DUAL USE TECHNOLOGY:

A Defense Strategy for Affordable, Leading-Edge Technology

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Preface

This report describes the Defense Department's strategy for preserving the technological superiority of U.S. forces at an affordable cost. Our strategy is to place greater reliance on the commercial sector to reduce costs, shorten acquisition cycle times and obtain technologically advanced defense equipment.

The dual use programs described in this report are instrumental to the Department's goal of moving away from separate defense and commercial bases to an integrated, national industrial base. I want to underscore my personal support for these programs. They are precisely the type of programs I see as vital to meet our nation's future defense needs.

As explained in the report, I believe a dual use technology and production strategy will allow the Department to leverage the overall U.S. industrial base and keep our weapon systems on the leading edge of technology--the winning edge.

Sincerely,

Paul G. Kaminski
Under Secretary of Defense
for Acquisition and Technology

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Executive Summary

Rapid advances in commercial technology combined with declining U.S. defense budgets have, in many cases, rendered DoD's traditional, defense-unique approach to technology development and procurement less affordable and less effective than in the past. It is critical that defense programs take advantage of cost-conscious, market-driven commercial production and leverage the huge investments in leading-edge process technologies made by private industry. It is also important that defense technologies and systems keep pace with the rapid product development cycles driven in critical areas by a highly dynamic commercial sector.

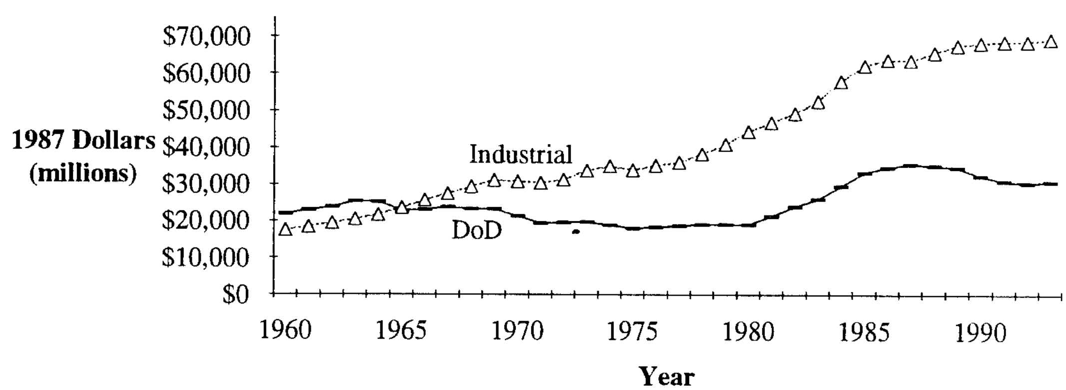
Dual use technology policy is a key component of DoD's investment strategy for maintaining the performance superiority and affordability of U.S. military forces in this new technological and economic environment. It builds upon the successful DoD acquisition reform effort. Elements of the dual use technology investment strategy serve to: (1) ensure that key elements of the domestic commercial technology base that are critical for national security remain at the leading edge; (2) support the transitioning of defense-sponsored technology and the integration of military production with the commercial base; and (3) facilitate insertion of commercial technologies into military systems. The benefits for the DoD will be better products—developed faster and at lower cost—and a vigorous, productive, and competitive commercial industrial infrastructure which, when coupled to the superior systems integration capability and defense-unique technologies provided by defense contractors, will ensure a superior U.S. military.

The Need for Change

For the past 50 years America's national security threat was primarily defined by the global nuclear and conventional capability of the former Soviet Union. The collapse of Communism and end of the Cold War profoundly changed the way national security needs are defined. Today we face challenges that are different but no less complex: the spread of nuclear weapons and other weapons of mass destruction; major regional, ethnic, and religious conflicts; uncertainty about democratic reform in the former Warsaw Pact and the developing world; and potential challenges to the economic viability of industrial capabilities vital to our national security.

Despite these changes, maintaining qualitatively superior military systems remains an essential goal of U.S. defense strategy. However, the prevailing economic and technical environment requires a new long-term approach to meeting this goal. With declining defense budgets, especially for acquisition, affordability has become even more important. Meanwhile, although Defense R&D and acquisition stimulated some of the most significant technological innovations of the twentieth century—e.g., in the semiconductor, computer and aircraft industries—the rapid growth of certain high technology industries has reduced the once central role of defense spending as a driving force for innovation. Overall, industrial R&D expenditures now greatly exceed those of the Department of Defense (DoD), as indicated in the graph below.[1]

Trends in DoD & Industrial R&D Expenditures, 1960-1993



[1]DoD data from Office of the Comptroller, *National Defense Budget Estimates for FY 1995*, March 1994, pp. 83-85. Industrial R&D outlays from National Science Board, *Science & Engineering Indicators—1993*, Washington, D.C.: U.S. Government Printing Office, 1993 (NSB 93-1), p. 332.

DoD's ability to take advantage of commercial product development cycles in dynamic industries has been hindered by its increasingly cumbersome, time-consuming acquisition process. For instance, the commercial computer and electronics sectors now introduce "next generation" products every three or four years. By contrast, DoD typically takes ten or more years to develop and upgrade new systems. As a result, military technology in fielded systems has grown increasingly expensive and distant from the commercial leading edge in many areas. (This situation would have been problematic even had the U.S. defense budget remained at Cold War levels.)

The need for DoD to reexamine its technology strategy is compelling. Maintaining access to the most advanced technologies at affordable prices will require fundamental changes. DoD and DOE must forge a new partnership with commercial industry, encouraging coordinated efforts that assure access to leading-edge technology in areas critical to the U.S. military. DoD must also make cross-cutting investments internally to facilitate the rapid adoption by the military of commercial products, processes, practices, and technologies. DoD will rely on defense-unique development and procurement only when a technology or system required for a national security mission has no commercial source, or where the investment risks are large and the time frame very long.

DoD's Dual Use Technology Concept

The dual use technology strategy represents a new way of doing business. DoD seeks to break down the barriers between commercial and defense industries and to institute compatible development and acquisition processes internally. An integrated, national industrial capability that achieves "world-class" benchmarks for cost, quality and cycle time, will allow DoD to exploit the rapid rate of product development and the market-driven efficiencies of commercial industry to meet military needs. By drawing on commercial technology and capabilities wherever possible, the military can attain three compatible objectives:

—Shorten weapon system development time and increase the pace at which technological improvements are incorporated into new military systems. This goal can be accomplished by introducing the commercial sector's continuous stream of updated technology during development, production and deployment phases.

—Reduce costs for procuring leading-edge technology. Commercial components, technologies and subsystems can, in many instances, be incorporated into military systems to meet the functional requirements at lower cost than technology that is uniquely developed from scratch for a specific military customer.

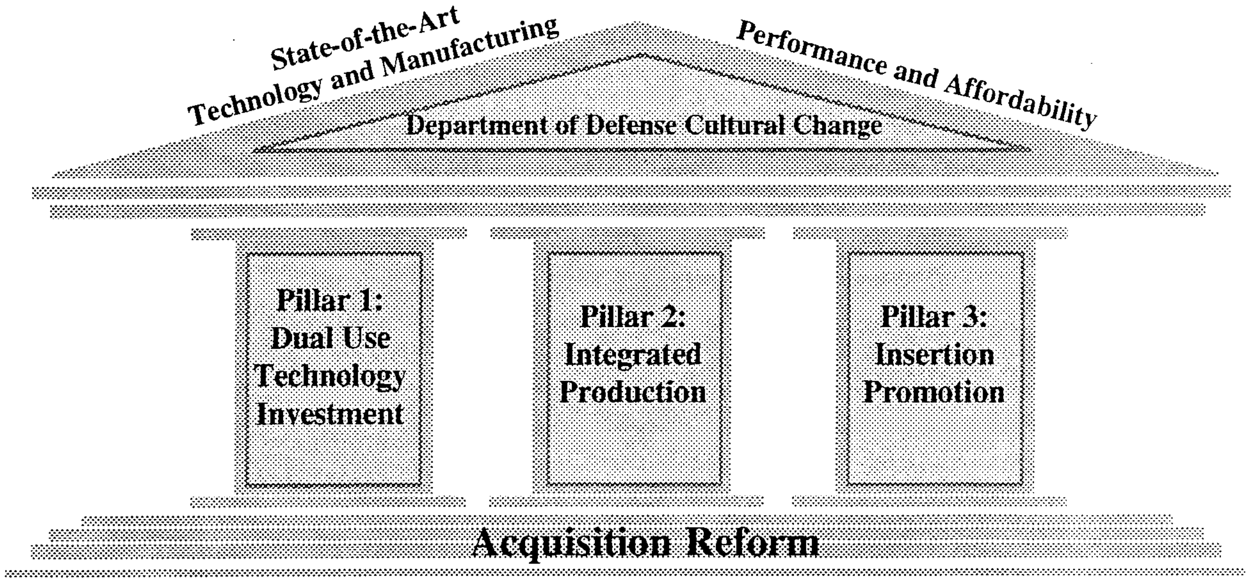
—Permit DoD to maintain its ability to respond rapidly to national security contingencies. Close integration with the private sector is imperative if the nation is to be equipped to gear up its industrial capabilities quickly to meet the military demands of a crisis.

DoD's ability to achieve these goals will require modification of its development and acquisition process to employ commercial business practices, in R&D as well as manufacturing. One cannot design a weapon system and then expect to find commercial parts with which to build it. Future weapons systems must be consciously designed to use state-of-the-art commercial parts and subsystems and to be built in facilities with integrated military and commercial production lines.

Acquisition reform is the foundation for this vision. The legal, regulatory and operational changes being pursued in acquisition reform support changes to DoD investment strategies, practices, and policy in three related areas, the "three pillars" of the dual use technology policy:

—investment in R&D on dual use technologies,
—integration of military and commercial production
—insertion of commercial capabilities into military systems

The DoD's acquisition reform effort seeks to bring about a simplified commercial-style procurement system that gives priority to acquiring commercial products and processes, and wherever possible eliminates those unique contracting, technical, and accounting requirements that form a barrier to greater military/commercial integration. Toward that end, on February 24, 1994, Secretary of Defense Perry set forth a dramatic vision for simplification of the way the Pentagon buys military systems, "Acquisition Reform: A Mandate for Change." As part of the mandate, on June 29, 1994 the Secretary directed the military Services "to use performance and commercial specifications and standards instead of military specifications and standards, unless no practical alternative exists to meet the user's needs." This represents a reversal of prior practice. requiring explicit approval to use military specifications and standards.



The "Three Pillars" of the dual use technology policy, with acquisition reform as a foundation, are supporting a change in the DoD defense-unique "culture" that will permit DoD to maintain state-of-the-art performance and affordability in military systems.

Other Steps to Acquisition Reform

With enactment of the Federal Acquisition and Streamlining Act of 1994,

- Federal and DoD acquisition regulation changes have been drafted and are in public comment period.
- DoD acquisition directive changes have been drafted.
- Services have established various procedures for granting waivers and tailoring internal Service requirements
- Performance specification training scheduled for Services.
- Services working closely with engineering societies, trade associations, etc. to identify milspec replacements.
- Threshold for simplified acquisition procedures established at $100,000, including a micropurchase threshold of $2,500
- Began installation of standard electronic commerce/data exchange system for DoD small purchases.
- Several statutory and regulatory pilot programs testing commercial acquisition processes are underway.
- Industries are being made aware of the changes DoD is making to accelerate their transition toward meeting DoD's new expectations.
- The conditions under which DoD requires certified cost or pricing data are being limited, making best commercial practices more broadly acceptable.

With acquisition reform as a foundation, the achievement of dual use technology policy goals can be accelerated by changing the way DoD makes investments. In order to maintain qualitatively superior military systems, the dual use technology strategy depends upon a commercial industrial infrastructure that can support our nation's security by supplying competitive and affordable products using the most advanced technologies. Hence, DoD will pursue a long-term defense R&D investment strategy that aims to ensure that the American commercial technology base remains at the leading edge in critical areas strategic to the U.S. military. In cases where commercial products require adaptation for military use, DoD will make long- and medium-term investments in the deployment of new manufacturing technology to promote the integration of military production with commercial production. (In those cases in which a requirement is truly defense-unique, DoD will continue its support of purely military production in the interest of national security.) DoD will also support the transitioning of defense-sponsored technologies to commercial applications in order to obtain defense savings through cost-conscious, market-driven production. Finally, wherever advantageous to U.S. national security, DoD will make investments internally to promote the near- and medium-term adoption of commercial materials, products, components, processes, practices, and technologies in military systems.

Making greater use of commercial technologies in defense systems and transitioning defense-sponsored technologies into commercial production facilities will mean that other government policy concerns—export controls, restrictions on foreign investments in domestic industries, the rules regulating national subsidies in international trade, the industrial organization of international industries supplying products and technologies used by DoD and its domestic suppliers, the international regime protecting intellectual property—will be ever more tightly linked to dual use technology policy and strategy. Hence, DoD actions will be coordinated with agencies such as Commerce, Energy, State, Treasury and others, including the U.S. Trade Representative, as needed. Likewise, the success of defense investments in R&D on dual use technologies will be fostered by increased cooperation with other federal government agencies and programs that are working with industry to develop and deploy leading-edge technologies (e.g., the National Information Infrastructure). The National Science and Technology Council's Committee on National Security will provide high-level coordination of these efforts.

First Pillar: Investment in R & D on Dual Use Technologies

With increased reliance on commercial suppliers, maintaining the technological superiority of U.S. military forces means that our commercial industry must be able to supply advanced products using leading-edge technologies at competitive, affordable prices. *Thus, a new goal for defense R&D is to ensure that our commercial technology base remains at the leading edge in areas critical to the U.S. military.*

With reduced defense budgets, targeted investment of limited R&D funds is of paramount importance. DoD will continue to support basic research in areas that have high potential for development of critical dual use technologies. Dual use investments aimed at developing specific technology for military use, assuring its availability, or supporting underlying industrial capabilities will be selected based on assessment of their relative importance to the Department of Defense. DoD, working with knowledgeable agencies, is conducting assessments of dual use technologies to identify priorities. The following three broad criteria will guide the selection of technology sectors for assessment as well as the resulting investment recommendations:

1. Criticality to U.S. military requirements. Dual use technology investments will focus on areas where the opportunities and payoffs for national security are greatest.

2. Need for government action. Initiatives selected will complement private activity and foster private investments which would not otherwise be made. The rationale for government action must be clearly articulated and specifically addressed in the initiative's design.

3. Opportunity for leverage.[2] A dual use initiative, by definition, is designed to create an opportunity for the U.S. military to exploit the current or future development of a technology in the commercial marketplace. Technological opportunities will be sought which are likely to lead to viable, self-sustaining industries capable of supplying the U.S. military.

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[2]If DoD considers it important to maintain the industrial base for a technology to support future defense needs (as determined by criteria 1 and 2 above), an initiative may still be warranted even if the technology is currently accessible and the opportunity for leverage is not high. Defense contingencies must be sufficiently likely to justify such support.

Among the key considerations will be:

—The probability of technical success
—The prospects for breakthroughs
—The scope of DoD activities which may be affected
—The potential savings to DoD from incorporating the technology in military systems
—The degree to which commercial industry is poised to manufacture and make use of the technology
—The potential for pervasive impact of the technology throughout industry.

DoD's dual use investments represent an ongoing, long-term commitment to develop the technologies required to ensure our national security. Its success depends on establishing relationships with industry of sufficient continuity that critical technologies can be nurtured to maturation. DoD will actively consult with industry in setting dual use investment priorities and will encourage competition among a variety of technological approaches. Flexible partnership agreements will be encouraged, and the government's rights to patents and technical data limited, so that firms receive the maximum incentive to develop new dual use technologies. (Since leveraging off of commercial success to reduce DoD's defense acquisition costs is an important goal of these partnerships, the Government can generally exploit these technology developments as products, not as "rights." DoD will develop internal controls to prevent compromise of existing company technologies, processes, core competencies, or products.)

The success of DoD investments in R&D on dual use technologies will be fostered by increased cooperation with other federal government agencies and programs that are working with industry to develop and deploy leading-edge technologies. DoD will also support participation in industrial partnerships with our foreign friends and allies, subject to national and economic security and national benefit and risk tests. (Commercial industry has concluded that international alliances can be an effective way to gain access to foreign technologies and products and to share the costs of technological leadership.) Finally, initiatives will be sensitive to other government policy objectives. In particular, given the leading role of the United States in supporting an open international trading system and the benefits that such a system has for our economic security, initiatives will be consistent with U.S. obligations under the General Agreement on Tariffs and Trade, the North American Free Trade Agreement, and the World Trade Organization.

DoD policies guiding dual use technology programs will ensure that initiatives are continually reassessed to take full advantage of the latest technological developments. Future dual use investment priorities will be guided by prospects for technological breakthroughs important to the U.S. military and the relative quality of R&D proposals across technology areas. Investments will support both component and systems-level technologies with direct application to military systems, and the development of critical material and production process technologies that are the underpinnings of technological advantage. The outcomes of initial (smaller) R&D projects will guide funding for subsequent (larger) projects. Along the same lines, initiatives will be subject to sunset provisions and clear measures of success to force and guide decisions about the viability of the initiative over the medium to long term. Periodic evaluations will be built into programs, along with "exit ramps" should objectives not be met or if unanticipated, early success is achieved.

Current DoD Dual Use R&D Focus Areas

The total FY '95 DoD investment in dual use research is $2.06B, approximately 25% of the total DoD Science and Technology budget. This DoD research effort is concentrated in four focus areas: information technology, advanced materials, advanced manufacturing, and advanced simulation and modeling. The table below shows the distribution of investment dollars in these areas; it includes those dual use technology initiatives, such as the Technology Reinvestment Program (TRP), which have been separately legislated and for which the performing/contracting agency and/or the mix of technology investments is not yet fully established. (The TRP is also a critical element of the second pillar of the dual use technology policy—integration of military and commercial production—and will be described further in that section.) The list does not include basic research (6.1) or other projects which have generic dual use potential but for which only the military goals are presently being pursued. It also does not include dual use S&T investments by the Military Services, the Ballistic Missile Defense Organization, the Defense Nuclear Agency or efforts such as the Strategic Environmental R&D Program (SERDP) or Federal Defense Lab Diversification Program.

Dual Use S&T Investments (6.2, 6.3)
FY `95 & '96 Appropriations ($M)

		FY '95		FY '96 (Req.)
ARPA CORE PROJECTS		**$1384.8**		**$1288.4**
Information Technology	$391.5		409.9	
Materials Technology	295.2		214.4	
Electronics Technology	563.4		535.4	
Advanced Simulation and Modeling	82.7		79.0	
Other ARPA	52.0		49.7	
OTHER LEGISLATED INITIATIVES				
Technology Reinvestment Project (TRP)		443.2		500.0
Small Business Innovative Research (SBIR)		161.0		161.0
Other RDT&E		73.7		16.1
TOTAL		$2062.7		$1965.5

Within the broad array of dual use technology projects represented by the table, there are areas of especially strategic importance to the DoD and the nation. Some representative examples are summarized briefly here. (More detailed discussions may be found in the Defense Technology Plan published in September 1994.) These examples give a flavor of the advantages to the U.S. military of leveraging commercial R&D and market-driven innovations and efficiencies.

Electronics Manufacturing

Electronics are critical to the performance, weight, size, reliability, interoperability, maintainability and cost of military systems. An increasing proportion of the value of such systems is dependent upon electronic products—up to 40 percent in some cases. (The current design of the F-16 Fighter, for example, includes 17,000 electronics components.) They are intrinsically important in radars, C3I and computer equipment, and weapons guidance and control systems. In the future, our soldiers in the field will have to be equipped with electronic information systems in order to maintain the type of advantages demonstrated by U.S. forces during Desert Storm.

Advances in semiconductor devices have been made possible by ever decreasing feature size and increasing device complexity. DoD has benefited greatly by leveraging the robust domestic commercial base of electronics systems and components. However, the underlying technologies for semiconductor manufacturing are becoming enormously expensive and difficult for individual firms to sustain. A systematic effort to maintain U.S. industrial leadership in electronics manufacturing—from input materials to equipment and components to electromechanical assembly—is of great importance for maintaining the superiority and affordability of military systems. DoD will invest over $500 million in supplier technology, infrastructure, and advanced applications research in FY '95.

A pivotal role in the electronics manufacturing infrastructure is played by lithographic technology, which, according to the Semiconductor Industry Association, is "both the dominant cost factor in wafer processing and the driving technology for increased chip functionality, and hence is the primary pacing technology for industry progress." DoD has worked with the semiconductor industry, partly through SEMATECH, to support the development of new lithography technologies. DoD participation reduces the risk for potential developers, making it possible for them to raise most of the required funding in the commercial market. Subsequently, DoD is able to maintain routine access to the latest technology without investing in the facilities themselves. With the next generation technologies pushing the limits of optical lithography, and advanced technologies such as X-ray, ion beam, and others all presenting both high risks and high costs to implement, it is important that the DoD continue to support development of a technology critical to the performance of its most advanced systems.

Along with lithography, a range of other semiconductor manufacturing technology efforts must be supported in conjunction with the U.S. semiconductor industry. One such area is electronics materials, including aluminum silicon carbide and silicon whisker reinforced metal matrix composites for electronic and other applications.

Flat Panel Displays

Flat panel displays (FPDs)—visual screens which are millimeters thick, very light, rugged, and portable—represent the next generation of display technology, and will be essential to maintaining superiority in the battlefield of the future. Current simulations of the F-15 cockpit, for example, suggest that merely having access to a large tactical situation display (which can be implemented only as an FPD) would raise our pilots' "kill ratios" by about 30 percent. Revolutionary future applications will include on-demand presentation of high resolution imagery and mapping data to individual soldiers in the field; the ability to call instantly on intelligence databases distributed around the globe; and the potential to sketch positions, observations, and proposed actions on a map display and communicate with widely dispersed units to mount coordinated actions.

DoD must have early access to the latest generation of leading edge display technologies while still in prototype form in order to work out the tactics and strategies for their use. DoD must also have assured access to responsive suppliers who will customize commercially-derived technology to produce displays that operate in both desert and Arctic temperature ranges, are readable in sunlight, have special color filters or sensors that work in a night vision environment, offer extremely high resolutions, and are available in nonstandard sizes. DoD must have affordable access that allows these systems to be fielded in significant numbers.

A recent interagency initiative—the National Flat Panel Display Initiative announced by the Deputy Secretary in April 1994—came out of a DoD-led study of FPDs. The FPD study concluded that to maintain technological superiority in future U.S. military systems, DoD needed early, assured, and affordable access to leading-edge FPD technologies, and is not currently assured such access. Currently, a handful of foreign firms dominate the FPD industry with over 90 percent of global production. The world's dominant supplier of FPDs and technology leader has been unwilling to work with DoD on its specialized requirements, and early and assured access to leading edge technology from other foreign producers remains speculative at best. Domestic producers have less than 3 percent of the market, and have virtually no capabilities for volume production of mainstream FPD products. Current U.S. investments in display production facilities focus on specialized or low-end products that are inadequate to meet key DoD needs or are insufficient in scale and scope to offer a reasonable assurance that a leading edge technological capability will be available to DoD in the future. While DoD's investments in FPD R&D to date have contributed to development of a solid domestic technology base, DoD does not yet have the required early, assured, and affordable access to FPDs.

Defense demand ultimately will be only a minor factor in the market and technology will fundamentally be driven by commercial demands. Hence, to ensure that DoD realizes economies of scale while remaining abreast of technological advances, the study recommended that DoD adopt a dual use strategy to meets its needs in this area, exploiting commercial R&D, economies of scale, and production capabilities, and that other agencies commit to a variety of activities to support these objectives. Under the National Flat Panel Display Initiative, DoD is increasing its investments in manufacturing technologies to help reduce the uncertainty and costs facing potential entrants into high-volume production.[3] (Firms receiving funding must demonstrate a serious and credible commitment to developing production expertise by investing in current generation production capability, and a commitment to support DoD display requirements.) DoD plans to spend a total of about $580 million on the National Flat Panel Display Initiative over the next five years, with industry providing a similar amount.

Microelectromechanical Systems

Microelectromechanical systems (MEMS) technology merges information processing and communication with sensing and actuation. This combination will increase the capability and affordability in a broad array of military and commercial applications: On-chip inertial measurement devices can provide advanced capabilities in both weapons systems (e.g., inertial guidance for ordinance, arming-safeing-fuzing with self-test & calibration) and automotive systems (e.g., air-bag deployment, side-impact, automatic braking); thrust vectoring for jet engines and rockets; fluid metering and regulation for field-portable analytical instruments, higher efficiency engines/fuel systems, printers, and biomedical equipment; precision electromechanical subsystems for mass data storage and optomechanical systems (aligners, switches, scanners and displays) ranging from fly-by-light systems and hand-held information systems to telecommunications networks and low-cost fiber optic connectors; and revolutionary advances in structural materials (e.g., support elements that react to changing loads and extreme operating conditions and which could be very useful in aircraft or structures subjected to extreme earthquakes or explosive stresses).

DoD investments (over $30 million in 1995) are aimed at realizing advanced MEMS devices and processes, developing and fielding MEMS systems, and catalyzing a MEMS technology infrastructure for design, fabrication, and evaluation of MEMS devices and systems. These objectives are being pursued in specific dual-use product and market areas and their associated manufacturing bases (MEMS is a 1995 TRP focus area). Early results have already led to dozens of MEMS-based inertial measurement products, driven by the automotive market but directly useful to the U.S. military. The use of a single, common semiconductor manufacturing process and the use of shared prototype production services have accelerated the rate of innovation and commercialization by making affordable MEMS designs and fabrication processes

[3]DoD will continue its core research program in display technologies and equipment and materials infrastructure. The Initiative also seeks to promote insertion of flat panels in DoD systems.

widely available. DoD investments will ensure the development of a robust, common MEMS technology base driven by high-volume commercial products that is also responsive to and affordable for the low-volume, specialized needs of military systems.

Advanced Composites for Aircraft

During the past 30 years, dramatic progress has been made in the development of new structural materials. Superior materials open up new engineering possibilities for the designer by offering the opportunity for more compact designs, greater weight efficiency, reduced operating cost, and longer service life in a wide variety of military systems and commercial products. In addition, these advanced materials can lead to entirely new military and commercial applications that would not be feasible with conventional materials.

Maintaining technology leadership in the use of advanced materials is vital to the U.S. military capabilities. Traditionally, such materials have been developed and used in military applications requiring very high performance characteristics, such as airplanes and spacecraft. The reduction in DoD demand for advanced materials due to decreasing weapons system procurement, without some compensating growth in civilian demand, increases concerns regarding the health of the U.S. advanced materials industry.

To respond to this concern, DoD is working to broaden the military use of advanced materials and to implement programs to expand the overall use of these technologies, including greater commercial use. DoD will focus its efforts on increasing the affordability of utilizing composite materials in both traditional and non-traditional applications. This can be accomplished by supporting associated technologies such as product-oriented computation and modeling and affordable processing and manufacturing, and by promoting insertion of advanced materials into components or systems. The approach is to develop part designs based on low cost manufacturing processes to improve confidence in both the cost of the components and the repeatability of the process. DoD will focus on areas of pervasive impact in partnership with firms that have a demonstrated commitment to commercializing these technologies. This program will coordinate and contribute to the Advanced Short Takeoff and Vertical Landing (ASTOVL) and Joint Advanced Strike Technology (JAST) programs to leverage results and avoid duplication of efforts. DoD funding for these efforts for FY 95-96 will be about $147 million. (Advanced composites is a 1995 TRP focus area).

Integrated High Performance Turbine Engine Technology (IHPTET)

Extending the range and payload of military aircraft, and reducing their operating costs are the goals of the Integrated High Performance Turbine Engine Technology Program (IHPTET). The IHPTET Program aims to double propulsion system capability for aircraft and cruise missiles. This program seeks to accomplish these goals by increasing the thrust/weight ratio while reducing the fuel consumption of turbine engines, and improving durability and maintainability. Seven engine manufacturers are participating in the program on a cost sharing basis.

The advances of this program will also provide benefits for civil aircraft. Virtually all large civil transport engines evolved from military programs, and in many cases, were direct derivatives of engines developed for the military. For example, the CFM56 engine, used in most Boeing 737 aircraft, is based on the core of the F101 engine used in the B-1. Six of the seven manufacturers participating in the IHPTET Program are active in both commercial and military markets facilitating the migration of technologies developed for the military into commercial products, providing a broad base of production capability for supporting future military needs.

Rotorcraft Technology

As military demand for rotorcraft declines, commercial sales become increasingly important for sustaining a robust and dynamic technology base. DoD proposes to bolster the industrial base for rotorcraft by establishing the National Rotorcraft Technology Center (NRTC). Modeled after the National Automotive Center which links the Big Three auto manufacturers and their suppliers with the Army and academia, the NRTC will facilitate collaborative rotorcraft R&D between government, industry and academe. The focus of this partnership will be the development of rotorcraft design, engineering, and manufacturing technologies. Industry will take a proactive role in defining the tasks to be undertaken. Among the areas being examined are: passenger and environmental acceptance, product and process development, aviation infrastructure, and civil and military standards. Project costs of $10-12 million per year will be matched by industry. This investment will leverage the approximately $100 million per year of ongoing Army, Navy, NASA and FAA rotorcraft science and technology programs.

High Density Data Storage Systems

Major improvements in military intelligence and analysis capabilities depend on the ability to store and retrieve rapidly vast amounts of digital data. High density data storage systems provide the means to satisfy these storage and retrieval requirements cost-effectively. Advances in high density data storage in magnetic, optical tape, and optical storage media, hardware, and software will enable the military to develop advanced information systems that make map images, targeting and position overlays, intelligence data, and video enhanced data bases available real-time during military operations.

Commercial demand will drive high density data storage markets. In order to stimulate the commercial capabilities needed to meet military requirements, DoD will support efforts to increase the storage capacity of magnetic and optical media with standard interfaces. As these technologies are developed for use in portable computers and information servers, they may be exploited by the U.S. military in future portable military information systems. These efforts will be led by $16 million of TRP funding in FY '95 and '96.

Wireless Communications

Wireless communications between mobile computer systems, in conjunction with traditional fixed communications networks, represent an extremely important capability for military command, control, and intelligence. Military benefits include smaller and more capable mobile field radios, higher bandwidth wireless communications, and higher speed fiber optic networks. These technologies will also support the development of revolutionary capabilities in manufacturing, health care, education, and business.

DoD is sponsoring research to develop a "whole" system context for mobile computing. The goal of this effort is to develop mobile computing and communications systems that will satisfy both military and commercial requirements at different capability levels, enabling low-cost, continually improving systems solutions to military C3I challenges. Efforts are focused on innovative methods for using spectrum efficiently and for supporting distributed sensor networks using wireless communications techniques. DoD support for these activities will be $33.5 million in 1995 and $40.5 million in 1996. (Wireless communications is a 1995 TRP focus area.)

Second Pillar: "Dual Produce;" Integration of Military into Commercial Production

The idea of "dual produce" is complementary to the strategy of making long-term investments in dual use technology critical to the performance of future military systems. In general, combining military with commercial production can lower DoD costs by permitting the sharing of fixed infrastructure costs and by taking advantage of cost-conscious, market-driven commercial practices. "Dual produce" opportunities may be realized even for defense-unique systems. For example, although producing finished tanks may require a separate facility, it may be possible to combine production of tank engines with commercial engines. (Formulation and implementation of acquisition reforms that reduce paperwork, auditing, and unique specifications for inspection, packaging and testing will be critical.) In cases where Defense must acquire products tailored to military requirements, development and deployment of flexible manufacturing capabilities may be needed to permit those military products to be produced efficiently at low volumes in facilities that also manufacture higher-volume commercial products. Hence, the dual produce concept will be pursued in two ways:

(1) Transitioning defense-sponsored technologies to commercial applications
(2) Developing and deploying new manufacturing technologies.

(1) Transitioning defense-sponsored technologies to commercial applications. Use of defense-sponsored technologies and products by commercial industry will enable DoD to lower product costs by taking advantage of mass production economies of scale as well as economies of scope (repetition of process across a family of lower-volume products). If Defense-sponsored technologies are adopted by commercial firms and improved, then military systems will also benefit. Finally, by strengthening the parts of the economic infrastructure on which DoD depends, successful commercialization of defense technologies can increase the likelihood that these technologies remain accessible and affordable for military use.

Commercial Application of a Defense Technology Lowers DoD Costs

During Desert Storm, the Army needed a large number of global positioning system (GPS) receivers to tell soldiers precisely where they were located on the battlefield. The milspec receiver cost $34,000, weighed 17 pounds, and would have taken 18 months to procure.

GPS, Continued

The Army was able to immediately acquire commercial GPS receivers that weighed three pounds and cost $1300. (Today, the military receiver, procured to commercial standards, costs about $1200; the price of the commercial counterpart has fallen to about $800.)

To be successful in its effort to transition technology to commercial applications, DoD must often do more than simply make technologies available. Efforts may be needed to help industry develop and demonstrate the feasibility of dual use products based on the technology, to accelerate industrial development of product standards and design formats in emerging new markets, to fund development of low-cost production technology, and to encourage initial market development by stimulating early government demand.

Setting the Stage for Commercial Application of MIMIC Technology

The far reaching impact of the dual use strategy can be seen in DoD's development of microwave monolithic integrated circuit (MIMIC) technology for use in military systems. MIMICs are solid state devices that receive, transmit, and process millimeter wave and microwave signals—they are the eyes and ears of a wide range of military systems, such as "smart" munitions.

Assessment by the DoD showed that incorporation of MIMICs into military systems was significantly hampered by their high cost, which in turn was a function of the low volume of the military market. For example, phased array radar chosen by the Air Force for the F-22 advanced tactical fighter employs 2,000 MIMIC-based transmit-receive modules, each of which originally cost $8,000. That added up to a $16 million price tag for the radar on every F-22.

The Air Force and ARPA worked with their contractors to reduce the price to about $2,000. To drive prices down further, they are now supporting efforts to apply the technology in such areas as collision avoidance systems for automobiles and trucks, satellite communications, and air traffic control signal processing. For example, radar for trucks based on MIMIC technology is expected to be commercially available by the beginning of 1995. The system will alert drivers when a vehicle might be in their blind spots or when they are following too closely for their speed. It is expected that accident rates could fall as much as 50% for trucks equipped with the system. Economies of scale in MIMIC production could reduce their cost sufficiently for application in automobiles.

Delco has sold about 2,000 of its $1,895 FOREWARN™ radar systems for school buses in the past year to test out the concept. A special joint venture between Hughes/Delco and HE Microwave produces both the school bus module and a fighter aircraft version on the same production line, with a changeover time of less than two hours. By using readily

MIMIC Technology, Continued

available commercial process technology and designing for manufacturability and easy testing, HE Microwave has achieved further reductions in the cost of both the civilian and military versions, and they are aiming for a production system that can make modules of various dimensions and performance characteristics without interruption.

DoD Develops Industry Standard Data Exchange Format to Aid Large-Scale Application of Multi-Chip Modules

Multi-chip modules (MCMs) are an advanced form of semiconductor packaging which integrate multiple bare integrated circuit die with a high-density multi-layer substrate. This packaging scheme is typically much smaller than a printed circuit board and therefore can reduce space requirements significantly. In addition, the closer spacing of ICs can increase processing speeds by 20 to 50 percent.

In order to design MCMs, engineers need to understand the operations of individual die in detail. However, producers have been reluctant to release such information due to concerns about divulging proprietary circuit details. The design task has been further complicated by the different data formats employed by different producers. Overall, the difficulty in designing MCMs has been an obstacle to their widespread deployment.

Developing an information exchange format to overcome the design bottleneck was too difficult and costly for any single firm to want to undertake. DoD made the decision to support the development by the entire industry of a Die Information Exchange (DIE) Format. The DIE Format permits semiconductor suppliers to specify certain electrical characteristics of their dies without divulging proprietary circuit details. Version 1.0 of the DIE Format, released in April 1994, provides administrative, material, geometric, electrical, thermal, supply, process, and logic simulation model data. The DIE Format is expected to be formally approved as an official industry standard by the end of the year.

The development of this "industry-owned" standard for MCMs provides a clear benefit for Defense. Such cross-cutting investments in infrastructure and standards are key to the success of Defense's dual use strategy.

The Technology Reinvestment Project (TRP), described in Pillar 1, is a key element of DoD's efforts to transition Defense-sponsored technologies into commercial applications. The TRP, a multi-agency effort managed by the Advanced Research Projects Agency, is aimed at creating technology development partnerships to foster dual use products and processes that meet both military and commercial needs. Such efforts often involve the adaptation of a defense-developed technology for the commercial market, thus lowering the cost and increasing the availability of the technology to DoD. TRP encourages defense prime contractors and suppliers to pursue dual use opportunities in partnership with commercial enterprises as a means to establish a broader production base for technologies vital to the U.S. military. (This partnering approach also provides a practical way of encouraging commercial companies to focus on the defense market.) TRP awards are based purely on technical merit.

Cost of Defense Technology Reduced Through Commercial Application

The Precision Laser Machining (PLM) Consortium, supported by TRP, brings together defense and commercial firms to put the speed and precision of military-developed laser technology to work in machine shops and manufacturing plants across the U.S. The use of laser-machining for airframe construction will reduce wind drag and increase fuel efficiency by five to nine percent. High volume production of lasers for commercial use will lead to lower laser costs for all manufacturing uses, including those used for production of military equipment.

The PLM Consortium is developing a new class of high-speed, high-precision laser machine tools using diode-array pumped solid state laser technology. For a broad range of defense and commercial products these new lasers will be able to cut and drill holes faster, deeper, and more accurately; cut and shape a wider variety of composite materials; weld aluminum and other materials that dissipate heat quickly; and allow for new applications by reducing the size of the heat-affected zone. For instance, more precise drilling of cooling channels in aircraft engines turbine blades can double the life of military engines.

The vertically and horizontally integrated structure of the PLM Consortium ensures that products will be responsive to user needs and will be factory-compatible. The Consortium plans to have new, cost-competitive laser tools ready for commercial use by 1996.

In its first call for proposals, TRP received 2,850 proposals requesting $8.5 billion in federal funds—more than 17 times the amount available. The $605 million ultimately awarded was matched by $845 million committed by the winning teams; i.e., each federal dollar leveraged $1.40 in non-federal investment.[4] This enthusiastic response continued in the second round competition, which awarded $203 million to 39 out of 237 proposals.

[4]The extent of industry willingness to share in the costs of a project is one of the most important measures of the project's potential commercial viability. This condition can be relaxed to the extent that DoD's has compelling and unique technological requirements, or DoD is investing in very long-term or high-risk areas.

The TRP augments efforts by the Services and defense agencies to transition their technology developments. To this end, DoD Laboratories are focusing investments on identifying opportunities for technology transfer. The labs have been delegated authority to execute cooperative agreements that provide for more flexibility in funded partnership arrangements with private industry.

(2) Developing and deploying new manufacturing technologies. Agile and lean manufacturing practices are being developed to permit low-volume production of military and commercial products at competitive prices. The capacity to form "virtual enterprises" —groups of vertically and/or horizontally integrated companies that come together via computer networks to pursue a specific market opportunity—will foster defense-related work at small- and medium-sized suppliers. Specific areas of investment in manufacturing technology include:

—Information services that facilitate distributed manufacturing and electronic commerce
—Data exchange interfaces to facilitate product data transfer
—Affordable and highly flexible machine tools and processing equipment
—Software tools to reduce machine set-up times and tool inventories
—Manufacturing cost modeling and analysis tools
—Manufacturing process modeling and adaptive control
—Automated process planning and factory simulation tools
—Metrics and benchmarks for pre-qualifying producers
—Pilot projects and technology demonstrations

Manufacturing Technology Project Increases Throughput, Improves Quality, and Reduces Costs

DoD sponsored the development of an adaptive welding system that controls weld parameters to maintain full penetration and consistent weld buildup, avoiding the variations experienced in manual welding operations. The system also provided real-time, filmless x-ray inspection of completed welds. The benefits have proven to be exceptional. For example, in one application—joining guide vanes to hubs to form a jet engine fan exit case—direct labor was reduced by a factor of seven, frequency of rework dropped from 80% to 8%, inspection setup time was reduced by 30%, and inventory costs were reduced by almost $1 million per year.

DoD's Manufacturing Technology Program, now part of the Manufacturing Science and Technology (MS&T) Program, sponsored the original research that led to the vision of agile manufacturing, one of the more prominent advanced manufacturing concepts. The objective is to produce items in small volumes as economically as in large scale production. Given appropriate dual use designs, this flexibility would allow the custom products that DoD needs to be economically produced in commercial production facilities, regardless of quantity. A renewed focus on flexible manufacturing and enterprise integration will be key elements of future MS&T programs.

An Investment in Production Efficiency Pays for Itself and Improves U.S. Competitiveness in the Precision Optics Industry

$11 million of Army MANTECH and OSD funding to the Center for Optics Manufacturing, leveraged by $16 million from the domestic optics industry, led to the development of the Opticam, a precision lens grinding tool. To date, the Army has saved $14 million on purchases of lenses used in the aiming system for JAVELIN, a portable anti-tank weapon. Meanwhile, machines being purchased by commercial producers (a majority of which are small businesses) has led to a 20-50% manufacturing savings for lenses used in cameras, copiers, and medical and scientific equipment.

Another initiative, the Dual Use Technology Applications Program (DUTAP) is funding production-related aspects of dual use technologies that complement DoD's R&D programs. Title III of the Defense Production Act will be one funding source DoD will use to establish dual use capabilities.

DoD Establishes Manufacturing Test Bed

DUTAP is bringing together a consortium of U.S. firms to develop manufacturing technologies for advanced active-matrix liquid crystal displays. A manufacturing test bed, distributed over four facilities located across the U.S., will help reduce the technical and manufacturing uncertainties which have been obstacles to the establishment of display manufacturing capabilities meeting both commercial and military needs. The test bed will be used to develop and evaluate manufacturing processes for thin film transistor substrates, cell assembly and liquid crystal filling processes, and display packaging and assembly operations.

Third Pillar: Insertion of Commercial Capabilities Into Military Systems

The third pillar of the dual use policy is to insert the best commercial materials, products, components, processes, practices, and technologies into military systems wherever possible. By making use of rugged and reliable, high performance components, technologies, and subsystems developed by commercial industry, the Defense Department will be able to achieve two objectives. First, the use of industry-standard upgrade paths will shorten development times and increase the pace at which improvements are incorporated into new military systems in critical areas. The commercial computer and electronics sectors introduce "next generation" products every three or four years. By contrast, DoD typically takes ten or more years to develop and upgrade new systems, by which time key components and technologies are often no longer leading edge. Second, because commercial components, technologies, materials, and subsystems may offer needed levels of functionality in military systems at greatly reduced costs, their use will generate significant cost savings. The same cost-conscious and market-driven efficiencies that lead to savings in the commercial sector will be realized by DoD.

The insertion pillar recognizes that acquisition reform and dual use technology investments are not, by themselves, sufficient to ensure use of commercial components and capabilities. Program managers and contractors still face up-front costs and risks in adopting commercial products and technologies—for example, the cost of determining that a commercial integrated circuit will withstand the necessary extremes of temperature and humidity, or the cost of engineering a commercial component to fit in an existing military system. DoD must try to offset those costs and risks, and it must do so at a level of organization above that of the individual weapon program so that common costs are shared rather than duplicated.

Also, to achieve the full benefit of commercial capabilities, DoD must strive to have systems "designed for dual use." Military equipment must be designed to use commercial materials, products, components, processes, and technologies to the maximum extent possible.[5] While some DoD systems may be able to make significant use of commercial materials and components, others may not. Nevertheless, these other systems may be able to take advantage of common manufacturing processes.

[5]The trade and export control implications of moving to greater use of commercial components will be addressed by the cognizant offices within DoD and other government agencies.

Designing for dual use encompasses a number of concepts such as commonality and standardization of parts, the use of fewer parts, modularity, flexibility, adaptability, and open architecture. Since about 85 percent of a product's life cycle cost is established during initial systems engineering design, DoD will need to perform early, integrated assessments of the "cradle to grave" life cycle cost, thereby enabling commercial insertion to occur in the most cost effective manner.

> **Commercial Integrated Circuits in Modular Avionics Radar**
>
> The Modular Avionics Radar (MODAR) is a family of low-cost radars based on DoD technology but assembled using commercial parts and practices. Different versions of the equipment, which is designed to be highly modular, are targeted for business and commuter planes, commercial air transports, and military tankers and transport markets.
>
> MODAR designers did not perceive the process of designing for dual use applications as significantly different than designing for just military or commercial applications. However, the cost of parts substantially decreased as a result. For example, the cost of a sample 24-pin programmable logic array was reduced from $37.45 using Defense Source Control Drawings to $17.85 when a standard military drawing and MIL-STD-883 were used. The cost was $15.17 when commercial parts were screened for a military temperature range (-55 to +125 degrees C), $12.50 when a commercial temperature specification (0 to 70 degrees C) was used, and $6.25 when a plastic-packaged commercial part using commercial temperature specifications was used. Overall, the use of commercial ICs rather than milspec parts resulted in an estimated 80% reduction in material costs, and lead times were cut by about one-third.

Designing for dual use will be complex for military systems. In the beginning, pilot programs and demonstrations will be helpful by providing "lessons learned." In general, implementation of the third pillar, inserting commercial items into military systems, will be an evolutionary process. It will require concerted, ongoing efforts in three areas:

(1) Active planning and programs for the insertion of commercial capabilities
(2) Providing program offices with the technical knowledge necessary to identify and assess insertion opportunities
(3) Organizing, identifying, and promoting DoD- and industry-wide opportunities to accelerate insertion in an effective and efficient manner

(1) Active planning and programs for the insertion of commercial capabilities. Designing for dual use will often require trading off performance and cost goals at different stages of a system's life cycle. Hence, continuity of program management is essential. Senior DoD leadership will issue guidance requiring the Services to create commercial insertion plans for ongoing development and upgrade programs. These plans should include projected cost savings and time schedules for their achievement. The basis of these plans should be twofold:

—First, the plans should include commercial insertion objectives, developed by program managers jointly with industry, that lead to program specific action plans. Such objectives might include elimination of source control drawings and procurement of fully functional modules that can be replaced when technology advances rather than repaired using obsolete technology.

—Second, they should require that explicit cost tradeoffs be developed to justify program management decisions. For instance, on new or upgraded systems, program managers should be required to assess the cost of incremental changes in performance relative to the need for the additional capability. For existing systems, opportunities should be identified where insertion of a commercial alternative could pay for itself in reduced support costs.

Tier II-plus Program's Innovative Approach to Achieving Commercial-like Practices

The DoD is conducting a joint Advanced Concept Technology Demonstration Program for an Unmanned Airborne Vehicle (UAV) prototype in which cost and time-to-product are the driving forces of the contracting process. Using ARPA's "Other Agreements Authority," the DoD request for bids specified desired system capabilities (based on joint Service users' and operators' input) and a fixed purchase price ($10 million dollars, based on DoD studies), rather than detailed performance and production requirements. This focus on "what DoD wants, not how to do it," created an incentive for contractors to analyze carefully cost vs. performance trade-offs before making bids. Furthermore, the short time frame for prototype delivery and fixed fly-away price encouraged contractors to propose use of commercial, off-the-shelf technologies and to drive out non-value added processes, practice and procedures. Most proposers chose to form partnerships with commercial companies—e.g., business jet airframe manufacturers.

An additional requirement in the DoD request for bids was for contractors to submit an integrated design and production plan. These plans permitted an integrated program view of cost, schedule and performance. Such plans could form the basis for continuity in program management should the program advance into full-scale procurement.

(2) Providing program offices with the technical knowledge necessary to identify and assess insertion opportunities. The "design for dual use" concept requires good data on life cycle costs, reliability, and performance across a span of operational environments. Therefore, DoD will also ensure that program offices have access to knowledge about leading-edge products and technologies in commercial markets, and have both the training and incentives needed to stimulate the qualification of commercial components for use in military systems. DoD will sponsor conferences, formal information exchanges, and electronic information services to enable both program managers and industry to systematically monitor technological developments worldwide in their technological field and related areas. Technical support groups, involving program management staff, original equipment manufacturers, suppliers, and defense labs, will determine whether a commercial technology is "acceptable" in a military system based on the specific cost and performance tradeoffs at the module, component, and product level. The combination of cost and performance tradeoff information and detailed knowledge of commercial opportunities will enable program managers to make informed decisions concerning the risks that they face in adopting such commercial capabilities.

Industry and Defense Develop a Process to Facilitate Insertion

The Single Channel Ground and Airborne Radio System (SINCGARS) Best Commercial Practices effort is a validation demonstration of pilot procedures for using non-military parts for the SINCGARS program. The majority of the program's military contractors have formed working groups with their customers to develop their own implementation plans. Each plan will be evaluated separately by the program manager. Experience derived from this effort will be used to shape other programs in the future.

(3) Organizing, identifying, and promoting DoD- and industry-wide opportunities to accelerate insertion in an effective and efficient manner. Adoption of commercial capabilities and designing for dual use often entail additional up-front investments in characterization, qualification, engineering, and acquisition-related processes. For example, a program may incur the cost of certifying that a commercial integrated circuit will withstand the necessary temperature extremes, or the cost of engineering a commercial component to fit in an existing military system. Because generic applications of components frequently cross individual program and Service boundaries, these investments are most efficiently made jointly by the Services. Without a joint approach, the collective benefits achievable by shifting to commercial capabilities might not be realized. Individual program managers, contractors, or even entire Services might not perceive enough specific benefit in their isolated application to justify such investments, and might be reluctant to allocate programmatic resources to the effort. Therefore, multi-service pilot projects should explore how commercial components can be used in different types of generic military applications and environments. Similarly, DoD should integrate and coordinate with industry-wide efforts in commercial standardization and qualification processes in lieu of each program developing its own unique approach.

Common, shared insertion data will also support the redesign of existing systems. For redesigns where the recurrence of up-front qualification and testing costs might be too costly, shared insertion data may enable cost effective technological improvement.

Making Insertion Happen

Case studies show that commercial integrated circuits (ICs) are being successfully used in many military systems and environments. For example, the Joint Surveillance Target Attack Radar System (JSTARS) program projects that modules using acceptable commercial plastic packaged ICs could be one-third the cost of those using milspec ceramic packaging.

Greater use of commercial (ICs) in military applications is addressed in a project of the Dual Use Technology Applications Program (DUTAP). This project is supporting a broad-based industry task force that has the following objectives:

- Determine to what extent and under what conditions successful use of commercial ICs by DoD has been accomplished to date.
- Identify issues and uncertainties limiting further successful application.
- Recommend experiments and demonstrations to objectively determine what can be done to accelerate the use of commercial ICs.
- Disseminate findings and lessons learned regarding the use of commercial ICs.

DoD Implementation and Policy Direction

DoD will take the following actions to implement the dual use technology strategy:

—Establish a Dual Use Technology and Production Working Group reporting to the Defense Industrial Base Oversight Council (DIBOC)

—In each Military Department, designate a senior executive or flag-level advocate who will be the focal point for dual use implementation
—Establish official DoD guidance to Defense Departments and Agencies for implementation of dual use technology policies
—Conduct assessments, in coordination with other agencies, to guide dual use R&D spending, production integration and technology insertion, and to facilitate coordinated interagency policy making
—Establish pilot and service lead programs to facilitate the insertion of commercial capabilities into military systems and the integration of military with commercial production
—Establish programs that encourage DoD laboratories to work with private industry to improve technology flow

To institutionalize a dual use focus within DoD and to address the need for high level guidance, DoD will establish a Dual Use Technology and Production Working Group reporting to the Defense Industrial Base Oversight Council (DIBOC). The working group will be the focal point for formulating DoD positions on dual use technology, including interagency, intergovernmental, industrial, and international organizations and associations. It will be the primary forum for the Services and the acquisition system to raise dual use technology issues. The working group will review dual use technology programs DoD-wide in order to (1) identify additional opportunities within DoD to pursue dual use technology policy goals; (2) ensure that dual use technology programs and initiatives are integrated and coordinated throughout DoD; and (3) discover opportunities for cross-cutting, high leverage investments. It will recommend policy, identify barriers to implementation, and update dual use strategy documents to improve the overall effectiveness of the dual use effort as it evolves.

The successful achievement of DoD's dual use technology objectives will require the complete involvement and support of the Military Departments. Since acquisition program managers are responsible for the development and acquisition of military equipment, they are in an excellent position to incorporate dual use technology practices into the defense acquisition process. Toward this end, each of the Military Departments will designate a senior executive or flag rank officer to serve as a Dual Use Technology Advocate. (The Commercial Item Advocate required by Section 8303 of the Federal Acquisition and Streamlining Act of 1994 could potentially serve in this role.) The Advocate will serve as the Military Department's focal point on dual use technology matters and be responsible for instituting policies, programs, and management controls that ensure the objectives of this plan are achieved. Advocates will have the lead, in coordination with the Under Secretary of Defense for Acquisition and Technology, in incorporating the dual use technology strategy into their Service's efforts in acquisition reform, maintenance of the industrial base, science and technology investments, and weapon systems development.

To foster the development of dual use technologies for future military systems (pillar1), DoD will conduct assessments to determine whether industry is well positioned to meet future military requirements. DoD has initially identified seven areas for assessment: semiconductor electronic devices, advanced materials, transport aviation, microelectro-mechanical systems, advanced computing, high performance networks, and satellite communications. Assessments will examine both component and systems-level suppliers to the U.S. military as well as those subtier industries that maintain and develop critical supporting infrastructure of material and production process technologies. The working group will identify additional areas for assessment. These assessments, performed in coordination with other agencies, will guide DoD's investments in dual use R&D, production integration, and technology insertion, and will be used as a basis for interagency policy formulation.

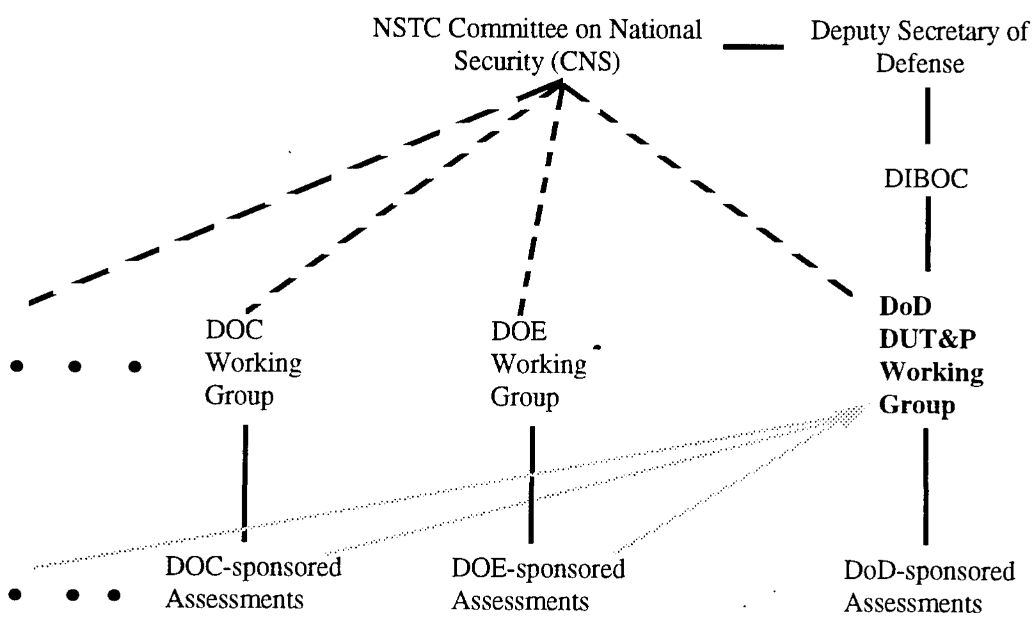
In the past, defense acquisition pilot programs and service lead programs have been used successfully to test new acquisition methods. Each Service will select at least three acquisition programs to be used as pilot or service lead programs for integration of military and commercial production (pillar 2) and insertion of commercial capabilities into military systems (pillar 3). Briefings on the status of these programs will be provided quarterly to the working group to facilitate sharing of "lessons learned" among program managers. The lessons learned will also form the basis of training course materials for use by government and industry personnel. Additionally, the working group will organize annual conferences on the dual use technology program, to include a review of these programs as well as an assessment of the overall progress toward implementation of the dual use strategy.

DoD laboratories will continue to work with private industry to improve technology flow. Based on the results of a recently established defense-wide working group, DoD will issue policies to promote the use of commercial technologies in DoD laboratories. In addition, the Federal Laboratory Diversification Program will promote technology transfer from defense laboratories to private industry by giving industry review panels the opportunity to evaluate the commercial prospects of defense-developed technology.

<u>Dual Use Efforts Across the U.S. Government</u>

Making greater use of commercial technologies in defense systems and transitioning defense-sponsored technologies will mean that other government policy concerns—export controls, restrictions on foreign investments in domestic industries, the rules regulating national subsidies in international trade, the industrial organization of international industries supplying products and technologies used by DoD and its domestic suppliers, the international regime protecting intellectual property—will be ever more tightly linked to dual use technology policy and strategy. Hence, DoD actions will be coordinated, with agencies such as Commerce, Energy, State, Treasury and others, including the U.S. Trade Representative, as needed. Likewise, the success of DoD investments in R&D on dual use technologies will be fostered by increased cooperation with other federal government agencies and programs that are working with industry to develop and deploy leading-edge technologies (e.g., the National Information Infrastructure).

The National Science and Technology Council's Committee on National Security (CNS) will provide high-level coordination of these efforts. The Deputy Secretary of Defense, who both participates in CNS and chairs the Defense Industrial Base Oversight Council (DIBOC), provides a linkage between DoD and interagency efforts as represented in the diagram below. An overview of Department of Energy (DOE) and Department of Commerce programs follows.



Department of Energy Dual Use Programs

The Department of Energy's Defense Programs (DOE/DP) continuing partnership with U.S. industry is providing industrial know-how and commercial best practices that enhance the DOE/DP's weapons-related technology base. The need to maintain the enduring nuclear weapons stockpile as a safe, reliable deterrent at significantly reduced cost requires that DOE expand its use of commercial products meeting extremely high quality and reliability requirements.

To accomplish this, DOE/DP must make support for dual use technologies, processes, and products a priority. Through its Technology Transfer Initiative and cooperative ventures through the weapons program, DOE has undertaken several key dual use initiatives. The Semiconductor Equipment Technology Development Program at Sandia National Labs aims to support the development of leading edge domestic capabilities in critical equipment technologies for wafer processing, equipment testing, contamination-free manufacturing, advanced high-density packaging, and improved health and safety. The agile manufacturing program establishes partnerships with industry to develop integrated tools for product, process and enterprise design and for intelligent knowledge-based control. These technologies are aimed at supporting the development of models and processes for cost-effective production of small-volume, defense-customized products. High Performance Computing Initiative seeks to leverage strong commercial interest in simulation and design to support DOE's continuing mission for certifying the safety, security, and reliability of the nation's nuclear stockpile in the absence of nuclear testing. Finally, the Aircraft Engines Advanced Materials Program employs 12 cooperative research and development agreements with industry to develop technologies that support weapons system development.

Department of Commerce Support for Dual Use Technology

The Department of Commerce is tasked with promoting trade, civilian technology development and deployment, and long-term economic growth. Commerce's promotion of industrial competitiveness complements DoD's defense-oriented dual use strategy.

Commerce's civilian technology efforts in Technology Administration are aimed at enhancing the overall health of the nation's industrial base. The Advanced Technology

Program at the National Institute of Standards and Technology provides matching funds to encourage U.S. business to conduct research on high-risk technologies with broad commercial applicability. The Manufacturing Extension Partnership works to deploy technologies to the small and medium sized manufacturers that are the foundation for the type of flexible and adaptive industrial base upon which DoD will increasingly depend.

The Bureau of Export Administration (BXA), as the government's licensing agency for dual use commodities and technical data, and enforcer of the Export Administration Act, leads the government's efforts to adapt U.S. strategic trade policies and dual use export controls to a rapidly changing global economic and national security environment. As a complement to licensing and enforcement, BXA conducts in-depth industry assessments of technologies identified by DoD as the most critical in the developing of future weapons systems. In 1994, BXA completed technology and industry assessments of advanced ceramics, advanced composites, artificial intelligence, optoelectonics, and superconductivity. BXA is currently supporting the DoD-sponsored investment assessments described in the previous section.