An Experimental Study of Triggered Multi-User Uplink Access with Real Application Traffic

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***Abstract*—The 802.11ax amendment introduced Triggered Uplink Access (TUA) to Wi-Fi to support uplink Multi-User (MU) MIMO. TUA coordinates simultaneous transmission of uplink users via an AP-transmitted trigger that gives an AP-selected group of users permission to transmit simultaneously for an AP-selected duration of time. Thus, TUA promises performance gains by enabling multi-user transmission and reducing contention overhead for access. In this paper, for the first time, we experimentally study the role of real application traffic on the performance of TUA. In particular, while TUA gains for fully backlogged traffic are well established, we show that bursty closed-loop traffic radically transforms performance. Using a real-time emulator, we experimentally evaluate the empirical limits of triggered uplink multi-user access with traffic from a real file transfer application and different uplink triggering strategies. Our results show that TUA significantly reduces file transfer latency compared to legacy single-user uplink, but unfortunately the standardized method for low-overhead backlog reporting leaves substantial benefits unrealized. Moreover, we show that unlike a single-user uplink, TUA has non-monotonic performance with respect to the frame aggregation limit.**

***Index Terms*—Medium access control, TUA, Reliable transport, Multi-user, MIMO, WLAN, IEEE 802.11ax**

I. Introduction

The 802.11ax amendment brings new features and modifica-

increase [1]. However, despite such potential for physical layer gains, in this paper, we for the first time, experimentally study the key impact of real application traffic driven by closed-loop TCP congestion control dynamics on multi-user uplink WLANs, and present the following contributions.

First we define and implement two uplink strategies for TUA with MU-MIMO: *(i)* Piggy-backed Backlog status Report (PBR), which is an 11ax-based simple and practical uplink strategy in which the only mechanism for a client to report backlog status information to the AP is piggy-backing the backlog status (number of bytes currently backlogged) on the header of an uplink data transmission, whether MU or single user (SU). In this strategy, the AP will only trigger TUA transmission for stations that have a non-zero backlog report from previous uplink channel accesses. *(ii)* Real-Time Backlog status information (RTB), in which the AP always has perfect real-time knowledge about the uplink backlog status from all associated stations. While not realizable in practice, we use this strategy as an empirical upper-bound for the performance of TUA. We implement both schemes on a flexible MU-MIMO real-time WLAN emulator [2] that supports real application traffic using existing operating system