Study on the Application of Modeling and Simulation to the Acquisition of Major Weapons Systems

27 September 1996

Command, Control, Communications and Combat Systems Steering Committee of the Undersea Warfare Division

American Defense Preparedness Association

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Foreword

This study on the Application of Modeling and Simulation (M & S) to the Acquisition of Major Weapons Systems was proposed by the American Defense Preparedness Association (ADPA) in the summer of 1995 in recognition of the potential impact of this technology on the acquisition process.

Modeling and Simulation has demonstrated considerable success and visibility in the training and performance-assessment worlds. A natural outgrowth is the expectation that the application of these new technologies will extend beyond the training and assessment applications to improve the effectiveness and efficiency of the acquisition of new systems.

The Department of the Navy Acquisition Reform Executive recognized that to achieve significant reductions in acquisition costs and cycle times would require a combination of not only novel technology applications but also significant changes in the business process and in the acquisition community culture. He further recognized that industry would play a determinant role in helping the government accomplish these goals. Consequently, the Acquisition Reform Executive requested the assistance of the ADPA in providing an industry perspective on the realities and promise of the application of Modeling and Simulation in a new business process and culture oriented toward acquisition reform.

Several previous initiatives have highlighted the potential benefit of applying M&S to the acquisition process. A summary of their results is contained in Appendix B. This study builds on those previous works and outlines a proposed implementation schema predicated on a shared responsibility and accountability between industry and government operating as collaborative partners. This collaboration will reduce the information ambiguities and decision delays associated with the present development and review process, resulting in lower risks and reduced total ownership costs.

Helmut Portmann
Study Chairman

ADPA Study on Role of M&S in Acquisition

Study Sponsor

Mr. Dan Porter
ASN (RDA) Acquisition Reform Executive

Objective

- **Help ASN (RDA) Obtain *Industry* Viewpoint on Application of M&S to Reduce Costs Significantly Throughout Entire Major Weapon Systems Acquisition Cycle**

Acknowledgments

The creation of this study was a team effort. We would like to give special thanks to VADM(R) Ted Parker and Mr. Jerry Bradshaw for their support, insight, and valuable advice. We would also like to extend special thanks to Mr. Mike Roberts for his active and supportive sponsorship.

In addition to the contributions of the listed authors, many people contributed their time participating in study workshops, reviewing the report and briefing materials, and providing valuable comments and suggestions:

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Executive Summary

Purpose

The purpose of this study, as directed by the Acquisition Reform Executive in his Terms of Reference (Appendix A), was to investigate the merits and challenges of a Simulation-Based Acquisition (SBA) approach for major weapon systems. The objectives were to assess the potential of achieving a 50-percent reduction in cycle time from military needs identification to Initial Operating Capability (IOC), with similar order of magnitude reductions in life cycle costs for a major weapon system. The approach was to consider the technical and business processes of developing complex systems, and to investigate the merit of using Modeling and Simulation tools in the planning, programming, budgeting, cost accounting, management, and oversight aspects to identify and remove non-value-added tasks by making process changes.

Scope

This study was to address the above issues from three frames of reference:

1. Technical merit of proceeding with SBA methods
2. Business integrity issues associated with such an approach
3. Changes necessary to facilitate such an approach

The study was not to focus on any particular weapon system, but rather to identify a set of issues and considerations that address how Modeling and Simulation could be applied in a new SBA environment. Accordingly, our study developed a vision of how such an SBA process would work, and also identified key business challenges and potential solutions that should be addressed in future pilot programs for Acquisition Reform.

Executive Summary (cont'd)

Study Conclusions

Modeling and Simulation tools, as well as new processes (IPPD and IPT) are already being successfully applied in a range of ongoing acquisition programs to reduce development time and life cycle costs. The issue is no longer whether extensive use of M&S tools has merit and benefits for acquisition, but rather how to develop and apply a new acquisition process in a deliberate and coordinated manner that uses these tools to maximum advantage and achieves even more dramatic cost and schedule reductions.

The challenge for Acquisition Reform, from this study team's perspective, is to provide the catalyst that will expand the growing successful application of M&S tools beyond vertical applications within individual programs so that even more significant cost savings benefits can be realized by sharing data, tools, and techniques between different acquisition programs. This requires not just the M&S tools and underlying infrastructure now being developed, but also a common data schema allowing unambiguous communication between government and industry (and between programs and stakeholders). Unambiguous communication is required to achieve full application of IPPD and IPT processes, and will serve as a catalyst to encourage a new acquisition culture to use the new tools and processes to achieve maximum results.

It is our conclusion that the appropriate vehicle for meeting this challenge is Simulation-Based Acquisition (SBA), which combines new process, new tools, and a new culture to develop a strong collaborative partnership between government and industry. Our study presents a candidate vision and concept of operations for how SBA would proceed for acquisition of a notional new combat system, and identifies the benefits and savings that could be realized .

There are unresolved issues - particularly with respect to industry's concerns regarding how to protect their competitive edge and proprietary ideas and realize a profit while helping the government effect significant reductions in acquisition costs. However, this study concluded that these issues have potential solutions and that none represent showstoppers. A clear rationale exists for pursuing SBA to support Acquisition Reform.

Executive Summary (cont'd)

Recommendations

The government should firmly establish SBA as the preferred manner of conducting IPPD-style acquisition, and should establish incentives for both government program managers and industry to ensure full and enthusiastic participation.

Carefully designed pilot programs, structured as engineering experiments with objectives and metrics, can demonstrate the utility of SBA to the acquisition community and stakeholders to catalyze the cultural change that is required. Pilot programs should be augmented with necessary additional funds, and should be focused not just on M&S tools, but the entire SBA process. Metrics should address the building of a program-to-program infrastructure that builds on the ongoing DoD investments in M&S.

The government should provide open access to government information and standard models to the appropriate industry participants in the pilot programs.

The government should redirect DoD investment in M&S to support and encourage development of an SBA specific infrastructure. The High Level Architecture (HLA) and other infrastructure components being developed by DoD are necessary but insufficient for the realization of SBA. Specifically, the following should be pursued:

- Develop a comprehensive system data schema that provides for common representation and data interchange mechanisms between government and industry standard databases.

- Develop key tools that would build on the DMSO HLA and serve to jump-start pilot efforts. Examples include a database repository tool, and common data library and M&S analysis tools that the acquisition executive would use to evaluate industry proposals. These tools would be shared with industry, and would differ from existent COEA M&S tools in that their emphasis would be on producibility.

Executive Summary (cont'd)

Summary

The SBA vision described in this report proposes a new role for the acquisition executives, where their burden would shift from the preparation of detailed language descriptions (RFPs) of the executive's vision of government's requirements, and the laborious evaluation of industry's responding language descriptions (proposals) of their understanding of the executive's description, to a more streamlined business process. That process would focus on using M&S analysis tools and proposal evaluation testbeds to ensure unambiguous communication between industry and government and a clear audit trail of the acquisition process. The result will be significant reduction in time required for system development, and dramatic savings in life cycle costs.

ADPA
The American Defense Preparedness Association

Chapter 1
Introduction

Introduction

Problem Statement - Complex System Acquisition Challenge and Opportunity

Budget constraints dictate that system managers have the processes and tools necessary to coordinate the complex schedules, risks, and technologies required to field and support major weapons systems successfully. An objective of reducing both the system life cycle cost and the development cycle time by 50% has been proposed to maintain the force structure and capabilities necessary to meet current and projected threats. Dramatic reductions in acquisition life cycle costs and schedule cannot be achieved by incremental improvements alone.

Today's acquisition reform environment presents an opportunity to effect the dramatic change that is required to maintain a robust military capability. Significant cost reductions require a new partnership between government and industry. This partnership can apply radically new processes and requires a new culture to fully enable Integrated Product and Process Development (IPPD).

ADPA Study on Role of M&S in Acquisition

Challenge

- Defense Systems Becoming Larger and More Complex
- Cost , Schedule, & Risks Excessive for Major Systems
- Acquisition Budgets Severely Constrained

Opportunity

- Acquisition Reform Represents Historic Opportunity
- M&S Can Be a Tool for Acquisition Reform
- Process Innovations Are an Essential Accelerator
- M&S Is an Enabling Technology for Cost-Performance Trade and Cost as an Independent Variable (CAIV)

Incremental Change Is Inadequate - We Need Dramatic Change

Introduction (cont'd)

The fundamental organizing principle for cost and cycle-time reduction is to develop an acute cost-awareness operating paradigm. This paradigm can be described at a high level as a six-step process, which is as follows:

1. Reducing cost and time requires that cost awareness be inculcated throughout the entire enterprise. This is enabled by collaboration with those partners most aware and sensitive to cost drivers; those partners are industry.

2. Collaboration with industry in a partnership relationship must begin early to establish and maintain sustained acute cost awareness.

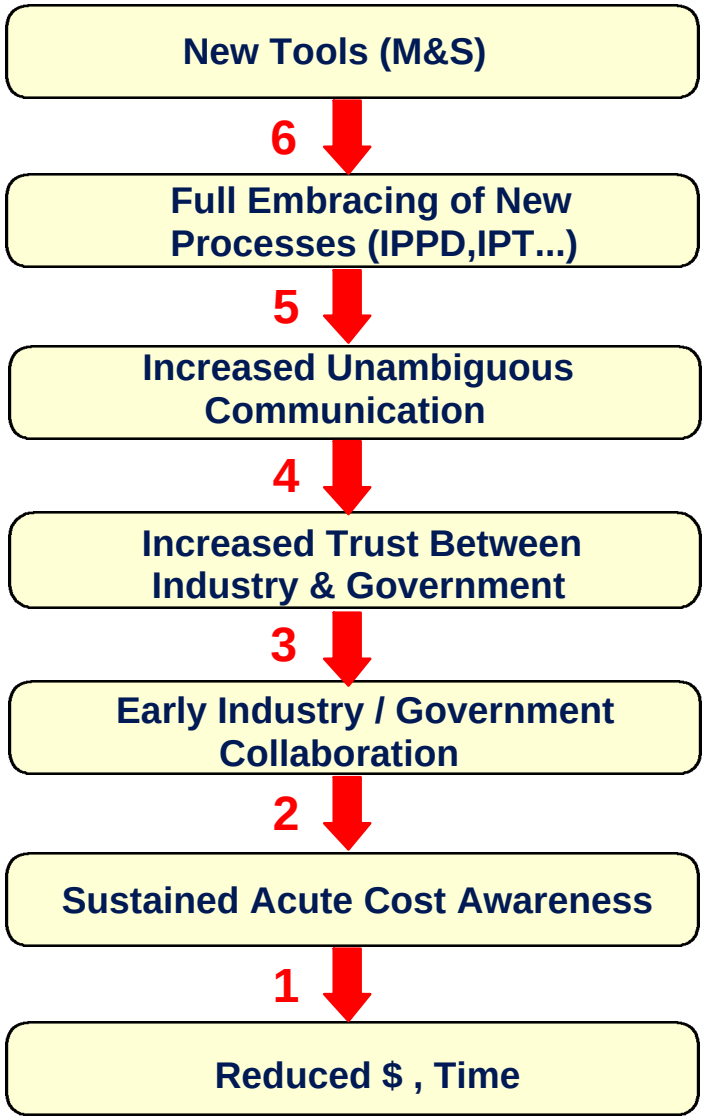
3. Establishment of a partnership relationship between government and industry requires a significant increase in trust. The government must trust industry to build the promised product, and industry must trust the government to protect proprietary knowledge and competitive advantage. Additionally, the stakeholders must trust the program.

4. Increased trust requires increased unambiguous communication throughout the system life cycle. Industry must understand the government needs, and government must understand the industry solutions.

5. Increased communication requires full embracing of new processes, such as Integrated Product and Process Development (IPPD) and Integrated Process Teams (IPTs), which are already in place.

6. Modern complex systems require significant bandwidth to communicate needs and solutions. New tools that assist the human are required to communicate efficiently and effectively. Modeling and Simulation tools promise to revolutionize the achievable communications bandwidth by helping people to visualize, understand, and evaluate needs and solutions quickly.

Fundamental Organizing Principle for Cost And Cycle Time Reduction



Introduction (cont'd)

It is important, however, to remember that the key ingredient is the people. M&S will not provide the answers and will not make the decisions. What it will provide is better information on a more timely basis, allowing decision makers to make better-informed, smarter decisions at the right time in the process, and helping people throughout the life cycle chain to understand the context and implications of those decisions.

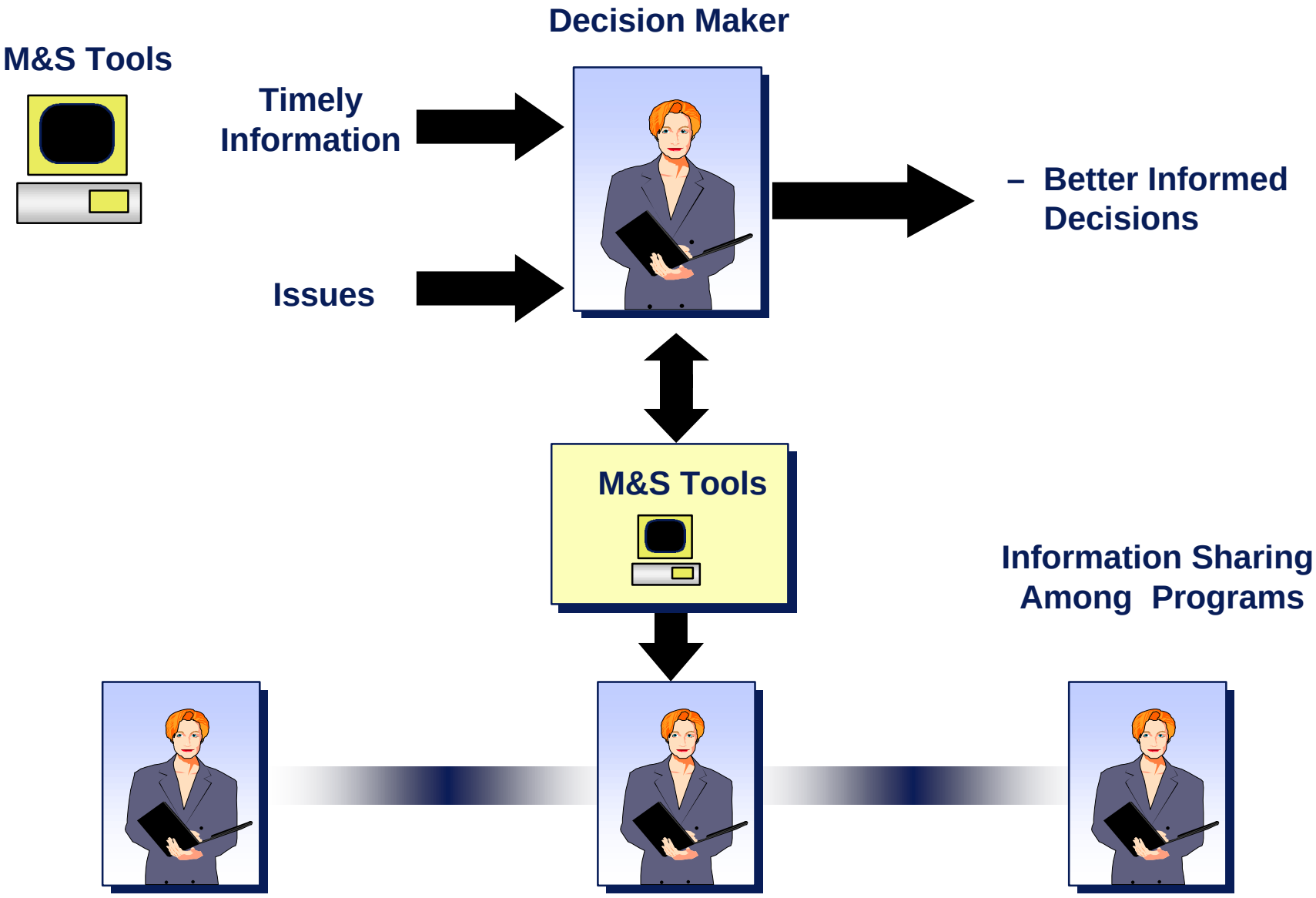
This application of M&S tools transcends individual acquisition programs and allows for the sharing and leveraging of information, not only within a given program but also between programs and stakeholders.

Recent improvements in M&S, mostly achieved through advances in signal and data processing and interactive displays, could enable significant changes to the government's approach to describing its needs to industry and evaluating industry's responses. The current procedure is lengthy and manpower intensive, thus more costly than necessary.

The government does employ M&S to establish its warfighting requirements for new or updated equipment, especially platforms, weapons, and sensors. This part of the acquisition process has taken on the rubric of Cost and Operational Effectiveness Analysis (COEA). It should be expected that COEAs themselves will become more efficient and less time-consuming as they settle into standard government–wide practice. Unfortunately however, the M&S employed in COEAs is typically left behind as the acquisition process moves beyond warfighting measures of effectiveness (MOEs) and passes the basic requirements to the acquisition executives. This level of government bureaucracy matches warfighting requirements with its own vision of the equipment needed to satisfy those requirements. The matching effort is normally lengthy and strenuously detailed, and served with more manpower than it took to derive the original requirements. The product of the matching effort is finally exposed to industry as a Request for Proposal (RFP).

Industry is aware that its response to RFPs will be judged, among other things, on compliance not only with the specifics of government's vision but also with its imagination constrained by to the limits of government's detailed description. This description is too frequently the product of "least common denominator" internal interactions, and is always influenced by existing designs. While this procedure guarantees the safest course for government, it also guarantees expenses in time and manpower.

M&S Tools Support the Decision Makers



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Modeling and Simulation in Systems Engineering

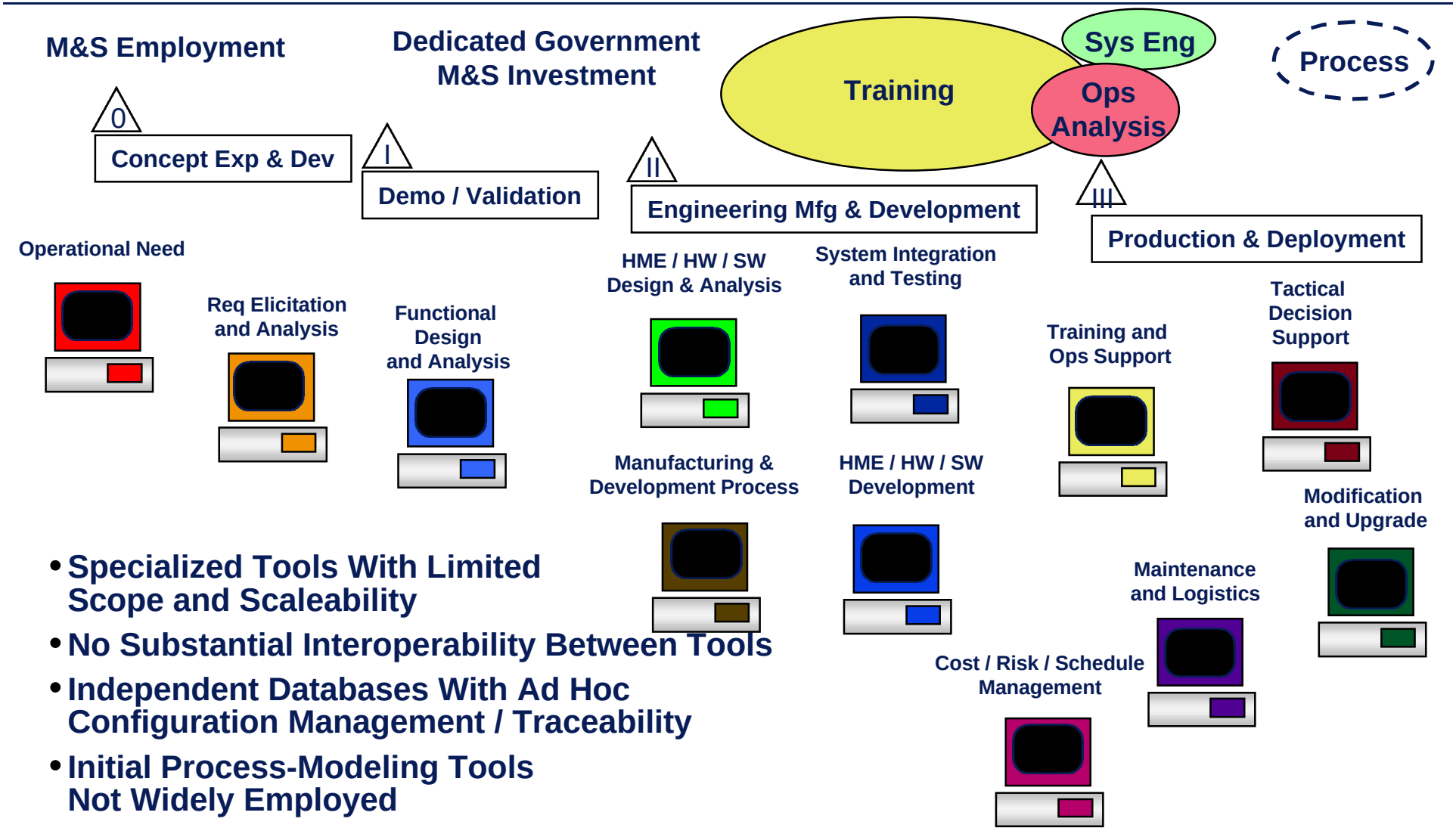
Today, a wide spectrum of Modeling and Simulation tools is employed in nearly every phase of the complex system-development process. There have been numerous reports discussing the role of Modeling and Simulation in the U.S. Department of Defense weapon system-acquisition process. The 1994 Naval Research Advisory Committee report on Modeling and Simulation stated that "Distributed Simulation Based Acquisition has high payoff for the Department of the Navy in terms of reducing time to production and reducing overall cost." This report and others suggest that while Modeling and Simulation is currently in use across a broad spectrum of acquisition applications, key infrastructure and application elements required to realize an integrated simulation-based acquisition capability for use in supporting future large-scale weapons system programs are not yet in place, or even necessarily in development.

A cursory summary of Modeling and Simulation use in the U.S. Department of Defense system-acquisition process, includes:

- early simulation of initial weapon system concepts in operational scenarios ;
- functional data flow and behavior modeling;
- analysis and simulation of candidate system implementations;
- simulation / stimulation supporting system integration and testing;
- operator and maintenance training;
- tactical decision aids, mission rehearsal, and operations support;
- maintenance and logistics support, and other activities.

Significant cost and schedule savings have been realized through the use of Modeling and Simulation in the complex system life cycle, particularly in the area of training. However, most Modeling and Simulation tools employed in the system-development process are highly specialized, generally cover a limited scope, and often are not scalable to large systems engineering teams working on big projects. Each tool employs its own data-representation and data-storage mechanism and, with limited exceptions, no substantial interoperability exists among tools at the semantic level (not even for the interchange of similar data structures).

Modeling and Simulation in Systems Engineering Today



- **Specialized Tools With Limited Scope and Scaleability**
- **No Substantial Interoperability Between Tools**
- **Independent Databases With Ad Hoc Configuration Management / Traceability**
- **Initial Process-Modeling Tools Not Widely Employed**

Largely Manual / Point Design / SIM LAGS Design

Modeling and Simulation in Systems Engineering (cont'd)

Clearly, a different approach to the utilization of these tools in the acquisition process is required. The following chapter discusses a vision for a new process within which a new culture uses these tools to maximum advantage for achieving significant schedule and cost reduction. The new process is called Simulation-Based Acquisition (SBA).

Chapter 2

Vision for New Acquisition Process and Culture

A Vision for a New Process and Culture

The current acquisition system could profitably be changed to exploit M&S in a new Simulation-Based Acquisition process.

Government could share with industry the M&S tools that are employed to determine the requirements for platforms, weapons, and sensors (the M&S tools employed in COEAs typically emphasize combat-effectiveness and affordability). This would minimize miscommunications between government and industry and would permit the latter to follow government's intellectual process from the beginning and throughout the COEAs.

Instead of depending upon the acquisition executives to provide a detailed description of the needed equipment, government could simply provide the results of the COEAs as they are mutually understood directly to industry.

Industry would use its vision and imagination to design appropriate equipment to match government's requirements as determined by the COEAs.

Vision

Significantly Reduce Cost and Schedule Through Sim-Based Acquisition While Improving Product Quality

- **A Process Based on Cooperative Partnership Between Government and Industry (and Within Industry Teams)**
- **Direct and Unambiguous Communication Between Government and Industry**

A Vision for a New Process and Culture (cont'd)

The role of the acquisition executive would change in the following way:

- The acquisition executive would establish M&S tools that would be employed to evaluate industry proposals. These tools would be shared with industry, and would differ from the COEA M&S tools in that their emphasis would be on producibility. Equipment designs would be drafted by industry to match the government's evaluation tools. Instead of matching industry's language descriptions of its offerings with government's detailed language descriptions of needed equipment, the acquisition executive would evaluate industry's electronically described designs in government's electronic M&S testbed. Comparisons of industry's competitive proposals would be made directly, and electronically, from testbed results. The analogy of one side of a Velcro fastening matching the other side is useful in visualizing this approach.
- The burden on the acquisition executive would shift from the preparation of detailed language descriptions (RFPs) of the executive's vision of government's requirements (one level of potential miscommunication), and the laborious evaluation of industry's responding language descriptions (proposals) of their understanding of the executive's description (another level of potential miscommunication) to the more streamlined business of maintaining and using the M&S evaluation testbed.
    - This new process can be called Simulation-Based Acquisition (SBA) .

Vision

- Change the Role of the Acquisition Executive

- Acquisition Executive Evaluates Industry's Electronically Described Designs in an M&S Testbed

- Burden on Acquisition Executive Shifts from Laborious Evaluation of Industry's Language (Proposals) to Evaluating Solutions in M&S Testbed

Simulation-Based Acquisition

Simulation-Based Acquisition is embodied by three principal components. The first is an advanced SBA systems engineering environment that employs formal methods and automation to support efficient design synthesis, capture, and assessment, as well as other complex system life cycle activities. The second component is a refined system-acquisition process that takes advantage of the SBA systems engineering environment capabilities. The third component is an evolved culture where enterprise-wide cooperation is the rule, and individual technical contributions and innovations are encouraged and efficiently managed.

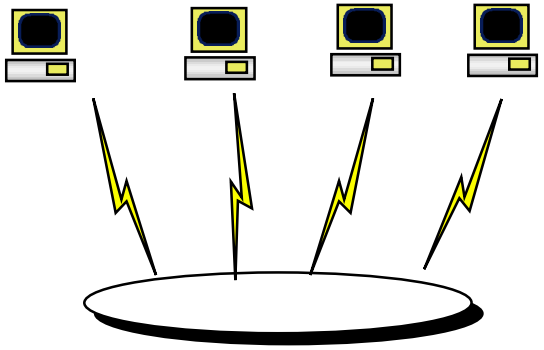
SBA is not an incremental step beyond the current systems engineering methods and tools employed today, but instead represents a major paradigm shift toward a comprehensive integrated design synthesis, capture, and analysis environment that addresses the entire system-development life cycle and the spectrum of engineering and management domains.

The central feature of the SBA vision is an advanced engineering environment that includes formal methods, tools and a common standard formal schema for system data representation. The SBA engineering environment provides a means for executing an extensible, tailorable, and repeatable process that results in creation of reusable design repositories and reengineerable products. The potential gains from use of such an advanced SBA environment will not be realized unless the engineering process, as well as the people and organizations, also evolve.

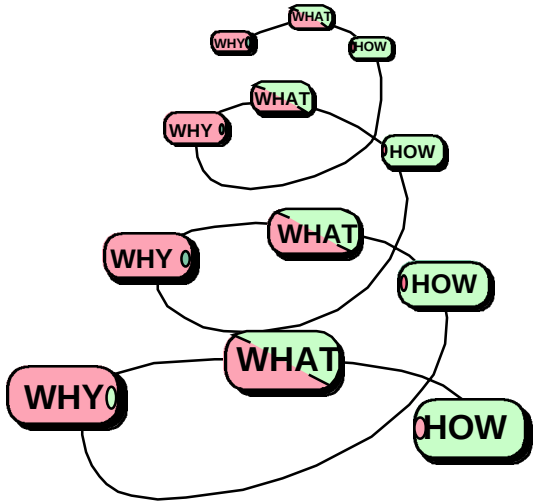
The benefits of the SBA process would not only be realized as time and cost savings within individual programs, but would also be manifested in cost savings by one program leveraging the design repositories and reengineered tools and products from other programs.

Simulation-Based Acquisition

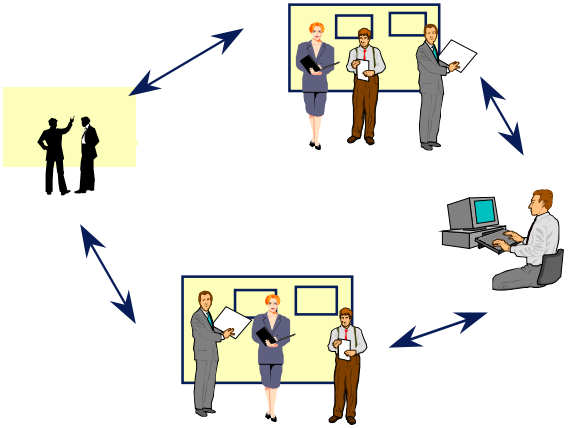
1. Advanced Engineering Environment



2. System Acquisition Process



3. Evolved Acquisition Culture



- **SBA Is a Comprehensive Integrated System Engineering Environment Coupled With an Iterative Acquisition Process and an Evolved Culture**
  - **Formal Methods, Tools, and Representations**
  - **Tailorable, Iterative Process**
  - **Refined Roles and Responsibilities**

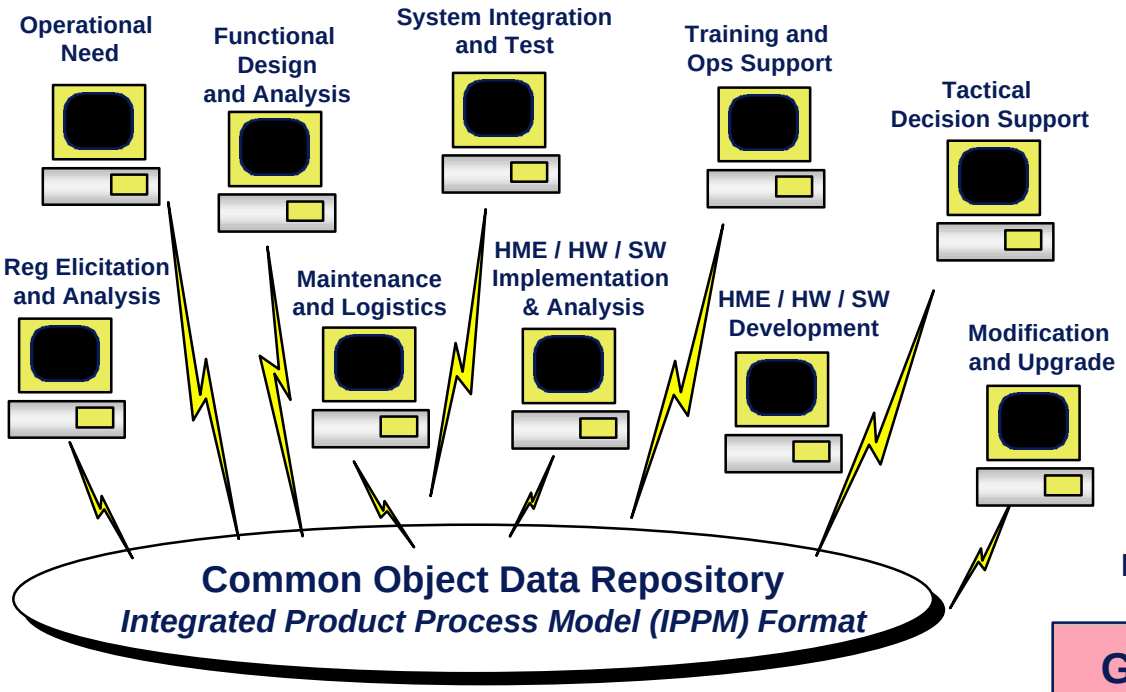
Vision for Future M&S Employment

One of the key elements of the SBA vision for employment of Modeling and Simulation in the acquisition of large, complex systems as described in this report includes an integrated SBA environment of systems engineering tools accessing a common object data repository. The central feature of a simulation-based acquisition environment is an integrated multidomain schema for representation of system design data. The common schema provides a formal means for capturing system information including top-level system requirements, environment considerations, conceptual design, functional design, implementation design, manufacturing, and management aspects. This schema provides a structured approach for representing and relating system information across the broad spectrum of engineering domains, enabling traceability and consistency analysis across these domains and over time. This formal information-representation schema is intended to provide a mechanism for, and the semantics for constructing a single consistent system information repository that can serve as a common database for advanced tool employment.

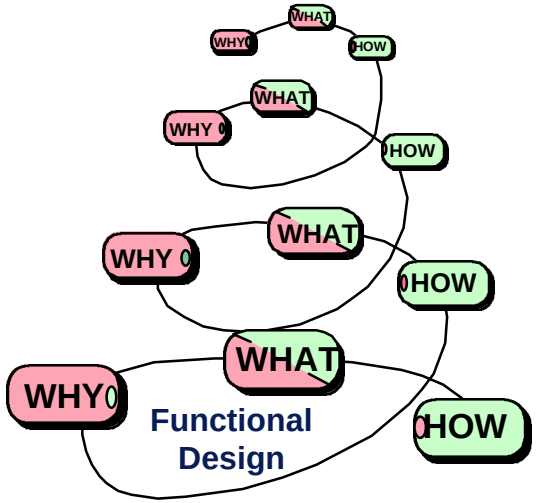
The SBA acquisition environment also supports an iterative system-acquisition process that is facilitated by the exchange of electronic system models between the government customer and the industry team providers. This iterative spiral process allows for rapid evaluation of multiple system options and stepwise optimization of the system design.

Vision for Future M&S Employment

Integrated M&S Environment



Iterative Process



Integrated Design Data Schema
- Comprehensive Multidomain Product Model Definition

Distributed Object-Oriented Design Database
- User-Transparent WEB-Style Access
- Internet Library

Collaborative Distributed Engineering
- Seamless Integration of Engineering Disciplines

Iterative Spiral Process
- Rapid Evaluation of Multiple Options
- Electronic Exchange of System Models

Integrated Process Teams
- HME and Information Systems

Efficient Automation / Multiple Baselines/Multidomain / Concurrent Simulation Capabilities

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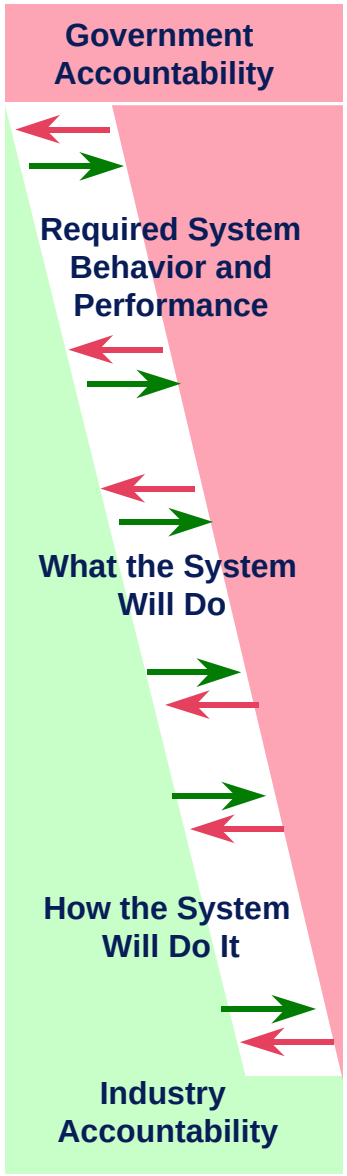
Key Design Domains Of SBA Iterative Process

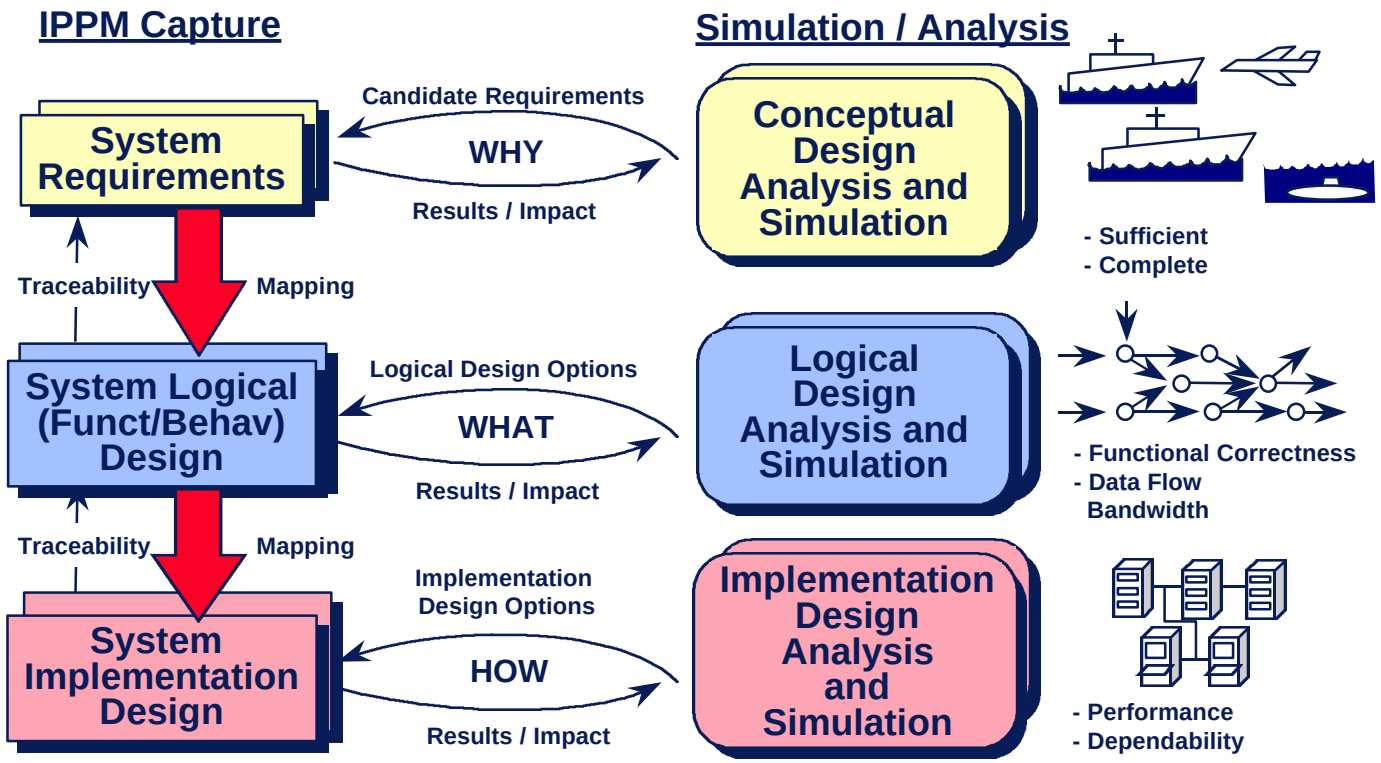
The three key SBA design domains, and the SBA concept of how the formal schema for design capture directly supports generation of executable system models, all focus on system-design activities that occur early in the system life cycle.

Three principal groups of activities are included in most of the common systems engineering processes in use today. The first group includes the specification of top-level system requirements and assessment of candidate system concepts. The second group includes the functional (or logical design which describes what the system must do (e.g., detect / classify / track / localize / attack) without regard to a specific implementation in hardware or software. The third group of activities addresses synthesis, capture, and assessment of the system-implementation design that includes hardware and software architectures as well as consideration of the operators as part of the system.

The formal schema representing each of these design domains is the vehicle for automatic extraction of executable system models supporting analysis and simulation in the various domains and at different levels of design abstraction. This formal unambiguous design-capture approach will also serve as a mechanism to enforce accountability on both the government and contractor teams.

Key Design Domains of SBA Iterative Process





Formal Schema for IPPM Capture Provides Direct Linkage to Simulation and Means to Address Government and Industry Accountability

SBA Operations Concept

As an example of the many ways in which Simulation-Based Acquisition (SBA) has potential to reduce life cycle costs and cycle times, we suggest use of the combat system acquisition scenario presented in the following SBA operations concept illustration.

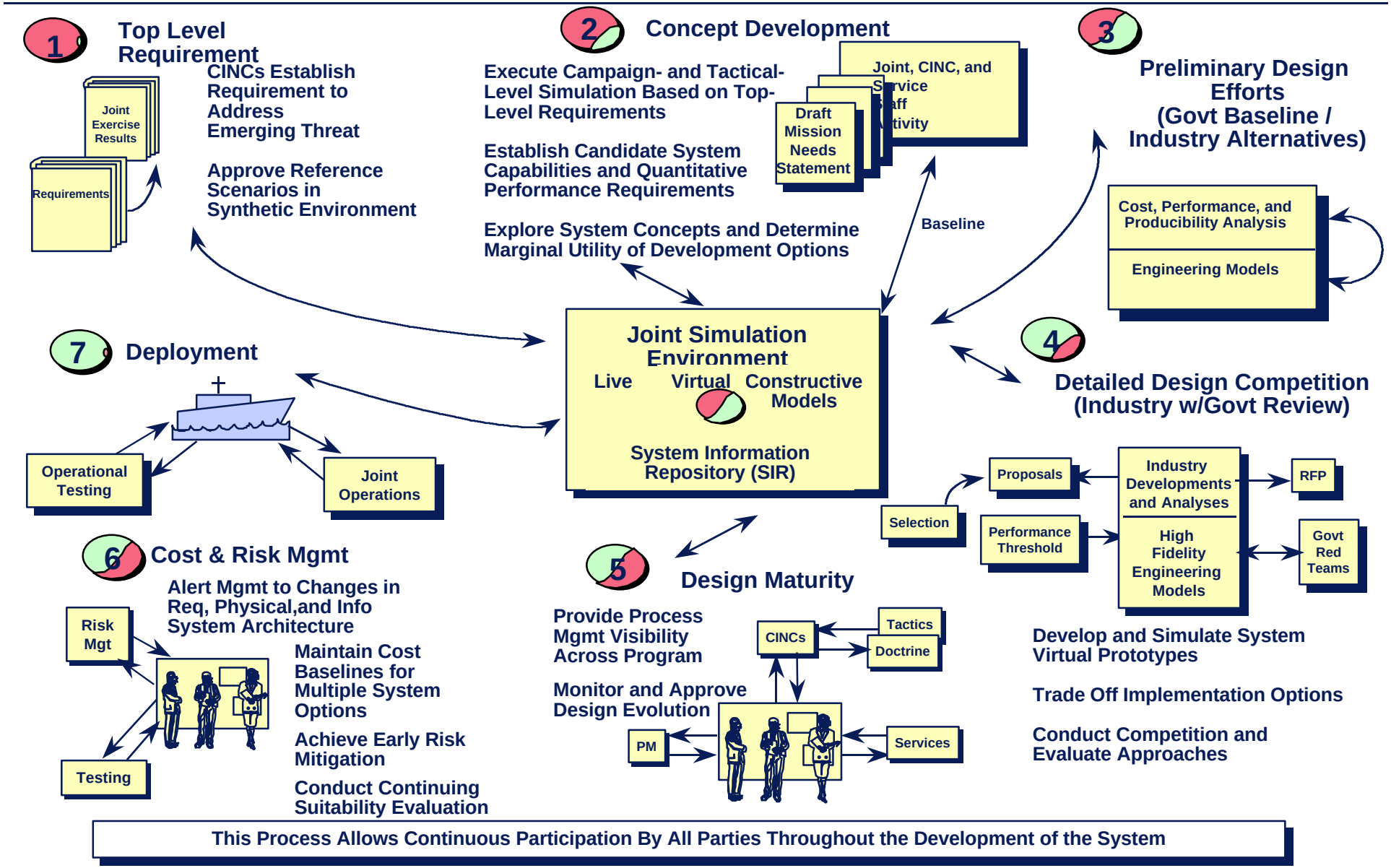
The following seven attributes of the SBA process are explored to visualize the concept of operations:

- Top level requirement
- Concept development
- Preliminary design efforts
- Detailed design competition
- Design maturity
- Cost and risk management
- Deployment

Note that although the various attributes of this concept are numbered and illustrated sequentially in the following example, the attributes are not actually sequential and do get executed with a significant amount of parallel activity.

These attributes are all linked via the system information repository (SIR) of the Joint Simulation Environment (JSE). The formal schema provides the unambiguous “language” that enables these linkages.

SBA Operations Concept



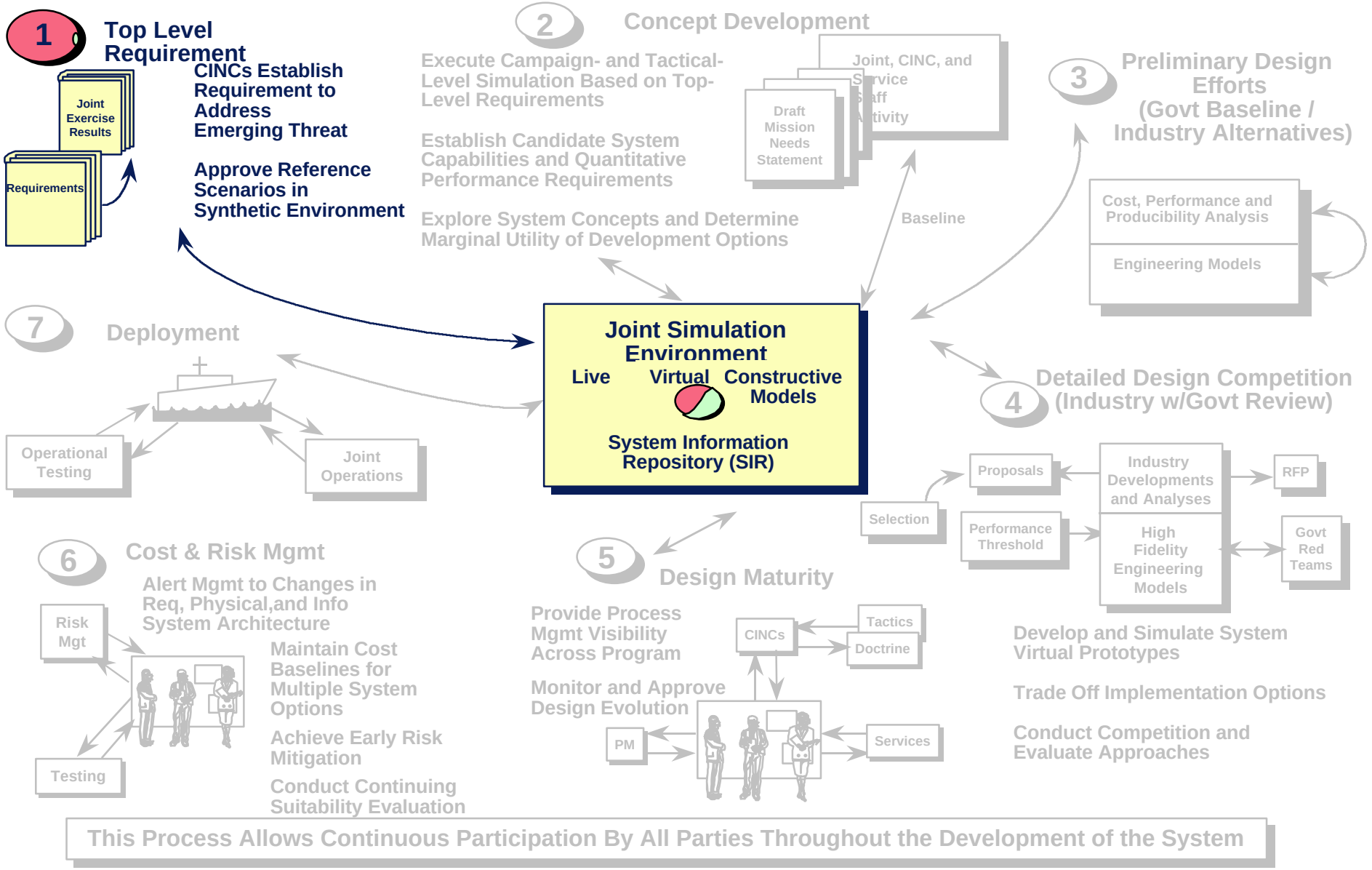
This Process Allows Continuous Participation By All Parties Throughout the Development of the System

Top-Level Requirement

Recognizing a potential Fleet vulnerability to the rapidly improving warfare capabilities of certain Third World countries, several warfighting CINCs include a requirement to address this threat in their annual Integrated Priority List (IPLs). In justifying the urgency of countering this future threat, they point to a series of Distributed Interactive Simulation (DIS) joint exercises during which they introduced enhanced Third World naval capabilities projected several years in the future. Because of the routine use for training and the demonstrated fidelity of their shared simulation models, the CINCs are confident that the unsettling results that have been obtained from repeated DIS exercise runs are valid reflections of future enemy capabilities and potential success.

Although some improvement in warfighting performance was achieved through tactical innovation during the DIS exercises, the CINCs believe that their warfighters have reached the plateaus of their tactics learning curves. They have also experimented with hypothetical enhancements to existing systems, but the impact of these improvements on "enemy" success in the exercises has been limited.

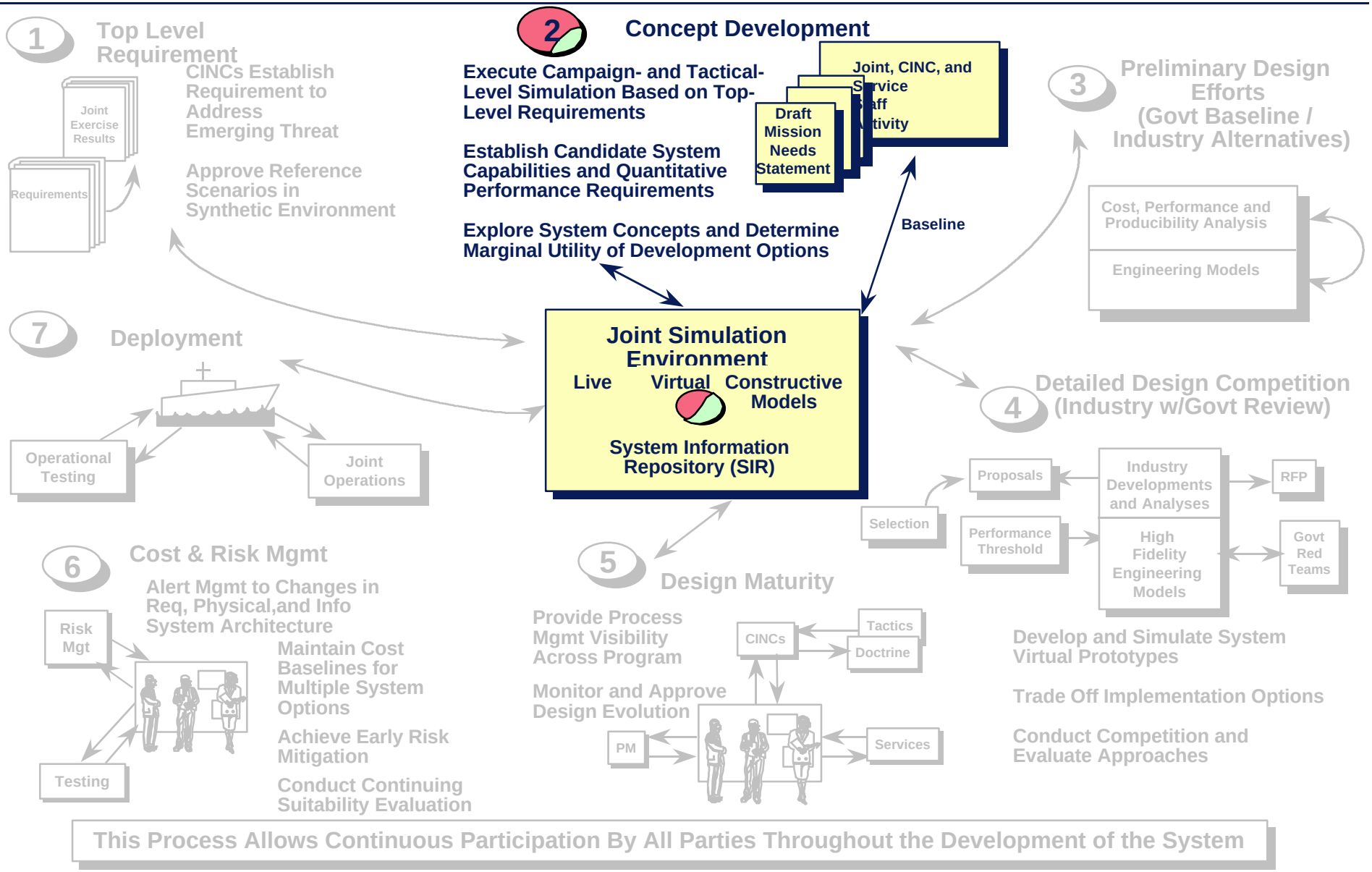
SBA Operations Concept



Concept Development

Having monitored via secure Distributed Interactive Simulation (DIS) links the conduct of the CINCs' exercises throughout the past year, the Joint and Service Staffs are well aware of the anticipated threat characteristics and their probable impact on future combat action. In fact, they have already begun a series of related studies to develop options and to assess the costs and capabilities of those options. Galvanized by the CINCs' IPLs, the Joint Chiefs have formally tasked the Joint and Service staffs to provide recommendations (validated by quantitative results) in 12 months. They further require that all studies and simulations be conducted within the Joint Simulation Environment (JSE), in which each of the staffs has full visibility into the simulation runs being conducted by its counterparts and all use the identical object-oriented databases in the System Information Repository (SIR). Because the JSE has also been used by the CINCs for their exercises, approved scenarios for candidate system evaluation are already available.

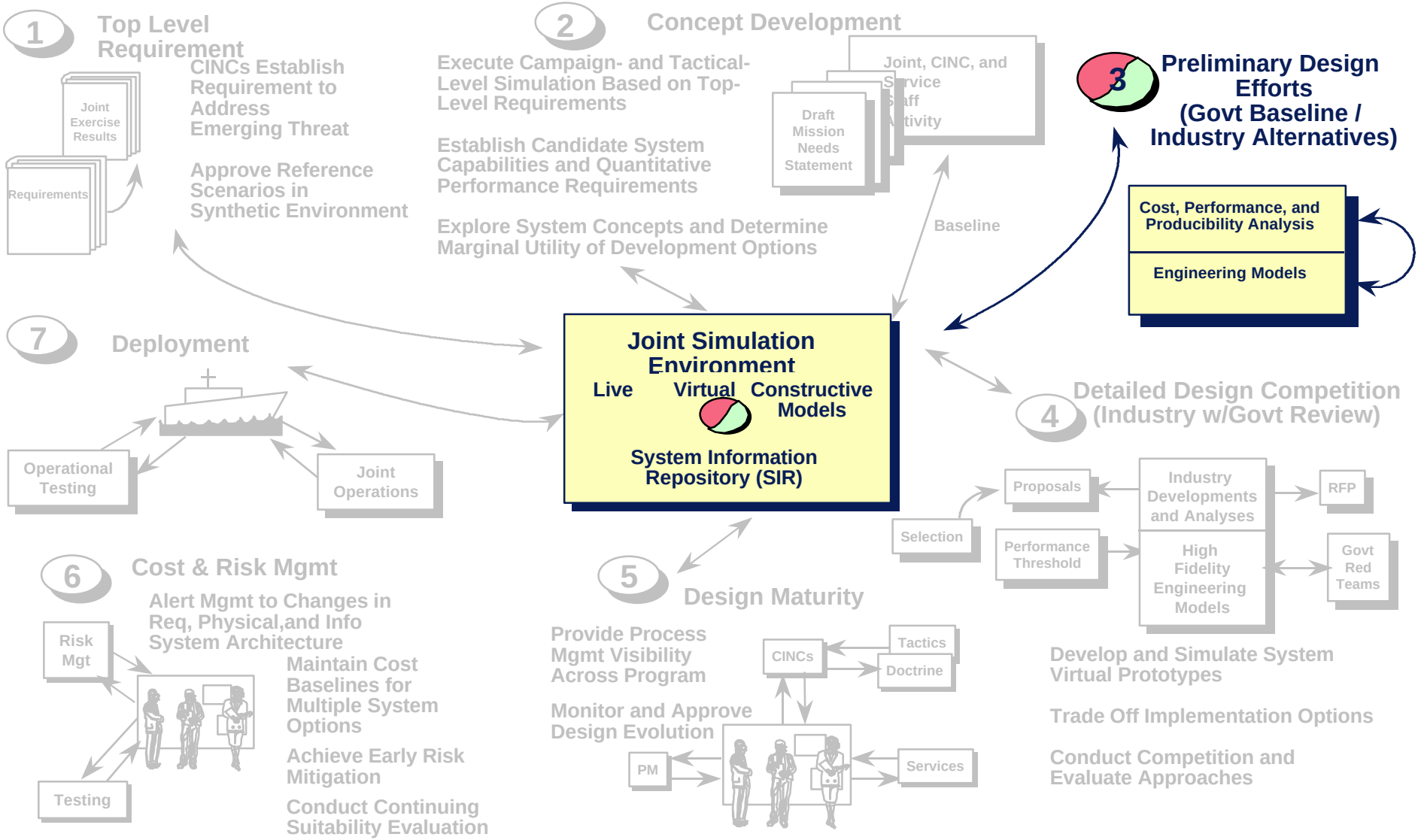
SBA Operations Concept



Preliminary Design Efforts

In view of the tight time constraint (12 months) for developing recommendations, numerous defense contractors with established past performance have been authorized access to the JSE. As the military staffs experiment with alternative solutions, those contractors are able to assess key system characteristics that seem to afford the greatest combat capability. They also evaluate the producibility and costs of alternatives. Those evaluations are based not solely on expert opinion, but also on the output of engineering models tied directly to the JSE. The contractors are able to recommend several high-payoff developing technologies for evaluation, suggesting in some cases the characteristics they would expect to provide, and in other cases actually interfacing their functional design models into the JSE simulation runs. Although all parties have access to the performance characteristics of proposed alternatives, only authorized government agencies have direct visibility into proprietary engineering models and solutions presented by contractors.

SBA Operations Concept



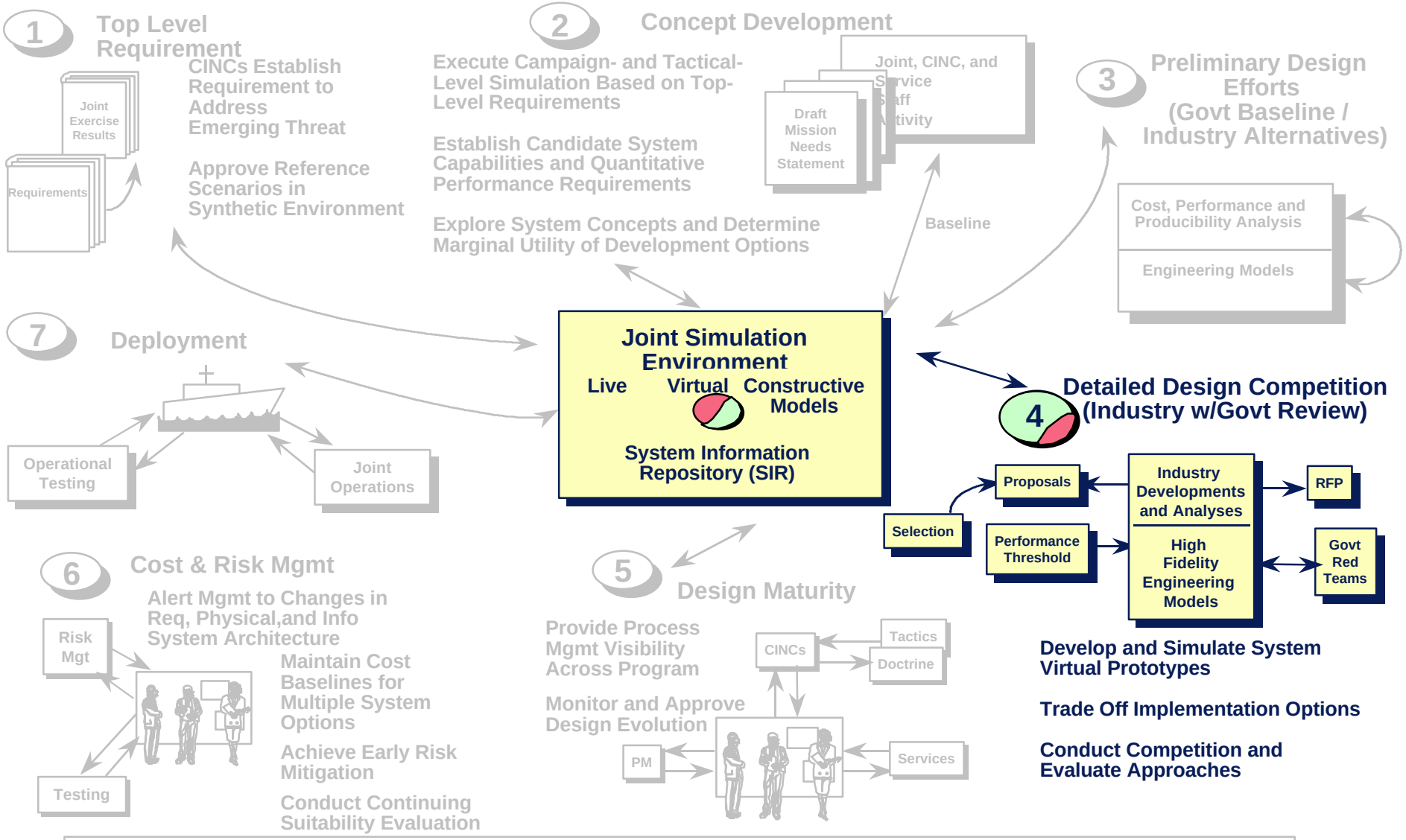
This Process Allows Continuous Participation By All Parties Throughout the Development of the System

Detailed Design Competition

Based on the results of JSE evaluations, the Joint Staff recommends more detailed assessment of two candidate systems whose performance has shown potential to counter the threat. With insight gained from having observed the JSE results unfold, numerous contractors quickly form two competing teams, while the other contractors shift to an inactive monitoring role. Intensive effort is applied to ensure the fidelity of the engineering models that produced the earlier results and to refine the architecture of the systems represented by them. As the military staffs observe refinements generated by the contractor teams, they establish a sequence of increasing performance thresholds. They also conduct "Red Team" exercises to counter the emerging systems with enemy tactics and weapons modifications. Red Team results are provided as feedback to the contractors. This "virtual competition" continues until the teams are unable to meet the latest trial thresholds within reasonable cost/schedule constraints. At that point, the Government issues a performance-based Request for Proposals (RFP) referencing the documented simulation scenarios, and invites cost and schedule proposals for each of several performance levels.

The contractor teams respond to the RFP with certified engineering models representing the characteristics of their proposed systems, together with associated cost/schedule bids. Assessing the cost/schedule proposals associated with each of the alternative performance levels in the RFP, the government selects a winning solution and contractor team. The contract consists largely of the engineering model proposed by the winner, as well as a record of the model's performance in the JSE environment and the cost/schedule proposed. A substantial portion of the contractor's incentive payment is to be predicated on his system's ability to perform at that proposed level in both virtual and live testing .

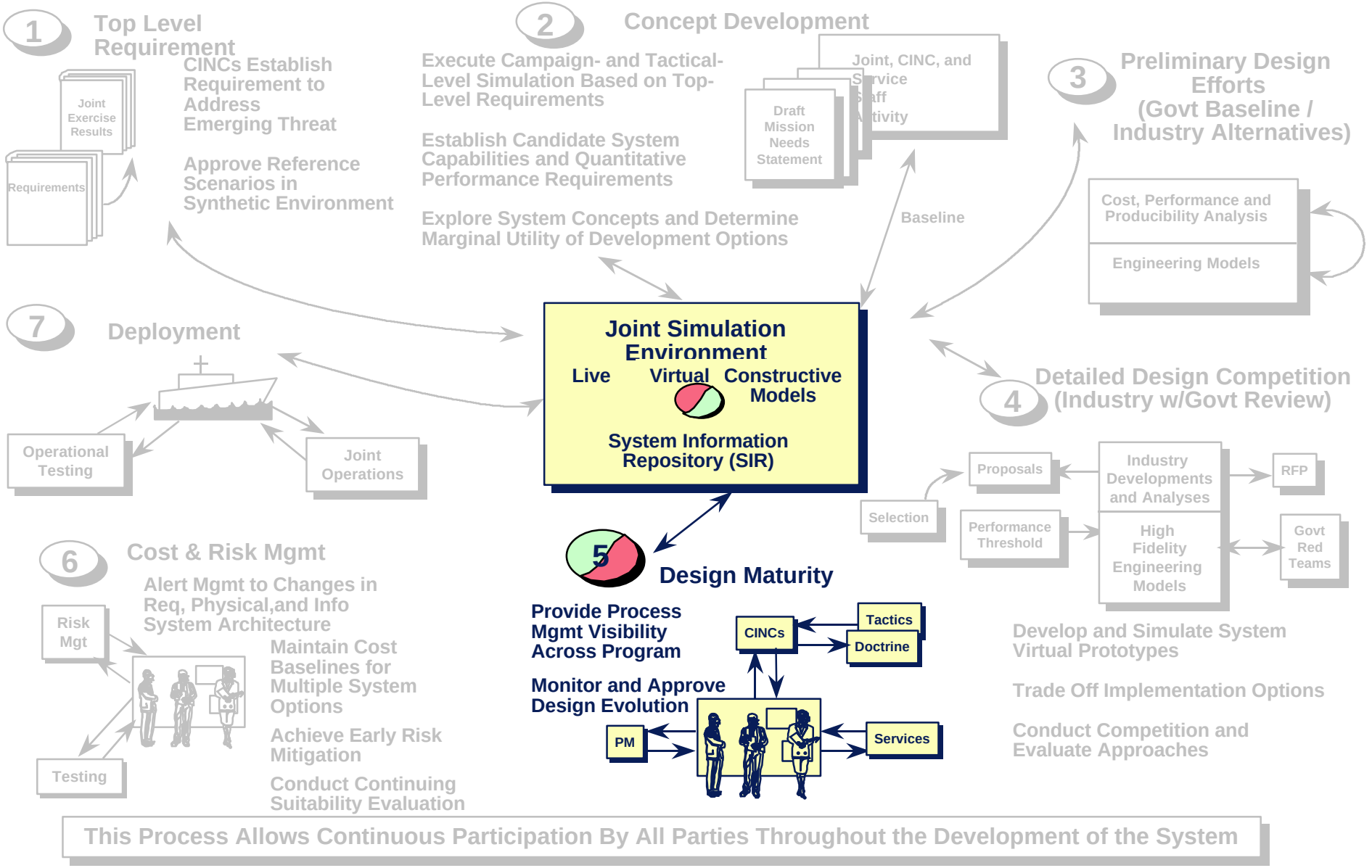
SBA Operations Concept



Design Maturity

Having a detailed representation of future system performance in the record of JSE exercise evaluations, the service sponsor finds that playback of those exercises to Congressional Staffs results in legislative confidence in the procurement and a more stable funding profile. As the system matures in design and the engineering model provides increasing detail relative to operating parameters, the CINCs exercise the model via the JSE to develop doctrine and tactics in advance of actual hardware deployment. In addition, they begin to train operators in land-based simulators that will transition over time to hybrid systems with increasing quantities of actual system hardware and software. Lessons learned from early introduction of warfighters to increasingly faithful representations of the deployable system are factored back into the system design as value engineering changes. The CINCs also monitor the maturing system to ensure that it will meet the enemy threat as that threat evolves during system acquisition.

SBA Operations Concept



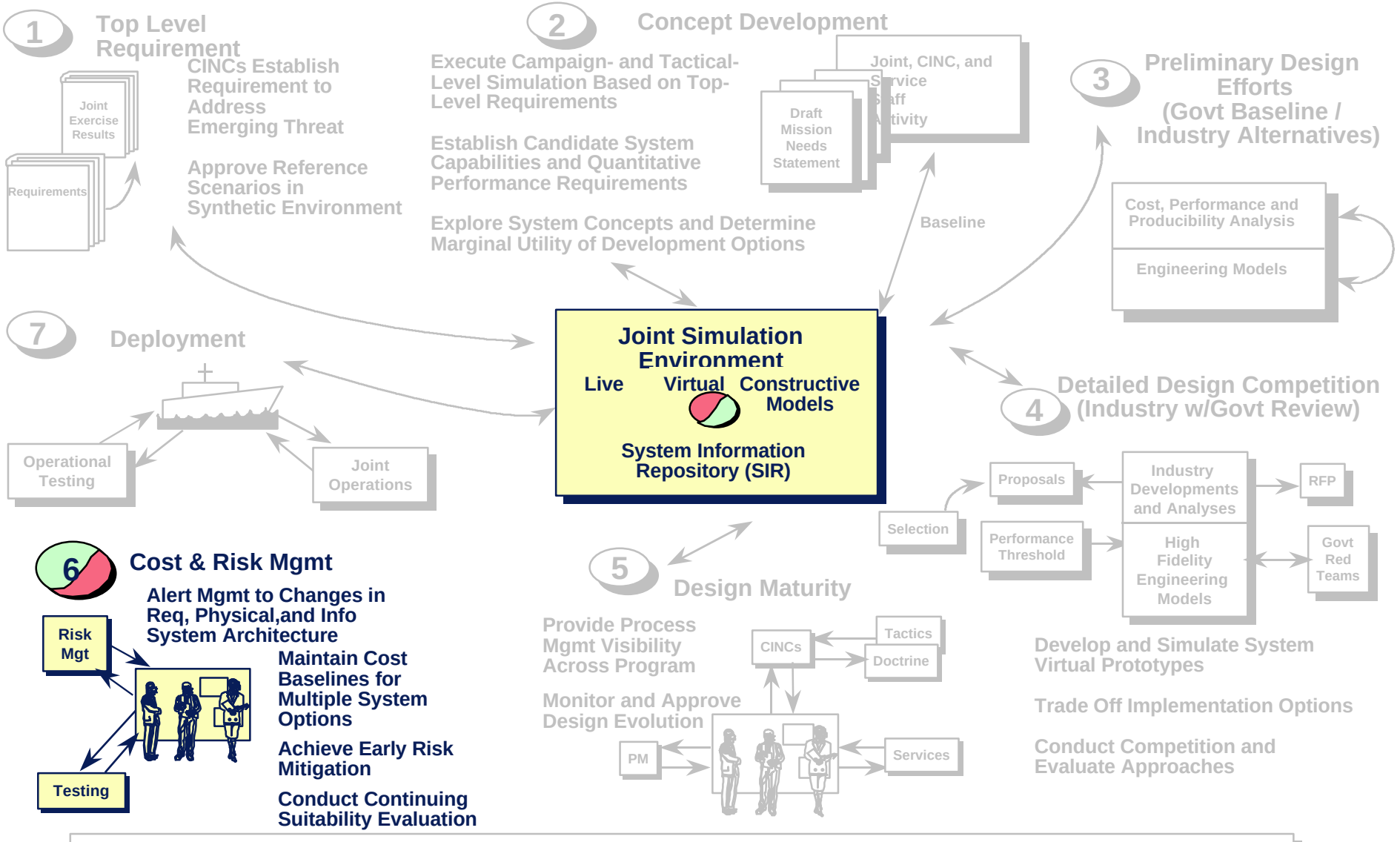
This Process Allows Continuous Participation By All Parties Throughout the Development of the System

Cost, Schedule, and Risk Management

Having conducted detailed system design using Simulation-Based Design (SBD) capabilities, the contractor is able to ensure acceptable form, fit, and human engineering of the system early in the development process. Cost- and schedule-management processes are tied directly to the detailed data contained in the SBD/SIR database, providing early alertment to potential risks. Risk-mitigation options are evaluated within the engineering model, and their cost schedule impacts are generated in repeatable and credible fashion.

Because the model continues to be operated within the JSE, the operational and testing communities have early opportunities to make recommendations for achieving improved suitability and operability, while also ensuring that testing will proceed smoothly when hardware is available. Proposed system enhancements are evaluated within the SBD/JSE environment to provide mutually consistent estimates of cost/schedule impact vs. performance gain.

SBA Operations Concept



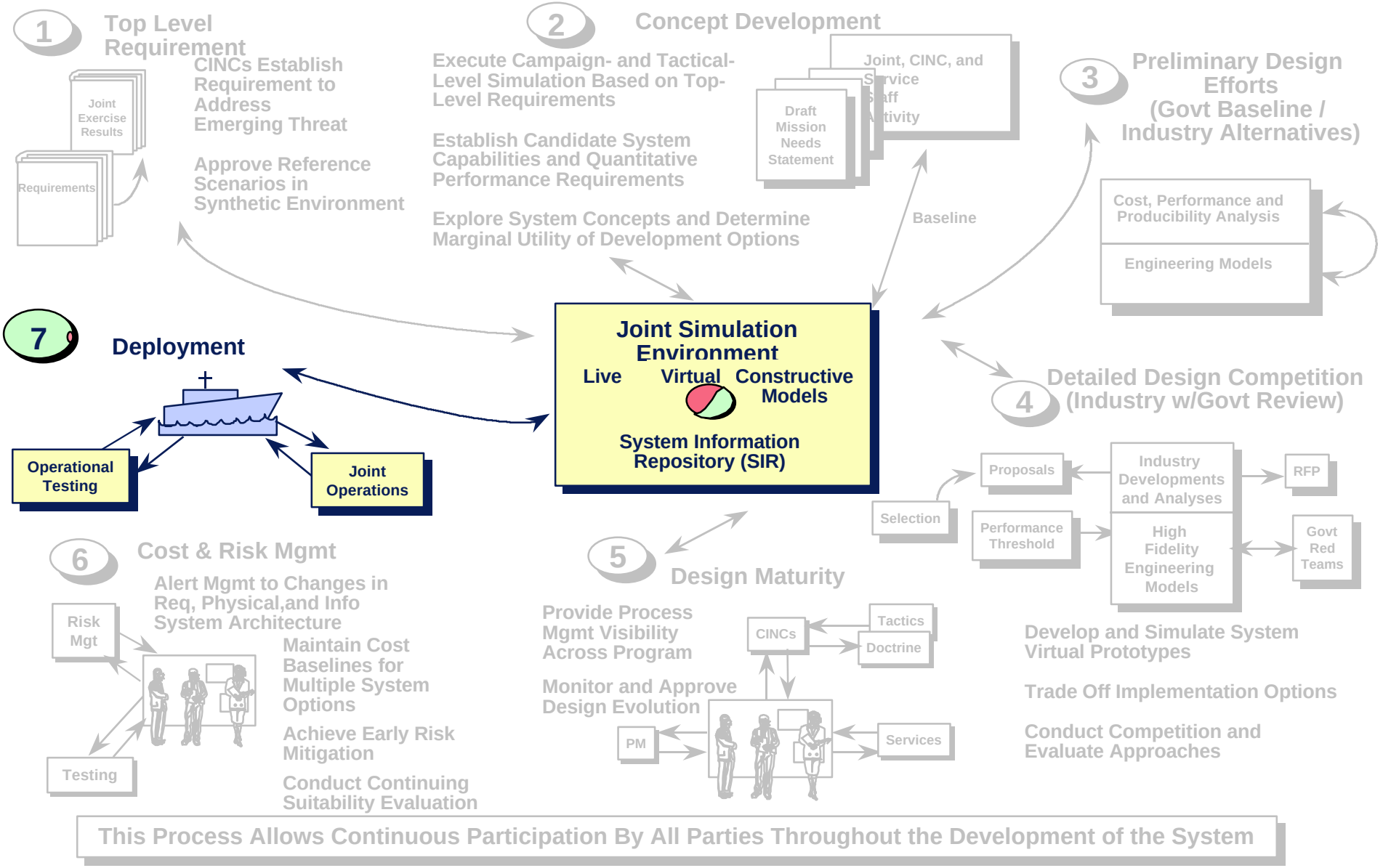
This Process Allows Continuous Participation By All Parties Throughout the Development of the System

Deployment

Continuous and detailed involvement of the warfighting CINCs in the acquisition process results in smooth transition from operational testing to system deployment. The Fleet operators and Joint Task Force Commanders are familiar with system operations and tactics from their "use" of the system within the JSE. Consequently, they are fully ready to incorporate the deployed units directly into joint operations with only a minimum of live training and familiarization.

Additionally, the simulation-based acquisition process that produces the deployed system has resulted in fewer errors and unanticipated "surprises," and less reworking. The continuous and unambiguous communication between the government developer, industry provider, and government user has produced a system that minimizes operational and support costs, because the decisions in the early stages of the acquisition were made on a well- informed basis supported by the people who are associated with the system at all phases of the life cycle.

SBA Operations Concept



SBA Environment Layers

Now it is reasonable to examine the tools, capabilities, and processes that will be required to support this SBA concept of operations.

The essential components of an advanced SBA environment can be partitioned into four categories that illustrate the architecture of such an environment at a high level. The foundation of the SBA environment includes generic computing infrastructure elements such as high-speed network communications, distributed operating systems and support utilities, high-performance computing hardware, object-oriented databases, advanced information visualization, and other broadly applicable computer technologies. The foundation also includes SBA-specific infrastructure elements such as:

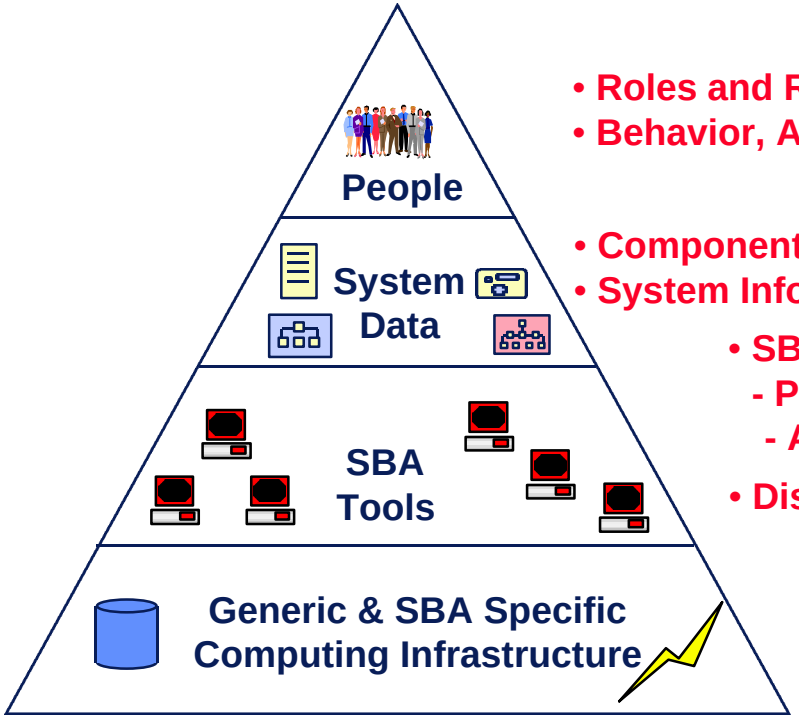
- a comprehensive IPPM schema for representation of the broad spectrum of SBA data,
- high-level architecture supporting development and execution of distributed simulations across a wide spectrum of domains and levels of abstraction, and
- a common virtual environment representing the world external to the system under development.

The next (second) category above the SBA infrastructure includes the application tools that support synthesis, capture, analysis, simulation, and optimization of large complex systems.

The third category represents the design libraries and reusable components from both commercial sources and existing system repositories. This collection of information serves as the central system information repository, and establishes a mechanism for supporting the entire system life cycle as well as reuse of SBA tools across programs.

The fourth category includes the people and organizations that will employ the SBA environment. The roles and relationships of the various participants must evolve with the development of the environment as must the behavior, attitude, and culture of individuals and organizations.

SBA Environment Layers



- Roles and Relationships
- Behavior, Attitude and Culture

- Component Libraries (COTS, Generic Conceptual)
- System Information Repositories

- SBA-Specific Design Capture and Assessment Tools
  - Physics-Based (HME) & Info Process (Combat System)
  - Acquisition and Business Process Modeling Tools
- Distributed System Design Repository

- Comprehensive Information Schema
- Adv Dist Sim Run Time Infrastructure (HLA/RTI)
- Synthetic Environments
- High-Performance Computing
- High-Speed Networks / Distributed OODBs
  Advanced Communications and Visualization

- Ongoing Efforts in Developing SBA-Specific Infrastructure Are Necessary but Not Sufficient to Support Future SBA Environment
  - DMSO HLA / ONR ECS / ARPA STOW
- SBA Tool Development Is Currently Hampered by Lack of Standards & Comprehensive Vision
- Across the Spectrum of Acquisition Domains
- There Is Currently No Structured Plan in Place to Achieve All of the Contents in the Pyramid

Chapter 3

Merits and Benefits of Simulation-Based Acquisition

Merit and Benefits of SBA

We have proposed changes in process, tools, and culture that support a new SBA paradigm, and have asserted that there are technical merits and benefits that will reduce acquisition cost throughout the life cycle.

SBA Tools will allow quick impact assessment of requirements changes and rapid evaluation of multiple design options. Emergent issues influencing the acquisition program can quickly be evaluated with respect to requirement impact, and the SBA schema and infrastructure described in this study will allow the quick evaluation of engineering design options to meet changes in requirements with a minimum of expended manpower to evaluate the potential approaches on a CAIV basis. The same holds for technology refresh / insertion opportunities.

The SBA process, with its common data schema and open shared database attributes, will also ensure efficient and effective unambiguous communication and understanding of design data between participants and stakeholders. The improved communications will also extend to the testing and evaluation community, resulting in a streamlined Test & Evaluation process that requires less physical testing.

SBA will also provide a much less expensive path for reuse and reengineering of existing designs - particularly as the infrastructure develops to support information sharing between acquisition programs. Proposed modifications to operational systems can be evaluated for cost / maintenance / operational impact by the users and life cycle supporters in a virtual environment that avoids many costly labor hours.

SBA, by virtue of the fact that the linked and automated processes can be automatically documented in an unambiguous manner using the common schema, will also provide a stronger audit trail that will reinforce and institutionalize both government and industry accountability. This will support the development and application of quantified past performance criteria in future selection processes.

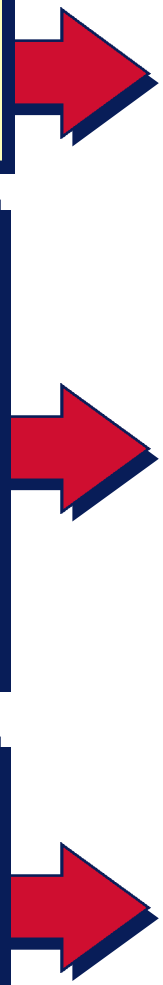
The result will be better product quality, reduced risk of costly design errors and redesign, and lower cost and development time in the initial acquisition stages leading to IOC.

Technical Merit & Benefits of SBA

Acquisition Evolution (Process)
- Iterative Exchange of Executable System Representations
- Distributed Collaborative Government/ Industry Systems Engineering Team

Advanced SBA Environment (Tools)
- Integrated Digital Design Capture and Simulation Environment
- Automated Design Consistency Checking and Traceability
- Direct Linkage from Design Capture to Simulation
- Automated System Engineering Product Generation
- SSS/SRS/HW Unit Spec/Test Doc

People (Culture)
- SBD Will Dramatically Reduce the Size of Systems Engineering Teams
- IPTs and Other New Organizational Concepts Will Prevail Over Time
- Changing Roles and Responsibilities Will Necessitate New Standards of Behavior and Attitude



Technical Payoffs
- Quick Impact Assessment for Changes in Requirements (e.g., Threat Change)
- Rapid Evaluation of Multiple Design Options
- Management of Technology Insertion Opportunities
- Efficient Communication and Understanding of Design Data
- Streamlined Integration and Testing
- Path for Reuse and Reengineering of Existing Designs
- Stronger Government and Industry Accountability

Programmatic Payoffs
- Better Product Quality
- Reduced Risk of Costly Design Errors / Redesign
- Lower Cost and Shorter Development Time

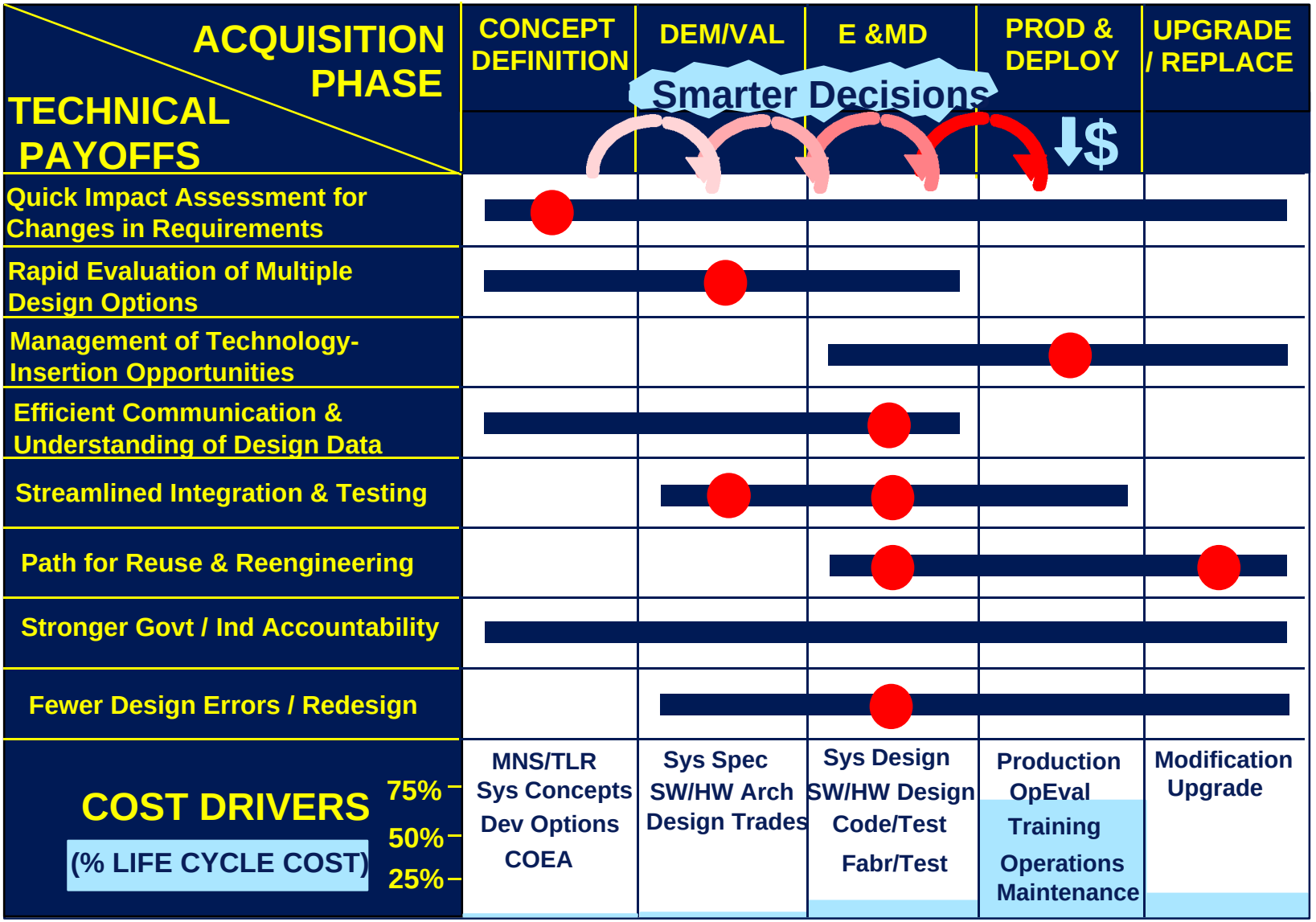
Merits and Benefits of SBA

The asserted merits and benefits of SBA to reduce acquisition cost must be examined in the context of the entire system life cycle. Since the predominant cost drivers occur during the production, deployment, and support of the system, it is fair to ask how an SBA process that has an emphasis during the early development phases can have a significant impact on life cycle cost reduction.

The answer to this question is that the SBA process helps the decision makers in making more informed, smarter decisions at the right junctures early in the process. The impact will be felt in reduced costs due to less mistakes, rework, and surprises discovered by the users and maintainers later in the cost-intensive phases of the life cycle. Additionally, the SBA tools and process allow for early exploration, evaluation, and validation of manning reduction concepts that will significantly reduce later life cycle costs if demonstrated to the customer and maintainers using virtual reality tools early in the development process.

The point is that an initial investment in SBA technology and process pays significant dividends later in the life cycle, when the significant cost drivers come into play. A dramatic reduction in life cycle costs can only be achieved if a system is designed originally to cost less to operate and maintain. SBA offers the tools and process that can help the decision makers accomplish this.

Merits & Benefits of SBA



Government and Industry Recognize Potential SBA Merits and Benefits

It can be argued that these SBA merits and benefits are only assertions, and remain to be proven. However, numerous ongoing acquisition programs are already demonstrating these benefits and merits in a piecewise manner, as is discussed in Chapter 5. Additionally, it is worth noting that the merits and benefits identified in this study by industry technical managers are generally consistent with those identified by previous government studies such as the Naval Research Advisory Council (NRAC) Report on M&S completed in November, 1994.

This indicates that both industry and government recognize the potential merits and benefits to be realized by applying SBA to acquisition reform.

Comparison of Government and Industry Thoughts on Benefits of M&S to Acquisition

NRAC Report on M&S
Nov 94

M&S Benefits to Acquisition:

- ID Min Reqts for Military Payoff
- Reduced Cycle Times
- Collapse DV & EMD Phases
- Build & Test Once vs. Twice
- Substantial Risk & Time Reduction
- "Lean" Manufacturing

ADPA Study 1996

Technical Payoffs

- Quick Impact Assessment for Changes in Requirements (e.g., Threat Change)
- Rapid Evaluation of Multiple Design Options
- Management of Technology Insertion Opportunities
- Efficient Communication and Understanding of Design Data
- Streamlined Integration and Testing
- Path for Reuse and Reengineering of Existing Designs
- Stronger Government and Industry Accountability

Programmatic Payoffs

- Better Product Quality
- Reduced Risk of Costly Design Errors / Redesign
- Lower Cost and Shorter Development Time

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Chapter 4

Business Challenges and Candidate Solutions

Business Challenges and Candidate Solutions

Business Challenges

The successful application of Modeling and Simulation to the acquisition process using the stratagem proposed in this study poses various business challenges for government and industry. Although these challenges are not insurmountable, focused and timely attention to their solution is essential if the SBA effort is to succeed. Of particular importance to government and industry alike, in the open information-exchange environment envisioned for this new paradigm, is the obvious need to maintain government and industry accountability and to protect proprietary data. In addition, there must be a carefully orchestrated and orderly transition to the new SBA paradigm, since any sudden and dramatic change in established program practices is certain to be met with resistance, token support, and mediocre success.

Another major challenge confronting the shift to the new SBA paradigm is the government's ability to express adequately the need for a program in unambiguous terms and to translate accurately this need into specific requirements. Similarly, with the SBA approach, industry must be able to present their proposed solutions clearly to satisfy the requirements, using an executable representation of the program.

Contractors historically have taken issue with the perceived subjectivity of government performance assessment for contract award, award fee determination, and contract fulfillment. The establishment of objective criteria in these areas is another matter for the government to address. Finally, before accepting this new SBA paradigm, industry leaders must be convinced that their investment will yield a favorable return and that the government is wholly committed to this acquisition approach .

Business Challenges and Candidate Solutions

- Establish an SBA Paradigm That Maintains Government/Industry Accountability and Protects Proprietary Data in an Open Information Exchange Environment
- Effect an Orderly Transition to the New SBA Paradigm
- Government Adequately and Unambiguously Express the Need
- Government Accurately Translate Need into a Requirement
- Industry Clearly Represent Proposed Solutions Using an Executable Representation
- Government Establish Objective Criteria for Contract Award and Performance Assessment
- Industry Must Realize a Return on Investment

Business Challenges and Candidate Solutions (Cont'd)

Establish an SBA Paradigm

The key to the SBA vision described in this report is a process within which Government and Industry openly share information and collaborate on an unprecedented level. Such a process requires a paradigm that maintains accountability both with the government and industry to ensure that a clear audit trail exists and that industry's proprietary data are adequately protected.

This challenge can be met with the employment of a multidomain partitioning system designed to encrypt and protect those data segments that industry legitimately considers proprietary, such as the implementation design for a given solution (the HOW). However, open access can be allowed to the synthetic environments and government-developed models that all industry competitors or team members would need to use to develop their solutions. Additionally, to a large extent, the conceptual design (that addresses the WHY) and the functional design (that addresses the WHAT) could also be shared in an open-access manner. The government would have to be sensitive to those aspects of both the conceptual and functional designs that legitimately represent "competitive edge" due to novel approaches or new concepts. However, these aspects, once identified and acknowledged, could also be protected by a properly constructed partitioning system.

The technical challenges posed by multi-domain partitioning are not insignificant, but they can be overcome, given the proper emphasis (such as is being pursued, for example, in the handling of classified data at various levels of classification within networked data processing and Command, Control, Communication, Computing, and Information (C^4I) systems.

Business Challenge and Candidate Solution

Establish an SBA Paradigm That Maintains Government/Industry Accountability and Protects Proprietary Data in an Open Information Exchange Environment.

- **Government Employ Multidomain Partitioning of System Design to Encrypt and Protect All Segments of the Implementation Design *(the HOW)* While Maintaining Open Access to Synthetic Environments and Conceptual Design *(the WHY)*, and Functional Design *(the WHAT)***
- **Foster Creative Exchange Between Government and Industry and Within Industry Teams and Willingness to Consider Multiple Design Alternatives**
  - **Discourage "Not Invented Here" and “We’ve Never Done It That Way”Attitudes**
  - **Encourage "King Has No Clothes" Disclosures**
- **Develop Unambiguous Executable Design Representations to Form the Basis for a Mechanism to Manage Accountability and Measure Performance**

Government and Industry Transition to SBA Paradigm

The transition of government and industry to the new SBA paradigm will require an orderly and well-orchestrated implementation approach if SBA is to gain wide acceptance in the acquisition community as an important augmentation to the procurement process. Program managers, faced with the problem of minimizing life cycle costs and development cycle times while meeting desired performance parameters, have the flexibility within the framework of DoD Regulation 5000.2-R to effect SBA now. However, a deliberate approach is suggested as opposed to trying to implement the concept in its totality at the onset. The foundation and culture to support the SBA paradigm should be built in deliberate and orderly steps to build confidence within the government, and to ensure achievement of DoD acquisition reform objectives by industry.

By conducting coordinated engineering experiments with components of the proposed SBA process infrastructure, capabilities produced during these experiments can be left in place and used as stepping stones to the achievement of successful simulation-based acquisition. The engineering experiments will also serve to educate the acquisition community in the understanding and exploitation of SBA principles when applied throughout the system-development process, and in the benefits to be realized from application of these principles.

Business Challenge and Candidate Solution

Effect an Orderly Transition to the New SBA Paradigm

- **Government Program Managers Have the Flexibility to Effect SBA Now**
- **Do Not Try to Do it All at Once**
- **Build the Foundation and Culture to Support the Paradigm in Steps by Conducting Coordinated Engineering Experiments That Produce Legacy Capabilities**
- **Engineering Experiments Leave in Place Components of the Infrastructure Required to Achieve Simulation-Based Acquisition**
- **Educate the Acquisition Community Via the Engineering Experiments**

Government Must Clearly Express Need and Requirements

It is imperative that government express the *need* in a clear and complete manner in order for industry to respond effectively. This requires a clean distinction between the needs and the requirements that will fulfill those needs. Primary initial government emphasis should be on the definition of the need. With a well-defined need, industry can use tools such as Modeling and Simulation to assist government in defining a set of requirements that will best meet the needs. Modeling and Simulation has been, and will continue to be, used to assist government and industry to eliminate alternative requirements that are not affordable, cost-effective, and/or adequate to fulfill the need. Use of M&S can save time and funds in all phases of programs, and the maximum benefit can be derived by initiating its application during the program-definition phase.

Review of development programs has shown that early application of M&S to assist in the extrapolation of needs to meaningful requirements can produce substantial savings in development and operational funds. Since the requirement defines "HOW to meet the need," a number of alternatives should be reviewed in establishing the requirement. M&S is particularly suited for performing that task in a cost-effective and timely manner. It can be used to assess not only performance trade-offs, but also the sensitivity of development and operational costs to variations in the requirement. That aspect can be most useful in defining the requirement in a manner that assures the maximum performance per dollar spent. The effective use of M&S in defining the requirement can reduce the amount of time and funds spent on nonproductive development efforts. It can also establish early in the program whether or not the specific requirement is affordable.

Business Challenge and Candidate Solution

Government Adequately and Unambiguously Express the Need

Government Accurately Translate Need into Requirements

- **Develop Executable Representations and Experimental Data Schemas and Test Them**
- **Use a Pilot Program for SBA Application in Concept Development and"Play" the Industry-Provided Executable Representation in Military Combined Real/Simulated Exercises**

Industry Must Clearly Represent the Proposed Solution

Industry must ensure that M&S *representations* accurately depict the total system performance and the environment. As Einstein once said, "All models are wrong; some models are useful." In assessing the value and cost-effectiveness of a given solution, the realism of the modeled system operation and its operating environment will determine its usefulness in assessing potential system performance. In meeting this goal of maximum realism, the establishment of an integrated system of M&S effort will enhance the ability of industry to provide realistic executable representations of their solutions.

An iterative and cooperative government and industry process throughout system development is envisioned in this future SBA environment. If the need is to be adequately expressed, the requirement must be accurately translated from the need, and industry must clearly express proposed solutions with an executable representation of the requirement. Initiation of a pilot program for the concept-development phase of SBA is recommended wherein the need, requirements, and proposed solutions would be expressed and tested with experimental data schema using an integrated design approach. The executable representations of the requirement prepared by industry would be played in a combination of real and simulated military exercises to investigate various concepts and determine the suitability of various options to satisfy the requirement.

Business Challenge and Candidate Solution

Industry Clearly Represent Proposed Solution Using an Executable Representation

- **Develop Executable Representations and Experimental Data Schemas and Test Them**
- **Use a Pilot Program for SBA Application in Concept Development and"Play" the Industry-Provided Executable Representation in Military Combined Real/Simulated Exercises**

Government Establish Objective Criteria For Contract Award and Performance Assessment

The development of objective criteria for award of contracts and definition of formal quantitative metrics for assessment of contractor performance are two areas that industry considers to be significant governmental challenge to assure unbiased and unprejudiced selection for contract award and performance assessment. In particular, the subjectivity in the processes currently used for measuring past contractor performance, determining award fees, and satisfying contract requirements continues to vex contractors and results in many, often needless, administrative and contractual disputes.

With the current trend in the acquisition process of giving contractors increased flexibility in satisfying a requirement, and with the concomitant government reduction of program oversight, increased responsibility and liability are imposed on the contractor. It is incumbent on the government to provide a process for contract award and performance assessment that eliminates, to the maximum extent practicable, subjectivity in the evaluation processes associated with these efforts. With the generation of objective criteria, M&S tools will make it easier for the government to oversee the processes, and to help produce and maintain audit trails.

Business Challenge and Candidate Solution

Government Establish Objective Criteria for Contract Award and Performance Assessment

- Government Develop and Articulate Formal Quantitative Metrics for Measuring
  - Past Performance
  - Award Fee
  - Contract Fulfillment
- M&S Tools Will Make it Easier for Government to Oversee the Process and Help Produce Audit Trails to Support Generation of Objective Measures
- Increased Flexibility and Reduced Oversight Must Be Accompanied by Increased Responsibility and Liability

Investment Return

Industry will assess the probable return on investment before expending substantial funds on any effort. Thus, government must ensure that programs are structured to ensure a reasonable probability that industry participants will achieve a fair return on investment for their full involvement in the effort. Obviously risk is involved, and the losers in a competitive procurement will not see a return on that specific effort. However, it is imperative that industry see the total procurement process as being fair and offering a reasonable probability of profit through continuing competitive efforts.

Government must also assess whether or not it wants to encourage participation by businesses that have not previously been involved in government development and procurement programs. This injection of "new blood" can strengthen the procurement process when innovation is required. Companies that are new to the government procurement process must see a reasonable chance for return on investment before they will make the decision to participate. An important factor in that assessment will be the perception of program stability. Industry will use M&S in the evaluation process to determine potential return on investment related to specific programs.

Simulation-based acquisition as envisioned in this study affords industry the opportunity to capture, analyze, transform, and communicate government needs and benchmarks with reduced effort because of the open access to government information and use of standard models. The iterative government/industry process using concurrent simulation capabilities based on a formal information schema should bound the investment risk for industry, since ambiguity is reduced and accountability is increased. The M&S approach will allow industry to focus on its strengths and to avoid dilution of limited resources in its efforts to capture additional business. This new paradigm will provide industry the opportunity to optimize its business process and enhance its ability to produce a quality product at lower cost.

Business Challenge and Candidate Solution

Industry Must Realize a Return on Investment

- **Open Access to Government Information and Standard Models Reduces Effort to Understand the Need and Government Benchmarks**
- **Less Ambiguity and More Accountability Provided by Formal Information Schema Bounds the Risk**
- **Allows Industry to Focus on Their Strengths, and Avoids Dilution of Limited Resources**
- **Allows Industry an Opportunity to Optimize Their Business Process Thus Providing a Quality Product at Lower Cost (More Room for Profit)**

CHAPTER 5

Conclusions and Recommendations

Conclusions

Modeling and Simulation tools, as well as new processes such as Integrated Product and Process Development (IPPD) executed by Integrated Process Teams (IPTs) are already being applied in a range of ongoing acquisition programs. Examples cited in the Collaborative Virtual Prototyping (CVP) Study completed by the Naval Air Systems Command in October 1995 included the following:

- The Joint Advanced Strike Technologies (JAST) Program is projected to realize life cycle cost savings on the order of $1.2B due to the application of lean and new business practices.

- The F22 Program projects savings of $161M due to the application of lean and new business practices.

- The NSSN Program projects savings of 25% on production costs, due to application of SBD / CVP tools.

The CVP study results and formal briefings presented at various open forums by these and other acquisition programs (example: NSSN presentation at Naval Submarine League's Submarine Technology Symposium 96) indicate to this study team that the merits and benefits of M&S as an enabling technology are beginning to be demonstrated. It is interesting to note that our conclusions on the merits and benefits of M&S were developed independently from the other studies listed in Appendix B, yet are fairly consistent with the findings of those studies. This would indicate that in this case, government and industry generally agree on the prospects and merits of M&S as an enabling technology for Acquisition Reform.

The challenge for Acquisition Reform is to provide the catalyst that will expand this growing successful application of M&S tools beyond vertical applications within programs so that cost savings benefits can be realized by sharing data, tools, and techniques between different acquisition programs. This requires the full development of the SBA infrastructure discussed in Chapter 2 that would provide a common data schema which would allow unambiguous communication not only between government and industry but also between programs.

It is our conclusion that the appropriate vehicle for meeting this challenge is Simulation-Based Acquisition (SBA).

Conclusions

- **M&S Tools and New Processes (IPPD and IPT) Are Successfully Used to Reduce Costs and Time in Ongoing Acquisition Programs (NSSN, SC-21, JAST, ...)**
- **The Merits and Benefits of M&S as an Enabling Technology Independently Identified by This Study and by Previous Studies (NRAC) Are Beginning to Be Demonstrated by These and Other Programs.**
- **The Challenge for Acquisition Reform is to Build on the Results from and Lessons Learned by These Vertically Oriented Programs by Constructing and Applying the Infrastructure Necessary to Share Data and M&S Tools / Techniques Among Programs.**
- **The Vehicle for Meeting This Challenge is Simulation-Based Acquisition (SBA)**

Conclusions (cont'd)

The new SBA culture described in this report is predicated on mutual trust between government and industry. This requires a strong early partnership between the two.

Industry does have concerns that need to be addressed. However, the majority of our study team viewed the concerns that had been identified as challenges which were not insurmountable but had potential solutions. None of those concerns were viewed as showstoppers.

Program managers already have considerable flexibility available within the framework of the revised DoD Regulation 5000.2-R. Various acquisition programs are demonstrating the high degree of available flexibility with innovative procurement and contracting approaches. Good examples are the competition and contracting process, as well as the technology refresh strategy employed by the NSSN Command, Control, and Communications (C^3I) Program, which won the Department of Defense Packard Award for Acquisition Excellence in 1996.

Conclusions (cont'd)

- **The New SBA Culture Requires a Strong Early Partnership Government and Industry**
- **Industry Has Concerns That Must Be Addressed for This Partnership to Work...But They Are Challenges With Potential Solutions and Not Showstoppers**
- **Program Managers Already Have Great Flexibility Available Within the Framework of DoD Regulation 5000.2-R to Effect SBA Now**

Conclusions (Cont'd)

Although we believe that the merits and benefits of M&S will result in acquisition cost savings, it is important to remember that Simulation-Based Acquisition requires not just the use of M&S tools, but also full application of new processes (IPPD and IPT) and a new acquisition culture that is willing to use the tools and apply the processes.

The M&S tools, used to maximum advantage in this new process, will help provide the right information in an efficient manner and on a timely basis to help the decision makers make smarter, more informed decisions at the right time. The result will be savings in time and dollars during development, and even more significant savings over the system lifecycle due to the delivery of a product that meets the user needs, requires less reworking, and is less expensive to operate and maintain.

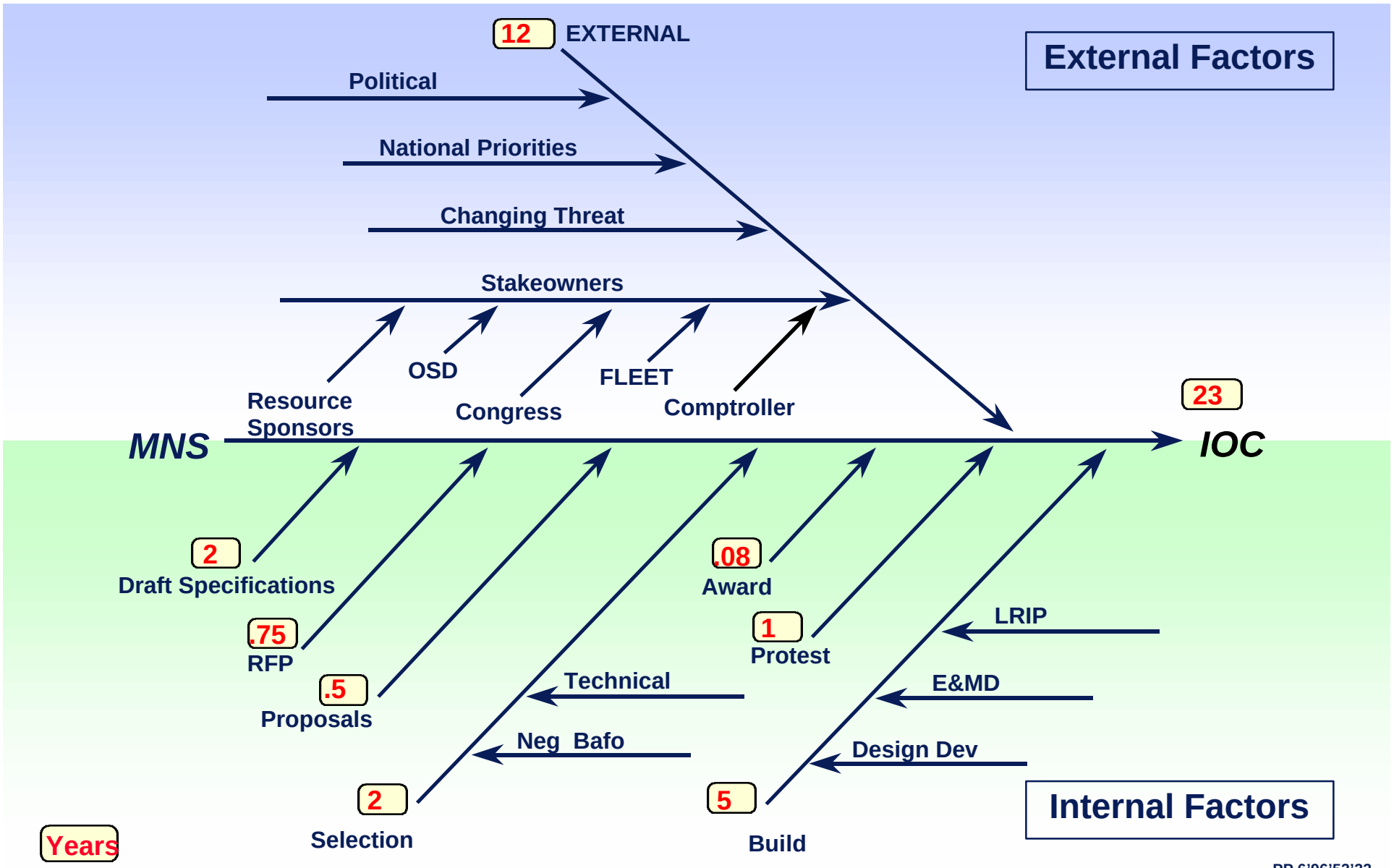
Conclusions (cont'd)

- SBA Requires Not Just M&S Tools, But a Marriage of:
  - A New Process (IPPD and IPT)
  - New Tools to Execute the Process (M&S)
  - A New Culture Willing to Use the Tools and Apply the Process
- Decision Makers Using the SBA Process Will Have the Ability to Make Smarter, Faster, More Informed Decisions Which Will Save Time and Dollars Throughout the Life Cycle.

Contributing Factors to MNS–IOC Time Line

Contributing factors that consume the time required to achieve Initial Operational Capability (IOC) from receipt of a Mission Need Statement (MNS) can be segregated into internal factors and external factors beyond the control of the acquisition program manager. It is possible to identify typical or nominal time periods associated with the various factors, and our study team felt that it is also possible to expect up to five years reduction in total time to IOC by reducing internal factors with the application of a new SBA process. These potential time savings fall far short of achieving a 50% reduction in time to IOC. This is because a significant percentage of the time expended while achieving IOC is consumed by the external factors.

Contributing Factors to MNS-IOC Time Line



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Reducing Time to IOC

Achieving more significant reduction in time to IOC will require reduction of the time added by external factors. This can be partially accomplished by recognizing that some of the external delaying influences could be due to lack of stakeholder understanding and confidence in a given program. Early and consistent unambiguous communication with all stakeholders, using the powerful M&S and multimedia tools now available, will ensure that complex issues and concepts are communicated in a simple, easy-to-understand manner. The result will be increased stakeholder confidence and support that will help mitigate external issues and program delays. It is difficult to quantify the savings in time to IOC that this approach will afford, but it is reasonable to expect additional time savings.

Even a time reduction of up to five years will provide an additional benefit of reducing the amount of development time during which external factors such as national priorities, political issues, and threat projections can exert external influences that affect the acquisition.

Reducing Time to IOC

"Assess the Potential of Achieving 50% Reduction in Cycle Time from MNS to IOC..."

- **Application of Available Flexibility in Contracting and Procurement Combined With Use of Proposed SBA Process Can Potentially Reduce Time to IOC by up to 5 Years.**
- **Additional Reduction in Time to IOC Must Be Achieved by Reducing External Factors. Key is to Gain Confidence and Support of Stakeholders by Using Multimedia and Virtual Reality to Communicate Complex Issues and Concepts in Simple, Easy-to-Understand Manner. This Approach Could Be Expected to Reduce External Delays.**

Summary of Conclusions

This study concluded that Simulation-Based Acquisition shows significant promise for achieving significant reductions in time from MNS to IOC, as well as cutting life cycle costs and improving quality. A candidate vision and concept of operations describing how SBA would proceed has been presented, and the anticipated merits and benefits of this approach have been identified. There are unresolved issues - particularly with respect to industry's concerns regarding how to protect their competitive edge and proprietary ideas and realize a profit while helping the government effect significant reductions in acquisition costs. However, this study concluded that these issues have potential solutions and that none are showstoppers. A clear rationale exists for pursuing SBA to support Acquisition Reform.

Summary of Conclusions

- **SBA Shows Significant Promise for Achieving Significant Reductions in Time from MNS to IOC as Well as Cutting Life Cycle Costs and Improving Quality**
- **A Candidate Vision for SBA Has Been Articulated, and Considerable Technical Merit Has Been Identified for Potential Near-Term and Long-Term Payoffs**
- **Several Issues (and Candidate Solutions) Have Been Identified, but no "Show Stoppers" were Found...Clear Rationale Exists for Pursuing SBA**

Recommendations

The government should firmly establish SBA as the preferred manner of conducting IPPD-style acquisition, and should establish incentives for both government program managers and industry to ensure full and enthusiastic participation.

Carefully designed pilots programs, structured as engineering experiments with objectives and metrics, can demonstrate the utility of SBA to the acquisition community and stakeholders to catalyze the cultural change that is required. Pilot programs should be augmented with necessary additional funds, and should be focused not just on M&S tools, but the entire SBA process. Metrics should address the building of a program-to-program infrastructure that builds on the ongoing DoD investments in M&S.

The government should provide open access to government information and standard models to the appropriate industry participants in the pilot programs.

The government should re-direct DoD investment in M&S to support and encourage development of an SBA specific infrastructure. The High Level Architecture (HLA) and other infrastructure components being developed by DoD are necessary but insufficient for the realization of SBA. Additionally, the following should be pursued:

- Develop a comprehensive system data schema that provides for common representation and data interchange mechanisms between government and industry standard databases.

- Develop key tools that would build on the DMSO HLA and serve to jump-start pilot efforts. Examples could include a database repository tool, and common data library and M&S analysis tools that the acquisition executive would use to evaluate industry proposals. These tools would be shared with industry, and would differ from existent COEA M&S tools in that their emphasis would be on producibility.

Recommendations

- **Firmly Establish SBA as the Preferred Manner of Conducting IPPD-Style Acquisition, and Establish Incentives for *Both* Government Program Managers *and* Industry to Make it Happen**
  - **Use Pilot Programs to Demonstrate the Utility of SBA for Fostering Cultural Change**
  - **Augment Designated Pilot Programs with Necessary Additional Funds**
  - **Pilots Should Focus on the SBA Process, Not Just on the M&S Tools**
  - **Pilot Metrics Should Address the Building of a Program-to-Program Infrastructure**
- **Provide Open Access to Government Information and Standard Models**
- **Redirect DoD M&S Investment to Support and Encourage Development of SBA-Specific Infrastructure Including:**
  - **Comprehensive System Data Schema (Providing Common Data Representation and Data Interchange Mechanisms)**
  - **Develop Key Tools to Build on DMSO High-Level Architecture and Jumpstart Pilot Efforts, e.g.,**
    - **Database Repository Tool**
    - **Common Data Library and Analysis M&S Tool**

ADPA
The American Defense Preparedness Association

Appendices

Appendix A

Terms of Reference

ADPA INVESTIGATION INTO THE APPLICATION OF ADVANCED DISTRIBUTED SIMULATION TO THE ACQUISITION OF MAJOR WEAPONS SYSTEMS

TERMS OF REFERENCE

Modeling and Simulation technology promises to change the way we work, the way we organize to execute that work, and the way in which we communicate the tasking and monitoring of that work. A natural application of this technology is towards improving the effectiveness and efficiency of our acquisition system. It is prudent to examine the issues and considerations associated with this specific application.

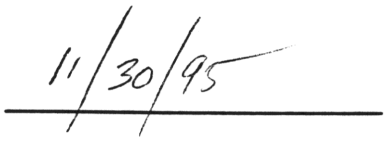
The context for this examination should be a hypothetical Total Ship Integrated Combat System for an Advanced Surface Combatant which might be authorized post 2005. Traditional Major Weapon Systems oversight milestone decision framework should not be used as a baseline. This study should consider a "clean slate" approach to redefine the tasks and methods needed to successfully determine military needs and yield a robust, cost effective solution in the most efficient and effective manner. The approach must balance the countermanding forces of maximum efficiency, preservation of the public trust in expenditure of public funds and the integrity of the moral contract between the acquisition community and the war fighter.

The focus of the details of the hypothetical system should be concentrated on the Undersea Warfare component(s) of such a system and the potential interfaces of that subsystem to the Total Integrated Combat System. It is expected that the ship will have to operate independently and as an element of a joint task force in a multi warfare environment.

The goal of the study is to assess the potential of achieving 50% reduction in cycle time from military needs identification to initial operating capability and make similar reductions in life cycle costs for a major weapon system. The approach should consider the technical and business processes of developing complex systems and extend the use of models and simulation in the planning, programming, budgeting, cost accounting, management, and oversight aspects to identify and remove non value added tasks by making process changes.

The overall objectives of the investigation should be to determine merits and shortfalls of a Simulation Based Acquisition approach for major weapon systems. The output should clearly address issues from at least three frames of reference; (1) technical merit of proceeding with simulation based acquisition methods; (2) business integrity issues associated with such an approach; and, (3) changes necessary in the contracting and procurement system processes necessary to facilitate such an approach.

The study should not result in a proposal for the target system, rather a set of issues and considerations should be provided as a result of examining how advanced distributed simulation could be applied to acquisition spectrum from needs identification through operations afloat and final disposal.



D.E.Porter **(Date)**
ASN(RDA)
Acquisition Reform Executive

Appendix B

Major Conclusions and Observations For Previous Studies

Conclusions and Observations

Acquisition Task Force on M&S June 94	NRAC Report on M&S Nov 94	Navy - Industry Conclave Nov 95
Effective, Integrated Use of M&S Impeded by Lack of Architecture	The DON Has Developed & Used M&S for Many Years, but Is Not a Significant Player in ADS	M&S Must be Employed by Program Managers & Requirement Setters in Performing Cost-Performance Trades
Lack of Architecture Means Not Getting Most out of M&S	The DON Has Only Begun to Participate in SBD/M	More M&S Tools Are Required
Need Clearly Designated Leadership & Coord Mech	Power & Significance of ADS May Be Greater than Anticipated	Industry Needs More Up-Front Information During Contract Bid Process • Will Reduce Protests • More Valid Proposals
Need More Education & Training on M&S for ALL Participants	ADS Exercises with Users Promises to Expose Strengths & Weaknesses of Military Forces & Tactics	
It is Time to Apply Adv M&S & Related Tools to Real Programs	M&S Benefits to Acquisition: • ID Min Reqts for Mil Payoff • Reduced Cycle Times • Collapse DV & EMD Phases • Build & Test Once vs. Twice • Substantial Reduce Risk & Time • "Lean" Manufacturing	Industry Has Spoken with a Single Voice for at Least 3 Yr: • 60/40 Depot Formula • $3M Comp Threshold

Appendix C

Study Briefings

ADPA Study on Role of M&S in Acquisition

Study Briefings Completed

- D. Porter *(ASN RDA Acquisition Reform Executive)*
- GEN(R) Elcher *(ADPA Deputy)*
- Acquisition Reform Senior Steering Group *(ARSSG)*
- ADPA Spring 1996 Meeting
- M. Langston *(DASN C4I)*
- Dr. P. Sanders *(Assistant Deputy DDTSE&E)*
- W.J. Shirley *(NAVSEA N08E)*
- DMSO Industry Day *(Acquisition Workshop)*
- T. Douglass *(PEO USW)*
- ASN/DARPA SBD Transition Team