



# Ensured Operational Readiness for Land Mobile Radio (LMR) Communications

## PROBLEM

Given the large number of subscriber radios on LMR Systems, radio maintenance managers currently do not have the adequate manpower or time to ensure operational readiness for Land Mobile Radio (LMR) communications. A common approach of servicing radios when they fail is Reactive Maintenance, not Preventative Maintenance (PM). With thousands of radios, it is often costly and time prohibitive to provide “Proactive Preventative Maintenance”. There is a high risk a radio would fail during an emergency when the first responder needs it the most.

## SOLUTION

The solution is LocusUSA’s DiagnostX™ System, the only long-range over-the-air Radio Waveform Analyzer in the market that analyzes all subscriber radios while they are in normal operation deployed in the field without any user intervention or impact on the radio system.

## PURPOSE

This paper provides an overview of the DiagnostX platform. It is an innovative approach to Over-the-Air radio testing resulting in early detection of potential mobile and portable radio transmission problems, narrowband performance verification and waveform analytics in trunked and conventional radio networks.

By way of uplink metrics, downlink control channel tracking, real-time signal processing, and time-based characterization of radio signals; a continuous status of each radio’s alignment can be attained and reported upon. By pre-identifying radio transmission problems, the organization will experience a higher level of system performance, reduced maintenance costs, and increased operational readiness.

DiagnostX makes these measurements on all radio control channel transmissions (i.e. registrations, affiliations, group voice requests, PTT access messaging, etc.) while the radios are in normal service.

## INTRODUCTION

Using measurement and signal intelligence techniques, the DiagnostX platform can evaluate:

- Common frequency related metrics
- Common FCC conformance measurements
- Statistical analysis of repeat performance

With these metrics, the inner workings and alignment of a radio can be evaluated. DiagnostX uses the uplink (radio transmit) side of the control channel in performing signal intelligence and therefore relies on a moderate RSSI (received signal strength indication) in making measurements of the incoming waveform. Once the threshold of RSSI is achieved, the DSPs (Digital Signal Processors) go to work at extracting the desired metrics and storing them in a database for further statistical analysis. Signals that do not qualify or exhibit poor measurement metrics due to poor signal transmissions such as low SNR (signal to noise ratio) and transmissions experiencing fading or interference are discarded. This process is performed without user intervention on live RF signals, in real-time, 24/7/365. Once the incoming waveform is captured, evaluated and stored in the database, a second level of statistical analysis, based on past transmissions of the radio over time, is used to verify any abnormality that would identify a poorly operating radio.

A viewing application, DiagnostX Viewer (DV), allows the Radio System Manager to review the evaluated metrics and schedule poorly performing radios for maintenance and alignment.

## HOW IT WORKS

DiagnostX is an OTA radio waveform analyzer system. It can be installed in any location where a receive antenna can be mounted or it can coexist at any established radio site.

## HOW IT WORKS (CONTINUED)

DiagnostX has an intelligent RF (radio frequency) receiver(s) that scans the radio network's downlink control channel frequencies to identify the frequency in use. Once the active downlink frequency is identified, the system tunes itself to the corresponding uplink (inbound) frequency and begins monitoring and analyzing all radio transmissions. For example, in an 800 MHz radio system, this is 45 MHz lower in frequency than the downlink (outbound) frequency.

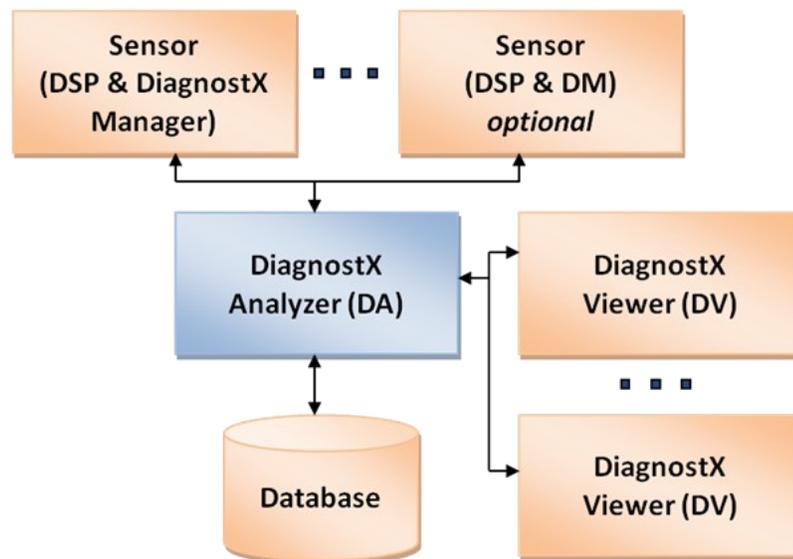
Once tuned to the uplink (inbound) control channel frequency, DiagnostX monitors and passes RF signals to the DSP (digital signal processor) for signal analysis and measurement. The DSP identifies and validates that the signal passing through the system is a desired radio transmission and has measurable signal components. The radio signal is oversampled, resulting in a more accurate analysis allowing DiagnostX to produce real-time signal metrics at bench test equipment accuracy. Once it is established to be a valid signal, the DSP analyzes the incoming transmission and compares it to:

- Mathematical representations of good signals
- Waveform specifications (FCC and manufacturer's standards)
- Signal intelligence algorithms

The DiagnostX System performs all the calculations related to radio performance and stores historical records in the system database. The analysis of the received waveforms indicates the operational characteristics of each radio. User-defined thresholds determine the radio's conformance to FCC requirements and manufacturer's specifications.

The database metrics are interpreted and displayed in real-time on an easy to navigate, information rich user interface, the DiagnostX Viewer (DV). All logged signal metrics are stored by the radio identifier and are easily retrieved for further analysis.

*DiagnostX Flow Diagram*



## BENEFITS

To ensure operational readiness, the radio communication links of the organization need to be continually monitored and maintained.

DiagnostX is a stand-alone, non-intrusive, OTA monitoring asset, developed to assist the radio service personnel by constantly monitoring the radios while they are operating in the field, ensuring operational readiness. By pre-identifying radio operational, problems the organization will experience a higher level of system performance and reduced maintenance costs.

## EXAMPLES OF OPERATION PROBLEMS

- Frequency Error, Oscillator misaligned: DiagnostX can identify this OTA on the live system before the user knows it is an issue.
- Modulation misaligned: DiagnostX can identify this OTA on the live system before the user knows it is an issue.
- Power, antenna and other mechanical attributes: Certain RF markers can help to identify field radio issues versus bench tested issues.

## EXAMPLES OF RADIO MAINTENANCE COST SAVINGS

Between 75% to 85% of radios in a network typically operate within specifications. Eliminates time spent by maintenance personnel measuring the performance of every radio.

- Eliminates NTF (no trouble found) radios. DiagnostX can analyze the radio in the field to verify it is the radio and not some other anomaly or user error.
- Reduces downtime of agency personnel. Scheduling and transport to and from the radio shop is costly.

DiagnostX has been tested in live radio networks and the results have been compared against bench testing of the same radio. The tests have proven the effectiveness and accuracy of DiagnostX in identifying problem radios. DiagnostX provides a breakthrough technological advantage by constantly monitoring and evaluating all radios on the network system. This ensures minimum hardware and personnel downtime and assures peak operational readiness.

## DIAGNOSTX

- Is not a Bench Service Monitor
- Does not require the radio to be placed in Test Mode to be analyzed
- Is not intrusive; does not impact the radio system

## CONCLUSION

Land Mobile Radio system managers with thousands of radios find it cost and time prohibitive to provide adequate Preventive Maintenance alignment of all radios on an annual basis. Waiting for radios to fail before sending them for repair and replacement is Reactive Maintenance and endangers the safety of First Responders and Public Safety Personnel.

Economic Proactive Preventative Maintenance with DiagnostX ensures Operational Readiness and eliminates the possibility of radios failing during an emergency when they are needed the most.

Reduced maintenance man-hours are achieved as statistics prove 75% to 85% of radios in a LMR network typically operate within specifications. DiagnostX identifies 24/7 which radios can stay deployed and which radios need Immediate attention. Annually significant reduced maintenance costs are achieved by only having to service 15% to 25% of all of the radios.

Ensured Operational Readiness for LMR Communications is achieved by Proactive Preventative Maintenance that can be easily managed. The system manager can schedule radio repairs proactively on a priority basis versus always reacting to radios after they fail.

For more information, please contact: [LocusUSA](http://LocusUSA).

### Patent Nos.

United States: #8,565,096, #8,948,022, #9,282,482, #8,600,371, #8,825,042, #9,432,866 #9,681,321 B2, #10,200,902

Canadian: #2,746,238 | Australian: #2010235881, #2012253596 #2015203442 | Other patents pending

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