

Chapter 9

An Overview of Maritime Wireless Mesh Communication Technologies and Protocols

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ABSTRACT

Maritime wireless mesh networks (MWMNs) are conceived to provide network connectivity for maritime users and enable them to communicate with correspondent users connected to terrestrial communication networks. The high cost and low data-rate of satellite and other legacy maritime communication technologies and systems deployed in MWMNs pose major limitation to establish reliable and affordable maritime communications. In addition, the design of routing protocols in MWMNs remains a significant challenge due to the lack of reliable communication infrastructure and complexity of maritime environment. This paper explains the existing maritime communication technologies and routing protocols which could be deployed in implementing reliable MWMNs. Comprehensive guidelines are outlined to easily understand and critically assess the different deployed maritime communication networks and systems with routing protocols, and identify the milestones in the process of developing and implementing broadband MWMNs.

1. INTRODUCTION

Due to the immense evolution of terrestrial wireless communication systems, numerous services and applications have been brought for mobile users. However, the development of high data-rate maritime applications still requires more reliable communication technologies and routing

protocols to meet the requirements of maritime communications (Boreli, Ge, Iyer, Dwertmann, & Pathmasuntharam, 2009). Despite the rapid development of satellite-based maritime communications, the satellite communication technology remains expensive due to the cost of launching satellite into orbit and the required stabilizers for on-board antennas. Legacy ultra-high (UHF)

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and very-high (VHF) frequencies based maritime communications have small capacity and cannot support high data-rate applications (Bekkadal, 2009). The existing maritime wireless and radio communication technologies can only support basic applications and services, such as text messaging, email, and web surfing (Son, 2011; Ta, Tran, Do, Nguyen, Vu, & Tran, 2011). On the other hand, maritime business applications show a steep ramp in deploying onboard ship management systems for logistic, surveillance, telephony or email applications, security and other transport-oriented applications. Also, more maritime shipping companies are offering staff social multimedia communications onboard their ships. The trend to provide high data-rate applications for maritime users ultimately increases and diversifies the requirements of maritime communications, which cannot be converged with the basic maritime communication technologies such as satellite and legacy communication systems, from the data-rate, quality-of-service (QoS), and cost perspectives.

In the literature, a lot of research works have focused on the development of new and better maritime communication technologies; however, less attention has been devoted to integrate multiple maritime wireless networks and systems or expand terrestrial networks to sea. To address this, a wireless mesh technology based on long-range wireless technology (WiMAX) is, therefore, a right candidate to expand existing terrestrial networks to form large-scale maritime networks in water environments (e.g. sea or ocean). The satellite broadband very small aperture terminal (VSAT) service is rapidly changing maritime communications, as it can provide high data-rate transmission, acceptable QoS and compatibility with IP networks along with the last-mile wireless access technologies, such as IEEE 802.11, IEEE 802.16 and 3GPP standards for cellular access networks (Mu, Kumar, & Prinz, 2011). To efficiently utilize these wireless communication technologies, net-

work resources have to be allocated in an optimal manner such that communication services can be provisioned to users with high quality. Seamless handover between different networks is also necessarily to automatically switch to the best underlying communication network and take the advantage of the readily available services within this network.

Mesh networks (ITU-R, 2010) are regularly distributed networks that generally allow transmission only to nodes' nearest neighbors. Mesh networks can also be described as peer-to-peer networks, since the network nodes are assumed to be identical. Even though all nodes may be identical and have the same computing and transmission functionalities, certain mesh nodes can be designated as mesh group leaders which then take on additional leadership functions to form a mesh network. If a group leader is suddenly disabled, another node can then inherit this role to take over the group leadership duties and recover the network in a real-time manner.

Multi-hop routing protocols enable maritime users to communicate and establish maritime data network with correspondent users connected to terrestrial networks. Multi-hop ad-hoc routing protocols, such as optimized link state routing protocol (OLSR), ad-hoc on distance vector (AODV), ad-hoc on demand multipath distance vector (AOMDV), and dynamic source routing (DSR) protocols have been proposed for maritime wireless mesh networks. While they have been validated for MWMNs, none of them has been found to be efficient in MWMNs (Kong, Pathmasuntharam, & Wang, 2009).

Figure 1 depicts a typical mesh network that expands the terrestrial networks further in a water environment through mesh network using multi-hop routing connections.

To maintain inter-operability with the existent maritime communications deployment and guarantee reliable maritime communications, legacy maritime communication technologies

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