Case Studies of Wireless LAN Problems

Abstract

This article describes cases studies of problems occurring in wireless LANs (local area networks). This is the fortieth article in a series on telecommunication technologies. This contribution is from the EMC Engineering Group, Technical Assistance and Support Center, Maintenance and Service Operations Department, Network Business Headquarters, NTT EAST.

Keywords: wireless LAN, Wi-Fi, access point

1. Introduction

The increasing popularity of mobile terminals equipped with wireless local area network (LAN) functions has driven the installation of wireless LAN access points (APs) in both indoor and outdoor locations and the creation of Internet connection environments in all sorts of places. In line with this trend, NTT EAST has made its 5th-generation home gateway compliant with the new IEEE802.11ac[*1] wireless networking standard and has been expanding its communication services using wireless LAN such as by launching FLET'S HIKARI (optical broadband) services capable of gigabit-class communications. Services in a variety of formats are also expanding such as Wi-Fi[*2] access for apartment buildings and Wi-Fi access for corporate use.

However, communication faults can occur as a result of insufficient signal strength, signal interference, incompatible communication protocols, and other factors. Finding ways of recovering from faults quickly and improving service quality has consequently become a matter of urgency.

In this article, we introduce recent case studies of wireless LAN problems handled by the Technical Assistance and Support Center.

2. Case study 1: Wi-Fi access for an apartment building

In this section, we describe a problem a customer had with Wi-Fi access for an apartment building and explain how it was rectified.

2.1 Overview and report

Wi-Fi access for apartment buildings is an Internet connection service via wireless LAN targeting a building of 4 to 12 units. In this service, any room in the building should be able to connect to wireless LAN via radio signals transmitted from shared APs installed outdoors. In this case study, a report was received that an AP connection could not be made from an indoor location, so an investigation was carried out.

2.2 Results of investigation and causes of fault

We considered the possibility that the signal strength of wireless LAN was insufficient, so we checked the manner in which the antennas were installed. We found some cases in which antennas were installed at a height midway between the first and second floors or on the ceilings of balconies, as shown in **Fig. 1**, and we surmised that the signals in such cases were not strong enough to reach indoors. The indoor signal-strength distribution measured with a wireless LAN tester [1] (a product developed by the Technical Assistance and Support Center and

*1 IEEE802.11ac: A wireless networking standard developed by the Institute of Electrical and Electronics Engineers (IEEE).

*2 Wi-Fi: A technology for wireless LAN with devices based on the IEEE 802.11 standards. Wi-Fi is a registered trademark of Wi-Fi Alliance.

Inappropriate height Attached to wall Attached to balcony ceiling

Fig. 1. Antenna installation formats (examples of inappropriate installation).

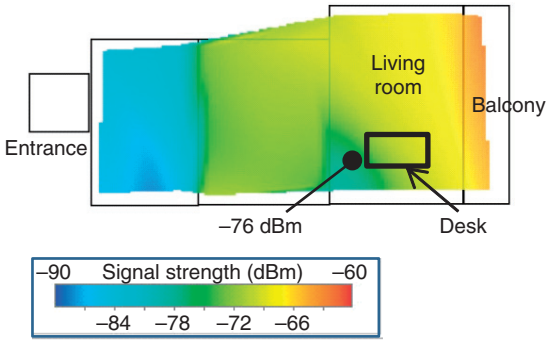

Fig. 2. Signal-strength distribution (before relocating antenna).

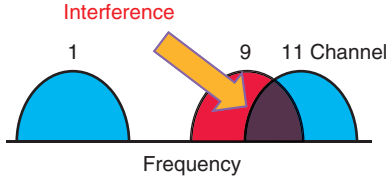

Fig. 3. Channel interference in 2.4-GHz band.

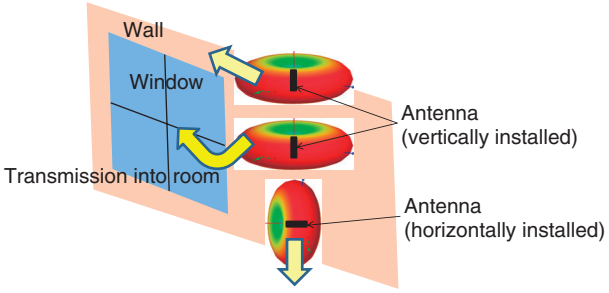

Fig. 4. Antenna signal transmission.

awarded a 2016 NTT EAST President's Commendation) is shown in **Fig. 2**. It was found that the signal strength in the living room where the customer was using wireless LAN was –76 dBm, which we considered to be insufficient.

Furthermore, considering that wireless LAN channel interference might be occurring, we measured the channel interference with the wireless LAN tester and found that channels 9 and 11 were indeed interfering with each other as shown in **Fig. 3**.

We surmised that the causes of the fault were insufficient indoor signal strength due to an inappropriate antenna installation format and interference of wireless LAN signals due to inappropriate channel allocation to the AP.

2.3 Proposed method

Since radio signals are more able to permeate through windows than walls, installing an antenna on the balcony side rather than the entrance side of a unit would make it easier for indoor terminals to receive signals. Signals from a Wi-Fi antenna are strongly transmitted in the direction perpendicular to the antenna direction as shown in **Fig. 4**. To therefore transmit radio signals efficiently into a room, the

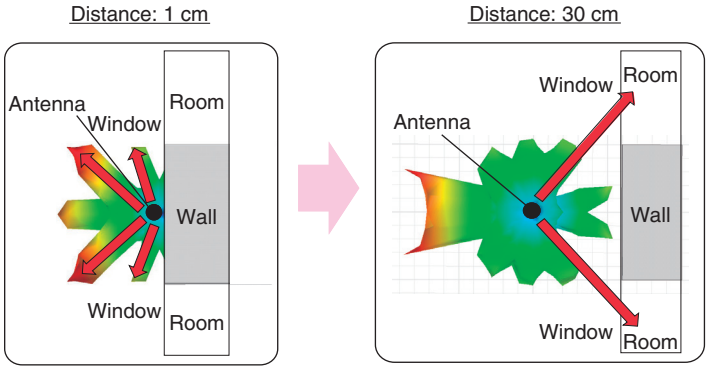

Fig. 5. Antenna transmission characteristics in 2.4-GHz band (simulation).

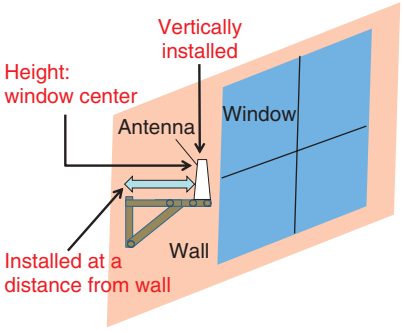

Fig. 6. Optimal antenna installation format.

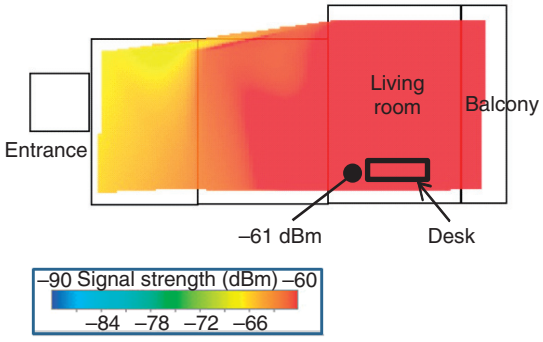

Fig. 7. Signal-strength distribution (after relocating antenna).

antenna should be vertically installed at a height aligned with the center of the window frame. Moreover, installing the antenna away from walls can secure a line-of-sight toward rooms, thereby achieving more efficient transmission of radio signals into rooms, as shown in **Fig. 5**.

Therefore, an optimal antenna installation format would be the one shown in **Fig. 6**. That is, the antenna should be vertically installed at a height corresponding to the center of the window and at a distance from the wall. The indoor signal-strength distribution after changing the antenna installation format is shown in **Fig. 7**. The signal strength in the living room was now –61 dBm, reflecting a 15 dB improvement compared with that before antenna relocation.

Finally, allocating wireless LAN channels 1, 6, and 11 as shown in **Fig. 8** can prevent the occurrence of interference.

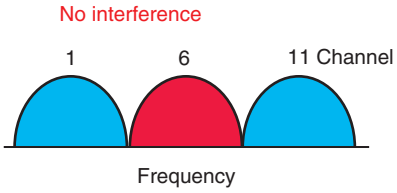

Fig. 8. Optimal channel allocation in 2.4-GHz band.

3. Case study 2: Wi-Fi access service for corporate use

The second case study involved a problem a customer had with Wi-Fi access for corporate use. We describe the problem and the countermeasure in this section.

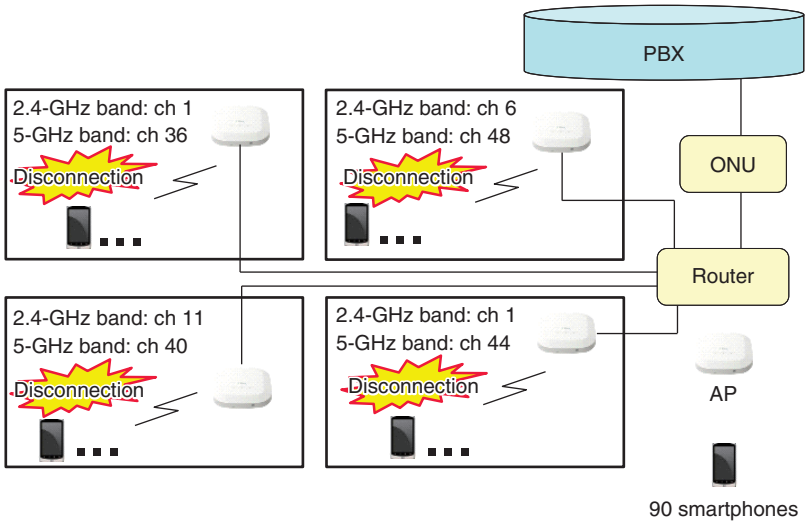

Fig. 9. Equipment setup.

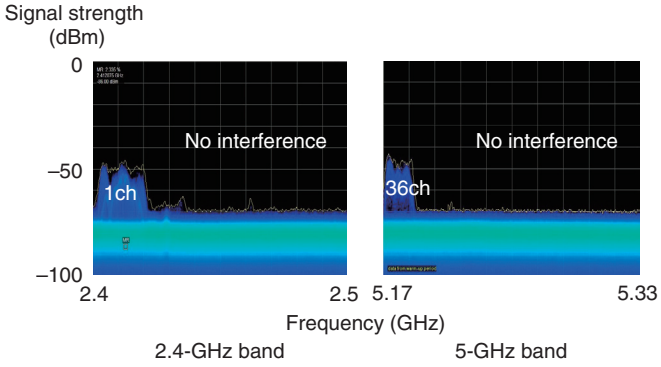

Fig. 10. Results of measuring radio-signal condition.

3.1 Overview and report

Wi-Fi access for corporate use is an Internet connection service via wireless LAN targeting corporate customers. This service delivers AP units to the customer, who then installs them at various indoor locations. There were four AP units (one per room) installed in the customer's office with each AP connected to a router, ONU (optical network unit), and PBX (private branch exchange), as shown in **Fig. 9**. 90 smartphones that could connect to these APs had been used. The customer reported that disconnections occurred.

3.2 Results of investigation and causes of fault

We used a spectrum analyzer to measure the radio-signal condition in both the 2.4-GHz and 5-GHz bands in a room where disconnections had occurred. The results of these measurements are shown in **Fig. 10**. Other than Wi-Fi signals, no interfering signals could be observed.

Next, using AirMagnet (a generally available wireless LAN analysis tool), we measured the protocol on the radio signal in a room where disconnections had occurred. The results are shown in **Fig. 11**. These results revealed that no Block Ack message (acknowledgment that data were received) was returned from the terminal after a data transmission from the AP when a disconnection had occurred (using smartphone A), which resulted in the resending of Block Ack Request messages from the AP. To troubleshoot

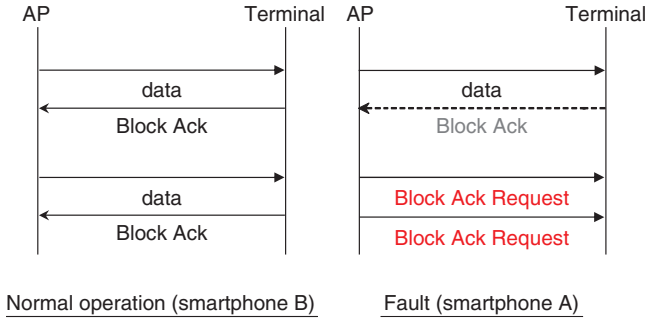

Fig. 11. Results of measuring protocol (case study 2).

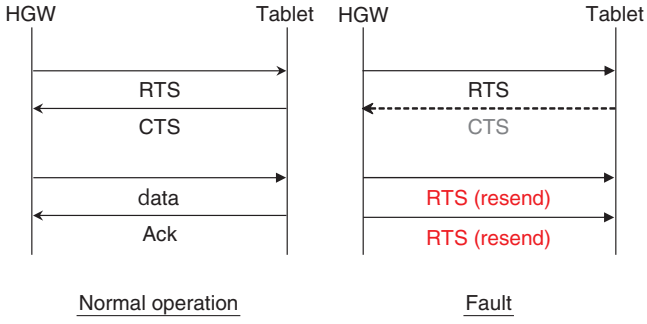

Fig. 12. Results of measuring protocol (case study 3).

this result, we used smartphone B and found that the protocol had no problem in the order of data→Block Ack→data and so on.

We therefore surmised that the cause of the disconnection when using smartphone A was that Block Ack messages that should have been transmitted in reply to data packets from the AP were somehow missing.

3.3 Proposal to the customer

We confirmed that smartphone A was outside the scope of this system's operational guarantee, so we proposed to the customer that smartphone A be replaced with a smartphone unit for which normal operation was guaranteed.

4. Case study 3: Home gateway (HGW) equipped with a wireless LAN function

The final case study involves a problem that occurred in a HGW.

4.1 Overview and report

A customer using a tablet terminal and a HGW equipped with a wireless LAN function reported that an application download would stop 2 to 3 seconds after starting.

4.2 Results of investigation and causes of fault

We measured the signal strength, channel interference, and interfering signals with a wireless LAN tester in the room, but found that no signal attenuation, channel interference, and interfering signals could be observed at the time of the fault.

We then measured the protocol for the radio signals. A download would normally be completed in the order of RTS (Request To Send)→CTS (Clear to Send)→data→Ack (acknowledgment that data were received), as shown in **Fig. 12**. However, at the time of the fault, the AP would resend RTS repeatedly, while no CTS would be returned from the terminal.

We surmised from these results that the non-return of the CTS message from the terminal to the AP caused the AP to repeatedly resend RTS messages, thereby stopping data transmission from the HGW

and bringing the download to a halt.

4.3 Countermeasure

We checked the operating system (OS) of the tablet terminal and found that it was an old version. We therefore updated the OS to the latest version, and confirmed that a download was completed.

5. Conclusion

In this article, we introduced recent case studies of wireless LAN problems handled by the Technical Assistance and Support Center. With the proliferation of various types of wireless LAN services, the causes of faults in these services are becoming increasingly diverse. The EMC Engineering Group of the Technical Assistance and Support Center endeavors to achieve prompt resolution of faults related to wireless LAN and to contribute to the smooth provision of communication services. To this end, it is actively engaged in technology dissemination activities through technical support, development, and technical seminars.

Reference

[1] K. Okamoto et al., "Introduction of Wireless LAN Tester toward Smooth Provision of Wi-Fi Services," IEICE Communications Society Magazine (B-plus), No. 25, pp. 38–43, Summer 2013 (in Japanese).