**Paper Title:** Joint Optimization of Energy and QoE with Fairness in Cooperative Fog Computing System

**Year:** 2018

**Conference:** IEEE International Conference on Networking, Architecture and Storage (NAS)

**Abstract—**Fog Computing as one of Mobile Edge Computing (MEC) paradigms deploys servers to the edge of networks to reduce the transmission latency. However, how to obtain the energy-effective cooperation policy among fog nodes to enhance the users’ quality of experience (QoE) under fairness still remains a challenging issue, where the fairness ensures that fog nodes are encouraged to take part in cooperation. Therefore, we first build up a cooperative fog computing system to process offloading workload on the entire Fog layer by data forwarding. Then we propose a joint optimization problem of QoE (average response time) and energy (average energy consumption) in integrated fog computing process with fairness. After that, we prove the convexity of the optimization problem and design a Fairness Cooperation Algorithm to obtain the optimal fairness cooperation policy of all fog nodes. Finally, by comparing with baseline algorithm and Distributed Optimization Algorithm, the numerical results show that our algorithm can effectively reduce response time reduction and energy consumption.

**Unique Contribution:**

In summary, the contributions of our work can be summarized as follows:

First, we formulate our optimization problem as minimizing joint energy consumption and response time instead of only energy consumption as a constraint.

Second, we consider the fairness among fog nodes in our problem to encourage fog node owners taking part in cooperation and formulate the fairness as the weights in the objective function. Finally, we propose a low-complexity algorithm to solve the optimization problem and the algorithm outperforms other algorithms in terms of reducing energy consumption and response-time simultaneously.

**System Model and Problem Formulation:**

Fog computing system usually represented by three layers structure:

Cloud layer, Fog layer and User layer.

**Fog layer:** Fog node is highly visualized computing system with finite resource.

It serves certain workloads of nearby users for saving users’ resources.

Usually, a task assigned to a fog node from nearby users has two options for operating:

operating at the fog node locally;

offloading the task to a cloud (or a cloudlet) of the Cloud layer.

**Newly introduced option:** designated fog node will forward full or partial task to other fog nodes in the Fog layer for cooperation computing.

**Assumption:** Fog layer is a fog computing network with a set of fog nodes. The fog nodes share load among each other. Each user is associated with one nearby fog node. Workload arrived at node is divided into equal partitions and forwarded to each node in the network. However, it is not necessary that each fog node must forward a part of its workloads to all other fog nodes in the Fog layer. (based on what criteria, will the load be forwarded?)

If fairness is not considered in this problem, the owners of nodes may reduce their contributed resource to cooperative fog computing system.

The amount of workload cannot go beyond the saturation of computation capacity at each fog node. A threshold of remaining capacity is considered.

**Performance Evaluation:**

We implement two comparison algorithms:

A baseline algorithm C1: every fog node executes the offloading workload without forwarding to others;

A Distributed Optimization Algorithm C2: also designed for the cooperative fog computing system that does not consider fairness and optimal power efficiency.

We implement the two comparison algorithms in same simulation scenarios as our algorithm for comparison.

**Comment:**

There is trade-off between avg. response time and energy consumption in the proposed approach. The more importance is given on fairness, the lower the avg. response time but higher the avg. energy consumption.

----------------------------------------------------------

-----------------------------

**Paper Title:** Towards Bandwidth Optimization in Fog Computing using FACE Framework

**Year:** 2018

**Conference:** 7th International Conference on Cloud Computing and Services Science (CLOSER 2017)

**Abstract—** The continuous growth of data created by Internet-connected devices has been posing a challenge for mobile operators. The increase in the network traffic has exceeded the network capacity to efficiently provide services, especially for applications that require low latency. Edge computing is a concept that allows lowering the network traffic by using cloud-computing resources closer to the devices that either consume or generate data. Based on this concept, we designed an architecture that offers a mechanism to reduce bandwidth consumption. The proposed solution is capable of intercepting the data, redirecting it to a processing node that is allocated between the end device and the server, in order to apply features that reduce the amount of data on the network. The architecture has been validated through a prototype using video surveillance. This area of application was selected due to the high bandwidth requirement to transfer video data. Results show that in the best scenario is possible to obtain about 97% of bandwidth gain, which can improve the quality of services by offering better response times.

**Unique Contribution:**

Given the computing capability offered by fog computing, it is necessary to investigate how to enhance network performance from it. Considering this context, in this paper we propose the FACE. It offers a framework with functionalities capable of either reducing or optimizing the network consumption. The functions provided are (F)iltering, (A)ggregation, (C)ompression and (E)xtraction.

In this paper,

we explained the definition and objectives of each function and also present potential scenarios where FACE can be applied. In order to test the capabilities of our solution, we performed an experiment using FACE frame-work in a video surveillance application. This context was selected due to the large amount of data generated by video cameras and due to the need of such applications for low latency. Results show that FACE framework provides significant reduction of data traffic, and it can be applied in the network infrastructure in a transparent way.

**Fog Computing:**

Fog computing is a virtualized platform that brings cloud computing services (compute, storage, and network) closer to the end user, in the edges of the networks.

Cloud computing resources will be geographically distributed to locations closer to the end users and/or IoT endpoints. This distributed infrastructure allows to get bandwidth savings by applying data processing across intermediary processing nodes, rather than only in the cloud.

**System Model and Problem Formulation:**

Fog computing system usually represented by three layers structure:

Cloud layer, Fog layer and User layer.

**Fog layer:** Fog node is highly visualized computing system with finite resource.

It serves certain workloads of nearby users for saving users’ resources.

Usually, a task assigned to a fog node from nearby users has two options for operating:

operating at the fog node locally;

offloading the task to a cloud (or a cloudlet) of the Cloud layer.

**Newly introduced option:** designated fog node will forward full or partial task to other fog nodes in the Fog layer for cooperation computing.

**Assumption:** Fog layer is a fog computing network with a set of fog nodes. The fog nodes share load among each other. Each user is associated with one nearby fog node. Workload arrived at node is divided into equal partitions and forwarded to each node in the network. However, it is not necessary that each fog node must forward a part of its workloads to all other fog nodes in the Fog layer. (based on what criteria, will the load be forwarded?)

If fairness is not considered in this problem, the owners of nodes may reduce their contributed resource to cooperative fog computing system.

The amount of workload cannot go beyond the saturation of computation capacity at each fog node. A threshold of remaining capacity is considered.

**Performance Evaluation:**

We implement two comparison algorithms:

A baseline algorithm C1: every fog node executes the offloading workload without forwarding to others;

A Distributed Optimization Algorithm C2: also designed for the cooperative fog computing system that does not consider fairness and optimal power efficiency.

We implement the two comparison algorithms in same simulation scenarios as our algorithm for comparison.

**Comment:**

Small-scale fat-tree can be used as an aggregated fog node.