902-2
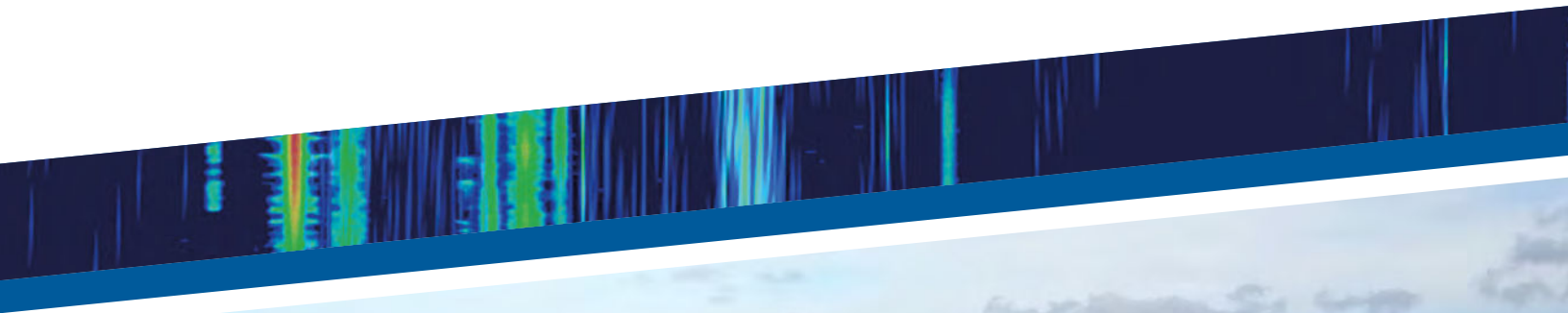
902-2 Integrated HF Signal Intercept, Collection, Geolocation and Analysis COMINT System

Your Mission: Strategic collection & location of geographically diverse HF signals

› Detection and geolocation of traditional and short-duration emitters
› Enterprise level system to support multiple operators
› Long and short range strategic HF collection and HFDF/Geolocation
› Modern design based on decades of 24/7/365 multiple system deployment

The TCI Model 902-2 employs a flexible clientserver architecture that provides a complete set of tools to carry out HF radio surveillance. The Model 902-2 combines TCI Model 802W N-channel direction finding system with TCI Model 850 Blackbird signal collection system to provide vanguard performance by instantaneously covering the entire HF band.

The 902-2 system rapidly detects and acquires any traditional or modern HF signals, and is capable of performing detailed analysis of specific signals of interest. The 902-2 can perform analysis manually or automatically in real time or in delayed (post-facto) mode. Analyses include detection, location, collection, classification and archiving of signal activities.

Typically the 902-2 is used to search the HF spectrum using extremely fine frequency resolution. When RF energy is detected, the system automatically determines the direction of the energy source and other important signal parameters. This information is then automatically archived for future analysis and can be simultaneously passed to operator client workstations in real time. The operator at a client workstation tasks the system to find a particular Signal of Interest (SOI) with specific parameters.

The system then processes archived or real-time data to find the SOI and its geographic position or location and presents this information to the operator.

The foundation of the 902-2 system is highspeed signal search, combined with detection and direction finding obtained by simultaneous, parallel processing of multiple, 28 MHz-wide receiver channels connected to an antenna array. The 902-2 is capable of performing automatic real-time analysis on all types of HF signals. The analysis provides transmitter parameters including frequency, direction and/or location, bandwidth, time and duration of transmission, and type of transmission.

Depend on the field-proven solution for surveillance of traditional and modern HF signals.

Key features

• Manual and automatic HF signal detection, location, collection, analysis and archiving.

• 2 MHz to 30 MHz frequency range (optionally down to 0.5 MHz depending on antenna type) with up to 28 MHz instantaneous real-time bandwidth.

• Signal search and filtering by signal frequency, direction, location, modulation, duration, bandwidth and type.

• N-channel DF architecture, one receiver per antenna, is unsurpassed for dealing with the HF signal environment.

• TCI DF First™ signal acquisition technology provides exceptional DF accuracy and speed.

• High dynamic range and excellent co-channel frequency resolution.

• Modular and scalable architecture for multi-user and/or multi-site applications operating 24/7.

• Field-proven direction finding algorithms using TCI and non-TCI antenna arrays.

• Tools for analysis and archiving of results.

• Local and remote control, including full network operation.

• Advanced signal detection, including optional modulation recognizer that automatically identifies specific signals of interest.

• Integrated Digital Downconverters (DDCs) with delay memory provide multichannel realtime collection.

• Easy to use Automation facility triggers automated actions (collection, alarming, analysis, etc.) when signals of interest are detected.

Options

• Software interface libraries available for integration with existing infrastructure.

• Single Site Location (SSL) processing.

• Adaptive Beamforming (Enhanced Copy).

• Superresolution DF, using MUSIC algorithm

• Modulation recognition for automated signal classification and Smart Recording.

• Universal Signal Detection.

• Snapshot Radio Audio Player.

• Lookback Collection.

• TEAM option allows intercept data to be transferred between Blackbird collection systems to a Blackbird Central Database server.

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TCI Model 902-2 HF COMINT Solution

TCI Model 902-2 provides the ultimate solution for supporting HF COMINT missions.

Precision HF Front Ends

A quality RF front end must deliver a combination of excellent sensitivity, high dynamic range and speed.

The 902-2 system uses the TCI Model 2621 high performance HF receiver which provides full HF coverage (2 to 30 MHz) with up to 28 MHz Instantaneous Bandwidth (IBW). A bank of HF pre-selectors allows selection of narrower frequency bands with increased rejection of unwanted out-of-band signals.

A digitizer provides full 16-bit resolution and the integrated GPS receiver tags the output data with precision timestamps as well as position information.

Wideband IQ Recording with Lookback Collection

When configured with the optional TCI Lookback Collection, wideband digital IQ data streams can be recorded continuously to a high speed RAID disk array. Unlike typical wideband recorders, TCI's disk array is uniquely configured to allow data to be read from the disk while writing. This allows extraction of past signal data from the disk without interrupting recording, enabling operators to collect IQ data for any past signal available on the recorder while all new signals continue to be recorded.

In addition to providing a data source for automated collection, Lookback Collection provides a collection safety net - ensuring that all signals of interest can be collected, even if discovered after transmission has terminated or during post-mission analysis.

DF First®

The 850 subsystem energy-detection process runs simultaneously with the 802W DF subsystem, which produces DF for all active signals. Known as DF First®, the availability of the angle of arrival for all incoming signals enables manual and automated search by direction - and when multiple DF sites are deployed, search by geolocation.

Spectral Recording

In addition to driving signal detection, the spectral data is saved into the 850 subsystem Collection Server where it can be retrieved and sent to clients to provide historic spectrogram views (known as Lookback Visualization).

To optimize spectrogram transfers, the server resamples and stores the incoming spectrogram data at multiple zoom levels. This ensures smooth scrolling, panning, and zooming for local clients - and makes it possible for remote clients over slow network links to efficiently retrieve past spectrogram views.
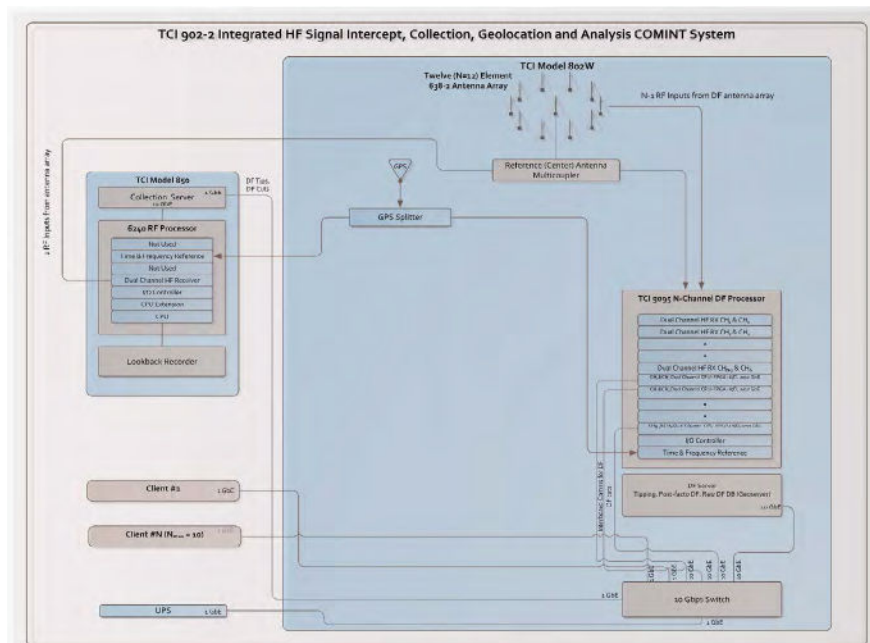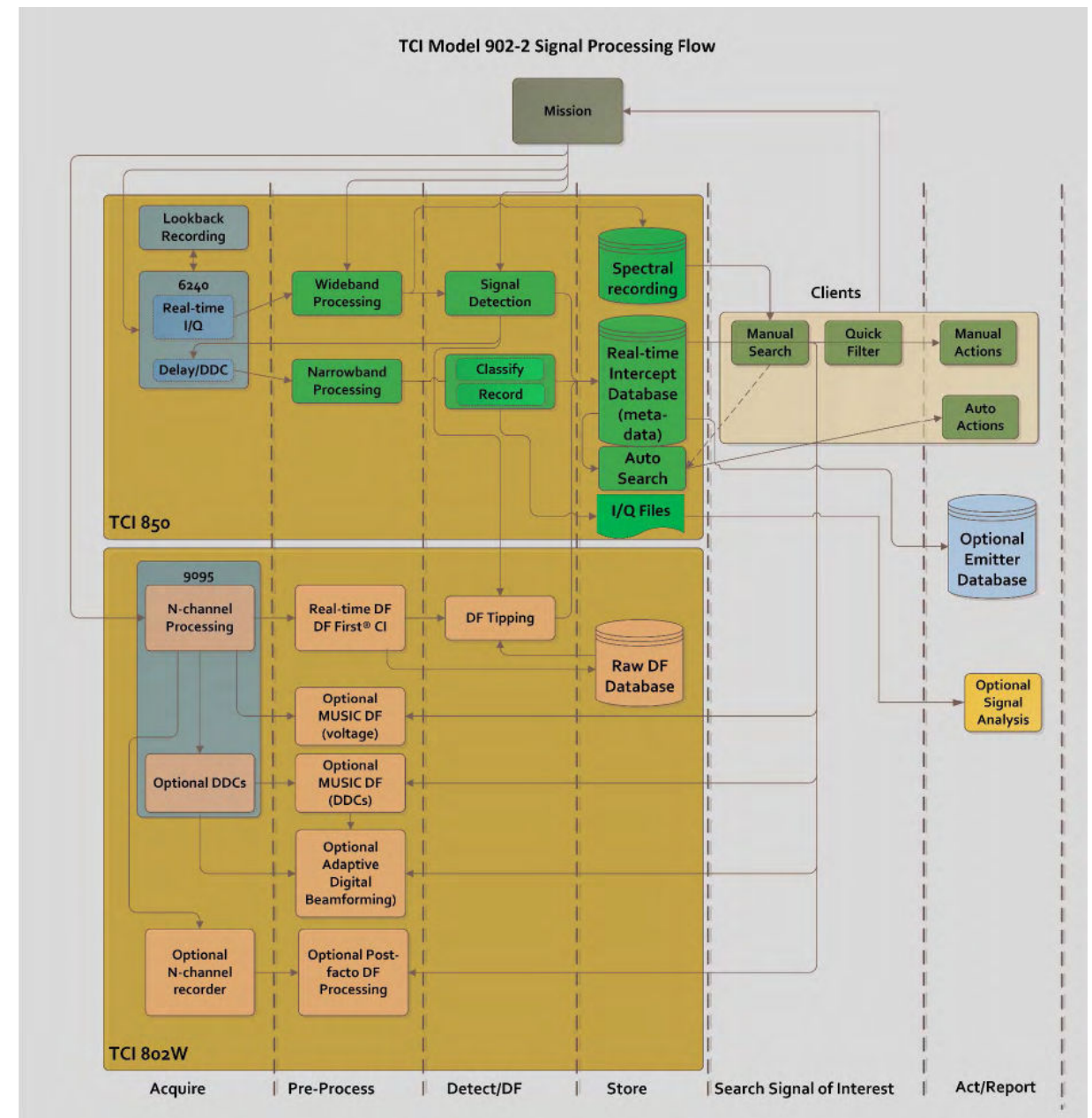
Automated Signal Detection

On every spectral update, the Model 850 subsystem analyzes the high resolution spectral data and automatically detects and catalogs the individual signal transmissions. For each intercept, the signal's external characteristics are automatically measured including time, frequency, bandwidth, power, and duration. The resulting intercept meta-data is recorded in the Collection Server's realtime database where it can be viewed by the user and drive automated tasking.

Multichannel Realtime Signal Collection

Once signals of interest are detected, they can manually or automatically trigger a variety of tasks, including collection and processing of IQ data. To facilitate collection, the RF Processor provides a bank of digital down-converters (DDCs). Each DDC can tune and zoom independently to a specific signal of interest and send the narrowband IQ data to the server for recording and further analysis. A wideband delay memory path preceding the DDC bank allows the DDC to acquire the start of the signal transmission, which compensates for any latency in wideband signal detection processing.

Smart Recording

TCI 850 subsystem Smart Recording feature combines realtime automated modulation classification with IQ recording. Smart Recording buffers the incoming DDC IQ data, while performing automated modulation classification. If a user specified modulation criteria is found, then the signal IQ data is recorded, including the buffered IQ data. This allows capture of first bit collection based on signal modulation characteristics.

902-2 Integrated HF Signal Intercept, Collection, Geolocation and Analysis COMINT System

Automated Modulation Recognition

The TCI 850 Modulation Recognition option provides automated modulation recognition for signals of interest. Classification can be initiated manually (via easy right click) using IQ data from the Lookback Collection array, or triggered automatically to use live DDC streams. The modulation recognizer automatically determines the signal's modulation characteristics, including:

› Modulation Type: Analog FM, AM, AM-DSBSC, LSB, USB, CW / pure carrier, BPSK, QPSK, pi/4-DQPSK, 8PSK, 16PSK, binary FSK, MSK, 3FSK, 4FSK, 8FSK, 16QAM, 32QAM, 64QAM, v.29, OOK, 4PAM, Manual Morse, Machine Morse, and Noise (contact factory for additional modulation types.)

› Symbol Rate
› Frequency Deviation

The resulting modulation information is appended to the intercept's meta-data record in the realtime database where it can be viewed by the user and drive further automated tasking.

Subsystems Included in 902-2

The 902-2 system consists of the following subsystems:

› TCI Model 850 Wideband Signal Acquisition and Collection
› TCI Model 802W Wideband HF DF System

  » DF/Monitoring Antenna Array and RF Distribution

  » Wideband N-channel Signal Acquisition and DF Processor

› Workstations for system tasking   and manual real-time and post-facto signal analysis

› Multi-site and external system interface

Model 850 Wideband Signal Collection System

The TCI Model 850 subsystem automatically stares at the entire HF spectrum, detecting and cataloging all signal activity. The system's easy-to-use client interface allows operators to view spectrum and signal activity in list, spectrogram, and map views, with intuitive controls that optionally include touchscreen and gesture support. When configured with TCI's Lookback Collection option, operators will never miss a signal of interest since IQ data for any past signal is recorded in the Lookback Storage Array, thereby allowing it to be extracted later and stored for later analysis without interrupting wideband recording.

Automation allows one or more actions to be triggered when signals are detected that match the automation search criteria. Available actions include optional Universal Signal Detection (USD) capability, which allows operators to create custom signal detectors on the fly without programming knowledge.

Model 802W Wideband N-Channel DF System

The TCI Model 802W uses N-channel architecture and an up to 28 MHz instantaneous bandwidth for high-speed simultaneous signal detection and DF. TCI's Field-proven, DF First™ technology optimizes performance, regardless of signal types or propagation conditions.

High instantaneous dynamic range and frequency selectivity (adjacent channel rejection) complement the N-channel architecture.

Each channel consists of wideband receiver, a high-speed digitizer and a digital signal processor (DSP).

Multiple DSP processors analyze all channels to a programmable resolutions of 100, 125, 200, 250, 500, 1,000, 2,000, 2,500, 5,000 or 10,000 Hz. The processors simultaneously detect signal activity in each channel and perform DF on all active channels. Signal activity and DF data are sent to the controller for further processing.

DF/Monitoring Antenna Array and RF Distribution

For direction finding, the Model 802W DF subsystem can be configured to operate with a variety of large aperture interferometer (I) and circular (C) antenna-array configurations using either TCI or non-TCI antennas :

› 9-element interferometer array of TCI 632 whip antennas
› 9-element interferometer array of TCI 620 loop antennas (I)
› 12-element circular array of TCI 632 whip antennas
› 12-element circular array of TCI 625 loop antennas
› 12-element circular array of TCI 638 whip antennas
› 24-element circular array of TCI 632 whip antennas
› 24-element circular array of TCI 638 whip antennas
› 20-element TCI 402 log-periodic circular antenna
› 24-element TCI 410 log-periodic circular antenna
› Customer-supplied / custom interferometer or circular array

Depending on the array type and its antenna-element count, either all or a subset of elements are used to achieve the optimal DF performance. The 'N' selected antenna elements (N varies between 9 and 13) are connected to the Signal Acquisition and DF Processor(s). For all array configurations an RF distribution subsystem ensures that the same antennas are used for both signal acquisition and DF processing.

902-2 System Operation

The functional diagram below shows how the N-channel architecture delivers exceptional performance for TCI's Model 902-2. The benefits of this architecture include higher sensitivity, improved frequency and time resolution. Also, incorporation of the MUSIC algorithm delivers super-resolution DF processing for fast, automatic estimation of the number of signals on the same frequency.

In addition, multi-channel digital down converters (DDCs) support automated signal modulation recognition for signals of interest.

The Model 902-2's unique ability to record N-channel IQ data allows DF post-processing with the ability to change processing parameters after the signals have been recorded.

TCI's Model 902-2 client-server architecture allows multiple operators to perform manual and automated processing of specific signals of interest.

The features and functions of TCI's Model 902-2 ensure the system is capable handling even the most complex signal scenarios.

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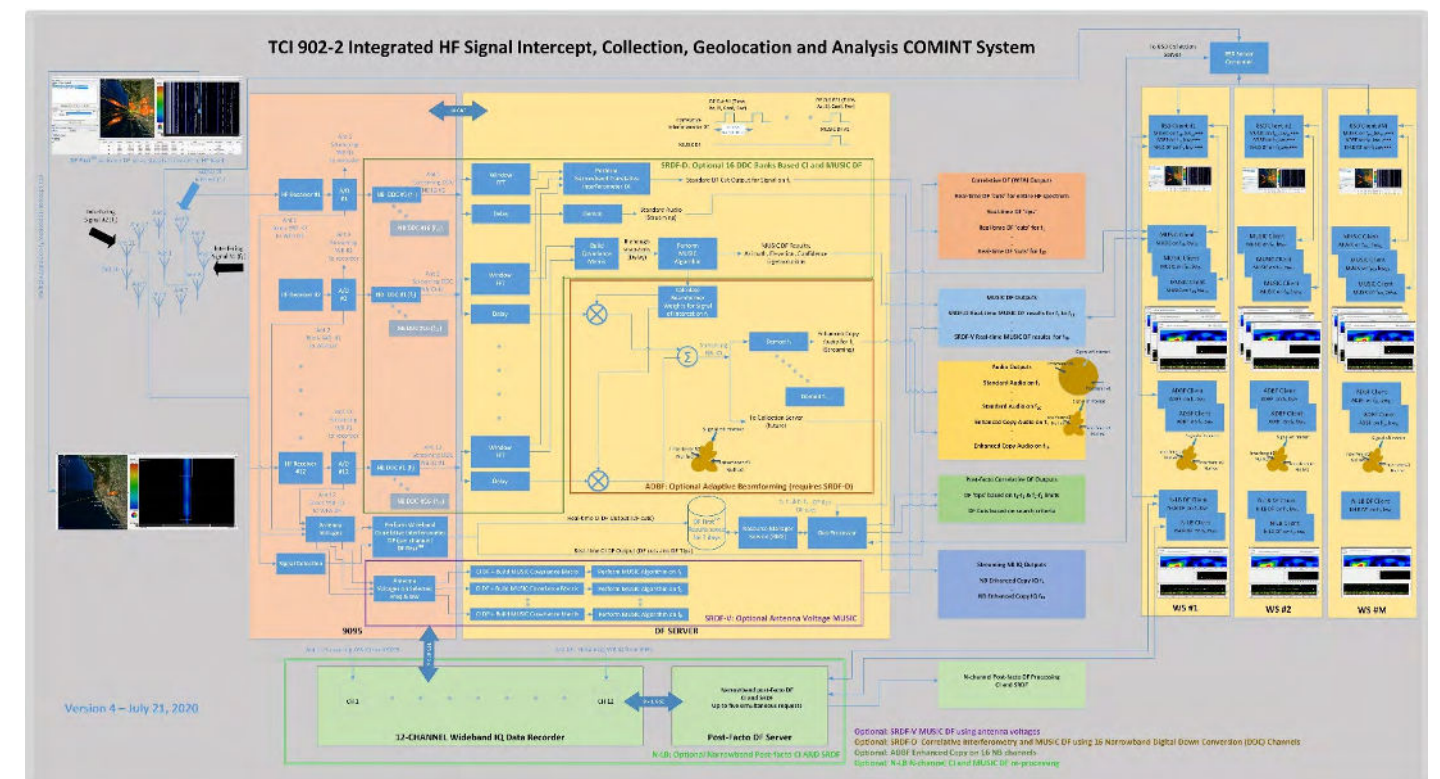
902-2 Integrated HF Signal Intercept, Collection, Geolocation and Analysis COMINT System

Dashboard
View complete system status at a glance.

Search Pane
Search desired signal attributes and click Execute Search to launch the search.

Actions
Right click an intercept in the list, map or spectrogram to instantly access actions such as tagging, analysis and reporting.

Spectogram
View search results on spectrogram display. Point at any signal to pop-up the intercept info window. Zoom in / out and scroll back in time to see past signals.

Map
View search results on intuitive map display.

List
View search results in list format. Click column heading to select columns and sort.

Easy to Use
The TCI Blackbird GUI provides the power of Blackbird with push-button simplicity. Blackbird is automatically detecting and cataloging all signal activity, enabling the operator to browse all detections or search for specific signals of interest using the integrated list, spectrogram and map displays.

Point and Shoot Simplicity
The new Blackbird's spectrogram display combines a traditional spectrogram view with an interactive detection database overlay. The unique, semi-transparent overlay shows detected signals from the realtime database. Simply point at any detected signal and a pop-up window shows the metadata for the intercept including any available modulation and DF results. It doesn't get any easier than that!

Search - Simplified!
To narrow the displayed results to only specific signals of interest, use Blackbird's easy to use Search pane to select the characteristics of the desired signals of interest. Or simply right click an intercept and use Blackbird's unique new Search Similar function to instantly find similar signals by frequency, spectral footprint or geolocation. No typing required!
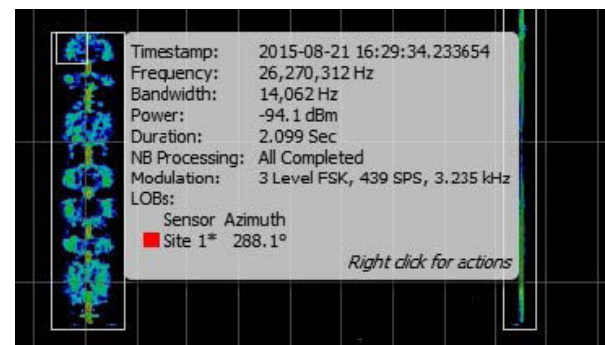
Redefining Search and Visualization
Unlike traditional spectrograms, Blackbird's implementation provides a unique, semi-transparent overlay showing the detected signal catalog.

Take Action
Once signals of interest are found, a simple right click opens the action menu. A variety of actions are available depending on loaded software options, including tagging, recording, Lookback Collection, modulation classification, AOA and TDOA geolocation, and re-porting. A "Send-To..." function instantly transfers the signal I/Q data to signal analysis and decode tools; and a "Copy-To..." function exports the I/Q data to external storage device or archive. The GUI also supports user-added custom actions to extend the analysis capability to instantly provide interoperability with external systems.

One Click Signal Analysis and De-coding
Process signals of interest with simple right-click action command

Time is on your side
Since Blackbird is automatically record-ing the spectral data along with the signal activity database, the operator can browse or search back in time (hours or even days) and view the past recorded spectral data with the detec-tion database overlay. And since the spectral data is resampled and recorded at multiple zoom levels, zooming and panning with live or recorded spectro-grams is fast...lightning fast!

Color Controls
Spectrogram data can be colored by power, direction or even tag.

Detection Overlay
Transparent overlay highlights detected signals.

Pop up Signal Info
Point at any detected signal to pop-up the signal info window. Right click to apply actions to the selected signal.

Spectrogram
Full spectrogram data served for live or past data.

Lookback Collection
With Lookback Collection, you can view past signals and collect them as well. Simply browse back in time or search for past signals of interest, then right-click to extract the signal's I/Q data from the built-in Lookback Storage Array. The Lookback Storage Array allows I/Q data to be extracted from the wideband recorder without interrupting recording and stored for later analysis. You will never again miss a collect for a critical signal of interest.

Make it Automatic
Blackbird's easy to use Automation facility makes the collection task even easier. Simply click the Automate button after any search and choose your desired auto actions. Blackbird automatically evaluates incoming intercepts against the Automation search criteria. Matching intercepts will trigger automated actions such as operator alerts, tagging, automated modulation classification, realtime or Lookback recording, Smart Recording (record based on signal modulation criteria), and AOA or TDOA geolocation. Automation tasks can aid online operators by automating laborious collection activities, or used to set up a completely automated search, collection and reporting mission — for unattended operation.


Search by Geolocation
When configured with TCI's Geolocation option, operators can define areas of interest to search for signals by geolocation.

Specialized Expertise in a Global Family

Communications Technology ("CommTech") is a global supplier of turnkey solutions for Communications Intelligence, (COMINT), ITU-compliant spectrum monitoring and management, direction-finding and geolocation, and antennas for communications and high-power radio broadcasting. Under the TCI brand, CommTech systems and solutions have been delivered to national defense departments, intelligence agencies, law enforcement bureaus, and spectrum regulators in more than 100 countries.

CommTech team members collaborate across business segments and borders to deliver greater efficiencies and better ideas for helping customers succeed. This commitment to innovation supports an array of customers whose missions depend on having a clear picture of their electromagnetic environment. For over 50 years, TCI's technical developments and advanced production capabilities have earned it a reputation for excellence in high-performance communications, spectrum monitoring, and signals intelligence systems.

TCI is a wholly owned subsidiary of SPX Technologies (NYSE:SPXC), a publicly traded firm based in Charlotte, North Carolina. SPX Technologies is a global, multi-industry manufacturing leader committed to operational excellence and execution. Learn more about TCI at www.tcibr.com and SPX Technologies at www.spx.com

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AN SPX TECHNOLOGIES PLATFORM

TCI INTERNATIONAL, INC. 3541
Gateway Blvd., Fremont, CA 94538-6585 USA

| Tel: 1-510-687-6100 | www.tcibr.com |

Enterprise Control Systems Ltd, ECS Technology Park, Wappenham
Northants. NN12 8WJ UK

| Tel: +44 (0) 1327 860050 | www.enterprisecontrol.co.uk |