

MFW: Mobile Femtocells utilizing WiFi A Data Offloading Framework for Cellular Networks using Mobile Femtocells

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MFW Operational Stages

Abstract

The ever growing data traffic generated by users in cellular networks is becoming more challenging and straining for cellular operators. Thus, developing efficient mechanisms that enable cellular operators to offload data traffic from their networks in a cost-effective manner is essential. To this end, we propose a generic framework (MFW) that exploits femtocells and WiFi networks. The framework allows cellular operators to offload part of the traffic load generated by mobile users in public transportation systems, viz.; buses, streetcars. Femto Base Stations (FBSs) are installed in these vehicles to offer cellular coverage for mobile devices, called the mobile FBS (mobFBS). The mobFBS utilizes ubiguitous WiFi as a backhaul to route the traffic to the cellular operator's network through WiFi. Mobile data users are categorized in our framework in different prioritized classes in order to efficiently allocate the mobFBS bandwidth to the maximum number of users. Efficiency is considered in terms of bandwidth utilization, enhancing capacity and managing grouped data traffic in vehicles. We elaborate on the performance of MFW via numerical experiments, emulating practical applications, viz. "Skype" and "YouTube", and demonstrate the efficiency of our framework in terms of data traffic offloading.

MFW Framework

We propose an efficient data offloading framework for cellular networks utilizing femtocells via WiFi networks; dubbed MFW. We propose to use the FBSs in public transportation vehicles. We name such FBSs in vehicles as mobile FBS (mobFBS). Each mobFBS has a WiFi transmitter installed on the roof of the vehicle to utilize urban WiFi Access Points, which are widely used and cover many urban cities, as backhauls. User Equipments (UEs) are connected to the onboard mobFBS instead of macroBSs. Only UEs with data sessions will be accommodated by the mobFBS. Nevertheless, we take into account the capacity of the mobFBS in terms of accommodated users and total available bandwidth. We categorize data UEs in different prioritized classes in order to efficiently allocate the mobFBS bandwidth to the maximum number of UEs.



MFW core operational stages

- **1. Triggering stage:** once a UE enters the coverage of mobFBS; a trigger to offload will be initiated based on a predefined network condition (e.g. mobFBS's RSSI, operator's preferences, enforced handover).
- 2. Classification stage: the macroBS receives the request of the UE then checks its status. If the status of UE is idle, or a the UE has a voice call, the UE remains connected to the macroBS. Yet, if it has a data session, the macroBS will classify the UE's data request in different classes based on the applications priority.
- **3. Decision stage:** the mobFBS receives a candidate UE to offload, it chooses which eligible UE to offload based on two conditions. First, the current number of UEs which are connected to a mobFBS. Second, the total bandwidth currently used in addition to the requested bandwidth.
- 4. Offloading stage: the macroBS will transfer the accepted candidate UE to the mobFBS and update network.

MFW Components and Instance

- UE: could be any handheld device that has a cellular interface (such as cell phones, laptops, smart phones, etc.).
- mobFBS: an enterprise FBS that. It is registered and preconfigured in all ubiquitously accessible WiFi APs. A mobFBS has preemptive priority in accessing roadside WiFi APs.
- macroBS: a regular existing macro-BS.
- WiFi transmitter: a WiFi antenna is installed on the roof of the vehicle to connect with accessible WiFi APs. The WiFi transmitter is wired to the mobFBS via wires. WiFi APs are owned by cellular operators or WiFi carriers. In the latter, the cellular operator makes service agreement with the WiFi carrier.



Results and Discussion

Telecommunications

Research Lab

We present numerical results of average data offloaded from the macroBS to the mobFBS. We also verify the efficiency of the proposed MFW instance using real world numerical examples. To elicit the efficiency of MFW on different classes, we assume two different cases. Case I is light traffic users and Case II is heavy traffic users. For this instance, we assume a number of UEs varying from 5 to 40. Numerical results determine the average offloaded data traffic from the macroBS to the mobFBS at a given time period.



