JUPITER

Advanced EW System

SOUTHWEST RESEARCH INSTITUTE® Top-Level Overview May 2024



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SwRI Corporate Overview

- Non-profit independent applied research engineering organization
- R&D in all major engineering and scientific fields
- \$9.4M/yr invested Internal Research and Development
- Total Revenue: \$796M ; ~3100 employees
- Over 1,500 acres facility in San Antonio, TX
- Over 2.5M square feet of laboratories, workshops & offices
- More than 1,500 patents; 52 R&D 100 Awards
- 12 locations in the United States plus United Kingdom and China
- 11 Technical Divisions
 - Chemistry & Chemical Engineering
 - Powertrain Engineering
 - Space Systems
 - Fuels & Lubricants Research
 - Intelligent Systems
 - Applied Power

- Applied Physics
- Space Science
- Defense and Intelligence Solutions
- Mechanical Engineering
- Solar System Science & Exploration





SwRI Headquarters, San Antonio, Texas

SwRI:Advanced Electronic Warfare Leader

Advanced EW Test - SPARTA



SwRI investment in Warfighter Capabilities via IR&D in advanced EW/Cognitive EW

JUPITER Development





Legacy EW Sustainment/Modernization

Developing advanced system solutions for more than 70 years.

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Open Firmware

JUPITER Benefits

- Largely Government owned
- Integrated system of advanced open architecture technologies: MOSA, SOSA™, and Big Iron
 - Low-cost upgrade path
 - Reduced life cycle cost
 - Remove vendor Lock
 - Inherently addresses current/future DMSMS
- Hardware (cards/backplane, firmware, software)
- SwRI led SOSA Hardware Acceleration committee
- Host platform agnostic
- Scalable/Configurable chassis payload as required by mission
- Rapid adaptation to changing mission
- Advanced ES and EA capabilities
 - Improved survival for warfighters
- High alignment with 16 AF Banshee Phoenix (BP) (ARCADE)



From OSA Concept to ES/EA Implementation





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Advanced Technologies

- ES
 - Wideband Digital Receiver
 - Ultra Wideband Situational Awareness
 - Digital Receiver – Next Generation Ultra Wideband
 - **Digital Receiver**
- EA
 - Digital Radio Frequency Memory
 - NIGHTJAR
 - LOOPER
 - NGHOST

- Cognitive EW
 - Adaptive ES/EA
- Technique Description
 - HOCA (Rapid Reprogramming)
- EW Test
 - SPARTA is currently testing OSA systems
- Legacy EW Support
 - Upgrading legacy systems to be more
 OSA compliant
- SwRI IR&D Investments



Wideband Digital Receiver

- Up to 8 tunable 2 GHz channels
- Successfully demonstrated: at multiple test facilities
- Key Differentiators:
 - SOSA Aligned



- Better characterization with high fidelity digital measurements
- Improved SWaP over existing receiver architectures
- Full characterization of wideband threats
- Successful characterization in the presence of high congestion



<u>Ultra</u>Wideband Situational Awareness Digital Receiver

- Constant staring
- Successful hardware prototype demonstration held September 2023
- Key Differentiators:
 - Ultra fast detection
 - SOSA aligned
 - Direction finding
 - Significant SWaP reduction



"Top 100 R&D Innovation in 2020" Acquisition algorithms for Jammer Analysis Software, SPARTA, also used in UWR program

• Single 3U card can replace several existing cards allowing for more mission specific resources



Next Generation <u>Ultra</u> Wideband Digital Receiver

- Utilizes next generation digital hardware sampling rates of 64+ GSpS
- Hardware prototype demonstration summer 2024
- Key differentiators:
 - SOSA Aligned
 - Low SWaP



Single UWR card will insert here versus multiple cards in today's systems

- Single 3U card can replace multiple existing narrowband Tx/Rx cards
- I2+ GHz of Tx/Rx instantaneous bandwidth
- Utilizing next generation machine learning to extract/improve features



NIGHTJAR

- HOCA Enabled "Smart" noise capability
- 4 Technique Generators (TG) per FPGA card
- Trigger capabilities based on Mini-Receiver pulse qualification
 - Enables low latency adaptive EA
- Proven Effective in Laboratory Demonstrations
 - 4 Technique Generators per channel
 - 2 GHz instantaneous bandwidth (I GHz per channel) per FPGA card



LOOPER

- HOCA enabled DRFM capability
 - Simple DRFM based techniques (Mini-DRFM)
 - HOCA facilitates technique sharing between platforms
- Proven Effective in Laboratory Demonstrations
 - I Technique Generators per channel
 - 2 GHz instantaneous bandwidth (1 GHz per channel) per FPGA

card





- Technique Description Language (TDL) Based DRFM capability
 - All typical DRFM based techniques
 - TDL facilitates technique sharing between platforms
- Proven Effective in Laboratory Demonstrations
 - 4 Technique Generators per channel
 - 2 GHz instantaneous bandwidth (1 GHz per channel) per FPGA

card



NGHOST

- Coherent techniques
 - Tunable repeater channel
- Frees up resources in DRFM
- Three or more output channels
- Successfully tested to counter a very lethal class of threats



HOCA

- Heterogeneous Open Computing Architecture (HOCA)
- Enables rapid reprogramming of EW systems by allowing:
 - Domain specific language that describes EA technique
 - Identifies hardware resource it should be delegated to

(Technique Generators, Firmware Assets, etc.)



Recent Successes

- JUPITER technologies as integrated into other systems have had the following successes
 - NGHOST validated
 - JUPITER (lab; initial capability) Successful demonstration
 - Against laboratory test emulators
 - Defeated multiple simultaneous modern threats with no engagements
 - JUPITER demonstration
 - Effective EA techniques
 - Threat detection and automated EA responses
 - Cognitive EW and Ultra Wideband Receiver

Internal Investment approved for future technology application



EW Test - SPARTA SPARTA Measurement Capabilities

- ECM characteristics
- Range deception
- Velocity deception
- Angle deception
- Multiple false targets
- AM (on/off) modulation rate
- AM (on/off) duty cycle
- Percent jamming
- Intrapulse characteristics
 - BPSK chip size & code
 - LFM/chirp bandwidth

Summary

- Coordination between range and velocitv
- PW modulation
- AM and pulse enveloping
- Spurious signals
- Gain & amplitude analysis
- Pulse drop-out
- Radar characteristics
- Multiple radar beams
- Pulse-to-pulse Freq, PPI, PW
- Scan rate



2.6 Intrapulse 2.7 Latency and Timing





Emerging Standards Enhancements

- Software Framework for "portable" EW Apps
- SOSA
 - JUPITER technologies as integrated into other systems
 - Designed with alignment to SOSA Snapshot 3, Technical Standard vI
 - Technical Standard v2 released August 2022
 - Continue maturation to the SOSA standard
 - 100Gige
 - PCIe 4.0
 - Security/encryption protocols



Tactical Aerospace

Premier Supplier for Aerospace and Avionic Quality Technology on New and Legacy DoD Systems

Avionics & Aerospace Engineering Design, Integration, & Test

- Avionics/Mission System Development, Modernization, & Sustainment
- Obsolescence Refresh or Re-Design
- Engineering: Systems, Electrical, Software, Firmware, Mechanical
- Cognitive/Neuromorphic AI: Electronic Warfare, Situational Awareness
- Advanced System Simulation, Human Factors, Training
- Lab, Depot, & Flight Line LRU/CCA Test Systems
- MOSA, SOSA, FACE, and Safety Critical Designs
- SAM/Radar Test Range Systems Obsolescence Re-Design & Refresh
- Embedded RTOS, Time & Space Partitioned SW Applications
- Integration, Qualification, Cyber, and V&V
- A-10 Maintenance/Field Support



















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Antenna and RF Design Capabilities

Design, development, test, integration, and production:

- Electrically-small antennas, ultrawideband (UWB) antennas, reconfigurable antennas, DF arrays, electronically scanned arrays,

switched beam arrays, metamaterials.

- Applications in comms, DF, TTL, SATCOM, over-the-horizon, radar; commercial and military.
- RF front end (RFFE) and associated electronics and passives.
- Integration on a variety of platforms from body-worn to airborne.
- Full RF spectrum: DC 110 GHz.













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Radiated Measurement Capabilities

- Full spectrum RF test capabilities.
- Anechoic chambers (100 MHz 110 GHz)
- 200-acre antenna test range











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SwRI F-15 Involvement



Avionic, Support and Test Equipment

-Life-extension work

-Sustainment and Modernization Planning

THE 5 MS OF AIRCRAFT LIFE EXTENSION

Measurement, Monitoring, Modeling, Maintenance, Modernization



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SwRI F-I5 Involvement (continued)



EW Pods

-Over 30 years of sustainment, IV&V, modernization, engineering services and development

Robotic depaint system used at Robins AFB



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