A soldier operates the One System Remote Video Terminal toughbook. (Photo: US Army)

GOING MODULAR

Ground control stations have typically been tailor-made for specific missions, but manufacturers are now taking a modular approach, providing greater flexibility and more capabilities.

By Heidi Vella

Traditionally, GCS for piloting unmanned vehicles have been designed and built to manage and control a specific mission or individual platform, leaving little space for flexibility. However, in recent years there has been a drive towards so-called modular GCS that can be tailored to the user's needs, offering versatility and adaptability. But what does 'modular' really mean?

Essentially, it involves utilising open-architecture software that is designed to make it easy to add, upgrade or swap capabilities into or out of a GCS. Some users may want a high level of flexibility and more capabilities, while others may prefer to keep costs down with fewer options.

According to manufacturers of modular GCS, the benefits do not end there. Modularity can result in more efficient handling of key properties like safety, training and mission criticality, as well as the possibility of using COTS technology for navigation, planning and assessment in order to reduce costs and improve efficiency.

As modularity evolves, other UAV control issues are being addressed. These include overcoming vendor lock – a user being tied to a GCS that can only use technology developed by one supplier – and capabilities such as being able to control several different systems – big or small – from one GCS, and even enabling the 'swarming' of many small UAVs at one time.

Increased flexibility

Leading manufacturers in the modular GCS field include Lockheed Martin, Raytheon and Textron Systems. All of them provide technology for the US military – an organisation that has been a key driver of modular systems.

In August this year, Raytheon announced it had been awarded a contract worth $104 million to modernise the GCS built by the company for the USAF's Northrop Grumman Global Hawk. The upgrade contract, which runs through to 2019, involves improving the GCS capabilities and flexibility by refactoring the software. This will make it service-oriented with the ability to rapidly drop in new services, as well as being more ergonomic and less expensive to maintain.

'The intention is to be able to bring just about any application into the software because the software will have an architecture that has an application interface to allow all providers to plug into that architecture,' said Todd Probert, VP for mission support and modernisation at Raytheon Intelligence Information. This is essentially open-architecture software, which he explained as a framework of common standards. 'This is just like an Apple cell phone, for example, which essentially has a core architecture that enables anyone to build and place applications on that architecture.'

Often, UV users are opting to pair the modular approach to GCS with common software architecture across different in-house platforms for increased efficiency and simplicity in terms of training and cost-effectiveness.

This is exactly what the US armed forces is doing. The USAF and USN have defined common standards for their control environments and are collaborating to make sure those common standards are just that across both services, said Probert. 'This will offer both the air force and the navy ease of training, as one seaman can be trained to operate on multiple platforms rather than having to have one person trained again and again on different platforms,' he added.

Getting more for less

Obtaining more capabilities for less cost and less bulk of equipment is the Holy Grail for equipment users and another driving force behind the modular/open-architecture GCS trend. GCS form a major component of the overall costs of unmanned systems, therefore any reduction in cost or numbers related to this will bring down overheads.

'I think our role within the GCS is to ask how we can incorporate new technologies in a cost-effective manner,' said Mike Suckow, lead engineer at the US Army's Common Systems Integration (CSI) office, who is working on the service's Tactical Open Government Architecture (TOGA) programme.

'I think that is the importance of the open-architecture approach, that it allows us to separate things out and reduce the amount of cost associated with tests and regression testing and the integration costs to put new things in.'

A common GCS, which the US forces are working towards, saves significant training costs. 'If a UV user can have a common system for payloads, radios and autopilots, that is going to reduce their operating costs and logistics chain and make operations a lot simpler because there are less people required and you don't need an individual specialist,' added Andy Horler, new business development manager at Lockheed Martin.

The US Army deploys Lockheed Martin's Universal GCS 4586, which utilises a design that houses flight-critical hardware and software in a modular configuration. It is based on the STANAG 4586 interoperability architecture. ▶

The RQ-11 Raven is one of the aircraft that has been tested under the US Army's TOGA programme. (Photo: US Army)

Asseco's GCS software, which uses Mavlink and STANAG 4586-type messages, is also built with modular architecture and allows easy integration of any UAV system setup. Tomasz Mosiej, senior UAV systems architect at Asseco Poland, explained why the modular approach is important: 'We know a lot of GCS solutions which are not modular and the integration with UAV platform or a C4ISR system is almost impossible.

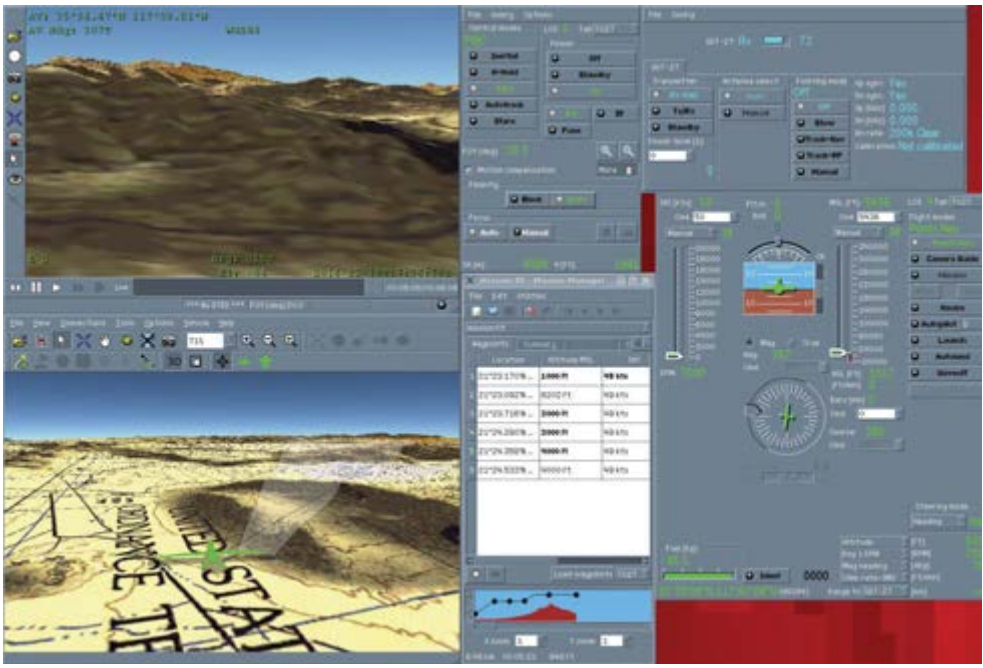
'When architecture is not modular, the integrator may have big problems with the integration process, which takes time and money. Our solution is very easy to integrate with any kind of third-party software or UAV platforms which are used within the civil and military market.'

But manufacturers of modular GCS point out there are other cost benefits associated with the technology. Modular control stations can harness more COTS products, negating the need for software to be developed from scratch, saving time and money.

Raytheon, for example, uses a mixture of COTS and specialised capabilities that its subject experts bring to the table. 'An example of that might be that we don't typically generate our own mapping software because we can get that from a COTS standpoint and they are maintained very well,' said Probert. 'Or, if we can build one map application or buy COTS that can apply across all our different domains, that is way more efficient than having to replicate that capability.'

In October, Textron Systems unveiled a new portfolio of modular multi-domain control and collaboration equipment that also utilises COTS. Developed based on user feedback, the new systems are Synturian Control, which a multi-platform, multi-vehicle, multi-domain control system that enhances collaboration and dissemination of information, and Synturian Remote, which has mobile, network-strengthened tools that enhance situation awareness through timely information and collaboration.

The company said that the Synturian family of products were designed around a service-oriented architecture for rapid integration of COTS software, allowing for an intuitive interface for streamlined training and logistics.



The Lockheed Martin vehicle control station allows increased levels of autonomy. (Image: Lockheed Martin)

Textron Systems is actively integrating the Synturian family with its own unmanned aircraft, including the Shadow tactical UAS and the Aerosonde small UAS.

Managing the payload

The One System Remote Video Terminal (OSRVT) developed by Textron for the US Army is helping the organisation adopt a more service-oriented software approach. The portable kit includes a tablet computer and a video receiver, radio and some antennas. The technology allows video from the UAV to be seen at the tactical edge, so a soldier not in direct line of sight with other assets can see the battlefield and improve situation awareness. There are over 3,000 of these devices in service throughout the US Army.

The kit is integrated with the ROVER 6 system, as well as platforms including Gray Eagle, Hunter, Puma, Predator, Raven and Shadow. OSRVT incorporates software modules, similar to apps, from different vendors into its key software, explained Mark Austin, OSRVT lead engineer at the US Army's CSI office, one of three product groupings within the Project Management Office UAS.

The US Army recently added OSRVT level 3, so that the technology can now control the payload of the UAV as well. The controller can more quickly observe and react to pass that control back to the aircraft's pilot.

'We have been able to incorporate some of the payload control features as well as some of the motion-detecting software,' said Austin. 'Instead of using voice communication back to the control station, the controller can take direct control and look at what they want to look at, minimising that time lag that could compromise the operation. That is a feature we are rolling out and that is really going to pay big dividends to the soldiers.'

This is possible because the base architecture the army uses allows it to have an open architecture and incorporate software modules from different places. 'This is why we can shop around and get the best bang for our buck,' he added.

Ultimately, it enables the software design to be more modular and take the best of what is available in the market, while minimising the integration cost of incorporating that software into the army's own systems.

Breaking the lock

Part of the overhaul of US Army GCS has been spawned from the TOGA programme. This aims to do exactly as Austin said – get better bang for its buck – and led to the development of a new system, known as TOGA GCS. The

technology is not currently in the field but is undergoing testing, and is expected be ready for use in 2019.

The TOGA programme was started around three years ago in order to prevent vendor lock. 'We had a problem in the paradigm in that we had vendor lock – we were looking at a future acquisition of an aircraft for our family that was smaller, along the lines of a quadcopter,' explained Suckow. Because of its GCS systems, the army could only go back to its prime vendor to buy an aircraft, but this didn't leave much leverage in terms of competition.

'We decided that if the government could control the interfaces and the construct of the GCS software, perhaps we could include dissimilar aircraft from different vendors,' he explained. 'We successfully realised that software solution, but it wasn't enough of a forcing function to get industry involved and interested. There was still a developmental hurdle to clear, to get from a reference architecture, which doesn't really "do" anything, to actually putting software onto hardware that does something.'

Suckow and his colleagues decided to evolve TOGA on the government-owned side and eventually realised a software solution to perform C2 of dissimilar aircraft with the TOGA GCS. This is small enough to be backpacked, a standard limitation for most unmanned army GCS. The team also developed corresponding hardware for the system, so the product evolved from a software-only item.

A year after TOGA's inception, Suckow and his team flew a Raven UAS and successfully landed it before launching a COTS quadcopter, with similar results, but this time using open-source software from the quadcopter vendor.

'Two years after the inception of TOGA, we realised our dream of breaking our vendor lock and bringing in a different tactical radio vendor and integrating its radio into our TOGA US government-owned GCS, and flew a light aircraft,' he said.

TOGA will eventually allow operators to control all of the army's small UAS with a single controller. There is also an initiative to determine if it can be the 'universal' controller to operate small ground robotics as well as aircraft.

Suckow said the US Army was also able to use COTS mapping technology and video transcoding software, which is open-sourced from the internet. 'Now we have stopped there, because from the open-source standpoint, we don't want to go and start out with something like an ARdu Pilot that everybody has access to because that makes us vulnerable.'

He explained how his team plans to mitigate the cyber-security risk: 'What we have done with TOGA is to begin with the Linux operating system in mind. This is because it seems that, generally speaking, that hackers go after the most proficient operating system available – Windows. Above and beyond that, there are tools that we run to ensure that only the applications we want to be running get run.'

However, there are security advantages to using open-architecture software and common platforms. 'It is more resilient by sheer virtue of having a common platform as you really only have to maintain that cyber resiliency in one platform instead of a multitude of them,' said Probert. However, he added that cyber security 'is not something that you can design once and walk away from, because the enemy changes his or her practices on a regular basis'.

Making decisions faster

As the modular capability of GCS improve further, it is likely that human involvement will progressively decrease. However, to what extent this will happen is up for debate. There are some highly sensitive areas to consider. Managing the payload is one of these and many believe there have to be limitations.

'Everyone likes to think about things that are straight plug and play – you can plug it into your laptop and it will work. However, it is unlikely that with sophisticated military technology you are ever going to achieve the point where you can plug it in and you don't have to do anything,' said Suckow. 'We are getting closer to that approach where you can do that and lower the high cost to maintain and test new capabilities. I think that is the key to future growth.'

One of the ways autonomy will undoubtedly grow in terms of the GCS is with data use. 'In the battlespace, there is a lot of data available. By use of autonomy and analytics, if you can take that data and do an analysis on it and come up with something to act on – a decision – if you can close that data-to-decision loop faster than your enemy, you are going to have an advantage,' said Probert.

> ***"Cyber security is not something that you can design once and walk away from, because the enemy changes his or her practices on a regular basis."***

'The point of having standards and an open architecture is the maximum of different systems can communicate with each other and use analytics algorithms to take people out of the loop, to close that data-to-decision loop faster,' he added.

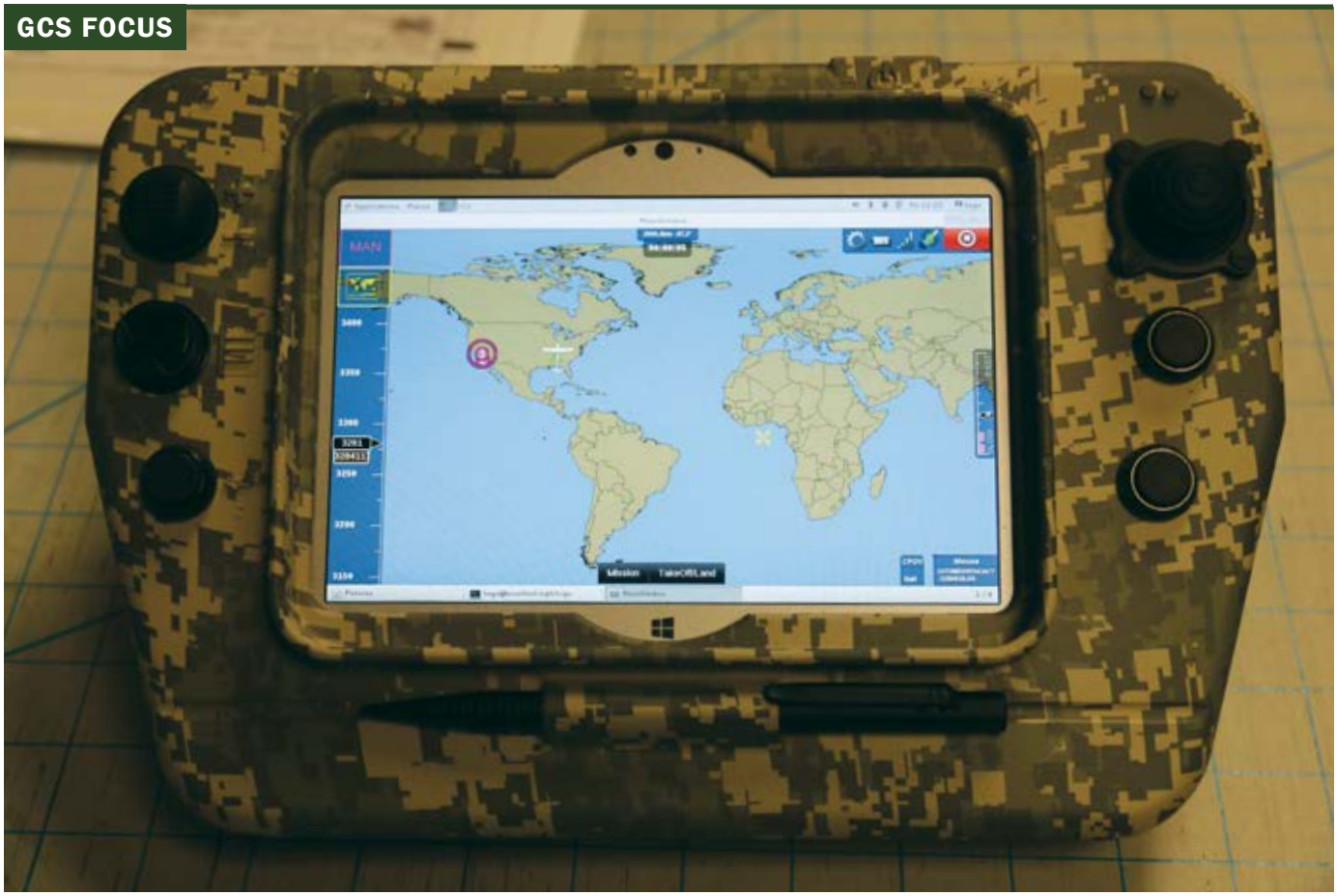
One way in which this is already happening is via swarming technology, which experts say could change the face of modern warfare. A swarm of UAVs is when several smaller systems fly in tandem and effectively 'talk' to each other, with distributed responsibility among them to allow a collaborative attack on an enemy target.

It is a completely different concept from any other type of unmanned warfare in that the operator does not control an individual aircraft, but pilots the whole swarm as a single unit, with the UAVs also able to make instant decisions as they operate.

'It is a bit sensitive to talk about,' said Probert, 'but the concept of having a network of UAVs take action on what the other UAVs are seeing or doing – it is all within that information analytics discussion. It is allowing quicker decision-making machine-to-machine versus person in the loop or a person doing command of the system.'

Actionable intelligence

The swarm of systems has optical sensors and communication relays and would likely be smaller and therefore harder to detect and disrupt, because the enemy would have to take out many aircraft without knowing what the critical node might be. In this sense, swarming creates a strong warfare resilience. ►



The latest form factor for the US Army's TOGA controller. (Photo: US Army)

Lockheed Martin is working on a newer version of its Universal GCS 4586, called VCS4586i, which is going to be focusing more on swarming and controlling the systems in a video game style. 'One of the key things for us throughout is the principle of flying the mission and not the aircraft,' said Horler. 'Flying the aircraft should be a secondary thing for the operator. If you are spending most of your time fighting it and trying to get the aircraft to fly, then you are not actually doing the task you have been sent out to conduct.'

He continued: 'What I mean by that is, when you look at current operations and operators, they have to sit in front of a station for very long periods of time – 14-15 hours – where they are sat staring at a screen trying to identify one target. To maintain that level of concentration over that time is very difficult, what we are trying to do is get away from that and deliver this actionable intelligence.'

To achieve this, Lockheed Martin extracts the information from 14 hours of operations and presents the things that actually matter to the operator, making it easier for them to do their job effectively. Although it is not quite completely autonomous swarming or operations, it is a further step in that direction.

Lockheed has demonstrated 16 Meggitt Hammerhead USVs being controlled in a swarm from a single GCS in the past. Demonstration of swarms using dissimilar UAS for reconnaissance was also trialled by Boeing in 2011. The systems communicated with each other autonomously and searched the designated area through self-generating waypoints and terrain mapping, while simultaneously sending information to teams on the ground.

In 2012, the same technology was used to control two ScanEagle UAVs using only a laptop and a military radio, demonstrating the ability to do away with a ground control network. As part of the USN's Low-Cost UAV Swarming Technology programme, the Office of Naval Research demonstrated a swarming configuration of 13 robotic boats that were able to perform a variety of tasks to protect a high-value ship from incoming craft.

Swarms, however, can be constrained because of the bandwidth necessary for multiple UAVs to talk to each other as well as to the GCS. Their communications would also be vulnerable to countermeasures. Swarming is already being trialled and used for certain operations; but because UVs in swarms are not under human control at all times, like most current systems, their use can make policy-makers cautious.

Complete autonomy when it comes to controlling unmanned systems is not commonplace yet, but there is a willingness from key users to follow the as-yet undefined limits of where the technology might be able to take them.

'The more burdens we can take away from the soldiers the better, and that is an ever-changing paradigm. It always has to be reactive and responsive to that maturation process,' said Suckow. 'I don't know where technology is going to take us; I just know that I am going to allow it to take us there.' ■