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In-building Mapping with the Anritsu S412E LMR Master and the MA8100A Series TRX NEON® Signal Mapper

Introduction

In-building wireless communications are essential to provide communications for law enforcement activities, for emergency medical treatment, for fire suppression, for carrying on the business of government, and for providing communications in time of disasters. There is abundant news of in-building events where public safety personnel have been called in to resolve problems and to support health and welfare needs. In all of these cases, effective and reliable communications are necessary for these professionals do their jobs effectively.

Figure 1. School Complex to In-Building Map

The role of enforcing in-building public safety needs (e.g., # occupants in a room) typically falls to the local fire marshal's staff. They rely on building codes and standards from the National Fire Protection Association (NFPA). Wireless communications standards are covered under NFPA 72 and NFPA 1221. Both standards prescribe periodic measurements to assure communications. For more information go to *http://www.nfpa.org*.

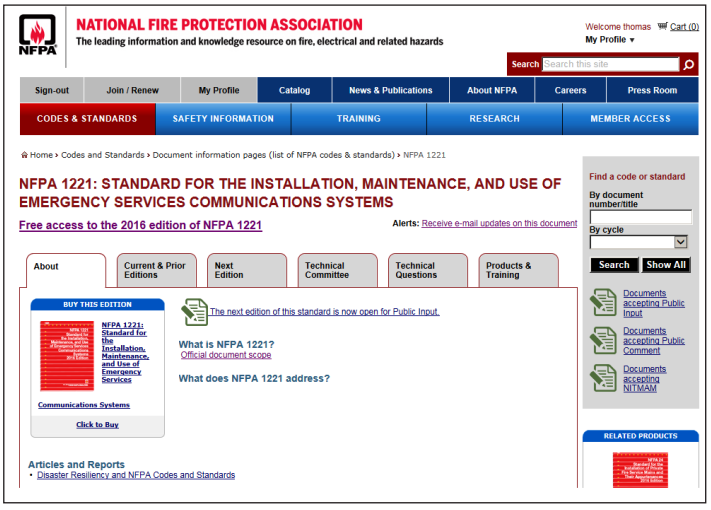

Figure 2. NFPA 1221 website

Historically, public safety communications were mostly based on powerful, external high site transmitters to supply sufficient signal levels to reach into buildings. Modern energy efficient building construction and increasing reliance on anytime, anywhere communications are causing installation of public safety radio enhancement systems. These systems, known in the technical community as Distributed Antenna Systems (DAS) take the external high site signals, amplify them and evenly distribute the signals throughout the building. For a description of the many differing technical approaches for DAS systems see "Understanding IBW Solutions", Anritsu document 11410-00885A.

This application note describes how to make in-building RF measurements to determine communications coverage.

Anritsu is a US supplier of battery powered, portable test solutions that are used by technicians and engineers who install and maintain communications systems. One model is focused on public safety systems, the Anritsu S412E LMR Master.

The S412E includes a GPS receiver to support outside building coverage mapping. Anritsu application note "S412E P25 Coverage Mapping" is available under document number 11410-00835A. The S412E has extensive coverage mapping measurement capability, including on screen map displays with measurement overlay. In addition to GPS outdoor mapping it includes indoor mapping using a user interface where the operator touches the map display to associate measurements to an in-building location.

Figure 3. Anritsu S412E LMR Master

The S412E has measurement modes specific for most public safety modulation technologies including NBFM, P25 phase 1, and P25 phase 2 that provide in depth analysis of a radio channel. Measurements are made in 12.5 kHz bandwidth using Telecommunications Industry Association (TIA) standard test signal patterns. Measurements include RF power (dBm). With an antenna attached, RF power measurement becomes Received Signal Strength Indication (RSSI). In addition to RSSI, for NBFM systems the S412E measures Signal to Noise and Distortion (SINAD) per the TIA 603 standard. For P25 systems the S412E provides Modulation Fidelity and Bit Error Rate (BER) per the TIA 102 standard. The TIA 102 standard recommends BER as the test of a P25 receiver function.

Anritsu has recently partnered with TRX Systems to introduce the Anritsu MA8100A Series TRX NEON Signal Mapper, a 3D in-building coverage mapping solution to provide coverage maps based on RF measurements from the S412E. The TRX NEON® Signal Mapper application provides an Android user interface so in-building measurements can be made at specific grid locations by simply watching the display of an Android smart phone or tablet and walking as needed within the grids. The in-building location is provided by the NEON Tracking Unit worn on the operator's belt which is equipped with a gyroscope, accelerometer, barometer pressure sensor, compass, and ranging sensors. The tracking unit communicates with the Android smart phone via a Bluetooth link. The S412E measurements are sent to the smart phone via a USB interface. The NEON Signal Mapper application provides three-dimensional results to help view measurements in stairwells and elevators.

The MA8100A includes the NEON Command Software, a PC-based software package that supports adding detailed floor plans and reviewing the measurement results. The NEON Command Software supports superposition of grids on top of floor plans to support mapping procedures per NFPA 72 and NFPA 1221.

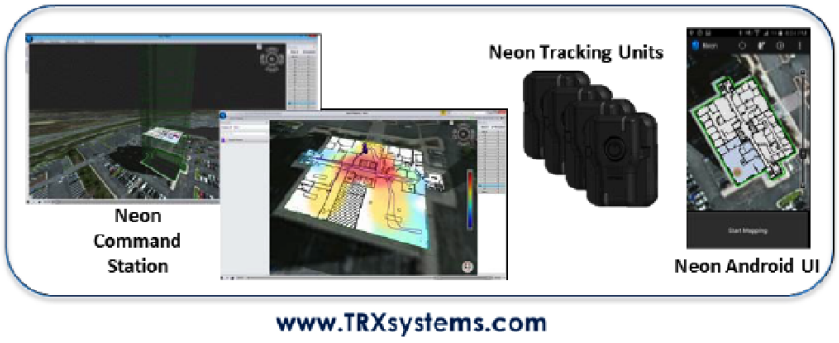

Figure 4. TRX Systems NEON® Mapping Solution

Setting up the S412E for Channel Power Measurement

Prior to conducting in-building mapping, the analyzer itself must first be configured to properly measure the signals of interest. Knowledge of various parametrics such as anticipated signal strength and variation, potential presence of interfering signals, and noise sources should be used in determining analyzer settings. A brief summary of the main analyzer setups is shown below. However, the user may want to refer to the instrument user manual for more detailed guidance.

1. Frequency

a. Set frequency to be measured as the spectrum analyzer center frequency.

2. Span

a. Set the span to 1 MHz for measuring 12.5 kHz channels.

2. Reference Level, Pre-Amplifier and Attenuator

a. Reference Level: Input signal levels are referenced to the top line of the graticule, known as the reference level. Depending on the amount of power anticipated in the signals to be measured, the reference level should be adjusted accordingly.

b. Pre-Amplifier and Attenuator: In order to present the proper signal level to the analyzer detection circuits, pre-amplification or attenuation can be adjusted on the signal input. The attenuator can be automatically adjusted as a function of the reference level. In general, signals below –40 dBm can use the pre-amplifier while signals over –30 dBm should be attenuated. For example, if the reference level setting is 20 dBm, attenuation should be set to 50 dB for a mixer input of –30 dBm.

3. Detector Type

a. Various detection circuits can be utilized. These include Peak, RMS, Negative and Sample. The type of detection is predicated on the user's measurement needs.

4. Filtering

a. Filtering should be used to measure signals in the presence of interferers. Filters can be added to the input of the analyzer to discriminate between wanted and unwanted signals, avoiding corruption of the measurement with adjacent high level signals.

5. Measurement mode

a. The NEON Signal Mapper application (run on an Andriod device) accepts channel power measurements from the S412E. To set up channel power measurements press "Shift" "Measure" and "Channel Power". The appropriate channel width will need to be entered. The Android device display will show the measurement values as they are taken.

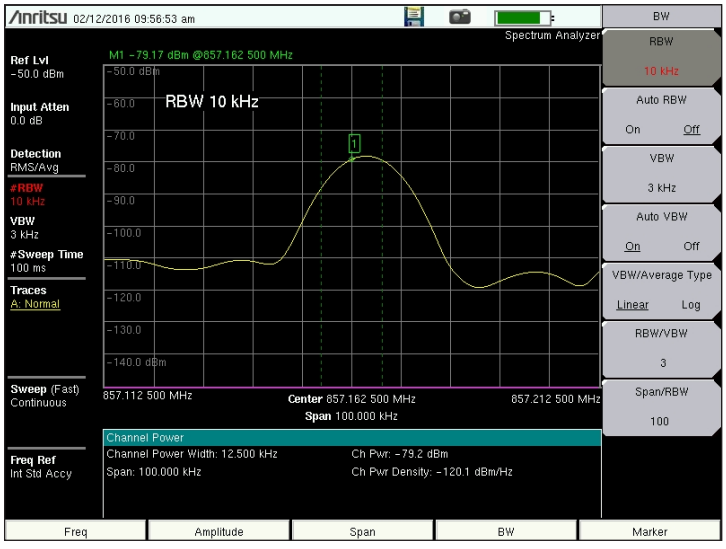

Figure 5. S412E Channel Power Measurement

Preparing a map with the NEON Command Software

1. Floor plans for each building should be located and converted to a graphics format (i.e., jpg, bmp, gif, etc.) format. A grid layout should be superimposed on the floor plan image. A walking plan could be superimposed as well if there are obstacles to prevent an X walking plan.

2. The address of the building should be entered into the NEON Command Software and the building to be mapped located on the PC screen.

3. The floor plan with grid / walking path should be attached to the building following the NEON Command Software user guide.

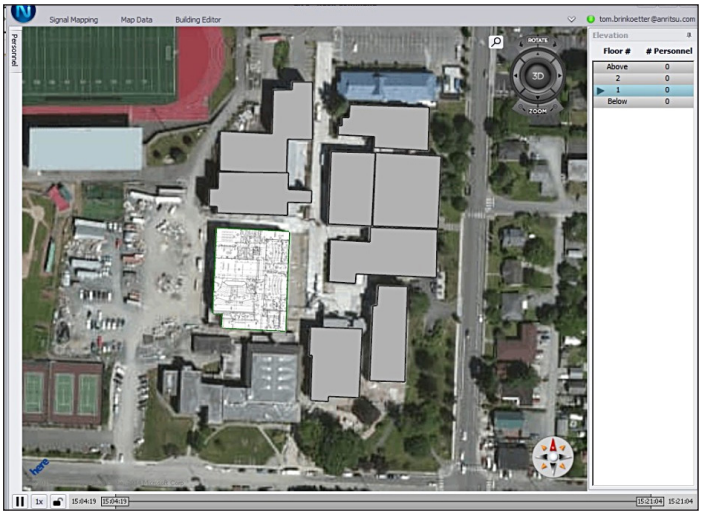

Figure 6. Using the TRX NEON Command Software to Place a floor plan onto a building

Connecting the S412E with a Measurement Antenna and the Android Smart Phone or Tablet

1. An Anritsu S412E would be placed on a cart and connected to a quarter wavelength measurement antenna 3 to 4 feet off of floor level and 3 to 4 feet away from the operator. The S412E should be set to measure the signal strength on the proper frequency. The Android device should be attached to the S412E via a USB OTG cable to transfer the measurements into the NEON software.

2. The NEON application should be run on the Android smart phone or tablet to view the maps and measurement results.

3. The NEON Tracking Unit should be associated with the Android smart phone or tablet and current location on the map verified.

Figure 7. S412E with Android phone and NEON Tracking unit

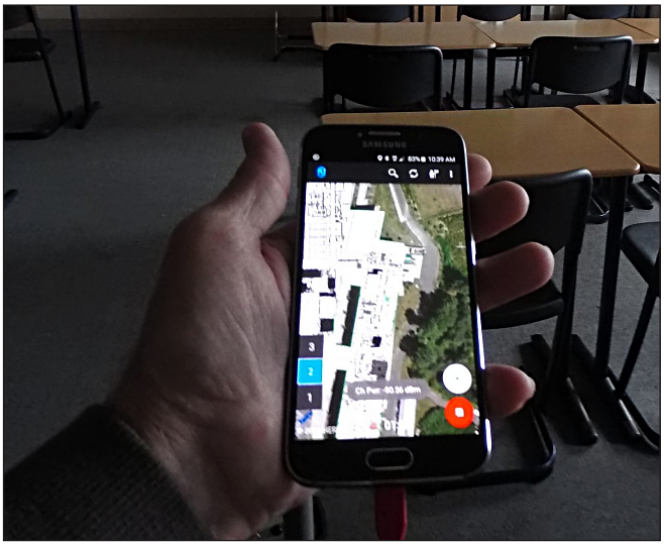

Figure 8. Observing the location and measurement results on an Android phone in a high school classroom.

Making Measurements

1. The operator would follow the NEON location calibration procedures shown on the Android smart phone or tablet.

2. The operator would walk the specified walking plan observing the location on the smart phone or tablet. When the walk is complete the operator should upload the measurement results with locations to the included NEON cloud storage or locally on the smart phone or tablet.

3. The measurement results can be reviewed using the NEON Command Software in 2D, 3D or as comma separated files with results for each measurement. The NEON Command Software provides a heat map display which uses an average of the measurements made to predict coverage around the walking path.

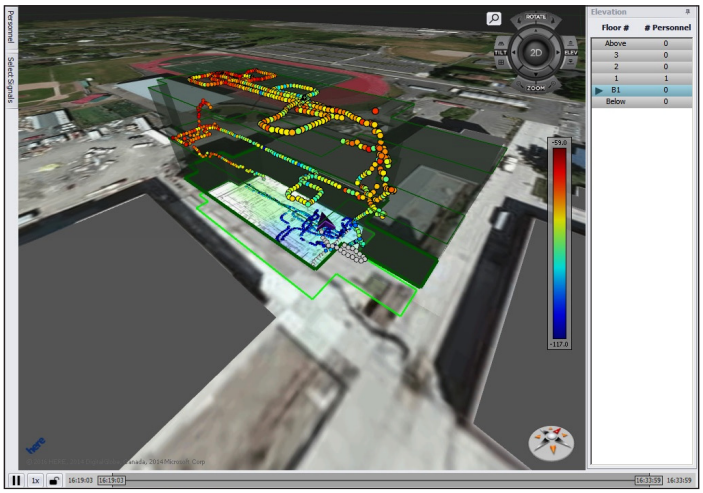

Figure 9. Using the NEON Command Software to view the signal strength inside 3 levels of the school.

Conclusion

Facility managers often need to verify Public Safety, Broadcast and Personal communications systems operate throughout the facility. Point location measurements of spectrum analyzer displays are commonly used to document signal levels.

The Anritsu S412E combined with the MA8100A Series 3D signal mapping solution provides a powerful in-building mapping solution so users can easily make measurements and create detailed maps and reports of in-building coverage.

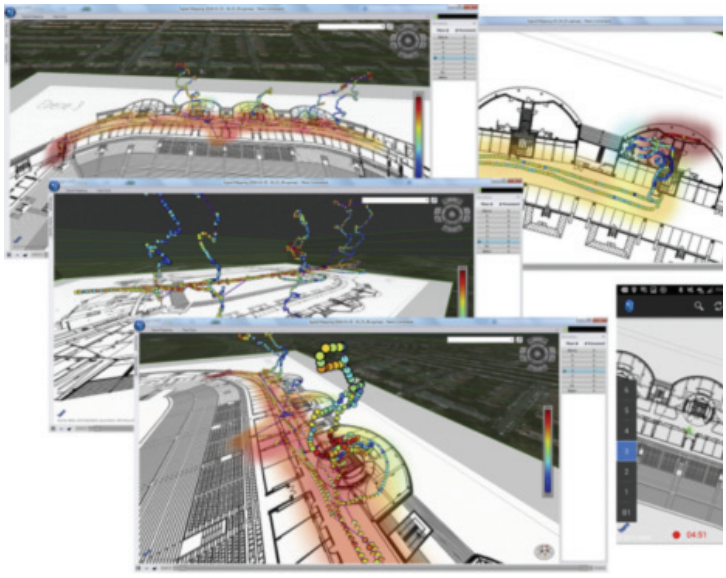

Figure 10. Signal Maps created using the MA8100A and Anritsu S412E LMR Master. Data visualization shown using the TRX NEON Command Software.

Figure 11. Anritsu Handheld instruments

Anritsu would like to thank Hatfield & Dawson Consulting Engineers in Seattle, WA for supporting the measurements and facilities used in this application note.

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NEON LOCATE. MAP. TRACK. INDOORS.

TRX systems LOCATE. MAP. TRACK. INDOORS.

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