Proposer Information Pamphlet (PIP)

HURT: Heterogeneous Urban RSTA (Reconnaissance, Surveillance, and Target Acquisition) Team

BAA 04-05

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This Broad Agency Announcement (BAA) will be open for **one (1) year** from the date of its publication in www.fedbizopps.gov and www.fedgrants.gov.

NOTE: Although this BAA will be open for one (1) year from the date of its publication in www.fedbizopps.gov and www.fedgrants.gov, the government anticipates that the majority of funding for this program will be committed during the first selection phase. To be considered for funding during the first selection phase, proposals must be submitted to DARPA no later than **12:00 PM Eastern Time on 13 February 2004.**

A Briefing to Industry was held on 20 November 2003 to discuss the information contained in this PIP and BAA, encourage discussion and teaming, and address any questions proposers may have regarding the goals and objectives of the HURT program. Questions and Answers generated from this briefing have been posted to http://www.darpa.mil/ixo/solicitations/hurt/index.htm for proposer review. Attendance at the Briefing to Industry is not necessary to respond to this BAA.

All questions pertaining to this BAA and PIP may be submitted to DARPA at the following e-mail address: BAA04-05@darpa.mil. DARPA may post updates to questions or comments periodically to the solicitation website:
http://www.darpa.mil/ixo/solicitations/hurt/index.htm

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B PIP ROADMAP

B.1 PROBLEM STATEMENT (SECTION C)

- Integrate a diverse set of unmanned RSTA (Reconnaissance, Surveillance, and Target Acquisition) vehicles into a team that is tasked as a pool of capabilities.
- Devise a multi-user command interface and prioritization scheme.
- Implement a collaborative controller, planner, and task allocator.

B.2 PROGRAM STRUCTURE (SECTION D)

- Three (3) technology-intensive components: Multi-user prioritizer; platform-independent capability models; closed-loop planning controller.
- One (1) Systems Integrator, whose duties include the software architecture, the communications network, the integrated demonstrations, and evaluation.
- Three (3) successive phases, each with live-flight demonstrations. The duration for phases 1, 2 and 3 are 14, 16 and 18 months, respectively.

B.3 TECHNICAL OBJECTIVES (SECTION E)

- Develop an expressive platform-independent representation for diverse RSTA assets, to include both mobility and sensing parameters
- Develop a tasking prioritization mechanism that allows the system to serve RSTA data to multiple users who may lack a complete tactical picture.
- Implement a planning controller that continuously and robustly serves user requests by appropriately controlling each asset through its native interface.
- Demonstrate the RSTA team in multi-vehicle tactical experimental scenarios at a MOUT (Military Operations in Urban Terrain) training site.

B.4 PROPOSAL MANAGEMENT (SECTION F)

- BAA release on or about 12 December 2003.
- Proposals due to DARPA 12 PM EDT Friday, 13 February 2004

B.5 PROPOSAL EVALUATION (SECTION G)

- First: Relevance to HURT Mission Objectives
- Second: Technical Innovation and Depth
- Third: Consistency with HURT Program Concepts
- Fourth: Personnel and Corporate Capabilities and Experience
- Fifth: Cost Realism and Value of Proposed Work to the Government

C PROBLEM STATEMENT

The future of warfare lies in the streets, sewers, high-rise buildings, industrial parks, and the sprawl of houses, shacks, and shelters that form the broken cities of our world. We will fight elsewhere, but not so often, rarely as reluctantly, and never so brutally.

Ralph Peters

C.1 THE DIFFICULTY OF MOUT OPERATIONS

For many centuries, Military Operations in Urban Terrain (MOUT) have been recognized as some of the most difficult and perilous of all combat operations. Yet, as worldwide populations tend toward urban areas, and as military targets tend toward technology centers and organizational headquarters, it is envisioned that the need for urban combat will increase in future conflicts.

Among the special characteristics of urban combat are

- **The potential for enemy concealment and deception**: urban areas offer an opponent a multiple of concealment options and a known infrastructure that can be used by an enemy to deceive advancing forces. Buildings, bridges, and other structures offer easy concealment for weapons, forces, and booby traps.
- **The potential for collateral damage**: although our capability to perform precision targeting and strike allows us to minimize collateral damage on the battlefield, the density of people, structures, and vehicles in the urban area of operations (AO) presents challenges for even the most accurate weapons technology.
- **Restrictive rules of engagement**: urban battles are fought in close proximity to indigenous personnel, and conservative rules of engagement are required to protect non-combatants and private property.
- **Fragmented situation awareness**: the urban AO is hostile to high-bandwidth wireless data communications and can result in loss of connectivity even at short distances. This effect is compounded by short line-of-sight (LOS) distances, which make visual reconnaissance difficult. Urban combat terrain is also rapidly changing, and pre-conflict battlespace awareness can become useless unless continually refreshed.

The HURT program has three objectives. First, allow warfighters to *directly* request real-time RSTA services from a team of unmanned assets in complex, three-dimensional urban terrain. Second, aggregate the information gathering capabilities of diverse platforms into collaborative teams that provide robust services on demand. Third, control multiple platforms to simultaneously and autonomously maneuver through the urban battlespace in order to deliver those services.

C.2 EMERGING TECHNOLOGY FOR URBAN RSTA

Over the past few years, uninhabited aerial vehicles (UAVs) have been recognized as critical to battlespace information gathering. Yet they have been used mostly for mid-to-high altitude intelligence, surveillance, and reconnaissance. Recently, control systems, sensors, and platform technologies have emerged that allow us to operate a new class of autonomous platforms that can function at low altitudes in congested and obstacle-rich airspaces. These vehicles can be small and inexpensive, man-portable, and expendable. DARPA and other DoD programs are enabling these vehicles to function autonomously with on-board decision-making and even peer-to-peer collaboration.

It is the intent of the HURT program to take advantage of these developments while adding a high-level tactical tasking interface, a task allocator, and a coordinating supervisory controller. When successful, the program will provide the following benefits that address the difficulties with urban RSTA as discussed above:

- **Distributed three-dimensional sensing:** Teams of agile unmanned platforms operating within the urban AO can gather sensory information in ways that neither high-altitude platforms nor fixed sensors can provide. Small agile platforms can position side-looking sensors in time and space in order to look into building portals, on vertical surfaces, under overhangs and overpasses, or into parking structures.
- **Close-in sensing and targeting:** The compressed times and distances associated with short-range urban conflict present challenges to target identification and mensuration. Stand-off sensors are often occluded or have only an oblique viewing angle, and can rarely provide the resolution necessary for positive identification. Only close-in sensing provides this information.
- **Robustness:** The HURT program will not directly address the survivability of unmanned systems at the platform level. However, by employing several platforms in teams, the services they provide can be maintained in the face of platform attrition and exhausted resources such as fuel. By dynamically re-allocating and re-tasking the platforms in real-time, the HURT system will provide a set of services that can be made self-repairing.
- **Persistence:** Perching platforms such as rotorcraft and loitering vehicles can provide a persistent viewpoint that can be used to gain a high-confidence understanding of the area of operations over extended periods of time.
- **Asset diversity:** Small platforms that can maneuver in the confined urban AO are also likely to have specialized payloads and physical characteristics, tailored to the function for which they were designed. By pooling assets of diverse capabilities, a rich set of RSTA services can be made available.
- **Collaborative operations:** Certain operations are inherently multi-platform tasks. Among these are multi-lateration to a target, the establishment of a multi-node communications infrastructure, and wide-area force protection. With the HURT system, mobile platforms could be made to work in such a collaborative fashion whether or not the component vehicles were intended to do so.

HURT will achieve all these benefits without altering the component platforms or their ground stations. HURT will act as a coordinating controller and task allocator that tasks the vehicles to perform these services at the request of one or more warfighters. The warfighters will not be required to pilot or operate any vehicle(s), but will need only to request the services that the team can provide. The HURT system will position and configure the resources in order to perform services at a particular place and time. In processing these requests, the system will correctly prioritize and route information so that the mission aims are achieved and the RSTA service levels are maintained.

C.3 TECHNOLOGY CHALLENGES FOR HURT

The use of many autonomous sensor platforms for urban RSTA as envisioned in HURT presents many challenges to the state of the art. Among these challenges are:

1) **User Management**: By allowing warfighters to directly request services that the HURT-controlled team of assets can provide, we must solve numerous problems associated with accepting commands from embedded clients. These include:

   - Where possible, the HURT system should determine asset tasking in order to service each information request with an accurate and timely response. There will be times when the requests cannot be scheduled or are for some other reason mutually exclusive. For those situations, a prioritization scheme must be developed. However, requests from embedded users may lack the mission context necessary to automatically prioritize them, and the system may need to mediate conflict by resorting to mission-level criteria and commander's guidance. In these cases, a mechanism must be in place to safely *deny* requests and inform the user as such. If more graceful degradation in service is feasible, for example by sacrificing a quality-of-service to one or more users, then the system must compute a satisfactory compromise.

   - Conversely, it may be possible to exploit synergies in the assets in order to optimize the execution of concurrent service requests. This may be achieved by commands to collectively-taskable vehicle (sub)teams in the future, or for currently available vehicles, by implementing collaborative control within the HURT Planning and Control component.

   - An interface must be provided so that a commander can provide mission guidance, value judgment, and any other information necessary to accurately prioritize and queue user requests. This information should be used for automated planning and allocation of assets to user requests, not merely as a planning tool for the commander.

   - Although input/output interface device technologies are *not* a focus of HURT, the users will require a non-interfering, compact means to communicate RSTA Service Requests (RSRs) to the system, and to receive the returned information. Specific formats for tactically-relevant RSRs must be developed in the course of the program (e.g., "provide video of <this intersection>", or "tell me when the state of <the HQ building, south door> changes"), and the returned information, as well as status feedback, must be provided to the requestor.

2) **Platform Modeling:** In order to task a diverse collection of arbitrary vehicles, an expressive but efficient model of these platforms and their capabilities must be developed. New technologies to model these systems will need to address – at minimum – the following issues:

- Diverse mobility, resource, and payload capabilities must be expressed for a wide variety of vehicles (e.g., rotorcraft, fixed-wing, ducted-fan, ground vehicles, fixed sensors, etc.) with a common formal language.
- The representation of these vehicle capabilities must include not only their static characteristics, but the semantics of any on-board autonomous behaviors they might possess.
- Not only individual, but *collective* vehicle capabilities must also be represented so such behaviors can be used to their fullest extent by the HURT system.

When planning and control is finished, the vehicles will need to be tasked, and because HURT will not include a direct vehicle interface, a translator will be needed from the common HURT semantic capability representation language back into the vehicles' own native command format, through its own ground controller.

3) **Planning and Control**: Once the capabilities of the team of assets are known and service requests have been received, the Planning and Control component must find ways to task the vehicles. In the HURT program, the complex and dynamic urban combat environment will stress the state-of-the-art in planning, task allocation, and control technologies in order to address the following difficulties:

- Any lack of autonomous on-board navigation, obstacle avoidance, or airspace management abilities must be compensated for by the added knowledge and control that the HURT system can provide.
- Dynamic re-planning and repair will have to be continuous and robust in order to complete the mission and maintain control of multiple vehicles performing concurrent tasks.
- As more intelligent platforms emerge, HURT must integrate and make full use of their capabilities. The planner and controller will therefore need to know how to control autonomous behaviors by providing those vehicles with high-level commands such as policies or intent, while also controlling simpler, less autonomous assets with low-level commands.
- It is envisioned that a *HURT command and control center* (HC3) will house one or more human operators (fewer is better), as directors, arbiters of conflict, targeting authorities, and problem solvers. The command center is also where a commander can monitor progress, provide mission guidance, and re-assess his own plans. The HC3 must therefore allow visibility and access to the HURT-generated plans and controls. The commander must be given the ability to overrule a plan, issue his/her own requests, and adjust user priorities.

4) **Integrated System**: In addition to the three component technology topic areas discussed above, the technical means to operate the system in tactical MOUT

environments will require systems integration, infrastructure support, experimentation, and transition. These requirements include:

- The Systems Integrator will be responsible for all common computing hardware and software, including interfaces to platform ground control components, the planning/control engine, the user prioritization scheme, information routing and management, and the HC3.
- The Systems Integrator must also select and maintain communications channels between the HC3 and the native ground stations. Additionally, for experimentation throughout the program, radio frequency management will be necessary in order to operate several vehicles in close proximity.
- End-of-phase experiments must be coordinated and managed through MOUT training site support and with military operational users. Component platforms will require verification, validation, and flight and range safety qualifications.
- Measures of performance necessary for the program to progress must be established and data collected in order to accurately gauge technology development progress. The level of effectiveness to the military user community must also be assessed to facilitate transition and adoption.

The HURT program will develop the above technologies and provide the following high-level benefits to the operational user, which may be a Marine air/ground task force, a special operations force, or an Army squad, company, or platoon:

- The HURT system will provide a unified, stable interface to the autonomous information-gathering capabilities of the component platforms and their collective assemblage. HURT will appear to the user as a distributed sensor.
- HURT requires no custom vehicles or customization of existing vehicles, relying on formal representations of abstracted capabilities, similar to the way a device driver describes the functionality of a computer peripheral. Thus, it is easily maintainable, flexible regarding team composition, and uniquely upgradeable relative to platform-centric approaches to autonomy.
- Users of HURT will require no piloting skills, platform experience, or unit-wide command-and-control authority. Their interface to HURT will be relatively insensitive to the composition of the vehicle team, thereby minimizing training and broadening warfighter access to unmanned vehicle resources.
- Because its capabilities are based on abstract formal representations of platform capabilities, and its planner/controller performs a match-making service between the team and the users, HURT will be able to always stay ahead of platform technologies, and will always be able to add value to unmanned systems. HURT will never become obsolete.

D PROGRAM STRUCTURE

D.1 SYSTEM CONCEPT

Figure 1 illustrates the operational command concept of the HURT. The warfighters will have an interface through which they can issue unambiguous, formally structured commands, possibly using quantitative input arguments such as a named area of interest. The HURT command and control center (HC3) will translate these service requests into vehicle commands that can be communicated to the individual platforms. Note that some platforms may already be networked (indicated by the web) and able to execute collaborative behaviors, while others can only be integrated through the task allocation performed at the HC3. Also note that the HC3 makes no attempt to directly communicate with the vehicles. Rather, it issues commands through their native interfaces, and therefore must issue platform-specific requests in a format that the native controllers can read and execute. These formats will be different for each platform in the team.

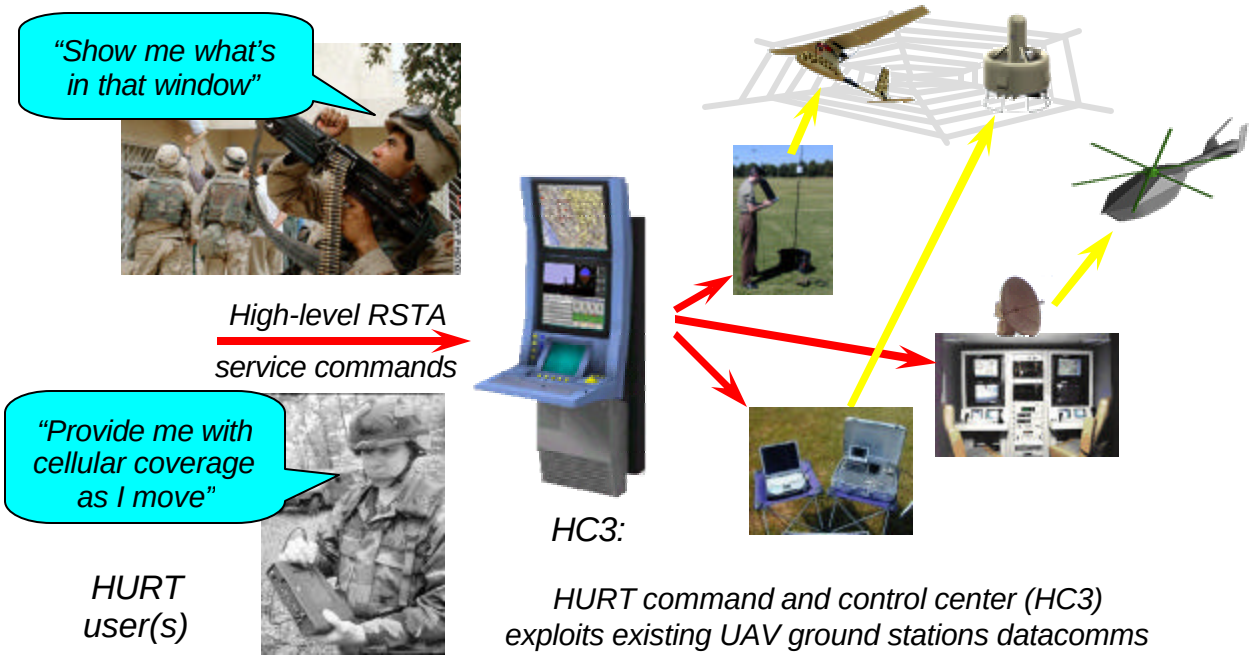

Figure 1. Operational concept for the HURT.

Figure 1 does not show the return information path, which flows from the assets, through their native transceivers, and back through the HC3, which then routes it back to the appropriate user. In this way, neither the vehicles themselves nor their ground segments need be altered to accommodate HURT, except for a data interface to be designed between the HC3 and the native controllers.

Figure 2 shows the functional diagram of the HURT system and the relationship between the three technology components discussed in the previous section. The interfaces between the components are illustrated with the arrows.

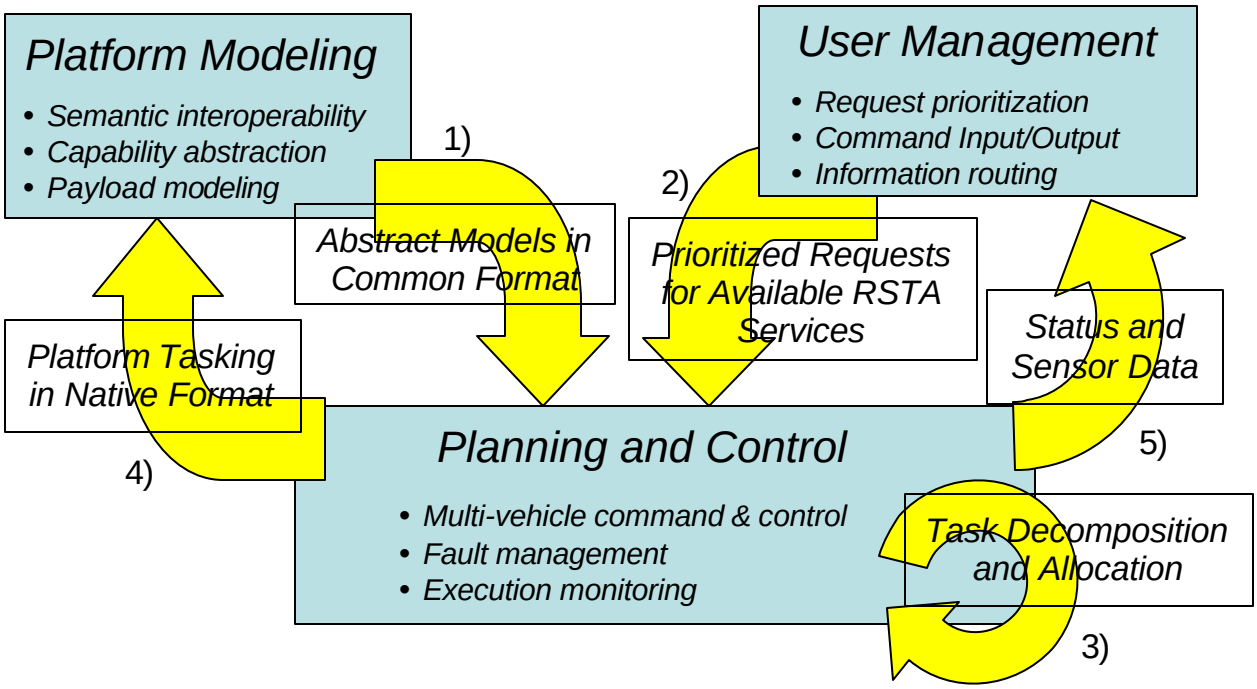

Figure 2: The HURT functional architecture comprises three technology components.

The flow of information in the system follows the arrows in the order given by the numbers:

1) A dataset of capability models is first built by assembling the platform and sensor models from the components that are available. These models are developed and recorded in advance, so that adding a platform to the team of assets is a matter of reading its models – in a common language – into a resource pool within HURT. This data is maintained within the HURT system

2) Users who are registered and qualified to issue requests will do so with unambiguously formatted statements, the RSRs. These may have a local priority assigned, especially if a single user issues multiple commands. After being received, the requests must then be prioritized with respect to mission level criteria and commander's preference, which the individual users may not know. It cannot be assumed that a user will faithfully assign mission-level priorities to requests even if he/she has complete knowledge.

3) Having access to a formally-expressed resource pool and a set of service requests, the Planning and Control component creates and initiates a plan that leads to the fulfillment of the requests via efficient use of the resources. Because of the dynamic nature of the battlespace, this will be a continual loop. This component functions by manipulating the resource models and requests through a planning and allocation

algorithm. Note that this manipulation may take place at different levels of behavior abstraction, because the diverse platforms will have different levels of autonomy.

4) When complete, the plan and control signals are translated into native platform commands, and communicated to the platforms. By translating the plan into platform-specific terms in the Planning and Control component, the HURT interface to the different native controllers will be simplified.

5) Finally, of course, the information requested must be returned to the appropriate user(s). Other information, in addition to the RSTA data, must also be relayed. A user will need status information on his request, feedback regarding denied or degraded availability, and status information. The *operator(s)*, who resides in the HC3, will also need plan representation and execution monitoring information, system status information, and summary data on RSRs in order to provide command decision support to the prioritization and allocation process.

D.1.1 The HURT Platforms

The most important characteristic of HURT is that it must have the ability to integrate arbitrary RSTA assets. These may be air vehicles (rotary- or fixed-wing, ducted fan, or other mobility type), ground vehicles, unattended sensors, subterranean vehicles, wall-climbing vehicles, etc., but platforms of highest interest to HURT are aerial vehicles. Each will have a unique dynamic model and constraint set. HURT will make no attempt to customize the vehicles or their control apparatus, but will depend entirely on the abstract representation of them and their sensors as capabilities, resources, and constraints.

Any on-board sensors and autonomous behaviors are also to be considered key features of the platforms' abstract model. Just as the mobility afforded by a vehicle's dynamic model is critical in tasking its motion, the model of its sensors must also be included as taskable resources. Similarly, if a platform has on-board autonomy at any level, whether it is simple see-and-avoid or complex on-board decision making, this capability must be considered a taskable asset and must be modeled. This autonomy modeling requirement applies to sensor behaviors as well. If an on-board sensor payload has an exploitation capability such as feature detection or automatic target recognition (ATR), that functionality should be considered a taskable resource.

It is expected that the System Integrator will provide and maintain a sufficient number of vehicles for development and testing. Note that vehicles are to be proposed only within the "System Integration" topic area. Furthermore, platforms and their models will have to be made openly available at no charge to other members of the HURT team. Further, no researcher-supplied platform may be customized for specific inclusion in HURT; it must be used "off-the-shelf", in the sense that its design and construction was un-influenced by the HURT system design. The government may provide the Systems Integrator with additional platforms for experimental or demonstration use.

D.1.2 The HURT Users

There are three classes of human constituents to the HURT system. The first are the warfighter *users* who request services from the system. It will be assumed in HURT

that users are individual warfighters at the company level or below, who are requesting services for real-time combat decision-making, as opposed to intelligence preparation for the battlefield (IPB), predictive battlespace awareness (PBA), or long range planning for command purposes. The purpose of this assumption is to flatten the organization of the user group and eliminate request prioritization biases based on echelon membership. Thus, all users will issue commands with equal default priorities.

The second and third classes of constituent consists of the *operator*(s) and the *commander*, who are resident in the HC3, which may be a shelter such as a building or a command and control vehicle. The operator(s) and the commander are outside of the immediate threat environment and therefore do not operate the HURT system for self-protection, but only as support to the warfighter users and for mission execution. HURT should be considered in direct support of the warfighter user unit, and is therefore part of a battalion- or company-sized command unit.

The operators are trained in the HURT system and can supervise its actions by taking an interactive role in plan generation and alternative selection, progress monitoring, routing, scene interpretation, target designation, and system verification. The operators perform any sort of decision making that the HURT system requires in normal operation or in system fault conditions.

The commander is in charge of mission execution, and are present to assimilate the RSTA data, make command decisions, and arbitrate prioritization conflicts that the HURT system cannot arbitrate automatically. It is this commander's guidance that forms a template for automatic request prioritization within the HURT User Management component. However, because the command center is the first place that a tactical picture could be assembled from the RSTA data being compiled there, the commander's guidance is subject to change on short notice, and it should not be assumed that the forward users have a complete knowledge of the tactical picture or mission status.

Secondarily, RSTA data gathered through the HURT system would be very valuable in order to populate and disseminate a real-time urban combat tactical picture. Such intelligence gathered by HURT would then be valuable at higher levels in the command hierarchy, but the use of this data for command decisions at the HURT operational level is not of concern for HURT technology development.

D.1.3 The HURT Controller

In this section, the term "HURT controller" is taken to mean the Planning and Control component. This component performs the allocation of RSTA resources to service requests, creates a plan for scheduling and executing the tasks necessary to fulfill these requests, translates this plan into commands that can be directly communicated to the native platform controllers, and monitors execution. It re-plans as necessary, and is also responsible for the correct routing of acquired RSTA data back to the user.

It is assumed that this controller is resident in the HC3, which is in a remote location relative to the high threat AO under which the users operate. This affords the system the luxury of hard-wired data links, safe shelters, and access to adequate power and

computational resources. Also available at the HC3 is connectivity to any intelligence or status data that the commander may need to direct the operation.

D.1.4 Components Outside of the HURT Concept

For complete operation of the system, certain advanced technical capabilities will be assumed that are either in development through other programs, are in acquisition, or are otherwise likely to be available by the time that HURT is adopted for operational use. This section discusses limitations and bounds on the HURT concept and which should limit the scope of proposals.

1) **Platform Technologies**: As discussed above, HURT will not fund the development of platform mobility, on-board autonomy, or other purely platform-based technologies. The capabilities that HURT adds to a team of vehicles will be purely by virtue of off-board control.
2) **Exploitation Algorithms**: Although the platforms may have on-board exploitation capabilities (such as sensor fusion, feature recognition, or ATR), and such algorithms will be useful for sensor interpretation at the HC3, HURT will not fund direct development of these algorithms. However, the HURT Platform Modeling component should include the concept of an *exploitation proxy*. An exploitation proxy can be considered an abstract functional model of an exploitation algorithm, so that the Planning and Control component can *plan* to take advantage of these capabilities by understanding their function from an input/output perspective. For example, a user might request a time-lapse replay of a scene, or a change detection analysis, and the HURT system should know how to invoke such a capability. These capabilities will be implemented in the system demonstrations and experiments, but they will not be developed within the program.
3) **Human-Machine Interface**: Human-Machine Interface (HMI) issues will arise between the user, operator and commander of the HURT system. Although a working demonstration of the HURT system cannot be realized without robust interfaces, developmental interface technologies such as multi-modal input/output, visualization, natural language understanding, 3-D imaging, etc., are not considered part of the HURT effort. It is assumed that offerors will include the most appropriate technologies *currently available to them* when proposing these HMIs. Similarly, human workload analyses and effectiveness studies will not be part of HURT, except that any interface proposed as part of HURT must be minimally able to accept the full range of tactical RSRs that might be developed within HURT without extraordinary effort on the part of the user. For example, an existing voice recognition input with a limited vocabulary and structured syntax to be used as an input mechanism would be an acceptable concept to propose.

D.2 MANAGEMENT CONCEPT

D.2.1 Program Elements

This solicitation requests ideas in four topic areas: three technical component development efforts, and one system-level integration effort:

- **Topic Area 1: User Management:** Design and construct the user interface mechanism, implementing tactical commands from a nominal original set that supports the Phase 1 demonstration plan (Section D.3) and augmenting them throughout the program. Develop the mechanism for accurately prioritizing, queuing, and determining necessary quality-of-service parameters for user requests so that the best service can be achieved subject to commander's guidance for mission achievement.
- **Topic Area 2: Platform Modeling:** Develop and implement the common capability representation, to include platform mobility, sensor models, and the semantics of any on-board autonomy, exploitation, or interoperability that might be available. The representation must be compatible with the Planning and Control component.
- **Topic Area 3: Planning and Control:** Determine and implement an appropriate planner, task allocator, and controller that accurately matches prioritized user requests with available RSTA team services. Perform plan monitoring, real-time re-planning, plan repair or a contingency capability for robustness, and manage the return of RSTA data en route back to the user.
- **Topic Area 4: System Integration:** Formulate a systems architecture for all the component technologies and assemble the pieces into a coherent, scalable, maintainable, and robust system, with the necessary native platform controller interfaces and data interfaces between all HURT internal components. Include communications management as necessary. Interface with military test sites to perform experiment coordination, design, verification/validation, range safety, and data/metrics definition and gathering. Coordinate and lead the field experiment components on behalf of the whole HURT team.

Efforts in all four topic areas may assume the availability of 1) a MOUT test site on a military base; 2) support for integration of HURT experiments with MOUT test site infrastructure and instrumentation; and 3) subject matter experts who can provide detailed explanations and advise on urban combat tactical operations and autonomous vehicle concepts of operations (CONOPS). It is also anticipated that the government will provide vehicle platforms subject to availability.

Teaming is encouraged. Offerors can propose to more than one area, but work performed in each area must be structured as a distinct work effort, with separate pricing. Offerors proposing to more than one area will have a limited number of pages to dedicate to each distinct topic area proposed. The topic areas covered by the proposal must be clearly identified on the cover page and in the text.

DARPA anticipates making up to four awards, selected so that all technical areas and the systems integration task are completely covered without duplication. It is anticipated that DARPA will make approximately $40 million available to fund HURT.

D.2.2 Government Team

DARPA intends to empanel an advisory team consisting of members from military science and technology laboratories, combat and UAV operational units, and senior

commanders. This team will be responsible for advising both the DARPA program office and the HURT researchers on urban combat operations, HURT-enabled tactics, techniques, and procedures (TTPs), and concepts of operations. The government team will also assist with test event planning and site arrangements, as well as interfacing to operational units and transition partners. HURT researchers may assume that the government team's advice and assistance will be available throughout the program. Individual members of the government team cannot also be part of a researcher (performer) team.

D.2.3 Program Phases

HURT will be conducted in three phases, lasting 14 months, 16 months, and 18 months. Bidders should propose tasks for all three phases, but funding for later phases is entirely contingent upon meeting system-level performance goals established for earlier phases. System-level performance goals appear in Section D.3.

1) **Phase I – Remote Autonomy:** HURT must demonstrate that coordinated autonomy can be achieved through control by the external (i.e., off the platforms) HURT system. This will require coordinated flight in a small MOUT site with large, well-known obstacles. The system will have to accomplish the simultaneous tasks of persistent wide-area surveillance and the ability to dispatch a sensor to a single user-designated point for a rapid-reaction close-up look ("911 response"). For planning purposes, assume Phase I extends from June 1, 2004 through July 31, 2005 (14 months).
2) **Phase II – Collective Autonomy:** The HURT system must manage diverse assets such that they achieve the collaborative task of maintaining a moving area of regard (AOR) around a moving ground target (e.g., to follow a suspect vehicle, or to maintain a moving zone of blue-force protection). These tasks will be in addition to the tasks in Phase I. For planning purposes, assume Phase II extends from August 1, 2005 through November 30, 2006 (16 months).
3) **Phase III – Tactical Autonomy:** Through continued consultation with the military user community, develop, implement, and experiment with operationally critical tactical commands to the system. These tactical scenarios for HURT should illustrate the spectrum of collaborative platform control capabilities, and at a minimum must demonstrate the system's ability to manage multiple users with conflicting priorities, demonstrate robustness to platform attrition, and implement a line-of-sight (LOS) communications infrastructure to a specified point. Other command examples might include:

   - "Monitor <designated area>"
   - "View <Coordinate> from <perspective>"
   - "Search <feature> for <pattern>"
   - "Map area defined by <bounds>"

   For planning purposes, assume Phase III extends from December 1, 2006 through May 31, 2008 (18 months).

D.2.4 Integration of Component Technologies for Demonstration

The HURT researcher team must participate in a preliminary design review (PDR) six months after the beginning of each phase, and a critical design review (CDR) six weeks prior to each end-of-phase demonstration. These reviews will be coordinated by the Systems Integrator and must be conducted collaboratively. Each technical component should deliver software, in accordance with the System Integrator's architecture and procedures, for integration into the HURT system approximately two months prior to each HURT demonstration. The demonstrations will occur approximately two months before the end of each phase, in order to allow time to assess the results and prepare for subsequent phases.

D.2.5 Simulation and Testing

It is anticipated that researcher-furnished vehicle platforms, as well as possibly government-furnished platforms and MOUT test site access, will be available for live-flight testing at pre-arranged mid-phase times, but that not all vehicles nor test sites will be available on-demand at other times. Offerors should ensure that their technology development process includes either simulation or local testing sufficient to verify the function of their component(s) throughout the course of each phase.

D.2.6 Experiment Design and Evaluation

With the System Integrator as lead, the experiment/demonstration at the end of each phase must be carefully designed and conducted in order to quantitatively assess progress toward the program goals, which are defined in section D.3. The culminating event for each phase will provide the program manager with performance measures necessary to justify additional phases, and should also include measures of performance that can be fed back to the individual technology component providers as indicators of the effectiveness of their component designs.

D.2.7 Technology Transition

The HURT program will be conducted with the advice and assistance of the Marine Corps Warfighting Laboratory (MCWL), headquartered at Quantico Marine Base, Virginia; the First Marine Expeditionary Force (1MEF), headquartered at Camp Pendleton, California; the Dismounted Battlespace Battle Lab (DBBL), headquartered at Fort Benning, Georgia; the Air Force Special Operations Command (AFSOC), and the Special Operations Command (SOCOM), headquartered at MacDill Air Force Base, Florida. These organizations represent the likely first adopters of HURT technology. Technology planning and development that requires models of specific organizational units may consider these units as prototypical. Note that HURT functionality does not conform to existing UAV doctrine and CONOPS; it is a goal of HURT to generate entirely new TTPs for the employment of autonomous RSTA assets.

Technology transition support will be provided by the Naval Air Systems Command (NAVAIR), Patuxent River Maryland; and the Air Force Research Laboratory (AFRL), Wright-Patterson Air Force Base, Ohio. Additional military units will be invited to participate and transition HURT technologies as the program progresses.

D.3 PROGRAM METRICS

Progress of the HURT program will be assessed near the end of each phase. In addition to component-level assessment metrics to be proposed by each component developer and by the Systems Integrator, these metrics gauge progress of the program for DARPA management, and provide the basis for continuation of funding for the program.

The HURT program will measure its progress by new capabilities introduced in each phase as shown in Table 1, as well as by quantitative effectiveness measures based on a fixed operational scenario, common to all phases. The fixed scenario includes the simultaneous conduct of blanket surveillance of an area, with event-triggered "911 response" to get eyes-on to an *a priori* unknown location. For this scenario, DARPA will use the following metrics to assess progress at the end of each phase:

1) **Autonomous Coverage:** This metric tests primarily the collaborative control capabilities of the system. Can the system successfully control a sufficient number of vehicles that a MOUT test site can be covered with blanket surveillance of every street, continuously and with minimal operator intervention? This will be measured in terms of the ratio of human operators required per vehicle. Fewer is better.
2) **Rapid Response:** This metric tests the re-planning and response time of the system. While the surveillance is maintained, the system must make available, on user request, a quick look "911 response" to a specific location within the AO. This will require the dispatch of an appropriate platform from the team to the requested location. The response time will be measured from the time of issue of the request to the time that the quick-look image is available. Faster is better.
3) **New Platform Integration:** This metric tests the efficiency with which platforms are modeled. In order to test how completely and easily a new platform and its capabilities can be integrated into the team, a new platform in a "sealed envelope" will be delivered to the team and the time it takes to read, register, and install its model will be measured. Faster is better. Note that the model need not be developed on-line; it will be delivered with the platform.
4) **Prioritization:** This metric tests the ability of the system to accurately prioritize and queue user requests in such a way that the actions taken by the team conform to the commander's intent. A confusion matrix will be generated that measures the number of user requests that conform to commander's intent and which are granted high priority, along with the number of user requests which conflict with commander's intent, and which are denied or assigned low priority. A higher percentage of correct responses is better.

All of these metrics will be assessed at the end of each phase.

In addition, new system capabilities are required at each phase, as indicated by Table 1, which corresponds to the goal of each phase as defined in Section D.2.3.

Table 1. Experimental scenarios for each phase, introducing new capabilities in each.

14 months	*16 months*	*18 months*
Phase 1	Phase 2	Phase 3
Remote Autonomy *HURT must demonstrate coordinated augmented autonomy*	***Collective Autonomy*** *HURT must manage collective tasks in a dynamic environment*	***Tactical Autonomy*** *HURT-controlled teams must effectively serve warfighters in tactical scenarios*
• = 3 air vehicles plus stationary sensors • .5km X .5km continuous street area coverage of MOUT site with portal revisit rate = 5 min. • Vehicles 100% autonomous (except for failure recovery) • Single user	• = 6 mixed vehicles in pool • Autonomous group behaviors: – coordinated search – maintain moving urban AOR with targets moving 50mph (human-assisted designation) • Autonomous track handoff • Two users	• = 8 mixed vehicles in pool • Mixed control capability: multiple users with overlapping requirements – LOS connectivity – Viewpoint maintenance • Fault tolerance: 10% comms dropouts and 50% platform degradation

Table 2. Summary of HURT phased metrics, in addition to the new capabilities introduced in each phase as shown in Table 1.

METRIC	PHASE I REMOTE AUTONOMY	PHASE II COLLECTIVE AUTONOMY	PHASE III TACTICAL AUTONOMY
Autonomous Coverage (operators per vehicle)	2	1	1/4
Rapid Response (time to eyes-on)	5 minutes	2 minutes	1 minutes
New Platform Integration (time from delivery of "sealed envelope" to operational use)	4 hours	1 hour	0.5 hours
Prioritization (percentage of prioritizations in compliance with stated mission objectives)	80%	90%	95%

E TECHNICAL OBJECTIVES

E.1 USER MANAGEMENT

E.1.1 Scope

The purpose of the User Management component is to ensure that the Planning and Control component has quantitative mission-valued metrics for each RSR that accurately and appropriately reflect progress toward to the mission goals, as defined by a commander's guidance.

Elements of the User Management component span the system boundaries, in the sense that some elements will reside on the user, and some at the HC3. They should include, at minimum:

1) The request input and feedback device and protocol, including a means to supply variable arguments such as named areas of interest.
2) A means for a user to assign local priorities to multiple requests.
3) A method through which the mission status can be communicated to the commander, and the commander's multi-dimensional guidance can be unambiguously captured and represented to the HURT system.
4) An algorithm for reconciling *m* requests from *n* users, arriving at a priority ordering of all requests that is compliant with the commanders guidance and all other constraints, and can be processed by the Planning and Control component when creating the plan in order to optimize the value of the services performed, and the qualities with which they are performed.
5) An algorithm for aggregating "common" requests; i.e., bundling RSRs that can be served with common asset controls.

E.1.2 Technical Challenges

This component has many dimensions and is complicated by operational factors such as situation awareness (SA) fragmentation, OPTEMPO, and uncertainty (the "fog of war"). In particular:

- **Embedded warfighter workload:** While it is not a goal of HURT to design non-interfering multi-modal interfaces to the warfighter, it is a requirement that HURT serve a warfighter whose immediate need includes self-protection and not RSTA asset operation. The warfighter should therefore be provided with the ability to fully exploit HURT capabilities while recognizing the need for a natural, efficient interface.
- **Fragmented SA:** While it may be feasible to create a complete ordering of user requests for users with a common operational picture, a single common purpose, and a rational decision process, it must be remembered for the HURT User Management component that the users, while all agents of the commander, are

in different threat environments and have only local situation awareness. They may be able to make decisions (i.e., issue requests) consistent with an original operation order, but as they become fragmented, so does the universe in which their best judgment is applicable.

- **Dynamics and Uncertainty:** The urban AO is characterized by short distances that are quickly traversed by vehicles and projectiles and which, when altered by battle, present rapidly changing and highly uncertain local environments to the warfighter. It must be assumed in HURT that the rate of change of the environment is on the order of seconds, and that the data a user or commander relies on as a basis for RSRs and prioritization may have a "freshness" and "certainty" that can affect progress toward mission goals.
- **Commander's Guidance:** The commander should be able to express mission guidance symbolically so that RSRs can be processed and prioritized, automatically, not as a task for the commander. Guidance can include such dimensions as target values, filters, areas of special interest, data currency and recency constraints, or exclusions (for example, "do not approach the radio building; it will alert them of our presence, and we are using them for intel").

User Management in HURT should account for environmental and operational realities of urban combat. It should embody a quantification and processing methodology that attempts to maximize overall measures of mission effectiveness, and must not result in a simple first-in-first-out queuing that satisfies greedy goals at the expense of the mission. Of course, it must be remembered that the executors of the mission plan are the embedded warfighters, so neglect of their individual requests in favor of a centrally decided RSTA plan is a strategy doomed to failure. The User Management component should be considered a pre-processing element that filters user requests according to mission (i.e., commander's) criteria, and produces a quantitative mission value function over the set of these RSRs suitable for processing by the Planning and Control component.

E.1.3 User Management Metrics

Proposers should describe a self-evaluation plan coordinated with, but extending beyond, the system evaluation described in Section D. User Management metrics may include, but should not be limited to:

- **Usability:** The efficiency with which a user can enter a complete command, and receive returned information, measured as the time necessary to ask for and receive RSTA. Faster is better.
- **Dimensionality:** The number of user-requests (#users x #requests) to which the system can assign mission-valued priorities per unit time. Higher is better.
- **Robustness:** The degree to which mission effectiveness is maintained despite changes in user requests and user priorities.
- **Responsiveness:** A user is likely to be most satisfied with the system when it performs as if he is the only user, given the impression of dedicated services. A

responsiveness measure might gauge the performance difference between single-user performance, and performance when the system is more heavily loaded.

- **Mission Effectiveness:** The extent to which mission-values assigned to RSRs correspond to mission effects and goals as established and evaluated by the commander.

E.2 PLATFORM MODELING

E.2.1 Scope

The purpose of the Platform Modeling component is to abstract and formally represent the capabilities of the RSTA platforms. These models must include the description of their mobility sufficient for the Planning and Control component to accurately control platform motion, but must also include a description of the on-board sensor package. High-level behaviors, if present, must also be modeled. High level behaviors for mobility might include on-board navigation or see-and-avoid algorithms. High-level behaviors for the sensor payloads may include on-board post-processing, exploitation, or compression.

The compiled set of platform and associated sensor models will need to be described in a language that can be easily communicated, is machine-readable and processable, and has close correspondence with the operations that the Planning and Control component will use in order to match capabilities with requests.

The representation for the capabilities will need to take a standardized form, so that in the future, any platform can join a HURT team simply by providing the HURT operators with a CD-ROM installation disk containing the "virtual" capability model of the platform. Thereafter, the HURT system will know how to use the platform in a team, because all of its behaviors are understood and symbolically represented. This is also true for existing platforms; i.e., they should be able to integrate into a HURT team with ***no*** alterations to the platform itself.

The representation will also be invertible, in the sense that when a plan is complete, a translator will be required in order to convert ordered plan elements back into the native command language of the platform. It is to be assumed that the neither the platforms nor their control stations will have embedded translators from the HURT capabilities representation; the HURT system must talk to each system in its own language.

E.2.2 Technical Challenges

An analogy can be made between a platform model and a "RSTA device driver," in the sense that the abstract platform model contains all of the information necessary to include the platform in an interconnected system. While this is an accurate way to think of the installation procedure for a new platform, some features of autonomous platforms and the HURT system make this analogy incomplete:

- **Autonomy:** It is a goal of HURT to integrate *any* platform into the system and use it to best serve the warfighters' RSTA needs. A survey of the current state-

of-the-art in platform autonomy indicates vehicles with diverse autonomy levels. These levels span capabilities such as autonomous navigation and problem-solving, team-forming, and on-board sensor-based behaviors. For HURT to take best advantage of such systems, it must understand how to task such behaviors at high levels. However, planning and control based on autonomous behaviors may be much more complex than planning based on atomic actions.

- **Non-Determinism:** Often associated with autonomy are estimation and decision-making algorithms, which are often non-deterministic in the actions they take and the execution times for each action. The HURT Planning and Control component must take this into account when planning tasks, so it must possess a characterization of such behavior.
- **Constraints:** Associated with real-world assets are real-world constraints. Many small vehicles suitable for use in confined spaces lack significant endurance, have a very high detectability signature, and have low-power transceivers, all of which constitute constraints that no planner/controller can afford to neglect.
- **Diversity:** The diversity in the platforms itself is a complicating factor for the Platform Modeling and Planning and Control components. While it might be easier to design a modeling language that expresses only the most atomic behaviors, such as one might use for simple non-autonomous ground sensors, a highly autonomous vehicle such as a UCAV or UCAR is not efficiently represented by merely atomic actions. It would be cumbersome to task such a vehicle by specifying a series of low-level atomic actions, when they are designed to accept and respond to high-level commands. The HURT system must represent and process a wide dynamic range of autonomous behaviors within the same processing system.
- **Exploitation Proxies:** An exploitation proxy is the representation of a data processing capability, such as a target identification, tracking, sensor fusion operation, change detection, or simple image filtering operation. Users will want to take advantage of these capabilities wherever they reside. HURT must know when they exist, how they are used, and how they can be incorporated into an effective plan.
- **Data-Driven Actions:** Just as the output of an exploitation algorithm is dependent on the scene with which it is presented, the behaviors of the HURT platforms will be sensitive to the data to which they are exposed. For example, a team of vehicles may be tasked to follow a moving ground target and report when and where it stops. In order to accomplish this task, they will need a shared understanding of *what* the target is (in their own terms, of course), and a *policy* for coordinating their actions, based on what the target does. Many vehicles will not possess the capability to perform such coordination with on-board processing (if they *can*, then this capability should be exploited – see below), so the HURT system will need such a capability.

Two critical issues for the Platform Modeling component are expressivity and extensibility. HURT requires a representation of capabilities that can express any RSTA platform anticipated for use in the program, plus any RSTA platform likely to emerge in the future.

E.2.3 Platform and Sensor Modeling Metrics

Proposers should describe a self-evaluation plan coordinated with, but extending beyond, the system evaluation described in Section D. Platform and Sensor modeling metrics may include, but should not be limited to:

- **Expressivity:** What percentage of the available behaviors of any platform is expressible by the HURT model of it? Higher is better.
- **Extensibility:** How easily and quickly can a new concept in autonomy or platform behavior be described in the HURT representation? Faster is better. How easily can the HURT pl Planning and Control component use these capabilities to serve the users? A new representation that is used often by the HURT system is better.
- **Efficiency:** In order that the representation of models remain bounded in complexity, and models of new platforms remain compact, how long a record does it take to fully express a platform capability? Shorter is better.
- **Model Library:** In order to test HURT, a library for HURT test vehicles will be required. How long does it take a developer to completely write and package a platform and sensors model? Faster is better.
- **Translator:** A HURT plan must be translated into platform-specific commands by a technology developed by the platform modeler. How quickly can a well-formed HURT plan be translated into a correctly-formed platform task, ready for execution by the platform? Faster is better.

E.3 PLANNING AND CONTROL

E.3.1 Scope

The Planning and Control component performs several functions within the same algorithmic framework. It performs all of the following functions, summarized by Figure 2.

1) It maintains a repository of platform and sensor models, as installed when each vehicle joined the team.
2) It receives a non-periodic stream of prioritized user requests. The priorities are fixed by the User Management component and may represent constraints on the plans to be generated.
3) It generates one or more feasible plans that can be translated into vehicle commands that will result in the requested information being returned to the appropriate user within a requested time bound.

4) It should adapt to changes in the environment, changes in the team composition, changes in platform health and status, and changes in user requests in real-time. This can be done through contingency planning, plan-repair, and dynamic replanning.

5) It passes fully validated and sequenced plans through translators (provided by the Platform Modeling component), then transmits the commands for timed execution by the platforms.

6) As sensor data is returned through the platforms, through their ground stations, and to the HC3, the appropriate data is further processed if necessary and routed to the appropriate user.

7) Additionally, status data (e.g., "still gathering image of stadium…") is returned to the user as needed.

The Planning and Control component is central to the operation of the HURT system, acting as the coordinating controller for multiple platforms, but also as the resource manager and information manager, connecting the users and operators to the information being gathered. It is critical that these processes be performed in real-time, which is defined in terms of seconds or less. Plans should be efficient, robust, and manageable by the HURT operator and the commander at the HC3.

E.3.2 Technical Challenges

The HURT Planning and Control component must perform these tasks in dynamic, uncertain environments and with input and output data that is unique to the HURT concept:

- **Planning with Autonomy:** Just as the representation of autonomy is a significant challenge for the Platform Modeling component, the *manipulation* of autonomy will be required by the HURT Planning and Control component. The capabilities to be selected, ordered, and allocated by HURT will span a diversity of levels of abstraction, and an efficient planner will work with these without necessarily decomposing them into atomic units, which would then be difficult or impossible to re-compose into autonomous behaviors that the platform can accept as a single command.

- **Planning with Diversity:** Also discussed in the context of Platform Modeling, it is important that the diversity in autonomy between component platforms be recognized in the design of the Planning and Control component. Some simple vehicles in use today have analog, radio-controlled interfaces, others accept waypoints, and others accept continuous trajectories. If a vehicle requires HURT control to navigate the urban environment, the Planning and Control component must provide that explicit control. If a vehicle is capable of getting from point *A* to point *B* in the urban environment without further detailed control, the HURT system must not attempt to take over low-level waypoint control.

- **Fault Management:** A key feature of HURT is that it must be seen by the user as a stable interface to a set of services. The operational behavior and control of the platforms should be completely transparent to users. As a result, platform

attrition, faults, communications channel variations, and the uncertain, dynamic environment should have as little effect on the user services as possible. This requires a robust real-time capability to re-configure and repair information-gathering processes. If necessary, it must inform the user when a delay due to re-configuration is in progress. The system must also execute contingency plans so that platforms have fall-back behaviors in the event of lost communications, exceeded range, etc.

- **Plan Monitoring:** The HURT operator(s) and commander at the HC3 must have visibility into the status of the current plan at any time. It must be apparent to the commander how the system is serving his forces, and he must have the opportunity to mediate planning conflicts and mutually exclusive user requests by issuing real-time command guidance. The operators must also have visibility into the system execution, monitoring system health and progress, viewing and processing the returned images, and taking pre-emptive actions when hazardous situations arise. A condensed form of status must also be transmitted to the users, who must get acknowledgements of their requests, estimated time for data return, and information on system data or capabilities that may or may not be available.

Above all, it must be remembered that the HURT system is providing real-time information necessary to the embedded warfighter, so that reliability and robustness are critical features.

E.3.3 Planning and Control Metrics

Proposers should describe a self-evaluation plan coordinated with, but extending beyond, the system evaluation described in Section D. Planning and Control metrics may include, but should not be limited to:

- **Command Latency:** Given a set of formally-expressed capabilities, the time necessary to construct a correct plan and deliver it through the translators to the platform ground stations for execution. Faster is better.
- **Information Latency:** Given a data stream provided by one or more RSTA platforms, the time necessary to post-process and deliver that data to the requesting user. Faster is better.
- **Robustness:** The time necessary to correct a plan or re-construct a new feasible plan in the event of the complete failure of platform or sensor components. Faster is better.
- **Adaptability:** The degree to which a plan in progress can be displayed to and understood by the commander and operator, who can then alter the plan or system parameters, after which it re-commences. Faster is better.
- **Utilization:** Given that the capabilities repository contains low-and high-level behaviors of all the platforms, it is assumed that plans consisting of high-level behaviors will be more efficiently executed than low-level behaviors. This metric

assesses the degree to which HURT takes full advantage of each platform's most automated behaviors. A predominance of high-level behaviors is better.

E.4 SYSTEM INTEGRATION

E.4.1 Scope

The purpose of the System Integration component is to

1) Interface the other components and synchronize HURT researcher team activities by establishing schedules and interface documents. This is especially important in the cross-cutting areas such as the commander's guidance prioritization technique, (provided by the User Management component, but implemented within the HC3), and the command translators (designed by the Platform Modeling component, but implemented with an interface to the Planning and Control component outputs).
2) Design and implement a system architecture in which all of the components are implemented, with additional para-functional execution management and system control. The software architecture should be modular, maintainable, and extensible. The hardware architecture should be compact, affordable, and suitable for use in the field, within a protected shelter, structure, or tent.
3) Design and implement the operator's and commander's interfaces, to be resident in the HC3. These must provide functional control of the Planning and Control component, and must allow the commander to express mission guidance in accordance with a format required for use by the User Management component.
4) Design and implement a communications infrastructure so that RSRs can be reliably issued and acknowledged (if supported by the platform). It can be assumed that wideband links will be feasible between the HC3 and the native platform controllers.
5) Prepare and coordinate the preliminary design reviews (PDR) and critical design reviews (CDR), six months after the start of each phase, and six weeks prior to each demonstration, respectively (see Section D.2.4).
6) Provide and manage a set of HURT platform vehicles, maintaining them and their models for experimental use. Interface with the government and service lab participants in coordinating the use of government vehicles, personnel, and facilities.
7) Perform experiment design and execution support, leading the HURT researcher team integration, through verification, validation, range safety, and execution.
8) Implement and integrate additional information management capabilities, such as image compression, image processing, archiving and playback, data mining, and search capabilities that the user can request.
9) Collect metrics and analyze experimental data. Experimental data must support other researchers in the assessment of their component-level metrics, and must support the DARPA program manager in support of program-level metrics necessary to progress to the next phase of the program.
10) Interface to existing user equipment and TTPs for interoperability.

The System Integration component is more than an integrator of component technologies. Those technologies are to be developed to address focused functionality independent of system architecture, and it is the System Integrator that designs the HURT system concept and makes it reality.

E.4.2 Technical Challenges

- **Data Management:** The platform capabilities, as represented to the system by the Platform Modeling component, must be maintained in a state useful for the Planning and Control component. If those representations include such states as fuel or other resource availability, the database of capabilities must be correspondingly maintained.
- **Platform Management:** It is expected that the System Integrator will select, maintain, and operate HURT platforms. Platforms suitable for urban RSTA must be evaluated, and information necessary to model them must be provided to the Platform Modeling component.
- **Infrastructure Services and Utilities:** The HURT architecture should be efficient and reliable, and should impose minimal latency or quality degradation on the information being routed from the platforms to the users. The HURT system should provide service utilities to the users and operators, such as startup and maintenance procedures, new platform installation procedures, and status checks. HURT should also provide information utilities such as old-record lookup, video archive replay, history information, and data processing algorithms that are only feasible to implement at the HC3 (such as multi-platform scene mosaicking).
- **Operator and Command Interfaces:** While the operator is trained in the structure and function of the HURT system, the commander may not be. Therefore an execution and process monitoring system useful to an operator may not be an efficient way for the commander to see the mission and provide guidance. This must be provided as two distinct interfaces.
- **Experiment Design:** The HURT program will have well-defined program goals, and the component researcher teams will have well-defined project goals. Each level must be assessed during each experiment. The overall effectiveness of the system must be functionally related to the performance of the component parts, so that successful and unsuccessful design choices can be correctly attributed and recommendations made for subsequent phases.
- **Service Organization Interfaces:** As the experiment designer and coordinator, the Systems Integrator will be the lead researcher interface to the government team, which consists of the HURT program office, technical agents, operator communities, and experimental test site personnel.

E.4.3 System Integration Metrics

Proposers should describe a self-evaluation plan coordinated with, but extending beyond, the system evaluation described in Section D. System Integration metrics may include, but should not be limited to:

- **Processing Latency:** Given a user request or a RSTA data set, the time to process and deliver it to the platforms or the user, respectively. Faster is better.
- **Usability:** Ease of use is essential for the commander and necessary for the operators, who will be dealing with multiple data streams. This can be measured in terms of training time. Faster is better.
- **Safety and Deconfliction:** Provide guarantees that platforms operating in a common airspace will neither collide with obstacles, nor with themselves. Measure in terms of 4-D minimal distance. Smallest distance with surest guarantee is best.
- **Maintainability and Extensibility:** The system design comprises developmental component technologies that are subject to change and upgrade. Time to revise, debug, and upgrade major components should be minimal.
- **Installation:** Time to install the capabilities of a new vehicle, from delivery of its capability database to availability of its services to the Planning and Control component. Smaller is better.

E.5 COLLABORATION

The HURT researcher team will be expected to collaborate for system integration and demonstration purposes, but each will be responsible for their own self-assessment and test reporting for each phase. Proprietary technologies or intellectual properties that a researcher desires to withhold from the team should be explicitly identified in the proposal.

A kickoff meeting will be conducted shortly after contract award. The kickoff, PDRs and CDRs will be group meetings.

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 FedBizOps BAA 04-05, constitutes a Broad Agency Announcement as contemplated in the FAR 6.102 (d)(2)(i). The FedBizOps announcement and this document are available online at **http://www.darpa.mil/baa/**.

F.1.2 BAA correspondence

All questions pertaining to this BAA and PIP may be submitted to DARPA at the following e-mail address: BAA04-05@darpa.mil. DARPA may post updates to questions or comments periodically to the solicitation website: http://www.darpa.mil/ixo/solicitations/hurt/index.htm. If e-mail is not available, please fax questions to 703-741-7853 (Attention: Jessica Greenhalgh). All requests must include the name, address, and phone number of a point of contact. Technical and contractual questions should include the originator's full name, email, and postal address in the text.

F.1.3 Frequently asked questions

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

F.1.4 Award(s)

This BAA affords proposers the choice of submitting proposals for the award of a Grant, Cooperative Agreement, Technology Investment Agreement, Contract, or Other Transaction for Prototype Agreement, or any other appropriate award instrument. The type of award instrument is subject to negotiations.

Proposers may choose to respond to any one, all, or any combination thereof, of the four (4) topic areas identified herein. However, as it is likely that multiple awards will be made against this BAA, it is critical to the success of the HURT program that proposers be prepared to carry out their selected research as a fully integrated member of the HURT team. Open communication, to include the ability and willingness to interchange information/data and ideas among the team members (to Government team members), will be a necessity for all awardees. Proposers are required to address this issue in their proposal, affirmatively stating their ability and willingness to operate in this manner.

F.1.5 Proposers

The government encourages proposals from non-traditional defense contractors, nonprofit organizations, educational institutions, small businesses, small disadvantaged business concerns, Historically-Black Colleges and Universities (HBCU), Minority

Institutions (MI), large businesses and Government laboratories. Teaming arrangements between and among these groups is also encouraged. However, no portion of this BAA or PIP will be set aside for HBCU and MI participation due to the impracticality of preserving discrete or severable areas of research in the technologies sought. Government/National laboratory proposals 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 05-261 § 3136. Any responsible and otherwise qualified proposer is encouraged to respond.

F.1.6 Eligibility

This BAA solicits proposals from all interested and qualified sources. Foreign participants and/or individuals may participate to the extent that such participants comply with any necessary Non-Disclosure Agreements, Security Regulations, Export Laws, and other governing statutes applicable under the circumstances.

F.1.7 Period of Performance

The HURT program is divided into three successive phases of 14, 16 and 18 months. The total HURT program duration is 48 months. While the earliest anticipated award is planned to occur in the third quarter of Government Fiscal Year 2004, the government may select for funding, subject to successful conclusion of negotiations, a proposer's entire proposal or portions thereof at any time. The total period of performance for the effort (to include all four topic areas) is anticipated to be 48 months. The Government may incrementally fund any awards under this BAA and PIP.

F.1.8 Program scope and funding

The Government anticipates multiple awards under this BAA. Proposers should offer the best possible solutions bringing together the best possible talent, investigative research effort, and techniques to offer solutions that may be used to meet the HURT program goals/objectives. It is anticipated that DARPA will make available approximately $40 million to fund HURT over the entire four-year program. Funding will be established based on accepted proposals.

This information is provided strictly to assist proposers in the development of their research solutions. The government reserves the right to change some, all, or none of these values, as it deems necessary.

F.1.9 Multiple-technology proposals

Offerors responding to multiple areas of this BAA should describe each topic area of the proposed work as a distinct work effort, separately priced in the cost section. Each technology component should stand alone, not be predicated on the award of any other effort or component. Proposers should bid efforts for all three program phases in the same proposal, and a budget for each phase should be included in the Cost Proposal.

F.1.10 Contract types

This BAA affords proposers the choice of submitting proposals for the award of a Grant, Cooperative Agreement, Technology Investment Agreement, Contract, or Other Transaction for Prototype Agreement, or any other appropriate award instrument. The type of award instrument is subject to negotiations.

F.1.11 Limitations on Other Transaction Authority for prototype projects

Proposers that submit an Other Transaction (OT) for Prototype Agreement for consideration, are advised that an OT for Prototype Agreement may be awarded if the following is applicable:

1. There is at least one nontraditional defense contractor participating to a significant extent in the prototype project, or
2. No nontraditional defense contractor is participating to a significant extent in the prototype project, but at least one of the following circumstances exists:
    a. At least one third of the total cost of the prototype project is to be paid out of funds provided by the parties to the transaction other than the federal Government. The cost share should generally consist of labor, materials, equipment, and facilities costs (including allocable indirect costs).
    b. Exceptional circumstances justify the use of a transaction that provides for innovative business arrangements or structures that would not be feasible or appropriate under a procurement contract.

NOTE: For purposes of determining whether or not a participant may be classified as a nontraditional defense contractor and whether or not such entity is participating to a significant extent in the prototype project, the following definitions and guidelines are provided:

"Nontraditional defense contractor" means a business unit that has not, for a period of at least one year prior to the date of the OT agreement, entered into or performed on:

(1) any contract that is subject to full coverage under the cost accounting standards prescribed pursuant to section 26 of the Office of Federal Procurement Policy Act (41 U.S.C. 422) and the regulations implementing such section; or
(2) any other contract in excess of $500,000 to carry out prototype projects or to perform basic, applied, or advanced research projects for a Federal agency that is subject to the Federal Acquisition Regulation

"Participating to a significant extent in the prototype project" means that the nontraditional defense contractor is supplying a new key technology or product, is accomplishing a significant amount of the effort wherein the role played is more than a nominal or token role in the research effort, or in some other way plays a significant part in causing a material reduction in the cost or schedule of the effort or an increase in performance of the prototype in question.

NOTE: Proposers are cautioned that if they are classified as a traditional defense contractor, and propose the use of an OT for Prototype Agreement, the government

reserves the right to require submittal of both a cost proposal under the guidelines of the FAR/DFARS, in addition to any cost proposal submitted in support of the use of an OT for Prototype Agreement, so that an evaluation may be made with respect to the cost tradeoffs applicable under both situations. Furthermore, the government reserves the right to negotiate either a FAR based procurement contract, or Other Transaction for Prototype Agreement as it deems is warranted under the circumstances.

F.2 SUMMARY OF IMPORTANT DATES

Table 3. Significant BAA events and deadlines provides a schedule of important events and dates associated with the HURT BAA:

DATE	EVENT	URL
24 October 2003	FedBizOpps Announcement for Briefing to Industry	http://www.darpa.mil/baa/rn04-01sn.htm
20 November 2003	DARPA Briefing to Industry on proposal process and BAA technical topics	http://www.tfims.darpa.mil/BTI/industryhome.asp
30 January 2004	Proposal registrations due at DARPA	http://www.tfims.darpa.mil/baa
13 February 2004 12 PM ET	Proposals due at DARPA	http://www.tfims.darpa.mil/baa
1 June 2004	Selections announced	
15 June 2004	Kick-Off meeting	

Table 3. Significant BAA events and deadlines

F.3 SUBMISSION GUIDELINES

Proposal abstracts ARE NOT requested in advance of full proposals. DARPA/IXO requires use of its BAA Tool. The tool is intended to facilitate an electronic process beginning with the proposal uploads through the review and evaluation of submitted documents. Instructions for use of the DARPA/IXO BAA Tool are available for download at: http://www.darpa.mil/ixo/solicitations/hurt/index.htm.

All offerors MUST register at: http://www.tfims.darpa.mil/baa 2 weeks prior to submitting a proposal. PLEASE NOTE: The deadline for registration is **01/30/04** at the URL listed above. Only the lead or prime offeror should register. One registration per proposal should be submitted. This means that an offeror wishing to submit multiple proposals should complete a single registration for each proposal. By registering, the offeror has made no commitment to submit. Proposal submissions must be unclassified. The offeror must upload the electronic version of the full proposal to the DARPA website by **12:00 PM (ET) 13 February 2004.** Proposals not meeting the format described in this PIP may not be reviewed.

Restrictive notices notwithstanding: Proposals may be handled, for administrative purposes only, by a support contractor. This support contractor is prohibited from competition in DARPA technical research and is bound by appropriate non-disclosure requirements.

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 presented at http://www.tfims.darpa.mil/T-fims_req.doc/ as part of their proposed deliverables.

F.5 SECURITY

The HURT program may involve classified data and results, especially as it relates to models of advanced platform technologies. If classified data is required in an offeror's proposal the offeror must show that personnel needed to perform the work possess the appropriate clearances. They must also show that they have facilities available to store and, if needed, process data at the appropriate level. See DOD Contract Security Classification Specification (DD Form 254) for additional security requirements associated to this program.

Classified submissions shall be in accordance with the following guidance:

Collateral Classified Information: Use classification and marking guidance provided by previously issued security classification guides, the Information Security Regulation (DoD 5200.1-R), and the Nationally Industrial Security Program Operating Manual (DoD 5220.22-M) when marking and transmitting information previously classified by another classification authority. Classified information at the Confidential and Secret level may only be mailed via U.S. Postal Service (USPS) Registered Mail or U.S. Postal Service Express Mail. All classified information will be enclosed in opaque inner and outer covers and double wrapped. The inner envelope shall be sealed and plainly marked with the assigned classification and addresses of both sender and addressee. The inner envelope shall be addressed to:

Defense Advanced Research Projects Agency
ATTN: IXO Office
Reference: BAA 04-05
3701 N. Fairfax Drive
Arlington, Virginia 22203-1714

The outer envelope shall be sealed with no identification as to the classification of its contents and addressed to:

Defense Advanced Research Projects Agency
Security and Intelligence Directorate, ATTN: CDR
3701 N. Fairfax Drive
Arlington, Virginia 22203-1714

All Top Secret materials should be hand carried via an authorized, two-person courier team to the DARPA CDR.

HURT may also include ITAR (International Traffic in Arms Regulations) restricted data. Organizations must present evidence that such data can be properly identified, isolated, and protected during conduct of their proposed work.

F.6 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, Mr. Michael Blackstone, mblackstone@darpa.mil, 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.

F.7 REQUIRED REVIEW AND INTERCHANGE MEETINGS

Awardees under this BAA will be required to present an overview of their proposed work at a Program Kick-off Meeting. Awardees will be required to attend preliminary design reviews (PDR) and critical design reviews (CDR), six months after the start of each phase, and six weeks prior to each demonstration, respectively. Awardees will be required to attend biannual Principal Investigator (PI) Meetings. It is expected that all key personnel will attend the PDR, CDR and PI meetings. Awardees will be required to attend the capstone experiments that culminate each phase of the program.

F.8 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 proposal under the FAR/DFARS and includes subcontractors, is required to submit a subcontracting plan IAW FAR 19.702(a) (1) and (2). The plan format is outlined in FAR 19.704. This plan will be formally requested at time of selection notification.

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 each of the proposals received.

Restrictive notices notwithstanding, proposals may be handled for administrative purposes only by support contractor personnel. These personnel are prohibited from competition in DARPA technical research and will have signed and be subject to the terms and conditions of non-disclosure agreements. By submission of its proposal, a proposer agrees that its proposal information may be disclosed to employees of these organizations for the limited purpose stated above. In the absence of any specific objections to this arrangement, the Government will assume proposers consent to the use these subject personnel in review of proposals submitted under this BAA. Only Government evaluators, however, will make technical evaluations and award determinations under this BAA.

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

G.2 CRITERIA FOR AWARDS

The criteria to be used to evaluate and select proposals for this project are described in the following paragraphs. Each proposal will be evaluated on the merit and relevance of the specific proposal as it relates to the program rather than against other proposals for research in the same general area, since no common work statement exists. Agency evaluators will consider technical factors as more important than non-technical factors (Personnel and corporate capabilities and experience, Cost realism). In accordance with FAR 35.016(e) the primary basis for selecting proposals for award shall be technical, importance to agency programs, and funds availability. Cost realism and reasonableness shall also be considered to the extent appropriate as described herein.

Proposals shall be evaluated against the following criteria, in descending order of importance:

G.2.1 Relevance to HURT mission objectives

- Understanding the nature and difficulties of urban RSTA, and proposing an innovative solution according to HURT objectives
- Evidence of ability to achieve HURT program goals and metrics
- Familiarity with operation of automated unmanned systems, in particular, small aerial vehicles
- Ability to develop component technologies in cooperation with other technology providers in a robust, scalable systems framework

G.2.2 Technical innovation and depth

- Understanding of the current state of the art in the technologies proposed
- Soundness of technology approach at the component level and systems level
- Degree of innovation and potential for revolutionary advance
- Justification of design choices as compared to alternative techniques

G.2.3 Consistency with HURT program concepts

- Consistency with the HURT system and program plan
- Depth and specificity of the proposed effort's system and program concepts
- Precision and coverage of the proposed effort's verification and testing plan
- Plan for collaborating with other technology developers and the Systems Integrator, as described herein

G.2.4 Personnel and corporate capabilities and experience

- Qualifications and experience of proposed technical personnel
- Availability of personnel for the duration of the contract
- Ability to collaborate in off-site integration and field experimentation
- Adequacy of proposed facilities (and platforms, if applicable)

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

It is anticipated that DARPA will make available approximately $40 million to fund HURT over the entire four-year program. It is DARPA's intention to fund only one proposal in each of the four topic areas (User Management, Platform Modeling, Planning and Control, and System Integration), though DARPA reserves the right to fund more than one proposal in an area, or none at all.

H PROPOSAL CONTENT

H.1 GENERAL INFORMATION

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

All eligible sources may submit a proposal (the original and eight copies) which shall be considered against the criteria set forth in Section G. Proposals with fewer than the maximum number of pages will not be penalized. Proposals exceeding the page limit will not be reviewed beyond the maximum page limit. Non-cost information incorporated into the unrestricted size Volume II cost proposal will not be considered. Proposers are encouraged to submit concise, but descriptive, proposals.

Proposal questions should be handled according to the process described in Section F. Proposers are advised that only 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.2 VOLUME 1: TECHNICAL PROPOSAL {PAGE LIMITED}

Table 4. Summary of required proposal contents summarizes the page limitations for the individual sections and items. Note that because multiple topic areas may be proposed in a single proposal, that the page limit depends upon the number of topic areas proposed. A proposal for all four topic areas is limited to 78 pages; a proposal for three topic areas is limited to 73 pages; a proposal for two topic areas is limited to 68 pages, and a proposal for a single technical area is limited to 63 pages. Recall the topic areas are 1) User Management, 2) Platform Modeling, 3) Planning and Control and 4) System Integration.

SECTION	PAGE LIMIT	TOPICS
Cover page	1	Offer identification
Table of contents	2	Proposal outline and page counts
Proposal roadmap	1	Summary of key elements of the offer
Problem statement	5	Definition of the component(s) of the HURT system concept being proposed Limitations of current approaches Identification of innovative approach of proposal
Program concept	13	Functional description of proposed components or system Expected technical progression over time Performance metrics
Technical approach	15 pages plus five pages for each topic area being proposed, for a maximum of 35	Survey of the current state of the art Approach for technology development Key ideas for future development Systems engineering plan and self-evaluation methodology
Management plan	20	Statement of work Schedule Deliverables (Description and delivery schedule) Proposed personnel Related experience Assertion of Intellectual Property Rights Security plan, if applicable
Evaluation factors	1	Summary of offeror's self-assessment factors

Table 4. Summary of required proposal contents

Format specifications include 12 pitch or larger type, single spaced, single-sided, and 8.5 by 11 inches with 1 inch margins all around the page. 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 should include material 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 preferred to qualitative generalities.

H.2.1 Cover Page

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

- BAA number
- Assigned DARPA control number (obtained from DARPA/IXO BAA Tool)
- Proposal title
- BAA topic area(s) addressed (e.g., User Management, Platform Modeling, Planning and Control, and Systems Integration)
- Proposer's single point of contact for all correspondence and communications

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 urban RSTA that pose the greatest technical challenges to the offeror; identify areas where increased automation of the type proposed can make the greatest contribution; and describe the military 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 to be in place at the end of the program, either as functions, services, or procedures. Explain relationships among them, and relationships to other elements of HURT. Amplify, and recommend improvements to, the HURT 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 HURT program-level goals, and recommend amplifications and improvements to the HURT 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. For integration and experimentation, explain how these metrics capture the level of support provided to the component developers. For each metric, project specific values that can be expected to be achieved at the end of each Phase, and the assumptions on performance required of other program elements in order for these projections to be valid.

H.2.6 Section E: Technical Approach

Explain, with specific examples relevant to autonomous vehicle operations if possible, the key technical ideas on which the program concept is based. Include at least:

- A summary of past and current efforts on which the proposed effort builds, or which were rejected as part of the design process;
- The baseline capability proposed to accomplish the program technical objectives for each phase. For Phase I, describe specifically the role of the technology in meeting these goals. For component developers, emphasize interfaces, data models, and capabilities that would most influence system design and experimentation efforts. For Systems Integrator, 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 the automated approach to urban RSTA described in this PIP. Emphasize any formal theories, performance analyses, or quantitative tradeoffs that lend weight to claims of performance.
- 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. Include a discussion of design decisions made.

For offerors proposing more than one topic area, 15 (fifteen) pages of Section E should describe the technical approach and benefits of the combined total technology proposed, and detailed discussions of individual components that align with HURT program areas should be limited to separately identified 5 (five) page subsections.

Proposals from both Technology Component (User Management, Platform Modeling, Planning and Control) developers and System Integrators should include detailed descriptions of capability goals, performance goals, informal evaluations and formal evaluations for their individual modules and systems. These plans should include estimates of the amount and kind of data needed to conduct 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. In plain English, clearly define the technical tasks/subtasks to be performed, their durations, and dependencies among them. For each task/subtask, provide:

1) A short (1-2 sentence) description of the objective of task;
2) A short 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);
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 the major activities and milestones for the proposed effort, aligned with the three phases of the HURT program. Indicate delivery of baseline technologies suitable for the integration process.

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

Section F.4: **Cost summary.** Summarize the cost of the proposed effort by Government Fiscal Year (GFY) as indicated by the two tables here. A GFY begins on October 1 of a given calendar year and ends September 30 of the ensuing year. Assume a program start date of 1 June 2004. Note that if HURT commences on 1 June 2004, it will end on May 31 in 2008.

Note that in Volume II, Cost Proposal, a budget broken down by program phase will also be required.

COST ELEMENT	GFY 04	GFY 05	GFY 06	GFY 07	GFY 08
Technical labor[1]	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx
Administrative labor[2]	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx
Other direct charges	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx
Indirect charges	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx
Fee	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx
Total	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx

Table 5. Summary of funding request by cost element.

ORGANIZATION	GFY 04	GFY 05	GFY 06	GFY 07	GFY 08
Prime	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx
Subcontractor A	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx
Subcontractor B	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx
Subcontractor C	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx
Total	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx	$x,xxx,xxx

Table 6. 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, work history, areas of expertise, and experience with advanced research of the type DARPA supports. Clearly state the portion of each person's time that will be dedicated to HURT during Phase I. Do not include resumes for people who will spend less than 50% of their time on HURT.

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 HURT. Emphasize projects on which proposed staff have worked, and indicate this fact when applicable.

Section F.7: **Facilities.** Briefly describe corporate facilities that will be available to support this effort. Describe vehicle platforms to be used, if applicable. Also describe a plan for identifying and safeguarding ITAR restricted data and materials.

Section F.8: **Security plan (if applicable).** If classified information is to be processed in the proposed work, briefly describe the plan to appropriately safeguard such

[1] 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.

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

information and to work with other, non-classified program components in HURT technology development and experimentation.

Section F.9: **Intellectual Property.** Clearly indicate restrictions on intellectual property for noncommercial and commercial items as described below.

Section F.9.1 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 "government purposes rights" for a period of five (5) years from the date of award, to all noncommercial technical data and noncommercial computer software generated, developed, and/or delivered under any award instrument, unless otherwise agreed to by the parties. Additionally it is understood that such rights will convert automatically to "unlimited rights" after such five (5) year period, notwithstanding any period of performance extensions that may result after the award instrument is executed, unless otherwise agreed to by the parties. 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."

A sample format 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)***

Section F.9.2: 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."

A sample format 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)***

Clearly specify what rights will be granted to the Government upon delivery of each software increment. In any case where those rights are more restrictive than "Government Purpose 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: 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 VOLUME 2: COST PROPOSAL {NO PAGE LIMIT}

In general, the cost proposal should provide summary and detailed cost breakdowns, by quarters of the Government Fiscal Year and by program phase. Proposers should assume a 1 June 2004 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 as described below.

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 for each topic area): Summary of all costs by Government Fiscal Year:
    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 for each topic area): Same elements as in Part 1 but summarized by program phase.

H.3.3 Budget Details

1. An administrative cover sheet to include:
   a. Name and address of proposer (include zip code);
   b. Name, title, and telephone number of Proposer's point of contact;
   c. (Award instrument requested: cost-plus-fixed-fee (CPFF), cost-contract--no fee, cost sharing contract--no fee, or other type of procurement contract (specify), grant, cooperative agreement, Technology Investment Agreement, Other Transaction for Prototype, or such other appropriate award instrument;
   d. Place(s) and period(s) of performance;
   e. Funds requested from DARPA for each distinct work effort and the total proposed cost; and the amount of cost share (if any)
   f. Name, address, telephone number and Point of Contact (or other administrative office (if known) (i.e., Office of Naval Research) of the Proposer's cognizant Defense Contract Management Agency (DCMA) administration office (if known);
   g. Name, address, telephone number, and Point of Contact of the Proposer's cognizant Defense Contract Audit Agency (DCAA) audit office (if known);
   h. Any Forward Pricing Rate Agreement information or other such Approved Rate Information or documentation that may assist in expediting negotiations (if available);
   i. Contractor and Government Entity (CAGE) Code,
   j. Dun and Bradstreet (DUN) Number;
   k. North American Industrial Classification System (NAICS) Number [NOTE: This was formerly the Standard Industrial Classification (SIC) Number];
   l. Taxpayer Identification Number (TIN) .
   m. All subcontractor proposal backup documentation to include items a. through l. above, as is applicable and available.

2. Detailed cost breakdown as follows:
   a. For each distinct work effort (topic area) total program cost broken down by Government Fiscal Year and program phase; further broken down by major cost items (direct labor, subcontracts, materials, travel, other direct costs, overhead charges, etc.);
   b. major program tasks by Government Fiscal Year and program phase;

c. an itemization of major subcontracts (labor, travel, materials and other direct costs) and equipment purchases;
d. a summary of projected funding requirements by month; and
e. the source, nature, and amount of any industry cost sharing

3. Supporting cost and pricing information 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.

4. Offerors requiring the purchase of information technology (IT) resources as Government Furnished Property (GFP) MUST attach to the submitted cost proposal the following information:
   a. A letter on corporate letterhead signed by cognizant organizational official and addressed to Dr. John Bay, DARPA/IXO, stating that you either can not or will not provide the information technology (IT) resources necessary to conduct the said research.
   b. An explanation of the method of competitive acquisition or a sole source justification, as appropriate, for each IT resource item.
   c. If the resource is leased, a lease purchase analysis clearly showing the reason for the lease decision.
   d. The cost for each IT resource item.

I ACRONYMS

1MEF	1st Marine Expeditionary Force (also, IMEF)
AFRL	Air Force Research Lab
AFSOC	Air Force Special Operations Command
AO	Area of Operations
AOR	Area of Regard
ATR	Automatic Target Recognition
BAA	Broad Agency Announcement
CDR	Critical Design Review
CONOPS	Concept of Operations
DBBL	Dismounted Battlespace Batttle Lab
FAR	Federal Acquisition Regulations
GFY	Government Fiscal Year
HC3	HURT Command and Control Center
HMI	Human-Machine Interface
HQ	Headquarters
HURT	Heterogeneous Urban RSTA Team
IPB	Intelligence Preparation of the Battlespace
ITAR	International Traffic in Arms Regulations
LOS	Line-of-Sight
MCWL	Marine Corps Warfighting Laboratory
MOUT	Military Operations in Urban Terrain
NAVAIR	Naval Air Systems Center
OPTEMPO	Operations Tempo
PBA	Predictive Battlespace Awareness
PDR	Preliminary Design Review
PIP	Proposer Information Pamphlet
RSR	RSTA Service Request
RSTA	Reconnaissance, Surveillance, and Target Acquisition
SA	Situation Awareness
SOCOM	Special Operations Command

T-FIMS	Technical and Financial Information Management System
TTPs	Tactics, Techniques, and Procedures
UAVs	Uninhabited Aerial Vehicles
UCAR	Unmanned Combat Attack Rotorcraft
UCAV	Unmanned Combat Air Vehicle