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ENHANCING NETWORK LIFESPAN INCLUDING GENERAL POWER BALANCE

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Abstract—In this paper, a disseminate routing algorithm,called Game Theoretic Strength Balance Routing Protocol (GTEB), is proposed to enhance the network lifespan by balancing strength consumption in a larger network area using geological routingprotocols (GRPs). The unbiased of the proposed protocol is to make sensor nodes diminish their strength at approximately the equal time, which is handle by addressing the load balance problem at both the region and node levels. In the region level,developmental game theory (DGT) is used to balance the traffic load to available sub-regions. At the node level, humantic game theory (HGT) is used to select the best node to balance the load in the selected sub-region. This twoa-level approach is shown to be an active solution for load balancing and enhancing network lifespan. This paper shows the use of developmental and humantic game theories in designing a robust protocol that offers significant improvement over existing protocols in enhancing network lifespan.

Index Terms—Strength balance, geological routing protocols, game theory, cellular sensor networks.

1. INTRODUCTION

ENHANCING network lifespan and sensor functionality is crucial for the successful utilization of cellular sensor networks (CSNs) in applications where replacing or charging strength storage units (i.e. batteries) is impractical or not cost active. For example, the ARGO [1] project deploys thousands of floating sensors together hydro-graphic data from sea and their strength supply cannot be replaced or recharged after they are released into the environment. Continue the sensors' lifespan can significantly reduce the cost of the ARGO project and help the researchers to realize the health of the oceans better. Considering the importance of such large data gathering projects, lifespan expansion of CSNs is extremely important. Although different techniques were proposed to enhance the lifespan of sensor networks, the

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most prominent approach is to equity the CSN communication in the network in order to diminish strength at a similar time or rate . In such approach, routing decisions play an important role in selecting candidate paths in order to equity strength in the network .

Geological routing protocols (GRPs) are more suitable for CSNs because they do not need routing tables, and therefore do not require route discovery and route maintenance mechanisms which acquire large overhead. However, GRPs require location information, which can be provided using general System (GS) in outdoor deployments, signal power and time of advent based location evoluatiom techniques in indoor deployments. Although these may increase the complication of the GRPs for networks where nodes do not move and the location of decline are fixed, the gains of simplicity of GRPs exceed the extra complication of obtaining location information. Routing protocol for low capacity and loss networks (RPL) as a GRP has been adapted for smart grid applications. One problem with GRPs is that they do not have a general view of the network, including strength information at regions and nodes. Providing this information can incur large overheads and increases complication. This issue is addressed in this paper by accepting shared and relatively simple algorithms to balance strength in order to enhance CSN lifespan.

A game theoretic (GT) approach is proposed to build a viable load balancing solution to enhance the CSNs lifespan. GT offers an interesting decision making mechanism in a shared and dynamic environment in absence of the general view and certainty. In this work, GRP is combinedwith GT in order to take advantage of inherent gains of this combination.This paper significantly enhances our initial work and provides detailed inqury and results. The strength balance problem is solved at the region and node levels. In region level strength balance (RLEB), the unbiased is to balance the strength consumption around a sender such that all subregions around the sender will participate fairly and diminish their strength approximately at the same time. After selecting the participating region, node strength balance (NEB) is required to select the most favorable forwarding node in this sub-region. Because the unbiaseds of RLEB and NEB are different, RLEB employs developmental game theory (DGT) and humantic game theory (HGT). DGT captures the dynamic strength changes in the sub-regions, whereas HGT captures the selfish behavior of the nodes to defend their strength.

First, a new method is developed for enhancing the network lifespan by balancing traffic at two levels: over regions and at the nodes in these regions. The strength balance at the region level is manage using DGT, while that at the node level is manage using HGT. Second, the strength hole problem in the CSN geological routing is mitigated using DGT. The strength hole problem occurs due to an uneven traffic load dispersal. For instance, nodes closer to the sink have to carry huge traffic load, which leads to a faster rate of strength consumption and can splitting the network.The excess of the paper is formed as follows.

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2.RELATED WORK

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Enhancing network lifespan can be manage using different methods such as altering transmission power as in, designing a power aware routing protocol as in and distributing traffic load among least power routes . Although each of those methods offers gains, the most possible is load balancing. However, there is no generally applicable load balancing solution for enhancing the network lifespan in GRPs. This paper provides a generally applicable solution to enhance network lifespan by balancing traffic load over regions and nodes, with scalable and shared manner using GT.

GRPs are popularity and are being employed for industrial applications such as advanced metering infrastructures for smart grid. Ahmed and Fisal in proposed a quadrant based directional forwarding scheme, called realtime load balance dispersal protocol (RTLD), which limitsthe forwarding task to a quadrant of the forwarding nodes. However, unnecessary transmissions in the selected quadrant may occur and some quadrants could be utilized more than others depending on the location of the expert. That is why it does not provide general load balance. GTEB distributes the load evenly among the regions nodes in the selected region. These features enable it to be more adaptive to changes in the strength dissipation in the subregions, as well as other parameters of the network such as node densities.GTEB does RLEB as well as NEB, but RTLD only does RLEB. It is interesting to explore the impact of the combination of RLEB and NEB on the network performance by comparing the RLEB protocol.

Game theory was proven to provide versatile solutions for dynamic and shared networking problems. HGT is used in GRPs for various problems related to end-to-end delay expansion, task allocation, relay selection, and network excess. Behzadan et al. in proposed a game theoretic heterogeneous balanced data routing (HBDR) algorithm for CSNs with a tree topology. In this protocol, a hierarchical network is constructed using HGT to provide a load balanced tree that maximizes network lifespan. Kamhoua et al. in proposed a GT based excess avoidance mechanism for a GRP around the line between the expert and destination. Naserian and Tepe in used the game theoretic routing to reduce routi by selecting forwarding nodes to keep connection without network splittinging. Neda et al. in proposed to use HGT in base stations for relay selection and transmission power allocation for the network. Lin and Wang used GT approaches to balance strength consumption by alternating cluster head roles among the nodes based on their available strength. Huietal proposed a united game theoretical load-balancing routing protocol to find out the best possible route in terms of end-to-end delay.

DGT is emerging as an important tool to solve dynamic networking problems due to changes in strength state, channel state and topology. For example, Niyato and Hossain in used DGT to allocate bandwidth for users based on the service cost of various cellular networks.Anastasopoulos et al. in employed DGT for traffic routing over multi-path cellular back-haul networks experiencing rain attenuation. Khan et al. in applied DGT to fairly distribute users to various cellular

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access network technologies for bandwidth and cost expansion. Altman et al. in designed an DGT based routing protocol for CSNs to control excess and reliability which were influenced by the cellular channel's characteristics.

In DGT is implemented to solve the packet forwarding problem when a network consists of heterogeneous nodes performing in networks with disparate authorities. This shows that the forwarding cooperation among authorities can emerge and provide stable communication. Both HGT and DGT are utilized simultaneously for strength balance in geological routing to prolong the network lifespan.

3. PROTOCOL DESCRIPTION

The proposed GTEB protocol is designed to provide strength balance to uniformly and randomly deployed multi-hop CSNs with homogeneous nodes where the transmission range is r. Initial strength of a node is E Joules. The nodes know their locations and the location of the destination node. The nodes learn their aquaintance' location by exchanging an initialization packet, which includes the location information of the node.

The strength cost of this initialization incurs a one packet transmission cost for each node and one overhearing cost to its aquaintance. The GTEB protocol considers geological routing in a stationary network. If the node is equipped with GS, the GS needs to only run in the nitialization phase to acquire the location of the node, then it can be turned off. That is why the strength cost of this initialization is not included in this paper. In the network, any node can be a expert and can report events periodically or at the instant they occur. The problem of achieving a network wide strength balance is broken down into the following two sub-problems: i) RLEB at sub-regions and ii) NEB within the sub-region. The strength balance at the region level is manage using DGT and the strength balance at the node level is manage using HGT. The transmissionrange of a sender is divided into K forwarding sub-regions based on the network densityBased on DGT, a sender forwards a packet to its neighborhood with the following information:

i) angle, which bounds the selected forwarding sub-region,

ii) Nk, the number of aquaintance in this sub-region,

iii) sender location (x,y),and

iv) packets assigned to this subregion. Carrying these 4 fields requires 5 bytes in the header. This information, provided by the packet. Then the nodes in the selected subregion will play a Nk-player non-cooperative humantic game to identify which one will be the potential forwarding node. Who wins the game becomes a sender node and plays its own developmental game to select the next forwarding region in order to balance strength consumption in its own surrounding.

The node neighbor discovery function depicted executed once at the deployment time of the network in order to allow nodes to learn the number of single hop aquaintance. Other operations will be tested whenever a node receives a new packet from one of its aquaintance. The node drops areceived packet node is a not located in the designated forwarding sub-region or if the packet has been forwarded before. A sender node evaluates the strength levels of

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K subregions, hence the computational complication of executing DGT is linear, that is O(K) 1. Since HGT runs once in each node in a forwarding sub-region, the computational complication of this step is constant. Therefore, the complication of running the protocol at each node is O(K). Strength consumption of these calculating is very small when compared to transmission and reception, therefore those were not considered in this paper.

3.1. Region Level Strength Balance

The unbiased of RLEB is to spread the forwarding task around the sender node fairly such that the surrounding nodes diminish their strength at the same time. DGT is employed to achieve this unbiased. We assume the total number of packets sent by the sender is _, which represents the total population of region level developmental game (RLEG). This population of the packets is shared to K forwarding sub-regions throughout the operation. Hence, a subregion k will forward _k packets and consequently the total number of packets that are forwarded.

Replicator dynamics evolve a new packet dispersal vector in every game interval until it reaches a stable state. The most important part of DGT is to design a fitness function which captures the strength consumption in the network. The fitness function will be used to identify the switching probability from one region to another region. Both of these will be utilized to obtain the dynamics to find the equilibrium solution. The fitness function Fk(X) for a packet in a RLEB is expressed in terms of gain and cost of utilizing a subregion for forwarding. The gain, Ek, represents the available remaining strength in the sub-region k. The cost of sending a is big O notation packet through a sub-region depends on,

i) transmission packet and reception energy,
ii) number of nodes in that region Nk,and
iii) number of packets sent through this region. where Etr and Etx are the strength consumed by a node while receiving and transmitting a packet, respectively. Christo Ananth et al. [5] discussed about Reconstruction of Objects with VSN. By this object reconstruction with feature distribution scheme, efficient processing has to be done on the images received from nodes to reconstruct the image and respond to user query. Object matching methods form the foundation of many state- of-the-art algorithms. Therefore, this feature distribution scheme can be directly applied to several state-of- the-art matching methods with little or no adaptation. The future challenge lies in mapping state-of-the-art matching and reconstruction methods to such a distributed framework. The reconstructed scenes can be converted into a video file format to be displayed as a video, when the user submits the query. This work can be brought into real time by implementing the code on the server side/mobile phone and communicate with several nodes to collect images/objects. This work can be tested in real time with user query results. After the sub-region selection, only one node will be selected Nk-player humantic game to forward the packet in NEB and the node will waiting the transmission cost.

3.2Replicator Dynamics

The replicator dynamics captured the proportions of inflow and outflow packets from one sub region to other. The selection of a sub-region is considered a strategy for a

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packet. In every game interval, a sender set the rate of packets to be forwarded through various forwarding sub-regions based on their residual energies. The switching probability from sub-region l to sub-region k, is associated with a region fitness values. This switching probability can be where Xl and Xk are the proportions of packets in the subregion l and k respective.

The sum of all probabilities of switching from sub-region k to all other subregions including the sub-region itself must be one, which is reflected by the following equation: The rate of the change in the number of packets that are forwarded through sub-region k represents the difference between the inflow and outflow packets. Accordingly, the differential equations of the replicator dynamics that capture the net change in the number of packets in the game interval (unit time) in sub-region k can be given.

3.3. Strength Dispersal

In these sets of experiments, the strength dispersal was studied to evaluate the strength consumption pattern in the network. The left upper subplot illustrates the initial strength of sensor nodes. The right lower subplot presents the remain ing strength in the network after 1150 hours of running with the GTEB protocol. It is observed that the protocol evenly dissipates the network strength over time.

4. CONCLUSION

This paper proposes a fully shared routing protocol, called game theoretic strength balance (GTEB), for maximizing the lifespan of CSNs. GTEB utilizes developmental game to capture dynamic changes on a macro scale, humantic game theoretic to capture selfish behavior of the sensor node, and the geological routing protocol to minimize routing overhead in the network. The combination of developmental and humanticgame theoretics with geological routing is shown to be active in improving lifespan of the network.

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