

Selected Developments in Commercial and Navy Acquisition Practices

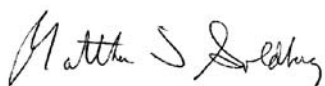
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A handwritten signature in black ink, reading "Matthew S. Goldberg". The signature is written in a cursive style with a large initial "M".

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Summary

Background

Since 1990, the Department of the Navy has significantly altered its acquisition practices. During the same period, commercial acquisition practices have changed as well. The Deputy Assistant Secretary of the Navy (Management and Budget) asked us to review developments in commercial and DoN acquisition practices and evaluate the suitability of adopting or adapting innovative commercial practices for the Department of the Navy (DoN).

In FY 2002, the DoN had total outlays of about \$100 billion. Subtracting its military personnel payroll cost of \$30.1 billion and its civilian personnel cost of \$9 billion means the DoN procured \$61 billion worth of goods and services in FY 2002.¹ Private companies regularly set and meet annual purchasing cost reduction targets of 3 to 7 percent [2]. The opportunities for DoN savings are sizable—an innovative practice that cut DoN purchasing costs by just 2 percent would save over \$1.2 billion per year.

Approach

Based on a survey of the business and trade press and interviews with senior acquisition representatives of large companies, we identified several innovative commercial acquisition practices. We collected information about the problems and advantages associated with each practice. This report documents selected DoN acquisitions that have incorporated the innovative practices we identified, and discusses the

1. According to a recent survey of purchasing levels by U.S. companies [1], the DoN would place behind only General Motors and Ford Motor Company in terms of total annual spending on goods and services.

appropriate conditions under which each practice would be most suitable for future DoN acquisitions.

Observations

Our findings are summarized in table 1. For each innovative practice, we list a few commercial and DoN examples, as well as the conditions under which each practice would be suitable for more widespread DoN application.

DoN has experience with innovative practices

For each innovative acquisition practice we considered, we found it used in one or more DoN acquisitions. If applied under the appropriate conditions in future acquisitions, these practices have the potential to provide further benefits. It was beyond the scope of this paper to quantify the extent of these potential additional savings across DoN procurement programs.

Some practices are beneficial only if the DoN is one of many buyers

We can classify the innovative practices considered in this report into two groups. The first group includes five practices (direct vendor delivery, third-party maintenance/logistics, maintenance/warranty bundled with equipment, leasing, and purchasing services rather than equipment) with the common element that each practice involves a greater contractor role in the procurement of equipment.

The benefits to be derived from this group of innovative practices depend to a large degree on the existence of other (non-DoN) buyers in the marketplace. In instances where the DoN is one of many consumers of a given good or service (most commercial off-the-shelf items would satisfy this criterion), the DoN could achieve savings by expanding its use of these practices. For instance, the DoN is not a large buyer of restaurant equipment (for a galley on base) relative to the total market and therefore may benefit from pooling its maintenance cost risk with other buyers through third-party logistics and bundled maintenance agreements.

Table 1. Innovative acquisition practices since 1990

Acquisition practice	Best suited for DoN if	Commercial examples	DoN examples
I. Practices that shift equipment-related risks away from the buyer			
Direct vendor delivery	<ul style="list-style-type: none"> - Inventory costs significant - Replacement frequency low - There are other buyers to pool risks/ get bulk discounts - Implemented at initial system acquisition 	- Philips Medical Systems (replacement parts)	- NAVICP (Sub Sonar Systems) - NAVSEA & NAVICP (Emergency Escape Breathing Device)
Third-party logistics	<ul style="list-style-type: none"> - Performance metrics and associated incentives clear - Third party can spread cost of maintenance infrastructure over many buyers 	-Avionics parts	- NAVSUP & FISC Norfolk (Galley Equipment) - TC-18 aircraft
Maintenance/warranty bundled with equipment	<ul style="list-style-type: none"> - Maintenance expense risks can be pooled over end users - Design/production choices significantly affect O&S costs - OEM has lower maintenance costs - DoN purchase is small relative to total market 	- Harley Davidson (manufacturing equipment) - Hospital equipment	- NAVAIR & NAVICP F-18 E/F Radar - T-45TS Trainer aircraft
Leasing	<ul style="list-style-type: none"> - Demand is short-term - Active resale market, predictable value at lease end - High transaction cost to reselling - Equipment depreciation independent of user behavior, or - Contractual restraints on user behavior not too costly - Competitive supply 	- Best Buy (computer servers) - Airlines (aircraft) - Hospital equipment	- NAVSEA & OICC Naples, Italy Support Facilities
Purchasing services vice equipment	<ul style="list-style-type: none"> - Criteria are those for “leasing” and “maintenance bundled with equipment” combined 	- DuPont, IBM (Manufacturing)	- Navy Marine Corps Intranet
II. Practices that alter the contractual relationship between buyer and supplier			
Partnering	<ul style="list-style-type: none"> - Long-term relationship - Volume purchases 	- Microsoft (computers) - Ford Motors (steel)	- NAVSUP, NRCC Det London (Spares)
Patent Licensing	<ul style="list-style-type: none"> - Improvement patents likely - Future access to patents necessary (for modifications, repair, etc.) 	- Aircraft data for simulator	- DoN Office of Technology Transfer
Incentives	<ul style="list-style-type: none"> - Objective, verifiable criteria - Accurate tracking of life cycle cost data 	- USPS Program Manager bonuses, shared-savings R&D	- Energy-savings contracts - V-22

Increasing contractor role



Other practices to improve incentives apply more widely

The potential benefits from the second group of practices (partnering, greater reliance on incentives, and greater attention to patent rights) can be achieved even when the DoN is the largest (or only) buyer of a given good or service. This group of acquisition practices benefits the DoN largely by providing better incentives (either to the contractor or within the DoN purchasing organization). The DoN could apply these practices more widely.

Introduction

Many new commercial acquisition practices have emerged in recent years. New technology and processes are producing savings in the commercial acquisition process. In this paper, we survey some of these individual practices, discuss the economics behind each practice, highlight actual examples of companies using them, and determine whether the DoN uses or could use the various practices. We present information gathered from business and academic publications, as well as from interviews with senior acquisition managers.²

Traditionally, the DoN has owned full equity in the equipment it has acquired, and has assumed all the risk associated with life-cycle maintenance, sparing, and support costs. Various innovative contractual forms are available that allow both equipment ownership and maintenance costs to be reallocated between the DoN and its suppliers. These practices include maintenance of retail stocks by suppliers (direct vendor delivery), third-party maintenance and logistics, bundling equipment with a maintenance agreement or warranty (also called prime vendor support or contractor logistics support), leasing equipment rather than buying it, and service purchase as opposed to equipment purchase.

Another set of innovative acquisition practices relates to the evolution of the buyer-seller relationship. Commercial practice has increased its reliance on long-term contracting with a smaller supplier base (partnering), detailed allocations of intellectual property rights, and incentives throughout the acquisition process.

In each section of the paper, we discuss a particular acquisition practice (or group of practices) and identify lessons from commercial experience as well as examples of DoD usage. Each section concludes

2. The commercial firms we interviewed were promised anonymity and are therefore identified in this report only by their industry.

with a list of criteria that would tend to make the practice more beneficial to a given DoN acquisition or purchase.

Maintenance of retail stock by supplier

One widespread innovation in acquisition practice is to rely on the supplier to manage the inventory of spare parts required to sustain the equipment over its lifetime. The alternatives are for buyers to order, warehouse, track, and deliver spare parts in house, or to employ a third party to perform these functions. (We review third-party logistics in the next section.) Buyers retain responsibility for performance of the required maintenance, either with an in-house workforce or through a third party. (Another section reviews original equipment manufacturer (OEM) and third-party maintenance.) In the military procurement context, this practice is often called “direct vendor delivery” of spares.

This practice is beneficial when expected failure rates for certain parts have a high variance because, when failure rates are uncertain, the buyer incurs a large expense by buying and storing spares for long periods of time. A supplier-managed stock of spares can pool the risk of failure time across many customers, thus reducing the cost of holding inventory. This works best if there are many potential buyers for a spare part—the manufacturer needs to produce and store only a few units (the expected number that will fail in a given month, say), instead of every end user having to buy and store its own unit. Even when there are only few buyers, savings may be possible if the manufacturer is able to manage inventory for the given parts at lower cost (including transportation) than the buyer.

Observations from commercial practice

Departing from OEM initial spares recommendations

A long-standing practice in industry is for the OEM to recommend the initial spares inventory. The OEM usually has data on the reliability of components, and thus can recommend the initial inventory to

ensure equipment uptime. Both the airline and the transportation companies cited these practices. Negotiating initial spares purchases at equipment purchase provides the buyer with the best leverage if the OEM is in a monopoly position for supplying the spares.

We spoke with managers from a transportation company that had departed from the typical initial stocking practice in the early 1990s. Instead of accepting the OEM's suggestion that they take delivery of all initial spares when the equipment was delivered, they identified and bought the critical parts first. They delayed their purchases of the other initial spares because they realized those parts would not be needed right away. This required very well-informed buyers: otherwise, buyers will over-purchase due to extreme caution. This delayed purchase frees capital. As long as a premium for later purchases is not required, the buyer benefits from this delay.

OEM direct delivery streamlines procurement

The U.S. Postal Service (USPS) uses vendor spares inventory management. Each USPS mail processing facility has a dedicated inventory space. When the USPS needs a replacement part such as a belt or a roller, it simply requests the part from the OEM online, who delivers it directly to the equipment site. Critical parts are expedited. The process is further streamlined because prices are negotiated in advance and the purchasing department is not involved during the replacement stage.

OEM management can lower inventory and improve availability

The USPS states that direct vendor delivery has significantly reduced the amount of inventory it holds.³ The USPS was initially worried that suppliers would not be able to meet its uptime needs, but it has been pleased so far.

The managers we interviewed from an aircraft leasing company said that they also offer a spare engine stocking and delivery program. For

3. The USPS believes that it can improve on OEM sparing using a stochastic demand methodology it calls "demand sparing," which appears to be similar to readiness-based sparing.

a fixed fee, the company guarantees the rapid delivery of a spare engine whenever a customer needs it. This service is possible because the company prepositions engines in a number of locations around the world.

DoD experience

Navy EEBD and aircraft parts

In the mid 1990s, the Navy awarded a 5-year, \$55 million contract for Emergency Escape Breathing Devices (EEBDs). The fleet's requisitions for replacement units pass through the NAVICP to the contractor, who directly ships the units to the customer. The units are not entered into the Navy Supply System, which generates significant savings by eliminating the cost of receiving, storing, and re-issuing the units from Navy inventory.

Lockheed Martin has a 6-year contract to supply spare replacement components for sonar systems on certain submarines. The contract has provisions for maximum delivery time (2 days within the continental United States (CONUS) and 3 days to Hawaii). Once again, the Navy does not need to stock spares.

NAVSUP and NAVICP procured a replacement Attitude Heading and Reference System for H-46 aircraft. The contract calls for complete commercial responsibility for wholesale inventory. The contractor is responsible for deciding the amount of inventory it must hold to meet the DoD requirement of 48-hour shipments.

U.S. Air Force C-5

Lockheed has a contract to manage the inventory of spare parts for the C-5. In December 2000, it was awarded a Defense Logistics Agency (DLA) contract to manage 11,408 consumable parts for the U.S. Air Force's fleet of 126 C-5 Galaxy aircraft. Lockheed's approach provides total asset visibility, individual order tracking, and forecasting analysis. The service incorporates an Internet-hosted ordering system that lets customers track orders. To reduce aircraft downtime, the

company uses ordering history data to predict parts demand in advance so that production of required parts can begin earlier.

Application to DoN acquisitions

Having the supplier maintain the stock of spares can achieve savings by reducing the amount of time a part is held. Suppliers may have a more dynamic view of the inventory levels and be able to respond more quickly to replenish stock. The DoN may not want to use this practice for certain “mission-critical” items where downtime may be very costly. To capture the full savings from such contracts, parts prices should be negotiated at the time of acquisition. Finally, the DoN may benefit from adopting the practice of delaying delivery of (and payment for) some noncritical initial spares.

Third-party maintenance/logistics

Third-party maintenance and logistics is an arrangement under which the equipment buyer outsources maintenance, repair, and/or sparing activities to a party other than the OEM. In exchange for a fixed fee, the third-party logistics provider assumes responsibility for these activities and will in some cases also manage OEM warranty claims. In addition, a third party can manage a stock of parts that the OEM provides on consignment. The parts are used as needed, and a third-party representative takes weekly inventories and replenishes the supplies.

Third-party maintenance and logistics can have benefits when the third party can operate more efficiently than the OEM or the owner, or competes more aggressively than the OEM.

Observations from commercial practice

A third party can achieve economies of scale

A third party can pool requirements to obtain volume discounts

Representatives of the commercial airline informed us that they have some contracts with local distributors who stock spares for them under consignment, with dedicated inventory and guaranteed delivery times. These distributors pool buys from many airlines to get better pricing on otherwise low or infrequent demand items. They have used a similar contract to handle avionics parts where the inventory was stocked annually based on predicted needs.

A third party can pool risks

Whereas ten different end users may each stock one unit of a spare part that has a 50-percent probability of needing replacement in a given year, a third-party logistics provider could serve all ten end users by stocking fewer than ten units of the part. The savings in

inventory holding costs are passed back to the end users. The commercial airline and the transportation company both cited this as a benefit to third-party logistics involving expensive avionics parts.

Similarly, Internet retailers can add new products to their offerings without taking on new inventory risks by contracting with “online category managers” who are third-party distributors that specialize in a particular product category (videos, compact discs, or sporting goods, for example). These distributors own the product inventory, thus freeing the multiple retailers they serve from the risk of substantial inventory investment.

A third party can spread fixed investments over more work

The aircraft leasing company we interviewed provides third-party maintenance services using its own experts trained in various types of aircraft. It provides smaller airline operators the benefit of a full-service maintenance solution without the need to invest in a maintenance infrastructure that would receive relatively infrequent use.

A third party provides competition for the OEM

The large manufacturer we interviewed uses third-party logistics and direct vendor delivery for bearings and other standardized, commodity-type items that it does not need to buy from the OEM. As a policy, it tries to buy as few spares from the OEM as possible. Third parties will make many parts (such as castings and rolls) that are interchangeable with OEM parts. To save on parts procurement, it sometimes also reverse engineers the equipment or cross-references against other parts. This manufacturer is often able to obtain certain parts from third parties at one-fourth the OEM’s price.

A third party can have a labor rate advantage

The manufacturer we interviewed operates in a unionized environment. Representatives reported that they sometimes benefit from hiring non-union third parties to perform certain maintenance checks that are required only once every 3 to 6 months.

Some firms have concerns about third-party quality

The transportation company representatives said they have not used third-party logistics mainly because they were not comfortable with the reliability of potential providers. However, the firms that have used third-party logistics did not report problems.

DoD experience

Galley equipment maintenance

FISC Norfolk awarded a contract in 2000 for the maintenance of galley equipment for seven galleys in the Norfolk area. The contractor coordinates all repairs (both preventive maintenance and emergency repairs), and handles warranties under the OEM agreement(s) for 490 pieces of equipment at the seven facilities.

Training aircraft maintenance

In 1997, DoD awarded a 10-year contract to maintain the Air Force and Navy fleets of TC-18 trainer aircraft and EC-18 special mission aircraft. The contractor, AAR, has facilities to provide similar services to commercial customers as well. The TC-18 and EC-18 (in addition to the E-3 and E-6) are built on the Boeing 707 commercial airframe.

Application to DoN acquisitions

Issues from DoD experience

In the Army, mobile maintenance is difficult

Army representatives told us that their main problem with contracting out logistics is that the maintenance function has to be more mobile in the Army than in the Navy or Air Force. The Marine Corps also requires mobile maintenance for much of its combat equipment.

There has been a trend toward contracting out logistics in the Army, but acquisition representatives have the impression it might have gone too far, to the point where many deployed support staff are not

trained soldiers. They feel this is the key tradeoff. The Army plans to study the effect of having contractors on the battlefield.

Suitability for DoN

Such an arrangement is beneficial for equipment that requires infrequent or low-volume repair or maintenance. A third party may offer more competitive pricing than an OEM.

Third-party maintenance and logistics is a useful strategy for equipment that satisfies most or all of the following criteria:

- The equipment is not mobile or deployed. Having contractors on the battlefield may impair war fighting capability.
- There are non-DoN users of similar equipment (it may have similar commercial variants). An example of this is the galley equipment in Norfolk.
- The equipment does not involve rapidly evolving or complex technology (in which case the OEM may be best qualified to perform maintenance). A good example of this is the maintenance contract for the TC-18 and EC-18 aircraft. These planes are based on the Boeing 707 design which dates back to the late 1950s.
- The equipment requires maintenance, repair, or spare parts too infrequently to justify investment in inventory or an in-house maintenance capability.

Maintenance-and-equipment bundling/ warranties

Acquiring equipment together with a warranty from the original equipment manufacturer (OEM) is a well-established practice. In recent years, the OEM has been bundling more maintenance and support services with the equipment. We group maintenance agreements and warranties together because the purpose of both is to shift risks associated with equipment maintenance and repair costs to the OEM. In this section, for convenience we may refer to one practice, although we generally mean both practices.

Such arrangements offer several advantages:

- The OEM may be relatively more efficient than the buyer in performing maintenance.
- The maintenance agreement furnishes an incentive for the OEM to reduce the life-cycle cost of equipment at the time of design and production.
- The OEM can minimize the risk of high-cost repairs by pooling repair expenditures across many customers.

The warranty specifies the length and scope of coverage. In some cases, the warranty simply specifies a schedule of repair costs, with the operator doing repairs in-house and the OEM providing reimbursement as described in the warranty. More comprehensive maintenance agreements cover diagnostic services and scheduled replacement of parts.

The future stream of maintenance expenditures usually involves some degree of uncertainty. This risk may be significant in instances where the supplier has few such agreements over which to pool risks, the risk of repairs depends predominantly on the behavior of the user, or the equipment is new technology with unknown reliability. In

such cases, the risk premium required by the supplier may make self-insurance (in-house maintenance) the cheaper alternative.

Observations from commercial practice

In practice, we found great variation across maintenance risk-sharing agreements. As an illustration of how comprehensive maintenance agreements can get, Harley Davidson has completely turned over its maintenance, repair, and overhaul (MRO) to the equipment manufacturers. Although Harley Davidson owns its assembly-line equipment, the equipment suppliers have full-time representatives on the shop floor who provide indirect materials and maintenance services. [3].

Also, the degree of maintenance-equipment bundling can vary even within a single firm. For instance, John Deere allows individual units to decide the degree to which MRO (for assembly-line equipment such as perishable tooling, hydraulics and pneumatics, safety supplies, etc.) is turned over to the supplier [4].

The airline representatives we interviewed said their airline uses “power-by-the-hour” maintenance agreements on some engines, under which it pays the engine OEM a monthly fee plus a charge based on total engine thrust used. However, because it always reserves the right to cancel such maintenance agreements, it retains the flexibility to shift work in-house in the future.

The variation in observed practice suggests that the economic feasibility of maintenance-equipment bundling varies from one situation to another and should be determined on a case-by-case basis.

Warranties allow unexpected high maintenance costs to be shared

The risks of maintenance costs can be shared by maintenance cost guarantees. For example, hospital equipment manufacturers estimate annual equipment maintenance costs for the first 5 years. If actual costs exceed the estimate, the manufacturer then pays part of

the over-run [5]. This practice is also used in the commercial airline industry.

Anyone who has personal auto and health insurance is familiar with deductible and co-pay agreements. The deductible and co-pay costs give the user some incentive to take care of the equipment. Under a full manufacturer's warranty, the user would not have such an incentive. This type of maintenance-cost sharing is likely to be optimal if it is difficult to determine whether user error or manufacturing defect caused the equipment to break down.

Warranty provisions can include reliability guarantees

Airline industry contracts include physical reliability guarantees (for example, minimum mean-time-between-failure (MTBF)) in the warranty or service agreement. This provision is intended to prevent the OEM from attempting to lower its maintenance cost by frequently replacing inexpensive parts, or "churning." Churning is costly to the airline because the aircraft is out of service (and thus unable to produce revenue) longer than necessary.

Warranties can be preserved by having the OEM certify buyer technicians

The airline we interviewed has a strong in-house repair and service capability (it even does repairs for other companies). The OEM trains the airline's mechanics and certifies the airline's repair facility. The airline then performs repairs and bills the manufacturer, with reimbursement rates predetermined in the warranty. Because parts do not have to be shipped back to the manufacturer, this system allows the airline to reduce the amount of time that equipment is out of service. A warranty will typically cover 3 to 4 years, and the airline has a dedicated warranty group to deal with claims. To better evaluate the value of warranties, this airline is planning to assess how original cost estimates (as typically reported by the manufacturer) for maintenance, repairs, and sparring have compared with realized costs.

The U.S. Postal Service uses a similar arrangement. The warranties on the automated sorting equipment it procures typically run 1 to 2 years. Here again, the OEM trains the operator and maintenance

staff, and provides site manuals and site spares so that maintenance can be performed in house. During the warranty period, the USPS staff performs some in-house repairs and bills the OEM, but most major repairs are done by the OEM. After the warranty expires, more of the major repairs are done in house.

The procurement contract sometimes specifies what it will cost the buyer in the future to have the OEM train new employees in preventive maintenance. This practice avoids the risk of the buyer's becoming captive to the OEM for training services once the equipment has been installed.

The OEM can subcontract

Many equipment manufacturers enter full-service maintenance contracts with their customers but then outsource the management of spares inventory. For example, Philips Medical Systems uses the UPS Logistics Group to deliver critical parts that are needed only occasionally [6]. Even after paying a premium for expedited delivery, Philips Medical saves a significant amount in support costs. Although the buyer could manage a number of contractors to obtain the same services, the OEM may benefit from economies of scale, and the buyer benefits by not having to manage non-core functions.

Using an in-house workforce has advantages

The OEM offers little advantage over buyers with strong in-house capability

Much like the USPS after the warranty, the manufacturing representatives we spoke with seldom depend on long-term OEM support or maintenance. Most of the machines their company uses require a full-time maintenance person, so they see no inherent advantage to contractor maintenance as long as their maintenance employees can be properly trained. Similarly, the defense contractor we interviewed said that its in-house maintenance team is just as efficient as OEM technicians.

A hospital purchasing agent said that, in general, maintenance and repair costs for hospital equipment are predictable. Most

sophisticated medical equipment has been approved by the Federal Food and Drug Administration (FDA) and is ISO9000 certified, so buyers have good published information on uptime and mean-time-between-failure which they can use to evaluate warranties and service agreements. Typically, larger facilities will assume more of the maintenance risk, and may even do repairs in house. This pattern fits well with theory because larger medical centers would tend to have more equipment over which to pool maintenance cost risks. All buyers normally obtain a short-term warranty, however.

Buyers can better integrate maintenance with operations

For its ground fleet, the transportation company we interviewed performs in-house repairs to control scheduling and minimize service disruption. It also bills the manufacturers for the cost of repairs according to a previously arranged warranty schedule. For their aircraft, representatives cited a new trend of more suppliers wanting to manage parts for life, especially for aircraft engines. The firm already outsources much of its higher-level component repair, but it does the more basic checks in house.

Much of the equipment the company buys is designed to last for many decades, but the warranty usually covers only the first year. To provide greater incentive for the supplier, the company's procurement contracts sometimes extend the performance guarantee to the period of the warranty. (The performance guarantee is a demanding set of performance criteria that the equipment must satisfy at delivery.)

OEM expertise is considered for critical items

The USPS has discussed buying contractor maintenance for anthrax detection equipment because many USPS employees felt that only expert individuals should handle such machines. This is one case where training may not substitute for an OEM's expertise.

Tracking warranties requires investment

Bar coding has helped the USPS to keep track of warranties. On one of its newest pieces of automatic equipment, all the parts are individually bar coded. The manufacturer said the bar codes would help it

keep track of failure rates, but the codes have also helped USPS do a better job of tracking warranties. The warranty period used to be pegged to the delivery of a fixed unit (say the 100th out of 200 total). This meant that some units were under warranty for only one year and some for three, depending on how long it took to deploy the equipment. Warranty periods were determined in this way because parts were sometimes taken off two machines and shipped together for repair, and it was difficult to keep the warranty periods separate. With bar coding, it is now possible to track each part individually.

Representatives from the transportation company felt that effective warranties must ensure that the ability to recover claims from the OEM is in place. If not, it is often better to negotiate a lower price instead of a warranty. They cited one example of a contract with a warranty that covered all consumable low-priced items within the first two years. But because the transportation company does not track nuts, bolts, and valves, it was impossible, in practice, to make any warranty claims on these parts.

To decide whether warranties are worth their price, buyers must calculate warranty value in terms of life-cycle cost saved. Manufacturers disclose mean time between failure and useful life on parts to assist in the calculation.

DoD experience

On the whole, bundled maintenance agreements have also become more widespread in military acquisitions since 1990. When a military contractor assumes some risk of future maintenance costs, it is often referred to as contract logistics support (CLS) or prime vendor support (PVS).

V-22 Osprey Power-by-the-Hour experience

The last several years have witnessed an upsurge in DoN acquisitions that incorporate contractor maintenance and warranties. A leading example of an innovative maintenance agreement in the DoN is the “Power-by-the-Hour” (PBTH) contract for the V-22 Osprey engines.

Under this maintenance agreement, the DoN pays Rolls Royce (RR), the OEM, an annual fixed fee of about \$1 million, an annual site fee (about \$320 thousand per site) for technical representatives who help with supply and maintenance, and an hourly engine usage fee that is based on the total load placed on the engine.

The hourly usage fee covers the cost of operational- (O-) level parts replacement and depot- (D-) level repairs. The contractor provides all maintenance except maintenance at the O-level. The service performs the O-level maintenance, which is limited to “remove-and-replace.” All removed components are then sent directly to Rolls-Royce for D-level maintenance.

PBTH excludes government-caused damage. This would include battle damage or damage caused by an operator or O-level mechanic (when a mechanic uses a hammer when he should have used a wrench or leaves parts inside the engine, for example). Any non-covered services are purchased under a Basic Ordering Agreement (BOA) with Rolls-Royce.

RAAF Lead-in Fighter

The Royal Australian Air Force (RAAF) contracted with BAE Systems in 1997 to provide training aircraft (lead-in fighters) together with deeper maintenance support throughout the equipment’s anticipated 25-year life. The RAAF specified its training requirements and allowed the contractor to decide the number of planes that would be built to satisfy these requirements.

BAE representatives suggested that such contracts were not widely used in the past because air forces preferred to perform their own maintenance. Due to increased credibility of life-cycle modeling and improved reliability of equipment, such contracts now provide less risk for the contractor and are thus more attractive to the customer because contractors demand lower compensation for bearing risk.

Payment to the contractor is based on the number of aircraft that BAE Systems provides in the “Daily RAAF Pool” (DRP). The DRP is defined as aircraft that are either serviceable or under “operational maintenance,” simple maintenance performed largely by the RAAF.

Any aircraft that is in “deeper maintenance” (with BAE Systems) or awaiting a spare is considered to be out of the DRP. Payments are decelerated by every aircraft that is out of the DRP on a daily basis.

The initial contract runs to 2006 and then is renewable for 5-year periods. The contract does not specify how to share any future savings from reliability improvements.

Additional DoN examples

The use of warranties provides a wealth of examples. Some warranties and maintenance agreements that have interesting features include:

- Replacement Inertial Navigation Unit (RINU): The agreement requires the contractor to repair and/or replace, free-of-charge, any failed system throughout a 20-year period.
- The ALR-67(v) (3) Radar Warning System (RWS) deployed on the F/A-18E/F “Super Hornet”: Over the 6-year contract, the contractor must achieve annual improvements in system reliability (measured in MTBF).
- Self-Contained Breathing Apparatus (SCBA) for Navy firefighters: The acquisition includes a comprehensive 15-year warranty on the regulator and an 8-year comprehensive warranty on the total system.
- Replacement Navigation Guidance System (NGS) flown on the F-14D and T-45A: The contract incorporates guarantees of reliability (measured in MTBF) and availability (replacement systems must be shipped to customers within 2 days). The contractor is responsible for repairing and replacing all failures for 15 years and has complete obsolescence management responsibility, which means deciding when and how to upgrade the equipment in light of technological advances. Thus the contractor has an appropriate incentive for technology insertion. The Navy neither buys nor holds any wholesale inventory.

U.S. Air Force C-17: government as subcontractor

The U.S. Air Force C-17 program has adopted an innovative “flexible sustainment” arrangement, which is a performance-based support contract that combines CLS and in-house support. Some performance metrics that determine the contractor’s compensation include reliability of aircraft and the time spent undergoing depot level repair or maintenance.

This contract is innovative also because the USAF support facility is a subcontractor to the prime, Boeing. This way the Air Force can meet the minimum 50-percent legal requirement for organic depot support. According to program representatives, a final depot support decision for the C-17 is due during FY 2003. The contractor earns an award fee based on performance metrics.

Application to DoN acquisitions

Issues from DoD experience

PBTH pros and cons

According to program representatives, thus far engine and contractor performance under PBTH has exceeded requirements. An indication of NAVAIR’s satisfaction is that, to date, the contract has had no modifications. A key advantage to PBTH is that the engine has 80-percent commonality with a commercial family of engines so there is less to design from scratch and a faster learning curve. This also provides Rolls Royce with economies of scale.

Some drawbacks to the PBTH cited by program representatives include the loss of in-house manpower and the resulting concern about future shortages of trained personnel. The largest challenge was implementing the integration of inventory management technology between NAVICP and Rolls Royce so that parts requisitions could be handled smoothly.

Improving PBTH (and other maintenance) contracts

Although in general the program has been successful, improvements could be made to the existing contracts. For example:

- *Establish explicit monetary performance incentives to align interests between OEMs and the DoN.* For instance, the hourly engine fee provides Rolls Royce with an incentive to make the cost-minimizing decision when trading off repair part cost and reliability. Rolls Royce does not, however, take into account the cost of impaired readiness that results when parts must be replaced too often, a cost that is borne by the DoN. As a result, the contractor might decide on a less reliable part than the military would choose. One possible remedy is to specify minimum reliability guarantees as commercial airlines do. Another remedy would be to charge the contractor for any downtime.
- *Incorporate provisions to ensure that improvements are shared between the provider and the DoN.* A primary justification for the program is that the contractor will improve efficiency over time. However, the government may not be able to capture these efficiencies in subsequent negotiations because the cost of switching providers may be prohibitively high, and an alternative provider (including the government) may not have the same ability to realize the savings. Some formal mechanism of sharing efficiency gains could be specified in the contract, although it would impose requirements for ensuring visibility in cost accounting.
- *Initiate contractor logistics support at an early stage to encourage the consideration of life-cycle cost in the design stage.* Finally, because it was not adopted until after the initial provisioning, the CLS agreement most likely did not provide strong incentives to minimize life-cycle cost during the design phase. In this particular case, it might not have made much difference because a large part of the engine design had previously been guided by commercial market forces. Future acquisitions may achieve greater cost reductions by initiating CLS agreements at the design stage.

- *Include minimum usage charges.* The contract does not require a minimum number of annual engine hours, which has hurt Rolls Royce during the period in which the V-22 has been grounded. Although this has benefited NAVAIR, it is likely that in future negotiations Rolls Royce will seek to minimize this risk. Including minimum usage charges may keep the OEM from increasing prices overall to prevent financial problems when expected usage levels are not met.

Hard use by the Army makes warranties risky for suppliers

U.S. Army acquisition representatives felt that warranties work well for items with predictable reliability. They cited Steiger tractors and the commercial warranty on the Blackhawk engine T700 as good examples. In general, however, the Army puts more stress on its equipment than commercial users put on theirs (the Army must land planes in the desert, for example) and this makes warranties riskier for suppliers.

Army officials also cited user moral hazard as an issue. For instance, John Deere used to issue a standard 2-year warranty on the lawn mowers it sold to the Army, but later reduced it to 1 year after finding that troops were “mowing rocks.” Moreover, when equipment is issued individually, there is a higher risk that warranties will be invalidated due to unauthorized use.

Another difficulty with warranties on sophisticated equipment is that contractors are not able to certify repair technicians at every Army depot. Contractors may be unwilling to warranty equipment if they cannot guarantee that certain repairs will be done by qualified individuals. This practice is similar to many manufacturers of consumer electronics who require users to bring warranted equipment to authorized repair shops.

The Army has difficulty taking advantage of warranties

Warranties are sometimes wasted by the Army because the coverage period starts upon delivery but most items the Army buys are delivered to a warehouse where they may sit for 1 to 2 years (often the entire length of the warranty). If warranties are to have the desired

incentive effect on equipment design, the coverage period should begin when the equipment is placed in service.

Tracking parts and equipment is especially costly for the Army because of high volumes and high turnover of equipment.

Finally, an increasing share of the Army's procurement investment is devoted to software, and a current challenge is to design warranties for software that will ensure on-time delivery and continuous updates.

Suitability for DoN

The evidence from both commercial and military practice suggests that the desirability of maintenance agreements must be decided on an item-by-item basis. In some cases the OEM is the best qualified to perform maintenance.

The risk-sharing advantages often arise from consolidating requirements across several customers; consolidation eliminates individual risk and permits efficient performance of aggregate workloads, which are less likely to vary. The defense manufacturer we interviewed indicated that these circumstances may not exist in many DoD purchases. Although in principle, this manufacturer believes it should provide maintenance for DoD systems because it is the most qualified, it hesitates to do so because it cannot spread risk across multiple customers. As an OEM for the DoD, it is primarily concerned with whether the future support costs can be predicted with accuracy. This manufacturer would hesitate to assume the maintenance risk for brand new systems, but would be willing to do so for commercial or legacy systems.

One recent study [7] lists criteria for the suitability of CLS and PVS for a particular system. The three main criteria are:

- *Uniqueness within DoD.* The less commonality the system has with other DoD systems, and the more it is supported in the commercial sector, the more likely it is that CLS will be beneficial. If a system is very similar to other DoD systems but not to commercial systems, it may be cost-effective to maintain a single

in-house support capability to service all of the common systems.

- *Facility and maintenance assets.* If DoD already has a large sunk cost in maintenance facilities (depots, intermediate maintenance activities, training facilities), equipment, and trained labor, then it has an already-paid-for infrastructure that makes CLS less attractive. This criterion may not be important if the DoD maintenance infrastructure can be transferred to the contractor.
- *System stability/technology change/reliability.* DoD would like to maintain systems that are stable, with a low propensity for technological change. If a system is constantly changing due to new technology or reliability issues, then past training becomes less valuable. As a result, it may be cost-effective to pursue CLS.

The V-22 program representative agreed with the last criterion, saying that maintenance bundling might be appropriate for any equipment that is complicated, such as forward-looking infrared radar (FLIR). However, equipment with a simple design can probably be supported in house.

Leasing instead of buying equipment

Under a leasing arrangement, the equipment supplier retains ownership (equity) risk but transfers responsibility for maintenance and repair to the user. The supplier may be under warranty to assume some of the maintenance risks, but typically the user is responsible for any required maintenance or repair that is not the result of manufacturing defects.

Leases are generally classified into two types, “operating” and “capital,” depending on their duration. Operating leases, which last for a term shorter than the expected useful life of the equipment, are attractive to buyers who have a short-term equipment requirement. At the end of the lease term, users have the option of returning the equipment to the lessor, buying the equipment (possibly at a pre-negotiated price), or extending the lease. Operating lease charges incorporate a risk premium that compensates lessors for bearing the residual risks of ownership and obsolescence.

Capital leases (or finance leases) cover most of the useful life of the equipment. This type of lease is used mainly as a source of financing. Rather than paying for the equipment up front, the user makes regular payments over its lifetime. Private sector users may choose to lease for tax reasons, because lease payments can be deducted more rapidly than interest and depreciation.

Equipment that a user already owns may also be leveraged to free up working capital through what is called a sale-leaseback. The user sells its equipment to a lessor but continues to use it and make lease payments.

Because the likelihood of equipment damage often depends to a great extent on user behavior, it is usually efficient for leases to impose some maintenance and repair risks on users. For instance,

auto leases usually require users to pay for regular oil changes, insurance, and any damage to the vehicle.

Observations from commercial practice

There are many examples of leasing in the commercial sector.

Leasing enables frequent upgrading

In many cases, the decision to lease is driven by a desire to avoid obsolescence. If a company wants to upgrade to new equipment every 2 or 3 years, it is often cheaper to lease. For instance, many hotels now lease furnishings, Best Buy leases a server farm to run all of its on-line retail [8], and the National Cancer Institute leases a Cray supercomputer from Silicon Graphics. By leasing as opposed to owning, they avoid the transactions and search costs associated with selling or upgrading the equipment after using it. In this way, users are able to maintain flexibility in their choice of fixed assets.

Leasing value is limited for lifetime owners

Of course, the related observation also applies. If a buyer intends to use equipment for all of its usable life cycle, operating leases are unattractive because they incorporate additional costs to cover lessor risks. For example, the USPS generally assumes that its equipment has a 10-year life although it may keep the equipment longer if it can be updated and modernized. In most cases, USPS plans to use its equipment for its entire service life, and thus has not found operating leases to be an attractive option.

Leasing reduces user risk of future value

Airline acquisition representatives increasingly view leasing aircraft as a way to reduce their exposure to the risk of future aircraft value. They believe an “exit” or disposal strategy is very important to have for planes, especially at present, when prices for second-hand airplanes have plummeted. This benefit from leasing, along with the ability to adjust fleet size quickly in response to changes in demand for air travel, are the most attractive aspects of leasing (the tax benefits are less valuable).

Operating leases are viable when a secondary market exists

The aircraft leasing company we interviewed acts primarily as a financing firm that purchases new planes for customers and arranges sale-leasebacks of planes belonging to other airlines that need to raise cash. The company also own several hundred airplanes which are available for operating leases. Its service is valued by the airlines because it quickly provides assets to meet the short-term needs of the airlines. The company can operate efficiently because the market for aircraft involves many customers, and the aircraft can be reused by these different customers.

In contrast, according to representatives at a ship leasing company, the commercial shipping industry uses mostly capital leases. Operating leases are not common, mainly because, in contrast to the situation for airplanes, there is little demand for used ships. The main reason for the lack of a used-ship market is that it's difficult to place an accurate value on a used ship. There are many different manufacturers to keep track of (including several from China and Romania) whereas there are only two main aircraft manufacturers. Also, little credible data exist on how much or how intensively a ship has been used in the past.

Operating leases require an ability to assess equipment status

Leasing markets work best when there are clear requirements to meet equipment certification standards. These requirements protect the lessor's asset value and discourage users from skimping on maintenance because they have no equity stake.

Aircraft lease contracts state that planes must meet Federal Aviation Administration (FAA) inspection requirements. The operator is responsible for maintenance, which it may outsource. Most ship leases require that the operators meet certification requirements set by the various classification societies, which serve a function similar to that of the FAA. Thus users bear the full risk of maintenance and repair. The certification is also an important requirement for getting insurance, which is a prerequisite for obtaining financing.

Capital leasing provides liquidity

A typical example of a capital lease comes from the textile industry, where Cherokee Carpet Industries leased a \$3.5 million piece of industrial equipment [8]. The primary reason for its decision to lease was to preserve cash to finance its rapid expansion. By leasing, it had more working capital available for core business growth investments.

Liquidity constraints imposed on the USPS by its debt ceiling recently led it to explore alternate financing arrangements. Ultimately it decided the leases it was considering were too complicated. The financial accounting for these transactions involved devices such as special-purpose entities, rendering it insufficiently transparent to non-accountants.

Leasing value is limited if the buyer has good access to capital markets

Again, the related observation is that capital leasing is not a valuable strategy for buyers who do not face liquidity constraints. The manufacturer we interviewed rarely uses leasing. It used to pay “in product” as a similar means to conserve liquidity. Instead of paying for the equipment up front, it would have the manufacturer finance the construction, and then buy output from the equipment manufacturer at an inflated price that would, over time, cover the cost of the equipment. It used to do this because it was a way to get cheap financing, but now it is so large that it can borrow more cheaply than its equipment suppliers.

DoD experience

Navy real estate leases

Navy use of leasing has been limited primarily to real estate. NAVFAC, OICC in Naples, Italy, is acquiring new support facilities. The design and construction are all on private land and are privately financed. The Navy has lease contracts with options for facility maintenance and buyout options for the future purchase of any facility if it proves economically beneficial.

Leasing to experiment with commercial-derivative combat ships

The Navy, in coordination with the Army, has recently entered an innovative lease agreement for a combat ship [9, 10]. The ship is a fast catamaran the Navy hopes to experiment with for two years to determine its ability to serve as a fast and maneuverable littoral combat ship. The leased catamaran was originally built in 1998 as a commercial automobile and passenger ferry. The military has made certain modifications, including a military-specification helicopter deck, a 10-ton crane, a ramp to rapidly load and discharge vehicles, and military-compatible command and control systems. At the end of the lease, the United States will return the ship to the builder (and lessor) Incat, a Tasmania-based company. Prior to a recent combat deployment, Incat had to revise the insurance coverage terms in the lease to account for the higher risk of combat-related damage.

Aircraft leases

USAF in-flight refueling aircraft

In a well publicized debate, the U.S. Air Force has been considering whether to lease 100 modified Boeing 767 jetliners to do in-flight refueling for military aircraft. Although the acquisition has not been finalized, preliminary indications are that the lease would cost roughly the same as a purchase (\$17 billion over 10 years).

The Air Force benefits from the lease primarily because the lease enables it to use funds from the operating account instead of the more limited procurement account. Additionally, the Air Force can spread the payments out over several years. The interest rate on the lease was reported to be between 4 percent and 5 percent, and the Air Force would have the option of buying all the aircraft at the end of the lease for an additional \$4 billion.

The Air Force has also been considering leasing an additional four Boeing 737 jets to be used as VIP transports for lawmakers and military flag officers. The projected lease cost for these jets is \$395.5 million, also roughly equal to the outright purchase cost [11].

NATO transport aircraft

Several European members of NATO recently decided to jointly lease as many as 15 transport planes [12]. They have ordered 196 new planes from the manufacturer Airbus, but these will not be delivered until 2010. Until delivery, a leasing arrangement will satisfy their short-term, interim airlift requirements.

Application to DoN acquisitions

Issues from DoD experience

Budgeting issues

One of the main reasons for leasing in the private sector, and in the DoD experiences is capital constraints. DoD has a unique set of circumstances regarding these liquidity constraints. Congressional appropriations can be volatile so the lessors are concerned about the government's ability to commit to long-term contracts.

Furthermore, government borrowing rates are almost always below private sector rates. Thus, leases, which incorporate the private sector cost of capital, often impose additional costs on the government.

In addition, the way in which leases are accounted for in Congressional appropriations or "scored" can affect the potential value of leasing. Most capital leases constitute an unfunded contingent liability that should be interpreted as requiring scoring (or being paid for) up front. This in turn defeats the purpose of "spreading" payments over time.

Secondary market issues

Two issues arise concerning the secondary market. First, there is no viable secondary market for combat equipment⁴. Thus, many of the reasons for leasing are not applicable. Second, even for equipment

4. To some extent, there is a secondary market composed of foreign military sales (FMS) of older combat equipment to largely poorer governments. However, DoD must approve all such sales, so this market is far from "free".

with a commercial secondary market, the customization required for military use imposes very significant costs, and probably provides little value to the commercial market. This drawback is exacerbated by the potential cost of early termination of the lease.

Suitability for DoN

Leasing may be a cost-effective option for the DoN if many or all of the following conditions are satisfied:

- The equipment is needed for only part of its useful life.
- There is an active resale market for the equipment.
- The DoN does not intend to make many modifications to the equipment.
- The DoN does not want to bear the risk of residual equipment value.

Purchasing services instead of equipment

Under this practice, the end user of equipment assumes neither ownership risk nor responsibility for maintenance costs. We can think of this practice as leasing bundled with maintenance. In exchange for a fixed fee, the user buys the right to use the given equipment for a specified time. Renting a car is a prime example. One can also think of this practice as outsourcing equipment supply. Often it is combined with outsourcing the labor required to operate the equipment as well. An example of the latter case would be chartering a bus and driver.

As with operating leases, this type of procurement is advantageous to buyers who have only a short-term need for the equipment. Purchasing services provides transaction cost savings (there is no need to buy and re-sell equipment) and savings from risk-pooling.

Renting out durable equipment services for fixed periods of time (as opposed to selling the equipment itself) provides monopoly equipment suppliers with greater ability to earn monopoly profits. This ability comes from the fact that a rental-only monopolist retains ownership of all equipment, which gives it an incentive not to flood the market and drive down price. A sales monopolist, on the other hand, having sold its first few units to consumers willing to pay a high price, will eventually want to lower its price to sell to the rest of the market. Intelligent consumers should foresee this and refuse to pay too high a price to begin with.⁵ For this reason, purchasing services rather than equipment is more likely to benefit buyers when there are many potential suppliers of the equipment. Also as in operating leases, the rental price must include a risk premium to compensate the supplier for bearing the risk of ownership.

5. This insight is known as the Coase conjecture, after an article by the economist Ronald Coase [13].

Users who buy services have limited ability to custom-tailor or modify the equipment to their liking. A user is constrained by the choices available in the market.

Observations from commercial practice

Firms that design technology and outsource production

A common form of purchasing equipment services (together with the labor to operate the equipment) in the private sector is the practice of outsourcing manufacturing. For instance, DuPont and IBM can become more specialized in the research and design of products by outsourcing the manufacturing [14, 15]. Contract manufacturers like Celestica are able to spread the fixed costs of maintaining an assembly line across several customers.

Saving from non-union wages and union resistance

The manufacturing company we interviewed occasionally purchases services rather than equipment. For instance, it has outsourced some of its logistics activities, specifically the personnel who weigh trucks as they leave the plant. Company representatives noted that the savings they realize from this practice come mainly from paying non-union wages.

At the same time, a key concern with outsourcing is the impact on the in-house labor force. For instance, the USPS has a heavily unionized labor force, which constrains its ability to outsource (which is a means of buying services instead of equipment).

DoD experience

NMCI

The DoN has been actively outsourcing many of the activities it used to perform in house. A prime example is the Navy Marine Corps Intranet (NMCI). Under this innovative agreement, the DoN will no longer own its computers or be responsible for maintaining its network. Instead, it will pay a fixed monthly subscription fee for the

services of a computer and network. This way, the DoN pays only for the services it uses.

The NMCI contract is expected to achieve savings by standardizing equipment as well as centralizing support, logistics, and management. The contractor has a built-in incentive to procure and provide reliable equipment. The agreement contains many specific performance criteria, with associated financial penalties if the contractor fails to deliver. The contract was awarded in 2000 so it is too early to assess whether the program has achieved the projected savings.

The Army is buying copies, not the copier

U.S. Army representatives mentioned that they have utilized performance-based service contracting, such as buying copies rather than the copier. Force command in Atlanta converted to this type of contract for photocopiers and realized significant savings.

Transport planes for the UK RAF

In an innovative contract, the United Kingdom is using leasing plus bundled maintenance to bridge transport requirements while it awaits production and delivery of 25 Airbus transport planes. In September 2000, the UK entered a \$700-million contract to lease four Boeing C-17 planes for a period of 7 years, with the option of two further annual extensions. Support and Royal Air Force (RAF) crew training is provided by the USAF-Boeing flexible sustainment team, for which the UK will pay \$500 million over the life of the contract.

Application to DoN acquisitions

Replacing equipment purchases with purchases of the end-service requirements is likely to yield savings for the DoN under the following conditions:

- The DoN has an infrequent or volatile demand for the equipment.
- There are other potential users of the equipment in the marketplace.

- There is a competitive supply of the end services.
- The commercially available equipment needs no modifications for DoN use.

Partnering and long-term contracting

The following definition of partnering appears on the Department of the Navy's Acquisition Reform website, "Partnering is a commitment between a buyer and supplier to improve communications and avoid disputes. Partnering is an informal means of building trust, eliminating surprises, anticipating and resolving problems, and avoiding disputes."

In the commercial context, we encountered several definitions. Partnering is a general commitment between buyer and supplier to pursue mutual goals. It acknowledges a long-term relationship (common destiny), thereby fostering more relationship-specific investment by both seller and buyer with the hope of generating larger payoffs in the future. Partnering may sometimes entail an explicit exclusivity clause under which the buyer agrees not to purchase from other suppliers. These varied definitions illustrate the ambiguous nature of partnering in practice.

The greater cooperation fostered by partnering offers several sources of potential savings:

- The supplier gets guaranteed future orders.
- The buyer gets a volume discount and more say in equipment design.
- A smaller supplier base makes it easier to monitor suppliers' cost and quality.
- Increased trust saves the cost of writing and enforcing detailed contracts.
- The supplier can develop more client-specific expertise to help it tailor client-specific solutions.

Observations from commercial practice

Chosen partners should reflect employees' preferences

A company's employees often have superior information about the pros and cons of various manufacturers' equipment. The Microsoft procurement manager "evangelizes" the use of "preferred" vendors throughout the company but faces a need to balance employee choice with company buying power [16].

The manufacturer we spoke with added that certain "integrated suppliers" and group purchasing concepts didn't work well for his company because the choices offered are too limited and they have many different types of equipment to maintain.

Nevertheless, the savings from buying in bulk can be substantial. For instance, a medical equipment procurement agent we interviewed cited average savings of 25 to 30 percent over best group purchasing organization prices (or government prices) by aggregating one-time, special project spending with ongoing capital spending within each buyer, as well as across buyers.

Partnering provides savings from standardization

The airline representatives we interviewed said their airline has recently entered a long-term sole-source procurement agreement for its aircraft. Under the deal, the airline has options to buy additional copies of the same plane without having to renegotiate the whole contract.

The airline knew it was losing leverage by entering this contract but calculated that the savings from aircraft standardization (lower maintenance and sparring costs, for example), as well as the better quality of the product would offset whatever competitive forces were given up. The fact that it already had a large number of aircraft (and expertise) from the manufacturer also factored into the decision.

The transportation representatives we spoke with said their company has also been exploring standardization of parts and configurations (the Southwest Airlines Model). In practice, they feel that

100-percent standardization is impossible because OEMs continually introduce new technology—and even new configurations—on later production runs of the same models. It comes down to a tradeoff of the costs and benefits of having a diverse air and ground fleet.

Long-term partnering can provide preferential treatment

Exclusive partnering allows the airline to receive some preferential treatment. One such benefit is that it can choose the mix of aircraft sizes it wants and pay the same unit price for all aircraft. The airline likes this feature because it allows flexibility in case its needs or demand changes in the future.

The USPS is similar to the DoN in that its contractors are asked to develop technology (such as the automated flat mail sorter) with limited outside application.

For the USPS, partnering is strategic. It feels that having a long-term supplier gives that supplier a chance to provide an ongoing monitoring and analysis of its needs and to develop new technology that is particularly suited to USPS. For instance, one supplier has effectively become its requirements provider in information technology. The supplier suggests ideas for adoption, and USPS is free to take them or leave them. USPS is also free to pay only for the idea and compete the implementation.

The buyer must know the supplier's cost structure well

In the airline-aircraft manufacturer partnership, there is no sharing or opening of accounting books to one another (this is true for the industry as a whole). The airline acquisition managers' perceptions of the supplier as a true "partner" were less than enthusiastic. They assumed that the supplier was consistently trying to find the highest price the airline was willing to pay. They remarked that the supplier usually uses the word "partner" only when it wants something.

According to the airline representatives, the key to success under such a sole-source agreement is simply to know the supplier's costs better than the supplier itself and negotiate well.

Another example is Ford Motors, which is moving to reduce its sheet-steel supplier base to make it easier to then monitor suppliers' costs and quality. In this case, partnering is not an exclusive sole-source relationship and competitive factors are retained [17].

Partner has opportunities to take advantage

The representative of the manufacturer we interviewed saw partnering as a chimera, and did not believe in "win-win" negotiations. He believed a good program manager should not go into a negotiation already prepared to make a concession. His company tries never to use sole source unless the item is absolutely unique.

Another reason the company is averse to "partnering" is because it is easy for the prime contractor to hide extra profits. For example, a contractor may own several of its subcontractors, who could sell their products to the prime contractor at inflated prices. The contractor could keep its own, visible, profit margin low while reaping large profits through its subsidiaries.

Maintaining competitive pressure while partnering

The USPS used to have about 15 suppliers, but with the contraction in USPS spending, it now has only a handful. It tries to maintain at least three healthy suppliers by spreading its spending. One danger from such a strategy is that a given supplier may realize that it is assured of receiving a share of USPS business simply because the USPS wants it to stay in business. Such a guarantee removes competitive pressure and reduces the supplier's incentive to perform well. This phenomenon is often referred to as "moral hazard." The USPS reported that it doesn't run into moral hazard problems because there is a second tier of suppliers that's capable of joining the first tier. To stay viable when they are not getting prime USPS business, suppliers in this second tier either produce a commercial product or they do a significant amount of work as a subcontractor. USPS is willing to abandon (and has done so in the past) top tier suppliers that don't meet expectations.

Representatives of the transportation company told us they keep two suppliers active to guard against the risk of strikes or other shocks and

to ensure a steady supply of ground vehicles. In their experience, there has been no resulting moral hazard problem because the suppliers are always competing for a larger share of their business. There is also always the risk of getting no sales in a given year.

In the markets for aircraft components, there are often only a few suppliers left. For such procurements, the transportation company's main leverage is on the quantity term (bulk discounts). It always looks to alternate sources of supply as well (for example, well-established online resale networks and swap markets). It also tries to use the same avionics on all its aircraft so that the supplier knows there will be a long-term commitment and stable demand.

DoD experience

The DoN has a small supplier base for its major ship and aircraft systems. The long-term nature of these procurement projects requires partnering almost by default.

Spare parts

Naval Regional Contracting Center (NRCC) Detachment London has partnered with major European industrial manufacturers for the purchase of spare parts. Article price lists (APLs) anticipate total demand over the upcoming year, thus enabling the sole-source manufacturer to give price breaks for its volume buys.

Missile defense

A DoD acquisition practice similar to partnering is called alpha-contracting (or delta-contracting, if more than one supplier is involved). Alpha and delta contracting emphasize partnering in the acquisition process, beginning with the solicitation package. Army acquisition representatives cited the example of Theater High Altitude Area Defense (THAAD) which is a 5-year-old program. Contractors were involved with the program office from the very start, even in the writing of the scope of work. This allowed increased information flow and insight into latest commercial technology.

Trucks

The Army also realized benefits from alpha contracting for the PLS truck (used for ammunition transport) Engineering Mission Module Program. The Army reports that cycle time was cut in half, proposal preparation costs were cut in half, and hardware costs were cut by 20 percent [18].

Explosives

In another program awarded in 1998, the Army Industrial Operations Command (IOC) used partnering to procure RDX/HMX explosives with the requirement that the Holston Army Ammunition Plant (HSAAP) be utilized as a production facility for the next 25 years. Competitors were allowed to develop and submit any performance plans that satisfied the Army's requirements. The winning proposal involved producing the ammunition at a different location for the first 5 years of the contract, during which time the HSAAP would undergo modernizing investment. Doing so yielded savings of \$183 million over the planned cost. This program is a good example of specifying critical requirements only and allowing contractors the flexibility to address the requirements creatively [19].

Application to DoN acquisitions

From the evidence gathered, it appears that partnering works best when there are alternate sources of supply to which the buyer can turn. Both the USPS and transportation company experiences support this finding. There is also evidence of savings that result from consolidated purchasing (hospital equipment is one example reported here). Partnering also yields benefits when a buyer requires its suppliers to make specific investments. Suppliers may be more willing to do so if they perceive that their partner status will give them a greater chance of winning future business. Examples of this include the USPS supplier who suggests information technology requirements, as well as an the airline's partner who allows the airline more choices over its particular mix of future aircraft.

Finally, acquisition managers must trade off the value of having diverse equipment and employee choice with the savings from aggregated purchasing. The diversity in legacy equipment may also influence the decision to partner. The larger the single supplier's share of existing equipment, the greater the economies from standardization are likely to be. Partnering with this supplier is likely to yield savings in logistics and maintenance on top of the volume discount.

Intellectual property management

The intellectual property (IP) generated as an input to or a by-product of equipment production has become a more valuable resource as the information-based economy has blossomed during the past decade. As a result, IP has garnered increased attention in acquisition contracts. Commercial firms have discovered it is important to assign property ownership clearly at the outset.

Intellectual property rights are intended to give inventors a monopoly position to reward them for innovation and creativity. Most of the practices detailed below are ways to mitigate the consequences of a monopoly supplier. Some issues we encountered include how to compete technology, clarifying ownership of IP created after the equipment has been delivered, how to handle modifications of patented technology, leveraging potential commercial applications of military technology, and the use of open platforms.

Observations from commercial practice

Suppliers may claim IP ownership *ex post* and charge for its use

The fact that certain earlier procurement contracts do not clearly specify who owns intellectual property has led to a current dispute between the commercial airline we visited and its OEM. The airline is now being asked to pay for information that used to be freely provided. Examples include service bulletins, equipment data to program a simulator, and data that the OEM calculated during production which the airline needs in order to make a modification. For certain equipment-related data that are generated from the airline's flights, the OEM either claims ownership or in some cases restricts the airline's ability to provide these data to a third party. The existing contract does not clearly define who owns all these rights,

and future contracts will be more explicit. Consequently, data rights are now an additional important item for negotiation.

The USPS generally doesn't pay for research and development (R&D), so the supplier owns the technology. The USPS does make sure that it gets ownership of any improvement patents, after which it can negotiate prices for cross-licensing.

One problem the USPS has encountered recently is "interfacing." It interpreted a certain contract to mean that USPS could freely add on new technology to the OEM's machine as it became available. But the OEM interpreted the contract more narrowly, and objected to adding on something that would involve slicing deep into its machine and possibly revealing something proprietary. In future contracts, it will be explicitly spelled out that the OEM is to make interfaces open and non-proprietary, and if there's something that is proprietary, USPS will pay the OEM to develop a non-proprietary, open version with which to interface.

To protect against being tied to the OEM for a significant percentage of the spares or upgrades, USPS always gets detailed drawings for spares so that it can compete the production. Equipment is upgraded and updated with new technology/software as it comes available over the life of the equipment. As a result, USPS seldom finds itself in a sole-source situation.

Competing the technology

USPS described a typical acquisition involving the development of new technology. Each potential supplier comes up with a design and builds a prototype. USPS pays for part of the cost of building a prototype, under a fixed-price contract. Then USPS deploys each prototype in numerous field trials in a representative sample of facilities for several months. The award is based on performance in the field trial, cost, and the technical proposal (criteria include past performance, spares, training, etc.)

The ability to compete the technology avoids the cost of paying monopoly rents to the patent holder. In the past, a company like Siemens-Dematic would own the technology for 20 years and would

license it to three or four equipment makers who would compete in manufacturing. USPS now competes the technology because it has found several qualified R&D firms in the marketplace.

Seek out new technology

Finally, even though USPS is subject to “buy American” laws, it still actively travels the world to look for the best technology. If it finds something better abroad, it will try to convince the developer to either license the technology to an American firm or open an office in the United States.

Capitalize on IP generated through one’s own operations

The transportation company we interviewed is very involved in the specifications for its vehicles because it has long historical data on operations and maintenance costs which it uses to inform design improvements.

This company has also realized revenue from the intellectual property it generates through operations. For instance, it has a life-cycle cost-minimizing maintenance model on aircraft service vehicles that it has sold to an airline.

DoD experience

Developing IP with both military and commercial application

Since 1990, the DoN has increased its use of Cooperative Research and Development Agreements (CRADAs) through its Office of Technology Transfer. Through these agreements, the DoN partners with private contractors to develop technology with joint military and commercial application. The DoN retains patent rights and offers private industry the option to license for commercial product development.

U.S. Army Land Warrior Program

The U.S. Army has a few programs that have been innovative in handling intellectual property issues. In the Land Warrior program, for instance, the government bought technology and licensed it back to

the contractors, also allowing them future commercial application. The program funded R&D under firm fixed-price performance-based contracts, and the contractors performed well ahead of schedule.

Building on the success of the Land Warrior program, Congress has asked the Army to spend \$25 million to start a technology incubator. This fund is similar to the CIA's \$300 million venture fund which operates to seek out and develop promising military technology that may also have future commercial application.

Application to DoN acquisitions

Issues from DoD experience

DoD business is a small piece of many high-technology markets

Instead of the traditional announcement in the Commerce Business Daily, the Land Warrior program actively sought out companies with cutting-edge technology in components (for example, technology using GPS and visors that let a soldier know where everyone else is). As a result, program managers were able to find suppliers of compelling technology who otherwise would not have initiated contact with DoD. According to these suppliers, DoD business is no longer large enough, relative to their other markets, to justify active pursuit of DoD contracts.

Buy or license up front all the IP that will be needed

Another way in which the Land Warrior program is innovative is in the allocation of IP rights. Under the traditional procurement system, the private sector developer of technology would often retain ownership of a necessary patent, only to use it later as leverage against the government customer.

To avoid such a situation, the Army contracted for greater ownership of technology in the Land Warrior program. It bought or licensed the pre-existing patents it needed (and funded development of new ones) and guaranteed the developers future access to these patents for potential commercial application. By owning the revenue stream

from any future patent use and by controlling all technology relating to its own application, the Army reduces future risk.

The General Accounting Office has also studied IP issues in procurement. One study of depot maintenance contracts found that a large percentage were awarded as sole-source, primarily because DoD had not obtained the technical data rights for many weapon systems. This made competing the maintenance work difficult and probably led to higher overall maintenance cost.

Clarify ownership of jointly developed IP

A third innovative feature of the Land Warrior program is its use of license fees to clarify IP ownership when the technology has been developed with joint inputs. For instance, one contractor had patented a laser range finder separately and wanted to mix this IP with new Army funding to develop new technology. In this case, ownership of the new patent would have been unclear.

To resolve this dilemma, the Army took its cues from private industry, which works by setting IP license fees. This way, the Army would either buy the patent at the outset and in the future, license it back to the contractor for any commercial application, or else pay the contractor a license fee and then own outright any resulting technology.

Consortia foster IP sharing and decentralized development

Finally, in the Land Warrior program the goal was to harness wide technology sharing so multiple companies all had guaranteed access to each other's technology for future potential commercial application, in exchange for "reasonable" license fees. Joining the consortium was contingent on agreeing to make your IP available to the other members.

Suitability for DoN

Elements of a successful IP strategy in acquisitions include:

- Pro actively seeking out suppliers with relevant technology
- Ensuring ownership of any IP that may be required to make future modifications, improvements, or repairs (for example,

technical drawings for spares), which may require purchasing independently developed technology

- Clarifying ownership of improvement patents
- Competing the development of technology
- Packaging organically generated IP for revenue opportunities.

Incentives

The acquisition process has also been evolving to incorporate more incentive-based compensation throughout the supply chain. In practice, commercial equipment contracts are individually tailored, but they share a standardized set of clauses that are necessary to protect buyers. Common devices include holdbacks, penalties, and bonuses.

Observations from commercial practice

Incentive pay for acquisition managers

The USPS has been running an internal pilot project for the last 2 years that pays bonuses to program managers and assistants who achieve successful acquisitions. USPS is also exploring ways to look back and track the actual realized cost of all equipment over its life cycle.

Contract penalties can be detrimental

The USPS has experimented with disincentives and penalties in the past but found they did not work as intended—often the supplier found it cheaper to pay the penalty than to comply. Such behavior eventually led to contract termination and many legal claims being filed on both sides.

The manufacturer we interviewed occasionally uses a penalty clause if taking a piece of equipment out of service would incur a significant cost.

The airline representatives emphasized that easy-to-verify variables are necessary for incentive clauses to work well. They have found that penalty clauses don't work very well for components or services because they create an adversarial relationship. Instead of assessing

penalties if an aircraft does not meet the performance criteria, they simply do not pay the OEM.

Shared savings contracts work only if savings are easy to identify

USPS has enjoyed success with shared savings contracts, which give contractors an incentive to perform by paying them a percentage of the value they provide USPS. USPS runs research tournaments⁶ for ideas that can result in objectively measurable savings. A good example of something objectively measurable is the optical recognition success rate for scanning software improvements. The value of reducing the error rate can be calculated with virtual certainty. USPS decided to let its suppliers conduct research (with in-house engineers competing too) and held competitions where the prize would be the first year's savings. The result of these tournaments has been an increase in read rate accuracy from 14 percent to 85 percent.

USPS officials expressed concern that perhaps they are paying too much for this type of tournament. The suppliers gladly sink lots of research funds into these competitions with no guarantee of any return. USPS worries that the incentives may be too strong, and that these firms may be more than willing to do the same research if the prize were only a half-year's savings.

One instance in which USPS chose not to enter a shared savings contract was with someone who wanted to sell a training system to reduce workers' compensation claims. It was simply too difficult to separate savings realized as a result of the training system from other factors.

Performance guarantees and early-delivery bonuses

The manufacturer we interviewed places incentives on its suppliers in more traditional ways, through performance guarantees. Upon delivery, if the equipment does not meet the performance criteria contracted for, it withholds final payment. The remedy language in case performance is not adequate is spelled out in the contract.

6. A research tournament is a competition in which several teams submit designs and/or prototypes, and the team judged to have the best design wins a prize.

Sometimes the manufacturer offers bonus payments to get equipment delivered sooner.

The airline representatives we visited said they seldom use bonus payments for early delivery or better performance on certain criteria because they believe the contractor is already being paid for the required specification.

DoD experience

V-22 PBTH

The V-22 program has a contract clause that gives the DoN all data rights if Rolls Royce fails to provide adequate service. However, program representatives felt the contract should have more monetary incentive clauses (both awards for better-than-expected performance and penalties for sub-par performance).

Base utilities

Energy savings performance contracts have also become very popular on DoN installations. Providers of more energy-efficient equipment are paid as a share of the realized utility savings.

Army performance-based contracts

Meanwhile, the Army has made extensive use of incentive payments. For the Apache program, formulas on reliability and other performance metrics determined an annual award fee. Despite the objective standard, there was heavy political pressure to award the fee every year even if it wasn't quite deserved. The contractor failed to receive the full award fee in only one year.

In a program for missile development, the contractor was awarded on the basis of successful test shots. Continuation of funding was contingent on demonstrated progress in public venues at every stage of development.

A large ADP buy for wholesale logistics modernization also used incentives. Seventy percent of the contract amount is a bonus tied to

performance (the contractor proposed this arrangement). It is unclear how much of the bonus is really “at-risk.” In the first year, the contractor received the maximum bonus.

Outcome-based contracting is also being considered for the replacement of M-16 automatic rifles. Contractors would be free to be more creative in achieving the Army’s desired outcomes, rather than following a military specification design. Payments under the contract would reflect performance in the various outcome measures.

Application to DoN acquisitions

Issues from DoD experience

DoD has poor incentives for program managers

The Land Warrior program manager expressed dissatisfaction with the lack of incentives offered to military program managers. He asserted that the DoD business model has been very process-oriented, and as a result, some program managers could not be fired because they had followed the process, regardless of the program outcome. There is thus little incentive to take any productive actions that are outside the standard procurement process, such as developing insight into technical solutions or actively seeking out new, potentially higher-value suppliers.

According to the Land Warrior program manager, because DoD program managers are so constrained by the process, it is difficult to assign blame or accountability when a program does not deliver the promised product at the promised cost. Instituting accountability is made even more difficult by the high turnover among DoD program managers.

Additionally, Army acquisition officials believe attention to life-cycle cost in the acquisition process is often lacking because (1) a program manager is rewarded based primarily on the capabilities delivered and (2) the contractor has no incentive to cut a future potential revenue stream in maintenance, repair, and overhaul. As a result, neither buyer nor seller has a strong incentive to reduce future

maintenance and support costs at the time of procurement. By contrast, the British and Israelis field their systems completely, so that the competing contractors know it will definitely be a longer term agreement.

The Army officials reported that new legislation is being debated that would allow separation of quantity and dollar-value in procurement contracts, so that savings could be used to buy more units. It is felt that this is one way to reward program managers for cutting costs.

Suitability for DoN

Incentives can play a beneficial role when applied properly throughout the acquisition process. Elements of successful incentive initiatives are:

- Objective, easy-to-measure performance criteria
- Accurate tracking of life-cycle cost to assess program manager performance. (This may be difficult to implement when there is high turn-over among acquisition managers.)

Potential pitfalls to avoid include:

- Offering too large a reward under shared-savings contracts (relative to a fixed-price procurement)
- Penalty clauses that engender adversarial relationships.

Note that incentives can be given not only to suppliers but also to acquisition managers.

Other innovative practices

In this section, we list several other innovative practices that emerged from our interviews with acquisition managers. They do not fit neatly into any of the categories identified previously.

Discounts for earlier payments

Air Force acquisition managers reported that they are saving \$1.5 billion on the C-17 program (equivalent to seven extra planes over the life of the contract) by paying Boeing earlier than in the past (this is allowed by DFARs). The government pays the cost of capital as a production cost, while the plane is being built, rather than at the end of the contract. Thus as Boeing incurs production costs, it is receiving some revenue to reduce its working capital requirements and is passing along the resulting savings. The airline representatives we interviewed also mentioned that sometimes suppliers will give them a discount for paying their bill earlier.

Streamlined negotiations

The USPS reported having more streamlined negotiations than the federal government. There are no separate “competitive range,” “discussions,” and “clarification” processes as in federal government negotiations. Instead, all negotiations are considered “discussions” therefore compressing the negotiations phase of the acquisition and reducing the time and money vendors spend waiting.

Simulations

Army representatives reported the increased use of simulations in the acquisition process. CAD, CAM, and stochastic modeling are increasingly used to do war gaming simulations, improve fidelity, and reduce the uncertainties of a system at an earlier stage when problems are

easier and cheaper to fix. One issue now is how to build simulation requirements into requests for proposals (RFPs).

Conclusion

In the last decade, both DoN and commercial purchasing practices have changed significantly in an effort to become more efficient. In this report, we surveyed the business and trade press and interviewed acquisition representatives of large companies in an effort to identify innovative commercial acquisition practices. We collected information about the problems and advantages associated with each practice, and identified conditions under which each practice would be most suitable for wider DoN application.

Table 2 summarizes our findings. For each group of innovative practices, we list a few commercial and DoN examples, as well as the conditions under which each practice would be suitable for more widespread DoN application.

As indicated in table 2, we were able to find at least one DoN application of each innovative practice we studied. However, it is possible that a greater number of DoN programs can benefit by implementing one or more of these innovative acquisition practices.

Almost all of the practices we identified are motivated by at least one of the following underlying objectives:

- Pool risks and demand across multiple buyers of the same item
- Provide suppliers incentives to manage life-cycle costs.

The benefits to be derived from the first group of innovative practices in table 2 depend on the existence of other buyers in the marketplace. These practices are direct vendor delivery, third-party maintenance/logistics, maintenance/warranty bundled with equipment, leasing, and purchasing services rather than equipment. In instances where the DoN is one of many consumers of a given good or service (most commercial off-the-shelf items would satisfy this criterion), the DoN could achieve savings by expanding its use of these practices.

Table 2. Innovative acquisition practices since 1990

Acquisition practice	Best suited for DoN if	Commercial examples	DoN examples
I. Practices that shift equipment-related risks away from the buyer			
Direct vendor delivery	<ul style="list-style-type: none"> - Inventory costs significant - Replacement frequency low - There are other buyers to pool risks/ get bulk discounts - Implemented at initial system acquisition 	- Philips Medical Systems (replacement parts)	- NAVICP (Sub Sonar Systems) - NAVSEA & NAVICP (Emergency Escape Breathing Device)
Third-party logistics	<ul style="list-style-type: none"> - Performance metrics and associated incentives clear - Third-party can spread cost of maintenance infrastructure over many buyers 	-Avionics parts	- NAVSUP & FISC Norfolk (Galley Equipment) - TC-18 aircraft
Maintenance/ warranty bundled with equipment	<ul style="list-style-type: none"> - Maintenance expense risks can be pooled over end users - Design/production choices significantly affect O&S costs - OEM has lower maintenance costs - DoN purchase is small relative to total market 	- Harley Davidson (manufacturing equipment) - Hospital equipment	- NAVAIR & NAVICP F-18 E/F Radar - T-45TS Trainer aircraft
Leasing	<ul style="list-style-type: none"> - Demand is short-term - Active resale market, predictable value at lease end - High transaction cost to reselling - Equipment depreciation independent of user behavior, or - Contractual restraints on user behavior not too costly - Competitive supply 	- Best Buy (computer servers) - Airlines (aircraft) - Hospital equipment	- NAVSEA & OICC Naples, Italy Support Facilities
Purchasing services vice equipment	<ul style="list-style-type: none"> - Criteria are those for “leasing” and “maintenance bundled with equipment” combined 	- DuPont, IBM (Manufacturing)	- Navy Marine Corps Intranet
II. Practices that alter the contractual relationship between buyer and supplier			
Partnering	<ul style="list-style-type: none"> - Long-term relationship - Volume purchases 	- Microsoft (computers) - Ford Motors (steel)	- NAVSUP, NRCC Det London (Spares)
Patent licensing	<ul style="list-style-type: none"> - Improvement patents likely - Future access to patents necessary (for modifications, repair, etc.) 	- Aircraft data for simulator	- DoN Office of Technology Transfer
Incentives	<ul style="list-style-type: none"> - Objective, verifiable criteria - Accurate tracking of life-cycle cost data 	- USPS Program Manager bonuses, shared-savings R&D	- Energy-savings contracts - V-22

 Increasing contractor role
 

The second group of innovative practices (partnering, intellectual property ownership, and explicit incentive-based contracting) can be applied even when the DoN is the largest, or the only, buyer of a given item. The benefits from these practices stem from aligning suppliers' interests with those of the DoN.

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