

Национальная  
технологическая инициатива

Пространство возможного

# Available technologies of underwater communication and navigation

Underwater GPS and Internet of underwater things

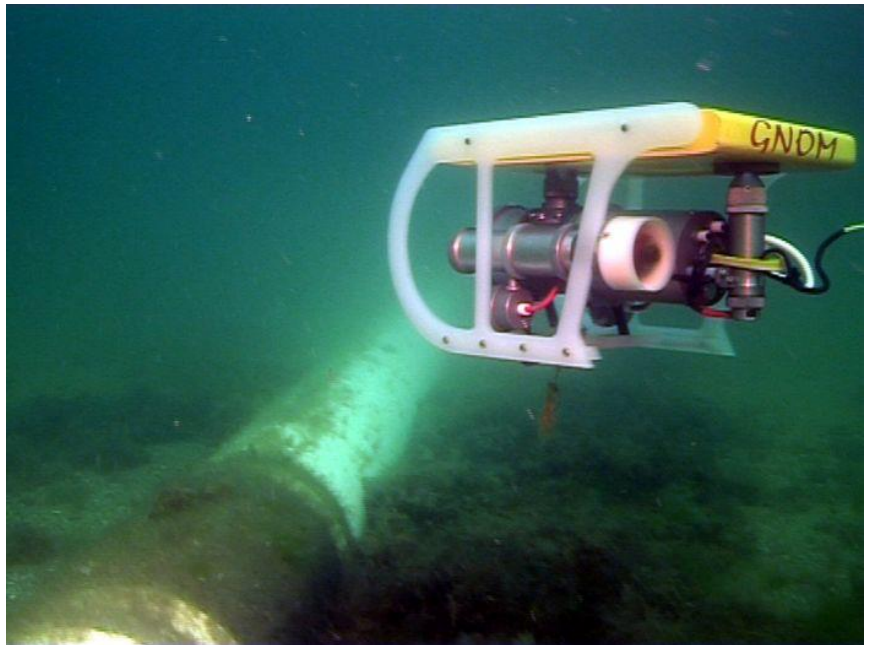
Arthur Abelentsev

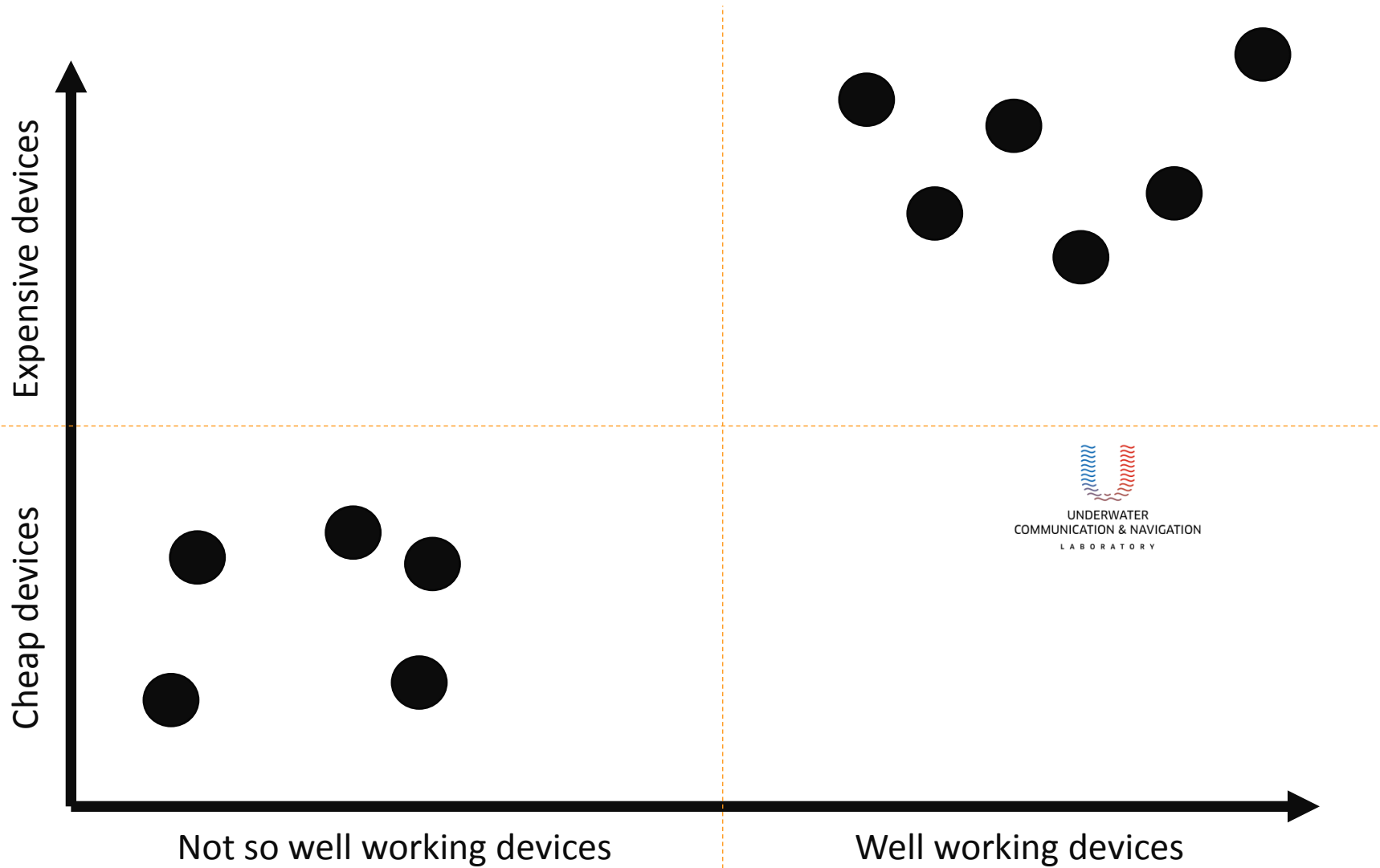
CEO

Underwater Communications & Navigation Laboratory

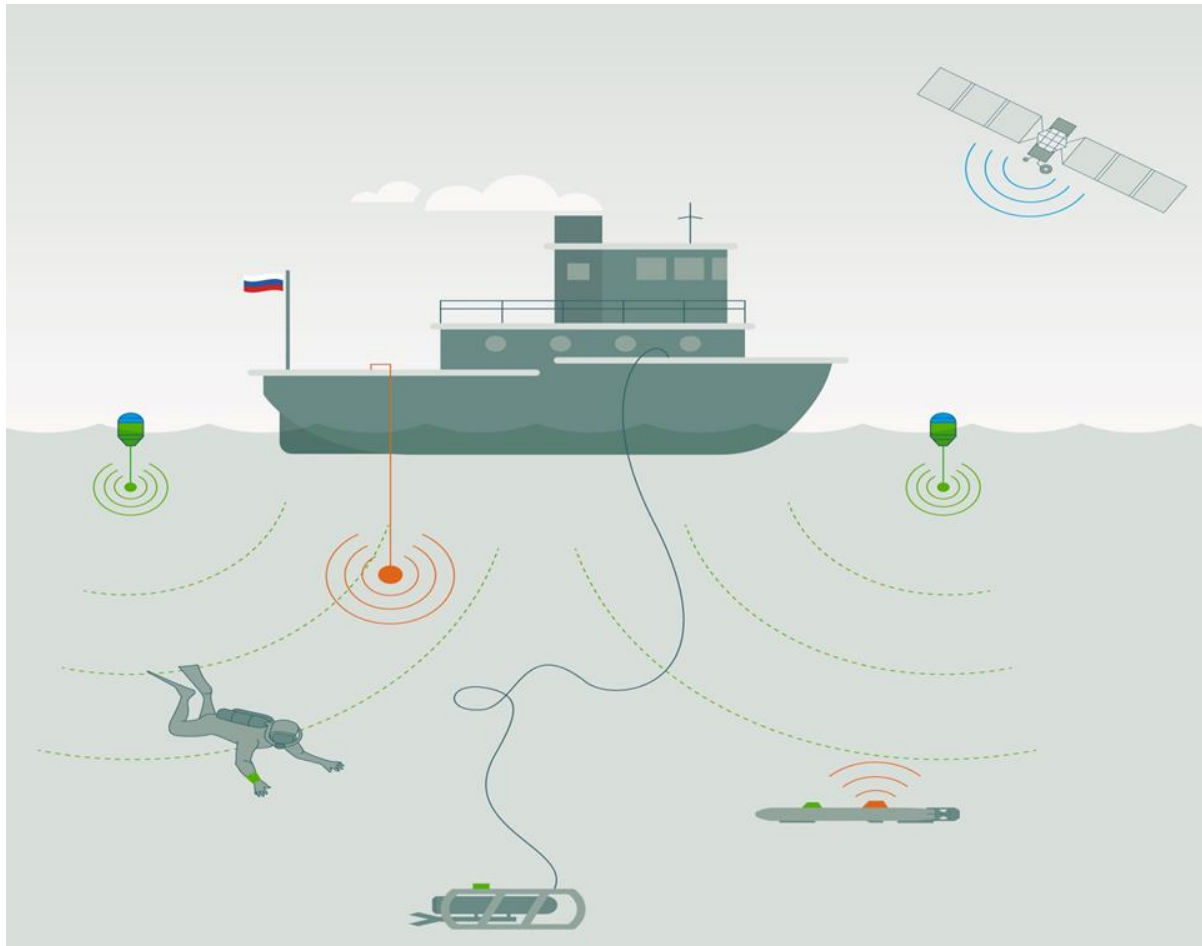
The same tasks as on the surface:

- Навигация
  - Map marking of various objects, damages, etc;
  - Checking the design position of elements of building structures;
  - Underwater archeology;
  - Path to specified points;
  - Diver's location control;
  - ...
- Data transmission:
  - Wireless transmission of commands to AUV;
  - Environmental monitoring;
  - Geological research;
  - Security control;
  - ...



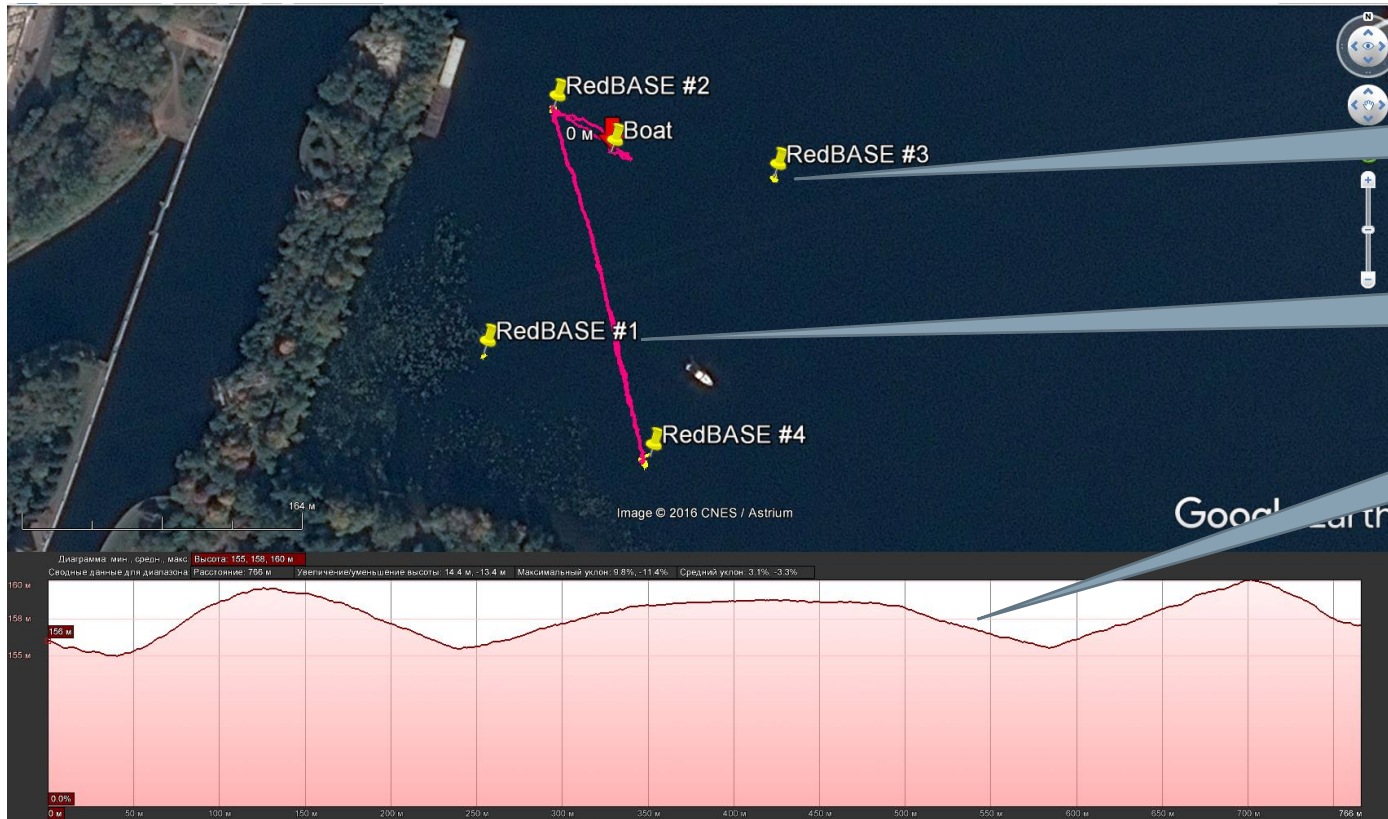


## Long baseline acoustic navigation system, built on the TDOA principle



- The only real underwater GPS in the world
- Absolute geographic coordinates + depth
- Unlimited number of simultaneous devices with the support of 4 floating buoys – repeaters
- Emulation of the GPS / GLONASS protocol
- Minimum weight and dimensions

## RedNODE – tracks from real bodies of water



Position of buoys

Diver movement track

Depth profile

November 2016  
Moscow channel

The diver came out successively on two buoys and returned back on his trail with a maximum deviation of 1.5 meters

RedNODE – tracks from real bodies of water



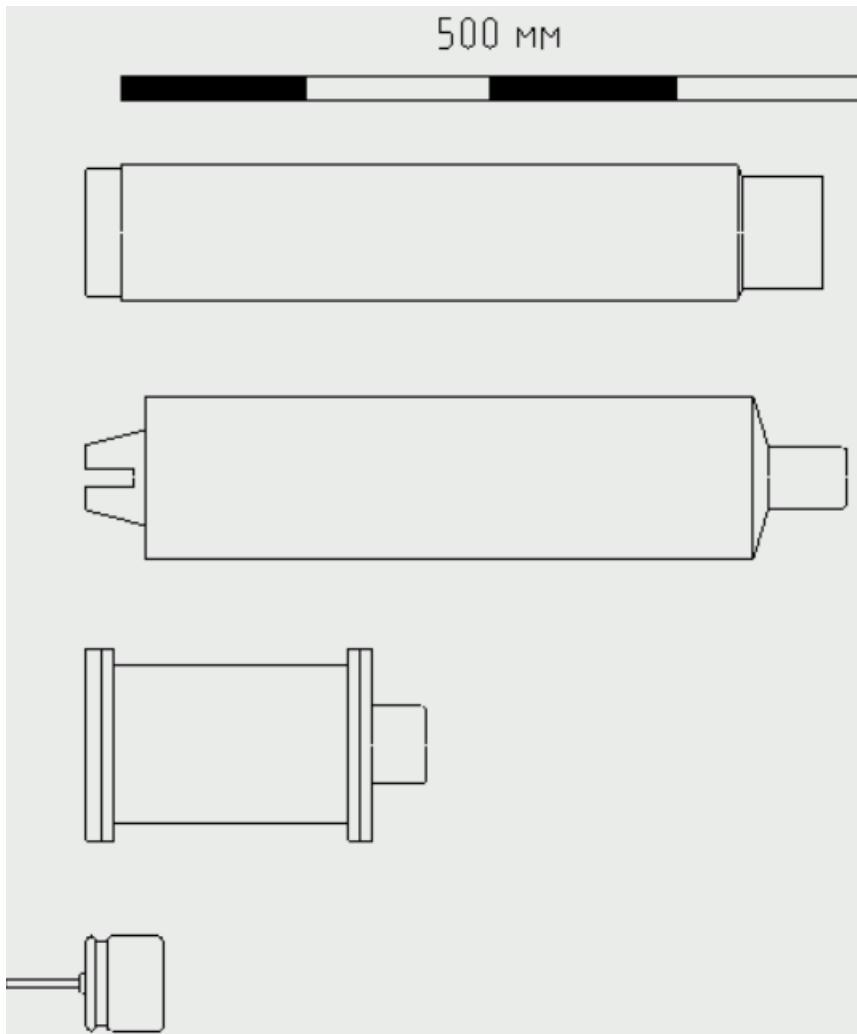
Position of buoys

Diver movement  
track

June 2017  
Holland Bay,  
Sevastopol

Consecutive output for three buoys and return to base in difficult conditions (pier, surf line)

Devices installed on the positioned object:



Sonardyne Compatt 6 Micro: 5.1 kg,  $\Phi 93$  x 499 mm  
Rx/Tx: 0.5/50 W

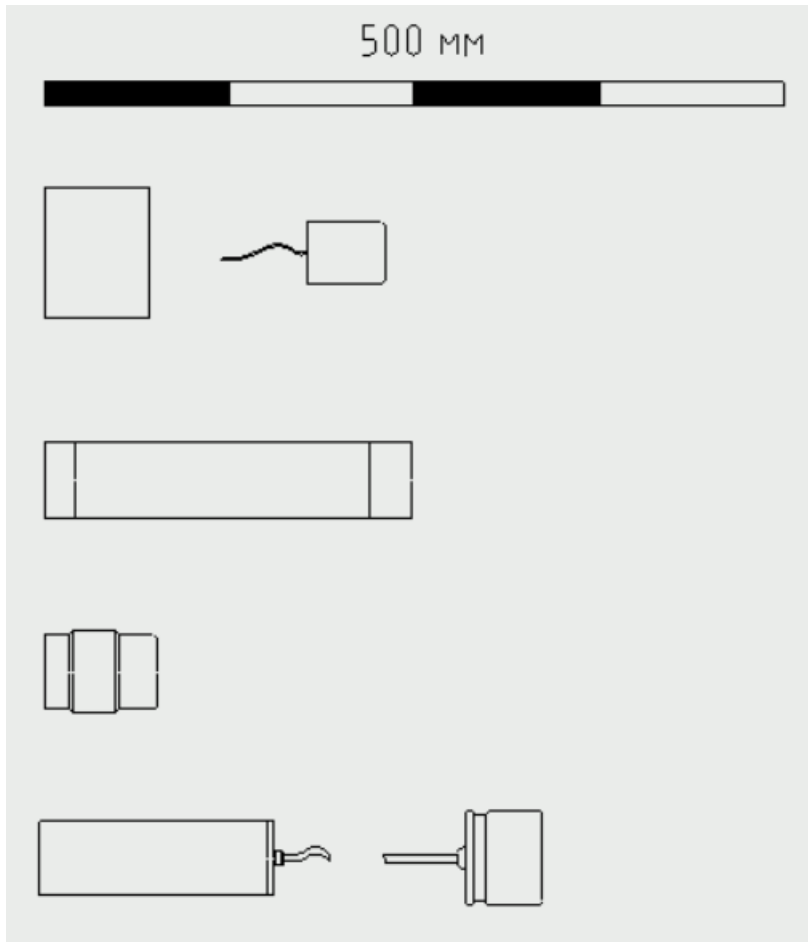
Evologics S2C Beacon, 6 kg,  $\Phi 110$  x 515 mm

LinkQuest Pinpoint 1500, 4 kg,  $\Phi 130$  x 230 mm  
Rx/Tx: 0.8/32 W

UC&NL RedNODE, 0.3 kg,  $\Phi 62$  x 65 mm,  
Rx: 0.3 W

Unlimited number of simultaneously working devices

Devices installed on the positioned object:



Evologics S2CM, 1.2 kg,  $\Phi 63 \times 310$  mm  
Rx/Tx: 0.8/35 W

Applied acoustics 1200A Series Micro Beacon, 0.8 kg  
 $\Phi 52 \times 248$  mm  
Rx/Tx:

MicronNav Transponder, 0.255 kg,  $\Phi 56 \times 76$  mm  
Rx/Tx: 0.285/3.5 W (**Distance – 500 m**)

UC&NL ZimaR, 0.3 kg,  $\Phi 62 \times 65$  mm,  
Rx: 0.3/10 W  
(**Distance – up to 8000 m**)

## RedBASE – sonar floating GNSS-Repeater



RedBASE buoy as a part of RedWave system implements long navigation base. It is made in the form of a plastic cylinder with a length of 600 mm and a diameter of 130 mm with a hydroacoustic antenna on the wire. Has a positive buoyancy, has a load-bearing eye for anchoring. It is equipped with modern high-performance navigation receiver GPS / GLONASS and innovative navigation acoustic transmitter RedWave.

- Dimensions(height x diameter) 597x146 mm
- Weight 4.8 kg
- Battery life up to 24 hours
- Operating temperature range 0 .. + 50 C
- Storage temperature range -20 .. + 60 C
- Full charging time (50Hz 220V) 10 hours
- Energy range of acoustic communication 3000 m

## RedNODE – navigation receiver for ROV AUV

The device is designed to provide navigational data for remote-controlled underwater vehicles (ROVs), autonomous unmanned vehicles (AUVs), with the support of a long navigational base formed by four RedBASE buoys. Provides data on the geographic location, depth and temperature of the water. This device does not have direct analogs both in Russia and abroad.



### Device Features

- Dimensions (diameter X height) 64 x 62 mm
- Weight (dry) 260 g
- Maximum depth 300 m
- Maximum number of simultaneous devices in the water area **Unlimited**
- Nominal accuracy of geographic position determination (intrinsic error), 2DRMS 0.84 m
- Nominal refresh rate of navigation data 1 Hz
- Supply voltage 5 V
- Current consumption 70 mA
- Interface (physical layer) RS-232 (RS-422 as agreed)



### **LunaBASE – reference point of the long-range navigation system LUNA**

- **Unlimited number of devices – theoretically you can cover any area**
- **Energy range of acoustic communication - 8000 m**
- **Up to 32 beacon-responders**
- **Address and broadcast transmission of telecommand commands**
- **Coordinate objects are produced "at the top"**

### **ARes – address beacon-transponder of the system LUNA**



- **Energy range of acoustic communication - 8000 m**
- **Up to 32 devices in one water area**
- **Built-in high-precision pressure sensor (+/- 2.5 cm, 300 m)**
- **The possibility of transmitting remote commands**



- The required number of buoys Luna BASE is installed on the pond
- On the positioned objects - beacons-responders Ares
- Software on any laptop will determine the presence of buoys itself
- The system will automatically poll the ARes beacons and determine their **geographic coordinates** as well as their depth and temperature.

Beacons can be autonomous and conjugated with a carrier, in the latter case it becomes possible:

- To send remote signals (code parcels) to underwater objects;
- To send broadcast commands to all objects at once;





## It is based on the LUNA system

- **Up to 555 autonomous nodes in the water area with a radius of 8000 m**
  - **up to 256 dynamically addressable nodes**
  - **up to 49 control nodes of actuators (20 commands address and broadcast)**
  - **up to 200 nodes of actuator control (4 commands address and broadcast)**
- **Range of acoustic communication - up to 8000 m**
- **Two-way access points with GSM / WiFi / Satellite communication modules**
- **Access to data of underwater nodes and control of actuators from the Internet**
- **Interface device with open source code and architecture for the fastest and easiest integration of various sensors**
- **Determining the geographic position of nodes during data exchange**



**If there is a task of measuring the parameters of the environment by autonomous sensors with the need for access from Internet**

- **Connecting User Sensors to the Universal Interface Device**
- **Conjunction of the interface device to the Hadean-NODE modem using a simple NMEA-like protocol;**
- **Arrangement of access points (at least one, if necessary, positioning nodes - at least three) in the water area;**
- **Arrangement of nodes;**
- **The system itself polls the sensor network and (if there are three or more access points) determines their locations during the data exchange.**

### The use of the Internet of underwater things :

- **Mariculture:** control of feeding parameters, turbidity of water, level of specific substances, temperature, distribution of these parameters across the water area, remote feeding control;
- **Pollution control:** control of the content of specific substances with distribution by area - in areas of drilling platforms and other structures for mining;
- **Perimeter protection:** analysis of indications of specific sensors and control of actuators based on these data;
- **Seismology and marine geology:** address and / or broadcast control of acoustic releases of bottom stations (a solution for broadcasting control of an unlimited number of devices is possible);
- **Any tasks** where an analysis of the parameters of the aquatic environment and the bottom with distribution over the water area is required and obtaining data on a time scale close to the real

## ***Underwater GPS:***

- **Creating a fully scalable system, with the ability to cover any surface - obtaining a truly global underwater navigation system;**

## ***Internet of underwater things:***

- **Improvement of the system for working with an unlimited number of underwater nodes;**
- **Preparation for the supply of OEM solutions;**
- **Cooperation with educational and research institutions for: the development of more advanced versions of the upper level protocols; location of test sites on various water bodies with open access to data;**
- **Development of autonomous access points using solar panels and local power stations (current, tidal energy, etc.)**

Questions, please!

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