

Common Control, Here & Now



AMREL Control Solutions
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The Need for Interoperability

In 2003, the U.S. forces invaded Iraq with fewer than 200 unmanned systems. Within 5 years, this number had climbed to over 18,000. Many subsystems, especially Operator Control Units (OCUs), were vendor-specific, proprietary and custom-built for each robot.

Dozens of separate OCUs are currently in deployment. The vast majority controls only a single asset type and cannot be modified to control others. This is especially frustrating since single-operator command and control of multiple-robot systems is necessary for force multiplication.

In addition to increasing cost of ownership and complicating training, the "stove-pipe" engineering of dedicated OCUs poses other problems. If an Unmanned Ground Vehicle's (UGV) mission is changed, the entire OCU may need to be replaced - a clumsy and burdensome process that challenges logistical support, and hampers mission flexibility.

To increase interoperability and integration, the Department of Defense (DoD) initiated several programs to develop a Common Operator Control Unit (COCU), i.e. a single configurable subsystem that can control heterogeneous sets of robots in varying mission scenarios. Well-known efforts include:

- **IBCT Modernization Rollout (Increment 1)** common control for unmanned systems, unattended sensors, and inter-unit communications.
- **Naval Surface Warfare Center's (NSWCDD)** proposal for a single Common Robotic Controller (CRC) that will operate unmanned tactical aerial/ground vehicles, and a network of tactical unmanned sensors.
- **Joint Architecture for Unmanned Systems' (JAUS)** standardization of architecture and interfaces.

Common Control, Here and Now

Obstacles to a COCU include the resource demands and complexity of running multiple operating systems, applications and configurations on a single hard drive. The solution is modularity.

For years, American Reliance Inc. (AMREL), a leading provider of rugged, mobile computing platforms, has been stressing modular solutions for OCUs, because:

- Eliminating peripherals reduces the footprint
- Swapping hard drives simplifies upgrades without compromising security
- Changing radio modules enables interoperability and eases integration

When AMREL applied modularity to a client's integration problem, it discovered a workable, interoperable solution. Common control has arrived.

The OCU Pros

In 2007, an engineering design firm approached AMREL with a problem. The Robotic Systems Joint Project Office (RSJPO) had hired the firm to upgrade the Multi-function, Agile, Remote, Controlled Robot (MARCbot). The firm was dissatisfied with the existing OCU configuration, in which the radio was tethered. A peripheral radio not only increased the OCU's weight and size (a key consideration when deployed in the field), but also necessitated a separate power supply and battery, which drained logistical resources.

Unfortunately, integrating the radio directly into the computer decreased the operating range, due to the increased noise-to-signal ratio generated by internal electronics. Range capabilities were critical for the safety of the MARCbot's operator, since one of its missions was IED detection.

Application Module

To meet this challenge, AMREL developed the patent-pending Application Module. As the name implies, Application Modules can be used for a variety of tasks. In this instance, a radio is integrated into the module, which is inserted into the computer's device bay. Application Modules configured this way are sometimes called Radio Control Modules (RCM). Designed for simple plug-and-play connectivity, RCMs are linked through AMREL's proprietary device bays to the connector hub (Ethernet, serial, USB, etc.).

The prototype performed beyond expectations. It not only met the minimum operation range requirements, it exceeded them. After an especially successful demonstration, a project manager for the RSJPO took the unusual step of calling and saying, "I salute AMREL."

This was the first use of an Application Module, a patent-pending application that would prove to be a solution to multiple problems.

The Tougher Book

After hearing of its success with the MARCbot, iRobot® contacted AMREL about replacing the Panasonic-based OCUs for their multi-mission tactical robot, the PackBot. iRobot had previously secured power supplies and mobile computing systems from AMREL and knew the quality of its work.

In addition to the above mentioned advantages of the RCM, iRobot learned that AMREL's mobile computing platforms cost less than the Panasonic systems. They were also more rugged (this prompted one wit to call AMREL's computer solutions "the tougher book").

Especially significant was that, unlike Panasonic, AMREL could customize its systems and extend its guarantee to include those modifications. Since it frequently deals with the highly specific needs of the military, AMREL has made customization the core of its business model. iRobot discovered that it no longer had to deal with multiple independent vendors for many of the required changes and that it could count on the manufacturer to back up the computing platform as it was actually deployed. AMREL was a true single-source supplier.

Today, the AMREL-supplied OCU is a mission critical subsystem of the widely deployed PackBot.

From Application Module to Modular Kit

Application Modules are used to control numerous unmanned systems. In fact, AMREL is the *only* supplier that has OCUs for multiple deployed robots.

Infinitely customizable, this module has been used in a number of radio and communication systems including FreeWave, Ubiquiti, and DTC and at frequencies of 2.4 GHz, 4.9 GHz, 5.9 GHz, and 900 MHz. A component has even been configured for fiber-optic control (this is useful when operating in a cave or underwater where radio transmissions are limited).

The Application Module is not limited to robots. AMREL has developed a module that communicates with AreaRAE sensor gas detectors. The military will require future OCUs to interact not only with a variety of robots, but with unmanned sensors as well.



Modular Common Control

Even though the Application Module concept was developed originally for the purpose of integration, it's clear that a modular OCU with an easily swappable communications module expands interoperability. Exchanging hard drives, radios, and other key modular components radically increase the functionality, not just of the OCU, but of the unmanned system itself.

Changing the mission as easily as changing a tire

The modular OCU solution creates new capabilities for field personnel. Before deployment, a commander would be able to design a modular OCU kit specific to his mission requirements. If his unit was assigned UGV assets for divergent missions, he would request an Application Module for each task. Since the commander can easily swap the modules, he no longer needs to plan for challenging logistic support, carry multiple OCUs on missions, or even replace the entire robot. Modularity gives a commander on-the-ground flexibility that does not exist with dedicated OCUs.

Modular kits enable the configuration of multiple platforms for multiple unmanned systems in a single device. If a combat unit uses a TUAV as well as a UGV, the kit can be outfitted with a module for each system. Change the system; change the module. It's that simple.

In the field, if a unit discovers it needs additional components, simple logistics can supply them with the appropriate module.

Sustainability of unmanned systems will increase, since modularity eases the replacement of broken parts. Once kits become standard for OCUs, providers can create modular components for their specific unmanned systems. Since production and procurement will be streamlined, costs and delivery time will be reduced.

AMREL is currently working with system integrators to create modules that enable operation of numerous unmanned systems as well as the monitoring of sensors. AMREL is expanding this concept to other components to create a common control capability.

The Flexpedient® Revolution

AMREL incorporated its extensive experience and expertise with modular systems into interoperable Flexpedient® Solutions. A typical Flexpedient® Solution is comprised of an AMREL ROCKY computer, an Application Module, and the hard drive. This simple combination is infinitely flexible, and able to configure an OCU that can control virtually any unmanned system.

Multiple Flexpedient® Solutions can be assembled from a Modular Unmanned Systems Kit & Interface Tools (MUSKIT). A one-box system, the MUSKIT enables field personnel to quickly put together multiple configurations of Application Modules, computers and hard drives as needed. Since modules can be outfitted for different applications, Flexpedient® Solutions can also be used to build instruments for biometric data collection and analysis as well as sensor monitoring.

While not a COCU in and by itself, it is a big leap forward toward DoD's goal of interoperability. This is the first OCU solution that allows a single device to control heterogeneous unmanned systems, even when they have diverse operating systems and different origins of manufacture.

Common Control with Proprietary Technology

AMREL's Flexpedient® modular approach enables common control, while allowing developers to preserve their proprietary technology. Providers simply integrate new applications into the modules, which are then proprietary. Modules are easily swapped in and out, thus allowing the end user to use one computer platform for common control.

Streamlined application distribution and validation

AMREL's Flexpedient® Solutions create a sustainability channel to identify and distribute new technologies. Since new developers are no longer responsible for the entire solution, they can quote the lowest possible price point. Furthermore, by attaching their application to AMREL's well-known ROCKY line of computers (thousands are actively deployed in theater), they have an easier time demonstrating and validating their technology.

The Bottom Line

The modular kit model creates an immediate, workable, attainable common control solution. It reduces the footprint of OCUs as well as their cost of procurement and maintenance. The modular kit solution increases interoperability, integration, sustainability, and the flexibility of the command & control of unmanned assets.

AMREL's Flexpedient® Solutions fulfill the promise of modularity. While a true COCU is years away, Flexpedient® Solutions currently deliver an unprecedented level of enhanced interoperability. System integrators and robot manufacturers don't have to wait for the future. AMREL has a common control solution for unmanned systems here and now.

Battlefield Proven Solutions

AMREL's 20+ year tradition of satisfying the specific needs of the military has led to a modular solution that's achieved an unprecedented degree of interoperability and integration. We are the only OCU-solution supplier to have control subsystems operating in multiple deployed unmanned platforms developed by different manufacturers. A few of the many deployed unmanned systems using our OCUs include:

iRobot's PackBot (UGV)

AMREL's OCU solutions have been combat tested by thousands of deployed PackBot Unmanned Ground Vehicles (UGV). Our one-piece OCU solution directly incorporates the radio card into an integrated Application Module, thereby simplifying the supply chain, reducing peripherals and decreasing the size & weight of the footprint. An unusually high level of interoperability is achieved through swapping Radio Control Modules of 2.4 and 4.9 GHz. This mature technology has a TRL of 9.



Applied Geo Technologies' MARCbot (UGV)



AMREL helped establish the reputation of the Multi-function, Agile, Remote, Controlled Robot (MARCbot) as an effective warfighter tool. Integrated into the main control system, the radio was encased in the hardened material of AMREL's unique Application Module, protecting it from interference of the internal electronics. The Application Module enabled a small form-factor OCU solution, but didn't decrease the operating range. Being able to control the MARCbot from a safe distance was a major factor in this pioneering robot's popularity, which led to an even greater demand by the military for unmanned systems.

SeaBotix's LBV (UUV)

AMREL supplies an OCU solution for SeaBotix's "Little Benthic Vehicle" (LBV), a "miniROV" (Remote Operated Vehicle). This Unmanned Underwater Vehicle (UUV) performs inspections, interdictions, surveillance, and a host of other missions at depth ratings from 150 to 600 meters. AMREL's fully rugged OCU completely meets military standards for severe maritime conditions.



RP Flight Systems' Spectra Flying Wing (UAV)



When RP Flight Systems needed a reliable command & control ground station for their Spectra Flying Wing, they chose our platform. In addition to the 900 MHz control frequency, this system's Application Module was configured to 2.4 GHz for image/data analysis. The Spectra Flying Wing is designed to operate in any environment for a

multitude of applications, including:

- Search & Recovery
- FBI / DHS
- Law Enforcement
- First Responders

DTC Communications

Narrowband COFDM is a superior means of transmitting video and data, both-line-of-sight and non-line-of-sight. When DTC Communications developed a specific narrow band COFDM application for robotic control, they selected an AMREL platform for its flexibility and widespread use by multiple unmanned systems. AMREL developed a multi-radio control module that weighed less than 2 pounds.



Ibis Tek



Using an AMREL platform, Ibis Tek developed a unique intelligent frequency agile bi-directional wireless data link that supports audio, video and command & control. Currently deployed on multiple unmanned systems, this highly capable application fits into a compact Application Module.

The Leader for Rugged Mobile Computing Solutions

Before it developed Operator Control Units (OCU), AMREL pioneered mobile computing solutions. In 1989, it designed and sold the first notebook in the US. AMREL also introduced the following fully rugged firsts:



**2000 – 1st
Pentium III
Rugged
Notebook**



**2004 – 1st Fully
4" Rugged PDA**



**2007 – 1st 12"
Rugged Tablet**



**2008- 1st
Handheld
Atom-based
computer**

For years, AMREL's well-regarded ROCKY series provided customized, fully rugged, computing platforms for the military. Considering AMREL's experience and expertise, supplying OCU solutions was a logical step.

Michael Castillo
Senior Manager, Robotics Program

One of Mike's many missions in his 15 years as an Army Special Forces engineer was finding IEDs.

"I would hold a knife loosely in my hand and poke it into the ground," he recalls. "You might say that my mission hasn't changed, but I've gone from being an effector arm for IED detection to a supplier of control solutions for unmanned systems that do the same job."



His military career has well positioned him to understand the technological and tactical needs of today's warfighter. In civilian life, he's worked in the world of computer information systems, dealing with issues of hardware and software as well as input/output data interaction.

As Senior Manager of the Robotics Program at AMREL, he is able to combine his first-hand experience in Iraq and Afghanistan with his knowledge of network data processing and business management. He works closely with AMREL's dedicated team of engineers and experts to develop modular control solutions.

In addition to his work at AMREL, Mike is an active member of the STEM Education Coalition, which serves to promote science, technology, engineering, and mathematics for students of all ages. An adjunct professor at Chaffey Community College, he has a BS in Business Information Systems from Devry University. He also is pursuing an MBA from the University of La Verne.

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The OCU Pros



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