

UNIVERSITI TEKNOLOGI PETRONAS
UNDERWATER ACOUSTIC COMMUNICATIONS: DATA PACKET SIZE
OPTIMIZATION WITH PERFORMANCE METRICS OF THROUGHPUT
EFFICIENCY AND ENERGY EFFICIENCY QUALIFIED UNDER
DIFFERENT BIT-ERROR-RATE

by

LOW TANG JUNG

The undersigned certify that they have read, and recommend to The Postgraduate Studies Programme for acceptance of this thesis for the fulfilment of the requirements for the degree stated.

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Date : 20th February 2012

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hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTP or other institutions.

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ABSTRACT

The research in designing new underwater acoustic (UWA) routing protocols and UWA media access control (MAC) protocols has spurred up a great interest in the UWA research community. However there are only a handful of research works and publications on UWA channel parameter optimization, notably in the area of data packet size optimization in the context of UWA channel performance metrics and the related energy efficiency issue. At the current situation the author is able to find only a few published works on data packet size optimization for UWA communications in contrast to the similar works in the terrestrial radio wave wireless communications.

The author of this dissertation is thus motivated to embark on a research to find an effective mechanism or algorithm to determine the optimal data packet size for UWA data transmissions qualified by two of the UWA channel performance metrics (termed as 2Q), namely throughput efficiency and energy efficiency with respect to various bit-error-rate (BER). This research leads to the construction of various databases based on the two metrics (the 2Qs) under different BER conditions. These databases are to be indexed by the proposed algorithm as a look-up graph (or as look-up table) to determine the optimal data packet size for effective and efficient data transmission in the UWA channel. Extensive simulations were conducted using ns2 network simulator with its embedded MIRACLE packages running on Ubuntu platform.

Some field and laboratory experiments were also conducted to verify the proposed algorithm. It should be noted here that the proposed algorithm is for a one hop data transfer i.e. data transmissions between a source-sink pair of nodes only. Multi-hop data transmissions is left as a future research and development direction for the interested readers.

The ultimate objective of this research is to design, develop and thus to lay down fundamental basis for the development of a new data packet size optimization technique (or algorithm) for UWA communications. This research is applicable to tropical shallow waters (commonly defined for a depth of 50m to 200m) with medium range of transmission of up to 2km between a sink node and a source node.

ABSTRAK

Penyelidikan yang melibatkan rekabentuk protokol laluan (routing protocol) baru untuk akustik bawah air (ABA) dan protokol kawalan akses media telah mencetuskan minat yang tinggi dikalangan komuniti penyelidik ABA. Akan tetapi tidak banyak penerbitan yang didapati dari komuniti ini yang berkaitan dengan kerja-kerja mengoptimakan ciri-ciri saluran ABA, terutamanya dalam bidang mengoptimasi saiz bungkusan data dalam konteks matrik prestasi saluran ABA, dan isu-isu berkaitan dengan kecekapan tenaga. Hanya beberapa penerbitan sahaja yang dapat diperolehi yang berkaitan dengan kajian optimasi saiz bungkusan data untuk komunikasi ABA. Situasi ini agak berbeda berbanding dengan bilangan penyelidikan yang serupa di kalangan komunikasi tanpa wayar yang berasaskan gelombang radio.

Faktor-faktor di atas merupa motivasi utama bagi penulis disertasi ini untuk mencari satu mekanisme atau algoritma yang dapat menentukan saiz optima bungkusan data dalam proses penghantaran data di komunikasi ABA. Algoritma ini akan diuji oleh dua matrik prestasi saluran ABA iaitu kecekapan "throughput" dan kecekapan tenaga di mana kedua-dua matrik ini berkaitan rapat dengan kadar-ralat-bit (bit-error-rate: BER). Dalam kajian penyelidikan ini berbagai pengkalan data yang berdasarkan kedua-dua matrik itu dapat dibina menerusi BER yang berbeda. Pengkalan-pengkalan data akan diberi indek oleh algoritma yang dicadangkan sebagai geraf rujukan (atau jadual rujukan) untuk menentukan saiz optima bungkusan data bagi tujuan penghantaran data yang lebih efektif dan cekap dalam saluran ABA. Kerja simulasi yang menyeluruh telah dilaksanakan dengan menggunakan perisian

simulasi jaring ns2 berserta pakej-pekaj MIRACLE ns2 (pakej ABA yang terbenam dalam ns2) yang dikendali atas system kendalian Ubuntu.

Beberapa kajian luar dan ujikaji makmal juga telah dikendalikan untuk mengesahkan algoritma yang dicadang. Perlu dinyatakan di sini bahawa alogoritma cadangan itu adalah untuk pemindahan data satu langkah (one hop) iaitu pemindahan data antara pasangan nod sumber-penerima (source-sink pair of node) sahaja. Penghantaran data untuk serba-langkah (multi-hop) telah ditinggalkan sebagai kerja kajian/penyelidikan dan pembangunan masa depan untuk penyelidik-penyelidik yang berminat dalam bidang ini.

Objektif muktamad penyelidikan ini adalah untuk mereka, membina dan menjadikan asas untuk membangunkan satu teknik (atau algoritma) baru yang boleh mengoptimakan saiz bungkusan data dalam komunikasi ABA. Skop kajian ini ialah untuk perairan cetek tropical (definasi lazim untuk perairan 50m hingga 200m dalam) dengan jarak penghantaran sehingga 2km di antara nod penerima dan nod sumber.

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