

Questions answered on June 03, 2015

Q: How will the Operator in the garage know that a point has been scored during a run?

A: The Field Lead may announce it over the radio to the Operator. The Operator may acknowledge the announcement. Neither the Team Field Lead nor the Operator may provide additional information during this exchange.

Q: Will completion of the Surprise task be visually obvious?

A: During rehearsal (Thursday), no. During the competition (Friday and Saturday), yes.

Q: Can the team field personnel take photos during a run?

A: No. For safety, the team field personnel must maintain full situation awareness, and not take photos or other media, talk loudly, and not talk on cell phones or radios (except when the Team Field Lead informs the Operator of a point scored).

Q: How many team field members may accompany the robot on a run?

A: Up to five. During some DARPA training events, the number was mistakenly given as four.

Q: Will the Wall task circle be filled in?

A: Yes.

Q: Will there be a line on the ground following the rubble course that must be crossed in order to complete the Rubble task?

A: Yes.

Q: Can teams drive the Polaris in either low gear or high gear?

A: Yes. Further, in a change from previous revisions, the default gear will be low, not high.

Q: For the Drive task, what is considered a "significant" displacement?

A: Movement of the base of the barrier by twelve (12) inches or more.

Q: The Rules document states that "once the robot has completed attempting the Indoor tasks and begins the Stairs task, it may not attempt more Indoor tasks" (p. Rules-7). What constitutes beginning the Stairs task?

A: Crossing the line marked on the ground between the Rubble task and the Stairs task, indicating transition from indoors to outdoors. When all contact points between the robot and ground lie beyond the line, the robot is considered outdoors.

Q: The Rules document states that "for Task 1 (Drive), the robot may only drive the vehicle forward, and may not drive rearward" (p. Rules-7). Will DARPA amend this rule to allow the robot to drive rearward?

A: Yes, the robot may drive the vehicle rearward.

Q: If a team requests a Reset during the Egress task, once the robot has been extracted from the vehicle, is the vehicle then removed from the course?

A: Yes.

Q: The Rules document states that "for Task 8 (Stairs), the robot may only ascend, and may not descend." Will DARPA amend this rule to allow the robot to descend the stairs?

A: Yes, the robot may descend the stairs.

Q: Can one person serve as both Field Lead and Robot E-Stop operator?

A: Yes.

Q: Can the team touch the Field Computer during a run?

A: Yes, but only during a Reset, and only with a DARPA escort, who is located at the Garage Information Desk.

Q: For the Drive task, can we calibrate the motion of the gas pedal with the RPM generated by the engine?

A: Yes. The team must chock all of the Polaris wheels. The team must place the vehicle in Park. The team must explain the procedure in detail to (a) the robot e-stop operator, (b) the course official, (c) the course safety official, and (d) the vehicle e-stop operator. The team may continuously actuate the gas pedal for no more than three (3) minutes.

Q: Can we bring our gantry onto the course during a Reset?

A: Yes, provided that it fits through the door or the opening between the Rubble task and the Stairs task.

Q: Can we remove the platform, which may block our egress during our run?

A: Yes. This is a change from previous versions of the Rules and Technical FAQ.

Questions answered on May 28, 2015, rev1

Q: For the Wall task, if we successfully cut a hole in the wall, may we drop the tool on the other side of the wall?

A: No. Do not drop or place the tool on the other side of the wall, because DARPA has support equipment there and the activated tool may damage that equipment.

Q: For the Wall task, we will use one type of tool. We would prefer that DARPA not place on the other type of tool on the shelf.

A: For fairness, we will set up the shelves and tools exactly the same way (within human precision) for each run for each team.

Q: During a reset, can the field team plug a laptop in and reconfigure robot firmware or settings?

A: Yes, reconfiguring firmware or settings during a reset is allowed.

Questions answered on May 28, 2015

Q: On page 12 in the rules document (and in other places in the FAQ), it is stated that the vehicle will be started and put into gear by the DRC Operations staff. May teams specify what gear (High or Low) that they want the vehicle placed into?

A: The Polaris will be put into High Gear, this allows for the smoothest acceleration and the course is flat. If the robot wants to shift gears, it may.

Q: The Rules document states that the Dewalt DCD980M2 only runs for approximately five (5) minutes before it must be re-triggered. Is that also true for the Dewalt DCS551 cordless rotary cut out tool?

A: Yes. If the tool turns off during the task, the robot may turn on the tool again, or use the second tool (if available).

Questions answered on May 27, 2015

Q: When we practice driving + egress mission, we found out that it is quite difficult to park the car very close to the platform. Therefore, many times the tire touches the platform. Is it ok?

A: The vehicle can touch but not significantly displace any part of the course, including the platform, the barriers around the driving course, and the barriers within the driving course. Displacements will be considered significant if they exceed boundary markers such as lines drawn on the ground. If the vehicle

and/or robot create a significant displacement of the barriers, or otherwise damage the course, the Safety official will order an e-stop. The e-stop will trigger a mandatory Reset.

Questions answered on May 21, 2015

Q: How do we document approval of vehicle modifications?

A: If a team corresponded with DARPA about modifications that they made to the vehicle, then the team must bring copies of that correspondence to the 02 June fit test.

Q: Do we know if we can use the GFE Netgear wireless router for our own robot's network needs? We have a sensor that communicates over wired ethernet, and it would be good to use the provided router, rather than adding yet another switch to our robot (and the cable mess that ensues).

A: The robot wireless radio is already configured to behave like a switch on the robot side. The teams are welcome to utilize up to four (4) of the five (5) available ethernet ports on the Netgear radio. We need at least one port to be able physically connect to the radio for configuration and testing purposes.

Questions answered on May 19, 2015

Q: For purposes of vehicle modification, what constitutes a "tool" (which is not allowed) and what constitutes an "addition" to the vehicle (allowed) that assists the robot in controlling the vehicle.

A: For the purposes of vehicle modification, a "tool" is defined as an object that humans use to install an addition, but has no function once the addition is installed. Example 1: A screwdriver used by a human to tighten a screw that locks the rest of the apparatus to the vehicle is classified as a "tool." Example 2: A screwdriver that remains part of a mechanical linkage that connects the robot to the gas pedal of the vehicle is not classified as a "tool." Example 3: A vise grip that clamps an addition to the vehicle, and remains attached to the vehicle performing the same function, is not classified as a "tool."

Q: For the Wall task, what will be the orientation of the upright drill when it is on the shelf? It would be most accessible if the drill was oriented so that the ON button is facing to the left (away from the drilling wall).

A: DARPA intends to make the on switch easy to reach, and will make reasonable efforts to roughly visually orient the upright drill as described. However, note that there may be fairly large tolerances in both position and orientation, so teams should be prepared for any orientation.

Questions answered on May 18, 2015

Q: For the Door task, what determines when the point is earned?

A: See the completion criteria for the Door task in the Scoring Guide part of the DRC Finals Rule book.

Q: For the Door task, what determines when the network transitions to Indoor mode?

A: Completion of the Door task.

Q: We have one question about the platform for the egress mission. In the rule book, there will be a platform 4 feet wide by 8 feet long and approximately 5 inches high. Can you tell us how will this platform be built? Is it going to be a structure by wood, or cement?

A: Wood.

Questions answered on May 12, 2015

Q: For Atlas teams - how do we manage the battery?

A: All field operations involving connecting the battery, connecting to shore power, recovery after a fall or reset, and transport after completing a run will be led by Boston Dynamics. Teams will still be required to

provide a Field team to prepare the robot in the vehicle, verify communications with the OCU at start and reset, and operate their e-stop. These procedures will be demonstrated on June 2nd and June 3rd for the Atlas teams.

Q: For Atlas teams - Does computer power on and pump power off constitute a SAFE state for Atlas, such that we could approach the robot and disconnect/reconnect shore power vs. battery power?

A: Yes. This will be done by Boston Dynamics staff for Atlas robots.

Q: For Atlas teams - Our only current method for providing shore power is through the big BDI emulator box, which requires 480V-3Phase. Will that be available at the start location, or will we need to bring a generator to the start line?

A: All Atlas operations outside of the garages will be done via the battery. The Atlas battery can receive a trickle charge via a 120V connection that will enable communications and computers to be powered on while maintaining the battery at near full capacity. This charger will be provided at the start line and connected by the Boston Dynamics Field team.

Q: For Atlas teams - Is our Deployment procedure acceptable? STAND_PREP is a BDI primitive, and the robot is "frozen". The robot will not move, but the pump is active, and it is necessary for the gantry operator to lower the robot in this state. Will DARPA's gantry at the start line permit this? If we are using our own engine hoist, the operator will be approximately 2m from the robot, behind the structure of the hoist. We believe eye protection is sufficient safety precaution in this situation, and regularly do this in our lab.

A: If a robot is not attempting the Driving task from the vehicle, the robot can stay under the gantry until T-2 in the start procedures. At times, the field team may have to get close to the robot. It is required all Field Team member wear proper safety gear.

Q: For Atlas teams - At the end of a run would it be acceptable to place the robot in a "frozen" state with pump on, such as STAND_PREP, at the end of a run? The field team could approach and hook up the belay prior to killing pump power. They would not need to touch the robot itself, just the carabiner or straps attached on top. We have never seen any robot motion in the frozen STAND_PREP mode, and believe it is a fairly benign state: eye protection should be sufficient here.

A: Yes, after the last attempted task is complete, the field team can approach the robot after the Operator has safed the robot.

Q: Will it be possible to do Comms checks at the starting line using shore power instead of battery power?

A: Yes. Shore power of 120V will be provided at the start. For Atlas teams, Boston Dynamics will be responsible for connecting and disconnecting this service.

Q: Can Atlas be powered on while seated in the Polaris?

A: Teams can likely use shore power with the robot in the Polaris to do comms checks etc. If teams want hydraulic power, it will pull from the battery.

Q: If an Atlas robot falls while attempting Tasks 2-8 and can't recover, the robot will be brought back to a reset area. It will be restarted under a gantry. What is the best way to disconnect from the gantry?

A: Boston Dynamics suggests you use a quick release device made for sailing, pictured below attached to our block and tackle. You tie a string to the ring, and the shackle opens when you pull on the string. Procedure would be: lift robot high with rope (block and tackle), power robot, make it crouch, lower robot to feet on ground with rope, stand robot, pull the quick release string from a safe distance, block and tackle release, robot go.



http://www.westmarine.com/buy/wichard--fixed-bail-snap-shackles--P002_060_001_509



Q: Will DARPA create a disconnect device for use by teams that need it (all Atlas teams plus..?), or should we all design our own?

A: DARPA will provide gantries, but Teams should prepare and bring the connection devices appropriate for their robot

Q: the grab bar that will be on the variant of the Polaris without the roll cage, is this bar required, or will we have the option to remove it?

A: Upon request, DARPA will remove the grab bar. You must communicate your request at the test-fit currently scheduled for 02 June.

Q: Can we use our own grab bar instead of the grab bar that will be on the variant of the Polaris without the roll cage?

A: Yes, provided that it is passive and can be installed in no more than five minutes with no tools.

Q: Does the time required to remove the grab bar count toward our “five minutes, no tools” limit?

A: No.

Questions answered on April 30, 2015

Q: Can we use the ICMP channels for time syncing?

A: Teams may use the ICMP channel to carry any recognized ICMP packet type, including TIMESTAMP and TIMESTAMP REPLY. DARPA reminds teams that the ICMP channel has a low bit-rate, a small buffer queue, and a policy that discards packets that would overflow that queue. Without careful management by a team of its ICMP packets, including the size and timing of those packets, this channel could induce variable transit time and packet drops.

Q: The Procedures for Conducting Runs at the DRC Finals document describes starting the run with the robot in the Polaris XP vehicle. When will the Polaris XP motor be started? When will the Polaris XP be placed into gear?

A: The Vehicle will be turned on and placed into gear at T-5.

Q: Can you provide more details about the June 2nd "Vehicle Shakeout"? How much time will each team have with the vehicle? Can we start the engine and test the gas pedal to engine RPM relationship? Can the robot take the vehicle for a spin? Will the Atlas teams have power (battery or wall) for the robot?

A: At the DRC Finals, driving of any Rangers or other utility on Fairplex property by any Teams or their Robot will not be allowed. The only driving will be during a Run administered by the DRC staff on June 4th (rehearsal) or June 5th and 6th (competition). We will have 1 hour scheduled on June 2nd for your teams to show the DRC staff any vehicle modifications and clarify the procedure for getting your robot into the vehicle. But the Polaris will be powered off the entire time.

Questions answered on April 23, 2015

Q: Is it possible for tasks such as the electrical plug and/or firehose to be reintroduced as surprise tasks?

A: Yes it is possible. However, no additional information about the Surprise task is available beyond what has been stated in the Rules document.

Q: Is it allowed to use the ICMP channel (exercising message types 13 and 14) to keep our OCS time synchronized with the robot?

A: While DARPA will not prevent teams from using the ICMP channel for time synchronization, any other messages on that channel may increase latency and defeat the purpose of time sync. Furthermore, ICMP is generally considered a mechanism to be used for non-routine things that are or border on error conditions (such as unreachable conditions or drops due to TTL expiration, etc). So it is somewhat at odds with the intent of ICMP to use it as a production channel.

Questions answered on April 8, 2015

Q: We are trying to find out whether any alternative travel insurance is needed for the team member, such as extreme sport, hazardous activities type or other. Wonder whether you might have any information on this topic from the past experience.

A: We are not aware of any need for teams to carry travel insurance. We neither encourage nor discourage this - it is a decision for you and your team to make.

Q: We suggest that during the race, a belay could be attached to the robot, provided that the team was willing to accept a penalty on the scores or time.

A: Belays will not be allowed.

Q: Can we choose another cloud service like ones of Amazon and IBM (of course at our cost)?

A: No.

Q: Who decides whether re-qualification is required or not, and when?

A: The DARPA Chief Official decides based on information provided by the team about the changes to the robot. The deadline for re-qualification is June 1, 2015. However, DARPA will make the decision as soon as

possible after being informed of the changes. In the case of uncertainty about whether a change should be mentioned or not, please ask by sending a message to TheRoboticsChallenge@darpa.mil

Q: Can we use a device which can pull up our robot while resetting our robot?

A: Yes. However, the device may be used on the course only during a Reset. DARPA will provide a gantry hoist with a hook at each of the four courses at both reset points. Teams are responsible for the attachment interface to their robot (ropes, straps, and similar). Teams will be responsible for their own reset and should plan equipment accordingly.

Q: Can we access the consoles of field computers while resetting our robot?

A: Yes, during a Reset. Note that the Field Computers will be in the Garage Building, over 300 meters from the course. Teams should use remote desktop software (for example rdesktop or xterm/ssh) whenever possible.

Q: How can we confirm that a valve is open visually?

A: The valve will be marked with a visually distinctive tape. The valve will be considered open when the tape has rotated 360 degrees (or more).

Q: Which kind of tools will be used for the Wall task?

A: Teams may choose between two drills:

- Dewalt DCD980M2 cordless drill or similar, and an additional side handle. This drill has a Morris 13042 bit or similar. The DCD980M2 has a trigger; to operate, the robot must grasp the drill and squeeze the trigger. This drill has a side handle, which the teams may set in any orientation or remove. The drill only runs for approximately five (5) minutes before it must be re-triggered.
- Dewalt DCS551 cordless rotary cut out tool or similar. The DCS551 has an on/off switch, not a trigger. This rotary tool has a DW6609 0.25 inch bit or similar. To operate this drill, the robot must grasp the drill and press the on/off switch. (Note that the on/off switch is guarded by a piece of yellow plastic that prevents accidental switching. Some robot “fingers” might have trouble making contact with the switch. Teams might consider adding a “bump” on the finger that improves access to the switch.)

One shelf, approximately 44 inches above the ground, will hold one of each type of drill. A second shelf, approximately 32 inches above the ground, will also hold one of each type of drill. All drills will be fully charged, set to the highest speed, in the OFF position, with pre-installed bits. The drills will be standing upright on their batteries (as opposed to lying on their sides on the shelf). If one of the drills ceases to function (for example because the robot dropped it, or the bit broke), the robot may use another drill.

Q: What is the starting position (standing, sitting, lying...) of the robot after resetting our robot?

A: The team may put the robot in any desired configuration during a Reset.

Q: If we choose not to try Drive and Egress from the beginning, 10min penalty will be applied?

A: No. The ten minutes applies only after a Reset. If the robot chooses to not drive, it must traverse the Drive task distance on its own (e.g., for legged robots, by walking). If it requires a reset during that traversal, then it must return to the starting point of the Drive task.

Q: We request that the Surprise task be moved back to the top of the steps outside. This allows easier comms but still encourages teams to try for the steps.

A: No. Because of the difficulty of falls, DARPA will keep the Surprise task “indoors.”

Q: Can we request more power for operator control stations? Seems like this is not a requirement that we had previously and we intend to bring lots of computers and monitors. We would prefer not to be optimizing for power.

A: No.

Q: The previous power limit for the Field Computer was 5 kW, and the current power limit is 8 kW, right?

A: No. The **total** power for the Field Computer and Operator Control Station, combined, may not exceed 8 kW.

Q: Can we request the platform for egress is removed prior to our run? It may hinder our progress and we don't need it.

A: No. There is enough room for the vehicle and robot to avoid the platform.

Q: Can we bring our own tool to cut the wall or do we need to use one of the cutting tools provided by DARPA?

A: The only permitted power tools are those supplied by DARPA. Teams may use their own passive tools.

Q: Can the field team notify the operator when the point has been achieved (as decided by field judges)?

A: No. DARPA may provide the operators with the running score, but this may have a delay, and teams should not rely on it to inform the operators.

Q: Will the teams be allowed to set up their choice of tools however we would like (placement and orientation on the shelf)?

A: No. For the Wall task, DARPA will place the tools on the shelf.

Q: If the DARPA team is placing the tools, how repeatable is the placement and orientation?

A: DARPA will ensure that the tools are placed on the shelf, standing up (battery packs down). DARPA will ensure that reasonable care is taken to place the tools in approximately the same configuration for all runs. However, the exact placement and orientation may vary from run to run.

Q: Will there be two tools available on the shelf, one as a spare?

A: Yes. See the answer to the "Which kind of tools will be used for the Wall task" question above.

Q: The text for the egress point has one sentence that is potentially confusing: "To earn the point for Task 2 (Egress), the center of mass of the robot (with no accessories) must do Task 1 (Drive) and start Task 2 (Egress) inside the unmodified vehicle." This makes it sound like you cannot modify the vehicle at all if you want the egress point. I believe that your intention was that the modifications are still allowed, but they cannot be used to hold the robot in a configuration that puts the COM outside the original vehicle's footprint.

A: Correct. Modifications are allowed, but if the robot's COM falls outside the vehicle as it was before modifications were made, it cannot achieve the point for Egress.

Q: For the Wall task in the Trials, we were able to select one of two different drill bits. Will we have this option again?

A: See the answer to the "Which kind of tools will be used for the Wall task" question above.

Q: At the Testbed in March, the indoor tasks were set up over asphalt. At the Finals in June, the indoor tasks will be set up over what kind of surface?

A: Asphalt.

Q: Task 1 Drive. Is it possible to get the information about approximate map for the Drive task before rehearsal? For the safe vision recognition, our team wants to put the barrier on both sides of the road.

A: No map will be provided in advance. Teams may observe the layout during a walkthrough presently scheduled for June 2, 2015. DARPA may move items a small distance at the start of each day. Each of the four courses may unavoidably be slightly different. Teams should not depend on precise a priori measurements.

Q: Task 4 & 5 Valve and Wall. In the draft book, 'Valve task' and 'Wall task' are divided. How about combine these two tasks together again to reduce locomotion time? (Just like what we saw in 'test bed')

A: No.

Q: In some case, drill bits are broken during cutting the wall. We used 1/8 inch bit with DeWALT DCS551 model. How about use thicker one? For example 1/4 inch bit.

A: See the answer to the "Which kind of tools will be used for the Wall task" question above.

Q: Task 7 Rubble Task. We think that purpose of 'Terrain task' and 'Debris task' are different. One is for 'locomotion' and the other is for 'removing objects'. So, how about separate these tasks again?

A: No. Teams may walk over or push aside the rubble – it is essentially a locomotion barrier.

Q: Task 8 Stairs. In the testbed, we saw the vision problem caused by sunshine which is reflected by stairs (which is made by stainless steel). Do you have any plan to prevent this problem? For example, using sand paper or painting or etc.

A: The stairs and landing will be given a matte finish to reduce glare.

Q: To allow a robot to drive the utility vehicle, is it permissible to use mechanical linkages to transmit motions from the robot to the vehicle controls? The robot's actuators would be the source of motion and the linkages would be passive mechanisms to transmit the robot's motions to create motion at the vehicle controls.

A: Yes. See Section 12 of the Rules document for other restrictions.

Q: May teams fasten passive mechanisms to the utility vehicle, making use of existing structures without modifying the vehicle? For example, if a team has chosen to use a utility vehicle with the seat and roll bar removed, can they use bolts to fasten to the brackets that once held the seatbelt receptacles or the roll bar?

A: Yes. See Section 12 of the Rules document for other restrictions.

Q: Can we use a device to passively relocate the pedal to the passenger's side?

A: Yes. See Section 12 of the Rules document for other restrictions.

Q: Can we attach a passive step to the vehicle?

A: Yes. See Section 12 of the Rules document for other restrictions.

Q: Along the same lines, a "curb" or platform only on the driver's side of the vehicle makes no sense since Atlas requires a step, and Atlas cannot sit on driver's side.

A: The rules are for all robots, whether or not they apply to Atlas.

Q: We prefer the padded seat without the roll cage, is there any way to make this happen? This is the configuration we used in the trials. If not, can we add our own padded seat over the plywood seat?

A: You can add your own padded seat. See Section 12 of the Rules document for other restrictions.

Q: Can we make active modifications to the Atlas robot? Such as cameras and IMU sensors.

A: Yes, but you must maintain the serviceability of the robot by Boston Dynamics.

Q: Will the door have an active closer or will it be free until it is pushed all the way open?

A: The door will not have an active closer. See Section 6 of the Rules document for more information about the door.

Q: When you say only a railing on the left of the stairs, will there be one at the top of the stairs on the right side (such as the railing for the top platform at the testbed) or is it assumed there will be no obstruction on the right of the robot for the entire distance?

A: There will be a railing on the right-hand side of the landing at the top of the stairs, as the robot ascends.

Q: For the Drive task, is it permissible to strap the robot into the vehicle, and then remove those straps as part of the reset process if we do not attempt Egress?

A: Yes.

Q: Do teams have to successfully complete the driving task in order to start and get points for egress?

A: Yes.

Can they still egress even if the vehicle becomes stuck somewhere that is not the goal area?

A: No points will be awarded for egress that is not in the goal area.

Q: Are teams allowed to position the vehicle behind the starting line for the driving task, i.e. angle it and move it to one side?

A: Yes, so long as the vehicle stays within the designated start area.

Questions answered on March 23, 2015

Q: Will the operators of the robots be able to walk around and look at the test course for the Finals prior to running on the course?

- measuring things

- touching things – feeling the strength of the magnet, stiffness of the valve, size of the drill bit, etc.

- looking at the mobility layout, etc

A: Yes, on Tuesday, 02 June, there will be a scheduled walkthrough for teams on the courses. However, teams will not have access before their run on the Rehearsal Day (Thursday 04 June), Day One (Friday 05 June), and Day Two (Saturday 06 June). Teams may measure and touch the course, but must not damage it.

Questions answered on February 27, 2015

Q: I have question/proposal on a TCP/UDP port range of the 10k limitation of MaxwellPro setup. Currently it seems the maxwell count up all packet go through 0-1023, but sometimes, someone install a some daemon program in a computer on the robot network, for example SMTP server, and that broadcasts the packets to the network and that'll will included within 10k limitation.

To avoid this, we have two choices, one is to be very carefully checks that software is installed in which computer and do not install any of non-related software in the computers, second is to put maxwell between firewall appliances to cut off the non-necessary packets.

So question/proposal is can we narrow down the range of ports used for the 10k limitation? I think we do not need all 0-1023 port, but only needs 22, 25, 80, 88, 443, ..., and 1000-1023 or something. This will avoid spend time on computer checking and buying extra firewall devices.

A: No. We understand the concern about unwanted traffic on Link 3. However, different teams use different ports, and we need to allow them to continue doing so. To clarify, the range of Link 3 port numbers is 0-2047.

Q: In the "Wireless Radio Kit and Estop Information Packet" from 2015/02/09, OCU IP addresses should be in the range 192.168.10.3-192.168.10.254 or assigned via DHCP (which uses a subset of that range). In the "Communications between Operator and Robot for the DRC Finals" document updated on 2015/01/27, section 4.2 states that the 10.N.1.x subnet should be used for the OCU computers, where N is our team ID number. These appear to be in conflict with each other, unless DARPA wants our machines to be on multiple subnets at the same time. Which IP address scheme should we setup for the March testbed and for the June Trials?

A: Please disregard the addressing you've seen in various 192.168.x.y subnets. These will **not** be in use at the testbed nor in trials. Please use the following addressing:

OCU Subnet: 10.9.1.x

Field Computer Subnet: 10.9.2.x

Robot Subnet: 10.9.3.x

At the testbed and trials, you will use the subnet mask 255.255.255.0 and 10.9.x.1 default gateway. For testing with your radios in the absence of the event routing infrastructure, you may change the subnet mask for your systems to 255.0.0.0 to allow for direct, non-routed, communications.

Do not use the address .1 in any of these subnets as that will be the IP of the subnet router.

Questions answered on February 17, 2015

Q: Regarding the plug task, any of the following information would be useful:

Has DARPA identified a specific plug they plan to use, what is it?

What are brands that make plugs similar to the one that will be used? Even if we can't know the exact plug, a general idea would be appreciated.

What are the general dimensions of the plug, can we get details on the minimum possible radius & height?

Where in a factory or building might this plug be located? What is its potential purpose? Plugging - water, oil, sewage, gas, other?

Will it be a commercially available plug, or a stand in/mockup

If none of the above can be answered, is there anything you can tell us about the plug we don't already know.

A: There is no additional information available about the plug task, however we are contemplating a zero force insertion socket with a magnetic hold. We look forward to the team feedback on the examples at the DRC Testbed.

Q: What do you mean by 'Jumbo packets'? Does it mean so-called 'Jumbo Frame'?

A: In the networking industry this is a slightly ambiguous term that evolved over the years. However, in this case it is intended to mean any Ethernet frame that is larger than 1514 bytes, including the 14 bytes of Ethernet header (that contain the source and destination MAC addresses and the type/length field) but not counting the Ethernet preamble, CRC. (We are not supporting any of the longer forms of Ethernet header, such as those used to support VLANs.)

The data within the Ethernet frame should be no greater than 1500 bytes. In other words an IPv4 MTU of 1500. The intent is to prevent the use of over-large Ethernet frames that might have difficulty passing over any intermediate networking media or equipment that does not handle larger than normal frames.

The Wikipedia article on this is at: http://en.wikipedia.org/wiki/Jumbo_frame

Q: The meaning of 'Packet size' is unclear. Does this mean just MTU or 'total length of packet'?

A: For purposes of rate limitation the size of a packet is the Ethernet frame size, which is usually the size of the IPv4 packet plus 14. (The reason we say "usually" is that it is possible for there to be a very short IPv4

packet that does not fully occupy the minimum size for an Ethernet frame.) In other words, we count the size of the Ethernet packet, including its 14 byte long header (source MAC, destination MAC, type/length) but not any preamble bits, trailer bits, or the CRC bits.

Q: When sending data through Links 1, 2, and 3, the data will be fragmented at the IP layer if the packet size exceeds MTU. We understand that the fragmented data does not contain the port information at the TCP/UDP layer. Will such fragmented data be dropped or sent?

A: IPv4 fragments will be dropped. An IPv4 MTU of 1500 should be used to avoid IPv4 fragmentation.

Q: Is the 5000 byte queue for Link 3 shared among ICMP/TCP/UDP protocols, or does each protocol have its own queue?

A: Each rate limited Link has its own queue. If a Link is bi-directional, each direction of traffic flow has its own queue. Thus, in the DCE, TCP and UDP packets on Link 2 will share the same queue. UDP and TCP packets on Link 3 will share their own queue, but it will be a different queue than used by Link 2, and there will be a separate queue for each direction of traffic. And each direction of ICMP packets will use yet another pair of queues.

Questions answered on February 11, 2015

Q: For the DRC Testbed event, will we be able to watch/spectate during the BDI shakeout?

A: No, this will be a closed event.

Q. For the DRC Testbed event, will we be able to have team members stay on days other than our scheduled two days?

A. No, because of space limitations and base access constraints, teams will only be invited for their scheduled days. Video will be collected of all experiments and given to all Qualified Teams

Q. Will there be a limited number of teams in the Finals?

A. Yes. All teams that qualify will be accommodated at the Finals.

Q. What are the qualification times to beat?

A. There is no time to "beat." The qualification requirements are listed in the Qualification for the DRC Finals document available on the DRC website http://theroboticschallenge.org/files/2014_11_19_DRC_Finals_Qualification_Release_2_DISTAR_23894.pdf. Some of those requirements do include a time limit.

Q: When do you expect to deliver the DARPA-supplied WiFi radios, antennas, and cables to the teams? We request some time to integrate prior to the March trip.

A: They are expected to ship Feb 9th.

Q: When do you expect to deliver the wireless E-stop system to the teams? Will use of this system be required for the March trip or can we use our own?

A: They are expected to ship Feb 9th. An E-stop is required for operation at Testbed, it is preferred that it is the DRC provided system.

Q: In the Nov 30 communications document, Figure 1 states that ports between 6384 and 24575 are transmitted via Link 2. Section 4.1 however states this range as 16384 to 24575. Can you clarify which is correct?

A: 16384 is correct.

Q: Will there be multiple wireless access points for a course, and do you expect dead zones?

A: No, there will be a single access point per course separated in frequency/channel and SSID/encryption key. We do not anticipate any dead zones.

Q: Will the blackout schedule for a given day of robot tests be distributed in an electronic format? If so, can we get the chosen file format ahead of time?

A: It has not been decided if the blackout schedule will be provided before the event. Sample blackout schedule files have been posted on the Forum and on <http://iwl.com/drc2015/>.

Q: Will DARPA provide network logging during the challenge so that we can debug issues that may occur? We anticipate that it will be hard for a team to figure out whether they have a problem or are being jammed in some way.

A: The network will continually be monitored for throughput and congestion, and this type of data will be logged to isolate and identify potential issues with the network. The data traversing the network will not be logged by DARPA and it will not be possible to recreate the entire network flow for any team using the DARPA collected network data. If a team desires to capture all their network traffic the team must accommodate this using their own resources (i.e. capture at the OCU, Field Computer, and/or Robot as the team desires). The RF spectrum utilized to provide bi-directional network connectivity will be monitored to determine if jamming may be occurring.

Q: Has the cloud been removed from the field computer, or was this an oversight? Having the extra storage and processing connected to the field computer makes more sense from our perspective.

A: Yes, it has been removed.

Q: Our team acquired a Maxwell Pro device to help us develop comms strategies prior to our March trip. Will DARPA allow the teams to receive your tentative software config as of now?

A: Yes. It is available on <http://iwl.com/drc2015/>

Questions answered on January 21, 2015

Q: Is there any indication of when Link 2 is in blackout or not? (That is, can our field computer detect the blackout without depending response via Link 3?)

A: There will be no signal over the network. There will be a visual indicator on the course for spectators.

Q: Can DARPA clarify the rate on Link 3. The document draft says "9600 bit/sec to 2,000 bit/sec."

Did you intend to invert min/max, or given comma usage did you intend 2 MBit/sec? Is this rate in each direction, or total rate? I would think single direction, but the Link 1 specifies total to + from data rate.

A: The data rate in Link 3 is still to be determined – DARPA will decide on this rate once we ascertain how well the teams are doing, based on site visits and performance at the DRC Testbed. The constant rate will be between 2,000 bit/sec and 9,600 bit/sec, and will be the same in each direction.

Q: We believe that the always-on "Link 3" with no latency does nothing to discourage direct human teleoperation of the robot ("puppeteering").

By not discouraging this approach, the designers are indirectly discouraging autonomous approaches since the present state-of-the-art allows a human with a low-latency connection to the robot to generally outperform autonomous algorithms.

However, many real-world disaster situations will not have good quality low latency links like the one proposed for Link 3 (e.g. satellite connections are generally around 2000bps with up to 5 seconds or more latency, and do not work at all without clear line-of-sight, for example, indoors). Given this reality, useful robots will have to be more autonomous to perform in real environments.

In light of this concern, we hope to encourage DARPA to consider for Link 3:

- a higher latency, such as 5 seconds, and
- a throughput value on the lower end of the range (such as 2000 bps).

A. DARPA does not presently plan to introduce latency to Link 3; however, DARPA reserves the right to add latency. DARPA will set the Link 3 rate low enough to make teleoperation impractical with currently known methods.

Q. Will DARPA provide a hardware or software implementation of Links 2 & 3 (the Degraded Comms Emulator) for teams to test before the trials? When can we expect this (on March 1 with the Link 1 radios or before)? This was essential in the 2013 trials (in that case we had the Mini-Maxwell) to work out designs and work around the quirks.

A. DARPA will not provide a hardware or software emulation for Links 2 & 3. DARPA has identified the Maxwell Pro as the equipment to be used to perform the Degraded Communications Emulator (DCE) function. DARPA will provide that equipment at the DRC Testbed and at the DRC Finals, but will not provide units separately to teams for the purposes of development. Teams may procure that unit on their own, or emulate its functionality with software tools such as 'tc' (the Linux traffic control tool).

DARPA will announce on the DRC Forum what firmware versions have been installed on the Maxwell Pro units at the DRC Testbed and at the DRC Finals. Teams may procure and install those firmware versions on their own.

DARPA will announce on the DRC Forum when the DCE Control Application is available. This application consists of a graphical user interface, and a component that acts behind the scenes to read the blackout schedule and send commands to the Maxwell Pro device.

Teams may test their comms systems under conditions expected to be similar to those at the Finals at the DRC Testbed in South Carolina in March.

Q. According to the Comms document: "Link 3 will also carry bidirectional traffic for Internet Control Message Protocol (ICMP) and will have a throughput of 4800 bit/s." Will this be 4800 bps in addition to the 2000-9600 bps for UDP/TCP?

A. Yes.

Q. Why is it necessary to treat ICMP differently from the other IP protocol types (i.e. UDP/TCP)?

A. The ICMP (Internet Control Message Protocol) channel will be used as a feedback channel for IPv4 packet problems - such as unreachable ports. It is not to be used as an alternate data channel. DARPA will be monitoring the usage of all of the channels through the DCE, so will be able to notice if a team is using more than the anticipated small amount of the ICMP channel capacity.

Q. What restrictions (if any besides the 4800 bps throughput limit) will be placed on the ICMP packet types and sizes used?

A. All of the rate limited channels have a defined maximum limit (in bytes) on the amount of packet data that will be queued before additional packets are silently dropped. The queue values are rather small to avoid the buildup of long queue. For the 9600 and 4800 bit/second channels that queue is 5000 bytes. A packet that arrives without enough empty space in the queue will be dropped. The only kind of packets that will be classified onto that channel have the following characteristics:

- DIX Ethernet framing (i.e. classical Ethernet without any IEEE 802.1Q VLAN headers) Ethernet type 0x0800 (IPv4)
- No MPLS
- IPv4 header
- IP protocol value of 1 (ICMP)

There is no particular limitation on the size of the ICMP packet except the same MTU <= 1500 restriction that applies to everything.

There is no validation of the ICMP data.

NOTE: The ICMP channel is to be used only for standard ICMP purposes and may not be used as an alternative monitoring or control channel.

Q. How will the throughput limits be enforced on links 1, 2, & 3 (e.g., using a token bucket filter or some other algorithm)? Will we be allowed to know the parameters of this algorithm or algorithms? How much buffering will be on Link 3?

A. When a packet arrives at the DCE a calculation is performed to determine when that packet should arrive at the destination. That calculation takes into account a number of things, such as the un-transmitted packets in the queue, packet framing overhead (that is where the 14 bytes of Ethernet header come from), and framing overhead. The outgoing Ethernet is presumed to be sufficiently fast that a packet will arrive at the destination when released from the queue with a transit delay that is insignificant.

In addition, on the fast path, there will be blackout periods. Packets that arrive during a blackout will be silently dropped; they will not enter any rate limit queue that may be in effect. In addition, when a blackout starts, any packets in the rate limit queue will be flushed from the queue and dropped.

The intent here is to make the system appear to be like a bit-channel that has intermittent outages with minimal in-path buffering - much like a simple switch opening or closing. Packets will not be re-sequenced within a channel.

Q. Why is the schedule for comms blackouts on Link 2 being provided to the teams the day before the runs? This seems to defeat the goal of the randomness by giving teams the ability to preload the blackout schedule into their network system.

A. The same blackout schedule will be used for all runs throughout the day. The schedule is being provided the day the before the runs so that teams that have earlier runs are not penalized compared to teams that have later runs and thus can deduce the schedule by observation. (Blackouts will be indicated to the public.)

Q. May we create custom cutting tools for the wall task (so long as we carry them, of course)? In particular, are there any safety or sportsmanship issue if we chose a more powerful tool than that provided by DARPA?

A. Our present thinking is that the point for the Wall task will be awarded only if the robot (a) turns on the DARPA-provided tool, and (b) creates the hole in the wall. The intent is to require the robot to demonstrate that it can adapt to a variety of conditions and tasks.

Q. Will DARPA provide the Maxwell Pro to all qualified teams by March 1, 2015?

A. No. DARPA will provide that equipment at the DRC Testbed and at the DRC Finals, but will not provide units separately to teams for the purposes of development. Teams may procure that unit on their own, or emulate them in software.

Q. In 2013 trials, there was a truss and 10 debris were placed. In final, I wonder that there is a truss in debris task track. And could you represent about debris configuration in picture or provide an example?

A. This has not yet been determined. We will experiment with different possible debris configurations at the DRC Testbed in March.

Questions answered on January 5, 2015

Q: For Link 3, is the bandwidth a total or will the link have 2000-9600bps (tbd) available independently in each direction?

A: The full bandwidth will be available in each direction.

Q: For Link 3, does the bandwidth include the Ethernet frame, the IP header or the UDP header?

A: The number of bits used for computing the rate limit is the size of the IPv4 packet (in bits) plus 112 bits for the Ethernet header on that packet.

Q: For Link 3, will there be latency added in either direction?

A: No.

Q: Will the Mini-Maxwell be used as the DCE to degrade the link?

A: No, the Maxwell Pro will be used.

Q: In the comms document, it is specified that Link 3 will have a bandwidth tbd between 2000-9600 bit/s. Based on previous communications, which spoke solely of 9600 bit/s, we decided to simplify our comms protocol to move away from the extremely efficient protocol we used in the VRC and go for a much more maintainable solution. If the bit rate is reduced significantly from 9600 bit/s, we have to redirect a lot of resources reviving our old protocol, instead of improving robot performance.

A: One of DARPA's objectives is to encourage autonomy. Another is to replicate real disaster communications conditions, where interference can be overcome with low bitrates. We will therefore choose an always-on bandwidth that is low enough that teleoperation with imaging feedback, even if compressed, is not practical. The bandwidth DARPA selects will be high enough that teams will be able to transmit commands to their robots and in return get information such as actuator status. DARPA does not expect teams to attempt to send image data over this link.

Q: Link 2 is said to drop all packets during the blackout period. Outside of sending point cloud/camera packets as fast as possible, possibly hundreds of times a second, and hope some make it through during the comms window, is there a more elegant way to know precisely when this window is open and send data only during that period?

A: No. However, team may wish to acknowledge data received from the robot on Link 2 by sending a short message back to the robot on Link 3.

Q: "Ports 1--1023 will specify that Link 3 (Bidirectional 2000- 9600 bit/sec) will be used for a particular message." On Unix systems, only root can bind to these ports. For ease of setup, we would like to request that this range is increased to include ports > 1024.

A: We will extend the range of port numbers to include ports > 1024. We plan to revise the Communications document to read as follows: If an IPv4 UDP or TCP packet arrives with a source *OR* destination port in the range 0x0000 (0) .. 0x07FF (2047) then it is classified into the slow path (Link #3)..

Q: Will there be belays/gantry at the testbed in March 2015?

A: No, the setup provided at the test bed will mirror what will be at Finals. Gantries and belays will not be provided. Teams are allowed to bring their own equipment to support their experimentation.

Q: Can we send someone to view the course outside of our scheduled practice days at the testbed event?

A: No, because of limited space and access restrictions at SPAWAR. Teams will be limited to access on their scheduled days. However, a high-level video of the experiments on the individual courses will be collected and provided to all qualified teams.

Q: During a comms "blackout," are packets dropped or kept?

A: Dropped. See the "Communications between Operator and Robot for the DRC Finals" document, which states: "Packets held by the DCE at the start of a blackout will be discarded; packets received by the DCE during blackout will be discarded."

Questions answered on November 20, 2014

Q: For the plug & receptacle task, is any kind of rotation alignment needed? Is it an electric plug with pins that need to be mated to the receptacle or is it a completely cylindrical and uniform plug?

A: The exact hardware has not been identified but it is planned that rotational alignment will not be required. It will not be a plug with small pins that need to be mated with a receptacle.

Q: For the Valve task, how far will the valve be from the wall?

A: After cutting through the wall, the valve will be close enough to the wall that an average-sized person could easily reach through the wall to grasp the valve without the elbows going beyond the front surface of the wall.

Q: For the Wall task, can we cut a hole so big that even the robot could pass through the hole?

A: No, the robot will not be able to pass through the wall. Though the cut out area will be large enough to allow for single or dual hand manipulation of the Valve. The outer limits of the permitted cutting area will be clearly marked.

Questions answered on October 14, 2014

Q: Is it permissible to change battery between any 2 of the 8 tasks in each run?

A: No. The rules forbid physical intervention of any kind.

Q: Will the driving course be on level ground or will there be downhill sections? - ie...We will need to actuate both pedals if we need to stop the vehicle on a downhill.

A: The driving course will be on level ground.

Q: Will the vehicle start in park/neutral or already in gear? A: The vehicle will start in forward gear. Q: Will we need to actuate the drive shift lever on the Polaris vehicle?

A: The vehicle will start in forward gear, and may end in forward gear. DARPA will e-stop the vehicle at the end, so it is not necessary to actuate the drive shift lever.

Q: Will turns on the course require backing up to maneuver around?

A: A human driver would not need to back up on the driving course.

Q: I would like to ask again is it possible to move the DRC finals event to the middle of the USA so it is fair to all teams.

A: An event this large requires significant lead time to coordinate the venue and the logistics necessary to make the event successful. DARPA is unable to meet your request to move the venue.

Q: Has there been any decision on which wireless e-stop will be used for the Finals?

A: That will be announced in the Comms document due out in November.

Q: I just wanted to ask briefly if the public will be able to attend The DARPA Robotics Challenge finals in June, and if so how could I go about purchasing tickets?

A: The Finals are free and open to the public. Tickets are not needed. There will be a charge for on-site parking (price not yet determined). The Finals will also be streamed to the Internet.

Q: Is there a way to ensure all the winning prize money ends up as a DARPA donation to Paragon Science Academy (a public charter non-profit school in Arizona) and/or to Arizona State University?

A: No. The prize will go to the best performing team, as specified in the Rules. What they do with the prize is up to them.

Questions answered on September 9, 2014

Q: We are following the DRC with great interest and are planning to rebuild some of the scenarios such as the obstacle terrain at our facility for testing of our mobile robots in standardized environments. Thus, we were wondering if it is possible to obtain CAD data for the tasks presented in the challenge. Unfortunately, I have not been able to find any freely available downloads for such files.

A: DARPA does not intend to publish detailed specifications or CAD data for the Finals tasks. DARPA expects that teams will use the descriptions in the Rules document and the "stages" from the DRC Trials (<http://archive.darpa.mil/roboticschallengetrialsarchive/sites/default/files/DRC%20Trials%20Task%20Description%20Release%2011%20DISTAR%2022197.pdf>) as a baseline.

Q: Let's say I and others qualify in February but need financial help in getting to California in June, can you help?

A: The DRC Program is not able to support teams that have not already received awards.

Q: Please clarify if the 1500 MTU packet size only applies to the data across the traffic shaper, or if it applies to all connections (e.g. robot-to-field, field-to-OCS, field-to-cloud, and ocs-to-cloud). Please specify network settings for the above connections.

A: It applies to all connections. No jumbo packets.

Q: Now that the Qualifications and Finals rules state that safety belays are no longer permitted what operational state shall the E-stop achieve? For instance, an unsupported robot will most likely topple over when the E-stop disables motive power. Are there any requirements, from the organizers, that the robot should attempt to obtain a reduced potential energy state before motive power is fully disabled? Or is the requirement/objective for immediate removal of motive power?

A: Immediate removal of motive power. An unpowered robots joints must be back-drivable by a strong person to save life or limb (this may damage the robot).

Q: During the DRC Trials, the bandwidth between the robot and OCS was specified in the rules as 1kbps - 1mbps. The current rules for the Finals do not mention any bandwidth range between the Field Computer and OCS. Is there an anticipated range of bandwidths teams should be expecting to operate within, in addition to the dropouts which will occur?

A: The anticipated maximum bandwidth between the OCS and the Field Computers will be 1Gbps. DARPA will provide more detailed information about the communications infrastructure in November 2014.

Q: What is the Bandwidth and Speed of the satellite link?

A: The DRC Finals network will not include a satellite link.

Q: Will the DCE (Degraded Communication Emulator) device be provided by DARPA or will the teams have to buy it?

A: DARPA will provide the units used at the Finals. DARPA will NOT provide units to the teams for development.

Q: If DARPA provides the DCE (Degraded Communication Emulator) device, will it support Windows, or can it only be used with Linux?

A: All networking systems in the DRC Finals are expected to be agnostic to operating systems.

Q: On the registration page there is an "Overview of Team/Robot" field. Is it possible to initially leave this blank and update this at a later time?

A: Yes, you may omit your team description on the registration page and you may include a link to your team webpage if you have one.

Q: For submitting qualification videos, could we re-submit videos that show faster robot times? This is a concern because speed might be used as a tie-breaker for qualifying for the finals. Our robot is more likely to have much better performance closer to the qualifications deadline, but we would like to submit qualifying videos demonstrating initial competency in the tasks much earlier if possible.

A: Teams are strongly encouraged to submit videos of progress on YouTube with pointers on the Forum so that DARPA and other teams can review. Teams must submit only a single qualification video before the deadline for DARPA's review.

Q: What is the steepest ladder that you intend to consider for the challenge?

A: Sixty (60) degrees. However, the ladder used for the Finals may be less steep than that.

Q: Our understanding via conversations is that the robot can be put into the vehicle PRIOR to the timer start. The hardware reconfiguration rules (Section 10) allows for hardware components to be left behind during a run. Does this explicitly allow teams to retrofit the vehicle with 'hardware components' that the robot leaves behind? For instance, teams might just put a wireless teleop system on the vehicle and 'leave it behind' when the robot gets off (the back). Is this approach ok? A: Teams may not use radios or other wireless communications devices not supplied by DARPA. Teams may not modify the vehicle beyond temporarily placing objects, such as ski poles, in it.

Q: For the qualification tasks and the DRC final this year, the robot has to use a wired network connection and a wired power connection like the DRC Trial last year, doesn't it? If so how to implement a wireless E-stop ?

A: Teams may demonstrate either wired or wireless e-stop in order to qualify.

Q: The qualification document explicitly states that the robot should have a wired estop button onboard the robot. Does a tethered (wired) estop count?

A: The Rules document does NOT state that the robot should have a wired estop button. Rather, the Rules document states that "an on-robot Emergency-stop button must be present and demonstrated to work." After qualification, teams will be supplied with a wireless e-stop that they must integrate by Finals.

Q: Will the public will be able to attend the DARPA Robotics Challenge Finals in June 2015, and if so, how could I go about purchasing tickets?

A: Current plans are for some or all of the DRC Finals to be open to the public. There will be no charge or tickets required for entrance.

Q: For task 3, our lab does not have a 10m run. Is it acceptable to walk in circles or in a zig-zag pattern? If so, this task will also be doable immediately (again, the BDI walking code provided will be adequate). The specification "Locomote a distance of at least 10 meters over flat ground" did not specify a path shape, so I'm guessing walking in circles is adequate, but a confirmation would be comforting.

A: Circles or zig-zag are both acceptable. Questions answered on July 31, 2014

Q: Can our robot use a walking stick or ski poles?

A: Yes.

Q: Can we place the walking stick or ski poles in the cargo bed of the Polaris vehicle, for the robot to take out after completing the driving task?

A: Yes.

Q: Can our robot drop the walking stick or skip poles and leave them where they fell?

A: Yes.

Q: Can we use a UAV or a throwable or launchable device?

A: No. For safety, airborne devices are not permitted.

Q: In the current rules document, DARPA says that the Degraded Comms Emulator "will treat packets atomically...the switch will not change position in the middle of a packet". Our question is what will be the maximum size limit for packets? Traditional Ethernet v2 networks use the 1500 MTU packets, while Atlas uses a ≥ 7200 MTU setting in order for the Multisense to properly stream data. The Mini-Maxwell devices used in the Trials only handled $MTU \leq 1500$, so teams need to know sooner rather than later what the hardware supporting the DCE allows. To be more specific, it's generally a bad idea to send UDP datagrams larger than the MTU size of network. So how much data teams can reliably send is somewhat tied to the MTU size allowed by the DCE.

A: 1500