850 Blackbird NextGen

Integrated Signal Search, Collection, Geolocation and Analysis System

Today's new and emerging threats are driving the need for updated signal intelligence capabilities that not only can detect, collect and analyze the newest signal threats, but geolocate them as well. To meet the demand for ever-increasing areas of operation, the system also must be easy to deploy and even easier to operate.

Building on the proven E3238s Blackbird capability and TCI's world-leading direction finding and geolocation technology, the new TCI Model 850 Signals Intelligence (SIGINT) system combines precision RF and DF hardware with the next generation of the original Blackbird software. The result is a new, fully integrated, COTS signals intelligence capability providing unparalleled signal search, detection, visualization, collection, wideband recording, DF/geolocation, analysis and reporting — redesigned with a modern, simplified, easy-to-use interface. It's the best of proven, classic Blackbird, modernized with new technology, DF/geolocation and simplified usability.

The new RF hardware is based on TCI's modular platform that provides both HF and VHF/UHF receivers and signal processing in a compact 4U chassis. Controlling the hardware is the next generation of Blackbird software, which has been re-engineered into a full client/server architecture that can support multiple simultaneous local or remote clients — or can run with no clients for automated/unattended operation.

TCI's updated, intuitive GUI includes an auto-setup capability, which allows an operator to specify desired signals of interest and employ the auto mission configurator to set up the front-end and detection parameters. The new Blackbird's Smart Signal Detection system catalogs all signal intercepts, and uses an intelligent processing engine to efficiently identify the specific targets of interest. When configured with TCI wideband DF options, TCI's DF First® technology tags all intercepted signals with angle of arrival, allowing search by direction and/or geolocation.

Operators can then run powerful searches for either live or past signals of interest based on any signal parameter (including emitter location), or use the new optional Lookback Visualization capability to scroll back in time and view colorized spectrograms overlaid with pop-up signal meta-data for detected signals. With the Lookback Collection option, you'll never miss a collect for a signal of interest since IQ data for any past signal can be extracted without interrupting recording.

The new Blackbird software also provides an easy-to-use automation facility that allows an operator to turn a manual search into an automated search, which can automatically trigger collection, alarms and other actions for matching signals of interest. Since TCI's Blackbird leverages classic Blackbird interfaces, it is compatible with a large installed base of signal analysis/decode packages, including popular GOTS backend signal processors. It's Blackbird — Redesigned for the Next Generation.

TCI

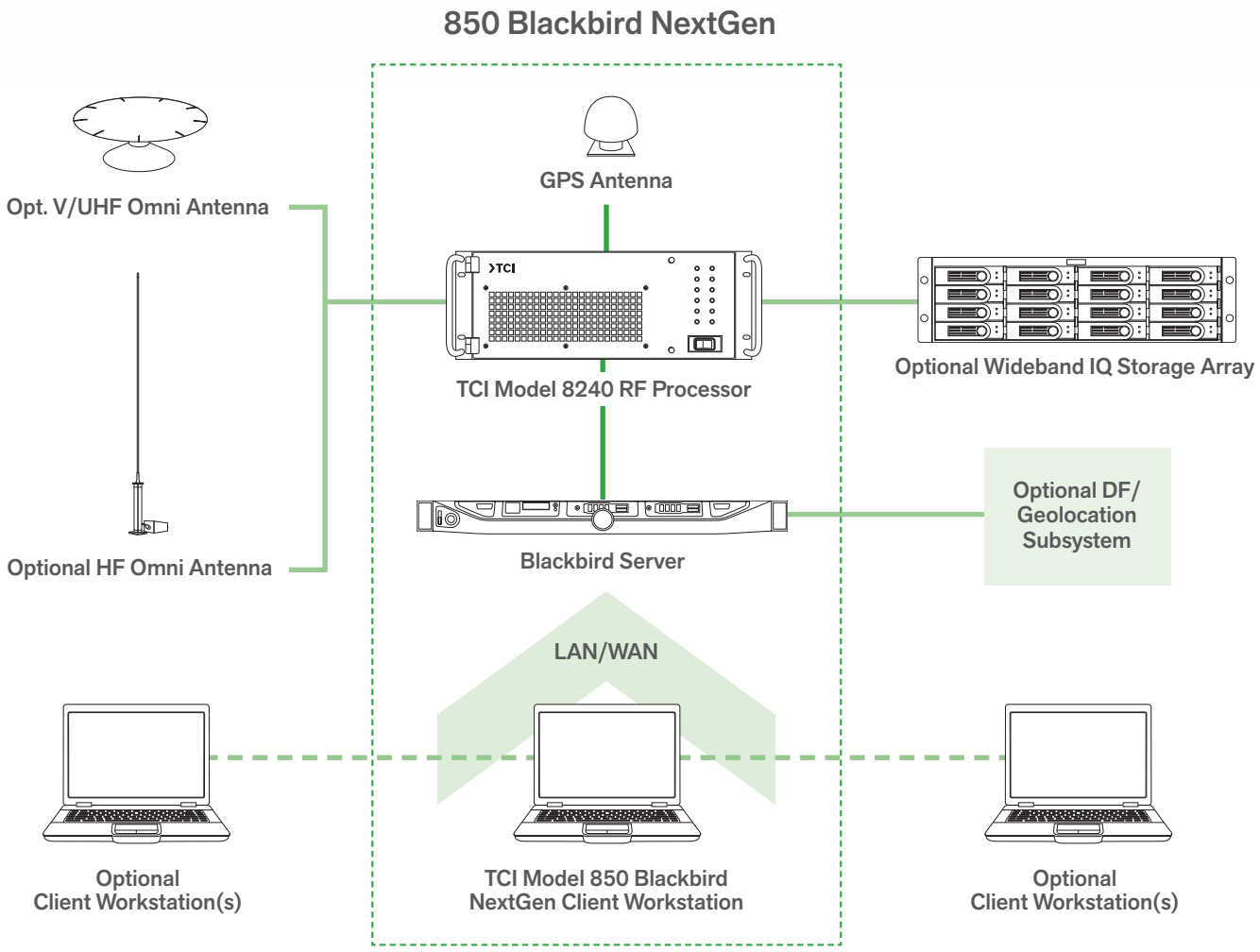
TCI Model 850 Blackbird combines redesigned Blackbird software with updated RF hardware and TCI's world-leading DF/Geo to deliver the Next Generation of Signals Intelligence.

KEY FEATURES

- TCI replacement for original E3238s Blackbird Signals Intelligence System.
- Fully integrated signal search, visualization, collection, wideband recording, DF/geolocation, analysis and reporting.
- New client/server architecture supports multiple simultaneous remote or local clients (or unattended operation).
- Reinvented GUI and automated mission configurator provides easy setup and intuitive operation.
- Advanced signal detection automatically identifies specific targets of interest.
- Powerful search and lookback visualization allow users to quickly find signals of interest, whether live or previously detected.
- TCI's DF First® technology provides search by direction and/or geolocation when configured with TCI DF/Geolocation options.
- Integrated DDCs with delay memory provide multichannel realtime collection.
- Automation facility provides automated actions (collection, alarming, tasking, etc.) when signals of interest are detected.
- Original Blackbird data interfaces ensure compatibility with existing signal analysis and decode packages including popular GOTS backend processors.
- HF, VHF, UHF, and low-SHF ranges (20 MHz to 3,000 MHz, 10 kHz to 30 MHz, or 10 kHz to 3,000 MHz).
- High dynamic range and excellent co-channel frequency resolution.

OPTIONS

- Frequency extension to 8 GHz.
- Modular / scalable RF processors for extended stare coverage (HF and V/UHF).
- Modulation recognition for advanced signal detection and classification.
- Wideband recorder, providing both wideband playback and TCI's exclusive Lookback Collection capability.
- Snapshot Radio Audio Player.
- Signal Analysis and Decode Suite with over 200 signal types.
- TCI DF and Geolocation options, including traditional AOA DF, triangulated AOA geolocation, on the move AOA triangulation, HF SSL, TDOA, and unique hybrid AOA/TDOA techniques



The TCI Model 850 Blackbird NextGen system is based on a modular, scalable systems architecture, which includes the following subsystems:

› TCI Model 8240 RF Processor is a compact modular processor that contains wideband receivers, digitizers, delay memory, digital down converters (DDCs), and realtime signal processing. The Model 8240 can be configured with either single- or dual-channel HF, single- or dual-channel VHF/UHF, or a combination of HF and VHF/UHF channels. Multiple Model 8240 processors can be used together to increase the number of RF channels for increased stare bandwidth.

› A GPS receiver connects to the RF Processor to provide precision timing and the location of the server when signals are recorded. A single GPS antenna can be shared among multiple 8240 processors.

› Optional TCI Model 3265 Wideband IQ Storage Array connects to the RF processor to record and play back wideband IQ data. A unique architecture of high-speed disks, and high-speed fiber channel connectivity allow data to be read from the disk while writing. Known as Lookback Collection, this allows signals to be extracted from the disk without interrupting recording. The Wideband IQ Storage Array is comprised of a combination of solid state (SSD) and standard HDD drives, which provides high throughput at a reasonable cost (with full SSD configurations also available for highly ruggedized applications). Each standard Wideband IQ Storage Array provides 6TB of storage, or about 7.5 hours of continuous recording of the full 40MHz IBW (or 15 hours of 20 MHz IBW, 30 hours at 10 MHz, etc.). For extended recording, a 12TB option is available, and multiple Wideband IQ Storage Arrays can be linked together to further increase storage if needed.

› The Blackbird Signal Processing Server is a high-performance, multi-core computer running the next generation of TCI Blackbird Server software. The server performs the signal detection and collection mission, including wideband signal processing, signal detection, realtime signal analysis, automated tasking, and realtime data storage. The server provides the interface to the TCI Blackbird clients, which can reside on the same machine or separate local or remote computers.

› The TCI Model 850 Blackbird Client workstations run the new NextGen client application, which provides the operator interface to the Blackbird NextGen system. A robust, scalable client/server design allows local clients to receive high-speed updates, but also allows for remote clients to operate over low-bandwidth networks.

› Optional TCI Omni directional antennas: TCI offers a variety of omnidirectional antennas, including full-coverage HF and full-range VHF/UHF, which fully complement the receivers in the RF processor.

› Optional TCI Wideband DF/Geolocation subsystems: The Model 850 can optionally deploy with a variety of wideband DF/geolocation options from TCI – including HF AOA (Angle of Arrival) DF (with SSL geolocation), VHF/UHF AOA DF to 8 GHz, triangulated AOA geolocation, TDOA (Time Difference of Arrival) geolocation or TCI's unique hybrid AOA/TDOA geolocation.

Precision HF and V/UHF Front Ends

The RF front end is the critical link in any SIGINT system. A quality RF front end must deliver a combination of excellent sensitivity, high dynamic range and high-speed — and the TCI Model 8240 RF Processor delivers on all counts. Boasting some of the best technical specifications in the business, the TCI RF processor can be configured with single- or dual-channel HF, single- or dual-channel VHF/UHF, or a combination of HF and VHF/UHF receivers.

The RF Processor's HF receiver provides full HF coverage (10 kHz to 30 MHz) with up to 28 MHz IBW. A bank of internal HF pre-selectors allows selection of narrower frequency bands with increased rejection of unwanted out-of-band signals.

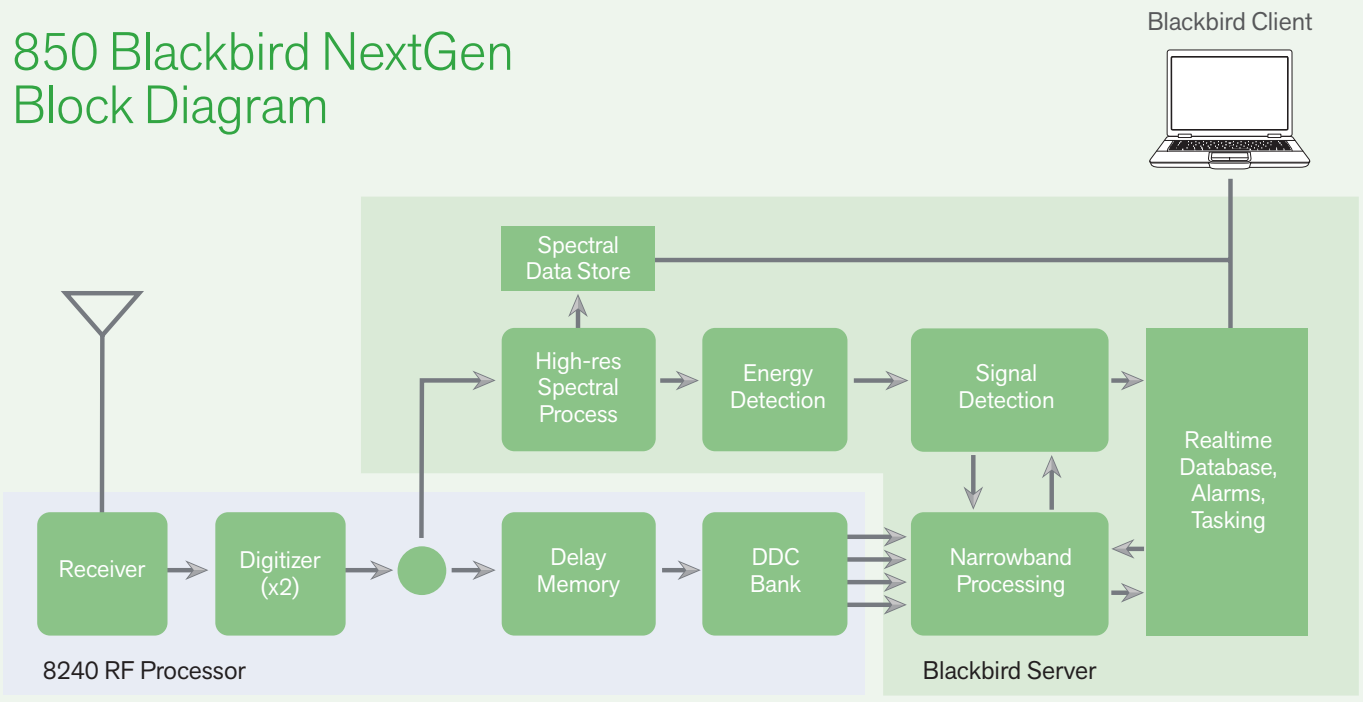
The RF Processor's VHF/UHF receiver provides standard coverage from 20 MHz to 3 GHz with optional frequency extension to 8 GHz. The receiver has a maximum IBW of 40 MHz per RF channel (providing up to 80 MHz of instantaneous stare bandwidth for dual-channel configuration). The VHF/UHF receiver contains internal pre-selectors and can operate in a reduced bandwidth mode to maximize dynamic range and increase rejection of unwanted out-of-band signals.

A dual-channel digitizer provides full 16-bit resolution on each RF channel, and the integrated GPS receiver tags the output data with precision timestamps (yes, good enough for TDOA) as well as position information.

Wideband IQ Recording with Lookback Collection

When configured with the optional TCI Model 3265 Wideband IQ Storage Array, the wideband digital data streams are recorded continuously to a RAID disk array. Of course the recorder provides traditional wideband playback mode (essential for batch post-facto processing of wideband data)*, but unlike typical wideband recorders the Model 3265's unique architecture and high-speed disks also permit data to be read from the disk while writing. This allows extraction of past signal data from the disk without

850 Blackbird NextGen Block Diagram



interrupting recording. Known as Lookback Collection, the function lets users effectively go back in time and collect IQ data for any past signal available on the recorder. In addition to providing a data source for automated collection, Lookback Collection provides a collection safety net — ensuring that critical signals of interest can always be collected, even if discovered during post-facto analysis.

High-Resolution Spectral Processing – frequency and time

The wideband digital data for each RF channel is sent from the RF Processor to the Blackbird server, where it is processed by the high-resolution spectral processing engine. Unlike typical search systems, the TCI RF processor delivers the data in regular high-speed time intervals. This enables the Blackbird signal detector to not only perform traditional 2-D spectral shape matching (amplitude vs. frequency), but also perform true spectral fingerprinting in 3-dimensions (amplitude vs. frequency vs. time)*. This significantly improves recognition for modems and other signals with time-variant spectral signatures.

Spectral Recording

In addition to driving realtime 2-D and 3-D signal detection, the spectral data is saved into the Blackbird NextGen Spectral Data Store where it can later 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 spectrogram scrolling, panning, and zooming for local clients – and makes it possible for remote clients over slow network links to efficiently retrieve past spectrogram views.

DF First®

When configured with an optional TCI wideband DF subsystem, the Blackbird energy-detection process is augmented with DF information, which is pushed from the DF subsystem to the Blackbird server for all active signals. Known as DF First®, the availability of the angle of arrival for all incoming signals enables search by direction – and when configured with multiple DF assets, search by geolocation.

Signal Detection – Smarter!

The energy and direction metadata for each active signal is recorded in the realtime database, where it triggers the higher-level signal/target detection process. The goal of signal/target detection is to efficiently identify the specific targeted signals of interest set up in the mission. Signal identification is based on realtime classification of the intercept's characteristics, including signal externals (frequency, bandwidth, power and duration), spectral fingerprint*, and modulation properties. The signal detector compares the current measured intercept metadata with the attributes of the target signals. If a metadata attribute is missing, the signal detector automatically tasks the acquisition/ calculation of the missing metadata, starting with the metadata that takes the least amount of processing resources. For example, if a target is specified with a certain bandwidth and modulation type, the modulation information is computed only if the bandwidth match is first satisfied (which requires less processing resources than measuring modulation type). The result is that signals of interest are efficiently identified in real time with minimum processing.

Multichannel Realtime Signal Collection

Once signals of interest are detected, they can manually or automatically trigger a variety of tasking, including collection 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 resulting narrowband IQ data to the server for recording and further analysis. A wideband delay memory path in front of the DDC bank allows the DDC to acquire the start of the signal transmission (catch the first bit), compensating for any latency in wideband signal detection processing.

TCI Model 8240 Wideband RF Processor

TCI 643, V/UHF Dual Polarized DF antenna

TCI Model 3265 Wideband IQ RAID Storage Array

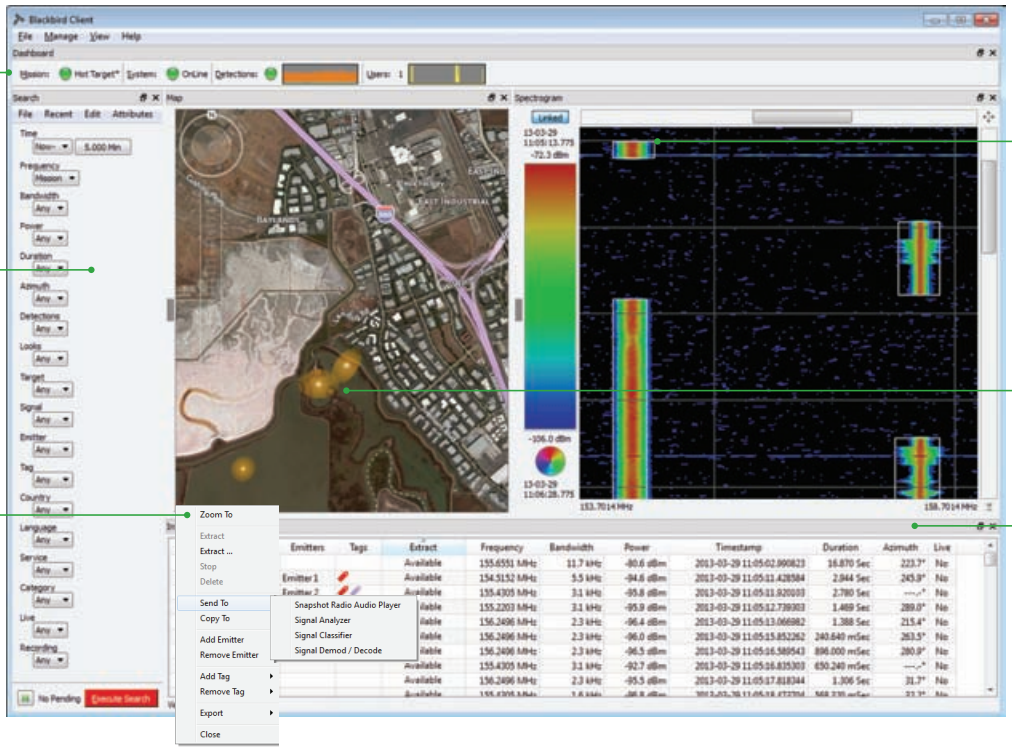
TCI 647 V/U/SHF DF and monitoring

The New Blackbird GUI

Dashboard
View complete system status at a glance.

Search Pane
Select desired signal attributes abnd 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.



Spectrogram
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.

Redesigned from the Ground Up

The new TCI Blackbird NextGen GUI has been completely reinvented from the ground up to provide both power and push-button simplicity. Complicated configuration and spectral displays are now replaced with a simple point-and-shoot search screen, with search results conveniently displayed in an intuitive list, map, and (for advanced users) spectrogram view. Topping it off is a new simple Dashboard pane that shows the complete system status at a glance.

Auto Configuration

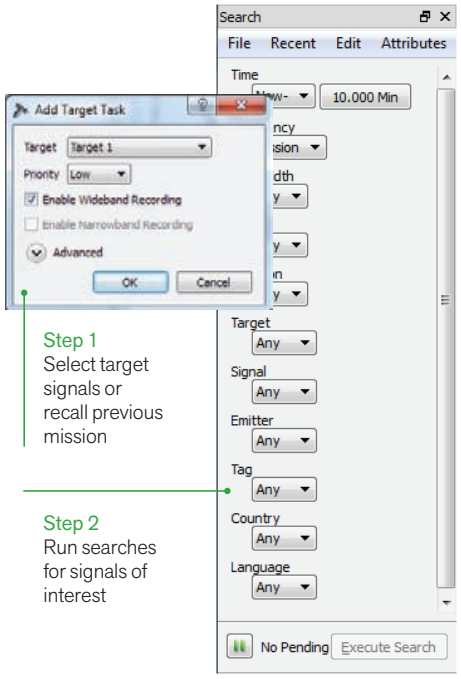
One of the most difficult tasks in SIGINT can be configuring the system for successful signal detection/collection. The new Blackbird's auto configuration facility automates the configuration task. Operators now simply select their target signals of interest, then sit back and let the new Blackbird NextGen configure the hardware front ends and detection parameters. Target packages can then be saved into missions, which can be instantly recalled by the operator.

Search – Simplified!

From the operator's perspective, the new streamlined search process can be summed up into 3 easy steps:

Step 1: Select desired target signals (or recall a preset mission)

The Model 850 Blackbird's auto configuration facility automatically configures the hardware and detection system for the specified targets and begins the acquisition and detection processing. Detected signals are loaded into the realtime database, with the specific target signals identified.

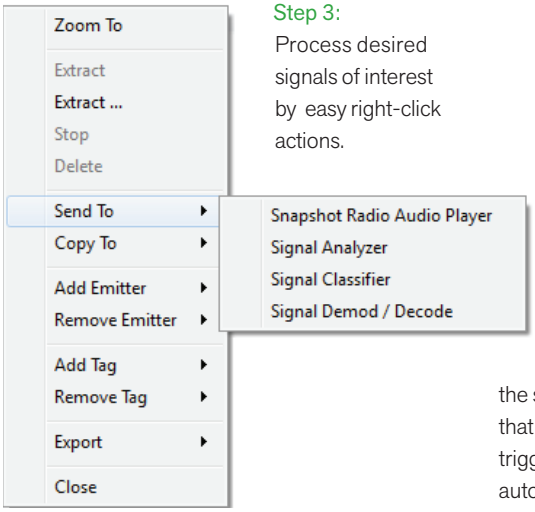


Step 1
Select target signals or recall previous mission

Step 2
Run searches for signals of interest

Step 2: Run simple searches for signals of interest (live or past)

Set search criteria based on any signal attribute, then click Execute Search. Search results are displayed in a list, on the map, or (for advanced users) on a unique spectrogram view with mouseover/pop-up intercept info display. Quick sorting and filtering can be used to further identify specific signals of interest and even replay a detection timeline. Searches can be saved for easy retrieval and re-run.

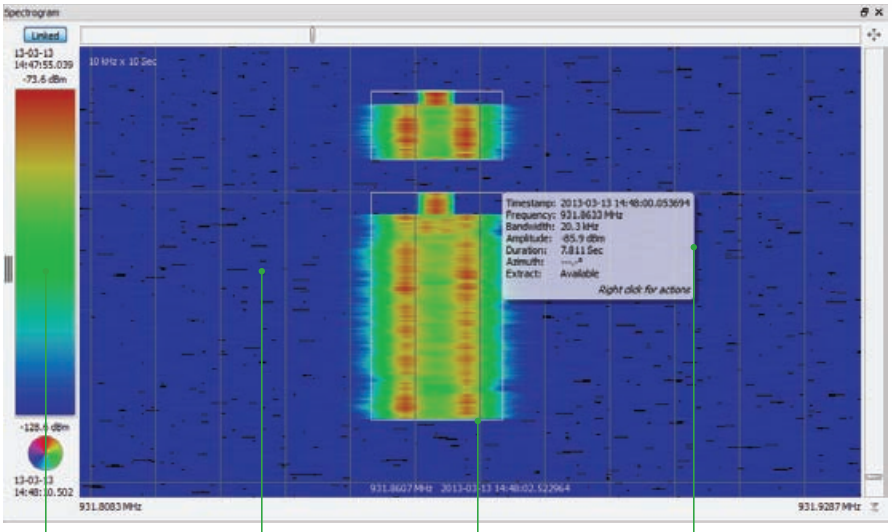


Step 3:
Process desired signals of interest by easy right-click actions.

A variety of actions are provided, including tagging, realtime recording, Lookback Collection extract, precision geolocation, and reporting. A "Send-To…" function instantly transfers the signal data to signal analysis and decode tools; and a "Copy-To…" function exports the signal data to an external location or archive. The GUI also supports user-added custom actions to extend the analysis capability to instantly provide interoperability with external systems.

Automating the Search Process

Once a successful search is created, it can be saved into the mission with an action list as an auto-search. The Model 850 Blackbird NextGen will automatically evaluate new intercepts against the specified auto-search criteria. Intercepts that match the search criteria will automatically trigger the specified actions. This easy-to-use automation facility can aid online operators with notification and alarms, or can be used to set up a totally automated search, collection and reporting mission – perfect for unattended operation.



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

Spectrogram
Full spectrogram data served for live or past data.

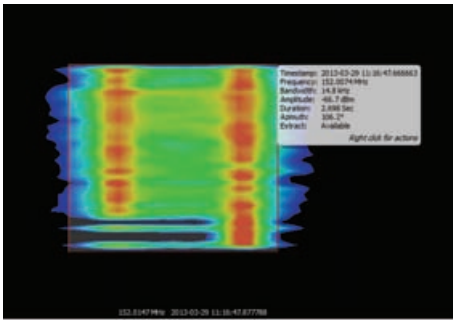
Detection Overlay
Transparent overlay highlights detected signals.

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.

Lookback Visualization

In addition to the easy-to-use signal search-by-attribute facility, operators can also take advantage of the new Model 850's Lookback Visualization capability to browse the spectrum (either live or past) for signals of interest. But unlike traditional spectrogram views, the new Blackbird's spectrogram provides a unique, semi-transparent overlay showing the detected signal catalog. Simply point at any detected signal and a pop-up window shows the metadata for the intercept. Then, right-click on the signal for instant access to the available processing actions.

To support fast spectral browsing, the model 850 Blackbird's server automatically rescales and stores the spectral data at multiple zoom levels (independent time and frequency zoom levels), so a minimum of spectral data need be transferred between the server and the client. The result is smooth spectral scrolling, panning and zooming – and the ability to operate remotely over slow networks.



Redefining Search and Visualization
Unlike traditional spectrogram views, the new Blackbird's spectrogram provides a unique, semi-transparent overlay showing the detected signal catalog.

Location, Location, Location!

When it comes to direction finding and geolocating signals of interest, TCI is the proven industry leader. And the new Blackbird makes full use of TCI's DF/Geolocation technology, including:

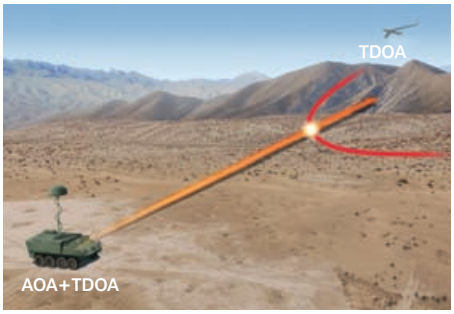
› **VHF/UHF AOA DF** – TCI's VHF/UHF Angle of Arrival (AOA) DF options provide wideband DF from 20 MHz to 3 GHz, with SHF option up to 8 GHz. Both vertical and dual-polarized versions are available. Since this is a wideband system, direction is computed for all signals in the scan range and pushed to the Blackbird server. Known as TCI DF First®, this provides DF data for all active signals, enabling Blackbird search by direction and geolocation.

› **HF DF** – TCI's Wideband HF DF options provide line of bearing and elevation, and can use Single Site Location (SSL) techniques to determine range and geolocate HF transmitters. Again, since this is a wideband system, direction is computed for all signals in the scan range, enabling search by direction.

› **Triangulated Geolocation** – Multiple AOA DF results are combined to calculate the emitter location. Since the individual AOA sources are wideband systems, geolocation can be performed on multiple simultaneous signals of interest – allowing the new Blackbird to search by geolocation. And since the AOA information is cached in the DF Server, the new Blackbird can go back in time and compute a fix for past signals of interest.

› **On the move Geolocation** – Moving DF platforms can geolocate transmitters by combining multiple AOA measurements gathered over time. Since the AOA information is pre-calculated with DF First® and stored in the signal database, the new Blackbird can go back in time and compute a fix for a signal of interest collected from multiple locations over time.

› **TDOA Geolocation** – Leveraging the RF Processor's precision time-stamping, Time Difference of Arrival (TDOA) techniques can be used for precision geolocation of target emitters. In addition, TCI offers a set of outdoor RF Sensors which can be deployed into a wide area to support distributed monitoring and TDOA geolocation.



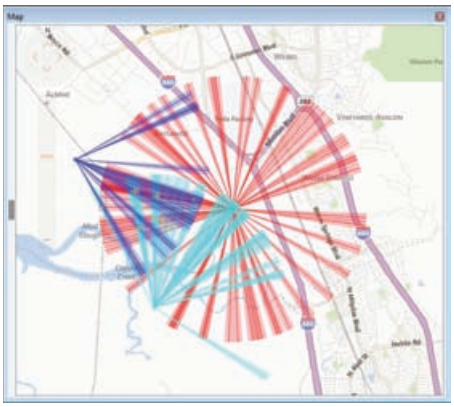
› **Lookback TDOA Geolocation** – When configured with the wideband recording option, precision time-stamped IQ data for past signals can be extracted from the recorder and used for TDOA geolocation. This allows users to perform precision geolocation for past signals of interest.

› **Hybrid Geolocation** – TCI's unique hybrid geolocation technology combines AOA and TDOA techniques to achieve directed precision geolocation with a minimum of TDOA assets. Hybrid TDOA has been developed to take advantage of both ground-based or airborne TDOA sensors, including a TCI exclusive miniaturized payload for the Boeing/Insitu ScanEagle UAV.

Interior of TCI Mobile Station

Integrated Mapping

Making the most out of the TCI DF/Geolocation options, the new Blackbird tightly integrates mapping displays and specialized search by direction/geolocation functions. Operators can zoom and pan the maps with intuitive controls (just like Google Earth) and can choose from satellite, street or terrain views. The new mapping capability makes use of an open industry standard mapping interface, currently providing compatibility with five of the most popular map providers. Custom or user-provided maps can also be supported, either online or from a local map server.



Intuitive Mapping Options

The new mapping capability makes use of an open industry standard mapping interface, currently providing compatibility with five of the most popular map providers.

TCI Model 850
Specifications Overview

System

› TCI Model 8240 RF Processor

ADC	2-Channels 16-bits per channel 90 dB SFDR
Digital Down-Converter (DDC)	64 Channels
GPS	Internal Receiver
Frequency Reference	OCXO, GPS disciplined
Connectivity	1GbE (optional 10GbE)
Reference Output	10 MHz, GPS disciplined
Mechanical	4U Rackmount
Power	250 W, 115-230 VAC
Operating Temperature	0º to 45º C
Weight	20 kg typical

› Optional Model 2621 Dual HF Receiver

Number of Channels	2
Frequency range	10 kHz to 30 MHz
Receiver in-band dynamic range	>85 dB
Noise Figure	12 dB, full gain
Pre-Selectors	13 bands
Input IP2	+60 dBm (typ. at +6 dB gain)
Input IP3	+30 dBm (typ. at +6 dB gain)

› Optional 2614 VHF/UHF Receiver

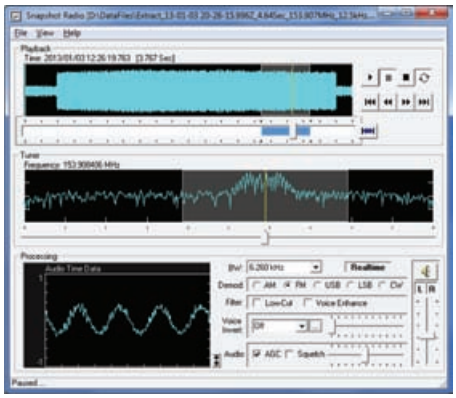
Frequency Range	20 MHz – 3000 MHz, Optional extension to 8 GHz
Instantaneous Bandwidth	40/4 MHz
Noise Figure	12 dB
Pre-Selectors	12 bands
Input IP2	+50 dBm
Input IP3	+16 dBm
In-band Dynamic Range	>85 dB typical (80 dB min.)

› Optional TCI Model 3265 Wideband IQ Storage Array

Capacity	6TB raw capacity standard, Optional 12TB
Interface	Fiber Channel (optical)
Mechanical	3U Rackmount
Power	525 W typ., 115-230 VAC
Operating Temperature	5º to 40º C
Weight	38.5 kg typical

Signal Analysis and Decode Options

Because the new Blackbird builds on a rich legacy and installed base of classic Blackbird systems, it can instantly take advantage of the wide variety of signal analysis tools created over the years for Blackbird. This includes the popular Snapshot Radio audio player, which is now re-branded under the TCI name; and an optional signal analysis and decode package, which offers advanced signal classification and a comprehensive set of HF and VHF/UHF signal decoders (over 200 signal types). The new Blackbird is also compatible with a wide variety of additional third-party signal analysis and decode tools, including popular GOTS backend signal processors.



TCI Model 850 Options

TCI Model 850 Signals Intelligence System	
› Model 8240 RF Processor	
Option 2621	Dual HF Channels
Option 2614	VHF/UHF RF Channel, 20-3000 MHz, 40 MHz IBW
Option 7234	SHF Frequency Extension, 8 GHz
Option WBR-1	Model 3265 Wideband IQ Storage Array, 6TB
› Blackbird NextGen Software	
Option MRS-1	Modulation Recognition for Server
Option BCSW-1	Additional Model 350 Client License
› Additional Software Options	
Option SSR	Snapshot Radio Audio Player
Option WCODE	Signal Analysis and Decode Suite with over 200 Signal Types
Option WCLNB	Narrowband Signal Classifier
Option WCLWB	Wideband Signal Classifier
Option WBV	Bit Stream Analysis Software
› DF / Geolocation Options	
Model 9091	HF Wideband DF System, N-Channel
Model 802C	HF Wideband DF System, Commutating Two-Channel
Model 803E	VHF/UHF/SHF Wideband DF System
Model 920	Hybrid AOA/TDOA Geolocation System, Ground-based Sensors
Model 922	Hybrid AOA/TDOA Geolocation System, UAV Sensor
› Additional Options	
Model 642	Omni-directional VHF/UHF Monitoring Antenna, 20 - 8000 MHz
Model 7031	HF Wideband Active Monopole Antenna, 9 kHz – 30 MHz
Model 632F-1	HF Wideband Monopole, 0.3 – 30 MHz
Model 625L	HF Crossed Loop, 0.2 – 30 MHz

Export of TCI International, Inc. systems and products may be subject to U.S. export controls. U.S. Export License may be required.

Specifications subject to change without notification.

*Consult factory for availability.

Custom Integrated Solutions

TCI's contribution does not stop at the box level. TCI's Special Programs Group is dedicated to tailoring COTS products to provide fully integrated and customized solutions. This includes everything from a few custom reports or training, to a fully integrated turnkey collection site.

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Specialized Expertise in a Global Family

TCI International, Inc., a leading supplier of end-to-end, ITU-compliant RF spectrum monitoring and management solutions, is a wholly-owned subsidiary of SPX Corporation. Headquartered in Charlotte, North Carolina, SPX is a multi-industry, Fortune 500 enterprise with operations in more than 35 countries and approximately 18,000 associates worldwide. SPX team members collaborate across business segments and borders to deliver greater efficiencies and better ideas for helping customers succeed and grow their businesses.

At TCI, this commitment to innovation serves civilian spectrum regulatory departments and provides COMINT, ISR, and DF solutions for Military, National Security and Intelligence agencies.

TCI has developed high-performance RF and spectrum monitoring solutions for more than 40 years. Our complete, in-house hardware and software engineering capabilities include RF/analog equipment design, system engineering and integration, digital Signal Processing (DSP) design and implementation and expert client-server software design and development.

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