Lecture Notes on Data Engineering and Communications Technologies 65

Leonard Barolli
Juggapong Natwichai
Tomoya Enokido *Editors*

Advances in Internet, Data and Web Technologies

The 9th International Conference on Emerging Internet, Data & Web Technologies (EIDWT-2021)

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Welcome Message of EIDWT-2021 International Conference Organizers

Welcome to the 9th International Conference on Emerging Internet, Data and Web Technologies (EIDWT-2021), which will be held from February 25 to February 27, 2021, in Chiang Mai, Thailand.

The EIDWT is dedicated to the dissemination of original contributions that are related to the theories, practices and concepts of emerging Internet and data technologies, yet most importantly of their applicability in business and academia toward a collective intelligence approach.

In EIDWT-2021, topics related to information networking, data centers, data grids, clouds, social networks, security issues and other Web 2.0 implementations toward a collaborative and collective intelligence approach leading to advancements of virtual organizations and their user communities will be discussed. This is because, current and future Web and Web 2.0 implementations will store and continuously produce a vast amount of data, which if combined and analyzed through a collective intelligence manner will make a difference in the organizational settings and their user communities. Thus, the scope of EIDWT-2021 includes methods and practices which bring various emerging Internet and data technologies together to capture, integrate, analyze, mine, annotate and visualize data in a meaningful and collaborative manner. Finally, EIDWT-2021 aims to provide a forum for original discussion and prompt future directions in the area.

An international conference requires the support and help of many people. A lot of people have helped and worked hard for a successful EIDWT-2021 technical program and conference proceedings. First, we would like to thank all authors for submitting their papers. We are indebted to program area chairs, program committee members and reviewers who carried out the most difficult work of carefully evaluating the submitted papers. We would like to give our special thanks to the honorary chair of EIDWT-2021 Prof. Makoto Takizawa, Hosei University, Japan, for his guidance and support. We would like to express our appreciation to our keynote speakers for accepting our invitation and delivering very interesting keynotes at the conference.

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EIDWT-2021 Keynote Talks

Contract Tracing During Covid-19 Pandemic: An Australian Experience Synopsis

David Taniar

Monash University, Melbourne, Australia

Abstract. Contact tracing is the activity of retrieving historical activities and trips for a person where his presence at a specific location might affect other persons within a certain radius. Related to a contagious disease, an infected person might spread the pathogens to nearby people during close contact that can trigger a chain reaction of community transmission. The biggest problem in obtaining the historical activities in a contact tracing procedure is privacy and security issues. The privacy issue refers to private-related sensitive information that is not meant to be shared with anyone. However, during a contact tracing investigation, the authorities have the right to know every detail from a suspected patient. The security issue refers to the safety of the shared private information to the authority. Due to these issues, many patients are reluctant to share their past activities to the authority. This condition makes it even harder to obtain the right information from the patients. The next consequence is that the spreading of the diseases will be off the radar since contact tracing could not be done correctly. Several methods have been proposed to help contact tracing procedures. In general, there are two types of contact tracing methods: proximity-based and trajectory-based. While the proximity-based method lacks historical trips and suffers from multi-platforms communication issues, trajectory-based suffers from privacy issues. This speech will discuss these methods together with their pros and cons. In conclusion, a method that can preserve privacy and retain the details of the trip will also be explained in this session as an alternative method to support contact tracing.

Privacy Violation from Joint Attacks on Incremental Datasets

Juggapong Natwichai

Chiang Mai University, Chiang Mai, Thailand

Abstract. Data are continuously collected and grown; therefore, the privacy protection mechanisms designed for static data might not be able to cope with this situation effectively. In this talk, I will first present the possible privacy violations, attacks, which could occur, including a newly discovered type of violation and joint attack. After the attacks are formulated, then the characteristics of the privacy attacks are extracted in order to find approaches to preserve the privacy efficiently. Lastly, the preliminary experimental results will be presented.

Contents

Enhanced Focused Beam Routing in Underwater Wireless Sensor Networks

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Abstract. Multi-hop transmissions in Underwater Wireless Sensor Networks (UWSN) have limited bandwidth and not stable links. Their objective consists in relaying data from each underwater device to the internet. Routing Protocols for UWSN are responsible for relaying data to the water surface, where an acoustic to electromagnetic converter uses well-established wireless communications to further relay them. Focused Beam Routing (FBR) is a well-known routing protocol for UWSN, which considers as forward candidates, only active neighbors which location is inside a cone specified by the direction from the forwarding node to the destination, an arbitrary angle and the communication distance.

In this paper, we propose an Enhanced FBR, which considers the depth of each candidate and limiting forwarding of data on not deeper nodes, and call it Depth-Based FBR (dFBR). We implement both FBR and its enhancement version (dFBR) in ONE Simulator, and compare their performances with Epidemic Routing (ER), a well-known routing protocols for Delay Tolerant Networks. The simulation results show that FBR and dFBR outperform ER in terms of Delivery Probability in our scenarios, where the buffer size is limited to a 30 MB memory.

Keywords: Underwater Wireless Sensor Networks · UWSN · Focused Beam Routing · FBR · ONE Simulator

1 Introduction

Underwater communications are shifting from military towards commercial applications [6]. They are becoming more and more popular in applications such as disaster detection/prevention, pollution monitoring in environmental systems, collection of scientific data in fields of biology and geology, mapping ocean floors in oceanography, coordinated navigation control and so on [1]. A typical application scenario includes several Autonomous Underwater Vehicles (AUVs), which are equipped with a wide range of sensors (environmental, chemical, navigation

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and so on). They explore the seabed, use their sensors to collect data and submit the sensed data up to the sea surface, where air-water interface ships, boats or buoys are located (see Fig. 1). Furthermore, these air-water interfaces might also use electromagnetic waves to send the aggregated data back to monitoring centers or data processing centers.

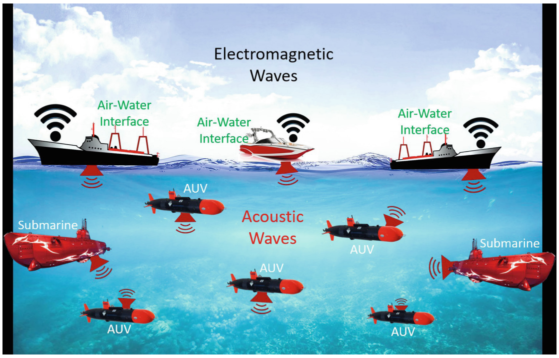


Fig. 1. Underwater acoustic communications and aerial wireless communications

The preferred communication media for underwater communications is acoustic waves in contrast to electromagnetic radio waves, which are widely used in the air. In fact, low frequency electromagnetic radio waves (30Hz–300Hz) can propagate for longer distances, but they require large antennae and high transmission power. Optical waves have better propagation, but they require directional coordination, which is almost impossible in underwater applications, where the devices are in constant movement [1].

Most of the research regarding the physical layer in underwater communications uses Phase Shift Keying (PSK) and Quadrature Amplitude Modulation (QAM) modulation techniques. With the increasing of processing capabilities of small devices, Orthogonal Frequency Division Modulation (OFDM) is also considered.

At the Medium Access Control (MAC) layer, Frequency Division Multiple Access (FDMA) does not work well with limited-band acoustic signals because they are affected by fading and multi-path [1]. Moreover, in acoustic communications there is a difference in delays between consecutive packets (jitter), which makes it very difficult to implement Time Division Multiple Access (TDMA) techniques. CDMA is so far the best solution, but newly designed techniques are yet to be developed, tested and implemented [2,5].

Because it is costly to implement network infrastructure in underwater environment, the network layer is mostly oriented towards adhoc architecture, where all participating nodes forward packets to other nodes, until the packets reach the intended destination. In fact, depending on the application, the adhoc architecture may consist of:

– Real-time data transmission, where participating nodes, either already know where to forward the received data, or the can find out in a very short amount of time. Such amount of time is usually considered as "the real time".
– Delay-tolerant data transmission, where different techniques are used to increase packet delivery ratio (PDR) even when there are no available routes to the intended destination. Delay-tolerant data transmissions, us the store-carry-forward paradigm, to transmit data from one node to another, until the data reach the destination.

Thus, existing adhoc and Delay Tolerant Network (DTN) Routing Protocols need to be redesigned, in order to deal with unstable links and high delay variance in underwater environment.

This paper's main objectives are: to introduce the implementation of FBR protocol, and compare its performance with Epidemic Routing (ER); and introduce an improved FBR, where the forwarding area is further narrowed down.

The remainder of the paper is organized as follows. In Sect. 2, we describe FBR, while comparing it to Epidemic Routing Protocol. In Sect. 3, we describe our simulation settings and discuss the simulation results. Then we conclude with conclusions and future works, in Sect. 4.

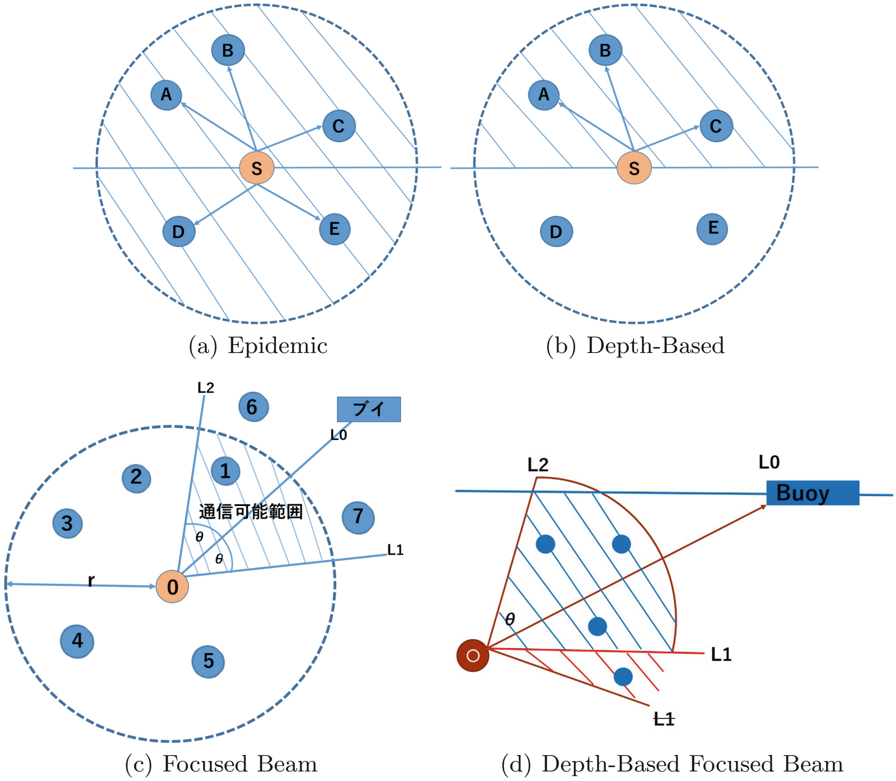
2 Focused Beam Routing

A more detailed description of FBR, can be found in [3]. Here we will shortly explain FBR in contrast to other routing paradigms in UWSN.

In UWSNs, the store-carry-forward paradigm is popular among routing protocols, hence Epidemic Routing (ER), which is visualized in Fig. 2(a), is the main forwarding technique. Here, the forwarding area is defined from the communicating distance, which in underwater environment is usually less than 100 m. One problem with ER protocol is that, the packets are copied to every possible relay node, creating a huge overhead in the network, which also impacts the network lifetime due to battery depletion. In fact in some applications, where nodes are scarce, the increased number of copies helps to increase the delivery probability, but in general, decreasing the overhead is beneficial for UWSN, because UWSN nodes also have limited storing resources.

Since the objective of routing protocols for UWSN in the majority of applications is to collect data to the modems in the water surface, and in order to decrease the number of copied packets, forcing nodes to strictly forward packets only to nodes that are closer to the surface has proven beneficial in terms of performance for these applications. This category of routing protocols is called depth-based routing (DBR) and is simplified in Fig. 2(b).

In order to furthermore decrease the overhead and energy consumption, some routing protocols, focus their forwarding area towards the surface data collector, and define it by a relatively small angle, as shown in Fig. 2(c). We implemented FBR as explained in the following.



(a) Epidemic (b) Depth-Based

(c) Focused Beam (d) Depth-Based Focused Beam

Fig. 2. Underwater routing protocol paradigms

2.1 Implementation of FBR in The ONE Simulator

While there are a lot of routing protocol proposed and implemented around the world, we could not find an open implementation of FBR that could be easily editable and verifiable in different scenarios. Thus we implemented FBR in the well-known The One Simulator. The following assumptions are made, in order to simplify the implementation:

- The environment is considered with only 2 dimensions: the width on the horizontal axis and the depth in the vertical axis.
- Every node knows every other nodes' location in every moment, which in fact is very difficult to achieve in reality without a well-established infrastructure.
- Every participating node is mobile and moves based on the Random Waypoint Mobility Model, as implemented in The ONE.

Table 1. Simulation parameters' settings

Parameters	Value
Number of buoys	1
Number of nodes	20, 40, 60
Movement model	Random waypoint
Simulation time	43200 s (12 h)
Simulation area	500 m × 500 m
Communication distance	50 m
Buffer size	30 MB
Message size	500 kB–1000 kB
FBR's angle (θ)	15°, 30°, 45°

– There is only one buoy, and all transmissions are directed towards this buoy, which is located in the middle top of our 2D environment.

Then, while referring to Fig. 2(c), whenever a participating node (node O) receives a new message or contacts a new node, the following happens.

Direction towards the Buoy is calculated as the angle in degrees of line L_0.
The angle of transmission θ defines the transmission area on both sides of line L_0. The new transmission area is confined by lines L_1 and L_2.
Communication distance confines the transmission area, which, in the best case scenario, is an arc.
Define the transmission area (shaded area), which makes the transmissions directed towards the buoy.

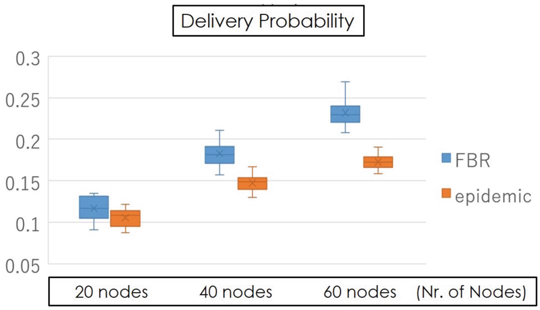
2.2 Depth-Based FBR

During our simulation phase, we noticed that, in some rare cases when the transmitting nodes were near the surface and far from the buoy, the performance of FBR would decrease. We introduced a depth-based hybrid version of FBR (dFBR), where, each node further limits their forwarding area to nodes that are not deeper than itself, as shown in Fig. 2(d). In some scenarios, especially when the FBR angle is relatively small, the depth-based limitation does not apply, but results in general show slightly improved performance, compared to the traditional FBR.

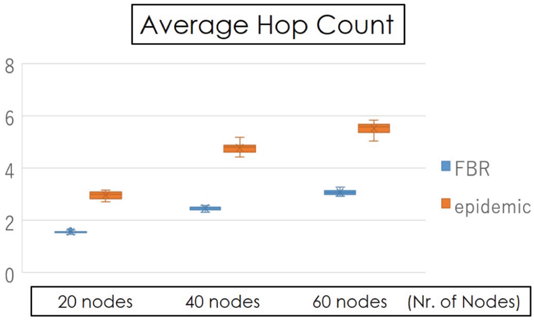
3 Simulations

In order to analyse the enhanced protocol, we conducted simulations in different scenarios as shown in Table 1. We used The ONE Simulator [4], which has already implemented the epidemic routing protocol and the store-carry-forward mechanism. We limited the buffer size of UWSN nodes, in order to see the effect of overhead packets.

In Fig. 3, we compare the delivery probability (DP) (number of delivered packets/number of sent packets) and average hop count (AHC) of the implemented FBR with ER for different number of nodes. The results show that ER has lower DP (see Fig. 3(a)), because nodes are forced to drop packets after their buffer has no more storage capacity. This can also be seen in Fig. 3(b), where we claim that packets are delivered in longer routes to the destination, because nodes in the optimal route have full buffers. We also noticed that, as the number of nodes increase, the delivery probability increases, because more routes become available to destination.



(a) Delivery Probability

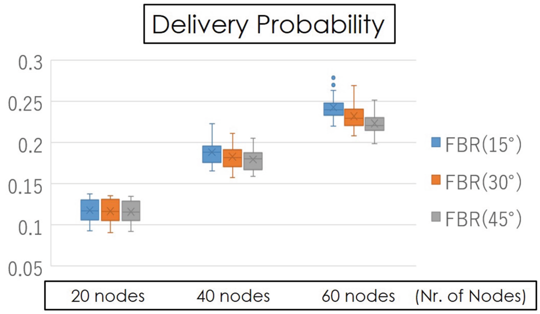


(b) Average Hop Count

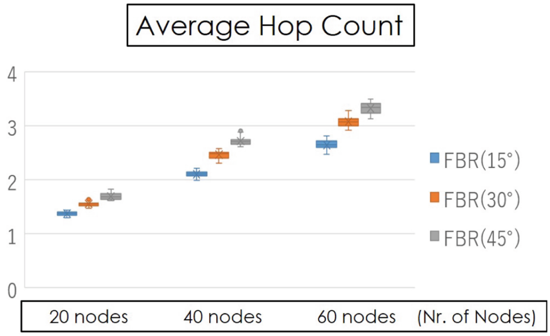
Fig. 3. Performance of FBR compared to Epidemic Routing, regarding the number of nodes.

In fact, ER is FBR with communication angle set to 180°. In order to investigate the effect of the communication angle in the performance of the network, we conducted the second simulations, with angles set to 15°, 30°, 45°. The results are shown in Fig. 4. When the number of nodes is small , the angle has almost no effect on delivery probability, but the average hop count increases when the angle increases. When the number of nodes is 40 and 60, the performance for both delivery probability and average hop count decreases, when the angle increases.

In Fig. 5, the performance of dFBR is compared to that of FBR, while the forwarding angle is changed from 15° to 45°. dFBR, slightly outperforms FBR in terms of DP, and we can clearly see that the AHC is smaller for dFBR. However, a thourough investigation is important to understand the effect of buffer size and other parameters.

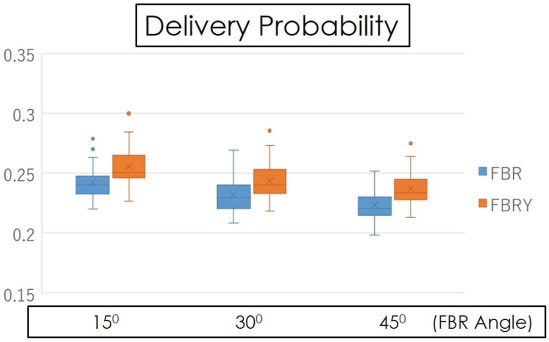


(a) Delivery Probability

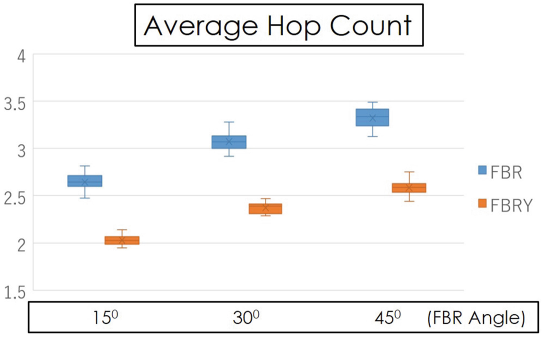


(b) Average Hop Count

Fig. 4. Performance of FBR compared for different angles, regarding the number of nodes



(a) Delivery Probability



(b) Average Hop Count

Fig. 5. Performance of dFBR compared to FBR, regarding the transmission angle.

4 Conclusions and Future Works

In this paper, we proposed an Enhanced FBR, which considers the depth of each candidate and limiting forwarding of data on not deeper nodes, and called it Depth-Based FBR (dFBR). We implemented both FBR and its enhancement version (dFBR) in ONE Simulator, and compared their performances with Epidemic Routing (ER), a well-known routing protocols for Delay Tolerant Networks. From the simulation results, we draw the following conclusions.

FBR shows better performance than ER, in scenarios where buffer size is relatively small.
When we increased the forwarding angle the performance of FBR decreased. The effect of the angle, shold be thouroughly investigated for all values af angle.
dFBR shows a slightly better performance than FBR. We still believe that FBR is suitable for a broad range of UWSN applications.

It still remains to be investigated the effect of forwarding angle in the energy consumption. This requires a deep analysis of MAC layer in UWSN and the acoustic spectrum.

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