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Reduction of Interference for Wireless Sensor Networks: A Regret Matching Based Approach

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Abstract: *In wireless sensor networks employed with multiple channels in order to reduce the interference as well as support parallel transmission. Energy usage over the network dramatically increased because of usage of multiple channels. To overcome this problem which was addressed above statement have been achieved by proposed a Regret Matching based Channel Assignment algorithm (RMCA). In this strategy each sensor node elect its choice of channels based on the channel state information which leads to reduce the interference. In RMCA approach is more distributed over network and limited information is exchanged among sensor nodes so that can achieve minimum delivery ratio even less number of flows performed. This algorithm performed well for time-variant flows and network topology. It provided better network performance in the case of delivery ratio and packet latency compared with existing methods such as CONTROL, MMSN and randomized CSMA.*

Deploy the sensor nodes over network and assign the non-overlapping channel for receiving packets from various sensor nodes. The utility function is derived based on the valid receiving ratio (VRR) and average packet transfer delay (ATD). Based on the utility function all sensor odes are completely measured without exchanging the information among other nodes. At last channel assignment by RMCA to the time-invariant transmission flows to reduce interference efficiently.

1. Literature Survey

Title1: *A practical multichannel media access control protocol for wireless sensor networks:*

Despite availability of multiple orthogonal communication channels on common sensor network platforms, such as MicaZ motes, and despite multiple simulation-supported designs of multi-channel MAC protocols, most existing sensor networks use only one channel for communication, which is a source of bandwidth inefficiency. In this work, the system design, implement, and experimentally evaluate a practical MAC protocol which utilizes multiple channels efficiently

Advantages: It has more channels for communications.

It is used to dynamically allocate channels for each mote in a distributed manner transparently to the application and routing layers.

Disadvantages: It is not sufficient to avoid network overload.

Title2: *MMSN: Multi-frequency media access control for wireless sensor networks:*

Multi-frequency media access control has been well understood in general wireless ad hoc networks, while in wireless sensor networks, researchers still focus on single frequency solutions. In wireless sensor networks, hardware devices are equipped with very limited communication ability and applications adopt much smaller packet sizes compared to those in general wireless ad hoc networks. Hence, the multi-frequency MAC protocols proposed for general wireless ad hoc networks are not suitable for wireless sensor network applications, which we further demonstrate through our simulation experiments. In this paper, the system propose MMSN, the first multi-frequency MAC protocol for wireless sensor networks. In the MMSN protocol, four frequency assignment options are provided to meet different application requirements. A scalable media access is designed with efficient broadcast support. Also, an optimal non-uniform back off algorithm is derived and its lightweight approximation is implemented in MMSN, which significantly reduces congestion in the time synchronized media access design. Through extensive experiments, MMSN exhibits prominent ability to utilize parallel transmission among neighboring nodes. It also achieves increased energy efficiency when multiple physical frequencies are available.

To reduce the communication cost, we propose a lightweight eavesdropping scheme. In eavesdropping, each node takes a random backoff before it broadcasts its physical frequency decision. During the backoff period, each node records any physical frequency decision overheard. When a node's backoff timer fires, it randomly chooses one of the least chosen frequencies for data reception. Compared with even selection, eavesdropping has less communication overhead, but it also results in more potential conflicts, because it only collects information within one hop for frequency decisions.

Advantages: It achieves increased energy efficiency when multiple physical frequencies are available.

Disadvantages: It cannot be evaluated with different sensor devices.

Title3: *Hop reservation multiple access for multichannel packet radio networks:*

A new multichannel MAC protocol called Hop Reservation Multiple Access (HRMA) for packet-radio networks is introduced, specified and analyzed. HRMA is based on very-slow frequency hopping spread spectrum (FHSS) and takes advantage of the time slotting necessary for frequency hopping. HRMA allows a pair of communicating nodes to reserve a frequency hop (channel) using a hop reservation and handshake mechanism on every hop to guarantee collision-free data transmission in the presence of hidden terminals. HRMA provides a baseline to offer QoS in adhoc networks based on simple half-duplex slow FHSS radios. The system analyze the throughput achieved in HRMA for the case of a fully connected network assuming variable-length packets, and compare it against an ideal multichannel access protocol and the multichannel slotted ALOHA protocol.

Advantages: It allows systems to merge and nodes to join existing systems.

Disadvantages: It does not analyze variants of HRMA with improved performance.

Title4: *Architecture and algorithm for an IEEE 802.11-based multi-channel*

The focus of this paper is on wireless mesh networks (WMNs). A WMN operates just like a network of fixed routers, except that they are connected only by wireless links. WMNs are gaining significant momentum as an inexpensive way to provide last-mile broadband Internet access. In this application, some of the nodes in the WMN are connected to the Internet via physical wires, while the remaining nodes access the Internet through these wired gateways by forming a multi-hop WMN with them. As deployment and maintenance of physical wires is a major cost component in providing high-speed Internet access, use of WMN at the last hop significantly brings down the overall system cost and offers an attractive alternative to DSL/cable modem. Another application of WMN is an enterprise-scale wireless backbone, where access points inter-connect using wireless links to form a connectivity mesh. Most of today's enterprise wireless LAN deployment is only limited to the access network role, where a comprehensive wired backbone network is still needed to relay traffic from/to wireless LAN access points. Use of WMN can effectively eliminate the wired backbone and enable truly wireless enterprises.

Advantages: As more interfaces within an interference range are assigned to the same radio channel, the effective bandwidth available to each interface decreases.

Disadvantages: A channel assignment algorithm needs to balance between maintaining network connectivity and increasing aggregate bandwidth.

2. EXISTING SYSTEM

In existing system, design static network where cahnnels are assigned based on the topplogy of static network. With this protocol implementation provided limited usage.It not able to perform instantaneous transmission flows so that can allow linited bandwidth for communication. This type of process not invollved for transmission flows excess bandwidth. At last the static flows not an efficient way to handle interference. To overcome above problem, it leads to dynamic channel communication.

To implement the above strategy, MAC protocol is designed for WSNs applications.Locally managed synchronizations and periodic sleeplisten schedules based on these synchronizations form the basic idea behind the Sensor-MAC (S-MAC) protocol. Neighboring nodes form virtual clusters to set up a common sleep schedule. If two neighboring nodes reside in two different virtual clusters, they wake up at listen periods of both clusters.Schedule exchanges are accomplished by periodical SYNC packet broadcasts to immediate neighbors. The period for each node to send a SYNC packet is called the synchronization period.

An important feature of S-MAC is the concept of message-passing where long messages are divided into frames and sent in a burst. With this technique, one may achieve energy savings by minimizing communicationoverhead at the expense of unfairness in medium access.

Spatial TDMA and CSMA with Preamble Sampling protocol is proposed, where all sensor nodes are defined to have two communication channels. Data channel is accessed with TDMA method, whereas the control channel is accessed with CSMA method.Nodes exchange their schedules by broadcasting it to all its immediate neighbors. This ensures that all neighboring nodes can talk to each other even if they have different schedules.

The node first listens for a certain amount of time. If it does not hear a schedule from another node, it randomly chooses a time to go to sleep and immediately broadcasts its schedule in a SYNC message, indicating that it will go to sleep after t seconds. Can call such a node a synchronizer, since it chooses its schedule independently and other nodes will synchronize with it. In an adaptive dynamic channel allocation protocol (ADCA) for wireless mesh networks which contains both static and dynamic flows. In the case of Cognitive Area network (CRNs) channel assignment balanced rate maximization and network connectivity.

Disadvantages:

- Lowly distributed and requires more information exchange among sensor nodes.
- S-MAC algorithm used more energy consumption via idle listening and overhearing.
- Single channel MAC protocols cannot handle this surging interference efficiently.
- More complex to configure than wired network.
- Still Costly at large.
- It does not reduce costs for installation of sensors.
- It does not allow us to do more than can be done with a wired system.

3. Proposed System

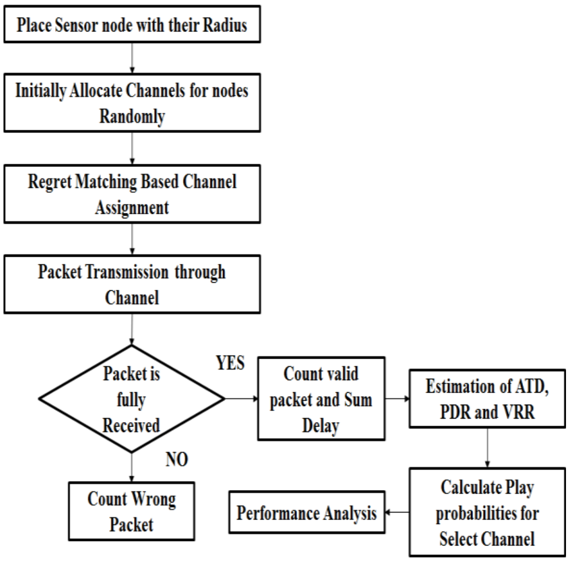
The proposed system, Regret Matching based Channel Assignment algorithm (RMCA) implemented where performed channel assignment algorithm dynamic manner to the time-invariant transmission flows. Based on the above mentioned algorithm can reduce interference efficiently.

Initially design sensor network with multiple nodes where each node located with simple half duplex transceiver and able to operate multiple channels. Anyhow each node selected only one channel for delivering packet at each stage. The selected channels are non-overlapping and not interfere with each other. Among the selected channel one channel performed as a control channel for broadcasting channel assignment information. The channels are acted as receiver centric way for sensor nodes. Such that each sensor nodes chosen one channel for receiving packets from other nodes and broadcasted this information to its neighbors nodes via control channel. Then the neighbors which are having packets for delivering, use this available channel to send packets. To reduce the interference which are caused by the selected channels.

Advantages:

- It is highly distributed and requires very limited information exchange among sensor nodes.
- It is proved that RMCA converges almost surely to the set of correlated equilibrium.
- RMCA can adapt the channel assignment among sensor nodes to the time-variant flows and network topology.

4. System Architecture



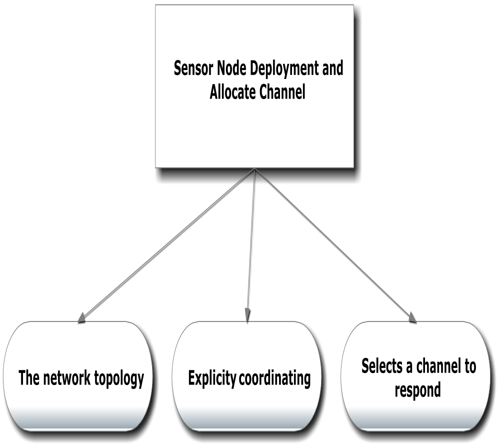
5. Modules

- ✓ Sensor Node Deployment and Allocate Channel
- ✓ Regret Matching Based Channel Assignment
- ✓ Packet Delivery Ratio (PDR), Valid Receiving Ratio(VRR) and Average packet Transfer Delay(ATD)
- ✓ Estimation of Play probability of channel.

5.1. Module Description

Sensor Node Deployment and Allocate Channel

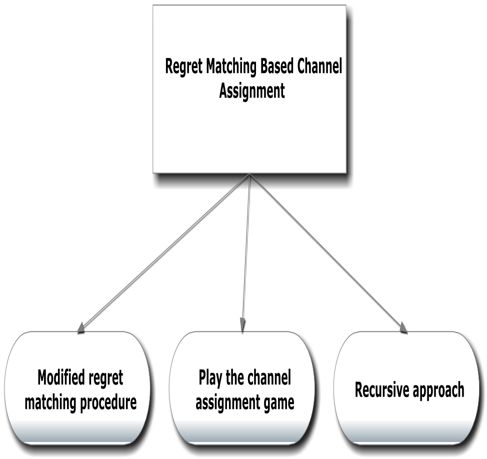
- In the receiver-centric channel assignment way, the channel the sender uses to send is determined by the receiver of the transmission, and the receiver-sender relationship is determined by the flows in the network and the network topology.
- Instead of explicitly coordinating, each sensor node only relies on a history of its observations to predict the environment variation and the actions of other sensor nodes, and then selects a channel to respond to this prediction.



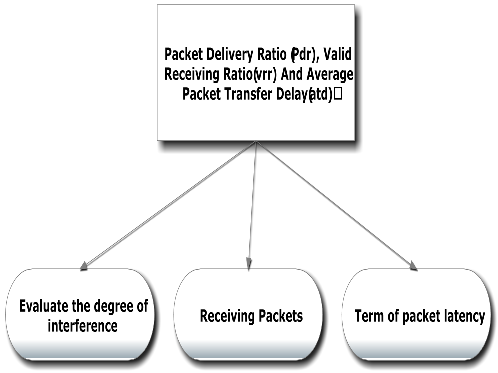
Regret Matching Based Channel Assignment:

- The system makes each sensor node perform a Modified Regret Matching procedure to play the channel assignment game to achieve a better tradeoff between energy consumption and network performance.
- The system proposes a recursive approach to compute the estimated average regret.

Based on the recursive approach, we summarize the Regret Matching based Channel Assignment algorithm for each sensor node.



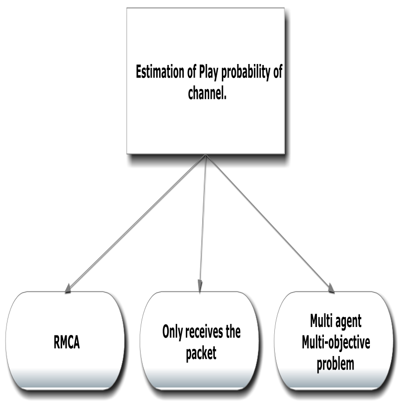
Packet Delivery Ratio (Pdr), Valid Receiving Ratio(vrr) And Average Packet Transfer Delay(atd): Three main metrics Packet Delivery Ratio (PDR), Valid Receiving Ratio and Average packet Transfer Delay—are considered to evaluate the degree of interference. For a sensor node receiving packets, some of them are sent to it and called valid packets while others are not sent to it but overheard by it. VRR is defined as the ratio of the valid packets the sensor node has received to all the packets heard by it.ATD is defined as average packet transfer delay of all the valid packets.ATD reflects the network performance in term of packet latency as well.



Estimation of Play probability of channel:

- The play probabilities assignment is based on a history of past experience the channel assignment by RMCA can adapt itself to the variation of the flows and network topology, and improve over time.
- The sensor node only receives the packet from the sender in each stage.

In the game theoretical framework, the problem is formulated as a multi-agent multi-objective problem.



Regret Matching based Channel Assignment algorithm (RMCA)

Algorithm 1 RMCA: Regret Matching based Channel Assignment algorithm for any node i

select randomly a initial channel s_i^1 to receive;
set $p_i^1(x)$=1/c for every $x \in C$;
set M_i^0=O;
for each stage k=1,2,... **do**
  valid_packet=0, *sum_delay*=0, *wrong_packet*=0;
  while the end of stage k is not reached **do**
    use s_i^k to receive packets;
    if a packet is sensed **then**
      if the packet is completely received and its destination is sensor node i **then**
        valid_packet++;
        sum_delay+=*delay_of_the_packet*;
      else
        wrong_packet++;
      end if
    end if
  end while
  $r_i(k)=\frac{valid\_packet}{valid\_packet+wrong\_packet}$;
  $d_i(k)=\frac{sum\_delay}{valid\_packet}$;
  use Equation (1) to compute $u_i^k(s_i^k, s_{-i}^k)$;
  use Equation (7) to update M_i^k;
  use Equations (8), (4) and (5) to compute P_i^{k+1};
  use play probabilities P_i^{k+1} to select the channel used at next stage $s_i^{k+1} \in C$;
  if s_i^{k+1} != s_i^k **then**
    broadcast s_i^{k+1} to the sender of sensor node i via a common channel at the end of stage k;
  end if
end for

6. Conclusion

In this project the system described about the dynamic channel assignment in WSNs to exploit parallel transmission and reduce interference.That is very different from existing dynamic channel assignment protocol. The system can achieve the challenges posted by the dynamic channel assignment in WSNs to exploit parallel transmission and reduce interference. This project proposes a new algorithm that is Regret Matching based Channel Assignment algorithm(RMCA). Regret Matching based Channel Assignment algorithm is highly distributed and exchanges very limited information for sensor nodes to dynamically select channels. It converges almost surely to the set of correlated equilibriums. The correlated equilibrium implies that all sensor nodes optimally respond to the environment and to the actions of other sensor nodes. Such channel adjustment makes RMCA achieve better network performance such as higher delivery ratio and shorter packet latency, and also makes RMCA flexible enough to deal with network flow andtopology variation.

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