A Novel Approach for IoT Tasks Offloading in Edge-Cloud Environments

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Abstract

Recently, the number of Internet of Things (IoT) devices connected to the Internet has increased dramatically as well as the data produced by these devices. This would require offloading IoT task to release heavy computation and storage to the resource-rich nodes such as Edge Computing and Cloud Computing. Although Edge Computing is a promising enabler for latency-sensitive related issues, its deployment produces new challenges. Besides, different service architectures and offloading strategies have a different impact on the service time performance of IoT applications. Therefore, this paper presents a novel approach for task offloading in an Edge-Cloud system in order to minimize the overall service time for latency-sensitive applications. This approach adopts the fuzzy logic algorithms, considering application characteristics (e.g., CPU demand, network demand and delay sensitivity) as well as resource utilization and resource heterogeneity. A number of simulation experiments are conducted to evaluate the proposed approach with other related approaches, where it was found to improve the overall service time for latency-sensitive applications and utilize the edge-cloud resources effectively. Also, the results show that different offloading decisions within the Edge-Cloud system can lead to various service time due to the computational resources and communications types.

Full Text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the latest manuscript can be downloaded and [accessed as a PDF](#).

Figures

Figure 1

An Overview of Edge-Cloud System

Figure 2

The Proposed Approach of Scheduling Offloading Tasks

Figure 3

Process of the Proposed Fuzzy Logic System

(a) Membership function for VM Utilization

(b) Membership function for Task Length

(c) Membership function for Transferred data

(d) Membership function for Delay Sensitivity

Figure 4

The Four Membership Functions

Figure 5

The Output Membership Function of the Fuzzy Logic System

Figure 6

Task Selection Phase

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Scenario started at 18/02/2020 17:36:19
Scenario: TWO_TIER_WITH_EO - Policy: UTILIZATION_BASED - #iteration: 1
Duration: 33.0 min (warm up period: 3.0 min) - #devices: 200
Creating tasks...Done,
Creating device locations...Done.
SimManager is starting...Done.
.....10%.....20%.....30%30%.....40%.....50%.....60%.....70%.....80%
# of tasks (Edge/Cloud/Mobile): 48869(48869/0/0)
# of failed tasks (Edge/Cloud/Mobile): 222(222/0/0)
# of completed tasks (Edge/Cloud/Mobile): 48647(48647/0/0)
# of uncompleted tasks (Edge/Cloud/Mobile): 30(26/0/4)
# of failed tasks due to vm capacity (Edge/Cloud/Mobile): 0(0/0/0)
# of failed tasks due to Mobility/Network(WLAN/MAN/WAN): 222/0(0/0/0)
percentage of failed tasks: 0.454276%
average service time: 1.134301 seconds. (on Edge: 1.134301, on Cloud: NaN, on Mobile: NaN)
average processing time: 1.072191 seconds. (on Edge: 1.072191, on Cloud: NaN, on Mobile: NaN)
average network delay: 0.062110 seconds. (LAN delay: 0.051209, MAN delay: 0.012486, WAN delay: NaN)
average server utilization Edge/Cloud/Mobile: 2.531046/0.000000/0.000000
average cost: 0.0$
Scenario finished at 18/02/2020 17:36:23. It took 4 Seconds
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Figure 7

A snapshot of the Simulation Results for One Scenario

SERVICE TIME

Figure 8

The Service Time of the Proposed Approach with other Related Approaches

NETWORK TIME

Figure 9

The Network Time of the Proposed Approach with other Related Approaches

PROCESSING TIME

Figure 10

The Processing Time of the Proposed Approach with other Related Approaches

Failed Tasks

Figure 11

11 Percentage of Failed Tasks of the Proposed Approach with other Related Approaches Part 1

Failed Tasks

Figure 12

Percentage of Failed Tasks of the Proposed Approach with other Related Approaches Part 2

Edge VM Utilization

Figure 13

Edge Server Utilization of the Proposed Approach with other Related Approaches Part 1

Edge VM Utilization

Figure 14

Edge Server Utilization of the Proposed Approach with other Related Approaches Part 2

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