RFI MEMO #037

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To: RFI Group
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Subject: Sensitivity of low frequency arrays to out of band signals from satellites.

Radio quiet zones offer little protection for unwanted emissions from satellites. Especially vulnerable are the low frequency arrays under construction or being planned for the 80 to 300 MHz range. Consider a single baseline interferometer using zenith pointing fixed antennas with 3 dBi gain.

The sensitivity is

$$F = \frac{s 8\pi K T_{sys}}{\lambda^2 G (2BT)^{1/2}}$$

where F = flux density $wm^{-2}Hz^{-1}$
s = SNR
K = Boltzmann's constant
λ = wavelength
G = antenna gain
B = bandwidth
T = integration
T_{sys} = system temperature

If the system is sky noise dominated

$$T_{sys} \sim 50\lambda^{2.5}$$

The motion of a satellite produces a fringe rate which filters the interference. For an angular rate of R relative to the sky the time a change of half a rotation of interferometer phase is

$$T = \lambda / (2bR)$$

where b = baseline length

Substituting the relations above

$$F = \frac{s 8\pi k 50 (bR)^{1/2}}{G B^{1/2}} \sim 500 J \left(-233 dBw / m^2 / Hz\right)$$

for R~3×10^{-3} radians/sec
b~100 m
s~1
G~2
B~10^6 Hz

These parameters are chosen to be representative of a sparse array in the 80-300 MHz range for a LEO satellite. The typical signal strength of an Orbcomm satellite in its allocated band of 137-138 MHz is -125 dBW/m^2/4kHz which is about 72 dB above the level that would produce significant interference if out of the allocated band.

For comparison the part 15 limit in the 88-216 MHz band is 150 μV/m at 3m which is equivalent to -82 dBw or -213 dBW/m^2 which is 40 dB below the level that might pose a problem for a low frequency array. Orbcomm has promised to meet ITU-R RA.769-1 spectral power density of -259 dBw/m^2/Hz and total power density of -194 dBw/m^2 within the radio astronomy band at 150.05-153 MHz. If the Orbcomm meets the RA.769-1 over the entire 80-300 MHz range, excluding 137-138 MHz, it should pose no problem to the MWA.