BAA 07-56 Deep Green
Broad Agency Announcement (BAA)

for

Information Processing Technology Office (IPTO)
Defense Advanced Research Projects Agency (DARPA)

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Part One: Overview Information

- **Federal Agency Name** – Defense Advanced Research Projects Agency (DARPA), Information Processing Technology Office (IPTO)
- **Funding Opportunity Title –** Deep Green
- **Announcement Type –** Initial Broad Agency Announcement (BAA)
- **Funding Opportunity Number –** BAA 07-56
- **Catalog of Federal Domestic Assistance Numbers (CFDA)** - N/A
- **Key Dates**
  - Proposal Due Date
    - Initial Closing - 12:00 noon (EDT), August 30, 2007
    - Final Closing - 12:00 noon (EDT), July 9, 2008
  - Industry Day – July 23, 2007

- **Concise description of the funding opportunity:** The Defense Advanced Research Projects Agency (DARPA) Information Processing Technology Office (IPTO) seeks strong, responsive proposals from well-qualified sources for a new technology program called **Deep Green**. **Deep Green** will build a battle command decision support system that interleaves anticipatory planning with adaptive execution. **Deep Green** must be capable of addressing the full spectrum of joint and combined arms capabilities available to the modular brigade commander, drastically increasing the option and future space. This will allow the commander to think ahead, identify when a plan is going awry, and help develop alternatives "ahead of real time." The commander (and his support staff) is involved in essentially two major asynchronous functions: generating options and making decisions. The goal of this program is to create a commander-driven system to assist the commander and his support staff in generating options or Courses of Action (COAs).

  Deep Green will aid in battle command and commander's visualization by creating technologies that make it easier for the commander to articulate options to consider and anticipate the possible futures that result from those options. This proactive analysis will help predict which possible futures are becoming more likely – before they occur. Given that information, the commander can make better decisions and focus planning efforts (the generation of future branches and sequels) on where they can be the most useful. To accomplish this, **Deep Green** will focus on the following functional components: The **Commander's Associate** (which consists of **Sketch to Plan** and **Sketch to Decide**), **Crystal Ball**, and **Blitzkrieg**.

  There are six (6) tasks under the envisioned **Deep Green** program:

  Task 1: Commander's Associate (Sketch to Plan and Sketch to Decide)
  Task 2: Blitzkrieg
  Task 3: Crystal Ball
  Task 4: Automated COA Generation

Task 5: Integration
Task 6: Test and Evaluation

Each of these tasks will be described in detail below. Offerors intending to bid on more than one task must provide ***separate*** proposals for each task. DARPA intends to select the best performer for each of the tasks separately. The performer selected for Task 6, Test and Evaluation, will not be selected for *any* of the other five tasks.

- **Grants and Cooperative Agreements will not be available under this solicitation.**
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Part Two: Full Text of Announcement

The Defense Advanced Research Projects Agency (DARPA) often selects its research efforts through the Broad Agency Announcement (BAA) process. The BAA will appear first on the FedBizOpps website, http://www.fedbizopps.gov. The following information is for those wishing to respond to the BAA.

I. FUNDING OPPORTUNITY DESCRIPTION

BACKGROUND

The United States has a compelling need for reliable information affecting military command, soldiers in the field, and national security.

Today's technical barriers include the following issues:

- New technology is needed for machine induction of intuitively expressed plans.
  - Multi-modal (sketch and speech) collaborative technologies must be extended to incorporate modern learning technology that induces plans and the user's intent from intuitive, coarse-grained plan descriptions.
- Existing AI planning & monitoring systems
  - are largely deterministic in nature, while the battlefield is inherently stochastic;
  - focus on full automation rather than commander-driven plan generation; and
  - are reactive in nature, re-planning after the plan has broken
- The current generation of combat models
  - run slowly,

- generate a narrow spread of possible outcomes, and
- require significant manual intervention.

PROGRAM GOALS

The overall goal of **Deep Green** is to provide a technology that allows the *commander* to:

- generate and analyze options quickly, including generating the many possible futures that may result from a combination of friendly, enemy, and other courses of action;
- use information from the current operation to assess which futures are becoming more likely in order to focus the development of more branches and sequels; and
- make decisions cognizant of the second- and third-order effects of those decisions.

Deep Green is composed of tools to help the commander rapidly generate courses of action (options) through multimodal sketch and speech recognition technologies. **Deep Green** will develop technologies to help the commander create courses of action (options), fill in details for the commander, evaluate the options, develop alternatives, and evaluate the impact of decisions on other parts of the plan. The permutations of these option sketches for all sides and forces are assembled and passed to a new kind of combat model which generates many qualitatively different possible futures. These possible futures are organized into a graph-like structure. The commander can explore the space of possible futures, conducting "what-if" drills and generating branch and sequel options. **Deep Green** will take information from the ongoing, current operation to estimate the likelihood that the various possible futures may occur. Using this information, **Deep Green** will prune futures that are becoming very improbable and ask the commander to generate options for futures that are becoming more likely. In this way, **Deep Green** will ensure that the commander rarely reaches a point in the operation at which he has no options. This will keep the enemy firmly inside our decision cycle.

Figure 1: Operational Concept for Deep Green

The venerable Observe Orient Decide Act (OODA) loop is no longer viable for an information-age military. Previous work has centered on speeding up the overall loop or developing technologies that work within a single phase of that loop. **Deep Green** creates a new OODA loop paradigm. The *Observe* (execution monitoring) and *Orient* (options generation and analysis) phases run continuously and are constantly building options based on the current operation and making predictions as to the direction the operation is taking. When something occurs that requires the commander's attention or a decision, options are immediately available. Ideally, the OO part of OODA is done many times prior to the time when the commander must decide. When the planning and execution monitoring components of **Deep Green** mature, the planning staff will be working with semi-automated tools to generate and analyze courses of action ahead of the operation while the command concentrates on the *Decide* phase. By focusing on creating options ahead of the real operation rather than repairing the plan, **Deep Green** will allow commanders to be proactive instead of reactive in dealing with the enemy.

DARPA is interested in the potential contribution of emerging DARPA technologies, such as those developed under the Real-Time Adversarial Intelligence & Decision Making (RAID) program or the Multi-cell and Dismounted Command and Control (M&DC2) program, to **Deep Green** functions. Areas where emerging DARPA technology might be brought to bear include:

- Automated course of action generation envisioned for **Commander's Associate**
- Brigade-level combat modeling envisioned for **Blitzkrieg**.

TERMINOLOGY

Insertion	Transition of technology into a particular operational use
Team	Prime contractor and any subcontractors
ABCS 6.4+	Army Battle Command Systems Version 6.4 + software
AUTL	Army Universal Task List
BOGSAT	Bunch of guys sitting around talking
C4I	Command and Control, Computer, Communications, and Intelligence
CPoF	Command Post of the Future
FBCB2	Force XXI Battle Command, Brigade and Below
JC3IEDM	Joint Command Control Communications Information Exchange Data Model
MIL STD 2525b	provides a formal, controlled method of drawing symbols to promote machine interpretation.
MSDE	Military Scenario Development Environment
MSDL	Military Scenario Definition Language
OTF	Objective Terrain Format (for OneSAF OOS)
PASS	Publish and Subscribe Services
PEO C3T	Army Program Executive Office for Command, Control and Communications-Tactical
PUCKSTER	Workstation operator in a simulation-driven exercise.
SISO	Simulation interoperability Standards Organization http://www.sisostds.org

PROGRAM STRUCTURE

The envisioned **Deep Green** program consists of three 12-month phases. **Deep Green** will focus on the brigade level in Phase I; however, by Phase III of the program, **Deep Green** will reside at both the brigade and battalion level and coordinate between those echelons. **Deep Green** will be focused on the modular or separate maneuver brigades. This means that in Phase II, **Deep Green** must be capable of addressing the full spectrum of joint and combined arms capabilities available to the modular brigade commander, drastically increasing the option and future space. In addition, it will focus on the following battlefield functional areas (BFAs): maneuver; mobility, counter-mobility and survivability; fire support; and intelligence. Bidders must address how their solutions for Phase I can be grown during **Deep Green** development to support these goals for Phases II and III.

Phase I will focus on developing the technology for the various **Deep Green** functional components: **Commander's Associate** (**Sketch to Plan** and **Sketch to Decide**), **Crystal Ball**, and **Blitzkrieg**. Component tests will be used to demonstrate

achievement of Phase I go/no-go metrics as illustrated below. This phase will focus on a mid-intensity conflict scenario, such as the operations of the 3rd Infantry Division during the invasion of Iraq or Masr al Sharif. Subject matter experts (SMEs), both government and consultants hired by the DARPA PM, will act as both component testers and judges, as needed. Testers will interact directly with the various components. OneSAF Objective System [1] will be used as the exercise driver.

Phase II will focus on combining the Phase I components into a functional, integrated system that will be required to run a series of force-on-force, human-in-the-loop experiments in a simulation center. The scenario complexity will be increased and focus on counter-insurgency operations. In Phase II, a broad subset of joint and combined-arms capabilities available to the modular brigade commander will be exercised. The SMEs will be organized into small brigade-level subset staffs, consisting of the commander, S-3 (operations officer), and S-2 (intelligence officer). Each staff officer will have their own "window" into **Deep Green**. In other words, the commander, S-3, and S-2 could be collaboratively developing options at the same time (**Sketch to Plan**) and be prompted for role-appropriate decisions independently (**Sketch to Decide**) from a common **Crystal Ball**. The staff will interact directly with the **Commander's Associate** (**Sketch to Plan** and **Sketch to Decide**). Again, OneSAF Objective System will be used as the exercise driver.

Phase III will integrate **Deep Green** with a Battle Command system such as CPoF where **Deep Green** will be "under the hood." A series of force-on-force, human-in-the-loop experiments in a simulation center and a tactical environment (e.g. the National Training Center) will be conducted. The complexity of the scenario will be increased to a large, Three-Block War Operation, such as Falluja or Basra. In Phase III, the full spectrum of joint and combined-arms capabilities available to the modular brigade commander will be exercised. Additionally, in Phase III, there will be a **Deep Green** at brigade level and one at each of the subordinate battalions. These **Deep Green** systems will coordinate the maintenance of their futures graphs in a seamless way. Again, the SMEs will be organized into small brigade-level subset staffs, consisting of the commander, S-3 (operations officer), fire support officer, engineer officer, and S-2 (intelligence officer). In addition to the Phase II goal of each staff officer having their own window into **Deep Green**, in Phase III, **Deep Green** will be expected to run at brigade level and at each of the subordinate battalions, with the futures graphs at each unit coordinated in a meaningful way. The Staff will interact with the **Commander's Associate** through CPoF; **Deep Green** will be a technology under the hood that is viewed through CPoF. Again, OneSAF Objective System will be used as the exercise driver.

The program will be organized around component providers building the **Commander's Associate**, **Crystal Ball**, **Blitzkrieg**, and a modest automated option generator. While the government will act as the management integrator, a separate technical integrator will be used to define interfaces between modules, approve data standards, and ensure interoperability between modules and with chosen battle command systems. To the

maximum extent possible, offerors should make use of services and functions allocated to other components of **Deep Green**, rather than create redundant capabilities.

While it will be the job of the Test and Evaluation contractor (see Task 6 description below) to construct a detailed test plan, program-level metrics for each component for each phase are outlined below. There will be two major test events in each phase, one in the middle of the phase to get a sense of progress, and one at the end of the phase to confirm or deny that phase metrics (goals) have been achieved. There may be additional, minor test events scheduled as needed to give confidence that progress is being made. Testing will be based on metrics associated with the various components, and if multiple awards are made in Phase I, the end-of-phase testing will be used as a basis for down-selection in the **Blitzkrieg** effort after the phase completes. Phases II and III will continue to test component capabilities but will also focus on overall system performance. Tests in Phase II and III will be force-on-force, human-in-the-loop tests with the goal of confirming whether system performance metrics have been achieved.

Scenarios for the force-on-force experiments will be based on training scenarios from the various tactics school houses and/or scenarios used for mission rehearsal exercises (MRX) used to certify units as ready to deploy to Afghanistan or Iraq. These will focus on mid-intensity conflict in Phase I, including the kinetic aspects of counter insurgency (COIN) and the three block war. The scenarios will become more sophisticated and more like the contemporary operating environment as **Deep Green** matures during development. The "planning staff" will be small groups of officers and students from the

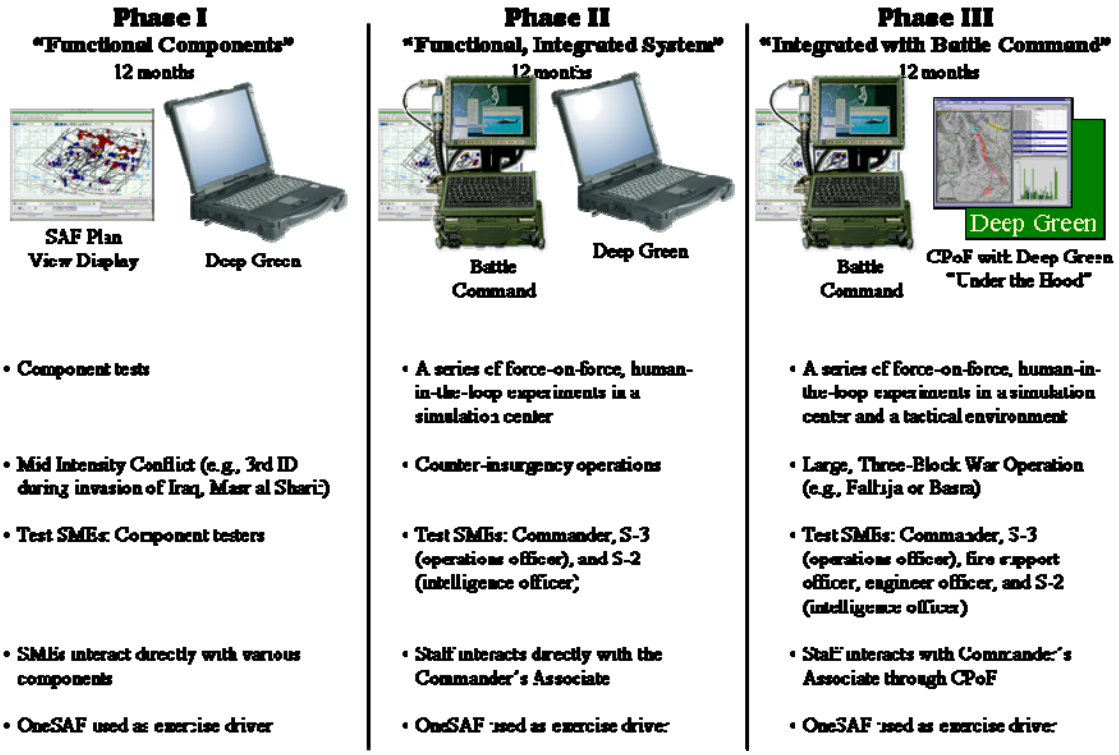


Figure 2: General Overview of Major Test Events

school houses consisting of a commander, an operations officer, and an intelligence officer. In Phase III, these staffs will be augmented with an engineer officer and a fire support officer.

DARPA will hire a number of SMEs to act as consultants to all the component developers and to act as graders during the test events. Some of these SMEs will be government, but some will be former military hired as consultants. DARPA will also seek government SMEs to act as test subjects. The contractor will have the responsibility for hiring additional test subjects, as needed, subject to DARPA prior approval.

Human factors are an important part of some of the **Deep Green** metrics. We will use a comprehensive and effective methodology from the Human Research and Engineering Directorate of the Army Research Lab.

Metrics of Overall System Performance:

These metrics are designed to show that a staff using **Deep Green** is more effective than a staff without **Deep Green** and will require less manpower.

Metric	**Phase I**	**Phase II**	**Phase III**
Improved tooth-to-tail. Measured by reduction in staff usually needed to accomplish brigade planning/execution for the milestone scenario.	T<80%	T < 50%	T <= 25%

Test methodology: The formulation of the detailed test plan for all program metrics falls under Task 6; however, this section provides general guidance on how this task will be evaluated. In Phase I and II, we are focused on the maneuver and fire support battlefield functional areas (BFAs). There are typically eight staff officers assigned to these roles, but they work in two separate shifts. The staff needed to operate **Deep Green** will be one maneuver officer and one fire support officer. In Phase III, we expand the number of BFAs to include mobility, counter-mobility and survivability, and intelligence. This will be tested by employing only two officers using **Deep Green**. This will require the system to provide the functionality for only two staff officers to take on the roles of multiple battlefield functional areas.

Score: T = # Staff with Deep Green / # Staff without Deep Green

Metric	**Phase I**	**Phase II**	**Phase III**
Commander's Performance. Measured by a single numerical score P, computed as a weighted function **f**(●) of mission accomplishment, friendly losses, enemy losses, neutral losses, time to accomplish tasks, and various human factors.	P = 1	P 1	P 2

Test methodology: The formulation of the detailed test plan for all program metrics falls under Task 6; however, this section provides general guidance on how this task will be evaluated. There will be two groups of test subjects, organized into staffs as described above. One staff will have Deep Green; the other won't. The staffs with and without **Deep Green** will participate in a set of force-on-force, human-in-the-loop tactical scenarios that they will "fight" as in any simulation-based training event. OneSAF Objective System (OOS) will be used as the exercise driver, adjudicating combat and stimulating the Common Operating Picture (COP). The performance of the staffs with and without **Deep Green** will be graded through a combination of objective and subjective measures. Subjective measures will be judged "blind," in that the panel of subject matter experts doing the grading will not know which teams were using **Deep Green** and which were not. While it is not intended that the various components be integrated into a complete system in Phase I, testing will need to make the case that staff reduction would have been possible by measuring the various components. Performance is evaluated through a function of mission accomplishment, friendly losses, enemy losses, neutral losses, time to accomplish tasks, and human factors analysis.

P = **f**(with Deep Green) / **f**(without Deep Green)

In addition to satisfying end-of-phase metrics, **Deep Green** components must be:

- able to process MIL STD 2525B symbols/images of *all* types;
- robust, scalable, and portable;
- open source and open architecture;
- fully documented; and
- modular in design.

PROPOSALS SOUGHT

This BAA seeks proposals that address the following **Deep Green** tasks, which are described in detail below. Proposed research should investigate innovative approaches and techniques that lead to or enable revolutionary advances in the state of the art. Proposals are not limited to the descriptions of services listed here, and alternative visions will be considered; however, proposals should address research that substantially contributes toward the goals stated and should be organized to fall within the named six tasks. Specifically excluded is research that primarily results in minor, evolutionary improvements to the existing state of practice or focuses on special-purpose systems or narrow applications.

Task 1: Commander's Associate (Sketch to Plan and Sketch to Decide)
Task 2: Blitzkrieg
Task 3: Crystal Ball
Task 4: Automated COA Generation
Task 5: Integration
Task 6: Test and Evaluation

Offerors are invited to submit proposals for one or more of the **Deep Green** tasks; however, separate tasks must be submitted via separate proposals. Offerors should format their proposals for Phase I, with Phases II and III priced as options. The winner of the Test and Evaluation task will *not* be awarded *any* of the other five tasks. If an offeror successfully bids on Task 6 *and* another task, DARPA, not the offeror, will determine which task will be selected for award.

Deep Green will be run as a team effort with the DARPA PM or his agent acting as the management integrator. The program will sink or swim on the collective performance of all performers. Lack of teamwork or breakdowns in communication between associate contractors will not be tolerated (see section VI.B.7).

NOTE: All software developed under Deep Green will, to the greatest extent possible, be open architecture and open source. To the extent possible under applicable pre-existing licenses, the government expects to acquire unlimited rights to all software, software documentation, and technical data developed under this program. To the greatest extent feasible, therefore, proposers should not include background proprietary software and data as the basis of their proposed approach. Proposers expecting to utilize, but not to deliver, open source tools or other materials in implementing their approach must ensure that the government does not incur any legal obligation due to such utilization. All references to "unlimited" or "government purpose rights" are intended to refer to the definitions of those terms as set forth in the Defense Federal Acquisition Regulation Supplement (DFARS) Part 227. See also Section 2.12 below for further details concerning intellectual property.

TASK DESCRIPTIONS

Task 1: COMMANDER'S ASSOCIATE:

The **Commander's Associate** has two major sub-components, **Sketch to Plan** and **Sketch to Decide.** The two components are discussed separately because in an open, modular architecture, it is envisioned that one or the other must be able to be replaced with new technologies over time without disrupting the entire system. A goal of the **Deep Green** program is to develop and apply computer software technologies to develop a **Commander's Associate** that automatically converts the commander's hand-drawn sketch with accompanying speech of his intent into a Course of Action (COA) at the brigade level. The **Commander's Associate** must facilitate option generation, "what-if" drills, and rapid decision making.

Although the main thrust of this effort is to develop technology to handle **Sketch to Plan**, the offerors should explain how the underlying technology can be quickly adapted to other applications, such as behavior generation for simulations and an interface to teach tactics to a computer student. **Sketch to Plan** will be evaluated in free-play, force-on-force exercises, in order to show that the results are not scripted and the capability is not brittle.

Task 1a: Sketch to Plan:

This component provides the commander the ability to generate quickly qualitative, coarse-grained COA sketches that the computer can interpret. **Sketch to Plan** will be multi-modal (both sketching and speech) and interactive. The computer will watch the sketch being drawn and listen for key words that indicate sequence, time, intent, etc. as the commander is creating the sketch. **Sketch to Plan** must be able to induce both a plan and the commander's intent from the sketch and speech. Unlike other approaches that are optimized around machine interpretations (i.e. constraining the sketching method to drag-and-drop modalities, forcing the human to learn the computer's 'language' to some extent), **Sketch to Plan** is optimized around the user free-hand sketching options over a map. It should be able to interpret free-hand drawing and not require the commander to think and draw in perfect, formal MIL STD specified way. Over time **Sketch to Plan** should learn the commander's sketching language as a variant, or approximation, of MIL STD 2525b. In addition, the **Sketch to Plan** component must be imbued with enough domain knowledge that it knows what it doesn't know and can ask the user a *small* set of clarifying questions until it

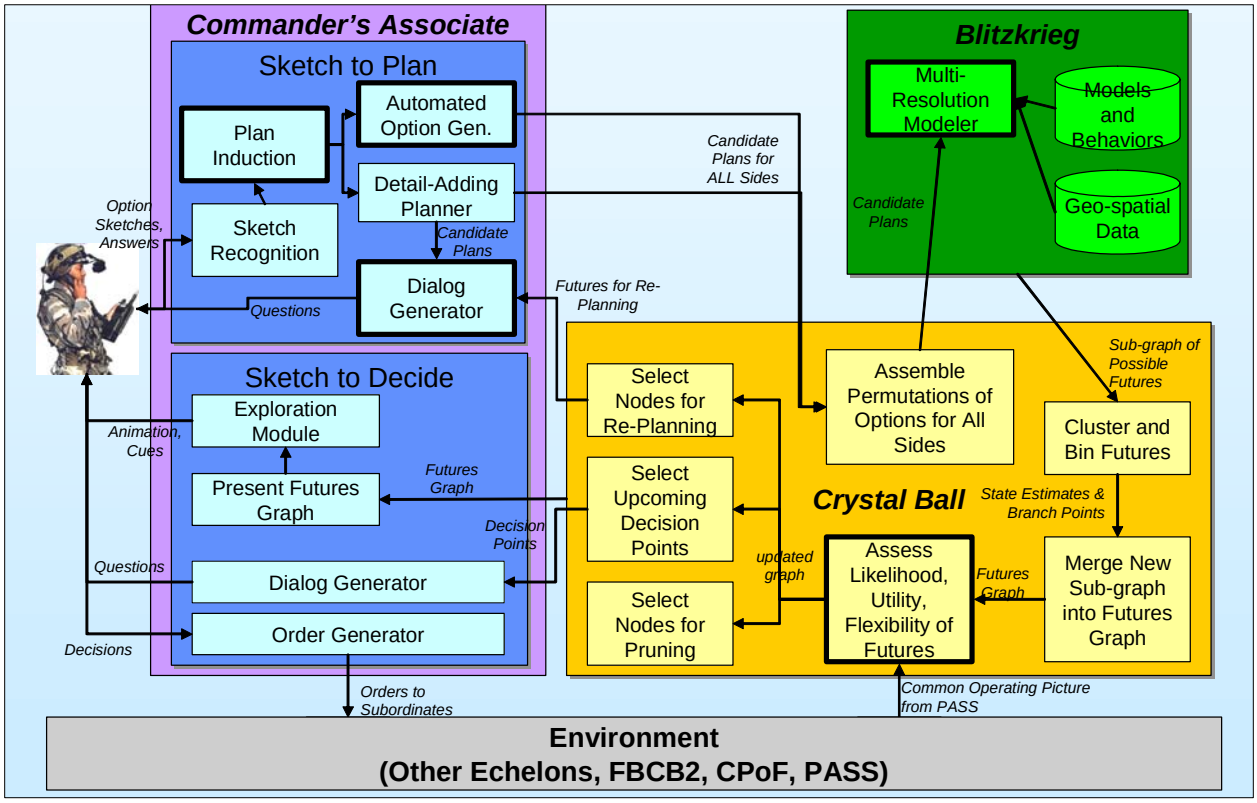
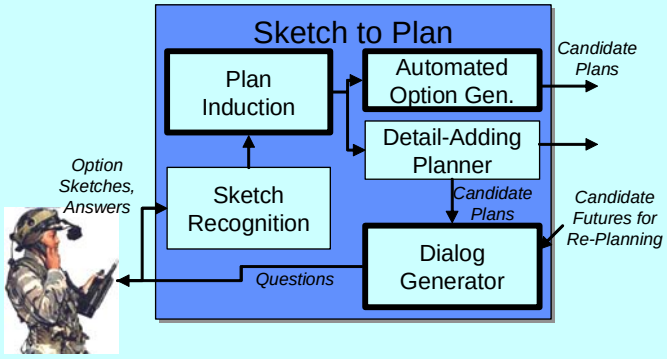


Figure 3: Architectural Overview of Deep Green

understands the sketch and can use it to initialize a combat model.

Sub-components of **Sketch to Plan** are the *Sketch Recognizer, Plan Inducer, Automated Option Generator, Detail-Adding Planner,* and *Dialog Generator*. The *Sketch Recognizer* converts a free-hand set of strokes, combined with speech, into a set of military objects, such as units and graphical control measures. The *Plan Inducer* takes the "bag of symbols" and induces the commander's plan and intent. The *Automated Option Generator* will be discussed later (See Task 4). The *Detail-Adding Planner* adds details to the commander-generated option so that it can be modeled by **Blitzkrieg**.

- Commander **draws** in "free hand" and **speaks**; STP interprets the symbols, replacing them with the correct standard military symbols
- STP *accurately* induces plans from sketch and speech, fills in missing details
- STP asks clarifying questions if it doesn't understand the sketch
- This allows commanders to specify an option at a coarse level, then move on to the next cognitive task



DARPA Hard: Inferring plan from sketch understanding, including clarifying questions between the commander and **Sketch to Plan;** automated option generation

Figure 4: Sketch to Plan Concept

Finally, the *Dialog Generator* helps **Sketch to Plan** understand the commander's option by formulating clarifying questions when necessary.

The output of **Sketch to Plan** will be a description of the option in the Military Scenario Definition Language [2] that will be enhanced to support "verbs." Commander's intent induced from the sketching and speech will be encoded in something conceptually similar to existing languages used for similar purpose [3], but the commander *must not* be required to formulate his statements of intent in artificial, stilted language. The goal is to interpret aspects of the sketch and speech in "free hand" and "free speech," and then have **Sketch to Plan** encode them in these formal languages.

Since MIL STD 2525b symbology is an evolving standard, the **Sketch to Plan** developer will also build an intuitive, graphical tool to enable tactical subject matter experts (SMEs) to define new symbology, without writing code or needing contractor support. That user-defined symbology must be recognizable by **Sketch to Plan** without recompiling the software or having to write code. Similarly, this tool should permit users to encode the NATO Standardization Agreement (STANAG 2019: APP-6A Military Symbols for Land Based Systems) equivalent of 2525b, if desired.

Metrics for **Sketch to Plan**:

The Sketch to Plan metrics are designed to measure the accuracy of the interpretation of the multi-modal inputs.

Metric	Phase I	Phase II	Phase III
Accurate recognition of sketched MIL STD 2525b symbols	A subset of the MIL STD 2525b symbols (approx. 1/5th of the total) are commonly used when describing military operations. For this subset, F 90%	For a subset consisting of 80% of all MIL STD 2525b symbols, F 90%	For all MIL STD 2525b symbols, F 90%

Test methodology: The formulation of the detailed test plan for all program metrics falls under Task 6; however, this section provides general guidance on how this task will be evaluated. As in English, where there are many thousands of words, but only a few thousand are used commonly, there is a subset of MIL STD 2525b symbols (approximately 20%) that cover approximately 80% of military operations. Given a set of operations orders, test subjects will be required to draw course of action sketches to accomplish those missions. For Phase I, the operations orders will be constructed or selected to require the most common MIL STD 252b symbols, i.e., the approximately 20% of the vocabulary that is used 80% of the time.

Score: $F = (2 \times H \times P) / (H + P)$, where

- #T = number of symbols that should be correctly interpreted (e.g., if the user draws 100 symbols that are valid in the sense that they are from the set of symbols that STP must be able to recognize in that phase of execution, then #T = 100)
- #I = number of symbols that are interpreted
- H (Hit rate) = number of correctly interpreted symbols / #T
- P (Precision) = 1 - False positive rate = number of correctly interpreted symbols / #I

Beyond interpreting individual symbols, the **Sketch to Plan** component is intended to interpret the commander's course of action. By analogy, **Sketch to Plan** understands a whole "sentence," not just individual "words."

Metric	Phase I	Phase II	Phase III
Accurate machine induction of user's intended plan. Subject matter experts judge key aspects of machine-induced plans by playing them through OneSAF.	S 70%	S 80%	S 90%

Test methodology: The formulation of the detailed test plan for all program metrics falls under Task 6; however, this section provides general guidance on how this task will be evaluated. Given a set of operations orders, a planning staff of human subjects (as defined above) will build plans using **Sketch to Plan**. These plans will be written out in a format, called Military Scenario Definition Language (proposed international standard submitted to SISO/IEEE) and simulated in OneSAF Objective System OOS. If **Sketch to Plan** works as expected, then the staff's own forces will do the right thing in simulation – they will follow the right avenues of approach and engage the right enemy units, etc. To make the evaluation of **Sketch to Plan** as objective as possible, the staffs will write down, prior to any simulation, what they expect their units to do during the simulation. We call these expectations *aspects of plans* (i.e., moving along an avenue of approach). The staffs will identify, in writing, the aspects of their plans that they want to see in the simulations. A panel of subject matter experts will then referee the staff's assessment of the proportion of aspects of their plans that were correctly simulated. The rules for scoring will be stringent--only those aspects of plans that were identified in writing prior to simulation can be scored, and **Sketch to Plan** can be penalized only if the subject matter experts agree that the staffs did, in fact, instruct **Sketch to Plan** in these aspects of the plans. An aspect that is both identified in writing prior to simulation and instructed properly by the staff will be called a *valid* aspect. The percentages reported in the table above refer to valid aspects of plans.

S = (# aspects of plan judged to be correct / # aspects of plan entered by user) x 100

In brief, **Sketch to Plan** must perform the following functions:

- Accept inputs in the form of pen strokes and speech from the user. The speech component is meant to provide information not easily captured in pen strokes and to disambiguate portions of the sketch.
- Interpret strokes from the user and generate a representation of the coarse-grained option.
- Fill in details of the option so that it can be used to initialize a combat model.
- Ask clarifying questions, if necessary, to better understand the option sketch.

Task 1b: Sketch to Decide:

When the commander is asked for a decision, **Sketch to Decide** will allow him/her to explore the future space to gain an appreciation for the ramifications of a choice. It is envisioned as similar to a comic strip with branch points that correspond to branch points in the futures graph. Scott McCloud [4] asserts that the idea of a comic in which the readers get to make a choice at the branch points is today "exotic" but may well become common in the future. Since the 1970s (and perhaps earlier), there have been novels and game books in which the reader is asked to make a decision and then is directed to a different page or paragraph, depending on the choice made. Recently at Northwestern University there has been mention of the idea of a comic graph [5]. The idea here is the same: the user gets to choose which path to follow at a branch point.

One can imagine the commander exploring the future space to understand how his courses of action may play out and identifying the critical branch (decision) points.

The subcomponents of **Sketch to Decide** are *Exploration Module, Presentation Module, Dialog Generator,* and *Order Generator*. The *Exploration Module* allows the commander to explore the graph of possible futures to understand the second- and third-order effects of decisions. The *Presentation Module* converts information from the futures graph into a representation that can be explored and also represents multi-dimensional information in an intuitive way. The *Dialog Generator* presents needed decisions to the commander and conducts a dialog with him/her until it understands the answer. The *Order Generator* formulates decisions from the commander into orders to subordinates and also provides that information to **Crystal Ball** for use in maintaining and/or updating the futures graph.

Sketch to Decide is designed to allow the user to "see the future," but this capability must be developed with care to prevent confusing the decision space. Humans are notoriously bad at thinking through probabilistic choices and even more so when there are competing outcome utilities. At each branch point, there are multiple decision dimensions/utilities that have to be considered, such as likelihood, risk, utility, resource usage, etc. In addition, the abstract nature of the state and the uncertainty of predictions, locations of units, etc. must be portrayed intuitively. Therefore, at any "frame" in the **Sketch to Decide** graph, the user can perform **Sketch to Plan** actions, allowing the commander to conduct "what-if" drills wherever he wants in the future

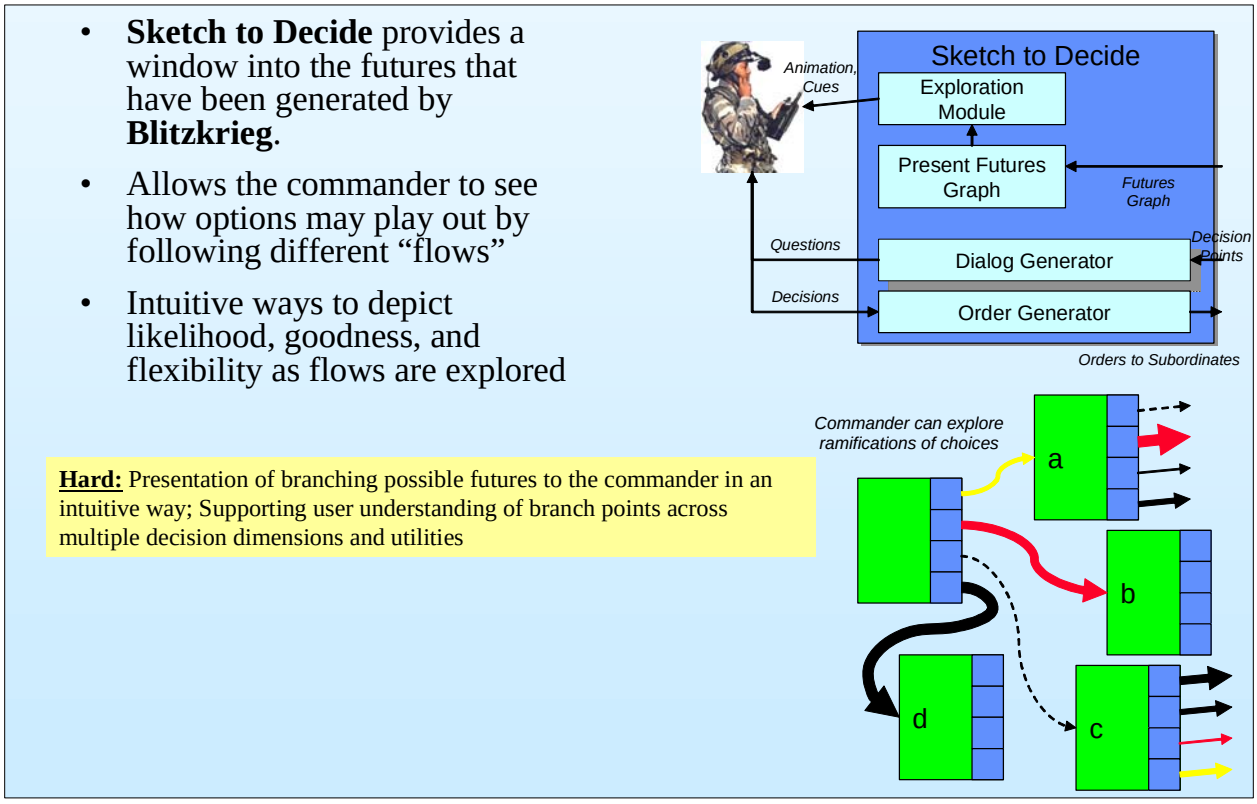


Figure 5: Sketch to Decide Concept

space. The user is going to need a lot of help in evaluating these options, especially because they are probabilistically weighted. By presenting decisions early and allowing the commander to explore the future space, **Sketch to Decide** supports adaptive execution, allowing the commander to make decisions when they are needed, rather than committing too early. Over time, **Sketch to Decide** should learn how and when to present information to the commander in a way that reduces cognitive load, aids in understanding, and supports rapid, accurate, effective decision making.

While **Blitzkrieg** (under the direction of **Crystal Ball**) generates a broad spectrum of possible futures (called the "future space"), **Sketch to Decide** is designed to help the commander explore the future space. Each node in the **Sketch to Decide** "graph" will correspond to a possible future in the future space graph. When **Crystal Ball** determines that the commander should generate some options at some future point, this will be done by drawing his attention to a node in the **Sketch to Decide** graph. By allowing the commander to explore this graph-like future space in a seamless and intuitive way, **Deep Green** will facilitate the commander's visualization. To assist this understanding of the future space, DARPA envisions the **Sketch to Decide** tool providing an intuitive, clever way of informing the commander of the likelihood, utility/value, and flexibility of each future.

The **Sketch-to-Decide** capability is critical to Deep Green's goals. In brief, **Sketch to Decide** must perform the following functions:

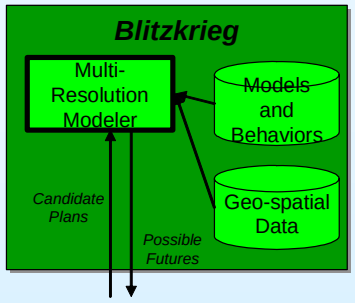
- Accept decision point inputs from **Crystal Ball**
- Accept input decisions from the commander
- Present needed decisions to the commander
- Present multi-dimensional information about the likelihood, risk, value/utility, and other factors about possible futures to help the command better understand the space of possible futures.
- Allow the commander to explore the future space to understand second- and third-order impacts of decisions
- Forward decisions to subordinates
-

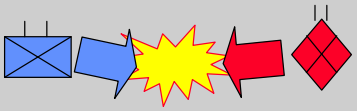
TASK 2: BLITZKRIEG:

Blitzkrieg is used to generate the possible futures that result from a set of plans (one plan for each side/force in the operation). Besides being very fast (the *blitz* in **Blitzkrieg**), it is designed to generate a broad set of possible futures. These futures should be feasible, even if not expected by human users. Over time, **Blitzkrieg** should learn to be a better predictor of possible futures, based on presented options. **Blitzkrieg** identifies branch points, predicts the range of possible outcomes, predicts the likelihood of each outcome, and then continues to simulate along each path/trajectory. Gilmer and Sullivan provide an example of a possible implementation of this idea [6] in which they determine branch points and continue to simulate along multiple paths. DARPA desires out-of-the-box thinking that will propose methods other than purely generating hundreds or thousands of "Monte Carlo" runs of a stochastic model and

- High speed combat model links the portfolio of plans to potential battlefield outcomes
- Uses multi-resolution modeling (components of varying resolution) to achieve acceleration
- No human intervention during execution
- Uses hybrid of quantitative and qualitative methods to identify branch points
- Permits large time warping

DARPA Hard:
•Determining qualitative branch points and using quantitative techniques to assess likelihoods of each branch
•Determining when and how to dynamically adjust model resolution to answer the appropriate question
•Massive time warping with little loss of fidelity





Example: two forces collide.
Qualitatively different outcomes include:
•Blue is destroyed
•Red is destroyed
•Blue begins to lose and withdraws
•Red begins to lose and withdraws
•The two forces choose not to engage
•And so on…

Figure 6: Blitzkrieg Concept

binning the outputs. This will require an innovative hybrid of qualitative and quantitative technologies.

As an example, two forces may collide with each other. The collision may be predicted with some sort of analytical model that accounts for non-determinism in rate of march of the forces. Qualitatively there are a number of possible outcomes of this collision: one side or the other may get quickly defeated, one side may begin to lose and withdraw, the two forces might avoid each other and continue on their way, both sides may choose not to engage each other, or both sides may become involved in an attrition slug-fest, etc. Quantitative models, such as Lanchester equations [7] or the Qualitative Judgment Model [8] might then be used to determine the likelihood of these various outcomes. Perhaps heuristic methods might be used instead of or in addition to these quantitative models. For instance, a fuzzy rule base might be used that takes into account aggressiveness of the opponents, their relative strengths, etc.

Blitzkrieg executes the plan as generated by the commander. This may mean that it will reach futures at which the operation cannot continue. This is good feedback for the commander and may result in **Crystal Ball** asking the commander to generate some options at those futures.

In warfare, all the players can be potentially moving at the same time, so predicting when these forces will meet, separate, etc. is challenging. The conditions of these meetings may, in fact, also impact the prediction of outcomes described in the previous

paragraph. Continuing with this scenario, due to the non-deterministic nature of each side's movement, speeds could indicate some likelihood that one side or the other would reach a key piece of terrain first. In this case, the force that arrived first might have an advantage in the ensuing engagement. If, on the other hand, the force that arrives first is in an exposed position, such as being in the middle of a river crossing or out in the open, the other side might have an advantage.

Today's class of combat models requires detailed terrain databases in order to function properly. **Blitzkrieg** will use more qualitative terrain representations. Commanders do not reason on the stem spacing and diameter of trees at breast height, vertical cone index of soil, or whether a particular area is composed of sandy clay loam. They reason about maneuver corridors, key terrain, and points of dominance. Of course, we do not want to "dumb down" **Blitzkrieg** to the extent that it provides little additional rigor than would an average human, but the right balance needs to be struck. At the same time, the creation of the abstract, qualitative terrain representation should be based on the same detailed terrain representation used in our current class of simulations for training, analysis, and experimentation so that these systems remain compatible. Ideally, we would want to create a translation mechanism that can take the more detailed terrain (e.g., an Objective Terrain Format [9] file) and generate the more abstract terrain needed by **Blitzkrieg** in an automated fashion.

Metrics for **Blitzkrieg**:

The Blitzkrieg metric ensures that the combat modeler very quickly develops high-quality predictions of possible futures.

Metric	**Phase I**	**Phase II**	**Phase III**
Reduced time to evaluate combinations of representative Blue and Red courses of action. (Canonical test case will involve 3 Blue COAs vs. 3 Red COAs.)	< 30 minutes	< 10 minutes	< 3 minutes

Test methodology: The formulation of the detailed test plan for all program metrics falls under Task 6; however, this section provides general guidance on how this task will be evaluated. Test subjects will be organized into small staffs, as described above, which will participate in several iterations of the following test: Given a series of tactical scenarios, the staffs will manually generate three options (courses of action) for the friendly forces (BLUE) and three for the enemy (RED). These options will be assembled into a 3x3 matrix of options (RED vs. BLUE). Each cell of this matrix will then be encoded and used to initialize **Blitzkrieg**. The time needed to simulate all nine plans will be summed. Performers will be given guidance early in the **Deep Green** program about the required level of fidelity for their simulations, and an independent evaluator will validate that **Blitzkrieg's** simulations do, in fact, achieve the required levels of fidelity; otherwise they will not be scored.

Score = average (total time to simulate all nine cells of the 3x3 matrix from all test instances)

In brief, **Blitzkrieg** must perform the following functions:

- Input: A set of options for each side/force
- Determine branch points and possible futures
- Assess, *a priori,* likelihood of each branch
- Continue to model each branch until culminating points are reached along each trajectory

Task 3: Crystal Ball

This component serves a few different functions. First, it controls the operation of **Blitzkrieg** in generating futures. Second, it takes information from the ongoing operation and updates the likelihood metrics associated with possible futures. Third, it uses those updated likelihood metrics to prune parts of the futures graph and nominate futures at which the commander should generate additional options and invokes **Sketch to Plan**. Finally, it identifies upcoming decision points and invokes **Sketch to Decide**. While **Crystal Ball** has a moderate role *prior* to execution, it is the backbone of the system *during* execution, as illustrated below. Over time, **Crystal Ball** must learn to be a better predictor of the likelihood of possible futures based on information from the ongoing operation.

Prior to Execution: During pre-operations planning, **Crystal Ball** receives options from **Sketch to Plan** for all sides and forces. The *Assemble Permutations* module generates the permutations of plans associated with all the sides and forces and sends them to **Blitzkrieg** to generate the possible futures that result from each permutation. If the commander used **Sketch to Decide** to inject branches and sequels into this process,

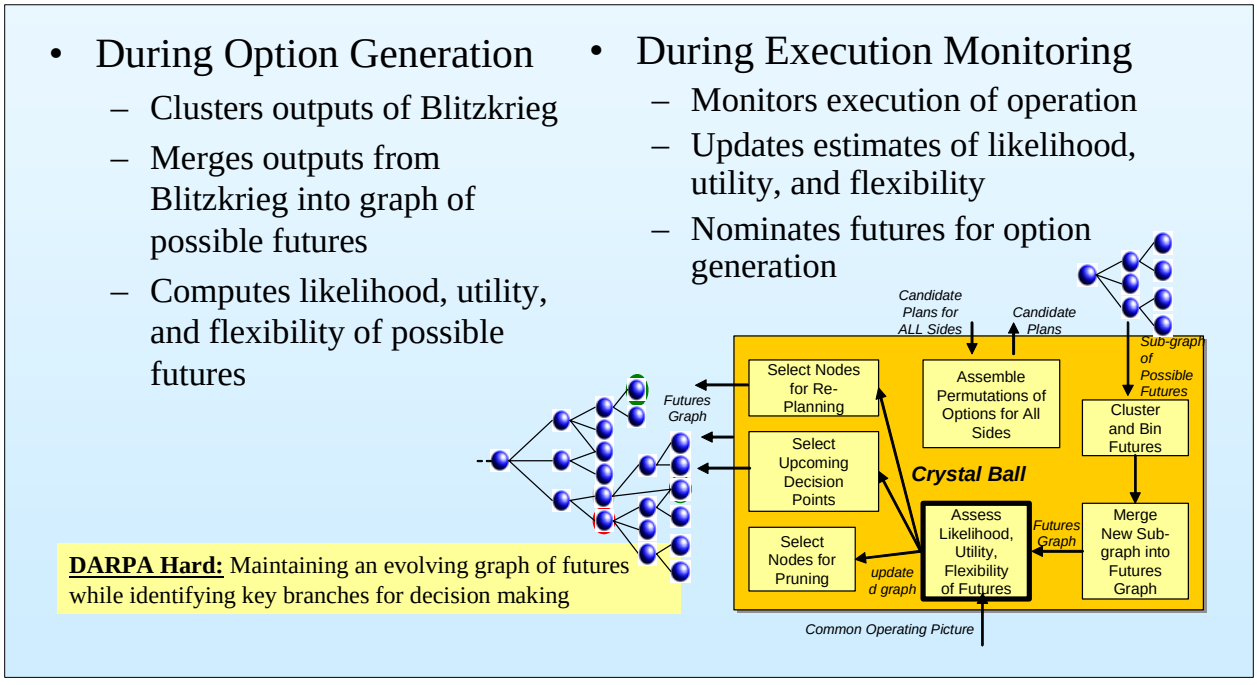


Figure 7: Crystal Ball Concept

additional runs of **Blitzkrieg** would be needed. **Blitzkrieg** returns sub-graphs of possible futures and branch points to **Crystal Ball** with annotations as to **Blitzkrieg's** *a priori* estimate of the likelihood of these options. Another function of **Crystal Ball** is to merge these sub-graphs so the futures that are qualitatively the same (regardless of which permutation of options generated them) are combined. This reduces the complexity of the future space, helps refine the list of critical branch points in the future space, and makes **Crystal Ball**'s during-execution job easier.

Crystal Ball also generates two additional metrics associated with the possible futures: value/utility and flexibility. Utility is a rating of how good the future is with respect to the goal of the operation. Utility cannot be based completely on some a priori estimate of "board position," casualty rates, etc. "Board positions" are really a measure of the location of entities with respect to key terrain, the objective, etc., but what constitutes key terrain can often be a function of the mission. Flexibility is a measure of how many branches from a future lead toward better utility. Most commanders would rather have choices than only one good path. If the battle is moving toward nodes with little flexibility, this indicates that the plan is "brittle" and perhaps can be easily derailed by enemy action – or our own mis-actions.

During Execution: Once the operation is underway, **Crystal Ball** will get information about the ongoing operation from the battle command systems, such as FBCB2, CPoF, or the publish and subscribe services (PASS) of ABCS 6.4+. For forces other than BLUE, this information is largely location and perhaps strength information fused from various intelligence sources. (This information fusion is not a part of Deep Green's objectives; Deep Green assumes the information it gets is the best available.) For BLUE forces this information will include information about location and strength, but also potentially information about logistics status, velocity, etc. **Crystal Ball** uses this information about the current operation to update the likelihood estimates. Having done that, **Crystal Ball** can compare the likelihood, utility, and flexibility and estimate which futures are likely to occur that have little value or flexibility. **Crystal Ball** will use this estimate to nominate to the commander futures at which he/she should focus some planning effort to build additional options/branches. **Crystal Ball** will identify the trajectory of the operation in time to allow the commander to generate options before they are needed. **Crystal Ball** will also use this information and additional heuristics to nominate futures for pruning from the graph and to identify decision points to send to **Sketch to Decide**. Pruning, however, will not be based purely on likelihood, but also on attributes such as risk to the operation.

If the commander reaches a future for which no options have been developed, he/she has been surprised and the enemy is now operating inside his/her decision cycle. **Deep Green** will ensure that the commander never reaches a future with no options.

Metrics for **Crystal Ball**:

The **Crystal Ball** metric is designed to measure whether **Crystal Ball** provides early enough notice that the operation is heading in an unexpected direction for the commander to formulate options before they are needed.

Metric	Phase I	Phase II	Phase III
Reduce blind alleys during execution. A "blind alley" occurs during execution when BLUE reaches an unpredicted or ill-prepared state (less than three good options available).	A < 80%	A < 50%	A < 20%

Test methodology: The formulation of the detailed test plan for all program metrics falls under Task 6; however, this section provides general guidance on how this task will be evaluated. There will be two groups of test subjects--one with **Crystal Ball** and one without it. Each group will be organized as a staff, as described above. The staffs with and without **Crystal Ball** will participate in a set of tactical scenarios, simulated in OneSAF Objective System (OOS). For each scenario, **Crystal Ball** will be seeded with a futures graph. As the tactical scenarios proceed, the staffs with and without **Crystal Ball** will anticipate possible futures and generate options in case they occur. Subject matter experts will observe both staffs. For staffs with **Crystal Ball**, if the simulated operation reaches a node in the futures graph at which **Crystal Ball** has fewer than three prepared options, this will be considered a "failure." For staffs without **Crystal Ball**, the subject matter experts will judge when the operation has reached a state at which the staff has fewer than three manually prepared options.

A = (# blind alleys with Crystal Ball / # blind alleys without Crystal Ball) x 100

In brief, **Crystal Ball** must perform the following actions:

- Input: Options from **Sketch to Plan**
- Input: Sub-graph of possible futures and branch points from **Blitzkrieg**
- Assemble permutations of options for all sides/forces and pass each permutation to **Blitzkrieg**
- Merge sub-graphs produced by **Blitzkrieg** into the futures graph
- Assess value/utility and flexibility of each generated possible future
- Take information from the ongoing operation and update the likelihood metrics associated with possible futures.
- Use those updated likelihood metrics to prune parts of the futures graph and nominate futures where the commander should generate additional options and invoke **Sketch to Plan**.
- Identify upcoming decision points and invoke **Sketch to Decide**.

TASK 4: AUTOMATED OPTIONS GENERATION:

The focus of **Deep Green** is on tools to help the commander (and staff) generate options quickly. Leaders from the field generally do not want machine-generated courses of action. Nevertheless, under **Deep Green**, DARPA intends to sponsor a small set of *modest* efforts to generate options automatically. While DARPA envisions **Deep Green** as a commander-driven battle command technology, the long-term vision

of **Deep Green** is for options to be generated by both the commander and the computer. The intent is to insert these technologies into **Deep Green** in follow-on phases, so that some options are generated by humans and others are generated by machines. Initially, DARPA expects the machine generation of options to be centered on making clever mutations of the human-generated options to increase the breadth of the futures generated. Successful implementations of this capability are targeted at inclusion as a sub-module in the **Sketch to Plan** component of **Deep Green.** In this vein, Task 4 performers will need to work closely with the **Sketch to Plan** performers to build a system that will work with the kinds of information that will come from the *Detail Adding Planner* sub-module.

Offerors should note that the **Deep Green** effort does not include support of machine-parsable operations orders or structured languages for commanders to specify goals or intent. Any efforts at automated options generation will need to realize this and infer intent from the human-generated options. It will be permissible for the machine to ask clarifying questions, but the goal is to avoid making the commander specify intent in a structured language.

TASK 5: INTEGRATION

The role of the integrator will be to provide and enforce the data standards and architecture that facilitates the rapid and seamless integration of the components developed in Tasks 1 through 4 into a fully functional system. In addition, the integrator will adapt (preferred) or create the open source bridging software that abstracts the mechanics of interoperability with fielded battle command systems from the components developed in Tasks 1 through 4. In other words, DARPA expects to have an abstraction layer that provides components developed in Tasks 1 through 4 with seamless, transparent interoperability with selected C4I devices, such as CPoF, FBCB2, Blue Force Tracker, and the PASS.

There are two major roles of integration within **Deep Green**: integration of the **Deep Green** modules and interoperability with external systems. The long-term goal of this effort is to ease the transition of **Deep Green** to the battle command and simulation communities without overly restricting the research efforts of the other module developers.

Technical integration of **Deep Green** Modules: Under the internal role, the integrator will choose data standards, such as MSDL, JC3IEDM, and the AUTL, that will ease transition of **Deep Green** to the battle command community and facilitate the efforts of other **Deep Green** module builders. The integrator is expected to peer-review data standards and architecture decisions with the other **Deep Green** developers before making decisions. As the management integrator, the DARPA PM will resolve conflicts between the System (Technical) Integrator and other performers. The integrator also will enforce data and architecture decisions, once made. The integrator also will develop, peer-review, and enforce architecture and interoperability standards between the various **Deep Green** modules. The integrator will ensure that, to the maximum

extent possible, component developers leverage functionality assigned to other components, rather than create redundant capabilities. Finally, the integrator will develop the open/open source architecture of Deep Green that will enable the multi-echelon functionality envisioned for Phase III. The development of this architecture will be made in consultation with the other component developers and will be subject to DARPA PM approval.

Interoperability with External Systems: The integrator will create an abstraction layer that hides the complexity of interacting with external battle command and communications systems from the **Deep Green** components. It is expected that the integrator will build an open source/open architected API that all **Deep Green** modules can use to get information about the current operation from selected battle command systems and to transmit decisions back to those battle command systems. As described earlier, it is envisioned that **Deep Green** will be eventually embedded in CPoF, so the integration contractor will be responsible also for *assisting* the **Commander's Associate** contractor(s) and the **Crystal Ball** contractor(s) with integration into CPoF.

TASK 6: TEST AND EVALUATION

DARPA intends for there to be two tests/experiments during each phase, about six months apart. The first test each year will be an interim status assessment. The second test is designed to determine whether the goals of the system have been met for that phase. In order to be eligible to move to subsequent phases, component developers must show compliance with overall system metrics described previously; however, compliance with these goals does not guarantee movement to the next phase. Government SMEs from the Federal Government/US Military schools where tactics are taught, and, to the extent DARPA determines may be necessary, additional consultants selected by the DARPA PM, will be employed to grade the performance of the system. Tests will be conducted in military facilities with active and retired military SMEs as graders and testers.

To the greatest extent possible, the Test and Evaluation contractor will build its test harness from open source components or software for which the government already has government use rights or unlimited use rights. The exercise driver will be *OneSAF Objective System*. Within the first 90 days of contract award, the Test and Evaluation contractor shall:

- Identify needed modifications to *OneSAF Objective System* to facilitate Phase I and Phase II testing.
- Identify tentative test scenario to inform the design of enhancements of MSDL, the enhancements of OneSAF Objective System, and the development of the other **Deep Green** components.
- Provide component developers with a test environment like the one envisioned for the mid-term and end-of-phase tests to facilitate development.

The Test and Evaluation contractor will update this test environment for component developers as necessary. The exact scenarios will not be provided to component developers prior to the test events. In addition to the major test events, there may be

additional, minor test events scheduled as needed to give confidence that progress is being made.

In Phase I the focus will be on component tests: **Sketch to Plan**, **Crystal Ball**, and **Blitzkrieg**. **Sketch to Plan**, for instance, would output a scenario file that could be used to initialize a constructive simulation. The option would be simulated while an assessment panel grades how closely the option matches what the commander drew and described. The exact testing methodology will need to be careful to grade **Sketch to Plan** and not the simulation. **Crystal Ball** will be tested by providing a hand-generated set of options for both BLUE and non-BLUE. Assessors would then grade the breadth of the futures generated by **Blitzkrieg**. **Blitzkrieg** would be provided one pair of BLUE and non-BLUE options and graded on the quality and plausibility of the futures generated, as well as how long it takes to generate them.

In Phase II, the plan is to have the entire system integrated, so that we can conduct human-in-the-loop, force-on-force experiments to judge the overall efficacy of the system. In Phases II and III, the exercise driver will be OneSAF Objective System (OOS). OOS provides the environment in which the commander's forces fight with the opposing forces. OOS will mimic the "actual battle" and provide that information as a stimulus to Force XXI Battle Command Brigade and Below (FBCB2). In Phase II the users will interact with a **Deep Green** box running **Sketch to Plan** and **Sketch to Decide**, while being able to view the common operating picture (COP) in their FBCB2 and/or CPoF. In Phase III, **Deep Green** will be integrated with CPoF (and/or the Common Viewer from PEO C3T, PM Battle Command). The force-on-force experiments will be conducted through CPoF.

The Test and Evaluation contractor will be responsible for designing the experiments in such a way that statistically relevant results can be extracted to determine whether phase go/no-go metrics for each component (as described above) have been achieved. These tasks include, but are not limited to:

- design of experiment
- administrative prep of experiment (including coordination with support personnel at selected test sites
- direction and execution of experiment
- hiring and training of SMEs as testers, graders, and test subjects not provided by the government (the government will approve contractor-hired personnel for test purposes)
- preparing experimental scenarios, cases, data, etc.
- data collection
- data reduction
- data analysis and preparation of experiment reports
- monitoring and advising developers to ensure that systems are fit for experiments
- software development in support of the above tasks

The Test and Evaluation contractor will hold a test readiness review a month prior to each major test event to ensure that: a) the test is ready to be conducted and b) the components or system are ready to be tested. The contractor is not responsible for software development, except software that must be purchased or developed in support of the other tasks listed. Offerors should also note that this effort does NOT include the cost of facilities, facilities-support personnel, or the procurement of test hardware, and these items should not be included in cost proposals.

DARPA is considering using experts from the Human Research and Engineering Directorate of the Army Research Laboratory to advise and assist in experimental design, data collection, and data analysis. The Test and Evaluation contractor must be prepared to work closely with these subject matter experts.

II. AWARD INFORMATION

Multiple awards are anticipated. The amount of resources made available to this BAA will depend on the quality of the proposals received and the availability of funds. The Government reserves the right to select for negotiation all, some, one, or none of the proposals received in response to this solicitation, and to make awards without discussions with offerors. The Government also reserves the right to conduct discussions if the Government later determines them to be necessary. If warranted, portions of resulting awards may be segregated into pre-priced options. Additionally, DARPA reserves the right to accept proposals in their entirety or to select only portions of proposals for award. In the event that DARPA desires to award only portions of a proposal, negotiations may be opened with that offeror. If the proposed effort is inherently divisible and nothing is gained from the aggregation, offerors should consider submitting it as multiple independent efforts. The Government reserves the right to fund proposals in phases with options for continued work at the end of one or more of the phases.

Awards under this BAA will be made to offerors on the basis of the evaluation criteria listed below (see section V - Application Review Information) and program balance to provide best value to the Government. Proposals identified for negotiation may result in a contract or other transaction, depending upon the nature of the work proposed, the required degree of interaction between parties, and other factors. The Government reserves the right to choose the appropriate instrument. Offerors should note that the required degree of interaction between parties, regardless of award instrument, will be high and continuous. Offerors should also note that this program will be a 6.3-funded effort, and therefore grants and cooperative agreements will not be awarded under this solicitation.

DARPA anticipates completing source selection in September and issuing awards to performers before the end of calendar year 2007; however, this is subject to change.

III. ELIGIBILITY INFORMATION

A. Eligible Applicants

All responsible sources capable of satisfying the Government's needs may submit a proposal that shall be considered by DARPA. Historically Black Colleges and Universities (HBCUs), Small Disadvantaged Businesses and Minority Institutions (MIs) are encouraged to submit proposals and join others in submitting proposals. However, no portion of this announcement will be set aside for Small Disadvantaged Business, HBCU and MI participation, due to the impracticality of reserving discrete or severable areas of this research for exclusive competition among these entities. Independent proposals from Government/National laboratories may be subject to applicable direct competition limitations, though certain Federally Funded Research and Development Centers are excepted per P.L. 103-337§ 217 and P.L 105-261 § 3136. Foreign entities and individuals may participate to the extent that such participants comply with any necessary Non-Disclosure Agreements, Security Regulations, Export Laws, and other governing statutes and regulations applicable under the circumstances.

B. Cost Sharing or Matching

Cost sharing is not required for this particular program; however, cost sharing will be carefully considered where there is an applicable statutory condition relating to the selected funding instrument (e.g., for any Technology Investment Agreement under the authority of 10 U.S.C. 2371).

C. Other Eligibility Requirements

The winner of the Test and Evaluation task will *not* be awarded *any* of the other five tasks. If an offeror successfully bids on Task 6 *and* another task, DARPA will determine which task will be selected for award, not the offeror.

1. Procurement Integrity, Standards of Conduct, Ethical Considerations, and Organizational Conflicts of Interest

Certain post-employment restrictions on former federal officers and employees may exist, including special Government employees (including but not limited to Sections 207 and 208 of Title 18, United States Code, the Procurement Integrity Act, 41 U.S.C. 423, and FAR 3.104). Prior to the start of proposal evaluations, the Government will assess whether any potential conflict of interest exists in regards to the DARPA Program Manager, as well as those individuals chosen to evaluate proposals received under this BAA. The Program Manager is required to review and evaluate all proposals received under this BAA and to manage all selected efforts.

If a prospective Proposer believes that a conflict of interest exists or may exist, the situation should be raised to the DARPA Technical Point of Contact specified in § 7.0, before time and efforts are expended in preparing a proposal. All Proposers and proposed subcontractors must affirm whether they are providing scientific, engineering, and technical assistance (SETA) or similar support to any DARPA technical office(s) through an active contract or subcontract. All affirmations must state which office(s) the Proposer supports and identify the prime contract numbers. Affirmations shall be furnished at the time of proposal submission. All facts relevant to

the existence or potential existence of organizational conflicts of interest (FAR 9.5) must be disclosed. The disclosure shall include a description of the action the Proposer has taken or proposes to take to avoid, neutralize, or mitigate such conflict. If, in the sole opinion of the Government, any conflict situation cannot be effectively mitigated by the proposer, the proposal may be returned without technical evaluation and withdrawn from consideration for award under this BAA.

Important note: if the offeror does not comply with the disclosure requirement, the proposal will be rejected.

IV. APPLICATION AND SUBMISSION INFORMATION

A. Address to Request Application Package

This announcement contains all information required to submit a proposal. Except as provided below, no additional forms, kits, or other materials are needed. This notice constitutes the total BAA. No additional information is available, nor will a formal Request for Proposal (RFP) or additional solicitation regarding this announcement be issued. Requests for same will be disregarded.

B. Content and Form of Application Submission

Responding to this announcement requires completion of an online cover sheet for each proposal prior to submission. To do so, the offeror must go to **https://csc-ballston.dmeid.org/baa/index.asp?BAAid=07-56** and follow the instructions there. Upon completion of the online cover sheet, a Confirmation Sheet will appear. Each offeror is responsible for printing the Confirmation Sheet and attaching it to every hard copy of the proposal. If an offeror intends to submit more than one proposal, a unique UserId and password must be used in creating each cover sheet.

All proposals must include the following:

- One (1) print original of the full proposal including the Confirmation Sheet. Please do not use 3-ring binders.
- One (1) electronic copy of the full proposal. This electronic copy must be:
  - on a CD,
  - in PDF or Microsoft Word for IBM-compatible format, and
  - clearly labeled with BAA 07-56, offeror organization, proposal title (short title recommended).

Proposals not meeting the format described in this BAA may not be reviewed.

Proposal Preparation and Format

The proposal shall be delivered in two volumes, Volume 1 (technical proposal) and Volume 2 (cost proposal). The technical volume should include sections 1 and 2 as described below. The cost volume should include section 3 as described below.

Proposals shall include the following sections, each starting on a new page (where a "page" is 8-1/2 by 11 inches with type not smaller than 12 point, margins not smaller than 1 inch, and line spacing not smaller than single-spaced). The submission of other supporting materials along with the proposal is strongly discouraged. All submissions must be in English.

Individual elements of the proposal shall not exceed the total of the maximum page lengths for each section as shown in braces { } below.

Proposal Section 1 - Administrative

1.1 Confirmation Sheet (as described above) will contain the following information:

- Announcement number;
- Technical topic area or task;
- Proposal title;
- Technical point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address;
- Administrative point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address;
- Summary of the costs of the proposed research, including total base cost, estimates of base cost in each year of the effort, estimates of itemized options in each year of the effort, and cost sharing if relevant;
- Contractor's type of business, selected from among the following categories:
    - WOMEN-OWNED LARGE BUSINESS,
    - OTHER LARGE BUSINESS,
    - SMALL DISADVANTAGED BUSINESS [Identify ethnic group from among the following: Asian-Indian American, Asian-Pacific American, Black American, Hispanic American, Native American, or Other],
    - WOMEN-OWNED SMALL BUSINESS,
    - OTHER SMALL BUSINESS,
    - HBCU,
    - MI,
    - OTHER EDUCATIONAL,
    - OTHER NONPROFIT
    - FOREIGN CONCERN/ENTITY.

1.2 Table of contents {No page limit}

Proposal Section 2 - Detailed Proposal Information

This section provides the detailed discussion of the proposed work necessary to enable an in-depth review of the specific technical and managerial issues. Specific attention must be given to addressing both risk and payoff of the proposed work that make it desirable to DARPA.

2.1 PowerPoint summary chart {1 chart}: a one slide summary of the proposal in PowerPoint that effectively and succinctly conveys the main objective, key innovations, expected impact, and other unique aspects of the proposal.

2.2 Innovative claims for the proposed research {1 Page}: This page is the centerpiece of the proposal and should succinctly describe the unique proposed approach and contributions. This section may also *briefly* address the following topics:

a. Problem Description. Provide a concise description of the problem areas addressed. Make this specific to your approach and the **Deep Green** component addressed by this proposal.
b. Research Goals. Identify specific research goals. Goals should address the technical challenges of the Deep Green component.
c. Expected Impact. Describe the expected impact of your research.

2.3 Proposal Roadmap {2 Pages}: The roadmap provides a top-level view of the content and structure of the proposal. It contains a synopsis for each of the roadmap areas defined below, which should be elaborated elsewhere. It is important to make the synopses as explicit and informative as possible. The roadmap must also cross-reference the proposal page number(s) where each area is elaborated. The required roadmap areas are:

a. Main goals of the proposed research.
b. Tangible benefits to end users (i.e., benefits of the capabilities afforded if the proposed technology is successful).
c. Critical technical barriers (i.e., technical limitations that have, in the past, prevented achieving the proposed results).
d. Main elements of the proposed technical approach.
e. Basis of confidence (i.e. rationale that builds confidence that the proposed approach will overcome the technical barriers).
f. Nature and description of end results to be delivered to DARPA. In what form will results be developed and delivered to DARPA and the scientific community? Note that DARPA encourages experiments, simulations, specifications, proofs, etc. to be documented and published to promote progress in the field. Offerors should specify both final and intermediate products.
g. Cost and schedule of the proposed effort.

2.4 Technical Approach {10 Pages}: Provide a detailed description of the technical approach. This section will elaborate on many of the topics identified in the proposal roadmap and will serve as the primary expression of the offerors' scientific and technical ideas.

2.5 Comparison with Current Technology {2 Pages}: Describe state of the art approaches and the limitations that relate to the particular **Deep Green** component addressed by the proposal. Describe and analyze state of the art results, approaches, and limitations within the context of the problem area addressed by this research. Demonstrating problem understanding requires not just the enumeration of related

efforts; rather, related work must be compared and contrasted to the proposed approach.

2.6 Statement of Work (SOW) {3 pages}: In plain English, clearly define the technical tasks/subtasks to be performed, their durations, and dependencies among them. The page length for the SOW will be dependant on the amount of the effort. For each task/subtask, provide:

- A general description of the objective (for each defined task/activity);
- A detailed description of the approach to be taken to accomplish each defined task/activity);
- Identification of the primary organization responsible for task execution (prime, sub, team member, by name, etc.);
- The exit criteria for each task/activity - a product, event or milestone that defines its completion.
- Define all deliverables (reporting, data, reports, software, etc.) to be provided to the Government in support of the proposed research tasks/activities.

Note: It is recommended that the SOW should be developed so that each Phase of the program is separately defined. Offerors should format their proposals for Phase I with Phases II and III tasks/subtasks as options. Do not include any proprietary information in the SOW.

2.7 Deliverables Description {2 Pages}: List and provide a detailed description for each proposed deliverable, including receiving organization and expected delivery date for each deliverable. Include in this section all proprietary claims to results, prototypes, or systems supporting and/or necessary for the use of the research, results, and/or prototype. If there are no proprietary claims, this should be stated. The offeror must submit a separate list of all technical data or computer software that will be furnished to the Government with other than unlimited rights (see section 2.12 below). As discussed earlier, DARPA has a strong interest in developing open-source, open architecture software with, to the extent possible, unlimited rights to streamline technology transition to materiel developers and the military research community, so offerors should be aware that significant limitations will have an impact on the evaluation of the proposal. Furthermore, the additional licensing agreements discussed in the Intellectual Property section below should be used to specify which licenses will apply to each component of the deliverables. Specify expected delivery date for each deliverable.

2.8 Management Plan {3 Pages}: Describe formal teaming agreements that are required to execute this program, a brief synopsis of all key personnel, and a clearly defined organization chart for the program team (prime contractor and subcontractors, if any). Provide an argument that the team size and composition are both necessary and sufficient to meet the program objectives. Provide detailed task descriptions, costs, and interdependencies for each individual effort and/or subcontractor. To the extent that graduate students and postdocs are involved in individual efforts, describe their role and contribution. Information in this section must cover the following information:

a. Programmatic relationship of team members;
b. Unique capabilities of team members;

c. Task responsibilities of team members;
d. Teaming strategy among the team members;
e. Key personnel along with the amount of effort to be expended by each person during each year; and
f. Government role in project, if any.

2.9 Schedule and Milestones: This section should include:

a. {1 Page} Schedule Graphic. Provide a graphic representation of project schedule including detail down to the individual effort level. This should include but not be limited to, a multi-phase development plan, which demonstrates a clear understanding of the proposed research; and a plan for periodic and increasingly robust tests over the project life that will show applicability to the overall program concept. Show all project milestones. Use "x months after contract award" designations for all dates.
b. {3 Pages} Detailed Task Descriptions. Provide detailed task descriptions for each discrete work effort and/or subcontractor in schedule graphic.
c. {1 Page} Project Management and Interaction Plan. Describe the project management and interaction plans for the proposed work. If proposal includes subcontractors that are geographically distributed, clearly specify working / meeting models. Items to include in this category include software/code repositories, physical and virtual meeting plans, and online communication systems that may be used.

2.10 Personnel, Qualifications, and Commitments {NO MORE THAN ONE PAGE PER KEY PERSON}: List key personnel, showing a concise summary of their qualifications, discussion of offeror's previous accomplishments, and work in this or closely related research areas. Indicate the level of effort in terms of hours to be expended by each person during each contract year and other (current and proposed) major sources of support for them and/or commitments of their efforts. DARPA expects all key personnel associated with a proposal to make substantial time commitment to the proposed activity and the proposal will be evaluated accordingly. It is DARPA's intention to put key personnel clauses into the contracts, so offerors should not bid personnel whom they do not intend to execute the contract.

Include a table of key individual time commitments as follows:

Key Individual	**Project**	**Pending/Current**	**2007**	**2008**	**2009**	**2010**
Jane Doe	Deep Green	Proposed	YYY hours	ZZZ hours	UUU hours	WWW hours
	Project 1	Current	2 hours	n/a	n/a	n/a
	Project 2	Pending	100 hours	100 hours	n/a	n/a
John Deer	Deep Green	Proposed				

2.11 {No page limit} Organizational Conflict of Interest Affirmations and Disclosure

All offerors and proposed subcontractors must affirm whether they are providing scientific, engineering, and technical assistance (SETA) or similar support to any DARPA technical office(s) through an active contract or subcontract. All affirmations must state which office(s) the offeror supports and identify the prime contract numbers. Affirmations shall be furnished at the time of proposal submission. All facts relevant to the existence or potential existence of organization conflicts of interest (FAR 9.5) must be disclosed. The disclosure shall include a description of the action the offeror has taken or proposed to take to avoid, neutralize, or mitigate such conflict. **Important note: if the offeror does not comply with this disclosure requirement, the proposal will be rejected.**

2.12 {No page limit} Intellectual Property

NOTE: All software developed under Deep Green will, to the greatest extent possible, be open architecture and open source. To the extent possible under applicable pre-existing licenses, the government expects to acquire unlimited rights to all software, software documentation, and technical data developed under this program. To the greatest extent feasible, therefore, proposers should not include background proprietary software and data as the basis of their proposed approach. Proposers expecting to utilize, but not to deliver, open source tools or other materials in implementing their approach must ensure that the government does not incur any legal obligation due to such utilization. All references to "unlimited" or "government purpose rights" are intended to refer to the definitions of those terms as set forth in the Defense Federal Acquisition Regulation Supplement (DFARS) Part 227. In addition, proposers should provide the following information:

a. **FARS/DFARS Noncommercial Items IP Restrictions: (Technical Data and Computer Software).**

Offerors responding to this solicitation requesting a contract to be issued under the FAR/DFARS shall identify all noncommercial technical data and noncommercial computer software that it plans to generate, develop, and/or deliver under any proposed award instrument in which the Government will acquire less than unlimited rights and to assert specific restrictions on those deliverables. Offerors shall follow the format under DFARS 252.227-7017 for this stated purpose. In the event that offerors do not submit the list, the Government will assume that it automatically has "unlimited rights" to all noncommercial technical data and noncommercial computer software generated, developed, and/or delivered under any award instrument, unless it is substantiated that development of the noncommercial technical data and noncommercial computer software occurred with mixed funding. If mixed funding is anticipated in the development of noncommercial technical data and noncommercial computer software generated, developed, and/or delivered under any award instrument, then offerors should identify the data, documentation, and software in question as subject to Government Purpose Rights (GPR). In accordance with DFARS 252.227-7013 Rights in Technical Data - Noncommercial Items and DFARS 252.227-7014 Rights in Noncommercial Computer

Software and Noncommercial Computer Software Documentation, the Government will automatically assume that any such GPR restriction is limited to a period of five (5) years in accordance with the applicable DFARS clauses, at which time the Government will acquire “unlimited rights” unless the parties agree otherwise. OFFERORS ARE ADVISED THAT OFFERS CONTAINING RESTRICTIONS ON INTELLECTUAL PROPERTY ARE BY NATURE LESS FAVORABLE AND VALUABLE TO THE GOVERNMENT. RESTRICTIONS WILL BE CONSIDERED IN THE EVALUATION PROCESS. If no restrictions are intended, then the offeror should state “NONE.”

A sample list for complying with this request is as follows:

NONCOMMERCIAL			
Technical Data Computer Software To be Furnished With Restrictions	Basis for Assertion	Asserted Rights Category	Name of Person Asserting Restrictions
(LIST)	(LIST)	(LIST)	(LIST)

b. FARS/DFARS Commercial Items IP Restrictions: (Technical Data and Computer Software)

Offerors responding to this solicitation requesting a contract to be issued under the FAR/DFARS shall identify all commercial technical data, and commercial computer software that may be embedded in any noncommercial deliverables contemplated under the research effort, along with any applicable restrictions on the Government’s use of such commercial technical data and/or commercial computer software. In the event that offerors do not submit the list, the Government will assume that there are no restrictions on the Government’s use of such commercial items. OFFERORS ARE ADVISED THAT OFFERS CONTAINING RESTRICTIONS ON INTELLECTUAL PROPERTY ARE BY NATURE LESS FAVORABLE AND VALUABLE TO THE GOVERNMENT. RESTRICTIONS WILL BE CONSIDERED IN THE EVALUATION PROCESS. If no restrictions are intended, then the offeror should state “NONE.”

A sample list for complying with this request is as follows:

COMMERCIAL			
Technical Data Computer Software To be Furnished With Restrictions	Basis for Assertion	Asserted Rights Category	Name of Person Asserting Restrictions
(LIST)	(LIST)	(LIST)	(LIST)

c. Non-FARS/DFARS IP restrictions: (Technical Data and Computer Software)

Offerors responding to this solicitation requesting a Cooperative Agreement, Technology Investment Agreement, or Other Transaction for Prototype shall follow the applicable rules and regulations governing these various award instruments, but, in all cases should appropriately identify any potential restrictions on the Governments use of any Intellectual Property contemplated under those award instruments. This includes both Noncommercial Items and Commercial Items. Although not required, offerors may use a format similar to that described above. OFFERORS ARE ADVISED THAT OFFERS CONTAINING RESTRICTIONS ON INTELLECTUAL PROPERTY ARE BY NATURE LESS FAVORABLE AND VALUABLE TO THE GOVERNMENT. RESTRICTIONS WILL BE CONSIDERED IN THE EVALUATION PROCESS. If no restrictions are intended, then the offeror should state “NONE.”

d. Patent dependencies – All offerors

Please include documentation proving your ownership of or possession of appropriate licensing rights to all patented inventions (or inventions for which a patent application has been filed) that will be utilized under your proposal for the DARPA program. If a patent application has been filed for an invention that your proposal utilizes, but the application has not yet been made publicly available and contains proprietary information, you may provide only the patent number, inventor name(s), assignee names (if any), filing date, filing date of any related provisional application, and a summary of the patent title, together with either: 1) a representation that you own the invention, or 2) proof of possession of appropriate licensing rights in the invention.

e. IP representations – All offerors

Please also provide a good faith representation that you either own or possess appropriate licensing rights to all other intellectual property that will be utilized under your proposal for the DARPA program. If you are unable to make such a representation concerning non-patent related intellectual property, please provide a listing of the intellectual property to which you do not have needed rights, and provide a detailed explanation concerning how and when you plan to obtain these rights.

2.13 Human use {No page limit}:
All proposals that involve the use of human subjects are required to include documentation of their ability to follow Federal guidelines for the protection of human subjects.

For proposals involving “greater than minimal risk” to human subjects within the first year of the project, performers must provide evidence of protocol submission to a federally approved IRB at the time of final proposal submission to DARPA. For proposals that are forecast to involve “greater than minimal risk” after the first year, a

discussion on how and when the offeror will comply with submission to a federally approved IRB must be provided.

Any aspects of a proposal involving human use should be specifically called out as a separate element of the statement of work and cost proposal to allow for independent review and approval of those elements.

If human use is not a factor in a proposal, then the offeror should state “NONE.”

Proposal Section 3 Cost Proposal – {No Page Limit}

3. 1 Cover sheet

- Name and address of offeror (include zip code);
- Name, title, and telephone number of offeror’s point of contact;
- Award instrument requested: cost-plus-fixed-fee (CPFF), cost-contract--no fee, cost sharing contract--no fee, or other type of procurement contract (specify), agreement, or other award instrument;
- Place(s) and period(s) of performance;
- Funds requested from DARPA for the Base Effort, each option and the total proposed cost; and the amount of cost share (if any);
- Name, mailing address, telephone number and Point of Contact of the offeror’s cognizant government administration office (i.e., Office of Naval Research/Defense Contract Management Agency (DCMA)) (if known);
- Name, mailing address, telephone number, and Point of Contact of the offeror’s cognizant Defense Contract Audit Agency (DCAA) audit office (if known);
- Any Forward Pricing Rate Agreement, other such Approved Rate Information, or such other documentation that may assist in expediting negotiations (if available);
- Contractor and Government Entity (CAGE) Code;
- Dun and Bradstreet (DUN) Number;
- North American Industrial Classification System (NAICS) Number [NOTE: This was formerly the Standard Industrial Classification (SIC) Number];
- Taxpayer Identification Number (TIN), and,
- All subcontractor proposal backup documentation to include the items above, as is applicable and available.

3.2 Cost Summaries: This section shall contain two tables: (1) The first table must summarize the proposed costs but break them down by project task and phase, i.e., show the costs of each project task for each phase with the task labels on the y-axis and the three phases on the x-axis. It may be appropriate to create a subtotal under some closely related tasks. Table entries should contain the dollar figure and a percentage that specifies the percentage of that phase’s total costs that are allocated to said task; (2) the second table should show the costs broken down by prime/subcontractor by phase, i.e., the labels of the prime/subcontractors should be on the y-axis and the three phases on the x-axis. Table entries should contain the dollar figure and a percentage that specifies the percentage of that phase’s total costs

allocated to said prime or subcontractor. **Offerors should format their proposals for Phase I with Phases II and III priced as options.**

3.3 Detailed cost breakdown:

Total program cost broken down by task and phase (by quarter). Cost breakdown categories:

- Direct Labor – Individual labor category or person, with associated labor hours and unburdened direct labor rates;
- Indirect Costs – Fringe Benefits, Overhead, General and Administrative Expense, Cost of Money, etc. (Must show base amount and rate);
- Travel – Number of trips, number of days per trip, departure and arrival destinations, number of people, etc.
- Subcontract – A cost proposal as detailed as the offeror's cost proposal will be required to be submitted by the subcontractor. The subcontractor's cost proposal can be provided in a sealed envelope with the offeror's cost proposal or will be requested from the subcontractor at a later date;
- Consultant – Provide consultant agreement or other document which verifies the proposed loaded daily/hourly rate;
- Materials – Should be specifically itemized with costs or estimated costs. An explanation of any estimating factors, including their derivation and application, shall be provided. Please include a brief description of the offeror's procurement method to be used;
- Other Direct Costs – Should be itemized with costs or estimated costs. Backup documentation should be submitted to support proposed costs.
- Costs of major program tasks and major cost items by year and month;
- Supporting cost and pricing information.

Supplementary information should be provided in sufficient detail to substantiate the summary cost estimates above. Include a description of the method used to estimate costs and supporting documentation. Provide the basis of estimate for all proposed labor rates, indirect costs, overhead costs, other direct costs and materials, as applicable.

3.4 Government Furnished Property

Contractors requiring the purchase of information technology (IT) resources as Government Furnished Property (GFP) MUST attach to the submitted proposals the following information:

- A letter on corporate letterhead signed by a senior corporate official and addressed to COL John Surdu, Program Manager, DARPA/IPTO, stating that you either can not or will not provide the information technology (IT) resources necessary to conduct the said research.
- An explanation of the method of competitive acquisition or a sole source justification, as appropriate, for each IT resource item.
- If the resource is leased, a lease/purchase analysis clearly showing the reason for the lease decision.
- The cost for each IT resource item.

C. Submission Dates and Times

The full proposal (original and designated number of hard and electronic copies) must be submitted in time to reach DARPA by 12:00 noon (EDT) 30 August 2007 (initial closing), in order to be considered during the initial evaluation phase. However, BAA 07-56 will remain open until 12:00 noon (EDT) 9 July 2008 (final closing date). Thus, proposals may be submitted at any time from issuance of this announcement through 12:00 noon (EDT) 9 July 2008, however, offerors are warned that the likelihood of funding is greatly reduced for proposals submitted after the initial closing date deadline.

DARPA will acknowledge receipt of complete submissions via email and assign control numbers that should be used in all further correspondence regarding proposals.

Failure to comply with the submission procedures may result in the submission not being evaluated.

D. Intergovernmental Review - N/A

E. Funding Restrictions

Authorization of precontract costs will be considered in situations of genuine urgency where programmatic benefits will accrue from their use.

F. Other Submission Requirements

Proposals MUST be submitted to DARPA in hard copy. Postal address: DARPA/IPTO, ATTN: BAA07-56, 3701 N. Fairfax Drive, Arlington, VA 22203-1714. For deliveries that require a phone number, such as FedEx or UPS, please use 703-696-2356, which is the DARPA mailroom. For hand deliveries, the courier shall deliver the package to the DARPA Visitor Control Center at the address specified above. To ensure proper handling, the outer package, as well as the cover page of the proposal, must be marked "IPTO BAA 07-56."

V. APPLICATION REVIEW INFORMATION

A. Evaluation Criteria

Evaluation of proposals will be accomplished through a scientific review of each proposal using the following criteria. While these criteria are listed in descending order of relative importance, it should be noted that the combination of all non-cost evaluation factors is significantly more important than cost.

1. Evaluation Criteria for Proposals Submitted under Task 1-Commander's Associate, Task 2-Crystal Ball, Task 3-Blitzkrieg, OR Task 4-Automated Option Generation:

a. **Overall Scientific and Technical Merit:** The overall scientific and technical merit must be clearly identifiable and compelling. The technical concepts should be clearly defined and developed. The technical approach must be

sufficiently detailed to support the proposed concepts and technical claims. Proposal must clearly conform to the stipulated metrics and evaluation plans. Proposal must also clearly define system integration approach and plans.

b. **Innovative Technical Solution to the Problem:** Offerors should apply new and/or existing technology in an innovative way that supports the objectives of the proposed effort. The proposed concepts and systems should show breadth of innovation across all the dimensions of the proposed solution.

c. **Potential Contribution and Relevance to the DARPA Mission**: The potential contributions of the proposed effort with relevance to the national technology base will be evaluated. Specifically, DARPA's mission is to maintain the technological superiority of the U.S. military and prevent technological surprise from harming our national security by sponsoring revolutionary, high-payoff research that bridges the gap between fundamental discoveries and their military use.

d. **Plans and Capability to Accomplish Technology Transition:** offerors should provide a clear explanation of how the technologies to be developed will be transitioned to capabilities for government use. Technology transition should be a major consideration in the design of experiments, particularly considering the potential for involving transition organizations in the experimentation process. The plan on how offeror intends to get developed technology and information to the user community will be considered. Also considered will be impediments to future transition, including intellectual property restrictions and use limitations on any and all components and sub-components.

e. **Offeror's Capabilities and Related Experience:** The qualifications, capabilities, project management plan, and demonstrated achievements of the proposed principals and other key personnel for the primary and subcontractor organizations must be clearly shown.

f. **Realism of Proposed Schedule:** The overall research agenda and timeline, including specific intermediate criteria, should clearly relate to theoretical obstacles that must be overcome.

g. **Cost Realism:** The objective of this criterion is to establish that the proposed costs are realistic for the technical and management approach offered, as well as to determine the offeror's practical understanding of the effort. This will be principally measured by cost per labor-hour and number of labor-hours proposed. The evaluation criterion recognize that undue emphasis on cost may motivate offerors to offer low-risk ideas with minimum uncertainty and to staff the effort with junior personnel in order to be in a more competitive posture. DARPA discourages such cost strategies. Cost reduction approaches that will be received favorably include innovative management

concepts that maximize direct funding for technology and limit diversion of funds into overhead.

2. Evaluation Criteria for Proposals Submitted Under Task 5-Integration:

a. **Overall Scientific and Technical Merit:** The overall scientific and technical merit must be clearly identifiable and compelling. The technical concepts should be clearly defined and developed. The technical approach must be sufficiently detailed to support the proposed concepts and technical claims. Proposal must clearly conform to the stipulated metrics and evaluation plans. Proposal must also clearly define system integration approach and plans.

b. **Innovative Technical Solution to the Problem**: Offerors should apply new and/or existing technology in an innovative way that supports the objectives of the proposed effort. The proposed concepts and systems should show breadth of innovation across all the dimensions of the proposed solution.

c. **Potential Contribution and Relevance to the DARPA Mission**: The potential contributions of the proposed effort with relevance to the national technology base will be evaluated. Specifically, DARPA's mission is to maintain the technological superiority of the U.S. military and prevent technological surprise from harming our national security by sponsoring revolutionary, high-payoff research that bridges the gap between fundamental discoveries and their military use.

d. **Offeror's Capabilities and Related Experience:** The qualifications, capabilities, project management plan, and demonstrated achievements of the proposed principals and other key personnel for the primary and subcontractor organizations must be clearly shown.

e. **Realism of Proposed Schedule**: The overall research agenda and timeline, including specific intermediate criteria, should clearly relate to theoretical obstacles that must be overcome.

f. **Plans and Capability to Accomplish Technology Transition**: offerors should provide a clear explanation of how the technologies to be developed will be transitioned to capabilities for government use. Technology transition should be a major consideration in the design of experiments, particularly considering the potential for involving transition organizations in the experimentation process. The plan on how offeror intends to get developed technology and information to the user community will be considered. Also considered will be impediments to future transition, including intellectual property restrictions and use limitations on any and all components and sub-components.

g. **Cost Realism:** The objective of this criterion is to establish that the proposed costs are realistic for the technical and management approach offered, as well as to determine the offeror's practical understanding of the effort. This will be principally measured by cost per labor-hour and number of labor-hours proposed. The evaluation criterion recognize that undue emphasis on cost may motivate offerors to offer low-risk ideas with minimum uncertainty and to staff the effort with junior personnel in order to be in a more competitive posture. DARPA discourages such cost strategies. Cost reduction approaches that will be received favorably include innovative management concepts that maximize direct funding for technology and limit diversion of funds into overhead.

3. Evaluation Criteria for Proposals Submitted Under Task 6-Test and Evaluation:

a. **Overall Scientific and Technical Merit:** The overall scientific and technical merit must be clearly identifiable and compelling. The technical concepts should be clearly defined and developed. The technical approach must be sufficiently detailed to support the proposed concepts and technical claims. Proposal must clearly conform to the stipulated metrics and evaluation plans. Proposal must also clearly define system integration approach and plans. Intellectual property rights limitations will be considered as part of this criterion.

b. **Innovative Technical Solution to the Problem**: Offerors should apply new and/or existing technology in an innovative way that supports the objectives of the proposed effort. The proposed concepts and systems should show breadth of innovation across all the dimensions of the proposed solution. Offerors should identify proposed test methodologies employed to demonstrate compliance with phase go/no-go criteria and how those methodologies will provide strong, statistical evidence.

c. **Potential Contribution and Relevance to the DARPA Mission**: The potential contributions of the proposed effort with relevance to the national technology base will be evaluated. Specifically, DARPA's mission is to maintain the technological superiority of the U.S. military and prevent technological surprise from harming our national security by sponsoring revolutionary, high-payoff research that bridges the gap between fundamental discoveries and their military use.

d. **Offeror's Capabilities and Related Experience:** The qualifications, capabilities, project management plan, and demonstrated achievements of the proposed principals and other key personnel for the primary and subcontractor organizations must be clearly shown.

e. **Realism of Proposed Schedule**: The overall research agenda and timeline, including specific intermediate criteria, should clearly relate to theoretical obstacles that must be overcome.

f. **Cost Realism**: The objective of this criterion is to establish that the proposed costs are realistic for the technical and management approach offered, as well as to determine the offeror's practical understanding of the effort. This will be principally measured by cost per labor-hour and number of labor-hours proposed. The evaluation criterion recognize that undue emphasis on cost may motivate offerors to offer low-risk ideas with minimum uncertainty and to staff the effort with junior personnel in order to be in a more competitive posture. DARPA discourages such cost strategies. Cost reduction approaches that will be received favorably include innovative management concepts that maximize direct funding for technology and limit diversion of funds into overhead

Award(s) will be made to offerors whose proposals are determined to be the most advantageous to the Government, all factors considered, including the potential contributions of the proposed work to the overall research program and the availability of funding for the effort. Award(s) may be made to any offeror(s) whose proposal(s) is determined selectable regardless of its overall rating.

NOTE: OFFERORS ARE CAUTIONED THAT EVALUATION RATINGS MAY BE LOWERED AND/OR PROPOSALS REJECTED IF SUBMITTAL INSTRUCTIONS ARE NOT FOLLOWED.

B. Review and Selection Process

It is the policy of DARPA to ensure impartial, equitable, comprehensive proposal evaluations and to select the source (or sources) whose offer meets the Government's technical, policy, and programmatic goals. Pursuant to FAR 35.016, the primary basis for selecting proposals for acceptance shall be technical, importance to agency programs, and fund availability. In order to provide the desired evaluation, qualified Government personnel will conduct reviews and (if necessary) convene panels of experts in the appropriate areas.

Proposals will not be evaluated against each other, since they are not submitted in accordance with a common work statement. DARPA's intent is to review proposals as soon as possible after they arrive; however, proposals may be reviewed periodically for administrative reasons. For evaluation purposes, a proposal is the document described above in IV.B – Content and Form of Application Submission.

Restrictive notices notwithstanding, proposals may be handled for administrative purposes by support contractors. These support contractors are prohibited from competition in DARPA technical research and are bound by appropriate non-disclosure requirements. Subject to the restrictions set forth in FAR 37.203(d), input on technical

aspects of the proposals may be solicited by DARPA from non-Government consultants /experts who are strictly bound by the appropriate non-disclosure requirements.

It is the policy of DARPA to treat all proposals as competitive information and to disclose their contents only for the purpose of evaluation. No proposals will be returned. Upon completion of the source selection process, the original of each proposal received will be retained at DARPA and all other copies will be destroyed.

VI. AWARD ADMINISTRATION INFORMATION

A. Award Notices

As soon as the evaluation of a proposal is complete, the offeror will be notified that 1) the proposal has been selected for funding pending contract negotiations, or 2) the proposal has not been selected. These official notifications will be sent via US mail to the Technical POC identified on the proposal coversheet.

B. Administrative and National Policy Requirements

1. Meeting and travel requirements

There will be a program kickoff meeting and PI meetings about twice every year that all key participants will be required to attend. Performers should also anticipate periodic site visits at the Program Manager's discretion. Contractors will be expected to participate in various technical exchanges and coordination and planning activities with DARPA and other participants. For budgetary purposes, sites should plan on sending representatives to two 3-day Deep Green workshops per year. These will be in addition to whatever travel is needed for collaboration within a research team.

2. Security classification

Security classification guidance on a DD Form 254 (DoD Contract Security Classification Specification) will not be provided at this time since DARPA is soliciting ideas only and does not encourage classified proposals in response to this announcement. However, after reviewing incoming proposals, if a determination is made that contract award may result in access to classified information, a DD Form 254 will be issued upon contract award. ***If you choose to submit a classified proposal you must first receive the permission of the Original Classification Authority to use its information in replying to this announcement.***

3. Human use

Proposals selected for contract award are required to comply with provisions of the Common Rule (32 CFR 219) on the protection of human subjects in research (http://www.dtic.mil/biosys/downloads/32cfr219.pdf) and the Department of Defense Directive 3216.2 (http://www.dtic.mil/whs/directives/corres/html2/d32162x.htm). All proposals that involve the use of human subjects are required to include documentation of their ability to follow Federal guidelines for the protection of human subjects. This includes, but is not limited to, protocol approval mechanisms, approved Institutional

Review Boards, and Federal Wide Assurances. These requirements are based on expected human use issues sometime during the entire length of the proposed effort.

For proposals involving “greater than minimal risk” to human subjects within the first year of the project, performers must provide evidence of protocol submission to a federally approved IRB at the time of final proposal submission to DARPA. For proposals that are forecasted to involve “greater than minimal risk” after the first year, a discussion on how and when the offeror will comply with submission to a federally approved IRB needs to be provided in the submission. More information on applicable federal regulations can be found at the Department of Health and Human Services – Office of Human Research Protections website (http://www.dhhs.gov/ohrp/).

Any aspects of a proposal involving human use should be specifically called out as a separate element of the statement of work and cost proposal to allow for independent review and approval of those elements.

4. Animal Use

Any Recipient performing research, experimentation, or testing involving the use of animals shall comply with the rules on animal acquisition, transport, care, handling, and use in: (i) 9 CFR parts 1-4, Department of Agriculture rules that implement the Laboratory Animal Welfare Act of 1966, as amended, (7 U.S.C. 2131-2159); and (ii) the guidelines described in National Institutes of Health Publication No. 86-23, “Guide for the Care and Use of Laboratory Animals.”

5. Publication approval

Any resulting award will include a requirement for DARPA permission before publishing any information or results on the program.

The following provision will be incorporated into any resultant procurement contract or other transaction:

> When submitting material for written approval for open publication, the Contractor/Awardee must submit a request for public release to the DARPA TIO and include the following information: 1) Document Information: document title, document author, short plain-language description of technology discussed in the material (approx. 30 words), number of pages (or minutes of video) and document type (briefing, report, abstract, article, or paper); 2) Event Information: event type (conference, principle investigator meeting, article or paper), event date, desired date for DARPA's approval; 3) DARPA Sponsor: DARPA Program Manager, DARPA office, and contract number; and 4) Contractor/Awardee's Information: POC name, e-mail and phone. Allow four weeks for processing; due dates under four weeks require a justification. Unusual electronic file formats may require additional processing time. Requests can be sent either via e-mail to tio@darpa.mil or via 3701 North Fairfax Drive, Arlington VA 22203-1714, telephone (571) 218-4235. Refer to www.darpa.mil/tio for information about DARPA's public release process.

6. Export Control

This program will be funded with 6.3 funding. Thus, with the exception of fundamental research aspects of the program (if any), contracts will be negotiated containing terms addressing the following substantive conditions:

- The Contractor shall comply with all U. S. export control laws and regulations, including the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 through 130, and the Export Administration Regulations (EAR), 15 CFR Parts 730 through 799, in the performance of the contract or agreement. In the absence of available license exemptions/exceptions, the Contractor shall be responsible for obtaining the appropriate licenses or other approvals, if required, for exports (including deemed exports) of hardware, technical data, software, and the provision of technical assistance.
- The Contractor shall be responsible for obtaining export licenses, if required, before utilizing foreign persons in the performance of this contract, including instances where the work is to be performed on-site at any Government installation (whether in or outside the United States), where the foreign person will have access to export-controlled technology.
- The Contractor shall be responsible for all regulatory record keeping requirements associated with the use of licenses and license exemptions/exceptions.
- The Contractor shall be responsible for ensuring that the provisions of this clause apply to its subcontractors**.**

7. Associated Contractor Agreements

All performers will have an Associated Contractor Agreement clause (see sample below under VIII.C.2) incorporated into the resulting award, in order to allow the free and open exchange of information. In part, the clause will state the following, “this clause is intended to ensure that there will be appropriate coordination and integration of work by the Deep Green associated contractors to ensure complete compatibility between equipment, data, and services for the Deep Green program, to prevent unnecessary duplication of effort, and to maximize commonality.” It is advised that all offerors carefully review the sample clause in its entirety.

C. Reporting

The award document for each proposal selected and funded will contain a mandatory requirement for four DARPA/IPTO Quarterly Status Reports each year, one of which will be an annual project summary. These reports will be electronically submitted by each awardee under this BAA via the DARPA Technical – Financial Information Management System (T-FIMS). The T-FIMS URL and instructions will be furnished by the contracting agent upon award.

In addition, each performing contractor (including subs) on each team will be expected to provide monthly status reports to the Program Manager.

VII. AGENCY CONTACTS

DARPA will use electronic mail for all technical and administrative correspondence regarding this BAA, with the exception of selected/not-selected notifications.

Administrative, technical or contractual questions should be sent via e-mail to BAA07-56@darpa.mil. If e-mail is not available, please fax questions to (703) 741-7804, Attention: Deep Green Solicitation. All requests must include the name, email address, and phone number of a point of contact.

Solicitation Web site and Electronic File Retrieval:
http://www.darpa.mil/ipto/solicitations/solicitations.htm.

VIII. OTHER INFORMATION

The solicitation web page at www.darpa.mil/ipto/solicitations/solicitations.htm will have a Frequently Asked Questions (FAQ) list and links to information on teaming and the industry day.

A. Collaborative Efforts/Teaming

Collaborative efforts/teaming are encouraged. A website (http://csc-ballston.dmeid.org/baa/DGteaming.htm) has been established to facilitate formation of teaming arrangements between interested parties. Specific content, communications, networking, and team formation are the sole responsibility of the participants. Neither DARPA nor the Department of Defense (DoD) endorses the destination web site or the information and organizations contained therein, nor does DARPA or the DoD exercise any responsibility at the destination. This website is provided consistent with the stated purpose of this BAA.

Offerors are encouraged to form strong, multidisciplinary teams. The goal of teaming is to achieve faster, stronger progress through critical mass efforts and address all aspects of this program to produce a complete system. Each team should submit a single, unified proposal from the prime contractor, i.e., subcontractors should not submit separate proposals. This also applies to consortiums submitting proposals.

B. Industry Day

An industry day will be held on Monday, July 23, 2007 (starting at 1:30 p.m., Arlington, VA EDT) to provide additional information and discussion on this topic. Details may be found on the solicitation website at http://www.dsic-web.net/meetings/p03r4yty/index.html. Attendees at the industry day are allowed to bring a single poster, not larger than 3 feet tall by 2 feet wide) to post in the industry day venue. These posters are for the purpose of announcing proposer capabilities and desires for teaming. Time will be allowed during the industry day for potential offerors to mingle.

C. Sample Associated Contractor Agreement Clause

(a)(1) This clause is intended to ensure that there will be appropriate coordination/integration of work by and among all Deep Green-associated contractors to ensure complete compatibility between equipment, data, and services for the Deep Green program, to prevent unnecessary duplication of effort, and to maximize commonality.

(2) The price of this contract includes legal consideration for the performance of the work in support of this contract and called for in the Associated Contractor Agreements.

(b) The Associated Contractors are as follows:

Name
Address
Responsibility: Deep Green, Component ___

(c) The contractor shall work and maintain close liaison with the associated contractors listed in paragraph (b) above. In order to assure accomplishment of this objective, the contractor shall enter into a written Associated Contractor Agreement with each of the other associated contractors.

(d) Each Associated Contractor Agreement between the contractor and an associated contractor shall provide for complete and unbiased exchange of technical information, interface data, and computer software ("Data") relating to their detailed responsibilities and procedures.

The following is a guide to be used in the development of each agreement:

(1) Identification of the data to be furnished among the associated contractors to facilitate procedures/schedules for the exchange of Data. Descriptive detail of the Data to be furnished or exchanged, with a specific date for delivery of each item thereof and containing such other mutual covenants and agreements that may be desirable or required to assure delivery or exchange of said Data in a timely manner and in a condition suitable for use by the recipient. (For example, this may extend to all information pertaining and essential to the design, development, fabrication, test, interface, modification and installation of equipment and provision of services hereunder, to the extent that each party may require such information to ensure the compatibility of their respective equipment, technical data, and services.)

(2) Services to be provided by one contractor to another (including such services as clerical support to visiting associated contractor personnel, unscheduled maintenance and technical support for equipment, etc.) to facilitate the performance of the respective contracts and the period(s) of time the services are to be provided to assure necessary interface actions and support activities.

(3) Materials to be provided to each other by the respective contractors in performance.

(4) The facilities and their location to be provided by each contractor to accommodate personnel assigned to provide the associate contractor's integration and support services, assurance of adequate working areas, power requirements, office

space and communication equipment which are essential for timely completion of the integration/support services.

(5) Delineation of respective interface responsibilities.

(6) Provision for furnishing copies to communications relative to performance of associate contractor responsibilities.

(e) In the event this exchange of data results in the need to obtain access to proprietary information, the contractor agrees to include in the Associated Contractor Agreements the terms and conditions under which the contractor and associated contractors agree to exchange such proprietary information. The Contractor hereby agrees not to use, modify, reproduce, release, perform, display, or disclose such proprietary information, unless specifically authorized in writing to do so under the applicable Associated Contractor Agreement(s).

(f) The Associated Contractor Agreements shall permit the exchange of data between the associated contractors. The Agreements shall be structured so that all contractors and associated contractors are obligated to protect proprietary information from all unauthorized use or disclosure for as long as such information remains proprietary.

(g) "Proprietary Information" means information that embodies trade secrets developed at private expense or business, commercial, or financial information that is privileged or confidential, provided that such information:

[_____] is not known or available from other sources without obligations concerning its confidentiality;

[_____] has not been made available by the owners to others without obligation concerning its confidentiality;

[_____] is not already available to the Government without obligation concerning its confidentiality; and

[_____] has not been developed independently by persons who have had no access to the information.

(h) Each Associated Contractor Agreement shall be submitted to the Government for review prior to execution. Following Government concurrence and execution by the associated contractors, each Associate Contractor Agreement shall be made an attachment to this contract. In the event of a conflict between the terms of this contract and terms of the Associated Contractor Agreement, the terms of this contract shall control.

(i) Where the contractor and an associated contractor fail to agree upon action to be taken in connection with their respective responsibilities, each conflicting contractor shall promptly notify the cognizant government PCO for Deep Green and furnish each conflicting contractor's recommendations for a solution. The contractor shall not be relieved of its obligations to make timely deliveries or be entitled to any other adjustment because of the contractor and its associate failure to: (1) resolve Associate Contractor Agreement disputes; (2) promptly refer matters to the PCO; or (3) to implement PCO directions.

References

1 OneSAF Objective System http://www.onesaf.org

2 SISO Standards Website, go to http://www.sisostds.org, Site Tools, File Library, download “MSDL_Specs.zip”

3 See, e.g., AFRL-IF-RS-TR-2002-32 Final Technical Report “Battlespace Challenges Problems Evaluation of High Performance Knowledge Bases (HPKB) Tools for Battlefield Awareness and Planning” Alphatech, Inc., documentation available at DTIC http://stinet.dtic.mil/info/s-stinet.html or National Technical Information Service (NTIS) at: http://www.ntis.gov/.

4 McCloud, S. (1994). *Understanding Comics: The Invisible Art*. New York, NY, HarperCollins Publishers, Inc. (Pg 105, ISBN 0-06-097625-X)

5 Forbus, K. D., J. Usher, et al. (2003). Qualitative Spatial Reasoning about Sketch Maps. Fifteenth Annual Conference on Innovative Applications of Artificial Intelligence, Acapulco, Mexico, American Association for Artificial Intelligence. (Pg 2 and Pg3)

6 Gilmer, J. B., Jr. and F. J. Sullivan (2005). "Issues in Event Analysis for Recursive Simulation." Proceedings of the 2005 Winter Simulation Conference: 8.

7 Lanchester Equations and Scoring Systems, www.rand.org/pubs/monograph_reports/MR638/app.html

8 Dupuy, T.N. (1995). *Attrition: Forecasting Battle Casualties and Equipment Losses in Modern War*. Falls Church, VA: Nova Publications.

9 Army Digital Terrain Catalog http://www.tec.army.mil/fact_sheet/ADTC.pdf and OneSAF Objective System http://www.onesaf.org

Notice: The use of references in this BAA is intended to be illustrative, rather than exhaustive, and it does not imply any government endorsement of particular authors or organizations, nor of any goods, services, or entities that may be named therein.