# Lockheed Martin CDL Systems

SOFTWARE SOLUTIONS FOR
UNMANNED VEHICLE SYSTEMS

# Software Solutions

## FOR UNMANNED VEHICLE SYSTEMS

# Who We Are.

Lockheed Martin CDL Systems specializes in the development, deployment, sales and application of unmanned systems for high-end commercial, civil and military applications. Our primary focus is developing software that helps our customers become highly effective using unmanned vehicles and the data they gather. Once a small technology start-up, we are a 40-employee workforce in Calgary, Alberta, Canada.

We leverage international standards and design our software to run on easy-to-find hardware. This provides our customers low lifecycle costs and long-term options for growth, sustainment and flexibility. Our software has been integrated with, and used to control, over 40 unmanned vehicle systems including propeller-driven aircraft, helicopters, jets, airships, convertible aircraft, rigid hull and inflatable boats, large-scale ground robots, quad-copters and solar wings. Our customer set is equally diverse including the U.S. Department of Defense, Canadian Forces, UK Ministry of Defense and commercial service operators. Our combined flight hours exceed 1.5 million.

With an emphasis on low cost, interoperability, automation and low-dependency architecture we support emerging technologies, safety and a growing dependency for actionable intelligence. We look forward to working with you in developing an unmanned future.

# 25 Years of Success

**1993**

First release of VCS for UTCS to control Barracuda USV

**1994**

VCS for UTCS flies Vindicator UAV

**1996**

VCS for UTCS operates multiple vehicles (USV and UAV)

**1998**

VCS for Shadow flies Shadow UAV

**2002**

VCS for Shadow deployed in theatre

**2004**

VCS-4586 (STANAG 4586) flies Grasshopper UAV

**2005**

VCS for Hunter flies Hunter UAV

**2006**

VCS for UTCS (Using STANAG 4586) deployed

**2007**

VCS-4586 flies Gray Eagle UAV

**2010**

VCS for UTCS operates 16 USV's in SWARMEX demo

**2011**

VCS-4586 in Manned Unmanned System Integration Capability demo

**2012**

LOCKHEED MARTIN

Acquires CDL Systems

**2013**

mGCS flies Maveric UAV

**2016**

VCS for Shadow achieves 1,000,000 flight hours

**2018**

VCSi flies Indago™ UAV

# What We Do.

## VEHICLE CONTROL STATION

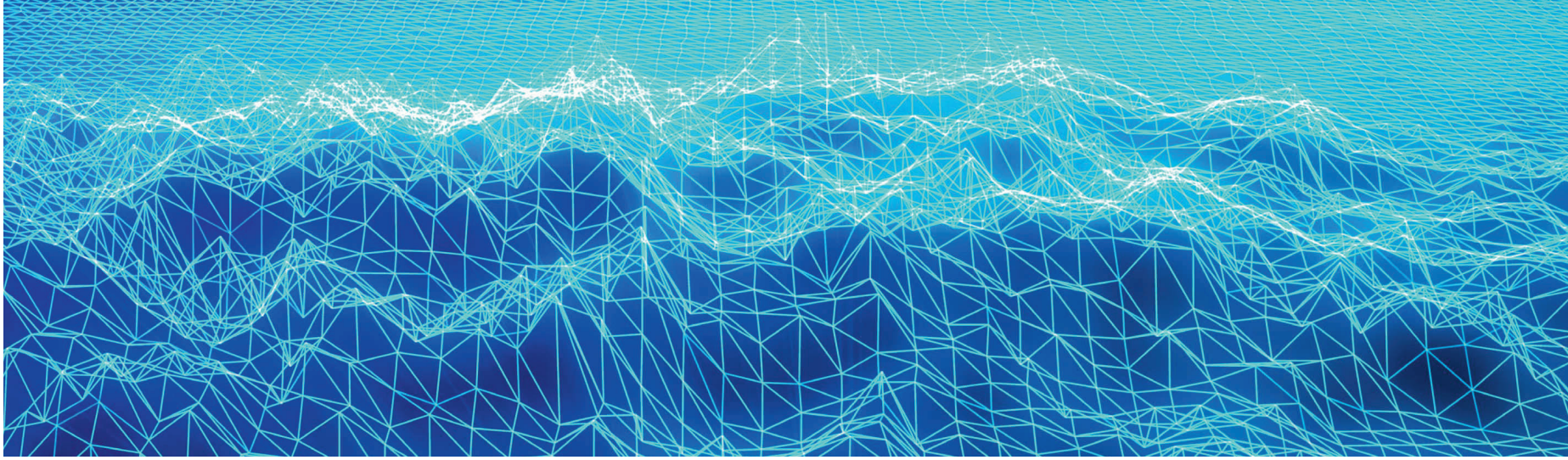
For over 25 years, Lockheed Martin CDL Systems has been at the forefront of unmanned vehicle command and control technology. Going back to 1992, we introduced two innovations to the industry – the Fly-by-Mouse interface, and an open communication language. Both of these innovations remain true today and a part of our control station paradigm.

Released for the first time in 2018, the VCSi is our newest and evolving software solution for controlling unmanned systems in multiple domains – from the air to the sea. While VCSi is optimized for use by operators in a seated configuration, using today's most modern and available computing hardware – the PC, it is not confined to that experience. VCSi is extensible from numerous screens down to a hand-held tablet, allowing for a form factor to match your operating environment. Our belief is not to pretend the operator is on-board the aircraft, but rather to treat the operator as an activity manager where they are presented with situational awareness from a global view, with localized sensor inputs. We have proven through our over million and half flight hours that safe operations of unmanned vehicles is best done by effectively managing complex data, and not holding on to a joystick.

As unmanned systems embark on missions measured in months, humans become supervisory participants in the activity, which involves focusing on objectives, threats, alerts and data. It is the data generated by unmanned systems which is of the utmost importance.

## ACTIONABLE INTELLIGENCE

Most unmanned systems capture data. However, large volumes of data are a problem in their own right. What users want is actionable intelligence – data condensed and presented to the decision maker which can immediately answer questions, solve problems, and spur action. Gathering data is useful, but the immediacy of decision-making transforms the value of an unmanned system. CDL Systems is leading efforts to extract actionable intelligence from UAS data by investing in advanced technology. Technologies such as Structure from Motion, Simultaneous Localization and Mapping (SLAM), Monocular Visual Odometry, Point Cloud Generation, Orthomosaicking, Machine Learning and Photogrammetry are all becoming a part of our offerings. We are merging those technologies into new product offerings that empower users. Paired with other Lockheed Martin partners, we are able to truly transform the intelligence generating capability of unmanned systems.



## Real-time Structure From Motion

The ability to generate 3D point clouds and 3D imagery in real-time as a vehicle flies.

## GPS Denied Operation

Using imagery to track the real-time position of an aircraft from passive imagery and not from satellite based triangulation.

## Site Mapping

The ability to compare architectural drawings to actual 3D imagery to gather progress updates.

## Tactical Surveying

The ability to produce wide area maps of tactical situations or installations.

## Earth Moving

The ability to generate immediate and up to date 3D renderings of terrain through mining or earth moving activities.

# Portfolio

We have worked alongside a diverse group of international clients on an array of unmanned vehicles and simulation platforms.

Advanced Subsonics Grasshopper
AeroVironment Raven B
Airbus Defence Do-DT 25/35/45/55
ATK Outrider
Aurora Flight Sciences Centaur
Aurora Flight Sciences Excalibur
Aurora Flight Sciences GoldenEye 80
Aurora Flight Sciences Lightning Strike
BAE Systems (ACR) Silverfox
BAE Systems Kingfisher
Boeing (Insitu) ScanEagle
Boeing A160 Hummingbird
Bosh Swiper
CAE STRIVE
CAE UAV Simulator
E.M.I.T. Sparrow
GA-ASI Gray Eagle (U.S. Army MQ-1C)
General Dynamics Canada FORESIGHT
Lockheed Martin Condor
Lockheed Martin Desert Hawk
Lockheed Martin Fury
Lockheed Martin Indago
Lockheed Martin Prepar3d
Lockheed Martin Vector Hawk
MBDA Fire Shadow
MetaVR VRSG
Northrop Grumman Hunter B (U.S. Army MQ-5B)
QinetiQ Target Systems Barracuda
QinetiQ Target Systems Hammerhead
QinetiQ Target Systems Humpback
QinetiQ Target Systems Mosquito
QinetiQ Target Systems Vindicator
Simlat STS-Pro
Textron Aerosonde
Textron Nightwarden
Textron Shadow 200 (U.S. Army RQ-7B)
Textron Shadow 400

We have gained recognition for our strong understanding of ground control software unmanned vehicle systems, experience in on-site integration and testing, and our personalized and long-term customer relationships. Our dedicated team of highly skilled engineers brings a wealth of expertise and innovation to the products and services we provide.

# Standarization & Quality

Throughout our history, CDL has always been committed to ongoing advocacy, quality control, continuous improvement, and international standardization. All of these are blended together to create a company committed to the growth of our industry, the success of our customers, and the long term safe integration of unmanned systems into society. CDL Systems has participated in the following initiatives.

"Typical Agile implementations are bare-bones and result in a lot of rework caused by poorly defined requirements, minimal planning, no design and narrowly focused testing. LM-CDL has refined its Agile implementation by adopting numerous additional engineering and project management practices from CMMI and elsewhere to create a well-defined and robust life cycle for creating software.

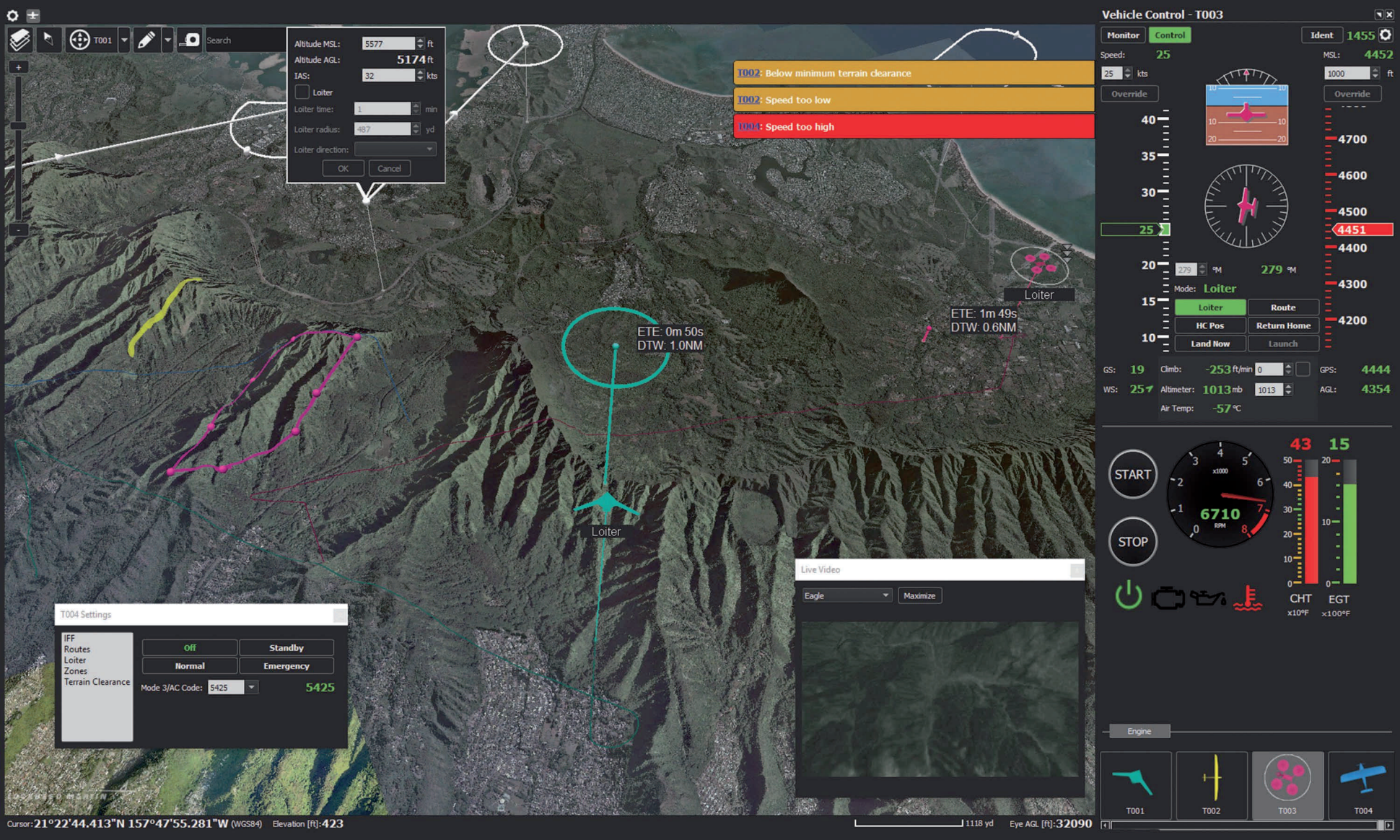
Their Agile implementation is supported with the use of tools to keep project data readily accessible and processes light-weight. The result is an excellent balance of the best features of Agile and disciplined engineering and project management practices."

Neil Potter

CMMI Lead Appraiser and Agile consultant

The Process Group

- ✓ Certified as Level 3 of the Capability Maturity Model Integration (CMMI) by the CMMI Institute. This software quality designation, achieved in 2012, and re-certified every 3 years, is a third party verification of our approach to quality processes.
- ✓ Transport Canada BVLOS working group. CDL participated in the TC working group to advocate for the safe integration of UAS into Canadian airspace.
- ✓ NATO STANAG 4586. CDL was one of the founding members of STANAG 4586 going back to 1998. We were the first company to fly a vehicle using this NATO standard communications language in 2004.
- ✓ NATO STANAG 4817. CDL is part of the Multi-Domain Control Station working group which is establishing a common framework for UxV control (Air, Sea, Underwater)
- ✓ DO-178C. CDL participated in the working group to define this revise standard for airworthiness in software development, including applicability to unmanned aircraft.
- ✓ Future Airborne Capability Environment – Lockheed Martin is the lead for FACE development, and CDL is designing our new software to be compatible with this modular architecture for the DoD.
- ✓ Agile Software Development. CDL participates in Agile software development conferences, including presenting papers and approaches.
- ✓ Domain Advocacy – CDL routinely presents papers and gives presentations to Unmanned Systems conferences and tradeshows to help with industry awareness and technological growth.


Vehicle Control - T003
Monitor
Control
Ident
1455
Speed:
25
kts
Override
MSL:
4452
ft
Override
T002: Below minimum terrain clearance
T002: Speed too low
T004: Speed too high
Altitude MSL:
5577
ft
Altitude AGL:
5174 ft
IAS:
32
kts
Loiter
Loiter time:
1
min
Loiter radius:
487
yd
Loiter direction:
OK
Cancel
Loiter
ETE: 0m 50s
DTW: 1.0NM
Loiter
ETE: 1m 49s
DTW: 0.6NM
279 °M
279 °M
Mode: Loiter
Loiter
Route
HC Pos
Return Home
Land Now
Launch
GS: 19
WS: 25
Climb: -253 ft/min
Altimeter: 1013 mb
Air Temp: -57 °C
GPS: 4444
AGL: 4354
START
STOP
6710
RPM
43
15
CHT
x10°F
EGT
x100°F
Live Video
Eagle
Maximize
T004 Settings
IFF
Routes
Loiter
Zones
Terrain Clearance
Off
Standby
Normal
Emergency
Mode 3/AC Code:
5425
5425
Engine
T001
T002
T003
T004
Cursor: 21°22'44.413"N 157°47'55.281"W (WGS84)
Elevation [ft]: 423
1118 yd
Eye AGL [ft]: 32090

# VCSi

## Modular Unmanned Vehicle Control Software

VCSi is the next generation product in the VCS family. Built upon our extensive experience, VCSi brings modular and extensible control to your system. VCSi is made in Canada, commercially available, and ITAR free. Its modular architecture allows you to purchase only the components you need for your system. A developer-friendly API and plug-in architecture allows you to easily add or extend functionality for your unique needs. Leverage our wealth of experience and unman your future with VCSi.

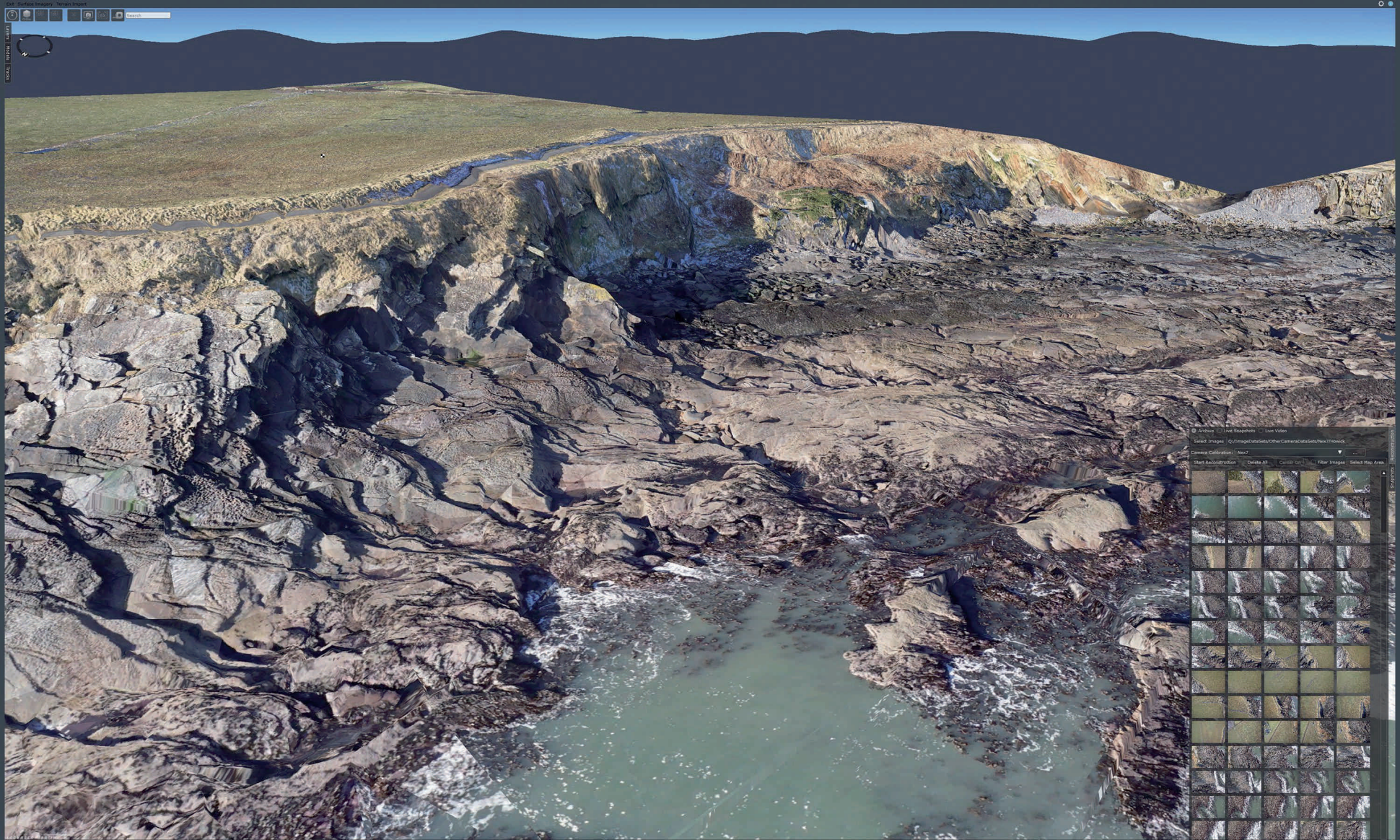
### international
Made in Canada commercial software, not subject to U.S. ITAR export regulations. Supports translation to different languages, including non-latin scripts.

### intuitive
Fly-by-mouse interface simplifies complex actions.

### interoperable
Multiple disparate vehicles can be easily and effectively controlled from a single station.

### interchangeable
Modular design allows you to purchase only the components necessary for your vehicle.

### indigenous
Robust plug-in architecture enables integration of local content and vehicle specific functions.


Archive
Live Snapshots
Live Video
Select Images
Q:/ImageDataSets/Other/CameraDataSets/Nex7/Howick
Camera Calibration:
Nex7
Start Reconstruction
Delete All
Cancel Orig
Filter Images
Select Map Area

# Hydra Fusion Tools™

## Turn Big Data into Actionable Intelligence

Flying an unmanned aircraft system (UAS) is no longer a stand-alone activity. Operators are inundated with large quantities of disparate data – in the form of maps, images, video, and intelligence – that they must compare and interpret before taking action.

Hydra Fusion Tools™ is a real-time Geospatial Information System that is our answer to the challenges presented by Big Data. Hydra Fusion Tools simplifies information by fusing this data to create a 3D world presentation that gives immediate 'in context' information.

The stand-out feature of Hydra Fusion Tools is its ability to simultaneously localize and map (SLAM) incoming video or still image feeds from the aircraft while it flies. These images are incrementally matched up, stitched together, and geo-registered resulting in an immediate and immersive 3D reconstruction. Combined with 3D models of objects, Hydra Fusion Tools creates a rendering of any site – construction zone, industrial plant, mine, or farmer's field.


U.S. Army MQ-1C Gray Eagle

# VCS and the U.S. Army

## One System Ground Control Station

The US Army has been using VCS or VCS-4586 to operate their large UAS assets since the turn of the century. This includes both the One System Ground Control Station and the Universal Ground Control Station (its replacement.) This allows the U.S. Army interoperable control for the RQ-7B Shadow, MQ-5B Hunter, and MQ-1C Gray Eagle. Our software is installed in every US Army shelter to conduct intelligence, surveillance, reconnaissance, and other tactical UAS missions. To date, the U.S. Army and U.S. Marine Corps have accumulated over 1,500,000 operational flight hours using VCS in-theater. VCS helps the U.S. Army control their fleet of dissimilar UAV platforms from a common operator-interface.

CDL Systems has remained and will continue to be an active, contributing partner of the U.S. Army for decades to come. As the Army's needs have evolved, so has our software, with VCSi offering a modular, extensible and easy to integrate solution for today's complex operational theatres.

RQ-7B Shadow

MQ-5B Hunter

Lockheed Martin Canada CDL Systems

QinetiQ Target Systems

Lockheed Martin Canada CDL Systems

# Multi-Domain Control

Since 1996, CDL has been controlling multiple unmanned vehicles at the same time in different domains. The Universal Target Control Station (UTCS), developed with QinetiQ Target Systems is a ground control solution developed collaboratively which demonstrated simultaneous control of and aircraft and a boat at the same time by a single operator. Over the years, the UTCS has advanced to control up to a swarm of sixteen boats at once, or eight aircraft at one time. The UTCS is deployed in military target operations worldwide in Canada, Greece, Japan, Norway, Saudi Arabia, Singapore, Sweden, Germany, Korea and the United States. Multi-domain control is part of our DNA, and integral to our offerings.

Effective Multi-Domain control requires and understanding of each domain, a clear grasp of each vehicle's mission parameters, and generic interfaces (both human and machine) to effectively execute the task at hand. Vehicles in different domains have commonalities and differences which have to be effectively compartmentalized in ground control station design to create effective operators and reduce the complexity of these advanced systems.

CDL has not only designed multi-domain control stations, but we've also pushed for, and participated in, standardization within NATO for these applications. This includes both STANAG 4586 and STANAG 4817. With our breadth of understanding of each domain across millions of operational hours, and our commitment to commonality and standardization, we are an excellent partner for future Multi-Domain Control station developments.


SONY

# Lockheed Martin Family of Systems

As part of Lockheed Martin, CDL is the tie that binds between our small UAS family of systems. Our mGCS software is the common ground station between the Indago, Desert Hawk, Condor, and Vector Hawk. Each unique vehicle is designed for a unique application, but with a common architecture. All of these aircraft include a common autopilot, common components, common datalinks, common payloads and of course, a common mGCS ground control station. Having mGCS as the solution for common control allows for reduced training, shared development costs, and more robust software.

# Lockheed Martin. Your Mission is Ours.™

www.cdlsystems.com

Lockheed Martin Canada CDL Systems
333 - 96 Avenue NE, Bldg 5000,
Suite 5301
Calgary, AB T3K 0S3
dustin.engen@lmco.com


www.lockheedmartin.com/cdl
PIRA: OWG201604008