Challenges and Opportunities to Facilitate the Early Adoption of Novel Technologies

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Introduction

The continued evolution of computational technology presents opportunities and challenges for many national security missions. Regular updates and evolutionary technological improvements require continued monitoring and work to ensure that mission operations work smoothly and efficiently. And major shifts in the technology landscape provide great opportunities for leap-ahead mission advantage, but taking advantage of these major shifts requires a great deal of work to be done anticipating the changes and ensuring that systems get changed to utilize these shifts.

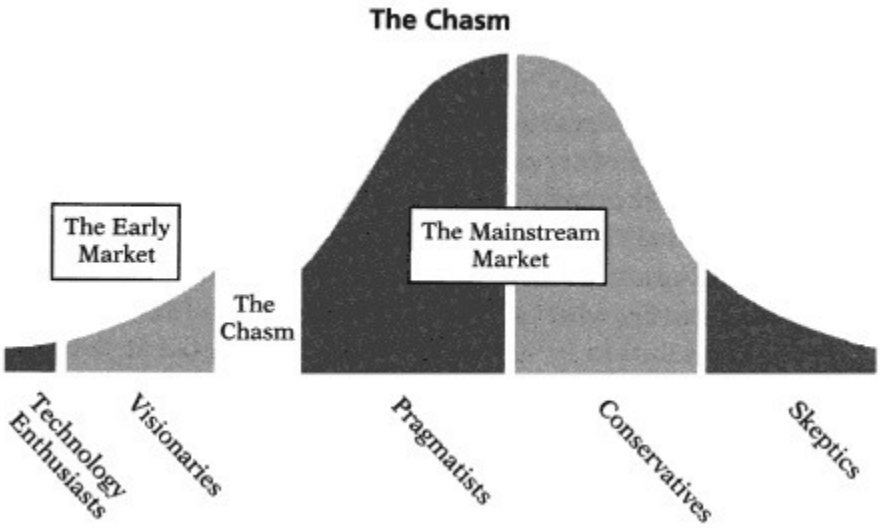

Figure 1
From E.M. Rogers, Diffusion of Innovations, 4th edition (New York: The Free Press, 1995)

The figure above describes a significant difference between The Early Market of technology adoption, and The Mainstream Market. This paper is written as a plan for a center-of-excellence to support national security organizations in their quest to take advantage of the Early Market of novel technology changes for significant mission advantage.

Adopting new computing technology is exciting and the promise of its advantages often elecits a significant amount of attention. From a mission-driven organization, the biggest dirver of this excitement is the potential for accomplishing the mission better.

According to Who?

Key Metrics for Mission Success

- Cost
- Time to solution
- Reliability
- Error rate
- Compatibility with existing systems

Different organizations have different constraints when it comes to key metrics for mission success. Reliability is the most important for some organizations, with a willingness to pay a premium in cost. In other organizations, time-to-solution is the most important metric: perhaps there is a tremendous amount of data that needs to be pulled-in and processed quickly while it still has mission relevance. There is no one-size-fits-all and making the match between the compuational impact, system impact, and operational mission impact is important.

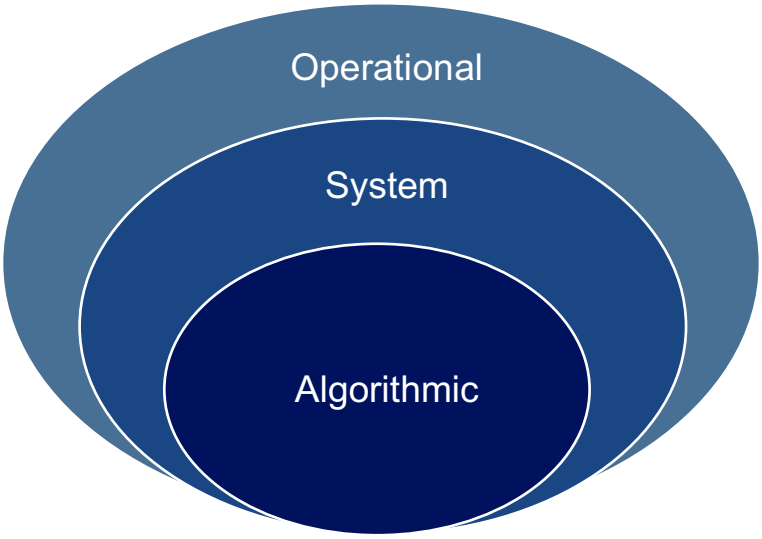

Figure 2: Division of Analysis into Algorithmic, System, and Operational components.

FACTORS FOR SUCCESSFUL ADOPTION.

Not only does a new technology need to provide algorithmic advantage over alternatives, but this new technology much be compatible with mission systems and with overall mission operations. Assessment of performance must be applied at three levels:

Is code good

Is system it runs on good.

Does it solve mission problem.

- Algorithmic – performance assessments of data processing
- System – task driven evaluations to capture overall system technical performance
- Operational – quantitative and qualitative performance assessments during mission-driven scenarios

Typical mission advantages of taking part in The Early Market vary. The biggest hope is that technology surprise will provide a distinct advantage over competitors. This potential mission advantage also includes the ability to work with vendors to shape the technology for initial missions. Working on novel technologies is also a very compelling activity for high-performing personnel, and pursuing these projects is a way to attract and retain talented staff. Finally, long term reputation of an organization can be strongly boosted when novel technologies are applied for mission application.

Several challenges exist for adopting novel technologies, which has been noted in several publicatoins. Very broadly, it's hard to adopt something new, it's had to know the mission impact, and it's hard to know the resources required ahead of time.

Additional challenges are the following (rom *Top 15 Barriers to Adopting New Technology* by Robert Treumann on LinkedIn Pulse):

1. Old habits die hard
2. Lack of leadership/support for innovation
3. Comfort level – effect of disruption
4. Time to make changes and adjust
5. Understanding of and ability to implement
6. Current processes or procedures
7. Budgetary priorities
8. Difficulty/availability/time for training
9. Resistance to learning new technology
10. Work stress/overload
11. Cost
12. Proof of value
13. Reliability – will it continue to provide value
14. User acceptance
15. Performance

And while these challenges apply to all organizations, there are government-specific challenges associated with national security and national defense projects. These challenges include acquisition- and policy-related challenges, as well as any difficulties associated with security or classificiation.

The coordinated approach described below is a broad outline of a center-of-excellence designed to facilitate the effective incorporation of new technologies for national security missions, while addressing the challenges mentioned above.

A Coordinated Approach to Facilitating the Effective Adoption of Novel Computing Technology

Broad Goals

dislike

Broadly speaking, the goals are to provide a centralized organization to do the following: Identify possible technologies, characterize the challenges and benefits of the technology, closely track the technology progress, and develop a path towards potential adoption. Some of these resources can be utilized by technical staff, other resources can be used by leadership trying to weigh planning decisions, other resources can be used by acquisition staff as they work to justify major purchases, and other resources by mission managers as they work to smoothly integrate the new technology into operations.

One way these activities can be organized is through Research/Engineering/Prototyping, Test & Evaluation, Workforce Development, and Transition Support. As shown in Figure 3, this organization of these activities requires continued feedback from one set of activities to another as the technology matures and as the owners of the natonal security mission better understand the ways in which the novel technology can support their mission.

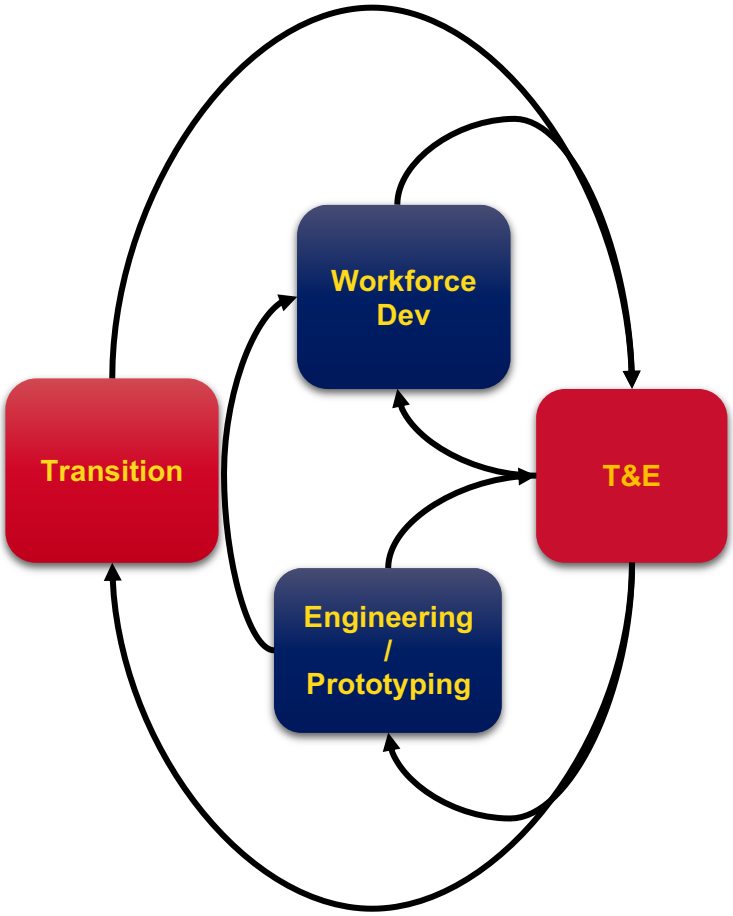

Figure 3

Major Activities

Addressing the challenges of participating in The Early Market for mission advantagerequires a multi-faceted approach over a long period of time. This approach reflects the fact that there is great uncertainty about whether the technology will ultimately be a suitable fit for an agency's mission. This approach also addressed the fact that what is needed to be successful with an early adoption varies depending in the maturity level of the technology and the readiness of the organization to make the technology work. To be successful in this approach, this proposed Center-of-Excellence is broken into five distinct Major Activities:

1. Technology Tracking
2. Development of Performation Metrics
3. Comparative Analysis of Mission-Focused Technology
4. Early Technology Access
5. Acquisition and Integration Analysis

1. Technology Tracking

Technology tracking represents a close observation and awareness of certain classes of technology through their various stages of maturity. This awareness can start as early as the theoretical or invention stages of the technology cycle, and can continue all the way through the product development and into the stage where there are early customers adopting the technology. Once the technology has been adopted by many customers, it likely will be supported through other means (sales teams, online forums, etc.) so it's outside scope of this paper that focuses on early adopters.

Technology tracking encompasses the following activities.

- Scouting for Novel Technologies
- Industry Status Reporting of Specific Technologies
- Vendor Product Reports
- Summaries of Recent Publications
- Reporting about Success of Early Adopter
- Preliminary Technical Analysis on Applicability to Mission

The deliverables from this effort will be reports and briefings to better inform customers who are open to adopting this new technology. This effort is largely mission agnostic, but at this stage some early analyses can be performed with rough estimates on how the early-stage technology can impact the mission. This major activity provides value to mission stakeholders by effective ingestion of a wide variety of sources to provide regular updates in areas that are difficult to develop expertis in. Deliverables can be delivered through face-to-face meetings at individual organizations and through community-wide workshops and meetings to provide briefing information to a wide audience.

2. Development of Performance Metrics

As the new technology matures, it is important to develop metrics to track its performance. These performance metrics are sometimes developed by the vendor, but often require outside groups to develop them. As an early adopter, it may fall upon the center-of-excellence to develop the metrics and then test the prototypes and early technology to determine if the technology is meeting the expected performance.

The metrics can reflect the raw computation power of the technology, and can also reflect other important aspects of the technology like input/output speed, power consumtion, variability, reliability, heat generated, size, or other system characteristics.

The need for new performance metrics is due to the novelty of the technology considered. Typical characteristics of microelectronic processor chips (clock speed, number of cores, local memory, etc.) may not have any relevance to the specialized microelectronics that are designed to operate in a totally different manner. And existing metrics may be a poor fit to mission-specific applications in the national security space.

Focus on output maybe rater than process?

Test suites are an important component to the effective use of newly-developed metrics. These test suites allow a broader community to utilize these metrics, and makes reporting on the results easier. These test suites may require multiple iterations to properly incorporate a suitable test set of data and incorporate the features of the novel technology properly.

i.e. What I'll build for KGs.

Devlierables associated with this Major Activity include delivery of the test suite, and delivery of the results over a range of conditions.

3. Comparative Analysis of Mission-Focused Technology

It is difficult to predict the effectiveness of novel technologies when they are integrated into mission applications. This activity is aimed at improving the predictive power of effectiveness. Focus on the mission is imperative.

Ultimate investment into the new technology will require a clear demonstration that the new technology will be expected to deliver better outcomes than other technologies. In this case, "better" will be measured in many ways including cost, performance, reliability, complexity, and other operational metrics.

The deliverables associated with this Major Activity will typically be a series of charts that highlight the most important mission metrics when different technologies are being used. These comparisons can be used to look for opportunities to deploy this technology as it becomes available.Deliverables for this activity will be models, technical analysis, and reports on these comparisons. This is facilitated by meetings and workshops to solicit input from government mission stakeholders.

4. Early Technology Access

It is difficult to understanding performance and incorporation into mission applications. Sometimes this requires expertimentation and testing. This early technology access includes acquiring prototypes for testing and playing with to demonstrate performance and experiment. This Major Activity will be resource-heavy, but can provide unparalleled access and testing.

The deliverables for this activity will vary. It encompasses on-site and cloud-based access to technologies, developmental access, suites of test tools, and other technology-specific tools.

5. Acquisition and Integration Analysis

This portion of the center is focused directly on mission integration. Part of this is to provide clear technical analysis for alternative solutions for the acquisition team. Other aspects of this include devising sytems requirements and determining sustainment resources needed. This acitivity also includes consideration of data interfaces and user analysis. Tasks and deliverables must be tailored to a specific purposes and to specific organizations since this portion will occur on the most mature technology that is being prepared for transition and integration.

Summary

Staying ahead of competitors through the employment of novel technology for mission advantage is a constant and challenging task, it is both a mission-centric activity and a technology-centric activity. There are advantages to centralizing this effort to provide support for a broad range of national security and national defense organizations.

This paper has presented a vision for a center of excellence to facilitate this technology tracking, testing, and transition activity. This vision is built upon lessons learned from the A2E2 program and is designed to serve as enduring transition of the A2E2 work into future programs in the intelligence community and Department of Defense.