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Content Caching and Scheduling In Wireless Networks with Supple and Stable Traffic

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ABSTRACT:

The rapid growth of wireless content access implies the need for content placement and scheduling at wireless base stations. We study a system under which users are divided into clusters based on their channel conditions, and their requests are represented by different queues at logical front ends. Requests might be elastic (implying no hard delay constraint) or inelastic (requiring that a delay target be met). Correspondingly, we have request queues that indicate the number of elastic requests, and deficit queues that indicate the deficit in inelastic service. Caches are of finite size and can be refreshed periodically from a media vault. We consider two cost models that correspond to inelastic requests for streaming stored content and real-time streaming of events, respectively. We design provably optimal policies that stabilize the request queues (hence ensuring finite delays) and reduce average deficit to zero [hence ensuring that the quality-of-service (QoS) target is met at small cost. We illustrate our approach through simulations.

INTRODUCTION:

THE PAST few years have seen the rise of smart handheld wireless devices as ameans of content consumption. Content might include streaming applications in which chunks of the file must be received under hard delay constraints, as well as

file downloads such as software updates that do not have such hard constraints. The core of the Internet is well provisioned, and network capacity constraints for content delivery are at the media vault (where content originates) and at the wireless access links at end-users. Hence, a natural location to place caches for

a content distribution network (CDN) would be at the wireless gateway, which could be a cellular base station through which users obtain network access. Furthermore, it is natural to try to take advantage of the inherent broadcast nature of the wireless medium to satisfy multiple users simultaneously.

An abstraction of such a network is illustrated in Fig. 1. There are multiple cellular base stations (BSs), each of which has a cache in which to store content. The content of the caches can be periodically refreshed through accessing a media vault. We divide users into different clusters, with the idea that all users in each cluster are geographically close such that they have statistically similar channel conditions and are able to access the same base stations. Note that multiple clusters could be present in the same cell based on the dissimilarity of their channel conditions to different base stations. The requests made by each cluster are aggregated at a logical entity that we call a front end (FE) associated with that cluster. The front end could be running on any of the devices in the cluster or at a base station, and its purpose is to keep track of the requests associated with the users of that cluster. The following constraints affect system operation: 1) the wireless network between the caches to the users has finite capacity; 2) each cache can only host a finite amount of content; and 3) refreshing content in the caches from the media vault incurs a cost.

Related Work:

The problem of caching, and content planning has earlier been studied for onlineWeb caching and distributed storage systems. A normally used metric could be a competitive magnitude relation of misses, presumptuous associate adversarial model. samples of add this context ar [3]–[5]. Load leveling and placement with linear communication

costs is examined in [6] and [7]. Here, the target is to use distributed and centralized whole number programming approaches to reduce the prices. However, this work doesn't see for network capability constraints, delay-sensitive

traffic, or wireless aspects. The techniques that {we will|we'll|we ar going to} use are supported the literature on planning schemes. Tassiulas et al. planned the MaxWeight planning algorithmic rule for switches and wireless networks in their seminal work [8]. They tried that this policy

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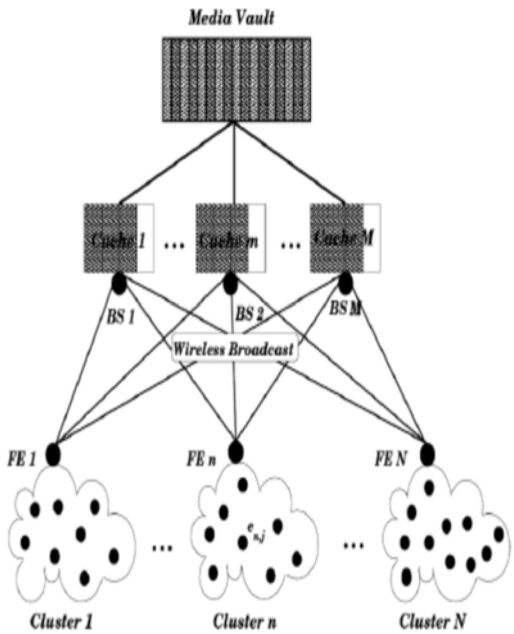
is throughput-optimal and characterised the capability region of the single-hop networks because the umbellate hull of all possible schedules.

Various extensions of this work that followed since ar [9]–[12]. These papers explore the delays within the system for single downlink with variable property, multirate links, and multihop wireless flows. However, these don't take into account content distribution with its attendant question of content placement. Closest to

our work is [13], which, however, solely considers elastic traffic and has no results on the worth of prediction.

SYSTEM IMPLEMENTATION:



Consider the content distribution network pictured in Fig. 1.There is a group of base stations and every base station is associated with a cache. The caches ar all connected to a media vault that contains all the content. The users within the system ar divided into clusters supported their geographical positions, and we let denote the set of those clusters. Also, as mentioned within the Introduction, there ar front ends in every cluster, additionally denoted
by whose purpose is to mixture requests from the users. Time is slotted, and that we divide time into frames consisting of time-slots. Requests ar created at the start of every frame. There ar 2 varieties of users

during this system inelastic and elastic based on the kind of requests that they create. Requestsmade by inelastic usersmust be happy inside the frame in which they were created. Elastic users don't have such a hard and fast deadline, and these users arrive, create asking, are served, and depart.

Conclusion:

In this paper, we studied algorithms for content placement and scheduling in wireless broadcast networks. While there has been significant work on content caching algorithms, there is
much less on the interaction of caching and networks. Converting the caching and load balancing problem into one of queueing and scheduling is hence interesting. We considered a system in which both inelastic and elastic requests coexist. Our objective was to stabilize the system in terms of finite queue lengths for elastic traffic and zero average deficit value for the inelastic traffic. We showed how an algorithm that jointly performs scheduling and placement in such a way that Lyapunov drift is minimized is capable of stabilizing the system. In designing these schemes, we showed that knowledge of the arrival process is of limited value to taking content placement decisions. We incorporated the cost of loading caches in our problem with considering two different models. In the first model, cost corresponds to refreshing the caches with unit periodicity. In the second model relating to inelastic caching with expiry, we directly assumed a unit cost for replacing each content after expiration. A max-weight-type policy was suggested for this model, which can stabilize the deficit queues and achieves an average cost that is arbitrarily close to the minimum cost.

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