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A New Way to Justify Test and Evaluation Infrastructure Investments

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Abstract

In 2013, the Congress directed that a study be conducted on the ability of the national test and evaluation infrastructure to effectively and efficiently mature technologies for defense-related hypersonic systems development through 2030. It further required that a report be submitted to the Congress on the study results, along with a plan identifying the capability needs and proposed defense-related investments. IDA supported both congressionally directed efforts and was subsequently tasked to provide a business case analysis for the proposed investments. For this analysis, IDA used an approach that expanded the cost-benefit "control volume" to include projected system development savings from the Milestone A Technology Maturation and Risk Reduction Phase decision to the Milestone C Production and Deployment Phase decision for three conceptual conventional hypersonic systems. This article describes the IDA-developed methodology used to successfully justify and secure full funding for the proposed five-year, $350 million Department of Defense Test and Evaluation infrastructure investment augmentation.

Introduction

State-of-the-art test and evaluation (T&E) capabilities are essential for successful development of new aerospace products as well as the upgrading of currently fielded products. Despite the unarguable fact that system development programs require a robust and continuing investment in research, development, test and evaluation (RDT&E), including the T&E infrastructure,[1] the Department of Defense (DoD) still must justify additional test infrastructure investments needed to effectively and efficiently develop and field future aerospace systems. This has proven to be a major challenge for facility owners and operators.

If the requirement is so clear, why is the justification so daunting? One reason is that the stewardship of U.S. test capabilities is largely stove-piped and subject to organizational budget pressure and constraints. This is further compounded by the fact that test facilities and test capabilities have historically been treated as cost centers, with their current and future existence determined by a return on investment (ROI) largely predicated on facility utilization metrics (such as occupancy rate or billable test hours per year) or anticipated demand (projected usage associated with known existing or new system development programs). The fact that the test community has struggled for decades to garner support for increased RDT&E infrastructure investments based on these metrics means that the metrics do not, by themselves, make a compelling business case.

In the annual head-to-head competition for funding between research and development (R&D) programs and T&E infrastructure improvements, R&D programs almost always win. The large number of T&E facilities that have either fallen into disrepair, been mothballed, or were closed over the past three decades because their utilization-based business cases failed provides compelling testimony to this reality. If the justification could be successfully made for T&E infrastructure improvements based on utilization metrics alone, the aerospace RDT&E infrastructure would be owned and operated by industry as a profit center. Absent a new, more compelling way of justifying T&E infrastructure investments, the United States is at risk of not having the capabilities needed for future product developments.

Using a Different Justification Lens

Rather than using a facility-focused lens that values increased facility utilization or reduced test cost as its primary investment justification metric, IDA proposed using an approach that values the potential programmatic cost savings that could reasonably be expected to accrue during system development from funding proposed T&E capability enhancements. The rationale behind the use of an investment justification process that treats test capabilities as part of the larger system development programs they support is that the cost of infrastructure sustainment, improvement, and modernization is far less than the cost of the negative consequences that result from going forward with higher development risk caused by not having the test resources—including the facilities, testing tools, test technologies, and workforce—needed to better understand the underlying physics associated with the concept(s) under development.

The IDA Methodology

The IDA value-based methodology involves expanding the analysis “control volume” for justifying T&E capability investments (as depicted in Figure 1) and then developing an acquisition program cost model from the Milestone (MS) A Technology Maturation and Risk Reduction Phase decision to the MS C Production and Deployment Phase decision based on actual cost and schedule data, including all aspects of T&E—for example, flight test schedules obtained from previously successful major defense acquisition programs

(MDAPs) of similar operational capability and/or system complexity. The model is tailored to system-specific programs (still in conceptual design) to estimate the additional cost and schedule growth those programs could encounter if they did not have an adequate T&E infrastructure (as the successful programs did).

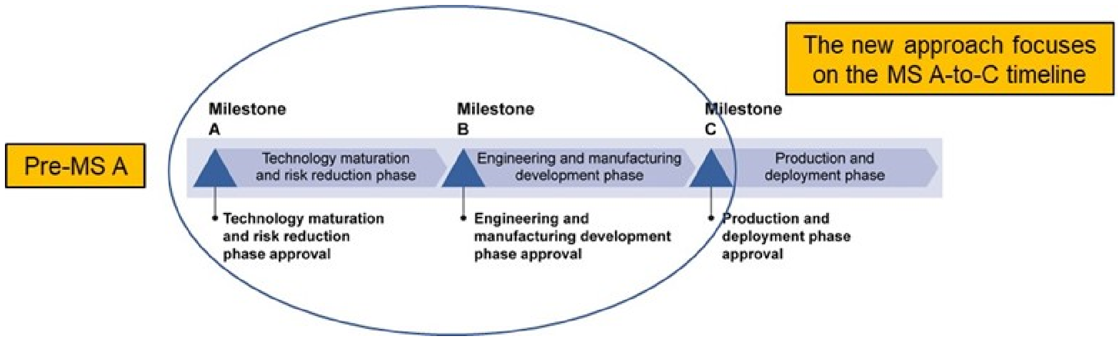

Figure 1. The Expanded Cost-Benefit Analysis Control Volume

It is worth noting up front that this is an extremely data-, time-, and analysis-intensive process requiring substantial involvement and preparatory work by a variety of study team members with experience in both strategic planning and large-scale program development; T&E facility owners; investment stakeholders; and subject matter experts (SMEs) having specific detailed knowledge and expertise in technology development and demonstration, developmental T&E (DT&E), and the allocation of costs across the various elements of system development.

It is further worth noting that this process has the greatest potential for success when the investment stakeholder funding the enhancements owns both the test infrastructure being enhanced and the system development programs deriving the cost savings—as in the case of the DoD—since the requisite expenditures and potential accrued savings are typically in different "funding pots" (or even in different government/industry organizations, as could be the case in the civil aeronautics sector).

Preparing the Pathway

Preparing the pathway to estimate the potential accrued savings for a conceptual system involves three critical steps. The first step is getting the attention of the decision-makers by making a compelling argument as to why the proposed test infrastructure enhancements are important to our nation—because if the decision-makers do not agree there is a compelling need for the proposed capability enhancements, the effort required to develop a value-based justification will be a waste of time and energy (and money). Benefits (or negative consequences) are typically characterized in terms of the military and/or economic impacts derived from the system developments they support. It is worth emphasizing, however, that while articulating the military and/or economic impacts is a necessary first step, experience has proven it is seldom adequate on its own merits to justify an increased investment.

The second step is to define the proposed vision, goals, and capability needs for the T&E infrastructure being enhanced. This step involves gaining consensus among the various participants and stakeholders on the requirements and desired end-states—often referred to as *socializing* the vision, goals, and capability needs. To that end, the assistance of SMEs is needed to help define (1) the key developmental test capability areas, (2) the requisite test objectives that must be successfully demonstrated in each capability area, and (3) those requisite test objectives and data requirements affected by the enhancements, for example as outlined in Table 1.

Table 1. Key Capability Needs (Example)

T/O #	Test Capability Area	Reqd. Perf Parameter	Approach/ Facilities	Test Conditions	Test Variables	Special Equipment	# Flt Conditions	Test Hrs/ Runs	Tot Time
1.0	Aerodynamics								
1.1	Stability & Control Effects								
1.2	Boundary Layer Transition								
1.3	Inlet Performance								
2.0	Aerothermodynamics								
3.0	Materials Characterization								
4.0	Propulsion								
5.0	Stage/Stores Separation								
6.0	Weather/Erosion								
7.0	Guidance/Nav/ Control								
8.0	System Lethality								
9.0	Survivability/ Vulnerability								
10.0	Flight Testing								

The third step in preparing the pathway involves determining the existing test capability gaps associated with meeting the capability needs in Table 1, then assessing which capability gaps are critical and must be closed. This is done by taking each identified gap and quantifying the first-order effects of not closing it on the technical risk, system design and development during both full-scale development (FSD) and DT&E, and system operation and sustainment (O&S), as illustrated in Table 2.

Table 2. Impact and Importance of Not Closing the Identified Capability Gaps (Example)

Gap No.	Capability Gap	Technical Risk (1st Order Effect on Technology Development)	System Design/Development Impacts (1st Order Effect on FSD/DT&E)	O&S Impacts (1st Order Effect on O&S Capabilities)	Importance
C-1	Lack of … Inability to …	• Inconsistencies between… • Inability to predict… • No knowledge of …	• Reduced confidence in the ability to… • Greater operability margins would be required, thereby increasing weight and/or reducing performance • Resolution could require many tens of flight tests to establish the required confidence for initial fielding	• Reduced system range would… • Reduced system effectiveness would…	High
C-2	Lack of … Inability to …	• Inconsistencies between… • Inability to predict… • No knowledge of …	• Reduced confidence in the ability to… • Greater operability margins would be required, thereby increasing weight and/or reducing performance • Resolution could require many tens of flight tests to establish the required confidence for initial fielding	• Reduced system range would… • Reduced system effectiveness would…	Medium

Based on SME assessments associated with each conceptual system application, numeric values ranging from 1 to 10 can be assigned to the importance and a Pareto chart (depicted in Figure 2) can be constructed to determine which gaps, if closed, would have the greatest overall value to each specific conceptual system application. This analysis is repeated for each of the conceptual systems and a collective set of capability gaps is then compiled for all the conceptual system applications included in the business case analysis (BCA), as in the example in Table 3.

This collective set of critical capability gaps forms the basis for the proposed plan that will be evaluated using the IDA-developed value-based methodology to justify T&E capability investments.

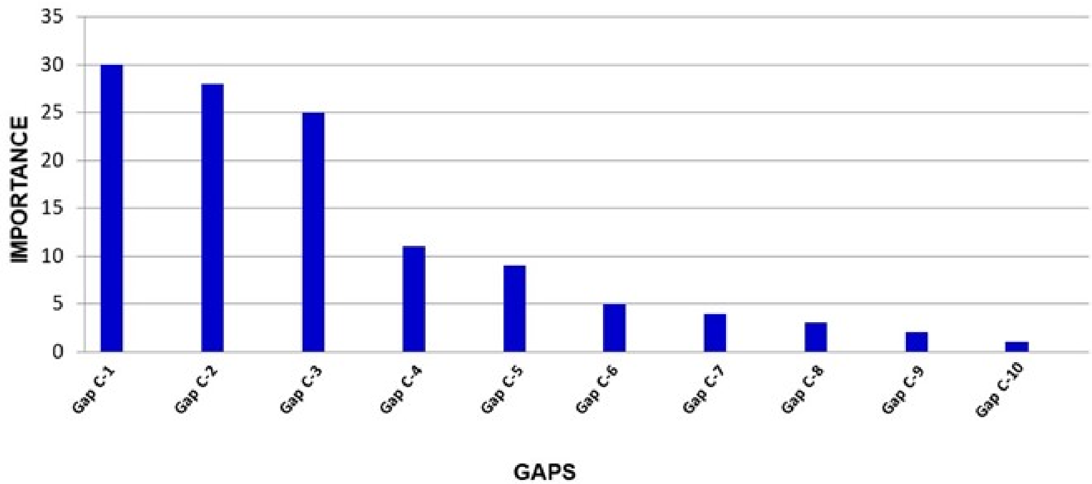

Figure 2. Importance of Not Closing the Gaps for Conceptual System C (Example)

Table 3. Collective Set of Critical Capability Gaps (All Conceptual System Applications) (Example)

System/ Gap No.	Capability Gap	System/ Gap No.	Capability Gap	System/ Gap No.	Capability Gap
A-1	Lack of ….	B-1	Lack of ….	C-1	Lack of ….
A-2	Inability to …	B-2	Inability to …	C-2	Inability to …
…	…	…	…	…	…
A-i	Inefficient CFD tools	B-i	Inefficient CFD tools	C-i	Inefficient CFD tools
		B-j	Lack of ….	…	…
				C-k	Lack of ….

Note: Yellow highlight identifies a gap that may be relevant to more than one conceptual application, but how the gap would be closed may differ from application to application.

Developing a Plan to Close the Gaps

After the pathway has been prepared, the next step in the process is to develop a proposed plan, which involves formulating a list of the projects that must be executed to close the critical capability gaps identified in Table 3. Each project must be defined in sufficient detail (typically one to three pages each) to describe its goal(s), how it will be executed (i.e., the tasks and sub-tasks that must be conducted to successfully complete the project), its execution timeline, any interrelationship it has with other projects in the list (i.e., does it receive input from or provide input to any other projects), and its estimated cost, by fiscal year (FY). From this, a listing can be constructed of all the projects included in the overall execution plan, as shown in Table 4.

Table 4. Project Listing by Conceptual System Application (Example)

Project Listing	Project No.
Conceptual System A	
Project Title A-1:	1
Project Title A-2:	2
Project Title …:	…
Project Title A-X:	X
Conceptual System B	
Project Title B-1:	X+1
Project Title B-2:	X+2
Project Title …:	…
Project Title B-Y:	X+Y
Conceptual System C	
Project Title C-1:	X+Y+1
Project Title C-2:	X+Y+2
Project Title …:	…
Project Title C-Z:	X+Y+Z

After the various projects have been identified and defined in sufficient detail, a cross-walk can be constructed between the projects and capability gaps to assess their interrelationships (as shown in Table 5). Being aware of these interrelationships can assist the program manager in assessing and managing risk during execution of the plan. The end-product of the plan development effort is an executable roadmap (as depicted in Figure 3) showing the projects that are being proposed for funding, their relevance to the conceptual systems used in the value-based justification, their time-phased connectivity to the MS A development "off-ramps" for the various conceptual systems, and the funding both currently programmed and required for each year of the program execution schedule. The difference between the funding programmed and what is required is the augmentation that is being justified using the IDA-developed process.

Table 5. Projects/Capability Gaps Cross-Walk (Example)

Gap #	Capability Gap	Projects												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**…**	**…**	**…**	**…**	**…**	**X**
A-1	Lack of …	X	X				X				X	X		X
A-2	Inability to …							X						
…	…	X			X		X							
…	…	X	X	X		X			X		X		X	
…	…		X	X					X	X			X	X
…	…		X					X				X		
A-i	Inefficient CFD tools		X		X	X				X			X	X

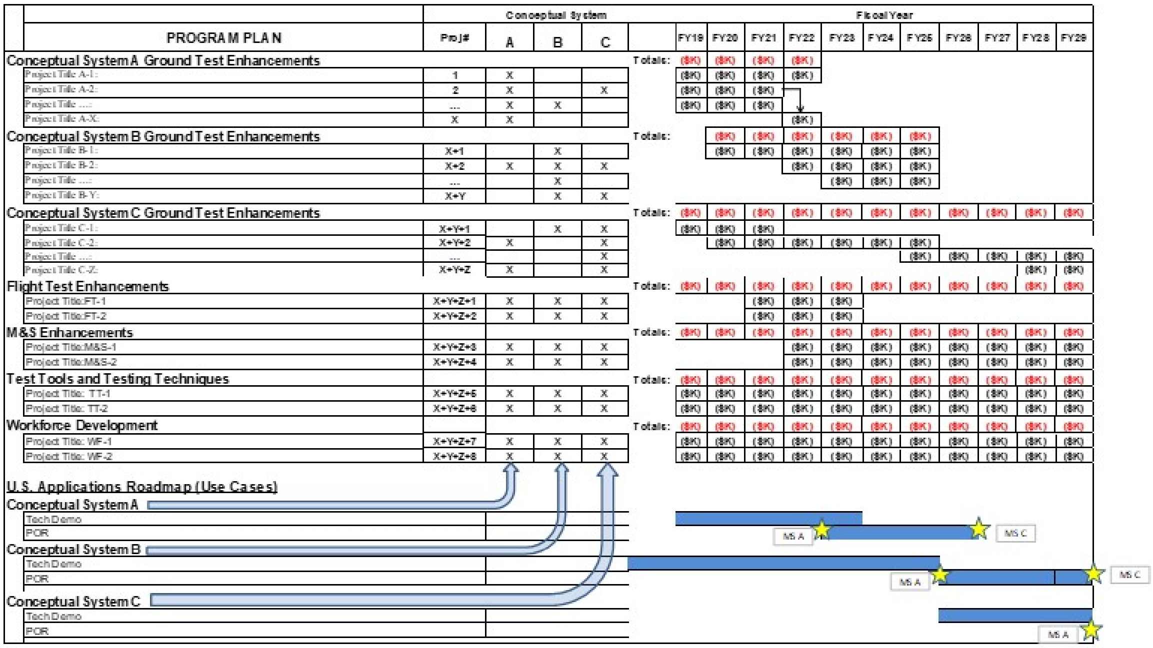

Figure 3. Illustration of Plan Roadmap

Once the plan roadmap has been constructed, it must be socialized with the broader community of capability owners and stakeholders. This involves creating an advocacy briefing package and scheduling a series of meetings with potential stakeholders and mid-level managers, starting at the bottom of the organization and working up the leadership chain.

The purpose of these meetings is to gather information that can be useful in refining the proposed investment augmentation justification (both technically and from a national importance perspective). To that end, the briefing package should clearly articulate the military and/or economic benefits and importance, the vision, the goal(s), the capability needs, and the plan for overcoming the identified gaps. During these meetings, the various views and perspectives offered by the participants should be captured, as these will undoubtedly reveal potential roadblocks to success (at least from their vantage points) that need to be addressed as progress is made up the management advocacy chain.

After these meetings have been completed, and (to the extent feasible) stakeholder and senior management issues and concerns have been addressed, it is time to quantify the cost and schedule impacts associated with not closing the capability gaps that have been identified for each of the conceptual system development programs being used in the justification analysis. The reason all the up-front planning and socialization efforts are necessary is because (as stated earlier) the value-based justification process is extremely data-, time-, and analysis-intensive, so “getting all your ducks in line” before starting will help minimize the probability of having to repeat the BCA.

Quantifying the Programmatic Impacts

IDA uses actual cost data collected on programs in similar mission areas to create a cost model for successful development programs with adequate T&E resources encountering typical problems. Schedule delays are then introduced, the frequency and length of which are determined by T&E SMEs—the proposition being that schedule delays are a direct result of a specific T&E capability gap that masks a design flaw from the design and development engineers.

In the example that follows, the T&E SMEs believed that enhancements in T&E resources (in this case the enhancement of wind tunnel capabilities) were needed to drive a successful design and that without it they would need additional (and relatively expensive) real-world flight tests to unmask even relatively simple design flaws.

The T&E SMEs hypothesized that the design flaws that required major redesigns would persist longer and be revealed later in the system development schedule.

Choosing Reference Programs

The three MDAP programs selected for use in this analysis—the Joint Air-to-Surface Standoff Missile (JASSM), Phased Array Track Radar Intercept of Target (PATRIOT) Advanced Capability 3 (PAC-3), and Terminal High Altitude Area Defense (THAAD)—bracketed the expected development challenges (and costs) the conceptual hypersonic missile system programs would likely face. Each of these three reference programs had a technology readiness challenge.

The operational attributes of these three successful missile systems are as follows:

- JASSM is a subsonic stealthy cruise missile that is used to attack surface targets. It is powered by an air breathing turbojet engine that provides sustained flight in the atmosphere and accomplishes target recognition and terminal homing via infrared (IR) imaging.
- PAC-3 is a tactical, hypersonic, ballistic missile that can achieve speeds of Mach 5+ and intercepts at altitudes of approximately 20 kilometers (km). It was the first MDAP that delivered hit-to-kill technology.
- THAAD is a hypersonic hit-to-kill ballistic missile that employs divert and attitude control technology and an advanced guidance, navigation, and control (GN&C) system to achieve its end-game mission. THAAD pushed the range (approximately 200 km) and altitude (150 km) envelopes beyond the PAC-3 missile.

Table 6 compares the characteristics of the reference programs to the three conceptual conventional hypersonic programs.

Table 6. Characteristics of Analogous MDAPs and Conceptual Hypersonic Programs

MDAP	MDAP Attributes	Parallel Conceptual Programs Analogy
JASSM	• Stealthy cruise missile • Sustained subsonic flight in the atmosphere • Air breathing turbojet engine • Target recognition/homing via IR imaging • Designed to hit surface targets	• Sustained hypersonic flight in the atmosphere • Air breathing scramjet engine • Target recognition and terminal homing • Designed to hit surface targets
PAC-3	• Tactical missile (Mach 5+) • Powered by a solid propellant rocket • Hit-to-kill technology • GN&C/Divert and attitude control	• Tactical missile (hypersonic) • GN&C/autonomous end-game
THAAD	• Hypersonic ballistic missile interceptor • Hit-to-kill technology • GN&C/Divert and attitude control • Extensive flight path (THAAD has an estimated range of 200 km and can reach an altitude of 150 km)	• Hypersonic vehicle • GN&C/autonomous end-game • Extensive flight path/similar altitudes

Identifying the Cost Drivers

Figure 4 shows a breakout of development costs for the JASSM, PAC-3, and THAAD programs in billions of dollars ($B) adjusted to FY 2014. (All cost values in this study were in FY 2014 dollars unless otherwise stated.) The cost values were derived from each program's Selected Acquisition Reports (SARs) and Contractor Cost Data Reports (CCDRs). The THAAD system program comprised two major development efforts: the ground radar and the THAAD missile. Only the portion associated with the missile development was used to inform this cost estimate. Cost Estimating Relationships (CERs) were derived from these cost data. Spacing on the horizontal axis is the average Munition Recurring Unit Cost (MRUC) reported during the development phase.

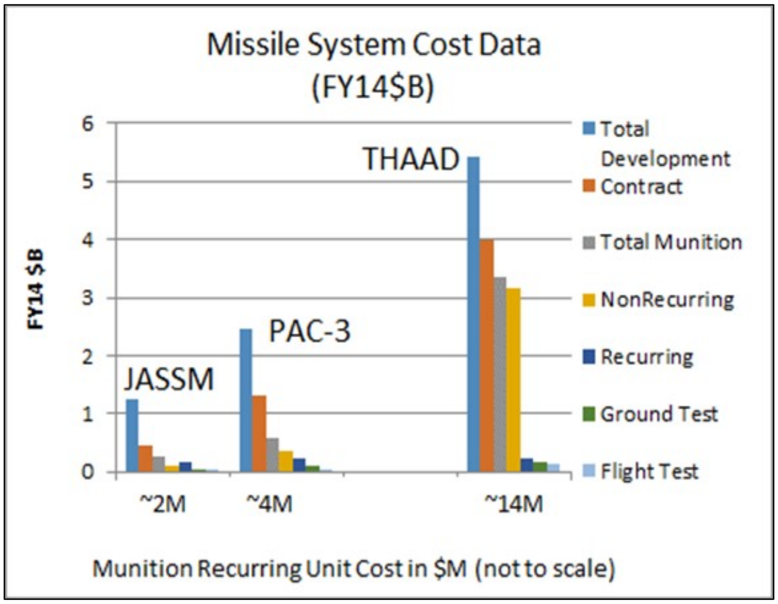

Figure 4. Actual JASSM, PAC-3, and THAAD Development Costs

Defining the Metrics

Figure 5 shows the initial estimated and final actual time intervals between MS A and MS C for JASSM, PAC-3, and THAAD as a function of MRUC. These data show initial schedules ranging from five to ten years and final (as executed) schedules ranging from eight to seventeen years. They also show actual schedule delays ranging from two to seven years. The straight lines suggest empirical relationships between development time for MDAPs and the MRUC.

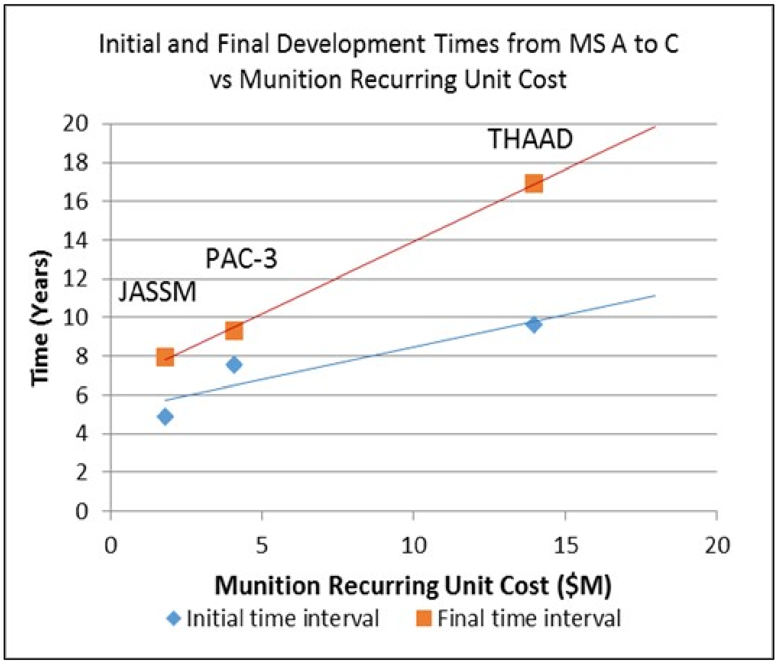

Figure 5. Actual Initial/Final MS A-to-C Time Intervals

Figure 6 shows the actual number of flight tests flown as a function of MRUC (calculated from the development CCDR). The number of flight tests displayed in this chart was compiled from actual data gathered from the JASSM Risk Reduction and EMD phases, PAC-3 and its predecessor Flexible Lightweight Agile Guided Experiment and Extended Range Interceptor programs, and the THAAD Program Definition and Risk Reduction (PDRR) and Engineering and Manufacturing Development (EMD) phases. The straight line represents an empirical relationship between the number of flight tests executed on MDAPs and the MRUC.

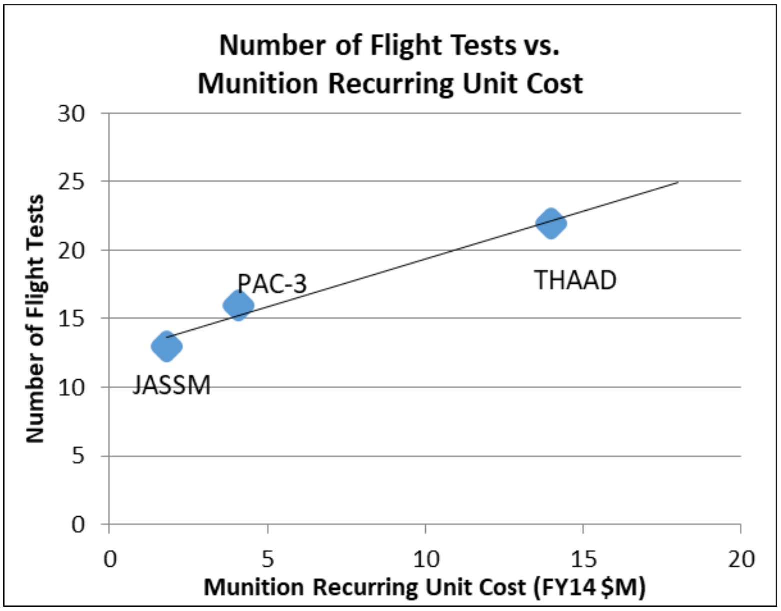

Figure 6. Actual Number of Fight Tests on JASSM, PAC-3, and THAAD

Figure 7 presents a frequency histogram of the time between flight tests (known as test centers) for the JASSM, JASSM Extended Range (JASSM-ER), PAC-3, PAC-3 Missile Segment Enhancement (PAC-3 MSE), and THAAD programs, as executed. The IDA study team used these data to inform its flight test schedules. According to these data, 90 percent of all flight test centers were below 12 months (with design flaws and schedule delays included).

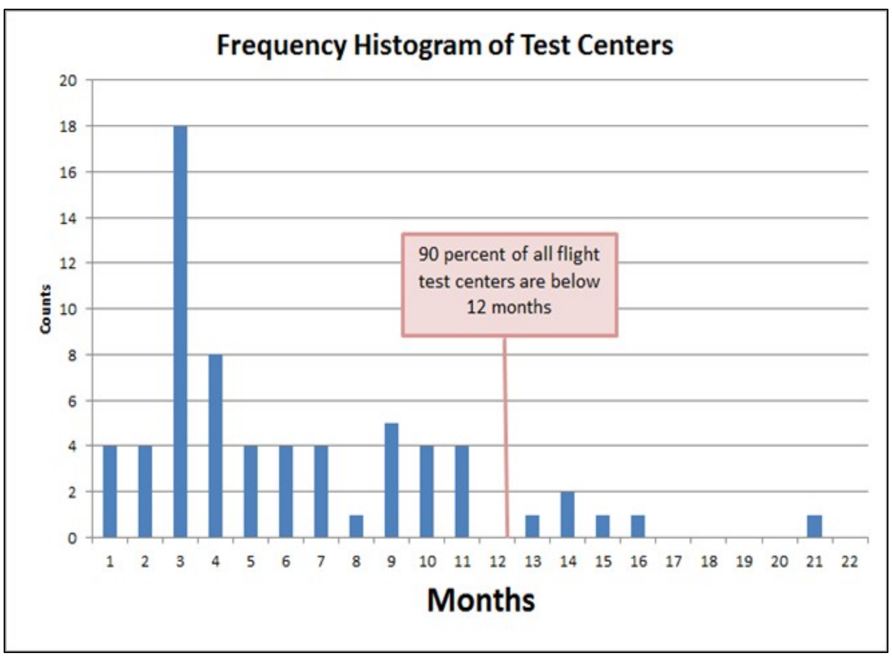

Figure 7. Actual Flight Test Centers

Building the Cost Model

The next step was to build a cost model based on the cost drivers and metrics, which provided the initial state of the program. Figure 8 depicts a sample resource-loaded schedule for a program executing with adequate T&E infrastructure. The different color bands represent the various elements of cost (as shown in Figure 4). The program depicted has three years of development and ground testing after MS A approval and prior to the first flight test. The flight test program executes with an average of four months between flight test centers. Since this schedule is populated with cost data from a model built with JASSM, PAC-3, and THAAD program data, it includes any design flaws, flight test failures, re-design efforts, and schedule delays inherent in those programs.

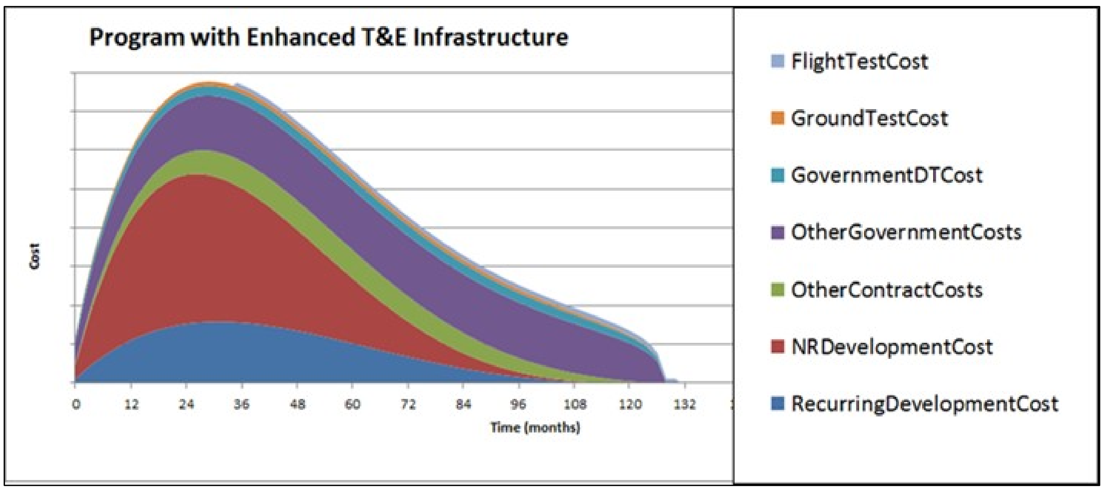

Figure 8. Sample Initial Resource-Loaded Schedule for a Program with an Enhanced T&E Infrastructure

Building the Cost Growth Model

Next a cost growth model was constructed based on the cost drivers and metrics. Output from the model visualizes the consequences to the program of not making the proposed investments—this provided the final state of the program. The T&E SMEs characterized the design and development problems each of the development programs might expect to encounter if the hypersonic T&E infrastructure were not enhanced prior to MS A and translated them into an estimated number of additional unanticipated design flaws that would persist past the critical design review. Table 7 shows the SME-generated analysis for the conceptual boost glide program; it shows five undetected design flaws in the lower right two columns.

Table 7. SME-Generated Analysis of Estimated Undetected Design Flaws for the Conceptual Boost Glide Program

Conceptual System A (with Enhancements)												
Test Type	Test Objectives Addressed	Est Test Cost ($K)	Est Test Time (weeks)	Number of Ground Tests			Total Cost ($K)	Experimental (Supplements Data)		Undetected Design Flaws (Possible F/T Failures)	
				Pre-MS A	MS A-B	Post MS B		MS A-B	MS B-C	MS A-B	MS B-C
Aero	1.1-to-1.5	4,000	8	2	2	0	16,000	baseline	baseline	baseline	baseline
Aerotherm	2.1-to-2.7	1,000	4	1	1	0	2,000	baseline	baseline	baseline	baseline
Materials	3.4-to-3.11	2,000	26	2	1	0	6,000	baseline	baseline	baseline	baseline
Propulsion	4.2-to-4.3	5,000	12	2	2	0	20,000	baseline	baseline	baseline	baseline
Stage/Store	5.1	500	2	0	2	8	5,000	baseline	baseline	baseline	baseline
Weather	6.1-to-6.3	2,500	12	0	2	2	10,000	baseline	baseline	baseline	baseline
GNC	7.5-to-7.7	2,000	8	0	2	2	8,000	baseline	baseline	baseline	baseline
Lethality	8.1	1,000	8	0	1	2	3,000	baseline	baseline	baseline	baseline
Conceptual System A (without Enhancements)											
Test Type	Test Objectives Addressed	Est Test Cost ($K)	Est Test Time (weeks)	Number of Ground Tests			Total Cost ($K)	Experimental (Supplements Data)		Undetected Design Flaws (Possible F/T Failures)	
				Pre-MS A	MS A-B	Post MS B		MS A-B	MS B-C	MS A-B	MS B-C
Aero	1.1-to-1.5	5,000	10	3	2	1	30,000			1	1
Aerotherm	2.1-to-2.7	2,000	8	2	1	0	6,000				
Materials	3.4-to-3.11	2,500	34	2	1	0	7,500			1	
Propulsion	4.2-to-4.3	7,000	18	2	2	1	35,000			1	
Stage/Store	5.1	500	2	0	2	12	7,000				1
Weather	6.1-to-6.3	2,500	12	0	3	3	15,000	2	4		
GNC	7.5-to-7.7	2,000	8	0	2	3	10,000				
Lethality	8.1	1,000	8	0	1	3	4,000				

Table 8 shows the SME-generated estimates of the capability gaps and design flaws for the three conceptual programs.

Table 8. Resulting Additional Major Design Flaws Resulting from Infrastructure Capability Gaps

Hypersonic Weapon System Type	Number of T&E Infrastructure Capability Gaps	Estimate of the Number of Additional Major Design Flaws
Tactical Boost Glide	7	3
Strategic Boost Glide	9	5
Scramjet Cruise Missile	10	9

Figure 9 shows the resource-loaded schedule (from Figure 8) with schedule delays due to the number of design flaws. The cost growth model was programmed to randomly introduce three-month delays between flight tests caused by the SME-estimated additional major design flaws as shown in Table 8.

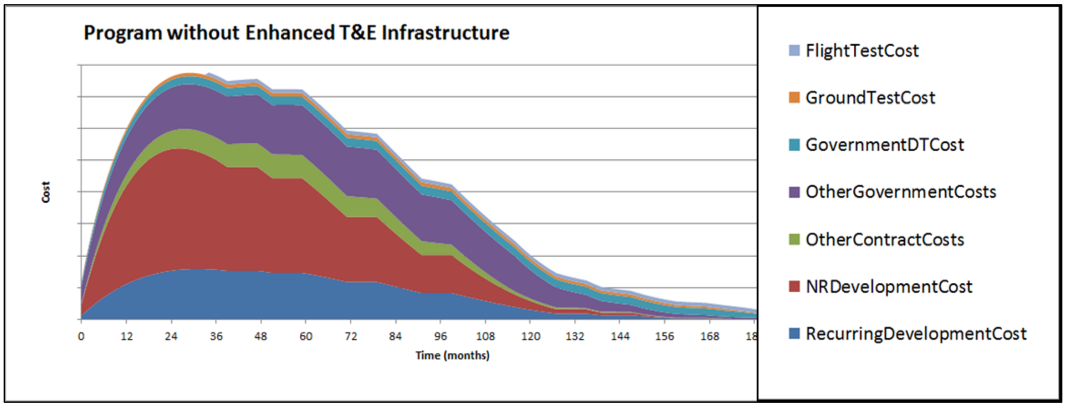

Figure 9. Sample Resource-Loaded Schedule w/ Added Schedule Delays

Calculating the Cost and Schedule Growth Savings

Simulations using the cost growth model were then run, and the estimated cost and schedule growth savings from the initial and final states of the program were calculated. Since the programs being assessed were in the conceptual phase of design, the IDA team had no preconceived idea of their estimated costs; therefore, the savings were calculated for four different estimated development program costs ranging from $1.3 billion (about the cost of the JASSM program) to $2.9 billion (slightly more than the PAC-3 program), as reflected in Figure 4.

IDA randomized the occurrence of the delays caused by encountering the number of unanticipated design flaws shown in Table 8 and reported the average of 1000 runs as the cost savings of the T&E infrastructure enhancements to the three conceptual development programs.

Table 9 shows the estimated savings for the range of development program costs from $1.3 to $2.9 billion. For reference, the IDA team included the initial RDT&E schedule in years (line 2), the number of flight tests (line 3) and the savings to the three conceptual programs if the unanticipated design flaws are avoided (lower right quadrant). (Again, all costs are in FY 2014 dollars and discounted[2] based on when they were saved in the resource-loaded schedule.)

Table 9. Study Results: Estimated Savings over a Range of Development Costs

Estimated Savings Over a Range of Development Costs					
	Range of Development Costs ($M)	1300	1800	2400	2900
	Initial RDT&E Schedule (Years)	9	10	10	10
	Number of Flight Tests	18	21	23	23
	Number of Additional Design Flaws	**Savings if the Design Flaws are Avoided ($M)**			
Tactical Boost Glide	3	100	150	200	270
Strategic Boost Glide	5	150	240	310	400
Scramjet Cruise Missile	9	240	380	530	690

Table 10 shows the calculated (discounted) net savings over the range of estimated development costs from $1.3 billion to $2.9 billion analyzed for the three conceptual systems: a scramjet cruise missile (CM), a tactical boost-glide (TBG) vehicle, and a strategic boost-glide (SBG) vehicle system. Each entry in Table 10 is the amount of the cost avoided by making the investment (i.e., the numbers from Table 9 less the $350 million investment). While there was no compelling evidence to make the investment based on the costs avoided for either the TBG or SBG programs, should DoD decide to pursue both (Table 10, bottom line), the investment option became more attractive.

Table 10. Study Results: Net Savings w/ Enhanced Hypersonic T&E Infrastructure

Net Discounted Savings				
	Range of Development Costs ($M)			
	1300	*1800*	*2400*	*2900*
	Savings ($M)			
Tactical Boost Glide	-250	-200	-150	-75
Strategic Boost Glide	-200	-125	-50	50
Scramjet CM	-125	25	175	325
Both TBG and SBG	-100	25	150	300

The results of this analysis indicated that, if DoD pursues the development of a scramjet-powered CM or the development of both a TBG and an SBG vehicle, either of these two courses of action could potentially result in a net positive ROI of $300 million or more for higher-cost development programs (that is, programs with a total development cost in the $2.9 billion range)—and the pursuit of all three systems could potentially result in a net positive ROI of over $600 million for higher-cost development programs.

Conclusion

The IDA-developed methodology was used successfully to justify and secure a five-year, $350 million T&E infrastructure investment augmentation for the DoD. Potential users of this process, however, are reminded again that it takes substantial time and effort—

and success is not guaranteed. In the hypersonic missile arena, preparing the pathway and developing the plan took over three years to complete and required substantial effort not only by the core IDA study team, but also by an extensive support team of government and industry SMEs who provided information and counsel on the key capability needs, the capability gaps, the impacts of not closing the gaps, and the proposed investment plan.

In addition, the actual BCA effort took another nine months to complete and required substantial archival research on the cost, schedule, and test frequency of comparative development programs. It then took an additional year to develop the Issue Paper for the budget augmentation and coordinate it up the DoD chain-of-command for inclusion in the FY 2017 President's Budget Request.

Thus, the overall time period from the beginning of the initial study effort to get the attention of the decision-makers until the arrival of the first dollar of new funding was five calendar years! In summary, it suffices to say that, while the use of this process to justify T&E infrastructure enhancements requires the investment of substantial time, cost, and commitment—as well as perseverance—the fruits of a successful BCA can be significant!

Biographies

Mr. Paul F. Piscopo provides consultant services to the Institute for Defense Analyses. Before retiring from DoD in 2004 with 37 years of service, he served as Special Assistant to the Director, Defense Research and Engineering (DDR&E) and Executive Director of the National Aerospace Initiative (NAI) Washington Office. Prior to accepting that position, he served as Chief-of-Staff for the President's Commission on the Future of the United States Aerospace Industry—and before that, as Associate Director for the Weapon Systems Directorate in the Office of the Deputy Under Secretary of Defense for Science and Technology.

Dr. Patricia Bronson is currently a research staff member at the Institute for Defense Analyses specializing in requirements analyses, cost estimation, resource planning, and root cause analysis for large, complex, defense systems and systems-of-systems known as major defense acquisition programs. Prior to joining IDA, she was an operations research analyst for the Cost Analysis Improvement Group within the OSD. Work products inform investment decisions by senior leadership. Her portfolio includes naval destroyers, combat and missile systems, military aircraft, unmanned aerial vehicles, and space systems.

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1 The test infrastructure includes the physical ground and flight test facilities, test tools, testing technologies, computational techniques, and the associated workforce.

2 The IDA study team used the real discount rates memo M-15-05 from Office of Management and Budget Circular A-94, Appendix C and the differences in the resource-loaded schedules to obtain time-phased savings to calculate the discounted costs.

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14. ABSTRACT

In 2013, the Congress directed that a study be conducted on the ability of the national test and evaluation infrastructure to effectively and efficiently mature technologies for defense-related hypersonic systems development through 2030. It further required that a report be submitted to the Congress on the study results, along with a plan identifying the capability needs and proposed defense-related investments. IDA supported both congressionally directed efforts and was subsequently tasked to provide a business case analysis for the proposed investments. For this analysis, IDA used an approach that expanded the cost-benefit “control volume” to include projected system development savings from the Milestone A Technology Maturation and Risk Reduction Phase decision to the Milestone C Production and Deployment Phase decision for three conceptual conventional hypersonic systems. This article describes the IDA-developed methodology used to successfully justify and secure full funding for the proposed five-year, $350 million Department of Defense Test and Evaluation infrastructure investment augmentation.

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