International Journal of Computing and Corporate Research

ISSN (Online) : 2249-054X

Volume 6 Issue 2 March 2016

International Manuscript ID : 2249054XV6I2032016-1

TIME CRITICAL APPLICATIONS AND DESIGN ISSUES IN UNDERWATER SENSOR NETWORKS

***Mr Pramod H B*[1]** ***Dr. Rajeev Kumar*[2]**

[1] *Research Scholor*

Department of Computer Science & Engineering

Shri Venkateshwara University,

Gajraula, India

hbpramod@gmail.com

[2] *Associate Professor*

Department of Computer Science & Engineering

Sri Venkateshwara University,

Gajruala Uttarpradesh,India

dr.r.kumar@ieee.org

ABSTRACT

Underwater Sensor Network (UWSN) or Acoustic Transmission below ocean is one of the emergent domains of research in the domain of wireless technology. There are assorted segments of research in various dimensions including energy optimization, effective routing, security, integrity, power optimization and many others. As in UWSN, there are major issues of non-reachability and energy harvesting which are addressed in many works. In this research manuscript, the time critical applications and issues in such virtual networks are underlined. In this paper, the extracts and findings from various protocols and algorithms in UWSN are investigated and proposed an effective approach for multipath communication so that the overall performance of network can be enhanced. In the concluding segment, the paper suggests multilevel transmission and dynamic clustering of data to be transmitted to ship installed base stations and then towards satellite. In this approach, the efficiency and related parameters can be optimized with higher degree of resource optimization.

Keywords - Acoustic Sensor Networks, Time Critical Applications, Underwater Sensor Network

INTRODUCTION

As we wholly classifies that computer science had magnificently positioned the sensor network on earth and on human body but still underwater is unscathed area and two third portion of globe is enclosed with seawater. Underwater sensor networks (UWSN) are the emergent and auspicious announcement framework which empowers a wide range of imperative applications. The characteristics of partial existing bandwidth, huge propagation delay and high bit fault rate (BFR) have posed several essential challenges . Unmanned or Autonomous Underwater Vehicles (UUVs, AUVs) equipped through underwater sensors, are also envisioned to discovery application in exploration of natural below marine resources and gathering of scientific data in collaborative monitoring missions. These potential applications will be complete viable by enabling communications amongst underwater devices. Underwater Acoustic Sensor Networks

(UW_ASNs) will entail of sensors and vehicles positioned underwater and network via acoustic links to perform collaborative monitoring tasks.

Underwater acoustic sensor networks enable a broad range of applications, including :

- Ocean Based Sampling Network
- Environment Based Monitoring
- Undersea or Underwater Exploration
- Disaster Management and Prevention
- Seismic Based Monitoring
- Equipments Monitoring
- Assisted Navigations
- Distributed and Tactical Surveillance
- Mine exploration

ACOUSTIC UWSN DESIGN AND CHALLENGES

Many applications of WSN have numerous restrictions but here we focuses on Underwater Wireless Sensor Network constraints such as partial energy resource, incomplete computing power and slow data broadcast rate of the wireless communication links concerning sensor nodes.

Several of the design encounters are summarized below:

- Deployment of nodes
- Limited Energy and Computational Capacities

- Memory Aspects
- Network Dynamics
- Energy and Power Efficiency
- Clustering and Aggregation
- Node and Link Heterogeneity
- Fault tolerance, Reliability and Integrity

CONSTRAINTS IN UWSN

Underwater Sensor Network or UWSN is having the unique constraint compared to the classical traditional networks having the implementations of security measures which are not practicable. In classical terms, such constraints are result of the limitations regarding sensor nodes, memory, energy, power, and transmission and processing power and due to ad hoc as well as wireless channel. Such constraints making the design of security based procedures more complicated are been categorized into the node constraints and network constraints

NODE CONSTRAINT

Security solutions require high computation, memory, storage and energy resources which creates an additional challenge when working with tiny sensor nodes. The specifications of three different types of nodes used in wireless sensor networks: Crossbow's MICA2, CSIRO's FLECK and Crossbow's I mote.

- Limited Memory
- Limited Energy
- Computation Factor

International Journal of Computing and Corporate Research

ISSN (Online) : 2249-054X

Volume 6 Issue 2 March 2016

International Manuscript ID : 2249054XV6I2032016-1

SOURCES FOR HARVESTABLE ENERGY

- Ambient Energy Source
- Human Power

BENEFITS OF ENERGY HARVESTING

- Reduction on the dependency factor of battery power
- Reduction in the installation cost
- Reduction in the maintenance cost
- Providing the long-term support and solutions

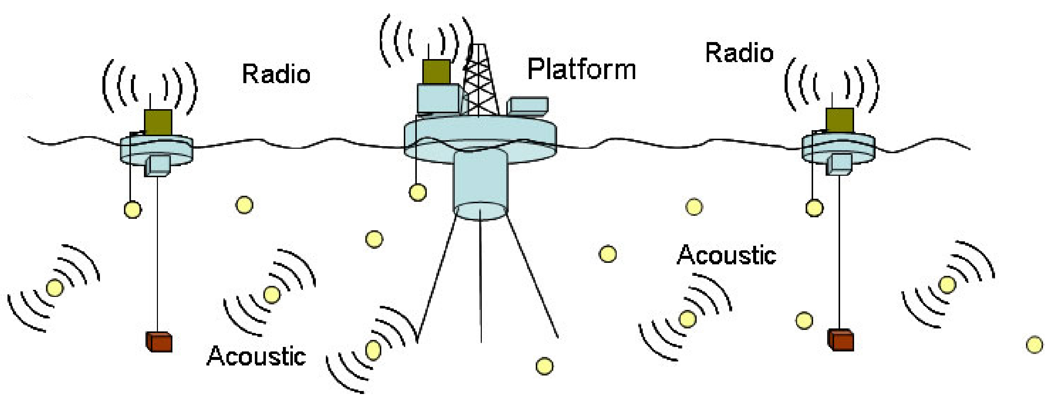

Figure 1 – Classical Dimensions of Acoustic UWSN

ENERGY MODEL IN UWSN

As energy is the major constraint in Underwater Sensor Networks. In this model the innovative mechanism is proposed for the energy resource for the sensors castoff in underwater, the conversion of tidal energy into the electrical energy, so the positioned sensors will not exoneration after limited days in assessment of using the Li-Ion batteries.

As tidal energy is a form of kinetic energy which is derived from the below equation

$$\mathbf{E} = \frac{1}{2} m \mathbf{v}^2$$

There are two types of tides, which are mentioned below:-

- Solar Tide → It is based on the Sun.
- Lunar Tide → It is based on the Moon.

As if we compare both tides we find that the height of lunar tide is more than the solar tide ∵ of gravitational power of moon, so we can say that in the night we find the high tides, due to that more energy generation is there. According to the study of ocean current we find that every moment there are tides through which we can generate the electrical energy for the sensors which we positioned in the ocean at various levels.

- **Height of Solar Tide**

  As we study in the day time at the top of the oceans there are the tides of 1Mtr. If we go downwards in the ocean at 500Mtr the height of tide is 2-3Mtr and if we go again 500Mtr down in the ocean then the height of tide is 4-5Mtr.

- **Height of Lunar Tide**

  As we study in the day time at the top of the oceans there are the tides of 2Mtr. If we go downwards in the ocean at 500Mtr the height of tide is 3-4Mtr and if we go again 500Mtr down in the ocean then the height of tide is 5-6Mtr.

DFD FOR ENERGY MODEL IN UWSN

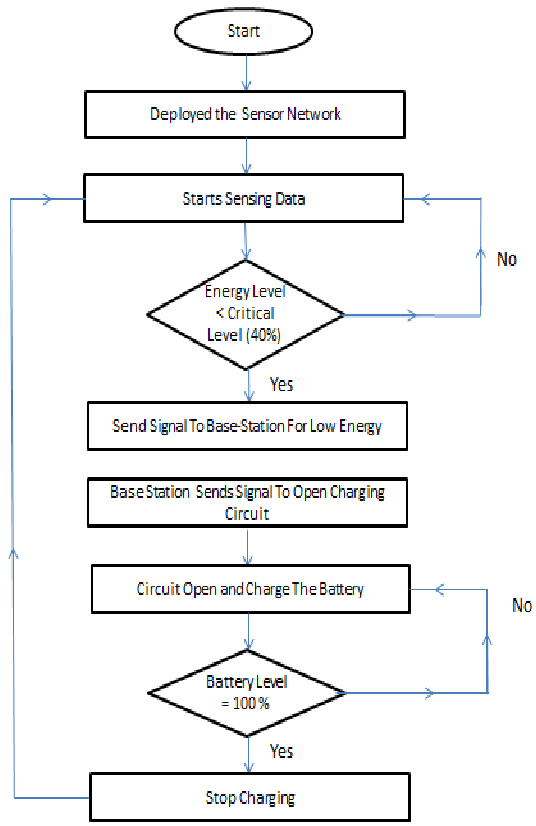

Figure 2 - Data Flow Diagram of Energy Model

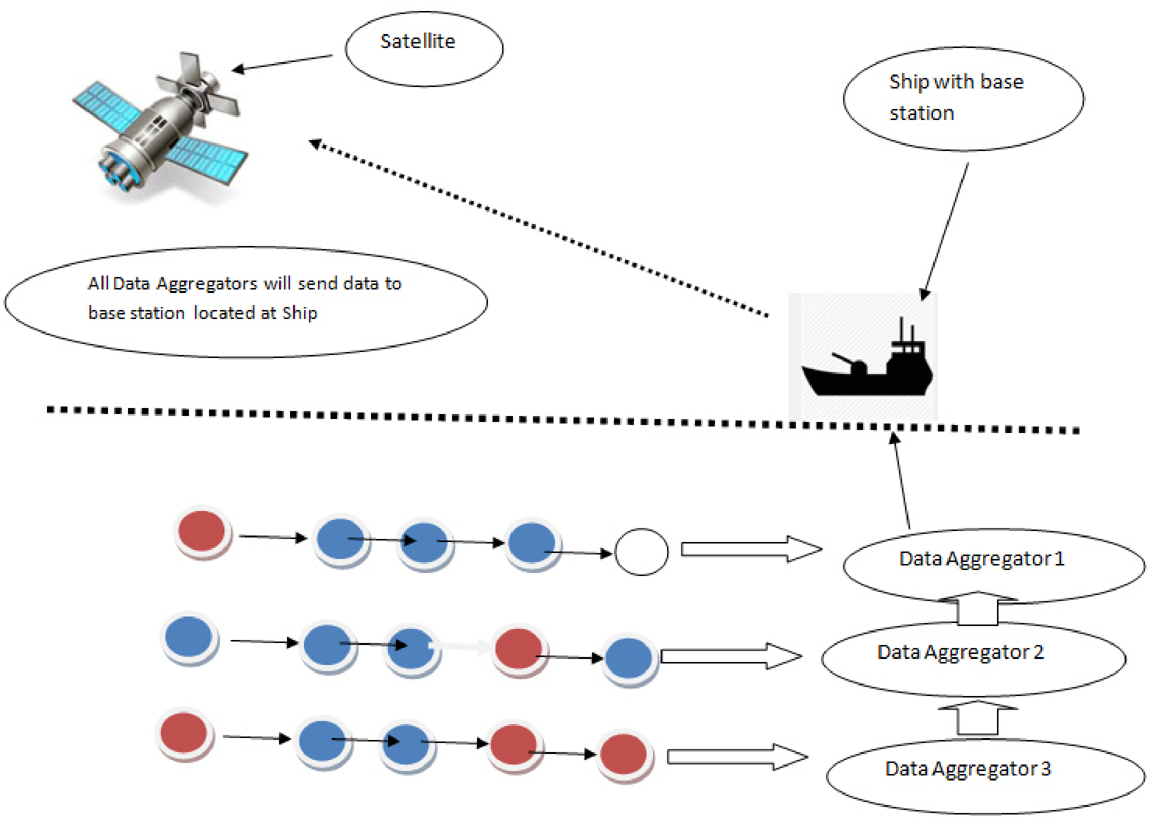

Figure 3 – Proposed Architecture of Energy Optimization and Design Aspects

Blue color nodes are full battery. Red color with less battery. If any node is less than 30% batter or any given threshold, it will be shown in red. After that base station will send signal to red nodes to activate their chargers to recharge themselves.

IMPLEMENTATION ASPECTS OF ENERGY RE-GAIN

First we derive the Basic Equation for Tidal Energy and that equation is implemented if and only if it is dimensionally correct. So the basic equation of tidal energy is mentioned below:-

$$e = \frac{1}{2} * a_{layer} * \rho_{sw} * g * h_t^{\ 2} \qquad (1)$$

Where:-

e = Energy

a_{layer} = Area of Basin

ρ_{sw} = Density of Water (1025 kg/m^3)

g = Acceleration due to gravity (9.81 m/s^2)

h_t = Height of Tide

Unit of a = m^2

Unit of ρ = kg/m^3

Unit of g = m/sec^2

Unit of h = m

$$e = m^2 * \frac{kg}{m^3} * \frac{m}{s^2} * m^2 \qquad (2)$$

After calculation of **equation 1** we find the result mentioned below;-

$$e = \mathcal{K}g\,(\frac{m^2}{s}) \qquad (3)$$

Now as we know the tidal energy belongs to Kinetic Energy so after calculating the kinetic energy we will find the same results, which is as shown below;-

$$\mathcal{KE} = 1/2 \ m\, v^2 \quad \textbf{(4)}$$

$$\mathcal{KE} = \mathcal{K}g \left(\frac{m^2}{s}\right) \quad \textbf{(5)}$$

As comparing **equation 3 & 5** we can say that the **equation 1** which we are using for implementation of energy is true

Out of total energy, only 30% of it can be utilized. So, net energy available

$$e = 30\% \ of \frac{1}{2} \ a\rho g h^2$$

$$e = 0.15 \ a\rho g h^2 \quad \textbf{(6)}$$

Now substituting the value of ρ & g.

$$e = 0.15 \ * a * 1025 * 9.81 * h^2$$

$$e = 1508.29 * a * h^2 \quad \textbf{(7)}$$

ENERGY AT TOP LEVEL (SEA LEVEL)

Assume that height range of tide is 1 m, so energy produced in the area of 500m*500m is

a = $2.5*10^5 m^2$

Now putting the values of **area and height of tide** in **equation 7** to find energy produced at top level (**E_{top}**) form tidal energy.

$$E_{top} = 1508.29 * 2.5 * 10^5 * 1^2$$

$$E_{top} = 3770.7 * 10^5$$

$$E_{top} = 3.8 * 10^8 J$$

After converting above equation into the mJ, the equation is

$$E_{top} = 3.8 * 10^{11} \, mJ \qquad \textbf{(8)}$$

The result comes out in the **equation 4** is the energy utilized for N number of sensor nodes deployed in the entire area (say the number of node is 500). So the energy utilized by 1 sensor (**E_{1top}**) is mentioned below:

$$E_{1top} = 3.8 * 10^{11} \, / \, 500$$

$$E_{1top} = 7.6 * 10^{8} \, mJ \qquad \textbf{(9)}$$

Now the conversion of Tidal Energy into Electrical Energy

From the principle of conservation of energy, the energy supplied by the tidal waves will be the electrical energy produced by the transducers. So electrical energy produced by 1 Transducer in the **Top Layer**.

$$E_{1top} = 7.6 * 10^{8} \, mJ \qquad \textbf{(10)}$$

Now converting the above electrical energy into Volts

It requires 1C or 1500 mA of current to charge a 5V Li-Ion Cell, where T_{tp} is total power generated for Li-Ion cell at top level;-

$$T_{tp} = E \, / \, C$$

$$T_{tp} = 7.6 * 10^{8} \, / \, 1$$

$$T_{tp} = 7.6 * 10^{8} \, V \qquad \textbf{(11)}$$

ENERGY AT MIDDLE LEVEL (SEA LEVEL)

Assume that height range of tide is 3 m, so energy produced in the area of 500m*500m is
$a = 2.5*10^5 m^2$

Now putting the values of **area and height of tide** in **equation 7** to find energy produced at middle level form tidal energy, where E_{mid} is the middle level of ocean.

$$E_{mid} = 1508.29 * 2.5 * 10^5 * 3^2$$

$$E_{mid} = 3770.7 * 10^5 * 3^2$$

$$E_{mid} = 33.9 * 10^8 J$$

After converting above equation into the mJ, the equation is

$$E_{mid} = 33.9 * 10^{11} \, mJ \tag{12}$$

The result comes out in the **equation 12** is the energy utilized for N number of sensor nodes deployed in the entire area (say the number of node is 500). So the energy utilized by 1 sensor is mentioned below:

$$E_{1mid} = 33.9 * 10^{11} / 500$$

$$E_{1mid} = 6.78 * 10^9 \, mJ \tag{13}$$

CONVERSION OF TIDAL ENERGY INTO ELECTRICAL ENERGY

From the principle of conservation of energy, the energy supplied by the tidal waves will be the electrical energy produced by the transducers. So electrical energy produced by 1 Transducer in the **Middle Layer**.

$$E_{1mid} = 6.78 * 10^9 \, mJ \tag{14}$$

CONVERTING THE ABOVE ELECTRICAL ENERGY INTO VOLTS

International Journal of Computing and Corporate Research

ISSN (Online) : 2249-054X

Volume 6 Issue 2 March 2016

International Manuscript ID : 2249054XV6I2032016-1

It requires 1C or 1500 mA of current to charge a 5V Li-Ion Cell, where T_{mp} is total power generated for Li-Ion cell at middle level;-

$$T_{mp} = E / C$$

$$T_{mp} = 6.78 * 10^9 / 1$$

$$T_{mp} = 6.78 * 10^9 V \quad \textbf{(15)}$$

ENERGY AT BOTTOM LEVEL (SEA LEVEL)

Assume that height range of tide is 3 m, so energy produced in the area of 500m*500m is

$a = 2.5*10^5 m^2$

Now putting the values of **area and height of tide** in **equation 7** to find energy produced at middle level form tidal energy, where E_{mid} is the middle level of ocean.

$$E_{bot} = 1508.29 * 2.5 * 10^5 * 5^2$$

$$E_{bot} = 3770.7 * 10^5 * 5^2$$

$$E_{bot} = 94.3 * 10^8 J$$

After converting above equation into the mJ, the equation is

$$E_{bot} = 94.3 * 10^{11} mJ \quad \textbf{(16)}$$

The result comes out in the **equation 12** is the energy utilized for N number of sensor nodes deployed in the entire area (say the number of node is 500). So the energy utilized by 1 sensor is mentioned below:

$$E_{1bot} = 94.3 * 10^{11} / 500$$

$$E_{1bot} = 18.86 * 10^9 mJ \quad \textbf{(17)}$$

CONVERSION OF TIDAL ENERGY INTO ELECTRICAL ENERGY

From the principle of conservation of energy, the energy supplied by the tidal waves will be the electrical energy produced by the transducers. So electrical energy produced by 1 Transducer in the **Middle Layer**.

$$\mathbf{E_{1bot} = 18.86 * 10^9\ mJ} \quad \textbf{(18)}$$

CONVERTING THE ABOVE ELECTRICAL ENERGY INTO VOLTS

It requires 1C or 1500 mA of current to charge a 5V Li-Ion Cell, where T_{bp} is total power generated for Li-Ion cell at middle level;-

$$\mathbf{T_{bp} = E / C}$$

$$\mathbf{T_{bp} = 18.86 * 10^9 / 1}$$

$$\mathbf{T_{bp} = 18.86 * 10^9\ V} \quad \textbf{(19)}$$

CONCLUSION AND SCOPE OF FUTURE WORK

In this work, an effective proposal towards the acoustic UWSN design is presented with the mathematical formulations. In the proposed model and multilayered architecture, the results can be found effective and having high integrity. In the future work, the metaheuristic approaches can be used for global optimization.

REFERENCES

[1] Ismail, N. S. N., Hussein, L. A., & Ariffin, S. H. (2010, May). Analyzing the performance of acoustic channel in underwater wireless sensor network (UWSN).

In Mathematical/Analytical Modelling and Computer Simulation (AMS), 2010 Fourth Asia International Conference on (pp. 550-555). IEEE.

[2] Yunus, F., Ariffin, S. H., & Zahedi, Y. (2010, May). A survey of existing medium access control (MAC) for underwater wireless sensor network (UWSN). In Mathematical/Analytical Modelling and Computer Simulation (AMS), 2010 Fourth Asia International Conference on (pp. 544-549). IEEE.

[3] Ahmed, N., Abbas, W. B., & Syed, A. A. (2012, November). A low-cost and flexible underwater platform to promote experiments in UWSN research. InProceedings of the Seventh ACM International Conference on Underwater Networks and Systems (p. 4). ACM.

[4] Yan, H., Shi, Z. J., & Cui, J. H. (2008). DBR: depth-based routing for underwater sensor networks. In NETWORKING 2008 Ad Hoc and Sensor Networks, Wireless Networks, Next Generation Internet (pp. 72-86). Springer Berlin Heidelberg.

[5] Shin, S. Y., Lee, S. J., & Park, S. H. (2009). MA: Multiple Acknowledgement Mechanism for UWSN (UnderWater Sensor Network). Journal of Korea Multimedia Society, 12(12), 1769-1777.

[6] Di Pietro, R., & Guarino, S. (2013, April). Data confidentiality and availability via secret sharing and node mobility in uwsn. In INFOCOM, 2013 Proceedings IEEE (pp. 205-209). IEEE.

[7] Vieira, L. F. M., Kong, J., Lee, U., & Gerla, M. (2006). Analysis of aloha protocols for underwater acoustic sensor networks. Extended abstract from WUWNet, 6.

[8] Wang, Y., Li, F., & Dahlberg, T. A. (2008). Energy-efficient topology control for three-dimensional sensor networks. International Journal of Sensor Networks, 4(1-2), 68-78.

[9] Caruso, A., Paparella, F., Vieira, L. F., Erol, M., & Gerla, M. (2008, April). The meandering current mobility model and its impact on underwater mobile sensor networks. In INFOCOM 2008. The 27th Conference on Computer Communications. IEEE. IEEE.

[10] Anguita, D., Brizzolara, D., & Parodi, G. (2009, June). Building an underwater wireless sensor network based on optical: Communication: Research challenges and current results. In Sensor Technologies and Applications, 2009. SENSORCOMM'09. Third International Conference on(pp. 476-479). IEEE.

Dr Rajeev Kumar received the M Tech and Ph D degrees in Computer Science & Engineering from Bhagwant University Ajmer, India, in 2013; He is Associate Professor College of Computer Science & Information Technology (CCSIT), Teerthanker Mahaveer University, Moradabad, and Uttar Pradesh, India. He is authored and coauthored more than 79 papers in refereed international journal and conferences like American Institute of Physics, New York Science international Journal New York City (USA), American Science Journal, BioInfo science Journal, Academic science of international journal (USA), International Journal of researcher, American Journal of Physics (USA) and many international Conferences and National Conferences, like IIT Roorkee (International Conference) etc. and serve as editor of different international journal, serve as a committee member in many IEEE , Springer International Conferences. In Books

publication 2 books published in international from USA and one contribution as book chapter in Taylor & Francis publication. His Current research interests in the area of Cloud Computing Wireless sensor network.

Mr. Pramod H B received B E and M Tech degrees in Computer Science & Engineering from Visvesvaraya Technological University, Belagavi, and Mysore University, India, in 2009 and 2012 respectively. He is an Assistant Professor in the Department of Computer Science & Engineering at the Rajeev Institute of Technology, Hassan. His Current research interests in the area of Wireless sensor network, mobile computing design and analysis.