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A COMPARATIVE STUDY ON NETWORK SLICING USING META-HEURISTIC ALGORITHM IN A NETWORKING ENVIRONMENT

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Abstract: Network slicing (NS) is a main allowing technology used in cellular 5G wireless communication networks.NS is introduced by 3GPP (Third Generation Partnership Project) in releases 15 or 16. 5G network is standardized with more software implementation to provide better flexibility and support different services. Virtualization of network functions, commonly called VNF is a software-based technique to enable different function. The NS technique is mostly suitable for computing-distributed environments. Two different approaches are the random-access network function called as RAN and the core network function called as CN, which are used for fast network function deployment. Here, different algorithms are used for finding optimal solution with less complexity and time.

Index Terms - Network-slice, Core Network (CN), Software-Define-Network (SDN), Network-Function-Virtualization (NFV), Genetic Algorithm, Random Access Network (RAN)

I. INTRODUCTION The extensive increase in use of gadgets causes a surge in mobile traffic across the global network. Due to increase in demand and a higher bandwidth requirement, A fifth-generation network is implemented. 5G provides better network connections and services. 5G technology also provides better flexibility and scalability. Software-defined network (SDN) and network function virtualization (NFV) are the main apparatuses of the 5G cellular network, which can solve network issues with changing physical infrastructure.[1]. Network slice helps divide the network for each use case, such as ultra-reliable low latency (called as URLL), enhanced mobile broadband (eMBB), IoT, etc. Network slicing enhances performance through optimal utilization of resources. With the increase in the number of devices, the services are characterized based on the cost plane and user plane. Here, performance depends on bandwidth, number of users, data rates, reliability, throughput, and latency [2] [1]. Similarly, network functionalities depend on radio resource management, security, isolation, mobility, etc. Network build-on software is used in SDN technology, and virtualization is used in NFV technology.

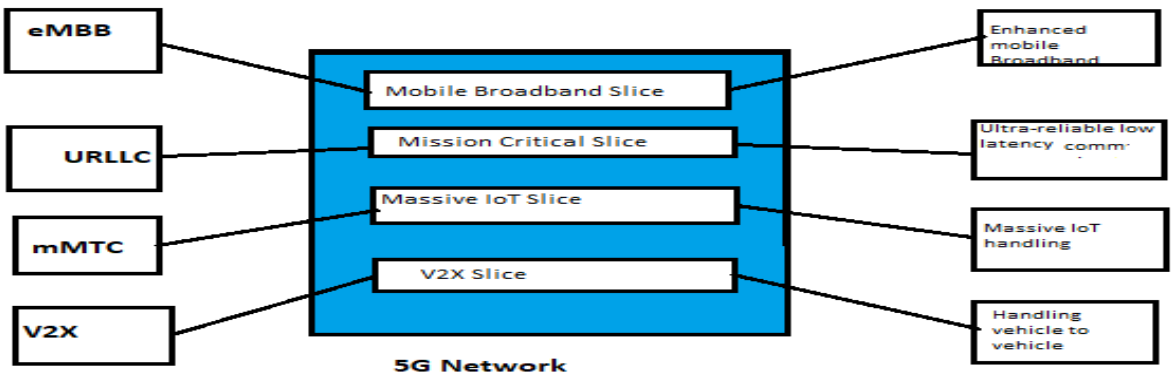


fig. 1: 5G network slicing architecture [4]

II.RELATED WORK The 5G network slice architecture creates multiple logical wireless networks for specific use cases. [3]. It allows a secure and scalable network that is isolated with the same setup. It has three layers. Mostly called service instance layers, they help form network functions. The second layer is the network slicing identifier, which helps in selection and identification. Thirdly, the resource layer, which contains network functions or resource infrastructure designed for providing different services to end-to-end users [5], Different slice instances combine to form a sub-network.

It has many functions, like SDN and NFV, which are combined into radio-access networks (RAN) and core networks (CN). [1] [2]. CN is the main element of a wireless network and performs connections with RAN and E2E users. It has different network instances, such as mobility management, session management, and mobility management. Service The core network is placed in the node centrally, and the random-access network is placed partly in the node centrally to improve network management. It offers software development and more flexibility. But CN and RAN are not easily distinguishable where the NS implemented is configured by using CN, RAN, and user equipment. RAN is the main component of 5G NS, and RAN consists of a base station and antenna. User equipment is connected to RAN and CN. RAN consists of three functions: radio unit (RU), distributed unit, and centralized unit. RAN provides radio access and manages resources and User equipment in 5G NS to increase the capacity data speed. It has two different plane functions: the control plane (CP) and the user plane (UP). CP functions include mobility and access management, policy control and authentication, etc. [8].

It has many use cases. URLL (ultra-reliable low-latency) use cases help to decrease latency [4]. It is mostly used in remote control, automation systems, and smart grids. Massive Internet of Things use cases help connect a huge number of devices. Enhanced mobile broadband use cases provide a high-definition media experience with better fidelity [6][7].

In the literature survey, we reviewed network slicing by using different functions and four different algorithms [1]. We have compared our results with the review paper [1] and obtained better optimal results. Here we obtain results in semi-log and log form. We found that the range of data rates increased from 200 Mbps to 3 Gbps and obtained better cost-effectiveness in different use cases. Also, we propose to obtain better latency by using different algorithms, and GA provides better results. The variation of results is clearly visible and shows a wider range of variation. Here, latency varies from 0 msec to 12.5 msec.

III.METHODOLOGY The logical network function called as VNF has been placed in a multilayer slice and designed for E2E users based on the cost function. E2E is placed in different network functions. RAN and CN functions are designed for softwarization and virtualization. Genetic algorithms are preferred to obtain optimal solutions and are also compared with different meta-heuristic algorithms. The total coverage is divided into different microcells, and each microcell has a cloud-RAN (CRAN). It consists of different base stations, commonly called RRH (Remote Radio Heads). The number of RRH connected to the base station and edge was computed in two layers [1]. Here, a network cloud operator is used as an operator. Then it connected to the infrastructure of a multiple-tenant cloud.

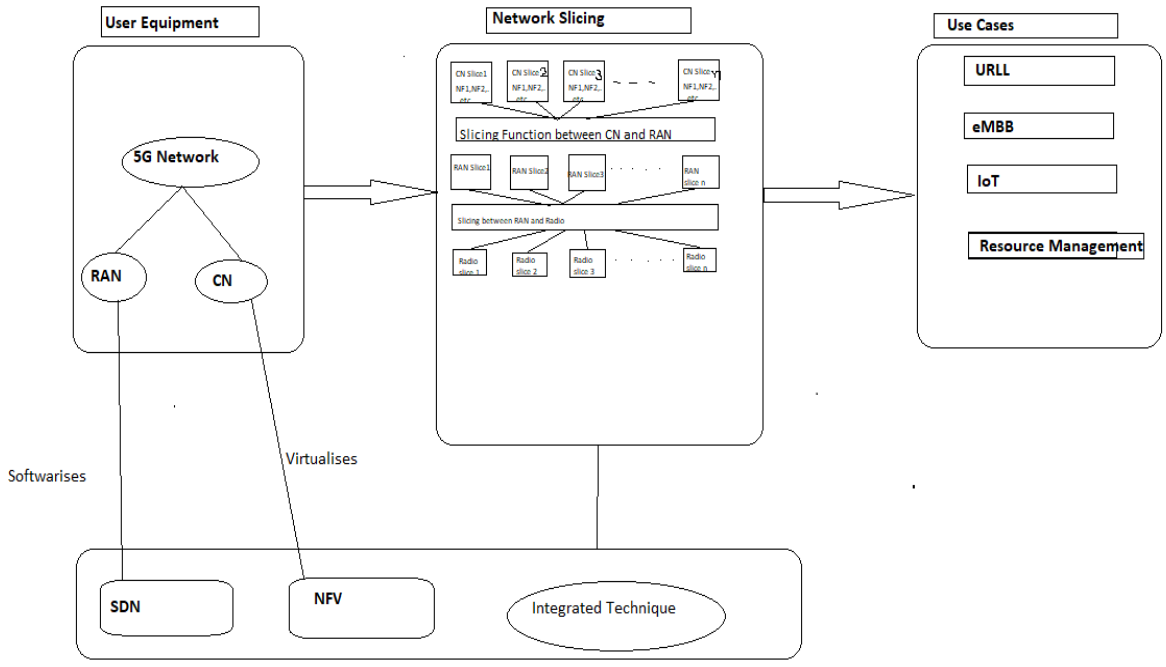


fig. 2: system model of network slicing

IV.PROBLEM FORMULATION To resolve issues with traffic capacity, we use a meta-heuristic algorithm to obtain a solution. Here, the genetic algorithm (GA), maximum preference algorithm (MPA), modified maximum preference (MMPA) algorithm, and ESA algorithm are used. The GA algorithm is used to create high-quality service with less time to fulfill real-time demand. It is very simple. The ESA algorithm is used to provide optimal cost on a priority basis, but it requires more time, which is unreasonable. MPA is a static-based deployment where solutions are obtained with the highest matching preference. But it is not always providing a feasible solution; it fulfills operator needs in most cases. To obtain a feasible result, MMPA works the same as MPA with a few limitations. It has a low cost of implementation compared to MPA.

V.RESULTS AND ANALYSIS

The 5G core network has control plane and user plane functions. CP and UP are separate from each other and provide scalability and flexibility. It also helps in designing efficient NS. The CP function deploys by using GA, MPA, and MMPA algorithms.

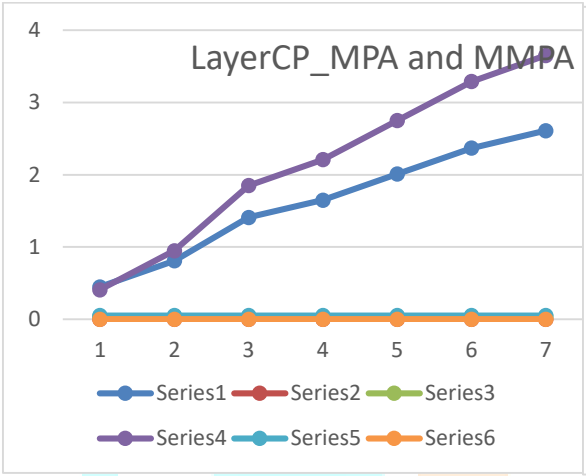


fig. 3a:layer CP by using MPA and MMPA

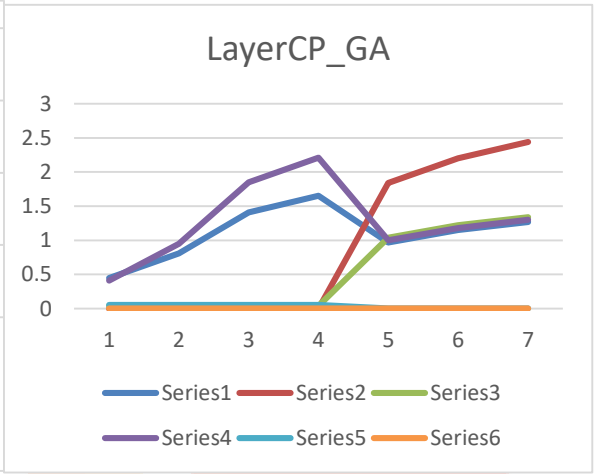


fig. 3b:layer CP by using GA

In URLL, user plane latency varies from 0 msec to 3000 msec, and the cost function varies with respect to user plane latency. The cost function changes by using different algorithms. The cost function varies from 0 to 12.5 msec. We have considered two different conditions and compared them. Semi-log and log are two different conditions. We optimized the cost function and obtained higher cost values compared to the other two MPA and MMPA algorithms.

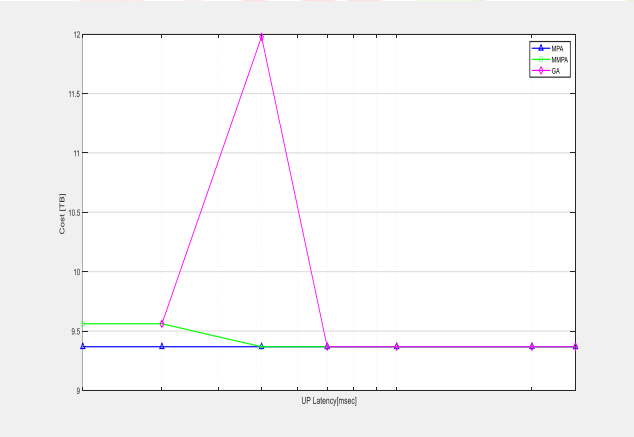


fig. 4a: semi-log graph of cost in TB with respect to user plane latency in URLL user case

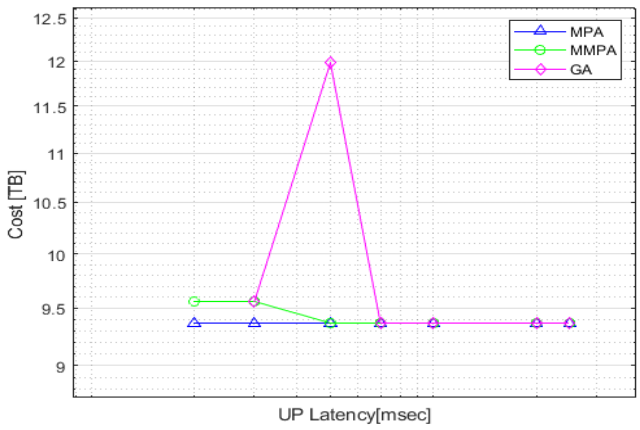
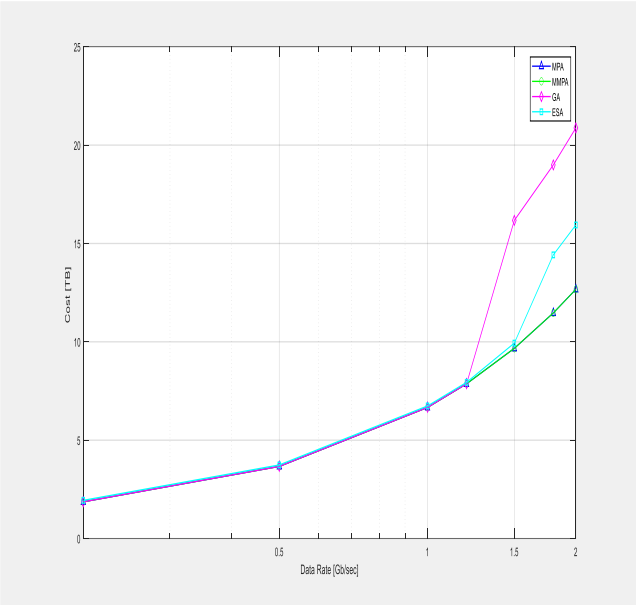


fig. 4b:log graph of cost in TB with respect to user plane Latency in URLL user case

In eMBB use cases, cost function varies with respect to data rates, and data rates vary exponentially with cost function in four different algorithms. If we plot the cost function against data rates in semi-log, the curve increases exponentially. Whereas, if we plot in logarithmic form the curve increases linearly. The MPA algorithm provides better results compared to the other three algorithms.



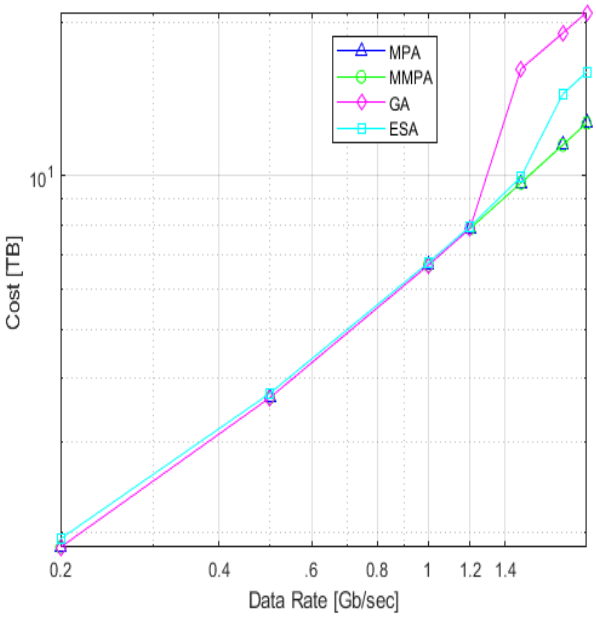


fig. 5a: cost function vs. data rate of the eMBB users in semi-logusers in log

fig. 5b: Cost Function vs. data rate of the eMBB

VI.CONCLUSION NS is able to differentiate between cellular 4G and 5G wireless networks. We can resolve the problem of the deployment of network functions. As there is a rigorous increase in demand for wireless networks, network slicing helps fulfill the requirements of end users. In the meantime, softwarization and virtualization are added to network architecture and also applied in wide diversity. An optimal solution is obtained by using a meta-heuristic algorithm. 5G NS provides an E2E logical network to achieve better coverage. We can also implement dynamic coverage.

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