Paper Review 2

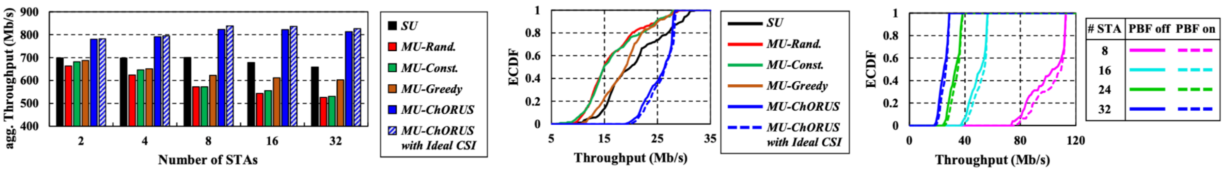
1. Paper summary.

   This paper focuses on improving the efficiency of Multi-User OFDMA (MU-OFDMA) in Wi-Fi 6 under high traffic loads. Previous studies showed that MU-OFDMA often performs worse than single-user transmissions when the network is busy, mainly because of extra coordination overhead. Most of those works only looked at low-traffic or uplink cases and ignored the fact that different sub-channels can have very different signal qualities due to frequency-selective fading.

   To solve this, the authors propose **ChORUS**, a new framework that makes MU-OFDMA “channel-aware.” It uses the existing IEEE 802.11ax sounding protocol to collect channel state information (CSI), applies the Hungarian algorithm to find the best RU allocation, and adjusts transmission power with the Power Boost Factor (PBF) to help weaker users.

   Based on both simulation and real-world channel data under saturated traffic, ChORUS improves throughput by up to 35% compared to existing methods and also maintains good fairness among users. Overall, the paper shows that making MU-OFDMA aware of frequency-selective channels can greatly boost Wi-Fi 6 performance in dense networks.

2. Analyze the result figure(s).



(a) Aggregate throughput (b) ECDF of individual user throughput (c) Effect of PBF on ECDF

Fig. 16. Network throughput performance in *RD20* topology according to the number of candidate users for MU-OFDMA.

   (a):

   Figure 16(a) tests whether ChORUS can improve the throughput of MU-OFDMA, especially when the number of users increases. The authors compared six methods—SU, MU-Rand., MU-Const., MU-Greedy, MU-ChORUS, and MU-ChORUS (Ideal CSI)—in a random-distance setup with 2 to 32 users. The x-axis shows the number of STAs, and the y-axis shows the total throughput in Mb/s.

   As the number of users grows, ChORUS keeps improving and reaches the highest throughput, getting very close to the Ideal CSI upper bound, while other schemes start to drop. For instance, with 32 users, ChORUS gives about 35% higher throughput than MU-Greedy, and both MU-Rand. and MU-Const. perform much worse.

This result shows that frequency-selective RU allocation really takes advantage of multi-user diversity. When there are more users with different channel conditions, ChORUS can assign each one to the frequency band that fits them best, leading to higher overall network capacity.

(b):

Figure 16(b) looks at how ChORUS impacts fairness and each user's throughput distribution. The idea is that by using channel-aware RU allocation, ChORUS can not only boost total throughput but also make performance across users more balanced than traditional MU-OFDMA schemes. The x-axis shows individual user throughput (Mb/s), and the y-axis shows the empirical cumulative distribution function (ECDF).

In the figure, MU-Rand. and MU-Const. have curves that stay mostly on the left side, meaning many users get low throughput. MU-Greedy does a bit better but is still uneven. In contrast, ChORUS shifts the whole curve to the right and almost overlaps with the Ideal CSI line, showing much better user performance overall.

This result suggests that ChORUS improves fairness by matching each user with the frequency band that best fits their channel condition. Weaker users get better throughput without hurting stronger ones, making the overall distribution more balanced.

(c):

Figure 16(c) shows how the Power Boost Factor (PBF) in ChORUS affects each user's throughput. The idea is that by taking some of the extra power from strong links and giving it to weak links, the system can make things fairer and help users with poor channels without lowering the performance of others. The x-axis shows per-user throughput (Mb/s), and the y-axis shows the ECDF.

In every case, the curve with PBF moves slightly to the right, meaning weaker users get higher throughput while stronger users stay about the same. The shift is bigger when there are 8 users and smaller when there are 32 users, since with more users, each one gets less power and there's less room for improvement.

Overall, this result confirms that PBF successfully redistributes transmission power. Even though the total throughput gain is small, it clearly improves fairness by boosting weaker connections and keeping strong ones stable, showing that ChORUS manages power more evenly across users.

3. Strengths and weaknesses of this paper.

   Strength:
   - ChORUS follows the IEEE 802.11ax standard and works with existing Wi-Fi 6 protocols, so it doesn't need any changes to the PHY or MAC layer. This means it could actually be used on current Wi-Fi 6 devices.
   - The paper clearly points out major problems—like performance drops caused by Minstrel rate control and fairness issues when only doing single-shot allocation—and gives convincing solutions. Its combined design of rate control and power assignment fixes these problems and shows real improvements.
   - Before introducing their framework, the authors also ran real experiments on commercial Wi-Fi 6 devices to prove that today's access points use fixed RU allocation. This makes their motivation and argument much more convincing.

   Weakness:
   - Getting and processing detailed CSI information is still hard in practice. Even though ChORUS uses the standard channel sounding method, it still needs extra computation and firmware access that most commercial APs don't allow. Without hardware support from vendors, it would be difficult to actually deploy.

4. Recommendation
   Overall recommendation: Strong accept.

5. AI Tools
   Use AI tools to explain the confusing part and summarize the points in the paper, including the problems, challenges, approaches, and the result. Also, the AI tools are used to generate the draft of my response, which I had revised later.