

# Mobile Data Offloading Estimation to determine Wifi Transferring Capabilities

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**Abstract:** - Over the last couple of years, the explosion of Wi-Fi enabled smartphones and 3G capable laptops coupled with the consumer and business demand for bandwidth hungry, real-time video and data applications have spiked the data traffic on mobile networks across the world, exponentially. According to Pyramid Research, the smartphone shipment is forecasted to grow from 232m units in 2010 to 532m in 2014. As a result of these new smart devices that put tons of new data-intensive applications in the hands of millions of cellular users, data traffic on today's 3G networks has increased drastically, to the point where data traffic is outpacing new revenue for the carriers. With analysts predicting that the global mobile data is set to double every year until 2013, the situation would aggravate further - creating a problem as well as an opportunity for carriers. This Paper proposes a distribution model-based simulator and a theoretical framework that enable analytical studies of the average performance of offloading are proposed. These tools are useful for network providers to obtain a rough estimate on the average performance of offloading for a given WiFi deployment condition.

**Keywords:** Data traffic; Mobile data offloading; Femto cells; RNC; SIPTO; APN; DPI;

## Introduction

The particular mobile business has observed incredible increase over the past couple of years, especially with terminology involving info traffic, which, currently surpassing voice traffic can be continuously increasing simply by a good order involving size on a yearly basis. World-wide cell info traffic can be anticipated to develop to help 10.8 exabytes (1 exa = 10<sup>18</sup>) monthly simply by 2016, which is a good 18-fold boost in excess of 2011 [1]. This unprecedented -boost with info traffic can be generating problems regarding active mobile communities. Cell phone info offloading, or just info offloading, means the application of contrasting network systems along with revolutionary processes for delivery involving info formerly qualified regarding mobile/cellular communities as a way to ease congestion along with make better usage of readily available network methods. The aim is always to retain top quality involving service (QoS) regarding consumers, even though in addition minimizing the cost along with impact involving having capacity-hungry companies within the cell network. It is envisioned which cell info offloading can be a vital business section with the longer term for the reason that info traffic upon cell communities is constantly on the boost rapidly. The main car owner regarding cell info offloading is actually the actual surge involving info traffic upon mobile communities, which is causing congestion along with in the end degrading customer expertise. This surge can be attributed to numerous factors: initial, the actual benefits involving high-end products including lap tops, tablets, along with touch screen phones, which could flourish traffic (eg. a smart dataphone can certainly create around 35 instances the actual traffic made by way of standard characteristic phone); minute, the actual increase with typical traffic every device, especially because of increasing cell network interconnection data transfer rates along with progress inside the electric battery lifetime involving cellular phones. These two factors boost a good individual's get in touch with time together with the actual network. Next will be the boost with cell movie content, which has greater tad rates in comparison with different cell content kinds. Aside from better info rates supplied by the existing creation involving mobile communities, which enhance the users' viewing expertise, significant monitor styles along with optimization involving movie regarding cellular phones in addition play a role to the increase involving movie traffic. Fourth, the actual access involving cell broadband companies from costs along with data transfer rates like these involving fixed broadband, with their increasing development in the direction of everywhere mobility are usually different surrounding factors with increase involving info traffic upon cell communities. Additional owners regarding cell info offloading incorporate charge lowering, improving customer expertise, along with home based business opportunities. Nearly all cell staff possess launched along with began to put into practice a cell info offloading technique. So far, Wi-Fi along with femtocells possess surfaced for the reason that preferred offloading systems. Besides info offloading remedies, staff have also been thinking of several involving optimization ways of alleviate congestion on the communities. The more common approach involving scaling network volume together with extra network apparatus (installing a lot more bottom gas stops every area) is actually readily available, however, not cost-effective along with feasible considering the velocity when the actual need regarding info companies can be increasing. The principle purpose of the content is always to supply the condition involving the actual fine art with cell info

offloading, protecting each design along with company elements. To the ideal from the authors' expertise, a real study does not really can be found inside the materials. All of those other content can be sorted the following. We all cover the existing cell info offloading remedies. Due to the fact Wi-Fi along with femtocells possess progressed as fully developed systems, they're insured with somewhat a lot more fine detail in comparison to different growing systems.

#### **Related Works:**

Information offloading via femtocells is effective for several factors, a few of which are the following [2]. First, the actual application happens largely inside (homes as well as offices). As outlined by certainly one of the actual posted studies, fifty-five percentage involving facts application happens in your house and twenty six percentage happens from the business office [3]. So, the actual employees obtain the chance to help offload weighty consumers via femtocells. Subsequent, femtocells represent an owner started and maintained program, and thus provide a seamless knowledge to help consumers. Third, femtocells can be started speedily, in contrast to classic macrocellular deployments, which in turn carry for a long time on account of internet site exchange, purchase involving radio stations commercial infrastructure and backhaul, and other identical things to consider. Inside femtocell situations, the actual traffic moves above the air program towards the femtocell (which is associated with the actual user's broadband connection), then over the web towards the operator's central community and/or different Web destinations. When a prospective subscriber comes into the actual insurance coverage involving femtocell, an individual tools (UE) routinely affiliates with it.

Traffic of which formerly flowed between the macrocell and also the UE now moves from the femtocell and also the subscriber's broadband relationship. The femtocell not merely offloads the actual Node W but radio stations community controller (RNC), which in turn additionally lowers the actual heap around the macrocellular community. A whole new typical, currently below development, referred to as selected IP traffic offload (SIPTO) [4], permits the actual owner to help offload selected types of traffic at a community node near to the actual UE's spot. The existing standardization procedure primarily takes 2 types of guidelines with regard to offloading: access position brand (APN) primarily based and serious packet check up (DPI) primarily based.

Any precise debate with SIPTO is out of the setting of this post. Curious audience is usually referred to [5]. Nevertheless, it is important to talk about of which by simply employing SIPTO, employees can offload the actual central community by simply making it possible for the actual traffic to help movement immediately in the femtocell towards the Web. Before relocating onto your next segment, we all in brief explain the actual comparable advantages and drawbacks involving femtocells and Wi-Fi since the two are usually main offloading alternatives. Seeing that Wi-Fi works throughout unlicensed companies, employees get access to much more substantial cost-free variety to -help look after just about any size involving Wi-Fi deployment. Femtocells, conversely involve mindful planning while they work throughout costly (licensed) and restricted variety companies. Femtocells record totally involving traffic, whether it's words as well as facts and no matter if this arises from a new feature phone, mobile phone, or possibly a laptop computer. This can be usually not feasible in the case of Wi-Fi.

Femtocells tend not to improve the electric power use with the actual terminal facet, whilst Wi-Fi permitted gadgets may possibly knowledge enhanced battery drainage because of the electric power forced to work 2 radio stations interfaces. In relation to facts rates, Wi-Fi could be the just technologies that may produce rates of up to 1000 Mb/s. Typically, consumers with cellphone communities require plenty of persistence to help get weighty multimedia systems records. Finally, femtocells can provide guaranteed QoS applying registered companies, whilst Wi-Fi can not. The existing system presents a quantitative study on the performance of 3G mobile data offloading through WiFi networks. The existing system recruited 97 iPhone users from metropolitan areas and collected statistics on their WiFi connectivity during a two-and-a-half-week period in February 2010. This trace-driven simulation using the acquired whole-day traces indicates that WiFi already offloads about 65% of the total mobile data traffic and saves 55% of battery power without using any delayed transmission. If data transfers can be delayed with some deadline until users enter a WiFi zone, substantial gains can be achieved only when the deadline is fairly larger than tens of minutes. With 100-s delays, the achievable gain is less than only 2%-3%, whereas with 1 h or longer deadlines, traffic and energy saving gains increase beyond 29% and 20%, respectively. These results are in contrast to the substantial gain (20%-33%) reported by the existing work even for 100-s delayed transmission using traces taken from transit buses or war-driving.

#### **Proposed Model:**

##### **A) Simulation model:**

A data request for upload (or download) arrives during typical active hours (9:00 24:00) to the phone of a user (or to an offloading server in a carrier's network) with a random inter arrival time and a random size selected from input distributions of a mean for inter arrival times and a mean for file sizes. We define *offloading efficiency* to be the total bytes transferred through WiFi divided by the total bytes generated.

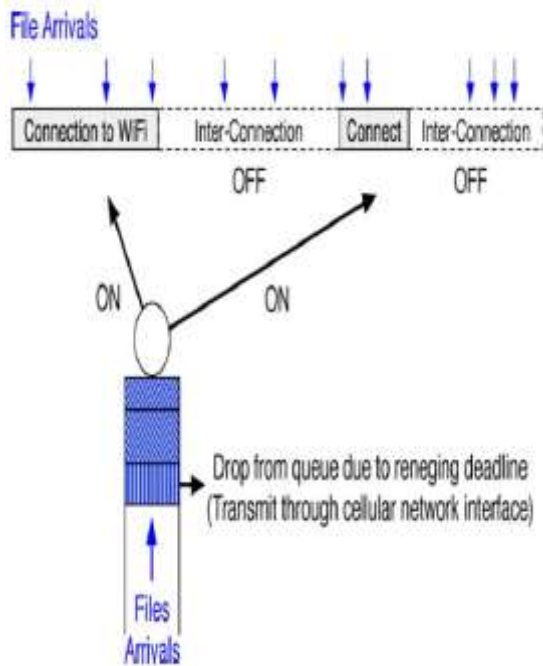


Figure 1: Simulation Setup

### B) Distribution Model:

The model-based simulation removes the necessity of detailed WiFi connectivity traces by abstracting the traces into closely matching distributions with few parameters. This method is helpful in predicting variation in offloading efficiency for the changes (e.g., additional deployment) in WiFi environment. Moreover, the framework referred to as a *queueing system with reneing and service interruptions*, models a user's data queue that switches the transmission interface between WiFi and cellular networks under a deadline. It provides a closed-form expression of offloading efficiency for some restricted cases. This theoretical framework is extremely helpful in predicting the offloading performance for diverse future WiFi deployments.

### C) Delay tolerant traffic

This technique exploits flexibility conjecture and prefetching to reinforce portable information offloading, which usually had been formerly suggested throughout. Flexibility conjecture gives information about the number of Wi-fi hotspots the node (vehicle) can come across, any time they'll be experienced, and for the length of time your node will be throughout just about every hotspot's selection. In addition to the aforementioned flexibility facts, most of us think that there is information on your predicted throughput in the Wi-fi hotspots as well as the portable network, in distinct opportunities along the vehicle's path; to the previous, the data incorporates both equally your throughput for moving information coming from a distant area, at the. grams., using an ADSL backhaul hyperlink, as well as the throughput for moving information coming from a community cache more than a Wi-fi hyperlink (this calculate is utilized solely in the case of prefetching). Prefetching might be advantageous in the event the throughput of moving information coming from a community cache in the Wi-fi hotspot is beyond your throughput from your data's original server area. This takes place in the event the backhaul hyperlink connecting your hotspot towards the World-wide-web offers reduced volume (e. grams., is usually an ADSL link) or maybe when it is busy; this is likely to be a little more widespread as the IEEE 802. 11n typical will become more widespread.

Pertaining to hold up understanding targeted visitors our own target is to maximize the amount of facts offloaded to be able to Wi-fi compatibility, although being sure that the main facts object will be shifted within a granted hold up threshold. The actual pseudo code for the treatment to be able to take advantage of mobility prediction as well as prefetching will be proven in Criteria 1. The method becomes your calculations as well as activities that the cellular node normally takes when this leaves the Wi-fi compatibility hotspot, hence provides simply cellular accessibility, then when this enters the Wi-fi compatibility hotspot. Initially, the procedure estimates the amount of facts that may be shifted over Wi-fi compatibility, as well as with this the amount of facts that needs to be shifted in the cellular multilevel.

Also, the procedure estimates the overall time period your node provides Wi-fi compatibility accessibility as well as, with this worth along with the holdup threshold, this estimates your length your node provides simply cellular accessibility. Via the amount of facts that needs to be shifted in the cellular multilevel along with the length involving mobile-only accessibility, your minimum throughput regarding transporting facts in the cellular multilevel may be projected. To perform prefetching, whenever your node leaves the Wi-fi compatibility hotspot the procedure estimates the amount of facts to get prefetched (cached) yearly Wi-fi compatibility hotspot along with the equivalent balance out; that balance out depends upon the amount of facts that is to be shifted in the cellular multilevel till the node actually reaches your next Wi-fi compatibility hotspot. When the node enters the Wi-fi compatibility hotspot, it may be lost many part of the information object approximately your balance out where facts continue to be cached inside the hotspot.

This can arise in case, because of a time period evaluation problem, your node actually reaches your Wi-fi compatibility hotspot sooner than time this acquired at first projected. However, your lost facts ought to be shifted through the facts object's initial distant area. Likewise, again because of a time period evaluation problem, the amount of facts cached inside the Wi-fi compatibility hotspot may be smaller sized as opposed to sum your node could have shifted whilst it is within your hotspot's variety. However, your node uses their remaining amount of time in your hotspot to be able to move facts through the facts object's initial area.

**Algorithm 1** Procedure to exploit mobility prediction and prefetching for delay tolerant traffic

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1: Variables:
2:  $D$ : size of data object to be transferred
3:  $T_{thres}$ : maximum delay threshold for transferring data object
4:  $N_{WiFi}$ : remaining WiFi hotspots to be encountered until  $T_{thres}$ 
5:  $D_{WiFi}^{min}$ : estimated minimum amount of data to be transferred in all WiFi hotspots that will be encountered
6:  $D_{mobile}$ : amount of data to be transferred over mobile network
7:  $T_{WiFi,i}^{min}, T_{WiFi,i}^{max}$ : min, max duration node is connected to WiFi  $i$ 
8:  $T_{mobile}$ : total duration that node is not in range of WiFi
9:  $T_{next WiFi}$ : average time until node enters range of next WiFi
10:  $R_{WiFi,i}^{min}, R_{WiFi,i}^{max}$ : min, max throughput of WiFi  $i$ 
11:  $R_{mobile}$ : throughput to download data over the mobile network
12:  $D_{WiFi, next}^{cache}$ : amount of data cached in next WiFi hotspot
13:  $Offset$ : estimated position in data object of data transferred until node enters next WiFi hotspot
14: Algorithm:
15: if node exits WiFi hotspot then
16:    $D_{WiFi}^{min} \leftarrow \sum_{i \in N_{WiFi}} (R_{WiFi,i}^{min} \cdot T_{WiFi,i}^{min})$ 
17:    $T_{WiFi}^{min} \leftarrow \sum_{i \in N_{WiFi}} T_{WiFi,i}^{min}$ 
18:    $D_{mobile} \leftarrow D - D_{WiFi}^{min}$  &  $T_{mobile} \leftarrow T_{thres} - T_{WiFi}^{min}$ 
19:    $R_{mobile} \leftarrow D_{mobile} / T_{mobile}$ 
20:    $D_{WiFi, next}^{cache} \leftarrow D_{WiFi, next}^{min} \cdot T_{WiFi, next}^{max}$ 
21:    $Offset \leftarrow R_{mobile} \cdot T_{next WiFi}$ 
22:   Cache  $D_{WiFi, next}^{cache}$  data in next WiFi starting from  $Offset$ 
23:   Transfer data over mobile network with throughput  $R_{mobile}$ 
24: else if node enters WiFi hotspot then
25:   Transfer data that has not been received up to  $Offset$  from original object location
26:   Transfer data from local cache
27:   Use remaining time in WiFi hotspot to transfer data from original object location
28: end if
    
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The procedure pertaining to taking advantage of ability to move prediction with no prefetching quotes the visitors expected to be transmitted above Wi-fi compatibility, along with eventually the volume of visitors to be transmitted within the cell phone multilevel plus the needed cell phone throughput.

**D) Delay Sensitive Traffic**

Comparable to hold off understanding visitors, once the cell phone node making a profit some sort of Wi-fi compatibility hotspot it quotes the balanced out along with the volume of information to be prefetched yearly Wi-fi compatibility hotspot which the node will certainly experience. Even so, as opposed to hold off understanding visitors, in order to lessen the exchange hold off pertaining to hold off delicate visitors, the node generally uses the utmost throughput that can be found from the cell phone multilevel. Furthermore, note that right now there We not any means of taking advantage of simply ability to move prediction (without prefetching) pertaining to hold off delicate visitors, because highest cell phone throughput is definitely applied.

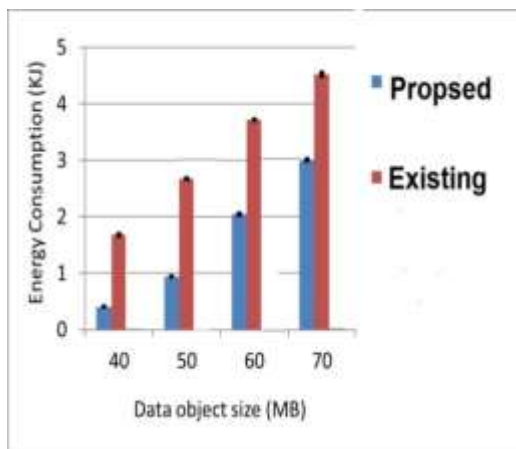
**Analysis:**

The analysis defines the efficiency of any system this system is tested for various efficiency and functionality aspects including

- Energy consumed
- Time taken to transfer
- Cost and capacity comparison

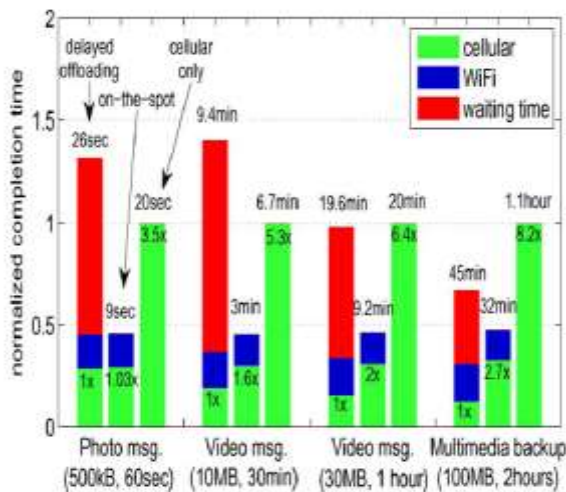
The existing in this section refers to the traditional 3G and broadband networks.

The first and foremost is the energy consumption the below figure represents the energy consumed by traditional transfer technique and the proposed off-loading technique as the size goes on increasing the proposed system works more efficiently.



**Figure 2: Energy Comparison**

The next aspect is to test the waiting time and the transfer times to do this we consider cellular networks and Wifi. The below figure clearly depicts that the proposed system outperforms the existing ones.



**Figure 3: Time Comparisons**

Now the final one is how much cost will be taken to construct the wifi technology and how much it differs from the traditional aspects. The below figure clearly depicts that the proposed Wifi-Offloading technique outperforms all the other techniques.



**Figure 4: Cost Vs Performance**

When it comes to network speed, Wi-Fi is the only wireless technology that can deliver data rates as high as 600Mbps. The following table provides a comparison of data rates and application level throughputs for Wi-Fi and mobile networks.

**Table 1: Network Speeds of Femtocell & Wi-Fi**

	Femtocell (HSPA)	Wi-Fi (802.11n)
Data Rates	14Mbps (3GPP release 5)	600Mbps
Throughputs	12Mbps	350Mbps
Modulation	OFDM	DSSS, and OFDM

**Conclusion:**

We've offered a wide analysis involving treatments that will exploit ability to move conjecture and also prefetching to be able to enrich portable files offloading, intended for both hold off understanding and also hold off vulnerable targeted visitors. Each of our analysis can be with regard to just how much involving offloaded targeted visitors, the results move hold off, as well as the strength consumption, and also displays the way the effectiveness is dependent upon several elements, including the files object dimension, the particular portable, Wifi, and also ADSL backhaul throughput, the amount of Wifi hotspots, as well as the robustness of the planned treatments to be able to occasion and also throughput opinion blunders.

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