FAA/Skyward Memorandum of Agreement (MOA) Bimonthly Report

January 2022*

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*Redactions and corrections made by Verizon February 2024

1. Table of Contents

2. Revision History

Revision	Date	Description of Revision
1.0	1/14/2022	Initial report

3. Overview of Flight Campaigns

Flight campaign start date: October 4th 2021
Flight campaign completion date: December 5th 2021
Total quantity of flight hours: 37
Total quantity of flights: 61 flights (53 flights have data)
Percentage of time with full C2 Link Connection: 99.086%
Percentage of time with full Cellular Network RF Environment: 63.825%
Uncrewed aircraft OEM and Model:

- Hitec Xeno Fx - Fixed wing
- Delair UX11 Ag - Fixed wing
- Censys Sentaero V2 - VTOL Fixed Wing

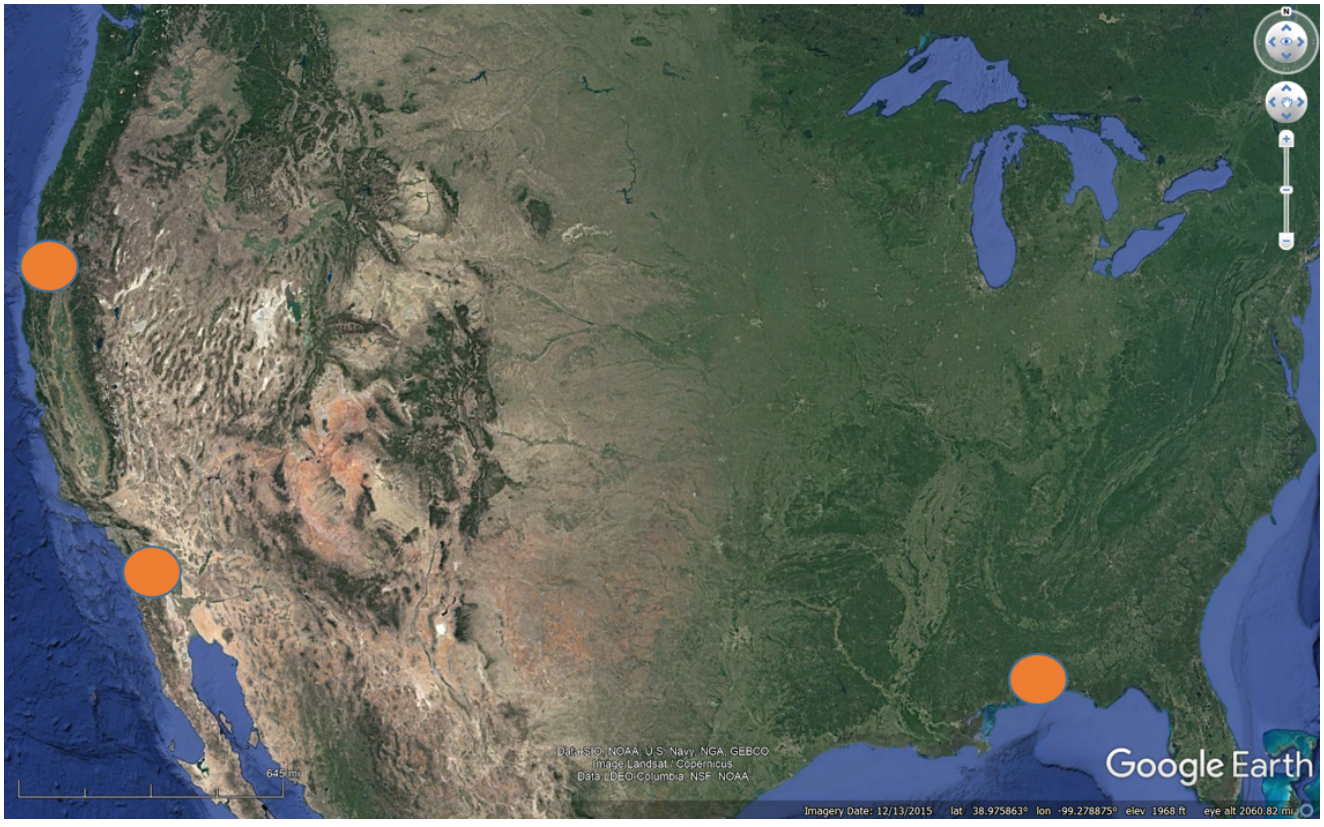

Figure 3.1 Overview of Operation areas

Figure 3.2 Sentaero VTOL FW LTE

Daytona, FL Photo credit: Tanmay Naik of Censys Technologies

4. Overview of Analysis Method

4.1 Altitude

For statistical reporting, only those logs corresponding to aircraft altitude > 5m are considered in order to filter out ground-based logs. Total quantity of flight hours includes all logged time corresponding to records where barometric height is greater than 5m

4.2 Full Connectivity

In order to accurately represent the impact of the RF environment and cellular connection availability on the performance of the C2 link, the concept of full connectivity is separated into two metrics: C2 link connection and cellular network RF environment. A degradation of the cellular network RF environment is expected to cause a degradation in the C2 link connectivity statistics.

Percentage of time with a “full C2 link connection” is defined as the amount of time that the UA is connected to the cellular network for command and control as represented by successful heartbeat messages logged at the same frequency as modem parameters, divided by the total amount of time that the UA is in flight and using LTE for the C2 link. This metric excludes flights that were executed to

intentionally exercise areas of known communication holes (see Section 4.3 “Replicate Communication Holes”).

Percentage of time with a “full cellular network RF environment” is defined as the amount of time that the onboard UE reports sufficient RF parameters such as RSRP and RSRQ divided by the total amount of the time that the onboard UE reports RF parameters. This metric excludes flights that were executed to intentionally exercise areas of known communication holes (see Section 4.3 “Replicate Communication Holes”).

4.3 Replicate Communication Holes

Communication failures occur for various reasons. If communication issues are observed in any of the campaigns, flight routes are executed to fly through, above, below, and around those areas to attempt to replicate issues that were observed. This effort aims to help us understand the conditions where the command and control link might fail.

5. Operational Area and Environment

5.1 DOEFLT-125 Panama City Beach FL

Operation ID: DOEFLT-125
Operational area name: Panama City Beach
Environment: Urban
Total quantity of flight hours: 9.01 hours
Total quantity of flights: 15 flights
Average altitude (50th Percentile): 90m
Maximum altitude: 131 (around 110 records are above 121m)
Operational Risk Assessment (ORA): Moderate
Objective: Baseline Mobile Field/Area Survey

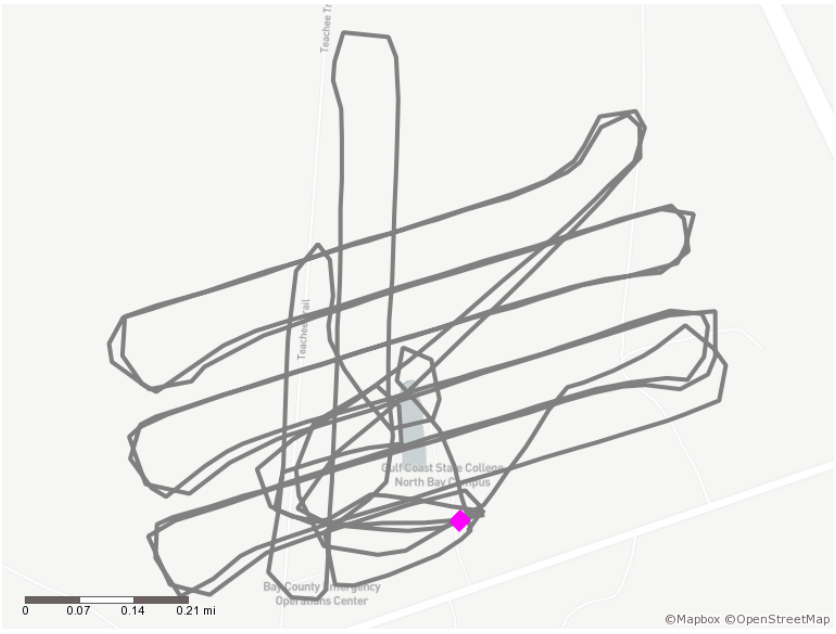

Figure 5.1 Flight routes in Panama City Beach

5.2 DOEFLT-126 Black Mountain

Operation ID: DOEFLT-126
Operational area name: Black Mountain CA
Environment: Urban
Total quantity of flight hours: 7.5 hours
Total quantity of flights: 17 (only 11 flights have complete data)
Multi-ops hours: 3.95 hours (missing around 6 hours of data from one of the aircraft: executed 10 hours)
Average altitude (50th percentile): 81m
Maximum altitude: 123m (1 record is above 122m)
Operational Risk Assessment (ORA): Moderate
Objective: Baseline Local Infrastructure inspection, long linear inspection

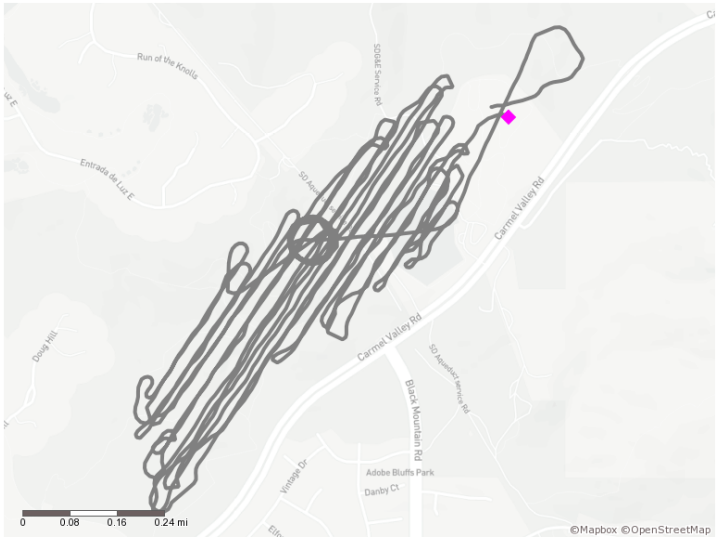

Figure 5.2.1 Single Flight Route with GCS Location Indicated by Pink Diamond

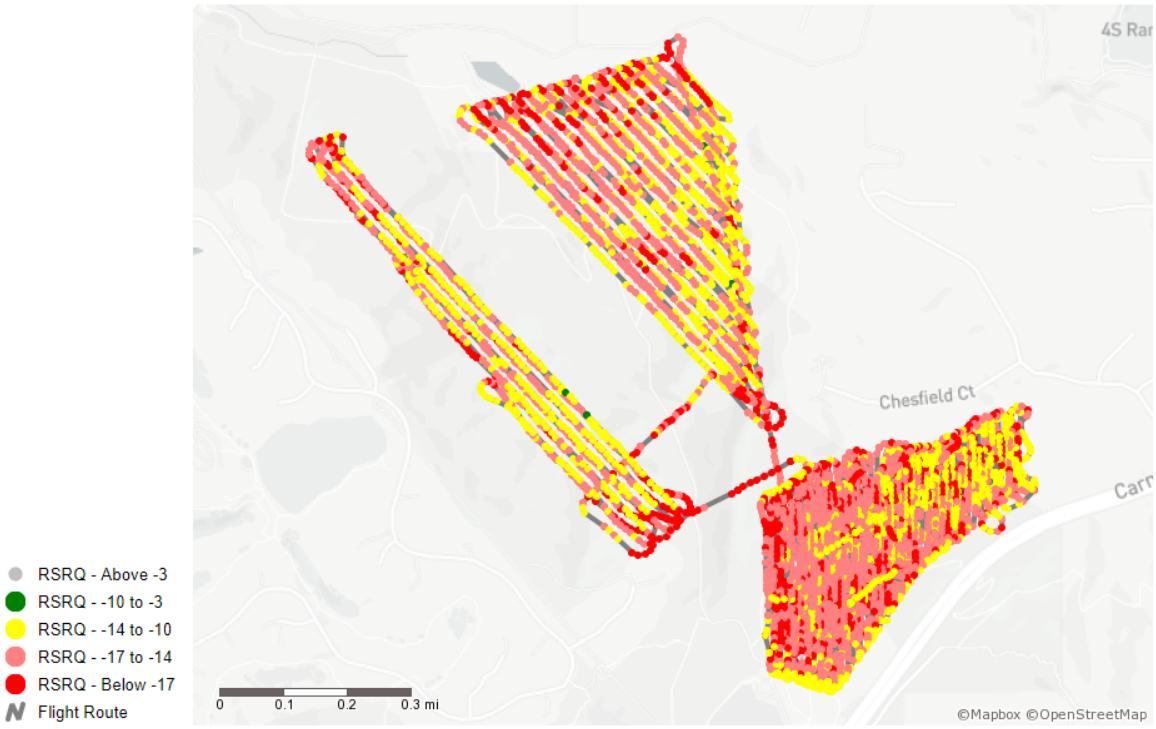

Figure 5.2.2 Multi UAS Operation Flight Route in Black Mountain

5.3 DOEFLT-131 Vancouver OR

Operation ID: DOEFLT-131
Operational area name: Vancouver OR
Environment: Urban
Total quantity of flight hours: 20.59 hours
Total quantity of flights: 30
Average altitude:
Maximum altitude:
Operational Risk Assessment (ORA): Moderate in all three campaigns under this operation (Campaign names: Old Evergreen, Washougal and Columbia Slough)
Objective: Baseline Local Infrastructure inspection, long linear inspection

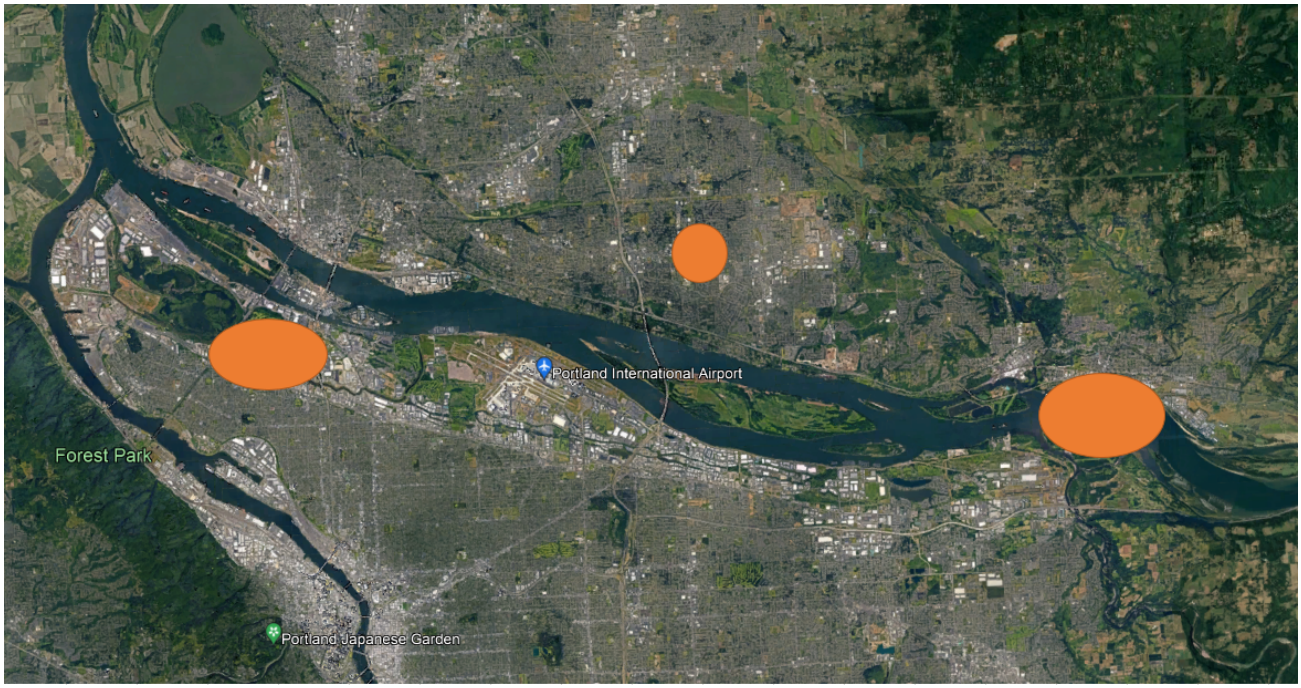

Figure 5.3.1 Various Flight Locations in Vancouver Campaign

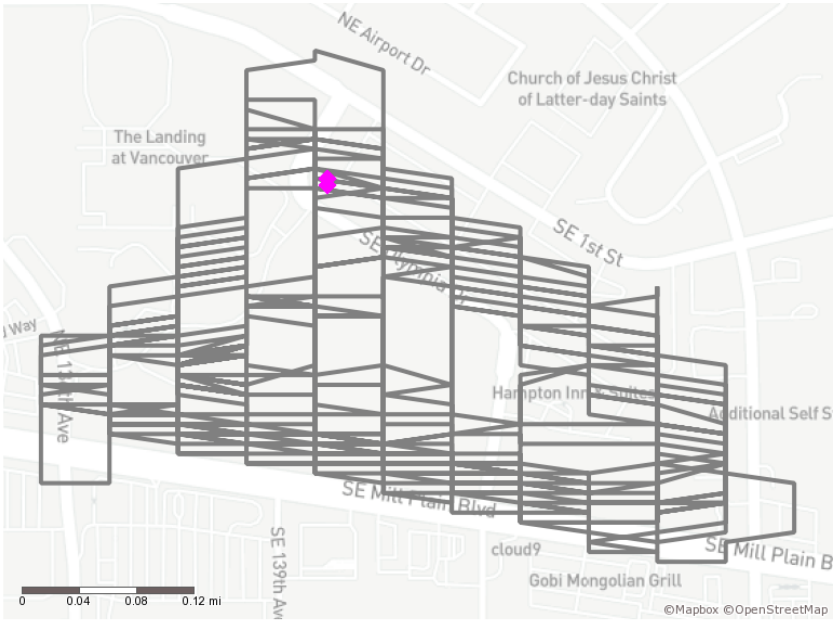

Figure 5.3.2 Old Evergreen Flight Route

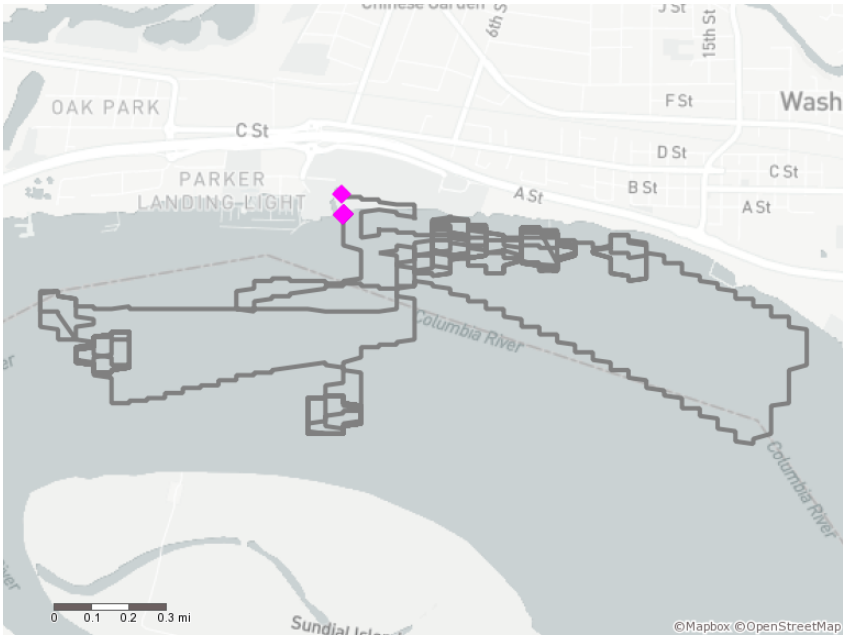

Figure 5.3.3 Washougal Flight Route

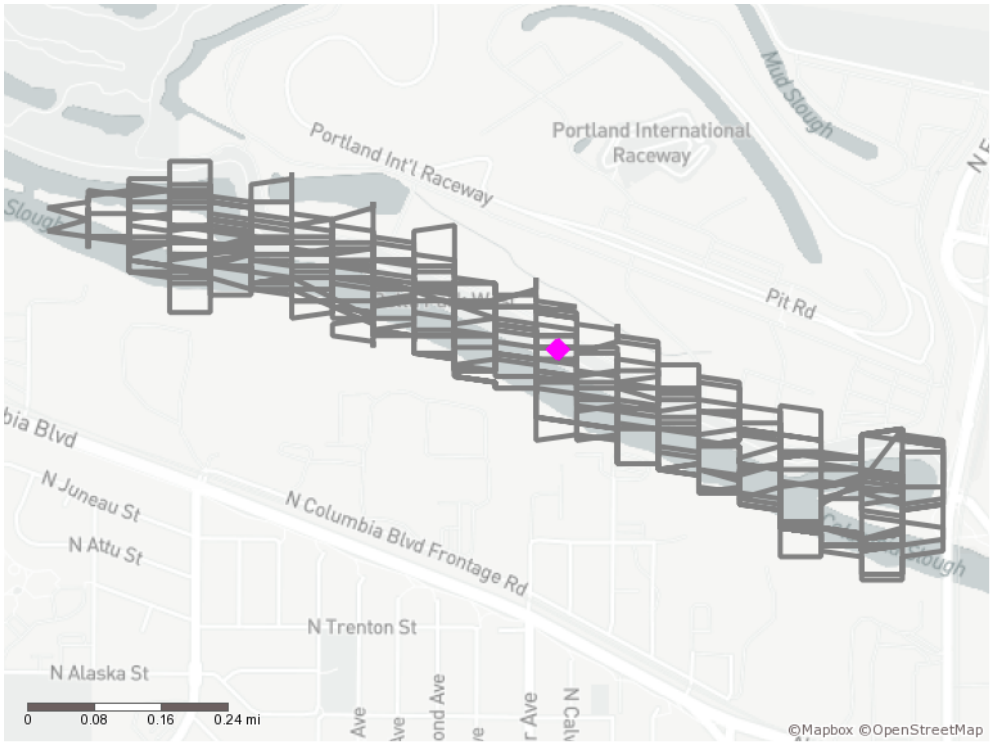

Figure 5.3.4 Columbia Slough Flight Route

6. UAS Configuration and Architecture

6.1 Reporting and Polling Frequency

Average reporting frequency for the aircrafts flown is as follows:

Hitec Xeno Fx: 1 seconds
Delair UX11 Ag: 1 seconds
Censys Sentaero V2: 3.54 seconds

6.2 C2 Network Architecture

Round trip latency is measured (UA>Verizon Network [redacted] >CS>Verizon Network ([redacted])>UA). Regardless of location of flight, all C2 data traffic is going through the Verizon core network site [redacted]

[redacted]

6.3 UAS Performance

Average Cruise Speed:

Hitec Xeno Fx: 12.31 m/s
Delair UX11 Ag: 15.2 m/s
Censys Sentaero V2: 16.57 m/s

7. Operational Environments

Environmental definitions come from the Census Bureau Urban and Rural classification. For more information please visit

https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/2000-urban-rural.html.

Percentage of time flown in the following classifications:
Urbanized Area: 100%
Urban Cluster: 0%
Rural: 0%

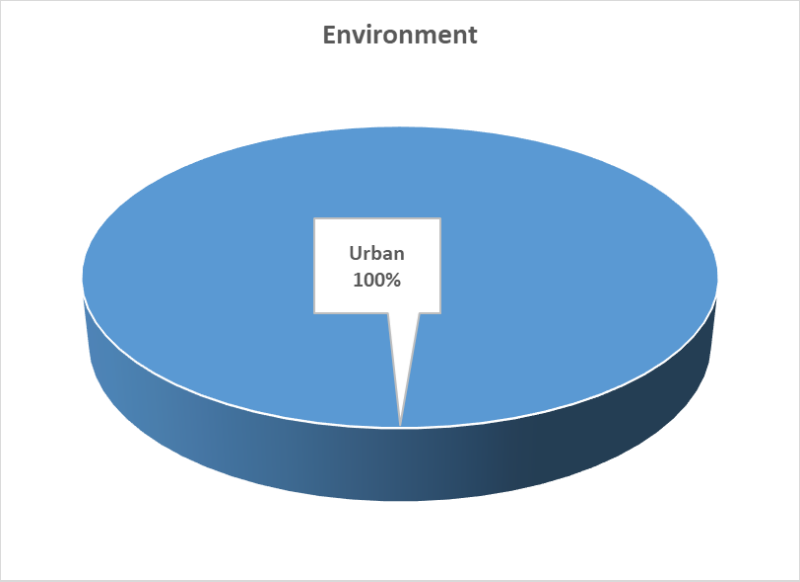

Figure 7.1 Environment Pie Chart

8. Cellular Metrics

8.1 Cellular Carriers and Bands

There were 3 bands utilized during the flight campaigns. Band 2 was utilized most often. The LTE link was used for C2 for the entirety of the flight campaign. Each aircraft used one SIM card provided by Verizon.

Band	Name	Bandwidth (MHz)	Mode	Downlink Frequency (MHz)		
				Low	Middle	High
2	1900 PCS	60	FDD	1930	1960	1990
4	AWS-1	45	FDD	2110	2132.5	2155
13	700 c	10	FDD	746	751	756

Table 8.1.1 Band and Frequency

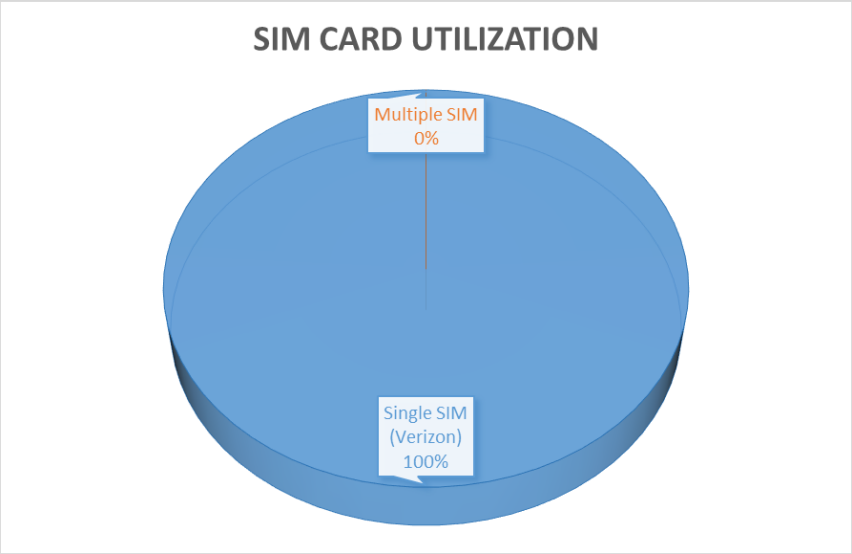

Figure 8.1.1 SIM Card Utilization Chart

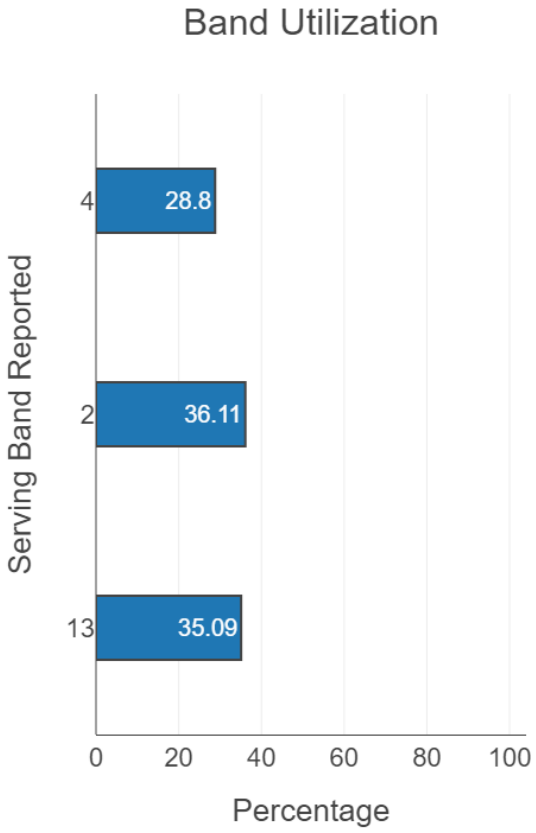

Figure 8.1.2 Band Utilization Chart

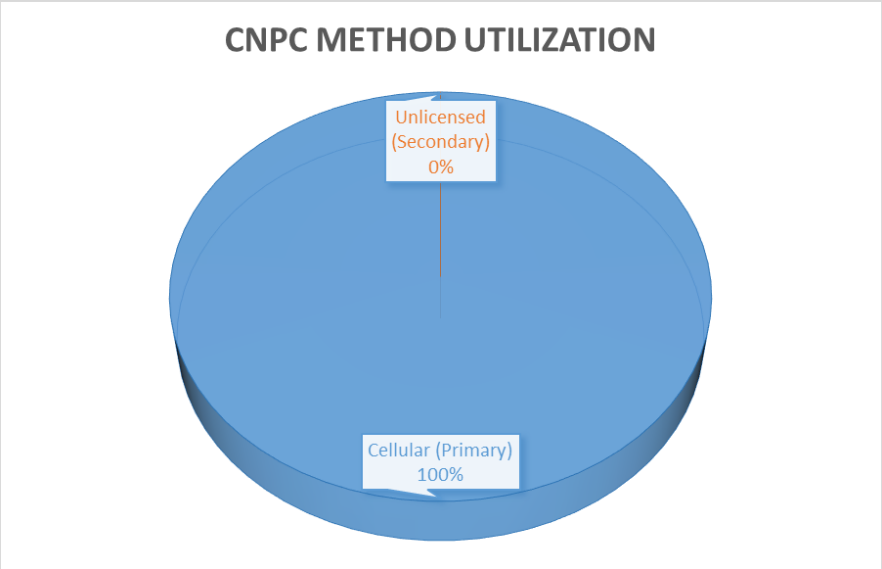

Figure 8.1.3 CNPC Method Utilization

8.2 Altitude

Altitude reporting mechanism: Barometric altitude. Calibrated at the takeoff location.
Average altitude: 79m

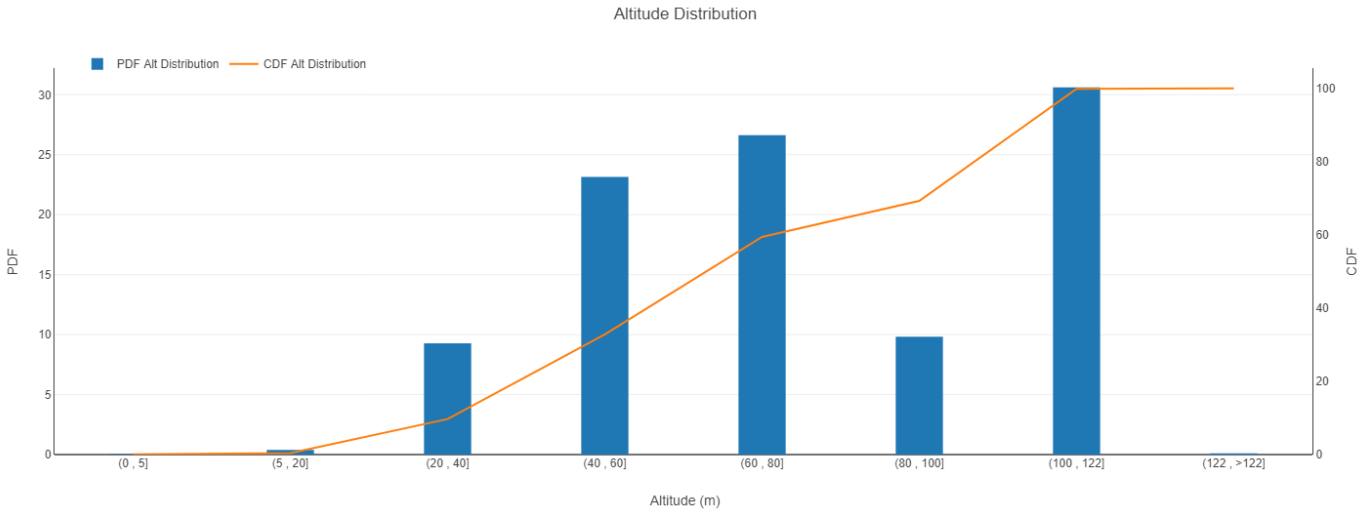

Figure 8.2.1 Operational Altitude Distribution Chart

Metric	Altitude (m)
5th Percentile	39
50th percentile	79
99th Percentile	120
Max	131* (*around 119 records above 122m out of 109380 records i.e. 0.11%)

Table 8.2.2 Operational Altitude Distribution Table

8.3 Distance

The “distance between the CS and UA” is defined as the calculated linear distance. This parameter is commonly of interest when analyzing UAS data due to the use of line of sight radios connecting the CS and UA. In this case the UA is connected to the CS via the cellular network, therefore the “distance between the CS and UA” does not depict the traveled distance of the communication link. See Section 6.2 for a description of the network architecture and the traveled distance of the communication link.

Average distance between UA and CS: 418m
Maximum distance between UA and CS: 2126m
The CS was stationary at all times and the take-off and landing location is in close proximity to the CS.

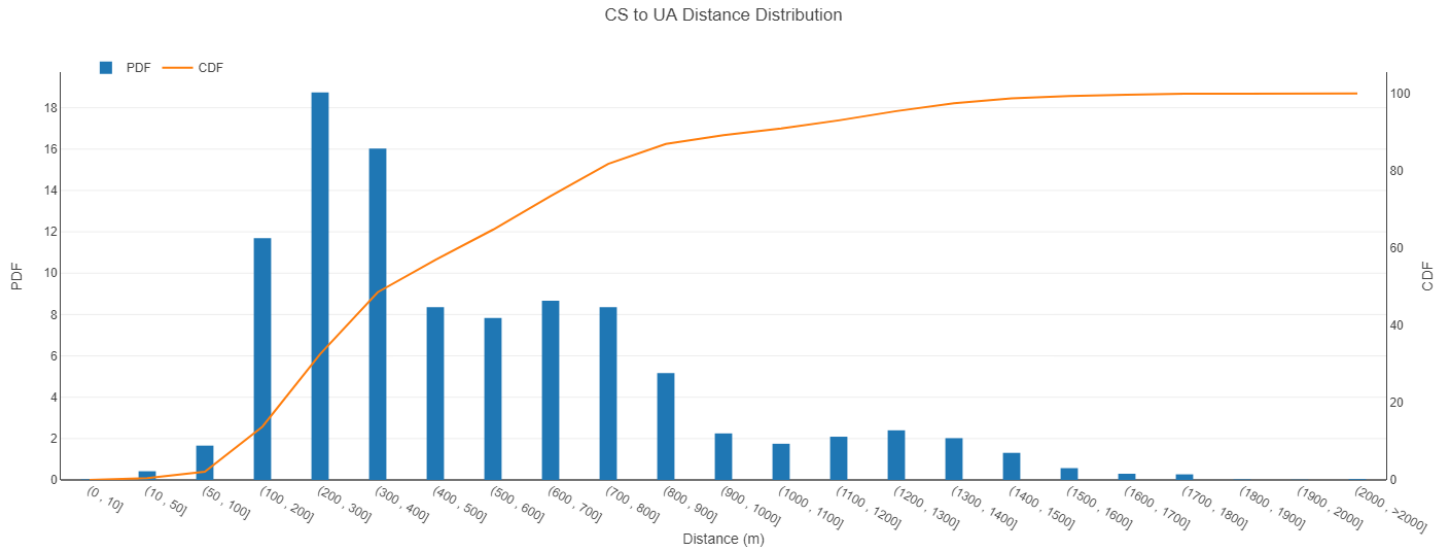

Figure 8.3.1 CS to UA Distance Distribution Graph

Metric	Altitude (m)
5th Percentile	134

50th percentile	418
95th Percentile	1277
Max	2126

Table 8.3.1 CS to UA Distance Table

8.4 Control Mode

Control modes reported as Loiter, Hold, Goto, and Auto are classified as automatic control modes.

Percentage of time in automatic control mode (barometric altitude > 5m): 97.6%

During the remaining 2.4% of flight time the UA was in a combination of semi-manual and other modes. (https://ardupilot.org/plane/docs/quadplane-flight-modes.html)

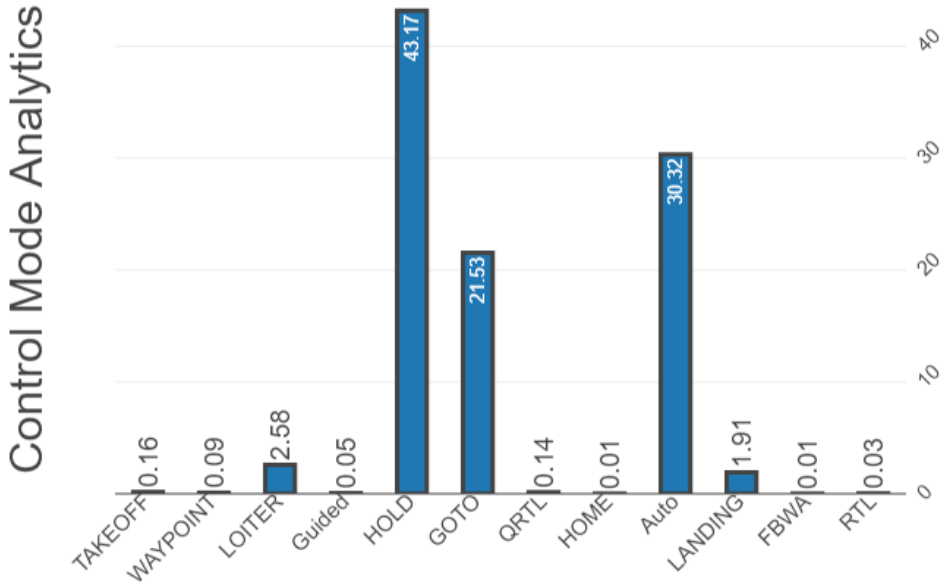

Figure 8.4.1 UA Control Mode Graph

8.5 Latency

Latency 99 percentile: 4,740ms
Latency 95 percentile: 514ms
Maximum latency: 27,926ms (single instance)

Round trip latency is measured (UA>Verizon Network ([redacted]) >CS>Verizon Network [redacted]>UA). Regardless of location of flight, all C2 data traffic is going through the Verizon core network site [redacted]

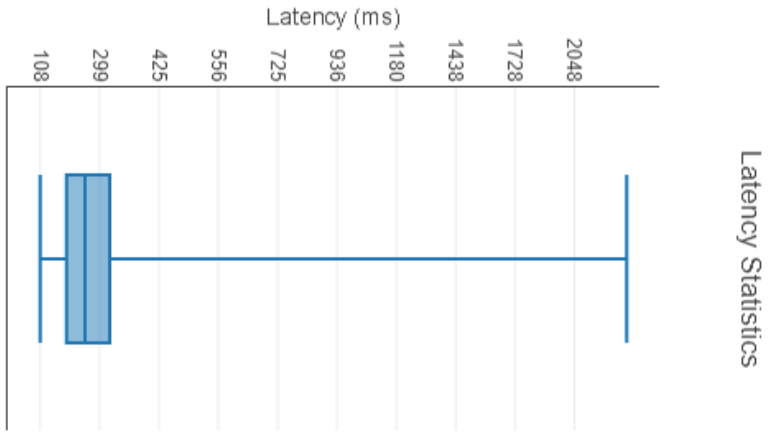

Figure 8.5.1 Latency Graph

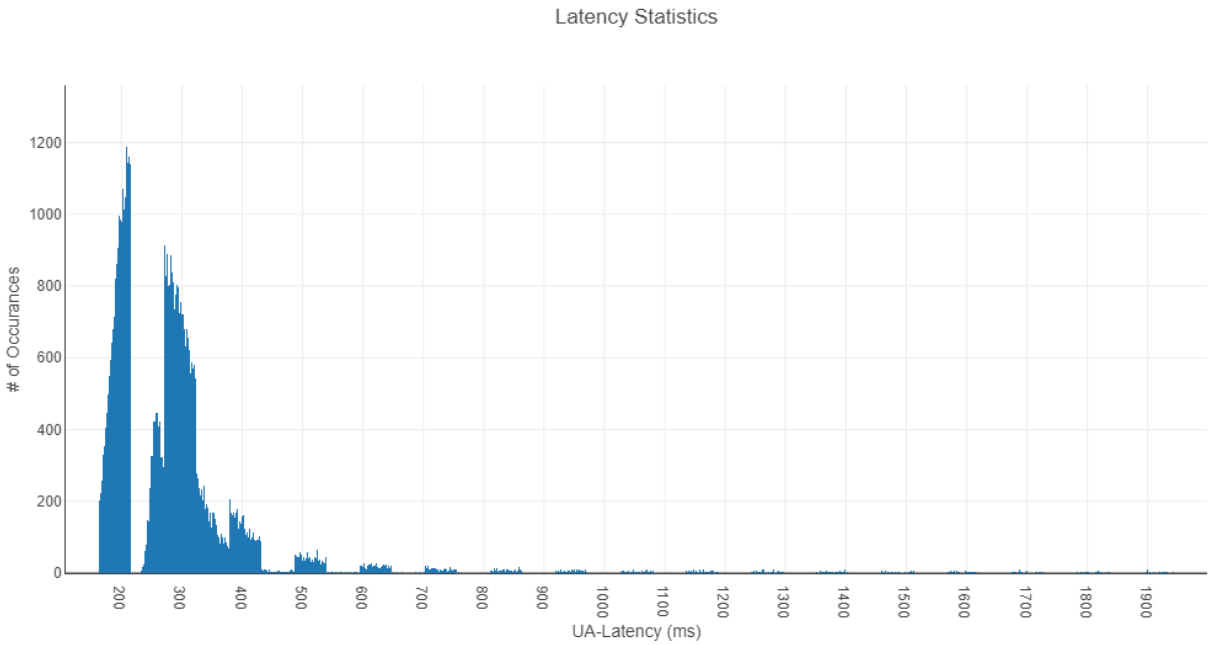

Figure 8.5.2 Latency distribution

Metric	Latency (ms)
5th Percentile	184
50th percentile	268
95th Percentile	514
99th Percentile	4,740
Max	27,926

Table 8.5.1 Latency Table

Aircraft (Autopilot)	Lost link trigger setup timer
Censys Sentaero (Pixhawk)	10s
Hitec Xeno Fx (Cube Black on custom carrier board)	10s
Delair UX11 Ag (Proprietary Autopilot)	10s

Table 8.5.2 Lost Link Declaration Duration

8.6 Signal Parameters

Minimum RSRP: –140dBm
Minimum RSRQ: -20dB

RSRP and RSRQ charts are not separated per band.

RSRP value reporting range is defined from -140 dBm to -44 dBm with 1 dB resolution per 3GPP standards. For more information please see section 9.1.4 RSRP measurement report mapping at this link: https://www.etsi.org/deliver/etsi_ts/136100_136199/136133/08.15.00_60/ts_136133v081500p.pdf

RSRQ value reporting range is defined from -19.5 dB to -3 with 0.5 dB resolution per 3GPP standards. For more information please see section 9.1.7 RSRQ measurement report mapping at this link: https://www.etsi.org/deliver/etsi_ts/136100_136199/136133/08.15.00_60/ts_136133v081500p.pdf

SINR and SNR are not standardized 3GPP parameters and measurement and logging can vary from OEM to OEM. In order to accurately present a comparison of different UAS configurations, SINR and SNR are not analyzed.

In all campaigns in this report, SINR or SNR was recorded but not analyzed.

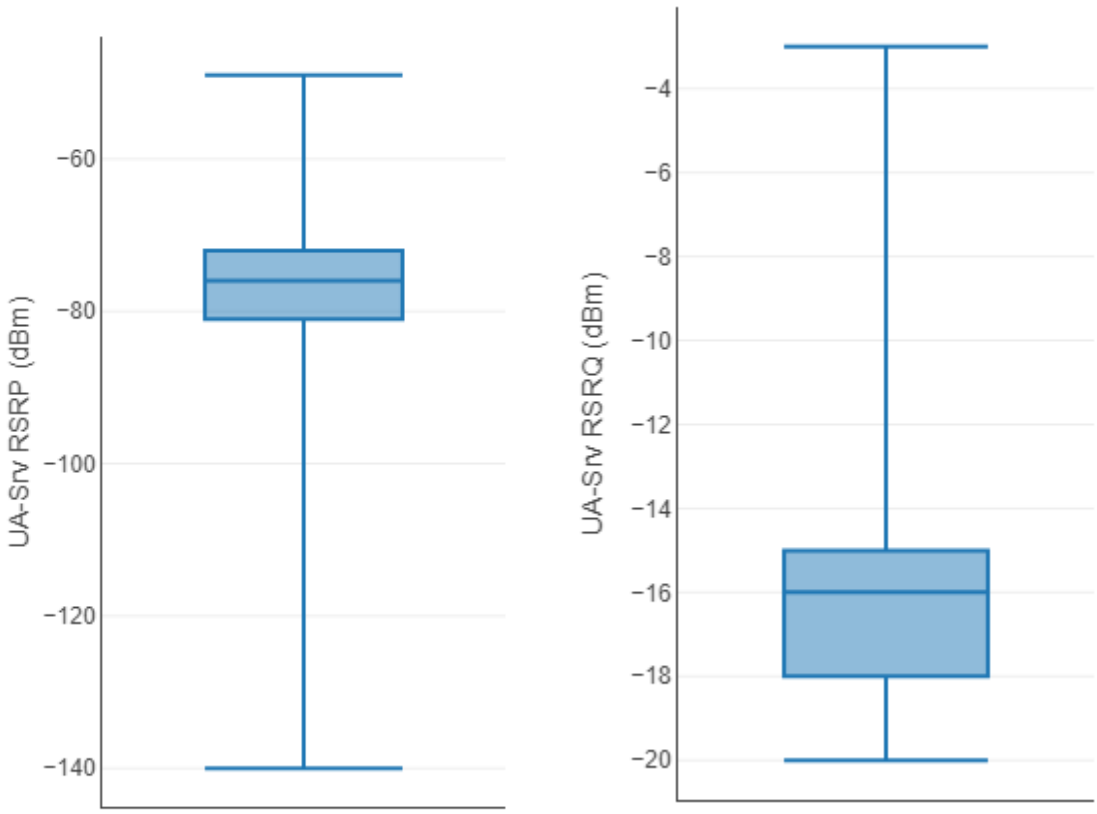

Figure 8.6.1 RSRP & RSRQ Box and Whisker plots

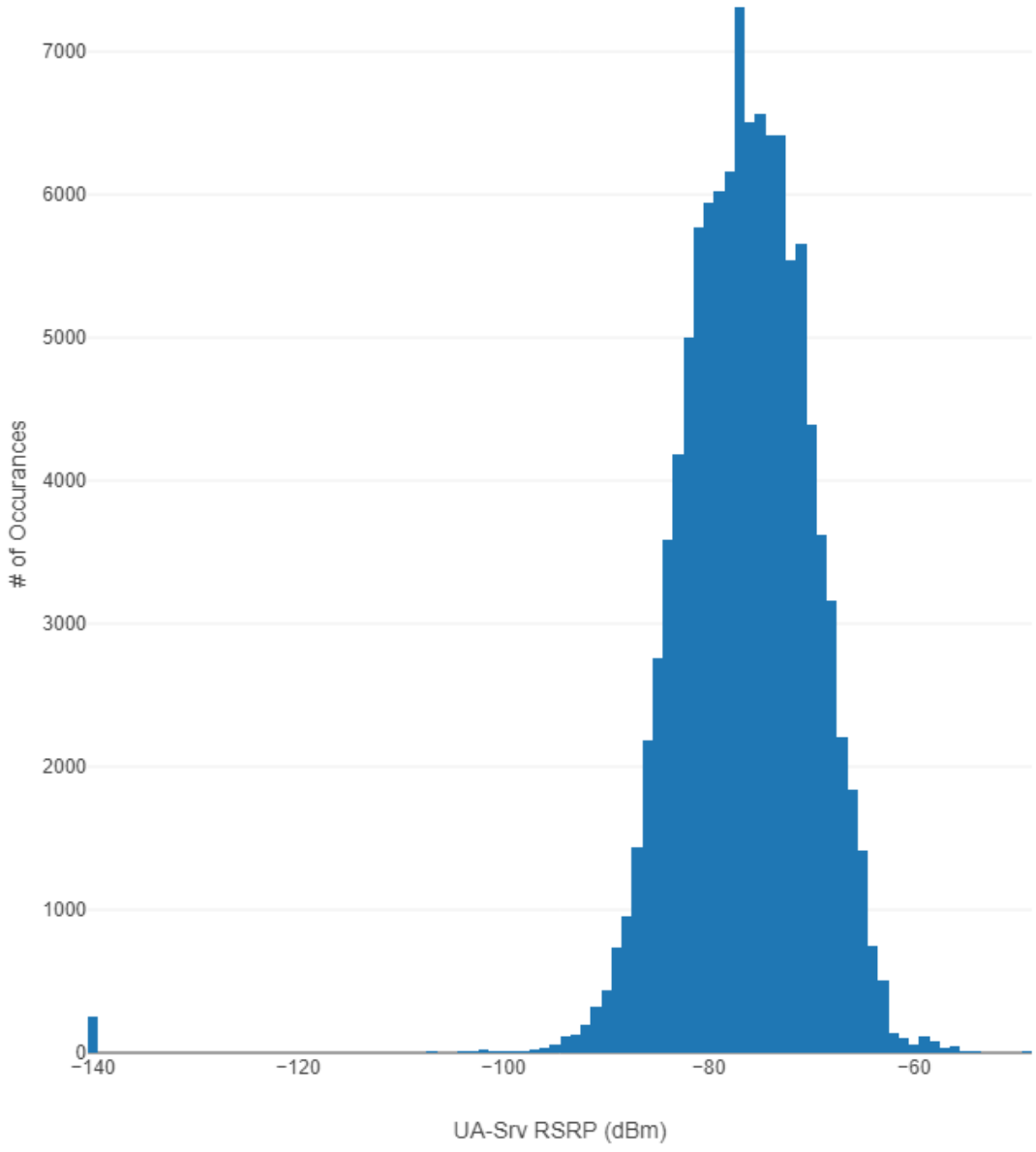

Figure 8.6.2 RSRP Distribution

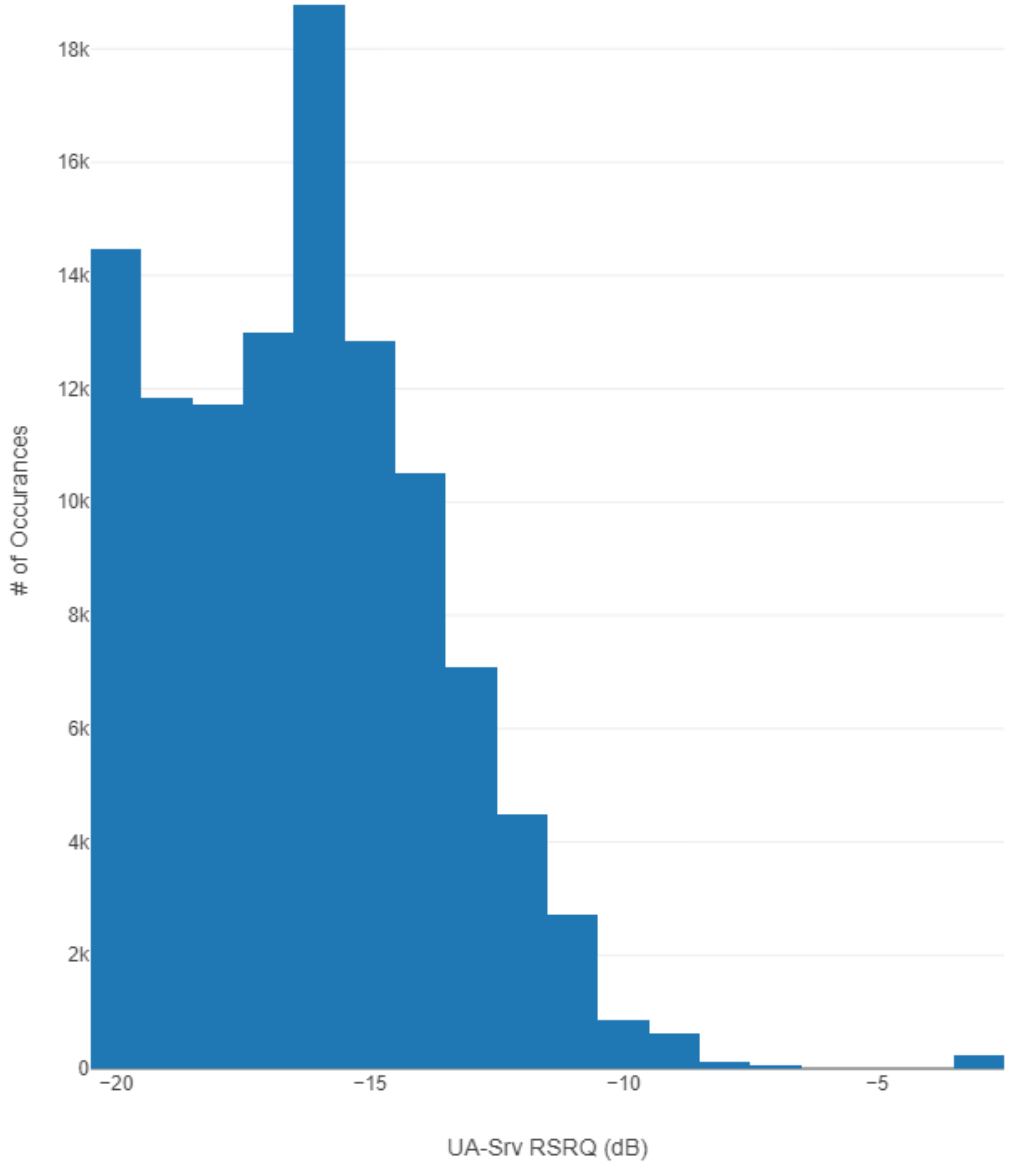

Figure 8.6.3 RSRQ Distribution

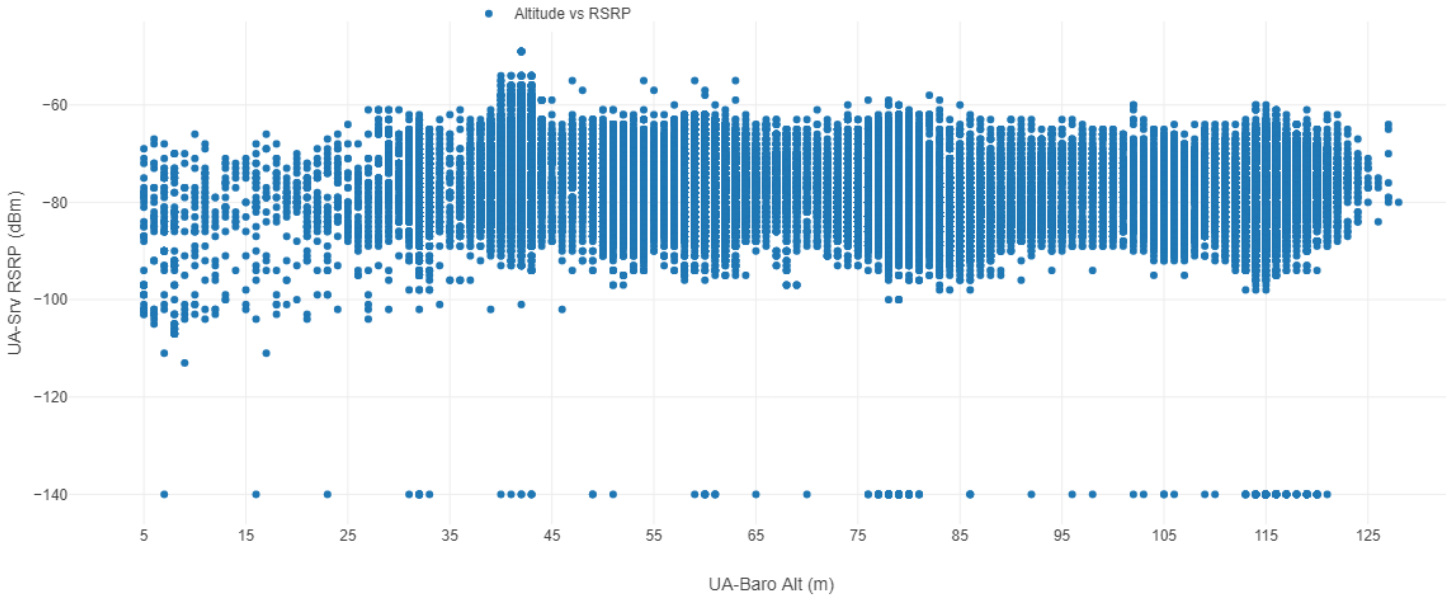

Figure 8.6.4 RSRP vs Altitude

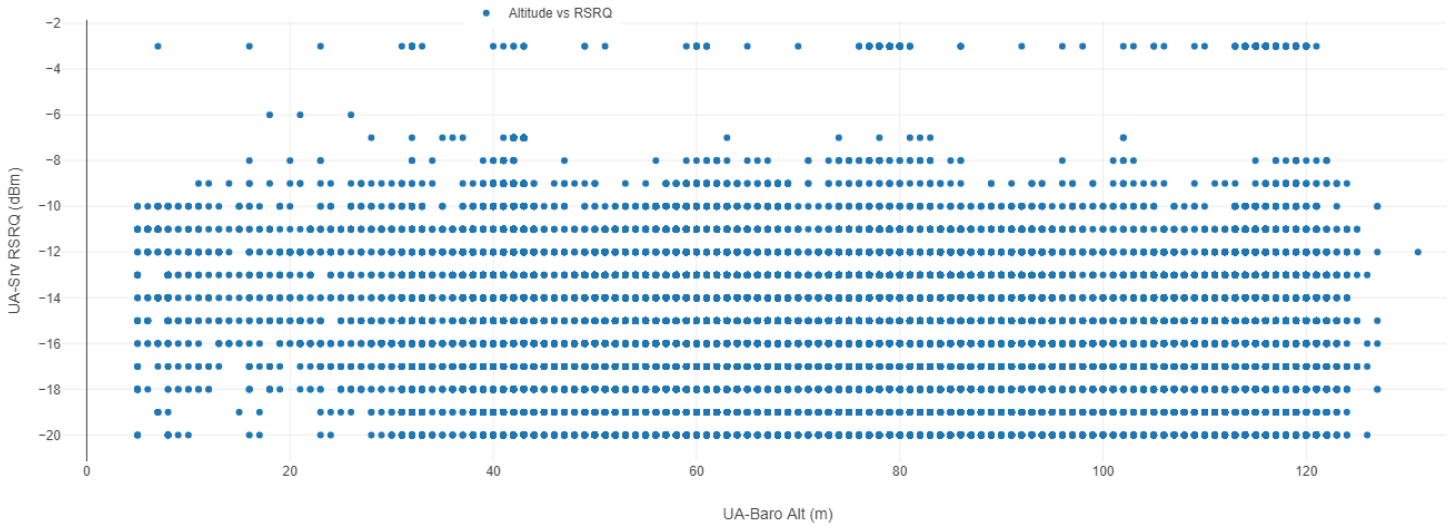

Figure 8.6.5 RSRQ vs Altitude

Metric	Altitude (m)	RSRQ (dB)
MIN	-140	-20
5th percentile	-86	-20
50th percentile	-76	–16
95th percentile	–67	–12

99th percentile	-63	–10

Table 8.6.1 RSRP & RSRQ Table

8.7 Cellular Network Handovers

Quantity of observed handovers: 7,707
Total quantity of flight hours: 37
Average cruise speed: 15 m/s

In cellular network systems a handover is defined as the process of transferring a data session from one cell to another cell. Handover logic may consider signal strength, channel utilization, channel capacity, cell density and other parameters when determining which channel to transfer the session to. The objective of the handover logic is to prevent interruptions to the session that could result in a dropped call or termination of the connection.

A cellular site may have multiple different cells with different bands and frequencies representing different sectors of the cell site. Due to the complex nature of handover trigger settings and cell selection algorithms, as well as the varying cell site design possibilities, a comparison of the quantity of handovers per mile of flight between different locations or UAS would not be a valid comparison. While handover failures may occur due to signal interference, cell availability and other causes, the UE is unable to record instances of unsuccessful handover attempts due to limitations of device logging capabilities.

8.8 Interference

There were about 10 hours of multi-UAS operations in the Black Mountain area under campaign DOEFLT-131, along with single UA operations in various locations. Local Verizon Network Performance team members were notified of flight operations prior to and during the flight campaigns referenced in this report. The Network team members were instructed to provide reporting on any observed abnormalities, such as interference KPI's, in the area of flight operations.

Additionally, 15min interval network data was analyzed for the serving and neighboring nodes/cells reported by UA. There was not any abnormal interference KPI's observed.

There were no reports of such abnormalities presented during the flight campaigns referenced in this report.

The frequency bands used during these campaigns do not include bands with aeronautical restrictions. There were no RPIC reports of interruptions to the C2 link caused by interference.

9. Anomalies and Accidents

9.1 Modem Firmware Test

In the October 2021 MOA Bimonthly Report Section 9.2 a root cause analysis was performed to determine the cause of the UA modem connections to Band 5 in the Panama City Beach location. As a result of the investigation, a new firmware version was obtained from the modem OEM (Microhard) and applied to the modem in the UA.

To test the new firmware version, the same aerial device that previously connected to Band 5 was tested on the ground in the same location with the latest Microhard firmware (build 1028 version 1.4.0) on 11/5/2021. Three boot up cycles and three soft boot ups were performed at the location tested previously, and six boot up cycles were performed at a secondary location 1,000 ft away. The UA modem with the updated firmware never connected to Band 5 (reported as Band 26).

Since the successful ground test with the new modem firmware, a total of 9 flight hours have been completed in the Panama City Beach location and there have been no occurrences of connection to Band 26/Band 5. All Microhard pMLTE ALO modems in the MOA flight test program have been updated to the latest firmware version and no further reports of connection to Band 26/Band 5 have been reported. All flight operators using the Microhard pMLTE have been requested to monitor UA modem data for connection to Bands other than 2, 4 and 13.

9.2 RTL Analysis

There were 16 instances of invocation of “Return to Land (RTL)” behavior in 9 of the flights in this reporting period. After an RTL event, if the communication link is regained and the pilot has determined it is safe to proceed with the mission, the pilot is requested to continue the mission without landing. This is represented in the analysis by multiple cases of RTL in a single flight.

Additionally, flight routes were executed that intentionally exercised the areas where RTL was observed in order to gather more information and understand behavior.

Mishaps and accidents were not reported in this reporting period.

9.2.1 DOEFLT-125 Panama City Beach RTL Root Cause Analysis

There were a total of 4 RTL events that occurred in Panama City Beach. On 11/17/2021, after the first RTL was invoked by the UAS, communication was established while the UA was returning to land and the pilot commanded the UA to continue the mission. The UA invoked RTL immediately after the command to continue the mission.

It was observed that around the time immediately preceding RTL invocation, there was change in Yaw, Roll and PCI in all three scenarios. Immediate changes in PCIs suggest ping-pong type behavior. RSRP changes during these PCI changes are moderate. In all three flights, the “Loss of C2” events occur around the same geographical area, indicating potential issues with RF dominance in that area. The area also has poor RSRQ, as shown in Figure 9.2.1.3. The RTL events are also followed by a higher rate of occurrence of changes in UA roll value as shown in Figure 9.2.1.2.

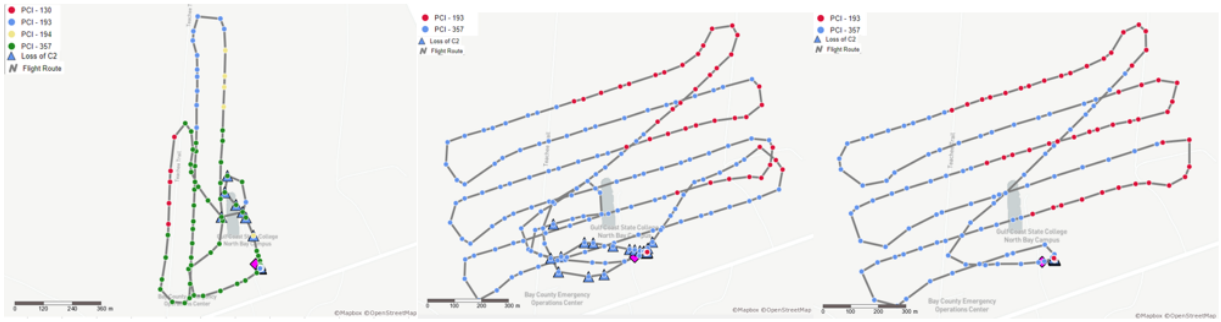

Figure 9.2.1.1 Panama City Beach RTL events. Left to right: 11172021 Flight 1, 11182021 Flight 1 and 11182021 Flight 2

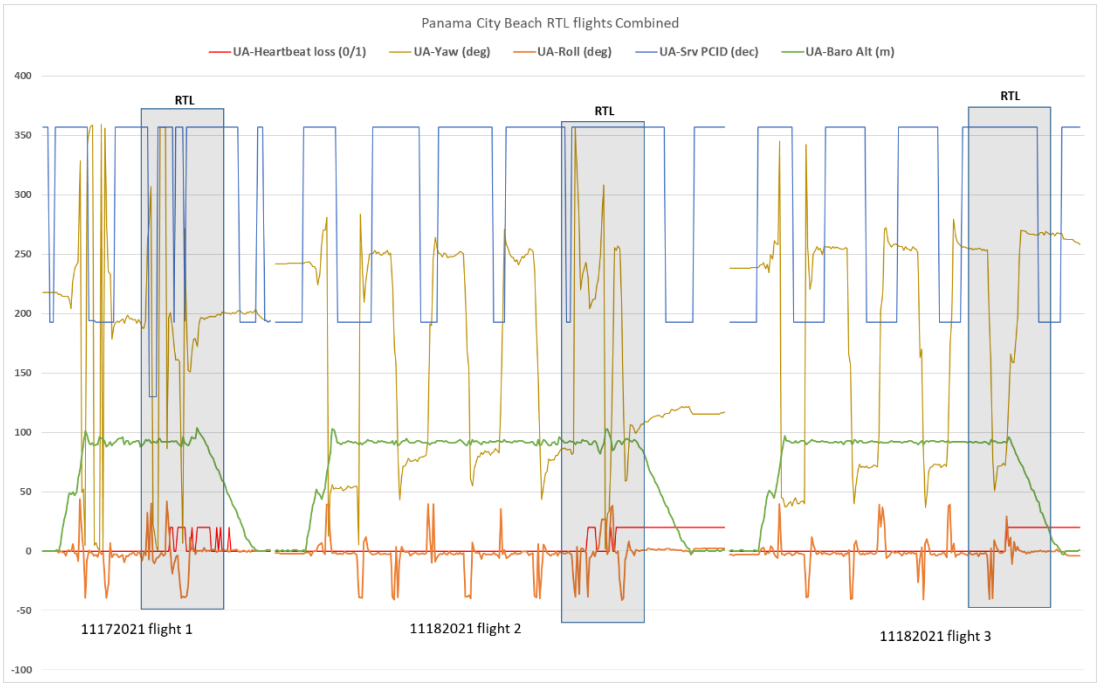

Figure 9.2.1.2 Panama City Beach Aircraft Yaw, Roll vs PCI along with Altitude and Heartbeat loss events

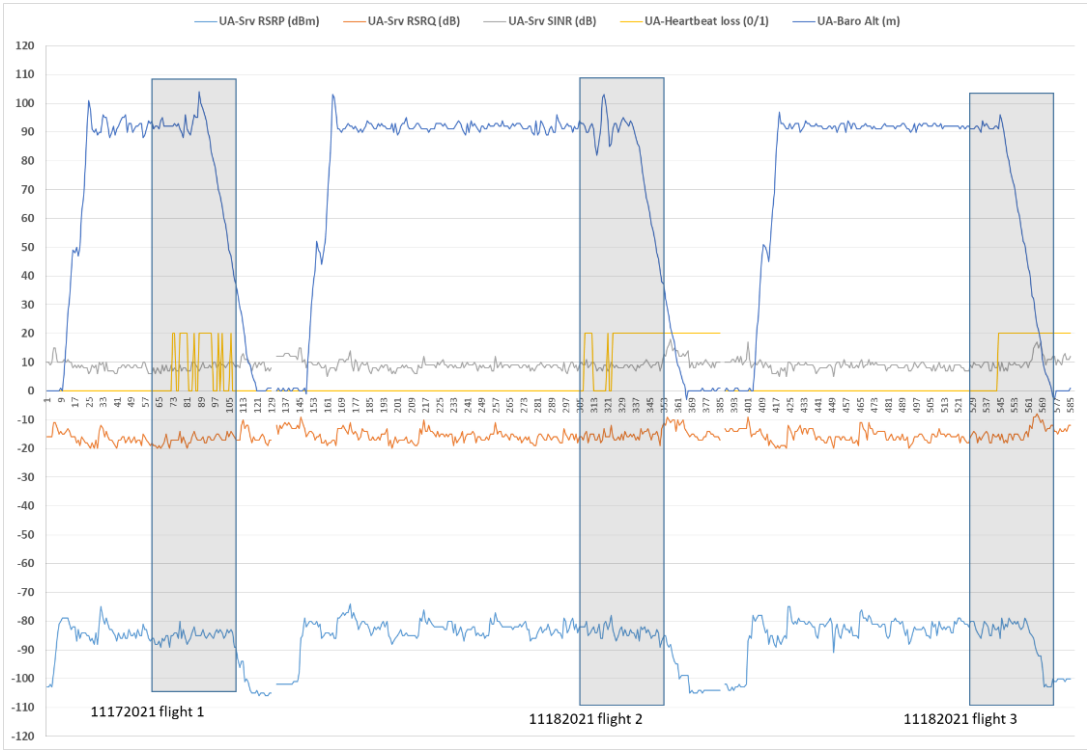

Figure 9.2.1.3 Panama City Beach RF conditions

9.2.2 DOEFLT-126 Black Mountain RTL Root Cause Analysis

A total of 1 RTL event was reported during the Black Mountain campaign on 11/10/2021. The RPIC monitored the link after the UA initiated the RTL procedure. After the LTE C2 link was re-established, the RPIC commanded the UA to loiter. No additional reports of RTL are noted after the re-establishment of the C2 link. Only 1 out of 11 flights had an RTL event in the Black Mountain campaign.

It was noted that the RTL event was followed by what appears to be an abrupt change in yaw and roll of the aircraft. This abrupt change could have caused simultaneous degradation of the serving cell signal and improvement of the neighbor signal strength. Such a change in signal strength (depicted in Figure 9.2.2.1) typically triggers a handover sequence per the design of the cellular network. Based on the available data, it is suspected that the UA lost the data connection to the LTE network due to an unsuccessful handover. It is notable that while the UA was executing the loiter command (shown after the RTL event in Figure 9.2.2.2), the changes in yaw and roll were gradual and PCI changes were infrequent. There were no additional reports of RTL during the loiter period after the initial RTL event.

Figure 9.2.2.1 Black Mountain Flight Route and RSRQ plot with RTL location (left) and snippet of RF conditions prior, during and after RTL (right)

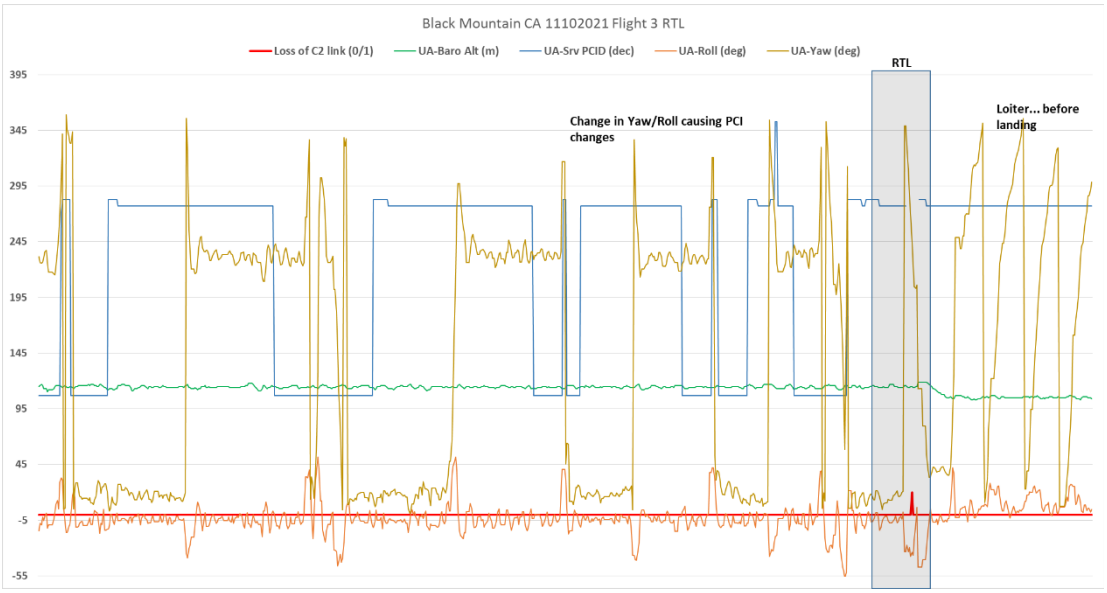

Figure 9.2.2.2 Aircraft Yaw, Roll vs PCI along with Altitude and Heartbeat loss events

9.2.3 DOEFLT-131 Vancouver (Old Evergreen) RTL Root Cause Analysis

There was 1 occurrence of RTL reported in the Old Evergreen operational area during Flight 3 on 10/15/2021. The RPIC monitored the link after the UA initiated the RTL sequence. After the LTE C2 link was re-established (approximately 18 seconds later), the RPIC commanded the UA to continue the mission. No additional reports of RTL were noted after the re-establishment of the C2 link and only 1 out of 11 flights had an RTL event in this operational area.

It is observed that even when RSRP is good on the serving PCI, the change in UA roll and yaw values is concurrent with the change in PCI. It is also noted that the change in PCI does not always result in better RSRP/RSRQ (Figure 9.2.3.2 and Figure 9.2.3.3). For instance, one of the cells is only reported when the UA has a certain yaw/roll which

occurs for a very short period (Figure 9.2.3.2). During this particular instance, RSRQ dropped from around -15dB to around -20dB, RSRP decreased from -74dBm to -84dBm, and PCI changed. When the UA changed its roll and yaw to achieve the desired heading, it is likely that the line of sight of the UA modem antenna to the serving cell abruptly changed causing the simultaneous degradation of the serving cell signal and improvement of the neighbor signal strength as shown in (Figure 9.2.3.4). Per the design of the LTE network, a cell with better signal strength is preferred and the change in connection is achieved through a handover. It is likely that the link failed during this handover process, however, in the absence of more granular data and lower level message logging it is not possible to verify the root cause. This area was flown multiple times and there were no additional reports of RTL

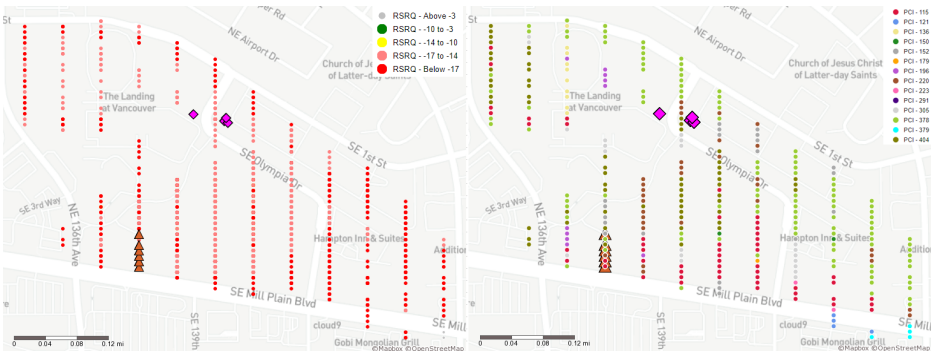

Figure 9.2.3.1 Old Evergreen Flight 3 RSRQ (left) and PCI (right) plot with RTL events

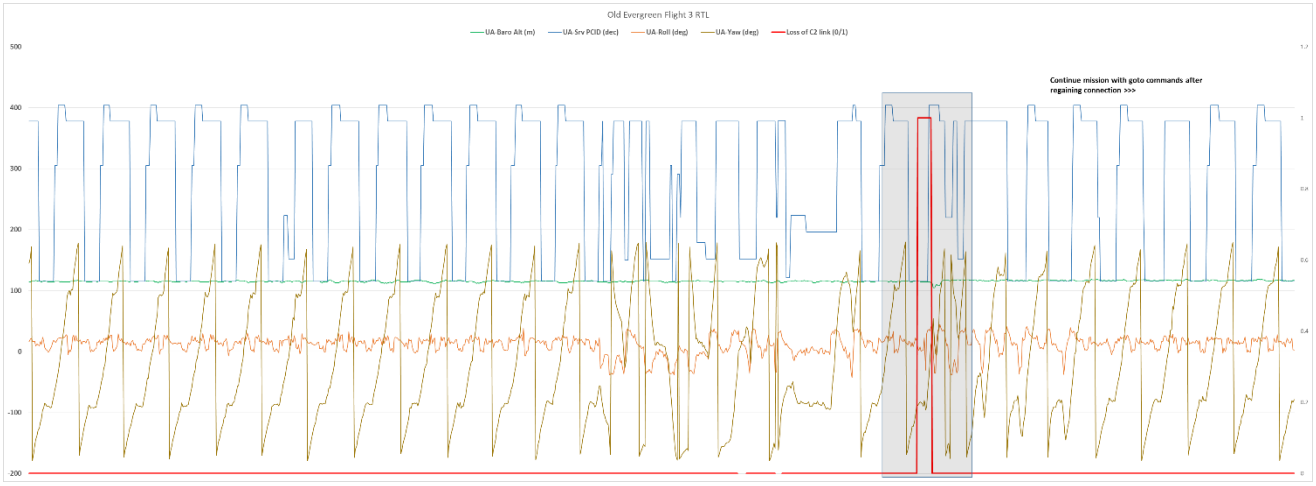

Figure 9.2.3.2 Old Evergreen Flight 3 PCI, RTL event, with aircraft Roll and Yaw

Figure 9.2.3.3 Old Evergreen Flight 3 UA PCI, RSRP along with aircraft Roll and Yaw

9.2.4 DOEFLT-131 Vancouver (Washougal) RTL Root Cause Analysis

Four out of 5 flights conducted in the Washougal operational area reported occurrences of RTL. Detailed analysis of the RTL events that occurred during Flight 1 on 10/08/2021 is presented in Section 9.2.4.1. Log files from the other flights in this location were analyzed and it was observed that the findings from Flight 1 on 10/08/2021 flight are representative of the conditions during the other RTL events.

On 10/08/2021 three flights were conducted. Three RTL events were reported during Flights 1 and 2, and 2 RTL events were reported during Flight 3. Flight 3 is excluded from this analysis because the full dataset for this flight is unavailable.

On 11/05/2021, 3 additional flights were conducted in the same area using a different aircraft. Two RTL events were reported each during Flights 1 and 2. The RPIC reported 4 RTL events for Flight, however this flight is excluded from the analysis because full dataset for this flight is unavailable.

Figures 9.2.4.1, 9.2.4.2 and 9.2.4.3 show the flight path and associated RF data (refer to legend). Figure 9.2.4.1 shows that there were reports of a high quantity of different serving PCIs in the area. Occurrences of loss of C2 link occur in the same general geographic area, except in one case where the occurrences of loss C2 link appear throughout the flight route (Figure 9.2.4.3).

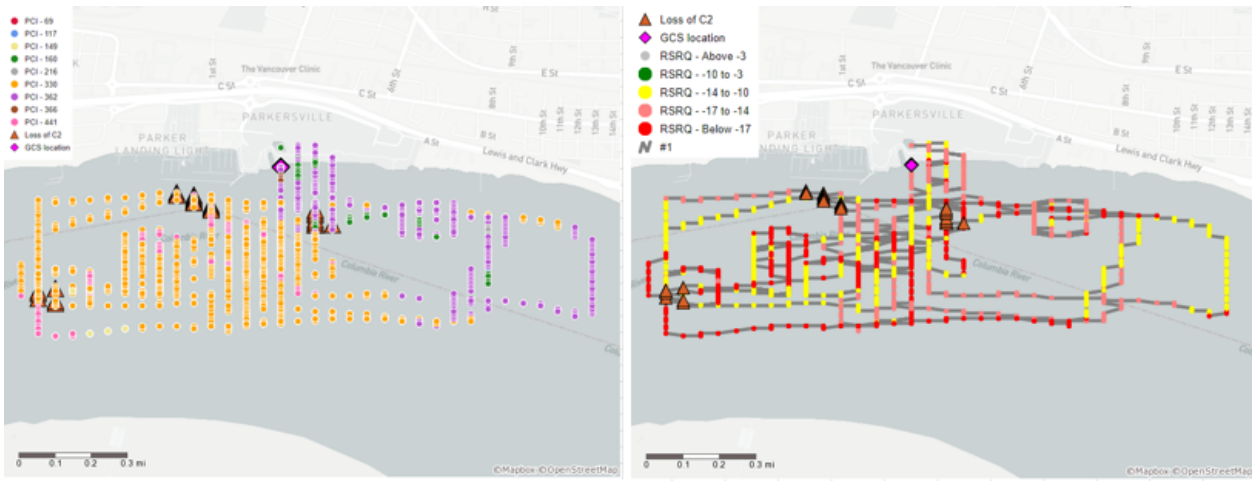

Figure 9.2.4.1 Washougal 10/08/2021 Flight 1 RTL events with PCI (left) and RSRQ (right) information

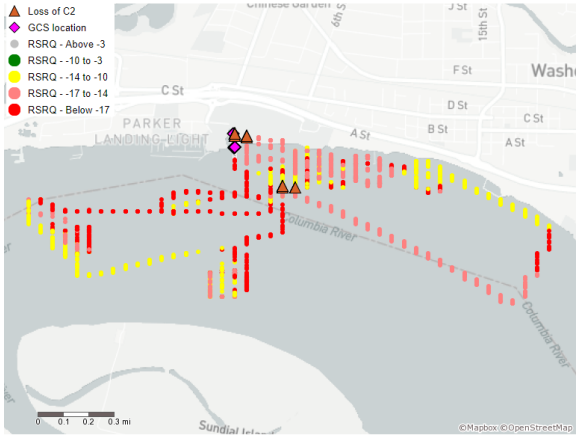

Figure 9.2.4.2 Washougal 10/08/2021 Flight 2 RTL events with RSRQ information

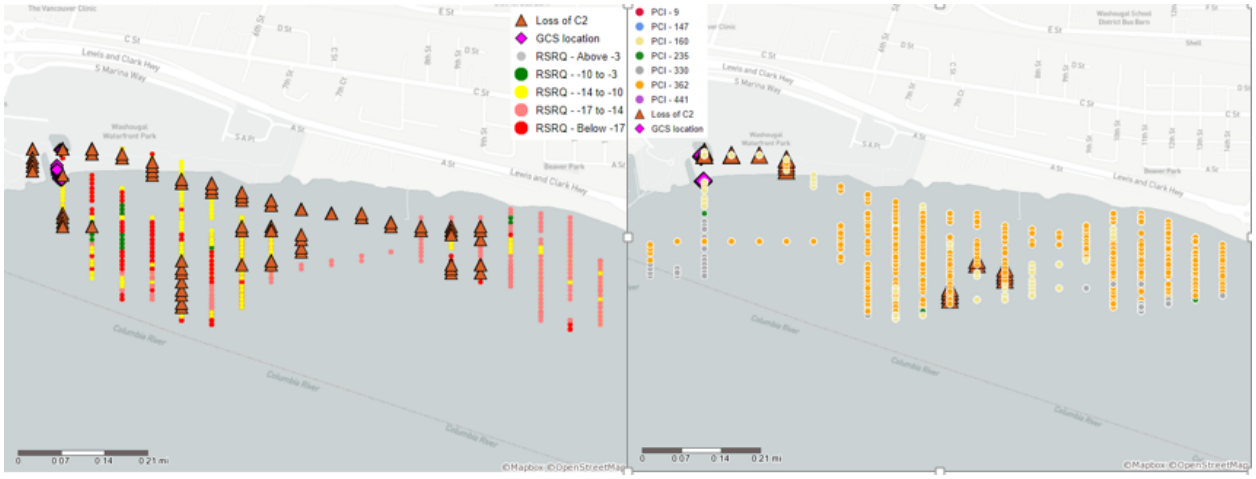

Figure 9.2.4.3 Washougal 11/05/2021 Flight 1 with RTL and RSRQ info (left), Flight 2 with RTL and PCI info (right)

[redacted]

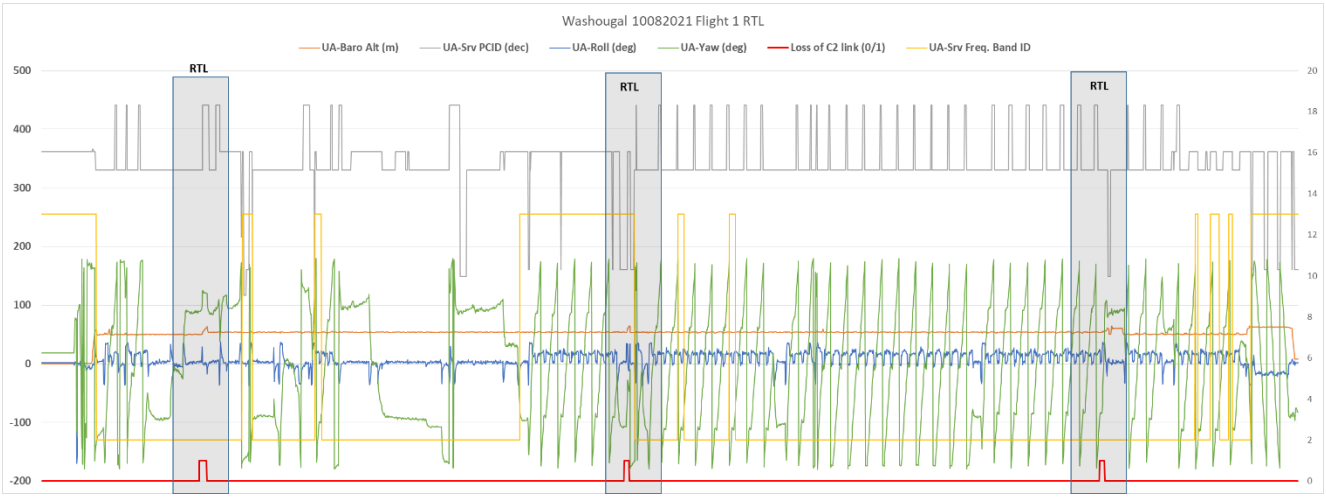

Figure 9.2.4.1.4 Washougal 1008 Flight 1 aircraft roll and yaw along with UA altitude, PCI and serving band

9.2.5 RTL Root Cause Analysis Conclusions

Occurrences of RTL were analyzed in four operational areas with varying RF conditions. Based on the analysis of data from the Panama City Beach and Washougal campaigns, it appears that the major contributing factor to the reported occurrence of RTL is poor RF conditions. In these two campaigns, RTL events were successfully replicated over multiple flights. However, in the Black Mountain and Old Evergreen campaigns the occurrences of RTL events were not replicated. During the Black Mountain campaign, only 1 out of 11 flights had an RTL event. In the Old evergreen campaign, 1 out of 11 flights had occurrences of RTL.

Analysis shows that in some cases there is a correlation between changes in UA roll, pitch and yaw, PCI changes and the loss of C2 link. It is suspected that a change in roll, pitch and yaw of the UA could result in simultaneous degradation of the serving cell signal and improvement of the neighbor signal strength, triggering a PCI change via a handover attempt. Frequent changes in PCI, both inter- and intra- band, could have a detrimental impact on the LTE C2 link performance. It is suspected that UA design decisions such as the location and orientation of the cellular modem antennas could impact the frequency or severity of occurrences of loss of C2 link due to change in aircraft orientation relative to the serving and neighbor cells. It is noted that the three UAs flown during the period of this report have dissimilar antenna configurations, including different combinations of antenna make/model, RF characteristics, quantity of onboard antennas installed (such as main and diversity antennas) and antenna orientation relative to the body of the aircraft.

10. References

10.1 Operational Risk Assessments

The following ORA was used to document preparation for both the Volusia Daytona Beach, FL and Panama City, FL flight operations.

Verizon - Skyward - Corporate

Volusia_Daytona_Beach_FL

Risk Assessment

Last Updated On Aug 06, 2021 16:43 PM UTC by Bri O'Neill

20 LOW	1 MODERATE	21 RISKS IDENTIFIED	MODERATE FINAL RISK 21 of 21 Completed
		13 RISKS MITIGATED	

Notes

Crew

1.1	Is the pilot certified and qualified for this mission?	Yes	LOW
	Mitigation: they have flown these systems or similar systems in these locations before		LOW
1.2	Has the pilot recently flown a similar mission?	Yes	LOW
1.3	Is the pilot qualified to fly this aircraft?	Yes	LOW
1.4	Is any crew member affected by fatigue or other factors that could impact performance?	No	LOW
1.5	Have all crew members been briefed on the operation?	Yes	LOW

Aircraft

2.1	Has the aircraft been inspected and determined to be airworthy?	Yes	LOW
2.2	Have Return-to-Home and Maximum Altitude values been checked?	Yes	LOW

	Mitigation: part of pre-flight checklist		LOW
2.3	Is the GPS signal within minimum required parameters?	Yes	LOW
	Mitigation: part of pre-flight checklist		LOW

Weather

3.1	Are cloud cover and ceiling within acceptable limits?	Yes	LOW
	Mitigation: part of pre-flight checklist		LOW
3.2	Is temperature within acceptable limits?	Yes	LOW
	Mitigation: part of pre-flight checklist		LOW
3.3	Is visibility within acceptable limits?	Yes	LOW
	Mitigation: part of pre-flight checklist. no night waiver in Volusia. checking on Panama City.		LOW
3.4	Are wind conditions within acceptable limits?	Yes	LOW
	Mitigation: part of pre-flight checklist		LOW
3.5	Is precipitation forecast during the scheduled operation?	No	LOW
	Mitigation: part of pre-flight checklist, will not fly if rain is forecast		LOW
3.6	Will the operation finish after civil twilight?	No	LOW

	Mitigation: unless we get night waiver		LOW

Location

4.1	Is the operation authorized in the airspace?	**Yes**	LOW
4.2	Are there populated areas near the operation such as parks, schools, or stadiums?	**No**	LOW
	Mitigation: well clear of populated areas, no flights over people		LOW
4.3	Are there heliports or congested air traffic near the operation?	**No**	LOW
	Mitigation: banner planes on beach but will be limited during weekdays during flights. No air traffic in Panama City.		LOW
4.4	Is there uneven terrain or significant elevation change in the area of operation?	**No**	LOW
	Mitigation: pretty much flat (Florida)		LOW
4.5	Are there hazards or obstructions in the area of operation?	**Yes**	MODERATE
	Mitigation: trees under 100 ft in Panama City waypoint file setup will disallow descending near trees		MODERATE
4.6	Are people other than the crew present in the area of operation?	**No**	LOW
4.7	Have takeoff and landing area(s) been surveyed?	**Yes**	LOW

Black Mountain

Hitec Commercial Drone Services

Black Mtn Day 2

Risk Assessment

Last Updated On Nov 10, 2021 18:00 PM UTC by Jim Bonnardel

18 LOW	3 MODERATE	21 RISKS IDENTIFIED 0 RISKS MITIGATED	MODERATE FINAL RISK 21 of 21 Completed

Notes

Crew

1.1	Is the pilot certified and qualified for this mission?	Yes	LOW
1.2	Has the pilot recently flown a similar mission?	No	MODERATE
1.3	Is the pilot qualified to fly this aircraft?	Yes	LOW
1.4	Is any crew member affected by fatigue or other factors that could impact performance?	No	LOW
1.5	Have all crew members been briefed on the operation?	Yes	LOW

Aircraft

2.1	Has the aircraft been inspected and determined to be airworthy?	Yes	LOW
2.2	Have Return-to-Home and Maximum Altitude values been checked?	Yes	LOW
2.3	Is the GPS signal within minimum required parameters?	Yes	LOW

Weather

3.1	Are cloud cover and ceiling within acceptable limits?	Yes	LOW
3.2	Is temperature within acceptable limits?	Yes	LOW
3.3	Is visibility within acceptable limits?	Yes	LOW
3.4	Are wind conditions within acceptable limits?	Yes	LOW
3.5	Is precipitation forecast during the scheduled operation?	No	LOW
3.6	Will the operation finish after civil twilight?	No	LOW

Location

4.1	Is the operation authorized in the airspace?	Yes	LOW
4.2	Are there populated areas near the operation such as parks, schools, or stadiums?	No	LOW
4.3	Are there heliports or congested air traffic near the operation?	No	LOW
4.4	Is there uneven terrain or significant elevation change in the area of operation?	Yes	MODERATE
4.5	Are there hazards or obstructions in the area of operation?	Yes	MODERATE
4.6	Are people other than the crew present in the area of operation?	No	LOW
4.7	Have takeoff and landing area(s) been surveyed?	Yes	LOW

Vancouver, WA

Verizon - Skyward - Corporate

DOEFLT-131 - Washougal

Risk Assessment

Last Updated On Oct 08, 2021 14:51 PM UTC by Dustin Schocken

21 LOW	21 RISKS IDENTIFIED 4 RISKS MITIGATED	LOW FINAL RISK 21 of 21 Completed

Notes

Crew

1.1	Is the pilot certified and qualified for this mission?	Yes	LOW
1.2	Has the pilot recently flown a similar mission?	Yes	LOW
1.3	Is the pilot qualified to fly this aircraft?	Yes	LOW
1.4	Is any crew member affected by fatigue or other factors that could impact performance?	No	LOW
1.5	Have all crew members been briefed on the operation?	Yes	LOW

Aircraft

2.1	Has the aircraft been inspected and determined to be airworthy?	Yes	LOW
2.2	Have Return-to-Home and Maximum Altitude values been checked?	Yes	LOW
2.3	Is the GPS signal within minimum required parameters?	Yes	LOW

Weather

3.1	Are cloud cover and ceiling within acceptable limits?	Yes	LOW
3.2	Is temperature within acceptable limits?	Yes	LOW
3.3	Is visibility within acceptable limits?	Yes	LOW
3.4	Are wind conditions within acceptable limits?	Yes	LOW
3.5	Is precipitation forecast during the scheduled operation?	No	LOW
3.6	Will the operation finish after civil twilight?	No	LOW

Location

4.1	Is the operation authorized in the airspace?	Yes	LOW
4.2	Are there populated areas near the operation such as parks, schools, or stadiums?	Yes	MODERATE
	Mitigation: Flight modes will keep aircraft in close proximity. RTH timer set to 10 seconds		LOW
4.3	Are there heliports or congested air traffic near the operation?	Yes	MODERATE
	Mitigation: Flights below 200' LAANC ceiling. Geofence enabled to avoid flight near airport		LOW
4.4	Is there uneven terrain or significant elevation change in the area of operation?	No	LOW
4.5	Are there hazards or obstructions in the area of operation?	Yes	MODERATE
	Mitigation: Area pre surveyed by RPIC to avoid obstructions		LOW
4.6	Are people other than the crew present in the area of operation?	Yes	MODERATE
	Mitigation: Flight area is over the Columbia River		LOW
4.7	Have takeoff and landing area(s) been surveyed?	Yes	LOW

11. Acronyms & Abbreviations

Acronym or Abbreviation	Definition
C2	Command and Control
CNPC	Control Non-Payload Communications
CS	Control Station
EKF	Extended Kalman Filter
FW	Fixed Wing
GCS	Ground Control Station
KM/H	Kilometers Per Hour
LTE	Long Term Evolution (4G)
MPN-GW	Mobile Private Network Gateway
OEM	Original Equipment Manufacturer
ORA	Operational Risk Assessment
P-GW	Packet Gateway
PNW	Pacific Northwest
RC	Remote Control
RF	Radio Frequency
RPIC	Remote Pilot in Command
RSRP	Reference Signal Received Power
RSRQ	Reference Signal Received Quality
RTL	Return to Launch
SIM	Subscriber Identity Module
SINR	Signal to Interference Plus Noise Ratio
SNR	Signal to Noise Ratio
UA	Uncrewed Aircraft
UAV	Uncrewed Aerial System
UE	User Equipment

VTOL	Vertical Takeoff and Landing