# MR-Edge: a MapReduce-based Protocol for IoT Edge Computing with Resource Constraints

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## Introduction

As the Internet of Things (IoT) grows exponentially, so do the volumes of data it produces. Cloud computing is a popular choice to process enormous amounts of IoT data because of its rich power and resources. However, this approach increases transmission cost and delay. Edge computing is proposed to remedy the Cloud-only processing architecture for IoT. Our design (MR-Edge) achieves IoT Edge computing by combining the powerful MapReduce programming model with the novel Information Centric Networking (ICN). It includes two procedures (task deployment and task maintenance) for the execution of IoT tasks. Experimental results show MR-Edge could significantly decrease network traffic compared with the centralized processing method.

## Aims

- Deploy data processing functions according to the capability of heterogeneous IoT devices
- Coordinate capable IoT edge devices working together for multiple IoT tasks simultaneously

## MR-Edge Design

- Differentiate IoT devices:
  - -Processing-capable nodes (Mappers or Reducers)
  - -Forward-only nodes (Forwarders)
- Task Assignment
  - -Define an ICN naming (BuildJobTree (BJT) Interest) for IoT devices to exchange routing information
  - -Construct a shortest-path job tree with the root of each user (Fig. 1)
- Task Execution and Maintenance (Fig. 2)
  - -Define an ICN naming (ComputingJob (CJ) Interest) to assign data processing functions
  - -Coordination of IoT nodes for individual job execution
  - -Maintenance of multiple jobs on each node

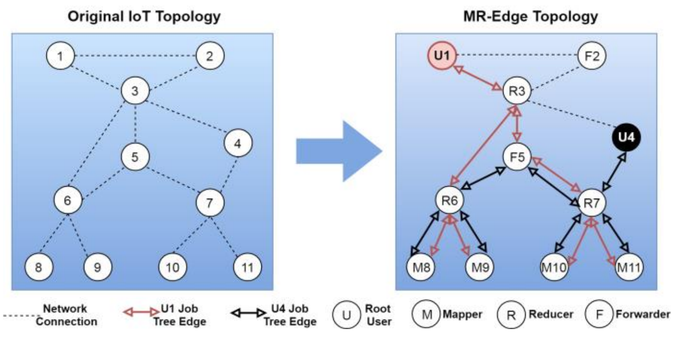


Fig. 1 Network Topology: Original IoT VS. MR-Edge

## Experimental Results

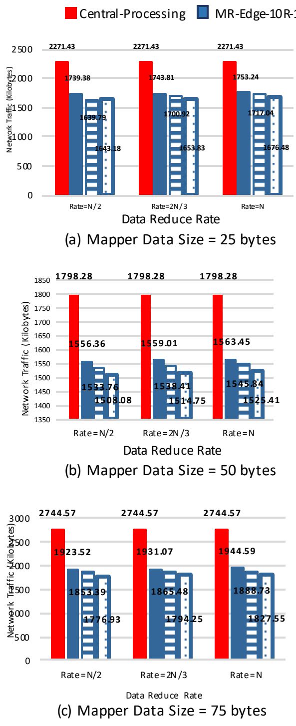


Fig. 3 Network Traffic Comparison

A set of tests are run to verify the feasibility of MR-Edge and also compares the IoT network traffic produced with and without our approach.

The total number of forwarders and reducers are fixed to twenty. We adopt three proportion of reducer/forwarders within the network: 10 Reducer and 10 Forwarders (a.k.a 10R-10F), 15R-5F and 20R-0F. We also change the number of mappers connected to each reducer and forwarder. The sent data size of mappers are 25, 50 and 75 bytes respectively.

The aggregated data size varies from N/2, 2N/3 to N. (N is the sum of received data.)

## Conclusions

The rapid expansion of IoT connects more and more computing devices to the network. The potential of these devices could be explored to improve the performance of IoT network. MR-Edge proposes a feasible solution which firstly considers the resource constraints of IoT devices, deploys tasks on capable ones and then organizes multiple edge nodes cooperating with each other to complete IoT tasks. With the aim to be a generic IoT Edge computing framework, our future work will mainly focus on developing a computation aware algorithm to build the job tree as well as the optimization on computational resources for multiple jobs.

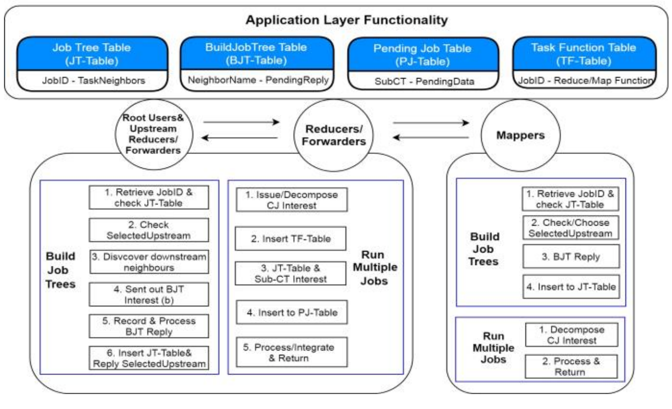


Fig. 2 MR-Edge Design