A New Way to Justify Test and Evaluation Infrastructure Investments

Paul F. Piscopo & Patricia Bronson, Ph.D.
Institute for Defense Analyses

16th Annual Acquisition Research Symposium
May 8-9, 2019, Monterey, California

Research Question

Can we justify an investment in T&E infrastructure based on potential programmatic cost savings that could reasonably be expected to accrue during a future weapon system development effort?

IDA | Methodology

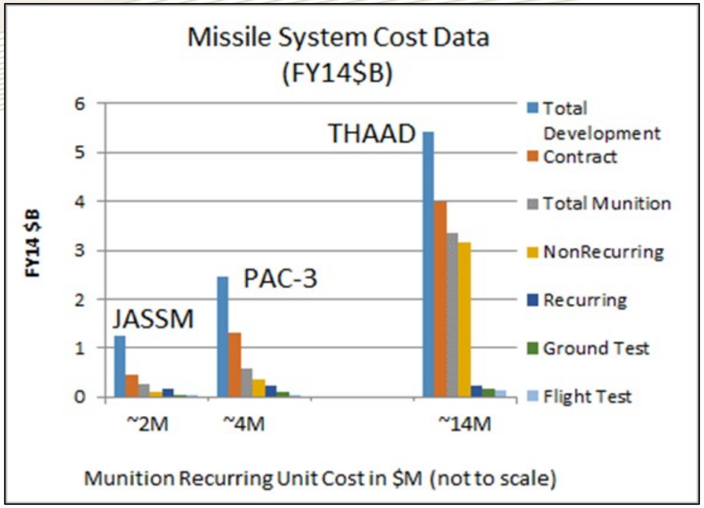
- IDA worked with T&E Subject Matter Experts (SMEs) who believed enhancements in T&E resources (in this case, wind tunnel capabilities) were needed to drive a successful design for a hypersonic missile and that, without them, some future potential program would need additional (and relatively expensive) 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.
- IDA identified three programs that bracketed the expected development challenges (and costs) a conceptual hypersonic missile system program would likely face, and developed a cost model based on the cost drivers and metrics, which provided the initial state of the program.
- Next, a cost growth model was constructed based on the cost drivers and metrics, and simulations were run.
- Last, estimated cost and schedule growth savings from the initial and final states of the program were calculated.

Characteristics of Analogous MDAPs and Conceptual Hypersonic Programs

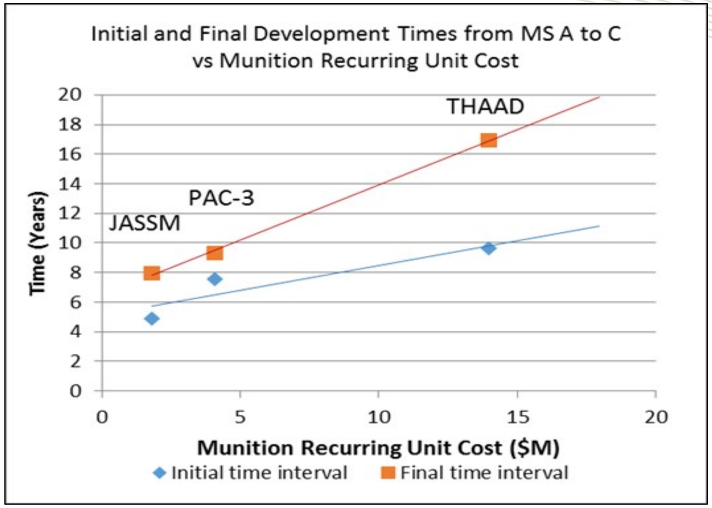
Table 6. Characteristics of Analogous MDAPs and Conceptual Hypersonic Programs

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

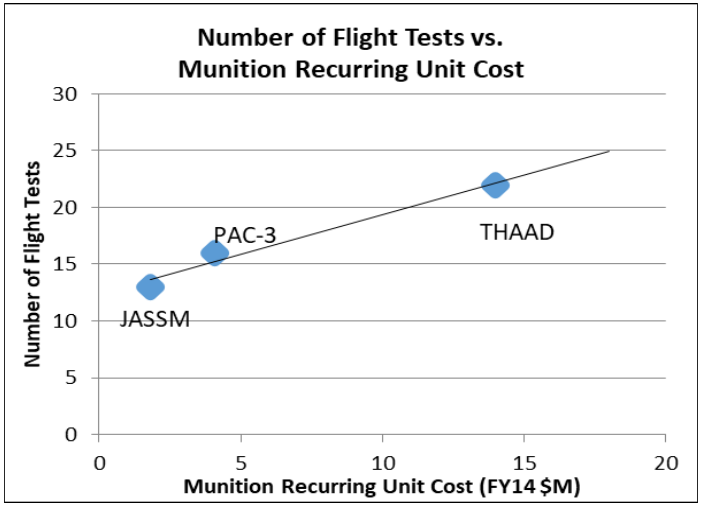
Cost Drivers



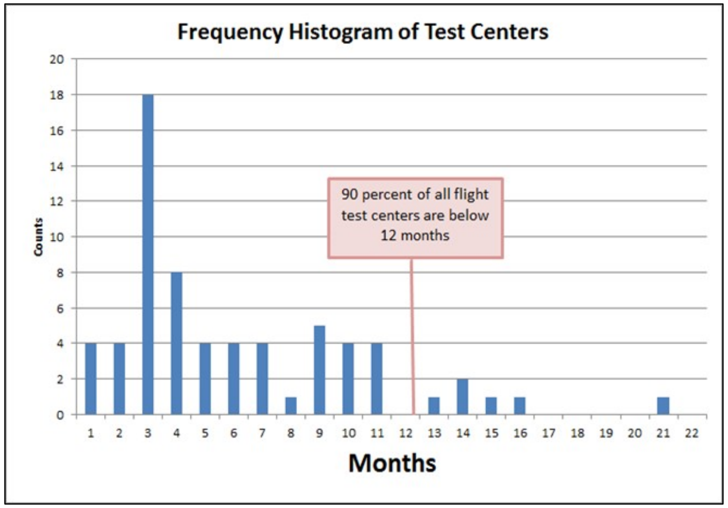
Actual JASSM, PAC-3, and THAAD Development Costs



Actual Initial/Final MS A-to-C Time Intervals

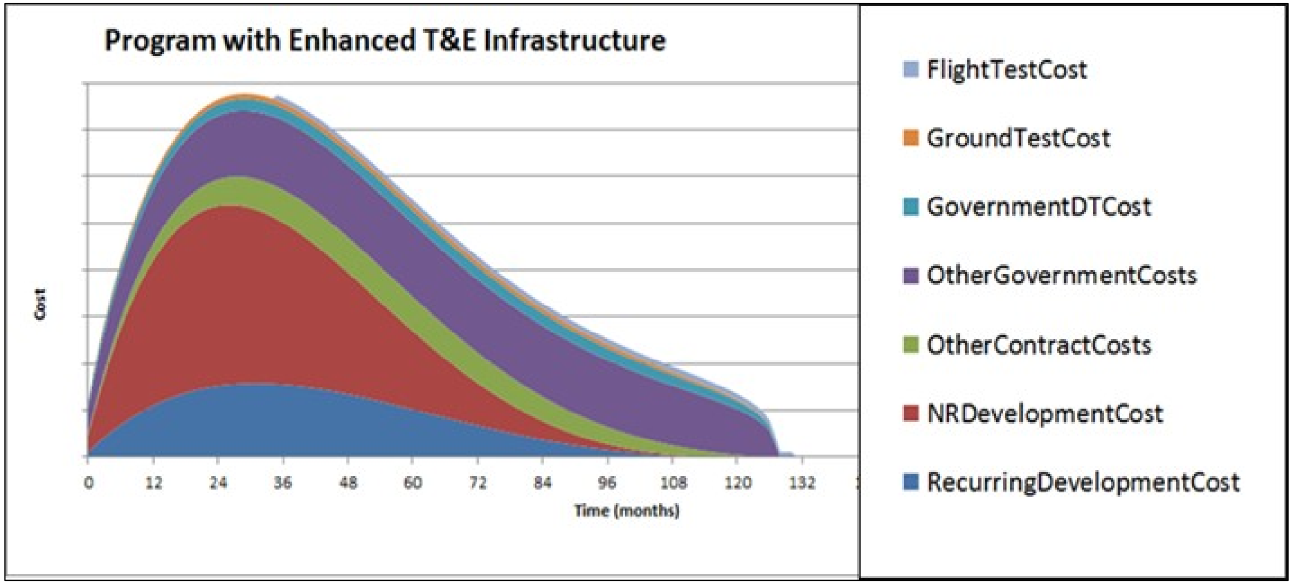


Actual Number of Fight Tests on JASSM, PAC-3, and THAAD



Actual Flight Test Centers

The Cost Model



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

Building the Cost Growth Model

Conceptual System A (with Enhancements)

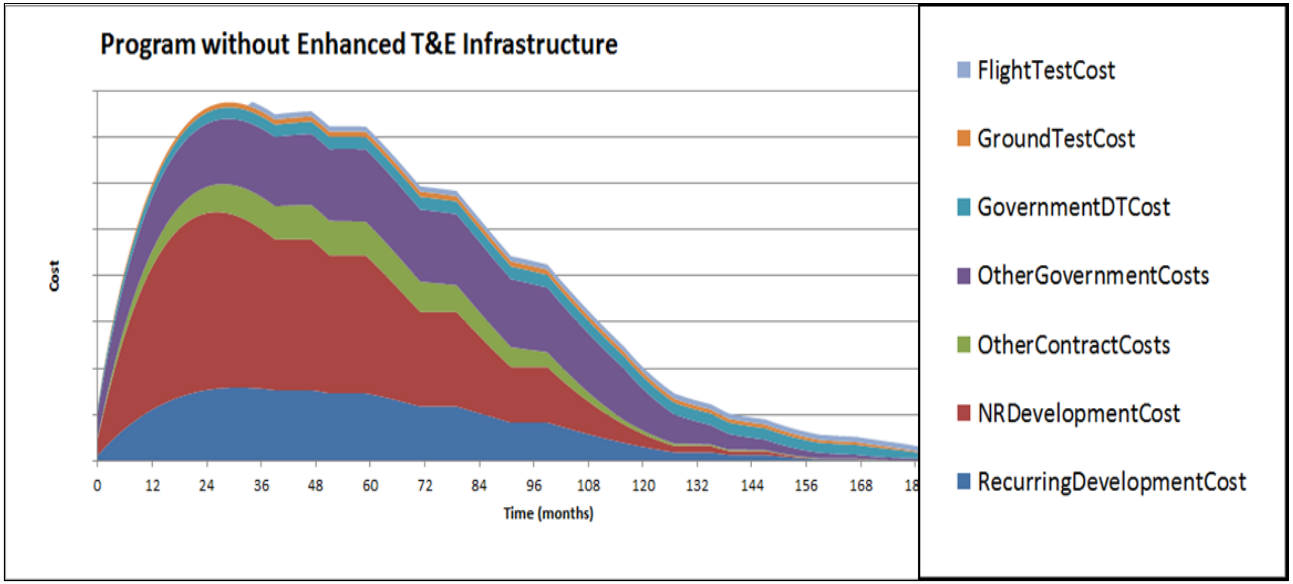
Test Type	Test Objectives Addressed	Est Test Cost ($K)	Est Test Time (weeks)	Number of Ground Tests			Total Cost ($K)	Experimental (Supplements Data)		Undetected Design Flaws (Possible F/T Failures)	
				Pre-MS A	MS A-B	Post MS B		MS A-B	MS B-C	MS A-B	MS B-C
Aero	1.1-to-1.5	4,000	8	2	2	0	16,000	baseline	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				

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

Running the Simulations



Sample Resource-Loaded Schedule w/ Added Schedule Delays

IDA | Conclusions

- The IDA-developed methodology was used successfully to justify and secure a five-year, $350 million T&E infrastructure investment augmentation for 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 research team, but also by an extensive support team of government and industry SMEs who provided information and counsel on the key capability needs, capability gaps, impacts of not closing the gaps, and proposed investment plan.