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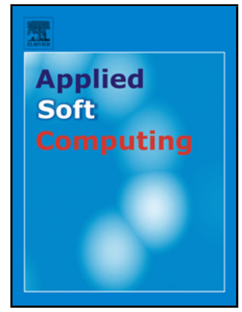

Title: Resource Multi-Objective Mapping Algorithm based on Virtualized Network Functions: RMMA

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Resource Multi-Objective Mapping Algorithm based on Virtualized Network Functions: RMMA

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Abstract

Existing radio access network systems are static and rigid; they cannot easily satisfy the increasingly large volume of mobile traffic. A new multi-objective optimization approach was developed to leverage the complexity and scalability of radio resource allocation in large-scale radio access networks. A mathematical model of virtualized resource mapping in a heterogeneous radio access network is proposed in this study. We expanded the dynamic differential evolutionary algorithm by regulating the weight parameters of each objective with machine learning to solve the mathematical model. Our approach is evaluated comprehensively in terms of complexity and convergence, and simulations are conducted to verify the proposed approach and demonstrate that the unilateral value of our multi-objective optimization can mirror the results of single-objective optimizations.

Index Terms

Multi-objective Optimization, Virtualization, Heterogeneous Radio Access Networks, Dynamic Differential Evolution, Mapping.

I. Introduction

Network virtualization can be used to visualize different software platforms in the same infrastructure, manage networking differentiation services, and facilitate different protocols across coexisting heterogeneous networks[1,2]. With the explosive growth of mobile traffic, heterogeneous radio access networks present a promising paradigm to improve system coverage and capacity as well as users' quality of experience (QoE)[3,4]; however, efficient resource use depends on the unified management of heterogeneous networks[5,6]. Therefore, network virtualization has become an effective tool to manage these networks[1,2] and is considered the key criterion of 5G networks in super-dense scenarios[3,4].

Resource mapping is an important aspect of network virtualization wherein a qualified subset is selected among virtualized network functions. This is an NP-hard problem that can be reduced to a multi-way separator problem[2]. When network traffic suffers from tidal problems, each objective optimization weight varies with traffic changes. The system should be energy efficient, and users' QoE should be guaranteed when network traffic volume is low; however, depending on application types and user preferences, users may perceive a good QoE with the same throughput when the network traffic volume is moderate. The system's throughput should be as large as possible when network traffic volume is high. Therefore, quickly identifying an optimized subset is of paramount importance. To adapt to different network traffic demands, the radio access system requires dynamic adjustment of base station transmission power and effective allocation of radio spectrum resources so that channel interference changes with network traffic. These considerations are similarly essential when dividing subsets.

In contrast to extant literature, our study focuses on the multi-objective resource mapping problem given changes in network traffic volume. The topology is based on federal architecture, such as C-RAN or Flog computing. Each federal district has different types of networks that are managed using virtual technology. We used a resource mapping method to optimize the network system's throughput, users' QoE, and the infrastructure's energy consumption as network traffic changed. The contributions of this paper are threefold:

(1) A multi-objective mathematical model of throughput, QoE, and network power consumption is formulated, which is solved by extending the dynamic differential evolutionary algorithm. The proposed approach demonstrates it is possible to leverage the dynamics and flexibility of heterogeneous radio access networks.

(2) Machine learning is adapted to regulate the objectives weighting coefficients; in doing so, the unilateral value of the dynamic differential evolutionary algorithm mirrors the results of single-objective optimizations.

(3) The algorithm is evaluated in terms of time complexity, convergence, and effectiveness via Markov analysis and a simulation experiment.

The remainder of this paper is organized as follows. Section 2 outlines related work. Section 3 provides the system model, and Section 4 presents the multiple attribute mapping mathematical model. Section 5 provides a mapping method for solving multi-objective optimization. Sections 6 and 7 present the objectives, performance metrics, and evaluation results. Section 7 concludes the paper.

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