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# RACE Resource Aware Cost-Efficient Scheduler for Cloud Fog Environment

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***Abstract: Fog computing is one of the new computing structures which takes the Cloud to the verge of the network. The structure is formulated for applications that need low latency. Fog Computing has been projected to improve the disadvantages of Cloud Computing. The system is confronted with the variability of dynamic resources that are heterogeneous and distributed. Hence, efficient scheduling and resource allocation are necessary to maximize the use of these resources and the satisfaction of users. In this paper, a resource-aware scheduler RACE (Resource Aware Cost-Efficient Scheduler) is proposed to distribute the incoming application modules to Fog devices that maximize resource utilization at the Fog layer, reduces the monetary cost of using Cloud resources with minimum execution time of applications and minimum bandwidth usage. This RACE comprises of two algorithms. The Module Scheduler in RACE categorizes the incoming application modules according to their computation and bandwidth requirements which are then placed by Compare Module. Comprehensive experimental results obtained from the simulation by using ifogsim simulator show that our approach performs better in most of the cases as compared to the Traditional Cloud placement and the baseline algorithm.***

***Keywords: Fog Computing, Resource Allocation, Module Schedular, Computing Structures.***

## I. INTRODUCTION

In Federated Vehicular Cloud Computing (FVCC), dynamic resource allocation having many problems like operating cost will be very high and delayed user requests and QoS also not that much good. Federated Vehicular Cloud Computing doesn't support IoT applications. Fog computing is a kind of network architecture that connects cloud computing with the Internet of Things .It is used to enhance the system efficiency and security. Fog computing is useful for when only selected data is required to send to the cloud. The selected data is useful for long term storage. Fog computing plays a vital role in IoT devices. It will allow the data transmission among IoT devices and cloud services. Always data transmission will be very faster because data will be stored in the network edge. Examples include Car to Car Consortium, Devices with Sensors, Cameras. So, in fog computing, dynamic resource allocation having many be good. Cost and Time will be less. Fog computing moves computing systems and storage very closest to the devices, applications, components. Because of this latency is greatly reduced. Generally, IoT devices will produce huge data. These devices are having less latency in fog computing. Since those are very nearest to the data source. Fog computing goal is to lower the latency and increase efficiencies. Advantages: Minimize the latency: Since it isvery nearest to the data source, prevents system failures, manufacturing line shutdowns. It will do the quick alerts and reduce the danger for users. Reduce the operating costs: Because of processing data in local, operating costs will be less. Enhance security: Since fog nodes are deployed using same policies, it will provide enhanced security.

Fog Computing Applications Smart/Connected car manufacturers: Fog computing plays a major role in connected vehicles. This feature will reduce the accidents and enhance the safe driving. Industrial IoT (IIoT): All manufacturing plants relies on the fog computing to get and process the huge amount of data in the local instead of cloud. It will increase the good data accuracy. Smart cities and grids: Accurate data is essential in all the systems which are available in smart cities. Using fog computing, sensor data will travel faster. In Federated Vehicular Cloud Computing (FVCC), dynamic resource allocation having many problems like operating cost will be very high and delayed user requests and QoS also not that much good. Federated Vehicular Cloud Computing doesn't support IoT applications. Fog computing is a kind of network architecture that connects cloud computing with the Internet of Things .It is used to enhance the system efficiency and security. Fog computing is useful for when only selected data is required to send to the cloud. The selected data is useful for long term storage. Fog computing plays a vital role in IoT devices. It will allow the data transmission among IoT devices and cloud services. Always data transmission will be very faster because data will be stored in the network edge. Examples include Car to Car Consortium, Devices with Sensors, Cameras. So, in fog computing, dynamic resource allocation having many advantages like resource utilization and Quality of Service will

## II. LITERATURE SURVEY

A. A. Khan, M. H. Rehmani, and A. Rachedi. Cognitive-radio-based internet of things: Applications, architectures, spectrum related functionalities, and future research directions. IEEE Wireless Communications, 24(3):17–25, June 2017.

Recent research and technology trends are shifting toward IoT and CRNs. However, we think that the things-oriented, Internet-oriented, and semantic-oriented versions of IoT are meaningless if IoT objects are not equipped with cognitive radio capability. Equipping IoT objects with CR capability has lead to a new research dimension of CR-based IoT. In this article, we present an overview of CR-based IoT systems. We highlight potential applications of CR-based IoT systems. We survey architectures and frameworks of CR-based IoT systems. We furthermore discuss spectrum-related functionalities for CR-based IoT systems. Finally, we present open issues, research challenges, and future direction for these CR-based IoT networks.

Maria Ganzha, Marcin Paprzycki, Wiesław Pawłowski, Paweł Szmeja, and Katarzyna Wasielewska. Semantic interoperability in the internet of things: An overview from the inter-iot perspective. Journal of Network and Computer Applications, 81:111–124, 2017.

The Internet of Things (IoT) idea, explored across the globe, brings about an important issue: how to achieve interoperability among multiple existing (and constantly created) IoT platforms. In this context, in January 2016, the European Commission has funded seven projects that are to deal with various aspects of interoperability in the Internet of Things. Among them, the INTER-IoT project is aiming at the design and implementation of, and experimentation with, an open cross-layer framework and associated methodology to provide voluntary interoperability among heterogeneous IoT platforms. While the project considers interoperability across all layers of the software stack, we are particularly interested in answering the question: how ontologies and semantic data processing can be harnessed to facilitate interoperability across the IoT landscape. Henceforth, we have engaged in a “fact finding mission” to establish what is currently at our disposal when semantic interoperability is concerned. Since the INTER-IoT project is initially driven by two use cases originating from (i) (e/m)Health and (ii) transportation and logistics, these two application domains were used to provide context for our search. The paper summarizes our findings and provides foundation for developing methods and tools for supporting semantic interoperability in the INTER-IoT project (and beyond).

Kyle E Benson, Guoxi Wang, Nalini Venkatasubramanian, and YoungJin Kim. Ride: A resilient iot data exchange middleware leveraging sdn and edge cloud resources. In 2018 IEEE/ACM Third International Conference on Internet-of-Things Design and Implementation (IoTDI), pages 72–83. IEEE, 2018

Internet of Things (IoT) deployments rely on data exchange middleware to manage communications between constrained devices and cloud resources that provide analytics, data storage, and serve user applications. In this paper, we propose the Resilient IoT Data Exchange (Ride) middleware that enables resilient operation of IoT applications despite prevalent network failures and congestion. It leverages programmable Software-Defined Networking (SDN)-enabled infrastructure along with both localized edge and cloud services. The two-phase Ride middleware extends existing publish-subscribe oriented IoT data exchanges according to application-specified resilience requirements and without IoT device client modifications. The first phase, Ride-C, improves IoT data collection by gathering network-awareness via a novel resource-aware adaptive probing mechanism and dynamically redirecting IoT data flows across multiple public and local (edge) cloud data exchange connections. The second phase, Ride-D, uses this information to disseminate time-critical alerts via an intelligent network-aware resilient multicast mechanism. Results from our prototype smart campus testbed implementation, Mininet-based emulated experiments, and larger-scale simulations show that Ride enables network awareness for greater cloud connection up-times, timely fail-over to edge services, and more resilient local alert dissemination.

C. Savaglio, G. Fortino, and M. Zhou. Towards interoperable, cognitive and autonomic iot systems: An agent-based approach. In 2016 IEEE 3rd World Forum on Internet of Things (WF-IoT), pages 58–63, Dec 2016.

Within the Information and Communication Technology hype cycle the Internet of Things (IoT) represents a prominent subject, being rich in potentiality as well as in development issues. In this paper, we face the IoT developing process first 'in the small' by designing the Smart Objects (SOs, representing the fundamental IoT building blocks) as agents, and after 'in the large' by treating the IoT systems as Multi Agent Systems (MASs). Indeed, the agent abstraction is a suitable paradigm to instill smartness and autonomy within a single SO and consequently to realize distributed, self-steering and heterogeneous IoT systems. In such directions, the Agent-based COoperating SO (ACOSO) middleware represents a viable solution for the programming, development and management of agent-based SO systems while its performance verification on different IoT networks of different scale has been made through the Omnet++ simulator.

Enas Ahmad, Maha Alaslani, Fahad R Dogar, and Basem Shihada. Location-aware, context-driven qos for iot applications. IEEE Systems Journal, 2019.

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In this paper, we identify the unique quality of service (QoS) needs of emerging IoT applications and propose SDN-based Application-aware Dynamic Internet of things Quality of service (SADIQ), a software-defined network (SDN) framework that addresses these needs. SADIQ provides location-aware, context-driven QoS for IoT applications by allowing applications to express their requirements using a location-based abstraction and a high-level SQL-like policy language, and the network to support these requirements through recent advances in SDNs. We implement SADIQ using commodity OpenFlow-enabled switches and an open-source SDN controller and evaluate its effectiveness using traces from two real IoT applications. Our results show that SADIQ improves the percentage of regions with error in their reported temperature for the Weather Signal application up to 45×, and improves the percentage of incorrect parking statuses for regions with high occupancy for the Smart Parking application up to 30×, under the same network conditions and drop rates.

## III. PROPOSED SYSTEM ARCHITECTURE

In the proposed system, a resource-aware scheduler is presented to distribute the incoming application modules to Fog devices. The placement strategy of Application modules from Fog layer to the Cloud layer introduced in our approach reduces the monetary cost of using Cloud resources with minimum execution time and minimum bandwidth usage. The main contribution of this paper are as follows: A Resource Aware Cost Efficient scheduler is proposed for the placement of application modules from Fog layer to the Cloud layer instead of directly sending it to the Cloud in order to achieve maximum resource utilization.

A priority mechanism is defined for the placement of application modules to minimize the bandwidth, execution time and monetary cost of using cloud resources. We have employed Resource Aware policy in iFogSim-simulated fog environment and compared with tradition cloud and Cloud Fog placement approaches from different standpoints. The performance results show significant improvement in favor of our policy

### *A. Advantages of Proposed System*

The system designs a fast access management with RACE (Resource Aware CostEfficient Scheduler).

The system uses in which Scheduling is the process of mapping application modules onto computing resources to efficiently utilize computing resources (such as CPU, memory, bandwidth, etc.,).

## IV. EDAGE COMPUTING

We have defined the following framework for the edge computing value chain

*1)* *Facility:* The physical site that includes the land/location for the edge data centre (e.g. area around mobile operator's cell tower), the data centre itself, power and cooling to support it and additional services to maintain and operate the site.
*2)* *Hardware:* This includes the hardware inside the data centre (racks, servers, processors and the maintenance and operators for these) as well as end-devices.
*3)* *Network:* Connectivity infrastructure to and from the edge site, as well as traffic routing controls and types of networks to optimise the delivery of content (e.g. CDN).
*4)* *Edge Cloud Infrastructure:* Virtual infrastructure supporting the edge workloads and applications, from the operating system, the virtualisation layer (which may be container-based), and the platforms for developers to access and manage the storage and compute infrastructure.
*5)* *Application/Software:* Applications that run on edge computing infrastructure, including network functions, and the application-specific tools that support these, for example analytics capabilities or APIs and platform-as-a-service products.
*6)* *Integration & Services:* Services that provide support to the customer employing and integrating edge computing at any stage of the value chain – including design and engineering services to create platforms for edge computing applications, or more traditional integration into existing (enterprise) systems.
*7)* *Open Source & Forums:* Communities that seek to accelerate edge computing – either by creating forums for discussion across stakeholders and industry partners or open

## V. APPLICATIONS

*1)* Spending explodes along with data generation
*2)* Telecommunications companies will play an increasing role
*3)* 5G boosts edge use cases

a) *Soil Quality:* Examining the soil moisture using a mobile device by checking the farm location and the soil color.
b) *Milch Animals' Health:* It tracks livestock's health using sensor data such as temperature, heart rate, etc., and provides insights about the health condition.
c) *Crop Health Analysis:* A predictive computation engine, such as drones, can be used to check the health of leaves based on color and the pores it has, whether attacked by insects, pests, or rodents.
d) *Examining Leaf's Health:* Drones can be used to check the health of leaves based on color and the pores it has, whether attacked by insects, pests, or rodents.

## VI. ADVANTAGES

1) *TM Security:* Edge AI can be used to improve ATMs' security, such as the video feed can be analyzed at the edge by integrating image recognition on ATMs. There is no need for human intervention. It is also not required first to transfer the data to the cloud. If the ATM tempers anyway, it will automatically shut down as soon as possible before any mishappening occurs. And then, it alerts the bank so that they can take action by contacting law enforcement.
2) *Data Privacy:* While using cloud computing to transfer data to a central location, it is mandatory to follow the privacy and security guidelines to reduce the chances of stealing data. But still, the chances of data loss are always there. Edge computing makes this task easier. It enables the banks and financial institutes to deploy applications across local branch offices and reduce the need for cloud computing and also the chance of loss of data.
3) Improves the Management of All Devices
4) Cheaper Operating
5) Effective For Minimizing User Intervention

## VII. CONCLUSION

In summary, we have highlighted that non-automatic setup and management of end devices in IoT systems are impractical and unachievable. The presence of the autonomic structure and algorithms that require minimal human intervention is the requirement of the hour. There are very few algorithms that achieve some self-* properties without requiring highperformance devices. Enabling technologies for autonomy were discussed which can fulfil the vision of an intelligent and autonomic IoT. It is not necessary to have all the autonomic enabling technologies implemented in one device. Rather, various aspects of autonomy need to be implemented throughout the end-to-end IoT system in addition to the minimal configuration for interoperability. In order to achieve true autonomy, a system should be able to make complex decisions without human intervention. True autonomy has not been achieved in any work, and currently, only partial autonomy is implemented in parts across various layers. We highlighted various technologies that are crucial for realizing the vision of autonomy in the IoT setting. We believe this work will serve as a guideline to influence the future research directions of autonomic computing in IoT.

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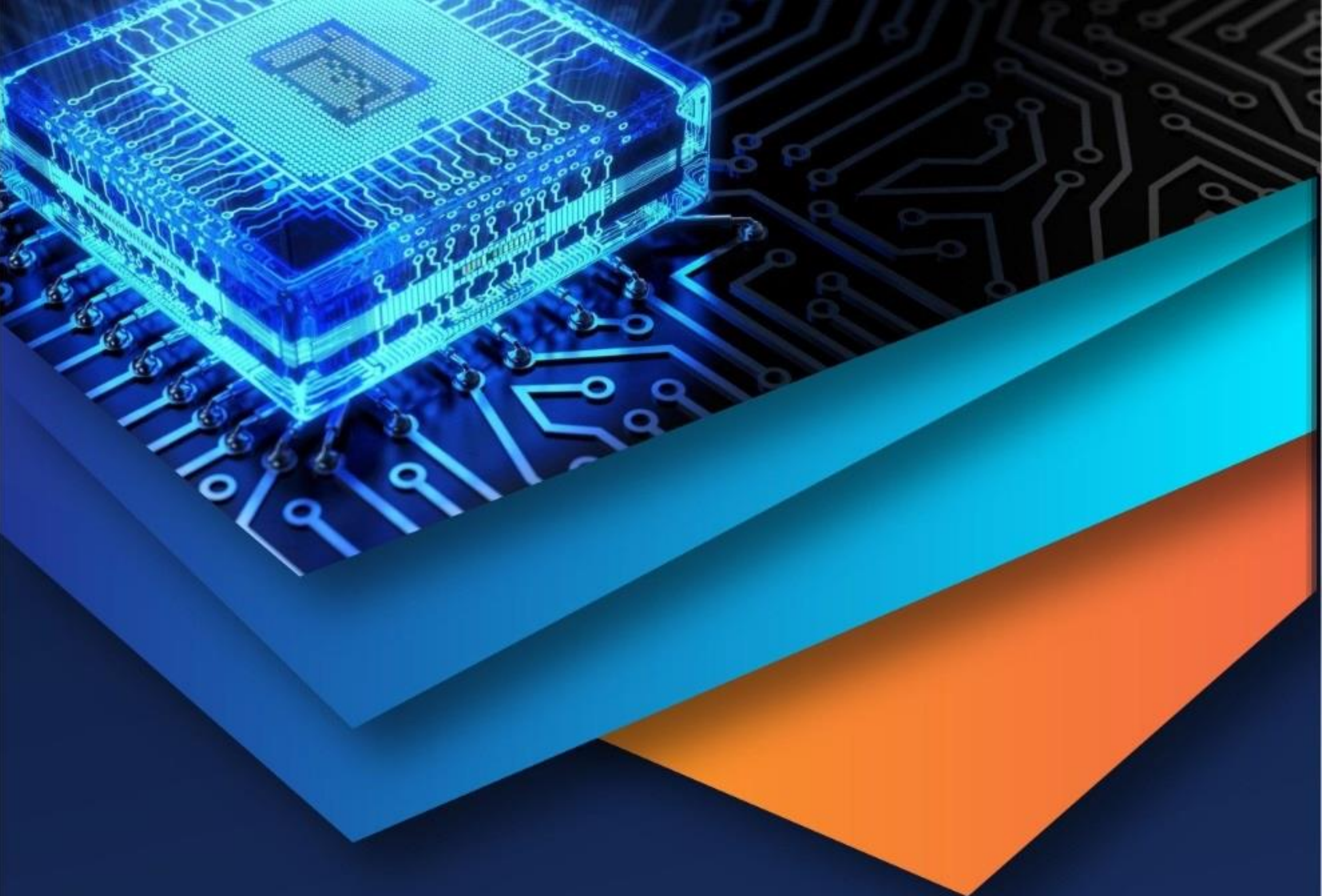

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