Ship-to-Shore Wireless Communication for Asynchronous Data Delivery to the Remote Islands

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Abstract. Nowadays, many people who live in remote islands of Indonesia are still facing difficulties in terms of access to information. In the locations where end-to-end communication is not available, the asynchronous approach can be utilized to send information in the form of digital data. In some areas, we could utilize passenger ships or ferries as physical carriers to deliver digital data to the people in the remote islands which are located at a particular range of distance from the ship's passing routes. This paper reports the channel performance of long-range WiFi connection oversea at 5 GHz using the real ship's route at the North Sulawesi province's water in Indonesia as a sample scenario. The measurement results showed that the most stable ship-to-shore communication can be achieved in ±15 minutes at the maximum distance between the ship and shore of about 4 km. The maximum channel capacity was 120 Mbps for upload (from ship to shore) and 53 Mbps for download (from shore to ship), which is enough to deliver gigabytes of information to the people at the islands every time the ship passes by.

1. Introduction

Although according to the recent data two-third of the world population is now enjoying mobile phone connection [1], yet many people, especially at the small and remote islands remain completely cut off. These islands generally have a little population and low income, hence making them economically challenging for building out telecommunication infrastructure [2]. This situation brings difficulties for the inhabitants to communicate and to access information from the outside worlds.

In such locations where the end-to-end communication is not available, the asynchronous approach can be utilized to send information in the form of digital data. This approach usually uses vehicles that physically carry a computer with a storage device and a limited telecommunication module (usually WiFi) between remote areas in order to effectively create a data communication link [3, 4]. In some areas, such as in North Sulawesi province of Indonesia, we could utilize passenger ships or ferries as physical carriers to deliver digital data to the people in the remote islands which are located at a particular range of distance from the ship's passing routes. As the ships usually have regular routes and schedules, we could also expect that the data can be delivered in a timely manner.

This paper reports the channel performance of long-range WiFi connection oversea at 5 GHz using the real ship's route at the North Sulawesi province's water in Indonesia as a sample scenario.

2. Material and Methods

2.1. Sample scenario & experiment

As the solution proposed in this paper utilizes passenger ships as physical carriers to deliver digital data to the remote islands, it is necessary to determine a sample scenario in which the solution will be tested. To do this, a continuous GPS tracking from the deck of a passenger ferry traveling its typical route from Manado to Tahuna was conducted. The data showed that the ship was cruising at an average speed of 13.32 knot and passing by a small island of Makalehi (coordinate 2°43'38.2"N 125°10'38.4") at about 2.17 km of minimum distance to its shore. This island has a population of 1,287 in an area of 4.2 km2 and situated at the border of Indonesia's sea territory. Makalehi island was chosen as the sample of the scenario as it is categorized as one of the small and outer islands by the Government of the Republic of Indonesia, and currently has no reliable telecommunication infrastructure to provide any data connectivity.
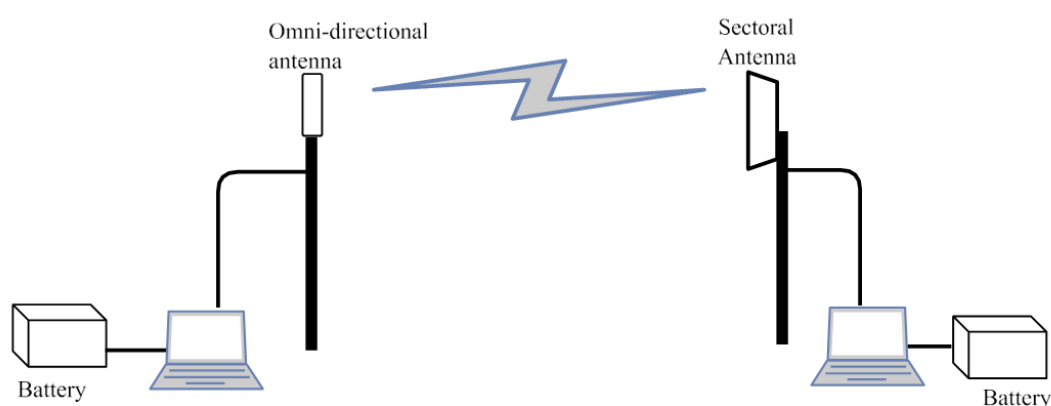

Figure 1: Configuration of equipment

To simulate the sample scenario, the experiment was focused to measure the channel capacity of long-range WiFi connectivity between a moving station on a chartered boat cruising at the same speed of passenger ship mentioned earlier (±13.32 knot), and passing by perpendicularly to a base station at the shore at least 2.17-km distance. The experiment was done at the Wori waters near Siladen island, while the base station was situated at a fishing dock of Bawoho village at the north of Manado city (coordinate 1°34'58.1"N 124°49'03.1"E).

2.2. Long-range WiFi antennas

The equipment of the long-range WiFi antenna system was separated into two subsystems: a) ship side, and b) shore side. The ship side used a dual polarity omnidirectional antenna (airMAX® Omni® AMO-5G13 from Ubiquiti Networks) with 13 dBi gain at 5 GHz, while the shore side used a sectoral antenna airMAX® AM-5G19-120 from Ubiquiti Networks) with 19 dBi gain at 5 GHz. Both antennas were elevated at 2 meters from the floor using iron tripods. Each of these antennas was connected to a wireless access point (Rocket®M AirMAX® Base Station from Ubiquiti), monitored remotely using a laptop connected to the access point using UTP cable. Due to the lack of power source at the boat and at the shore, all equipment at each side was powered by a deep-cycle 12V 100Ah battery (Luminous®) with an inverter. Figure 1 shows the configuration of the equipment.

3. Result and Discussions

Figure 2 shows the GPS tracking and timing of the ship's location while measuring the channel performance. The shore's base station is located at the mainland and showed as a white asterisk. The boat was cruising from north to southwest toward the channel between Tongkaina Cape and Bunaken Island.
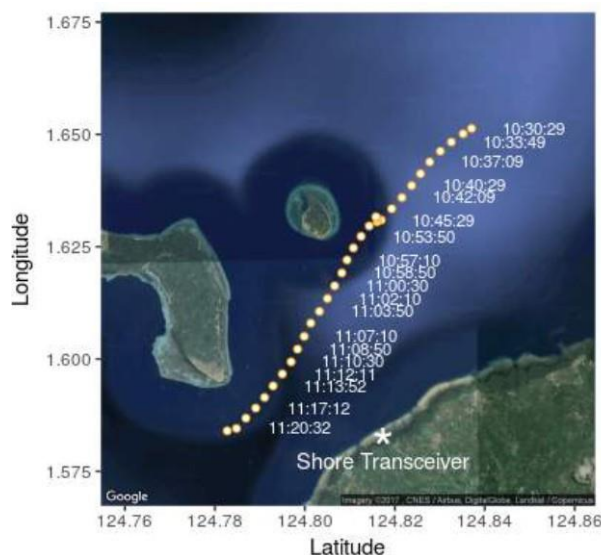

Figure 2: Ship's location GPS tracking

The measurement was done in the duration of 52 minutes and the ship's distance to the base station is shown in Figure 3. As can be seen from this figure, the ship's closest position occurred 39 minutes after the measurement began (Figure 4). Clearly, the signal levels changed proportional to the distance between the ship and the base station, as shown by Figure 5. Only for comparison, in Figure 5 we also included signal level's data from a directional antenna that was included in the experiment.

With a more focusing on the results from the omnidirectional antenna, the data of wireless channel capacity, which is the maximum amount of traffic or signal that can move over the communication channel [5], are shown in Figure 6 and 7. Tx channel capacity defines the capacity of data transmission from ship to the shore, while Rx channel capacity means the capacity from shore to ship. As shown from these data, the channel capacity of both Tx and Rx were increased significantly between 11:00 to 11:15 of the measurement time. The maximum Tx channel capacity was 120 Mbps and the maximum Rx channel capacity was 53 Mbps.
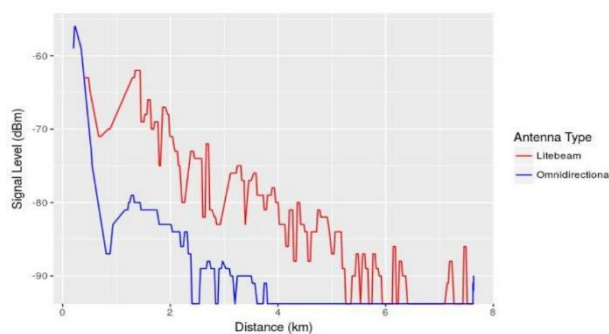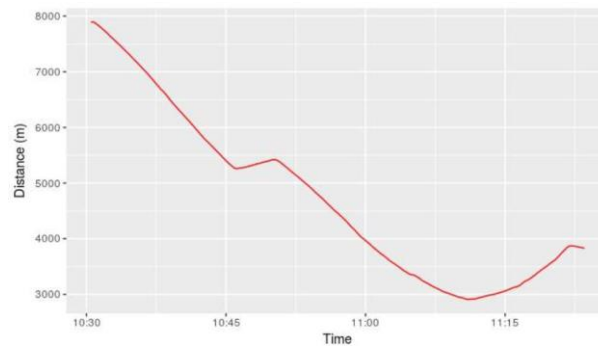

Figure 3: Distance to signal strength

The 1st International Conference on Sustainable Engineering Practices (IConSEP)   Penerbit Fakultas Teknik
Universitas Sam Ratulangi

Journal of Sustainable Engineering: Proceedings Series 1(1) 2019   doi:10.35793/joseps.v1i1.13

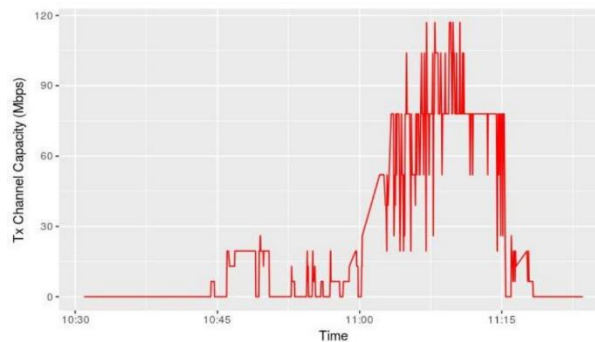Figure 4: Distance between the ship and the base station
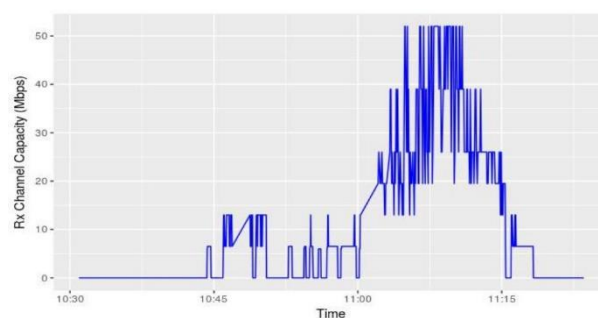

Figure 5: Upload Channel Capacity.

Figure 6: Download channel capacity

4. Conclusions

The measurement results showed that the most stable ship-to-shore communication can be achieved in a duration of ±15 minutes at the maximum distance between the ship and shore of about 4 km. The maximum channel capacity was 120 Mbps for upload (from ship to shore) and 53 Mbps for download (from shore to ship), which is enough to deliver gigabytes of information to the people at the islands every time the ship passes by. This shows that this asynchronous approach using ship-to-shore wireless communication can be used effectively for data delivery to the remote islands.

Acknowledgments

References

[1] GSMA Intelligence, "Definitive data and analysis for the mobile industry", 2017. [Online] Available: https://www.gsmaintelligence.com

[2] Mauro Margalho Coutinho, Alon Efrat, Thienne Johnson, Andrea Richa, and Mengxue Liu, "Healthcare Supported by Data Mule Networks in Remote Communities of the Amazon Region," International Scholarly Research Notices, vol. 2014, Article ID 730760, 8 pages, 2014. doi:10.1155/2014/730760.

[3] R. C. Shah, S.Roy, S.Jain, and W.Brunette, "DataMULEs: modeling and analysis of a three-tier architecture for sparse sensor networks," Ad Hoc Networks, vol.1, no. 2-3, pp.215–233, 2003.

[4] Shyam, "Connecting Remote Islands: GSM and Broadband Networks for Indonesia," Vihaan Networks Limited, 2015. [Online] Available: http://www.vnl.in/media/4989/16- vnl_br_connecting-remote-island_r2.pdf

[5] Techopedia, "Channel Capacity," [Online] Available: https://www.techopedia.com/definition/248 73/channel-capacity