**DARPATech, DARPA's 25th Systems and Technology Symposium**
**August 8, 2007**
**Anaheim, California**
**Teleprompter Script for Mr. Roger Hall, Program Manager, Virtual Space Office**

Space Situational Awareness

» **ROGER HALL:**
DARPA's vision to introduce more flexibility, adaptability, and affordability into the future space architecture creates many new technical challenges…
and strongly spotlights the need to expand our nation's capabilities that collectively give us what we call "space situational awareness."

As you just heard from Owen, there is more uncertainty than ever as to when, where, and how hostile action will be taken against our space assets.

However, we should avoid fooling ourselves by asking IF hostile action will occur…

Our current low earth orbit dilemma is the result of that kind of optimistic and unrealistic thinking for way too long...

We need an integrated collection of space surveillance systems –
an architecture –
that is leak-proof.

We want to NEVER
lose track of ANY satellite from the time it is launched or released into orbit.

We need capabilities that enable us to know
who owns and operates that satellite,
how healthy it is, and
what it can REALLY do.

Most importantly, this architecture must provide the right kind of data to support WHATEVER strategy we develop for countering threats posed by those satellites.

In the face of potential threats to our space systems,
how will we adapt?

What new capabilities will we develop?

Once again…
expect uncertainty.

It is hard to forecast the new directions in which the U.S. will be driven to respond.

If in the near term,
our satellite systems continue to have no more defensive capability than they do now, we probably will be forced into an "attribution-based architecture."

Attribution –
what I mean is…
we need to gather an "undisputable chain of evidence" from the time a satellite is launched until a hostile action occurs.

This will at least allow us to clearly answer the question "who did what?"

And that knowledge supports national responses we can take right now --
diplomatic, military, economic, whatever.

Looking to the far term, we've dreamed up numerous concepts to counter threats to our space systems.

New defensive capabilities, either built into future spacecraft,
or onboard spacecraft standing guard over our high value assets have been envisioned.

Every one of those new concepts demand increased performance or new kinds of information out of our space situational awareness architecture.

Owen's vision for frequent, short-turnaround launches or the flexible repositioning of many small networked spacecraft introduces unique challenges and opportunities to situational awareness.

F6 architectures will place MANY small objects
in relative proximity
for long periods of time.

However, F6 also affords us the opportunity to embed local tracking, positioning, and threat warning functionality into the mix, enhancing awareness in and around the cooperating cluster.

Recent demonstrations, like Orbital Express, illustrate the high tempo of operations which can occur, often unpredictably, when just two satellites are in proximity –
things can happen quickly and the need for adequate situational awareness data right now can decide success or failure of such missions.

But back to the near term…

We have today's surveillance architecture – a confederation
ground-based radars and small telescopes.

We have one aging space-based visible sensor, soon to be replaced by a new
space-based system of similar capability.

Call that the "baseline" space-situational awareness architecture.

Over the next 2-3 years, DARPA will
complete development and will demonstrate two new ground-based systems that will significantly reduce the deficiencies in our "baseline" and help us move towards a nearly leak-proof "attribution-based architecture."

DARPA's Space Surveillance Telescope program will show we can build a wide field of view ground-based system that lets us detect, track, and discriminate between very small, dim objects in deep space orbits.

High sensitivity to find those small, dim objects -- and high search rates of the visible sky –
these are usually difficult requirements to satisfy with a single telescope design.

In DARPA's Space Surveillance Telescope we've achieved an effective compromise.

The Space Surveillance Telescope is a three-and–a-half meter F-1 telescope with a large, curved focal plane array.

Combined with very fast step-and-settle capabilities,
the Space Surveillance Telescope will enable a quick search of all deep space objects visible from a ground site multiple times a night.

This telescope system will tell us precisely
where objects are,
where they are going, and give us an overall idea how stable they are.

However, other capabilities are needed to appropriately identify the objects we are tracking.

Identification can be accomplished in many ways.

You can measure distances and dimensions with radar range profiles or can obtain radar and electro-optical images – this gives you the size and shape of the object being tracked.

You can also monitor signals and emissions from a satellite across the entire electromagnetic spectrum.

Some of these signals and emissions can help you better understand what a spacecraft is doing or how healthy it is.

Once again,
investments to develop, demonstrate, and field new, specialized characterization capabilities can probably only be justified by
what they enable.

We have to be able to answer questions like, "Why do we need this capability?,"

"What would we do differently if we had this data?,"

"What can we not do now because we lack this data?"

Since 1981, the Haystack radar system has provided positional data and images of satellites
in all orbit altitudes
out to deep space.

We routinely use such images to verify identity and determine health and status of satellites.

DARPA's Deep View radar upgrade program will show we can build a ground-based system that can provide high resolution images of small satellites in the same deep space orbits covered by the Space Surveillance Telescope.

When the joint DARPA / Air Force program to upgrade Haystack is complete, this new radar will provide images which will give us a factor-of-10 improvement in our ability to measure small physical features of spacecraft.

A very high search rate with the Space Surveillance Telescope… and the ability to zero in and characterize satellites with Deep View radar -- these are two valuable new tools to help us reach for that leak-proof "attribution-based architecture."

Beyond SST and
Deep View, DARPA is investigating advanced LIDAR technologies and techniques to provide additional dimensions of characterization.

The Long View program is a proof of concept program to demonstrate LIDAR-based ISAR imaging of GEO targets.

If feasible, Long View will demonstrate a

ground-based system can achieve 2-3 orders of magnitude better resolution than the current Haystack system.

While a single Space Surveillance Telescope, Deep View radar system, and the Long View program are good starts, they provide incomplete capabilities as single systems at single ground sites.

We will need to build additional copies of these systems at other locations worldwide
to obtain capability
where we need it.

Daylight and weather outages limit the time when these ground-based systems can view satellites.

These outages are predictable and exploitable by a knowledgeable and determined adversary.

Ongoing trade studies within the Air Force and OSD are looking at the benefits of multiple Space Surveillance Telescope and Deep View radar systems properly spaced around the world.

Those studies are also looking at numerous space-based surveillance concepts.

Unfortunately,
whenever we think about a space-based approach,
we immediately have to contend with the high cost of access to space.

A simple cost comparison will illustrate what I mean:

1 expendable launch vehicle = 1 to 2 Space Surveillance Telescopes

One satellite of the class of the Air Force's Space-Based Space Surveillance system = 5 to 7 Space Surveillance Telescopes

Both satellite-based and ground-based surveillance systems require ground infrastructure,
personnel somewhere to operate them, communication assets pipe their data to where it is needed.

Obvious conclusion:

Based upon our current satellite design and launch practices, sending significant portions of our nation's space surveillance architecture into space is an expensive proposition.

Satellites we buy to perform these missions had better take big bites out of the gaps in our "attribution architecture", or provide cost benefits in some obvious way.

Surveillance satellites that reduce dependence and manning requirements for costly overseas ground sites may justify the high cost.

Our ground-based telescopes and radars experience weather or day/night viewing outages.

Space assets that eliminate tracking outages of ground sites may justify the high cost.

Probably the more compelling reason for placing space surveillance assets in space is to give us essential data to respond in some new way to a threat.

Otherwise, as we have seen numerous times in the last decade, it will

be difficult to sustain support for the large investments.

There is plenty of room for improvement in our country's space situational awareness capabilities.

Closing the remaining gaps in even this "attribution-based" approach will require new and novel technical solutions.

DARPA is looking for your good ideas for new and affordable ground and space-based approaches to obtain space situational awareness.

Looking further out in the future, some of you may be involved in development of new defensive space systems.

These system concepts will almost certainly reveal the need for new or advanced ways to obtain space situational awareness.

These will also be of interest to DARPA.

Thank you.

And now here's Fred Kennedy to talk about Space Protection.