CRFS WIDEBAND INTELLIGENT SPECTRUM MONITORING SYSTEM OVERVIEW – Quick Guide to show applications and capability of the System (Hardware and Software)

This document is intended to give an initial overview of the CRFS product range. It covers the most common applications of the product. It is not meant to be a comprehensive description of all the hardware or software features that are available.

For particular customer applications, Vicom can provide system configuration assistance and undertake scripting for presentation of data in formats other that what is provided for in the suite of Analysis Tools.

Services available include the use of a propagation analysis tool to evaluate optimum node locations, taking into account terrain features, and (unknown) transmitter parameters.

Refer also to document ***CRFSOverview.pdf***.

Applications:

1) In-building RF monitoring systems for detection of transmitting devices- for example government buildings, embassies, prisons, meeting rooms, secure areas.
2) Location of interfering signals and rogue transmitters in a geographic area – examples public venues, sports arena, city block.
3) Detection and geo-location of unauthorized transmitters – simultaneous monitoring of the signal from a transmitter at different setup locations. This allows the determination of the location of the unknown transmitter to be displayed on a map. This can apply to stationary or moving transmitters.
4) Spectrum monitoring and management – example help national regulators get the most out of the spectrum , making decisions relating to spectrum useage, sharing, and release, license enforcement.
5) Perform signal strength surveys and plot results on map.
6) Military Spectrum Planning and monitoring – evaluation of equipment operation in the presence of hostile RF environment.
7) Record spectrum data for later analysis.

Elements of CRFS solution:

The elements listed below are to give an overview of the basics to cover most applications. Other hardware and software is available for special deployment situations and analysis.

1. **RFeye NODE**. This is the receiver and processor which does spectrum scanning and provides data output in accordance with scanning programs setup in the node using the Application Software in the NODE. It incorporates a GPS receiver.
2. **Antennas.** Either Omnidirectional or Directional Arrays. Antennas have calibration factors which allow level measurements to be converted into field strength (uV/M).
3. **Application Programs and scripts.** This is the software which runs on the NODE to perform scans and determine the data which is output for further analysis.
4. **ANALYSIS Software.** There are a number of software tools which run on a PC for analysis of the data collected by the logger. These include:
   4.1. RFeye SITE – for realtime managing complex spectrum operations over large areas, or within buildings, and providing geo-location. Signal Recognition (by analysis of modulation types) and Propogation Analysis (for geospacial modelling on the environment to plan best Node location) are additional "plug-ins" to this analysis tool.
   4.2. RFeye MAP - This is for post analysis of data collected using the LOGGER Application running on a mobile NODE, and display of signal strengths on a map.
   4.3. RFeye Monitor – For collecting and managing spectrum data from a network of widely distributed NODES.
   4.4. RFeye Manager – For managing a large number of NODES in a network, including remote software management and batch configuration.
5. **Hardware Configuration**. – A number of equipment configurations incorporating the NODE are available. (Backpack, Stormcase, Outdoor Mounting, Ceiling Mounting)

1. RFeye NODE (Receiver)

There are two basic hardware solutions for the receiver. Both are available in an IP67 enclosure and are intended for outside operation in extreme environmental conditions. The receiver incorporates a Linux Processor to manage data collection. The Nexus Node is the higher performance receiver.

1.1. **Standard** Node (Full Spec in document ***crfs-md00037-d02-rfeye-node.pdf***)

1.1.1. 10MHz to 6GHz (up to 18GHz with Block Down Converter)
1.1.2. Sweep speed 40 GHz/sec.
1.1.3. Instantaneous Bandwidth 20MHz max.
1.1.4. Resolution BW Min 18Hz
1.1.5. Noise figure <4GHz = 8dB, >4GHz =11dB
1.1.6. Weight 2.0Kg
1.1.7. Operating range -30 to +55 deg C
1.1.8. DC power 10–56V, Power consumption 15–25W. Separate DC connector or POE both available.
1.1.9. 170mm x 60mm x 125mm
1.1.10. GPS receiver, cellular modem, Ethernet, USB, internal SSD.

Figure 1.0: **RFeye Node**

1.2. **Nexus Node.** (Full Spec in document ***crfs-md00034-c06-rfeye-nexus.pdf***)

1.2.1. 100KHz to 18GHz

1.2.2. Sweep speed 150 GHz/sec at 2kHz resolution bandwidth.

1.2.3. Instantaneous Bandwidth 100MHz max.

1.2.4. Tuning Resolution 1Hz

1.2.5. Noise figure <12GHz = 9dB, >12GHz =11dB

Figure 1.1: **RFeye Nexus**

2. Antennas

2.1. Omnidirectional Antennas – Covering 10MHz to 6 GHz. (See RFeye Antenna document ***crfs-md00030-c06-outdoor-mounting-kit-and-antennas.pdf***)

Figure 1.2: **Omnidirectional Antenna**

2.2. Directional Antennas. These are electronically “steered” antenna arrays used for AOA direction finding. A variety of array antennas cover the band from 20 MHz to 18 GHz. (See RFeye Arrays in document ***crfs-md00033-c04-rfeye-arrays.pdf***

Figure 1.3: **RFeye Array**

2.3. RFeye hardware can be installed in-building using an installation kit designed to place the equipment within a ceiling void, with only the receiving antenna visible within the room.

Figure 1.4: **Ceiling Antenna**

2.4. The Outdoor Mounting Kit is designed to accommodate a range of IP67 rated omnidirectional antennas to cover the frequency range from 10 MHz up to 18 GHz. (See RFeye Outdoor Mounting Kit document ***crfs-md00030-c06-outdoor-mounting-kit-and-antennas.pdf***)

Figure 1.5: **Outdoor Mounting Kit**

3. Applications running on NODE

(See RFeye System Software in document ***crfs-md00038-d04-rfeye-system-software.pdf***)

3.1. A number of Applications are available to run on the NODE. These produce data in various formats for either 'live' or 'off-line' analysis. The parameters (such as frequency ranges, scan intervals, alarm threshold) are configured by generating scripts which are called up by the applications.

3.2. The applications are:

3.2.1. **LOGGER.** This is the "workhorse" application for scanning frequency bands. It provides continuous spectrum data collection and processing. The parameters for configuring this include Scan start and stop, Resolution Bandwidth. The output data includes Timestamp, GPS Location, Levels at Frequencies set by the scan start and stop and resolution bandwidth. Data produced by this application is stored in BIN files, which can be interpreted by ANALYSIS Tools. The BIN file can be used in RFeyeMAP. There is also a data management tool which can convert the BIN files to CSV files. This size of the BIN file is set in the scripting.

3.2.2. **RECORDER**. This is similar to LOGGER, providing continuous spectrum data collection. The parameters for configuration are similar to LOGGER. A difference from LOGGER is that it produces output to NCP files. The NCP files can be viewed and analyzed with RFeye SITE. The data can be played back with RFeye SITE. The NCP file can also be used in RFeyeMAP.

3.2.3. **STATIONS.** This is for monitoring specific frequencies, rather than bands. It provides a timestamp, GPS location, Frequency, Bandwidth, Level Deviation, Occupancy information, for the specified frequencies to be monitored. It outputs data to a CSV file.

3.2.4. **SURVEY**.

3.2.5. **THRESHOLD**.

4. Analysis Software running on PC

(See RFeye System Software in document ***crfs-md00038-d04-rfeye-system-software.pdf***)
(See RFeye Detect Datasheet for use of RFeye Site Software used for plotting location on a map (geolocation) ***crfs-md00027-c06-rfeye-system-detect.pdf***)
(See RFeye Secure Datasheet for use of RFeye Site Software used for in-building location ***crfs-md00026-c05-rfeye-secure-detect.pdf***)

4.1. **RFeye SITE.**

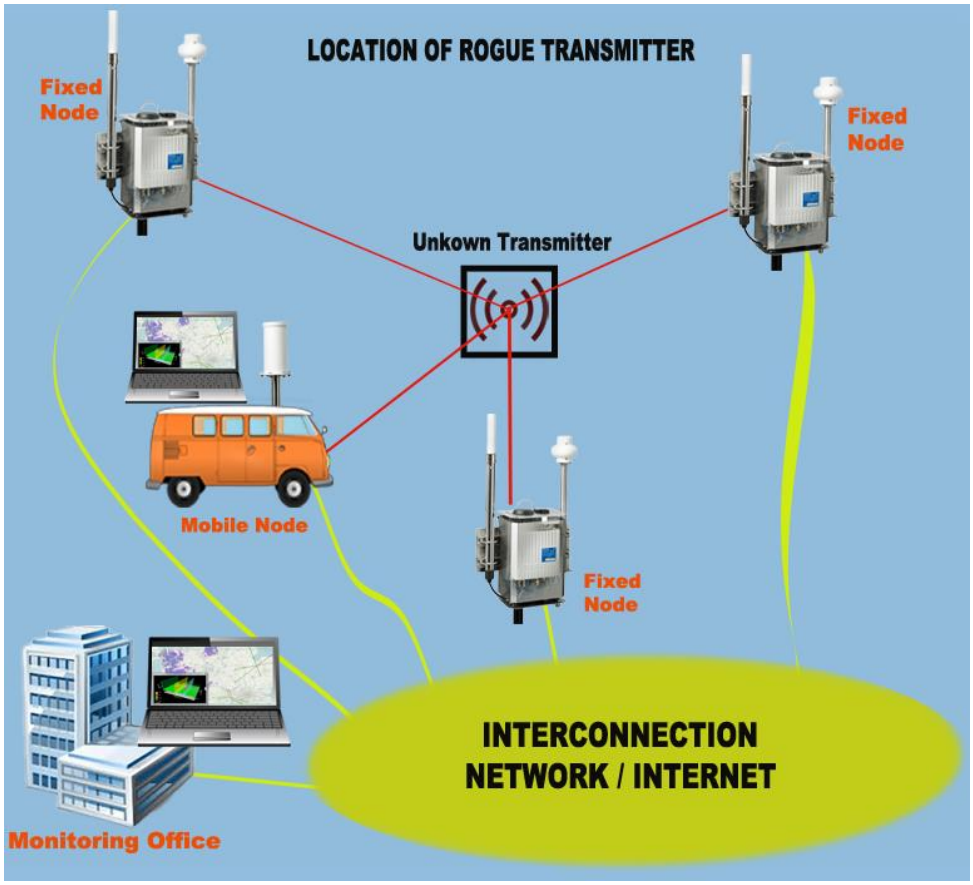

Figure 1.6: **Location of Rogue Transmitter**

4.1.1. This connects to one or more NODES in realtime, (via ethernet or cellular modem) to display current activity such as spectrum of selected bands, masks, and alarms. A large number of nodes may be simultaneously viewed, subject to the bandwidth of the network between the NODES and the PC running SITE. The location of the nodes being monitored is displayed on a map (eg Open Street Maps).

4.1.2. Geolocation of transmitters can be done by selecting the part of the spectrum of interest, and one or all of: TDOA, AOA, POA techniques, applied to produce a heatmap overlay on the Map tile to show the location probability of the particular transmitter. TDOA is the analysis of the time delay between the same signal received all the nodes. POA is the analysis of different power levels of the same signal received at the nodes. AOA is the analysis of the direction of the same signal received at all the nodes. This requires the use of directional antennas at the NODE sites.

4.1.3. The real-time activity can be recorded and played back at a later time. It can also be played back simultaneously with live data. This is used to superimpose AOA information from a mobile node taken in one location with the information collected by this node moved to another location – thus getting AOA position from a single node.

4.1.4. Displays available also include Waterfall (Frequency vs time, with signal level displayed as a graded colour, Demodulated IQ data). FM signals can be demodulated, and the audio recovered.

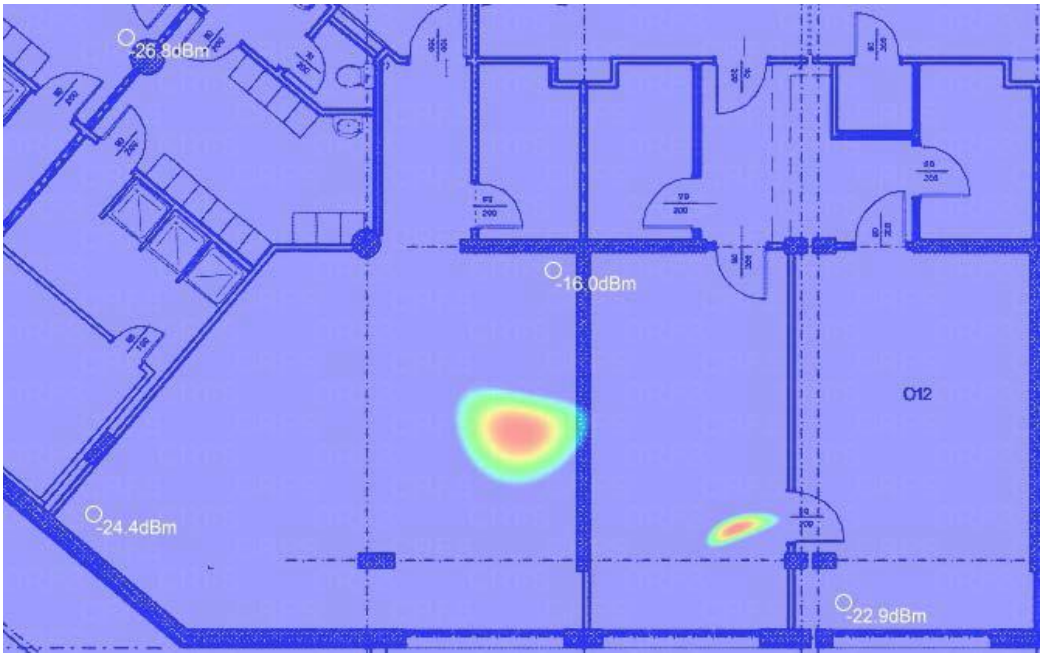

Figure 1.7: **POA geolocation of transmitters**

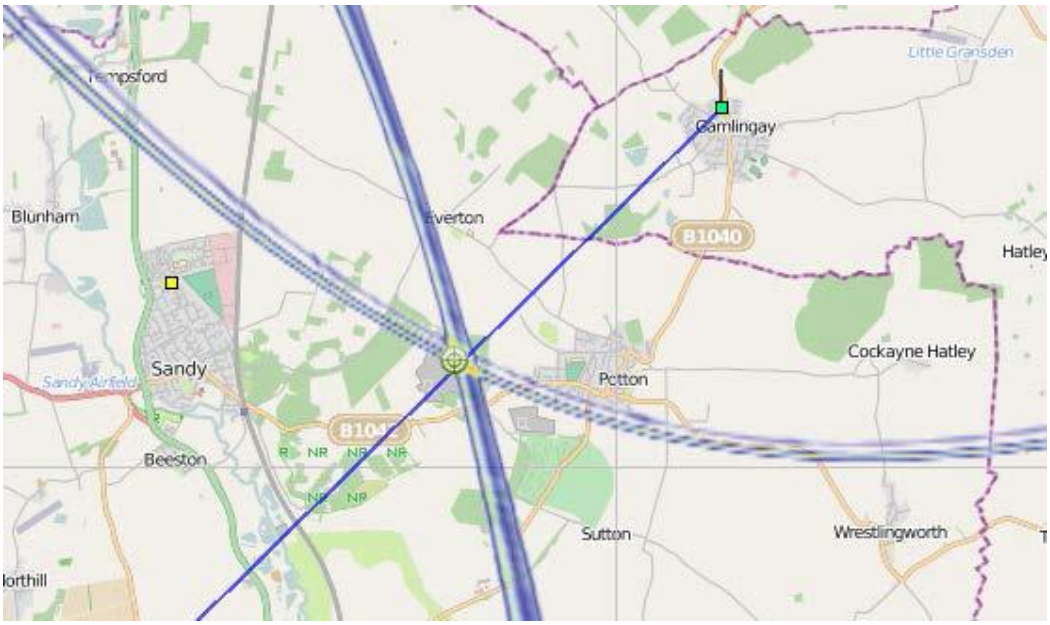

Figure 1.8: **Geolocation of transmitters**

4.2. **RFeye MAP.**

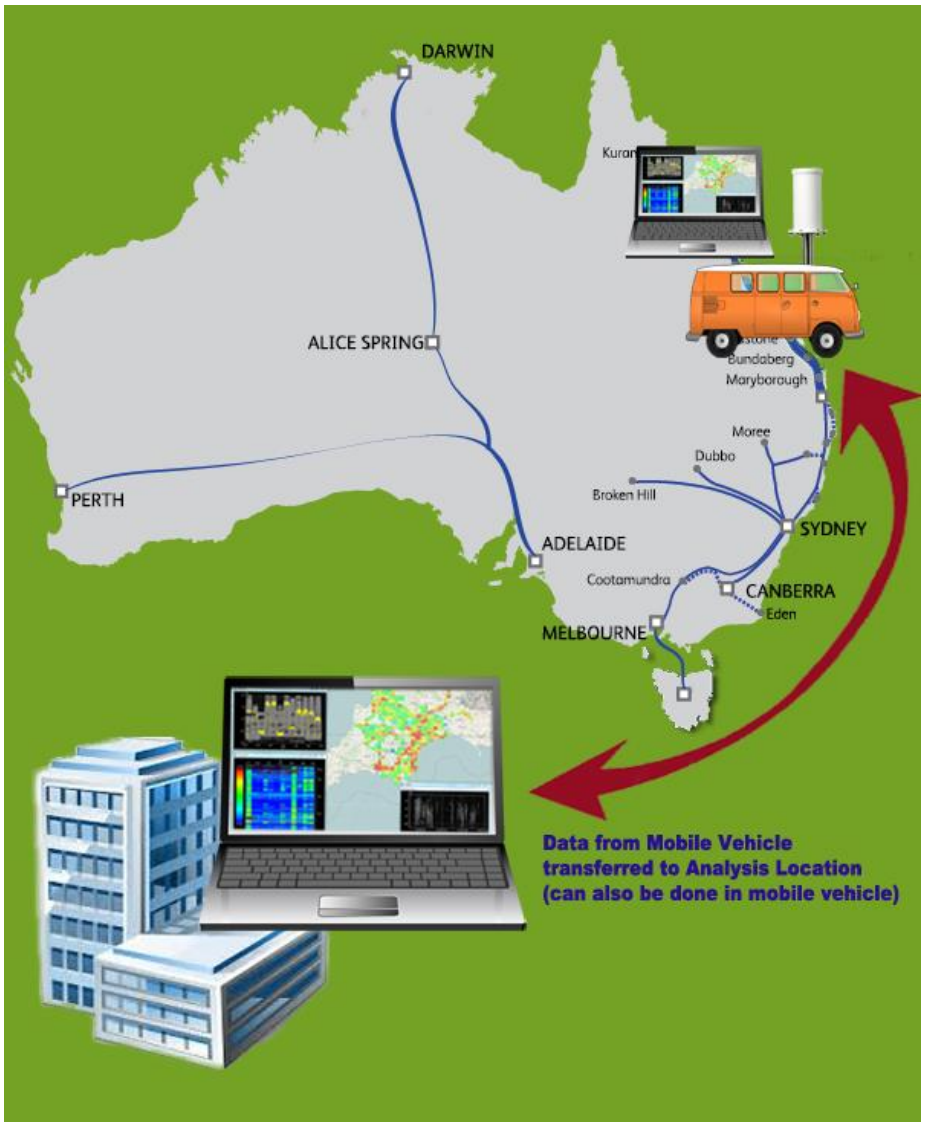

Figure 1.9: **Field Strength Mapping**

4.2.1. This is for post analysis of data collected using the LOGGER program running on the NODE, and display of signal strengths on a map, represented as graded coloured pixels overlaid on the map tile.

4.2.2. Very large data sets can be managed with this tool, as it can "span" together multiple data files. This aggregates data which may have been collected over a number of days.

4.2.3. The data to be displayed can be selected as a set from the total data based on criteria such as frequency band, time.

4.2.4. Processes such as averaging, peak, and utilization, can be applied to the data displayed, and the signal strength "pixel" size displayed on the map can be selected.

4.2.5. On the map display, moving the cursor to any point where data has been displayed will show the spectrum of the recorded data at that point.

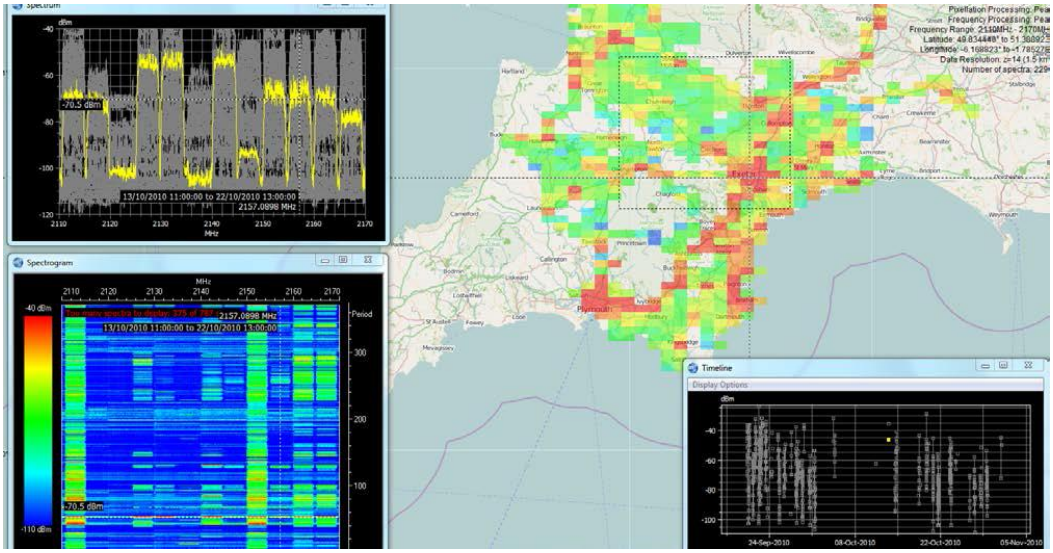

Figure 2.0: **Combined view of selected data points with map, spectrum, spectrogram and timeline plot**

5. Hardware Configurations

5.1. Backpack. (See RFeye BackPack document ***crfs-md00005-c03-rfeye-backpack.pdf***)

5.2. Stormcase. (See RFeye StormCase document ***crfs-md00016-c04-rfeye-stormcase.pdf***)

5.3. Outdoor Mounting. (See RFeye Outdoor Mounting Kit document ***crfs-md00030-c06-outdoor-mounting-kit-and-antennas.pdf***)

5.4. Ceiling Mounting. (See RFeye Node document ***crfs-md00037-d02-rfeye-node.pdf***)

5.5. Evaluation System. (See RFeye Evaluation System document ***crfs-md00003-c03-rfeye-evaluation-system.pdf***)