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Effect of Changes in Implementation of LTE-U Application in UDP and TCP/IP Protocol

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Abstract: The demand of internet is rising in exponential manner and it will increase more as advent of internet of things. With respect to demand the cost of running services will become high. So as to decrease the operational cost and traffic among different subscribers, the sharing will be a last option in order to reduce traffic and demand. In this paper there is sharing of LTE bands with Wi-Fi in order to reduce the traffic and increase the throughput of system. All the calculation are undergo through ns3 simulator. This paper also brings out the application of LTE bands using unlicensed with Wi-Fi bands by implementing it as FTP model in TCP model. The quantity and quality of licensed and unlicensed network differ from each other in an abnormal way. The demand of future is to use fast and safe internet in a cheap way. For this, various industries are trying to adapt LTE-U so that cheap and highly access Internet will be provided to users. This paper involves the application of LTE-U with Wi-Fi and analyzes the effects on UDP and TCP protocols.

Keywords: LTE-U, FTP, SDL, Unlicensed Spectrum, UDP, TCP.

I. INTRODUCTION

In today scenario, the usage of internet has increased in a random order. In future the world will face the scarcity, as there is limited use of licensed spectrum. The usage of LTE in unlicensed spectrum will speed up the data rate. The throughput of system will increase a lot. The only disadvantage is the cochannel interference of LTE network in Wi-Fi system, more energy consumption in wireless networks. To reduce these, certain algorithms has to be put in order to decrease complexity of the system. With the increase in use of wireless applications, there will be effect on quality of services. To achieve the growing data demand, the use of unlicensed spectrum will increase the opportunities of telecom companies. The usage of LTE in unlicensed spectrum has proposed by Qualcomm Technologies. This technology allows users to use both technologies for achieving highly generated network having less congestion. It will be possible only by usage of small cell base station, transmitting the signal orthogonally in a multiple access.
With the many advantages of using LTE in unlicensed spectrum, there are certain challenges to be modified before using it. First is, the usage of LTE system in unlicensed mode will deal with current Wi-Fi subscribers. Second is, limitation of power usage to both network. As we know the impact of LTE network is very high in comparison to other radio access technology, the power consumption will be more in case of LTE radio access technology. Thirdly is, the collision of packets transmitted by both LTE and Wi-Fi in unlicensed spectrum. Lastly, the main issue is of throughput of both network will be affected in unlicensed spectrum. To resolve these problems the system should analysis the process of transmission according to both radio access technologies. From this both technologies can travel and share the same path. This will increase the steadiness of the system. To overcome the effects, we should know the procedure of transmitting the network in unlicensed spectrum.

1.1 **Size of the cell:** There are various types of cell used for communication between two or multi users. It acts like a medium over which signal wraps and transmit. In early days the use of cell was designed in a manner that, more cell size, more signal will transmit. The concept of frequency reuse compactly reduces the need of large cell size. Today we use different small cells which are used in different applications. For example, femto cell whose range is 10m, pico cell whose range is less than 200m., Microcell whose range is less than 2km.

1.2 **Channel selection:** The knowledge of channel selection while transmitting a signal especially in a unlicensed spectrum should be there. If we know where and how to transmit a signal in a clean channel, there will be less congestion in a network. There are three channel granted by Unlicenced National Information Infrastructure that can be used in used in unlicensed spectrum. These are:

1. U-NII-1: It can be used for band number 252 (5150-5250 MHz).
2. U-NII-2: It can be used for band number 253-254, (5250-5275 MHz) but reserved for specific use.
3. U-NII-3: It can be used for band number 255, (5725-5850 MHz).

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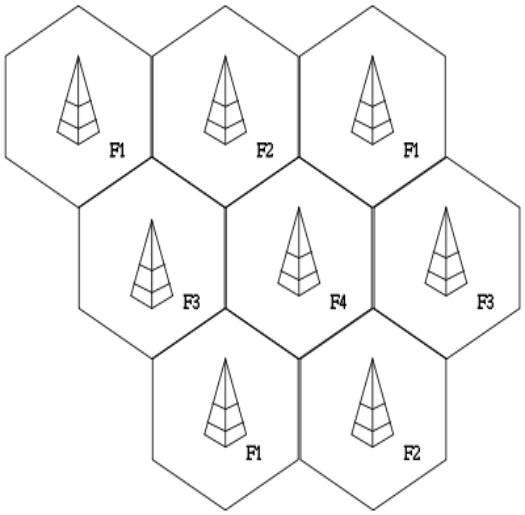

Figure 1 frequency reuse

If we a proper and clean channel, we can transmit the channel without the packet losses. When we talk about the transmission of LTE signal in unlicensed spectrum, there will be chances of collision between Wi-Fi and LTE signals. So if want to transmit the signals in unlicensed band there will be some process which will enhance to transmit both signals simultaneously. First is transmit on the basis of TDD manner means there is some channel occupancy time allotted to both networks to transmit the signal. Secondly is, the transmission on the basis of FDD basis where both network get their different channel zone. This term will weaken the whole network as channel distribution will change the path of both signals.

1.3 **Modulation Process:** As we know, different versions of Wi-Fi use QPSK, 64QAM, OFDM modulation technique to transmit the signal, whereas LTE network uses OFDM as downlink mode and SC-FDMA as uplink mode to transmit the signal. There is a lot of differences in transmitting parameters and range of transmission of both networks. So, the approach of both signals is to achieve high quality signal at low data rates. This is only possible when there is little interference and the correct usage of least congested channel.

II. TRANSMISSION TECHNIQUES IN LTE-U

There are different techniques to transmit the LTE signal and Wi-Fi signal. These are supplementary Downlink, Carrier Aggregation- time division LTE, standalone LTE-U.

2.1 **Supplementary Downlink:** This method was proposed by Qualcomm to increase network's downlink capacity. Mainly , this is a way to increase the system throughput by using unlicensed spectrum as extra unused carrier are mixed with used downlink & uplink carriers. In this case when the downlink traffic of the small cell exceeds a certain threshold and sharing of network is there then SDL can be turned on for offloading. It decreases the interference from continuous radio signal transmission from LTE-U in unlicensed channel. It results in interference reduction as both signal sharing a same channel.

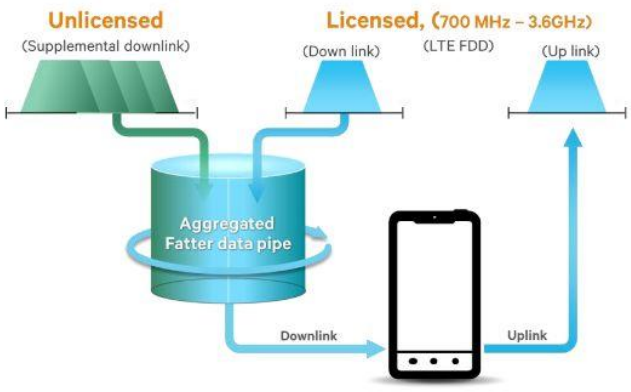

Figure 2.1 SDL mode unlicensed mode is combined with only downlink

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2.2 **Carrier aggregation:** In carrier aggregation, the unlicensed spectrum is used as reserved TD-LTE mode. In this, we can keep as extra to both downlink and uplink traffic. It is the most important technology in LTE-Advanced which combines multiple radio frequency bands in a network to increase the data rates, network capacity and user throughput. In this, licensed spectrum is used in case of primary cell to give a robust connection to control the signal flow. In case of secondary cell, unlicensed spectrum is used to support the efforts done by user data to increase system performance.

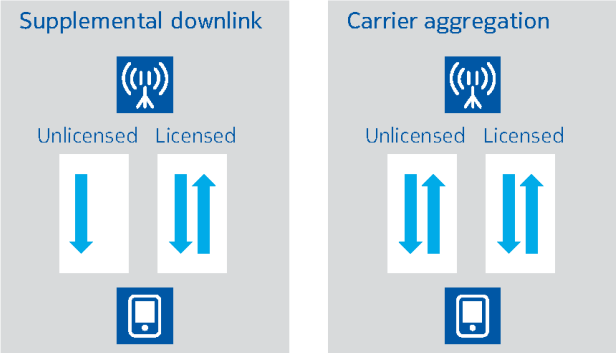

Figure 2.2 SDL mode and Carrier Aggregation modes

2.3 **Standalone LTE-U:** In this mode, both data and control signals are transmitted on unlicensed spectrum.. This case of transmission gives effective transmission as there is no need of relying the signal on licensed or unlicensed spectrum. this mode is a smoothest form of transmission technique but it also lack of smart controlling of signal transmission. It is used for those areas having high congestion areas with low signal strength. A wireless unified network allows operators to mix indoor/outdoor environments.

III. COLLISION AVOIDANCE PROTOCOLS

With the help of some protocols, the coexistence of Wi-Fi and LTE in unlicensed spectrum is possible.

3.1 **Listen Before Talk (LBT):** In case of countries having the need of listen before talk. It enables the sensing period of weak signal. As we know, the strength of transmission and penetration of LTE signal is more than Wi-Fi signal. So LTE signal will show its effect in same band with Wi-Fi. This will led to interference in a channel. To resolve this "listen before talk" method is introduced to reduce the co-channel interference among different users. In this Wi-Fi will be at listen mode till LTE signal is transmitting its signal. As LTE signal completes its transmission, Wi-Fi signal will start its transmission. It means one signal will be at listen mode and other one will carry its transmission process.

3.2 **Carrier Sensing Adaptive Transmission (CSAT):** As name implies, both the signals will sense the clean carrier while transmission their channel. In this method the duty cycle is allotted to each of the signal for transmission. It operates in TDM-fashion in which there is less chances of interference between two signals. In this, when LTE-U is in on state, Wi-Fi is in off state and when Wi-Fi is in on state, LTE will be in off state. According to LTE-U, small cell detects the performance on channel. If these small cells find the free unlicensed channel, they can carry their transmission. If it is not, then CSAT will provide them a least congested channel and thus preserve the time for transmission.

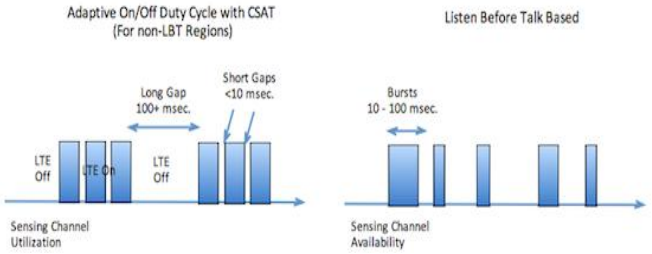

Figure 3.1 CSAT vs LBT

3.3 **Almost Blank Subframe (ABS) :** This algorithm will give surely a success to coexistence of Wi-Fi and LTE in unlicensed spectrum. This will not only provide the blank subframe to LTE user but also eliminates the interference

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between both signals. As we know, the data rate of LTE is too fast, so the packets involved in transmission lost due to its transmissions. It creates a confusion to Wi-Fi and it stops its transmission. Once it receives acknowledgement from LTE, it start its transmission. This will led to pure channel access to both users of Wi-Fi and LTE.

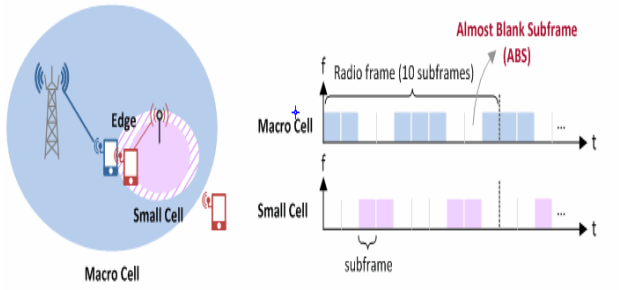

Figure 3.2 Almost Blank Frame Subframe allocation

3.4. Modified Listen Before Talk method: From the adaptation of Listen Before Talk method, it changes in the usage of LTE-U signal. This will increase the system throughput of system. As we know impact of LTE-U signal w.r.t. Wi-Fi. But at same time in case of LBT LTE-U uses fixed time domain. In this new method, user first listens to a channel before transmission. If a channel is free, the user will get frame block and then start the transmission in F_B. In this, user will not go backoff when a channel is busy. It will continuously listen a channel until a channel become idle and once channel becomes idle the user will take the frame block and start its transmission.

IV. IMPLEMENTATION OF LTE-U NETWORK WITH WI-FI COEXISTENCE ON UDP AND TCP/IP PROTOCOL

We have studied the coexistence parameters related to coexistence of Wi-Fi and LTE coexistence in a unlicensed spectrum. In this, we will study the models or protocols which will show the effect of LAA channel with Wi-Fi. For this we have taken a FTP model for a reference for it. As we know UDP is User Datagram Protocol. This protocol has no impact on connection of two or more users. Its system throughput will vary according to the network quality transmitted by system, whereas TCP/IP is a Transmission Control Protocol/Internet Protocol. This protocol is between two network residing in a same plane for interaction. It deals with handshaking from both sides. If in a one network, quality degrades, it will receive the impact on overall output of whole system. For comparison of both the system, we have taken a FTP model in order to see the coexistence results. All the results are generated in ns3 simulator. Ns3 simulator is network simulator3. It is open source simulator.
We have showed the impact of 4SC scenario on the throughput, latency and voice latency of UDP and TCP flow.

Figure 4.1 FTP traffic model

Table 4.2 Parameters for traffic model 1

Parameter	Statistical characterization
File Size ,S	0.5 Mb
User arrival rate λ	Poisson distributed with arrival rate λ

Here we will show the FTP model which is basically used to transmit the files from one place to other. In case of UDP it is one way process, whereas in case of TCP/IP it first joins a connection between by receiving acknowledgement and after it transmit the signal. The table shows that the whole process is Poisson based distribution of network. In the simulation we show the impact of the same values of λ and E_d. According to it, each user transfer files according to Poisson distribution using lambda. It varies from [0.5, 1, 1.5, 2, and 2.5]. From it, traffic varies with value of lambda increases. In it, every user has its own file generation according to λ and all the files are generated from node in backhaul network towards one of the user. If the value of λ is 1, it means at every second one user will be transferred from backhaul network towards random UE. In our simulations, the argument --- ftp lambda will give the value according to user arrival rate. The value of λ is fixed and can create different types of traffic. We can also calculate the throughput of the system by putting IP protocol layer which is above of Wi-Fi or LTE devices.

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In this phase, we perform the 4-SC scenario, where there are LAA and Wi-Fi networks. After getting result the throughput and latency CDF of 4-SC coexistence simulation. It is operated when there is LAA/Wi-Fi coexistence technologies in unlicensed band using LBT. FTP over UDP/IP connection has been obtained. The results are according to -62 to -82dBm LAA energy detection (ED) threshold, and the FTP user arrival rate is greater than 0.5 seconds. As we described previously in IP layer throughput is defined as number of received bits divided by difference between the time difference of last and first packet of the flow.
From the results, IP packet size of UDP based file transfer application is 1028 (1000 bytes + UDP and IP headers). Each stream comprises of 354 packets of 1448 bytes for IPv4. From it, it is clear that operator A (LAA) has better throughput of 140Mbps. From it, operator A (LAA) performs better than operator B (Wi-Fi).

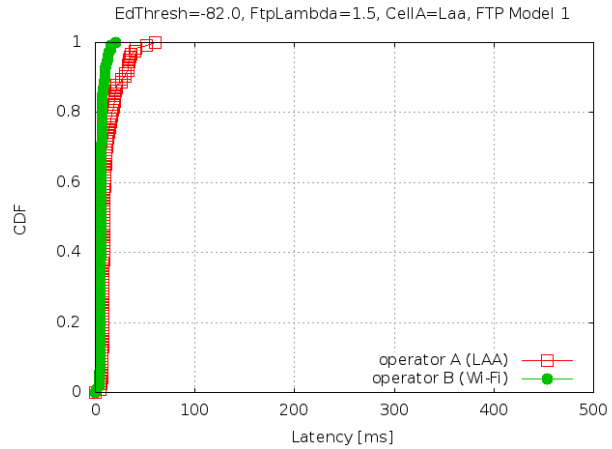

Fig 4.2 FTP model implementation: latency at lambda=1.5

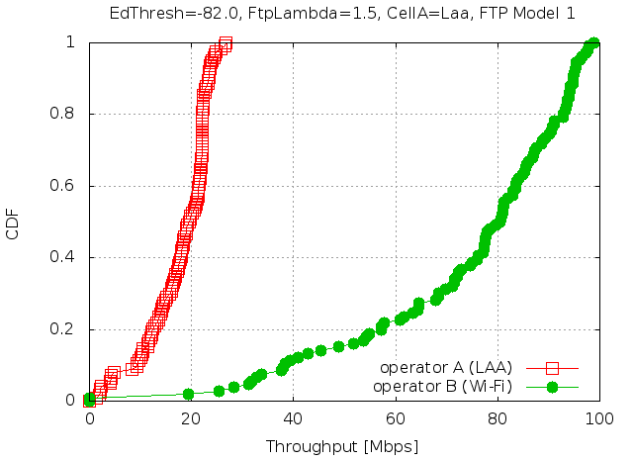

Fig 4.3 FTP model implementation: throughput at lambda =2.5

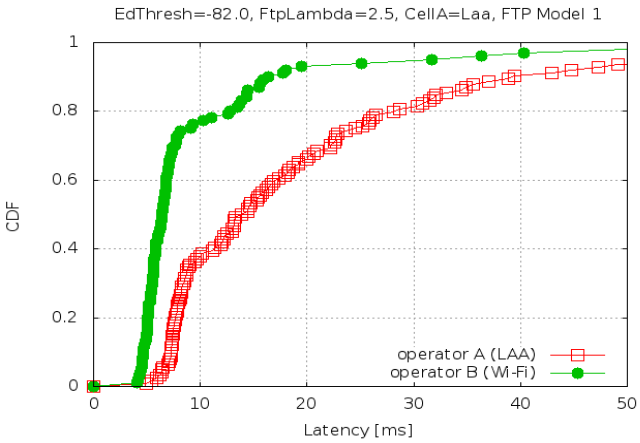

Fig 4.4 FTP model implementation : latency at lambda =2.5

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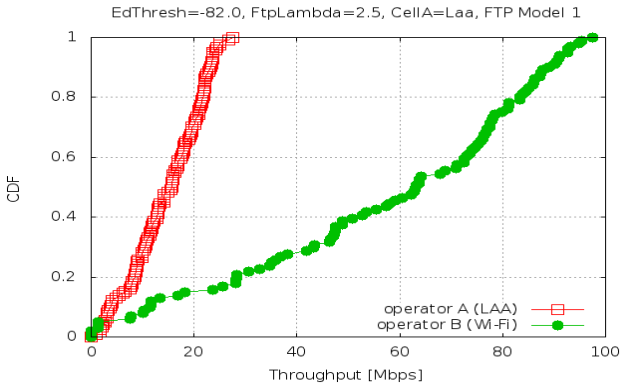

Fig 4.5 FTP model implantation : throughput at lambda =2.5

V. CONCLUSION

As we seen in respective diagrams the strength of signal in variety of frequency should be ensure to develop the LTE production in Wi-Fi bands in order to minimize the interference as well. The development of various scenarios which will led to the deployment of LTE signals in unlicensed bands will emerge as new revolution by certain companies like Qualcomm, Alcatel, T-Mobile, Version etc. These companies will provide breakthrough regarding current development in order to develop future markets . If these results which come through simulation will come in form of testing this deployment , it will provide variation of frequency and strength will not be fixed at particular frequency.

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BIOGRAPHIES

Divya Kumar Gupta was born in Bikaner, Rajasthan, India. He received his B.Tech degree in Electronics & Communication Engineering from Govt. Engineering College Bikaner, Rajasthan. He is currently pursuing M.Tech in Digital Communication from Rajasthan Institute of Engineering & Technology. His areas of interest are OFDMA, SC-FDMA, LTE-U, Wi-Fi.

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