ADVANCED TECHNOLOGY

A METHOD FOR PRIORITIZING REPAIR OF SIGNAL LEAKAGE IN AN HFC NETWORK BASED UPON FIELD MEASUREMENT OF LTE SIGNAL STRENGTH

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CHANGING DIGITAL LANDSCAPE REQUIRES NEW DEVELOPMENTS TO KEEP UP

The advent of wireless Long Term Evolution (LTE) 4G technology operating at frequencies utilized by cable television operators has required cable networks to perform high frequency leakage detection at LTE frequencies. Egress of QAM signals from the cable network can adversely affect the LTE base transceiver station (BTS) performance by raising the BTS noise floor and effectively decreasing the coverage area. A Verizon engineer stated the wireless carrier's position very clearly – "we paid $8 billion for that spectrum, we expect it to be clean". To be a good neighbor with the wireless companies, you need to quickly repair any leaks that could affect their spectrum. Additionally, ingress of LTE signals at the leak location can adversely affect the quality of the signal transmission of the QAM channels and adversely affect all subscribers downstream of the leak location – so from a quality of service and customer satisfaction perspective it is important to quickly react to those leaks as well.

As has been unquestionably proven through installation of LTE leakage equipment at hundreds of locations, there are simply too many leaks to reasonably to fix them all in any short-term timeframe. Fig. 1 provides a real example from a system with over 8,000 leaks in an approximately 100 sq. mile area.

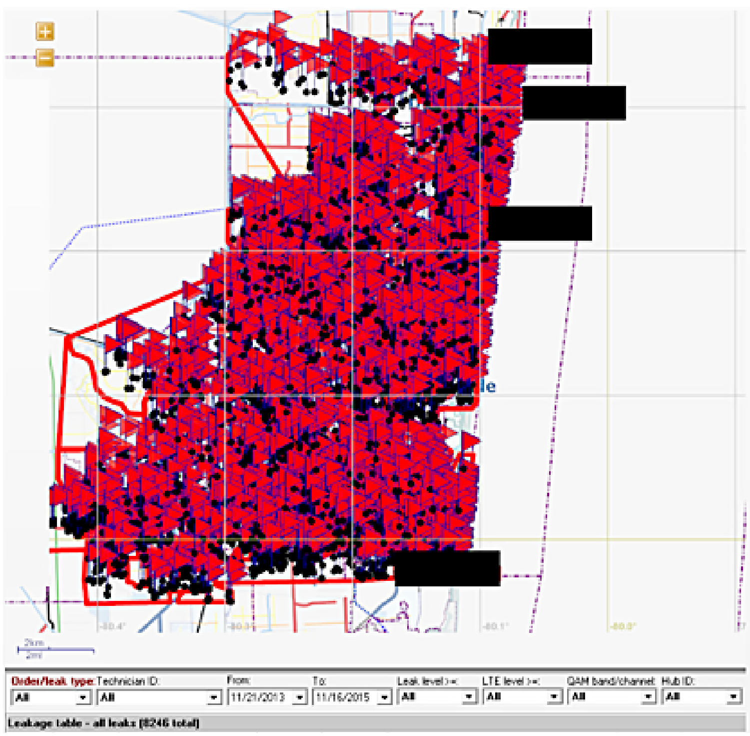


Figure 1

PROLIFERATION OF LEAKS REQUIRES NEW STRATEGY

With the existence of so many high frequency leaks, it is imperative to prioritize repair in a way that focuses on the most network affecting leaks first, both from an egress and an ingress perspective. Basing repair decisions solely upon the amplitude of the detected leak is ineffective and will not result in the most network affecting leaks being prioritized, because it fails to account for the LTE signal strength at each leak location. For example, a detected leak that is distant from an LTE transmitter, where the LTE signal strength is very weak or non-existent, is of significantly less priority to repair because it is unlikely that egress at that location will affect the LTE BTS performance or that the LTE signal ingress will affect the quality of the QAM signal. Comparing this to a leak of the same or lower amplitude in proximity to an LTE transmitter where the LTE signal strength is very strong, the likelihood of both ingress and egress related impairment is very high and therefore this leak should have priority. Expanding upon this, it is more important to fix a small or medium size leak at a location with strong LTE signal level than it is to fix a large leak at a location with weak LTE signal level.

LTE signal strength varies greatly even within seemingly close areas, as illustrated in the chart in fig. 2. Signal strength levels were captured each second over a short 3 minute driveout. There was a difference of over 30dB in signal strength. Leaks at those locations with the strongest LTE levels should be prioritized first, and locations with the weakest levels can be essentially ignored. The red and green lines represent arbitrary thresholds for prioritization, which can be changed over time.

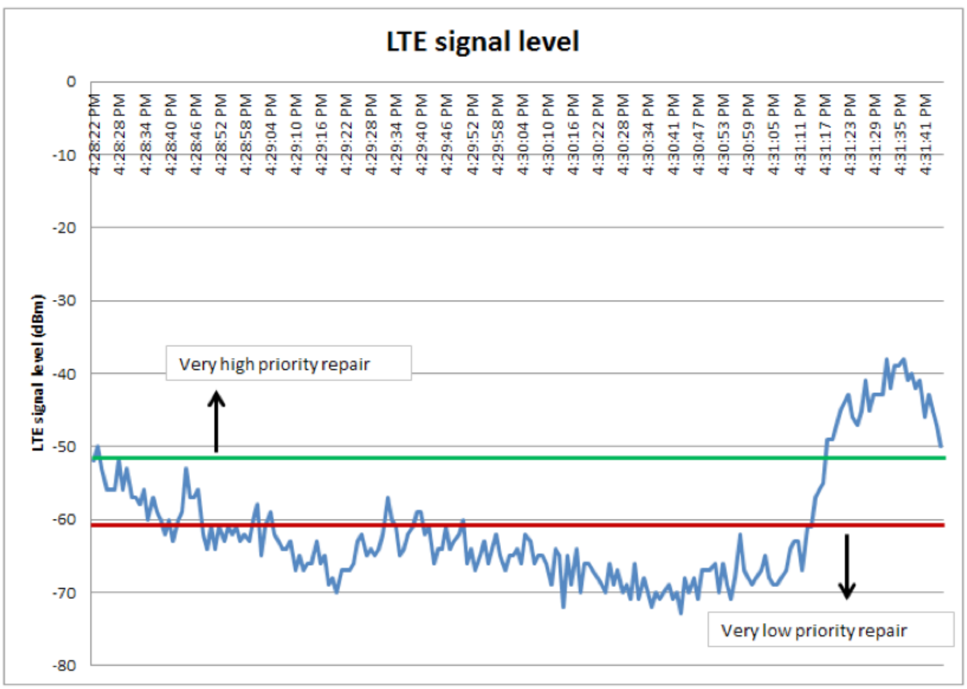


Figure 2

FULL COVERAGE OF THE LTE SPECTRUM

To capture this data, QAM Snare field detectors utilize agile tuners and can quickly tune to any relevant frequency. QAM Snare also utilizes a cross-correlation detection process that is performed in just a fraction of a second, allowing ample time for detection to be performed at multiple channels: in the aeronautical band for FCC CLI compliance, in the LTE band for LTE egress and ingress mitigation, and at a middle frequency to look for ingress from terrestrial channels or possible future 600MHz lower frequency LTE ingress and egress when that spectrum auction is complete. Three frequency monitoring provides a means to cover essentially the entire spectrum. This cross-correlation process has been optimized for efficient data transmission and utilizes an accumulation time of 1ms that is repeated one or more times per second.

As described, two channel correlation is active only .2% of the time. In order to make the desired measurement of the LTE signal strength, the tuner jumps to the LTE downlink and Public Safety frequencies and scans across the entire band during these inactive time periods, recording the maximum signal. This information is then updated to the leakage database to give every leak in the database an associated LTE signal level that can be used for prioritization of repair. Additionally, this technique is implemented without any additional hardware cost. Figure 3 highlights the LTE downlink frequencies between 728MHz and 776MHz utilized in the US, where the tuner will jump and perform the signal strength measurements. It is also configurable to scan at other LTE frequencies used in other parts of the world.

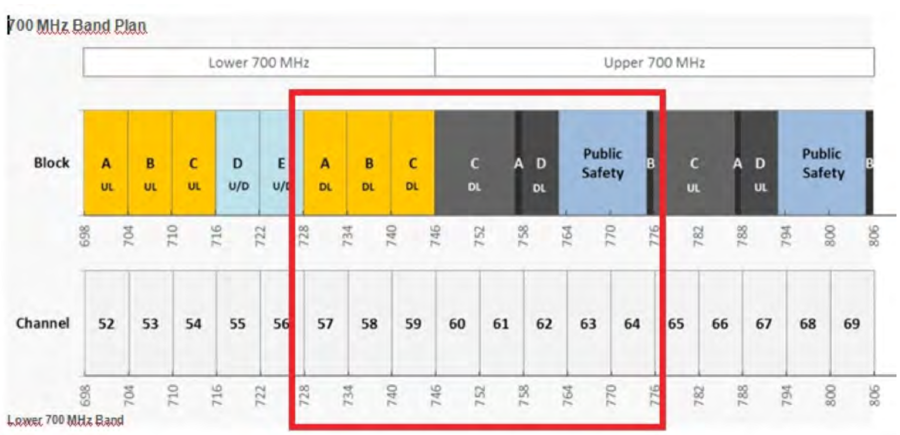


Figure 3

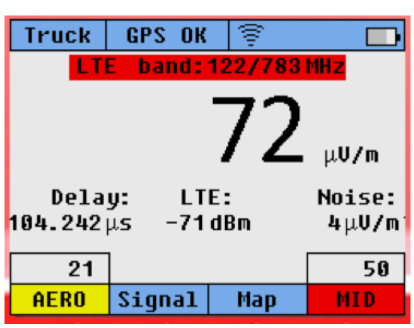
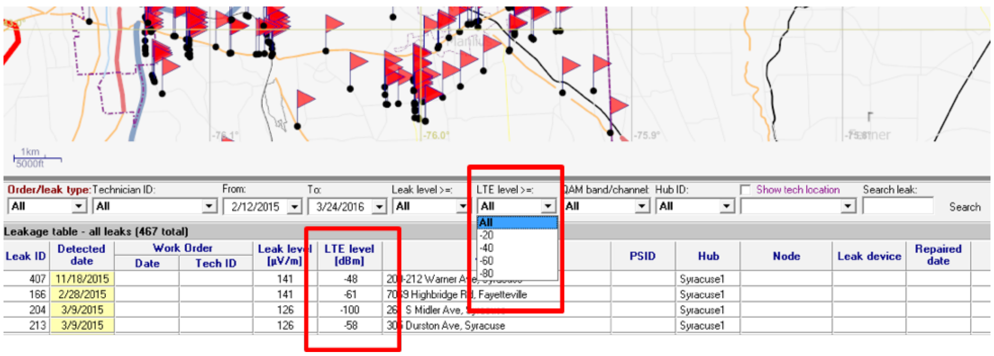
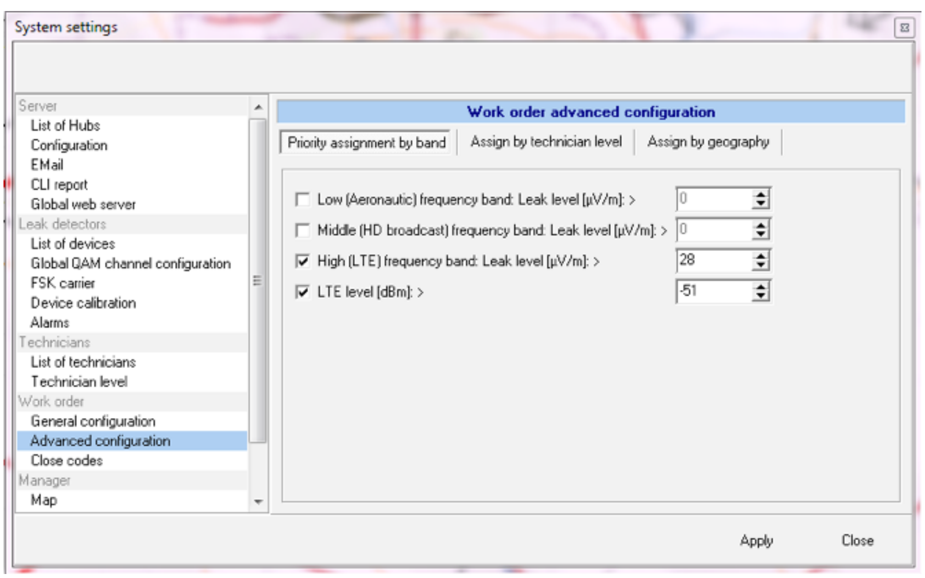


Figure 4

Detector screen showing LTE signal strength

An example of the database containing LTE level as well as the ability to display leaks by LTE level is shown below, along with a means to generate work orders prioritized by LTE level and leak amplitude.





CONCLUSIONS

Prior to developing the described method of measuring LTE signal strength, the only way to attempt repair prioritization was to mark tower location on a map and prioritize based upon proximity to the tower. Testing of this method quickly showed that it was not effective—factors such as tower height, terrain profile, other structures and building, MIMO and beam focus, and BTS output power overwhelmed the distance factor. Locations close to towers often had much weaker LTE signal strength than locations hundreds of yards away. It simply didn't work. Additionally, there is no database of tower locations. Towers are often hidden and the tower's operating frequency is often uncertain. If it is not LTE co-channel with the cable network it is irrelevant. Furthermore, the trend of micro-cells, pico-cells, etc., makes it such that we really have no idea where the transmitters are located- measuring LTE signal strength is the only effective way to effectively and intelligently prioritize.

One caveat to this method relates to the trend of attaching small cells directly to the cable network. The required network integrity in these areas is much greater than for other locations and close attention needs to be placed here. Even very small leaks could be the source of LTE ingress. As such it would make sense to add these locations to the leak database and make sure all leaks in close proximity to the transmitter receive a high priority for repair.

We have developed technologies and methods of implementation that account for recent changes to the cable network. By scanning simultaneously on multiple bands and prioritizing repairs according to relative signal strength, cable repair technicians can adapt to the modern cable landscape.

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