A Compact NDN Architecture for Cluster based Information Centric Wireless Sensor Networks

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ABSTRACT

This poster proposes a lite variant of Named Data Networking (NDN) architecture specially designed for single-channel cluster-based information-centric wireless sensor networks. The proposed framework incorporates the fundamental requirement of short but human-readable names for cluster-based wireless sensor networks (WSNs) that can fit into 127 bytes Maximum Transmission Unit (MTU) size. As the nodes in WSN can be heterogeneous in terms of data generation, therefore, the name integrated lite query structure in our framework can significantly improve the process of data collection. Moreover, the proposed forwarding strategy for inter-cluster and intra-cluster communication may reduce the unnecessary packet transmissions in the network, which improve the network performance.

CCS CONCEPTS

• **Networks** → **Network design principles**; **Naming and addressing**;

KEYWORDS

Named Data Networking, Wireless Sensor Networks, Cluster

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1 INTRODUCTION

In cluster-based Wireless Sensor Networks (WSNs), the nodes can be of two types: reduced function device (RFD) and full function device (FFD). An FFD potentially has higher computational resources than RFD and can initiate a network formation process and act as a cluster head. An RFD may associate itself with one of the available FFD and cannot accept any association requests from other nodes. The RFD is responsible to perform sensing tasks and forward the received Interest or Data packet(s) to the potential recipient.

From the content perspective, mostly WSNs application users are more interested in fetching the updated information rather than the location of the nodes in the network [1]. Thus, to fulfill this fundamental requirement, Named Data Networking (NDN) [2] can be well-suited architecture for WSN. However, the simple request-response communication model of NDN requires necessary modifications in various aspects to support the communication requirements of cluster-based WSNs.

We, therefore, propose a lite variant of NDN architecture for cluster-based Information-centric wireless sensor networks named CCIC-WSNs. In our proposed framework the namespace design for FFD is different from the RFD and incorporate the fundamental requirement of short length. The lite query structured integrated with the names decreases the number of transmissions in the network by concatenating multiple content objects in a single data packet. Furthermore, our novel forwarding strategy for inter-cluster and intra-cluster communication significantly decreases the packet transmissions in the network.

2 CCIC-WSN

Following subsections shed lights on our proposed lightweight NDN architecture for cluster tree WSN.

2.1 Compact Naming

The namespace design for FFD (cluster heads) varies from RFD namespace design, since the computational power and storage capacity of FFD are normally higher than RFD. Figure 1 illustrates the naming schemes for both FFD and RFD.

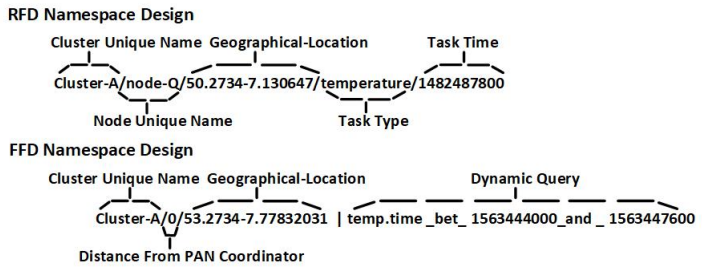

Figure 1: CCIC-WSN Namespace Design

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2.2 Lite Query Structure

Dynamic query integrated with the name can fetch multiple unique response objects in a single Data packet and hence the number of transmissions will be relatively small. For example, a dynamic query in the following name: Cluster-B/1/55.2734-6.77832031 | "temp.time_bet_1563444000_and_1563447600 describes a filter for all temperature values obtained between two time intervals.

2.3 Packet Types

In addition to the conventional Interest and Data Packets, the proposed architecture has 4 new packet types: 1) cluster head selection request 2) cluster head selection response 3) association request and 4) association response. All of these packets are following the rituals of NDN Interest and Data packet. An un-associated node wishes to join the network employ these packets for cluster head selection procedure. We added a packet type field in both Interest and Data packets which indicates the type of all aforementioned packets and can be used for 1) distinguishing conventional Interest and Data from these packets 2) taking appropriate actions while caching the content on intermediate nodes.

2.4 Communication Scenarios

In cluster-based WSN, the communication can be of two types: 1) intra-cluster communication and 2) inter-cluster communication. In intra-cluster communication, when node-C (Figure 2) receives an Interest packet, it will check the name, if the packets belong to its cluster then the node will forward it, otherwise the packet will be dropped. In inter-cluster communication, since the packet may belong to the node (node-G in Figure 2) in another cluster therefore, it will not be dropped rather forwarded towards potential cluster head.

2.5 New Node Association

When joining the network, an un-associated node chooses a cluster head for association purpose by employing parent selection process. The node will forward a cluster head selection request Interest packet and cluster head will respond with cluster head selection response Data packet by adding the information such as 1) distance from Personal Area Network (PAN) coordinator, 2) the number of child nodes associated with them and 3) traffic load. The un-associated node may receive multiple response packets from different clusters and try to associate itself with the cluster head which has a minimum distance from PAN, smaller number of child node and less traffic load on it. After deciding the cluster head, the node will forward an association request Interest packet towards potential cluster head which then responds with an association response Data packet. Finally, the cluster head will share (by employing sync protocol) the new node information with other cluster heads in the network so that they may construct a dynamic query accordingly in the future.

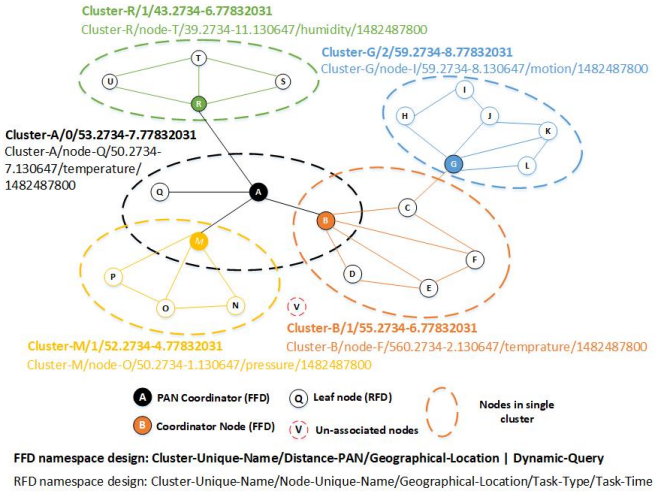

Figure 2: Cluster based Information Centric Wireless Sensor Network

3 CONCLUSION AND ON-GOING WORK

In this poster, we proposed a lite variant of NDN for cluster-based WSN. This work is in the early stages. We are currently modifying the codebase of ndnSIM and Networking Forwarding Daemon(NFD) to incorporate the changes such as addition of new field in Interest and Data packets by employing reserved numbers, support of lite and dynamic query component in Interest packet by mapping the keywords and operators to the fixed-length numbers, devising a new forwarding strategy to incorporate intra-cluster communication, inter-cluster communication and new node association process.

There are some important open research areas yet to be explored. First, how to handle a scenario in which a single query returns a large amount of data that may not fit in a single Data packet. Second, the caching should be very effective since there may be multiple types of Data packets with different nature of the content. Finally, how to limit the number of transmissions in inter-cluster communication.

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