ADVANCED TECHNOLOGY

QAM SNARE TECHNOLOGY, HOW IT WORKS

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FOR THE FIRST TIME, QAM SNARE PROVIDES A METHOD TO DIRECTLY DETECT AND MEASURE LEAKAGE FROM DIGITAL CHANNELS IN AN HFC NETWORK

INTRODUCTION

This paper describes how the innovative QAM Snare technology can precisely and quickly locate the source of signal leakage in an HFC network. This new method has many advantages over other techniques:

- It can detect and measure leakage directly from digital channels over the entire channel bandwidth - not just a single narrow frequency.
- It can be used simultaneously for compliance, maintenance, and troubleshooting forward ingress.
- It provides visibility to a set of very real plant impairments that previously went unnoticed.
- It is agile, can be used at frequencies across the spectrum, and can detect on up to three channels simultaneously.
- It is impervious to multipath
- The location process is significantly more accurate - by using GPS and a technique called Time Difference of Arrival (TDOA), multiple leak detection points are used to determine the exact GPS coordinates of the leak source.
- False alarms are eliminated.

HIGH LEVEL DESCRIPTION

QAM Snare™ is an evolution of the successful Arcom Digital Xcor technology, which utilizes passive radar signal correlation techniques to detect and range the distance to nonlinear distortions (CPD). This same correlation process is at the core of QAM Snare technology, although the implementation and signals utilized for leakage detection are different. The gist of it is that QAM Snare operates by capturing samples of a desired (or multiple) QAM channels at the headend (or at multiple hubs). These samples are time-stamped using the GPS reference clock, then forwarded to a server containing georeferenced hub boundaries. Leakage detectors in the field connect to the server over a wireless network and receive the signal samples from the hub corresponding to their current location. The field detector utilizes a local antenna to capture off-air signal samples of the same channel(s). The field device also contains a GPS receiver used to precisely time stamp the signal samples it has acquired locally. The samples are then time synchronized and a cross correlation process is employed.

This process compares the two sets of data – the samples from the QAM channel at the headend and the samples of the QAM channel detected over free space. When there is correlation between samples, a QAM leak has been detected. The correlation process outputs the magnitude of detected leaks as well as valuable information on the time delay from the headend to the detection point. This time delay information is used to calculate the exact GPS coordinates of the leak – only Arcom can provide this capability.

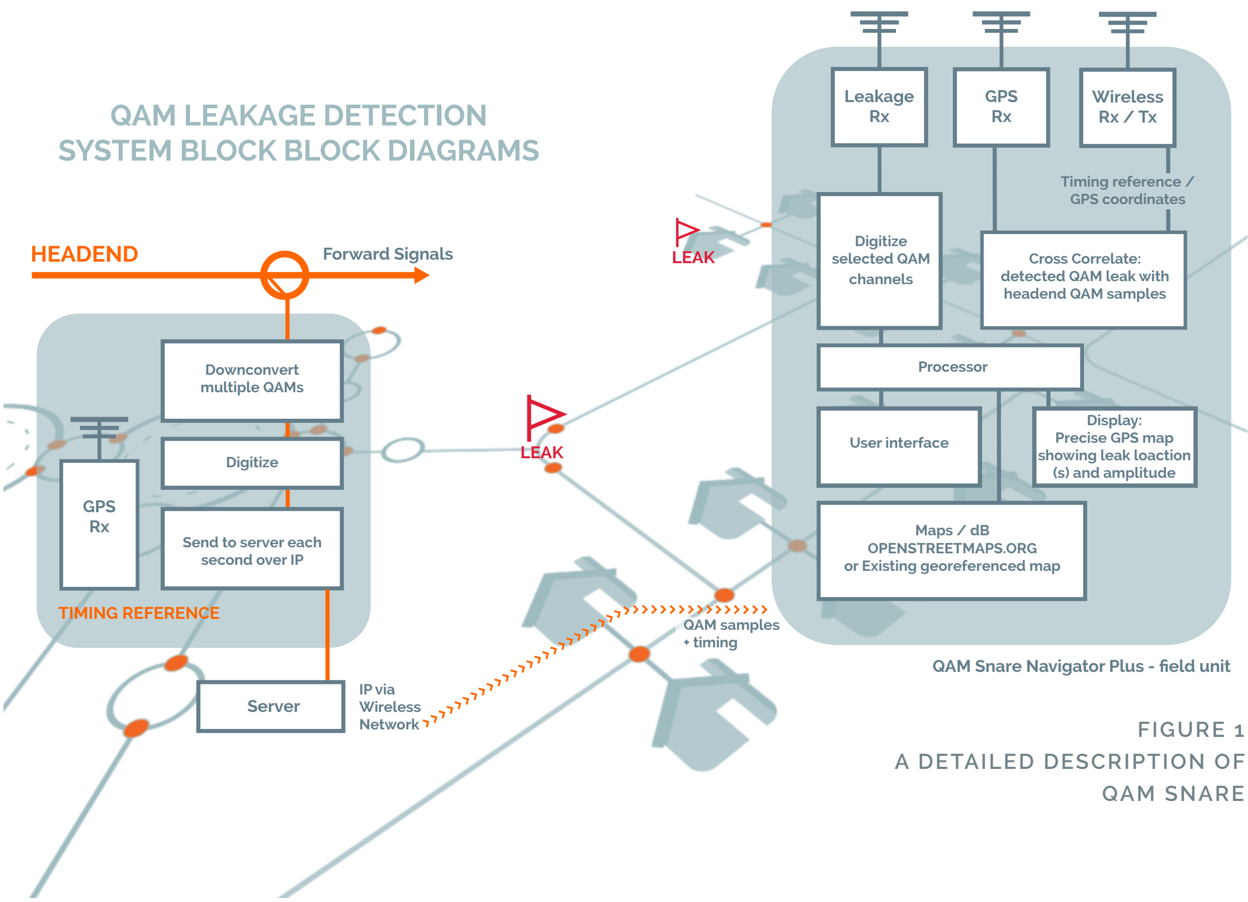

FIGURE 1
A DETAILED DESCRIPTION OF QAM SNARE

IMPLEMENTATION OF THE TECHNOLOGY

The system has been realized in three main components: A QAM Snare™ headend signal processor, a server, and several varieties of field units used to detect the leak and troubleshoot the exact deficient network component. Field units used for driveout or mobile detection are installed in service vehicles to continuously monitor for QAM leakage on up to three channels simultaneously. Every second, data packets from the headend are received and compared with signals pulled off the vehicle local antenna to determine if QAM leakage is present. Whenever locations with leakage are detected the data is processed and the exact GPS coordinates of the leak and the actual 10 ft. source magnitude is calculated, all in real time. A flag identifying the location is then displayed on the field unit so that it can be immediately repaired, if desired. Complete leak data summary statistics, vehicle drive routes, measured LTE downlink signal strength (for prioritization of repair), current status of previously detected leaks and work orders – as well as a myriad of other details – are maintained in an openly exportable database. The software screenshots in figure 2 below show the output of the cross correlation process as well as a map view showing the vehicle route and the flagged leak location.

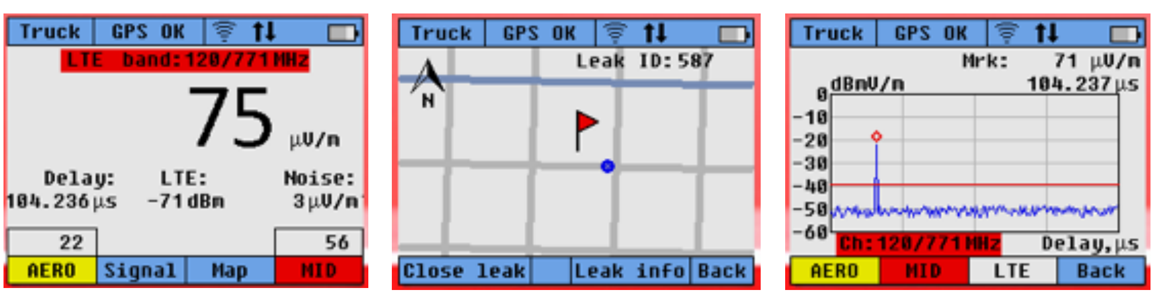

FIGURE 2
CORRELATOR RESPONSE, DETECTED VIEW AND MAP VIEW

TIME DIFFERENCE OF ARRIVAL

The technique employed to resolve the exact leak location is properly termed Time Difference of Arrival (TDOA). TDOA looks at differences between the time delays of multiple detection points in order to resolve the exact GPS coordinates of the source. Differences in time delays from various detected points create a horizon along which possible source locations could reside. These curves are represented mathematically, and can be solved for the GPS point common to multiple curves – which is the location of the leak source. QAM Snare™ software internally creates and solves these equations to determine the precise GPS coordinates of the leak.

/ BOTTOM LINE

QAM Snare™ represents a massive improvement over previous generation signal leakage detection technology, and a unique and vastly improved approach in comparison to other commercially available technologies that attempt to detect carriers inserted between QAM channels. QAM Snare provides many benefits not available from any other leakage platforms. The fact that the detector is agile and can sensibly be configured for detection at the LTE band is critically important in order to get an accurate measurement of either LTE affecting egress or LTE affected ingress. Considering the trend of deploying microcells with high-level transmitters co-located with the HFC network, this issue will become highlighted over time. Additional benefits include an integrated ability to jump to LTE downlink frequencies and measure LTE signal strength for each location during portions of each second while the detector is idle and non-correlating. This ability is very important in order to maintain a framework that tracks which leaks should be prioritized for mitigation – relying solely on detected leak level is ineffective. As field deployments have proven, there are too many leak locations to realistically fix them all within a realistic budget, a prioritization methodology is a must. Additionally, the final identification step is simple and foolproof, since multipath is eliminated in software – manifesting in a very different and positive experience for the technician.

.01 Provides visibility to very real high frequency impairments.

.02 QAM Snare provides a method to locate leakage from digital channels.

.03 Status quo methods to find leakage of digital signals will not work because the signals appear as noise.

.04 TDOA is used to exactly pinpoint the location of the leak in the HFC network – utilizing GPS coordinates.

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