An Architecture for Ocean Bottom UnderWater Acoustic Sensor Networks (UWASN)

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Abstract

Ocean bottom sensor nodes can be used for oceanographic data collection, pollution monitoring, offshore exploration, and tactical surveillance applications. To make these applications viable, there is a need to enable underwater communications among sensors. Wireless Underwater Acoustic Networking (UWASN) is the enabling technology for these applications [1]. Underwater Networks consist of a variable number of sensors that are deployed to perform collaborative monitoring tasks over a given area. Some possible applications of the underwater acoustic sensor networks are *Distributed Tactical Surveillance*, *Ocean Sampling Networks (OSN)*, *Pollution Monitoring* and other environmental monitoring (chemical, biological, etc.), *Mine Reconnaissance*.

Major challenges in the design of underwater acoustic networks are: i) battery power is limited and usually batteries can not be recharged; ii) the available bandwidth is severely limited [2]; iii) channel characteristics, including long and variable propagation delays, multipath and fading problems; iv) high bit error rates; v) underwater sensors are prone to failures due to fouling.

The traditional approach for ocean-bottom is to deploy underwater sensors that record data during the mission, and then recover the instruments [3]. This approach has the following disadvantages: i) the recorded data cannot be accessed until the instruments are recovered, which may happen months after the beginning of the mission; ii) no interaction is possible between onshore control systems and the monitoring instruments; iii) if any failure or misconfiguration occurs, it may not be possible to detect them before the instruments are recovered; iv) the amount of data that can be recorded during the mission by every sensor is limited.

In order to overcome these disadvantages, a new architecture for ocean-bottom surveillance is proposed. A group of sensor nodes are anchored to the bottom of the ocean with deep ocean anchors. By means of wireless acoustic links, underwater sensor nodes are interconnected to one or more *underwater sinks* (uw-sinks), which are in charge of relaying data from the ocean bottom network to a surface station. Uw-sinks are equipped with two acoustic transceivers, an *horizontal* and a *vertical* one. The first is used by the uw-sinks to communicate with the sensor nodes, while the second is used by the uw-sinks to relay data to a *surface station*. Vertical transceivers must be long range transceivers for deep water applications. The surface station is equipped with multiple acoustic transceivers, one for each uw-sink deployed. It is also endowed with a long range RF or satellite transmitter to communicate with the *onshore sink* (os-sink) or to a *surface sink* (s-sink). Sensors can be connected to sinks by means of direct links or through multi-hop paths. In case of multi-hop paths, as in terrestrial sensor networks [4], data produced by a sensor is relayed by intermediate sensors until it reaches the uw-sink. This results in energy savings and increased network capacity. The objective of the architecture we propose is to exploit multi-hop paths and, at the same time, to minimize the signaling overhead necessary to construct underwater paths.

References

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