Sea-Skimming Missile Tracking Radar Array (SEMTA)

SBIR Kick-off Meeting

June 29, 2021

Period of Performance: 06/10/21 – 09/15/23

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Agenda

- Corporate Overview
- Technical Discussion
  - Air Force Needs
  - Intellisense's SEMTA
  - Phase II Work Plan
- Key Personnel

Corporate Overview

Intellisense Systems creates advanced sensing and display solutions supporting the *data continuum* from acquisition to visualization

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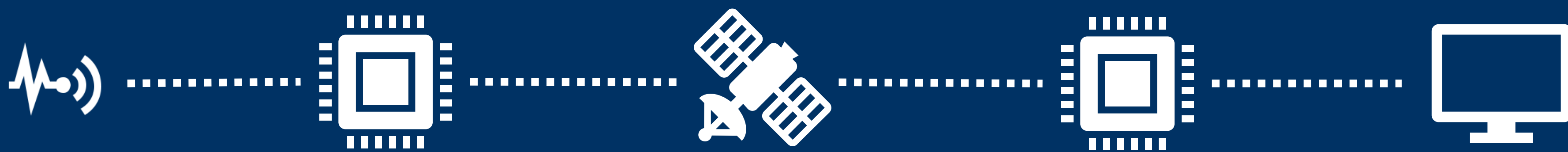
Intellisense Systems Overview

- Founded in 2017 – as a spin-off from Physical Optics Corporation (POC)
- Private, Employee-Owned Company
- Government Recognized Small Business
- 160 Employees with ~100 skilled Engineers and Scientists
- Certified to ISO9001:2015/AS9100D and ISO9001:2015/AS9110C; CMMI-DEV:ML3
- DCAA-audited and DCMA-approved Accounting and property management systems.
- Full-rate production programs

- Financially Stable and Profitable
  - ~$40M Annual Revenue (2020)
  - Significant Cash Reserves
  - No Long-Term Debt
- >70,000 ft^2 of Facilities in Torrance, CA
- Security Cleared Facilities
- 30 Issued patents and 10 pending
- Strategic Advisory Board

The Data Continuum from Sensor to Display



Sensor data acquisition

- Environmental
- Acoustic
- Seismic
- Structural
- Image (UV/VIS/IR)
- LIDAR
- RADAR

Processing

- Compression
- Sensor Interpretation
- Recognition
- Classification
- Augmented Intelligence (AI)
- Machine Automation and Control
- Data logging

Communications

- Iridium
- Cellular 4G/5G
- Bluetooth®
- WiFi
- LiFi
- Cabled

Processing

- Cloud Management
- Big Data
- Augmented Intelligence (AI)
- Human Machine Interfaces (HMI)
- Non-Destructive Inspection
- Machine Automation and Control
- System Optimization
- Open-Architecture Avionics Systems

Visualization

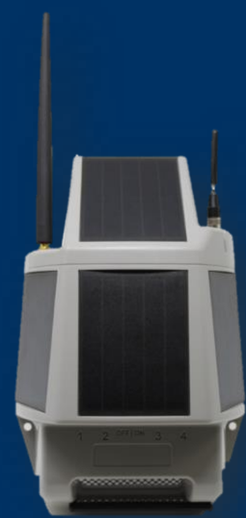
- Avionics Displays
- Rugged Displays
- Smart Displays
- Image Fusion
- Image Enhancement
- Night Vision
- AR/VR Goggles
- Web-based User Interfaces

State-of-the-Art Manufacturing Facility

- Our infrastructure supports technology transition, based on well-established processes for production and testing.
- The Intellisense manufacturing capabilities include electronics fabrication, unit qualification testing, systems integration, and volume production with full quality assurance.
- Our facilities have Secret clearance, comply with all applicable ITAR provisions, and meet all applicable environmental laws and regulations.
- Intellisense Systems operates in accordance with CMMI-DEV:ML3 standards and has achieved ML3 benchmark in 2019. Our QMS is certified to ISO9001:2015/AS9100D and ISO9001:2015/AS9110C.

Commercial Off-The-Shelf (COTS) Products

All-in-one
Weather
Stations



IoT
Flood
Sensors

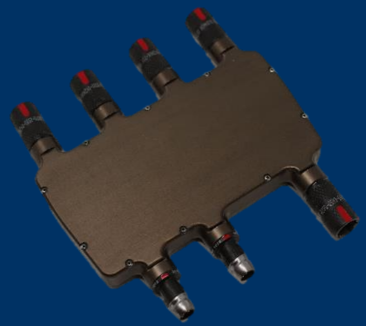
Rugged
Avionics
Displays

2021 Emerging Technologies

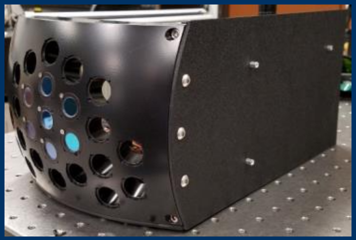
RADEC: AI with hardware for RF/EW identification and counter measure

DReTL: Atmosphere turbulence LIDAR for DEW applications

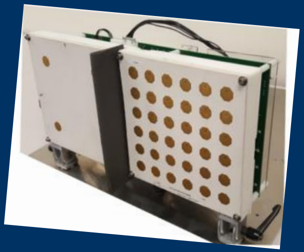
IROWL: EO/IR sensor enhanced by built-in AI and wireless communication



WASP: 7-port wearable power management



AURUM-ON: Computer vision for autonomous systems

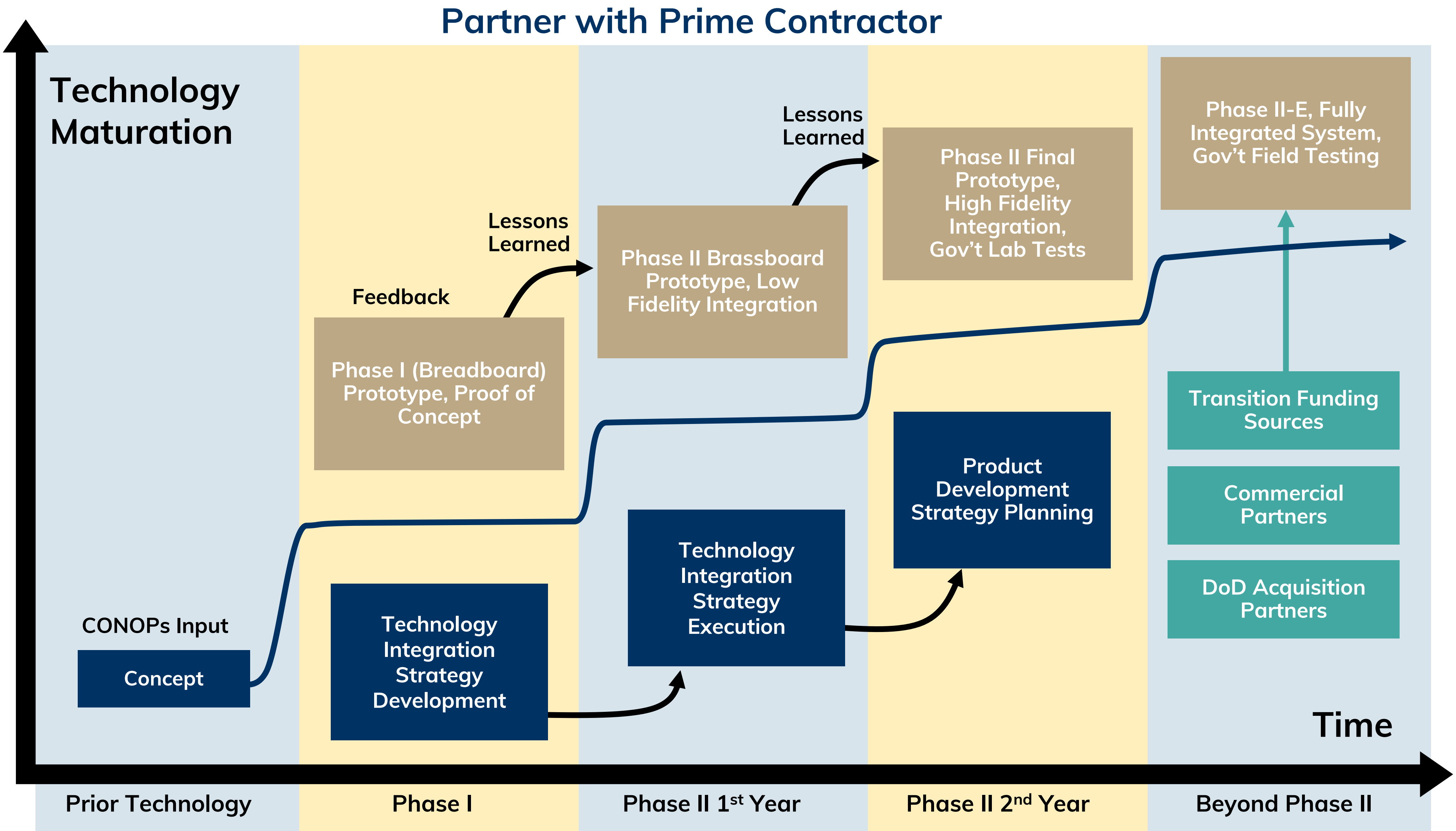


PAN-UAS: Portable RADAR for counter UAS

PAISLEY: Automated platform for surveillance and sensing

NUFEP: Active eye-protection goggles

SBIR Technology Transition Roadmap



Technical Discussion

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Review of the Air Force's Needs

- The United States Air Force (USAF) is seeking a means to improve target detection and tracking over water ranges utilizing unmanned surface vehicles (USVs). The intended target is a low radar cross section (RCS) sea-skimming (low altitude) missile flying at supersonic speed. The required tracking accuracy is 10 meters in 2D horizontal coordinates.
- Testing on water ranges is currently limited by the inability of land-based and ship/barge-based radars to track targets over-the-horizon, while a full use of the Gulf of Mexico is essential for long-range test missions requiring system under test (SUT) tracking.
- A new surface-to-air radar system for use on an USV would significantly increase target tracking coverage over water and improve the tracking accuracy. Furthermore, using a fleet of autonomous USVs would enable the USAF to leave the radar systems in the sea for long periods of time between tests and wake them up and configure them for testing on demand.
- Although the horizon limit may be overcome with airborne radars like AN/APG-81 or AN-APY-9, these radars provide neither sufficient detection and tracking range nor tracking accuracy of low RCS targets. In addition, separation of the sea-skimming missile radar return from sea clutter might be a harder problem for airborne than for surface-based radars.

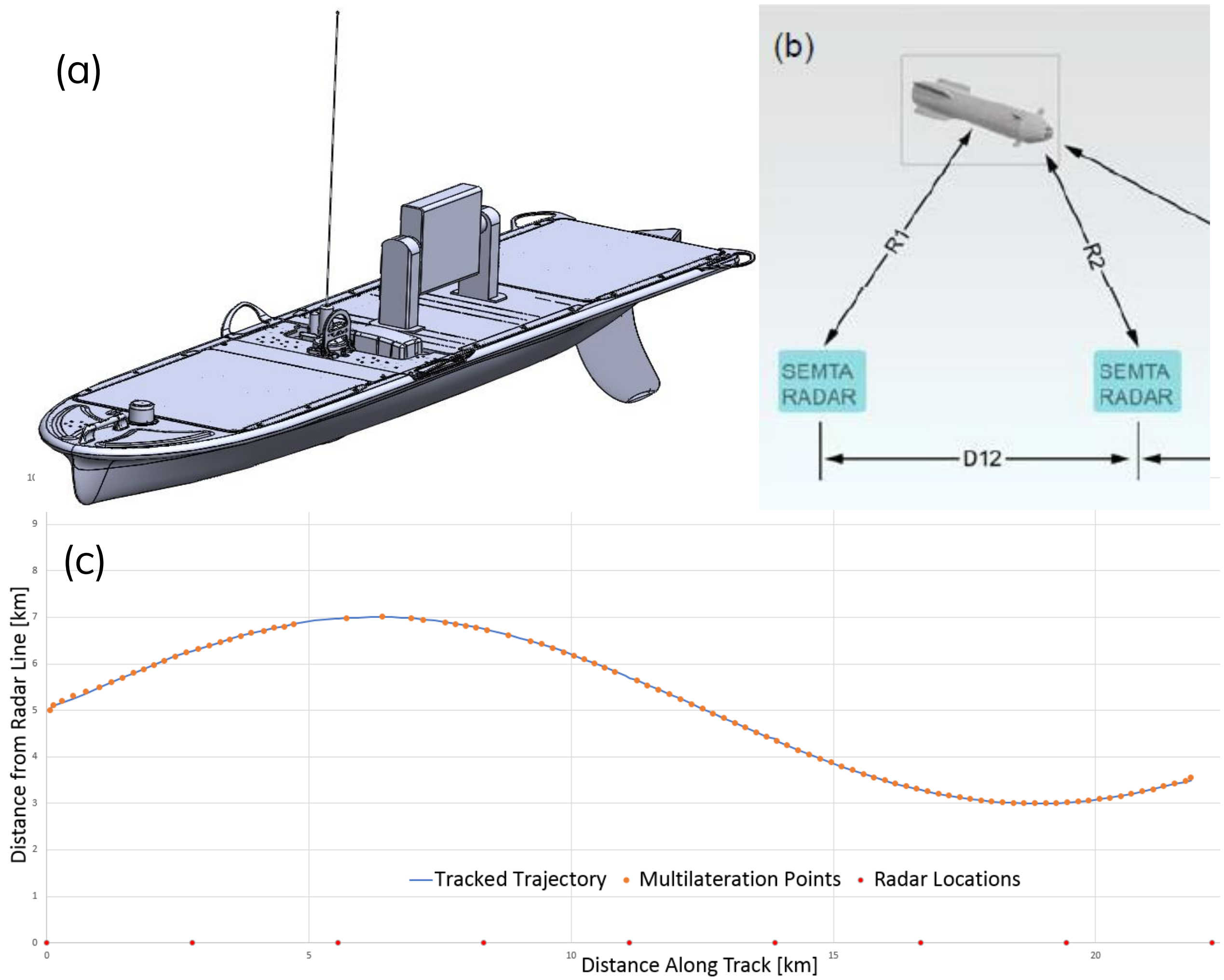
Intellisense's Solution: Sea-Skimming Missile Tracking Radar Array (SEMTA)

In Phase II, Intellisense Systems, Inc. (Intellisense) will advance the development of the new Sea Skimming Missile Tracking Radar Array (SEMTA), proven feasible in Phase I, for high accuracy tracking of a low-altitude supersonic missiles while operating from nonstationary USV platforms.

The SEMTA system operates in a multi-sensor configuration and is based on a compact radar design and new data processing approach. SEMTA radar sensors form a scalable linear array configuration along the target's trajectory to create a composite over-the-horizon field of view (FOV). Multilateration is applied using data from at least two radars to calculate the target's position with an accuracy of <10 m at ranges up to 5 nmi. The SEMTA tracker collects and fuses data from all the radars in the array and computes the target's composite flight trajectory.

A compact radar, installed on an USV, utilizes the USV's power, Global Positioning System (GPS), and communication systems and controls its movements to compensate for the hydrodynamic forces. SEMTA radars can operate in search, tracking, and search-while-tracking modes.

Intellisense's Solution:
Sea-Skimming Missile Tracking Radar Array (SEMTA)



SEMTA system: (a) X-band radar sensor installed on Wave Glider USV; (b) single target tracking with a linear multi-sensor array configuration - red dots on the X axis mark positions of the sensors; (c) bilateration localizer uses range measurements from two closest sensors for accurate calculation of 2D coordinates of the missile.

Results of Phase I Work

Phase I Objectives

Objective 1. Definition of the system requirements considering the USAF's requirements.
Objective 2. Definition and development of the system architecture.
Objective 3. Feasibility demonstration of the SEMTA system.
Objective 4. Definition of the commercial market for SEMTA technology.

All Phase I objectives were accomplished by executing the project tasks as described in the following sections.

In Phase I, Intellisense first developed SEMTA's conceptual system architecture and modeled and simulated it in MATLAB®. Intellisense then developed the conceptual design of the SEMTA radar sensor, including the antenna, transceiver, and modulation waveform, and selected the main COTS components. Intellisense developed and built a breadboard prototype of the RF Module, tested the prototype's performance at the seashore, and summarized the test results, demonstrating the feasibility of the SEMTA technology. Finally, Intellisense developed the mechanical design concept of the SEMTA radar and the stabilization mechanism that will enable its installation and operation on a Wave Glider USV. Intellisense completed all the tasks and met all the objectives of Phase I, including the exploration of technology transition and commercialization paths.

Phase II Development and Transition to Phase III Commercialization

In Phase II, Intellisense will finalize the system architecture and configuration through a design review with the USAF, mature the system design, develop and build the radar unit prototype and conduct performance verification experiments. At the end of Phase II, the SEMTA system will be ready for evaluation and demonstrations through testing of a dual-sensor system (on shore). The specific focus will be on executing the technology development plan to address all the USAF requirements for a compact multi-sensor radar system ready for installation on USVs and capable of high accuracy tracking of fast low-flying targets.

The success of Phase II will lead directly to Phase IIE transition for integration and testing with USV platforms, package ruggedization, system qualification for compliance with MIL-STD-810G and other applicable standards, and low-rate initial production (LRIP), qualification, and a follow-on production/acquisition strategy. The goal is to support not only military but also potential civilian applications. The SEMTA system and its derivatives can certainly be used with military and civilian platforms in marine and ground-based installations and adapted to security and surveillance to replace big and expensive radar systems with a scalable array of compact low-cost sensors.

SEMTA Phase II Objectives

- Objective 1

Refinement of the SEMTA design through simulation and analysis to meet the USAF requirements

- Objective 2

Development and integration of the SEMTA prototypes

- Objective 3

Testing and characterization of the SEMTA prototypes

- Objective 4

Exploration of the commercialization and transition pathway of the SEMTA technology

Phase II Statement of Work (SOW)

Task 1. Improve System Architecture to Address Requirements (Objective 1)

Based on results achieved in Phase I, Intellisense will review and refine the SEMTA system architecture and system specifications and conduct a design review with the USAF. Requirements for specific modules (i.e., subsystems) will be defined. This task will also include identifying technical and programmatic risks.

Task 2. Develop RF Module (Objective 2)

Intellisense will develop the RF Module, including the radar antenna, transceiver, modulation waveform, and ADC. The major parts of RF Module will be designed, tested, and optimized separately before integration of the base prototype. For antenna design, Intellisense will collaborate with our consultant, Dr. Aramais Avakian.

Task 3. Develop Digital Module (Objective 2)

Intellisense will develop a Digital Module that contains a processing system-on-module (SoM), radar controller, and power management circuit. The SoM will be based on a multiprocessor system-on-chip (MPSoC) that enables real-time implementation of the radar signal processing algorithms.

Task 4. Develop DSP and Embedded Control Software (Objective 2)

Intellisense will adapt, enhance, and optimize the DSP algorithms, developed in MATLAB in Phase I, to achieve real-time processing throughput, convert the algorithms to C/C+ code and port them to the Digital Module MPSoC. Intellisense will also develop a single sensor tracker software for the MPSoC-based embedded Linux environment and radar control application, including the scheduler and power management. Finally, Intellisense will develop the communication and control software interface with the USV devices, including support of the satellite communication.

Phase II Statement of Work (cont.)

Task 5. Integrate and Test Base Prototype System (Objective 2)

Based on results of Tasks 2-4, Intellisense will develop and integrate a base prototype of the SEMTA radar sensor, including the RF Module, a MPSoC evaluation kit and a laptop. Intellisense will perform functional and performance tests and identify design improvements based on test results and lessons learned from component development and first prototype integration and testing.

Task 6. Develop Tracker, Visualization, and Network Application Software (Objective 2)

Intellisense will develop the software applications for the central processing unit, including the tracker operating on the data collected from all the SEMTA sensors, the visualization of the SUT's trajectory, and the satellite network data processing to recover the sensor data.

Task 7. Develop Mechanical Housing (Objective 2)

Intellisense will develop the mechanical housing and mounting hardware for the RF Module. Intellisense will also develop, build, and test the stabilization mechanism for the RF Module. Finally, Intellisense will develop a payload box for the functional prototype that contains the Digital Module and other components.

Task 8. Iterate Prototype Design (Objective 2)

Intellisense will refine the RF Module, Digital Module, and radar DSP and control software based on results of testing in Task 5. Based on integration and test results of Task 7, Intellisense will refine the mechanical design. Based on test results from Tasks 4-6, Intellisense will refine the software design.

Phase II Statement of Work (cont.) and Deliverables

Task 9. Fabricate and Integrate Functional Prototype System (Objective 3)

Intellisense will fabricate all the updated hardware modules and subsystems and integrate the functional prototype system.

Task 10. Perform Characterization Experiments (Objective 3)

Intellisense will perform lab and outdoor testing of the prototype system's functionality. Intellisense will then perform characterization experiments and quantify performance of the SEMTA tracking system.

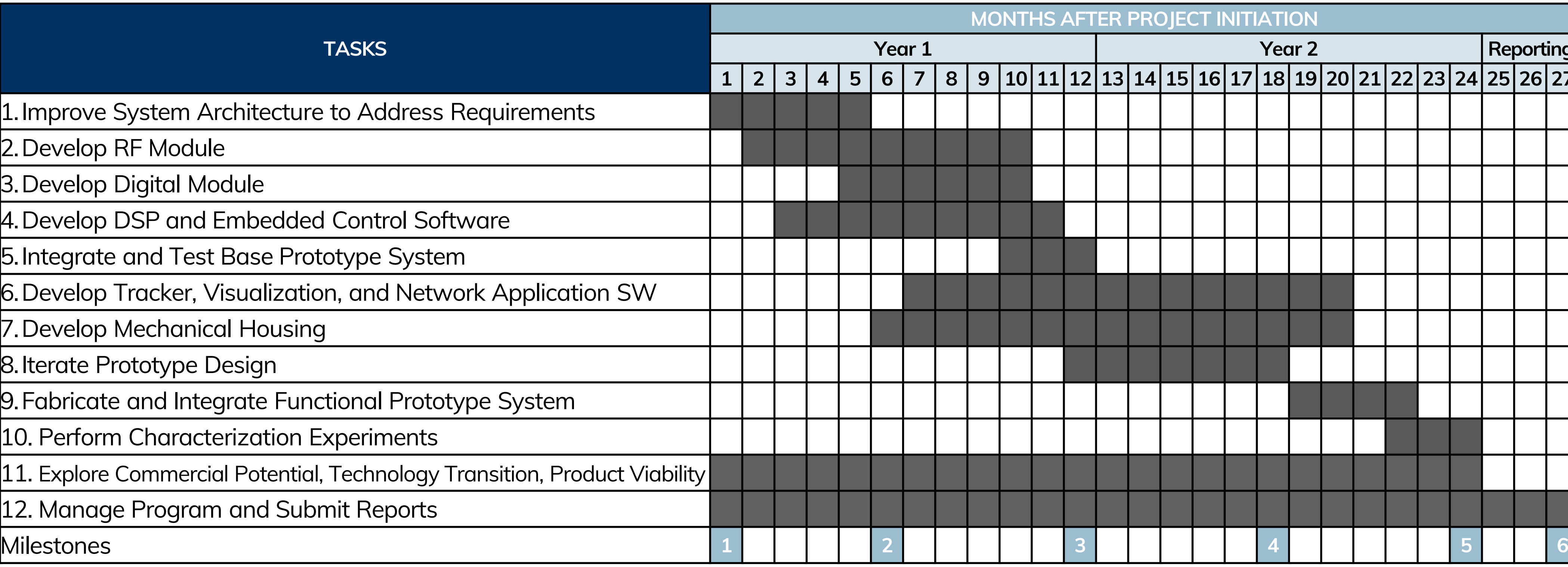
Task 11. Explore Commercial Potential, Technology Transition, Product Viability (Obj. 4)

Intellisense will explore the potential to transition the SEMTA system to the USAF programs and commercial markets. A technology transition strategy and product roadmap will be developed. We will prepare a preliminary Phase III development plan to transition the technology to USAF use. Sources of Phase IIE and Phase III guidance and matching funds will be identified early in the project. Intellisense will survey the marketplace and identify applications for the SEMTA technology, including derivative products.

Task 12. Manage Program and Submit Reports

Intellisense will undertake program management and reporting, as well as communication with the Technical Point of Contact (TPOC). Intellisense will prepare and submit reports in accordance with contractual requirements. Program management will include planning and monitoring funds allocated for specific tasks and periods of the project, scheduling, preparation, and submission of reports on time, scheduling review meetings and demonstrations according to the schedule and milestones.

Phase II Task and Milestone Schedule



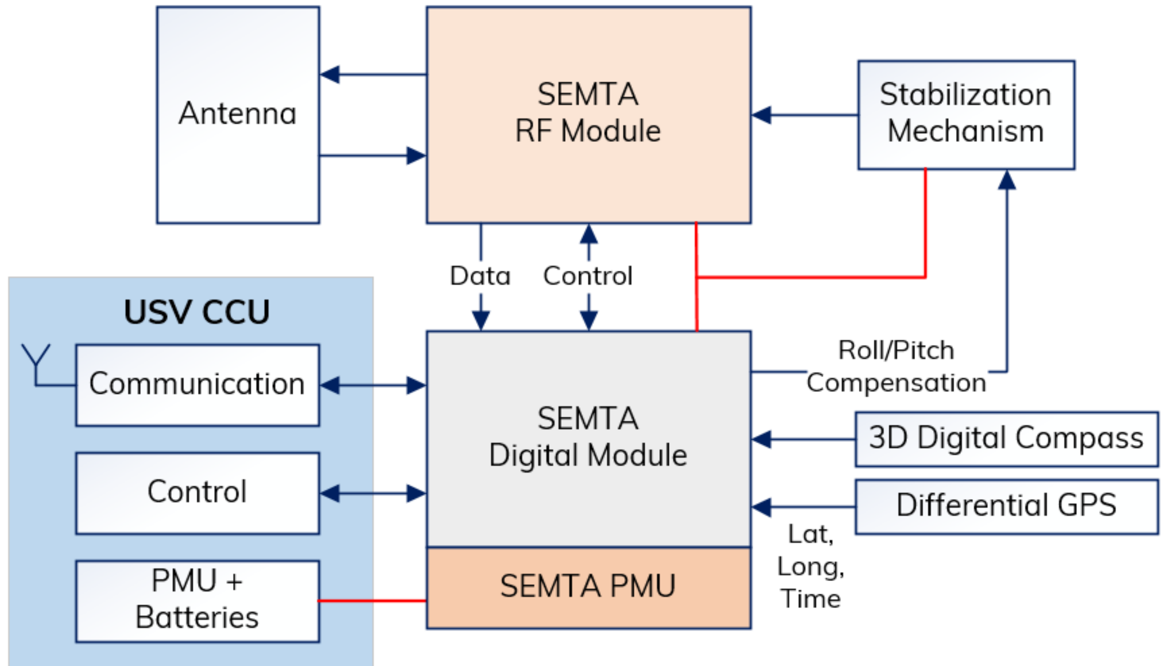
Milestone 1: Kick-off
Milestone 2: Architecture and specifications review
Milestone 3: Base prototype testing complete
Milestone 4: Design refinement complete
Milestone 5: Performance testing complete
Milestone 6: Final report and close-out

Period of Performance: 6/10/2021 to 09/15/2023
Total Contract Value: $750,000

Phase II Deliverables

CLIN	Description
0001	Quarterly Progress Reports (#1-8)
0002	Presentation Material (Kickoff and Technical Review Meetings)
0003	Scientific and Technical Report (Draft and Final)
0004	Operation & Maintenance Manual (Draft and Final)
0005	Hardware/Software System
	Inventions Report

Refinement of System Architecture (Task 1)



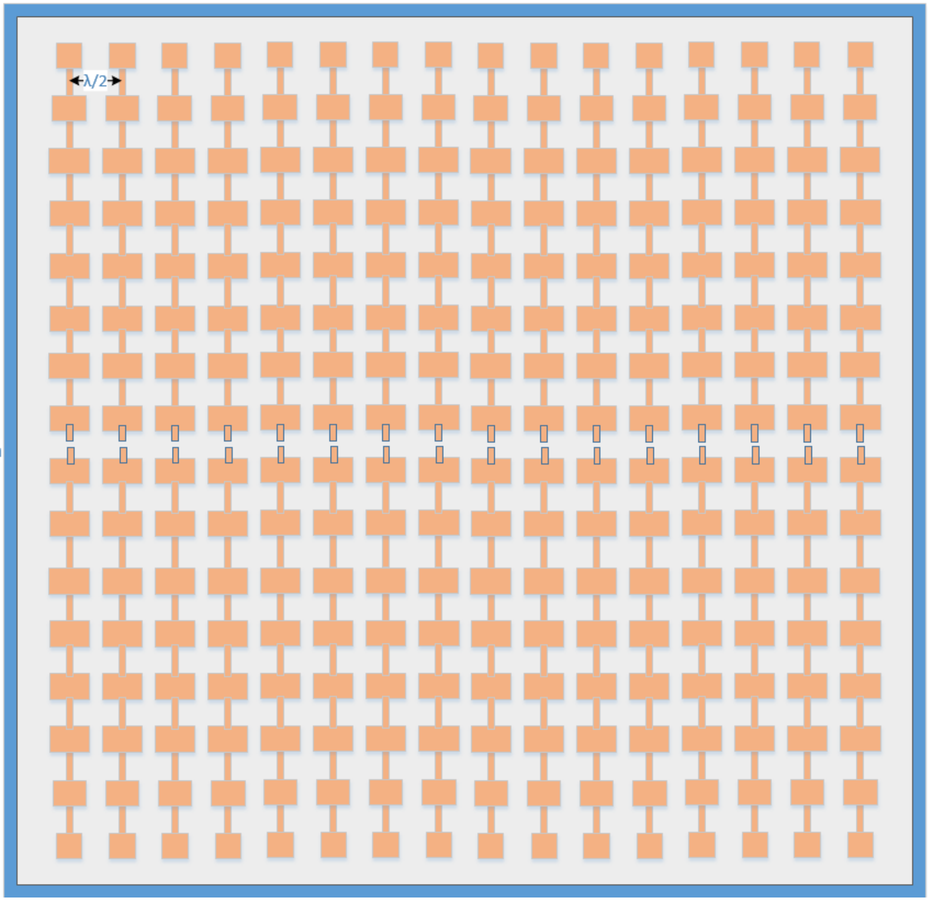
The RF Module with antenna, placed above the USV's surface, uses the stabilization mechanism that compensates for the roll and pitch of USV movements to keep the SUT within the antenna's FOV. The RF Module digitally interface with the Digital Module located in the USV's payload box. The Digital Module executes the sensor control application that manages the RF Module's operation and interfaces with the USV's CCU, which provides USV navigation, communication, power management and rechargeable batteries, and is used to transmit the sensor output data to the remote server. The RF Module uses the 3D Digital Compass data and USV wave measurements to calculate the roll/pitch compensation needed to stabilize the RF Module. It also uses a differential GPS to calculate the USV's actual position and timing, which is essential for high-accuracy sensor tracking.

Refinement of System Architecture (cont.)

Preliminary Key Performance Parameters for a Single SEMTA Sensor

Parameter	Phase II Threshold	Phase II Objective
Detection Range (nmi)	1.5–3	1.5-5
Range Accuracy (m)	<5	<3
Maximum Velocity of the Target (m/s)	400	600
Average Target RCS (m^2)	0.01	0.01
FOV Azimuth / Elevation (°)	90 / 30	
Monopulse Capability	Azimuth	
Operational Frequency Bandwidth (GHz)	9.3–9.6	
Waveform	Linear frequency (chirp) modulation	
Electronic Angular Scanning	Azimuth	
Size (W×D×H) $in.^3$: RF Module / Digital Module	12×12×3 / 12×6×6	
Weight (lb)	10	
Power Consumption (W)	80	50
Estimated Production Cost	$15,000	$10,000

Development of RF Module (Task 2)



The planar microstrip antenna (11 in. × 11 in. aperture) contains a 16-element 1D linear array placed on the side of the PCB made with high-frequency, low-loss dielectric materials and enables electronic beam steering capability in the horizontal direction. Each antenna element is fed from the via at the center of the line. The antenna has a 7°-wide pencil-type beam, electronically scanned in the horizontal direction, and its expected gain is 27 dBi. The antenna's operational bandwidth of 300 MHz supports frequency diversity operation, which allows separation of signals from multiple radar sensors. Intellisense will use HFSS software for the antenna development and performance evaluation.

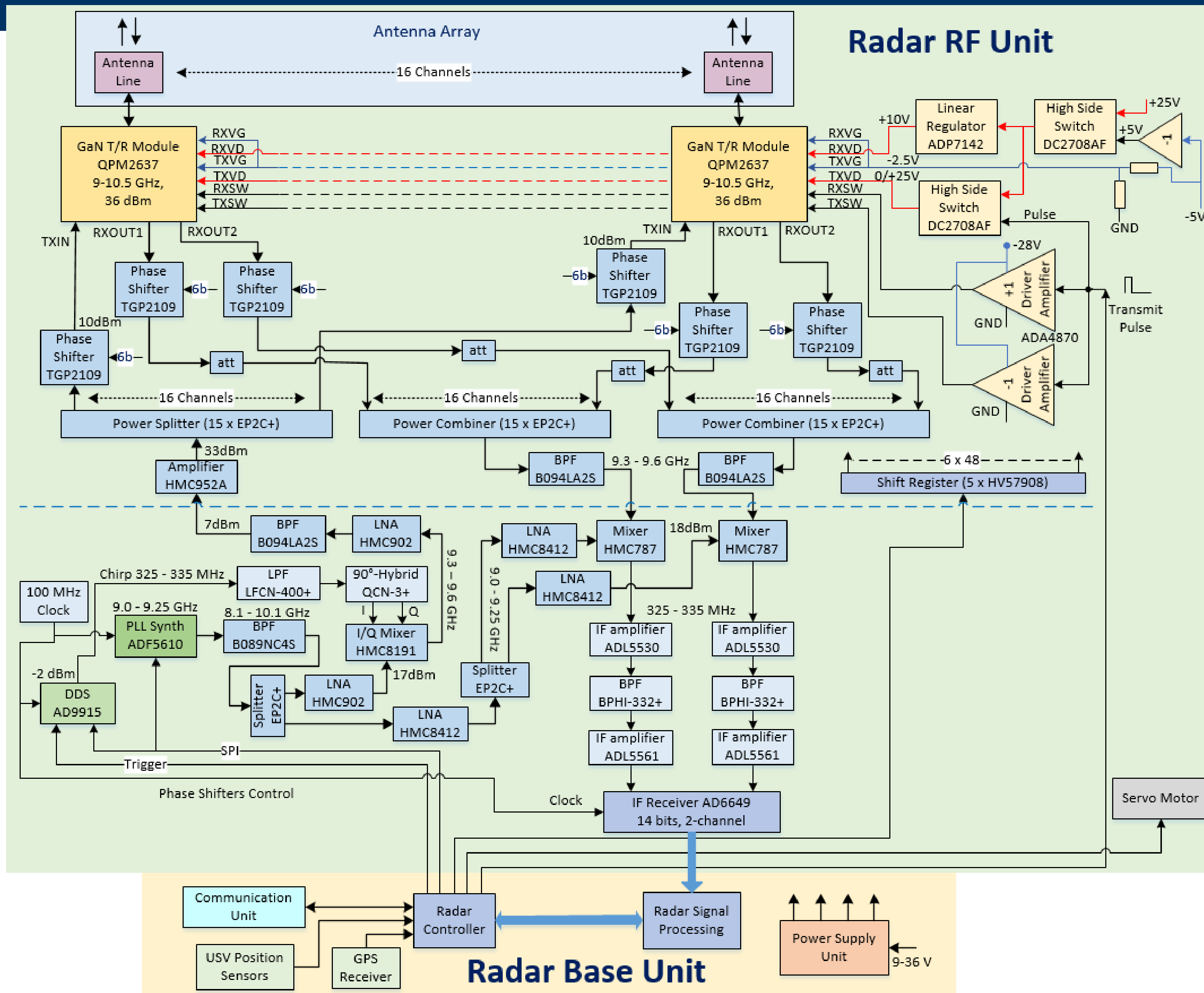
We will integrate the antenna and transceiver's RF front-end circuit on the same PCB by placing components on the back side of the antenna to reduce interconnection losses and radar SWaP-C.

Development of RF Module (cont.)

Schematic diagram of the radar RF module that integrates antenna and transceiver and provides connections to the radar base module.

The radar transceiver will be designed as a two-PCB assembly: above and below the blue dash-line, with the top half located on the antenna PCB.

The radar signal sources, up/down conversion and ADC circuits will be implemented on a separate PCB.



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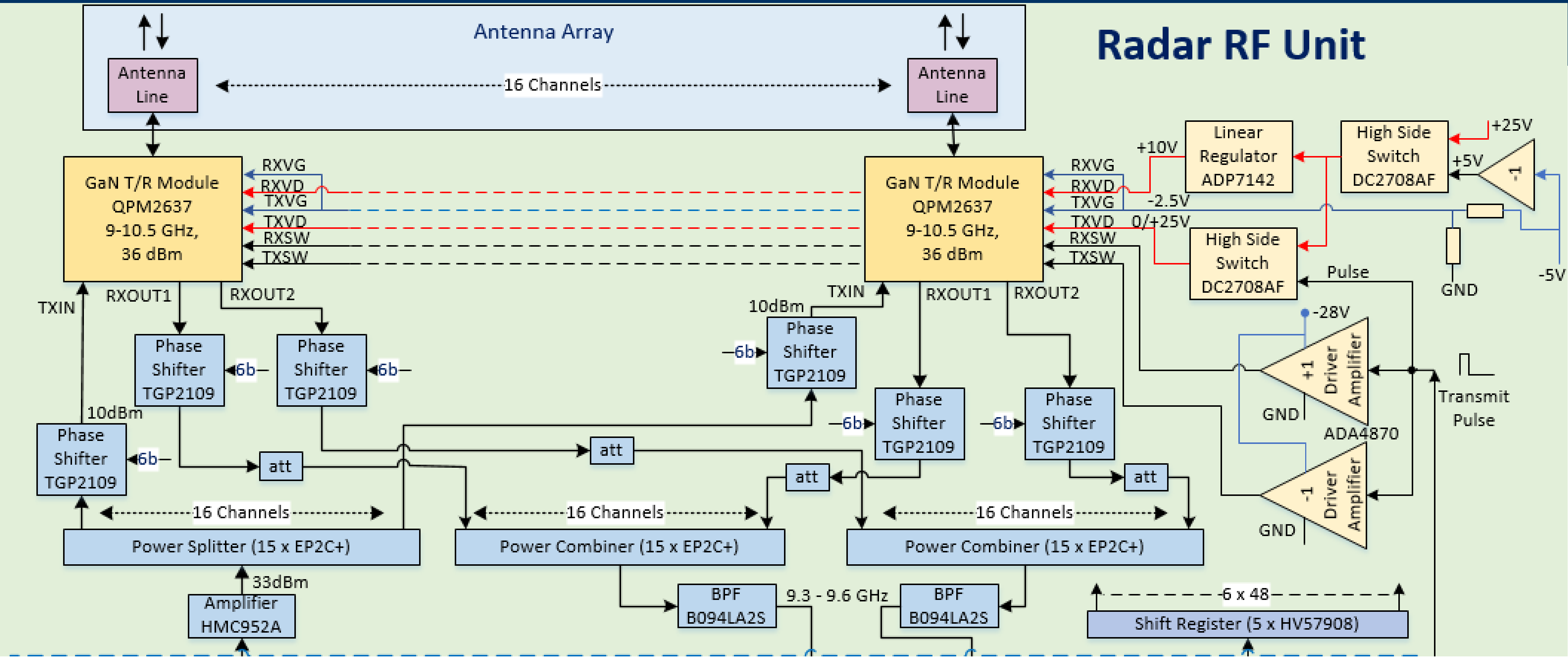
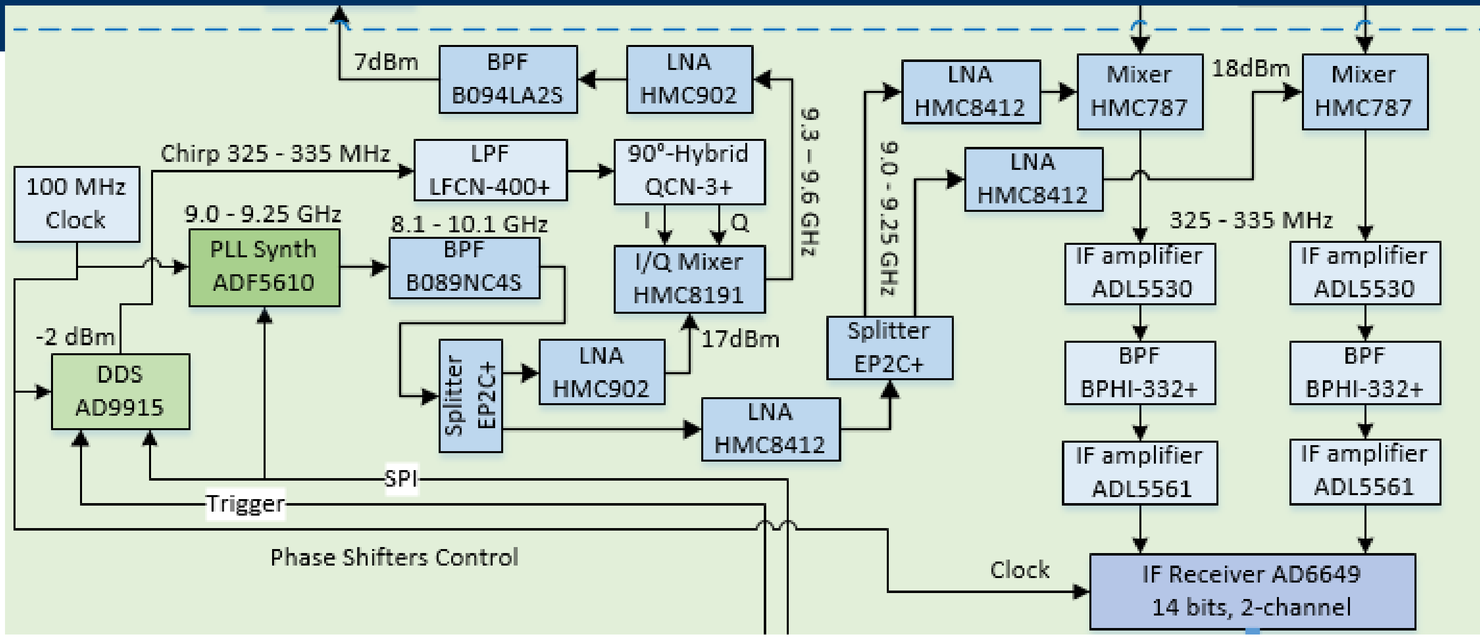
Development of RF Module (cont.)



The transceiver incorporates 16 QPM2637 T/R modules that feed the antenna 16-channel linear array. Each T/R module features one transmit input and two receive outputs with dedicated phase shifters. The dual output is utilized for monopulse operation to follow the fast-moving target by using the phase shifters control. The saturated transmit power of the QPM2637 is 4 W, which provides 64 W total RF peak power of the radar. The 6-bit digital phase shifters with 5.625° resolution are used to steer the transmit and receive beams. The phase shifters are controlled by a shift register line, which is loaded from the radar controller and includes five 64-channel serial-to-parallel converters. Each of three 16-channel power splitters/combiners includes 15 two-way devices each and serves as a radar corporate feed.

Development of RF Module (cont.)



The SEMTA radar design will support chirp modulation waveform as pulse compression method. The big advantage of the chirp is its Doppler tolerance, which allow to use relatively long pulse for high-speed target detection to increase the radar average power. Direct digital synthesizer (DDS) is an ideal tool to generate the chirp waveform. The chirp-length will be varied in the 5 - 20 μs range depending on the expected target range. The pulse duty cycle can be as high as 25% and can as low as 5-10% for close range operation. The nominal chirp bandwidth of 10 MHz corresponds to 15 m range resolution and expected range accuracy of ~3 m. The 325-335 MHz chirp signal from DDS (AD9915) is up-converted with 9.0-9.25 GHz LO signal, generated by PLL synthesizer (ADF5610), to obtain the RF transmit waveform in 9.3-9.6 GHz frequency range. On the receive side, RF-signals are down-converted to 325-335 MHz IF-signals and than converted to digital form by using direct IF digitizing technology with two-channel IF receiver AD6649. The IF-signals are converted to I and Q baseband signals digitally to achieve higher accuracy than analog down-conversion and reduce number of components on the board.

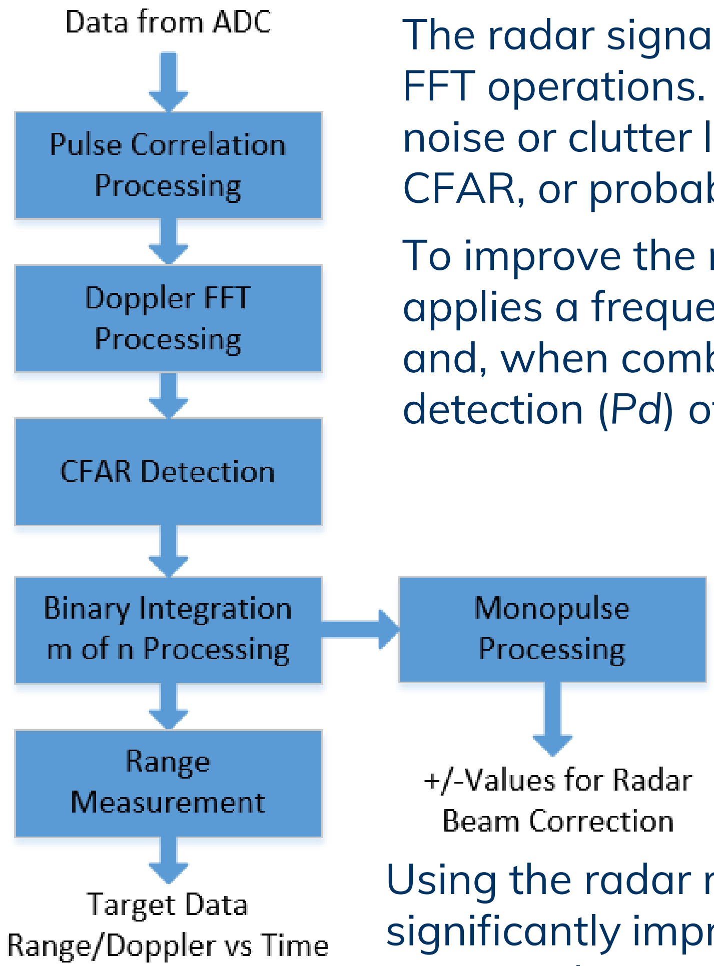
Development of Digital Module (Tasks 3)

Intellisense will design the Digital Module integrating iVeia or equivalent SoM based on Xilinx Zynq® UltraScale+™ MPSoC. To integrate a Zynq SoM, we will develop a carrier board that provides external connectivity via standard interfaces and incorporates communication ports, power management, and additional functionality of the Digital Module. The Zynq SoM has been selected because it integrates a field-programmable gate array (FPGA) in the programmable logic (PL) section and a multi-core processing system (PS) that includes two to four ARM® Cortex®-A53 processors and two Cortex-R5 real-time processors. We will implement FPGA-based hardware accelerators for computation intensive radar signal processing operations. The less intensive computations (tracking and control algorithms) will be performed by ARM processors. Also, the real-time processor will be used to execute the stabilization algorithm that continuously monitors the sensor position and computes the compensation angle for the RF Module to keep it in a vertical position.

The Digital Module will be built, and unit tested before integration of the functional prototype.

iVeia™ Atlas-II-Z8 SoM with Xilinx Zynq® UltraScale+™ MPSoC XCZU9EG, 4 GB DDR4 PS and 2 GB DDR4 PL, 4×GTR and 16×GTH serial transceivers. The SoM is 2.125 in. × 3.375 in. × 0.25 in.

Develop DSP and Embedded Control Software (Tasks 4)



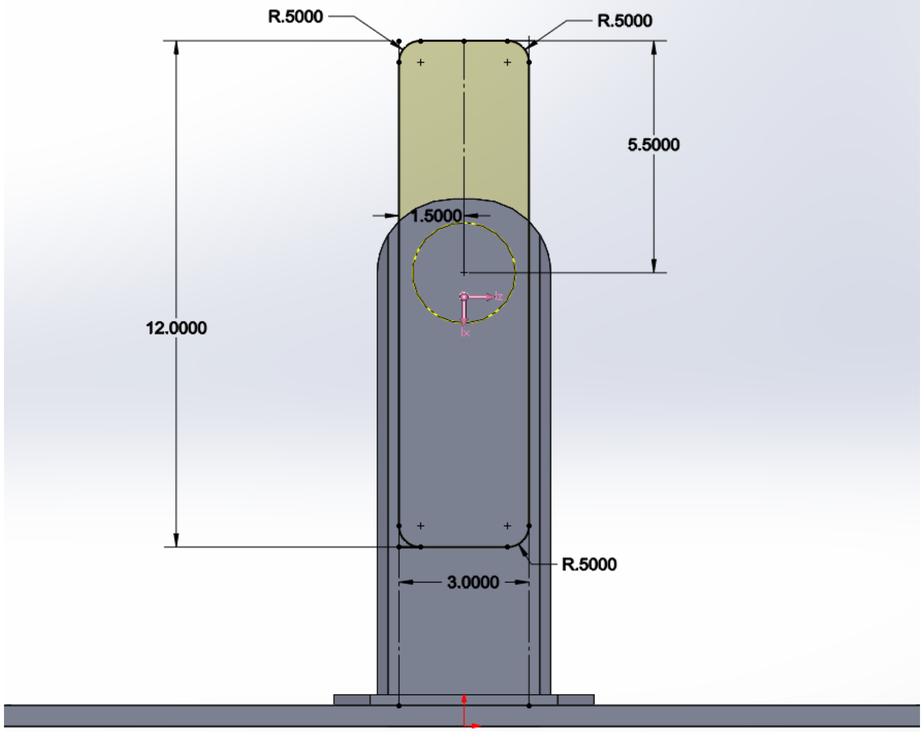
The radar signal processing is based on pulse correlation processing and Doppler FFT operations. A constant false alarm rate (CFAR) processor calculates an average noise or clutter level from radar data and determines the threshold level to maintain CFAR, or probability of false alarm (*Pfa*).

To improve the radar's capability to detect the fluctuated target, SEMTA radar applies a frequency diversity technique that can decorrelate the target return signal, and, when combined with *m* of *n* binary integration, provides high probability of detection (*Pd*) of low RCS targets with a low false alarm rate.

The dual beam capability of the radar receiver can simultaneously obtain radar data from two beams slightly shifted (approximately by a beam width or 7°) in the horizontal direction and implement monopulse operation in the azimuth direction. Comparing the two magnitude values for each position allows us to calculate the target's angular shift from the monopulse center and correct the shift by using electronic beamsteering control.

Using the radar range measurement technique (e.g., centroid algorithm) allows to significantly improve the accuracy of determining the range of a single target when compared to nominal radar range resolution. The range data sequence with timestamps provided by the GPS clock and the GPS coordinates of the radar platform is transferred via a USV Iridium communication link to the SEMTA server that collects and processes data from all the SEMTA sensors by applying the multilateration and Kalman filter tracking algorithms to calculate an accurate target trajectory.

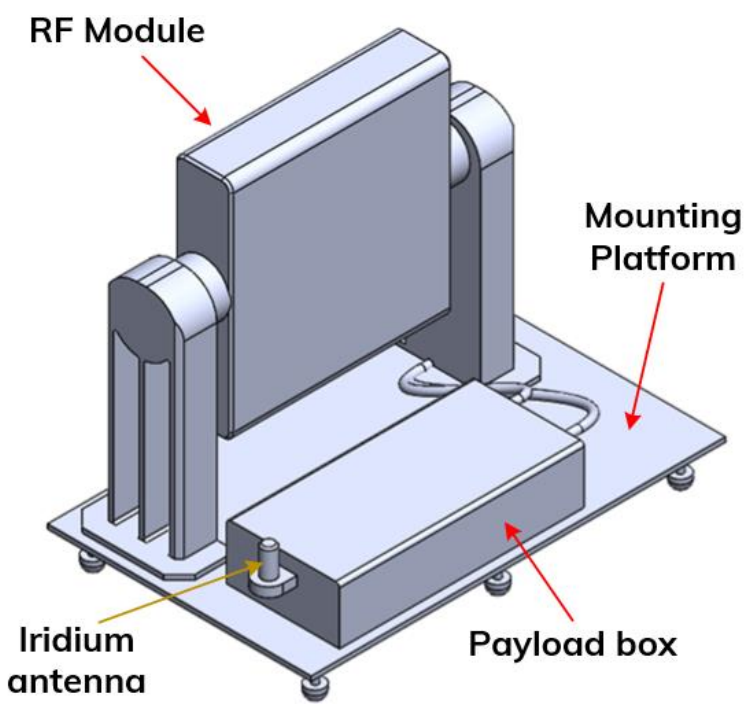
Development of Mechanical Design (Task 7)



Intellisense will develop the mechanical housing for the RF Module and Digital Module and the mounting support for installation of the RF Module on the Wave Glider USV. The RF Module housing will include a radome for the antenna side to minimize RF losses and beam distortion. The RF Module is installed in a waterproof housing and is maintained in a vertical position by the stabilization mechanism. The power and signaling cables are routed through the motor housing support. The entire housing is environmentally sealed and the bearings within the supports are sealed with environmental O-rings and grease to prevent any salt spray or salt fog intrusion. The support height may be increased up to 4 ft to make the radar higher and less sensitive to interference from waves.

The radar utilizes active motor-controlled compensation for the sea wave-induced roll and pitch movements of the Wave Glider in the form of brushless direct current (DC) servo motors, thus addressing the SEMTA radar's sensitivity to the roll and pitch movements of the Wave Glider due to the narrow (7°) vertical beamwidth of the radar antenna. A roll and pitch sensor (e.g., EC336A – a high accuracy 3D digital compass from SkyMEMS with ±0.1° roll/pitch accuracy) will provide roll and pitch angles to the onboard radar controller to calculate the motor-controlled radar panel position. In accordance with the SEMTA concept, the mechanical compensation accuracy is not directly related to the target positioning accuracy and should be in the 2° range to avoid sensitivity degradation of the radar sensor. The yaw deviation of the Wave Glider from the nominal direction will be compensated by electronic beam steering of the radar antenna in the horizontal direction.

Prototype Development (Tasks 5, 8, and 9)



Intellisense will develop two prototype systems. First, we will develop a base prototype of the SEMTA sensor that incorporates the RF Module and Xilinx Zynq MPSoC evaluation kit (EVK) emulating the Digital Module. The primary objective of the base prototype is to validate the RF Module design and evaluate its performance. The radar signal processing will be performed in MATLAB on the data preprocessed and recorded by the EVK. The test results of the base prototype will be analyzed to correct and refine the radar design for the next development stage.

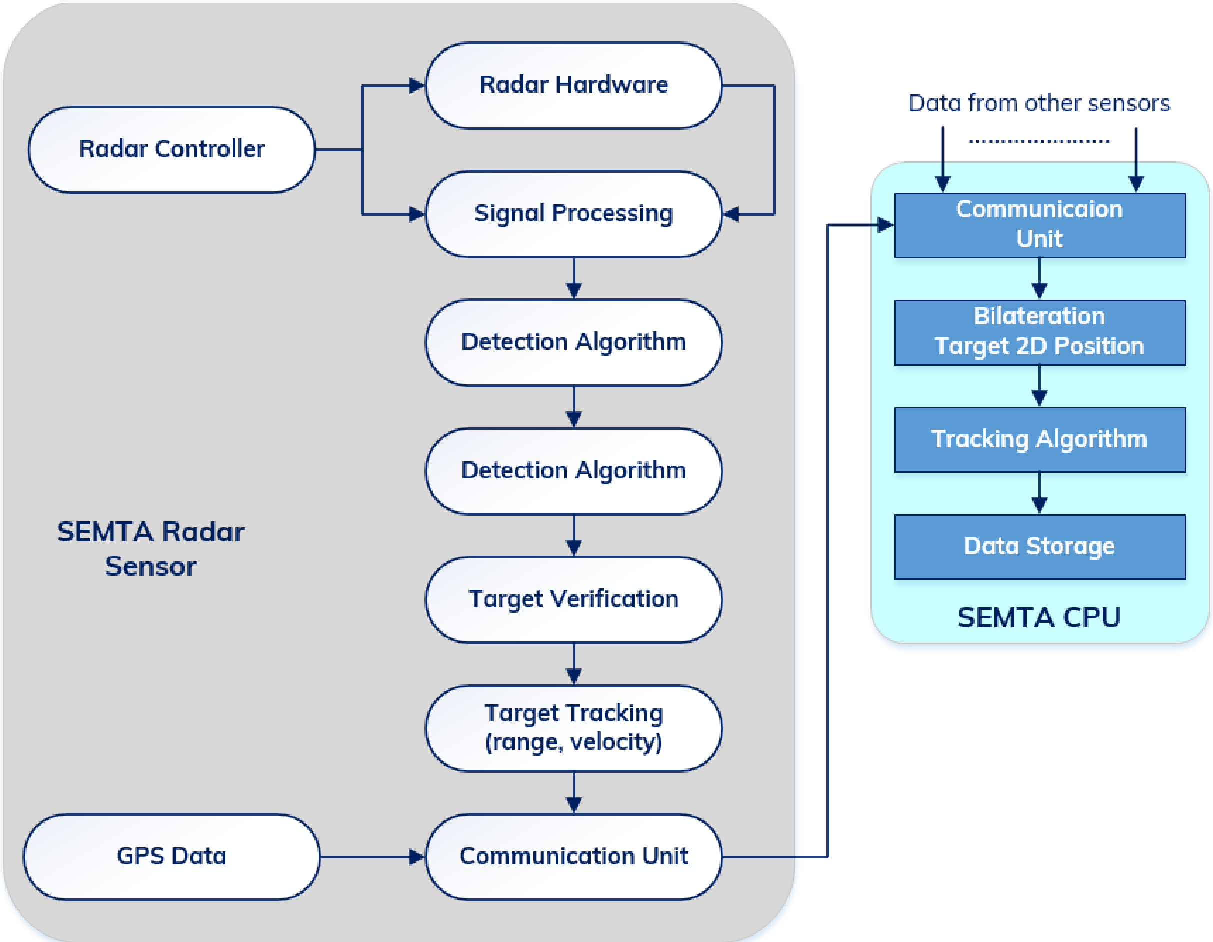
Then we will develop a functional system prototype that consists of two radar sensors and a remote computer with access to a website hosting sensor data transferred over Iridium network. This prototype will integrate fully functional RF Module and Digital Module. The RF Module will be housed in an enclosure designed for installation on Wave Glider USV. The Digital Module, PMU, and supporting components, including an Iridium network modem, will be housed in an enclosure representing a payload box of the USV. The prototype will be powered by batteries representing the USV batteries. It will support real-time detection and tracking of the SUT by each sensor and transmission of the sensor data to a remote processing unit via a satellite network.

Develop Tracker, Visualization, and Network Application Software (Task 6)

The SEMTA tracking algorithm operates at two levels: sensor and server.

1. The sensor-level tracking allows each radar to verify and track the target. At this level, the radar controller, located on a USV platform, classifies detected targets to separate an airborne target from birds or other objects and clutter. After the target under test is verified, the radar will use the horizontal monopulse technique to track the target by controlling the antenna beam within its area of coverage (sensor-level tracking).

2. The server-level tracking is executed by the SEMTA server (in the control center), which collects data from all the radar sensors in the SEMTA system, calculates the accurate target's horizontal coordinates for each measurement by using the multilateration algorithm, and then tracks the target's trajectory by using a Kalman filter to filter out noise and accidental errors.



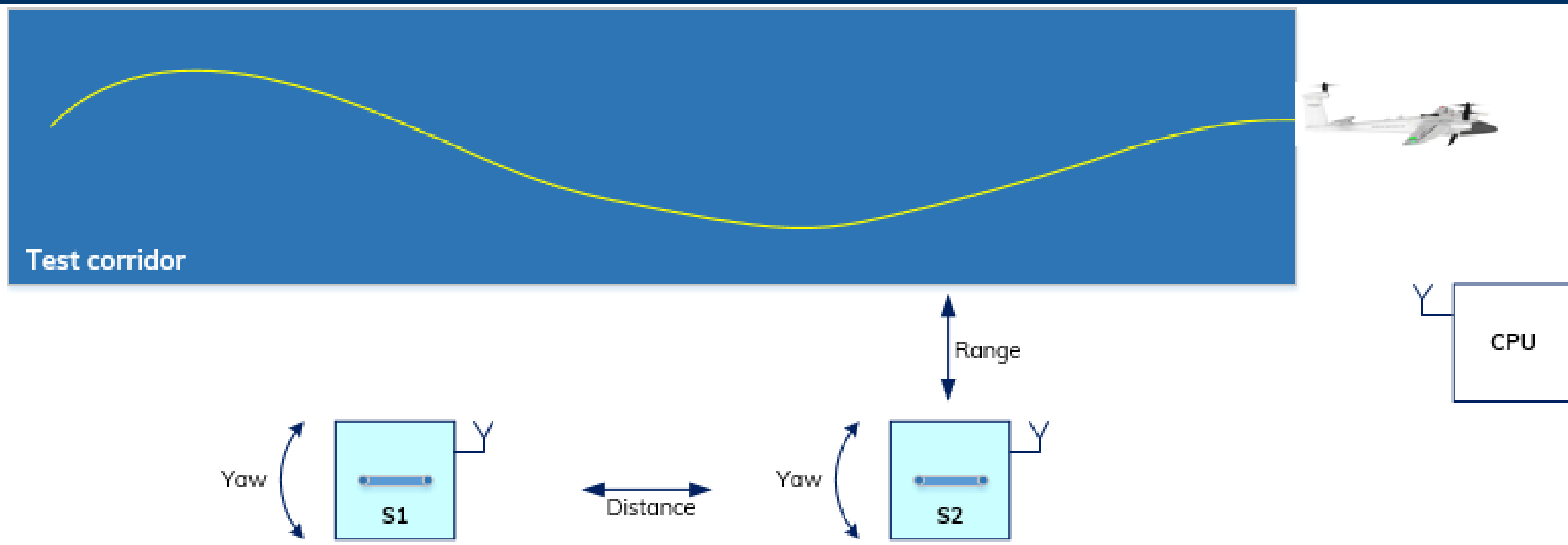
Develop Tracker, Visualization, and Network Application Software (cont.)

As the individual radar tracking is based on standard monopulse operation, the multistatic radar tracking algorithm executed on the SEMTA server is a unifying component of the SEMTA system. The multilateration localizer precedes tracking but is considered an integral part of the SEMTA tracking algorithm. The calculated target coordinates and velocity data will be used by the single-target tracking algorithm. The tracking is based on the predictor-corrector algorithm of the Kalman filter with nearly constant velocity target kinematic model.

Intellisense will develop a visualization of the SUT trajectory that also shows location and orientation of SEMTA sensors and, potentially, the conditions during the measurements (e.g., sea state).

Intellisense will also develop a satellite network application that collects the messages transmitted by SEMTA sensors via a satellite (Iridium) network to the cloud or a remote computing center and passes it to the tracking algorithm.

Characterization Experiments (Task 10)



Intellisense will conduct experiments in an open area using a dual-sensor configuration of the SEMTA prototype system and a fix wing drone representing a SUT. The experiments will include several trajectories and configurations with variable distances between sensors and between sensor and SUT. We will keep the sensors in GPS determined positions during the test and will vary the antenna direction for each sensor to emulate the USV yaw motion in the allowed range of ±15° (compensation for roll and pitch motions will be tested separately). The radar sensors S1 and S2 will be installed on the ground and communicate with the central processing unit (CPU) via Iridium network. The sensor antennas face the planned SUT trajectory.

For each test scenario, the sensors will detect and track the SUT and transmit the tracking details to the CPU for data fusion and multilateration computation. We will evaluate the system performance for the given test setup and SUT characteristics. We will then estimate the SEMTA system performance for an intended target, a low supersonic sea-skimming missile, and devise an optimal system setup.

Key Personnel

Mr. Victor Khodos, Senior RF Engineer
Principal Investigator, development of the RF circuits and antennas

Mr. Alexander Genusov, Director, Electronic Systems Development
System design and project management

Mr. David Harris, Group Leader, Electronics
Design of the Digital Module and FPGA, implementation of the acceleration engines

Mr. Sean Holloway, Research Engineer
Modeling and simulation of SEMTA in MATLAB

Mr. Ryan Waltman, Mechanical Engineer
Development of housing and stabilization solutions

Mr. Samuel Ferguson, Software Engineer
Development of the embedded software and stabilization algorithm

Mr. Drew Yenzer, Electronics Engineer
Design of the RF transceiver PCB

Dr. Min-Yi Shih, CTO, VP, & GM, Emerging Technologies Department
Program management, technology transition, and commercialization

Mr. Christian Veeris (LtCol, USMC, Ret.), VP, Corporate Business Development
Contacting customers and users of the proposed SEMTA technology

Back-up Slides

Corporate Products

Intellisense Systems Development Model

Small Business Innovation Research (SBIR) Technology Development

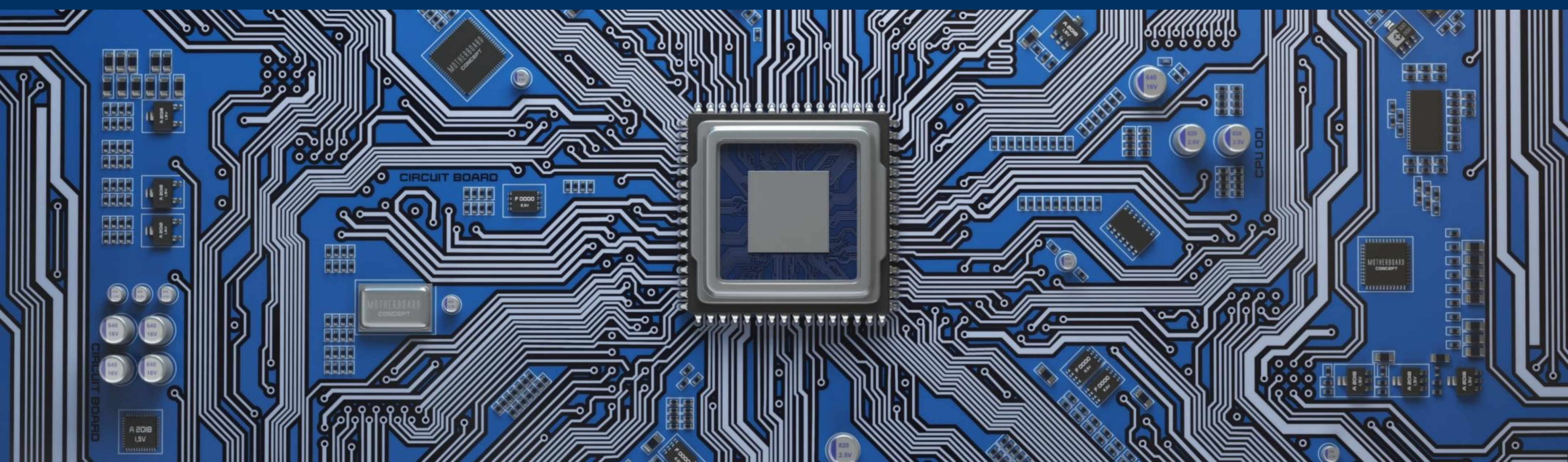
BAAs
RFP/RFQs

Internal Investment

Development

Transition

Production



Micro Weather Stations (MWS®)

Intellisense Systems offers a variety of true All-In-One weather stations. We've integrated the data storage, wireless communications, batteries, and solar collectors into each unit. No external components need to be connected by wires. Deployed in 60+ countries across all 7 continents.

True All-In-One Meteorological Stations

- Integrated data logging, solar power, and processor
- Two-way Iridium satellite connection
- Integrated panoramic imaging
- Expansion port
- Rugged and portable
- Easy 60 second installation
- Autonomous operations

Weather Data Collected

- Temperature
- Barometric pressure
- Humidity
- Wind speed
- Wind direction
- Compass reading
- Angular tilt
- Visibility
- Dust accumulation
- Lightning distance
- Visual imagery
- Precipitation amount
- Present weather
- GPS location

MWS-M525
Military version features Iridium satellite communications with 12 sensors reporting 27 environmental parameters.

MWS-M625
Military version features Iridium satellite communications with all the features of the M525 plus a 10,000 ft. LIDAR ceilometer

MWS-C400
Commercial version features cellular LTE-M communications with 10 sensors reporting more than 20 environmental parameters.

MWS-C500
Commercial version features cellular LTE-M communications with 12 sensors reporting 27 environmental parameters, including panoramic imaging.

MWS-C600
Commercial version features cellular LTE-M communications with all the features of the C500 plus a 10,000 ft. LIDAR ceilometer

Integrated Weather Observation System (IWOS)

Weather Data Reported

- Temperature
- Barometric Pressure
- Altimeter Setting
- Relative Humidity
- Wind Speed
- Wind Direction
- Compass Reading
- Longitude / Latitude
- Cloud Height up to 25,000 ft.
- Present Weather*
- Visibility*
- 360° Panoramic Imagery*
- Lightning Distance*
- Lightning Frequency*
- Lightning Direction*

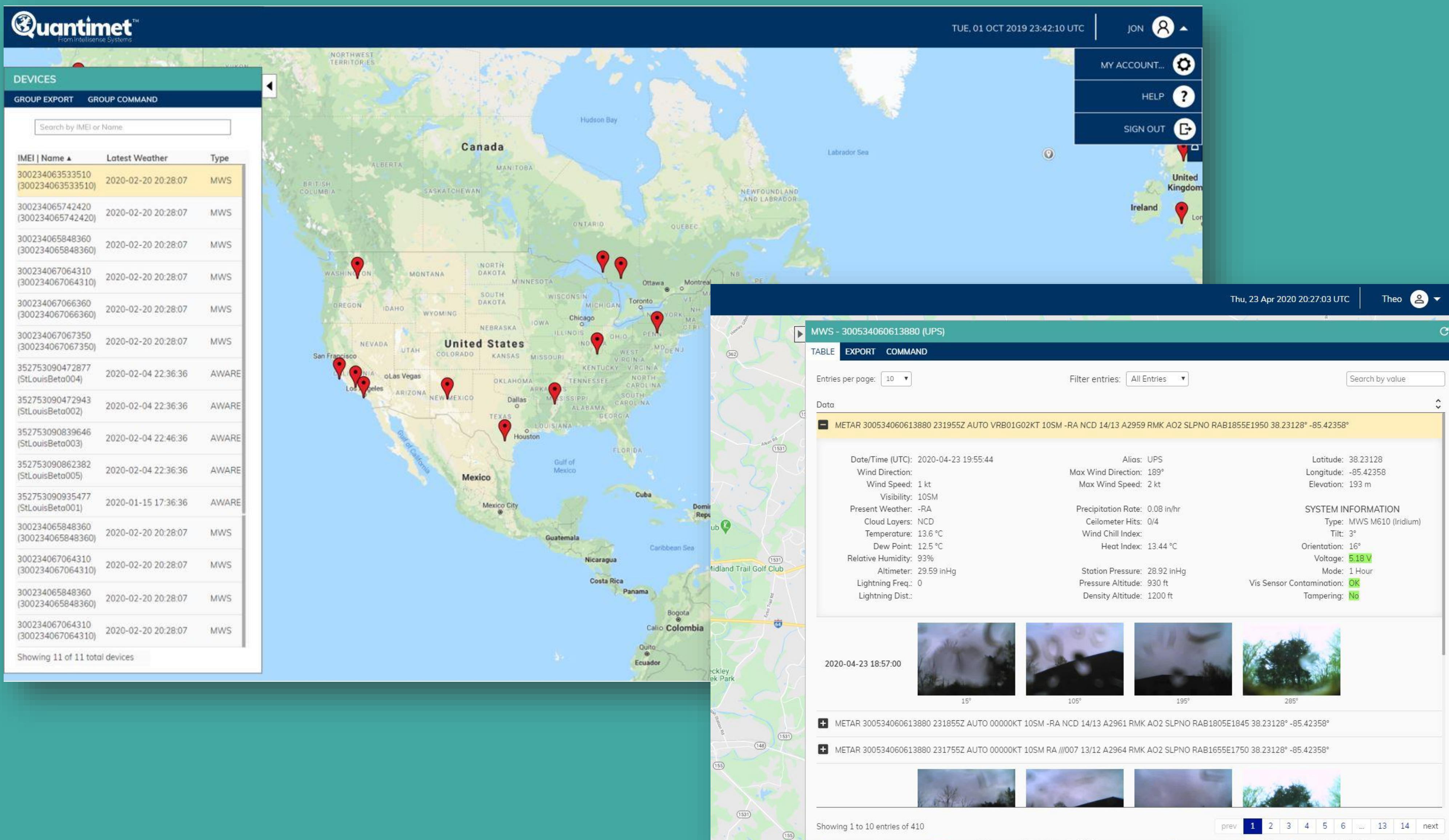
*Available 2022

MVP Modules

- 25K-Foot Ceilometer & Precipitation Module
- Iridium SATCOM & GPS Module
- Ultrasonic Wind Sensors
- Temp, Humidity, & Pressure Module
- High Accuracy Pressure Module
- Lightning Sensor & Command Module

Viewing and Control Options:

Quantimet™
From Intellisense Systems



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