

DARPA Robotics Challenge
Questions & Answers

CONTRACTS

- C1. Are foreign organizations eligible for funding? Is so, can they be a lead or just a subcontractor and are there any limitations in funding amount or percentages that can go to the foreign organization?
- A. Yes, foreign organizations are eligible for funding, and may be a lead or a subcontractor.
- C2. Do any additional rules apply to non-U.S. led organizations?
- A. Under this BAA, no additional rules apply to non-U.S. led organizations.
- C3. "Could you please explain the publication policy? Could participant publish their research results in journals and conferences? The BAA includes some sections regarding this issue. However, it would be great if you may provide simple explanations regarding the way we may publish research results obtained in this program. "
- A. BAA Part II, Section VI.B.4 describes the publication policy.
- C4. Are there arrangements for teaming opportunities?
- A. DARPA has not established a teaming website. However, DARPA encourages teaming where appropriate (see BAA Part II, Section III.D.1)
- C5. Are there any suppliers that track A is restricted from purchasing off the shelf software, components, or parts?
- A. Any supplier except the GFE providers may be used in track A.
- C6. Will the Government exercise its option under 28 USC 1498 to indemnify entrants against patent infringement? Or is it the entrant's responsibility to obtain rights to any necessary intellectual property?
- A. Awards made under this BAA will likely include the FAR clause 52.227-1, "Authorization and Consent" or similar language.
- C7. Can Track B teams choose to spread out the 750k over the second period of Phase 1 and Phase 2?
- A. No. The proposed amount for a phase may not exceed the ceiling amount specified for that particular phase in the BAA. Phase 1 funds may not be "carried forward" into Phase 2.
- C8. Should we submit the proposal with the technical description and budget only for the first nine months or for the entire period (27 months)?
- A. Proposals must address the entire program.

- C9. Please explain and extend on this point in the BAA: DARPA desires Unlimited Rights, as defined in DFARS 252.227-7013 and -7014 to all deliverables generated by the DARPA Robotics Challenge performer under this effort except clearly-identified, widely-available, commercial software tools, with their commercial availability described and substantiated in the proposal. To what extent does DARPA enforce this clause and what exceptions can be made? What is a deliverable in the sense of this clause?
- A. The language referenced in the question above has been deleted from the BAA by Amendment 1. However, per BAA Part II, Section VIII, proposers must still submit a separate list of all technical data or computer software that will be furnished to the Government with other than unlimited rights. Apart from the minimum reporting requirements listed in BAA Part II, Section VI.C for all performers (see page. 14 for additional Track A performer deliverable requirements) proposers are free to define their own deliverables which are the means by which technical data/computer software would be made available.
- C10. Assuming that we compete in Track A. Can I use part of the funding in phase 1 during the month 16th-27th (phase 2)? For example, can we spend \$2.5M in phase 1 and \$1.5M during phase 2? The question is relevant because the cost related to labor cost won't change that much between the two phases.
- A. No. See Question C7 above. Proposers should follow the guidelines outlined in the BAA Part II, Section I.G.
- C11. Will contractors who are provided a sole-source contract on this program be entitled to propose to Track A or Track B?
- A. No. The GFE Platform supplier and the GFE Simulation supplier may not compete on Track A, Track B, Track C, or Track D.
- C12. For a performer on track D, who is self-funded, do they have to provide or offer Intellectual Property Developed for their project to DARPA, given that DARPA did not fund it?
- A. No.
- C13. When evaluating the proposals, how much weight is given to groups and individuals in the proposal with existing DoD and DARPA relationships or contract awards? This was a factor in the DARPA Urban Challenge award process as we learned during our Track A proposal debriefing, so am wondering what weight, if any, is given here.
- A. BAA Part II, Section V.A. on page 31 of the BAA defines the evaluation criteria.
- C14. If we use a commercial product that is part of our IP as a component of the resulting system, and it requires some adaptation to be used in the resulting system, is it sufficient for us to make available the new version of the product commercially? Or do we have to make available the details of the adaptation?

- A. Apart from the minimum reporting requirements listed in BAA Part 2, Section VI.C for all performers (see page. 14 for additional Track A performer deliverable requirements) proposers are free to define their own deliverables which are the means by which technical data/computer software would be made available. It depends if the IP in question is proposed by the performer as a deliverable or not.
- C15. Is it acceptable for a bidder to procure hardware from a third party that provides a substantial part of the project capability? What happens to "Unlimited Rights" in those circumstances?
- A. Yes, it is acceptable. Hardware itself is not technical data. Restrictions on the use of technical data associated with the hardware may be asserted by the third party. Any restrictions on the Government's use of this data must be identified per BAA Part II, Section VIII.
- C16. Do "Unlimited Rights" take effect if the project doesn't pass the Critical Design Review
- A. The Government's rights to technical data and computer software commence upon contract award and remain in effect in perpetuity.
- C17. If proposing on Track B, should the cost proposal cover only the first 9 months, or the entire program?
- A. The proposal should address the entire program.
- C18. Is there any type of award method that is best suitable for overseas teams?
- A. There is no preference in award type for overseas performers. Overseas teams are eligible to receive any of the award instruments specified in the BAA. Please note that proposers (U.S. or overseas) without DCAA-approved accounting systems may experience a significant delay in receiving an award if they propose cost reimbursement procurement contracts due to the need to have their accounting systems approved by DCAA prior to receipt of the contract.
- C19. Can we hire students that are not US citizens?
- A. The BAA does not impose any restrictions on hiring. Other restrictions may apply.
- C20. Is being Track D the only way to keep our development software as our own property, aside from requesting that the government get less than unlimited rights? Asking from a business IP standpoint.
- A. The Government obtains no rights to software for Track D performers as they will not receive Government funding. The Government's rights to software for other tracks will depend on the source of funds that contributed to the software's development. If the Government contributes funds to the development of the software it typically obtains certain rights to the software.

- C21. If a track B software team is also supporting a track A hardware team, can the track A team indicate that in their proposal?
- A. Yes.
- C22. Is it true that the government wants unlimited rights to the resulting robot? Does that mean that the vendor gets no rights to the robot produced? If so, that seems to be a BIG problem. It seems to me that the robot will be worth FAR more than \$2 million. That is, such a robot could be offered on the open market for probably under \$100,000 each and a company could make BILLIONS not just a few million.
- A. Providing the Government with Unlimited Rights to technical data/computer software is not a requirement of this BAA. A proposer's IP posture will not be considered during evaluation (Refer to BAA Part II, Section V for the evaluation criteria). Further, the Government getting unlimited rights does not mean that a performer forfeits all of its rights.
- C23. What about non-disclosure agreements? Is the government going to sign NDAs so that vendors have some hope that their ideas are not just given away to others - or stolen by others?
- A. All proposals submitted are source selection sensitive information and will be protected as such. Disclosing procurement information outside the Government by Government employees is a violation of the Procurement Integrity Act. Violators are subject to criminal penalties. All non-Government consultants/subject matter experts with access to the proposals are strictly bound by non-disclosure agreements. See BAA Part II, Section V, B.
- C24. I already have a robot very similar to the GFE robot. It would require a few modifications to match the GFE, such as purchasing an already developed portable electric hydraulic pump, and modifying the hands. Would it be a good idea to propose under track A (I am not really designing new hardware or innovating in terms of hardware), or can I propose under track B to a) use track B funds or get some additional funds (through the M3 program) to modify my robot? b) also get the GFE robot?
- A. Simply explain your situation in your proposal. We will consider various alternatives you propose and evaluate your proposal based on the one best meeting the evaluation criteria.
- C25. The compressed timeline and limited funding for the Track B evaluation is not likely to provide resources for a break through addressing the problem of behavioral synthesis, which will be required to fully address the general solution to separating the human/predictive model/robot as shown in the bottom row of your presentation slide.
One could imagine an engineered approach to defining behaviors and GUI/comms specific to this challenge, but one that does not generalize to other challenges.
Is DARPA's evaluation criteria weighted more toward proposals with a higher likelihood of short term success in this challenge, or long-term solutions to the general problem?
- A. There will be enough novelty in the actual competition to preclude highly tuned solutions. The notional events given in the BAA should guide your proposal writing, but in a general

way. Solutions that over-fit to particular events will not be as attractive as general solutions.

- C26. The BAA states that “DARPA desires Unlimited Rights [...] to all deliverables.” Would DARPA accept Government Purpose Rights (GPR) instead of Unlimited Rights? Also, if we receive non-federal funding in addition to DARPA funding, will DARPA request Unlimited Rights to the IP developed at private expense?
- A. The language referenced in the question above has been above deleted from the BAA by Amendment 1. Typically the source of funds with which technical data/computer software are developed determines the Government’s rights. See BAA Part II, Section VIII for additional information.
- C27. One of our team members works for a government lab. We are expecting to buy some of his time for use in this project using DARPA funds granted for this project. Since his employer would not be providing any funding for this endeavor, or subsidizing it in any way, do we still need to meet the requirements of paragraphs 1.6 and 1.7?
- A. The eligibility requirements in Section IIIA (p. 18) apply to proposals that may include Government or Government funded entities. See also Paragraphs 1.6 and 1.7 on p. 25. If this question refers specifically to a Government employee performing in an individual capacity outside of their official job duties see the guidance provided at <http://www.oge.gov/Topics/Outside-Employment-and-Activities/Outside-Employment-Limitations/> for executive branch employee outside employment limitations.

PROGRAMMATIC

- P1. For teams that are given government furnished equipment, will they be able to continue using the GFE after the competition, either through transferal of ownership to them or long-term loan to them?
- A. As part of their contracts, teams will be required to return the GFE Platforms at the conclusion of the program.
- P2. Can an organization and/or PI lead both a Track A project and a Track B project? If not, can they lead a project on one track and be a sub on a project on the other track?
- A. An organization and/or PI may in theory participate on more than one team. However, a key personnel clause will be included in all awards. This clause will require a selected team, as a condition of award, to honor the key individual time commitment(s) included in its proposal and could potentially preclude organizations/Pis from leading multiple teams. Furthermore, DARPA often selects among proposals with strong evaluations by building a portfolio with a diversity of approaches. While possible, it is unlikely that common key personnel on multiple projects will be able to support a diversity of approaches.
- P3. If a team starts on Track A and is in the top 8, thereby making it into phase 2, but determines that their software would be more competitive on the GFE hardware, can the team switch to using GFE for Phase 2, or do they have to stay with their original robot hardware that they developed?

- A. This would be unlikely due to the number of assets available but will be handled on a case-by-case basis.
- P4. For self-funded teams, can they purchase the GFE Platform? If so, what will the price be?
- A. Self-funded teams (Track D) can contact the GFE Platform supplier directly. DARPA will neither determine costs nor provide support for those platforms.
- P5. What are the rules of the competition? How will scoring be done?
- A. The rules and scoring approach will be announced no later than the Program Kickoff meeting.
- P6. When is the Program Kickoff meeting?
- A. The Program Kickoff meeting is planned for October 2012.
- P7. Is this program related DARPA's HACMS?
- A. No, the DRC has no official ties to any program but expects to build on technology developed by previous efforts.
- P8. Is there an approximate date for the Virtual Disaster Response Challenge?
- A. The approximate date of the Virtual Disaster Challenge is June 2013.
- P9. On page 12 of DARPA BAA-12-39 it says "Register NLT April 1, 2013 for Track C". What is the meaning of "NLT"?
- A. "NLT" is an abbreviation meaning "no later than."
- P10. At what point during the process (BAA, Challenge Kick-Off, etc.) will the fine details of the challenge be available for all participants?
- A. DARPA intends to publish the competition rules and scoring approach no later than the Program Kickoff.
- P11. When will the GFE hardware be available for test for Track B performers (months after contract award)? Will the hardware with all necessary test equipment be available at each performer's site or will this be run at a government / GFE facility?
- A. The Track B and Track C teams with top performance on the Virtual Disaster Challenge will receive GFE Platforms in approximately July 2013. Recipients of the GFE Platforms will use them at their own facilities for development, and at DARPA's facilities for the DRC1 and DRC2 competitions.
- P12. How soon will the design specifications of the GFE platform be available to Track B performers?
- A. The GFE Platform design specifications will be announced no later than Program Kickoff.
- P13. Will Track B performers have the opportunity to influence the GFE hardware design?
- A. No. Track B performers will not be involved in designing the GFE Platform.

- P14. Is DARPA separately awarding funds for the development of the GFE Simulator?
- A. DARPA intends to award a contract for the GFE Simulator as announced in DARPA SN-12-34.
- P15. For track-B teams, is it necessary/advantageous to include personnel with expertise in robotic hardware, computer vision, and other areas that will become relevant only after the Virtual Challenge?
- A. Track B proposals must address the entire program.
- P16. Should track-B proposals focus on the simulation work, or should they develop detailed plans for both periods of Phase 1 as well as Phase 2?
- A. Track B proposals must address the entire program.
- P17. PowerPoint Summary Slide: should it be prepared in PowerPoint and then converted to PDF, or should it be submitted as a PowerPoint file?
- A. The summary should be submitted as a PowerPoint file.
- P18. The announcement implies that top 6 simulation teams who are given the GFE Platform and then eliminated in Disaster Response Challenge 1 can no longer participate. Is there an option for such teams to still participate in Disaster Response Challenge 2 even though they did not receive funding for Phase 2?
- A. Teams eliminated at any stage are invited to participate in Track D. For Track B teams eliminated, they will not have access to the GFE Platform after DRC 1.
- P19. Will track-B teams have any advantages over track C-teams, other than the 375k in funding?
- A. No. Track B teams will not have any advantages over Track C teams other than funding.
- P20. In case the GFE Simulator turns out to be inadequate, is there an option to use a different simulator in the Virtual Challenge, assuming it meets certain criteria - such as fitting empirical data from the GFE Platform better than the GFE Simulator?
- A. The Virtual Challenge competition will use the GFE Simulator.
- P21. Can each Track B team bring its own (possibly custom-modified) GFE platform to the competition, or will we have to use DARPA's robot?
- A. Track B teams will use the GFE Platform and in most cases not be allowed to modify the platform.
- P22. May a Track B team also register to continue as Track C in case they are not funded?
- A. Yes, a team must register for Track C through the registration tool to be established at Program Kickoff in October 2012.
- P23. When will the Track C registration open?

- A. The Track C registration will open in October 2012.
- P24. Will Track B proposers automatically qualify as Track C participants if their proposal is not selected for funding?
- A. No, teams not selected for Track B will have to register for Track C, but the process will be straight forward.
- P25. For Track A, what kind of budget or team size would you suggest to allocate for the areas of design, control, sensing and autonomy in proportion to each other?
- A. It is up to the proposer to define the composition of the team.
- P26. Are additional sensors allowed or are we just limited to the ones on the robot? For example, could a Track B team supply a bolt-on sensor to be carried by the GFE robot in addition to its native sensors?
- A. In general, no. However, DARPA may consider rare exceptions on a case by case basis.
- P27. How will the 100 Track C participants be selected? Will there be an application and evaluation process?
- A. The Track C participants will be selected on a first come basis.
- P28. The presenter from Boston Dynamics implied that some of the features are not yet available or unknown. Is there a risk with this bot not being available or very useable in time of contract kick-off?
- A. DARPA expects the GFE Platform to be available as planned.
- P29. With respect to Gazebo, it sounds like there are planned but unimplemented features that are important for use. Is there a risk of it not being available or very useable in time of contract kick-off?
- A. DARPA expects the GFE Simulator to be available as planned.
- P30. We have a robotics control platform that we've applied to prior DARPA challenges and many commercial projects. Is there an opportunity for us to offer use of this platform to participants?
- A. It is up to the teams, not DARPA, to determine what components to use and how to procure them.
- P31. Is there any information available in regard to the ambient conditions for robots in competition? Can we just assume "perfect" conditions, i.e. a sunny 70 degree day with no fog or haze and bright sunlight?
- A. The venues for the DRC1 and DRC2 competitions have not been defined yet, so the expected meteorological conditions are not yet known. But the event is planned to deal with a real world environment.

- P32. Can a track B software team also support a track A hardware team as well as work with the GFE robot?
- A. An organization and/or PI may in theory participate on more than one team. However, a key personnel clause will be included in all awards. This clause will require a selected team, as a condition of award, to honor the key individual time commitment(s) included in its proposal and could potentially preclude organizations/PIs from leading multiple teams. Furthermore, DARPA often selects among proposals with strong evaluations by building a portfolio with a diversity of approaches. While possible, it is unlikely that common key personnel on multiple projects will be able to support a diversity of approaches.
- P33. To win the Phase 2, \$2M prize, do you have to just beat the other competitors, or do you also have to perform above a set of DARPA-set metrics?
- A. To win the prize, the robot must perform all of the challenge tasks and score highest.
- P34. What are the advertising opportunities for corporate sponsors on GFE? Can we repaint / put stickers on the GFE to match sponsor colors and logos?
- A. Temporary cosmetic changes to the GFE Platform that do not affect performance and are not offensive will be allowed within reason.
- P35. For the competitions, if you have GFE, will we use our copy in the competition, or will our software run on a government owned GFE copy?
- A. Teams receiving GFE Platforms will compete using those platforms.
- P36. If your GFE breaks, how will maintenance be done?
- A. The GFE Platform supplier will be responsible for maintenance of the GFE Platforms.
- P37. Are humans allowed to change batteries on a robot during the A competition or does the robot have to change its own batteries?
- A. In Phase 1, a platform must complete each event without intervention.
- P38. Do TRACK D participants need to submit any documentation of intent to participate in the DARPA Robotics Challenge under the current BAA?
- A. No. Details for participation in Track D will be described at Program Kickoff in October 2012.
- P39. How will Track D Participants be informed of competition changes, updates and simulation releases?
- A. Though the program website which will be launched no later than October 2012.
- P40. When will Track D Participants have access to simulation information, specifications, and software?
- A. Participants wanting access to the simulation should register for Track C.

- P41. Will the simulation be available during the challenge? What limitations with there be on this resource?
- A. Yes. The number of cloud resources will be managed by the program.
- P42. Will DARPA provide testing facilities (for the performers to test their robots) at a DARPA location or at the location of each performer? Or, do we need to include in the budget the cost of setting up a testing facility at our location (e.g. the cost to install industrial ladder, pipes, valves, etc.)?
- A. DARPA plans to establish one or more test sites to allow teams to shake out on events similar but not exactly the same as those to be used in DRC 1.
- P43. Some large research institutions have more than one group capable of performing Track A and/or Track B. Can an institution receive multiple awards assuming different Principal Investigators for each award? Is there anything that would restrict receiving awards on different tracks (e.g. one award on Track A and one award on Track B)?
- A. An organization and/or PI may in theory participate on more than one team. However, a key personnel clause will be included in all awards. This clause will require a selected team, as a condition of award, to honor the key individual time commitment(s) included in its proposal and could potentially preclude organizations/Pis from leading multiple teams. Furthermore, DARPA often selects among proposals with strong evaluations by building a portfolio with a diversity of approaches. While possible, it is unlikely that common key personnel on multiple projects will be able to support a diversity of approaches.

TECHNICAL

- T1. Must the robot be humanoid?
- A. No. DARPA expects the robot to operate in human environments and use human tools, but DARPA does not require a humanoid form with two arms, two legs, one torso, and one head. A system with, for example, 3 arms, 4 legs, and 2 heads, is acceptable, so long as it performs all of the challenge tasks.
- T2. Must the robot be bipedal? Can it have three legs, or tracks, or wheels?
- A. No, the robot need not be bipedal. The robot can use non-bipedal locomotion, as long as the system performs all of the challenge tasks.
- T3. Does the robot need to perform all of the challenge tasks, or can it do only some of the challenge tasks?
- A. The robot must perform all of the challenge tasks.
- T4. For Track B teams that receive a GFE Platform, can they modify the GFE Platform?
- A. In general, no. However, DARPA may consider rare exceptions on a case by case basis.
- T5. For teams that receive a GFE Platform, can they perform maintenance on the GFE Platform?
- A. No. The GFE Platform supplier will perform all maintenance.

- T6. Must a single robot perform all events, or can a team of robots cooperate, while each robot specializes on one single task?
- A. A single robot must complete all of the challenge tasks. The robot may be marsupial or reconfigurable, but the robot shall not leave parts of itself behind.
- T7. Will the GFE Platform have an open design?
- A. The GFE Platform Software Application Programmer Interfaces (APIs) will be open. The GFE Platform Hardware design will not be open.
- T8. Must the robot accomplish the challenge tasks autonomously without a human in the loop?
- A. No. DARPA expects an operator to be in the loop providing supervisory control. The scoring approach will favor autonomy; Section I.D of the BAA states that “for two systems that perform the scenario equally well, the scoring approach will favor the system that has the lower data rate.”
- T9. Must teams release their software as open source and make it available to the public after the competition is complete?
- A. No. DARPA encourages but does not require open source software.
- T10. When will DARPA release details of the communication specifications?
- A. No later than the Program Kickoff meeting.
- T11. Can we use a wired communications link between the robot and the mobile base vehicle?
- A. Section II.D of the BAA states that commands and data must be able to be communicated by a wireless link or a wired link. Approaches that work only with a wired tether for commands and data may have limited applicability in real-world disaster scenarios.
- T12. What is DARPA's position on open-sourced hardware design (mechanical, electrical)?
- A. DARPA encourages but will not require Track A participants to make their hardware designs available open source.
- T13. It seems that the communication quality is critical for the developers to strategize the control algorithm. When will details of the communication specifications be available to proposers?
- A. Details on the communication quality will be available during Phase 1. Proposers are encouraged to detail what capabilities they could provide based on varying levels of bandwidth and latency. System performance should degrade gracefully as communications quality degrades.
- T14. Simulating a multi-body, floating-base robotic system in an environment with several conditions (debris, rough terrain, possibly a crippled plant etc.) seems pretty challenging. A simulator called OpenHRP3 (developed by AIST, Japan) may be capable of populating such items (such a 3-D environment with a floating-base multi-body system); however, it still needs further

improvements in terms of software. Is there any already-developed simulator package to simulate such complicated scenarios? Will you use a simulator based on Open Dynamics Engine?

- A. DARPA intends to award a contract for the GFE Simulator as announced in DARPA SN-12-34.
- T15. Will time limits on the challenge be applied to the entire challenge or individual tasks?
- A. For DRC1, time limits will apply to each event. The time limit values have not been determined yet. The intent is to design most events to be optimally completed within approximately 10 minutes.
- T16. Are there restrictions (power, space, environmental) on the operator/controller of the robotic platform? (E.g. can it be assumed that the operator and control system are indoors with air conditioning and house power?)
- A. The operator will likely be indoors, and provided with reasonable space and power.
- T17. What level of behaviors will the GFE have when it is delivered to Track B performers and will this be limited to locomotion?
- A. The details will be announced at program kickoff but if can be assumed the GFE robot will include a few basic control modalities (e.g. straight walking, arm motion).
- T18. Will Track B performers have the ability to over-ride the built-in GFE platform autonomous behaviors?
- A. Yes.
- T19. What are the specifications (resolution, range, field of view, frame rate) of the sensors on the GFE platform (tactile, stereo, etc.)?
- A. The GFE Platform specifications beyond what was described at Proposer's Day will be provided no later than at Program Kickoff.
- T20. Will performers be permitted to extend the GFE Platform with custom sensor/actuators (mounting and interface restrictions)? If so, does the GFE Platform provide standard h/w interfaces (e.g. USB)?
- A. In general, no. However, DARPA may consider rare exceptions on a case by case basis.
- T21. Is tactile feedback included on the GFE platform?
- A. The hands have not been selected but will include some sensing.
- T22. Does the GFE platform include a neck to move the sensor head? If so what are the degrees of freedom on the neck?
- A. The GFE Platform will have a neck. The GFE Platform specifications beyond what was described at Proposer's Day will be provided no later than at Program Kickoff.

- T23. Does the GFE platform include a torso? If so is there a waist joint and what are the degrees of freedom?
- A. The GFE Platform will have a torso. The GFE Platform specifications beyond what was described at Proposer's Day will be provided no later than at Program Kickoff.
- T24. What is the sensing included in the GFE simulator?
- A. The GFE Simulator will include the sensors on the GFE Platform, and others as well. The GFE Platform sensors have not yet been selected. The GFE Simulator will enable users to define their own sensors.
- T25. Will the simulator include models of the tools (vehicle, ladder, human tools) and disaster city (including rubble outside of the ground terrain) required in the challenge?
- A. Yes.
- T26. How long is the tether for the GFE platform?
- A. The length of the power tether will suffice to complete the challenge events. The actual length has not yet been determined.
- T27. What level of access will be provided to GFE Platform software? Will performers be able to modify GFE Platform software, or will access be only through published APIs?
- A. Access to the GFE Platform software is expected to be through Application Programmer Interfaces (APIs).
- T28. What type of operating system environment is provided on the GFE Platform (os, memory, cpu type, i/o capabilities, etc.)? Can track B performers add additional computing capabilities to the GFE platform?
- A. This will be handled on a case-by-case basis. The GFE Platform will include processing intended for the teams and not needed for the low-level control of the GFE Platform. The type and version of the operating system has not yet been selected.
- T29. Will the GFE Platform provider also contribute a robot model for use in the GFE Simulator? If so, will it include all closed loop controls?
- A. The GFE Simulator will include a model of the GFE Platform, and include low level closed loop controls.
- T30. In the Virtual Challenge, will the control software be allowed to read the full internal state of the GFE Simulator, or will it be limited to using simulated sensor data - and if so, what data?
- A. The interface between the control software and the GFE Simulator has not yet been defined. Details will be published by the Program Kickoff. It is unlikely the control software will be allowed to read simulator state other than that of simulated sensors.

- T31. Are there limitations on the amount of computing power that can be used? For example, can teams rent Amazon HPC clusters (or access private clusters) of unlimited size and use them for real-time data processing and control during the Challenges?
- A. The amount of computing power available for the Virtual Challenge will be limited (amounts have not yet been decided) and will be equal for all participating teams.
- T32. How much onboard computing will be embedded in the GFE Platform (Multicore? GPU?)?
- A. The type of computing available on the GFE robot will be described at Kickoff. Teams proposing to Track B should plan for current state-of-the-art computing.
- T33. Does computing need to be onboard?
- A. No. However, proposers should keep in mind the communications limitations described in BAA Section 1.D.
- T34. How flexible will the software environment be on the robot? Like LittleDog where there's a black box API? Can we run Linux / ROS on a processor on the robot?
- A. A CPU on the robot will be provided. In addition, Teams can run software on an operator control station they provide keeping in mind the bandwidth and latency limitations.
- T35. Please describe your goals for the communication bandwidth and latency -- and how you plan to set and adjust these during the challenges?
- A. The range of values for communications bandwidth and latency has not yet been determined. They will be announced no later than the Program Kickoff meeting. We plan to adjust these to modulate the difficulty of the challenge to be hard, but not impossible.
- T36. Can we now (during the proposal preparation) obtain some or all of the technical specs for the stereo camera and for the laser radar device that will be a part of the GFE Platform?
- A. The sensors for the GFE Platform have not yet been selected. They will be announced no later than the Program Kickoff meeting.
- T37. Will the GFE Simulator have a built in model of the GFE Platform, or does the performer need to build it?
- A. The GFE Simulator will include a model of the GFE Platform, and not include the closed loop controls.
- T38. Is the bandwidth limit bi-directional?
- A. The bandwidth limits have not yet been identified. The uplink and downlink limits may be different.
- T39. Will GFE come with some baseline legged locomotion software (e.g., open-loop level-ground walking; a routine to stand up from a fallen position; etc.), and/or low-level control (force control, PD loops, etc.) on board?

- A. The details will be announced at program kickoff but if can be assumed the GFE robot will include a few basic control modalities (e.g. straight walking, arm motion).
- T40. GFE Platform: can we obtain its technical specs and/or the user manual or technical specs/user manual of the currently available robot(s) that GFE Platform will be based on?
- A. This will be provided at Program Kickoff.
- T41. GFE Simulator: can we obtain its user manual or the user manual of the currently available software that GFE Simulator will be based on?
- A. This will be provided at Program Kickoff.
- T42. Is data communication through the tether allowed?
- A. DARPA may use a physical tether for communication; however, bandwidth and latency will be constrained and monitored.
- T43. What are the constraints on managing the tether? Is a support team allowed to handle that?
- A. For safety, no personnel will be allowed near an operating robot.
- T44. Is a safety cable allowed to prevent the robot from falling on the ground during the Challenge?
- A. Yes.
- T45. Will the GFE have a standardized safety hook on the back or other attachment points for back-up support if it falls during in-lab testing?
- A. The GFE Platform design has not yet been finalized. Safety supports appear to be a reasonable component.
- T46. Is the GFE robot allowed to carry an extra tool?
- A. No, the tools required to complete an event will be provided.
- T47. Will the hands of the GFE provide haptic feedback?
- A. The GFE Platform hands are expected to be equipped with sensors. The hands have not yet been selected, so the sensor specifications are not known yet.
- T48. Will GFE platform be power autonomous, or tethered with hydraulics like PETMAN?
- A. The GFE Platform will have a power tether.
- T49. What is GFE platform power source (Battery / Electric, Gasoline / Hydraulic, etc.)? And is it safe and quiet for indoor/lab operation?
- A. The GFE Platform power system will include an offboard generator, a power tether, and an onboard electric motor driving a hydraulic pump.
- T50. Will we need to have a lab for the GFE robot that can handle IC engine exhaust, or will there be an electric version that can be (temporarily) powered by an umbilical or batteries?

- A. The GFE Platform will not use an internal combustion engine.
- T51. Will any aspects of the platform description and simulation code be released before kickoff so that teams can familiarize themselves with it before the award date?
- A. The specifications will be released no later than kickoff, i.e. possibly but not necessarily before.
- T52. Will vehicle ingress require operating an exterior door handle, and if so what type?
- A. The utility vehicle has not been selected yet, so the door type and handle type are not yet known. If a vehicle with doors is selected, opening it will not be significantly more challenging than other door-opening events.
- T53. Will the vehicle key be in the ignition upon ingress? Or will it be tucked above the sun visor like in the movie "Terminator"? If not, how will it be provided to the robot?
- A. We have not yet decided. This is one of the ways DARPA will vary the difficulty of the challenge to adjust for team performance.
- T54. What must the robot do with the vehicle key after the driving portion ends?
- A. We have not yet decided. This is one of the ways DARPA will vary the difficulty of the challenge to adjust for team performance.
- T55. Will vehicle egress require operation of an interior door handle, and if so what type?
- A. The utility vehicle has not been selected yet, so the door type and handle type are not yet known. If a vehicle with doors is selected, opening it will not be significantly more challenging than other door-opening events.
- T56. Where will the hand tools be located initially? Where should they be deposited after use?
- A. The tools will be within the workspace defined at the event. As long as the event is successfully executed the tools can be placed safely anywhere in the workspace.
- T57. What sensor and CPU payloads, if any, can each Track B team add to its GFE platform?
- A. A CPU on the robot will be provided for the Track B team's use.
- T58. Will any third-person views of the robot, e.g. a telephoto shot when outdoors, or feeds from a succession of security cameras as the robot moves around indoors, be available to the operator(s)? If so, will these views be continuous or intermittent?
- A. DARPA does not currently plan to provide third-person views of the robot. DARPA will consider providing these if the need arises.
- T59. What will the simulated world provided during Phase I contain? Will it have: a road; a vehicle with doors and handles; rubble; a structure with a doorway, handle and blocking debris; a ladder; a catwalk; a leaking pipe and valve; and a pump assembly and replacement pump? Will

mechanisms such as vehicle ignitions and door handles in the simulated world, when manipulated appropriately, produce the expected effects?

- A. The simulated environment will have challenge events modeled to the greatest fidelity possible. The details that will be used during the Virtual Challenge will be described at Program Kickoff.

T60. Will the Track C teams that have access to the cloud-based simulator be selected based on their registration information?

- A. Track C teams will only be determined by the order in which they register not the details of the team itself.

T61. When is the final form of the GFE simulator expected?

- A. The first version of the GFE Simulator will be released no later than the Program Kickoff meeting.

T62. Can you please clarify the roughness of the terrain for the dismounted mobility tasks? Do you anticipate that it would be suitable for a tracked or wheeled vehicle, or is a “dexterous walker” required?

- A. The terrain has not yet been identified. The BAA states that the terrain will be easily traversable by a human.

T63. “This terrain will be easily traversable by a human”. Does this imply human walking or does it extend to scrambling?

- A. The phrase "easily traversable" suggests that scrambling is not necessary.

T64. Are there any restrictions on the communication infrastructure that the PI wants to deploy between the robot and the human supervisor? For example, are we allowed to direct the robot to deploy a communication system in real time to facilitate communication between the robot and the supervisor?

- A. DARPA will provide the communications infrastructure.

T65. Regarding the GFE humanoid, exactly what functionality will be provided “out-of-the-box” for mobility and manipulation? For example, will the humanoid have the ability to balance and walk, or will we be given at most the ability to command joint positions/movement and we need to provide this functionality?

- A. The GFE Platform will have the ability to balance and walk.

T66. What level of messaging will be provided with the GFE simulator?

- A. The GFE Simulator messages have not yet been defined.

T67. For Track B teams who desire to use the GFE robot platform, is the control interface on the user side in the challenge also government-furnished equipment, or is it supplied by the proposer?

- A. The GFE Platform does not include an operator interface.

- T68. Could the Track B team supply some type of "hardware" (let's say, some kind of virtual reality helmet) to be used on the human side in conjunction with the GFE robot?
- A. Users of the GFE Platform are responsible for definition and implementation of an operator interface.
- T69. What are the software interfaces' types to the GFE robots?
- A. The Application Programmer Interface to the GFE Platform has not yet been defined. It will be defined at program kickoff.
- T70. Will there be six axis wrist force/torque sensors?
- A. The GFE Platform sensor suite has not yet been determined.
- T71. Will the low-level behaviors developed by Boston Dynamics be available to performers? That is, at what level does our software interact with the GFE?
- A. Teams will interact with the GFE robot through API's established by the vendor.
- T72. In leak detection, the environment will provide sound. Will there be sound sensors on the GFE?
- A. The GFE Platform and the GFE Simulator will both include microphones.
- T73. Could you comment on the ability to simulate complex multicontact interactions using Gazebo?
- A. Details of the Simulator will be described at Kickoff. Gazebo will be significantly enhanced during the program.
- T74. For the GFE Robot, if it is power tethered, how can it navigate the environment of the challenge? Will not the tether get in the way or limit the range of the robot?
- A. The power tether is expected to limit the range of the robot and possibly constrain the motions of the robot, but it will be possible to complete the events with the tether.
- T75. Will the simulator come with a robot model of the GFE hardware or will we need to create our own model?
- A. The GFE Simulator will include a model of the GFE Platform.
- T76. Will there be sensor and actuator models (noise, limitations, etc.) in the simulator? \
- A. The GFE Simulator will include sensor and actuator models.
- T77. Will ankle of GFE be 1-DOF or 2-DOF? Rob Playter said 1, but then a slide of his had 2.
- A. The slide also stated one (1) DOF for the ankle.
- T78. Which programming languages will be supported on the GFE Simulator/Platform? I and most of my colleagues are hardcore Java guys. It's looking like PERL, C, and C++ are the primary languages to use. Does a non-language dependent protocol/API exist? Any input you can provide will be appreciated.
- A. APIs will be provided that work with ROS, beyond that it is up to the individual team.

- T79. When will information about the hand be available? We can provide humanlike tactile sensing but need specs regarding mechanical platform and maximal forces, electrical power and data bus capacity.
- A. The hands have not been selected but will include some sensing.
- T80. How will added sensors be integrated into the simulation platform?
- A. If a team proposes and is approved for an added sensor, they will be responsible for providing the model.
- T81. What level of control is provided for the GFE robot?
- A. Control of the robot will be done to the robot through API's.
- T82. Does the GFE Platform (Boston Dynamics) software provide the foot placement and stability control, or does the performer?
- A. We anticipate that stability will be provided by the GFE provider. We anticipate that foot placement beyond walking will be provided by the performer. This may change. Details will be available at program kickoff.
- T83. Does the API allow for both higher-level (e.g. speed and yaw rate), and low-level control (e.g. joint angles and rates)?
- A. Yes.
- T84. The Boston Dynamics presentation showed what appeared to be a BumbleBee stereo vision rig. Will Track B teams have access to the vendor software libraries for stereo vision processing?
- A. For all COTS sensors, any provided information will be passed on to the teams.
- T85. Is all software expected to run on the single CPU provided for user software?
- A. For software on the robot, yes. In addition, Teams can run software on an operator control station they provide keeping in mind the bandwidth and latency limitations described in the BAA.
- T86. Is there a GPU available?
- A. The GFE Simulator may run on a GPU, with processing speed and memory to be determined. The GFE Platform is not expected to be equipped with a GPU.