Indonesian Journal of Electrical Engineering and Computer Science
Vol. 8, No. 3, December 2017, pp. 667 ~ 669
DOI: 10.11591/ijeecs.v8.i3.pp667-669

Nautical Ad-hoc Network Application Development for Maritime Communications

Samson Joseph
Department of Nautical Science
AMET University, Chennai

Abstract

High data rate communication in terrestrial wireless scenarios can be accomplished by setting up Base Stations (BS) on the ground. But applying the similar technique to maritime communication may not be suitable because owing to the geographically constrained nature of the ocean, henceforth, MF/HF modems, extensive-distance transmission characteristics with low data-rate are commonly employed in maritime communiqué. Inmarsat is conservatively used in Maritime satellite communiqué in order to reimburse for low data-rate transmission of MF/HF modems, but its main negative aspect is high cost. To improve the transmission speed along with low price, in general, a network whose architecture is similar to Vehicular Adhoc Network (VANET), that permits peer-to-peer transportation without BS, i.e., ad-hoc network is critical. An ad-hoc network for nautical environment named as Nautical Ad-hoc Network (NANET) was proposed. Multiple access and duplexing schemes are used to implement the nautical network for corresponding NANET scenarios.

Keywords*: High Frequency, Code Division Multiple Access/Collision Avoidance, NANET.*

1. Introduction

At present, HF and Very High Frequency (VHF) bands are used for the naval communication. A typical example of PACTOR-III is considered for maritime communication structure using HF band and its typical coverage lies between 4,000 km and 40,000 km. Development and analysis of AIS applications as an efficient tool for vessel traffic service is discussed by [1]. Another example of naval communication is Automatic identification system (AIS) utilised with the help of VHF band, which takes up Self-Organized Time Division Multiple Access (SOTDMA) to thwart conflict and safety information about the ships are provided for safety transportations. Modulation coding schemes for adaptive HF data communication system is described by [2]. To maintain elevated data rate transmission, satellite communication system is utilised that costs more expenses on announcement and end piece of equipment deployment. Comparative performance evaluation of MAC protocols in ad hoc networks with bandwidth partitioning is explained by [3]. At the moment, several researches explore the low cost clarification to the elevated data transmission on the ocean. High speed maritime mesh networks are described by [4]. TRITON project in Singapore utilises, researchers are difficult to build up a system based on the IEEE 802.16 interconnect mode and the 802.16e standard with higher data rate and up to 150km transmission range from the ports. Linked waters are discussed by [5]. In the 802.16 Mesh modes are proposed to be used in maritime infrastructure. In the case of port communiqué, it is potential to apply the implemented global wireless communiqué system with added deployment of Base Station on the coast, e.g., Wireless-broadband-access for SeaPort (WISEPORT). Routing in vehicular ad hoc networks is described by [6]. However it is not achievable to deploy BS on the sea and in the case of near shore and on the sea communication. To defeat this, mesh and ad-hoc network structure are modified, which have to believe the precise factors for maritime communiqué, such as mobility and the forwarded path of the ship, ship compactness on the sea, and ocean wave variation, etc. Mobile satellite communications and application-specific protocol architecture are discussed by [7] [8]. The drawback of Mesh/ad-hoc network for maritime communication can be overcome by using NANET, which includes manifold access and duplexing schemes for NANET to support the further research.

Received August 11, 2017; Revised October 24, 2017; Accepted November 15, 2017

2. Requirements for Maritime Wireless Communications

The function of detection, tracking, and examination presented by maritime communication scheme is incredibly imperative for the protective sailing and data transformation between ships, i.e., E-mail, Short Message Service (SMS), and etc, are essential. Effective dose reduction through ventilation scheme is discussed by. The dense distribution of ships are taken into consideration and analysed that the majority ships have supplementary than one ship within the remoteness of 30km to itself, generally 50km. In the case of VHF band modem, it can cover 30km with the data rate of 9.6~14.4kbps. If one ship has neighbouring ship surrounded by 30km, the mesh or ad-hoc network can be put up by multi-hop connections. But condition follows if no neighbouring ship surrounded by 30km; it's unattainable to create the mesh or ad-hoc network. It uses HF band modem by implementing dual mode operation.

2.1. NANET Structural Design in Shore:

If the ship falls under the base station then it can be able to exchange information directly with BS. Nevertheless, if a ship moves outer from the coverage area of BS, Mesh system have to be configured with erstwhile ships or buoy Access Point (AP) due to the nonappearance of straight association to the BS. The network architecture for the maritime wireless communications of the shore is shown in the figure 1. The dotted lines and solid lines in Fig. 1 signify the VHF band link for the maritime communications and the UHF band link for the terrestrial, respectively.

2.2. NANET Structural Design in Ocean:

BS is absent in the case of NANET ocean architecture of the network, for the reason that the ocean is too far from the ground territory and it is not sensible to set up BS on the sea. As a result, ad-hoc network is projected to be applied, which necessitates no BS's for peer-to-peer connections. Distinct the Mesh network in the shore, there is no readily available link to BS by multi-hop. If there is no ship within the transmission coverage area distance of very high frequency band modem then it should communicate using the active HF band modem. The transmission distance of HF band modem is approximately up to 40,000km; hence it can communicate in a straight line ith BS fixed in the land.

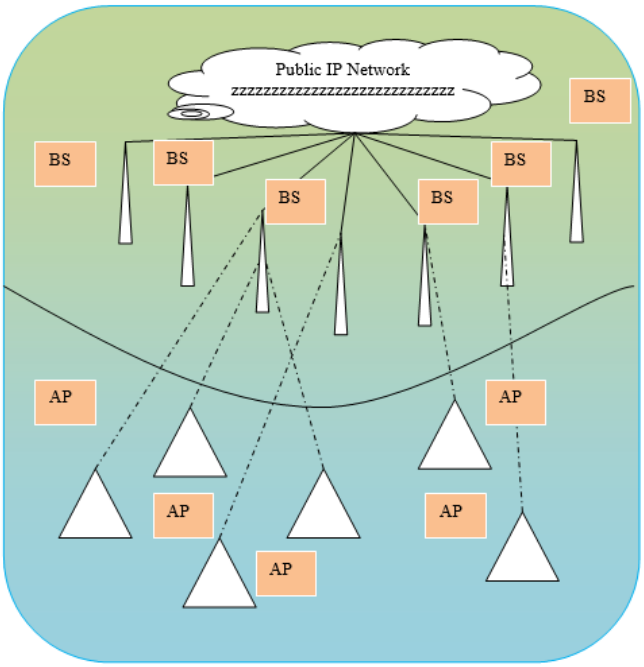

Figure 1. NANET Structural Design in Ocean

3. Multiple Access and Duplexing methods for Mesh Network:

The chief distinction among mesh and ad-hoc networks is the subsistence of BS in the network. Due to the BS in Mesh network, centralized arrangement algorithms for Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA) and congestion free multiple accesses can be used.

3.1. Multiple Access method for Mesh Network

In Mesh cases, base station utilizes centralized arrangement schemes, such as TDMA, FDMA and Code Division Multiple Access (CDMA) based Contention-free Multiple Access methods. M-WiMAX is selected for the baseline PHY layer, and features of TDMA and FDMA are analysed.

3.3. Duplexing Schemes for Mesh Network

The comparison between Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD) are analysed for duplexing method. The added carrier frequency in FDD increases the higher transmission rate in this method. Nevertheless, the added carrier frequency is expensive and the simultaneous broadcast and response roots to more hardware complication. In order to overcome the cost and hardware complications, TDD is used with lower communication data rate compared in the midst of FDD.

3.3. Throughput Analysis of NANET

Throughput is the average of successful data transmissions delivered to the base station with high transmission rate. The average throughput is predictable using equation 1.

$$Throughput = \frac{\sum_{0}^{n} Pkts\ Received\ (n) * Pkt\ Size}{1000} \quad (1)$$

4. Conclusion

HF and VHF bands have longer transmission range property since it is used for maritime communications. AIS is developed only because the VHF is not released for maritime communications, and the fact changes since the world two-way radio communication conference (WRC) 2007 where the VHF band has been owed for maritime infrastructure. By building mesh and ad-hoc network the basic scenario of NANET with low cost and high data rate in the VHF band are implemented. For harbour, the existing global communication network by installing BS near the shore. For shore and ocean, mesh and ad-hoc network is adopted with TDMA/TDD and CSMA/CA, respectively.

Reference

[1] S.J. Chang. *Development and analysis of AIS applications as an efficient tool for vessel traffic service.* In Proc. Oceans. 2004: 2249-2253.

[2] Abd Rahim Mat Sidek and Ahmad Zuri Sha'ameri, Ā. *Evaluation of modulation coding schemes for adaptive HF data communication system*. In Proc. IEEE NCTT. 2008: 267-272.

[3] Kaynia M., Oien G.E., Jindal N., and Gesbert, D. *Ā Comparative performance evaluation of MAC protocols in ad hoc networks with bandwidth partitioning*. In Proc. IEEE PIMRC. 2008.

[4] Shankar Pathmasuntharam, J., Peng-Yong Kong, Ming-Tuo Zhou, Yu Ge, Haiguang Wang, Chee-Wei Ang, Wen Su, and Harada, H., ĀTRITON: *High speed maritime mesh networks*. In Proc. IEEE PIMRC. 2008.

[5] Friderikos, V., Papadaki, K, Dohler, M., Gkelias, A., and Agvhami, H. Ā Linked waters. *IEE Commun. Engineer.* 2005; 3: 24-27.

[6] Fan Li and Yu Wang. Ā Routing in vehicular ad hoc networks: A survey. *IEEE Veh. Tech. Mag.* 2007. 2(2): 12-22

[7] W.W. Wu, EF Miller, WL Pritchard, RL Pickholtz. *Ā Mobile satellite communications*. Proceedings of the IEEE. 1994; 82 (9).

[8] W.B. Heinzelman, A.P. Chandrakasan, and H. Balakrishnam. An application-specific protocol architecture for wireless microsensor networks. *IEEE Trans. on Wireless Comm.* 2002; 1(4):660-670.