AUV Communications

(Recommended for 8th – 12th Grades)

How do scientists talk to Puma and Jaguar AUVs when they are 4000 meters under the ocean?

Digital Information Packets

Communication in water uses sound waves. Although sound waves are much slower, they travel much farther than either light or radio waves in water. All communication with sound depends on arrangements of frequency (pitch) and amplitude (loudness). When humans talk we use the sound patterns of speech, but a computer circuit responds to wave patterns that it can interpret as a rapid sequence of "on" and "off" states. Each tiny "on" or "off" part of the sound wave is called a "bit," which is the fundamental unit of digital computing.

A bit by itself does not carry much information because it can only be on or off (represented as "1" or "0"), so the computer on the AUV uses a string of eight bits—called a byte—as its basic unit of information. In human language, a byte is like a letter, a number, or other symbol. There are 256 combinations of eight bits (binary counting) so the computer has 256 "letters" for communication.

With all the things an AUV has to do, it has very little time to "talk" to the scientists on the ship above, so it sends limited information packets composed of 32 bytes about every two minutes. Between information packets, it checks its position relative to the ship and the LBL net (long baseline navigation), receives a 32-byte information packet from the ship, and its checks its position again.

It is as if the AUV talks in sentences that only have 32 letters. At first that does not seem like much information, but we will find that it is plenty.

If you tried to talk in sentences containing 32 letters, it would come out like this:

`WITH A BYTE PER LETTER YOU CAN SAY THIS.`

(We are counting letters and punctuation, but not the spaces.)

`DO YOU HAVE MY PEN? I NEED TO HAVE IT NOW.`

`Or you might say…`

`I GOT A IN MATH. CAN I USE THE CAR TONITE?`

(Of course 'tonite' is spelled incorrectly!) If you always spoke in 32-byte sentences your language would sound simple, but engineers organize information packets so they can communicate as much information as possible using only 32 bytes. Your home address an example of organized information. In most cases a few well-placed words and numbers identify one house on one block in one city in the entire world.

`BOB SMITH 290 OAK AVE SUNVILLE AZ 50505`

A mailing address avoids extra words by using a set order for information. We all assume that your name appears first, then the street, and so on. Another method used to shorten words is to use abbreviations. (Think "LOL" when you text or IM your friends!)

SHORT ACTIVITY:

Write out your home address and count the number of bytes that are used. Can you write your address in a 32 byte information packet? If it is more than 32 bytes, use abbreviations to shorten it. Make up abbreviations if you have to!

Information Packets for AUVs – A Classroom Simulation

Codes and secret messages seem like the tools of spies, but everything happening inside a computer consists of digital code in which groups of 8 bits make a "byte" of information. *Puma* and *Jaguar* communicate with 32-byte information packets.

The ship and the AUVs send the same information back and forth to each other again and again, so the structure of the information is always the same, like your mailing address. With an established structure, a lot of information can be relayed with 32 bytes.

How much can you communicate about yourself using 32 letters or numbers?

First, set up a list of specific information. Next, establish a key for all answers. Remember that for each byte, the computer can read one letter or number. Here is a list, but you can modify it. Many of the options could be expanded. Notice that computers start counting from 0.

Byte	Description		Key to Data Values
0	1st Name (first letter)	–	A - Z
1	(second letter)	-	A – Z
2	(third letter)	-	A – Z
3	2nd Name (first letter)	-	A – Z
4	(second letter)	-	A – Z
5	(third letter)	-	A – Z
6	My height (cm)	–	digit (times 100 cm)
7		-	digit (times 10 cm)
8		-	digit (times 1 cm)
9	Hair color (key list)	-	Black-1, Brown-2, Blond-3, Red-4, other-5)
10	How far I live from school (km)	–	digit (times 10 km)
11		-	digit (times 1 km)
12		-	digit (times 0.1 km)
13	Color of my shirt or jacket	–	red=R, orange=O, yellow=Y, green=G, cyan=C, blue=B, magenta=M
14	How I get to school	-	walk=1, car=2, school bus=3, city bus=4
15	My lunch period	-	number 1 - 9
16	Buying lunch or brought lunch	–	buying=0, brought=1
17	What I brought for lunch	-	sandwich: ham=H, chicken=B, cheese=C, other=O
18	(Buying – enter 0)	-	chips=C, pretzels=Z, pickle=P
19		-	coke=C, Pepsi=P, soda=S, milk=M, juice=J
20	My favorite class	–	Engl=E, math=M, sci=S, hist=H, lang=L, other=O
21	Sport I participate in	-	basebl=B, footbl=F, socc=C, lax=L, (List more)
22	Club I am in	-	(Make a list)
23	What I am doing after school	-	(Make a list)
24 to 31	Other – Set up the code for whatever you want to know. It is ok to have unused bytes.		

Name _____

Thirty Two Byte Information Packets

Fill in the information using the key list of code values. Each byte can contain one letter or one number.

Byte	Description	Code
0	First Name first letter	
1	second letter	
2	third letter	
3	Last Name first letter	
4	second letter	
5	third letter	
6	Height (cm) first digit	
7	second digit	
8	third digit	
9	Hair color	
10	How far I live from school first digit	
11	second digit	
12	third digit	
13	Color of my shirt or jacket	
14	How I get to school	
15	My lunch period	
16	Lunch - buy or brought	
17	What I brought for lunch sandwich	
18	chips, etc.	
19	drink	
20	My favorite class	
21	Sport I participate in	
22	Club I am in	
23	What I am doing after school today	
24		
25		
26		
27		
28		
29		
30		
31		

Follow-up:

1. Cut off just the list of code values. See your personal profile in “code” form.
2. Cover up or omit your name. Shuffle and hand out papers. Guess whose paper you have.

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Information Packets used on AUVs

We have looked at what bytes are and how a lot of information can be contained in a 32 byte information packet. Here we see the actual information transferred between the ship and the AUV.

AUV to Ship:

Byte	Description
0	Code tells this message is from the AUV.
1 2 3	X, or east-west position of the AUV with respect to predetermined origin on the sea floor. Three bytes are used for this.
4 5 6	Y, or north-south position of the AUV with respect to predetermined origin on the sea floor.
7	Compass heading of the AUV
8 9	Depth of the AUV in meters measured from the surface
10 11	Altitude of the AUV in meters measured from the sea floor.
12 13	Current goal.- where the AUV is in its mission.
14 15 16	Current goal X position in meters.
17 18 19	Current goal Y position in meters.
20 21	Current goal depth in meters.
22 23	Most recent round trip travel time for LBL transponder A.
24 25	Most recent round trip travel time for LBL transponder B.
26 27 28 29 30	Five bytes available for science data. Puma and Jaguar report Eh sensor values and Optical Backscatter data.
31	One-way travel time data

Ship to AUV:

Byte	Description
0	Code tells this message is from the ship.
1 2 3	X, or east-west position of the ship with respect to predetermined origin on the sea floor. Three bytes are used for this.
4 5 6	Y, or north-south position of the ship with respect to predetermined origin on the sea floor.
7	Compass heading of the ship
8 9	Depth of the ship's sound receiver (acoustic modem) in meters
10 11	Altitude of ship's acoustic modem in meters
12 13	Time value
14 15 16 17 18 19 20 21 22 23 24 25	12 bytes used to relay information from statistical analysis of the vehicle's position.
26 27	Speed of sound in water – difference value from 1500m/s
28 29 30	Unused bytes
31	One-way travel time data