SBIR 23.4 R4 Q&A Telecon Transcript
07 September 2023

- SOCOM234-004: Out-of-Band GNSS Tracker
- SOCOM234-005: Slim Form Cargo Loader/Unloader

SBIR Process Timeline

22 Aug 2023: Topics issued for pre-release
06 Sep 2023: USSOCOM begins accepting proposals via DSIP
21 Sep 2023: DSIP Topics Q&A closes to new questions at 12:00 PM ET
05 Oct 2023: Deadline for receipt of proposals no later than 12:00 PM ET

SOCOM234-004 : Out-of-Band GNSS Tracker

1. Is there a particular data transmission frequency that is desired (i.e. higher or lower than existing GNSS frequencies)?

The initial submission did say UHF but if you can find something that meets the requirements in VHF we're okay with that so frequency range that we're okay with you guys exploring and working at would be anywhere from about 50 megahertz to 3 gigahertz. I think the bigger question is, what are the types of frequencies do we want to avoid, which I think actually answers a couple of these. The typical UAS frequencies for commercial UAS are, and these are bands, so these aren't exact frequencies there's space and bandwidth around these that we want to avoid is 433, 868, 915, 1200-1300 megahertz. Moving up to the gigahertz band 2.4 gigahertz and 5.126 gigahertz since this is sub 3 gig, 5.1 shouldn't come into play. Those are frequencies that we would want to avoid. Now, what I want to highlight, is it's okay if a solution that you are investigating could enter these bands in addition to being out of band. If you had a radio that was tunable across 200 and 900 megahertz, that would be okay as long as we have the ability to not be in that band. That doesn't have to have like weird band breaks or anything like that. It's okay your solution covers a range of capability. Keep in mind that ideally, we meet the requirements across that range.

2. What is the distance that a transmitted signal out of GNSS band needs to reach to relevant receivers or is this part of the Phase I study output desired?

We're, interpreting this as just the range between the transmitter and receiver? We think we are requesting 40 clicks right now. We had as target 20 clicks with an omni-directional antenna and transmitter and seat receiver with a UAS at a nominal height of 300 ft AGL. If you guys want to map out some free space path loss, that's the number. What would be really great is that 40 km number with all the same restrictions.

3. Is encryption on transmitted data desired/required?

We think it is a nice to have. We don't think it needs to be any kind of crazy mill spec, crypto, loaded encryption, or anything like that like. If this thing had commercial AES to some basic level where you enter a password or a small pass key, that would be fine. Strictly on a nice to have objective basis. While we're on the matter of encryption, we would like the transmitter, and potentially the receiver, again trade space we can explore, to log their transmitted and/or received location to like a little SD Card. This is for diagnostic analysis purposes, especially if you know our UAS experiences a catastrophic power failure. Well, that's not going to be logging itself anymore. So, having a record to help us identify what went wrong can be helpful. If possible, we would also like that data storage, that again it can just be to whatever super basic commercial standard. The idea would be, we're not

trying to let free cheese get out there if this thing, you know, goes down or somebody nefarious picks it up, or another situation we have is we're testing stuff. A lot of the common tracking systems, vendors have that demodulated and decoded in their system. So, if we want to make sure that a vendor is playing fair, we can go in, we can say, “Hey, set the passcode to whatever”, and then ideally, that makes it more challenging for the vendor to be nefarious.

4. Are there any data transmission protocol requirements? (CDMA, TDMA, FSK, PSK, etc?). Do any Mil-Std-188 requirements need to be met?
No, there are no requirements for that or mil-standards. If you have some that you recommend, or you find the one that meets our requirements, go for it, let us know. But for the most part, we're leaving the approach open to you as to how you might do the multiple access or meet the data rates and receive sensitivities and distances that we are requesting. We hope that gives you some flexibility in the approach.

5. Do you want a combined position result from all satellite sources? Or position reported by each individual GNSS system? GPS position separate from Galileo?
This is intriguing. There have been a couple of applications where something like this might be nice, but at the most, this would be nice to have. Worst case we could always pull the separate ones out from the data or the logs. For the most part we would prefer a combined position result be presented. We are also requesting that the GNSS signals that are chosen to be transmitted are user configurable so we can go in and alter that as necessary. Then the system would only transmit said data.

6. Are you interested in specific sub-bands of UHF frequencies? Does the transmitter need to be capable of adjusting frequency sub-band during mission?
About 50 Megahertz to 3000 Megahertz, avoiding those common ISM and UAS bands. No, it does not need to be capable. We don't expect to have a need for bi-directional communication for that. In some cases, it's actually not preferable to have that. We're totally fine with plugging in a USB table and configuring that device. Also on that, please no wi-fi or wireless configuration of the device, or, if it is, it has to be able to be physically disabled, cannot be the primary method of configuration.

7. Do you have a specific radio in mind?
Nope. Please use whatever you feel meets the requirements.

8. Are there any transmitter form factor requirements beyond the weight limitation? Is battery included in the weight limit? Will there be access to UAS power?
We would prefer target transmitter size to be approximately the size of 2 decks of playing cards arranged in whichever way you want, so that the flat faces of the cards are touching: Hamburger style, hot dog style, lengthwise, width wise, whatever you prefer. That does not include battery or antennas. An ideal objective size would be approximately 4 in x 1 in x 1 in, and would include battery and antenna, and that battery would meet our power requirement for sustaining high-rate communication and the long-term low-rate communication, which is in their requirement document. There will not be access to UAS power. The reason being that we want the system to operate completely and utterly independent of the UAS power system. It's expected that the UAS power system is going to run down earlier than a tracker battery and be done in 10 minutes, 20 minutes, an

hour. Or in a catastrophic event, there's no power available on the UAS at all, and we would want the tracker to operate independent of that, for those reasons.

9. Could you clarify the receiver output as wired only, or inclusive of wireless.
We would highly prefer if the receiver output was wired only. If you were including wireless, or if it was something that just happened to be included on one of the chips you chose like, if you just decided to use an ESP 32 or something, it must have a physical disablement option to physically disable that wireless capability if you add it. It's secondary, but there must be a primarily wired option.

10. What is the flight time? What power support is needed for the system? Is it part of weight constraints or will we be able to tap into existing power?

The need is to have a tracker that fulfills two primary functions, function number one being high-rate tracking, high-rate being approximately 1 to 10 Hertz target, 1 to 20 Hertz objective. For a period of time, that's typically 40 minutes, but on longer flights can get up to about 4 hours. Kind of the high-rate period, that's worst case would be 20 hertz or 4 hours. We don't have anything that flies longer than that, so it's no longer in the sky, which means either there is a successful flight, or we are going to go and look for it. After that, we would like the tracker to switch to a lower rate mode again. Those rates are user-configurable, by the way, if I did not mention it, and that lower rate mode just needs to be once per minute. We would like that to last 48 hours, minus the length of time of the initial high-rate mode. So, the worst case would be 44 additional hours. Obviously, if we're doing a user-selected battery, that kind of complicates it. But we hope that this encourages you to scope the power draw of the device, so that a reasonable size battery, reasonable being, let's say approximately the size of the device itself, would be able to sustain it for that length of time. Then, if we want a larger one or a bigger one for whatever reason we have the option of doing that.

We are requesting an external connector that is either a common RC connector or something that's a little environmentally better. So some highly preferred connectors, but again, this could be trade space up to y'all, is an XT30 nylon RC connector, a JST connector: that’s the standard 2 pin with a little red plastic housing or a Molex SL Series locking keyed connector, and we can provide the information on that series if you're not familiar with it.

Power is not part of the weight restraint for the target, it is for the objective. We will be able to tap into existing power negative due to the reasons described earlier.

11. What are the SWAP constraints within the drone for mounting the unit? What is the volume available for the GNSS transmitter and antenna?
The GNSS transmitter and antenna should all be within the same transmitter unit. So, like the radio transmitter and the GNSS receiver. Ideally, that whole thing is like one unit that we kind of showed on the slide earlier. SWAP constraints within the UAS for mounting the unit depends. We intend to move this thing around between multiple UAS. Full disclosure, we're probably going to Zip Tie/Velcro dual lock and tape it, inside the UAS if we can, outside the UAS if we must. For UAS that we use a lot, we'll probably develop something a little more sophisticated on our end, like 3-D printed bracketry or whatnot. But that's not something you all have to deal with. The takeaway here is ideally whatever, case or enclosure that you select would be capable of being mounting-friendly for some of those methods that I described.

12. Are there any limitations between the frequency 300 MHz to 3 GHz that we cannot use? Can we use IMS frequency?

50 Megs to 3 Gigahertz is approximately the range that we're looking at. The limitations are the ISM bands. Those are a no-go. Your system can operate there but it cannot be the primary band of operation. If it crosses it, it's okay.

13. Is there an existing ground station this needs to work within? If so, is there an ICD we need to work within to communicate with the ground station?
No, there is not.
No, because there isn't one. That being said, we do have a request and the requirement that it is a nice to have, we would like the APIs, that is a target. Whatever data stream is coming off these receivers, we want to be able to ingest it into our other systems, and we have some specific programs we'd like that to work with. Those are Blue Marble, Global Mapper, Google Earth, Rover, and U-blox's u-center at a minimum. We have some others that are a little more out there, but in general, if the stuff looks like a typical GNSS stream, it'll probably work with most of these. As an objective stretch goal, nice to have, if we had the information about the broadcast, such that a sophisticated person with an SDR could look at and go "Okay, yeah, I can make a receiver for this." I was able to execute that, and that would be nice. But that's very much a stretch goal.

14. What is the minimum number of simultaneous transmitters to tracked be per unit time?
We think there's a lot of trade space here. We will give you a functional answer. It's common for us to be operating one to four UAS at a time, so it would be pretty nice if we could have four transmitters being able to be flying around broadcast in their position, and for one receiver under optimal conditions, to pick up all four of these transmitters. Now, how you execute that if you achieve that simultaneity via the time, frequency, code, or some other method, we leave that up to you. If it can only be two things, or if you're like "Oh, that's easy. I can do ten." That's great! Again, this requirement is kind of squishy, but we don't want to have each of those teams that you saw in that overview carrying around four receivers to four different aircraft. How you approach this using unique IDs on the transmitters, and there might have to be a little bit of user trust right like this is a broadcast type thing, I have to make sure that the user didn't do a stupid human trick and program my transmitter to be at frequency A and my receiver is opened up accidentally at frequency A plus one, now it doesn't work. It is okay to accept that the users here are a little more technical. They're used to dealing with configurable radios. They're spectrum people. We've got all kinds of spectrum tools that we use every day. So, we're willing to accept a little bit of risk here on the user side that there's trust that the users can configure this stuff appropriately, and if they can't, they're smart enough to debug that they did not configure it appropriately.

15. What are the minimum-security requirements?
This is a totally unclassified capability. We're primarily using for convenient tracking the UAS in-flight and then safety and recovery operations afterwards. This is strictly being used CONUS. This is not like going out to a battlefield or anything like that. Security wise, we're just trying to keep our data secure from people without a need to know, or curious folks, or nefarious vendors. So, security requirements, they're pretty light. The encryption is just strictly commercial, and we're just being excessively cautious there to try to not give away any free cheese that doesn't need to be given out. And again, that's also just a nice to have. Hopefully that's all we need on the security requirements.

16. Upon successful completion of Phase I, will Phase II be subject to Direct-to-Phase II bidding from other candidates?
Right now that's going to be TBD.

17. What is the target 1 sigma accuracy of the PNT solution?
We're not sure we 100 % track the terminology here, but if this is asking, how accurate does the solution need to be? We would say, we're okay with normal plus or minus fifteen-meter GNSS accuracy. That's okay, if you're thinking of the accuracy of a standard U-blox M8N receiver, you're in the right ballpark. If you can get better with a fancy or nicer newer receiver, that's great. But whatever equivalent an M8N receiver provides is totally acceptable.

18. Who supplies the UHF antenna? Do plan to change frequencies between missions?
While Phase I here is a research thing in a magical, perfect world that this thing appeared on my desk today, and in perfect form, there'd be a little pelican case, and it would have let's say three to five antennas for a transmitter and receiver that would operate across the band of interest. So, if you had a radio that theoretically was programmable from 200 to 900 Megahertz, there might be an antenna in there cut every 100 Megahertz or so just a little monopole, but it's totally acceptable. The Government can always go and make and procure more SMA monopole antennas. They're cheap, they're easy, but in a perfect world like three to five of those would show up. If you do any kind of research or anything like that, you have a nominal frequency that you selected, and there's just one antenna that's fine.

It depends sometimes, but ideally, for the most part, we would like the configurations on these things to be well-configurable by the user. Ideally, we can save them off onto an external device and load them so hopefully once we find a couple of configurations that work for us on a particular day, or for a particular set of missions that we are going after, we can set it and forget it. Ideally, we're not changing frequencies between missions. But Murphy shows up sometimes, and sometimes you have to adjust fire. We're okay with recabling up to the thing with a laptop or phone or tablet and altering that across the system.

19. Are these retrofittable to current systems or embedded on UAV?
They are not retrofittable to current systems. If that means what we think it means. We're embedded on a UAV. Mounting wise, hopefully we can stick it inside some of these that are a little bit larger, but some of them like a Mavic, you're not getting it inside that thing, you're taping it to the bottom or the top. Ideally the size and form factor enable that mounting solution.

20. When or where can we get a copy of the requirements?
You can request the slide deck, so we'll also send over the requirements document to the SBIR Program Management Office where you can request it.

21. Is it desirable to be able to change frequency during a flight?
No, not at this time, because that would require a bi-directional communication. We just prefer not to have that at this time.

22. Are there any tx unit cost targets?
We've worked with some similar transmitters that were like 70% of what we wanted. One example that we feel comfortable sharing is, actually it's a model rocket tracker from a company called Big Red B. Makes a 900-Megahertz model rocket tracker. It's little U-blox radio. It has an XB transmitter, and it fits in that nice 1in x 1in x 4 in form factor we described. That's about $200 or so is what it's sold for. We're not saying that's a great price target. But if we were okay with that thing being at 900-Megahertz and being just covered in shrink wrap, it's pretty close. If you have something like that, that was frequency programmable with an SMA Connector, the data and power connectors that we

requested, and a relatively environmentally sealed box to try to keep it out of the elements a little bit, and whatever that additional cost would add like, that's really nice to have. We do want to buy a decent amount of these things, or we can't commit the Government to it, but we should say the Government has a need for a decent amount of these, but that is also tempered by a price like this thing cannot be $10,000. If it was $1,000 it might hurt, but if it is like sub-500, that's not bad at all. Seeing comparative technologies, as an engineer speaking, we think that that's appropriate. Obviously, research low-rate numbers, it changes things.

23. ip rating ie rain

These are kind of squishy. This is from us going on Wikipedia, reading IP ratings and making an educated guess on what we would want. Ideally, the transmitter and receiver both have an ingress protection against dust of a level five for a target and a level six for objective. The reason being, we fly this thing around in the desert and 30 mile an hour winds that are getting rocks and dust kicked up at them all the time by props, so ideally, the system is not affected by dust getting in or just doesn't let it in at all. The transmitter system ideally has ingress protection against water of level 4W. That's just specifically weather-resistance is the intent here, and the objective would be level 7W. The reasoning here is, if we've got to fly through some light rain to get back to land before things get real nasty, because the UAS certainly don't have level 7, we would like a tracker to function at or beyond what the UAS itself can. If rain takes the UAS down, because a sudden storm comes out, we wouldn't want the tracker to go out as well. Ideally level 7. So the situation there is, this thing falls in a puddle or in a maritime environment it falls down in the water, and it's floating on the surface, a little bit immersed. Anything beyond that, obviously it's going to be a loss. Receiver ingress protection ideally against water is level 4W and objective would be level 6W. The reasoning being there, we're going to take this thing out to the field. We're going to tape it to a folding table. We're going to put it on the tripod, or we might lash it to a mast, or like the roof of a truck, and if we get into some light rain we've got to drive around, that's the level of protection we're looking for.

24. Is the 200g weight limit inclusive of battery?

No for the target, but we believe our objective was inclusive of the battery weight. If you had a nominal battery.

25. Are there constraints regarding min/max transmit power?

There are not direct constraints regarding that. But hopefully there are some guidelines that are insinuated by the range request. Whether you achieve that with high power, low received sensitivity or low power, high received sensitivity, or some sort of other capability, that's up to you. Hopefully, that is additionally bounded by the endurance requirements. If you just make a 10-Watt transmitter, you're going to run down your battery and not meet the endurance requirements.

26. What is the data Payload size for the 20HZ update rate?

In the requirements document we are asking if the data payload can be configured to have user selectable inclusion or non-inclusion of certain GNSS messages and the data payload. It's kind of a stretch goal. The main things we need are latitude, longitude, altitude, heading, speed, fixed type and numsats, as well as if there is a transmitter unique ID, we would like that to be transmitted as well. We think we're okay with there being some restrictions, perhaps voice to the user via the GUI on certain data being included for a higher update rate. If the GUI's like "Hey, you want 20 Hertz, like the packet needs to be this size, and you can't include all this extraneous stuff in like the UBX spec or the NMEA 0183 spec", we think we're okay with that. Again, that requirement is kind of squishy. So, we

would be willing to accept some impacts to messaging to achieve that higher update rate.

27. Is this an open sky system only or do you need supplemental sensor correction for location data?

We're assuming that this is asking about RTK or DGPS systems, so the system must be able to operate by itself in an open sky without supplemental data, but if that supplemental data happened to be nearby, or you chose a GNSS receiver that is capable of using RTK or DGPS, or receiving FBASS satellite, that's totally fine. It's not a requirement. It's a "that's nice to have" if it just so happens to get that enhanced fixed. But we don't require an RTK system or a system that is capable of corrections.

28. Loss of GPS for a given period of time ie dead reckoning

Assuming the question is, how do we want the system to handle that or behave? We would prefer not to increase the SWAP cost of the system with any kind of substantial IMU that would be necessary to really maintain an accurate heading. If you guys want to put, let's call it a UAS grade IMU on there to try to sustain that, that's fine. If your GNSS already has that in there that's great. But if GPS totally goes out, we probably got bigger problems. We don't think if this is a strictly commercial like a GPS went out like we're kind of out of luck. We think that might just be a condition that we have to accept, so we don't think we have any hard requirements that this thing has to do any kind of dead reckoning, to any level of accuracy. If it's on there, and it happens it's nice to have, but definitely not a requirement.

29. Will these be installed on existing UAS with embedded GPS systems in addition?

Yes, they will be installed on the UAS with existing embedded GPS systems, but we would like them to operate effectively, wholly, independently of the existing GPS systems of the UAS. We will add the pilots and operators and make sure we do due diligence to make sure that if we mount a transmitter, we keep it away from any EMI interferes, or that thing has an LNA on it that's screaming, we will just have to accept the risk and do what we can to make sure that those systems do not interfere with each other.