Proposal Information Pamphlet (PIP)

Dynamic Tactical Targeting: Tactical Exercises and System Testing (DTT:TEST)

BAA 05-04

8 October 2004

Fort Dix, New Jersey, supports test and evaluation of tactical sensor, communications, and exploitation systems. With variable weather, significant forest cover, and considerable vehicular clutter, it provides a stressful environment for systems intended to detect, track, identify, and engage ground targets. It also permits collection against well-truthed targets, allowing objective, statistically significant performance characterization of new technologies. This allows major acquisition programs to require, with confidence, specific performance from exploitation, fusion, and sensor management capabilities.

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- Elicit, and estimate progress against, commanders' tactical mission needs.

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- Develop five technology-intensive software components: 1) report-based registration, 2) target motion prediction, 3) all-source tracking, 4) proactive sensor tasking, and 5) mission specification and assessment.
- Conduct two system-oriented activities: 1) system design and integration; and 2) experiment analysis using field data.

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- Electronic proposals due to DARPA by no later than Noon EST Monday, 29 November 2004.

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- First: Relevance to DTT:TEST mission objectives.
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C PROBLEM STATEMENT

C.1 DEFINITION OF DYNAMIC TACTICAL TARGETING

Current events in Afghanistan and Iraq continue to demonstrate that the United States' ability to detect, identify, and track ground vehicles requires many different sensor modalities. Signals intelligence (SIGINT) can provide cues about potential vehicle location and type, but only persist as long as the target chooses to emit. Stationary video sensors can provide equally good cues about vehicles, but only as long as the target chooses to remain in the field of view of the sensor. For evasive, mobile targets, we simply cannot assume any cooperative behavior – they'll not emit, and they'll avoid known sensor coverage. Rather, we have to counter these targets' own, inherent agility with overmatching agility offered by our own intelligence, surveillance, and reconnaissance (ISR) sensor systems.

For example, airborne radar, whether Synthetic Aperture Radar (SAR) or Ground Moving Target Indication (GMTI), can defeat evasion by allocating energy over areas of thousands of square kilometers within a few seconds. But even the best radar cannot provide clear, unambiguous vehicle identification. Airborne Electro-Optical and Infrared (EO/IR) or laser radar (LADAR) imagery, whether still or video, can provide high-confidence identity, but at a cost to agility – the cameras require some kind of cueing to capture a target in their fields of view, and time to fly to a location close enough to the target to avoid terrain obscuration and overcome atmospheric attenuation.

So we have an ever-increasing inventory of national, theater, and tactical sensors, no one of which can simultaneously 1) search large areas, 2) obtain precise target identification, and 3) maintain track on more than one target at a time. But we don't have enough airborne video sensors to assign one sensor to every vehicle of interest – particularly in inclement weather (e.g., clouds, snow, sandstorms) when sensor performance is degraded.

However, we should be able to synchronize the complementary capabilities of these diverse sensing systems, and thereby achieve a force-level capability that exceeds the collection of platform-level capabilities. For example, Rivet Joint detection of an SA-6 radar could cue a U-2 to collect a SAR image within the error ellipse of the detection, precisely locating the target. The SAR report could cue a Predator to a position from which an operator could obtain positive visual ID. A JSTARS could simultaneously be tasked to detect motion of the target using occasional GMTI dwells around the target, while the Predator moves on to investigate other SAR detections. When GMTI indicates target motion, its dwell rate could be increased to maintain high-confidence track on the vehicle until it approaches other vehicles, when the Predator could be re-assigned to the SA-6 to maintain track through a town containing dense civilian traffic. Eventually, when the SA-6 reaches a position with a sufficiently low collateral damage estimate, it can be engaged: true birth-to-death tracking.

This is the definition of Dynamic Tactical Targeting (DTT): *continuously cross-cue a large set of heterogeneous, partially controllable sensor platforms to maintain track on* *known targets, while maintaining search efforts to find new candidate targets*, so that known targets can be held at risk until a commander authorizes engagement. Abstractly, the sensors can be viewed as a pool of resources, and mission needs (search an area, maintain track on a designated vehicle) as prioritized demands. DTT is the process that continuously, and proactively, assigns resources to demands as the situation changes: new missions are defined, known vehicles move, new vehicles are found, existing tracks degrade, etc.

The DTT program began in 1999, and is ending this year. It developed an initial set of software components, integrated into a complete, closed-loop system, that clearly validated the above premise. But it did so only on simulated data. Simulated data simply cannot contain all of the artifacts and error sources present in the real world – artifacts which must be overcome in order to establish user acceptance. So this DTT: Tactical Exercises and System Testing (DTT:TEST) program has been created to validate the DTT capability in live exercises, leveraging companion efforts in the Army (affiliated with the Future Combat System (FCS)) and Air Force (affiliated with the Distributed Common Ground Station (DCGS)).

C.2 TRANSFORMATION TO NETWORK-CENTRIC SENSING

Historically, sensor systems have been vertically integrated: sensors transfer raw data to signal processors aboard the platforms that carry them, which send processed data to trained exploiters either aboard the platform, or at a remote ground station. These operators then determine how best next to use the sensor.

DTT departs from this historical practice by assuming a fully network-centric architecture. While raw signals may never flow over the network, we assume that all-source exploitation reports do (albeit subject to some processing latency). And commanders have connectivity to all platforms, so that cross-tasking can take place rapidly. These assumptions are consistent with architectures already being developed and installed by elements of the Distributed Common Ground Station program.

In network-centric sensor management, we no longer want to perform *platform*-based tasking. Rather, we want to task an ISR *force* – a collection of sensor-equipped platforms which can be employed to support a variety of tasks such as search, change detection, identification, tracking, and damage assessment. But as we move to network-centric sensor management, other trends conspire to make the problem harder:

- **More sensor platforms:** As connectivity increases, more sensors will join the ISR force. The distinctions between national, theater, tactical, and organic sensors will blur. For example, unattended ground sensors, emplaced by Marines to protect an exposed flank, could detect approaching vehicles against which national capabilities could be employed to maintain long-term tracks.
- **More sensor types:** As sensor technologies mature, more diverse sensors are in line for deployment. LADARS may be employed on low-altitude aircraft to provide shape information, at night. Foliage penetrating radars now exist that can detect vehicles under forest cover. Hyperspectral sensors may help distinguish military from civilian vehicles by analyzing surface materials. While

the range of observables will increase, the circumstances under which they may be employed are likely to become more restrictive.

- **More diverse target types:** Somalia, Afghanistan, and now Iraq are showing us that highly motivated opponents will not confine themselves with operating only with military equipment. By converting civilian vehicles to military needs, they increase the demand on sensors to obtain distinguishing information.
- **More evasive targets:** Operations in Kosovo, Tora Bora, and the Philippines underscored the fact that adversaries will use terrain features – forests, caves, narrow valleys – to evade sensing. They will move on unconventional routes, to unconventional locations, using unconventional tactics. Convenient assumptions about behavior (e.g., "vehicles stay on roads", or "vehicles move to pre-surveyed hide sites") no longer apply – increasing the demand for direct sensing.
- **Occasional permissive environments:** Kosovo, Afghanistan, and especially Iraq demonstrate that threats to US forces persist even after major conflict ends. One implication is that coalition forces may be intermingled with civilians and threats. Because coalition forces supply relatively precise self-location information, there is an opportunity to exploit this "blue force" data for real-time validation and calibration of models built into processing algorithms.
- **Smaller staffs:** Pressures to reduce staffs, especially on overseas deployments, will continue, adding to needs for increased automation.

The DTT:TEST program has two high-level objectives. First, *increase the robustness of technology, to better deal with the vicissitudes of real-world operations*. Second, *extend that technology to deal with ISR challenges observed in current conflicts*, beyond the traditional force-on-force scenarios addressed by DTT.

C.3 EMERGING TECHNOLOGY FOR NETWORK-CENTRIC SENSING

Over the past decade, several programs, including DTT, have produced new technologies that significantly improve registration, track maintenance, target motion prediction, sensor tasking, and commander interfaces. These offer new potential to achieve the two objectives asserted above, and include:

- **Simultaneous localization and mapping:** By extending the concept of "target" to include additional, reliably detectable objects, these techniques provide a unified framework to estimate simultaneously sensor and target parameters;
- **Particle filtering:** By replacing linear/Gaussian parametric models of target motion with nonlinear, stochastic simulations, emerging particle motion models allow higher-fidelity characterization of evasive targets that deliberately exploit terrain features to avoid detection, or that constantly strive to reach a destination.
- **Adaptive hypothesis management:** Conventional breadth- and depth-limited approaches to track hypothesis management have been extended with methods that partition the target space into clusters, factor the hypothesis space into different aspects (e.g., motion modeling vice emission activity), merge similar

hypotheses, and reserve memory to maintain alternative hypotheses on high-priority targets for arbitrarily long periods of time;

- **Rolling-horizon control:** Sensor management is fundamentally a problem involving planning under uncertainty, which is computationally intractable in any real problem domain. Recent work mitigates this by scheduling sensor tasks over a finite horizon, updating the plan long before that epoch ends, and reusing partial results from the first epoch to reduce computation in the second;
- **Commander interfaces:** New developments in visualization and collaboration concepts have provided new symbologies and modalities by which a group of mission commanders, needing to share a common pool of resources, can define mission needs, review proposed courses of action, and adjudicate priorities;
- **Live testbeds:** The training, test, and evaluation communities have added a number of data collection instruments and analysis tools that can supply reasonably accurate ground truth against which the performance of sensor management systems can be judged.

It is the intent of DTT:TEST to leverage all six of these advances within a single program concept:uniting sensor registration, all-source track fusion, target motion prediction, automated sensor management, and collaborative commander interfaces within a unified, model-based system design; testing that combination of technologies against real-world data, some of which will be well-truthed through range instrumentation and providing a framework that is explicitly aligned with Air Force and Army efforts to insert advanced technology into the Distributed Common Ground Station and other processing-intensive weapon systems.

C.4 THE COMING TRANSFORMATION OF ISR FORCES

The current concept of operations for multi-sensor ground stations is clearly evolving towards all-source analysis and network-centric tasking. What is less clear is how the relationship between these ground stations and platform controllers, on the ground or aloft, will evolve. For purposes of this solicitation, it is reasonable to assume:

1) **Image (still and full-motion) exploitation:** This will continue to be performed by humans, with some machine aids, operating in the context of the tasking behind the imagery. This process will introduce delays, but will result in small location errors, and target characterization limited only by image quality and collection conditions.
2) **Signals exploitation:** Reports on emitter type and location will be generated by real-time signal processors, and supplied with minimal latency. Exploitation of SIGINT internals will be done manually, and, when security considerations permit, made available to the multi-sensor ground station, with considerable latency.
3) **GMTI radar exploitation:** Depending on the sensor platform, these data may arrive at the ground station either as raw reports, or as tracks formed from raw reports, generally with latency of a few seconds.
4) **Asset status:** Status of sensors and the platforms that carry them will be reported to the multi-sensor ground station, albeit with some latency.

5) **Communications:** Limitations on communications connectivity and bandwidth will ease, but latencies of many minutes may persist either due to processing time induceded by human analysts and operators at intermediate stages.

6) **Data transforms:** Front-end software will convert native data and metadata into a common format, probably expressed in a general purpose markup language. The content of the converted data will be limited by the formats native to the sensors. In particular, quantitative error statistics and confidence levels on reports or tracks may not be available from many tactical sensing systems.

7) **Data stores:** All data arriving in the ground station will be placed in a persistent store that supports both ad hoc queries and standing information product requests.

8) **Displays:** Various browsers will be available to display both current and historical contents of the data stores.

9) **Sensor tasking:** Tasking can be conveyed to sensors and platforms at widely varying levels of detail, from missions ("follow that vehicle") to radar service requests ("visit this area every 10 seconds with an appropriate GMTI waveform").

DTT:TEST envisions the development of automated tools which will: 1) align the transformed sensor data to a common geospatial reference system; 2) correlate data across sources into consistent target tracks; 3) predict future target motion; 4) create sensor-specific tasking that develops the most effective way to employ sensors in the context of anticipated target motion (for targets in track) and remaining search tasks (for targets yet to be discovered); and 5) allow a commander and her staff to maintain situation awareness and supervise the operation of the automation.

The DTT:TEST program will build and integrate technologies for theses five areas, and exercise them on real-world sensor data, both recorded and live. Some of these technologies may be drawn from those funded by the original DTT program, but *IXO is aware of, and interested in, other, equally mature technologies that may outperform those employed by DTT to date*.

D PROGRAM STRUCTURE

D.1 SYSTEM CONCEPT

This section describes the basic framework of the DTT:TEST program; Section E will define the specific technical capabilities being solicited to populate this framework.

Figure 1 illustrates the major elements of the DTT:TEST program. The DTT system (light blue) consists of five software components. It will be interfaced to an exercise environment (olive) through interfaces (light green) that translate data between DTT and external formats. (The test environments and software interfaces will be provided by the Government, and are not subjects of this BAA). Supporting activities (peach) include system-level design and performance analysis activities.

The DTT:TEST system contains five technology-intensive *components*. These components will be developed in parallel, coordinated efforts as the program proceeds. This Broad Agency Announcement (BAA) solicits proposals to develop these five technology components, using novel technologies to achieve the functional capabilities outlined in Section E.

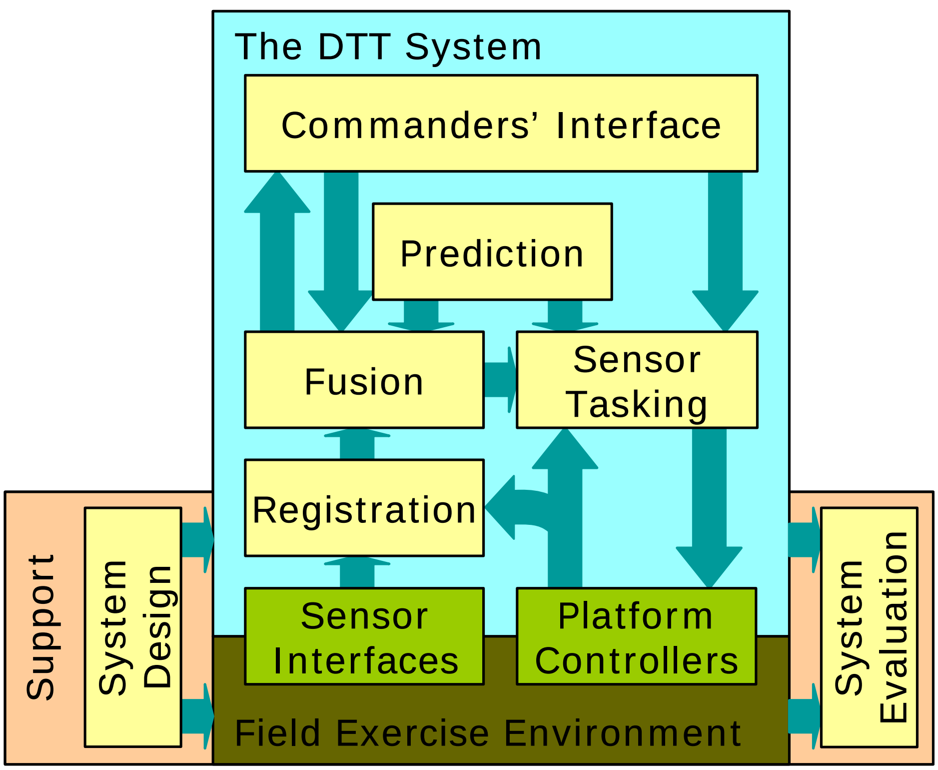

Figure 1: The DTT:TEST Functional Architecture mates five technology components with external test environments to demonstrate real-world performance of network-centric ISR.

The DTT:TEST system will be exercised against various field environments. For proposal purposes, assume these are: 1) an Army testbed at Fort Dix, currently supporting the C4ISROTM program; 2) an Army testbed at Fort Benning, currently supporting the FCS program, and 3) an Air Force facility at Langley Air Force Base, currently supporting its DCGS program. DTT testing will occur at the Advanced Recognition Capability (ARC) lab, in the Air Force Research Lab's (AFRL) Building 620, located on Wright-Patterson Air Force Base (WPAFB). Testing will involve collaboration between three separate institutions: 1) the Government will organize connectivity between the ARC and exercise partners; 2) a system evaluation contractor will operate the ARC during exercises and simulation-driven tests; and 3) a system design contractor will assemble, test, and install DTT system software in the ARC.

To carry out these exercises, the technology components must be integrated and tested together, through a common system design and software infrastructure. These exercises must be planned, executed, and analyzed to measure objectively progress towards program goals.

D.1.1 Inputs to the DTT system

The DTT:TEST system nominally expects seven principal inputs:

1) Models: Models of sensor platform dynamics, sensor capabilities (fields of view and regard, detection statistics, localization errors, and location errors), and target characteristics (signatures, equipment loads, and speed as a function of environmental conditions). Components will convert system-level models into internal forms, and maintain the ability to operate with new models as the program progresses. Components may modify internal models on-the-fly if evidence permits.

2) Context (weather, terrain): Definitions of the topography, vegetation, cultural features, and meteorological conditions that characterize the area of interest (AoI) and constrain mission elements. Components will convert data from externally-standardized formats (e.g., National Geospatial-intelligence Agency standards) into internal forms, and operate over any area on the planet without modifications.

3) The ISR force: The platforms (ground and airborne) and sensors (emplaced or mobile) available to support ISR operations in an AoI, along with the periods during which they will be available.

4) Missions (fixed and contingency): Commanders' mission-level needs for ISR support, defined in terms similar to those used in Army Priority Information Requests (PIRs). These will be created by a commander and her staff; DTT will elicit these from those people and translate them to a form to support automated processing in its components. Commanders may add, delete, or adjust missions at any time.

5) Sensor data: Annotated, report- and track-level (no pixels, no raw signals) information derived from sensors related to vehicular targets and environmental features that can assist registration. Annotations may include source, target location, most likely type, and perhaps some qualitative confidence information; they are unlikely to include detailed pedigrees or error statistics.

6) Sensor/platform status reports: Periodic reports, often delayed, of the position, orientation, and operating status of ISR platforms and the sensors they carry.

7) Friendly vehicle status reports: Periodic reports, often delayed, of the position, orientation, and operating status of friendly vehicles operating in the area observable to the ISR force.

Specific formats for these inputs will be developed by the software design and integration contractor, in collaboration with component technology developers.

D.1.2 Outputs of the DTT system

The DTT:TEST system is expected to produce three major outputs:

1) **Mission status:** Indicators to the ISR commanders of the health of the system and progress against defined mission objectives. Metrics for this output include completeness and ease of interpretation by non-technical field personnel.
2) **Situation estimates:** Continuously updated estimates and confidences of locations, orientations, velocities, and identities of detected targets, along with indications of areas searched without obtaining detections, presented to the ISR commanders. Metrics for this output include accuracies, both absolute (e.g., mean square errors between estimated and truth locations) and relative (e.g., chi-square statistics on the same quantities, using estimated covariances).
3) **Sensor tasking:** Routes (for controllable, mobile platforms) and schedules of tasks (for all sensors). Presented to the ISR commanders for approval, and perhaps modification, these eventually flow to sensor controllers wherever they may be positioned. Metrics for this output include feasibility and utilization rates.

Specific formats for these outputs will also be developed by the software design and integration contractor, in collaboration with component technology developers.

D.1.3 Key interfaces within the DTT system

The DTT:TEST system envisions several additional, internal component interfaces:

1) **ISR mission definitions:** Formally defined mission definitions, including area and targets of interest, priority or utility function, operating constraints, and mission type (e.g., search, tripwire/warning, count, track). Produced by the Mission Generation and Assessment component; used by the All-Source Tracking and Proactive Sensor Tasking components to allocate both computational and sensor resources.
2) **Predicted vehicle locations:** Time-phased descriptions of areas reachable by a vehicle, given a vehicle's starting area, type, and state. Produced by the Target Motion Prediction component; used by the All-Source Tracking and Proactive Sensor Tasking components.
3) **Target state estimates:** Estimated position, velocity, and identity of all detected vehicles, constructed by combining data from all sensors. Produced by the All-Source Tracking component; used by the Mission Generation and Assessment component (for reporting to commanders) and the Proactive Sensor Tasking component (to update sensor tasking assigned to mobile targets).

4) **Registered sensor data:** Reported sensor data, adjusted to remove systematic errors, biases, or calibration artifacts from raw sensor data. Produced by the Report-Based Registration component; used by the All-Source Tracking component.

Specific formats for these data flows will also be developed by the software design and integration contractor, in collaboration with component technology developers.

D.1.4 Technology Components of the DTT system

The five DTT technology components utilize the previously described interfaces. DTT:TEST is intended to develop the highest and most robust level of automation possible for these components, recognizing they will always be supervised by a commander and her staff. In addition to the five DTT Technology Components, this BAA requires efforts in System Design and Integration (see Section D.2.5 below) and Experiment Design and Evaluation (see Section D.2.6).

1) **Report-Based Registration (Registration):** Use reported sensor/platform status reports, correlations between sensor data and fiducials, and correlations of sensor reports to friendly vehicle status reports, to estimate parameters associated with systematic sources of error in sensor/platform reporting processes. Continuously adjust current and historical sensor data to mitigate these errors. Modify reported confidence information to account properly for this adjustment.
2) **Target Motion Prediction (Prediction):** Given an initial area in which a vehicle is hypothesized to exist, and some indication of the vehicle type, use terrain and environmental knowledge to compute the area, as a function of time, the vehicle can reach. Ensure that the predicted area is valid for both benign and evasive targets.
3) **All-Source Tracking (Fusion):** Combine report- and track-level data into a consistent set of target tracks and accompanying state estimates, both current and historical. Properly account for reporting delays between sensors and the DTT system, and processing artifacts (e.g., statistical correlation) introduced along that path. Allow the use of vehicle-specific identity information ("fingerprints") to correlate reports and tracks separated widely in time. Regularly and frequently update target state estimates to maintain a current situation estimate.
4) **Proactive Sensor Tasking (Control):** Given a set of missions, partial knowledge of targets expressed as target state estimates and predicted location envelopes, an ISR force consisting of fixed and mobile sensors, a set of operating constraints, and knowledge of terrain and weather, construct physically feasible, and operationally permissible, platform routes and sensor tasking schedules to maximize mission accomplishment. After approval or modification by commanders, publish the routes and schedules to the affected systems. Continuously update the routes and schedules as target estimates change, as platforms and sensors execute their missions, and as mission commanders refine mission definitions.
5) **Mission Generation and Assessment (Command):** Continuously update situation estimates derived by the DTT system on a physically separated, networked set of command workstations. In this context, elicit ISR mission needs from mission commanders through a shared, collaborative workspace. Transform graphical and

tabular input data into a formal machine representation capable of guiding sensor tasking. Display system-derived sensor routes and schedules for approval or modification. Track progress against each mission, and generate alerts when missions appear infeasible.

Technologies for each of the components developed in this program are coordinated through the activities of the software design and integration task, and evaluated through a formal assessment process.

D.1.5 Components outside the DTT system

Because DTT:TEST emphasizes robust construction of target state estimates produced through sensor cross-cueing, technical progress cannot be measured only on a component-by-component basis. DTT:TEST will evaluate components as a closed-loop control system, through interactions with external sources of data. Interfaces between DTT:TEST components and the exercise facilities will be developed under separate funding. Scenarios, force structures, and sensor characteristics will be provided through external documentation. Since real-world sensors have sensitive capabilities, this information will be classified. Participants in the DTT:TEST program must have facilities and personnel approved for creation and storage of SECRET information, and are encouraged to have at least one person cleared for SI/TK access. (See attached DD Form 254.)

D.2 MANAGEMENT CONCEPT

D.2.1 Program Elements

This solicitation requests ideas in seven related areas: five technical component development efforts, and two system-level design and assessment efforts:

- **Registration:** Design and construct the “Report-based Registration” component, demonstrating increases in accuracy, robustness, and computational efficiency as the program progresses;
- **Prediction:** Design and construct the “Target Motion Prediction” component, demonstrating increases in accuracy, robustness, and computational efficiency as the program progresses;
- **Fusion:** Design and construct the “All-Source Tracking” component, demonstrating increases in accuracy, robustness, flexibility, and computational efficiency as the program progresses;
- **Control:** Design and construct the “Proactive Sensor Tasking” component, demonstrating increases in mission utility, robustness, flexibility, and computational efficiency as the program progresses;
- **Command:** Design and construct the “Mission Generation and Assessment” component, demonstrating increases in utility, flexibility, and scalability as the program progresses;

- **System design and integration:** Establish common data representations that support information exchange among the technical components; develop a DTT:TEST system architecture and supporting inter-component software substrate; build and operate an unclassified, Internet-accessible software integration facility; and deliver, test and verify functional behavior at the ARC;
- **Experiment design and evaluation:** Define system- and component-level metrics; design instrumentation to obtain data from field instrumentation and components to compute those metrics; maintain and operate a classified DTT:TEST exercise facility (in the ARC); and establish and maintain secure, low-latency connectivity between the ARC and exercise partners.

Teaming is permitted, but encouraged only when the specific individuals proposed have previously-established working relations.

Offerors may submit proposals to more than one area, with a separate proposal for each area. However, no individual technical person should be named in more than one proposal.

DARPA anticipates making up to two awards for each of the technical components, and at most one award for each of the design efforts. While DARPA may award more than one technical component to a single offeror, each component must be proposed separately. In the event of two awards for a technology component, only one will be carried forward to the second year of the program.

D.2.2 Program Phases

DTT:TEST will be conducted as a single, 24-month effort. For planning purposes, assume this effort extends from 1 January 2005 through 31 December 2006.

D.2.3 Program Spirals

This effort consists of 8 quarterly development spirals. Each spiral involves:

- Definition of system-level functionality upgrades
- Updates to interface control documents
- Definition of test coverage and schedule at the integration facility
- Delivery of intermediate component software to support testing
- Delivery of a final version of the system to the classified exercise lab.

Exercises will be conducted on an opportunistic basis, managed to conform to schedules of other activities sponsoring the exercises. Each exercise will be conducted using the then-current version of the system software in the ARC. In addition, the ARC will contain a Government-supplied simulation capability to support functional testing and evaluation.

D.2.4 Component Technologies

Each technical component should deliver software, in accordance with the System Designer's architecture and procedures, for integration into the classified exercise facility approximately one month prior to each DTT:TEST assessment.

Each technical component must be prepared to support System Design and Experiment Design activities. Because there will be no formal contractor/subcontractor arrangements between the Design contractor and the component developers, each component developer must include in its final proposal a signed one-page commitment that will become legally binding upon contract award, agreeing to conform to the design decisions made by the System Design and Integration contractor. Any component proposal lacking such a commitment will not be selected.

Component development may involve the skills of advanced algorithm designers, a blend of junior and senior software engineers, and data analysis for diagnosis and performance assessment. Development teams consisting of two to three dedicated individuals, including a designated, full-time Principle Investigator, are preferred.

D.2.5 System Design and Integration

The System Design and Integration effort should:

- collaboratively define representations of models and information products shared by technical components;
- establish and refine a system design as components mature;
- provide a software framework into which components can be installed, consistent with those used by our transition partners;
- integrate components into that framework during quarterly development spirals;
- provide continuous, unimpeded access by the component developers to the integration facility; and
- coordinate setup and design of the integration facility with that of the classified testbed.

These activities should include representation from, and review by, representatives from each component developer, AFRL staff, the Experiment Design effort, and Government managers.

System Design efforts may involve technologists familiar with technologies that embedded in the components, senior software designers, and people familiar with fielded systems. Efforts consisting of three to four dedicated individuals, including a designated, full-time Principle Investigator, are preferred.

D.2.6 Experiment Design and Evaluation

The Experiment Design and Evaluation effort should:

- refine system-level program metrics stated in Section D.4 and work with component developers to translate them into component-level metrics;

- use rigorous experimental design techniques to methodically explore tradeoffs between metrics;
- develop tools to reduce and analyze experiment data obtained from that instrumentation, for all major functions in the DTT:TEST system architecture; and
- feed back experiment data and suggested failure causes to system design and component development teams throughout the spiral design process.

These activities should include representation from, and review by, representatives from each component developer, AFRL staff and support contractors, the System Design effort, and Government managers.

Experiment Design and Evaluation efforts may involve expertise in experiment design, statistical performance modeling, real-time secure communication protocols, and facility operation. Experiment efforts consisting of three to four dedicated individuals, including a designated, full-time Principle Investigator, are preferred.

D.3 EXPECTED TRANSITION PATH

DTT:TEST technologies are targeted to transition into both Air Force and Army variants of the Distributed Common Ground Station (DCGS), scheduled to begin a major capability upgrade in 2007. The DTT:TEST Project Office has formed partnerships with the DGCS System Program Offices, the Air Force Research Laboratory, the C4ISROTM Program Office, the Space and Naval Warfare Command, and the Air Force Command and Control, Intelligence, Surveillance, and Reconnaissance Center (AC2ISRC), who will together assist DARPA to transition capability to fielded systems.

D.4 PROGRAM METRICS

Progress of the DTT:TEST program will be assessed at the end of each spiral. In addition to component-level assessment metrics to be proposed by each component developer, these metrics gauge progress of the program for DARPA management, and provide the rationale for continuation of funding for the program.

D.4.1 System Performance Metrics

DARPA will use five metrics to assess progress at the end of each spiral:

- **Track coverage:** What fraction of targets in a scenario is in track at any given time? Higher is better.
- **Track length:** What is the median track? Higher is better.
- **Track identification accuracy:** Of those tracks which have been labeled, how many are consistent with the ground truth target type? Higher is better.
- **Track location quality:** What is the mean square location error between a track position estimate and target ground truth? Lower is better.

- **Utilization:** What percentage of each sensor's lifetime is included in a sensor plan? Higher is better.

Specific performance thresholds desired by program end are stated below.

D.4.2 Component-level Test Conditions

To evaluate each of the components, DARPA expects to evaluate the DTT:TEST system under the conditions designed to stress technical components in the following ways:

SOLICITATION AREA	EXPECTED OPERATING CONDITIONS
Registration	Estimate and correct for internal sensor biases affecting data from 5 types of ground sensors, and 10 types of airborne platforms.
Prediction	Predict target motion for periods up to 1 hour, maintaining 99% of targets in the prediction envelope, but eliminating 75% of the search area around a start point.
Fusion	Maintain location and identity estimates on 25 military targets moving evasively among 1,000 civilian vehicles in an area of 1,000 km^2.
Control	Generate tasking for 100 ground sensors, 25 controlled airborne assets, and 10 uncontrolled overhead assets to maintain 95% coverage, and median track life of 1 hour, of military vehicles operating in rough terrain during inclement weather.
Command	Elicit prioritized mission needs, spanning the full range of Army Priority Information Requests, from, and present them to, three collaborating commanders.
System Design and Integration	Define, exercise, and validate information flows among software components, using an unclassified integration facility with unimpaired Internet access.
Experiment Design and Evaluation	Operate a classified test facility, interacting with live sensors, capable of real-time performance, and of computing track-level metrics in near-real time

E TECHNICAL OBJECTIVES

This section describes the Government perspective on challenges facing all seven program elements of this solicitation. Offerors should explicitly address at least these issues in their technical approach, and are welcome to address others as well.

E.1 REPORTS-BASED REGISTRATION (REGISTRATION)

E.1.1 Scope

The purpose of the Reports-based Registration component is to reduce association ambiguities faced by a tracker that are caused by systematic misalignment, miscalibration, or invalid assumptions in sensor signal processors. This has been demonstrated very effectively for imagery, where a controlled image base exists to which incoming imagery may be aligned. The DTT challenge is to build a similar approach, but one that works on data sets containing reports, not images, and which contain streaming information, such as GMTI or video MTI tracks.

The approach taken by Registration assumes the availability of additional side information of two types. First is a set of stationary fiducials, whose location and characteristics have been derived from source such as intelligence analysis, open-source media, or other Government surveys. Second is a set of high-quality, high-confidence tracks on vehicles, moving or not, supplied by friendly forces. The first may be available globally, the second only in permissive environments. DTT Registration should operate in either case, naturally showing improved performance in the latter.

The technical basis for state-of-the-art Registration algorithms is dynamic, model-based estimation, based on the theory of stochastic processes. However, three aspects of the real world limit the applicability of these theoretical techniques to DTT, and offer opportunities for innovation:

- **Reporting delays:** Data arrive after several seconds of communications delay, and often several minutes of exploitation delay. So some currently-arriving data help estimate sensor biases in the past, and corrections for those biases must be brought forward to the other currently-arriving data that have suffered less delay. Moreover, as time proceeds, bias estimates for data having arrived in the past will continue to change, and hence corrections must be updated as well.
- **Unknown models:** Many tactical sensors have neither been developed through formal system engineering processes, nor set up to report a full set of internal process parameters. So many of the sources of systematic error are neither documented nor have real-time status reporting. Part of the Registration problem will be to identify the missing elements of these transformations.
- **Sparse fiducials:** In many cases, targets of interest will deliberately move to areas for which little prior survey information, or common terrain features (e.g., roads) exist. Without fiducials, errors cannot be estimated. Therefore the Registration component should provide mechanisms to generate sensor tasking to observe nearby fiducials when registration errors grow large.

E.1.2 Technical Challenges

Technical descriptions should address at least six key factors of the problem:

- **Feature set:** The aspects of a target or fiducial referenced in incoming reports and assumed to be maintained in a fiducial database. Traditionally, these are locations of a feature's centroid and a vector of object characteristics (e.g. pulse parameters, surface materials, or length/width statistics). DTT is not interested in signal- or image-level features such as wavelet coefficients or unlabeled edges.
- **Fiducial types:** Objects in the real world, observable to DTT sensors, that can be precisely geo-located through other means. Particularly important are fiducials that can be observed in two or more sensing modes, such as rotating radars (observable to GMTI and SIGINT sensors) and roads (observable to SAR and video). Emplaced fiducials, such as radar tags or blue force tracking systems, should be considered but not be required.
- **Error sources:** The sources of error accumulated through the entire processing chain from target/sensor interaction to a report's arrival at DTT. These could include atmospheric refraction, sensor pointing errors, camera miscalibration, navigation system drift, and clock offsets, as just a few examples.
- **Fiducial assignment:** The mechanism by which a report is determined to match a fiducial, and therefore used as a basis for bias estimation. The approach to fiducial assignment should tolerate missing and delayed information, and be consistent with the feature set proposed.
- **Data association:** The logic used to generate candidate report-to-fiducial assignments in dense areas. For example, when friendly forces are operating in an area being observed by JSTARS GMTI reporting to DTT, the Registration component will have to sort out which of the MTI reports are reflections from the friendly vehicles (and therefore can be used to estimate biases) and which are from other vehicles (and therefore must be adjusted to reduce errors caused by biases).
- **Update frequency:** Every arriving report on a fiducial can be used to refine estimates of biases. Every refinement of a bias estimate could be applied to every report received to date. This approach, while optimal in some sense, could lead to thrashing and performance challenges on downstream components. A more flexible approach would limit the frequency of adjustments to sensor data to times when there is a significant benefit to the corresponding error reduction.

E.2 TARGET MOTION PREDICTION (PREDICTION)

E.2.1 Scope

The purpose of the Prediction component is to compute the region a vehicle can reach in a given time. Prediction should be structured as a computational service, callable by any other component in the DTT system. Given an area in which the vehicle starts, some history of the vehicle (in the form of a historical track estimate), a time horizon over which the Prediction should apply, and operating context such as terrain, weather, and traffic density, Prediction should compute a sequence of descriptions of the area in which the vehicle may reside. These predictions may be expressed as a bounding envelope, but techniques that offer some form of probability weighting over the area are preferred.

The major operational factors that make Prediction difficult are:

- **Terrain limitations:** Terrain slope, vegetation type, hydrological conditions, temperature, and visibility affect speed and route selection.
- **"Rational operators":** Drivers of all vehicles have goals, and chose routes and speeds to achieve those goals. While the set of goals can be quite varied, and not known to DTT, purely statistical models of drivers (e.g., Brownian motion, Markov transitions among road segments) are unrealistic.
- **Move-stop-move:** Drivers may not be moving all the time. They may stop at a destination, but they may also stop for breaks, for other traffic, or to evade GMTI radar detection.

E.2.2 Technical Challenges

Technical descriptions should address at least five key factors of the problem:

- **Foundation data:** The information about roads, terrain, land cover, hydrology, and weather required for the algorithm to operate. One may assume the availability of standard NGA foundation products; offerors needing additional terrain data should explain how those data may be produced from generally available sources.
- **Mobility model:** Existing mobility models range from dead reckoning through linear/Gaussian extrapolation to nonlinear particle filters. Offerors should explain the mathematical structure of their models, and assess the applicability of those models in situations where the factors that affect mobility (e.g., vehicle type) are not perfectly known.
- **Target behavior:** Assumptions on target behavior range from simple on-road constraints to complex assumptions about driver goals and objectives. Offerors should enumerate the assumptions they expect to make about target behavior, and assess the validity of those assumptions in a variety of tactical conditions.
- **Output content:** Outputs may range from simple region bounds to a probability distribution over some reachable region. Offerors should describe the range of outputs they are prepared to produce, and the one(s) they recommend be included in the DTT system design.
- **Performance model:** The quality of the Prediction services should be assessed on its own, independent of DTT system performance. Offerors should describe the metrics they will use to evaluate stand-alone Prediction performance, and the internal procedures they will use to assess those metrics.

E.3 ALL-SOURCE TRACKING (FUSION)

E.3.1 Scope

The purpose of the Fusion component is to combine report and track data, from all sources, into a common set of current target state estimates (including position and identification) and historical tracks (extending several hours into the past). The tracks should include statistical quality factors, such as covariances on location estimates, and probability distributions on target identity. The major challenges to Fusion are:

- **Data quality:** Data from tactical sensors will contain errors (some of which will be reduced through Registration), ambiguities, and outright mistakes. Fusion should exploit redundant and overlapping coverage by multiple sensors to reduce estimation errors, association ambiguities, and upstream errors (e.g., break source tracks into sub-segments when it is clear that misassociations have occurred).
- **Inter-vehicle interactions:** Fusion should properly account for closely-spaced vehicles, which cannot be resolved by certain sensors, along with kinematic interactions among vehicles traveling along the same road, through the same intersection, or as part of an organized group (e.g., convoy).
- **Sensor models:** Fusion should be able to incorporate models of new sensors (expressed as fields of view, fields of regard, detection probabilities, false alarm rates, reporting errors, etc.) without impact on internal algorithms. Technical approaches based upon domain-specific heuristics, which are not extensible to new sensor types, are strongly discouraged.
- **Target descriptions:** The set of target types should not be limited to some externally defined enumerated list (e.g., known military vehicles in the inventories of former Soviet territories). Offerors should consider extensible target type descriptions, ones that can be modified on-line to include new vehicle types, and that can be dynamically extended to vehicle-specific identifiers (e.g., RF signatures, license plates, color).

E.3.2 Technical Challenges

Technical descriptions should address at least four key factors of the problem:

- **Upstream latencies:** Data arriving at DTT will have suffered delays caused by many factors: communications constraints, processing delays, and, most critically, human elements of the image exploitation process. Fusion should have a clear, logical approach for dealing with these delays and the physics underlying their causes. Approaches that simply attempt to Predict time-late reports to some current processing time are strongly discouraged.
- **Limited pedigrees:** Upstream processing may be performed by algorithms or people whose logic is not known, and whose performance characteristics are not explicitly described in arriving data. Innovative ideas in pedigree reconstruction and on-line quality assessment are very much encouraged.

- **Combinatorial complexity:** Traditional fusion algorithms include logic to generate hypotheses that correlate reports from one source to those from another. In a purely theoretical sense, the number of such hypotheses grows exponentially with the number of reports. Many heuristics have been proposed to limit this complexity, but many of these heuristics are founded on assumptions that are not operationally valid. A key element of Fusion design should be to define a process whereby assumptions that reduce combinatorial complexity are validated on real-world data supplied through DTT:TEST exercises.
- **Track quality analysis:** To drive the Proactive Sensor Tasking component, Fusion tracks need to include indicators of quality. While metrics for individual tracks are well-established, a big role for sensor tasking is to obtain information that discriminates among a set of otherwise-ambiguous hypotheses. Innovative ideas for describing hypothesis-level ambiguities among a set of tracks are highly desirable.

E.4 PROACTIVE SENSOR TASKING (CONTROL)

E.4.1 Scope

The purpose of the Control component is to continuously update plans for future sensor operations, including both the routes that platforms follow, and the collection tasks that sensors perform. The major challenges for Control are:

- **Tasking structure:** Demand for sensor data will stream from many sources: the mission commanders (to search high-interest areas), Registration (for observations of fiducials to reduce sensor bias estimation error), and Fusion (to obtain identity information on unknown targets, or to reduce target localization error). Control must insert all of this tasking into a common utility or prioritization scheme in order to consistently assess the value of competing collection plans.
- **Airspace management:** Airborne platforms must be given routes that are both feasible and effective. Feasibility includes both physical factors (e.g., terrain avoidance) and operational factors (e.g., headwinds, safety). Effectiveness includes both platform factors (e.g., long baselines for SAR, low velocity for GMTI collections) and observability (e.g., penetration of clouds or foliage).
- **Platform models:** Control should be able to incorporate models of new sensors (expressed as fields of view, fields of regard, detection probabilities, false alarm rates, reporting errors, etc.) and platforms (expressed as altitude, velocity, and acceleration constraints) without impact on internal algorithms. Technical approaches based upon domain-specific heuristics, which are not extensible to new platform types, are strongly discouraged.
- **Sensor utilization:** Assuming that, in the future, communications and exploitation constraints will ease, Control should seek to maximize the value contributed by all sensors. This should include the insertion of sensing tasks, however low their value, in otherwise unused time between higher-value tasks.

- **Plan approval:** It is doubtful that field operators will allow collection plans generated by Control to be executed without human review and modification. Control should be able to adjust plans in response to local constraints added during review of candidate plans by reviewers (e.g., "move the third leg of the route for the Tern 5 miles west".

E.4.2 Technical Challenges

Technical descriptions should address at least four key factors of the problem:

- **Mission-to-utility translation:** Requests for sensing will be expressed in mission-level terms: search an area, maintain a track, establish an identity, reduce location uncertainty, observe a fiducial. Control technologies inevitably include some evaluation criterion to rank alternative plans. Proposals in this area should clearly describe a model-based approach for converting prioritized missions into this evaluation criterion.
- **Consistency of prioritization:** Commanders will expect plans produced by Control to respect their priorities. Approaches that contain formal mechanisms by which this consistency can be guaranteed are highly encouraged.
- **Consistency with current asset state:** Plans will not be executed perfectly. Traditional closed-loop control methodologies suggest that corrections to plans should thus be generated continuously, as execution is continuously compared to established plans. While technically optimal in some sense, this approach imposes undue burdens on both mission commanders (to approve incremental plan modifications) and to platform operators (to respond to incremental modifications). Innovative ideas for determining discrete points in time when a plan should be revised, particularly when actual platform states diverge from plans, are of great interest.
- **Sensor quality models:** The utility of a collection task will not really be known until the data from that task are incorporated by Fusion into a situation estimate. However, Control must estimate that utility as part of its criterion for ranking alternative plans. Approaches that rely upon explicit models of sensor performance, and information-theoretic gains offered by those sensors, are strongly encouraged.

E.5 MISSION GENERATION AND ASSESSMENT (COMMAND)

E.5.1 Scope

The purpose of the Command component is to match mission needs and products, as perceived by human commanders, with information needs and products, as consumed and produced by other DTT components. The major challenges for Command are:

- **Mission diversity:** Field commanders employ sensors for many different purposes. Most of these purposes are conventional, and well-documented in training material. Some are truly innovative, and cannot be pre-determined.

Command component developers should be able to capture all conventional ISR missions without restricting commanders' abilities to innovate.

- **Operational preferences:** For the foreseeable future, it is safe to assume that the demand for ISR products will exceed the capability of sensors to provide them. The demand unsatisfied should be the demand of least value. To quantify "least value" requires a way to elicit preferences from field personnel, who are not necessarily well-versed in the mathematics of decision theory, in a manner that supports consistent plan evaluation by the Control component.
- **Plan editing:** Not all operational preferences can be stated a priori. Often important tactical considerations will not be apparent until a commander critiques a plan and realizes that some factor renders it undesirable. The Command component should support this case-by-case expression of preferences, ideally using these editorial adjustments as additional evidence of implicit operational preferences.

E.5.2 Technical Challenges

Technical descriptions should address at least five key factors of the problem:

- **Mission definition language:** The set of pre-defined missions, and their attributes, from which an operator may define a specific mission need. Approaches that allow the set of mission definitions to be extended on-line are of great interest.
- **Collaboration:** Missions will be defined by many users of Fusion products. Approaches that allow geographically-separated commanders to define missions, perhaps with contextual knowledge of other missions in play, are encouraged.
- **Priority elicitation and adjudication:** Because demand for ISR services will exceed supply, the Control component must create plans that satisfy the most important mission needs. Because several commanders will be generating mission needs, there is no single source that defines "most important". Innovative ideas to elicit and adjudicate conflicting priorities from collaborating commanders are essential to DTT.
- **Situation and plan visualization:** Traditional visualization techniques render target tracks as sequences of icons, and projected plans as platform trajectories, all overlaid on maps. These capture well the kinematic aspects of a situation and plan, but omit aspects relating to information quality, ambiguities, plan value, and future decision points. Ideas for extending traditional iconic displays to include richer elements of DTT information products are eagerly awaited.
- **Mission assessment:** As part of the priority elicitation process, commanders will need feedback on how current operations are meeting existing needs. If they observe a discrepancy between their operational expectations and the effectiveness of current ops, they can adjust their mission priorities. But this requires a method to display both current and projected mission-level

effectiveness, and ideas in this area are critical to the human/machine interface that drives DTT.

E.6 SYSTEM DESIGN AND INTEGRATION

The purposes of the System Design and Integration effort are 1) to provide a framework through which interactions between technical components can be managed and supported, 2) to tie those components together into a single system that operates in real time, and 3) to support field exercises that involve disciplined collaboration among installations of technical components at geographically separated sites (nominally ARC, Ft. Dix, New Jersey, and the DCGS-X facility at Langley Air Force Base).

While much of this effort will involve conventional management of cooperative software development efforts (technical component development), there are six areas where the DTT:TEST program concept desires innovative, but disciplined, integration efforts:

- **Extensible ontologies:** The set of sensors, platforms, and target types of interest to DTT are not precisely known at this time, and, in fact, will always be subject to modification. We encourage agile approaches to system design, and documentation thereof, that can expedite changes required to address specific exercise opportunities.
- **Control:** For live exercises, the DTT system must operate in real time. Ideas for a system design to balance load, based on instrumentation of component performance, are encouraged.
- **Models:** The specific sensors and platforms available for each field test may not be known until a month or so before the test. Ideas for rapidly compiling sensor and platform models, expressed in mathematical terms needed by all DTT components, are important.
- **Foundation data:** All DTT components rely upon a consistent set of foundation data – terrain, roads, land cover, weather, etc. The system design should include approaches, and support software, for compiling these data from available sources.
- **Field interfaces:** The specific interface formats for sensor data, asset status reports, and plan publication will vary from one exercise to another. Approaches to rapidly modify interfaces to suit specific test opportunities are encouraged.
- **Functional testing:** A major role of the system integrator is to diagnose inconsistencies and errors among assumptions made by component developers. Some of these will be syntactic – locations expressed in decimal degrees vice degree/minute/second. These can be found by standard software QA techniques: peer review, code walkthroughs, etc. The truly difficult inconsistencies – assumptions of independence among random variables, consistency of error models with reality – cannot be detected this way. The most important role of the integration effort is to detect, diagnose, and recommend remediation for these semantic inconsistencies. Approaches to functional

testing, especially based on formal statistical analyses, are very strongly encouraged.

To focus on these issues, and to minimize imposition of external risk on the component developers, DTT:TEST expects all developers to use well-established software design methodologies and tools, including formal test plans and test coverage analyses, rigorous configuration control, and problem reporting/tracking mechanisms.

E.7 EXPERIMENT DESIGN AND EVALUATION

The purpose of the Experiment Design and Evaluation effort is to provide objective evaluation of progress towards DTT:TEST system goals, and to generate insight for component developers regarding their respective impacts on performance, especially weaknesses that offer opportunities for improvement. This involves four efforts:

- **Testbed operation:** Operate the ARC testbed in three modes: 1) simulation, using data from existing, installed simulations; 2) open-loop testing, using recorded data from previous exercises to assess system performance; and 3) closed-loop exercises, where Control-generated plans are provided to assets in the field.
- **Exercise support:** Establish connectivity to and from sensors and platforms operating in live environments. For proposal purposes, assume: 1) live data from DCGS is available, but authority to control sensors is not; 2) live data and control authority exists for tactical exercises at Ft. Dix in an FCS contest; and 3) DTT: TEST will participate in JEFX-06.
- **Exercise monitoring:** As exercises progress, monitor, and rapidly diagnose problems with, interactions between DTT and external sensors. This includes problems encountered with connectivity (e.g., firewall permissions), security (e.g., encryption and authorization), quality of service (e.g., latency, dropouts), and functionality (e.g., unexpected errors in source data).
- **Performance analysis:** For each exercise or simulation test, analyze system-level performance to provide DARPA with an objective assessment of system capability and operational performance.

It is expected that the Experiment contractor be able to maintain two full-time staff at the ARC in Building 620 at WPAFB.

F PROPOSAL MANAGEMENT

F.1 GENERAL INFORMATION

F.1.1 Definition of BAA as contemplated in the FAR

The information provided in this Proposer Information Pamphlet (PIP), in addition to that provided in the FedBizOpps BAA 05-04, constitutes a Broad Agency Announcement as contemplated in the FAR 6.102 (d)(2)(i). The FedBizOpps announcement and this document are available online at http://www.darpa.mil/ixo/solicitations/dtttest/index.htm.

F.1.2 BAA correspondence

DARPA will use electronic mail for all technical and administrative correspondence regarding this BAA. Administrative, technical or contractual questions should be sent via e-mail to BAA05-04@darpa.mil. If e-mail is not available, please fax questions to (703) 741-0081 (Attention: Dr. Robert R. Tenney, Room 634). All correspondence, including questions, must identify the company or organizational source and include the name, address, email address and phone number of a point of contact.

F.1.3 Frequently asked questions

All questions and answers of relevance to the community will be posted to a "Frequently Asked Questions" accessible at: http://www.darpa.mil/ixo/solicitations/dtttest/index.htm.

F.1.4 Multiple proposals

Offerors responding to multiple areas of this BAA should submit one complete proposal per topic. Each proposed effort should stand alone, and not be predicated on the award of any other effort. No individual technical contributor (person) can be proposed in more than one response.

F.1.5 Contract types

Awards are anticipated to be in the form of Procurement Contracts or Other Transactions. Grants or Cooperative Agreements are also possible.

F.2 SUMMARY OF IMPORTANT DATES

Table 2 provides a schedule of important events and dates associated with the DTT:TEST BAA:

DATE	EVENT	URL
15 October 2004	FedBizOpps Anouncement and Proposer Information Package published	http://www.darpa.mil/ixo/solicitations/dtttest/index.htm
29 October 2004	Proposal registrations due at DARPA	http://www.tfims.darpa.mil/baa
29 November 2004[1] 12:00 Noon EST	Proposals due at DARPA	http://www.tfims.darpa.mil/baa
15 December 2004	Selections announced	
19 January 2005	Kick-Off meeting	AFRL Building 620

Table 2. Significant BAA events and deadlines

F.3 SUBMISSION GUIDELINES

Proposal abstracts ARE NOT requested in advance of full proposals. DARPA will employ an electronic upload process for proposal submissions for BAA 05-04. Performers may find guidance for proposal submission at: http://www.darpa.mil/ixo/solicitations/dtttest/index.htm.

Organizations planning to submit proposals must register at http://www.tfims.darpa.mil/baa**.** Only the lead or prime organization should register. One registration per proposal should be submitted. This means that an organization wishing to submit multiple proposals should register separately for each proposal. The deadline for registration is 29 October 2004. By registering, the Proposer has made no commitment to submit.

F.4 TFIMS REPORTING REQUIREMENTS

The T-FIMS Interactive reporting system facilitates technical and expenditure reporting on line. Information on this system may be found at http://www.tfims.darpa.mil/. Offerors shall satisfy the T-FIMS reporting requirements described at http://www.tfims.darpa.mil/Tfimsreqdoc.asp as part of their deliverables.

F.5 SECURITY

The DTT:TEST Project will deal with classified data and results. DTT:TEST will require periodic development , testing, and demonstration in a classified facility – the ARC. Therefore, proposers must show that all personnel have SECRET clearances or better. They must also show that they have facilities available to store and process these data. Finally, each offer is encouraged to propose one person who possesses the SI/TK clearances necessary for visits to field and exercise facilities.

[1] Proposal submission by 24 Nov 2004 is encouraged; however, proposals will be accepted through 29 Nov 2004.

G PROPOSAL EVALUATION

G.1 GENERAL CONSIDERATIONS

Proposers are encouraged to submit concise, but descriptive, proposals. The Government reserves the right to select for award all, some, or none of the proposals received in response to this solicitation and to award without discussions. All responsible sources capable of satisfying the Government's needs may submit a proposal. Historically Black Colleges and Universities (HBCUs) and Minority Institutions (MIs) are encouraged to submit proposals and join others in submitting proposals; however, no portion of this BAA will be set aside for HBCU and MI participation due to the impracticality of reserving discrete or severable areas of technology for exclusive competition among these entities.

It is the policy of DARPA to treat all proposals as competitive information and to disclose the contents only for the purposes of evaluation. The Government may use selected support contractor personnel to assist in administrative functions only. For this solicitation, non-Government advisors from SET Associates Corporation, who have signed appropriate non-disclosure and conflict of interest statements, may assist in the proposal administration when their assistance is required. However, they will not participate in the final source selection process.

Proposers are advised that only contracting officers are legally authorized to contractually bind or otherwise commit the Government.

G.2 CRITERIA FOR AWARDS

The selection of one or more sources for awards will be based on an evaluation of the entirety of a Proposer's response (both technical and cost aspects) to determine the overall merit of the proposal in response to the announcement. Proposals shall be evaluated against the following criteria, in descending order of importance:

G.2.1 Relevance to DTT:TEST mission objectives

- Understanding of the depth and breadth of ISR missions and systems.
- Familiarity with current and previous work on related components and systems.
- Awareness of current and projected support to ISR commanders.

G.2.2 Consistency with DTT:TEST program concepts

- Consistency with the DTT:TEST system concept.
- Commitment to comply with decisions by the System Design contractor.
- Precision and coverage of the proposed effort's metrics.

G.2.3 Technical innovation and depth

- Understanding of the current state of the art.

- Capability offered as the baseline at the start of the program.
- Degree of innovation and potential for revolutionary advance.
- Justification of design choices as compared to alternative techniques.

G.2.4 Personnel and corporate capabilities and experience

- Qualifications of proposed technical personnel.
- Availability of personnel for the duration of the contract.
- Proposer's experience related to the proposed technology area.
- Adequacy of proposed facilities.
- Adequacy of security plan.

G.2.5 Cost realism and value of proposed work to the Government

- The total cost relative to benefit.
- The realism of cost levels for facilities and staff.
- The cost-effective use of existing equipment and software.
- Competitive costs on procurements.

H PROPOSAL CONTENT

H.1 GENERAL INFORMATION

Proposal abstracts ARE NOT requested in advance of full proposals.

Technical and cost proposals must be submitted as separate volumes (Technical as Volume I, Cost as Volume II), and must be valid for 180 days.

All eligible sources may submit a proposal through the BAA web site (http://www.tfims.darpa.mil/baa). Proposals exceeding the page limit will not be reviewed beyond the maximum page limit. Non-cost information incorporated into Volume II will not be considered.

Proposal questions should be submitted according to the process described in Section F. Proposers are advised that only Government contracting officers are legally authorized to contractually bind or otherwise commit the Government.

Proposers should apply the restrictive notice prescribed in the provision at FAR 52.215-12, Restriction on Disclosure and Use of Data, to trade secrets or privileged commercial and financial information contained in their proposals.

It is DARPA's policy to treat all proposals as competitive information and to disclose the contents only for the purposes of evaluation. The Government may use selected support contractor personnel to assist in administrative functions only.

H.1.1 Procurement Integrity, Standards Of Conduct, Ethical Considerations

Certain post-employment restrictions on former federal officers and employees may exist, including special Government employees (Section 207 of Title 18, United States Code). If a prospective Proposer believes that a conflict of interest exists, the situation should be raised to the DARPA Contracting Officer specified in Section 1.7 before time and effort are expended in preparing a proposal. All Proposers and proposed sub-contractors must therefore 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.

The Government intends to comply with procurement integrity statutes and regulation and DFARS 252.227-7016 in its treatment of information submitted in response to this BAA solicitation and marked with the individual or company's legend (see paragraph 4.1.1 below). The proposer is cautioned, however, that portions of the proposal may be subject to release under terms of the Freedom of Information Act (FOIA), 5 U.S.C. 552, as amended. In accordance with FOIA regulations, the proposer will be afforded the opportunity to comment on, or object to, the release of proposal information.

H.1.2 Subcontracting

Pursuant to Section 8(d) of the Small Business Act (15 U.S.C. 637(d)), it is the policy of the Government to enable small business and small disadvantaged business concerns to be considered fairly as subcontractors to contractors performing work or rendering services as prime contractors or subcontractors under Government contracts, and to assure that prime contractors and subcontractors carry out this policy. Each Proposer who submits a contract proposal and includes subcontractors is required to submit a subcontracting plan IAW FAR 19.702(a) (1) and (2) with their proposal. The plan format is outlined in FAR 19.704.

H.2 TECHNICAL PROPOSAL

Each technical proposal shall be limited to a total of 42 or fewer pages (including cover, index, charts, figures and tables). Each proposal shall include the sections and items described in Table 3.

Format specifications include 12 point or larger type, single spaced, single-sided, on 8.5 by 11 inch paper with 1 inch margins all around the page – no foldouts. Each section should begin at the top of a page. All pages shall be numbered. The page limitation includes all attachments, etc. Pages in excess of this limitation will not be considered by the Government.

Offerors using this PIP as a template for their proposal will satisfy all format requirements.

Offerors should include information contained in the PIP only by reference (e.g., [PIP E.2.3]), not by verbatim quotes nor by simple paraphrasing. Specific examples of problems, approaches, or goals are more effective than qualitative generalities.

Section	Page limit	Topics
Cover page	1	Offeror identification
Table of contents	2	Proposal outline and page counts
Proposal roadmap	2	Summary of key elements of the offer (win themes)
Problem statement	5	Challenges of tactical sensor cross-cueing perceived by offeror Limitations of current automation known to offeror Opportunities for improvement offered in proposal
Program concept	5	Internal functional architecture for proposed effort Expected technical progression over time (capabilities) Expected performance gain over time (quantitative metrics)
Technical approach	15	Survey of the current state of the art (table) Description of your current baseline capability available 1 January 2005 Key ideas to meet goal of processing live data Methodology for self-evaluation using field data
Management plan	10	Statement of work (table) Schedule (table) Deliverables (table) Proposed personnel Related experience (paragraphs) Statement of rights claimed for software deliverables Security plan
Commitment	1	Legally binding (upon award) commitment to conform to system design decisions
Evaluation factors	1	Summary of offeror's assessment of evaluation factors

Table 3. Summary of required proposal contents.

H.2.1 Cover Page

The cover page should uniquely identify the offer, including the following information:

- BAA number.
- Assigned DARPA control number.
- Proposal title.

- BAA category addressed (e.g., Target Motion Prediction, or System Design and Integration).
- Proposer's legal corporate name and mailing address.
- Proposer's single point of contact for all correspondence and communications.
- Each subcontractor or consultant being proposed (if any), with mailing address and point of contact for each.

H.2.2 Section A: Table of contents

The Table of Contents should, at a minimum, provide an index to all primary and secondary headings in the technical proposal.

H.2.3 Section B: Proposal roadmap

This page should summarize, preferably in bullet format, the major points and themes of the proposal, in terms of a) problem addressed, b) program structure, c) technical approach, and d) management plan.

H.2.4 Section C: Problem statement

This section should define and delineate the problem to be addressed by the proposed effort. It should define the aspects of a particular task area that pose the greatest technical challenges to the offeror; identify areas where increased automation of the type proposed can make the greatest contribution in the context of field experimentation; and describe the component-level performance payoff if the proposed effort succeeds.

H.2.5 Section D: Program concept

This section should establish the intellectual framework for the proposed effort in three parts:

Section D.1: **Proposed enabling capabilities.** Define the capabilities available at the start of the DTT:TEST program, as software functions, services, or procedures. Explain relationships among them, and relationships to other elements of the system. Amplify, and recommend improvements to, the overall system concept.

Section D.2: **Proposed capability development.** Explain how the capabilities defined in Section D.1 may evolve over time, either through a development sequence, performance enhancement, or the phased introduction of new technology. Show how this evolution supports the program-level goals, and recommend amplifications and improvements to the program concept.

Section D.3: **Proposed performance metrics.** Define the metrics by which the effort will internally assess progress towards the final set of capabilities. For component development efforts, explain how these metrics relate to the program-level metrics, preferably within the context of a quantitative model. For integration and experimentation, explain how these metrics capture the level of support provided to the component developers.

H.2.6 Section E: Technical approach

Explain, with specific examples relevant to real-world tactical sensor management, the key technical ideas on which the offer is based. Include at least:

- A summary of available technologies, and rationale for the selection of the ones on which the proposed effort builds.
- The baseline capability that would be used during the first development spiral. For component developers, emphasize interfaces, data models, and capabilities that would most influence system design and experimentation efforts. For system designers and experimenters, emphasize the technical and procedural frameworks into which component developers will be asked to fit.
- Key ideas that will form the basis for progress beyond the baseline capability. Include specific examples illustrating how the ideas address crucial factors encountered in registration, prediction, fusion, sensor management, and commander interfaces. Emphasize any formal theories, performance analyses, or quantitative tradeoffs that lend weight to claims of scalability.
- The process that the offeror will use to assess the rate of progression of technical capability over time.

This is the critical section of the proposal. It must address the specific technical approach, technical rationale and strategy for accomplishment of technical goals, and should elaborate upon (but not be redundant with) Section D. The technical rationale section must include technical arguments to substantiate claims made in Section D. Include comparisons with other ongoing research indicating both advantages and disadvantages of the proposed effort/approach.

All proposals should describe expected capability and performance goals, along with internal processes to gauge them. These plans should describe the amount and kind of data needed to conduct internal evaluation. These goals and evaluation plans will be reviewed and coordinated in program-wide meetings after program initiation.

H.2.7 Section F: Management approach

This section should describe the tasks and resources offered to carry out the technical approach described.

Section F.1: Statement of Work. Define the technical tasks/subtasks to be performed, their durations, and dependencies among them. For each task/subtask, provide, in a tabular format:

1) A short (1-2 sentence) description of the objective of task;
2) A short (1-2 sentence) description of the approach to be taken to the task;
3) Identification of which organization is responsible for task execution;
4) The resources allocated to each task (funds, person-months and duration); and
5) The exit criterion for each task - a product or event that defines its completion

Section F.2: **Program schedule.** Provide a Gantt chart showing internal activities planned within a typical 3 month spiral.

Section F.3: **Deliverables.** Define deliverables associated with the proposed research, both software (e.g., to the system integrator and AFRL testbed) and reporting. See also Section F.4 of this PIP.

Section F.4: **Cost summary.** Summarize the cost of the proposed effort as indicated by the two tables here. Assume a program start date of 1 January 2005, so that contract years align with calendar years. Note that DTT:TEST plans to end on January 1, 2007.

Please pay particular attention to the labels on the rows of this chart. An inability to properly separate direct labor charges from other charges may lead to delays in contract award.

Cost Element	CY05 Q1	CY05 Q2	CY05 Q3	CY05 Q4	CY06 Q1	CY06 Q2	CY06 Q3	CY06 Q4	Total
Technical labor[2]	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	x,xxx,xxx
Administatrative labor[3]	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	x,xxx,xxx
Other direct charges	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	x,xxx,xxx
Indirect charges	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	x,xxx,xxx
Fee	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	x,xxx,xxx
Total	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	x,xxx,xxx

Table 4. Summary of funding request by cost element.

[2] Technical labor includes designers, software engineers, analysts, and other staff with degrees in science or engineering who contribute directly to the technical objectives of the program.

[3] Administrative labor includes contractual, financial, secretarial, and other staff with non-technical degrees who support the technical staff.

Cost Element	CY05 Q1	CY05 Q2	CY05 Q3	CY05 Q4	CY06 Q1	CY06 Q2	CY06 Q3	CY06 Q4	Total
Prime	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	x,xxx,xxx
Subcontractor A	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	x,xxx,xxx
Subcontractor B	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	x,xxx,xxx
Subcontractor C	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	x,xxx,xxx
Total	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	xxx,xxx	x,xxx,xxx

Table 5. Summary of funding request by performing organization.

Section F.5: **Personnel.** Provide a one-page summary of the qualifications of each person proposed for this effort. Describe their education, clearance level, work history, and areas of expertise. Clearly state as a percentage the portion of each person's time that will be dedicated to DTT:TEST during Phase I. Do not include resumes for people who will spend less than 50% of their time on DTT:TEST. Include subcontractor/consultant key technical personnel, identified as to their organizational affiliation.

Section F.6: **Related experience.** Provide short summaries of related work accomplished or in progress by any member of the offeror's team that offers technology or transition potential for DTT:TEST. Emphasize projects on which proposed staff have worked, and indicate this fact when applicable. Clearly differentiate between prime contractor related experience and subcontractor related experience.

Section F.7: **Facilities.** Briefly describe corporate facilities available to support this effort.

Section F.8: **Security plan.** Briefly describe the plan to place people into the secure AFRL facility during evaluations, and to process data collected and derived from those evaluations. Identify the key person(s) who has/have SI/TK clearances.

Section F.9: **Submission Handling/Rights In Technical Data And Computer Software/Patent Rights – General.**

Noncommercial Items: (Technical Data and Computer Software)

Proposers responding to this BAA 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. Proposers shall follow the format under DFARS 252.227-7017 for this stated purpose. In the event that Proposers do not submit the list, the Government will assume that it automatically has "unlimited rights" to all software the Proposer has produced under this contract. The Government may use the list during the source selection evaluation process to evaluate the impact of any identified restrictions, and may request additional information from the Proposer, as may be necessary, to evaluate the Proposer's assertions. If no restrictions are intended, then the Proposer should state "NONE."

Table 6 shows a sample format for complying with this request.

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)

Table 6 Noncommercial Items

Commercial Items: (Technical Data and Computer Software)

Proposers responding to this BAA 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 Proposers do not submit the list, the Government will assume that there are no restrictions on the Government's use of such commercial items. The Government may use the list during the source selection evaluation process to evaluate the impact of any identified restrictions, and may request additional information from the Proposer, as may be necessary, to evaluate the Proposer's assertions. If no restrictions are intended, then the Proposer should state "NONE."

Table 7 shows a sample list for complying with this request.

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)

Table 7 Commercial List

Where the rights to any technical data/computer software are more restrictive than "Government Purpose Limited Rights" as defined by the FAR, provide a plan for mitigating the impediments such restrictions pose to transition to field users.

H.2.8 Section G: Commitment

For component developers, this page should explain the form and scope of the commitment to honor the design decisions made by the System Design and Integration contractor, whoever that turns out to be. It should be signed by an official with legal signature authority. Language on its face should make it legally binding upon contract award.

H.2.9 Section H: Evaluation factors

This page should summarize, preferably in bullet format, the offeror's self-evaluation of the proposal against the factors defined in Section G of this PIP.

H.3 COST PROPOSAL

In general, the cost proposal should provide summary and detailed cost breakdowns, by fiscal year quarter, for a phased program as described earlier. Proposers should assume a 01 January 2005 start date.

Volume II of the proposal shall consist of a) a Budget Cover Page, b) a Budget Summary, part 1 and 2, and c) budget details. Please restrict Volume II to thirty pages of strictly financial, legal, and contractual data.

H.3.1 Cover page

This must include the words "Cost Proposal" and shall otherwise be identical to the Volume I cover page as described in Section H.2.1.

H.3.2 Budget summary

1) Part 1 (one page): Summary of all costs by calendar year, consistent with Tables 4 and 5 contained in Section F.4 of the technical proposal:
    a. Labor hours by labor category;
    b. Labor costs by labor category;
    c. Equipment purchases and materials
    d. Travel
    e. Other indirect costs
    f. Fee
    g. Total
2) Part 2 (one page): Cost breakdown by task and calendar year, using the same task numbers as in Technical Proposal statement of work.
3) Include any other relevant details and language that support or qualify the information in the budget summary, but no more than 27 pages thereof.

H.4 REFERENCES

H.4.1 Security Classification Guide: DARPA-CG-289

H.4.2 "Dynamic Tactical Targeting Presentation": 22 September 2004.

I ACRONYMS

ACO	Administrative Contracting Officer	HBCU	Historically Black Colleges and Universities
AOC	Air Operations Center	HTML	HyperText Markup Language
ARC	Advanced Recognition Capability	ISR	Intelligence, Surveillance, and Reconnaissance
ATO	Air Tasking Order	IT	Information Technology
AWACS	Airborne Warning and Control System	ITAR	International Traffic in Arms Regulations
C4ISR OTM	C4ISR On-The-Move	IXO	Information Exploitation Office
CAOC	Combined Air Operations Center	JTR	Joint Travel Regulations
COTS	Commercial off-the-shelf	LADAR	Laser Radar
DARPA	Defense Advanced Research Projects Agency	LOE	Level of effort
DCAA	Defense Contract Audit Agency	MI	Minority Institutions
DCGS	Distributed Common Ground Station	PIP	Proposer Information Pamphlet
EO/IR	Electro-Optical and Infrared	SAR	Synthetic Aperture Radar
FAR	Federal Acquisition Regulation	SETA	Scientific and Engineering Technical Assistance
FCS	Future Combat System	SIGINT	Signals Intelligence
FedBizOps	Federal Business Opportunities	SOW	Statement of Work
GFD	Government furnished data	TIN	Taxpayer Identification Number
GFE	Government furnished equipment	UCAVs	Unmanned Combat Air Vehicles
GMTI	Ground Moving Target Indication		