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RECENT ADVANCE IN MOBILE EDGE COMPUTING AND CONTENT CACHING

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Abstract:- Nowadays digital media service is highly increasing as the number of wireless subscription is growing heavily. To meet this growing need, mobile wireless networks have been advanced at a huge pace over recent days. However, the architecture of live mobile networks, with limited volume and range of bandwidth of the radio access network and small bandwidth of the radio access network and small bandwidth back-haul network, can not handle the heavily increasing mobile traffic. Newly, we have seen the growth of new mechanisms of data caching and transfer methods through the transitional caching server.MEC is recognized as a key to 5G networks. This paper is aimed to present a survey on Recent advance in mobile edge computing and text caching, in MEC(Mobile Edge Computing) deploy an edge server and content caching within the mobile networks, we have identified and discussed some important open challenges in mobile edge computing with text caching

1.INTRODUCTION

Multi-access Edge Computing (MEC), commonly known as Mobile Edge Computing, is an ETSI (**European Telecommunications Standards Institute)** defined network architecture concept that enables cloud computing capabilities and IT service environment at the edge of the cellular network, the basic idea behind MEC is to becoming closer to the cellular customers, by running an application and performing related processing task, it reduce the network congestion and application perform better. This technology is design to be implemented at the cellular base station or the other edge nodes, it gives services for customers like enables flexible and rapid deployment of the new application, and also allows cellular operators to open their radio access network (RAN) to authorizes third parties, such as application developers and content providers Content caching is a performance optimization mechanism in which data is delivered from the closest servers for optimal application performance. For example, in a single server text or content can be copied and distributed across various data centers and clouds. If anybody wants to content that needs to be accessed, the content can be retrieved from any of the cached locations based on geographic location, performance, and bandwidth availability. Third parties can be handled wireless network operator can allow edge computing and rapidly deploy new applications for the mobile users by those allows edge services and service providers. In deferent words, MEC allows the processing of data near the end-users where the actual data is generated and also tries to avoid the use of a centralized data warehouse. MEC uses different types of technologies like Video streaming and Entertainment e-services from the edge, video analytics application, AR/VR applications, surveillance applications, IoT edge gateway, enables Autonomous cars, Edge caching, etc Key features of edge caching studied in the context of 5G network. As effective cooperation of edge caching nodes needs to be calculated, a hybrid architecture that trappings the benefits of edge caching and cloud access networks were proposed to further utilize cloud-based radio access networks and provide a more flexible caching service in 5G mobile systems, a caching scheme with virtualization evolved packet core concept was introduced in, where third-party service providers can be adaptively authorized. In Content delivery processing physical layer technology plays a vital role, it is critical that the physical layer also be considered while designing the caching control mechanism.

For more, content caching inside MEC has incontestable to be helpful because of the exploitation of assorted varieties of BSs (Base Stations) for MEC, the longer-term edge networks area unit thought of to be varied. thus, in edge networks, the caching will be position at various places in several BSs. The content requested by users is fetched from the central server at the beginning of the content that isn't available at the edge .then caching is impose to stay a copy of the content for future use. if the data is read/accessed from a cluster server each time, a slow back-haul link will initiate significant delay whereas delivering the content to end-users

Further, with the deployment and development of several BSs and cheaper storage units, installing caching mechanisms at Small Base Station as well as at Macro Base Station has become cost-effective and easy recently. In the development of wireless networks, the device-to-device communication with device level storage units will allow the user level content caching to base itself upon interests and some community relation between users the basic architecture of edge computing and content caching is shown in figure 1.

With software-defined networking (SDN) and network functions virtualization (NFV) in place, communication and computing functionalities square measure converging in 5G networks Following these developments, jointly optimizing

IJARCCE

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caching and computing capabilities in mobile networks might offer higher potency for users' applications with extensive computation demands and continuous content delivery. However, the caching capability improvement brought by computing resource consumption is usually neglected. In increased reality applications, it is common to follow to withdraw some key options from the originally captured videos to avoid wasting caching and transmission resources it's so crucial to require advantage of computing resources to alleviate the strain on caching resources for the nodes with poor storage resources.

Figure 1: the basic architecture of edge computing and content caching

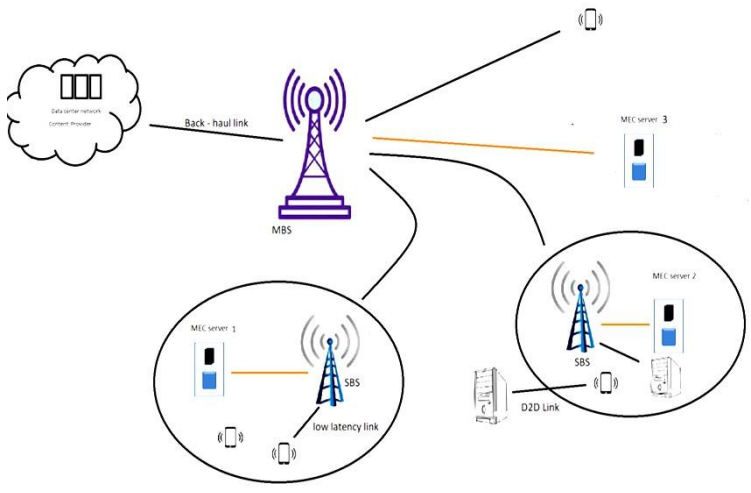
The content choice method considers that contents ought to be cached, what contents are to be updated, and how long the content ought to be cached one of the factors is content quality, which is often used as a really necessary issue for quick content retrieval. Another is content diversity that helps to extend the classes of content cached regionally.
The network resources, such as computing, cache storage size, energy, and communication bandwidth within the MEC-enabled network, should be controlled for their effective usage. For better efficiency, it is required to significantly optimize how to insert the caching data, what data to be cached, and how to evict contents from the cache storage by taking into account diversity, data quality, and end-user mobility.
Caching improvement deals with the issues related to improvement on networks additionally as user performance, like network architecture, analytical approaches, and content caching ways...

The remainder of the article is organized as follows, 1. computing at the edge network.

2. caching replacement strategies.
3. presents the behavior and performance of the caching system
4. Research challenges.
5. Conclusion.
6. Reference

1. COMPUTING AT THE MOBILE EDGE NETWORK.

Edge computing platform with 5G creates huge opportunities in every business. It brings computation and data/ information storage nearer to wherever information is generated, enabling better data control, reduced prices, quicker insights, and actions, and continuous operations. In fact, by 2025, seventy-fifth of enterprise data will be processed at the edge, compared to nowadays its has only 10%.



1.1 Objectives of MEC

The primary goal of MEC is to lower the latency and enhance the quality of experience for the end-users. Completely different wireless applications or systems might have different performance needs, like delay needs, which might be met through MEC networks. we tend to gift performance objectives that edge computing provides in mobile wireless networks within the following subsections

1.1.1 Minimization of latency computation latency becomes one every of the foremost necessary topics in recent years. To realize the bold millisecond-scale latency demand in 5G networks, the European Telecommunications Standards Institute (ETSI) has initialed a study item, specifically mobile edge computing (MEC), that offers application developers and content suppliers cloud-computing capabilities at the sting(edge) of the mobile network. Moreover, through mobile edge computation offloading (MECO), the end-to-end delay of mobile devices will be considerably reduced by offloading intensive computation employment to the proximate MEC server for execution

1.1.2 Maximization of network capacity

The 5G wireless network is predicted to support n times the higher volume of mobile data per sector than the present 4G network to handle this expected vast data, future wireless networks need higher capability within the RAN, backhaul,

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and front haul. data offloading yet as context-aware computation offloading area unit a mixture of technologies that area unit expected to deal with a number of the challenges within the RAN on prime of utilizing additional spectrum with higher spectrum potency MEC and content caching may facilitate increase the network capability by caching common content to the sting/edge and BSs, and by saving the backhaul bandwidth

1.1.3 Maximization of energy consumption Many works are done to judge the energy efficiency of edge computing Various optimization schemes have been proposed to minimize energy consumption in both individual devices and networks. For computation offloading in next-generation heterogeneous networks, the energy price related to task computing and file transmission is considered one of the central price elements [10]. it's necessary to design an associate energy efficient data/computation offloading theme, that put together optimizes radio resources and energy consumption whereas minimizing the general latency. In [10], finish devices square measure into 3 varieties in line with their skills and needs. Wireless channels of MBSs and SBSs square measure allotted to mobile devices in line with their priority till all devices receive needed channels. At each iteration, the theme ensures the system obtains a minimum energy price. The results have shown that the projected theme has lower energy consumption, significantly with an
oversized variety of user

1.2Computation offloading
MEC permits the SDs to offload computational intensive tasks to the near edge nodes for providing higher quality-of-services (QoS). The recently projected offloading methods, chiefly think about a
centralized approach for a restricted range of SDS

1.2.1 Single-MEC Server and Single-User Scenario Scheduling methods for offloading within the single-user case ought to be deployed to keep down the delay and energy consumption to combat stochastic channel conditions in wireless networks. In, a threshold-based planning policy has been proposed to minimize the energy consumption for single- and multi-server situations

1.2.2 Single-MEC Server and Multi-User Scenario The data or computation offloading the multi-user situation is far more complicated and should contend with complicated problems from planning to allocation compared with one user offloading. It is known that multi-user offloading is an NP-hard downside. This problem will be resolved victimization suppositious approaches wherever a social best equilibrium will be achieved

1.2.3 Centralized Multi-MEC Network and Multi-User
Scenario
A device a tool/offload its contents or computation to a different close device victimization device-to-device communication to leverage further computation resources of another device once it's attainable. The end devices collected as a group may be wont to give such services, instead of the sting server, the machine tasks might be alternative nearby mobile devices. The programming drawback for offloading to a different device is predicted to differ from that of offloading to the server

1.2.4 Distributed Multi-MEC Network Without Load Sharing
Typically usually of procedure tasks are completed to edge servers. While choosing the edge servers to reduce delay and energy consumption to maximize QoE for task offloading, we want to think about different parameters, like CPU cycles, offloading link capability, energy
consumption, cache size, etc

1.2.5 Distributed Multi-MEC Network With Load Sharing User mobility is one among the foremost necessary options to be thought about in the edge network since mobility determines the affiliation setup time and habitation time between users and servers. The mobility of finish users leads to a dynamically dynamical topology that directly impacts task offloading strategies

2. CACHING LOCATION AND CACHE REPLACEMENT STRATEGIES

I . Caching location
In MEC, we have a tendency to might deploy edge servers and content caching inside the mobile networks. In typical wireless cellular networks for caching, we could cache the content at the core network, end-devices, and RAN With MEC caching and edge server, the data congestion could be reduced significantly. the various locations for caching in MEC networks are mentioned within the following subsections a)MBS's
b)SBS’s
c)End device caching

IJARCCE

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BSs in heterogeneous networks square measure the places where caching and edge server square measure deployed and where caching is also done reactively and proactively. SBSs square measure expected to be heavily deployed within the next generation of heterogeneous wireless networks. Device to Device (D2D) communication is additionally expected in 5G wireless networks. within the D2D framework, finish devices may leverage their storage for caching the content, which can significantly reduce delay. Caching in D2D are often done hand in glove
among finish users by forming clusters or separately

II . Caching insertion strategy
The following subsections available some cache
insertion methods in MEC-enabled system

a) Caching everywhere
Caching every place is that the least conservative means of caching the contents within the MEC system. It might be thought of as an option for the system wherever no optimization is required, from the supply to the end-user, where doable content is going to be cached that may introduce extra burden on storage or further burden on handling the recent caches
efficiently

b) Caching with probability
Most problems on caching all over can be handled by victimization caching with likelihood therefore on enhance the storage efficiency and scale back the caching redundancy. The caching with likelihood info is utilized and may improve cache efficiency. The content of upper usage probability is cached whereas that of lower usage
the likelihood isn't cached

c) Mobility-based caching strategy Mobile users might move from one location to a different or one wireless network to a different network that makes the users move from one edge server to a different and one cache server to a different. once users haven't finished downloading the content from one cache server before moving to another location, the downloaded content might not be helpful unless there is a mechanism to hand-off properly from one cache server to another. Thus, supported the user's mobility direction, content should be cached to supply the best feasible service with least delay

d) Hierarchical cooperative caching
Data may be cached victimization] gradable/hierarchical framework to use the storage and caching effectively. The ad presents a noteworthy idea of caching: use neighbors storage house to cache the content and use your own space for storing, and/or strangers date space for storing for caching

e) Interest-based cooperative caching Caching of the content will be done to support the interest of the content from users. as an example, throughout getting nighttime residential, MEC could cache movies of sure sorts supported the population, like youngsters movie if the given location has a lot of youngsters and action pictures if the given location has a lot of adults who watch action movies fairly often.

III. Caching eviction/replacement strategy
In computing, cache algorithms square measure optimizing directions, or algorithms, that a malicious program or a hardware-maintained structure will utilize to manage a cache of knowledge hold on on the pc. Caching improves performance by keeping recent or often-used knowledge things in memory locations that square measure quicker or computationally cheaper to access than traditional memory stores. once the cache is full, the algorithmic rule should select that things to discard to create space for the new ones. the subsequent sections offer some approaches for cache replacement methods...

Bélády's algorithm
First-in first-out (FIFO)
Last in first-out (LIFO) or First in last out (FILO)
The least recently used (LRU)
Time aware least recently used (TLRU)
Most recently used (MRU)
Pseudo-LRU (PLRU)
Random replacement (RR)

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Segmented LRU (SLRU)
Least-frequently used (LFU)
The least frequent recently used (LFRU)
LFU with dynamic aging (LFUDA)
Low inter-reference recency set (LIRS)
CLOCK-Pro
Adaptive replacement cache (ARC)
Adaptive Climb (AC)
Clock with adaptive replacement (CAR)
Multi queue (MQ)
Pannier: Container-based caching algorithm for compound objects

3. CACHING SYSTEM BEHAVIOURS/PERFORMANCE AND NETWORK OPTIMIZATION

3.1 Caching system behavior/performance Caching system behavior and performance are depending on caching policies and caching replacement approaches as mentioned in previous sections. there's no single quality approach that fits all applications and needs of various users. whereas decisive that caching approach is a could be a to a given structure or application, we'd like to think about all features and characteristics so we will support the appliance, then select the simplest approach for content caching and cache replacement strategies There are many models within the state of the artwork that analyze caching behavior and performance. For instance, the ad used the Markov chain model to review the behavior of the caching system. The ad studied the caching system using a discrete-time Markov chain. The ad gave the policy structure of the Markov chain as a replacement for the LRU approach. The ad used the stationary Markov model whereas finding out the user quality for caching using real trace info of mobile users.

3.2 Network optimizations
Network optimization could be a set of best practices used to improve network performance. A variety of tools and techniques can be used to monitor and improve network performance such as bandwidth management, minimize latency, global load balancing, and packet loss monitoring
.There are many studies for caching network optimization. In, the software-defined networking enabled caching was studied for wireless networks. The ad studied the energy-conscious caching during a wireless hot network used to get the required trade-off performance between access latency and energy utilization. Cooperative caching was studied to attenuate the expected delay and maximize the general system performance. A clustering-based caching arrange for wireless divergent network systems has been studied to complement the performance

4. OPEN RESEARCH CHALLENGE

In this section, some problems and challenges area unit highlighted that area unit provided direction to analyzers for more research during this area

a. Heterogeneity and scalability
As edge devices use completely different access technologies as well as 3G, 4G, 5G, Wi-Fi, and WiMax, therefore, a feature of heterogeneity ought to be catered in the sleek functioning of MEC operations. This necessitates the supply of scalability for various platforms with varied variety of users

b. Availability and security
The availability of resources is generally dependent upon server capability and wireless access medium for making the certain constant service delivery. on convenience, security of data and applications from any fresher ought to be catered with physical measures

c. Standard protocol
MEC being a recent technology is evolving through the phases of implementation associated needs standardization emanating from the collaboration of trade and researchers over an in agreement platform the standardization of edge computing may well be a way to make an open domain for all, together with analysis fellows and industries as well. As a brand new approach, MEC has not been standardized and appropriately enforced, and this creates a lot of issues. The analysis and development for standardization might facilitate expedite the widespread deployment of MEC systems for edge computing and content sharing

IJARCCE

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d. User mobility

The quality of the end-users causes frequent disconnections with edge networks in MEC systems. once the devices are traveling, the overall performance significantly degrades. one of all the difficult problems is to find the associate best resolution to handle quality in MEC enabled wireless networks

e. Pricing policy

User mobility is common in MEC networks. awaited to the heterogeneity of networks, it's difficult to possess a generic rating for usage charge. So, developing a dynamic rating
the policy is one in every one of the challenges in MEC service

f. Efficient deployment

Minimizing the latencies through best utilization of information measure is also achieved with economical readying of MEC. However, it's troublesome to optimize the spectrum usage with dependence on complicated system parts.

5. CONCLUSION

In this survey paper, we've given a survey on recent advances in mobile edge computing and content caching in edge servers. We have summarized not only some approaches of edge computing and content caching however additionally completely different problems with edge computing and caching and cache replacement ways that aim to boost the end-user's quality of experience in terms of reduced latency and high outturn. We have also given some open challenges and future analysis directions on the topic.

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