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Using Balanced Data Distribution Scheme for Energy hole Avoidance in UWSN

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Abstract—**Energy efficiency is one of the major concerns in UWSNs due to limited energy budget of the underwater sensor nodes. In this paper, the solution of avoiding energy holes in UWSNs is discussed while taking in to consideration of the unique characteristics of the underwater channel.so here proposed Even Data Distribution scheme to tackle the energy holes created due to unbalanced energy consumption in UWSNs. Using this scheme, to balance the energy usage through the network provided that sensors can use multiple transmission range when they send or forward the periodically generated data. In this proposed scheme the sensor node can able to adjust their transmission range up to three possible levels. And also determine the set of possible next hops with the associated load weights that lead to a fair energy consumption among all under water sensor. Hence energy holes can be avoided and consequently the network lifetime is highly increased.**

Keywords-Underwater sensor node, sinkhole problem, network lifetime,stability period.

I. INTRODUCTION

Under water wireless sensor networks (UN-SNs) are considered to be a key asset in offshore exploration, tsunami warning, and mine reconnaissance. Consequently UW-SNs are gaining a remarkable momentum in the research community. Acoustic communication is deemed to be the enabling technology for UWSNs.Indeed, electromagnetic waves tend to scatter and to be absorbed in conductive salty water with in a very short distance from the transmitter and receiver to be aligned in order to form a link and tend to be effective on very short range compared with the desired communication distances.

Conceiving network protocols especially tailored for under water acoustic networks faces serious challenges. Indeed, under water channel imposes unique and harsh characteristics such as the high attenuation, bandwidth limited under water acoustic channel and limited battery power. In fact battery budget of underwater sensors is not only limited but most importantly cannot be recharged, as solar energy cannot be exploited.

Because of the aforementioned sensors, UWSNs required protocol that make judicious use of the limited energy capacity of the UWSNs. The protocols designed for terrestrial wireless sensor networks (WSNs) cannot work well for UWSNs. Because of different implementation environments. Radio and optical signals are mostly affected by absorption loss in underwater environment and cannot be used for under water communication. Acoustic signals are used as transmission media in UWSNs instead of radio signals. Because its have low absorption high speed (1500m/s) limited bandwidth due to this

reason it can able to transmit the data to long distance.Once the appropriate deployment is defined another crucial way that should be well exploited to extend the lifetime of a UW-SN is load balancing. Accordingly, all the sensors consume energy budget as smoothly and uniformly as possible.

In [1] UWSNs it was shown that the random deployment of nodes in the network field. Due to the closest sensors to the sink tend to deplete their provided amount of energy faster than other sensors. This unbalanced energy consumption is liable to drastically reduces the life time of sensor networks that is why it should be avoided the largest possible extent

In this paper the existing scheme of NRF and BR is compared to the proposed BDD scheme. This scheme is mainly introduce for avoiding energy holes in UW-SNs is proposed and thoroughly evaluated. Our ultimate aim is to balance the energy consumption among all under water sensor that are manually deployed according to a defined deployment pattern. Our proposed solution dictates that each under water sensor can tune its transmission range among three possible way, there are small, medium, and large. the transmission range of each sensor node is logically adjusted for evenly distributing the data fraction among the next hop neighbor nodes.it strive for deriving the optimal load weight for each possible range that lead to fair energy consumption among all sensor in the network and hence avoiding the energy hole problem.

II.RELATED WORK

Our research community is getting interest in UWSNs during last 15 years. They proposed many routing protocols for energy balancing in the network but the energy hole creation due to unbalanced energy consumption is one of the key issues. In this section some existing protocol to solve energy hole problem in UWSNs are discussed

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In spherical hole repair technique (SHORT) [1] is proposed to repair the coverage holes which are created due to energy holes. it has three phases (i)knowledge sharing phase (ii)network operation phase (iii)hole repair phase its take the advantages of redundant overlapping of sensing range of node in dense UWSN. But it is not suitable for delay sensitive application

In [4] address the type of node deployment like random deployment, cube deployment, and regular tetrahedron deployment scheme will be employed. its give a high network connectivity

Fatmabauabdallah also address the energy hole problem in [2]UWSNs and propose a balance routing scheme solution decides the load weight for each possible sensors next hops along with the appropriate transmission range that lead the fair energy consumption throughout the network

In [9] [10] multipath power control transmission for time critical applications in UWSNs. its a cross layer approach used to improve the overall energy efficiency but hop by hop retransmission is not possible and also give low end to end delay

In[12] author proposed EPULRP consist of two phase, first layer phase, a layer structure is formed around the sink node and second communication phase one relay node is identified from each layer to forward the packet.

III.THE BDD SCHEME

Energy balancing in UWSNs is important to prolong the network lifetime. When the data load of every sensor node in the network field is distributed in such a manner that minimum energy is utilized, then the energy of the network is balanced. In this section, the BDD protocol is described in detail. In WSNs many authors address the energy hole problem, where each sensor node using a transmission range ***r*** to report the data direct to the sink. They concluded that energy hole is unavoidable using a nominal transmission range ***r***.Therefore ,UWSN propose the BDD scheme the work in which each sensor node adjusts its transmission power according to the transmission distance. Node sends data direct to the sink using transmission range dt_x,as well as one hop distance r and two hop distance 2r to evenly distribute the energy among all sensor nodes of the network.

The underwater channel model: The transmission loss of an acoustic signal is given below

$$TL = k.\ 10log(l) + l.10log(a(f)) \quad -(1)$$

Where, l -distance in km, f- frequency, k-spreading factor. K=2 for spherical spreading and k=1.5 for practical spreading and k=1 for circular spreading

In eqn (1) 10 log (a (f)) is the absorption coefficient (in dB/km), which can be calculated using Thorp's formula:

$$Log_{10}\ a(f)=0.11\ (f^2/1+f^2)+44(f^2/4100+f^2) +2.75*10^{-4}f^2+0.003 \quad -(2)$$

Attenuation in underwater acoustic channel is given in db as follows:

$$A\ (l\ f) = l^k\ a\ (f)^{\ l} \quad -(3)$$

The PSD of ambient noise is given below

$$N\ (f) = N_t(f) + N_8(f) + N_w(f) + N_{th}(f). \quad -(4)$$

Energy Consumption Model: The energy consumption of sensor nodes is due to transmission and reception and the total energy consumed by transmitting a packet of $P_n$bits over a distance l is given as follows:

$$E_{tx}\ (l) = P_T(l) \times P_n / C_{3\ dB\ (l)} \quad -(5)$$

The energy spend in receiving a packet on $P_n$bits is gn below

$$E_{rx}\ (l) = P_{rx} \times P_n / C_{3dB(l)} \quad -(6)$$

Where, P T –transmitting power P r x – receiving power

$C_{3db(l)}$ – capacity which is maximum allowed over bandwidth $B_{3db(l)}$and it can calculated as follows:

$$C_{3db(l)} = \int_{B_{3db(l)}} \log_2 \left(1+\frac{P_{tx}(l)/B_{3db)}(l)}{A(l,f)N(f)}\right) df \quad -(7)$$

The BDD scheme is designed for continuous monitoring applications. So the sensor is continuously monitor the environment and report the data to the sink. This scheme will operated as follows. In phase-I network configuration of all sensor nodes are informed about their location and distance from the sink. In phase II load weight of each corona is calculated. Then finally data is transmitted according to the calculated load weights in phase III. Each of the phase is discussed in detail below

A. *Network configuration*

Before transmitting the data, the HELLO packet is send throughout the network. this packet contains information about each node's coordinates and residual energy status. If node is introduced to the network , it share the HELLO packet to the neighbors. Otherwise if a node is discarded from the network .

B. *Load distribution phase*

Before starting the sensor node transmission, the load weight $\{W^1, W^2, W^3\}$ is calculated for each transmission range $\{r, 2r, dt_x\}$.In NRF scheme each node forward data using transmission range{r} and BR scheme using the transmission range{r,2r} the new scheme introduce the transmission range {r,2r,dtx}The packet load distribution for all coronas of the network is discussed detailed in this section. In the BDD scheme, to find weights W^1, W^2, and

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W^3 respectively for dividing the total data in to three fraction; small, medium and large.

$W^1 = \beta_1 * \beta_2$ - (8)

$W^3 = (\beta_2)^2$- (9)

$W^2 = 1-\beta_2(\beta_1+\beta_2)$ - (10)

Where, $\beta_1+\beta_2 = 1$

$W^2 = 1-\beta_2$ - (11)

Where β_1,β_2 are load weights. The sum of all load weight is given as

$W^1+ W^2+ W3 = 1$ and $W^3 > W^2 > W^1$.

Corona	β_1	β_2
Corona 1	1	0
Corona 2	0.02	0.98
Corona 3	0.35	0.65
Corona 4	0.14	0.86
Corona 5	0.25	0.75
Corona 6	0.17	0.83
Corona 7	0.18	0.82
Corona 8	0.15	0.85
Corona 9	0.13	0.87
Corona 10	0.1	0.9

TABLE I: Packet load distribution of BR scheme

Corona	W^1	W^2	W^3
Corona 1	1	0	0
Corona 2	0.02	0.98	0
Corona 3	0.23	0.35	0.42
Corona 4	0.12	0.14	0.74
Corona 5	0.19	0.25	0.56
Corona 6	0.14	0.17	0.69
Corona 7	0.15	0.18	0.67
Corona 8	0.13	0.15	0.72
Corona 9	0.11	0.13	0.76
Corona 10	0.09	0.1	0.81

TABLE II: Packet load distribution of BDD scheme

C.Data transmission phase

During the data transmission phase, each corona transmits the total data generated plus received. Each corona has the data D which is generated by nodes in that corona, the data D_{i+1} received from one hop neighbors with load weight $W^1{}_{i+1}$ and the data D_{i+2} received from two hop neighbors with weight $W^2{}_{i+2}$. The total data $Dc_{i,t}$ by corona Ci is given below:

$$D_{C_{i,r}} = \sum_{k=1}^{n} D_{C_{i+k}} \quad \forall \quad 1 \leq i \leq C-2$$ - (12)

Where D is the average no/- of packets generated by each node in Ci per unit of time.

The energy consumed by each node during data reception from single hop multi hop neighbor nodes is given as:

$$e_{S_{C_i}} = Erx(r) \sum_{k=1}^{n} (D_{C_{i+k}} \cdot W^1_{i+k})$$ - (13)

$$e_{M_{C_i}} = Erx(2r) \sum_{k=1}^{n} (D_{C_{i+k}} \cdot W^2_{i+k})$$ - (14)

By adding eq. (13) and eq.(14),we get:

$$e_{i,r} = \left(Erx(r) \sum_{k=1}^{n} D_{C_{i+k}} \cdot W^1_{i+k} \right) + \left(Erx(2r) \sum_{k=1}^{n} D_{C_{i+k}} \cdot W^2_{i+k} \right)$$ - (15)

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$$e_{i,t} = \left(Etx(r) \sum_{k=1}^{n} D_{C_{i+k}} \cdot W_{i+k}^{1} \right) + \left(Etx(2r) \sum_{k=1}^{n} D_{C_{i+k}} \cdot W_{i+k}^{2} \right) + \left(Etx(dtx) \sum_{k=1}^{n} D_{C_{i+k}} \cdot W_{i+k}^{3} \right)$$
- (16)

Thus, the total energy consumption at corona Ci is calculated as,

$$e_i = e_{i,r} + e_{i,t}$$
- (17)

The total energy consumption of nodes in each corona is analyzed by calculating the energy consumption for receiving and transmitting of data over network.

The working flow of proposed scheme is given below:

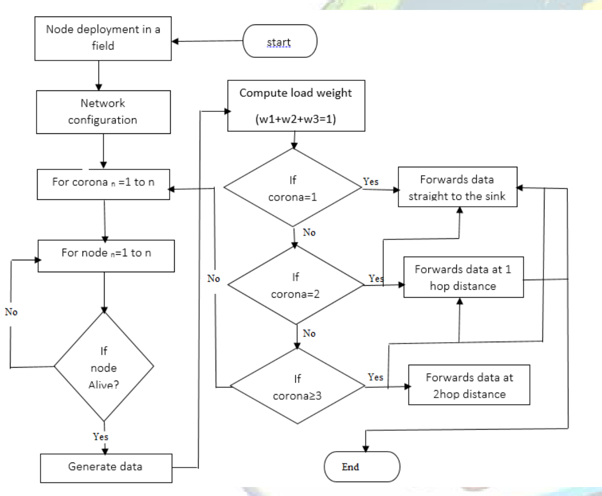

Fig (1): flow chart of BDD scheme

This diagram will explain the working flow of the scheme, here the data is transmit by three levels. Forward the data straight to the sink .using one hop and multi hop distance for transmission.

And also it is mentioned that our approach adjusts data distribution weights for energy balancing, also adjust their transmission power depend on their distance.

IV. PERFORMANCE EVALUATION

In this section, the performance of the BDD scheme is evaluated. There are 100 sensor nodes deployed uniformly in a circular network field of radius = 1000m the width of each corona in 100m.each sensor node uses a variable transmission range and generates data of 10 packet/s.

For performance evaluation we consider following metrics.

(1)First Node Dead Time (FNDT): The lifetime of the first node in the network is called as FNDT

(2)All Node Dead Time (ANDT): The lifetime of the all node present in the network is called as ANDT

(3)Packet Load Distribution(PLD): The total load of the network is distributed among the all nodes for three transmission{r, 2r,dtx}

(4)Residual Energy (RE): The difference between the initial energy and the total energy consumed by each sensor nodes after transmitting and receiving data

(5)Network Lifetime (NL): Total lifetime of the network from initialization to till ANDT

The following section, give the detail of implementing BDD scheme in Homogeneous Environment

A. Implementation of BDD scheme in homogeneous environment:

The implementation of BDD in homogeneous environment where the all nodes in the network have the same energy. Therefore the initial energy of each node is 10J.In the NRF scheme, corona near the sink has a maximum loadas compared to other coronas because the transmission rangeof each node in the network is {r} and each corona exceptthe outer most corona receives cumulative data of the previouscorona. The nodes near the sink quickly deplete their energydue to maximum load and an energy hole is created near thesink.

In the Homogeneous-Balanced Routing (Homo-BR)scheme, a packet load distribution matrix is derived forthe transmission range {r, 2r} to evenly distribute theenergy consumption among all coronas. Data traffic load isminimized by less than 40 packet/s and the minimum energyconsumption is achieved at one-hop neighbor corona of thesink in Homo-BR scheme using variable transmission range,i.e., {r, 2r} but the energy consumption of two-hop neighborcorona of the sink is increased due to which all sensor nodesof corona 2 die within no time and an energy hole is creatednear the sink.

In the Homogeneous-BDD (Homo-BDD) scheme, the total traffic load at each coronais balanced because some fraction of the data is directly sentto the sink and the energy consumption among all coronasis balanced using hop-by-hop and direct transmissions. It isfound from the simulation results that the energy consumptionof corona 10 nodes in the Homo-BDD scheme is greaterthan that of the Homo-BR scheme because data packets aresent directly as well as hop-by-hop to the sink using the transmission range {r, 2r, dtx}

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V. SIMULATION AND RESULT

.The BDD scheme shows a tradeoff between data load balancing and energy consumption of the network. To achieve load balancing by adjusting the transmission power level of the sensor nodes. Nodes forward data to the sink directlyas well as hop-by-hop in the BDD scheme. In order to avoid energy holes, it minimize the data load on 1-hopand 2-hop neighbors of the sink. The load is distributedamong all nodes to minimize the energy consumption atnodes near the sink. For load balancing, the sensor nodesat long distance directly forward data to the sink using adirect transmission range and deplete relatively high energy. Thus, the Homo-BDD routing protocol achieves balancedload distribution at the cost of high energy consumption.

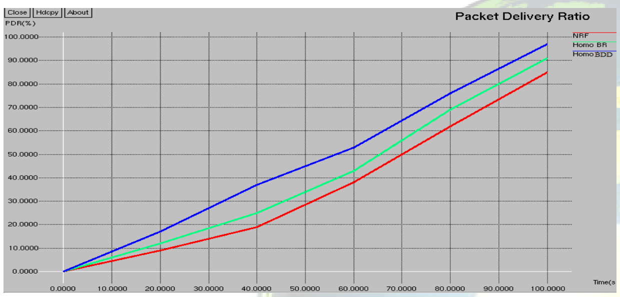

Fig 2 packet delivery ratio

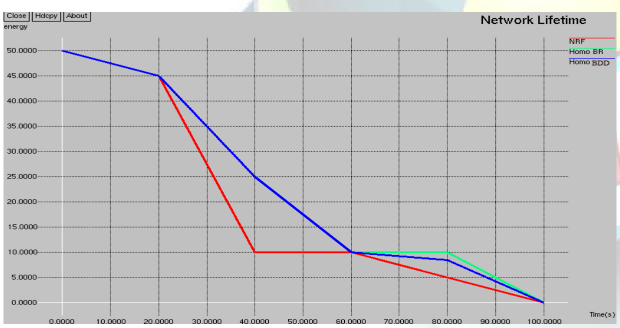

Fig 3 network lifetime

TABLE III. SIMULATION PARAMETER

Simulator	Aquasim
channel	Underwater channel
Attenuation model	Thorp's model
Network layer	Vector based forwarding

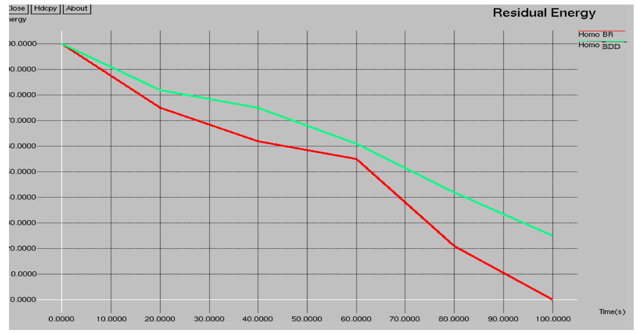

Fig 4 residual energy

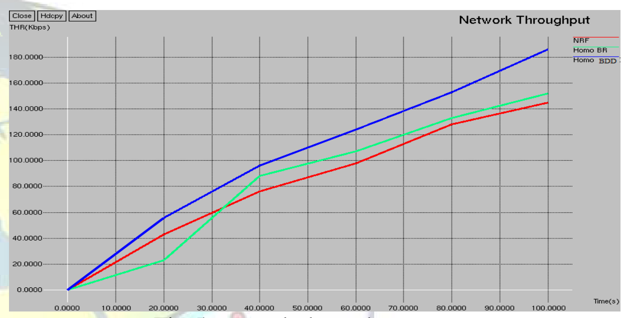

Fig 5 network throughput

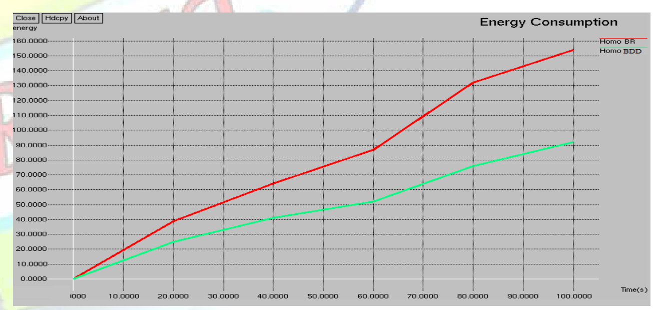

Fig 6 Energy consumption

VI.CONCLUSION

Energy balancing in UWSNs is one of the key requirementsbecause of limited energy resources. In UWSNs, the sensornodes consume high energy when there is an unbalanced load. The proposed a BDD scheme to balance the load and toavoid energy holes in the network. The BDD scheme isspecifically designed to solve the energy hole problem when anode does not find a forwarder node in the next corona to reach the sink. In NRF and BR schemes, nodes near thesink in corona 1 and corona 2 were out of energy because ofunbalanced load and energy hole was formed near the sink andthe network was totally disabled. At the end, most of the sensornodes of the network which were far from the

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sink were aliveand had maximum residual energy. In the BDD scheme thediscussed problem is solved and sensor nodes continuouslyreport data to the sink, even nodes are out of energy inthe next corona. The stability in the network is achievedby implementing sensor nodes in a heterogeneous simulationenvironment. The results showed that BDD outperformsexisting schemes in terms of stability period, network lifetimeand throughput.In the future, we will work on detecting the energy holesin UWSNs using analytical modelling. The energy hole repairtechnique is also interesting in proactive and reactive modes of a network. Moreimportantly,changes in node locations due todrift or mobility will give rise to additional challenges in theproposed scheme. We have plans to address these challengesin the future.

REFERENCES

[1]On energy hole and coverage hole avoidance in underwater wireless sensor networks Kamran Latif, NadeemJavaid,Ashfaq Ahmad, Zahoor Ali Khan, Nabil Alrajeh, Majid Iqbal Khan IEEE sensor journal 2016

[2]Joint Routing and Energy Management in UnderWater Acoustic Sensor Networks FatmaBouabdallah, ChaimaZidi, and RaoufBoutaba, *Fellow, IEEE* IEEETRANSACTIONS ON NETWORK AND SERVICE MANAGEMENT-2016

[3]Optimizing the Number of Hops and Retransmissions for Energy Efficient Multi-hop Underwater Acoustic Communications Fabio Alexandre de Souza, Bruno Sens Chang, GlauberBrante, Richard Demo Souza, Marcelo Eduardo Pellenz, and Fernando Rosas IEEE SENSOR JOURNAL 2016

[4]Impacts of Deployment Strategies on Localization Performance in Underwater Acoustic Sensor Networks Guangjie Han, *Member, IEEE*, Chenyu Zhang, Lei Shu, *Member, IEEE*, andJoel J. P. C. Rodrigues, *Senior Member, IEEE* IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 62, NO. 3, MARCH 2015

[5]Geographic and Opportunistic Routing for Underwater Sensor Networks Rodolfo W.L. Coutinho, AzzedineBoukerche, Luiz F.M. Vieira, and Antonio A.F. Loureiro IEEE TRANSACTIONS ON COMPUTERS,2015

[6]Energy-Efficient Multichannel MAC Protocol Design for Bursty Data Traffic in Underwater Sensor Networks Chih-Min Chao, Ming-Wei Lu, and Yu-Cheng Lin IEEE JOURNAL OF OCEANIC ENGINEERING, 2014

[7]Mobi-Sync: Efficient Time Synchronization for Mobile Underwater Sensor Networks Jun Liu, Michael Zuba, Student Member, IEEE Computer Society, ZhongZhou,ZhengPeng, Jun-Hong Cui, and Lance Fiondella, member,IEEE Computer SocietyIEEE TRANSACTIONS ON PARALLEL AND DISTRIBUTED SYSTEMS, VOL. 24, NO. 2, FEBRUARY 2013

[8]Void-Aware Pressure Routing for Underwater Sensor Networks Youngtae Noh, Member, IEEE, Uichin Lee, Member, IEEE, Paul Wang, Member, IEEE,Brian Sung Chul Choi, Member, IEEE, and Mario Gerla, Fellow, IEEE IEEE TRANSACTIONS ON MOBILE COMPUTING, VOL. 12, NO. 5, MAY 2013

[9]Efficient Multipath Communication for Time-Critical Applications in Underwater Acoustic Sensor Networks Zhong Zhou, Student Member, IEEE, Zheng Peng, Student Member, IEEE,Jun-Hong Cui, Member, IEEE, Member, ACM, and Zhijie Shi, Member, IEEE, Member, ACM IEEE/ACM TRANSACTIONS ON NETWORKING, VOL. 19, NO. 1, FEBRUARY 2011

[10]On Joint Frequency and Power Allocation in a Cross-Layer Protocol for Underwater Acoustic Networks JosepMiquelJornet, *Student Member, IEEE*, MilicaStojanovic, *Fellow, IEEE*, and Michele Zorzi, *Fellow, IEEE*IEEE JOURNAL OF OCEANIC ENGINEERING, VOL. 35, NO. 4, OCTOBER 2010

[11]A Machine-Learning-Based Adaptive Routing Protocol for Energy-Efficient and Lifetime-Extended Underwater Sensor Networks Tiansi Hu, Student Member, IEEE, and YunsiFei, Member, IEEE, IEEE TRANSACTIONS ON MOBILE COMPUTING, VOL. 9, NO. 6, JUNE 2010