BAA 07- 46
Proposer Information Pamphlet (PIP)

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

LANdroids

This BAA will be open until June 5, 2008.

NOTE: Although this BAA will be open for one (1) year from the date of its publication on www.fbo.gov, the Government anticipates that the majority of initial funding for this program will be committed during First Selections. To be considered for funding during First Selections, full proposals must be received no later than **12:00 NOON EDT on 16 August 2007.**

A Bidder's Briefing Day will be held on 06 July 2007 to provide additional information and discussion on this topic. Details may be found on the solicitation website at www.darpa.mil/ipto/solicitations/solicitations.htm.

BAA 07-46, LANdroids

1. PROGRAM OBJECTIVES AND DESCRIPTION

1.1 Introduction

The Defense Advanced Research Projects Agency (DARPA) Information Processing Technology Office (IPTO) is soliciting proposals for LANdroids, a new program to develop intelligent autonomous radio relay nodes that exploit movement to establish and manage mesh networks in urban settings. The goal is to create small, inexpensive, smart robotic radio relay nodes that dismounted warfighters drop as they deploy in urban settings. The nodes then self-configure and form a mesh network – a temporary infrastructure that establishes communications over the region. As the situation changes, the nodes will adapt the network, such as self-healing if nodes are destroyed by the enemy. Through movement and density, the LANdroids will enable effective communications in complex non-line-of-sight (NLOS) environments like those found in urban settings – dealing with phenomena like fades and shadows through strategic self-placement and chaining of the relays.

The program will have four tasks to which bidders may propose: LANdroids Control Software, LANdroids Robot Development, and evaluation of each of these. Production cost is a driver in both the Control Software and Robot Development areas. The LANdroids control software must be lightweight – effective but suitable for processors of performance roughly comparable to what you might find in a portable device such as a typical cell phone.

The LANdroids robots, which will consist of a radio, robotic platform, battery, and small processor, will be expendable. Dismounted warfighters must be able to drop and go – benefiting from the infrastructure while it is in place but not being required to move back into harm's way to retrieve the robots.

To encourage appropriate solutions, the target award size for LANdroids software development is $1,000,000 or less, per 12 month phase, per effort, excluding any proposed options. On the LANdroids robot side, the target is to demonstrate a platform that would have a final production cost of $100 per LANdroid at modest volumes (e.g., one thousand units). Recall, the goal is effective communications via small, inexpensive, smart, mobile radio nodes. Multiple awards are anticipated.

The program is envisioned to have three 12-month phases. Subsequent phases will depend on availability of funds among other factors. Proposals must address a single task – proposers that wish to address more than one of the four areas should submit separate proposals for each. See section 2 for task descriptions.

DARPA will host a Bidder's Briefing Day for the LANdroids program on 06 July 2007. For more details and registration information please go to http://www.darpa.mil/ipto/Solicitations/solicitations.htm. Additional BAA details follow.

1.2 Motivation and Concept of Operations

While radio communications work well in line-of-sight (LOS) environments, urban settings are non-line-of-sight (NLOS) and this hinders communications. The obstacles found in NLOS environments reflect, refract, diffract, and absorb radio signals. This leads to signal loss or attenuation, multi-path fading, shadowing, and an overall complex signal propagation

environment that is difficult to accurately predict *a priori.* The net effect is poor or unreliable radio communications for warfighters moving through these settings. The key insight, however, is that location matters greatly when it comes to signal strength. For example, in multi-path settings, moving short distances, (such as ½ of a wavelength), can yield a substantial improvement in signal strength. Location also matters greatly for phenomena such as shadowing. LANdroids will exploit this phenomenon by being intelligent in their choice of location, and by routing signals from warfighters as they conduct their operations.

A notional LANdroid is shown in Figure 1. The LANdroid consists of a robotic platform (providing appropriate mobility and sensing capabilities), processor, radio, and power source – a small, inexpensive, smart, mobile radio relay node. The idea is that warfighters will carry many of these and deploy them as they move through a region, as shown in Figure 2. The LANdroids will then move and self-configure to form a mesh network over a region, Figure 3. This establishes a temporary communications infrastructure that covers the initial warfighters, subsequent warfighters, deployed sensors, UGVs, etc. Any device (green dots on figures 2-6) operating in the region will have communications via the mesh network.

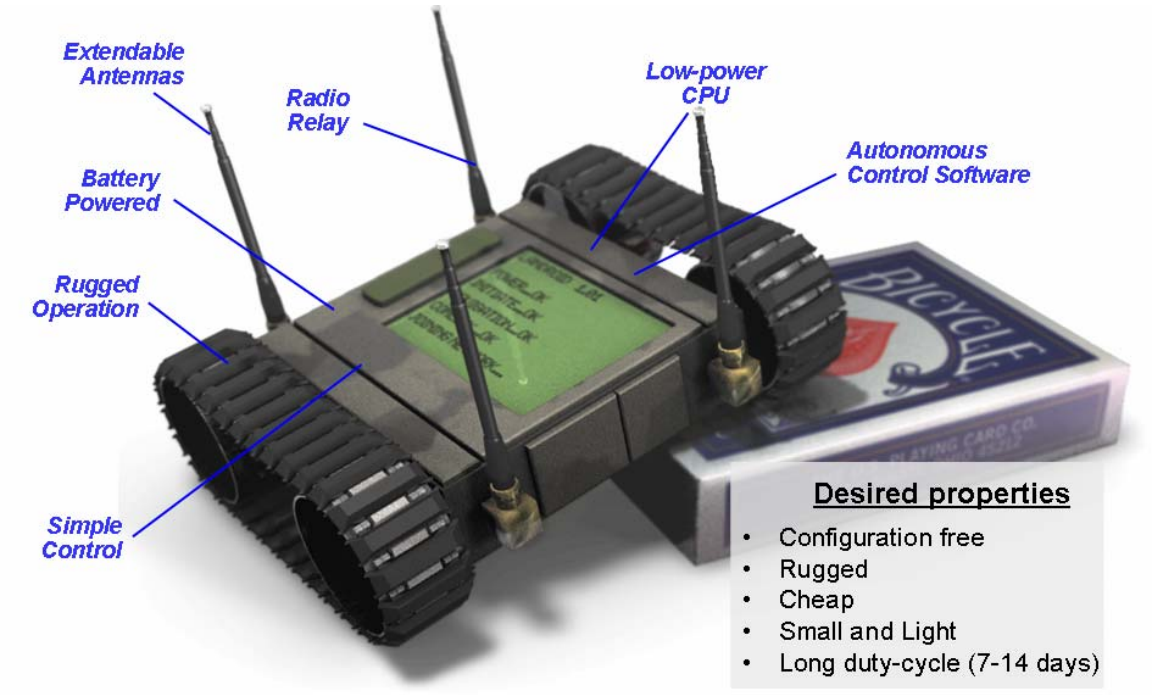

Figure 1 – Notional LANdroid

Figure 2 – LANdroids (Green Dots) Will Be Deployed as The Warfighters Deploy

Figure 3 –Self-Configuring Multi-path, Multi-hop Mesh Network Routes Packets (Yellow Dots)

The advantage of a mesh network approach to communications is resiliency – the network is multi-path, multi-hop, and multiply connected, as shown in Figure 3. If a node should go down or be taken out by an enemy, the packets from other nodes will find other routes to reach the gateway. This leads to another strength of a LANdroid system – in the event that a node goes down, the network can self-heal to cover that region. Figure 4 shows the gap created by a node

going down and Figure 5 shows the network after self-healing. Exploiting movement further, LANdroids will also implement "tethering" or network stretching to keep warfighters or devices covered as they move through the region, Figure 6.

Figure 4 – Node Destroyed and Warfighter in That Region Is Without Good Communications

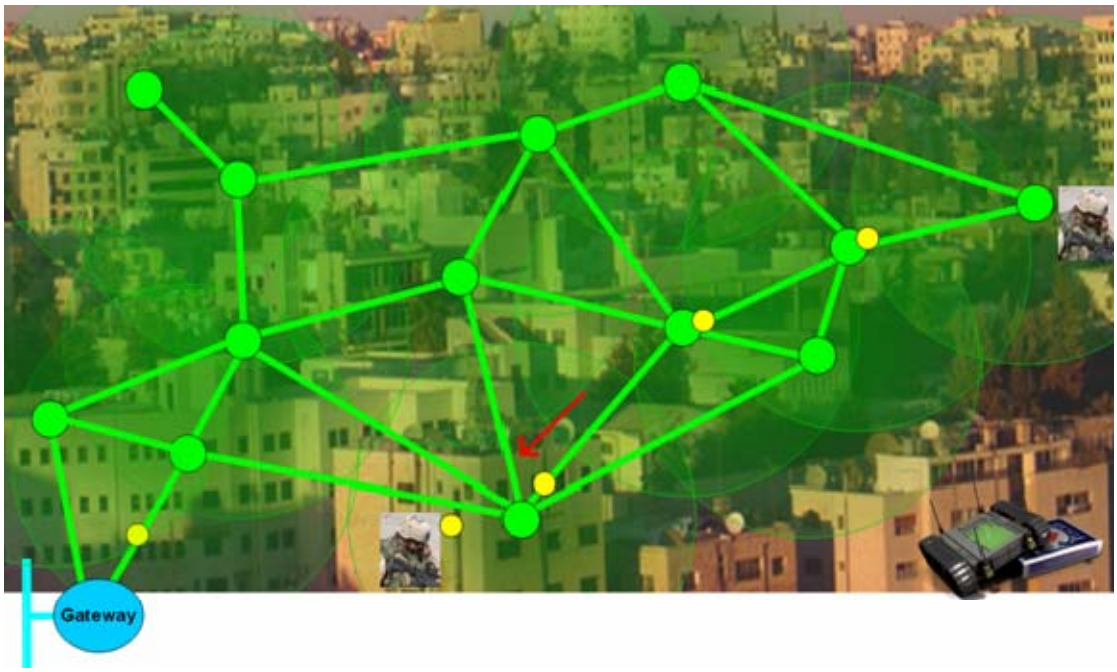

Figure 5 – LANdroid Networks Will Self-Heal

Figure 6 – LANdroid Networks Can Stretch to Keep Warfighters Covered (Tethering)

1.3 Important RF (Radio Frequency) Signal Propagation Concepts

LANdroids proposers should have working knowledge of RF communications. This section is not intended as a tutorial but attempts to point out a few important concepts that may pertain to LANdroids. This set of concepts is not an exhaustive list – proposers may have other insights.

One important concept is that when it comes to communications, location matters greatly. Figure 7 shows a signal strength map around a building in an urban setting of an FM radio signal that is broadcasting from the other side of an urban environment. The signal strength map contains instances of both multi-path fading and shadowing. Multi-path fading typically means that there are large variances within small areas. In this example, a 20dB change in signal strength was measured within 10 feet. At higher frequencies (e.g., 2.4 GHz), the wavelength is shorter. Variance of this type will occur typically within shorter distances. One-half to one-quarter of a wavelength are reasonable distances in which to expect variance in a multi-path setting. This concept matters to LANdroids because small changes in location can greatly impact signal strength – LANdroids will make such small changes.

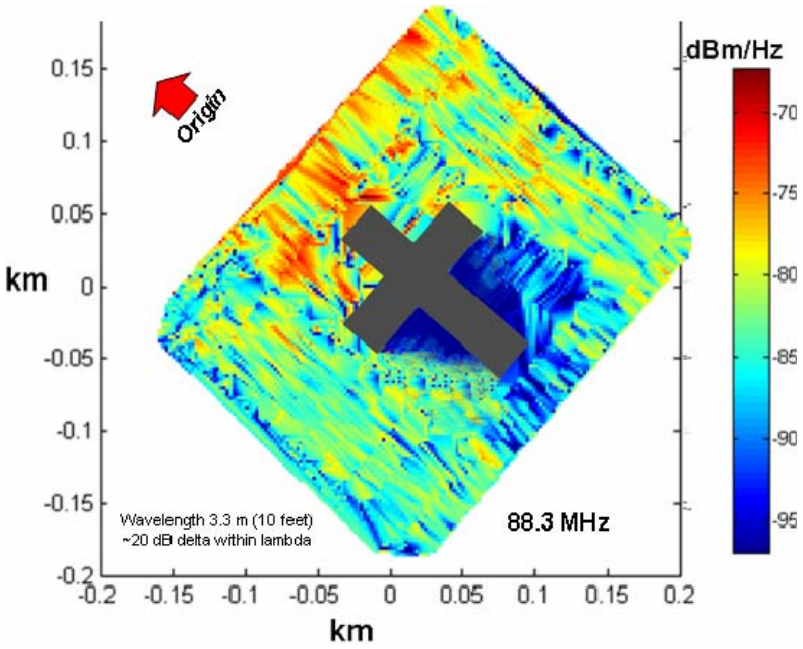

Figure 7 – Signal Strength Map around Facility in Urban Setting

Figure 7 also shows shadowing illustrated by the deep blue regions in which the building is blocking the signal. In these regions, the signal strength is typically much weaker and the area of poor performance can be much larger than those caused by multi-path fading. Shadows are another phenomenon that LANdroids can deal with by carefully choosing their locations.

Another important concept is that it is often difficult to predict the signal propagation characteristics within an urban environment. Angle of incidence matters, where an emitter is located matters, even the building materials themselves can impact signal strength. We deal with this in the civilian world through a manual measure, test, and improve, cycle. This is one approach for cell phone tower placement. The implications for LANdroids is that they must determine where exactly to "sit" based on the situation – not based on pre-programmed maps or other approaches predicated on having detailed knowledge *a priori*. Such knowledge may augment a given approach but there will always be an element of deciding (online) where a given LANdroid should locate itself.

Another important concept is that the dynamics of the world impact what constitutes a good location. Moving a convoy of trucks, removing a structure or building, putting a new structure or building in place, can impact RF connectivity. Change can also be caused by noise or other emitters in the environment. A LANdroid that finds a good position in which to sit at time t_1 may need to move or adjust its position at time t_2.

All of these phenomena translate into a need for movement and once intelligent autonomous movement is incorporated into communications, other features such as self-healing, can be introduced to further leverage the platform.

It is important to note that other techniques such as Multiple-Input Multiple-Output (MIMO) are being developed for dealing with NLOS settings (particularly multi-path fading) and are completely complementary to LANdroids. A MIMO-enabled radio means that the LANdroid will perform better in a multi-path setting and the LANdroid can enable the MIMO radio to improve performance by finding a better location for it or even changing the orientation of the antennas to maximize the MIMO capabilities. MIMO, null steering, beam forming, antenna

polarization, are all designed to deal with situations in which the radio does not get to choose its own location. With LANdroids the radio *does* get to choose its own location. LANdroids and advances in basic radio and antenna, technology are entirely complementary. (Note that the LANdroids program will not invest in basic research in these areas – LANdroids are consumers of this technology).

A natural question for LANdroids is the issue of antenna height. Generally height is a good thing when it comes to RF signal reception. This is a potential issue for LANdroid robot developers to address.

1.4 LANdroids Capabilities and Environment Scope

Through intelligent autonomous movement, the LANdroid capabilities, shown in Figure 8, to be created in this program include:

- *Self-Configuration* – once deployed (dropped or thrown), the LANdroids must self organize to form a mesh network over the coverage region. This entails detecting neighboring nodes, establishing connections to one or more gateways, and ensuring that the region is covered with communications. The boundaries of the coverage region will be defined in Phase I using static network clients, placed by the evaluation team, and in Phase II using both static and moving clients. One can liken the static clients to virtual walls. Proposers may propose alternate ways to "mark" coverage regions.

- *Self-Optimization* – in multi-path environments, small movements can often greatly impact signal strength. Even once a network is formed, LANdroids should continue to make movements 'in the small' to improve their signaling environment, i.e., find locations in which the signal strength is higher.

- *Self-Healing* – if a LANdroid node is destroyed by an enemy, powers down, or otherwise fails, leaving a gap in the coverage region, the network should detect this event and self-heal to the best extent possible. This may entail neighboring LANdroids moving or larger network shifts.

- *Tethering* – as warfighter clients move through a LANdroid covered region, the network itself should adapt and stretch to keep them covered with communications when possible. This includes intelligent relaying around obstacles or into shadows. When it is not possible to keep the warfighter client covered, the network should recognize this and advise the warfighter client to drop another LANdroid to extend the range.

- *Intelligent Power Management* - the goal of LANdroids is to create a temporary communications infrastructure for all communication-dependent devices operating in a given region. Longevity is important. LANdroids solutions must reason about power conservation and make explicit decisions about whether or not to move, whether it is possible to power down (because another LANdroid is covering the same area), etc. With respect to movement, the power required when the LANdroid is moving will be greater than the power required to run the radio subsystem. However, if a LANdroid can move and find a better signal environment, it may be able to turn down the transmit power on its radio and thus save power in the long run. While the exact power trade-off characteristics will depend on both the movement efficiency of the LANdroid and potential increases in signal strength, it is possible to spend power to save power (spend short-term power on movement to save long-term power on radio).

Figure 8 – LANdroid Capabilities

For both the software and robotic areas, the program will develop LANdroids for use in settings where the ground is relatively level and traversing complex terrain is not required. In general, warfighters will deploy LANdroids in urban areas they want covered with communications and the warfighters themselves will provide a large percentage of the basic locomotion, i.e., will carry the LANdroids to a general setting and drop them. LANdroids are a solution that combines both density and intelligent autonomous movement. Thus, in practice there will be conditions under which LANdroids are unable to navigate a given terrain in order to self-heal or otherwise make large adjustments in the network.

As planned, testing of the software area will be done indoors in a multi-level facility or building, as shown in Figure 9. Robot proposers need not limit themselves entirely to indoor settings though both the size constraint (warfighters will carry many LANdroids, i.e., pocket size) and the urban use model should be considered in LANdroid robot design.

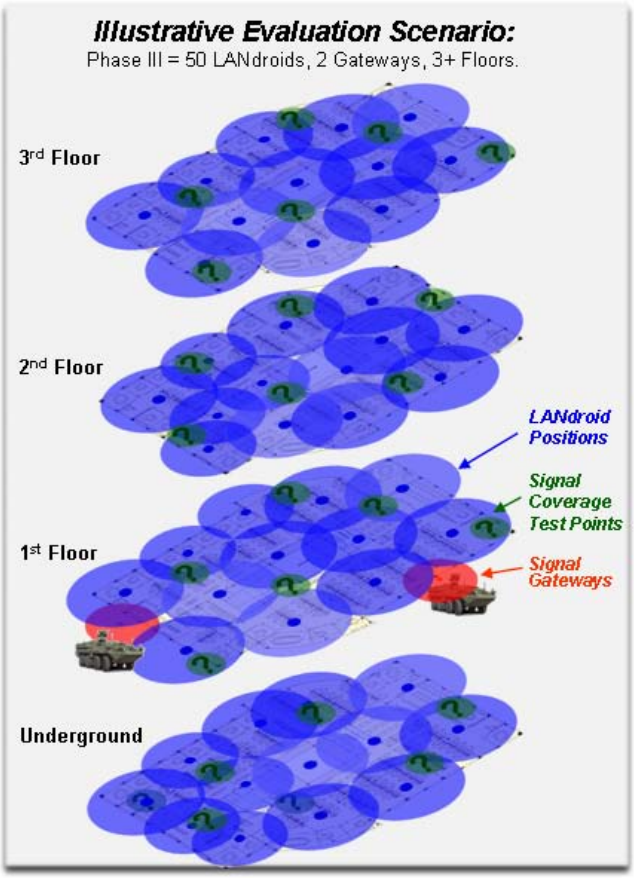

Figure 9 – Illustrative Indoor Evaluation

1.5 Deployment Models and Geolocation

LANdroids will be deployed by dismounted warfighters during normal operations. The fashion in which LANdroids are deployed may impact the LANdroids control algorithms. One deployment model is simply random dropping of LANdroid nodes. The implications of this model are that the LANdroids must discover one another and form a network in a bottom-up fashion. This approach implies (1) no initial connection to a gateway, and (2) no guaranteed initial connection to other LANdroids. A different deployment model is placement-by-indicator, i.e., the warfighter carries a signal-strength meter or some other device that indicates to him that he is in a weak signal environment and should deploy a LANdroid. This deployment model improves the odds that the LANdroids will have some initial connection to another LANdroid or to a gateway node. If this model is employed, each successively deployed LANdroid may have an initial connection back to one or more gateways (via a chain of LANdroids). Both deployment models should be considered.

With respect to geolocation, several models are possible. At one end of the spectrum, LANdroids may be deployed without any strong knowledge of their surroundings and without any absolute location information. Under this model, LANdroids must rely on local sensors to give them a sense of location relative to their starting point. This is the model primarily envisioned for LANdroids – small, inexpensive, and not requiring large amounts of knowledge or pre-programming. While LANdroids move in physical space, they are managing signal space and

notions of location may be weak or approximate. Proposers are welcome to propose enhancements to this model or alternative models that are within the spirit of LANdroids being small, inexpensive, and smart.

2. LANDROIDS TASKS

The program will have four tasks to which bidders may propose: LANdroids Control Software, LANdroids Robot Development, and evaluation of each of these. Proposers are welcome to submit proposals against both technical and evaluation tasks. However, no individual team will be awarded both technical and evaluation responsibilities for the same task. Figure 10 shows the relationship between the LANdroids Control Software task and the LANdroids Robot Development task. From a high-level, the LANdroids Control Software task is focused on the intelligent control that enables LANdroids to move and manage a communications mesh. The LANdroids Robot Development task is focused on the supporting hardware and lower-level software, (such as basic robotic movement behaviors). Details follow.

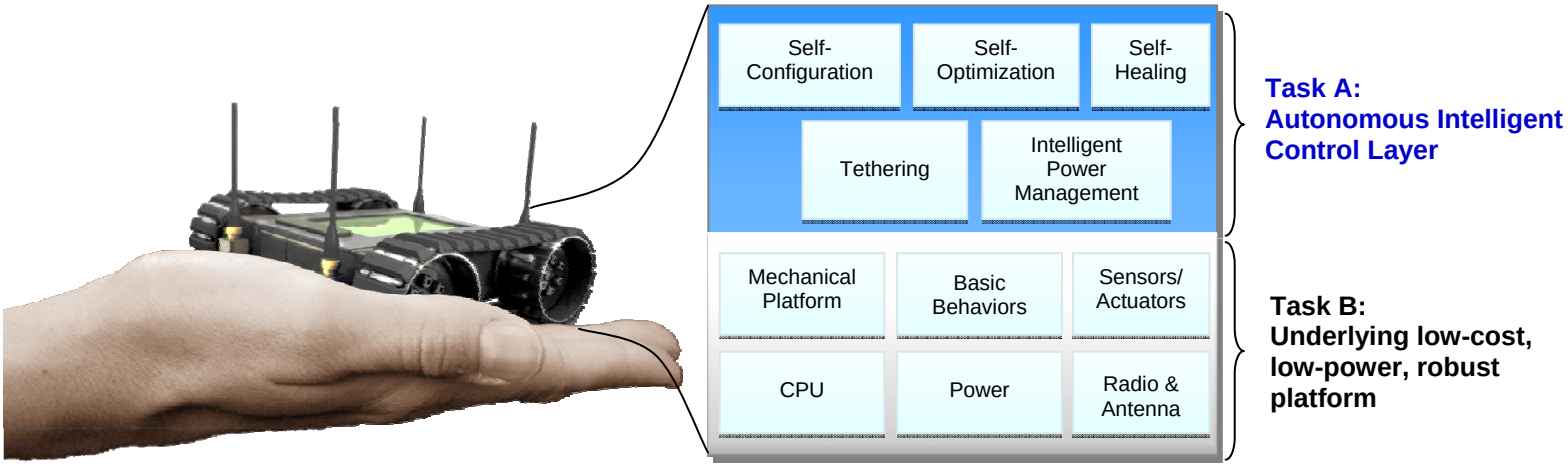

Figure 10 – Notional LANdroid Illustration and Technical Task Scope

2.1 Task A – LANdroids Control Software

Proposers on this task must create a software architecture and develop the necessary algorithms to implement the capabilities described above. The capabilities will be developed in a phased fashion as defined in the sections that follow. Aspects of the problem that Task A proposers should consider include:

- Coordination of LANdroids decision making – LANdroids share a common global goal (form an effective mesh network over a region) while relying primarily on local decision making. Achieving global coherence may require communication-based coordination or other techniques such as encoding conventions or inferring system/world state.

- Local reasoning – LANdroids must reason in order to create the desired system properties, e.g., self-healing. A wide range of approaches are possible. Task A proposers should be clear about how they are going to equip LANdroids to produce the desired properties.

- Robotic behaviors – LANdroids may need new or unique robotic behaviors in order to realize the desired properties. In particular, signal strength maps will be highly situation specific and may need to be learned, via exploration, online. It is important to note that when two or more neighboring LANdroids are moving concurrently, their signal strength maps may be changing concurrently due to changes in their relative distances, changes in signal propagation angles, etc., so the learning of signal strength maps and the behaviors that produce them may be interdependent with LANdroids coordination.

This list of issues is not exhaustive or complete. The goal is to produce the desired system capabilities (self-configuration, self-optimization, self-healing, tethering, intelligent power management). There are many possible technical approaches to producing these desired system capabilities -- a wide range of solution approaches are possible and encouraged. The focus of Task A, however, is on the software required to control the LANdroids. This task will not focus on basic research in supporting technologies such as embedded operating systems or generalized software frameworks.

Task A proposers will do their research using government specified robotic platforms to support comparison across the efforts. One possible research platform is the *iRobot Create* educational robot plus a *GumStix* (from *Way Small Computing*) and a *WifiStix*. Other candidates of similar capabilities are being considered. Note that the *iRobot Create* platform is somewhat "sensor limited." While this is consistent with the small, smart, inexpensive, LANdroids concept, proposers may suggest additional low cost, low power sensors that might be included on the platform to enable/improve LANdroids capabilities. With respect to network protocols, DARPA, in conjunction with awarded efforts, will select an existing Mobile Ad-hoc Network (MANET) protocol for the Phase I effort where said protocol is to be used by all awarded efforts.

2.2 Task B – LANdroids Robot Development

Proposers on this task must create a LANdroid robotic platform that can support the software developed under Task A. Research should focus on the robotic platform and novel combinations of existing technologies, (such as antennas, power, radio, etc). Basic research in these areas (such as a proposal dedicated entirely to developing a new antenna), is beyond the scope of the program. A wide range of LANdroid robot solutions are possible – including a highly specialized, and possibly limited, platform. Again, the vision is small, inexpensive, intelligent, and disposable, communications relays.

Items that proposers should consider in the design of their LANdroids include:

1. *Fundamental Platform Requirements* – At a basic level, LANdroids platforms must satisfy three fundamental constraints: they must be small, robust, and inexpensive.

> 1a. *Size*: LANdroids must be small enough that they will not be cumbersome for the warfighter to carry. As such, target LANdroids platforms should be no larger than 1,000 cm^3 (= 1 liter ~= 61 in^3) carrying volume, and weigh no more than 1,000 grams (~2.2lbs).
>
> 1b. *Robust*: A LANdroid is meant to be carried into the field, and as such it must not be a brittle or delicate platform. Since the platforms are expected to be inexpensive and potentially disposable, they will not be expected to fully meet stringent MilSpecs standards. However, they must be sufficiently rugged and robust to perform credibly and

reliably in the field. For the purposes of this task, we will evaluate platforms based on their ability to withstand reasonably hostile environments in terms of mechanical shock, vibration, temperature, dust and humidity.

1c. *Inexpensive*: LANdroids must be simple and inexpensive enough to be deployed in large numbers and ensure not only full radio coverage, but also seamless self-healing when nodes become disabled. For this purpose, proposers must define a platform that would be very inexpensive to produce in moderate volume (e.g., 1000's). While the platform cost constraints will not be measured directly from the demonstrated platform, proposers must carefully itemize component costs and demonstrate that the target costs can be realistically met for a moderate volume production run.

2. *Basic Capability Requirements* – In addition to the fundamental platform attributes, the LANdroid robot platform must also demonstrate basic capabilities required to support the control software. These include:

2a. *Movement*: The LANdroid platform must be capable of moving at a speed of at least 0.5m/sec over a typical indoor urban environment (e.g., concrete, asphalt, carpet). Stair climbing capabilities are not required, as warfighters will often provide the coarse-grained movement though novel ideas are welcome.

2b. *Simple Behaviors*: LANdroids operate in the physical world and should include some core behaviors that support higher-level LANdroid control. Specifically, LANdroids should detect obstacles and have basic behaviors to support simple navigation around obstacles and simple control responses, e.g., *stop motors*. A basic 'dead-reckoning' navigation ability is also desired. To create these capabilities, it is expected that LANdroid platforms will be equipped with a basic set of sensors (e.g., bump, drop, direction, movement). Proposers may choose the specific types of sensors to be used. Novel ideas are welcome, though they should remain as compliant with the cost and dimensional constraints of the platform as possible.

2c. *Power*: Given LANdroid's stringent size and cost constraints, it is expected that power will be a challenging design requirement. LANdroids must be able to power not only their own movement and control, but also the onboard radio relay, as well as host the processing power required for the LANdroid control algorithms. Platforms will be evaluated by measuring the time they can sustain simultaneous movement, processing and communication – as such, both higher capacity batteries as well as lower power consuming components are desirable. Platforms will also need to implement a reliable mechanism for reporting remaining power level to the onboard controller.

3. *Platform Payload Requirements* – To carry out its signal relay mission, the LANdroid platform payload must include two additional modules: A processor module, including a CPU and memory, capable of hosting a range of different control algorithms, and a radio relay module capable of receiving and transmitting radio signals.

3a. *Processor Module*: LANdroids will need to include basic processing and data storage capabilities. A low-power microcontroller and solid state memory devices will be needed for running both low-level LANdroid control, as well as hosting control algorithms that are being developed in Task A of the effort. While the computational capabilities of the LANdroid platform will be limited by its cost and power constraints, it should be sufficient for hosting reasonably complex control algorithms.

3b. *Radio Relay Module*: In order to relay warfighter communication, the LANdroid must be capable of receiving and transmitting radio signals. For the purposes of this task, all LANdroid platforms must include support for 802.11g communication (radio and antenna). The platform should not be narrowly engineered around the 802.11 protocol, however, but should also allow the replacement of the radio relay module with an alternative radio. The 802.11g module must provide current radio received signal strength and transmit power consumption to the higher-level LANdroid control software and should support transmit power adjustments by said software.

2.3 Task C – Evaluation of LANdroids Control Software

This task focuses on the evaluation of the LANdroid control software. Expertise here should include understanding of radio signals and communications. Duties include, but are not limited to:

- Designing detailed test scenarios and evaluation plans.
- Locating and securing a proper site(s) for testing.
- Defining an auto deployment surrogate, e.g., signal strength meter.
- Assisting in the selection of an off-the-shelf MANET protocol for all Task A performers to use during Phase I.
- Conducting pilot evaluations at a test site at months 6, 9, and 11 in each phase.
- Conducting end-of-phase evaluations.
- Supplying all necessary equipment for evaluation measurement.
- Reporting results to DARPA.

2.4 Task D – Evaluation of LANdroids Hardware

This task focuses on the evaluation of the LANdroid robot hardware. Expertise here should include understanding of robotics, mechanical engineering, and power requirements. Duties include, but are not limited to:

- Designing detailed test scenarios and evaluation plans.
- Locating and securing a proper site(s) for testing.
- Defining appropriate benchmark tests for the processor and radio.
- Conducting pilot evaluations at a test site at months 6, 9, and 11 in each phase.
- Conducting end-of-phase evaluations.
- Supplying all necessary equipment for evaluation measurement.
- Reporting results to DARPA.

3. PHASES, METRICS, AND EVALUATION

3.1 Phases, Metrics, and Evaluation for Task A (LANdroids Control Software)

On the LANdroid Control Software task there is a progression of features and a gradual increase in problem size over the course of the three envisioned program phases. Proposals should address all program phases though – if space constraints limit discussion – the emphasis should be on meeting the objectives of the first phase.

The milestones per phase for LANdroid Control Software are:

1) Phase I (12 months) – Core Capabilities
   - Scale – 10 LANdroids (coverage over 1 floor).
   - Test hardware: Government specified platforms.
   - Capabilities: (1) self-configuration (both auto drop and ad-hoc deployment), (2) self-optimization, (3) self-healing.

2) Phase II (12 months) – Intelligent Power and Tethering
   - Scale – 15 LANdroids (coverage over 2 floors).
   - Test hardware: Government specified platforms.
   - Capabilities: (1) self-configuration, (2) self-optimization, (3) self-healing, (4) intelligent power management, (5) tethered mode / network stretching, (6) customization of an existing MANET protocol to support LANdroid load/power balancing.

3) Phase III (12 months) – Scale, Heterogeneity, Dynamics, Modes
   - Scale – 50 LANdroids (coverage over 3+ floors).
   - Test hardware: Government specified platforms.
   - Demonstration of algorithms running on Task B LANdroid platforms
   - Capabilities: (1) self-configuration, (2) self-optimization, (3) self-healing, (4) intelligent power management, (5) tethered mode / network stretching, (6) LANdroid customized network protocols for load/power balancing, (7) heterogeneity (systems consisting of multiple gateways, static relays, warfighter handheld relays, and non-relaying static and mobile radios), (8) dynamic obstacles in environment, (9) dynamic RF interference, (10) dynamic LANdroid modes (programmable objective functions, e.g., maximize power savings, maximize throughput, etc.).

In each phase new capabilities will be introduced, but performers must maintain their previous capabilities (and these will be retested with each phase).

For the LANdroid Control Software, performance will be measured according to the following three sets of metrics:

1) Overall system performance:
   - *Coverage Percentage***:** % of test points connected to gateway with throughput >= 1Mbps, latency < 500 milliseconds. *Test point* is a term used to denote a point from within a defined coverage region; i.e., some point other than where the LANdroid itself is situated but a point that the LANdroid is to provide communications coverage.
   - *Longevity*: amount of time until 10-50% of the test points lose connection to gateway. This metric focuses not on the longevity of individual LANdroids but instead on the longevity of the communications infrastructure provided by the LANdroids. As individual LANdroids power down, others will expend energy to self-heal, etc.

2) Communications optimization:
   - *Throughput, Latency:* performance from each LANdroid node to the gateway. The intuition for scoring communications optimization separately is that two LANdroid solutions may obtain an equal coverage percentage score but one may find better locations for the LANdroids so that the communications performance is improved.

3) Coordination costs:
   - *Convergence Time:* initial & reconvergence post a dynamic event. This metric assesses *how long* it takes for a LANdroid solution to form or reform the network.
   - *Message Overhead:* # messages and # bytes averaged over *t*. This metric assesses the overhead of the coordination process in terms of messages and network traffic. If an effort is using communication-free mechanisms to coordinate LANdroids, this metric will still apply but they will receive an appropriately "good" score in these areas.

At the end of each phase, the LANdroid Control Software will be scored using these metrics according to a weighted average. This scoring serves as one aspect of the gate requirements. In order for an effort to be eligible to move to the next phase, it must meet gate requirements. In addition, all work and subsequent phases is contingent on funding. The phase gates have two elements:

- Efforts must beat two baselines: (a) static relays, and (b) a communication-free algorithm that simply causes a LANdroid to move in an attempt to heal/adapt when a neighboring node disappears. Movement will terminate if/when the predecessor of the LANdroid's neighbor is rediscovered.
- Ranked ordering of the teams developing LANdroid Control Software according to a weighted average.

Figure 11 shows the breakdown of problem size, capabilities, metrics, and potential weights (for the weighted average) by phase.

Phase	# LANdroids # of Floors	**Capabilities, Weights, and Metrics** (weights for weighted average ranking of teams)
I	**10 LANdroids** **1 Floor**	Capability: Self-configuration (30%). Metric(s): coverage percentile (Auto-drop & ad-hoc).
		Capability: Self-optimization (10%). Metric(s): throughput & latency (concurrent).
		Capability: Self-healing (30%). Metric(s): coverage percentile (post node death).
		Property: Coordination costs (30%). Metric(s): (re)convergence time, # msgs, # bytes.
II	**15 LANdroids** **2 Floors**	Retest all Phase I capabilities with 2 floors and 15 LANdroids (23%).
		Capability: Intelligent Power Mgmt (23%). Metric(s): longevity.
		Capability: Tethering (23%). Metric(s): coverage percentile.
		Capability: Customized network load balancing for power (8%). Metric(s): longevity.
		Property: Coordination costs (23%). Metric(s): (re)convergence time, # msgs, # bytes.
III	**50 LANdroids** **3+ Floors**	Retest all Phase I & II capabilities with 3+ floors and 50 LANdroids (24%).
		Capability: Heterogeneity & multiple gateways (25%). Metric(s): coverage percentile.
		Capability: Dynamic obstacles (13%). Metric(s) coverage percentile sampled over t.
		Capability: Dynamic interference (13%). Metric(s): coverage percentile sampled over t.
		Capability: Programmable objective function (5%). Metric(s): boolean check.
		Property: Coordination costs (20%). Metric(s): convergence time, # msgs, # bytes.

Figure 11 – Phases, Size, Capabilities, Weights, and Metrics

3.2 Phases, Metrics, and Evaluation for Task B (LANdroid Robotic Platform)

The program is envisioned to have three 12 month phases. On the LANdroid Robot task, the phases move from small quantities of coarse prototypes to larger volumes of proof-of-concept prototypes.

1. *Fundamental Platform Requirements*

1a. *Small*: For Phase I, performers will not be required to demonstrate a platform that meets all size target requirements. They will, however, need to document how their Phase I platform leads to a Phase II platform that meets all size constraints. For Phases II and III, compliance with the 1,000-cm^3 and 1,000-gram requirements will be ensured by physically measuring the platforms during evaluation exercises.

1b. *Robust*: While Phase I platforms will not undergo formal stress tests, they will need to perform all navigation and power endurance tests in a typical urban environment (asphalt, concrete and/or carpet floors). Performers will also be required to document how their Phase I prototype platform will lead to a robust Phase II platform that meets all environmental stress constraints. For Phases II and III, compliance with robustness requirements will be assessed by an independent certification team. Platforms will be stress-tested to assess whether they meet a well-defined (TBD) set of environmental requirements (mechanical shock, vibration, temperature, dust and humidity).

1c. *Inexpensive*: While Phase I prototypes will not need to fully meet the $100/platform requirement, performers will need to submit component and component cost lists for both the Phase I prototype platform, as well as for the expected Phase II platform. For Phases II and III, the component lists will be carefully evaluated to ensure that the proposed platform does indeed realistically meet the unit cost requirements.

2. *Basic Capability Requirements*

2a. *Movement*: At the end of each of the three phases, each LANdroid platform will be timed in both a straight-line and a curved or figure eight pattern. Platforms must meet or exceed 0.5m/sec over various urban surfaces (concrete, asphalt, carpet).

2b. *Simple Behaviors*: At the end of each of the three phases, low-level navigation will be evaluated using two tests. First by demonstrating the platform's ability to autonomously explore its environment, navigating around a set of obstacles (walls, cliffs/drops, etc.), and second, by demonstrating the ability to return to within-a-threshold-distance of its starting position after following a simple path.

2c. *Power*: Platforms must demonstrate an ability to support simultaneous movement, navigation and communication during the life of the mission. This will be accomplished by placing the platform in a room filled with obstacles and wireless network connectivity. The time until either the platform comes to a halt or when the periodic network connectivity test fails (whichever comes first) will be the figure of merit for power autonomy. By the end of Phase I, platforms must remain active for a period of at least five hours, and by Phases II and III, demonstrate at least a ten-hour mission life.

3. *Platform Payload Requirements*

3a. *Processor Module*: At the end of Phase I, platforms will need to demonstrate an ability to run a basic LANdroid control algorithm, as well as a standard CPU/memory access benchmark concurrently with radio operation/autonomous navigation. The processing figure of merit will be the benchmark score. Platforms will be expected to meet a minimum threshold value and are encouraged to exceed it. At the end of Phase II, platforms will need to demonstrate the ability to effectively implement a control algorithm developed in Phase I of Task A. The figure of merit will be how well the platform is able to host this control algorithm. By Phase III, the hardware platform and control software will need to be jointly developed, and the test will be the effectiveness of the LANdroid system as a whole.

3b. *Radio Relay Module*: At the end of Phase I, two prototype nodes will be used to establish radio communication performance. Each of these nodes will be placed in different positions and will be tested for the maximum sustainable connection speed. Test one will be "line-of-sight" – each node will act first as receiver and then as transmitter and will be placed at increasingly longer distances from each other. Test two will be similar to one, but with an increasingly larger number of walls and other obstacles between the nodes. At the end of Phase II, platforms will need to implement a control algorithm developed in Phase I of Task A. The figure of merit will be how well the platform hosts this control algorithm. By Phase III, the hardware platform and control software will need to be jointly developed, and the test will be the effectiveness of the LANdroid system as a whole.

4. GENERAL INFORMATION & OTHER REQUIREMENTS

4.1 Web site, ongoing Q&A

The solicitation web page at http://www.darpa.mil/ipto/solicitations/solicitations.htm will have information on the Bidder's Briefing Day and possibly a Frequently Asked Questions (FAQ) list.

4.2 Proposer eligibility

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

4.3 Submission process

Proposals not meeting the format described in this pamphlet may not be reviewed. Proposals MUST be submitted to DARPA in hard copy. Any submissions sent via fax or email will be disregarded. Responding to this announcement requires completion of an online Cover Sheet for

each Proposal prior to submission. To do so, the proposer must go to https://csc-ballston.dmeid.org/baa/index.asp?BAAid=07-46 and follow the instructions there.

Each proposer is responsible for printing the Confirmation Sheet and attaching it to every proposal copy. If a proposer intends to submit more than one Proposal, a unique UserId and password must be used in creating each Cover Sheet.

All proposals must include the following:

- One (1) print original of the full proposal including the Confirmation Sheet. Please do not use 3-ring binders.

- One (1) print copy of the full proposal including the Confirmation Sheet. Please do not use 3-ring binders.

- One (1) electronic copy of the full proposal. This electronic copy must be:
  - On a CD
  - In PDF or Microsoft Word for IBM-compatible format
  - Clearly labeled with BAA 07-46, proposer organization, proposal title (short title recommended)

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

The full proposal (original and designated number of hard and electronic copies) must be submitted in time to reach DARPA by 12:00 PM (EDT) 16 August 2007 (initial closing), in order to be considered during the initial evaluation phase. However, BAA 07-46 LANdroids will remain open until 12:00 NOON (EDT) 5 June 2008 (final closing date). Thus, proposals may be submitted at any time from issuance of this announcement through 12:00 NOON (ET) 5 June 2008, however, proposers are warned that the likelihood of funding is greatly reduced for proposals submitted after the initial closing date deadline.

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

4.4 Administrative Notes

Restrictive notices notwithstanding, proposals may be handled for administrative purposes by support contractors. These support contractors are prohibited from competition in DARPA technical research and are bound by appropriate non-disclosure requirements.

Subject to the restrictions set forth in FAR 37.203(d), input on technical aspects of the proposals may be solicited by DARPA from non-Government consultants/experts who are strictly bound by the appropriate non-disclosure requirements.

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

4.5 BAA correspondence and administrative addresses

DARPA will use electronic mail for all technical and administrative correspondence regarding this BAA, with the exception of selected/not-selected notifications. These official notifications will be sent via US mail to the Technical POC identified on the proposal coversheet.

Administrative, technical or contractual questions should be sent via e-mail to BAA07-46@darpa.mil. If e-mail is not available, please fax questions to (703) 741-7804, Attention: LANdroids Solicitation. All requests must include the name, email address, and phone number of a point of contact.

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

Postal address: DARPA/IPTO, ATTN: BAA 07-46, 3701 N. Fairfax Drive, Arlington, VA 22203-1714. For deliveries that require a phone number, such as FedEx or UPS, please use 703-696-2356, which is the DARPA mailroom.

For hand deliveries, the courier shall deliver the package to the DARPA Visitor Control Center at the address specified above. To ensure proper handling, the outer package, as well as the cover page of the proposal, must be marked "IPTO BAA 07-46."

4.6 Period of performance, acquisition plan, funding, and award information

Multiple awards are anticipated. The amount of resources made available to this BAA will depend on the quality of the proposals received and the availability of funds. This program will be a 6.3-funded effort and therefore proposers should note that grants and cooperative agreements will not be awarded under this solicitation. Proposals identified for negotiation may result in a contract or other transaction depending upon the nature of the work proposed, the required degree of interaction between parties, and other factors. The Government reserves the right to choose the appropriate instruments. Proposers should note that the required degree of interaction between parties, regardless of award instrument, will be high and continuous. In addition, since this is a 6.3 funded effort proposers should be aware that they will be required to comply with all U.S. export control laws and regulations (see section 4.12. for additional information).

As soon as the evaluation of a proposal is complete, the proposer will be notified that 1) the proposal has been selected for funding pending contract negotiations, or 2) the proposal has not been selected. The Government reserves the right to select for negotiation all, some, one, or none of the proposals received in response to this solicitation, and to make awards without discussions with proposers. The Government also reserves the right to conduct discussions if the Source Selection Authority later determines them to be necessary. If warranted, portions of resulting awards may be segregated into pre-priced options. Additionally, DARPA reserves the right to award without discussions, and to accept proposals in their entirety or to select only portions of proposals for award. In the event that DARPA desires to award only portions of a proposal, negotiations may be opened with that proposer. If the proposed effort is inherently divisible and nothing is gained from the aggregation, proposers should consider submitting it as multiple independent efforts. The Government reserves the right to fund proposals in phases with options for continued work at the end of one or more of the phases. Awards under this BAA will be made to proposers on the basis of the evaluation criteria listed below (see section 6 - Proposal Evaluation Criteria), and program balance to provide best value to the Government.

4.7 Meeting and travel requirements

There will be a program kickoff meeting and all key participants are required to attend. The program will also follow the conventional model of two Principal Investigator (PI) meetings per 12 month period. Performers should also anticipate periodic site visits at the program manager's discretion.

4.8 Reporting requirements

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

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

4.9 Human use

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

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

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

4.10 Security classification

The Government anticipates that proposals submitted under this BAA will be unclassified. In the event that a proposer chooses to submit a classified proposal or submit any documentation that may be classified, the following information is applicable.

Proposers should develop and include in their proposals a brief description of their strategy either to participate in potential classified phases of LANdroid or to transition their technology to other entities that can participate.

Security Classification guidance on DD Form 254 will not be provided at this time since DARPA is soliciting ideas only. After reviewing the incoming proposals, if a determination is made that the award instrument may result in access to classified information, a DD Form 254 will be issued and attached as part of the award. Proposers choosing to submit a classified proposal must first receive permission from the Original Classification Authority to use their information in applying to this BAA. An applicable classification guide should be submitted to ensure that the proposal is protected appropriately.

Classified submissions shall be in accordance with the following guidance:

Collateral Classified Data: Use classification and marking guidance provided by previously issued security classification guides, the Information Security Regulation (DoD 5200.1-R), and the National Industrial Security Program Operating Manual (DoD 5220.22-M) when marking and transmitting information previously classified by another original 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 (USPS only; not DHL, UPS or FedEx). 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 (DARPA)
ATTN: BAA 07-46, DARPA/IPTO, Dr. Tom Wagner
3701 North Fairfax Drive
Arlington, VA 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 (DARPA)
Security & Intelligence Directorate, Attn: CDR
3701 North Fairfax Drive, Suite 255
Arlington, VA 22203-1714

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

Special Access Program (SAP) Information: Contact the DARPA Special Access Program Central Office (SAPCO) at 703-526-4052 for further guidance and instructions prior to transmitting to DARPA. All Top Secret SAP must be transmitted via approved methods for such material. Consult the DoD Overprint to the National Industrial Security Program Operating Manual for further guidance. It is strongly recommended that you coordinate the transmission of SAP material and information with the DARPA SAPCO prior to transmission.

Sensitive Compartmented Information (SCI) Data: Contact the DARPA Special Security Office at 703-812-1984/1994 for the correct SCI courier address and instructions. All SCI data must be transmitted through your servicing Special Security Officer (SSO). All SCI data must be transmitted through SCI channels only (i.e., approved SCI Facility to SCI facility via secure fax).

Proprietary Data: All proposals containing proprietary data should have the cover page and each page containing proprietary data clearly marked as containing proprietary data. It is the proposer's responsibility to clearly define to the Government what is considered proprietary in nature.

Proposers must have existing and in-place prior to execution of an award, approved capabilities (personnel and facilities) to perform research and development at the classification level they propose.

4.11 Publication approval

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

(a) There shall be no dissemination or publication, except within and between the Contractor/Awardee and any subcontractors, of information developed under this contract or contained in the reports to be furnished pursuant to this contract without prior written approval of the DARPA Technical Information Officer (DARPA/TIO). All technical reports will be given proper review by appropriate authority to determine which Distribution Statement is to be applied prior to the initial distribution of these reports by the Contractor/Awardee.

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

4.12 Export Licenses

The Contractor shall comply with all U. S. export control laws and regulations, including the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 through 130, and the Export Administration Regulations (EAR), 15 CFR Parts 730 through 799, in the performance of a resulting contract. In the absence of available license exemptions/exceptions, the Contractor shall be responsible for obtaining the appropriate licenses or other approvals, if required, for exports of hardware, technical data, and software, and for the provision of technical assistance.

The Contractor shall be responsible for obtaining export licenses, if required, before utilizing foreign persons in the performance of this contract, including instances where the work is to be performed on-site at any Government installation including installations in the United States, where the foreign person will have access to export-controlled technical data or software.

The Contractor shall be responsible for all regulatory record keeping requirements associated with the use of licenses and license exemptions/exceptions.

The Contractor shall be responsible for ensuring that the provisions of this clause apply to its subcontractors.

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

Certain post-employment restrictions on former federal officers and employees may exist, including special Government employees (including but not limited to Sections 207 and 208 of Title 18, United States Code, the Procurement Integrity Act, 41 U.S.C. 423, and FAR 3.104).

Accordingly, it has been confirmed that the DARPA Program Manager is a Government employee and, as such, is unlikely to have a potential conflict of interest with any potential offerors. However, prior to the start of proposal evaluations, the Government will assess whether any potential conflict of interest exits in regards to the DARPA Program Manager as well as those individuals chosen to evaluate proposals received under this BAA.

Certain post-employment restrictions on former federal officers and employees may exist, including special Government employees (18 U.S.C. 207). If a prospective proposer believes that a conflict of interest exists, the situation should be raised to the DARPA Technical Point of Contact before time and efforts are expended in preparing a proposal.

5. PROPOSAL PREPARATION AND FORMAT

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

Proposals shall include the following sections, each starting on a new page (where a "page" is 8-1/2 by 11 inches with type not smaller than 12 point) and with text on one side only. Apart from what is described in Sections I and II, the submission of other supporting materials along with the proposal is strongly discouraged. All submissions must be in English.

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

Section I. Administrative

A. Confirmation Sheet

The confirmation sheet (described under “Submission Process” of this announcement) will contain the following information:

- Announcement number;
- Technical topic area (Task A, B, C or D);
- Proposal title;
- Technical point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address;

• Administrative point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address;

• Summary of the costs of the proposed research, including total base cost, estimates of base cost in each year of the effort, estimates of itemized options in each year of the effort, and cost sharing if relevant;

• Contractor's type of business, selected from among the following categories: "WOMEN-OWNED LARGE BUSINESS," "OTHER LARGE BUSINESS," "SMALL DISADVANTAGED BUSINESS [Identify ethnic group from among the following: Asian-Indian American, Asian-Pacific American, Black American, Hispanic American, Native American, or Other]," "WOMEN-OWNED SMALL BUSINESS," "OTHER SMALL BUSINESS," "HBCU," "MI," "OTHER EDUCATIONAL," "OTHER NONPROFIT", or "FOREIGN CONCERN/ENTITY."

B. {No page limit} Table of contents

Section II. Detailed Proposal Information

This section provides the detailed discussion of the proposed work necessary to enable an in-depth review of the specific technical and managerial issues.
Page-counts are maximums.

A. {1 Page} Innovative claims for the proposed research. This page is the centerpiece of the proposal and should succinctly describe the unique proposed contribution.

B. {1 Page} Proposal Summary. The summary provides a top-level view of the proposal. It contains a synopsis (or "sound byte") for each of the areas defined below. It is important to make the synopses as explicit and informative as possible. Where appropriate, the summary should also cross-reference the proposal page number(s) where each area is elaborated. The summary areas are:

1. Main goals of the proposed research (stated in terms of new, operational capabilities).
2. Tangible benefits to end users (i.e., benefits of the capabilities above).
3. Critical technical barriers or technical limitations that have, in the past, prevented the operational capabilities/benefits described above.
4. Main elements of the proposed approach.
5. Summary of why the proposed approach will overcome the technical barriers.
6. Expected results of this work (unique/innovative/critical capabilities to result from this effort, and form in which they will be defined).
7. Evaluation plan summary.
8. Cost of the proposed effort for each performance year.

C. {2 Pages} Research Objectives:

1. Problem Description. Provide a concise description of the problem areas addressed by this research.

2. Research Goals. Identify specific research goals of this project. Identify and quantify expected performance improvements from this research. Identify new capabilities enabled by this research.

3. Expected Impact. Describe expected impact of the research project, if successful. Characterize the influence this work is expected to have on the relevant contributing research communities.

D. Technical Approach and Evaluation:

1. {12 Pages} Technical Approach. Provide a detailed description of the technical approach being taken to create LANdroids.

2. {2 Pages} Comparison with Current Technology. Describe state-of-the-art approaches and the limitations that relate to the proposed approach.

3. {2 Pages} Evaluation/Experimentation Plans and Metrics. Proposers should clearly define appropriate internal metrics and evaluation plans for their approach. These plans and metrics will be used by DARPA to supplement the program-wide evaluations and to prepare individual efforts for program-wide evaluations. Proposed metrics and plans should complement the general program-wide metrics and evaluation plans.

E. {3 Pages} Statement of Work (SOW). Provide a statement of work, written in plain English, outlining the scope of the effort and citing specific tasks to be performed, references to specific subcontractors if applicable, and specific contractor requirements.

F. {1 Page} Schedule Graphic. Provide a graphic representation of project schedule including tasks, milestones, evaluation events, etc.

G. {2 Pages} Teaming and Tasking (if applicable). Provide rationale for why your team is necessary and sufficient for addressing the technical challenges of the selected program task. Include an organizational chart. Describe the breakdown of roles and tasks to individual team members and/or subcontractors as appropriate given the team composition be used. Note: this section is not necessary for individual (non-team) submissions.

H. {1 Page} Project Management and Interaction Plan. Describe the project management and interaction plans for the proposed work. If proposal includes subcontractors that are geographically distributed, clearly specify working/meeting models. Items to include in this category include software/code repositories, physical and virtual meeting plans, and online communication systems that may be used.

I. {2 Pages} Deliverables Description. List and provide detailed description for each proposed deliverable. Include in this section all proprietary claims to results, prototypes, or systems supporting and/or necessary for the use of the research, results, and/or prototype. If there are no proprietary claims, this should be stated. The proposer must submit a separate list of all technical data or computer software that will be furnished to the Government with other than

unlimited rights (see DFARS 227.) Specify receiving organization and expected delivery date for each deliverable.

J. {1 Page} Technology Transition and Technology Transfer Targets and Plans (if applicable). Discuss plans for technology transition and transfer. Identify specific military and commercial organizations for technology transition or transfer. Specify anticipated dates for transition or transfer. (This section is not applicable to proposals submitted under Tasks C or D).

K. {5 Pages} Personnel and Qualifications. List of key personnel, concise summary of their qualifications, and discussion of proposer's previous accomplishments and work in this or closely related research areas. Indicate the level of effort to be expended by each person during each contract year and other (current and proposed) major sources of support for them and/or commitments of their efforts. DARPA expects all key personnel associated with a proposal to make substantial time commitment to the proposed activity.

Include a table of key individual time commitments as follows:

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

L. {1 Page} Facilities. Description of the facilities that would be used for the proposed effort. If any portion of the research is predicated upon the use of Government Owned Resources of any type, the proposer shall specifically identify the property or other resource required, the date the property or resource is required, the duration of the requirement, the source from which the resource is required, if known, and the impact on the research if the resource cannot be provided. If no Government Furnished Property is required for conduct of the proposed research, the proposal shall so state.

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

N. {2 Pages per option} Options. Proposers are welcome to propose options and enhancements to the tasks defined in this document. For any proposed option or enhancement, proposer

should include a detailed example or scenario that supports the option or enhancement. The government is not required to read or score options.

O. {3 Pages} Power Point Materials. Include three Power Point slides where slide #1 summarizes the proposed approach and includes key graphics and concepts, and slides 2-3 expand on the technical approach being taken.

P. {Optional} Movie. Proposers may submit a short movie illustrating some of their related work in robotics. All movies must be provided in a standard computer readable medium (e.g., CD or DVD) and use a standard computer playable format (e.g., .wmv, .avi, .mov, .mpg). Government is not required to review.

Q. {No page limit} Organizational Conflict of Interest Affirmations and Disclosure. All proposers and proposed subcontractors 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 organization conflicts of interest (FAR 9.5) must be disclosed. The disclosure shall include a description of the action the proposer has taken or proposed to take to avoid, neutralize, or mitigate such conflict.

R. {No page limit} Intellectual Property

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

Proposers responding to this solicitation requesting a contract to be issued under the FAR/DFARS, shall identify all noncommercial technical data, and noncommercial computer software that it plans to generate, develop, and/or deliver under any proposed award instrument in which the Government will acquire less than unlimited rights, and to assert specific restrictions on those deliverables. Proposers shall follow the format under DFARS 252.227-7017 for this stated purpose. In the event that proposers do not submit the list, the Government will assume that it automatically has “unlimited rights” to all noncommercial technical data, and noncommercial computer software generated, developed, and/or delivered under any award instrument, unless it is substantiated that development of the noncommercial technical data, and noncommercial computer software occurred with mixed funding. If mixed funding is anticipated in the development of noncommercial technical data, and noncommercial computer software generated, developed, and/or delivered under any award instrument, then proposers should identify the data, documentation, and software in question, as subject to Government Purpose Rights (GPR). In accordance with DFARS 252.227-7013 Rights in Technical Data - Noncommercial Items, and DFARS 252.227-7014 Rights in Noncommercial Computer Software and Noncommercial Computer Software Documentation, the Government will automatically assume that any such GPR restriction is limited to a period of five (5) years in accordance with the applicable DFARS clauses, at which time the Government will acquire “unlimited rights” unless the parties agree otherwise. PROPOSERS ARE ADVISED THAT OFFERS CONTAINING RESTRICTIONS ON INTELLECTUAL PROPERTY ARE BY NATURE LESS FAVORABLE AND VALUABLE

TO THE GOVERNMENT. RESTRICTIONS WILL BE CONSIDERED IN THE EVALUATION PROCESS. If no restrictions are intended, then the proposer should state "NONE."

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

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

b. FARS/DFARS Commercial Items IP Restrictions: (Technical Data and Computer Software) Proposers responding to this solicitation requesting a contract to be issued under the FAR/DFARS, shall identify all commercial technical data, and commercial computer software that may be embedded in any noncommercial deliverables contemplated under the research effort, along with any applicable restrictions on the Government's use of such commercial technical data and/or commercial computer software. In the event that proposers do not submit the list, the Government will assume that there are no restrictions on the Government's use of such commercial items. PROPOSERS ARE ADVISED THAT OFFERS CONTAINING RESTRICTIONS ON INTELLECTUAL PROPERTY ARE BY NATURE LESS FAVORABLE AND VALUABLE TO THE GOVERNMENT. RESTRICTIONS WILL BE CONSIDERED IN THE EVALUATION PROCESS. If no restrictions are intended, then the proposer should state "NONE."

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

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

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

Proposers responding to this solicitation requesting a Technology Investment Agreement, or Other Transaction for Prototype shall follow the applicable rules and regulations governing these various award instruments, but in all cases should appropriately identify any potential restrictions on the Governments use of any Intellectual Property contemplated under those award instruments in question. This includes both Noncommercial Items and Commercial Items. Although not required, proposers may use a format similar to that described in Paragraphs 3.4.1 and 3.4.2 herein. PROPOSERS ARE ADVISED THAT OFFERS CONTAINING RESTRICTIONS ON INTELLECTUAL PROPERTY ARE BY NATURE LESS FAVORABLE AND VALUABLE TO THE GOVERNMENT. RESTRICTIONS WILL BE CONSIDERED IN THE EVALUATION PROCESS. If no restrictions are intended, then the proposer should state "NONE."

d. Patent dependencies

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

e. IP representations – All proposers

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

Section III. Cost proposal

The cost volume should be a separate document from the technical and management volume comprising sections I through II.

A. Cover sheet

- Name and address of proposer (include zip code);

- Name, title, and telephone number of proposer's point of contact;

- Award instrument requested: cost-plus-fixed-fee (CPFF), cost-contract--no fee, cost sharing contract--no fee, or other type of procurement contract (specify), agreement, or other award instrument;

- Place(s) and period(s) of performance;

- Funds requested from DARPA for the Base Effort, each option and the total proposed cost; and the amount of cost share (if any);

- Name, mailing address, telephone number and Point of Contact of the proposer's cognizant government administration office (i.e., Office of Naval Research/Defense Contract Management Agency (DCMA)) (if known);

- Name, mailing address, telephone number, and Point of Contact of the Proposer's cognizant Defense Contract Audit Agency (DCAA) audit office (if known);

- Any Forward Pricing Rate Agreement, other such Approved Rate Information, or such other documentation that may assist in expediting negotiations (if available);

- Contractor and Government Entity (CAGE) Code;

- Dun and Bradstreet (DUN) Number;

- North American Industrial Classification System (NAICS) Number [NOTE: This was formerly the Standard Industrial Classification (SIC) Number];

- Taxpayer Identification Number (TIN); and

- All subcontractor proposal backup documentation to include items a. through l. above, as is applicable and available.

B. Detailed cost breakdown

Total program cost broken down by fiscal year. Cost breakdown categories:

- Direct Labor – Individual labor category or person, with associated labor hours and unburdened direct labor rates;

- Indirect Costs – Fringe Benefits, Overhead, General and Administrative Expense, Cost of Money, etc. (Must show base amount and rate);

- Travel – Number of trips, number of days per trip, departure and arrival destinations, number of people, etc;

- Subcontract – A cost proposal as detailed as the proposer's cost proposal will be required to be submitted by the subcontractor. The subcontractor's cost proposal can be provided in a sealed envelope with the proposer's cost proposal or will be requested from the subcontractor at a later date;

- Consultant – Provide consultant agreement or other document which verifies the proposed loaded daily/hourly rate;

- Materials – Should be specifically itemized with costs or estimated costs. An explanation of any estimating factors, including their derivation and application, shall be provided. Please include a brief description of the proposer's procurement method to be used;

- Other Direct Costs – Should be itemized with costs or estimated costs. Backup documentation should be submitted to support proposed costs;

- Costs of major program tasks and major cost items by year and month; and

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

C. Government Furnished Property

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

• A letter on corporate letterhead signed by a senior corporate official and addressed to Dr. Tom Wagner, Program Manager, DARPA/IPTO, stating that you either can not or will not provide the information technology (IT) resources necessary to conduct the said research;

• An explanation of the method of competitive acquisition or a sole source justification, as appropriate, for each IT resource item;

• If the resource is leased, a lease/purchase analysis clearly showing the reason for the lease decision; and

• The cost for each IT resource item.

6. PROPOSAL EVALUATION CRITERIA

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

For evaluation purposes, a proposal is the document described in PROPOSAL PREPARATION AND FORMAT Section I, Section II, and Section III (see above.) DARPA's intent is to review proposals as soon as possible after they arrive; however, proposals may be reviewed periodically for administrative reasons.

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

6.1 Overall Scientific and Technical Merit

The overall scientific and technical merit must be clearly identifiable and compelling. The technical approach must be clear, convincing, and well developed. Where appropriate, integration of different technologies should be clear and well defined. Proposers should demonstrate an awareness of prior/related art and an awareness of the LANdroid problem domain itself. Examples that illustrate key concepts are encouraged and the LANdroid problem domain is the preferred application domain for said examples. Proposers should clearly conform to the stipulated metrics and evaluation plans. For Tasks A and B, proposers should also specify experimentation plans that prepare efforts for the program-wide evaluations and may specify additional effort-specific metrics if appropriate. For Tasks C and D, proposals may include candidate additional experimentation plans for the program and additional metrics.

6.2 Innovative Technical Solution to the Problem

Proposers should apply new and/or existing technology in an innovative way that supports the objectives of the proposed effort.

6.3 Plans and Capability to Accomplish Technology Transition

Proposers should provide a clear explanation of how the technologies to be developed will be transitioned to capabilities for government use. Positive impact is desired. Articulation of key

relationships with military service units and/or identification of transition paths is encouraged. Proposals should inspire confidence that the technical work will culminate in a transitionable technology. Intellectual property restrictions will be assessed.

6.4 Proposer's Capabilities and Related Experience

The qualifications, capabilities, and demonstrated achievements of the proposed principals and other key personnel for the primary and subcontractor organizations must be clearly demonstrated. Level of effort must be realistic, convincing and appropriate.

6.5 Realism of Proposed Schedule

The overall research agenda and project timeline should be clearly defined and compelling.

6.6 Cost Realism

The overall estimated costs should be clearly justified and appropriate for the technical complexity of the effort. Evaluation will consider the value of the research to the government and the extent to which the proposed management plan will effectively achieve the capabilities proposed.