Abs:Co-existence of Wi-Fi and LTE Unlicensed (LTE-U) in shared or unlicensed groups has drawn developing consideration from both scholarly community and industry to enable more efficient spectrum utilization and provide greater broadband capacity. The main point of consideration during this study is that both WIFI and LTE-U should co-exist fairly without interrupting routine WI-FI activities, as LTE-U can alter it’s duty cycles accordingly with the motive of gaining a larger spectrum. In this paper we develop RNN based LSTM network to learn WIFI traffic demands i.e. the idleness/business of WIFI channels. WIFI signals are captured using an empirical setup which is then feed into LSTM model, this way the model trains itself to get acquainted regarding WIFI activites. Based on this knowledge, LTE-U will thereby learn priorly about the WIFI activities as the model train itself and will allocate itself on channels which are kept idle for a longer time or un-occupied. This way both WI-FI and LTE-U will not have to compromise for their duration and can access the unlicensed band efficiently. This results are than compared with an algorithm for duty cycle estimation of LTE where a threshold is set at WIFI AP to check whether it misbehaves or not. The main goal of this article is to prove how the LSTM network can prove to be an efficient approach in comparison with the duty cycle method where both WI-FI and LTE-U have to compromise for their duration.

Intro:LTE operators are thus interested in utilizing the 5GHz unlicensed bands mainly used by WIFI. From the user perception this mean high data rate, high reliability and robust mobility [1]. However the coexistence between WIFI and LTE is not an easy task because the two technologies completely employ different medium access protocols. WIFI follows the CSMA/CA protocol, senses the medium and allows others to complete their transmission before attempting it’s own [7]-[8], while LTE transmits continuously without sensing. This results in a serious degradation of WIFI activities performance. Thus the main challenge is to enable coexistence with high LTE throughput and zero degradation in routine WIFI activities.

Motiva: \newlne Since long machine learning algorithms are used to extract valuable information from data. Survey in comprehensively describes survey in CR architectures using machine learning. The traditional Artificial Neural Networks is widely used where it trains every example with forward pass. The serious shortcoming of ANN’s is they cannot process time series data as they cannot store information due to absence of memory elements and cannot model long term dependencies [9]-[10]. The former shortcoming is resolved by Recurrent Neural Networks as they process sequences of data. In order to solve the shortcoming of long term dependencies LSTM networks are used

Contri: For this LSTM networks are used in this paper which trains itself from historical data of WIFI signals and acknowledges LTE about WIFI activities to optimize its transmission accordingly. The main contribution of this paper are summarized below.

Sys: \newline

LTE system is saturated due to tremendous mobile traffic demands, meanwhile due to private access WI-FI system has limited active users and unsaturated traffic. In fact WI-FI systems are underutilized and thus leaves a lot of unoccupied spectrum bands [13]-[14]. Hence LTE can exploit the unlicensed band under-utilized by WIFI to enhance LTE network capacity.

Framework: In order to exploit the temporal dependencies the previous sensing event is fed along with the current sensing event and thus the received signal, in general can be expressed as metioned in [15]:

Dataset: An environment of WI-FI nodes was created and packets were transmitted from between WI-FI nodes. WI-FI protocols were then used to calculate the transmission time of packets, using which energy values have been obtained. This energy values were then used to train LSTM model using Deep Learning simulator.The generated data was divided into three classes training, validation and test datasets. A detailed description of NS3 parameters has been mentioned in Section IV.

Perform: \newline Later, $P\_{d}$ which is the detection probablity for number of times WI-FI signaals are correctly identified and $P\_{f}$ which is the false alaram probablity for number of times WI-FI signaals are not correctly identified

Wifi datset: \newline\newline In order to generate a larger dataset an another LSTM model namely Vanilla LSTM was impelmentd using keras library [17]. A Vanilla LSTM is an LSTM model that has a single hidden layer of LSTM units, and an output layer used to make a prediction.In this case, we define a model with 50 LSTM units in the hidden layer and an output layer that predicts a single numerical value.The model is fit using the efficient Adam version of stochastic gradient descent and optimized using the mean squared error, or ‘mse‘ loss function.Once the model is defined, we can fit it on the training dataset.After the model is fit, we can use it to make a prediction.We can predict the next value in the sequence by providing the input.

Train: long sequences during training.An LSTM layer with 100 hidden units was created.The LSTM layer parameters are mentioned in Table2.\n

\newline: It is evident from Fig6 that as the training time and iterations increases the model keeps on training it and more accurate results are obtained making loss almost zero in the end. This result is can be used by LTE system to monitor WI-FI activities and identify the idle/busy slots.[18]

Transm: fter obtaining $\Hat{\alpha}$, the spectrum manager needs to

determine whether the LTE-U AP violates the rule i.e. try to gain more spectrum by transmitting for a duration longer then the decided threshold.Its performance is measured by probability of detection $P\_{d}$ and probability of false alarm $P\_{f}$ , i.e.,\newline

Compare results: We consider a typical cycle period of 160ms , and set $\alpha\_{max}$ to 0.5, $L\_{max}$

to 1100ms. The true $\alpha$ is varied from 0.49 and 0.52.

For each \alpja value, the experiment is repeated 200 times.

The new results obtained are shown in Fig.9 where gain is obtained for the case where $\gamma=0$. It is evident from Fig.7. that using LSTM model for WI-FI signals and thereby calculating their duty cycles gain is obtained in comparison to the results mentioned in article

Con: Further this results were compared with a proposed duty cycle approach to detect possible misbehavior, and analyzed its performance in terms of detection and false alarm probabilities. Our results show that the proposed LSTM scheme have a higher detection probability and lower false alarm probabilities [1]. Hence LSTM model proves extremely efficient for time series data and long term dependencies. The way for fair co-existence of WIFI and LTE is an important issue of prospect research.