April 25, 2010 Sugar Shot Tracking/Recovery Debrief

Pre-Launch Communication

In an effort to unify the communication path I created the mail list, SSTrackingRecovery@googlegroups.com. As it turned out this helped with the non-Stratofox members, but there was a bit of a disconnect between the Stratofox members and the non-Stratofox members early on. Stratofox did add the SSTrackingRecovery address to their mail list, but I am not certain that much traffic was passed in this fashion, since it was fairly late in the pre-launch preparations. I think that pre-launch preparation would be improved with a better communications path between all parties. There are essentially 3 groups of people involved in the tracking and recovery efforts: Stratofox, SAR people, and others. The communication between the SAR people is well developed. We have callouts at all times, so we are used to communicating frequently via email, text message, phone, and the radio. I suspect that this is true for Stratofox as well. The coordination among the "other" group has hopefully been improved by the mailing list. I would like to improve the pre-launch commo with the Stratofox folks, since they are integral to this effort. I am hoping that the inclusion of the SSTrackingRecovery list on their list will help in this regard. I understand and appreciate the need for a unified address in various organizations. As long as there are people that are part of both lists, then communication can occur.

Also, the creation of the text message "callout list" is very useful for enroute commo. We use this successfully for all time-sensitive commo in the SAR community. With a single message I can communicate with my team or the entire county. It is very efficient. I think that the fluid nature of these launches would continue to benefit from such a list. This is especially true with folks who are travelling from all over the state to participate in launches. Currently the list is under my jlehman.org domain. It is a forwarder that accepts mail at a single address and ships it to the wireless devices via an SMS-Email gateway. Folks who filled out this form are on the list.

I have also successfully used Twitter for such communication. Using Twitter can give the same sort of text message capability with additional functionality such as easily reporting locations, web page integration, and a robust API that allows interaction with the service from a variety of platforms and applications. Still, the basic Twitter SMS functionality is best for our application. The downside to Twitter use is that people have to set up an account, then enroll their phone to receive and send SMS messages to Twitter. Also, one is dependent upon the reliability of the Twitter site. The barrier to entry is greater with Twitter compared to the simple email forwarder.

Sugar Shot may want to consider setting up a Twitter account and displaying the info on their website. It is an easy way to quickly push launch information to the public and other interested parties. In checking, sugarshot, and ss2s are already taken. sugarshot2space and SS2Space are currently available, however. For an example of the use of Twitter in the SAR community you can follow @SBSAR. (Other examples in SAR are @CaveRescue. My personal account is @JeffLehman). You can see how a Twitter feed can display on a web page at www.sbsar.org. There are a number of strategies when deploying Twitter in this fashion. I would be more than happy to discuss such things.

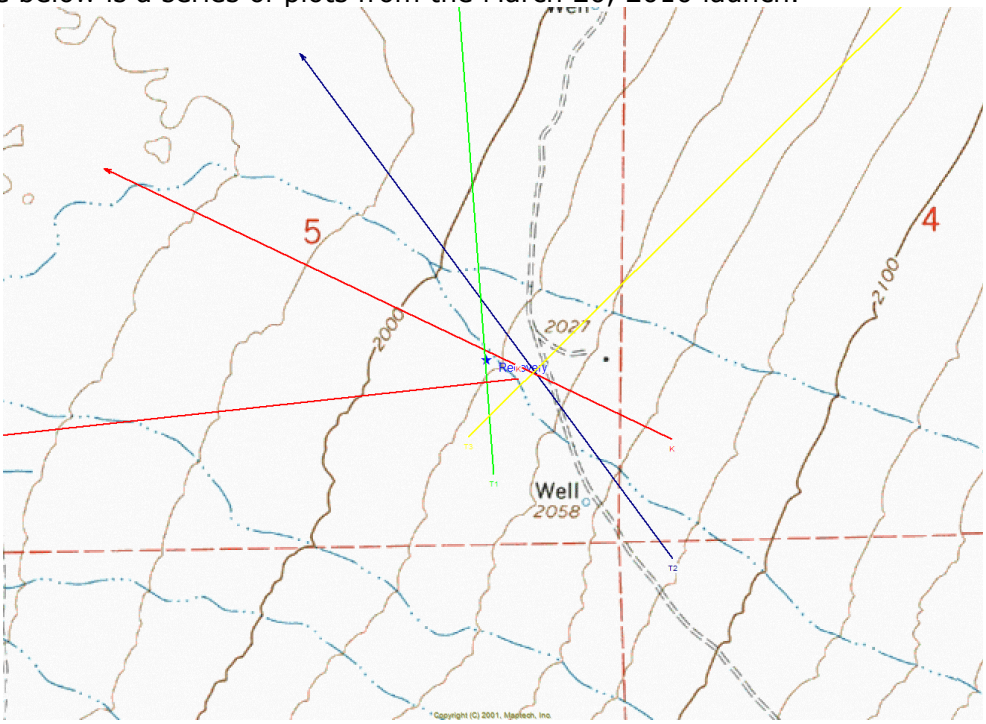
Beacon Tracking

Method

We have successfully tracked two Sugar Shot launches by applying the techniques that SAR teams use to track ELT beacons. The one advantage of the rocket tracking over the ELT tracking is that we have a pretty good idea where things will end up, so we can optimally position tracking teams prior to the event. The big difference for us is that ELT transmitters are not flying through the air.

During the launch tracking teams attempt to keep a lock on each beacon. For each good lock, an azimuth is recorded. Since the whole in-air tracking is complete in just a few minutes, it is difficult to plot the points in real time. After it is determined that the packages are on the ground, or lock is no longer possible, then the azimuths are plotted in reverse chronological order.

The image below is a series of plots from the March 20, 2010 launch.

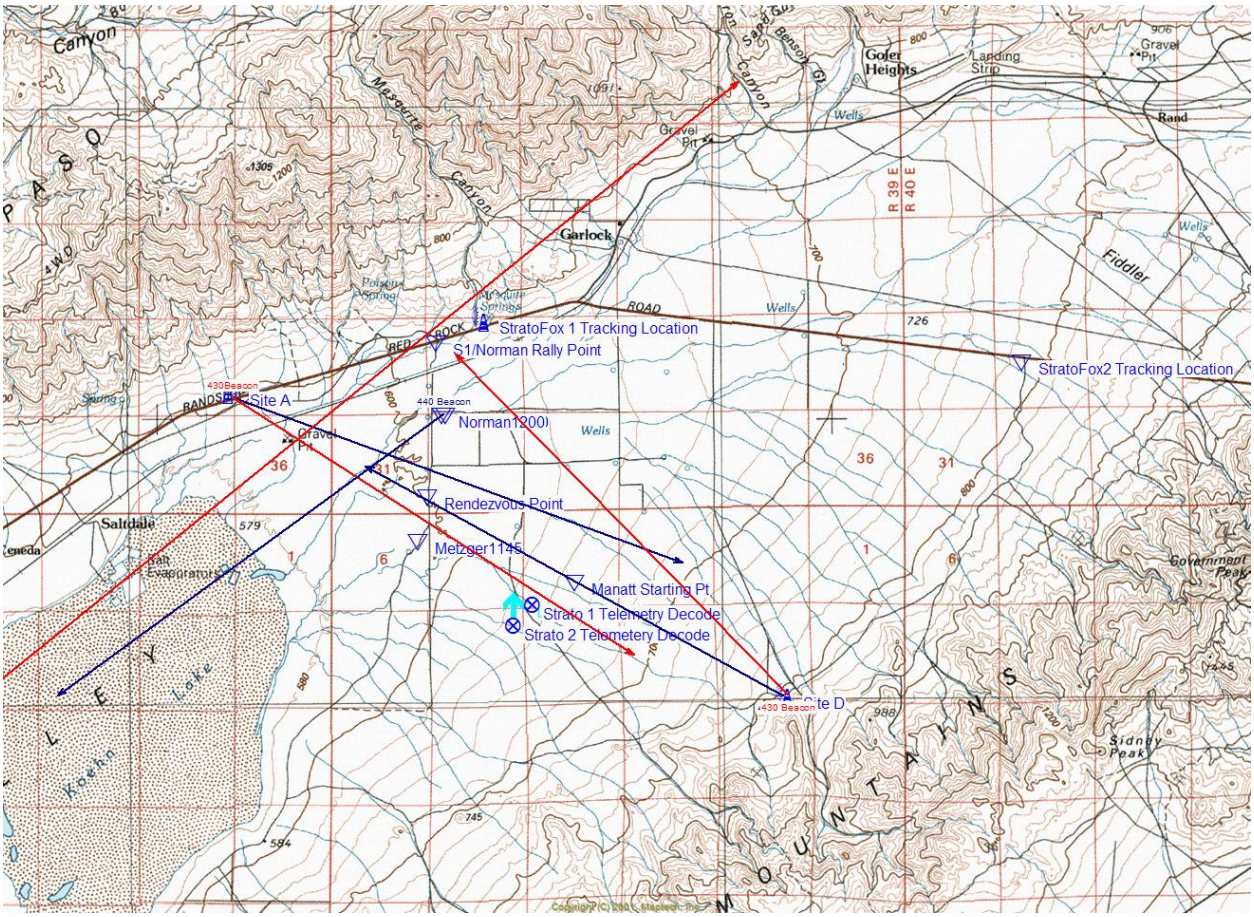


Intersections of these plots are then used to determine areas with high probability of area (POA) and tracking/recovery teams are then directed to these locations by the person running the plotting operation. Along the way they continually check for signal and attempt to get an azimuth to report to the person plotting the points. Now, the search is much more of an ELT style search.

The Search on April 25

The search on Sunday occurred in this fashion. A visual tracking of the payload was possible, so our focus was on the booster. Also, we had a good telemetry hit from the Stratofox folks which was rather close to where the payload was actually recovered. The

payload was recovered before we were able to plot the points. The image below shows the payload bearings in red and the booster bearings in blue.



We only had two plots for the booster beacon. Unfortunately, they pointed at each other. We needed a third to narrow things down, but we played the hand we were dealt. We chose an area with high POA given the beam headings from "Site A" and "Site D". This is labeled "Rendezvous Point" on the map above. We sent the team at "Site D" to head toward this location, periodically checking for booster beacon signal. The team at "Site Norman" was sent to meet "Stratofox 1" at the location marked, "S1/Norman Rally Point". Their assignment was to distribute directional antennae between the two teams, and to head south to the "Rendezvous Point". During this time, folks at the launch site began a search around the launch site where some debris was found.

About an hour into the search, "Team Norman" got a radio signal from the booster. As it turned out, it was probably because somebody searching from the launch site found the booster section, and picked it up. This made for a better RF reception situation.

Jeff Lehman April 2010

Lessons Learned

Team Composition

As with any RDF operation, 3 tracking stations are the minimum requirement. Since we are tracking both a booster and payload, we need a minimum of 2 radios and 2 antennae at each location as well. From the test this past Sunday, it also seems that multiple stations listening to the telemetry is also helpful. I suspect that the telemetry is sufficiently captured with an omni-directional antenna, but a beam is probably better. Ken Manatt was using a beam to capture the telemetry, and the Stratofox guys were using omni antennas. The following is an optimum tracking team complement.

- 1 vehicle
- 3 UHF directional antennae
- 3 Compasses
- 3 UHF receiving radios
- Ability to decode telemetry (hopefully APRS) on one of the UHF radios
- 1 mobile radio in vehicle
- 3 2m HTs for commo if folks go on foot
- Paper and pen for recording data
- 4 people (1 to run each radio and 1 to help record and attend to things during launch)

We found that unless there are two people per radio/antenna (one to record an azimuth), that there isn't sufficient time during launch to maintain lock and get good data recording. Mark Kinsey and others came up with the idea of drawing a line in the soil for each solid lock. We then worked backwards chronologically to shoot the bearings with the compass. I think that it is important to plot all of the bearings even though the last one is probably the one closest to the ground. The reason is that there is uncertainty in all of the measurements, and we may benefit from a bit of averaging over time.

For future launches it is probably a good idea to keep one tracking team at the launch site. Since it isn't unusual for things to land nearby, it would be useful to have folks on-site to speed the search. Also, in the event that a grid search is necessary, it would be nice to be a bit more systematic in the search near the launch site. This would make it easier to determine areas already searched and to efficiently deploy resources.

Suggestions for the Designers

If there was any way to increase the rate of the beacon, it would make it much easier to track. I understand that battery life is an issue, but if it was possible to have the rate increase at apogee, then decrease again after some predetermined time, it would make it easier to get a good lock on the way down where the likelihood of a good signal is greater.

Also, it may be more conducive to tracking if the APRS protocol is used for the telemetry, and an FM signal were used. The folks from Stratofox had a few suggestions as does Ken Manatt.