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AN EFFICIENT DYNAMIC RESOURCE SHARING FOR A MULTI-VENDOR WIRELESS NETWORK VIRTUALIZATION

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ABSTRACT

Service diversity in the fifth generation of mobile communication (5G) has introduced crucial challenges in the resource management and Radio Access Network (RAN) infrastructure. To overwhelm these difficulties, Wireless Network Virtualization (WNV) has been proposed as a promising key technology to enable emerging services and respond to user and operator demands. WNV reduces operator implementation and operation costs and utilizes the resources to be distributed dynamically among virtual operators by decoupling hardware infrastructure and service providers into different entities.

In this work, a typical WNV system is designed and simulated to visualize system operation and task management among the Infrastructure Providers (InPs), Mobile Virtual Network Operators (MVNO), and user equipment (UE). In the system design, multiple InPs own the hardware resources and provide isolated slices to the MVNOs, where several MVNOs purchase channel resources from InPs and service their UEs. A new system model is derived mathematically where a dynamic inter-user inference is considered for the first time with multiple InPs under 5G radio conditions. Moreover, an economic model is integrated with the proposed WNV system to evaluate overall expenses and revenue for each player. The process of selecting MVNOs by different InPs and dynamically allocating resources to the UEs is proposed to be two levels; paring UEs with the MVNOs at the first Level and then distributing InP resources to the UEs via pre-selected MVNOs at the second Level.

For this purpose, hierarchical game-matching and Particle Swarm Optimization (PSO) algorithms are proposed to address dynamic resource allocation complexity and provide optimum resources to the UEs, maximizing InPs revenue and user throughput. The simulation results show both algorithms' robustness in optimizing the expenses and gaining UEs throughput. Furthermore, integrating the economic scheme with the derived WNV model facilitates the optimization of profits and cost reduction for the involved players. This methodology guarantees the financial viability of the network and ultimately provides advantages to all stakeholders. As well as the obtained UEs engagement reached 98% of the total users who contributed to the resource request. It is a high rate of user admission within acceptable time intervals and complexity. Results indicated a trade-off between the two proposed algorithms regarding convergence and accuracy; PSO obtained faster convergence, while the matching game provided higher throughput and better end-user performance.

KEYWORDS: WIRELESS NETWORK VIRTUALIZATION; RESOURCE ALLOCATION; MATCHING GAME; PSO; RESOURCE PRICING.

1. INTRODUCTION

In the ever-changing world of wireless communication technologies, the arrival of 5G and RAN has started a new era of connection and services. As the demand for various applications rises, the efficient administration of network resources becomes essential to ensure optimal performance and user satisfaction. In this light, WNV emerged as a paradigm shifter with the potential to fundamentally change resource allocation and pricing strategies in 5G network slicing within RAN contexts (Oladejo et al., 2021; Oladejo & Falowo, 2019).

WNV changes network design by virtualizing physical resources. This virtualization creates various simulated networks for different services and applications. WNV's interaction with dynamic resource allocation and pricing models allows network operators to distribute resources in real-time, depending on user and service needs. Dynamic resource allocation with WNV enables the development of more adaptive, responsive, and economically feasible network systems (Hirayama et al., 2022).