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A Machine Learning based Methodology for Dynamic QoS Management

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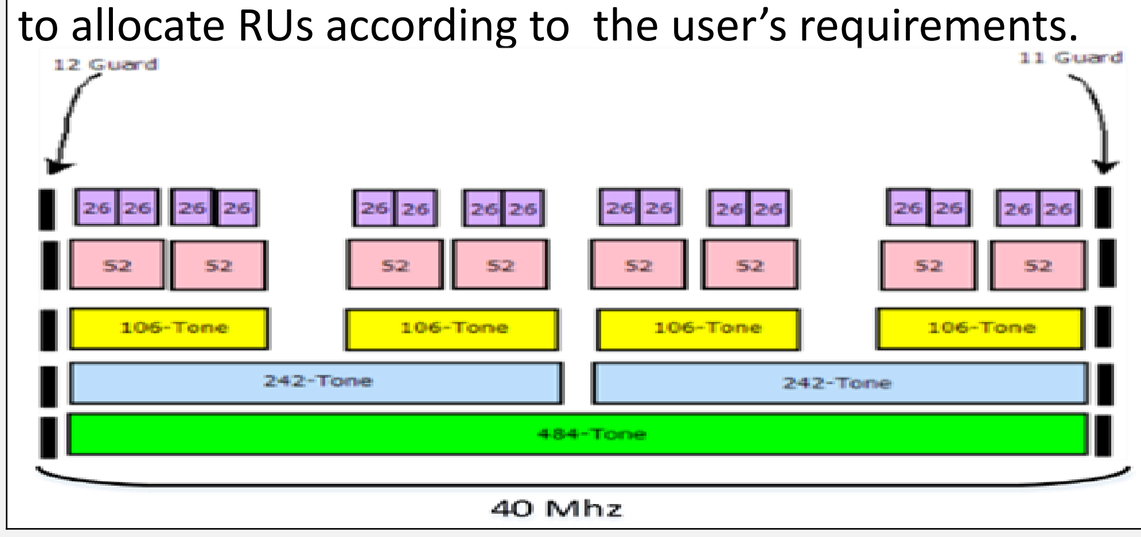
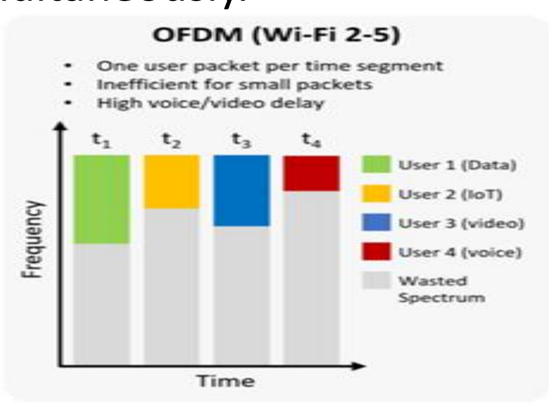
Introduction and Background

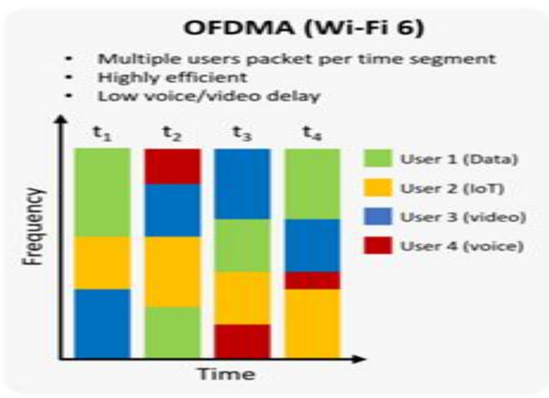
Nowadays, both companies and public places such as airports need to install Wi-Fi to meet the needs of people using the Internet. In these places, there are hundreds of people using Wi-Fi to download files, watch videos, or play online games. These activities have different throughput requirements.

As depicted in the right picture, there are different sizes of RUs to meet different user needs. Under this mechanism, which size of RU should be allocated to a user becomes a problem. Thus, my PhD project is to develop an algorithm to allocate RUs according to the user's requirements.



In 2019, IEEE released a new generation of wireless network standard, IEEE802.11ax. It introduces a new mechanism, Orthogonal Frequency Division Multiple Access(OFDMA). In OFDMA, the channel is divided into many parts by the Resource Units(RUs) so that multiple users can get channel to transmit their packets simultaneously.





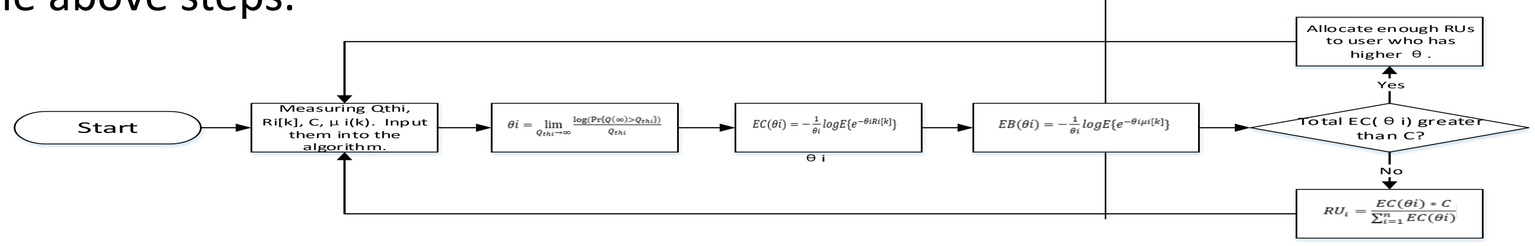
The Statistical QoS might be a useful parameter to estimate the user's requirement of throughput. In this method, the max rate of packets arriving at the buffer can be estimated by the Effective Capacity(EB) and the max service rate can be estimated by the Effective Bandwidth(EB). EC and EB can be estimated by the Large Deviation Process(LDP).

Proposed Methodology

1. Measuring the parameters which are related to the EC and EB.
2. Calculating the every user's QoS exponent θ, which can reflect the delay requirement of every user.
3. Calculating EC and EB according to θ.
4. Checking whether total EC is greater than the available capacity of the channel.
5. If yes, the user who has higher θ should get enough RUs first. If not, allocating RUs according to the proportion of every user's EC.
6. Repeating the above steps.

Jain's Fairness Index is a method advanced by Raj Jain, a professor of Computer Science and Engineering in the Washington University School of Engineering and Applied Science at Washington University in St. Louis, Missouri. The figure below is the formula of this method.

$$\mathcal{J}(x_1, x_2, \ldots, x_n) = \frac{(\sum_{i=1}^{n} x_i)^2}{n \cdot \sum_{i=1}^{n} x_i^2} = \frac{\overline{\mathbf{x}}^2}{\overline{\mathbf{x}^2}} = \frac{1}{1 + \widehat{c_v}^2}$$



Qthi: The queue threshold for useri. Can be regarded as the available buffer size. Ri[k]:The bits served in last time interval for useri. μ i(k):The arrival rate in last time interval for useri.
C: Available channel bandwidth now. θ i: The QoS exponent for useri. EC(θ i) : Effective capacity for useri(max arrival rate). EB(θ i): Effective bandwidth for useri(max service rate).
RUi: The RUs for useri. n: The number of users in the wireless network.

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