

## Unattended Maritime Systems (UMS) Optical Subsystem Q&A Telecon

1. **Are subsystems required to meet both tier 1 and tier 2 needs, or will solutions that only meet one tier be considered?** We would consider one tier, but the goal is to have both tiers at the same time. If certain people have a tier one solution and you only have a tier two solution, probably the best route then would be to have you guys work together so we can have both on the system at the same time.
2. **Are the algorithms for vessel detection and classification part of this effort or you only need the optical systems that allow acceptable vessel sizes to detect?**  
*(Answered in conjunction with the #3 question below)*
3. **Does tier 1 subsystem need to come with software that detects and classifies vessels from 3 to 4 NM, or one only needs to show appropriate vessel sizes?** The users are not looking for anything that requires any level of air automation to the extent of detection. We're going to be relying on another system to essentially provide a tip for a queue. We're looking for the other portion of the system to provide that tip so that the optical systems will allow us to help identify the presence of something on the horizon or within the horizon.
  - a. **So, I guess that means as a result, you're not expecting the optical subsystem to have software embedded in that performs either a detection level of confidence or a classification of vessel type or anything else, is that correct?** I think that's an accurate statement. We want the level of optical fidelity to identify the presence of a vessel with one system and then with our higher resolution system, be able to start pulling the characteristics off of that vessel at a given range. The range will obviously be determined by the optics used. We believe software does not need to be embedded with the optical systems.
4. **What is the maximum weight allowed for tier 1 and for tier 2 systems?** It's going to be dependent upon your design and how that weight affects the sea worthiness of the vehicle.
5. **How many types of ships are planned for classification?** We have not stipulated the quantity of different types of vessels, but this is to detect the presence of the vessels. Also, the queue being handed off could be of any size, weight, shape, you know, class, category, etc. This allows the operator to see within the image that something is there and then they hand off the information to an analyst to dig into the task of classifying the type of vessel or class of ship etc.
  - a. **So, for everybody's basic understanding, is the output of the optical system going to be utilized by an operator and we're not going to be doing the output of the optical system to run it through any kind of software that's going to try to automatically classify things? We're just going to depend on operator knowledge to determine that.** That's the intent for this first step. Ultimately, we want to have less operator cognitive load required. That could be a future

objective, but it's my understanding with this first effort, there's no intention of that.

**6. Can you be more specific about the "close-in" SA for the tier 2 system. What range?**

Yes, for tier 2, we've specified we're looking at a fixed field of view cameras and we're trying to cover 360. It's not going to be an exceedingly long range, like 300 meters or 400 meters, it'll probably be a little shorter. It will depend on what combination of number of cameras and lens types that you propose. That will give us an idea, given the number of pixels in the image, what a reasonable range would be for a target. It would vary based on the size of the target. If we want to see a canoe, it's going to be close, and an aircraft carrier would be a lot farther off. It is hard to describe in terms of what the actual range is.

**7. How long, wide, tall, and heavy are the current SV-3?** The dimensions are very similar to what liquid robotics provides. About 3 meters by 80 centimeters by 23 centimeters is a quick spec that I just researched off the web. This is what the SV-3 Wave Glider looked like.

**8. How much electrical power can the SV-3 provide the Optical subsystem?** It's available as part of the spec for the system itself, but we don't have that information for electrical power available for the sub system.

**9. Can the SV-3 provide iridium communication services for the Optical subsystem, or does the Optical subsystem need to provide its own iridium transceiver?** Yes, the Iridium subsystem is already on board, and you will have to be able to provide the data so we can push it through. When looking at the spec sheet provided by liquid robotics, it says Iridium 9602. It is speedy but also it has a RUTICS option.

**10. Does the SV-3 have a mast to mount the sensors on, if so, how tall is it and what are the weight limits?** I am not 100 percent sure since I have not seen one straight out of the box. However, an inquiry with full spec would highlight whether that mass exists or not. Its size, its dimensions, et cetera.

**11. What is the expected dollar value and period of performance for the award?** The goal of the period of performance is to get this kicked off somewhere around mid-November to early December, with an end date at the end of June, so that we are ready in July. We don't have an expected dollar value. We have ideas, but we don't want to influence people. Please give us your ideas and what you think it's going to cost and we'll see what we can do.

**12. What is the anticipated cost of the technology and how many SV-3 Wave Gliders are planned to be outfitted with this technology?** We're not going to discuss what we think it's going to cost. As far as I know, we are only planning on outfitting one unit for the upcoming test.

**13. Any targets other than ships to be considered in describing the systems capabilities?** That's been discussed, but I think the primary focus for this effort would be vessels. We would be interested in seeing what else is possible given a particular optical system, but we'll stick with just ship classification or ship visual identification.

- 14. Will algorithms be executed onboard for stabilization, detection, and classification? If so, do the algorithms already exist or will they be developed here?** I'm pretty sure the answer for detection and classification is no. However, regarding stabilization, given that it is on the water, I think if you wanted to include something that provided a more stable over time image capture, I don't think they would be opposed to that. However, as far as I can tell in the TFA, we did not request it. We are open to anything to get a clearer visual of what's going on.
- 15. Are the ICD and IDL written to SOF specifications and use NSW Data Formats, or will the integration be using BOEING LR System ICD and Video Data Formats?** I think ultimately the intent would be a) make the system work, b) integrate it with the comms links that are available. But making this a, for lack of a better term, generic capability that doesn't look unique or identifiable towards any one particular organization would be the intent. So, I don't expect there's a desire to make anything NSW specific about this.
- 16. Should the solution include built in iridium modem and antenna?** The Iridium modem is, whether it's an SPD modem or a standard modem that can do both is already in the system. So that'll include the antenna, so the answer to this one is no.
- 17. Are there restrictions on part sourcing for the prototype? Can parts be sourced from worldwide vendors?** I think just whatever we can do to keep things as commercial as possible and not unique enough that if someone were to come upon this and it gets tied up in a fishing net, it doesn't look so unique that it points directly back to the U.S. If we can go to Amazon and can get, do we really know where it comes from? Probably not. I would say maybe, with the exception of certain Chinese-made parts, it might become an issue. And so, we don't end up in a situation where we are having to ban DJI products for use because of reporting over the internet requirements, things like that. I don't think we have concerns much there with this type of system.
- 18. For Tier 2 subsystem, how will the "Areas of Interest" be determined? Onboard AI?** This goes back to what was discussed at the very beginning. The area of interest that the camera will be directed to look at will be provided by another system on board so that the camera system won't need that type of level of smarts. The system on board should provide, at minimum, a line of bearing.
- 19. What is the project development and system costs desired budgets?** Again, this is an initial prototype proof of principle concept development. So, we are not looking for Cadillac type for this first prototype, we just want to put something together that is proof of principle that we can test on the system at sea. So, that's about all I want to say in terms of what the scope in terms of cost might be. That's going to be up to your design, how detailed do you want to get and what kind of parts you want to use. But we don't have a target number for cost.
- 20. For Subsystem Tier 1, what is the "outside source" for Pan/Tilt/Zoom commands?** Direction to the camera will be provided by an outside source.
- 21. Tier 1 refers to "a COTS high resolution camera" (singular). A deliberate restriction or can multiple cameras be used for different parts of the EM spectrum?** In order to 1) make it fairly easy to do this initial prototype and 2) for evaluation purposes on our end,

we're looking for COTS HD cameras that are just standard visible cameras. We're not looking for long wave or midwave or any of the other fancy ones that are typically more expensive and harder to get. On the restriction aspect of the question, we don't know what the art of possible is, and we certainly don't want to limit ideas as they move forward in this process. I think there's a lot we don't know about this problem set. So, if any solutions are available that help in how to better classify something from a distance, then we certainly would be open to it. But as of what we put in the TFA, the only thing we were looking for was low light performance.

- 22. Please clarify the electrical interface between the Detection and the requested optical system.** As far as the detection output from the other side of the payload, I don't know what the format is specifically. I believe it's a digital output, but again don't know the full specs of it.
- 23. What bandwidth is available for transmitting the image near real time to humans working remotely? Or, what size .jpg can be supported?** I think there's two different aspects to this. First and primarily is the notification to the remote operator. And I believe that's going to get piped over Iridium. So, whatever size and format can be pushed with relative ease over that pipe.
- 24. How will the pan/tilt/zoom commands be provided to the tier 1 system?** Azimuth orientation for the tier 1 camera could be provided by the previously developed RF payload which outputs Line Of Bearing data as a feature already; the gimbal/self-stabilize feature would take care of the tilt/elevation since we're looking at objects at the surface, not necessarily needing to change elevation orientation; the zoom function could be handled via the platform organic C2 link/Iridium infl but we believe there are some smart cameras on the market that have object detect and digital zoom capabilities that might be leveraged to meet the zoom requirement and eliminate the need to infl camera control commands – would actually be ideal if feasible due to the latency inherent to Iridium data transfer. Bottom line is there are many unknowns in working to solve the requirement and we don't want to limit the possible technology solution when there are potentially a number of ways to crack the code on this.
- 25. Do you intend to specify the parts of the EM spectrum that you require (or desire) to be covered?** For parts of the EM spectrum with this effort, I think we're mostly concerned with the visible. We may address the other options later on down the road. But I think for this effort, they're mostly concerned with low light and daytime visual.
- 26. Para 2.2 refers to (T) and (O) in relation to resolution, low light performance and elevation. Please confirm meaning of T and O in this context.** T is threshold and O is objective. So, where you see T in the low light, that's the basic item that we're looking for. But if you can achieve O, that's even better, but it's not required.
- 27. What is the smallest size of vessel you require to be detected at 5 Km?** Again, there's a lot we don't know about what is possible within this environment. I mean, we're really good at doing things over ground, but over water, you know, still to be determined. So, I think, given a particular optic, what can be done is still a question that's out there. And I think we purposely left this one fairly vague and undefined just to see what is available and doable within the given environment.

- 28. It states a separate white paper for each capability, does this mean you want a separate white paper for: 1) The comms architecture, 2) the Imagery system, etc?** This is basically only concerned with imagery system and the comms architecture is already on the platform and we'll just be tapping into it. So, you're not required to submit any white paper for the communications architecture, just the optical prototype.
- 29. Will SV-3 Wave Guide specifications/functional performance characteristics be made available? Vessel SWAP, Comms throughput, etc.** We've determined already that we will have to round up all of the specs that we can't publish, put them together, and provide them to everybody.
- 30. Are vessel numbers and flags to be identified as well?** I think for vessel number and flag identification, that would be more of going back to the T and the O, but not necessarily versus O. Fairly undefined at this point as far as what can be done, and if we can get to that level, I think that would be the ideal situation.
- 31. Given the operational regime of the SV-3. are you expecting high or low amounts of background clutter w.r.t image processing and extracting/identifying a ship?** Background clutter is something that's been discussed here quite a bit. That's a situational problem set to deal with, but expect there to be a high amount of background clutter. So, that'll obviously dictate the type of optics used.
- 32. What is required for over the horizon? Is optical sufficient or is something else required?** Depending at what height the camera systems are, that'll dictate roughly how far the horizon will be, which will limit the ability to see certain vessels. Obviously, a bigger vessel, taller vessel is visible at a larger range, but we're not requesting anything over the horizon.
- 33. Given the form factor of the SV-3, are you expecting to mount the optic on a sensor stalk, or closer to the vehicle surface?** We want to keep this as minimally detectable as possible, but we also want to get some reach out of the optics, too. Higher is not necessarily better, because you're dealing with more pitch and roll of the vessel itself. But certainly, we suspect there's a happy medium between the range of optics and balance of the vessel.
- 34. Going back to using AI or computer vision software to detect and classify vessels – has this been looked at?** The use of AI to automatically detect and classify is not part of this effort.
- 35. Does the optical subsystem need to include a mast?** This one's kind of tricky from the perspective of we want the proposals and your creative ideas to come up with a way to detect that the range is required. So, if your solution includes a mast, then I would think you would design for including a mast onto a wave glider. However, if you know of another way of providing the optics, that's acceptable.
- 36. Are there minimum framerate requirements for live feed or for local storage?** I don't think we're considering live video off of this platform, but that doesn't mean we couldn't accept video snippets that are being sent over the modem. We have an iridium pipe that we've got to stuff things through to take into consideration. There is another backhaul mechanism that will be available on board the platform we can't discuss at this

level, but I don't know what the throughput specs are of it. I doubt that it's going to give us live video, I think 2 maybe 3 frames per second tops is where I would start looking.

- 37. Are there any RMF accreditation requirements?** We're pretty much looking at an optical subsystem and we're not doing any AI/ML as part of this or that anything would be part of another subsystem or something at the back end. So, at least for this prototype, I would say there aren't any RMF requirements.
- 38. What's the rough order latency for image capture to analyst reception?** For this one, we can really speak to the Iridium side and from personal experience. I mean, Iridium is Iridium. You might get it in 10 seconds, you might get it in two minutes. So, it's kind of a tough question to answer. It's really up to the architecture.
- 39. Do you require separate white papers for each capability? Architecture, Comms, IMINT?** The only thing we're asking for is white papers on the optical subsystems. No comms, no IMINT analysis type software or anything else. Just the optical subsystem on board the wave glider. Pretty much do the requirements that we asked for in the TFA. Just one white paper on the optical subsystem.
- 40. Is this solution replacing an existing capability or is it new capability?** This would be a new capability. We currently don't have an optics system identified or in use today.
- 41. Just to clarify – are separate proposals needed for the Tier 1 and Tier 2 cameras or should there be one proposal that includes both?** Again, it's just one submission that goes over your ideas for Tier 1 and Tier 2 portions of the optical solution.
- 42. What will be the driver to your selection design, features, and pricing?** It's likely to be design feature pricing, I would say, first, is the white paper proposed feasible? Is it doable, realistic? And then the features in the pricing are always desirable things. If it's affordable or not affordable. However, right now I'm focused on the technical aspect of it. Can it be done? And can you get it done in time?
- 43. Would you entertain a Comm capability if it made a huge improvement? i.e., reducing wave action interference for better throughput for the IMINT!** I think whatever it takes and makes sense to do to reduce time required by analysts to classify is of interest. I don't think it would make a huge improvement. That would be a decision that you guys would have to make because you already have Comms on there and I don't know what your capacity is for adding a different comm capability. But reducing wave action isn't really going to affect Iridium much. It's already a very slow comm link and wave action isn't a big thing for it because it's already used on vessels all over the world anyway, but I don't think you would improve it much anyhow.
- 44. Is there potential for large orders beyond the prototype in the future?** Yeah, and I would add that this project's more focused on the optical challenge more than the comms, however, that is a big, big consideration. It's solving the optic pieces what our focus is. I hate to answer with this generic response, but I guess it depends. It depends on the system. It depends on the price, depends on the performance. It really does depend on a few factors prior. And it all depends on your definition of large orders. If you're asking or really need 10,000 of these, no, but I can't tell you what the actual need would be in the future. That has not been determined yet.

- 45. Is there any advantage in delivering ahead of schedule?** So, a contract hasn't been written with respect to providing incentives of delivering ahead of schedule, which is a consideration. However, I could say we do have a short timeframe to get it done by June to meet the events in the future. I think from the viewpoint of this is going to be issued through SOFWERX, I don't believe that we're going to be doing any features in that effort that it's going to pay a benefit to anybody by being early. I think what we're more concerned with is taking the time to get it done right, but on the schedule that we need. If you have your prototype designed and delivered ahead of schedule, I would say that it just benefits you from the perspective of you will be able to fine tune it and make sure it's going to perform.
- 46. In addition to tech data regarding SV3, can similar be proved for the Iridium? The channel is probably shared with other comms needs, what bandwidth available?** Yeah, we can provide you information on Iridium, but I can tell you if we're going to end up using short bursts of data, you're basically limited to what is essentially sending a series of text messages. So, you would break your imagery up into chunks that could be sent via that path, and if it ends up being RUDICS, then you're limited to a connection that is basically 2.4 kilobits per second. That's the bandwidth. And is it shared with other comms needs? It might be, but it's a basic first in, first out through the modem. So, that would be something that would be termed by the onboard comms processor, not this subsystem.
- 47. Can a pan & tilt solution with a single imager be provided?** If this question is: can a single, optical package be the deliverable, I think that is sort of dependent upon what the capability is. I think the initial discussion that kicked all this on the requirement side off is we know we can probably do one level of imagery on one side and a higher level of imagery on another side. But if there is a single package out there available that can do both at the ranges requested, I don't know that there's a hard requirement to say no to that.
- 48. If you don't want AI to detect and classify vessels. The intent is for images to merely be sent over Iridium and then processed on the operator side.** The initial notification image will definitely be going over Iridium. The follow-on activities for higher resolution imagery go over a separate pipe. But, again, I don't have the specs for those for what the pipe looks like.
- 49. Does the link require encryption? I believe DoD issues a requirement for all imagery to be encrypted.** I think for this one, the Iridium encryption is sufficient for just our raw data needs. Iridium itself doesn't encrypt, that is usually your subsystem that does that, so you get the data packets in, you encrypt them, and then you just push them over to the Iridium modem. That's usually how it works. So, I would believe if there is encryption involved, your comm subsystem already handles that.