International Journal of Research
Available at https://pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 20
SEPTEMBER 2018

Increasing the Performance of 5g Networks by Combining Caching and Multicast

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Abstract

One of the major goals of the 5G technology roadmap is to create disruptive innovation for the efficient use of the radio spectrum to enable rapid access to bandwidth-intensive multimedia services over wireless networks. The biggest challenge towards this goal lies on the difficulty in exploiting the multicast nature of the wireless channel in the presence of wireless multiple users that rarely access the same data at the same time period. The combined use of wireless caching mechanism and multicasting has been shown to be a promising solution to simultaneously serve multiple unicast demands via a single multicast transmission, which helps in efficient use of bandwidth. Anyway, the question of how these theoretically-proven throughput gains translate in the context of a practical implementation that accounts for all the required coding and protocol overheads. In this paper, we first provide an introduction about emerging caching-aided multicast technique, including state of art schemes and their performances which are not proven. Later, we focus on the most competitive scheme proposed and describe a fully working prototype implementation. In this paper introducing some concept to improve energy efficiency of 5G network. That performance improvement satisfy demand on mobile data with minimal energy expenditures. This excellent development is achieved by combine the concept of caching and multicast. Caching procedure is based on the idea of storing the popular content at the Small-cell Base Stations via backhaul links. Multicast is used to reduce energy and bandwidth consumption of wireless network by serving concurrent user requests for the same content via common multicast stream. Combination of Cache and multicast is effective when there is occurring repeated

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 20
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requested for a few content files appear over time. It can indeed reduce energy costs. The gains over existing caching schemes are 19% when users tolerate delay of three minutes, increasing further with the sharpness of content access pattern.

***Key Words**: 5G network, Cache, Multicast, Heterogeneous cellular networks, small-cell base stations, Macro-cell base station, Radio access networks Key*

1. INTRODUCTION

Currently, are witnessing the worldwide growth of mobile data traffic that is expected to continue over the next few years, reaching exabytes per month. To handle this large data requests, the emerging 5th generation 5G systems need to improve the network performance in terms of energy consumption, throughput and user experienced delay, and at the same time make a better use of the network resources such as wireless bandwidth and backhaul link capacity. Two candidate solutions that have been investigated are caching and multicast. On the first issue, there is an increasing interest for in network caching architectures where operators cache popular content files at the Evolved Packet Core EPC or at the Radio Access Network RAN, e.g., in dedicated boxes or at the cellular base stations. With the presentation of a myriad of sensible hand-held devices, user requests for mobile broadband are experiencing partner degree exceptional ascent. The mighty development of data transfer capacity hungry applications like video gushing and transmission document sharing are already pushing the limits of current cell frameworks. Inside the following decade, pictured media-rich mobile applications like telecommunication and 3D optics would require data rates only unendurable with fourth era (4G) networks. The steadily developing interest for higher data rates and capacity require offbeat speculation for taking after era (5G) cell frameworks. Agreeable interchanges have such guarantee! Helpful interchanges speak to a substitution classification of wireless correspondence procedures amid which network nodes encourage each other in handing-off information to grasp spacial differing qualities benefits. This new transmission paradigm ensures key execution picks up as far as connection irresponsibleness, otherworldly strength, framework capacity, and transmission change. Agreeable correspondence has been widely contemplated inside the writing, and stuck terminal transferring (which includes the readying of low-power base stations to help the correspondence between the supply

and along these lines the goal) has already been encased inside the 4G future Evolution (LTE)-Advanced standard. Mounted terminal transferring acquires improvements cell frameworks, however the total capability of participation might be acknowledged exclusively through the usage of device handing-off. The term device here alludes to a mobile telephone or the other movable wireless device with cell property (tablet, portable workstation, and so forth) a user claims. Device transferring makes it feasible for devices amid a network to execute as transmission transfers for each unique and notice a tremendous unconstrained work network.

2. PROBLEM STATEMENT

The upcoming 5th generation (5G) systems need to improve the performance of network in terms of energy consumption; throughput and user experienced delay, and at the same time make a better use of the network resources such as wireless bandwidth and backhaul link capacity. Two candidate solutions that have been investigated are caching and multicast. On the second issue, many operators take advantage of multicast to efficiently utilize the available bandwidth of their networks in delivering the same content to multiple receivers, multicast is often used for delivering sponsored content, e.g., mobile advertisements in certain locations, downloading news, stock market reports, weather and sports updates. In order to answer the question raised, we consider a HCN model that supports caching and multicast for the service of the mobile users. Requests for the same content file generated during a short-time window are aggregated and served through a single multicast transmission when the corresponding window expires (batching multicast). To ensure that the user experienced delay will be limited, the duration of this window should be as small as possible. For example, users may tolerate a very small start-up delay for video streaming applications, whereas larger delay may be acceptable for downloading news, stock market reports, weather and sports updates. The multicast stream can be delivered either by a SBS that is in communication range with the requesters in case that the respective file is available in its cache, or by the MBS which has access to the entire file library through a backhaul link. Clearly, a MBS multicast transmission can satisfy requests generated within the coverage areas of different SBSs that have not cached the requested file. However, it typically induces higher energy cost than a SBS, since the distance to the

receiver is larger and it also needs to fetch the file via its backhaul link.

3. PROPOSED SYSTEM

Academia and industry consider caching and multicast independently one from the other and for different purposes. On one hand, caching is used to shift traffic from peak to off-peak hours by exploiting the periodic pattern of traffic generation. This is realized by filling the caches with content during off-peak hours (e.g., nighttime), and serving requests for the stored content by the caches peak-time (e.g., daytime). On other hand, multicast is used to reduce energy and bandwidth consumption by serving concurrent user requests for the same content via a single point-to-multipoint transmission instead of many point-to-point (unicast) transmissions. Paramount importance to design caching and multicast mechanisms for servicing the mobile user requests with the minimum possible energy expenditures. For a given anticipated content demand, the caching problem asks for determining in which caches to store each content file. This becomes more challenging in HCNs where users are covered by multiple base stations and hence content can be delivered to requesters through multiple network paths. On the second issue, many operators take advantage of multicast to efficiently utilize the available bandwidth of their networks in delivering the same content to multiple receivers, multicast is often used for delivering sponsored content, mobile advertisements in certain locations, downloading news, stock market reports, weather and sports updates. Meanwhile, multicast has been incorporated in3GPP specifications in which the proposed technology for LTE is called Evolved Multimedia Broadcast and Multicast Services eMBMS. Commercial examples of eMBMS are Ericsson and Qualcomm LTE Broadcast solutions. This technology can be used across multiple cells where the transmission across them is synchronous using a common carrier frequency. Hence, multicast consumes a subset of the radio resources needed by an unicast service. The resources that are remained can be used to support transmissions towards other users, thus enhancing network capacity.

4. PROPOSED PROCESS

A HCN consist of a Macro Cell Base Station (MBS) and multiple Small cell Base Stations (SBS) and/or relays. Caches can be installed at SBS and targeting to offload

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traffic from the collocated MBS. Cache filled with popular content files at Evolved Packet Core (EPC) or at the Radio Access Network (RAN). SBS allow spatial reuse, and so they can increase significantly capacity and coverage. Caching content at the wireless edge has gained considerable traction as a promising technique for future wireless networks. The idea of edge caching comes from the possibility of significantly reducing the backhaul usage by bringing the content closer to the end users. Exploiting the new capabilities of future multi-tier networks, numerous works have investigated the potential benefits of caching content in densely deployed SBS equipped with storage capabilities. Several ways to assess the performance of caching have been proposed, e.g. from an information-theoretic perspective and from an outage probability point of view. One measure of great interest is the energy efficiency (EE), which has gained considerable attention in the last few years.

Multicasting tends to be more feasible method of supporting group communication than unicasting or broadcasting, due to its nature of allowing transmission and routing of packets to multiple destinations using fewer network resources. And also with widely spread deployment of wireless networks, the capabilities which are improving fastest on mobile devices, and an increasing rate of highly developed mobile work force globally, content and service providers are increasingly interested in supporting multicast communications over wireless networks.

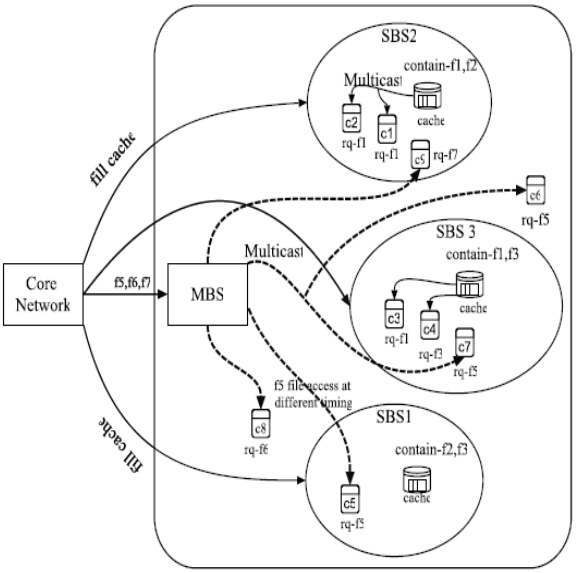

Fig 1: SBS Architecture

Applications of wireless multicast support grouped users of defense command and control, online education, and intelligence in transportation systems. Many new e-commerce applications, consists of mobile auctions, will also gain significant benefit if group communication among mobile users is supported by wireless networks. These two excellent concepts are merged to reduce the data traffic in wireless communication. HCN model that supports caching and multicast for the service of the mobile users. Requests for the same content file generated

during a short-time window are aggregated and served through a single multicast transmission when the corresponding window expires. To ensure that the user experienced delay will be limited, the duration of this window should be as small as possible.

Randomized Rounding Algorithm:

Using randomized rounding techniques, we develop a multicast-aware caching algorithm that achieves performance guarantees under the assumption that the capacity constraints can be violated in a bounded way.

Step 1: Compute a min-cost fractional set cover x ∗ {\displaystyle x^{*}} (an optimal solution to the LP relaxation).

Step 2: Let λ ← ln (2. | ...

Step 3: For each s ′ ∈ S {\display style s'\in {\mathcal {S}}} do: ...

Step 4: Return x ′ {\display style x'}.

Local caching of requested files at the SBS's has been developed, aiming at reducing the traffic generated when transferring the requested content from the core network to the users. The cache design policy carefully takes into account the fact that an operator can serve the requests for the same file that happen at nearby times via a single multicast transmission. That is, Multicasting is the transfer of messages to multiple destinations simultaneously, using fewer networks. The data is delivered to each links only once, and are copied when the links to the other destinations are divided, thus creating an optimal distribution path. It reduces unnecessary packet duplication. Overall combination of caching and multicasting incurs less traffic in mobile communication and expand energy efficiency.

Advantages:

- Multicast services doesn't wait for all system request. It only response the requests for the same file that happen at nearby times. So this proposed system reduced the time delay.
- This system enhancing the network capacity.
- Because of the Caching concept, the distance between core network and end-user device is reduced. It satisfies the demand on data traffic.

5. PROPOSED SYSTEM PROCESS MODULES

The major demand in mobile communication is mobile data. To handle this large amount of data requests, the

emerging 5th generation systems need to improve the network performance in terms of energy consumption, throughput and user experienced delay, and at the same time make a better use of the network resources such as wireless bandwidth and backhaul link capacity. Two candidate solutions that have been investigated are caching and multicast.

A. Caching Process

A cache is a temporary storage used by wireless network to reduce the average cost (time or energy) to access data from the main storage location. The cache is a smaller, faster memory which stores copies of the data from popular used main memory locations. When the mobile station wants to access the popular file, the cache storage provides that file to mobile station. This reduce the distance between storage to the end user.

B. Multicasting Process

Multicasting provides delivery to multiple destinations belong to same multicast group. Multicasting reduces the communication costs for applications that send the same data to multiple recipients. Instead of sending data via multiple unicast transmissions, a single multicast transmission minimizes the link consumption of bandwidth, sender and router processing, and delivery delay. To preform multicasting process, group of mobile stations are selected on the bases of user request. That is the user requests within a short-time window are aggregated and served through a single multicast stream when the corresponding window expires.

C. Content Caching

Intuitively, caching should be effective when there is enough content reuse; many recurring requests for a few content files appear over time. In next generation 5G systems where the demand for mobile data is often massive, and a variety of new services such as social networking platforms and news services employ the one-to-many communication paradigm, e.g., updates in Tweeter, Facebook, etc., it is expected that multicast will be more often applied.

D. Multicast Delivery

Multicast should be effective when there is significant concurrency in accessing information across users; many users concurrently generate requests for the same content file. Such scenarios are more often during events with numerous co-located people that are interested in the same contents, during sporting games, concerts

and public demonstrations with often tens of thousands attendees.

E. Network Optimization

In this section, we numerically evaluate the energy savings achieved by the proposed multicast-aware caching algorithms over existing caching strategies. The main part of the evaluation is carried out for a sporting event with thousands of attendees covered by a MBS and several SBSs. Additional scenarios differing in the population density, number of SBSs and energy costs are evaluated, which lead to an understanding of how the savings vary in different regions and markets. Overall, we find that moving from a conventional caching scheme to one enhanced with multicast-awareness can indeed reduce energy costs, and the benefits are higher when the demand is massive and the user requests for content are delay tolerant.

F. 5G Wireless Networks

Clearly, it is of paramount importance to design caching and multicast mechanisms for servicing the mobile user requests with the minimum possible energy expenditures. For a given anticipated content demand, the caching problem asks for determining in which caches to store each content file. This becomes more challenging in HCNs where users are covered by multiple base stations and hence content can be delivered to requesters through multiple network paths. Also, the caching problem differs when multicast is employed to serve concurrent requests for the same content file. Compared to unicast communication, multicast incurs less traffic as the requested file is transmitted to users only once, rather than with many point-to-point transmissions. Hence, the caching problem needs to be revisited.

G. Solution Design

Using randomized rounding techniques, we develop a multicast-aware caching algorithm that achieves performance guarantees under the assumption that the capacity constraints can be violated in a bounded way. Also, we describe a simple-to-implement heuristic algorithm that provides significant performance gains compared to the existing caching schemes. Using system parameters driven from real traffic observations in a crowded event, we show the cases where the next generation HCN systems should optimize caching with concerns on multicast delivery. The proposed algorithms yield significant energy savings over existing caching schemes, which are more pronounced when

the demand is massive and the user requests can be delayed by three minutes or more.

5. Conclusion and Future Work

In this article, we tend to specify the limitations of current receptive networks and arranged a remarkable proactive networking paradigm wherever storing assumes a critical part. By misusing the prophetical capacities of 5G networks, and additionally ideas of setting mindfulness and informal organizations, it had been demonstrated that pinnacle knowledge movement requests will be extensively diminished by proactively serving unsurprising users requests, by means of storing key substance at each the base station and user's devices. The main idea implemented in project is to combining the caching and multicasting concept. This increase the energy efficiency of the wireless communication. In contrast to the traditional caching schemes that simply bring popular content close to the users, proposed caching strategy is carefully designed to additionally exploit the multicast opportunities. Multicast is the efficient technique for delivering data to the particular group of cellular network. In this project multicast delivery, the data to nodes which request same file in the nearby time. The overall concept faces the problem of NP-hard. Two effective algorithms are implemented to overcome the NP-hard problem. That is performance guarantees and heuristic algorithm. These both algorithms executed to reduce the cache miss and unicast transmission (i.e.) improve the opportunity of cache hit with multicast transmission. The improvement over conventional caching schemes are 19% with the sharpness of content access pattern. Overall, the project can be seen as an attempt to combine caching and multicast in a methodical way as a means of improving energy efficiency in 5G wireless networks.

Future work of the project is to investigate more about the delay tolerance of the network. Then try to improve the energy efficiency of the network. And also the goals for future work include further research on cache management and multicasting methods, as well as evaluating them on new, larger datasets of content request patterns.

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