

REVIEW PAPER

MOBILE HYBRID DATA BARGES–ROLE OF THE NAVY IN CLOUD COMPUTING AND INTERNET ACCESS

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Abstract

The Nigerian Navy faces significant challenges due to low budgetary allocations in comparison to advanced naval organizations across the globe. The occurrence of COVID–19 pandemic is also envisaged to result in significant budget cuts thereby affecting the navy’s ability to meet its goals. This challenge can be addressed by transforming the role of the Nigerian Navy. The discussion in this paper identifies the roles that the Nigerian Navy can play in enabling the emergence of a new era in information and communications technology via the use of maritime resources for the support of computing. In addition, the paper recognizes the revenue earning potential and the leading role available to the Nigerian economy as a technology developer and enabler in the context of the blue economy.

Keywords – *Nigerian Navy, Information and Communication Technology, Transformation*

1.0 INTRODUCTION

The navy plays an important role in using technology for securing maritime resources and conducting its routine ocean patrols. It is also important for the navy to morph in responding to its operational challenges. This is especially important in developing countries like Nigeria where pressing budgetary allocations imply that fewer capital resources are made available to the Nigerian Navy (Nkala, 2017; Martin, 2014). The low budgetary allocation to the Nigerian navy has resulted in low maritime securing capacity as the Nigerian navy does not have a sub-marine (Salau, 2016). Nigeria’s Navy Director of Information, Commodore Christian Ezekobe is noted to have said that Nigeria plans to acquire a submarine as part of the Revised Nigerian Navy Transformation Plan (R–NNTP). However, prevailing economic realities make the realization of this goal a challenge for Nigeria. The probability of budgetary cuts should be expected to increase due to the negative economic outcomes accompanying the COVID–19 pandemic. This makes the acquisition of a submarine less feasible and more challenging.

In addition, oil dependent nations with significant maritime resources have experienced a revenue decline due to the occurrence of COVID-19. A solution that addresses this challenge is required. Such a solution can be realized by identifying new applications for maritime resources. This enhances the revenue generating capacity of maritime resource applications. In this case, the identified application is useful in a post – oil era.

Therefore, it is important for the Nigerian Navy to transform into a revenue generating organization without compromising on its core maritime security mandate. The discussion in this paper recognizes this need and proposes that the Nigerian navy can play an important role in cloud computing and the enabling of internet access in Nigeria and West Africa. The Nigerian navy has the potential to generate significant income by playing a crucial role in the provisioning of infrastructure for enabling internet access, data storage and computing. This is because of the increasing demand for internet access in Nigeria and the West African region. However, it is important to propose, identify and design new technological solutions that can reposition the Nigerian Navy to play this role. This should be done while recognizing the important role of other similar technological infrastructure. A suitable infrastructure in this regard is sub-marine cable networks that convey traffic in a bi-directional manner between Nigeria and other countries. However, sub-marine cables do not provide data storage or computing capabilities. Instead, they focus on high throughput data transfer.

An emerging technological area that makes use of maritime resources is that of ocean-based data center cooling. This area is of key significance because of the increasing relevance of online content. For example, web portals, services and social media sites such as Google, Microsoft outlook, Office 365, Facebook, WhatsApp, and Netflix have data centers playing a key and an integral role. The hosting of data centres is also important for ensuring conformance to standards on data sovereignty. This is because of the key role that data access plays in national security, an important goal for the Nigerian Navy.

The Nigerian Navy is tasked with the key role of combating against the efforts of piracy. However, this battle is fought in a single – sided manner. This is because the main method of mitigating against piracy is via naval patrol where naval staffs often engage in combat and subsequently arrest suspected pirates. It is important to consider the role that social media i.e. information on sites such as Facebook, Twitter, Instagram, and WhatsApp can play in developing a smarter approach to ensuring security. In addition, it is essential that the Nigerian Navy and other naval forces in West Africa find other approaches to generate revenue that complements their budgetary allocations.

The challenge of discharging the mandate of maritime security and defence necessitates a transformation of the Nigerian Navy from its current role. The Nigerian Navy command has a significant potential to play a key role in technological development, provide regulatory oversight in addition to providing robust, smart and sophisticated maritime security. For example, the United States Navy has played a key role in the birthing and development of the internet. The pioneering role of the United States Navy has given it a significant control over the Dark-Net via the development and controlled distribution of

enabling browser software such as TOR (Martin, 2016, Salau, 2014). However, the Nigerian Navy plays a less involving role in comparison to the United States Navy especially in the area of the internet development and access. Nevertheless, the Nigerian Navy has the potential to play a significant role in this regard; and also use the benefits of this position to address operational challenges. The discussion of the prospects in this regard is the aim of this paper.

The discussion in this paper proposes the transformation of the Navy from an organization that provides national security services to one that is capable of playing a key role in the internet age while generating revenue, enable the emergence of new technologies that are useful from a national perspective; and also provide maritime security in a sophisticated manner by leveraging on technological advances. The discussion in this paper makes the following contributions:

- 1) First, it proposes a mobile hybrid data barge suitable for the provisioning of data storage and access services; and also acting as a data centre network node that provides internet access. The mobile hybrid barge is intended to enable the Nigerian Navy earn external income (internally generated revenue). The resulting income is suitable for use in the acquisition of sophisticated maritime security hardware such as sub-marines. The proposed mobile hybrid barge functions as a network node and also executes traffic analysis. In addition, multiple mobile hybrid barges can be deployed in the designated sub-surface regions of maritime resources. Furthermore, mobile hybrid barges are deployed in arrays and equipped with video and camera for remote maritime surveillance purposes.
- 2) Second, the paper presents an intelligent maritime security mechanism that analyses outbound social media traffic from Nigeria. The aim of the proposed analysis is to detect patterns that indicate the presence of malicious elements i.e. pirates and could be pirates planning the operation and execution of maritime related crimes. In this role, the mobile hybrid barge functions as a network traffic analyzer. The mobile hybrid barge functioning in this capability can alert the naval command station of results detected as regards the patterns and presence of malicious intents. The implied data transmission is realized via satellite with global coverage. However, low cost communication methods can also be used where deemed necessary.

The rest of the paper is structured as follows. Section 2 presents the technology and payload architecture of the proposed hybrid data barge. Section 3 discusses the role of the proposed mobile hybrid data barge in enabling internet access and enhancing the provisioning of improved, smarter and sophisticated and improved maritime security. Section 4 discusses the potential benefits of the proposed solutions to the Nigerian economy. Section 5 concludes the paper.

2.0 PROPOSED HYBRID BARGE-DESIGN AND SUB-SYSTEMS PAYLOAD

The ocean has been recognized to be capable of hosting data centers in cloud computing platforms. This is because of the ocean's cooling capability that reduces the data center

operational costs. The use of the ocean in this manner is recognized by Microsoft (Roach, 2018; Cutler, 2017) and Google (Gough, 2015, Carroll, 2013). Additional research addressing the technological requirements and potential of underwater data centers can be found in (Periola, 2019; Periola, 2020).

Microsoft aims to deploy underwater data centers in the sub-marine environment i.e. below the ocean's surface. Google in (Gough, 2015, Carroll, 2013) proposes the use of barges sited on the ocean's surface as data centers. The ocean barge being proposed by Google utilizes the ocean's water for its cooling. The locations i.e. underwater location and ocean surface have their trade-offs. Data centers that are located in the sub-surface interact closely with marine life and pose more threats to marine bio-diversity than data centers located on the ocean's surface.

The proposed mobile hybrid data barge aims to combine the benefits of sub-surface and ocean surface locations. The barge can change locations from a sub-surface region to the near ocean surface region. This case is described as the first transition. It can also move from near ocean surface region to a sub-surface region at a given depth. The change of location in this manner is called the second transition. The first transition is necessitated by different conditions such as the need to transmit data to the naval command station via satellite. It is also important for the mobile hybrid data barge to execute the first transition when onboard energy sources are depleted and recharging via solar arrays at the surface is required. In this case, transition to the surface is necessary when electricity generated from wave and tidal energy at sub-surface region is low.

The second transition is important when underwater monitoring is required. It is also essential to transition from the near surface ocean region to the sub-surface ocean region when near surface ocean region have a high temperature. In addition, the second transition becomes important when wave or tidal energy significantly exceeds solar energy that can be received via incident solar irradiation at near-ocean surface.

The mobile hybrid data barge determines and executes the required transition via an onboard intelligent decision making sub-system. In addition, the proposed barge incorporates additional sub-system that interact to enable it deliver its expected functionality. These additional sub-systems are:

1) Hybrid Power Sub-System: The mobile hybrid data barge derives its operational electrical power from an onboard battery array. The battery array is initially charged prior to the deployment of the hybrid data barge. In addition, the battery array is charged via onboard marine electrical converters or solar panels. The marine electrical converter generates electricity from wave or tidal energy in the sub- surface or near ocean surface region. The solar panels are stowed in the mobile hybrid data barge and are de - stowed when the mobile hybrid data barge migrates to the near ocean surface and is exposed to incident solar irradiation.

2) Electromechanical Sub-System: In the hybrid data barge, the electromechanical sub-system comprises of motors that enable barge motion in either the first transition

or second transition. The motors derive their operational power from the hybrid power sub-system. The use of servomotors is preferred in the realization of the electromechanical sub-system because of their easy programmability and integration with motion sensors. The input of the motion sensors integrated with servomotors in the electro-mechanical sub-system are used for decision making by the computing sub-system.

3) Computing Sub-System: The computing sub-system is realized via an onboard computer. The onboard computing is realizable via an array of Raspberry Pi modules or other embedded onboard computing modules. The computing sub-system executes the logic that determines when the first transition and second transition are necessary. In executing this role, the computing sub-system hosts data and program storage entities i.e. hard disks, read only memory and random-access memory modules.

4) Data Sub-System: The data sub-system hosts servers enabling the realization of the functionality of the data center in the proposed hybrid data barge. The servers enable the proposed mobile hybrid data barge to execute the functionality of data storage, social media access and network node. The number of servers hosted by the data sub-system is determined by program plan, budget, capabilities of the power subsystem and electro – mechanical subsystem. In addition, the data sub – system hosts a heat exchanger module that enables the storage and use of ocean water for server cooling.

5) Communication Sub-System: The communication sub-system enables the reception and transmission of data by the hybrid data barge. The component of the communication sub-system depends on the deployment strategy that is used in the design of the hybrid data barge. The communication sub-system can leverage on the wide coverage of sub-marine cable coverage. The use of sub-marine cable is essential when the use of the mobile hybrid data barge for the analysis of data traffic (security purposes) is intended. In this case, the mobile hybrid data barge incorporates an optic cable interface and functions as a node in sub-marine fibre optic cable network. Essentially, the main communication is realized subject to the coverage of sub-marine fibre optic cable network. The fibre optic cable network is connected to a communications facility hosted by the Nigerian Navy.

The block diagram of the mobile hybrid data barges showing relation between the power, electromechanical, computing, data and communication sub-systems is presented in Figure 1.

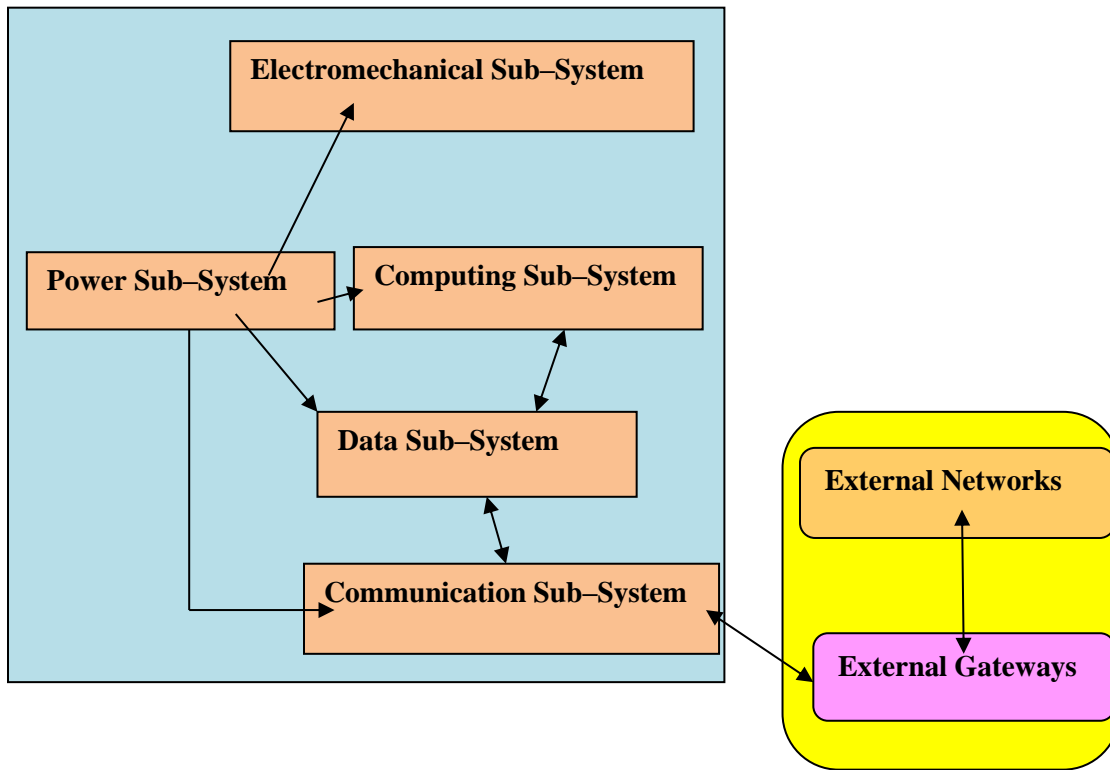


Figure 1: Relations between sub-systems in the mobile hybrid data barge and external networks.

A flowchart showing the execution of the functionalities of the power and electro – mechanical sub–systems is presented in Figure 2.

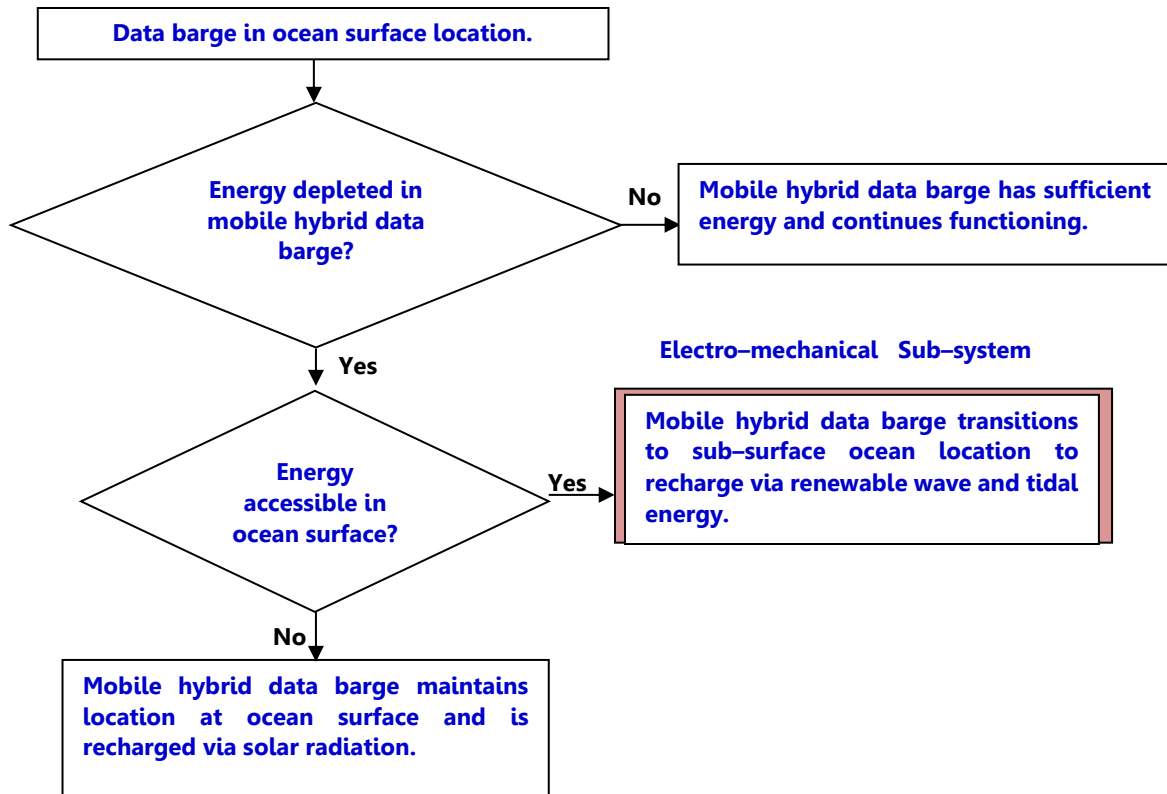


Figure 2: Flowchart showing execution of functionalities in the proposed mobile hybrid data barge.

Block diagram showing the execution of the functionalities of the computing, data and communication sub-systems is presented in Figure 3.

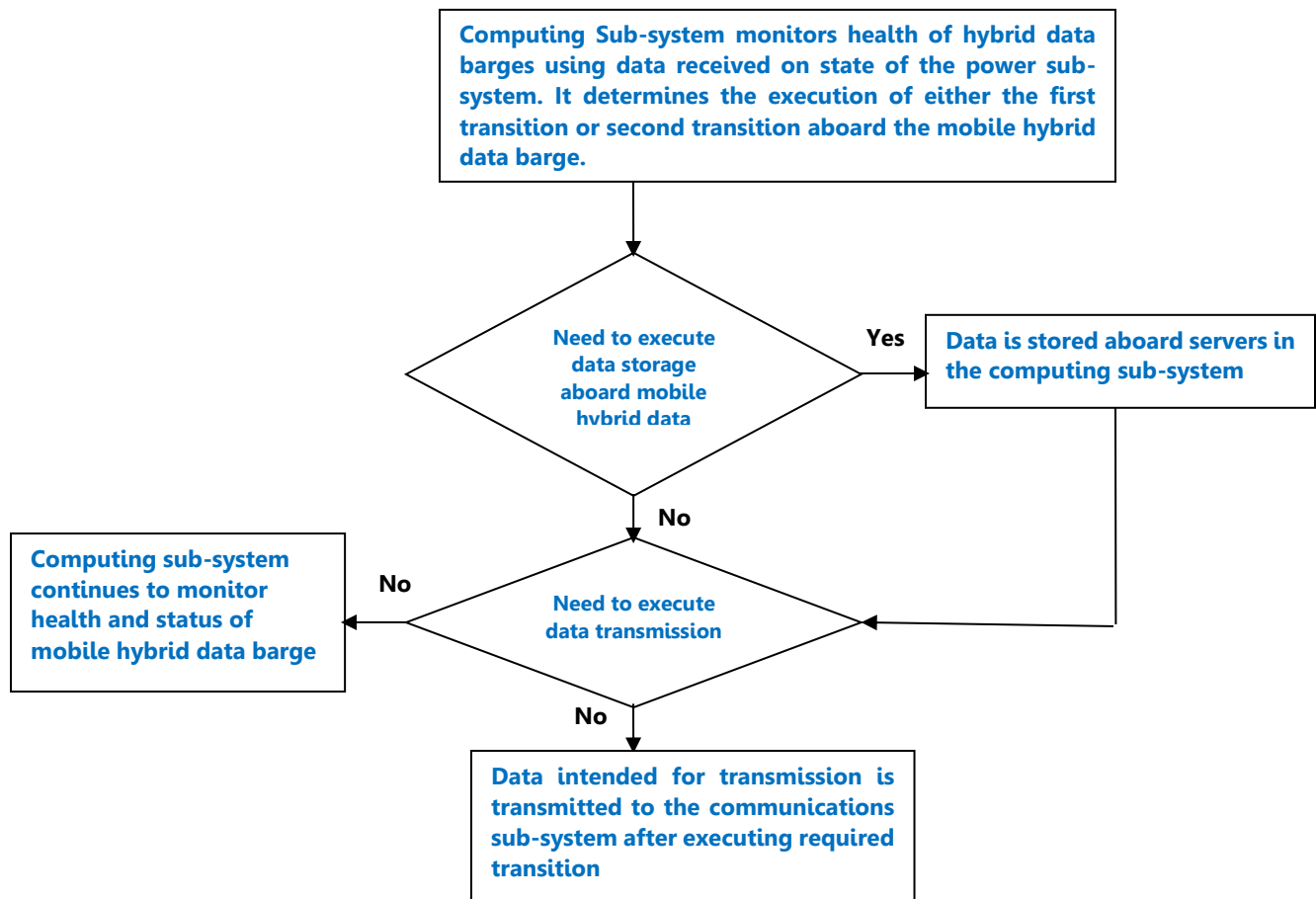


Figure 3: Execution of tasks enabling data storage and transmission in the proposed mobile hybrid data barge.

3.0 MOBILE HYBRID DATA BARGE – SECURITY AND ENABLING SUPPORT FOR INTERNET ACCESS

The need to provide internet access is recognized to be important on a global scale. Currently, internet provisioning services are mostly operated by telecommunications and internet service providers. However, there is insufficient access to the internet especially in select maritime communities within developing countries. This challenge is also applicable to Nigeria. The use of the proposed mobile hybrid data barge in an array formation and deployment is suitable for the provisioning of internet access in Nigeria’s maritime communities. The analysis of content access trends is an important capability that can be used by the Nigerian Navy in executing its maritime security mandate. For example, traffic traversing the mobile hybrid data barge can be analyzed for usage of words and phrases that are sensitive to naval security. Examples of such are oil bunkering, how to identify ship cargo, and getting access to ship route information. The detection of

such phrases especially by individuals who are not working in registered maritime companies and organizations can be deemed as security red flags.

The inferred analysis is realized by integrating the mobile hybrid data barge as a core component of the internet exchange point. The mobile hybrid data barge being used in this manner analyses the traffic for the detection of sensitive words and phrases in an automated manner without human intervention. This is necessary to ensure the confidentiality of non–security sensitive traffic. In the case of the detection of security–sensitive traffic, additional human intervention is required to capture a profile of the social media handle i.e. the person who owns the account for further analysis. Further analysis in this context implies developing a profile of the person concerned for further verification.

In addition, the Nigerian Navy can also provide specialized support services for the use of the mobile hybrid data barge when used in different roles within telecommunication networks and applications. This is necessitated by the need to provide ubiquitous internet connectivity. However, this is currently hampered by the availability of suitable and enabling technology. In providing the support for internet access, the proposed mobile hybrid data barge can function in three roles. These are **(i)** online content cache aggregator, **(ii)** network edge node and **(iii)** network integrated enterprise data center.

A mobile hybrid data barge can also be used to realize the functionality of a content cache aggregator. In this capacity, the mobile hybrid data barge stores information on frequently accessed content. The online content cache aggregator is connected to a central network entity such as the Nigerian internet exchange point. Nigeria has internet exchange points at five locations i.e. Lagos, Abuja, Port Harcourt, Enugu and Kano. Port Harcourt, Lagos and Enugu are maritime locations that can host hybrid data barges that execute the function of aggregating frequently accessed online content. The online content cache aggregator enables a reduction in the access latency of frequently accessed content.

A network edge node essentially enables the provision of cloud computing services to specialized services in a given location. In contrast to a data center, the use of a network edge node enables the storage and access of data at low latency. In its role as a network edge node, the proposed mobile hybrid data barge enables the analysis of network traffic with maritime security preferences. The network edge node essentially hosts network data analytic algorithms. The role of the network edge node can be used by entities such as enterprise cloud computing service providers such as MainOne, Rack Data Center, Information department of international oil companies and the Nigerian Navy. The Nigerian Navy is in a vantage position to provide support services for the use of the mobile hybrid data barge by these entities. In addition, the use of the proposed mobile hybrid data barge in these applications can be brokered by telecommunication service providers who now subscriber to the Nigeria’s Navy technical capabilities.

Furthermore, the proposed mobile hybrid data barge can be used as an enterprise data center. The proposed data center is realized via the combination of several data barges in an array. This is because a data center is intended to provide a significant storage capability being expected to function as a data center. A data center can provide functionalities enabling the delivery of enterprise data storage capabilities for different organizations. The use of data centers in this capability has a low cooling cost due to the significant benefits of cold water from the maritime resource.

The Nigerian Navy has a significant technical resource that can propel and enable the development of the proposed hybrid data barge. In addition, the Nigerian Navy can also provide ongoing technical support for the functioning of hybrid data barges deployed in the roles of an online content cache, network edge node and large-scale enterprise data center.

4.0 POTENTIAL BENEFITS

The design, development and deployment of the mobile hybrid data barge can enlarge Nigeria's economy from the perspective of the blue economy. The use of the mobile hybrid data barge provides new opportunities beyond the current reliance on oil exports for revenue. This is because of the increasing role of data services in Nigeria and West Africa economy. The use of the proposed mobile hybrid data barge in the role of an online content cache aggregator, network edge node and enterprise data center can provide significant benefits in terms of delivering internet connectivity. In its role as the provider of key and enabling technical support, the Nigerian Navy stands a significant chance of earning crucial revenue that can be used to strengthen the execution of its mandate in the provisioning of its core maritime security mandate.

Besides the revenue earning benefit, pioneering the efforts in the use of the mobile hybrid data barge gives the Nigerian Navy a regulatory head start. It positions the Nigerian Navy in to develop experience-based standards that are suitable for future entrepreneurs and start-ups. This is beneficial for the growth of the blue economy sector in Nigeria and also in West Africa where Nigeria plays a leading role.

5.0 CONCLUSION

The discussion in this paper identifies the need for the Nigerian Navy to transform and generate more revenue to finance its operations. This is necessitated by the capital constraints being experienced by the Nigerian Navy since Nigeria is a developing nation. In addition, the paper proposes a pathway and identifies potential applications in the aspects of enabling future cloud computing by leveraging on Nigeria's maritime resources. The paper proposes the mobile hybrid data barge for the realization of different applications in the context of the rapidly growing information and communications technology industry in Nigeria. The discussion in the paper also recognizes different roles and capabilities in which the proposed mobile hybrid data barge can be used in networking applications. Furthermore, the role of the Nigerian Navy as a technology support service provider with revenue earning potential is identified and discussed. Additional work is needed in the area of determining the suitability of different

maritime resources, alignment with national objectives in the blue economy initiative and the ability of maritime resources to support network components. Furthermore, future research will focus on the role of the proposed mobile hybrid data barges in complementing terrestrial wireless networks quality of service in maritime areas.

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