# Providing Enhanced Reliable Routing using Reactive Protocol for Wireless Sensor Networks

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***Abstract*—Providing reliable and efficient communication is crucial in wireless sensor networks. Transmission failure in Industrial wireless sensor networks can result in missing or delaying of process or control data which is intolerable. Enhanced reliable routing using reactive protocol provides efficient packet delivery in fading channels against existing reactive routing protocols in industrial applications even when operated in harsh environment. A backoff scheme introduced finds a guide path, and then data packets are sent towards the destination through cooperative forwarding without using local information. With simulations it is demonstrated that comparatively it achieves improved packet delivery ratio, maintaining high energy efficiency and low delivery latency to existing protocols.**

***Index Terms*— *Reactive routing, guide path, cooperative forwarding.***

## 1. INTRODUCTION

Wireless sensor networks constitute spatially distributed sensors to monitor parameters like sound, temperature, vibrations etc. Sensory data comes from the sensors deployed in various locations. Wireless sensor networks perform sensing and processing the sensing data according to the requirement of network. Sensor may register the data on occurrence of event or periodical sensing may be done depending on the application. Industrial application of wireless sensor network is mainly in Industrial process monitoring and controlling machines. Civilian application includes environment and habitat monitoring, health care applications etc. Many applications of wireless sensor networks require smaller node size and smaller node components. Sensor node lifetime depends on battery inside it. Because of wireless nature, applications demand long life of battery, hence energy of sensor nodes must be used very efficiently

A typical wireless sensor node consist of a sensor unit to perform sensing operations, memory unit for storage of sensed data, battery for power requirements, processor and transceiver for transmitting and receiving of data. Transceiver is provided with limited range antenna and limited memory is provided in sensor node to facilitate smaller size.

Due to technological advances most of traditional industrial wired communication networks today are replaced by wireless sensor networks, since they offer several advantages like fast and ease of installation and maintenance. Industrial wireless sensor networks operate under harsh environment conditions, nodes may also be subjected to radio frequency interference, highly corrosive environment, high humidity levels, dirt, dust and vibrations, which pose major challenge to performance. Industrial wireless sensor network applications such as industrial process monitoring and control, plant monitoring and factory automation requires reliability and timeliness forwarding. However traditional routing may find limitations in industrial applications due to harshness of environment. Transmission failure in industrial application is unacceptable since it may cause delay or missing of process or control data finally resulting in economic losses.

Scalability, fault tolerance, network topology, transmission media, operating environment and power consumption are the factors that influence design of routing protocol for wireless sensor networks. Requirement is to connect source destination pair with shortest distance, minimum hops, in shortest possible time, providing enhanced reliability. When source and destination pairs are away from one hop distance, one node among the set of one hop neighbors of source has to be to be selected to forward the packet to destination. Forwarder nodes are selected based on different metrics like hop count, packet delivery ratio etc.

Proposed scheme uses opportunistic routing to improve energy efficiency in wireless sensor networks. Opportunistic routing is one of the flat based reactive routing protocols, an effective cross layering technique to combat fading channels hence improving robustness and energy efficiency in wireless sensor networks. Advantage of opportunistic routing is enhancement of reliability and transmission range. The idea here is to take the advantage of broadcast nature of wireless communication, involving multiple neighbors of sender into local forwarding. A set of forwarding candidates are specified in packet assigned with some priority in network layer, only one actual forwarder node chosen in a in MAC layer. Reactive routing protocol are designed to reduce bandwidth and storage cost, they dynamically build route between source and destination

pairs. Proposed scheme increases the resilience to link dynamics for Wireless sensor networks.

## 2. RELATED WORK

Industrial wireless sensor networks have been increasingly applied in industrial automation due to a great number of benefits such as convenient installation, flexible deployment and cost efficiency. They are frequently deployed in harsh industrial environments with electromagnetic disturbances, moving objects and non-line-of-sight communication. Because of the vulnerability of the wireless signal, Industrial wireless sensor networks are under high risk of transmission failures, which may result in missing or delaying of process or control data. For industrial automation, missing the process or control deadline is intolerable, which may terminate industrial application and finally result in economic loss and safety problems.

From hierarchy point of view, the high reliability and low latency can be achieved from different network layers. On MAC layer, existing protocols in industrial wireless sensor networks provide automatic repeat request to improve reliability at the cost of real time performance. An alternative method is to use Forward Error Correction (FEC) mechanism to provide more reliable transmissions and reduce the number of acknowledgement messages by recovering erroneous data. On network layer, routing protocol plays an important role in both communication reliability and latency. Traditional routing protocols in industrial wireless sensor networks s are either hardly able to fulfill both of these requirements or overcomplicated. Here possibilities of introducing FEC into industrial wireless sensor network under the requirements of the existing standard on MAC layer are explored, compatible and flexible FEC schemes on MAC layer for industrial wireless sensor networks without violating the standard format is proposed. Routing protocols based on flooding are proved to increase the Packet Delivery Ratio (PDR) by transmission diversity [1].

The applications of Industrial Wireless Sensor and Actuator Networks (IWSAN) are time-critical and subject to strict requirements in terms of end-to-end delay and reliability of data delivery. A notable shortcoming of the existing wireless industrial communication standards is the existence of overcomplicated routing protocols, whose adequacy for the intended applications is questionable. This paper evaluates the potentials of flooding as a data dissemination technique in IWSANs. The concept of flooding is recycled by introducing minimal modifications to its generic form and compared with a number of existing wireless sensor protocols, in a variety of scenarios. The simulation results of all scenarios observed show that our lightweight approach is able to meet stringent performance requirements for networks of considerable sizes. Furthermore, it is shown that this solution significantly outperforms a number of conventional wireless sensor network routing protocols in all categories of interest [2].

Lifetime is the most important concern in wireless sensor networks due to limited battery power of sensor nodes. Moreover, it should be capable of timely fulfilling its mission without losing important information in event-critical applications. This paper focuses on designing an energy-efficient and energy-aware real-time routing algorithm aiming to explore the long lifetime routing schemes in which delay constraint is satisfied in the presence of lossy communication links. To achieve this goal, energy-aware forwarding protocol utilizes an optimum distance real-time routing algorithm to minimize energy consumption in unreliable wireless sensor networks. Simulation results reveal that the proposed algorithm outperforms other existing schemes in terms of energy consumption, network lifetime, and miss ratio. The tendency to use high performance low cost products in wireless communications technology has led to the rapid development of wireless sensor networks. Considering that communication costs (transmission power) are usually more than computing costs, energy efficient routing algorithms are very important in multi-hop wireless sensor networks where the constituent nodes have batteries with limited energy. Several energy-aware routing protocols define the link cost based on the power required to transmit a packet on it, and accordingly employ minimum cost routing algorithms to determine the "minimum total transmission energy" route from source to destination. However, in most scenarios, the metric of actual interest is the operational network lifetime, not the transmission energy of individual packets. Through the energy-aware routing mechanisms, the residual energy on each node is the basis of the routing decisions. The main objective of these algorithms is to avoid the extinction of nodes due to exhaustion of their battery power.

Although energy efficiency is usually the primary concern in WSNs, the requirement of real-time communication is becoming more and more important in emerging applications. Here, out-of-date information would be irrelevant and even lead to negative effects on the system monitoring and control. A real-time sensor system has many applications, especially in intruder tracking, medical care, fire monitoring, and structural health diagnosis. However, its wireless nature, limited resources (power, processing, and memory), low node reliability, and dynamic network topology dramatically make it different from the traditional real-time systems. Thus, in addition to the resource constraints, the globally time-varying network performance and the node-communication reliability should be considered in developing real-time applications over Wireless sensor networks.

However, the previous works on real-time routing often assume the wireless links to be reliable. This is clearly too optimistic since even under benign conditions, wireless communication links are unreliable and often unpredictable due to various factors like fading, interference, multi-path effects, and collisions. Besides, end-to-end delay is extremely impressed in path reliability. If a poor path is chosen for data delivery, the loss rate will be heavy and

retransmissions will cause extra energy consumption and shorter network lifetime. Furthermore, more traffic also yields a higher collision probability and delivery delay. It has been shown why energy spent in potential retransmissions is a proper metric for reliable energy-efficient communications.

A Long Lifetime Real-time Routing protocol proposed (LLRR) which is designed to achieve the aforementioned requirements in WSNs. It provides real-time data delivery in unreliable WSNs, while considering energy awareness. The primary contribution of this project is to provide an optimum distance routing. It can be used to prevent packet loss in real-time communications and to guarantee significant improvement in terms of energy consumption and network lifetime.

To achieve these objectives, each neighboring node is assigned a probability of being selected to forward a packet provided it satisfies the real-time requirement. This probability is a function of three parameters: the residual node energy, the distance to the straight path between the current node and the sink, and the effective transmission energy cost which includes the energy spent in potential retransmissions. Finally, from a set of eligible neighboring nodes satisfying the real-time requirement, a node with a higher probability is more likely to be selected [3].

## 3. NETWORK MODEL

We consider dense static multihop WSN deployed in sensing field assuming plenty of neighbors for a node since opportunistic routing are effective only for higher density nodes. Periodically HELLO messages are exchanged between nodes to keep track of neighborhood information. In opportunistic routing each neighboring node that hold the data packet serves as caches, thus downstream node can retrieve packet from them, with this we find virtual guide path. Three main modules are: route discovery module, potential forwarder selection and prioritization module and forwarding decision module.

Route discovery module finds and maintains the route information of each node, each node involved in cooperative forwarding stores the downstream information, it already knows next hop forwarding candidates. Rest two modules are responsible for run time forwarding. When node successfully receives a packet and is one of the intended receivers, incoming packet is cached and timer is started to return ACK message. If there is no higher prioritized forwarder sending acknowledgment before timer expires ACK is broadcasted, packet is delivered to upper layer, triggering a receiving event in network layer. Then potential forwarder selection and prioritization module attaches the ordered forwarder list in header of data packet for next hop, finally outgoing packet is submitted to MAC layer and forwarded towards destination.

## 4. SYSTEM DESIGN

This work overcomes some limitations of existing protocol by using opportunistic routing. Idea of opportunistic routing is to use the path diversity for cooperative caching. Architecture is middle ware design across MAC layer to increase link dynamics for IWSNs. It consists of three main modules namely: route discovery module, potential forwarder selection and prioritization module and forwarding decision module. Reliable route discovery module finds and maintains route information of each node. Rest two modules are responsible for run time forwarding. When a node successfully receives a data packet, the forwarding decision module checks whether it is one of the intended receiver or not. If it is one of the intended receiver, node will cache the incoming packet and backoff timer is started to return an acknowledgment, where the timer value is related with its ranking in the intended receiver list .If there is no other forwarder candidate with higher priority transmitting an acknowledgment before expiry of backoff, acknowledgment is broadcasted and packet is delivered to the upper layer, which triggers a receiving event in the network layer. Then the potential forwarder selection and prioritization module attaches the ordered forwarder list in the data packet header for the next hop. Finally, the outgoing packet will be submitted to the MAC layer and forwarded towards the destination

## 5. SIMULATION RESULTS

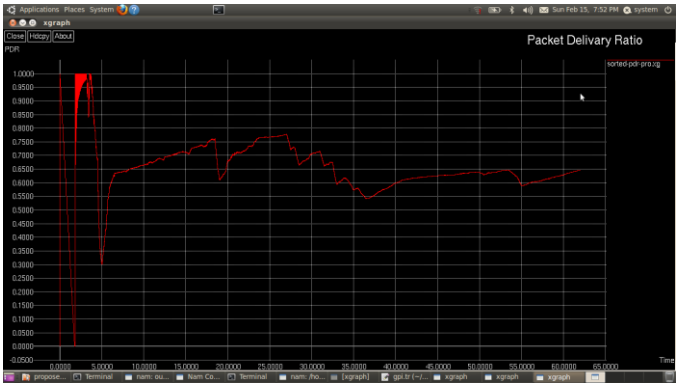
Simulation of routing protocol is done by using network simulator (NS2) software due to its simplicity and availability. NS is a discrete event Simulator targeted at networking research. We consider following evaluation metrics.

•Packet delivery ratio: the ratio of the number of packets received by the destination to the total number of packets sent by the source.

• End to end delay: the time taken for a packet to be transmitted from the source node to the destination node.

• Data transmission cost: it is measured as the total number of data transmissions for an end-to-end delivery per packet.

•Control message cost: it is defined as the total number of control message transmissions (such as RTS, CTS and ACK) for sending a single packet to the destination.




## 5. CONCLUSION

It is shown that proposed scheme shows high packet delivery ratio, considering end to end delay it shows 50% improvement over existing reactive routing protocols. It incurs 5% higher transmission cost compared to ideal scheme, while for existing schemes two or three retransmission is required for successful transmission on average.

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