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A SURVEY ON MOBILITY-AWARE AND DELAY-SENSITIVE SERVICE PROVISIONING IN MOBILE EDGE-CLOUD NETWORKS

R.Thamarai selvi[1] ,MS.E.Padma M.Tech[2]
[1]*PG Scholar, Department of Computer Science and Engineering, Nandha Engineering College (Autonomous), Erode, Tamilnadu, India*
[2]*Associate Professor, Department of Department of Computer Science and Engineering, Nandha Engineering College (Autonomous), Erode, Tamilnadu, India*

ABSTRACT
Mobile edge computing (MEC) has emerged as a viable technique for pushing the cloud frontier to the network edge, enabling network services to be provisioned in close proximity to mobile consumers. Serving customers at the edge of the cloud can minimize service latency, lower operational costs, and increase network resource availability. Along with MEC, network function virtualization (NFV) is a viable strategy for implementing various network service functions as software in cloudlets (servers or clusters of servers). Giving mobile consumers virtualized network services can improve their service experience, simplify network service deployment, and make network resource management easier. However, mobile users roam arbitrarily inside networks, and different users often request various services with varying resource needs and latency requirements. As a result, it is a significant issue to provide dependable and smooth virtualized network services for mobile users in a MEC network while satisfying their specific latency needs, subject to network resource limits. This research focuses on the supply of virtualized network function services for mobile users in MEC while taking user mobility and service latency requirements into mind. We begin by posing two novel optimization issues for user service request admissions, with the goals of maximizing accumulative network utility and accumulative network throughput over a certain time horizon. Then, for the utility maximization issue, we design a constant approximation approach. We also create an online method for the problem of accumulative throughput maximization. Finally, we use experimental simulations to assess the performance of the suggested methods. The results of the experiments show that the proposed algorithms are promising.
Keyword: Mobile Edge computing, network function virtualization, VNF instance deployment, virtualized service provisioning, approximation and online algorithms, delay-sensitive request admission, utility gain maximization, user mobility, cloudlets or edge-clouds, resource allocations and provisioning in MEC, optimization problems

1. INTRODUCTION

MOBILE gadgets, such as smart phones and tablets, are becoming increasingly popular as business, social networking, and personal leisure communication tools. Meanwhile, for the convenience and enjoyment of users, more and more computation-intensive mobile apps with advanced features, such as interactive online gaming, object recognition, and voice control, are being created. However, the execution of computing/storage heavy apps on portable mobile devices is severely hampered by the mobile devices' low compute, storage, and battery capabilities. Offloading computation-intensive apps to faraway clouds with abundant processing and storage resources can considerably expand the capabilities of mobile devices.

However, doing so may result in unavoidable lengthy response latencies, as clouds are often located far away from their end customers, degrading the user experience of utilizing the services, particularly for services with tight latency requirements. Mobile Edge Computing (MEC), as a cloud complement architecture, delivers cloud services to mobile consumers at the network edge, dramatically reducing reaction time. The MEC architecture can take use of mobile devices' capabilities to offload application services to adjacent edge-clouds (cloudlets). As a result, mobile device service quality and energy

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usage may be considerably improved. Instead of purpose-specific hardware middle boxes, servers will implement diverse network function services as software components in cloudlets. This adds a new degree of cost savings and network function deployment flexibility.

1.1 MOBILE EDGE COMPUTING

MEC, formerly known as mobile edge computing, is a sort of edge computing that extends the capabilities of cloud computing by moving it to the network's edge. MEC is an ETSI (European Telecommunications Standards Institute) effort that began with the goal of installing edge nodes on the mobile network but has now grown to include the fixed (or eventually converged) network.

Unlike traditional cloud computing, which takes place on remote servers located far from the user and device, MEC allows activities to take place in base stations, central offices, and other network aggregation sites. MEC is mostly used to improve the performance of existing services like as content delivery or caching, but it is also becoming a significant enabler for new applications. MEC will enable new revenue-generating (5G) use cases while also potentially improving telecom efficiencies in serving widely dispersed high-throughput content use cases. As a result, MEC can benefit both customers and telcos.

1.2 NETWORK FUNCTION VIRTUALIZATION

Network functions virtualization (NFV) is the use of virtual computers to replace network appliance hardware. A hypervisor is used by the virtual machines to operate networking software and activities such as routing and load balancing. Other reasons for using network function virtualization include:

• Pay-as-you-go NFV models can cut expenses since firms only pay for what they require.

• Fewer equipment: Because NFV runs on virtual computers rather than real machines, fewer appliances are required, resulting in lower operational expenses.

• Scalability: Scaling the network architecture with virtual machines is faster and easier, and it eliminates the need for extra hardware.

The benefits of network function virtualization include many service providers believe that the benefits exceed the dangers. Traditional hardware-based networks need network administrators to buy specialised hardware devices and manually configure and connect them in order to construct a network. This is time-consuming and needs specialist networking knowledge. NFV enables virtual network functions to operate on a normal generic server under the management of a hypervisor, which is significantly less expensive than acquiring custom hardware devices. A virtualized network makes network configuration and management considerably easier. Best of all, because the network is operated on virtual machines that are easily supplied and managed, network capabilities may be altered or added on the fly. The dangers of virtualizing network functions

NFV improves network responsiveness, flexibility, and scalability. It has the potential to cut equipment costs and speed time to market. However, security hazards exist, and network functions virtualization security concerns have proven to be a barrier to widespread adoption among telecoms companies. Here are some of the concerns that service providers must consider while deploying network function virtualization:

Why Physical security protections are ineffective: Vitalizing network components makes them more vulnerable to new types of assaults than physical equipment secured in a data centre.

• Malware is harder to isolate and contain: Malware travels more easily across virtual components operating on the same virtual computer than between hardware components that may be isolated or physically separated.

• Network traffic is less transparent: Because traditional traffic monitoring tools struggle to detect potentially harmful abnormalities in network traffic going east-west between virtual machines, NFV necessitates more fine-grained security solutions.

• Numerous types of security are required for complicated layers: Network functions virtualization systems are inherently complex, with multiple levels that are difficult to safeguard with blanket security measures.

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1.3 VNF INSTANCE DEPLOYMENT

VNF deployments are extensively used in the heart of wired and wireless networks, and have mostly replaced physical appliances like as SBCs, IMSs, and EPCs. These NFV systems are often powered by Intel-based servers and provide highly scalable performance.

VNFs are often deployed as virtual machines (VMs) using Linux KVM or VMware spheres hypervisors on commercial off-the-shelf hardware (COTS). Physical network functions (PNF) are historical network appliances that run on proprietary hardware, as opposed to Virtualized Network Functions (VNF). Virtual network functions (VNFs) are virtualized processes that were previously performed by proprietary, specialised hardware. Individual network and network security tasks are moved from dedicated hardware devices to software that runs on commodity hardware via VNFs.

1.4 VIRTUALIZED SERVICE PROVISIONING

Virtual provisioning is a virtual storage network (VSAN)-based solution that allows storage capacity to be supplied to devices on demand. This procedure enables virtualized systems to manage and allocate physical disc storage attached to virtual machines (VM). Virtual provisioning servers are intended to ease storage management by allowing storage managers to satisfy capacity needs on-demand. Virtual provisioning creates the illusion that a host, application, or file system has more storage than it actually has.

Advantages of virtual provisioning

• Lowers IT expenses

.• Reduces the number of physical servers required on a company's facilities.

• Reduces energy usage since there are fewer physical servers using electricity.

•Establishes independent user environments.

• Provide low-cost web hosting.

1.5 APPROXIMATION AND ONLINE ALGORITHMS

An approximation approach for the minimal vertex cover issue is a basic example, where the aim is to pick the fewest collection of vertices such that every edge in the input graph has at least one chosen vertex. Approximation algorithm types Approximation approach with fully polynomial time. The constant factor The knapsack issue. Approximation algorithms are often employed when finding an ideal solution is difficult, but they may also be used when a near-optimal solution can be obtained fast and a perfect answer is not required. The paper employs three approximation techniques: linearization, system identification, and a forward Euler discretization approach. Linearization is accomplished by the use of first order Taylor Series approximation, with the linearization point selected to be at the designated set point of interest.

1.6 UTILITY GAIN MAXIMIZATION

Utility maximisation is a strategic approach in which individuals and businesses seek the greatest amount of enjoyment from their economic actions. When a company's resources are limited, for example, management will pursue a strategy of acquiring items or services that deliver the most advantage. The utilitarian philosophers Jeremy Bentham and John Stuart Mill created the notion of utility maximization. It was introduced into economics by English economist Alfred Marshall. A traditional economics assumption is that the price of a product that a buyer is willing to pay is a close approximation of the maximum value that they obtain from the acquired thing.

When selecting numerous items, the criterion for maximum utility is that the customer equalizes the marginal utility per pound spent. MUA/PA = MUB/PB, where MU is marginal utility and P represents price, is the condition for maximizing utility.

A consumer's uses aim to maximise overall utility; for every dollar spent, they should spend it on the item that provides the most marginal utility per dollar spent. The assumptions Utility theory regulates individual decision making in economics. The learner must comprehend an intuitive explanation for each of the following assumptions: completeness, monotonicity, mix-is-better, and rationality (also called transitivity).

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1.7 USER MOBILITY

Mobility in wireless networks refers to a node, Mobile Node (MN), or occasionally a subnet changing its point of attachment to the network while maintaining continuous communication with the network. Handover refers to a change in the point of attachment of the MN to the network. In an Active Office, user mobility reflects human activity in a context-aware and ambient-intelligent environment. This study discusses user mobility by sensing changes in location. We researched how to detect precise, near, and expected user position using a range of sensors (e.g., Wi-Fi and Bluetooth) and how the sensors integrate in an Active Office to offer interoperability. In the Merino layering architecture, i.e. the architecture for scalable context processing in an Intelligent Environment, we created a model to anticipate and proximate user position using wireless sensors.

1.8 CLOUDLETS OR EDGE-CLOUDS

The resource intensive tasks can be offloaded to it for processing hence will reduce latency, bandwidth and save a lot of time.Edge computing is an alternative architecture to cloud computing for applications that require high-speed and high availability. This is because apps that rely solely on the cloud for storing and processing data become dependent on internet connectivity – and therefore subject to its inherent unCloudlets are edge computing concepts that are essentially small-scale clouds. They serve as low-latency offloading units for new sensor-based and real-time streaming applications. 'Cloudlets are mobility-enhanced small-scale cloud data centres situated at the edge of the Internet,' according to a common definition. So, by leveraging cloudlets, resource-intensive activities may be offloaded to it for processing, resulting in reduced latency, bandwidth, and time savings. Edge computing is a cloud computing architectural option for applications that demand high speed and availability. This is due to the fact that apps that rely only on the cloud for data storage and processing become dependent on internet access - and therefore vulnerable to its inherent instability. Here are some scenarios when edge computing might be most useful. The most typical use of edge computing is to increase the speed and reaction time of end-user devices..

Here are some scenarios when edge computing might be most useful. The most typical use of edge computing is to increase the speed and reaction time of end-user devices.

1.9 RESOURCE ALLOCATIONS AND PROVISIONING IN MEC

By exploiting neighbouring servers as the edge cloud to provide task offloading execution service for a smart mobile device (SMD) via wireless access points, mobile edge computing (MEC) may dramatically increase the performance of mobile apps (APs). The edge cloud and AP, on the other hand, will not give free services. Their radio frequency and processing capacity are limited, yet the number of service requests from diverse mobile devices might be enormous. The purpose of this article is to create a pricing method for optimally allocating limited resources in the MEC system based on SMD budgets. To that purpose, we first describe a MEC resource market model that can provide genuine insight into the motivations for resource sharing at network edges. Computation and radio resources may be exchanged between resource suppliers (AP and edge cloud) and purchasers in the model (SMDs).

Furthermore, we use microeconomic theory to determine the best budget allocation approach for the SMD in order to maximize its usefulness within a constrained budget. Furthermore, we present an Equilibrium Price Finding (EPF) technique to determine the MEC system's equilibrium price, maximizing overall system utility and resulting in efficient resource allocation. Finally, simulation results show that, when compared to state-of-the-art resource allocation methods, our optimal budget allocation algorithm is more effective at finding budget allocation strategies, and our equilibrium price finding algorithm is more effective at achieving market equilibrium to optimally allocate computation and radio resources in the MEC system.

1.10 OPTIMIZATION PROBLEMS

An optimization issue is the task of finding the optimal answer among all conceivable solutions in mathematics, computer science, and economics.

Companies, for example, frequently want to reduce manufacturing costs while increasing revenue. In manufacturing, it is frequently preferable to utilise as little material as possible to package a product

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of a specific volume. An objective function, decision variables, and restrictions are all part of any optimization issue. Formulating an optimization problem entails converting a "real-world" problem into the mathematical equations and variables that compose these three components. In optimization challenges, we want to find anything that maximizes or reduces some function. When developing algorithms for optimization problems, we must demonstrate that the method provides the best available answer. Occasionally, at each phase, develop a global optimum - but you need proof.
There are two sorts of optimization methods: exact optimization methods that ensure finding an optimal solution and heuristic optimization methods that provide no guarantee of finding an optimal solution.

2.LITERATURE SURVEY

cloudspider: combining replication with scheduling for optimizing live migration of virtual machines across wide area networkssumitKumar Bose et al. argued in this study that a virtual machine (VM) may be scheduled for execution at geographically different cloud sites based on the cost of compute and the load at these locations over its lifespan. However, due to the huge size of the VM image, translocating a live VM across highlatencylowbandwidth wide area networks (WAN) within'reasonable' time is almost difficult. In this research, we address this issue by integrating VM scheduling and VM replication methodologies. We suggest, in particular, selectively replicating a VM image across multiple cloud locations, selecting a replica of the VM image as the primary copy, and propagating incremental changes at the primary copy to all other replicas of the VM image. The replica placement options are based on parameters that impact long-term costs, such as the average perunit cost of storage and the average perunit cost of compute at various cloud locations, in addition to the VMs' 'end-user' latency needs. We suggest compensating for the higher storage needs caused by replication by utilising de-duplication algorithms to explore the inherent similarity that exists among distinct VM images. The construction of a suitable replica placement technique that reduces extra storage needs is a critical challenge that naturally emerges in this integrated replication and scheduling context for decreasing migration latencies associated with live migration of VMs across WAN. This issue is addressed in this study as part of our CloudSpider integrated replication and scheduling design. We explore the trade-offs involved in the design of a replica placement method and offer an approach that considers deduplication ratios between pairs of VM images when deciding on VM image replica placement. Preliminary tests suggest very good prospects.[1]
Task offloading for mobile edge computing in software defined ultra-dense network Min Chen et al. stated in this study that with the development of current creative applications (e.g., augmented reality, self-driving, and different cognitive applications), more and more computation-intensive and data-intensive jobs are becoming delay-sensitive. Mobile edge computing on an ultra-dense network is predicted to be a viable solution for satisfying the requirement for reduced latency. However, the scattered computing resource in edge cloud and energy dynamics in mobile device batteries make offloading jobs for consumers difficult. In this research, we examine the task offloading problem in an ultra-dense network, intending to reduce latency while preserving the battery life of the user's equipment. We specifically formulate the task offloading problem as an NP-hard mixed integer nonlinear programmed. To solve it, we divide the optimization issue into two subproblems: job placement subproblem and resource allocation subproblem. We present an efficient offloading strategy based on the resolution of the two sub-problems. When compared to random and uniform task offloading strategies, simulation findings show that the suggested technique may cut task length by 20% while saving 30% energy. In this study, we first propose a software defined super dense network architecture (SD-UDN). Then, we suggest a method for offloading tasks to edge clouds or processing them locally. To reduce work time, computer resources are appropriately assigned to each activity. To our knowledge, this is the first research of task offloading in SD-UDN for mobile edge computing.[2]
Network function virtualization: state-of-the-art and research challengesRashid Mijumbi et al. presented in this study Network Function Virtualization (NFV) as a substantial change in

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telecommunication service providing has garnered significant interest from both business and academia. NFV has the ability to significantly reduce Operating Expenses (OPEX) and Capital Expenses (CAPEX) by divorcing Network Functions (NFs) from the physical devices on which they operate, as well as enabling the deployment of new services with higher agility and faster time-to-value. The NFV paradigm is still in its infancy, and the research community has a wide range of chances to build novel architectures, systems, and applications, as well as examine alternatives and trade-offs in creating technologies for its effective adoption. In this article, we examine the state-of-the-art in NFV and highlight prospective research avenues in this domain after analysing NFV and its interaction with related topics such as Software Defined Networking (SDN) and cloud computing. In addition, we provide an overview of significant NFV initiatives, standardisation activities, early implementations, use cases, and commercial solutions. Because of consumer demand for real-time, on-demand, online, low-cost, short-lived services, TSPs have been compelled to explore for innovative ways to supply these services that are nimble and save OPEX and CAPEX. NFV has emerged as a potential solution to making network equipment more open, allowing TSPs to become more flexible, faster at service innovation, and lower operating and maintenance (O&M) costs. It seems obvious that NFV, together with the closely linked and complementary technologies of SDN and cloud computing, will play a significant role in future telecommunications service providing. We presented NFV, detailed its architecture as specified by ETSI, offered a reference business model, and investigated critical design concerns in this project. We next discussed current research on merging NFV with closely related disciplines such as SDN and cloud computing. We also discussed significant specification and standardisation initiatives, research studies, commercial products, and early NFV proof of concept implementations. Finally, we reviewed the important research topics that will be critical to the development of NFV as well as its application to ICN and IoT, as well as summarised the survey findings. We feel that if these areas are not studied, TSPs using NFV may wind up relying on vendor-proprietary solutions to fill these gaps, which would be contrary to the original goal of NFV[3].

optimizing service replication for mobile delay-sensitive applications in 5g edge network In this research, Ivan Farris et al. claim that Extending cloud infrastructure to the Network Edge provides a breakthrough for supporting delay-sensitive applications in next-generation 5G cellular networks. To accommodate user mobility, quick migration of service instances across edge nodes is essential in this context to provide ultrashort response times. To address this issue, proactive service replication is seen as a potential technique for reducing total migration time while ensuring the appropriate Quality of Experience (QoE). Provisioning replicas across numerous edge nodes, on the other hand, increases the resource consumption of limited edge nodes and the associated deployment cost. Given the two competing goals, we study several optimization models for proactive service migration at the Network Edge that might take use of prediction of user mobility patterns in this research. We describe two Integer Linear Problem optimization strategies in particular, with the goal of reducing the QoE degradation caused by service migration and the cost of replica deployment. The efficacy of our recommended solutions is demonstrated through performance evaluation. One fundamental objective of the forthcoming 5G network is to offer ultra-low latency applications by enabling service provisioning at the network's edge. To meet the high latency requirements, new technologies to deal with user mobility in a dispersed edge cloud environment are necessary. To reduce QoE deterioration during service migration between multiple edge nodes, the adoption of proactive replication mechanisms is interesting. We suggested two linear optimization techniques for replication-based service migration: the min-RM approach tries to minimiseQoE deterioration during user handover, while the min-NSR approach prioritises service replication cost reduction. The simulation findings demonstrated the effectiveness of each solution in meeting its design objectives and give helpful information for network and service orchestrators in next-generation 5G cloud-based networks.[4]

approximation algorithms for the nfv service distribution problem In this paper, Hao Feng et al. propose Distributed cloud networking, which builds on network functions virtualization (NFV) and software defined networking (SDN) to enable the deployment of network services as elastic virtual

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network functions (VNFs) instantiated over general purpose servers at distributed cloud locations. The goal of this paper is to design fast approximation algorithms for the NFV service distribution problem (NSDP), which is to determine the placement of VNFs, the routing of service flows, and the associated allocation of cloud and network resources that satisfy client demands at the lowest possible cost. In the case of load-proportional costs, we show that the resultant fractional NSDP can be stated as a multi-commodity-chain flow issue on a cloudaugmented graph, and we build a queue-length based method, QNSD, that achieves an O() approximation in time O(1/). We then examine the issue where resource costs are a function of the integer number of assigned resources, and we build a form of QNSD that effectively pushes for flow consolidation into a small number of active resources in order to reduce total cloud network cost. The NFV service distribution problem (NSDP) has been defined as a multi-commodity-chain network design issue on a cloud-augmented graph. We demonstrated that under loadproportional prices, the resultant fractional NSDP becomes a multi-commodity-chain network flow issue with optimum polynomial time solutions, and we proposed QNSD, an iterative queue-length method that achieves an O() approximation in time O(1/). We also hypothesised that QNSD converges in time O(1/) by utilising the momentum acquired while integrating differential queue backlogs across consecutive iterations, and demonstrated this with simulations. The issue where resource charges are a function of the integer number of allotted resources was then addressed. By reducing the integer NSDP to MCND, we demonstrated that it is NP-Hard, and we devised C-QNSD, a heuristic algorithm that constrains the evolution of QNSD to effectively concentrate flows into a restricted number of active resources.[5]

mobility aware partition of mec regions in wireless metropolitan area networks Along with the fast growth of mobile applications, Xingjian Guan et al., have stated in this study that Mobile Edge Computing (MEC) receives considerable interest in recent years. The amount of service handovers caused by user mobility between MEC areas has a significant influence on QoE and service operating costs. By carefully separating a metropolitan area into distinct clusters, we present a randomised technique to limit the number of potential handovers between various MEC zones in this paper. Preliminary results show that the proposed technique can discover suboptimal partitions with fewer hand evolvers. Service handover occurs often in the MEC scenario due to user migration, yet it may cause service disruption and increased costs. In this presentation, we present MAPA, a randemised MEC partition method that splits a WMAN into numerous service regions to reduce the frequency of handovers between regions. The evaluation findings show that MAPA might minimise the number of handovers more efficiently than the previous technique. Although having large MEC regions reduces the amount of handovers, mobile users at the region's edge may incur lengthier network delays when offloading to cloudlets in the region's centre. Furthermore, as compared to remote clouds, cloudlets often have restricted compute power. As a result, the issue is to carefully organise MEC areas in order to limit the cost of probable service handovers while not increasing network latency. Meanwhile, the proposed approach for wireless metropolitan area networks should be scalable (WMAN).[6]

it’s hard to share: joint service placement and request scheduling in edge clouds with sharable and non-sharable resources Mobile edge computing, as presented by Hana Khamfroush et al. in this research, is an emerging technology that offers resource-intensive yet delay-sensitive applications from the edge of mobile networks, where a significant difficulty is allocating limited edge resources to competing demands. While previous works frequently make the simple premise that resources assigned to distinct users are non-shareable, this assumption does not apply to storage resources, where users interested in services (e.g., data analytics) based on the same set of data/code can share storage resources. Meanwhile, each user request requires non-shareable resources (e.g., CPU cycles, bandwidth). Through combined service placement and request scheduling, we investigate the optimum provisioning of edge services with non-trivial needs for both sharable (storage) and non-sharable (communication, compute) resources. We show that in the homogeneous situation, while the task is polynomial-time solvable without storage limitations, it is NP-hard even if each edge cloud has infinite communication or computing resources. We further show that the hardness is caused by

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the service placement subproblem, but the request scheduling subproblem can be solved in polynomial time using maximum-flow techniques. Both subproblems are NP-hard in the general situation. For the homogeneous situation, we provide a constant-factor approximation approach, and for the general case, we construct efficient heuristics. According to our trace-driven simulations, the suggested algorithms, particularly the approximation method, can achieve near-optimal performance, serving 2-3 times more requests than a baseline solution that optimises service placement and request scheduling individually. under communication, processing, and storage restrictions, the challenge of joint service placement and request scheduling in mobile edge computing systems We not only verify the NP-difficulty of the problem, but we also pinpoint the core cause of hardness by a detailed complexity study. We also provide a polynomial-time approach for the homogeneous case with approximation guarantee and efficient heuristics for the general case. Our tracedriven assessments reveal that the suggested methods, particularly the approximation guarantee technique, may achieve nearoptimal performance while drastically lowering running time when compared to the optimal solution.[7]

optimal cloudlet placement and user to cloudlet allocation in wireless metropolitan area networks In this study, Mike Jia xand et al. claim that mobile apps are becoming more computation-intensive, but the computational capabilities of portable mobile devices is constrained. Offloading an application's responsibilities to neighbouring cloudlets, which are clusters of computers, is a powerful approach to minimise the completion time of an application on a mobile device. Despite a substantial body of study in mobile cloudlet offloading technology, little attention has been paid to how cloudlets should be deployed in a particular network to improve mobile application performance. We investigate cloudlet deployment and mobile user allocation to cloudlets in a wireless metropolitan area network in this research (WMAN). We provide an algorithm for the problem that allows cloudlets to be put in user-dense parts of the WMAN and allocates mobile users to the cloudlets while balancing their burden. We also carry out experiments using simulation. The simulation results show that the suggested algorithm's performance is highly promising. Cloudlets are a critical technology that improves the performance of many mobile applications. So far, relatively little thought has been given to cloudlet placement in WMANs. We demonstrated in this research that strategically placing a small number of cloudlets in a WMAN may considerably enhance the performance of mobile user apps. We provided an effective approach for handling the problem of cloudlet placement. We also ran simulated tests to assess the performance of the suggested methods. The simulation results showed that the suggested method has a lot of potential. Although the focus of this research was on the system reaction time in relation to the placements of the cloudlets to be put, there are other critical aspects that require additional exploration in the future. For example, consider the link between total cloudlet insertion cost and system response time. The expenses of cloudlets are divided into two categories: deployment costs and maintenance/replacement costs. Because the technology used to create cloudlets is similar to that used to create distant clouds, it is logical to predict that cloudlets will have similar costs to cloud services. However, there are significant distinctions between them (such as size) that must be investigated in order to get an appropriate assessment of cloudlet costs.[8]

qos-aware task offloading in distributed cloudlets with virtual network function servicesPushing the cloud frontier to the network edge, as advocated by Mike Jia yang et al., has piqued the interest of not only cloud operators in the IT service/software business, but also network service providers that provide different network services to mobile consumers. Network service providers, in particular, may satisfy the expectations of mobile consumers by putting cloudlets in metropolitan area networks and adopting virtualized network functionalities. We present a unique task offloading issue in a metropolitan area network in which each offloaded job requires a specific network function with a maximum tolerated latency and distinct offloading requests may require various network services. Within a restricted time horizon, we strive to maximise the number of requests granted while reducing their admission cost. We first demonstrate that the task is NP-hard, and then construct an efficient solution by reducing it to a sequence of minimal weight maximum matching in auxiliary bipartite networks. We also take into account dynamic changes in offloading request patterns over time and

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design an effective prediction method to release and/or generate instances of network services in various cloudlets to save money. Finally, we use experimental simulations to assess the performance of the suggested methods. The results of the experiments show that the proposed algorithms are promising. For additional cost savings, we developed an efficient algorithm for the problem using a novel reduction that reduces the problem to a series of minimum weight maximum matching problems in auxiliary bipartite graphs, as well as an effective prediction mechanism to predict instance releases and creations in different cloudlets within the network. Finally, we used experimental simulations to assess the performance of the suggested approach. The suggested method appears to be promising based on experimental findings.[9]

cloudlet load balancing in wireless metropolitan area networks In this research, Mike Jia et al. claim that as wireless communication technology progresses, more and more people rely extensively on portable mobile devices for work, leisure, and social interactions. Despite the fact that such small mobile devices might provide a variety of interesting applications, their processing resources are constrained owing to their portability. This may be solved by remotely conducting computation-intensive activities on cloudlets, which are clusters of local computers. As more individuals use the Internet via mobile devices, it is fair to anticipate that cloudlet services will be offered to the public in the near future via easily accessible public wireless metropolitan area networks (WMANs). However, the old concept of considering cloudlets as isolated data centers-in-a-box must be abandoned, as there are evident advantages to joining numerous cloudlets to build a network. In this research, we look at ways to manage workload among several cloudlets in a network to improve mobile app performance. We first present a system model to capture the response times of offloaded activities and then define a novel optimization problem to identify an ideal redirection of jobs across cloudlets that minimises the maximum of the average response times of tasks at cloudlets. We then present a problem-solving method that is both quick and scalable. Finally, we use experimental simulations to assess the performance of the proposed approach. The experimental findings show that the suggested method has a great potential for lowering task response times. Cloudlets are an essential technology that improves the performance of mobile applications. As wireless Internet connection expands, publicly open and easily accessible cloudlets will be critical to future mobile computing. We investigated the subject of cloudlet load balancing in a WMAN and suggested a fast and scalable solution for workload balancing across cloudlets to reduce task average response time. The suggested technique appears to be promising based on simulation findings [10].

the internet topology zoo The study of network topology has gained a considerable lot of attention in the previous decade, but has been impeded by a lack of correct data, as argued by Simon Knight et al. in this publication. Existing topological measurement methods have shortcomings, and debates over their significance have eclipsed more relevant problems concerning network structure. The Internet Topology Zoo is a repository of network data derived from information made public by network providers. As such, it is the most precise large-scale collection of network topologies known, and it includes meta-data that could not be measured. We can now answer questions regarding network structure with greater precision than ever before, as demonstrated by a preliminary investigation of the PoP-level topology of over 140 networks. We discover a diverse range of network configurations that do not all adhere to any evident concept. The Internet Topology Zoo is a new data collection based on hand transcription of public network diagrams. It now has 232 networks and is continually developing. This dataset has already been used to do statistical analysis of PoP-level network topologies. The Zoo will present several options for future research, including analysis of networks at other levels, such as the physical level, and cross-level comparisons. Most significantly, the Zoo serves as a resource for individuals seeking to validate data or test algorithms on real-world networks.[11]

profit maximization of nfv-enabled request admissions in sdns. In this research, Weifa Liang et al. suggest Network Function Virtualization (NFV) and Software-Defined Networking (SDN) as critical milestones in the evolution of communication networks. Their integration creates a more flexible and manageable software-based network environment, raising expectations for network service providers

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to reduce capital expenditures (CAPEX) and operating costs (OPEX). They also present technological difficulties. One such problem is managing the deployment of virtualized network functions (VNFs) and directing the data traffic of each NFV-enabled request through the network functions that are defined. In this article, we use the flexibility and cost-efficiency of NFV and SDN for NFV-enabled request admissions in SDNs, and we pose profit maximisation issues for static and dynamic NFV-enabled request admissions. If the problem size is modest, we initially propose an integer linear programming (ILP) solution in the static version; otherwise, we design a fast approximation approach with a proved approximation ratio for the static request admissions. Then, using VNF instance migrations and idle VNF instance releases back to the system, we offer an efficient online approach for dynamic request admissions. Finally, we use experimental simulations to assess the performance of the suggested methods. The simulation results show that the suggested methods are quite promising. Profit maximisation for NFV-enabled request admissions in a software-defined network under snapshot and limited time horizon scenarios, given that certain instances of VNFs have been deployed in data centres in the SDN For the snapshot example, we first developed an ILP solution and an approximation technique with a proved approximation ratio. Then, for dynamic request admissions, we suggested an online method. We opportunistically executed live VNF instance migrations and idle VNF instance releases to lower the implementation cost of dynamic request admissions. The experimental findings show that the suggested algorithms are quite promising.[12]
profit maximization for admitting requests with network function services in distributed cloudsTraditional networks require expensive dedicated hardware devices as middleboxes to execute Service Function Chains of user requests by routing data traffic along middleboxes in the service function chains before reaching their destinations, as proposed by Yu Ma et al. in this research. Network Function Virtualization (NFV) is an exciting virtualization technology that uses software to execute network services in servers or data centers. The combination of NFV with Software Defined Networking (SDN) simplifies and lowers the cost-of-service function chain provisioning. In this paper, we consider dynamic admissions of delay-aware requests with service function chain requirements in a distributed cloud with the goal of maximizing the service provider's profit, assuming that the distributed cloud is an SDN with data centers in different geographical locations and different electricity prices. This unique optimization issue is initially defined as a dynamic profit maximization problem. The offline version of the issue is then shown to be NP-hard, and an integer linear programming solution is developed. Finally, addressing the problem, we suggest an online heuristic. In addition, for a particular example of the issue in which the end-to-end latency requirement of each request is low, we design an online method with a provable competitive ratio. Finally, we conduct experimental simulations to assess the performance of the suggested methods. The results of the simulation show that the proposed algorithms are promising. By dynamically admitting delay-aware requests with network function service needs, we solve the dynamic profit maximization issue in distributed clouds, assuming that each request is accepted on a pay-as-you-go basis and subject to different network resource capacity restrictions. For the offline form of the problem, we initially presented an ILP solution. Then, for the problem, we created an online heuristic. We also created an online solution with a provable competitive ratio for a subset of the issue in which the end-to-end latency restriction of each request can be low. Finally, we ran practical simulations to evaluate the performance of the suggested methods. The experimental findings show that the proposed algorithms are viable.[13]
experiments of recreating the frequency domain properties of seawater channel for underwater optical communication. In this study, Li Ma et al. propose that optical communication is a possible method for realizing underwater wireless communication. Because the physical size is limited, the experiment of underwater optical communication in the laboratory differs from that in the real ocean environment. Although artificial scattering agents have been used to recreate underwater optical communication channels under various water quality conditions for several decades, the similarity between experimental water and natural water, such as the similarity in frequency domain characteristics, is not reliable. Several types of agents are investigated in this work in order to

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accurately adjust the optical coefficients of experimental water. The frequency domain characteristic of an optical communication channel in experimental water is then measured and compared as a criterion for the dependability of water recreation. The results reveal that the kind and particle size of the agents have a substantial impact on their optical characteristics, and that the concentration of the agents has an impact on the frequency domain component of the optical communication signal. The optical characteristics of water were tested using two distinct types of artificial scattering agents with varying particle sizes. Pure nanoscale SiO2 might be used as a novel scattering agent. The findings indicate that the kind and size of agents have an effect on the optical properties of water. More research is needed to see if alternative types of artificial agents can be used to create water that is more akin to genuine saltwater. In the experiment, the optical characteristics of water have a greater impact on signal spectrum distortion than the type of agent. We intend to do more studies, maybe examining the influence of artificial scattering agents on beam propagation.[16]

mobile edge computing: a survey on architecture and computation offloading In this research, Pavel Mach et al. claim that technological progress of mobile user equipment (UEs) such as smartphones or laptops goes hand in hand with the emergence of new mobile apps. However, executing computationally intensive apps on the UEs is hampered by the UEs' low battery capacity and energy consumption. A suitable method for prolonging the battery life of the UEs is to offload the apps that require extensive processing to a traditional centralised cloud (CC). However, this method involves substantial execution delay due to the transfer of offloaded apps to the cloud and back, as well as the time spent computing at the cloud. Such a delay is uncomfortable and renders unloading ineffective for real-time applications. To address the issue of latency, a new emergent idea called as mobile edge computing (MEC) has been presented. The MEC pushes processing and storage resources to the mobile network's edge, allowing highly demanding applications to function at the UE while fulfilling stringent latency constraints. Operators and third parties can additionally use the MEC computer capabilities for specialised applications. In this work, we first discuss the MEC's key use cases and reference situations. Following that, we evaluate existing strategies for incorporating MEC functions into mobile networks and analyse current MEC standardisation progress. The heart of our investigation is thus centred on a user-oriented use case in the MEC, namely computation offloading. In this sense, we split computation offloading research into three major areas: I computation offloading decision, ii) computing resource allocation inside the MEC, and iii) mobility management. Finally, we highlight lessons learnt in the MEC domain and suggest open research issues that must be solved in order to fully benefit from the MEC's potential. This allows for the offloading of extremely demanding calculations to the MEC in order to meet the rigorous latency requirements of applications (e.g., real time apps) while also reducing energy usage at the UE. Despite the fact that research on the MEC is picking up steam, as seen by this poll, the technology is still in its infancy. In this sense, the MEC paradigm brings numerous significant difficulties that must be solved in order to fully satisfy all stakeholders involved, including mobile operators, service providers, and consumers. The alpha and omega of contemporary MEC research is how to ensure service continuity in extremely dynamic circumstances. This section lacks study and is one of the barriers to implementing the MEC idea. Furthermore, contemporary research verifies solutions mostly in relatively simplified circumstances and through simulations or analytical assessments. Nonetheless, genuine testing and trials under more realistic assumptions are necessary to demonstrate the predicted values introduced by the MEC.[15]

service entity placement for social virtual reality applications in edge computing While social Virtual Reality (VR) applications such as Facebook Spaces are becoming popular, they are incompatible with traditional mobile- or cloud-based solutions due to their processing of massive amounts of data and the exchange of time-sensitive metadata, as proposed by Lin Wang et al. in this paper. Edge computing may better meet these requirements, but it remains an unresolved topic to deploy social VR apps on an edge infrastructure while maintaining economic operations of edge clouds and sufficient quality-of-service for users. This report gives the first formal investigation into the topic. We describe and construct a combinatorial optimization problem that encompasses all interconnected

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objectives. We present ITEM, an iterative approach with quick and large "moves" in which we create a graph to encapsulate all costs and transform the cost optimization into a graph cut issue in each iteration. We may concurrently establish the location of many service entities by finding the minimal s-t cut using known max-flow algorithms, and therefore the original problem can be addressed by solving a series of graph cuts. Our studies with large-scale, real-world data traces show that ITEM converges quickly and beats baseline techniques by a factor of more than two in one-shot placement and by a factor of roughly 1.3 in dynamic, online situations where users roam arbitrarily inside the system. We present the first formal research of the service entity placement problem for social VR applications in edge computing in this work. With a complete cost model, we outline the primary problems and offer a unique method based on iteratively solving a sequence of minimal graph cuts. The algorithm is adaptable and may be used both offline and online. Extensive trials validate the suggested algorithm's performance. As the convergence of VR and edge computing becomes more popular, the approach presented in this study will serve as a starting point for further research in this area. Several research concerns remain unanswered, including the development of online algorithms for SE placement that account for the cost of edge cloud reconfiguration. We defer to them for future work.[16]

budgeted cell planning for cellular networks with small cells In this research, Shaowei Wang et al. propose a Heterogeneous Network (HetNet), in which tiny cells are placed within the coverage of macro cells, to increase capacity and improve coverage of a cellular system. Tiny cells outperform macro cells in terms of inexpensive installation and operating costs due to their small physical sizes and low transmission powers. As a result, HetNet is regarded as a cost-effective solution to the ongoing radio spectrum dilemma. HetNet, on the other hand, introduces a new paradigm in cellular network planning. We investigate the budgeted cell planning issue in HetNet in this research, with the goal of maximizing the number of traffic demand nodes whose needed rates are fully supplied with a given budget. Our optimization effort is difficult, and the given problem is difficult to solve, due to limits in actual cellular systems such as power limitations, available bandwidth, and traffic needs. We offer an approximation approach that delivers an e1 2e fraction of the optimal, providing not just quality-guaranteed answers to the budgeted cell planning issue, but also important insights into how to design a HetNet with low capital investment. Preliminary numerical findings demonstrate that tiny cells can considerably boost the capacity of a cellular system if they are correctly constructed. HetNets' budgetary cell planning difficulty We strive to choose a subset of candidate cells that will maximise the number of completely fulfilled TDPs while keeping the overall deployment cost under a certain budget. In addition to including both small and large cells, our network model takes into account realistic restrictions in cellular networks, such as transmission power of different types of cells, spectrum limitations, and traffic needs.

capacitated cloudlet placements in wireless metropolitan area networks In this research, we explore the cloudlet placement problem in a large-scale Wireless Metropolitan Area Network (WMAN) that comprises of numerous wireless Access Points, as proposed by Zichuan Xu et al (APs). Despite the fact that most present research in mobile cloud computing primarily focus on energy savings of mobile devices by shifting compute-intensive workloads from them to faraway clouds, the access latency between mobile users and the clouds is typically substantial and, in some cases, unacceptable. Cloudlet, a novel technology, is capable of bridging this gap and has been proved to greatly improve mobile device performance while fulfilling mobile consumers' snappy reaction time needs. In this study, we investigate deploying many cloudlets with varying computing capacity in certain critical local sites in a WMAN to minimise mobile users' average cloudlet access time at various APs. We first frame this problem as an unique capacitated cloudlet placement problem, in which K cloudlets are assigned to various locations in the WMAN with the goal of minimising the average cloudlet access time between mobile users and the cloudlets answering their requests. Then we present a quick but efficient heuristic. We design an unique approximation approach with a guaranteed approximation ratio for a particular example of the issue in which all cloudlets have the same computational capability. Furthermore, we investigate assigning user requests to cloudlets by developing an

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effective online mechanism for doing so. Finally, we use experimental simulations to assess the performance of the suggested methods. The results of the simulation show that the proposed methods are promising and scalable.[18]

efficient algorithms for capacitated cloudlet placements In this research, Zichuan Xu et al. claim that mobile cloud computing is developing as a primary ubiquitous computing platform to deliver rich resources for diverse mobile device applications. Although the majority of recent research in mobile cloud computing focus on energy savings for mobile devices by shifting computation-intensive workloads from mobile devices to remote clouds, access delays between mobile users and remote clouds are often long and, in some cases, uncomfortable. Cloudlet, as a novel technology, is capable of bridging this gap and considerably improving mobile device performance while satisfying mobile consumers' sharp reaction time needs. We investigate the cloudlet placement problem in a large-scale Wireless Metropolitan Area Network (WMAN) with multiple wireless Access Points in this research (APs). We first construct the problem as an unique capacitated cloudlet placement problem, in which K cloudlets are placed in strategic locations across the WMAN with the goal of minimising the average access time between mobile users and the cloudlets that serve them. Then, using Integer Linear Programming, we suggest a precise solution to the problem (ILP). We suggest an efficient heuristic for the problem instead, due to the ILP's low scalability. We design innovative approximation methods with guaranteed approximation ratios for a particular version of the issue in which all cloudlets have similar computing capacity. If the K cloudlets have already been installed, we provide an online mechanism for dynamically assigning user requests to various cloudlets. Finally, we use experimental simulations to assess the performance of the suggested methods. The simulation results show that the suggested techniques are both promising and scalable.[19]

task offloading with network function requirements in a mobile edge-cloud network Pushing the cloud frontier to the network edge near to mobile customers, as recommended by Zichuan Xu et al., has piqued the interest of cloud operators as well as network service providers. The deployment of cloudlets in metropolitan area networks, in particular, enables network service providers to deliver low-latency services to mobile consumers while satisfying their Quality-of-Service (QoS) criteria by executing their defined virtualized network functions (VNFs). We present a unique task offloading issue in a mobile edge-cloud network, where each offloading job asks a specific network function with a reasonable latency. Through either sharing existing VNF instances or creating new VNF instances in cloudlets, we attempt to maximize the number of requests permitted while minimizing the operational cost of admitted requests within a restricted time horizon. We first demonstrate that the issue is NP-hard, and then design an efficient online solution for it by breaking it down into a sequence of minimal weight maximum matching problems. We further build an effective prediction system for fresh VNF instance constructions and idle VNF instance releases, taking into account dynamic changes in task offloading request patterns over time, to further reduce the network service provider's operational costs. In addition, for a particular example of the issue when the latency requirements of requests are insignificant, we design an online method with a competitive ratio. Finally, we use experimental simulations to assess the performance of the suggested methods. The results of the experiments show that the proposed algorithms are promising.[20]

Imrus Salehin et al., have suggested in this study An Artificial Intelligence Based Rainfall Prediction Using LSTM and Neural Network [21] The most challenging problem of meteorology is to forecast rainfall. In this work, we suggested a model for predicting the amount of rainfall that can be easily computed utilising artificial intelligence and LSTM approaches. This is a sophisticated method for calculating rainfall. The deep learning strategy is particularly beneficial for this sort of method implementation, as seen by its accuracy. A long short-term memory technique is used to assess memory sequence data, compute prior data quickly, and generate the best forecast. Because the majority of the population in this country rely on agriculture, this forecast method is critical. A timely rainfall assessment will boost crop yields and lower agricultural expenditures. Taking all of these elements into account, we developed our model, which will assist us in determining the quantity of rainfall. To do this, we gathered data from six different areas. We used six factors to forecast

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(temperature, dew point, humidity, wind pressure, wind speed, and wind direction). We achieved 76% accuracy in our job after examining all of our data. For the best results, we also use a large dataset of long-term weather data.

Anomaly Detection on LoT Network Intrusion Using Machine Learning [22] Zhipeng Liu et al., have argued in this research that improving the security of loT networks is one of the most pressing concerns confronting the information technology sector. With significant numbers of loT devices being created and deployed, it is difficult for these devices to interact securely without sacrificing performance. The limitations occur because most loT devices are power restricted, limiting their processing performance. As a result, using encryption and authentication to protect against harmful cyber-attacks is problematic. The intrusion detection system (IDS) logically rises to the top of the security food chain. Anomaly-based network intrusion detection is critical in protecting networks from various hostile activity. In this study, we use several machine learning techniques to detect abnormalities in the loT Network Intrusion Dataset. The findings are encouraging, as we were able to reach 99%-100% accuracy while being very efficient.

Prashant Mhaskar et al. proposed in this paper Fault-Tolerant Control of Nonlinear Processes: Performance-Based Reconfiguration and Robustness [23]. This work considers the problem of control system/actuator failures in nonlinear processes subject to input constraints and presents two approaches for fault tolerant control that focus on incorporating performance and robustness considerations, respectively. In both techniques, a family of possible control configurations for the process under evaluation is defined initially, characterised by various controlled inputs. The construction of a Lyapunov-based predictive controller that guarantees closed-loop stability from an explicitly described set of beginning circumstances is used to integrate performance considerations initially (computed using an auxiliary Lyapunov-based nonlinear controller). A hierarchical switching policy is developed that uses stability considerations (evaluated by the presence of a state in a control configuration's stability region) to determine the suitability of a candidate backup configuration, and then performance considerations are used to choose between the suitable backup configurations. Following that, we look at the challenge of applying fault-tolerant control to nonlinear systems that include input limitations and uncertainty. To that purpose, for each possible control configuration, we first construct a robust hybrid predictive controller that assures stability from an explicitly specified set of beginning circumstances, subject to uncertainty and limitations. The activation/deactivation of the constituent control configurations is then orchestrated using a switching policy.

In the dynamic and competitive world, technology has transformed the speed of all industries. Artificial intelligence is a technology that allows the industry to expand at a quicker rate while also effectively completing their task. This technology has spread to different areas such as finance, human resources, marketing, and manufacturing. The AI system has helped the company to improve its current performance and conduct activities more effectively on a daily basis. People working at various managerial levels are currently working under pressure and realising the necessity for artificial intelligence at the workplace owing to the dynamic and competitive environment. The authors conducted the study using quantitative research, and the data was analysed using regression methods. AI as a technology plays a part in several HR processes, beginning with talent acquisition and progressing through analysing people's performance at work. This research will investigate the relationship between artificial intelligence and HR functions, as well as the many activities done by the HR department. The goal is to comprehend factors like as innovativeness and how HR operations are used.

Salvatore Gaglio et al. suggested a method for detecting human behaviours using information detected by an RGB-D camera, notably the Microsoft Kinect, in this study. Our approach is based on the estimation of some relevant human body joints using the Kinect; three different machine learning techniques, namely K-means clustering, support vector machines, and hidden Markov models, are combined to detect the postures involved in an activity, classify them, and model each activity as a spatiotemporal evolution of known postures. Experiments were carried out on the Kinect Activity

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Recognition Dataset, a novel dataset, as well as the CAD-60, a publicly available dataset. Our technique outperforms four related research based on RGB-D image fusion, hierarchical Maximum Entropy Markov Model, Markov Random Fields, and Eigenjoints, in that order. The results we obtained, i.e., precision/recall of 77.3% and 76.7%, and the capacity to distinguish actions in real time, indicate promise for practical use.

3. COMPARISON ANALYSIS

Title	Techniques & Mechanisms	Parameter Analysis	Future Work
CloudSpider: Combining Replication with Scheduling for Optimizing Live Migration of Virtual Machines Across Wide Area Networks	We proposed combining VM replication with VM scheduling to reduce migration latencies. We compensate for the increased storage demand caused by the increased number of copies in the proposed approach by examining similarities across distinct VM images using cutting-edge de-duplication algorithms.	Different scheduling techniques may then be developed to investigate different options for optimizing replica location placement for each of the VMs. The efficacy of an integrated replication and placement approach in decreasing storage needs is strongly reliant on the quality of the replica placement algorithm, as demonstrated.	Cloud Spider, a technology created as part of the integrated replication and scheduling architecture, may intelligently distribute clones of VM images at several sites, reducing storage requirements in the future.
Task Offloading for Mobile Edge Computing in Software Defined Ultra-dense Network	We first propose a software defined super dense network design (SD-UDN). Then, we suggest a method for offloading tasks to edge clouds or processing them locally. To reduce task time, computing resources are appropriately assigned to each task. Simulation results demonstrate that our suggested system is more efficient than random and uniform computation offloading techniques.	In SDUDN, a simulation experiment for task offloading for mobile computing is presented. The experimental results are divided into three sections: I we compare the proposed SDTO with several task offloading schemes in terms of task duration and energy cost; (ii) we investigate the effect of task computation amount on the evaluated metrics; and (iii) we investigate the effect of task data size on task offloading performance.	We will examine task offloading in more complicated deployments with user mobility in future work.
Network Function Virtualization: State-of-the-art and Research Challenges	We presented NFV, outlined its ETSI-defined architecture, offered a reference business model, and	TSPs have been compelled to explore for new methods to supply these services in a more agile and cost-effective	It is obvious that NFV, together with the closely linked and complementary technologies of SDN

	discussed critical design concerns. We next discussed current research on merging NFV with closely related disciplines such as SDN and cloud computing.	manner. NFV has emerged as a potential solution to making network equipment more open, allowing TSPs to become more flexible, faster at service innovation, and lower operating and maintenance (O&M) costs.	and cloud computing, might play significant roles in future telecommunications service providing.
Optimizing Service Replication for Mobile Delay-sensitive Applications in 5G Edge Network	We suggested two linear optimization techniques for replication-based service migration: the min-RM approach tries to minimiseQoE deterioration during user handover, while the min-NSR approach prioritises service replication cost reduction.	We study several optimization models for proactive service migration at the Network Edge that can take use of user mobility pattern prediction. We describe two Integer Linear Problem optimization strategies in particular, with the goal of reducing the QoE degradation caused by service migration and the cost of replica deployment.	Each solution's efficiency in fulfilling its design purpose and providing important information for network and service orchestrators in next generation 5G cloud-based networks.
Approximation Algorithms for the NFV Service Distribution Problem	Cloud networking is based on network functions virtualization (NFV) and software defined networking (SDN) to enable the deployment of network services as elastic virtual network functions (VNFs) instantiated on general purpose servers in scattered cloud locations.	By reducing the integer NSDP to MCND, we demonstrated that it is NP-Hard, and we devised C-QNSD, a heuristic algorithm that constrains the evolution of QNSD to effectively concentrate flows into a restricted number of active resources.	In the future, to successfully concentrate flows into a small number of active resources.
Mobility Aware Partition of MEC Regions in Wireless Metropolitan Area Networks	MAPA is a randomised MEC partition strategy that divides a WMAN into different service areas in order to decrease the number of handovers between regions.	In terms of the number of handovers, the proposed approach is compared to a graph-based greedy algorithm with varied parameter values. The most frequently communicated sections	To minimise the amount of handovers and increase the algorithm's efficiency in the future.

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		are continually connected until the cluster size is met.	
It's Hard to Share: Joint Service Placement and Request Scheduling in Edge Clouds with Sharable and Non-sharable Resources	The suggested techniques, particularly the approximation algorithm, can achieve near-optimal performance, serving 2-3 times as many requests as a baseline solution that optimises both service placement and request scheduling individually.	When compared to the ideal solution, the technique with approximation guarantee can attain near optimal performance while considerably lowering running time.	In the future, to cut running time and optimise the solution for the difficulties.
Optimal Cloudlet Placement and User to Cloudlet Allocation in Wireless Metropolitan Area Networks	In a wireless metropolitan area network, we investigate cloudlet deployment and mobile user allocation to cloudlets (WMAN). We provide an algorithm for the problem that allows cloudlets to be put in user-dense parts of the WMAN and allocates mobile users to the cloudlets while balancing their burden.	We demonstrated that strategically placing a small number of cloudlets in a WMAN may increase the performance of mobile user apps dramatically. We provided an effective approach for handling the problem of cloudlet placement.	The updated system model is projected to be able to track and forecast user mobility within the network in the future, as well as deliver higher prediction accuracy.
QoS-Aware Task Offloading in Distributed Cloudlets with Virtual Network Function Services	Within a restricted time horizon, we strive to maximize the number of requests granted while reducing their admission cost. We first demonstrate that the task is NP-hard, and then construct an efficient solution by reducing it to a sequence of minimal weight maximum matching in auxiliary bipartite networks.	In a wireless metropolitan area network, we investigated an unique task offloading issue in which each offloading job has a maximum tolerated latency and various requests require different sorts of services from the network's cloudlets. We concentrated on increasing the number of offloading request admissions while lowering admission costs within a particular time frame.	Improve the cost-cutting strategy in cloud technology and deliver better algorithm performance in the future.

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Cloudlet Load Balancing in Wireless Metropolitan Area Networks	To improve mobile application performance, we examine ways to balance workload among several cloudlets in a network. We first present a system model to capture the response times of offloaded activities and then define a novel optimization problem to identify an ideal redirection of jobs across cloudlets that minimizes the maximum of the average response times of tasks at cloudlets.	Finally, we use experimental simulations to assess the performance of the proposed approach. The experimental findings show that the suggested method has a great potential for lowering task response times.	To develop a quick and scalable method for balancing workloads among cloudlets in order to reduce the average response time of jobs in the future..
The Internet Topology Zoo	The Internet Topology Zoo is a repository of network data derived from information made public by network providers. As such, it is the most precise large-scale collection of network topologies known, and it includes meta-data that could not be measured.	We can now answer questions regarding network structure with greater precision than ever before, as demonstrated by a preliminary investigation of the PoP-level topology of over 140 networks. We discover a diverse range of network configurations that do not all adhere to any evident concept.	The Zoo will present several options for future research, including analysis of networks at other levels, such as the physical level, and cross-level comparisons.
Profit Maximization of NFV-Enabled Request Admissions in SDNs	They also present technological difficulties. One such problem is managing the deployment of virtualized network functions (VNFs) and directing the data traffic of each NFV-enabled request through the network functions that are defined. In this article, we use the flexibility and cost-efficiency of NFV and	We investigated the profit maximisation problem for NFV-enabled request admissions in a software-defined network under both snapshot and finite time horizon scenarios, assuming that certain VNF instances were placed in data centres in the SDN.	To improve the algorithm's performance in the future

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	SDN for NFV-enabled request admissions in SDNs, and we pose profit maximisation issues for static and dynamic NFV-enabled request admissions.		
Profit Maximization for Admitting Requests with Network Function Services in Distributed Clouds	We consider dynamic admissions of delay-aware requests with service function chain requirements in a distributed cloud with the goal of maximising the service provider's profit, assuming that the distributed cloud is an SDN composed of data centres located in different geographical locations and with different electricity prices.	For the offline form of the problem, we originally offered an ILP solution. We then created an online heuristic to solve the problem. In addition, for a particular example of the issue where the end-to-end latency restriction of each request might be insignificant, we created an online solution with a proven competitive ratio. Finally, we used experimental simulations to assess the performance of the suggested methods. The results of the experiments show that the proposed algorithms are promising.	In the future, the performance of the algorithm should be evaluated in comparison to the suggested method.
Experiments of Recreating the Frequency Domain Properties of Seawater Channel for Underwater Optical Communication	Several agents are investigated in order to accurately adjust the optical coefficients of experimental water. The frequency domain characteristic of an optical communication channel in experimental water is then measured and compared as a criterion for the dependability of water recreation.	In the experiment, the optical characteristics of water have a greater impact on signal spectrum distortion than the type of agent. We intend to do more studies, maybe examining the influence of artificial scattering agents on beam propagation.	In the future, the influence of artificial scattering agents on beam propagation must be minimised.
Mobile Edge Computing: A Survey on Architecture and Computation Offloading	We begin by describing the MEC's key use cases and reference situations. Following that, we evaluate existing	The MEC paradigm brings numerous significant difficulties that must be solved in order to fully satisfy all	Real testing and trials under more realistic assumptions are necessary in the future to demonstrate the

	strategies for incorporating MEC functions into mobile networks and analyses current MEC standardization progress. The heart of our investigation is thus centered on a user-oriented use case in the MEC, namely computation offloading.	stakeholders involved, including mobile operators, service providers, and consumers. The alpha and omega of contemporary MEC research is how to ensure service continuity in extremely dynamic circumstances.	predicted values introduced by the MEC.
Service Entity Placement for Social Virtual Reality Applications in Edge Computing	the first serious investigation into this issue We describe and construct a combinatorial optimization problem that encompasses all interconnected objectives. We present ITEM, an iterative approach with quick and large "moves" in which we create a graph to encapsulate all costs and transform the cost optimization into a graph cut issue in each iteration. We may concurrently establish the location of many service entities by finding the minimal s-t cut using known max-flow algorithms, and therefore the original problem can be addressed by solving a series of graph cuts.	Extensive trials validate the suggested algorithm's performance. As the convergence of VR and edge computing becomes more popular, the approach presented in this study will serve as a starting point for further research in this area.	Several research concerns remain unanswered, including the development of online algorithms for SE placement that account for the cost of edge cloud reconfiguration. We defer to them for future work.
Budgeted Cell Planning for Cellular Networks with Small Cells	In HetNet, we investigate the budgeted cell design issue, with the goal of maximizing the number of traffic demand nodes whose needed rates are fully supplied with a given budget. Our optimization effort is	We build a 1 2 - approximation approach to assign TDPs to a given set of cells by reducing the power consumption of a cell with specified bandwidth, and then an e1 2e approximation algorithm is devised to	The interference issue should also be thoroughly researched in order to develop a more viable cell planning method for HetNets in the future.

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	difficult, and the specified problem is difficult to solve, due to practical cellular system restrictions such as power limitation, available bandwidth, and traffic needs.	address the target budgeted cell planning issue. There are also preliminary numerical data and explanations of interference difficulties. Relay nodes should be studied for future development.	
Capacitated Cloudlet Placements in Wireless Metropolitan Area Networks	Then we present a quick but efficient heuristic. We design an unique approximation approach with a guaranteed approximation ratio for a particular example of the issue in which all cloudlets have the same computational capability. Furthermore, we investigate assigning user requests to cloudlets by proposing an efficient algorithm.online algorithm for such an assignment. We finally evaluate the performance of the proposed algorithms through experimental simulations	Finally, we used experimental simulations to assess the performance of the suggested methods. According on the simulation findings, the proposed algorithms are quite promising.	The algorithm's performance and efficiency should be improved in the future.
Efficient Algorithms for Capacitated Cloudlet Placements	We investigate the topic of cloudlet placement in a large-scale Wireless Metropolitan Area Network (WMAN) comprised of several wireless Access Points (APs). We first construct the problem as an unique capacitated cloudlet placement problem, in which K cloudlets are placed in strategic locations across the WMAN with the goal of minimising the average access time	It requires a quick but scalable heuristic. We created two unique approximation techniques for a particular form of the issue in which all cloudlets have equivalent computing capacity, depending on whether all user requests have identical resource needs. Finally, we used experimental simulations to assess the performance of the suggested methods.	In the future, we will investigate the impact of delay between users and their APs.

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	between mobile users and the cloudlets that serve them.		
Task Offloading with Network Function Requirements in a Mobile Edge-Cloud Network	In a mobile edge-cloud network, we propose an unique task offloading issue in which each offloading job requires a specific network function with a reasonable latency. Through either sharing existing VNF instances or creating new VNF instances in cloudlets, we attempt to maximize the number of requests permitted while minimizing the operational cost of admitted requests within a restricted time horizon.	We also looked at a particular version of the problem in which there were no end-to-end latency limitations for requests, for which we proposed an online method with a proved competitive ratio. Finally, we used experimental simulations to assess the performance of the suggested methods.	In the future, to give more optimal algorithm instance generation, release, and cost savings.

CONCLUSION

We examined reliable and smooth virtualized network service provisioning on a mobile edge-cloud network by taking user mobility and service response latency sensitivity into account in this research. We began by developing two new optimization problems: the network utility maximization issue and the online throughput maximization problem. For the first problem, we devised a constant approximation approach, and for the second, we constructed an efficient online solution. Finally, we used experimental simulations to assess the performance of the suggested methods. The results of the experiments showed that the proposed algorithms are promising.

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