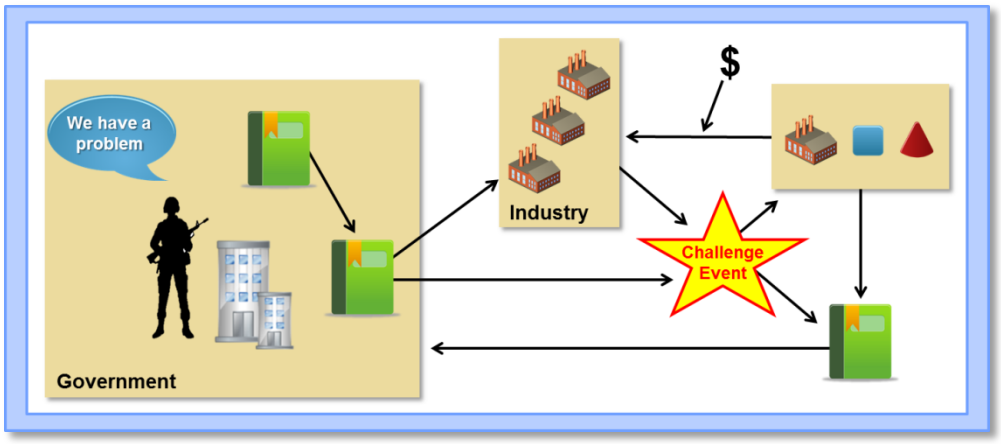
Challenge-Based Acquisition

Stimulating Innovative Solutions
Faster and Cheaper
By Asking the Right Questions



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Executive Summary

The DoD acquisition process needs Challenge-Based Acquisition (ChBA).

- The current DoD acquisition process is flawed. Fewer than half of the DoD Major Defense Acquisition portfolio programs meet established metrics for cost or performance.
- ChBA provides an alternative that lets government and industry work together to meet mission-related needs.

ChBA functions through cooperation between government and industry and allowing each to perform its best role.

- Government communicates its needs through challenges that are analogous to a desired capability.
    - Challenges are transparent and understandable.
    - Challenge apparatus are obtainable or accessible by any party.
    - Challenges may include guaranteed reward for success.
- Industry accepts the challenge
    - It expends corporate assets to meet the challenge.
    - It expects to recoup expenses by selling its solution to the government.
    - It hopes to refine its solution for sale outside the government.
    - It develops and submits its solution for government assessment.
- Government assesses industry submissions using published, transparent criteria for success
- Government takes some action on the results
    - It purchases one or more challenger offerings, or
    - It refines and reissue the challenge, or
    - It does nothing.

The Joint Improvised Explosive Device Defeat Organization (JIEDDO) used ChBA.

- JIEDDO faced the sudden need for a new class of robot for the war in Afghanistan.
- JIEDDO issued challenges that communicated the soldier's need.
- Challenges were drawn from standards developed by NIST.
- Six vendors accepted the challenges and brought robots at their own expense.
- Testing determined that two classes of robot were needed to meet user needs.
- JIEDDO clarified and reissued challenges.
- Responses resulted in fielded systems in less than one year.

ChBA fits into the DoD acquisition process

- It applies most naturally to small, technology-driven capabilities, but it can be used for aspects of large acquisitions.
- It supports the process described in DoD Instruction 5000.02.
- Acquisition law and regulation allow demonstration testing and ChBA.

For ChBA to be successful, acquisition leaders must commission and sponsor early-adopter programs that fit well into the ChBA paradigm.

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Mandate for Change

Fewer than half of the DoD Major Defense Acquisition portfolio programs meet established metrics for cost or performance.[1] Even worse, entire programs were cancelled for cost overruns under the Nunn-McCurdy Amendment after spending billions of dollars.[2] According to GAO, 50 out of 74 breaches involved engineering design issues discovered after production had begun.

> *It's time to fundamentally change the way that we do business in Washington. To help build a new foundation for the 21st century, we need to reform our government so that it is more efficient, more transparent, and more creative. That will demand new thinking and a new sense of responsibility for every dollar that is spent.*[3]
>
> – President Barack Obama

Traditional acquisition approaches, geared towards protecting the government from fraud and waste, create an arms-length relationship between the contractor and the government. A paper specification becomes the primary interface between mistrusting parties. This limits dialog, teaming, and the flow of ideas through discovery. Both parties are bound to early, hasty decisions, resulting in cost overruns, design failures, and unattained performance goals. This paper proposes a challenge-based approach to acquisition that encourages industry to innovate and to invest in creating viable solutions.

Acquisition Practices

Challenge-Based Acquisition (ChBA) is a practice that lets the private sector work for the government rather than against it. In the 1980's, the DoD recognized that specifications are burdensome and costly. Acquisition reforms deleted many military specifications from contracts and emphasized outcome and performance. ChBA takes those reforms to the next step. ChBA saves money and time by increasing government focus on needed capabilities while engaging private industry's speed and innovation. ChBA is founded on codifying government needs as objective concrete challenges that are issued to a marketplace of competing vendors.

Using ChBA, the government communicates its needs through challenges that are analogous or identical to a desired capability. Industry responds to the challenges without extraneous constraints. Challenges abstract away irrelevant concerns and are analogs for the government needs. For example, challenges could extract unclassified portions of a need out of an otherwise classified situation. Challenges must be transparent and understandable. If possible, challenge apparatus should be obtainable or accessible by any party wishing to address the challenge. Concrete challenges can convey nuanced levels of control in acquisition that are not possible with static specifications. ChBA creates a division of labor where the government focuses on its needs and private industry focuses on solutions.

When a challenge is accepted by industry, government agencies observe the challenger's performance and then take one of these actions:

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[1] Defense Acquisitions - Assessments of Selected Weapon Programs, GAO-11-233SP, www.gao.gov/assets/320/317081.pdf, March 2011.
[2] Trends in Nunn-McCurdy Breaches, GAO-11-295R, www.gao.gov/assets/100/97334.pdf, March 2011.
[3] President Barack Obama, Weekly Address, April 25, 2009.

- Purchase one or more of the challenger offerings based on confidence in the product utility demonstrated during the challenge.
- Refine and reissue the challenge based on what was learned during challenge performance. This can be part of an exploratory or incremental government strategy. Sequences of challenge can also be used to partition a multi-faceted problem.
- Do nothing. Challenge results did not inspire confidence that the government needs would be met, precluding the risk of wasteful acquisition. Alternatively, the challenge might have had desirable side effects such as the creation of private markets from which the government can benefit without further intervention.

Although ChBA is best known today as the basis for cutting edge projects like DARPA's Grand[4] and Urban[5] Challenges or the SpaceX[6] space delivery system, the concept is much older. In 1714, an Act of Parliament established the British Longitude Prize[7]. The determination of longitude was crucial to maritime navigation which supported British global exploration, trade, and colonization. The Longitude Board, which administered the prize, did not fund technical research but simply promised monetary awards based on the accuracy of proven results: £10,000 for 60 nautical miles of accuracy, £15,000 for 40 nautical miles, and £20,000 for 30 nautical miles. The prize encouraged development of the maritime chronometer which revolutionized global navigation.

The Wright Brothers' contract with the U. S. Army[8] is another example of reward for performance. The Wrights came to Fort Myer, Virginia, to compete in Army flight trials in June 1909 to prove their airplane's performance. Over several weeks, the Wrights fulfilled each challenge, including the official speed trial. The contract stipulated that they would receive a 10 percent bonus for every full mile per hour above 40. Their average speed was 42.5 miles per hour, which rewarded them with a $5,000 bonus and brought the final purchase price of the airplane to $30,000.

In more recent times, the aviation industry continues to make ChBA-like opportunities. When aircraft operators abstracted away the details of engine design and simply challenged power plant makers to perform in terms of thrust, weight, and efficiency, General Electric's Jack Welsh conceived the idea of performance-based logistics. He sold "power by the hour"[9] which relieved aircraft owners of the need to inventory, maintain, and repair engines. As a result, costs of engine inventories, maintenance, and repair were cut dramatically in the commercial airline industry.

ChBA can change perspective in both product providers and consumers. It demonstrates outcomes using stated criteria that are met through proof of delivery and not just a proposed design. ChBA application can:

- Field the correct solution the first time,
- Avoid rework cost and schedule slips,

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[4] DARPA Grand Challenge, en.wikipedia.org/wiki/DARPA_Grand_Challenge_(2005), October 2005.
[5] DARPA Urban Challenge, archive.darpa.mil/grandchallenge/index.asp, November 2007.
[6] SpaceX Corporation, www.spacex.com/company.php.
[7] Longitude Prize, en.wikipedia.org/wiki/Longitude_prize.
[8] The Aerial Age Begins, airandspace.si.edu/wrightbrothers/age/1910/military.cfm
[9] Power by the Hour: Can Paying Only for Performance Redefine How Products Are Sold and Serviced?, knowledge.wharton.upenn.edu/article.cfm?articleid=1665, February 2007.

- Accelerate the assimilation new technology, and
- Encourage parallel functionality and interoperability development.

Challenge-Based Acquisition Strategy

For ChBA to work, it must be easy to get in and easy to get out. That is, any company with the resources and good ideas to address a challenge must be given the chance. Equivalently, a challenger that succeeded in the past but fails in the present should be swept aside. As such, the utility of ChBA depends on the existence of multiple companies capable of addressing a government challenge within their capital risk tolerances. The availability of capital is a key component of the environment in which ChBA operates.

Table 1 compares government and civilian approaches to the acquisition of small and large products. The best examples of free enterprise can be found in the acquisition of small products for the civilian market. A small product is one that can be brought to market with capital obtained from private sources. In this domain, if industry can envision a better mouse trap, get money to design, produce, and market it, then it is in business. The free market will either embrace the product or not. If it does, industry makes money, repays its investors, and considers improving the product line. If it does not, it goes broke, investors attempt to recover their money by liquidating industry assets, and life goes on.

Table 1. Challenge-Based Acquisition Market Context

Acquisition Size	Civilian Market	Government Market
Small	Free Enterprise Private business operates in competition and largely free of state control. Successful companies flourish and unsuccessful companies are allowed to fail.	Challenge-Based Acquisition Government specifies what it needs in terms of concrete challenges. Multiple companies risk their own capital to address the challenge in anticipation of production contracts.
Large	National Industrial Policy Shifts national resources to specific industries in order to gain international competitive advantage. Examples include the US automobile bail out and agricultural subsidies.	Traditional Acquisition The government writes a specification and industry bids to implement the specified capability. Private enterprise cannot afford the capital risk needed to design and produce goods such as warships and fighter planes without government purchase guarantees.

Large products in the civilian world are obtained through national industrial policy. Products in this context include a self-sufficient national energy supply, a viable source of domestic automobiles, or agricultural exports to balance the national trade account. While the United States does this implicitly through regulation and legislation, other nations have explicit policy agencies like the Japanese Ministry of Economy, Trade and Industry[10] (METI).

[10] Ministry of Economy, Trade and Industry, en.wikipedia.org/wiki/Ministry_of_Economy,_Trade,_and_Industry

Traditional acquisition is applicable when the government needs to acquire large products like warships and fighter planes. For large acquisitions, industry does not have sufficient capital risk-tolerance to answer a challenge without a guaranteed government market. There can be competition but it is not based on product performance but rather on vendor estimates of the cost to satisfy a specification. Large acquisitions can also be incremental rather than revolutionary in capability. The next warship or fighter plane has a lot in common with the system it will replace. When this is true, the predecessor system capabilities become an implicit part of the new system specification. In other words, the new system specification is a delta beyond the specification of the system it replaces. This tight coupling from one system generation to the next could be a barrier to the application of ChBA which relies on the ability of a challenge to capture user needs.

ChBA is best used when the government needs to obtain small products. Small products are those that can be built to address a challenge using private capital and without the reduced risk of a guaranteed government market. In this case, ChBA is analogous to civilian free enterprise in Table 1. Free enterprise uses market preference to choose winners while ChBA uses challenge satisfaction to choose winners.

One risk of ChBA is a lack of challengers. The size or likelihood of a reward for meeting a challenge may not be enough to entice private industry to risk its capital. If too few challengers come forward, the government may:

- Make clear the financial reward for meeting a challenge or
- Reduce industry's capital risk by offering stipends.

It is important that winning a challenge is a win for the winner. It is common to hear government officials talk about cost saving in terms of reducing contractor profit and increasing government oversight. These remarks are made in the context of contracts that overrun cost and schedule or have Nunn-McCurdy breaches. But they are disincentives for innovative industry which thrives on profit. Money should be saved by acquiring more efficiently rather than squeezing profits. Allowing a challenge winner to profit has two effects:

- Incentivizes the winner to compete again and
- Serves as a beacon to attract other competitors to future challenges.

Government Role

Government takes on a new role in ChBA. In traditional acquisition, the government communicates its needs in a specification and hopes that fulfillment of the specification will address mission needs. The specification could be under-constrained, over-constrained, appropriately-constrained, or simply wrong. If the specification is under-constrained or wrong, mission fulfillment is unlikely. If the specification is over-constrained, it could be impossible to implement. But this won't keep contractors from claiming that the over-constrained specification can be implemented and, in the process, spending a fortune on a fool's errand. The fundamental flaw in this process is the failure to recognize that specification and design are linked.

Henry Ford is supposed to have said "If I had asked people what they wanted, they would have said faster horses."[11] More recently, Steve Jobs said "You can't just ask customers what they

[11] quoteinvestigator.com/2011/07/28/ford-faster-horse

want and then try to give that to them. By the time you get it built, they'll want something new."[12] End users have difficulty imagining radical alternatives or inventive solutions when they have a working solution at hand. Soldiers, for example, are good at finding innovative solutions to combat problems using their supplied equipment and whatever they can find on the battlefield. Similarly, they are expert at predicting success of incremental improvements to devices and techniques. However, it is hard to extend this innovation beyond the readily conceivable. Even the brightest horse riders would have had trouble picturing the utility of the Model T. Analogously, involving soldiers in the specification of battlefield needs limits the inventiveness of potential solutions.

If, when Henry Ford asked the people what they wanted, he heard; "I want to get to my destination faster and with comfort and affordability" we would have a different situation. In this case the people issued a concrete challenge, get there faster with comfort, rather than a specification, a faster horse. Unfortunately agents of government, like Ford's public, don't think in terms of challenges but in terms of tighter specifications to existing solutions.

So, if challenges are a better way to communicate what the government needs and soldiers don't express themselves in terms of challenges, what is to be done? Some government agency must take responsibility for creating challenges on behalf of the users. In doing so, the government assumes risk because challenge creation requires the ability to:

- Generalize user experience and needs
- Decompose complex goals into sequences of challenges
- Design concrete challenge apparatus
- Perform statistical analysis of challenge results
- Find unclassified analogs to classified situations

This requires vision, engineering, and commitment beyond what is needed to issue requests for proposals or Broad Agency Announcements. Even though this may be seen as risk in the current acquisition environment, it makes a positive demand on government leadership. ChBA asks the government to rise to the intellectual level of industry by creating thoughtful challenges that give industry the latitude for innovation and get the users what they need.

The flow of a hypothetical challenge-based acquisition is shown in Figure 1. The process begins when the government becomes aware of a user's need. The acquiring agency or its technical support organization postulates a capability that can satisfy the user's need. This is a creative process and requires more technical insight than simply recording what the user has requested.

With a desired capability in mind, a set of concrete performance challenges are crafted that demonstrate the ability of the envisioned capability to solve the user's problem. As an example, the user problem could be that soldiers need better situational awareness when fighting in urban areas. The envisioned capability could be some sort of information sharing mechanism. A supporting challenge might be to show that solders, while receiving urban combat training, have better scores when using a candidate challenge solution than those who did not use the solution.

[12] Steve Jobs interview with Inc. Magazine for its "The Entrepreneur of the Decade Award" as quoted on en.wikiquote.org/wiki/Steve_Jobs, April 1989.

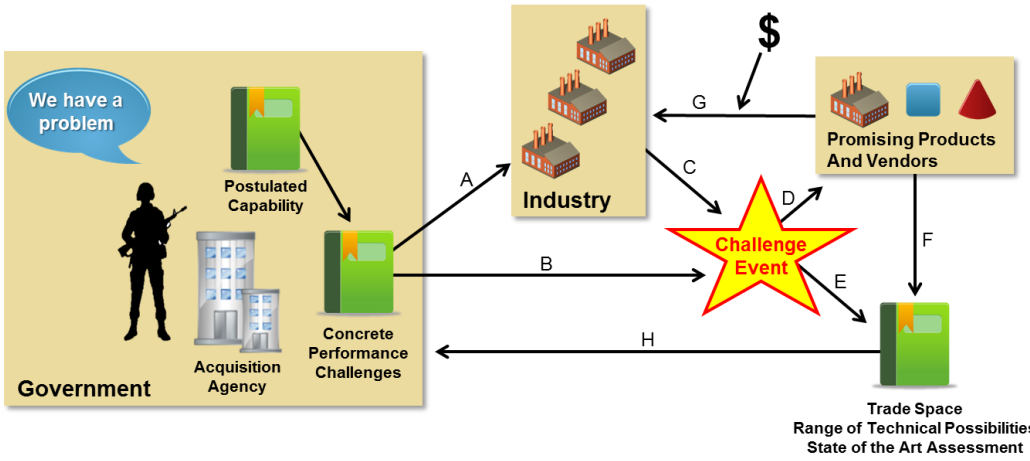

Figure 1. Challenge-Based Acquisition Process

Two activities begin once the challenge descriptions are in hand:

- Challenge descriptions are advertised to industry who begin to decide if accepting the challenge is in their economic best interest and, if so, to formulate solutions. This is depicted by arrow A in Figure 1.
- Physical test methods are designed and arrangements made for challenge execution, depicted by arrow B.

The challenge event can vary from large, periodic, public occasions to a private, one-time visit to a testing laboratory. At arrow C, industry decides to attempt the challenge. There are two results available when industry attempts a challenge:

- Increased government knowledge of potential solutions and their vendors. Depicted by arrow D.
- Understanding of the trade space in which a solution might be found. Arrows E and F show that this understanding comes from both observed challenge-event performance and information available about promising vendors and their products.

Arrows G and H show that ChBA can be a cyclic process:

- Industry may return to make another attempt at challenges. The government may also take this opportunity to directly fund promising vendors. Direct funding rewards vendors for their initiative and incentivizes them to make another challenge attempt, depicted by arrow G.
- Based on improved knowledge of the needed capability and the technical trade space, the government can revised the challenges and begin the process again, depicted by arrow H. This can be important for the acquisition of complex systems where multiple steps may be needed to correctly state the challenge or arrive at the needed technology.

Case Studies

Case Study: JIEDDO

The Joint Improvised Explosive Device Defeat Organization[13] (JIEDDO) mission is to "Reduce the effectiveness and lethality of IEDs, to allow freedom of maneuver for joint forces, federal agencies, and partner nations in current and future operating environments."[14] In its strategic plan, JIEDDO recognizes the ability to "Employ authorities, flexible resources, streamlined processes, and effective oversight to drive the research and development community to rapidly field C-IED solutions"[15] as one of its enduring capabilities. The computer screen saver, depicted in Figure 2, carries JIEDDO's serious messages to the staff every day. This intensity of purpose and need for rapid action makes JIEDDO well suited for ChBA.

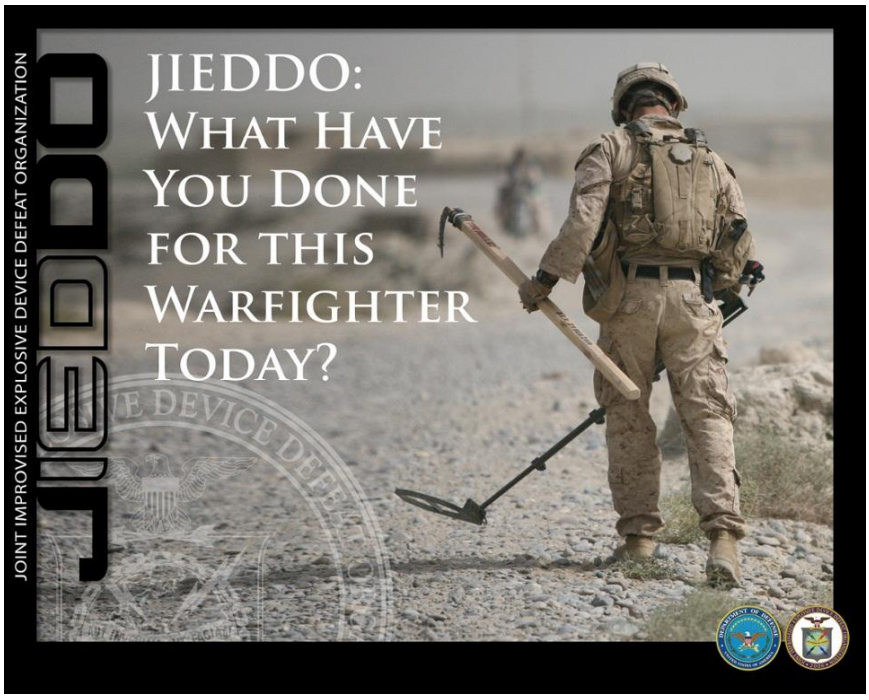

Figure 2. JIEDDO Organization-Wide Computer Screen Saver

In the summer of 2011, JIEDDO faced the sudden need for a new class of robot for the war in Afghanistan. JIEDDO issued concrete challenges that communicated the soldier's need. The challenges were drawn from the suite of Response Robot Performance Standards[16] developed by the National Institute of Standards and Technology[17] (NIST). The NIST test method suite has a range of mobility and duration assessment devices that are excellent models of the challenges robots face in Afghanistan.

[13] Joint Improvised Explosive Device Defeat Organization, www.jieddo.dod.mil
[14] www.jieddo.mil/content/docs/20120116_C-IEDStrategicPlan_ExSum_Final-Web.pdf
[15] *Ibid*
[16] Department of Homeland Security Response Robot Performance Standards, www.nist.gov/el/isd/ks/response_robot_test_methods.cfm
[17] National Institute of Standards and Technology, www.nist.gov

Six vendors accepted the challenge and brought their robots, at their own expense, to NIST for assessment. Some robots met the challenges. Others displayed large gaps between promised capability and actual demonstrated performance. The results of the challenges and the concrete characteristics of the robots were presented to field users in Afghanistan. The challenge performance helped users understand the performance trade space and see that a single class of robot alone could not meet their needs.

The original request from the field was over-constrained. No one type of robot could meet all the requirements. As a result, two classes of robot were identified to address the concerns of two distinct user communities. This important distinction was not found in the original field request.

In addition to clarifying what the user really needed, the challenge process encouraged vendors to improve their products before the government committed to a purchase. The challenge brought transparency and mutual vendor visibility sparking beneficial competition and product improvement. Within months, vendors asked to return to NIST, again at their own expense, to have another opportunity to confront the challenges and improve JIEDDO's perception of their quality. ChBA enabled JIEDDO to go from the initial request to fielded systems in less than a year.

Case Study: JTRS

The Joint Tactical Radio System[18] (JTRS) has been regarded as unsuccessful[19] having consumed more than $15B over 15 years[20] and delivering only a small fraction of its envisioned capability. It is instructive to review the JTRS experience to see where ChBA might have contributed to a better outcome. Remember, however, that large programs, like JTRS, do not fail for a single reason, so humility and caution are appropriate when attempting to harvest lessons learned.

JTRS began in 1998 to create a family of radios for use by all DoD Services based on DARPA's SPEAKeasy[21] software-defined-radio (SDR) technology. An SDR is "a radio that includes a transmitter in which the operating parameters of frequency range, modulation type or maximum output power … can be altered by making a change in software without making any changes to hardware components."[22] Such flexibility promised to save money through consolidated acquisitions and usher in a new era of interoperability between and within the DoD Services. None of this happened, however, as JTRS departed from the key ChBA tenant: build concrete challenges that capture the essence of what the user needs and leave the rest open to industry innovation.

The original proponents of JTRS believed that SDRs would flourish if the government created a software ecology to support their acceptance. This was problematic for two reasons. First, SDR technology is an enabler and not an objective. The SPEAKeasy demonstration proved what SDRs technology could do. With that knowledge, the government should have challenged

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[18] Joint Program Executive Office JTRS, jpeojtrs.mil/Pages/Welcome.aspx

[19] "Failure to communicate: Inside the Army's doomed quest for the 'perfect' radio" www.iwatchnews.org/2012/01/10/7816/failure-communicate-inside-armys-doomed-quest-perfect-radio

[20] Pentagon Shutters Joint Tactical Radio System Program Office, www.nextgov.com/mobile/2012/08/pentagon-shutters-joint-tactical-radio-system-program-office/57173/?oref=nextgov_today_nl, August 2012.

[21] Software Defined Radio – Origins, Drivers and International Perspectives, edited by Walter Tutlebee, Wiley and Sons, 2002.

[22] FCC Order: Facilitating Opportunities for Flexible, Efficient, and Reliable Spectrum Use Employing Cognitive Radio Technologies, hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-57A1.doc

industry to create radios with all the desirable properties found in SPEAKeasy. Instead, the government undertook to create a software framework, tools, standards bodies, repositories, oversight boards, and other components of an ecology with the aim of helping industry build SDRs.

The second problem was the notion of software ecology itself. Software ecology construction is like nation-building. Both are complex social and economic activities whose genesis and design are not well understood. Either SDR was a profound idea around which an ecology would grow or it was not. The government spent large amounts of money advocating a software ecology and, in hindsight, could have remained a technology consumer communicating its needs to industry through challenges.

How might ChBA have addressed the JTRS goals of lower cost, flexibility, and interoperability?

> **Cost** – Challenge vendors to produce a radio, or functional prototype, they would be willing to manufacture in a specified quantity at a desired price.
>
> **Flexibility** – Ask challengers to demonstrate a radio with functionality X. Once done, give them the description of a new functionality Y. Measure how long it takes the vendors to respond to the change.
>
> **New Functionality and Interoperability** – Government creates a breadboard reference implementation of the new functionality. This can be done by government labs, FFRDCs, or private research organizations. The breadboard is not limited by size, weight, or power consumption but must accurately produce the needed waveform and networking functionality. Challenge industry to create the same capability in a battlefield form factor. Interoperability of future systems, potentially from different vendors, is defined by the ability to work correctly with the breadboard reference implementation.
>
> **Legacy Compatibility** – Make examples of legacy radios available to industry. Challenge them to create a new radio that communicates with the legacy radio.

Case Study: HLA

The DoD High Level Architecture for Modeling and Simulation[23] (HLA) is a mechanism to enable multiple independent computer simulations to interoperate. It was the unification of two predecessor technologies: the Aggregate Level Simulation Protocol[24] and the Distributed Interaction Simulation[25] protocol and became the DoD standard for simulation interoperability. While the HLA program was not explicitly a ChBA effort, it demonstrates some important tenets.

HLA has three parts: a software interface that connects simulations, conventions for modeling exchanged data, and rules to govern the process. The software interface and supporting infrastructure system posed a barrier to HLA acceptance. Without supporting infrastructure software, known as the Run Time Infrastructure (RTI), how could the government require the

[23] DoD High Level Architecture: An Update, www.cc.gatech.edu/computing/pads/PAPERS/High_Level_Architecture_For_Simulation.pdf
[24] Aggregate Level Simulation Protocol, en.wikipedia.org/wiki/Aggregate_Level_Simulation_Protocol
[25] Distributed Interaction Simulation, en.wikipedia.org/wiki/Distributed_Interactive_Simulation

use of HLA, be sure the interface specification was correct, or know if client simulations were employing HLA properly? The solution was a government-developed, reference RTI.

A sequence of reference RTI implementations were constructed collaboratively by Massachusetts Institute of Technology / Lincoln Laboratory and MITRE, the creators of DIS and ALSP respectively. The reference implementations enabled early experience with HLA while it was evolving and becoming IEEE, OMG, and NATO[26] standards. The reference implementation also facilitated the creation of an RTI Verification Facility capable of automatically testing thousands of RTI behaviors.

Once the HLA definition was standardized, early adopters were employing HLA, and a facility existed to test RTI implementations, the government dropped support for its reference RTI implementations. At this point the government was effectively issuing a challenge to the software industry to build and sell commercial RTIs. The terms of the challenge were essentially these:

- The reference RTI implementation proved that it was possible to build an RTI that implements the HLA interface,
- There is a small and growing community of HLA users that will need RTIs,
- HLA evolution is in the hands of a stable, international, and open body – the IEEE,
- To assure adherence to the standard, the DoD will only buy RTIs that are certified by the RTI Verification Facility,
- No additional money will be invested in the reference RTI so industry does not need to fear government competition,
- To ensure transparency and encourage competition, the government will publish the list of verified RTIs.

The challenge worked. Within months, there were commercial RTI implementations and supporting tools being sold by vendors in both the United States and Europe. Technical education companies began to offer HLA courses. After almost 10 years, the HLA standard is still being maintained by private industry through the IEEE at no cost to the government.

Aligned Acquisition Approaches

There are few if any original ideas in the ChBA concept. It generalizes and builds on other existing concepts. In this section Capability-Based Acquisition and the Defense Acquisition Challenge are discussed in the ChBA context.

Capability-Based Acquisition

ChBA has much in common with capability-based acquisition. ChBA builds on the capability-based requirements process directed by the Secretary of Defense[27] for use by the Missile Defense

[26] RTO Technical Report 50 - NATO HLA Certification, ftp.rta.nato.int/public//PubFullText/RTO/TR/RTO-TR-050///TR-050-$$ALL.pdf, June 2002.

[27] Missile Defense Program Direction, memorandum from the Secretary of Defense, www.pogoarchives.org/m/dp/dp-rumsfeld1202memo.pdf, February 2003.

Agency. Capability-based acquisition[28] is an attempt by the Missile Defense Agency to address deficiencies[29] highlighted in a GAO report on industry best practices:

- Requirements are set too early, too high, and are too inflexible,
- Product developers are relatively uninvolved in setting requirements,
- The competitive nature of funding motivates the military to over-promise system performance to obtain program approval,
- Over-promised system expectations are transformed into rigid requirements by the inflexible acquisition system and, consequently, consume more resources than anticipated to correct delivery failures.

The approaches to acquisition used by the Missile Defense Agency[30] are instructive.

A basic problem faced by the missile defense builders is reliance on yet-to-be-invented technology. The national agenda required design of the missile defense system to begin before all the necessary technology had been created. The Missile Defense Agency's approach to this problem was to define the capability of the desired acquisition rather than attempting to write specification that included potentially non-existent technology. "A capability can be defined as the ability to perform a course of action … leading to a desired outcome. The capabilities-based acquisition process requires that we identify these capabilities, their requirements, conditions and metrics, and then acquire the right equipment and information services to support the desired capabilities."[31]

Capability-based acquisition and ChBA share the goal of increased focus on capability and relaxed dependency on specification. Capability-based acquisition does this to allow new technology time to evolve. ChBA does it to give industry latitude for creativity. "A capability-based system acquisition is successful if it provides additional capability that is worth the cost."[32] A ChBA acquisition is successful if it demonstrates utility by meeting a challenge representative of user needs.

Capability-based acquisition and ChBA differ in their employment of traditional specifications. In capability-based acquisition, when a technology is sufficiently mature to be employed, the capability description that required the new technology is replaced by a traditional specification. The specification is then used as it would be in a normal acquisition. On the other hand, ChBA relies on the challenge, and not a specification, to communicate government needs.

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[28] Defense Acquisition University definition of Capability-Based Acquisition, acc.dau.mil/CommunityBrowser.aspx?id=245486&cid=271505&lang=en-US

[29] Best Practices - Better Matching of Needs and Resources Will Lead to Better Weapon System Outcomes, GAO-01-288, www.gao.gov/new.items/d01288.pdf, March 2001.

[30] Missile Defense Agency's Vague $923 Million Deal, www.nextgov.com/defense/whats-brewin/2012/07/missile-defense-agencys-vague-923-million-deal/56815/, July 2012.

[31] Capabilities-Based Acquisition...From Theory to Reality, www.doncio.navy.mil/chips/ArticleDetails.aspx?ID=3309, September 2004.

[32] Capability-Based Acquisition in the Missile Defense Agency, www.ncmahq.org/files/Articles/JCM04_pp10-19.pdf, Summer 2004.

Defense Acquisition Challenge

The Defense Acquisition Challenge program[33] solicits technology proposals on an annual cycle from small and medium-sized enterprises. The proposals are for technologies to be introduced into existing acquisition programs where improvements in performance, affordability, manufacturing, or operational capability are expected.[34] The assumption is that the new technology is of off-the-shelf readiness and will replace or augment some aspect of a current procurement. The program is designed to help companies break into the defense market and stimulate innovation.

The challenge in the Defense Acquisition Challenge is for industry to find a place where their products fit into something the government is already buying. In this way it shares the ChBA goal to avoid reliance on explicit specification as a way to lead acquisition. In ChBA, the challenge communicates the needs of the government. In the Defense Acquisition Challenge, the existence and nature of an ongoing acquisition advertises opportunities to new players. The message from the government is an item is going to be purchased in all cases and industry is challenged to provide products that improve it at the component, subsystem, or system level.

The Defense Acquisition Challenge is a promising way to encourage innovation and bring new players into the market. By its design, however, it only improves existing, conventional acquisition programs. Such programs may have expended significant resources just to expose opportunities for innovation which, if successful, will render parts of the original acquisition redundant. ChBA has the advantage of being able to start fresh and avoid forcing industry to accept the constraints of an ongoing acquisition. Viewed another way, the Defense Acquisition Challenge is an example of ChBA where the challenges are not explicitly designed by the government but inferred by industry from existing, specification-based acquisitions.

Alignment with Defense Acquisition System

Defense Acquisition Management

The Defense Acquisition Management System guides the procurement of major military systems. In Section 3 above, it was argued that ChBA is best for smaller acquisitions which are usually not controlled by the full DoD Instruction 5000.02 guidance.[35] Even for large acquisitions, however, ChBA can enhance the standard process by efficiently providing many of the 5000.02 specified components. To appreciate this, a short review of DoD Instruction 5000.02 is helpful. The Defense Acquisition Management System is divided into five phases depicted in Figure 3:

> **Materiel Solution Analysis** – Assess potential materiel solutions and perform an Analysis of Alternatives. This phase begins when an Initial Capabilities Document is approved that contains an analysis of current mission performance and potential concepts from across the DoD. It ends when the Analysis of Alternatives is complete and materiel solution options, identified in the Initial Capabilities Document, are recommended.

[33] Authorized by Title 10, USC, Sec 2359b and the 2003 Defense Authorization Act.
[34] Defense Acquisition Challenge (DAC) Program, cto.acqcenter.com/osd/portal.nsf/InfoDAC?ReadForm
[35] DoD Instruction 5000.02, www.dtic.mil/whs/directives/corres/pdf/500002p.pdf, December 2008.

Technology Development – Determine and mature the appropriate technologies needed for the full system. Critical technology elements, identified in the previous phase, must be demonstrated using prototypes.

Engineering and Manufacturing Development – Develop the full system or some increment of the full system capability. This includes full system integration and creation of an affordable and executable manufacturing process.

Production and Deployment – Achieve an operational capability that satisfies mission needs. This includes low rate production for evaluation of major systems and full production or procurement of smaller systems.

Operations and Support – Execute a support program that meets readiness and operational requirements and sustains the system, in a cost-effective manner, over its total life cycle. This phase also includes disposal of the system at the end of its life.

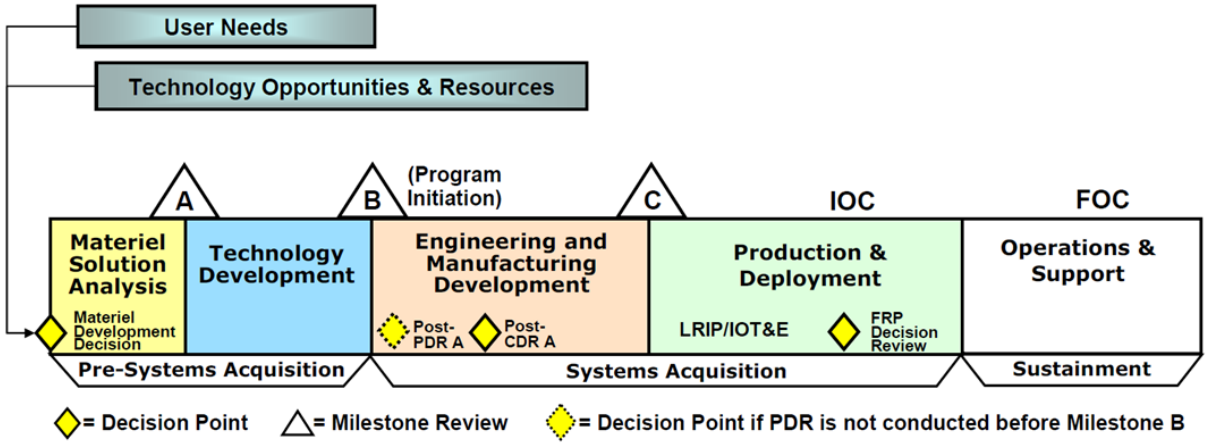

Figure 3. The Defense Acquisition Management System Phases

The Defense Acquisition Management System recognizes the need for an evolutionary approach to acquisition. It states that "an evolutionary approach delivers capability in increments, recognizing, up front, the need for future capability improvements."[36] Increments are managed through repeated application of the Technology Development and Engineering and Manufacturing Development phases.

ChBA finds applicability in the early phases of the Defense Acquisition Management System and in the general evolutionary approach. Specific opportunities for ChBA application are:

- ChBA, as discussed in Section 4, can support an evolutionary approach by incrementally demonstrating capability through a sequence of challenges that build toward the ultimate capability.
- The Materiel Solution Analysis phase calls for the creation of an Initial Capabilities Document.[37] This document is required to contain a description of needed capability and could be used to guide the design of supporting challenges.

[36] *Ibid*, page 13, paragraph 2.a.
[37] *Ibid*, page 15, paragraph 4.c.3.

- The Materiel Solution Analysis phase also calls for the creation of an Analysis of Alternatives. The Analysis of Alternatives enumerates the critical technology elements needed by each proposed material solution.[38] From a pure ChBA standpoint, this is unnecessary because the technology needed to create a capability is only the concern of industry. If, however, the government does become involved in selecting and maturing technologies, a challenge, based on the needed capability, could be used to explore the range of candidate technologies and assess their maturity.
- The Technology Development phase "is a continuous technology discovery and development process reflecting close collaboration between the S&T community, the user, and the system developer."[39] This objective can be served by a standing challenge. A standing challenge is one that persists through time as multiple challengers attempt a range of solutions. Normally, when a challenge is met, it is withdrawn and the victorious vendor's product is procured. A standing challenge gives industry a chance to improve on existing solutions. It also encourages the discovery of game-changing solutions to challenges that have already been solved with more pedestrian technologies.
- The Technology Development phase requires the creation of a Technology Development Strategy. "For an evolutionary acquisition, the Technology Development Strategy shall include a preliminary description of how the materiel solution will be divided into acquisition increments based on mature technology and an appropriate limitation on the number of prototype units … that may be produced ..."[40] A ChBA approach to the Technology Development Strategy is to design a challenge that proves the maturity of each needed technology. The challenge may or may not require a prototype but focuses on attainment of the technological capability.

Federal Acquisition Regulations

Federal acquisition regulations provide for qualification testing and demonstrations to ensure successful performance. Federal Acquisition Regulation (FAR) *Part 2.101, Definitions*, includes the following provision: "Qualification requirement" means a Government requirement for testing or other quality assurance demonstration that must be completed before award of a contract. The FAR and the Defense Federal Acquisition Regulation Supplement (DFARS) contain regulatory and policy guidance to allow testing of designs before implementation and fielding. *FAR Part 11, Describing Agency Needs*, recognizes the need to test, under FAR 11.801 Pre-award in-use evaluation: Supplies may be evaluated under comparable in-use conditions without a further test plan, provided offerers are so advised in the solicitation. The results of such tests or demonstrations may be used to rate the proposal, to determine technical acceptability, or otherwise to evaluate the proposal.

Recent acquisition law, regulation, and policy emphasize investing in design development and prototyping in Defense acquisitions to mitigate performance risk and cost growth. In the Weapon Systems Acquisition Reform Act (WSARA) [41] of 2009, Congress mandates that the Secretary of Defense ensure that the acquisition strategy for each major defense acquisition program include

[38] *Ibid*, page 15, paragraph 4.c.5.
[39] *Ibid*, page 16, paragraph 5.a.
[40] *Ibid*, page 17, paragraph 5.c.7.a.
[41] Weapon Systems Acquisition Reform Act, www.dtic.mil/whs/directives/corres/pdf/DTM-09-027.pdf, December 2009.

requirements to demonstrate capabilities using competitive prototypes, and ensure that appropriate trade-offs among cost, schedule, and performance objectives are considered before development start. DoD Instruction 5000.02 issued in 2008 requires a materiel development decision prior to a program's entry into the acquisition process, causing program offices to invest more funds to mitigate technical risk. Under Secretary of Defense for Acquisition, Technology, and Logistics, in his "Better Buying Power" [42] memorandum recognized the need to make DoD acquisitions more affordable through added investments at the beginning of the acquisition process to ensure a cost-competitive result.[43] GAO recognizes in their report that acquisition activities require higher upfront investments in systems engineering and other areas to reduce longer term development risk, even as DoD's budgetary resources shrink.

Recent precedent has shown that testing has occurred for capabilities and not just specifications:

Information Technology – The federal and commercial market has taken advantage of the highly-competitive, fast-paced environment of IT. Most software manufactures are asked to prove that their software works within an environment and that it can integrate into a larger system. Commercial manufacturers often provide free demonstrations at trade shows and tabletop exercises. The government participates in these product capability sessions. In the 1980's the Navy required hardware and software demonstration testing prior to award at vendor expense on their Computer-Aided Design/Computer-Aided Manufacturing acquisitions (CAD/CAM-II), ensuring that the high-end workstations would perform as promised and to the specification.

Space Transportation – The space industry has had a long history of proving performance in a challenge-based environment. Space Ship One is a suborbital air-launched space plane that completed the first manned private spaceflight in 2004 and won the US$10 million Ansari X Prize for meeting the challenge of going into Space. Space Exploration Technologies Corporation, or SpaceX, is a space transport company headquartered in Hawthorne, California, founded in 2002 by former PayPal entrepreneur Elon Musk. On 25 May 2012, SpaceX made history as the world's first privately held company to send a cargo payload, carried on the Dragon spacecraft, to the International Space Station.

Military Combat Systems – Mine Resistant Ambush Protected (MRAP) vehicles are a family of armored fighting vehicles used by the United States armed forces among others. The design was led by the United States Marine Corps. The purpose of the design is surviving Improvised Explosive Device attacks and ambushes. On July 31, 2007, the Marine Corps Systems Command launched an MRAP II pre-solicitation, to develop a new vehicle that offers more protection than current MRAP vehicles. The U.S. Army Research laboratory worked to ensure the technologies used in Frag Kit 6[44] armor upgrade project would be available to MRAP II designers. The initial testing at the Aberdeen Proving Grounds served to disqualify vehicles that did not meet requirements. The design run-off resulted in only two vendors who could pass the demonstration test.

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[42] Better Buying Power Public, acc.dau.mil/bbp.

[43] USD (AT&L) Better Buying Power Initiative: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending Removing Obstacles to Competition, acc.dau.mil/adl/en-US/491947/file/62644/3-2a PromoteCompetition-RemoveObstacles 11Oct11 (JJH Review Jan 12) DS.pdf, January 2012.

[44] www.army.mil/article/21023/ria-jmtc-rolls-out-first-frag-kit-6

Based on the analysis described above, acquisition law and regulation allow demonstration testing to ensure contractor performance. Precedence has been set through acquisitions in several industries, such as IT and space, where ChBA techniques have been successfully applied. Therefore, it is legal and practical to apply ChBA-like methods to satisfy a critical challenge.

Implementation of ChBA

ChBA implementation requires a solid business case to succeed, one that focuses attention on the real areas of military concern and avoids discussion of irrelevant courses of action. It should be created early and kept transparent to minimize misunderstandings between government and industry stakeholders. A business case should:

- Identify a needed capability or opportunity,
- Make a case for change,
- Describe expected outcomes and benefits,
- Identify stakeholders and their perspectives,
- Address risks, and
- Provide financial justification.

The scope of the ChBA business case needs to be determined by a number of factors, such as the real problem to be solved, the support to the mission, the economic health and competitiveness of the industry, and financial constraints. The scope identifies outcomes, deliverables, project teams, resources, schedule, assumptions, and barriers. Defining the scope of the business case identifies needed resources and avoids wasted activities.

The business case must identify key ChBA stakeholders who will contribute to the project success. Stakeholders for a ChBA approach include users, suppliers, the testing community, military oversight organizations, and financial managers. Stakeholders play a key role in successful business case management. Managing stakeholders will gain widespread approval of ChBA and ensure that the needs and expectations are met. Therefore, ChBA should not be restricted to meet the interests of one or a small number of stakeholders, but reflect the needs of the broader community of interest.

Risks are inherent with any change to a process or product. The ChBA business case must clearly articulate the risks in terms of cost, schedule, performance or technology. ChBA can use benchmarks and known standards such as Technology Readiness Level (TRL) assessments, to gauge the level of risk involved with meeting the challenge and then deploying that solution. Risk analysis must also consider any barriers to overcome with the ChBA approach to demonstration and test of the challenge.

A ChBA business case must contain a cost-benefit analysis and present alternatives and scenarios. The types of costs to be considered include opportunity costs (costs to pursue the challenge), hidden costs, marginal costs of producing only on or a few products, cost of private and public capital investment, sunset or terminal costs to the inventory, and the time value of money for the investment. Since ChBA can be viewed as additional effort over and above the traditional acquisition process for requirements generation and test, it is important to consider all costs to demonstrate and test the challenge by both the government and industry. Benefits can be calculated in two generic categories of tangible (immediately obvious), and intangible (do not directly reflect improvement to the project). Benefits can be further classified as quantifiable

(measurable) and unquantifiable (indirect impact). The full analysis of costs and benefits can be tailored to each ChBA business case.

A ChBA business case should answer these questions:

- Does the government have a plan that describes the desired capability as a set of concrete challenges? Can this plan be effectively communicated to senior leadership?
- Can the challenges be communicated to industry? Are the challenge metrics well understood?
- Are there decision criteria that determine when a specific level of challenge performance implies procurement risk is sufficiently low?
- Where does ChBA fit in the market context? Will perspective challengers have sufficient capital risk-tolerance to participate? What are the economic incentives for industry to participate?
- Is there a source of challenge funding available prior to the beginning of the procurement budget?
- How will the government intention to offer a challenge be communicated to industry? Since innovation can come from unlikely places, what is the plan to reach beyond traditional providers?
- Will all acquisition stakeholders tolerate the uncertainties inherent in a challenge-based acquisition?
- Is the technical expertise available to design the necessary challenges?
- How long will it take and how much will it cost to create the needed challenge designs?
- Who will execute the challenge and where will it be performed? How much will it cost?
- Are the challenge metrics well understood? Are they completely transparent to potential challengers?
- Do the challenge metrics encourage growth of capability in the correct direction?
- For complex capability acquisitions, are proper steps taken to inform industry that the path to success is through a sequence of exploratory challenges? Symmetrically, are steps taken to avoid the appearance that each incremental challenge is simply a pass or fail test.
- Can the government estimate how long it will take industry to create a challenge solution? If not, will the user community tolerate that level of schedule uncertainty?

Acceptance

There is a gap between the latitude allowed by current acquisition law and the state of acquisition practice. This suggests that the culture of acquisition needs attention. Program managers reduce their risk by practicing acquisition techniques they have seen succeed elsewhere. So, steps should be taken to overcome the cultural hurdles to broader acceptance.

Success breeds success. Working examples of ChBA need to be publicized within the acquisition and the supporting professional community. Program managers will feel more comfortable embracing ChBA if they can point to other successful ChBA programs. To get this started, senior leadership must be convinced of ChBA utility so that they will commission a few early-adopter programs. The managers of these early-adopter programs must operate under senior leadership imprimatur and protection. Success of the early-adopters will then encourage more cautious program managers to follow suit.

Conclusion

ChBA can solve a class of acquisition problems defined by industry capital risk tolerance and the ability of the government to express user needs in terms of concrete challenges. It is a logical next step in the current wave of acquisition reforms. ChBA has proven itself in the world of civilian advanced technology acquisition and has been demonstrated successfully in limited areas with the DoD. It requires a renewed government commitment to technical involvement in acquisition while reducing detailed emphasis on specifications. The acquisition agent acts on behalf of the user to create challenges that, if fulfilled, also fulfill the user's needs. This requires creativity, imagination, and technical insight. ChBA encourages the best in industry by freeing them from the constraints not related to challenge success. It encourages new players to participate and creates a level playing field for all involved. ChBA is both legal and practical to use within the current federal acquisition system. Above all, it is an efficient means for stimulating industrial innovation and reducing government acquisition time and costs.

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