Estimating the Required Separation Distances to Avoid Interference from Citizens Broadband Service Transmitters into C-Band Earth Stations

Prepared on behalf of American Broadcasting Companies, Inc.

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COMSEARCH
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1 Introduction

The FCC has proposed a new Citizens Broadband Service ("CBS") to operate in the 3,550-3,650 MHz band.[1] The FCC has also proposed incorporating the Part 90 Wireless Broadband Service 3,650-3,700 MHz band into the CBS regulatory regime with Higher Power Operation Zones where operation would be permitted at the present Part 90 maximum power levels.[2] Transmitters in these bands have a potential to cause interference to C-Band earth stations receiving in the adjacent 3,700-4,200 MHz band. For various sets of assumptions, this paper calculates the maximum per-exposure distances necessary to avoid harmful interference due to the out-of-band emissions (OOBE) of the CBS transmitters and due to potential oversaturation of the earth station low-noise block downconverters (LNBs). These distances should provide an estimate of the size of zones around the earth stations where harmful interference could possibly be received.

[1] Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, *Notice of Proposed Rulemaking and Order*, FCC 12-148 (rel. Dec. 12, 2012) *("NPRM").*

[2] *Id.* at ¶¶ 77-82.

2 Technical Factors

The transmitter and receiver parameters used in the study and the modes of interference considered in the distance calculations are discussed below.

2.1 CBS Technical Characteristics

The FCC proposes a maximum CBS transmitter power of 0.2 W (23 dBm) and a maximum antenna gain of 7 dBi, making the maximum transmitter EIRP 1 W (30 dBm), regardless of bandwidth.[3]

The FCC also proposes to authorize Higher Power Operation Zones where power up to the present Part 90 Wireless Broadband Service limit could be used.[4] This limit is 1 W per MHz up to a maximum of 25 W per 25 MHz.[5]

CBS use of spectrum would be governed by a Spectrum Access System (SAS) database based on device geolocation.[6]

2.2 Earth Station Antenna Off-Axis Gain

To estimate the path loss required from CBS transmitter to earth station receiver, and thus the separation distance for line-of-sight (LOS) conditions, it is necessary to know the gain of the earth station antenna towards the interfering transmitter. C-band earth stations communicate with geostationary satellites using high gain antennas directed towards the southern sky. In Part 25 the FCC prescribes limits for the off-axis radiation patterns that earth station antennas must meet.[7] Orienting an earth station antenna towards a particular satellite involves setting the azimuth and elevation "look angles" of the antenna. In the northern hemisphere, to receive from a satellite at a longitude far to the east of the earth station location requires an azimuth just south of 90° and a low elevation angle. To receive from a satellite at a longitude far to the west of the earth station location requires an azimuth just south of 270° and a low elevation angle. Between these two extremes an earth station would use higher elevation angles and azimuth angles more to the south with the highest elevation angle occurring for a satellite at the same longitude as the earth station. To promote sharing with terrestrial services, Part 25 also limits the elevation angle an earth station may use to five degrees or greater.[8]

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[3] *Id.* at ¶ 131.
[4] *Id.* at ¶79.
[5] *See* 47 C.F.R. §90.1321.
[6] *NPRM* at ¶¶ 95-96.
[7] See 47 C.F.R. §25.209(a)(3) and (c)(1).
[8] See 47 C.F.R. §25.205.

Generally, the smallest discrimination would occur if a CBS transmitter were on the same azimuth as the earth station antenna azimuth look angle. Then the off-axis discrimination angle would match the elevation look angle assuming an approximately horizontal direction towards the CBS transmitter. Taking this into account along with the FCC pattern limits, the highest earth station antenna gain towards a CBS transmitter would normally be 14.5 dBi for the lowest elevation angle of five degrees. We can also consider higher elevation angles of 15° and 30° and the corresponding maximum gains of 2.6 dBi and -4.9 dBi, respectively. Finally, for angles greater than 48° off boresight, the FCC pattern requirement reaches a floor value of -10 dBi. Calculations for these gain values will give an assessment of the separation distances required for various conditions. The floor gain value -10 dBi will define the minimum separation distance for off-axis angles greater than 48 degrees including to the north of the earth station.

2.3 Out-of-Band Emissions

In addition to the desired spectrum, transmitters emit low level signals outside the intended frequency range. These out-of-band emissions (OOBE) may appear as co-channel interference to an earth station receiver, so that receiver filtering could not be used to mitigate the interference. Although the proposed CBS OOBE limit is a fixed value across the adjacent C-band, it should not be assumed that a transmitter would emit a constant out-of-band power spectrum at or near the limit. Instead, the OOBE would tend to be spurs affecting only particular frequencies or small ranges. Therefore this interference, if it occurs, should affect only certain transponder frequencies rather than the entire band. In addition, spurious interference from multiple CBS transmitters would be unlikely to occur within the same 1 MHz segment(s) in the 3,700-4,200 MHz band and therefore when considering multiple exposures this interference would not add on a power basis. It will not be possible, however, to predict which transponder frequencies might be affected.

The FCC notes that the OOBE limit presently applicable to the 3,650-3,700 MHz band is 43+10log(P) dB (per MHz) and asks for comment on the appropriate limit for the 3,550-3,650 MHz band.[9] The 43+10log(P) limit is equivalent to OOBE of -13 dBm/MHz (-43 dBW/MHz). The ITU and LTE Advanced radio specifications incorporate this as the basic Category A OOBE limit. ITU and LTE Advanced also identify a more stringent Category B limit at -30 dBm/MHz (-60 dBW/MHz).[10] As the calculations will show, the necessary separation distances would be much smaller for equipment meeting the Category B limit versus the Category A limit.

The assumed earth station receiver input thermal noise power -148.6 dBW/MHz is based on a receiving system noise temperature of 100 K, consistent with Report ITU-R M.2109. The objective for OOBE interference used in the calculations is -158.6 dBW/MHz, an I/N ratio of -10 dB, consistent with recommendation ITU-R SF.1006.

2.4 LNB Oversaturation

In most earth station receivers, a low noise block downconverter (LNB) is the first stage of electronics a signal encounters after the antenna. Many LNBs that are in service are not equipped with any filtering for the adjacent 3,550-3,700 MHz band. A strong signal in the 3,550-3,700 MHz segment appearing at the LNB input could oversaturate the amplifier, affecting the ability to receive the desired 3,700-4,200 MHz band. This oversaturation interference results from the fundamental emission of the CBS transmitter entering the earth station receiver.

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[9] *NPRM* at ¶ 138.

[10] 3GPP TS 36.104 version 11.3.1 Release 11: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception" (Feb. 2013), Table 6.6.4.1.1.1-1 and Table 6.6.4.1.2.1-1. Also Recommendation ITU-R SM.329-12: "Unwanted Emissions in the Spurious Domain", (Sept. 2012).

While a filter may be added between the antenna and the LNB, there are practical limits as to how effective such a filter may be while at the same time passing the desired C-band frequencies above 3,700 MHz. Filters should be effective to mitigate interference caused by transmitters in the 3,550-3,650 MHz band, but less effective for those in the 3,650-3,700 MHz band and perhaps ineffective for transmitters just below 3,700 MHz.

We anticipate that typical CBS small cell transmitters would use 10 MHz or 20 MHz channels under the LTE Advanced specifications. Figure 1 shows spectra that may be used to represent these signals based on the emission mask requirements. Figure 2 shows the response of a commercially available filter designed to be used between the antenna and LNB of a C-band earth station to reduce or eliminate interference from transmitters outside the 3,700-4,200 MHz band. A calculation of the power of these LTE signals through the filter results in the selectivity curves shown in Figure 3. From these selectivity curves we found the values in Table 1 at particular transmitter frequencies for use in the subsequent distance calculations.

LTE Channel Bandwidth (MHz)	LTE Transmitter Frequency (MHz)	Selectivity (dB)
10	3555	58.9
10	3600	44.5
10	3645	29.8
10	3655	14.8
10	3675	2.0
10	3695	0.7
20	3560	56.8
20	3600	44.1
20	3640	30.8
20	3660	7.7
20	3675	2.4
20	3690	0.9

Table 1: Filter Selectivity

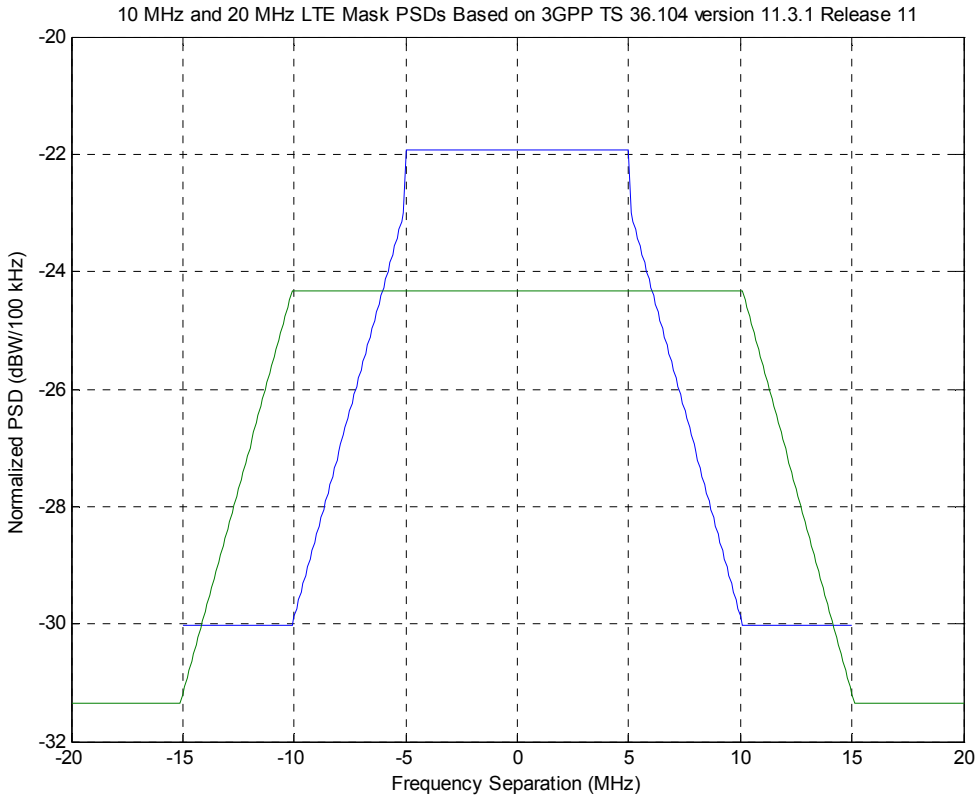

Figure 1: 10 MHz and 20 MHz Channel Power Spectra Based on LTE Emission Mask Requirements

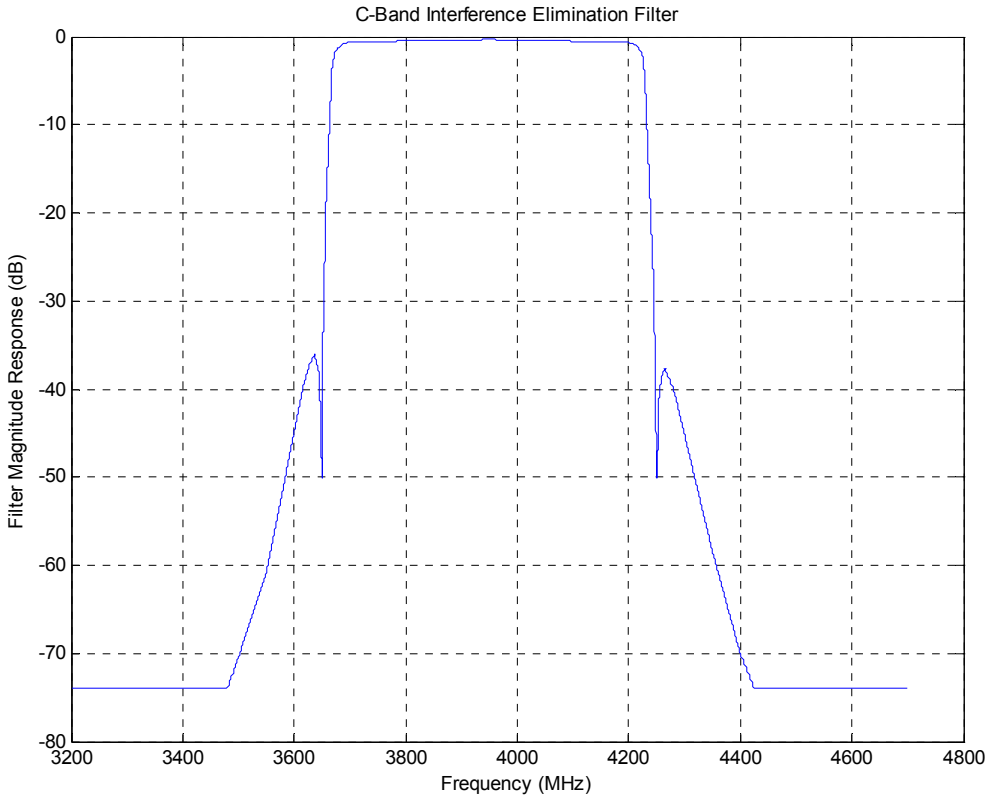

Figure 2: Response of Commercially Available C-Band Interference Elimination Filter

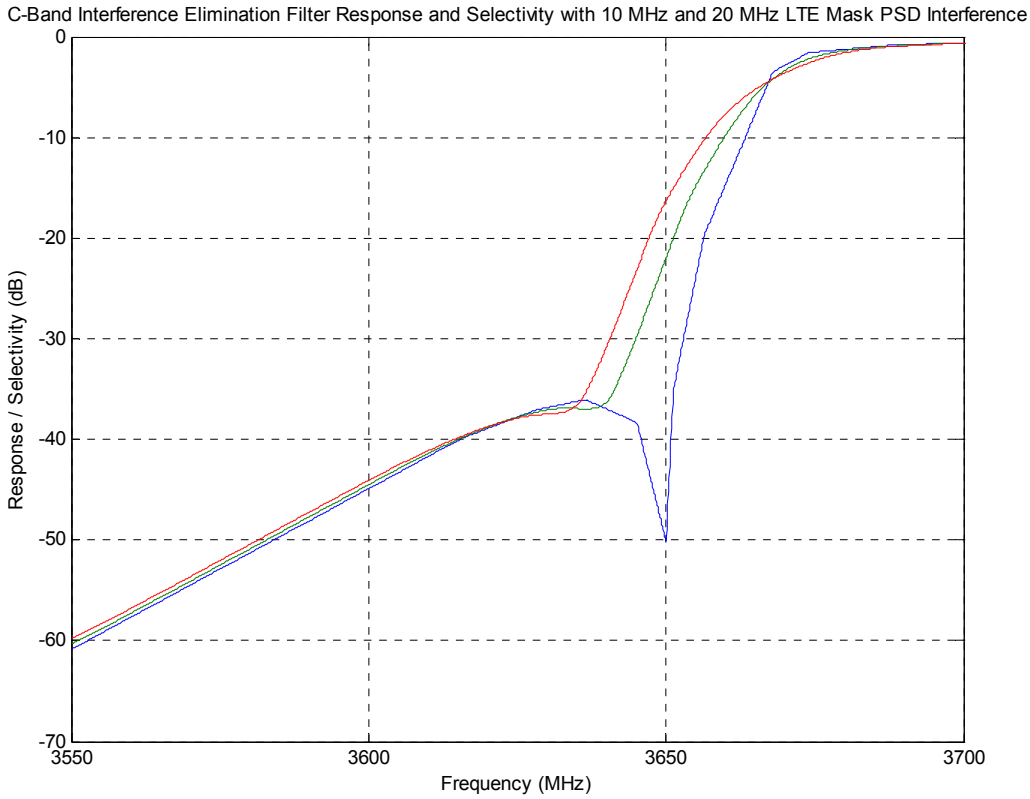

Figure 3: Interference Elimination Filter Response and Selectivity to 10 MHz and 20 MHz LTE Mask PSD Signals

For the oversaturation calculations we use an interference objective of -55 dBm which is a typical LNB input level to cause 1 dB compression. While the total power of the desired and interference signals together should meet this objective, the calculations assume that the power of the desired carriers would be significantly lower and thus negligible in the oversaturation calculation.

3 Results

Table 2 shows the calculations and resulting separation distances for interference from OOBE. The necessary separation distance to avoid the possibility of interference was calculated for both the Category A and Category B OOBE suppression requirements, and for minimum, low, typical, and high elevation or off-axis angles from the earth station antenna. Interference could occur at a worst-case distance of 47.6 km, based on minimum off-axis discrimination and the Category A OOBE limit. However, for typical off-axis discrimination, the separation distances would be 5.1 km and 0.7 km for Category A and Category B, respectively.

Tables 3, 4, and 5 show the calculations and resulting separation distances for interference from LNB oversaturation. Table 3 is for CBS transmitters in the 3,550-3,650 MHz band. Table 4 is for transmitters in the 3,650-3,700 MHz band using the proposed CBS power levels. Finally, Table 5 is for Higher Power Operation Zone transmitters using the power levels of the Part 90 Wireless Broadband Service. In each table the distance calculations are shown for the various combinations of:

- Channels of 10 MHz and 20 MHz Bandwidth
- Channels at the lower band edge, at mid-band, and at the upper band edge
- Minimum, low, typical, and high earth station elevation (off-axis) angles
- Earth station receivers without and with an interference elimination filter

In Table 3, the maximum distances without filtering for the 3,550-3,650 MHz band are 628.1 m for the minimum off-axis angle and 66.9 m for the typical off-axis angle. With filtering the distances are reduced to 20.2 m or less for the minimum angle and 2.2 m or less for the typical angle.

For transmitters in the 3,650-3,700 MHz band, filtering would be less effective due to the reduced frequency separation. If the FCC authorizes operation in the band at the proposed CBS power level, Table 4 shows that distances up to 576.9 m (minimum off-axis angle) and 61.4 m (typical off-axis angle) may be required. If the FCC authorizes operation in the band at the higher Part 90 power levels, Table 5 shows that distances up to 2524.9 m (minimum off-axis angle) and 268.9 m (typical off-axis angle) may be required.

All of the calculated distances are based on the worst-case assumption of line-of-sight (LOS) propagation. Obviously, for interference paths blocked by terrain or above-ground obstacles, the necessary separation distances would be reduced.

CBS Transmitter OOBE Limit	CBS OOBE Power Level (dBW/MHz)	CBS Antenna Gain (dBi)	CBS OOBE EIRP (dBW/MHz)	ES Receiver System Input Noise Temp (K)	ES Receiver Thermal Noise Power Level (dBW/MHz)	ES Receiver Interference Objective (dBW/MHz)	ES Antenna Elevation	ES Antenna Off-axis Angle (deg)	Worst-Case ES Antenna Gain towards CBS Transmitter (dBi)	Required Loss (dB)	Required Distance If LOS (km)
43+10log(P) / Category A (ITU & LTE)	-43	7	-36	100	-148.6	-158.6	Minimum	5	14.5	137.1	47.6
43+10log(P) / Category A (ITU & LTE)	-43	7	-36	100	-148.6	-158.6	Low	15	2.6	125.2	12.1
43+10log(P) / Category A (ITU & LTE)	-43	7	-36	100	-148.6	-158.6	Typical	30	-4.9	117.7	5.1
43+10log(P) / Category A (ITU & LTE)	-43	7	-36	100	-148.6	-158.6	High	≥ 48	-10.0	112.6	2.8
Category B (ITU & LTE)	-60	7	-53	100	-148.6	-158.6	Minimum	5	14.5	120.1	6.7
Category B (ITU & LTE)	-60	7	-53	100	-148.6	-158.6	Low	15	2.6	108.2	1.7
Category B (ITU & LTE)	-60	7	-53	100	-148.6	-158.6	Typical	30	-4.9	100.7	0.7
Category B (ITU & LTE)	-60	7	-53	100	-148.6	-158.6	High	≥ 48	-10.0	95.6	0.4

Table 2: Per-exposure Separation Distances to Avoid Interference from Out-of-Band Emissions (OOBE)

CBS EIRP (dBm)	CBS Channel Bandwidth (MHz)	CBS Channel Center Frequency (MHz)	ES Antenna Elevation	ES Antenna Off-Axis Angle (deg)	Worst-case ES Antenna Gain Towards Interferer (dBi)	Interference Objective (dBm) (LNB Saturation Level)	Required Path Loss without Filter (dB)	Required Distance without Filter (m)	Filter Selectivity (dB)	Required Path Loss with Filter (dB)	Required Distance with Filter (m)
30.0	10	3555.0	Minimum	5	14.5	-55.0	99.5	628.1	58.9	40.7	0.7
30.0	10	3600.0	Minimum	5	14.5	-55.0	99.5	628.1	44.5	55.0	3.7
30.0	10	3645.0	Minimum	5	14.5	-55.0	99.5	628.1	29.8	69.7	20.2
30.0	10	3555.0	Low	15	2.6	-55.0	87.6	159.1	58.9	28.7	0.2
30.0	10	3600.0	Low	15	2.6	-55.0	87.6	159.1	44.5	43.1	0.9
30.0	10	3645.0	Low	15	2.6	-55.0	87.6	159.1	29.8	57.8	5.1
30.0	10	3555.0	Typical	30	-4.9	-55.0	80.1	66.9	58.9	21.2	0.1
30.0	10	3600.0	Typical	30	-4.9	-55.0	80.1	66.9	44.5	35.6	0.4
30.0	10	3645.0	Typical	30	-4.9	-55.0	80.1	66.9	29.8	50.2	2.2
30.0	10	3555.0	High	≥ 48	-10.0	-55.0	75.0	37.2	58.9	16.1	0.0
30.0	10	3600.0	High	≥ 48	-10.0	-55.0	75.0	37.2	44.5	30.5	0.2
30.0	10	3645.0	High	≥ 48	-10.0	-55.0	75.0	37.2	29.8	45.1	1.2
30.0	20	3560.0	Minimum	5	14.5	-55.0	99.5	628.1	56.8	42.7	0.9
30.0	20	3600.0	Minimum	5	14.5	-55.0	99.5	628.1	44.1	55.4	3.9
30.0	20	3640.0	Minimum	5	14.5	-55.0	99.5	628.1	30.8	68.7	18.1
30.0	20	3560.0	Low	15	2.6	-55.0	87.6	159.1	56.8	30.8	0.2
30.0	20	3600.0	Low	15	2.6	-55.0	87.6	159.1	44.1	43.5	1.0
30.0	20	3640.0	Low	15	2.6	-55.0	87.6	159.1	30.8	56.8	4.6
30.0	20	3560.0	Typical	30	-4.9	-55.0	80.1	66.9	56.8	23.3	0.1
30.0	20	3600.0	Typical	30	-4.9	-55.0	80.1	66.9	44.1	36.0	0.4
30.0	20	3640.0	Typical	30	-4.9	-55.0	80.1	66.9	30.8	49.3	1.9
30.0	20	3560.0	High	≥ 48	-10.0	-55.0	75.0	37.2	56.8	18.2	0.1
30.0	20	3600.0	High	≥ 48	-10.0	-55.0	75.0	37.2	44.1	30.9	0.2
30.0	20	3640.0	High	≥ 48	-10.0	-55.0	75.0	37.2	30.8	44.2	1.1

Table 3: Per-exposure Separation Distances to Avoid LNB Oversaturation from CBS Transmitters in the 3,550 – 3,650 MHz Band

CBS EIRP (dBm)	CBS Channel Bandwidth (MHz)	CBS Channel Center Frequency (MHz)	ES Antenna Elevation	ES Antenna Off-Axis Angle (deg)	Worst-case ES Antenna Gain Towards Interferer (dBi)	Interference Objective (dBm) (LNB Saturation Level)	Required Path Loss without Filter (dB)	Required Distance without Filter (m)	Filter Selectivity (dB)	Required Path Loss with Filter (dB)	Required Distance with Filter (m)
30.0	10	3655.0	Minimum	5	14.5	-55.0	99.5	628.1	14.8	84.7	114.1
30.0	10	3675.0	Minimum	5	14.5	-55.0	99.5	628.1	2.0	97.5	497.5
30.0	10	3695.0	Minimum	5	14.5	-55.0	99.5	628.1	0.7	98.8	576.9
30.0	10	3655.0	Low	15	2.6	-55.0	87.6	159.1	14.8	72.8	28.9
30.0	10	3675.0	Low	15	2.6	-55.0	87.6	159.1	2.0	85.6	126.0
30.0	10	3695.0	Low	15	2.6	-55.0	87.6	159.1	0.7	86.9	146.1
30.0	10	3655.0	Typical	30	-4.9	-55.0	80.1	66.9	14.8	65.3	12.1
30.0	10	3675.0	Typical	30	-4.9	-55.0	80.1	66.9	2.0	78.1	53.0
30.0	10	3695.0	Typical	30	-4.9	-55.0	80.1	66.9	0.7	79.3	61.4
30.0	10	3655.0	High	≥ 48	-10.0	-55.0	75.0	37.2	14.8	60.2	6.7
30.0	10	3675.0	High	≥ 48	-10.0	-55.0	75.0	37.2	2.0	73.0	29.4
30.0	10	3695.0	High	≥ 48	-10.0	-55.0	75.0	37.2	0.7	74.2	34.1
30.0	20	3660.0	Minimum	5	14.5	-55.0	99.5	628.1	7.7	91.8	258.3
30.0	20	3675.0	Minimum	5	14.5	-55.0	99.5	628.1	2.4	97.1	475.9
30.0	20	3690.0	Minimum	5	14.5	-55.0	99.5	628.1	0.9	98.6	565.3
30.0	20	3660.0	Low	15	2.6	-55.0	87.6	159.1	7.7	79.9	65.4
30.0	20	3675.0	Low	15	2.6	-55.0	87.6	159.1	2.4	85.2	120.5
30.0	20	3690.0	Low	15	2.6	-55.0	87.6	159.1	0.9	86.7	143.2
30.0	20	3660.0	Typical	30	-4.9	-55.0	80.1	66.9	7.7	72.4	27.5
30.0	20	3675.0	Typical	30	-4.9	-55.0	80.1	66.9	2.4	77.7	50.7
30.0	20	3690.0	Typical	30	-4.9	-55.0	80.1	66.9	0.9	79.2	60.2
30.0	20	3660.0	High	≥ 48	-10.0	-55.0	75.0	37.2	7.7	67.3	15.3
30.0	20	3675.0	High	≥ 48	-10.0	-55.0	75.0	37.2	2.4	72.6	28.2
30.0	20	3690.0	High	≥ 48	-10.0	-55.0	75.0	37.2	0.9	74.1	33.5

Table 4: Per-exposure Separation Distances to Avoid LNB Oversaturation for CBS Transmitters in the 3,650 – 3,700 MHz Band

Higher Power Operation Zone EIRP (dBm)	Higher Power Operation Zone Channel Bandwidth (MHz)	Higher Power Operation Zone Channel Center Frequency (MHz)	ES Antenna Elevation	ES Antenna Off-Axis Angle (deg)	Worst-case ES Antenna Gain Towards Interferer (dBi)	Interference Objective (dBm) (LNB Saturation Level)	Required Path Loss without Filter (dB)	Required Distance without Filter (m)	Filter Selectivity (dB)	Required Path Loss with Filter (dB)	Required Distance with Filter (m)
40.0	10	3655.0	Minimum	5	14.5	-55.0	109.5	1983.7	14.8	94.7	360.3
40.0	10	3675.0	Minimum	5	14.5	-55.0	109.5	1983.7	2.0	107.5	1571.4
40.0	10	3695.0	Minimum	5	14.5	-55.0	109.5	1983.7	0.7	108.8	1822.0
40.0	10	3655.0	Low	15	2.6	-55.0	97.6	502.4	14.8	82.8	91.2
40.0	10	3675.0	Low	15	2.6	-55.0	97.6	502.4	2.0	95.6	398.0
40.0	10	3695.0	Low	15	2.6	-55.0	97.6	502.4	0.7	96.9	461.5
40.0	10	3655.0	Typical	30	-4.9	-55.0	90.1	211.2	14.8	75.3	38.4
40.0	10	3675.0	Typical	30	-4.9	-55.0	90.1	211.2	2.0	88.0	167.3
40.0	10	3695.0	Typical	30	-4.9	-55.0	90.1	211.2	0.7	89.3	194.0
40.0	10	3655.0	High	≥ 48	-10.0	-55.0	85.0	117.4	14.8	70.2	21.3
40.0	10	3675.0	High	≥ 48	-10.0	-55.0	85.0	117.4	2.0	82.9	93.0
40.0	10	3695.0	High	≥ 48	-10.0	-55.0	85.0	117.4	0.7	84.2	107.8
43.0	20	3660.0	Minimum	5	14.5	-55.0	112.5	2805.4	7.7	104.8	1153.6
43.0	20	3675.0	Minimum	5	14.5	-55.0	112.5	2805.4	2.4	110.1	2125.8
43.0	20	3690.0	Minimum	5	14.5	-55.0	112.5	2805.4	0.9	111.6	2524.9
43.0	20	3660.0	Low	15	2.6	-55.0	100.6	710.6	7.7	92.9	292.2
43.0	20	3675.0	Low	15	2.6	-55.0	100.6	710.6	2.4	98.2	538.4
43.0	20	3690.0	Low	15	2.6	-55.0	100.6	710.6	0.9	99.7	639.5
43.0	20	3660.0	Typical	30	-4.9	-55.0	93.1	298.8	7.7	85.4	122.8
43.0	20	3675.0	Typical	30	-4.9	-55.0	93.1	298.8	2.4	90.7	226.4
43.0	20	3690.0	Typical	30	-4.9	-55.0	93.1	298.8	0.9	92.2	268.9
43.0	20	3660.0	High	≥ 48	-10.0	-55.0	88.0	166.0	7.7	80.3	68.3
43.0	20	3675.0	High	≥ 48	-10.0	-55.0	88.0	166.0	2.4	85.6	125.8
43.0	20	3690.0	High	≥ 48	-10.0	-55.0	88.0	166.0	0.9	87.1	149.4

Table 5: Per-exposure Separation Distances to Avoid LNB Oversaturation for Higher Power Operation Zone Transmitters in the 3,650 – 3,700 MHz Band

4 Conclusions

CBS transmitters that are located close to C-band earth stations may be capable of causing harmful interference due to out-of-band emissions and/or LNB oversaturation. The following factors should be considered with respect to this interference:

- The look angles used by the earth station significantly impact the maximum distances at which interference could occur.
- Requiring CBS transmitters to meet the ITU/LTE Category B OOBE limit rather than the Category A limit would significantly reduce the distance at which interference could occur.
- Greater distances would generally be needed to avoid OOBE interference compared to LNB oversaturation interference; however, spurious OOBE should only affect limited C-band frequencies while LNB oversaturation would affect the ability to receive any frequency.
- Filters should be highly effective to mitigate LNB oversaturation interference from transmitters in the 3,550-3,650 MHz band that is the primary subject of the FCC proposals.
- Filters may be less effective or ineffective for transmitters in the adjacent 3,650-3,700 MHz band (to the extent the FCC proposals involve this band).

Filters are also available that provide greater attenuation of the 3,650-3,700 MHz band by beginning to roll off above 3,700 MHz. Such filters could be used to eliminate interference into earth stations that do not require use of transponder frequencies immediately above 3,700 MHz.

5 Contact Us

For questions or information regarding this paper, contact:

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Appendix: Filter Information

Enhanced Performance C-Band Interference Elimination Filter

Model 13961WE

The optimum filter choice for eliminating interference from WiMAX, RADAR and virtually any other potential source of out-of-band interference.

Combining model 13961W performance with special component-plating processes, the model 13961WE offers truly enhanced performance.

No other C-band interference elimination filter within the industry offers all of these features:

Length:	5.49” (13.9 cm)
Weight:	1.125 lb. (0.51 kg)
Passband VSWR:	1.44:1 Max.
Group Delay Variation:	7 nS Max.
Insertion Loss:	0.3 dB Approx. @ center band 0.3 dB Approx. roll off @ band edges
Rejection :	45 dB Min @ 3.65 GHz / 4.25 GHz 60 dB Typ @ 3.55 GHz / 4.35 GHz 70 dB Typ @ 3.50 GHz / 4.40 GHz

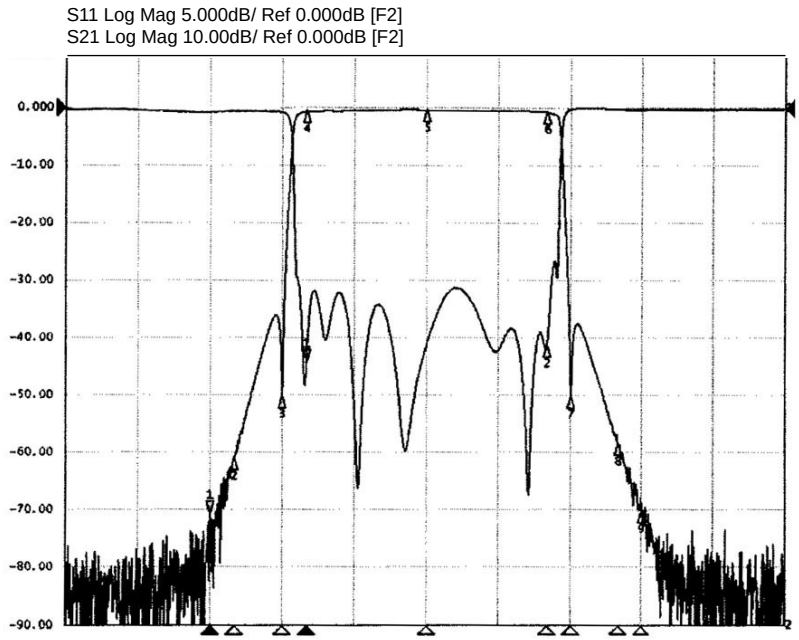
Utilizing a durable and true one piece body/flange construction, the 13961WE is shipped with hardware & gasketing and is ready to install between the feedhorn and the LNB/LNA.

International bands are also available.

Other Specifications:

Passband:	3.7 - 4.2 GHz
Transmit Band Rejection:	> 70 dB Typ from 5.8-6.5 GHz
Flanges:	CPR229G (Input) CPR229F (Output)

Marker	
1	3.5000000 GHz -70.524 dB
2	3.5500000 GHz -60.894 dB
3	3.6500000 GHz -50.119 dB
4	3.7000000 GHz -0.6069 dB
5	3.9500000 GHz -0.3256 dB
6	4.2000000 GHz -0.6396 dB
7	4.2500000 GHz -50.147 dB
8	4.3500000 GHz -58.397 dB
9	4.4000000 GHz -70.036 dB



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13961WE

Price: $425.00

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Rejection :..... 45 dB Min @ 3.65 GHz / 4.25 GHz
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70 dB Typ @ 3.50 GHz / 4.40 GHz

Other Specifications:

Passband:..... 3.7 - 4.2 GHz

Transmit Band Rejection:..... > 70 dB Typ from 5.8-6.5 GHz

Flanges:..... CPR229G (Input)
CPR229F (Output)
Finish:..... White Enamel

Utilizing a durable and true one piece body/flange construction, the 13961W is shipped with hardware & gasketing and is ready to install between the feedhorn and the LNB/LNA.

International bands are also available.

Additional Product Information

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C-Band Earth Stations

Counts by State / Territory

State / Territory	Abbrev	Stations
Alaska	AK	444
Alabama	AL	76
Arkansas	AR	52
Arizona	AZ	73
California	CA	398
Colorado	CO	112
Connecticut	CT	58
Delaware	DE	9
Florida	FL	260
Georgia	GA	137
Hawaii	HI	38
Iowa	IA	44
Idaho	ID	23
Illinois	IL	103
Indiana	IN	120
Kansas	KS	55
Kentucky	KY	65
Louisiana	LA	110
Massachusetts	MA	62
Maryland	MD	100
Maine	ME	36
Michigan	MI	121
Minnesota	MN	89
Missouri	MO	88
Mississippi	MS	61
Montana	MT	47
North Carolina	NC	146
North Dakota	ND	24
Nebraska	NE	49
New Hampshire	NH	23
New Jersey	NJ	104
New Mexico	NM	63
Nevada	NV	34
New York	NY	204
Ohio	OH	199
Oklahoma	OK	73
Oregon	OR	49
Pennsylvania	PA	212
Rhode Island	RI	10
South Carolina	SC	53
South Dakota	SD	22
Tennessee	TN	91
Texas	TX	241

Utah	UT	39
Virginia	VA	154
Vermont	VT	19
Washington	WA	103
Wisconsin	WI	89
West Virginia	WV	53
Wyoming	WY	23
American Samoa	AS	8
District of Columbia	DC	17
Gulf of Mexico	GM	48
Guam	GU	6
Marianas	MP	2
Puerto Rico	PR	50
US Virgin Islands	VI	6
Total		**4995**

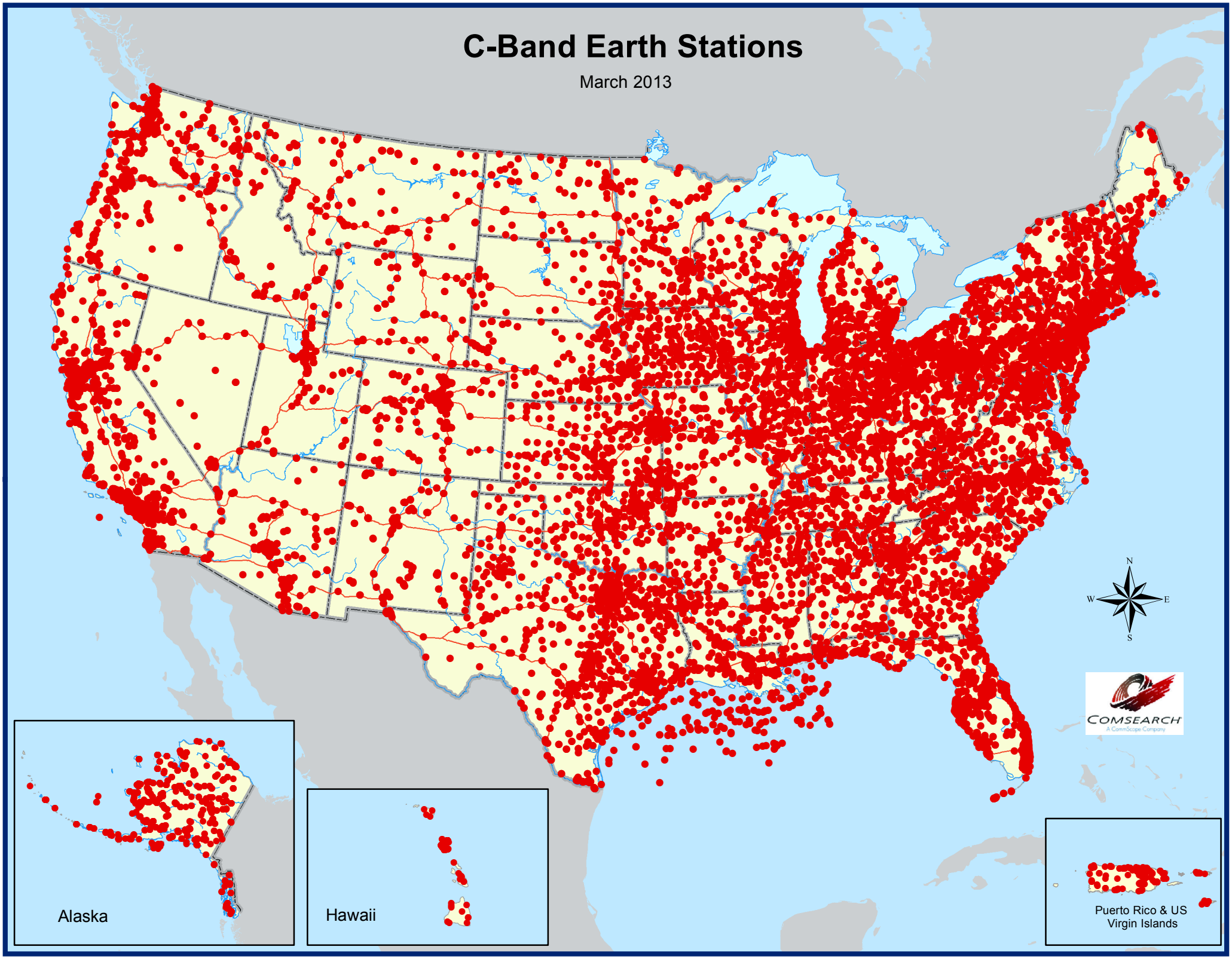
C-Band Earth Stations

Top Ten Licensees

Licensee / Affiliate	Stations
Associated Press	958
Comcast	518
National Public Radio	358
Time Warner	225
Fox Television / News	188
Alascom, Inc.	187
ABC / Disney	167
GCI Communication Corp.	142
RCN Corporation	115
Intelsat	80

C-Band Earth Stations

March 2013



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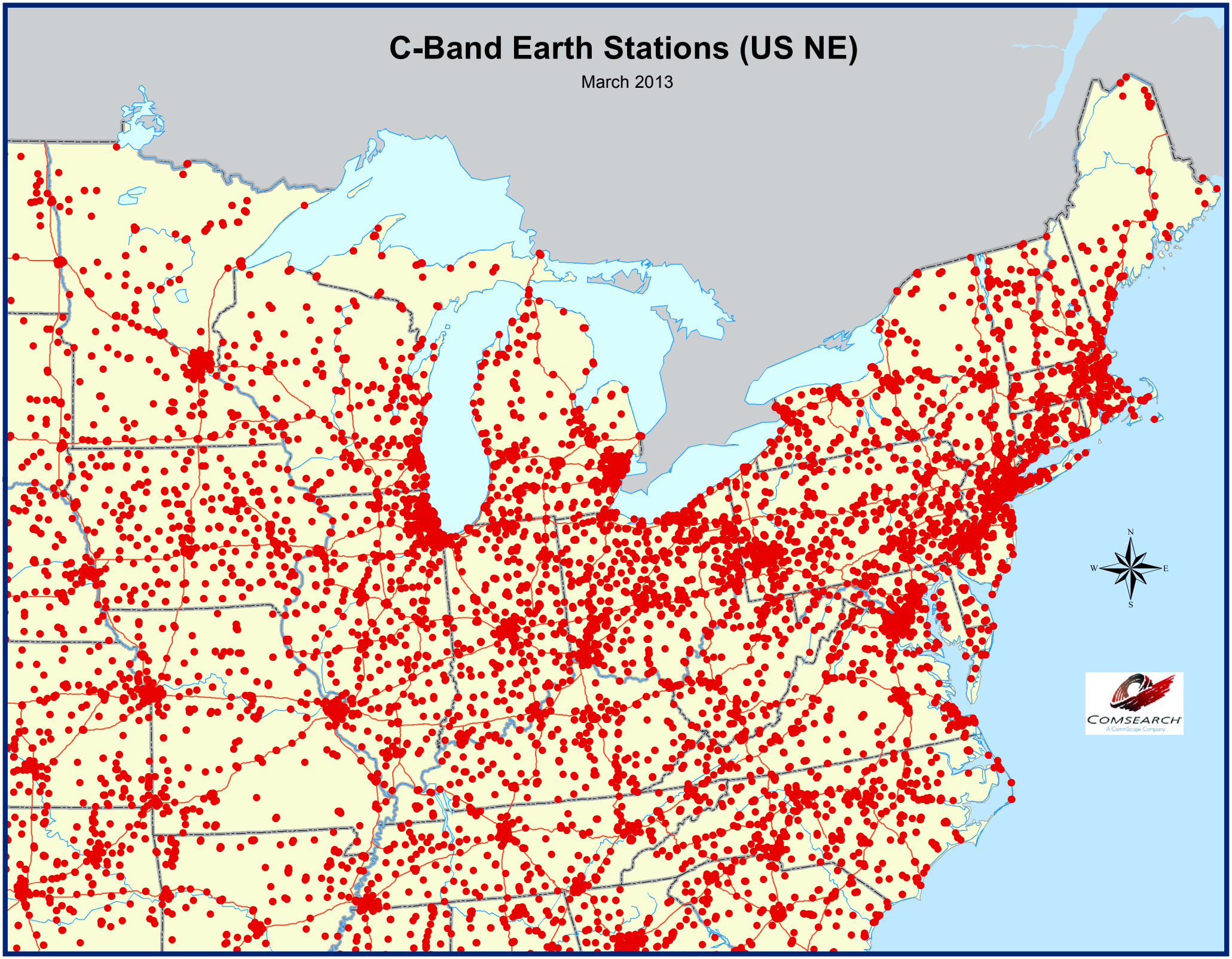

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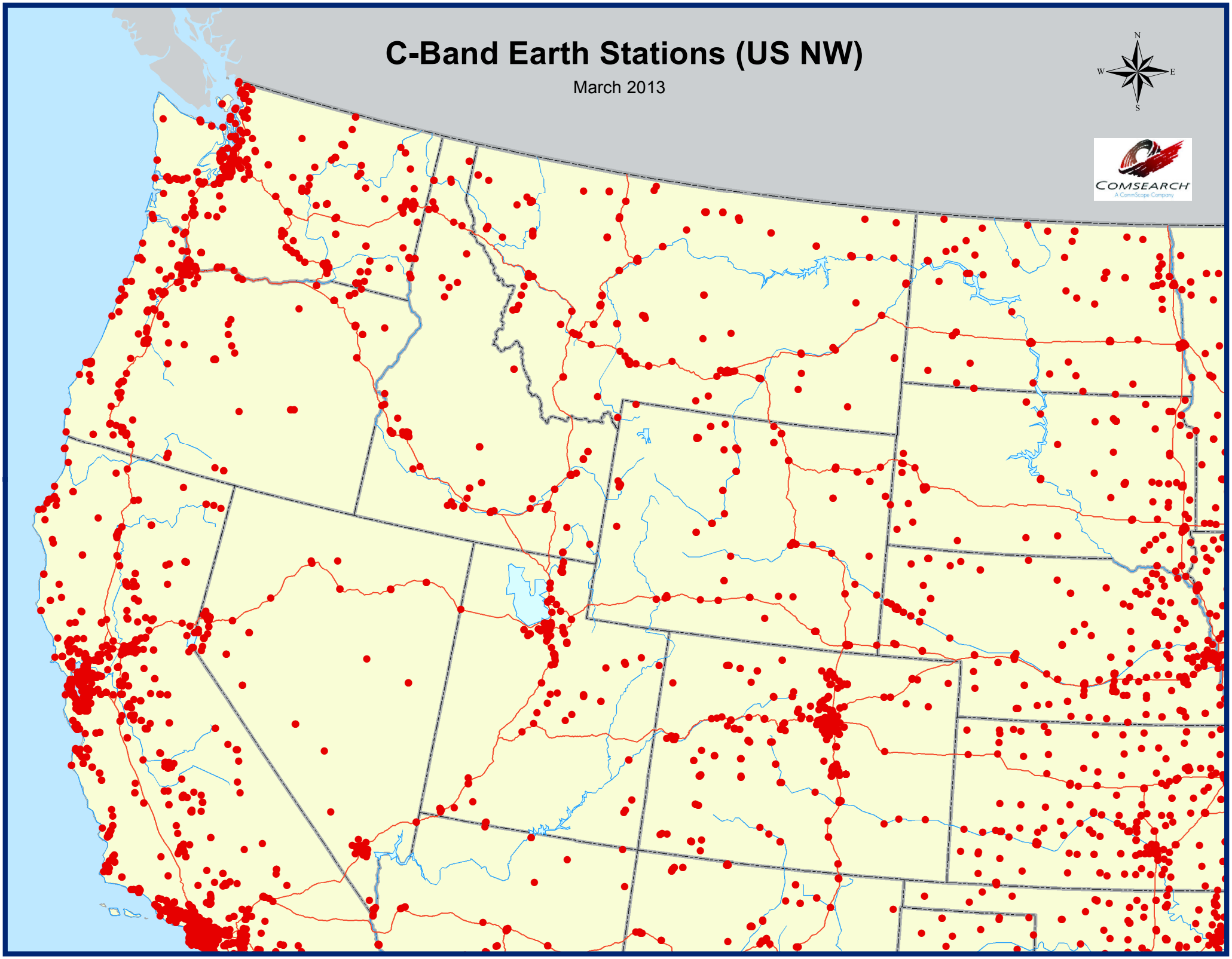

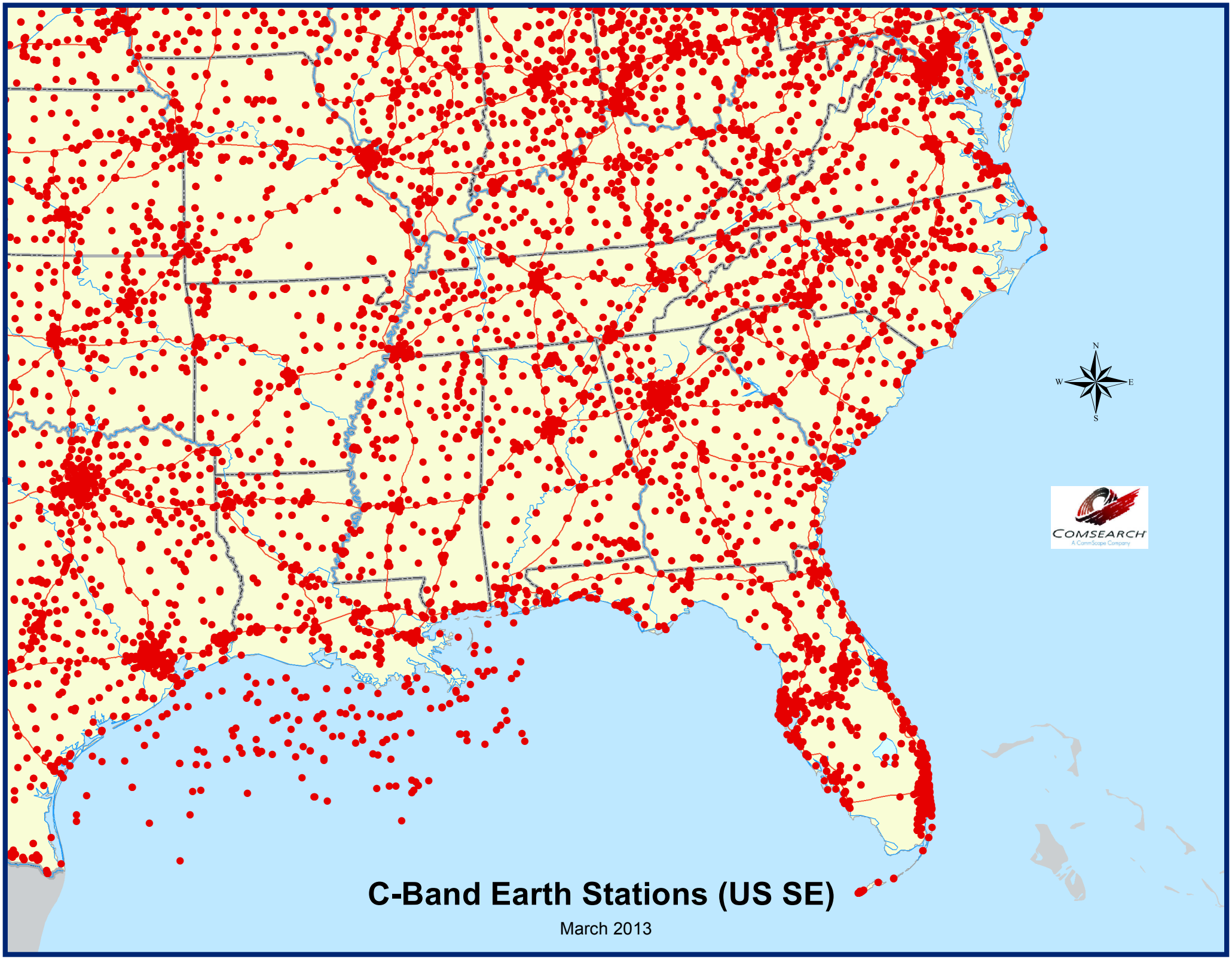

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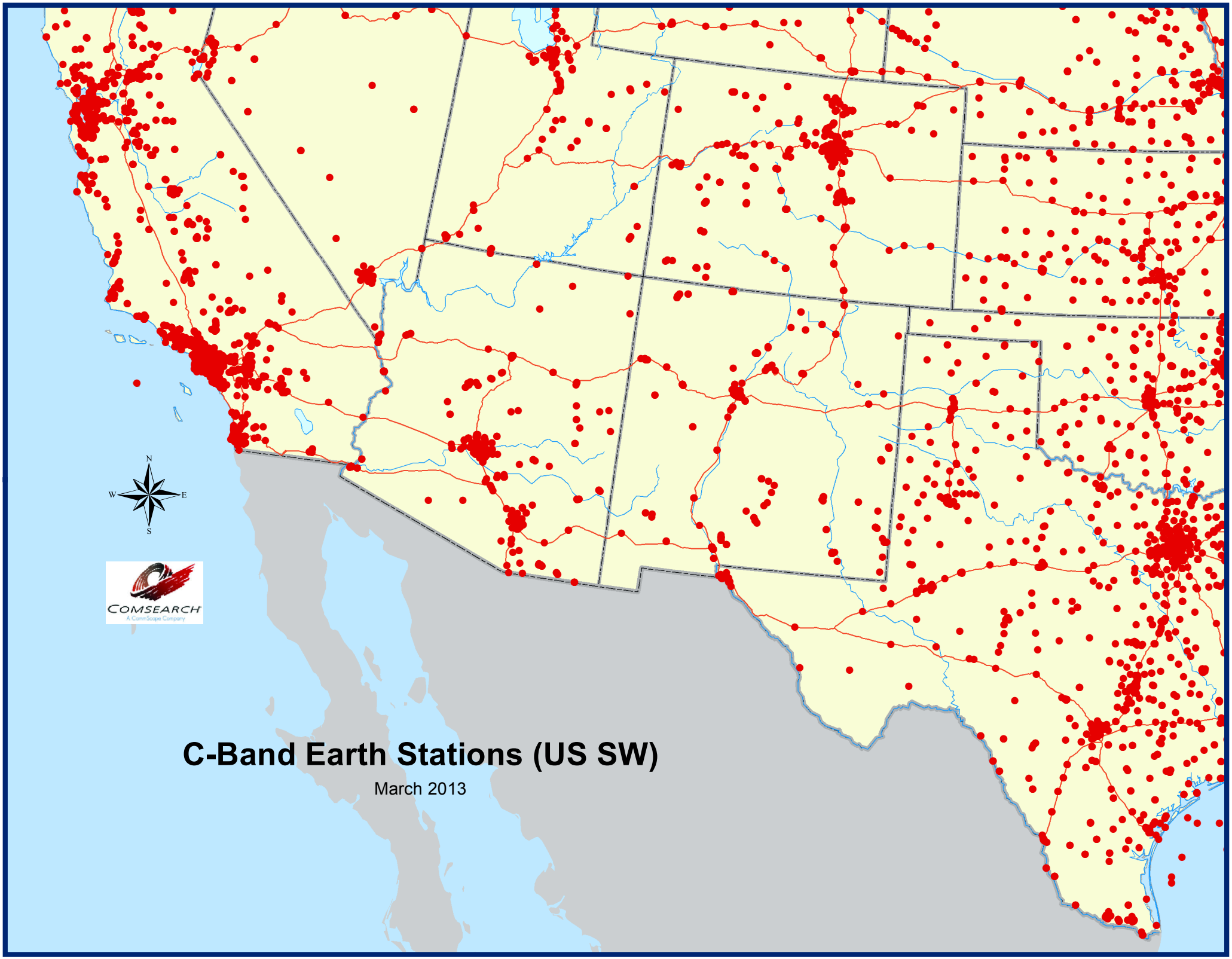
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