

## UW-APL PROJECT v4.0.4

This document describes update to SWIFT project by Sutron, Corp., for UW-APL.

### Requirements

Changes to be made in this update:

- Add/verify support for multiple serial cameras, using same model as previously used. Increase image acquisition rate to 0.5 Hz or higher.
- Include timestamp in camera file names. The timestamp should be specified to millisecond resolution. Goal is to correlate separate images and data as close as possible in time, so snapshot timestamp as accurately as possible.
- Support integration and test.
- Delivery by January 1, 2019

### Sensor Configuration

The sensor compliment is not fixed but is entirely determined by the blocks added to the graphical setup. Sensors using a COM port may be placed on whatever COM port is desired. For such sensors, make sure PIN9 is configured properly to control power to the sensor, where needed:

- AQ (HR), SIG: RI
  - Obtain “pcf” config file using “aquapro.exe -cu”
- PB200: SW12
- Iridium Modem: RI
- Microstrain 3GX: SW12
- Ellipse: SW12
- Camera: SW5
- Aanderaa CS 4319: SW12
- ECO Puck: SW12
- Aanderaa CS 4831 O2 Optode: SW12
- WetLabs SeaOWL: SW12

### Transmissions

Iridium transmissions are expected to be hourly, over Iridium modem. Suggest setting Tx Time be set on the 10-minute mark. Transmission destination is determined by modem provisioning. UW-APL’s plan is to have DOD provision modem to send to custom email address. Transmissions from units will be received as attachments to emails. The modem’s IMEI number (unique number assigned to modem) will appear in email subject line.

A transmission for a given hour will typically consist of 3 to 4 emails, with each associated data **packet** containing 340 bytes or less. The Iridium system does not guarantee packets arrive in order at

destination. The email body specifies a time-stamp for the message, which can be used to determine when the message originated.

### Packet Header

Each packet (email attachment) begins with an **ASCII header and optional sub-header** describing where the message “fits” within the set of messages for the hour:

- The header uses a single byte in the ASCII printable range to make it easy for humans to interpret the content, identifying the packet type.
  - “0” means self-timed contained in single packet
  - “1” means self-timed spread across multiple packets, or “extended”
- The self-timed extended packet type includes a comma-delimited sub-header to describe the subset of data being sent. The first sub-header differs from all subsequent sub-headers, in that it includes the total size of the data being sent
- In the following tables, bracketed text, e.g. “<packet-type>”, denotes a field replaced in an actual transmission by real data. All chars outside of bracketed text are literals

### Packet Structure

|               |              |        |
|---------------|--------------|--------|
| <packet-type> | <sub-header> | <data> |
|---------------|--------------|--------|

#### Sub-header 0:

|                                   |
|-----------------------------------|
| ,<id>,<start-byte>,<total-bytes>: |
|-----------------------------------|

#### Sub-header 1 thru N:

|                     |
|---------------------|
| ,<id>,<start-byte>: |
|---------------------|

**Where...**

|               |    |  |
|---------------|----|--|
| <packet-type> | := | Numeric ASCII character defining packet type.<br>Types for UW-APL:<br>0 := Self-timed (single packet)<br>1 := Self-timed extended (multiple packets) |
| <id>          | := | Numeric ASCII text defining the message id.<br>Starts at "0". Rolls over after "99"  |
| <total-bytes> | := | Numeric ASCII text defining the total number of data bytes to be sent (data only, does not include overhead bytes)                                   |
| <start-byte>  | := | Numeric ASCII text defining which byte of total-bytes is the start byte of the current packet.<br>Starts at 0  |

**Example**

|  |                                       |
|--|---------------------------------------|
| Example showing two packet transmissions where the total size is 512 bytes (note, total size is of the data payload, and does not include the overhead of the header). The example uses a message id of 42 |                                       |
| Packet 1:  | 1,42,0,512:<payload bytes 0 thru 319> |
| Packet 2:  | 1,42,320:<payload bytes 320 thru 511> |

**Packet Payload**

The data spread across the packets of a transmission also has a structure:

- The payload data is binary, transmitted Least Significant Byte (LSB) first
- Floats are single precision stored per IEEE 754 32-bit spec (4 bytes)
- Each section begins with an integer specifying the sensor type, followed by another integer specifying the number of bytes in the section

**Payload Structure**

The following table defines the structure of the data payload for SWIFT v3.3. Use the tool, "SBDCvt" provided by Sutron, to decode the payload. Note: input file to SBDCvt should contain only the payload, not the Iridium header.

| Name         | Data Type  | Description                                    |
|--------------|------------|--|
| Payload Type | ASCII char | "7" = SWIFT v4.0 (with Signature enhancements) |

One or more sensor structures, as defined below  
 (“Miscellaneous” structure containing battery voltage will always be included)

### *Aquadop HR (“AQH”)*

| Name  | Data Type  | Description                                  |
|-------|------------|--|
| Type  | 1-byte int | = 0  |
| Port  | 1-byte int | Com port index, i.e., 2, 3, 4, 6, 7, 8, or 9 |
| Size  | 2-byte int | = 64 bytes following                         |
| A(0)  | Float      | Value of A(0)                                |
| A(1)  | Float      | Value of A(1)                                |
| ...   | ...        | ...  |
| A(15) | Float      | Value of A(15)                               |

### *Aquadop non-HR (“AQD”)*

| Name     | Data Type  | Description                                  |
|----------|------------|--|
| Type     | 1-byte int | = 1  |
| Port     | 1-byte int | Com port index, i.e., 2, 3, 4, 6, 7, 8, or 9 |
| Size     | 2-byte int | = 160 bytes following                        |
| Mean(0)  | Float      | Mean(0) beam 1                               |
| Mean(1)  | Float      | Mean(1) beam 1                               |
| ...      | ...        | ...  |
| Mean(39) | Float      | Mean(39) beam 1                              |

### *PB200 (“PB2”)*

| Name   | Data Type  | Description                                  |
|--------|------------|--|
| Type   | 1-byte int | = 2  |
| Port   | 1-byte int | Com port index, i.e., 2, 3, 4, 6, 7, 8, or 9 |
| Size   | 2-byte int | = 80 bytes following                         |
| WDMean | Float      | Value of wind direction mean                 |
| WDSTD  | Float      | Value of wind direction standard deviation   |
| WSMean | Float      | Value of wind speed mean                     |
| WSSTD  | Float      | Value of wind speed standard deviation       |
| PBLat  | Float      | PB200 Latitude                               |

|                       |            |  |
|-----------------------|------------|--|
| PBLon                 | Float      | PB200 Longitude  |
| PBYear                | 4-byte int | PB200 Year   |
| PBMonth               | 4-byte int | PB200 Month  |
| PBDay                 | 4-byte int | PB200 Day  |
| PBSeconds             | 4-byte int | PB200 seconds into the day (decimal digits map to hhmmss, e.g., 170859 = 17:08:59) |
| ATMean                | Float      | Value of air temperature mean  |
| ATSTD                 | Float      | Value of air temperature standard deviation  |
| BPMean (new in v3.2)  | Float      | Mean baro pressure bars  |
| BPSTD (new in v3.2)   | Float      | Standard deviation baro pressure bars  |
| COGMean (new in v3.2) | Float      | Course Over Ground, mean direction unit  |
| COGSTD (new in v3.2)  | Float      | Standard deviation, COG direction unit   |
| SOGMean (new in v3.2) | Float      | Speed Over Ground, mean speed scalar   |
| SOGSTD (new in v3.2)  | Float      | Standard deviation, SOG scalar   |

*IMU*

| Name   | Data Type  | Description                                  |
|--------|------------|--|
| Type   | 1-byte int | = 3  |
| Port   | 1-byte int | Com port index, i.e., 2, 3, 4, 6, 7, 8, or 9 |
| Size   | 2-byte int | = 1796 bytes following                       |
| Hs     | Float      | Significant wave height                      |
| Tp     | Float      | Dominant period s                            |
| Dp     | Float      | Direction deg T                              |
| E(0)   | Float      | Spectral energy density $m^2/Hz$             |
| ...    | ...        | ...  |
| E(41)  | Float      | ...  |
| f(0)   | Float      | Frequency Hz                                 |
| ...    | ...        | ...  |
| f(41)  | Float      | ...  |
| a1(0)  | Float      | Normalized spectral moment a1                |
| ...    | ...        | ...  |
| a1(41) | Float      | ...  |
| b1(0)  | Float      | Normalized spectral moment b1                |
| ...    | ...        | ...  |
| b1(41) | Float      | ...  |

|          |            |   |
|----------|------------|---|
| a2(0)    | Float      | Normalized spectral moment a2                     |
| ...      | ...        | ...   |
| a2(41)   | Float      | ...   |
| b2(0)    | Float      | Normalized spectral moment b2                     |
| ...      | ...        | ...   |
| b2(41)   | Float      | ...   |
| IMULat   | Float      | Value of IMU Latitude                             |
| IMULon   | Float      | Value of IMU Longitude                            |
| hAz(0)   | 4-byte int | Histogram of vertical acceleration                |
| ...      | ...        | ...   |
| hAz(31)  | Float      | ...   |
| bcAz(0)  | Float      | Bin centers of hAz                                |
| ...      | ...        | ...   |
| bcAz(31) | Float      | ...   |
| hAh(0)   | 4-byte int | Histogram of magnitude of horizontal acceleration |
| ...      | ...        | ...   |
| hAh(31)  | Float      | ...   |
| bcAh(0)  | Float      | Bin centers of hAh                                |
| ...      | ...        | ...   |
| bcAh(31) | Float      | ...   |
| hVh(0)   | 4-byte int | Histogram of magnitude of horizontal velocity     |
| ...      | ...        | ...   |
| hVh(31)  | Float      | ...   |
| bcVh(0)  | Float      | Bin centers of hVh                                |
| ...      | ...        | ...   |
| bcVh(31) | Float      | ...   |

### *Aanderra CS 4319 ("ACS")*

| Name             | Data Type  | Description                                  |
|------------------|------------|--|
| Type             | 1-byte int | = 4  |
| Port             | 1-byte int | Com port index, i.e., 2, 3, 4, 6, 7, 8, or 9 |
| Size             | 2-byte int | = 12 bytes following                         |
| ConductivityMean | Float      | Conductivity mean                            |
| TempMean         | Float      | Temperature mean                             |
| SalinityMean     | Float      | Salinity mean                                |

*Aanderra CS 4831 O2 Optode ("ACO")*

| Name             | Data Type  | Description                                  |
|------------------|------------|--|
| Type             | 1-byte int | = 12   |
| Port             | 1-byte int | Com port index, i.e., 2, 3, 4, 6, 7, 8, or 9 |
| Size             | 2-byte int | = 4 bytes following                          |
| O2 Concentration | Float      | O2 Concentration Mean                        |

*WetLabs SeaOWL ("SWL")*

| Name               | Data Type  | Description                                  |
|--------------------|------------|--|
| Type               | 1-byte int | = 13   |
| Port               | 1-byte int | Com port index, i.e., 2, 3, 4, 6, 7, 8, or 9 |
| Size               | 2-byte int | = 4 bytes following                          |
| FDOM Reported Mean | Float      | FDOM Reported Mean (Column 14)               |

*ECO Puck ("ECO")*

| Name   | Data Type  | Description                                  |
|--------|------------|--|
| Type   | 1-byte int | = 5  |
| Port   | 1-byte int | Com port index, i.e., 2, 3, 4, 6, 7, 8, or 9 |
| Size   | 2-byte int | = 12 bytes following                         |
| F2Mean | Float      | Column 2 mean                                |
| F4Mean | Float      | Column 4 mean                                |
| F6Mean | Float      | Column 6 mean                                |

*Miscellaneous*

| Name           | Data Type  | Description         |
|----------------|------------|---------------------|
| Type           | 2-byte int | = 6                 |
| Size           | 2-byte int | = 4 bytes following |
| BatteryVoltage | Float      | Battery voltage     |

*PIC*

| Name | Data Type  | Description                                  |
|------|------------|--|
| Type | 1-byte int | = 7  |
| Port | 1-byte int | Com port index, i.e., 2, 3, 4, 6, 7, 8, or 9 |

|               |            |   |
|---------------|------------|---|
| Size          | 2-byte int | = Number of bytes in picture following (varies) |
| Picture (jpg) | Bytes      | Bytes comprising jpg image                      |

### *Vaisala 536 ("SDI-a")*

| Name    | Data Type   | Description                                    |
|---------|-------------|--|
| Type    | 1-byte int  | = 8  |
| Port    | 1-byte char | SDI-12 address char, e.g., '0', '1', etc.      |
| Size    | 2-byte int  | = 48 bytes following                           |
| WDMean  | Float       | Value of wind direction mean deg               |
| WDSTD   | Float       | Value of wind direction standard deviation deg |
| WSMean  | Float       | Value of wind speed mean m/s                   |
| WSSTD   | Float       | Value of wind speed standard deviation m/s     |
| ATMean  | Float       | Value of air temperature mean C                |
| ATSTD   | Float       | Value of air temperature standard deviation C  |
| RHMean  | Float       | Mean relative humidity %                       |
| RHSTD   | Float       | Standard deviation relative humidity %         |
| BPMean  | Float       | Mean baro pressure mbars                       |
| BPSTD   | Float       | Standard deviation baro pressure mbars         |
| RainAcc | Float       | Rain accumulation mm                           |
| RainInt | Float       | Rain intensity mm/h                            |

### *Signature ("SIG")*

| Name                   | Data Type  | Description                                  |
|------------------------|------------|--|
| Type                   | 1-byte int | = 9  |
| Port                   | 1-byte int | Com port index, i.e., 2, 3, 4, 6, 7, 8, or 9 |
| Size                   | 2-byte int | = 4 to n bytes following                     |
| nBurstCells            | 2-byte int | 0 min, 128 max                               |
| A(0)                   | Float      | Value of A(0)                                |
| A(1)                   | Float      | Value of A(1)                                |
| ...                    | ...        | ...  |
| A(nBurstCells-1)       | Float      | Value of A(nBurstCells-1)                    |
| nAvgCells              | 2-byte int | 0 min, 64 max                                |
| EastMeans(0)           | Float      | Value of EastMeans(0)                        |
| ...                    | ...        | ...  |
| EastMeans(nAvgCells-1) | Float      | Value of EastMeans(nAvgCells-1)              |



|                         |       |                                  |
|-------------------------|-------|----------------------------------|
| NorthMeans(0)           | Float | Value of NorthMeans(0)           |
| ...                     | ...   | ...                              |
| NorthMeans(nAvgCells-1) | Float | Value of NorthMeans(nAvgCells-1) |

### *SBG Ellipse ("SBG")*

| Name   | Data Type  | Description                                  |
|--------|------------|--|
| Type   | 1-byte int | = 10   |
| Port   | 1-byte int | Com port index, i.e., 2, 3, 4, 6, 7, 8, or 9 |
| Size   | 2-byte int | = 1196 bytes following                       |
| Hs     | Float      | Significant wave height                      |
| Tp     | Float      | Dominant period s                            |
| Dp     | Float      | Direction deg T                              |
| E(0)   | Float      | Spectral energy density $m^2/Hz$             |
| ...    | ...        | ...  |
| E(41)  | Float      | ...  |
| f(0)   | Float      | Frequency Hz                                 |
| ...    | ...        | ...  |
| f(41)  | Float      | ...  |
| a1(0)  | Float      | Normalized spectral moment a1                |
| ...    | ...        | ...  |
| a1(41) | Float      | ...  |
| b1(0)  | Float      | Normalized spectral moment b1                |
| ...    | ...        | ...  |
| b1(41) | Float      | ...  |
| a2(0)  | Float      | Normalized spectral moment a2                |
| ...    | ...        | ...  |
| a2(41) | Float      | ...  |
| b2(0)  | Float      | Normalized spectral moment b2                |
| ...    | ...        | ...  |
| b2(41) | Float      | ...  |
| cf(0)  | Float      |  |
| ...    | ...        | ...  |
| cf(41) | Float      | ...  |
| Lat    | Float      | Value of IMU Latitude                        |
| Lon    | Float      | Value of IMU Longitude                       |

*Y81000 ("Y81")*

| Name             | Data Type  | Description                                       |
|------------------|------------|---|
| Type             | 1-byte int | = 11  |
| Port             | 1-byte int | Com port index, i.e., 2, 3, 4, 6, 7, 8, or 9      |
| Size             | 2-byte int | = 960 bytes following                             |
| Ustar            | Float      | Wind friction velocity                            |
| Epsilon          | Float      | Dissipation rate                                  |
| MeanU            | Float      | Mean wind velocity east-west                      |
| MeanV            | Float      | Mean wind velocity north-south                    |
| MeanW            | Float      | Mean wind velocity updraft                        |
| MeanTemp         | Float      | Mean sonic temp                                   |
| Anisotropy       | Float      | Metric for the inertial sub range of the spectrum |
| Quality          | Float      | Metric for ustar estimate                         |
| Freq(0)          | Float      |   |
| ...              | ...        | ...   |
| Freq(115)        | Float      | ...   |
| TkeSpectrum(0)   | Float      |   |
| ...              | ...        | ...   |
| TkeSpectrum(115) | Float      | ...   |

## Network Configuration

Configure Digi radio as Access Point for shore PC, and Subscriber Unit for SWIFTs.

When using Digi radios for WiFi bridge of SBG Ellipse data, be sure to set the Default Gateway in the Xpert to the IP Address of the Digi Access Point radio. This appears to be required in order for socket clients on the Xpert to be able to succeed in making connections to the host PC (but was not required in order to accept incoming connections, e.g., Xterm).

### Autopoll Setup

Three (3) Xpert Tasks  
 Task types = "Capture"  
 Task #1 Connection Settings  
   IP Address: 0.0.0.0  
   IP Port: 3001  
 Task #2 Connection Settings  
   IP Address: 0.0.0.0  
   IP Port: 3002  
 Task #3 Connection Settings  
   IP Address: 0.0.0.0  
   IP Port: 3003

