RADIO FREQUENCY INTERFERENCE ANALYSIS REPORT

Smartlink on behalf of T-Mobile

Site ID: VA70332A
Site Name: VA70332A

June 27, 2017

COMMONWEALTH OF VIRGINIA
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No Harmful Interference is predicted as a result of T-Mobile's proposed collocation affecting existing Public Safety systems operating in the vicinity of the site.

*The subject property address is: 332 Rip Rap Road and is no longer 1012 Thomas Street.

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1.0 Executive Summary

This report presents a radio frequency interference (RFI) analysis which was performed on the VA70332A site. The RFI analysis consists of transmitter noise, receiver desensitization, intermodulation, harmonic and transmitter spurious output interference. The report consists of Sections that provide details of the communications site, antenna systems, operational frequencies and each interference analysis mode.

A summary of the interference analysis results is depicted in the following Table.

Interference Analysis Mode	Type Mix	Status	Summary	Worst-Case Margin (dB)
Transmitter Noise	N/A	Passed	No Interference was predicted	33.2
Receiver Desensitization	N/A	Passed	No Interference was predicted	71.4
Transmitter Intermodulation	1 Tx	Passed	No Interference was predicted	N/A
Transmitter Intermodulation	2 Tx	Passed	No Interference was predicted	N/A
Transmitter Intermodulation	3 Tx	Passed	No Interference was predicted	N/A
Transmitter Intermodulation	4 Tx	Passed	No Interference was predicted	N/A
Transmitter Intermodulation	5 Tx	Passed	No Interference was predicted	N/A
Receiver Intermodulation	1 Tx	Passed	No Interference was predicted	N/A
Receiver Intermodulation	2 Tx	Passed	No Interference was predicted	N/A
Receiver Intermodulation	3 Tx	Passed	No Interference was predicted	N/A
Receiver Intermodulation	4 Tx	Passed	No Interference was predicted	N/A
Receiver Intermodulation	5 Tx	Passed	No Interference was predicted	N/A
Transmitter Harmonics	N/A	Passed	No Interference was predicted	N/A
Transmitter Spurious Output	N/A	Passed	No Interference was predicted	N/A
Interference Level Summing - C/(I+N)	N/A	Passed	No Interference was predicted	N/A
Wideband IM Spectral Analysis	N/A	N/A	No Analysis performed	N/A

The analysis was performed with the setup options depicted in the Table below.

Analysis	Description
Receiver Performance	Receiver Sensitivity Threshold
Receiver Bandwidth	Receiver Dependent
Antenna Patterns Considered	No (Worst Case)
Measured Antenna Isolation Data	No
Filters/Multicouplers Considered	Yes
Number of Simultaneous Transmitters Mixed	5
Highest Intermodulation Order Tested	7
Condense Intermodulation Hit Quantity	Yes - 1000/Order
TX IM Bandwidth Multiplication	Yes
Tx/Rx Systems Excluded	None
Site File Name	VA70332A.dta
Report File Name	VA70332A.docx
WirelessSiteRFI Software Version	10.0.8

2.0 Site Description

The communication systems located at this site are described in this section as well as the configuration of the antenna systems.

The site parameters are:

Site Name: VA70332A
Site Description: Monopole
Address: 1012 Thomas Street
Hampton, VA 23669
Latitude: 37:2:3.25 N
Longitude: 76:21:15.51 W
Elevation: 3' (AMSL)
Notes: T-Mobile is proposing to install antennas at the 120 foot level on the monopole. The final antenna count will be 12 antennas.

2.1 Communications Systems

System	Provider	Technology	Frequency Band
1	T-Mobile (Proposed)	LTE-2100	1710 - 2180 MHz - AWS
2	T-Mobile (Proposed)	UMTS-1900; LTE-1900	1850 - 1995 MHz - PCS
3	T-Mobile (Proposed)	LTE-700	698 - 806 MHz - 700 MHz Band
4	City Hall Building	FM Land Mobile	150 - 174 MHz - Land Mobile
5	City Hall Building	FM Land Mobile	420 - 470 MHz - Land Mobile
6	City Hall Building	FM Land Mobile	746 - 806 MHz - 700 MHz Band
7	City Hall Building	FM Land Mobile	806 - 896 MHz - Land Mobile
8	Hampton City Hall to Big Bethel	Microwave	5925 - 6875 MHz - 5 GHz Microwave
9	Big Bethel back to City Hall	Microwave	5925 - 6875 MHz - 5 GHz Microwave
10	Hampton City Hall to Buckroe	Microwave	5925 - 6875 MHz - 5 GHz Microwave
11	Buckroe back to City Hall	Microwave	5925 - 6875 MHz - 5 GHz Microwave

2.2 Antenna Systems

Ant #	Mfg	Antenna Model	Gain (dBd)	Hgt (ft)	Orient (deg)	Sec-tor	Ant Use	Transmission Line Type	Line Loss (/100')	Line Length (ft)
1	Ericsson	AIR32 B66A B2A	15.86	120	50	A	Dplx	Fiber	0.001	150
2	Ericsson	AIR32 B66A B2A	15.86	120	120	B	Dplx	Fiber	0.001	150
3	Ericsson	AIR32 B66A B2A	15.86	120	180	C	Dplx	Fiber	0.001	150
4	Ericsson	AIR32 B66A B2A	15.86	120	180	C	Dplx	Fiber	0.001	150
5	Ericsson	AIR32 B66A B2A	15.86	120	50	A	Dplx	Fiber	0.001	150
6	Ericsson	AIR32 B66A B2A	15.86	120	120	B	Dplx	Fiber	0.001	150
7	Ericsson	AIR32 B66A B2A	15.86	120	180	C	Dplx	Fiber	0.001	150
8	Ericsson	AIR32 B66A B2A	15.86	120	180	C	Dplx	Fiber	0.001	150
9	Commscope	F-65C-R1	13.63	120	50	A	Dplx	Fiber	0.001	150
10	Commscope	F-65C-R1	13.63	120	50	A	Dplx	Fiber	0.001	150
11	Commscope	F-65C-R1	13.63	120	50	A	Dplx	Fiber	0.001	150
12	Commscope	F-65C-R1	13.63	120	120	B	Dplx	Fiber	0.001	150
13	Commscope	F-65C-R1	13.63	120	120	B	Dplx	Fiber	0.001	150
14	Commscope	F-65C-R1	13.63	120	120	B	Dplx	Fiber	0.001	150
15	Commscope	F-65C-R1	13.63	120	180	C	Dplx	Fiber	0.001	150
16	Commscope	F-65C-R1	13.63	120	180	C	Dplx	Fiber	0.001	150
17	Generic	Omni	6	120	0		Tx/Rx	7/8 in. Foam	0.45	150
18	Generic	Omni	6.6	120	0		Dplx	7/8 in. Foam	0.85	150
19	Generic	Omni	9	120	0		Dplx	1-5/8 in. Foam	0.72	150
20	Generic	Omni	9	120	0		Dplx	1-5/8 in. Foam	0.72	150
21	Generic	Microwave	36.2	120	303.2		Dplx	EW	1.5	150
22	Generic	Microwave	36.2	120	123.2		Dplx	EW	1.5	150
23	Generic	Microwave	36.2	120	63.9		Dplx	EW	1.5	150
24	Generic	Microwave	36.2	120	243.9		Dplx	EW	1.5	150

3.0 Transmitter Frequencies

Freq #	Ant #	Provider	Model	Technology	Channel Label	ID	Frequency	Power (Watts)	BW (KHz)
1	1	T-Mobile (Proposed)	Ericsson	LTE-2100		A	2140.000000	32	10000
2	1	T-Mobile (Proposed)	Ericsson	LTE-2100		B	2150.000000	32	10000
3	2	T-Mobile (Proposed)	Ericsson	LTE-2100		C	2140.000000	32	10000
4	2	T-Mobile (Proposed)	Ericsson	LTE-2100		D	2150.000000	32	10000
5	3	T-Mobile (Proposed)	Ericsson	LTE-2100		E	2140.000000	32	10000
6	3	T-Mobile (Proposed)	Ericsson	LTE-2100		F	2150.000000	32	10000
7	5	T-Mobile (Proposed)	Ericsson	UMTS-1900		G	1952.500000	32	5000
8	5	T-Mobile (Proposed)	Ericsson	UMTS-1900		H	1957.500000	32	5000
9	5	T-Mobile (Proposed)	Ericsson	LTE-1900		I	1965.000000	32	10000
10	6	T-Mobile (Proposed)	Ericsson	UMTS-1900		J	1952.500000	32	5000
11	6	T-Mobile (Proposed)	Ericsson	UMTS-1900		K	1957.500000	32	5000
12	6	T-Mobile (Proposed)	Ericsson	LTE-1900		L	1965.000000	32	10000
13	7	T-Mobile (Proposed)	Ericsson	UMTS-1900		M	1952.500000	32	5000
14	7	T-Mobile (Proposed)	Ericsson	UMTS-1900		N	1957.500000	32	5000
15	7	T-Mobile (Proposed)	Ericsson	LTE-1900		O	1965.000000	32	10000
16	9	T-Mobile (Proposed)	Ericsson	LTE-700		P	731.000000	40	5000
17	12	T-Mobile (Proposed)	Ericsson	LTE-700		Q	731.000000	40	5000
18	15	T-Mobile (Proposed)	Ericsson	LTE-700		R	731.000000	40	5000
19	17	City Hall Building	Other	FM Land Mobile		S	154.265000	100	16
20	17	City Hall Building	Other	FM Land Mobile		T	154.295000	100	16
21	18	City Hall Building	Other	FM Land Mobile		U	453.050000	100	11
22	18	City Hall Building	Other	FM Land Mobile		V	453.750000	100	11
23	19	City Hall Building	Other	FM Land Mobile		W	773.531250	100	12.5
24	19	City Hall Building	Other	FM Land Mobile		X	773.806250	100	12.5
25	19	City Hall Building	Other	FM Land Mobile		Y	774.031250	100	12.5
26	19	City Hall Building	Other	FM Land Mobile		Z	774.081250	100	12.5
27	19	City Hall Building	Other	FM Land Mobile		AA	774.331250	100	12.5
28	20	City Hall Building	Other	FM Land Mobile		AB	806.037500	100	8
29	20	City Hall Building	Other	FM Land Mobile		AC	806.287500	100	8
30	20	City Hall Building	Other	FM Land Mobile		AD	806.562500	100	8
31	20	City Hall Building	Other	FM Land Mobile		AE	806.812500	100	8
32	20	City Hall Building	Other	FM Land Mobile		AF	809.712500	100	8
33	20	City Hall Building	Other	FM Land Mobile		AG	809.962500	100	8
34	20	City Hall Building	Other	FM Land Mobile		AH	810.462500	100	8
35	20	City Hall Building	Other	FM Land Mobile		AI	810.712500	100	8
36	20	City Hall Building	Other	FM Land Mobile		AJ	810.962500	100	8
37	20	City Hall Building	Other	FM Land Mobile		AK	811.512500	100	8
38	20	City Hall Building	Other	FM Land Mobile		AL	811.762500	100	8
39	20	City Hall Building	Other	FM Land Mobile		AM	812.762500	100	8
40	20	City Hall Building	Other	FM Land Mobile		AN	813.762500	100	8
41	20	City Hall Building	Other	FM Land Mobile		AO	814.762500	100	8
42	20	City Hall Building	Other	FM Land Mobile		AP	851.450000	100	8
43	20	City Hall Building	Other	FM Land Mobile		AQ	851.537500	100	8
44	20	City Hall Building	Other	FM Land Mobile		AR	852.062500	100	8
45	20	City Hall Building	Other	FM Land Mobile		AS	853.325000	100	8
46	20	City Hall Building	Other	FM Land Mobile		AT	853.687500	100	8
47	20	City Hall Building	Other	FM Land Mobile		AU	853.835800	100	8
48	20	City Hall Building	Other	FM Land Mobile		AV	853.912500	100	8
49	20	City Hall Building	Other	FM Land Mobile		AW	858.637500	100	8
50	21	Hampton City Hall to Big Bethel	Other	Microwave		AX	5974.850000	.63	5000
51	22	Big Bethel back to City Hall	Other	Microwave		AY	6226.890000	.63	5000
52	23	Hampton City Hall to Buckroe	Other	Microwave		AZ	6034.150000	.63	5000
53	24	Buckroe back to City Hall	Other	Microwave		BA	6286.190000	.63	5000

4.0 Receiver Frequencies

Freq #	Ant #	Provider	Model	Technology	Channel Label	ID	Frequency	Sen (dBm)	BW (KHz)
1	1	T-Mobile (Proposed)	Ericsson	LTE-2100		A	1740.000000	-102	10000
2	1	T-Mobile (Proposed)	Ericsson	LTE-2100		B	1750.000000	-102	10000
3	2	T-Mobile (Proposed)	Ericsson	LTE-2100		C	1740.000000	-102	10000
4	2	T-Mobile (Proposed)	Ericsson	LTE-2100		D	1750.000000	-102	10000
5	3	T-Mobile (Proposed)	Ericsson	LTE-2100		E	1740.000000	-102	10000
6	3	T-Mobile (Proposed)	Ericsson	LTE-2100		F	1750.000000	-102	10000
7	5	T-Mobile (Proposed)	Ericsson	UMTS-1900		G	1872.500000	-110	5000
8	5	T-Mobile (Proposed)	Ericsson	UMTS-1900		H	1877.500000	-110	5000
9	5	T-Mobile (Proposed)	Ericsson	LTE-1900		I	1885.000000	-102	10000
10	6	T-Mobile (Proposed)	Ericsson	UMTS-1900		J	1872.500000	-110	5000
11	6	T-Mobile (Proposed)	Ericsson	UMTS-1900		K	1877.500000	-110	5000
12	6	T-Mobile (Proposed)	Ericsson	LTE-1900		L	1885.000000	-102	10000
13	7	T-Mobile (Proposed)	Ericsson	UMTS-1900		M	1872.500000	-110	5000
14	7	T-Mobile (Proposed)	Ericsson	UMTS-1900		N	1877.500000	-110	5000
15	7	T-Mobile (Proposed)	Ericsson	LTE-1900		O	1885.000000	-102	10000
16	9	T-Mobile (Proposed)	Ericsson	LTE-700		P	701.000000	-102	5000
17	12	T-Mobile (Proposed)	Ericsson	LTE-700		Q	701.000000	-102	5000
18	15	T-Mobile (Proposed)	Ericsson	LTE-700		R	701.000000	-102	5000
19	17	City Hall Building	Other	FM Land Mobile		S	154.265000	-116	25
20	17	City Hall Building	Other	FM Land Mobile		T	154.295000	-116	25
21	18	City Hall Building	Other	FM Land Mobile		U	453.050000	-116	11
22	18	City Hall Building	Other	FM Land Mobile		V	453.750000	-116	11
23	19	City Hall Building	Other	FM Land Mobile		W	803.531250	-116	12.5
24	19	City Hall Building	Other	FM Land Mobile		X	803.806250	-116	12.5
25	19	City Hall Building	Other	FM Land Mobile		Y	804.031250	-116	12.5
26	19	City Hall Building	Other	FM Land Mobile		Z	804.081250	-116	12.5
27	19	City Hall Building	Other	FM Land Mobile		AA	804.331250	-116	12.5
28	20	City Hall Building	Other	FM Land Mobile		AB	851.037500	-116	8
29	20	City Hall Building	Other	FM Land Mobile		AC	851.287500	-116	8
30	20	City Hall Building	Other	FM Land Mobile		AD	851.562500	-116	8
31	20	City Hall Building	Other	FM Land Mobile		AE	851.812500	-116	8
32	20	City Hall Building	Other	FM Land Mobile		AF	854.712500	-116	8
33	20	City Hall Building	Other	FM Land Mobile		AG	854.962500	-116	8
34	20	City Hall Building	Other	FM Land Mobile		AH	855.462500	-116	8
35	20	City Hall Building	Other	FM Land Mobile		AI	855.712500	-116	8
36	20	City Hall Building	Other	FM Land Mobile		AJ	855.962500	-116	8
37	20	City Hall Building	Other	FM Land Mobile		AK	856.512500	-116	8
38	20	City Hall Building	Other	FM Land Mobile		AL	856.762500	-116	8
39	20	City Hall Building	Other	FM Land Mobile		AM	857.762500	-116	8
40	20	City Hall Building	Other	FM Land Mobile		AN	858.762500	-116	8
41	20	City Hall Building	Other	FM Land Mobile		AO	859.762500	-116	8
42	20	City Hall Building	Other	FM Land Mobile		AP	806.450000	-116	8
43	20	City Hall Building	Other	FM Land Mobile		AQ	806.537500	-116	8
44	20	City Hall Building	Other	FM Land Mobile		AR	807.062500	-116	8
45	20	City Hall Building	Other	FM Land Mobile		AS	808.325000	-116	8
46	20	City Hall Building	Other	FM Land Mobile		AT	808.687500	-116	8
47	20	City Hall Building	Other	FM Land Mobile		AU	808.835800	-116	8
48	20	City Hall Building	Other	FM Land Mobile		AV	808.912500	-116	8
49	20	City Hall Building	Other	FM Land Mobile		AW	813.637500	-116	8
50	21	Hampton City Hall to Big Bethel	Other	Microwave		AX	6226.890000	-72	5000
51	22	Big Bethel back to City Hall	Other	Microwave		AY	5974.850000	-72	5000
52	23	Hampton City Hall to Buckroe	Other	Microwave		AZ	6286.190000	-72	5000
53	24	Buckroe back to City Hall	Other	Microwave		BA	6034.150000	-72	5000

5.0 Transmitter Noise Analysis

Transmitter noise interference occurs because a transmitter radiates energy on its operating frequency as well as frequencies above and below the assigned frequency. The energy that is radiated above and below the assigned frequency is known as sideband noise energy and extends for several megahertz on either side of the operating frequency. This undesired noise energy can fall within the passband of a nearby receiver even if the receiver's operating frequency is several megahertz away. The transmitter noise appears as "on-channel" noise interference and cannot be filtered out at the receiver. It is on the receiver's operating frequency and competes with the desired signal, which in effect, degrades the operational performance.

The analysis predicts each transmitter's noise signal level present at the input of each receiver. It takes into account the transmitter's noise characteristics, frequency separation, power output, transmission line losses, filters, duplexers, combiners, isolators, multi-couplers and other RF devices that are present in both systems. Additionally, the analysis considers the antenna separation space loss, horizontal and vertical gain components of the antennas as well as how they are mounted on the structure. The gain components are derived from antenna pattern data published by each manufacturer.

The analysis determines how much isolation is required, if any, to prevent receiver performance degradation caused by transmitter noise interference. The Table below depicts the results of this analysis. For each receiver, the transmitter that has the worst-case impact is displayed. The Signal Margin represents the margin in dB, before the receiver's performance is degraded. A negative number indicates that the performance is degraded and the value indicates how much additional isolation is required to prevent receiver performance degradation.

Receiver Provider	Receive Channel	Receive Frequency (MHz)	Transmitter Provider	Transmit Channel	Transmit Frequency (MHz)	Attn Required (dB)	Attn Provided (dB)	Signal Margin (dB)
None								

No transmitter noise interference problems were predicted.

6.0 Receiver Desensitization Analysis

Receiver desensitization interference occurs when an undesired signal from a nearby "off-frequency" transmitter is sufficiently close to a receiver's operating frequency. The signal may get through the RF selectivity of the receiver. If this undesired signal is of sufficient amplitude, the receiver's critical voltage and current levels are altered and the performance of the receiver is degraded at its operating frequency. The gain of the receiver is reduced, thereby reducing the performance of the receiver.

A transmitter can be operating several megahertz away from the receiver frequency and/or its antenna can be located several thousand feet from the receiver's antenna and still cause interference.

The analysis predicts each transmitter's signal level present at the input of each receiver. It takes into account the transmitter's power output, frequency separation, transmission line losses, filters, duplexers, combiners, isolators, multi-couplers and other RF devices that are present in both systems. Additionally, the analysis considers the antenna separation space loss, horizontal and vertical gain components of the antennas as well as how they are mounted on the structure. The gain components are derived from antenna pattern data published by each manufacturer.

The analysis determines how much isolation is required, if any, to prevent receiver performance degradation caused by receiver desensitization interference. The Table below depicts the results of this analysis. For each receiver, the transmitter that has the worst-case impact is displayed. The Signal Margin represents the margin in dB, before the receiver's performance is degraded. A negative number indicates that the performance is degraded and the value indicates how much additional isolation is required to prevent receiver performance degradation.

Receiver Provider	Receive Channel	Receive Frequency (MHz)	Transmitter Provider	Transmit Channel	Transmit Frequency (MHz)	Attn Required (dB)	Attn Provided (dB)	Signal Margin (dB)
None								

No receiver desensitization interference problems were predicted.

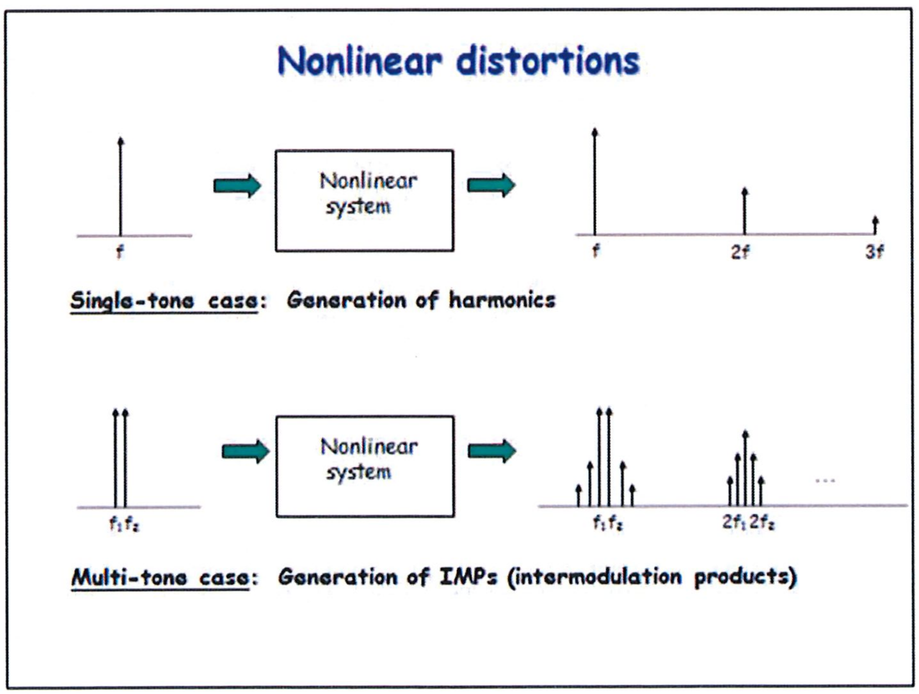
7.0 Intermodulation Interference Analysis

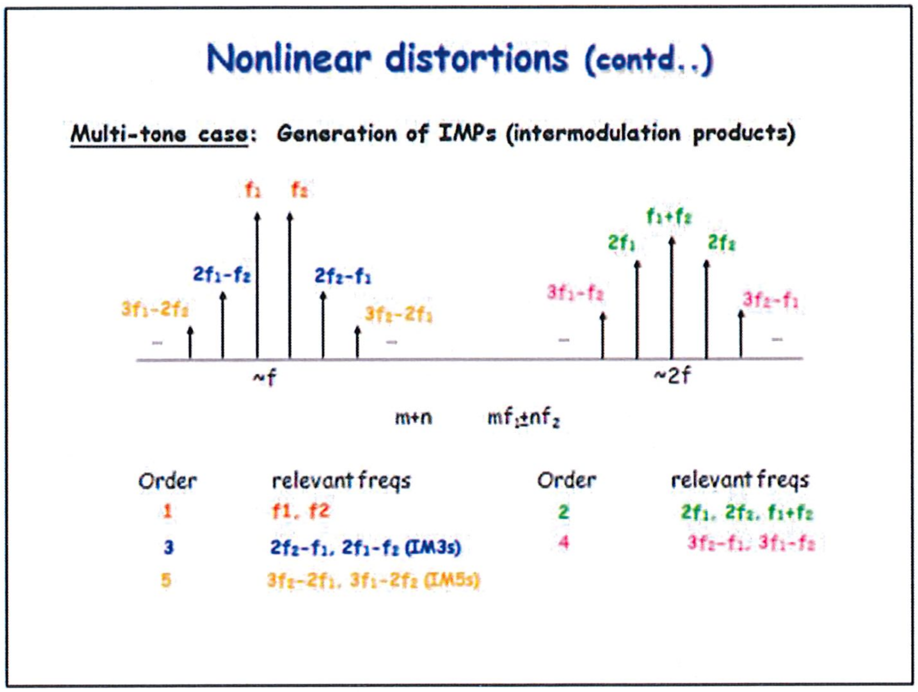
There are three basic categories of Intermodulation (IM) interference. They are receiver produced, transmitter produced, and "other" radiated IM. Transmitter produced IM is the result of one or more transmitters impressing a signal in the non-linear final output stage circuitry of another transmitter, usually via antenna coupling. The IM product frequency is then re-radiated from the transmitter's antenna. Receiver produced IM is the result of two or more transmitter signals mixing in a receiver RF amplifier or mixer stage when operating in a non-linear range.

"Other" radiated IM is the result of transmitter signals mixing in other non-linear junctions. These junctions are usually metallic, such as rusty bolts on a tower, dissimilar metallic junctions, or other non-linear metallic junctions in the area. IM products can also be caused by non-linearity in the transmission system such as antenna, transmission line, or connectors.

Communication sites with co-located transmitters, usually have RF coupling between each transmitter and antenna system. This results in the signals of each transmitter entering the nonlinear final output (PA) circuitry of the other transmitters. When intermodulation (IM) products are created in the output circuitry and they fall within the passband of the final amplifier, the IM products are re-radiated and may interfere with receivers at the same site or at other nearby sites. Additionally, these strong transmitter signals may directly enter a receiver and drive the RF amplifier into a nonlinear operation, or if not filtered effectively by the receiver input circuitry, these signals could mix in the nonlinear circuitry of the receiver front-end or mixer, creating IM products directly in the receiver.

The frequencies of IM mixing are known as nonlinear distortions. The images below depict how these IM products are derived when passing through a nonlinear junction/system.





Not all of the mixing possibilities are significant in creating interference signals. Some fall "out-of-band" of the receiver and the higher order IM products are usually weaker in signal strength.

7.1 Transmitter Generated Intermodulation Analysis

Intermodulation in transmitters occurs when a signal from another transmitter is impressed on the nonlinear final output stage circuitry, usually via antenna coupling. The power level of the IM product is determined by the power level of the incoming extraneous signal from another transmitter and by a conversion loss factor. The conversion loss factor takes into account the mixing efficiency of the transmitter's final output stage. Conversion loss differs with transmitter design, adjustment, frequency separation of the source signals, and with the order of the IM product.

The analysis calculates all possible IM product frequencies that could potentially interfere with receivers at the communications site based on each receiver's individual bandwidth. It then predicts each IM signal level present at the input of each affected receiver. For each IM frequency, the analysis considers all possible sources of IM generation in the transmitters. For example, if there are four transmitters involve, the analysis will calculate the IM signal level that would be generated in each transmitter. For this example, that would be four possible mixing conditions.

The analysis takes into account the transmitter's power output, modulation bandwidth, conversion losses, transmission line losses, filters, duplexers, combiners, isolators, multi-couplers and other RF devices that are present in each system. Additionally, the analysis considers the antenna separation space loss, horizontal and vertical gain components of the antennas as well as how they are mounted on the structure. The gain components are derived from antenna pattern data published by each manufacturer.

The analysis determines how much isolation is required to prevent receiver performance degradation for each IM interference signal that occurs. Receivers experiencing transmitter generated intermodulation interference are depicted in the following Table.

Tx 1 Source Mix Tx		Tx 2 Source		TX 3 Source		Tx 4 Source		Tx 5 Source		Intermod Hit		Affected Receiver		Attn Need
ID	Freq (MHz)	ID	Freq (MHz)	ID	Freq (MHz)	ID	Freq (MHz)	ID	Freq (MHz)	Freq (MHz)	Ord	ID	Freq (MHz)	
None														

No transmitter generated intermodulation interference problems were predicted.

7.2 Receiver Generated Intermodulation Analysis

Within a receiver, when two or more strong off-channel signals enter and mix in the receiver and one of the IM product frequencies created coincides with the receiver operating frequency, potential interference results. This internal IM mixing process takes place in the receiver's RF amplifier when it operates in a nonlinear range and/or in the first mixer, which, of course, has been designed to operate as a nonlinear device.

Receivers have a similar conversion loss type factor and receiver performance is commonly described in terms of conversion loss with respect to the 2A - B type products. Here, conversion loss is the ratio of a specified level of A and B to the level of the resulting IM product, when the product is viewed as an equivalent on-channel signal. Receiver conversion loss varies with input levels, AGC action, and product order.

The analysis calculates all possible IM product frequencies that could potentially interfere with receivers at the communications site based on each receiver's individual bandwidth. It then predicts each IM signal level present at the input of each affected receiver. For each IM frequency, the analysis considers that the IM signal is generated directly in the receiver.

The analysis takes into account the transmitter's power output, modulation bandwidth, conversion losses, transmission line losses, filters, duplexers, combiners, isolators, multi-couplers and other RF devices that are present in each system. Additionally, the analysis considers the antenna separation space loss, horizontal and vertical gain components of the antennas as well as how they are mounted on the structure. The gain components are derived from antenna pattern data published by each manufacturer.

The analysis determines how much isolation is required to prevent receiver performance degradation for each IM interference signal that occurs. Receivers experiencing receiver generated intermodulation interference are depicted in the following Table.

Tx 1 Source		Tx 2 Source		TX 3 Source		Tx 4 Source		Tx 5 Source		Intermod Hit		Affected Receiver		Attn Need
ID	Freq (MHz)	ID	Freq (MHz)	ID	Freq (MHz)	ID	Freq (MHz)	ID	Freq (MHz)	Freq (MHz)	Ord	ID	Freq (MHz)	
None														

No receiver generated intermodulation interference problems were predicted.

8.0 Transmitter Harmonic Output Interference Analysis

Transmitter harmonic interference is due to non-linear characteristics in a transmitter. The harmonics are typically created due to frequency multiplers and the non-linear design of the final output stage of the transmitter. If the harmonic signal falls within the passband of a nearby receiver and the signal level is of sufficient amplitude, it can degrade the performance of the receiver.

The analysis takes into account the transmitter's harmonic characteristics, output level, transmission line losses, filters, duplexers, combiners, isolators, multi-couplers and other RF devices that are present in each system. Additionally, the analysis considers the antenna separation space loss, horizontal and vertical gain components of the antennas as well as how they are mounted on the structure. The gain components are derived from antenna pattern data published by each manufacturer.

The analysis determines how much isolation is required to prevent receiver performance degradation for any harmonics that fall within a receiver's passband. Receivers experiencing transmitter harmonic interference are depicted in the following Table.

Transmitter		Harmonic		Affected Receiver		Attn Needed
ID	Frequency (MHz)	Frequency (MHz)	Order	ID	Frequency (MHz)	
None						

No transmitter generated harmonic interference problems were predicted.

9.0 Transmitter Spurious Output Interference Analysis

Transmitter spurious output interference can be attributed to many different factors in a transmitter. The generation of spurious frequencies could be due to non-linear characteristics in a transmitter or possibly the physical placement of components and unwanted coupling. If a spurious signal falls within the passband of a nearby receiver and the signal level is of sufficient amplitude, it can degrade the performance of the receiver.

The analysis takes into account a transmitter's spurious output specification, output levels, transmission line losses, filters, duplexers, combiners, isolators, multi-couplers and other RF devices that are present in each system. Additionally, the analysis considers the antenna separation space loss, horizontal and vertical gain components of the antennas as well as how they are mounted on the structure. The gain components are derived from antenna pattern data published by each manufacturer.

The analysis determines how much isolation is required to prevent receiver performance degradation for any transmitter spurious signals that fall within a receiver's passband. Receivers experiencing transmitter spurious output interference are depicted in the following Table.

Transmitter		**Affected Receiver**		**Attn Needed**
ID	**Frequency (MHz)**	**ID**	**Frequency (MHz)**	
None				

No transmitter generated spurious interference problems were predicted.

10.0 Interference Power Level Summing Analysis

This section of the report provides a simulation of Intermodulation (IM) interference, transmitter wideband noise and receiver desensitization interference occurring on each individual receiver when all transmitters at the site are active at the same instance in time. Even though individual interference modes may not be reported in other report sections, this summing analysis represents a worst-case interference scenario.

However, the probability of this interference occurrence for an individual receiver could be low since it depends on the utilization of the transmitters involved in the interference generation.

The carrier-to-noise C/(I + N) ratio for each receiver is based on the aggregate of interference power levels. A negative C/(I + N) ratio indicates that the performance of the receiver could possibly be degraded by the value shown.

The following Table presents this data:

Receiver		Interference Power Level (dBw)				
Channel Label	**Freq (MHz)**	**Tx Noise**	**Rx Desense**	**IM Power**	**Aggregate**	**C / (I+N)**
None						

11.0 Discussion and Recommendations

Sitesafe has provided FCC research on this site and used this information whenever possible in this study. Public Safety systems operating within one mile of the site were requested to be considered in this analysis by the local jurisdiction. The City Hall Building was considered at a distance of 3870.24 feet and bearing of 121.3 degrees.

Conclusion: there is no indication that the proposed collocation by T-Mobile will cause interference to the existing Public Safety systems operating in the vicinity of the site.

12.0 Professional Certification

Engineering Statement Re:

Potential for Interference to Existing Services

At

VA70332A, for Smartlink on behalf of T-Mobile

My signature on this study hereby certifies and affirms:

That I am employed by Sitesafe, Inc. which provides engineering services to clients in the Radio Communications field; and

That I have examined the technical information supplied by Smartlink on behalf of T-Mobile and their representatives relating to their intention to install antennas, transmitters and associated technical equipment on an existing communication site, on an existing tower/structure, currently identified as VA70332A; and

That the technical equipment to be installed by T-Mobile represents the state of the art and that it has been carefully designed to preclude the possibility of interference to other services, including the transmission and reception of broadcast AM, FM, and Television and other communications services, such as police, fire, utility and other public safety and public service facilities as well as private communications installations, such as cordless telephones, and Citizen's Band and Radio Amateur stations; and

That the equipment to be installed by T-Mobile, meets or exceeds all Federal Communications Commission emission requirements to avoid interfering with other services and home/business equipment; and

That frequency information provided by Smartlink on behalf of T-Mobile concerning existing installations on this structure has been examined to estimate the potential for interference to existing and proposed operations, resulting from the introduction of the T-Mobile's operation; and

That this examination involved the computation of intermodulation products, transmitter harmonics, receiver desensitization, and transmitter spurious emissions produced by the combination of frequencies associated with existing services known to currently operate at the VA70332A site, and these frequencies, which could be used by others at the VA70332A site

That intermodulation products were computed (as a minimum) for the fundamental (f_0), second ($2\ f_0$) thru seventh ($7\ f_0$) harmonic components of frequencies at this site; and

That predicted products were not found to potentially cause intermodulation to T-Mobile's proposed operations or to the other licenses currently operating at the VA70332A site; and

That no additional isolation needs to be provided between antennas in the horizontal and vertical planes, and the attenuation along the nadir and zenith associated with vertical plane radiation patterns; and

That after examination the levels of RF energy present at the VA70332A site, receiver sensitivity will not be degraded by either the existing or T-Mobile's proposed operations; and

That, if interference were to occur as a result of T-Mobile's operations, T-Mobile would be expected to recognize its responsibility to act promptly to take steps necessary to correct the interference, including, but not limited to, filtering and frequency coordination; and

In summary, it is stated here that there is not an indication that the installation being proposed by T-Mobile will create interference to their own operations, or the operations of any of the services currently operating at the VA70332A site. Even in the event that, upon installation of T-Mobile's equipment, interference was determined to exist and to be the actual interference source, frequency coordination and filtering would be T-Mobile's primary corrective course of action, and should successfully eliminate the problem.

Certain generic technical assumptions regarding power settings, filtering, and equipment characteristics were made in preparing this analysis, as this technical information was not made available by the client.

Thank You for Using Sitesafe for Your RF Engineering Needs.