Espy teamSENTINEL®

Highly scalable, streaming wideband recording, direction finding (DF) sensors:

The teamSENTINEL family of radio frequency collection, and DF-enabled sensors are optimized for extended recording and acquisition band-width. They provide simultaneous monitoring, analysis, and recording of time and frequency coherent, wideband RF spectrum, through Espy's teamSOIGNE® signal-mining GUIs.

Frequency band coverage of each sensor is determined by the RF Conditioner module selected. Options exists to support HF, HF/DF, V/UHF, and V/UHF-DF operations, as well as Dual-band operations (HF and V/UHF concurrently). All teamSENTINEL sensors are QuickAssist-AI/ML signal classification enabled and Theater Net-Centric Geolocation (TNG) node compliant when configured and operated with the necessary GPS-disciplined references.

SPECIAL FEATURES

▶ Collect and store up to 50 days of wideband RF energy for retroactive signal processing (including DF) and analysis.

▶ QuickAssist – Artificial Intelligence / Machine Learning (AI/ML) Automated Signal Detection and Categorization.

▶ Theater Network-Centric Geolocation (TNG) compliant time and frequency operations.

▶ Options for frequency coverage from as low as 10 kHz up to 6 GHz currently available.

▶ Recorded stare bandwidths from 11 MHz to > 1 GHz with support for multiple independently tunable stare elements.

Sensor Modules - The teamSENTINEL family of wideband sensors are modular, flexible, and highly scalable, providing a very cost-effective platform that can be easily adapted to support a wide range of mission requirements. TeamSENTINEL subsystems are built using a combination of industry leading COTS solutions, and Espy developed hardware and soft-ware solutions.

RF Conditioner   - This module utilizes COTS software defined radio (SDR) while applying bandpass filtering and attenuation as necessary, prior to digitization and stream digital IF out via 10GigE ports formatted in Vita49 standard. HF, V/UHF, and Dual-band sensors are available in both DF and non-DF configurations. All RF Conditioner modules incorporate a GPS subsystem to provide built-in, TNG-compliant, system operations for most mission. requirements (this subsystem can be bypassed if an external GPS-disciplined reference is mandated). Multiple RF Conditioner modules can be ganged together to increase a sensors acquisition bandwidth.

RF Distribution Modules   - Espy designs and builds a family of commutative DF sequencer modules, RF multicouplers, and RF band switches, to address the stringent operational and performance requirements of our wideband HF and V/UHF capabilities. One or more DF Sequencer modules can be configured to support a wide range of Espy-designed and 3rd party DF antenna configurations. DF Sequencers are time coherent with receivers, to guarantee maximum angle-of-arrival DF stare bandwidths from 11 MHz to > 1 GHz with support for multiple independently tunable stare elements.

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SPECIFICATION	HF	V/UHF
MAX Channel Sample Rate	5.6 Msps	147.2 Msps
MAX Channel Recorded Bandwidth	4.9 MHz	128 MHz
MAX Number of Channels/Tuners	12	>16
MAX Acquisition Bandwidth	29.4 MHz	>1 GHz
System Receive Freq Range[2] (MHz)	1.7 - 31.25	20-6000
Base Sensor Recording Capacity	22 Hours	7 Hours
Max Sensor Recording Capacity	50 Days	9.2 Days
DDR[1] Narrowband Extract Storage	>220 GB	>220 GB
Max DDR Extract Duration	Hours +	Hours +
Max DDR Extraction Bandwidth	4.9MHz	128 MHz
Typical SFDR (single tone)	>98 dB	>75 dB
Typical Sensitivity	-115 dB	-100 dB
Typical DF Accuracy[3]	~2^O RMS	~2^O RMS
Theater Net-Centric Geolocation (TNG)	Ready	Ready
Disk Storage Data Protection	RAID 6 (no data loss <3 HDs)	
Ruggedization Level	Commercial	Commercial

[1]Digital Drop Receiver [2]Frequency Coverage depends on sensor configuration

[3]DF-enabled sensor and antenna array required

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WORLDWIDE CORRELATION & COLLABORATION

Interoperability - Multiple teamSENTINEL-family sensors, as well as multiple teamSOIGNE client workstations, can be distributed around the world to allow remote data sharing and system control. A single client workstation can monitor and control multiple front-end sensors using teamVIEW®. Likewise, a single sensor can interface with multiple clients and/or sensors. Remote monitoring and control capabilities, along with Espy's field-proven reliability, mean that front-end teamSENTINEL sensors can be effectively operated and maintained, even when located thousands of miles from an operations center.

Retroactive Signal Prosecution - Retroactive, ("post facto", "after action" or "look back") signal processing refers to the ability of teamSENTINEL sensors to perform energy prosecution (digital drop record (DDR) file extraction, energy detection, baud detection and transmitter geolocation) from signals recorded in the past. Since teamSENTINEL DF-enabled sensors record all the data in the wideband stare necessary to compute a DF, and not just detected energy bursts, any signal visible to the systems analyst (SA) in the spectrum can be tasked for geolocation, regardless of how far in the past it was recorded.

Collaborative Exploitation of the RF Spectrum - Espy's family of teamSENTINEL sensors are designed to operate as an interconnected team. Multiple sensors can be networked together to create a fabric of geographically dispersed sensor sites, connected to a distributed community of SAs and subject matter experts (SME). From a single GUI, Espy's teamVIEW capability provides SAs with access to the wideband spectrum collected from multiple teamSENTINEL senors. Any front-end sensor in the SAs teamVIEW® can be selected as the primary spectrum, and used to extract, and/or geolocate energy received at that sensor. Every SA action is recorded to a database, and immediately distributed to other SAs and SMEs currently connected to the common sensor network.

HIGH-PERFORMANCE SIGNAL PROCESSING

QuickAssist – Artificial Intelligence / Machine Learning: QuickAssist enables Automated Signal Detection and Categorization through Convolutional Neural Network/Image Recognition AI techniques to streamline the complex process of characterizing the RF environment. Leveraging teamSENTINEL's QuickAssist algorithm, signals are identified through visual waveform attributes. Utilizing CV-based Fully Convolutional Networks (FCNs), QuickAssist generates thumbnail images for energy detections and compares them against reference thumbnails for precise categorization.

Energy Extraction: Digital drop receiver (DDR) files can be manually or automatically extracted with a wide range of signal bandwidths and sample rates up to the entire channel bandwidth. Each ARM can support hundreds of random-access DDR extractions per minute through automated tasking interfaces, all while the system is actively recording new energy.

Energy Prosecution: Because of its high sample rate wideband recording capability, teamSENTINEL is especially well suited for the collection of fast frequency sweeping, and frequency agile signals. Visual detection and analysis of a wide variety of modulation types is made easy through teamSOIGNE's signal mining tools. Entire wideband channels can be extracted for specialized post-processing, and months of sensor prosecution IQ and metadata results can be stored in an industry-standard SQL database.

Transmitter Geolocation: TNG and DF-enabled teamSENTINEL sensors allow retroactive direction finding and geolocation of any energy selected from the recorded delay buffer. Individual sensors configured with DF antenna arrays can generate lines of bearing (LOBs). DF and TNG enabled sensors can produce angle of arrival DF fixes and/or TNG fixes when networked together. Both Commutative and N-channel DF solutions are available. Geolocation results are displayed interactively on a OpenStreetMap® enabled 3-dimensional globe which is linked to the primary spectrum display and related signal metadata.

RF-CONDITIONER MODULE OPTIONS

RF Conditioner Modules	# 10GbE SFP Outputs	# Antenna Inputs	# Tuner Channles	Channel BW (MHz)	MAX Aggregate BW (MHz)
HF GEN2 D1H2	1	2	2	29.4	29.4
HF GEN2 D1H4	1	4	4	31.5	31.5
VUHF GEN2	4 or 8	2, 4 or 6	4, 8 or 16	11,22, or 44	704
VUHF GEN 3	2 or 4	2, 4 or 6	2, 4 or 8	16,32,64 or 128	1024

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All teamSENTINEL sensors and teamSOIGNE signals analysis workstations are sold with a 5-year Return-to-Factory limited warranty, and a 5-year of Software Update Service subscription.

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