Interference-aware Indoor Localization Utilizing Multi-link Operation

Jin-Min Lee, Jung-Hyun Moon, and Il-Gu Lee*

Department of Future Convergence Technology Engineering,
Sungshin Women's University, Seoul, Korea
{csewa56579, MoonJh.Sungshin}@gmail.com, iglee@sungshin.ac.kr

Abstract

As the number of devices using wireless communication increases, research on high-precision indoor localization based on wireless communication is being actively conducted. However, conventional Wireless LAN (WLAN)-based indoor localization is vulnerable to unintended interference, and because it uses only a single frequency band, it is difficult to avoid interference such as jamming attack. Therefore, in this study, we propose a method to increase localization performance by excluding links with interference signals and utilizing them for localization in a Multi-link Operation (MLO) environment of 802.11be.

keywords: interference-aware, indoor localization, MLO, L-LTF

1 Introduction

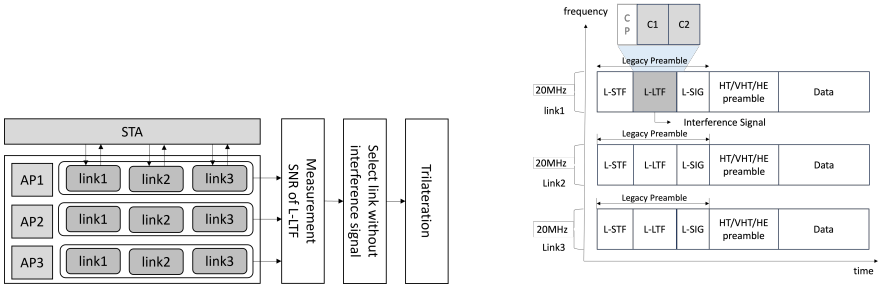
As the number of devices using wireless communication increases, research on high-precision indoor localization based on wireless communication is actively being conducted. However, performance degradation due to unintended same-channel interference signals and interference due to jamming attacks in high-density network environments can reduce accuracy. Existing wireless LAN-based indoor localization is vulnerable to unintended interference, and because it uses only a single frequency band, it is difficult to avoid interference such as jamming attack [1]. Therefore, in this study, we propose a method to increase localization performance by excluding links with interference signals and utilizing them for localization in a multi-link operation (MLO) environment of 802.11be.

2 Proposed scheme

The proposed scheme assumes that Access Points (APs) using three links communicate based on station (STA) and MLO, as shown in Figure 1 (a). The STA can measure its location by transmitting broadcast signals to nearby APs and selecting three APs at the closest location. During the communication process for localization, the signal may be affected by interference due to a jamming attack or a co-channel interference signal. Therefore, the proposed method measures the Signal-to-Noise Ratio (SNR) of the Legacy-Long Training Field (L-LTF) in packets transmitted and received at each link to check the link affected by the interference signal. In the proposed method, noise and interference were assumed to be noise. That is, when it is determined that there is noise in the SNR measurement, it is determined that there is an interference signal in the packet. The proposed method performs trilateration using only packets that do not generate an interference signal.

The 7th International Conference on Mobile Internet Security (MobiSec'23), Dec. 19-21, 2023, Okinawa, JAPAN, Article No. P-41

*Corresponding author: Department of Future Convergence Technology Engineering, Sungshin Women's University, Seoul, 02844, Korea, Email: iglee@sungshin.ac.kr



(a) (b)

Figure 1: (a) Interference-aware indoor localization utilizing multi-link operation, (b) SNR measurement using L-LTF

Figure 1 (b) shows an AP of one of the three APs in Figure 1 (a), and each of the three links in the AP has a bandwidth of 20 MHz. The Physical layer Protocol Data Unit (PPDU) of Wireless LAN (WLAN) is divided into preamble and data field, of which legacy preamble has L-LTF. In link 1 in Figure 1 (b), the interference signal is on the L-LTF. The proposed method calculates SNR using the fact that the L-LTF has two identical symbols (C1, C2) as shown in Equation (1) and (2) to check whether there is an interference signal in the L-LTF. C1 and C2 have the same signal and noise, so if you add and subtract, only the signal and noise can be obtained and SNR can be calculated as shown in Equation (3).

$$C1 + C2 = (Sp + Np) + (Sp - Np) = 2Sp \tag{1}$$

$$C1 - C2 = (Sp + Np) - (Sp - Np) = 2Np \tag{2}$$

$$SNR = 2Sp - 2Np \tag{3}$$

3 Conclusion and Future works

Precise indoor localization is an important study because it can be used in various fields such as indoor Internet of Things device location-based applications, medical care, and disaster situations. Therefore, in order to solve the deterioration of localization performance due to interference, this study proposed a method of localization excluding links of signals with interference based on 802.11be's MLO. We proposed a plan to improve localization performance by using the L-LTF of the WLAN PPDU to check whether there is an interference link. Future research will compare interference confirmation in the Data field with performance in the realistic test-bed.

Acknowledgement: This work was partly supported by grants of the Korea Institute for Advancement of Technology (KIAT) funded by the Korean Government (MOTIE) (P0008703, The Competency Development Program for Industry Specialist) and the MSIT under the ICAN (ICT Challenge and Advanced Network of HRD) program (No. IITP-2022-RS2022-00156310) supervised by the Institute of Information & Communication Technology Planning & Evaluation (IITP).

References

[1] Ge M. Pitner T Mbarek, B. An adaptive anti-jamming system in hyperledger-based wireless sensor networks. https://link.springer.com/article/10.1007/s11276-022-02886-1, 2022.