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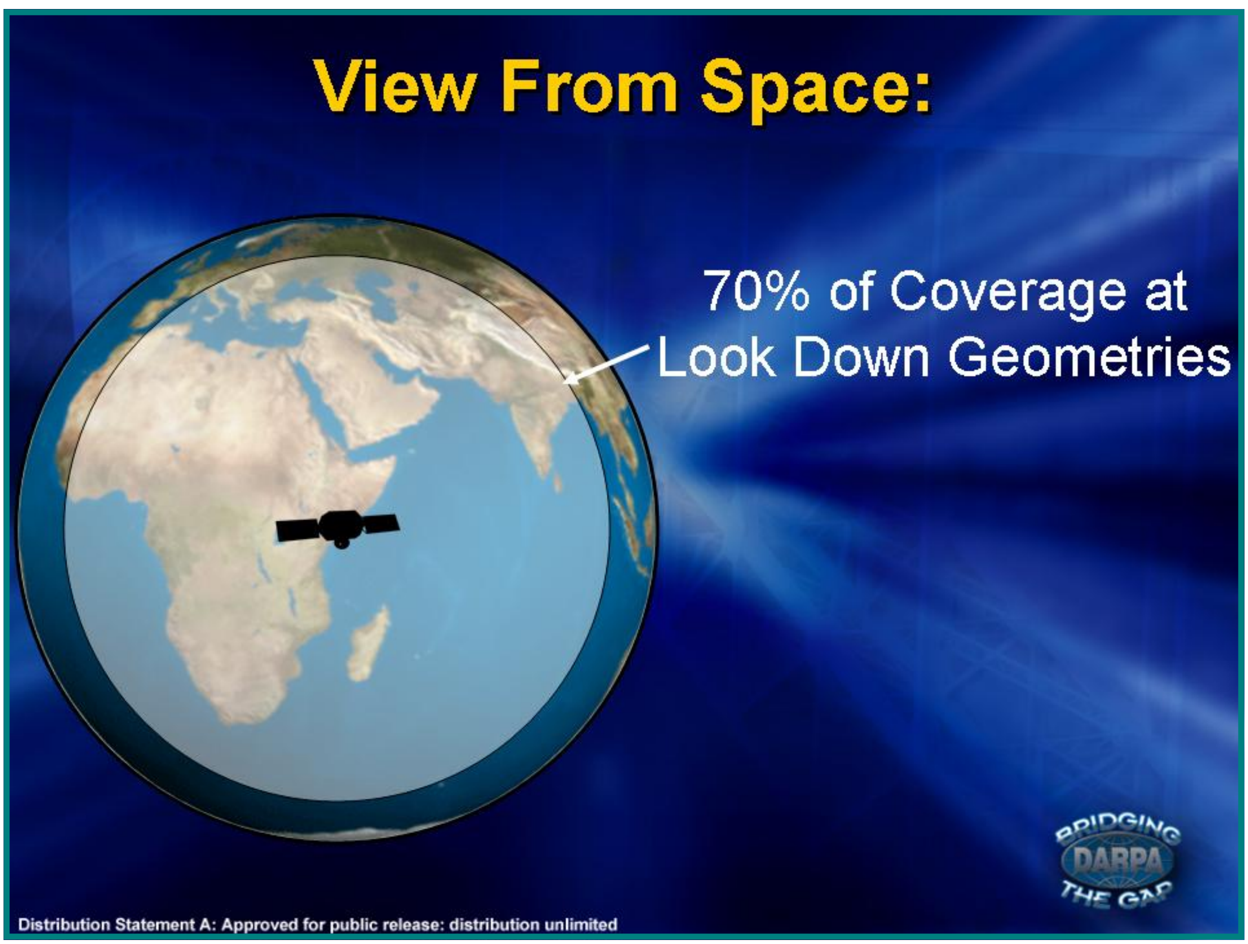
Supporting the Warfighter from Space

Why is space so important to our future capabilities? To appreciate this, we should review recent changes in the basic missions of space assets. Throughout the Cold War, space provided strategic surveillance of slow-moving projects behind the Iron Curtain—the collection of data about test facilities, submarines in construction bays, and black projects in sheds.

We still need to follow such projects in some parts of the world. However, future space assets must also perform a new range of tactical missions. The geopolitical significance of single targets such as a weapon of mass destruction or a terrorist cell is enormous, and our space surveillance must be able to track such critical targets. Space may or may not be the final frontier, but we have come to regard it as the ultimate high ground for tactical as well as strategic collection. It offers, it seems, unsurpassable tactical advantages for the new combat challenges we face.

You know the reasons why. Space and near-space provide the warfighter the keys to victory in modern warfare: communications, navigation, intelligence, surveillance, and reconnaissance. Space also provides us with something unattainable in any other way—access to denied areas. A closed society may not like that we pass overhead, but it's



our right to do so from space, over any place on the globe.

There are other advantages that make space the ultimate high ground. Space assets enjoy a high degree of survivability. For most nations, satellites are very difficult, if not impossible, targets. They are hard to destroy tactically and it is even harder to justify their destruction politically and diplomatically.

Space is also the ultimate high ground because space assets require few in-theater logistics. Unlike AWACs, JSTAR, or Rivet Joint, there are no crews that have to be refreshed, no machinery to be maintained, and no gas tanks to be constantly refueled. Space assets can operate autonomously at high levels of performance for years.

The high ground of space provides the ultimate in responsiveness—persistence, providing a latent 24/7 global capability that cannot be matched. With persistent space, you're always there, always available. There is nothing more responsive than that.

Lastly, space is the ultimate high ground because the geometry is better. Topography, both natural and man-made, is less of an issue when looking down from space. Consider this: about 1 percent of the coverage from an airborne platform is at useful look-down geometries. For a space platform, up to 70 percent of its coverage is at useful look-down geometries. There is no better way to observe a sphere with a diameter of 13,000 km than from the distance of space.

For most of history—the Greek, Roman, Spanish and British empires—to be a great power meant to be a sea-faring nation. Maritime dominance remains a critical way to project power. But, for all the reasons just discussed, if the United States is to be a superpower in the 21st century, we must keep our lead as the world's premier space-faring nation. We have to retain this high ground, just as we must retain our maritime superiority.

We believe near-space can provide some of the same advantages as space; namely, persistence and vastly reduced logistics. For that reason, DARPA's near-space programs, as well as our space programs, aim to provide new technologies that will give the American warfighter powerful new capabilities.

One of our most important space programs is the Innovative Space-based Radar Antenna Technology program (ISAT). This program is developing new technologies that enable huge radar antennas, many times larger than anything deployed in space before. These enormous radar antennas will enable the continuous life-to-death tracking of high-value ground targets, anywhere, anytime. Just as GPS transformed our military by allowing us to always know our location, ISAT will transform our military by allowing us to always know our enemy's location.

Large space antennas can also enable, improve, and transform many other space missions such as communications, electronic intelligence, and—by making more capable microsatellites—small, quick, and easy to launch yet expandable to large scales and highly capable once in space.

To enable these new capabilities, the ISAT program is developing two essential technologies. We have the deployable space antennas that will be very compact on launch, but will unfold to extremely large dimensions in space, from roughly the size of a sport utility vehicle, when stowed, to the size of the Empire State Building when fully deployed in orbit. The second essential technology is the metrology and associated calibration techniques that can measure the dynamically changing shape of such large structures to an accuracy of 1 millimeter, and correct electronically for any deformations from the ideal. In other words, we need to launch and deploy something the size of the Empire State Building, measure its shape with the accuracy of a dime's width, and use that information to form a perfect beam. How's that for DARPA hard?

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In the last year, three teams saw their plans for an ISAT 2010 flight demonstration pass a preliminary design review, and we learned a lot. We learned it is possible to make the structure so light its weight is an insignificant part of the overall spacecraft weight, and yet stiff enough so its metrology and calibration requirements may no longer be driven by the yaw and pitch of the spacecraft, but instead by the thermal snap caused by the spacecraft passing in and out of sunlight.

This year, we are funding two teams to attain Technology Readiness Level 5 for these key ISAT technologies and pass the critical design review for the ISAT flight demonstration system. We will then select a single team to build and operate the ISAT demonstration spacecraft and show that ISAT technologies are ready for the warfighter.

ISAT is about radar. In the optical domain, we started the Large Aperture Space Structures Optical (LASSO) program. By developing the technologies for 150-meter optical apertures that can provide 15-centimeter resolution from a geostationary orbit, LASSO will enable continuous optical imaging and tracking that will transform the way the warfighter uses optical surveillance data. Due to the high loads and out-gassing experienced during launch, the high precision required by optics, and microgravity properties of the space environment, we believe the best solution is to design on-orbit manufacture of the optical payload.

Last year, five teams were selected to perform initial design trades and technology assessment and development. Next year, DARPA expects to solicit proposals to develop the LASSO technologies, leading to a LASSO demonstration 5 years from now.

Often you do not have to get to orbit to enjoy some of the advantages of space. You can utilize the persistence and greatly reduced logistics provided by near-space. Our Integrated Sensor is Structure (ISIS) program is developing the technologies that will place a large airship with outstanding sensor capabilities on station for 1 year without refueling. With such a low logistics requirements, near-space assets are the perfect partners for our space systems.

Space and near-space have the makings of a strong partnership for this new world of tactical challenges. Space provides 24/7, latent, global persistence, just what we need for low-intensity conflicts and the Global War on Terror. Near-space provides surge surveillance and communications capacity, just what you need locally for high-intensity conflicts with hundreds of thousands of troops in a given theater of operations.

ISIS has taught us a great deal about near-space. In fact, both environments, space and near space, share many similar challenges. Both are inhospitable. Both require very light-weight avionics, electronics, and structures—in space, because of the cost and conditions of launch; in near-space, because of the difficulty of staying aloft. Both space and persistent near-space platforms must harvest all their energy from the environment and efficiently store it for use when sunlight is not present.

It is very appropriate that both the Air Force and DARPA combined the oversight of space and near-space programs. With this partnership in mind, DARPA is soliciting proposals to develop the light-weight hull material, antennas, power, and energy storage technologies that can be integrated into the structure of a stratospheric airship.

Of course, every program I have discussed represents another element in the asymmetric advantages of US Forces. As we are all aware, any asymmetric advantage makes a very tempting target. Our adversaries are keenly aware of the power of our space assets. They will not rest in their attempts to find ways to degrade and destroy them.

In the past, we successfully showed we can overcome the jamming of our satellite navigation systems. Can we also protect the uplinks of our satellite communications systems? The Novel

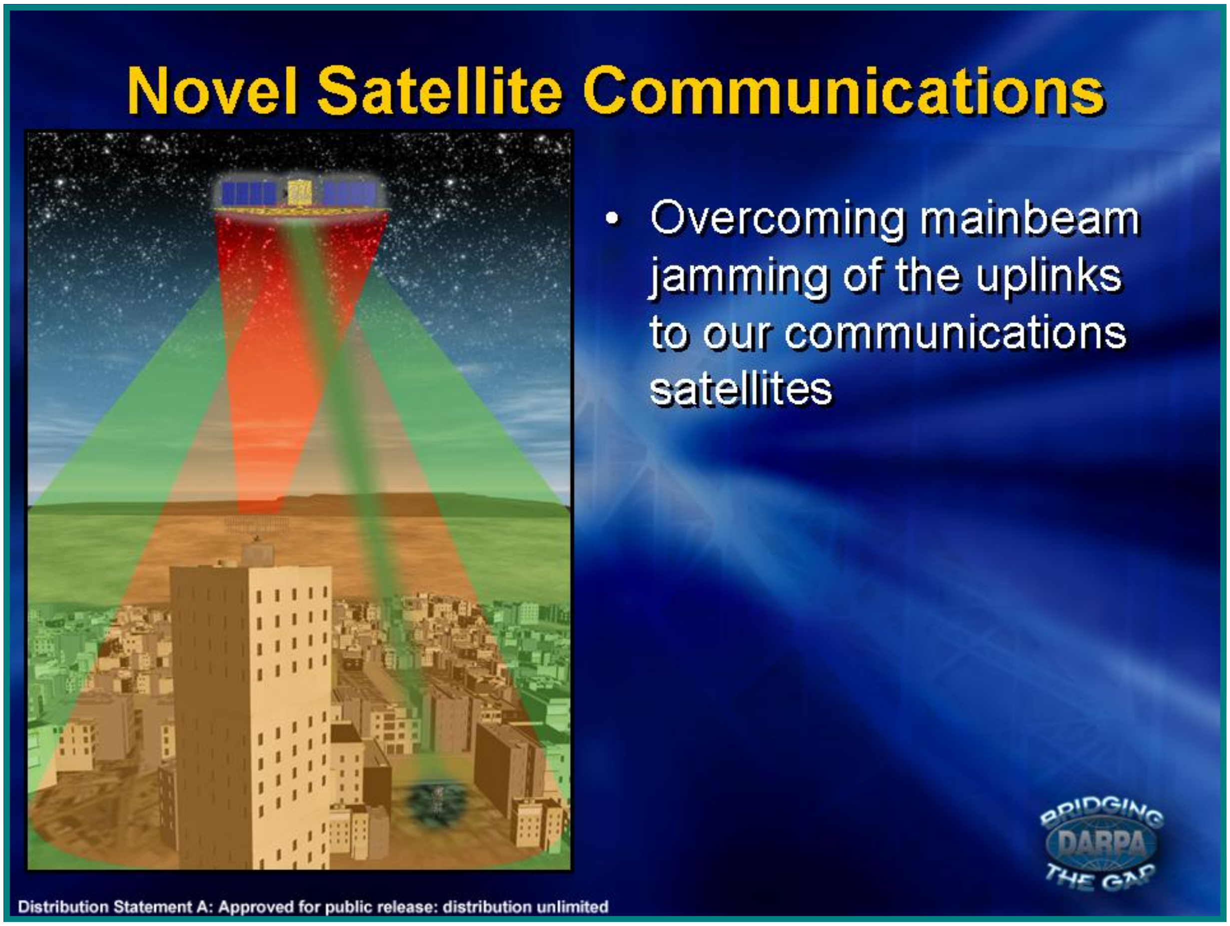
Satellite Communications program (NSC) is using new phenomenologies to overcome this vulnerability, ensuring that our troops will always have robust satellite communications available.

Last year, we performed field testing that confirmed the properties of the antijam phenomenologies we are exploiting. This year, three teams are developing the algorithms and techniques that exploit these phenomena to provide a robust antijam capability for our communications satellites. Next year, we will publish a new solicitation asking for proposals to build a real-time NSC demonstration system. In November, potential bidders for the next phase of the NSC program will be welcome to attend our workshop where the progress of all three contractors will be presented.

In addition to the upcoming LASSO, ISIS, and NSC solicitations, we are interested in any ideas you have for space and near-space that can be used to further support the warfighter.

Today, we have the ability to image and map any portion of our planet's surface. Tomorrow, in addition to knowing the surface of our planet, we would like to image and map below the surface, to perform an MRI, if you will, of Earth.

The ability to map the inside of buildings, tunnels, sewers, and other larger underground facilities is a capability that will be of great value to our military. Such a capability will enable us to find and monitor the facilities that produce weapons of mass destruction, substituting empirical evidence for the guesswork of intelligence. It will also give warfighters a 3D map for urban operations. Make no mistake: such deep imaging of Earth represents a true DARPA-hard challenge. The radar frequencies that will penetrate far enough into Earth to see deeply buried facilities do not provide the resolution required to detect and image those



facilities. We need to find some way to simultaneously achieve the penetration and resolution we need.

Protecting our space assets from electronic countermeasures is also critical to our successful use of space. Our GPX program answered the mail for navigation, and NSC is doing the same for communications. We now need to do the same to protect our space-based surveillance assets, otherwise our enemies will soon be deploying both optical and radio frequency jammers to blind our space-based surveillance systems.

It is important to keep in mind how rapidly space technology is developing. It was only 60 years ago this October that one of my favorite science fiction authors discovered the geostationary orbit and proposed a global communications grid with what he called "extraterrestrial relays" in orbit. Arthur C. Clarke, now in his late eighties, lives just a few miles from the tsunami tragedy that unfolded along the beach in Sri Lanka. He noted that this tragedy was made as accessible to world viewers as local news, thanks, of course, to these geostationary communications satellites. Space technology is now such an ordinary part of global media that it is surprising to think how far we need to go to fully access its potential for keeping peace.

In thinking through this challenge, we might keep in mind a memorable description of the process of invention from Sir Arthur, a description that often seems to describe the life of a DARPA program. Arthur Clarke said, "Every revolutionary idea seems to evoke three stages of reaction. They may be summed up by the phrases: One, it's completely impossible; Two, it's possible, but it's not worth doing; and, Three, I said it was a good idea all along."

When it comes to the capabilities discussed today, we are ready to hear your good ideas and put them in practice. And I hope we will all say that these were good ideas all along.