

Applied Research Laboratory at the University of Hawai`i | Georgia Tech Research Institute

TIDES

Technology Incubation, Demonstration and Experimentation Support | November 3 - 4, 2022



This report summarizes the activities, participating organizations, and demonstrated technologies during the third Technology Incubation, Demonstration and Experimentation Support (TIDES) event conducted in Honolulu, Hawai'i on November 3-4, 2022.

On behalf of the Applied Research Laboratory at the University of Hawai'i (ARL at UH) and the Georgia Tech Research Institute (GTRI), we thank the TIDES 2022 participants for successful demonstrations and discussions highlighting exciting technologies that address important mission needs.

TIDES 2022 focused on the central role that 5G infrastructure and innovative technologies play in support of real-time situational maritime domain awareness in a multi-domain environment.



A handwritten signature in blue ink that reads "Margo H. Edwards".

Margo Edwards, Director
Applied Research Laboratory at
the University of Hawai'i
ARL at UH



A handwritten signature in black ink that reads "Rusty I. Roberts".

Rusty Roberts, Director
Aerospace, Transportation and
Advanced Systems Laboratory
GTRI



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Acronyms

5GATE	5G at the Tactical Edge
AI	Artificial Intelligence
AI/ML	Artificial Intelligence/Machine Learning
AMPD	Additive Manufacturing with Predictive maintenance and Dynamic inventory
AOR	Area of Responsibility
ARL at UH	Applied Research Laboratory at the University of Hawai'i
ATAK	Android Tactical Awareness Kit
CBRNE	Chemical, Biological, Radiological, Nuclear, and Explosives
COP	Common Intelligence/Operating Picture
CTI	Chesapeake Technology International
DoD	Department of Defense
FOB	Forward Operating Base
GEOINT	Geospatial Intelligence
GTRI	Georgia Tech Research Institute
HRAPS	Health Readiness and Performance System
JADC2	Joint All-Domain Command and Control
JTF	Joint Task Force
MDA	Maritime Domain Awareness
MiSos	Mini Sondes
MRR	Mid-Range Reconnaissance
OSINT	Open-Source Intelligence
Pre-CLUE ISR	Preparation for Contested, Littoral, Uncrewed, Environmental Intelligence, Surveillance, and Reconnaissance
PONI	Portable Operational Network Integrator
PRS	Personal Reconnaissance System
RAPTOR	Rapid Tactical Operations and Reconnaissance
RF	Radio Frequency
SATCOM	Satellite Communications
SCCI	Sandoval Custom Creations, Inc.
SDK	Software Development Kits
SIPR/NIPR	Secret Internet Protocol Router/Non-classified Internet Protocol Router
SNB	SIPR/NIPR in a Box
STUN	Secure Transit through Untrusted Networks
TAK	Tactical Assault Kit (MIL)/Team Awareness Kit (CIV)
TAMU	Texas A&M University
TIDES	Technology Incubation, Demonstration and Experimentation Support
TRL	Technology Readiness Level
UARC	University Affiliated Research Center
UAS	Uncrewed Aircraft System
UAV	Uncrewed Aerial Vehicle
US	United States
UGV	Uncrewed Ground Vehicle
USCENTCOM	United States Central Command
USINDOPACOM	United States Indo-Pacific Command
VRS	Vehicle Reconnaissance System
WISR	Wide-Area Intelligence, Surveillance, Reconnaissance Discovery
WWIS	Windward Intelligence System

Introduction

The TIDES event, coordinated by ARL at UH, brings together military, industry, and academia to solve problems through collaboration. It is designed to align with area of responsibility (AOR) requirements and fosters participation by small, innovative companies that have developed high-impact capability. TIDES is a test and evaluation platform designed to help technologists incubate innovative technologies in diverse, realistic settings and identify and address technical issues. It also provides an opportunity for technology developers to demonstrate and experiment with new and evolving technological capabilities in an operationally relevant environment and obtain insight into technology gaps and emerging needs. TIDES is organized around specific themes to ensure relevance to a range of missions for the sponsor(s), and participants and observers are invited through their affiliation with professional organizations, or their past participation in TIDES and other exercises.

The TIDES design comprises three parts. The first part is incubation, which includes testing of emerging technologies in Hawai'i to assess their readiness in isolated or integrated settings and identify problem areas. After follow-on development to resolve technical issues, the demonstration and experimentation (second and third) parts insert the technologies, with unit sponsorship, into exercises or training events for user-operational military utility assessment.

TIDES helps enrich collective assessments of technologies to understand better the multiple considerations affecting operational effectiveness. Unscripted field testing reveals the effects of weather, wind, water, blowing sand, radio frequency (RF) interference, and communications disruption. TIDES also shows the potential impact of these chaotic elements on the decision chain and human-machine interaction. By providing the Department of Defense (DoD), industry, and academia with the opportunity to collectively test emerging technologies, ARL at UH and GTRI foster holistic performance assessments, incorporating cultural, environmental, and interoperability factors.

TIDES 2022 was conducted on Moku o Lo'e, O'ahu, Hawai'i on November 3-4, 2022 (Figures 1 and 2). To address requirements stipulated by the United States Central Command (USCENTCOM) J8 and the United States Indo-Pacific Command (USINDOPACOM), the selected focus for TIDES 2022 was the integration of 5G at the Tactical Edge (5GATE) with Maritime Domain Awareness (MDA).



Figure 1: TIDES 2022 participants, morning demonstration.

Rationale & Objective

The DoD established the Joint All-Domain Command and Control (JADC2) initiative to connect sensors from all military services into a single cohesive network. To implement JADC2, each military department created their own program, from the Air Force's Advanced Battle Management System to the Navy's Project Overmatch to the Army's Project Convergence. Central to these initiatives is the ability to: detect and communicate relevant information rapidly and securely between and among sensors, warfighters, and decision makers; operate across all domains with tolerance of physical and virtual impediments; and seamlessly incorporate all United States (US) military services as well as those of allies and partners. Success in future contests will require flexible, dispersive sensing and communication systems optimized to prevail in austere and contested environments across long distances with minimal pre-positioned infrastructure.

Modular, secure, robust, and interoperable sensing and communications supporting US and allied forces at the speed of relevance requires concerted efforts, involving the US and allied defense industrial bases, government laboratories, industry, and academia. The threat landscape is becoming less permissive, more diverse, and more complex, and the defense innovation community must evolve to pioneer solutions that match these challenges. By rapidly fielding technology capabilities to address novel and emerging problem sets, the defense innovation ecosystem can facilitate interactions between innovators and warfighters that more quickly transition capability from concept to operations.

The 5G (and future generations) technology standard involves changes in the spectral, functional, and performance nature of communications through attached services. 5G enables faster download speeds, improved data quality, enhanced encryption capabilities, and increased bandwidth, allowing applications involving effective connectivity of multiple devices. Technical characteristics related to the frequencies in the 5G range, however, present challenges in the deployed 'tactical edge' condition that must be defined and resolved through experimentation.

MDA involves gathering information on the maritime domain to assess situations that have the potential to impact safety, security, the global economy, or the environment. MDA ranges from knowledge of harbor and littoral maritime conditions to observation of regional deviations in maritime shipping and operations patterns that indicate potential threats. MDA relies on sensors, secure communications, and signal exploitation through deep learning and fast computation. The integration of 5G capability with MDA will facilitate rapid knowledge acquisition to support time-sensitive decisions.

The desired objective for TIDES 2022 was to provide a platform for new partnerships and collaborations to propel integration of 5GATE operations and MDA capability in alignment with AOR needs for the Indo-Pacific.



Scenario Description

A situation is developing in the Pacific AOR involving a potential action on an island in contested waters. Coalition forces desire to establish an island presence to collect information. A shore party has been formed and is working to verify a safe landing beach zone. Entry to the island requires rapid establishment of trusted, durable communications and MDA, centered around a command post that is supported locally by edge computing and linked to an offshore command ship.

The shore party requires wide-area, high-resolution discreet surveillance capability for safety and to launch an uncrewed aerial system-borne 5G communications link to connect the command post to an inland forward operating base (FOB). The FOB requires secure communications, spectrum management, edge computing, intrusion detection, soldier health monitoring, and knowledge of the AOR threat environment. Once established, the FOB will support coalition operations at the tactical edge to assure 'information dominance.' Assured actions can then occur, the result of awareness superiority driven by the combination of 5G and MDA, even though the shore party is embedded in a zero-trust environment.



Figure 2: TIDES 2022 participants visiting Zone 1.

Demonstration Site

TIDES 2022 featured thirteen organizations that conducted technology demonstrations at Moku o Lo'e located in Kāne'ohe Bay, O'ahu, and operated by the Hawai'i Institute of Marine Biology (HIMB) of the University of Hawai'i. Figure 3 provides a general location for Moku o Lo'e while Figure 4 shows a closeup of the different zones established to perform the demonstration.



Figure 3: Map of O'ahu, Hawai'i indicating the windward side of the island (top). Detail showing Moku o Lo'e location (bottom).



Participating organizations were set up in various zones according to their function and interoperability.

Zone 1. The ground control station was established in Zone 1. A shore post with secure wireless connection via a Long-Range Wide Area Network was also established. A Starlink terminal was set up in that area by Texas A&M University (TAMU) to provide satellite communications (SATCOM). The ARL at UH Preparation for Contested, Littoral, Uncrewed, Environmental Intelligence, Surveillance, and Reconnaissance (Pre-CLUE ISR) maritime communications system was used to create a secure environment for tactical communications while performing the landing and shore operations. Aspects of the Pre-CLUE ISR system on display included the Skyfront Perimeter 8 uncrewed aircraft system (UAS) and a fiber-optic backhaul.

A floating dock in Zone 1 was designated the "USS Sand Dune," representative of an offshore ship providing up-to-date maritime intelligence through distributed command and control software. The ARL at UH's Seabed Node served as a subsea communications relay point connecting the USS Sand Dune to a beach access location, which enabled communications between terrestrial operators and offshore locations. The ARL at UH's Mini Sondes (MiSos) were distributed in the waters surrounding the Seabed Node and periodically reported environmental data to it over acoustic communications. Dell Federal was also present in Zone 1, adjacent to the beach access, where they demonstrated their 5G-supported edge computing technology.

Zone 2. FOB B was set up in Zone 2 where another Starlink terminal was installed. Fornetix established a Honeywell SATCOM terminal that demonstrated identity, credentials, and access management by bringing security, scalability, and interoperability through systems.

Zone 3. In proximity to FOB B, Zone 3 was set up as FOB A, which hosted a Joint Task Force (JTF) that communicated with Zone 4. The JTF included technologies from Hawkeye 360, Windward US, and CyOne. The surveillance data from Hawkeye 360 and analytics from Windward US were transmitted to CyOne's Wide-Area Intelligence, Surveillance, Reconnaissance Discovery/Common Intelligence/Operating Picture (WISRD COP) and mission planning application that collected and managed information in real time to provide intelligence support for targeting and assessment to inform and support tip/cue tasking to the Hawkeye RF geospatial intelligence (GEOINT) satellites.

The communications and interoperability center composed of TAMU and Tribalco, Chesapeake Technology International's (CTI) Tactical Assault Kit (MIL)/Team Awareness Kit (CIV) server, Teledyne FLIR's 5G relay, and the Naval Information Warfare Center's (NIWC) Portable Operational Network Integrator (PONI) was also located in Zone 3. Tribalco demonstrated their Secret Internet Protocol Router/Non-classified Internet Protocol Router (SIPR/NIPR) in a Box (SNB) solution, and the SCATR Corporation implemented their Secure Transit through Untrusted Networks (STUN) algorithms to enhance the security of the TIDES network traffic.

Android Tactical Awareness Kit (ATAK) smartphones operating on both 4G and 5G networks represented edge devices for the warfighter to support complex communication and coordination needs, with smartphones operating on 4G able to be secured up to US Top Secret or Secret partner-nation levels. A connection with the US Army, simultaneously conducting an exercise in Kona, Hawai'i, was established via the PONI to represent another arm of the Pacific Island operation.

GTRI demonstrated the Health Readiness and Performance System (HRAPS), which consists of a wearable sensor system providing real-time monitoring of the physiological and geolocation data of soldiers during high-intensity training exercises. HRAPS includes the development of a network system comprised of cloud-based storage and a modular local network that allows for the transport and visualization of real-time data about soldiers over long distances.

Zone 4. In this Zone, the tethered R80D SkyRaider uncrewed aerial vehicle (UAV) from Teledyne FLIR hosted the Sandoval Custom Creations, Inc. (SCCI) Rapid Tactical Operations and Reconnaissance (RAPTOR) platform. An electro-optic infrared sensor collected data which was processed by RAPTOR technology to rapidly detect objects of interest. Additionally, the R80D was equipped with a 5G node to connect with the inland FOBs.

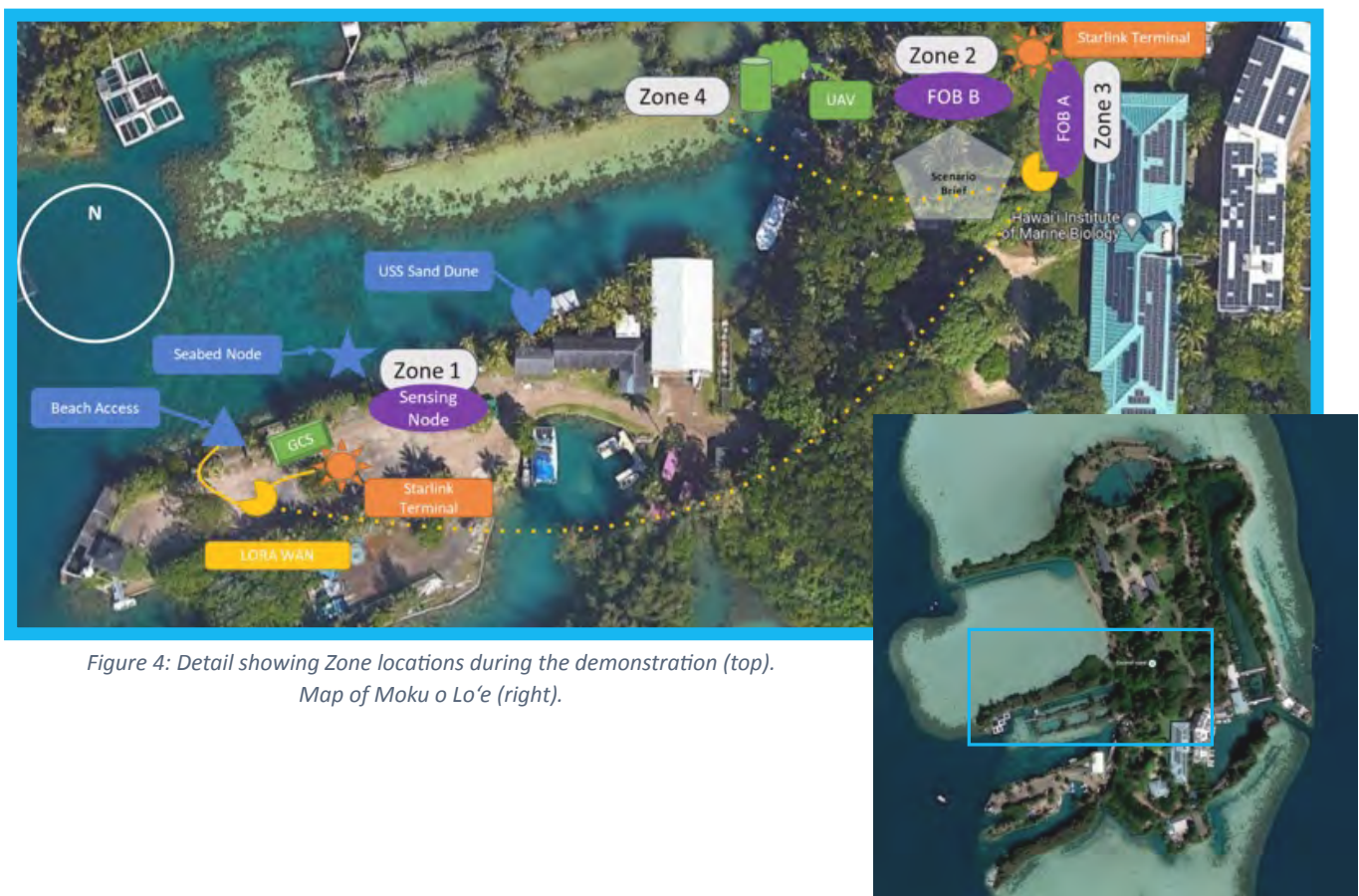


Figure 4: Detail showing Zone locations during the demonstration (top).
Map of Moku o Lo'e (right).

Technologies Demonstrated

Figure 5 shows the operational viewpoint and connections to the FOB between the various participants to TIDES 2022. A brief description of the technologies presented by each organization follows.

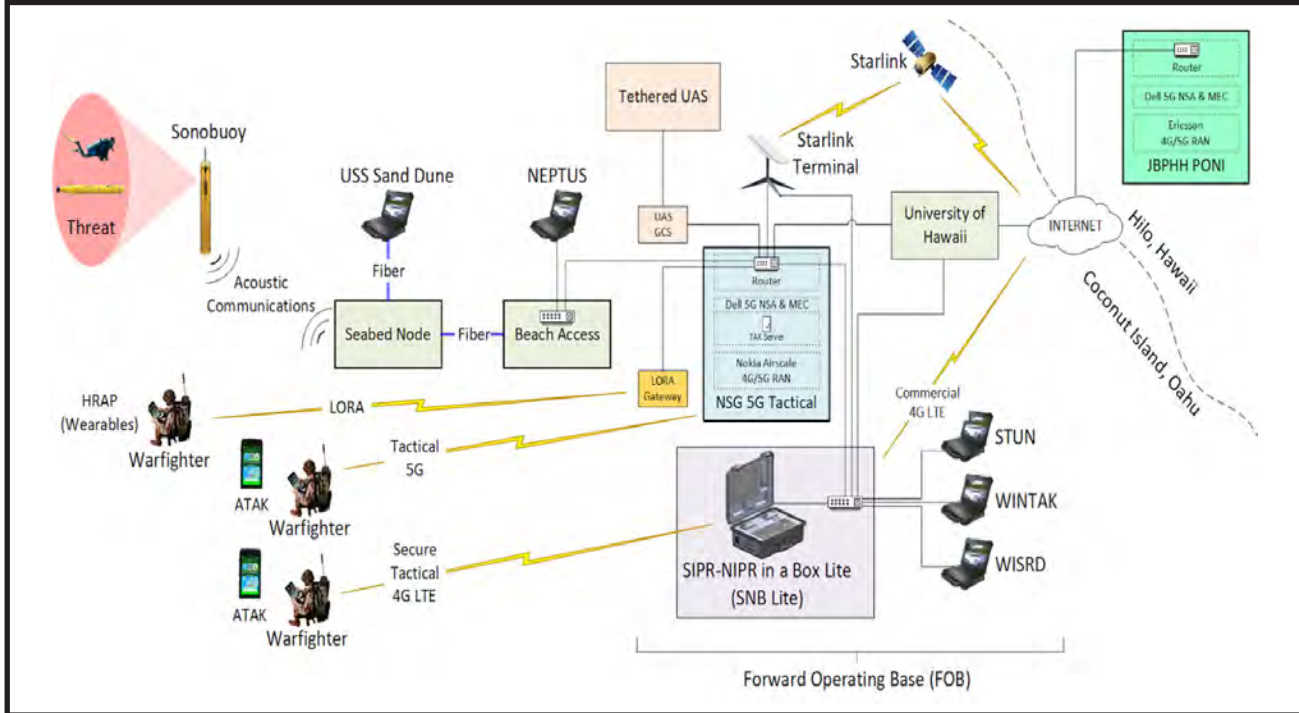


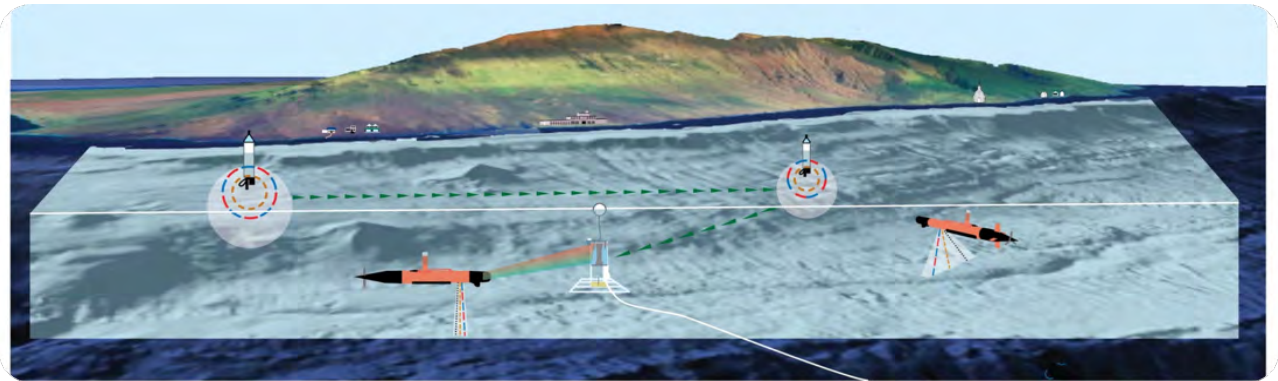
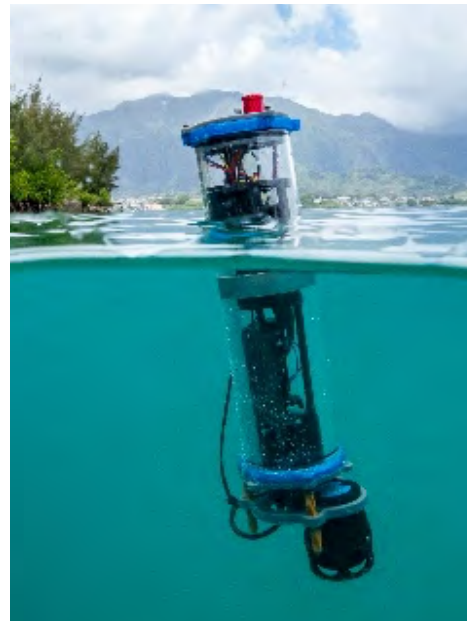
Figure 5: Interoperability of technologies demonstrated during TIDES 2022.



Figure 6: Site of TIDES 2022, Moku o Lo'e.

Pre-CLUE ISR

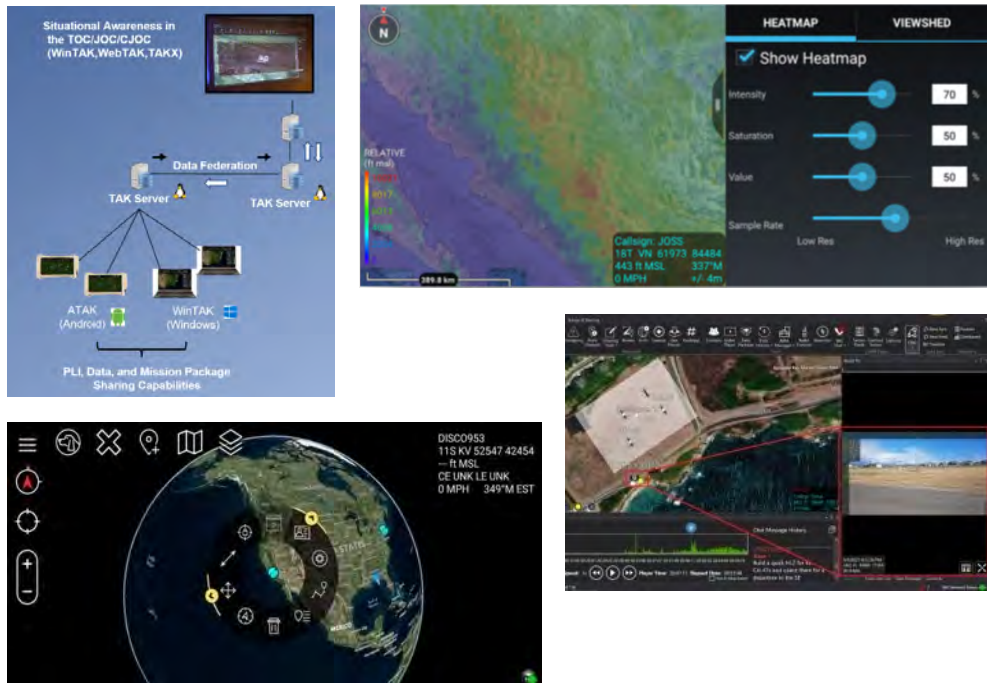
The ARL at UH demonstrated the capability for establishing a clandestine information dominance pathway to support crewed operations during TIDES 2022. A series of underwater fiber optic cables enabled communication to the base station. The demonstration characterized a “cube” of the littoral environment in three phases: observability, mission support, and attrition. Pre-CLUE ISR features uncrewed vehicles that gather information to support crewed operations. Pre-CLUE ISR leverages the use of rapidly manufacturable, low-cost Mini Sondes (MiSos) and a seabed communications relay node connected by single-mode fiber-optic cable. Measurements include geoposition, temperature, pressure, and sound velocity, which are reported to a remote base station and visualized under a unified COP. Pre-CLUE ISR is designed to establish information dominance in contested littoral zones where traditionally accessible radio or satellite communication pathways may be blocked or pose a risk.



TAK Server - Tactical Assault Kit (MIL)/Team Awareness Kit (CIV)

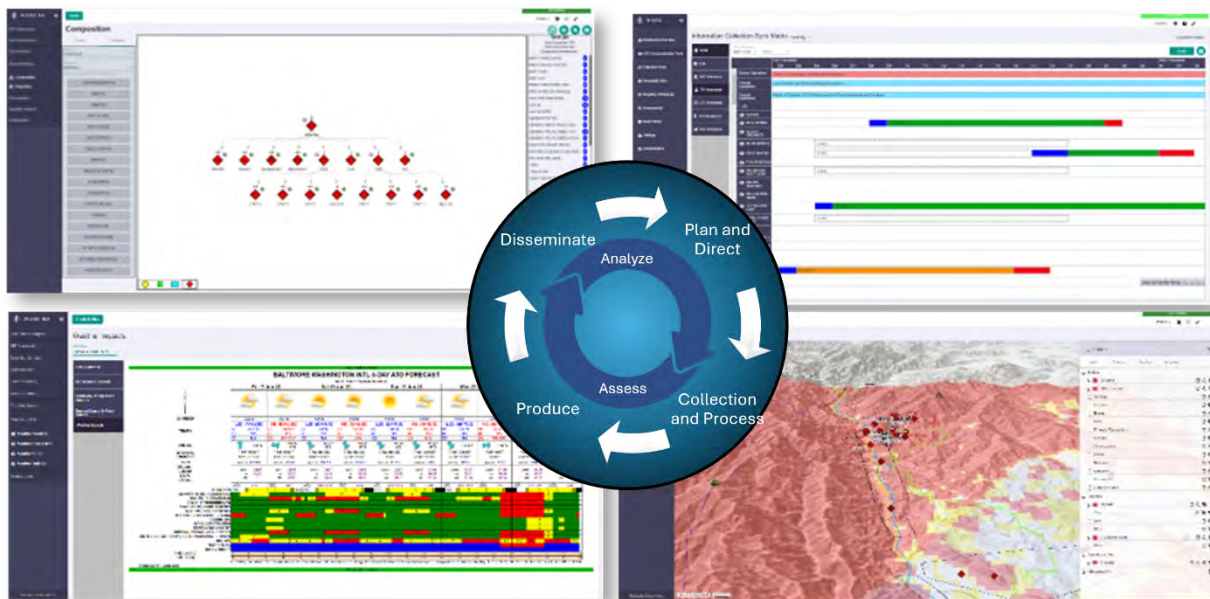
CTI, a trusted partner of Raytheon and the TAK Product Center, demonstrated a Cross-Platform (Android, Windows, Linux, etc.) Government-off-the- Shelf server that has a built-in, Web-Based Common Operating Picture. The TAK Server connects mobile users in a cross-platform environment and provides end-user connectivity, network administration, and database storage. It also allows multiple TAK instances to communicate (serving as a bridge) when peer-to-peer communications are not possible.

Other features include position location information, data, mission package sharing capabilities, and full control over data federation and filtering. Technologies demonstrated this with live local and remote video processing displayed locally on a single-pane-of-glass user interface.



Wide-area ISR Discovery (WISRD) Experimental Technology

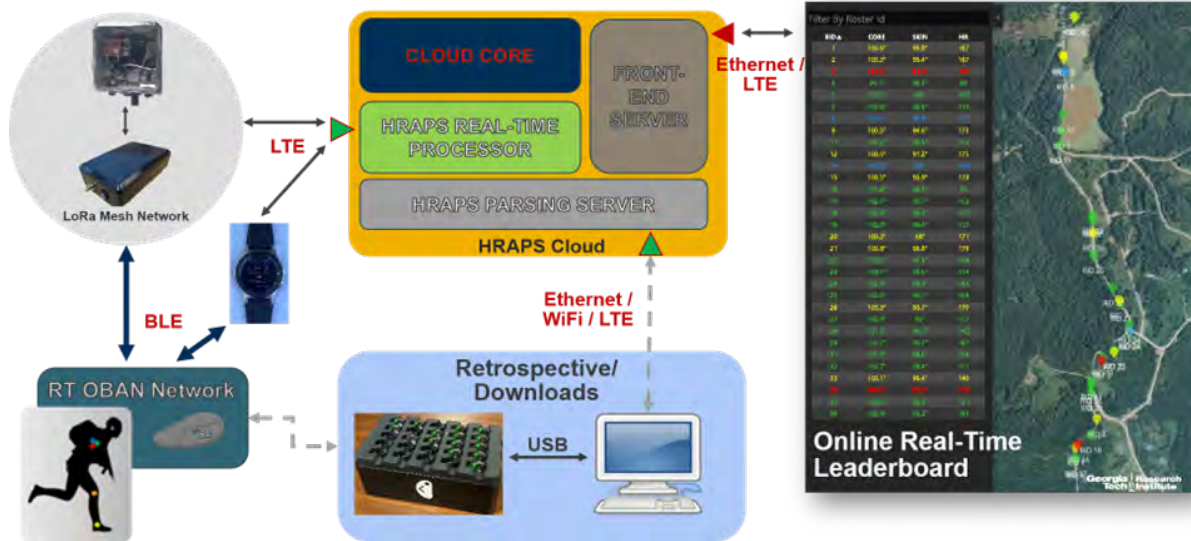
CyOne has developed its proprietary modular web-based COTS product line called WISRD that leverages integrated state-of-the-art open-source technology and Defense Information Systems Agency-approved Ironbank Docker containers to enable end-to-end support of WISRD's four modules: WISRD-Collection Management (WISRD-CM), WISRD-Support to Targeting (WISRD-ST), WISRD-All Source (WISRD-AS), and WISRD-Weather Effects (WISRD-WX). The WISRD product line of capabilities is sponsored by the Army's Intelligence Battle Lab and provides support to RAVEN-X and Arcane Lightning. WISRD capabilities and ability to maintain interoperability with multiple Joint and Army systems has been demonstrated and has been well-received by users in both organizations. WISRD's federated services demonstrates the effective integration of the latest in open-source technologies that add efficiencies toward intelligence warfighter tasks while retaining the flexibility to utilize both local and cloud-hosted computing resources.



Health Readiness and Performance System (HRAPS)

GTRI's HRAPS system is a framework for real-time monitoring of service members during training exercises, allowing for the transport and visualization of physiological and geolocation data over long distances. HRAPS required the development of a real-time network system with a cloud-based storage and a modular local network and consists of: real-time monitoring of physiological and geolocation data during high intensity training exercises; a local communications network allowing for the transport of real-time data via mesh network over long distances; applications to provide an easy interface to sensors and system configuration capabilities; and cloud architecture for data ingestion, storage, visualization and security.

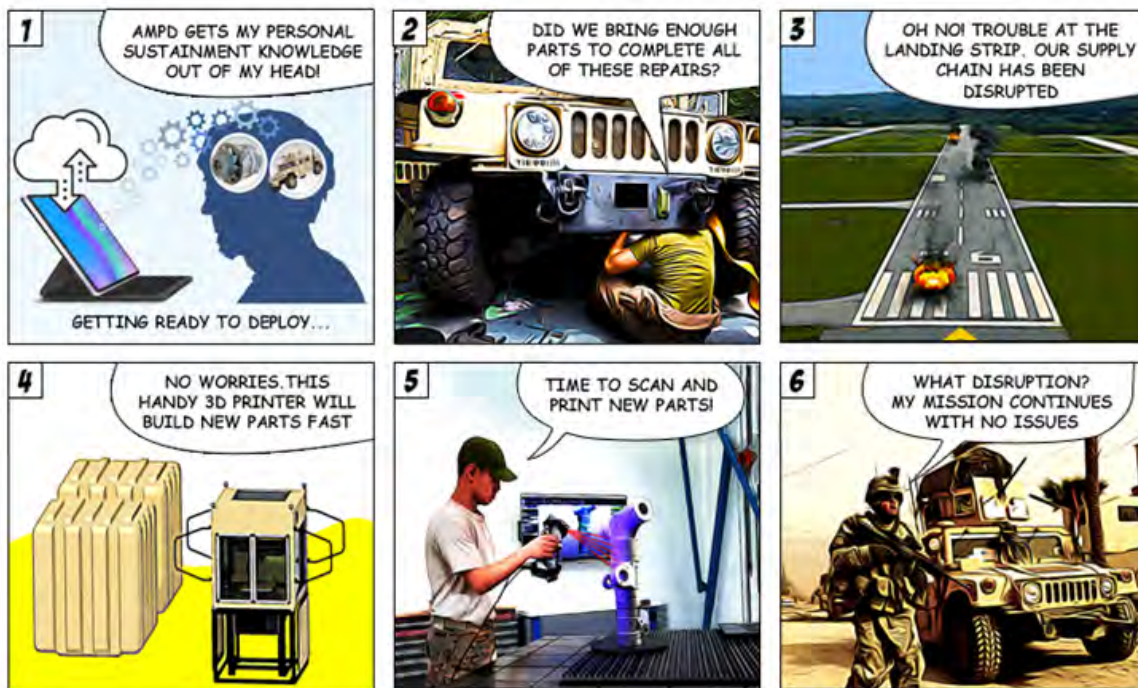
HRAPS technology is currently in use for field demonstrations with: 75th Ranger Regiment, Fort Benning, GA; 169th Engineering Battalion, Fort Leonard Wood, MO; USMC Crucible, MCRD Parris Island, SC, and USMC Infantry Officer Course (IOC), MCB Quantico, VA.



Additive Manufacturing with Predictive maintenance and Dynamic inventory (AMPD)

Additive manufacturing was demonstrated to improve mission readiness and dramatically reduce inventory needed for deployment. The Hui Huliau/Kairos Inc./Mission Solutions Group (H2KAIROSMMSG) implemented additive manufacturing along with artificial intelligence/machine learning (AI/ML) into a predictive sustainment model and demonstrated an improvement in mission readiness with unit-level data capture/sharing and mitigated supply chain risks by dramatically reducing the inventory needed for deployment.

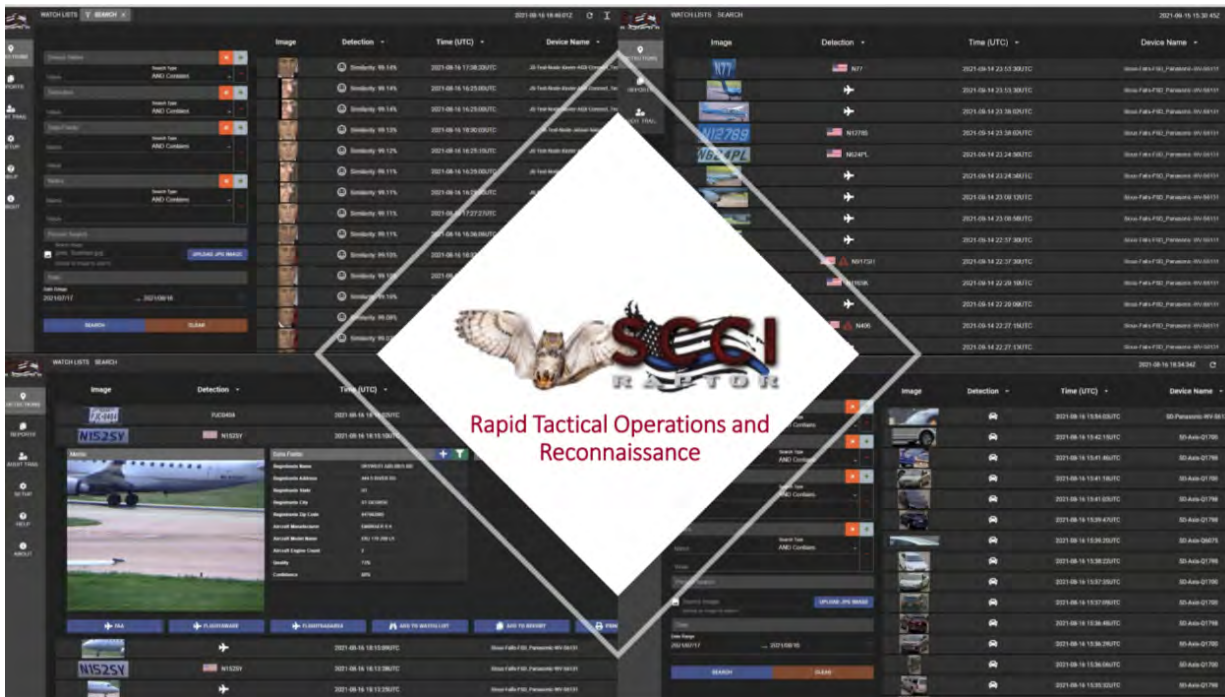
A typical AMPD system consists of: CL1720 3-D Printing System, High Temperature Extrusion and one cubic foot build volume, Integrated High-Performance Computer, fully integrated ML Knowledge Graph (Tiger AI Platform), 3D Scanner, and a Unit-Level Knowledge Capture Program.



Rapid Tactical Operations and Reconnaissance (RAPTOR)

Sandoval Custom Creations, Inc. (SCCI) demonstrated video surveillance hardware/software integration, using live local and remote video processing to provide a single-pane-of-glass information solution to present multiple analytic modes to the end user. RAPTOR leverages a variety of analytic Software Development Kits (SDKs) from several vendors. These SDKs run at the edge or on a hosted server in a data center or cloud, and process a live Real-Time Streaming Protocol feed from a camera sensor, generating a detection based on the analytic type.

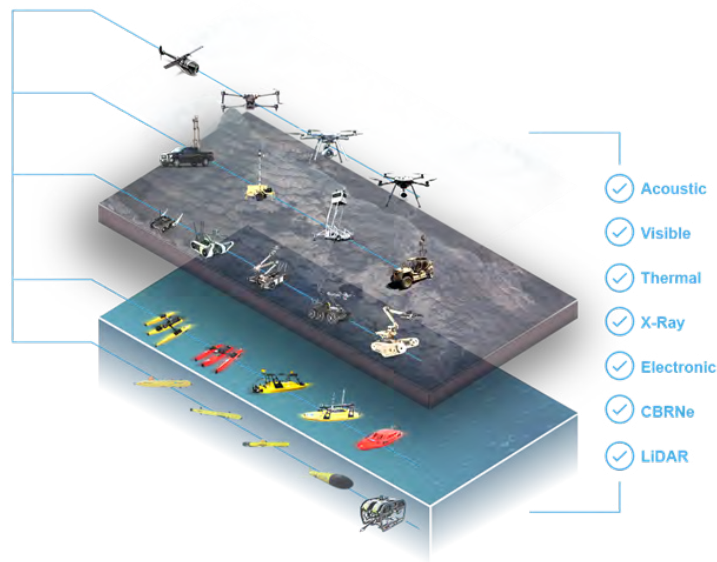
This technology falls under Open-Source Intelligence (OSINT)/Video Analytics/Long Range ISR and is currently in use with the US government. It could aid DoD OSINT analysis, particularly video stream analysis, by using software to perform certain processing, exploitation, and dissemination functions. RAPTOR does not replace humans but uses technology to help humans do what only humans can do - make intelligent data-driven decisions.



Deployable and Developmental Unmanned Technologies (Any Threat, Anywhere)

Teledyne FLIR develops and manufactures solutions for enhanced imaging, advanced surveillance and security, and the accurate detection, identification, classification, and suppression of Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) threats for global military, law enforcement, public safety and other government entities. Teledyne FLIR offers the world's most advanced unmanned air and ground systems portfolio and has delivered more than 11,000 unmanned systems to customers in over 55 countries (17 within USINDOPACOM). Teledyne FLIR's family of systems includes:

- Black Hornet 3 Personal Reconnaissance System (PRS): Smallest combat-proven Nano UAV
- Black Hornet 3 Vehicle Reconnaissance System (VRS): Base Protection
- R80D Skyraider Mid-Range Reconnaissance (MRR): Platform with unique sensing capabilities ranging from LiDAR to CBRNE
- Wingman VRS: Prototype 3D Mock-Up of Next Generation VRS System
- PackBot Uncrewed Ground Vehicle (UGV)



SIPR-NIPR in a Box (SNB)

SIPR-NIPR in a Box (SNB) is a USCENTCOM program that contains a family of systems (SNB, SNB Lite, secure edge devices and UAS payloads). The SNB family of products are secure expeditionary systems that provide seamless, assured, interoperable voice and data communications between U.S. and partner nations across disparate military and commercial communication networks (SATCOM, radios, cellular, and IP-based networks). The highly configurable SNB family of systems feature modular designs and open architectures which provide tailorable solutions to meet diverse mission needs.

First generation SNB systems are currently deployed with US Marine Corps units as Technology Readiness Level (TRL) 9 systems. Tribalco, a National Security Agency Commercial Solutions for Classified Trusted Integrator, developed next-generation SNB systems with secure 4G LTE cellular base stations including secure edge devices (NIPR, SIPR, Partner Nation networks).



Windward Intelligence System (WWIS)

WWIS is an open-source unclassified Software as a Service tool that enhances the missions of defense branches and intelligence agencies to safeguard national interests and security from global safety and security threats using applied AI/ML for behavioral analysis of the global maritime ecosystem. The platform fuses multi-layered, multi-sourced open-source data with machine learning to create a comprehensive utilization profile overview and an automatic risk profile for every vessel, maritime company, ultimate beneficiary, container, wet bulk cargo, and seaport in the world. The system connects the dots and discovers potential risks as they emerge by fusing artificial intelligence (AI) with the Automatic Identification System, RF satellites, ownership structures, reference imagery, and supply chain and cargo data to enable a 360-degree view of the maritime environment. The system is at TRL 9, ready for immediate deployment.

WWIS can help increase maritime situational awareness using behavioral analysis to analyze the economic utilization profiles of maritime entities to identify new leads for investigation on the following security threats: illegal, unreported, and unregulated (IUU) fishing, sanctions violations, maritime smuggling, and non-commercial operations.

The screenshot displays the WWIS interface with the following sections:

- Sanctioned Entries:**
 - Sanctions List:** Vessel does not appear on sanctions list.
 - Sanctioned Country Flag:** Flag is not sanctioned country flag.
 - Sanctioned Company:** Company does not appear on sanctions list.
- Behavioral Risk Indicators:**
 - Port Calls Profile:** No visits to sanctioned ports detected.
 - Loitering Activity:** No anchoring or drifting in sanctioned areas detected.
 - Dark Activity:** No Dark Activities in sanctioned areas detected.
 - Ship to Ship Activity:** No suspicious STS activities detected.
 - Flag Hopping:** No suspicious flag changes in the past year detected.
- ID & Location Tampering:** Identify and location tampering detected.

The detailed view for **Location Tampering** shows:

- High probability of location manipulations**
- Related Country:** Venezuela (with a [View on Map](#) button)
- Start:** 22.12.20 18:57 UTC
- End:** 14.02.2021 19:03 UTC
- Duration:** 22d 1h 54m
- Powered by:** Vermax
- Cargo details:**

Type	Category	Operation	Volume	Origin	Destination
Crude oil	Category	Loading	690.3k (bbl)	Iran, Lavan	Venezuela
- Additional information:** During this time frame, the vessel manipulated its GPS system, transmitting a false location and possibly was engaged in a transshipment in Venezuela.
- Details** (expandable)



Participating Organizations

The table below provides a brief description of the organizations who participated in TIDES 2022.

Organization	Description
ARL at UH	The ARL at UH is youngest of five U.S. Navy-sponsored University Affiliated Research Center (UARCs), founded in 2008. The ARL at UH has grown rapidly in the past decade, undertaking \$40 million in research for government and industry in FY21. The lab leverages its proximity to test sites, access to USINDOPACOM, and Hawai'i's mild climate and environmental diversity to imagine and develop agile, innovative and cost-effective solutions to problems impacting our stakeholders, our community and our planet.
CTI	CTI is a mid-sized defense technology and services company with a mission to create government open platforms and applications addressing Defense and Intelligence customer requirements. CTI deploys a variety of open source and open, government-owned geo-visualization tools (TAK and RAPTOR), software-defined radio frameworks (GNU Radio and Redhawk), and Apache tools (Hadoop and Spark) for extensive data analysis and machine learning. CTI is composed of subject matter experts within all aspects of spectrum-dependent operations, including signals intelligence and RF sensors, Electromagnetic Warfare, communications, navigation warfare, and Directed Energy.
CyOne, Inc.	CyOne, Inc. is comprised of a team of highly experienced, trained, and motivated cyber security specialists, software development engineers, intelligence analysts, and technological consultants who develop software into mature capability sets and solution to support global DoD operations.
GTRI	GTRI is the non-profit, applied research division of the Georgia Institute of Technology (Georgia Tech). Founded in 1934 as the Engineering Experiment Station, GTRI has grown to more than 2,800 employees supporting eight laboratories in over 20 locations around the country and performs more than \$782 million of problem-solving research annually for government and industry. As a UARC, GTRI's researchers combine science, engineering, economics, policy, and technical expertise to solve complex problems for the US Federal Government, state, and industry. GTRI develops highly effective, practical solutions that are put into action, and as a non-profit research institute, is able to deliver workable solutions and manufacturable products by bringing together the right mix of talent, experience, and creativity to every project.
Fornetix	Fornetix is a cybersecurity platform enabling Zero Trust while delivering critical encryption automation, access controls, authorization services, and machine identity to the federal government and commercial enterprises around the globe. VaultCore is an elite encryption key management solution that allows to automate compliance, enforce key rotation and eliminate human error effortlessly with the capacity to manage millions of encryption keys. It is a scalable key management solution and can handle the large volume of encryption keys necessary to protect valuable data. VaultCore can operate from a centralized, simple to use, web-based User Interface from which to view, review and control key access and use.
Hawkeye 360	Hawkeye 360 is an RF data analytics company that operates a first-of-its-kind commercial satellite constellation to identify, process, and geolocate a broad set of RF signals. Value from this unique data is extracted and processed using proprietary algorithms, fusing it with other sources to create powerful analytical products that solve hard challenges and allow to draw out actionable insights for global customers. Products include maritime domain awareness and spectrum mapping and monitoring that provide the ability to identify and geolocate sources of radio frequencies from space, previously invisible.

H2KairosMSG	Team H2KairosMSG (Hui Huliau, Kairos, and Mission Solutions Group (MSG)) designs, develops, manufactures, markets, and distributes technologies that enhance the warfighters' perception and awareness. The technologies and related AI/ML techniques apply intelligence to embrace perfect information exchange to derive a more thorough understanding of each mission. The team provides sophisticated cybersecurity analysis and implementation by integrating governance and compliance with operational security threat avoidance activities. Additionally, Team H2KairosMSG's combination of cybersecurity and information technology management services allows clients to plan, maintain, enhance, and protect the technology required to improve the efficiency and effectiveness of their mission objectives.
SCCI	SCCI is a premier designer and supplier of covert and overt surveillance equipment and components to federal, state, and local law enforcement and military organizations. SCCI designers and technicians, along with their elite fabrication partners and a complete graphic and print shop, can design and manufacture almost any covert concealment or overt surveillance system. All work is completed at facilities in the US.
Teledyne FLIR	Teledyne FLIR designs, develops, manufactures, markets, and distributes technologies that enhance perception and awareness. It brings innovative sensing solutions into daily life through thermal imaging, visible-light imaging, video analytics, measurement, diagnostic, and advanced threat detection systems. Teledyne FLIR offers a diversified portfolio that serves several applications in government, defense, industrial, and commercial markets and develops products that help first responders and military personnel protect and save lives, promote efficiency within the trades, and innovate consumer-facing technologies.
TAMU	TAMU is a public, land-grant, research university in College Station, Texas. It was founded in 1876 and became the flagship institution of the Texas A&M University System in 1948. TAMU is dedicated to the discovery, development, communication, and application of knowledge in a wide range of academic and professional fields. Its mission of providing the highest quality undergraduate and graduate programs is inseparable from its mission of developing new understandings through research and creativity. TAMU is one of the nation's leading research institutions, with researchers who are making discoveries that can improve lives and impact the world.
Tribalco, LLC	Tribalco, LLC is a global C6ISR systems integrator providing mission-critical information technology and telecommunications solutions worldwide to government and commercial customers. The diverse portfolio of integrated services and solutions spans the entire technology lifecycle from design and engineering to procurement and systems integration through follow-on operations and sustainment. Tribalco's capabilities and expertise comprise a multitude of disciplines across the technology spectrum, including land mobile radio, telecommunications design and procurement, terrestrial-based communications, video teleconferencing solution design, microwave and satellite communications, IT integration, installation, and equipment procurement, secure wireless infrastructure design, training and technical assistance, spectrum management, and program management and consulting services.
Windward US	Windward US is the leading maritime AI company, providing an all-in-one platform for risk management and maritime domain awareness needs. By leveraging unmatched maritime domain expertise, augmented by best-in-class artificial intelligence and machine learning, the platform enables the prediction of future activities, and reduces uncertainty in interpreting data.



Summary & Conclusions

The basic tenet of TIDES is that there is no substitute for field experimentation. No matter how effectively a technology performs in simulation or in a laboratory, it must be tested in an unpredictable environment to be honestly evaluated. Field experimentation that brings together sponsors, technology developers, and the user community in a realistic environment serves as an accelerator for transitioning technology to support DoD requirements. TIDES was created to provide a realistic, uncontrolled setting to develop and enhance technology from incubation to operations.

TIDES 2022 allowed the participants to assess what can be achieved with current 5G technologies and define the focus of future efforts. Ease of deployment, packability, simplicity of network connection, tactical bandwidth availability, and the ability to operate in contested environments were discovered via experimental testing. TIDES 2022 identified the potential for network discovery and disruption given that some 5G line-of-sight communication antennas and relays might be visible by opponents.

Working together with support from USCENTCOM, USINDOPACOM, and industry partners, ARL at UH and GTRI successfully executed the third TIDES event, a demonstration showcasing several technologies simultaneously. TIDES 2022 accomplished the objective of bringing together contributors to the intersection of 5GATE and MDA in an expeditionary setting on an island and achieving 5G communications among disparate participants with minimal preplanning. TIDES 2022 set the stage for a continuing series of demonstrations to provide knowledge to decision makers within the Indo-Pacific AOR. Readers are encouraged to reach out to the technologists featured in this report for discussions and potential follow-on collaboration.



Figure 7: Deploying a fiber-optic cable into the small boat harbor at Moku o Lo'e.



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