Integration nation

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In this era of tight budgets, the U.S. needs to fly its ISR sensors longer and combine intelligence collections more effectively. **Retired Air Force Lt. Gen. David Deptula**, CEO of Mav6, explains.

Given all that is going on in the world today — politically, economically, militarily and in the information domain — there is no better time to illuminate a 21st-century approach to intelligence, surveillance and reconnaissance.

There are three critical elements that if fully embraced, combined and actualized in a mutually reinforcing architecture, can increase ISR output using fewer resources and in a more cost-effective manner. These elements are:

- Greater airborne persistence.
- Sensor-to-sensor integration providing immediate tipping and cuing.
- Data processing at the point of origin.

My hope is to raise awareness about the synergy of these three elements when applied in combination by the users of ISR in the military, commercial sector and intelligence community. Taking an integrated approach to long-duration aircraft, sensors of different modalities and on-board processing at the point of data origin will result in the "next big thing" in the world of ISR.

Looking at these three elements, several questions come to mind that policymakers should address: Why is it that, in this day and age, the U.S. government still purchases ISR equipment from companies that insist on using proprietary formats? Why are the benefits of ISR integration not clearly articulated in joint doctrine, and actualized among the combatant commands in joint and integrated ISR concepts of operation? Why are the functions of intelligence, surveillance and reconnaissance still segregated in some services while integrated in others?

UNBLINKING EYE

Airborne persistence should be the first ingredient of a 21st-century integrated ISR approach. To achieve greater ISR capability we need to invest in aircraft that can provide more persistence than is possible today using current remotely piloted aircraft (RPA) and camera-equipped geostationary satellites. If any one thing has catapulted the utility of RPAs to the forefront of interest of governments today, it is their ability to observe an area, person or activity of interest for extended periods of time and to a finer resolution than is possible from geostationary orbit. Changes in the structure, status and behavior of targets of interest can be detected, identified and characterized, which increases the likelihood that the users of that information will be able to obtain their objectives.

Today, airborne systems provide persistence that varies from hours to days. Low-Earth-orbit satellites provide fine-resolution snapshots but only during intermittent orbital passes. Geostationary satellites provide continuous overwatch, but because they are positioned 22,236 miles above the Earth, they cannot match the resolution of a high-definition video camera operating at a range of tens of miles or less.

This is an area where fixed-wing RPAs — such as the Air Force's Predators, Reapers and Global Hawks and the Army's Gray Eagles, Shadows, Ravens and others — have achieved a sweet spot over the last decade. However, these aircraft also have some significant drawbacks in terms of payload capacity, duration, range, operating requirements and logistics.

Despite these limits, demand for persistence is growing, and the ISR production process will have to operate at higher update rates. Targets such as individuals, ships or other vehicles change location rapidly, driving the need for a high degree of persistence. Furthermore, potential adversaries are getting smarter, which means ISR systems must increasingly discern whether a detected change is due to a random natural occurrence or whether it is a case of denial and deception. Adversaries are learning to hide in complex environments, essentially lowering the strength of their detectable signatures relative to their environment. This amplifies the need for persistence in order to detect more subtle changes.

The nature of the users' objective will also affect the requirement for persistence. If the objective is to determine the general location of a ship, then a lower update rate may be acceptable. On the other hand, if the objective is to closely monitor a specific moving ship, then there will be a premium for persistence to ensure up-to-date information.

When speed is not a priority and operations are conducted in permissive airspace, lighter-than-air aircraft — both free flying (airships) and tethered (aerostats) — are more cost-effective for increasing persistence. Direct operating and support costs are historically fractions of equivalent fixed-wing and rotary-wing capabilities. This is due to less fuel consumption, smaller equivalent power plants and less complexity. Lighter-than-air aircraft provide much greater capability trade space between altitude, persistence and payload, and are accordingly more flexible than fixed-wing aircraft.

Lighter-than-air aircraft provide unique capabilities such as much greater stability and lower vibration as a better host for a greater number of sensors, and they are often large enough to allow for very accurate geolocation capability through triangulation of signals provided from widely dispersed antennas that cannot be achieved on fixed-wing RPA or manned aircraft. This is particularly advantageous for achieving improved signals intelligence (SIGINT) accuracies. A single airship with a modular payload compartment cannot only carry multiple sensors of different types, but can be configured to rapidly exchange sensor payloads in a matter of hours.

Airships are less sensitive to small changes in drag, and when properly configured allow for very easy integration of new payloads, enabling plug-and-play capability and a degree of modularity simply not achievable in other aircraft. By no means are they "be all and end all" solutions to hosting airborne ISR, but many of the historical weaknesses of lighter-than-air aircraft are addressed by modern systems.

SENSOR INTEGRATION

The collective history of conflict throughout the last century — the world wars, the Cold War and the conflicts of the last quarter of the 20th century — exemplified industrial-age warfare. Intelligence was a massive, personnel-intensive operation aimed at supporting national and military decision-making. What we wanted was information, and we rapidly pursued the technologies that enabled us to get it.

Those capabilities — imagery, communications and signals intelligence from air, sea, land and space, human intelligence and every other variant— spawned separate organizations and separate processes for tasking, collection, handling, analysis and dissemination. Those organizations and processes became known individually as "cylinders of excellence" or "stovepipes."

In true factorylike, assembly-line form, intelligence, surveillance and reconnaissance were each individually organized around very specialized inputs and outputs: Take a photograph, process the film, interpret the information, create a picture, write a report, and deliver it to the relevant decision-maker. The intelligence cycle was sequential, so it comes as no surprise that ISR was similarly divided.

Today's approach to ISR springs from this legacy. The major airborne ISR platforms were built along those lines: RC-135s, RC-12s and EP-3s for SIGINT; U-2s, RF-4s, SR-71s and Constant Hawk for imagery intelligence; Joint STARS for ground moving target indicator; E-3s for airborne moving target indicator; and there are many others that were designed primarily as single intelligence or "INT" focused aircraft.

There has been a major shift over the last decade toward designing aircraft to carry different sensor types, sometimes on the same mission, but more by reconfiguring them on the ground. Examples include variants of the U-2, Global Hawk, MC-12 Liberty, MQ-1 Predator and MQ-9 Reaper. They can carry assortments of electro-optic, infrared, radar imagery, electronic intelligence and SIGINT sensors. However, the processing, exploitation and dissemination of the data collected from these different sensors is generally still accomplished in stovepipes of ground stations, analysts and organizations associated specifically with a particular ISR type.

For the vast majority of today's ISR systems, integration, change-out and reconfiguration of sensors on airborne platforms are expensive and time-consuming endeavors. This is because heretofore sensors have been seen as systems unto themselves and not as components or subsystems in an increasingly complex collection and reporting system. The result has been to customize platforms to fit the particular mechanical, power and data interfaces instead of having the sensor meet the interface requirements of an airborne collection system. A contributing factor to this costly legacy is that a substantial number of sensor providers embrace "one-off" customization as an important part of their ISR business models. This is why most sensor providers continue to feature proprietary technology in their product lines. By developing proprietary data formats, feeds and interfaces, vendors have "forced" aircraft to adapt or customize to host their particular sensors. This has the effect of driving up initial procurement and recurring costs while further entrenching sensor-oriented rather than effects-oriented capability development.

'I suggest that innovation is the preferred course.'

The challenge of dealing with proprietary equipment needs to be solved if we are to field a cost-effective ISR enterprise. Some have proposed a standard interface specification for ISR sensors and adherence to that standard as a prerequisite to sensor integration. The problem with this approach is the time it takes to achieve agreement on the standard, to promulgate it and enforce compliance. It can take years to implement a standard due to the time it takes to reach consensus within the community, and resistance by sensor vendors who view standardization as adverse to their businesses.

An alternative that promises the benefits of standardization while avoiding the challenges to its acceptance is called Service Oriented Horizontal Information Exchange (SOHIX). This is a methodology for enabling sensor integration by mitigating the impact of unique and proprietary interfaces. It can be quickly implemented because it is not a standard per se but rather a method for facilitating the transfer of interface information via standard technologies, namely Extensible Markup Language (XML). This is a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable. In the same way XML is used to define and present Web pages on the Internet, it can be used to identify how sensors communicate with the collection system to include the extraction and passing of command and control and collected ISR data. In this way, it reduces cost and time-to-implement because customization is mitigated at the data level, thereby obviating the need for highly specialized, "one-off," hardware integration.

SOHIX does not require the sensor vendor to change configuration elements such as software, firmware, signal output schemes or communications protocol. Consequently, it protects the vendor's intellectual property and allows for technological "big leaps" because it is not architecturally restrictive. SOHIX promotes the concept of multiuse platforms and mission-tailorable sensor suites. One platform can support several ISR missions because sensors can be changed out in hours instead of the weeks or months associated with current aircraft hardware-oriented integration. Also, mission planners are able to configure sensor suites that are tailored to meet the specific collection requirements of a mission as opposed to using a suboptimal set of sensors hard-wired to a particular platform. Plus, it can provide the means to achieve automated cueing by enabling rapid machine-to-machine interactions, for example, between SIGINT sensors and high-definition electro-optical/infrared sensors that can rapidly solve high-priority operational and intelligence objectives.

POINT OF ORIGIN

To grasp the ISR revolution we require today, consider that from the beginning of time until 2003, a total of five exabytes of information were created. We now create five exabytes of data every two days, and that rate is accelerating. This large data problem is significant, and we are not going to solve it by continuing to do data management the way we have been doing it.

Given a SOHIX architecture on a high-payload platform that can stay airborne days at a time, how are we going to process all the data that will result and get the information to users in real time? As fields of view and video capture rates increase, the amount of data that must be stored onboard the platform grows dramatically. The next family of sensors deployed will exceed the gigapixel threshold and operate at multigigahertz rates. As a result, the data capture rate on the platform will exceed the capacity of current radio frequency data links.

This means high-speed processing and massive data storage will have to be done onboard the aircraft. This is possible today because of the computing industry's ability to package supercomputerlike input/output devices and big-data storage hardware into small, lightweight, relatively low-power systems capable of operating in austere environments. Given the payload capacities of airships, the size, weight and power requirements of these systems are less challenging than on fixed-wing aircraft.

Today, the U.S. continues to spend vast sums of money acquiring motion video and single-dimension intelligence with the same RPAs and old manned ISR aircraft, when newer technologies and innovative techniques are available. The good news is that the ISR community has friends in the information technology industry — Facebook, Amazon, Google, YouTube — who are solving similar problems. We can learn from them, and use them as we seek greater ISR capability. These companies and others like them thrive on agility and are always seeking the "next big thing," meaning an even faster and easier way for their customers to exchange information with one another.

The next big thing in ISR must be a 21st-century system that provides vastly more ISR per dollar than with currently deployed manned and/or remotely piloted ISR aircraft. This can be done by capitalizing on the synergy accrued from merging greater airborne persistence with sensor-to-sensor integration and data processing at the point of origin. Two modern airships can provide continuous 24-hour persistence at not less than five days between aircraft sorties. These long-duration capable aircraft could simultaneously host the following sensor payloads: wide-area electro-optical (EO), wide-area infrared (IR), long-range EO/IR, wide-area motion imagery providing images to tens of users simultaneously, multimode radar with Ground Moving Target Indicator performance, and SIGINT that can provide precision geolocation at ranges of more than 300 kilometers. All of this can be accomplished with an open-architecture modular payload infrastructure that supports field-expedient installation, exchange or sharing of sensor payloads.

With respect to communications, this integrated capability could provide air-to-air and air-to-ground bandwidth to transmit lossless compressed sensor data to a local or remotely located multimission ground station while supporting omni-directional transmission of image chips to individual hand-held smart devices. Data processing can be accomplished onboard with sufficient storage to correlate and fuse data from all desired sensor payloads. This capability can include sufficient on-platform processing to minimize air-to-air and air-to-ground data communications requirements, maximize sensor-to-sensor cueing and reduce sensor-to-user latency to seconds. In other words, dramatically more and better ISR capability can be provided at a fraction of the cost and without anywhere near the number of additional personnel required by conventional manned or remotely piloted ISR aircraft.

The bottom line is that today we have it within our capability to merge platforms of great persistence with open architecture design that allows multi-INT payload integration, enabling sensor-to-sensor cueing using increased SIGINT accuracy due to large antenna arrays, with onboard processing that reduces bandwidth requirements for wide-area sensors. Along with a modular payload design that allows for rapid sensor and data link change-out, this approach could provide a game-changing ISR capability that in terms of endurance is orders of magnitude more cost-effective than the ISR RPAs, segregated ISR-specific manned aircraft and unchangeable ISR payloads carried by satellites that are in use today.

We can maintain the status quo, or we can embrace and exploit change through disruptive innovation. I suggest that innovation is the preferred course. The Defense Department needs to rapidly adapt new technology to the innovative concepts of operation that technology enables and deliver the next ISR "big thing" sooner rather than later. ■

Retired Air Force Lt. Gen. David Deptula was the service's first deputy chief of staff for intelligence, surveillance and reconnaissance. He is now CEO of Mav6 LLC, maker of a 370-foot-long airship that will carry the Blue Devil 2 multi-sensor payload if the project is funded by the Pentagon.