ADVANCED TECHNOLOGY

A COMPARATIVE ANALYSIS OF 612 MHZ LEAKAGE DETECTION VERSUS LTE FREQUENCY LEAKAGE DETECTION – A CASE STUDY

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The Arcom Digital QAM Snare is an agile leakage detection platform that detects analog, QAM, and OFDM signals at multiple frequencies simultaneously. Since the platform is agile, we are able to essentially operate at any frequency band. That being said, in hundreds of installations and demos performed over the past seven years, we've seen trends in numerous locations where there are simply more leaks the higher in frequency that you go.

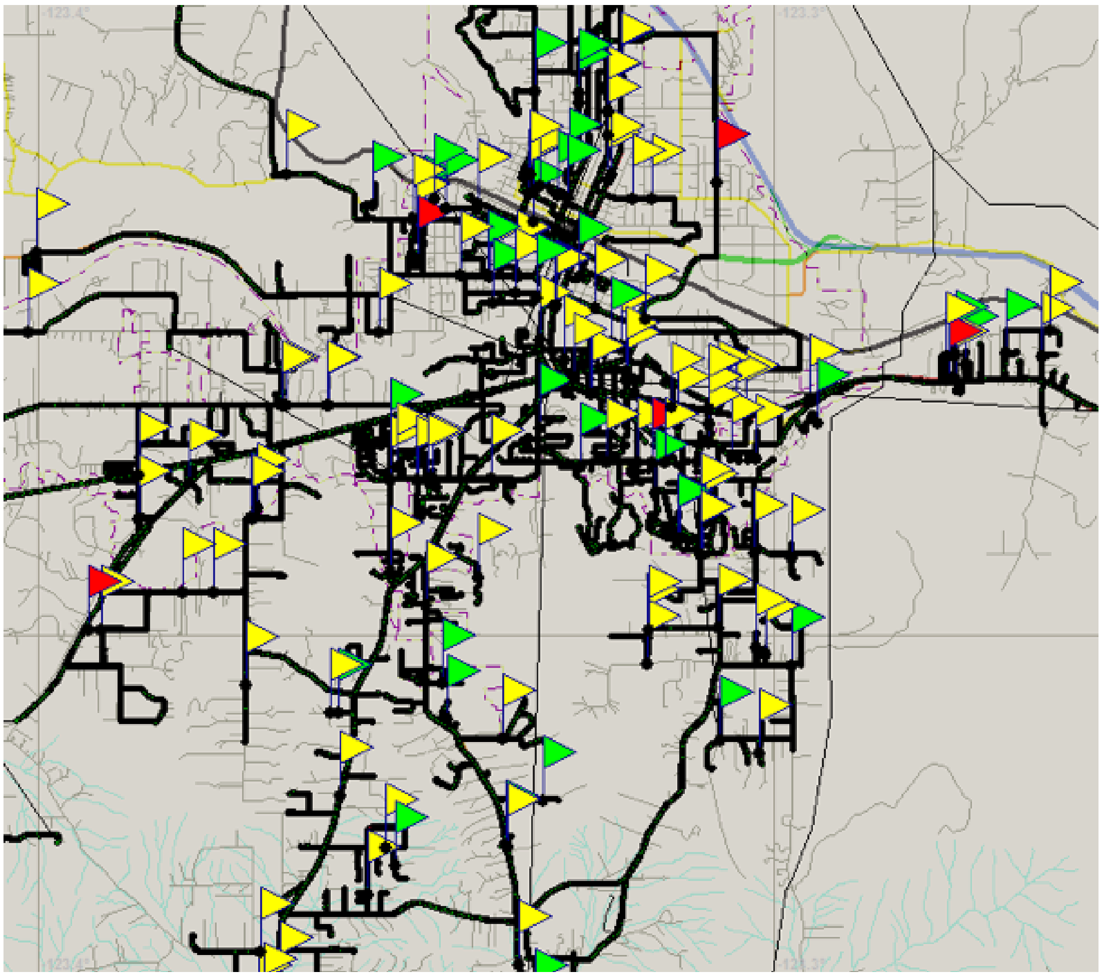
Because of this, and because one focus of the high frequency leakage detection programs is to mitigate LTE egress and ingress, we feel it is sensible to detect at the LTE band or very close to it. This will help ensure that the LTE focus is maintained. Of course, there are some leakage detector vendors that have technology that is only able to operate at a fixed frequency of 612 MHz, and not surprisingly, these vendors take the position that there is no difference between detection at 612MHz and at the LTE band. This case study will directly address this point, and provide data showing their representations to be completely false.

Since QAM Snare is able to simultaneously detect leaks at multiple frequencies, vehicles were outfitted to detect QAM channels at 141MHz (aeronautical band), 609MHz (what we consider to be a mid-band frequency), and at 789MHz (adjacent to the LTE band). The noise floors at 609MHz and at 789MHz were equivalent, so there was no difference in the detector sensitivity between the two channels[1]. The aeronautical band was included in this testing because the vehicle was already outfitted for detection at that frequency, but it is not a focus of this case study. It is also generally accepted that there is no correlation between detection at the aeronautical band and the UHF band.[2]

[1] This assumption of equivalent sensitivity cannot be made when comparing QAM Snare to different technologies because of the superior processing gain inherent in the correlation technique.

[2] Hranac, R. & Tresness, G., "Another Look at Signal Leakage, the Need to Monitor at Low and High Frequencies," In Presentations and Collected Technical Papers, SCTE Cable-Tec Expo '12, October 17-19, 2012, Orlando, FL

The vehicle drove 489 plant miles in the system of a major MSO located in the Pacific Northwest, identifying 188 leak locations. Below, the system footprint is shown with leakage locations flagged.

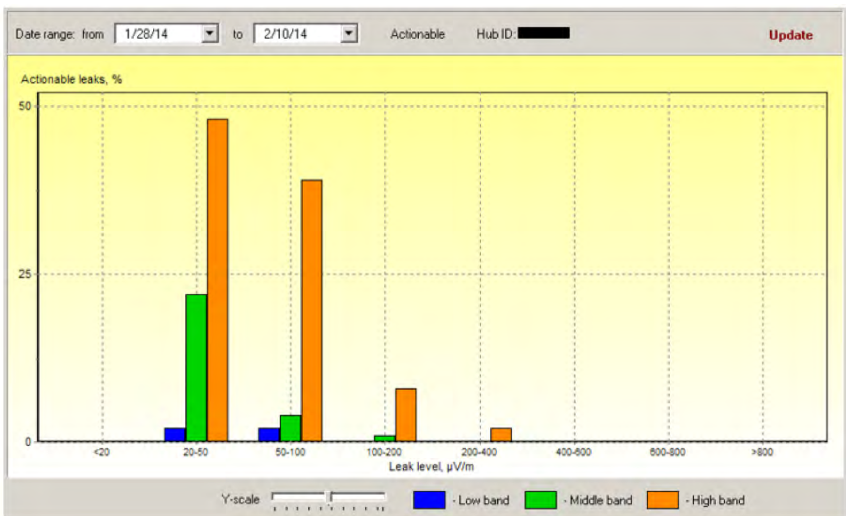


The chart below provides a sampling of the differences in data between the three frequencies. There are no absolutes: there are some locations where a leak existed at 789MHz and did not at 609MHz, and vice versa.

Work order	Lat	Long	Address	Ch17 141MHz	Ch88 609MHz	Ch123 789MHz
118	42.4[redacted]	[redacted]3.31654	1200 Grand[redacted]	0	0	281.8
33	42.4[redacted]	[redacted]3.34832	1848 SW Ab[redacted]	0	56.2	223.9
51	42.4[redacted]	[redacted]3.36061	1685 Redw[redacted]	0	22.4	158.5
57	42.4[redacted]	[redacted]3.34864	508 SW Wa[redacted]Dr	0	20	158.5
69	42.5[redacted]	[redacted]3.38839	7838-7850[redacted]	0	63.1	141.3
86	42.3[redacted]	[redacted]23.3671	5848-5900[redacted]	12.6	39.8	141.3
100	42.4[redacted]	[redacted]23.3077	733-799 NE[redacted]	0	15.8	125.9
12	42.4[redacted]	[redacted]3.30887	1401 Hamil[redacted]	0	0	112.2
94	42.4[redacted]	[redacted]3.27612	144 Rivawa[redacted]	0	22.4	112.2
43	42.[redacted]	[redacted]3.37103	2254 Arnol[redacted]	0	44.7	100
48	42.4[redacted]	[redacted]123.367	1990 Redw[redacted]	0	31.6	100
45	42.[redacted]	[redacted]3.38048	2622-2644[redacted]	0	0	89.1
49	42.4[redacted]	[redacted]3.40152	3767-3771[redacted]	0	0	89.1
66	42.4[redacted]	[redacted]3.36984	5301-5375[redacted]	0	0	89.1
102	42.4[redacted]	[redacted]3.32007	680-684 Su[redacted]	0	0	79.4
140	42.4[redacted]	[redacted]3.34727	2849-2851[redacted]	0	0	70.8
107	42.4[redacted]	[redacted]3.30877	1600-1618[redacted]	79.4	7.1	56.2
133	42.3[redacted]	[redacted]3.33554	715 Homev[redacted]	50.1	39.8	35.5
1	42.4[redacted]	[redacted]3.32711	620 Rogue[redacted]	0	31.6	0
60	42.4[redacted]	[redacted]3.31741	853 SE M St[redacted]	0	28.2	0
109	42.4[redacted]	[redacted]3.32482	670 Fruitda[redacted]	44.7	25.1	0
148	42.3[redacted]	[redacted]3.35918	205-233 Mc[redacted]	11.2	15.8	0
172	42.4[redacted]	[redacted]3.35121	1883 SW Al[redacted]	0	28.2	0

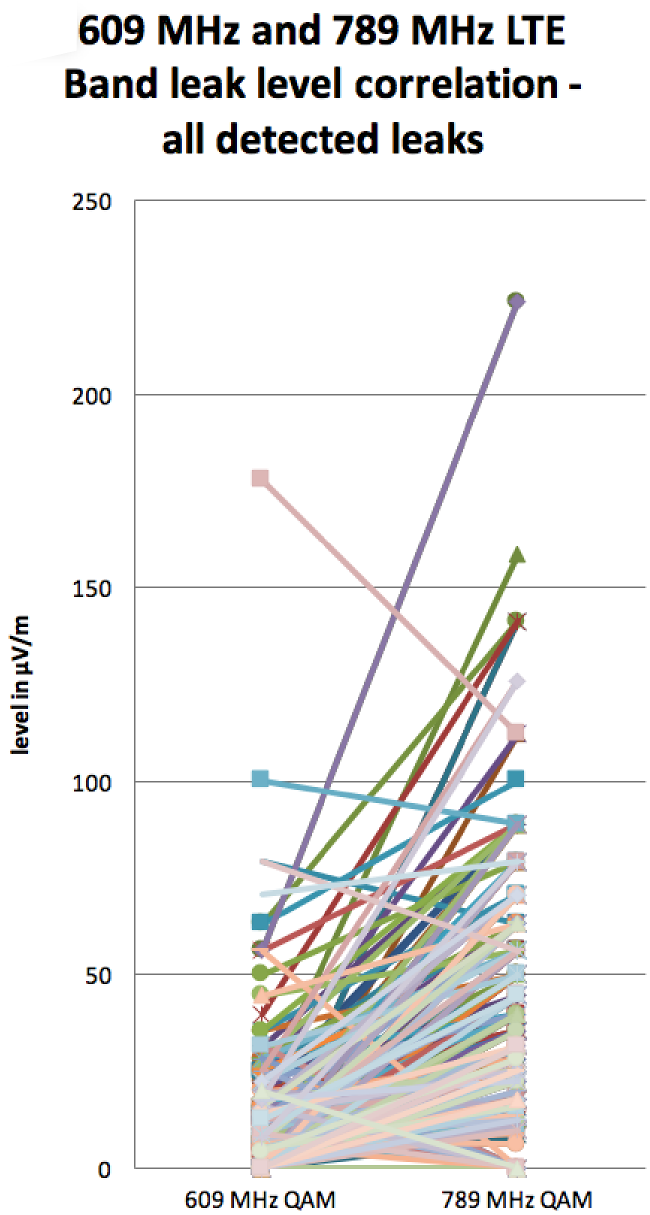
locations and addresses redacted

The QAM Snare Manager software provides the ability to summarize leaks in the database in a variety of ways. Here the quantity of actionable leaks detected at the Low (141MHz), Middle (609MHz), and High (787MHz) frequency bands are displayed, and grouped by detected leak level. For each grouping, it's clear that the trend follows significantly more leaks detected at 787MHz versus 609MHz.

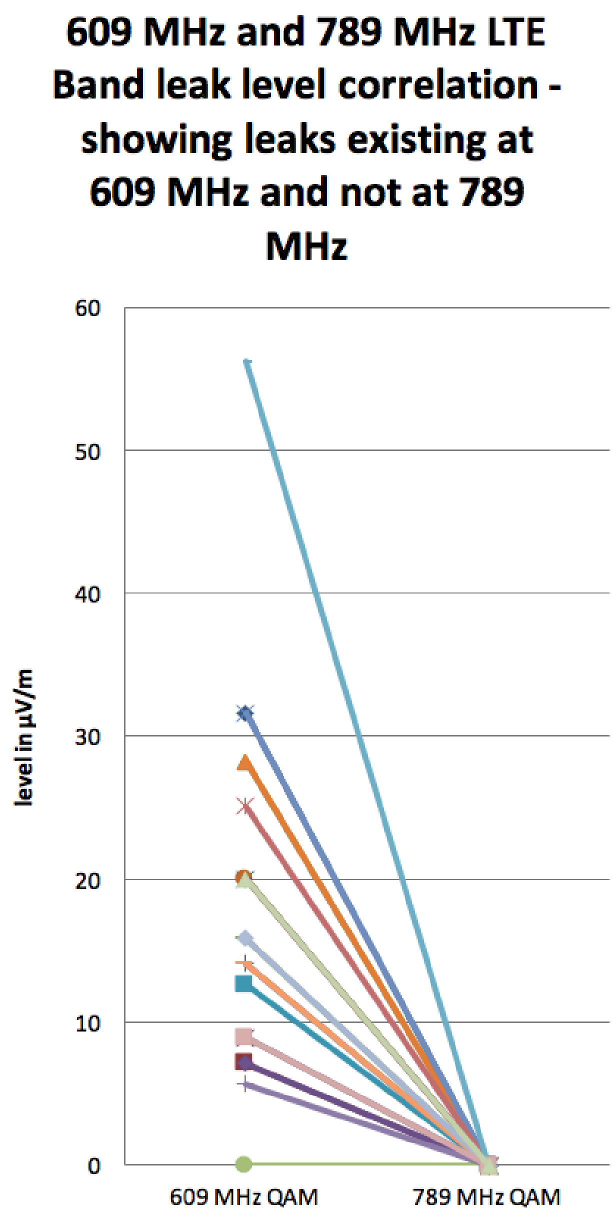


Since it is well known, and generally accepted, that there is NO correlation between leak levels in the Aeronautical band and the UHF band, we will focus on differences between detection at 609 MHz and the LTE band. The graph below shows detected levels recorded at both frequencies, at each of the 188 leak locations collected during driveout. The lines between the data points serve to only link the data point sets for each leak; it is not intended to interpolate any leak value between the points.

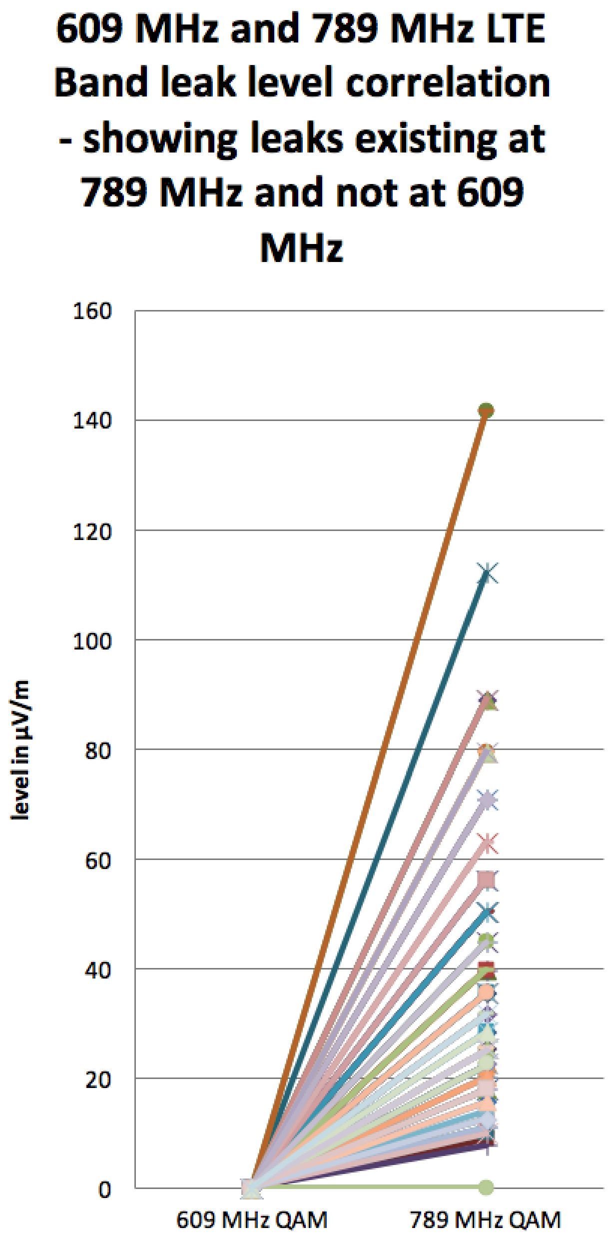
It can be seen that some leaks are significantly higher at 609 MHz, some are significantly lower at 609 MHz, some are relatively the same, some exist at 609 MHz and do not exist at 789 MHz, and vice versa. There are no hard and fast rules apparent.



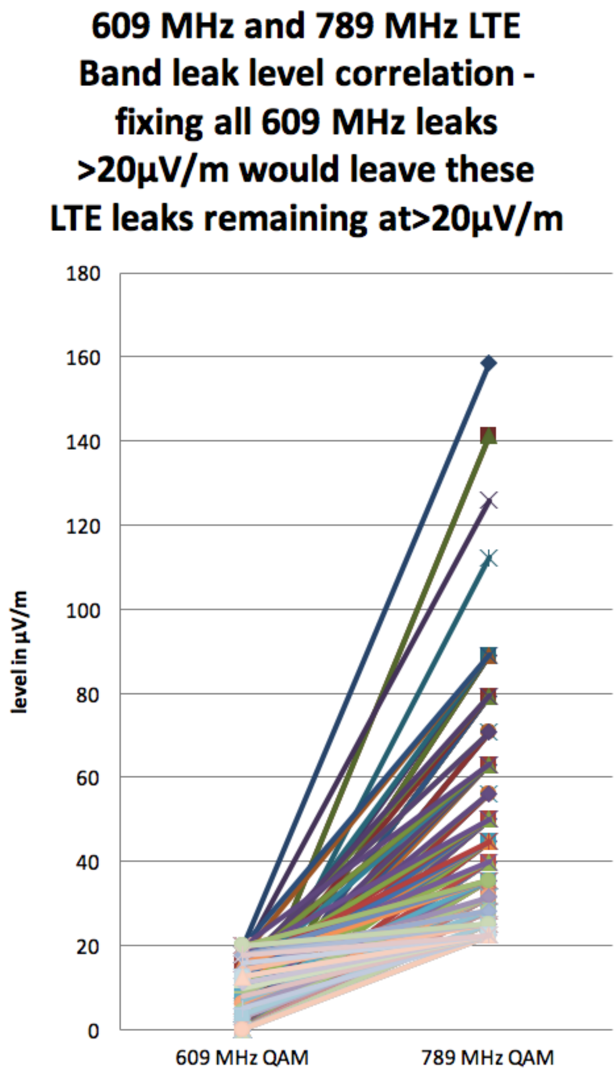
The only trend to take from this data is that in general the majority of lines slope to the left, indicating a higher detected level at the LTE band as compared to 609 MHz. This trend has been observed in various locations. There are simply more leaks, and at greater level, the higher in frequency that you detect.



A deeper analysis of the data tells an interesting story. Every leak has a frequency response – it does not behave the same at all frequencies. The data below is filtered to show those leaks that existed at 609MHz but did not exist at 789MHz. The quantity of leaks in this category is 15 out of 188 – or 8%. Using resources to fix these leaks would be a wasted effort, from the perspective of improving LTE egress and ingress, because a leak did not exist at the LTE band, and there could be no corresponding improvement.



In the next scenario we will filter the data in the opposite fashion and display those leaks that existed at 789MHz in the LTE band, but not at 609MHz. The number in this category is 37% of the total leaks. An obvious conclusion from this is that if a strategy were employed to fix all leaks at 609 MHz, it would not ensure that LTE leaks would be mitigated. In fact, greater that 1/3 of all the LTE leaks would still be invisible. This speaks to the fact that there are, in general, greater quantities of leaks the higher in frequency.



In the next chart, the data is filtered to provide insight into how this would play out operationally, as to which leaks would remain untouched in the LTE band if repair rules were driven by 609 MHz detected level. As aforementioned, huge quantities of LTE leaks exist in every cable network – there are too many to attempt to fix them all within any reasonable timeframe. Some prioritization schema must be employed. The data to the left is filtered in the hypothetical scenario that rules are established such that all leaks at 609 MHz greater than 20µV/m would be scheduled for repair. To present a fair comparison and for clarity, leaks existing at the LTE band that are < 20µV/m have also been filtered. As can be seen, after completion of fixing larger leaks at 609MHz, the quantity of remaining leaks in the LTE band that are > 20µV/m represent 55% of the total number of leaks! And many are very large and likely very problematic. Clearly, an LTE leak mitigation strategy based upon 609MHz detection rules will not be effective.

/ CONCLUSIONS

The data presented clearly shows vast differences in results when leakage detection is performed at 609MHz, as compared to 789MHz at the LTE band. 609MHz performance is weakly correlated to detection at the LTE band and operationally it would be difficult to develop an effective process to manage LTE ingress and egress mitigation without detection being performed at the LTE band.

Arcom Digital has been a proponent of an Intelligent Prioritization process to provide a structure as to how to manage the leakage repair process. The first element/condition of this process is to ensure that leakage is measured at a relevant frequency, representative of the LTE band leakage profile. If the measurement is not performed at such a frequency, then repair resources will be expended with no corresponding benefit – i.e. repair is not being directed at the right problem. The data presented in this case study clearly shows that 609MHz does not satisfy this condition.

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