TRANSCRIPT

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THIS IS A RUSH TRANSCRIPT AND MAY CONTAIN ERRORS. USERS ARE ADVISED TO CONSULT THEIR OWN TAPES OR NOTES OF THE SESSION IF ABSOLUTE VERIFICATION OF WORDING IS NEEDED.

Q: Welcome to Lieutenant General Michael Hamel. He's the Commander of Space and Missile Systems Center, part of Air Force Space Command out at LA Air Force Base. I never understood why it's called SMC when it's--

A: You think SMSC it should be?

Q: Right.

A: I think they wanted a three letter acronym so they had to drop something. [Laughter]. That was the most vulnerable letter.

Q: The "system" is always the first thing to go. [Laughter].

Q: General Hamel was here in October of 2006 and I was unkind enough to go back to the transcript. I want to read something back to you.

A: You hate to hear your words thrown back at you.

Q: I know. Someone asked about a space incident in which the Chinese had illuminated an American satellite. Of course a number of things up there have happened since then, but this is what you said. "For too long we've sort of been in a mode of postulating what might or might not happen to our satellites and what we might or might not do about it. I think certainly a lot of this now forces us to think more seriously about what we might do if we were to face some kind of purposeful attack or interference." You go on to say that you took this very seriously during the days of the old Soviet Union, but that a lot of our capability had withered away since the Cold War and now it was time to build it back up.

What have we done?

A: That's a good place to start. We clearly have an imperative based upon our dependence upon space certainly in our military but I'd say more broadly how the nation depends upon space capabilities for our daily well being. We drive our cars and they whisper to us based upon GPS, and we have transactions at the gas pump that are cleared over satellite systems. We really truly have become dependent upon space as a society in ways in which we don't fully understand.

In my mind one of the key issues that we must consider in the years to come here is there are likely adversaries, there are likely parties that will look to find ways to be able to disrupt our military, our society, and I think space is likely to become an increasingly attractive place to look to how it is not only do we take this asymmetric advantage, as well as potentially disrupt more broadly critical infrastructures and other things that we depend upon as a society.

So I think it's one of the things our nation does, is it looks to our military to be the ones that protect our national, our public interests, our citizens, and I think there's an imperative that's now coming into sharper focus about us being able as a military to be able to have better space situational awareness as we refer to it, and that means having knowledge about all the objects in orbit, what are they doing, both friendly as well as hostile systems. So the idea of being able to keep track of everything that is in space, whether it represents a threat, what is it doing, and how is it that we can maintain continuous awareness of those activities and objects if the first imperative. That's a necessary step in order to make sure that we can adequately protect all of our space capabilities that we're so dependent upon. And there's a whole array of things I'd be happy to talk about in terms of the kinds of steps that we're taking, both programmatically, architecturally and operationally, although that's not my particular responsibility today. But we are really taking a very comprehensive and aggressive look at all these.

Q: I wish you would go into some detail about, you're a program guy and it's a programmatic question. We've heard space situational awareness for some time. How has your program changed over the last year and a half?

A: Again, sort of harking back to the earlier comments I made, during the Cold War we had a very very significant investment in sensor systems, in command and control centers, to be able to keep track of what the Soviet Union was doing in space. But largely that was focused around the geography and the kind of systems that the Soviet Union was operating. Obviously now in the aftermath we have a whole broader array of actors out there, systems that are both intergovernmental as well as commercial. So a lot of what we're doing now is taking many of the systems that were built for one purpose, whether that be dealing with a missile warning against a potential Soviet attack, scientific radar systems, now even the case of new missile defense systems, and trying to

knit these together in a way in which we can really draw upon all kinds of sensing phenomena, whether that be radar systems, optical trackers, and put it into really a modern net centric architecture so that we're able to provide much more rapid, current knowledge of all the objects in space, of what it is that they are doing.

So our program that we're really pursuing now, that has been presented to Congress in 2008, initial funding, we're now going to be growing that in the future, referred to as integrated space situational awareness, and it really is more about how do we net together as a first priority many of the sensor systems that we already have to make them much more efficient and responsive at the same time that we would then be looking to new kinds of sensor systems that we would add in that would help deal with this much broader array of space actors, whether that be in Asia, Europe or elsewhere. Again, much of what we have today is really focused on the geography and the focus on the Soviet Union.

Q: Space-based radar, that's sort of been off the scope for a couple of years now, but we understand work continues and that we may hear something within the next, according to my able colleague here, we may hear something within the next 45 days or so about a new program, a new plan. Can you discuss that at all or lay it out for me?

A: Our role at the Space Missile Center for several years is we have been providing a number of people and support services, if you will, things like contracting and financial management, so a lot of the detailed programmatics in terms of the content and direction, that's not been part of my direct responsibility. I've really been in a support role to the space radar program.

As I understand it now because of the continued reductions in funding, and questions have been raised by the Congress and others about the maturity of the technology, the affordability of the systems concepts, and frankly I read the press just like you do, that we'll be going through a reexamination, most likely a restructuring of the program. Whether it's put on to a longer term technology development demonstration program as opposed to where we have really been has been focused on, if you will, a next generation of space radar beyond what we are currently operating and projected to operate. So my understanding is over the course of the next several months there's likely to be a new program plan as a result of the funding reductions and better gearing it to the other programs, such things as the future imagery architecture program that is undergoing development now.

Q: There's a new Defense Science Board study about directed energy that came out in December. Since space-based radar would be a source of high power microwave, and since the Defense Science Board study said that was one of the areas where they saw some possibility for operational use of directed energy, is there any association there?

A: First, I'm not familiar with the Defense Science Board study but I will tell you that in general any of our space-based radar or other kind of high powered radiating systems in

the big scheme of things are still pretty low power. They're measured in hundreds of watts of average power, and to be able to operate from space to the ground, whether we're talking about GPSes or to space radar, it's still relatively low compared to the kind of high powered microwave systems that have been explored for possible use on the battlefield.

Q: How about space to space?

A: The big thing is that the laws of physics define the amount of power you can actually impart on something is inversely dependent upon the square of the range, so you have to generate an awful lot of power.

Q: So you have hundreds of watts. So why do you need a system to--

A: One has to look at this in a sense of what potential interaction is to a target satellite. Again, I'm not familiar with the Defense Science, we have studied this for a number of years.

Q: You did, though, talk about new sensor systems. Can you--

A: The kind of sensor systems we really are looking at are largely, particularly on space-borne platforms are optical kind of sensor systems. Again, one of the things we sometimes forget is space is a very very large place, and as you well know we're tracking upwards of 15,000 detectable objects in space right now and keeping track of them to ensure that we avoid collision and other kinds of hazards, if you will. Those are just objects that are relatively large size--ten centimeters or so. There's lots more objects in space and one of the key things is again, you have to be able to operate not just from the surface of the earth but out in space to really be able to effectively detect and track many of these smaller objects.

So a lot of what we're looking at now are optical sensors that can be flown on satellite systems. Probably the most immediate one that we're really excited about is the space-based space surveillance system that's in development now that we're looking to have its first launch by the spring of 2009. And this for the first time will really give us a very agile ability to both search large volumes of space as well as to be able to rapidly be able to detect and track objects--such things as new satellites being placed in orbit. We'd be able to actually observe the reflected light from the satellite, the rocket body, as it travels from low earth orbit to a higher orbit.

Q: Was that a payload you were counting on that we just shot down?

A: This is a new systems development--

Q: And that was a passive optical system.

A: That was an NRO satellite that you'll have to talk to the NRO about.

Q: But what you were just talking about is part of the family.

A: That is one of the integrated space situational awareness. That's one of the space elements of that.

But the other thing we're looking at that I think has a lot of promise is the idea, one of the areas of greatest interest is the geostationary belt around the equator out at 19,000 miles. There's a lot of both military as well as commercial, civil, and scientific satellites that operate there and it's sort of the old saying in real estate, that location is everything. Well there are particular areas that tend to be more advantageous and if you will, crowded. So one of the things we're looking at is how can we perhaps put additional sensor systems on as, if you will, ride share or piggyback sensors on a variety of satellites, both military as well as possibly even commercial systems, that could do such things as providing a bit of a neighborhood watch program so that you're able to look around in adjacent areas of the geostationary belt and to keep track of objects that are out there and whether or not there are any close approaches that are occurring and the like.

So we think this idea of adding to the complement of sensors systems, to be able to look at key places in space and to be able to keep track of objects is a very key part of this integrated space situational awareness.

Q: Kind of like a spacecraft craft.

A: A technique that we're looking at increasingly is how can we get better military/commercial collaboration, if you will, that will actually operate in our mutual interest.

Q: How could you draw commercial people into that? They can get drawn into a war that way. Would they be paid--

A: I think that's part of what we're looking at now. My boss in Air Force Space Command, General Bob Kehler, has really been calling for looking at a new strategic approach to how it is that we conduct some of our important space missions.

The reality is that the Department of Defense is the single largest customer of commercial space capabilities--communications, remote sensing systems and the like. We think there are a lot of opportunities for looking at some different kind of strategic approaches and partnering, if you will, that will take that basic relationship of being already an existing customer to how it is that we work in a more collaborative way of sharing information, perhaps providing opportunities for new business ventures.

Q: Conventional strike missile. I understand the background of it, where you've been

with that, but I wonder if you can give us an update of where you stand now and looking ahead, some of the near term issues you're going to tackle both at kind of the macro level or policy level, then further down, the technology level.

Last May I spoke with some Air Force Space Command people at the headquarters level and they were talking about using money from congressional add-ons to do some technology demonstrations that modified like the 108 submunitions and looking at this bichonic delivery concept. So if you can comment on all that.

A: First of all, I can't talk about the policy. I'd be happy to talk to you a little bit about what we're trying to do technically and programmatically.

From an Air Force perspective all the way back to the earliest days of the ballistic missile program we had a very very robust developmental organization and structure, and again in the aftermath of the Cold War we really got focused on how do we sustain the existing, both the Minuteman as well as the Peacekeeper weapon systems out in the field. And we've had a very successful modernization that is about 80-plus percent completed now with upgrading the propulsion systems and the guidance systems, many of the other systems other than Minuteman.

Both our sustainment as well as some of the underlying technical developments to support the fielded system is still an imperative and we need to continue to assure that that those deployed weapon systems are safe and secure, reliable and effective.

At the same time, some of those basic technologies, such things as guidance systems and reentry bodies, and when we do talk about conventional kinds of munitions or weapon systems, there are some unique and distinct kind of challenges in terms of how would you deliver, what are the weapons effects, what kind of accuracies you need to have.

So for a number of years now we've had what we refer to as our demonstration validation program. It's had a couple of objectives, one of which is to continue to invest in key enabling technologies for such things as conventional strike or precision global strike capabilities. And also to ensure that we're maintaining a viable industrial base. In many of these cases, these are absolutely a unique technology to ballistic missile kind of systems. We can't just depend upon what's happening in the commercial developments, whether that be for propulsion capabilities or for guidance or reentry systems. So the purpose of the demonstration and validation program really has been two-fold, to continue to advance key technologies, but also assure that we have a strong industrial base.

As relates to the conventional strike missile, we have been studying different concepts and options, looking at what kind of targets and weapons effects and what kind of accuracy and delivery ranges and systems concepts for a number of years. Certainly the Commander of Strategic Command has stated that he believes he needs to have the capability to be able to strike targets anywhere on the face of the earth within a very very

short period of time with a conventional kind of system. We're looking at different concepts. In fact there's been presses to look at perhaps are there some ear term demonstration capabilities that could be pursued that would really validate some of these weapons effects and military utility. So we are looking at those systems and particular enabling technologies.

As far as what has happened in the past year is that the Congress has established now what's referred to as a defense-wide account, the intent of which is to provide a source of funding for which the different services--Navy, Air Force, Army--with whatever concepts and proposals they may have, in effect they compete for funding that would be managed by the Department of Defense and the Commander of STRATCOM for the most promising concepts and technology advances, and we definitely intend to put forward our ideas for that funding that's in that defense-wide account.

Q: The money that you already have gotten with the congressional plus-up, how are you applying that--

A: We are mostly focusing that on the elements of the guidance systems, reentry bodies. There is some look at the different kind of munitions and the kind of effects, and again, this spans all the way from being able to strike very hard targets to wide, disbursed kind of softer targets and the rest of that. So there's a fairly broad and comprehensive effort right now that we're pursuing largely in conjunction with the other services as well as with the national labs. Looking at discreet technical questions and issues and then in effect pulling that together to say this particular demonstration would validate a certain kind of combat effects.

Q: Is your baseline concept still [Minotaurs] based out of Vandenberg?

A: Most of our concepts still look at using the, if you will, retired ICBM systems. We happen to call those Minotaurs right now because that's just the contract we have that uses those systems for space launched vehicles and the like, but we would certainly envision that any near-term demonstrations we would probably use, retired ICBM components, whether that be Minuteman or Peacekeeper. Vandenberg right now is an attractive place from the standpoint of being able to conduct tests because that is where we have traditionally done all of our longer range ballistic missile tests.

Q: Finally, when is your notional start date for like a natural program going beyond this demonstration and validation phase?

A: For an actual program? I think it still would be speculative now. Our focus right now is on a nearer term kind of demonstrations that would really validate effectiveness of a different kind of delivery systems, weapons effects, accuracy and the like.

Q: Is there anything non-kinetic in that list of weapons effects?

A: Non-kinetic. As in?

Q: HPM, EMP, electronic attack.

A: All the concepts we're looking at right now are kinetic in one fashion or another. Either the unitary kinetic kind of systems, explosives, disbursed dispensed munitions and things of that nature.

Q: Yes, sir. Last week when General Kehler spoke in front of the Hill, the Army's FCS program was brought up in regards to the TSAT reductions. I was just wondering where discussions kind of stand with the Army and Air Force and how the Army plans to use space assets for that program?

A: I will tell you that every interaction I have had is that there is absolute, unequivocal, steadfast support from both the Army, the Marine Corps or Navy in terms of their dependence upon future space capabilities, whether that be communications, data systems, GPS, surveillance reconnaissance systems. As relates to the communications and the FCS, clearly the whole Army's concept of how it is that you have disbursed small unit operations that can operate over broad areas of the battlefield are totally dependent upon having very responsive, highly mobile communications that can link together small units of action. That was really the whole driving concept behind, at least one of the major concepts and demands behind the TSAT program, was being able to support ground forces in the 21st Century. So things such as com on the move, being able to share large volumes of data, that's really at the heart and some of the driving requirements for the TSAT system and program as we know it today.

You're probably aware, and I believe General Kehler did speak about this, that the department is looking at, not so much the question of what the requirements are, but the phasing, and to ensure that the delivery of the on-orbit capability matches when the ground forces, the airborne forces, are actually going to be in place. So there are efforts going on right now that are looking at the phasing, and to ensure that we're looking at the right dates by which those systems need to be in place. But I've heard no question whatsoever that the articulated requirements and the concepts by which we would integrate all these capabilities together with ground, land and air forces, I've heard nothing that says that there's any real question about that.

Q: Just in terms of, from what's been discussed with me is the unprecedented bandwidth that the FCS program would use. Does that bring any concerns with space assets, the TSAT program specifically?

A: The TSAT system and program as it's conceived today is an extraordinarily sophisticated system. You're probably aware that the fundamental building blocks of it are that we would have laser cross-links and communications capability that basically will expand from millions of bits a second to billions of bits per second. Likewise, the on-board ability to do internet protocol, IP based communications routing basically will

allow diverse and very different forces on the ground to be able to directly communicate through this IP-based networks on orbit.

So the basic design of the system is one that really does push the state of the art at least one or two orders of magnitude in terms of bandwidth and what can be delivered to individual units, whether that be ground forces or major command and control nodes and the rest of that. As I say, it's on the order of a couple of orders of magnitude growth in bandwidth that the system is designed to actually be able to deliver to end customers. So it represents just an extraordinary leap in capabilities both technically as well as operationally.

Q: Two quick ones, both a little bit different. One is, in the conventional strike is there a desire to try to hit mobile targets?

A: Right now that has not been something that we've been asked to look at. For the basic concepts of being able to over very very long ranges to be able to precisely deliver a munition or an armament and to be able to achieve a kinetic effect is a pretty substantial challenge. Adding onto that, being able to also be able to strike a mobile or moving target, that is beyond right now where we're looking at.

Q: So it's off the table.

A: I wouldn't say off the table, I'm saying it's not what we're looking at right now.

Q: Secondly, there's roles and missions talk in Washington, the Air Force seems to be thinking that space situational awareness being their role that it needs to guard. Do you use any effort by other services to [inaudible] part of the space mission or to increase their [inaudible]?

A: I will tell you, I don't think there's ay question that the Air Force is the principal service that brings the preponderance of military space capability. As relates, we really believe in the Air Force that space is a distinctive medium of operations, just as air, land and sea. Over time we have seen, we need to be a little bit mindful that we've only operated in space for 50 years now so we are still growing in terms of our understanding of sort of the doctrine, the occupational and tactical art. But we really believe in the Air Force that we understand this as a service better than any other service. We bring more capabilities in terms of forces, people and the like. So this whole notion of having space situation awareness is really about being able to operate and have freedom of operation in space. So we think it's very important that that be focused and assigned clearly to a service that has the capacity to perform that mission.

Having said that, though, there is still room for lots of other contributors. Just as we have air power that is delivered by the United States Navy that becomes part of a joint fight, we think likewise that having space operations for which all joint capabilities can be brought together is critical. I'll give you an example. But right now some of the most

capable sensors that we are developing and fielding right now are being done by the Missile Defense Agency. Some very very sophisticated sensors to be able to detect and track objects in space, near space if you will, and so we want to make sure that those sensors are integrated into this overall architecture so that when the priority is or the mission is to be able to perform space situational awareness we can draw upon all those sensor systems.

We believe that that really is appropriately a role that's got to be assigned to a service and we think it is logical for the Air Force to be the principal service that provide space situational awareness.

Q: Looking kind of long term budget-wise, you mentioned in response to Bob's question in particular it seems as though increasing space plans. With defense budgets supposed to be, supposedly getting pinched in the out years, how do you see your own budget going and what do you take as a priority?

A: We are clearly seeing pressure just as all the services in different areas across the DoD in terms of the out year budgets. In my mind part of the imperative, and one of the things we are really working on very diligently is looking for ways to achieve efficiencies at the same time we're assuring operational effectiveness. So I'll point you to one example. One of the things we've done, probably the single most challenging aspect of any kind of space operations business is we have to be able to reliably and predictably get into orbit, access to space, space launch. I think most of you are probably aware that over the past decade this nation has really achieved an extraordinary accomplishment and that is we have developed and now fielded two world class new space launched systems, the Atlas V and the Delta IV. The challenge we have though, is because of again, tightened budgets and the rest of that, the amount of actual demand that we are likely to put on those two vehicles, the production, the flight rates and the rest of that were relatively low.

So as a result what we did was, there was a proposal from industry that we agreed to and that would then actually create a single joint venture that will operate these two systems that have previously been developed and produced by Lockheed Martin and Boeing, are now coming together under an organization, an entity, called United Launch Alliance. But what the real intent behind that is is to achieve efficiencies and economies while still having assured access to space capabilities. So it's combining the engineering work forces, the production facilities, the launch crews to achieve efficiencies has been a key part of that.

So coming back, I think we're going to see more and more pressures looking to us and to industry to find ways to continue to be able to perform the mission, but to do so with greater economies, and that's a lot of what we're going to be looking for, as I mentioned, on these questions of possible military and commercial collaboration. How can we in effect get one plus one to add up to more than two, if you will, so we can get the necessary military capability but to do so in a more cost effective way.

Q: And your priorities moving forward?

A: Our priorities right now, after, I think everybody around the table is probably aware, we've had a tough decade, if you will, in terms of programs that have had problems. We've had Nunn/McCurdy breaches, we've had overruns, there's a wholes series of launch failures that occurred in the late 1990s. So we really believe that we are getting our programs back on track. And frankly, the sharpest focus we've got to have now is delivering many near term capabilities. Within the next 18-24 months we will have first time launches and deployments of five major new operational capabilities in space. Things such as the wideband global sat com system. We've had the first vehicle that will launch very successfully, undergoing tests and turn it over to the operators, but we'll have that whole constellation populated here within the next 12 months. We have the GPS-2F satellite which is going to bring some very substantial new capabilities to both civil users as well as the warfighters. We have the advanced EHF system which is an order of magnitude more protected communications capability than what the MILSTAR system is providing today. Likewise I talked about the space-based space surveillance system which is going to provide an order of magnitude more capability than the predecessor MSX space-based visible system. And finally, by the latter part of 2009 the SBIRS geostationary sensor system that again is going to provide dramatic new capabilities will be launched by the latter part of 2009.

So our locked focus over the next 18-24 months is to successfully complete those developments and to successfully launch and to actually get all those systems into operation. I think we're going to see a massive increase in terms of military operational space capability over the next 18-24 months.

Q: I wanted to ask you about [inaudible] weaponizing space, especially in [inaudible]. Many lawmakers, especially Democrats, have been very [inaudible] to give the [inaudible] the $10 million to do the space XBand. After the Chinese satellite shoot-down and now the US more recently, is that argument no longer valid, that they don't want to [inaudible] arena?

A: That's a complicated discussion to get into.

I wouldn't want to comment necessarily on the specifics of any particular program that's being proposed, but I will tell you as a career-long space person, I think the key in this whole debate about weaponization is to first understand how critically dependent we are upon space. And that we as a nation derive extraordinary asymmetric advantages in terms of our world leadership, our military capabilities and the like. This is an advantage that we do not want to lose and that we want to continue to be the world leaders. That means that we have to be able to protect our space capabilities. That means making them harder, making them more reactive when they do face a threat. We have to assure that we can use our space capabilities when and where they're needed.

Likewise we have to understand that other nations have taken notice of how much benefit we derive from the use of space and they're making huge investments likewise, both in satellites they put into orbit as well as how do they use space capabilities, be it for regional purposes, or how do they extent their own influence, prestige and role in the world beyond their own borders.

So I think what has happened is that we have naturally seen the growing engagement in space and the information age and its use by many many countries and we must be prepared that when our satellites and our systems are threatened, to be able to defend those and likewise when our interests, whether they be on the battlefield, in free commerce are threatened by others that are using space in ways that threaten it, we have to be able to deny their ability to impede our use of space. We all as a matter of international norms accept the free and open use of space. And when that's threatened, it's an obligation we have to ensure that we can protect America's interests.

Q: In looking forward, how do you get support of Congress and other people to give you the funding to start moving forward on some of the--

A: I personally believe one of the less helpful things is getting caught in a lot of debates about weaponization. Because quite frankly, one of the real questions is at the end of the day the real purpose and use of space is how do you influence and employ things on earth. And frankly, the satellites are just one piece of an overall architecture. We have control links, we have user equipment, we have data processing centers. So you have to think about space more broadly.

The idea of focusing on weapons in space to me becomes a bit of a distractor from that bigger question about how do we have assured ability to use space capabilities? And likewise, how can we assure that adversaries and enemies don't use their space capabilities?

It could be as simple as how is it that an adversary gets an image off of Google Earth that could somehow threaten American lives or interests? That is an example of a space threat that we may face in the future. So we can't just simply get caught up and distracted by arguments about weaponization of space when I fact the kind of world we face is far more complicated. So I think a lot of what our interests are is to be able to educate the American public, our elected officials, about why protecting our interest in space is so critical to our continued world leadership and our well being.

Q: Did you expect the argument to change or shift this year in light of the US shoot-down?

A: I wouldn't want to necessarily comment on that but I think certainly, and Bob here quoted me a bit, we've been watching this very closely. Other countries are making large investments in their own space capabilities. I think the test that was done by the Chinese a year ago was not unexpected from the standpoint of those of us that watch this very

closely and monitor. I think it does now force a debate and an awareness on the part of the American public, our elected officials, that this is no longer, as I said, something that's hypothetical, but rather it is now a demonstrated capability for which we must take notice and contemplate any inaction on our part what might be the consequences for generations to come.

Q: General, you mentioned protecting space capabilities and we've mentioned China a little bit this morning. Can you talk a little bit about the threat assumptions out there, the threats out there that sort of drive your programmatic decisions, both in terms of [inaudible] capability, [inaudible], non-state actors and so forth?

A: I really can't get into specific classified information but I'll give you an example about one area that we have the responsibility for that we do take very seriously. The Global Positioning System is literally ubiquitous. I would argue that precise positioning and timing is the fundamental enabler of the information age. Being able to synchronize everything around the globe from timing and positioning is absolutely critical. Yet the only way that really functions is for user receivers to be able to collect the signal. Well, it is a very very weak signal and it's very, it's relatively easy for commercial kind of devices and uses to be able to get disrupted.

So one of the things we worry very much about is how do you protect GPS users and their equipment to be able to receive the signals? We both want to improve the signals from the satellite, but you also have to improve the user equipment to be less susceptible and vulnerable. Even in such things as what we refer to now as urban canyons or the degree to which GPS is used indoors and elsewhere for various military, civil operations and the like.

The fact is that the technology is such that it's relatively available in many many parts of the world. Literally Radio Shack parts, together with a modicum of electrical engineering education, you can actually generate jamming and disruptive wave forms to particular types of GPS signals and user equipment.

So part of our job is to make sure that we are building the right kind of equipment, particularly for our military users, that has greater protection and anti-jam capability to be able to deal with some of those kinds of threats. So it's not just, again, about satellites in orbit, it's also about the user equipment to assure that they have an assured availability and use to perform the intended purpose.

Q: A number of countries are active. Do you view China as kind of the country that's farthest ahead, that seems the most intent on [inaudible]?

A: Certainly we've seen a lot of press reports that there has been a huge growth in China's investment in their military forces. As I understand it, basically double digit growth in their military budgets.

We're also seeing countries such as India, Israel, others, even less affluent economically developed countries that are starting to make investments in space.

And frankly, part of the hurdle of getting into space has been reduced by virtue of having various countries, Russia for example is offering rides for secondary payloads and small satellites and the like, so this is really, you take a look at the number of nations, where we were 15-20 years ago in terms of what we referred to as space-faring nations, it was literally single digit. Now we're up to 30-40 separate nations, all of which are flying satellites in orbit. So we see a huge growth. And I think it is both a matter of deriving economic and military benefit from it, but it's also a bit of a statement of having arrived on the world stage, if you will, to become now a space-faring nation. I think there's going to be a lot of continuing investment. But clearly, there are a handful of nations that have made this a very purposeful national agenda.

Q: Can you talk at all about the pressure put on those GPS satellites because of the situations in Iraq and Afghanistan? Any impact by--

A: I'd be happy to. The good news about GPs is it's available to everybody. It's a broadcasted signal, and quite frankly most of the brains for GPS are in the user equipment, whether it be in your dashboard or it's integrated into the weapon system.

What we have done though is because of the ever-increasing demand for better and better accuracy, that we actually have for a number of years now as GPS satellites come within view of that particular theater, we'll actually, if you will, tune them up to improve their accuracy so that in the theater we actually get the best possible accuracy that we can be delivering.

So yes, we put some demands on the operating crews to be able to monitor as well as to update and to maintain the best possible service, most accurate service in the CENTCOM AOR to support them.

Q: If I could also, last year after China's test there was this so-called clean sheet look at space surveillance networks.

A: Yes.

Q: It's been a little while now as that's made its way through the Air Force. Can you talk at all about what came of that analysis? Some of the conclusions?

A: Again, that goes back to my earlier remark that much of our current space surveillance capability is really based upon the Cold War, Soviet Union view. It's interesting, most of our radar systems that we use today were originally deployed to be missile warning radars, and not surprisingly, they were facing over the North Pole regions. Now we start finding out that there are different geometries, different regions and the rest of that in which satellites are flying and concentrated. So part of this clean

sheet was to go back and say in a perfect world, and if the only thing you had to abide by were the laws of physics, what could you actually do? So this clean sheet did look at a whole array of different concepts, deployments of ground-based and space-based sensors, and not surprisingly, it turned out to be a rather eye-watering total bill to be able to employ that.

But again, you've got to start with what's the universe of possibilities? One of the things we have really been focused on at the Space and Missile Center is developing some modeling and architecture tools to do what we refer to now as best value. To in effect look at all the regions in space, the kind of objects, where we have gaps, and to look at where would the next best dollar get invested to be able to close the gap? And frankly kit's a combination now of not only monitoring routine things--objects that are already in orbit, but also to be able to detect and to be able to closely track events that are occurring, or activities.

Again I go back to my earlier point that there are certain regions of the geostationary belt that sort of in a space sense are getting rather crowded. There are places, for example 90 degrees east in the geostationary belt, you take a look at where that is, that's sort of over the central part of Asia, and guess what? There's a lot of satellites that want to operate there. [Laughter]. As a result you have things like radio frequency interference. You have individual owners, operators, nations that are maneuvering satellites to maintain their position. Well we have to kind of monitor that to make sure that those movements are not threatening, and likewise to assure that there's not possibilities of potential collision of these objects. Even though space is a big place, the fact is that you do need to exercise some measure of monitoring of what is actually going on.

Again, coming back, a lot of what we are doing is focusing on how do we take many of today's sensor systems, integrate the information data. It's in effect, as I mentioned, it would be good to have those commercial and international owners and operators share with us their knowledge of where their satellites are. As opposed to us having to use radars or optical trackers to keep track of it. They told us where it was. It would be a whole lot easier.

So it's some of this collaboration and net centric data fusing and the rest of that that we think really is the key for the future and that's a lot of what our architecture, best value architecture is telling us.

Q: General, you mentioned earlier this access to [inaudible] people have. Could you go into that a little bit more, like why you see a threat to that, and what you might be doing to restrict some of that access, and maybe expand on it a little bit? What are some of the other areas of civilian access to space intelligence or whatever that's sort of making your list?

A: Clearly one of the things that is happening is we're seeing a significant growth in both

commercial and civil remote sensing capabilities. We've seen that pointed out here. A number of systems in this country and with friends and various international other nations, are actually developing and fielding capability, that are able to provide quite frankly some very good capabilities. It wasn't too many years ago that would have been our cutting edge reconnaissance capability, now are commercially purchasable products, if you will. One of the things as a matter of national policy, we clearly wanted to continue our aerospace industry and our commercial providers to be at the very competitive, cutting edge of what it is that is, if you will, generally available in the marketplace. So we've both encouraged that, but also want to make sure that the kind of information that may actually get out into public domain and use is not going to threaten our legitimate security interest.

So some of the restrictions that have been placed is the currency of the data. For example, on one hand the ability to go off and surveil a particular region where we may be engaged in military operations or there may be some kind of evolving crisis, that's going to be generally available to whomever chooses that's operating a satellite to look in that region. What we would like to do, though, is to make sure that it does not have current tactical value, if you will.

So time latency becomes a critical part. One can't preclude being able to look at where are runways located, where are munitions and various military posts and garrisons and things of that nature, but you'd certainly not want to have something that literally is within hours, had data collected within hours that could be used by an adversary just through the use of a credit card transaction.

Q: How do you stop that?

A: Part of it is, again, that's part of our motivation is we would like to have US companies that are at the forefront of this such that we can, as a matter of practice, ensure that there is not data of greater currency than what we believe is militarily acceptable.

Q: So do you sort of strong-arm them to not release that--

A: There are restrictions on their licenses in terms of what can and cannot be done, in terms of latency, timeliness, resolution, things like that. So again, that's part of our national interest to ensure that we set the conditions, if you will, not only for US companies but also set some of the norms in terms of how on an international or allied basis are being used.

Q: We've talked a lot about space situational awareness and I think most of the people at this table are familiar with that as being sort of the first step to improving space operations, but I'm curious if we can go a little step farther and talk about counter-space systems. Specifically, RAIDERS Block 20 is one that has been tossed around. What's going on there? What are you going to actually be buying? What's the requirement that

you're trying to fulfill with technology? Also, one that was in the budget world a while back but sort or dissipated was the counter reconnaissance system. Space Command has said that requirement still exists even though that program name has not been visible in the budget. What's going on to try to fulfill that requirement?

Q: Those are good questions. First of all, I'm not certain that we always do ourselves a favor with some of the acronyms and gobbledy gook we come up with, and hopefully I'm not quoted on that. [Laughter]. But this alphabet soup of different programs probably doesn't help us.

Basically there's two components that you've touched on here. One is, what are the protective and defensive systems that we are working on. And the RAIDER systems, for those who don't necessarily track this, this is really Rapid Attack and Identification capability.

The first element of this has really been focused on if we should experience a disruption of our communications capabilities, the first thing you've got to do is one, identify it. But then what you really want to do is to locate it and to attribute it. Is it something that just happens to be, if you will, fratricide or our own co-channel interference? Or is it some kind of very purposeful jamming or disruption that's going on? So that's part of our first block of this is to be able to not just know that we've got disruption on our communications link, but to be able to isolate, identify and do something about it.

The Block 20 of the RAIDERS is really focused more on the satellite systems and developing ability to monitor what is happening on board the satellite, both its in place, in situ sensor systems, as well as how do I correlate across multiple satellite systems? Sort of the nightmare scenario is to start simply seeing satellites blink off and not know whether or not that's as a result of some kind of environmental effect with geomagnetic storm, or is there some very purposeful interference in a campaign going on to actually deny these capabilities?

So a lot of what RAIDERS is about is being able to extract more knowledge and information of individual satellite platforms, plus to be able to correlate those in a way that really gives you an integrated picture. Then you're in a position to be able to take action, if you will, to protect those.

So those are all kind of in the domain of protection and defense of our own systems, services and platforms overall.

The other part you refer to really talks about how do we deny and disrupt adversaries' use of space against us, if you will. So if it turns out that al-Qaida is using a communication system to coordinate their attacks and say is it responsible if we know that's going on to simply say that gee, I guess because that's being done over a commercial satellite or it's another foreign entity or whatever else, I guess that just has to happen.

So part of the systems we have worked on, things like counter communication system, you've touched on others, and I can't go into a lot of details. I think you all understand that and respect it. But this is part of our investment, to ensure that we are fielding capabilities that when adversaries are using space in a way that threatens American lives and our forces and our friends and allies, we must have the ability to take that away from them. Our focus is primarily on reversible non-permanent kinds of effects, but these are capabilities we must continue to work on to ensure the combatant commanders are not subject to that kind of threat when they're going into operations.

Q: So when do you actually plan to procure RAIDERS Block 20? And what is it that you're buying? Is it computer systems, is it--

A: Yes.

[Laughter].

A: Quite frankly, as I said, we're moving into some new ground here. It isn't just a matter of the systems, there is also operational and tactical art that we are developing when we talk about space situation awareness and how it is that we correlate and integrate across very very divergent systems. We have military, we have intelligence systems, we have commercial, all of which are being simultaneously employed in military operations. So part of this is how do you integrate across many many different, for lack of a better phrase, bureaucratic stovepipes? And so part of this is getting accessibility to the data. That's a lot of where the net centric, sort of modern, if you will, search engine kind of architectures that we need to be able to get in place where we can expose data from all kinds of sources, be those intelligence systems, military satellite and commercial systems, so that we can actually develop an understanding of the status of those systems, how are they being employed, when are their disruptions, when are they maneuvering? So a lot of what RAIDERS is doing is the foundational architecture work that yes, it involves developing software. There's new communications connections and the like, but it's primarily focused on how do you in effect take, say modern IP based systems and data fusion and data mining techniques to be able to actually integrate this into now a very widespread netting of sensor systems and satellites?

Q: What is the timeframe?

A: We are actually, one of the things I'm very excited about and have been a very strong proponent of, the first element of this integrated space situational awareness is to begin a rapid prototyping effort. We're focusing that on the Joint Space Operation Center out at Vandenberg. And the idea here now, as they have taken on this responsibility for space situation awareness and directing the space surveillance network, is to co-locate an ability to do rapid prototyping on new net centric architecture.

So instead of the old stovepiped Cold War system that we are operating with today, we

want to right next door to it have a place where we can be doing rapid development of new concepts, visualization, fusion engines, sensor access, so that as we prove new capabilities that are solving real operator problems today that we can actually migrate it into the operational baseline. So instead of having five and ten year development cycles, we really are talking about 90 day cycles for taking new software capabilities and be able to test them rapidly, prove them out and actually get them into the hands of the operators.

Q: A GAO report that was released last week on space acquisitions asserted that there was a lack of low cost launch. I wonder if you can comment on that and maybe talk about some of the programs you're working on to boost low cost launch.

A: As I mentioned previously, it's sort of the holy grail that we're all searching for is the free access to space. [Laughter].

Q: That will happen. [Laughter].

A: I will just tell you that having again been in this business a long time there is nothing we do that is more perilous, more unforgiving and harder than launching objects into space. I actually had the opportunity last week to visit down at Cape Canaveral and get up to eights on both the Delta IV and the Atlas V programs. This is really remarkable engineering and operation that goes into one of these and I would commend to any of you that haven't had the chance to either go crawl around a launch pad or to see a launch or whatever else, you need to do it to really understand.

This is amazing stuff, to be able to launch a 10, 20, 30,000 pound satellite into orbit. It is extraordinarily demanding. And you don't get two chances to do it right. I truly believe, one of my regrets is that we have not appreciated the enormous accomplishment that has happened in this nation as a result of the Atlas V and Delta IV programs, the two EELVs.

We have basically operated for four decades without any truly significant advances, if you will, in terms of our rocket systems and our launch vehicles. That program has been extraordinarily successful. We're a hundred percent successful in every launch we've had thus far, and I'll probably get this wrong, but I think we're up to 13 or 14 launches. In the history of the space age there's never been a case where we have not had any kind of early-on launch failure. So this program's been extraordinarily successful. It is very modern in terms of the engineering, the manufacturing, the integration. Significant reductions in the amount of touch labor and all the rest of that, so it's been extraordinarily successful. But we all recognize it's still costing upwards of $100 million per launch, that that's a very expensive proposition.

So we are looking at ways to try to reduce the cost of launch. Some of the things we're doing right now is looking at how do you exploit retired ballistic missile motors? You're probably familiar with the Minotaur program that provides us I think some very

efficient and cost effective means, but they tend to be relatively small payloads. They're in the few thousand pounds to orbit category as opposed to the tens of thousands of pounds that we have with the EELV programs.

I'm sure you're aware there are a number of startup ventures such as SpaceX and others that are looking at ways to truly reduce the cost further, if you will, but I think we have come to the conclusion that while there may be some interesting and innovative designs and business practices, that we have kind of reached the point of diminishing returns in terms of how much real efficiency and how much we can really expect to get with our traditional staged chemical propulsion kind of expendable systems.

So one of the things that we are looking at is kind of taking the next step which we think is the logical next step, and that is actually pursuing some kind of reusable system. Not reusable as we knew back in the decade of the 1990s with such things as the X-33 and the Venture Star program which was a single staged orbit. What we're talking about now is a multiple stage where one of the stages might be a reusable system. We think it makes most sense for the first stage to be a reusable system where you're able to recapture and refly most of the high value hardware and then you simply have a relatively inexpensive upper stage. And so we're working the systems concepts, what are some of the key enabling technologies with that.

None of us are na1ve enough to believe that somebody's going to write a check for this because even in the case of a modest demonstration we're still talking upwards of a billion dollars. But clearly unless we pursue some different kind of concept here, as I say, we're pretty well convinced we've reached the point of diminishing return. And the cost per pound to orbit, we're not going to change that equation very much unless we have a very determined and focused effort with both new concepts, system concepts, as well as some technology and reusability we think is key. You can't throw away everything every flight and expect to ever be efficient. We've got to get to the point where we are routinely reusing major elements of our launch system.

Q: But what do you see as the potential of some of these startups such as SpaceX or Air Launcher?

A: I think, again, the real key has got to be what is the demand for those particular services? And there is a bit of a philosophy of if you build it they will come, and that may be the case. But frankly, we don't have a long line of 1000, 2000 pound class satellites that are just waiting to get launched.

Part of this is we've got to work both sides of the equation. You've got to work both the launch system and try to make it as cost effective as you can, which will hopefully open the door for more opportunities, for more cost-effective satellites, but if we don't build more cost-effective satellites, you're not going to increase the demand for the launchers.

So there's a complex relationship here, and part of the thing we're doing with such

efforts and initiatives as the responsive space, is trying to work both sides of that equation, if you will. Again one of the things I will tell you I fervently believe in is that while the systems that we operate and build today, the tens of thousands of pound class vehicles are extraordinary in terms of what they do and our dependence upon them, we also need a class of systems that is much more responsive. Those that can actually be configured and postured in months, if you will, as opposed to the other systems that literally are a billion dollars and take years.

Q: General, back to conventional strike. One of the recurring themes in congressional action on that class of programs, not just the '08 build, but prior years, is they really don't want to blur the line between nuclear and conventional. This is outside of your lane entirely, it's way beyond, but the signature of a Minuteman is the signature of a Minuteman and [inaudible]. Can you talk about even conceptually how you go about addressing that? Or is this simply a robust perception that you're going to have to change people's minds on?

A: Again, this is not something I'm directly involved in. I'd just tell you as sort of a practitioner that's been around a while, I think one of the real questions has been the ambiguity associated with the platforms and locations and the like. I truly believe that there are ways to create transparency measures and the like where it becomes clear that, you take the wrap off and say here, see this is what it is. There's no question about it. If something flies out of this location, then you can be assured that this is the kind of system it is.

So I personally believe you can create some fairly bright lines between what are nuclear missile systems versus conventional, but it's going to require some good care and I think very open dialogue and engagement about what our intentions and capabilities are.

Q: I was wondering if there was [inaudible], to have the opportunity to shoot down a satellite recently. I was wondering if there were any lessons learned from that that you could share with us.

A: Again, I was not involved, although I had a lot of friends that were involved. But I will tell you something that to me was fairly impressive. No matter what a lot of to'ing and fro'ing, if you will, about the whole event mission, but to me it was very very impressive that within a relatively short order of determining that we had an issue that we as a nation were able to make some modifications to a system, that we were able to go through procedures development. It had to tie together an enormous number of disparate pieces.

One of the things the Air Force and my good friend General Willy Shelton who is the Commander of 14th Air Force and the Joint Functional Component Command for Space, part of the issue here was not just simply whether or not you could intercept, but also what would be the consequences if that was successful or unsuccessful, and depending upon where the object might have ultimately come in. There were

consequences you might have to deal with.

So they had to plan through to be able to potentially deploy teams to be able to deal with hazardous materials and the like.

So I was very impressed that in a relatively short order we took a situation that I don't think anybody had ever conceived before. I've participated in lots of war games and nobody had ever come up with this one before. And to put together a very effective engagement that required a lot of different sensor systems, Navy platforms, deployable teams and the like. And we were prepared to deal with any number of eventualities, depending upon the success of the intercept.

So to me, I think everybody should be very proud, no matter whether you were for it, against it, or whatever else. This was really kind of an amazing achievement to be able to pull together and to take a disparate set of capabilities and to perform a very very professional operation.

Q: Remember she had asked if we were looking at hitting mobile targets, ballistic missiles, and you said no, we weren't really spending a lot of time on that. But in the new study on China, China's defenses, there seems to be a fair amount of emphasis placed on the Chinese use of ballistic missiles to target ships at sea. So are they ahead of us? Is it being overstated in the study? Or is there a disconnect there?

A: I will tell you that there are enormous number of different efforts ongoing, looking at different kind of weapon systems, whether they be standoff attack missiles or other kinds of gravity delivered systems, the rest of that, that are looking at different kinds of targets, whether they be mobile, moving targets, fixed targets, and the rest of that. All I was saying is that in our work to date it really has been focused on delivering an effective munition, whether that be against a point target, disbursed target, or the like.

That's not to say that in the future if somebody said gee, I really need to be able for that conventional strike missile to be able from 4,000 miles away to be able to engage a moving target, there are ways in which we could look at delivering a munition, if you will, over those ranges that could actually be able to track and engage a moving target. I'm just saying that right now that's not something that's in our trade space that we're looking at. We really are looking at it in terms of how do you deliver against fixed or moveable targets.

Q: Is it your impression, though, that the Chinese are putting more emphasis on it than we are?

A: I would not want to speculate on that at all. I don't know enough about what all we're doing and what they're doing.

Q: It's also true that the Chinese ASAT was mobile. Not mobile, it was relocatable.

A: It could be. It's of a size, that particular interceptor is of a size that it could be launched from any number of different places, so it is moveable. But I wouldn't necessarily call it mobile.

One of the key things that's really important on this is this idea of promptness. That is even in the best of cases it still takes time to set up a particular missile system, likewise to be able to launch it and then disassemble and move. That's what a key part of this promptness is, is to be able to upon determination that you need to strike a target, is that from decision to actual flash, that it's relatively short such as within the cycle of the adversary actually being able to do something. That's another key component.

Q: Minuteman III. Congress has asked you to look at keeping it to [inaudible].

A: Yes.

Q: Is the issue, as you explore that, is the issue whether the Minuteman bus itself can be kept that long? Or is the issue can you make improvements to the basic bus that's many decades old to meet the requirements for 2030?

A: The real issue is sustaining the basic weapon system. Not necessarily expanding its capabilities beyond where it is today. And the real issue there is, as I mentioned, we have actually done a comprehensive upgrade and modernization of key components such as the propulsion, the guidance system, and other elements. This represents upwards of $8 billion investment over the past decade that we've put into making this viable and modern.

But the thing is, Minuteman was originally deployed in the 1960s. I mean it's 40 years old right now. So looking forward another 20 or 30 years, there are additional modernization of ground equipment, mundane things such as handling equipment for the, some of these are old trucks and trailers and things like that. So we've got a very comprehensive program that looks at all elements of the system to include the booster systems, the guidance systems, the support equipment on the ground, maintenance equipment and the like, and to make sure that we're continuing to refresh that. So the only issue that we have at this point in time is that we have a good process for monitoring either aging or loss of reliability and taking corrective actions before that becomes a limitation on the weapon system.

So we will continue to make those investments. The only question we have at this point in time is what's going to be the ring of problems we encounter in 2020 to 2030. In many cases, you take a look at some of these systems, it's literally vacuum tube kind of technology that we're dealing with. So how much, going back and having to be able to rebuild, requalify, reengineer components that literally were produced four decades ago. That continues to be a challenge with us, but it's one that we think we're going to able to manage.

Q: I think we're out of time. For those that don't know, this is probably your last time through. General Hamel's retiring in May. So we're happy to have had you a couple of times here. It's been very useful.

A: Thank you for the opportunity. I've got great respect for what particularly this group does in terms of reporting on the defense issues and the rest of that. So thank you for affording me the opportunity.

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