

# Communications Protocol, v0.5

2018 Maritime RobotX Challenge

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## Background

This document describes the communications protocols to be used during the 2018 Maritime RobotX Challenge for the purpose of reporting vehicle status and completion of mission tasks. Each team's implementation of the requirements, outlined below, will be tested during the Challenge. RoboNation shall provide teams support to test this implementation prior to the RobotX Challenge.

## Requirements

### Network Information

During operations, teams will be provided with a hard-wired connection (RJ-45) to the Technical Director's network. This connection must be used to transmit the Autonomous Maritime System (AMS) heartbeat and other required reports. When connected to the TD network, the team's computer must request an IP address from a TD Network DHCP server. Once connected, they should establish a TCP connection to a server with an address and port number, correlating to the selected course. Address and port numbers for each course will be provided during the event. A different NMEA sentence will be defined for each challenge requiring communication between the AMS and a judge.

**Teams are responsible to provide a robust and reliable data link between the AMS and the team's ground console.**

### General Message Information

All communication will be formatted as a NMEA-like sentence characterized by the following guidelines:

- Each message's starting character is a dollar sign.
- The next five characters identify message type.
- All data fields that follow are comma-delimited.
- Where data is unavailable, the corresponding field remains blank (it contains no character before the next delimiter).
- All dates and times are to be reported in Hawaii Standard Time (HST).
- The first character that immediately follows the last data field character is an asterisk.
- The asterisk is immediately followed by a checksum represented as a two-digit hexadecimal number. The checksum is the bitwise exclusive OR of ASCII codes of all characters between the \$ and \*.
- <CR><LF> ends the message.

A different NMEA sentence will be defined for each challenge requiring communication between the vehicle and a judge. The vehicle SHOULD NOT transmit any particular message at a rate more than once per second (1Hz) .

## Heartbeat Message

The AMS is required to transmit a heartbeat status message at a frequency of 1 Hz. This heartbeat will be used to verify the link has been established with the TD Network and competition equipment. In addition, this channel will be used to relay information specific to a challenge during its run attempt. The fields for the heartbeat message are shown in Table 1, and followed by an example heartbeat message.

**Table 1. RobotX Heartbeat Message Fields**

Name	Example	Description	Notes
<b>Message ID</b>	\$RXHRB	Protocol Header	
<b>HST Date</b>	101218	ddmmyy	Provide date in Hawaii Standard Time (HST)
<b>HST Time</b>	161229	hhmmss (24hr time format)	Use Hawaiian Standard Time
<b>Latitude</b>	21.31198	Decimal degrees	Provides ~1.11m accuracy
<b>N/S indicator</b>	N	N=north, S=South	
<b>Longitude</b>	157.88972	Decimal degrees	Provides ~1.04m accuracy
<b>E/W indicator</b>	W	E=east, W=west	
<b>Team ID</b>	AUVSI	Team ID	5-character code assigned by TD
<b>System Mode</b>	2	Current mode of AMS 1=Remote Operated 2=Autonomous	
<b>AUV Status</b>	1	Current mode of the AUV 1=Stowed 2=Deployed 3=Recovered 4=Fault 5=Killed	<ul style="list-style-type: none"> <li>The STOWED state used only when the AUV is secured to the AMS and has not yet been DEPLOYED.</li> <li>The DEPLOYED state is used when the AUV has been successfully from the AMS.</li> <li>Recovered can be used only after the AUV has been previously deployed.</li> <li>Use the FAULT code if the AUV is not in the RECOVERED or STOWED state and is in a faulted state. The TD team may help to recover the AUV.</li> <li>Use the KILLED state when the AUV propulsion is killed and the system is safe to approach.</li> </ul>
<b>Checksum</b>	06	Bitwise XOR	
<b>&lt;CR&gt;&lt;LF&gt;</b>		End of message	

Heartbeat Example Message:      \$RXHRB,101218,161229,21.31198,N,157.88972,W,AUVSI,2,1\*06

## Entrance and Exit Gates Task Message

The Entrance and Exit Gates message provides a method for the AMS to report the gate in which it detects an active beacon.

**Table 2. Entrance and Exit Gate Message Fields**

Name	Example	Description
Message ID	\$RXGAT	Protocol Header
HST date	101218	ddmmyy
HST time	161229	hhmmss
Team ID	AUVSI	Team ID (assigned by TD)
Active Entrance Gate	1	Gate 1, 2, or 3
Active Exit Gate	2	
Light Buoy Active	Y	N = Light Buoy Off (circle Black Buoy) Y = Light Buoy On (circle light buoy)
Light Pattern	RBG	Colors identified from first to last over time R=red, B=blue, G=green
Checksum	25	
<CR><LF>		End of message

Entrance and Exit Gate Example Message: \$RXGAT,101218,161229,AUVSI,1,2,Y,RGB\*25

## Scan the Code Task Message

The Scan the Code task requires that the AMS locate and observe a buoy with a light bar to determine the light pattern displayed. The AMS must then transmit the detected light pattern using the protocol specified in Table 3. An example is provided below the table. When the AMS transmits this message the TD system will echo received message back to verify transmission.

**Table 3. Light Buoy Message Fields**

Name	Example	Description
Message ID	\$RXCOD	Protocol Header
HST date	101218	ddmmyy
HST time	161229	hhmmss
Team ID	AUVSI	Team ID (assigned by TD)
Light Pattern	RBG	Colors identified from first to last, over time R=red, B=blue, G=green
Checksum	49	
<CR><LF>		End of message

Light Buoy Message Example: \$RXCOD,101218,161229,AUVSI,RGB\*49

## Identify Symbols and Dock Task Message

The Identify Symbols and Dock task requires that the AMS identify an assigned colored shape and dock in the bay with that shape. The AMS may report the detected shape and color of the bay, in which it plans to dock, using the protocol specified in Table 4. An example is provided below the table. When the AMS transmits this message the TD system will echo received message back to verify transmission.

**Table 4. Identify Symbol and Dock Message Fields**

Name	Example	Description
Message ID	\$RXDOK	Protocol Header
HST date	101218	ddmmyy
HST time	161229	hhmmss
Team ID	AUVSI	Team ID (assigned by TD)
Shape Color	R	Color of the shape in the docking bay R=red, B=blue, G=green
Shape	TRIAN	CRUC=Cruciform TRIAN=Triangle CIRCL=Circle
Checksum	28	
<CR><LF>		End of message

Identify Symbols and Dock Example Message:       \$RXDOK,101218,161229,AUVSI,R,TRIAN\*28

## Detect and Deliver Task Message

The Detect and Deliver task requires that the AMS identify an assigned colored shape and deliver a payload into one of the holes, on the surface correlating to the identified colored shape. The AMS may report the detected shape and color of the face in where it will deliver its payload using the protocol specified in Table 5. An example is provided below the table. When the AMS transmits this message the TD system will echo received message back to verify transmission.

**Table 5. Detect and Deliver Message Fields**

Name	Example	Description
Message ID	\$RXDEL	Protocol Header
HST date	101218	ddmmyy
HST time	161229	hhmmss
Team ID	AUVSI	Team ID (assigned by TD)
Shape Color	R	Color of the shape on the face being targeted R=red, B=blue, G=green
Shape	CIRCL	CRUCI=Cruciform TRIAN=Triangle CIRCL=Circle
Checksum	32	
<CR><LF>		End of message

Detect and Deliver Example Message:       \$RXDEL,101218,161229,AUVSI,R,CIRCL\*32