AUV-RM: Underwater Sensor Network Scheme for AUV Based River Monitoring

Stan Tyan[1], Seung-Hyun Oh[1]

[1] Department of Computer Science and Engineering,
Dongguk University, Gyeongju Campus 707, Sekjang-Dong,
Gyeongju 780-714, Gyeongsangbuk-Do, South Korea

{stan, shoh}@dongguk.ac.kr

Abstract. As over 70 percent of the earth's surface is covered by water, it is desirable to deploy underwater sensor networks to support river monitoring research applications. Underwater Acoustic Sensor Networks use acoustic waves and are characterized by long and variable propagation delays, intermittent connectivity, limited bandwidth and low bit rates. Within this research we propose a framework with a custom protocol stack for river monitoring. Proposed framework perfectly fits into the latest notion of Internet of Underwater Things architecture and in future can be utilized not only for the shallow river monitoring but also in such extended applications as pipeline surveillance, harbour security and fish farms monitoring.

Keywords: underwater, acoustic wireless sensor networks, Autonomous Underwater Vehicle (AUV), medium access control.

1 Introduction

Underwater acoustic communication is a hot research topic nowadays, since it is clearly seen as the enabling technology to establish a network of fixed and mobile underwater sensors. A range of scientific issues in underwater communication such as quite narrow available bandwidth and high propagation delay [1] are investigated. Increased interest in water resources has resulted in a growing number of infrastructures located near the rivers. In this work authors address this research area.

AUVs, or Autonomous Underwater Vehicles, is integral part of the Internet of Underwater Things (IoUT) [2] and have been used by scientific laboratories for over 40 years. Since then, technology has progressed allowing AUVs to have a variety of imaging, chemical, biological, acoustic, and oceanic sensors that can be changed with ease based on the needs.

Within this research we propose an AUV based UW-ASN Scheme for an effective river monitoring with hybrid architecture. The solution is based on custom flood type routing protocol and tailored MAC protocol. Proposed architecture, unlike any other existing solutions, carefully couples the routing protocol that is based on the FLOOD

algorithm [3], and custom MAC protocol tailored exactly for river monitoring requirements. This architecture provides higher throughput and conserves more battery power at mobile nodes by significantly reducing number of retransmissions.

The remainder of this paper is organized as follows. In Section 2 we briefly review related research studies. Section 3 introduces proposed solution for AUV based mobile UW-ASN and describes customized protocols used for our study. Finally, Section 4 draws the conclusion and future work.

2 Related Studies

An in-depth view of the IoUT was provided by Mari Carmen Domingo [2]. Its different characteristics, relevant application scenarios and main benefits have been described and thoughtfully discussed. Still, there are many research challenges that remain wide open for future investigation.

UAN10, a real world field experiment was conducted by Andrea Caiti et al [4]. Authors described the architectural design and implementation on AUVs of the Folaga class of a mission supervisor handling the communication, environmental sampling and decision-making tasks for the integration of the AUV.

3 Proposed Scheme Design

We find that user scenario constraints are often neglected. In this research practical, technical and economic constraints are as important as theoretical performance. For this reason we have chosen a relatively simple MACA protocol as a basis for our MAC layer and very simple routing protocol. We intend to show that this choice will perform well in our network and traffic scenarios.

The utilized network configuration used for this research can be seen on Fig. 1.

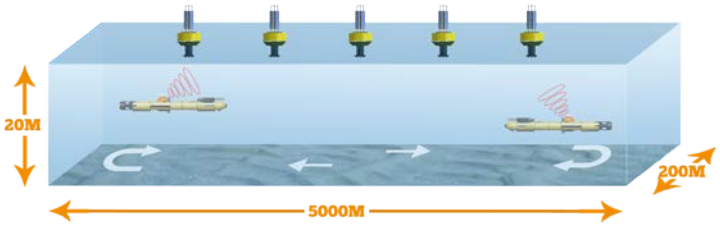

Fig. 1. River UW-ASN Deployment Scheme.

Most of the research works pertaining to underwater sensor networks have been on the issues related to physical layer [5], while issues related to network layer such as routing techniques are a relatively new area, thus providing an efficient routing algorithm, which becomes an important task.

AUV-RM's network discovery is based on the well-known flooding principle [3]. AUV node initiates the algorithm by sending a Flood packet. Every node hearing it repeats the Flood packet with a random delay.

The basic rule of the proposed MAC protocol scheme is: transmit without any control packets involved. In the challenging underwater environment exchanging Request To Send / Clear To Send (RTS/CTS) packets before actual data transmission is not justified due to low propagation speed in the water, as well as spending too much of throughput and energy on overhead packets and not data packets.

Basic MACA is not an optimal protocol regarding average delivery rate and medium utilization and several improvements of MACA for underwater communications have been proposed in the literature [6].

4 Conclusion and Future Work

In this paper, we have proposed an AUV based underwater sensor network scheme for river monitoring. Proposed approach utilizes efficient custom routing and Mac layer protocols in order to reduce data retransmissions, and therefore conserve more battery power.

There are several directions for future work. Performance of the proposed protocol must be thoroughly studied and evaluated using simulations to such metrics as throughput, end-to-end delay, collision rate and energy consumption.

Acknowledgments

This work was supported by the MKE (Ministry of Knowledge Economy) [A004700008], Development of realistic sense transmission system with media gateway supporting multi-media and multi-device.

References

1. Akyildiz, I.F., Pompili, D., Melodia, T.: Underwater acoustic sensor networks: research challenges. In: Ad Hoc Networks Journal 3, pp. 257-279 (2005)
2. Domingo, M.C.: An overview of the internet of underwater things. In: Journal of Network and Computer Applications, vol. 35, issue 6, pp. 1879-1890 (2012)
3. Rustad, H.: A Lightweight Protocol Suite for Underwater Communication. In: Advanced Information Networking and Applications Workshops, pp. 1172-1177 (2009)
4. Caiti, A., Calabro, V., Dini, G., Duca, A.L., Munafo, A.: AUVs as mobile nodes in acoustic communication networks: Field experience at the UAN10 experiment. In: Proc. IEEE OCEANS'11, pp. 1-9, Spain (2011)
5. Espada, J.P., Martínez, O.S., Lovelle, J.M.C., Bustelo, B.C.P., Álvarez, M., García, A.G.: Modeling architecture for collaborative virtual objects based on services. In: Journal of Network and Computer Applications, vol. 34, issue 5, pp. 1634-1647 (2011)
6. Tran, K.T.M., Oh, S.H.: A Cooperative MAC Scheduling Scheme for Underwater Sensor Networks. In: Applied Mechanics and Materials, vol. 295-298, pp. 903-908 (2013)