NATO Space Operations Assessment

Revised January 2009

Joint Air Power Competence Centre

JAPCC

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The Joint Air Power Competence Centre (JAPCC)

NATO Space Operations Assessment

Revised January 2009

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30 January 2009

I am pleased to release a revised NATO Space Operations Assessment, comprising both NATO and National Space activities. This project was undertaken by the Joint Air Power Competence Centre (JAPCC) at the request of Allied Command Transformation (ACT). This Assessment paints a picture of where NATO Space Power is today, and provides recommendations for NATO to fully integrate Space into operations. This document outlines steps to better enable Transformation by addressing the need to develop NATO Space Power and better integrate Space capabilities.

This revision to the Assessment delivered to ACT in May of 2008, corrects minor administrative errors, and clarifies and expands several sections. The major updates include the recommendation to establish a Space Office at NATO HQ and new Annexes providing information on ISR satellites and the military applications of Space. Chapters 4, 5 and 6 are also significantly revised.

The opinions and recommendations expressed in this paper are the JAPCC's and are not approved positions by NATO or its member Nations. Any errors or omissions in this paper are the responsibility of the JAPCC. The JAPCC encourages comment and feedback or to make corrections. For further information, contact the JAPCC's Space Project Director, Air Commodore Jan van Hoof at vanhoof@japcc.de, or our Space Operations Subject Matter Expert, Major Tom Single at single@japcc.de.

Friedrich Wilhelm Ploeger
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NATO Space Operations Assessment
Executive Summary

Space is a part of our daily lives and today's modern society has become dependent upon the services provided by Space systems. They provide global situational awareness and are a critical enabler of civil and military operations. Space has become 'ordinary,' with 15 Nations now operating satellites. Historically, many space-based capabilities have been considered 'too sensitive' to discuss outside of National boundaries. The recent development of Space capabilities by many Nations and increasing security and defence challenges require a more proactive approach. Space has not been adequately addressed and there is an urgent need to take action on the challenges identified in this Assessment.

In performing its core missions, NATO's operations are entirely dependent on Space: possibly even non-functional without Space support. Services provided by Space systems are virtually transparent to end-users and are often taken for granted. Typically, personnel (civilian and military) have very little, if any, training and education on Space. Consequently, the full potential and advantages that Space capabilities have to offer has not yet been realised. Furthermore, in recent years, Space capabilities have become available to just about anyone. There are not adequate contingency plans for adversary use of Space or denial of our own Space capabilities. 'With the requirement to meet threats from wherever they may come, the Alliance will operate in a wider Strategic environment,'[1] and this Assessment shows there are pressing matters to address.

The fundamental question to be answered is 'what is the way ahead for Space in NATO?' This Assessment confirms the importance of Space to current operations and to transformational ambitions. The methodology consisted of document research, key stakeholder engagement and critical analysis of programmes, processes and policies. Valuable input was incorporated from 33 stakeholder organisations that participated in a Space Workshop hosted by the JAPCC in April 2008. This Assessment captures the large Space community of interest. Nineteen gaps were identified and 23 recommendations are provided on governance, force development, planning and integration, concept development and experimentation, and standards and interoperability.

An holistic approach to Space is needed. The current approach to Space is piecemeal, a bottom-up effort lacking overarching structure or direction. While this may have been adequate in the past, the complexities of modern security challenges demand a more deliberate approach to Space. Space systems have been recognized as a key enabler to act independently, prevent and resolve conflicts and crises, and are critical to supporting NATO. Nations are developing their own Space capabilities for defence and security with little input from NATO. If we do not determine what the Alliance's requirements for Space capabilities are, then the Nations will continue to duplicate efforts, field systems that are not interoperable, and retain stove-piped intelligence networks. It is the assertion of the JAPCC that Space Power is absolutely as essential to operations as Land, Maritime and Air Power and that Transformation requires the effective exploitation of and assured access to the Space Domain.

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[1] Bi-Strategic Command Strategic Vision: The Military Challenge, August 2004, p. 2. The NATO strategic vision identifies globalization as the first key factor and driver for change in the wider strategic environment.

The top priority is to establish a Space Office. Much needed governance must be established, to include a Space Policy and Military Space Strategy. Without these, our security and operations are at risk. We have not thought through all of our requirements for Space, fully integrated National capabilities, developed holistic plans, considered the consequences of no action, or prepared sufficient risk mitigation strategies. It is essential to assure access to the Space capabilities that our economies, decision makers and military forces have come to depend upon.

Space Situational Awareness (SpSA), the ability to detect, monitor and assess activities in Space, is a prerequisite for being able to assure access to the Space Domain. Deliberate planning, increased cooperation and focus are needed to provide much needed SpSA. Unfortunately, there are not sufficient tools or personnel in the current force structure to adequately address SpSA or other Space activities. There are only 5 Space operational planners established in the NATO Command Structure. A broader awareness of Space capabilities must be developed. This includes education and training on Space at both National and NATO courses and schools. Space activities must also be incorporated into exercises and wargames with high priority.

These issues are highlighted by International Security Assistance Force (ISAF) operations. Due to the limited exposure prior to deployment, Space is not as fully integrated or utilized as it could be. Unlike Air assets, most personnel are not aware of Space capabilities and therefore don't realise that Space capabilities exist that may be able to provide support. Space capabilities must be as fully integrated and used as Air capabilities. There is a tremendous amount of existing Space capability, but we must better connect them with our customers in the field. To assist in this effort, a NATO Space Operations Coordination Centre (NSpOCC) should be established to better support our forces and to effectively conduct Combined Space Operations (CSO).

In summary, NATO is challenged to provide the governance, force structure and expertise to better make use of all available Space capabilities. History shows that humans have fought for dominance over every medium which contributes to commerce. Space may well prove to be no different. As such, it is increasingly important to protect and assure access to Space capabilities. We cannot afford to make critical mistakes and fail to deliver the required capabilities and effects to our Soldiers, Sailors and Airmen.

Chapter 1 – Introduction

The 20th Century proved that you must have control of the Air.
The 21st Century will prove that you must have control in Space.

Col Daniel Lewandowski, JAPCC, 2008

1.1. The impact of Space systems in today's society cannot be underestimated. We have become dependent on the capabilities and information delivered to, from and through Space. Space has the advantages of persistence, perspective, penetration, and it provides reachback capability. As such, Space systems provide critical information in a timely manner. They have become part of our everyday life and our society has become reliant upon them. Satellites enable a level of global situational awareness that couldn't have been imagined just a few short years ago. While NATO has some access to military systems, its forces rely heavily on civilian Space capabilities to support National security and defence activities.

1.2. Today's Society Depends on Space. Space systems are integrated into our daily lives as shown in Figure 1. Navigation and timing Space systems enable financial transactions, precision farming, and precise package tracking. Weather satellites provide data and images critical to shipping, agriculture and air travel. Space systems enable food management for our growing world population, and can monitor air quality and urban planning. Telecommunications satellites make possible tele-medicine, provide our television, internet and communications needs virtually anywhere in the world. The Space industrial base is a significant factor. World institutional Space expenditures are estimated to have been about United States Dollars (USD) 251 billion for the year 2007.[2] This does not include related private Space, sciensce and technology expenditures.

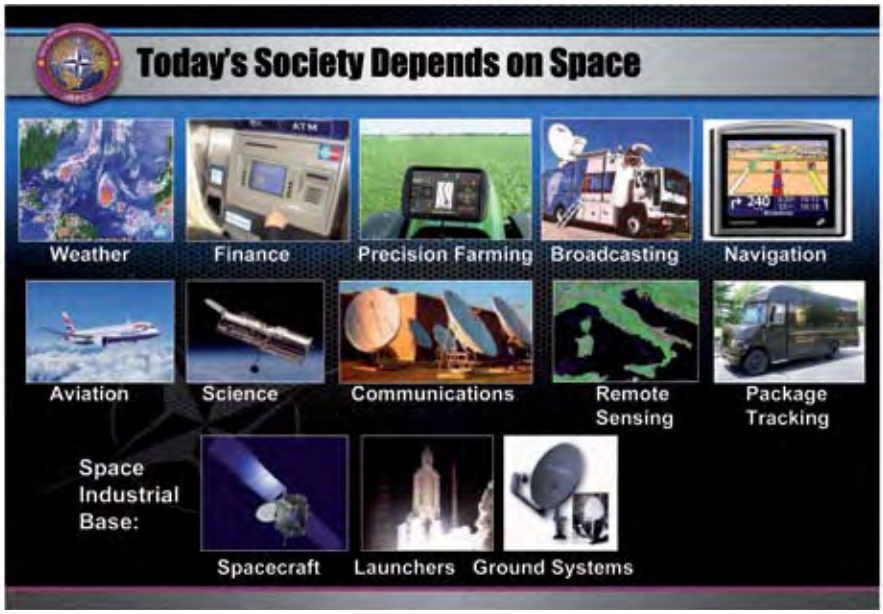


Figure 1 Society Depends on Space

[2] Source: The Space Report 2008, The Space Foundation.

1.3. Space Enables Global Situational Awareness. Figure 2 shows examples of how satellites can be used for remote sensing to provide information on treaty violations and verification, monitoring situations related to disasters, pollution, resource availability, civil unrest, refugee migration and population/urban growth. Environmental problems can be monitored and solved using space-based applications. Satellites help us to understand climate change, extreme weather events, and ecosystem changes. Measurements and observations from Space can help marine and forest management, as well as help enforce environmental regulations. Scientific study of the impact of Space on the Earth's environment is crucial to solving current and future environmental impacts. Satellite imagery can also be used to aid decisions in humanitarian disasters, as was demonstrated during the United States response to Hurricane Katrina in New Orleans and in picking suitable food drop locations to speed relief to refugee camps in Darfur, Africa.

Figure 2 Space Enables Global Situational Awareness

1.4. Space Enhances National Security. Space-based observation allows decision makers to manage risk and enhance our national security. Satellites provide global coverage for missile warning and tracking. Telecommunications and remote sensing satellites enhance border security, port security and security at high value events such as the G-8 Summit and the Olympics. Space capabilities assist air and road traffic management and emergency response teams for natural disasters or hazardous materials accidents. Satellite imagery helps track and interdict illegal activities and conduct counter-drug operations. Space improves efforts to prepare for, respond to, recover from, and prevent threats as summarized in Figure 3.

Figure 3 Space Enhances National Security

1.5. Security and Military Operations are Dependent on Space. Today's warfighters rely on Space capabilities for Command and Control (C2), communications, situational awareness, and Intelligence, Surveillance and Reconnaissance (ISR). Because of meteorological satellites, forces no longer have to wonder how weather will impact future operations. The Global Positioning System (GPS) provides precise Position, Navigation and Timing (PNT) information to expeditionary and mobile forces. Additionally, Defense Support Program (DSP) satellites provide missile warning and tracking information. Space systems enable Friendly Force Tracking (FFT) for Shared Situational Awareness (SSA), enable precision engagement of Time Sensitive Targets (TST), and shorten the Joint Air Tasking Cycle. Figure 4 shows how Space can support today's military operations where forces are expected to have the flexibility to conduct direct action, reconstruction and stabilization activities.

Figure 4 Space Supports Military Operations

1.6. The persistence (always on orbit), perspective (high altitude), penetration (no over-flight restrictions), and reachback (provides combat support without being physically located with forward forces) of Space systems provide forces with beyond line of sight secure communications. With this capability, they can visualize the battlefield and conduct intelligence preparation of the battlespace, conduct precise manoeuvring and targeting, have real-time weather and near real-time imagery. Space is a critical enabler for all military forces. Forces can also utilize Space capabilities for security and stabilization operations, to assist indigenous forces, for medical and humanitarian operations and for reconstruction efforts. As NATO transforms and becomes Expeditionary using an Effects Based Approach to Operations (EBAO), and as the Alliance develops the NATO Network Enabled Capability (NNEC), Space must be fully integrated in order to maximize its potential capabilities and best provide support to our warfighters.

Background

1.7. The European Union (EU), European Space Agency (ESA), and NATO Nations are pursuing their Space interests and are acquiring many different capabilities. Nations have varying Space ISR and communications systems, as well as Air, Land and Maritime systems that are, in most cases, neither Joint nor interoperable networks. Further, Nations are developing national defence networks that are either not connected, or only partly connected to the NATO network along with a broad range of national ISR programmes. NATO is actively managing SATCOM, theatre missile defence, and other mission areas, but without addressing all Space operations mission areas. Providing oversight to all Space mission areas is extremely challenging because Space capabilities are inherently interdisciplinary and touch almost all other mission areas. This complexity has contributed to a lack of oversight, direction and management of Space Power in NATO.

1.8. Implementing the recommendations provided in this Assessment to develop space-related governance may raise concerns about legal considerations. The 'Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies' (known simply as the Outer Space Treaty) dated 27 Jan 1967[3] is the most important pillar of Space law. According to this treaty, Space is for peaceful purposes in the interest of and for the benefit of all nations. The military use of Space is addressed in Articles III and IV of the Outer Space Treaty. Article III states that Space activities are to be carried out in accordance with international law, and in accordance with the Charter of the United Nations. This confirms the prohibition of the use of force and the right of national (individual or collective) self-defence with regard to Space. Article IV prohibits the stationing of nuclear weapons and weapons of mass destruction in Space and on other celestial bodies. The Outer Space Treaty does not, however, prohibit military use of Space. The use of satellites for military reconnaissance and communication purposes, the defensive use of conventional weapons, the transit flight of ballistic missiles and the stationing of anti-satellite (ASAT) weapons are not expressly prohibited. Besides the Outer Space Treaty of 1967, there are four additional Space treaties based on the Outer Space Treaty: 1) the Space Rescue Agreement (1968), 2) the Space Liability Convention (1972), 3) the Space Registration Convention (1979) and 4) the Moon Agreement (1979). NATO's proposed role in Space based on this Assessment would not be inconsistent with or in violation of any existing treaties, agreements or policies.

[3] The Outer Space Treaty has 98 state parties to the treaty, and is the basic international agreement of space law.

In Europe, in particular, there is a distinct lack of policy on military Space activities. It would benefit the international Space community if there were policy and guidance from the Alliance on its position on the use of Space for security and defence.

1.9. Within the EU, ESA, NATO, and the member Nations, there are modifications to the use of existing Space capabilities and systems as well as an eagerness to acquire new capabilities such as small satellites, missile defence and ISR. Many organizations and agencies, both military and civilian, are involved with capability improvement, from concept to operation, which makes stakeholder management a complex challenge. There is an urgent requirement to address Command, Control, Communications, Computers and ISR (C4ISR), of which Space is a critical enabler. Without comprehensive strategic direction for Space operations, it will be difficult to enhance joint operations. For example, the NATO Defence Requirements Review (DRR) lacks coherence of robust Joint Space requirements; however, there has been positive progress in certain areas such as Joint ISR (JISR), SATCOM and NNEC.

1.10. Recognizing the need to assess the current state of Space operations in NATO, to determine gaps and to better utilize Space Power, Allied Command Transformation (ACT) tasked the JAPCC to provide a NATO Space Operations Assessment.

Aim

1.11. This Assessment aims to inform and influence warfighters, commanders, and policy makers in ACT and other NATO staffs by providing a description and common understanding of NATO Space operations today. Therefore, the focus is placed on Space related issues at the strategic and operational level, which we consider valid for developing a holistic approach to Space operations. Next, the NATO Space Operations Assessment aims to target the current and future programmes by identifying the gaps between the current capabilities and future capability requirements.

1.12. **The fundamental question to be answered is 'How should NATO proceed in Space operations?'** This paper provides a starting point for NATO to get on track for Space operations. Measurable objectives resulting from this paper include: the establishment of Space governance in NATO through a Space Policy and an over-arching Space Strategy, the establishment of new Space personnel postings and the integration of Space operations into exercises and operations. All of these are designed to help provide more capability for our forces and improve support for NATO operations.

Vision for Space Operations

1.13. In the widest sense, NATO Space operations enables military and political leaders, through interconnectedness and global awareness, to accomplish their missions. NATO Space operations contribute to a fully interoperable and interdependent network-enabled Joint and Combined expeditionary military capability that enables decision superiority in order to achieve desired effects.

1.14. The JAPCC envisions that this NATO Space Operations Assessment will be championed by ACT and Allied Command Operations (ACO) and that the need to address NATO Space operations will be presented to the Military and Political Committees, and to the Nations, with the aim to implement the recommendations outlined in this paper.

Scope

1.15. As requested by ACT, the JAPCC determined where there are gaps in NATO Space operations and provided recommendations on closing the gaps. The paper investigates Space operations today and future trends, identifies capability gaps and provides short and long term solutions for NATO Space operations, to better enable operational outcomes guided by EBAO. This will include interoperability and integration of Space into Joint operations.

1.16. The paper begins with the imperative for transformation and explains why NATO must begin the process of thinking about Space today and act on the recommended courses of action. A short synopsis of Space activities is provided in Chapter 2. Chapter 3 provides a strategic overview of current Space activities in NATO, followed by a chapter describing emerging areas for NATO involvement in Space. Gaps and recommendations are provided in Chapter 5 with conclusions drawn in Chapter 6. Supporting information is provided in various annexes.

Methodology

1.17. This Assessment consisted of document research, key stakeholder engagement and critical analysis of programmes, processes and policies. Essentially, our work captures the large Space community of interest engaged with Joint Space Power. This Assessment was heavily influenced by the experience of the United States military Space operations as they have the vast majority of Space capability, military Space personnel and mature policies, doctrine and processes. Research was also conducted to determine European and other national Space activities and policies.

1.18. The NATO Space Operations Assessment is written from a strategic perspective. Space operations cannot be viewed in the isolation of a single environment. Attempts were made to keep the paper at the strategic level, but in some cases, operational level examples are used to illustrate points or for clarification. Furthermore, we acknowledge that military action is but one pillar in the broader Comprehensive Approach; however, this Assessment is focused on military Space concerns.

1.19. The assumption was made that there would be a willingness to share information on the part of participating institutions toward a common goal to benefit NATO. Due to the aggressive schedule of the Assessment, a robust and in-depth investigation of all agencies or mission areas was not feasible. The JAPCC developed a letter with 25 questions on Space operations for Headquarters International Security Assistance Force (HQ ISAF). The answers from HQ ISAF were used to make broader recommendations for NATO expeditionary forces. Additionally, the JAPCC conducted a 'NATO Space Workshop' in Kalkar, Germany on 22 April 2008, to allow NATO staff officers and representatives from member Nations to discuss the draft Assessment and the recommendations prior to submission to ACT. Feedback, ideas and comments were incorporated into this Assessment.

Imperative for Transformation – Why NATO Must Address Space Today

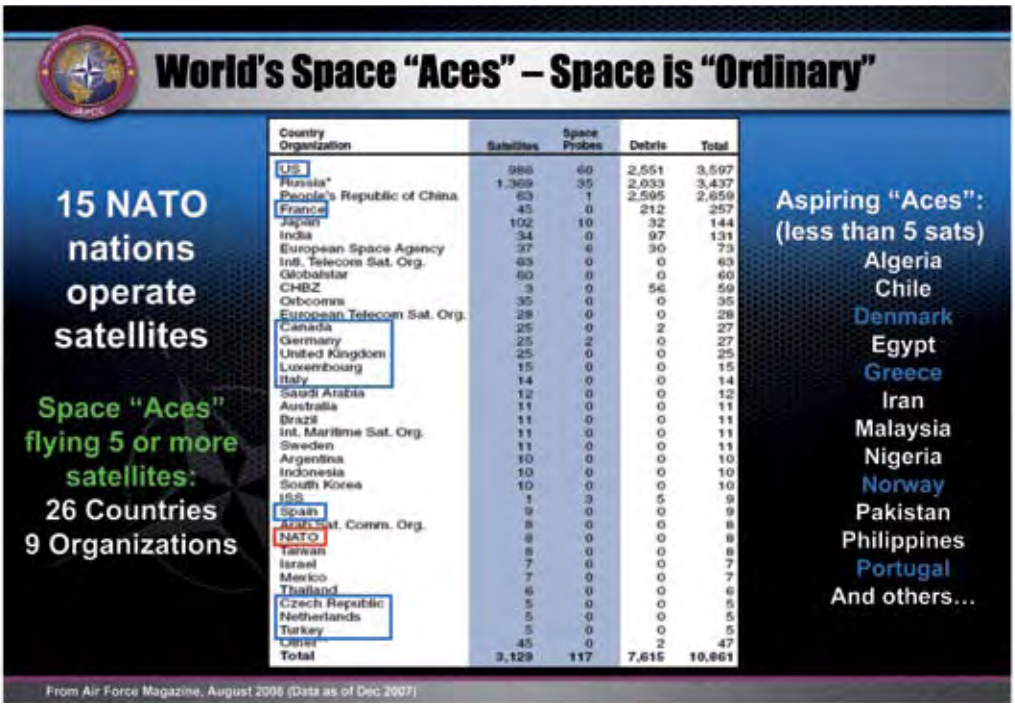
1.20. The question will inevitably be asked: Why does NATO need to talk about Space now? We already have SATCOM, ISR, GPS and weather data, isn't that all we need? NATO doesn't have a Space Policy, why do we need one now? It was stated

several times during the JAPCC research that NATO doesn't need Space expertise, the Nations will provide it if necessary. However, the more important question to ask is what are the consequences and risks of NOT addressing Space operations in NATO? Space is a capability that contributes to effective C2 and intelligence, and precise engagement; all essential operational capabilities for NATO. **Without NATO Space Policy and direction, those essential operational capabilities are at risk because we simply have not thought through the Alliance's Space needs, developed any strategy, considered the consequences of no action, or prepared any risk mitigation strategies. In effect, NATO is operating with unnecessary risk.**

1.21. Transformation. The world has changed since 2001. For the first time, NATO invoked Article V in response to the terrorist attacks on the United States; NATO reorganized itself, issued new Comprehensive Political Guidance and is developing expeditionary military forces. NATO currently has forces in harm's way in Afghanistan (ISAF), Kosovo (KFOR),[4] the Mediterranean (Operation Active Endeavour), and until recently Africa with the Darfur Operation. Additionally, the NATO Response Force (NRF) is on call to react to any security and defence need almost anywhere in the world. It is postulated in this paper that **Space Power is essential in all expeditionary operations.**

1.22. Integration. Today's modern military force has an increasing dependence on the integration of Space systems for coalition and expeditionary operations. Space capabilities and effects are critical contributions to transformation to an expeditionary, network-enabled Joint force. Forces must take full advantage of available Space capabilities to function, often without even knowing they are. This requires planning, integration and interoperability. Space systems are expensive, take a long time to develop and require technical expertise. Additionally, one of the hardest challenges is managing the information and data derived from Space systems and creating the processes to plan and integrate Space capabilities. In particular, communications and information systems must have common standards and be interoperable. In order to be effective, ISR information derived from Space systems must be managed, shared and exploited in order to support the warfighter and decision makers. **Furthermore, member Nations are developing their own Space capabilities for national defence and security needs with little input on military Space operations requirements from NATO. If NATO does not determine what its requirements for Space are, then Nations will continue to duplicate efforts, field systems that are not interoperable, and retain stove-piped intelligence networks.** With cooperation and planning, NATO can get more capability for the few precious resources that the Nations devote to Space systems.

1.23. Dependence. NATO and national forces and the Nations have become dependent on Space systems for all aspects of power application: economics, politics, information and military. A holistic approach must be taken by NATO to address Space operations, because it has become so vital to our everyday lives. Moreover, most of the Space capabilities that NATO has come to rely on are now available to our adversaries. The fundamental tenet of this paper is that Space Power is essential to mission success.



Country Organization	Satellites	Space Probes	Debris	Total
US	986	60	2,551	3,597
Russia*	1,369	35	2,033	3,437
People's Republic of China	63	1	2,595	2,659
France	45	0	212	257
Japan	102	10	32	144
India	34	0	97	131
European Space Agency	37	6	30	73
Intl. Telecom Sat. Org.	63	0	0	63
Globalstar	60	0	0	60
CHBZ	3	0	56	59
Orbcomm	35	0	0	35
European Telecom Sat. Org.	28	0	0	28
Canada	25	0	2	27
Germany	25	2	0	27
United Kingdom	25	0	0	25
Luxembourg	15	0	0	15
Italy	14	0	0	14
Saudi Arabia	12	0	0	12
Australia	11	0	0	11
Brazil	11	0	0	11
Int. Maritime Sat. Org.	11	0	0	11
Sweden	11	0	0	11
Argentina	10	0	0	10
Indonesia	10	0	0	10
South Korea	10	0	0	10
ISS	1	3	5	9
Spain	9	0	0	9
Arab Sat. Comm. Org.	8	0	0	8
NATO	8	0	0	8
Taiwan	8	0	0	8
Israel	7	0	0	7
Mexico	7	0	0	7
Thailand	6	0	0	6
Czech Republic	5	0	0	5
Netherlands	5	0	0	5
Turkey	5	0	0	5
Other	45	0	2	47
Total	3,129	117	7,615	10,861

Figure 5 Nations Operating Satellites

1.24. Space is 'Ordinary'. Space operations are not new. Space is another environment and must be addressed. As shown in Figure 5, more than 26 nations and 9 organizations operate more than five satellites each,[4] making them 'Space Aces.' NATO has 11 'Space Aces' and 4 Nations that operate less than 5 satellites. NATO Nations are 'players' in the global Space community. ALL of the NATO Nations are users of Space. While generally considered strategic in nature and vital to a nation's prestige and security, Space systems have become commonplace and the secrecy once associated with Space should no longer exist. Commercial Space systems provide, at a reasonable cost, a capability that until recently was classified and only available to the most advanced nations. It has become quite 'ordinary' to use and operate Space systems.

1.25. Threats. As we have become more dependent on Space systems, vulnerabilities and risks have been created. There are real and credible threats to Space systems. The ground systems are vulnerable to attack. There has been demonstrated use of GPS and SATCOM jammers. Anti-satellite (ASAT) weapons have been demonstrated by the Soviet Union, the United States, and in January of 2007, China demonstrated its capability by destroying one of its aging weather satellites at an altitude of more than 500 miles. The potential exists for ground-based laser weapons, electro-magnetic pulse, and co-orbital ASAT weapons. Additionally, there are risks of collision from Space debris and impacts from solar events. There have been many instances of satellite telecommunications interference and piracy. The technology is relatively inexpensive and readily available for pirates to disrupt a commercial satellite and hold it for ransom. Space terrorism and piracy, shown in Figure 6, is a very real threat and NATO has not yet addressed this critical threat.

[4] Air Force Magazine, August 2008.

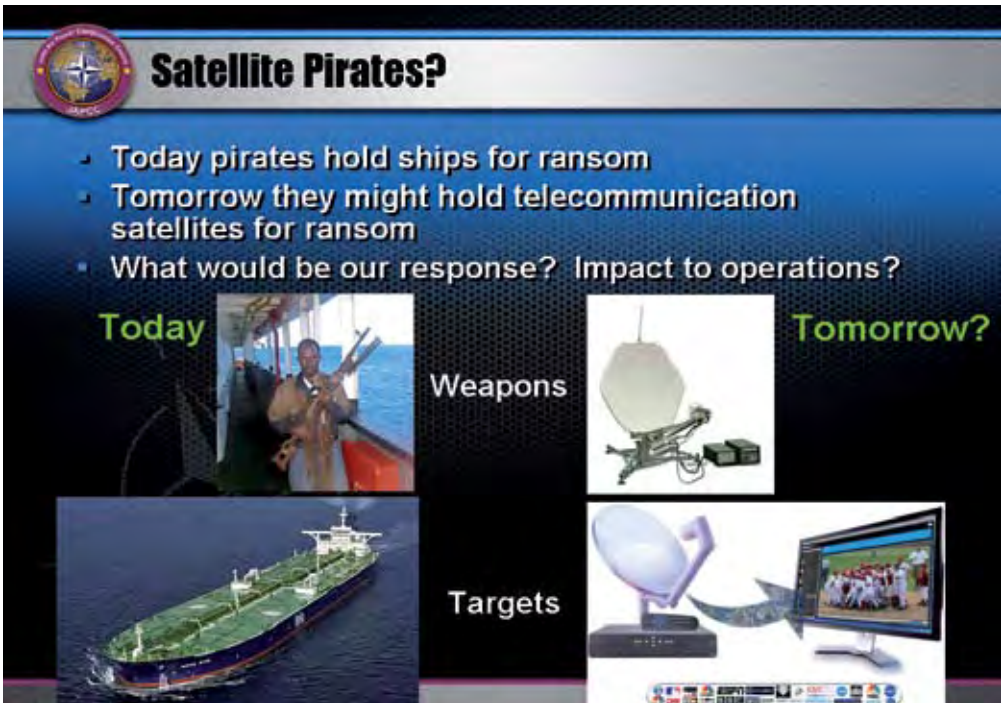


Figure 6 Pirate Threat to Space Systems

1.26. Adversary Use of Space. The rapid advancement of commercial satellite technology in the last several years has made space-based services available to NATO's adversaries. Third-world nations, non-governmental organizations and even terrorists have access to the benefits of Space. Services such as satellite phones and GPS are inexpensive and allow communication, navigation and tracking anywhere in the world. High resolution imagery may be purchased over the internet. Even offensive weapons such as satellite telecommunications and GPS jammers are becoming commonplace and easily accessible. Furthermore, many nations are developing their own Space capabilities for security and defence. It is vital that NATO move decisively to address Space in order to counter this new use of Space by its adversaries.

1.27. Risk of Becoming Marginalized. Since NATO has not yet addressed Space operations from a holistic view of the mission area, NATO risks becoming marginalized over time. Member Nations continue to develop Space capability. They are modernizing their forces, changing their organizational structures, and developing Space policy and guidance. Without the right Alliance leadership, there is an increased risk of divergent governance regarding Space programmes. Coalition operations will see increased risks and vulnerabilities. The EU, civil Space agencies and member Nations are moving forward on Space, but NATO has not. NATO has not provided leadership in addressing military needs for Space capabilities; consequently, the EU and ESA have begun to address security and defence applications of Space. Other organizations and nations are rapidly leaving NATO by the wayside. **There is an urgent need for NATO to state the intended Alliance use of Space capabilities and to provide input to the development of the next generation of Space capabilities.**

1.28. Satellite Trends. There are trends that also increase the consequences of not addressing Space operations. There are a limited number of slots available in the geosynchronous orbit, used primarily for telecommunications and some

intelligence satellites. Most of the important slots have been taken and nations and consortiums must protect their very valuable location. Furthermore, the crowded electro-magnetic spectrum, increased interference, limited frequencies and the growing demand for bandwidth place further demands on SATCOM. Consequently, the size of those satellites is getting larger in order to maximize the benefit of the location. On the other hand, technology for miniaturization and reduction in cost allow smaller satellites to be built for launch into low earth orbit with increasingly capable payloads. These two trends are driving changes. First, geosynchronous systems are increasingly important to the global economy and industry; nations are working on ways to protect and assure the services they provide. Secondly, affordable smaller satellites are becoming viable; subsequently, more nations, agencies and industry partners are becoming involved in Space. Space capabilities are vital for both civil and military applications and there are often conflicting interests. Consequently, for NATO, there is a need to address international cooperation, standards, interoperability, transparency and situational awareness in Space. Global Space trends are further discussed in Chapter 2.

1.29. Combined Operations. There are many NATO Nations in Space and this number will continue to grow. NATO is conducting combined land, sea and air operations; the next progression is Space. Currently in ISAF, the forces of Australia, Canada, France, Germany, South Korea, Japan, the Netherlands, the United Kingdom, and the United States are conducting combined air operations.[5] All of them also operate satellites (civilian and/or military). As Nations have become well versed in conducting combined air operations, they should also now address how to conduct Combined Space Operations (CSO). Space is a critical enabler of expeditionary operations and out of area operations. NATO forces must have assured access to Space capabilities. As Nations develop Space capability for security and defence, NATO must determine how to integrate and utilize that capability. How can NATO take advantage of the new Space capabilities developed by France, Germany, Italy, the United Kingdom and others? As Space systems become more affordable, NATO Nations such as Spain, Turkey and others will have Space capability. NATO is conducting combined land, sea and air operations. It is time to address how to conduct combined Space operations.[6]

1.30. In summary, there are consequences and risks if NATO does not begin to address Space operations. There are many reasons why NATO must address Space today. Historically, Space systems have been politically sensitive and considered a national strategic asset, but times are changing. Space is not the mystery it once was and is affordable to many NATO Nations. Space capabilities are greatly needed by today's modern forces and they are increasingly becoming reliant upon the services provided by Space capabilities. This reliance on Space creates potential vulnerabilities that our adversaries could exploit. As such, it is important to understand how the Space community is changing so that NATO can address these important issues.

[5] Nations identified in various USAF air power summaries available on www.af.mil.

[6] United Kingdom and Germany have identified the need for an organization to provide a consolidated Space picture for situational awareness. This will better enable the opportunity for combined Space operations in the future.

Chapter 2 –
Space Activities: Industry, Policy, Security and Defence

Today the kind and quality of systems which a nation develops can decide the battle in advance and make the final conflict a mere formality-or can bypass conflict altogether.

General Bernard Schriever

Global Trends

2.1. Space has become an integral part of our security and defence operations; however, that was not always the case. Space capabilities were developed during the Cold War and were limited to only a very few nations that had the technology, resources and political will to develop them. Space systems have always been considered a strategic asset and therefore were developed under a veil of secrecy, primarily to be used by the intelligence community. There were not many threats to the systems, other than the Space environment itself. Figure 7 shows how Space operations have changed in recent years. Today, we have been able to push the limits of technology and deliver space-based effects to the individual soldier, sailor and airman. As more and more nations and commercial companies have become involved in the Space community, it is much more complex, contested and crowded. Furthermore, the type of operations being conducted by our forces demand that we move from a 'must protect' mindset to one of 'must share' to better enable precision engagement and decision superiority.

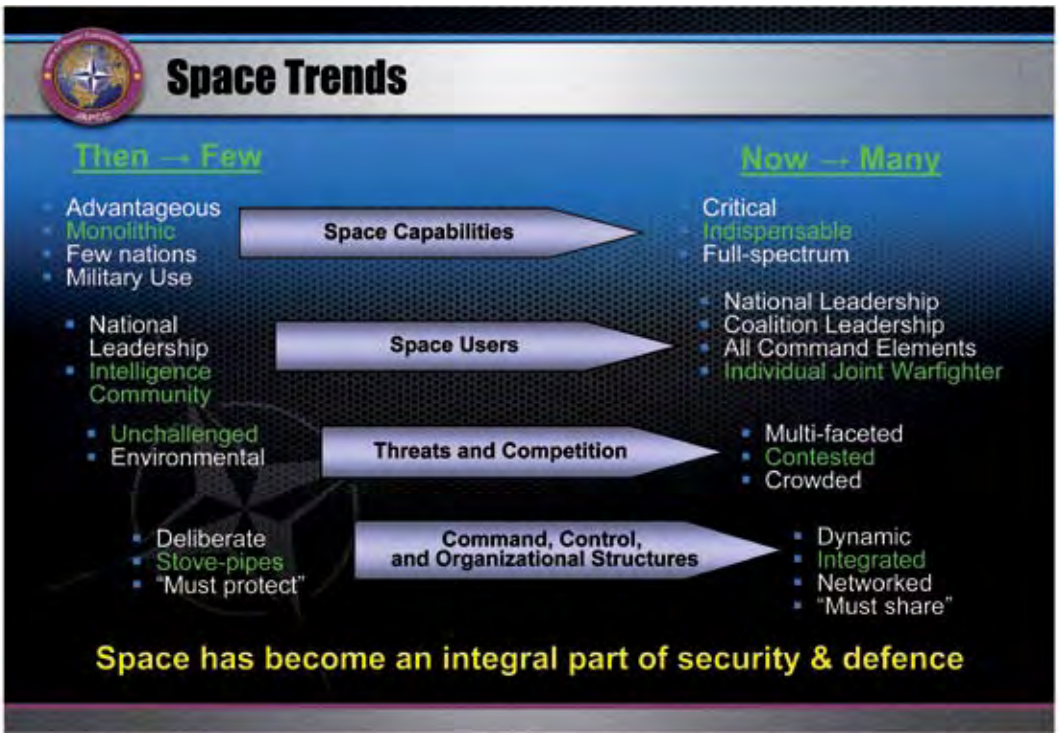


Figure 7 Space Operations Trends

2.2. There are several trends that will impact the need for civil and commercial use of Space systems. Global climate change is increasingly seen as a major economic and security issue. Catastrophic climate events could displace millions of people due to floods, water shortages, drought or severe storms. Energy costs and sources

will continue to be at the top of the agenda for many nations. Pollution and resource monitoring will also continue to be major issues. Earth observation from satellites can greatly contribute to monitoring and predicting events around the world. Governments and industry increasingly rely on information provided by Space systems for decision making on the economy, security and defence. Many nations in Europe, along with the United States, Russia, China, Japan, India, Canada, and others are increasing their efforts on developing Space capability and are continuing to spend more money on Space systems.

2.3. 'Space Security 2008,' an annual report published by SpaceSecurity.org, provides a snapshot of the developments for 2007 and trends for the future.[7] The report states that there is a growing threat to spacecraft from debris as the rate of debris creation increases. This is driving a trend for increased awareness of Space debris threats and continued efforts to develop guidelines for debris mitigation. Increased Space surveillance capabilities will be required to support collision avoidance. Additionally, there is growth in the number of actors gaining access to Space, and priorities and funding levels for civil Space programs are changing as dual-use (civil and military) applications are being developed. The trend is also for the continued increase in cooperation between civil Space programs as the industry seeks to expand applications and accessibility. The trend has been, and probably will continue, for overall growth in the global Space industry.

Global Space Sector

2.4. In order to understand the impact of Space to NATO and the member Nations, it is important to understand the economics: How much is being spent and by whom? The Space Foundation estimates 2007 global Space activities at USD 251 billion, see Figure 8.[8] The market is dominated by commercial industry; however, the United States Government accounts for nearly a quarter of the money spent in the Space industry. Due to different rules and regulations of reporting for each nation, global institutional Space budgets and Space revenues are difficult to estimate.

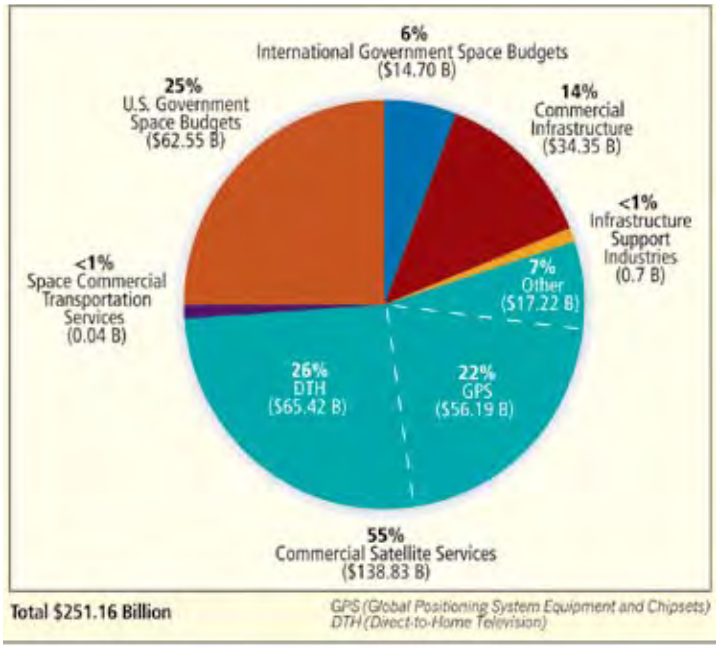


Figure 8 Global Space Activity for 2007

[7] 'Space Security 2008 Executive Summary'. The Space Security Index is the only annual, comprehensive, and integrated assessment of Space security. It provides background information and in-depth analysis on the key Space security trends and developments of eight indicators of Space security. The Space Security Index is informed by the views of over 130 Space experts from 17 countries in the civil, commercial, and military Space sectors. It can be accessed at www.spacesecurity.org.

[8] The Space Report 2008. The Space Foundation was founded March 21, 1983, as a non-profit organization 'to foster, develop and promote, among the citizens of the United States of America and among other people of the world ... a greater understanding and awareness ... of the practical and theoretical utilization of Space ... for the benefit of civilization and the fostering of peaceful and prosperous world.' The report can be accessed at www.spacefoundation.org.

For comparison, it is estimated by the European Space Policy Institute (ESPI) to be about USD 177 billion in 2006.[9] Due to the level of detail and focus on European Space activities, it is useful to highlight here the results of the ESPI study. The total Space industry revenues are estimated to be USD 112 billion, with the majority of the revenue generated by satellite services. Civil and military institutional budgets accounted for the remaining USD 65 billion in 2006. Military and intelligence applications are the majority of the public allocations to global Space activities, with an estimated 56% of the total. The remainder is allocated to civil Space programmes. While the overall total of spending on Space programmes is increasing, the difference of investment by countries varies greatly, with the overwhelming amount being invested by the United States. ESPI estimates that the United States public Space budget is approximately USD 53 billion, while Europe invests around USD 7.6 billion and Japan about USD 1.5 billion.[10] Figure 9 illustrates the estimated spending of the major Space powers.

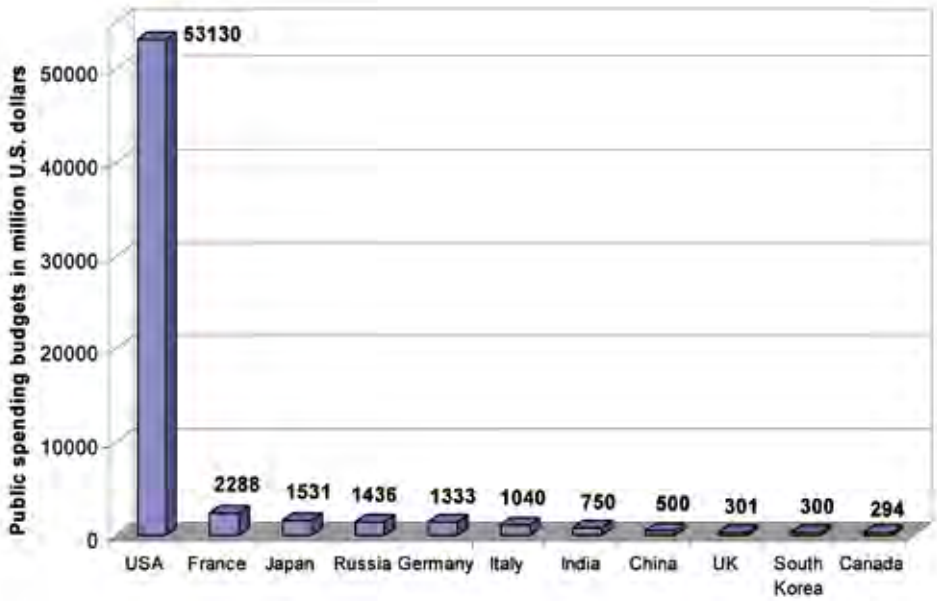


Figure 9 Estimation of the Public Space Budgets in 2006 of the Major Space Powers[11]

Another comparison that shows the disparity in Space investments is the Space budgets as a percentage of Gross Domestic Product (GDP). As expected, the United States invests the greatest percentage with approximately 0,433%. The next two closest nations, but still far behind the United States are France and Russia, with around 0,125% and 0,081% respectively. Figure 10 illustrates the Space budgets as a percentage of GDP for 2006. It can be seen that many of the NATO Nations have a Space budget, and if you discount the United States, which spends 10 times as much on average, the rest of the NATO member Nations allocate no more than 0,125% of their GDP, a very small percentage of their total budgets.

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[9] Source: ESPI Report 6, September 2007. All rights reserved. The mission of the European Space Policy Institute (ESPI) is to provide decision-makers with an independent view and analysis on mid- to long-term issues relevant to the use of Space. Through its activities, ESPI contributes to facilitate the decision-making process, increases awareness on Space technologies and applications with the user communities, opinion leaders and the public at large, and supports students and researchers in their Space-related work. The report was accessed at: www.espi.or.at.

[10] Ibid.

[11] Ibid.

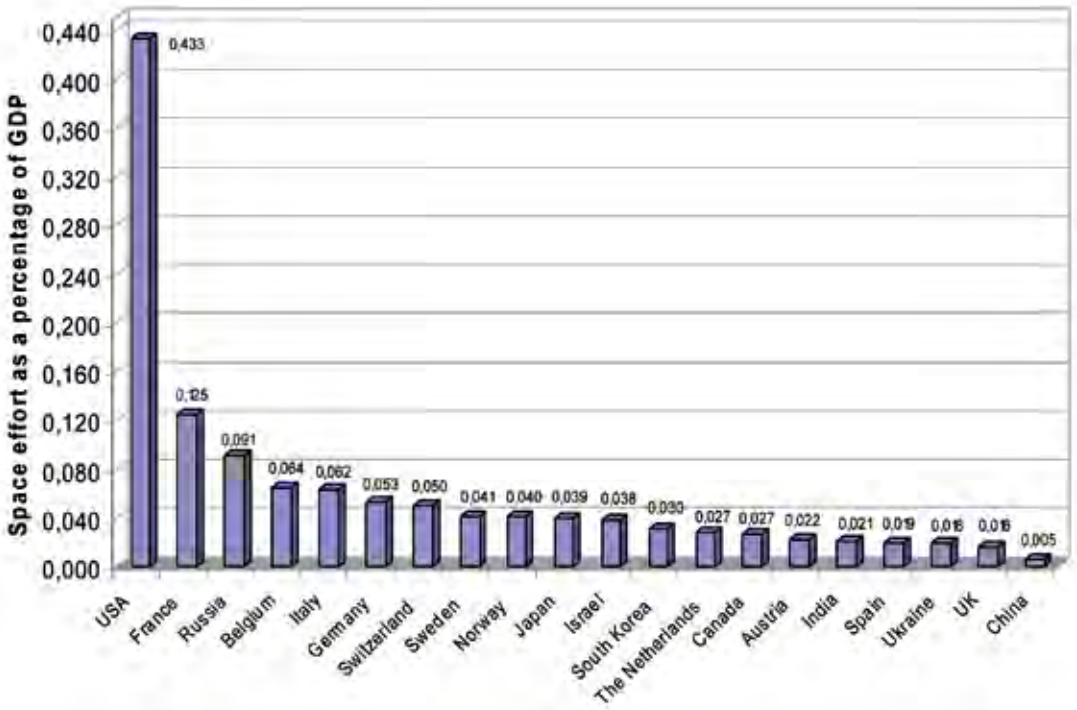

Figure 10 Estimation of the Major 20 Public Space Budgets as a % of GDP in 2006[12]

2.5. While small when compared to the United States, European public Space spending is the second largest in the world, comprising about 10% of all public investment in Space. Approximately 87% of the institutional Space budgets are dedicated to civil applications, with only a small percentage for defence programmes.[13] European spending and allocation on Space is shown in Figure 11. Most of the money is allocated to the ESA, followed by national programmes, the European Meteorological Satellite Organization (EUMETSAT) and the EU. Most European nations allocate the majority of their Space funding to the ESA with only France, Germany, Italy and the United Kingdom having wide ranging national activities and domestic programmes. **There is national and EU interest in Space activities and because there are security and defence applications of Space activities, the Alliance should also have a keen interest.**

2.6. Figure 12 and Figure 13 show the European allocation and budgets for 2005. France by far has the largest national Space budget, followed by Italy and Germany, with the United Kingdom a distant fourth. France spent more than 140 million Euros in 2006 on just security and defence programmes, or about 72% of the total European expenditure on Space security related programmes. What is not shown is that the EU, in its Framework Programme covering 2007 to 2013, has allocated 1.43 billion Euros over 7 years for Space, 85% of which is for the Global Monitoring for Environment and Security (GMES) programme. European countries have identified Space assets as a priority and are increasingly allocating funding. However, while Europe has some collective security programmes, most member states are left to their own resources with limited bi-national or multi-national cooperation programmes.

[12] Ibid.
[13] Ibid.

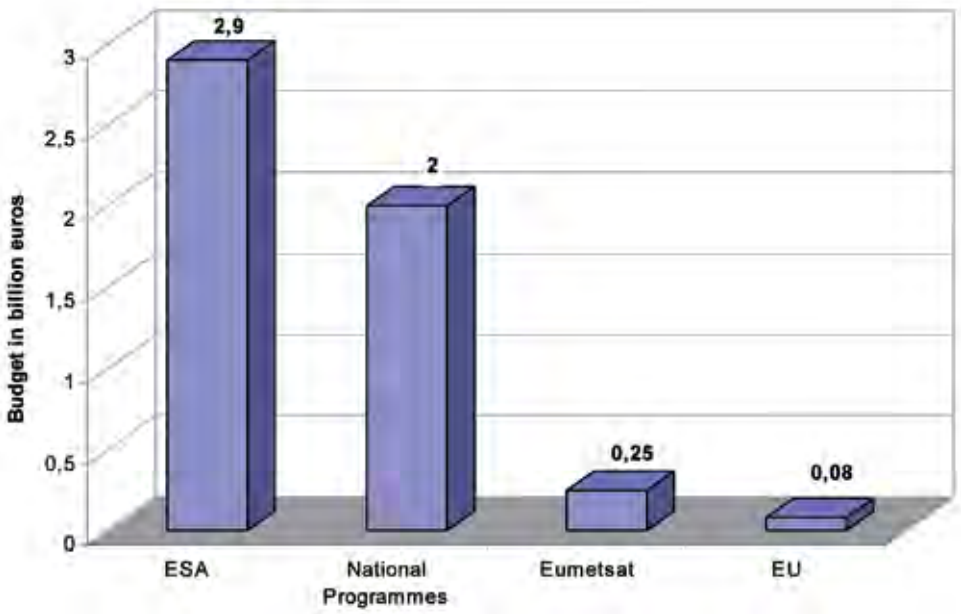

Figure 11 Estimated European Civil Public Expenditure in 2006[14]

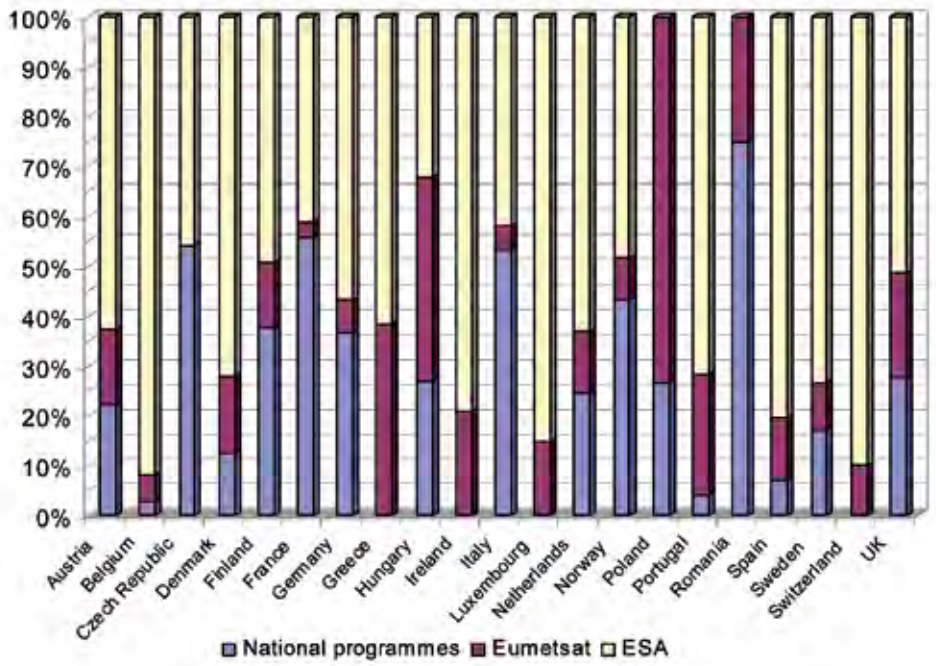

Figure 12 Estimated Shares of National Institutional Investments in Space in 2005[15]

[14] Ibid.
[15] Ibid.

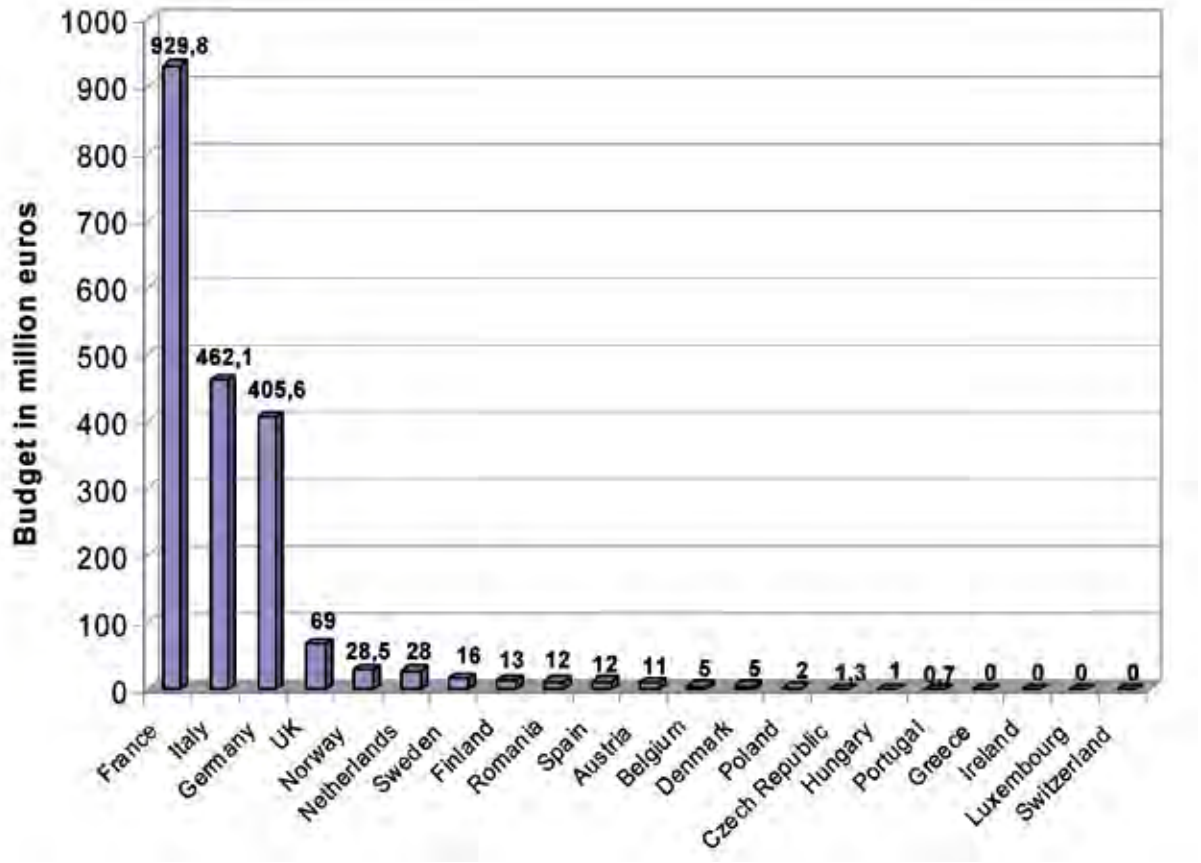

Figure 13 Estimate of the National Space Budgets in 2005[16]

2.7. The Space market is quite large and there are many individual sectors. It is interesting to note where revenue is being generated; it's not in building and launching satellites. In Report 6 from ESPI, it is estimated that of the USD 111 billion commercial Space market, satellite-based products and services are the biggest portion of commercial global revenues. In particular, digital broadcast services, fixed satellite services, ground stations and equipment make up around USD 89 billion with satellite manufacturing, the launch industry, GPS equipment, insurance and tourism comprising the remaining USD 22 billion. The most significant sector of the industry is satellite services, which represents 59% of the total Space revenues. Digital broadcast services are primarily Direct To Home (DTH) television and satellite radio services. Fixed satellite services provide telephone, data, video transponder leasing and remote sensing. Intelsat is the largest commercial operator with more than 50 satellites,[17] operating more satellites than every nation except for the United States and Russia. For remote sensing, there are only a few providers of Commercial Satellite Imaging (CSI). However, the CSI market is increasing, with the GEOEye being the largest commercial remote sensing company in the world with revenues of more than USD 150 million in 2006.

2.8. An important aspect to the Space industry is the workforce. Some Nations question if they should invest in the Space industry. The numbers speak for themselves. In the United States, there are more than 266 thousand employees in the Space industry.[18] These employees were paid on average more than USD 88 thousand per

[16] Ibid.
[17] Satellite information available at www.intelsat.com.
[18] The Space Report 2008.

year, more than double the average wage in the private sector (Figure 14). Clearly, a strong Space industry is beneficial to national and local economies.

Figure 14 United States Space Industrial Wage vs. Private Sector for 2006

Space Policies and Strategies

2.9. In April of 2007, the first European Space Policy was adopted.[19] This document established a comprehensive political framework for the cooperation, development and exploitation of Space systems in Europe. The Policy presents the European vision for Space and related priorities and objectives. It also provides strategic direction for future activities in Space and important actions to be taken. However, it only briefly mentions security and defence activities. At the EU's Fourth Space Council in May 2007, the Space Policy was endorsed along with a resolution that 'highlighted the strategic nature of the Space sector, which contributes to the independence, security and economic development of Europe and recognizes the actual and potential contributions from Space activities to support EU policies.'[20]

2.10. In October 2006, ESA released Agenda 2011 which provides the overall roadmap for all ESA stakeholders. In the document, three priorities driving ESA were identified, the second of which is the development and promotion of integrated applications (Space and non-Space) and integration of the security dimension in the European Space Policy.[21] The policy addresses current and future programmes, including the synergies that can be created between civil and defence services. ESA has clearly shown leadership in asserting its capabilities and expertise in Space related security and defence issues.

2.11. The major Space Nations in Europe are France, Germany, Italy and the United Kingdom. France has issued a series of high-level policy documents, including one in 2007 that argues 'Europe is losing ground to the United States, China, India and Russia due to their growing Space budgets and that Europe should act soon to avoid falling too far behind.'[22] Additionally, the Minister of Defence issued a document in February 2007 that proposed a Europe-wide effort to increase military Space capabilities through reciprocal dependence on nationally owned space-based military assets.[23] Germany, Italy and the United Kingdom all have civil or military Space policies active or under development.

2.12. The United States issued a new National Space Policy in 2006. The United States remains 'committed to the exploration and use of outer Space by all nations for peaceful purposes, and for the benefits of all humanity.'[24] Major areas of emphasis include the development of a cadre of Space professionals, reforming Space acquisition, Space situational awareness, intelligence activities, Space protection and

[19] Communication from the Commission to the Council and the European Parliament on 'European Space Policy' COM (2007) 212 26/4/2007.
[20] Council of the European Union 'Resolution on the European Space Policy' DS 471/07 16/5/2007.
[21] ESA 'Agenda 2011 – A Document by the Director General and Directors.' October 2006.
[22] Source: ESPI Report 6.
[23] French Ministry of Defence 'Let us Make more Space for our Defence. Strategic Guidelines for a Space Defence Policy in France and Europe.' February 2007.
[24] United States National Space Policy available from the White House Office of Science and Technology Policy (OSTP) at www.ostp.gov.

interagency collaboration. New areas included homeland security, radio frequency spectrum access and protection, orbital assignments, and others. One of the biggest Space policy 'events' for the United States in recent years, was the successful Chinese ASAT test on 11 January 2007. This anti-satellite weapon demonstration stalled high-level talks and awakened the international community to the vulnerabilities of satellites. **NATO currently has no programmes in place to defend against ASAT attacks.**

2.13. Other nations are also actively pursuing Space policy, strategy and other Space activities. Russia, Japan, China and India are all heavily involved in Space activities. Emerging Space powers include South Korea, Brazil, Israel, South Africa and others. Space has indeed become quite 'ordinary.'

Security and Defence Activities

2.14. It should no longer be surprising that Space assets are required for modern armed forces. Although they grew out of requirements of the Cold War, the recent events in Kosovo, Iraq, Afghanistan, and more broadly in Africa and Asia, have convincingly demonstrated the need for reconnaissance and telecommunications satellites. More and more countries are committing to significant Space programmes for their own security and defence concerns. Three trends are contributing to the increased participation in security Space activities. First, the **costs are declining for access to Space**. Second, past participation was limited to civilian Space due to the consideration that Space was to be used for **peaceful purposes**. **Many nations are now interpreting this as 'non-aggressive' rather than 'non-military' activities.** Lastly, **Space systems are often dual-use**, meaning they can be used for civil and military purposes.[25]

2.15. As mentioned previously, the United States is by far the largest spender in military Space with almost half of the world total. Its leadership in military Space programmes is unlikely to be challenged in the near future. However, many European countries have acknowledged the strategic importance of Space for political, economic, and military needs. Currently, there are eight NATO Nations conducting military Space activities: Belgium, Canada, France, Germany, Italy, Spain, the UK, and the United States. While Europe spends about 30 times less than the United States on military Space activities per year, there are advances being made. France, Italy, Germany, the United Kingdom and the United States are developing their own dedicated military systems for telecommunications and remote sensing. However, no single European nation can afford to develop a wide range of Space capabilities like the United States. If Europeans want access to greater Space capabilities, they will need to cooperate. France has taken a leadership role in European Space activities and is advocating avoiding duplication of effort and reducing redundancy. **The Alliance Nations must agree to a common set of military objectives, operational requirements and funding prior to developing the next generation of satellites.** Participation in ESA has been their primary means of cooperation, but in the future, increased cooperation on Space through NATO is another viable option.

[25] Source: ESPI Report 6.

2.16. The EU has been placing increased emphasis on Space programmes as its role in providing global security has expanded in recent years. **Space systems have been recognized as a key enabler to act independently, prevent and resolve conflicts and crises, and are critical to supporting the European Security and Defence Policy (ESDP)**[26] **and European Defence Agency (EDA) activities.**[27] Europe must be able to respond to global natural and humanitarian disasters as well as security and defence operations.

Additionally, the United States National Space Policy identifies areas for international military cooperation, in particular the sharing of intelligence for shared situational awareness. Creating a cooperative architecture that links civil and military Space capability and allows access by member states is absolutely critical to supporting NATO, ESDP and the EDA. **A clear Space policy for security and defence for all members is required to accomplish this objective and NATO is the logical organization through which to advance a Military Space Policy and Strategy.**

'The United States Government will pursue, as appropriate, and consistent with U.S. national security interests, international cooperation with foreign nations and/or consortia on space activities that are of mutual benefit and that further the peaceful exploration and use of space, as well as to advance national security, homeland security, and foregn policy objectives.'

– U.S. National Space Policy, 31 August 2006

' ... to develop and pursue a joint strategy and establish a coordination mechanism on international relations. This strategy should be consistent with Member State activities and is aimed at strengthening Europe's role in the global space field and at benefiting from international cooperation ...'

– Space Council Resolution on European Space Policy, 22 May 2007

[26] Presidency Report on ESDP, 18 June 2007; the 4th Space Council Resolution on the European Space Policy dated 22 May 2007; and the White Paper 'Space: a new European frontier for an expanding Union An action plan for implementing the European Space policy' COM(2003) 673 dated 11 November 2003.

[27] European Defence Agency, 'An Initial Long-Term Vision for European Defence Capability and Capacity Needs.' Oct., 2006.

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Non-Sensitive Information – Releasable to the Public

Chapter 3 – NATO Space Operations Today

Engines of war have long since reached their limits, and I see no further hope of any improvement in the art.

Sextus Julius Frontinus
Strategemata, Introduction to Book III, AD 84

3.1. NATO has been active in Space since the 1960s, starting with its own communications satellites, weather and intelligence activities. The Alliance has had involvement in many of the Space mission areas and even operated the NATO I, II, III, and IV series of communications satellites, but for the most part, NATO relies on national and civil Space capabilities to accomplish its missions. As described in Chapter 2, European nations are primarily involved in commercial and civil Space systems and applications. European nations have realized that most satellites are dual-use, meaning that they can be used for both civil and security and defence applications. More and more, European nations are developing their own Space capability, emphasizing the 'non-aggressive' use of Space. This trend for national policy for civil use of Space is slowly changing as it becomes imperative for security and defence to utilize Space capabilities.

3.2. Today's expeditionary warrior faces many challenges. ISAF forces in Afghanistan are fighting an adversary that pushes the limits of NATO's capabilities and commitments. The typical soldier, sailor, airman, or special operator in Afghanistan doesn't know what Space does, is capable of, or how to get access to Space support; the basic user simply sees the results of the planning that went into delivering the capability. However, someone must be filling the role of the Space planner. If, for example, a Special Operations Forces (SOF) air planner wanted commercial satellite imagery analysed and exploited for mission planning, are the intelligence assets and processes in place for this to happen and are there satellites available to provide the imagery? Other questions might be: What theatre missile warning and tracking architecture has been established? Are SATCOM and information networks assured? There are many Space related matters to consider, most of which are transparent to the user, but if they are not coordinated and controlled, the mission may fail. This chapter will present a strategic overview of the state of affairs of Space operations in NATO. The closing section focuses specifically on ISAF.

Governance

3.3. The Military Committee has not issued any guidance specifically for Space operations, only for some of the sub-mission areas. However, 'NATO's Strategic Vision: The Military Challenge,' states that '[the Alliance]…must develop the ability to gather and exploit all-source intelligence, including that derived from space-based systems.'[28] The fundamental doctrine document related to Space operations is Allied Joint Publication (AJP) 3.3, Air and Space Operations, dated May 2002. AJP 3.3 provides guidance on the planning and execution of air and Space operations, primarily for NATO Combined Joint Task Force operations. Chapter 6 provides a short overview of Space mission areas. Component Commander (CC)-Air Ramstein has been responsible for maintaining the Bi-Strategic Command (Bi-SC) Functional Planning Guide for Space Operations, dated April 2002. This document provides some detailed planning instructions for integrating

[28] Bi-SC Strategic Vision: The Military Challenge, August 2004.

Space into operations. The third Space guidance document is ACT DIR 75-2-N, Space Operations Joint Functional Area Training Guide (JFATG), dated January 2006. This document states that 'in order for the future of NATO operations to be successful and modernized, Space must be integrated effectively. Personnel with Space backgrounds and expertise should be placed in Strategic, Operational, and Tactical Headquarters.' Furthermore, 'training must be conducted as a routine part of the normal training cycle and must not be deferred until the outbreak of action.' NATO must train in peacetime in order to be effective in combat.

3.4. There is other Space related guidance, a sample of which is listed below. There is NATO COMAIRNORTH OPDIR 001 – SPG Annex DD Space Operations. Standardization Agreements (STANAGs), too many to list, but include STANAG 4636: Space and Nuclear Hardening Guidelines for Military Satellites, STANAG 4633: NATO Common ELINT Reporting Format, and STANAG 7023: NATO Primary Image Format. Other documents include the ANP-3(A), NATO Satellite Navigation Warfare Framework, Military Committee (MC) decision 115/25: Meteorological Support to NATO Force, MC 165: Military Related Scientific and Technological Trends, MC 166: NATO Indication and Warnings Systems, the Military Intelligence Programme (MIP) 255, and the Guidance for Operational Planning.

3.5. While not NATO documents, there is other important Space governance that impact NATO Space operations. The UN Office of Outer Space Affairs, the UN Committee on the Peaceful Uses of Space (COPUOS), the Commission of the EU and ESA have issued Space policies, guidance, or other papers. Additionally, many NATO Nations have their own national and military Space policies and strategies. A list of some Space policy documents can be found in the list of References at Annex M.

3.6. While this may seem like comprehensive guidance for NATO, it is not. There is no NATO Space policy, no military Space strategy, no Space doctrine document, and no Space Joint Tactics, Techniques and Procedures (TTPs) documents. Mission areas such as offensive and defensive counterspace and Space surveillance are not addressed. Strategic and operational planners are challenged to find the appropriate guidance directing the integration of Space capabilities and effects. There is no overarching strategic framework for long term Space capabilities acquisition and research, or direction to the member Nations on required Space capabilities (other than a few specific sub-mission areas such as SATCOM and ISR). This leads to an inability of the NATO Research and Technology Organization (RTO) to prioritise properly. The RTO must guess what research it will pursue and what the most important research areas are with regard to Space.

3.7. It is important to note that there has been precedence set for the Alliance Nations to agree on Space issues at the political level. The NATO Nations are signatories to the UN's Outer Space Treaty of 1967 and the European nations have agreed to the recently published EU Space Policy in 2007. While cooperation amongst the Nations is difficult, it is not insurmountable. 15 NATO Nations have also been able to establish the E-3A AWACS component and 12 Nations have recently agreed to acquire the C-17 for strategic airlift. If NATO further develops Space Power and establishes a Space Policy and other governance, there are no international or National agreements, treaties or other arrangements that will be violated. In fact, it is surprising that NATO has not already become more involved in Space.

Missions

3.8. AJP 3.3, dated 2002, outlines the Space mission areas and describes the attributes of Space that are useful to a Joint force and the role of military Space, along with providing an overview of Space capabilities. Summarized in Table 1, are the two NATO Space mission areas. Space Control (SC) includes counterspace, Space environment, satellite operations and spacelift. Force Enhancement, the mission area focused on delivering capabilities to the warfighter, includes environmental sensing, ballistic missile warning, navigation and positioning, and communications. A short overview briefing of NATO Space Operations mission areas is included in Annex B.

Table 1: Summary of NATO Space Mission Areas

Space Control	**Counterspace**	Offensive and Defensive Counterspace
	Contributing Capabilities	Space Surveillance
		Space Environment Ops
		Satellite Operations
		Spacelift Operations
Force Enhancement	Improving combat effectiveness of military forces using Space systems	
	Surveillance of Terrestrial Environment	
	Environmental Sensing	
	Ballistic Missile Warning	
	Navigation and Positioning	
	Communications	

3.9. An updated AJP 3.3 is currently awaiting ratification by the Nations, however, the chapter on Space operations needs further revision to better address NATO's needs. United States Space doctrine has evolved and Joint Publication 3–14, Space Operations, was just published in January, 2009. Current United States Air Force (USAF) Space doctrine uses four Space mission areas: Space Support, Force Enhancement, Space Control and Force Application. The United States also commonly uses the following Space capability categories: Missile Warning and Defence; SATCOM; PNT; ISR; SC; Space Access; Space C2; Environmental Monitoring; Force Application; and Satellite Operations. The term Counterspace has been replaced by the term SC, which comprises the following sub-mission areas: Space Situational Awareness, Offensive SC and Defensive SC (this should not be confused with typical usage of the concept Air Command and Control). For this paper, the term Space Control will be used instead of the term Counterspace.

Overview of Current NATO Space Activities

3.10. Space Control. Space Control can be classified into Space Situational Awareness (SpSA) and offensive and defensive Space activities. NATO has addressed these missions in a limited way. As NATO does not have fielded Space units or systems, Space C2, Space support and Space lift have not yet been adequately addressed. As more nations and commercial companies are developing military Space capabilities, there is an increasing need to protect those systems and assure access to Space services.

SpSA is required to understand the status of friendly systems as well as to determine the intent and capability of adversary Space systems. SpSA needs to include not only tracking objects in Space, but also operational and link status. There is limited capability to monitor and protect SATCOM links and it is relatively easy to jam or interfere with those links. The ground segment continues to remain the most vulnerable component of a Space system and is subject to kinetic attack, cyber or network attack and electronic warfare. NATO has not sufficiently addressed this mission area.

3.11. Meteorology and Oceanography (METOC). Commonly known as weather information, METOC is another mature and well developed mission area for NATO. MC Decision 115/25 governs NATO's weather policies. Each Nation is responsible for meteorological support for its own forces whether assigned to a NATO commander or not. Each Nation is directed to furnish all other NATO Nations with the greatest possible assistance in the provision of weather support. NATO is able to utilize the EUMETSAT, the United States Defense Meteorological Satellite Program (DMSP) and other earth monitoring Space systems. EUMETSAT and DMSP are just a few of the many international and world-wide METOC satellites available for use by NATO. A robust dissemination system has been established that integrates surface, air and Space information and delivers the required information. The Military Committee Meteorological Group (MCMG) supports the Military Committee directly with policy, information and advice. At the operational level, one area that requires improvement is for planners to assess the impact of terrestrial weather on missile warning and on space-based ISR assets. Depending on the type of system, weather can greatly impact the usefulness of satellite remote sensing capabilities.

3.12. ISR. Space-based intelligence is normally provided to NATO through national representatives in the NATO J2 organisation or from the Intelligence Fusion Centre. The NATO J2 organisations are fed by National intelligence capabilities that are either on site or contacted via reachback capabilities. One key interest area that requires attention is satellite imagery and analysis. NATO relies on its members to provide needed imagery, whether from air, military satellites or commercial satellite imagery vendors. Additionally, the EU Satellite Centre (EUSC) maintains an extensive database of commercial imagery and has some analysis capability, as well as the ability to process classified information. NATO has used this capability in the past. There is, however, a complex system for requesting imagery and for the EUSC to recover costs. Their founding charter establishes the customer, cost and request mechanisms.[29] In the last several years, significant advances have been made and commercial companies are now able to provide high resolution imagery and some analysis capability. Furthermore, many more Nations are now operating Space systems capable of Imagery Intelligence (IMINT). European nations have access to Electro-Optical (EO) and Synthetic Aperture Radar (SAR) imagery as shown in the chart below. Annex C provides an overview of ISR systems operated by NATO Nations. Numerous inquiries to NATO forces have identified the need for more space-based intelligence products. Typically, they are not being requested because the forces don't know what products are available to them. Additionally, there is not a clear process or understanding of what Space systems and capabilities NATO has access to.

[29] Joint Action – European Union Satellite Centre document: 'Council Joint Action 2006/998/CFSP of 21 December 2006 amending Joint Action 2001/555/CFSP on the establishment of a European Union Satellite Centre' available at www.eusc.europa.eu.

It seems though, that the major hurdle is not the technology or availability of space-based ISR systems (Figure 15) rather, it is the lack of data policy and management for space-based intelligence. There is a tremendous amount of existing capability if we can only connect our customers in the field with those Space capabilities.

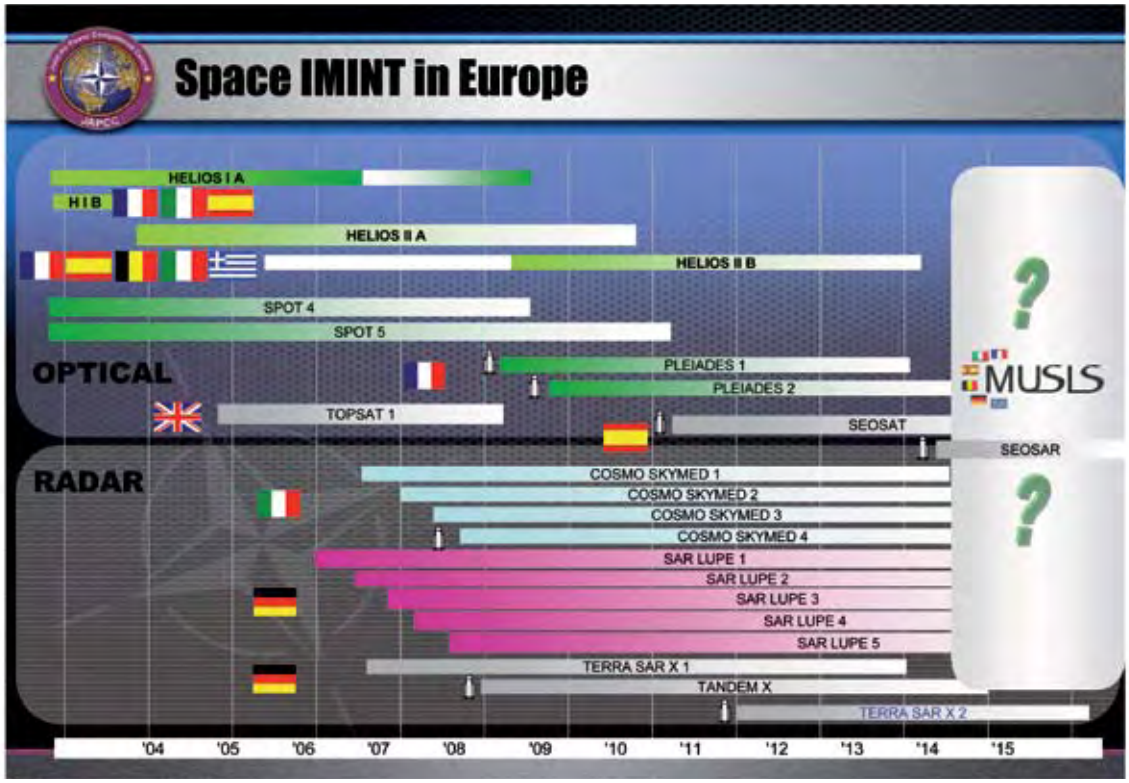

Figure 15 European Space IMINT Systems

3.13. Missile Warning and Defence. This mission area is also fairly robust and mature since NATO has been involved in these operations for some time. NATO receives Shared Early Warning System (SEWS) data and warnings from the United States. However, the early warning dissemination network is not robust in NATO. Under the Air Command and Control System (ACCS) Programme, the Active Layered Theatre Ballistic Missile Defence (ALTBMD) upgrade, and other missile defence programmes, the architecture is becoming more resilient and the mission area continues to mature. A further area for improvement lies in better dissemination of space-based missile warning and tracking. For ISAF, the Regional Force Protection Alerting (RFPA) system is being developed. However, currently in Afghanistan the missile warning notification network is weak at best. The technology exists to disseminate the warnings, but the procedures and architectures for dissemination are not as robust as they could be for NATO forces.

3.14. PNT. The NATO standard is the United States Global Positioning System (GPS). STANAGs 4294 and 4392 provide standards for GPS systems. NATO is not currently engaged in the Galileo satellite navigation programme, but should be involved in the future. Oversight and analysis will have to be completed to determine NATO's need to utilize Galileo in the future. There is a lack of education and awareness of threats and vulnerabilities to GPS. The Navigation Warfare Working Group at NATO HQ is trying to investigate this area, but for security reasons, data is difficult to release to the group. Increased emphasis should be placed at the tactical and operational levels to address navigation warfare.

3.15. SATCOM. The SATCOM community in NATO is probably the most mature Space mission area in NATO. Because strategic communications were so important during the Cold War, NATO developed a dedicated system, known as the 'NATO' series of satellites that was launched by the United States and operated by the United Kingdom and United States. The United Kingdom has since taken the lead for the programme and has leased the communication services from a commercial company (Paradigm Secure Communications). This arrangement seems to be working at providing dedicated, leased bandwidth to NATO. NATO has a SATCOM Post 2000 (NSP2K) services contract to continue to deliver the required SATCOM services. Additionally, the NATO Communication and Information Systems Services Agency (NCSA) maintains constant vigilance over the information systems through a 24/7 network operations centre. Current UHF and SHF capabilities are provided by the United Kingdom (SKYNET), France (SYRACUSE), and Italy (SICRAL) under contract with NATO. Additionally, the United States provides use of the UHF Follow-On (UFO) satellites, and in the future, Mobile User Objective System (MUOS) satellites for UHF service. All have some form of protection. NATO is currently leasing Ku and Ka band from commercial vendors. NATO is working on plans to deliver EHF capabilities in the near future. However, most forces must rely on their own national terminals and link capability. While NATO is working hard to address SATCOM capability, there are challenges. In Afghanistan, there was initially a lack of SATCOM resources to meet operational needs, which caused NATO to contract a commercial service to bridge the gap. Lack of SATCOM and bandwidth continue to be challenges. For example, there are two NATO Signals Battalions that deliver strategic SATCOM services to deployed NATO HQs. Manning is an issue for these Battalions. While this mission is mature and receives robust efforts, there are still areas for improvement. The NCSA and NATO Command, Control and Consultation Agency (NC3A) support the MC with policy, planning, information and advice on SATCOM.

3.16. Space Support to Friendly Force Tracking. There are several other applications where Space can contribute to operations. Space can provide specialized support to Special Forces and should be further developed for NATO. Another application is Friendly Force Tracking (FFT), which uses satellite communications and GPS. FFT has proven extremely effective for situation awareness in Iraq and Afghanistan to positively identify friendly forces. FFT (the United States uses the term Blue Force Tracking or BFT) is primarily used for land forces and helicopters. Based on United States experience and available commercial systems, NATO has begun fielding its own FFT devices. There are challenges with interoperability due to the fact that several member Nations have or are fielding their own systems. NATO's current programme is being led by ACT and supported by NC3A. This is a fairly new capability for NATO and should continue to be matured. The current programme is modest in its ambition and funding and further analysis should be done to determine future requirements and additional ways Space can better support the programme. The FFT architecture can greatly contribute to expeditionary operations, precision engagement, special operations and manoeuvre warfare.

3.17 Space Support to Personnel Recovery Operations. Space can also support Personnel Recovery operations, as shown in Figure 16. Space is critical as both a collector and reporter of information. The advantage of space-based collectors is that they are nearly real-time (they are already on orbit) and they can be used in situations

where NATO does not have Air Supremacy or persistent coverage from organic air ISR systems. This capability is currently integrated into United States Combined Air Operations Centres (CAOCs) and should be further expanded into NATO CAOCs.

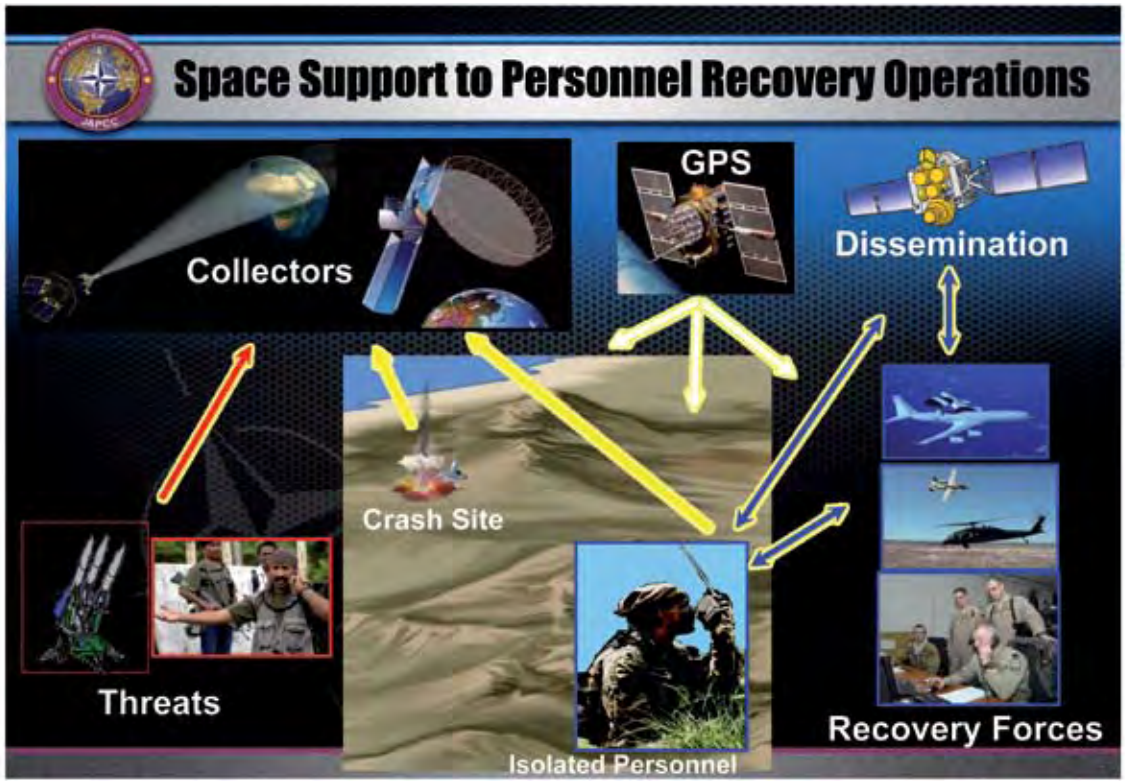

Figure 16 Space Support to Personnel Recovery Operations

Research and Technology (R&T)

3.18. Since Space touches so many different mission areas and organizations in NATO, it would be challenging to list all space-related science and technology programmes. For illustrative purposes, there are efforts of the NATO Research and Technology Organisation (RTO) listed here. They are representative of the research and emerging Space technology areas that are applicable by all NATO organizations, programmes and National and civil efforts. RTO uses Exploratory Teams (ET), which form for a short duration (2-3 years) of focused effort; the teams stand down when their work has been delivered. Table 2 shows the space-related ETs (as of April 2008).

3.19. The RTO has been given responsibility for the 'holistic management' of NATO R&T. This includes an oversight responsibility to ensure that all the NATO R&T agencies (such as the NATO Undersea Research Centre (NURC), NC3A, NATO Industrial Advisory Group (NIAG) and RTO) deliver synergistic outcomes for NATO and the Nations. RTO includes Space in its Rolling Plan; however, it currently states only that Panels should try and balance their portfolios (Air/Sea/Land/Space) and offers a list of recommended Space research topics made by the Space Science and Technology Advisory Group (SSTAG), whose term has ended and no longer exists. Therefore, NATO and RTO currently do not have any long term management of Space research.

Table 2: NATO RTO Exploratory Teams

2008 ETs	
AVT-ET-087	Systems Requirements Review for Small and Multi-functional Spacecraft
AVT-ET-091	Thermal Management Challenges and Solutions for Air, Land, Sea and Space
IST-ET-047	System of Systems for Early Warning in NATO
IST-ET-048	NATO NEC over SATCOM in NATO
SCI-197 / ET	Satellite Constellations and Formation Flying
SCI-205 / ET	Emerging Space System Concepts
SET-ET-054	Space Based Hyperspectral Data & Services in NATO
SET-ET-056	Microsatellite Based Surveillance of Space
2007 ETs	
AVT-ET-078	Lightweight Multi-functional Space Structures for Micro Satellites and Space Vehicles
AVT-ET-079	Spacecraft Technologies
AVT-ET-086	Near-Space Vehicles: Technologies & Military Utility
IST-ET-047	System of Systems for Early Warning in NATO
IST-ET-048	NATO NEC over SATCOM in NATO
SCI-196 / ET	Integration of Space Assets into Systems Concepts
SCI-197 / ET	Satellite Constellations and Formation Flying
SET-ET-054	Space Based Hyperspectral Data & Services in NATO

Personnel and Training

3.20. In 2002, Regional Headquarters Allied Forces Northern Europe pointed out to SACEUR that NATO did not have the necessary Space expertise in its headquarters and planning staffs.[30] Consequently, the NATO School was tasked to develop a training course for Space planners. To date, NATO has stood up the NATO School Space Operational Planning Course, but has not implemented many of the other recommendations in the letter and still does not have the required level of Space expertise. Furthermore, NATO commanders have not emphasized that their assigned Space personnel take a proactive role in ensuring Space is planned and integrated into operations; typically, Space personnel are assigned to other non-Space related duties.

3.21. The challenge of developing Space planners in NATO is that there are no Space systems to manage or operational Space units. In the United States Air Force (USAF), the Space operator can be a great integrator of multi-disciplinary capabilities. Space operations significantly contribute to J2 Intelligence functions and J6 Communication functions. Other areas are not so clear cut. The value of the operational Space planner is the ability to integrate and use all the capabilities Space can offer and to have a holistic approach to the mission area. The Intelligence community collects and analyses information; the communications community ensures the links are connected, while the Space operator (typically working in J3/5) should be worried about threats, vulnerabilities, planning and execution. So this raises the question, 'What isn't getting done due to the lack of Space planners?' Annex D provides a list of notional Space planner tasks. There are risks associated to not accomplishing these Space related tasks.

3.22. The table below shows the difference in assigned Space operations personnel between the United States and NATO. Unsurprisingly, the United States has by far the majority of Space personnel available. It is necessary for NATO to focus on the lack

[30] Letter from RHQ AFNORTH to SACEUR dated 30 July 2002 (document is NATO Restricted).

of Space personnel and expertise on its staff. NATO Space operators are assigned to CC-Air Ramstein and Izmir, JFC-Brunssum and Naples, the NATO School and the JAPCC. Given that all these personnel are USAF Space operators, the JAPCC has opened a second Space position targeted specifically at NATO's European members.

Table 3 Current Space Operations Personnel

US Space Personnel	NATO Space Personnel
Deployed Space Operators in the Middle East AOR	
▪ 40+ US Air Force	▪ 1 - HQ ISAF, Kabul (deployed by USAF, NOT filled by NATO personnel)
▪ 50+ US Army	
▪ 1+ US Navy	
Total Number of Space Operators in Military Forces	
▪ 4500+	▪ 7 - All USAF (only 1 is working space issues full time)

3.23. The small group of Space personnel deployed to support ISAF is extremely challenged. They have all been USAF Space operations personnel. Typically, they do not receive specific training on performing Space planner duties, have not worked with NATO before, and spend significant time at the beginning of their deployment 'learning the ropes' before they can become effective. In Figure 17, the Space Liaison Officer (LNO), on the left, at HQ ISAF explains to a visiting Joint Warfare Centre officer how Space is integrated into operations and supports a variety of security and stabilisation activities.

3.24. Training and education are extremely important because NATO does not have any Space operations units and must 'grow' their Space expertise. The primary method

Figure 17 HQ ISAF Space LNO Explains How Space is Integrated Into the Fight

of training NATO staff officers is at the NATO School, which offers a 5-day Space Operational Planning Course twice per year. There has been a waning of interest in the course, which may lead to reducing the course offering from twice to once per year. In the Spring of 2008, the JAPCC proactively advertised to the HQ staffs the importance of building Space expertise and the enrolment went from 6 to 30 students. Since the first Space course was offered in 2003, the NATO School has graduated 137 personnel from the course, with another 29 students graduating from the course in May 2008. Considering that typical NATO postings are for 3 years, most of the graduates from the course have left NATO. This raises the question of how relevant and effective the course is, and how are the graduates being utilized? Additionally, there are several NATO online courses available: Introduction to Satellite Operations, NATO Space Support, NATO School Force Enhancement from Space, and NATO Space Applications. Many national Staff Colleges, and until recently the NATO Defence College, offer a focused 'Space Day.' However, for the most part, **the typical NATO officer has very little, if any, training and education on Space operations planning.** NATO and the member Nations must fully support the NATO School's Operational Space Planner Course.

3.25. In the international Space community, there are various courses, conferences, and symposia. The International Space University in Strasbourg, France, the United States Air Force Institute of Technology, the Naval Postgraduate School and many others offer space-related graduate degrees. The United States has also established the National Security Space Institute (NSSI) to educate its military and government civilians on Space operations. The NSSI has recently begun to offer basic Space education to other nations, including Australia and the United Kingdom. The NSSI is also developing an introduction course that will be open to Allied Nations. Additionally, the United Kingdom's Air Warfare Centre has a week-long Military Applications of Space seminar to introduce its forces to Space.

Space Operations in ISAF

3.26. **Space capabilities are being used to support ISAF operations. However, due to the limited exposure to Space capabilities prior to deployment and the limited number of personnel in ISAF with Space expertise, Space capabilities are not as fully integrated or utilized as they could be.** A short overview of NATO Military Applications of Space, shown in Figure 18, is provided in Annex E. Continuity of the Space personnel continues to be an issue and the lack of NATO personnel filling the position contributes to the problem (the HQ ISAF Space LNO position has been filled by USAF personnel not assigned to NATO since the creation of the position in early 2007). NATO does have Space personnel that could fill the position, but to date, NATO Space personnel have been primarily deployed to non-Space positions. It is vitally important that the Space planner tasks identified in Annex D be accomplished in both NATO and ISAF.

3.27. The JAPCC requested detailed information from HQ ISAF in the form of 25 questions that were sent to the Air Liaison Element, where the Space planner position is assigned. The responses were extremely insightful to the challenges in ISAF and highlight the need for Alliance Military Space Strategy, doctrine and TTPs. It is important to note that the ISAF Space personnel are neither filled from the NATO staff nor trained on NATO or ISAF prior to deployment. The questions sent to ISAF are included in Annex F; however, the responses are classified ISAF/NATO Secret.

Figure 18 Current Space Effects in Irag & Afghanistan

The document is available from the JAPCC upon request. The 2 United States Space officers deployed to HQ ISAF in April 2008 are shown standing in Figure 19.

3.28. Several issues from the survey are important to summarize here. In response to the first question, it was highlighted that strategy-to-task planning is of paramount importance, so if no Space strategy exists, Space activities will not receive the appropriate level of focus. Furthermore, when a Space strategy is developed, Space Effects Teams should be embedded in lower echelon units since headquarters and planning staffs have no Space expertise. The Space planners in ISAF spend significant time educating other staff members on Space capabilities instead of focusing on planning and integration. Additionally, it would be beneficial to have a properly trained and qualified Senior Space Officer assigned to ISAF.

Figure 19 United States Space Operators (standing) at HQ ISAF CJOC

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Chapter 4 – Future NATO Space Capability Requirements

The future battle on the ground will be preceded by battle in the air [and in Space]. *This will determine which of the contestants has to suffer operational and tactical disadvantages and be forced throughout the battle into adopting compromise solutions.*

Field Marshal Erwin Rommel

4.1. This chapter will discuss some of the emerging thoughts on Space operations for NATO. NATO has focused on the Force Enhancement support that Space Power can provide; however, missions are always evolving and there is a challenge for military capability to keep up with rapid changes in the security environment and technological advances. As new Space capability is acquired by the Alliance Nations, NATO must address how it will conduct Space operations in the future. The three major mission areas that need to be addressed are: SpSA, assuring the Space domain and conducting Combined Space Operations (CSO).

Table 4: Transformation of the Operating Environment

NATO Transformation	
20th Century	**21st Century**
Static	Agile
Reactive	Proactive
Regional	Global
Mass	Maneuver
Attrition	Precision
De-confliction	Coherence
Supply Point Logistics	Integrated Logistics
National Intelligence	Fused Intelligence
AIR POWER is Decisive	**SPACE POWER is Decisive**

Need for Space Situational Awareness

4.2. **Modern military forces now take Space support for granted. They assume that there will be communications, weather, missile warning and tracking, navigation and timing data, and ISR capability provided by Space. As NATO continues to transform to a Joint expeditionary military force, there will be increasing demands for Space.** NATO will continue to have demands for increased SATCOM bandwidth and capability, in particular for protected communications used by far-flung military forces. Fighting the 'Long War' in remote, austere environments using the smallest possible ground force against non-state adversaries will increase the dependency on Space Power. Command and control, intelligence and information are provided via Space and Close Air Support/precise engagements provided by Air Power are also reliant on Space. **History shows that humans have fought in and for dominance over every medium which contributes to commerce. Space may well prove to be no different. As such, it is increasingly important to protect and ensure access to commercial and military Space systems.**

4.3. A majority of Space services are provided by commercial or civil satellites. As pointed out in Chapter 1, there are many risks to users of Space capabilities. For example, if a Special Operations team loses their SATCOM capability in the field, was it due to loading the wrong crypto, being on the wrong frequency, experiencing unintentional interference, intentional SATCOM jamming, a satellite malfunction,

a solar event, or an ASAT attack? If a Predator crashes, was it a mechanical failure, pilot error, loss of GPS, loss of the command link due to jamming, or another cause? Perhaps a commercial Space service provider contacts their military customer and says their system is offline. Was it a network attack on the satellite command system on the ground? Did Space debris hit a satellite? Is the satellite being interfered with? It is critical that NATO develop SpSA in order to answer these questions. Figure 20 illustrates the need to have SpSA. The United States has recognized this need and has placed a high priority on developing SpSA. There are on-going efforts to share Space surveillance data (tracking of objects in Space) and to create a user-defined Common Operating Picture (COP) for Space. NATO must know the operational status of the satellite and its payload, and the link status to be able to determine the operational impact to its users. Moreover, the risk to satellites from Space debris is a significant and increasing concern. NATO should contribute actively to international efforts to mitigate the creation of Space debris and to ensure Space flight safety. **NATO needs the capability to monitor Space assets before it can assure the Space domain. SpSA is a strategic necessity and requires a COP.**

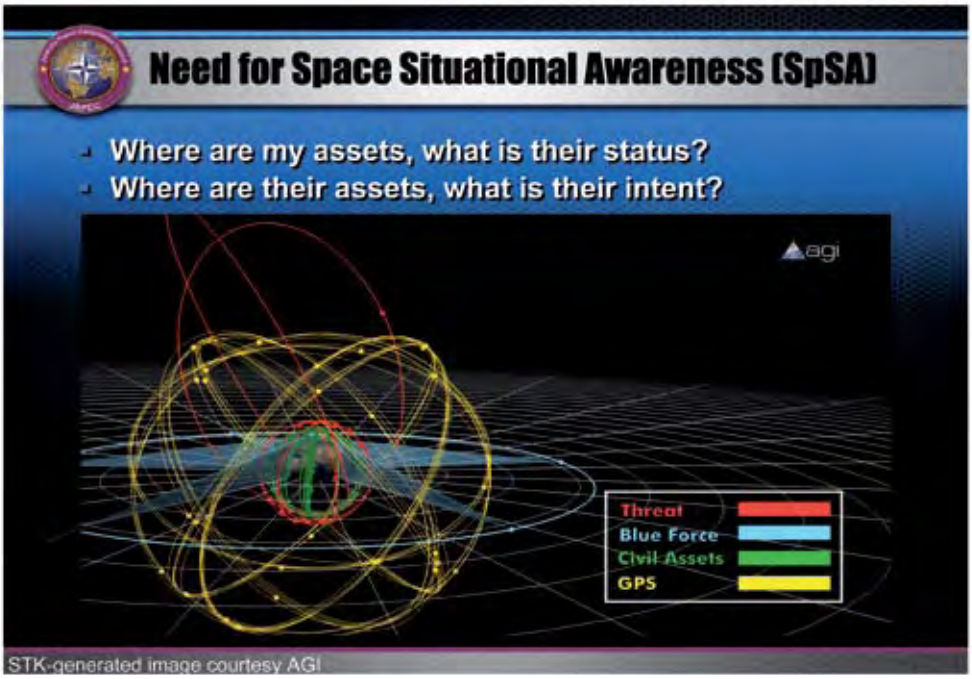

Figure 20 Need for Space Situational Awareness

Need to Assure the Space Domain

4.4. Once SpSA has been achieved, NATO can then determine if an incident was hostile, unintentional or simply just a satellite malfunction. Unintentional interference can be corrected, for the most part. There are already established organizations and procedures. However, for an attack on a Space system, how would NATO respond? What if, instead of pirates taking ships on the open sea, they held a commercial satellite operator for ransom and denied operational use of SATCOM for combat operations? As satellites are generally considered high value strategic assets to a nation, an attack would not be treated lightly. **NATO should develop capabilities in order to protect the Space systems upon which our economies, decision makers and military forces have come to depend.** Some options include standards in Space system design to protect against attack, fusing Space surveillance data to create situational awareness, force protection of Space systems infrastructure and establishing Space doctrine and tactics.

NATO has not yet adequately addressed current or future requirements to assure the Space domain. It should be a top priority to ensure freedom of action and access to Space capabilities and furthermore, to consider the need to deny those same capabilities from its adversaries if required.

4.5. While many nations have demonstrated the capability to conduct offensive SC activities, NATO must determine if there is the political will for the Alliance to engage in such activities. Despite the existing threats of satellite jamming and piracy, and of the demonstrated Chinese ASAT capability in 2007, the JAPCC assesses that the NATO Alliance is not willing to adopt a stance that would endorse the conduct of offensive or aggressive SC operations. However, NATO must ensure free access to and freedom of action in Space for all peaceful purposes. Cooperation between Nations to share data, enforce responsible Space practices and provide SSA is needed.

Need to Conduct Combined Space Operations

4.6. A major challenge for all NATO mission areas and capabilities is the need to exchange information. Significant efforts are required to better integrate and utilize space-based intelligence capabilities. The paradigm must shift to a mindset of 'must share' versus 'must protect' for Space-based intelligence and information. As Nations develop their own Space systems, NATO must establish an architecture, which can incorporate those systems. Several Nations have developed significant space-based ISR capabily in the last couple of years. As shown in Annex C, there are many existing space-based ISR capabilities to be integrated. Futhermore, in the future, constellations of small satellites and ground or space-based systems for Space surveillance will have to be integrated. **NATO should identify areas of technological interest of each nation and develop a long-term plan to deliver capabilities and effects.**

4.7. Most certainly, NATO and all of its member Nations are users of Space and some are also conducting military Space operations. The Alliance has significant communication and intelligence capability. The establishment of interoperable networks, like the Multi-sensor Aerospace-ground Joint ISR Interoperability Coalition (MAJIIC) and the connectivity provided by NNEC will greatly enhance the integration of Space ISR capabilities. The stand-up of the Intelligence Fusion Center, in support of NATO, is another great step at integrating national capability. This is not enough. Operations support requires a streamlined and smooth tasking and dissemination process. Intelligence requirements must be stated during force generation as they may require significant planning and expense. Increased cooperation is needed to ensure mutual security, to take advantage of synergistic effects, to provide backup capability, to improve training and to ensure a healthy Space industry. **NATO must work to better integrate national Space capabilities, both in existing and in future systems and to improve the information and database management, along with the dissemination process. Most importantly, NATO must provide education and training about Space Power and capabilities available to our Joint and Combined forces to fully employ an EBAO.**

4.8. While the United States military has, by far, the most Space capability and mature Space doctrine, even they are challenged to conduct Joint Space operations. As other member Nations develop and deploy Space capabilities, it is necessary for NATO to address how to conduct CSO. One advance in technology that will potentially drive this change is the proliferation of small satellites for communication and ISR.

Apart from a small number of NATO members, Space systems are too expensive and technologically challenging for any single nation to field large satellites. While existing commercial satellite imagery services meet many needs for NATO, they may not meet all operational requirements. **The reductions in Space lift cost, advances in miniaturization and advancing sensor technology are making constellations of small satellites feasible for all Nations in NATO. It is very possible for a small group of Nations or for the Alliance to use common funding to acquire a constellation of small satellites in low earth orbit to provide a credible ISR capability.** The system could be operated by a commercial company providing an ISR service. Day to day, Nations would have access to the capability based on the percentage of funding. During a crisis, the Alliance, the EU or a Joint Force Commander could have direct tasking authority of the system. This would reduce demands on national intelligence systems and provide intelligence releasable to NATO forces. The benefits also include cost savings due to block buys, the ability to refresh technology, improve capability with more frequent launches, and sharing the cost among many Nations.

4.9. Command and control issues will have to be resolved. In the future, as more Space capability is developed and provided by the Nations, it will become necessary to fuse and maximize the use of all available Space capability. A NATO Space Operations Coordination Centre (NSpOCC) could maintain SpSA and conduct coordination of Allied and National Space forces. The AJP 3.3 currently in coordination, presents the concept of a Space Coordination Authority (SCA). The SCA is the single authority within a Joint force to coordinate Joint Space operations and integrate Space capabilities. This provides unity of effort for Space operations in support of the JFC's campaign. However, this authority must be further developed in order to be executed. In summary, **steps must be taken TODAY to facilitate conducting Alliance CSO in the future.**

Effects Based Approach to Operations and Identifying Requirements

4.10. As NATO embraces an EBAO, Space Power must be a key consideration. There is a need for an holistic approach to Space operations. Currently, Force Enhancement services are organized in functional mission areas: theatre missile defence, ISR, communications, navigation, METOC, etc. For example, the Joint ISR (JISR) community is concerned about providing the right mix of capabilities; assets from surface, air and Space. They work to determine what the right mix of capabilities is, how to store the data and information and how to disseminate intelligence products. The communication community worries about SATCOM capability, capacity and ensuring the NNEC is provided. However, who looks at the architecture as a whole, as it relates to operations, threats and vulnerabilities, or at maximizing the use of Space Power to achieve economic, political and military aims? When planners are determining the best way to achieve desired effects, who is looking at the adversary's use of Space and the resulting impacts to their decision making process? What are the links and nodes and usage of Space capabilities? This is typically an intelligence function, but does NATO have the proper Space expertise in the intelligence mission area? Again, referencing the example Space planner tasks in Annex D, this list highlights potential areas of risk associated with not accomplishing those tasks.

4.11. Work must also continue on defining future Space capability requirements. The JAPCC will be supporting the Defence Requirements Review 11 Space Operations Working Group. NATO should determine the Space capabilities, tools and technology

needed to support overall military requirements. The two tables below list examples of a number of key applications of Space capabilities. Annex G provides a simple framework for NATO to consider evaluating Space systems. An in-depth analysis should be conducted to fully evaluate the military utility of Space systems for NATO. This analysis should consider all the mission areas to which Space could potentially contribute to, such as intelligence, personnel recovery, missile warning and defence, logistics, and others. Fundamental requirements include the capability for global monitoring, information on the environment, and supporting security needs. This may include dual-use intelligence and information systems. **Key capabilities to be developed are a system to provide SpSA (perhaps information provided from a member nation), SC capabilities to assure the Space domain, and an architecture to better integrate national Space ISR systems. A NATO small ISR satellite capability merits serious consideration. Finally, and most importantly, NATO must develop commanders and personnel with technical Space expertise.**

Table 5: Military Requirements for Space

• Map creation	• Locating enemy & non-combatant forces
• Crop yield prediction	• Continual monitoring of order of battle
• Disaster monitoring	• Identification of human activity
• Treaty verification	• Monitoring reconstitution of forces
• Population monitoring	• Operations planning (weather)
• Terrain analysis	• Intel preparation of the battlefield
• Threat assessment and warning	• Navigate on the land/air/sea
• Personnel recovery	• Missile warning and defence
• Weapons selection, targeting	• Counter narcotics
• Battle damage assessment	• Military capability assessment
• Damage assessment using change detection	• Focused/agile logistics

Table 6: Civil Requirements for Space

• Hydrological (water) assessment	• Global situational awareness
• Infrastructure assessment	• Incident report/violations
• Support to local police and militia	• Treaty/inspection verification
• Monitoring recovery operations	• Weather forecasting
• Population demographic assessment	• Telecommunications
• Commerce + Finance	• Science + Aviation
• Natural resource exploration	• Utilities management
• Market research and analysis	• Construction and planning
• Agriculture	• Emergency management
• Tax assessment	• Counter narcotics

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Chapter 5 – Gaps and Recommendations

The traditions among all the armed services are much older than any government, more conservative than any department of government, and more sure to build on a foundation that they are certain of, rather than to take any chance of making a mistake.

Brigadier General Billy Mitchell

The only thing harder than getting a new idea into a military mind is getting an old one out.

B.H. Liddell Hart

5.1. The world we live in today is very different from 10 years ago. The Cold War has ended. Threats and the security environment have changed. NATO forces are expeditionary. As Land and Maritime Power matured over the centuries, Air Power likewise developed over the last several decades. Warfare in the 20th Century proved that Air Power was decisive in operations and that efforts must be made to take and maintain control of the Air. The coming century will most likely show that Space Power and control of Space will also be decisive.

5.2. NATO will need to place the appropriate level of emphasis on developing Space Power. It is time for the Alliance to break the paradigms of the past and develop the Space operations mission area. The top priority is to establish a Space Office and issue appropriate governance. Without governance, NATO cannot maximize the integration of essential Space capabilities to support the warfighter. With an eye towards transformation and the challenges that may lay ahead for the Alliance, this Chapter outlines gaps and recommendations in NATO Space operations.

Space Power is Essential

5.3. At the foundation of this Assessment is the tenet that **Space Power is absolutely as vital to operations as Land, Maritime and Air Power.** In fact, Space capabilities are a key enabler to ALL operations in every domain: from a small ground operation, a naval engagement on the open seas, or a single aircraft flying a resupply mission. Space capabilities are used in all operations; big or small, near or far. Therefore, **Transformation to an expeditionary, network enabled Joint military force must occur with modern Space capabilities.** This Assessment has provided background information and outlined the importance of Space to operations. NATO must recognize that Space is absolutely essential for operations. Until the last few years, there were many reasons why NATO did not have to address Space operations, but it is imperative for security and defence that Space is now addressed.

Gap 1: *Space Power is not addressed at the same level as Land, Maritime, and Air Power.*

Recommendation 1: Issue a Bi-SC long-term vision statement on Space Power. Space Power is essential to NATO and the mission area should be expanded and matured. From the highest levels in the Alliance, it must be made clear that Space is vital to operations and a secure future. A proposed Vision for NATO Space Power could be: 'To ensure that Space capabilities contribute to network enabled Joint expeditionary military forces,

to better achieve desired effects.' Additionally, to increase awareness of Space capabilities and the importance of Space Power, NATO should develop a short Executive-level Space seminar to be briefed at the highest levels within NATO and the member Nations.

Leadership and an Holistic Approach

5.4. It has been observed that there is a lack of an holistic approach for Space operations. This includes the need for leadership at all levels to address the requirement to better integrate Space capability, particularly for ISR and expeditionary operations. NATO staffs do not have robust Space expertise; therefore, champions are needed at all levels to give the appropriate emphasis to Space operations. Commanders must encourage Space personnel to do their jobs to develop Space Power. Because Space touches so many mission areas and can be used for civil and military operations, an holistic approach is essential for Space operations. Commanders should have renewed vigour in determining warfighter capability requirements for Space operations and providing a long term plan for Space.

Gap 2: *Lack of oversight and holistic approach to Space operations.*
Recommendation 2: Establish a Space Office at NATO HQ. Establishing a NATO Space Office should be the number one priority of all the recommendations in this Assessment, as it will make important and long-lasting impacts on NATO Transformation. Figure 21 shows an holistic approach to Space to provide capabilities and effects to the warfighter. It has become clear that what is needed for NATO is a single office responsible for oversight of Space personnel and programs for the Alliance. In order to engage with international organizations and the Nations, to establish Space policy and positions, and to develop long range planning, and

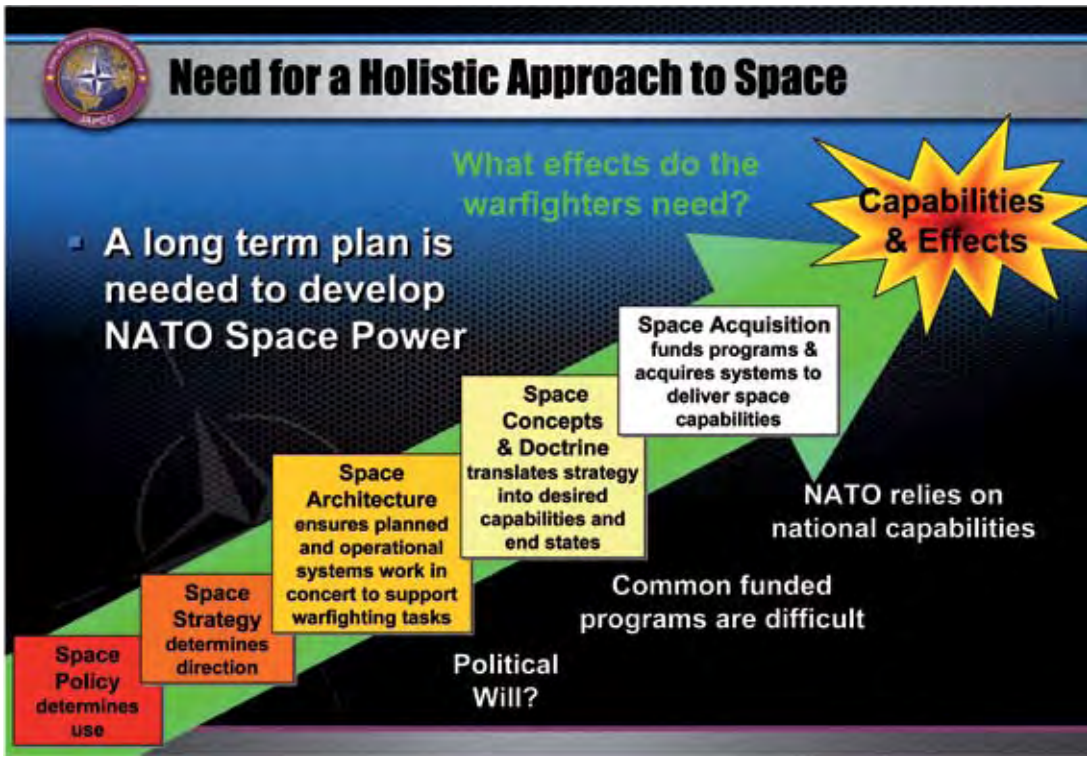

Figure 21 Holistic Approach to Space Power

a Space architecture for NATO, a Space Office should be established at NATO HQ. This office should have 8 positions: a Director and Deputy Director and two branches of three personnel each. One branch should be responsible for planning, programming and architectures while the other branch would be focused on current operations and the integration of existing capabilities. There should be a mix of military and civilian personnel for continuity and expertise. This office should be established immediately, and then could be given the overall responsibility to implement the recommendations of this Assessment.

Gap 3: *Lack of appropriate emphasis on Space Power by Commanders at all levels.*
Recommendation 3: Commanders at all levels should place an appropriate emphasis on fully developing and utilizing Space capabilities by issuing guidance to their organizations. Space supports all components and all operations; therefore, Space should be a priority for all commanders. Commanders at all levels should emphasize to their staffs the importance of fully utilizing Space capabilities. NATO should have a two pronged approach for addressing Space operations, from the top down and from the bottom up. At the highest levels, senior leadership must recognize the need for Space Power and establish governance. Strategic and Operational planners must better integrate existing Space capabilities and establish warfighter requirements for future capability. It is vital for commanders at all levels to enthusiastically support the integration and protection of Space services and capabilities.

Governance

5.5. NATO has very well established governance and doctrine for most mission areas. Governance and doctrine form the foundation of military planning and execution. Without overarching guidance, commanders and planners are left on their own to determine how to integrate and use Space. Governance also provides direction to the Alliance and member Nations. Nations should provide Space capability based on a long term Alliance Space strategy. Governance provides direction to ensure Alliance security and defence missions, while also avoiding needless duplication of effort. There is a distinct lack of governance for Space operations, from the highest level of strategic guidance down to TTPs.

Gap 4: *Lack of governance to include the need for a Space Policy, Military Space Strategy, Concept of Employment, Concept of Operations and appropriate Space doctrine.*
Recommendation 4: Develop a NATO Space Policy and Military Space Strategy. Nations must decide to address Space in an Alliance context. A key step will be the development of a Space Policy, from which the military staff can develop a strategy. Without these vital documents, using Space in truly transformational ways will be limited. To begin the debate, the JAPCC has prepared a separate paper titled ‘Considerations for a NATO Space Policy’, included at Annex H and ‘Tenets of a Military Space Strategy’ are included at Annex I. This should serve as a starting point for discussions. Subsequently, a Concept of Employment and a Concept of Operations should be developed. Establishment of doctrine and TTPs are also crucial. Work should begin immediately on an Allied Joint Publication for Space Operations and an Allied Joint Tactics Publication.

Gap 5: *Existing Space guidance is out of date.*
Recommendation 5: Revise all existing guidance directly related to Space operations, starting with the Bi-SC Functional Planning Guide for Space Operations. This includes AJP 3.3, the Bi-SC Functional Planning Guide for Space Operations, and ACT Dir 75-2-N Space Operations Joint Functional Area Training Guide. Additionally, the JWC should consider the development of an Operational Handbook for Space Operations until appropriate doctrine and TTPs are developed.

Force Development

5.6. The human dimension must be addressed. NATO forces are not properly organized, trained and equipped to integrate, utilize and conduct Space operations. There is an inadequate number of personnel assigned to perform Space operations duties. The few assigned Space personnel are not properly employed. Headquarters staff at all levels do not have the required level of Space expertise. NATO must treat Space the same as it treats Air and other domains. There must be appropriate organizations to provide Space capabilities and personnel educated and trained on Space.

Gap 6: *A general lack of awareness and education on Space Operations.*
Recommendation 6: Awareness of Space should be incorporated at military education courses, such as at National and NATO Staff Colleges. NATO and Nations should build expertise by sending students to universities, such as the International Space University, and others, and increase cooperation with other United States and European schools with Space expertise. Additionally, staffs receiving training and briefings should also routinely have awareness training on Space operations. Those Nations with Space training should make a greater effort to make Space training available to the Alliance.

Gap 7: *Lack of Space personnel and expertise on staffs at all levels.*
Recommendation 7: Establish a Senior Space Officer position at ACT and ACO and appropriate Space positions within the Command Structure to provide focus and advice to senior leaders. The positions at ACT and ACO should be led by an experienced Space specialist at the OF-5 or higher level. Furthermore, personnel should be assigned at all levels, to include the various components, JFCs and organizations. A detailed proposal is included at Annex J. With currently 7 assigned Space operations personnel across NATO, the JAPCC recommends an additional 32 positions, for a total of 39 Space operations billets. Future considerations should also include creating Space Intelligence specialists to be able to assess Space threats and vulnerabilities. Furthermore, a Space Operations Working Group under the NATO Standardization Agency (like the current Air Operations Working Group, Maritime Operations Working Group, and Land Operations Working Group) may not be needed at this time. However, in the future, to provide oversight and ensure an holistic and comprehensive approach to Space, a Space Operations Steering Group should be established at the Military Committee and Bi-SC level, followed by the creation of a Space Operations Working Group under the NATO Air Force Armaments Group (NAFAG). A Space Operations Integrated Capabilities Development Team (ICDT) could be established to provide coordination and oversight.

Recommendation 8: Establish Space positions at NC3A. NATO requires Space expertise and the ability to conduct analysis and studies. A Senior Space Scientist position should be created as well as a Space IPT, consisting of 3 Space scientists. This IPT would be able to support the proposed Space Office as well as ACT and ACO. While NC3A has expertise in SATCOM, Geospatial Intelligence (GEOINT) and other Space related areas, there is a lack of expertise in some areas. A dedicated Space IPT would be part of the holistic approach to Space operations.

Recommendation 9: Develop a core of Space specialists. Initially, Nations could probably contribute a few of their Space operations personnel to fill new NATO staff positions. However, since there are so few Space experts in most of the Nations, NATO would have to grow an organic Space expertise. Personnel with operational, intelligence, communications or other areas of expertise with the ability to learn a technical mission area, could be selected for a 3 year Space operations special duty posting. NATO would have to create a training pipeline, but could leverage existing NATO and national training courses. With some fundamental training and education, these officers would 'learn by doing' and perform Space planning duties. Manning should be Joint and multi-national, NOT just USAF Space operations personnel. The added benefit is that these officers would return to their National forces, further increasing Space expertise in the Alliance. Additionally, since the United States has over 4500 Space operators, NATO and European nations should investigate increased exchange officer opportunities. Since the Air domain has matured over the last decades, one possibility may be to change existing exchange officers from pilots to Space officers. Furthermore, it is highly recommended to establish a United States Strategic Command Joint Functional Component Command Space (JFCC-Space) Liaison at SHAPE, as well as EDA and ESA Liaison positions in ACT to better cooperate on, and integrate Space activities.

Gap 8: *Lack of training to properly integrate and use Space Power.*
Recommendation 10: Space should immediately be incorporated into National and NATO training. ACT DIR 75-2-N Space Operations Joint Functional Area Training Guide states: 'in order for the future of NATO operations to be successful and modernized, Space must be integrated effectively. Personnel with Space backgrounds and expertise should be placed in Strategic, Operational, and Tactical Headquarters. The training must be conducted as a routine part of the normal training cycle and must not be deferred until the outbreak of action.' However, NATO currently lacks Space experience and personnel to provide robust and realistic exercises and training. The NATO School's Space Operational Planning Course should be kept up to date and relevant as possible. It is critical that NATO organizations support the course with guest speakers and students.

Gap 9: *Lack of Space operations activities in exercises and wargames.*
Recommendation 11: Space events should immediately be incorporated into National and NATO exercises and wargames. NATO does not have Space expertise on staff for exercise planning; it should ask for support from the Nations, while developing its own capability. The United States, France, ESA and others,

have personnel with wargame and exercise planning experience. It is vital to train in peacetime to be effective in combat. It takes time to build expertise, create realistic inputs and scenarios and to field the required Space related equipment and systems. Operational commanders must be challenged with adversary use of Space, and denial of their own access to Space capabilities, which will highlight the need to develop NATO Space Power. The Joint Warfare Centre and JFCs should immediately begin incorporating Space activities in exercises at all levels.

Planning and Integration

5.7. NATO should better integrate and use Space capabilities. One example is Space ISR systems. A major limiting factor is the inability to exchange intelligence due to classification caveats. NATO must continue to advocate the sharing of intelligence information and re-evaluating the classification of national intelligence products. Key to employment of Space capability is the planning and integration done in advance of a crisis. Effort must be made to fight jointly. NATO has been able to integrate land, maritime and air forces. Certain aspects of Space are already integrated. However, as NATO develops and integrates Space capabilities, the same level of effort must be made to maximize the use of Space. The United States' primary method of integrating Space into the fight is through CAOCs and warfighting headquarters. NATO CAOCs do not have Space operators as part of their manning construct. A NATO Space Operations Coordination Centre (NSpOCC) may be needed to fuse national Space capabilities.

Gap 10: *Lack of adequate integration and planning at all levels.*

Recommendation 12: Currently assigned Space operations personnel should be better utilized. NATO Space specialists should be actively pursuing Space integration and better utilization of Space capabilities, not other duties. Furthermore, since NATO does not have adequate Space operations doctrine, these specialists should address issues such as: fully developing the concept of a Space Coordinating Authority (SCA) and what is the proper construct for Space personnel in an expeditionary force or Combined Joint Operations Centre (CJOC)? Space supports all the components; therefore, requests for Space support must be consolidated at the Joint level. Typically, an Air Component Commander will be assigned responsibility for Space; therefore, it is recommended that NATO assign Space Planners to each of the planned CAOCs, with the first priority being the Interim Deployable CAOCs (IDCAOC). However, there remains a need for someone at the Joint level to be assigned overall responsibility for Space. For example, Space capabilities can be utilized for FFT, Missile Warning, support to Personnel Recovery, conducting counter-narcotic and Counter-Improvised Explosive Device (C-IED) operations. Space personnel should be focused on delivering value to the warfighter. The NATO CAOCs should build relationships with United States CAOCs which have Space personnel assigned to them. In light of the recent NATO Summit, where its members recognized the emerging need to protect NATO (and Europe in particular) from Missile Attack, the value of a reliable Ballistic Missile Warning and Tracking System based on space-based sensors to achieve this goal should be stressed in order to trigger and promote NATO activities in that area.

Gap 11: *Lack of integration and planning to support expeditionary operations.*
Recommendation 13: Conduct an assessment of Space operations in the ISAF and the NRF to provide specific recommendations on how Space Power can be better integrated into NATO Expeditionary Operations. NATO must leverage existing Space expertise and capabilities to more effectively plan, integrate and support expeditionary forces and out of area operations. The NRF and groups such as the Expeditionary Operations ICDT do not have Space expertise. It is essential that Space expertise from other organizations is leveraged to the maximum extent possible. Expeditionary Operations planners should continue to leverage Space-related expertise in missile defence, ISR, communications, etc. An assessment of ISAF and NRF Space needs is critical to identifying valid capability requirements and to then incorporate them into the existing requirements processes.

Gap 12: *NATO forces are not fully utilizing commercially available Space services and products.*
Recommendation 14: Continue to utilise and expand use of Commercial Satellite Imagery (CSI). CSI has proven extremely useful to decision makers and warfighters and its use should be increased. NC3A published a NATO Restricted report in April of 2007 entitled 'Investigation into the optimum provision of commercial satellite imagery into the International Stabilisation of Afghanistan Force.' This report was initiated to capture the CSI requirements in terms of resolution, access times, age of data and product accuracy. Potential methods of accessing data were also investigated. This was followed in April 2008 with the unclassified report 'Study on availability of high resolution satellite data.' The study considered 22 satellites with high resolution (10 metres or less) optical satellite sensors and 7 high resolution radar satellites. For military applications requiring 1 metre or better resolution the following commercial satellites were identified: EROS, GeoEye, IKONOS, IRS 2A, KOMPSAT 2, OrbView 3, Pleiades, Quickbird and WorldView satellites. Three radar satellites provided at least 1 m resolution: TerraSAR-X, RISAT and COSMO-SkyMed.[31] NATO should more aggressively pursue arrangements, procedures and training to integrate these existing Space ISR capabilities. **Unfortunately, while there are terabytes of data available, there are challenges in analysis and dissemination to the front lines. Training of both operations and intelligence personnel on space-based ISR products and request procedures is vital to success. The goal is to get the right intelligence to the right person at the right time. Many planners and warfighters are not aware of the capabilities and availability of CSI and therefore don't request those products.** NATO GEOINT personnel must actively market available capability and products. Use in training and exercises prior to deployment would greatly enhance use during combat operations. Furthermore, NATO should become involved in European Space activities such as the Global Monitoring for Environment and Security (GMES), the Multinational Space-based Imaging System (MUSIS), Galileo, and the European Space Situational Awareness Project. NATO must ensure that information from GMES, MUSIS and other national systems are available for NATO forces. Furthermore, NATO should articulate its military requirements to owners of these programmes.

[31] 'Study on availability of high resolution satellite data,' NC3A Report April 2008. This document is a working paper and does NOT represent a formally approved NC3A opinion, conclusion or recommendation.

Gap 13: *NATO has not fully integrated national Space capabilities and systems.*
Recommendation 15: Increase sharing of National space-based ISR information and products by developing appropriate procedures, and security and data management policies. In the last couple of years, there has been significant Space-based IMINT capability developed by the Nations and commercial companies. Clear and comprehensive data management and exchange policies and procedures must be more fully developed. Is there a way to increase the data available to the Alliance from National Space systems? Is there a way to make such data more accessible to the soldier in the field, the air planner, or the sailor on the ship? The United States has significant military Space capability. Canada and the European nations are fielding their own national Space capabilities. It is necessary for NATO to make the best use of those capabilities. NATO efforts such as MAJIIC and NSP2K offer opportunities for better integration and sharing of data. NATO Strategic Commands and Nations should look into how to support and contribute to these capabilities to the greatest extent possible. Additionally, the Intelligence Fusion Centre should explore further methods of acquiring and sharing Space data and information. NATO's RTO and NC3A should explore technologies that will help to protect classified information while simultaneously allowing for its greatest possible availability.

Recommendation 16: Establish a NATO Space Operations Coordination Centre (NSpOCC). The NSpOCC would provide a single point of contact, around the clock, where any NATO force could reach back for Space support. SpSA is required for assuring the Space domain. Efforts should be made to establish closer ties with the United States Joint Space Operations Center (JSpOC) and the various European Space and satellite centres. This allows a 'one stop shop for Space' that would support many customers and operations at the same time and be a force multiplier for the warfighter. A key step will be to identify the necessary tools and systems that will be required for the NSpOCC. The Nations and commercial operators would provide data feeds for NSpOCC; not operating the satellites. Responsibilities would include coordination of National Space assets, Space intelligence and analysis, status monitoring and other Space specific tasks. Low cost and near-term capability could be obtained by establishing a Space cell at an existing CAOC or other operations centre. One possibility could be in Kalkar/Uedem Germany, where the JAPCC, CAOC2/IDCAOC, the German national Air Policing Centre and in the near future, the German Space Situational Awareness Centre. Other options include collocating it with the Intelligence Fusion Centre in the United Kingdom or the EU Satellite Centre in Spain. A NSpOCC would most certainly leverage existing facilities and capabilities. The NSpOCC would provide NATO the ability to have a Space Order of Battle and to maintain strategic SpSA.

Concept Development and Experimentation

5.8. Due to the lack of NATO personnel with Space expertise, there is a distinct lack of Space concept development. Furthermore, operations in Afghanistan and elsewhere can provide valuable lessons if they are captured and implemented into exercises and training. TTPs are also being tested and developed, in particular by United States Space operators in Southwest Asia, but are not being adequately documented.

There are many thought pieces, future capabilities vision documents and the like that do not adequately incorporate Space Power.

Gap 14: *Lack of Space Power thoughts and concepts in doctrine development, wargames, thought papers, etc.*
Recommendation 17: Assigned and external Space personnel should be better leveraged to develop Space Power thoughts and concepts for the Alliance and the Nations. Discussions, concept papers and conferences should include discussions on space-related issues. The few assigned Space specialists should be more focused on leveraging Space capabilities for Alliance forces and there is no existing forum to facilitate discussions, identification of issues or develop Space Power concepts. NATO should continue to utilize the JAPCC to develop thoughts on Space Power. Organizations such as the JWC, Joint Analysis and Lessons Learned Centre (JALLC), NC3A, the RTO and others should build their Space expertise to be able to contribute to moving the Alliance forward in developing Space Power. Furthermore, NATO should establish space-related symposiums, conferences and other forums.

Recommendation 18: Capture space-related lessons learned and best practices into doctrine and TTPs. It is always a challenge to learn from one's experience. All military forces plan, execute, monitor and assess operations. Processes are in place to develop tactics, capture lessons learned and incorporate them in exercises in training, hopefully before the next operational deployment. The same process must be applied to Space operations. Cutting edge ideas and technology are being tested in Afghanistan, NATO and the Nations must not lose experience gained in the field. Additionally, some Nations are ahead of NATO in developing Space doctrine and guidance, and NATO should use those documents to build its own expertise.

Programme Management

5.9. Some Space mission areas such as SATCOM are mature and mission requirements are well understood. However, NATO must understand and prioritize how to best utilize Space Power. Space-related activities may take place in C2 of forces, theatre missile warning and tracking and defence, PNT, global situational awareness, FFT, and intelligence and operations planning. However, NATO has not adequately determined what its requirements for Space capabilities are, nor provided oversight on Space research and technology development. Since there is little oversight of Space operations, NATO must better determine its operational requirements for future capabilities. Challenges with cost overruns, programme delays, political agendas, and rapidly changing technology make programme management seem very daunting. Leadership, oversight and clear capability requirements are essential.

Gap 15: *Insufficient understanding of Space capabilities and lack of prioritization of Space operations capability requirements.*
Recommendation 19: Develop a Space Road Map. An holistic, rigorous, and structured approach is required for Space operations, which should include a road map or other long term plan for Space. Emerging Space technology, such as constellations of small satellites, must be assessed for military utility for NATO. There must be a close dialogue between Nations developing their own systems.

SpSA and SC capabilities are required by NATO. However, these capabilities must be evaluated and prioritized against many competing demands. Warfighters clearly need capabilities provided by Space Power. NATO must deliver the best possible capabilities to those in harms way. A Space Road Map would establish the long-term priorities and goals for the Alliance.

Gap 16: *Lack of oversight for Space research and technology programmes.*
Recommendation 20: Establish permanent oversight for Space research, technology and development. The RTO is challenged by a small staff trying to provide oversight to many research areas. Since the Space Science and Technology Advisory Group (SSTAG) expired, there is a gap in NATO's oversight and management of Space research and technology. Options include a Space Operations Steering Committee, a Working Group, or some other formal body. NATO spends resources on Space research, and therefore should optimally manage those funds and personnel. A Space Strategy and other high level guidance would also help to provide direction to researchers and programme managers.

Gap 17: *Lack of robust Space operations involvement in the DRR process and long term capability planning.*
Recommendation 21: Conduct a formal study on the need for SpSA, capabilities to assure the Space domain, and the potential utility of small satellites. The DRR process should apply as much effort to the Space working group as it does to other disciplines. The results should be incorporated into defining future NATO Space capability requirements. The availability of satellites to support any military operation is no longer a desired capability, but rather a key requirement. However, it is not only a matter of spending more money, but spending it more wisely. The key is to ensure operational requirements are stated with respect to performance, availability, robustness, mission confidentiality and security.

Standards and Interoperability

5.10. For all Allied military systems, there is a need for robust standards and interoperability for Space systems. Member Nations will continue to develop their own Space capability; it is critical for NATO to issue standards so that in the future, data may be easily exchanged in a network-enabled environment. There are many organizations involved with standardization and interoperability of Space related capabilities, but more work must be completed. Developing technologies, such as missile defence, FFT, and SpSA must receive the appropriate level of standards to ensure interoperability of data, information and systems. NATO has focused significant efforts on standardization and interoperability of C4ISR systems, some of which are Space systems. Efforts should continue to have high emphasis placed on C4ISR systems as they are the backbone to all operations. NATO should continue to establish formal agreements to share and exchange information from Space based systems.

Gap 18: *Lack of a comprehensive review of Space related STANAGs to determine specific technical areas to be addressed.*
Recommendation 22: Review existing space-related systems and capabilities to ensure maximum standardization and interoperability.

The C4ISR process is regulated by a significant number of STANAGs. A focus area should be increasing the exchange of Space ISR information and Space surveillance data. There is great potential for FFT systems, and NATO must ensure they are standardized between common funded and National systems. There is an urgent need to ensure the interoperability of Space systems currently under development by the Nations.

Gap 19: *Lack of comprehensive management for interoperability of current and future Space systems remote sensing data, such as small ISR satellites and Space surveillance data.*

Recommendation 23: Engage with the Nations, EU, ESA and the EDA to define security and defence requirements for existing and planned Space systems. Establishing a NATO Space Office will enable the Alliance to engage with other organizations. Because there is no office responsible for Space in NATO, the Nations, EU, ESA and EDA have no mechanism to interact, other than in functional mission areas. This is not an adequate approach. For example, there are several programmes trying to connect various databases and insure the widest dissemination of intelligence data. NATO should have a common database for commercial satellite imagery and other products. If NATO were to develop its own small satellite capability or receive data supplied from the Nations or other sources, the data must be readily available and releasable to its forces. Efforts must continue to allow greater information exchange and better dissemination of intelligence. **Increasing fiscal constraints demand increased cooperation to create synergy, reduce duplication of effort and ensure interoperability. We cannot afford to make critical acquisition mistakes and fail to deliver the required capabilities to our soldiers, sailors and airmen.**

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Chapter 6 – Conclusions

Victory smiles upon those who anticipate the changes in the character of war, not upon those who wait to adapt themselves after the changes occur.

Giulio Douhet

If I always appear prepared, it is because before entering on an undertaking, I have meditated for long and have foreseen what may occur. It is not genius which reveals to me suddenly and secretly what I should do in circumstances unexpected by others; it is thought and preparation.

Napoléon

6.1. This NATO Space Operations Assessment focuses attention on the importance of Space to current operations and to transformational ambitions. Its aim is to inform and influence commanders and policy makers about NATO's vital Space interests, identify capability gaps, and it offers recommendations to address those gaps. There are many member Nations operating satellites and pursuing their own National Space priorities, sometimes in parallel, but often on divergent paths. NATO's approach to Space is piece-meal, a bottom-up effort with no overarching structure or direction. NATO has an opportunity to shape the Alliances' future Space capabilities and this Assessment offers a basis to guide the way forward.

6.2. The Assessment includes valuable input from 33 stakeholder organizations that participated in a Space Workshop hosted by the JAPCC in April 2008, thereby creating momentum for a NATO Space initiative. This Assessment identifies 19 gaps and 23 recommendations on key areas such as governance, force development, training, concept development and experimentation, standards and interoperability. There are short and long-term recommendations, but all are designed to strengthen NATO's capability as an expeditionary and network-enabled force.

6.3. There are always costs associated with change and transformation. However, Space can truly be transformational for NATO even with only a small investment. Existing governance already dictates space-related activities that NATO should be performing and new tools and capabilities are required for planning and operations. Many of the recommendations are low or no cost, only requiring the political will to implement. Investing in the establishment of a Space Office will reap huge benefits for the Alliance and all of the Nations will benefit from this action. Even the establishment of a NSpOCC would not have to be a major capital investment. In fact, many of these recommendations are aimed at an holistic approach to better utilize scarce resources.

6.4. Space Has Become 'Ordinary'. Many Nations are operating their own satellites and ALL of those Nations rely strategically, militarily and commercially upon information and services from Space. NATO began flying its own communication satellites in 1970, almost 40 years ago. Once available to only a few nations, those 'highly classified state secret' capabilities and products are now widely available from commercial Space service companies. Space has become quite ordinary and it is time to break the paradigm that Space capabilities are veiled in secrecy, are strategic in nature only or are too politically sensitive to discuss in an Alliance forum. As responsible military leaders, we need to recognize that Space is just another mission area and

it is long past time to develop Space Power. Space-based capabilities and services are so important to today's operations that NATO cannot afford not to address this mission area.

6.5. Space is a Critical Enabler. Space is vital to expeditionary and out of area operations. In performing its core missions, NATO's operations are entirely dependent on Space, possibly even non-functional without Space support, yet NATO has no holistic approach to Space operations. Globalization demands Space capability as a requisite enabler of NATO's transformation as an expeditionary, network-enabled force. Space provides those joint enabling capabilities that we've become reliant upon for global situational awareness, decision superiority and precision engagement. Consequently, the United States military often refers to Operation Desert Storm in 1991 as the 'first Space war' because almost every aspect of operations was dependent to some extent on support from space-based systems. Today, NATO is faced with its 'first Space war' in Afghanistan. We must focus on how to use Space assets to enhance our capability and to generate desired effects. This requires a well thought out approach.

6.6. Need for Deliberate Planning and Governance. Defence systems take many years to develop, test and field. Our soldiers, sailors and airmen need Space capabilities to achieve effects and we need to deliver systems and services to meet their needs. As such, NATO must assure access to, and make better use of, the Space domain. To date, there is little governance addressing the Space domain. There is no holistic approach for Space; systems are addressed in functional areas, even though most Space systems support more than one mission or functional area. Therefore, a NATO Space Policy is very much needed to define the direction for the use of Space capabilities by the Alliance. From this starting point, a Military Space Strategy can be developed. These strategic level documents are needed to develop sound concepts, plans and system requirements. Governance and well thought out deliberate planning will ensure that the Alliance has the Space capabilities needed to meet its mission objectives for years to come.

6.7. Need for Increased Cooperation. No Nation can afford to go it alone. There are more requirements for Space capabilities than resources. However, there are already a lot of Space capabilities available to NATO. Nations, as well as commercial Space service companies, have the existing capability to provide much of what NATO may need for communications, ISR and other mission areas. Moreover, there are emerging mission areas, such as the need to assure and protect our Space capabilities, the need to improve SpSA and the need to begin conducting CSO. Furthermore, the development of small satellite technology offers the opportunity for many more Nations to become involved in the Space business. In order to best utilize existing capabilities, to reduce duplication of effort on future systems and to ensure interoperability of Space services and products, there must be increased cooperation on Space between the Nations, NATO and other organizations. NATO must engage with the Nations, EU, ESA and the EDA to define security and defence requirements for existing and planned Space systems.

6.8. The Road Ahead. Although the development of a NATO Space Policy is considered critical, it would be a long-term effort. There are, however, a few immediate actions that would pay great dividends for NATO transformation. In particular, quick wins could be realized by putting more emphasis on Space in exercises and incorporating Space expertise into the NATO Command Structure. NATO must have an appropriate number of Space specialists assigned to its Command Structure organizations. This should include the Strategic Command HQs, the Joint Force Commands, and the Joint Warfare Centre as a minimum. There should also be a strategic level effort to champion the development of Space Power by advocating a Space Policy and Strategy. Additionally, NATO nations should immediately begin incorporating Space activities into National training and exercises. To begin conducting Combined Space Operations, a Space Office at the NATO Headquarters and a NATO Space Operations Coordination Centre are needed. They will integrate NATO and National Space capabilities and to provide a single point of contact for NATO Space matters, to include support to the warfighter in the field. NATO must also determine its requirements for SpSA and its need to protect Space capabilities and services. Oversight is also required for Space research and technology.

6.9. There are consequences and risks if NATO does not begin to address Space operations immediately. Historically, Space systems have been politically sensitive and considered a National strategic asset, but times are changing. Space is not the mystery it once was and is now affordable to many Nations. Most importantly, lest we forget, NATO has airmen, soldiers and sailors conducting combat operations around the world in remote, austere conditions. Military planners and operators are desperate for more Space capabilities to achieve desired effects, but do not have the programmes, doctrine and training required. As the Alliance has developed Land, Sea and Air Power, it is long past time to develop Space Power. The JAPCC has targeted its crosshairs on Space with the NATO Space Operations Assessment. NATO … it is now time for action!

NATO must make better use of, and assure access to, the Space domain.

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Annex A: Summary of Recommendations

1. Issue a Bi-Strategic Command (SC) long-term vision statement on Space Power.
2. Establish a Space Office at NATO HQ.
3. Commanders at all levels should place an appropriate emphasis on fully developing and utilizing Space capabilities by issuing guidance to their organizations.
4. Develop a NATO Space Policy and Military Space Strategy.
5. Revise all existing guidance directly related to Space, starting with the Bi-SC Functional Planning Guide for Space Operations.
6. Awareness of Space should be incorporated at military education courses, such as at National and NATO Staff Colleges.
7. Establish a Senior Space Officer position at Allied Command Transformation (ACT) and Allied Command Operations (ACO) and appropriate Space specialist positions within the Command Structure to provide focus and advice to senior leaders.
8. Establish Space positions at the NATO Command, Control, and Consultation Agency (NC3A).
9. Develop a core of Space specialists.
10. Space should immediately be incorporated into National and NATO training.
11. Space events should immediately be incorporated into National and NATO exercises and wargames.
12. Currently assigned Space operations planners should be better utilized.
13. Conduct an assessment of Space operations in the International Security Assistance Force (ISAF) and the NATO Response Force (NRF) to provide specific recommendations on how Space Power can be better integrated into NATO Expeditionary Operations.
14. Continue to utilise and expand use of Commercial Satellite Imagery (CSI).
15. Increase sharing of National space-based ISR information and products by developing appropriate procedures, and security and data management policies.
16. Establish a NATO Space Operations Coordination Centre (NSpOCC).
17. Assigned and external Space personnel should be better leveraged to develop Space Power thoughts and concepts for the Alliance and the Nations.
18. Capture space-related lessons learned and incorporate best practices into doctrine and Tactics, Techniques, and Procedures (TTPs).
19. Develop a Space Road Map.
20. Establish permanent oversight for Space research, technology and development.
21. Conduct a formal study on the need for Space Situational Awareness (SpSA), capabilities to assure the Space domain, and the potential utility of small satellites.
22. Review existing space-related systems and capabilities to ensure maximum standardization and interoperability.
23. Engage with the Nations, European Union (EU), European Space Agency (ESA) and the European Defence Agency (EDA) to define security and defence requirements for existing and planned Space systems.

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Non-Sensitive Information – Releasable to the Public

Annex B: NATO Space Operations Overview Briefing

World's Space "Aces" – Space is "Ordinary"

15 NATO nations operate satellites

Space "Aces" flying 5 or more satellites:
26 Countries
9 Organizations

Country Organization	Satellites	Space Probes	Debris	Total
US	986	60	2,551	3,597
Russia*	1,389	35	2,033	3,437
People's Republic of China	63	1	2,595	2,659
France	45	0	212	257
Japan	102	10	32	144
India	34	0	97	131
European Space Agency	37	6	30	73
Intl. Telecom Sat. Org.	63	0	0	63
Globalstar	60	0	0	60
CHBZ	3	0	56	59
Orbcomm	35	0	0	35
European Telecom Sat. Org.	28	0	0	28
Canada	25	0	2	27
Germany	25	2	0	27
United Kingdom	25	0	0	25
Luxembourg	15	0	0	15
Italy	14	0	0	14
Saudi Arabia	12	0	0	12
Australia	11	0	0	11
Brazil	11	0	0	11
Int. Maritime Sat. Org.	11	0	0	11
Sweden	11	0	0	11
Argentina	10	0	0	10
Indonesia	10	0	0	10
South Korea	10	0	0	10
ISS	1	3	5	9
Spain	9	0	0	9
Arab Sat. Comm. Org.	8	0	0	8
NATO	8	0	0	8
Taiwan	8	0	0	8
Israel	7	0	0	7
Mexico	7	0	0	7
Thailand	6	0	0	6
Czech Republic	5	0	0	5
Netherlands	5	0	0	5
Turkey	5	0	0	5
Other	45	0	2	47
Total	**3,129**	**117**	**7,615**	**10,861**

Aspiring "Aces": (less than 5 sats)
Algeria
Chile
Denmark
Egypt
Greece
Iran
Malaysia
Nigeria
Norway
Pakistan
Philippines
Portugal
And others…

From Air Force Magazine, August 2008 (Data as of Dec 2007)

Space Operations Mission Areas

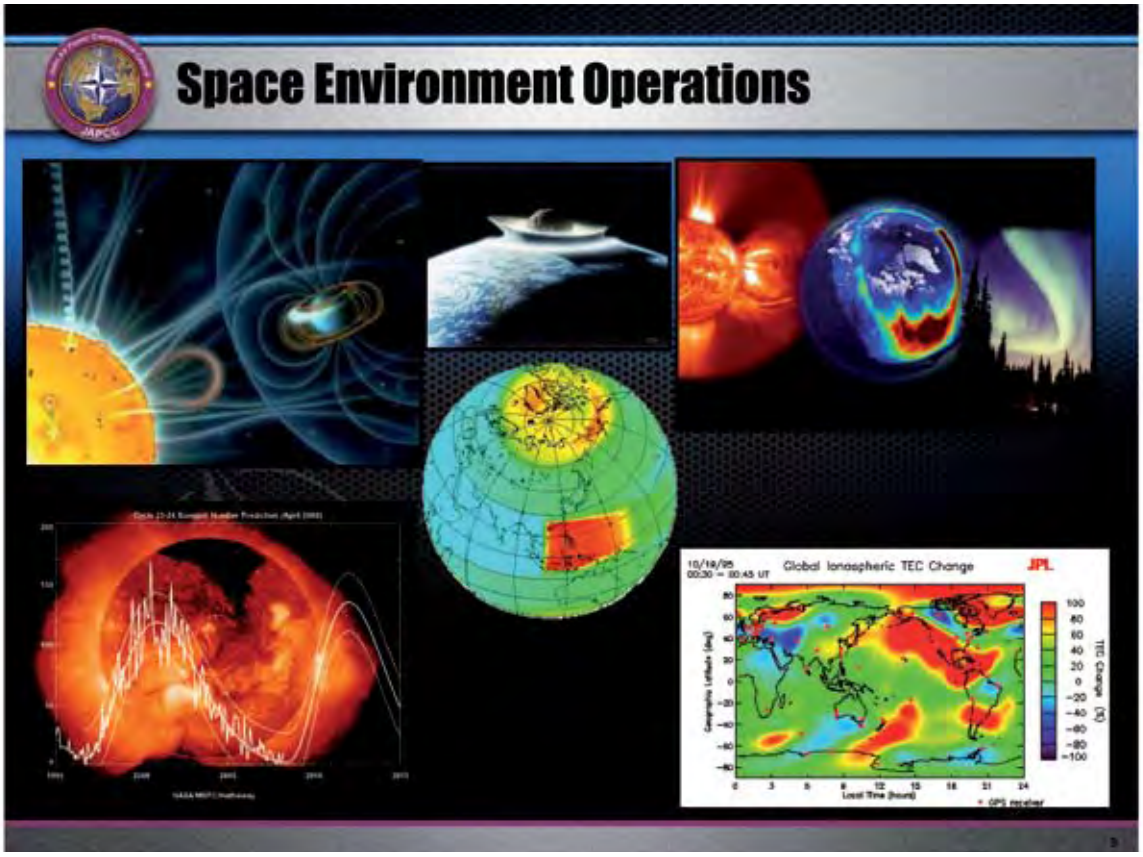
AJP 3.3 Air & Space Operations (2002)

Space Control	Counterspace	Achieving and maintaining space superiority
	Contributing Capabilities	Space Surveillance
		Space Environment Ops
		Satellite Operations
		Spacelift Operations
Force Enhancement	Improving combat effectiveness of military forces using space systems	
	Surveillance of Terrestrial Environment	
	Environmental Sensing	
	Ballistic Missile Warning	
	Navigation and Positioning	
	Communications	

Non-Sensitive Information – Releasable to the Public

Space Control
Television station in Kabul

Space Control - Counterspace
Offensive Counterspace – destroy or neutalize an adversary's space systems or the information they provide
Deception, Disruption, Denial, Destruction
Network & ground segment attacks, ASAT attack
Defensive Counterspace – reduce and preclude an adversary's counterspace operations and preserve our ability to use friendly space systems
Active Defense, Passive Defense
Encryption, hardening, redundancy, deception
Space Situational Awareness
Protection
Prevention



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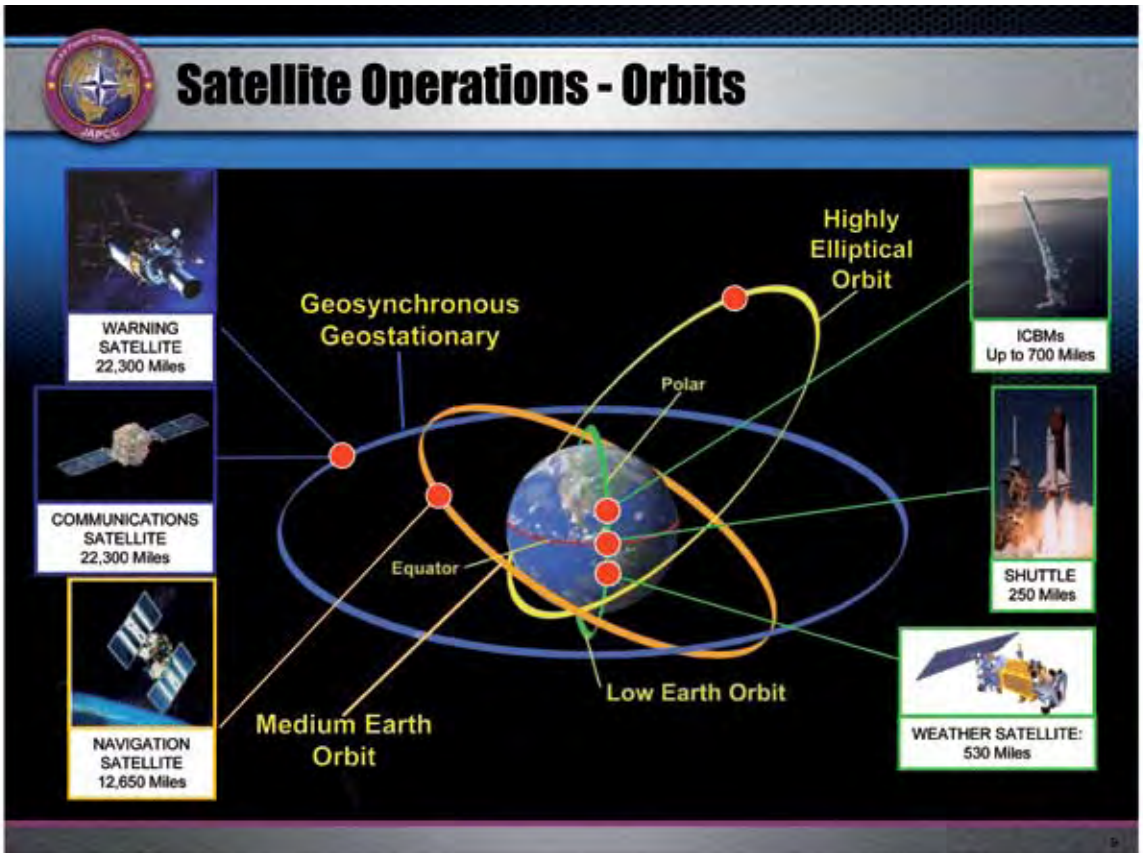
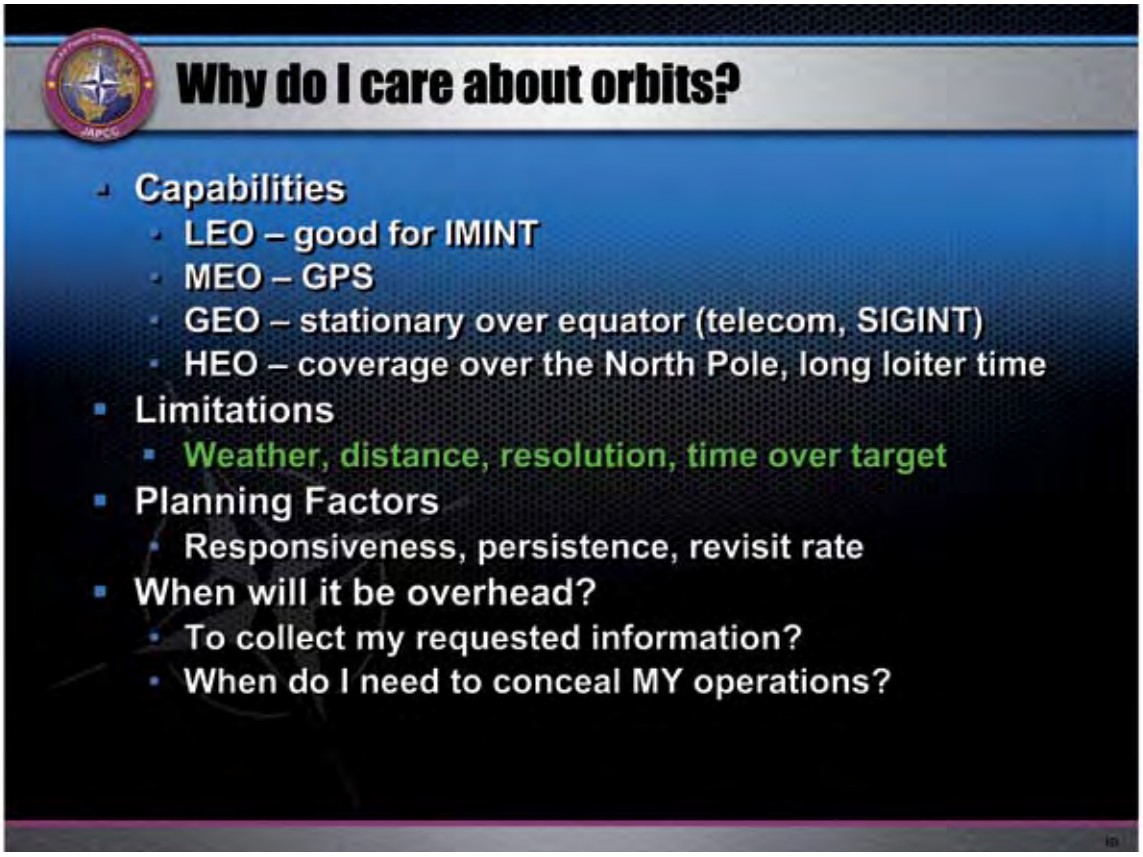
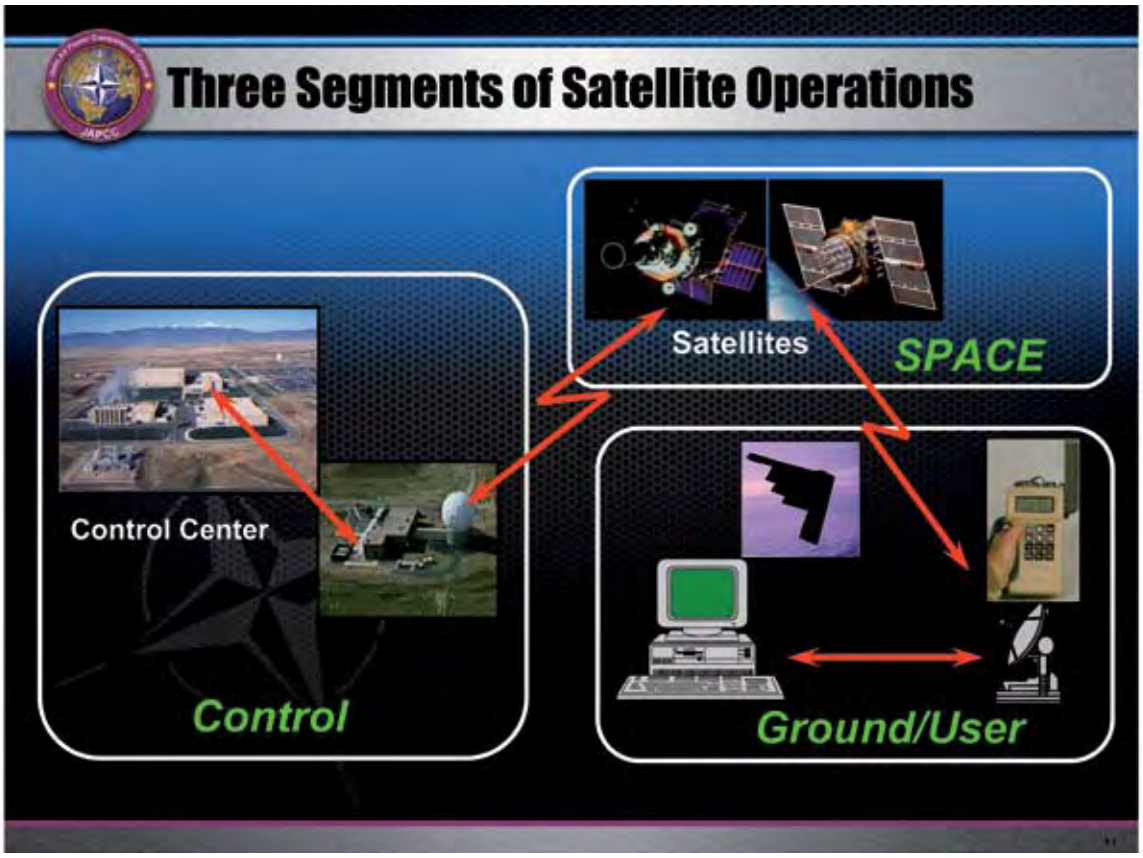
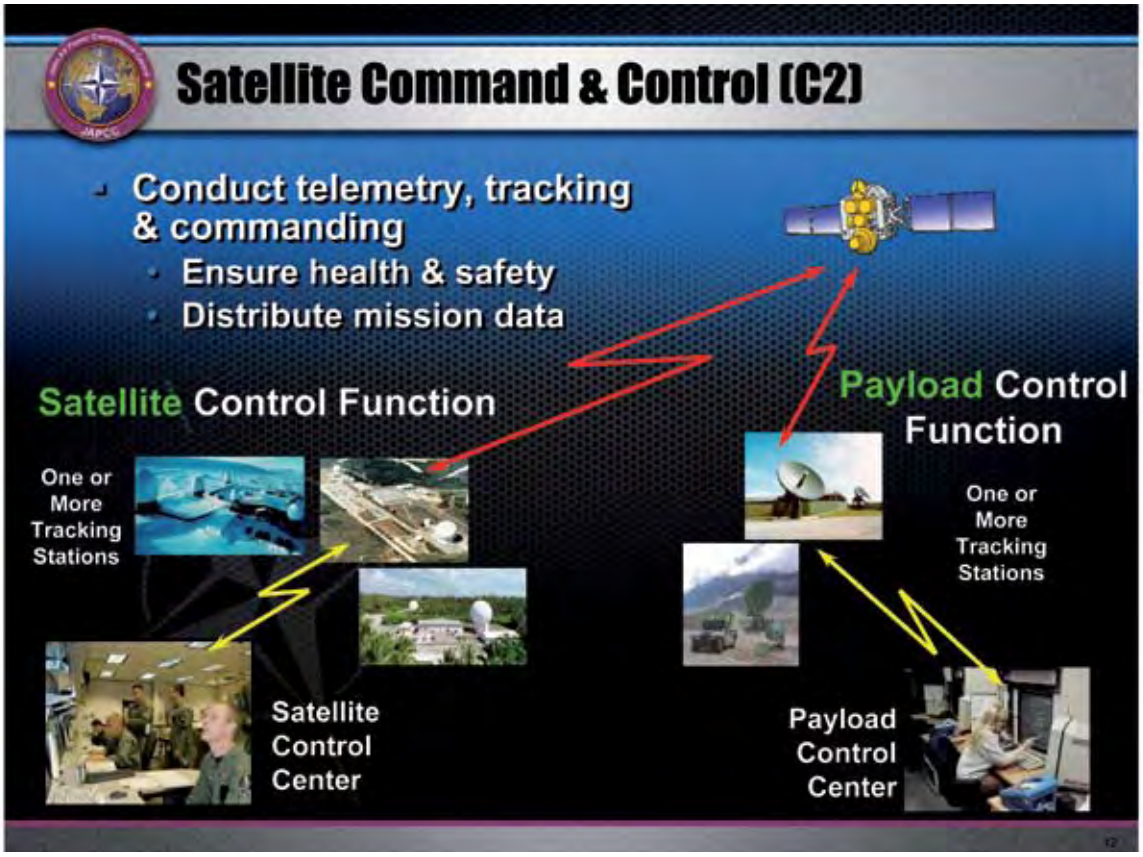

Satellite Operations - Orbits
WARNING SATELLITE 22,300 Miles
COMMUNICATIONS SATELLITE 22,300 Miles
NAVIGATION SATELLITE 12,650 Miles
Geosynchronous Geostationary
Highly Elliptical Orbit
Polar
Equator
Medium Earth Orbit
Low Earth Orbit
ICBMs Up to 700 Miles
SHUTTLE 250 Miles
WEATHER SATELLITE: 530 Miles


Why do I care about orbits?
Capabilities
LEO – good for IMINT
MEO – GPS
GEO – stationary over equator (telecom, SIGINT)
HEO – coverage over the North Pole, long loiter time
Limitations
Weather, distance, resolution, time over target
Planning Factors
Responsiveness, persistence, revisit rate
When will it be overhead?
To collect my requested information?
When do I need to conceal MY operations?





Non-Sensitive Information – Releasable to the Public

Satellite Operations Considerations

- Satellites have "anomalies" and scheduled maintenance (but we have to fix them from the ground!)
  - Can potentially impact ops
- Satellite Operations
  - Ground Segment most vulnerable segment
  - Protecting them is vital to the satellite's mission
- Space operations crews have specialists on satellite subsystems, commanding, ground systems and the payload
- Satellites don't just stay in orbit, we have to work to keep them there!

Spacelift Operations

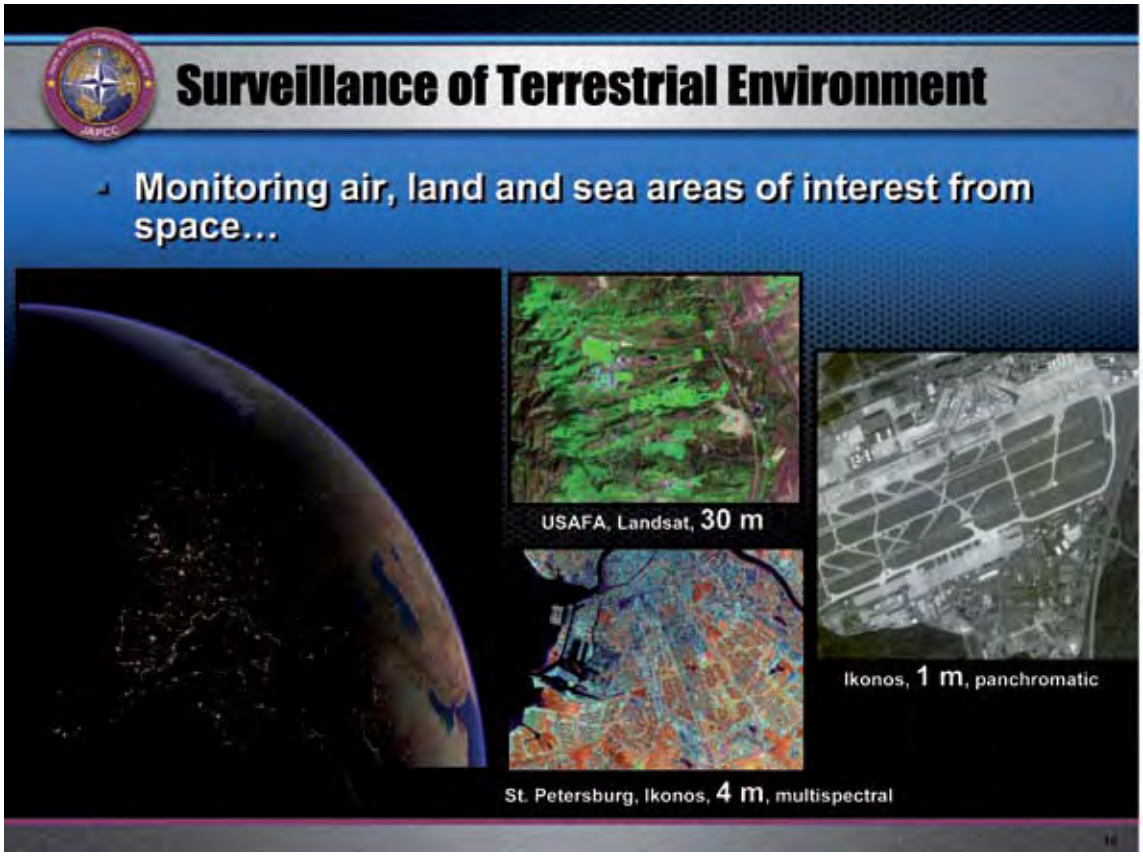
- Deliver satellites, payloads and material to space

SPACE SHUTTLE

DELTA IV

ATLAS V

ARIANE FAMILY



Non-Sensitive Information – Releasable to the Public

Intelligence, Surveillance & Reconnaissance

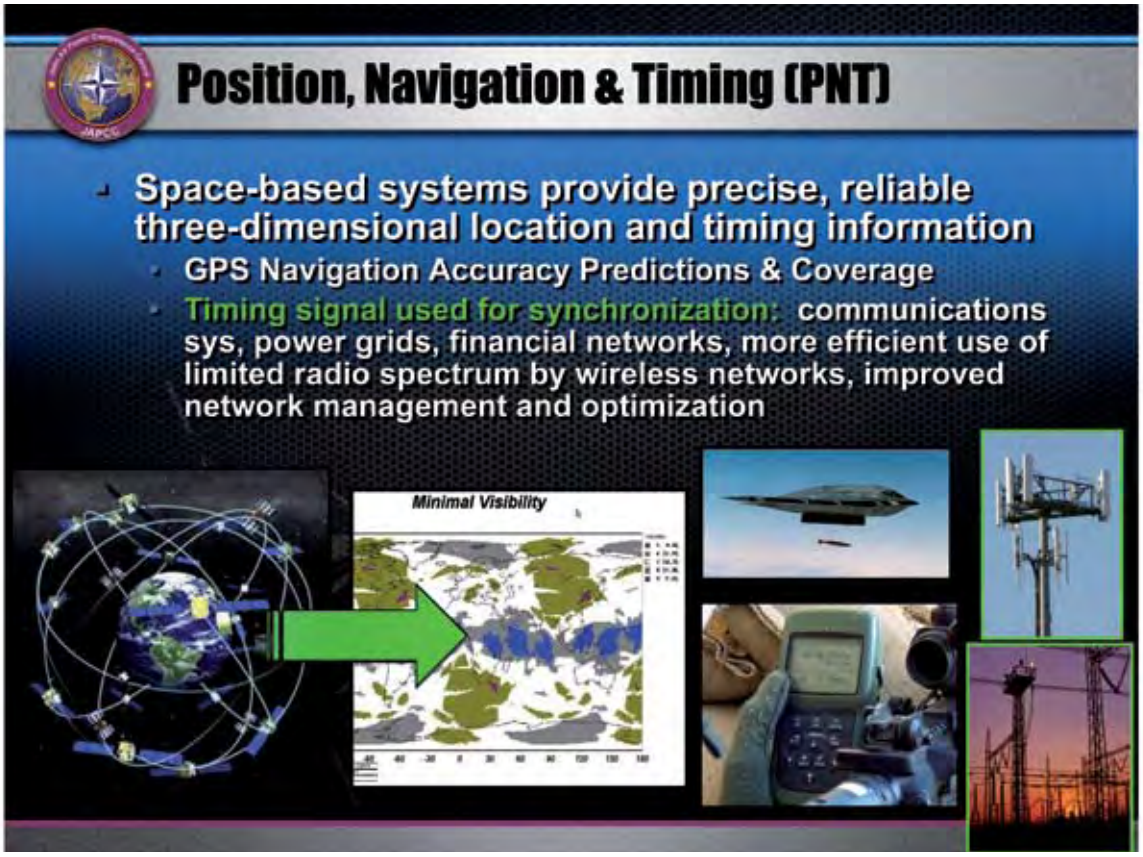
- Space systems can provide Imagery Intelligence (IMINT), Signals Intelligence (SIGINT) and Measurement and Signature Intelligence (MASINT) and Pattern of Life (PoL) intelligence
- Application in NATO
  - Tool to enhance operations planning
  - Intelligence preparation of the battlespace (IPB)
    - Imagery: commercial, civil, military
  - Battle damage indications
  - Support to humanitarian operations
- Need to synchronize capabilities with tactical and theater airborne ISR assets

Environmental Sensing

- Meteorological and Oceanographic (METOC) information that may affect operations

GEOSTATIONARY METEOROLOGICAL SATELLITES

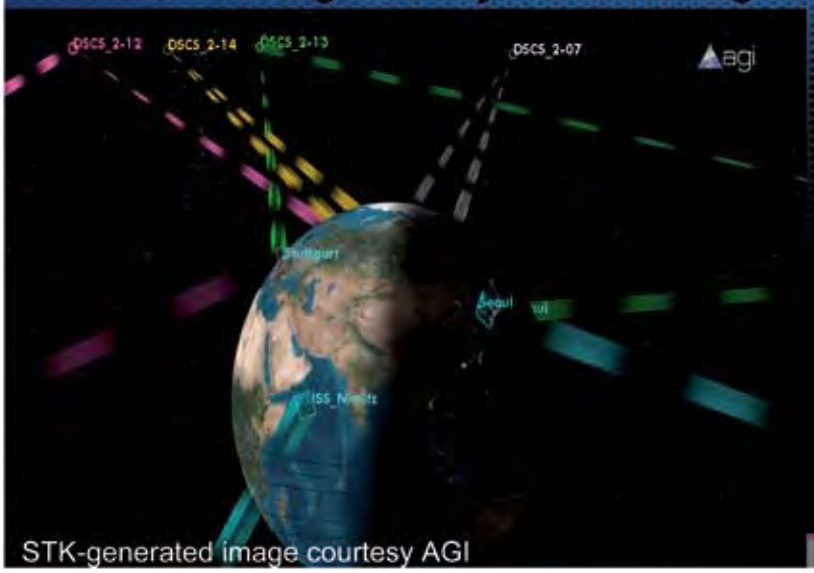
LOW EARTH POLAR ORBITING METEOROLOGICAL SATELLITES

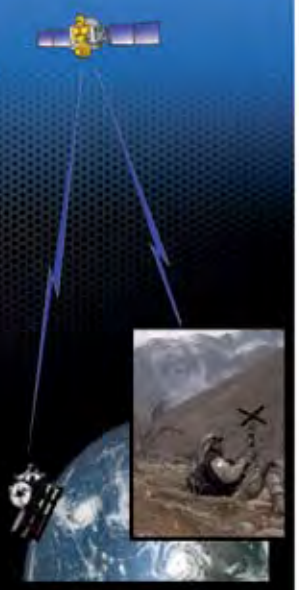


Non-Sensitive Information – Releasable to the Public

Satellite Communications (SATCOM)

- Military, civil and commercial systems can be used for C2, disseminate plans, and intelligence beyond line of sight





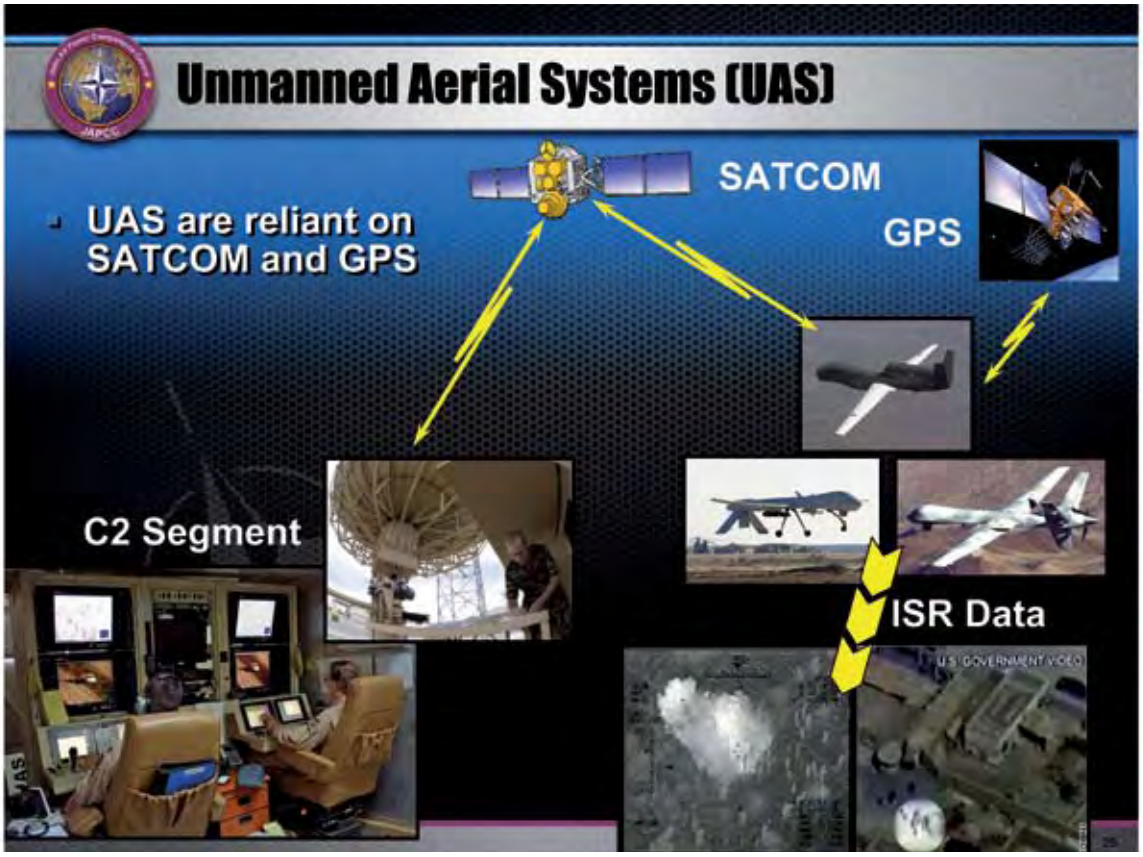
STK-generated image courtesy AGI

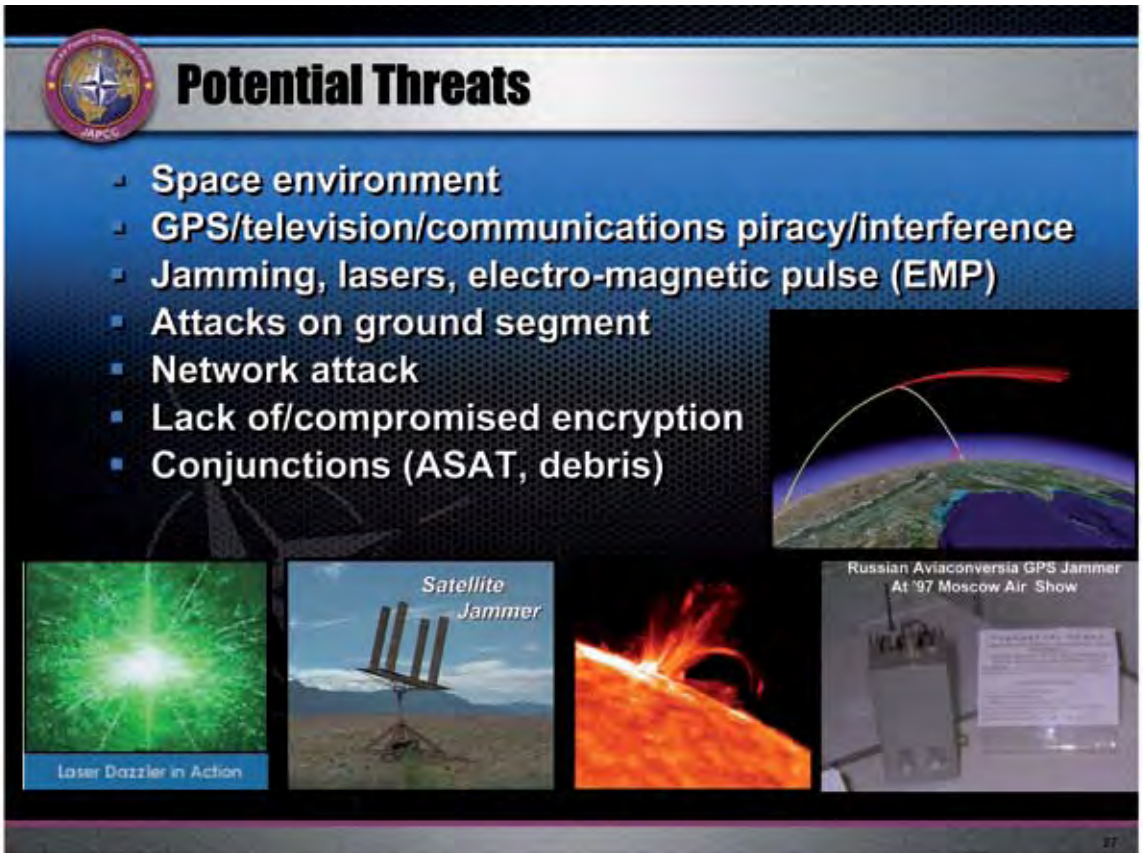
SATCOM (cont)

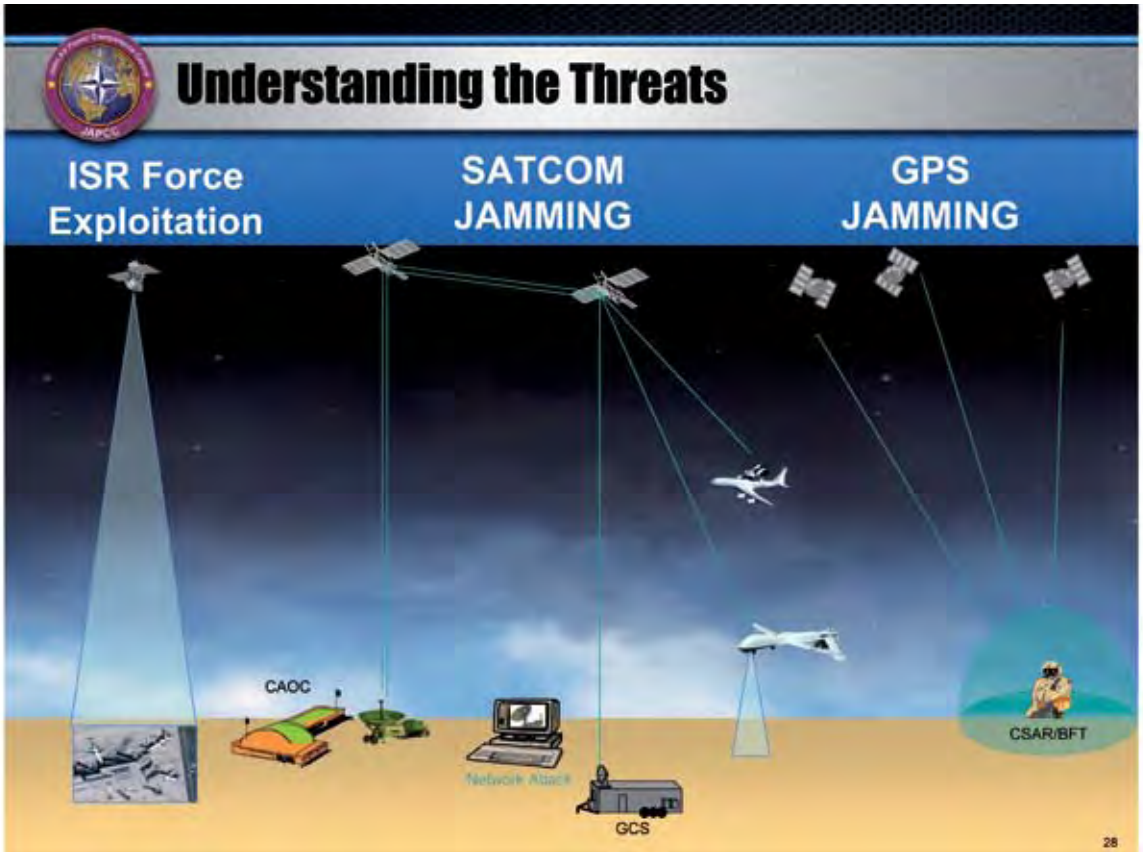
- Military and commercial communication satellites provide data, voice, video, television, and Internet
- Space weather effects on communication monitored daily
- Application in NATO
  - UHF SATCOM: secure voice and data, low-data rate, fixed or mobile terminals, single channel
  - SHF SATCOM: secure voice and data, high-data rate, normally fixed terminal, multi-channel
  - EHF SATCOM: survivable voice and data, reduced data rate, mobile

Non-Sensitive Information – Releasable to the Public

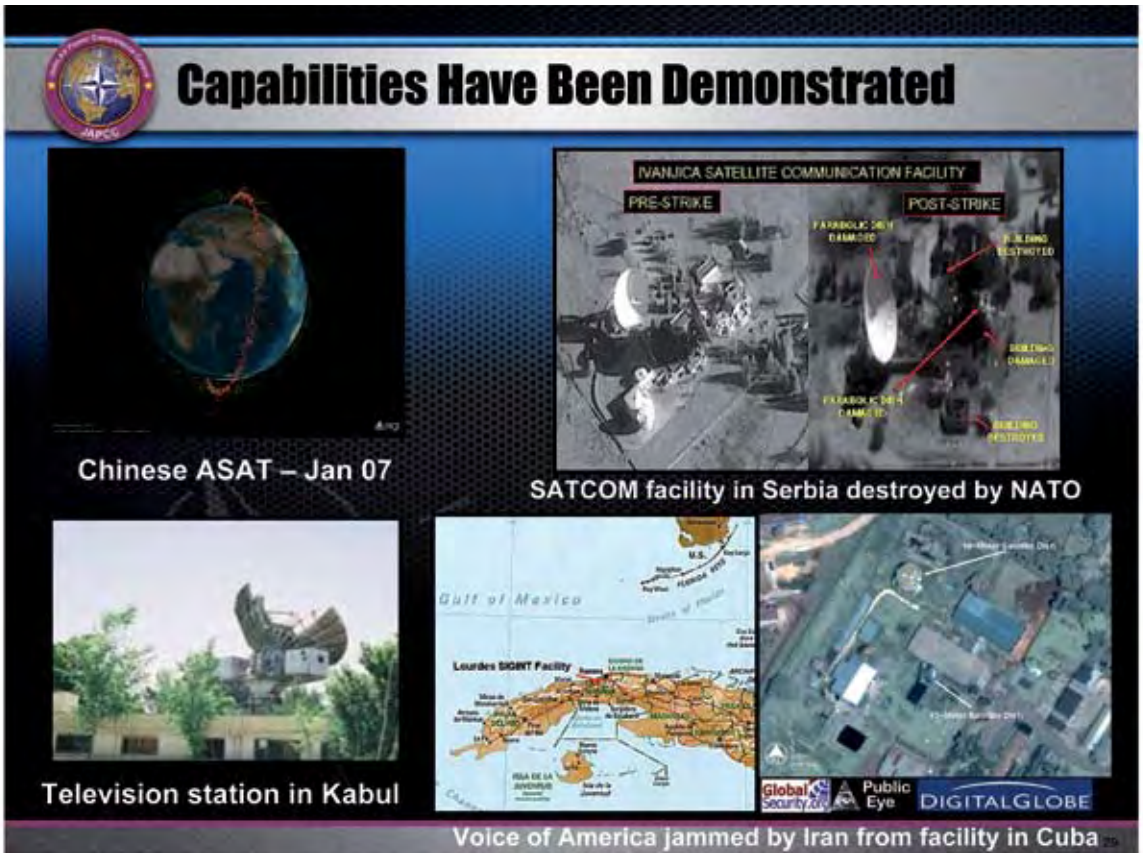
Space Systems Vulnerabilities
Deny any part of the network…
Satellites
SPACE
Control Center
Control
Ground/User


Unmanned Aerial Systems (UAS)
UAS are reliant on SATCOM and GPS
SATCOM
GPS
C2 Segment
ISR Data





Non-Sensitive Information – Releasable to the Public



Example: Chinese Countering Space

- *Open source reporting suggests that China is developing an increasingly sophisticated understanding of US imagery collection capabilities and is steadily taking steps to evade both Western intelligence & commercial satellite & aerial reconnaissance*
- A deputy chief of staff of the Jinan Military Region's 54th Group Army stressed that failure to evade enemy sensors spells doom on today's battlefield since "detection means destruction" in warfighting that relies on information technologies and sensors
- PLA media suggested that some units are using "satellite imagery" and reconnaissance aircraft for feedback to help them understand their vulnerability to potential enemy systems

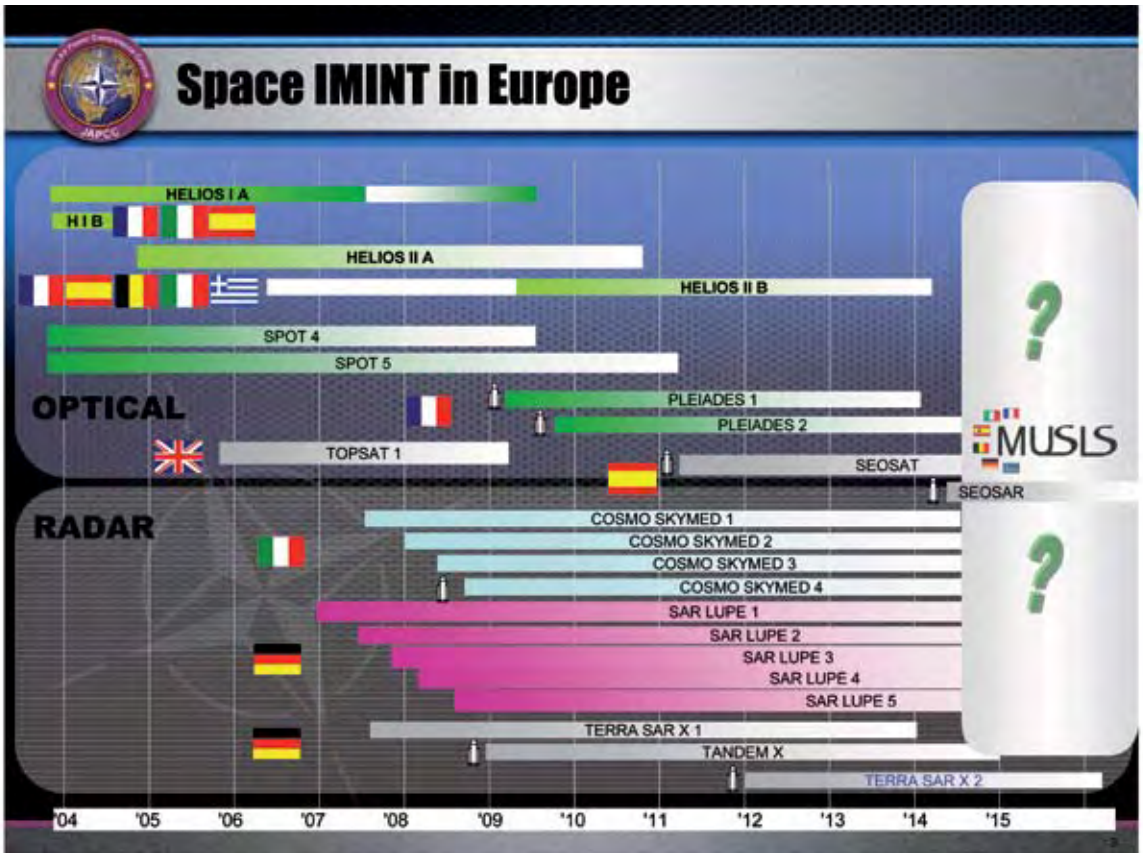
Non-Sensitive Information – Releasable to the Public

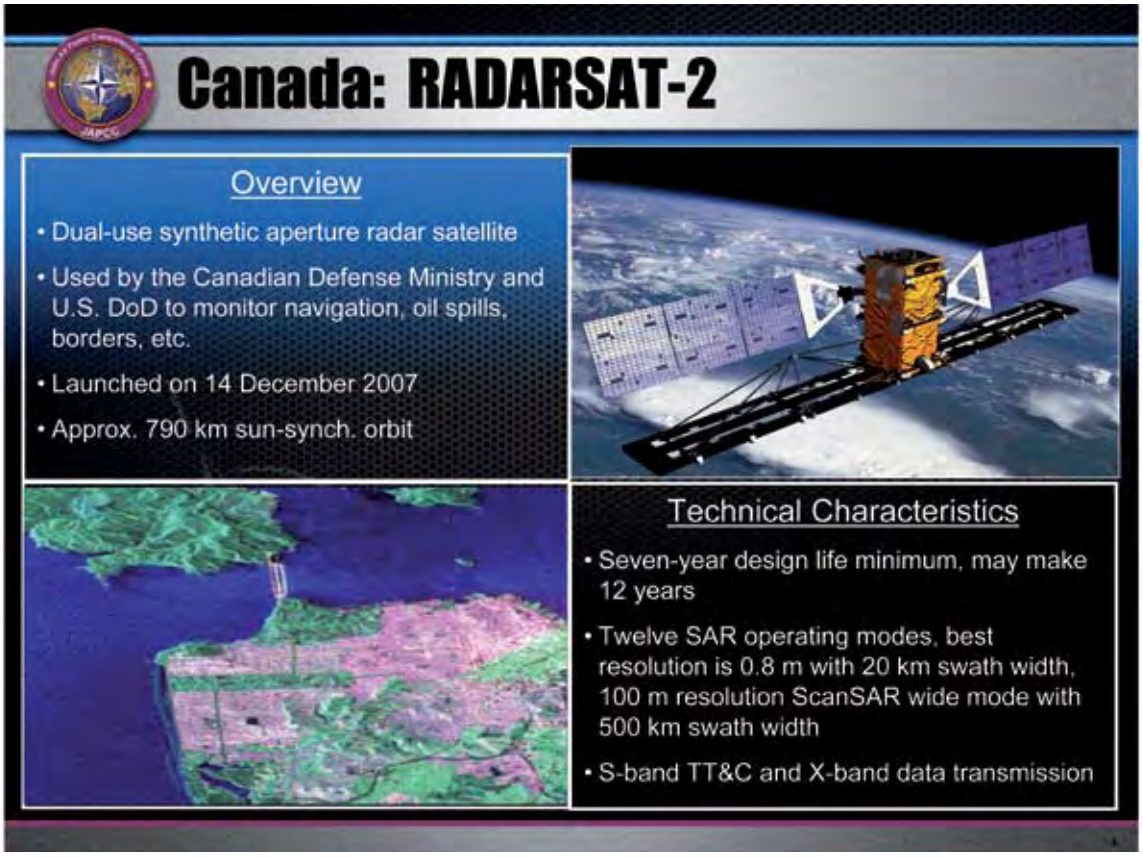
Annex C: National ISR Satellite Systems[32]

NATO Nations in Space

Nation	Science	Telecom	ISR
Canada	✓	✓	✓
Czech Rep.	✓		
Denmark	✓		
France	✓	✓	✓
Germany	✓	✓	✓
Greece		✓	
Italy	✓	✓	✓
Luxembourg		✓	
Netherlands	✓		
Norway		✓	
Portugal		✓	
Spain	✓	✓	
Turkey		✓	
United Kingdom	✓	✓	✓
United States	✓	✓	✓

[32] Note: All information was obtained from open source material on the internet.





Non-Sensitive Information – Releasable to the Public

France: SPOT

Overview

- Electro-optical and infrared imaging satellite
- Used by the French Defense Ministry; images available for sale/exchange
- To be replace by two Pleiades satellites
- Launched on 3 May 2002
- Approx. 822 km sun-synch. orbit

Technical Characteristics

- Five-year design life
- Resolution: 2.5 m to 5 m in panchromatic mode and 10 m in multispectral mode
- S-band TT&C and X-band data transmission

France: Helios-2A

Overview

- Electro-optical and infrared imaging satellite
- Used by the French Defense Ministry; imagery will be shared with Germany, Italy, Belgium, and Spain
- Launched on 18 December 2004
- Approx. 700 km sun-synch. orbit

Technical Characteristics

- Five-year design life
- Press reports better than 1 m resolution
- S-band TT&C and X-band data transmission

France: Essaim

Overview

- A four satellite constellation serving as ELINT platform demonstrators
- Used by the French Defense Ministry
- Launched on 18 December 2004
- Approx. 675 km sun-synch orbit

Technical Characteristics

- Three-year design life
- Only three satellites are needed for geo-location accuracy of less than 100 m, with the fourth satellite flying as a backup asset

Germany: SAR Lupe

Overview

- Five satellite synthetic aperture radar satellite constellation in 3 planes
- Used by German Defense Ministry; data sharing agreement with France and Italy
- Constellation launched between December 2006-July 2008
- Approx. 520 km orbit

Technical Characteristics

- Ten-year design life
- Resolution of at least 1 m
- S-band TT&C and X-band data transmission

Non-Sensitive Information – Releasable to the Public

Germany: TerraSAR-X

Overview

- Synthetic aperture radar (SAR) satellite
- Used by German Defense Ministry; first Public-Private Partnership with DLR and Astrium
- Launched 15 June 2007
- Approx. 514 km orbit

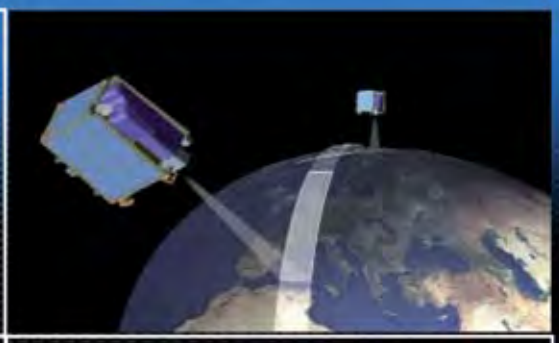
Technical Characteristics

- Five-year design life
- Active phased array X-band SAR with up to 1 m resolution
- Tracking, Occultation, and Ranging (TOR) package
- Laser Communication Terminal (LCT)

Germany: RapidEye

Overview

- RapidEye is a German company that operates five electro-optical imaging satellites
- Primary customers for the RapidEye constellation are in the agricultural market
- Launched 15 June 2007
- Approx. 514 km orbit



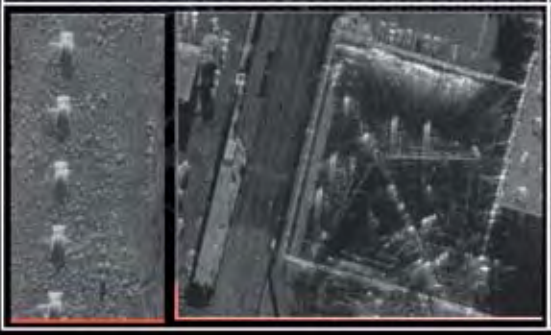
Technical Characteristics

- Seven-year design life
- Each carries a five band multi-spectral optical imager capable of 6.5 m resolution and a swath width of 78 km
- S-band TT&C and X-band data transmission

Italy: COSMO-SKYMED

Overview

- 3 synthetic aperture radar satellites on-orbit
- Used by the Italian Ministry of Defense; data sharing agreement with France
- 1 more satellite planned
- Launched in June 2007 and October 2008
- Approx. 640 km sun-synch. orbit



Technical Characteristics

- Five-year design life
- Resolution: Can provide imagery in four operation modes with a best spatial resolution of ~1 m
- X-band data transmission

United Kingdom: DMC

Overview

- Built by SSTL, Disaster Monitoring Constellation (DMC) operates five electro-optical imaging satellites
- Partners include Algeria, Turkey, Nigeria, China and the UK
- Launched between 2002 and 2005
- Approx. 630 km sun-synch. orbit

Technical Characteristics

- 32 m GSD resolution
- S-band TT&C and X-band data transmission

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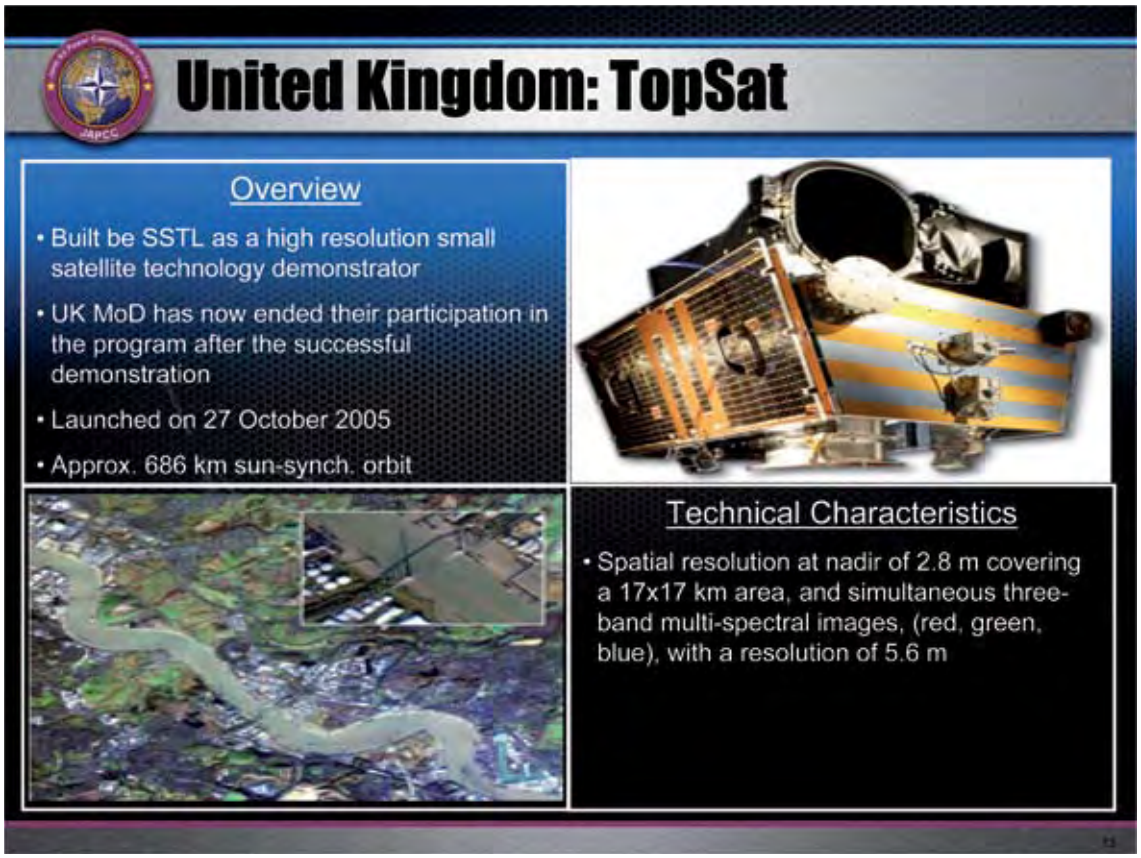
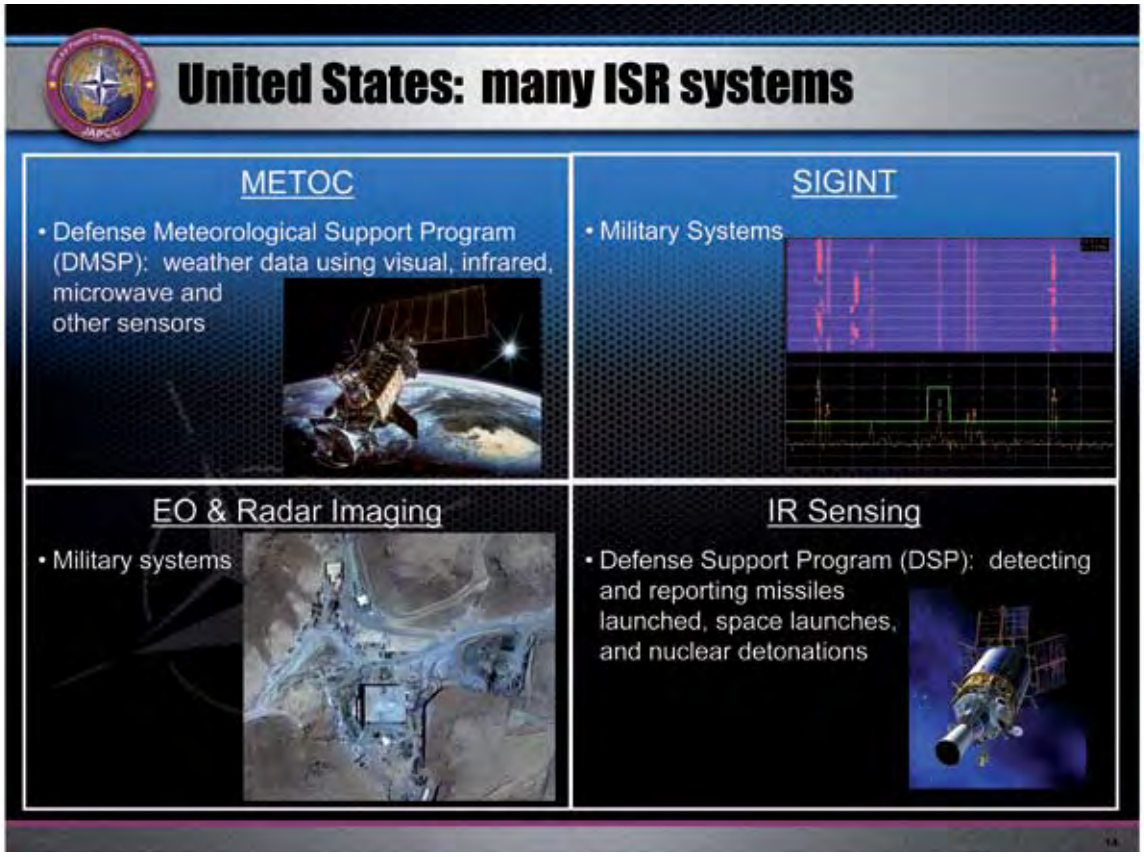
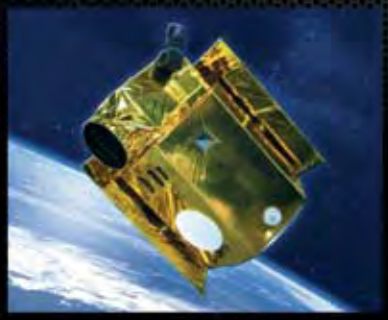
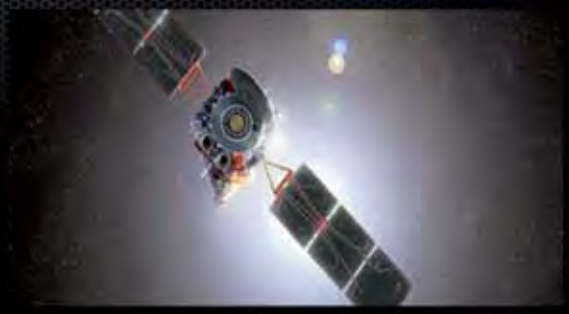

United Kingdom: TopSat
Overview
• Built be SSTL as a high resolution small satellite technology demonstrator
• UK MoD has now ended their participation in the program after the successful demonstration
• Launched on 27 October 2005
• Approx. 686 km sun-synch. orbit
Technical Characteristics
• Spatial resolution at nadir of 2.8 m covering a 17x17 km area, and simultaneous three-band multi-spectral images, (red, green, blue), with a resolution of 5.6 m


United States: many ISR systems
METOC
• Defense Meteorological Support Program (DMSP): weather data using visual, infrared, microwave and other sensors
SIGINT
• Military Systems
EO & Radar Imaging
• Military systems
IR Sensing
• Defense Support Program (DSP): detecting and reporting missiles launched, space launches, and nuclear detonations

Spain: SEOSAT & SEOSAR

- SEOSat (Spanish Earth Observation Satellite) to be launched in 2011
  - Optical imager with a 2.5-meter ground resolution in black-and-white mode and 10 meters in color
- SEOSAR, now known as Ingenio, launch is expected around 2015





MUlti-national Space-based Imaging System

- France, Germany, Italy, Spain, Belgium and Greece cooperating on designs for space-based surveillance systems (EO & SAR)
- This system could be operational somewhere around 2015-2017, around the time that the French Helios and joint French-Italian Pleiades IMINT satellites need replacement
  - The German SAR Lupe and Italian Cosmo-SkyMed radar satellites will last up to 2018

MUSIS

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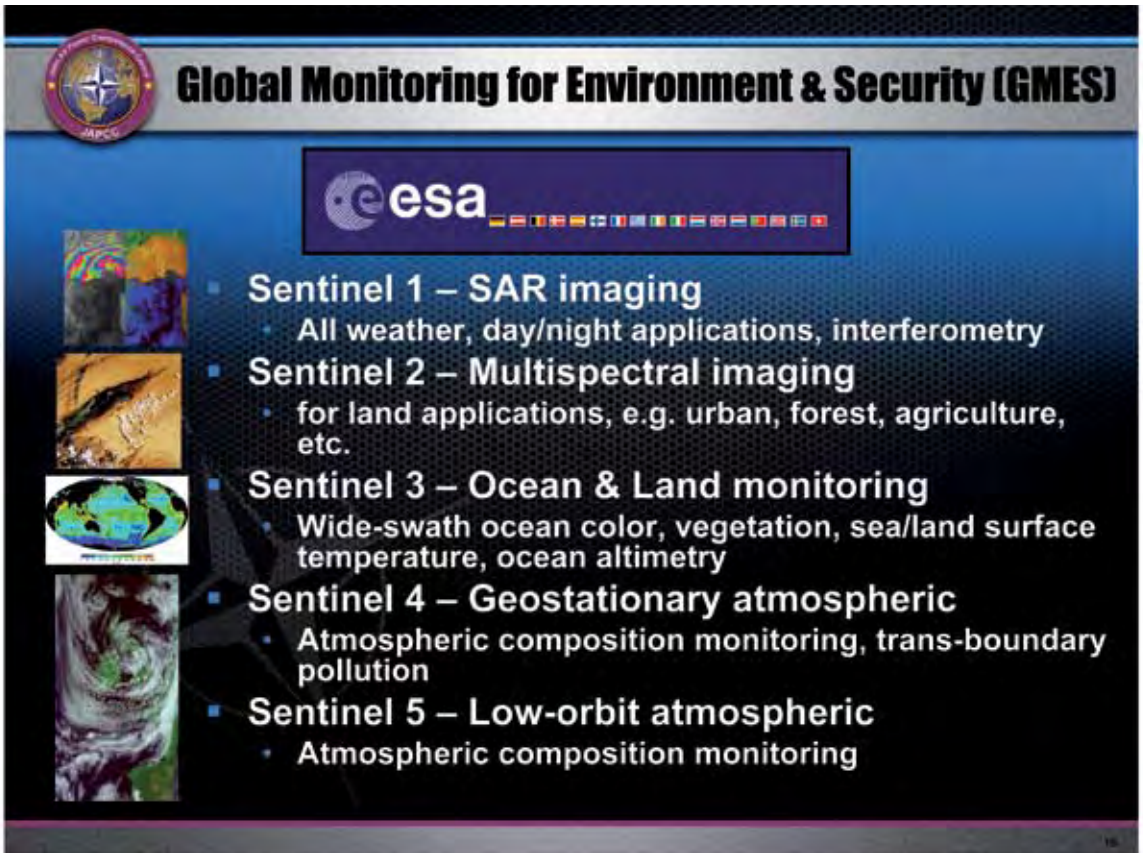
Global Monitoring for Environment & Security (GMES)
esa
Sentinel 1 – SAR imaging
All weather, day/night applications, interferometry
Sentinel 2 – Multispectral imaging
for land applications, e.g. urban, forest, agriculture, etc.
Sentinel 3 – Ocean & Land monitoring
Wide-swath ocean color, vegetation, sea/land surface temperature, ocean altimetry
Sentinel 4 – Geostationary atmospheric
Atmospheric composition monitoring, trans-boundary pollution
Sentinel 5 – Low-orbit atmospheric
Atmospheric composition monitoring

Joint Air Power Competence Centre
JAPCC
Major Tom "Solo" Single, USAF
JAPCC C4ISTAR Branch – Space Ops SME
NATO Email: single@japcc.de
www.japcc.org

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Non-Sensitive Information – Releasable to the Public

Annex D: Space Operations Officer Responsibilities

Adapted from Appendix D, FM 3-14 (United States Army)

The Space Operations Officer (SOO) is responsible for providing space-related operational support and expertise on Space capabilities. The SOO integrates Space force enhancement and Space control operations, and supports both deliberate and crisis action planning. The SOO routinely works in conjunction with other members of the coordinating and special staffs (such as the J2, J6, fire support element, and Space weather officer). The SOO focuses on the integration of the wide range of Space capabilities available to the commander. The SOO provides support to the staff to ensure they are fully cognizant of Space support available to provide space-based communications, navigation and timing information, environmental monitoring, and ISR. The SOO is careful not to cross organizational lines when representing space-based capabilities. The coordination responsibilities discussed below as they pertain to the J2, J3, J6, and EW/IO, are guidelines for staff interaction. To properly execute assigned tasks, the SOO is aware of the challenges the unit faces and is prepared to offer Space solutions, when applicable. SOOs are a significant conduit for Space to the warfighter, and their effectiveness can positively influence mission accomplishment.

The primary tasks of the SOO are:

- Analyse higher headquarters orders from a Space perspective.
- Develop Space specific specified, implied, and essential tasks.
- Develop the Space Estimate and coordinate the Estimate with other staff sections to incorporate it into the mission analysis effort.
- Recommend space-specific PIR and/or information requirements to the J2.
- Provide input to course of action (COA) analysis.
- Integrate USSTRATCOM-unique capabilities in missile warning (DSP), navigation (GPS), environmental monitoring, and SATCOM capabilities into staff planning.
- Ensure coordination and integration with all applicable IO cells.
- Analyse the potential employment of additional Space operational capabilities.
- Write annex N (Space) to be included in the applicable plan and/or order, when a COA has been selected.

Space Operations Staff Officer Coordination Duties

Coordination with J2 includes the following:

- Ensure the J2 Aerospace Control Element (ACE) is aware of allied, enemy, and rest-of-the-world Space order of battle.
- Develop the Space analysis contribution to the IPB.
- Develop J2 space-related intelligence requirements and recommend its inclusion in the Collection Plan.
- Maintain Space situational understanding by regularly reviewing intelligence products. Ensure the ACE is aware of significant Space intelligence data to incorporate into the ACE all source analysis effort.
- Monitor status of enemy space-related targets (user segment, ground stations, communications links to and from the satellite, and the satellites).

- Ensure the J2 staff is aware of commercial and non-threat foreign Space systems that may be utilized by the adversary. Provide space-related recommendations/ requirements to the Collection Manager.
- Analyse effectiveness of DSP to identify threat missile activity and support BDA and situational understanding requirements. Ensure J2 is aware of DSP technical intelligence and battle Space characterization capabilities.
- Provide Space weather assessments and integrate Space weather updates into the Space Estimate. Monitor status of the DMSP constellation.
- Determine and monitor vulnerabilities to supporting space-based surveillance, reconnaissance, or attack. Be familiar with the threat to Allied systems and protect those systems by minimizing or eliminating the threat and implementing protection measures.

Coordination with J3 includes the following:

- Maintain close coordination with theJ3/5 staffs to ensure Space integration into all future planning efforts.
- Maintain close coordination with the current operations section regarding Space input to staff update briefs, warning orders, FRAGOs, and so forth.
- Provide recommendations to apply military, civil, and commercial Space systems and concepts for land force applications.
- Ensure the J3 understands the role of the Space team, and integrate into daily operations. Provide Space products and support, and allow the SOO to sustain a 24/7 Space staff capability.
- Monitor the effectiveness of the Tactical Event System (TES) to support command Theatre Ballistic Missile (TBM) early warning requirements, in coordination with the Air Defense Element (ADE).
- Monitor status of friendly Space systems, platforms and operations. Ensure appropriate staff elements are notified of space-related issues that may affect the operation.
- Know the Space command and control network within theatre, specifically, the location and mission of the entity assigned as Space authority and, if assigned, the Space coordination authority.
- Ensure BFT and GPS capabilities are optimally supporting the land elements. Execute staff planning and training related to BFT.
- Know the capabilities and limitations of U.S. Space and associated ground systems. Know what space-related support is available within theatre.
- In coordination with Air Defence Artillery Element, ensure dissemination and warning of TBM attacks is timely and accurate. Provide staff training on capabilities and limitations of DSP and TMW.
- In concert with the J2, J6 and J7, analyse and monitor the command operations security (OPSEC) posture from a Space perspective.
- In concert with the J2, J3 (fire support coordinator), and J6, nominate enemy Space assets for targeting, as required.
- Implement Space control prevention measures to prevent the adversary from using friendly and allied systems, such as communications channels and GPS signals.
- Ensure measures are in place to protect Allied Space assets, such as force protection of ground stations and antennas, and/or targeting the adversary's means of threatening U.S. assets.

- Ensure that critical ground segments of friendly Space systems are designated as restricted operations zones (ROZs) in the airspace command and control element plan and are on the air defence/TMD defended asset list.
- In garrison, supervise the Space training programme and monitor the level of Space capabilities training within the command.

Coordination with J6 includes the following:

- Ensure the J6 staff is aware of the Space weather/enemy threat to SATCOM that was developed in the Space analysis for the IPB.
- Ensure J6 is aware of all service and commercial SATCOM capabilities that may contribute to unit mission accomplishment.
- Determine and recommend to the J6 SATCOM-related essential elements of information.
- Ensure J6 is aware of SATCOM C2 organizations that contribute to operational contingency support.
- In coordination with the J3, ensure BFT systems are functioning.
- Provide status of supporting SATCOM systems, to include known deficiencies and planned outages.

Coordination with EW/IO includes the following:

- Provide information on space-based products that could support IO requirements.
- Provide a representative to the EW/IO working group.
- Include IO requirements in the Space operations appendix to the operations annex.
- Coordinate IO requirements with higher headquarters.
- Coordinate with the EW/IO targeting officer to include adversary Space system elements in the targeting process.
- Provide insight into the red/gray/blue Space order of battle and blue Space operational status.

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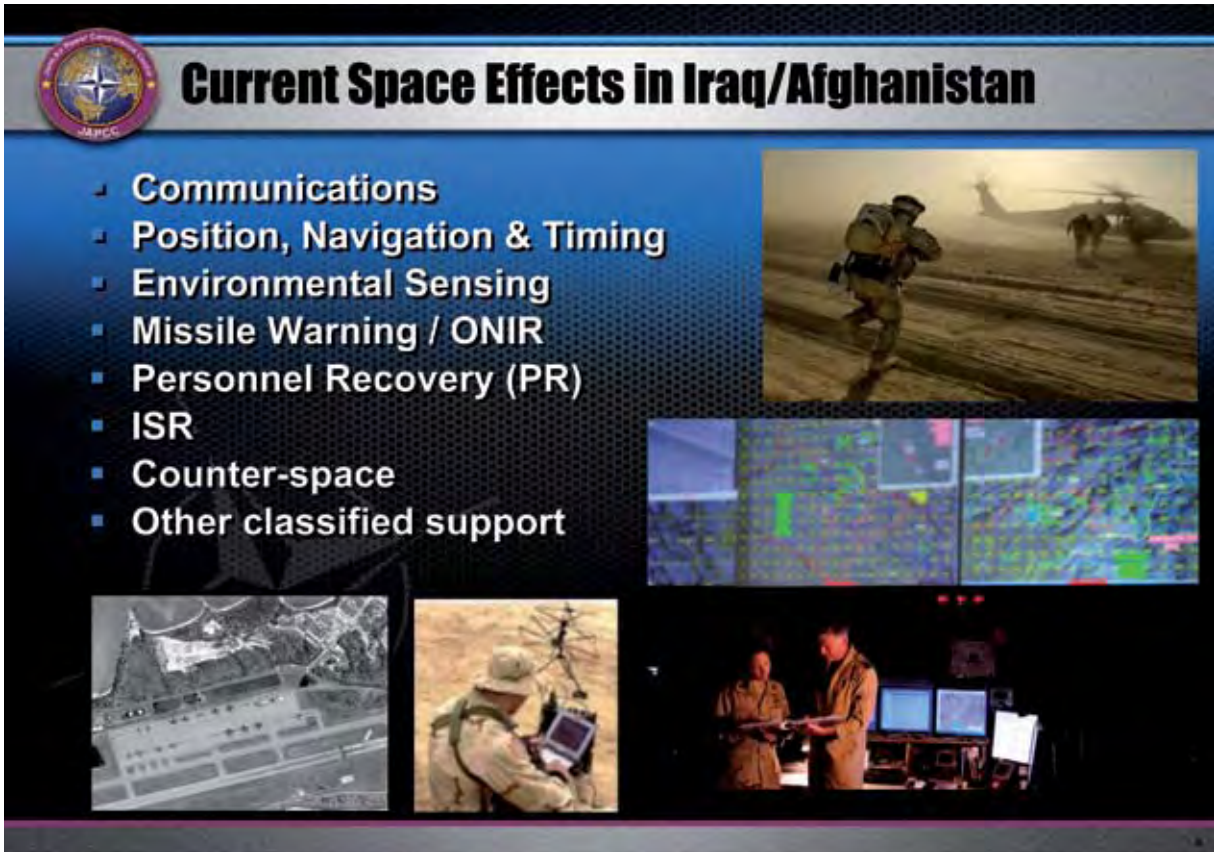
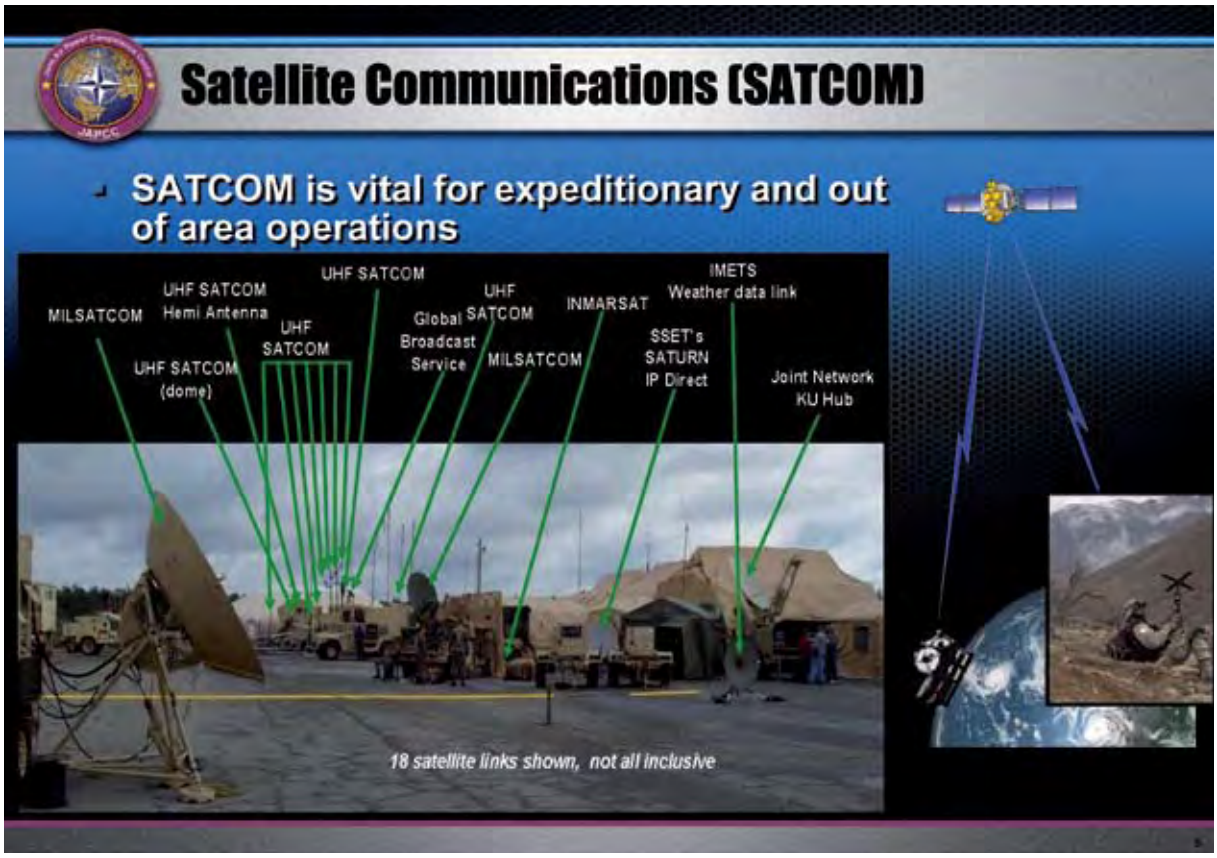
Non-Sensitive Information – Releasable to the Public

Annex E: NATO Military Applications of Space Briefing



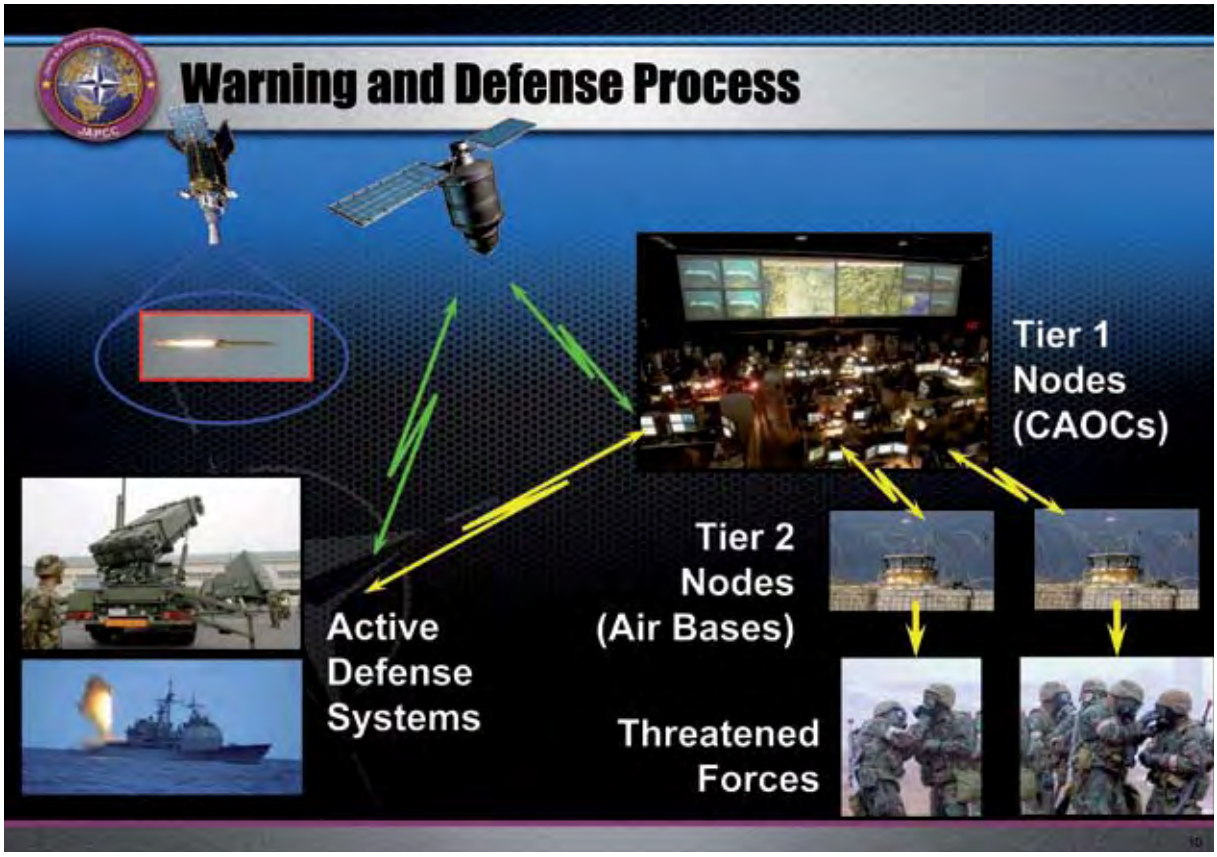
Non-Sensitive Information – Releasable to the Public

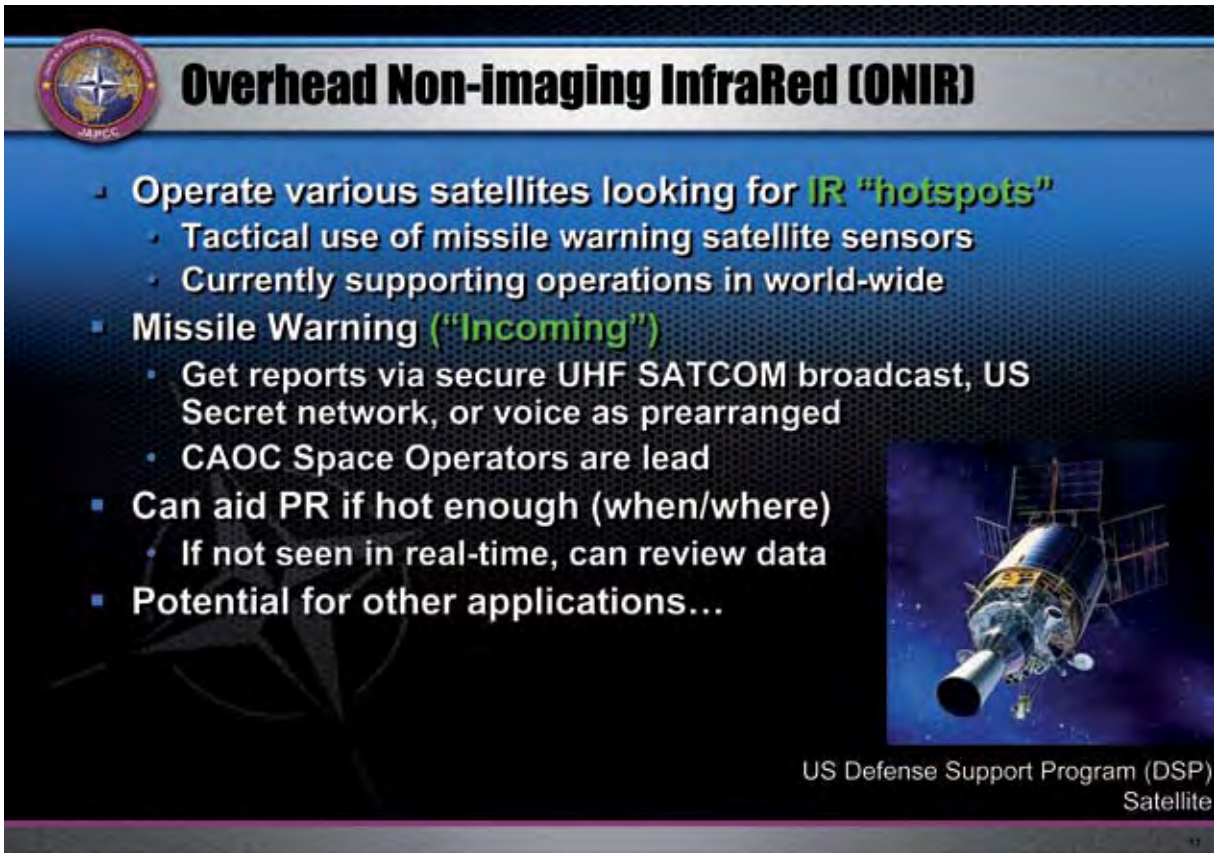

Satellite Communications (SATCOM)
SATCOM is vital for expeditionary and out of area operations
MILSATCOM
UHF SATCOM Hemi Antenna
UHF SATCOM (dome)
UHF SATCOM
UHF SATCOM
Global Broadcast Service
UHF SATCOM
MILSATCOM
INMARSAT
SSET's SATURN IP Direct
IMETS Weather data link
Joint Network KU Hub
18 satellite links shown, not all inclusive

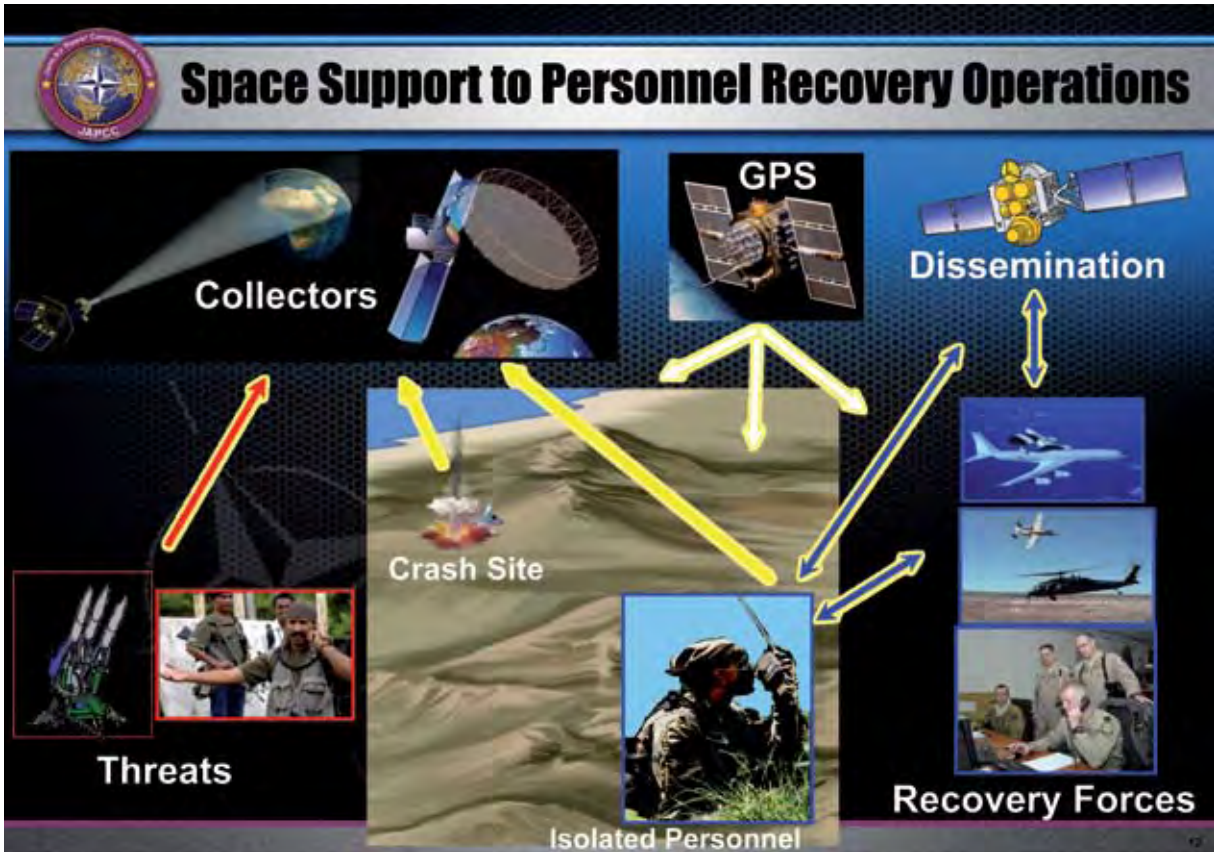
Military Applications of PNT (GPS)

Non-Sensitive Information – Releasable to the Public

Missile Warning Architecture
Missile Launch Detection
Mission Control Station
Missile Warning Notification

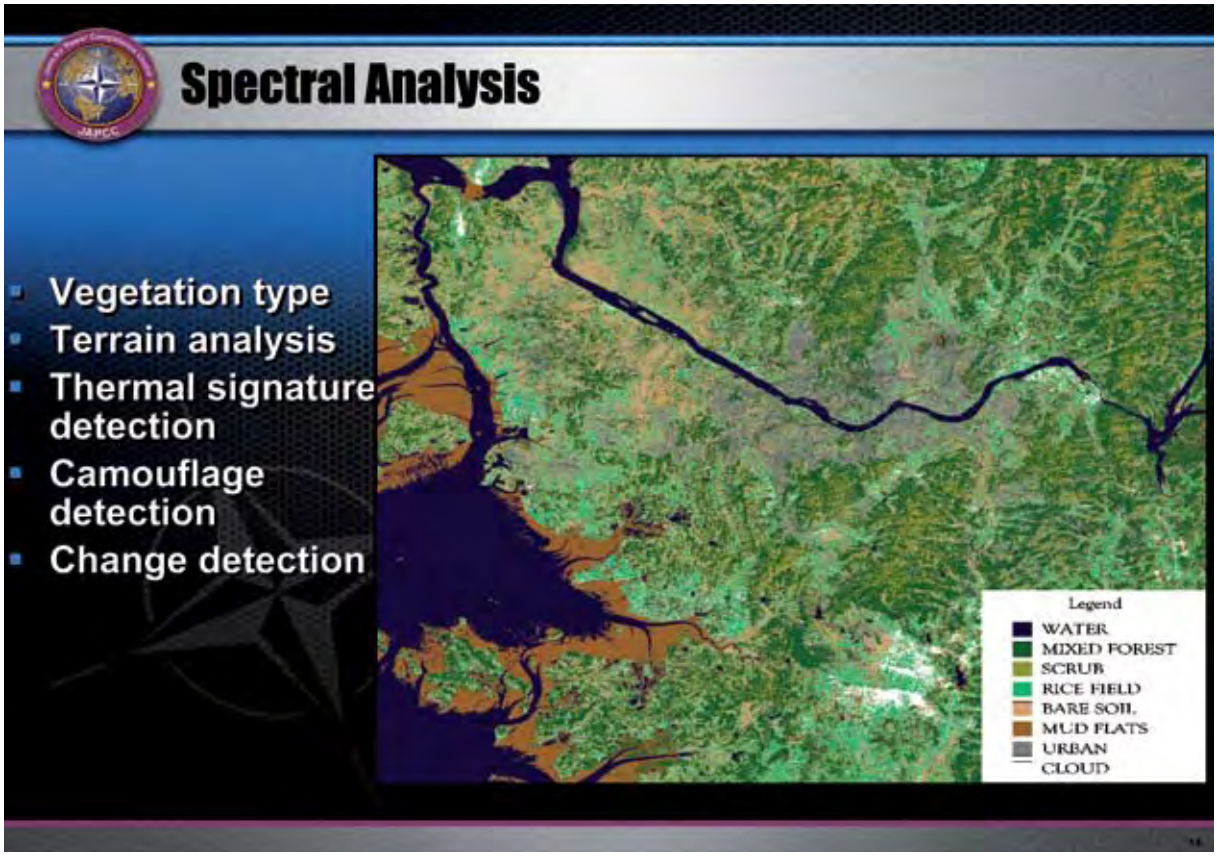

Warning and Defense Process
Tier 1 Nodes (CAOCs)
Tier 2 Nodes (Air Bases)
Active Defense Systems
Threatened Forces

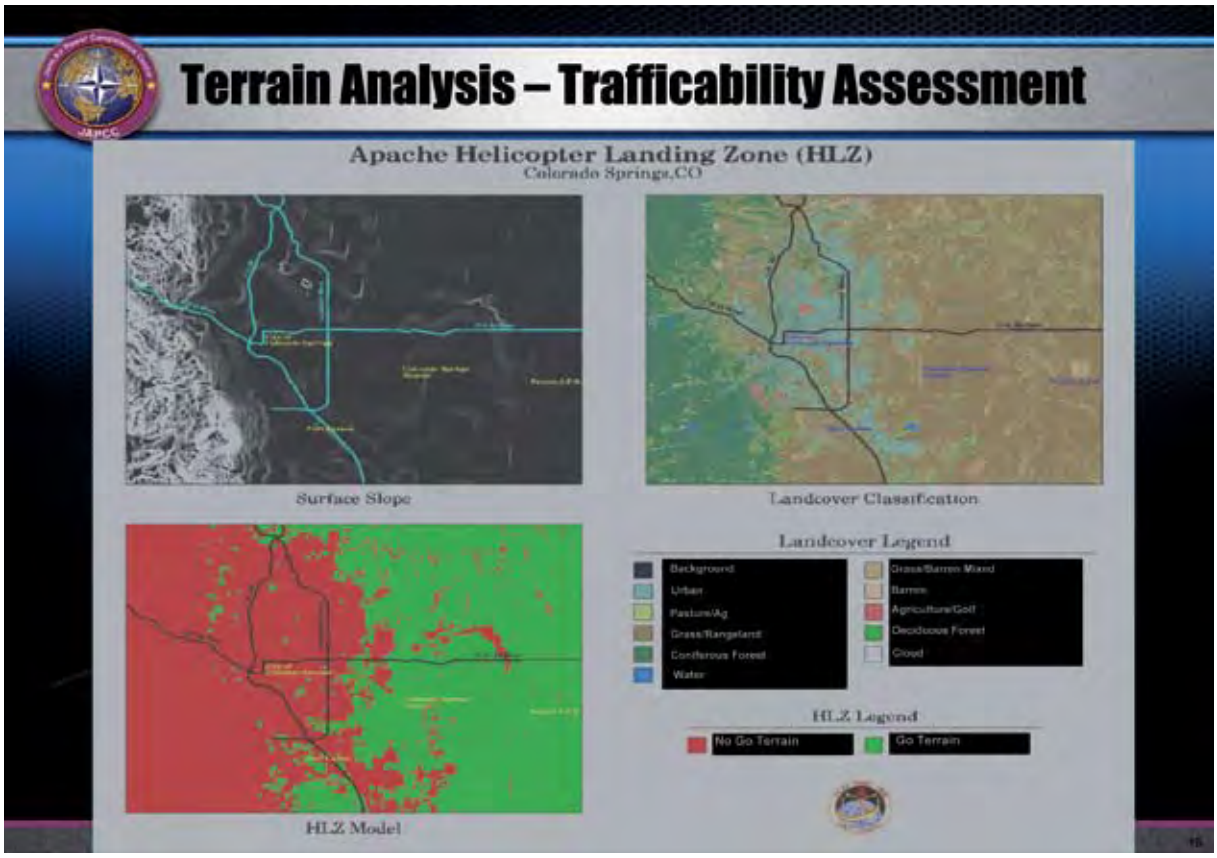


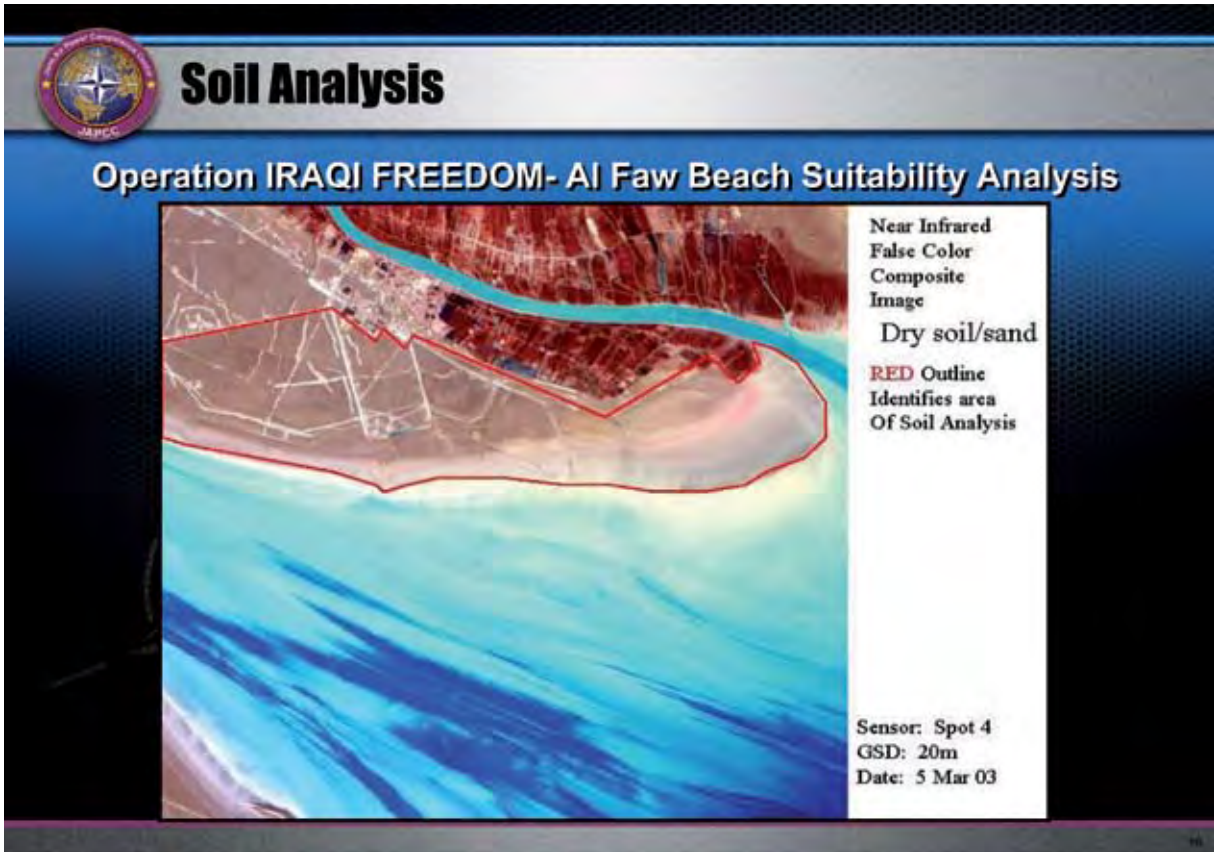


Non-Sensitive Information – Releasable to the Public

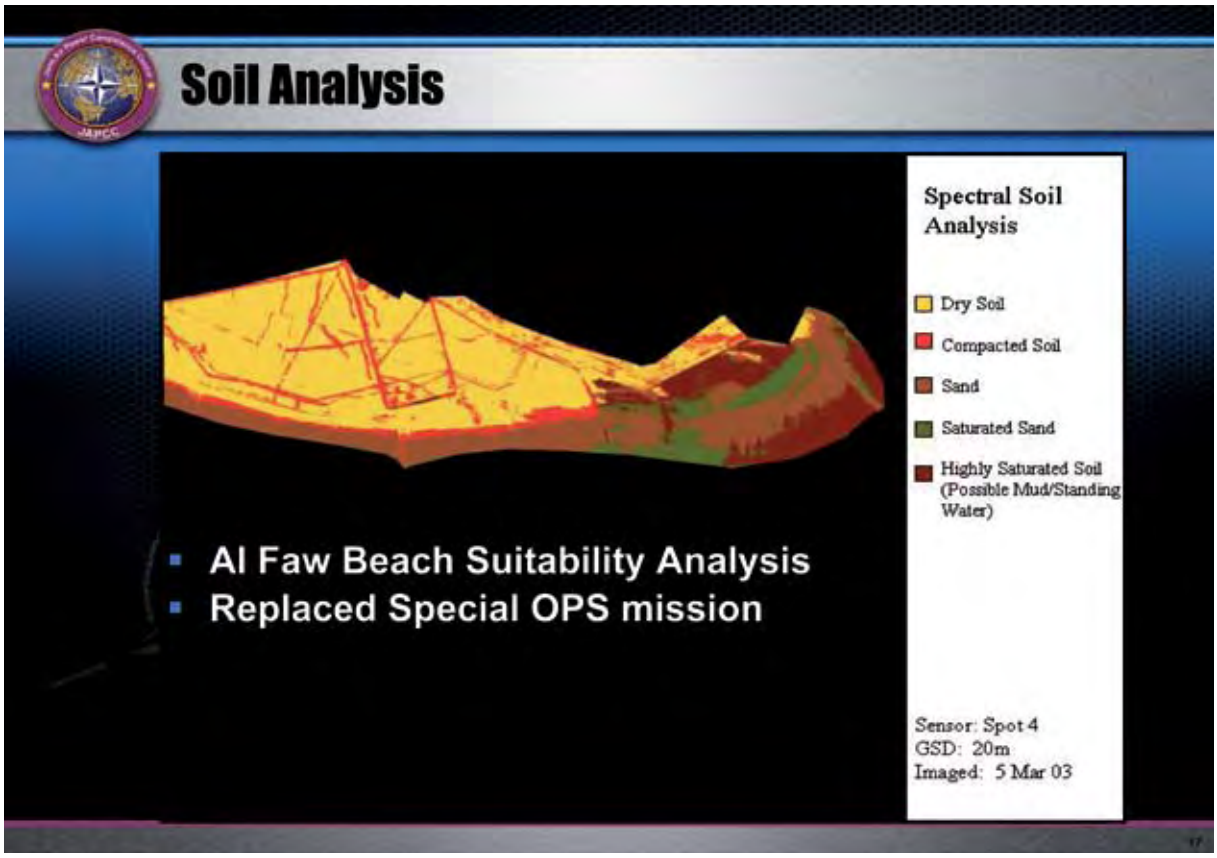
Space-based ISR
IMINT, SIGINT, ELINT, MASINT
Fuse with other sources of Intel
SIGINT + IMAGERY + HUMINT = Actionable Intel
STK-generated video courtesy AGI

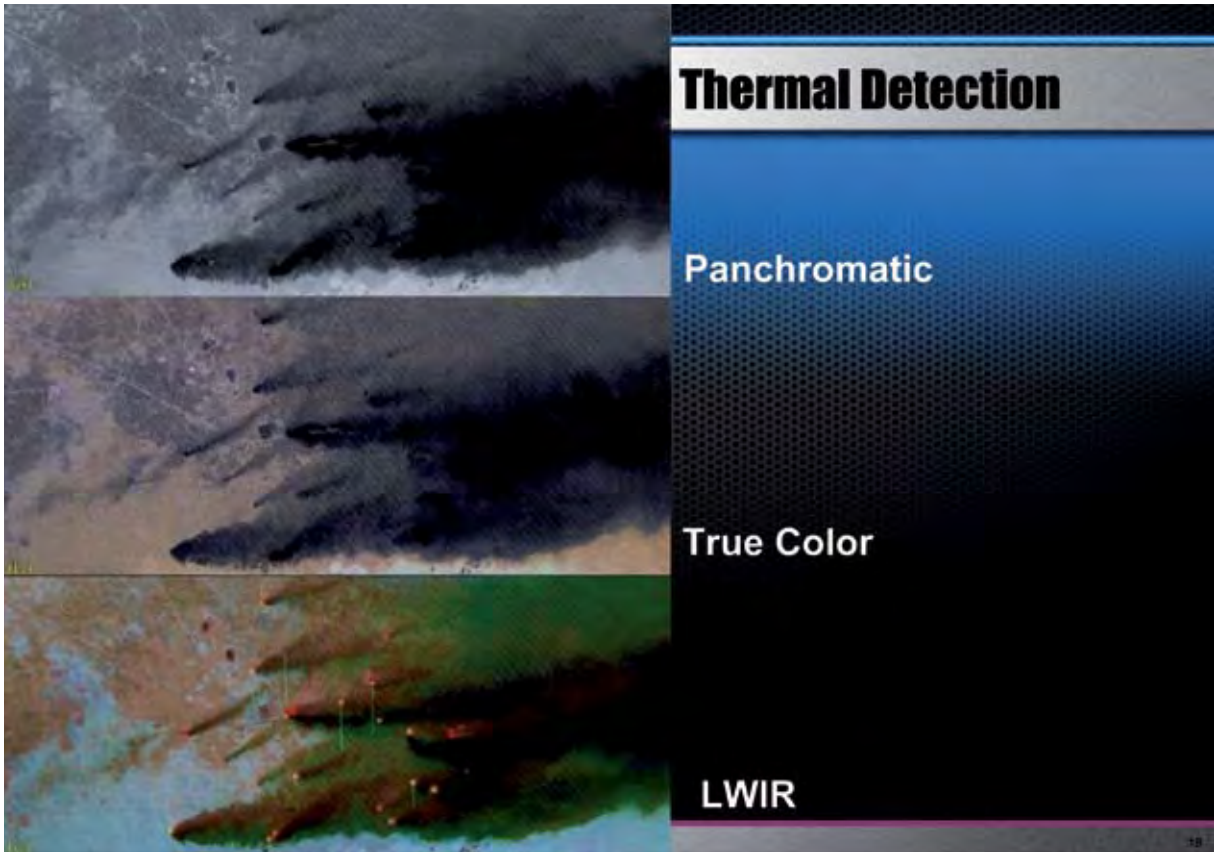

Spectral Analysis
Vegetation type
Terrain analysis
Thermal signature detection
Camouflage detection
Change detection
Legend
WATER
MIXED FOREST
SCRUB
RICE FIELD
BARE SOIL
MUD FLATS
URBAN
CLOUD

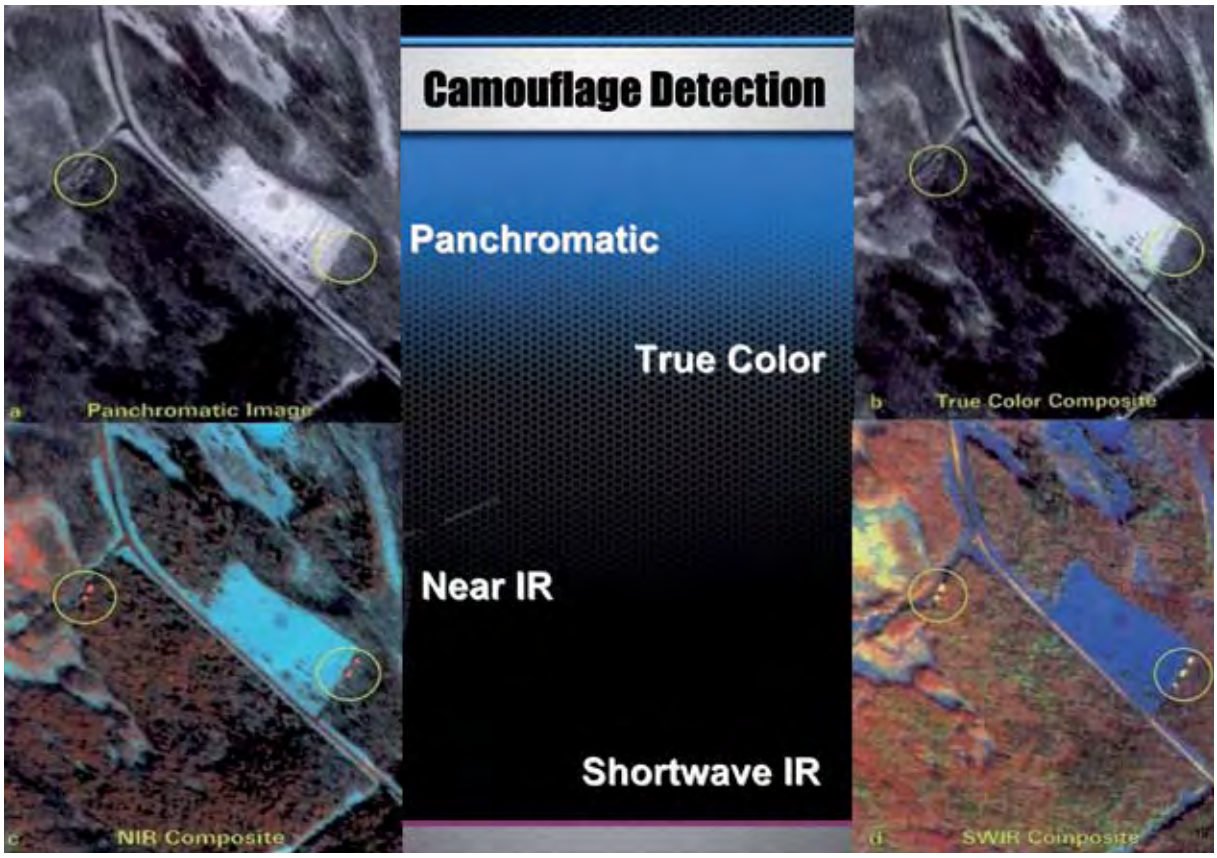


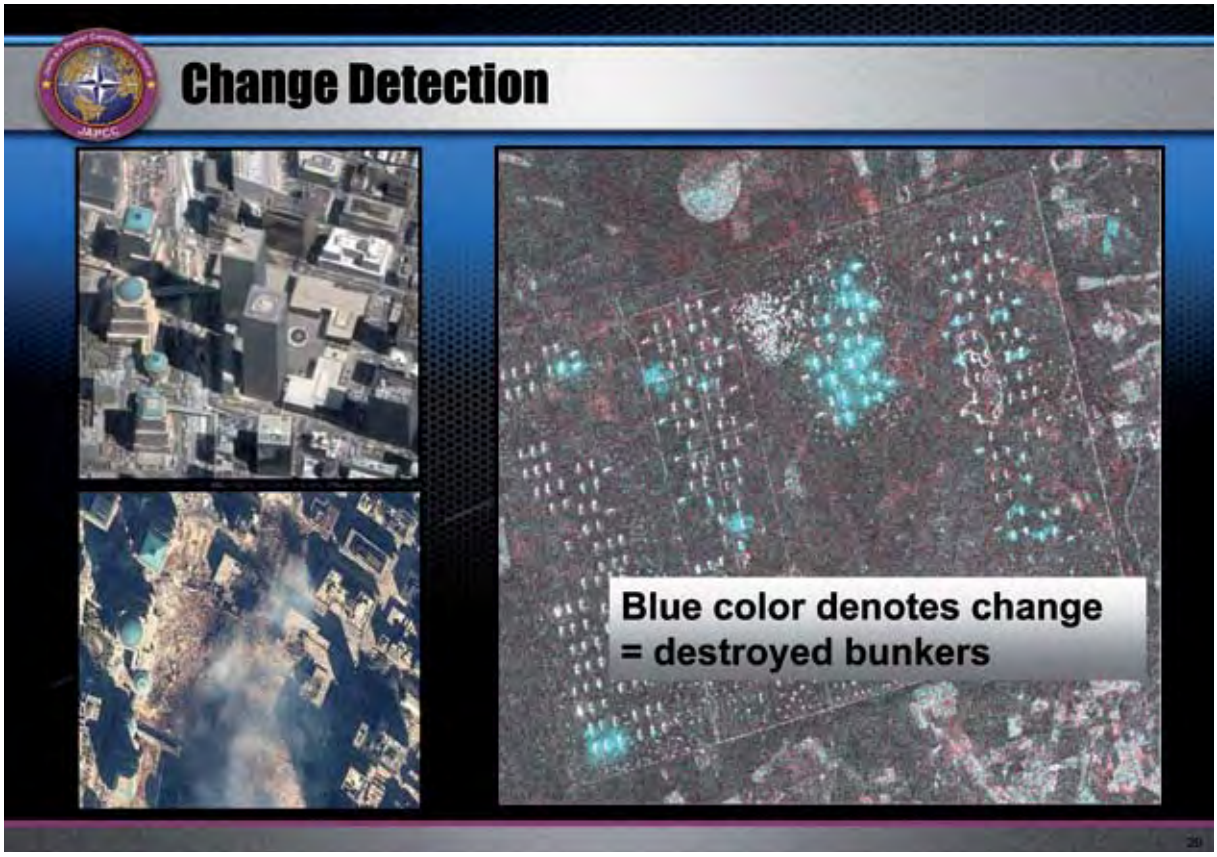


Non-Sensitive Information – Releasable to the Public

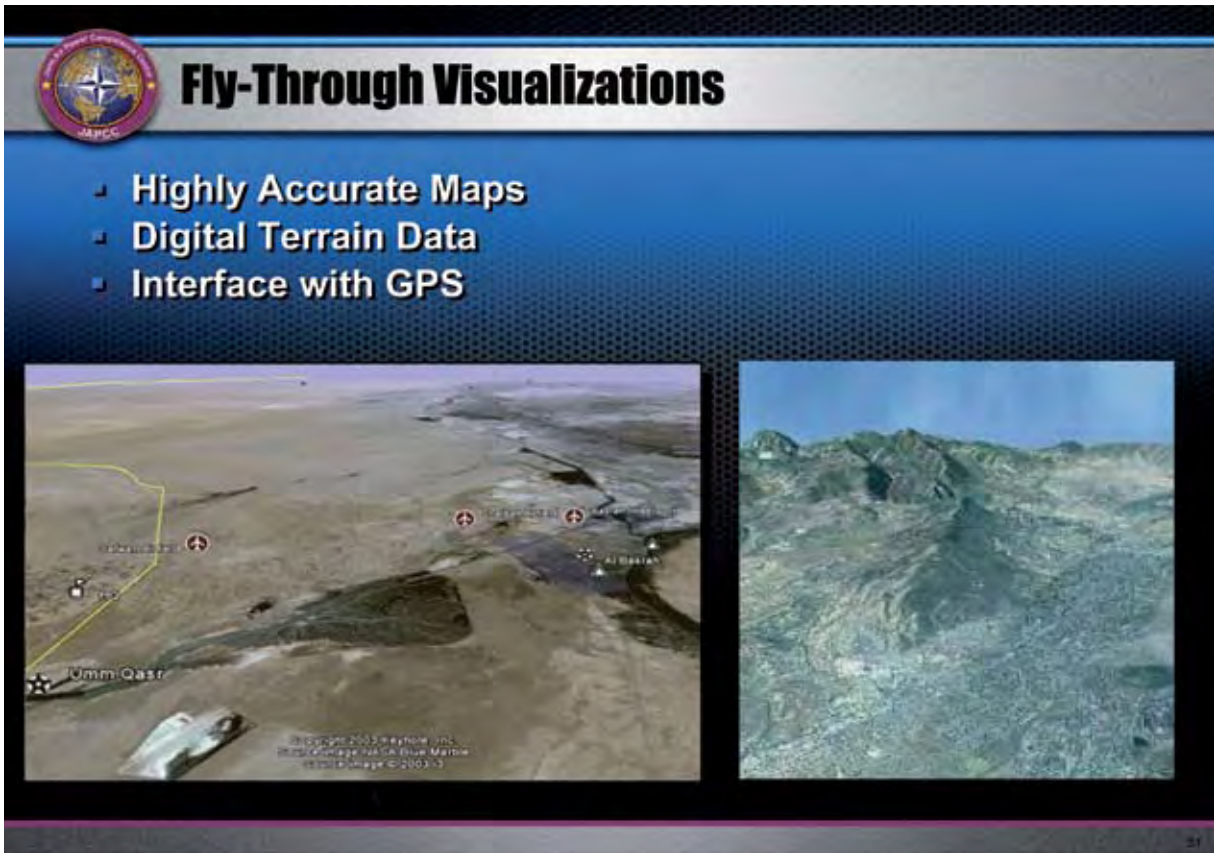

Soil Analysis
Spectral Soil Analysis
Dry Soil
Compacted Soil
Sand
Saturated Sand
Highly Saturated Soil (Possible Mud/Standing Water)
Al Faw Beach Suitability Analysis
Replaced Special OPS mission
Sensor: Spot 4
GSD: 20m
Imaged: 5 Mar 03


Thermal Detection
Panchromatic
True Color
LWIR





Non-Sensitive Information – Releasable to the Public


Fly-Through Visualizations
Highly Accurate Maps
Digital Terrain Data
Interface with GPS
Umm Qasr

Commercial Satellite Imagery (CSI) is Vital
Baghdad Oil Fires
Abandoned Brick Factory
CIA Field Facility
Military & Civil Use … and it's UNCLASSIFIED!

Applications for CSI

MILITARY APPLICATIONS

- Intelligence Preparation of the Battlespace
- Mission Planning
- Mission Rehearsal
- Imagery Intelligence Analysis
  - Camouflage Detection
  - Thermal Signatures
  - Chemical Signatures
  - Surface Penetration
  - Canopy Penetration
- Warning of Chem/Bio Weapons Release (Post Rel)
- Tracking of Chem/Bio Weapons Dispersal
- Mapping

GOVERNMENT APPLICATIONS

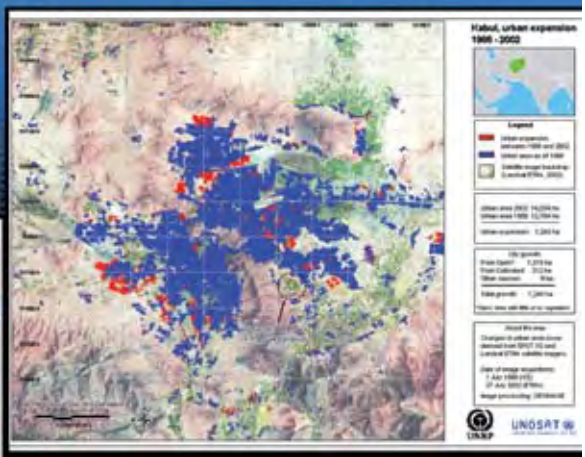
- Arms Control Treaty Monitoring
- Environmental Applications
  - Violation Detection
  - Violation Evidence
  - Remediation of HAZMAT Release
- Emergency Management
  - Natural Disasters
  - Terrorism (WMD Used)
- Agriculture/Nature Apps.
  - Crop Yields
  - Forest Mgmt.
  - Soil Studies
  - River Mgmt.
- Town Planning
- Tax Assessment

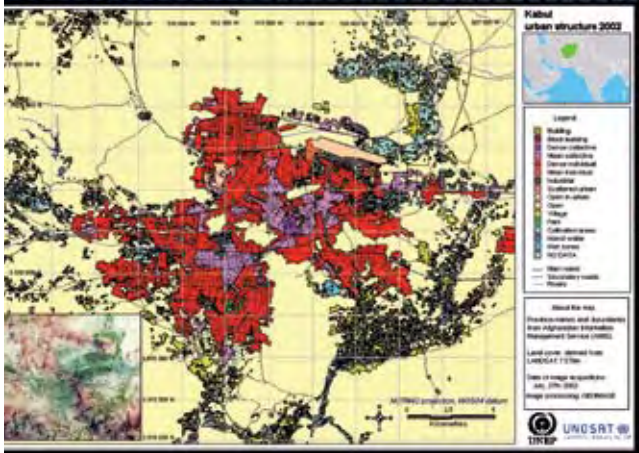
CIVIL APPLICATIONS

- Oil & Mineral Exploration
- Facilities Management
- Utilities Management
  - Planning
  - Engineering
  - Maintenance
- Emergency Management
  - Power
  - Water
  - Communications
- Market Research & Analysis
- Planning/Development & Construction
- Civil Engineering
- Surveying and Mapping
- Agribusiness Management

Population Demographics & Monitoring

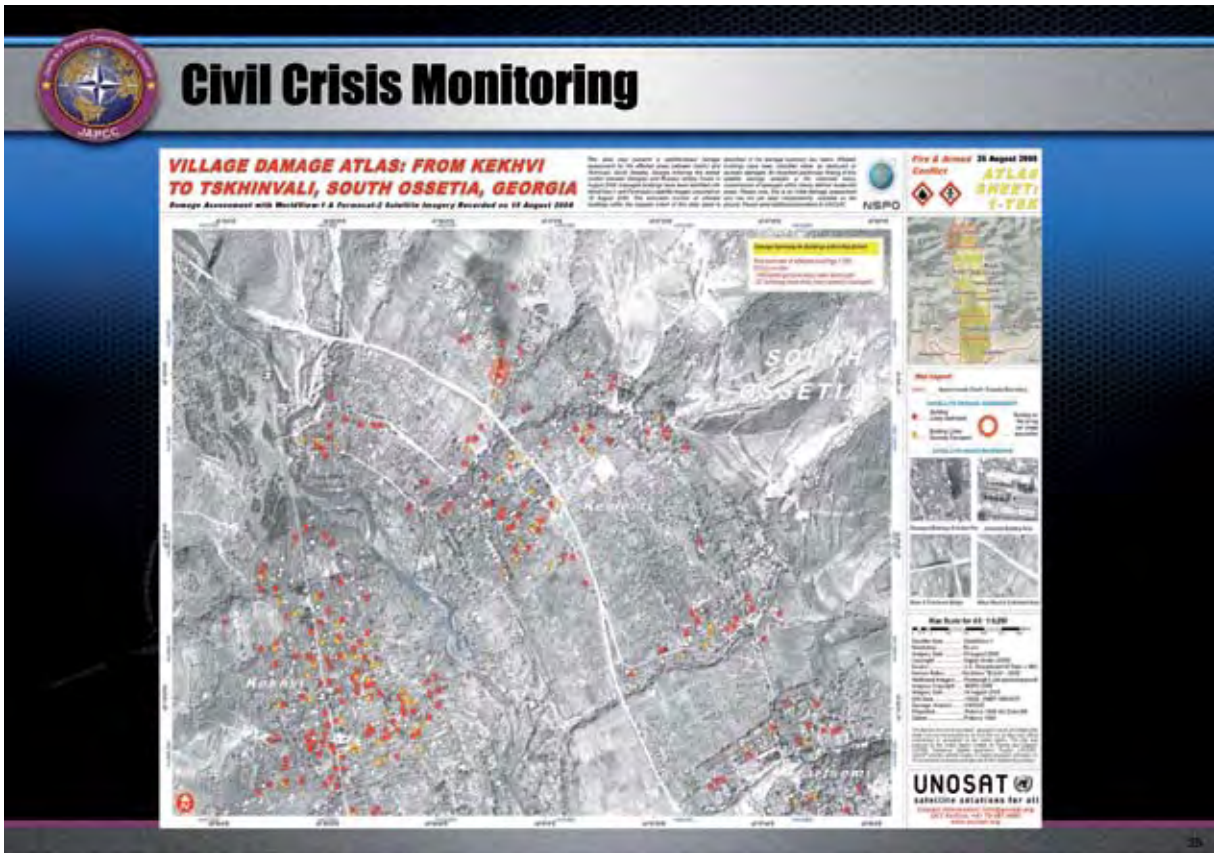
Kabul Urban Expansion Map using satellite image change detection

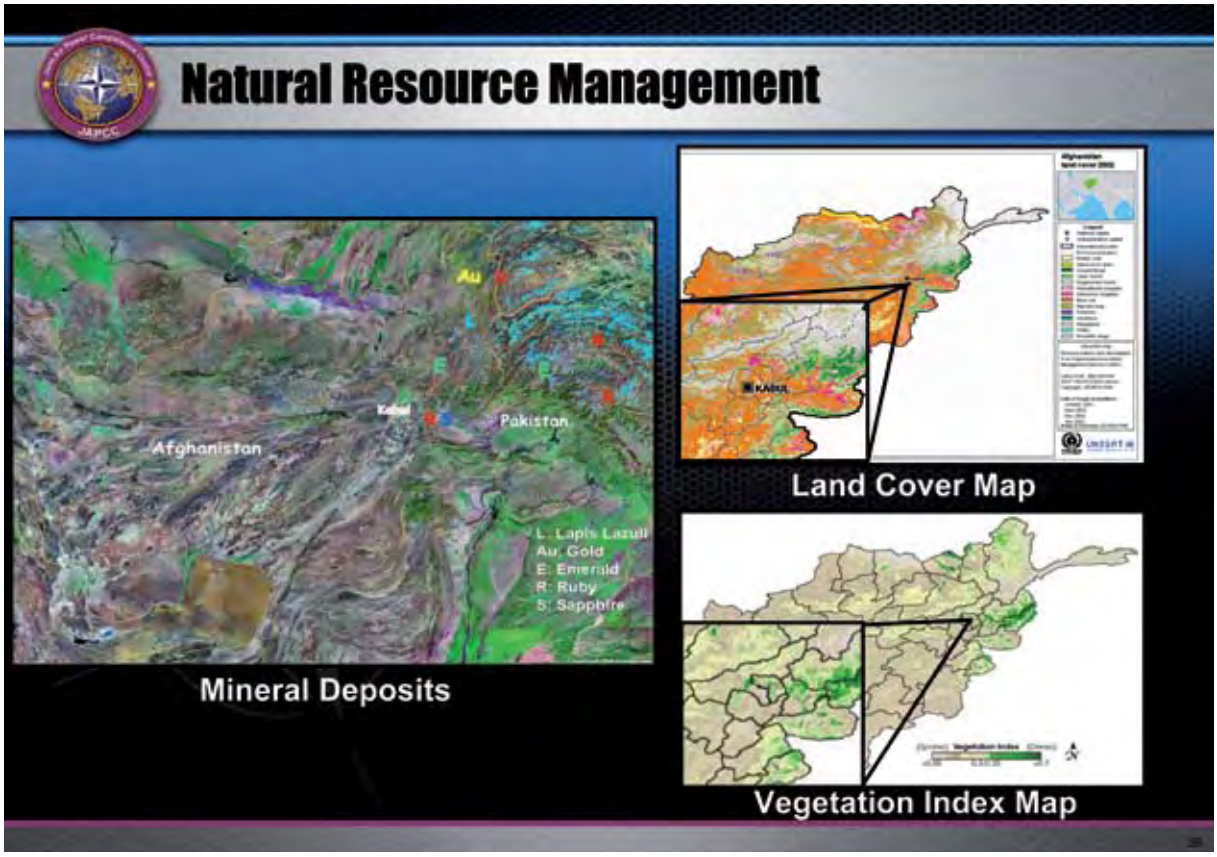


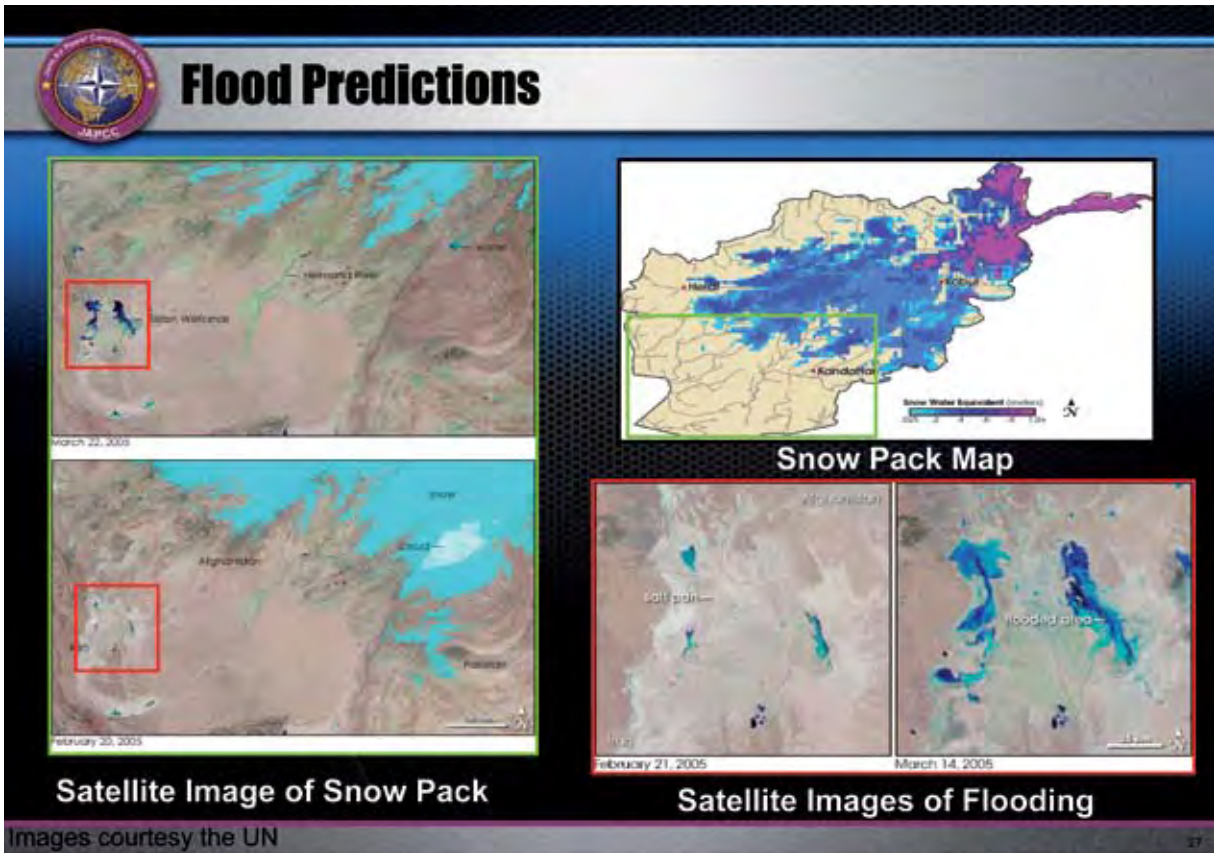


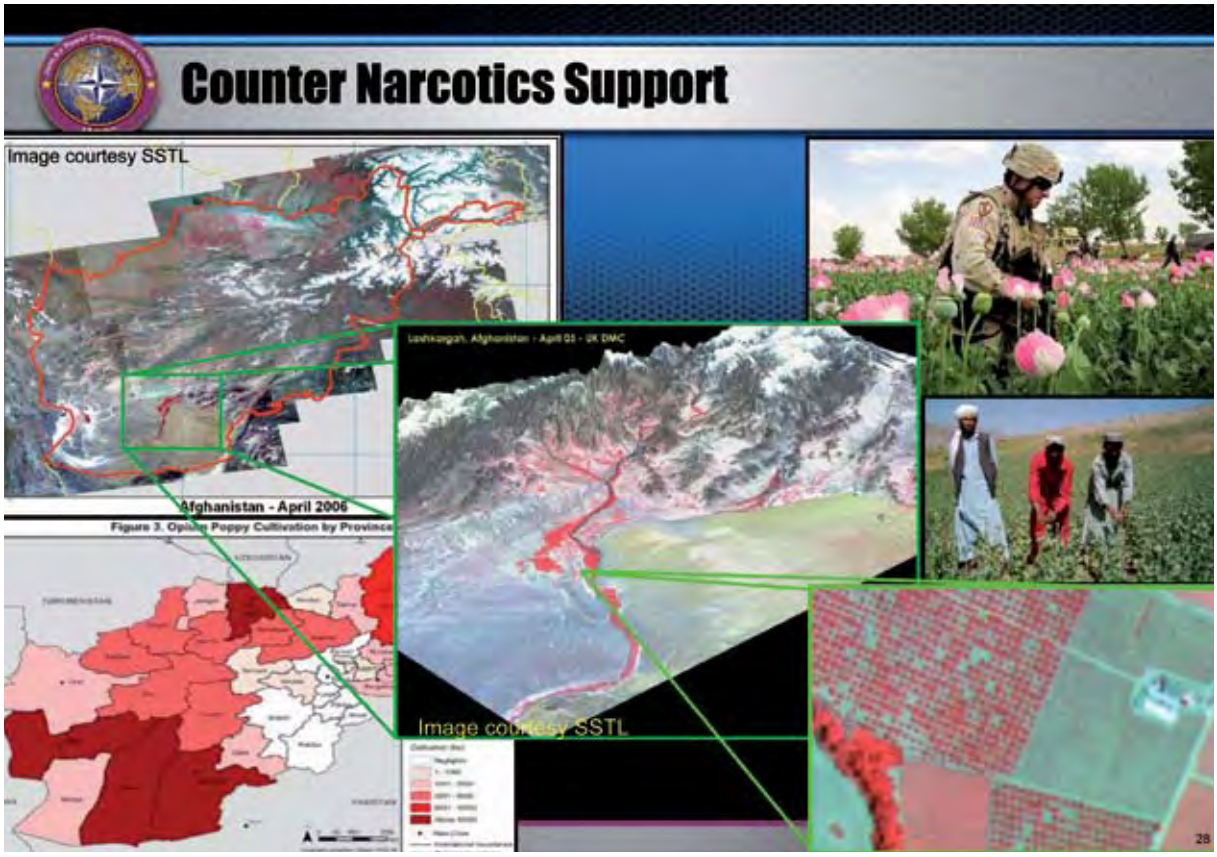
Kabul Urban Structure Map with satellite image & map overlay

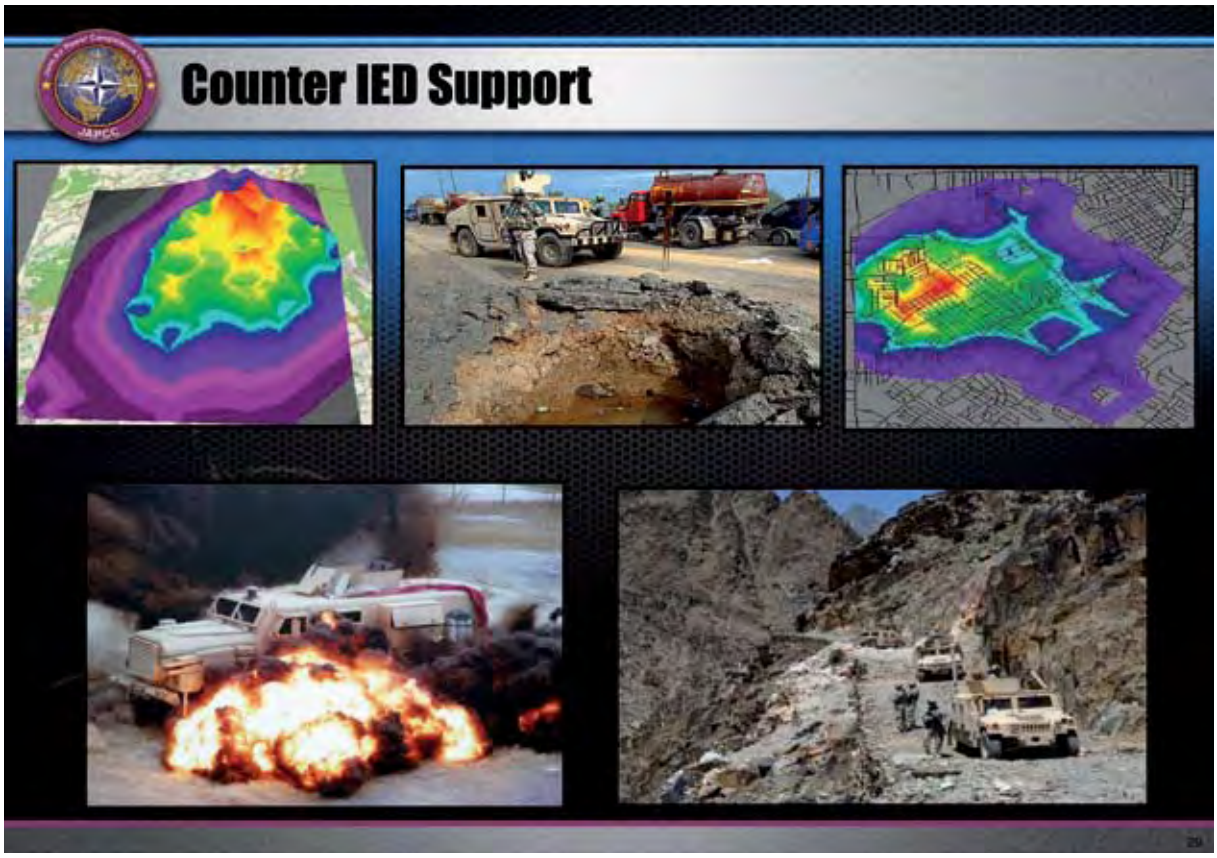
Non-Sensitive Information – Releasable to the Public

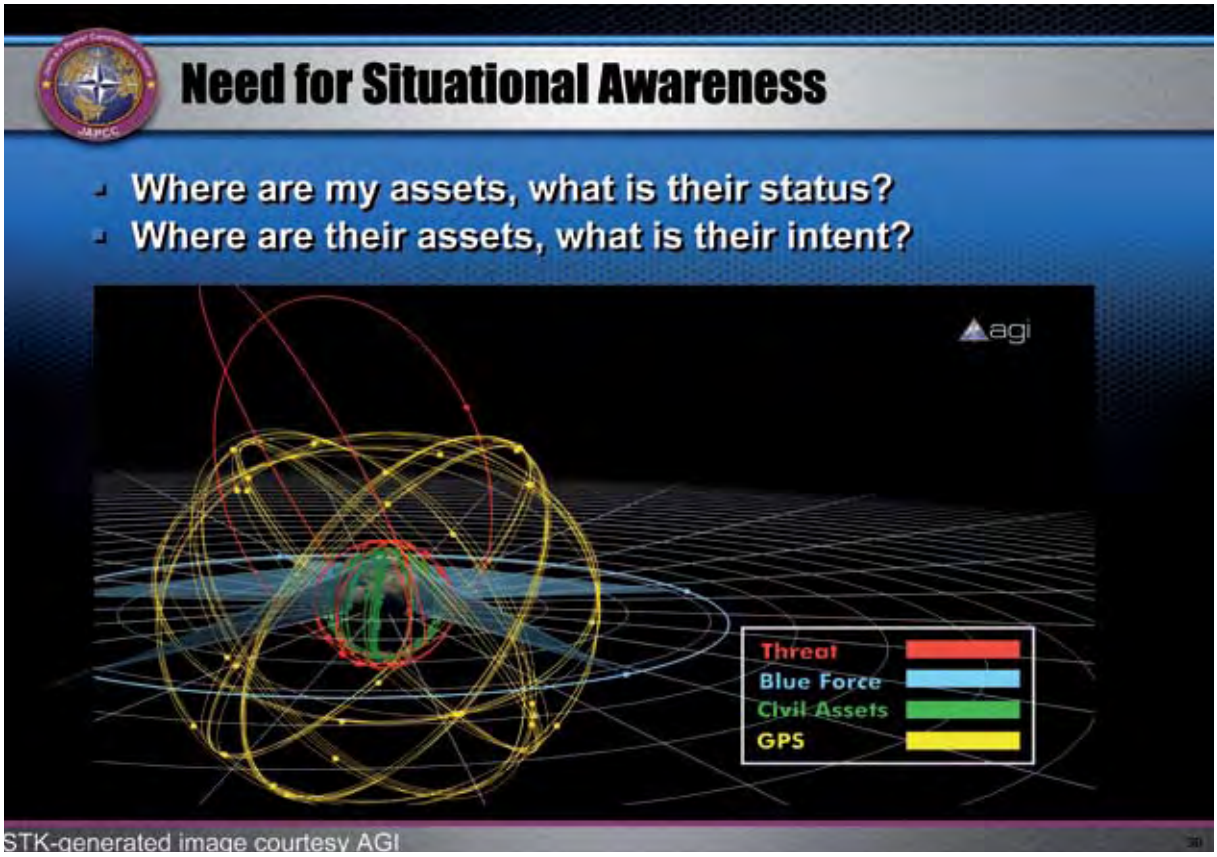

Civil Crisis Monitoring
VILLAGE DAMAGE ATLAS: FROM KEKHVI TO TSKHINVALI, SOUTH OSSETIA, GEORGIA
NSPO
UNOSAT


Natural Resource Management
Au
L
E
R
S
Kabul
Pakistan
Afghanistan
L: Lapis Lazuli
Au: Gold
E: Emerald
R: Ruby
S: Sapphire
Mineral Deposits
KABUL
Land Cover Map
Vegetation Index Map


Flood Predictions
Snow Pack Map
Satellite Image of Snow Pack
Satellite Images of Flooding
Images courtesy the UN
February 21, 2005
March 14, 2005


Counter Narcotics Support
Image courtesy SSTL
Afghanistan - April 2006
Image courtesy SSTL


Counter IED Support


Need for Situational Awareness
Where are my assets, what is their status?
Where are their assets, what is their intent?
agi
Threat
Blue Force
Civil Assets
GPS
STK-generated image courtesy AGI

Assuring the Space Domain

Defensive Space Activities

- SATCOM Protection
  - Kinetic
  - Non-kinetic
- Operation Silent Sentry
  - Non-Kinetic DCS capability
  - Available capability through the CAOC
- Multiple Electro Magnetic Interference (EMI) events to date
  - Blue on blue
  - Red on blue
  - Gray on blue

Offensive Space Activities

- Disrupt, deny, degrade, deceive or destroy OMFs space capabilities

Need to have assured access to space capabilities

Agenda

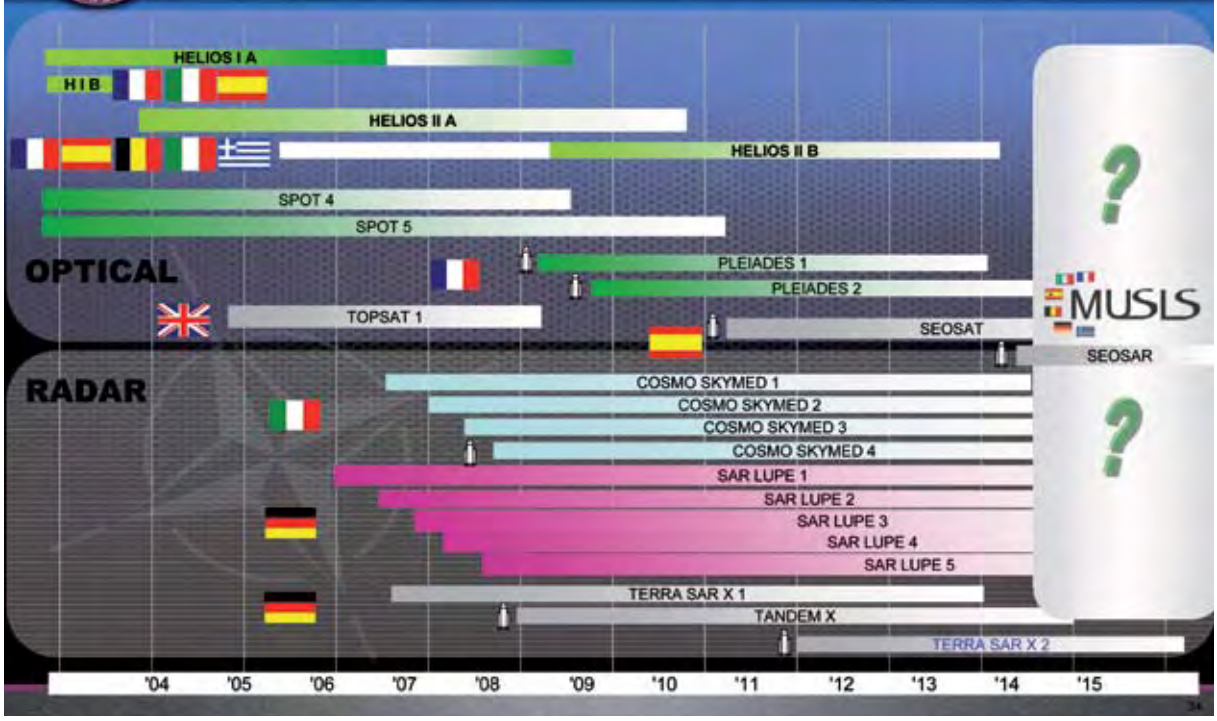
- Meeting the Warfighter's Needs for Space
- Integrating Space Capabilities

Non-Sensitive Information – Releasable to the Public

NATO Nations Operating Satellites

Nation	Science	Telecom	ISR
Canada	✓	✓	✓
Czech Rep.	✓		
Denmark	✓		
France	✓	✓	✓
Germany	✓	✓	✓
Greece		✓	
Italy	✓	✓	✓
Luxembourg		✓	
Netherlands	✓		
Norway		✓	
Portugal		✓	
Spain	✓	✓	
Turkey		✓	
United Kingdom	✓	✓	✓
United States	✓	✓	✓

European Space-based ISR Systems



Combined Space Operations (CSpO)

- No nation can afford to go it alone!

- Cooperation is Needed
  - Satellite Needs/Usage
  - Security/Classification
  - Technology Transfer
- Command Relationships
  - US/Canada/France/Germany/Italy now individually tasking their respective national ISR systems – how do we integrate them into NATO?

CSpO will be challenging…
The time to begin the dialogue is now!

US CAOC Space Team

- The Director of Space Forces (DIRSPACEFOR or DS4) is a US Air Force senior advisor who "facilitates coordination, integration, and staffing activities" of space related activities
- CAOC Combat Ops Division Space Cell is the lead for space support in theater, available 24 x 7
- Located at the CAOC, Al Udeid, Qatar

Non-Sensitive Information – Releasable to the Public

US Joint Space Operations Center (JSpOC)
Allows reachback – "One stop shop for space"
Produces the JSTO
Provides situational awareness and "products"
A force multiplier for the Space Operator
Supports ALL US CAOCs
Forward deployed CAOC/CJOCs

Joint Air Tasking Cycle
CJTF/Component Coordination
JTL, ROE, & Apportionment
Target Development
JIPTL
Weaponeering & Allocation
AOD & MAOP
ATO Development
ATO, ACO, & SPINS
Force Execution
Results
Operational Assessment
BDA & Recommendations

Joint Space Tasking Cycle

Strategy

- Strategy to Task (S-T-T) Analysis
- Space operations planning
- Intent / guidance – Space Ops Directive
- Operational assessments
- COA development

ISR

- Conduct Space Predictive Battlespace Awareness for OSC/DSC
- Provide dynamic space IPB
- Assess space links and nodes

Combat Ops

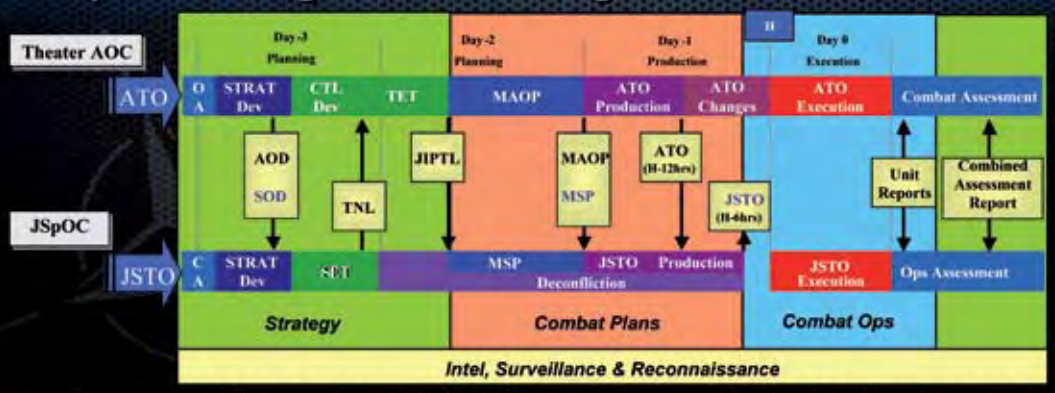
- JSTO execution & assessment
- 24/7 Theater reachforward
- Maintain Single Integrated Space Pictu
- Coordinate space support for C/JFACC objectives
- Missile Warning Sensor C2
- Mission Cell structure – integration of Ops, ISR, Comm, Weather

Combat Plans

- Develop execution plans for space operations
- Master Space Plan (MSP) and Joint Space Tasking Order (JSTO) development
- Defensive Counterspace Team

ATO / JSTO Synchronization

- Space Systems: low density/high demand
- Multiple users/priorities – assets belong to the nations
- Coverage time/location limited by satellite orbit
- Space is integrated into the fight!



- Standard Weekly JSTO Cycle can shift to Daily Cycle in support of theater tempo

Non-Sensitive Information – Releasable to the Public

Challenges: "The last tactical mile"

- Releasability
  - Change of paradigm needed: "must protect" to "must share"
  - Some US products are Rel/ISAF – but not to NATO
- No national training/exercises that include Space – first exposure could be in ISAF
- Don't know what products/services to ask for
- Need for increased cooperation and integration of national space capabilities
- All nations use space, but we need to ensure space capabilities are integrated at the last tactical mile

Connecting the customer with the capability

Joint Air Power Competence Centre

JAPCC

Major Tom "Solo" Single, USAF

JAPCC C4ISTAR Branch – Space Ops SME

NATO Email: single@japcc.de

www.japcc.org

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Annex F: ISAF Space Questions

Response is Classified ISAF/NATO Secret, contact JAPCC for details.

Questions submitted to HQ ISAF:

1. NATO does not have a Space policy or military Space strategy. In your opinion, would having this high level guidance allow better Space integration and transformation to better support the ISAF warfighter? How could it potentially help support the warfighter?
2. Should ISAF forces have Space 'smart' personnel embedded in NATO units, similar to United States Army Space Support Elements? Have any HQ ISAF staff taken the NATO School's Space Operational Planning Course?
3. In your opinion, are NATO personnel trained to an appropriate level to request support from Space capabilities when they deploy to ISAF? Are they better trained/ experienced after their ISAF deployment to capitalize on Space capabilities?
4. In your opinion, would it be beneficial to have a Senior Space Officer assigned to the JFC in major NATO exercises and wargames, prior to deployment to support ISAF, with the goal of exposing more leaders and planners on Space capabilities and how to request them?
5. Are there appropriate Space doctrine, tactics, techniques and procedures in place for ISAF forces to take advantage of Space capabilities?
6. Are there any shortfalls in equipment related to providing Space support (theatre downlinks, CIS requirements (software programmes, networking, etc.)?
7. NATO currently does not have doctrine or requirements in the Space control mission area, are there requirements in this mission area in AFG that NATO should address?
8. Are there areas where it would benefit NATO to have a common funded Space programme (other NATO examples are AWACS, various CIS projects and in the future AGS)?
9. Should NATO investigate the potential for constellations of small satellites to provide ISR and communications support to its static and expeditionary forces, would these systems potentially provide military utility?
10. NATO and ISAF will utilize more UASs in the future, based on United States experience in OIF and OEF, what types of concerns/issues should NATO address with respect to SATCOM bandwidth and links?
11. If NATO forward deploys its AWACS capability, what Space support should be requested/planned?
12. Would NATO benefit from having a Combined Space Operations Centre (CSpOC) to coordinate, plan and integrate member Nations (and potentially NATO) Space capabilities and to better provide reachback for NATO expeditionary forces?
13. Is the current process of requesting Space support adequate or does NATO/ISAF need a Space Tasking Order to request support from Space capability provided by member Nations?
14. How many Space Support Requests have been submitted from ISAF forces? Total number from all forces in AFG? Total number requested from Iraq?
15. Are there any SATCOM issues in AFG that ISAF forces have had to resolve or is ongoing? Are there training issues or common problems (for example, personnel not trained on VSAT terminal operations and maintenance)?

16. Has the Shared Early Warning System been fully integrated and developed, specifically, is the missile warning network in AFG effective? Are there any related issues/improvements to be made in the theatre missile warning mission area? What are the missile warning requirements for the ISAF forces?
17. In the area of intelligence derived from Space based systems, are ISAF warfighters receiving required products/support, and if not, please provide specific examples of products that ISAF/NATO should have or recommendations on improvements to be made. What are ISAFs requirements for Space based intelligence capabilities? How can NATO solve the integration of exchange of national intelligence sources?
18. Is ISAF looking at the exploitation of Space by the enemy and if not, would this be useful? Do NATO forces have the expertise to be able to conduct this analysis?
19. Should NATO train its forces on how to develop a Space Order of Battle (SOB) and should ISAF begin building a SOB?
20. Is there sufficient reachback and support from ISAF forces to the USCENTAF CAOC for Space support?
21. Have there been GPS or SATCOM interference issues and are there processes in place to mitigate and resolve these issues? Does ISAF have enough SATCOM bandwidth and terminals? Any other issues or recommendations for improvement?
22. Are Friendly Force Trackers/Blue Force Trackers being optimally used in AFG and are ISAF units integrated into United States operations? Are there interoperability or network issues? What are ISAF units using these trackers for (situational awareness for land component, CSAR support, etc.)? What requirements should NATO have for Friendly Force tracking?
23. Would providing NATO Space planners on planning staffs improve support to the ISAF warfighter? If so, what are some the basic training requirements/performance standards/duties for these Space planners?
24. Have Space capabilities proven to have military utility to ISAF forces? Can you provide some specific examples of mission areas and success stories?
25. Are there other observations or recommendations you would make to improve the integration of Space capabilities for NATO forces and to help transform future capabilities?

Annex G: Military Utility of Space for NATO Matrix

This matrix provides a strategic-level example of the type of analysis that should be conducted for Space systems and is by no means comprehensive. The Defence Requirements Review should accomplish a detailed analysis with key stakeholders with technical expertise.

Mission Analysis → Capability Needs → Candidate Space Systems

Mission	Capability	Space System	Candidates
Intelligence, Surveillance and Reconnaissance	• Reconnaissance, detection, identification	• Imaging Satellites • SIGINT & ELINT Satellites • Missile Warning and Tracking Satellites	• Optical, infrared, radar imaging satellites • SIGINT & ELINT satellites • GEO or LEO orbits • Constellations or single asset • Military or commercial • Owned or leased
Command and Control	• High bandwidth & data rates • Interoperable • Secure	• Telecommunication Satellites • Data Relay Satellites	• Protected wideband EHF/SHF frequency telecommunications
Information Exchange	• High bandwidth & data rates • Interoperable • Secure and non-secure	• Telecommunication Satellites	• Protected wideband EHF/SHF frequency telecommunications • Unprotected UHF frequency telecommunications

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Non-Sensitive Information – Releasable to the Public

Annex H: Considerations for a NATO Space Policy

Background

1. Space gives us the capabilities to address many challenges of the 21st Century. It is essential and urgent to make effective use of these capabilities in the implementation of a wide range of policies. Space-based systems provide improved weather forecasts, satellite broadcasting and advanced navigation services; they open up new opportunities in tele-education and tele-medicine. They are critical to key areas of the economy: communication systems, electrical power grids, and financial networks all rely on satellite timing for synchronization. Space also contributes to the knowledge-based society, providing tools for understanding our planet, its origins, its environment, the Solar System and the Universe. Space can contribute to NATO cohesion and identity, reaching citizens across all Nations. Space systems have become an integral part of our economies, politics, security and defence.

2. Militarily, there has been significant growth in the strategic importance of space, especially as NATO forces have become expeditionary. NATO increasingly relies on Space systems for on-going operations. Recently, many member Nations, the European Union (EU), European Defence Agency (EDA) and the European Space Agency (ESA) have also recognized the importance of and need for Space capabilities for security and defence activities. Consequently, they have issued Space policies and strategies and are rapidly moving to better utilize, develop and integrate Space capabilities. The many political, security and defence challenges that NATO and the member Nations are facing makes a NATO Space Policy a strategic necessity for the Alliance.

3. Nations and their armed forces have become reliant on satellite services such as telecommunications, earth observation, missile warning and global navigation and timing. Space systems enable global situational awareness and provide the intelligence and information relied upon by decision makers. As a critical enabler for security and defence operations, Space systems are vital to the Alliance in both peacetime and crisis. A comprehensive approach to Space operations is important for NATO to develop the overarching framework to be able to deliver effects to its political leadership and military forces.

Introduction

4. Land and maritime warfare evolved over many centuries. Since the invention of the airplane in the early part of the last century, it has been proven that control of the air is critical to military operations. Space is the next medium that must be addressed. As NATO transforms to an expeditionary Joint force, it is important to have a clear long term vision for how the Alliance should use Space and provide guidance on priorities and capabilities. Space systems support the Nations, the Alliance, the European Union (EU) and civilian and commercial entities. Many Nations and organizations (such as the EU and the United Nations) have issued Space policies, strategies and white papers on Space. A NATO Space Policy is increasingly necessary to provide guidance for the Alliance use of Space for security and defence.

5. This policy forms the foundation for the Alliance, national and public investment in Space to better provide for security and to enable combined Space operations. The Alliance requires strategic direction on the use and integration of Space capabilities to ensure interoperability and reduce duplication of efforts on similar Space systems.

6. This policy is needed to define how the Alliance will use Space assets. Policy and guidance helps to define how existing capabilities will be used and to provide direction for the development of new capabilities. There is a need to plan for Space systems and capabilities today due to long lead times and the great expense of Space systems. The priorities for Space today and in the future must be shared amongst the Nations. Currently, Space in NATO is fragmented into narrow functional areas. Until there is policy, strategy and guidance, we will continue to work in an ad hoc way. This policy is a first step and should be followed by the development of a strategy, doctrine and other guidance to ensure the Alliance makes best use of the advantages and capabilities offered by Space.

Guiding Principles

7. **Space will be used for peaceful purposes.** The Alliance is committed to the exploration and use of Space by all Nations for peaceful purposes. The Alliance will pursue peaceful uses of Space, and preserve the right to protect National assets and capabilities. NATO seeks to cooperate with other nations and organizations in the peaceful use of Space to extend the benefits of Space and to protect and promote freedom and security. Peaceful purposes allow NATO security and defence related activities in pursuit of National and collective security.

8. **Long-term Strategic Need for Space.** Successful NATO transformation to an expeditionary, network enabled, Joint and Combined military force requires improvements in its Space capabilities. Political and military activities depend on assured access to information and intelligence in support of crisis management and global security operations. Space capabilities enable the monitoring of the proliferation of weapons of mass destruction, verification of international treaties, the protection of national borders and critical infrastructure, and prevention, response and recovery activities for natural and man-made disasters. The Alliance must have a long-term strategy for securing and maintaining access to Space capabilities.

9. **NATO must develop Space Power.** The Alliance and its member Nations will pursue the development of Space Power to strengthen its leadership position and ensure that Space capabilities and technologies are available for National, Alliance, and global security and to support policy objectives. Therefore, the Alliance encourages civil exploration, scientific discovery and environmental monitoring activities such as EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites) and GMES (Global Monitoring for Environment and Security). NATO must deliver a foundational level of Space support, no matter the operation, nation or location. The foundational level of support available to all forces will be telecommunications, missile warning and defence, remote sensing and navigation, positioning and timing, and protection of those Space services. Strategy and plans must be developed to provide that support.

10. **NATO must focus on Space activities to support the warfighter**. NATO and various stakeholders must focus on those activities to support and better enable the warfighter. The Nations must make better use of existing National and multi-national Space systems and foster increased integration and cooperation. In particular, Nations have shared needs for telecommunications, remote sensing, and navigation and timing. NATO must develop a Space architecture that allows for reachback and to coordinate in theatre with deployed forces.

11. **NATO must have assured access to Space.** The Alliance considers Space systems to have rights of free passage through Space without interference. Purposeful interference with a nation's Space system is considered an infringement of its rights. Furthermore, the entire Space system (ground segment, Space and command and control links) are vital to National and Alliance interests. The Alliance will preserve the rights, capabilities, and freedom of action in Space; deter others from impeding those rights and take those actions necessary to protect its Space capabilities. If necessary, the Alliance may deny adversaries use of Space capabilities hostile to Alliance interests. NATO will not develop launch systems, but may be a user of these systems. As such, member Nations, civil and commercial entities should provide assured access to Space.

12. **NATO must build Space expertise.** While delivering Space systems to provide capabilities and effects to the warfighter and decision makers is paramount, the Alliance must also develop Space professionals to acquire and operate these systems. NATO requires Space expertise at all levels and should have personnel assigned to Tactical, Operational, and Strategic level headquarters. Additionally, because NATO does not currently operate Space systems, extraordinary efforts are required to develop NATO Space professionals. Space personnel should be developed to be able to plan and integrate Space capabilities and effects.

13. **Space system acquisition has unique requirements.** Space systems are extremely expensive and complex. The life cycle costs of Space systems are different from other types of systems and typically only a small number of 'units' will be purchased. Consequently, there is often not a chance to correct deficiencies in future blocks or upgrades. It is vital when planning and developing Space systems and capabilities, that acquisition and programme managers have expertise on Space programmes. Expertise is needed for programme management and to follow a systems engineering approach to development. Oversight and active management of Space programmes is required. Feedback and lessons learned from operations, exercises and the components are critical for shaping future Space capability requirements.

14. **A healthy Space industrial base is important.** It is vital to enable and develop a robust and dynamic, globally competitive commercial Space sector. This is necessary to promote innovation, strengthen Alliance leadership, ensure economic prosperity and security, and to protect National interests. Space is mutually beneficial to all Nations and the Alliance encourages international cooperation with other nations and entities.

15. **Spectrum and Orbital Management.** As more nations and entities operate Space systems, the increased strain on spectrum and orbital management requires the most efficient use of limited frequencies and orbital assignments. There must be increased cooperation to better manage these limitations.

16. **Orbital debris must be mitigated.** Risk of collisions from orbital debris poses a significant risk to all nations operating satellites. NATO Nations will seek to minimize creation of orbital debris by government and non-government operations in order to preserve the Space environment. Nations will continue to follow international efforts to ensure flight safety, mitigate risk, and share Space surveillance information as is required to maintain situational awareness. To this end, nations are encouraged to increase cooperation and sharing of sensor data, standardization of surveillance data and orbital parameters and the development of a robust global Space surveillance network.

Foundational Guidelines

17. The Alliance is currently reliant upon the capabilities and systems provided by its member Nations and obtained from commercial sources. NATO must have a Space architecture that allows integration of common funded and National Space systems. Future NATO and National systems must be interoperable. Furthermore, NATO should ensure commercially procured services are interoperable with Alliance systems.

18. Military forces must ensure Space capabilities are used for maximum effect. The Alliance and its Nations will pursue Space technologies, to include research, development, testing, and operation of Space systems. The Alliance encourages and may facilitate commercial and scientific exploration and advances in technology. As technologies advance, the Alliance should make use of small satellite capabilities. Treaty monitoring and transparency and security-building measures should be incorporated into Space activities.

19. The primary focus of Alliance Space activities is the development and use of force enhancement capabilities. Force enhancement capabilities provide telecommunications, intelligence, weather, missile warning, navigation, and other Space services to the warfighter. National and Alliance funding must be put towards delivering those capabilities that can most benefit the warfighter and decision makers.

20. Telecommunications are required for expeditionary operations, for command and control, and for information and intelligence exchange. It is vital that the Alliance develop robust secure satellite communication systems and radios. The Alliance must balance the use of dedicated and protected satellite communication systems with unprotected commercial services. Furthermore, satellite communication systems should use common standards be designed to be interoperable and provide for cost reductions by sharing of capability.

21. Earth observation and remote sensing are important for security and defence. The Alliance requires assured access to robust optical, infrared, multi-spectral and radar observations systems. Significant effort should be made to utilize and integrate commercial satellite capabilities and services. Future systems should be designed to be interoperable, to share command and control networks and ensure data and products can be easily exchanged.

22. Position, navigation and timing information from Space will continue to be imperative for civilian and military applications. The Alliance will continue to use GPS as its standard space-based navigation and timing system but will evaluate the need to use the future Galileo system. There are increasing threats and vulnerabilities to Space navigation systems and those risks must be mitigated.

23. The Alliance will maintain capability to provide ballistic missile warning and defence. Through data sharing and integrated defence systems, the Alliance intends to deter aggression from a position of strength by ensuring information superiority and the ability to defend its Nation's interests. The Alliance must have Space capabilities to provide continuous, strategic and tactical warning and be part of a multi-layered integrated missile defence system.

24. Space surveillance is needed to ensure Space flight safety and to provide Space situational awareness. Increased cooperation and information exchange is required. International efforts to establish a robust global Space surveillance network and integrating sensors into the United States Space surveillance network should be pursued to more effectively monitor Space systems, debris and other potential threats.

25. The Alliance requires access to imaging, signals and electronic intelligence satellite capabilities, as these are vital to decision superiority.

26. The protection of Space systems and assured access to Space capabilities is a top priority for the Alliance. Space systems must be protected from land, sea and air attacks as well as from jamming and interference. The information systems must be protected from intrusion and network attacks. Protective measures and techniques should be designed into the ground and Space segments. The Alliance must develop capabilities, plans and options to ensure freedom of action of Space capabilities, and if necessary to deny such freedom of action to its adversaries.

27. A great challenge is the sharing of Space based intelligence information. The Nations have experience in exchanging intelligence provided by air platforms, but due to the strategic nature of satellite systems and classification issues, the Nations have less expertise in space-based intelligence. Some intelligence will always be kept at the National level, but significant effort must be made to exchange information and intelligence. In light of the current security threats and an era of increased trust and cooperation, Nations must review what information and products can be exchanged in the framework of the Alliance. The emphasis must be on moving from a 'need to know' to a 'need to share.' The Alliance must develop an intelligence architecture to collect, manage, store, analyse and disseminate space-based products. Education and training of personnel on available Space capabilities and products and the request and collection management process must be a top priority that will immediately benefit our warfighters.

28. Core to developing a viable capability and to ensure standards and interoperability is developing Space professionals. This small core of personnel highly trained and educated on Space can be leveraged by the Alliance. The Nations must incorporate Space into military education at all levels. While NATO can provide standards and objectives for training, it is not only a NATO responsibility. It is expected that all the Nations will begin to develop a core of Space specialists. Furthermore, when filling NATO posts, care must be taken to man them with the right people having the appropriate training and experience.

29. Exercises and training events must incorporate Space activities. Commanders must be challenged to solve problems that include employment and loss of Space capabilities during exercises. Space capabilities and activities must be incorporated and integrated into existing boards and processes. Space capabilities support Joint forces and all of the components must have Space expertise. To foster

increased cooperation and provide reachback capability, the Alliance should develop a NATO Space Operations Coordination Centre to fuse National and Alliance Space capabilities and to better provide support to decision makers and the Joint warfighter.

International Cooperation

30. Many nations will continue to pursue their own National Space programmes. The security challenges facing today's nations are great and resources are increasingly scarce. Nations with limited funding for Space programmes should seek increased opportunities for partnerships and cooperation in the interest of Alliance security. Many Space systems are dual-use, for both civilian and defence applications. In order to reduce duplication of capabilities and to best leverage the limited funding for Space capabilities, the Nations should pursue increased international cooperation, partnerships, and participation in dual-use systems.

31. NATO will engage with the European Union, the European Defence Agency, European Space Agency and National agencies and departments to strengthen Space policy, strategy and information exchange. There must be greater cooperation and closer partnerships in order to develop Space Power for the Alliance. NATO must leverage the Space expertise and experience of other organizations until an appropriate level of Space expertise is developed in the Alliance staff.

32. Security Classification: The research, technology, development, operations and products of Space activities shall be classified as necessary to protect sensitive information. However, in the interest of trust building and collective security, Nations will ensure systems and procedures are developed to safeguard classified information in order to more widely share intelligence and information. Confidence building measures, verification and standardization are required to operate in today's collaborative environment. Information assurance and security must remain a top priority.

Annex I: Tenets of a NATO Military Space Strategy

Introduction

- Space Power is vital to all operations and is a key enabler of decision superiority
- NATO must better leverage national Space capabilities
- Need to foster an environment of trust to better enable sharing of information and intelligence
- Space needs to be fully integrated with Air, Land, Sea and Cyberspace
- Space Power is a critical enabler of expeditionary operations and JISR

Capabilities and Integration

- Efforts must be made to better utilize Space ISR for support to SOF and CSAR
- Priorities are for force enhancement and support to the warfighter
  - This includes: SATCOM, missile warning, intelligence, PNT
- Since Space systems are vital to National security and military operations, NATO must have assured access and those systems must be protected
- JFCs and NRF must plan and integrate Space now

Force Development

- Personnel with Space expertise should be placed at Tactical, Operational and Strategic level headquarters and staffs
- Space activities must be integrated into exercises and training events
- Member Nations are expected to provide basic education on Space capabilities
- NATO must develop a core of Space professionals and commanders must place importance on planning and integration of Space capabilities
- NATO must develop personnel with Space intelligence expertise
- Must capture lessons learned and develop TTPs

Acquisition and Technology

- Programmes must have executive oversight
- Space programmes require specialized development and acquisition processes
- Emerging Space technologies should be leveraged
- Dual-use technologies should be pursued
- Small satellites offer potential

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Non-Sensitive Information – Releasable to the Public

Annex J: Recommended Space Personnel Postings

Organization	Rank	Duties
Current Positions		
CC-Air Ramstein	OF-3	A3/5 Space Planner/Staff Officer
CC-Air Izmir	OF-3	A3/5 Space Planner/Staff Officer
JFC-Brunssum	OF-3	J3/5 Space Planner/Staff Officer
JFC Naples	OF-4	J3/5 Space Planner/Staff Officer
ACT Ele. @ SHAPE	OF-3	Missile Defence Planner/Staff Officer
NATO School	OF-3	Space Course Manager
JAPCC	OF-3	C4ISTAR Branch Space SME
Total Current	**7**	
New Positions		
International Staff	OF-4	Senior Space Officer
MC IMS	OF-4	Senior Space Officer
NATO HQ Space Office	OF-5	Director, NATO Space Office
NATO HQ Space Office	OF-4 or Civilian	Dep Dir, NATO Space Office
NATO HQ Space Office (x2 military, x4 civilian)	OF-4	NATO Space Office Staff
NC3A	Civ (OF-5 equiv.	Senior Space Scientist
NC3A (X3 civilian)	Civ (OF-4 equiv)	Space Scientist
ACT	OF-5	Senior Space Officer SACT; SG/WG Chair
ACT	OF-3	Space Staff Officer
ACO	OF-5	Senior Space Officer
ARRC	OF-3	Space Planner/Staff Officer
JHQ Lisbon	OF-4	Space Planner/Staff Officer
CC Land Heidelberg	OF-4	Space Planner/Staff Officer
CC Land Madrid	OF-4	Space Planner/Staff Officer
CC Maritime Northwood	OF-4	Space Planner/Staff Officer
CC Maritime Naples	OF-4	Space Planner/Staff Officer
JAPCC	OF-3	FCC Branch Space SME
JWC	OF-3	Exercise Space Planner/SME
JALLC	OF-3	Space Lessons Learned
CAOCs (x4)	OF-3	Space Planning & Integration
JFTC	OF-3	Space Integration and Training
RTO	OF-5	Space Executive Management
Total New Positions	**32**	
Expeditionary Positions (as required)		
NRF (x3 per NRF)	OF-4	Space Planning & Integration
HQ ISAF (x2)	OF-4	Space Planning & Integration

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Annex K: Record of Discussion for the NATO Space Workshop

The purpose of the workshop was to obtain feedback from NATO Staffs and other organizations on the draft NATO Space Operations Assessment that the JAPCC is preparing for ACT. The workshop provided a forum to discuss the gaps and recommendations in the Assessment and to exchange information and ideas. This was an important first step for developing Space Power in NATO.

The workshop was held on 22 April 2008, at the JAPCC Conference Centre in Kalkar, Germany. The format consisted of background briefings provided by the JAPCC, followed by four discussion panels. The panels consisted of one or two guest presentations followed by a group discussion. The agenda is included at Attachment 1. The workshop included more than 50 people from over 30 different organizations. A complete list of participants is included at Attachment 2.

The workshop started with a welcome from the JAPCC's Assistant Director of Capabilities. The JAPCC then gave an overview briefing on Space Operations and provided a moderator for the event. Chatham House rules were used; therefore, no individuals or organizations are attributed to comments in this record of discussions.

There were two actions from the workshop:
Action for participants: Deadline for inputs on the paper, Friday 2 May

Action for the JAPCC: to find out from ACT future actions and timeline for response to the Assessment and share with the community of interest

Panel 1, titled 'The Need for NATO Space Governance,' included briefings from the European Space Agency (ESA) and the European Space Policy Institute (ESPI). The ESA briefing covered their current activities related to security and defence. ESPI presented thoughts on what a Space policy would be used for and introduced questions to be answered in order to arrive at a Space policy. There was general consensus that a long term plan for Space was needed by the Alliance. It was pointed out that it will be a significant task for NATO to establish a Space Policy, as it will require political involvement by the Nations. Part of a long term plan for Space is tied to programmes and funding. Without overarching guidance, it is difficult to secure funding and compete against other priorities. Discussions will have to occur at the Military Committee (MC) and the International Military Staff (IMS) level. The 'Ops' organizations must get involved in determining the need for integration of Space capabilities. A fundamental question to be answered is if a NATO nation requests Space support, what is the process and how can NATO support that request?

While it will be challenging in the near-term to have a over-arching Space Policy, there exists other avenues to integrate Space. Existing space-related guidance, doctrine and programmes should further address the need for integration of Space capabilities. **A recurring comment was the need to immediately begin incorporating Space activities into exercises and training events.** Training objectives related to Space should be standardized and implemented at the Joint Warfare Centre (JWC) and the

Joint Functional Commands (JFCs). Along this theme, a concern was raised that **without standards and guidance, how can the member Nations train their staffs to a proper level with regard to Space?**

Part of the long term guidance that is needed is areas for investment in time, money and people. There is a need to engage on many fronts. Training and exercises at the lower levels. Programme management, policy and guidance must be addressed at the highest levels. Since the Nations provide Space systems and capabilities, there must be political direction to translate warfighter needs into programmes that deliver effects. In the short term, NATO must document current capability shortfalls, lessons learned and increase awareness and education. Mid-term, NATO needs to determine what future capabilities are needed and achieve cohesion so efforts are moving in the same direction. **Space in NATO is fragmented into stove-piped areas; until there is policy, strategy and guidance, we will continue to work in an ad hoc way.**

Panel 2, titled 'Determining NATO's Space Capability Requirements,' included a briefing by the National Security Space Office (NSSO) from the United States. The NSSO laid out a framework for addressing the Space mission area and the process for translating policy into warfighter effects. It was stated that 'If you mass, you're dead. But we need the Space and information systems for precision engagement. Space allows us to do it in a way we've never been able to do before.' Questions such as: 'Do you want your SATCOM protected? Is agility important? Is communications on the move important? Will you be in an austere environment? What will you do about your adversary using Space? How will we plan to support operations and how do we assure those capabilities?' were posed to the participants for discussion. Additionally, it was suggested that we want to use new technology to be better at what we do, but how to organize and allocate resources to get there? What's the vision/policy for Space (long term)? There should be enough policy/ guidance to move forward, but that doesn't mean we can't move forward without it. NATO should consider what are the operational concepts and plans needed to pull the capabilities together to deliver the effects and how do we resource them?

A generic construct is: Policy > Concepts > Capabilities > Effects. What do we want to be able to do, what do we need to be delivered for capabilities to achieve effects? Part of the solution is the need to also invest in a Space cadre: the people to integrate and operate. For NATO, how do we leverage and protect capabilities? NATO has three options for Space systems: it could own its own Space capabilities, Nations can allocate capabilities, or if you have a global system, NATO could buy one more to be integrated for the use by NATO.

A point was made that if you can't make the case for the need for a policy, then why do you need it? For example, what happens when you face an adversary that takes away your Space capability? What constitutes an attack on a Space system? How are you going to deal with it? NATO needs to have a coordinated, integrated approach between the Nations; this is how a policy helps you accomplish your mission. If a nation turns to NATO for help, after national capabilities have been exhausted, how will NATO respond? NATO needs to look at all national Space policies and see what's needed. Additionally, for NATO/ISAF missions, chains of command and responsibilities are not clear. **There are several layers to consider: bilateral, multi-lateral, and NATO**

relationships. There needs to be a foundational level of Space support, no matter the operation, nation or location. How do we do it, and what are the requirements?

A concern that was repeated was the need to protect and defend various Space systems. There are various political sensitivities for Space programmes, but it was generally agreed that determining who is responsible for defending Space systems is important. The nation or company providing the system is responsible, but it is much more complex than that, such as, who would pay to protect commercial SATCOM or imaging systems being used by NATO? How can we support the decision makers and warfighters? Rules of Engagement will have to be developed.

There has been some great work done on programmes so far, however, what's needed is a policy as over arching cover for all the individual programmes. Once you have overarching direction, priorities and guidance, then you can have CONOPS and other documents. What about the feedback mechanism? What about lessons learned? None are documented on shortfalls of Space for ISAF. Some units get great support, some get none. **A policy will define how you can use your assets. Policy helps to define how you use the provided capability. Where will NATO be in 2030? There is a need to plan for Space today due to long lead times and expense. What are the priorities for Space?** Is it SATCOM, or is it ISR? We have limited resources that needed to be applied. We may need to have a NATO common system. An option is to do an additional buy for global connectivity and access. For example, the Australians recently purchased a WGS satellite from the United States which provides them national capability and access to the entire network for a greatly reduced cost to them trying to develop it on their own. NATO could potentially solve its EHF needs by purchasing an AEHF satellite.

NATO must better utilize existing capabilities, but it is not clear what can be provided by Space to the forces. How do we want to use what's out there today? In other more mature communities, like logistics, there is understanding of the mission requirements, systems and the direction needed; and it's being implemented. ACT should create a map for where we are going. For example, an area for concern is assured access to Space. There are increasing needs for national security and there are competing demands to share warfighting capability with NATO.

Several comments were made relating to missile warning and defence. In light of the recent Bucharest Summit, it was suggested that the JAPCC address early warning systems and Space support to missile defence.

Training and educating personnel on Space capabilities was again raised as an issue. Forces must have an appreciation for Space, but what is the best way to build that expertise? It is different from training a Space cadre to operate Space systems, NATO and most of the member Nations don't have Space systems. To build staff officers smart on Space will be challenging. If you pull an officer out for a special duty assignment in Space, what is their career/progression? It is hard to pull out for a single Space tour and then go back to their Nations. However there should be training at the low level for a quick win. At the JFC J7 level, they can incorporate Space training activities today. Our commanders are smart. **They need to be challenged to solve problems during exercises**, such as dealing with SATCOM and GPS outages and attacks on Space systems. This will help change the emphasis on Space at the operational level.

As a final thought, it was pointed out that the NAFAG (NATO Air Force Armaments Group) has some place holders for Space, defined as 'aerospace' capabilities. There is a May meeting on Space ISR. How can Space can influence NAFAG? NATO needs to educate the HQs and train the warfighters. The politicians need to be educated so they understand the need for a Space policy.

Panel 3, titled 'Integrating National Space Capability,' included a briefing from the United Kingdom's HQ Air C2 branch on Space integration. The European Union Satellite Centre (EUSC) provided an overview briefing. The UK is developing a Concept of Employment for a Space Operations Coordination Centre (SOCC), with an estimated stand-up date of 1 Aug 08. Key to development of Space Power is to find a high ranking sponsor and then establishing a Space working group for oversight. The UK has created a virtual Space community across many organizations. They have looked at how other policies/strategies are being developed, for example cyberspace. How are they formulating their policy? The SOCC is basically a translation function, taking Space information and translating it into warfighter capabilities and effects. Foreign disclosure has been and continues to be difficult; meaning releasability of Space products from the United States. NATO should look at inter-service exchanges, not just international and engage with industry as well. There is a need for command and staff training at all levels. The RAF has opened postings at the Fylingdales radar to their other services. A comment was made that the general public needs to understand Space at a broad base level. Space can be marginalized, you can't just put in Space control activities; Space is an enabling medium, so you need to provide benefits today. However, if Space is important to your forces it must be addressed. If you want Space after fighting starts, we need to put in Space control to ensure them later.

A comment was made on whether NATO should have a Space CoE separate from JAPCC or to stand-up a **NATO Space Component Command**. Space is another aspect that commanders have (and need). We must figure out how to exchange the products provided by the Nations. Interoperability problem and products must be in standard format or converted to a NATO format. An Intelligence person planning collection must know what's available from the Nations. We need to develop TTPs and collaborate more. We need to know who has what and who needs what. Space is another source of information, which the Commander has to be educated to use. The customer must know the capabilities and know what to ask for. We have to start with training. **We need to add Space expertise to existing boards and processes**. For example, NATO probably does not need a separate Space coordination board.

A comment was made that feedback from ISAF is that they get zero Space support. Is this where we want to be in the 21st century? It's a formal Alliance, not a coalition, so we need proper guidance, support and direction. NATO needs a short, medium and long term space vision. We are still operating in an ad hoc fashion. We need to determine what is not available to ISAF/NATO. What Space capabilities are available to the ISAF troops on the ground? Where is the list of national Space capabilities that ISAF can call upon? Space capabilities are usually not on the CJSOR. Deployed individuals are left to their own means to get Space support.

Again the issue was raised on how to train personnel and develop Space expertise. An example was used that it is reasonable to expect a pilot to be put into an Air Operations Centre and 'pick it up,' but it isn't reasonable to expect them to quickly

pickup Space expertise. Creating exchange positions between member Nations and the United States and putting them in Joint Space positions would be very challenging. It will be easier if Space is integrated into existing NATO operations centres. **All the Nations should have an expectation that their forces have some knowledge of Space capabilities. This shouldn't be only a NATO responsibility.** This is one area where a Space Policy/Strategy would be helpful.

Panel 4, titled 'Conducting Combined Space Operations,' included slides sent from HQ ISAF on Space planning, issues and successes. The JAPCC covered the briefing on behalf of a Space planner in Afghanistan. A comment was made that NATO should focus on force enhancement capabilities, that Space control often gets too much attention. National capabilities should focus on protecting the domain rather than developing NATO capability to defend satellites. **It is more important for NATO to focus on what are the gaps, and how can we help the troops on the ground.** Additionally, Space control is where many of the political sensitivities and releasability issues are. However, NATO should address Space control as it relates to attacking command and control, ground terminals, buying imagery, etc, but not attacking satellites. Another comment was made to not dismiss NATO doing Space control. Ground systems, both military and civil must be protected. Guidance is clearly needed to address this mission area.

There was discussion on the need for a **NATO Space coordination centre**, a one-stop shop to help users ask the right questions. This would be a node with the knowledge, to go work missile warning, GPS, etc. The centre would do the reachback and pushing forward of information. The United States Director of Space Forces is that node in USCENTCOM. NATO needs a similar central point of contact. The best bang for the buck will be a small core of experts to work on the behalf of the rest. NATO should keep existing J2/J6 processes. A suggestion was made for the **need to have an Allied desk at the United States Joint Space Operations Centre (JSpOC) and potentially at the UK SOCC**. It was suggested that NATO could stand up a separate Space centre, but that was not recommended. It could be co-located within another operations centre or could be integrated in the CAOCs as the United States has done. It was generally agreed that there should be a central node to consolidate Space requirements from the expeditionary warfighter. Precedence as been established with the Special Operations Centre in SHAPE as a central coordination centre for the Nations. **Policy must address the need for reachback and to coordinate in theatre as well.**

An example was presented from personal experience in ISAF. In ISAF 7, they had minimal communications, no airborne relay, no VSAT (Very Small Aperture Terminals) terminals, no beyond line of sight communications. They didn't have the C2, there were outages. Then, in ISAF 10, they had lots of C2 platforms and capabilities, now, the problem was which one to use? What will be the NATO standard? As the guy on the ground, they don't know what Space can do for them. Every out of area, expeditionary operation will be different, but Space enables them all when you first hit the ground. **What's needed first is for Space personnel on the component staffs, to train and provide capabilities info.** The RCs don't know what they can do and need help learning what to ask for. Space personnel need to sell the capability and most importantly, prove that they can deliver support. Air Power was proven by precise engagement, flying shows of force, shaping operations, etc. Space will need to prove it can provide help

and that it works. **We have to man NATO with the right people, and this includes the Space position in HQ ISAF,** it should be filled with NATO personnel, not someone deployed from the United States with no NATO experience.

There were discussions on creating new exchange officer positions in Nations and to create new NATO Space billets. **It was generally agreed that during the PE reviews, the Space personnel positions should not be deleted.** The question was asked if there might be support from the Nations to have Space exchange officers. It was pointed out that the United States helped build air expertise: by sending our experts out to the Allies. There are existing exchange officer positions, perhaps it should be evaluated if some of them can be converted from pilots to Space personnel. Liaison officers are not as effective since releasability and classification issues are harder than exchange officers. Another option is to have embedded Allied personnel in places like the JSpOC or other Space centres. NATO could have staff officers at ESA and the EUSC. It was generally agreed that it makes sense to have a central focus on Space expertise. NATO needs to manage its Space expertise better and have one place for commanders to go to for advice on Space. At the senior level, they need exposure on Space. There should be 'Space days' at all staff colleges. They need to be trained to start asking questions. NATO needs to provide top cover by asking Nations to support.

The JAPCC provided some closing remarks. The JAPCC is starting the process with the Space Operations Assessment and thus is drawing attention to Space in NATO. NATO has become too reliant on Space for the focus/efforts to stop. NATO must make steps forward. **It was overwhelmingly agreed that NATO must get Space into exercises.** NATO needs to develop Space training objectives. ACT is focused on support to the warfighter. We need to help determine what part Space contributes and we need to work with SHAPE to get those operations requirements for Space defined. Additionally, NATO needs some expertise in JALLC to capture those lessons and requirements. Developing Space requirements is hard; you don't know what you don't know. We need to start with what are the warfighter effects needed. What needs do I have? Focus first on the effects. This will be a long process to develop Space Power in NATO. Some practical solutions were discussed during the workshop. We must keep taking steps forward.

Attachment 1 – Agenda

Begin	End		Event
0850	0900		Admin Remarks
0900	0910		Opening Remarks
0910	0930		Space Operations Overview
0930	1045		Panel 1 – The Need for NATO Space Governance Presentations by ESA and ESPI
1045	1100		Break
1100	1215		Panel 2 – Determining NATO's Space Capability Requirements Presentation by NSSO
1215	1330		Lunch
1330	1445		Panel 3 – Integrating National Space Capability Presentation by UK HQ Air and EUSC
1445	1500		Break
1500	1615		Panel 4 – Conducting Combined Space Operations Presentation from ISAF
1615	1630		Wrap-up
1900	2100		Informal Dinner – Ratskeller, Kalkar

Note: There was an icebreaker event held at the Hotel Cleve the evening of 21 April.

Attachment 2 – Participants

Total Organizations Represented: 33
Total Registered Participants: 49
Total Participants: 55 (including JAPCC national representatives)
Nationalities present: 14

1. ACT
2. AFSPC/A8I
3. ALCC HQ Heidelberg
4. ALTMBD PO
5. ARRC
6. EMA (LO by BMVg)
7. CC-Air Ramstein
8. DEU MoD
9. DLR
10. EADTF (Heidelberg)
11. ESA
12. ESP Intel Centre
13. ESPI
14. European Space Liaison – USAF
15. European Union Satellite Centre
16. GAF Transformation Centre
17. HQ SACT EO ICT
18. IABG mbH
19. JAPCC
20. JFC – Brunssum
21. JFC-B J3/CJOC
22. JFC-N J5
23. MCC-Northwood
24. NATO Defence Investment Div.
25. NC3A
26. NSSO
27. RTO
28. United States SAF/IA
29. Secure World Foundation
30. SHAPE J3 TMD
31. UK HQ Air
32. United States Air Staff
33. USAFE DS4

Annex L – List of Acronyms

ACCS	Air Command and Control System
ACO	Allied Command Operations
ACT	Allied Command Transformation
AEHF	Advanced Extremely High Frequency
AJP	Allied Joint Publication
ALTBMD	Active Layered Theatre Ballistic Missile Defence
ANP	Allied Navigation Publication
AOD	Air Operations Directive
ARRC	Allied Rapid Reaction Corps
ASAT	Anti-satellite
ATO	Air Tasking Order
AWACS	Airborne Warning and Control System
BDA	Battle Damage Assessment
BFT	Blue Force Tracking
Bi-SC	Bi-Strategic Command
C2	Command and Control
C4ISR	Command, Control, Computers, Communications, Intelligence, Surveillance and Reconnaissance
CAOC	Combined Air Operations Centre
CAS	Close Air Support
CC-Air	Component Commander-Air
CJOC	Combined Joint Operations Centre
C-IED	Counter-Improvised Explosive Device
COA	Course of Action
COMAIRNORTH	Commander Air North
COP	Common Operating Picture
COPUOS	Committee on the Peaceful Uses of Space
CSAR	Combat Search and Rescue
CSI	Commercial Satellite Imagery
CSO	Combined Space Operations
DIR	Directive
DMSP	Defence Meteorological Support Program
DRR	Defence Requirements Review
DSP	Defence Support Program
DTH	Direct to Home
EBAO	Effects Based Approach to Operations
EDA	European Defence Agency
EHF	Extremely-High Frequency

ELINT	Electronic Intelligence
EMP	Electro-Magnetic Pulse
EO	Electro-Optical
ESA	European Space Agency
ESDP	European Security and Defence Policy
ESPI	European Space Policy Institute
ET	Exploratory Team
EU	European Union
EUMETSAT	European Meteorological Satellite Organization
EUSC	European Union Satelitte Centre
EW	Electronic Warfare
FFT	Friendly Force Tracking
GDP	Gross Domestic Product
GEO	Geosyncronus Earth Orbit
GEOINT	Geospatial Intelligence
GMES	Global Monitoring for Environment and Security
GPS	Global Positioning System
HEO	Highly Elliptical Orbit
HQ	Headquarters
HUMINT	Human Intelligence
ICDT	Integrated Capabilities Development Team
IDCAOC	Interim Deployable CAOC
IMINT	Imagery Intelligence
IMS	International Military Staff
IO	Information Operations
IPB	Intelligence Preparation of the Battlespace
IPT	Integrated Program Team
IR	Infra-Red
ISAF	International Security Assistance Force
ISR	Intelligence, Surveillance and Reconnaissance
JALLC	Joint Analysis and Lesson Learned Centre
JAPCC	Joint Air Power Competence Centre
JFATG	Joint Functional Area Training Guide
JFC	Joint Functional Command
JFCC	Joint Function Component Command
JHQ	Joint Headquarters
JIPTL	Joint Integrated Prioritzed Targets List
JISR	Joint Intelligence, Surveillance and Reconaissance
JSpOC	Joint Space Operations Center
JSTO	Joint Space Tasking Order

JWC	Joint Warfare Centre
KFOR	Kosovo Forces
LEO	Low Earth Orbit
LNO	Liaison Officer
MAJIIC	Multi-sensor Aerospace-ground Joint ISR Interoperability Coalition
MAOP	Master Air Operations Plan
MASINT	Measurement and Signature Intelligence
MC	Military Committee
MCMG	Military Committee Meteorological Group
MEO	Medium Earth Orbit
METOC	Meteorology and Oceanography
MIP	Military Intelligence Programme
MSI	Multi-Spectral Imaging
MUOS	Mobile User Objective System (satellite)
MUSIS	Multinational Space-based Imaging System
NAFAG	NATO Air Force Armaments Group
NASA	National Air and Space Administration
NATO	North Atlantic Treaty Organization
NC3A	NATO Command, Control and Consultation Agency
NCSA	NATO Communication and Information Systems Services Agency
NIAG	NATO Industrial Advisory Group
NNEC	NATO Network Enabled Capability
NRF	NATO Response Force
NSP2K	NATO SATCOM Post 2000
NSpOCC	NATO Space Operations Coordination Centre
NSSI	National Security Space Institute
NSSO	National Security Space Office
NURC	NATO Undersea Research Centre
ONIR	Over-head Non-imaging Infra-Red
OPDIR	Operations Directive
PNT	Position, Navigation and Timing
PoL	Pattern of Life
PR	Personnel Recovery
ROE	Rules of Engagement
RTO	Research and Technology Oranisation
SACEUR	Supreme Allied Commander - Europe
SAR	Synthetic Aperture Radar
SATCOM	Satellite Communications
SC	Space Control
SCA	Space Coordination Authority

SEW	Shared Early Warning
SHAPE	Supreme Headquarters Allied Powers Europe
SHF	Super-High Frequency
SIGINT	Signals Intelligence
SOF	Special Operations Forces
SOO	Space Operations Officer
SPG	Strategic Planning Guidance
SPINS	Special Instructions
SpSA	Space Situational Awareness
SSA	Shared Situational Awareness
SSTAG	Space Science and Technology Advisory Group
STANAG	Standarization Agreement
TST	Time Senstive Targets
TT&C	Tracking, Telemetry and Control
TTPs	Tactics, Techniques and Procedures
UAS	Unmmand Aerial System
UFO	UHF Follow-On (satellite)
UHF	Ultra-High Frequency
UN	United Nations
USAF	United States Air Force
USD	United Stated Dollars
VSAT	Very Small Aperature Terminal

Annex M: References

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