The Next Steps in Advanced Intelligence, Surveillance, and Reconnaissance (ISR) Radar

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...Jack knows I have bandwidth envy.....

One hundred years ago next month, the German inventor Christian Huelsmeyer applied for and received a patent in his native country for the telemobiloscope, a ship anti-collision device utilizing the reflection of electromagnetic pulses.
With not much more than a battery, a spark plug, and an antenna, recent inventions in their own right, Christian demonstrated the concept in 1904 to an enthusiastic but short-lived audience.
As with many inventors, Christian was somewhat ahead of his time.
Better known as radar, his invention drew wide-reaching attention decades later, too late for Christian to make any money, but in time to influence, if not decide the outcome of a future world war....
And as we celebrate the centennial of Christian's invention, we are still drawn to and rely heavily on these systems today, and with good reason.
For ISR specifically, radar offers unparalleled capabilities, providing rapid surveillance of large areas and broad situational awareness from a safe distance, day and night, and in virtually any kind of weather,... very much the same attributes that drew Christian to the telemobiloscope almost a century ago.

A testimony to the utility of ISR radar is the wide variety of ISR radar systems our Nation currently deploys including JointSTARS, Global Hawk, U2 and Predator, among others.

As pointed out by our previoius speaker, ISR radars typically offer low resolution products as compared to their optical counterparts.
Details as to the nature and location of ground targets under illumination are often insufficient to support targeting decisions.
The warfighter has, sadly, come to accept these limitations, often calling on optical systems to provide actionable data.
Unfortunately, optical systems are generally short-range and fair-weather... so the guy taking the picture is often-- typically put in harm's way, whether he's a pilot getting good EO from 5 kilometers or a dismount bringing a weapon home with a laser designator.

IXO would like to re-think -- re-invent ISR radar to provide decision-grade information to the warfighter, from safe range, whenever and wherever he needs it.

So what attributes do I envision for future ISR radars, say 10 to 20 years from now?

First, the systems will be robust, able to adapt to changes in the environment, both natural and man-made.
Our ISR systems will be deployed to and expected to operate effectively in theaters that span the globe.
The systems must be capable of adapting to the variability of such natural elements as background clutter, atmospheric effects, and vegetation.
It is equally important to anticipate an adversary's attempts to compromise the effectiveness of our systems.
Since an adversary's tactics will evolve in unpredictable and potentially debilitating ways, our systems must be designed with change in mind-not simply incremental improvements to an existing baseline, but more fundamental changes relating to system configuration and function, to better address an evolving threat.

Second, the systems will be persistent, providing data continuously over large theaters.
In the future, the timing, pace, nature and location of war may be dictated by

others.
Being at the right place at the right time cannot be left to chance; it must be guaranteed through the persistence of our systems.
For wide-area surveillance, one normally thinks of long-endurance UAVs.
But let's not confuse endurance and persistence.
Not only must our systems be present, they must observe....and there lies the challenge.
Events occur on several time scales, all requiring persistent observation.
Local responses to bomb detonations, say for bomb damage assessment, can last less than a second, target tracks can last for minutes, even hours with updates measured in small seconds.
Monitoring of choke points, borders, and facilities may require days, weeks, even months of continuous observation.
And there may be several such locations in theater that need attention.
Unless we anticipate darkening the skies with sensors, our systems must be capable of viewing several, 10's to 100's of areas within their line-of-site concurrently and continuously, a capability that we can only dream about today.

Third, the systems will support the identification of friend, foe, and non-combatant to facilitate targeting in complex environments.
While our ISR radars are often called upon to provide situational awareness and cueing, they are seldom used to make targeting decisions, without significant contextual support, to validate the target.
Of course, this is with good reason.
Available data products are generally of insufficient quality to provide positive identification in the eyes of those responsible for making decisions.
But do we have to violate the laws of physics, or simply bend them a bit, to provide actionable data?

This RF imagery suggests that a little "bending" can produce some impressive results.
And while the bandwidth and synthetic and real apertures required to produce this image are substantial relative to today's systems, we believe that an appropriate, long-term investment in ISR can give the warfighter actionable products from standoff, say 200 kilometers range.
This would be a significant advance.

Finally, the systems will provide precision geolocation to reduce the size of munitions required to destroy targets and to minimize the potential for collateral damage.
When the difference between the location of a foe and a non-combatant or even a friendly may be meters, and when the effective radius of some munitions is similarly measured, it is very important to know the locations of targets with sufficient accuracy before engaging them.
While our existing ISR systems offer reasonable surveillance, their ability to provide targeting-quality geolocation solutions against specific classes of targets, such as time-critical ground movers and short-on-time emitters, is limited.

Networked solutions, combining target returns from a spatially diverse set of sensors on different platforms, will, as demonstrated in IXO's AMSTE program, provide targeting quality geolocation.
As greater bandwidth and more ubiquitous communications emerge, and as sensor tasking moves from platform-specific to network-centric solutions, network targeting will move from the experimental environment of a DARPA demonstration program to the battlefield as an operational capability.
Of course, as with any successful program, AMSTE exposed challenges that must be overcome including time-continuous tracking in traffic, maintaining track in the presence of target maneuvers, and correctly associating radar returns from different systems before fusing them to generate a geolocation solution.

And it's important to note that observations required to produce networked solutions may not always be available, due possibly to unfavorable viewing geometries, a lack of observers, tasking conflicts, or the available collectors may simply lack the

spatial diversity required to produce good geolocation estimates.
As such, we must not overlook single platform solutions, which in many configurations offer the promise of targeting quality geolocation from standoff ranges.
Practical issues that currently limit single-platform performance such as airframe effects, navigation errors, array calibration errors, and target coherency could, we believe, be overcome with an appropriate investment in related algorithms and technologies.

(Pause)

So that's my vision of the future for stand-off ISR systems.
Our goal is to provide the warfighter with long-range RF sensing, delivering decision-grade information whenever and wherever he needs it.
We obviously have a long way to go, and we'll need your help getting there.
How?! Simply look at the deficiencies.

Help us develop enabling architectures that can adapt and reconfigure to operate effectively in the presence of an evolving threat.
Help us invent new architectures, technologies, and algorithms leading to sensors supporting hyper-levels of concurrency- systems that offer true persistence, not simply long endurance.
Develop algorithms, stable signal systems and navigation suites to help us deliver sensors offering near-optical quality imagery from safe ranges.

And give us targeting-quality geolocation through advances in network-centric technologies such as high bandwidth communications and precision relative navigation, and offer innovations in areas such as signal and array processing to support network-entric and single-platform solutions alike.

And once we've done that, and the warfighter is willing to engage targets using our wonderful radars, ISR and T, ---
T for targeting ----- radars, well maybe then, and only then, can we tell those near-sighted optical guys, like our previous speaker Dr. Jack McCrae, to leave the targeting to us.

And now is probably a good time to move on to the more neutral ground of command and control, with Dr. Bob Tenney.