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# DoD Space Based Requirements: Increasing DoD Access to Space

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**DoD SPACE BASED REQUIREMENTS:  
INCREASING DoD ACCESS TO SPACE**

**ABSTRACT**

This paper concerns itself with an examination of DoD's need to expand space based capabilities to support military operations while focusing on the current launch environment as the greatest limiting factor to achieving expanded exploitation of space for DoD requirements.

There is a discussion of existing launch systems, facilities and capacity as well as current and experimental efforts in both payload and launch vehicle technology. A description of commercial practices regarding payload and launch vehicle utilization is contrasted with DoD's approach and a projection of demand for launch access is compared against launch availability.

An examination of certain technical, procedural and acquisition alternatives for improving launch capacity is presented concluding with selected low cost recommendations for achieving the objective of increasing the ability to access space.

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**DoD SPACE BASED REQUIREMENTS:**

**INCREASING DoD ACCESS TO SPACE**

**THE DoD MUST INCREASE SPACE BASED CAPABILITIES.**

**Current Capacity is Insufficient to Support DoD Needs.**

Despite aggressive plans for the exploitation of space for military purposes, the potential of space to provide secure communications, tactical targeting, intelligence, positioning, weather and other support functions remains virtually untapped. While there have been major successes in certain areas such as geopositioning, the experience of Desert Shield/Storm has demonstrated that far more capability will be needed to effectively support contingency operations and global reach.

While the Air Force has concentrated on providing satellite support for high priority command and control communications, intelligence and other direct combat operations, the area of combat service support has not been adequately addressed by any of the services, either in planning or the budget process.

**Contingency Operations Require Global Capability.** Experience has shown that there is insufficient capacity for Joint Command and Control requirements during combat operations which forces combat service support requirements off the network. As an example, during Desert Shield/Storm Theater through Division level medical communications needs were satisfied by Navy commercial contracts despite being part of the Army's approved military network. Other requirements for satellite processing beyond basic communications were not satisfied, reducing the effectiveness and reactive

capability of ground forces.

It was fortunate that there were commercial satellite circuits available to serve DoD needs in that area of the globe. Despite current agreements with commercial communication providers, increasing demand and treaty constraints may limit access so that it cannot be assumed that commercial communication services will always be available to enhance military capability.

A summation of an Army perspective of current space based support can be found in a 23 June 1992 draft version of ARMY SPACE INITIATIVES<sup>1</sup> ;

Army's role in space and its effective use of space assets have yet to be fully recognized by Army decision makers ...The leadership is becoming aware that there is an increased requirement for space prompted by the need for information over a larger battlefield with fewer units, changes in joint operations doctrine that result in range extension needs from our communicators, and a new mode of split base - sanctuary operations.

Many of the space assets used by Army forces have been placed there by other organizations for indications and warning rather than for tactical purposes and thus have not been optimized for the timely satisfaction of Army requirements...**Effective use of space must be better recognized as a potent force multiplier**

The Army is not alone in its recognition of the need for increased and somewhat specialized satellite capabilities. The Navy has contracted with Hughes Aircraft for a network capability and left design and launch issues to be resolved by the contractor. The Navy protected itself from launch failures by contracting for an operational network rather than a series of satellites and

launches controlled by the Air Force with no guarantee of success.<sup>2</sup>

The DoD Must Establish an Effective Process to Meet Requirements. In this time of reduced resources and major changes in doctrine, the services cannot afford to continue the current approach to requirements development and prioritization. So long as the lead service provides the funding for these projects, it is only to be expected that other services will be expected to "piggyback" or accommodate their specialized needs to the excess capacity rather than have their requirements be a primary concern.

Even consolidating services' needs into a joint requirement often results in elimination of high priority service specific capability due to payload design constraints or concentration on satisfaction of joint command and control capacity. The continuing efforts of the Air Force to terminate the MILSTAR program serves to confirm the lack of incentive for a lead service to satisfy other service requirements. With budget levels being reduced even further, pressure on joint program funding can only continue.

The DoD must Establish a Routine, Efficient Launch Process. In December, 1992 NASA launched the last military oriented shuttle mission. Current plans for DoD launch requirements are limited to use of Expendable Launch Vehicles (ELV) as a more reliable and less costly launch system. Other than research efforts, DoD payloads are being designed for existing ELV capacity and are too large for the alternative launch vehicles now in testing.

Assuming continued funding and despite progress in the

development of cheaper, more efficient satellites, the limiting factor in a rapid increase of space based operations is the extreme limitation of launch facilities. Not only are there only two sites able to launch satellites or payloads over 600 lbs to low earth orbit (LEO) or geostationary orbits, these facilities are technically outdated, functionally limited and require major refurbishment between launches.

Due to limited launch facilities, launch availability has already been scheduled for both DoD, civil government and commercial users into 1995 and beyond.<sup>3</sup> While government requirements have priority, the primary limiting factor is launch pad availability. Although there have been significant advances in the development of plane launched vehicles and other launch alternatives, these approaches are limited to small payloads and are still being refined. Any improvement in launch availability must address current operations and how they may be improved.

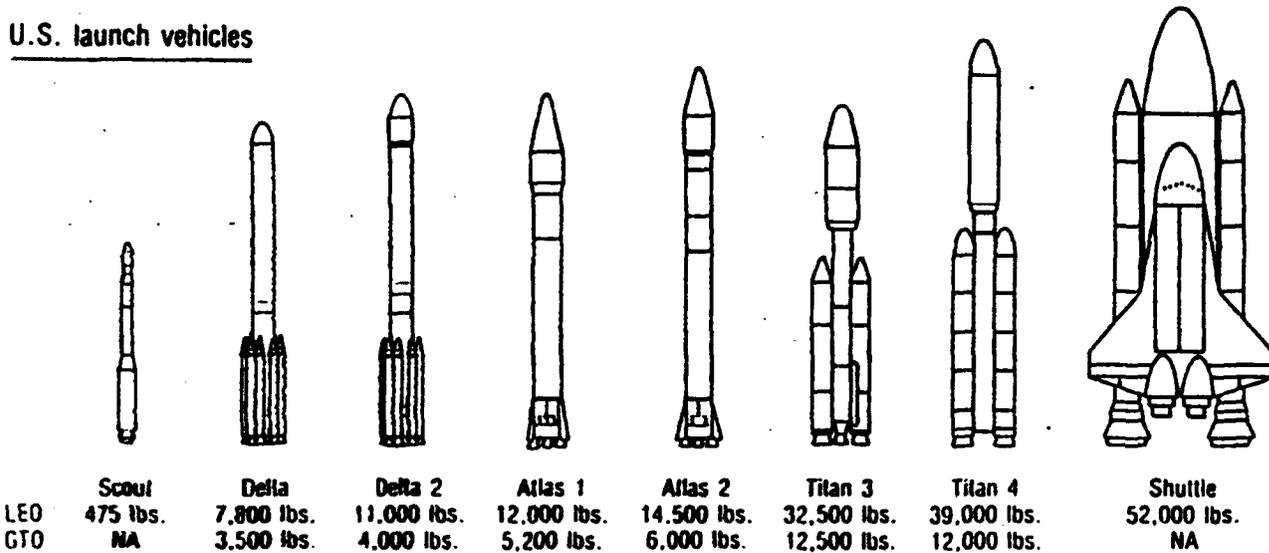
The DoD must provide incentives for improving launch capability either through contractual means or through changes in requirements control, design approach and operational procedures.

#### THE COMMERCIAL ENVIRONMENT

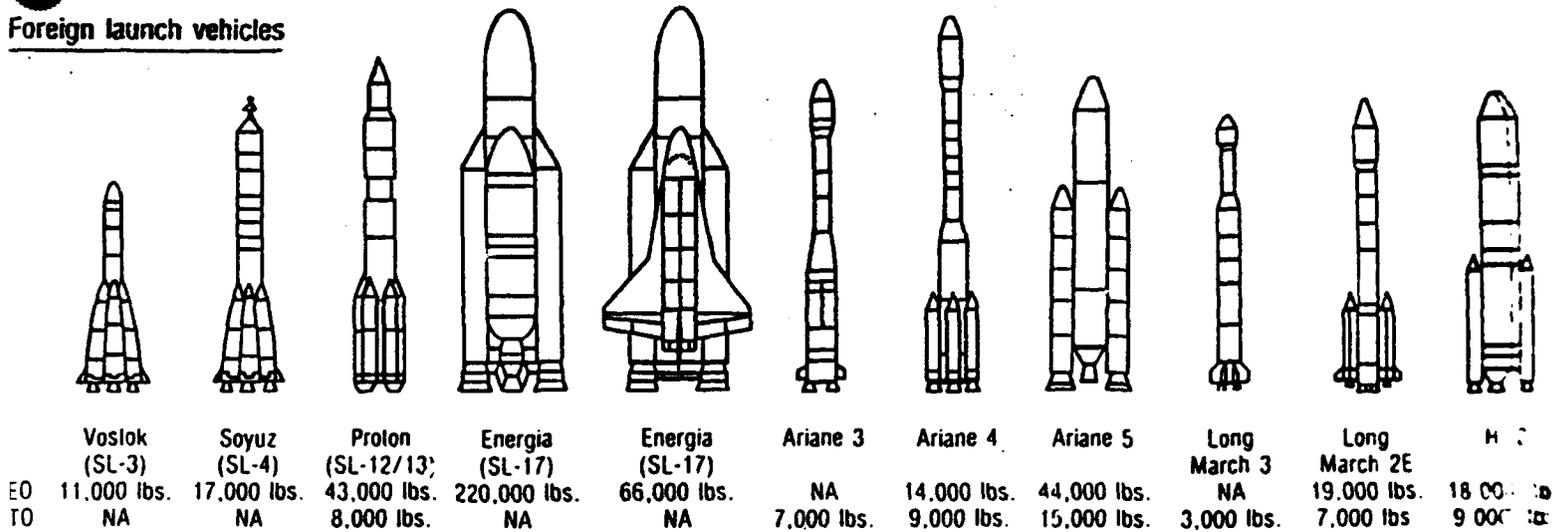
The Commercial Space Launch Industry. Until the early 1970s, there was no commercial demand for launch services. When private industry began to require these services, they were obtained through NASA which used one of four ELV alternatives depending upon the size of the payload.

Figure 1 Launch Vehicles

U.S. launch vehicles



Foreign launch vehicles



Y: GTO = Geostationary Transfer Orbit; LEO = Low Earth Orbit  
 SOURCE: Office of Technology Assessment, 1990.

From that time until today, each size ELV is manufactured by a different corporation. The largest is Titan, built by Martin Marietta; next is Atlas, built by General Dynamics; Delta is built by McDonnell Douglas; and Scout, primarily a suborbital ELV which can be used by small payloads to reach polar orbit from the west coast, is built by LTV Aerospace. While there are more than one version of these ELVs, none overlaps with another type resulting in a monopoly based upon payload weight. See Figure 1 for a comparison of U.S. launch vehicles and foreign launch vehicles and their payload weights.

By the early 1980s, U.S. government policy directed the sole use of the shuttle as a launch vehicle. The Air Force was successful in maintaining contracts for other vehicles as a backup to the shuttle and the manufacturers pressured both the Reagan administration and Congress to permit commercial sales of their ELVs. In 1983, the administration published policy for the conduct of commercial launch services and designated the Department of Transportation as the responsible agency. The Commercial Space Launch Act of 1984 codified this policy and further defined DOT's responsibilities.<sup>4</sup>

The necessity for alternative launch vehicles was tragically demonstrated in January, 1986 by the loss of the shuttle Challenger. In August, 1986, following the administration's adoption of a mixed fleet approach to launch vehicles which utilized both ELVs and the shuttle, President Reagan issued a directive limiting NASA to providing shuttle services to only those

missions which required unique shuttle capability or which had security considerations.<sup>5</sup> This served to protect the fledgling commercial launch industry despite charges that NASA had unfair competitive advantage due to government subsidies.

The launch industry is still limited by the lack of launch facilities. There are only four facilities in the U.S., two of which can support orbital launches and all of which are owned by NASA or DoD. NASA provides these facilities at a cost reimbursement basis but commercial access must compete with government requirements which continue to have priority. This limitation coupled with the complexity of the assembly and launch process establishes the number of possible launches per year.

The highest number of orbital launches to date occurred in 1990 when 17 of 18 attempts were successful. Of that number, 9 were military, 1 was civilian government and 7 were commercial payloads.

The difficulty in developing and scheduling space launches is further complicated by the practice of the separate manufacturing of payload and launch vehicles which requires significant amounts of custom integration before launch. Although there is excess capacity in the ELV industry, fabrication is often extended to match either payload schedules or, more frequently, launch pad availability to avoid potential damage to the vehicle or payload.

The Launch Service Market. Private communications satellites have created the greatest non-governmental demand for commercial ELV launch services to date. Technology improvements will allow

further expansion of the market by permitting cost effective, reliable communications through satellites in other than a geostationary orbit.

Government policy requiring use of commercial launch services by civil agencies has kept governmental demand at 69% of the total market.<sup>6</sup> Both the FY91 and FY92 appropriations acts required NASA to use commercial launch services for every requirement other than manned flights, continuing the demand. While DoD has some flexibility due to national security concerns, administration policy continues to stress use of commercial launch services.

Total revenues, including sub-orbital flights, for 1991 were \$380m, down from 1990's \$570m. Projections for 1992 are estimated at \$500m.<sup>7</sup> The projected demand for DOT licensed orbital launch services is from 20 to 35 flights per year between 1991 and 2000. At \$45m to \$200m per launch, depending on payload size, revenues could exceed \$2b annually for orbital flights alone.<sup>8</sup> These projections may not have high reliability due to the rapid changes in technology and the potential for replacement of both mission and delivery systems by more cost effective alternatives.

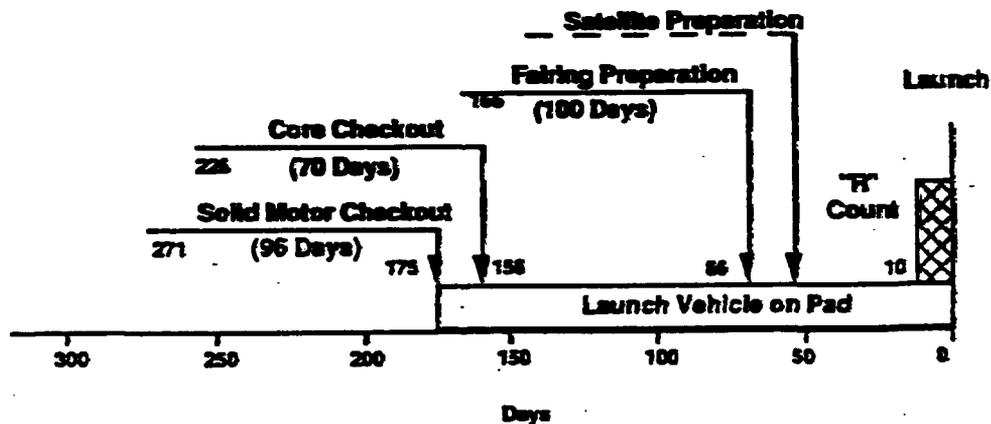
#### THE OPERATIONAL ENVIRONMENT

Current Launch Facilities and Operations As stated earlier, there are two facilities which support orbital launches: the Eastern Launch Site, Cape Canaveral Space Center, and the Western Launch Site, Vandenberg Air Force Base. The Eastern Launch Site has two Delta pads, two Atlas/Centaur pads and two Titan IV pads. The Western Launch Site has one Delta pad, one Titan IV pad and one

Scout pad. Additionally, there is a second Titan IV pad under construction. Facilities for the Space Shuttle are not included.

Current operations can require over six months between launches at these sites<sup>6</sup> to repair damage, assemble the next vehicle and integrate the payload. Although development and test programs had reached a sustained rate of two launches per month during the 1960s, current practices often incorporate both assembly and checkout on the pad rather than at the factory or other facility. In addition, checkout, test and other operational practices can last over 60 days. An example of the Titan IV launch preparation process is shown below in Figure 2.

### Titan IV Processing Flow (West Coast)



**Figure 2 - Launch Vehicle Assembly Time Frame**

The current process also requires a unique engineering fit between vehicle, payload and launch pad facility. While this approach has optimized the engineering of payload capacity, the

time and cost tradeoff for such customized efforts is certainly sufficient to question this method of design and preparation.

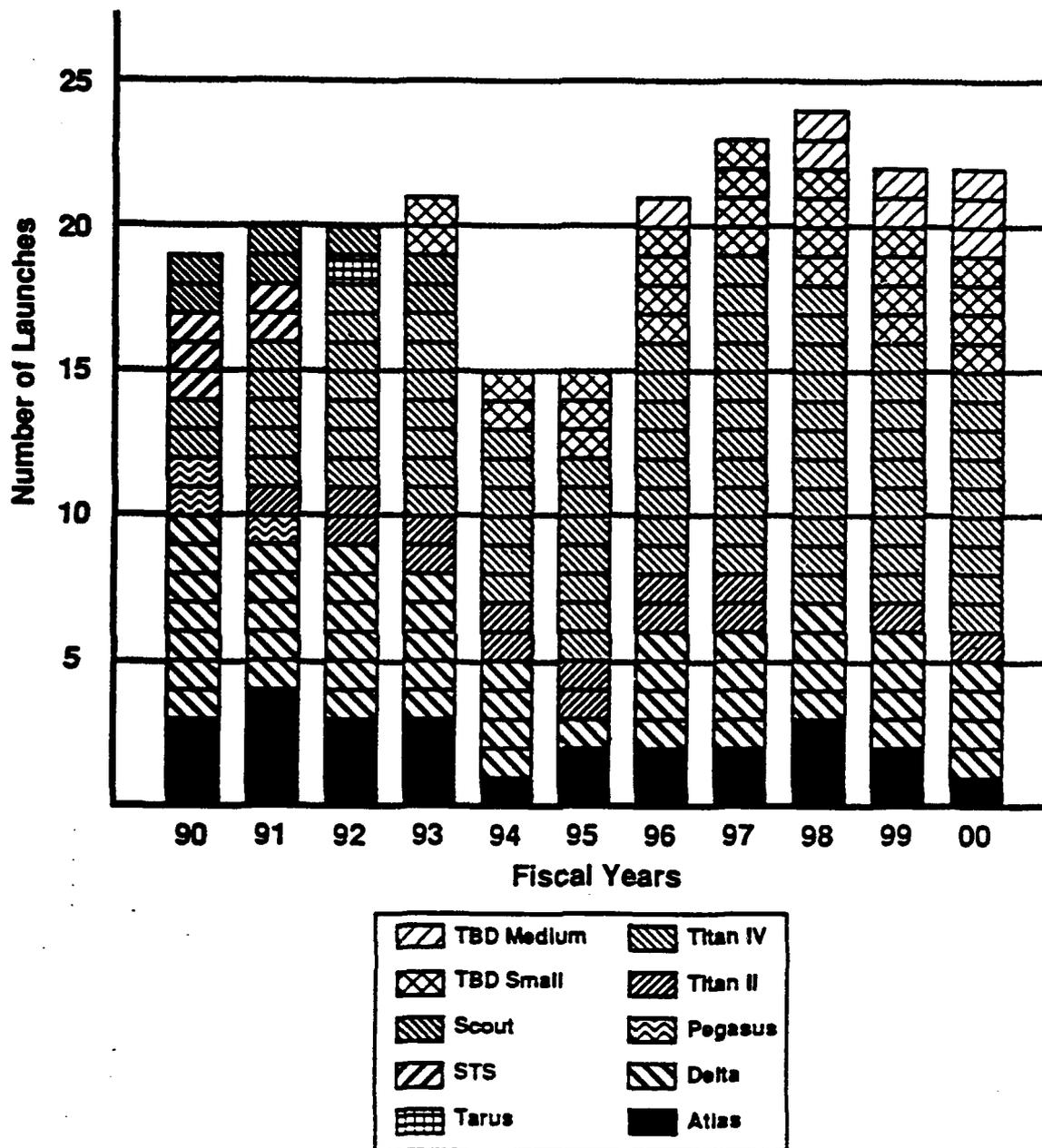
Contracts for launch services are primarily on a cost plus fee basis which does not provide an incentive to reduce the time required and may result in increased costs. NASA and DoD missions typically cost between \$3,000 and \$11,000 per pound to launch which includes the vehicle and launch services but not payload costs.<sup>10</sup>

Improving this process, either through a reduction in complexity or through an improvement in design and development processes could save significant amounts while increasing the potential for reducing the time between launch.

If some design standards could be agreed to, the need for specific vehicle engineering by the satellite fabricators could be reduced or eliminated. This would require high levels of cooperation between the government and the space industry with some incentive to the industry for increased efficiency other than that normally provided by a cost type contract. A larger profit margin may balance increased efficiency with relatively flat demand.

Some mechanism for reducing pad turnaround is required. Currently projected National Security launch requirements alone will exceed Titan IV pad availability with a low of six launches scheduled in 1994 and a high of 11 in 1997 as shown in Figure 3. With only four pads available (assuming completion of the second pad at the Western Launch Facility) and six months on pad for assembly and checkout, a maximum of eight launches per year is theoretically possible. Should any delays or accidents occur, this

Figure 3 - National Security Launch Vehicle Requirements



Source: Defense Science Board; National Space Launch Strategy; 1990

pace could not be achieved.

With this demand for extremely limited launch availability, additional launches to support enhanced service unique satellite capability, even assuming that procurement dollars are made available, will be virtually impossible to achieve. A rapid, cost effective alternative must be developed to break the current strangle hold on space access.

The Impact of Government Contract Practices Despite current law and policy directing increasing use of commercial launch services, both the DoD and NASA continue to specify engineering solutions to both payload and launch vehicle requirements. In addition, these contracts require considerable participation by government personnel in the manufacturing, assembly and launch service processes. Coupled with the typical documentation requirements of DoD procurements, these constraints add not only cost but time to space program efforts.

Commercial firms continue to maintain that excessive government oversight and restrictive specifications are unnecessary and that the associated costs far exceed the actual cost of a failed mission.<sup>11</sup> While this complaint may possibly be contested by government launch agencies, the fact that the government continues to apply research and development methodologies and oversight to essentially commercial products and services cannot be argued.

As a comparison, government costs to design and build payloads range from \$40,000 to \$650,000 per pound with the primary variable

in cost the amount of fuel carried by the payload versus operational components. The lower the amount of fuel, the higher the payload costs. Commercial communications satellites however, often cost \$10,000 per pound; orders of magnitude in difference for essentially similar products. While government payloads are often unique or utilize new technology, the wide disparity in costs must be questioned in terms of cost effectiveness, how much is too much?

Continuation of the practice of allowing launch vehicle manufacturers to ship at the component level rather than a complete vehicle adds not only to the time required for preparation at the governments's facility, but increases test requirements by two to three times. Each component is tested under government supervision at the plant, and after shipping; prior to assembly, following assembly and then a total system test is performed.

Insistence on government personnel participation in detail design reviews, launch preparation and procedures and other tasks that after thirty years should be relatively standard also adds to the cost and time required for launch. Documentation to support this level of detail and government participation in the launch process has been described by contractors as onerous and unnecessary.<sup>12</sup>

While NASA has reduced its level of participation in ELV launches the Air Force continues to demand detailed engineering, test and launch information as well as requiring government inspections and participation in launch services. The Air Force defends its practice as required to protect government assets at

the launch facility and adds that their expertise is relied upon by contractors.

The Navy's success in contracting for the "end item" system and leaving the design, manufacturing and launch implementation to the contractor coupled with the high success rate of commercial payloads tends to support the government contractor's contention rather than the government's.

#### ALTERNATIVE APPROACHES

The possible alternatives which could improve access to space range from such technological thrusts as satellite or launch vehicle design, through process improvements to the use of innovative acquisition approaches. A discussion of these alternatives is provided for consideration.

##### Technological Alternatives

Satellite Improvement There are a number of efforts, including some promising DARPA projects, to develop a family of smaller satellites. While still in research and development, small store and forward satellites called MACSATS<sup>13</sup> show some potential for supporting future Army war fighting. While these smaller satellites have less capability and may result in longer time lags to complete a communication transmission, lower cost and greater flexibility could more than balance the performance trade off for other than command and control capacity.<sup>14</sup>

Smaller satellites could be launched on small or medium launch vehicles or as "piggybacks" if unused capacity of large launch vehicle payloads is available. This flexibility could serve to

accelerate launch schedules as well as provide a quick response capability not now available.

Army participation in the development and testing of smaller satellites has been estimated at an annual amount of \$15-30m with comparable participation projected by the other services. This approach would permit each service to benefit from joint research and development while retaining the ability to customize a network for their specific needs.

While promising, the effectiveness of these smaller satellites and their capacity to support contingency operations is still being researched.

Launch Vehicles Research into improvements to ELV design and alternative launch systems are also being pursued. While these programs have been drastically reduced as a result of increasing budget cuts, preliminary findings show promise for application in block upgrades to existing systems at a minimum.

The Advanced Launch System (ALS) program had initially focused on development of a new, heavy lift launch capability. The current program has been somewhat restructured to pursue technological improvements that have application to generic space transportation, current systems included. By applying a new approach to essentially 1960s launch vehicles, improved lift, increased reliability, reduced cost and more efficient production could be realized in the mid to long term at a much lower cost than full development of a totally new launch vehicle. These improvements have little or no impact on reducing the time to launch

difficulties caused by limited launch facilities discussed earlier, but the potential for streamlining fabrication and payload integration processes could be of benefit.

There are also two programs researching a Single Stage to Orbit (SSTO) capability. A DoD/NASA effort to develop the National Aero-Space Plane (NASP) is investigating the potential of an air breathing plane capable of extending its flight into extra-atmosphere altitudes. This vehicle would have a return capability and be man-rated in addition to using a runway rather than a launch pad. A second DoD effort is pursuing a recoverable launch vehicle that may or may not be man rated. This approach uses many proven items and projects launch and return of the vehicle to a bare launch pad. The immediate application of these approaches to support LEO and GEO payload requirements is not clear at this time, but breakthroughs in materials, propulsion fuels and fuels handling could have near to mid term application to other launch systems.

A third approach, development of small, plane launched vehicles is perhaps closer to implementation than the previously mentioned programs. The concept of this program, the "Pegasus" approach is to launch essentially a "booster" vehicle from a flying platform. This approach not only would eliminate constraints on launch vectors associated with terrestrial launch sites but would also provide an extremely responsive capability relative to current launch facilities.

Initial operation of this vehicle have been satisfactory. Launch of small military communications satellites in 1992 did not

reach the planned orbit but the satellites are useable. In February 1993, a Brazilian satellite was successfully launched which served to confirm the capability of this system.<sup>15</sup>

A significant drawback of both the NASP and Pegasus systems is the extremely limited payload capacity. Most current communication satellite designs could not be launched from either system. The projected maximum payload to LEO for Pegasus is currently estimated at 1,000 lbs, a fraction of a typical payload which can range from 8,000 to 39,000 lbs.

By developing communications payloads of under 1,000 lbs, and utilizing the flexibility of both launch schedule and satellite placement in orbit, research into smaller satellite payloads could be leveraged by these complementary launch systems.

Despite these advances in technology, there are still no clear alternatives to provide increased launch capacity in the near term. This is due in part to payload development time frames as well as launch vehicle and infrastructure constraints.

Process Improvements In comparison to launch vehicle technology which has not appreciably changed since the 1960s, launch operations and procedures have become increasingly complex and time consuming. A further impediment to efficiency are the growing limitations of the aging facilities themselves which also rely on outdated technology. These factors have resulted in increased labor intensive operations which add to both the time and cost required for launch operations.

A combined process of facility neglect and leisurely assembly

of payload and vehicle, partly resulting from the planned exclusive use of the shuttle, has evolved to become a major constraint on launch operations and schedule. During the early 1980s, the launch process for ELVs expanded to the time available. Even after 1986 and the increasing use of ELVs, this process has remained in place with little or no attempt at improvement.<sup>16</sup>

Each year that passes without some investment in improving the launch facility infrastructure results in higher modernization costs for the future as well as increasing operating and launch service costs to perform today's tasks.

Although the on pad time of medium ELVs is less than for Titan IV, the highest vehicle specific launch rate per annum ranges from four for Titan III and Atlas/Centaur to 18 for Delta II. This could be a reflection of the fabrication process since only the Delta II production rate of 12 per year is less than the launch rate of 18. In all other cases, the production rate matches or marginally exceeds the launch rate. Since there is significant excess capacity available for production, an increase in launch pad availability could be matched by increased production.

As ELV production lines were restarted in 1986 and 1987, vehicle parts began to be "short shipped" for assembly, payload integration and system testing on the pad rather than in the development facility. This procedure has continued despite growing difficulties and the increased time and costs required for assembly and testing. This approach has also created the need to stock spare components on site at the launch facility to repair or

replace components damaged during installation or by exposure to the weather.

Test equipment at the launch facility is both older and different from those at the manufacturing facility. This has resulted in increased time required for testing and retesting as well as significantly increased costs due to the time required to complete the component and system testing process at the launch site.

The age of the launch facilities also adds to the labor intensive nature of the entire process by requiring additional personnel to perform tasks that could be automated. Repair and testing of the range and launch facility equipment itself can significantly delay launch schedules adding further costs and causing increasing schedule impacts.

While NASA has budgeted for facility repair required for continued operations, only the DoD/NASA Advanced Launch System has a program to seriously investigate new technologies to improve the launch process. The ALS program however, is only funding a research effort, there is no current effort in either DoD or NASA to apply any new launch technology or processes to improve existing launch capabilities.

Sharply reducing the on pad time for each launch would provide greater flexibility in launch preparations as well as increase launch opportunities. This reduction could be accomplished by accepting only fully assembled and tested vehicles at the launch facility. The ability to integrate payloads at either a

contractor's or other government site other than the launch facility would further reduce the time to launch period.

The upgrade and modernization of range and launch facility testing and tracking equipment to include the automation of as many processes as possible would further improve turnaround and therefore launch availability.<sup>17</sup>

The government's approach to launch procedures is often a driving force in the time required for launch. Additional stress on streamlining these activities would provide incentive to personnel to find ways to reduce the time required for launch preparation.

Acquisition Alternatives Obviously, better management of existing contracts could be used to increase efficiency. Refusal of less than complete vehicles should be permissible under existing contracts with no changes. Consideration of modifications to existing cost plus fixed or award fee contracts to add incentives for greater efficiency at government facilities should also be relatively easy to negotiate. Other factors such as redundant government tests or other processes could be considered for elimination. Reduction of government demands are likely to have little or no contractual impacts and could result in both a time and cost reduction to the overall contract.

In future contracts, for other than intelligence, command and control or other classified applications, the acquisition strategy should focus on the provision of a commercial type capability rather than the development of a specific item to meet government

specifications. The primary objective of these contracts should be to follow commercial practice as closely as possible in order to achieve the significant savings in commercial payload development costs over government costs.

Another area of cost saving and potential schedule reduction in this approach would be to reduce as much as possible government participation during the development and launch process. By contracting for an operational network or other capability, the contractor would be fully responsible for the development, test and launch of whatever would be required to meet the stated function. Government testing would be limited to evaluation of the final capability and the approach, design and other functions would be left to the contractor to determine and manage. This approach could be structured on a fixed price basis, but only if it is common commercial practice. The major consideration should be to leverage cost and schedule reductions from following common practice as closely as possible.

A comprehensive review of existing launch manifests should be undertaken to determine if there is any excess payload capacity that could be used to launch government satellites. Optimization of manifests could accelerate schedules for efforts currently under production. Launch service cost sharing would be the incentive to both commercial and governmental entities to participate in this type of cooperative effort.

Another approach to increasing non command and control capability relatively quickly would be to investigate the

possibility of either adding circuits to commercial satellites in development or through the purchase of circuits already planned. Again, the government must attempt to follow commercial practice to avoid delays and unnecessary increase in costs. If the government attempted to add specifications, documentation or test requirements, it is highly unlikely that a commercial firm would add government circuits to a commercial satellite.

One critical item for consideration in pursuing acquisition alternatives is the continuing reduction in budget levels for DoD space efforts. The addition of capability will be competing against force structure requirements and other acquisition programs that historically have been viewed as basic to DoD operations. In this climate, low cost methods of providing capability will have the greatest potential for success.

The use of agreements to provide capacity in times of emergency or crisis should be continued and expanded. This approach, similar to the Civilian Reserve Aircraft Fleet (CRAF) agreements would quickly add capability without requiring new satellites or accelerated launch schedules. This strategy should be extremely low cost since actual use of the capacity would not occur until activated in time of crisis. Actual use of the circuits may be costly, but should not be more than the commercial rate structure. The current planned use of this commercial capability for other than command and control requirements provides further support to the contention that commercially developed and qualified satellites are fully acceptable for military applications.

The government could pursue cooperative efforts where the government would provide either services, facilities or other value to contractors in an attempt to reduce costs. If the problems in launch procedures could be eliminated, more frequent launch opportunities would be available. These dates could be used in negotiations as a benefit to contractors willing to provide either dedicated capability or payload capacity for government use.

The streamlining of launch operations would also result in cost reduction of launch services and could be used to gain consideration from contractors with existing scheduled launches that could be used to reduce government cost of payload as well as cost to launch.

A slightly more risky approach would be to have the government acting as an insurer for a joint launch of commercial and government payloads. This strategy is based upon launch reliability rate of over 90%.

If DoD placed monies in a revolving fund to offset launch services and a portion of the replacement costs of the vehicle and payload, the long term costs of individual vehicles and payloads could be reduced. These funds would be used to reimburse government operating costs of using launch facilities and would be replenished by both government and commercial users of these facilities. Initially, rates would be more than actual launch costs to provide funds to cover potential losses.

Excess funds would be built up until there were sufficient levels available to replace items lost through launch failures. At

this point, the government could provide full insurance for contractors which would reduce the government's overall cost to launch. When a launch failure did occur, launch service rates would revert to the level required to replenish the revolving fund.

This approach would result in some instability in launch service rates but should result in generally lower costs, not only for launch services but also for payloads since the insurance would not be at an additional cost to the developer or the government's launch contractor.

#### RECOMMENDATIONS

Procedures The most cost effective approach to improve launch access is to improve the operations process. Current practices should be reviewed and aggressive measures taken to reduce the time required for launch.

Modernization of launch-facilities should be accelerated. Process improvements through automation of some launch procedures and replacement of outdated equipment will also reduce time requirements.

The type and quantity of tests and other launch procedures should be reviewed to eliminate redundancy and to implement streamlined operations.

Implementation of these recommendations would avoid the time and cost required to build additional launch facilities while improving launch availability.

Technology Research into smaller satellites and new space based technology, especially communication alternatives should

continue and funding should be increased if possible. The recent availability of a reliable, flexible launch system such as Pegasus must be exploited to the maximum extent possible.

Modification through incorporating ALS improvements into larger ELVs should be made as quickly as possible. While the existing technology has proved its reliability over the last thirty years, the focus now should be on greater trust and lower cost as well as reliability.

Acquisition Perhaps the greatest improvements in time and cost control can be achieved through use of commercial practices rather than the current highly interventionist process.

Although there is likely to be significant reluctance to eliminating detailed control over design, development and operations, DoD must recognize that the development and use of satellite and launch capability is now a commercially available service and is no longer a high risk research effort.

Pursuit of alternative means of providing capability can also be beneficial. Lease of services rather than purchase of an end item is only one way to rapidly increase capability at a lower cost. The use of agreements to provide capability during emergencies should also be expanded to provide on demand capability over as much global surface as possible.

Cooperative efforts should be investigated and implemented as quickly as possible in order to reduce costs. The government must learn to leverage its assets and to "buy smart" rather than continuing to concentrate on the best technology regardless of

continuing to concentrate on the best technology regardless of cost. The government can add value to commercial ventures and receive in return a lower cost capability in a shorter time frame.

#### CONCLUSION

The government can take near term action to improve access to space without significant cost impact. Concentration on operating procedures and acquisition strategies can have a quick payoff for projects underway. Continued research will also dramatically increase capability but should be integrated into existing systems to gain quick benefits rather than withholding new technology until a totally new system is completed.

In the current environment of dramatic budget reductions, the DoD must use every opportunity to use technology as a force multiplier. Space based systems have significant potential in this area. Exploitation of global communication, observation and other space based applications must be supported by a responsive launch capability in order to effectively support future war fighting strategy and the planning process.

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