

# Research on Remote Monitoring Protocol of Power System Based on Wireless Sensor Network

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**Abstract.** Wireless sensor network with large number of nodes, can form a network by self-organizing, which can collect and process real-time parameters in the node coverage area. In some hazardous working environment for remote electric power monitoring, wireless sensor network is used to realize remote monitoring, which can improve the system efficiency. This paper proposes an event-driven hierarchical routing protocol ECRT, which ensures reliable data transmission between clusters, and effectively reduces the energy waste of nodes, and achieves network load balancing.

## 1. Introduction

With the development of wireless communication, electronics and sensing technology, wireless sensor networks composed of sensors with sensing, data processing and short-range wireless communication functions are widely used in remote power network monitoring and control. Sensor nodes are deployed in the monitoring area. When anomalies occur, the surrounding nodes can respond quickly and report the situation timely by multi-hop routing. In order to ensure the timely detection of faults and ensure the reliability and timeliness of message transmission, we will face the challenge.

To solve this problem, we propose an Event-driven Cluster-based Reliable Transport Protocol (ECRT), which uses a reliable cluster-to-cluster transmission mechanism to guarantee the reliability of routing. The main features of the ECRT protocol are as follows:

- (1) effective routing. In ECRT, table-driven routing and on-demand routing are combined to achieve reliable end-to-end data transmission.
- (2) reliable transmission. ECRT adopts the cluster-to-cluster message recovery strategy, and achieves reliable end-to-end transmission through packet relay between clusters.
- (3) support data fusion. Since the data packets generated by the perception nodes after the event have great correlation and redundancy in time and space, data fusion at the cluster head can effectively reduce the amount of data transmission.
- (4) energy efficiency. By using on-demand routing method, the routing will be established only when the event occurs. Normally, the node does not need to maintain routing information.

## 2. Relative works

In the research of sensor networks, various routing protocols are proposed for event monitoring and reliable transmission. As early as 2001, TEEN protocol [1], which was proposed for responsive sensor networks, was sensitive to the numerical changes of the monitored values rather than the values themselves, thus introducing the concept of events for the first time. The PSFQ [2] (Pump Slowly,



Fetch Quickly) protocol proposed later is a reliable transmission protocol for the first time in sensor networks. It implements strict end-to-end reliable transmission by inserting transmission packets and hop-to-hop message recovery mechanism into the network at slow speed, mainly for the management and reconstruction of sensor nodes. Reference [3] proposes ESRT protocol, which takes the ratio of event packets successfully received by sink node as the reliability index and adjusts the sending frequency of source node to make the network reach the optimal state to meet the application requirements. HPEQ [4] protocol is a simple and effective hierarchical routing protocol. It establishes a path by establishing a hop tree with sink nodes as its root. Each node forwards packets only to neighboring nodes with the least hop distance from sink nodes.

In the remote monitoring and control application scenario of power network, these protocols either affect the sending speed of messages because of the heavy resource occupation of nodes, or cause path failure due to node failure or link instability, which will affect the spread of the entire network.

### 3. ECRT protocol

In this part, we introduce the node types in ECRT protocol and the implementation process of the protocol. The implementation of ECRT protocol is divided into three stages: cluster establishment, initial configuration, data transmission.

#### 3.1. Nodes in ECRT protocol

In ECRT protocol, nodes are divided into three types according to their different functions: cluster head nodes, cluster relay nodes and ordinary member nodes.

(1) The cluster head node is mainly responsible for the data fusion of intra-cluster packets, the sending of packets, and specifying inter-cluster routing information for packets. The table structure maintained by cluster head node includes: global routing table, cluster relay node list, member node list.

(2) A cluster relay node is called a cluster relay node. The cluster relay node belongs to only one cluster. As an inter-cluster relay node, it is mainly responsible for establishing a local path for packets through the current cluster and providing a cluster-to-cluster message recovery mechanism. Cluster relay nodes maintain cluster relay routing tables and local routing tables.

(3) Ordinary member nodes are members of a cluster, which are mainly responsible for perceiving events, forming data packets and reporting to the cluster head.

#### 3.2. Cluster Establishment

Cluster election is based on the LEACH [5] cluster building method, which randomly generates  $p\%$  of cluster heads and broadcasts CH\_NOTE messages to neighboring nodes. The message includes message survival time TTL and cluster identifier CID (Cluster ID). The neighbor node receives the CH\_NOTE message and becomes a member node. It records the CID of the cluster identity and the number of hops  $n$  reaching the cluster, and returns the message to the cluster head node to report its ID and energy status. The cluster head node establishes a list of members' nodes based on the CH\_ACK message received.

#### 3.3. Initial Configuration

After the cluster is established, the network needs to be initialized and configured. This is divided into two stages. First, a global routing table is set up to broadcast GRT (Global Routing Table) messages from sink nodes to the whole network. This message records the cluster ID CID of the cluster passing along the route. Each cluster head node establishes a global routing according to the GRT message information received. The table. Secondly, a local routing table is set up, in which the cluster head broadcasts LRT (Local Routing Table) messages in the cluster, records the nodes along the route, and the cluster relay node and the ordinary member node receive and forward the messages, and establishes the local routing table.

#### 3.4. Data Transmission

When the node monitors the event, it sends data packets to the cluster head immediately. The cluster head node specifies the cluster path for the packet according to the global routing table, and then sends the packet to the cluster relay node connected with the next cluster. After receiving the packet, the

cluster relay message is forwarded to the next cluster relay node according to the local routing table. Such relaying until the message arrives at the sink node. Messages only need to find and establish paths for the first transmission, and subsequent large numbers of packets are transmitted directly along this path.

#### **4. Specific scheduling algorithm and performance analysis**

##### *4.1. local path discovery and recovery*

Cluster relay node broadcasts a message CIF in the current cluster using a path discovery algorithm similar to DSR [6]. The message includes the current cluster ID CID, the next cluster ID NCID (Next CID), the number of hops from the source node N, and the node ID passed by. When a cluster relay node receives a packet, it first checks whether the NCID in the packet is in its own relay routing table entry. If it exists, it adds its own ID to the packet and returns in reverse order according to the original path. If it is not in its own table item, discard this message. According to the CIF returned, the source node selects a path with the least number of hops to join its routing table and starts forwarding data along this path. The source node can save multiple non duplicate paths at the same time as backup. With this strategy, we can ensure that the path to sink node can be quickly established after the event occurs.

##### *4.2. Cluster-to-Cluster Recovery*

Unlike the hop-to-hop reliable packet recovery mechanism in PSFQ, ECRT adopts cluster-to-cluster packet recovery strategy. Cluster relay node caches packets, sets the waiting time TTL and sends them to the next cluster relay node. Ordinary nodes in the middle path are only responsible for forwarding packets, and do not backup packets in the cache. When the message arrives at the next cluster relay node, the node caches the message and sends the ACK message to the previous cluster relay node to confirm the transmission is successful. After receiving the ACK message, the cluster relay node releases the resources occupied by the original message. If the original cluster relay node has not received the ACK message after the TTL time, then it begins to retransmit, if the retransmit exceeds a certain number of times (for example, four times) is still unsuccessful, then it determines that the original path is damaged, and begins to use the backup path or start a round of routing discovery process.

##### *4.3. cluster fixing strategy*

The function of cluster head in hierarchical routing protocol is more complex than that of member nodes, and the energy loss is faster, which becomes the bottleneck of the whole network life cycle. In ECRT, we propose cluster fixed strategy, cluster head rotation, but cluster members remain unchanged. When the energy loss of the cluster head node reaches a certain level, the EN\_REQ message will be broadcast to the neighboring node of the non-cluster relay node, and the node with more energy will be selected from the neighboring node, then the SET\_CH message will be sent to the neighboring node and appointed as the new cluster head. In the process of cluster first round change, cluster identifier CID remains unchanged to ensure that the global routing table is still correct. This strategy can not only achieve load balancing locally, but also avoid the huge overhead of flooding in the whole network.

#### **5. Conclusion**

In the application of remote power network monitoring based on sensor networks, the ECRT data transmission protocol using cluster-to-cluster message transmission mechanism can guarantee the reliability and fault tolerance of routing. Cluster-to-cluster packet caching mechanism ensures reliable transmission between clusters and eventually achieves end-to-end reliable transmission; local path discovery and recovery mechanism can re-find available paths when a node is damaged or a link failure occurs, but does not affect the paths of other parts of the globe. Ringing. Cluster fixed strategy, cluster head rotation but cluster members remain unchanged, solve the problem of unbalanced network load, while avoiding the huge overhead of re-clustering in the whole network, and effectively improve energy efficiency.

## References

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