Briefing of the Working Group on the Health of the U.S. Space Industrial Base and the Impact of Export Controls

February 2008
Preamble

• “In order to increase knowledge, discovery, economic prosperity, and to enhance the national security, the United States must have robust, effective, and efficient space capabilities.”
- U.S. National Space Policy (August 31, 2006).
Statement of Task

- Empanel an expert study group to [1] review previous and ongoing studies on export controls and the U.S. space industrial base and [2] assess the health of the U.S. space industrial base and determine if there is any adverse impact from export controls, particularly on the lower-tier contractors.
- The expert study group will review the results of the economic survey of the U.S. space industrial base conducted by the Department of Commerce and analyzed by the Air Force Research Laboratory (AFRL).
- Integrate the findings of the study group with the result of the AFRL / Department of Commerce survey to arrive at overall conclusions and recommendations regarding the impact of export controls on the U.S. space industrial base.
- Prepare a report and briefing of these findings
Working Group

- Thomas Young, Consultant, Co-Chair
- Bill Ballhaus, Aerospace Corp, Co-Chair
- Pierre Chao, Center for Strategic and International Studies, Co-Chair

- Richard Albrecht, Moog
- Jeffrey Bialos, Johns Hopkins
- Lincoln Bloomfield Jr., Palmer Coates
- David Danzillo, Emcore Photovoltaics
- John Douglas, Aerospace Industries Association
- Paul Kaminski, Technovation
- John Klineberg, Consultant

- Lon Levin, SkySeven Ventures
- Tom Marsh, Lockheed Martin, retired
- Tom Moorman, Booz Allen Hamilton
- J.R. Thompson, Orbital Sciences
- John Tilelli, Cypress International
- Robert Walker, Wexler & Walker Public Policy Associates
Methodology

- Leveraged broad set of interviews and data from:
  - US government
    - Department of State, Department of Defense (OSD/Policy, OSD/AT&L, DTSA, STRATCOM, General Council), NRO, Department of Commerce, NASA, FAA, GAO
    - Congress
  - Foreign governments and agencies (Asia and Europe)
  - US industry
    - Boeing, Lockheed Martin, Northrop Grumman, ATK, Moog, Swales, GeoEye, SES Americom
  - Other experts
- Leveraged comprehensive survey of space industrial base undertaken by AFRL/Department of Commerce
- Working group generated consensus set of findings and recommendations
Principles

1. Space is critically important to U.S. national security
2. Global leadership in space is a national imperative
3. Similarly, sustaining technological superiority in space is a U.S. national interest
4. Given the interdependence between the defense, intelligence, civil and commercial sectors of space, U.S. leadership in all four is important [see chart, p.42]
5. A strong space industrial base is important
6. A prudent export control policy is necessary to control sensitive technologies
7. The U.S. must have unimpeded access to the technologies (global and domestic) needed for national security space systems
Executive Summary

The Health of the Space Industrial Base:

**Finding 1:** Overall financial health of the top tier manufacturers in the space industrial base is “good”, but there are areas of concern within the broader health of the industry.

**Finding 2:** As earlier studies have documented, the ability of the government and industry to meet program execution commitments remains inadequate.

**Finding 3:** The U.S. space industrial base is largely dependent on the U.S. defense/national security budget.

The implication is that the national security community “owns” the U.S. space (manufacturing) industry, and must either provide for the health of the industry (“arsenal strategy”) or encourage it (and enable it) to participate more in the global market place to broaden its economic base.
Executive Summary (continued)

The International Landscape and the Impact of Export Controls (1/3):

- The U.S. and its space industrial base is operating/competing in an increasingly globalized and interconnected environment
  
  **Finding 4:** There are rapidly emerging foreign space capabilities and the U.S. does not control their proliferation.

  **Finding 5:** U.S. preeminence in space is under challenge in many areas.

  **Finding 6:** The current export control policy has not prevented the rise of foreign space capabilities and in some cases has encouraged it (ITAR-free space products).

  The grand strategic intent of the space export controls is not being achieved

- In some cases, the space export control policy is running counter to the national space policy

  **Finding 7:** U.S. leadership in space benefits significantly from access to foreign innovation and human capital. That access is becoming increasingly difficult.
Executive Summary (continued)

The International Landscape and the Impact of Export Controls (2/3):

- In some cases, the space export control policy is running counter to the national space policy (continued)

**Finding 8:** The current export control policy is constricting U.S. engagement and partnership with the rest of the global space community, and is feeding a growing separation between the U.S. space community and an emerging non-U.S. space community.

**Finding 9:** Some elements of the export controls laws are in conflict with U.S. National Space Policy, which has as one of its goals to “encourage international cooperation with foreign nations on space activities that are of mutual benefit” and states that “space-related exports that are currently available or are planned to be available in the global marketplace shall be considered favorably”.


Executive Summary (continued)

The International Landscape and the Impact of Export Controls (3/3):

- U.S. industry is losing share in the international market and turning away from those markets, with the greatest burden being borne by the 2nd and 3rd tier of the industry

**Finding 10:** The U.S. share of the global space markets is steadily declining, and U.S. companies are finding it increasingly difficult to participate in foreign space markets.

**Finding 11:** Export controls are adversely affecting U.S. companies’ ability to compete for foreign space business, particularly the 2nd and 3rd tier.

And it is the 2nd/3rd tier of the industry that is the source of much innovation, and is normally the most engaged in the global market place in the aerospace/defense sector

- The goal is to bring space export control policy in line with the national space policy, achieve its strategic intent while not creating unintended negative consequences to industry

**Finding 12:** A U.S. export control policy that protects sensitive security space capabilities is important.

**Finding 13:** There is unanimous agreement that the export control process can be improved without adversely affecting national security.
Executive Summary - Recommendations

1. The Administration and Congress should review and reconcile the strategic intent of space export controls. [Findings 6,7,8,9]

2. Critical space technologies should be identified and should remain on the Munitions List and under the State Department ITAR process. [Findings 4,5,9, 12]

3. Remove from the Munitions List commercial communications satellite systems, dedicated subsystems, and components specifically designed for commercial use; provide safeguards by having Defense Department identify critical space components and technologies that should always require licensing and referral. Have the appropriate executive branch departments conduct a study to see if other space technologies should be removed from the USML (e.g., weather satellites). [Findings 4,5,7,10, 11, 12, 13]

4. Annually review the appropriateness of designating specific satellite and other space systems, components, and capabilities as Munitions List items based on criticality of items and on their availability outside the U.S. [9,13]

5. Additionally, Congress could amend the legislation related to satellite export licensing and adopt some of the best practices being used in other processes – set timelines, technology thresholds, de minimus rules, and special licensing vehicles. [Findings 8, 9, 10, 11, 12, 13]

6. The Secretary of Defense and NASA Administrator, in addition to the Secretary of State, should have the authority to grant real-time, case-by-case, specific time period exemptions for anomaly resolutions deemed to be in the national interest based on criteria from the National Space Policy. [Findings 8,9]

7. Create a special program authority to permit timely engagement of U.S. participants in multinational space projects. [Findings 7,8,9]

8. Increase the dollar threshold for satellite exports Congressional notification and establish a mechanism to allow the threshold to adjust with inflation. [Findings 8, 10, 11, 13]

9. Relevant space-related government agencies should collaboratively undertake an annual assessment of their industrial base. [Findings 1, 3]
Health of the Space Industrial Base

Findings 1: Overall financial health of the top tier manufacturers in the space industrial base is “good”, but there are areas of concern within the broader health of the industry.

Findings 2: As earlier studies have documented, the ability of the government and industry to meet program execution commitments remains inadequate.

Findings 3: The space industrial base is largely dependent on U.S. defense/national security budgets.
Findings 1: Overall financial health of the top tier manufacturers in the space industrial base is “good”, but there are areas of concern within the broader health of the industry

- “For at least the last decade, the space industry has experienced high volatility, high risk, market bubbles and financial losses” Space Foundation White Paper, April 4, 2006
- There is currently a recovery under way in the space industry, particularly as the national security space sector undertakes the upgrading/replacement of virtually every type of capability in orbit
- The financial health of the space manufacturers has recovered, but margins remain thin and below the average for the general aerospace/defense industry – particularly the 2\textsuperscript{nd} and 3\textsuperscript{rd} tier [see chart of manufacturer’s profits, p. 43]
  - AFRL survey shows average margins of primes has recovered from deep losses in 2003/2004 to reporting 2.5% net margins in 2006
  - …and average net margins of 5% at the 2\textsuperscript{nd}/3\textsuperscript{rd} tier
  - Note this stands in contrast to average net margins of 5% for primes and 6-8% for the 2\textsuperscript{nd}/3\textsuperscript{rd} tiers in the defense sector; let alone 9% in the high technology manufacturing sectors of the general economy
Findings 1: Overall health of the industrial base (Continued)

The areas of concern about the space industrial base include:
• Identified weaknesses in the 2nd and 3rd tier of the industry - e.g. where there is only one domestic supplier, financially weak supplier, etc.

<table>
<thead>
<tr>
<th>Selected Areas of Concern in the Space Supplier Base</th>
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<tbody>
<tr>
<td>• Solar Cells</td>
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<td>• Li-Ion Batteries</td>
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<tr>
<td>• Travelling Wave Tubes</td>
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<tr>
<td>• Visual Imagers</td>
</tr>
<tr>
<td>• Optical Coatings</td>
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<tr>
<td>• Read-out Integrated Circuits</td>
</tr>
<tr>
<td>• Infrared Focal Plane Arrays</td>
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<tr>
<td>• Solar Cell Substrates</td>
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</tbody>
</table>

Source: Aerospace Corp analysis, 2006

- Note: a healthy 2nd/3rd tier is important given the role it plays in generating innovation
• …and well reported looming issues with the space-related workforce, particularly with the next generation  [see chart from OSD report, p. 44]
Findings 2: As earlier studies have documented, the ability of the government and industry to meet program execution commitments remains inadequate

- The issue of program management and systems engineering skill shortages in government and industry have been well identified in numerous studies over the last five years [see detailed comments from reports, p. 45]
  - “Lack of specific objectives and milestones”
  - “Shortfalls in experience levels”
  - “critical skill shortages in program management, systems engineering, and software development”, etc.

- The problem has been recognized, and there are initiatives in place to address this situation (but it is too early to determine effect). However, the desire to build complex, system-of-systems exacerbates the skills issue. Furthermore, it takes up to 10 years to “grow” systems engineers and multiple program experiences are critical (given the limited number of new starts participation in all space sectors or internationally is therefore important)
Findings 3: The space industrial base is largely dependent on U.S. defense/national security budgets

- Percent of market dominated by U.S. defense/national security/government customers more akin to naval shipbuilding or tanks, than aerospace or other parts of aerospace/defense

Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007
Health of the U.S. Space Industrial Base

Implies that the national security community “owns” the U.S. space industrial base, and must either provide for the health of the industry (“arsenal strategy”) or encourage it (and enable it) to participate more in the global market place to broaden its economic base.
International Landscape and the Impact of Export Controls

- The Global Landscape
- National Space Policy and Export Control
- U.S. Industry, the International Markets and Export Control Policy
- Export Control Policy
The Global Landscape

**Findings 4:** There are rapidly emerging foreign space capabilities and the U.S. does not control their proliferation

**Findings 5:** United States preeminence in space is under challenge in many areas

**Findings 6:** The current export control policy has not prevented the rise of foreign space capabilities and in some cases has encouraged it.
Findings 4: There are rapidly emerging foreign space capabilities and the U.S. does not control their proliferation

Findings 5: United States preeminence in space is under challenge in many areas

• Where the U.S. was once part of a very exclusive club, the number of nations active in space continues to grow
  • Triple the number of countries with their own positioning/navigation systems since 1999
  • Double the number of countries with their own reconnaissance/earth observation satellites since 1999
  • A dozen countries able to launch their own satellites
  • 38 countries with operational control over their own communication satellites

• Furthermore, the sophistication of overseas and commercial capabilities continues to increase
  • Example: Russia, France, Israel, Korea and India all possess commercial imaging satellites of one meter resolution or better
  • Example: Canada, European Space Agency, Italy, Germany and Japan possess civil radar imaging satellites; soon India and Argentina will join the list; China has launched two military radar imaging satellites

[See detailed chart for more info, p. 46]
Findings 4 & 5: Rapidly emerging foreign space capabilities and U.S. preeminence in space is under challenge (continued)

- In the global commercial communications satellite market, where the U.S. had a technical and qualitative lead over the international competition in the 1990s, that competition has significantly closed the gap in the last decade
  - Since 1998, European and Asian manufacturers of satellites have gone from delivering satellites that were smaller, had fewer transponders, lesser payload power and shorter lives to manufacturing satellites of equal weight, number of transponders, payload power and lifespan

[see detailed table comparing U.S., European and Asian satellite capabilities, p. 47]

- As much as the U.S. would like to control this spreading of capabilities, international activity continues
  - Sino-Russian cooperation
  - Russian-European cooperation
  - Russian-Indian discussions
Other space faring nations continue to make strides, whether they have access to U.S. technology or not.

Since 1999 China has:

- Launched an indigenous navigation system
- Launched first 3m satellite
- Conducted its first manned spaceflight
- Tested an ant-satellite missile
- Sold the first Chinese built satellite to a foreign buyer (Nigeria)
- Launched first lunar probe

[see detailed chart of Chinese and Indian space milestones, p. 48]
Findings 6: The current export control policy has not prevented the rise of foreign space capabilities and in some cases has encouraged it.

- For years, China has chafed at efforts by the United States to exclude it from full membership in the world’s elite space club. So lately China seems to have hit on a solution: create a new club. (NY Times, May 23, 2007)

- “It’s a shame, but it’s not for me to comment on U.S. law, only to note its effects, and for the Rover, ITAR would have made cooperation too complicated to be feasible. … We are now obliged to develop our autonomy in various areas, which is no bad thing … We may also find partners besides NASA” – Daniel Sacotte, head of ESA’s Human Spaceflight program (May 30, 2005)

- “It is a matter of particular pride that international technology denial regimes have not impeded your efforts — in fact, they have spurred you to greater heights”, Indian Prime Minister to ISRO (Indian Space Research Organization), September 21, 2005

- Other examples include:
  - European Space Agency spending funds to develop a European supplier of solenoid valves, in order to remove that U.S. part from European space propulsion systems
  - CASA of Spain, which had limited capability as supplier of reflectors, funded to develop reflectors by non-U.S. satellite primes as part of ITAR-free movement. Now a global competitor in reflectors.

The grand strategic intent of the space export controls is not being achieved
National Space Policy and Export Controls

Findings 7: U.S. leadership in space benefits significantly from access to foreign innovation and human capital, but access is becoming increasingly difficult.

Findings 8: The current export control policy is constricting U.S. engagement and partnership with the rest of the global space community, and is feeding a growing separation between the U.S. space establishment and an emerging non-U.S. space establishment.

Findings 9: Some elements of the export controls laws are in conflict with U.S. National Space Policy.
Findings 7: U.S. leadership in space benefits significantly from access to foreign innovation and human capital, but access is becoming increasingly difficult

• The U.S. has historically employed a successful model of being a “vacuum cleaner” of the world’s best innovation, technology and human capital; and then turning this raw technology into value-added space and defense systems
  • U.S. has been leveraging foreign innovation/human capital in space for 60 years
    - From Werner von Braun to use of the Russian RD-180 engines on the U.S. Atlas IIIA
  • “The key to maintaining U.S. technological preeminence is to encourage open and collaborative basic research. The linkage between the free exchange of ideas and scientific innovation, prosperity, and national security is undeniable”
    - National Security Advisor Rice (2001)
  • Given that foreign students earn more than half of the science, technology and engineering PhD’s and foreign-born workers make up more than a quarter of the U.S. ST&E workforce – the inability to access this group automatically shrinks the available talent pool
  • Furthermore the total applications of foreign graduate students to U.S. universities was down 19% in 2004-2007
Findings 8: The current export control policy is constricting U.S. engagement and partnership with the rest of the global space community, and fed a growing separation between the U.S. and an emerging non-U.S. space community.

- “Collaboration between U.S. and European scientists is harder now than it was before U.S. technology-transfer rules were tightened in 1999 … U.S. government officials charged with reviewing bilateral or multilateral science projects have been so worried about being accused of letting sensitive technologies slip into the wrong hands that they have overcompensated” – Nobel laureate George F. Smoot (Space News, February 8, 2007)

- “[Export Control rules cause] problems between us and our international partners that are really more of a problem than the benefit we are gaining by having the … restrictions in there,” – William Gerstenmaier, NASA's associate administrator for space operations (Space News May 21, 2007)

- “[A] contractor workforce comprises the majority of the [International Space Stations] operations workforce and must be able to have a direct interface with the IP operations team to assure safe and successful operations. Their interactions and their ability to exchange and discuss technical data relevant to vehicle operations or severely hampered by the current ITAR restrictions.”…”Currently the ITAR restrictions and the IPs' objections to signing technical assistance agreements are a threat to the safe and successful integration and operations of the Station.” – Tommy Holloway, Chair, International Space Station (ISS) Independent Safety Task Force (House S&T Committee, 7/24/2007)
Findings 8: The current export control policy is constricting U.S. engagement and partnership (Continued)

- One specific area where export controls are constraining U.S. engagement related to Technical Assistance Agreements. TAA’s which are critical for partnerships and marketing are taking longer to approve, from average of 52 days in 2003 to 106 days in 2006 (in competitive situations, 60 days response time to RFP’s is not unusual)

- Another area of concern regarding U.S. international engagement and partnership is the ability to conduct anomaly resolution

[see table for detailed data, p.49]
Findings 9: Some elements of the export controls laws are in conflict with U.S. National Space Policy

- One of the goals of the National Space Policy is to “encourage international cooperation with foreign nations on space activities that are of mutual benefit”; it also states that “space-related exports that are currently available or are planned to be available in the global marketplace shall be considered favorably”.

<table>
<thead>
<tr>
<th>Among the unintended consequences:</th>
<th>Corresponding section in US National Space Policy:</th>
</tr>
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<tbody>
<tr>
<td>The munitions list is not consistent with the current assessment of which space technologies that should be controlled</td>
<td>“As a [effective export policy] guideline, space-related exports that are currently available or are planned to be available in the global marketplace shall be considered favorably”</td>
</tr>
<tr>
<td>The U.S. space export control regime does not match its goals of both enabling cooperation with allies and denial of capabilities to opponents. The current regime does not provide policy makers with the nuance or flexibility needed to serve the National Space Policy</td>
<td>“Develop and deploy space capabilities that sustain U.S. advantage and support defense and intelligence transformation; … Develop capabilities, plans, and options to ensure freedom of action in space, and, if directed, deny such freedom of action to adversaries”</td>
</tr>
<tr>
<td>Satellites and their components were placed on the U.S. Munitions List due to Congressional action with the intent of limiting the spread of space technology. However, this has had the unintended consequence of encouraging the proliferation of space capabilities, has not prevented the rise of other space powers but has impacted U.S. competitiveness.</td>
<td>“Refrain from conducting activities that preclude, deter, or compete with U.S. commercial space activities, unless required by national security or public safety”</td>
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<td>There has been an adverse industrial and technological impact to the U.S. ITAR implementation introduces a friction for U.S. companies competing in the global market, as much as $600 million a year, which in turn feeds space development that the U.S. is not involved in</td>
<td>“A robust science, technology, and industrial base is critical for U.S. space capabilities… Use U.S. commercial space capabilities and services to the maximum practical extent”</td>
</tr>
<tr>
<td>The continuation of our legacy of beneficial collaboration with foreigners has been impeded, as has our ability to do anomaly</td>
<td>“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 space, as well as to advance national security, homeland security, and foreign policy objectives”</td>
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</table>

Findings 9: Some elements of the export controls laws are in conflict with U.S. National Space Policy
U.S. Industry, the International Markets and Export Control Policy

Findings 10: The U.S. share of the foreign space markets is steadily declining, and U.S. companies are finding it increasingly difficult to participate in foreign markets.

Findings 11: Export controls are adversely affecting U.S. companies’ ability to compete for foreign space business, particularly the 2nd and 3rd tier.
Findings 10: The U.S. share of the foreign space markets is steadily declining, and U.S. companies are finding it increasingly difficult to participate in foreign markets

• Study after study shows the same results, an erosion of U.S. share of the global commercial satellite market since the late 1990s [see detailed charts for examples, p. 50-52]
  • FAA, Institute for Defense Analyses, Satellite Industries Association, NASIC

• “One European aerospace executive said export customers were asking for systems which were ‘ITAR free.’” Defense News (June 19, 2007)

• “We will not buy from U.S. due to export controls.” Canadian TELESAT

• Other examples where U.S. components and technology are being designed out include:

  - Creation of ITAR-free European apogee motor
  - ITAR-free European thruster control valves
  - ITAR-free European star tracker
  - Microwave components from the Astrium Megha-Tropiques mission instruments
  - Alcatel satellite bus
  - zGRACE mission where U.S. systems integrator was replaced by a foreign contractor
Findings 10: ...and U.S. companies are finding it increasingly difficult to participate in foreign markets (cont’d)

• US companies frustrated by uncertainty that ITAR involves

It is easy to understand ITAR licensing requirements for a defense article or service

I can predict with confidence the amount of time it takes for my company to obtain an export license from my government

The unpredictable amount of time that it takes my company to obtain an export license hinders my company’s strategic decision making

Source: Booz Allen survey of U.S. industry executives, May 2006
Findings 10: ...and U.S. companies are finding it increasingly difficult to participate in foreign markets (cont’d)

- So much so, that it impacts the space industry’s confidence in being able to compete in foreign markets

Will your company be well positioned to compete in the (domestic/foreign) markets in the 2008-2012 period?

Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007
Findings 11: Export controls are adversely affecting U.S. companies’ ability to compete for foreign space business - particularly the 2nd and 3rd tier.

- U.S. is the only country that classifies commercial communications satellites as a “munition”
- U.S. export controls are cited as the #1 barrier to foreign markets by industry [see detailed chart, p. 53]
- An average $600 million per year of lost revenues due to licensing issues has been cited by industry (Caveat 1: there may be double counting between industry competitors; Caveat 2: the data does not include competitions that were not pursued by US industry due to ITAR) [see detailed table, p. 54]
- The burden on the 2nd and 3rd tier of the industry is particularly heavy
  - Compliance costs averaged $50M per year for the industry [see detailed chart, p. 55]
  - Costs have increased 28% since 2003
  - As a percent of foreign sales, the cost burden on Tier 3 companies is nearly 8 times that of Tier 1 firms (Less resources = less investment)

<table>
<thead>
<tr>
<th>Total costs of compliance divided by foreign sales</th>
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<tbody>
<tr>
<td><strong>Tier 1</strong></td>
</tr>
<tr>
<td>2003</td>
</tr>
<tr>
<td>0.9%</td>
</tr>
<tr>
<td>2.0%</td>
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<tr>
<td>8.0%</td>
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</table>

Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007
Findings 11: Export controls are adversely affecting U.S. companies’ ability to compete (Continued)

- Once commercial satellites were placed on the Munitions List, given the structure of the ITAR (any component on a munitions list item is a munition), the 2nd and 3rd tier of the industry were impacted… intended or not

“We never wanted to control parts and components.”

Former Director, Space Monitoring Division of DoD Defense Threat Reduction Agency, speech at Satellite 2007 conference (reported by The Space Review, February 26, 2007)
Export Control Policy

Findings 12: A U.S. export control policy that protects sensitive security space capabilities is important.

Findings 13: There is unanimous agreement that the export control process can be improved without adversely affecting national security.
**Findings 12:** A U.S. export control policy that protects sensitive security space capabilities is important.

“Exports of **sensitive or advanced** technical data, systems, technologies, and components, shall be approved only rarely, on a case-by-case basis. These items include systems engineering and systems integration capabilities and techniques or enabling components or technologies **with capabilities significantly better** than those achievable by current or near-term foreign systems.”

– National Space Policy (2006)
**Findings 13:** There is unanimous agreement that the export control process can be improved without adversely affecting national security.

- The Departments of State, Defense and Commerce are all undertaking reform exercises to reduce processing times and streamline the export control licensing process.
- There are numerous broad export control reform efforts under way.

**President Bush’s Technology Agenda:**

“The current high tech export control system is awkwardly structured, hindering U.S. businesses, while failing to strengthen our national security.”

**Coalition for Security and Competitiveness: Recommendations for Modernizing Export Controls on Munitions List Items (2007):**

“[T]he U.S. export control system must be modernized so that it is better able to respond quickly and effectively to evolving security threats, and promote our nation’s continued economic and technological leadership.” (p. 1)

*Recommendations: Provide more resources and high level attention while streamlining the process.*

Studies by National Academies of Sciences, Defense Science Board, NATO Industrial Advisory Group, Hudson Institute, Heritage Foundation, CSIS and others
Findings 13: There is unanimous agreement that the export control process can be improved without adversely affecting national security (continued)


From the State Department International Security Advisor Board Report:
"The Department of State should be prepared to facilitate international cooperation in the use of space through U.S. export policies. The Department of State, therefore, in its regulation of satellite exports, should focus on ways to streamline the licensing process. While it is obviously essential to protect U.S. national security and space control, the current process damages U.S. cooperation with friends and allies and weakens the U.S. commercial space satellite industry and the underlying industrial base that develops civil, commercial, military, and intelligence space assets.

The current International Traffic in Arms Regulations (ITAR) list is too broad. It includes too much technology that is widely available internationally. Moreover, a single international transaction involving commercial space technology now often requires multiple licenses. Licenses often come with extensive restrictions that make resubmission necessary, causing further delay and uncertainty for U.S. manufacturers in the commercial international market place.

State ISAB Recommendation #10: The State Department should review the technology in the International Traffic in Arms Regulations (ITAR) list with a view toward regulating key technologies and exporters. The State Department needs to move toward issuing licenses that are sufficiently broad to enable the process to move forward more quickly."


Recommendations
Recommendations

1. The Administration and Congress should review and reconcile the strategic intent of space export controls.

2. Critical space technologies should be identified and should remain on the Munitions List and under the State Department ITAR process.

3. Remove from the Munitions List commercial communications satellite systems, dedicated subsystems, and components specifically designed for commercial use; provide safeguards by having Defense Department identify critical space components and technologies that should always require licensing and referral. Have the appropriate executive branch departments conduct a study to see if other space technologies should be removed from the USML (e.g., weather satellites).

4. Annually review the appropriateness of designating specific satellite and other space systems, components, and capabilities as Munitions List items based on criticality of items and on their availability outside the U.S.

5. Additionally, Congress could amend the legislation related to satellite export licensing and adopt some of the best practices being used in other processes – set timelines, technology thresholds, de minimus rules, and special licensing vehicles.

6. The Secretary of Defense and NASA Administrator, in addition to the Secretary of State, should have the authority to grant real-time, case-by-case, specific time period exemptions for anomaly resolutions deemed to be in the national interest based on criteria from the National Space Policy.

7. Create a special program authority to permit timely engagement of U.S. participants in multinational space projects.

8. Increase the dollar threshold for satellite exports Congressional notification and establish a mechanism to allow the threshold to adjust with inflation.

9. Relevant space-related government agencies should collaboratively undertake an annual assessment of their industrial base.
Detailed Data Backup
Principles – Space Sector Interdependence

- Defense
- Civil
- Military Space
- Interplanetary
- Warning
- MASINT
- SIGINT
- IMINT
- Intelligence
- Commercial
- Communications
- SAT C²
- Launch
- PNT
- Technology
- Industrial Base
- Space Surveillance

Source: Booz Allen Hamilton

[Return to Main Presentation]
Data for Findings 1: Overall financial health…

Space Manufacturer Profit Margins by Tier

Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007
Data for Findings 1: Overall financial health… (Continued)

• There continue to be looming issues with the space-related workforce, particularly with the next generation

Source: OSD report, 2006
Data for Findings 2: As earlier studies have documented, the ability of the government and industry to meet program execution commitments remains inadequate.

- Commentary from various studies:
  - “DOD has not established specific space objectives that are linked to overall program goals and resource requirements, nor has it established specific performance goals or other mechanisms to measure program outcomes…the services do not have clearly defined space objectives and milestones to guide their initiatives, nor does DOD have a mechanism to ensure successful accomplishment of integrated efforts without gaps and duplications” (GAO, *Defense Space Activities: ... Further Management Actions Needed*, 2003, pp. 19-20).
  - “The authority of program managers and other working-level acquisition officials subsequently eroded to the point where it reduced their ability to succeed on development programs … Widespread shortfalls exist in the experience level of government acquisition managers, with too many inexperienced personnel and too few seasoned professionals … The lack of dedicated career field management for space and acquisition personnel has exacerbated this situation” (DSB, *Acquisition of National Security Space Programs*, 2003, p. 3).
  - “DOD’s major weapon system program managers and program executive officers … pointed to critical skill shortages in program management, systems engineering, and software development” (p.1). “The majority of major acquisition programs in DOD’s space portfolio have experienced problems during the past two decades that have driven up cost and schedules and increased technical risks.” (p. 7). (GAO, *Space Acquisition: Actions Needed to Expand and Sustain Use of Best Practices*, 2007).
Data for Findings 4: There are rapidly emerging foreign space capabilities and the U.S. does not control their proliferation

Findings 5: United States preeminence in space is under challenge in many areas

<table>
<thead>
<tr>
<th># of countries / Time period</th>
<th>Launch own satellites</th>
<th>Launched human spaceflight</th>
<th>Own positioning/ navigation system</th>
<th>Launched own recon / earth observation sat.</th>
<th>Control over own COMSAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>10</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>1999</td>
<td>12 (+Ukraine, Brazil)</td>
<td>2</td>
<td>2</td>
<td>14</td>
<td>32</td>
</tr>
<tr>
<td>2007-8</td>
<td>12</td>
<td>3 (+China)</td>
<td>6(+China, India, EU, Japan)</td>
<td>27</td>
<td>38</td>
</tr>
<tr>
<td>2010-2025</td>
<td>Steady growth</td>
<td>India, ESA and Japan active</td>
<td>Full operationalization of EU, Asian systems</td>
<td>Steady growth</td>
<td>Steady growth</td>
</tr>
</tbody>
</table>

[Return to Main Presentation]
Comparison of Satellite Capabilities (1990s vs 2000s)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Select or Representative Spacecraft</td>
<td>ASTRA-1G / Anik F2</td>
<td>AMC-1 / AMC-11</td>
<td>Intelsat 709 / SATMEX 6</td>
<td>AMC-5 / KoreaSat 5</td>
<td>ST-1 / Anik F-1</td>
<td>Chinasat 6 / NigComSat 1</td>
<td>/ Superbird 7</td>
</tr>
<tr>
<td>In-orbit reliability/failure</td>
<td>25 built before first malfunction in 1998 / 75% of buses had insurance claim</td>
<td>Named by Frost &amp; Sullivan as “most reliable” for most apps.</td>
<td>86% platform reliability after 10 years.</td>
<td>2 satellites reported as malfunctioning (1 lost as a result); / Solar panel failure took out first</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of transponders</td>
<td>32 / 102</td>
<td>24 / 48</td>
<td>36 / 60</td>
<td>16 / 36 (up to 110)</td>
<td>30 / 84</td>
<td>24 / 28</td>
<td>0 / 28</td>
</tr>
<tr>
<td>Life span (years)</td>
<td>15 / &lt;10</td>
<td>15 / 15</td>
<td>15 / 15</td>
<td>10 / 15</td>
<td>15 / 15</td>
<td>8 / 15</td>
<td>0 / 15</td>
</tr>
<tr>
<td>Payload power (BOL kW)</td>
<td>6.6-8 / 16</td>
<td>7 / 6.5</td>
<td>3.9 / 14</td>
<td>-- / 9-16</td>
<td>6.5-7 / 16</td>
<td>4 / 7-10</td>
<td></td>
</tr>
<tr>
<td>Weight (BOL lbs)</td>
<td>5,467 / 8,390</td>
<td>3,520 / 5,095</td>
<td>4,850 / 5,082</td>
<td>1,692</td>
<td>3,300 / 6,490</td>
<td>2,320-2,740 / 5,000</td>
<td></td>
</tr>
<tr>
<td>Total production by 2006</td>
<td>72 / 16</td>
<td>21 / 16</td>
<td>66 (all models)</td>
<td>12 / 7</td>
<td>7 / 10</td>
<td>5 / 3</td>
<td></td>
</tr>
</tbody>
</table>

Source: CSIS
Data for Findings 4 & 5: Rapidly emerging foreign space capabilities and U.S. preeminence under challenge (cont’d)

**Indian Space Milestones**
- 1962: Space program started by Vikram Sarabhai
- 1975: First satellite launch (“Aryabhata”)
- 1979: First (experimental) Earth observation satellite (“Bhaskara-1”)
- 1980: First indigenous satellite launch (“Rohini-1”)
- 1984: First manned space mission (part of Soviet mission)
- 1997: First satellite launched using indigenous polar satellite launch vehicle
- **1999: Satellites returned to U.S. Munitions List**
- 2001: First “high resolution” (~1m) imaging satellite
- 2004: Partners with Russia on GLONASS navigation system
- 2007: Initial operational capability of indigenous GAGAN navigation system
- 2007: First launch and retrieve of (unmanned) spacecraft

**Chinese Space Milestones**
- 1956: Space program started by Qian Xuesen
- 1971: First (store and forward) communications satellite
- 1973: Manned spaceflight program started
- 1975: First successful recon satellite launch
- 1990: “Biosat” containing 60 animals and plants
- 1990: First commercial satellite launch (Asiasat-1)
- **1999: Satellites returned to U.S. Munitions List**
- 1999: First launch and retrieve of (unmanned) spacecraft (Shenzhou-1)
- 2000: Initial operational capability of indigenous Beidou navigation system
- 2000: First “high resolution” (~3m) imaging satellite
- 2003: First manned spaceflight (Shenzhou-5)
- 2005: Two astronauts in orbit perform experiments (Shenzhou-6)
- 2007: Anti-satellite missile launch
- 2007: First Chinese built satellite for a foreign buyer (COMSAT for Nigeria)
- 2007: First lunar probe launched

Source: CSIS
Data for Findings 8: The current export control policy is constricting U.S. engagement and partnership

<table>
<thead>
<tr>
<th>Year</th>
<th>TAA Submitted</th>
<th>TAA Approved</th>
<th>% Approved</th>
<th>TAA avg. time (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>508</td>
<td>439</td>
<td>86%</td>
<td>52</td>
</tr>
<tr>
<td>2004</td>
<td>610</td>
<td>565</td>
<td>93%</td>
<td>59</td>
</tr>
<tr>
<td>2005</td>
<td>829</td>
<td>722</td>
<td>87%</td>
<td>85</td>
</tr>
<tr>
<td>2006</td>
<td>698</td>
<td>627</td>
<td>90%</td>
<td>106</td>
</tr>
</tbody>
</table>

Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007
Data for Findings 10: The U.S. share of the foreign space markets is steadily declining

**Source:** Satellite Industry Association

**1995 Worldwide Share of Satellite Exports 2005**

**Source:** NASIC
Data for Findings 10: The U.S. share of the foreign space markets is steadily declining (Continued)

<table>
<thead>
<tr>
<th>Major Commercial GEO Satellite Programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Apstar</td>
</tr>
<tr>
<td>Intelsat</td>
</tr>
<tr>
<td>SES Astra</td>
</tr>
<tr>
<td>Telesat Canada</td>
</tr>
<tr>
<td>Chinasat</td>
</tr>
<tr>
<td>Inmarsat</td>
</tr>
<tr>
<td>JCSat</td>
</tr>
<tr>
<td>Panamsat</td>
</tr>
<tr>
<td>SES Americom</td>
</tr>
<tr>
<td>Asiasat</td>
</tr>
<tr>
<td>BSAT</td>
</tr>
<tr>
<td>DirecTV</td>
</tr>
<tr>
<td>Echostar</td>
</tr>
<tr>
<td>Loral Skynet</td>
</tr>
<tr>
<td>New Skies Satellites</td>
</tr>
<tr>
<td>XM</td>
</tr>
<tr>
<td>Arabsat</td>
</tr>
<tr>
<td>Eutelsat</td>
</tr>
<tr>
<td>Express</td>
</tr>
<tr>
<td>Insat</td>
</tr>
</tbody>
</table>

Source: Institute for Defense Analyses
Data for Findings 10: The U.S. share of the foreign space markets is steadily declining (Continued)

Source: FAA Office of Commercial Space Transportation Database

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Data for Findings 11: Export controls are adversely affecting U.S. companies’ ability to compete for foreign space business - particularly the 2\textsuperscript{nd} and 3\textsuperscript{rd} tier.

- U.S. export controls are cited as the #1 barrier to foreign markets by industry
Data for Findings 11: Export controls are adversely affecting U.S. companies’ ability to compete for foreign space business - particularly the 2nd and 3rd tier.

- An average $600 million per year of lost revenues due to licensing issues has been cited by industry (Caveat 1: there may be double counting between industry competitors; Caveat 2: this figure does not include competitions that were not pursued by US industry due to ITAR)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Sales Subject to Licensing ($Millions)</th>
<th>Lost Sales Attributed to Licensing ($Millions)</th>
<th>Lost Sales as a % of Opportunities (Total Sales + Lost Sales)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>1,569</td>
<td>64</td>
<td>31.2%</td>
</tr>
<tr>
<td>2004</td>
<td>2,342</td>
<td>19</td>
<td>17.6%</td>
</tr>
<tr>
<td>2005</td>
<td>6,166</td>
<td>118</td>
<td>9.2%</td>
</tr>
<tr>
<td>2006</td>
<td>3,226</td>
<td>8</td>
<td>13.7%</td>
</tr>
</tbody>
</table>

Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007

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Data for Findings 11: Export controls are adversely affecting U.S. companies’ ability to compete for foreign space business - particularly the 2nd and 3rd tier.

- The burden on the 2nd and 3rd tier of the industry is particularly heavy.

Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007

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Appendix

Title XV, Subtitle B – Satellite Export Controls

SEC. 1511. SENSE OF CONGRESS.

It is the sense of Congress that--

(1) United States business interests must not be placed above United States national security interests;
(2) United States foreign policy and the policies of the United States regarding commercial relations with other countries should affirm the importance of observing and adhering to the Missile Technology Control Regime (MTCR);
(3) the United States should encourage universal observance of the Guidelines to the Missile Technology Control Regime;
(4) the exportation or transfer of advanced communication satellites and related technologies from United States sources to foreign recipients should not increase the risks to the national security of the United States;
(5) due to the military sensitivity of the technologies involved, it is in the national security interests of the United States that United States satellites and related items be subject to the same export controls that apply under United States law and practices to munitions;
(6) the United States should not issue any blanket waiver of the suspensions contained in section 902 of the Foreign Relations Authorization Act, Fiscal Years 1990 and 1991 (Public Law 101-246), regarding the export of satellites of United States origin intended for launch from a launch vehicle owned by the People's Republic of China;
(7) the United States should pursue policies that protect and enhance the United States space launch industry; and
(8) the United States should not export to the People's Republic of China missile equipment or technology that would improve the missile or space launch capabilities of the People's Republic of China.

Title XV, Subtitle B – Satellite Export Controls  (Continued)

SEC. 1513. SATELLITE CONTROLS UNDER THE UNITED STATES MUNITIONS LIST.

(a) Control of Satellites on the United States Munitions List.--Notwithstanding any other provision of law, all satellites and related items that are on the Commerce Control List of dual-use items in the Export Administration Regulations (15 C.F.R. Part 730 et seq.) on the date of the enactment of this Act shall be transferred to the United States Munitions List and controlled under section 38 of the Arms Export Control Act (22 U.S.C. 2778).

SEC. 1516. RELATED ITEMS DEFINED.

In this subtitle, the term ``related items'' means the satellite fuel, ground support equipment, test equipment, payload adapter or interface hardware, replacement parts, and non-embedded solid propellant orbit transfer engines described in the report submitted to Congress by the Department of State on February 6, 1998, pursuant to section 38(f) of the Arms Export Control Act (22 U.S.C. 2778(f)).
§ 120.1 General authorities and eligibility
(a) Section 38 of the Arms Export Control Act (22 U.S.C. 2778) authorizes the President to control the export and import of defense articles and defense services. The statutory authority of the President to promulgate regulations with respect to exports of defense articles and defense services was delegated to the Secretary of State by Executive Order 11958, as amended. This subchapter implements that authority. By virtue of delegations of authority by the Secretary of State, these regulations are primarily administered by the Deputy Assistant Secretary for Defense Trade Controls and Managing Director of Defense Trade Controls, Bureau of Political-Military Affairs.

§ 120.2 Designation of defense articles and defense services.
The Arms Export Control Act (22 U.S.C. 2778(a) and 2794(7)) provides that the President shall designate the articles and services deemed to be defense articles and defense services for purposes of this subchapter. The items so designated constitute the United States Munitions List and are specified in part 121 of this subchapter. Such designations are made by the Department of State with the concurrence of the Department of Defense. For a determination on whether a particular item is included on the U.S. Munitions List see §120.4(a).
§ 120.3 Policy on designating and determining defense articles and services.
An article or service may be designated or determined in the future to be a defense article (see §120.6) or defense service (see §120.9) if it:

(a) Is specifically designed, developed, configured, adapted, or modified for a military application, and
   (i) Does not have predominant civil applications, and
   (ii) Does not have performance equivalent (defined by form, fit and function) to those of an article or service used for civil applications; or
(b) Is specifically designed, developed, configured, adapted, or modified for a military application, and has significant military or intelligence applicability such that control under this subchapter is necessary.

The intended use of the article or service after its export (i.e., for a military or civilian purpose) is not relevant in determining whether the article or service is subject to the controls of this subchapter. Any item covered by the U.S. Munitions List must be within the categories of the U.S. Munitions List. The scope of the U.S. Munitions List shall be changed only by amendments made pursuant to section 38 of the Arms Export Control Act (22 U.S.C. 2778).

§ 121.1 General. The United States Munitions List.
(a) The following articles, services and related technical data are designated as defense articles and defense services pursuant to §§38 and 47(7) of the Arms Export Control Act (22 U.S.C. 2778 and 2794(7))….
§ 121.1 General. The United States Munitions List (Continued)
Category XV—Spacecraft Systems and Associated Equipment

*(a) Spacecraft, including communications satellites, remote sensing satellites, scientific satellites, research satellites, navigation satellites, experimental and multi-mission satellites.

*Note to paragraph(a): Commercial communications satellites, scientific satellites, research satellites and experimental satellites are designated as SME only when the equipment is intended for use by the armed forces of any foreign country.

(b) Ground control stations for telemetry, tracking and control of spacecraft or satellites, or employing any of the cryptographic items controlled under category XIII of this subchapter.

(c) Global Positioning System (GPS) receiving equipment specifically designed, modified or configured for military use; or GPS receiving equipment with any of the following characteristics:

   (1) Designed for encryption or decryption (e.g., Y-Code) of GPS precise positioning service (PPS) signals;
   (2) Designed for producing navigation results above 60,000 feet altitude and at 1,000 knots velocity or greater;
   (3) Specifically designed or modified for use with a null steering antenna or including a null steering antenna designed to reduce or avoid jamming signals;
   (4) Designed or modified for use with unmanned air vehicle systems capable of delivering at least a 500 kg payload to a range of at least 300 km.
§ 121.1 General. The United States Munitions List
Category XV—Spacecraft Systems and Associated Equipment (Continued)

(d) Radiation-hardened microelectronic circuits that meet or exceed all five of the following characteristics:

(1) A total dose of $5 \times 10^5$ Rads (Si);
(2) A dose rate upset threshold of $5 \times 10^8$ Rads (Si)/sec;
(3) A neutron dose of $1 \times 10^{14}$ n/cm$^2$ (1 MeV equivalent);
(4) A single event upset rate of $1 \times 10^{-10}$ errors/bit-day or less, for the CREME96 geosynchronous orbit, Solar Minimum Environment;
(5) Single event latch-up free and having a dose rate latch-up threshold of $5 \times 10^8$ Rads (Si).

(e) All specifically designed or modified systems or subsystems, components, parts, accessories, attachments, and associated equipment for the articles in this category, including the articles identified in section 1516 of Public Law 105–261: satellite fuel, ground support equipment, test equipment, payload adapter or interface hardware, replacement parts, and non-embedded solid propellant orbit transfer engines (see also Categories IV and V in this section).

Note: This coverage by the U.S. Munitions List does not include the following unless specifically designed or modified for military application (see §120.3 of this subchapter):

(1) Space qualified travelling wave tubes (also known as helix tubes or TWTs), microwave solid state amplifiers, microwave assemblies, and travelling wave tube amplifiers operating at frequencies equal to or less than 31GHz.
§ 121.1 General. The United States Munitions List
Category XV—Spacecraft Systems and Associated Equipment (Continued)

(2) Space qualified photovoltaic arrays having silicon cells or having single, dual, triple
junction solar cells that have gallium arsenide as one of the junctions.
(3) Space qualified tape recorders.
(4) Atomic frequency standards that are not space qualified.
(5) Space qualified data recorders.
(6) Space qualified telecommunications systems, equipment and components not designed or
modified for satellite uses.
(7) Technology required for the development or production of telecommunications equipment
specifically designed for non-satellite uses.
(8) Space qualified focal plane arrays having more than 2048 elements per array and having a
peak response in the wavelength range exceeding 300nm but not exceeding 900nm.