An Efficient Transmission Scheme Using Simultaneous Transmit and Receive Technology for Railroad Communications in Next Generation Wireless LAN

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Abstract. In next generation Wireless Local Area Network (WLAN), increasing spectral efficiency is indispensable in order to provide enhanced throughput. Spectral efficiency can be increased though Simultaneous Transmit and Receive (STR) technology. In this paper, an efficient WLAN transmission scheme using STR technology is proposed. Since STR technology allows simultaneous reception while receiving, at most network throughput can be doubled. However, in order to utilize STR technology, at least two non-interfering parties are required. Railroad communication environment of busy railroad station is able to provide good STR environment with plenty number of non-interfering communication parties. Therefore, the proposed scheme is able to provide very efficient railroad communication scheme.

Keywords: WiFi, IEEE 802.11, Simultaneous Transmit and Receive, Full-duplex, IT Convergence, Railroad Wireless Communication

1 Introduction

As users’ demand for broadband wireless communication services increases, International Telecommunication Union (ITU) standardized 4G wireless standards called IMT-Advanced \cite{1}. IEEE 802.16 Task Group m of IEEE 802.16 working group developed the standard for IMT-Advanced \cite{2} and also 3rd Generation

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Partnership Program (3GPP) developed the standard for IMT-Advanced [3] in order to meet or even exceed the IMT-Advanced requirements. In order to meet users’ requirement for broadband services, IEEE 802.11 based Wireless Local Area Network (WLAN) technology [4] also has been evolving. Since May 2014, next generation WLAN standard, IEEE 802.11ax has commenced the standardization of new MAC and PHY layers. IEEE 802.11ax targets to provide at least four times improvement in the average throughput per station in a dense deployment scenario, while maintaining or improving the power efficiency per station [5].

STR technology enables a transmitter or a receiver to receive or transmit packets while it is transmitting or receiving. Since STR makes simultaneous transmission or reception possible, system throughput with STR technology can be increased maximum two times more than system throughput with single transmission technology. One of major difficulties of STR technology is finding non-interfering communication pairs. Therefore, in order to provide high probability of finding non-interfering communication pairs, there should be many communicating mobiles. Railroad communication, especially railroad communication of busy stations, is able to provide favorable environment for STR communication with many active communicating mobiles.

Fig. 1. WLAN STR transmission scheme
In this paper, an efficient WLAN transmission scheme using STR technology for railroad communication is proposed. In order to adopt STR in WLAN, a new WLAN STR protocol to initiate STR communication needs to be designed. In this paper, a novel efficient WLAN STR protocol is designed by exploiting favorable aspects of railroad communication.

2 Proposed WLAN STR Transmission Scheme

Fig. 1 shows the proposed WLAN STR transmission scheme. Access Point (AP) has data to transmit to Station1 (STA1) in the example of Fig. 1. When AP has data to transmit performs backoff procedure after Distributed Coordination Function Inter-Frame Spacing (DIFS) time following DCF procedure. Fig. 1 is a station initiated STR transmission case where a STA first commences data transmission to AP by transmitting Ready-To-Send (RTS) and then AP initiates STR communication by transmitting RTS’. In this case, AP performs backoff procedure with larger initial backoff window value in order to increase the probability of STR communication. RTS’ is a modified RTS for STR and its usage is to notify stations of STR communication commencement. In the example, RTS’ is destined to STA1 and overheard by STA2 due to the broadcast nature of wireless communication. By receiving RTS’, both STA1 and STA2 know that STR communication will be initiated. In the station initiated STR transmission case as shown in Fig. 1, STA2 regards RTS’ as Clear-To-Send (CTS) from the AP. There are two ways for STA2 to decide its data transmission time. One is using the reception time of RTS’. Data transmission time is $2\text{SIFS} + \text{CTS transmission time}$. This time can be set as a transmission timer at the time of RTS’ reception. When a transmission timer expires STA2 starts data transmission as shown in Fig. 1. The other method is overhearing the data transmission from the AP to STA1. In the conventional DCF, ACK should be transmitted right after the data transmission and SIFS. However, in case of STR transmission ACK transmission cannot be initiated right after the data transmission and Short Inter-Frame Spacing (SIFS) because the AP cannot send both data to STA1 and ACK to STA2 at the same time. Therefore, STA2 needs to wait longer time than the conventional ACK waiting time. Once ACK is received from STA1, the AP is able to transmit ACK to STA2. By receiving ACK from the AP, the STR communication ends.

3 Conclusion

In this paper, a novel and efficient WLAN transmission scheme using simultaneous transmit and receive technology is proposed. The proposed WLAN STR transmission scheme is anticipated to show excellent performance in railroad communication since communication environment of railroad communication, especially busy railroad stations provides favorable STR conditions with many non-interfering pairs.
References

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