An Improved Data Offloading Framework for Effective Mobile Data Offloading in Campus Network

Lateef Ahmad Bhat
Research scholar, ECE,
Surya World, India

Pallavi Chandel
Assistant professor, ECE,
Surya World, India

Abstract: Data offloading is a technique to transfer data between different networks like mobile network to WiFi networks. WiFi or Wi-Max networks are very fast and require no spectrum fees to implement them. Whereas Mobile networks require the spectrum reservations which are highly costly and heavily affect the service charges offered by the cellular service providers. In our proposed scenario, we are using controlled data transfer mechanism to offload data between mobile network and campus wireless network to facilitate the calling facility in the campus for the smart-phone users using Wireless network in the campus.

Keywords: Data offloading, MESHNET, Mobile data offloading, WiFi, WiMAX.

I.   INTRODUCTION

Later mobiles phones were only able to connect through cellular networks, hence were able to transfer data through cellular networks only. The evolution in the handset technology has taken mobile networks to an all new level, where they are very much capable of running multiple tasks and multi-tasking. The new mobile phones are capable of communicating through cellular networks using SIM cards. The new mobile handsets are also capable of communicating through Wireless (Wi-Fi), Bluetooth or RF interfaces. The researchers have found all new ways of efficiently using the data networks in combinative form to create heterogeneous networks. The researchers have developed the method to inter-connect Wi-Fi networks and mobile networks for the cellular data offloading. Cellular data offloading is the method to transfer the cellular calls over Wireless networks, which facilitates an efficient use of wireless network resources.

Figure 1.1: The difference of Speeds and Licensing norms between mobile networks and wireless networks

From a scientific point of view where the progress has been phenomenal in terms of market penetration as well as global impact on society, the world of wireless communications is one of the biggest engineering success remarks of the last many decades. From the first experiments with radio communication by Guglielmo Marconi1 in the 1890s, the road to truly mobile radio communication has been quite long. As we know, the first generation (1G) mobile radio systems based on analog transmission for speech services was introduced in the early 1980s. To understand the complex 3G mobile-communication systems of today, it is also important to understand where they came from and how cellular systems have evolved from an expensive technology for a few selected individuals to today's global mobile-communication systems used by almost half of the world's population. Developing mobile technologies has also changed, from being a national or regional concern, to becoming a very complex task undertaken by global standards developing organizations such as the 3GPP (3rd Generation Partnership Project) and involving thousands of people.
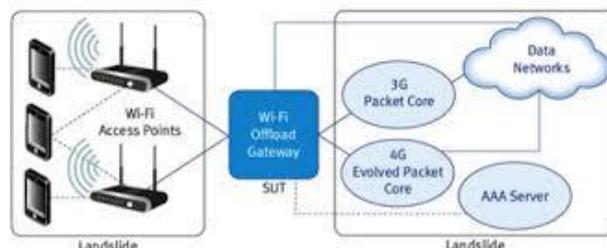

Figure 1.2: Toggle data between Wi-Fi networks and Mobile networks

Mobile communication technology evolved rapidly due to the increasing demands for higher data rates and higher quality mobile communication services and much has been written on the mobile network operator's need to address the increasing demand for data services especially for Smart phones users. New generation of Smartphones like iPhones, BlackBerry, Android and Windows Mobile can work together with 2G/3G/4G enabled mobile networks and wireless networks for the Internet Access like laptops and netbooks are bringing Internet experience. The amount of mobile data traffic communicated over cellular networks is growing exponentially which is a great opportunity and a big challenge for the mobile communications industry. Mobile use of many popular social networking services is opening the door for millions of Terabytes to enter into the mobile networks (as it is explained in the next sections of this chapter). 2G/3G/4G mobile networks are currently overloaded, due to the increasing popularity of various applications for Smart phones. As a result of this, mobile network operators are much concerned about the revenues.

In this research work, the main focus is addressing how to overcome the mobile network congestion by offloading a portion of mobile data traffic to complementary wireless access networks using WiFi. By data offloading, we mean the use of complementary network technologies for delivering data, originally targeted for transmission over cellular networks, in order to save money and relieve the mobile telephony network. WiFi offloading leverages the fact that most laptops and Smartphones have embedded capability for wireless communication using the IEEE 802.11 standards. As we can see it from the next sections of this chapter, mobile data offloading is forecasted to double in the next five years, according to a recent study from research industries.

II. LITERATURE SURVEY

Subramanian Vasudevan et. al. proposed Enabling Data Offload and Proximity Services Using Device to Device Communication over Licensed Cellular Spectrum with Infrastructure Control mechanism. The authors have proposed an all new scheduling problem based on 3G networks. Petros S. Bithas et. al. have developed Hybrid Cellular/WLAN with Wireless Offloading: Enabling Next Generation Wireless Networks solution. The authors have used frequency reuse technique to take on the problem of wireless offloading. M.H. Qutqut, F.M. Al-Turjman, and H.S. Hassansein have worked on MFW: Mobile femtocells utilizing WiFI: A data offloading framework for cellular networks using mobile femtocells. The authors have proposed a data offloading framework (MFW) to exploit WiFi networks and femtocells. Lu Xiaofeng et. al. proposed offloading mobile data from cellular networks through peer-to-peer Wi-Fi Communication based subscribe-and-end architecture. Authors have developed a subscript & send architecture to take on the data offloading mobile data. Mi. Jeong Yang have proposed Solving the data overload: Device-to-device bearer control architecture for cellular data offloading. In this research, the authors have explained a number of aspects related to the cellular data offloading. Authors have developed a hybrid solution using 3GPP network combined with Local IP addressing scheme to offload selective data. Han, Bo, Pan Hui, and Aravind Srinivasan have proposed Mobile data offloading in metropolitan area networks. Thomas, Giles, et al. have introduced wave-induced motions of gas cat: A novel catamaran for gas processing and offloading.

III. EXPERIMENTAL DESIGN

The proposed model will be using the mobile data offloading between the cellular and Wi-Fi networks. The proposed technique will use intelligent data controllers (IDC) inside the Wi-Fi networks instead of the mobFBS used in the previous research work. The intelligent data controller will be capable of handling the sessions between the cellular and Wi-Fi networks, facilitate the smooth data sharing, higher data transfer rate, etc. Prominently, it will be capable of differentiating between the data type and data source and destination locations, which will make it feasible to transfer the data between two IDCs over the internet. This will reduce the load from the cellular networks in the real time. The IDCs will be controlled by the BTS in the cellular network (also called macro BTS or central BTS). The IDCs will take the source and destination information and the permission to transfer data directly to other Wi-Fi networks using internet connections from the BTS only.

The proposed project has been developed using network simulator 2. The mobile data offloading has been shown performing in the simulation. The mobile data offloading is the technique to send and receive the data between other types of network to facilitate the mobile network coverage, increased speed and to utilize the resourced effectively. The mobile data offloading may be used or configured to increase the speed of the data transfers, for example, offloading mobile data in wi-fi or wi-max environments. In order to increase the coverage and transmission/internet speed of mobile/cellular networks, they can be used in a hybrid mode along with Wi-Fi by using the mobile data offloading technique into wifi or wimax environments. There are two types of mobile data handling and routing exists in the wifi/wimax network clusters. First, it is based upon the active routing and connectivity using the mobile or user nodes in the network segment, whereas the second variant is more manageable, quick and reliable. The second mode is based upon the routing and data transmissions through access points in the Wi-Fi environments. Our technique is specifically proposed for the educational campuses with Wi-Fi or Wi-Max enabled. The access points need to be able to run and forward the intercommunication or other messages to one another by finding the accurate routes.

Therefore, the smart phones need to be connected to the Access Points in their area/cell/cluster. A MANET handles multi-hop data transfer between nodes using the BTSes, also called Sink, which can be either an AP or other types of HOTSPOT. In our proof of concept or implementation simulation, we have used network simulation to prepare the simulation. The simulation consists of two types of network, one running over AODV and connected through wireless. Other, running over an effective and wired network. The mobile user's are simulation as the users with the smart phones

as ending point of an end-to-end connection through the AP. We provide smartphone-to-BTS-to-smartphone real-time data transfer or phone calls, at several hops of distance through the Wi-Fi network. Current MANET protocols are not proven to be ready to handle high mobility or dense networks as reviewed in Chapter 4. The goal of this chapter is to give an insight into the design of a new MANET technique, which we call "Mobile Assisted Ad-hoc Networking" (MASS-ANET). MASS-ANET is based on the assumption that, in addition to a short range radio link, the nodes in the network have a global link.

IV. RESULT ANALYSIS

The proposed model has been implemented in the NS-2 simulator using a scenario of 15 wireless nodes. All of the nodes are having a transmission radius of 250 meters. The nodes are divided into two types of wireless network clusters. The nodes in the mobile network cluster are represented in the black colour. The mobile network cluster is representing the communications between the mobile network users and BTSes. The mobile network cluster is made of total 9 nodes. Node IDs ranging between 0 and 8 are the 9 number of nodes members of the mobile network part of the proposed model simulation. The other cluster is Wi-Fi cluster or campus cluster. The campus cluster is made of 6 nodes ranging between 9 and 14. The mobile cluster is using the traffic speeds ranging between 10 Kbps and 100 Kbps whereas the Wi-Fi cluster (Campus Cluster) is using the traffic speeds ranging between 1 Mbps and 10 Mbps. The mobile nodes are using AODV based mobile communications. The mobile communications offer the long range connectivity to facilitate the inter-nodal calling and internet connectivity between the mobile network users.
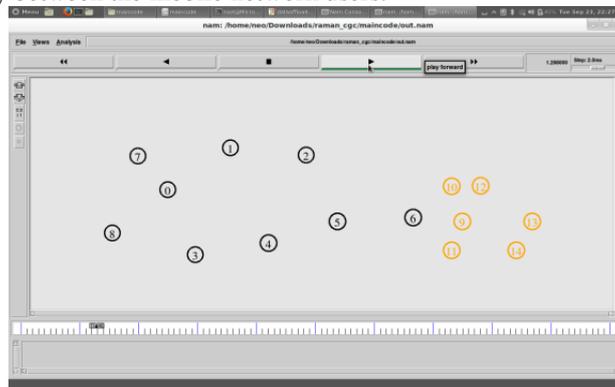

Figure 5.1: The mobile data offloading scenario in the proposed system.

The mobile networks offer lower speeds when compared to the Wi-Fi or Wi-Max networks. The mobile networks can be divided into three major categories on the basis of generations on the basis of current mobile technological trends in India. The Indian mobile companies offer 2G, 3G and 4G services to its users. The 2G service is having the highest number of mobile users when compared to the other two. The 2G services are the least expensive and equipped with lowest speeds. The 3G and 4G technologies are considered fast but these technologies lack in the performance when compared to the Wi-Fi networks. Also 3G and 4G network services are expensive (sometimes very expensive) than 2G networks in the terms of calling charges, data charges and other services offered by the mobile operators in the country.
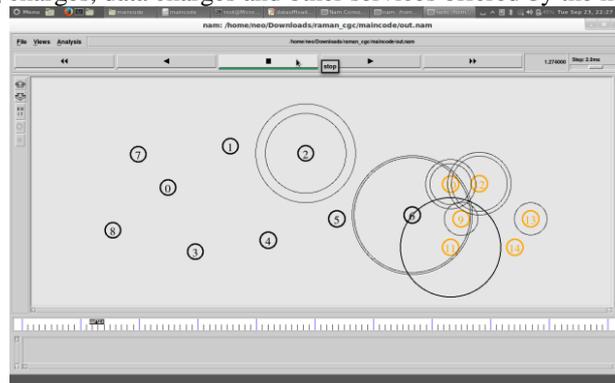

Figure 5.2: Occurrence of communications in the mobile data offloading scenario simulated in the Network Simulator 2

The 2G networks are offering the cheapest services than the other two contenders which is reason behind its popularity. The mobile users using 2G services on smart phones face the slower internet speeds, connection lost, performance lags and many other draw backs while compared to other two networks. The 3G and 4G networks are available in the prime and selected cities in the country which makes it unavailable in the larger part of the country. The larger part of the country has been covered with 2G network services only. A higher number of educational campuses fall in the countryside areas around the cities. Most of the large sized educational campuses do not come under the coverage of 3G or 3G networks. Also the setup costs of these (3G and 4G networks) are quite higher, which prevents the mobile operator initiatives to faciliatet these services in the areas with the lower user density.
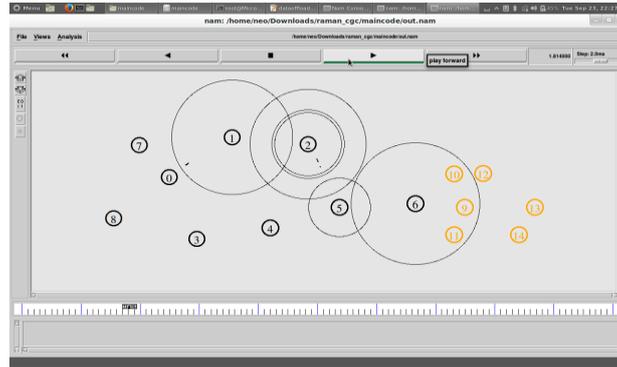
Figure 5.3: A call in progress in the proposed model simulation

There is a possibility of providing the higher speeds to the mobile network users in the educational campuses by using the novel method of mobile data offloading. The mobile data offloading the term used to represent the hybrid network created by combining the mobile network with other high speed form of network like Wi-Fi or Wi-Max. The mobile data offloading technique requires a special form of setup which includes the fusion of the networks on the demarcation point between the two networks and the mobile applications to access the mobile services from the Wi-Fi or Wi-Max services. The users may have to register themselves with the mobile network controlled application server installed in the Wi-Fi networks. The applications installed on the user's smart phones setup the connection with the mobile networks once the registration process is finished. The users can access high speed internet through the Wi-Fi connection merged with the mobile networks using the mobile data offloading techniques.

The proposed model has been well tested under various situations in the mobile network simulation. The hybrid mobile data offloading network has been well tested for the performance parameters of delay, throughput, drop rate and network load. The nodes in the proposed model simulation have performed well in terms of all of the above parameters. The network load, throughput, data drop rate and throughput has been recorded lesser than the ordinary mobile networks under the similar situations.

The maximum delay recorded in the simulation is ranging between 0 and 12 milliseconds. (Figure 5.4) The delay is the parameter represents latency of a packet when it was being sent between two nodes. The time taken for a packet to reach the destination from the source is called the total delay. The throughput (Figure 5.5) is the parameter represents the capacity of a node or a network to send the data per second.
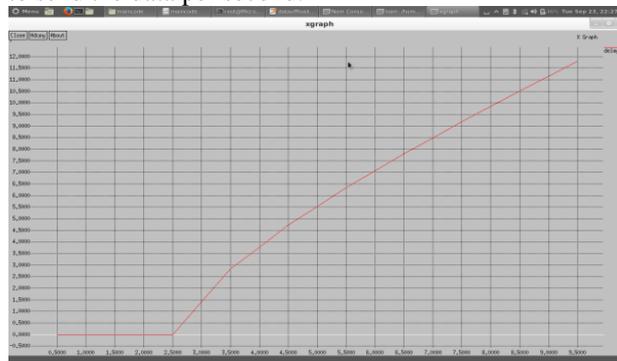

Figure 5.4: The graph of delay in mobile data offloading simulation
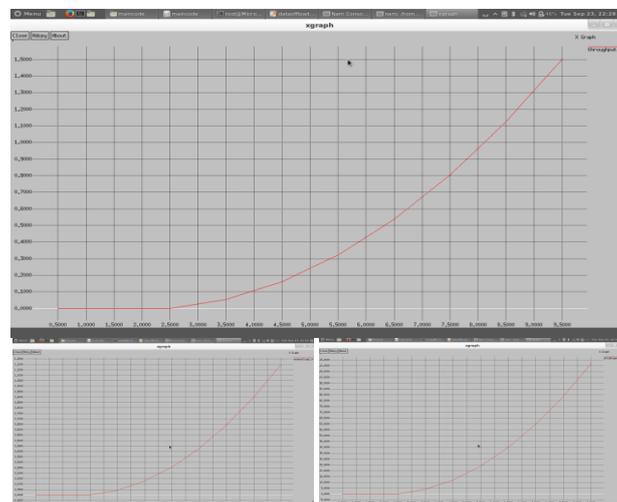

Figure 5.5: The graph of throughput, network load and packets dropped in mobile data offloading simulation

The throughput of the hybrid network has been recorded between 0 and 1.5 Gbps. The 0 gpbs is the value recorded when no data is being sent between the nodes in the initial stages. Once the data transfers start, the throughput starts going up. The maximum limit of the throughput is 1.5 Gbps.

The network load and packet drop rate has been also recorded on the lower limits as compared to the ordinary cellular network performances. The network load has been recorded as maximum as 1200 bits, whereas the packets drop rate has been recorded at maximum rate of 14 packets per stream.

V. COMPARATIVE ANALYSIS

The performance of the proposed model has been compared to the performance of the existing system based upon the opportunistic communication based mobile data offloading approach designed for social participation. The results have been compared on the basis of traffic load over cellular networks during the offloading and non-offloading periods. The testing has been performed on the basis of variable length simulation time programmed to produce the results in the similar parameters.
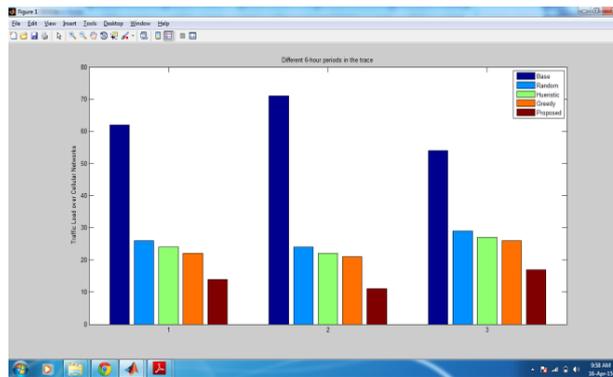

Figure: The comparative analysis of the proposed scheme with existing scheme based upon opportunistic offloading approach.

VI. CONCLUSION

The proposed model has been tested with many real-time situations in order to understand and know its effectiveness. The proposed model has been proved to be effective than the existing models in terms of load, delay and throughput. The simulation scenario has been tested under the varying amount of data traffic flowing between the two networks. The proposed mode is more crash proof than the existing systems which lowers the chances of system failure than the existing mobile data offloading systems. The proposed model has been recorded with minimum delay and higher throughput which makes it effective in terms of performance than the existing mobile data offloading systems.

In the future the proposed model can be enhanced to work more efficiently. The proposed model can be embedded with some effective load balance algorithm for route path optimization.

REFERENCES

[1] Petros S. Bithas et. al., "Hybrid Cellular/WLAN with Wireless Offloading: Enabling Next Generation Wireless Networks", IJSAC, vol. 1, pp. 1-29, IEEE, 2013.
[2] Mi. Jeong Yang, Soon Yong Lim, Hyeong Jun Park, Nam Hoon Park, "Solving the data overload: Device-to-device bearer control architecture for cellular data offloading", IVTM, vol. 8, issue 8, pp. 31-39, IEEE, 2013.
[3] M.H. Qutqut, F.M. Al-Turjman, H.S. Hassanein, "MFW: Mobile femtocells utilizing WiFI: A data offloading framework for cellular networks using mobile femtocells", ICC, vol. 1, pp. 6427-6431, IEEE, 2013.
[4] Lu Xiaofeng, Hui Pan, P. Lio, "Offloading mobile data from cellular networks through peer-to-peer Wi-Fi Communication: A subscribe-and-end architecture.
[5] Subramanian Vasudevan, Kathiravetpillai Sivanesan, Satish Kanugovi and Jialin Zou, "Enabling Data Offload and Proximity Services Using Device to Device Communication over Licensed Cellular Spectrum with Infrastructure Control", VTC Fall, vol. 78, pp. 1-7, IEEE, 2013.
[6] Han, Bo, Pan Hui, and Aravind Srinivasan. "Mobile data offloading in metropolitan area networks." *ACM SIGMOBILE Mobile Computing and Communications Review* 14.4, pp. 28-30, 2011.
[7] Thomas, Giles, et al. "Wave-induced motions of gas cat: A novel catamaran for gas processing and offloading." *ASME 2009 28th International Conference on Ocean, Offshore and Arctic Engineering*. American Society of Mechanical Engineers, 2009.
[8] Han, Bo, et al. "Mobile data offloading through opportunistic communications and social participation." *Mobile Computing, IEEE Transactions on* 11.5, pp. 821-834, IEEE, 2012.
[9] Wi-Fi Alliance. Wi-Fi certified^{TM} n: Longer-range, faster-throughput, multimedia-grade Wi-Fi networks. Sept 2009.
[10] OLSRD an adhoc wireless mesh routing daemon. Getting ad-hoc mode on android. http://www.olsr.org/?q=olsr on android.

[11] A.Neumann, C.Aichele, and M.Linder. Better Approach To Mobile Ad-hoc Networking (B.A.T.M.A.N.). IETF Draft, Oct 2008.

[12] B.Das and V.Bharghavan. Routing in ad-hoc networks using minimum con- nected dominating sets. In IEEE International Conference on Communica- tions, volume 1 of ICC '97, pages 376–380, Jun 1997.

[13] C.Bettstetter, G.Resta, and P.Santi. The node distribution of the random waypoint mobility model for wireless ad hoc networks. In IEEE Transactions on Mobile Computing, volume 2, pages 257–269, Jul 2003.

[14] C.E.Perkins and E.M.Royer. Ad-hoc on-demand distance vector routing. In Proceedings of the Second IEEE Workshop on Mobile Computer Systems and Applications, WMCSA '99, pages 90–100, New Orleans, LA, Feb 1999. IEEE Computer Society.

[15] Cisco. Cisco visual networking index: Global mobile data traffic forecast update, 2010-2015. 2011.

[16] D.B.Johnson and D.A.Maltz. Dynamic source routing in ad hoc wireless net- works. In Mobile Computing, pages 153–181, 1996.

[17] DiscussTech.org. Difference between 2G and 3G. http://discusstech.org/2011/07/difference-between-2g-and-3g/, July 2011.

[18] D.Murray, M.W.Dixon, and T.Koziniec. An experimental comparison of rout- ing protocols in multi hop ad hoc networks. In Australasian Telecommuni- cation Networks and Applications Conference, ATNAC '10, pages 159–164. Auckland, New Zealand, Nov 2010.

[19] D.Zhou, M.T.Sun, and T.H.Lai. A timer-based protocol for connected dom- inating set construction in ieee 802.11 multihop mobile ad hoc networks. In Proceedings of the International Symposium on Applications and the Internet, SAINT '05, pages 2–8. IEEE Computer Society, Jan 2005.

[20] E.Kranakis, H.Singh, and J.Urrutia. Compass routing on geometric networks. In 11th Canadian Conference on Computational Geometry, CCCG '90, pages 51–54, Aug 1999.