A Review on Underwater Wireless Sensor Networks

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Abstract- Underwater Wireless Sensor Networks (UWSNs) support various applications like pollution monitor, tsunami warning, offshore exploration, planned surveillance, etc. Distinctive top features of UWSNs like low available bandwidth, large propagation delay, highly dynamic network topology, and high error probability pose many challenges for designing efficient and reliable communication protocols. This paper has reviewed extension of IAMCTD (Improved Adaptive Mobility of Courier nodes in Threshold-optimized DBR protocol for UWSNs) that's targeted on enhancing network reliability and throughput for critical-range based applications. Extension of IAMCTD scheme avoids control overhead that has been contained in IAMCTD for implementing changes thorough threshold. The movement pattern of courier nodes alongside reducing communication burden on nodes increases throughput as well.

Keywords-Chirp z-transform, discrete cosine transform (DCT) wavelet transforms (WT) and singular value decomposition (SVD), UWSN, courier nodes, depth threshold

I.   INTRODUCTION

On the planet earth, 71% of the outer lining is secured with seas; this massive region contains bounteous assets and different animals. As more individuals turn their center to the seas, there's been developing enthusiasm toward inquires about with this field. Nonetheless, the seas environment is actually eccentric and risky a big part of the submerged ranges are the region individuals can't reach by and by. Individuals spontaneously take into consideration the sensor systems that have been broadly utilized within nature. The sensor systems have now been quickly connected in seas, which are precisely the underwater wireless sensor systems (UWSNs).

 Underwater wireless sensor systems (UWSNs) have taken in a quickly developing enthusiasm from specialists amid the previous few years. Because of the top features of easy deployment, self-management, and no requirement for infrastructure, UWSNs can link thorough amount of perspectives, for example, as naval surveillance, earthquake and tsunami forewarning, climate and ocean observation, and water pollution tracking. In these applications, every node must come together with others in sensing occasions of enthusiasm by exchanging obtained information. To really make the information gathered from sensor nodes meaningful, the positions of related nodes are generally required. As recently, different node localization algorithms for UWSNs have already been proposed.

 Different as terrestrial sensor systems, UWSNs have unique attributes, for example, high propagation delay, restricted transfer speed, and high error rate since acoustic signs are utilized for communications, as opposed to radio signs. Hence, their communication protocols for UWSNs must certainly be developed to take into account these characteristics. In UWSNs, flooding-based routing protocols are favored for their capacity of lessening the routing overhead so far as no need of way setup and support. Additionally, these routing protocols can expand the packet delivery ratio by permitting different duplicates of a package to attain the sink along diverse ways.

Challenges of Underwater Wireless Sensor Networks
The design of underwater wireless sensor networks might be confronted by many challenges like:
- Available bandwidth is quite limited.
- Underwater channel is severely impaired, particularly because of multi-path and fading.
- Propagation delay in underwater is five orders of magnitude more than in radio frequency (RF) terrestrial channels, and extremely variable.
- High bit error rates and temporary losses of connectivity (shadow zones) might be accomplished, as a result of extreme qualities of the underwater channel.
- Battery is constrained and typically batteries can't be energized, also because solar energy can't be misused.
- Underwater sensors are prone to failures consequently of fouling and corrosion.

II.   UNDERWATER SENSOR NETWORK ARCHITECTURE

UWSN architectures might be classified in lots of ways. One classification discriminates between static, semi-mobile, and mobile architectures, another popular UWSN classification method is definitely to divide UWSNs into two-dimensional (cover ocean floor) and three-dimensional (includes depth as a dimension), UWSN are often single-hop, multi-hop, or hybrid (single-hop individual sensors, multi-hop clusters). Architectures might be grouped into short-term,

time-critical applications, and long-term, non-time-critical applications. RF, optical, and acoustic wave based architectures are another solution to take into account the available UWSNs. Fig. 1 shows the absolute most typical UWSN architecture. The individual nodes |have now been anchored at the ocean floor. They're usually smaller in proportions, battery operated, and they mostly transmit data via acoustic modems. The cluster heads may also be anchored to the ocean floor. Along with having acoustic modems. Cluster heads are designed with acoustic transceivers, namely a vertical and a horizontal transceiver. The horizontal transceiver is utilized by the cluster head or uw-sink to keep in touch with the sensor nodes to be able to: i) send commands and configuration data to the sensors. This communication will happening between underwater sink and cluster check out sensors. ii) Collect monitored data. This communication will happening between sensors to cluster head or sink. Cluster heads communicate via horizontal acoustic modes with other individual nodes within the cluster. The data transfer from node to cluster head might be single-hop (each node communicated to the cluster head directly) or multi-hop. Just in case there's a multi-hop path, as in terrestrial sensor networks, the data created by a source sensor is relayed by intermediate sensors until it reaches the uw-sink. This results in energy savings and increased network capacity but advances the complexity of the routing functionality as well. The vertical transreceiver is employed by the uw-sinks to relay data to a surface station. Vertical transceivers must certainly be long range transceivers for deep water applications because the ocean is usually as deep as 10 km. The top station is equipped with an acoustic transceiver that's the ability to handle multiple parallel communications with the deployed uw-sinks. Finally base or surface station will send the sensed data to on-shore base station via RF signal.
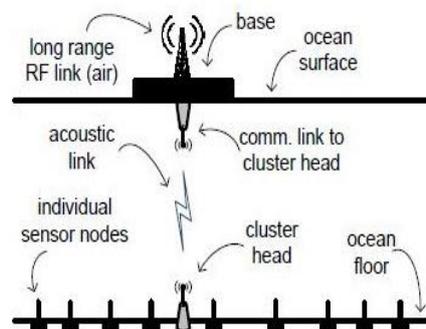

Figure 1. 2D architecture of underwater sensor network [19]

Unlike TWSNs (Terrestrial wireless sensor networks) , the hardware of the cluster head node is dissimilar from other nodes, because it's additional functionalities like a direct communication link with the ocean surface. Hence, a TWSN's cluster head switching feature (which increases the overall network lifetime by efficiently distributing the power consumption among nodes) can not be present in UWSNs. Also, the cluster head is potentially the absolute most security-vulnerable component in UWSNs military applications, as it is really a single point of failure node.

Fig. 2 shows an alternate solution 3D UWSN architecture. 3d underwater networks are accustomed to detect and observe phenomena that can not be adequately observed in the form of ocean bottom sensor node, i.e., to accomplish cooperative sampling of 3D ocean environment. In 3D architecture, sensor node floats at different depth to manage to observe the given phenomenon. In this architecture each sensor is anchored to the ocean bottom and designed with a traveling buoy that'll inflate with a pump. The buoy pushes the sensor towards the ocean surface. The depth of sensor then might be regulated by adjusting the size of wire that connect the sensor to the anchor, through an electronically controlled engine that reside on sensor. 3D architecture may have all nodes directly communicate to the outer lining base or may have only cluster heads communicate directly to the base. In the former case, all nodes are of exactly the same type, but communication might be more energy intensive than that of the cluster head approach. The cluster head approach requires only the cluster head to keep a long-range communication modem. On another| hand, the clustered approach is vunerable to single point of failure. Military applications are extremely sensitive to single point of failure hardware components.
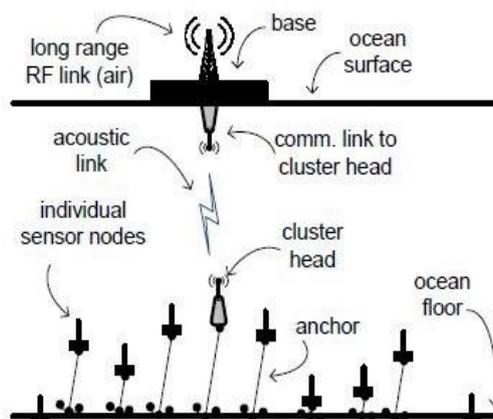

Figure 2. 3D architecture of underwater sensor network [19]

II.A. Network Topology

The network topology is generally an essential element in determining the power consumption, the ability and the reliability of a network. The key objective of a power efficient topology scheme is to improve network lifetime by reducing the entire or individual energy usage of nodes. This is accomplished by utilizing an optimal topology deployment scheme (i.e. minimum quantity of sensors to be deployed), or an optimum topology management scheme (i.e. form a cluster), or both schemes combined. Hence, the network topology must be carefully engineered and post-deployment topology optimization must be performed, when possible. A two group categorization may be made in accordance with a sensor's mobility. 1) Static UWSNs, by which sensors are anchored after deployment; 2) Mobile UWSNs with free-floating sensors.

Static UWSN

 The key characteristic of static architecture is that the sensors will be relatively static after deployment, meaning negligible movement. The network might be anchored into two-dimensional (2D) or three-dimensional (3D) space [10].

Two-dimensional space

In the 2D case, the topology might be grid, cluster, tree, or linerelay deployment. Figure 3 shows an underwater sensor network organized in a cluster-based scheme. Each sensor is interconnected three alkaline C cells. Three C cells can offer 27 Wh and four days of continuous operation with all sensors and communication hardware fully powered. I. Vasilescu et al. [7] has additionally built another generation underwater sensor network called AquaNodes. Now each sensor node is powered by seven 2 amp/hour Lithium ion batteries. When compared with the last experiment, when all of the the different parts of the node run at full power the battery provides 2 weeks of continuous operation.

II.B. Modem Technology

 Like the terrestrial, in the underwater sensor network the modem is accountable for implementing the physical layer of the network stack. The modem is accountable for the information transmission and reception over the network, while the larger network layers are accountable for MAC protocols (link layer), routing protocols (network layer), transport protocols (transport layer), and data processing (application layer). To more than one head sensors (gateways) by utilizing wireless acoustic links. The top sensors are network devices responsible for relaying data from the ocean bottom network to a floor station [10].

To improve the robustness and energy efficiency, a two dimensional multi-tier topology was proposed by W. K. G. Seah and H. X. Tan [11]. The topology contains sensor clusters where each cluster has more than one local aggregation points. These aggregation points, called virtual sinks, form a mesh network.

Sensors transmit their data through multi-hop to local sink via virtual sink within their own cluster. For a given multi-tier topology it has been shown that the multipath approach always incurs lower latency and is more reliable and energy efficient when the channel becomes harsh. At this point it can be said that clustering is one good method that can lead to a more energy efficient and reliable underwater network. It is a method proposed by many researchers that provides a convenient framework for resource management. It can support many important network features, such as channel access for cluster members, power control and routing. On the other hand it has not been widely yet on mobile underwater sensors. Sensors transmit their data through multi-hop to local sink via virtual sink within their particular cluster. For certain multi-tier topology it's been shown that the multipath approach always incurs lower latency and is more reliable and energy efficient once the channel becomes harsh.

   Now it could be stated that clustering is one good method that may cause a far more energy efficient and reliable underwater network. It's a technique proposed by many researchers that gives an easy framework for resource management. It could support many important network features, such as for example channel access for cluster members, power control and routing. On another hand it hasn't been widely yet on mobile underwater sensors. After transport by the currents and dispersion, the sensors must reorganize as a network to be able to maintain communication [13]. which transmit data, as an example via radio, to the on-shore command center.
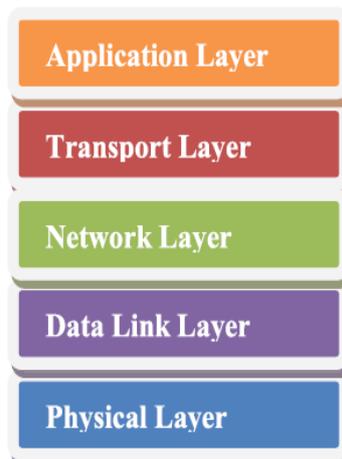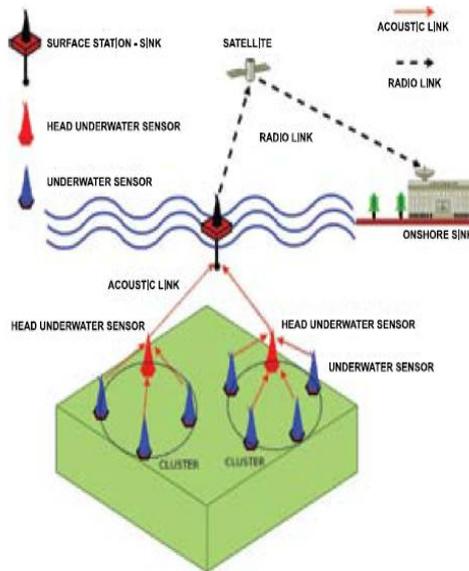

Figure 3 . Typical underwater network stack

Figure 4. Two-dimensional (2D)

Typical applications might be oceanography, marine biology, deep-sea archaeology, seismic predictions, pollution detection and oil/gas field monitoring. Mobile UWSNs for short-term time-critical aquatic exploration: These generally include networks of underwater sensors that collect data and forward them to the top control center via multi-hop acoustic routes. Typical applications might be underwater natural resource discovery, hurricane disaster recovery, anti-submarine military mission and loss treasure discovery.
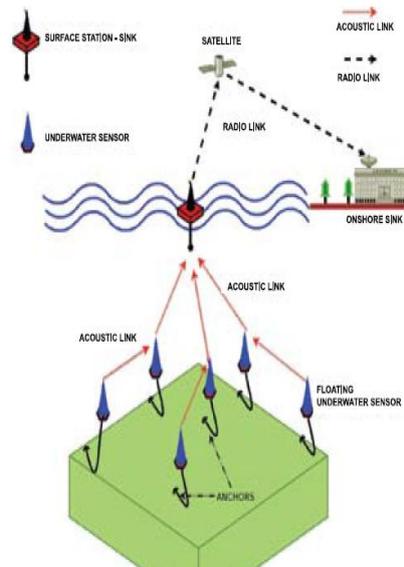

Figure 5. (3D) Three Dimension

Mobile UWSN
In comparison to the static, a mobile UWSN is a self-organizing network. Underwater sensor nodes may be redistributed and moved by the aqueous processes of advection and dispersion.
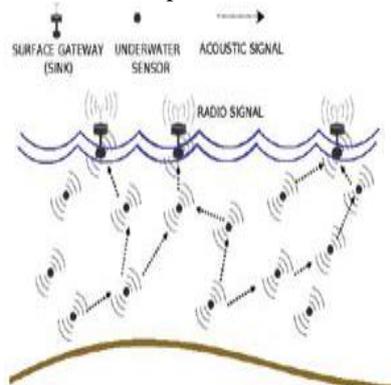

Figure 6.   A Mobile Underwater Sensor Network

III. UNDERWATER IMAGE ENHANCEMENT TECHNIQUES

There are some UWSN techniques by which we can get information about the protocols used in under water sensor networks.

III A. VBF

VBF is just a location-based routing approach for UWSNs. In this protocol, state information of the sensor nodes isn't required since simply a few nodes are involved during packet forwarding. Data packets are forwarded along redundant and interleaved paths from the origin to the sink, which supports handling the specific situation of packet losses and node failures. It's assumed that each and every node previously knows its location, and each packet carries the positioning of all the nodes involved including the origin, forwarding nodes, and final destination. The forwarding path is specified by the routing vector from the sender to the target. The minute a bunch is received, the node computes its relative position about the forwarder. Recursively, all of the nodes receiving the packet compute their positions. Just in case a node determines that it's close enough to the routing vector, it puts a distinctive computed position in the packet and continues forwarding the packet; else, it surely discards the packet. In this manner, most of the packet forwarders in the sensor network form a "routing pipe", the sensor nodes in this pipe are eligible for packet forwarding, and those that aren't nearby the routing vector don't forward. Fig. 5 illustrates the fundamental notion of VBF.
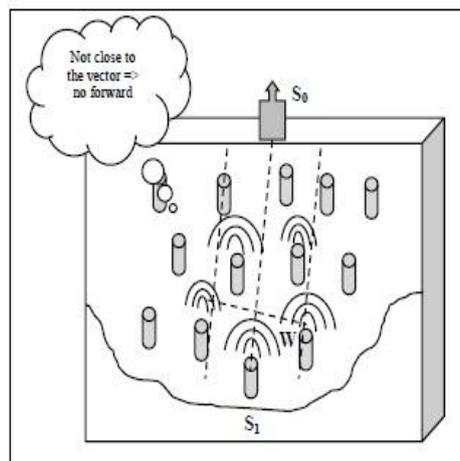

Figure 7.VBF routing protocol for UWSNs

VBF has many essential drawbacks. First, utilizing a virtual routing pipe from source to destination can impact the routing efficiency of the network with various node densities. In certain spaces, if node deployment is sparser or become sparse due with a node movement, then it's possible that few as well as no node will lie within that virtual pipe, that'll result in the information forwarding; even it's possible that some paths may exist from pipe. Eventually, this could result in small data deliveries in sparse spaces. Second, VBF is very sensitive regarding the routing pipe radius threshold, and this threshold can impact the routing performance significantly; such feature might not be desirable in the real protocol developments. Furthermore, some nodes over the routing pipe are utilized again and again to have the ability to forward the information packets from sources to the sink, that could exhaust their battery power.

IIIB. Robustness Improved Location-Based Routing for Underwater Sensor Networks (HH-VBF)

The requirement to overcome two problems encountered by the VBF, i.e. small data delivery ratio in sparse networks, and sensitivity to the routing pipe's radius, the HH-VBF (hop-by-hop VBF). HH-VBF forms the routing pipe in a hop-by-hop method, enhancing the packet delivery ratio significantly. Though it is on the cornerstone of the exact same notion of routing vector as VBF, as opposed to utilizing a single virtual pipe from the origin to the sink, it defines an alternative solution virtual pipe across the per-hop vector from each forwarder to the sink. In this protocol, each node can adaptively make packet forwarding decisions predicated on its current location. This design can directly bring those two benefits: First, since each node includes a unique routing pipe, the most pipe radius may be the transmission range. Second, in sparse networks, HH-VBF will receive a data delivery path however the total amount of eligible nodes might be small, so long as there exists one in the network.

IIIC. VBVA Routing Protocol

A Vector-Based Void Avoidance (VBVA) routing protocol, extends the VBF routing protocol to look after the routing void problem in UWSNs. VBVA assumes two mechanisms, vector-shift and back-pressure. The vector-shift mechanism can be used to route data packets over the boundary of a void. The back-pressure mechanism routes data packets backward to bypass a concave void. VBVA handles the routing void problem on demand and thus doesn't have to know network topology and void information in advance. Hence, it is extremely robust to manage mobile voids in mobile networks. Simulation outcomes of VBVA revealed that are designed for both concave and convex voids effectively and efficiently in mobile underwater sensor networks only if these voids are within the forwarding pipe, as the voids far from forwarding pipe isn't solved by VBVA.

IIID. L1-ABF PROTOCOL

The angle-based flooding approach is within this proposed routing protocol. This routing mechanism isn't predicated on sensor node location information and has been created for delay and power efficient multi-layer communication in underwater acoustic networks. In this routing mechanism, there's no significance of a sender node to understand its location or the located part of the ultimate destination (Sink) before transmitting the information packets. Anchor nodes flood the sensed data towards the most effective sinks via the most effective of layer nodes. The forwarder node will define the flooding zone utilising the initial angle $\Theta = 90 \pm 10K$. Here, K is just a variable and carries a finite group of values, K, (1, 8). After defining the flooding zone, the node will send Hello Packets (HP) within the defined zone and await the Hello Reply (HR). If you have no HR received, the node increases the value of K in the initial angle, to improve its flooding zone before the basic condition is met $(0 < \Theta < \pi)$.

IV. LITERATURE SURVEY

Bayrakdar, Yonca et al. [1] provided a guideline on usage of existing underwater routing protocols, identified their shortcomings, and gave an insight about what is necessary to design an efficient and reliable underwater routing protocol. Design of efficient routing protocols for underwater sensor networks is challenging as a result of distinctive characteristics of the water medium. Chu, Yan et al. [2]combined underwater communications among underwater devices, takes usage of the cross layer design, considered the physical layer, modulation and forward error correct interaction, media access control and routing interaction. On the basis of the research on wireless sensor networks, combined with characteristics of physical layer, the functionalities and characteristics were considered in a comprehensive way, the cross layer design was studied thoroughly, and the cross layer link transmission algorithm and cross layer link optimization were proposed helping to make the scare resource effective utilization. Waldmeyer, Marc et al. [3] presented a multi-stage AUV-aided localization scheme for UWSNs. The proposed method combined the flexibleness and localization accuracy of an AUV-aided localization, the energy efficiency of "silent localization" and improved localization coverage with k-stage localization based on sensor nodes. Hu, Tiansi et al. [4] proposed a novel acoustic-optical hybrid architecture for underwater wireless sensor networks, and a multi-level Q-learning based routing protocol, MURAO, for such networks. The network is physically partitioned into several groups and logically split into two layers. The upper-layer group leaders supervise the routing in the lower layer, and the lower-layer group members carry out the particular data packet routing. Ren, Yongji et al. [5] proposed a novel cube-scan-based 3d (3D) multi-hop localization algorithm for large-scale UWSNs. Firstly, on the cornerstone of the geometric constraint relationship and the depth information of sensor nodes, they effectively restrict the scope of the to-be-localized node position with a feasible set. Davis, Almir et al. [6] presented an summary of UWSNs, their applications, and their challenges. Additionally they presented a survey of various UWSN architectures currently utilized in deployed UWSN systems. Iqbal, Junaid et al. [7] meant to deal with such type of uncertainties and closely examine even minor variations occurring in signal attenuation in cases of spherical and cylindrical spreading. Wahid, Abdul et al. [8] proposed a connectivity-based routing protocol (named CRP) for underwater wireless sensor networks (UWSNs). CRP considers the reliability issue due to high error rate in UWSNs. Farahani, Nima K. et al. [9] proposed two related queuing networks, one for modeling the wireless node mobility and another for representing the procedure of multi-hop packet transmission in respect with considered MAC and routing algorithms. Li, Shiwei et al. [10] presented the efficient deployment of surface for underwater wireless sensor networks. To familiarize with underwater wireless sensor networks deployment, they started giving background informative data on the architecture and trajectory of the sinking node. Debont, Matthew et al. [11] proposed m-courses (Monitoring Courses), an account means to fix localize events in an underwater wireless sensor network. These networks includes surface gateways and relay nodes. GPS can localize the positioning of surface gateways that may then distribute their locations through the network using acoustic modems. Felamban, Muhamad et al. [12] investigated node placement for building an initial under water WSN infrastructure. They formulated this problem as a nonlinear mathematical program with the target of minimizing the sum total transmission loss under certain number of sensor nodes and targeted coverage volume. The obtained solution is the place of every node represented utilizing a truncated octahedron to fill out the 3D space. Liu, Linfeng et al. [13] proposed a localization algorithm for beacon error problem. The error beacons are filtered via an iteration selection process, after your localization is executed with traditional localization algorithm, such as for instance as an example Centroid or Trilateration. The computation and complexity of algorithm is analyzed and is proven preferable. The simulation results suggested this algorithm can raise the positioning accuracy effectively by the filter of error beacons. Zhu, Guangming et al. [14] proposed a distributed localization scheme based on mobility prediction for mobile underwater wireless sensor networks. Anchor nodes perform self-localization and mobility prediction, and serve as reference nodes to localize ordinary nodes. Braca, Paolo et al. [15] indicated that optimal disambiguation might be pursued by deriving the total Bayesian posterior distribution of the prospective state. The analysis is corroborated by simulations that report the potency of the particle-filtering tracking. Elmannai, Wafa et al. [16] proposed a fresh solution for underwater Wireless Sensor Networks to overcome the matter that's due to the ionized nature of seawater. This work presented a methodology to improve enough time of WSNs. The wireless sensors have three main functions: sensing, processing and transmitting. Pouryazdanpanah, K. Maryam et al. [17] proposed a revised routing protocol that employed dual sinks on the water surface which improves network lifetime. Zhu, Zhiwen et al. [18] proposed a multi-hop localization scheme. Firstly, ordinary nodes between anchors and unknown nodes are set as routers to have the shortest paths with a greedy approach; secondly, the shortest paths are approximately fitted into a direct distance between two nodes; finally, the positions of unknown nodes might be calculated by trilateration.

V. CONCLUSION AND FUTURE SCOPE

UWSNs assistance many uses such as for instance contamination checking, tsunami dire warnings, international discovery, designed surveillance, etc. Exceptional top features of UWSNs such as for instance reduced accessible bandwidth, significant propagation put off, extremely strong community topology, and high problem odds offer many obstacles designed for designing effective and reliable conversation protocols. This specific job perform has researched additional time related to IAMCTD (Improved Adaptive Mobility related to Mail nodes within Threshold-optimized DBR project meant for UWSNs) who has targeted in bettering community excellence and throughput meant for critical-range based mostly applications. Expansion related to IAMCTD system prevents command cost to accomplish business that has been within IAMCTD meant for employing adjustments thorough threshold. The specific action pattern related to mail nodes along with decreasing conversation load in nodes grows throughput because well. Furthermore, security time has additionally been superior and node density for every around remains somewhat large improving the entire community reliability. The specific target related to the task is always to consider the Expansion related to IAMCTD and locate the most effective near future recommendations to enhance this IAMCTD further.

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