White Paper :: | || |

DETECTING LEAKAGE OF DIGITAL CHANNELS IN AN HFC NETWORK

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

Introduction

This paper introduces a new method to precisely and quickly locate the source of signal leakage in an HFC network. This new method has many advantages over status quo techniques:

- It can detect and measure leakage directly from digital channels – in an all digital environment this means that it will no longer be necessary to allocate a 6MHz channel for leakage detection purposes.
- 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 can be used to detect LTE interference
- It is impervious to multipath
- The location process is significantly faster and more precise - 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.

High level description

The technology and product are named QAM Snare™. Simplified, it operates by capturing samples of a desired QAM channel at the headend. These samples are time stamped using the reference clock from the GPS system, and are subsequently transmitted over a wireless network to a field location. At the field location there is an antenna and a sensitive detector that is used to record samples of the noise-like QAM channel. Similar to the processing at the headend, the GPS timing information is used to time stamp the moment the samples are recorded. Additionally, for leak location purposes, information on current GPS coordinates is also retained. A cross correlation process is then employed where the two sets of data are compared – 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, with certainty a QAM leak has been detected at its specific frequency. The correlation process will output the magnitude of detected leaks as well as the time delay from the headend to the detection point. From this information the exact GPS coordinates of the leak can be determined.

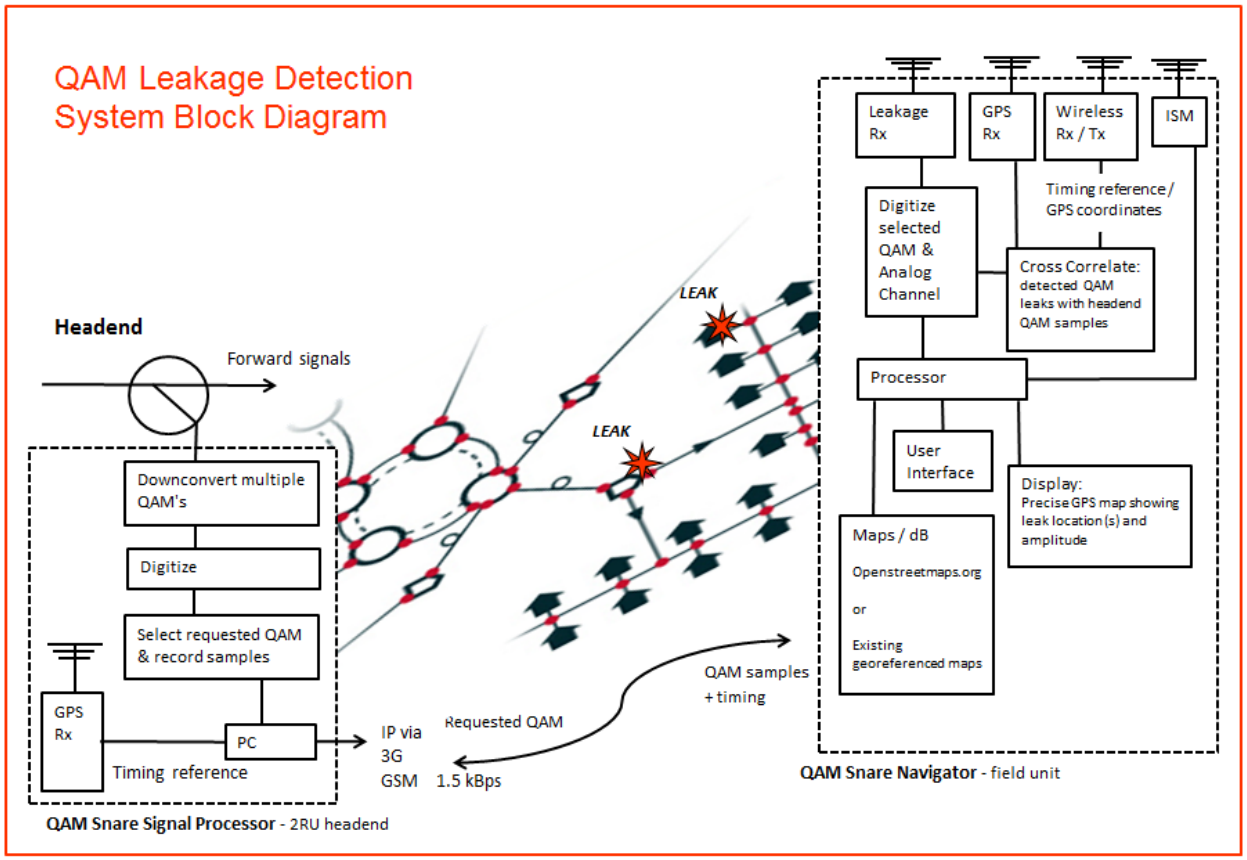

Figure 1:

A detailed description of QAM Snare™

Implementation of the technology

The system has been realized in two main components: A QAM Snare™ headend unit, and several varieties of field units used to detect the leak and troubleshoot the exact deficient network component. Field units are permanently installed in service vehicles and continuously monitor for QAM leakage at the desired channel. 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. In real time, when 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. A flag identifying the location is then displayed on the field unit such that if desired it can immediately be repaired. Complete leak data summary statistics, vehicle drive routes, current status of previously detected leaks and work orders, and 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.

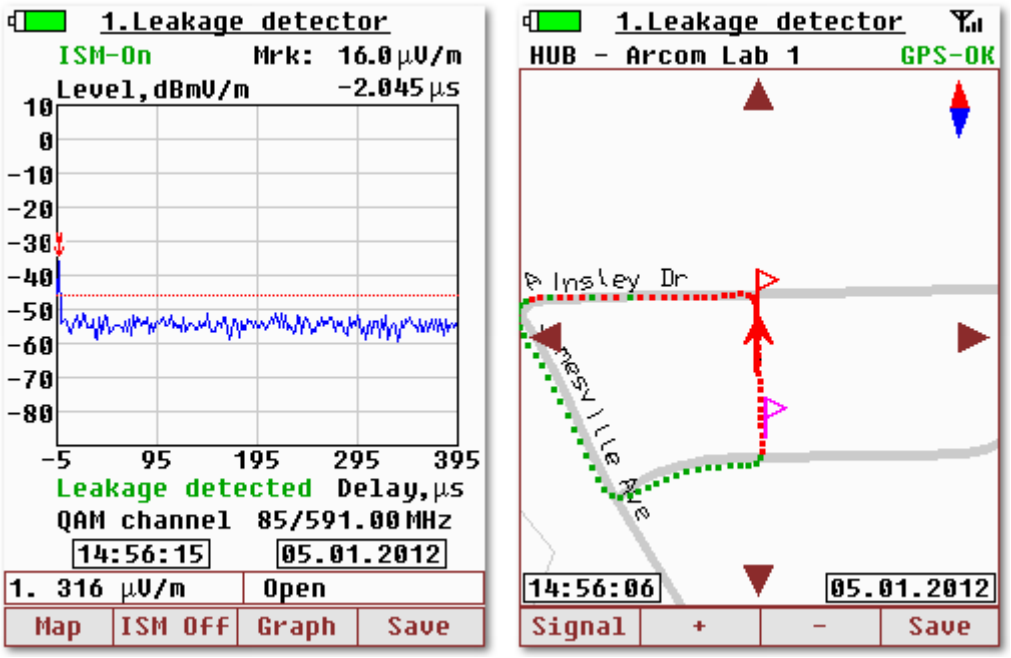

Figure 2:

Correlator response and map view

Time Difference of Arrival

The technique employed to resolve the exact leak location is properly termed Time Difference of Arrival (TDOA). Simplified, it looks at differences between 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 nonlinear equations to determine the precise GPS coordinates of the leak.

QAM Snare™ represents a significant improvement over previous generation signal leakage detection technology, and for the first time provides cable operators the ability to find and resolve QAM signals leaking from HFC networks. Status quo leak detection techniques are not effective on leaks from QAM TV signals because the leakage signal presents simply as noise. In the past, cable television network leakage mitigation programs have solely focused on the aeronautical bands. QAM Snare™ additionally can be used at higher frequencies, such as those that coexist with LTE and White Space devices. QAM Snare™ field use has proven the existence of numerous leaks at high frequency that do not appear at the traditional leakage detection frequencies. These leaks are all associated with very real impairments, and provide the operator with newfound visibility to weaknesses in the plant; and when desired – the ability to quickly isolate and repair.

> .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 Time Difference off Arrival is used to exactly pinpoint the location of the leak in the HFC network – utilizing GPS coordinates.

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