

GROUNDAWARE®

GROUNDWARE® TECHNOLOGY & APPLICATION OVERVIEW

An OWL Whitepaper

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**OBSERVATION
WITHOUT
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OVERVIEW

Observation Without Limits LLC (OWL) and its parent company, Dynetics Inc., have more than 40 years of experience in using advanced surveillance technologies to meet complex requirements. From this background, we offer our public- and private-sector customers high-tech ground surveillance solutions to enhance awareness, deterrence, and responsiveness to physical security threats. An effective solution should perform equally well in all weather and lighting conditions (while eliminating false alarms and minimizing nuisance alarms), provide intelligent event-based alarms and notifications, enable focus on actual threats, integrate easily with existing systems and infrastructure, and be easy to access, use, install, and maintain. Our GroundAware® Surveillance Sensor and Information Systems meet these requirements and provide the highest-performance and best-value option for surveillance, deterrence, and response to today's ever-growing ground-based security threats.

INTRODUCTION TO GROUNDWARE

OWL is pleased to provide an overview of GroundAware technology and high-level notional recommendations for installation and integration of GroundAware and associated elements for critical infrastructure owner/operators. This full-featured ground surveillance system will provide advanced situational awareness and real-time deterrence and response capabilities. The system will be designed to help protect critical infrastructure owner/operators from bad-actor threats, as well as to minimize theft and vandalism at challenging sites of all types and sizes (see Figure 1).



Figure 1. Example of complex site where GroundAware provides automated real-time monitoring.

GROUNDWARE TECHNICAL OVERVIEW

The GroundAware product line (Figure 2) offers the following advanced features:

- All-new digital multi-beamforming S-Band radar technology designed specifically for ground and low-altitude surveillance, constantly scanning its field of view
 - Ensures highest reliability and accuracy, with fewest nuisance alarms
 - Enables full system performance in all weather and lighting – no degradation during rain, snow, sleet, fog, or other inclement weather
 - Operates at low frequency to avoid conflicts with common radio frequency (RF) systems potentially nearby
- Real-time, wide-area detection and tracking in all-weather/lighting conditions at ranges of up to 4 km, with a 120°-360° azimuth field of view and 20° to 40° elevation field of view
 - Tracks humans beyond 2 km range, vehicles at to 4 km, drones at 1 km range; see Figure 4 below for screenshot of GroundAware tracking and classify target
 - Enables coverage of large areas with the fewest sensors
- Fast data update rates ensures accuracy and reliability of target detections, tracking, and classification of targets in real time
 - Software-defined scan rates with 4 Hz default

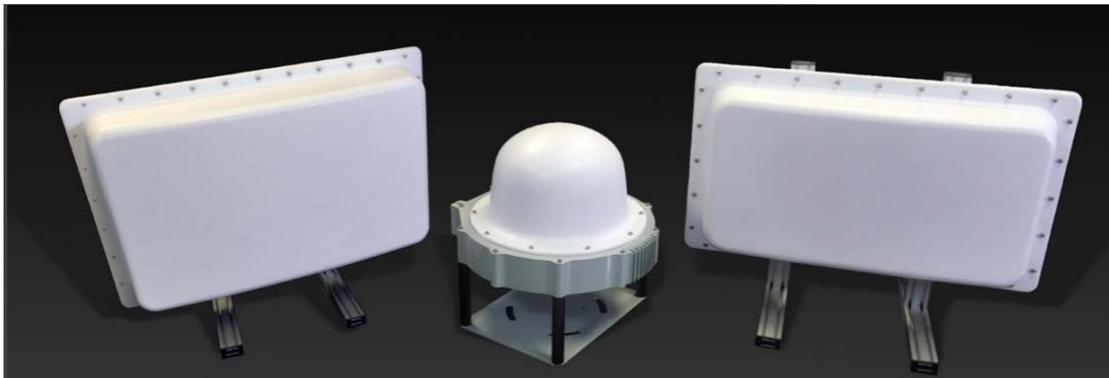


Figure 2. GroundAware product line features the GA9000, GA1360, and GA4120, with a range of coverage options to meet diverse security needs for critical sites of all types and sizes.



Figure 3. Actual test data from customer site, showing a human target accurately tracked and classified as a person at 2.3 km.

- Target classification capabilities for differentiating among different types of intruders – humans, animals, water and ground vehicles, drones, and larger aircraft (see classification information presented in Figure 3)
 - Highly accurate classifier with quantified and demonstrated performance in complex environments
 - Results in alarms and alerts only on targets of interest to avoid nuisance alarms
 - High classification accuracy of targets enabled by “staring” nature of radar that transmits and receives simultaneously, unlike rotating radars with hardware driven track update rates. All targets in GroundAware’s field of view are simultaneously updated multiple times per second (up to 8 times per second).
- Intuitive user interface/dashboard for security operators
 - Google® Maps-based graphical user interface is completely web-based and accessible on desktop and mobile platforms; minimizes user training and eliminates the need for any special software to be installed on users systems
 - Serves as surveillance dashboard where data from GroundAware, cameras, and other sensors integrated and presented for users
 - User-defined symbology – objects can be depicted by different shapes, colors, or even icons based on classification



- Intelligent alarms and notifications
 - User-defined geofences drawn and configured on GroundAware interface to create alarm zones (see Figure 4) to focus surveillance in specific areas
 - Data on targets, including classification and heading, used to customize alarming on targets of interest in areas of concern
 - Automatic notifications via text or email sent to responders at desktop or on mobile devices; audible and visible alarms triggered for responders

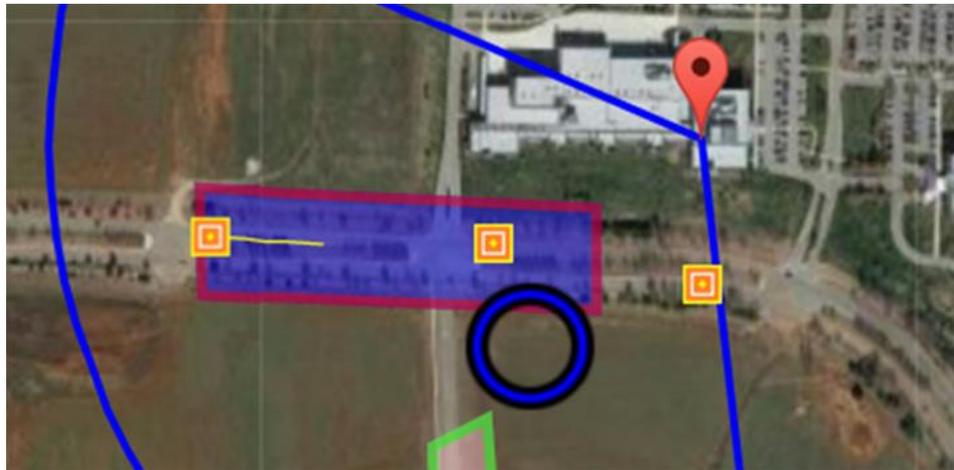


Figure 4. User-defined alarm zones permit GroundAware users to customize alarming in specific areas to address specific surveillance objectives.

- Automatic logging of alarm data for after-action review and analysis for incident forensics, prosecution support, and improvement of security posture (see Figure 5)



Figure 5. As alarms occur, GroundAware logs all data related to the alarm, including detailed track information and real-time radar and video imagery.



- Easy IP-based integration with other security assets (see Figure 6)
 - Demonstrated ability to integrate quickly and easily with new or existing cameras, video management systems (VMS), access control systems (ACS), event management, physical security information management systems (PSIM), and other common security systems

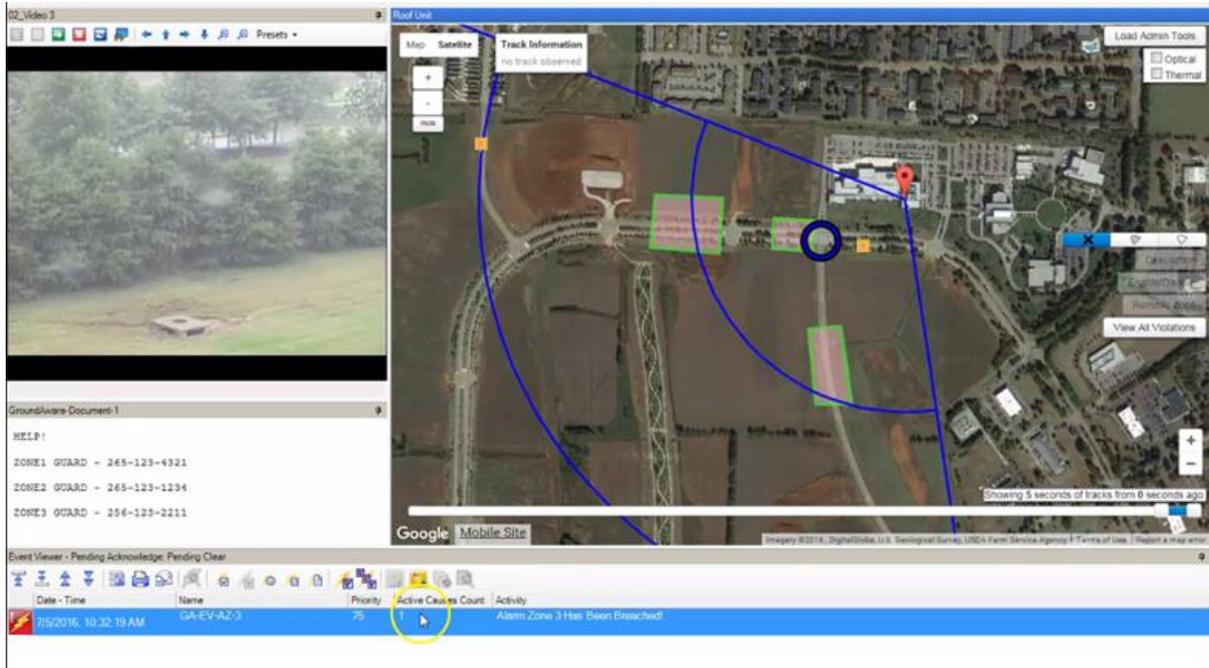


Figure 6. User interface shows common example of GroundAware integration with PSIM and VMS systems. Concept of operation is that GroundAware detects targets in real time; when alarm criteria are met target information is sent in real time to PSIM and VMS to trigger deterrent and responsive next steps per established security policies and procedures.

- Minimal investment in infrastructure required for implementation
 - GroundAware units can be installed on new structures as well as on poles, rooftops, sides of buildings, or other existing structures using industry-standard mounting hardware
 - Allows for expeditious installation and configuration to meet unique requirements at minimal cost
 - Demonstrated ability in other complex customer environments to complete mechanical, electrical, and network integration in maximum of 1-2 days

- Solid-state design, with no moving parts
 - Fully software-defined radar operation and waveform transmission/processing
 - Minimizes maintenance and support issues, permits remote administration, configuration, and support that saves time and cost
- Support for comprehensive layered security plans
 - Unique wide-area coverage provided by GroundAware provides new layer of security to augment current systems, fencing, and human monitoring
 - Integration with other layers of security (cameras, VMS, PSIM, security lights, audio-warning systems, etc.) provides other systems with real-time tracking data, as well as automated triggering of deterrent and responsive actions
- Low total cost for surveillance coverage
 - Wide-area, long-range coverage of large areas (750-2,000 acres)
 - Results in minimized investment in both sensors and infrastructure (power and connectivity) required to support GroundAware sensors
 - Reduces costs to implement and maintain surveillance systems

Table 1. Detailed specifications for GroundAware product line.

	GA1360	GA4120	GA9000
			
Physical Size	18" x 18" x 18"	30" x 17" x 7" per face	33" x 20" x 12" per face
Weight	25 lbs.	45 lbs.	75 lbs.
Power Draw	35 W	75 W per face	300 W per face
Instrumented Range	10 m to 1 km	100 m to 5 km	100 m to 15 km
Azimuth FOV	360 degrees	120 degrees per face	120 degrees per face
Elevation FOV	40 degrees	20 degrees	Selectable from 12 to 90 degrees at manufacture time
Azimuth Accuracy	2 degrees	0.5 degrees	0.25 degrees
Elevation Accuracy	N/A, 2D measurements	N/A 2D measurements	0.5-2 degree (depends on elevation FOV)
Vehicle Detection Range	1 km, given radar height, LOS	>4 km, given radar height, line of sight	>10 km, given radar height and line of sight
Walker Detection Range	0.5 km, given radar height, LOS	2 km, given mounting height and LOS	>7 km, given radar height and LOS
Class 1-2 Drone Detection Range	0.25 km, given height and LOS	1.5 km, given radar height and LOS	>5 km, given height and LOS (15 degree elevation FOV)

HYPOTHETICAL RECOMMENDATIONS FOR COMMON OWNER/OPERATOR

The example recommendations below are based on common critical infrastructure sites and typical security objectives that OWL encounters. These are provided for consideration of how GroundAware and associated elements would be used to enhance security at a site often encountered. OWL would typically engage a customer in conversations and an onsite assessment to better understand specific requirements and how to best meet them.

For this hypothetical site, OWL recommends an advanced, integrated ground surveillance system to provide highly accurate situational awareness of its perimeters, construction sites, and other areas of concern. This includes capabilities to automate real-time deterrent and responsive actions as intrusions occur. OWL's recommendations include the following elements: the GroundAware GA1360 (Figure 7) and GA4120 (Figure 8) Surveillance Sensor and Information Systems; existing or new high-performance point/tilt/zoom (PTZ) camera systems (such as the FLIR PT-606 in Figure 9) with ambient light and infrared video capabilities; and a back-end user interface and alerting server (included with GroundAware). This GroundAware-based system would be integrated with the customer's video surveillance cameras, VMS, and ACS as part of a layered security approach for the customer.

This same GroundAware-based system approach has been successfully installed and integrated and is currently in ongoing operation at a range of OWL customer sites around the U.S.

This same system will provide the hypothetical customer a comprehensive, configurable, and fully integrated ground surveillance system to provide real-time situational awareness and automated deterrence and responsiveness. Various options are available for installation and integration of GroundAware at construction sites or in other areas of concern.

This customer can take advantage of the GA1360's 360-degree coverage for sites where 1 km surveillance range is sufficient. The GA4120's longer-range surveillance out to 4 km range offers opportunities to cover larger areas with the fewest number of sensors. As with any RF-based solution, GroundAware achieves greatest performance when line of sight exists for the area to be surveilled. Below in Figure 10 are notional deployment scenarios for the customer's consideration.



Figure 7. GA1360 with PTZ camera.



Figure 8. GA4120 with PTZ camera.



Figure 9. GroundAware is integrated with PTZ cameras such as the FLIR PT-606 day/night camera.

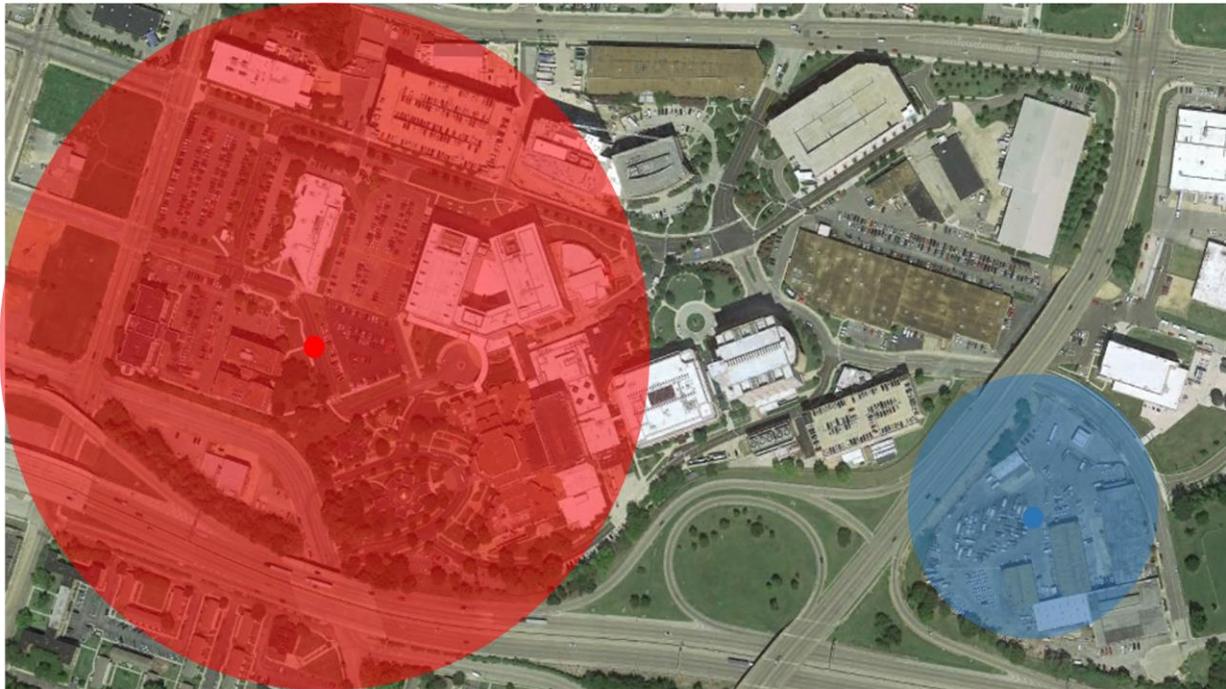


Figure 10. Example deployments of GroundAware at hypothetical customer site include: (1) longer-range deployments of GA4120 units atop buildings or towers to provide up to 360-degree coverage of large areas of customer site (shown in red highlighted area); and (2) shorter-range deployments of GA1360 units on mobile platforms or temporarily on other structures.

Regardless of how GroundAware sensors are deployed permanently or on mobile platforms for temporary deployments (see Figure 11), security operators will benefit from an intuitive web-based GroundAware user interface that can be accessed from any desktop or mobile device, along with alarm notifications that can be sent to and received by operators responsible for responding to security events.

GROUNDWARE CONCEPT OF OPERATIONS

The GroundAware digital multi-beamforming radar delivers detection, tracking, classification, and automated cue-to-slew video verification of intruders in all weather and lighting conditions without false alarms, providing a new level of accuracy and reliability among available surveillance systems.

GroundAware enables security operators to customize detection, cue-to-slew video surveillance, and notifications to only those targets that meet predetermined alarm criteria. These alarm zones are user-configurable by security operators based on day, time of day, size, location, target direction, and target classification (human, vehicle, animal, aircraft, and drone).

GroundAware also enables users to draw “silent zones” to demarcate areas in which the radar will neither track nor alarm on targets. These silent zones permit security operators



to avoid alarming on common targets that raise no security concerns – another means of eliminating nuisance alarms.

When integrated with VMS and ACS systems, GroundAware will notify those systems in real time when alarms take place in all weather and lighting conditions. Security operators no longer have to constantly monitor video screens, hopeful of looking at the right screen and the right time to observe an intruders.

With GroundAware working in the background, intruders are detected and tracked in real time. If the intruder meets alarm criteria, GroundAware automatically prompts operators of intrusions within the VMS and instantaneously cues and slews cameras to track the intruder. At the same time, other intruder data – classification, heading, speed, etc. – are sent to the VMS.

The full GroundAware-based system, including integrated PTZ cameras, is to operate on the customer’s network. Integration with VMS and ACS would also be accomplished via IP interface over the customer’s network. All notifications and alerts are communicated via



Figure 11. GroundAware deployed on mobile platform for temporary deployments.

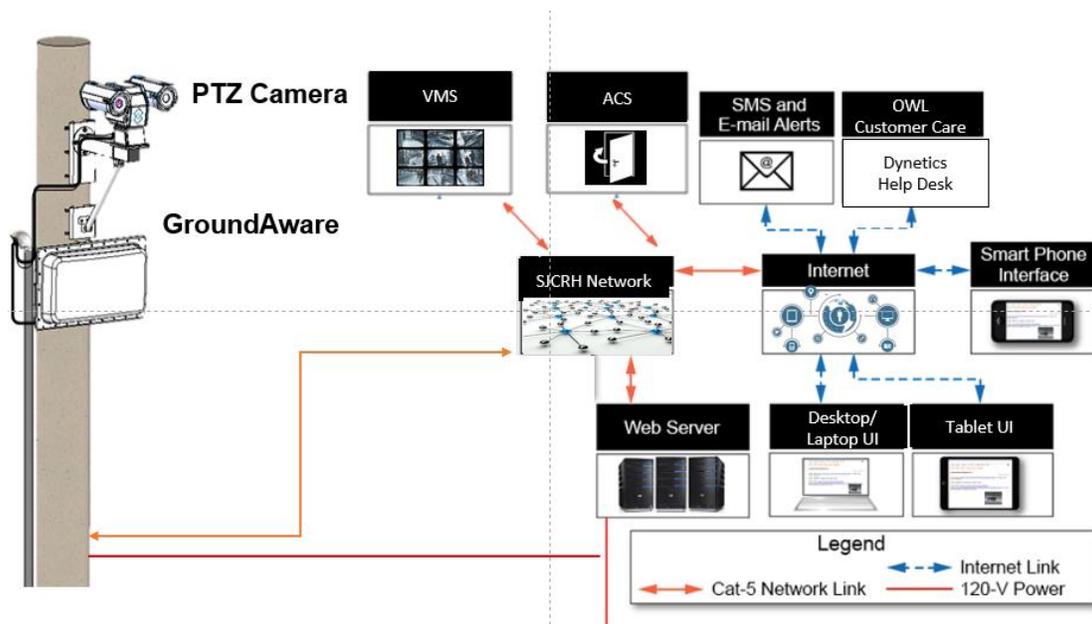


Figure 12. The GroundAware-based system will operate entirely on the *customer’s* network, including integration with other systems and communication with users.

the customer's network and over the Internet to security operators.

Through the fully integrated and networked approach described above, GroundAware augments the value of the customer's substantial video investments by reducing the need for continuous human monitoring and automating the cuing and slewing of cameras. Similar approaches can also be used to share real-time GroundAware information with the ACS.

In working with a real-world customer, OWL would collaborate with the customer to customize a fully integrated GroundAware surveillance system that leverages VMS and ACS assets to meet security objectives on a comprehensive basis.

INSTALLATION, TRAINING, SUPPORT, AND MAINTENANCE

In the hypothetical customer example, just as with actual customers, OWL will fully deliver the GroundAware-based ground surveillance system, including physical installation, software integration with the VMS and ACS systems, deliver administrator- and user-level training on the customer site, and provide ongoing technical support to ensure that the GroundAware-based system is properly configured and fine-tuned to meet changing needs. With the purchase of GroundAware comes a one-year full warranty and maintenance plan that includes ongoing support and configuration services, software updates, and full replacement guarantee within 72 hours in the event of hardware failure. This same full-warranty and maintenance coverage is available for subsequent years for an additional fee.

After installation, integration and training are complete, customer personnel managing and using the GroundAware -based system will have access to the OWL Customer Care team via toll-free support line, support email account, and online support portal. OWL Customer Care team members will ensure expeditious and effective support regarding day-to-day user questions, configuration questions or requests, upgrades, or any potential technical support issues. OWL Customer Care will work with customer personnel to ensure that all appropriate OWL resources are employed to address support requests in the timeliest manner possible, while ensuring that customer personnel are kept informed on the resolution status of their calls for support.

BACK-UP INFORMATION

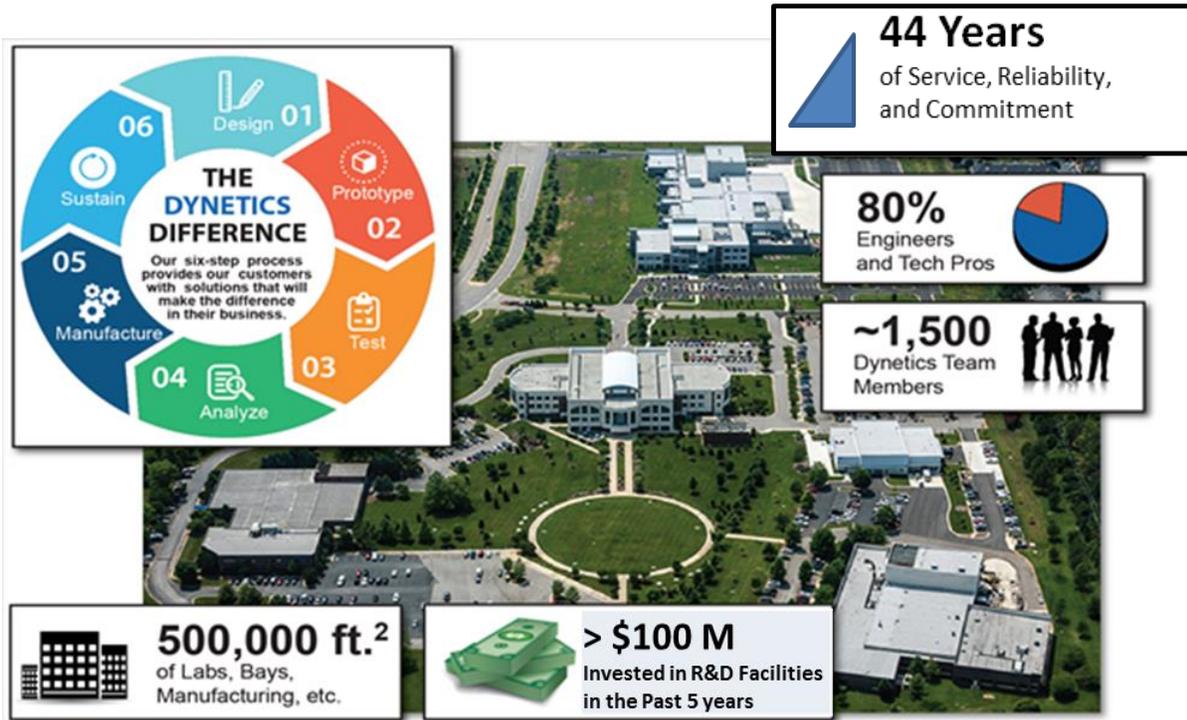
OVERVIEW OF OBSERVATION WITHOUT LIMITS (OWL)

OWL is a business entity established by Dynetics Inc. in 2017 to manage capital, intellectual property, and direct customer relationships for Dynetics' commercial critical infrastructure security pursuits. OWL products are manufactured by Dynetics, and all related design, development, testing, assembly, installation, integration, sales, support, and training activities are performed by Dynetics employees. OWL serves as the prime contractor and Dynetics serves as subcontractor for customer projects.

Founded in 1974, Dynetics Inc. is an employee-owned and privately held company that provides responsive, cost-effective engineering, scientific, and IT solutions for national security, cybersecurity, space, and critical infrastructure security sectors. Our staff includes approximately 1,500 employees who work at our headquarters in Huntsville, Alabama, and more than 15 other locations. Dynetics' annual revenue has exceeded \$300 million for the past two years and \$280 million for the past four years. With this growth, Dynetics has invested more than \$170 million on world-class research, development, and manufacturing facilities, equipment, and capabilities, as we continue to recruit and retain top-tier technical staff. The formation of OWL, as referenced, was made possible by the strength, strategic vision and growth-oriented planning by Dynetics' leadership.

Dynetics and OWL are committed to ongoing quality, safety, and process improvement. We have the staff, tools, and licensing to work with the materials and equipment required for the work we do. Our facilities in Huntsville, Alabama, are certified to ISO 9001:2008 and AS 9100C for design, manufacture, production, testing, research, and development of government systems and projects, commercial electronic diagnostic equipment, and space systems, test stands, and ground support equipment, as required by contract. In addition, we have been appraised to CMMI DEV Maturity Level III for software development projects that deliver product to external customers. We have also been approved to customer-specific special approval requirements and supplier awards for quality and excellence from partners such as Raytheon, Boeing, and NASA.

From this position of strength and growth, Dynetics and OWL have the expertise, capabilities, and resources to provide our customers with a holistic technical approach to the development, delivery and support of high technology solutions, including design, testing, analysis, prototyping, manufacturing, and sustainment. The figure below summarizes the facilities, experience, personnel, and distinctive technical approach that enable Dynetics and OWL to provide customers more than just a sensor but high-quality, high-value products and services with the capabilities, expertise, and strength to stand behind those solutions.



Dynetics, the parent company behind OWL, brings the technical competence, breadth, and stability of a large company, while maintaining responsiveness.

The Dynetics portfolio of specialized services and products, including complex end-to-end systems, are focused on serving the needs of customers in the following strategic business areas: radar and sensor technologies, unmanned systems, intelligence solutions, weapons technology, strike systems, space solutions, complex interface development and integration solutions, and cyber solutions.

The figure below summarizes Dynetics' strategic business areas, which focus us clearly on technologies, such as GroundAware®, that fulfill the demanding requirements of our customers in a range of industries.

With capabilities typical of a larger business and the agility of a small business, Dynetics is capable of serving as a prime contractor, subcontractor, and manufacturer for a range of customers with complex, highly technical needs. Our customer list includes: Alabama Power, Georgia Power, Louisville Gas & Electric, Ameren, U.S. Army, Missile Defense Agency, Defense Intelligence Agency, NASA, Boeing, Raytheon, Ford, Chrysler, Nissan, Southern Company, Denver International Airport, State of Tennessee, Auburn University, and the University of Alabama in Huntsville. OWL, in partnership with Dynetics, is positioned to serve GroundAware customers.



Dynetics Strategic Business Areas



GroundAware® Surveillance

- Critical infrastructure security
- Two models offer long- and short-range detection with fast data updates and real-time classification of four different targets
- Low-cost units easily integrate with existing systems
- Lifecycle and support warranty



Intelligence

- Foreign materiel exploitation (FME)
- Radar; missile; and command, control, communications, computers, and intelligence (C4I) scientific and technical analysis
- Defensive threat systems analysis
- Electronic warfare test & evaluation



Radars and Sensors

- Advanced radar signal processing
- Foreign weapon systems analysis
- Intelligence, surveillance, & reconnaissance (ISR)
- Reconnaissance, surveillance, & target acquisition (RSTA)



Weapons Technology

- Test and evaluation solutions
- Modeling, simulation, and analysis
- Telemetry and calibration systems



Strike Systems

- End-to-end system development, including advanced seeker technologies and guidance, navigations, and control
- Enhanced-lethality warhead design
- Testing of warheads, including arena, fragment recovery, target defeat, insensitive munition, and safety testing



Space Solutions

- Propulsion systems and mechanical and propulsion testing
- Small satellite development
- System integration and assembly
- Mission design and vehicle sizing
- Vehicle structure design and manufacturing



Cyber Solutions

- Compliance, test, and risk management
- Business information technology services
- Hardware and software cyber detection



Unmanned Systems

- Hardware, software, and payload integration
- Flight test operations and support
- Counter-UAS

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Dynetics provides a broad portfolio of highly specialized engineering and technical solutions and complex end-to-end products in strategic business areas, which provide unique technical depth and breadth for addressing the requirements of the OWL customers and users of GroundAware.