D-TA SYSTEMS

The Future Of EMSO

2026

EW EMITTERS

MRSE Threat Signal Emulation Products Brochure

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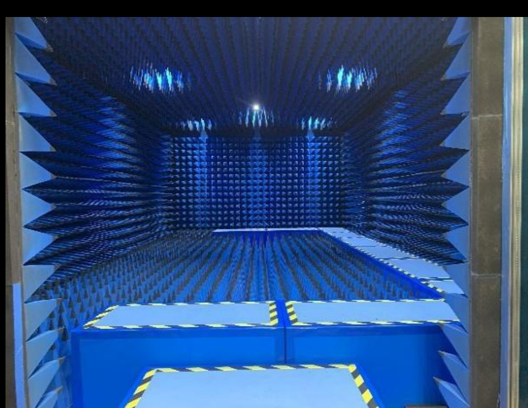
MRSE
Multi-Channel Radar Signal Emulator

Index:



About D-TA Systems

D-TA SYSTEMS
The Future Of EMSO

Founded in 2007, D-TA designs, develops and manufactures spectrum processing solutions for demanding applications. D-TA's standard products cover virtually all aspect of Electromagnetic Spectrum Operations (EMSO): from spectrum sensing to spectrum creation. D-TA is the only SMB capable of offering complete turn-key solutions for all EMSO missions.

D-TA products are results of 'out of the box' thinking, technical innovation, and no-compromise development that fulfills the company's mandate to cut deployment risk, time, and cost by orders of magnitude. All D-TA products use antenna level digitization, high-speed optical networks as data backbone and software centric processing.

All D-TA products, including ESM/ELINT Radar, EW Emulation and Extreme-SWaP optimized products for disposable EMSO missions, are based on just two sub-systems (LRUs) connected by high-speed optical cables: a smart sensor-interface unit; and a (commercially available) processing server. The approach simplifies system design, installation, maintenance, and future upgradability.

Over the years D-TA has assembled a highly qualified technical team that has unparalleled expertise in RF, IF and Network system design and real-time multi-core software processing and EMSO application development. D-TA's management staff has significant domain expertise and successful track record of managing and growing innovative businesses. D-TA has extensively equipped R&D and manufacturing facilities, including its own anechoic chamber. D-TA has over 50 active customers in FVEY, NATO and QUAD countries. Many of them are repeat customers.

Paradigm Shift in EW Emulation

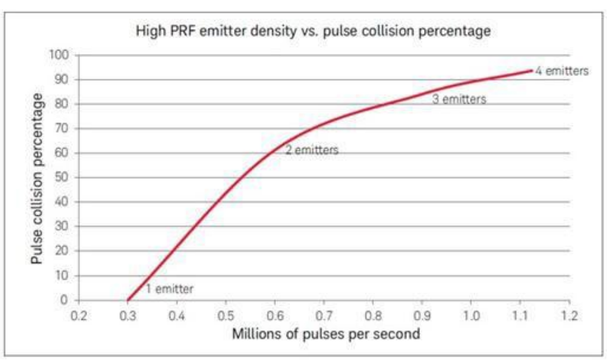
D-TA's Multi-Channel Radar Signal Emulator (MRSE) solution is based on the concept of streaming I/Q data (baseband waveform data) from deep memories (hard drives) to tunable RF transmit units. The electromagnetic environment is either computed or collected, sample by sample, for all frequency bands of interest and the information (baseband I/Q data) is stored in hard drives. Upon playback the EM environment is reproduced accurately, irrespective of the number and types of signals (communications, radar, noise and/or interferences) in each frequency band.

The competing DDS based approach (used by all legacy vendors) can only emulate one pulse at a time (per RF channel) based on the description of the pulse (PDW) and not the environment. As a result, the emulation is not a true reflection of the environment, and it is hard to create a dense EM environment without using a large number of RF channels as signals (pulses) are dropped when collision happens.

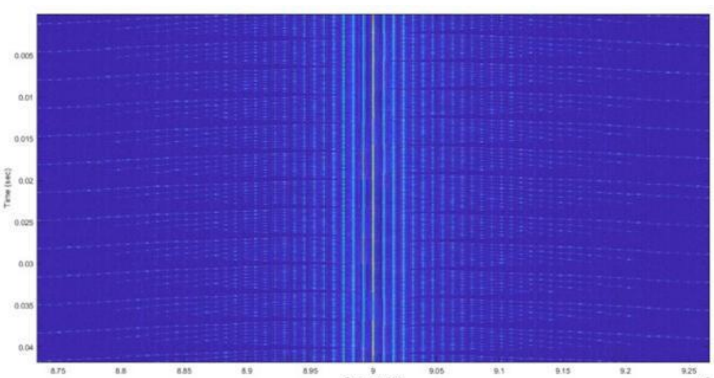
The MRSE solution does not suffer from these problems as any waveform and scenario that can be mathematically represented, can be reproduced (emulated).

The compelling advantages include:

- No signal drops out;
- Unlimited emitters in each frequency band of each RF channel;
- True emulation of EM environment (signals, noise, and interferences);
- Simultaneous emulation of multiple threats from multiple directions;
- Large waveform data storage capacity (minimum 24 TB) for long duration simulation;
- Data conversion service for legacy data bases: EWIRDB, Others;
- Optional D-TA's own unclassified threat library (DEW DOS) with over 10,000 emitters; and,
- Open-architecture & software-based solution that can be readily upgraded.



Conventional DDS based approach drops over 90% of the signals as emitter density increases.



D-TA's I/Q streaming approach does not suffer fron the signal drop out problem. Screenshot of waterfall display shows 66 emitters of varying frequency and PRI

Figure 1: DDS vs I/Q Data Streaming.

MRSE Base System:

D-TA's MRSE system essentially consists of two subsystems: a commercially available RAID server for data generation (computation of waveform I/Q data) and storage (DGEN-DSTOR); and D-TA's RF Transmit unit (RFGEN). The baseband I/Q data is supplied from DGEN-DSTOR to RFGEN using high-speed fiber-optic cables (10/40/100 GbE networks). The base systems provide maximum 0 dBm output for injection mode testing using RF cables. For free space radiation mode testing (in outdoor test ranges or in chambers), RFGEN is fitted with appropriate power amplifiers and antennas based on user EIRP requirement. MRSE base system is offered in 1, 2, 4, 8, 16 or more RF output channels. The IBW is 500 MHz or 1 GHz. The RF output channels can be independently, or phase coherently tuned. The former allows multiple frequency bands to be simultaneously emulated (multi-band emulation).

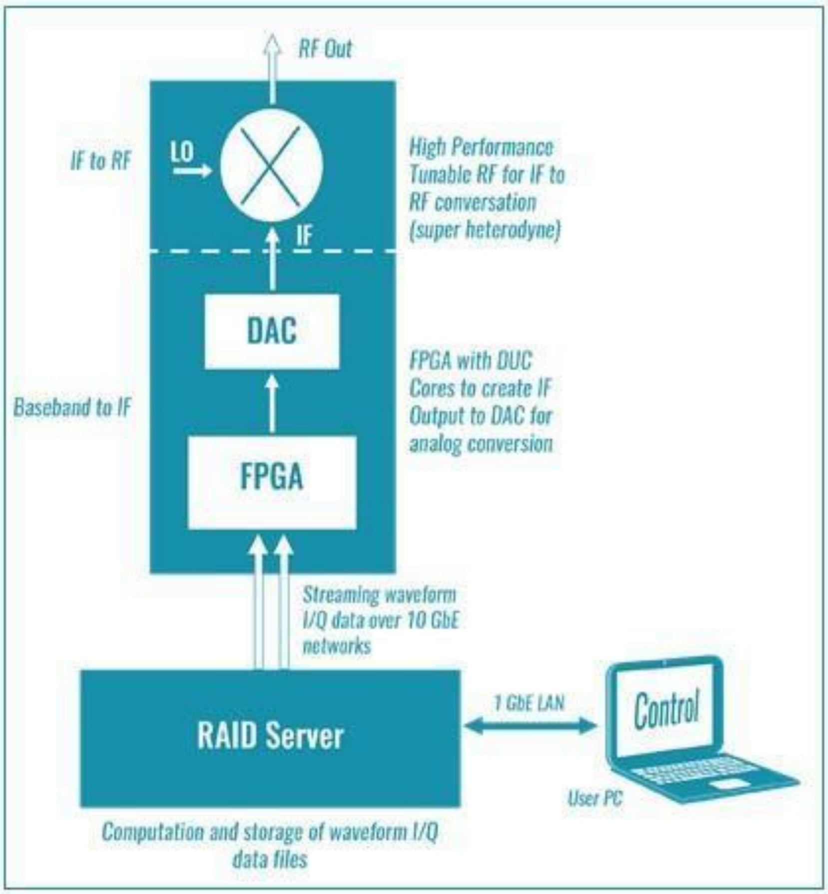


Figure 2: MRSE Block Diagram

The latter is used for multi-port DF testing of radar warning or ESM receivers. Virtually any number of emitters can be generated in each frequency band. The output power is 0 dBm or less.

The standard frequency tuning range is 0.5 to 18 GHz, optionally 40 GHz. The minimum waveform storage capacity is 24 TB. In a multi-band application, the RF outputs are combined prior to power amplification (if used) as a result there are multiple independently tuned RF outputs, each of bandwidth up to 1 GHz. Any number of emitters can be accommodated in each band without any signal drop out. In a multi-port DF application (primarily for injection mode testing), each RF output channel is connected to an antenna port of the receiver under test. The RF output is modified (amplitude and phase) by the receiver antenna beam pattern for the required angle of arrival of the signal and the signal frequency. The MRSE software can model multiple emitters, targets, and receivers with their motion dynamics, waveform parameters, antenna characteristics, antenna-array geometries, beamwidth, and scan patterns.

Multiport & Multi-Band Solution for RWR/ESM System Testing (Indoor)

The MRSE-5000-4T is a standard MRSE configuration with 4 phase coherent channels. It only occupies 3U rack space. The frequency tuning range is 0.5 – 18, or 40 GHz. The instantaneous BW is 500 MHz or 1 GHz. Multiple MRSE-5000-4T systems can be operated synchronously to create 8-, 12-, or 16-port solutions. In this case all channels are operated synchronously. Multiple 4-port systems are tuned independently to create targets in multiple frequency bands simultaneously.

A convenient way to test RWRs/ESM receivers is in an indoor test bench and exciting the antenna ports with realistic threat signals. A multi-port (multichannel) MRSE system can be used to provide signals at the antenna ports. The signal levels are typically less than 0 dBm at each port, hence there is no need for Power Amplifiers and no need to radiate threat signals. Figure 4 shows a simple example of testing a RWR using a 4-port MRSE-5000-4T.

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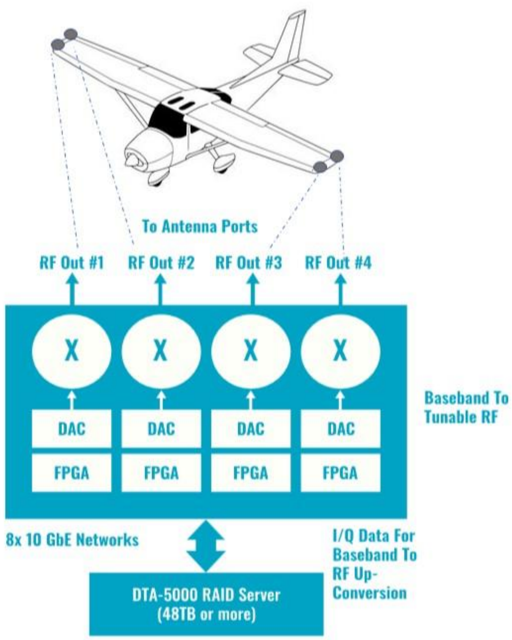


Figure 1:RWR testing by injecting threat signals to the antenna ports via RF cables.

MRSE-5000-4T
(4-Port & 1 Band)

2 x MRSE-5000-4T
(4-Port & 2 Bands or 8-Port & 1 Band)

Figure 2: MRSE-5000-4T System can be used for 4-port DF Testing. Multi-port & Multi-band DF testing. MRSE-5000-16T system shown above right uses four (4) MRSE-5000-4T systems. It can be configured for 1x16T, or 2x8T, or 4x4T as discussed. All 16 channels are operated phase coherently for 16 -port configuration. For 8- and 4-port configuration, each 8 and 4 channels are operated phase coherently.

Creating Directional Signals:

As discussed, RWRs and ESM systems use multiple antennas to estimate signal direction. The common techniques are Mono-pulse DF and Correlative Interferometry. The basic concepts are illustrated below with two different antenna array types.

A simple example of a 4-quadrant antenna array comprising of 4 spirals with 90-degree spacings for 360-degree coverage is shown below. The beam patten plots shown below indicate that a signal arriving at a certain angle will have its amplitude scaled by the antenna responses. The receiver corresponding to antenna, will see the signal amplitude is scaled by factor a1, and the receiver corresponding to antenna b will see its amplitude scaled by factor b1, and so on.

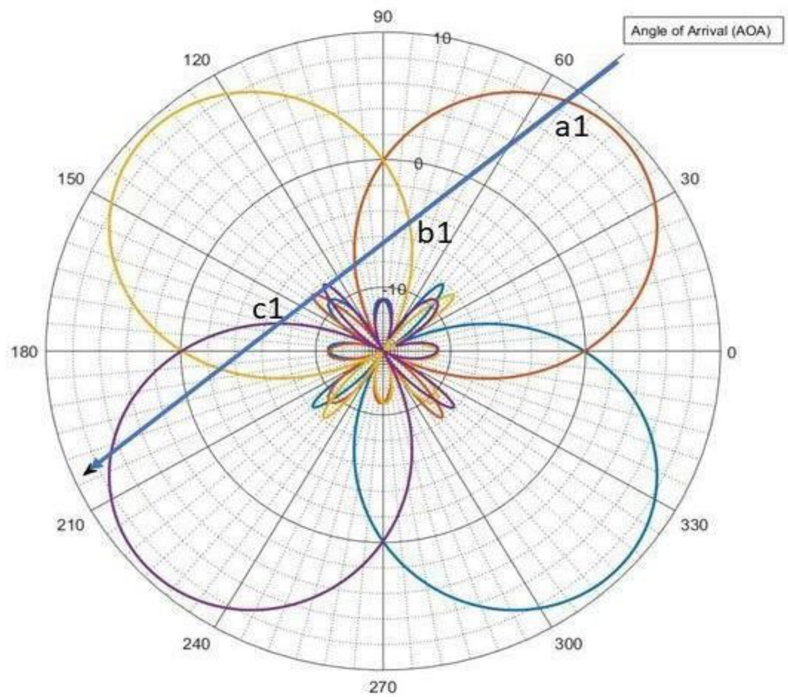


Figure 5: Beam pattern intercepts for a signal with a certain angle of arrival.

For direct injection mode of testing, one must create signals at the antenna ports or the input of the receivers. Each RF output of MRSE is connected to an antenna port. For the simple case of a 4-port system above, a threat signal direction can be created as follows:

Ch 1 output (applied to antenna port A) = Threat Signal 1 x a1

Ch 2 output (applied to antenna port B) = Threat Signal 1 x b1

Ch 3 output (applied to antenna port C) = Threat Signal 1 x c1

Ch 4 output (applied to antenna port D) = Threat Signal 1 x d1

MRSE-5000-xT: General System Specifications:

Item	Standard Specification	Option/s
No of RF Output Channels	1, 2, 4, 8, 12, 16	More than 16
Frequency Tuning Range	0.5-18 GHz	0.5 – 40 GHz
Instantaneous BW	1 GHz	
Tuning Option	Independent or Phase Coherent	Both
Tuning Resolution	1 MHz (Finer resolution with frequency offset during generation)	Contact factory for finer resolution
Type of Emitters	Radar & Communications	
Spurious (Incl. Harmonics)	-50 dBc (Typical)	
Noise Floor	-55 dBm @ 1 GHz BW	
Pulse On/Off Isolation	55 dB	
Phase Noise	<-110 dBc/Hz @ 10 kHz offset	
Pulse Width Range	50 ns – 50 ms or more	
PRI Range	500 ns – 1 sec or more	
FMOP Accuracy	1 kHz	
PMOP Accuracy	< 2 deg	
Scan Rate	50 ms to 10 sec	
Amplitude Control	0 to 40 dB	
MRSE Software for Waveform & Scenario Generation	Standard License 1 per system	
Waveform Design Features	Variable PW with Staggering/Jittering PRI/PGRI, Pulse Doublets, Triplets/n-Truplets, Frequency Hopping, 19 Types of Pulse Radar and 15 Types of CW Radar MOP	
Waveform Storage Capacity	24 TB	96 TB or more
Pulse Drop Out	None	
No. of Emitters in Active Band	Unlimited	
Interfacing to Customer Threat Library		Offered as Option
D-TA's Open-Source Threat Library (DEW DOS)		Offered as Option
System Packaging	2U rack-mount (19" rack) or custom for MRSE-5000-1T	Custom Rugged Package
Power Consumption	375 W (max) for MRSE-5000-1T	

Portable EW Threat Simulator (PETS) for Over-the-Air Test & Training
(Low-Cost Threat Emitter)

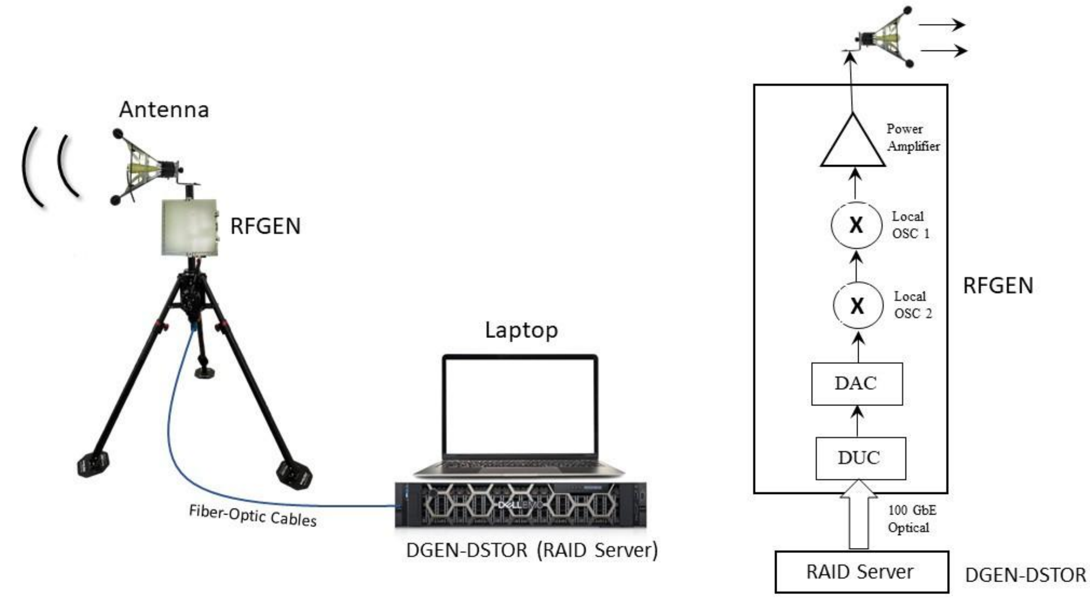
Ensuring the proper operation of Radar Warning Receivers (RWRs), Electronic Support Measures (ESM), Electronic Attack (EA), and other Electronic Warfare (EW) receivers via rapid and realistic testing is vitally important as the use of EW systems proliferate across all platforms from sea to land to air to space. D-TA's PETS system enables realistic and repeatable over the air testing for short-ranges (100 m or less). PETS, based on D-TA's Multi-Channel Radar Signal Emulator (MRSE) concept, is a rapidly deployable and portable system that simulates realistic and complex electromagnetic operating environments (EMOEs) with sufficient power for short-range test and evaluation of EW systems.

PETS can create a dense electromagnetic operational environment with complex threat signals, and it can be used for mission readiness validation, and not simply for 'go/no-go' tests.

Figure 6: PETS Dockside Testing

Key Features:

- *Electromagnetic Operational Environment Emulation (EMOE) by I/Q Data Streaming from Deep Memories (Hard Drives)*
- *Signal Type Agnostic (Radar, Comms, Interference & Noise)*
- *Unlimited emitter density in each frequency band (No Sigal Drops Out)*
- *0.5 – 18 GHz frequency range, optionally up to 40 GHz*
- *1 GHz IBW*
- *30-50 dBm EIRP*
- *1 or More RF Output Channels (Each with 1 GHz IBW)*
- *Up Mast RF Circuitry (RFGEN) avoids use of long RF cables and maximizes EIRP*
- *Waveform Data (I/Q) Generation and Storage Server (connected to RFGEN via optical network) with 24 TB Storage*
- *Horn Antenna (or other) in a weather-proofed radome*
- *Rugged 5m Adjustable Tripod Mast*
- *Rugged transit cases*
- *Transit case to full operation in 30 mins.*
- *Optional Power Source (Portable Generator)*
- *Optional Unclassified Threat Library*



PETS System Components **PETS Block Diagram**

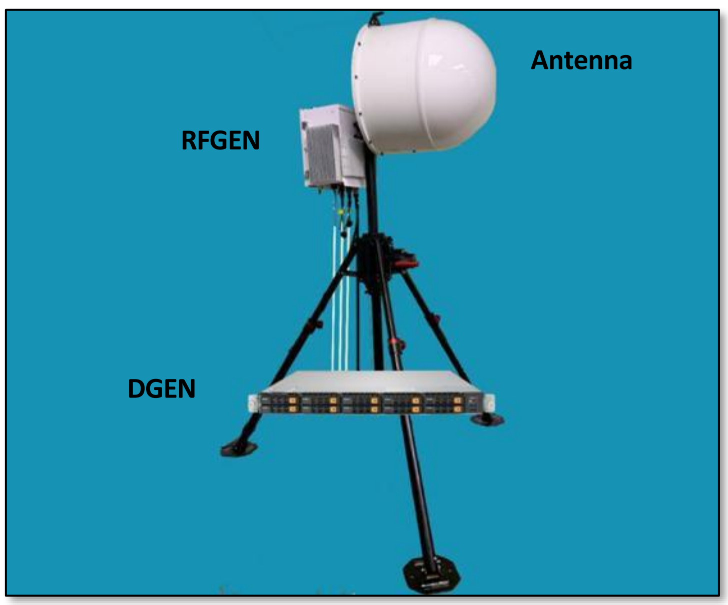


Figure 7: PETS system block diagram and actual view. Note that RFGEN (including PA and Radio) is mounted up mast. Fiber-optic cables are used to transfer data and control to DGEN-DSTOR (Raid server) which can be placed a long distance away from the antenna site.

Technical Description:

The basic PETS system Is a single channel system with 1-18 GHz frequency coverage and 1 GHz IBW. The EIRP is 50 dBm. The extended frequency range option is up to 40 GHz. The PETS system is also offered in 2, 4 and 8 channels for simultaneous emulation of up to 8 bands (8 GHz spectrum) with in 1-18 GHz frequency range. For multi-channel versions, only the Power Amplifier (PA) is mounted up mast. The PETS is a standard product that has been deployed in different variants with multiple customers.

The PETS system is provided with extensive software support for waveform and scenario generation, I/Q data storage and playback (I/Q data streaming) for RF Emulation.

D-TA also offers an open-source threat library (DEWDOS) with over 4,000 emitters and 36,000 modes. A Signal Visualization and Analysis (SVAS) software is also available for recorded waveform data (I/Q data) validation and for predicting SUT response as the SVAS can create signal threads from generated I/Q data files.

Range Vs Frequency (Value-Focused System):

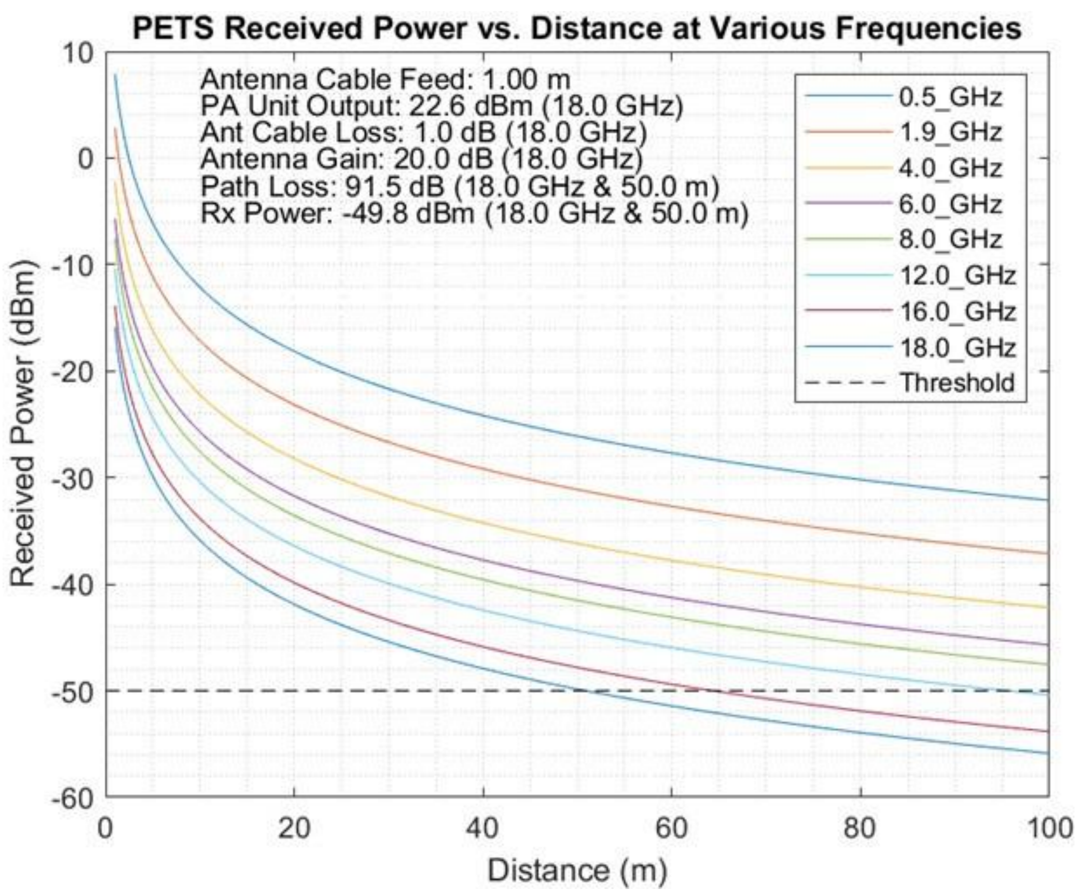


Figure 8: Range (received RF power at the skin of the target) vs distance at different frequencies. The plot is for the lowest power PA offered with PETS

PETS Broad Specifications:

Item	Standard Specification	Options /Comments
No of RF Output Channels	1	4 or More
Frequency Tuning Range	1 – 18 GHz	1-40 GHz
Instantaneous BW (IBW)	1 GHz	-
Operating BW	125 MHz, 250 MHz, 500 MHz or 1 GHz	User Programmable
Frequency Tuning	Independent	-
Noise Floor	-55 dBm (Full BW)	-
SFDR	50 dBc (Before PA)	
Output Power for Direct Injection Mode Testing	0 dBm or less	
Output Power for Over-the-Air / Chamber Testing	30 dBm	Up to 50 dBm
Pulse Width Range	0.01 to 50000 µsec	
PRI Range	0.05 to 10000000 µsec	
Scan Rate	0.05 to 10 sec	
FMOP Accuracy	16-Bit	I/Q Data Word Length
PMOP Accuracy	16-Bit	I/Q Data Word Length
Amplitude Control	120 dB	
Waveform Design Features	Variable PW with Staggering, Jittering, PGI/PGRI, Doublets, N-Triplets, and Frequency Hopping and 19 Types of Pulse Radar and 15 Types of CW radar MOPS.	The I/Q streaming method can generate any waveform and any scenario that can be mathematically represented.
Waveform Storage Capacity	24 TB	Higher Storage Capacity Offered.
No. of Emitters in Active Band	Unlimited	Advantage of I/Q streaming

PETS+ for Long-Range (Over-the-Air) Test & Training

While D-TA's PETS system is for over-the-air (OTA) testing of stationary targets over short ranges, the PETS+ system is designed for long ranges, for naval and air test ranges. The range can be 50 Nautical Miles (NM) and beyond. The PETS+ system covers a frequency range of 1-40 GHz. It can provide EIRP of 1 MW or more. A collection of PETS+ systems (each called a Threat Node) can be operated from a common C2 to replicate an Integrated Air Defense System (IADS) for air combat training. Each Threat Node can create a dense electromagnetic environment, and it is signal type agnostic, implying military and civilian radars, cell tower, microwave links and other signals can be simultaneously emulated representing an airport environment. For mobile operation PETS+ node is installed on a trailer.

Mobile, Value-Focused Surface EW Threat Emitters:

Modern battlefields have evolved into electromagnetic battlegrounds where dominance of the electromagnetic spectrum (EMS) has become a critical strategic issue. Both military and civilian actors extensively exploit this spectrum for a multitude of applications. The coexistence of multiple actors and uses leads to increasing congestion of the EMS.

To maneuver and operate effectively within this dense and congested electromagnetic operational environment (EMOE), aircrafts are equipped with onboard electromagnetic warfare (EW) systems, featuring advanced EM sensors. These sensors provide critical situational awareness of the surrounding environment.

Crew training on EW systems is a critical component of the operational readiness process. It necessitates the deployment of sophisticated electromagnetic signal generators within designated training areas to simulate the complex and dynamic electromagnetic environment encountered in real world operational theaters.

D-TA has introduced a highly advanced THREAT2 (Theatre Replication for Advanced Test & Training) trailer is a value-focused, highly mobile EW threat range training system capable of supporting both 5th gen and legacy combat aircrafts. THREAT2 nodes use D-TA's PETS+ EW threat emulators for RF environment emulation with high EIRP. D-TA's unique I/Q data (waveform baseband data) streaming from deep memories (computer hard drives), can create any signal type with any characteristic and virtually unlimited emitter density without the signal dropout problem of legacy systems.

PETS+ Threat Emitter Node:

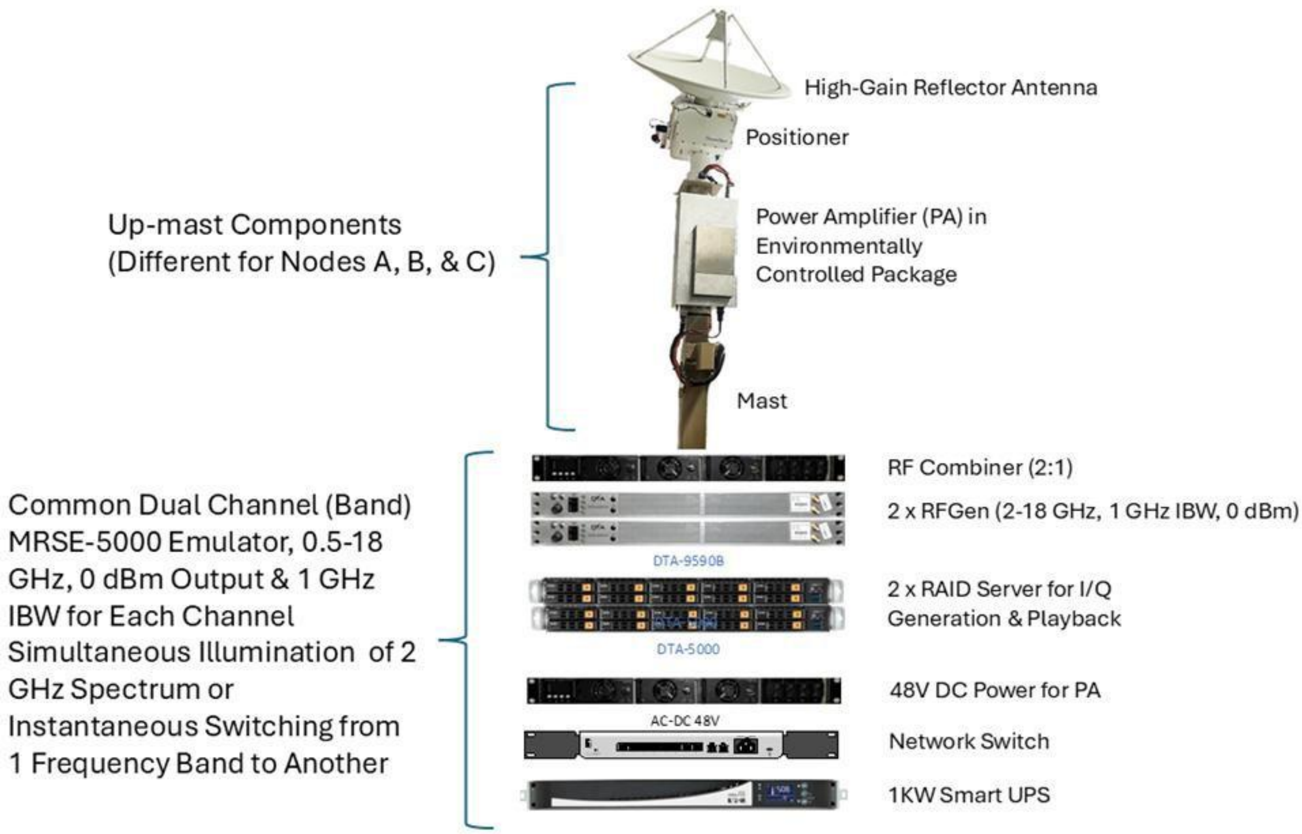


Figure 9: PETS+ threat emitter node with high EIRP and wide frequency range.

THREAT2 (IADS)

A Threat2 Trailer may include 1, 2 or 3 PETS+ Emitter nodes. Each PETS+ node has different frequency range and EIRP specifications. D-TA's current offer includes Acquisition/Seach Emitter (Node A) with a frequency coverage of 2-18 GHz; Track Emitter (Node B) with a frequency coverage of 6-18 GHz; and Targeting Emitter (Node C) with a frequency coverage of 18-40 GHz and EIRP around 80 dBm at 40 GHz. The IBW is 1 GHz for all nodes. Note that these specifications are not fixed and may change to meet different application requirements.

Figure 9 showed a PETS+ node that includes D-TA's dual-channel MRSE-5000 wideband radar emulator that is housed in an environmentally controlled rack. The MRSE-5000 system is based on I/Q (baseband waveform time samples) data from deep memories, as a result the emulator is signal-type agnostic and can create a dense electromagnetic operational environment (EMOE) with out any signal drop out. Each channel offers an instantaneous bandwidth (IBW) of 1 GHz, consequently two 1 GHz spectrum (adjacent or separated) can be simultaneously illuminated. Alternatively, spectrum can be switched instantly from one channel to the other.

Figure 10(a) shows D-TA's 3-emitter node trailer that includes emitter nodes A, B and C.
Fig 10(b) shows a single- node trailer which can include any of the three nodes.

The trailers are double-axle trailers. Both trailers have their own power sources (generators) and include adjustable masts. For each node the power amplifier, positioner and reflector antenna are mounted up mast to reduce RF cable losses. The recent designs use rack-mount amplifiers for higher EIRP and ease of serviceability. The emitter node C continue to use up mast power amplifiers as it uses a waveguide to transfer high frequency Rf signals from the PA to the antenna. The positioners are controlled by Aircraft's time, speed, position information to track the aircraft. ADSB, IFF or Link16 interfaces are used to collect tracking data. Visual & Electro-optical camera interfaces for target tracking are also offered.

The recent design also includes node D (200 MHz to 2 GHz) for generating communication signals and node B+ (8-12 GHz) for generating 10 MW EIRP using a 1024 element AESA array. The B+ node also offer the ability to track up to 4 targets simultaneously at a slightly reduced EIRP. An additional acquisition/search emitter node (node A') is being considered with a fan beam antenna.

The trailers are designed to be land, air and sea transportable. For sea transportation a 20' ISO container is used. The trailers are also provided with lightning protection system, storage area and manual stabilizer feet.

The following tables provide specifications for all 5 emitter types discussed above for the THREAT2 trailer. As discussed previously, the base emulator is identical for all 3 nodes. Node C includes the 18-40 GHz block RF upconverter which is mounted up-mast. The EIRP (estimated at full duty cycle) is a function of the PA power output and antenna gain. Range (RF power at the skin of the target) vs frequency plots are provided in figures 11 to 15 for all 5 emitter nodes.

THREAT2 Major RF System Specifications (Nodes A, B & C):

System Element	Acquisition/Search Emitter, System A (2-18 GHz)	Track Emitter , System B (6-18 GHz)	Targeting Emitter, System C (32-37 GHz)
Base Emulator	2 × MRSE-5000, 0.5–18 GHz, 1 GHz IBW, Unlimited emitters	Same	Same (18-40 GHz Block RF Up Converter mounted up-mast
Antenna	2-18 GHz, 4' (1.2 M) Reflector, Single Polarization	6-18 GHz, 4' (1.2 M) Reflector, Single Polarization	18-40 GHz, 4' (1.2 M) Reflector, Single Polarization
Beamwidth, Gain	8.0 to 1.0 Degree, 20 – 39.5 dBi	2.7 to 1.4 Degree, 29 – 36 dBi	1.9 to 1.1 Degree, 38.2 – 43.8 dBi
Pan/Tilt Unit	Azimuth: 50°/s, Elevation: 20°/s, 360° azimuths, 0° - 90° tilt, 100 kg Capacity	Same	Same
Antenna Mast	Up to 15 ft Fixed	Same	Same
PA Module Power, Psat	300 W	500 W	50 W
EIRP (CW)	85.7 dBm@ 18 GHz	92.4 dBm@18 GHz	90.1dBm@37 GHz
Generator Option	See Trailer Specifications	Same	Same
Environmental	RV-style Heat/AC, supports -40°C to +40°C operation	Same	Same
Electro Optical Tracker	Target recognition to 20km, auto-tracking, 2m object size	Same	Same
Target Tracking (Antenna Cuing)	Air Traffic data for real-time aircraft feeds, LINK16 optional	Same	Same

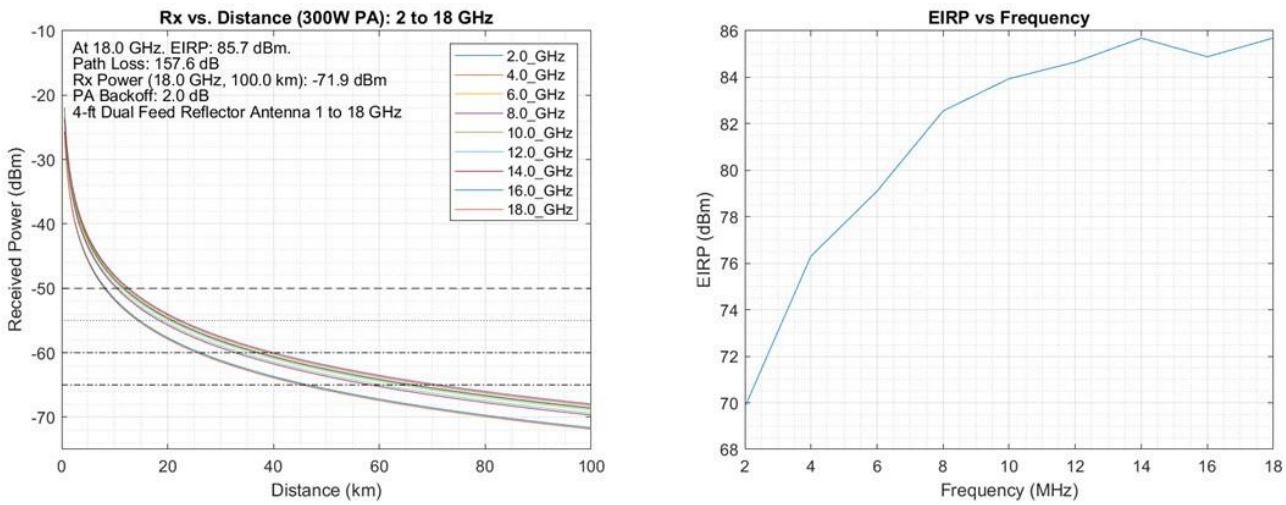


Figure 11: Received power at the skin of the target vs distance at various frequencies for System A (right) and EIRP vs frequency plot (right)

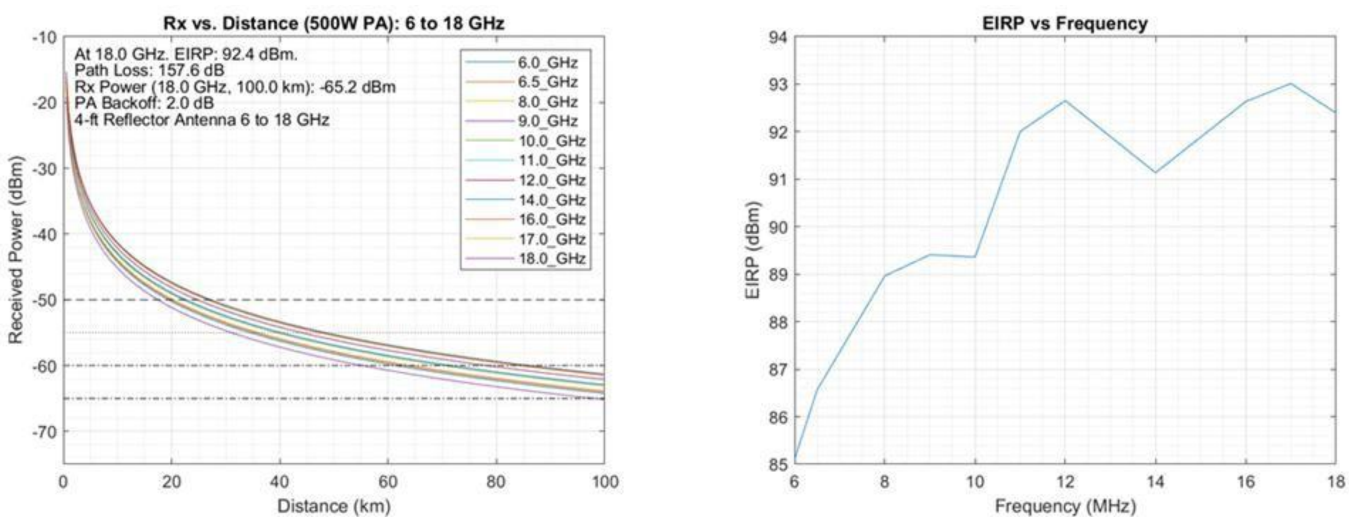


Figure 12: Received power at the skin of the target vs distance at various frequencies for System B (right) and EIRP vs frequency plot (left)

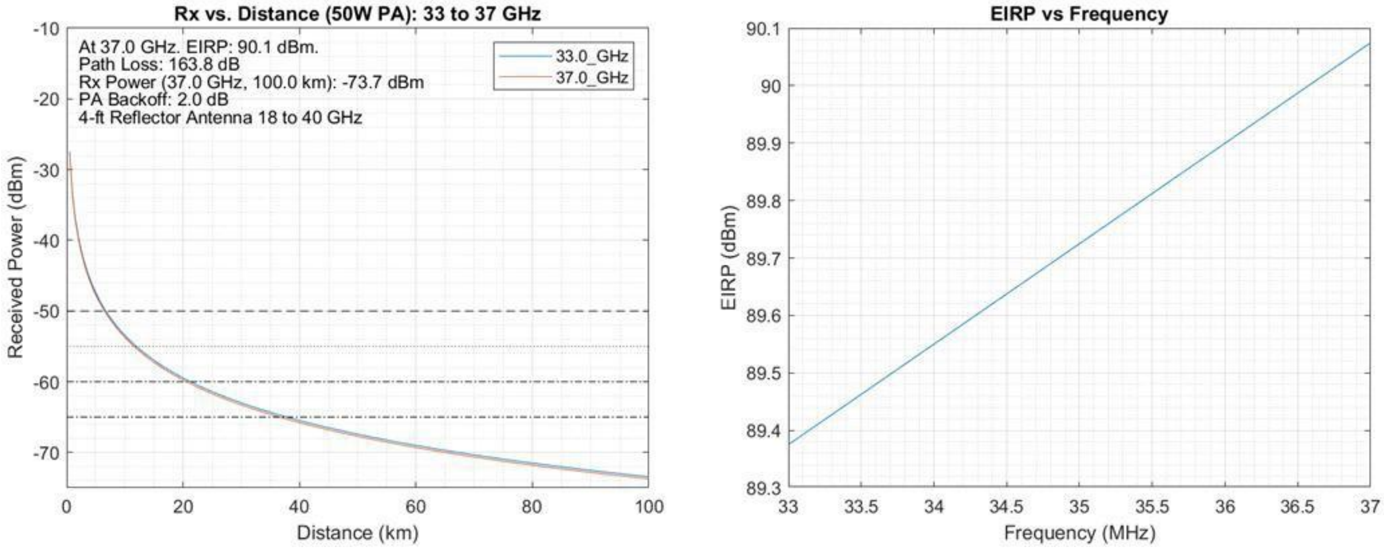


Figure 13: Received power at the skin of the target vs distance at various frequencies for System C (left) and EIRP vs frequency plot (right)

THREAT2 Major RF System Specifications (Nodes D & B+):

System Element	Comms Emitter, System D (0.2 -2 GHz)	Enhanced Track Emitter, System B+ (8-12 GHz)
Base Emulator	2 × MRSE-5000C, 0.1-6 GHz,100 MHz IBW, unlimited emitters in each band	2 × MRSE-5000, 0.5–18 GHz, 1 GHz IBW, unlimited emitters in each band
Antenna	LPDA 200 – 2000 MHz	8-12 GHz, 1024 Element AESA Array with 4 Sub arrays
Beamwidth, (Gain)	60 deg, 8dBi	~2.37° at 8 GHz. & ~1.57° at 12 GHz.
Pan/Tilt Unit	Positioner: Azimuth: 50°/s, Elevation: 20°/s, 360_0 azimuths, 0° - 90° tilt, 100 kg Capacity	±60° in azimuth & ±30° in elevation. Electronic beam steering in microseconds
Antenna Mast	Up to 15 ft Fixed	Same
PA Module Power, Psat	225 W	1024 x 40 W
EIRP (CW)	56.4 dBm at 2 GHz	96.9 dBm@12 GHz
Power Consumption	< 1 KW Total	5.2 KW Power Consumption
Environmental	RV-style Heat/AC, supports -40°C to +40°C operation	Same
Electro-Optical Tracker (Optional)	Not included	Same
Target Tracking (Antenna Cuing)	Air Traffic data for real-time aircraft feeds, LINK16 optional	Same

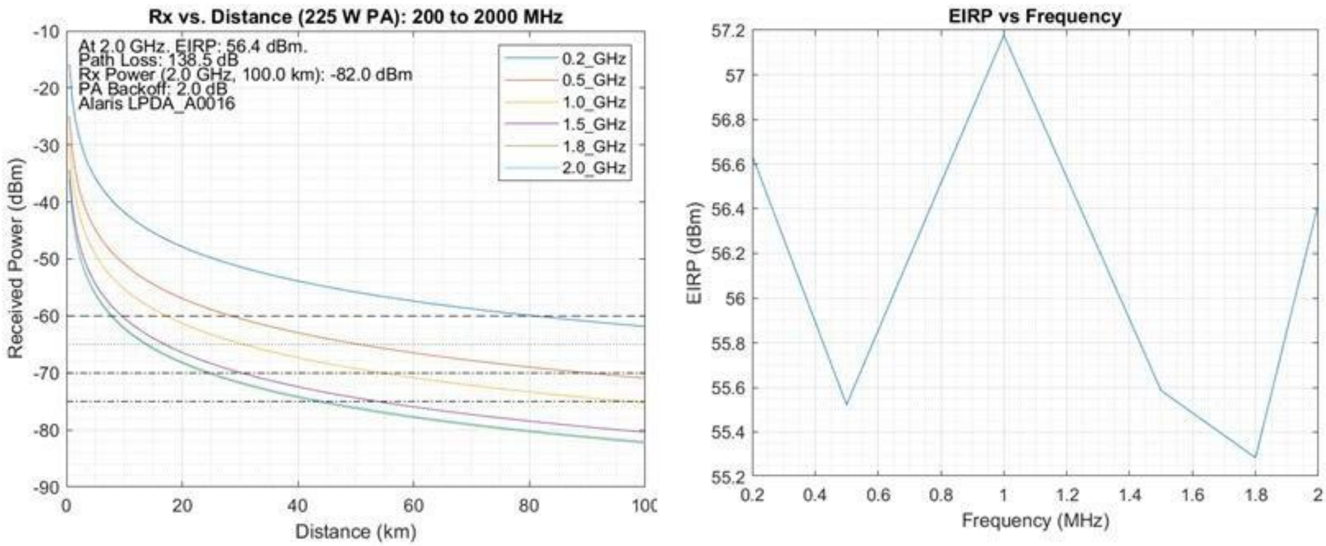


Figure 14: Received power at the skin of the target vs distance at various frequencies for System D (left) and EIRP vs frequency plot (right)

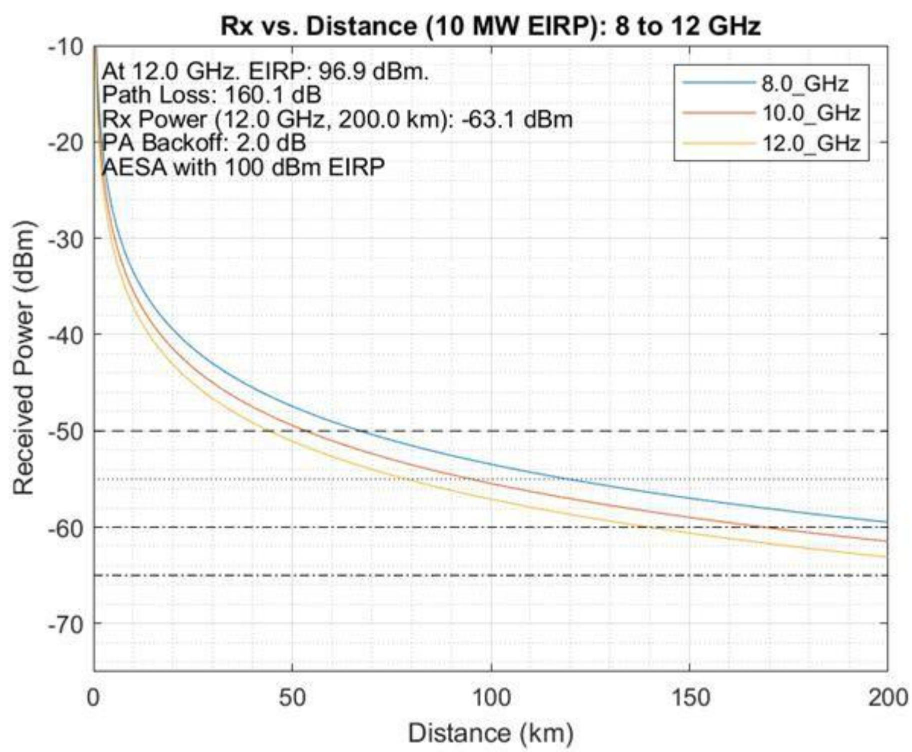


Figure 15: Received power at the skin of the target vs distance at various frequencies for System B+ (AESA)

ESM System for Range Monitoring:

D-TA's portable MFEL-5000 UAS ESM receiver system can be used to effectively monitor range activity and collecting aircraft jammer responses. The system provides pulse-by-pulse bearing which can be used to discriminate between transmitted and received signals. The MFEL UAS system offers frequency coverage from 2-18 GHz and an IBW of 500 MHz. Frequency extension to 40 GHz and IBW extension to 1 GHz are available as options.

The UAS system can be operated synchronously with the THREAT2 system offering sample by sample correlation between receive and transmit signals. The recorded I/Q data files of the ESM system can be analyzed by D-TA's highly powerful SVAS software.

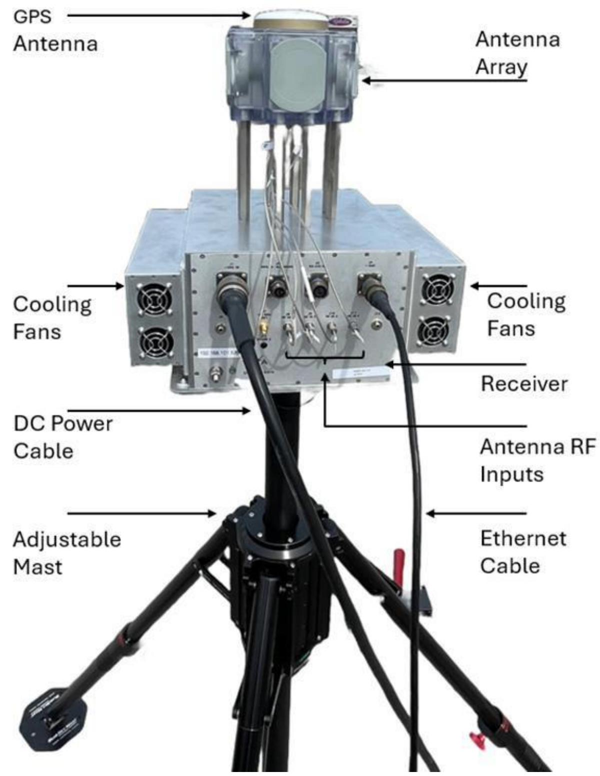


Figure 16: MFEL-5000 UAS system for range monitoring and aircraft jammer response collection

Command & Control:

At the heart of the system is the Command-and-Control Center which manages and coordinates all THREAT2 nodes. This center integrates the various nodes into a cohesive operational environment, providing real-time monitoring, event detection, and response management. The center ensures seamless communication across nodes, enabling a unified and efficient training or testing operation.

- Range Tattletale: The system includes a range monitoring tool that processes customer-supplied aircraft data—callsign, position, elevation, time, course, and speed. This data feeds the geo-fence monitoring system to start and stop events, feeds the tracking algorithm to generate antenna pointing instructions and is also sent to the presentation layer to plot and display aircraft paths, heading, speed, and locations.
- THREAT2 Software: The application that supports user defined threat profiles for nodes, monitors event triggers, starts and stops node reactions and provides overall situational awareness of the mission and nodes. The system is also able to handle direct antenna control from external system.

THREAT2 Software:

The THREAT2 software has multiple components: **MRSE designer** software creates platforms, emitters and their modes and generate I/Q waveforms; **THREAT2 Core** software creates Threat profiles (Threat Profile is waveform and antenna scan), creates events, such as geofence violations, elapsed time, on jam, on fire, or manual, to move between Threat profiles; **Air Traffic Management (ATM)** software provides interfaces, such as Asterix, ADS-B, Link-16 and others, evaluates geofence violation and creates events, and predicts future aircraft positions by using a predictive tracker algorithm; **THREAT2 Node** software controls each node to emulate a Threat profile and receives aircraft track data to steer antenna appropriately when tracking.

Tattletale Software:

The primary purpose of the *Tattletale* software is to ingest third-party air-traffic data, and to perform the transformations necessary in adapting it to THREAT2's data interface. The Tattletale may be configured to ingest air-traffic data through various mediums (called input streams) and will transform and distribute this data to various locations/formats as necessary (called output streams).

Geofence Monitor:

The Geofence Monitor software provides geofence evaluation and geofence violation notifications to the rest of the THREAT2 system. It uses live aircraft data (directly from) to detect, and relay geofence violations (entry and exit).

Predictive Trackers & Tracker Controller:

The *Predictive Tracker* attempts to predict the aircraft's future track, based-on it's current and historical positional information. Typically, the Tracking algorithm is triggered by the event of 10 updates for a particular call sign and produces time series values for all the parameters for up to 10 points in future. The *Tracker Controller* is a supporting software, whose task is to provision and to terminate tracker processes.

In-addition to the components above, the ATM includes two additional supporting software:

- Message Broker: The ATM Message Broker acts as the central communications and data-distribution hub for the ATM. All ATM components communicate through this software, and external clients (ex. Node C2) may connect/subscribe to the various datatypes transmitted through this component.
- *Event Recorder: The ATM Event Recorder is responsible for intercepting and recording all ATM events to a time-series database (ex. InfluxDB). This component records Air-traffic data, Geofence Violations and other internal events for playback & archiving.*

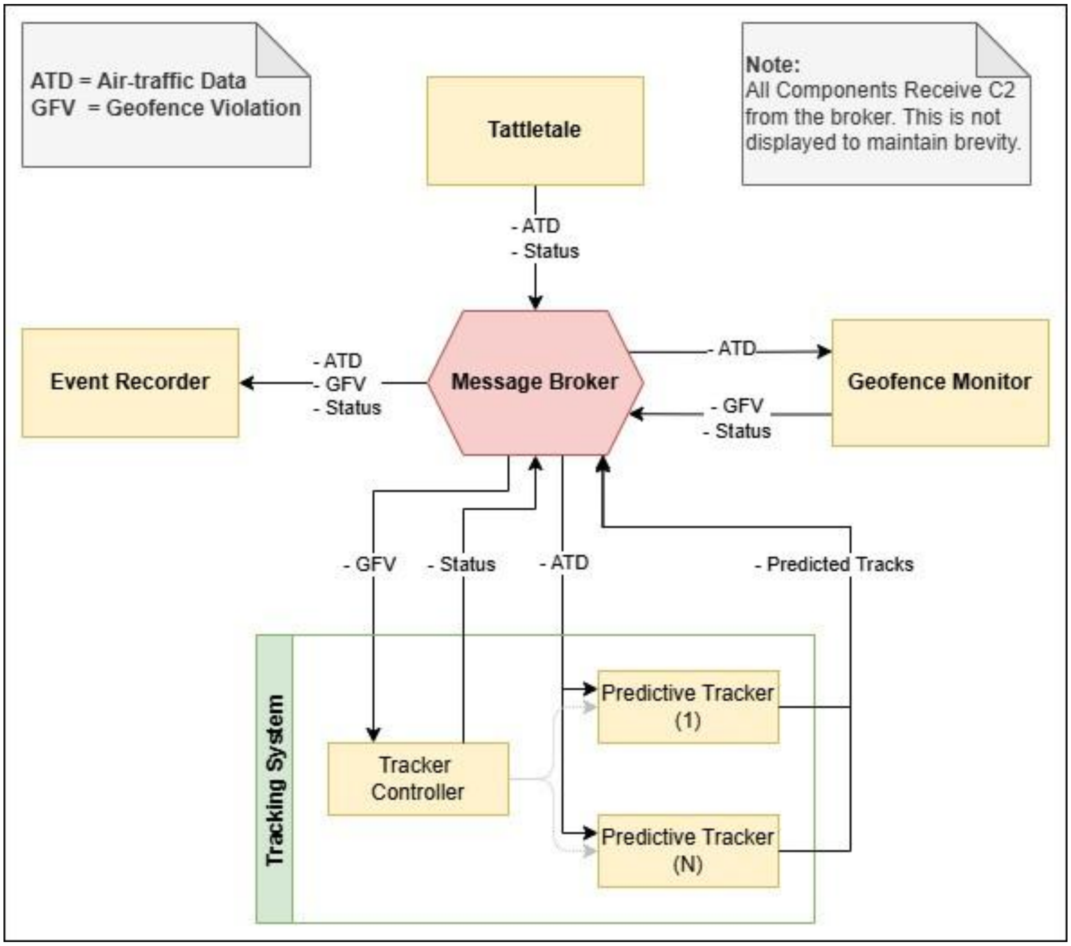


Figure 17: Tattletale software communications diagram

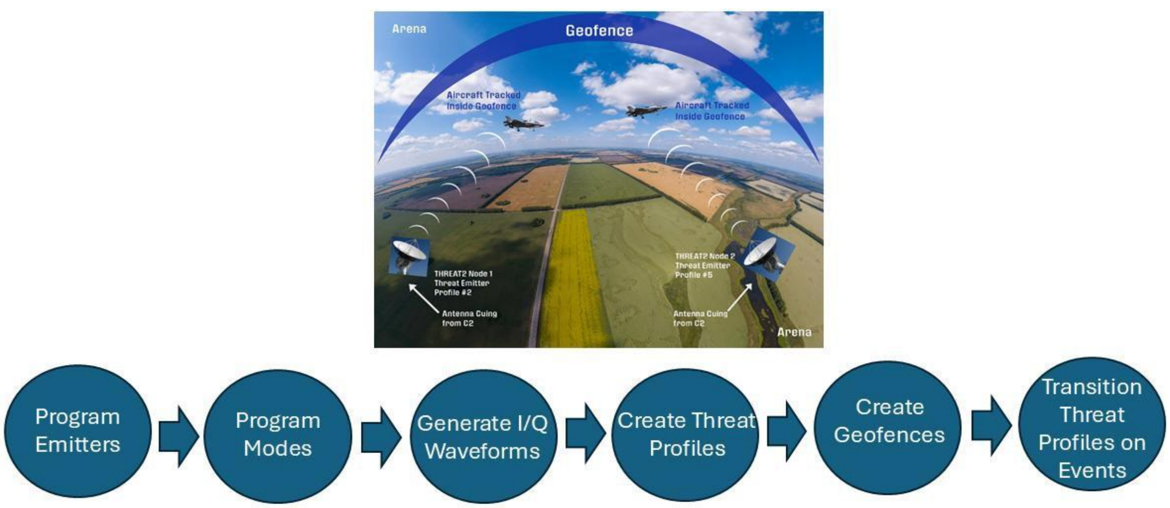


Figure 18: Programming sequence illustrating the Concept of Operations (CONOPS)

IADS Replication using Multiple THREAT2 Trailers:

THREAT2 trailers can be either a stand-alone emulator or a node in a series of nodes. This enables the user to operate the trailer independently or as a part of a networked array of trailers.

Each Trailer responds to operator commands and queries via a secure dedicated web-based application that provides real-time status, scenario scripting, and manual override functions.

Replication of an integrated air defense system (IADS) consisting of multiple military and civilian assets can be accomplished by using multiple THREAT2 trailers that are mobile and rapidly reconfigurable.

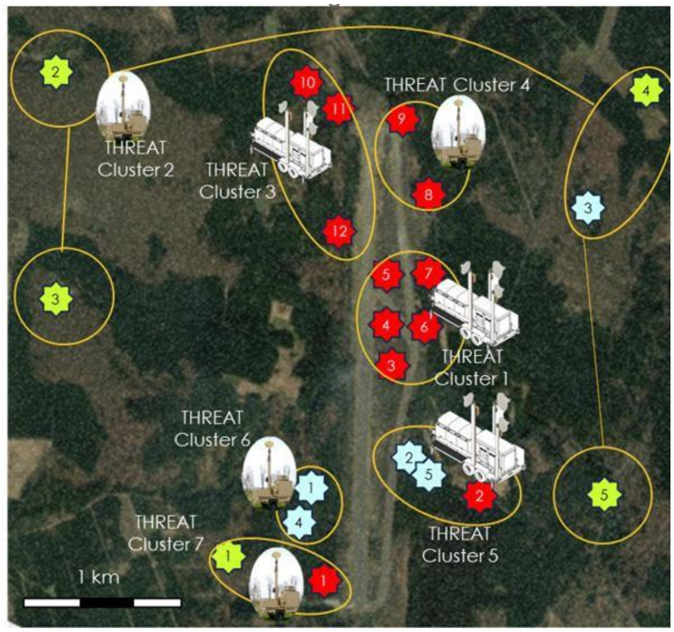


Figure 19: Illustration of IADS replication by using multiple THREAT2 trailers for air combat training.

Figure 20: : THREAT2 testing with 4th & 5th Gen Aircraft.

Networked THREA2 Trailer Command & Control:

THREAT2 is an open-range electronic warfare (EW) test and training system designed to realistically replicate modern air defense environments. The system consists of multiple radio frequency (RF) nodes deployed across large geographic areas. Due to the distributed nature of open-range deployments, hardwired infrastructure is not universally available, requiring command, control, and monitoring functions to operate over wireless communication links.

THREAT2 deployments generally fall into three practical configurations:

- Sites with dedicated hardwired connectivity between locations.
- Sites that rely entirely on wireless communications.
- Mixed environments combining fixed infrastructure and wireless links.

Regardless of the deployment configuration, THREAT2 must function as a single, coherent system, maintaining deterministic behavior, safety, and clearly defined control authority under all connectivity conditions.

Distributed Control Requirements:

The following defines the minimum operational and system constraints for THREAT2 distributed control.

Control Scope and Consistency:

- The control system shall provide a unified mechanism to command, monitor, and coordinate all THREAT2 RF nodes deployed within a single open-range site.
- Commands issued to THREAT2 shall be interpreted and executed consistently across all nodes, without the need for deployment-specific procedures.
- Each THREAT2 node shall operate within a well-defined state model, ensuring deterministic, observable, and traceable state transitions.

Connectivity and Network Tolerance:

- The control system shall operate over both hardwired and wireless communication paths.
- Variations in latency, bandwidth, or link availability shall not compromise operational safety or control authority.

Authority and Safety:

- Control authority shall be explicit, unambiguous, and enforceable at all times.
- Loss of connectivity shall not result in unsafe RF emission or undefined system behavior.

Scalability and Extensibility:

- Control model shall support scaling the number of THREAT2 nodes without requiring architectural change.
- Networking and control capabilities shall be extensible without redesigning RF mission hardware.

THREAT2 Node Overview:

Each THREAT2 node includes a fiber-optic network interface used for command, control, and monitoring within a distributed deployment. Fiber connectivity provides electrical isolation and a deterministic local control path at the trailer or site level.

Each node incorporates an integrated firewall that enforces local security and control boundaries. All external communications are subject to node-level security policies, ensuring that access is explicitly authorized regardless of the surrounding network environment.

Distributed Connectivity Architecture:

THREAT2 deployments must support reliable command and control across large open-range environments, where fixed networking infrastructure may be limited or unavailable. Embedding wide-area wireless networking capabilities directly into each RF node would significantly increase system cost, power consumption, and integration complexity.

To address this, THREAT2 explicitly separates mission execution from networking infrastructure:

- RF nodes are dedicated to mission execution and controlled RF operations.
- Wide-area distributed connectivity is provided by dedicated Mobile Ad Hoc Network (MANET) nodes, deployed as part of the site architecture.

MANET nodes enable resilient, infrastructure-independent networking between the Central Office (CO) and distributed THREAT2 nodes. A single MANET node can support multiple THREAT2 trailers, allowing networking capacity to be shared and scaled independently of RF mission hardware.

Each THREAT2 trailer connects to the MANET via a short local fiber-optic link. This approach provides electrical isolation, a clean security boundary, and a consistent integration model across all deployment scenarios.

Rationale for MANET-Based Connectivity:

Distributed THREAT2 operations require wireless connectivity capable of supporting reliable, low-latency command and control across large geographic areas. The connectivity solution must operate independently of fixed infrastructure and allow rapid deployment.

Alternative approaches present significant limitations:

- Very high frequency (VHF) radio links lack sufficient bandwidth to support distributed control, monitoring, and status reporting across multiple nodes.
- Commercial cellular networks introduce uncontrolled latency, availability, and dependency on external providers.
- Directional point-to-point wireless links can provide high bandwidth but require precise alignment with the Central Office, increasing setup time and sensitivity to terrain and line-of-sight constraints.

Mobile Ad Hoc Networking (MANET) provides an infrastructure-independent, wide-area wireless solution well suited to THREAT2 deployments. MANET nodes support rapid setup and shared connectivity across multiple trailers without requiring direct point-to-point links to the CO. While latency and throughput are affected by hop count in multi-hop wireless networks, these factors can be managed through deployment planning and network scaling.

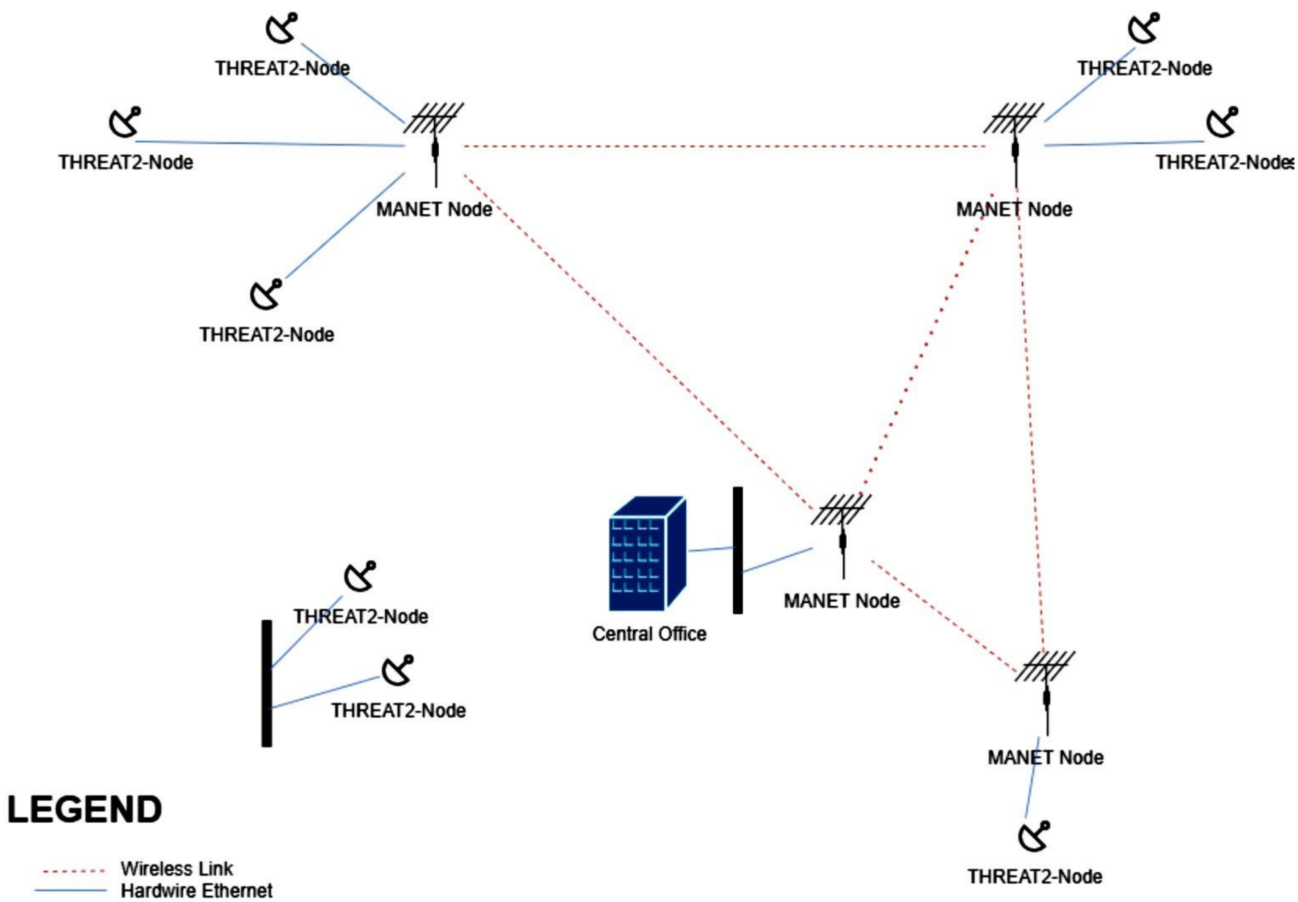


Figure 21: THREAT2 Distributed Communication Architecture.

Deployment Flexibility:

THREAT2 employs a single, adaptable connectivity architecture that operates consistently across all range environments:

- Dedicated MANET nodes provide wide-area wireless connectivity where fixed infrastructure is unavailable.
- Standardized hardwired interfaces at each trailer support integration with existing infrastructure.

Hardwired and MANET-based connectivity can be combined within a single deployment without modification to the control or security model. This allows THREAT2 to operate consistently across hardwired, wireless, and mixed environments using a unified architectural approach.

Conclusion:

THREAT2 achieves reliable distributed control through architectural design rather than per-node networking specialization. By externalizing wide-area wireless networking to dedicated MANET nodes and standardizing hardwired interfaces at each trailer, THREAT2 delivers a flexible, scalable, and deployment-agnostic connectivity solution. This architecture supports hardwired, wireless, and mixed environments using a single control model, while allowing networking technologies to evolve independently of core RF mission hardware ensuring long-term adaptability, safety, and operational coherence.

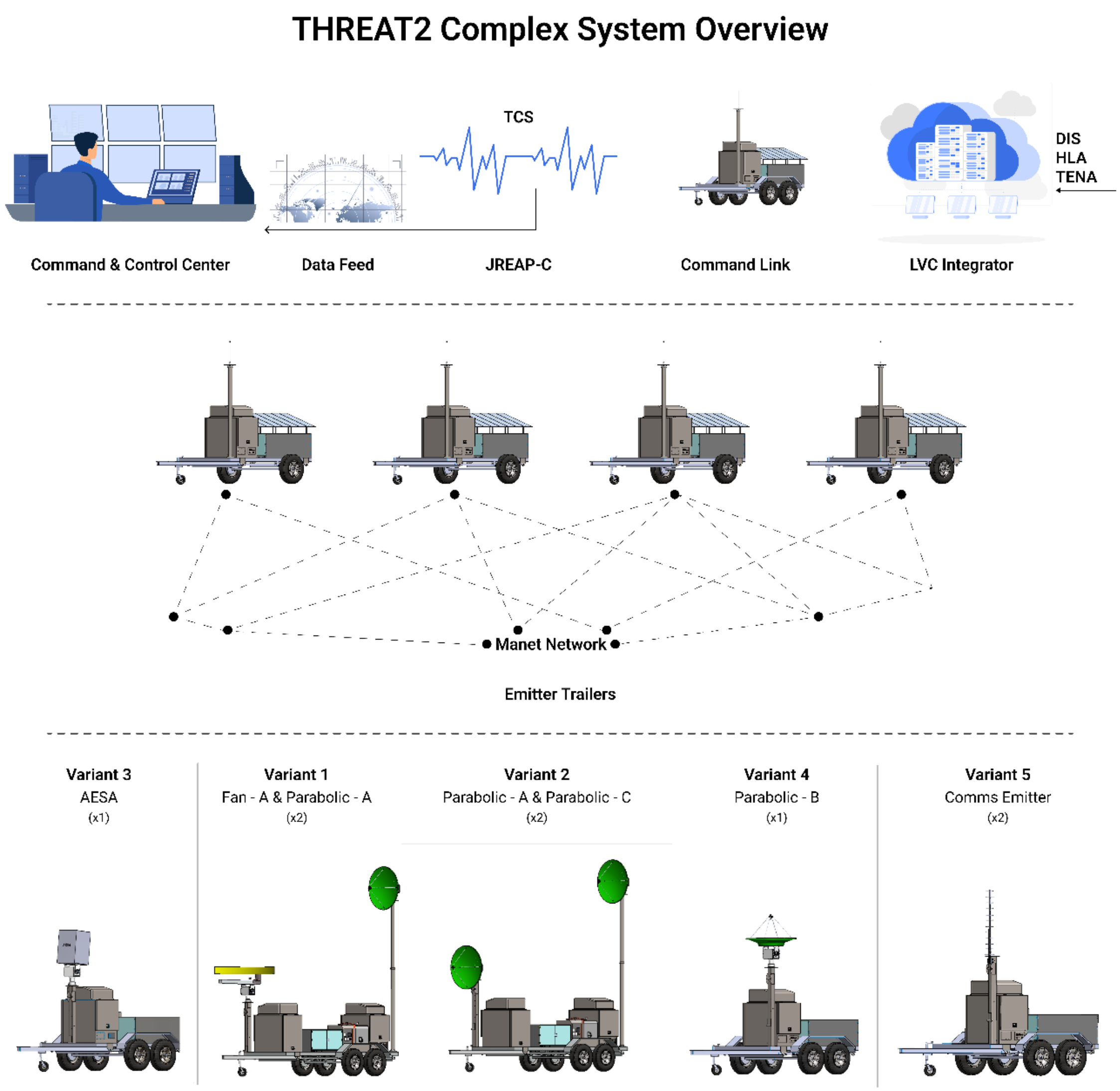


Figure 22: A Typical THREAT2 System layout.

Software Highlights

The PETS system software leverages MRSE Designer software for the design of signals and emissions and their generation onto the library server. DTA's MRSE Designer software is a pre-installed web application running on the user device. It stores data in a NOSQL database typically stored in the user device. The database classification is typically set by the data source used to create the waveforms, signals and emissions, and the context information input by the user. The database may be backed up, restored or moved to different storage locations. Access to the database is essential for MRSE Designer to function.

Waveforms may be designed by filling in signal parameters on the web application through the graphical user interface, an upload file through the GUI of a JavaScript Object Notation file (an open standard data structure) or a mass database importation performed by DTA from a user's data source translated into the MRSE data structure.

Signal beam shape and scan definitions have two levels of detail: Simplified for quick definitions and detailed for more mathematically intensive calculations. Either method may be used and may be intermixed depending on the needs of the user.

I/Q data can be generated once the user has defined the emitters, their modes and on and off times in the emitter mode designer utilizing the previously entered waveforms, beam shapes and scans. I/Q data is only generated when the user device is connected to the library server where the operator is given the choice to generate the I/Q data stream with or without scan patterns, or both at the same time. This enables playback of the I/Q data stream to be either the pure waveform with the system antenna providing the scan pattern and movements or the scanning waveform which when played back emulates a scan pattern through the amplitude and signal changes inherent in the I/Q data.

Signal Visualization & Analysis (SVAS) Software for Recorded I/Q Data:

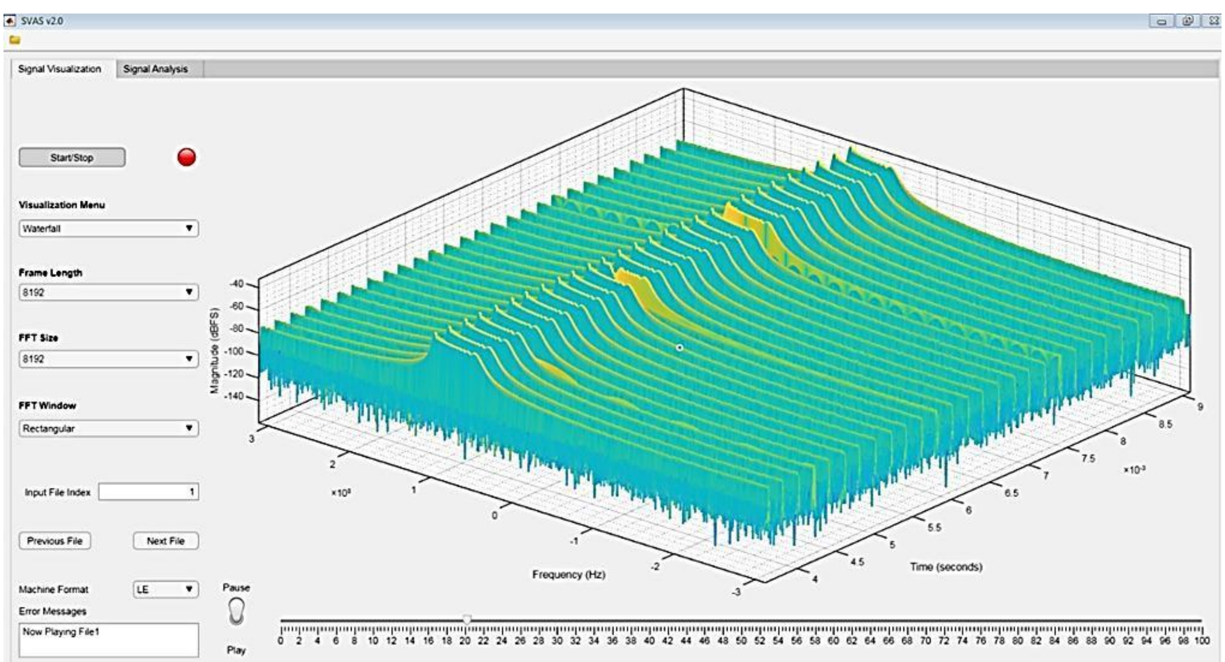


Figure 23: SVAS Signal Display

Signal Visualization Functionality:

a. Visualization of recorded signals within Frequency-Temporal space;
b. User-defined Time and Frequency resolution on the data;
c. Interactive GUI with slider controls and quick navigation features to examine any portions of the recordings on-the-fly; and,
d. Measurement tools to facilitate measurement of time-frequency parameters of the signal.

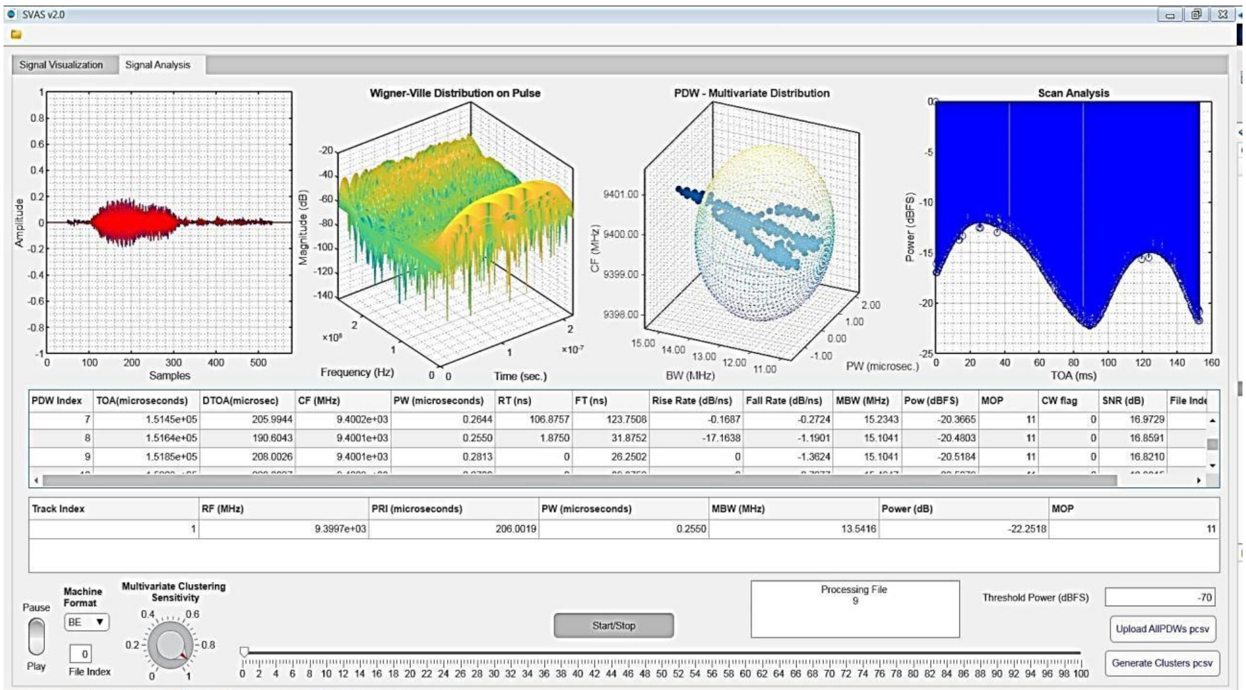


Figure 24: SVAS Signal Visualization

Signal Analysis Functionality:

a. Signal detection and measurements;
b. Intentional and Unintentional Modulation on Pulse (IMOP and UMOP) identification;
c. Pulse Descriptor Word (PDW) generation;
d. Autonomous and unsupervised clustering of PDWs using multivariate statistics;
e. Emitter track creation and autonomous fusion based on multivariate proximity;
f. Scan analysis display and measurement tools for estimating scan periods and scan types; and,

DEW-DOS Open-Source Threat Library:

D-TA offers an open-source (unclassified) threat library with over 10,000 emitters. Not every researcher, scientist, engineer, or technician have access to classified electronic warfare data to enable their work. Nor may they need the precision of classified data; instead, relying on representative and typical emitters to perform their activities in a rapid fashion without all of the requirements that come along with accessing and protecting classified data. Our unclassified database of over 10,000 emitter modes includes emitters spanning the globe and has examples of nearly every type of platform and emitter. The database is completely editable and changeable to reflect the parameters and characteristics of signals unique to your requirement. Contact us for more information.

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D-TA Systems

D-TA offers cutting-edge solutions for Electro-Magnetic Spectrum Operations (EMSO) to those who protect us.

From Antenna and RF Design to High-Speed Networks and Multi-core Real-Time Software Technologies, D-TA controls the technology stack to bring you end-to-end solutions for:

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- EW Threat Emulation for device testing and operator training
- Over-The-Horizon Radar for long-range surveillance
- Wideband multi-channel RF & IF record/playback
- Extreme-SWaP and mission agnostic EMSO solutions

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