# Review of Wi-Fi Offloads in LTE Network

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*Abstract*— Cellular networks are overloaded by mobile data traffic because of fast growth of mobile broadband services and the widespread use of smart phones. Application of smartphone, laptops internet etc. are increasing day by day. All this is causing congestion problem. Data revenue problem is a major problem for the network operators. One of the solutions to alleviate this problem is the offloading of mobile data traffic from the cellular access technology to the Wi-Fi access network. Wi-Fi access point is widely deployed by customers or by the operators so can be easily used for offloading technique. This paper reviews the models and architecture of offloading in between LTE network and Wi-Fi access network. Limitations of using Wi-Fi as alternative access network is also discussed in this paper and brief of ANDSF is provided in the paper.

***Keywords***: LTE, Access Selection, ANDSF, Wi-Fi Access Points, Offloading

## I. INTRODUCTION

Mobile communication technology has evolved rapidly in recent years, because of high data rate and QoS demands. Cellular network deployment is nearly ubiquitous. It provides a wide range of advanced services. It is predicted that the mobile data traffic will increase drastically over the coming years. Due to increasing subscriber populations, networks are constantly evolving to serve and satisfy the uses. Application of Smartphone, tablets, notebook and cellular mobile networks are rapidly increasing in large number and as a result, an exceptional demand has created for ubiquitous connectivity and quality of service. In survey report of Ericsson [1] it is assumed that by end of 2016 a laptop might generate about 10GB and a smartphone about 3 to 4GB. In figure 1 given by ericsson it is shown that data traffic in mobile network are excepted to double in year till 2016, in comparison to voice traffic.

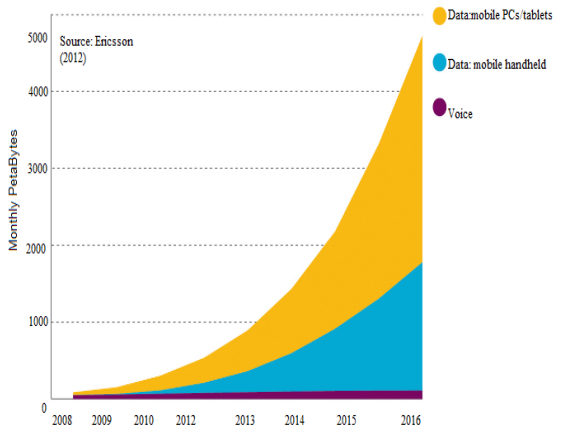


Fig. 1: Mobile traffic

This increasing in data traffic is contributing to the revenue growth for mobile operators when more and more consumers use data traffic generating devices such as advanced Smartphone's and PCs. In future for operators it will be a problematic situation to fulfill the overall demand of the consumers. For it they are searching for alternative solutions. Offloading can be one of the best situations in this case.

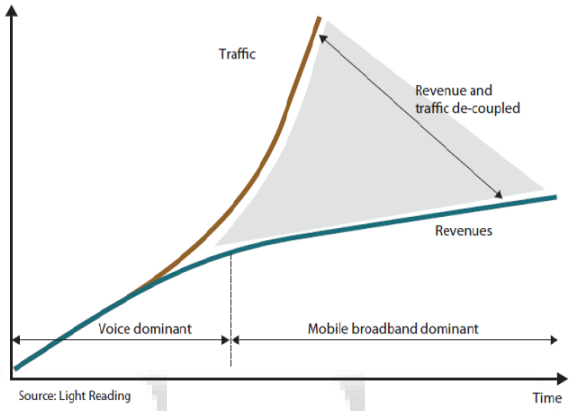


Fig. 2: Revenue Traffic Graph

## II. WI-FI OFFLOADING

Wi-Fi stands for wireless fidelity which is a local area wireless system. It provides a wireless connectivity solution (based on IEEE 802.11 standard). IEEE 802.11 is a set of media access control and physical layer specifications created and maintained by IEEE standard committee [2]. It also allows an electronics device in exchanging the data to internet by 2.4GHz (UHF band) and 5GHz (SHF band). Mobile data offloading is the use of alternative network technologies for delivering data originally targeted for cellular networks. Main complementary network technologies used for mobile data offloading are Wi-Fi and femtocell. It is predicted that in coming year's mobile data offloading will become a new industry segment due to the surge of mobile data traffic. Femtocell also called small cell is small, low-power cellular base station. It is designed for use in small areas. In this process it is connected to the operator by broadband network, and can supports two to four active mobile phones in the defined region. It also allows extending of service coverage indoors in case of limited availability. For operators, attractions to femtocell are improvements to coverage and capacity in indoors. It is an alternative way to deliver the benefits of fixed convergence. FMC architectures require a new handset (having dual mode) which can work with unlicensed spectrum [6]. Femtocell can work with existing handsets. For it, it requires installation of access point that can use licensed band. Wi-Fi offloading is just the offloading of 3G or 4G mobile users to Wi-Fi access network. Many times it is more cost-effective access method for mobile broadband

 

services. In it, since the subscribers and electronic devices tend to connect to Wi-Fi whenever available, here in this case mobile operators need to follow their subscribers in Wi-Fi surrounding [3].

*A. Advantages of Wi-Fi Offloading*

Most of the data traffic generated is static in nature so using Wi-Fi as alternative network provides both user and operator benefits. Since it a unlicensed spectrum it can be reused. Now, mostly all the smartsphone come with Wi-Fi supports or inbuilt Wi-Fi so in future it will be very easy and cost effective to integrate the cellular network and wireless access network. It provides good performance and sufficient level of Quality of service to the users and operators. It is a cost efficient way of offloading large amounts of data traffic. In Wi-Fi offloading process, automatic handoff form cellular network to wireless network occurs when a user is in Wi-Fi coverage and again handoff occur for Wi-Fi to cellular network when out of coverage.

3GPP consider Wi-Fi to be an important complimentary technology for delivering mobile broadband. It has specified different network architecture and methods to integrate Wi-Fi access networks into mobile networks [5].

*B. Disadvantage of Wi-Fi Offloading*

Wi-Fi has some limitations. In Wi-Fi offloading, the access points used are untrusted access points i.e. they are not owned by cellular service providers and so don't provides secure connection to EPC. Since it is an unlicensed spectrum, its transmitted power is limited and as result coverage is also limited. In it, another major problem that may occur is IP related i.e. IP address obtain for LTE network and Wi-Fi network may sometime can create problem in Wi-Fi offloading. Sometime existing APs don't provide a means to authenticate with core network using cellular network e.g. SIM (GSM), USIM (LTE) etc. It also doesn't facilitate a means to UE by which they can select an AP which can provide them connectivity to core network of their server provider.

Problem that may come in Wi-Fi offloading is that it does not support QoS (guaranteed bit rate and prioritization) for delay sensitive services. Whereas, Wi-Fi doesn't provides high speed mobility such as LTE [4].

## III. WI-FI OFFLOADING MODELS

*A. Model1: Wi-Fi Offloading Architecture*

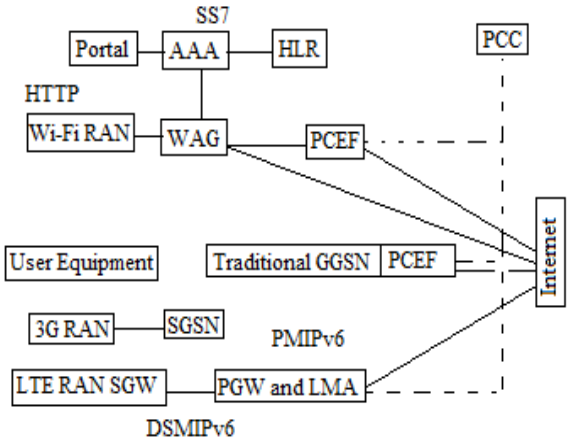


Fig.3: Architectural model

3GPP standard differentiates two different types of Wi-Fi access (commonly known as non-3GPP access) [7]:

- Untrusted : It was early part of the Wi-Fi specification in 3GPP Release 6 (in 2005). It includes those Wi-Fi accesses that don't have sufficient security system (i.e. authentication, encryption, etc.) or either not under control of network operator (like public open hotspot, subscriber's home WLAN, etc.).
- Trusted : It refers the operator build Wi-Fi access network having over air encryption and a sufficient secure authentication code system. It was part of LTE standard in 3GPP Release 8 (in 2008). In spite of designing on trusted model, 3GPP don't offer guidance for integration with 3G/2G packet core currently.

*B. Model2. System architecture for offloading*

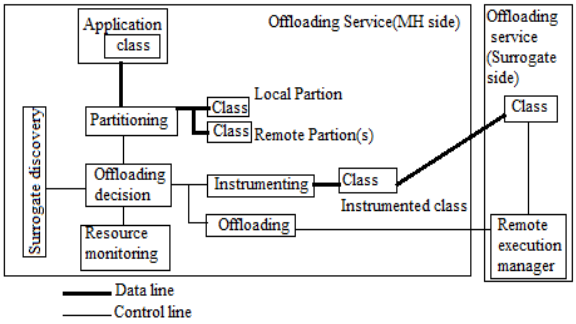


Fig. 4: System architecture

This is client-server system architecture used for the offloading [8]. In it

- MH side: On this side when a offloading request is received, either from end user by graphical user interface of the offloading service or from application concerned, resource information (like memory, CPU utilization, bandwidth etc.) are collected by resource monitoring modules.
- After this the offloading decision engine invokes the partitioning module. It causes partition of composing classes into one local execution and one or more remote execution partition(s). Now surrogate discovery module is invoked and simultaneously instrumenting module is also triggered. These classes are serialized and then they are migrated to other surrogates.
- In last, classes are de-serialized and resume their execution in a remote execution environment.

## IV. ANDSF

ANDSF stands for access network discovery and selection function. It is an entity within an evolved packet core of a system architecture evolution (for 3GPP compliant mobile networks). Its purpose is to assist UE for discovering non-3GPP access networks (like Wi-Fi/WiMAX), so that it can be used for data communications in addition to the 3GPP access networks (like HSPA/LTE). It also provides the UE with rules policing the connection of the access networks through the S14 interface. An ANDSF can provide the following information to a UE, based on operator configuration:-

- **Intersystem mobility policy (ISMP):** Information of inter-system mobility policies and access network specific data is provided by ANDSF, to

 

assist mobile node by performing the inter-system handover decision. It provides network selections rules for a UE with no more than one active access network connection. This means that, the UE uses the inter-system mobility policy when it can route IP traffic only on a single radio access interface at a particular time. It is able to transmit handover indications for handover execution which results in immediate handover triggering process. Also, ANDSF can provide handover optimization when it has information of the source and target access networks for the UE. This optimization will reduces time it takes to complete the critical handover function.

- **Intersystem routing policy (ISRP):** It provides network selection rules for a UE with potentially more than one active access network connection (e.g., both LTE and Wi-Fi). UE uses intersystem routing policies in case it has to route IP traffic simultaneously over many active access network connection. For this, UE may employ IP Flow Mobility, Multiple Access PDN Connectivity in order to meet the operator routing or data traffic offloads. Order of preference is:-

(1) Deciding when an access network is restricted for a specific IP traffic flow and/or a specific APN.
(2) Selecting the most preferable access networks and/or APNs that will be used by the UE when available to route IP traffic that matches specific criteria.

- **Discovery information:** It provides a list of networks that may be available in the vicinity of the UE and information assisting the UE to expedite the connection to these networks. Upon request, the ANDSF transmits a list of access networks available in the neighborhood to the UE along with the information of about available access networks which is based on area or location of data. For example, to check on radio interface including access technology type (WLAN or WiMAX), access network identifier, Network ID is used in case of WiMAX and incase of the 3GPP access technologies Tracking Area or PLMN or Cell Identities are used. In addition to this, validity conditions i.e. conditions indicating when the provided access network discovery information, when the UE made the selection and when an UE connects to a new access network, all these information, the network should be able to inform ANDSF.

## V. Conclusion

Wi-Fi offloading offers a suitable solution to the increasing mobile internet data demand. It can alleviate congestion from operator's network. And at same time can provide them with new business opportunities by adopting different offloading strategies. The different offloading models proposed, helps in decreasing the traffic congestion on LTE/cellular network. This helps the operators to decrease their gap between the revenue and the demand or requirement of the consumers for cellular traffic. Thus use of Wi-Fi as alternative access network i.e. for offloading purpose from LTE/cellular network is increasing and the industry is paying more importance on it since it is cost effective also. Offloading models for LTE network on Wi-Fi proposed till now have their own limitations. The models proposed are based on certain assumption and specific condition.

## VI. Future work

Mobile data offloading is a new industry segment due to the surge of mobile data traffic. In future, revenue problem will be a big problem for mobile industry. So efficient and feasible models should be designed and implemented so that the performance of Wi-Fi is up to mark and can provide sufficient level of quality of services. Presently the offloading models proposed are condition specific i.e. have many predefined assumption like mostly the techniques and models proposed are for static data i.e. mobility issues are not considered. So for better results and real life feasibility we have to consider all the parameters at the same time which can effects the Offloading process.

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