The Impact of the Changing Nature of Deterrence on Space

A Forces Transformation and Resources Seminar
Marshall Hall, Room 155, Fort Lesley J. McNair, Washington, DC 20319
April 13-14, 2009

Monday, April 13th - Actions and Responses

0900-0915 **Welcome and Introductory Remarks**
Dr. James M. Keagle, Director, Transforming National Security Seminar Series, Center for Technology and National Security Policy, NDU

0915-1000 **Keynote Address: Strategic Assessment**
Brigadier General Jay Santee, Principal Director, Space and Cyber Policy, Office of the Assistant Secretary of Defense for Global Strategic Affairs

1000-1030 **Break**

1030-1145 **The Contested Regime: Space Treaties, Pledges and Initiatives**
Theme: What are the advantages and disadvantages of a treaty-based approach? How can American priorities help shape such initiatives? What role will changing technologies play in supporting or undermining international agreements in space.
Dr. James Lewis, Senior Fellow, Center for Strategic and International Studies
Colonel Philip A. Meek, USAF (Ret.), Attorney and Counselor, Austin, TX
Colonel M.V. Smith, USAF, PhD Student, University of Reading, U.K. and (Former) Chief, Future Concepts, National Security Space Office

1145-1245 **Lunch**

1245-1400 **A New Balance: Thresholds for a Successful Strategy of Deterrence**
Theme: What constitutes a hostile act? How do space capabilities affect the strategic calculus for the conduct or deterrence of irregular, conventional, or nuclear conflicts? In an escalating conflict, for instance, is the destruction of a military satellite equivalent to the loss of a naval destroyer? Is it appropriate for the U.S. to draw clear 'red lines?'
Major General Jim Armor, USAF (Ret), CEO, The Armor Group, LLC
Mr. Dean Cheng, Senior Asia Analyst, Center for Naval Analyses
Mr. Bruce MacDonald, Senior Director, Congressional Commission on the Strategic Posture of the United States, United States Institute of Peace

1415-1430 **Break**

1430-1545 **Response Options**
Theme: Is an attack against U.S. space infrastructure equivalent to other kinds of conventional attacks? The challenge is not to become enamored by the more fascinating threats, but to address the more simple and probable ones. Consider, for example, how the U.S. might respond to the destruction of a commercial imager? What constitutes the range of possible responses?
Colonel Sean D. McClung, Director, National Space Studies Center, Air University
Dr. Karl Mueller, Senior Political Scientist, RAND
Marcia S. Smith, President, Space and Technology Policy Group

1545-1600 **Closing Remarks**
Dr. James M. Keagle, Director, Transforming National Security Seminar Series, Center for Technology and National Security Policy, NDU

Tuesday, April 14th – Technologies, Capabilities, and Resources

0900-0915 **Welcome and Introductory Remarks**
Dr. James M. Keagle, Director, Transforming National Security Seminar Series, Center for Technology and National Security Policy, NDU

0915-1030 **Understanding Dependencies - Physical Infrastructure**
Theme: Overview of space military architecture, current vulnerabilities, and threats. Discussions will include a possible framework for incorporating space-based assets into nuclear, information, and conventional deterrence strategies.
Mr. Richard H. Buenneke, Deputy Director, Office of Missile Defense and Space Policy, Bureau of International Security and Nonproliferation, U.S. Department of State
Dr. Roger F. Pajak, Senior Intelligence Officer, National Reconnaissance Office
Mr. Brian Weeden, Technical Consultant, Secure World Foundation

1030-1045 **Break**

1045-1200 **Understanding Dependencies - Electronic Infrastructure**
What steps can the DoD take to protect against disruptive electronic, cyber, and targeted attacks against America's vital space architecture? How can the interagency work with private industry and the international community to produce more resilient security posture?
Dr. Martin Libicki, Senior Management Scientist, RAND
Mr. Martin Oetting, Senior Project Lead, Space Protection Program, The Aerospace Corporation
Dr. Scott Pace, Director, Space Policy Institute, Elliott School for International Affairs, George Washington University

1200-1300 **Lunch**

1300-1415 **Scenario: A Space Degraded Environment**
Theme: How should the DoD plan to function in a space-degraded environment? What are the implications for other domestic agencies? This panel should consider examining terrestrial and space-based contingencies.
Dr. Andrew May, Analyst, Office of Net Assessment, Office of the Secretary of Defense
Dr. S. Pete Worden, Director, Ames Research Center, NASA
Dr. Peter L. Hays, Associate Director, Eisenhower Center for Space and Defense Studies

1415-1430 **Break**

1430-1545 **Senior Policy Panel**
Theme: This panel will consider the meaning of "space based" issues. As part of the global commons, the importance of space is related to its broader strategic context. Space policy, consequently, demands a cross-cutting, whole-of-government approach. How can policy-makers help ensure space is one part of the issue, rather than the entire issue?
Ambassador Roger Harrison, Eisenhower Center for Space and Defense Studies, United States Air Force Academy
Dr. Ronald M. Sega (Ret), Vice President for Energy, the Environment and Applied Research, Colorado State University Research Foundation
Major General Richard E. Webber, Assistant Deputy Chief for Air, Space and Information Operations, Plans and Requirements, Headquarters U.S. Air Force

1545-1600 **Closing Remarks**
Dr. James M. Keagle, Director, Transforming National Security Seminar Series, Center for Technology and National Security Policy, NDU

SPEAKER BIOGRAPHIES

Maj Gen James Armor

Major General Jim Armor retired from the U.S. Air Force in January 2008, where his last position was as Director of the National Security Space Office (NSSO) in the Office of the Under Secretary of the Air Force, at the Pentagon. His 34-year AF space career included assignments as Director, Signals Intelligence (SIGINT) Systems Acquisition and Operations at the National Reconnaissance Office (NRO), Vice Commander of the Warner Robins Air Logistics Center at Robins AFB, GA, and Program Director of the NAVSTAR Global Positioning System (GPS) at Los Angeles Air Force Base, CA. He served in a variety of space staff and program management positions, including being qualified as a DoD Space Shuttle payload specialist. He is currently CEO of the Armor Group, LLC, VA, a consultancy for space systems, where he supports several space industry contractors and is a consultant to Sandia National Laboratory, Senior Advisor to Applied Physics Laboratory, and a Visiting Scientist for the Software Engineering Institute. Additionally, he is an Independent Director on the Boards of Integral Systems, Inc., MD, and NAVSYS Corporation, CO, and serves on two National Research Council Committees: the US Civil Space Program, and the Air Force STEM (Scientific, Technical, Engineering, and Math) Workforce.

Mr. Richard Buenneke

Richard H. Buenneke is the deputy director for space policy in the Office of Missile Defense and Space Policy, Bureau of International Security and Nonproliferation at the United States Department of State in Washington, D.C. In his current position, Mr. Buenneke leads the planning and implementation of diplomatic and public diplomacy activities relating to U.S. national security space policy. Before joining the State Department in March 2007, Mr. Buenneke was a senior policy analyst at The Aerospace Corporation, where he served as lead analyst for the National Security Space Office's work on commercial satellite protection. Mr. Buenneke has nearly 25 years of professional experience in field of national security space policy. He holds bachelors degrees in economics and systems engineering from the Wharton and Engineering schools of the University of Pennsylvania. Mr. Buenneke also holds masters' degrees in policy analysis from George Washington University's Elliott School of International Affairs and the Pardee RAND Graduate School.

Mr. Dean Cheng

Dean Cheng has spent nearly two decades studying Chinese and Asian security and economic issues. He is currently a Senior Asia Analyst at CNA, a not-for-profit think-tank, where he specializes in Chinese military issues, with an emphasis on China's space program. Prior to joining CNA, he was a senior analyst with SAIC. He began developing his expertise on the Chinese defense industrial complex while working at the US Congress' Office of Technology Assessment. He has spoken at the National Defense University, RAND, the

Center for Strategic and International Studies, and the US Air Force Academy's Eisenhower Center for Space and Defense Studies, and has written on Chinese joint doctrine, the military and technological implications of the Chinese space program, and the dual-use nature of Chinese industrial and scientific infrastructure.

Ambassador Roger Harrison

Ambassador Roger G. Harrison is the Allan & Malcolm Lockheed and Glenn L. Martin Professor in Political Science and Director of the Eisenhower Center for Space and Defense Studies at the United States Air Force Academy. He was a career Foreign Service Officer who was Ambassador to Jordan from 1990 to 1993. He had previously been Deputy Assistant Secretary for Political Military Affairs, Political Counselor at the U.S. Embassy in Tel Aviv and Deputy Political Counselor of U.S. Embassy London. Ambassador Harrison also served at the White House as Deputy Director for Planning of the National Security Council Staff under President Ford. Other overseas assignments for the State Department included Manila and Warsaw. He was Associate Professor of Political Science at the Air Force Academy on detail from the Department of State from 1977 to 1979. Following his retirement from the State Department, he was John M. Olin Professor of National Security at the Academy from 1993-4. Immediately prior to his designation as Director, Center for Space and Defense Studies, Ambassador Harrison was Dean of the Near East South Asia Center for Strategic Studies of the National Defense University. A 1965 graduate of San Jose State College, he holds a Ph.D. in Government from Claremont Graduate School and also studied at Pembroke College, Oxford and the Free University of Berlin.

Dr. Peter Hays

Peter L. Hays is a retired Air Force Lieutenant Colonel who has been analyzing national security space issues for more than 20 years and wrote a dissertation is on the evolution of U.S. Military Space Doctrine during the Cold War. Since September 2004, he has served as a Senior Scientist with Science Applications International Corporation supporting the Policy and Strategy division of the National Security Space Office in the Pentagon, an Associate Director for the Eisenhower Center for Space and Defense Studies at the USAF Academy, and an Associate Visiting Professor with the Space Policy Institute at George Washington University. He has assisted in the development of products such as the Space Posture Review, 05 Quadrennial Defense Review, National Security Space Strategy, Space Situational Awareness Strategy and Roadmap, National Defense University Spacepower Theory Study, and National Military Strategy for Space. He holds a Ph.D. from the Fletcher School of Law and Diplomacy, an M.A. from the University of Southern California, and was a 1979 honor graduate of the USAF Academy. During his Air Force career he served internships at the White House Office of Science and Technology Policy and National Space Council and taught space policy courses at the USAF Academy, School of Advanced

Airpower Studies, and National Defense University. He currently teaches the Space and National Security seminar at George Washington University. Major publications include: Spacepower for a New Millennium (McGraw-Hill, 2000), "Going Boldly—Where?" (Aerospace Power Journal, Spring 2001); and United States Military Space (Air University Press, 2002).

Dr. James Lewis

James Andrew Lewis is a senior fellow and program director at CSIS where he writes on technology, national security and the international economy. Before joining CSIS, he worked in the Federal government as a Foreign Service Officer and as a member of the Senior Executive Service. His assignments involved Asian regional security, military intervention and insurgency, conventional arms negotiations, technology transfer, sanctions, internet policy, and military space programs. Lewis received his PH.D. from the University of Chicago. Lewis has authored more than forty publications on a range of topics since coming to CSIS, including: "Assessing the Risks of Cyber Terror and Cyber War," "Strengthening Law Enforcement Capabilities for Counter-Terrorism;" "Globalization and National Security, "The Limits of Arms Transfer Restraint," "China as a Military Space Competitor," "Foreign Investment and Sovereign Wealth," "Intellectual Property and Development," "Critical Infrastructure Protection and Cyber Terrorism: Mass Destruction or Mass Annoyance?" "Foreign Influence on Software," and "Waiting for Sputnik: Basic Research and Strategic Competition." His most recent work was as Project Director for the CSIS Cybersecurity Commission and its report, "Securing Cyberspace for the 44th Presidency."

Dr. Martin Libicki

Martin Libicki (Ph.D., U.C. Berkeley) has been a senior management scientist at RAND since 1998, focusing on the impacts of information technology on domestic and national security. This work is documented in commercially published books, Conquest in Cyberspace: National Security and Information Warfare, and Information Technology Standards: Quest for the Common Byte as well as in numerous monographs, notably Cyber-Deterrence and Cyber-War, What is Information Warfare, The Mesh and the Net: Speculations on Armed Conflict in a Time of Free Silicon, and Who Runs What in the Global Information Grid. He was also the editor of the RAND textbook, New Challenges New Tools for Defense Decisionmaking. His most recent assignments were on the subjects of organizing the Air Force for cyber-war, exploiting cell phones in counter-insurgency, developing a post-9/11 information technology strategy for the U.S. Department of Justice, using biometrics for identity management, assessing DARPA's Terrorist Information Awareness program, conducting information security analysis for the FBI, and evaluating In-Q-Tel. Prior employment includes 12 years at the National Defense University, three years

on the Navy Staff as program sponsor for industrial preparedness, and three years as a policy analyst for the GAO's Energy and Minerals Division. He has also received a master's degree in city planning from U.C. Berkeley (1974).

Mr. Bruce MacDonald

Mr. MacDonald is an independent contractor serving as Senior Director to the U.S. Strategic Posture Review Commission, a bipartisan body headed by former Defense Secretaries William Perry and James Schlesinger. He was project leader for the Council on Foreign Relations' study of China, Space Weapons, and U.S. Security, which the Council published in 2008. He was Assistant Director for National Security at the White House Office of Science and Technology Policy from 1995-1999 and previously was a professional staff member at the House Armed Services Committee, where he worked on Air Force acquisition, space, and missile defense issues, and earlier was senior national security adviser to Senator Dale Bumpers of Arkansas. He worked at the State Department in the Bureau of Politico-Military Affairs, where he served on and chaired the Interagency START Policy Working Group and served on the U.S. START delegation in Geneva. He started his career as a staff scientist at a consulting firm where he supported the OSD SALT Task Force and worked on advanced missile defense concepts. Mr. MacDonald graduated with honors in aerospace engineering from Princeton University and received two masters degrees from Princeton, one in aerospace engineering with a specialty in rocket propulsion, and the second in public and international affairs from the Woodrow Wilson School. Mr. MacDonald is a member of the Council on Foreign Relations and the American Institute of Aeronautics and Astronautics.

Dr. Andrew May

Dr. Andrew May is an analyst in the Office of Net Assessment (OSD). He has worked in ONA for the past eight years, initially as a contractor and since 2005 as a government employee. His principal areas of responsibility include the OSD/NA Summer Study, the nature and scope of future net assessments, and assorted projects related to strategy and strategic planning. He has also been at work on a preliminary net assessment focused on the military exploitation of space. Before coming to ONA Dr. May worked at SAIC (1998-2005) where he supported ONA, DTRA, and other DoD customers. Dr. May received his PhD in History from Emory University in 1998.

Colonel Sean McClung

Colonel Sean D. McClung is Director of the National Space Studies Center at Air University, Maxwell, AFB, Alabama, where he leads space research programs for all colleges, institutions, organizations and centers at Maxwell AFB and conducts cooperative efforts with universities and centers nationwide in order to develop and communicate

innovative, space-focused ideas that contribute to national and global security and foster maturity of thought on space and the profession of arms. He also serves as a member of the faculty and staff in the Joint Warfighting Department of Air War College. Col McClung is a career joint space and information operations professional with 26 years in space, missile warning & defense, command and control and information operations at US Strategic Command, US Northern Command, US Special Operations Command, the Missile Defense Agency, US Space Command, HQ Strike Command United Kingdom, North American Aerospace Defense Command, AF Space Command, Strategic Air Command and other organizations. He holds a Bachelor of Science degree from Warrington College at the University of Florida, and a Master of Arts from International University London, England. His professional military education includes Squadron Officer School, Air Command and Staff College, Air University's Air War College, and numerous specialty courses including the Space Applications Advanced Course, Radar Operations, Space Object Identification, national and theater warning operations and others. Col McClung has authored and co-authored numerous articles and publications in subjects including Chinese Air and Space capabilities, Public Diplomacy, Missile Track File Correlation and Data Fusion, and National Missile Defense. He is the recipient of the Master Space Operations Badge with decorations including the Defense Meritorious Service Medal (5), the Meritorious Service Medal (1), the Joint Service Commendation Medal (2); the Combat Readiness Medal (3), the Air Force Expeditionary Service Medal (2) and the Global War on Terrorism Service Medal.

Mr. Philip Meek

Mr. Phil Meek has a general law practice in Austin, Texas, including space law and policy matters. Prior to moving to Austin in September 2008, Mr Meek was an Associate General Counsel (International Affairs), Department of the Air Force, the Pentagon, for 13 years. His primary portfolio consisted of space law and policy, space arms control, information warfare, and the law of armed conflict. Before accepting his position with the Air Force General Counsel, Mr Meek served as an Air Force Judge Advocate for 25 years, with senior JAG assignments including Director of International and Operations Law, HQ USAF, the Pentagon, and a "triple-hatted" position as Staff Judge Advocate for three commands concurrently, specifically, Air Force Space Command, United States Space Command, and North American Aerospace Defense Command, Peterson AFB, CO. He retired with the rank of colonel.

Dr. Karl Mueller

Dr. Karl P. Mueller is a Senior Political Scientist in the Washington office of the RAND Corporation, where he specializes in strategy-related research sponsored by the U.S. Air Force and Army. Before joining RAND in 2001 he was a professor of comparative military studies at the USAF's School of Advanced Air and Space Studies (SAASS). Dr. Mueller

has written and lectured on a wide variety of national security subjects, including deterrence and coercion, grand strategy, economic sanctions, airpower theory, nuclear proliferation, space weaponization, and counter-terrorism policy. His most recent RAND publications are Striking First: Preemptive and Preventive Attack in U.S. National Security Policy, Air Power in the New Counterinsurgency Era, and Dangerous Thresholds: Managing Escalation in the 21st Century.

Mr. Martin Oetting

Mr Oetting has spent over two decades in the Aerospace industry, acquiring a broad spectrum of expertise in Defense, Intelligence, and Commercial space systems. He has focused on such diverse areas as space operations, missile defense, tactical exploitation of national capabilities, and space protection and defense. He is currently supporting the Space Protection Program, which was jointly established one year ago by the Commander of Air Force Space Command and the Director of the National Reconnaissance Office. The mission of the Space Protection Program is to preserve national security space effects through an integrated strategy to articulate vulnerabilities, assess threat impacts, identify options and recommend solutions leading to comprehensive space protection capabilities.

Dr. Scott Pace

Scott Pace is the Director of the Space Policy Institute and a Professor of Practice in International Affairs at George Washington University's Elliott School of International Affairs. His research interests include civil, commercial, and national security space policy, and the management of technical innovation. From 2005-2008, he served as the Associate Administrator for Program Analysis and Evaluation at NASA. Prior to NASA, Dr. Pace was the Assistant Director for Space and Aeronautics in the White House Office of Science and Technology Policy (OSTP). From 1993-2000, Dr Pace worked for the RAND Corporation's Science and Technology Policy Institute (STPI). From 1990 to 1993, Dr. Pace served as the Deputy Director and Acting Director of the Office of Space Commerce, in the Office of the Deputy Secretary of the Department of Commerce. He received a Bachelor of Science degree in Physics from Harvey Mudd College in 1980; Masters degrees in Aeronautics & Astronautics and Technology & Policy from the Massachusetts Institute of Technology in 1982; and a Doctorate in Policy Analysis from the RAND Graduate School in 1989.

Dr. Roger Pajak

Dr. Roger F. Pajak is Senior Intelligence Adviser with General Dynamics Advanced Information Systems. He was formerly the National Counterintelligence Officer for Russia and the Middle East in the Office of the National Counterintelligence Executive (NCIX). Prior to joining NCIX, Dr. Pajak was Director, National Security Group, Orion Scientific Systems, Inc., serving at the National Drug Intelligence Center as senior adviser on National

Intelligence and Russian Organized Crime and lecturer on Intelligence writing and analysis. While with the U.S. Government, Dr. Pajak served as National Intelligence Adviser for Russia, Central Europe, and the Middle East and Senior Adviser for Counterterrorism to the U.S. Secretary of Treasury. There he served as a principal adviser to the Secretary on Russian and Middle East affairs, as well as on Counterterrorism, International Organized Crime, and Critical Infrastructure Protection. An authority on Russian and Middle East affairs, Dr. Pajak spent 1988-89 as Visiting Professor of Strategy at the Naval War College. He is an Adjunct Fellow with the Center for Strategic and International Studies, an Adjunct Professor at the University of Virginia, and Visiting Lecturer at the Defense Intelligence College. Dr. Pajak is a widely published and recognized authority on Russian and Middle East politics and foreign policy, the international arms trade, and nuclear proliferation. He has lectured widely overseas on behalf of the U.S. Department of State and in the U.S. at the Senior Military Colleges, the Foreign Service Institute, and the FBI Academy.He received a Bachelor's degree in International Relations from Michigan State University, a Master's degree in Russian Area Studies from Harvard University, and a doctorate in International Relations and Russian Area Studies from American University. Dr. Pajak is a Fulbright Scholar and a Colonel (Ret.) in Military Intelligence in the U.S. Army Reserve.

Brig. Gen. Jay Santee

Brig. Gen. Jay G. Santee is Principal Director, Office of the Deputy Assistant Secretary of Defense (Strategic Capabilities); Office of the Assistant Secretary of Defense (Special Operations/Low-Intensity Conflict and Interdependent Capabilities); Office of the Under Secretary of Defense for Policy, the Pentagon, Washington, D.C. He is responsible for providing policy advice and support to the Secretary of Defense and other senior Department of Defense leaders by formulating, recommending, integrating, and implementing policies and strategies to improve United States strategic capabilities. This encompasses DOD policy relating to requirements, capability development, operations, declaratory policy, employment, and international cooperation or agreements in the areas of missile defense; nuclear forces; global strike; space; and information operations, including computer network operations. General Santee entered the Air Force as a distinguished graduate of the U.S. Air Force Academy. He has served on the Pentagon staffs of the Assistant Secretary of the Air Force (Acquisition) and the Department of the Navy (Research, Development and Acquisition). The general has also served as Vice Commander of the 14th Air Force, Air Forces Strategic, and as an operations division chief in U.S. Space Command. His commands include a space warning squadron, space operations group and a space wing. During Operation Iraqi Freedom, he was Director of the 14th Air Force Air and Space Operations Center where he planned, tasked and directed joint space forces in support of worldwide military operations. In 2004, he served as the Director of Space Forces at the 1st Air Force Combined Air and Space Operations Center at Tyndall AFB, Fla., throughout relief and recovery operations resulting from hurricanes Katrina and Rita. General Santee

has more than 1,800 flying hours in the F-111 and EF-111, including more than 120 combat hours during Operation Desert Storm.

Dr. Ronald Sega

Dr. Ronald M. Sega holds a B.S. in math and physics from the U.S. Air Force Academy in Colorado Springs, an M.S. in physics from Ohio State University and a Ph.D. in electrical engineering from the University of Colorado. Dr. Sega is the Woodward professor of systems engineering at Colorado State University and is the vice president for energy, environment and applied research with Colorado State University Research Foundation. He also serves as special advisor to the Colorado State University president for energy and the environment. Dr. Sega was a faculty member in the College of Engineering and Applied Science at CU-Colorado Springs, also serving as dean from 1996-2001. He served as technical director of the Laser and Aerospace Mechanics Directorate at F.J. Seiler Research Laboratory at the U.S. Air Force Academy, and as assistant director of the Space Vacuum Epitaxy Center at University of Houston. He was director, defense research and engineering, and the chief technology officer for the Department of Defense, from 2001-2005. He retired from the Air Force Reserve in 2005 after 31 years in the Air Force as a command pilot, having served at Air Force Space Command and as reserve assistant to the chairman of the joint chiefs of staff. He most recently was the under secretary of the Air Force from 2005-2007. Dr. Sega has authored or co-authored more than 100 technical publications, has served on numerous local, regional and national advisory and governance boards, and is a Fellow of the American Institute of Aeronautics and Astronautics (AIAA) and the Institute of Electrical and Electronics Engineers (IEEE). A former astronaut, he flew aboard Space Shuttles Discovery (1994) and Atlantis (1996). He also led the Air Force team that won the overall Presidential Award for Leadership in Federal Energy Management in 2007.

Colonel M.V. "Coyote" Smith

Colonel M.V. Smith is a PhD student of strategic studies at the University of Reading in the United Kingdom. Most recently he served as the Chief of “Dream Works,” which is the Future Concepts shop in the Pentagon’s National Security Space Office. Dream Works explores, develops, advocates, and links future concepts, capabilities, and promising technologies to advance the art of space faring across the security sector. He was the director of the Space-Based Solar Power Study, and served as a Visiting Military Fellow at National Defense University. He has served in various space and missile positions and as an instructor at the USAF Weapons School. He was Commander of the 321st Missile Squadron at F.E. Warren Air Force Base in Cheyenne Wyoming, where his unit was recognized as the “Best ICBM Squadron in Air Force Space Command.” During Operation ALLIED FORCE he served in the Combined Forces Air Component Commander’s Strategy Cell and on the Guidance, Apportionment, and Targeting Team. During Operation

ENDURING FREEDOM, he served at USCENTCOM Headquarters as a strategist on General Tommy Frank's staff and in the Space and Information Operations Element. He later served as the chief air and space power strategist in the Pentagon's Strategic Planning Council during Operation IRAQI FREEDOM.

Ms. Marcia Smith

Marcia Smith is President of Space and Technology Policy Group, specializing in news, information and analysis of civil, military and commercial space activities and other technology areas. From 2006-2009, she was Director of the National Research Council's (NRC's) Space Studies Board and from 2007-2009 additionally was Director of the NRC's Aeronautics and Space Engineering Board. For 31 years prior to joining the NRC, Ms. Smith was a specialist in aerospace and telecommunications policy for the Congressional Research Service (CRS) at the Library of Congress, Washington, D.C. She had been with CRS since 1975, serving as a policy analyst for the members and committees of the U.S. Congress on matters concerning U.S. and foreign military and civilian space activities, and on telecommunications issues including the Internet (and formerly on nuclear energy). From 1985-1986, Ms. Smith took a leave of absence to serve as executive director of the U.S. National Commission on Space. Among her many professional activities, Ms. Smith is a Fellow of the American Institute of Aeronautics and Astronautics, a Fellow of the American Astronautical Society (AAS), and the North American Editor of the quarterly journal Space Policy. A graduate of Syracuse University, Ms. Smith is the author or co-author of more than 220 reports and articles on space, nuclear energy, and telecommunications and Internet issues.

Maj. Gen. Richard Webber

Maj Gen Richard E. Webber is the Assistant Deputy Chief for Operations, Plans and Requirements, Headquarters U.S. Air Force, Washington, D.C. General Webber is responsible to the Secretary of the Air Force and the Chief of Staff for formulating policy supporting air, space, counterproliferation, homeland security, weather and cyber operations. General Webber was commissioned a second lieutenant upon graduation from the U.S. Air Force Academy in 1975. He has commanded a missile squadron, support group, missile operations group, and missile wing equivalent and two space wings. His staff assignments include Headquarters North Atlantic Treaty Organization International Military Staff, the Air Staff, Headquarters Strategic Air Command, Headquarters Air Force Space Command, and Vice Commander of the Aerospace Command and Control & Intelligence, Surveillance and Reconnaissance Center. General Webber is a command space and missile operator with qualifications in the Minuteman II, Minuteman III, Global Positioning Satellite and Counter Communications System weapon systems. Prior to his current assignment, he served as Director of Installations and Mission Support, Headquarters Air Force Space Command.

SPEAKER BIOGRAPHIES

Mr. Brian Weeden

Brian Weeden is a consultant with the Secure World Foundation on space security and sustainability issues. His current research focuses on enabling global space situational awareness, development of the technical architecture for space traffic management, and strategies for protecting space assets. Brian spent nine years as an officer in the U.S. Air Force working in space and ICBM operations. From 2004 through 2007 he was part of US Strategic Command's Joint Space Operations Center where he directed the orbital analyst training program and developed tactics, techniques and procedures for space situational awareness. Brian has a B.S. in Electrical Engineering from Clarkson University, M.S. in Space Studies from the University of North Dakota and is a graduate of the International Space University Space Studies Program (2007, Beijing).

Dr. Simon Worden

Dr. Simon P. "Pete" Worden (Brig. Gen., USAF, ret.) is the Director of the NASA Ames Research Center. Prior positions for Dr. Worden include: Research Professor of Astronomy, Optical Sciences and Planetary Sciences at the University of Arizona; Director of Development and Transformation, Space and Missile Systems Center, Air Force Space Command; Consultant to the Defense Advanced Research Projects Agency (DARPA) on space related issues; Congressional Fellow with the Office of Senator Sam Brownback as advisor on NASA and space issues; Staff officer for the President's National Space Council. Dr. Worden spearheaded efforts to revitalize U.S. civil space exploration and earth monitoring systems. He has authored or co-authored more than 150 scientific technical papers in astrophysics, space sciences, and strategic studies, served as a scientific co-investigator for two NASA space science missions and is a recognized expert on space issues – both civil and military. Dr. Worden retired in 2004 after 29 years of active service in the United States Air Force.

Space Deterrence Issues

The Impact of the Changing Nature of Deterrence on Space

Center for Technology and National Security Policy

National Defense University

Dr Pete Hays

14 April 2009

Space Trends

Then--Few		Now--Many
• Useful • Advantageous • Monolithic	Space Capabilities	• Critical • Indispensable • Full-spectrum
• National Leadership	Space Users	• National Leadership • All Command Elements • Individual Joint Warfighter
• Unchallenged • Environmental	Threats and Competition	• Multi-faceted • Contested • Crowded
• Deliberate • Stove-pipes	Command, Control, and Organizational Structures	• Dynamic • Integrated • Networked

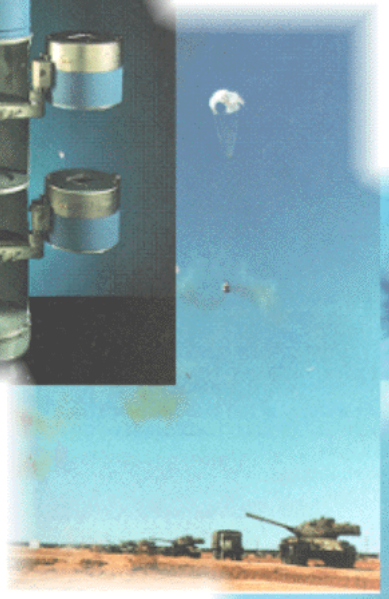
Space has become an integral part of both military operations and the global economy

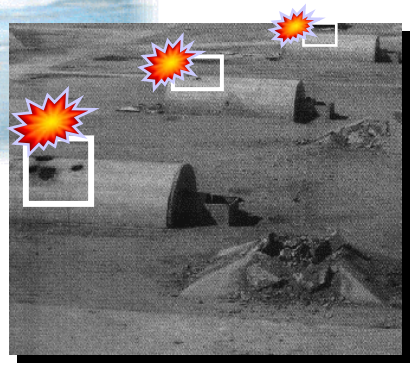
Old Way Of Warfare: Attrition

- Surface centric
- Estimated intelligence
- Force-on-force
- Mass bombing raids
- Many weapons per target
- High casualties/collateral damage
- Inaccurate weapons
- Airpower as a supporting force

World War II: 1941-1945

Transitional Warfare: Precision



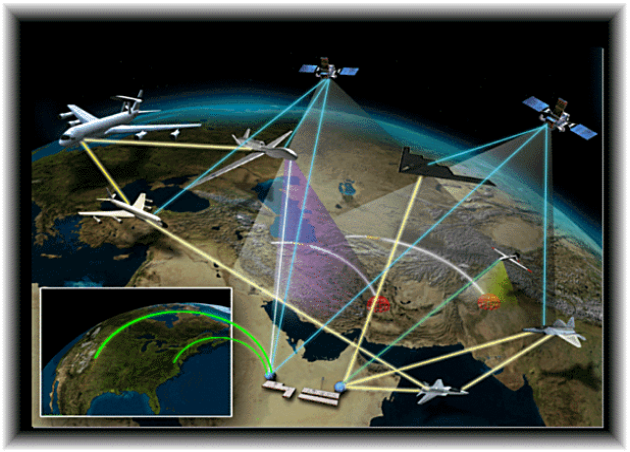


- Air centric
- Near real-time intelligence
- Emergence of nodal attack
- Stealth technology
- Fewer aircraft per target
- Precision guided munitions (7%)
- Airpower as a supported force

Desert Storm: 1991

Today's Way Of War: Integrated

Common Operational Pictures



Coalition Air Ops Centers

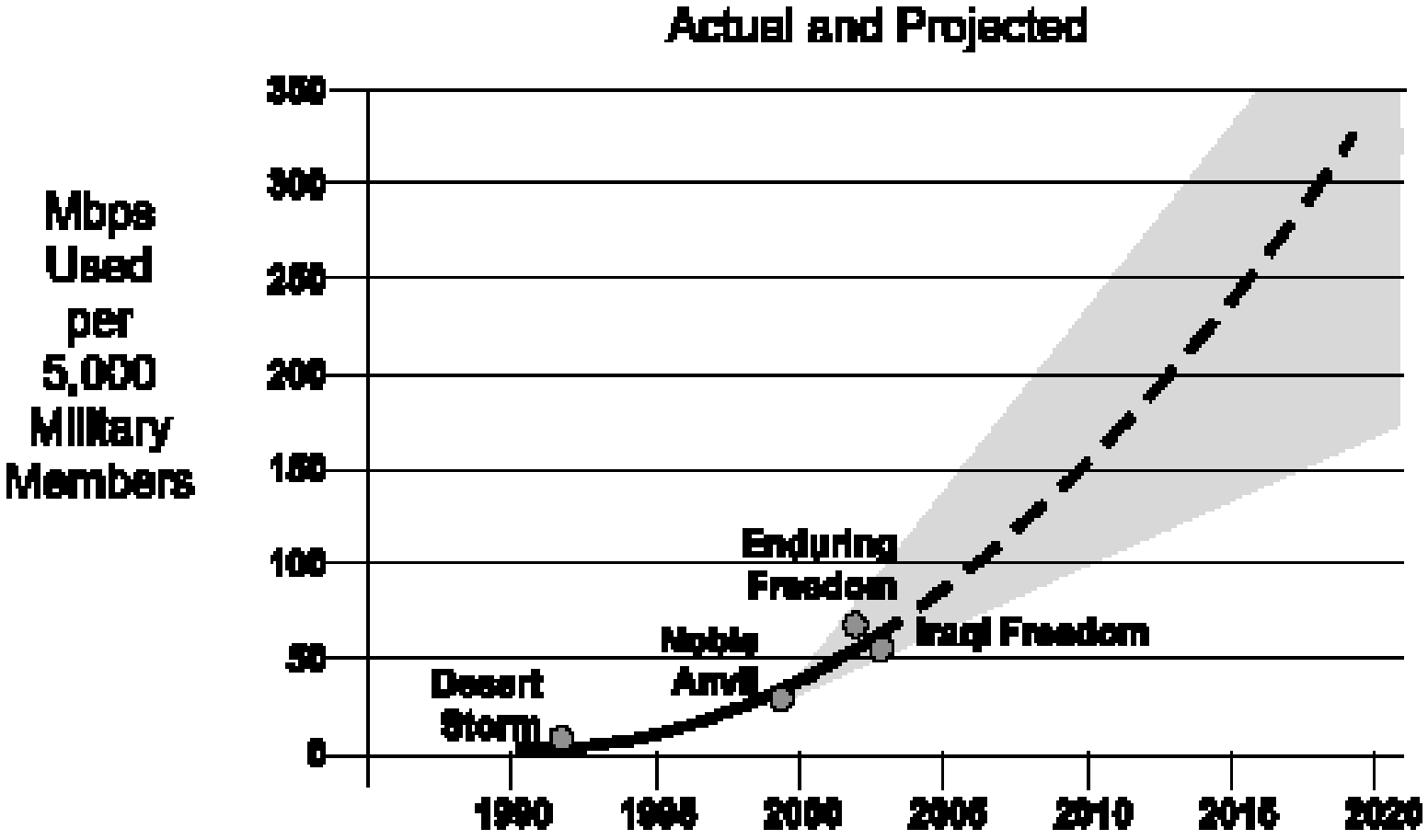
- **Air, space & info centric**
- **Joint & coalition warfare**
- **System-of-systems focus**
- **Highly integrated C^4ISR**
- **Maximum use of precision guided munitions (70% total, near 100% of critical targets)**
- **Very few aircraft per target**
- **Minimum collateral damage**

Allied Force, Enduring Freedom, Iraqi Freedom: 1999-

A Space Enabled Reconnaissance-Strike Complex: The New American Way of War

KTO, 1991	Unguided	245,000	92%
(Desert Storm): 37 Days	Laser/EO-guided	20,450	8%
1 Mbps/5K Forces			
Serbia, 1999	Unguided	16,000	66%
(Allied Force)	Laser/EO-guided	7,000	31%
78 Days; 24.5 Mbps/5K	GPS-guided	700	3%
Afghanistan, 2001-02	Unguided	9,000	41%
(Enduring Freedom)	Laser/EO-guided	6,000	27%
90 Days; 68.2 Mbps/5K	GPS-guided	7,000	32%
Iraq, 2003	Unguided	9,251	32%
(Iraqi Freedom)	Guided	19,948	68%
29 Days; 51.1 Mbps/5K			

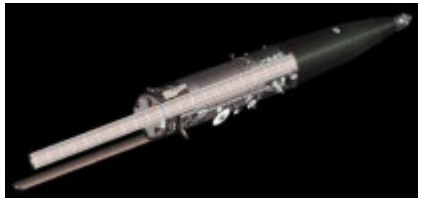
Growth in SATCOM Demand



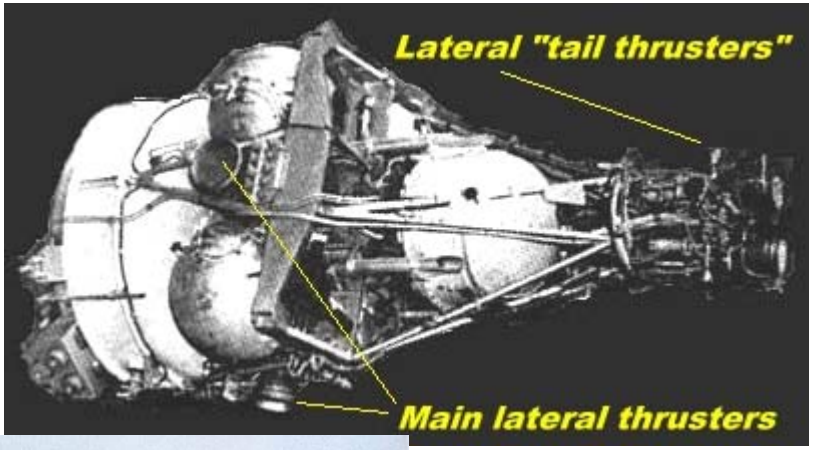
	Primary Value and Functions of Military Space Forces	*Space System Characteristics and Employment Strategies*	*Conflict Missions of Space Forces*	*Appropriate Military Organization for Operations and Advocacy*
Sanctuary	• Enhance Strategic Stability • Facilitate Arms Control	• Limited Numbers • Fragile Systems • Vulnerable Orbits • Optimize for NTMV	• Limited	NRO
Survivability	Above functions plus: • Force Enhancement	• Terrestrial Backups • Distributed Architectures • Autonomous Control • Hardening • Redundancy • On-Orbit Spares • Crosslinks • Maneuver • Less Vulnerable Orbits • Stealth • Attack Warning Sensors • 5 Ds: Deception, Disruption, Denial, Degradation, Destruction • Reconstitution Capability • Defense • Convoy	• Force Enhancement • Degrade Gracefully	Major Command or Unified Command
Control	• Control Space • Significant Force Enhancement		• Control Space • Significant Force Enhancement • Surveillance, Offensive, and Defensive Counterspace	Unified Command or Space Force
High Ground	Above functions plus: • Decisive Impact on Terrestrial Conflict • BMD		Above functions plus: • Decisive Space-to-Space and Space-to-Earth Force Application • BMD	Space Force

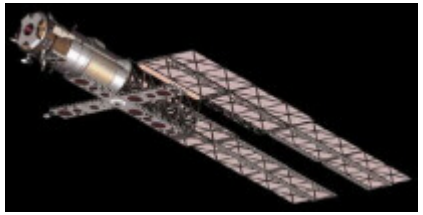
Attributes of Military Space Doctrines

Soviet Space Systems and Co-Orbital ASAT

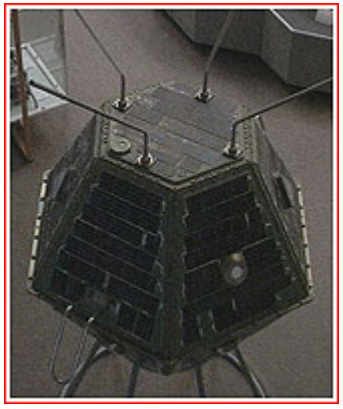


Rorsat





Eorsat



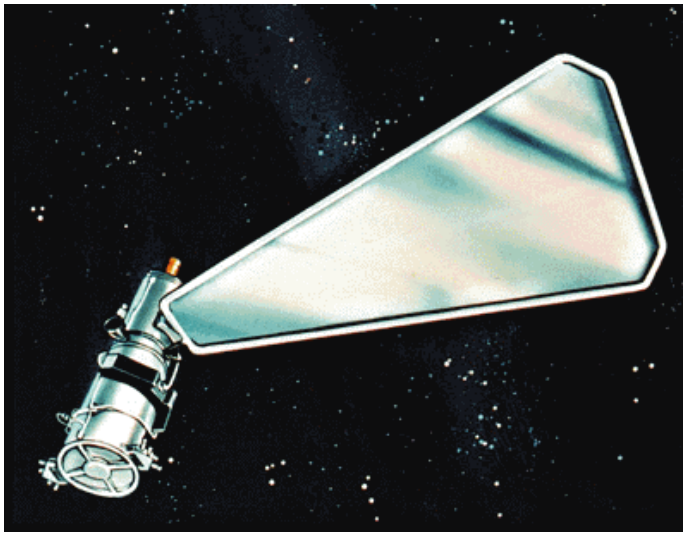
DS-P1-M Target Satellite

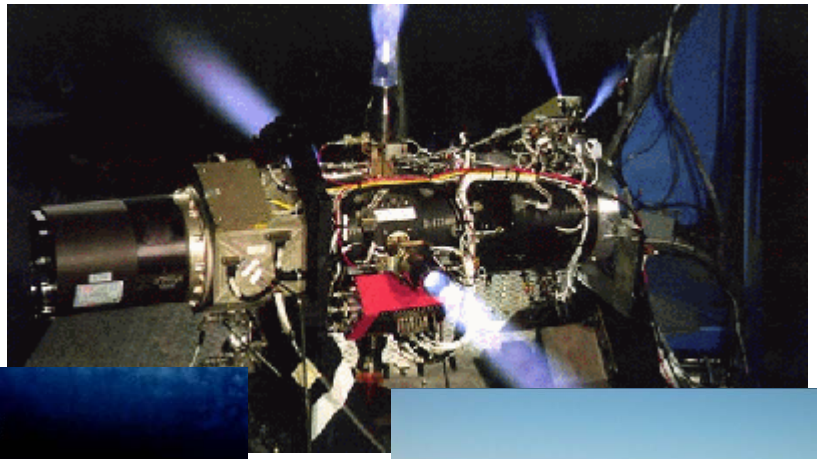
Energia carrying Skif DM (Polus) prototype "battle station"

Soviet Space Systems and Co-Orbital ASAT

- **Many details remain classified or are lost to history; system used two types of satellites: co-orbital active killers (Istrebitel or killer) and passive targets**
- **First tests, Polyot-1 and Polyot-2, conducted in 1963 and 1964. Total of 19 target satellite tests and 22 killer satellite tests; FOC in 1972; last test on 18 Jun 1982**
- **Killer satellites tested in 1970s ready for launch in 90 min (Tsiklon booster); could close within less than 1 km of target in 40-50 min**
- **Aug 1983 Yuri Andropov announced moratorium on design, construction, and testing of system; moratorium ended in Sep 1986**
- **During May 1987 Baikonur visit Michael Gorbachev saw co-orbital ASAT and prototype ASAT and ABM platform called Narvad (Guard). General Zavalishin escorted Gorbachev and used opportunity to advocate resumption of testing. Zavalishin pointed at similar developments in US and promised to cover up ASAT launches so no one would suspect tests were taking place. As Zavalishin recalls, "...Gorbachev issued incoherent and wordy explanations, which concluded with a polite, but resolute refusal."**
- **Ironically, only few days after this conversation, on 15 May 1987, first heavy-lift Energia rocket blasted off from Baikonur, carrying Skif DM (Polus) spacecraft, later described as prototype "battle station" in space. Due to a software glitch, the 90-ton-class spacecraft never made it into orbit**

US ASAT Systems and Residual Capabilities





US ASAT Testing and Systems

- Bold Orion air-launched, nuclear-tipped ASAT tested in late 1950s; world's first known test 19 Oct 1959
- Programs 505 and 437 ground-launched, nuclear-tipped ASATs operationally deployed 1963-70
- NSDM 345 in Jan 77 called for development of air-launched KEW ASAT
- MHV ASAT successfully tested on 13 Sep 1985; Congressional restrictions led to cancellation in 1989; KEASAT was follow-on system
- MIRACL tests in Oct 1997; highlighted satellite vulnerability to DEW
- ASAT potential of BMD systems: BP and ABL

ASAT Arms Control Efforts

- **Development and testing of ASAT capabilities not covered by OST or other space agreements**
- **Two-Track Diplomacy with three rounds of US-USSR ASAT negotiations 1978-79**
- **USSR testing moratorium 1982-86; Congressional restrictions on MHV ASAT testing**
- **DST was only “bucket” of AC that did not lead to agreements during 1980s-90s**
- **PAROS efforts at CD and UNGA Resolutions**

Five Potential Paths to Use of Space Weapons

High-Altitude Nuclear Detonation

Slippery Slope

Boost-Phase BMD

Flag Follows Trade

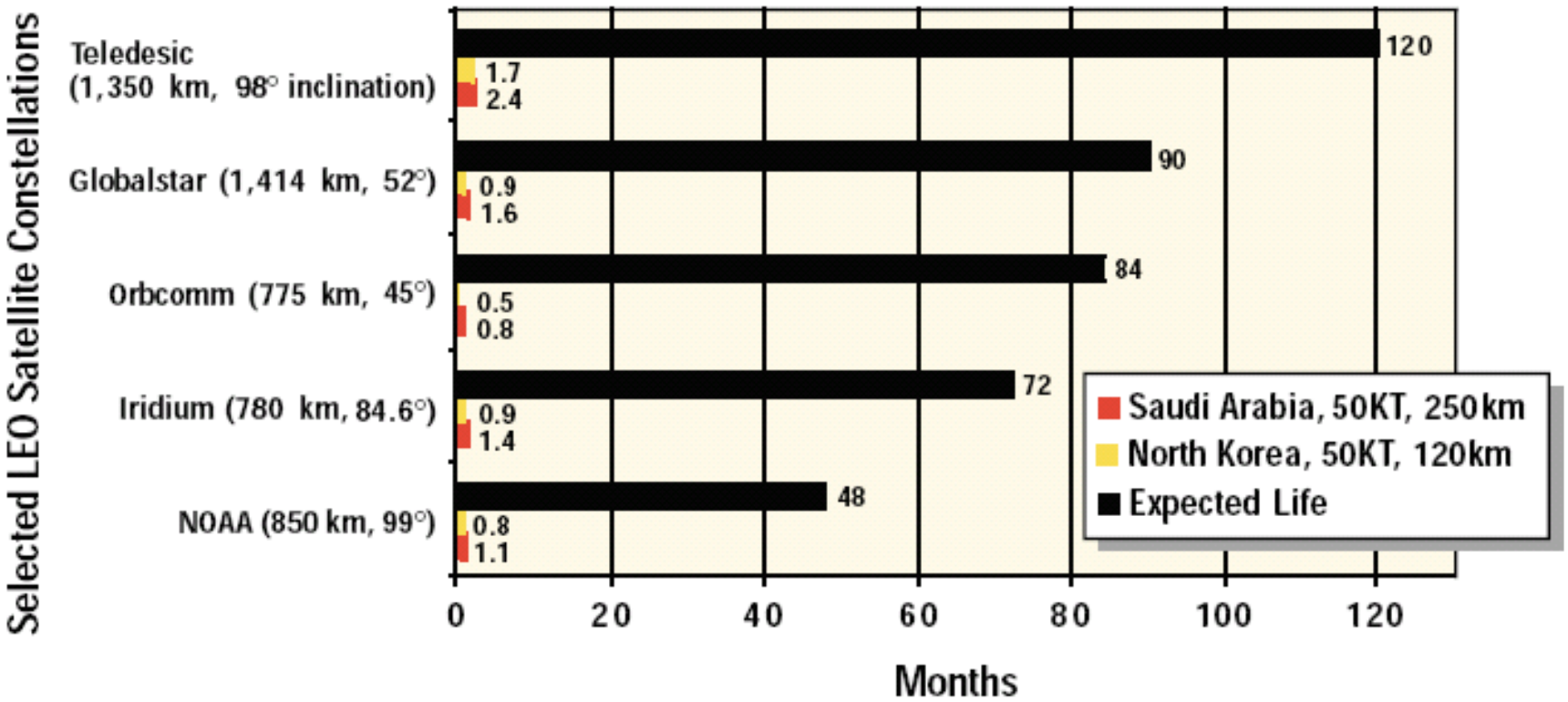
Astropolitiks

High-Altitude Nuclear Detonation

- Potential to Disable *all* Nonhardened LEO Satellites
- Prompt Kill for LOS; Effect falls with $1/R^2$
- Gradual Fatal Dose in Weeks to Months
- Potential for $50B+ in Damage
- Starfish Test July 1962; 1.4 MT
- Hardening Possible for 2-3% System Costs

– DTRA HALEOS Study, April 2001

Figure 18: Estimated Effects of Low-Yield, High-Altitude Nuclear Detonations on the Service Lives of Selected LEO Satellites



Note: System hardness assumed twice natural environment

Source: Data from Webb, "Implications of Low–Yield High Altitude Nuclear Detonation," slides 47 and 64.

Slippery Slope

- Range of “weapon-like” options: 5Ds, EW, Laser “Dazzling,” Space Mines, Many Residual Capabilities
- “If force application is construed broadly enough to include terrestrial-based applications of military force aimed at affecting orbital systems and their use, one can argue that space warfare has already arrived even though no space-based weapons are currently deployed.”
  - Barry D. Watts, *The Military Use of Space*, 2001

Boost-Phase BMD

- Space is Best Basing Mode for Global Boost-Phase Coverage; No Crisis Deployment or Contested Airspace/Littoral
- Limited Engagement Window (70-300 sec); Predelegation or Man-in-the-loop?
- Even Limited BMD System can have Significant ASAT Capability
- Crisis Stability; Expense; Technologies

Flag Follows Trade

- Neomercantilist Military Protection of New Economic and Strategic Center of Gravity
- "Our investment in space is rapidly growing and soon will be of such magnitude that it will be considered a vital interest—on par with how we value oil today . . ." "it is not the future of military space that is critical to the United States—it is the continued commercial development of space that will provide continued strength for our great country in the decades ahead. Military space, while important, will follow."

  – General Howell M. Estes, III, 1998

Astropolitiks

- Withdraw from current OST-dominated space regime; establish benign free-market sovereignty in space
- Use current and near-term capabilities to seize military control of LEO
- Establish "a national space coordination authority" to "define, separate, and coordinate the efforts of commercial, civilian, and military space projects."
  - "The ultimate goal . . .is not the militarization of space. Rather, the militarization of space is a means to an end, part of a longer-term strategy. The goal is to reverse the current international malaise in regard to space exploration, and to do so in a way that is efficient and that harnesses the positive motivations of individuals and states striving to improve their conditions. It is a neoclassical, market-driven approach intended to maximize efficiency and wealth."
    - Everett C. Dolman, *Astropolitik*, 2001

Insights for Deterrence Concepts and Issues

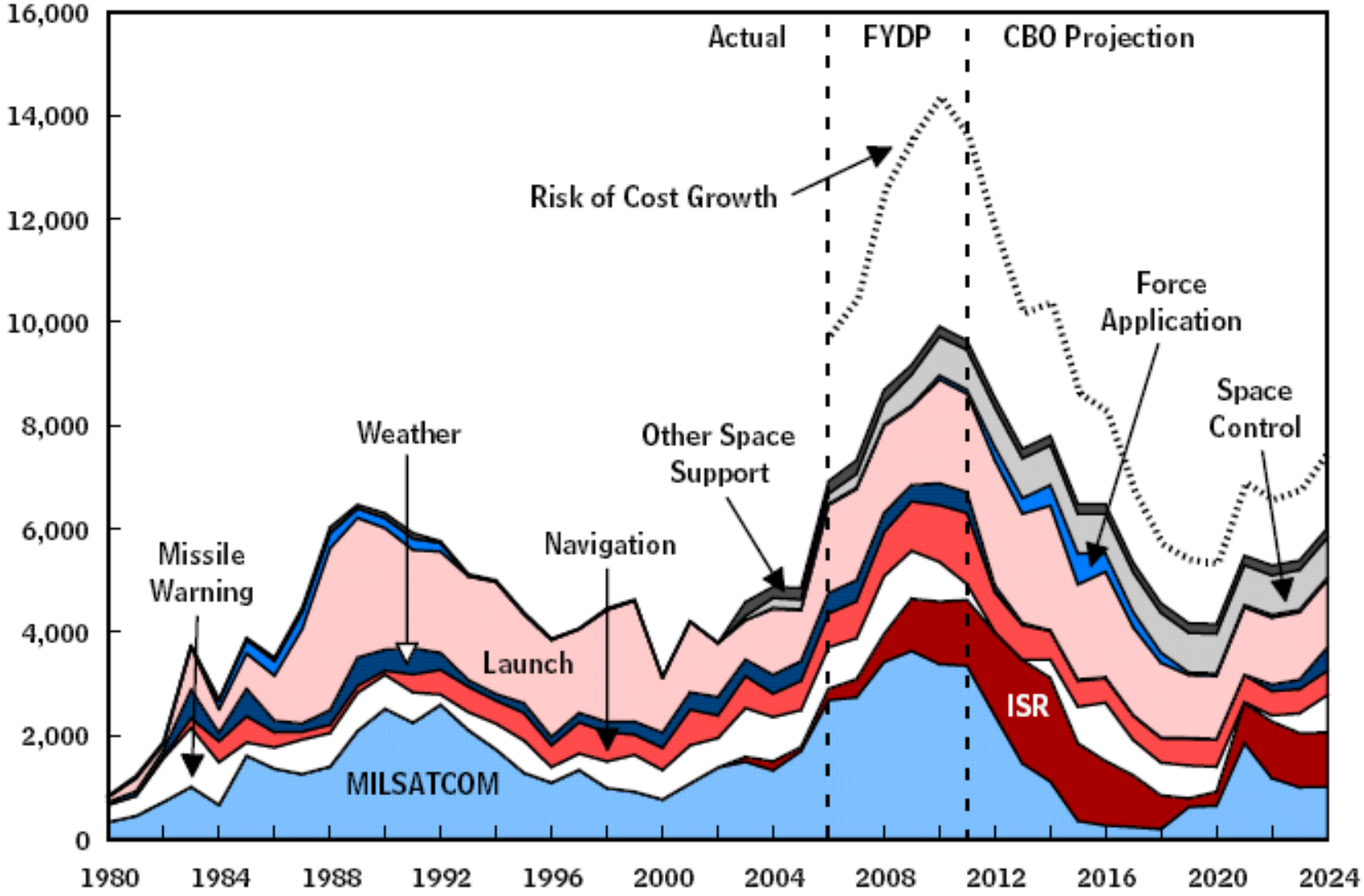
- Albert Wohlstetter, "The Delicate Balance of Terror," 1958
- Morton Halperin and Thomas Schelling, 1961
  - Reduce likelihood of war
  - Reduce severity of war
  - Reduce costs of preparing for war
- Fred Ikle, "After Detection, What?" 1961
- Robert Jervis, "Cooperation Under the Security Dilemma," *World Politics* 1978
  - Can analysts distinguish between offensive and defensive military systems? Are offensive or defensive systems dominant?
- Paul Nitze Criteria for SDI, 1985
  - Defensive system should be survivable
  - Defensive system should be cost effective on the margin
- Ashton Carter, "Paradox of ASAT Arms Control," 1986
- Kevin Chilton and Greg Weaver, "Waging Deterrence in the Twenty-First Century," 2009
  - Deterring Space Attacks
    - Convince competitors they will reap little benefit
    - Efforts to deny US space capabilities will likely fail
    - US military forces ready to fight without space
    - US posses means to ensure enemy will pay price incommensurate with benefits

Backup Slides

Force Enhancement Missions, Primary Orbits, Major Systems

Environmental Monitoring	Communications	Position, Navigation, and Time	Integrated Tactical Warning and Attack Assessment	Intelligence, Surveillance, and Reconnaissance (ISR)
Polar LEO	Geostationary Orbit (GSO)	Semi-synchronous Orbit	GSO and LEO	Various
Defense Meteorological Support Program (DMSP) ---------- National Polar-Orbiting Operational Environmental Satellite System (NPOESS)	Defense Satellite Communications System (DSCS) II, DSCS III, Ultra-High Frequency Follow-on (UFO), Milstar, Global Broadcast System (GBS), Iridium, commercial systems ---------- Advanced Extremely High Frequency (AEHF), Wideband Gapfiller System (WGS), Mobile User Objective System (MUOS), Polar Military Satellite Communications System, Transformational Communications System (TSAT)	Global Positioning System (GPS) GPS II GPS IIR GPS IIR-M ---------- GPS IIF GPS III	Defense Support Program (DSP), GPS ---------- Space-Based Infra-Red System (SBIRS) High, Space Tracking and Surveillance System (STSS)	Imaging (IMINT) Satellites, Signals Intelligence (SIGINT) Satellites, commercial systems ---------- Future Imagery Architecture (FIA), Integrated Overhead SIGINT Architecture (IOSA), Space Radar

Major Military Space Program Investments (Millions of 2006 dollars)



Current National Space Policies

- **National Security Presidential Directive (NSPD)-15, Jun 02, directed review of national space policies**
- **Space NSPDs completed to date:**
  - **NSPD-27, U.S. Commercial Remote Sensing Space Policy, 25 Apr 03**
  - **NSPD-28, U.S. Nuclear Weapons Command and Control Safety and Security, 20 Jun 03**
  - **NSPD-31, U.S. Space Exploration Policy, 14 Jan 04**
  - **NSPD-39, U.S. Space-Based Position Navigation and Timing Policy, 8 Dec 04**
  - **NSPD-40, U.S. Space Transportation Policy, 21 Dec 04**
  - **NSPD-49, U.S. National Space Policy, 31 Aug 06**

U.S. Commercial Remote Sensing Policy

- **Goals:**
  - **Rely to max practical extent on US Commercial Remote Sensing (CRS) capabilities to meet USG needs**
  - **Focus USG remote sensing on meeting needs that CRS cannot satisfy**
  - **Develop long-term relationship between USG and US CRS industry**
  - **Enable US CRS to compete successfully, while ensuring protection of NSS and foreign policy**
- **NSPD-27, 25 Apr 03, Classified**

The U.S. will advance and protect the nation's leadership in remote sensing activities by sustaining and enhancing U.S. industry.

U.S. Space-Based PNT Policy

- **Goals:**
  - **Provide US PNT without dependence on foreign PNT**
  - **Provide civil PNT free for civil and commercial uses**
  - **Improve capabilities to deny hostile use of PNT**
  - **Improve performance of national security and civil PNT**
  - **US PNT remain essential components of Intl PNT services**
  - **Provide US technology in applications using space-based services**
- **NSPD-39, 8 Dec 04, Classified**

The U.S. will remain the pre-eminent leader in providing space-based PNT for military purposes and competitive with foreign providers for civil, commercial, and scientific purposes.

U.S. Space Transportation Policy

- **Goals:**
  - **Provide reliable and affordable space access**
  - **Demonstrate initial capability for operationally responsive space lift**
  - **Develop space transportation for human space exploration**
  - **Sustain technology development for next generation space transport**
  - **Sustain and promote U.S. space transportation industrial base**
  - **Increase U.S. industry's international competitiveness**
- **NSPD-40, 21 Dec 04, Unclassified**

The U.S. will maintain the capability to access and use space in support of national security, civil, scientific, and economic interests.

U.S. National Space Policy

- **Goals**
  - **Strengthen U.S. space leadership and ensure space capabilities are available in time to further national security, homeland security, and foreign policy objectives**
  - **Enable unhindered U.S. operations in and through space to defend our interests there**
  - **Implement and sustain an innovative human and robotic exploration program with the objective of extending human presence throughout the solar system**
  - **Enable a dynamic, globally competitive commercial space sector in order to promote innovation, strengthen U.S. leadership, and protect national, homeland, and economic security**
  - **Enable a robust science and technology base supporting national security, homeland security, and civil space activities; and**
  - **Encourage 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 outer space as well as to advance …**
- **NSPD-49, 31 Aug 06, Classified**

Those who effectively utilize space will enjoy added prosperity and security and will hold a substantial advantage over those who do not

DOD Space Policy Themes

- DoDD 3100.10, 9 Jul 99

- **National Interest – Space is a medium**
- **Strategic Enabler – Space power is important to the nation**
- **Information Superiority – Space delivers C3ISR support**
- **Deterrence – Space integral to deterrent posture**
- **Defense – Space contributes if deterrence fails**
- **Freedom of Space – Space systems have right of passage**
- **Integration – Space will be integrated into strategy, CONOPS, education, TTPs, Ops, contingency plans**
- **Defense-Intelligence Cooperation – Coordination of NSS capabilities**
- **Intersector Cooperation – Intel, Civil and Commercial partnerships**
- **International Cooperation – Space part of coalition strategy**

Teets, Mar 05: Top National Security Space Priorities

- Achieve Mission Success in Operations and Acquisition
- Develop and Maintain a Team of Space Professionals
- Integrate Space Capabilities for National Intelligence, Warfighting, and Homeland Security
- Produce Innovative Solutions for the Most Challenging National Security Problems
- Ensure Freedom of Action in Space

Sega, Mar 06: Top National Security Space Priorities

Improve the integration of space capabilities across the national security space community
Get "back-to-basics" in space acquisition
Ensure the viability and proficiency of our space professional and S&T workforce

Intelligence Sector Drivers

- Horizontal Integration
  - Role of DNI, NRO, NGA, USD(I)
- Young DSB Report: Future Imagery Architecture
  - Costs, Capabilities, and Coverage Issues
- Space Radar Capabilities, AESA
  - DTED, SAR, and SMTI

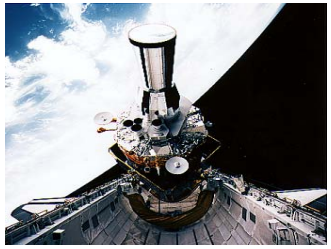
Defense Sector Drivers

- Recapitalization and Protection
- Increasing Reliance on Commercial Satcom: 80% in OIF
  - Transformational Communications Architecture: AEHF, WGS, TSAT, C/NOTM
- Young DSB Report: SBIRS and EELV
- Space Radar Capabilities: MTI
- Organization and Management Issues: Young IAP and Schlesinger Task Force Recommendations

Four Defense Space Mission Areas

- Space Support
- Force Enhancement
- Space Control
- Force Application

NSS Capability Categories



Missile Warning / Defense

SATCOM

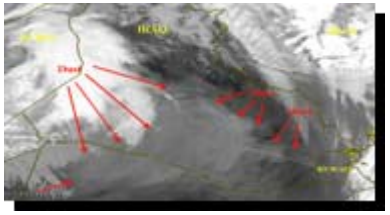
Position, Navigation & Timing (PNT)

Intelligence, Surveillance & Reconnaissance (ISR)

Space Control

Space Access

Space C2



Environmental Monitoring

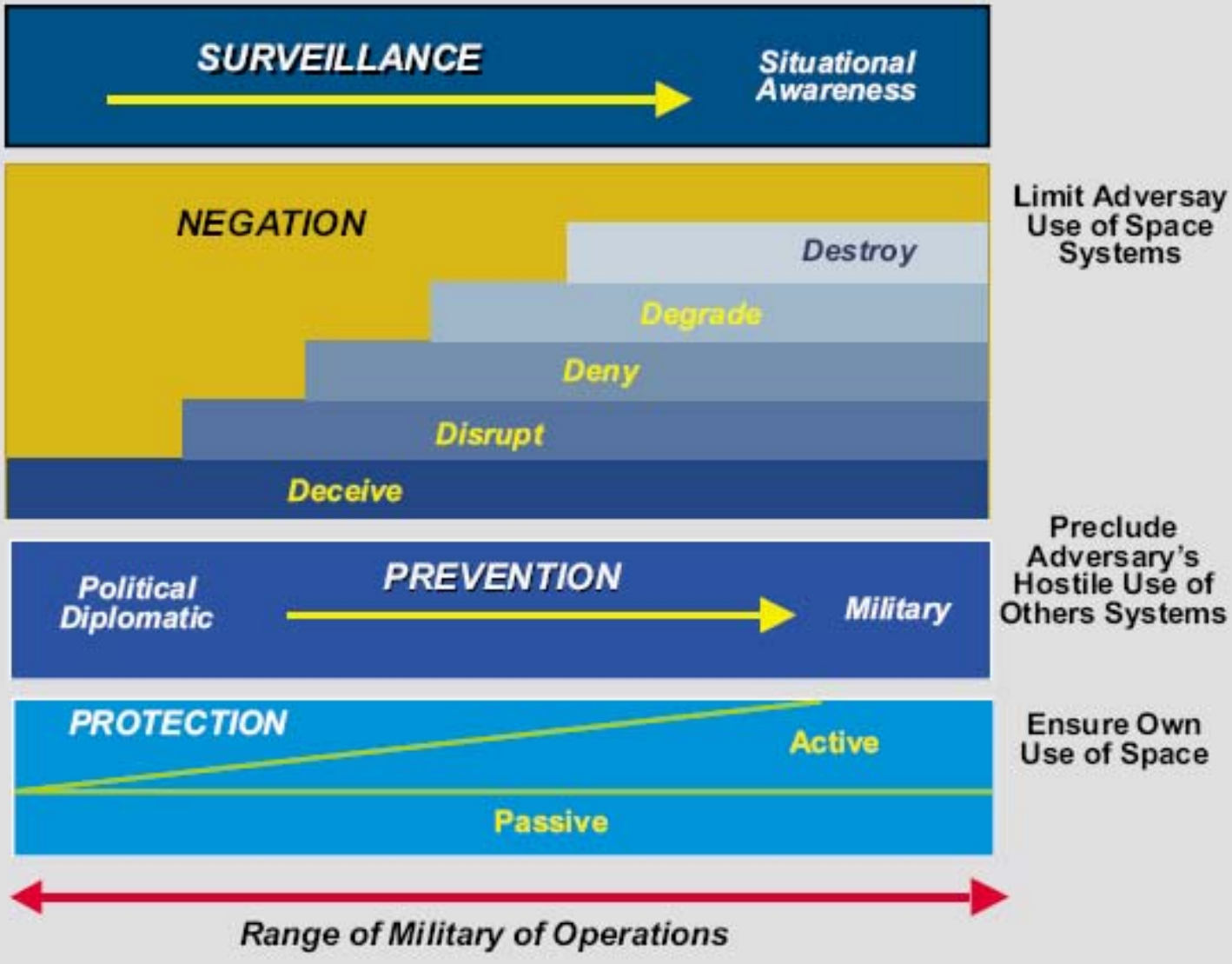
Force Application

Science & Technology
anagement (People, Infrastructure.
Industrial Base

Satellite Operations

Enabling

SPACE CONTROL MISSIONS



SPACE CONTROL MATRIX

Gain or Maintain Space Control

Provide Freedom of Action in Space for Friendly Forces

Deny Freedom of Action in Space to Enemy Forces

PROTECTION
Employ active and Passive defensive measures to ensure US and friendly space systems operate as Planned

SURVEILLANCE
Detect, identify, assess, and track space objects and events

PREVENTION
Employ measures to prevent adversary use of data or services from US and friendly space systems for purposes hostile to the US

NEGATION
Disrupt, deny, degrade, deceive, or destroy adversary space capabilities

Battle Management Command, Control, Communications, Computers, and Intelligence

Space Doves

- **“Unlike the strategy for nuclear weapons, there exists no obvious strategy for employing space weapons that will enhance global stability. If the precedent of avoiding destabilizing situations is to continue—and that is compatible with a long history of US foreign policy—one ought to avoid space-based weapons.”**
  - **Lt Col Bruce M. Deblois, “Space Sanctuary,” *APJ*, 1998**

Militarization Realists

- **"fighting *into* space looks feasible and we should plan for the eventuality. Fighting *in* space shows little promise, while fighting *from* space looks impractical for the foreseeable future, with or without treaties."**
  - **Maj William L. Spacy II, *Does the United States Need Space-Based Weapons*, 1999**

Inevitable Weaponizers

- **“we know that every medium—air, land and sea—has seen conflict. Reality indicates that space will be no different. Given this virtual certainty, the United States must develop the means both to deter and to defend against hostile acts in and from space.”**

  – Space Commission Report, 2001

Space Hawks

- [concerted development of space weapons by the United States] "will buy generations of security that all the ships, tanks, and airplanes in the world will not provide. . . . Without it, we will become vulnerable beyond our worst fears."
  - Sen Bob Smith (R-NH) "Challenge of Space Power," *APJ*, 1999

Space Deterrence, Space Doctrine, and U.S. Security

"The Impact of the Changing Nature of Deterrence on Space"

National Defense University
April 13, 2009

Bruce W. MacDonald
Senior Director
Congressional Commission on the
Strategic Posture of the United States
(for identification purposes only)

What Does the Strategic Landscape of Space Look Like?

- What are we trying to accomplish in space?
- What do we want deterrence to achieve?
- What are implications of deterrence?
- How does the strategic landscape of space operate? Until we understand this, it will be difficult to have a sound space policy, which is a prerequisite for:
  - Effective space strategy and doctrine, prerequisite for:
  - Sound space acquisition policy
- **Space policy, strategy and doctrine should drive space acquisition, not the other way around**

Need Better Understanding of Space Deterrence, Doctrine, and Stability vis-à-vis China, Others

- "In addition to planning and programs, it is important to encourage a debate on space power to include development of a space deterrent theory. We need something similar to the intellectual ferment that surrounded nuclear deterrence."

  General Tom Moorman, Retired VCS, USAF, March 2008

- How does deterrence in space work? What are points of instability? How do we "signal" other side? What constraints does deterrence place on us? Very little thinking on this in U.S., similar to U.S. nuclear thinking in late '40's/early '50's
- Need to understand what China, Russia, and others are thinking and doing on space doctrine, space stability, and the new strategic landscape of space
- Impact of Nth countries on space deterrence

Serious Risks of Future Space Instability

- Inherent risk of strategic instability when relatively modest defense investments can create disproportionate danger to an adversary
- Inherent risk of crisis instability when "going first" pays much greater benefits than "going second"
- Multiple issues need to be addressed:
  - What U.S. space strategy, and resulting acquisition strategy, in that order, would promote U.S. security interests and reduce space instability over the longer term?
  - How do China and Russia see space stability? How will this shape their OCS doctrine, acquisition, strategies, diplomacy?

2006 U.S. Space Policy Fails To Answer Key Stability Issues

- Calls U.S. space capabilities “vital to our national interests,” a first with important implications: deemed “top national priority”
- Policy also reserves right to deny adversaries “the use of space capabilities hostile to U.S. national interests”
- **But attacking others’ space capabilities invites attacks on our own, which our policy tellingly calls a vital national interest**
- Highly unstable situation in a crisis with near-peer space power, further aggravated by greater U.S. space dependence
- Evolving technology guarantees greater threats to these “vital national interests” in the future
- Contradictory objectives, never explained; but could make sense if:
  - Governing force doctrine is deterrence: no indication this is case
  - U.S. could maintain space dominance – unlikely beyond short term
  - Attacks were limited + localized, i.e., tactical, not strategic; escalation?
- Potential for strategic and crisis instability in space seems high and likely to grow with advancing technology, but 2006 space policy ignores these fundamental issues

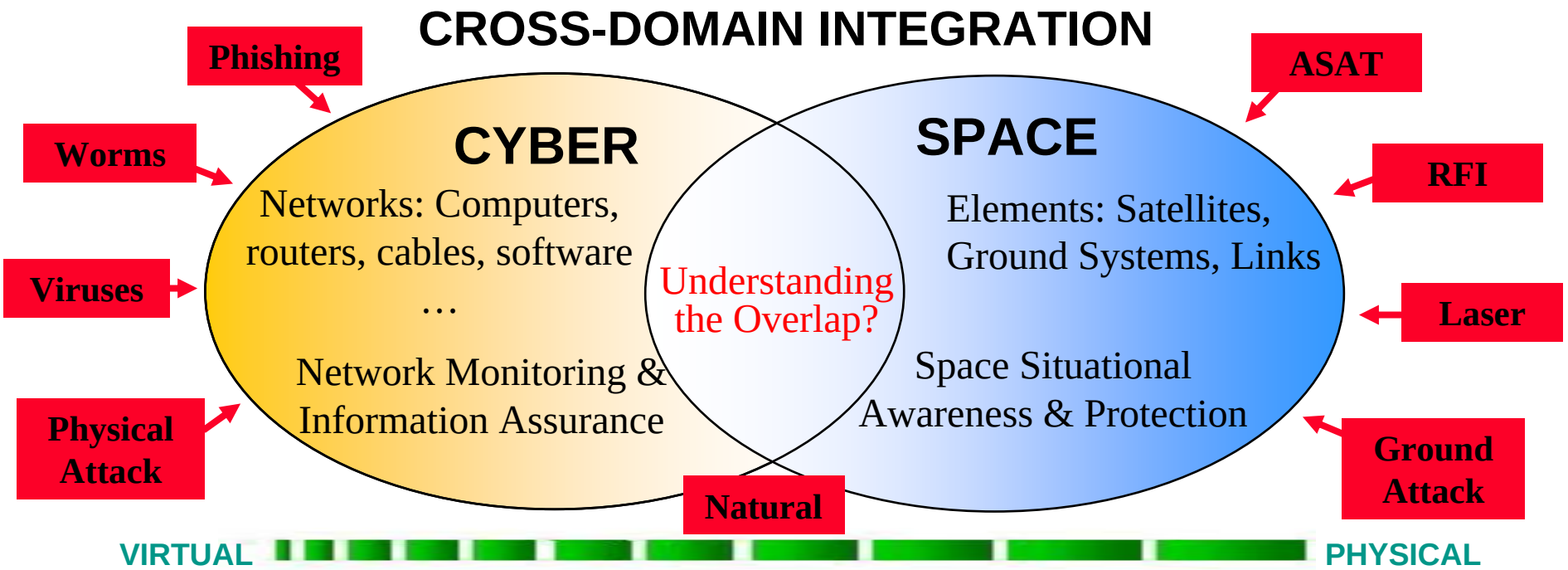
U.S. Goal Should Be a Stable and Secure Space Regime

- Secure, stable space environment (strategic and crisis stability) that encourages space conflict prevention, reinforces space deterrence
- Focus on stability, deterrence, and transparency
- Promote behavior that maximizes U.S. ability to utilize space and minimizes operational and other problems
  - Codes of conduct/rules of road, debris mitigation, space traffic mgmnt.
  - Confidence building measures, agreements that constrain most destabilizing dimensions of offensive space capabilities
- Reduce adversary incentives to strike U.S. space assets or take other destabilizing space actions; ensure space service continuity
  - Distributed capabilities, many nodes, defense in depth; have back-ups
  - Enhanced attribution techniques, more robust SSA/space intelligence
  - Maintain “strategic ambiguity” over responses to adversary actions
- Be able to deter others from attacking U.S. space capabilities:
  - For space peers/near-peers: offensive space capability with reversible effects, other criteria -- <u>but what kind, what level, and to what purpose</u>?
  - Space-based offense is vulnerable, destabilizing. U.S. policy now opposes
  - For space non-peers, no special offense likely needed

Differential Space Deterrence

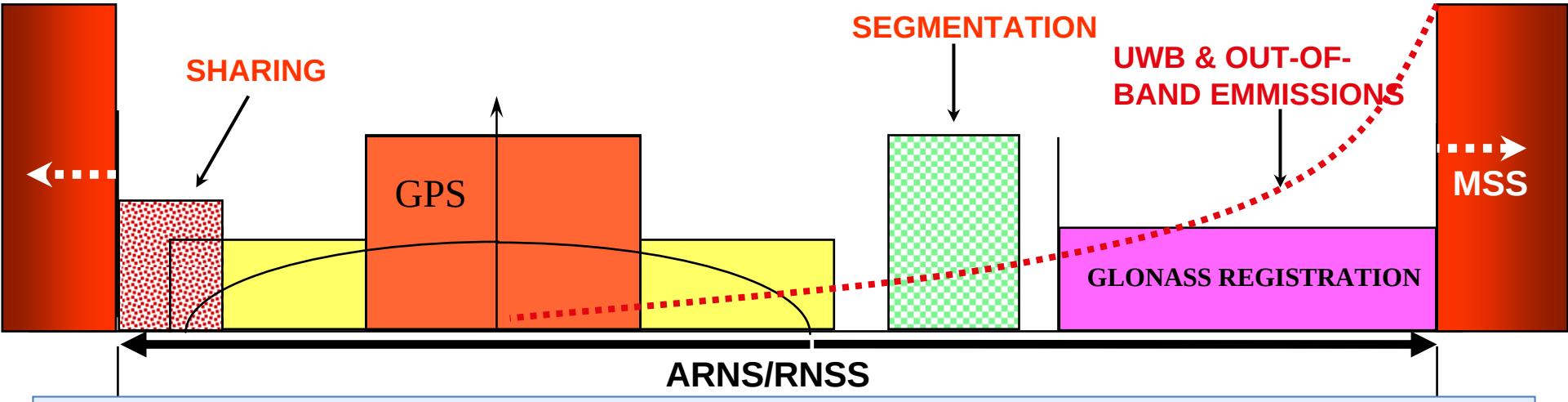
- Different U.S. space assets have different response implications, e.g., DSP vs. GPS
- Need flexible response capabilities -- “massive space retaliation” reduces credibility
- Declaratory policy has a major role in space deterrence
  - Should have more clarity on “red lines” than on responses
  - Ambiguity and clarity both needed, can complement each other
  - Say what we mean, mean what we say
- Objective should be to avoid space conflict if possible and to terminate as early as possible if deterrence fails
- U.S. should think very, very hard before <u>initiating</u> offensive space action, given our major space dependence. A “no first use” pledge should be considered for purely practical reasons.

Space and Cyber Contested Domains



- **Space and Cyber are global in nature, very electronically focused**
  - **Some common elements, synergy when combined**
  - **Cyber has unique attributes regarding speed / range, and a psychological element of cyber (ever had your PC infected?)**
- **Perspectives**
  - **Cyber: space is just another transport medium**
  - **Space: cyber (IT) is just a tool to operate and maintain space systems**
- **Space and Cyber Situational Awareness**
  - **An attack on one domain can directly impact the other**
  - **Requires integrated methods for attack detection, characterization, and response (Ops Center collaboration)**
- **Mitigation**
  - **NSPD 49, NSTAC, HSPD 7**
  - **Designation as Critical Infrastructure / Key Resource (Communication and Information Technology Sectors)**
  - **Physical protection, redundancy, proliferation, reconstitution, path diversity**

GPS can be Harmed Several Ways



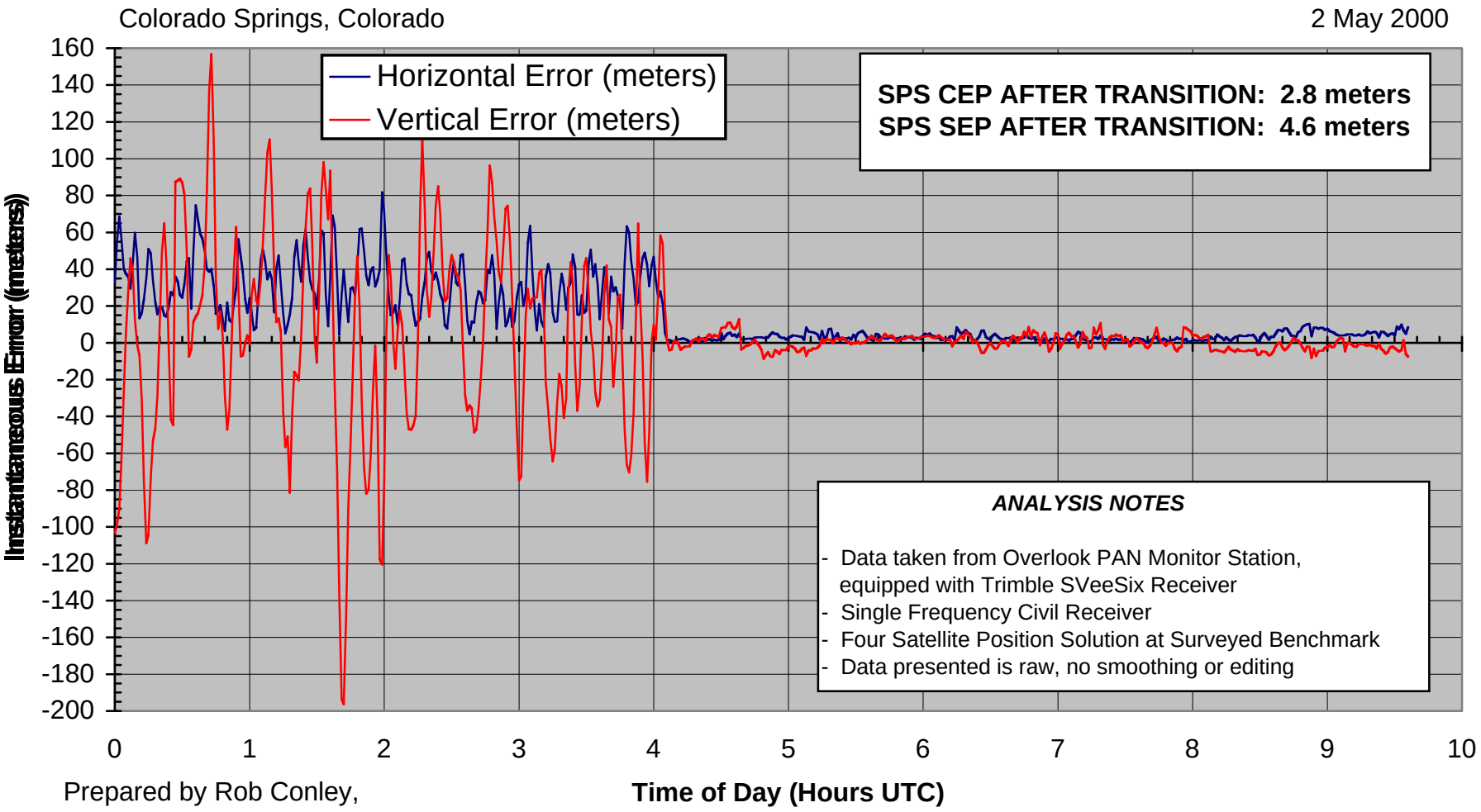
The ARNS/RNSS spectrum is a unique resource

- **Sharing harms safety-of-life applications**
- **Out-of-band and ultra wide-band emissions raise the noise floor**
- **Segmentation prevents future evolution**

Spread spectrum GPS signals are unlike communication signals

- **10^{-16} W received power**
- **One-way**

SA Transition -- 2 May 2000



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RESPONSE OPTIONS TO ATTACKS ON SPACE ASSETS

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2006 National Space Policy

- The United States considers space systems to have the right of passage through and operation in space without interference. Consistent with this principle, the United States will view purposeful interference with its space systems as an infringement on its rights.

2006 National Space Policy (cont)

- The United States considers space capabilities – including the ground and space segments supporting this – vital to its national interests. Consistent with this policy, the United States will:
  - Preserve its rights, capabilities, and freedom of action in space;
  - Dissuade or deter others from either impeding those rights or developing capabilities intended to do so;
  - Take those actions necessary to protect its space capabilities;
  - Respond to interference, and
  - Deny, if necessary, adversaries the use of space capabilities hostile to US. national interests.

RESPONSE REQUIRES A DECISION-TREE APPROACH

- ARE WE 100% CERTAIN IT WAS AN ATTACK?
  - Many failures are difficult to diagnose
  - Could be design flaw, space weather, other malfunction
- WHAT KIND OF ATTACK WAS IT?
  - Kinetic (ground-launch, space mine, deliberate collision)
  - Laser
  - Electromagnetic interference
  - Cyber
- WHAT WAS ATTACKED?
  - Military satellite
  - Commercial satellite
  - Civil satellite
  - Dual use satellite
  - Single or multiple satellites
  - Ground-based infrastructure

RESPONSE REQUIRES A DECISION-TREE APPROACH (2)

- WAS DAMAGE PERMANENT OR TEMPORARY?
- DO WE KNOW WHO DID IT?
  - How do we know?
  - Are we 100% certain? Absolutely 100%?
  - If so, do they have space assets of their own to protect?
- WHY DID THEY DO IT?
  - To test their capabilities?
  - To test our response?
  - As prelude to major military action?
  - What do they expect our response to be?

RESPONSE REQUIRES A DECISION-TREE APPROACH (2)

- RANGE OF RESPONSE OPTIONS AVAILABLE BASED ON THE ANSWERS TO THOSE QUESTIONS, including:
  - Diplomatic (UN condemnation)
  - Economic sanctions
  - Non-kinetic attack on their space assets (we've made it clear we do not want kinetic attacks that ruin the neighborhood)
  - Military attack on ground infrastructure

Space Architecture Choices and Physical Dependencies

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The Reality of Physics

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- Space is not the "ultimate high ground"
  - Only true if you are Earth-bound with no capability to access space
  - Disadvantages in mass, surprise, and maneuver vs Earth-based capabilities
- "Invisibility" is a poor choice to base your security on
  - Cyber Golden Rule: security through obscurity is no security at all
- Defense in space is much, much harder than offense
- Limited options for using classical reprisal deterrence to protect US space assets
  - Political / economic costs of attacks against ground based assets or sanctions?

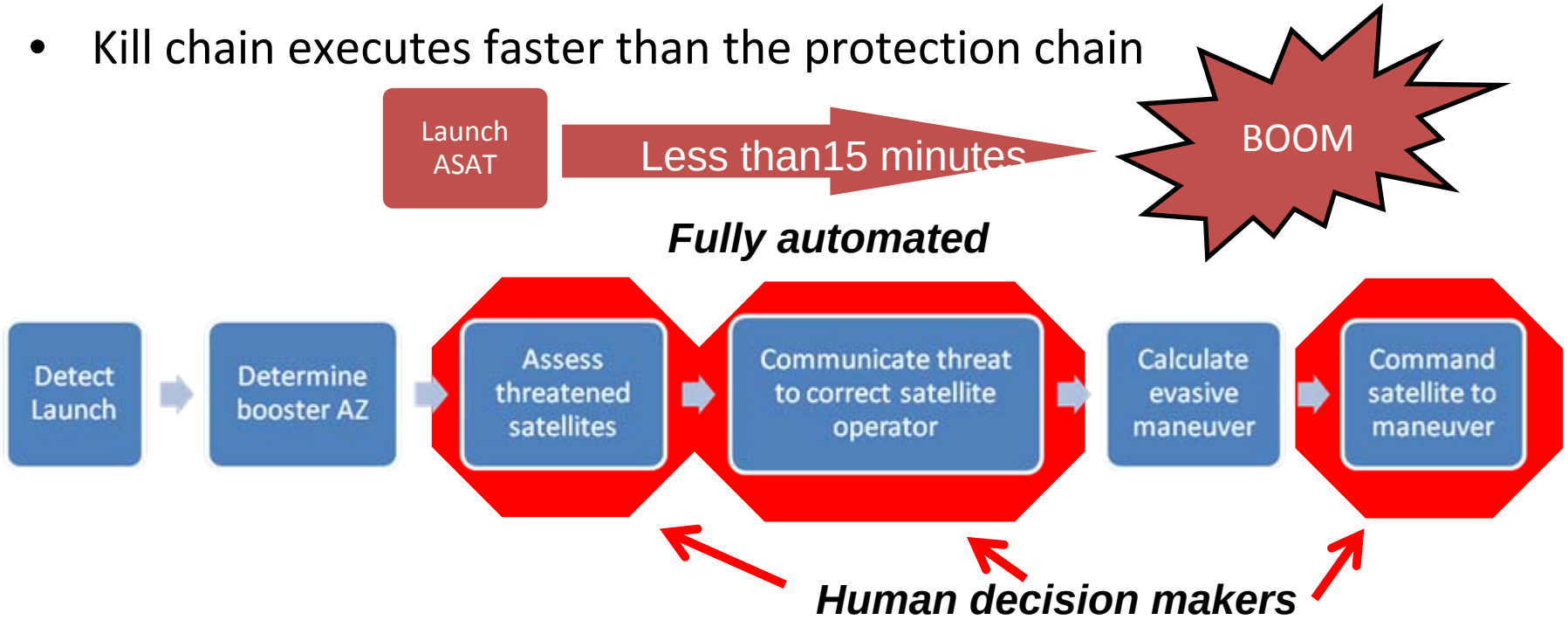
Architecture choices in the new reality

- During the end of the Cold War, there was a belief that space was a sanctuary
  - US and USSR dominate use of space and counterspace
  - Both had much to lose from attacks on space-based systems
  - Tacit understanding that space systems were off limits, even though more counterspace capabilities existed than now

- Choices made for satellite constellation architecture during this paradigm may not be the right choice for the current situation
  - Proliferation of both space-based capabilities and counterspace systems
  - US painfully reliant on space systems for military and intelligence capabilities
  - Space systems are vulnerable to physical attacks because they were conceived at a time when that was not a concern

The problem with reactive maneuvers…

- Kill chain executes faster than the protection chain



- Could ***possibly*** solve the answer with on-board auto-detection systems
- Physics of last minute maneuvers almost impossible (delta-v)
- False alarms (Sun glints? Passing debris?) and spoofing prevention
- What's the risk of accidental airbag deployment?

…and pre-emptive maneuvers

- Maneuvering high-value satellites before crossing into hostile territory would put them out of range of direct ascent ASATs….***but***:
  - What's the quality of your intelligence on the ASAT locations?
    - Are the ASATs mobile?
  - How do these avoidance maneuvers affect the ability of these satellites to conduct their missions?
    - Sun-sync: change in altitude requires change in inclination, both affect ground-track repeat
  - How many times can you do this before fuel is an issue?
    - 10 ASATs at < $100M each force a $1B satellite to maneuver 10 times for 100% of its fuel = Attacker Win

If a maneuvered satellite cannot fulfill its mission, the attacker wins!!

The Choice

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Small constellation of a few "Rolexes"

- Advantages
  - Extraordinary capabilities
  - Organizational and industrial familiarity and experience
  - Simplified C2
- Disadvantages
  - High value targets, impossible to protect
  - Extremely expensive
  - Temporal resolution

or

Distributed constellation of microsatellites

- Advantages
  - Capability degrades gracefully from launch or on-orbit failure, or enemy attack
  - Greatly increased capacity
  - Incremental constellation upgrades for new capabilities
- Disadvantages
  - Might not be technically possible to achieve high levels of resolution

Possible role of denial deterrence

- Shift development of future space systems towards redundant constellations of microsatellites
  - Many nodes reduces vulnerability to kinetic attacks
  - Exploit acquisition and manufacturing advantages
  - Design systems that are interchangeable, interleaving, and flexible for the end user
- Funnel adversaries towards non-kinetic means
  - Jamming, hacking, spoofing
  - Dangerous, yes, but probably non-destructive attacks which will leave asset intact and not impact long-term sustainability of space
- Focus on increasing defenses within this reduced attack surface

Inherent advantages…

- Doesn't need to be specifically crafted for a certain adversary in a certain situation
- Don't need to know who the adversary is (only method of attack)
- Don't actually need the adversary to be deterred
  - if system is truly distributed and redundant then any kinetic attacks will have little to no effect on overall system performance

…and possible disadvantages

- Is the technology ready for distributed satellite constellations?
  - Optical interferometry
  - Packetized, routable C2 and comms
  - Links between multiple satellite constellations and air, ground and sea capabilities
- Initial acquisitions and manufacturing learning curve
  - Radical shift (at least for US military space)
  - Will the military-industrial complex get behind a less-sexy satellites?
- Cyber and RF attacks become primary concerns
  - Much less of a chance to degrade/destroy space environment, but potentially lower entry costs for potential adversaries

Role of space situational awareness

- Some level of international SSA capability could serve as a deterrent on attacks in space
  - Increase international awareness of the consequences of irresponsible action in space
  - Increase transparency of States' actions in space
  - Need to balance sharing and security, define differences between civil and military SSA

- A multilateral SSA system can give a geographically distributed sensor system more economically than a unilateral system

- Possibly lay foundation for verification of future space legal regimes concerning prohibited ***actions***

3rd Party Solution

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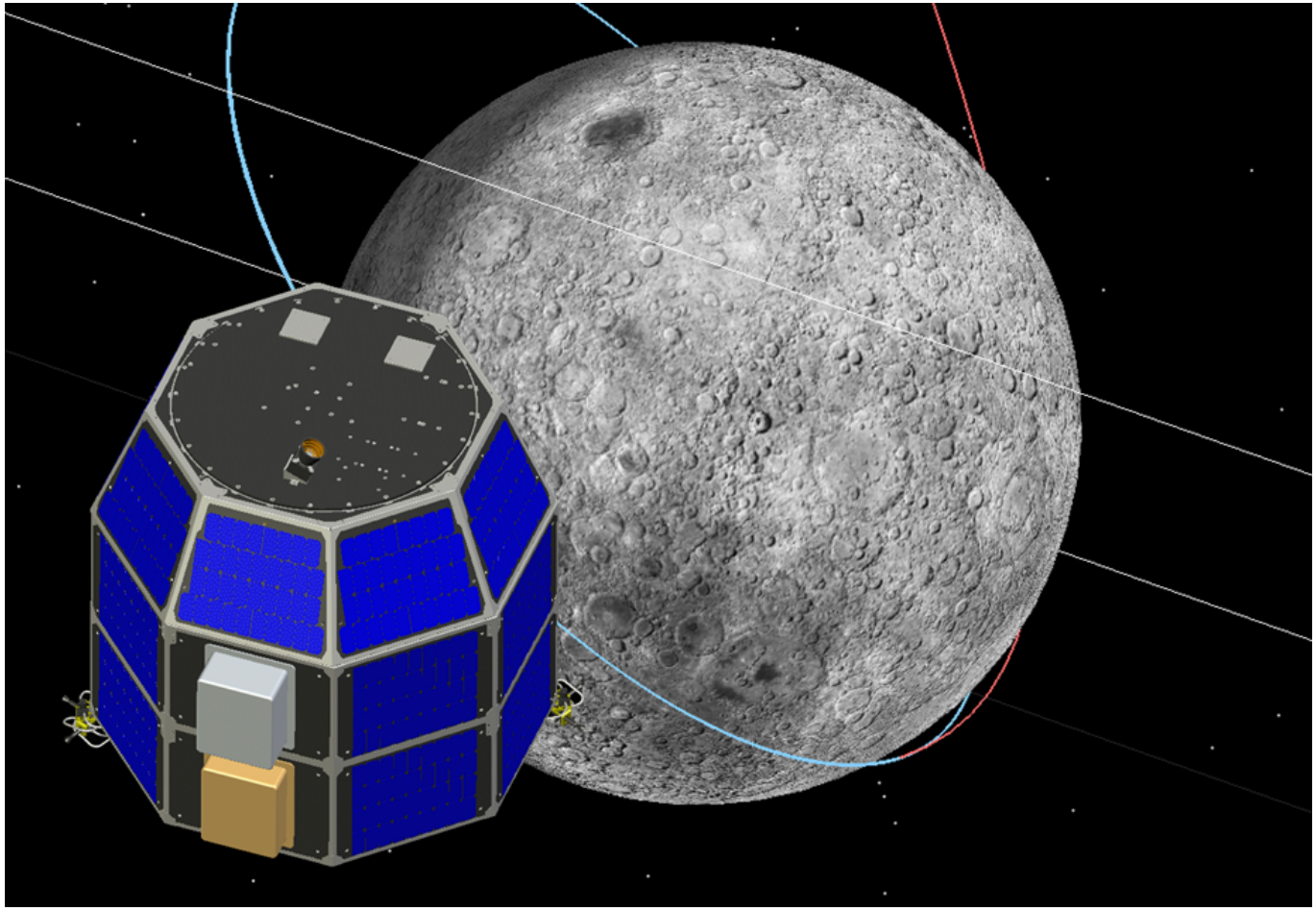
- Using 3rd Party satellites (Allies, commercial entities) for space capabilities could also provide some benefits
  - Extra layer of redundancy should indigenous capabilities be attacked
  - Could provide some level of deterrence against attack
    - Especially if adversary is also using same 3rd party solution themselves

Closing thoughts

- Deterrence does have applications for protecting space assets, but not necessarily in the classical sense (and not by itself)
  - Should be part of an overall **National Space Security Strategy**

- Denial deterrence and the shift towards distributed, redundant, microsatellite infrastructure is the primary means of countering kinetic ASAT weapons

- US ***must*** put as much intellectual analysis into space security concepts as it did Cold War strategies
  - See recent Council on Foreign Relations report on China

Lunar Atmosphere and Dust Environment Explorer (LADEE)