Wideband Recording RF/DF Sensors

teamSENTINEL®

Highly-scalable, streaming wideband recording, LF through mid-SHF, dual band and direction finding (DF) sensors

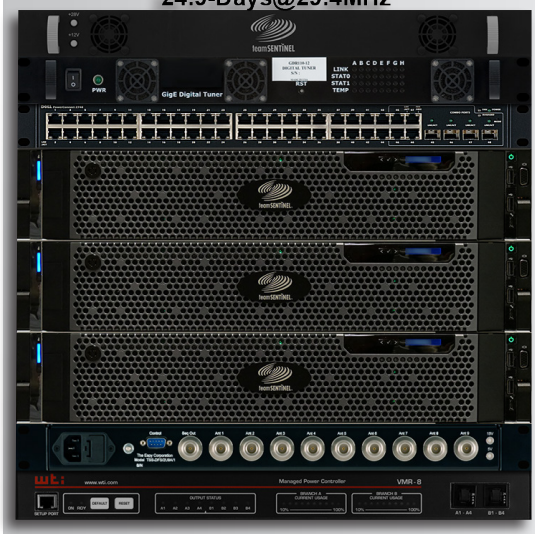
The teamSENTINEL family of radio frequency collection, and DF-enabled sensors are optimized for extended recording and acquisition bandwidth. They provide simultaneous monitoring, analysis, and recording of time and frequency coherent, wideband RF spectrum, through Espy's teamSOIGNE® signal-mining GUIs.

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 Theater Net-Centric Geolocation (TNG) node compliant when configured and operated with the necessary GPS-disciplined referencees.

- ***Collect and store up to 50 days of wideband RF energy for retroactive signal processing (including DF) and analysis***
- ***Theater Network-Centric Geolocaiton (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 le ading COTS solutions, and Espy developed hardware and software solutions.

teamSENTINEL HF/DF Sensor
24.9-Days@29.4MHz



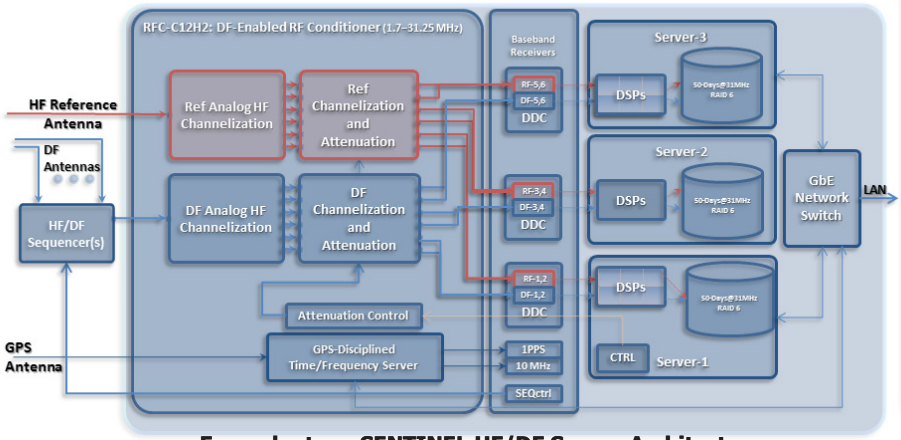
RF Conditioner This module preconditions and channelizes the received wideband analog RF signal, applying bandpass filtering and attenuation as necessary, prior to digitization. HF, V/UHF, and Dual-band sensors are available in both DF and non-DF configurations. All RF Conditioner modules incorporate 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.

Digital Receiver Modules TeamSENTINE sensors utilize a COTS 16-channel digital baseband receiver for HF applications, and a variety of COTS single, and multi-channel, digital receivers for the V/UHF bands. All receivers are GPS-disciplined, and time and frequency coherent, to provide TNG node-compliant time and frequency stability and accuracy.

TeamSENTINEL Acquisition Servers One or more teamSENTINEL servers provide the resources necessary to support the spectrum acquisition, recording, and signal processing of digital RF channels streamed from integrated receivers. Additional servers can be added to increase the wideband stare coverage, and/or recording capacity, of a sensor. Servers are configured with 12 hard disk drives (HDDs) in a RAID 6 array, ensuring no data loss for up to two HDD failures per server. TeamSENTINEL sensors utilize a Dell R740xd 2 RU servers Powered By CentOS® to maximize recording capacity, acquisition bandwidth, and signal processing capability.

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 accuracy.

TeamSENTINEL RFC-C12H2: Single-band, 29.4 MHz DF-enabled

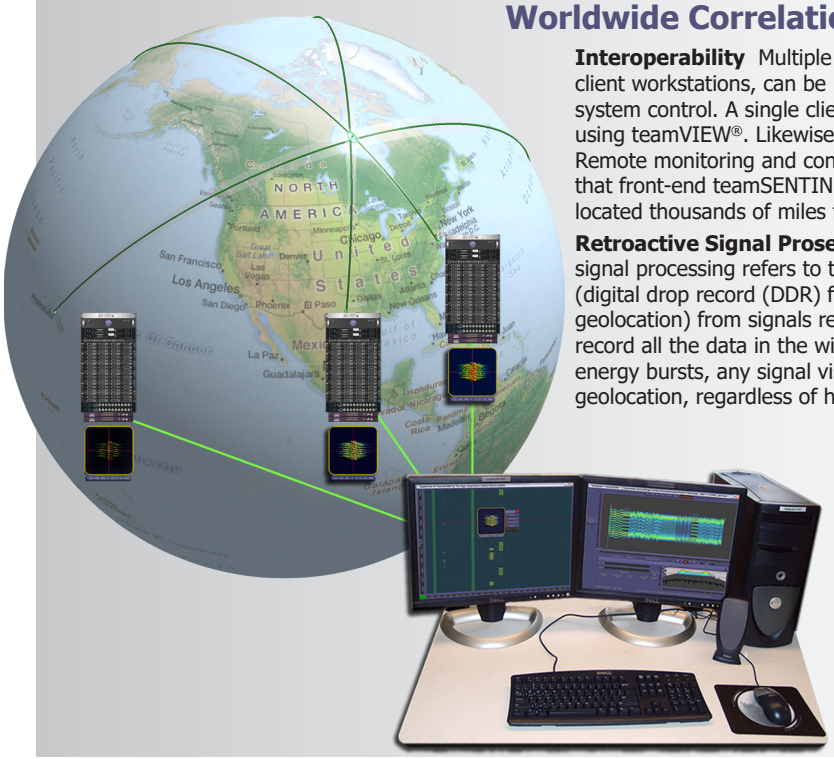


Example: teamSENTINEL HF/DF Sensor Architecture

SPECIFICATION	HF	V/UHF
MAX Channel Sample Rate	5.6 Msps	51.2 Msps
MAX Channel Recorded Bandwidth	4.9 MHz	44 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	4.9 MHz	44 MHz
Typical SFDR (single tone)	>98 dB	>75 dB
Typical Sensitivity	-115 dB	-100 dB
Typical DF Accuracy [3]	~2° RMS	~2° 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.

Worldwide Correlation and 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 an SQL database, and immediately distributed to other SAs and SMEs currently connected to the common sensor network.

High-Performance Signal Processing

Energy Extraction Digital drop receiver (DDR) files can be manually or automatically extracted with a wide range of signal bandwidths and sample rates [2, 4, 8, 10, 20, 80, 160 or 640 KHz or the entire channel, 5.6 Msps]. Each ARM can support hundreds of random-access DDR extractions per minute through automated tasking interfaces, all while the system is activly 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.

RF-Conditioner module options

RF-CONDITIONER MODULES	HF	V/UHF	DF	TNG	FREQUENCY RANGE (MHZ)	NO. TUNER CHANNELS	CHANNEL BW (MHZ)	MAX BW (MHZ)
RFC-C6H2	√		√	√	1.7-31.25	12	4.9	29.4
RFC-D2U2		√		√	20—6,000	8	11, 22, 44	352
RFC-D4U4		√		√	20—6,000	16	11, 22, 44	704
RFC-D2U2-DF		√	√	√	20—6,000	4	11, 22, 44	176
RFC-DC4U4-DF		√	√	√	20—6,000	8	11, 22, 44	352
RFC-C6H2-D2U2	√		√	√	1.7-31.25	12	4.9	29.4
		√		√	20—6,000	8	11, 22, 44	176

Transmitter Geolocation TNG and DF-enabled teamSENTINEL sensors allow retroactive direction finding and geolocation of any energy selected from the recorded delay buffer. Individule 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.

teamSENTINEL®

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.

"**es|py** (e spi', i-) ***vt.*** **-| pied', -| py'ing** to catch sight of; make out; discover; detect; find"

- Merriam-Webster

Corporate Headquarters
13033 Trautwein Road
Austin, Texas 78737
P: (512) 261-1016
F: (877) 570-6250
www.espy.com
sales@espy.com

The Espy Corporation
"Helping discover the way"

V.20181212