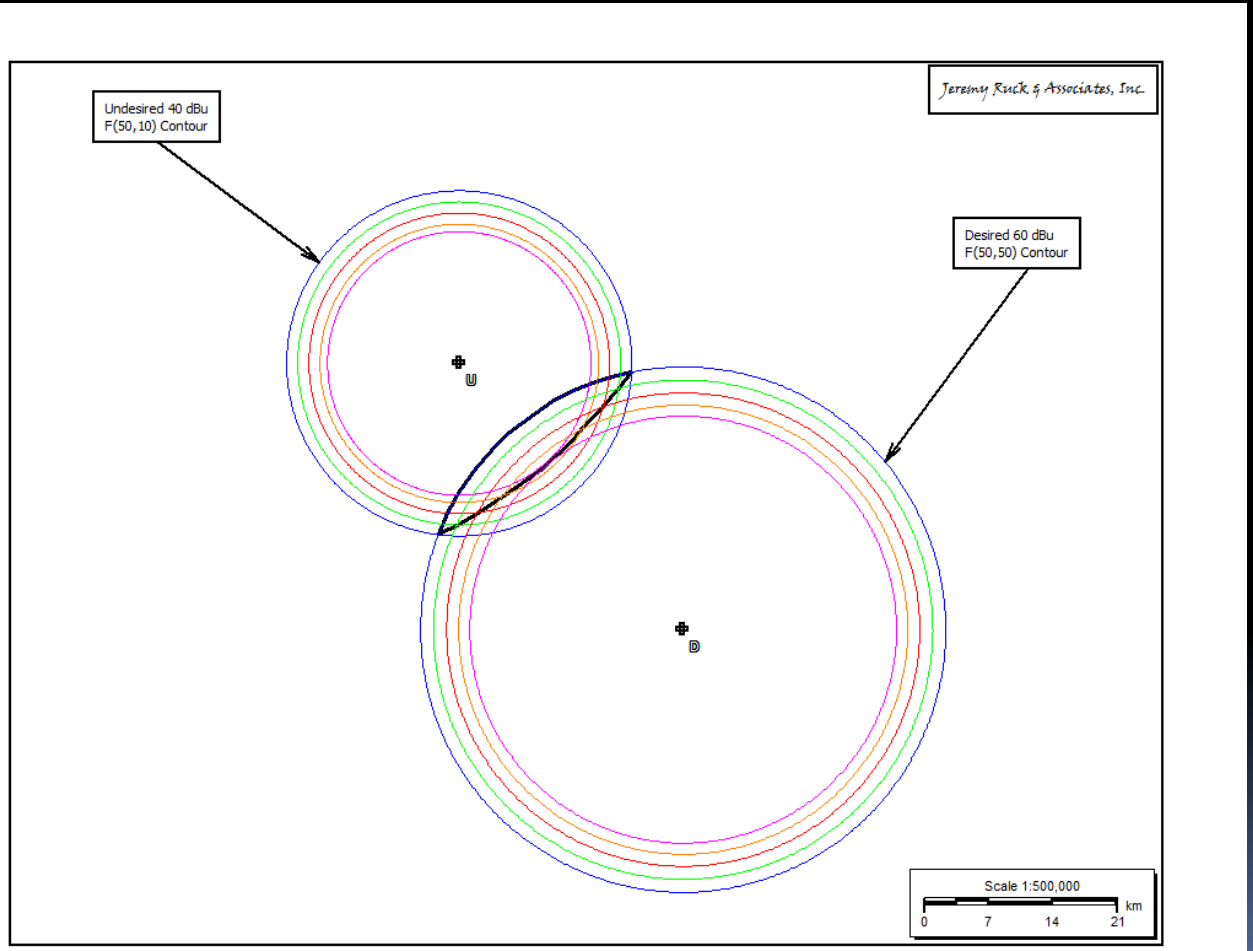

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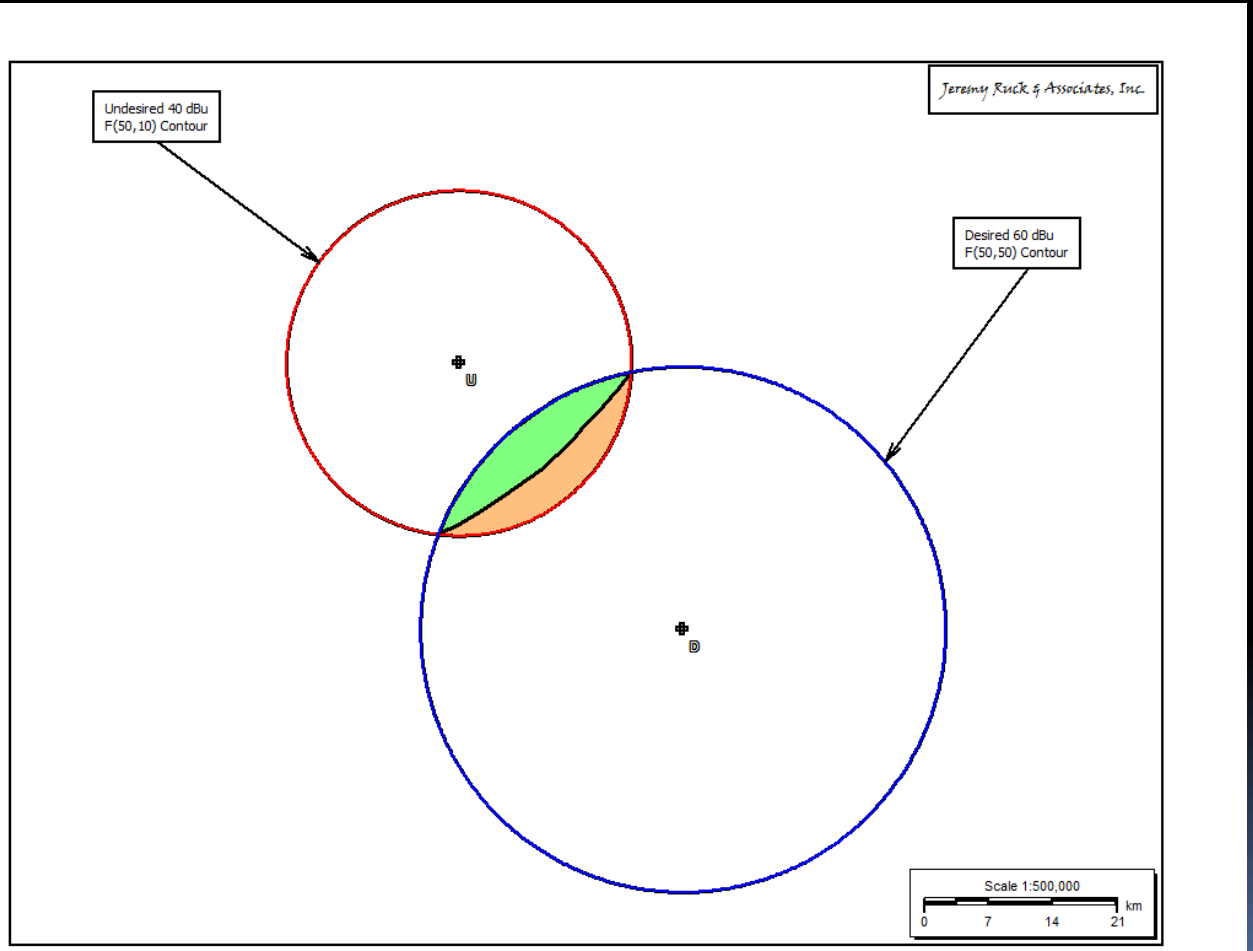


Interference

- Proximal U/D analysis using free-space.
- Establish desired field strength.
- Ratio plus desired is interfering.
- Result is 3-dimensional interference region.
- Shape/place region with vertical pattern.

Interference

$$S = \frac{E^2}{Z_0}$$

- "S" is calculated power density.
- "E" is electric field intensity.
- "Z_o" is Free-space impedance.
- Electric field intensity based on target field strength.
- Free space impedance 120π or approximately 377 ohms.

Interference

$$S = \frac{P}{4\pi R^2}$$

- "S" is calculated power density.
- "P" is isotropic power in Watts.
- "R" is distance in meters.
- Multiply power by 1.64 or add 2.15 dB to convert from isotropic.
- Combine both equations and rearrange to solve for R.

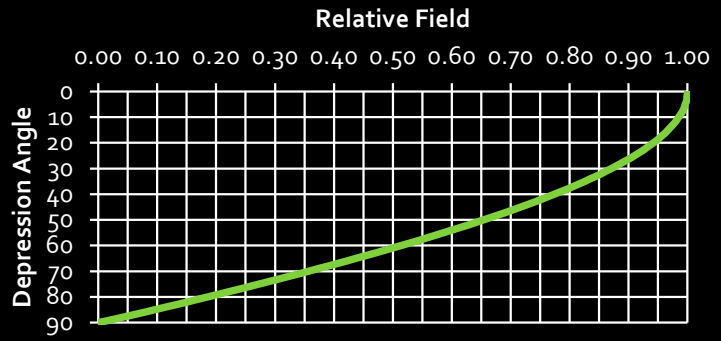
Interference

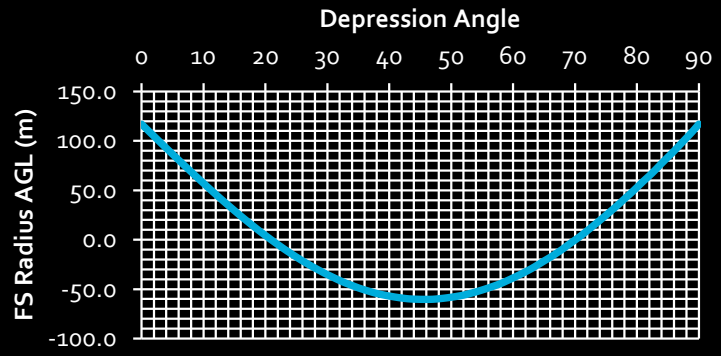
$$R^2 = \frac{P}{4\pi \frac{E^2}{Z_0}}$$

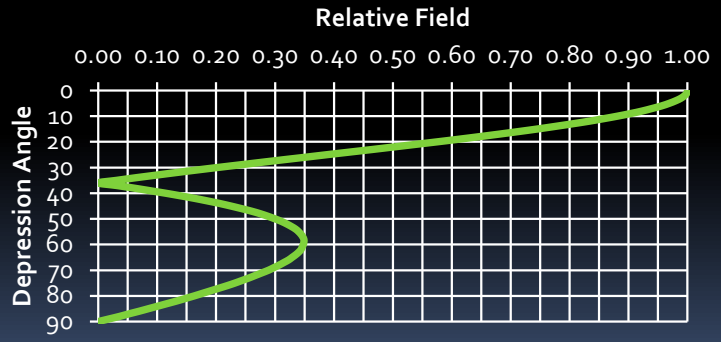
$$R = \frac{7\sqrt{P}}{E}$$

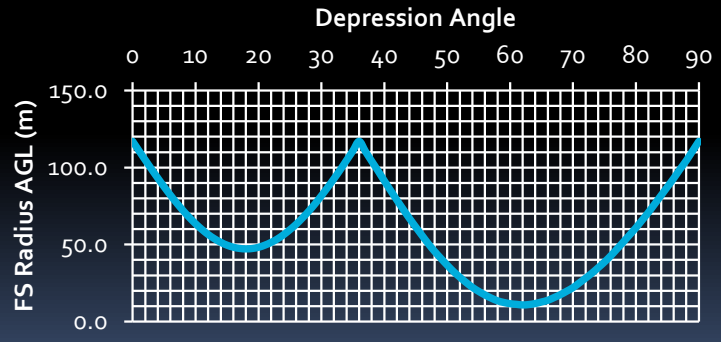
- Antenna pattern varies “P”.
- Depression angle varies “R”.
- Use trigonometry to solve.
- Distance can be approximated.
- “R” in meters.
- “P” in Watts.
- “E” in Volts per meter.

Interference









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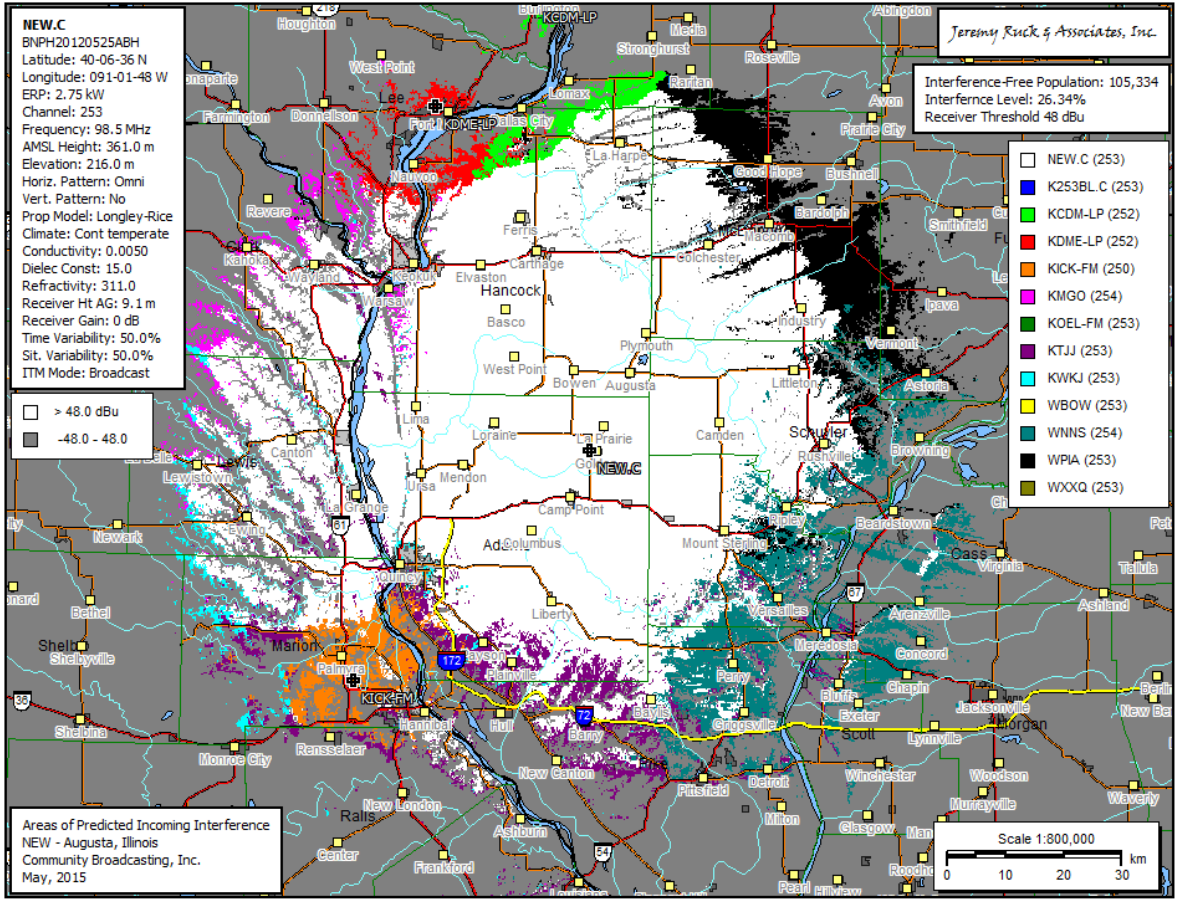

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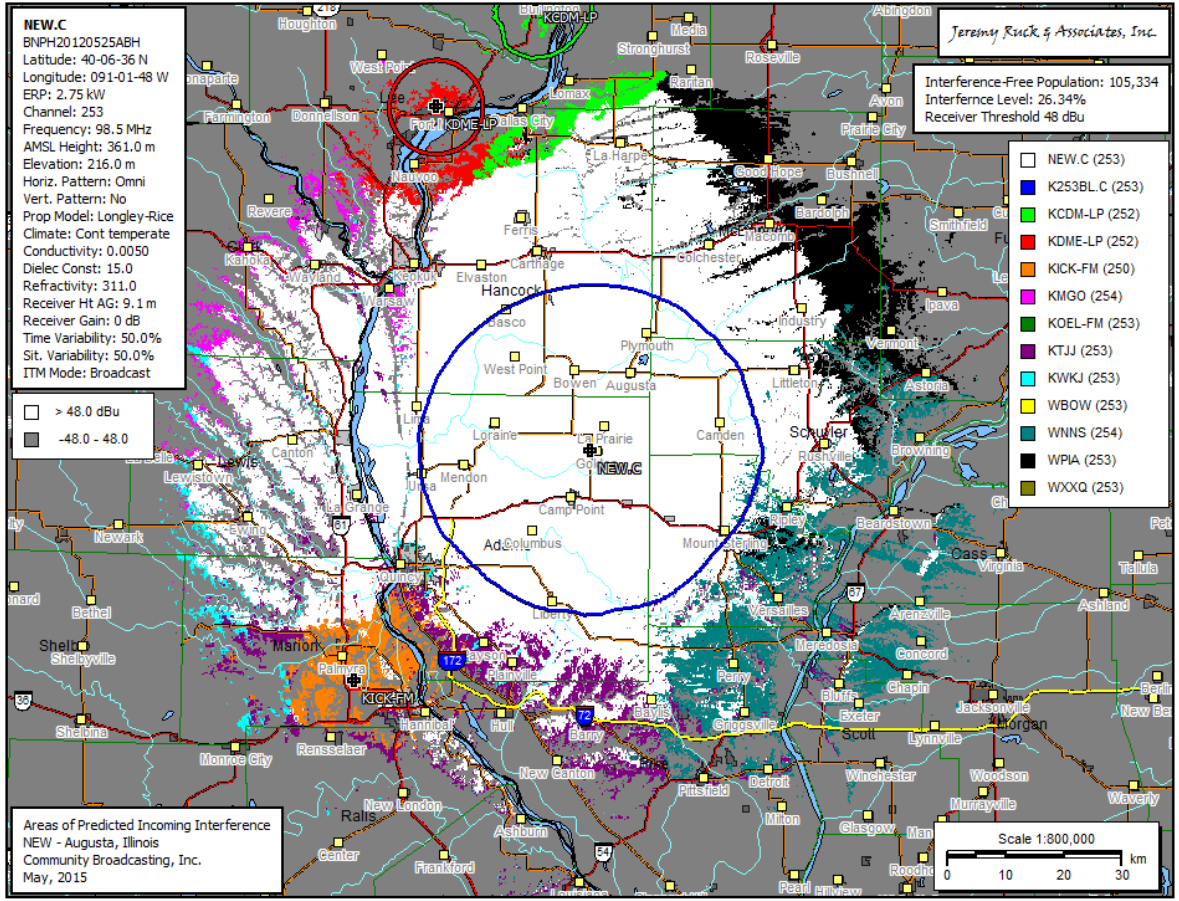

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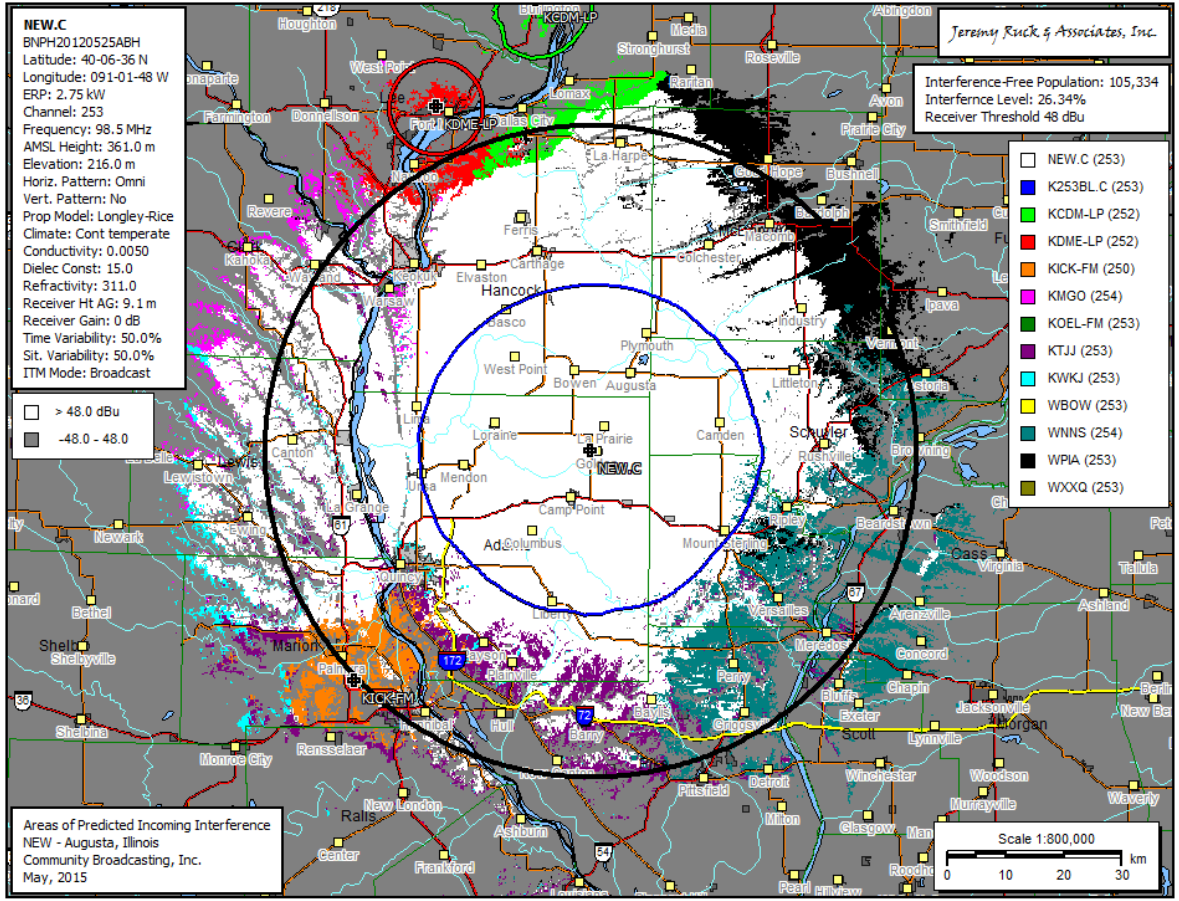

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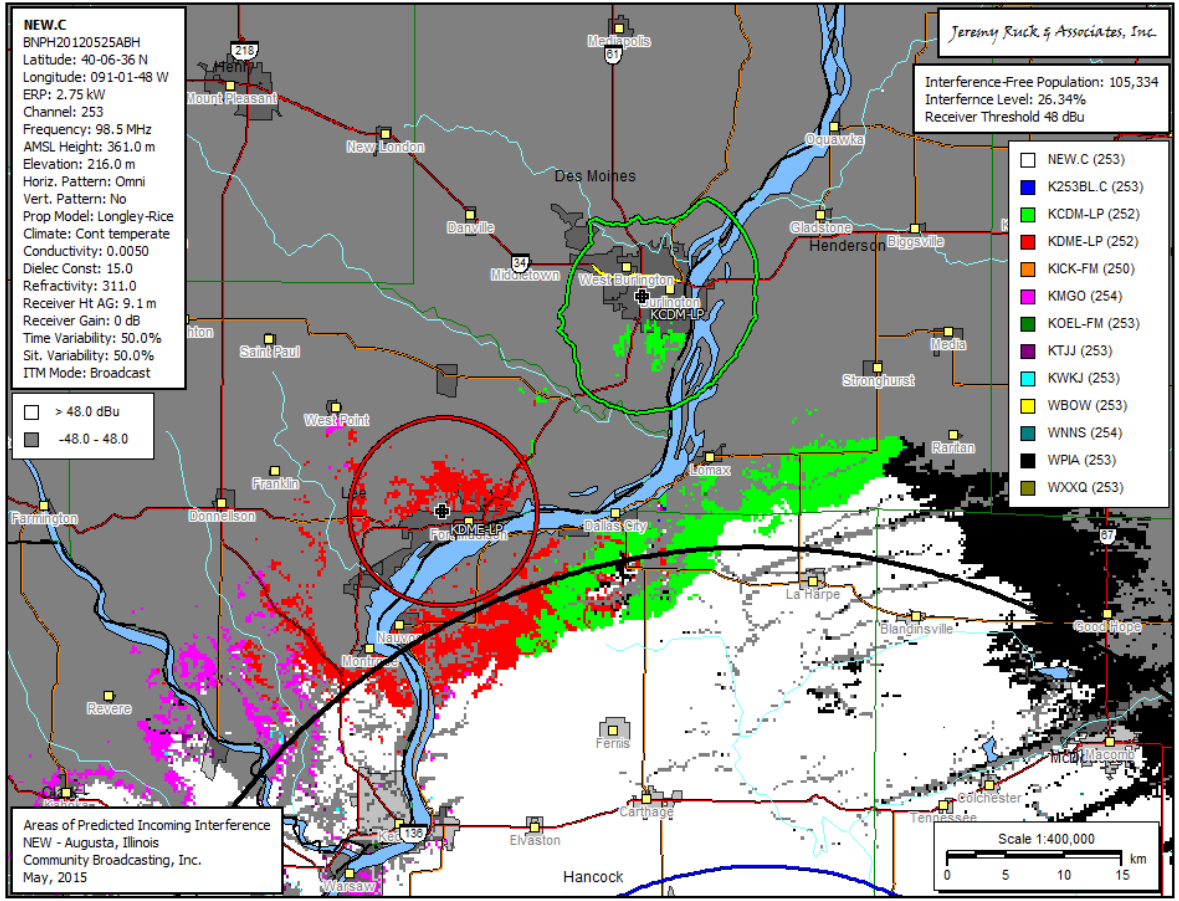

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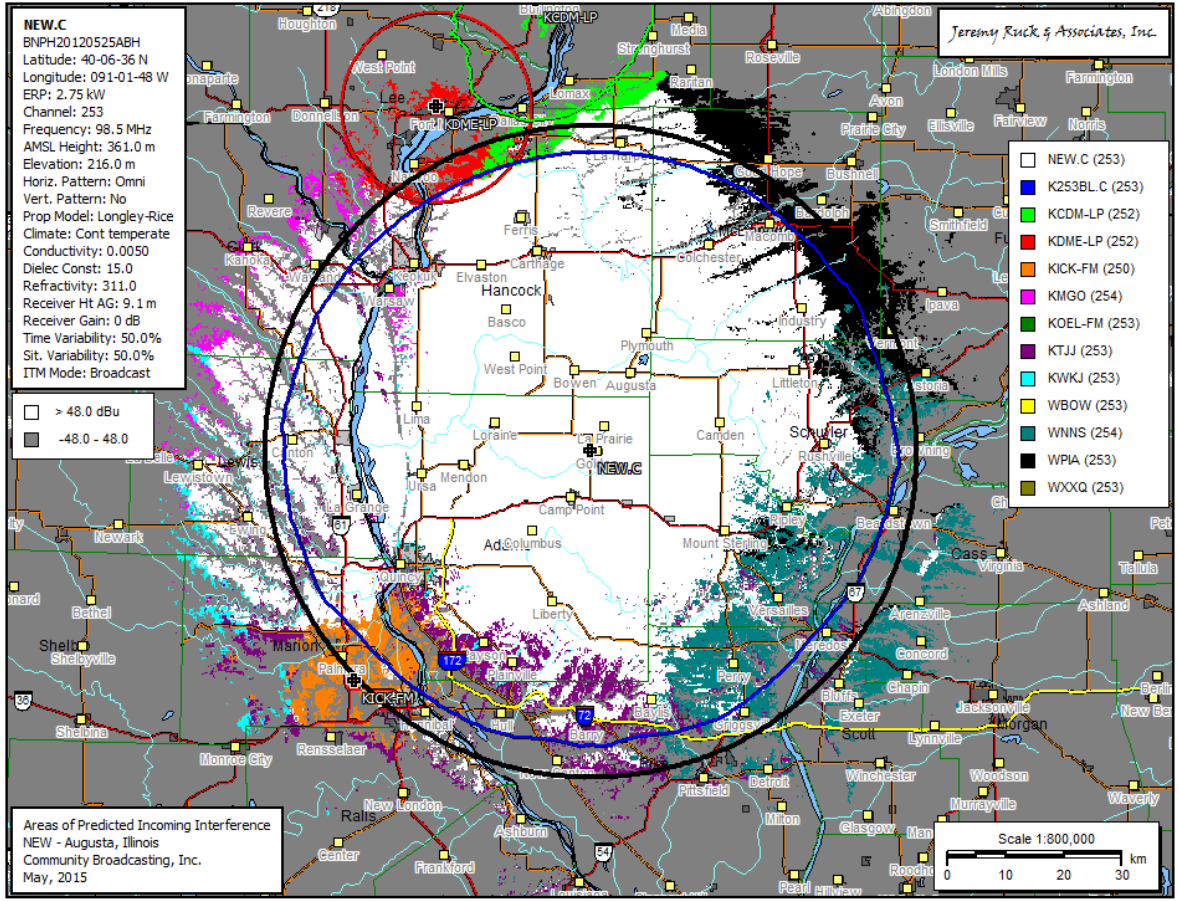

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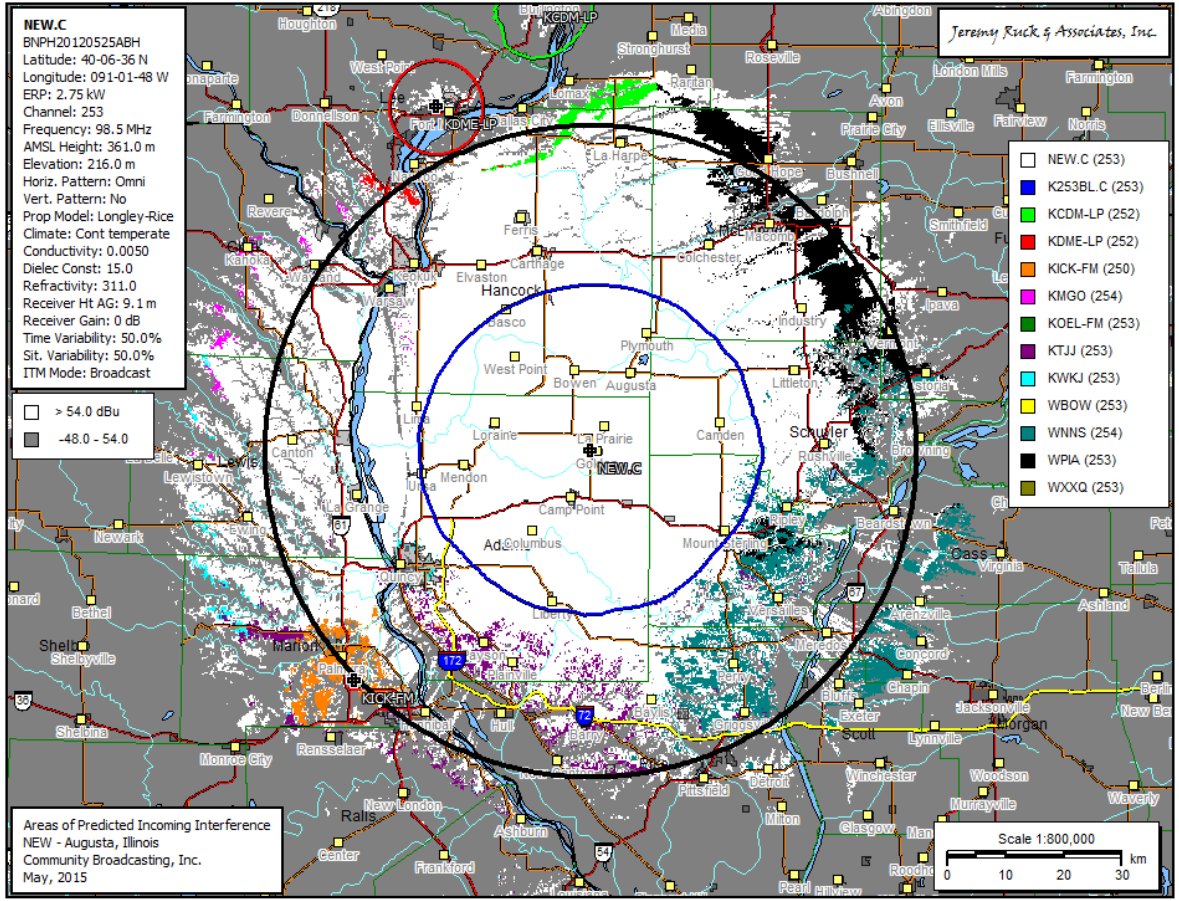

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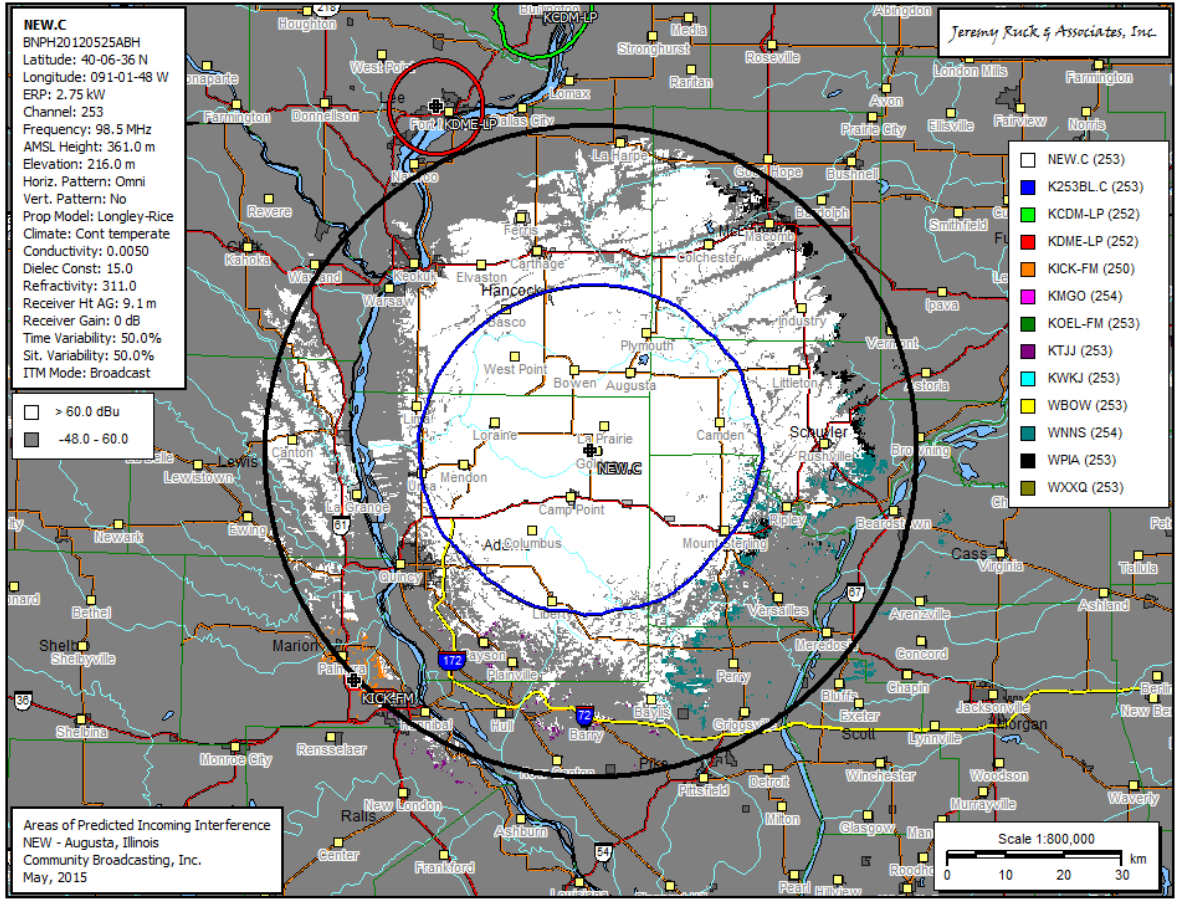

Interference

- Terrain dependent models best estimation.
- Signal levels evaluated at each cell.
- Contours fall apart in unusual terrain.
- Longley-Rice probably most widely used.

Technical Criteria

- LP-10 class eliminated. LP-100 remains.
- Maximum 100 Watts at 30 meters HAAT.
- 60 dBu contour distance 5.6 kilometers.
- Minimum 50 Watts at 30 meters HAAT.
- Contour distance 4.7 kilometers.
- Absolute minimum ERP is 1 Watt.
- Absolute maximum HAAT is 450 meters.

Interference

Station class protected by LPFM	Co-channel minimum separation (km)		First-adjacent channel minimum separation (km)		Second and third adjacent channel minimum separation (km)
	Required	For no interference received from max. class facility	Required	For no interference received from max. class facility	Required
LPFM	24	24	14	14	None
D	24	24	13	13	6
A	67	92	56	56	29
B1	87	119	74	74	46
B	112	143	97	97	67
C3	78	119	67	67	40
C2	91	143	80	84	53
C1	111	178	100	111	73
C0	122	193	111	130	84
C	130	203	120	142	93

- Provides minimum spacings.
- Provides minimum spacing for no received interference interference.
- Standard ratio basis.
- Spacing table buffer.

Interference

Station class protected by LPFM	Co-channel minimum separation (km)		First-adjacent channel minimum separation (km)		Second and third adjacent channel minimum separation (km)
	Required	For no interference received from max. class facility	Required	For no interference received from max. class facility	Required
LPFM	24	24	14	14	None
D	24	24	13	13	6
A	67	92	56	56	29
B1	87	119	74	74	46
B	112	143	97	97	67
C3	78	119	67	67	40
C2	91	143	80	84	53
C1	111	178	100	111	73
C0	122	193	111	130	84
C	130	203	120	142	93

- Examine co-channel situation for Class A.
- Required spacing 67 km.
- Class A protected contour 60 dBu F(50,50).
- LPFM interfering contour 40 dBu F(50,10).
- Distance 52.1 km.
- Spacing Buffer 15 km.

28.3 km + 23.8 km = 52 km

Interference

Station class protected by LPFM	Co-channel minimum separation (km)		First-adjacent channel minimum separation (km)		Second and third adjacent channel minimum separation (km)
	Required	For no interference received from max. class facility	Required	For no interference received from max. class facility	Required
LPFM	24	24	14	14	None
D	24	24	13	13	6
A	67	92	56	56	29
B1	87	119	74	74	46
B	112	143	97	97	67
C3	78	119	67	67	40
C2	91	143	80	84	53
C1	111	178	100	111	73
C0	122	193	111	130	84
C	130	203	120	142	93

- Examine 1st adjacent situation for Class C3.
- Required spacing 67 km.
- Class C3 protected contour 60 dBu F(50,50).
- LPFM interfering contour 54 dBu F(50,10).
- Distance 49.2 km.
- Spacing Buffer 18 km.

39.1 km + 10.1 km = 49 km

Interference

Station class protected by LPFM	Co-channel minimum separation (km)		First-adjacent channel minimum separation (km)		Second and third adjacent channel minimum separation (km)
	Required	For no interference received from max. class facility	Required	For no interference received from max. class facility	Required
LPFM	24	24	14	14	None
D	24	24	13	13	6
A	67	92	56	56	29
B1	87	119	74	74	46
B	112	143	97	97	67
C3	78	119	67	67	40
C2	91	143	80	84	53
C1	111	178	100	111	73
C0	122	193	111	130	84
C	130	203	120	142	93

- Examine 2nd adjacent situation for Class A.
- Required spacing 29 km.
- Class A protected contour 60 dBu F(50,50).
- LPFM interfering contour 54 dBu F(50,10).
- Distance 29.4 km.
- NO BUFFER.

28.3 km + 1.1 km = 29 km

Interference

Distance to FM translator 60 dBu contour	Co-channel minimum separation (km)		First-adjacent channel minimum separation (km)		Second and third adjacent channel minimum separation (km)—required
	Required	For no interference received	Required	For no interference received	
13.3 km or greater	39	67	28	35	21
Greater than 7.3 km, but less than 13.3 km	32	51	21	26	14
7.3 km or less	25	30	15	16	8

- Translators get the short end of the stick.
- Assume 13.3 km radius.
- 40 dBu F(50,10) LPFM Radius 23.8 km
- 13.3 km + 23.8 km = 37.1 km 2 km buffer!
- Assume 13.2 km radius.
- 13.2 km + 23.8 km = 37 km

Interference

- Translators have to use contours.
- Interference not a two-way street with LPFM.
- If you are a translator licensee beware of LPFM encroachment. It can limit your options!

Full Power Protections

- 70 dBu / 3.16 mV/m service contour.
- Community of License.
- 73.215 predictions within community of license where field strength > 1 mV/m.
- I.F. protections 91 dBu.

3rd Adjacent Protections

- They still remain.
- Cover stations and translator/booster input.
- 3 minute suspension if FCC notified.
- Specific section on translator input.
- LPFM protect SCA reading services.

Translator Inputs

- Applies when LPFM is 3rd adjacent to input.
- No LPFM within 2 km of translator.
- No LPFM within 10 km if located +/- 30°.
- Section 73.827 governs.

Translator Inputs

- U/D ratio less than 34 dB at receive antenna.
- Complies with distance equation.

$$d_u = 133.5 * 10^{\left(\frac{P_{LPFM} + G_{ru} + G_{rd} - E_d}{20}\right)}$$

- No LPFM within 10 km if located +/- 30°.

Thank You!

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