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A Few Thoughts on ISR and Unmanned Systems
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The C4ISR explosion
The need for Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) is a major force driving the tremendous growth in unmanned systems. C4ISR systems constitute approximately 5% of many national defense budgets. One estimate of global C4ISR market in 2010 is $63.6 billion.

Changing our thinking
Broadly speaking, the ISR components (Intelligence, Surveillance and Reconnaissance) are sensor systems that collect raw data for the C4 components (Command, Control, Communications, Computers), which analyze and distribute the processed information. The fact that ISR and C4 are often combined into a single acronym not only highlights their interdependency, but also how rapidly advancing technology is blurring the distinctions in which these issues have been traditionally discussed.

A good example of how our thinking has changed is the concept of C4 as the "back end." In the past, information was collected by sensors on the "front end" (ISR) and sent back to commanders located away from combat operations. However, operational forces are demanding real-time ISR. The "back end" is more and more located at the front. What was formerly a strategic tool (intelligence) is now a tactical one, another distinction that is losing its strength.

Unmanned systems
In order to meet the insatiable hunger of warfighters for ISR information, the Department of Defense (DoD) has turned to unmanned systems as the primary vehicles of collection. Sensors packages on unmanned systems collect electronic signals, optical images, radar data, and infrared images on sea, ground, and in the air.

The advantages of unmanned systems for ISR missions are widely celebrated. In addition to assuming risks normally carried by warfighters, they never blink and never tire. They represent a smaller target than their manned counterparts, and are cheaper to replace & operate.

Data overload
Some of the most prominent problems associated with ISR platforms concern bandwidth and data rates. "We're moving from megabytes to terabytes to petabytes of data being collected," explained Col. J.R. Gear, at the 10th annual C4ISR Journal Conference.

Consider the evolution of visual images collected by Unmanned Aerial Vehicles (UAV). Originally, they could focus on only one target at a time, an impractical limitation in a busy battlefield. To boost those capabilities, Defense Advanced Research Projects Agency (DARPA) developed Autonomous Real-time Ground Ubiquitous Surveillance — Imaging System (ARGUS–IS) with the goal that a single UAV can have 65 independent video feeds. When 3D imaging, real-time targeting capabilities, IED jammers, and a strategy for deploying "swarms" of unmanned systems are added, the communication highway becomes impossibly crowded. The ever-increasing data requirements can be seen to be in a race with ever-improving technology.

Security

Remote Video Terminals (RVT) enable warfighters to view sensor information real-time on the ground. Unfortunately, the enemy likes to use RVTs as well, and in one publicized incident intercepted raw data from a UAV. Use of encryption and key words may preclude some members of a mission team from viewing sensor information. Remember, the goal is to present an integrated picture from multiple sources of data to operational forces in *real time*. There's literally no time to determine what information may be too sensitive to relay to the front.

(A well-known irritation of allied forces in theater is their inability to access data from unmanned platforms, especially ironic after the discovery of the enemy's interception. I wonder if anyone in response to their complaints has replied, "Go ask the enemy.")

Uncertainty of sensor development

What does bandwidth consumption and security have to do with sensors? Everything. ISR platforms are an integration of technologies and capabilities. Sensor packages as well as the frame, engine, controller, and communication link must work seamlessly in order to complete the mission.

Ideally, sensors are small, low power, and easily deployed. However, how low is low power? Say the sensor is on a platform in which a spec was added late in the development cycle that its transmission much be encrypted. The platform would need an additional capability to destroy the keying material if it is compromised. This could make the platform bigger and more power hungry than the original spec. That's less power for the sensors as well as the transmission of the data. Will everything still work as designed?

The relatively minor change described above is trivial compared to the real-life obstacles facing sensor developers. Much of the time, they literally have no idea which platform will use their sensors, which makes development even more of a guessing game than it should be.

The rise of COTS

Uncertainty about the final configuration is a major factor in slowing down the rapid acquisition of new technologies. In contrast, the commercial sector has been vigorous is

the development and adoption of the latest advances. Even more than cost savings, this has been the reason behind the DoD's big push to purchase Commercial Off The Shelf (COTS) products, instead of going the traditional design-to-spec route.

Conclusion

This is by no means a complete overview of the issues facing C4ISR and Unmanned Systems. Other factors that should be considered are autonomy, network design, ruggedness, interoperability, and power (See "Don't believe the bunny").

Technological problems call not for only technological changes, but also for changes in thinking as well. The Defense industry needs to face these issues head on, assume responsibility, exercise imagination and embrace cooperation as well as competition.

At the recent Robotics Rodeo, a development team (which included AMREL) demonstrated an interoperable payload controller prototype, which had modular payload packages. Not only did it easily transfer command & control functions from one UGV to another within minutes, but it also transferred the sensor capabilities as well.

In fielding a system that enabled interoperable capabilities for a sensor package, they demonstrated a possible solution to the development bottleneck that has plagued the DoD's acquisition and deployment cycle. Even more than the technical accomplishment, the team's assumption of a leadership role and the willingness to work together are the kind of changes that are needed for unmanned systems to fulfill its potential for ISR.